

Report of the 2010 Independent Review Panel (IRP) on the Reasonable and Prudent Alternative (RPA) Actions Affecting the Operations Criteria And Plan (OCAP) for State/Federal Water Operations

Prepared for: **Delta Stewardship Council, Delta Science Program**

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Scope and Intent of Review: This report represents the findings and opinions of the IRP assembled by the Delta Science Program to provide scientific advice intended to assist with a review of the efficacy of OCAP RPA implementation from June 2009 through September 2010. After reviewing a required set of written documents (listed in Appendix 1), the IRP convened at a technical workshop in Sacramento, CA on 8-9 November 2010. The 2-day workshop provided a forum for the panel to consider additional and updated information and new research findings and to discuss issues related to the application of RPA actions. The original schedule provided for the IRP to deliberate on the morning of the second day, but scheduling of workshop presentations constrained the panel's deliberations to a 2.5 hour period over lunch, after which the panel was asked to present initial assessments and impressions when the public workshop reconvened at 2:30 pm on 9 November. Subsequent panel communication and deliberations were conducted via email and conference call in the course of drafting the final report.

The intent of this first annual review is to inform the National Marine Fisheries Service (NMFS) and the U.S. Fish & Wildlife Service (USFWS) as to the efficacy of the water operations and regulatory actions prescribed in their respective OCAP RPAs during the 2010 water year. The panel also was encouraged to suggest appropriate adjustments to the RPAs or their implementation in the 2011 water year based on insights from the prior year's water operations and new scientific research findings.

The panel was not charged with evaluating the scientific basis or conceptual validity of the process underlying the original RPAs, nor any legal issues related to the development or application of the RPAs.

EXECUTIVE SUMMARY

The review panel appreciates the daunting challenge faced by all of the agencies attempting to balance California's existing commitments and growing human demands for water resources with the protection and restoration of aquatic habitat that is essential to ensure the present and future survival of the Delta ecosystem's non-human components and the ecosystem services that they provide to society. We commend their efforts to cooperate and integrate activities directed at achieving this goal and hope efforts will continue to improve collaboration.

The Panel also recognizes that this is the first year of implementing the OCAP RPA actions and it would be unrealistic to expect immediate and measurable changes in the population dynamics of the listed species in response to the RPA actions. That said, the Panel perceived a distinct focus on meeting the RPA objectives in terms of physical targets (i.e., flows and temperatures) with little explicit indication of integration with the biology/ecology of the listed species. We caution that the focus on meeting operational targets should not carry over into the planning of data needs and studies necessary to improve what should be very real connections between the RPA Actions and their effects on the listed species. The focus of management in the region needs to transition from a reliance on net flow triggers to the incorporation of relevant tidal and seasonal characteristics of the ecosystem at temporal and spatial scales relevant to the movement of fish through the Central Valley and Delta. In particular, the goal to avoid further jeopardy to listed species in the Delta should be focusing on first principles of fish behavior and cognitive ecology in order to drive efforts to disassociate fish from poor quality (i.e., sink) habitats that are an unintended consequence of water operations.

Currently, RPA actions tend to rely on physical metrics and triggers that are linked, at least in concept, to vital rates and life histories of the listed species. The challenge is to link RPA actions to vital rates within life stages, and ultimately to the population dynamics of the listed species within the ecosystem. This will require the refinement of tools for the accurate prediction of spatially-explicit variation in physical factors and the behavior of fishes. The panel was encouraged to learn of new models (e.g., NOAA/NASA temperature real-time model for river reaches) and ecological research (e.g., responses of delta smelt to tides and turbidity) that are moving in this direction. The panel strongly encourages the development of these types of novel tools and insights.

The effectiveness of RPA actions in meeting operational targets was usually adequate in 2010, but this was very nearly an average water year and it seems likely that many of the temperature and flow targets will not be met in substantially drier years. Under less favorable conditions, the effects on water exports are much more reliably predicted than effects on the populations of listed species.

The process of coordinating real-time operations with technical teams was not always transparent. The technical teams are meeting regularly to discuss available information and make recommendations, but it is sometimes unclear how the available expertise translates to operations especially in cases where the responsible agency makes a determination that contrasts with the advice of the technical team. Recommendations of the technical teams were at times based on historical patterns and the expert opinions of the current team members rather than having a basis in an objective template that could be followed and justified in subsequent years. The current teams may comprise individuals who have a great deal of long-term experience in the system, and their opinions regarding actions may be valid and useful, but in the future the composition of these groups will change and so there is a need to encourage progress toward developing more objective and transferable standards for the recommendation of when, where and to what degree RPA actions should be applied.

The panel does applaud the fact that most of the technical teams prepare detailed notes from their meetings that are made available online. This improves the transparency of the deliberation process by the technical teams and documents their decisions. We encourage this to continue.

We found it useful and helpful that there were specific proposals to adjust several RPA Actions that were presented to our panel at the workshop to help focus our review. For the future, it would be even better if proposals were presented to a panel prior to the workshop to assist in preparation. Providing the science support and logic behind any proposed adjustments is useful. The handout provided at the workshop by NMFS on their proposals was helpful, as were the written comments provided later by the Department of Water Resources (DWR). We only regret that perhaps more discussions on the pros and cons of these proposed adjustments did not occur during the open sessions at the workshop to better assist us in evaluating them.

Regarding the preliminary proposals for adjustments of various OCAP RPA actions, the panel had a range of opinions on the specifics, seeing merit in some (e.g., Proposal I.A –Part 2), but questioning the reasoning behind others (e.g., Proposal V.3). In some cases, the panel was reluctant to take a strong position on a proposal until such time as the DWR and other affected agencies had an opportunity to consult with NMFS.

Although not part of our formal charge, some recommendations are intended to improve the format of information presented to future panels. There is considerable benefit in standardizing the format for the presentation of materials to the panels in both written and oral form. Presentations regarding the RPAs should contain certain common threads that include: (1) geographic orientation to the portion of the Delta being discussed (it should not be assumed that all panel

members can immediately geo-reference in the system as well as those who work in it frequently), (2) whether each RPA action that was intended to be applied was conducted or not, and why, (3) any known or measured responses of the fish populations or life stages targeted by the RPA actions. The latter may be a more reasonable request after multiple years of observations and data are available under the RPAs. Finally, it would be very useful to allow more time for panel deliberation while the group is assembled at the workshop; 2-2.5 hours over lunch was inadequate for the panel to organize its thoughts and develop a consensus on the many complex issues under consideration.

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INTRODUCTION

The Sacramento-San Joaquin Delta comprises a complex system of natural distributaries and human-engineered channels, levees and a mix of agricultural and urban areas that have replaced former wetlands and floodplains. Significant structural alterations of the ecosystem date back to the mid-nineteenth century. Many of the anthropogenic changes in the Delta and in its upstream tributaries were designed to store, redirect and convey water to meet human demands within the region.

Water in the Delta is essential habitat for resident and migratory fishes and an important resource supporting a variety of uses (e.g., agriculture, power generation, drinking water, etc.) that produce goods and services for the human population both within and outside of California. It is generally accepted that the chronic multi-decadal alteration of the natural ecosystem associated with meeting the demands of an increasing human population in the watershed have contributed to profound changes in the system's aquatic fauna, including a persistent decline in certain species of native fishes. Consequently, some of these jeopardized species have been afforded protection under the Endangered Species Act (ESA).

Within the historical context of engineered water resource management in the Delta, formal legislative recognition that water and other habitats should be managed to restore and enhance the Delta ecosystem as a coequal goal with providing a reliable water supply to California (SBX7, Nov 2009) represents a novel conceptual approach.

Background on the OCAP RPA review process: NOAA's National Marine Fisheries Service (NMFS) and the U.S. Fish and Wildlife Service (USFWS) each issued a Biological Opinion on the long-term Operations, Criteria, and Plan (OCAP) of the Central Valley Project (CVP) and State Water Project (SWP) that included Reasonable and Prudent Alternative (RPA) actions designed to compensate for or avert any project-caused: (1) jeopardy to listed species or (2) adverse modification of critical habitat for these species in accordance with section 7 of the Endangered Species Act (ESA). The specific RPA Actions in NMFS' OCAP Opinion (Section 11.2, pages 581-671) include both broad and geographic division specific RPA Actions. The specific RPA Actions in the USFWS' OCAP Opinion (Appendix B, pages 324-381) are organized by Delta smelt life stages. The RPA Actions in both OCAP Opinions provide specific objectives, scientific rationales, and implementing procedures. The NMFS Opinion primarily addresses issues involving wild winter- and spring-run Chinook salmon (*Oncorhynchus tshawytscha*), Central Valley steelhead (*Oncorhynchus mykiss*) and green sturgeon (*Acipenser medirostris*). The USFWS Opinion relates to jeopardy issues involving delta smelt (*Hypomesus transpacificus*).

NMFS' Opinion requires the U.S. Bureau of Reclamation (USBR) and NMFS to host a workshop no later than November 30 of each year to review the prior

water year's operations and to determine whether any measures prescribed in the RPA should be altered in light of information learned from the prior year's operations or research (NMFS' OCAP Opinion, section 11.2.1.2, starting on page 583). Amendments to the RPA must be consistent with the underlying analysis and conclusions of the Biological Opinions and must not limit the effectiveness of the RPA in avoiding jeopardy to the ESA listed species or result in adverse modification of critical habitat. The U.S. Secretaries of Commerce and Interior have directed that this annual review be expanded to include a review of the implementation of the USFWS RPA as well.

Panel charge: The panel was charged with reviewing the implementation of the OCAP RPA associated with the NMFS Biological Opinion for the time period 4 June 2009 through 30 September 2010, and the RPA associated with the USFWS Opinion for 1 October 2009 through 30 September 2010. The charge focused on four categories: (1) effectiveness of the Actions for each RPA, (2) approaches (i.e., study designs, methods and implementation) taken in meeting the objectives of the RPAs, (3) coordination of real-time operations with the technical teams, and (4) potential improvements to the RPAs Actions.

