SFCWA
State & Federal Contractors Water Agency
1121 L Street, Suite 802, Sacramento, CA 95814

October 1, 2010

Mr. Charlie Hoppin
Chair, State Water Resources Control Board
1001 I Street
Sacramento, CA 95814

Mr. Philip Isenberg
Chair, Delta Stewardship Council
650 Capitol Mall
Sacramento, CA 95814

RE: Critique of SWRCB Report: Development of Flow Criteria for the Sacramento San-Joaquin Delta Ecosystem

Dear Mr. Hoppin and Mr. Isenberg:

Legislative requirements provide that the Delta Stewardship Council use the subject report to inform its Delta Plan and that the Bay Delta Conservation Plan also be informed by this report. Recognizing this, SFCWA feels that the report deserved a critical review to place the use of the report in additional context, in addition to the many qualifying statements made in the report which caution the reader as to its limitations. SFCWA commissioned a panel of knowledgeable biological scientists, statisticians, water system modelers and engineers to review this report, analyzing the quality of its biological basis and reviewing potential water supply implications should its recommendations be pursued.

Attached are two analyses, Appendix A to this letter is a review of the biological support cited in the report for the flow recommendations. Appendix B is a summary of expected impacts to water supply, power generation and impacts to other public trust uses that would ensue if the flow recommendations were to be pursued. It is these types of effects which would have to be considered in a broad analysis of public trust values and whether particular flow objectives are in the public interest.

Summary of Technical Review of Flow Criteria

Technical experts in biology, statistics and ecosystem science have reviewed this report on behalf of SFCWA and make the following summary observations, with page references for Appendix A, are provided where appropriate.

1. The SWRCB made no distinction in determining best available science to support their recommendations by distinguishing between unpublished data submitted in the report's development process, peer reviewed papers and papers published in scientific journals. Unsupported statements often appear to be taken at face value.

2. Review of the scientific support for flow for various species shows that in many instances the best available science was not used and that findings in the cited studies often contradict conclusions of the report, and citations were selective or misinterpreted:

    a. American Shad - p. 1
    b. Juvenile salmonids - p. 2
    c. Use of particle tracking models - p. 7
    d. Recommendations regarding San Joaquin inflow-export ratio – p. 11-15
    e. Old and Middle River flow restrictions - p. 15
    f. Longfin Smelt - p. 18-27
    g. Delta Smelt – p. 28-30
    h. Sacramento Splittail – p. 31-33
    i. Starry Founder – p. 33
    j. California Bay Shrimp – p. 34

3. The report relies on the same scientific analysis that has been criticized by the United States District Court for the Eastern District of California, apparently containing fundamental analytical and statistical errors and/or misapplication the underlying scientific literature. The Court may rule that it was arbitrary and capricious for federal agencies to rely on these analyses.

4. Ignores the abundance of data showing exports do not influence San Joaquin Salmon Survival and incorrectly concludes the need for inflow/export ratio controls – p.10-14

Benefits Unanalyzed and Speculative

The Report in the main argues that fish abundance was better prior to reduction in flows but makes no attempt either through population dynamic modeling or other analysis to determine the likely benefit of the proposed measures. No attempt is made to quantify the benefit of the flow measures and causal mechanisms for linking flow to abundance are almost completely lacking.

No Recognition of Underlying Predation Problem

Many of the flow measures are based on the simple contention that more flows increase survival of species, specifically salmonids. What is lacking is any serious analysis of the actual underlying reasons for loss of the fish, which is not necessarily due to lack of water but rather to an unnatural system dominated by non-native predator fish. Recent data collected by the National Marine Fisheries Service on juvenile salmon survival show that in the four most recent years where salmon were fitted with radio tags that survival rates are only about 2-10% for Sacramento river juvenile salmon, which is about four times worse than other major salmon rivers such as the Colombia and Fraser Rivers. Synthesis of 22 telemetry studies on the San Joaquin River system indicate that smolt survival is but 6% on average. These data also show that the fish are not lost in either diversions on the river or at the SWP and CVP pumps, and are likely the result of excess predation. With predation being at the core of such survival rates, no amount of flow is likely to significantly improve salmon production prospects. Flows recommended in the report could mask a critical underlying problem of the current ecosystem which should be addressed directly, not through means that unnecessarily impact water supply.

Summary Water Supply Impacts Assessment Analysis

In the Draft Flow Criteria Report, an attempt was made to analyze the water supply impacts of the flow criteria proposed. This appendix was not included in the final report. On behalf of the Northern California Water Association, MBK engineers, who are specialists in modeling water supply operations of California water systems, analyzed supply impacts on Sacramento Valley users and CVP/SWP exports. A summary of this analysis is provided and their report previously provided by NCWA is attached as appendix B and summarized as follows.

Gross Supply Impacts are Catastrophic

The additional Delta outflow required in the SWRCB report would require a statewide reduction in consumptive use of water of about 5.5 million acre feet, which amounts to a 69% reduction in use of water from the Delta watershed. Using an average replacement cost of supply based on current costs of recycled water projects in urban areas and the least expensive seawater desalination projects, of about $1,100 per acre-foot, the annual added cost of replacement supply is over $6 billion annually. While replacing the first few hundred thousand acre-feet would likely come at unit costs lower than that, beyond a million acre-feet costs would escalate far beyond $1,100/AF and thus this estimate is considered very conservative.

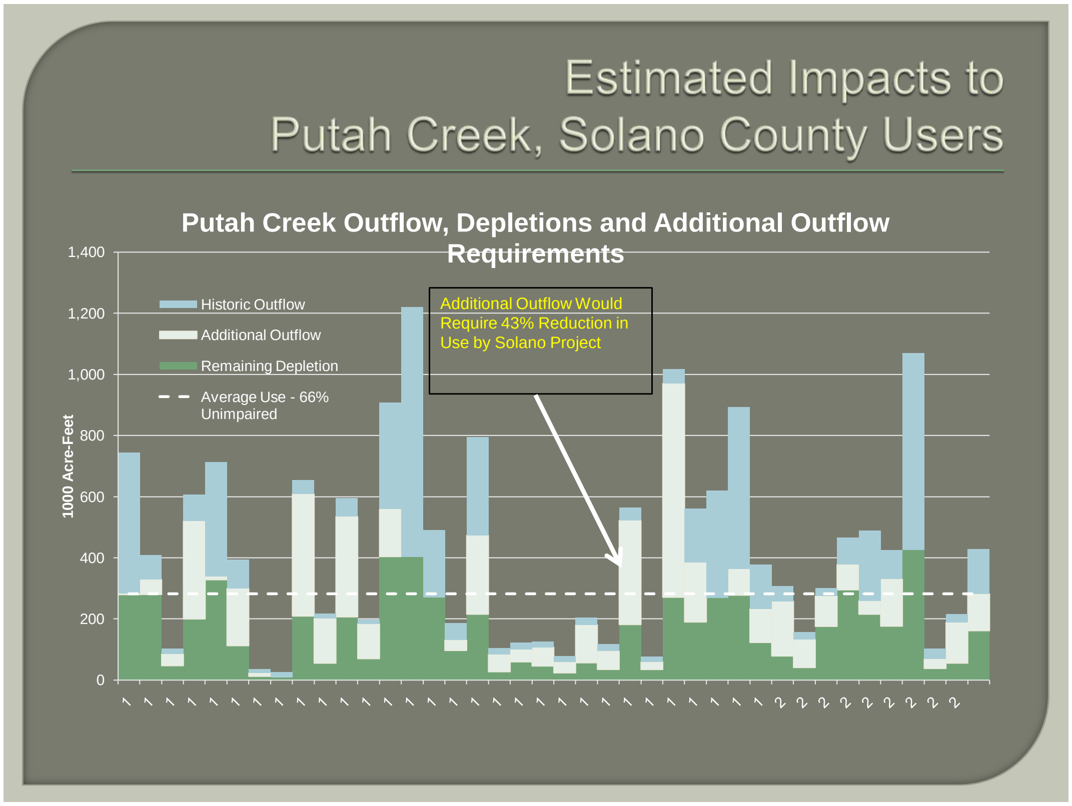
Examples of Individual Watershed Impacts

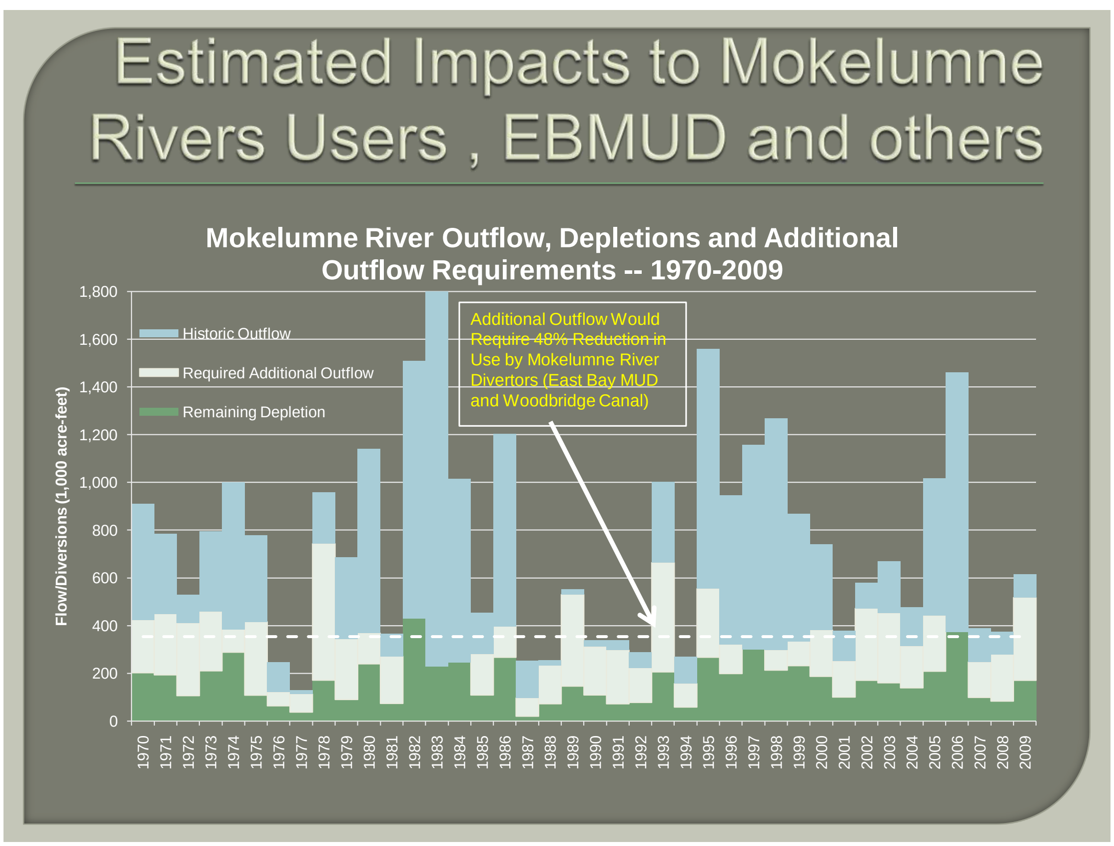
SFCWA has analyzed the impacts of the flow proposals on two isolated watershed systems in accordance with the Report's recommendation that "Flow should generally be provided from the tributaries in proportion to their contribution to unimpaired flow." Impacts to the Putah Creek watershed which serves Solano County and the Mokelumne River, which primarily serves East Bay Municipal Water District serving much of the east San Francisco Bay Region would see a 43 to 48% reduction in water available to those regions as shown below.

The SWRCB Initial Water Impact Analysis Underestimates Impacts

The withdrawn analysis of water supply impacts likely underestimates actual impacts for the following reasons:

- The models relied on unrealistically increasing Trinity River diversions into the Sacramento River Watershed.
- In an attempt to minimize impacts on cold water pools in reservoirs necessary for salmon spawning, excess cutbacks were allocated to Sacramento Settlement Contractors, resulting in understated supply cuts to CVP and SWP export contractors.
- The model runs overstated San Joaquin River flows beyond proposals in the report, resulting in a lessening of the impacts on South of Delta exports and North of Delta reservoir releases.


Estimated Impacts to
Putah Creek, Solano County Users
Putah Creek Outflow, Depletions and Additional Outflow Requirements
Historic Outflow
Additional Outflow
Remaining Depletion
Average Use - 66% Unimpaired
Additional Outflow Would Require 43% Reduction in Use by Solano Project
1000 Acre-Feet
1,400
1,200
1,000
800
600
400
200
0


Estimated Impacts to Mokelumne Rivers Users , EBMUD and others
Mokelumne River Outflow, Depletions and Additional Outflow Requirements -- 1970-2009
Historic Outflow
Required Additional Outflow
Remaining Depletion
Additional Outflow Would Require 48% Reduction in Use by Mokelumne River Divertors (East Bay MUD and Woodbridge Canal)
Flow/Diversions (1,000 acre-feet)
1,800
1,600
1,400
1,200
1,000
800
600
400
200
0
1970
1971
1972
1973
1974
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No analysis of groundwater impacts was made. Less surface water use will result in less groundwater percolation and loss of surface supplies will increase pressure on groundwater. Lowered groundwater levels will have negative impacts on streamflow.

- No impacts to loss of hydropower were made. Increases in stream flow recommended in spring months would most often require bypass of powerplant turbines. Increased frequency of storage pools below hydropower release points would result in further loss of production. Loss of storage to produce both summertime peak power and Valley water deliveries would likely put the electrical grid of California at significant risk of peak power shortages. While no quantitative analysis has been made, operators consulted believe replacement costs will amount well into hundreds of millions annually and could destabilize California's electrical grid. Replacement electrical supply would also be at much higher marginal costs and present greenhouse gas issues. SFCWA and others plan to develop analytical tools to address these issues.

Impacts to other Public Trust Resources

The Report's flow recommendations would create unmanageable impacts to preservation of cold water pools necessary for salmon spawning below reservoirs. For example, loss of storage in Shasta reservoir would cause cold water pool level reserves mandated in federal Biological Opinions to be violated in about three of every four years. These impacts are also underestimated as the report does not assess the impacts of lower summer releases on temperatures necessary to maintain salmon in the Sacramento River below the dam (see figures 4 and 5 of Appendix B).

As recognized by the SWRCB, no analysis is made to public trust resource impacts of upstream fisheries within reservoirs, or recreational and attendant economic impacts of loss of storage and total effective loss of reservoir values by frequent drawdowns to dead storage.

<u>Flow Criteria Impact Underscores the Need for a Comprehensive Approach</u>

The SWRCB has acknowledged many of the limitations of its Flow Criteria report. These limitations and the impracticality of implementing the recommendations due to clearly unacceptable impacts underscore the need for a comprehensive approach that achieves the coequal goals of water supply reliability and Delta ecosystem health. To afford the needed improvements to habitat, investments in alternative water supplies, reduction in wastewater effluent pollution, suppression of non-native predators, modification of Delta conveyance and increasing storage opportunities for both water supply and environmental flows, California's economy will need to recover and thrive. Ensuring a flow regime that works with other investments in ecosystem restoration and water supply reliability is imperative in assuring such recovery.

Sincerely,

Byron M. Buck
Executive Director

Appendix A to State and Federal Contractors letter of October 1, 2010 to Charlie Hoppin, SRCWB and Philip Isenberg, Delta Stewardship Council

Technical Review of FINAL SWRCB Flow Criteria

Compiled by Brad Cavallo (MS, UC Davis), Terry Erlewine P.E. (MS, CSU Fresno), Dr. William J. Miller (PhD, UC Berkeley), Lloyd Fryer (BS, California State University Bakersfield), David Fullerton (MS, UC Berkeley), Mike Aceituno (MS, California State University Sacramento)

American shad (*Alosa sapidissima*)

The SWRCB's FINAL report, "Development of Flow Criteria for the Sacramento-San Joaquin Delta Ecosystem (August 3, 2010) asserts that "*American shad exhibit a weak but significant relationship to X2*" (SWRCB at 64) before equating specific flow volumes with X2 positions (SWRCB at 64-65), noting that X2 is a "*surrogate for tributary and mainstem river inflows to the Delta that support egg and larval survival*" (SWRCB at 64). To support the assertion of an X2-abundance relationship for American shad, the FINAL report cites Kimmerer (2002) and Kimmerer *et al.* (2009). Stevens and Miller (1983) is also indirectly cited to argue for an increase in habitat as a possible causal mechanism for the X2-abundance relationship. Yet it is acknowledged that no causal relationship for an X2-abundance relationship is known. In the case of American shad, high outflow in one year is associated with an increased FMWT Index in that year, but high flow in one year is also associated with reduced FMWT Index in succeeding years. The net effect is essentially zero as the two relationships are basically mirror images and thus cancel each other out. Therefore, flow criteria for American shad are not supported by the best available science.

Chinook salmon

The current population of winter-run spawns only on the Sacramento River between Keswick Dam and the Red Bluff Diversion Dam. Winter-run probably did not spawn in this area historically because they were adapted to spawn in the clear, spring-fed streams flowing through the porous volcanic formations around Mt. Shasta and Mt. Lassen (Moyle 2002). Because Shasta Dam now blocks their migration to historical spawning areas upstream, winter-run persist in the Sacramento River today only because of cold water releases from Shasta Dam during the summer months. Flow criteria to benefit downstream species would diminish the cold water pool.

Although winter-run escapements in 2007 and 2008 were less than 3,000 fish, there was a slight rebound in 2009 when winter-run escapement was estimated at 4,483 adults.

Fall-run escapement data for 2009 are available (at least as preliminary numbers) and should be used on page 51 of the FINAL report in addition to the 2007-08 data. Preliminary estimates of fall-run escapement in 2009 are 39,500 adults (PFMC Preseason Rpt. Feb. 2010). The decline observed in 2007 and 2008, as found by the National Marine Fisheries Service, was determined to be primarily the result of poor ocean conditions because other conditions affecting these broods in freshwater were not unusual (Lindley *et al*. 2009). Unfortunately, this trend appears to be continuing. As a result, severe salmon harvest restrictions (ocean commercial and sport and freshwater sport) continue to be applied by the Pacific Fishery Management Council.

The population abundance goal should add that the Pacific Fishery Management Council has established a Sacramento River fall Chinook escapement goal of 122,000 to 180,000 natural and hatchery spawners in order to maintain commercial and sport fisheries. Escapement goals for winter-run and spring-run are maintained at the ESA standard (determined by NMFS in a separate biological opinion for commercial salmon harvest).

Incorrect temperature criteria cited for juvenile salmonids

In describing life history characteristics for salmonids, the FINAL report states, "*Optimal water temperatures for the growth of juvenile Chinook salmon in the Delta are between 54°F to 57°F (Brett 1952).*" (p.50) This statement is incorrect for two reasons. First, contrary to the clear implication, Brett (1952) provides no specific assessment of optimal temperatures of juvenile Chinook in the Sacramento-San Joaquin Delta. Second, more recent studies, including those specifically addressing Central Valley salmonids, show that Chinook juveniles can achieve optimal growth at temperatures as warm as 65°F (see synthesis provided by Marine 1997; Zedonis and Newcomb 1997; Clark and Shelbourn 1995), while steelhead can achieve optimal growth at temperatures as warm as 68°F (Cech and Myrick 1999; EPA 2001). The available data do not support the temperature criteria cited in the FINAL report.

