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National Oceanic and Atmospheric Administration
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MEMORANDUM FOR: ARN: 151422SWR04SA9116, (PCTS # 2008/09022)

FROM: Rhonda Reed, Section 7 Biologist, Southwest Region

REVIEWED BY: Maria Rea, Supervisor, Sacramento Area Office

SUBJECT: Documentation on the Development of the Reasonable and Prudent Alternatives (RPA) to Avoid Jeopardy to CV Steelhead in the Stanislaus River, Specifically as Relates to Flow and Temperature

I. Introduction

The overarching objectives of the RPA Actions to Avoid Jeopardy to CV Steelhead in the Stanislaus River are:

1) Maintain suitable conditions (temperature and flow) for steelhead survival year round below the East Side Division dams, to the greatest extent downstream that is used by *O.mykiss,* and create seasonally suitable conditions for adult and juvenile migration; and

2) Restore and maintain critical habitat for spawning, rearing, and passage that is adversely modified by operations and that also affects survival and reproductive success.

This technical memo primarily addresses investigations used to develop operational criteria of the East Side Division that affect Objective 1 above. The RPA actions for the Stanislaus River are based on information provided in the effects analysis of the opinion. Temperature guidance for steelhead life history stages is based on EPA (2003), and flow requirements are based on In-stream Flow Incremental Methodology (IFIM) by Aceituno (1993).

IFIM

II. Information and Rationale Used in The Process of Developing Stanislaus River Flow Schedule For Central Valley (CV) Steelhead

The Project Description (PD) of the Biological Assessment (BA) describes that under the New Melones Transitional Plan (NMTP), New Melones operations will be based, in part, on annual allocations of water to various purposes or users, based on a three tier system: High-Allocation Years, Mid-Allocation Years, and Conference Years (BA Chapter 2, pg 2-65). Based on Aceituno (1993), CV steelhead habitat requirements may be met only in High-Allocation Years. Based on the 28-year history of New Melones operations, this condition has occurred in only 40

88-92 Drought
2001-05
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percent of years. The process for allocating water in Conference Years is basically that the parties will negotiate allotments. In Mid-Allocation years, the fishery allotment is less than what is needed for CV steelhead. However, under the past IPO operations, downstream water quality objectives frequently provide flows that are beneficial to salmonid needs, and these flows have not been attributed to the fishery allotment. Consequently, it is possible that flow conditions might be suitable for steelhead habitat, but the modeling tools and operational guidance do not provide sufficient information to determine that daily and seasonal flows are within optimum parameters for CV steelhead. Further, the models tend to use a variety of "look-up tables" in place of operational rules, so a look-up table for water quality needs may allocate 10 cfs daily for the month of May; and the look-up table for fishery needs may allocate 150 cfs daily for the month, but there are no definitions or rationale for these allocation levels and no interplay among these factors that would ensure that minimum flows are provided consistently for CV steelhead. Therefore, not only are the operational criteria for New Melones releases unclear, there are no operational parameters defined that would provide beneficial flows for CV steelhead. The most common examples of the problems with this approach under the present IPO occur in January and in September. Flows are typically dropped in January when regulated water quality standards change, resulting in decreasing the wetted spawning habitat and dewatering early-spawned eggs. In September when factors other than Stanislaus River flows cause Delta water quality standards to be met, Reclamation typically drops in-stream flows which reduces habitat for rearing CV Steelhead and causes more frequent temperature exceedances for rearing temperatures. Modeled results identify the same problem periods under the NMTP).

The task at hand was to identify operational criteria that would minimize or prevent flows below optimal levels as defined by the IFIM (Aceituno 1993) and presented as follows in the Opinion:

Table 6-16. Comparison by life stage of in-stream flows which would provide maximum weighted usable area of habitat for steelhead and Chinook salmon in the Stanislaus River, between Goodwin Dam and Riverbank, California (adapted from Aceituno 1993). No value for Chinook salmon adult migration flows was reported.

Life Stage	Steelhead Flow	Steelhead Timing	Fall-Run Flow	Fall-Run Timing
Spawning	200	Dec-Feb	300	Oct 15-Dec 31
Egg incubation/fry rearing	50	Jan - Mar	150	Jan. 1-Feb 15
Juvenile rearing	150	all year	200	Feb 15-Oct 15
Adult migration	500	Oct-April	-	

It is important to note that Aceituno (1993) made no analysis of flow needs for salmonid emigration in the spring.

Several approaches to define such operational criteria were deployed in the process of developing the final Stanislaus River Flow Schedule. These included: (1) a "look-up table"; (2) a fractional unimpaired flow approach; (3) flow schedules built with fall-run in mind which were then modified to address specific steelhead life history requirements; and finally, (4) adaptation of (3) to provide sufficient flows for CV steelhead as well as preventing excessive drawdown of New Melones Reservoir.