Six questions were posed to the panel. These are provided verbatim in Appendix 2 of this report, but were addressed by the panel in a manner that was intended to minimize redundancy in responses related to each RPA while preserving the intent and purpose of the charge.

Acknowledgements: The members of the panel appreciate and acknowledge the efforts of the agency and technical team representatives who prepared the written materials and delivered the workshop presentations that were the basis for this report. We recognize that much of the material had to be compiled, analyzed and organized in a relatively short time. Despite the many competing demands on the workshop participants, the materials were presented professionally and on schedule. The panel wishes to express a special thanks to the Delta Science Program staff for providing the organization and logistical support to facilitate our task. In particular, Cliff Dahm (Lead Scientist) and Sam Harader (Program Manager) facilitated discussions at the workshop and Lindsay Correa (Environmental Scientist) deftly attended to a wide variety of technical and provisional details in support of the panel.

PANEL COMMENTS ON OCAP RPA ACTIONS IN WATER YEAR 2010

The panel was charged with responding to questions for each RPA. These were outlined in two forms: In Exhibit A, Attachment 1 of the formal charge to the IRP, our review was to focus on four issues in the implementation of OCAP RPAs and we were asked to respond to 6 questions (See Appendix 2).

In an attempt to minimize redundancy in our responses, we conflated the issues and reorganized the questions into four categories listed in Table 1 along with their relationships to the original questions in the charge.

We then developed Table 2 to organize the NMFS RPA Actions applied to the rivers and tributaries outside the Delta into topical groupings of temperature, flow, habitat restoration, barriers, habitat passage above dams, and other actions. Table 3 was developed for Actions relating to salmonids in the Delta, and Table 4 for Actions relating to delta smelt. There was too little information presented on green sturgeon this year to warrant a separate table. The RPA Actions are identified in the first column of each table. The NMFS Actions are listed by the numerical reference in the first column of the OCAP ACTION Summary: Master Matrix

(http://www.deltacouncil.ca.gov/delta_science_program/pdf/workshops/OCAP_2010/RPA%20Summary%20Matrix%20of%20the%20NMFS%20and%20USFWS%20OCAP%20Opinion%20RPAs.pdf). The USFWS Actions dealing with delta smelt are listed as Actions 1 through 4.

The panel's opinion regarding an Action or suite of Actions is provided in the cells of the table. The opinion can be presented as a single word response (e.g., adequate) or annotated by a capital letter (e.g., A) that refers to an expanded narrative from a list of points following each table. Each table also includes one or more rows for general comments on an entire column in the table or a column under each topical group.

Blanks in the tables indicate that actions were either not implemented because of ongoing coordination, or the panel had insufficient information to formulate a response.

Table 1. Relationships of the categories in our analysis of the issues to specific questions in the IRP charge.

Our categories	Issues to review	Questions in IRP charge
I. Efficacy	(1) Effectiveness of Actions in meeting the objectives of the RPA	1(a) How effective was the implementation of RPA Actions?
II. Approach	(2) Study designs, methods and implementation procedures used	2(a) Were study designs appropriate for evaluating effectiveness of Actions?
		2(b) What study designs are more appropriate?
		2(c) How could indicators of RPA Actions be improved?
III. Coordination	(3) Effectiveness of process for real-time coordination with technical teams	1(b) How effective was real-time coordination of operations?
IV. Improvements	(4) Potential improvements to Actions to meet RPA objectives	3 How can RPA Actions be improved?

Table 2. RPA outside Delta for salmon in WY 2010

Action	Description	River	I Efficacy	II Approach	III Coordination	IV Improvements
Temperature						
General comment			A	B		C
14-23, 31	Compliance	Sacramento	Adequate	E	Adequate,	D
11, 12	Compliance	Clear Creek	Adequate.		Adequate	F
46, 47, 48	Compliance	Stanislaus	Adequate		Adequate	
39	Compliance	American	Adequate	Very good	Very good	
40	Structural improvement	All dams	Adequate	Adequate	Adequate	
Flow						
General comment			A	B		
8,	Pulse attraction	Clear Creek	Adequate	Very good	Adequate	
9, 13	Channel maintenance	Clear Creek	In planning			
48	Migration cues	Stanislaus	Very good	Very good	Very good	
38, 41		American	Adequate			
Habitat restoration						
General comment						
33-35	Floodplain	Sacramento	Adequate			
10	Gravel	Clear Creek	Adequate			
49	Spawning habitat	Stanislaus	In planning			
50,51	Floodplain	Stanislaus	In planning			
		American				
25	Restore creek	Battle Creek	Adequate			
Barriers						
General comment						
26-30	Delays at RBDD	RBDD	Adequate	Adequate	Adequate	None
36-37	Migratory delay	Sacramento				
Habitat and passage above dams						
General comment						
67-78		All rivers	In planning			
24		Sacramento	In planning		Adequate	G
52		Stanislaus	No action			
42		American	No action			
Other Actions						
43-45	Hatchery plan	American	In planning			
86	Funding program					

NARRATIVE NOTES FOR TABLE 2

- A. As designed to achieve physical targets, the actions were generally effective.

- B. Action is a physical compliance – it needs to be related to presence and bioenergetic responses of fish.
- C. Improved temperature predictions were demonstrated by the NOAA/NASA study which should replace the concept of temperature compliance points with continuous spatial temporal predictions of temperature in the river and tributaries of the Central Valley. Linking the predictions from models with temperature and precipitation across seasonal and yearly scales should vastly improve the efficacy of within year and across year decisions on allocations of cool water resources in the system.

The weakest link in the system appears to be how this high quality temperature information will be used by fisheries managers. The example presented in the review was a simplistic but useful first step. However, we see a temperature management system of greater potential. We recommend further development that links spatial-temporal life-stage specific fish distributions with the spatial-temporal temperature distributions. The system needs to include bioenergetic models that characterize effects of temperature on growth and survival across multiple life stages. While the underlying bioenergetic theory and information is available for this linkage, the effort is not trivial. For example, effect of temperature on growth will be complex because fish size affects both immediate survival and survival in later life stages. Furthermore, survival does not increase linearly with fish size but typically exhibits a threshold type response, such that the changes in size have little impact on changes in survival for the smallest and largest fish.

- D. Need to link better forecasting of seasonal flow with down stream temperature modeling and then link effects of temperature on fish vital rates: egg, juvenile, and adult survivals, egg incubation time, juvenile growth. Strongly encourage implementation of the temperature forecasting and assessment program described by NOAA.

We believe the temperature compliance needs to be improved by linking spatial/ temporal distribution of temperature in the river with the spatial/temporal distribution of fish. The NOAA/NASA presentation for improving predictions of stream temperature and linking these with fish would be a significant improvement to temperature control. However, this program too can be improved. The existing project considered effects of growth on juveniles. Effects of temperature on other life stages (adults, egg incubation, and also green sturgeon) need to be included in the system. Considerable work is available on the impact of daily temperature across salmon life stages (Marine and Cech, 2004; Murray and McPhail, 1988; Myrick and Cech, 2001, Sullivan et al. 2000; USEPA, 2001) and so there are no outstanding conceptual limitations to expanding the system. The panel emphasizes that an integrated real-time temperature compliance system that ingrates long (90 day and above) forecasts with

real-time temperature predictions linked to biological models that consider growth, egg development rate and survival should be a goal for temperature compliance. Such a system comes under RPA 23 but the panel encourages a longer term program to integrate temperature flow management with fish biological needs throughout the Central Valley.

- E. The temperature compliance points were qualitatively related to the distribution of winter-run Chinook. It is not known why the compliance point was established downstream (Jelly’s Ferry) when aerial redd surveys in 2010 indicated redds were upstream of Airport Road Bridge.

Preseason temperature planning is unclear. The documentation was inadequate to assess the efficacy of coordination in real time or the effectiveness of the action on fish. Because the temperature compliance point is adjusted over the year as the conditions in water storage, tributary flows and precipitation, reaching temperature compliance is difficult if the water is available and impossible if cold water storage is not available and temperature conditions over the year are unfavorable.

- F. Compliance points should be re-evaluated and possibly moved to better match actual fish habitat usage.
- G. While “fish population data” was listed in the presentation as a priority for data collection, the panel was not presented much about this topic, though the potential for competition and/or interbreeding of transported fish with native (or put and take fisheries) populations is of importance. We hope that risk assessment for major habitat degradation (e.g., the Cantara loop metam sodium spill in the Sacramento River in 1991) is also being considered.

Table 3. RPAs in Delta for salmon in WY 2010

Action	Description	Region	I Efficacy	II Approach	III Coordination	IV Improvements
General comments						H
53, 54 ,55	Delta Cross Channel	Delta CC	Adequate	Partially Adequate		L
56, 57	Vernalis E/I	San Joaquin	Inadequate	I		
58	OMR flows	OMR	Adequate		J	L
59-63	Salvage efficiency and loss	CVP and SWP pumps CC Forebay	Under development		K	M
64	Delta operations group DOSS		Adequate			

NARRATIVE NOTES FOR TABLE 3

- H. A lag time of 1-2 weeks real time monitoring of winter and late fall Chinook in reading coded wire tags (page 18 DOSS Technical Report) makes the real-time response to Chinook migration problematic. However, the delay results from reading data on the tag, not tag detection. The detection of tags is immediate and so the number of tagged fish represents data that is essentially available in real time. While there are likely important reasons to know the identity of specific fish (i.e., where, when or by whom it was tagged), the presence or changing numbers of tagged fish at a specific location provides information on timing of emigration that can be useful in implementing RPAs.
- I. As stated in the DOSS Technical Report (page 19), the formulation of the second trigger was mathematically incorrect.
- J. Adequate for salmon but action not currently coordinated with delta smelt program – coordination will require completion of work on delta smelt studies.
- K. The management of Export/Import (E/I) program and impact on fish entrainment is uncertain.
- L. Behavioral diversion barriers. The research on behavioral bubble barriers to divert fish at the head of Old River (HOR) and Georgiana Slough (GS) are critical research projects with some risk but significant potential. Behavioral diversion of salmon in a tidally fluctuating system is a great challenge and if successful would contribute to maintaining both salmon survival and water supplies to California. The essential goal, to route fish independent of flow, was first identified in the EWA review nearly a decade ago. Unfortunately, the level of effort to achieve this ability is below what is needed.