Unsupported (and likely incorrect) assertion that high Sacramento River inflows are needed to prevent "reverse flows" harmful to juvenile salmonids

In describing Sacramento River inflows needed for juvenile salmonids, the FINAL report (p. 54) states: *"Recent studies and modeling efforts have found that increasing Sacramento River flow such that tidal reversal does not occur in the vicinity of Georgiana Slough and at the Cross Channel Gates would lessen the proportion of fish diverted into channels off the mainstem Sacramento River (Perry et al. 2008, 2009). Thus, closing the Delta Cross Channel and increasing the flow on the Sacramento River to levels where there is no upstream flow from the Sacramento River entering Georgiana Slough on the flood tide during the juvenile salmon migration period (November to June) will likely reduce the number of fish that enter the interior Delta and improve survival. (DOI 1 at 24). To achieve no bidirectional flow in the mainstem Sacramento River near Georgiana Slough, flow levels of 13,000 (personal communication Del Rosario) to 17,000 cfs at Freeport are needed (DOI 1 at 24)."* This claim is problematic in three areas. First, the cited studies (Perry *et al*. 2008, 2009) do not support or even address the claim that increasing Sacrament River flows reduce tidal reversals in the stated areas. Rather, Perry *et al*. (2008, 2009) describes behavior and survival of acoustically tagged juvenile salmonids. Nowhere do these papers evaluate or describe Sacramento River flows necessary to prevent "tidal reversal." Second, the other source for this claim of Sacramento River inflows necessary to prevent tidal reversals at the DCC and Georgiana Slough is a personal communication with Del Rosario and DOI 1 at 24. However, DOI does not provide any data or citation to support this claim, rather it only repeats citations to Perry *et al*. and to the same personal communication with Del Rosario. Third, in contrast to the faulty (or absent) citations provided in the report, detailed hydrodynamic data and modeling tools are available to assess the occurrence of tidal reversal and to assess flows necessary (if any) to prevent such events. The DSM2-Hydro simulation model is one such example. Though a thorough hydrodynamic model-based simulation evaluation is beyond the scope of this review, a cursory analysis illustrates that reverse flows do not occur in Georgiana Slough for Sacramento River flows at least as low as 10,312 cfs (Figure 1). Though tides do cause flows to wax and wane, flows in Georgiana Slough never go negative or reverse within the range of Sacramento River inflows considered by Kimmerer and Nobriga (2008).

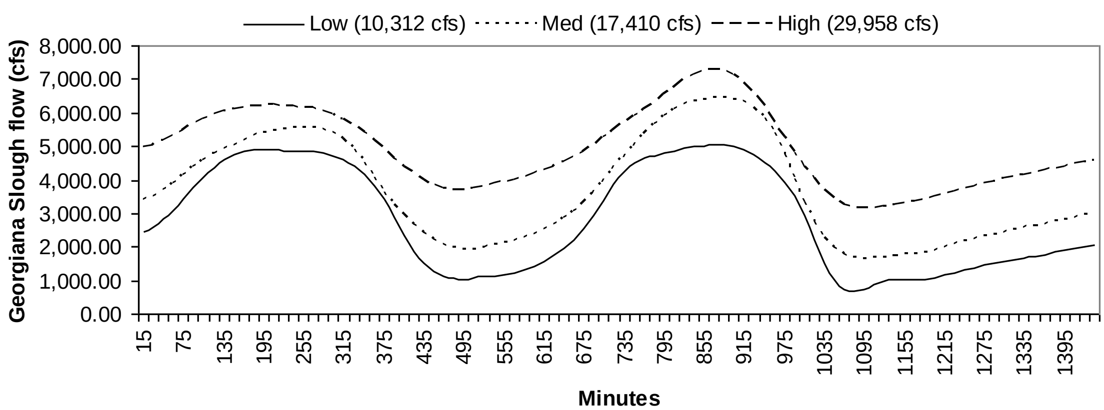


Figure 1. Sacramento River flow effect on tidal flux. Flows predicted by DSM2 Hydro (15 minute increments) for Georgiana Slough at three different levels of Sacramento River inflows (Low, Medium, High) with the Delta Cross Channel closed. Based on DSM2 Hydro data from Kimmerer and Nobriga (2008). See Kimmerer and Nobriga (2008) for a description of assumptions for physical modeling.

DSM2-Hydro simulations do indicate that Sacramento River flows influence the proportion of Sacramento River water entering Georgiana Slough (Figure 2), but the effect is rather subtle and does not approach the dramatic flow reversals cited in the report. As discussed by Kimmerer and Nobriga (2008), closure of the Delta Cross Channel gates also has a dramatic influence on flows into Georgiana Slough. Closing the DCC gates increases flows into Georgiana by as much as 32% and thus acts to reduce benefits which might be achieved by increasing Sacramento River flows.

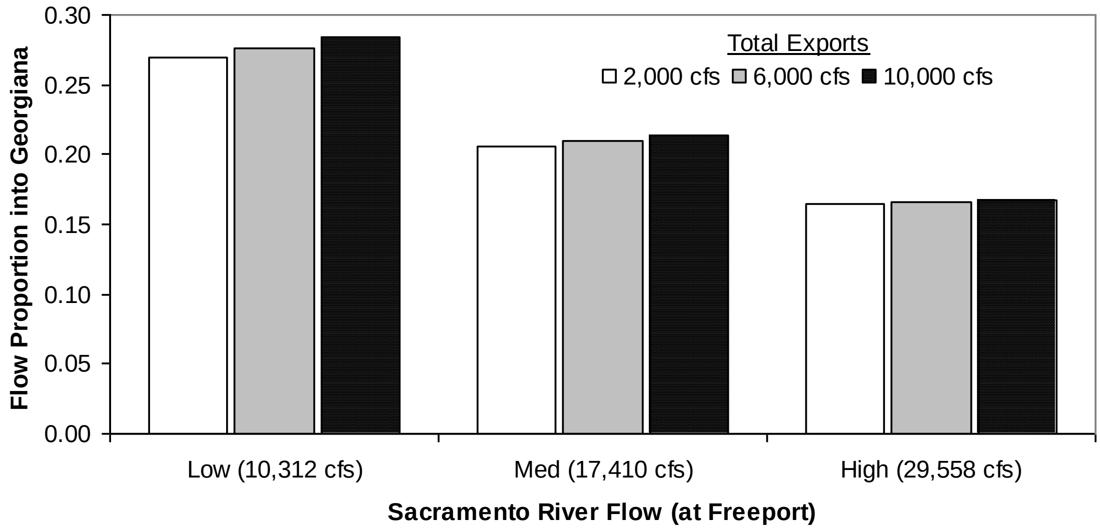


Figure 2. Proportion of Sacramento River entering Georgiana Slough as a function of Sacramento River inflows and exports. Based on DSM2-Hydro data from Kimmerer and Nobriga (2008). See Kimmerer and Nobriga (2008) for a description of assumptions for physical modeling.

In describing its final flow recommendations, the FINAL report concludes, "*information indicates that flows of 13,000 cfs to 17,000 cfs may be needed on the Sacramento River at Freeport to prevent salmon from migrating through Georgiana Slough and the interior Delta where survival is substantially lower*" (p. 115). However, Figures 1 and 2 above show that Sacramento River flows cannot "prevent" salmonids from entering Georgiana Slough.

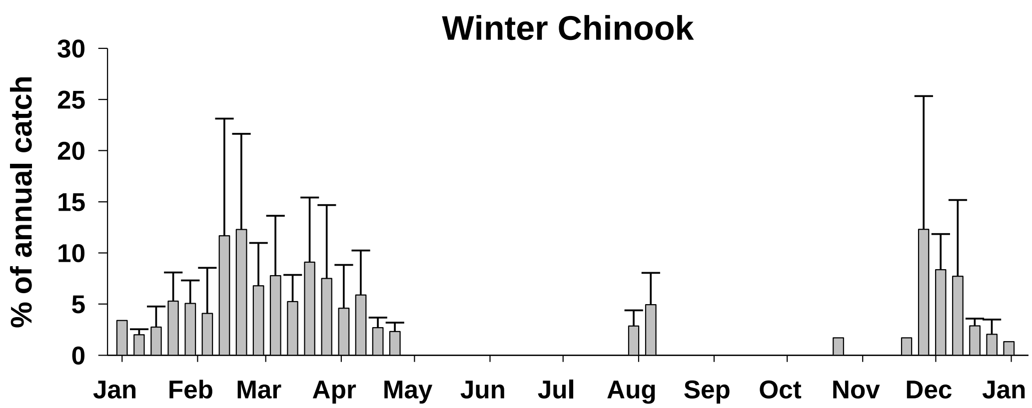
The "reversal" event referred to in the report and related citations are not reverse flows such as occur in Old and Middle River as a result of exports. Rather, it is likely a transitory event occurring on some flood tides when the Sacramento River stage gets ahead of river stage on Georgiana Slough. The result is that flows into Georgiana Slough will be higher until the tidal stage equalizes. However, this event is not a reverse flow in the sense used elsewhere in the report. The duration and biological significance of the flood tide stage balancing at Georgiana Slough is uncertain. Given this uncertainty, flood tide stage balancing should be the subject of detailed hydrodynamic and biological assessment, not personal communications and unpublished papers, if it is to be used as a justification for increasing Sacramento River flows. Operations of the DCC should also be considered as part of any assessment for factors influencing flows and entrainment risk at Georgiana Slough.

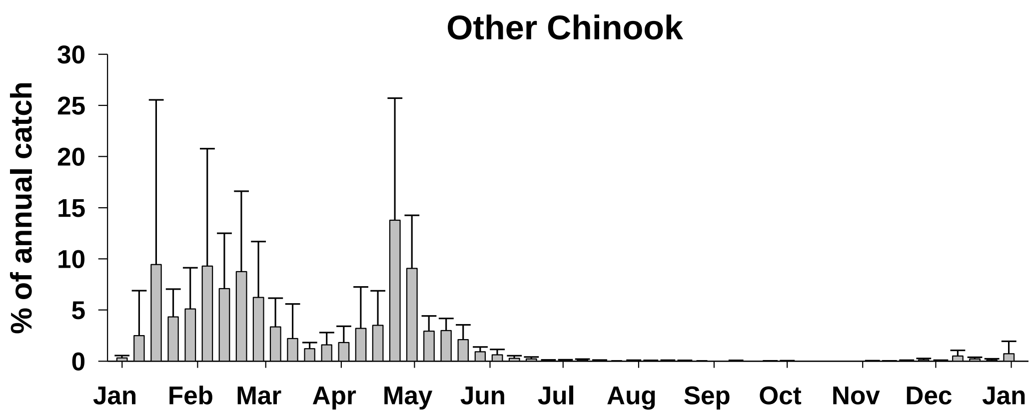
Based on the above, the flow recommendations in the FINAL report are not supported by the best available science.

Selective use of rotary screw trap data unadjusted for trap-efficiency to support high Sacramento River flows in the fall

In describing fall Sacramento River inflows needed for juvenile salmonids, the FINAL report states (p. 54-55): "*Monitoring of emigration of juvenile Chinook salmon on the lower Sacramento River near Knights Landing also indicates a relationship between timing and magnitude of flow in the Sacramento River and the migration timing and survival of Chinook salmon approaching the Delta from the upper Sacramento River basin (Snider and Titus 1998, 2000a, 2000b, 2000c, and subsequent FINAL DRAFT reports and data as cited in DFG 1 at 7). The emigration timing of juvenile late-fall, winter-run, and spring-run Chinook salmon from the upper Sacramento River basin depends on increases in river flow through the lower Sacramento River in fall, with significant precipitation in the basin by November to sustain downstream migration of juvenile Chinook salmon approaching the Delta (Titus 2004 as cited in DFG 1 at 7). Sacramento River flows at Wilkins Slough of 15,000 to 20,000 cfs following major precipitation events are associated with increased emigration (DFG 1 at 7 and NMFS 7 at 2-4). Delays in precipitation producing flows result in delayed emigration which may result in increased susceptibility to in-river mortality from predation and poor water quality conditions (DFG 1 at 7). Allen and Titus (2004) suggest that the longer the delay in migration, the lower the survival of juvenile salmon to the Delta (as cited in DFG 1 at 7). DFG indicates that juvenile Chinook salmon appear to need increases in Sacramento River flow that correspond to flows in excess of 20,000 cfs at Wilkins Slough by November with similar peaks continuing past the first of the year (DFG 1 at 7).*" This analysis and rationale for fall Sacramento River flows in excess of 15,000 cfs is flawed in two significant ways. First, the data and reports cited here are based upon DFG's operation of rotary screw traps (RST) at Knights Landing. The ability of RSTs to capture outmigrating juvenile salmonids is itself highly sensitive to factors like river flow, turbidity, and fish size (see Montgomery *et al*. 2007). It is inappropriate to report and analyze raw RST catch data as indicative of survival or abundance without specifically accounting for the efficiency of the RST. Unfortunately, DFG does not conduct such trap-efficiency experiments for Knights Landing RSTs, nor do they generate estimates of juvenile salmonid passage which account for factors like river flow, turbidity and fish size. Thus, raw catch at Knights Landing cannot appropriately be used to draw the conclusions indicated in the FINAL report.

Second, analyzing catch from Sacramento River trawls (at Sherwood Harbor) conducted by the USFWS provides another information source. Trawl data is particularly valuable because it is thought to be less subject than RSTs to very low and variable capture efficiency. Figure 3 depicts Sacramento Trawl catch from 1995-2001 (based upon publicly available data from the BDAT website). This data shows, for example, that Jan-Apr winter-run Chinook outmigrants are consistently detected in the Sacramento Trawl. Low catch in the Knights Landing RST during this period was presented (in the FINAL report) as evidence of poor survival or delayed outmigration of juvenile salmonids due to low flow conditions. The more reliable catch data from the Sacramento River trawl illustrates that poor and unknown trap efficiency is a more cogent explanation for observed patterns of juvenile salmonid catch at the Knights Landing RSTs. It is not clear why the report or background materials provided to the SWRCB by resource agencies did not properly evaluate available data on Sacramento River juvenile salmonid emigrants. However, it is clear that the analysis and rationale based upon Knights Landing RST catch to support high fall Sacramento River flows is significantly flawed and are scientifically insufficient to support higher Sacramento River flows in the fall.





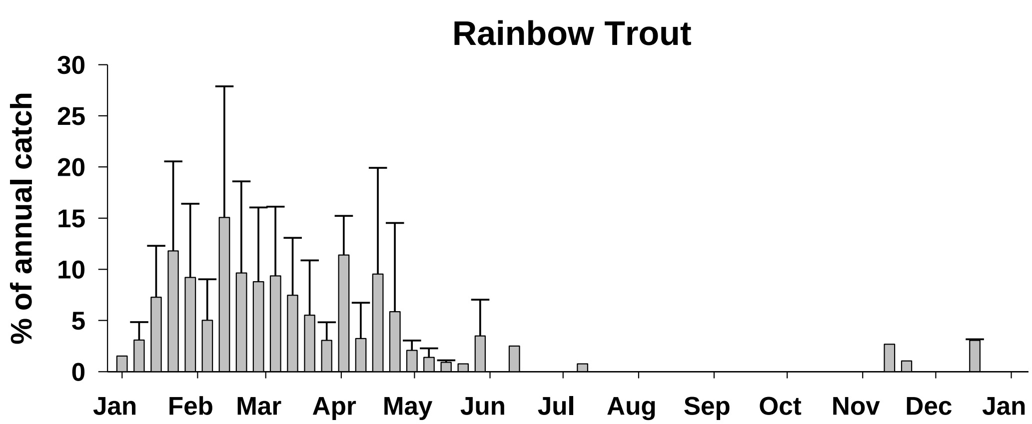


Figure 3. Average percentage of the annual catch taken each week for the specified race of juvenile salmonids in the trawl fished at Sacramento by USFWS, 1995-2001. Whisker lines are standard deviations.

Misuse of Vogel (2004)

The FINAL report (p. 60) supports its view that project exports adversely affect salmonid survival by reference to a 2004 radio telemetry study conducted by David A. Vogel on San Joaquin River salmonids. Referring to this study, the report states: "*Analyses indicate that tagged fish may be more likely to choose to migrate south toward the export facilities during periods of elevated diversions than when exports were reduced."* This interpretation conflicts directly with Vogel (2004), which concluded*:* *"**These experiments could not explain why some fish moved off the mainstem San Joaquin River into south Delta channels.** Due to the wide variation in hydrologic conditions during the two central Delta studies, it was difficult to determine the principal factors affecting fish migration. Based on limited data from these studies, it may be that a combination of a neap tide, reduced exports, and increased San Joaquin River flows is beneficial for outmigrating smolts, but more research is necessary." (emphasis added)* This is a non-trivial error as no other studies support the hypothesized effect of increased exports, where migratory juvenile salmonids are drawn away from the mainstem San Joaquin River. The misuse of Vogel (2004) in the NFMS BiOp was noted by Judge Oliver Wanger (OCAP BiOp Preliminary Injunction Findings of Fact and Conclusions of Law, Doc 346 at 122-123) as not rational or scientifically justified and hence should not be used to support specific flow recommendations.

Reliance on particle tracking model (PTM) results to assess effect of exports on migratory juvenile salmonids.

The SWRCB report (p. 60) relies directly on PTM results and interpretations from the NMFS BiOp regarding the effect of exports on juvenile salmonids. Arguments regarding NMFS' use of the PTM have to-date been dismissed as "*a dispute among scientists*" (OCAP BiOp Preliminary Injunction Findings of Fact and Conclusions of Law, Doc 346 at 51). However, a review of the best available science shows the dispute over the use of PTM is not a dispute among scientists, but instead is a dispute between NMFS' unsupported findings and virtually all of the evidence in the administrative record. This record indicates that PTM is not a valid surrogate for movement of juvenile salmonids which are volitional and can swim at rates at least twice the level of currents in the Delta.

a. NMFS' Failure to Address the PTM Limitations Described by Kimmerer and Nobriga (2008)

In support of their Reasonable and Prudent Alternative (RPA), NMFS expressly relies upon the PTM results as described by Kimmerer and Nobriga (2008). The BiOp states: *"NMFS considers this information useful in analyzing the potential 'zone of effects' for entraining emigrating juvenile and smolting salmonids"* (BiOp at 361). A key failure of the NMFS BiOp is its failure to recognize and address the model's limitations as described by Kimmerer and Nobriga (2008).

