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ARNOLD SCHWARZENEGGER, *Governor*
JOHN McCAMMAN, *Director*

February 7, 2010

Charles R. Hoppin, Chair
State Water Resources Control Board
1001 I Street
Sacramento, CA 95814

Subject: Additional Information Related to the San Joaquin River Flow and Southern Delta Salinity Objectives Included in the 2006 Water Quality Control Plan for the San Francisco Bay/ Sacramento-San Joaquin Delta Estuary

Dear Mr. Hoppin:

The Department of Fish and Game (Department) would again like to thank the State Water Resources Control Board (SWRCB) for the opportunity to provide input at both your January workshop on the Draft Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives) released on October 29, 2010 and through these follow-up comments. As was stated previously, the Department commends the SWRCB staff for their diligence to this point with the complex water issues involving the Sacramento-San Joaquin Delta (Delta) and its watershed.

We agree with the general consensus that was heard from the panel members at the January workshop that flow within the San Joaquin River system is vitally important for California's fish and wildlife resources, and that adequate flow within and from the San Joaquin River to the Delta is necessary to restore and maintain sustainable and resilient populations of these resources. The Department continues to offer our assistance to the SWRCB and your staff by providing sound science and biological expertise as you follow a phased approach to address these issues. With this in mind, and to fulfill our public trust responsibilities, the Department offers the following additional information to address questions and concerns expressed by the Board Members, comments regarding the presentations made at the workshop, comments submitted to the SWRCB, and recommendations for implementing new flow objectives. Should you have any questions or require clarification, please contact me at (916) 445-1231.

Sincerely,

Carl Wilcox

Carl Wilcox
Water Branch Chief

Enclosure

Conserving California's Wildlife Since 1870

Additional Information Related to the San Joaquin River Flow and Southern Delta Salinity Objectives Included in the 2006 Water Quality Control Plan for the San Francisco Bay/ Sacramento-San Joaquin Delta Estuary

Further Response to Questions from the Board

On Using a Percentage of the Unimpaired Flow. As the Department has stated before, we support the use of natural flow regime based flow criteria for the San Joaquin River (SJR) and its tributaries. Many of the panel members at the January workshop discussed the benefits and weaknesses of using the calculated unimpaired flow as the basis for setting these flows and we agree with the caveats as presented. We also understand that implementing this method has some difficulties and almost unlimited options. As shown in the Draft Technical Report on the Scientific Basis for Alternative San Joaquin River Flow and Southern Delta Salinity Objectives (Report), unimpaired flow fluctuates wildly from occasional early winter storms with direct rainfall runoff, to large snowmelt runoff occurring in April, May and June in nearly all years. Biologically, instream flow fluctuations are desirable, provided the descending portion occurs more gradually than ascending instream flows. The Department supports the method of averaging short duration flows rather than the averaging of long duration flows. Short-term (3-5 days) unimpaired flow averaging would still provide swings in instream flows, while long-term averaging would minimize these flow variations. We believe variable flow patterns will best restore conditions that meet salmonid biological requirements. The Department also realizes the many uncertainties associated with developing reliable runoff forecasts. Therefore, we suggest the SWRCB develop a system irrespective of forecast information as discussed below in our recommendations for implementation.

Temperature. Several questions were asked at the workshop regarding water temperature issues in relationship to the requirements for healthy salmon and steelhead. The Department recommends that the SWRCB continue to explore the effects of potential flow-setting requirements on downstream water temperatures. Although this is a complicated issue, basing flow releases on a natural flow regime, with a fair share from every tributary that also maintains desired ecological processes, would lessen the impacts of the minimum current flow requirements for most of the river throughout most of the year for most year types. We do have some concerns about the ability to maintain summer and fall temperatures for steelhead immediately downstream of the rim reservoirs and would recommend that this area of analysis be a priority as this process moves forward.

Below are examples displaying the relationship between flows and water temperatures during the appropriate time of year for different anadromous life-stages.

The Department strongly believes that reducing late spring water temperatures is necessary to maximize smolt out-migration habitat quality, which is a precursor to maximizing smolt out-migration abundance. Specific information about Tuolumne River thermal requirements necessary to maximize smolt out-migration habitat quality is presented in Figures 1 and 2. These figures demonstrate that increased late spring flows are strongly associated with reduced water temperatures and that as spring flow increases, water temperature substantially decreases.

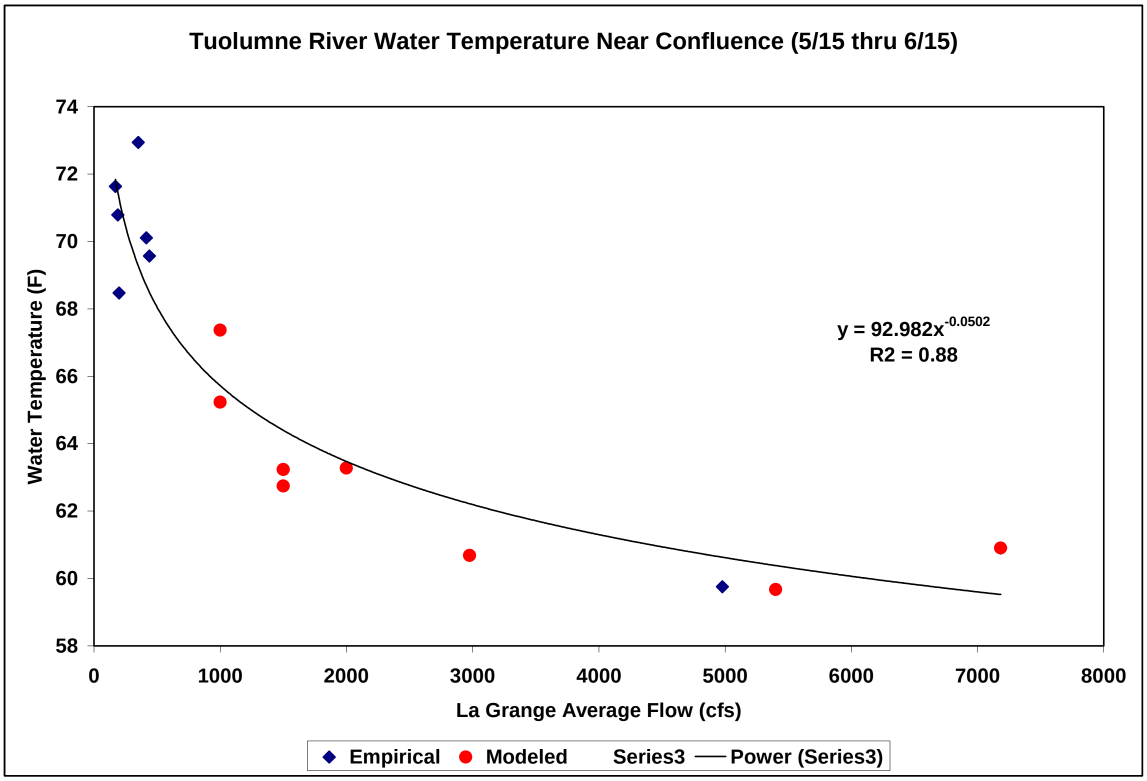

Figure 1: Comparison of Tuolumne River water temperature with instream flow levels.

Figure 1 data points include historical flow and water temperature response results for years 1999 through 2006 (e.g. time frame is May 15 to June 15). May 15 is the approximate date the water districts begin to decrease flows, yet approximately 30 percent of the smolts are still present in the river. The data points are either empirical (real field data) (blue diamonds) or modeled (red circles) per the San Joaquin River Basin HEC5Q Water Temperature Model Developed for the CalFed Ecosystem Restoration Program. Each empirical data point represents the 32 day average (May 15 to June 15) of daily maximum water temperatures. For the modeled data, the data point represents temperatures at 1800 hours (on a daily basis) which corresponds to the daily maximum water temperature. The non-linear line (Series 3-Power) (i.e. curved line instead of a straight “linear” line) is derived from the combined empirical and modeled generated data sets. The smoltification water temperature criteria is 59°F (15°C).