The Look-up Table

The initial attempt at defining such operational criteria was to propose a "look-up table" that would set minimum flows by month, as a minimum operational standard to be applied to within +_ 10 percent (Draft Opinion RPA, December 11, 2008). This was combined with additional flow management actions to create an adult attraction flow in October, augmented spring emigration flows, and periodic channel forming flows of 5,000cfs on a one to three-year schedule. Although the look-up table was an attempt to state fish flow needs in a format that appeared to be familiar to Reclamation, the comments we received from Reclamation and California Department of Water Resources about this action indicated general confusion in the presentation of the table and about how the flow-related actions would interact. This response prompted an evaluation of other approaches.

1) The Fractional Unimpaired Flow Approach

This approach considered devoting a set percentage of daily unimpaired flow as the release schedule for fish needs. This approach was abandoned because it was not clear how to define what the appropriate percentage allocation should be given that this schedule would mimic the natural hydrograph with which CV steelhead evolved. However, inflow into New Melones is not unimpaired, owing to many upstream dams for hydropower and other purposes, so it was not clear that such an operational approach could be implemented. Further, if the percentage were set incorrectly, the frequency of unsuitable flow conditions could be increased. Without a substantial level of time and modeling expertise, it did not appear feasible that NMFS could develop this approach, so it was abandoned from consideration in this RPA.

2) The Modified Fall-run Flow Schedules

In January 2009 I consulted with California Department of Fish and Game (CDFG) biologists (Dean Marston, Tim Heyne) and U.S. Fish and Wildlife Service (FWS) biologists (John Wikert, Roger Guinee), requesting their recommendations. The Anadromous Fish Restoration Program (AFRP) flows were discussed as an option. I did not actively pursue them because I felt that these recommendations were heavily focused on salmon and presented a set of priorities for flow allocation that balanced steelhead needs in the context of fall-run priority needs. Additionally, my understanding is that the AFRP flow recommendations are lower than what was recommended in the Working Papers, because the flow schedules ultimately recommended they had to meet the "reasonable-ness" criterion as implied by the Central Valley Project Improvement Act. More recent modeling studies by CDFG on spring outmigration flows for salmon provide further indication that the AFRP flows may not be inadequate for some life history stages (CDFG 2008).

for Salmon!

The first flow schedule suggested by CDFG was a simple schedule, including a fall adult attraction flow and "table-shaped" spring emigration flows. These schedules would vary by water-year type, with higher flows in wetter years (Figure 1).

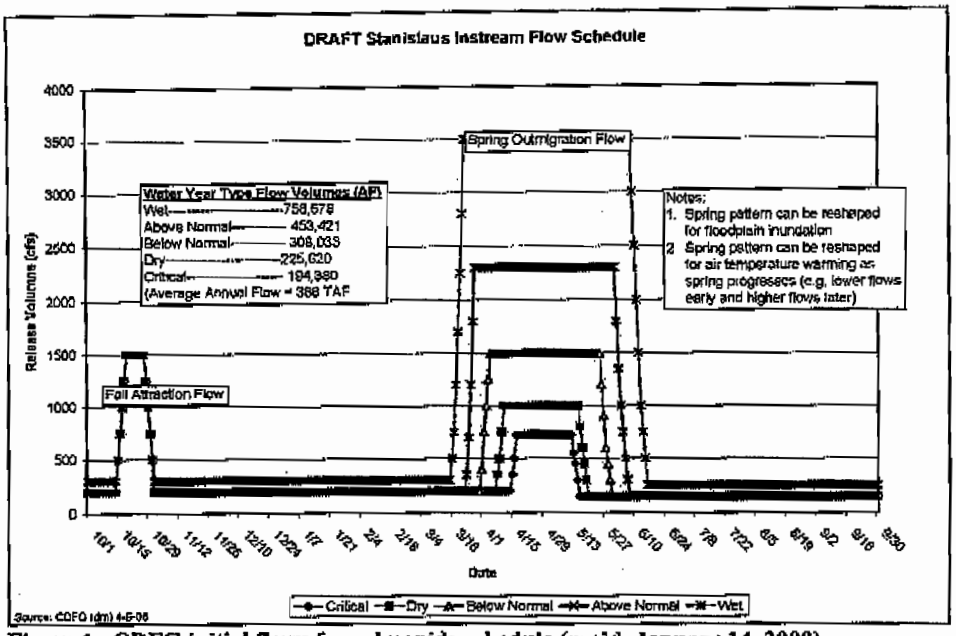

Figure 1. CDFG initial flows for salmonids schedule (rec'd. January 14, 2009)

Subsequent discussion continued by telephone among the parties about the relative needs for steelhead in such a flow schedule, compared to fall run. Topics discussed included:

- Did CV steelhead need a fall attraction pulse? (Yes, based on the fact that the counting weir detects adult CV steelhead at the same time [and not before]; that the fall attraction flows bring in adult fall-run; and based on the likely improvements of these flows on poor water quality conditions further downstream.)