First, Kimmerer and Nobriga (2008) state that PTM "*was a useful predictor of entrainment probability if the model were allowed to run long enough to resolve particles' ultimate fate*" and "model *accuracy varies depending on the length of the simulation.*" However, NMFS did not modulate or otherwise condition its use of the PTM results to reflect "the length of the simulation." NMFS appears to have simply disregarded Kimmerer and Nobriga's words of caution.

Second, Kimmerer and Nobriga (2008) note that the PTM model "*has not been calibrated.*" Calibration allows for the testing of model outcomes against the full array of evidence in the real world. Kimmerer and Nobriga further warn that "*comparisons with field data described above do not constitute a sufficient calibration*." However, contrary to Kimmerer and Nobriga's warnings, NMFS' PTM technical memorandum asserts that *"[t]he model has been calibrated with data from monitoring stations throughout the Delta*." NMFS does not explain how it has transformed a non-calibrated PTM model into a calibrated PTM model that is consistent with Kimmerer and Nobriga (2008).

Third, NMFS' use of PTM does not apply a simulation period that corresponds to anticipated fish behavior. NMFS' principal objective in using the PTM results of Kimmerer and Nobriga (2008) was to gain insights on the fate of particles at five junctions on the mainstem of the San Joaquin River in response to exports and flows. Given the rapid and directed movements of salmonid smolts, it is inappropriate to use the fate of particles integrated over weeks or months to even roughly assess salmonid smolt survival; they simply do not act like weightless, behaviorless particles. However, Kimmerer and Nobriga (2008) state that the PTM could be a "*useful predictor of entrainment probability if the model were allowed to run long enough to resolve particles' ultimate fate*." The analysis set forth in NMFS' PTM memorandum does not resolve this conflict between Kimmerer and Nobriga's concerns and the BiOp's application of the PTM to salmon behavior. Though several figures in the PTM memorandum depict the fate of particles at five day increments, the only instance where the memorandum specifically mentions PTM results over a short time horizon occurs on page 3 of the memorandum, where NMFS reports that "*the typical pattern following injection at station 912 was a period of several days with little or no entrainment*." Thus, in the one instance where a time horizon of only several days was discussed, which is more typical of outmigrating smolts, the results indicated no material entrainment effect.

Finally, NMFS' underlying premise for using PTM conflicts with the recommendations of Kimmerer and Nobriga (2008). As noted above, NMFS invoked the PTM and the Kimmerer and Nobriga (2008) study because it "*considers this information useful in analyzing the potential 'zone of effects' for entraining emigrating juvenile and smolting salmonids.*" However, Kimmerer and Nobriga expressly stated that *"[w]e are, furthermore, not inclined to define a 'zone of influence' of the pumps on the basis of our results.*" Thus, NMFS chose to use the PTM precisely for the role that Kimmerer and Nobriga declined to recommend it for. The SWRCB should not make a similar mistake.

b. NMFS did not address evidence in the record that was critical of the use of the PTM to explain salmon behavior

SFCWA is not aware of any studies which support PTM as an appropriate tool for assessing salmonid migration behavior, yet there are at least two scientific studies that strongly suggest that PTM is an inappropriate vehicle to assess outmigrating salmon behavior. First, Baker and Morhardt (2001) compared the transit time and migration patterns of released coded wire tagged salmon and simulated neutrally-buoyant particles. Baker and Morhardt conclude that salmon smolt passage through the Delta "*is considerably shorter than the transit time for neutrally-buoyant tracer particles, at least in hydraulic simulations*." According to the authors, "*Figure 5* (reproduced below) *shows an example comparing the speed of smolt passage and the speed of tracer particles for a release made on April 4, 1987, in which 80% of the smolts were estimated to have been recovered after two weeks, but only 0.55% of the tracer particles were recovered after two months*." Comparing smolt migration and particle distribution patterns, Baker and Morhardt (2001) remarked that *"[n]ot only do the tracer particles which reach Chipps Island take a long time to get there, but most of them go somewhere else*." Baker and Morhardt (2001) reported: "*That somewhere else is the CVP and SWP pumps, at least for the hydraulic simulations available to us. Figure 6 shows that for the April 27, 1987 simulations, 77% of the tracer particles ended up at the export pumps, while only 13% of the smolts arrived there*." The authors characterize these differences as "*striking*" and explain that the results are due to the fact that "*smolts actively swim toward the ocean, and the bigger they are the faster they do it."*

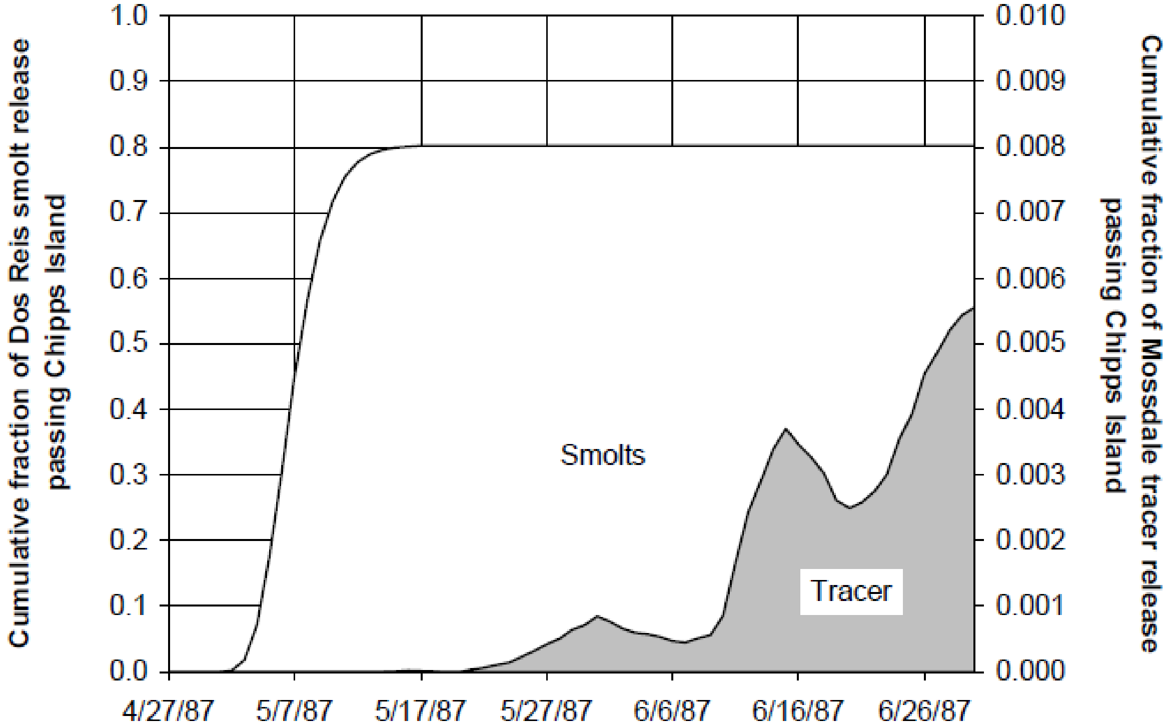


Figure 5 from Baker and Morhardt (2001). Comparisons of the movements of salmon smolts and passive particles released near the head of Old River on April 27, 1987. Cumulative recoveries at Chipps Island of smolts released at Dos Reis, and simulated mass flux past Chipps Island of tracer material released at Mossdale. The smolt recovery data have been fitted to an inverse Gaussian distribution. Hydraulic simulations by Flow Science (1998).

Second, DWR also conducted analyses comparing observed coded wire tag recoveries with predicted recovery timing and location as predicted by PTM and concluded: *"The result of the comparison of timing and magnitude of CWT Chinook recoveries and PTM particles passing Chipps Island shows that there is no correlation. This is shown in the last two figures in this attachment. There are factors other than hydrodynamics affecting juvenile Chinook emigration through the south Delta not accounted for in the PTM. Based on the 24 experiments graphed in this evaluation, the PTM results are an adequate surrogate for "timing" of salmonid emigration in only very high flow years like 1995, 1998 and 2006. But for the rest of the years, intermediate and low flow years, the PTM results would result in significant project regulation 3 to 6 weeks beyond emigration timing."* The DWR analysis was included as part of its April 24, 2009 comments on the FINAL NMFS BiOp. Although these two studies were available to NMFS prior to the issuance of the BiOp, the NMFS June 3, 2009 technical memorandum addressing the PTM does not discuss or reference the specific results of these studies.

Thus, reliance on the NMFS BiOp PTM analysis for salmonids is not scientifically justified and should not be used to support Delta flow recommendations for salmonids.

Appendix A to State and Federal Contractors letter of October 1, 2010 to Charlie Hoppin, SRCWB and Philip Isenberg, Delta Stewardship Council

Reliance on the NMFS BiOp recommended OMR restrictions and San Joaquin River inflow/export ratio as restrictions necessary to benefit juvenile salmonids are not supported by the best available science.

Flow recommendations from the SWRCB report (p. 119-126) rely specifically on OMR and San Joaquin River inflow-to-export restrictions required as part of the RPA in the NMFS BiOp. As the summary below indicates, these recommendations are not supported and in many cases are directly contradicted by the best available science.

a. **Best available science does not support export restrictions required by the NMFS BiOp San Joaquin River inflow-to-export ratio**

The NMFS BiOp contains two components related to exports and San Joaquin River flows: (1) a San Joaquin River flow requirement measured at Vernalis; and (2) a limit on export pumping operations in the southern Delta (BiOp at 641-645). These same requirements have apparently been adopted as Delta flow recommendations in the FINAL report.

Depending upon flow conditions in the San Joaquin River, the BiOp limits collective project export pumping from April 1 to May 31 to a 4-to-1 Vernalis inflow/export ratio. NMFS contends that this export limit will benefit outmigrating San Joaquin River basin and Calaveras River steelhead and that reduced project pumping will assist the survival of Sacramento River salmonids (BiOp at 645). However, the evidence collected during 10 years of experimental flows in the VAMP program and tagging and telemetry studies of salmon outmigration indicates that export levels are not a significant factor in determining salmonid survival. Further, NMFS has provided no evidence to support the 4-to-1 Vernalis inflow/export ratio as being an appropriate export limit for the protection of the salmonids.

Notwithstanding more than twenty years of scientific research and investigation directly focused on the precise subject, San Joaquin River fishery studies have not produced any evidence showing a negative relationship between salmonid survival and project pumping. A review of multiple studies shows the relationship between salmonid survival and project exports have either failed to establish any statistical relationship between exports and survival or have surprisingly shown a positive relationship between exports and survival. The excerpts below provide specific examples.

- Kjelson, Loudermilk, Hood, and Brandes. "The Influence of San Joaquin River Inflow, Central Valley and State Water Project Exports and Migration Route on Fall-Run Chinook Smolt Survival in the Southern Delta During the Spring of 1989," WRINT- USFWS 24 [WGCP - USFWS 4]) Stockton, CA, Fishery Assistance Office (1990): *"**Survival of tagged smolts released under low export conditions was not greater than for those released under high export conditions** (Table 4). This was an unexpected result as we believed conditions for survival should have improved when exports were lowered, since direct losses at the Project facilities were decreased, flow in* *the mainstem San Joaquin was increased and reverse flows in the Delta were eliminated." (emphasis added)*

- Brandes and McLain. "Juvenile Chinook Salmon Abundance, Distribution, and Survival in the San Sacramento-San Joaquin Estuary," Fish Bulletin 179, Vol. 2 (2001): *"To determine if exports influenced the survival of smolts in the San Joaquin Delta, experiments were conducted in 1989, 1990 and 1991 at medium/high and low export levels. Results were mixed showing in 1989 and 1990* ***that survival estimates*** *between Dos Reis and Jersey Point* ***were higher with higher exports*** *whereas in 1991 between Stockton and the mouth of the Mokelumne River (Tables 11 and 12) survival was shown to be lower (0.008 compared to 0.15) when exports were higher. . . . In addition, results in 1989 and 1990 also showed* ***that survival indices*** *of the upper Old River groups relative to the Jersey Point groups* ***were also higher during the higher export period****, but overall still about half that of the survival of smolts released at Dos Reis (Table 11)."* (emphasis added)

- San Joaquin River Group Authority. "2005 Annual Technical Report": *"Regression of exports to smolt survival without the [Head of Old River Barrier] were weakly or not statistically significant (Figure 5-17) using both the Chipps Island and Antioch and ocean recoveries,* ***but both relationships indicated survival increased as exports increased****."* (emphasis added)

- California Department of Fish and Game. "Final DRAFT 11-28-05 San Joaquin River Fall-run Chinook Salmon Population Model": *"There is* ***no correlation between exports and adult salmon escapement*** *in the Tuolumne River two and one-half years later (Figure 24)."* (emphasis added)

- Mesick, McLain, Marston and Heyne. "DRAFT Limiting Factor Analyses and Recommended Studies for Fall-run Chinook Salmon and Rainbow Trout in the Tuolumne River" (February 27, 2007): *"[P]reliminary correlation analyses suggest that the combined State and Federal export rates during the smolt outmigration period (April 1 to June 15)* ***have relatively little effect*** *on the production of adult recruits in the Tuolumne River compared to the effect of winter and spring flows. Furthermore,* ***reducing export rates*** *from an average of 264% of Vernalis flows between 1980 and 1995 to an average of 43% of Vernalis flows and installing the head of Old River Barrier between 1996 and 2002 during the mid-April to mid-May VAMP* ***period did not result in an increase in Tuolumne River adult recruitment*** *(Figures 3 and 17)."* (emphasis added)

- Ken B. Newman. "An Evaluation of Four Sacramento-San Joaquin River Delta Juvenile Salmon Survival Studies" (March 31, 2008): *"The Bayesian hierarchical model analyzed the multiple release and recovery data, including Antioch, Chipps Island, and ocean recoveries, simultaneously.... There was* ***little evidence for any association between exports and survival****, and what evidence there was pointed towards a somewhat* ***surprising positive association with exports****."* (emphasis added)

- Lastly, in a published 2001 paper, Brandes and McLain summarized the results of their export/salmon survival research by observing: *"[t]here is* ***no empirical correlation at all between survival in Lower San Joaquin River and the rate of CVP-SWP export****.*" Based upon their review of the evidence, Brandes and McLain concluded that "***no relationship between export rate and smolt mortality*** *suitable for setting day-to-day operating levels has been found*." (emphasis added)

It might be argued that these examples are cherry picked; however, this is not the case, and we are not aware of any statistical analysis in the record that shows a negative relationship between San Joaquin River salmonid survival and project export levels. As the SJRGA 2005 Annual Technical Report concluded: *"[e]xports do not appear to explain additional variability in smolt survival over that using flow alone, in data obtained with the HORB in 1994, 1997 and between 2000 and 2004."*

The NMFS BiOp and the FINAL report nonetheless implicates project exports as a causal factor in salmonid survival by conflating San Joaquin River flow and project export levels into a flow/export ratio. This conflation of flow and export data does not provide scientific support for export restrictions. The BiOp represents that the "data and analysis supporting" the inflow-to-export ratio is set forth in Appendix 5 of the opinion (BiOp at 645). A careful review of the studies referenced in Appendix 5 discloses that most of these studies do not support the limit on exports.

For instance, DFG has independently confirmed that San Joaquin River salmonid production does not correlate to project exports. In a 2005 study entitled "San Joaquin River Fall-run Chinook Salmon Population Model", DFG observed that *"[i]n every instance where salmon production was high, Vernalis flows are in excess of 10,000 cfs. Conversely when salmon production was low, Vernalis flow levels are less than 2,000 cfs (Figure 19). The question becomes is it the flow, or the exports?*" In an attempt to answer this question, DFG took a close look at smolt survival data on the San Joaquin River. The DFG study found that *"Smolt survival data collected during VAMP shows* ***that juvenile survival increases as exports increase*** *(Figure 19). In addition, smolt survival as a function of the exports to Vernalis flow ratio has a low correlation (Figure 20), indicating that* ***Delta export level, relative to Delta inflow level, does not influence juvenile salmon survival*** *on a regular, normal, or repetitive pattern."* (emphasis added) SFCWA agrees with DFG that smolt survival seems to have little or no statistical relationship with export levels but are cautious to conclude that it must therefore be flows. Such "if not A then B" thinking such as this does not allow for analysis of potentially more powerful factors, such as the effect of non-native predator species on San Joaquin River salmonids, which recent studies are finding has a significant negative effect on smolt survival (CITE).

After reviewing the same VAMP data considered by NMFS in Appendix 5, DFG observed: "*[h]ere again, the variable that seems to be controlling salmon production (e.g. survival) is spring Delta inflow, not spring Delta export.*" The DFG report then reviewed all available salmon smolt survival data and adult salmon escapement data available and stated: *"In conclusion, while the influence of Delta exports upon*

SJR salmon production is not totally clear, overall it appears that ***Delta exports are not having the negative influence upon SJR salmon production*** *they were once thought to have. Rather it appears that Delta inflow (e.g., Vernalis flow level) is the variable influencing SJR salmon production, and that increasing flow level into the Delta during the spring months results in substantially increased salmon production." (emphasis added)* Again, since DFG admits there is apparently little or no statistical relationship for export effects on smolt survival, it makes no sense for the SWRCB to adopt the NMFS BiOp's inflow/export ratio. All that can be reliably inferred is that there is a statistical relationship with flow, although causal factors of this relationship have not been determined. Causal relationships should be established to support any flow recommendations and, should the analysis of causal relationships show that flow is merely masking another factor, such as predation, the masked factor should be directly addressed rather than using flow as a surrogate.

DFG was sufficiently convinced of the "*lack of substantial cause and effect relationships*" between Delta exports and salmon survival that in developing its San Joaquin River salmon model, DFG expressly excluded consideration of Delta exports as a factor in the model's development. Unfortunately, this model ignores other factors likely to be important, such as predation, and has other limitations.

In Appendix 5, NMFS purports to find biological support for its adoption of the 4-to-1 Vernalis inflow/export ratio from Figures 10 and 11 in the appendix. However, Figure 10 is a regression analysis that only considers the relationship between Vernalis flow and salmon smolt survival. Project exports are not a factor considered in the analysis. Figure 11 reviews the relationship between the Vernalis inflow/export ratio and returning adult escapement 2.5 years later, but nothing in the Figure 11 analysis or Appendix 5's summary of the analysis explains how NMFS derived the 4-to-1 ratio from the data displayed in Figure 11. Moreover, the DFG 2005 review of project exports and adult escapement 2.5 years later in the Tuolumne River (Figure 24) discloses that "*no correlation*" can be found between these variables. Thus, Mesick *et al*. (2007) confirms DFG's 2005 assessment.