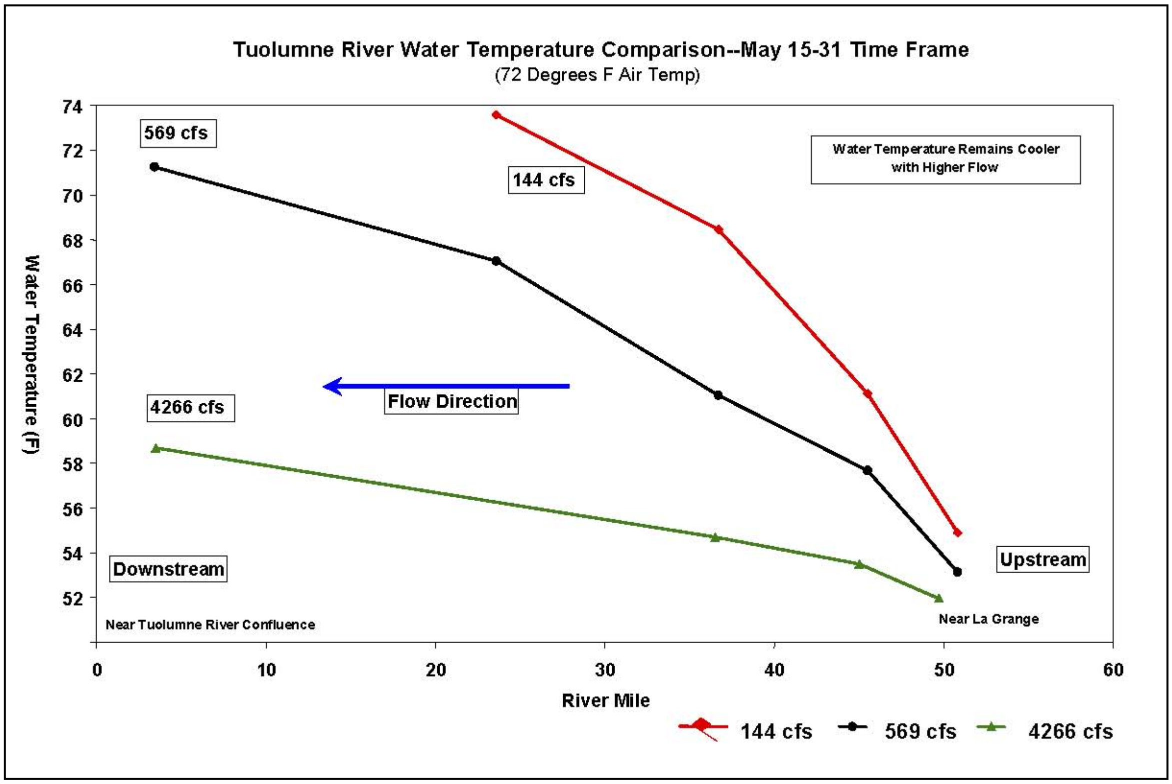

Figure 2: Spring Tuolumne River water temperature as function of flow level.

Figure 2 shows the relationship between La Grange Dam water release volumes and water temperatures. There is a logical inverse relationship where increasing flows results in decreasing water temperatures further downstream of La Grange Dam. The greater the flow the farther downstream cooler water is provided. This cooling of the water temperatures is seen from the dam to the mouth of the river during the late spring time period when salmon smolts are migrating out of the Tuolumne River. Both the reduced and elevated flow levels depicted in this figure occurred during similar meteorological conditions (approximately 72ºF). In general, elevated flows have the ability to withstand meteorologically induced thermal warming of the water as it moves downstream in the Tuolumne River. The presence of colder water extends the smolt outmigration window, increasing smolt outmigration survival and abundance.

Merced River Water Temperature Model. - Merced Irrigation District (Merced ID) has developed and calibrated a Water Balance/Operations Model and a Water Temperature Model. We have reviewed the results from the two models for the Case 1 scenario, which represents Merced ID's current project operations. According to Merced ID's Water Balance/Operations Model Technical Memorandum (Merced Irrigation District 2010):

> *"The model was developed and validated with inputs designed to represent historical operations. It was then used to develop two separate base case scenarios. The first scenario represented*

> *current conditions (Case 1) and includes flows and releases Merced ID is currently obligated to provide.* ***Case 1 represents how Merced ID currently operates the Project, and includes all current physical, regulatory and contractual constraints.****"* [Emphasis added.]

Through inspection of selected model results, as discussed below, we can identify and isolate direct project effects on water quality (temperature) and quantify (streamflow) variables. The following three plots depict the Case 1 results from the water balance/operations model for the reach below New Exchequer Dam and for the reach below the Crocker-Huffman diversion dam. The plots also depict the Case 1 results from the water temperature model for the reach immediately below McSwain Dam, the reach immediately below the Crocker-Huffman Diversion Dam, and for the Merced River at the Highway 59 bridge. To be consistent with the Pre-Application Document, water years 2006, 2000, and 1990 were selected as representative wet, normal, and dry water years, respectively.

By comparing the simulated project releases below New Exchequer to the simulated instream flow releases below Crocker-Huffman, we can identify the direct project effects on water quantity (e.g., streamflow) in the lower Merced River. This is particularly evident during the November/December through March/April period when Merced ID is taking little or no water through its Main Canal diversion at the Crocker-Huffman impoundment.

In addition, by comparing the simulated mean daily water temperatures from project releases below McSwain Dam to the water temperatures below Crocker-Huffman and at the Highway 59 bridge, we can identify the direct project effects on water quality (e.g., temperature) in the lower Merced River.

During the representative wet water year, project releases from New Exchequer are nearly identical to the instream flow releases below Crocker-Huffman during November 1 through February 28 period when Merced ID is not taking water through its Main Canal diversion. In addition, project releases through New Exchequer for rain and snowmelt runoff operations in early-January, early-March, early- April, late-April, late-May, and early-June are commensurate with the instream flow releases below Crocker-Huffman. The additional power generation releases through the New Exchequer powerhouse from early-July through late-July are also easily identifiable and directly affect streamflows below Crocker-Huffman.

Direct project affects on water temperatures below Crocker-Huffman are also easily identifiable during the representative wet water year. The water temperature is generally below 13.9°C (57°F) at Highway 59 through July 1 when the project is making the rain- and snowmelt-related operational releases. However, when the project ceases these operations, the water temperature quickly increases to 20.6°C (69°F) until the additional July power generation releases serve to moderate the water temperatures. During the late-July through mid-September period when only the minimum required flow is released below Crocker-Huffman, the water temperature at Highway 59 is consistently at 22.2°C (72°F) to 22.8°C (73°F). During the late-September period when project releases below New Exchequer increase for power generation purposes, the instream releases below Crocker-Huffman increase and the water temperature at Highway 59 quickly drops to around 15.6°C (60°F).

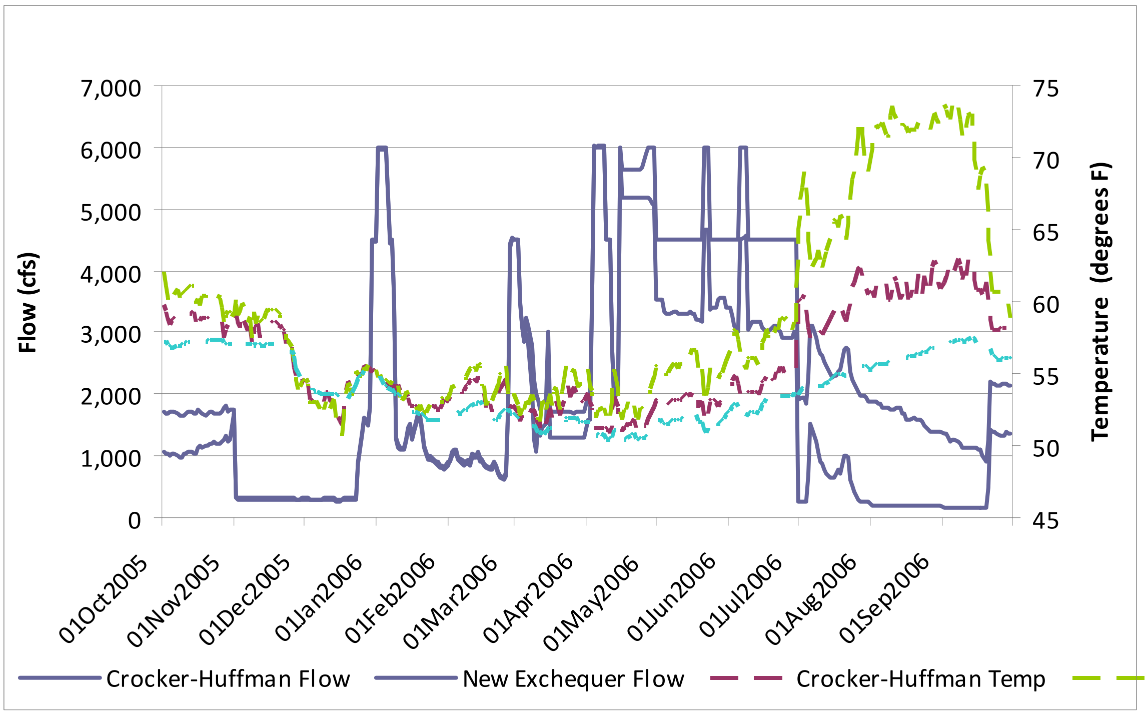

Figure 3: Lower Merced River - Water Year 2006 (Wet)

During the representative normal water year, project releases from New Exchequer are again nearly identical to the instream flow releases below Crocker-Huffman during the December 1 through February 29 period when Merced ID is not taking water through its Main Canal diversion. In addition, project releases through New Exchequer for rain and snowmelt runoff operations during the mid-February through the mid March period are again commensurate with the instream flow releases below Crocker-Huffman. Project releases to meet Davis-Grunsky and the Vernalis Adaptive Management Plan (VAMP) release requirements during the mid-April thru mid-May period can also be observed and directly affect streamflows below Crocker-Huffman.