- Variability in flow triggers appears to be important to promote anadromy in steelhead versus residualization.

- Variability in spring pulse flows tends to show elevated activity in out-migrants at rotary screw traps (RST).

- Do steelhead need spring pulse flows, or can they just swim out on their own? CV steelhead are captured at the RSTs before the pulse flows, so early smolts may not need a spring pulse. However, the spring pulse does improve downstream water quality conditions for smolts that are leaving later, and this may be more important than for swimming assistance.

- The unimpaired hydrograph showed elevated flows in the San Juaquin River at Vernalis, well into July in most years. So, would it be beneficial to extend the falling limb of the spring pulse to better replicate evolved conditions? Would there be added benefits to riparian tree recruitment?

- How could, or should, this schedule accommodate geomorphic flows?
- Can we get a temperature model run of the proposed flow schedule?

In response to these discussions, the March 3, 2009, version of the Draft RPA proposed the flow schedule in Figure 2.

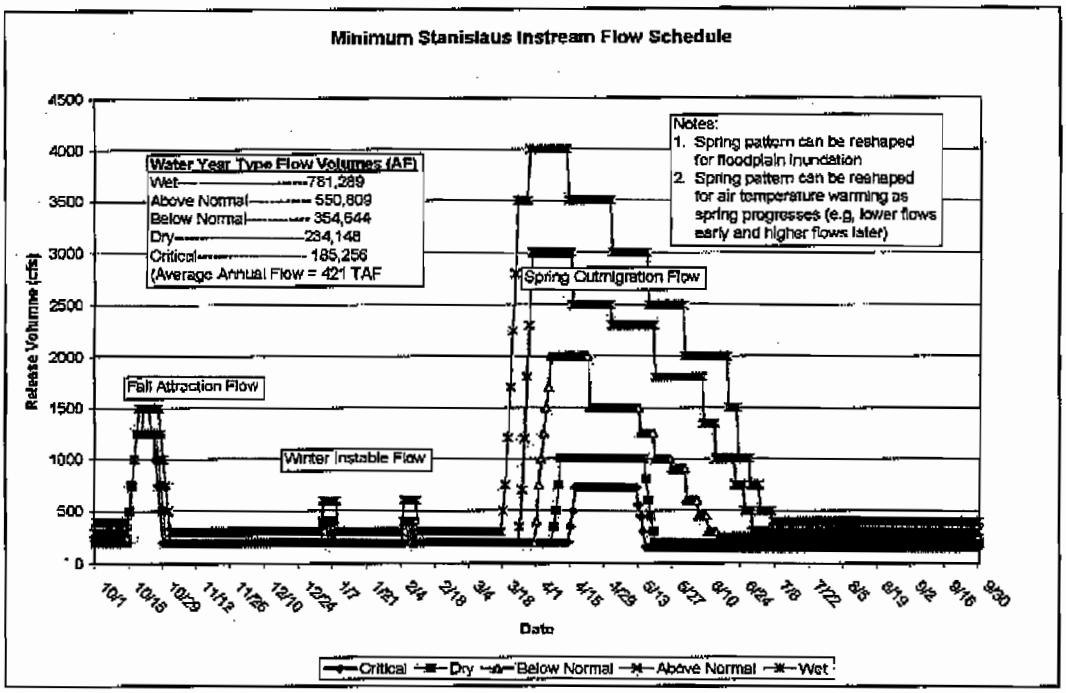

Figure 2. March 3, 2009, Draft RPA Stanislaus Minimum Flow Schedule.

The schedule was developed from: (1) the SJR salmon model (V.1.0) (output for doubling salmon and calculating the Stanislaus flow contribution (spring time); then (2) using other information (such as RST data, escapement patterns, and Aceituno [1993]) to fill in and shape the non-spring time periods. The basic approach was to take the standard salmon needs hydrograph and insert higher flows in time periods where the flow was not at least at the steelhead minimum based on the IFIM. In the dry years, we leaned toward meeting what was described in the IFIM as rainbow trout minimum flows, and in the wetter years the base is more the minimum flows recommendation for steelhead. The biggest change was in the summer where we added more minimum flow both to ensure that the IFIM need of 150 cfs is met for rearing, and, in wetter years, to provide better summer temperatures. The spring pulse flow was changed to have an extended recession limb to give smolts an extended invitation to leave. It also helps maintain a better riparian zone, particularly the large trees which germinate in spring and need a slow drop in water elevation to give their roots time to grow. Small pulse flows were inserted in the winter months to mimic unimpaired flow variability, which seems to be important in increasing the modeled frequency of anadromy in steelhead (Cramer Fish Sciences 2009).