In a separate technical memorandum dated May 29, 2009 supplied with the NMFS BiOp, NMFS further attempts to justify the 4-to-1 ratio based upon a 1989 study by Kjelson and Brandes; however, this study did not find any correlation between project exports from the southern Delta and salmon survival. Instead, the study confirmed what other studies have shown, that a positive correlation exists between salmon survival and San Joaquin River flow at Vernalis, again without identification of causal factors. The technical memorandum also cites to the SJRGA 2007 Annual Technical Report in support of the 4-to-1 ratio. However, the 2007 report declines to reach this conclusion and instead states that *"[t]he relationship of survival to exports is difficult to detect based on the data gathered to date*." The report continues by stating that *"[t]he escapement data for adult salmon indicate that the flow/export ratio explains more of the variability in the adult escapement than flow alone without the HORB, but the smolt survival data is too limited to detect these effects, if they are real.*" Thus the 2007 report does not support the 4-to-1 ratio, but instead voices clear doubts as to whether the relationship between exports and salmonid survival is in fact "*real*." In short, neither Kjelson and Brandes 1989 nor the 2007 Annual Technical Report supports NMFS's decision to adopt a 4-to-1 inflow/export ratio.

In light of the above, the SWRCB's adoption of the NMFS BiOp's 4-to-1 inflow/export ratio in the FINAL report is not supported by the best available science.

b. Best available science does not support calendar based restrictions on Old and Middle River flows

According to NMFS, calendar based OMR restrictions are intended to "*[r]educe the vulnerability of emigrating juvenile winter-run, yearling spring-run, and CV [Central Valley] steelhead within the lower Sacramento and San Joaquin rivers to entrainment into the channels of the South Delta and at the pumps due to the diversion of water by the export facilities in the South Delta.*" (BiOp at 648) The RPA purportedly achieves this objective by requiring the export projects to limit exports to a level that produces flows in Old and Middle River (OMR) no more negative than -5,000 cubic feet per second (cfs) to -2,500 cfs. (BiOp at 648-650). The action triggers for the OMR flow limits are either:

(1) A calendar based trigger that mandates the CVP and the SWP to achieve OMR flows of -5,000 cfs, starting on January 1st and ending on June 15th of every year. This trigger forces the projects to reduce exports to meet the OMR flow requirement even if the export facilities fail to entrain a single salmon smolt during this six month period. (BiOp 648, AR 0016728).

(2) A salvage based trigger requires the export projects to achieve OMR flows as low as -2,500 cfs depending upon the amount of salmonid salvage that has occurred at the export facilities. In its May 18, 2010 Findings of Fact and Conclusions of Law re: Plaintiffs' Request for Preliminary Injunction, the Court concluded: *"NMFS's choice of -5,000 cfs as the calendar based ceiling is not scientifically justified and is not based on best available science."* (Doc. 347 at p. 65.)

The calendar based component of OMR restrictions should not be supported in the FINAL report for the following reasons: (1) as previous presented, evidence does not support NMFS' use of PTM as a tool to explain salmonid behavior; (2) evidence does not support NMFS' contention that project export operations alter salmon behavior and therefore adversely affect their survival; and (3) the Court has already found that this restriction is not based on the best available science.

In addition to the PTM results, the BiOp relies upon a series of fishery studies to support the OMR limits. However, a close review of these studies shows that, at best, they provide inconclusive or ambiguous support for the action.

Misattribution of Newman (2008). NMFS in Appendix 5 has cited to a 2008 paper prepared by Dr. Ken B. Newman for the proposition that the Delta Action 8 studies of Sacramento River coded wire tag releases "*found a statistically significant negative association between survival of fish moving through the Delta interior and export volume.*" Based upon its review of this study, the BiOp states: *"[t]here was a negative association between export volumes and the relative survival of released salmonids*." (BiOp at 373) However, Dr. Newman did not use the word "*significant*" in describing the relationship because he concluded from his Bayesian analysis that there was very little difference in the model results with exports and without exports. Newman (2008) actually states: "*The preferred model based on DIC* [a measure of model fit] *is the multinomial with log transformed [theta] and uniform priors for the [variances] (Table 11), but all the multinomial models yielded quite similar results. The DIC for this model, 427.0, however, was only slightly less than the DIC for the models without exports (the "Interior" models where minimum DIC was 427.7)."*

Thus, Dr. Newman concluded that the DIC value for a model without exports was not much higher than the corresponding model with exports. In a follow-up analysis of the Delta Action 8 data, Newman and Brandes found that the "*relationship between exports and the relative survival of Georgiana Slough releases seems relatively weak*" and they could not conclude that "*exports are the cause of this lower relative survival*."

Improper extrapolation from Perry and Skalski (2008). NMFS has similarly misapplied the 2008 study by Perry and Skalski. Specifically referring to the results of Perry and Skalski (2008), the BiOp explains that *"[t]he probability of ending up at the Delta export facilities or remaining in the interior delta waterways increases with increased export pumping, particularly for those fish in the San Joaquin River system*." (BiOp at 383). However, the Results and Discussion sections of Perry and Skalski (2008) do not contain any reference to project exports. Moreover, Perry and Skalski (2008) expressly recognizes that *"[c]urrently, there is limited understanding of how water management actions in the Delta affect population distribution and route-specific survival of juvenile salmon."*

Misstatement of Vogel (2004) conclusions. As described previously, the NMFS BiOp and the FINAL report both misrepresent the findings of Vogel (2004) in an attempt to support OMR flow restrictions. As previously discussed, the Court determined that NMFS' use of Vogel (2004) to support its BiOp was not rational and not scientifically justified.

In light of all the examples provided, it is clear that the FINAL report's acceptance of the NMFS BiOp OMR flow restrictions is not supported by the best available science.

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Longfin smelt (*Spirinchus thaleichthys*)

Longfin smelt's relationship with X2 is often referred to as the strongest of the fish-flow relationships (Kimmerer 2002l Kimmerer *et al*. 2008; Dege and Brown 2004). These flow criteria note that the population abundance of longfin smelt is positively related to Delta outflow during winter and spring (p. 66) and that its population abundance as measured by the FMWT is inversely related to the number of fish salvaged (p. 66). Admission is made that the biological basis for the spring outflow relationship is unknown, but <u>speculation</u> by Baxter *et al.* (2009) that the larvae benefit from increased downstream transport, increased food production, and reduction in entrainment losses at the export pumps is mentioned. Several existing sources provide insight into potential causations of longfin smelt declines: (1) Rosenfield and Baxter (2007) plotted age-1 and age-2 average percent presence using the Bay Study and Suisun Marsh Survey data compared to average winter-spring outflow and found a positive but weak signal. The predictive power of the relationship was especially weak for age-2 (spawning) fish, which Rosenfield and Baxter pointed out could be explained by their anadromy. (2) Rosenfield and Baxter (2007) further identified food limitation as a causative factor in the decline of longfin smelt. (3) Baxter *et al.* (2008) identified grazing by *Corbula amurensis* on prey as the cause of the post-1987 decline in longfin smelt, especially a summer food decline as a major stressor on age-0 longfin juveniles. (4) Sommer *et al.* (2007) noted food web changes caused by *Corbula* grazing may be responsible for reduced fall recruitment in 2003-2005. (5) Moyle (2002) speculated that the continuing decline of longfin smelt abundance is attributable to multiple factors acting synergistically - the impact of introduced species on longfin food supply, extreme flooding during spawning, impacts of introduced predators, and toxic substances as possible contributors. (6) The Bay Institute in its petition to list longfin smelt (2007) cited outflow, entrainment, food-related impacts of invasive species, toxic pollutants, water temperature increase, and physical disruption of spawning habitat and critical prey species habitat by dredging. (7) Glibert (2010) performed CUSUM analyses on nutrient ratios and food web organisms and found a strong relationship between, among other things, declines in *E. affinis* and changing nutrient ratios.

Here there are numerous sources pointing out the weakness of flow relationships with longfin smelt as well as identifying potential causes of declines. Yet the FINAL report cleaves to the belief that more flow equals more fish. These sources should have been considered in the FINAL report.

In considering the speculated flow effects on longfin smelt, much credence is given to the TBI/NRDC materials, which allegedly link the spring Delta outflows to fish salvage during March-May (see TBI/NRDC 4 at 17). TBI's Figure 8 (TBI/NRDC 4 at 17) inappropriately related <u>total</u> annual entrainment with <u>spring</u> outflows. Spring outflows obviously cannot affect entrainment during other seasons. When

March-May salvage is considered (corresponding with spring), the result is a power relationship with Delta outflow, with salvage approaching zero when average outflow is greater than about 14,000 cfs (Figure 4). The existing X2 standard is nearly always sufficient to meet this outflow. Indeed, normalized salvage has been high only once (2002) in the 15 years since the SWRCB's Decision 1641 was instituted. TBI/NRDC does not demonstrate that higher outflows are needed or that salvage is an important stressor on longfin smelt.

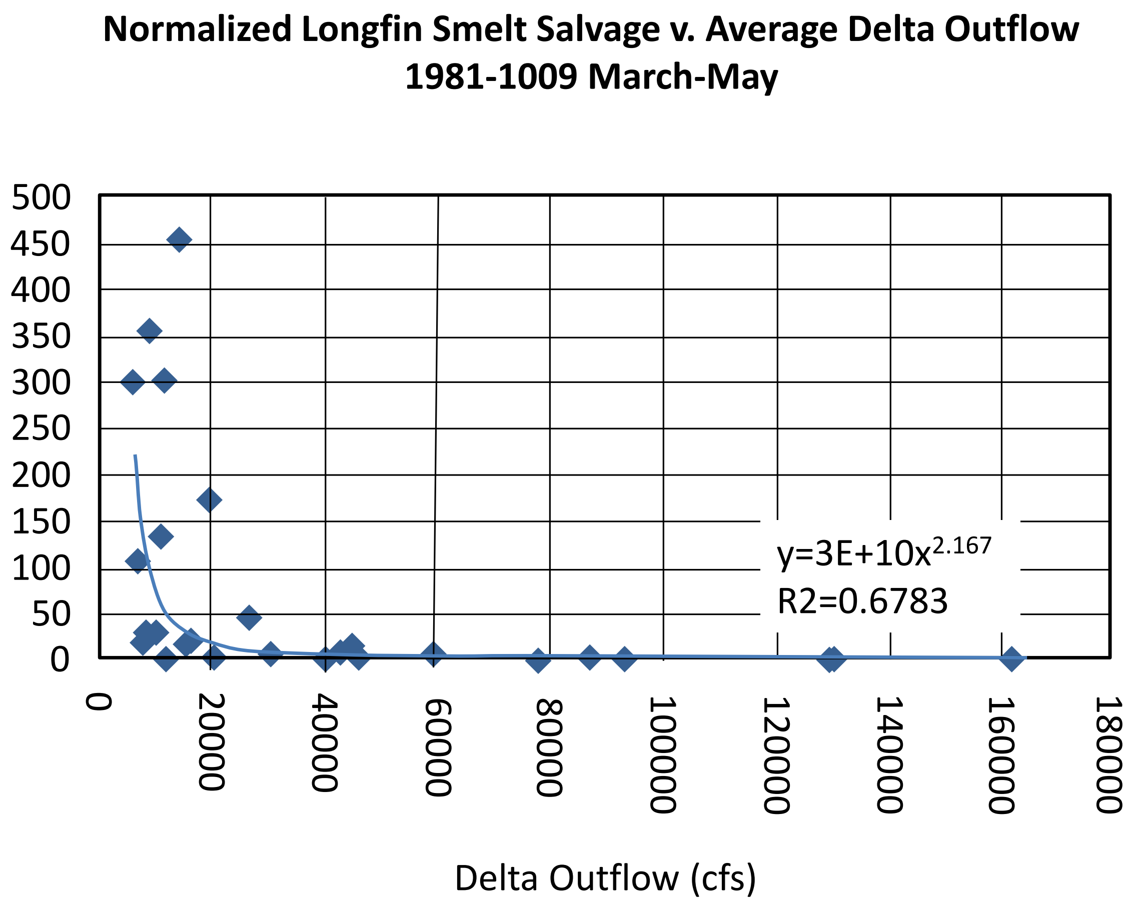

Figure 4. Longfin smelt salvage (March-May) as a function of Delta outflows (March-May). Outflows from DAYFLOW; structured salvage from ftp://ftp.delta.dfg.ca.gov/BayStudy/LongfinSmelt/ for the Bay Study and normalized using previous year's age-1 CPUE from the Bay Study.

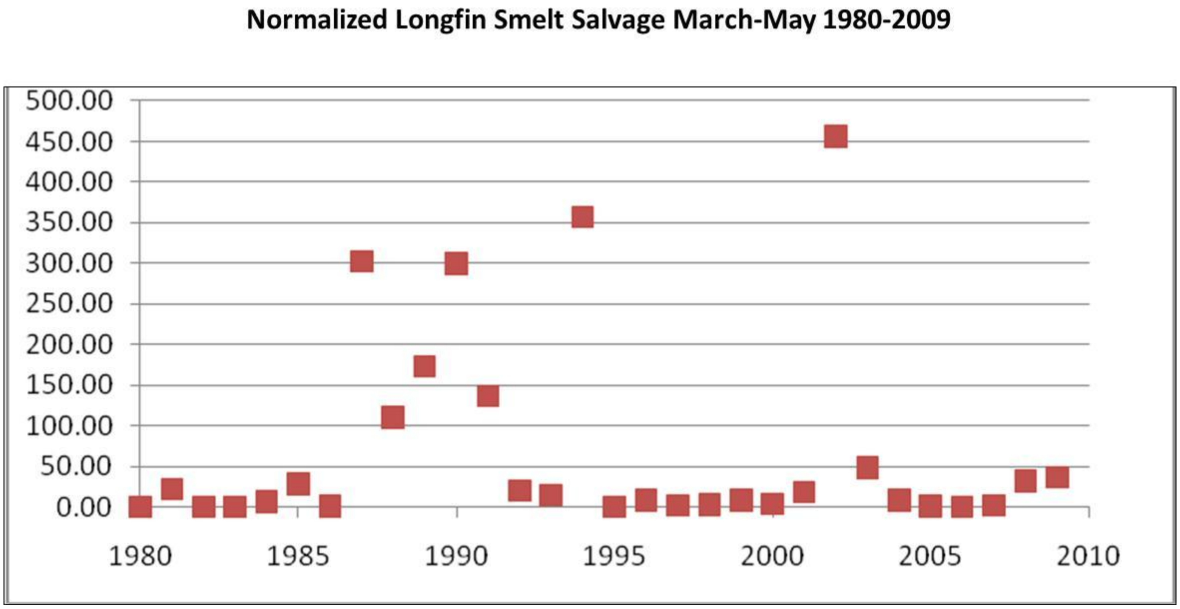

Figure 5. Normalized longfin smelt salvage (March-May)

TBI's Figure 11 (TBI/NRDC 4 at 20) purports a significant relationship between the FMWT Index of spawning-age longfin and total salvage of longfin smelt from 1993-2007, explaining that their negative correlation indicates that increases in salvage are not a result of increased abundance. The biological mechanism for the FMWT Index in one year being inversely related to salvage the next year is unapparent, as is its predictive power. SFCWA reanalyzed the relationship from 1981-2007 (excluding the year 2006 which had zero longfin salvage) and found a very strong relationship ($p<0.001$) but with very weak predictive power ($R^2=0.09$) and a large range around the trend (Figure 5). This indicates that no real conclusions can be drawn about long-term longfin salvage and abundance as measured by the FMWT.

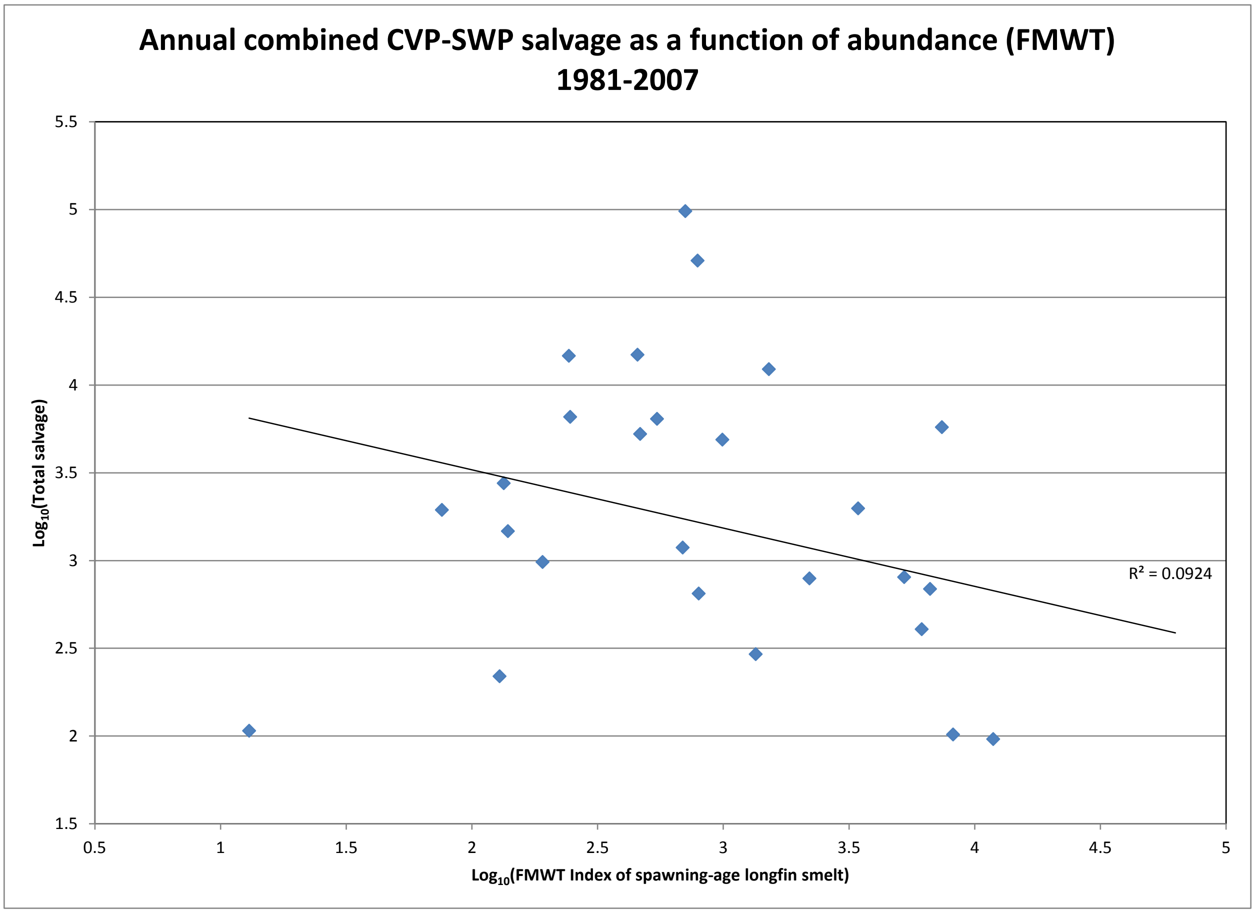

Figure 6. Total salvage as a function of abundance. CVP-SWP salvage from http://www.dfg.ca.gov/delta/Data/Salvage/. FMWT Index for longfin smelt from http://www.dfg.ca.gov/delta/data/fmwt/charts.asp.