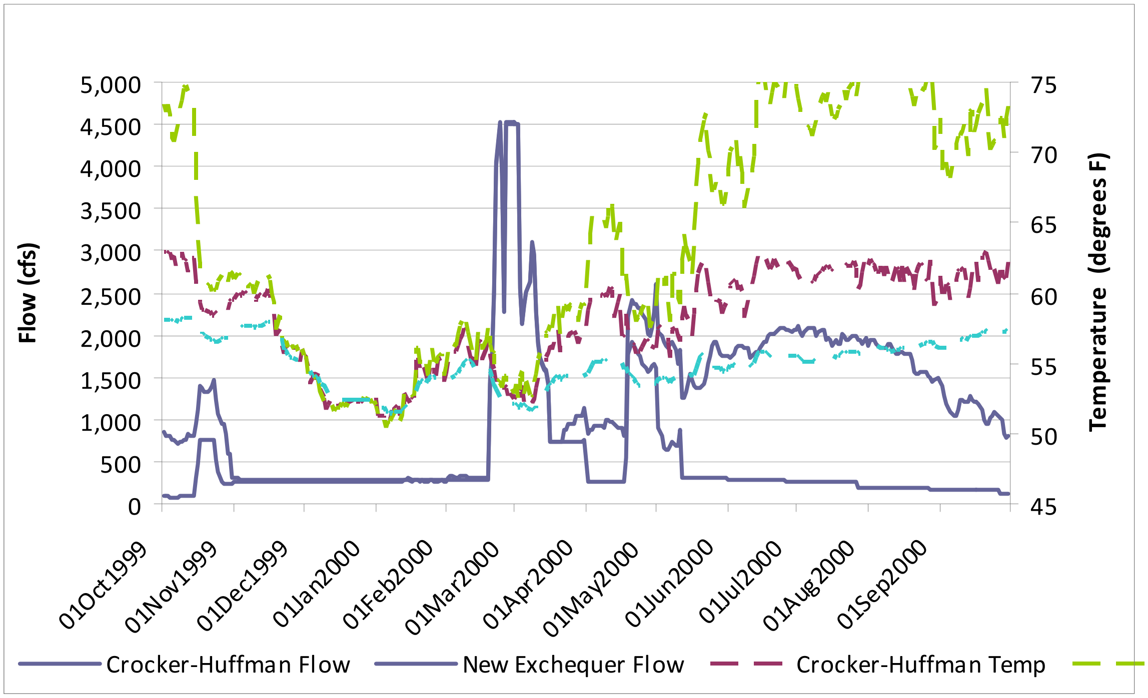

Figure 4: Lower Merced River - Water Year 2000 (Normal)

Direct project affects on water temperatures below Crocker-Huffman are also evident during the representative normal water year. During the early- to mid-April period, instream flow releases below Crocker-Huffman are 250 cubic feet per second (cfs), and the simulated mean daily water temperatures at the Highway bridge are approximately 18.3°C (65°F). When project releases are increased to meet VAMP requirements, as discussed above, the water temperatures drop to less than 15.5°C (60°F). Once the instream releases below Crocker-Huffman are returned to their base flow in mid-May, the simulated mean daily water temperatures at the Highway 59 bridge quickly reach 21.1°C (70°F) or higher.

During the representative dry water year, project releases from New Exchequer are nearly the same as the instream flow releases below Crocker-Huffman during the November 16 through February 28 period when Merced ID is taking little or no water through its Main Canal diversion at Crocker-Huffman. Project releases to meet the fall fishery release requirement during the last two weeks of October are also quite evident.

Direct Project affects on water temperatures below Crocker-Huffman during the representative dry water year are easily identifiable–particularly when compared to the normal water year plot presented above. During the representative normal water year, mid-summer project releases hovered around 2,000 cfs while simulated mean daily water temperatures were generally between about 21.1°C (70°F) and about 23.9°C (75°F) at the Highway 59 bridge and between about 15.6°C (60°F) and 17.2°C (63°F) immediately below Crocker-Huffman. However, during the representative dry water year, mid-summer project releases hovered around 1,000 cfs while simulated mean daily water temperatures were generally between about 23.9°C (75°F) and 26.7°C (80°F) at the Highway 59 bridge and 18.3°C (65°F) immediately below Crocker-Huffman. Thus, the direct effect of higher project releases serves to reduce water temperatures in the lower Merced River–even with comparable instream releases below Crocker-Huffman.

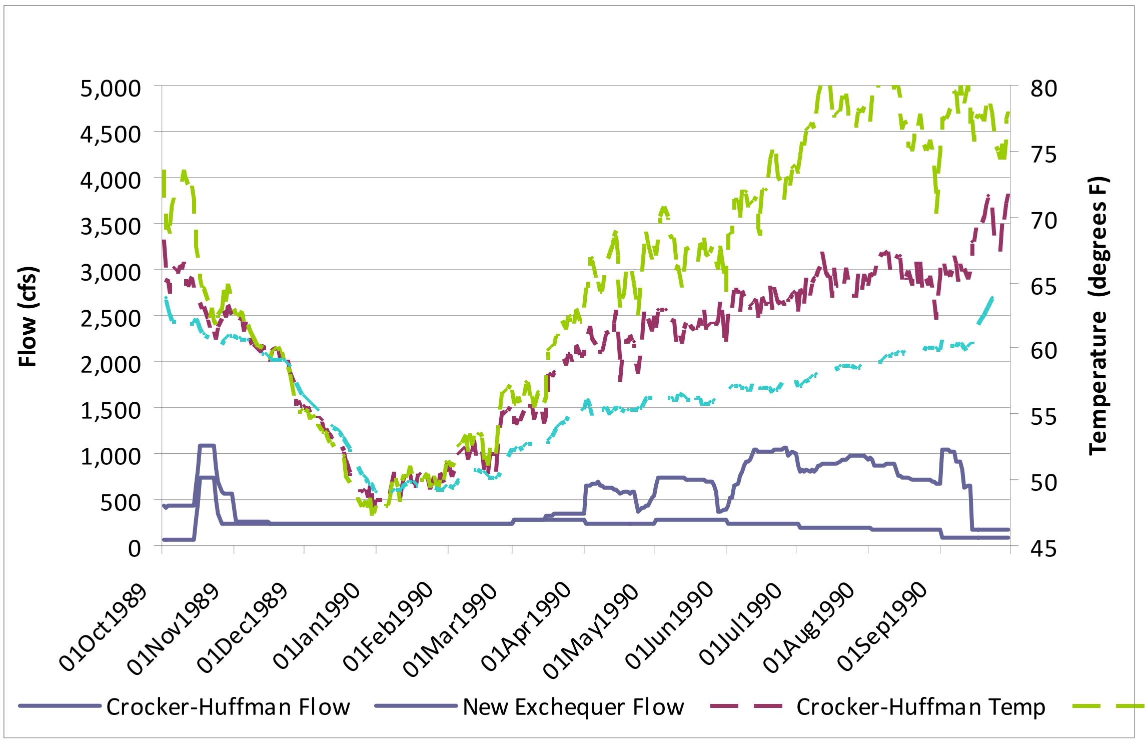

Figure 5: Lower Merced River - Water Year 1990 (Dry)

In summary, the observed direct project effects as described above, demonstrate a direct relationship between lower water temperatures and increased flows.

In addition, Board members expressed concern that additional flows from the mainstem of the SJR above the confluence of the Merced River may have negative impacts to the temperature of the system below the confluence due to the potentially high water temperatures developed in the mainstem as the water travels the 150 miles from Friant Dam. The Department agrees with several of the panel members that this issue is important. However, the highest flows required under the San Joaquin River Restoration Program (SJRRP) will occur in the spring when safe temperatures will be easier to maintain. Additionally, the SJRRP understands that they must manage these temperature issues so that a viable population of salmon can be restored to the mainstem of the San Joaquin above the Merced confluence without impacting other anadromous fish in the system.

Cause and Effect of Water Temperature on Salmon Juveniles. There is direct evidence for cause and effect of water temperature limiting salmonid populations in the SJR tributaries. The evidence strongly indicates that fall-run Chinook salmon smolts do not leave the river unless they have adequate (lower) water temperatures. In summary, water operations of the lower rim dams/reservoirs directly affect water temperatures in the lower SJR tributaries by reducing flows in the spring. This lack of flow results in elevated water temperatures in the lower tributary nursery and out-migration corridors preventing sufficient production of juvenile salmon. Lack of adequate juvenile production in the tributaries, and corresponding survival into and through the South Delta, prevents SJR tributary salmon populations from maintaining levels that are at a low risk of extinction, are considered to be in good condition, and provide substantial contribution to inland and ocean fisheries.

Substantial water operation and water temperature data have been collected in the SJR basin. The Department analyzed these data, and compared them against water temperature criteria for Chinook salmon and steelhead rainbow trout (EPA 2003), and concluded that water temperature was impaired for these two species in the SJR basin.

These water operations and water temperature data, along with ambient air temperature, have been incorporated into a hydrodynamic and thermodynamic computer simulation model (Dotan et.al. 2009). This model, referred to as the lower SJR basin water temperature model (Temperature Model), indicates that reservoir water operations (e.g. storage patterns and release volume) can decrease water temperatures in the lower SJR tributaries. Thus, there is a direct nexus between SJR tributary reservoir operations and water temperature conditions in the lower river sections. Further evidence of this linkage is shown in the Temperature section above. Tributary flows based on a percentage of unimpaired flow patterns would lower water temperatures during the spring when colder water temperature is crucial for smolt development and emigration (e.g. outmigration) success.