CDFG recommended that these scenarios (especially the driest three scenarios) be run through the San Joaquin Basin temperature model to identify if there are any issues with temperature in summer and fall. This post processing of the proposed flows would likely identify a few corrections for hot spots. CDFG also expressed concern that fall pulse flows in the driest years should be considered on a real-time management basis to prevent drawing in fish only to leave them in the spawning reach at low flows during a time when the ambient air temperatures may remain high in late October and early November; causing warm water temperatures.

On March 20, 2009, NOAA's National Marine Fisheries Service (NMFS) received comments on Stanislaus flows in this March 3 Draft RPA. They asserted that the flows used too much water and that Reclamation is prohibited from releasing more than 1500 cfs in non-flood conditions.

To evaluate these comments, we were able to borrow the time and skills of Derek Hilts, Hydrologist from U.S. Fish and Wildlife Service Sacramento Office, Division of Water Operations. He initially used EcoSim to quickly evaluate the effect of the Stanislaus flow schedule on New Melones storage over time (Hilts 2009). The results indicated that the flow schedule more fully used the storage capacity of the reservoir, and it did result in lower storage levels; especially in successive drought years such as the early 1990's (Figure 3). Reclamation's analysis of likely hydrological scenarios discounts the probability of the extreme drought of the 1990's, and instead uses the dry period of 1922-34 as representative of sustained drought conditions. Nonetheless, we considered that we should develop an exception process to prevent substantially depleting the reservoir under these conditions, for both water supply and temperature management considerations. Higher flow rates in wetter years resulted in more operational dry and critically dry years, but overall flow-related habitat conditions were appreciably better for fish in approximately 66 percent of years. The NMTP would produce good flow conditions for CV steelhead in only 40 percent of years.

When evaluating the effect on salmonids of an operational strategy on the Stanislaus River, Reclamation would normally take the CalSim modeled results and conduct post processing to determine temperature effects. When we met in early March to discuss the March 3 version of the RPA with the action agencies, we requested help from Reclamation to do temperature modeling on these flows using their tools. In subsequent discussion with USFWS and CDFG, the need to perform temperature modeling on these flows was also identified, but NMFS and USFWS lacked internal expertise to perform the modeling. CDFG was unable to assist with running the San Joaquin River Basin temperature model because of funding freezes. Tetra Tech was hired by NMFS to assist with such activities under the guidance of Craig Anderson, Hydrologist, NMFS, Habitat Conservation Division, Southwest Region. Insufficient time was available for them to learn and apply the specifics of operating the model.

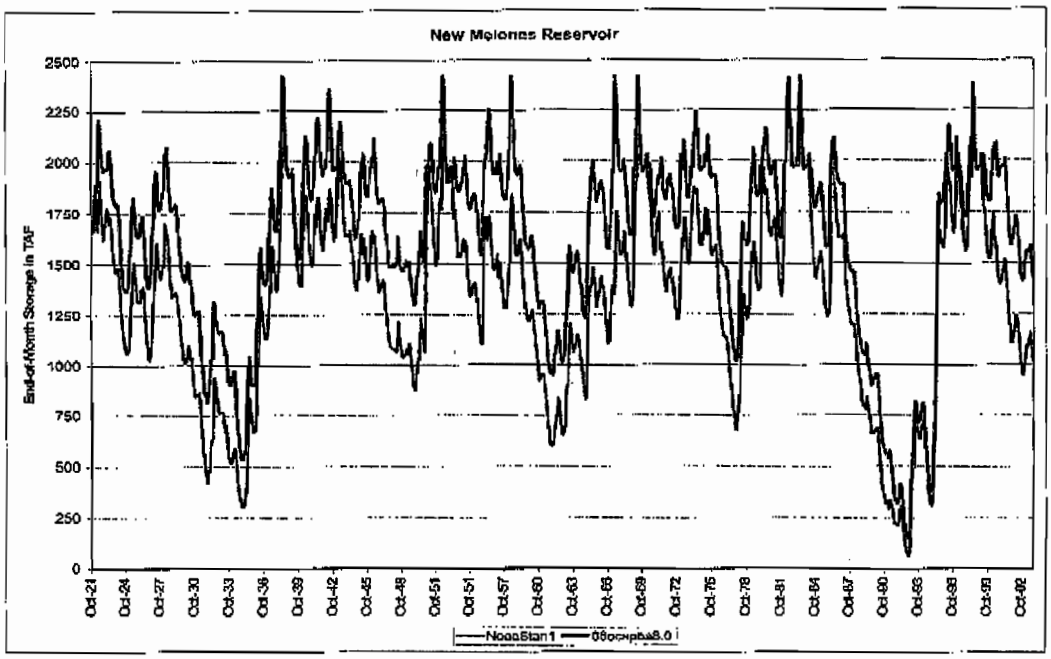

Figure 3. EcoSim evaluation comparing New Melones Reservoir storage when operated under the March 3 proposed Stanislaus River flows (Pink-NoaaStan1) and when operated under Study 8.0 (full implementation of Proposed Action) from the BA.

