The Informational Proceeding to
Develop Flow Criteria for the Delta Ecosystem

Noticed For March 22, 23, and 24, 2010

Closing Comments

Submitted On Behalf Of
The San Luis & Delta-Mendota Water Authority,
State Water Contractors,
Westlands Water District,
Santa Clara Valley Water District,
Kern County Water Agency, and
Metropolitan Water District of Southern California

"…[I]f anybody offered you [flow] numbers today, it would be a real disservice."

Oral Testimony
Dr. William Bennett, Day 2

"An effort focused on increased flow as "pretty much a Band-Aid."

Oral Testimony
Dr. William Bennett, Day 2

"[T]he scientific evidence suggests that delta outflow alone is not the answer."

Oral Testimony
Dr. Lenny Grimaldo, Day 2

Feyrer similarly reiterated "flow alone is not going to do the trick."

Oral Testimony,
Mr. Frederick Feyrer, Day 2

Baxter explained "the only species of pelagic fishes that I think that outflow alone would bump would be longfin. And even there, there are other circumstances in the delta that I have concerns about that would need to be dealt with right along with . . . the whole list of stressors for pelagic organism decline."

Oral Testimony,
Mr. Randall D. Baxter, Day 2

"You know, delta outflow alone can't do the job."

Oral Testimony,
Mr. Don Stevens, Day 2

"I think that the evidence does suggest there will be many benefits to public trust resources by modifying delta outflow. But that, alone, if it's going to – alone, it is unlikely to substantially increase or stabilize the population strictly in isolation."

Oral Testimony,
Dr. Erica Fleishman, Day 2

"I do not think . . . that outflow by itself will stabilize the pelagic species."

Oral Testimony,
Mr. Jerry Johns, Day 2

SECTION 1. INTRODUCTION

The San Luis & Delta-Mendota Water Authority, State Water Contractors, Westlands Water District, Santa Clara Valley Water District, Kern County Water Agency, and Metropolitan Water District of Southern California, collectively referred to herein as the "State and Federal Water Contractors", recommend that the State Water Board accord the term "criteria" its plain meaning and prepare a report to the legislature that: (1) tells its members that the scientific community uniformly agrees that establishing numerical flow goals without reference to complementary habitat improvements and stressor reductions cannot inform any entity as to what volume, quality, and timing of water necessary for the Delta ecosystem under different conditions, and (2) explains the process and the scientific method through which judgments or decisions on numeric flow criteria to protect public trust resources may be based. *See* www.merriam-webster.com/dictionary/criteria (defining criterion as "a standard on which a judgment or decision may be based).

The State Water Board should provide this decision making framework for planning efforts, like the Delta Plan and the Bay Delta Conservation Plan, as the information called for in the legislation. The State Water Board should urge (as within this process it cannot mandate), through this framework that specific flow requirements be developed as a key element within a comprehensive program intended to address all of the multiple stressors affecting public trust resources. The State Water Board should urge that any plan developed pursuant to the framework be tested using life history models to assess whether the effort is likely to provide population level benefits. Without such testing, this and successor State Water Boards will find it impossible to ensure that proposed flows strike a reasonable balance among the competing needs of all public trust resources, and a balance between competing needs of public trust resources and other beneficial water uses that result in more reliable water supplies for municipal, industrial and agricultural water users. Article X, Section 2 of the California Constitution and the public trust doctrine as enunciated in the *Audubon* decision demand no less.[1]

Until the State Water Board exercises its judgment and makes flow and water quality decisions within the context of a comprehensive program (based on the criteria it develops), the State Water Board should rely upon the flow parameters contained in for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary Water Quality Control Plan, subject to certain modifications. As described later in these Closing Comments, *see* page 27 et seq., during the "near term", the State Water Board should note that there may be a need to increase flexibility when implementing objectives both to ensure better protection of the public trust resources[2] and balance between competing needs of public trust resources and between the needs of public trust resources and the needs of other beneficial uses. Further, during the "near term", the State Water Board should acknowledge that, to ensure public trust resource protection occurs, other actions need to be considered. For example, consideration should be given to (1) improving the nutrient balance by providing a better balance between nitrogen to phosphorous and thus restoring the Delta's food web, (2) modifying the intakes to the Yolo Bypass to permit more frequent flooding from Sacramento River,[3] (3) coordinating the Yolo Bypass modifications with additional actions

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[1] As discussed below, these obligations are specifically made applicable to SB 1 through Water Code Section 85023, which states that, "The longstanding constitutional principle of reasonable use and the public trust doctrine shall be the foundation of state water management policy and are particularly important and applicable to the Delta."

[2] For example, storage releases to maintain X2 at Roe Island might deplete cold water pools that would be more beneficial than any potential habitat benefits provided by the storage release.

[3] The targeted management of flows can provide benefit where uncontrolled flows are unavailable and the use of operational flows is reasonable. For example, the Yolo Bypass has been the subject of considerable attention. Under current configurations, the fixed elevation of the Freemont Weir is 33.5', which means that flows in the Sacramento River must exceed about 56,000 cfs before the weir is overtopped. This is a flow rate that cannot be managed by reservoir reoperations. It occurs during storm events when natural flows from unregulated tributary streams choke the Sacramento River main stem. However, by notching the weir, as proposed by the BDCP, to elevation 17.5", water can begin flowing into the Bypass at about 15,000 cfs of in-river flow. This is a difference of about 80,000 acre feet per day or nearly 2.5 million acre feet a month to reach the same goal. This type of "physical solution" provides a means of addressing an ecosystem requirement far more efficiently than does a flow-based approach. Using the physical solution principle, where appropriate, is a vastly superior means of addressing ecosystem needs than is the blunt instrument flow-based approach. Further, where a physical solution is possible, to

in the Cache Slough area to improve flooded habitat, (4) implementing a "Mark-Select" fishery, and (5) encourage harvest of introduced species.

The State and Federal Water Contractors make these recommendations based upon the best available scientific information. At the flow proceedings, there was no consensus among the panel participants on the volume, quality, and timing of water necessary for the Delta ecosystem under different conditions necessary to protect public trust resources. The State and Federal Water Contractors' recommendation is guided in large part by the consensus that was reached by the U.C. Davis group on three critical scientific points:

SCIENTIFIC POINT 1: "*Flows needed to support desirable Delta fishes are likely to have changed from pre-European settlement conditions because of extreme landscape changes*." Fleenor et al., On Developing Prescriptions for Freshwater Flows to Sustain Desirable Fishes in the Sacramento-San Joaquin Delta, p. 5.[4]

SCIENTIFIC POINT 2: "*A more fundamental, mechanistic, and process-based view of how changes in freshwater flow may interact with components of the habitat, ecosystem, and management actions to support desirable fish populations is more likely to provide more reliable insights*." Fleenor et al., On Developing Prescriptions for Freshwater Flows to Sustain Desirable Fishes in the Sacramento-San Joaquin Delta, p. 16.[5]

SCIENTIFIC POINT 3*:* "*It might be useful for regulators to offer several sets of flow prescriptions, each coupled with different sets of habitat development and other actions*." Fleenor et al., On Developing Prescriptions for Freshwater Flows to Sustain Desirable Fishes in the Sacramento-San Joaquin Delta, p. 28.[6]

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not utilize such an approach would arguably violate both the public trust principle which requires a balancing of competing uses and the reasonable and beneficial use mandates of Article X, Section 2 of the State Constitution. And, where large flows are needed to address ecosystem needs, such as potentially flooding the Yolo Bypass to certain depths, large outflows to flush the system, etc., the State Water Board should be relying on the natural occurrence of large uncontrolled flows that spill from the system on a periodic basis.

[4] *See also* Oral Testimony of Peter Moyle, UC Davis, Day 2 ("We have a completely artificial system out there"); Mike Bryan, City of Stockton, Day 3 ("You've seen some of the historic dendritic channels of the delta compared to the channelized nature of the delta today. And it's a radical change in the hydrograph"); Susan Paulsen, City of Stockton, Day 3 ("We know that prior to about 1920, a lot of the channelization that we see now had already happened. A lot of the marsh land had already been lost").

[5] *See also id*. p. 27; Oral Testimony of Wim Kimmerer, UC Davis, Day 1 ("The ecosystem approach is the one that's favored in the scientific community"); Leo Winternitz, Nature Conservancy, Day 1 ("I think a mechanistic approach can be means to develop outflow criteria"); Russ Brown ICF International, Day 1 ("I am very much supportive of this what I'm thinking of mechanistic approach"); Peter Baker, EDF, Day 1 ("As far as I'm concerned, mechanistic approach is the only way to develop outflow criteria that are very useful"); Jay Lund, UC Davis, Day 1 ("If you look at only outflow criteria, I think it will be a fragmentary and insufficient response for the native fish"); Bill Bennett, UC Davis, Day 2 ("It's not just the flows. . . . I think with making modifications to the habitat such that at any given point in time you have more variable habitat conditions across the delta overall will give you a much higher probability [of success]"); Don Stevens, CSPA, Day 2 ("Delta outflow alone can't do the job"); Fred Feyrer, DOI, Day 2 ("Just to reiterate, everybody pretty much hit the main points, is that flow alone is not going to do the trick").

[6] *See also* Oral Testimony of Leo Winternitz, Nature Conservancy, Day 1 ("You have to look at the whole range of flows and the seasons of flows"); Jay Lund, UC Davis, Day 1 ("Seasonal and interannual variability of these flows is also important, not just having a constant minimum in some sense or a constant maximum"); Bill Bennett, UC

The State and Federal Water Contractors' recommendation is consistent with the conclusion of William E. Fleenor, William A. Bennett, Peter B. Moyle, and Jay R. Lund, who wrote:

> The performance of native and desirable fish populations in the Delta requires much more than fresh water flows. Fish need enough water of appropriate quality over the temporal and spatial extent of habitats to which they adapted their life history strategies. Typically, this requires habitat having a particular range of physical characteristics, appropriate variability, adequate food supply and a diminished set of invasive species. While folks ask "How much water do fish need?" they might well also ask, "How much habitat of different types and locations, suitable water quality, improved food supply and fewer invasive species that is maintained by better governance institutions, competent implementation and directed research do fish need?"

William E. Fleenor, William A. Bennett, Peter B. Moyle, and Jay R. Lund, *On Developing Prescriptions for Freshwater Flows to Sustain Desirable Fishes in the Sacramento-San Joaquin Delta*, pp. 28-9.

SECTION 2: BACKGROUND

A. Legal Authorities

The directive to State Water Board to develop flow criteria must necessarily be guided by the "foundation for state water management" and the basic goals of Senate Bill No. 1 of the 2009-2010 Seventh Extraordinary Session (Stats. 2009 (7th Ex. Sess.) ch 5, § 39) (SB 1).

1. The Foundation And Basic Goals For Flow Criteria

In SB 1, the California Legislature instructed: "[t]he longstanding constitutional principle of reasonable use and the public trust doctrine shall be the foundation of state water management policy and are particularly important and applicable to the Delta." Water Code, § 85023. Under the reasonable use doctrine, the State Water Board must ensure all of California's waters are "put to beneficial use to the fullest extent of which they are capable." Cal. Const. Art. X, § 2. As directed by the California Legislature:

> [T]he use or flow of water in or from any natural stream or water course in this State is and shall be limited to such water as shall be reasonably required for the beneficial use to be served, and such right does not and shall not extend to the waste or unreasonable use or unreasonable method of use or unreasonable method of diversion of water.

Id. The State Water Board explains that its Article X, section 2 of the California Constitution mandate:

> [R]equires all use of water to be "reasonable and beneficial." These "beneficial uses" have commonly included municipal and industrial uses, irrigation,

Davis, Day 2 ("Just setting a number the way it has been done in the past has not worked for the public trust or for water").

> hydroelectric generation, and livestock watering. More recently, the concept has been broadened to include recreational use, fish and wildlife protection, and enhancement and aesthetic enjoyment.

www.swrcb.ca.gov/waterrights/board_info/water_rights_process.shtml.

As applied to fish and wildlife resources, beneficial use is defined as "ensuring that fish and wildlife populations do not drop below self-perpetuating levels." State Water Board Decision 1639, p. 19 (defining State Water Board policy regarding the "relative benefit to be derived from all beneficial uses" in Water Code section 1257). Further, as the California Supreme Court articulated, a "beneficial use" does not equate to a "reasonable use." *Joslin v. Marin Municipal Water District* (1967) 67 Cal.2d 132, 143. "The mere fact that a use may be beneficial . . . is not sufficient if the use is not also reasonable." *Id*.[7]

Under the State Water Board's "public trust obligation," the State Water Board must "affirmative[ly] [] take the public trust into account in the planning and allocation of water resources." *National Audubon v. Superior Court* (1983) 33 Cal.3d 419, 447. However, the public trust doctrine does not require the State Water Board to sacrifice any one beneficial use for the benefit of public trust resources. Instead, the public trust doctrine incorporates the principle of feasibility. The Court in *National Audubon* explained:

> The state has an affirmative duty to take the public trust into account in the planning and allocation of water resources, and to protect public trust uses whenever feasible. Just as the history of this state shows that appropriation may be necessary for efficient use of water despite unavoidable harm to public trust values, it demonstrates that an appropriative water rights system administered without consideration of the public trust may cause unnecessary and unjustified harm to trust interests. As a matter of practical necessity the state may have to approve appropriations despite foreseeable harm to public trust uses. In so doing, however, the state must bear in mind its duty as trustee to consider the effect of the taking on the public trust, and to preserve, so far as consistent with the public interest, the uses protected by the trust.

Id. at 446 (emphasis added)(citations omitted).

The constitutional mandate for reasonable use cannot be conflated with public trust balancing. In fact, the determination of reasonableness must be addressed even if a public trust need appears valid and necessary. In other words, satisfying Article X, Section 2 requires a separate analysis. The State Water Board must ensure that the flow criteria being developed will in fact significantly reduce the problem under consideration (the best science test) and does so in a manner that does not result in a waste or unreasonable use of water.

In SB 1, the California Legislature overlaid these foundational principles with four basic goals for the management of the Delta. The goals are:

[7] See also State Water Resources Control Board v. Forni (1976) 54 Ca.App.3d 743, 749-50.

> (a) Achieve the two coequal goals of providing a more reliable water supply for California and protecting, restoring, and enhancing the Delta ecosystem. The coequal goals shall be achieved in a manner that protects and enhances the unique cultural, recreational, natural resource, and agricultural values of the Delta as an evolving place.
>
> (b) Protect, maintain, and, where possible, enhance and restore the overall quality of the Delta environment, including, but not limited to, agriculture, wildlife habitat, and recreational activities.
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> (c) Ensure orderly, balanced conservation and development of Delta land resources.
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> (d) Improve flood protection by structural and nonstructural means to ensure an increased level of public health and safety.

Cal. Pub. Resources Code, § 29702(a)-(d).