Water temperatures can impair juvenile Chinook salmon (smolts) in several ways: i) inducing adult mortality as adults migrate into the SJR and tributaries to spawn (i.e. pre-spawn mortality), ii) reducing egg viability for eggs deposited in stream gravels, iii) increasing stress levels and therefore reducing survival of juveniles within the tributary nursery habitats, and iv) reducing salmon smolt out-migration survival as smolts leave the nursery habitats within tributaries to migrate down the SJR to Vernalis and through the South Delta. Direct evidence for cause and effect of water temperature limiting SJR salmon production occurs within the last category, smolt survival.

Water temperature criteria for Chinook salmon smolts have been developed by USEPA Region 10 (EPA 2003). These criteria (Table 2) have been substantially peer reviewed. The Department relied on these criteria because the EPA completed a very thorough literature review for water temperatures to protect cold water fish species (trout and salmon), referencing 41 sources that included five issue papers. The issue papers, in turn, referenced nearly 700 citations. As a result, EPA's recommendations are grounded in a broad spectrum of the scientific literature across North America, including California, parts of Europe and New Zealand for developing chronic protective temperature criteria for anadromous fish populations across multiple generations. This approach is consistent with the Department's emphasis on chronic population based thresholds for reproductive success and recruitment success of an entire population across each generation. Taking a chronic exposure approach recognizes the evolutionary importance of multi-year class life history strategies of salmon and steelhead. In contrast, acute to sub-acute exposure to high temperatures emphasizes "tolerance" temperatures, which is the survival of a group of individuals across a short time period.

Table 2. EPA temperature thresholds for Pacific migratory salmonid species and life stages.

Salmonid Life History Phase Terminology	**EPA-based Recommended Temperature Thresholds to Protect Salmon and Trout**[1] (Criteria are based on the 7-day average of the daily maximum values)
Adult migration	<64°F (<18°C) for salmon and trout migration <68°F (<20°C) for salmon and trout migration - generally in the lower part of river basins that likely reach this temperature naturally, <u>if</u> there are cold-water refugia available [but no evidence of such refugia are available for the San Joaquin, Stanislaus, Tuolumne and Merced Rivers]
Incubation	<55°F (<13°C) for salmon and trout spawning, egg incubation, and fry emergence
Juvenile rearing (early year)	<61°F (<16°C) for salmon "core" juvenile rearing - generally in the mid- to upper part of river basins
Smoltification	<59°F (<15°C) for salmon smoltification <57°F (<14°C) for steelhead smoltification (for composite criteria steelhead conditions are applied)
Juvenile rearing (late year)	<64°F (<18°C) for juvenile salmon and steelhead migration plus non-Core Juvenile Rearing - generally in the lower part of river basins

[1] Water temperature thresholds taken from: United States Environmental Protection Agency (EPA). 2003. EPA Region 10 Guidance for Pacific Northwest State and Tribal Temperature Water Quality Standards. EPA 910-B-03-002. 49 pp. April. The EPA identified temperature unit is: Seven day average of the daily maximum water temperature (7DADM).

In addition, EPA (2003), stated:

> *"This metric is recommended because it describes the maximum temperatures in a stream, but is not overly influenced by the maximum temperature of a single day. Thus, it reflects an average of maximum temperatures that fish are exposed to over a weeklong period. Since this metric is oriented to daily maximum temperatures, it can be used to protect against acute effects, such as lethality and migration blockage conditions. This metric can also be used to protect against sub-lethal or chronic effects (e.g., temperature effects on growth, disease, smoltification, and competition)…"*

EPA (2003) also stated:

> *"It is important to note that there are also studies that analyzed sub-lethal effects based on maximum or 7DADM temperature values which need not be translated for purposes of determining protective 7DADM temperatures. For example, there are <u>field studies</u> (emphasis added) that assess probability of occurrence or density of a specific species based on maximum temperatures [Issue Paper 1, Haas (2001), Welsh et al. (2001)]. These <u>field studies</u> (emphasis added) represent an independent line of evidence for defining upper optimal temperature thresholds, which complements laboratory studies."*

As such, this criteria (e.g. 7DADM) is a chronic threshold to protect a population of anadromous fish across multiple generations. In addition, this is an average, meaning a range of values, not constant values, were used to calculate a criteria value. Elevated daily temperatures across 7 days indicate the fish are not being briefly exposed across time. The daily water temperature range is very narrow at higher temperature values (as opposed to a wide range of values) in the SJR and tributaries, thus the fish are not briefly exposed to elevated temperatures.

As is evident in the above table (e.g. EPA Temperature Criteria), water temperatures above 59°F are too warm to adequately protect chinook salmon smoltification. This is seen in three ways: i) number of adult recruits relative to average daily maximum water temperature at the Merced River Mouth during the early spring time period (Figure 6), ii) the number of natural adult recruits relative to the number of days that the maximum water temperature at the Merced River mouth when less than 59ºF for the spring time period (Figure 7), and iii) juvenile (smolt) salmon survival as a function of water temperature indicating that as water temperature rises smolt survival decreases (Stillwater Sciences 2004). Collectively, these data indicate that juvenile salmon (smolts) are not emigrating in sufficient quantity from SJR tributaries to keep SJR salmon populations in good condition. This helps explain why both the Tuolumne and Merced River fall-run Chinook salmon populations are at a high risk of extinction because natural production has greatly been reduced during the spring in most years due to elevated spring time water temperatures that have prevented adequate smolt production (Mesick 2009, 2010).

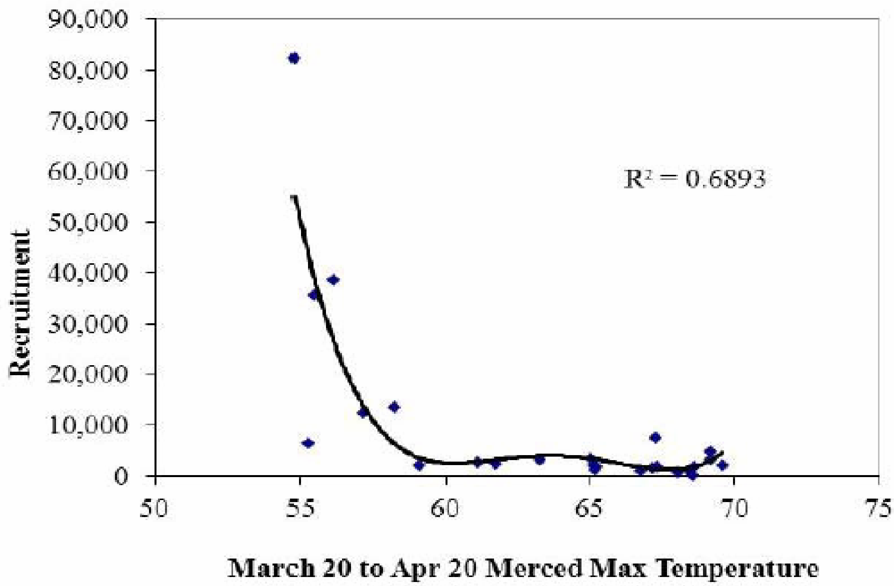

Figure 6: The number of natural adult recruits relative to the average daily maximum water temperature at the Merced River mouth form March 20 to April 20 when the cohorts migrated as juveniles toward the ocean from 1980 to 2004. Adult production sharply decreases when water temperatures are greater than 59ºC (From Mesick 2010).

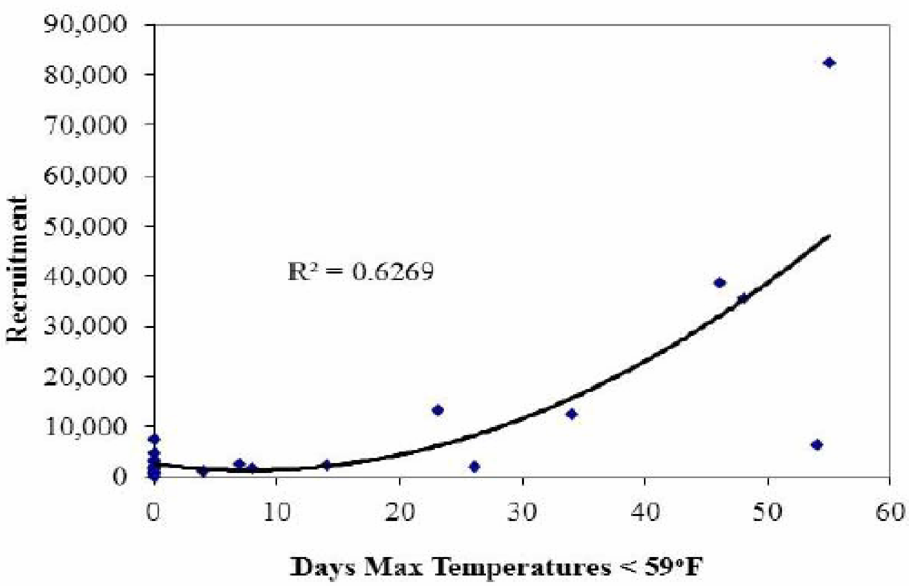

Figure 7: The number of natural adult recruits relative to the number of days that maximum water temperature at the Merced River mouth was less than 59° F from March 20 to June 15 when the cohorts migrated as juveniles toward the ocean from 1980 to 2004. From Mesick (2010).