In an April 14 meeting with Ron Milligan, Reclamation, and others, Ron asked for something other than block allocations. I explained the Stanislaus River minimum flows graphic from the March 3 draft RPA. Issues raised were his understanding that Reclamation couldn't exceed 1500 cfs because of seepage. Roger Guince pointed out that the 1500 cfs cap related to a ruling in a judgment that applied only to the period that New Melones reservoir was filling, and no longer applies (per Jim Monroe, FWS). Kaylee Allen (Reclamation) said she was researching the issue and wasn't sure of outcome. I asked how long it takes for high flows to cause seepage problems. Ron was not definite, but implied about ten days.

Ron also asked if it were possible to move channel-forming flows into their flood management period, as those would be easier to do without the seepage issues. I agreed to look into it, and John Hannon agreed to revisit the RST data for smolts and key migration times. Derek Hilts asked if Reclamation could run their temperature model on this flow schedule, and Ron indicated he would discuss that with his modeling staff.

3) CV Steelhead Modified Pulse Flow Schedule:

In response to the comments received in the meeting with Ron Milligan and others on April 14, I looked at how to modify the peak flows to achieve migration cueing, geomorphic flows, and minimize seepage issues. I did not limit flows to 1500 cfs, but decreased the duration of the flows in excess of that level. The changes were applied in the spring, with higher peak flows scaled to water-year type, repeated thru spring to give migration cues and facilitate geomorphic processes (Figure 4).

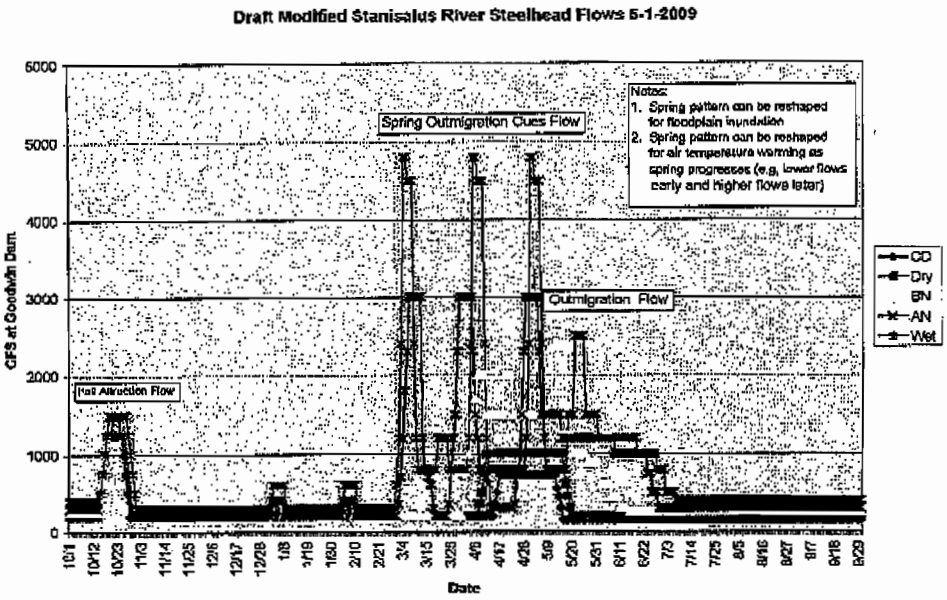

Figure 4. Modified Stanislaus flow schedule with Multiple Spring Pulses and ramp down to 800cfs. (Created May 1, 2009)

I evaluated whether it was possible to do channel-forming flows earlier, looking at John Hannon's steelhead emigration analysis (Hannon 2009). His analysis showed a median departure date of March 1, so an earlier pulse could assist earlier exiting smolts to cue their migration; but high flows in January through March risk scouring of both steelhead and fall-run redds. Hannon also included a historical presentation of monthly flows (Flow Charts Tab in Hannon 2009 spreadsheet), which showed that pre-New Melones Dam high flows would occur in February (peak ~5,000 cfs, median ~1,000 cfs), but were highest in May (peak ~8,000cfs, median ~ 2,300cfs). So, as a compromise to correlate geomorphic flows with flood releases, I proposed the first pulse in early March. This could cause some redd scouring, but it would be closer to the period when unimpaired flows would have produced similar high flows and would allow for some fry to have emerged. The EcoSim modeling (Hilts 2009a) showed less impact on New Melones storage with this schedule of multiple pulses of shorter duration, still scaled to water-year type. That said, an exception procedure should still be developed for the instances of multiple dry years as no action (even in the proposed BA PD) could seriously deplete reservoir levels.