2. <u>The Directive to Establish Flow Criteria</u>

The Legislature directed "early actions" to be undertaken to further the stated goals. The State Water Board's development of "new flow criteria for the Delta ecosystem necessary to protect public trust resources" is one of those early actions. Water Code, § 85086(c)(1). For "the purpose of informing planning decisions for the Delta Plan and the Bay Delta Conservation Plan", the Legislature directed the State Water Board to develop the criteria pursuant to its "public trust obligations," and using the "best available scientific information." *Id*. The flow criteria must consider the "volume, quality, and timing of water necessary for the Delta ecosystem under different conditions." *Id*. That specific directive must be read in context of the foundation and basic goals for the flow criteria.[8]

In addition to the foundational principles, when establishing flow criteria, the State Water Board must be mindful of two limitations imposed on it by the Legislature. The Legislature directed the State Water Board to establish flow criteria through an "informational proceeding" and ordered "[t]he flow criteria [] not be considered predecisional with regard to any subsequent board consideration of a permit, including any permit in connection with a final BDCP." Water Code, § 85086(c). As a result of these limitations, neither changes in water quality objectives nor water rights can be implemented unless and until the State Water Board conducts and completes a water quality proceeding and water rights proceeding. Those types of proceedings have at times taken in excess of 5 years to complete. Accordingly, the flow criteria can only serve the purpose established by the Legislature – to inform "planning decisions for the Delta

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[8] *See, e.g., Stigall v. City of Taft* (1962) 58 Cal.2d 565, 571 ("The statute must be construed with reference to the purpose intended by the law-making body. When the true intention of the legislature is ascertained it must be given effect"); *McKesson v. Lowery* (1959) 51 Cal.2d 660, 662 ("It is a fundamental rule of statutory construction that the statute be scrutinized in the light of the legislative intent."); *Freedland v. Greco* (1955) 45 Cal.2d 462, 467 (Statutes should be interpreted to promote rather than defeat the legislative purpose and policy"); *Grannis v. Board of Medical Examiners* (1971) 19 Cal. App. 3d 551, 559 (In carrying out a section of the penal code, the Court required the policy behind the legislature's enactment of the section to be taken into account).

Plan and the Bay Delta Conservation Plan." Water Code, § 85086(c). The difficulty today is that within the context of the Delta Plan and the BDCP, flow criteria must be applicable regardless of when the flow requirements are considered during the course of the restoration process. Hence, flow criteria will be useful as guidance over the phases of development, rather than as strictures as has been suggested by certain participants.

Finally, the flow criteria must be based upon the "best available scientific information" and take into account "the changing characteristics of the Delta, including sea level rise, additional flooded islands, changes in water diversions, . . . new invasive species," and the impacts that other stressors are having on species for which flows are providing a level of protection. Among these other stressors are contaminants, altered nutrient loads, changes in food availability and quality.

SECTION 3: <u>SCIENTIFIC APPROACH AND POINTS OF CONSENSUS</u>

A. FLOW IN ECOLOGICAL CONTEXT

The State Water Board cannot determine the flow needed to protect public trust resources in a vacuum. The State Water Board must develop flow requirements after considering each of the factors that influence each fish species throughout its life history. *See, e.g., Fleenor et al.*, On Developing Prescriptions for Freshwater Flows to Sustain Desirable Fishes in the Sacramento-San Joaquin Delta, p. 16. *See also id*. p. 27. Ecosystems, whether riverine or estuarine, consist of temporally and spatially variable physical, chemical, and biological characteristics and a suite of physiological, behavioral, and life history traits. Among other factors, consideration must be given to water quality, water temperature, the food web, contamination, habitat alteration (*i.e.*, armored levees, channel straightening, loss of tidal marsh), and climatic changes.

Indeed, the health of an ecosystem, and thus the ability to protect public trust resources, is the product of multiple processes, typically understood in terms of a hierarchy of factors "where each component exerts influence on other components – usually at the same or lower levels – and all components ultimately influence the character of the stream, lake, or estuary." *Spence et al.* (1996) *citing Frissell et al*. 1986 and *Naiman et al*. 1992. According to *Spence et al*. (1996):

> Elements at the top of the hierarchy (*e.g.*, climate, geology, topography, soils, and vegetation) have pervasive effects on other processes occurring in a basin or watershed (*e.g.*, sediment delivery, hydrology, nutrient cycling, riparian features) that give rise to the water body characteristics (*e.g.*, water quality, flow regime, habitat structure, aquatic biota).

Spence et al. (1996), pp. 31-2.

B. SUMMARY OF PROCEEDINGS

1. <u>Hydrology/Hydrodynamics</u>

A fundamental, undisputed fact about the Delta is that hydrology and hydrodynamics have been vastly altered by human activity. Looking back into history, some of the most far reaching changes began as early as the 1850s and 1860s, when hydraulic mining deposited millions of cubic yards of rock and soil into the tributary streams where it was then carried into the main river channels and finally into the Delta and the Bay, raising bed levels by many feet. The changes continued as California sold off hundreds of thousands of acres of swamp lands that had previously provided natural flood relief when high river flows topped the low stream banks and inundated the surrounding lands. In addition to moderating river flows, these flooded areas had provided vital habitat for both aquatic and terrestrial species. As levees were built to convert those lands from swamps to farms, hundreds of miles of dendritic channels were eliminated and over 300,000 acres of Delta marsh were lost, with significant impacts on tidal hydrodynamics. The low, periodically flooded marsh lands and the dendritic channels that had calmed the tidal forces and allowed the Delta to remain fresh were virtually gone. On top of this, the Sacramento River and Delta waterways were converted to a prismatic, leveed highway to pass flood waters since the adjacent marshes were no longer available. The tides now had a super highway that allowed saline water to move upstream, changing the character of the estuary's salinity field even more.

In the early 20th century, large scale agriculture in the Delta and upstream began removing millions of acre feet of water. As the era of dam building emerged, Shasta Dam, Friant Dam, Folsom Dam, Oroville, New Bullards Bar, New Melones, New Don Pedro, New Exchequer, and other dams (1960s and 1970s) significantly reduced peak flows (often flood flows) by storing water and modified flows in other seasons up or down depending on their release patterns. The CVP constructed the Delta Cross Channel specifically to alter the hydrodynamics of the Delta in order to move fresh water to its diversion facility, and water has been diverted from the Delta channels by both the CVP and the SWP.

None of this is in dispute and most of it cannot be reversed. But in the face of all this change, one aspect of Delta hydrology has been a constant. Precipitation has fallen as rain or snow, which in turn has created runoff. Further that runoff is variable from year to year and month to month and the patterns are unpredictable. Water that was once stored in the Delta and upstream marsh areas and slowly drained back to the rivers as flows decreased is now stored in reservoirs and released later for power generation, navigation, and diversions for farming and urban uses throughout the State.

At the same time that humankind was changing the hydrology and hydrodynamics of the Delta system, other changes were also occurring that were just as critical. The act of constructing levees, many of them rock-lined, and straightening channels so they could more efficiently handle flood flows destroyed vegetation and undercut banks and essentially, in the words of one expert, converted a river and upper estuary into what appears to resemble the All American Canal. At the same time the system was being "homogenized" and/or "sterilized" from an ecosystem perspective, it was being polluted with toxics and inundated with waste discharges from an ever growing urban population. In addition, new species were introduced, some intentionally, others through ship ballasts and similar "accidental" sources. Some of these non-native species became icons of the state and federal fish agencies and the sport fishing lobby, notwithstanding their predatory impact on native species.

The challenge facing California is how to fix the Delta in a manner that recognizes that irrevocable changes have occurred. In the past, scientists working on Delta issues have focused on one of the categories of change described above – the hydrological and hydraulic modifications caused by operation of the CVP and SWP projects – to the exclusion of everything else. This singular focus has worked to the detriment of the system as a whole, as each effort to "fix" the Delta by further regulating only the hydrology or hydrodynamics failed. Scientific efforts have begun to focus scientific attention on the other stressors and have opened the door (slightly) to approaches that are not flow-centric. Nevertheless, many continue to maintain this flow-centric fixation, as evidenced by the testimony of some participants to the Delta flow proceedings that have chosen to interpret the legislative language that triggered these flow criteria proceedings as exclusively designed to increase the volume of flows and by some of the other oral presentations at the hearings where suggestions that lower trophic food production could be affecting fish population being met with derisive responses by other panel members.

The State and Federal Water Contractors, of course, fully recognize that the aquatic community in the Delta requires hydrologic and hydrodynamic conditions that support their life strategies. But the State and Federal Water Contractors also recognize that providing that physical support will not help the species if they are suffering from food deprivation. As of now, the State and Federal Water Contractors have not seen any scientific evidence or even scientifically based inference that changes in hydrology or hydrodynamics in the Delta over the past ten years have caused the declines in the POD species or in salmonids. *See* Exhibit 1 hereto, "*Dispelling the Myth The Recent Decline In Fish Dependent Upon the Delta Was Caused By Insufficient Flow*".

Thus, it is highly unlikely that throwing more flows at a problem that was not caused by lack of flows will fix the problem this time any more than it did in the past.

An example of the flow-centric, Central Valley Project/State Water Project focused approach to Delta science, Dr. Bennett, on the third day of the hearings, alleged that there had been a step change in fall outflows from the Delta in the early 2000s that was caused by increased CVP and SWP pumping. Exhibit 2 below depicts historic exports and historic Delta flow that include the time periods just before and just after Dr. Bennett says a step change in fall X2 occurred. As can be seen there was no step change, Delta hydrology continued to show its classic variability, and the relationship of unimpaired inflow to outflow did not significantly change. The lack of higher inflows during the post-2000 period is a function of the series of drier water years. Exhibit 3 below is a graph showing the unimpaired September, October and November Delta inflow from 1921 through 2008. Exhibit 4 below compares the relationship of fall inflow to fall outflow for the periods 1970 through 1999 (blue) and 2000 through 2009 (red). It can clearly be seen that fall Delta inflow has the strongest influence on the amount of fall outflow and that there was little, if any, difference between the two plotted periods with respect to the inflow/outflow relationship. During the so-called POD years changes in fall X2 locations were primarily the result of low fall inflows, and those inflows patterns are very similar to low inflow events that occurred in dry cycles in the early 20s, the early 30s, the late 50s and early 60s, 1976-1977, and the 1987-1992 drought. Dr. Bennett's step change is only a step change if one limits their comparison of recent fall flows to those that occurred during the very wet period in the late 90s. The long term unimpaired inflow average is unchanged and any change in the inflow/outflow relationship is barely discernable. Fall outflows are most highly dependent upon precipitation that falls during those months, a factor which cannot be controlled.

All hydrologic analyses must begin by recognizing that uncontrollable factors dominate in the Delta. Therefore, when considering the use of flow to address Delta ecosystem needs, whether in terms of hydrology or hydrodynamics, the State Water Board should keep in mind that the hydrology of the Delta system is influenced largely by natural events and tidal actions that are beyond the control of humans and that the hydrology still evidences a great deal of variability. The amount that this variability can be impacted by changes to water project operations was grossly overstated during the recent proceedings.

Perhaps the greatest disservice to the State Water Board's effort to formulate flow criteria were flow recommendations that focused solely on so-called Delta needs without distinguishing when those needs could be fulfilled by uncontrolled Delta inflow and when those recommendations would either be impossible (even with full unimpaired flows) or would require exhausting existing storage pools to the total detriment of the upstream ecosystems and all other beneficial uses of water that rely on those reservoirs. While stream systems can be managed to some limited degree with controlled flows, it is unrealistic to manage the Delta ecosystem on that basis. The water projects are unable to control conditions in the Delta as natural forces like the tides and natural hydrology have an overwhelming influence on the system. The water projects already contribute substantial quantities of flow to meet ecosystem needs, therefore attempting to meet the additional flows, including experimental flows, as proposed by the DEFG or others is both unrealistic[9] and unreasonable.

The State and Federal Water Contractors will later in these Closing Comments apply some of the hydrology and hydrodynamic issues in the context of the specific fish species that are to be protected. At this point, however, the State and Federal Water Contractors simply urge the State Water Board to place hydrology and hydrodynamics in the proper perspective as one element of many that may be impacting fish species and to follow the admonition of most of the experts that appeared at the hearings that flow alone cannot fix the Delta. This approach is consistent with the views of many of the experts that appeared at the hearings; but for purposes of this proceeding, Dr. Jay Lund, seconded by Drs. Fleenor and Gartrell, summarized the above most succinctly in his testimony when he stated:

> My last point I guess really goes to one of the phrases that has frequently appeared in these questions: Developing outflow criteria for the Delta. I worry about that. I think outflows are important, but I think also the health of the native species in the Delta is going to require more than just outflow criteria. If you look at only outflow criteria I think it will be a fragmentary and insufficient response to the native fish.

2. Pelagic Fish

The evidence presented to the State Water Board does not support the contention that pelagic species can be protected by dedicating additional outflow. Since new outflow standards are not the answer, the State Board should consider actions that are expected to increase species abundance. For pelagic species, the Pelagic Panel, Tr. 132:24-25. Since new outflow standards are not the answer, the State Water Board should consider actions that are expected to increase species abundance. For pelagic species, the recommended actions should therefore address food

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[9] See testimony of Walter Bourez, on behalf of the Sacramento Valley Water Users, at http://www.swrcb.ca.gov/waterrights/water_issues/programs/bay_delta/deltaflow/docs/exhibits/svwu/svwu_bourez_test.pdf.

limitation by re-establishing the optimal nutrient balance in the Delta, and the restoration of habitat, particularly floodplain habitat.

a. *Pelagic Fishes Are Not Limited By The Size Of Their Habitat; Rather Nutrients Have Degraded The Quality Of Their Habitat*

Pelagic species, like delta smelt, longfin smelt and splittail, require abiotic habitat conditions that include appropriate water temperatures, turbidity, and salinity. These species also require certain physical habitat structures such as floodplains and shallow water habitats. Currently, the size of the habitat is generally determined by calculating habitat volume as defined by the X2 salinity zone. The quality of that habitat is defined by the other factors: temperature, turbidity, physical habitat and the availability of an abundant food supply.

(i) <u>Smelt are not limited by the size of their habitat.</u>

The size of the available habitat for delta smelt and longfin smelt is generally defined in terms of the X2 zone, which is the distance up the axis of the estuary to the daily averaged near-bottom 2-psu isohaline, expressed as a given range of salinity and water depth. Delta smelt are euryhaline, meaning they tolerate a wide range of salinities. (Fish and Wildlife Service, Notice of 12 Month Petition Finding at 5.) Delta smelt may move in relation to X2, but they are not absolutely tied to its location. In fact, a significant portion of the population (approximately 40%) reside in the Cache Slough complex and Deepwater Ship Channel, which is removed from the influence of the X2 zone. Moreover, to gain access to Cache Slough, Delta outflow must be in the lower range of flows. *See* Exhibit 5. At higher outflows, delta smelt are washed out of the Delta toward San Pablo Bay.

However, there is no reason to increase Delta outflow, and potentially harm delta smelt by cutting off access to Cache Slough, because Delta smelt and longfin smelt are not limited by the size of their habitat. As Dr. Wim Kimmerer testified, delta smelt do not appear habitat limited, "…because the abundance relationship is much flatter. It's not statistically significant. And so it looks like the delta smelt during this time period are kind of unresponsive to the volume of physical habitat as defined by salinity." Oral Testimony, Dr. Wim Kimmerer, Day 1. If a statistically significant coordination between delta smelt abundance and the location of spring X2 ever existed, it has disappeared. *See*, State and Federal Water Contractors Written Testimony, pp. 2-3.