It is important to clarify what TBI's Figure 11 does not say – it does not indicate that salvage affects abundance as measured by the FMWT or other abundance indices. If salvage was a significant factor affecting longfin population as expressed by the FMWT Index, the logical conclusion one would expect is that high relative entrainment would lead to a low FMWT Index. Figure 5 simply does not bear this out. In fact, an examination of longfin distributions show that they are rarely in the zone of influence as characterized by Baxter *et al.* (2009) (see Appendix 1 attached hereto). The highest risk of entrainment for longfin smelt would occur if they were found in the lower San Joaquin River, near Franks Tract, in the southeast Delta, or the central Delta. Yet their distributions, both historically and at present, indicate they are infrequently found in these regions and, when found, are only in low numbers.

Grimaldo *et al.* (2009) describes the hydrodynamic "footprint" of water diversions (non-tidally average OMR daily flows), which is referenced in the FINAL report to demonstrate that OMR reverse flows result in an exponential increase in salvage loss. Without understanding the effect on the population of the salvaged fish, the actual significance of Grimaldo *et al.*'s findings is not apparent, especially when considering Figure 5 above.

Baxter *et al.* (2009) reached similar conclusions as Grimaldo *et al.* (2009) using a particle tracking model to predict the fate of larval longfin smelt. For PTM results to be valid, an assumption must be made that behaviorless particles adequately simulate larval fish, which is rarely the case. As well, the insertion points must reflect the actual areas where fish are found. The insertion points used by Baxter *et al.* (2009) were Stations 716, 711, 704, 809, 812, 815, and 906, the latter four of which are located in the south and eastern Delta. Appendix 1 attached hereto demonstrates that longfin smelt are seldom in these regions in large numbers.

A positive correlation between *Eurytemora afffinis* abundance and spring outflow is noted as providing further support for a spring outflow criterion (Kimmerer 2002, Figure 7 reproduced below).

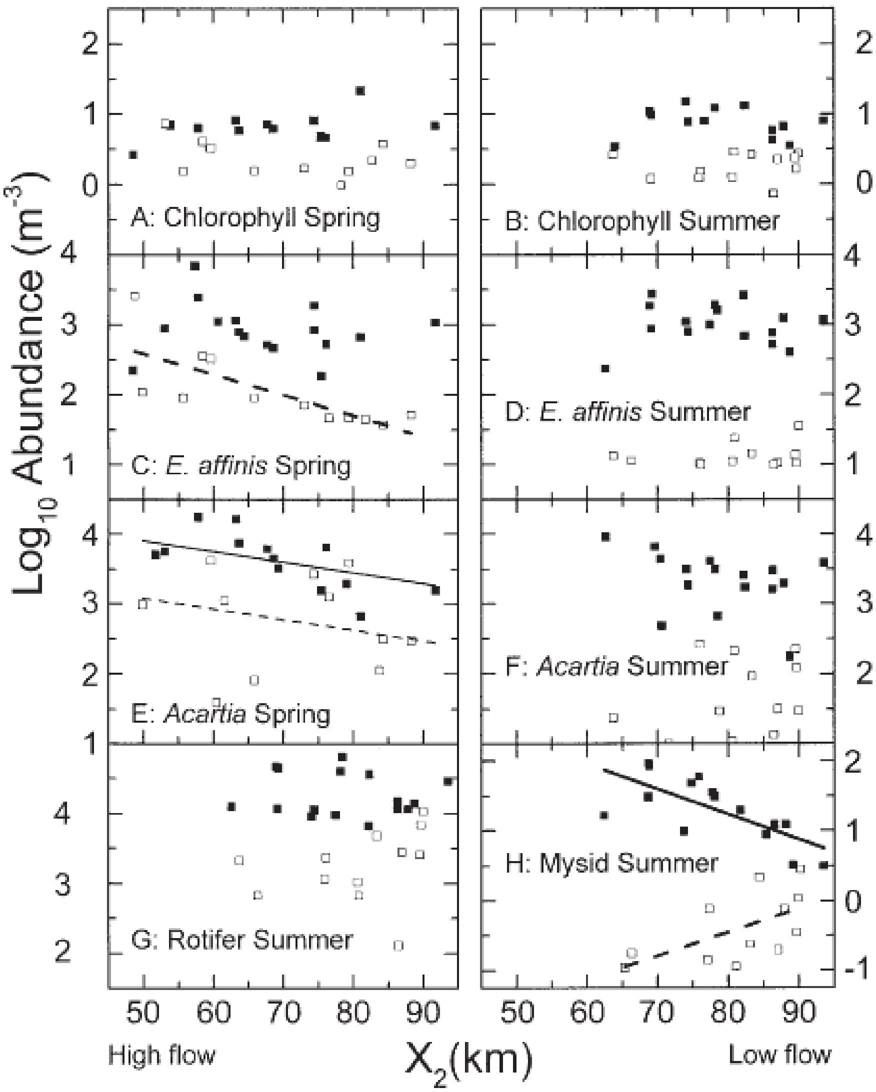

Figure 7 from Kimmerer (2002). Plankton abundance plotted against X_2 and lines, data up to 1987; and dotted lines, 1988 to 1999.

Kimmerer (2002) explained that potential causes of the above relationships could involve higher nutrient levels associated with higher flows (the agricultural model) or through stratification. However, the response of phytoplankton (as measured by chl-*a* concentration) has shown little response to freshwater flow either before or after *Corbula amurensis* became abundant (Fig. 7A,B). In the Delta, in spring, chl-*a* has actually decreased with increasing flow, apparently because of decreasing residence time (Jassby *et al.* 2002 *in* Kimmerer 2002). Kimmerer (2002) further noted that without an increase in food supply with flow, there is no reason to expect any specific growth rate to increase with increasing flow for any of the taxa shown in Figure 7 above. The food supply for zooplankton such as *E. affinis* is mostly phytoplankton (i.e., algae). Yet increasing flows stifle phytoplankton growth. This conundrum offers little help in establishing spring outflow criterion.

The outflow criteria suggested for stabilizing and increasing longfin smelt are a close mirror of those recommended by TBI/NRDC based on water year type. SFCWA has discussed above the lack of significant correlation between late winter and spring Delta outflows and the FMWT Index for longfin, the lack of understanding of the population level effect of salvage, and the probable lack of response of phytoplankton and zooplankton to flows. Therefore, the FINAL report's recommendations for longfin smelt cannot be said to be founded on the best available science.

DFG's written summary presents a correlation between the FMWT and X2. Though the correlation between FMWT and average X2 does exist, the FMWT is also well correlated with other factors, including average Suisun Bay turbidity, dissolved inorganic nitrogen and *E. affinis* densities during the first few months after eggs are hatched. Moreover, X2 cannot explain the long-term decline in longfin abundance because there has not been a long term trend in spring X2. Thus, while X2 is correlated with wiggles in longfin abundance each year, the actual decline in longfin abundance is more likely to be linked to declines in its food supply. Restoration of longfin abundance thus probably hinges upon increasing longfin food supplies, particularly *E. affinis*, rather than on increasing flows.

The importance of food supply can be seen in a regression of average CPUE of age-0 longfin smelt from August to October (young-of-the-year from the Bay Study's Midwater Trawl) v. (1) CPUE of age-1 longfin the previous February to May (parents' generation); (2) Average X2 from April to June; and (3) Average *E. affinis* densities from April to June from Suisun Bay to the confluence. The resulting equation is:

Log (Longfin CPUE) = 0.62 * log(longfin Previous Year CPUE) + 1.0 * log (Average Delta outflow) + 1.0 * log(Average *E. affinis* densities). $R^2 = 0.83$. p values all < 0.0002.

Thus, young-of-the-year longfin abundance increases roughly as the square root of the abundance of pre-spawning adults (suggesting the existence of density dependence) and is directly correlated with outflow and food supplies. However, <u>X2 patterns show no consistent trend while *E. affinis* densities have collapsed over the past 30 years</u>. The effect is shown in Figure 8. The decline of longfin smelt is thus likely caused by the collapse of food supply. Any recovery of longfin smelt can only be based upon a recovery of food supply. Finally, Dr. Patricia Glibert and Dr. Richard Dugdale's work on the food supply consequences of increased loading of nutrients into the Bay-Delta system and changes in nutrient ratios may point to a way to increase food supplies.

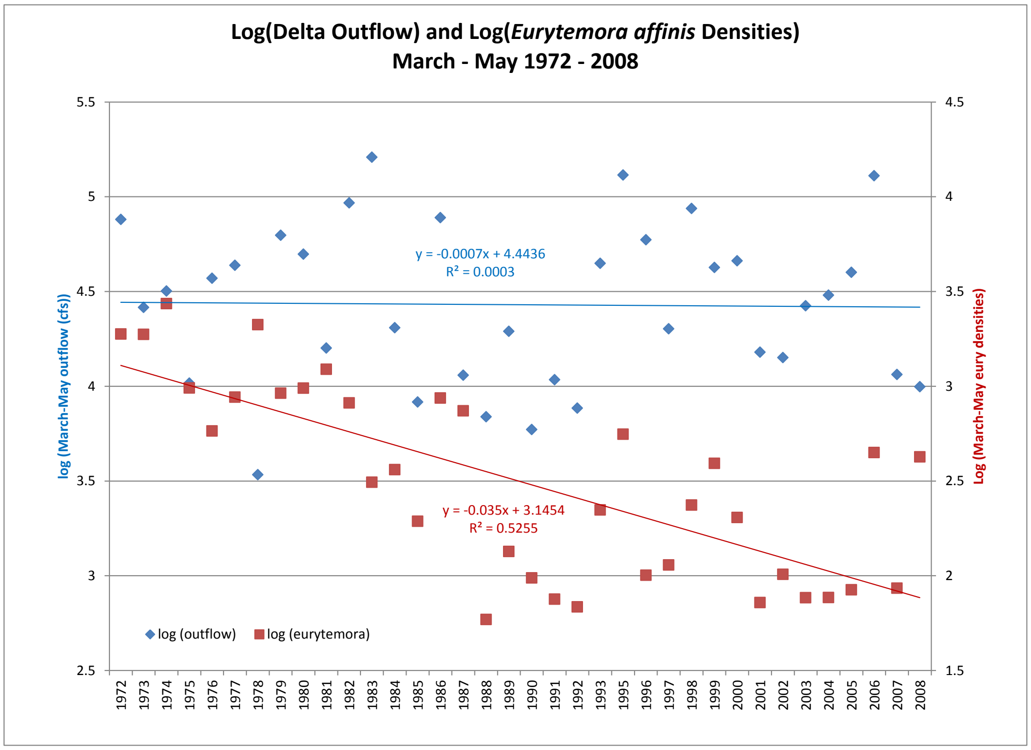

Figure 8. Trends in Delta outflow and *E. affinis* densities from 1972 to 2009.

Another way of observing the futility of attempting to influence longfin abundance through flow enhancement is to observe the decline in the relationship between the FMWT and log Delta outflow over time. Figure 9 shows the relationships over three time periods. The abundance continues to be correlated with X2, but the response of abundance to log outflow is now an order of magnitude lower than it was as recently as the early 1980s. Figure 10 shows what the longfin historical abundance might have been if the log(FMWT Index) v log(Previous FMWT Index) and log(Delta outflow) relationship from 1989 to 2009 were valid for the entire historical period using, not historical, but unimpaired flows. That is, the entire unimpaired outflow of the Central Valley watershed is capable of making only very minor improvements in the longfin FMWT Index.

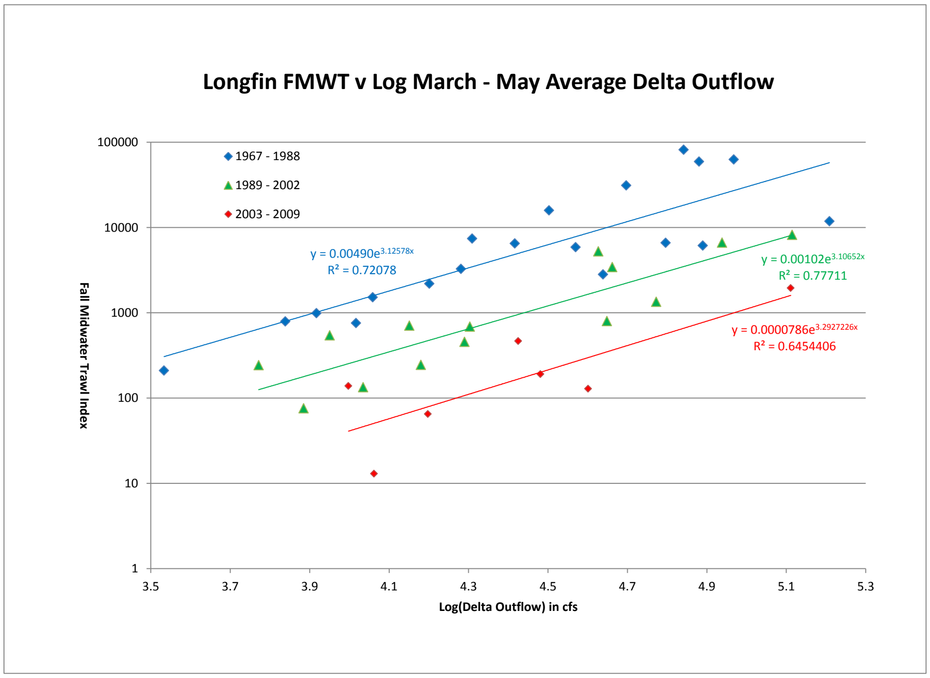

Figure 9. Fall Midwater Trawl Index v. log(Delta outflow) over various time periods.

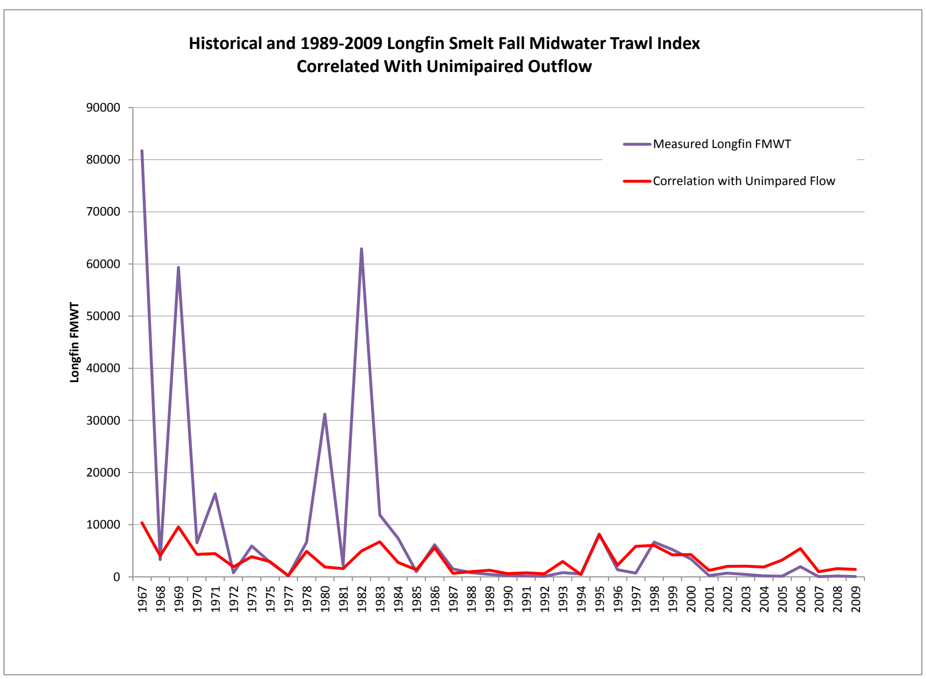

Figure 10. Historical Fall Midwater Trawl Index and Index if the relationship existing between FMWT and (1) Previous Fall Midwater Trawl and (2) log(Delta outflow) existing since 1989 had existed for the entire historical period.

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Delta smelt (*Hypomesus transpacificus*)

The FINAL report accepts the opinion that delta smelt undergo an annual upstream migration to spawn, triggered by Sacramento River flows in excess of 25,000 cfs (SWRCB at 70). Recent monitoring reveals a year-round, non-migrating sub-population in the west Delta and Liberty Island region of Cache Slough (Nobriga *et al*. 2005; Sommer *et al*. 2009), which is acknowledged by the SWRCB (SWRCB at 70). These regions are similar to the historical habitat conditions that existed in the Bay-Delta prior to its reclamation into agricultural lands and flood control corridors. Catch of delta smelt in these regions is thought to be a substantial portion of the population; ~42% of the Spring Kodiak Trawl catch during March-May since 2005 has been in the Cache Slough complex (Sommer *et al*. 2009). Therefore, establishment of flow criteria specific to migration of delta smelt from or to the south Delta ignores the accumulating data that a large portion do not migrate at all. In fact, with such a substantial portion of the population spawning, rearing, and maturing in the west Delta and Cache Slough regions, it is not known whether high south Delta flows to elicit migration may in fact inhibit their reaching these upstream regions. Additional research is needed before any south Delta flow objectives for migration can be supported.

It is known that delta smelt prefer turbid conditions. Turbidity in the Bay-Delta is not a function of flows, per se, but rather a function of storm activity that induces erosion (Wright and Schoellhamer 2004). In fact, sediment loads have been dropping for the Sacramento River. Grimaldo *et al*. (2009) evaluated whether salvage followed large precipitation events, known as “first flush” events. Such “first flush” events are not typically long-lasting. Therefore, recommendation of a specific flow as a migration trigger without considering turbidity is not supported by the best available science and could result in large flows without biological benefit for delta smelt because these are not necessarily related to turbidity.

The notion that maintaining fall X2 downstream of the confluence is not strongly supported. Even though the National Academy of Science characterized the fall X2 requirement in the USFWS BiOp effects analysis (2008) as “conceptually sound,” they also characterized the weak statistical relationship between the location of X2 and the size of smelt populations as “difficult to justify.” An independent peer review of the USFWS effects analysis (2008) questioned the utility of the fall X2 habitat analysis, noting that a few data points may have had high influence on the outcome. The independent reviewers even questioned whether the fall X2 stock-recruit model was inappropriate for the data used (Rose *et al*. 2008 at 7). SFCWA previously expressed its concerns to the SWRCB in its written testimony and exhibits submitted February 2010. SFCWA appreciates that the SWRCB did not include a fall X2 flow criteria for delta smelt.

After admitting that no statistical relationships have been found between spring outflow and delta smelt population abundance (SWRCB at 71), the FINAL report discusses at great lengths Grimaldo *et al*. (2009), which discusses these matters. SFCWA shares the concern raised by Rose *et al*. (2008) when they noted that the USFWS effects analysis, based in part upon an unpublished manuscript of Grimaldo *et al*. (2009), should have normalized the salvage for population size (Rose *et al*. 2008 at 6). Because it failed to consider population size, Grimaldo *et al*. (2009) is of little use for establishing delta smelt flow criteria.