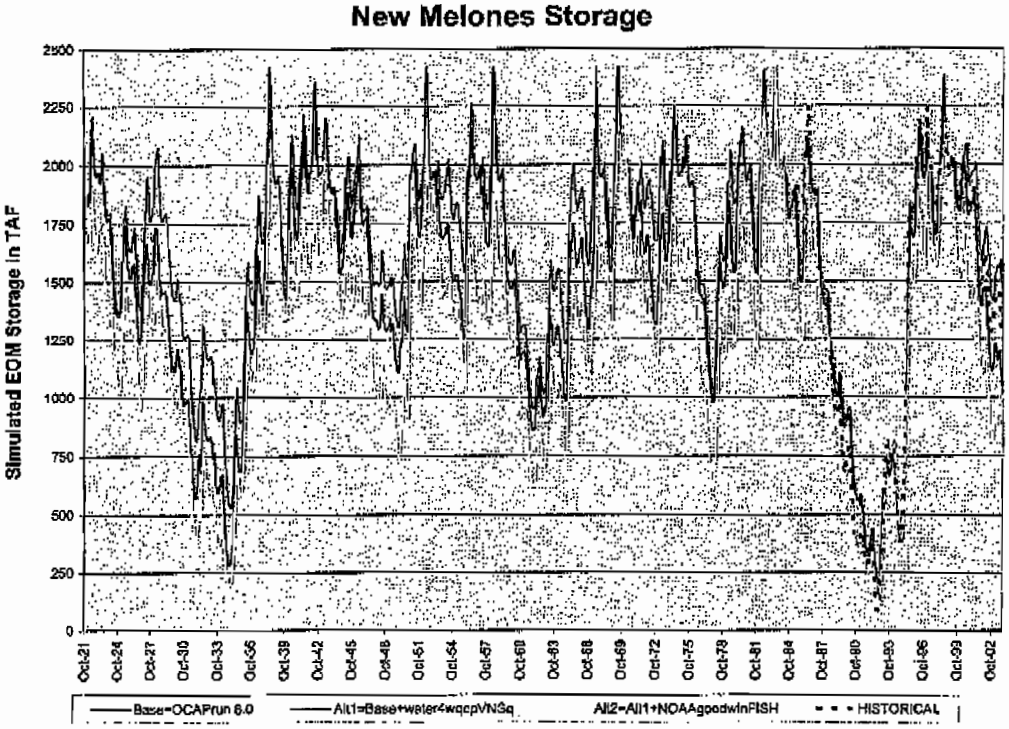

Figure 5. New Melones Storage Levels as Operated with CV Steelhead Modified Pulse Flow Schedule (Hilts 2009a)

The final flow schedule was adjusted to prevent pulse flow drops from falling below 800 cfs and prevent a known stranding problem (Roger Guinee 2009 pers comm.) and to slightly increase highest flows to 5,000 cfs in order to provide a minimum channel forming flow (Kondolf *et al.*, 2001). In practice, peak flows may get be higher in wetter years if 1999 is any indicator, but would require higher storage (Figure 6), starting the water year. These minor changes showed no ostensible difference in New Melones storage levels.

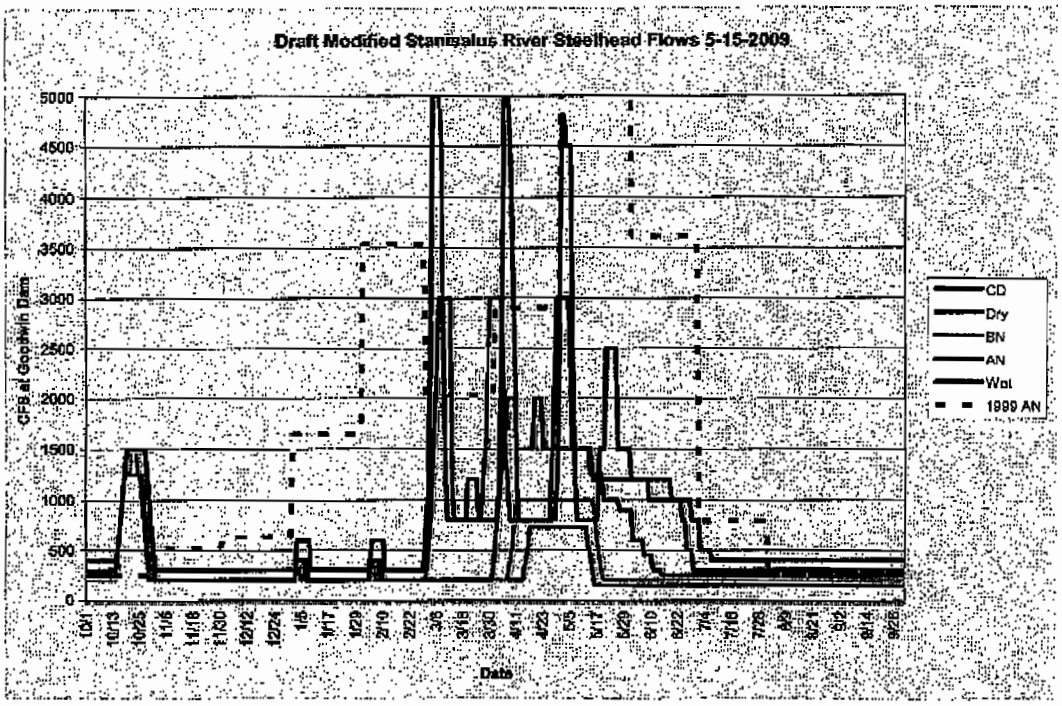

Figure 6. Final Stanislaus River Flow Schedule for RPA, With Example of Above Normal Release Pattern From 1999 (dotted line).