While the correlation between the location of X2 and longfin smelt abundance remains, it has significantly degraded in recent years. *See*, State and Federal Water Contractors Written Testimony, pp. 2-3. Moreover, longfin have a more varied life cycle than delta smelt, having been observed over a rather large area of the Pacific Coast, including Alaska, British Columbia, Washington, Oregon, and several locations in California. DFG Status Review at 6.[10] In light of their extensive range, it is unlikely that longfin are truly limited by the size of their habitat, regardless of their weak relationship with X2.

[10] A Status Review of the Longfin Smelt (*spirinchus thaleichthys*) in California, California Department of Fish and Game, Report to the Fish and Game Commission, January 23, 2009.

Even though the UCD panel accepted there was compelling evidence that delta smelt and other pelagic species are not limited by the size of their habitat, they nevertheless insisted on interpreting the data in the construct of flow. Instead of accepting that habitat as defined by flow (X2) is not driving the trends in population abundance, Dr. Wim Kimmerer and the DEFG experts concluded that the "random noise" of other stressors are "interfering with the signal" of the effect of flow and exports. Oral Testimony, Dr. Wim Kimmerer, Day 1. The DEFG panel apparently concluded that researchers would have observed a strong correlation between flow and population abundance, or a strong correlation between entrainment at the project pumps and population abundance, if other factors, like food, were not interfering with the relationship. *Id.* However, the more plausible interpretation of the science, as testified to by Dr. Gilbert is that the so-called noise is in fact driving population abundance. Oral Testimony, Dr. Patricia Glibert, Days 2 and 3. This "noise" is not masking the effect of the flow response or even the effect of entrainment; rather, these factors have a weak or non-existent influence on population abundance. Moreover, as we have never understood the mechanism underlying the previous and existing relationships between abundance and flow, it is likely that somewhere in the "noise" is the actual cause of the remaining relationships with flow. The obvious conclusion is that delta smelt and other pelagic species are not limited by the size of their habitat. Pelagic species are limited by the quality of their habitat.

(ii) Smelt limited by the quality of their Habitat.

The quality of the existing habitat is partly determined by the spatial variability of physical habitat structures. Variability of physical habitat within the mixing zone enables pelagic species to move from areas less favorable to areas that are more favorable over the usual range of changing conditions. The BDCP is proposing thousands of acres of habitat restoration projects designed to improve the quality of pelagic species habitat, including projects in Suisun Marsh and in Delta channels. The BDCP is also proposing large floodplain restoration projects in the Yolo Bypass. Splittail are expected to be the greatest beneficiaries of the floodplain restoration projects as the science strongly suggests that splittail abundance is directly related to the availability of floodplain habitat. (http://www.dfg.ca.gov/delta/reports/splittail/summary.asp. ("Floodplain inudation appears to provide the best explanation for increased abundance [of splittail] in high outflow years.].)

The quality of pelagic species habitat is also dependent on factors like water temperatures and turbidity. Delta smelt actually tolerate a fairly wide range of temperatures from 7.5ºC to 25.4ºC in the laboratory (Fish and Wildlife Service, Notice of 12 Month Petition Finding at 5, *citing* Swanson *et al* 2000), and may be found in warmer waters in the environment. (*Id.*, *citing* Feyrer *et al* 2007.) Regardless, upstream reservoir releases cannot be used to manage water temperatures in the Delta, therefore outflow is not a viable temperature management tool. Also as will be discussed in the section on salmon, reservoir releases do not reliably generate measureable changes in turbidity in the Delta. The Bay Institute agrees, "[i]n general, the attributes that are listed there are not necessarily amenable to our management of outflow…They are much more of a function of uncontrolled flows, particularly with regard to turbidity." Oral Testimony, Dr. Christina Swanson, Day 1. Therefore, reservoir releases are not a tool for generating turbidity.

The quality of the habitat is affecting species abundance because pelagic species in the Delta are food limited. The recent National Academy of Sciences Review agrees, stating that:

> Significant changes in the food web may have affected food abundance and food quality available to delta smelt. From changes in zooplankton to declines in chlorophyll to increases in submerged aquatic vegetation, these changes have enormous effects on the amount and quality of food potentially available for various fish species (e.g., Muller-Solger et al., 2006; Bouley and Kimmerer, 2006).

NAS Report at 34.[11] The IEP concluded similarly stating, "…low and declining primary productivity in the estuary is likely a principle cause for the long-term pattern of relatively low and declining biomass of pelagic fishes." POD Synthesis of Results at 20.[12] Evidence of food limitation in delta smelt and other pelagic species is significant as:

> Preliminary information from studies on pelagic fish growth, condition and histology provide additional evidence for food limitation in pelagic fishes in the estuary (IEP 2005). In 1999 and 2004, residual delta smelt growth was low from the Sacramento-San Joaquin confluence through Suisun Bay relative to other parts of the system. Delta smelt collected in 2005 from the Sacramento-San Joaquin confluence and Suisun Bay also had high incidence of liver glycogen depletion, a possible indicator of food limitation. Similarly, during 2003 and 2004 striped bass condition factor decreased in a seaward direction from the Delta through Suisun Bay.

POD Synthesis Results at 22.[13] In the past, it has been assumed that the introduction of the Amur River clam has been the only factor significantly affecting the observed changes in food web. However, more recent research provides strong evidence that the balance of nutrients in the Delta have been driving the observed changes in the quantity and quality of the phytoplankton and zooplankton communities at the base of the food web. In fact, these changes in the foodweb likely provided the optimum conditions for the opportunistic clam species to invade the Delta.

As the State and Federal Water Contractors described in their opening written testimony, and as Dr. Patricia Glibert and other experts on the panels affirmed, there is a wealth of research supporting the interaction between nitrogen and phosphorous and the effects of the balance of these nutrients on the abundance and speciation of the base of the food web. State and Federal Water Contractors' Written Testimony, at 32; Oral Testimony, Dr. Patricia Glibert, Days 2 and 3. The physiological literature strongly supports the concept that different algal communities use different forms of nitrogen. Diatoms generally have a preference for nitrate; dinoflagellates and cyanobacteria generally prefer more chemically reduced forms of nitrogen (ammonium, urea, organic nitrogen). The ratios of the major elements also affect algal

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[11] A Scientific Assessment of Alternatives for Reducing Water Management Effects on Threatened and Endangered Fishes in California's Bay Delta, National Academy of Sciences, Committee on Sustainable Water and Environmental Management in the California Bay-Delta, The National Academies Press, Washington D.C., 2010 ("NAS Report").

[12] Pelagic Organism Decline Progress Report: 2007 Synthesis of Results, January 15, 2008.

communities, particularly nitrogen and phosphorous. The fact that the balance of nutrients in aquatic environments regulates the communities of phytoplankton is far from being a new concept, as it is a phenomenon that has been observed around the world, for example:

- Tolo Harbor, Hong Kong: There was an 8-fold increase in dinoflagellates between 1979 and 1986 due to phosphate loading and a decrease in the nitrogen to phosphorous (N:P) ratio. Once the phosphorous was removed from the sewage effluent that was being discharged into the harbor, there was a resurgence of diatoms and a decrease in dinoflagellates. Lam and Ho 1989.[13] More detailed studies showed that whenever the N:P ratio fell below 10:1, the number of dinoflagellates increased.

- Tunisia: In Tunisian lagoons it was observed that dinoflagellates increased every autumn when the N:P ratio declined. Romdhane et al. 1998.[14]

- Germany: A 23-year time series off the coast of Germany documented the general enrichment of these coastal waters with nitrogen and phosphate and a four-fold increase in the nitrogen to silica (N:Si) and phosphorous to silica (P:Si) ratios. Radach et a 1990.[15] This was accompanied by a decrease in the diatom community and an increase in the occurrence of *Phaeocystis*, a foam producing flagellate. Mass occurrences of this species began in 1977 in the North Sea (Cade and Hegeman, 1986),[16] and increased in cell abundance and bloom duration through 1985. The general nitrogen and phosphorous enrichment of that coastal area resulted in winter concentrations an order of magnitude higher than the adjacent Atlantic waters. Lancelot 1995.[17] Riegman (1995)[18] further showed that in mixed phytoplankton assemblages in the laboratory, *P. poucheti* became dominant only when the N:P ratios were 7.5 or lower, and when the N:P ratios was 1.5, there was almost complete *P. poucheti* dominance.

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[13] Lam, C. W. Y. and K. C. Ho. 1989. Red tides in Tolo Harbour, Hong Kong, p. 49–52. *In* T. Okaichi, D. M. Anderson, and T. Nemoto (eds.), Red Tides: Biology, Environmental Science and Toxicology. Elsevier, New York.

[14] Romdhane, M. S., H. C. Eilertsen, O. K. D Yahia, and M. N. D Yahia. 1998. Toxic dinoflagellate blooms in Tunisian lagoons: Causes and consequences for aquaculture, p. 80–83. *In* B. Reguera, J. Blance, M. L. Fernandez, and T. Wyatt (eds.), Harmful Algae. Xunta de Galicia and Intergovernmental Oceanographic Commission of United Nations Educational, Scientific and Cultural Organization, Paris, France.

[15] Radach, G., J. Berg, and E. Hagameir. 1990. Long-term changes of the annual cycles of meteorological, hydrographic nutrient and phytoplankton time series at Helgoland and at LV Elbe 1 in the German Bight. *Continental Shelf Research* 10:305– 328.

[16] Cade, G.C and J. Hegeman. 1986. Seasonal and annual variation in Phaeocystis poucheti (Haptophyceae) in the westernmost inlet of the Wadden Sea during the 1973 to 1985 period. Netherlands Journal of Sea Research 20:29–36.

[17] Lancelot, C. 1995. The mucilage phenomenon in the continental coastal waters of the North Sea. *Science of the Total Environment* 165:83–102.

[18] Riegman, R. 1995. Nutrient-related selection mechanisms in marine phytoplankton communities and the impact of eutrophication on the planktonic food web. *Water Science and Technology* 32:63–75.

- Florida Coast: Along the western coast of Florida it has been shown that dinoflagellates dominate the coastal system when the N:P ratio is less than 16, diatoms dominate when the N:P ratio is between 8 and 24, and cyanobacteria dominate when the N:P ratio is greater than 24 Glibert *et al* 2004; Heil *et al* 2007.[19]

During the expert panel, Dr. Cliff Dahm provided yet another example, describing a presentation by Dr. Robert Twilley, who had been the leading expert on restoration in south Florida and in the Louisiana gulf coast, stating:

> And basically the point of his talk was that we're worried about flows in Florida. We're worried about flows in the Mississippi River drainage and in coastal Louisiana. But we've also started to do some restoration where we have tried to put back certain flow conditions into the system, and a lot of times those systems as the restoration efforts have moved forward haven't moved in the direction we desired. And he said, in Florida, the reason why is phosphate in the water. And the reason why in the gulf coast, there's a lot of nitrate in the water. So I would suggest that we do have a nutrient issue that probably needs to be dealt with.

Oral Testimony, Dr. Cliff Hahm.

Even though the effect of the nutrient ratio on the base of the food web, and the cascade of effects up the food chain, is well established; some on the expert panel were unconvinced, with Dr. Bill Bennett calling the science "old school." (Oral Testimony, Dr. William Bennett, Day 3.) The comment by Dr. Bennett derives from the growing appreciation that simple food "chains" (phytoplankton-zooplankton-fish) are rare in ecosystems, and that a great deal of complexity exists in the food "web." While it is true that food webs are complex and there is a great deal of diversity in what can be grazed, there is no disputing that nutritional factors and nutrient stoichiometry affects higher trophic levels. There are numerous relatively recent studies relating the ratio of N:P to physiology and behavior of higher trophic levels. Main, et al (1997; Elser et al (1988); Turner (2002); Sterner and George (2000).[20] Moreover, Kimmerer (2004)[21] confirmed that "[t]he ultimate energy source for the foodweb…is a combination of local production by phytoplankton and other plants…Zooplankton are a key link between primary production and small fish."

[19] Glibert, P.M., C.A. Heil, D. Hollander, M. Revilla, A. Hoare, J. Alexander, and S. Murasko. 2004. Evidence for dissolved organic nitrogen and phosphorus uptake during a cyanobacterial bloom in Florida Bay. *Mar. Ecol. Prog. Ser*. 280: 73-83; Heil, C.A., M. Revilla, P.M. Glibert and S. Murasko. 2007. Nutrient quality drives phytoplankton community composition on the West Florida Shelf. *Limnology Oceanogr.* 52: 1067-1078.

[20] Main, T.M., D.R. Dobberfuhl, and J.J. Elser. 1997. N:P stoichiometry and ontogeny of crustacean zooplankton: A test of the growth rate hypothesis. Limnology and Oceanography 42: 1474-1478; Elser, J.J., M.M. Elser, N.A. Macray, and S.R. Carpenter. 1988. Zooplankton-mediated transitions between N and P limited algal growth. Limnology and Oceanography 33:1-14; Turner, E. 2002. Elemental ratios and aquatic food webs. Estuaries 25: 694-703; Sterner, R.W. and N.B. George. 2000. Carbon, nitrogen and phosphorus stoichiometry in cyripinid fishes. Ecology 81: 127-140.

[21] Kimmerer, W. 2004. Open water processes of the San Francisco Estuary; from physical forcing to biological responses. San Francisco Estuary and Watershed Science 2(1). http:scholarship.org/uc/ite/9bp499mv.

There are numerous syntheses that demonstrate strong relationships between total phytoplankton production and fish production on broad scales. (*e.g*. Iverson 1990, Nixon and Buckley, 2002.)[22] In two recent studies, it was shown that long-term average fish production is controlled by phytoplankton production (Ware and Thompson 2005, Chassot, *et al*, 2010).[23] In fact, the quality of nitrogen form has been repeatedly found to relate to fish production. This is the concept of "new" and "regenerated" production (Dugdale and Goering 1967).[24] Regenerated production, based on ammonium (and other "regenerated" nutrients such as urea and organic nitrogen) tend to support more bacteria, "microbial loop" trophic systems, while "new" production, based on nitrate, tends to support more diatoms leading to fish production (Eppley and Peterson 1979).[25] In systems for which the rate of supply of "new" nitrogen is relatively high, the total production of the system is generally higher than in systems for which this rate of supply is small (*e.g.*, Eppley and Peterson 1979; Gilbert 1988, 1998).[26] Therefore, Dr. Bennett's suggestion that changes to the bottom of the food web would not necessarily cascade up to fish species is not supported by the peer-reviewed literature.