In summary, smolts are not leaving SJR tributaries in sufficient quantity to maintain SJR salmon populations in good condition. Providing higher spring flows, which would occur within a percentage of unimpaired flow framework, would result in colder water temperatures and higher smolt production in the SJR tributaries, higher smolt production entering, and exiting, the South Delta. Increased spring flows from the SJR tributaries has additive benefits by moving more juveniles into, and through, the South Delta. Increased juvenile (smolt) production is necessary to improve adult production and overall population health and resiliency.

Adaptive Management. The Board Members asked several questions related to adaptive management. As many panelists responded, since science cannot predict with much precision how the SJR ecosystem will respond to a changed flow regime, especially considering all the uncertainties associated with future land use and climatic conditions, we strongly support implementing an adaptive management program. Below, in our comments on implementation, we further explain how we would recommend that the SWRCB use the concept of adaptive management to implement their amendments to the Basin Plan.

Water is Fish Habitat. At one point during the workshop there was a discussion about water as habitat. The Department strongly supports the concept that water does provide the living space for aquatic organisms that live within the water column. This living space has two components, quality and quantity. In order for aquatic populations to be viable, they need both adequate quantity and quality of that living space. Through many State and federal programs, society has invested a tremendous amount of funding, regulation and other efforts to address the quality of this space. Unfortunately, as the hydrological section of the Report illustrates, the quantity of living space has continued to decrease over time as more water has been diverted for other beneficial uses. The Department strongly believes that adequate flows, both for the processes they support, and for the living space it provides, be a primary goal for the SWRCB in setting flow requirements.

Responsibility of Water Managers for Conditions Outside of their Control. Some of the discussion during the workshop concerned the question of whether the water managers would be responsible for all the population fluctuations to the targeted fish species. In this case, the situation was postulated that if ocean conditions caused a decline in the number of adult salmon returning to spawn, the water managers would be required to mitigate for these impacts. Healthier out-migrants are better able to withstand adverse ocean conditions. The Department considers water managers responsible for providing conditions that protect and maintain populations of public trust fisheries downstream of their facilities. We understand that the anadromous fish of the SJR have undergone stresses in the Pacific Ocean in the past and have been able to maintain population numbers much greater then current populations.

Ecological Relationships and Thresholds. Lastly, during the workshop the concept of thresholds was mentioned. The Department believes that an understanding of how thresholds affect the system is important in setting flow criteria. The concept of a natural flow regime takes into consideration that there are many thresholds in the environment that aquatic organisms rely upon. These range from the physical thresholds related to the energy required to entrain sediment in the water column (and hence affecting turbidity and channel forming mechanisms), to physiological thresholds involved in temperature affects on metabolism, to behavioral thresholds influencing where various fish species and/or life stages occupy different areas within the channel cross section. Thresholds are part of the reason that ecological systems are tremendously complex and why future conditions/outcomes are difficult to predict. The Department recommends, as discussed below, that the SWRCB implement flow criteria using adaptive management and strong scientific support.

Comments Regarding Presentations at the Workshop

Comments to SJRGA Presentation to the State Board. The Department is concerned that the the San Joaquin River Group Authority's power point presentation to the Board and their document entitled " Appendix 1_Report on Flow vs Escapement Model and Environmental Data" by Gary Lorden, Ph.D and Jay Bartroff, Ph.D. do not appropriately characterize the Department's SJR salmon model and the data used in it's development, It should be clarified that the data set the authors criticized was not used in any version of the Department's Salmon Model. The Department in its separate update on the status of model development will address these concerns in more detail .

The Department is concerned that the underlying premise of the consultant's report and power point presentation is not consistent with what is known about historical unrestricted flows, historical numbers of salmon, salmon biology and ecology.

One important note that the Department would like to recognize about the SJRGA's submittal (Lorden and Bartroff report) is in Section two where the authors make this statement about their evaluation of spring flow and escapement 2.5 years later: "**For example, it is clear that water temperature may have a large affect on escapement**" (emphasis added). The Department agrees with the SJRGA submittal and the authors findings that water temperature is substantially influencing fall-run chinook salmon in the SJR basin and that it has a profound affect upon SJR salmon production.

Predation and Mortality. Some of the stakeholders in this process propose a non-flow explanation for why SJR salmon are in decline. For this, they point to predation, specifically striped bass abundance, as the primary limiting factor. Matt Nobriga et.al. (2007) found that striped bass (younger than age 3) were opportunistic predators and salmon were a relatively minor component of the prey items found in juvenile striped bass stomachs during the March through June time periods. Therefore comparing striped bass abundance (age 3+) and SJR salmon abundance (adult production) trends through time (Figure 8) should indicate whether striped bass are the controlling factor. The comparison does not demonstrate a relationship between SJR salmon and striped bass. Striped bass abundance can rise, decline, and/or remain static concurrent with SJR salmon trends. A scatter plot of the same data, even with a two year off-set to allow for a lag in striped bass population response (e.g. build up in years with higher salmon abundance or decline in years with low salmon abundance), reveals no correlation in population abundance trend patterns. Although a formal statistical investigation is needed to confirm this, there does not appear to be any density dependent relationship between striped bass and SJR salmon, which means there is not evidence that striped bass are controlling or limiting the SJR salmon population.

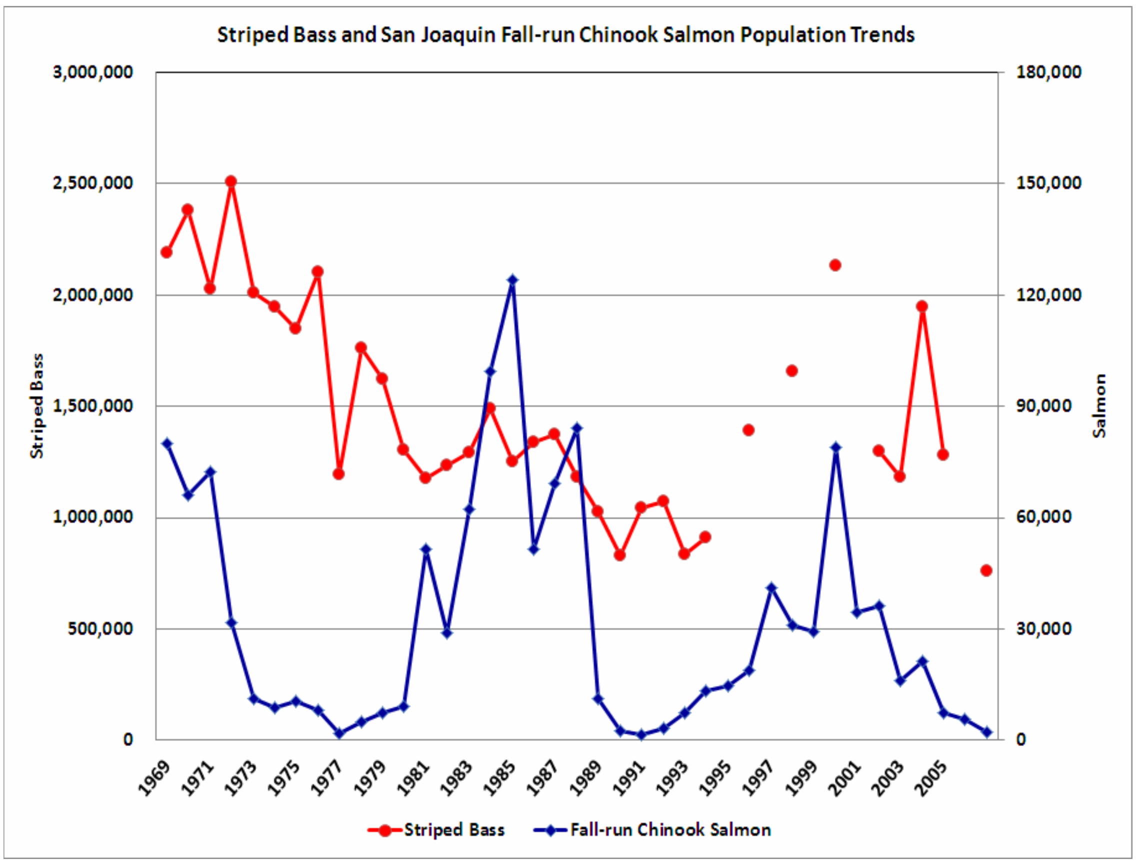

Figure 8. Striped Bass and San Joaquin River (e.g. Merced, Tuolumne, and Stanislaus) fall-run chinook salmon population trends.