Upon seeing the applied release pattern from 1999, I am satisfied that the proposed minimum flow schedule provides a default minimum flow pattern that is a significant improvement for CV steelhead in all but driest of years and that can fall within the operational patterns conducted by Reclamation in recent years.

III. Interaction of San Joaquin River Inflow to Export Ratio Action and the Minimum Stanislaus River Flows Action

The Stanislaus River flow schedule for the RPA was developed from the initial perspective of providing appreciable benefits to CV steelhead as they inhabit the Stanislaus River, to avoid jeopardy from project operations. However, these flows and operations are an integral part of a larger migratory route and a larger water management system. Additional actions proposed in the RPA addressed the conditions encountered by CV steelhead further downstream in the San Joaquin River. Additional modeling was conducted to evaluate actions relating to the ratio of San Joaquin River inflow at Vernalis to export levels. For complete discussion of these analyses, see Craig Anderson's CVP/SWP operations biological opinion technical memorandum under the subject heading *Modeling Tools and Associated Analyses Utilized in Developing the San Joaquin River Inflow to Export Ratio Action and the Minimum Stanislaus River Flows Action for the 2009 NMFS OCAP BO* (Anderson 2009). This modeling was conducted in an exploratory manner; first looking at the inflow:export relationship, and ultimately uniting the analyses of

these actions in their upstream to downstream relationship. The ability to achieve inflow:export ratios was determined to be related to available storage at upstream reservoirs, including New Melones; so the action evolved to include a relationship between the New Melones Index (NMI) and in-stream flows.. While the initial development of the Stanislaus River flow schedule considered the water-year classification system from a general perspective, such as the 60-20-20 index for the San Joaquin River, the rate of depletion of New Melones Reservoir in successive years of drought suggested that some mechanism, related to storage levels, should be developed to manage operations in these exceptional conditions. The integration of the NMI into that process appears to offer a useful planning tool.

The effect of dedicating Stanislaus water to purposes at Vernalis generally reduced the NMI for any given year. This increases the likelihood that for the same inflow, a water year will fall into a drier classification. As the annual flow pattern is determined by the water-year type and the NMI is expected to be lower, this will reduce the frequency of the highest final flow regimes and increase the frequency of the lowest flow regimes. This is illustrated in Figure 6 below. When the Vernalis RPA was imposed (yellow line), modeled as a minimum flow requirement at Vernalis April 1 through May 31, the frequency of each Goodwin minimum in-stream flow allocation generally shifted to the right as compared to the condition without the Vernalis RPA (blue line). This results in more years under the lower flow conditions and fewer under the higher conditions, but the flow patterns and peak magnitudes do not change for a given year type. The lower flow (drier year) patterns provide adequate conditions for the fish comparable or better than the Study 8 conditions, and the higher flows provide an appreciable benefit for survival conditions and habitat quality.