Dr. Bennett further testified it was "inconceivable" that ammonia could be affecting the base of the food web. Oral Testimony, Dr. William Bennett, Day 3. Dr. Bennett is apparently unaware of the large body of scientific research describing ammonium suppression of algae productivity, which was first observed as far back as the 1930s (*e.g.*, Ludwig 1938; Harvey 1953).[27] Some of the early field demonstrations of this phenomenon were by MacIsaac and Dugdale (1968, 1972),[28] followed by research in the Chesapeake Bay by McCarthy *et al* (1975, 1977).[29] Ammonium suppression of nitrate uptake when both nutrients are in ample supply

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[22] Iverson, R.L. 1990. Control of marine fish production. Limnol. Oceanogr. 35: 1593-1604; Nixon, S.W. and B.A. Buckley. 2002. "A strikingly rich zone"- Nutrient enrichment and secondary production in coastal marine ecosystems. Estuaries 25: 782-796.

[23] Ware, D.M. and R.E. Thomson. 2005. Bottom-up ecosystem trophic dynamics determine fish production in the Northeast Pacific. Science 308: 1280-1284; Chassot, E., S. Bonhommeau, N.K. Dulvy, F. Melin, R. Watson, D. Gascuel, and O. Le Pape. 2010. Global marine primary production constrains fisheries catches. Ecol. Lett doi: 10.1111/j.1461-0248.2010.01443x.

[24] Dugdale, R C and J.J, Goering. 1967. Uptake of new and regenerated forms of nitrogen in primary productivity. Limnol. Oceanogr. 12:196-206.

[25] Eppley, R.W. and B.J. Peterson. 1979. Particulate organic matter flux and planktonic new production in the deep ocean". Nature 282: 677-680.

[26] Eppley, R.W. and B.J. Peterson. 1979. Particulate organic matter flux and planktonic new production in the deep ocean". Nature 282: 677-680.; Glibert, P.M. 1988. Primary productivity and pelagic nitrogen cycling, pp. 3-31. In: Blackburn, T.H. and Sørensen, J.(eds.), *Nitrogen Cycling in Coastal, Marine Environments.* SCOPE, Wiley; Glibert, P.M. 1998. Interactions of top-down and bottom-up control in planktonic nitrogen cycling. *Hydrobiologia*. 363: 1-12.

[27] Ludwig, C.A. 1938. The availability of different forms of nitrogen to a green alga (Chlorella) Am.J.Bot. 25:448-458; Harvey, H.W. 1953, Synthesis of Organic Nitrogen and Chlorophyll by Nitzschia Closterium. J. Mar. Biol. Res. Assoc. U.K. 31:477-487.

[28] MacIsaac, J.J. and R.C. Dugdale , 1958. The Kinetics of Nitrate and Ammonium Uptake by Natural Populations of Marine Phytoplankton. Deep-Sea Res. 16:45-67; MacIsaac, J.J. and R.C. Dugdale, 1972. interactions of light and inorganic nitrogen controlling nitrogen uptake in the Sea. Deep-Sea Res. 19:209-232.

[29] McCarthy, J.J., W.R. Taylor and J.L. Tasft, 1975. The dynamics of nitrogen and phosphorous cycling in the open water of the Chesapeake Way. In: T.M. Church (ed.) Marine Chemistry in the Coastal Environment. American Chemical Society Symposium Series 18. Washington D.C., pp. 664-681.

should not be confused with the preferential use of ammonium by phytoplankton when nitrogen is limiting. Under the latter conditions, phytoplankton will use ammonium preferentially because it requires less energy than nitrate. Under the former conditions, the cells must cope with an excess and in doing so, their metabolism is altered away from an ability to assimilate nitrate. Total primary productivity is suppressed as a result. This is particularly problematic for the Bay-Delta as it is already a comparatively low producing estuary. Jassby *et al*., 2002.[30]

The Sacramento Regional County Sanitation District ("Sanitation District") testified[31] that the notion that ammonium has detrimental effects on the ecosystem "strains credulity" and cited three separate studies in the Delta that all found that the occurrence of the harmful algae, *Microcystis aeruginosa* is not related to ammonium concentration. Oral Testimony, Dr. Diane Engle, Day 3. Indeed, Microcystis is one of those phytoplankton species able to cope with high ammonium. However, many other species, especially diatoms, do not. Consequentially, if nutrient regulation of the phytoplankton community is viewed as a whole, clear regulation by ammonium emerges; a picture that does not emerge when the examination is limited to *M. aeruginosa*. Dr. G. Fred Lee agreed, "[h]aving looked at blue-green algal blooms for 50 years all over this country and trying to understand these, there's no question that the ratios affect the numbers, types, and occurrence of various types of algae. No question at all." Oral Testimony, Dr. G. Fred Lee, Day 3. Dr. Cliff Dahm concurred, "…of particular interest in the Delta is microcystis…It's also the form of the nutrient and the ratio of that nutrient to other nutrients in the system that need to be considered." Oral Testimony, Dr. Cliff Dahm, Day 3.

The Sanitation District further testified that ammonia concentrations in Suisun Bay have not been increasing, rather "[t]he range of values from year to year falls within a band, which has been flat since the mid-1980s." Oral Testimony, Dr. Diana Engle, Day 3. They state that annual averages of nutrient loading are irrelevant, suggesting a more appropriate analysis of nutrient loading would only include two months: April and May. *Id.* The State and Federal Water Contractors disagree with the Sanitation District's manipulation of the data to only include two months of the year. Nevertheless, the Sanitation District's manipulation of the data does not change the fact that the nutrient loading in Suisun Marsh has been steadily increasing over time. *See*, Increasing Trends In Nutrient Loading In Suisun Marsh, April-May, Exhibit 6.

The Environmental Defense Fund simply stated that they just did not "believe" that nutrients have changed that much. However, as Dr. Glibert testified the long-term nutrient data show several significant trends. There has been a change in the N:P ratio in the Delta, an increase in total N loading, a decrease in total P loading, and a change in the dominant form of

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[30] Jassby, A.D., J.E. Cloern, and B.E. Cole, 2002. Annual primary production: patterns and mechanisms of change in a nutrient-rich tidal estuary. Limnol. Oceanogr. 47:697-712.

[31] Contrary to statements by the Sanitation District, its discharge may be having a chronic toxic effect on pelagic species. The Sanitation District testified that ammonia/um concentrations have not exceeded acute-to-chronic ratios (ACR). Oral Testimony, Day 3, Other Stressors Panel. However, Dr. Inge Werner's research applied the default ACR of 12.4 that is used by the Regional Board, the basis for which is described in TenBrook et al 2009, instead of the ACR that the Sanitation District objected to, she finds evidence of potential chronic ammonia/um toxicity. Dr. Werner's LC50 determinations for delta smelt showed that the average ammonia/um concentrations reported by SRCSD exceed the chronic toxicity threshold for delta smelt. Werner et al 2009. This is a concern, as quite a few delta smelt were caught in beach seines this year very near the Sanitation District's outfall, where the ammonia/um concentrations tested by Dr. Werner are most relevant.

nitrogen from nitrate to ammonium. The variation in these nutrient concentrations and ratios is highly correlated with variations in the base of the food web, primarily the composition of algae, but also the composition of zooplankton. Dr. Glibert also testified that these changes in the balance of nutrients in the Delta could not be addressed by increasing dilution flows. Oral Testimony, Day 3, Other Stressors Panel. While additional dilution could at times reduce the effects of ammonium from wastewater treatment plant discharges, dilution cannot be used to achieve the appropriate N:P ratio.[32] *Id.* In addition, as ammonium concentrations continue to increase, greater and greater dilution flows would be required to counter the effects.

b. *The flow proposals that recommend replacing existing flow requirements with new numeric targets are inherently flawed.*

The proponents of flow recommendations want the State Water Board to disregard the minimum level of scientific rigor that is generally applied to decisions of this magnitude, thereby urging the State Water Board to rely on the their best professional judgment. The State Water Board should reject their invitations to "be bold" and should refuse to make recommendations based on outdated scientific theories and ideology.

The UCD team and several of the environmental organizations provided flow recommendations. The UCD team was clear that they did not provide an actual recommendation with the intent that it be adopted stating, "…although it may be tempting to grasp at these numbers, this should be avoided in favor of developing better scientific and regulatory processes for prescribing defensible quantities of water on a renewable basis." UCD Panel, Developing Prescriptions, pp. 2-3. Nevertheless, as they actually provided numbers, the UCD flow example is included in this discussion.

The Natural Heritage Institute, American Rivers, Environmental Defense Fund, The Bay Institute, and the UCD panel offered winter, spring and fall outflow recommendations as measured by X2. UCD Panel PowerPoint, Functional Flow Approach, p. 14; AR-NHI Summary at 5; Environmental Defense Fund Summary at 4; The Bay Institute Summary at 2. Each recommendation would push the X2 further out toward the Golden Gate. *Id.* However, these organizations did not provide any specific scientific justification for their proposals; none could explain the biological mechanisms for any perceived relationship with flow other than increased productivity with floodplain inundation; and contrary to the repeated refrain of The Bay Institute in its oral testimony, the previously identified correlations between outflow (X2) and the abundance of various pelagic species have degraded or have disappeared entirely. *See, e.g.*, Oral Testimony, Day 3, Hydrodynamics Panel. Significantly degraded statistical correlations do not justify changing the existing outflow standard.

The UCD outflow example is purportedly based on historic studies, but even the drafters admitted the flow numbers have limited utility stating:

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[32] Other experts on the panel agreed with Dr. Glibert, indicating that changes in nutrient ratios were a significant concern. Dr. Cliff Dahm stated, "…I do think a coupled nitrification/ de-nitrification process that reduced the amount of inorganic nitrogen and turned it to nitrate could have a beneficial overall effect on the system." Oral Testimony Day 3, Other Stressors Panel.

> They are numbers that are in the literature. I don't think they have much validity by themselves. And the fact it wasn't like we spent months and months coming up with them. We went to the easiest source we could find to get these numbers.

Oral Testimony, Day Two, Anadromous Panel. Moreover, the studies the UCD panel relied on were generally tied to the prior correlations between species abundance and X2, which no longer exist (if they ever did) or have been substantially degraded (depending upon the species).

The relationship between the Fall X2 and delta smelt abundance is even more attenuated, as previously discussed in detail. *See*, State and Federal Water Contractors Written Testimony, p. 9. The National Academy of Sciences ("NAS") agrees, and recently concluded after the review of the FWS Fall X2 action that:

> Although there is evidence that the position of X2 affects the distribution of smelt, the weak statistical relationship between the location of X2 and the size of smelt populations makes the justification difficult to understand. In addition, although the position of X2 is correlated with the distribution of salinity and turbidity regimes, the relationship of that distribution and smelt abundance indices is unclear.

NAS at 4, emphasis added. Dr. Bennett agreed that he could not determine if X2 would actually benefit pelagic species because, "…the links between what happens with that action, all the processes and how it translates into more fish are very weak." Oral Testimony, Day 2, Pelagic Panel. There is no basis for recommending a new fall outflow.

The Bay Institute also proposed changes to the OMR requirements currently contained in the OCAP biological opinions. The Bay Institute Summary at 3. However, this organization is recommending OMR flows completely outside of any agency recommendation or published scholarly analysis. In fact, the NAS was unable to determine the justification for the existing OMR requirement in the current biological opinions, which are significantly less restrictive than what the The Bay Institute is proposing in this forum. Specifically, the NAS observed that:

> …the historical distribution of smelt on which the relationship with OMR flows was established no longer exists. Delta smelt are now sparsely distributed in the central and southern delta (www.dfg.ca.goc/delta/data), and pump salvage also has been extremely low, less than 4% of the 50-year average index. Since 2005, a significant portion of the remaining smelt population, 42% (Sommer et al, 2009), is in the Cache Slough Complex to the north and is therefore largely isolated from the central delta.

NAS at 39. The NAS committee was perplexed by the existing OMR requirements because it was unclear at what OMR flow entrainment increased. NAS at 39. Moreover, even at very negative flows (starting around -6,100 cfs) when entrainment would generally be expected to increase, there is no evidence that increased entrainment would have a population effect. *Id*. Regardless, as the issue of the effects of the water projects and specifically the OMR requirement are the subject of ongoing litigation, the State Water Board should refrain from considering the validity of OMR flows.

The State Water Board should also reject the C-WIN recommendation for additional outflow on the San Joaquin River to support the habitat needs of pelagic species. C-WIN Summary Statement at 4. There is no evidence that any sort of flow from the San Joaquin River would support delta smelt spawning activity. Even if true, the habitat that would be created by a San Joaquin River flow would be in the south Delta, which is an area of the Delta that is particularly inhospitable due to higher temperatures and lower turbidity conditions, therefore not an area where delta smelt or other pelagic species would likely flourish.

And finally, the UCD panel proposed "experimental" flows aimed at driving the invasive clam population and *Egeria densa* from the Delta. UCD Panel PowerPoint, Functional Flow Approach, p. 14. As previously explained, Delta outflow is ineffective as a method of managing the invasive clams. *See* State and Federal Water Contractors Written Summary at p. 34. In short, the clams are able to re-populate quite rapidly after high flow events, thus flows cannot be used to reliably control clam abundance. *Id*. The proposal for management of *E. densa* through manipulated flows involves allowing salinity to intrude deep inside the Delta, which is infeasible for many reasons including the maintenance of water quality standards. *See* Contra Costa Water District Questions on Written Testimony, Attachment at 1-7. Regardless, the UCD panel proposal misses the mark as there is compelling evidence that the abundance of clams and *E. densa* is driven by the currently skewed nutrient ratios in the Delta. *Id*. at 34-37. Therefore, nutrient management rather than flow management would be the most effective response.

In light of the absence of scientific justification for any sort of change to the existing outflow requirements, the State Water Board should decline to make any new outflow recommendation at this time. All of the proposals are completely infeasible, and certainly unjustified in light of the fact that we cannot expect to see any change in the existing abundance of pelagic species from any of the flow proposals and many of the proposals are impractical and impracticable.

3. <u>Anadromous Fish</u>

The testimony provided by virtually all parties was remarkably consistent as to what environmental factors affect anadromous fish that use the Delta for a part of their life histories. For example, Jonathan Rosenfield, appearing for the Bay Institute, stated:

> As we've heard from testimony before we'll get into more later and we've already talked about, the delta environment is a challenging environment for these fish, both because of temperatures naturally occurring and other temperature problems: Water quality, predators, microcystis, et cetera, you name it.

Mark Tomkins, for American Rivers, listing his concerns, stated:

> One, of course, is floodplain inundation and access for fish to floodplains. Temperature is number two as another very important one, and the third and fourth kind of go hand in hand. And that's suspended sediment and transport movement of sediment into the delta from the upper tributaries.

The emphasis from nearly all the experts was related to the basic needs of the fish for friendly suitable habitat that contains (a) turbid waters (making it more difficult for predators to find and eat them), (b) floodplain type geomorphology (young salmonids use seasonally inundated floodplains and associated flooded vegetation (once again to hide them from predators and to provide food sources), (c) proper temperature conditions, and (d) suitable water quality (absence of toxics).