The current approach to behavioral barriers in the Delta has been largely trial and error in which a system is envisioned and then deployed for testing; tracking trajectories or final destinations of tagged fish encountering the barrier. This approach has been used for decades in the Columbia River system at great cost and with limited success (Anderson 1988). Current studies in the Delta appear to be on a similar path. Developing efficient behavioral guidance systems requires an understanding of both the physical environment on scales relevant to fish and the temporal response of fish to the environment (Anderson 1988, 1991; Goodwin et al. 2006, 2007; Nestler et al. 2008; Kemp et al. 2006). Linking the environment to fish behavior requires a detailed description of the flow environment, the sensory signals relevant to the fish and knowledge of the fish's response to the sensory information. Linking these elements in a predictive model has been done in other systems (Goodwin et al. 2006) and the approach can be readily applied to the Delta.

However, such a program requires an integrated team with expertise in computational fluid dynamics, fisheries, animal behavior and computer modeling as well as expertise in laboratory studies of fish behavior and field expertise in fish diversion.

We understand that the VAMP review panel (Hankin and others, 2010) strongly recommended a return to a physical barrier at the HOR for the reason of routing more flow down the main stem of the San Joaquin River to improve outmigrant survival. Therefore, the GS barrier, to be implemented for the first time this winter (WY 2011), may have the greatest potential.

- M. The proportion of fish in salvage varies based on alterations of such factors as the primary bypass ratio at the Tracy Fish Collection Facility (study using Chinook salmon; Reclamation, 2008). The Panel recommends further collaboration between the water and fish agencies in assessing the variable efficiency of salvage as related to water operations and the completion of studies proposed by Reclamation pursuant to the 2004 NMFS OCAP Opinion (e.g., Evaluation of the percent loss of salmonid salvage due to cleaning the primary and secondary louvers at the Tracy Fish Collection Facility, mentioned on page 343 of the current NMFS Opinion).

Table 4. RPA for delta smelt in WY 2010

Action	Description	I Efficacy	II Approach	III Coordination	IV Improvements
General comments		T	N	T	O
Action 1a Limit OMR to -2000 cfs	Protect first flush based on turbidity and salvage	Inadequate	P		P
Action 1b	Protect after first flush based on salvage				
Action 2 OMR range -1250 to -5000 cfs	Protect after Action 1 based on fish data, delta conditions, salvage	Partially adequate	Q	Q	P, R
Action 3 limit OMR to -1250 or -5000 cfs	Minimize larval entrainment based on temperature and spent females	S	R		
Action 4	X2 management of adult habitat	No Action			

NARRATIVE NOTES FOR TABLE 4

- N. The new delta smelt studies, which are coordinating sampling with the temporal patterns of tides and turbidity, represent a major advancement in research on this species and potentially for management of the Delta. Previous studies, on which the current RPA Actions are based, focus on net flows and turbidity, in particular the net flows in the OMR. The newest research, albeit currently limited in spatial and temporal scope, has demonstrated that delta smelt and other Delta species can respond to their local tidally driven environment which in turn may affect their movements within the Delta. A fresh perspective may even lead to improvement of sampling protocols for these species that will allow not only a better understanding of migration patterns within the Delta but also improve the accuracy of estimates of abundance. The panel strongly encourages this research and timely incorporation of the findings into new management strategies or possible future adjustments to the RPA Actions that may lead to reduced entrainment of delta smelt without further restrictions on water delivery.
- O. The new studies measuring fish and water properties on tidal scales are innovative and important to providing the foundation for improved management of the Delta resources. Characterizing the spatial/temporal patterns of turbidity, salinity and flow at scales relevant to fish is an excellent initial step. However, the behavioral models that are so far being used in the Delta to link fish movement to the physical environment are inadequate. The Resource Management Associates (RMA) Smelt Behavior Model is based on unrealistic hypotheses for smelt movement, including the assumed response of delta smelt to horizontal gradients in turbidity and salinity and the stopping rule in the inner Delta. Detailed review comments on this model are contained in the 2-gates project review available at: http://www.science.calwater.ca.gov/events/reviews/review_2gates.html. The model builders have commendable expertise in modeling the physical environment but the top-down approach and a fine-tuning of the existing model with new data is discouraged. The use of the particle tracking model (PTM) to represent adult delta smelt behavior is also inadequate. In short, any rectified behavior, which moves fish upstream on the flood tide without realistically expressing the actual cues that induce the behavior, is simply inadequate. The goal should be to develop, from first principles, a behavioral model for how multiple species in the Delta, not just delta smelt, respond to their local environment. Such an effort will require a collaboration of experts from a variety of fields, including computational fluid dynamics, fisheries, animal behavior and computer modeling, as well as expertise in laboratory studies of fish behavior and fish diversion.

P. During 2010, Action 1 was never triggered because the average daily turbidity at Victoria Canal did not exceed 12 NTU for three consecutive days. Considering the close proximity of the Victoria Canal monitoring station to the south Delta pumps, this may have been a fortuitous occurrence because the data suggests that when the turbidity at that station exceeds 12 NTU it may be too late to avoid entrainment of at least some adult delta smelt that presumably would have moved into the south Delta with the higher turbidity water. During the first flush of 2010 (which began the week of Jan 24th), OMR flows were already curtailed to be no more negative than -5,000 cfs by the salmon Biological Opinion (RPA Action IV.2.3). That level of OMR flow was sufficient to prevent turbid Sacramento River water from being drawn down to the Victoria Canal station and triggering the Action. Without the salmon Action, however, it is likely that OMR flows would have been higher, and the delta smelt Action would have been triggered. Delta smelt protection should not rely on the salmon Action. The panel feels it would be wise to adjust slightly the trigger for Action 1 so that it gives an earlier warning for the first flush. Adjusting the trigger to be a three-day average of the monitoring stations at Prisoners Pt, Holland Cut, and Victoria Canal might be adequate, although some analyses should be done to confirm this and determine whether a trigger of 12 NTU is the appropriate magnitude. The SWG has suggested five alternative sites for use in WY 2011, which can be considered also. As the new research on delta smelt (see N above) attempting to link tidal activity, turbidity and fish movements becomes available it may provide useful additional guidance for Action 1. The SWG has acknowledged this and has already proposed to incorporate peak turbidity on the incoming tides as a consideration in their evaluation process of entrainment risk level for delta smelt. However, it is important to understand how fish behavior links to turbidity and tidal activity (for example, movements may not be related to turbidity on incoming tides). As much as possible, the goal should be to link fish behavior to the physical triggers.

The turbidity data from 2010 did show that an OMR flow objective as restrictive as -2,000 cfs may not be necessary in years of average or below average hydrology in order to keep turbidity in the south Delta low (below 12 NTU) and delta smelt entrainment minimal. In 2010, for example, OMR flows of -5,000 cfs proved adequate with a first flush of 57,000 cfs (on the Sacramento River at Freeport). These data suggest that the OMR flow objective required in Action 1 should really depend on the size of the first flush. The larger the first flush, the less negative the OMR flow objective that will be needed. The panel recommends that this idea be further investigated as additional years of turbidity data are collected and improved numerical models of sediment transport are developed and become capable of accurate turbidity prediction.

Q. In as far as salvage of delta smelt reached a level of concern (92) but did not exceed the incidental take limit of 123 fish, it could be concluded that the Action contributed to reducing take. However, it is also possible that the apparent success was due in part to the generally low abundance of delta smelt in the system. The incidental take limit is indexed to an estimate of delta smelt abundance from the Fall Mid-Water Trawl, but the accuracy of that value depends largely on the variance associated with the abundance estimate.

The SWG recommended, based on a team consensus (though not unanimous) and a total expanded salvage of 24 delta smelt, that OMR be set no more negative than -2000 cfs. The technical team believed that there was enough current and historical evidence to indicate that delta smelt were actively migrating and were vulnerable to further entrainment and salvage mortality. A peak in salvage was anticipated because the team believed that migratory adults already entrained into OMR, were vulnerable to pumping operations. Although no rationale was apparent, the USFWS rejected the SWG recommendation and instead determined that -4000 cfs was sufficient to protect the fish. By the following week, the anticipated peak in salvage had not materialized and it was concluded that it had been avoided. This is interesting because it suggested that an anticipated level of jeopardy was avoided even at an export flow double that recommended by the technical team.

There are two issues that arise from this instance. The first is a question of coordination with the technical team. The process by which the recommendation of the SWG was rejected is unclear even though the outcome appeared to be favorable (i.e., an anticipated level of jeopardy was avoided while export flows were not unduly affected). In fact, according to Table 2 of the SWG Report to the IRP, the USFWS determination of allowable export flows exceeded (i.e., OMR flows were more negative) that recommended by the SWG on 4 out of 17 times (about 24% of the time). The same table also shows that the observed OMR flow range exceeded the range allowable under the USFWS Opinion in 4 of 15 cases (about 27% of the time). However, it should be noted that the amount by which flows exceeded allowable limits was usually – though not always - minimal. It is also notable that observed flow ranges tended to be in the upper end of the allowable range on most occasions. This is partly due to the use of a 14 day running average in determining OMR flow ranges, but operating near the upper end of the allowable range does tend to invite incidents that exceed the set limits.