The FINAL report further accepts the Grimaldo *et al*. (2009) conclusion that minimizing reverse OMR flows during periods when adult delta smelt are migrating into the Delta could substantially reduce mortality. An evaluation of the distribution of delta smelt based on the Kodiak Trawl, which targets spawning delta smelt, does not bear this out. Table 1 lists the Kodiak Trawl distributions of adult delta smelt from 2002-2008. For fish to be entrained, they must be located in the southern or eastern portion of the Delta where the export projects are located. Delta smelt are seldom found in these regions, suggesting that smelt are seldom at risk of entrainment by reverse OMR flows.

year	survey	survey mid-date	Napa River	Car-quinez Strait	Suisun Bay	Chipps Island	lower Sacra-mento River	lower San Joaquin River	Suisun Marsh	Cache Slough	Sacra-mento Ship Chan-nel	upper Sacra-mento River	near Franks Tract	south-east Delta	east south-east Delta	east central Delta	sum for SE & E-SE Delta
2002	1	8-Jan	0%	5%	11%	6%	3%	19%	30%	1%		0%	21%	3%	0%	1%	4%
2002	2	5-Feb	0%	2%	3%	0%	7%	18%	47%	0%		1%	22%	0%	0%	0%	0%
2002	3	5-Mar	1%	0%	2%	0%	42%	2%	32%	12%		0%	6%	0%	3%	2%	3%
2003	1	19-Feb	0%	0%	27%	16%	8%	4%	14%	20%		0%	7%	1%	2%	0%	3%
2003	2	18-Mar	0%	0%	21%	10%	40%	0%	5%	16%		4%	2%	0%	0%	2%	0%
2003	3	15-Apr	0%	0%	5%	0%	33%	2%	0%	3%		8%	49%	0%	0%	0%	0%
2003	4	14-May	0%	0%	62%	0%	10%	8%	0%	18%		0%	0%	0%	0%	3%	0%
2004	1	13-Jan	1%	0%	1%	4%	0%	21%	35%	0%		0%	29%	1%	7%	0%	8%
2004	2	13-Feb	0%	0%	2%	1%	36%	8%	29%	0%		0%	23%	0%	0%		0%
2004	3	10-Mar	0%	0%	14%	5%	20%	2%	22%	0%		0%	35%	0%	1%	1%	1%
2004	4	6-Apr	0%	0%	3%	1%	45%	7%	0%	1%		2%	40%	0%	0%	0%	0%
2004	5	5-May	0%	0%	0%	0%	23%	40%	0%	5%		0%	33%	0%	0%	0%	0%
2005	1	26-Jan	0%	0%	24%	7%	34%	0%	23%	3%		0%	9%	0%	0%	0%	0%
2005	2	24-Feb	6%	0%	5%	4%	16%	1%	60%	7%	1%	0%	0%	0%	0%	0%	0%
2005	3	24-Mar	0%	0%	9%	19%	32%	0%	8%	8%	19%	5%	0%	0%	0%	0%	0%
2005	4	19-Apr	0%	0%	11%	8%	33%	0%	3%	5%	39%	0%	0%	0%	0%	0%	0%
2006	1	18-Jan	26%	9%	12%	7%	0%	8%	26%	2%	7%	0%	5%	0%	0%	0%	0%
2006	2	15-Feb	24%	4%	32%	5%	2%	2%	14%	3%	8%	0%	4%	2%	0%	1%	2%
2006	3	15-Mar	31%	0%	10%	9%	3%	0%	3%	4%	32%	0%	6%	0%	0%	0%	0%
2006	4	12-Apr	5%	0%	0%	2%	4%	3%	1%	0%	80%	0%	6%	0%	0%	1%	0%
2006	5	9-May	0%	0%	39%	39%	0%	13%	0%	3%	0%	0%	0%	0%	0%	6%	0%
2007	1	9-Jan	0%	0%	0%	21%	31%	5%	25%	3%	6%	0%	10%	0%	0%	0%	0%
2007	2	7-Feb		0%	0%	17%	34%	0%	6%	0%	43%	0%	0%	0%	0%	0%	0%
2007	3	8-Mar	0%	0%	6%	18%	11%	0%	29%	2%	34%	0%	0%	0%	0%	0%	0%
2007	4	4-Apr	0%	0%	0%	3%	9%	0%	2%	0%	86%	0%	0%	0%	0%	0%	0%
2007	5	2-May	0%	0%	0%	0%	10%	0%	3%	0%	87%	0%	0%	0%	0%	0%	0%
2008	1	9-Jan	0%	2%	11%	7%	58%	0%	1%	1%	19%	0%	1%	0%	0%	0%	0%
2008	2	6-Feb		0%	0%	8%	4%	0%	0%	5%	77%	0%	4%	0%	0%	1%	0%
2008	3	12-Mar	0%	0%	0%	3%	5%	0%	3%	1%	82%	0%	6%	0%	0%	0%	0%
2008	4	9-Apr	0%	0%	0%	0%	39%	0%	0%	0%	61%	0%	0%	0%	0%	0%	0%
2008	5	7-May	0%	0%	0%	0%	26%	0%	0%	3%	71%	0%	0%	0%	0%	0%	0%
		avg.	3%	1%	10%	7%	20%	5%	14%	4%	24%	1%	10%	0%	0%	1%	1%

Table 1. Distribution of adult delta smelt based on Kodiak Trawl data, 2002-2008. Data from http://www.dfg.ca.gov/delta/projects.asp?ProjectID=SKT.

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Sacramento Splittail (*Pogonichthys macrolepidotus*)

The FINAL report describes the need for adequate flows to achieve inundation of floodplain habitat in the Yolo Bypass in above-normal and wet years. SFCWA agrees with this general finding. It may be useful to review some background information on splittail that is not mentioned in its life history within the DRAFT report.

Splittail are very fecund, with each female producing up to 150,000 eggs (Feyrer and Baxter 1998). Splittail spawning occurs over flooded vegetation in tidal freshwater and brackish water habitats of estuarine marshes and sloughs and slow-moving, shallow reaches of large rivers (Sommer *et al.* 2007). The Yolo and Sutter Bypasses, Butte Creek, Butte Sink, and Cosumnes River floodplains serve as important splittail spawning and early rearing habitat (Sommer *et al.* 1997), as they approximate the large, open, shallow water areas in which splittail prefer to spawn. In wet, high flow years when these areas tend to flood, splittail abundance can increase dramatically. The years 1998 and 2005 had particularly high abundances following multiple dry years when abundance was reduced.

Survey data other than the FMWT have not shown declines in splittail abundance or distribution. The FMWT is not efficient at sampling splittail because it samples portions of the water column that are generally not used by splittail. For instance, the FMWT samples in open channels, whereas splittail are primarily found in shallower near-shore waters. Also, the FMWT does not sample the upstream range of splittail (Sommer *et al.* 2007). Other survey data, such as the USFWS beach seine survey, have shown greater abundances of splittail than the FMWT, especially in wet years. USFWS' beach seine survey is designed to sample near-shore waters where splittail are typically found.

It is not unusual for splittail abundance to drop in dry years when inundation events do not occur. If one investigates alternative sampling data to the FMWT, which is inefficient at catching splittail (see Sommer *et al.* 2007), there is no evidence that splittail abundance has shown an unusual decline. Its life history is closely linked with flow events which inundate floodplains and riparian areas (Daniels and Moyle 1983; Sommer *et al.* 1997; Harrell and Sommer 2004; Moyle *et al.* 2004; Kratville 2008). Even though their primary spawning activity is associated with wet years, some spawning takes place almost every year along the river edges and backwaters created by small increases in flow (Kratville 2008). When one focuses on surveys that sample floodplains and riparian areas, such as the Suisun Marsh Survey, the State Water Project salvage index, and the U.S. Fish and Wildlife Beach Seine Survey (see Moyle *et al.* 2004 for a summary of sampling data), one finds that splittail abundance is not unusually low (see Sommer *et al.* 2007).

Historically, splittail reportedly were found throughout the central valley, extending as far north as Redding, CA, and as far south as the historic Tulare and Buena Vista Lakes (Moyle *et al.* 2004). Except for these historic lakes, splittail are still distributed below dams throughout the San Joaquin River and Sacramento River watersheds, as well as the Bay-Delta (Kratville 2008). Sommer *et al.* (2007) Table 1 explains that splittail are still widely distributed and that their distribution has not changed substantially since the 1970s.

Several ecosystem restoration efforts are underway, including several CALFED-sponsored projects, CVPIA habitat restoration efforts, USACE restoration efforts on Prospect Island, CDWR restoration on Decker Island, and several other smaller efforts. Since 2003, additional restoration activities have been completed or are on the near-term horizon. Both the BDCP and the NMFS BiOp contemplate changes to the Fremont Weir on the Sacramento River in order to increase both the area and frequency of Yolo Bypass seasonal inundation. A range of 17,000-20,000 acres will be seasonally inundated under these proposals, with benefits to splittail as well as salmonids.

The BDCP also anticipates restoring at least 5,000 acres in the Cache Creek complex, at least 1,500 acres in the Cosumnes/Mokelumne River regions, at least 2,100 acres in the western Delta, at least 5,000 acres in the southern Delta, and at least 1,400 acres in the eastern Delta. Much of these areas are within the distribution of splittail. While the Delta Stewardship Council's Delta Plan is not yet developed, it will be based on the Delta Visions report (1/29/2008) which called for developing a more heterogeneous estuarine environment, including expanded seasonal and tidal wetlands. Based upon the ongoing and anticipated habitat restoration projects, splittail spawning and rearing habitat will be greatly expanded at a wide range of flows.

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Starry Flounder (*Platichthys stellatus*)

Delta outflow criteria based on the X2-abundance relationship are not explicitly stated for starry flounder, but it is clear that they are based on the X2-abundance relationship asserted for longfin smelt. Kimmerer (2002a) and Kimmerer *et al.* (2009) are offered as the only support for an outflow-abundance relationship for starry flounder, neither of which offer a causal mechanism. In the case of starry flounder, SFCWA notes that the FINAL report states that DFG was the only participant to submit outflow recommendations (SWRCB at 82) and indicates that the proposed criteria are "*consistent with California Department of Fish and Game recommendation for starry flounder*" (SWRCB at 83). DFG's testimony and exhibits do state that starry flounder are associated with March-June outflows, offering several hypotheses for causal mechanisms, none of which are established by the best available science: (1) outflows can provide chemical cues to larvae and juveniles to facilitate locating estuarine nursery habitat; (2) high outflows generate bottom-oriented upstream-directed gravitational currents that assist immigration; and (3) flows enhance the area of low salinity habitat selected by young starry flounder.

Kimmerer (2002) has shown lower relative abundance per unit X2 after the invasion of *C. amurensis*, evidence of food limitation. Because of the profusion of *C. amurensis*, it cannot be stated that higher outflows will translate into more food. DFG admits in its written summary that flows alone are insufficient to sustain or recover the low salinity zone ecosystem.

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California Bay Shrimp (*Crangon franciscorum*)

Kimmerer *et al*. (2009) and Jassby *et al*. (1995) are offered as support for an outflow-abundance relationship for bay shrimp, although neither reference mentions causal mechanisms for the relationship. As with starry flounder, DFG's recommendations for bay shrimp were adopted in the FINAL report. Nutrient and food web shifts explain the declines in bay shrimp as well or better than flows. Glibert (*in press*) advances a plausible linkage between these shifts and the explosion in the populations of numerous invasive species, including *C. amurensis*. The best available science does not support specific flow criteria for bay shrimp at this time.

Variability, Flow Paths, and the Hydrograph

The FINAL report (p. 88) provides Figure 10 to show the loss of flow variability when unimpaired and actual June Delta outflows are compared. Unfortunately, only June is shown. The month of June has scant rainfall and upstream reservoirs are filling with snowmelt, so a loss of variability is unsurprising. What the FINAL report leaves unknown is whether the other 11 months show similar losses in variability. Any flow recommendations that address flow variability for months other than June are unsupported in the FINAL report.

Additional points

The FINAL report (p. 6) recognizes the fact that the Delta ecosystem is likely to dramatically change within 50 years due to large-scale levee collapse. The FINAL report then suggests that such landscape-changing events are likely to promote a more variable, heterogeneous estuary that will be better for desirable estuarine species. Uncertainties about how a post collapse Delta would work overwhelm our scientific understanding. There is as much likelihood that large portions of the Delta could become a homogeneous saline lake of undesirable habitat as there is that there will be an increase in heterogeneous, desirable habitat. The FINAL report should not have suggested that a post collapse Delta will be better than present conditions, either for desirable species or water management.

It is clear that DFG's recommendations were used as the basis for X2-outflow criteria for American shad, starry flounder, and bay shrimp, since the proposed criteria are nearly identical for all three species.

<u>American shad</u>: X2 at 75km to 64km between April and June (pp.64-65)

(**~11,400 cfs to ~29,200 cfs**)

Starry flounder: X2 at 65km to 74km between February and June (p.82)

(**~11,400 cfs to ~26,815 cfs**)

Bay shrimp: outflow at **11,400 to 26,815** between February and June (p.84)

Longfin smelt are used as a surrogate when determining Delta outflow criteria for other estuarine species. This approach is taken because the X2-abundance relationship is thought to be strongest for longfin smelt. The FINAL report notes the similarity of Delta outflow criteria for starry flounder and bay shrimp to those for longfin and delta smelt, stating regarding starry flounder: "*This net Delta outflow recommendation is similar to those proposed for the protection of longfin smelt, delta smelt, and Crangon sp.*" (SWRCB at 83). Regarding bay shrimp, the report states: "*The outflow recommendations are similar to those proposed for protection of both longfin smelt and delta smelt*" (SWRCB at 84).

By the time the FINAL report gets to its flow recommendations, reference to delta smelt is dropped, concluding on page 99: "*It appears that winter-spring outflows designed to be protective of longfin smelt would benefit the other upper estuary species evaluated,*" and "*75% of 14-day average unimpaired flow is needed during the January through June time period to promote increased abundance and improved productivity for longfin smelt and other desirable estuarine species.*" [Emphasis added]. This is further emphasized by the absence of delta smelt in the statement regarding bay shrimp on page 102 (contrasted with a similar assertion on page 84 which referred to both longfin smelt and delta smelt).

It appears that SWRCB staff was not confident in making the argument of an X2-abundance relationship for American shad, bay shrimp, and starry flounder separately. This lack of confidence is not without considerable cause since the X2-abundance relationships for these species are misleading. The reason the FINAL report uses longfin smelt as the basis for American shad, starry flounder, and bay shrimp outflow criteria is that it is apparently the only species for which the SWRCB is confident in making the X2-abundance argument. Therefore, they base the specific Delta outflow criteria on this single species. Yet the FINAL report acknowledges that the evidence for a strong X2-abundance relationship for longfin smelt is rapidly diminishing (SWRCB at 100).

The report admits that flow conditions are likely only one factor affecting abundance. The FINAL report acknowledges on page 102 that flow is only one factor affecting abundance, admitting in a discussion of an analysis of historical flows: "*Use of the pre-Corbula flow-abundance relationship underscores the need to address other stressors that may be affecting longfin smelt abundance concurrently with improved flow conditions*". Thus, the FINAL report only gives a passing acknowledgement to the need for a much more comprehensive analysis to quantify the actual impact of various flows on specific species.

SFCWA believes that flow criteria for American shad, starry flounder, and bay shrimp should not be inferred from another species (longfin smelt) that does not share their life history characteristics.

In fact, in several places the report acknowledges that *"[a]s our understanding of the effect of contaminants on primary production and species composition in the Sacramento River and Delta improves, flow criteria may need to be revisited.*" (p. 127). The legislative mandate required the Board to "*include the volume, quality, and timing of water necessary for the Delta ecosystem*…" (emphasis added) in this report. SFCWA believes best available science already supports establishing nutrient criteria as a more effective and efficient means to protect public trust resources than changing the flow criteria that already exist in D-1641. As we have presented in previous submittals to the Board, relationships between nutrient concentrations and ratios and the abundance of numerous species are much stronger than those between flow or X2 and species' abundance.

In addition to the voluminous body of literature on nutrient impacts to estuaries worldwide, recent research in the Delta also supports establishment of nutrient criteria. Wilkerson, et al. (2006) and Dugdale *et al*. (2007) show that "*bloom levels of chlorophyll are evident only when nitrate uptake occurs and that nitrate uptake only takes place at lower ambient ammonium concentrations.*" They conclude that ammonium concentrations greater than 4 μmol L^{-1} inhibit nitrate uptake by diatoms and thus suppress bloom formation. This level of ammonium is exceeded a majority of the time in the Sacramento River and in Suisun Bay. Parker *et al*. (*in prep*) conclude that "[*t]he quantitative reduction in primary productivity and nitrogen uptake at various points in the river was predictable and strongly related with NH_4 concentrations*."

In addition, the long-term data from the Delta show several significant trends. Glibert (*in press*) found that variations in nutrient concentrations and ratios are related to variations in the base of the food web, primarily the composition of algae, to variations in the composition of zooplankton, and to variations in the abundance of several fish species. Glibert (*in press*) states, *"[t]he overwhelming conclusion here is the fact that relationships between nutrients and fish are stronger than those of flow and fish (comparison of Figs. 20, 21 and Table 1).*" Glibert further states, *"[t]he present study supports the premise that reduction of the NH_4^+ effluent into the Bay Delta is essential to restoring historic pelagic fish populations and that until such reductions occur, other measures, including regulation of water pumping or manipulations of salinity, as has been the current strategy, will likely show little beneficial effect."*

Where the DRAFT report does acknowledge a water quality impact on the aquatic community, it chooses to address the water quality impairment with dilution flow rather than with source reduction. Not only is this approach contrary to the Clean Water Act, it is a wasteful and unreasonable use of waters of the State. For example, the report addresses low dissolved oxygen levels in the San Joaquin River with higher flows to dilute the upstream algal biomass rather than with actions to reduce the upstream load of oxygen demanding substances. A 2003 Central Valley Regional Water Board report attributes 30% of the oxygen demanding substance load to the City of Stockton Regional Wastewater Control Facility and 70% is to upstream algae loads (Gowdy and Grober 2003). Flows do not contribute loads of oxygen demanding substances they merely dilute the load.

The FINAL report should have addressed water quality impacts with source controls, not by using flows to dilute the problem.

The FINAL report (p. 93) mentions ammonium as an interesting hypothesis and mentions Dr. Pat Glibert, but does nothing with the information other than suggest more experiments are needed to evaluate the effect of nutrients on primary production and species composition. Comparatively, powerful weighting is given to the TBI/NRDC information on longfin smelt, which is the sole basis for the recommendation for 75% of unimpaired flow, even though X2 has no established causal relationship with longfin smelt and does not explain its decline over the last several decades.