This lack of a discernable controlling relationship is not surprising since predation is a long term natural ecological process and that predation of SJR juvenile salmon occurs by vectors including birds, mammals, and fish other than striped bass. Basic ecological principles lead to an assumption that in a system containing multiple predators, such as the Delta, the removal of one predator will be replaced by another. There is evidence for this ecological principle in the SJR basin from large scale habitat restoration projects conducted on the Tuolumne River (TID

2000) where the highest numbers of smallmouth bass occurred at sites with the lowest numbers of largemouth bass. In this system, predation occurs by both native (pike minnow) and non-native fish species and has occurred historically, occurs now, and will continue in the future. Since striped bass and SJR salmon have already co-existed for more than a century in this system, most any perturbations from its introduction should have already been muted by the adjustment by other predatory species. Similar findings of relationships between striped bass and Sacramento fall-run Chinook salmon abundance are also found when considering the existing data (Nobriga and Feyrer 2008, Lindley et al. 2009).

As the Department has previously demonstrated, juvenile salmon production, not predator abundance, is controlling SJR salmon production, The more that tributary and in-delta nursery and out-migratory corridor habitat conditions are favorable to juvenile salmon production, the greater the number of adult salmon produced. We have shown that late winter-spring flow magnitude, duration, and frequency are intricately tied to improved juvenile salmon rearing conditions and population abundance.

Another indication that predation is not the primary controlling factor for salmon production comes from monitoring of our hatchery production. The Department out-plants a large fraction of its hatchery produced juvenile salmon, in the Delta where striped bass populations are high. Out-planting is done in the Delta because of the higher juvenile to adult survival rates that occur from out-planting as compared to in-tributary plantings.

Lastly, improved flow conditions have multiple benefits including reduced water temperatures favoring smoltification and outmigrant survival, improved rearing conditions, and reduced predation. Several sources have documented this last point including Myrick and Cech (2001). Also Bowen and Bark (2010), who evaluated the effectiveness of a non-physical fish barrier at the divergence of the Old and San Joaquin Rivers, stated this about how improved flows affected predation of smolts at the barrier:

> *"It now seems even more likely, given the results of 2010 monitoring, that the high 2009 predation rates we observed were a function of the dry year in the San Joaquin River. Smolts and predators might have been concentrated into a smaller volume of water than in average or wet years. Such a concentration could result in higher encounter rates between predators and smolts leading to an increased predation rate. In addition, lower velocities in drier years may lead to a bioenergetically advantageous situation for large-bodied predators in the open channels near the Divergence."*

In summary, Bowen and Bark (2010), have preliminarily concluded that flow has a direct influence upon predation rates in the area where the Old and Main Rivers split. They also point out very clearly that low flow conditions make prime conditions for predators. Thus, improving flows provides conditions favorable for juvenile salmon.

Floodplains. During their presentation, the San Joaquin River Group Authority (SJRGA) defined floodplains in a manner that does not capture the ecological services that floodplains can supply to a river and estuary and argued that the only floodplains to be considered are those downstream of Vernalis. Ecologically, floodplains are those areas activated by flow events that occur at disjunct intervals anywhere within the river system. The ecological services an inundated area provides to a river or estuary may be accrued every year for those areas of the river cross section that are located between yearly minimums (summer flows) and maximums (spring runoff). Additional services are supplied by areas that are activated less than yearly, including some services supplied by flows that only occur during extreme events. In regards to the SJRGA's overly narrow consideration of the location of the SWRCB's concern with floodplains, the Department supports your staff's assertion in its DTR that the SJR is part of an ecological system that cannot be considered as disparate pieces. Although the longitudinal location of activated floodplains has a major influence on what ecological services are supplied to specific reaches (and the species that occupy those areas), when addressing flow regimes all the potential floodplains need to be considered.

On the San Joaquin River system, the recent hydrology of the last few decades typifies a system that has tightly controlled water releases under normal conditions, but cannot completely control the extreme events. As evidence of this, consider the mainstem of the SJR above the confluence of the Merced River. In many areas, the natural channel of the river is not able to convey its "designed" capacity and in some reaches cannot convey even minimum flows due to encroachment on what would naturally be its yearly activated floodplain. This results in a near total loss of the ecological services that should be supplied by hydrologic events that would reflect an above normal, but not extreme event.

In addition, as discussed in the Department's earlier comments to the Report, the hydrology of the system is greatly modified after a series of dry years in that the water storage reservoirs are at very low levels and use the first wet year after a dry series of years to recapture long term storage. This response by water managers greatly reduces those ecological services that could be supplied by activation of floodplain areas at a time when these services have been already absent for an extended period. In essence, water operators prolong the reduction of ecological services from floodplains by favoring the long-term water supply over the ecosystem.

Flood Protection. The SJRGA displayed in a slide a highly modified river bank and then discussed the limited value of higher flows activating these floodplains. The river bank they displayed showed the river up against a rip-rapped levee. They then stated that a great majority of the SJR downstream of Vernalis was confined by levees. In reality, the majority of the SJR's banks, though confined by levees, are not nearly so highly protected by rip-rap and do not look like the displayed reach. The Department does share their concern that rip-rapped levees do not supply much ecological services, but we also understand that there are many alternative approaches to flood protection and flood risk mitigation that are ecologically sensitive and are being considered.

For instance, the Department of Water Resources is currently undertaking an extensive effort to address the Central Valley's flood system. In their regional conditions report produced as part of this effort, they document the high level of concern that local officials have with the capabilities of the system to handle flood events. They are currently working on a Central Valley Flood System Conservation Strategy in which the Department is assisting. The intent of this effort is to provide flood protection and risk reduction through ecologically sensitive methods. As part of this process, the Department will continue to work towards moving existing levees back from the river channel, especially where levees are contiguous with the normally wetted channel, installing benches in those areas where levees cannot be set back to provide space for floodplain habitat, and to remove or discourage incompatible land uses within the 100-year floodplain. We strongly believe that increasing the ecological resilience of the SJR is compatible with the reduction of flood risks and strengthening the flood protection system.

<u>Responses to Comments Submitted Regarding the SWRCB's Draft Report</u>

Regarding City of San Francisco Comment Letter to the State Water Resources Control Board. The Department reviewed the City of San Francisco (City) comments prepared by Mr. Ron Yoshiyama and has the following comments to the temperature section.

General Comments. The temperature section provides a review of the literature that has been presented in the past and provides no significant new information. The City's summary of optimal, sub-optimal, poor to sub-lethal, unsuitable, and lethal temperatures are in agreement with the literature and the optimal ranges are within the Department's recommendation using the EPA (2003) seven day average daily maximums (7DADM).

The City's interpretive synthesis and local adaptation sections emphasizes tolerance to warm temperatures for groups of individuals, but does not discuss these stressed individuals reproductive success in relation to the population across generations.

The Department concurs salmonids can survive in their upper temperature range. However, there is no discussion as to reproductive success or success of the progeny when adult fish are exposed to these warmer temperatures and lay eggs that hatch. Again, this question needs to be evaluated against chronic population based thresholds and across multiple generations of fish.

The City restated what has been stated in the past about historic accounts (late 1800's) of San Joaquin Valley fish being considered for transplant to the southeastern US, which did not happened, and fish sightings in the valley floor before dams were blocking their native spawning grounds. In the past, little was known about anadromous fish life history. And further, determining the occurrence or abundance of coldwater refugia on the Valley floor created from groundwater and surface water interaction can not be done.

The City uses the terms adaptation and acclimation interchangeably. Most of their statements apply to acclimation, not adaptability. Across the millennium, anadromous fish co-evolved with their environment. Thus, adaptation is population based, takes generations and is an evolutionary process. Whereas, acclimation is individual based and requires multiple exposures to acclimate the individuals. As such, the Department's emphasis is to provide temperature thresholds to protect a population of anadromous fish across many generations. The use of population level thresholds for reproductive success and recruitment across multiple generations should be the basis for evaluating population protection.

Specific Comments. Page 15 Paragraph 2 last sentence - The last sentence about average criteria being impractical is a significant assumption. In fact, wastewater dischargers prefer having a regulatory average criteria. This allows dischargers to make corrections and stay within compliance when they have an acute failure in their system and go above the threshold. The same is true for maintaining water temperatures. It is much easier to manage water based on average criteria across a designated time period than trying to stay under or above a single numerical value.

Page 15 Paragraph 4 second sentence -

> *However, the variability in salmonids responses to thermal effects shown by those reviews warrants caution in strictly applying simple, single-value temperature criteria over broad spatial areas and extended time periods without due regard for nature variability of environmental conditions with which the salmonids have evolved.*

This would be true if salmonids natural environmental conditions that they evolved with still existed today. The natural evolutionary conditions no longer exist due to human impacts, such as dams blocking natural flows and fish migrations, water diversion, loss of riparian habitats, loss of underground water seeps, pollution, and sedimentation. This statement also agrees with the Department's use of a 7-Day Average Daily Maximum criteria, as presented by the EPA (2003). It also eliminates the use of a simple, single-value criteria, because water temperatures can oscillate above and below the average criteria value, but as long as the average stays below the criteria, the criteria is met. For example, the 7DADM criteria for migrating adult Chinook salmon is 18°C. If the daily water temperatures oscillated above and below 18°C on a daily basis, but the 7DADM remains below 18°C, the criteria is met. This example would be dependent on having cold water refugia during each 24-hour period and/or cold water refugia present during the heat of the day. If the criteria were a single numeric value such as 18°C, then, whenever the temperature exceeded this value, there would be non-compliance, most likely on a daily basis during the hottest part of the day. Unfortunately, cold water refugia no longer exists due to inadequate flows, declining groundwater levels, surface water diversions, and loss of shading due to riparian habitat destruction.