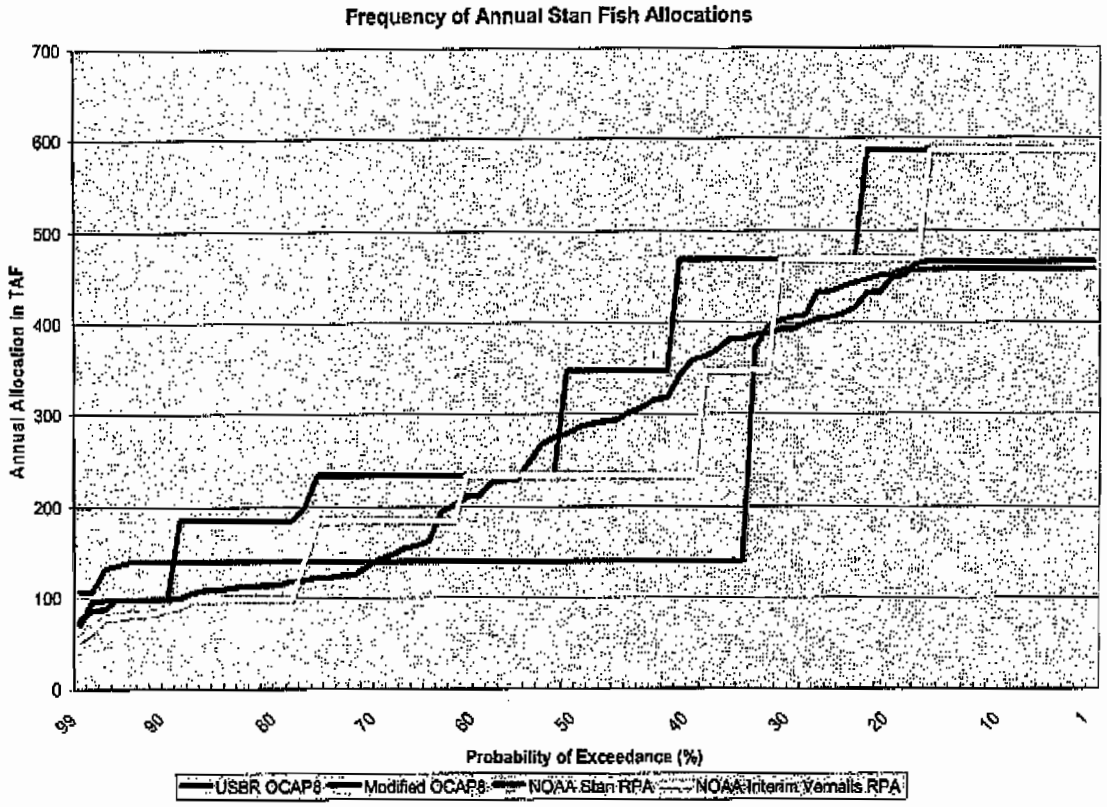

Figure 6. Probability of exceedance for simulated annual Stanislaus Fish flow allocations for OCAP study 8.0 simulation, the modified OCAP study 8.0 simulation, the minimum Stanislaus flows (Stan) RPA simulation, and the interim SJR1:export (Vernalis) RPA simulation.

IV. Temperature Modeling

Reclamation did conduct temperature modeling on the Modified Fall-run Flow Schedules presented in the March 3, 2009, draft RPA, and provided a copy of the results to NMFS on May 5 (Reclamation 2009). At that point in time, we had modified the March 3 Stanislaus flow schedule to the CV Steelhead Modified Pulse Flow Schedule. Nonetheless, the temperature analyses were informative. The results showed similar temperature exceedance problems as compared to Study 8.0 results in summer of dry and critically dry years, but the RPA action provides better flows for habitat quality and thus survivability. Given that these model runs were done on large continuous spring flow (March 3 version), I would expect that temperature evaluations for subsequent flow schedules would show no change or an improvement in temperature conditions. This expectation is based on the fact that Reclamation's temperature model didn't show much change in temperature as a result of the proposed fish-friendly flow

pattern, and that the subsequent flow schedules required less water to be delivered from storage; which would preserve a larger coldwater pool.

V. Summary

The Stanislaus Flow pattern developed through this process is intended as default minimum flow schedule to avoid jeopardy on CV steelhead. The RPA identifies that this schedule shall be implemented in consideration of maintaining appropriate temperatures for CV steelhead life history requirements as identified in the RPA. NMFS recommends that additional temperature modeling runs be conducted to fine tune the precise flow schedule, within the constraints of the RPA as written. The action is written so that the flow schedule can be modified in real-time operations management process and can be improved with new information, such as from in-stream flow habitat evaluations underway or subsequent temperature modeling. A possible mechanism for an exception procedure to prevent extreme draw-down of New Melones Reservoir in extended drought conditions was to tie the flow schedule to the New Melones Index in Anderson (2009).

VI. References Cited

Anderson, C. 2009. Modeling Tools and Associated Analyses Utilized in Developing the San Joaquin River Inflow to Export Ratio Action and the Minimum Stanislaus River Flows Action for the 2009 NMFS OCAP BO. Technical Memorandum to Administrative record AR #151422SWR04SA9116 May 29, 2009

California Department of Fish and Game. 2008. Presentation to the State Water Resources Control Board Workshop on Potential Flow Standards on the San Joaquin River for Beneficial Uses for Fish and Wildlife. September 17. www.waterboards.ca.gov

Cramer Fish Sciences. 2009. Flow and temperature effects on life history diversity of *Oncorhynchus mykiss* in the Yakima River basin. Unpublished internal report.

Hannon, J. 2009. personal e-mail communication subject: Stani Screw Trap steelhead data. Sent to R. Reed, B. Oppenheim, and J. Stuart of NMFS. April 15.

Hilts 2009. ECOSIM runs. Compare2calsimRuns_(82yrs)4R2.xls. February 12, 2009

Hilts 2009a. *Compare3runs_20090421.xls* . April 21, 2009

Reclamation 2009. Handouts summarizing results of temperature modeling of March 3 draft RPA Stanislaus River flows. Distributed at a meeting with NMFS on May 5, 2009. file StanTempRPTonRPAflowsDFT20090427.pdf

Stanislaus flow patterns spreadsheet.