SFCWA also notes that flow recommendations may, among other things, reduce predation risk (e.g., SWRCB at 60, 124). Nowhere, however, does the FINAL report mention the need to address the problem of predation itself. Recent analyses of four years of acoustic tag data by Dr. Robert MacFarlane of the National Marine Fisheries service indicates that losses of salmon on the Sacramento river are up to four times greater than other significant salmon watersheds and that the tag data show that diversions are not causing this effect, nor are the juvenile salmon reaching the south Delta pumps. In some years barely 2% of juvenile salmon make it out to the ocean. It would appear that excess predation within the water column or by birds is accounting for this effect. Flow variations during these study periods have not shown any survival effect. SFCWA recommends the SWRCB invite Dr. MacFarlane to discuss his preliminary findings, since predation in river reaches upstream of the Delta negates the value of Delta flow criteria.

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Gowdy M J, Grober LF. 2003. Total Maximum Daily Load for low dissolved oxygen in the San Joaquin River. Staff report to the California Environmental Protection Agency, Regional Water Quality Control Board, Central Valley Region. June 2003.

Parker AE, Dugdale RC, Wilkerson FP. *In prep*. Biochemical processing of anthropogenic ammonium in river and estuarine water columns.

Wilkerson FP, Dugdale RC, Hogue VE, Marchi A. 2006. Phytoplankton blooms and nitrogen productivity in San Francisco Bay. *Estuaries and Coasts* 29(3): 401–416.

Analysis of the July 20, 2010 Draft SWRCB Delta Flow Criteria Report Appendix B and Supporting CalSim Studies

The intent of Appendix B in the Draft SWRCB Delta Flow Criteria Report (Report) was to assess potential impacts of the Delta flow criteria to water supply and reservoir storage in the Central Valley and Delta. Evaluation of impacts was performed using CalSim II. Appendix B analysis assumptions were developed by SWRCB staff and implemented with technical support from the DWR.

MBK Engineers was asked by Sacramento Valley Water Users to review the CalSim simulations supporting Appendix B, document impacts on water supply and reservoir storage, and assess the reasonableness of the impact assessments given the underlying study assumptions. SWRCB staff provided MBK Engineers with the two CalSim scenarios – Scenarios A and B – and the CalSim baseline used in the Appendix B analysis. MBK Engineers had no involvement in the development of the Scenario studies or assumptions.

Scenario Description

Scenario A includes only Category A criteria as outlined in the Report. Scenario B includes both Category A and B criteria. Both scenarios were developed using a CalSim baseline (BO baseline) that includes the Delta smelt and salmon Biological Opinion RPA’s. The BO baseline was a very close approximation of the CalSim model used to support the DWR March 2010 *Draft State Water Project Delivery Reliability Report 2009*. The flow and water quality criteria contained in the baseline (D1641, Biological Opinions, etc.) remained in both Scenarios A and B. Category A and B flow criteria were implemented as additional requirements, not replacements. The impacts reported in Appendix B were measured by comparing Scenario A and B water supply and reservoir operations to the BO baseline. For further discussion of the scenario assumptions, refer to Attachment 1.

Analysis of Results

A brief summary of analytical results for some key system components is presented to demonstrate the extreme impacts of the proposed Delta flow criteria. This summary includes Delta outflow, water supply, and reservoir storage impacts. Because of the nature of the modeling performed in support of Appendix B, many of the impacts may be significantly underestimated.

Figure 1 shows, by water year type, the total average annual additional Delta outflows that would occur under Scenario A when compared to the BO baseline. On an annual average basis, outflow would conservatively be increased by 5,500,000 acre feet. It’s important to note that any increase in Delta outflow must come from an equivalent reduction in consumptive use in the Delta watershed including Sacramento basin, San

Joaquin basin, the Delta, and areas of export. Therefore, the 5,500,000 acre feet increase in Delta outflow will result in a 5,500,000 acre-feet decrease in consumptive use.

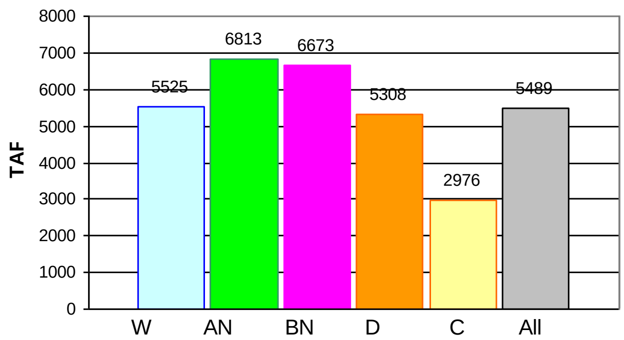

Figure 1 Scenario A Average Annual Increases in Delta Outflow over BO Baseline By Water-Year Type For 1922-2003

Sacramento and San Joaquin River Basin Water Use

Information submitted to the SWRCB by the Center for Watershed Sciences, University of California – Davis, in their report titled: *On Developing Prescriptions for Freshwater Flow to Sustain Desirable Fishes in the Sacramento-San Joaquin Delta, January 2010*, demonstrated that the annual average difference between unimpaired and historical Delta outflow for the 1986-2005 period is about 10,000,000 acre-feet. If SWRCB D1641, CVPIA, the smelt and salmon Biological Opinions, and other recent actions had been in effect for the entire 1986-2005 period of record, the difference between unimpaired and impaired outflow would have been reduced to approximately 8,000,000 acre feet. The difference between unimpaired and impaired Delta outflow represents consumptive use in the Delta watershed. So under existing laws and regulations and given the recent hydrology of 1986-2005, a rough estimate of combined annual average consumptive use and exports is 8,000,000 acre-feet. As discussed in the preceding paragraph, the proposed Delta flow criteria will cut this by 5,500,000 acre-feet on an annual average basis – a 69% reduction. This is very significant.

North-of-Delta Water Supply

Table 1 and Table 2 quantify Scenario A and B North of Delta deliveries by project and contractor type and compare them to baseline values. Key findings are:

- CVP Settlement Contractor deliveries were cut on average by 88% in Scenarios A and B.
- Deliveries to SWP Settlement Contractors were cut by 42% and 43% on average in Scenarios A and B respectively.
- Such cuts would not be allowed under existing contracts and water rights. As such, impacts of the Delta flow criteria are being underestimated elsewhere.

Table 1 Comparison of Scenario A and Base NOD Surface Water Deliveries

	CVP					SWP			CVP/SWP
	AG	M&I	Refuge	Sac. SC	Total	M&I	Fea. SC	Total	Total
Base	215	195	85	1860	2356	23	949	971	3327
Scenario A	44	203	59	224	530	19	539	557	1088
Difference (Scenario A - Base)	-171	8	-27	-1637	-1826	-4	-323	-414	-2240
Percent Difference	-79%	4%	-31%	-88%	-77%	-18%	-42%	-43%	-67%

Table 2 Comparison of Scenario B and Base NOD Surface Water Deliveries

	CVP					SWP			CVP/SWP
	AG	M&I	Refuge	Sac. SC	Total	M&I	Fea. SC	Total	Total
Base	215	195	85	1860	2356	23	949	971	3327
Scenario B	43	197	58	223	522	21	530	551	1073
Difference (Scenario B - Base)	-172	3	-27	-1637	-1834	-2	-327	-420	-2254
Percent Difference	-80%	1%	-32%	-88%	-78%	-9%	-43%	-43%	-68%

Shasta Storage and Cold Water Pool

Figure 2 illustrates impacts to end-of-April Lake Shasta storage. The exceedance probability plot compares baseline, Scenario A, and Scenario B Shasta storage with the NMFS BO end-of-April Shasta storage target of 3.8 million acre-feet. Key findings include:

- Baseline Shasta storage exceeds the NMFS BO end-of-April target 77 % of simulated years.
- Scenario A and Scenario B Shasta storage exceed the target in only 24% of simulated years.
- Such a reduction in end-of-April storage would significantly reduce the availability of cold water pool for summer and fall release.

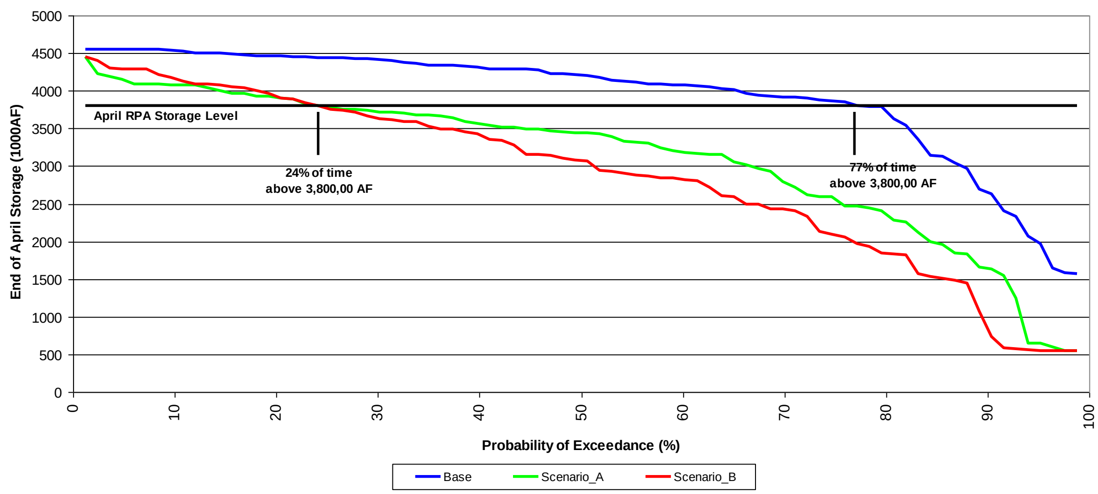

Figure 2 Probability of Exceedance Plot of Lake Shasta end-of-April storage

Figure 3 illustrates impacts to Lake Shasta carryover storage (end-of-September). The exceedance probability plot compares baseline, Scenario A, and Scenario B Shasta storage with the NMFS BO end-of-September Shasta storage target of 2.2 million acre-feet. Key findings include:

- Baseline Lake Shasta carryover storage exceeds the NMFS BO target of 2.2 million acre-feet in 81% of simulated years
- Scenario A Lake Shasta carryover storage exceeds the target in 67% of simulated years
- Scenario B Lake Shasta carryover storage exceeds the target in 57% of simulated years
- Cuts to CVP Settlement Contractor deliveries, though unreasonably large, were unable to restore Shasta carryover to baseline levels. According to SWRCB staff, the intended purpose of the delivery cuts to Settlement Contractors was to alleviate impacts to Shasta storage and cold water pool. The cuts were unsuccessful.

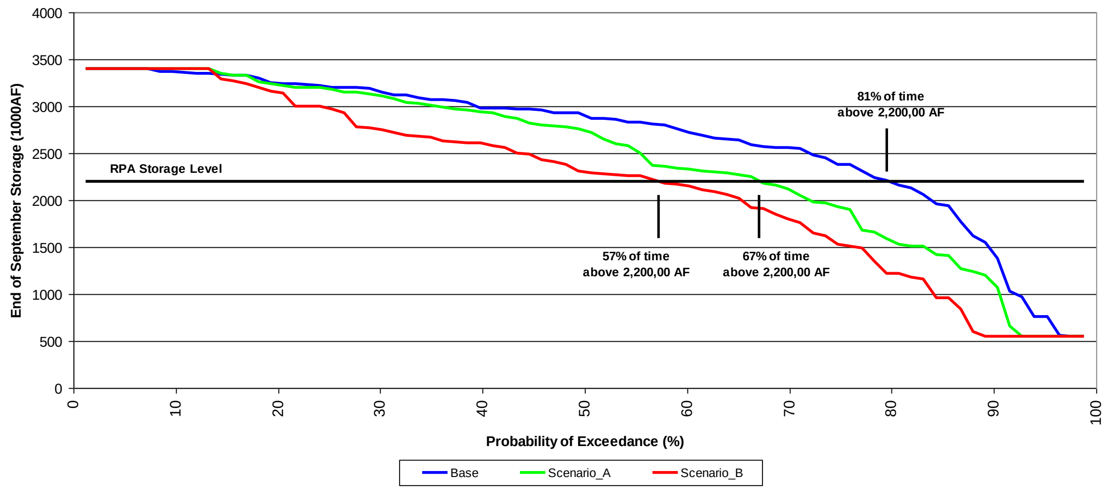

Figure 3 Probability of Exceedance Plot of Lake Shasta Carryover Storage

Keswick Dam Releases

Figure 4 shows the percent difference in Keswick Reservoir releases between Scenario A and Base by month and water year type; Figure 5 similarly illustrates the percent difference between Scenario B and Base. Key findings include:

- In both scenarios, winter and spring releases are significantly increased to meet the Delta flow criteria.
- In both scenarios, summer releases are significantly reduced in response to cuts in Settlement Contractor deliveries.
- The summer reductions in Keswick releases may not be allowable in real-time operations due to temperature impacts downstream of Keswick.
- If summer Keswick releases can not be significantly reduced from the baseline, Scenarios A and B are underestimating storage impacts of the Delta flow criteria at Shasta.

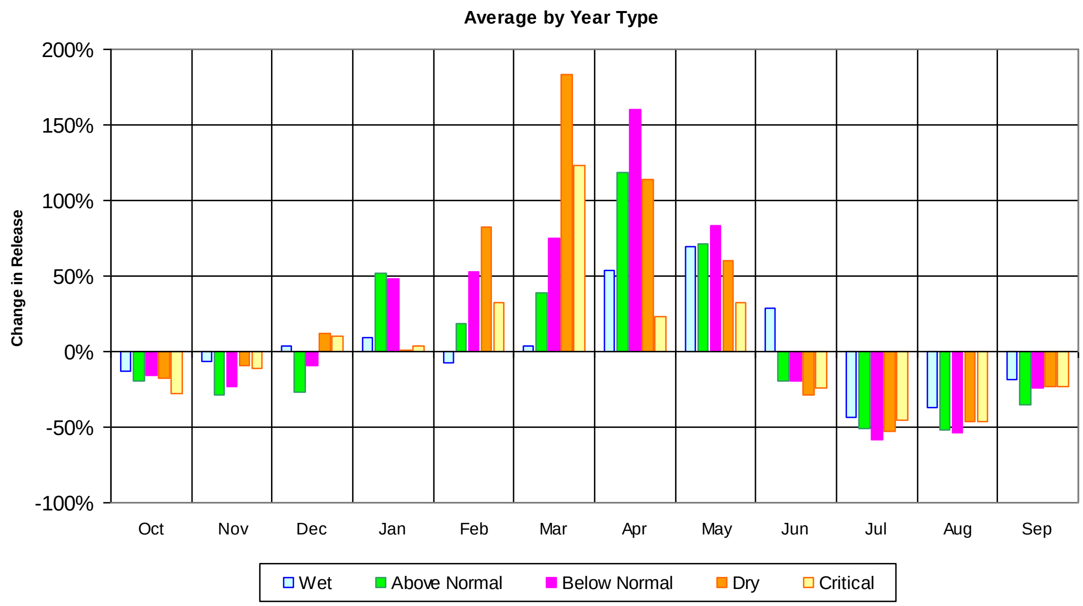

Figure 4 Percentage change in Keswick release between Scenario A and Base by month and water year type

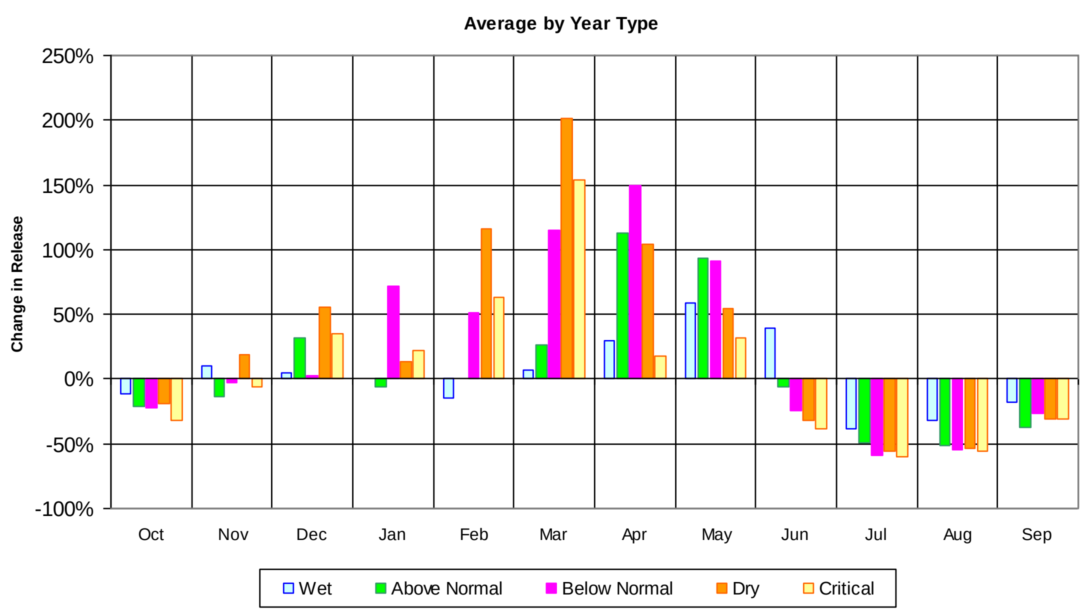

Figure 5 Percentage change in Keswick release between Scenario B and Base by month and water year type

Lake Oroville Storage

Figure 6 and Figure 7 illustrate Delta flow criteria impacts to Lake Oroville storage at the end-of-April and end-of-September, respectively. As shown in Figure 6, there could be a sizable reduction of available cold water pool going into the summer months.