Page 24 Table 3 - Moyle et al (2007) was not listed in the Literature Cited section and Moyle et al (2010) is an incomplete administrative draft report that was not finalized nor approved for release. It is inappropriate to use or cite such a reference. As such, both of these references were not available for review to confirm the values presented in Table 3. We recommend disregarding the information presented in Table 3 of the City's letter.

Page 27 Paragraph 2 - Temperatures need to be optimal for the entire life-stage, not just the peak periods. In addition, smolts are still migrating out during the month of June.

Page 29 part "a" Paragraph 3 - In relation to Rancheria Creek, there is no reference to whether there were existing cooler pool refuges that were within a reasonable distance for the fish to sense and swim to.

Page 29 part "b" Paragraph 2 - Again, the City states that fish can survive at very warm temperatures, although no scientific information was presented that shows these fish had optimal reproductive success and recruitment across multiple generations.

Pages 29 to 30 part "c" - Again, the conditions described were before construction of dams and diversions and at a time when fish could migrate up to higher elevations where cold water existed in their natural spawning and rearing grounds. Chinook salmon were never introduced to the southeastern US, because the waters are too warm. In addition, the States of Wisconsin and Michigan have a very viable non-native Coho salmon, Chinook salmon and steelhead fisheries in Lake Michigan. Lake Michigan water temperatures are cool enough for the growth and survival of these three species; however, none of these fish reproduce in the surrounding streams because the waters are too warm for reproductive success. As such, these species are captured in the streams, spawned, and raised in hatcheries to maintain the fisheries.

Additional Comments or Information on Scientific Basis

Climate Change. While impacts of additional stressors to the SJR and Delta brought on by climate change are likely to be severe, there are many efforts underway to address them. The Department realizes that there are several ways to adapt to potential climate change. These include:

- Increase and maintain connectivity of natural habitat, especially along river corridors
- Restore valley wetlands, riparian communities and other habitat types that connect ecological communities and provide ecological services to each other
- Identify and conserve important ecological services by preserving key areas that do or can provide these services such as groundwater infiltration that can capture higher runoff, and hold in the soils in a manner that can increase subsurface flows into river channels later in the year
- Increase acquisition of important lands for conservation
- Improve management on currently held public lands to increase ecosystem resilience
- Increase collaboration and communication between stakeholder groups
- Provide incentives for private landowners to conserve important linkages and habitats

The Department recommends that the SWRCB consider issues related to climate change carefully and offers our continued support in addressing these issues.

Evaluating Salmon Populations. The Department recommends that the SWRCB use brood year cohorts rather than annual escapement data to evaluate long-term SJR flow and the response of salmon populations. There is a more direct relationship between these, and annual escapement data is more reflective of the total response by salmon populations to the flow regime in any year. Since the relative percent of the age of return of adults to the freshwater system varies, a truer picture is better determined by focusing on the total year class instead of assuming standard percentage of return age.

The Department recognizes that these issues are complex and need further analysis. The Department would like to reiterate our intention to assist the SWRCB staff with this evaluation using the basin wide HEC5Q model developed to analyze the relationship between water supply and downstream temperature impacts. We are confident that we have the tools and expertise to undertake this evaluation.

We also want to make sure that the SWRCB understands that the Department's earlier flow recommendations that your staff used in developing the SWRCB draft report were based on flows needed to support the anadromous fish populations within the system during critical life stages. In our analysis, these earlier recommendations are best represented by a natural flow regime for the system based on 50% of the unimpaired inflow to the rim reservoirs.

Modeling. As you are aware, the Department is involved in several modeling projects related to the SJR system. We support bringing the best science to bare, including using different types of ecological modeling such as life-cycle models, which may be more robust than some other more conceptual models. The model developed by the Department for this process, the San Joaquin River Fall-run Chinook Salmon Population Model Version 1.6, is based on the salmon life-cycle. As a result of this flow setting process and the feedback the Department has received, we continue to develop and refine the model. The Department will report to the SWRCB on our progress on this more comprehensive version of our San Joaquin River Salmon model in a separate letter.

Salinity. While salinity in the SJR is not typically a significant issue for fish and wildlife, the following conditions should be considered:

- Hypersaline conditions such as agricultural tile-drainage ponds like those in the Tulare basin or industrial waste water ponds
- Salt loading of our wildlife area soils
- Trace elements and heavy metals mixed in the saline water complex

Additionally, the Department is concerned that increasing flows, which in turn increases assimilated capacity for salts and other constituents of concern that are regulated by concentration, could increase the salt loading downstream (total mass delivered). This could be a problem if the associated constituents such as selenium and other trace elements affect organisms on a mass loading basis instead of, or in addition to, a concentration basis. This issue would be further exacerbated in areas such as the south Delta, where net flows are not large enough to move contaminants through the system.

Other constituents of concern exist in the Delta such as mercury, selenium, and nutrient loading that result in toxic algae blooms and reduced dissolved oxygen Increased flows in the SJR will help move these substances out of the area, but providing flows for salinity alone may not be sufficient to address all of these other constituents of concern.

Recommendations on Implementation

Increase Flows. The Department realizes that developing reliable runoff forecasts has many uncertainties. Therefore, we suggest the SWRCB develop a system that does not rely on forecast information. That is, a program that is backward looking only. Basing the instream flows on unimpaired flow averaging over two to five days including a short (two to three days) lag time could result in a manageable system. Measuring these flows should occur downstream of the major control or re-regulating structures so that the desired or required instream flow is what enters the rivers. Any irrigation demands should be above these flows. Tributary riparian diverters historically diverted significant flows relative to historical instream flows. With flows in the range of 40 to 60 percent of unimpaired, these diversions will be much less significant. The Department understands the liability associated with potential flooding and realizes an upper instream flow limit matching existing channel capacity must be a part of the program. Also, during wetter years, the desired instream flows as a percent of unimpaired flow will have to be subordinate to flood operating criteria relative to each major reservoir's minimum conservation pool.

The Department also recommends that whatever method the SWRCB utilizes be as simple and straight forward as possible. The following three graphs present a simple method of calculating instream flows based on 30, 40 and 50 percent of unimpaired flows using a 3-day averaging with a 3-day lag period. For example, the instream flow on May 1 is based on the average unimpaired flow for April 24-26. May 2 is the average for April 25-27 and so on. Each of the three graphs is for year 2003 (dry) and shows the 30, 40 and 50 percent unimpaired flow compared with the calculated unimpaired and actual downstream flows. As stated, these figures over-simplify the issue in that they do not consider reservoir operations as far as carry-over storage needed to provide sufficient water supply during drought years. The Department understands and supports the need to model a full-range of operations and water-year types in order to assess the full impact on all beneficial uses during its flow setting analysis.

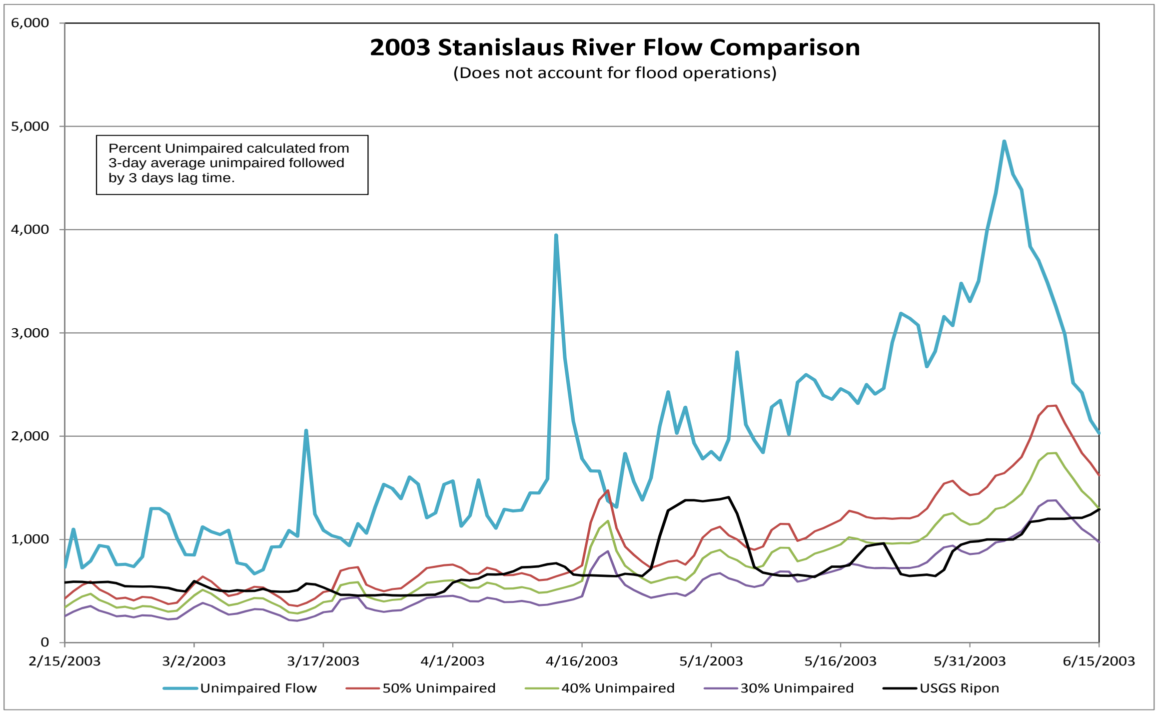

Figure 9: Examples of a percent of unimpaired flow for the Stanislaus River using 2003 to illustrate the hydrology.