The second issue that arises from the discrepancy between flow recommendations of the SWG and the ultimate determination of allowable flows by the USFWS is the connection between the biology of the vulnerable delta smelt population and the action triggers. Lacking accurate

real-time information on the population size and locations of vulnerable sub-populations, the SWG recommendations are based largely on historical patterns, salvage numbers and the individual experience/expert opinions of the individuals within the working group. The potential problems here are that while historical patterns might predict general trends, they are usually not sufficiently sensitive in predicting events in any given year, and composition of the SWG will inevitably change over time, as will the level of first-hand experience with studying delta smelt and the Delta ecosystem.

- R. Salvage is certainly a qualitative indicator of mortality that can be linked to water operations, but it remains a questionable quantitative measure of population jeopardy. Currently, salvage is used as an indicator of entrainment with the assumption that some constant proportion of entrained fish is taken in salvage at the state and federal fish facilities. Recent research on delta smelt entrainment into the SWP has indicated that salvage may not be a "consistent index" (Tools for Delta Smelt Management

Workshop: http://www.deltacouncil.ca.gov/delta_science_program/pdf/workshops/OCAP_2010/tech_teams/USFWS/Tools%20for%20Delta%20Smelt%20Management.Workshop%20Summary.pdf). The panel recommends expedient incorporation of the existing and newly emerging efficiency data into a new entrainment index.

Given the current precarious status of delta smelt, it seems unlikely that refinements in population estimates or model development will proceed quickly enough to improve the understanding of the relationship between water operations in the Delta and delta smelt populations. Until more refined methods relating delta smelt population dynamics to variation in the quantity and quality of its Delta habitat, there may be ways to develop an incremental improvement in the use of available information. For example, sophisticated refinements to tools are not necessary to recognize – even at the most basic level – that not all individuals salvaged represent an equal amount of jeopardy to the population. The expected lifetime contribution to reproduction in a population (i.e., Fisher's reproductive value) varies in a manner that can be calculated from age-specific survivorship and per capita fecundity at a given age (Kozlowski 1993). A pre-spawn adult female delta smelt or one containing mature or maturing eggs is a much greater loss to the future population than a larva, an adult male, or a spent female. Consequently, a scientifically defensible ecological connection between salvage and jeopardy would weight the protection afforded to different life stages in the population. In practical terms, it is advisable to adjust the allowable incidental take of delta smelt for different life stages. This also provides some flexibility in the RPA action when the water resource costs are high to protect individuals that are likely to contribute little to the future population size.

- S. There is no metric by which to evaluate the effectiveness of the action on early life stages, which are not accurately counted among the salvage values.
- T. The 2010 Water Year was considered below – but close to – average. Drier years are likely to present greater problems related to demand for proportionally higher exports and a greater pressure for legal remedies. Successful legal challenges to any of the actions have potential to: (1) inhibit the actual effectiveness of the action, (2) preclude any evaluation of efficacy, and (3) inhibit agency coordination (if agencies are on different sides of proceedings). Consequently, linking vital rates and the population dynamics of delta smelt to the physical flows targeted by the RPA actions needs to be a high priority for future studies involving delta smelt.

PANEL RESPONSES TO PROPOSALS FOR ADJUSTMENTS OF OCAP RPA ACTIONS

Proposal I.A – Old and Middle River (OMR) Flow Management

***Issue #1:** Water was not exported at the maximum allowed last year when RPA Action IV.2.3 required OMR to be no more negative than -5,000 cfs. The operators were operating to a conservative OMR of no more negative than -4,000 cfs, because one swing of the tide can cause OMR to fluctuate by up to 1,000 cfs.*

***NMFS Proposal I.A (part 1) for Adjusting OMR Actions:** One of the formulas (by DWR, USGS, or MWD) can be used to predict OMR in order to provide flexibility and enable operating OMR closer to the OMR limit. Actual OMR would need to be monitored also in order to confirm that the predicted and actual OMRs track closely.*

The panel understands the challenge that DWR and Reclamation face in attempting to avoid exceeding negative OMR flow objectives without keeping export levels at overly conservative (low) levels. Because the physical configuration of the SWP export facilities allows more control over the level of south Delta diversions than the Federal (CVP) facilities, it is DWR that often must shoulder the greater burden in fine-tuning diversion levels so as to meet OMR objectives.

The USFWS and NMFS asked for our comments on the above proposal to consider adjusting their OMR flow management actions to use an empirical equation to forecast levels of exports that will theoretically satisfy an OMR flow objective instead of requiring that the flow objectives be met with the actual

measured OMR flows. The idea is that this adjustment would make managing project operations to meet flow objectives more straightforward and allow for some increase in exports because a factor of safety will not have to be built into operations to ensure compliance.

Before providing our specific comments on this proposal, we offer some background on Old and Middle River flows and the factors that affect their variability.

Background: The measured flows and water surface heights in both Old River and Middle River vary strongly with the tides. The OMR data for the winter (Dec-Mar) of water year 2010 are graphed in Figure 1 to illustrate this point. Maximum ebb (positive) flows and flood (negative) flows in both rivers during this period were in the range of 10,000 to 15,000 cfs, with tidal flows in Middle River slightly higher than those in Old River. The daily tidal range¹ in water surface heights varied between approximately 2 and 4 feet. The largest ranges in the tidal heights and flows occur on the spring tides and the lowest ranges on the neap tides. This spring-neap cycle occurs over a 14-day period and varies in magnitude on an annual basis (the greatest spring tides occur during late-December and late-June).

The more slowly varying flows and water surface heights shown by the thick black curves in Figure 1 were calculated hourly by a low-pass (Godin) filter that is used to remove the tidal oscillations from the time series. The OMR flows used in meeting the objectives defined in the biological opinions are calculated from these hourly filtered flows by first computing a daily mean flow for each river and then summing these daily values for Old River and Middle River. The combined daily total flow for both rivers is referred to as the “net” or “tidally averaged” OMR flows.

Hutton (2008) provides a good discussion of the factors affecting net OMR flows and evaluates the limitations and performance of the various empirical models available to predict them. OMR flows are affected most by the amount of water diverted from the south Delta and, to a lesser degree, by the inflow to the Delta from the San Joaquin River at Vernalis. Tides and meteorological factors can play a role also as discussed below. A key point is that for any reasonably accurate short-term (several days to a week) forecasting of OMR flow the actual daily diversions into Clifton Court Forebay (CCFB), not the daily SWP exports from the forebay, are needed. The forebay inflows (diversions) are not as easily managed as SWP export pumping and they can deviate significantly on a short-term basis from the exports as shown, for example, by the two months of data from 2001 plotted in Figure 2 (data for wy2010 were not available). Hutton (2008, Figure 7-2, p. 85) provides further comparisons of the

¹ The daily tidal range is the difference between daily maximum and daily minimum water surface heights. A daily tidal range in flows is similarly defined as the difference in the daily maximum (ebb) and daily minimum (flood) flows

daily forebay inflows and outflows and shows they are significantly different on a daily time scale, although they tend to collapse to closer values as the data are averaged over 14 days. Unfortunately, the instantaneous inflows to the forebay are not directly measured; they are estimated,² so there is some uncertainty regarding the accuracy of the estimates.

During periods of reasonably steady San Joaquin River inflows to the Delta, it is likely that variations in inflows to Clifton Court Forebay may explain much of the observed short-term variability in net OMR flows not explained by exports. The tidal spring-neap cycle and meteorological factors are often implicated as causing significant variability in observed OMR flows, but these factors may be more indirect than direct causes of variability. They are indirect causes because they affect the CCFB inflows, which in turn affect the OMR flows. Daily inflows to the forebay depend on the difference in water surface elevations outside and inside the forebay during the periods of each day when the gates are in the open position. As can be seen in Figure 1 (see, in particular, the month of December), the tidal spring-neap cycle causes a 14-day rise-and-fall in mean Delta water surface heights. The water surface heights tend to rise during the more energetic spring tides and fall during the neap tides. This can lead to a tendency toward greater inflows to the forebay on spring tides and lesser inflows on neap tides depending on how the opening and closing times for the forebay gates are adjusted to account for these effects. The project operators are aware of the spring-neap tidal cycle and do try to account for it.

During storm events in winter and spring, changes in atmospheric pressure and wind also can lead to significant fluctuations in water surface heights in the Delta that can affect diversions into the forebay. Figure 3 illustrates the more than one foot rise in tidally averaged water surface height on Middle River that resulted from the large storm and low-pressure system that occurred over northern California during the week of January 18, 2010. This particular storm led to the “first flush” event of the winter that caused daily flows on the Sacramento River at Freeport to reach 55,000 cfs by Jan 24. It is typical for this type of low-pressure event observed in previous years to correspond with a significant oscillation in OMR flows as also occurred in 2010 (see Figure 3, second graph from bottom). OMR flows first become more strongly negative as the estuary water levels rise, and then become less negative as project operations adjust, high pressure returns, and Delta water levels fall.

The time series for daily, 5-day, and 14-day averages of the OMR flows measured during the winter of WY2010 are graphed in Figure 4. During the period from January 20 through the end of March a combination of the NMFS³ and USFWS RPA actions required a flow objective that was mostly -5,000 cfs³.

² Inflows to Clifton Court Forebay are indirectly estimated by the DWR Delta Field Division using a mass balance approach (Le, 2004) or by gate equations developed by Hills (1988).

³ For a short period from February 10-18, 2010 the OMR flow objective was lowered temporarily to -4,000 cfs.

The average flows that occurred were slightly lower than this objective (approximately -4,500 cfs). The 5-day averages were also maintained at levels that were no more negative than the required 25 percent of the targeted flow objective for the 14-day average. Overall, the project operators did an excellent job with the difficult task of closely meeting the flow objectives during 2010, but without exceeding them. However, because there were only a few transitions in the flow objectives during 2010, the task was easier than what might happen in future years.