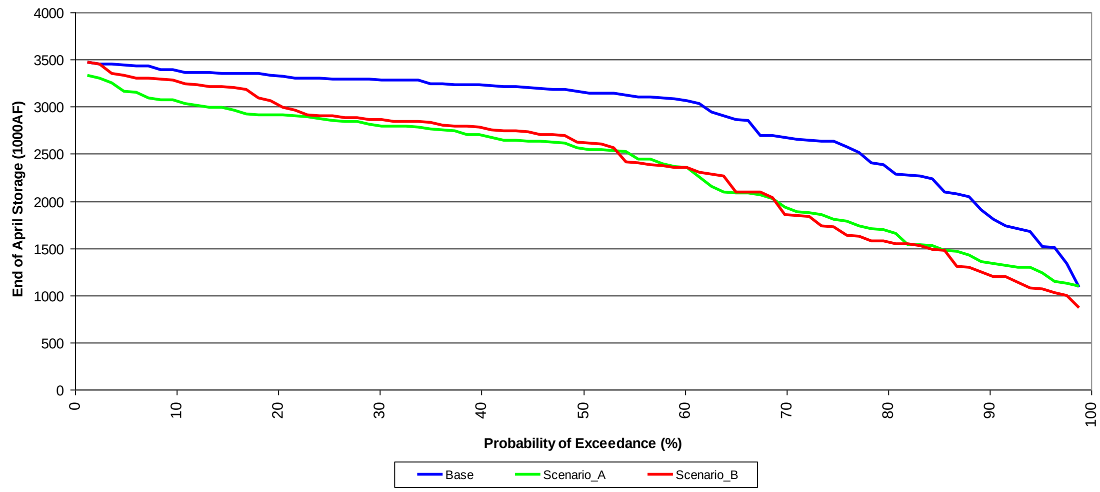

Figure 6 Probability of Exceedance Plot of Lake Oroville end-of-April storage

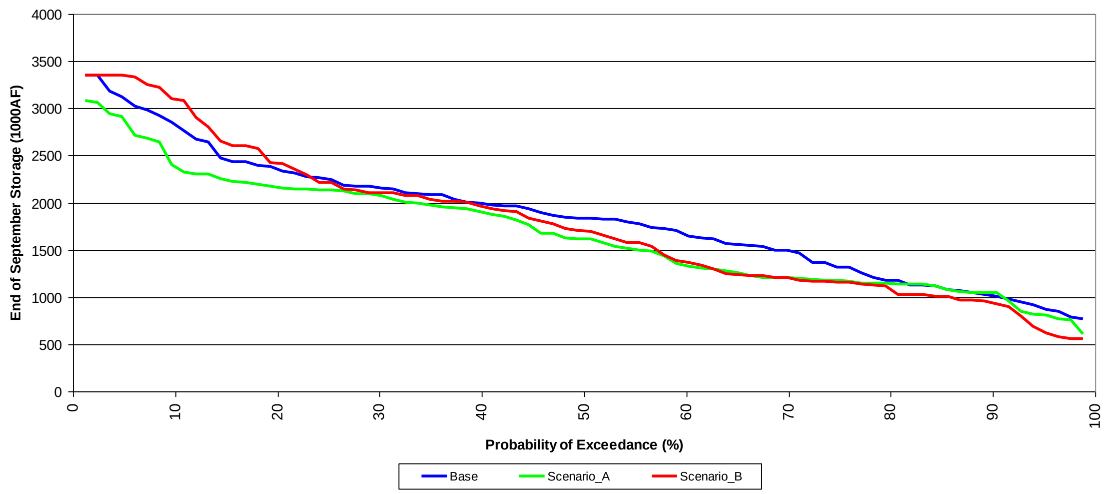

Figure 7 Probability of Exceedance Plot of Lake Oroville Carryover Storage

Folsom Lake Storage

Figure 8 and Figure 9 illustrate Delta flow criteria impacts to Folsom Lake storage at the end-of-April and end-of-September, respectively. As shown in Figure 8, there could be a sizable reduction of available cold water pool going into the summer months.

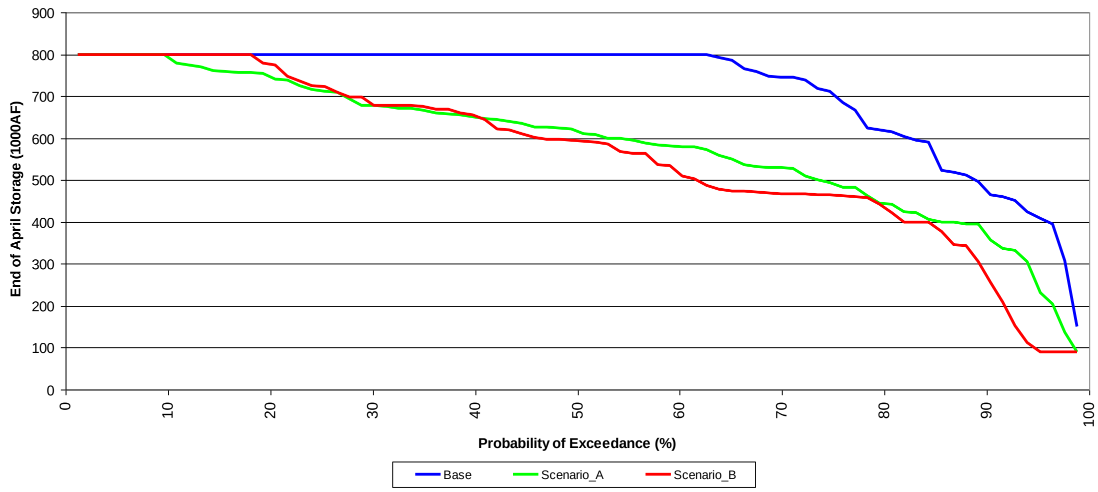

Figure 8 Probability of Exceedance Plot of Folsom Lake end-of-April Storage

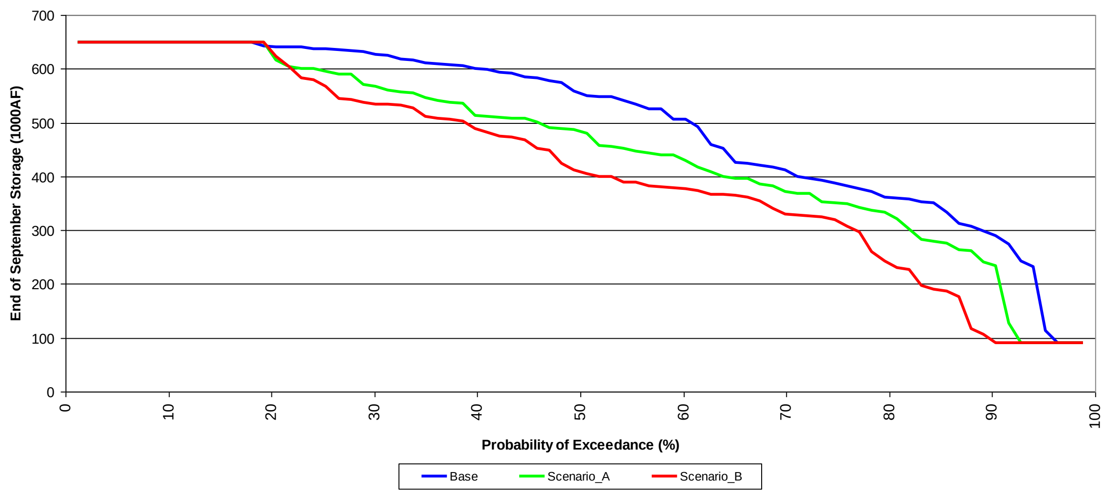

Figure 9 Probability of Exceedance Plot of Folsom Lake Carryover Storage

South-of-Delta Water Supply

Table 3 and Table 4 quantify Scenario A and B South of Delta deliveries by project and contractor type and compare those values to the baseline. Key findings:

- Cuts in South of Delta deliveries are in addition to already significant cuts caused by the FWS and NMFS BO's.
- Under the BO's, SWP Table A contractors receive approximately 60% of entitlement on average (2.5 million acre-feet of contractors' 4.2 million acre-feet entitlement).
- With the Delta flow criteria contained in the Report, SWP Table A contractors' deliveries were cut by 24% and 18% as compared to baseline in Scenario's A and B respectively.

- Deliveries in Scenarios A and B are equivalent to 45% and 50% of entitlement.
- South of Delta exporters were given lower priority than North of Delta storage in both Scenarios A and B. As such, further cuts in exports would likely have little positive impact on North-of-Delta storage.

Table 3 Comparison of Scenario A and Base SOD Deliveries

	CVP					SWP				CVP/SWP
	AG	M&I	Refuge	Exchange	Total	Table A	Art. 56	Art. 21	Total	Total
Base	874	116	273	852	2115	2492	90	50	2632	4747
Scenario A	493	78	226	816	1614	1898	24	29	1951	3565
Difference (Scenario A - Base)	-381	-38	-47	-36	-501	-594	-67	-20	-681	-1183
Percent Difference	-44%	-33%	-17%	-4%	-24%	-24%	-74%	-41%	-26%	-25%

Table 4 Comparison of Scenario B and Base SOD Deliveries

	CVP					SWP				CVP/SWP
	AG	M&I	Refuge	Exchange	Total	Table A	Art. 56	Art. 21	Total	Total
Base	874	116	273	852	2115	2492	90	50	2632	4747
Scenario B	531	79	224	793	1627	2050	35	48	2134	3761
Difference (Scenario B - Base)	-343	-37	-49	-59	-488	-442	-55	-2	-498	-987
Percent Difference	-39%	-32%	-18%	-7%	-23%	-18%	-61%	-3%	-19%	-21%

Delta Flow Criteria Report's Understatement of Impacts

Appendix B shows significant impact to both water supply and cold water pool if the recommended flow criteria were to take effect. However, due to assumptions made in the supporting CalSim studies and the lack of focus on groundwater and hydro-power it is likely that the impacts are significantly underestimated. Following are reasons for the understatement of impacts.

Trinity Imports

It was not noted in Appendix B that imports of water from the Trinity River to the Sacramento River basin were increased significantly in Scenarios A and B as compared to the baseline (48 TAF/ year and 65 TAF/year respectively). Based on CalSim operations logic, the increase was expected. As Shasta and Folsom Lake were drawn down, more water was imported from the Trinity to meet the Delta flow criteria while maintaining a storage balance between the CVP reservoirs. However, it is not realistic to expect large increases of Trinity Imports to support the new criteria because there are problems with the fishery on the Trinity River as well. Given the model is allowing additional imports, it is underestimating the impact to Shasta and Folsom storage.

San Joaquin River Flow at Vernalis

San Joaquin River Flow at Vernalis is overstated for three reasons:

i) In the model runs, SWRCB implemented a 75% unimpaired flow requirement at Vernalis from February to June rather than the recommended 60% as found in the Delta Flow Criteria Report.

ii) In Scenario B, the model mistakenly required 75% unimpaired flow at Vernalis from October to January when there was no such requirement in the Report.

iii) The San Joaquin River basin is not being reoperated from the baseline and therefore does not show the likely reduction in flow at Vernalis caused by the refilling of reservoirs in other months.

The overstatement of San Joaquin River flows at Vernalis has caused an understatement of impacts in Appendix B since the increased Vernalis flows are meeting Delta requirements that would have otherwise been met through reduced South-of-Delta exports or increased North-of-Delta reservoir releases.

San Joaquin River Basin

The SWRCB does not address potential impacts in the San Joaquin River Basin. It was not modeled in Scenarios A and B. However, the impacts to the San Joaquin will be just as severe as those illustrated in the Sacramento basin. There will be significant reductions in cold water pool to maintain fisheries on the Stanislaus, Tuolumne, and Merced Rivers. Water supply diverted from the San Joaquin River and its tributaries for in-basin consumptive uses will be reduced dramatically.

Dead Pool

As reported in Appendix B, storage in Trinity, Shasta, and Folsom reservoirs are reduced to dead pool for a significant number of months in Scenarios A and B. This is referred to as a “broken system”, where the model loses the ability to release water for in-basin use obligations. The same reservoirs are also reduced to dead pool storage in the baseline, but it is for a much shorter period of time. In real-time operations, such loss of control of the system must be avoided. Appendix B does not quantify the costs of having a broken system or the costs of avoiding it.

Groundwater

Effects to groundwater are not assessed in the analysis performed for Appendix B. Decreases in applied water for agriculture will result in less deep percolation to groundwater, thereby reducing groundwater contribution to stream flow. Because a significant portion of ground water recharge is due to applied irrigation water, there would likely be a significant decrease in stream accretion. This decrease is not reflected in the analysis, therefore the water supply and reservoir impacts are significantly underestimated.

In the absence of available surface water, irrigators will likely pump more ground water to compensate. A large degree of prolonged increases in groundwater pumping will likely lead to lower groundwater tables, and possibly mining of groundwater, throughout the Sacramento River basin. This increase in groundwater pumping and corresponding decrease in stream accretions is not addressed in the Appendix B analysis leading to a significant underestimate of impacts.

Lower groundwater tables will reduce groundwater contribution to stream flow in most streams and rivers throughout the Sacramento Valley. There are many smaller streams that contain critical habitat for endangered species, this habitat may be significantly reduced with decreases in groundwater tables.

Hydro-Power

Decreases in reservoir storage, described above, will reduce hydropower production. In addition to decreases in reservoir elevations, the timing of reservoir releases required to satisfy the proposed flow criteria will result in high flows when power needs are the lowest and greatly reduced flows with power requirements are the greatest. Spring time requirements described in the proposed criteria will cause reservoir releases to exceed power plant capacities, further reducing hydropower production. In addition, low reservoir storage resulting from the proposed flow criteria will likely render power houses useless and force reservoirs to use low level outlets that bypass power houses. The loss of hydropower will require the state to use alternative energy sources, including increases in fossil fuels, which lead to increases in green house gas emissions.

Refuges

Water supply impacts to refuges have not been fully quantified in the Appendix B analysis. However, there will likely be significant reduction in refuge water supply. This may cause reductions in habitat and affect water fowl.

Attachment 1

List of Category A criteria found in the SWRCB Delta Flow Criteria Report:

1. Delta Outflow: 75% unimpaired net Delta outflow from January through June.
2. Sacramento River: 75% unimpaired flow at Rio Vista from April through June.
3. San Joaquin River: 60% unimpaired flow at Vernalis from February through June.
4. San Joaquin River: October 10 day pulse flow at Vernalis of 3600 cfs
5. Delta Exports: Maximum Vernalis flow to export ratio of 0.33 during October pulse flow

List of Category B criteria found in the SWRCB Delta Flow Criteria Report:

6. Delta Outflow: Fall X2 requirements from September through November
7. Delta Outflow: 2006 Bay-Delta Plan Delta outflow objectives
8. Sacramento River: 75% unimpaired flow at Rio Vista from November through March
9. Sacramento River: Wilkins Slough pulse flows starting in November
10. Sacramento River: Positive flows downstream of Georgiana Slough from November through March
11. Sacramento River: 2006 Bay-Delta Plan flow objectives at Rio Vista
12. San Joaquin River: 2006 Bay-Delta Plan October pulse flow at Vernalis
13. OMR Flows: Greater than -1500 cfs during March and June of dry and critical water years
14. OMR Flows: Greater than 0 or -1500 cfs in April and May of dry and critical years depending on the FMWT index for longfin smelt
15. OMR Flows: Greater than -5000 cfs in all water year types from December through February
16. OMR Flows: Greater than -2500 cfs when salmon smolts are present
17. Delta Exports: Vernalis flows to exports ratio greater than 4 when juvenile Salmon are migrating in the San Joaquin River
18. Jersey Point: Positive flows when salmon are present in the Delta
19. Delta Exports: 2006 Bay-Delta Plan export to Delta inflow ratio

Scenario A Delta Flow Criteria Implementation

Scenario A implemented criteria 1-4. However, there were differences between the Delta Flow Criteria Report specifications and the CalSim implementation of criteria 3 and 4 as follows: The third criterion, as implemented in the model, required 75% unimpaired flow at Vernalis instead of the specified 60%, and criterion 4, as implemented, required an average October Vernalis flow of 1200 cfs rather than a 10 day pulse flow of 3600 cfs. The fifth criterion was not implemented in Scenario A.

Scenario B Delta Flow Criteria Implementation

Scenario B implements criteria 1-3 of Category A. Unlike Scenario A, Scenario B imposed caps on the unimpaired flow requirements. The caps were 70,023 cfs for Delta outflow (1), 40,000 cfs for Rio Vista flow (2), and 17,000 cfs for Vernalis flow (3). Scenario B does not include criteria 4 and 5 of Category A.

Scenario B implements criteria 6, 7, 8, 11, 12, 13, and 19 from Category B as numbered above. However, some of the implementations require explanation. Criterion 6, the Fall X2 requirement, is the same as the requirement in the current Delta smelt biological opinion. So while it's included in Scenario B, it's also included in Scenario A and the baseline. Criteria 7, 11, 12, and 19 are also included in the baseline and Scenario A as part of the 2006 WQCP. Criterion 8, the November through March Rio Vista unimpaired flow requirement, is limited to the same cap (40,000 cfs) as criterion 2 in Scenario B.

Many of the Category B criteria are dependent on the presence of fish. These criteria -- numbered 9, 10, 14, 16, 17, and 18 above -- are not implemented. However, there is overlap between the OMR criteria in the Delta smelt biological opinion and the OMR criteria recommended in the SWRCB Delta Flow Criteria Report. As such, there are stringent OMR criteria applied from December – March and June in the baseline and both scenarios. Furthermore, the salmon biological opinion sets a minimum Vernalis flow to export ratio of 4 in the months of April and May. As such, Scenario B implements criterion 17 in April and May, just as in the baseline, but does not in March.

Based on Scenario B input, there is another issue to address. An additional unimpaired flow requirement at Vernalis was imposed in Scenario B that was not part of the final SWRCB Delta Flow Criteria Report. The unspecified constraint calls for 75% of unimpaired flow at Vernalis from October through January. According to SWRCB staff, this was part of a previous draft of the criteria but was dropped. Scenario B was not changed to reflect the last minute edit. Therefore, in summation, the differences in flow requirements between Scenario B and the baseline are criteria 1-3 and 8 with the imposed caps on flow requirements, criterion 13, and the unspecified October-January Vernalis flow criteria.

San Joaquin River Vernalis Flow Assumption

In both Scenarios A and B, it was assumed that the necessary reservoir releases would be made and deliveries cut to meet the new San Joaquin River flow criteria at Vernalis (3 and 4). It was also assumed that the baseline flows, when in excess of the proposed criteria, would be maintained. This assumption does not account for the likely reduction in releases during non-criteria months to fill reservoirs depleted by the criteria. Therefore, Scenarios A and B are overstating the water that will be available from the San Joaquin River.

Settlement Contractor and Water Right Delivery Cuts

For both Scenarios A and B, the following reductions were imposed on CVP Settlement Contractor's contract entitlement according to water year type:

Year Type	Reduction
Wet	80%
Above Normal	90%
Below Normal	100%
Dry	100%
Critical	100%

Consumptive use in CVP settlement contractor's place of use was also reduced to prevent large increases in groundwater pumping to replace the lost surface water deliveries.

Reductions were not directly placed on SWP Settlement Contracts or Feather River Water Rights. Instead, consumptive use at the place of use was reduced by water year type:

Year Type	Reduction
Wet	30%
Above Normal	45%
Below Normal	55%
Dry	45%
Critical	45%

The intent was to both reduce surface water deliveries and groundwater pumping.

South of Delta Exports

South-of-Delta exports, except those necessary for health and safety (900 – 1100 cfs), were given a priority one step up from Delta surplus in Scenarios A and B. This means that North-of-Delta reservoirs do not release water to support Delta exports. In Scenarios A and B, exports would otherwise be Delta surplus as defined using the proposed Delta outflow criteria combined with existing flow and water quality regulations.

Other Issues

Stage 1 transfers are included in both the Scenarios and baseline. In Scenario A, there is on average 18 TAF per year more transferred from NOD to SOD. These exports do not come out of Delta surplus. They were probably created with increased groundwater pumping.

There are likely more Sacramento Basin delivery cuts implemented in Scenarios A and B than are being accounted for in Appendix B. For instance, consumptive use at node 17302 and 11306 were cut according to the same schedules listed above for SWP Settlement Contractors. This results in a 123 TAF/yr reduction in surface water diversions that isn't accounted for in Appendix B or in the North-of-Delta delivery calculations in Table 1 and Table 2 of this report.