Recognition of these habitat needs was pretty universal among the experts, but when asked if Delta flows could provide such habitat conditions, some of the responses were rather remarkable. Drs. Rosenfield and Moyle described the importance of Delta flows similarly:

> So I would say that a key limit on these fish related to flow is getting them through the hazardous environment, you know, relatively unscathed past all these various hazards. (Rosenfield)

and

> So the key thing for delta outflows right now is getting the fish through the system when they're entering it. Hopefully, in the long run, we'll be recreating habitat that they can hang out in, Cache Slough and places like that. In the short run, getting them through is really important. (Moyle)

In other words, these witnesses said that we have made a mess of the main river channels through the Delta – filling them up the non-native predators and turning them into stale rip-rap lined flood channels that are the anthesis of what a young salmon would prefer – and the best thing to do with flow is to use it to wash those fish through the system and out into the ocean as fast as possible. Jon Burau of the USGS probably summed up the state of this estuary most simply and eloquently:

> These [the Delta channels] have been optimized for conveyance and flood protection essentially. And they're a system of conveyance canals and not an ecosystem. You know, if you look functionally at the geomorphology, and people have been talking of that, those channels are closer cousins geomorphologically to the All-American canal. They are prismatic. They have steep sides. Most of them are rocked. And you know very few people in this room would expect to have a lot of ecosystem services from the All-American canal. And it seems a little bit unreasonable to expect a network of those canals would provide ecosystem services. So when we talk about geometry, there's the web effect, which I probably won't go into now, the fact everything is connected. But at the scale of the channel, these things [the Delta channels] don't really look like natural river channels. And that certainly -- I'm not an ecosystem expert -- but I expect that that has a pretty dramatic effect on how this ecosystem functions.

Under these conditions, how likely is it that flow alone will make things better? The clear answer is very unlikely and virtually every scientist recognized that to be the case. Yet some of the presenters, without much specificity or citation to science based analyses, suggested that flow alone might help either under the fast transport theory, or as a means of increasing turbidity or lowering water temperatures. A review of the underlying science, however, quickly dispels any notion that flows that are within manageable ranges would have any measurable impact on these key habitat conditions or provide more rapid transport.

First, the science is clear that water temperatures in the western Delta are controlled by ambient air temperatures. Even in the upper reaches of the Delta they are controlled by air temperatures except in high flow years when the sheer volume of uncontrolled flow creates adequate temperatures throughout the system.

Second, attached as Exhibit 7 are two documents related to turbidity. The first, prepared by the USGS, shows that turbidity increases require rainfall and rainfall related stormwater runoff flow events – i.e., natural hydrologic variability. Releases from reservoirs are not operationally capable of producing the forces and volumes needed to create large volumes of turbid water. The second is a graph showing the relationship of flows at Freeport to increases in turbidity. Turbidity does not significantly begin to increase until flows reach between 30,000 and 40,000 cfs. This flow magnitude corresponds to the rainfall events described in the USGS document and does not correspond to a flow level that can be maintained by operational management.

Finally, attached as Exhibit 8 are two graphs that show that the rate of outmigration of salmon smolts is largely independent and unrelated to flow.

a *Sacramento River Salmon Smolts*

Salmon smolts use the Delta as a migration corridor from their upstream natal spawning and juvenile rearing areas to the ocean. As noted above and in Exhibit 8, there is no credible evidence that modification of the currently mandated flows through the tidal reaches of the Delta (i.e., from approximately Rio Vista downstream) would have any measurable affect on the rate of movement of these smolts through the Delta. Smolts are capable of ocean survival and are volitional swimmers who move through the tidal forces at their own chosen rate. Thus, to the State and Federal Water Contractors, it is unreasonable to believe that new flow criteria would provide sufficient velocities to blast these fish through the dangerous Delta. A far more logical approach would be to remove the dangers and, as suggested by Dr. Moyle, return the Delta habitat to a condition where the salmon can linger and grow.

Further, using stored water to increase flow rates, even if they could increase the rate of juvenile salmon transport, would be foolish when (a) increasing the survival and the success of the salmon migrating through the Delta can be better achieved through stressor removal and (b) the use of such storage would jeopardize cold water pools in reservoirs upstream of their natal areas. Manipulation of in-Delta flows in a manner that reduces the quantities of cold water stored in those reservoirs could cause damage magnitudes greater than any perceived downstream benefit to the species.

The greatest stressor to downstream migrating smolts is predation by non native species, in particular, striped bass and black bass. Results of recent acoustic tagging studies have shown high levels of mortality of juvenile salmon migrating downstream in the Sacramento River that are thought to be largely the result of predation mortality (e.g., McFarlane and Ammann (2009) estimated 90% mortality for late fall run salmon smolts migrating in the Sacramento River to the ocean). The influence of predation on this low survival cannot be controlled or reduced by flow. In addition to the unwise introduction and protection of these non-native predatory fish, the two factors that affect predation are (1) the conversion of the Delta channels from meandering courses with undercut banks, cover habitat, and other refugia to prismatic, rock-lined flood channels and (2) the reduction in turbidity. Neither of these stressors can be measurably influenced by flow changes involving operation releases from upstream reservoirs.

With respect to smolt entrainment into the Central Delta from the Sacramento River, little new information was provided. Two of the routes by which salmon enter the Central Delta, Georgiana Slough and Three Mile Slough, are natural channels. The other route, the Delta Cross Channel, is now thoroughly regulated under this Board's Decision 1641 and the current National Marine Fisheries Service biological opinion. Current records demonstrate that few Sacramento River smolts enter the Central Delta through the non-natural route. Further, when the Cross Channel gates are closed, more smolts enter the Central Delta through Georgiana Slough since the stage of the Sacramento River is higher at the mouth of the Slough when water is not being diverted through the Cross Channel. There is no new data that would indicate that the Board, through these proceedings, needs to suggest new Cross Channel operational criteria. This is particularly true given the plan to construct an isolated conveyance facility that will significantly alter the use of and hydrodynamics related to the Cross Channel gates.

One final observation needs to be recorded with respect to flows and the survival of salmon smolts in the Sacramento River portion of the Delta. The PCFFA, through its witness Bill Kier, relied heavily, if not exclusively, on a 1987 report by Marty Kjelson that studied the survival of smolts under various conditions. While Dr Kjelson's work may have been the state of the science in 1987, the state of the science twenty-three years ago cannot be compared to that which exists today. Our understanding of correlations, migration pathways and survival based on advancements in the use of acoustic tag technologies, and the habitat needs of the species are vastly superior today, and thus we must carefully consider whether papers that are nearly a quarter century old can be used as a reliable technical basis to set criteria in 2010. An example of the risk of using this report is illustrated by one passage in the Kjelson study that the PCFFA failed to mention. At page 26, the report states:

> The abundance of smolts at Chipps Island from 1978 to 1987 appears to be influenced by the rate of river flow. The correlation between smolt abundance and mean daily flow at Rio Vista during April through June has a correlation coefficient of 0.90 (Figure 3-6). *While the correlation coefficient was significant, there was no apparent relation between flow and smolt abundance at flow levels between 7,000 and 19,000 cfs.* When including data from the two high flow years, 1982 and 1983, a significant correlation was observed. In those years we saw a major increase in out-migrants. *Unfortunately, we did not have a mean April-June flow that fell between 20,000 and 50,000 cfs to evaluate smolt production under those conditions.*
>
> Mean Rio Vista flow (April—June) is well correlated (r=0.82. p<0.0l) with mean flows entering the Delta at Sacramento during the previous December to March period of fall-run incubation and rearing. *Thus, the large numbers of smolts leaving the Delta in 1982 and 1983 could in part be the result of the increased flow upstream during incubation and rearing as noted by Stevens and Miller (1983).*

Italics added.

What we know today is that 1982 and 1983 were very wet years that produced ideal cold water conditions in the upper watershed. We also know that the consistent flows of over 50,000 cfs in the spring months likely created ideal turbidity conditions by activating geomorphic forces in small , unregulated watersheds downstream of the major storage reservoirs and that these two years resulted in the highest total outmigration of smolts from the Sacramento River since records have been kept – in 1983, a difference of almost 15 million fish. We also know that flow management through reservoir releases cannot recreate the flows of 1982 and 1983. Finally, we now recognize that Stevens and Miller (1983) were correct and that the two years that created a correlation as shown on Table 3-6 of the Kjelson report were not related to flows at Rio Vista, but by upstream conditions and irreproducible spring habitat conditions throughout the Delta. There is no indication that flows of 20,000 cfs measured at Rio Vista (as recommended by PCFFA) would begin to repair the habitat and predation issues that vex the Delta today or speed up the passage of smolts through the system.

b. *Sacramento River Salmon Fry*

The contribution to the adult salmon population of salmon fry who are displaced from upstream rearing habitat by territorial competition or are involuntarily washed out of their natal areas and, therefore, must hold over in the Delta until they become smolts, is poorly understood. Those younger fish primarily enter the Delta when upstream, high-flow events (generally greater than 40,000 cfs in their upstream rearing areas) so disturb their rearing areas that they are displaced downstream into the lower river and Delta and end up in locations less well suited for their maturation process. These fish do move somewhat with the flow, particularly in the river reaches above the tidal influence, as they do not possess the same swimming capabilities of their smolt kin. However, by definition they typically move into the Delta on uncontrolled high flow and reservoir spill events and these should be avoided if possible (which is usually not possible) and certainly no flow criteria should be adopted that would increase the incidence of upstream flows reaching the point where fry rearing habitat is so disrupted that they are forced downstream prematurely. Once they are in the Delta, transport flows are not an issue as they must reside in the Delta for several months until they become smolts. Once again, if anything is to be done to improve the survival of salmon fry, it rests with restoring lost habitat and reducing predation.

c. *San Joaquin River Salmon Smolts*

A great deal of testimony and exhibits focused on the San Joaquin River salmon runs. However, most of it dealt with what flows should be provided upstream of the Delta (above Vernalis), a topic that seems to be outside the scope of these proceedings as noticed by the Board. In fact, at the prehearing workshop, the Board informed the parties that upstream San Joaquin flow issues would be excluded from the Delta flow criteria process since the Board was commencing separate water quality control plan hearings on that subject.

The only issue relevant to Delta flows was the disclosure (most recently in Dave Vogel's report on the VAMP experiments and results of the 2009 non-physical barrier tests conducted by Bowen) of massive losses of San Joaquin River salmonids to predation from non-native species. Once again, some argued that high Delta flows could be used to wash the smolts quickly through the lower San Joaquin River and South Delta. However, there is no evidence that this premise is correct because, as with Sacramento River smolts, high flows are unlikely to solve the predation problem. The stressor itself, the proliferation of non-native predatory fish, needs to be directly addressed rather than waste hundreds of thousands of acre feet of water in what will likely be a futile gesture.[33]

d. *Steelhead*

The State and Federal Water Contractors are not aware of any new information related to steelhead trout that would not be covered by whatever flows are maintained for salmonids.

4. <u>Toxic Events In The Delta Are Significantly Affecting Anadromous and Pelagic Species</u>

See Exhibit 9.

SECTION 3: <u>RECOMMENDED RESPONSE TO THE LEGISLATURE</u>

One participant in the flow proceeding urged the State Water Board to "be bold." The State and Federal Water Contractors agree. The State Water Board must base its flow criteria on scientific evidence. A 2009 publication by the Public Policy Institute of California, "California Water Myths,"[34] some of whose authors are part of the DEFG, debunked the myth that water/flows are the solution to increasing fish populations. PPIC did not, and the State and Federal Water Contractors do not, argue that flow is irrelevant; however, the report makes clear that multiple factors are related to fish abundance, that other factors may be more important than flow and that more water may, under various circumstances, do more harm than good.[35]

> How much water do the fish need?" This question stems from the assumption that simply allocating more water will lead to healthy fish populations. Those involved in managing water resources know that this assumption is wrong. Yet it remains the primary (if not sole) focus of debate, often to the detriment of other, more important factors for species recovery.

The PPIC report cites several factors to be considered with respect to how much flow is needed.

> 1. [M]ore water is not always better for fish. If the water is of the wrong quality—in terms of temperature, sediment, nutrients, and contaminants—it does

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[33] As just discussed, studies on flow and export effects (the VAMP Program) have incidentally identified a serious problem with predation (90+% predation mortality through the SJR part of the Delta), the magnitude of which renders all other effects virtually inconsequential and probably explains the questionable relationship between survival and river flow. See e.g., Vogel, Evaluation of Acoustic-Tagged Juvenile Chinook Salmon Movements in the Sacramento-San Joaquin Delta During the 2009 Vernalis Adaptive Management Program (2010); Naman, Predation by Hatchery Steelhead on Natural Salmonid Fry in the Upper-Trinity River, California (2008); Nobriga and Feyrer, Shallow-Water Piscivore-Prey Dynamics in California's Sacramento-San Joaquin Delta (2007); Harrell and Sommer, Patterns of Adult Fish Use on California's Yolo Bypass Floodplain (2003); Orsi, Predation Study Report (1967).

[34] *See* "California Water Myths," Public Policy Institute of California, December 2009, by <u>Ellen Hanak</u>, <u>Jay Lund</u>, Ariel Dinar, Brian Gray, Richard Howitt, Jeffrey Mount, Peter Moyle, and Barton "Buzz" Thompson, see: http://www.ppic.org/main/publication.asp?i=890

[35] *Id* at 16.

little good and may do harm. Less water of better quality might support larger and healthier desirable fish populations.

2. [W]ithout sufficient physical habitat, more water does little good and may cause harm.

3. [P]oorly timed flows can be ineffective or counterproductive.

4. [M]any factors can affect wild fish populations, such as salmon and steelhead, that migrate between rivers and the ocean. These factors range from ocean conditions,[36] to rates and timing of pumping from the South Delta pumping plants, to interactions with fish of hatchery origin (Moyle and Bennett, 2008). Thus, putting more water down a river without addressing problems at other locations may not significantly improve fish populations.

5. [S]cience simply cannot accurately and precisely predict how much water the fish need. Large uncertainties are unavoidable in assessing the magnitude, timing, frequency, and duration of ecological flows. To address these uncertainties, adaptive management strategies, which view all environmental flows as experimental and establish procedures for adjusting them, will be required (National Research Council, 2004).[37](internal citations omitted.)

In sum, the best available scientific information, as well as the law, instructs the State Water Board to approach flow as one factor within a comprehensive plan that evaluates and then integrates all factors into cohesive whole. That is what the State Water Board should tell the Legislature. Delta flows are a complex mechanism interacting with many other ecosystem factors. It is not a manner of simply finding the right flow.

From a scientific perspective, a determination of the volume, quality, and timing of water necessary for the Delta ecosystem under different conditions necessary to protect public trust resources is necessarily dependent upon multiple factors. Like pieces of a puzzle, flows, contaminants, nutrients, habitat, channel configurations, predation, invasive species, land development, exports, inflows, and other stressors must all be managed synergistically. They must also be managed to positively affect the species stability at a population level. A focus on one life stage with little or no understanding of how stressors affect later life stages is a recipe for failure.

The law demands the same approach. Under the law, the State Water Board must consider (1) the potential competing needs of different public trust resources, (2) whether the recommended flow will serve a beneficial use, (3) whether the recommended flow is reasonable, (4) how the recommended flow may affect other public trusts resources, and (5) how the recommended flow may affect other beneficial uses.