Panel response to proposal I.A (part 1): We have no strong objections to this proposal. It most likely will not introduce any significant increased variability in OMR flow that could affect entrainment of delta smelt or outmigrating juvenile salmonids. Of course, if a goal of the proposal is to increase exports slightly, allowing the 14-day average of OMR flows to fluctuate a specified amount more negative than the objective flow might be a solution also. Larger negative fluctuations in the 5-day averages could also be allowed to improve flexibility for the operators. A goal could be to relax requirements enough so that the operators could use a predictive equation of their choice to set export levels and yet remain in compliance with the OMR action. In any case, we suggest to USFWS and NMFS that they further explore whether much of the troublesome short-term variability in OMR flows that is not explained by exports is explained simply by the variability in the actual south Delta diversions from the estuary. If diversions explain much of the variability, it might be wise to seek improved and real-time measurements of CCFB inflows for use in managing diversions. Accurate real-time measurements would conceivably allow setting more precise closing times for the CCFB gates once a diversion objective has been met. If a goal of USFWS and NMFS is to reduce any relatively large, project-related short-term variability in OMR flows, then the prediction equation used in the adjusted action could be applied for setting an objective on forebay inflows (diversions) rather than for exports. This approach may not be as favorable to the SWP operators because it would again present more logistical difficulties than managing exports, but it would reduce short-term variability in OMR flows if that becomes a concern.

Issue #2: *In situations when the required OMR flow drops several times in quick succession, project operators have expressed a concern that the protective standard has been set in a way that can be very difficult to meet [see example in the October 2010 Delta Operations for Salmonids and Sturgeon (DOSS) annual report, page 20].*

NMFS Proposal I.A (part 2) for Adjusting OMR Actions:

- *To provide flexibility in operations, when a fish density trigger is met, the export reduction floor shall be 1,500 cfs (i.e., the project operators would not*

be required to go below 1,500 cfs in order to meet OMR) until the required OMR limit (e.g., no more negative than -3,500 cfs) is met.

- *As long as the operators make all “good faith efforts,” we could consider that compliance, even if the specific OMR limit is not met.*
- *There may be more flexibility in the OMR, and therefore, exports, later in the averaging period.*

Panel response to proposal I.A (part 2): This proposal makes sense. We understand that it is necessary to keep at least one pump operating at the Jones Pumping Plant to provide water to locations where no other source is available. This requires setting a floor of about 1,500 cfs on exports. The overall issue, however, of how to deal with transitions in OMR flow objectives is a challenging one, especially if changes in flow objectives occur in rather rapid succession and also considering that long-duration (14-day) moving averages are used to define the flow objectives in the RPA actions. NMFS has provided fairly complicated transition language in their Biological Opinion (p. 649). An alternative solution to transitions may be to base compliance on the use of an equation that defines exports or diversions based on the OMR flow objective as considered in the part 1 proposal above. During the first 7 days⁴ after and (if necessary) before the flow objective is changed either up or down, the equation would be used in place of the OMR objective. On the 8th day the 14-day average would again apply. The MWD equation (Hutton, 2008) is the most accurate equation right now. The equation proposed by the Contra Costa Water District, which is to define total exports for a given OMR flow objective by

$$\text{Exports} = -1 * (\text{OMR flow objective}) + 0.5 * (\text{SJR flow})$$

might be adequate, but is probably simpler than warranted considering that better equations are available and they are all easy to apply. According to information provided by NMFS and USFWS, DWR has drafted a proposal for new transition language. We will wait to hear what their proposal is.

Proposal I.B – Calendar-based OMR Trigger (for NMFS RPA Action IV.2.3, Biological Opinion p. 648)

Issue: *DWR asked that the Panel carefully consider whether the calendar-based OMR trigger is an appropriate action upon which to regulate the operations of the export facilities. DWR believes that NMFS, in order to support their hypothesis that exports draw salmonids off their normal migratory route, improperly relied upon a Particle Tracking Model.*

⁴ 7 days represents one-half the time period of a 14-day moving average

NMFS Proposal I.B for Adjusting Calendar-based OMR Trigger: *Nothing new is proposed for this component of the RPA. Calendar-based trigger is necessary, as there is significant Sacramento winter-run Chinook salmon (winter-run) present in the Delta as of January 1st of each year. In addition, Central Valley (CV) spring-run Chinook salmon (spring-run) and CV steelhead from the San Joaquin River Basin continue their outmigration well into June. This action is necessary to keep the salmonids away from the zone of influence of the export facilities.*

Panel response to proposal I.B: The Panel is reluctant to endorse the calendar-based OMR trigger used in NMFS RPA Action IV.2.3 without studying the monitoring data more carefully. We are unsure whether juvenile winter-run Chinook or juvenile steelhead are present in the Delta during January of all years and in sufficient numbers to justify the curtailing of exports through an OMR action. A preliminary look through the 2009/2010 data report by Llaban (2010) that was provided to the Panel to review appears to show no winter-run caught in the Sacramento Trawl during January and none observed in the salvage until just after the time of the first flush on the Sacramento River in late-January. Also, it seems as if few or none were caught in the central Delta, south Delta, or San Joaquin River beach seines until late-January or thereafter. If our interpretations of these data are correct (and they might not be) it would seem that in 2010 a Jan 1st trigger date for an OMR Action might have been earlier than needed. Could it be that juvenile winter-run do not enter into the Delta in significant numbers until the first-flush event on the Sacramento River? If so, perhaps triggering the action before the first flush is not warranted. There are years such as 2000, 2001, 2007, and 2009 where the first flush did not occur until February. It would seem worthwhile to review the monitoring and salvage data for these years to identify whether juvenile winter-run were in the Delta during January.

Regarding Action IV.2.3 in general, the Panel feels additional acoustic tagging studies in the north Delta would be valuable to better understand the importance of exports and negative OMR flow levels in affecting survival through the Delta for Sacramento River juvenile Chinook salmon. The Panel understands that earlier coded-wire-tagged release-recovery studies in the north Delta (Delta Action 8 Experiments, etc.) have been somewhat inconclusive regarding export effects on survival. The use of acoustic tags and in-river receivers, however, is a promising alternative to CWT data that can provide valuable information regarding fish survival through individual reaches and their route selection. Key questions that could be answered are: What are the percent routing and survival of Sacramento River fish through the major migration routes (Sacramento River, Sutter/Steamboat Sloughs, Delta Cross Channel and Georgiana Slough)? Of the fish departing from Georgiana Slough and entering the central Delta, what percentage is lost through direct or indirect

effects of exports? An ongoing research program to answer these questions is needed so that the debate over Action IV.2.3 does not have to continue.

Regarding the issue of particle tracking raised by DWR, the Panel agrees with DWR that particle-tracking modeling studies using neutrally buoyant particles are *not* a good surrogate for the fine-scale migratory behavior of salmon smolts or for estimating the transit time of smolts through the Delta. What little that is known about the migratory progress of smolts in estuaries is that their movements are in steps, characterized by swimming in the direction of the current followed by periods of holding in areas of low current velocity. These are not behaviors described by neutrally buoyant particles. On the other hand, in the process of migrating to the sea, smolts are thought to cue almost entirely on downstream flow direction. Because neutrally buoyant, particle-tracking modeling gives clear indications of flow directions, it can be a useful tool in helping to forecast how movements of smolts through the Delta may be influenced by flow.

Proposal I.C – 2nd Trigger to Reduce OMR to no more negative than -3,500 cfs (for NMFS RPA Action IV.2.3, Biological Opinion p. 649)

***Issue:** The 2nd trigger, as written in RPA table, is not workable in its current form (see NMFS' March 12, 2010, Determination based on the DOSS advice from March 11, 2010 at http://swr.nmfs.noaa.gov/ocap/2010-03-12_NMFS_determination.pdf). A subgroup of DOSS convened several meetings to recreate the second trigger. The proposed second trigger has not been vetted through the DOSS group, and therefore, DOSS has not provided advice to the Water Operations Management Team (WOMT) and NMFS (per process provided in Opinion pages 582-583) regarding the corrected second trigger.*

NMFS Proposal I.C for Adjusting 2nd Trigger to reduce OMR to no more negative than -3,500 cfs: Based on NMFS participation on the DOSS subgroup, NMFS believes the first stage of the second trigger is as follows:

- First stage: daily loss > 8 fish/thousand acre feet (TAF) exported multiplied by exports (in TAF); and
- Second stage: daily loss > 12 fish/TAF multiplied by exports (in TAF).

Panel response to proposal I.C: The panel chooses, without bias, not to comment on adjusting of the 2nd trigger because insufficient information was provided.

Proposal II – San Joaquin Inflow-to-Export Ratio Action (NMFS RPA Action IV.2.1, Biological Opinion p. 641)

***Issue:** While this action restricts total exports (normally to low levels) during April and May based on the inflow-to-export ratio, it does not specify whether exports occur from the CVP or SWP. Because high predation mortality occurs in the Clifton Court Forebay (CCFB), and the louver efficiency at the Skinner Fish Facility is lower when pumping is low, it may be wise to consider keeping the CCFB gates closed during this action so as to reduce salvage and loss.*

NMFS Proposal II: for Adjusting the San Joaquin Inflow-to-Export Ratio Action:

- *Keep the CCFB closed, and pump the water from south of the louvers at the Tracy (Federal) facility to the CCFB to provide water for the Byron-Bethany Irrigation District and for the State to pump.*
- *This conceptual proposal will need engineering/feasibility review.*
- *With the intertie likely to be operational starting in 2012, there will be more flexibility to export water from the Tracy facility, especially during April and May.*

Panel response to proposal II: The panel understands the thinking behind this proposal, but is unsure how effective it will be based on information that has been learned from the coded-wire tag (CWT) and acoustic-tag (AT) experiments done since 2000 as part of the Vernalis Adaptive Management Plan (VAMP). If an effective fish barrier⁵ is deployed at the head of Old River (HOR), and exports are kept at the low level (typically 1,500 cfs) that is necessary to satisfy the inflow-to-outflow ratio for this Action (Action IV.2.1), it is unlikely that enough outmigrating San Joaquin River salmonids will become entrained into the CCFB during April and May to justify a need to close off the forebay entirely. Between 2000 and 2004, the data from the VAMP CWT experiments done with a physical HOR barrier in place and low exports (approximately 1,500 cfs – 2,250 cfs) show that expanded salvage estimates from the combined projects' fish facilities were no more than a few hundred of the tagged experimental fish. In the experiments during 2001 and 2003, it was less than 50 fish. These experiments were done with release sample sizes of from 50,000 to 100,000 tagged juvenile salmon (from the Merced River Hatchery) released on the San Joaquin River at either Durham Ferry or Mossdale. A table summarizing the numbers from these experiments can be found in Newman (2008, Table 5). In 2009, an AT experiment for VAMP was done that included periods when the bubble barrier at the HOR was not turned on. Vogel (2010, Table 13) detected only three (estimated) live acoustic-tagged smolts in the forebay at a monitoring station located immediately inside (west) of the CCFB entrance gates. These three fish were from a sample size of 173

⁵ The 2010 Delta Science Program review of the VAMP program (see Hankin and others, 2010) made convincing arguments for employing an operable physical barrier at the head of Old River.