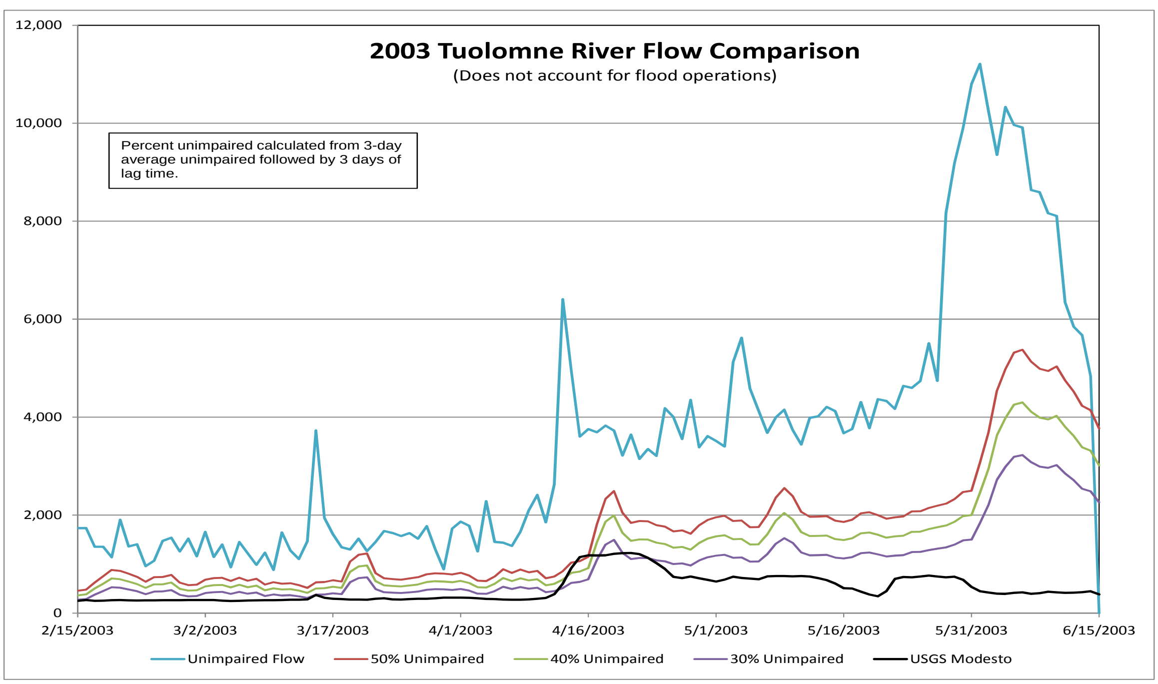

Figure 10: Examples of a percent of unimpaired flow for the Tuolumne River using 2003 to illustrate the hydrology.

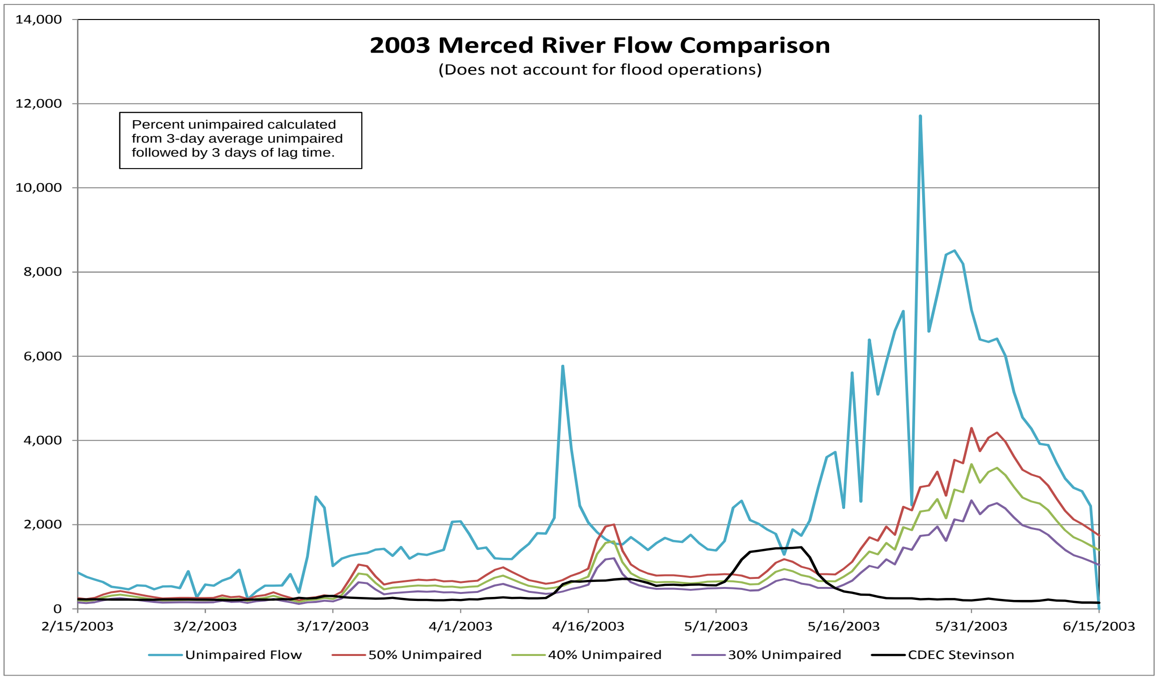

Figure 11: Examples of a percent of unimpaired flow for the Merced River using 2003 to illustrate the hydrology.

A significant benefit these flows provide is increased instream flow during late May into June when temperatures begin rising to levels harmful to salmonids. These flows should drive suitable temperatures downstream to the confluence into the lower SJR and into the Delta at a time when smolts are leaving the system would be thermally stressed or experience significant mortality from the high temperatures created by existing flow patterns. These modified flow patterns further mimic the natural hydrograph and provide a more “naturally occurring” environment suitable to migrating salmonids.

Implementation of Adaptive Management. There is widespread agreement among natural resource management agencies that complex ecosystems need to be managed adaptively. In a system like this that has a very complex social setting, the need for adaptive management is even more apparent. The Department not only recommends that the SWRCB undertake an implementation program based on this concept, we do not believe it can be avoided considering that your Basin Plans have historically been reviewed and amended as knowledge and conditions change.

The Department and those agencies and organizations that work with us have learned many important lessons from monitoring, modeling, and managing the Delta and its watershed over the last few decades. One such lesson is that discrete goals and objectives need to be stated as part of the management of such a complex system at the outset. These goals and objectives need to be the basis for setting adequate performance measures that then can be assessed as implementation actions are taken. We recommend that the SWRCB pay particular attention in setting these goals and objectives, and in setting performance measures as they set up an implementation plan.

The Department recommends that the SWRCB develop specific biological goals that are consistent with the SWRCB's current Narrative Doubling Goal. Specifically, the Department recommends adoption of a goal to double the number of smolts outmigrating from each SJR tributary (e.g. Stanislaus, Tuolumne, and Stanislaus Rivers) and the goal to double the number of smolts surviving to and through the South Delta. These doubling goals should include all water year types and average across all year types, although emphasizing the less-than-wet water year types (e.g. wet years where flood release flows actually occur in the SJR basin).

In order for adaptive management to be successful, feedback to decision makers has to occur. This feedback is based on maintaining a strong science review of all study designs that are part of a comprehensive monitoring program and the synthesis of these monitoring studies, and finally, the dissemination of this information. The Department recommends that the SWRCB continues its reliance on independent experts for this along with an open process such as workshops where the various agencies and stakeholders can participate. The Delta Independent Science Board and the Delta Science Program provide a mechanism for achieving this. We also recommend that a portion of your implementation plan address this need for a strategy to synthesize information and the dissemination of this information and knowledge to all parties that will be potentially involved in future goal setting (the next iteration of the adaptive management cycle).

As shown by CalFed (Deas et al. 2008) and many other large scale programs (North 2009), models should be developed and used to predict specific changes in the ecosystem from planned flows. These models, if used in conjunction with well designed studies and implementation projects, can be used to test current hypotheses. The results of this process would lead to new hypotheses and potentially readjusting models. The Department will continue to assist the SWRCB and the other stakeholders by using our current models, participating in data acquisition, and applying our model expertise in modifying and/or developing new models.

Summary

Finally, the Department would like to re-iterate our main recommendations. We highly recommend a flow criteria based the concept of a natural flow regime as defined in the scientific literature and based on calculated unimpaired inflow into the rim dams. These flow criteria need to be analyzed for their sufficiency in protecting salmonid populations at all life stages, for reproductive success, and across generations. We stand ready to provide assistance, including working with our model, to help evaluate the benefits and impacts of alternative flow standards.

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