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[36] The best available science shows poor ocean conditions caused the recent declines in salmon escapement. See What caused the Sacramento River fall Chinook stock collapse? S. T. Lindley et al. (2009). National Marine Fisheries Service Report to the Pacific Fisheries Management Council. Available online at www.pcouncil.org/bb/2009/0409/H2b_WGR_0409.pdf.

[37] *Id* at 16, et seq.

As such, the State Water Board should provide the Legislature with a report that (1) outlines the legal constraints under which the State Water Board operates, (2) summarizes the information presented to it on hydrology, water quality, pelagic fish, anadromous fish, and hydrodynamics, (3) sets forth possible, near-term numeric flow criteria with ranges and appropriate caveats, (4) outlines the conceptual approach for long-term efforts to protect public trust resources, which necessarily includes the volume, quality, and timing of water necessary for the Delta ecosystem under different conditions, but also includes recommended actions to address all other stressors on public trust resources.

A. NEAR TERM

For the near-term (possibly 2010-2020), the State Water Board should affirm that the scientific information provided to it does not indicate that flow criteria different from the existing flow objectives established in the 2006 Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary, as amended, would provide measurable enhancement for the public trust species. That affirmation, however, should include recognition of the need to increase flexibility in implementing objectives both to ensure better protection of the public trust resources[38] and balance between competing needs of public trust resources and between the needs of public trust resources and the needs of other beneficial uses. The State Water Board should also recommend that, to ensure public trust resource protection occurs more comprehensively, more immediate actions be considered. For example, consideration should be given to (1) improving the nutrient balance and thus restoring the Delta's food web, (2) modifying the intakes to the Yolo Bypass to permit more frequent flooding from Sacramento River, (3) coordinating the Yolo Bypass modifications with additional actions in the Cache Slough area to improve flooded habitat, (4) implementing a "Mark-Select" fishery, and (5) encourage harvest of introduced species.

B. LONGER TERM

For the longer-term (approximately 2020+), the State Water Board cannot adopt meaningful flow criteria without defining each element of the broarder program (i.e., extent of habitat actions, potential changes in points of diversion, etc.). Given the short time frame provided by the legislature to adopt flow criteria, the most the State Water Board can do is encourage efforts to carry out comprehensive plans that consider volume, quality, and timing of water necessary for the Delta ecosystem under different conditions necessary to protect public trust resources.

The flow component should consider:

- Levels of inflow during each month in each water-year type.
- Levels of outflow during each month in each water-year type.
- Flows interior to the Delta, including any channel modifications, gates, or barriers.

The remainder of the plan should consider:

[38] For example, storage releases to maintain X2 at Roe Island might deplete cold water pools that would be more beneficial than any potential habitat benefits provided by the storage release.

- Reducing loads of toxic contaminants in discharges from wastewater treatment facilities (ammonia, ammonium, endocrine disrupters, pesticides).
- Reducing loads of toxic contaminants in urban runoff.
- Reducing loads of toxic contaminants in discharges from agricultural lands (pesticides, herbicides).
- Removing non-native submerged and floating aquatic vegetation.
- Modifying existing commercial and sport fishing regulations.
- Screening, removal, relocation, consolidation, modification and/or alteration timing of water diversions for agriculture, municipal and/or industrial uses.
- Reducing illegal harvesting.
- Reducing population levels of introduced species.
- Implementing physical changes to habitat and geomorphology, such as notching weirs and alterations to change tidal impact.
- Restoring and preserving marsh, riparian, and upland habitat in the Delta.

EXHIBIT 1

Dispelling the Myth The Recent Decline In Fish Dependent Upon the Delta Was Caused By Insufficient Flow.

A number of entities participating in the State Water Board's flow proceedings made assertions that could lead the State Water Board to conclude that flow is the most important factor affecting the abundance of pelagic and anadromous fish dependent upon the Delta. Those entities also asserted that more flow was therefore needed to "protect public trust resources" within the Delta. There is no evidence to support those assertions or assumptions. The major evidence in support of the conclusion that flow did not cause the problem is as follows:

1. The relationships between abundance and spring X2 (Delta outflow) that are the basis for much of the argument that flows are the problem, have broken down over the last fifteen plus years. Some other important factor(s) is(are) controlling abundance.

2. The recent patterns of fall X2 show no statistically significant relationship with the recent abundance declines.

3. Direct mortality of anadromous fish by the Central Valley Project and State Water Project is typically less than 1% of outmigrating juveniles. Abundance of anadromous fish has no important statistically significant relationship with operation of the Central Valley Project and State Water Project. Experiments to estimate "indirect" mortality of anadromous fish by Central Valley Project and State Water Project show no important, statistically significant relationship between Central Valley Project and State Water Project and anadromous fish abundance.

4. Long after the major changes occurred in the magnitude, timing, and variability of flow, abundance of almost all fish species dependent upon the Delta were at levels much high then they are today, indicating that other, non-flow factors are causing the declines.

EXHIBIT 2

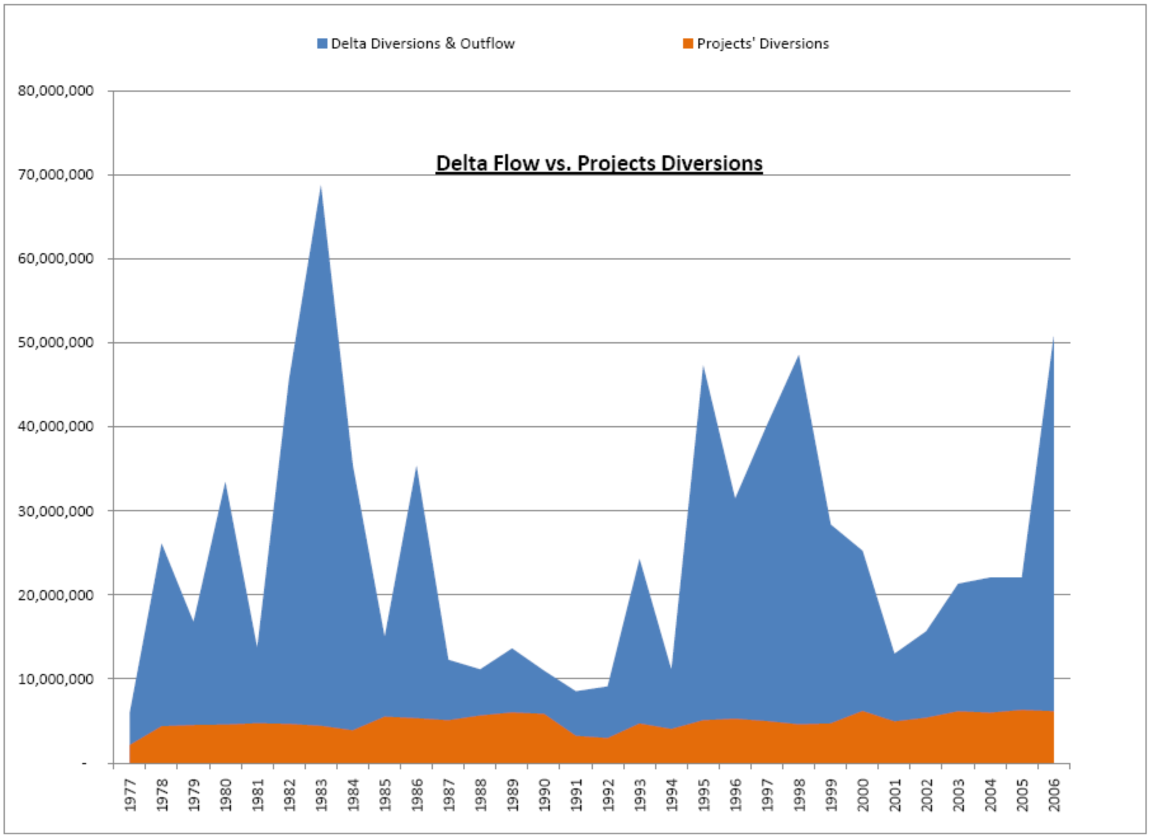
Delta Diversions & Outflow
Projects' Diversions
Delta Flow vs. Projects Diversions
80,000,000
70,000,000
60,000,000
50,000,000
40,000,000
30,000,000
20,000,000
10,000,000
-
1977
1978
1979
1980
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EXHIBIT 3

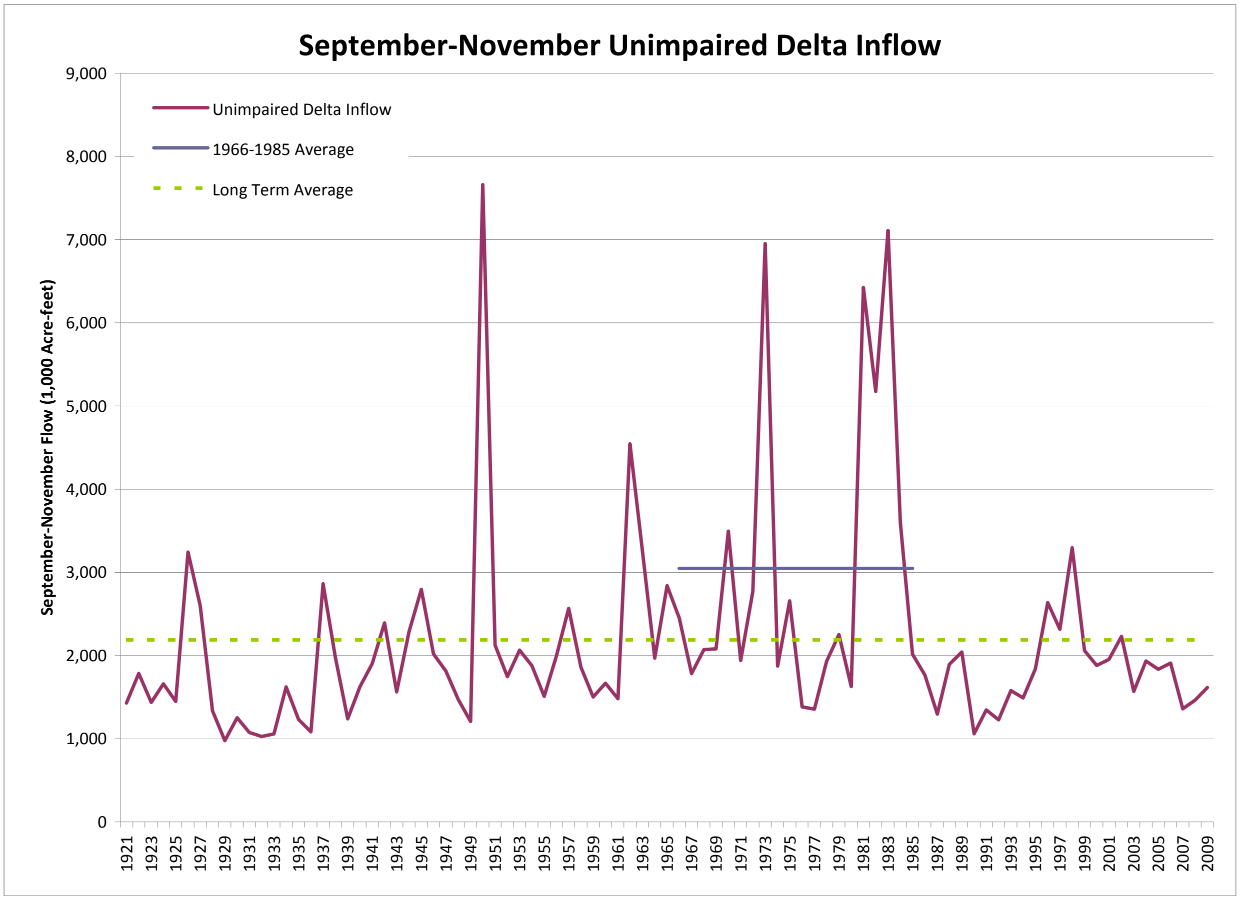

September-November Unimpaired Delta Inflow
Unimpaired Delta Inflow
1966-1985 Average
Long Term Average
September-November Flow (1,000 Acre-feet)
0
1,000
2,000
3,000
4,000
5,000
6,000
7,000
8,000
9,000
1921 1923 1925 1927 1929 1931 1933 1935 1937 1939 1941 1943 1945 1947 1949 1951 1953 1955 1957 1959 1961 1963 1965 1967 1969 1971 1973 1975 1977 1979 1981 1983 1985 1987 1989 1991 1993 1995 1997 1999 2001 2003 2005 2007 2009

EXHIBIT 4

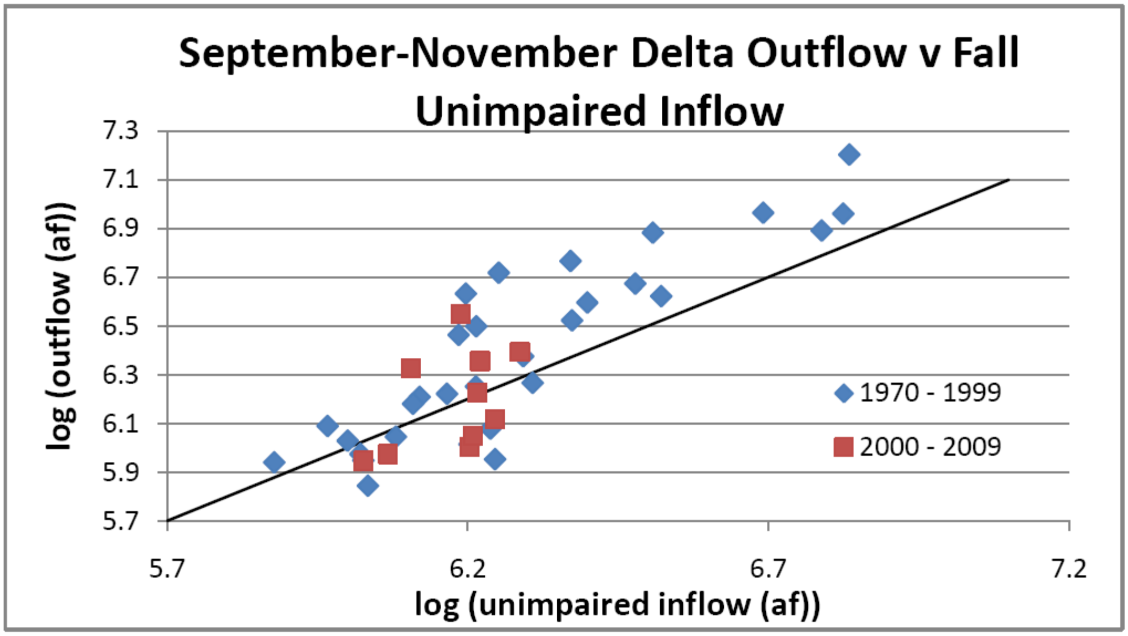
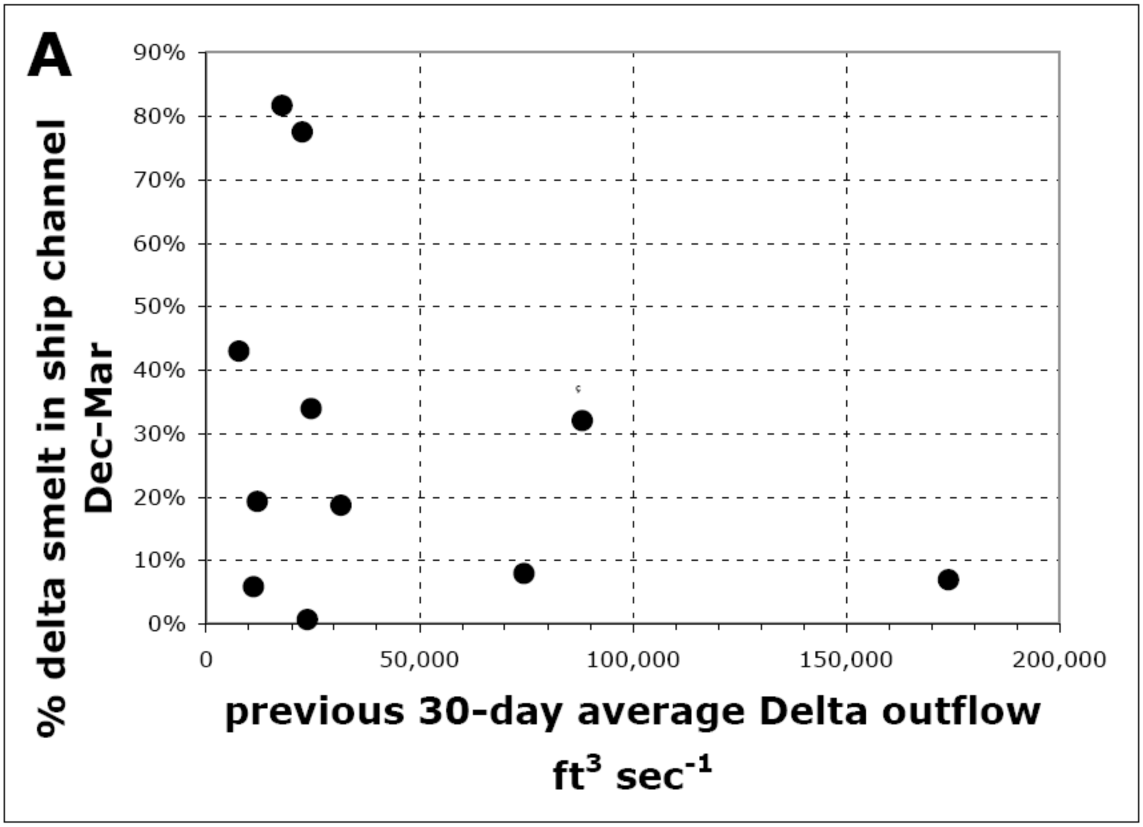