(estimated) live acoustic-tagged smolts that entered Old River and were detected at the Old River at Middle River flow split. A total of 77 (estimated) live acoustic-tagged fish were detected just outside (east of) the entrance to the forebay gates, so tagged fish were in the vicinity of the entrance. What appeared to happen is that at the very low SWP export levels during VAMP, the CCFB gates were opened only periodically, typically at night, for such short periods that only a few fish became entrained. This experiment suggests that even when fish enter Old River, if SWP exports are very low, entrainment into the forebay may also be low. Because Action IV.2.1 will generally require higher San Joaquin River inflows at Vernalis during April and May than the previous VAMP pulse flows, we should expect even lower entrainment rates into the forebay. Overall, because entrainment levels into the forebay during April and May are expected to be so low, and considering that DWR has concerns about meeting their minimum levels of demand for the SWP during this action if the entrance gates are kept closed for two full months, we feel that it is not necessary to implement this action at this time. If new AT experiments indicate that significant numbers of fish released on the San Joaquin River are entrained at the CCFB, then this proposal could be reconsidered.

Regarding Action IV.2.1 and the above proposal, the Panel was provided a lot of additional information by DWR regarding their feeling that a negative statistical relationship does not exist between project exports and survival of San Joaquin River salmonids through the Delta. DWR did a thorough job of summarizing the literature on this subject through March, 2010. Regarding the Action itself, DWR noted that they “strenuously objected to its inclusion” in the RPA for the NMFS Biological Opinion. However, evaluating the scientific basis or conceptual validity of the process underlying the development of any RPA Action was specifically not in the charge to this panel, although we could propose or consider adjustments to Actions in light of information learned from the prior year’s operations or research. The Delta Science Program did provide the Panel as part of our supplemental reading material the most recent review of the VAMP study by Hankin and others (May, 2010). That report does provide some new insights into the issue of exports and San Joaquin salmon survival through the Delta. We feel that additional acoustic-tagging studies on the San Joaquin River and in the south Delta hold promise for better quantifying whether levels of exports (or OMR flows) play a role in affecting the percentage of salmonids that leave their normal migratory route or are delayed in their migration through the Delta.

Proposal III – Shasta Reservoir February Forecast using a 90% Exceedance Forecast (NMFS RPA Action I.2.3, Biological Opinion p. 597)

Issue: Reclamation’s 90% exceedance forecast, as required in the RPA, is conservative for the benefit of fish, but is frustrating to agriculture as they

cannot accurately plan and project their crops and water allocation. For example, Reclamation's initial water allocation for water year 2010 was 5%, and they eventually increased it to 40%.

NMFS Proposal III for Adjusting Shasta Reservoir February Forecast:

- Improve 90% exceedance forecast.
- NOAA's National Weather Service (NWS), through its Climate Prediction Center (CPC), has a new tool that can predict climate over the next 90 days.
- Reclamation should initiate an effort to hindcast its 90% exceedance forecasts in previous years, and compare them to the NWS's 90-day climate prediction.
- During a 5-year trial period, have Reclamation continue to conduct February forecasts using the 90% exceedance forecast, and also use the NWS' 90-day climate prediction, for informational purposes only to see how the NWS' 90-day forecast tracks. If the NWS' 90-day forecast is fairly accurate, consider the adaptive management change to forecasts using that tool as the best available science.
- NMFS will work with NWS to issue a 90-day climate/weather prediction.

Panel response to proposal III: The panel agrees that more accurate long-range forecasts would be beneficial to all project stakeholders and encourages monitoring of developments in climate prediction and rigorous testing of models. The National Weather Service Climate Prediction Center's long-lead forecast tool appears especially promising for air temperatures, but we note that precipitation is predicted with "marginal skill" except in cases of strong El Niño or La Niña conditions (<http://www.cpc.noaa.gov/products/predictions/90day/tools.html>; accessed 11/27/10). In addition to working with the National Weather Service to improve exceedance forecasting, it seems reasonable to take advantage of existing collaborations between NMFS, NASA and academic climate scientists (discussed by Eric Danner during this workshop in terms of short-time step stream temperature modeling) to develop larger/longer scale forecasts based on advanced coupled ocean-atmosphere global circulation models.

Proposal IV – Stanislaus Operations

Issue: Implementation of the spring pulse flow on the Stanislaus River resulted in an inverted pulse at Vernalis.

NMFS Proposal IV for Adjusting Stanislaus Operations

- The Stanislaus Operations Group (SOG), the San Joaquin River Group, and NMFS need to communicate to determine the flexibility within the RPA and to maximize the multipurpose use of water.

- *Add text to RPA Action III.1.1 (Opinion page 620) that provides SOG with the flexibility needed to make minor refinements, as necessary, in conjunction with VAMP flows.*

Panel response to proposal IV: The panel encourages additional cooperation to improve flexibility and maximize multipurpose water use within the San Joaquin River watershed. The Stanislaus Operations Group as defined in RPA action III.1.1 was formed to explore “real-time operational flexibility” and already makes minor refinements in prescribed actions (e.g. altering the timing of the January pulse to coincide with precipitation).

Proposal V – Immediate and Near-Term Significant Improvements to Increase Survival or Reduce Predation of Listed Species

Issue: The most direct benefit to listed species is to increase their survival, or reduce their predation, as they migrate through the Delta.

NMFS Proposal V for Adjusting Actions Related to Increasing Survival or Reducing Predation of Listed Species in the Delta:

1. *Consider opportunities for a more successful barrier at the Head of Old River. This proposal is consistent with the engineering solutions prescribed in RPA Action IV.1.3 (Opinion page 640).*
2. *Consider opportunities to significantly reduce predation rates at the pumping facilities themselves, immediately, or in the near term. For example, screening predators from entering the CCF to assist in the implementation of RPA Action IV.4.2(2) (Opinion page 656).*
3. *Accelerate the timing for implementation of RPA Actions IV.4.1-IV.4.3.*

Panel response to proposal V: The Panel strongly encourages development of barriers that divert fish from low-quality (sink) habitats created as an unintended consequence of water operations. However, the Panel has insufficient information on the opportunities noted in Proposal V.1 for improving the success of engineering solutions in RPA Action IV.1.3. The “consideration of opportunities” is a vague proposed action and assessing the effectiveness of such an action would be a subjective exercise. It is difficult to determine how the proposed adjustment differs substantively from the portion of the original Action IV.1.3 that was intended to reduce entrainment risk for Central Valley steelhead migrating through the Delta from the San Joaquin River. The Panel sees major challenges in developing effective diversion barriers that require careful consideration of ecological and behavioral factors as well as engineering factors. As outlined in Table 3 note L, the Panel believes that insufficient attention is currently given to these behavioral issues and encourages expanding the team to include the needed expertise. For example, the U.S Army Corps of Engineers has demonstrated expertise in applying cognitive ecology principles to fish diversion (e.g. Goodwin et al. 2006).

Proposed adjustment V.2 shares with V.1 a similar vague objective to “consider opportunities” for reducing predation at the pumping facilities. Without knowing the details of the opportunities, the Panel finds it difficult to encourage this adjustment to Action IV.4.2 (2). Also, any attempt to screen predators from entering Clifton Court Forebay would likely be costly and may bear a low likelihood of success. The Panel considers preventing listed species from entering Old River and the south Delta in the first place a potentially more productive course of action that minimizes not only predation but other negative effects of pumping (e.g., disruption of migratory patterns and mortality/morbidity associated with physical contact with screens etc.) Reducing the currently reliable prey stream for predators created by the pumping facilities, would ultimately reduce predator abundance near the facilities.

The Panel is concerned that the adjusted alternative proposed in V.3, which accelerates the timing for implementation of Action IV. 4.2(2a), may be unrealistic, in which case it would be neither reasonable nor prudent as a short-term goal. At the least, the Panel suggests consultation with DWR prior to revising the schedule for this action.

RECOMMENDATION FOR FORMAT OF REPORTS PRESENTED TO FUTURE REVIEW PANELS

The panel noticed a great deal of variability in the quantity and format of data and interpretations thereof, both in the presentations at the OCAP annual review workshop and in the written reports provided by the technical working groups prior to the workshop. Panelists were provided >400 pages of technical reports as primary review documents less than two weeks before the workshop, as well as several hundred pages of background reading. A standardized report format, clearer identification of the indicators to be considered in assessing the effectiveness of RPA actions, and better integration of abiotic and biotic data would be extremely helpful for future review panels. Clarity and inclusive data presentation are paramount, as independent review panelists should not be expected to have insider knowledge of the myriad agency monitoring programs and their results.

For the written technical reports, the general format of the Stanislaus Operations Group and Delta Operations for Salmonids and Sturgeon Group reports (i.e. list of acronyms, detailed table of contents, explicit listings of successes, issues, and clarifications) could serve as a template for all future technical reports. This panel would like to see, however, the addition of a chapter elucidating the impacts or potential impacts of operations on the species. For example, to what extent do areas influenced by salmonid spawning season temperature controls overlap with suitable gravels and/or actual use by salmonids during the water year? From discussions at the end of the workshop, it became apparent that in some cases at least those data exist, but were not always clearly presented. Summary graphs are very helpful (more so than long tables), but working groups should take care

to make sure that all graph axes are labeled, which was not always the case in reports for this year.