September-November Delta Outflow v Fall Unimpaired Inflow
log (outflow (af))
7.3
7.1
6.9
6.7
6.5
6.3
6.1
5.9
5.7
5.7
6.2
6.7
7.2
log (unimpaired inflow (af))
1970 - 1999
2000 - 2009

EXHIBIT 5



A
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
% delta smelt in ship channel
Dec-Mar
0
50,000
100,000
150,000
200,000
previous 30-day average Delta outflow
ft3 sec-1

EXHIBIT 5 (cont.)

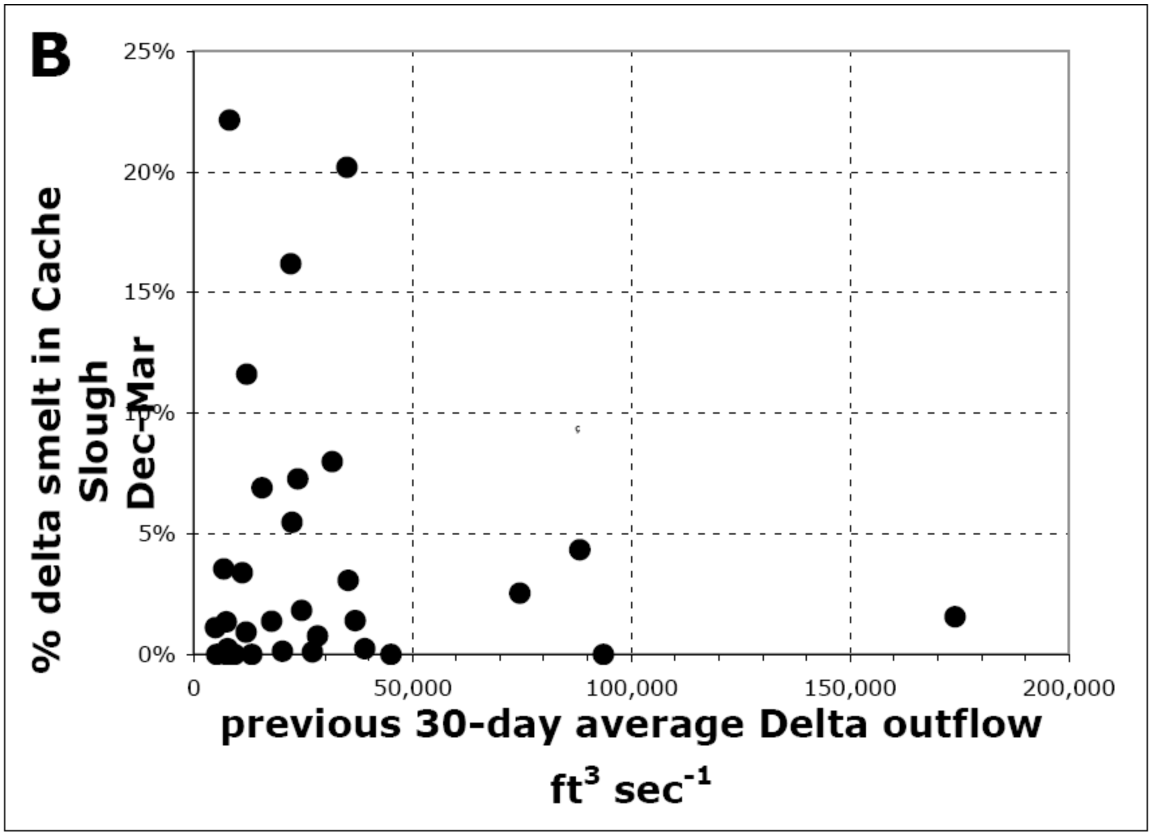
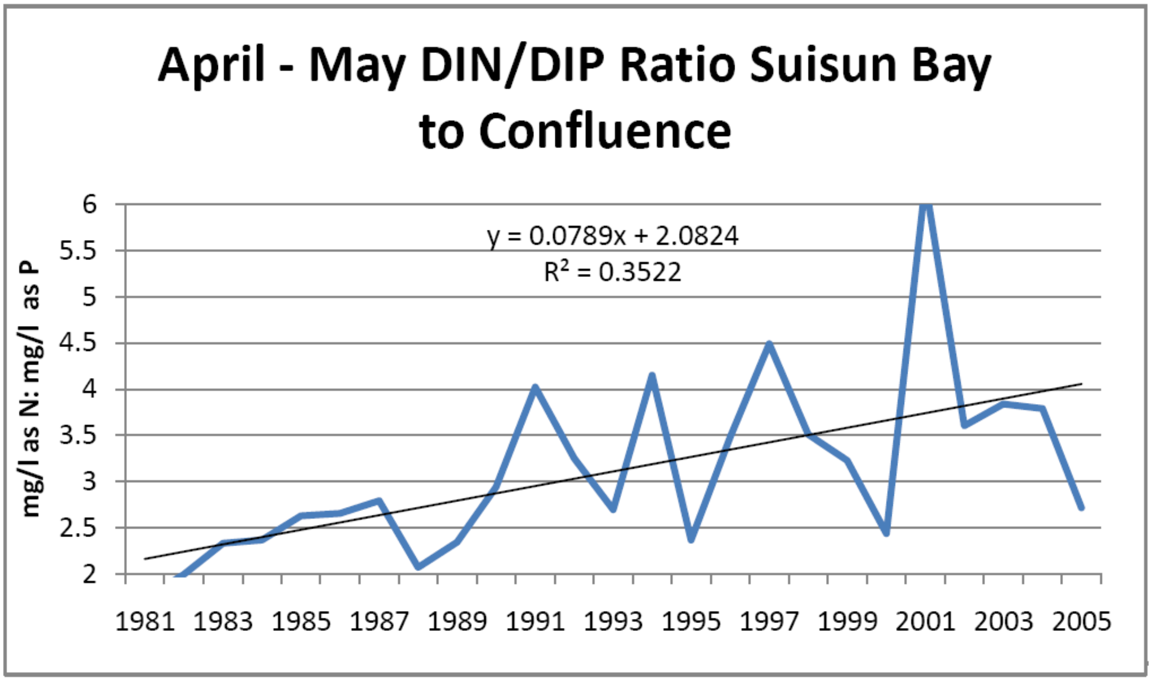


EXHIBIT 6



DIN=Dissolved Inorganic Nitrogen, DIP=Dissolved Inorganic Phosphorus

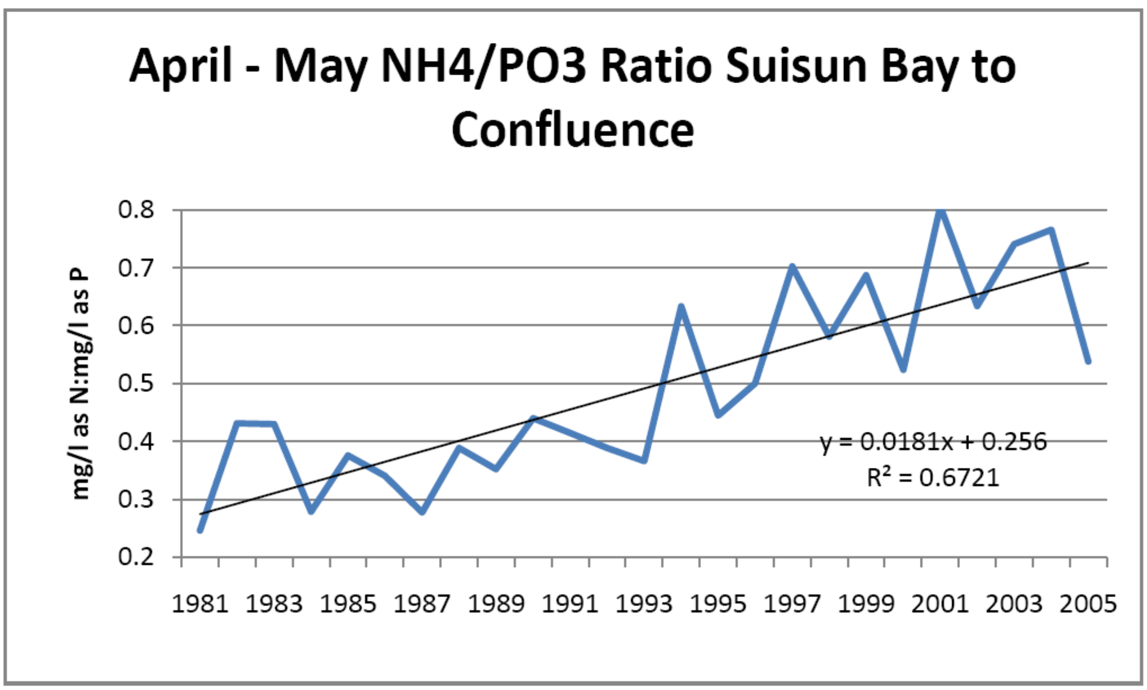
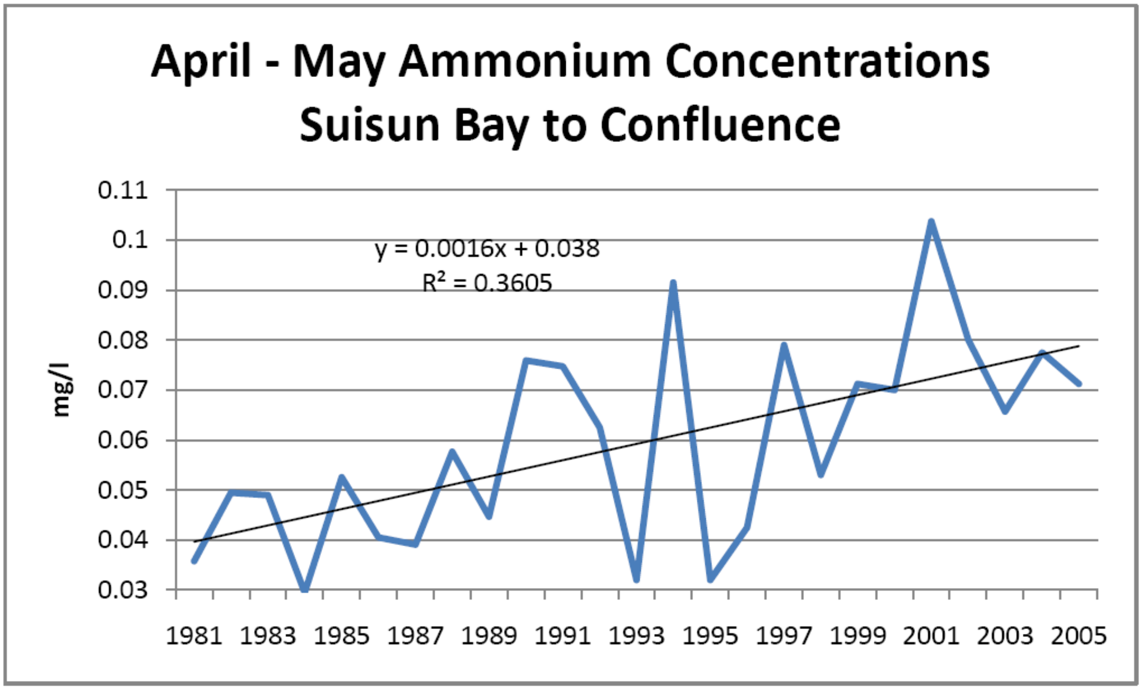


Exhibit 6 (cont.)