In oral workshop presentations, it would be useful to the panel for presenters to avoid a chronological narrative of the year's activities, which in most cases was provided in the written technical report, and instead focus on a succinct analysis of metrics of success and issues that arose for each applicable action. Again, integration of abiotic targets (e.g. temperature at a specific control point, pulse flows at a particular time) with biologically pertinent information would facilitate judgment on whether a given RPA action is meeting its objective with respect to avoiding jeopardy to a listed ESU or DPS.

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FIGURES

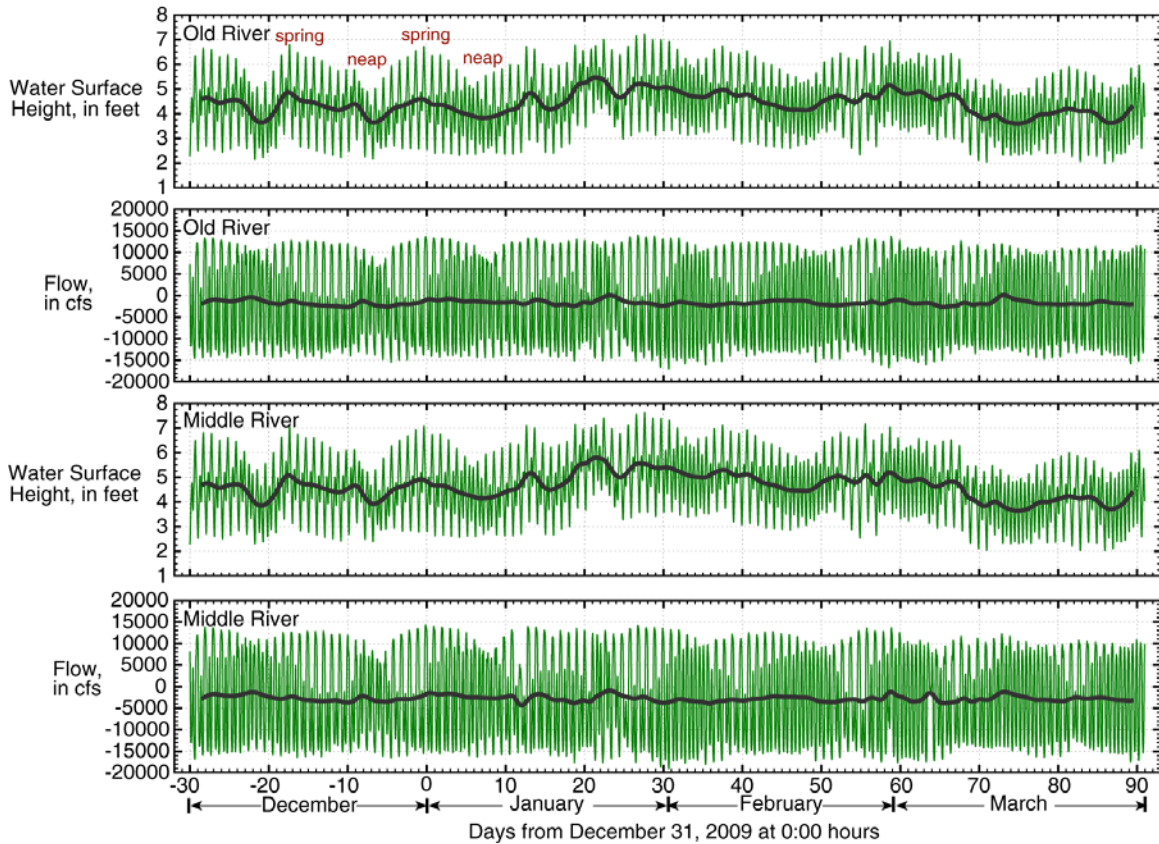


Figure 1 -- Graphs showing measured time series of 15-minute tidal water surface heights and flows (in green) from the USGS gaging stations on Old River and Middle River adjacent to Bacon Island. The data were downloaded from the California Data Exchange Center (CDEC). By convention, ebb (outgoing) flows are assigned positive values and flood (incoming) flows are assigned negative values. The time period plotted is winter (Dec - Mar) of water year 2010. Tidally averaged water surface heights and flows calculated using the standard USGS tidal (Godin) filter are shown by the thick black curves. The tides of maximum range are called spring tides and the tides of minimum range are called neap tides. The spring-neap cycle repeats itself once every 14 days, but varies in magnitude through the year. The greatest spring tides occur during late-December and late-June of each year.

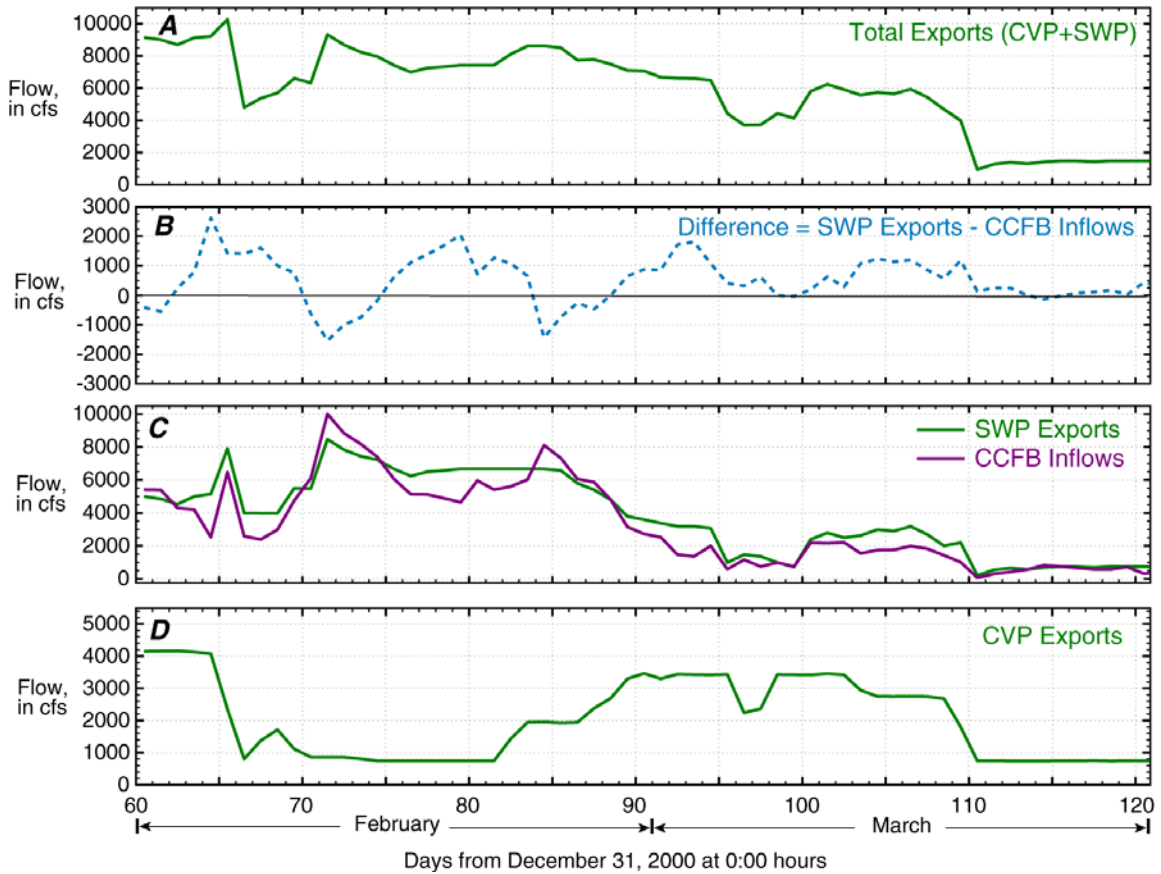


Figure 2 -- Graphs showing time series of daily values during Feb-Mar of 2001 for **A)** total exports (CVP+SWP), **B)** the difference in SWP exports from the Clifton Court Forebay (CCFB) and inflows to the forebay, **C)** SWP exports from the CCFB and inflows to the forebay, and **D)** CVP exports. Export data were taken from DAYFLOW. The CCFB inflows were calculated by Kate Le (DWR) using a DWR spreadsheet based on the Hills (1988) equations.

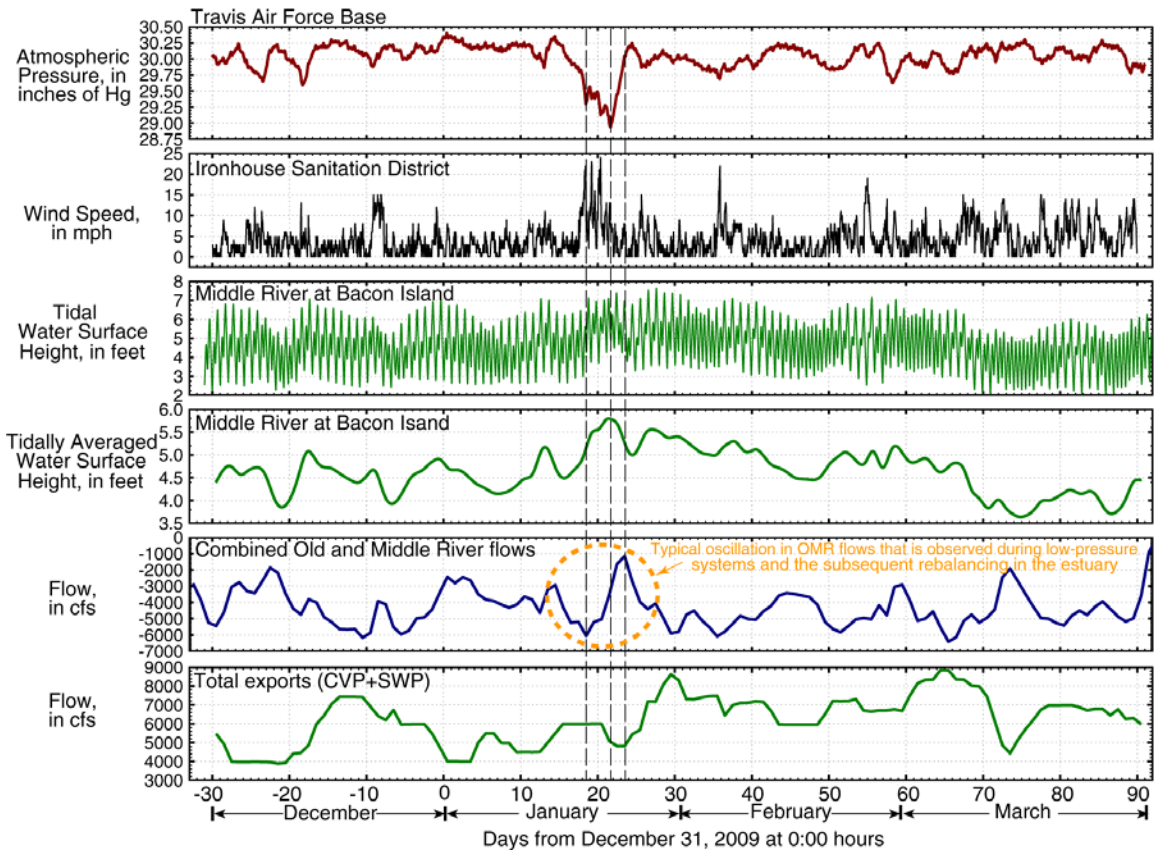


Figure 3 -- Graphs showing effects from a low-pressure system during January of 2010 on water surface heights in Middle River and on combined flows in Old and Middle Rivers. The exports data were taken from the table provided to the panel in the draft DOSS Technical Team Report (dated October 2010). The daily data for combined Old and Middle River flows came from the USGS National Water Information System (NWIS) data base. (The data for Old River and Middle River were retrieved individually and then added together.) All other data came from CDEC.

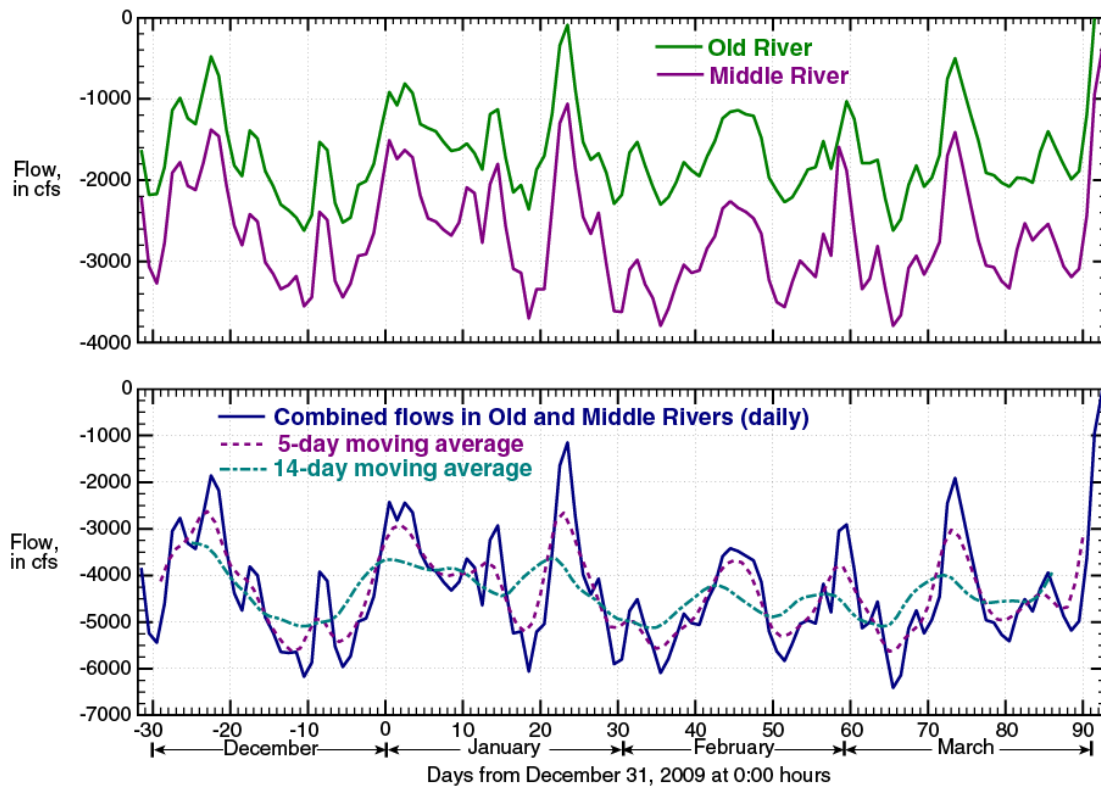


Figure 4 -- Graphs showing time series of the measured daily flows during the winter (Dec-Mar) of water year 2010 in Old River and Middle River (top) and the combined flows in Old and Middle Rivers (bottom). The combined flows in Old and Middle Rivers are plotted as daily values, 5-day moving averages, and 14-day moving averages. The data are from the Old River and Middle River gaging stations operated by USGS adjacent to Bacon Island. The data were taken from the USGS NWIS data base. The 5-day and 14-day moving averages were computed by the panel.

APPENDIX 1

Review Materials Available to the 2010 OCAP Independent Review Panel

I. The following documents were provided in electronic format as required reading by the panel prior to the 2-day workshop in Sacramento, CA on 8-9 November 2010:

- Clear Creek Technical Working Group (CCTWG) Annual Review Report
- Annual Report of Activities: Interagency Fish Passage Steering Committee
- OCAP Biological Opinion Review (DRAFT June 2009 – September 2010): Fish Actions Implemented Pursuant to the NOAA Biological Opinion on the Sacramento River
- Sacramento River Temperature Task Group
- Red Bluff Diversion Dam Technical Team 2010 Report to the Independent Review Panel
- Annual Review of American River Operations as They Relate to Implementation of the Reasonable and Prudent Alternative for the Central Valley Project and State Water Project Operations Criteria and Plan
 - ARG Attachment 1 - USFWS Draft Summary of Lower American River Fish Actions 10-7-2010
 - ARG Attachment 2-1 - Meeting Notes Jun 09-Nov 09
 - ARG Attachment 2-2 - Meeting Notes Jan 10-Sep 10
 - ARG Attachment 3 - Chapter 1 – Background
 - ARG Attachment 4 - Chapter 3 - Water Operations Summary Jun 09-Sep 10
- Annual Report of Activities (June 5, 2009 to September 30, 2010): Stanislaus Operations Group (SOG)
- Delta Operations for Salmonids and Sturgeon Group – 2010 Annual Report – October 2010
- Smelt Working Group Report to the Independent Review Panel - Water Year 2010
 - Attachment 1 - Delta Smelt Risk Assessment Matrix
 - Attachment 2 - Final Smelt Working Group Notes
 - Tools for Delta Smelt Management Workshop Summary

II. The following additional reports were made available in electronic format for supplemental use in providing historical context for the panel:

- NMFS OCAP Opinion, section 11.2.1.2, pages 583-671
- USFWS Biological Opinion on the Long-Term Operational Criteria and Plan (OCAP) for coordination of the Central Valley Project and State Water Project (pages 279-285 and 324-381)
- RPA Summary Matrix of the NMFS and USFWS OCAP Opinion RPAs
- National Academy of Science's March 19, 2010 report
- VAMP peer review report
- State Water Board's Delta Flows Recommendations Report
- Task 3: Green Sturgeon Research

III. Additional written materials provided to the panel after the 8-9 November 2010 workshop (there was no implicit or explicit obligation on the part of the panel to consider these materials in its review):

- A CD containing a cover letter from Terry Erlewine (General Manager, State Water Contractors) to Cliff Dahm (Lead Scientist, Delta Science Program) and additional materials, including **71 documents representing declarations and determinations from legal proceedings relating to the NMFS and USFWS OCAP Biological Opinions and RPAs**. The cover letter, dated 4 November 2010, requested that the current panel charge be amended to require consideration of these additional documents. The Panel Charge was not amended.
- A **133 page pdf document** forwarded to the panel by Sam Harader (Delta Science Program) **representing post hoc comments from the state's Department of Water Resources on conceptual proposals for adjustments to NMFS OCAP RPA actions** presented to the panel at the public workshop in Sacramento on 8 November 2010.

APPENDIX 2

Verbatim questions as presented in the panel charge defining the scope of this review (from Exhibit A, Attachment 1 of the Charge to the Delta Science Program Independent Review Panel for the OCAP Integrated Annual Review):

- 1) (a) How effective was the implementation of each RPA Action (in some cases a Suite of Actions) in meeting its objective (NMFS' OCAP 11.2.2, pages 587-671 and USFWS' OCAP Attachment B, pages 324-381)?

(b) How effective was the process for coordinating real-time operations with the technical teams' analyses and input as presented in the OCAP Opinions? [NMFS' OCAP Opinion (pages 582-583) and USFWS' OCAP Opinion (page 280)]?
- 2) (a) Were the scientific study designs, methods, and implementation procedures used appropriate for evaluating the effectiveness of the RPA Actions?

(b) What scientific study designs, methods, and implementation procedures might be more appropriate for evaluating the effectiveness of the RPA Actions?

(c) How could the scientific indicators used for measuring the effectiveness of the RPA Actions be improved?
- 3) How can each RPA Action be improved to more effectively meet the objective of the RPA Action (or in some cases a Suite of Actions)?