<u>EXHIBIT 7</u>

Sacramento River First Flush of Sediment Predictor

Chifung Wong and David Schoellhamer, UC Davis, November 2009

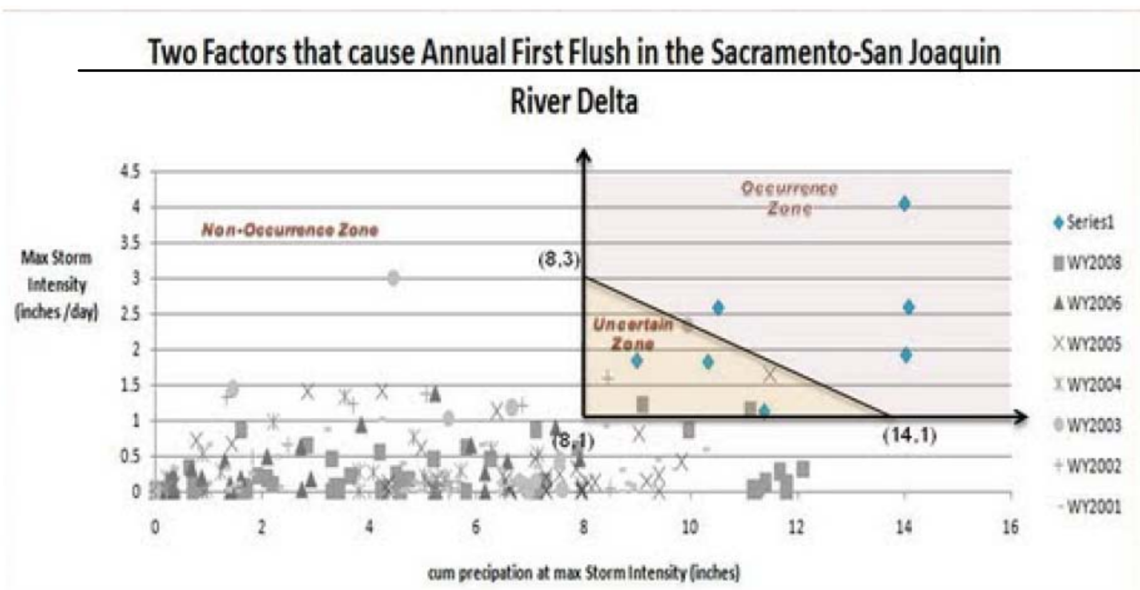
Objective: Predict when the first flush of sediment in the Sacramento River watershed will occur, based on precipitation, to aid water quality monitoring.

Predictor:

Cumulative rainfall for the 8-station Sacramento Valley index (station 8SI in CDEC) is greater than 8 inches. This indicates ground saturation.

8SI rainfall intensity greater than 1 inches/day. Once the ground is saturated, an intense storm is needed to generate first flush.

Here is a chart to show that the occurrence of first flush is uncertain when values of cumulative precipitation and Max Storm Intensity have reached the minimum requirements above. There are three zones in the figure: non-occurrence, occurrence, and an uncertain zone where first flush may or may not occur.



First flush quantitative definition: When the suspended sediment concentration in the Sacramento River at Freeport is greater than 4 times the October average concentration. This definition was produced with discharge and suspended sediment data from USGS (Water Year 1989-2008). This quantitative definition and data was the initial phase of the project and were used to develop the figure above. This Predictive Model is produced by using 8 water years of data from CDEC (WY2001-08) because 8SI daily data started in WY2001.

EXHIBIT 7 (cont)

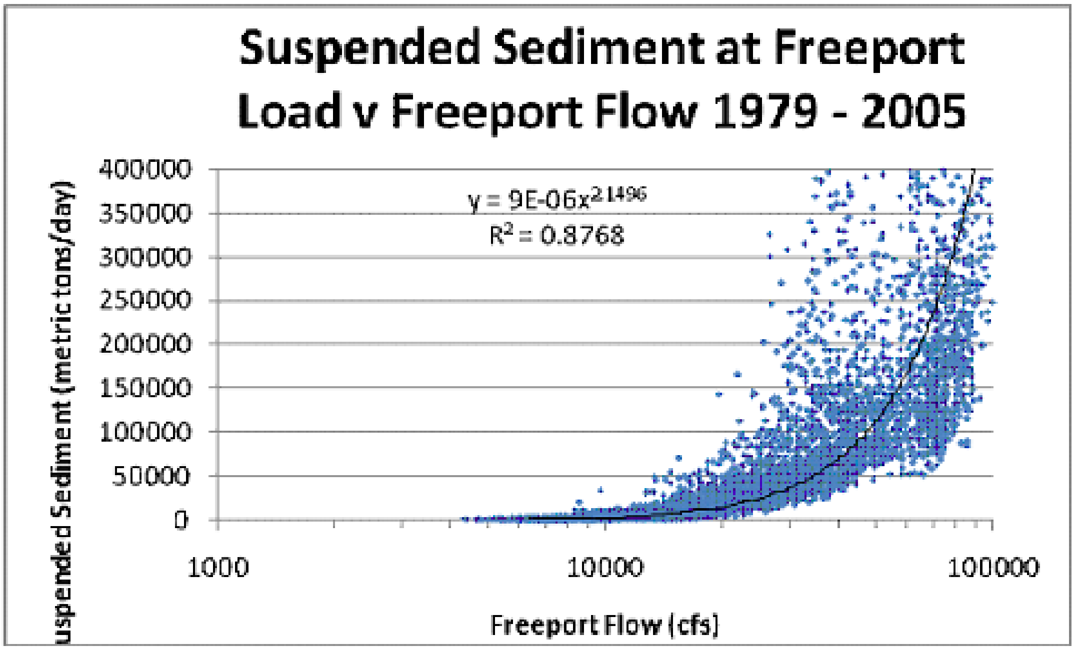


EXHIBIT 8

The data depicted in the following graph were obtained from the United States Fish & Wildlife Service. The data were collected form 1980 to 2001 and result from releases of more than 10 million salmon. The graph charts travel time against flow over the 30 days following release and 60 days following release.

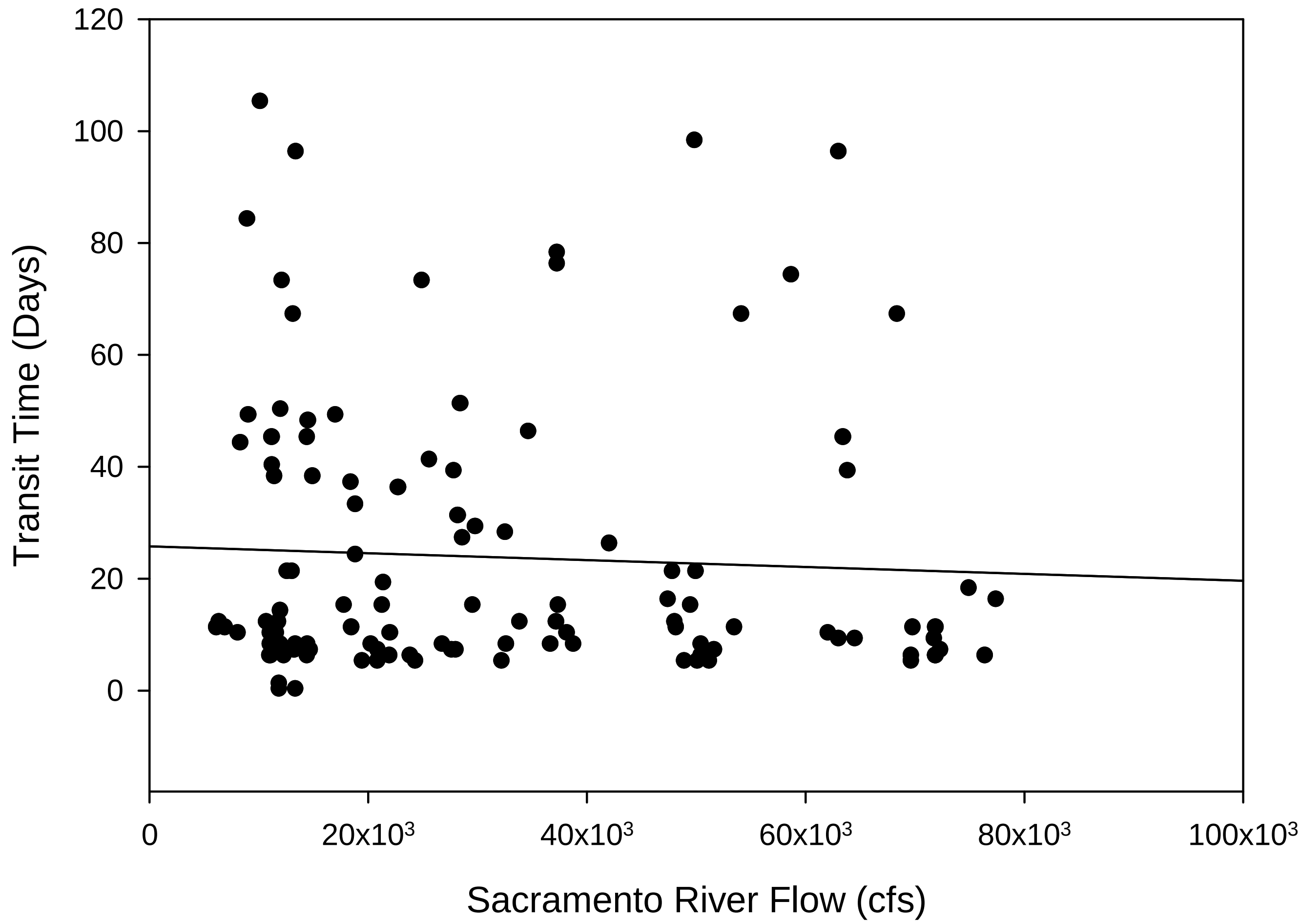


EXHIBIT 8 (cont)

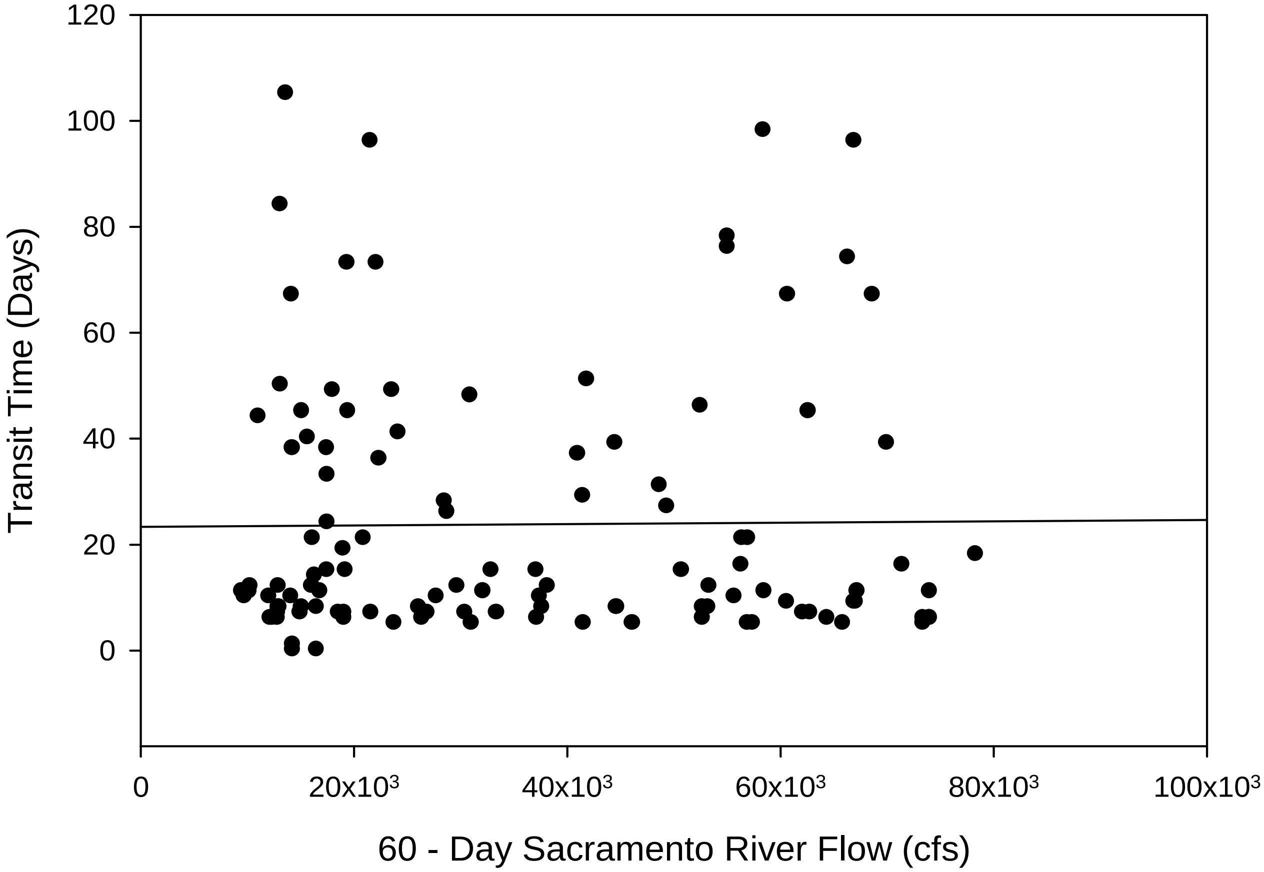


EXHIBIT 9

Toxic Events In The Delta Are Significantly Affecting Anadromous and Pelagic Species

As the expert panel testified, toxic contamination in the Delta is widespread and the toxic effects of these compounds are being transferred from one generation to the next. Dr. Bennett stated:

> …there are contaminants in the system. Pollutant concentrations have certainly been found in many of the organisms out there, so-called public trust resources. There have been studies that have demonstrated correlations between pollutant loading and abundances of fish and other resources…For fish, I would say the closest thing to a population level effect that I've seen is sort of accumulation of heavy metals, PCBs, and things, the tissues of older female striped bass, how that gets transmitted to eggs and how that debilitates the larvae.

Oral Testimony, Day 3; *see also* State and Federal Water Contractors' Opening Statement at 40. The National Marine Fisheries Service has determined that the pesticides commonly used in the Delta are likely to jeopardize anadromous species. State and Federal Water Contractors' Opening Statement at 77. The United States Fish and Wildlife Service ("FWS") has recognized that pesticides are a particular concern for delta smelt as their spawning season corresponds with the rainy season and the peak application of many pesticides. *Id.* In fact, Kuivila and Moon (2004) found evidence that delta smelt were exposed to a complex cocktail of pesticides during sensitive juvenile life stages. *Id.*

Dr. Jim Haas, of the FWS, identified endocrine disruptors as a particular concern stating:

> There have been a number of studies conducted by U.S. Geological Survey and other entities that have basically found endocrine disruption in fish in terms of intersex when they look for it…

Oral Testimony, Day 3. The State and Federal Water Contractors' provided information about endocrine disruptors in their Opening Statement at pages 77-78, including references to studies that identified intersex delta smelt.

Some of the pesticides in the Delta are acutely toxic to many fish species. Dr. Cliff Dahm testified that pyrethroid concentrations may be acutely toxic as:

> The work that have been published here recently in the peer-reviewed literature on pyrethroids has shown that pyrethroids at levels that are quite commonly found in the American River and in the lower Sacramento River are acutely toxic to at least one fairly commonly aquatic invertebrate, Hyallella azeteca.

Oral Testimony, Day 3. The State and Federal Water Contractors provided a detailed discussion of the research that Dr. Dham is referencing in their Opening Statement at pages 38-40.

Dr. Haas further explained that even though many of the toxic compounds in the Delta are at levels not believed to be acutely toxic these compounds are likely having a sublethal or chronic effect, as:

> The other thing that crops up frequently with longer-lived species, like the white and green sturgeon, selenium contamination, and potential effects on reproduction, although the concentrations tend to be at or around threshold levels for reproductive impairment. The same is probably true of mercury, again in those same species.

Oral Testimony, Day 3. The State and Federal Water Contractors' discussed chronic toxicity in the Delta in their Opening Statement at page 41.

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