Response to The Bay Institute March 21, 2005 Submittal: Bay-Delta Plan Periodic Review/Vernalis Flows

The Bay Institute commented that the February-April 14 and May 16 to June flow objectives do not sufficiently protect anadromous and native resident fishes and estuarine habitat. The recent decline of San Joaquin Chinook salmon runs was used to substantiate this claim along with the claim that low inflow from the San Joaquin River has contributed to the low abundance of native fishes in the south Delta. The Bay Institute has not provided valid justification for these claims or for its flow proposal. This document examines key assumptions and analyses presented by the Bay Institute.

The Sacramento River and San Joaquin River Basins: Different Environmental Systems

The Bay Institute's submittal compares the hydrology of the San Joaquin and Sacramento River systems to imply that lower inflow of the San Joaquin is a causal factor in the decline of San Joaquin Chinook salmon runs. Evidence of the difference in the patterns of escapement in the San Joaquin River basin compared to the Sacramento River is used to bolster this claim.

The Bay Institute comments do not discuss or even acknowledge substantial differences in hydrology, drainage complexity and connection with the Delta between the Sacramento and San Joaquin River systems and the difference in the salmon management infrastructure between the two Central Valley basins.

Three major salmon hatcheries (Coleman, Feather River and Nimbus) support the Sacramento River fall run compared to the single, smaller Merced River Fish Facility on the San Joaquin River basin (Table 1). Another important difference is the four Chinook salmon runs in the Sacramento basin (spring, fall, late fall, and winter runs) compared to only the fall run in the San Joaquin River—a difference that undoubtedly reflects the dissimilar environmental regimes of the two basins.

Table 1. Fall-run Chinook Salmon Release Data for Hatcheries in the Sacramento and San Joaquin River Basins (CDFG and NMFS 2001)

Hatchery	Brood 1998 – Release 1999 Production	Location for Release
Coleman NFH	13,030,993 smolts + 755,073 fry (fry program discontinued after 99 year release)	Smolts released primarily in Battle Creek; fry released below RBDD
Feather River	7,921,787 smolts (regular production)	San Pablo Bay and study release sites in Delta
	2,098,920 (Salmon Stamp Program	San Pablo Bay
	500,000 fry (for trib. stocking)	Trucked to various tributaries
Nimbus	4,486,000 smolts	San Pablo Bay
	540,870 fingerlings	Trucked to Sac. R. tributaries
Merced	913,329 smolts	60% volitional release at hatchery, 40% specific sites for study releases. (44% Merced; 12% Tuolumne, 12% Stanislaus; 32% San Joaquin)
Mokelumne River Hatchery production not included.		

The two systems have very different physical features and hydrology, which means that comparing factors that affect Chinook salmon escapement between the two basins is comparing "apples and oranges." The Sacramento River system is much larger with many more tributaries (American, Bear, Feather, and Yuba rivers and Clear, Butte, Battle, Chico, Deer and Mill creeks and the Sacramento River) compared to the San Joaquin River Basin with only the Stanislaus, Tuolumne and Merced Rivers.[1] The drainage areas of the San Joaquin and Sacramento rivers are 13,537 and 21,250 square miles, respectively (USFWS AFRP). Logically there is more widespread and diverse spawning and rearing habitat in the Sacramento River basin compared to the San Joaquin basin. The Sacramento River system has rainfall driven hydrology whereas hydrology in the San Joaquin is dominated by snowmelt, which suggests that resident fish populations must respond and adapt to different hydrologic regimes. The Sacramento River receives imported water from the Trinity River and has more reservoir storage capacity (15,629,000 acre-feet) compared to the San Joaquin River where storage is more limited (10,614,000 acre-feet [USFWS AFRP]) and water is exported. This has implications for the range of management actions that are available within each basin.

Outmigrating salmonids on the San Joaquin River must transit the South and Central Delta, whereas outmigrating salmonids on the Sacramento system do not. A number of interconnected, environmental factors affect smolt survival through this area, and consequently, the difference in patterns of escapement to the two basins may arise from many factors other than, or in addition to, flow during the smolt outmigration period. A key concern for smolt passage from the San Joaquin basin is mortality related to State Water Project (SWP) and Central Valley Project (CVP) exports in the South Delta. Smolts arriving at the Delta from the San Joaquin River have a choice of either continuing through the larger, Old River channel (which eventually leads to dead-ends or CVP and SWP export pumps), or moving through the lower San Joaquin River to the north past Stockton. Even when there is no export pumping, about 60 percent of the water at this Old River-San Joaquin River junction flows to the Old River channel, and initial studies suggest that a higher percentage of Chinook salmon smolts travel in that direction than would be expected if they simply went with the flow (Baker and Morhardt 2001). Smolts moving past the Old River may subsequently be diverted into channels downstream that lead back to the export pumps, such as the Turner Cut and Columbia Cut channels.

Chinook Salmon Abundance and Vernalis Flows

Trends in Chinook salmon escapement in the San Joaquin River tributaries have been cyclical since 1952 when record keeping began ranging from a high of over 80,000 fish to a low of a few hundred. Escapement has been, and continues to be, cyclical on 7 to 9 year periods of highs and lows. The trends, including the most recent downward trend (since 2000) is shown in Figure 3 of the TBI submittal. The Bay Institute's submittal misrepresents this most recent decline as a unique multi-year population decline that is directly related to Vernalis flows. The Bay Institute's comments fail to acknowledge that similar declines occurred prior to 1950, in the 1950's, in the 1960's, in the 1970's in the 1980's and 1990's. Furthermore, the 7-year time period since implementation of the Bay-Delta Plan, which includes mostly Dry or Below Normal water years, is insufficient to assess recent population trends.

[1] The Calaveras River is part of the San Joaquin River Basin, but has its confluence with the San Joaquin River in Stockton and does not affect flow at Vernalis.

Figure 1 presents the number of fall-run Chinook salmon returning to the Stanislaus, Tuolumne and Merced Rivers from 1952 to 2003 based on data from California Department of Fish and Game "Grandtab," which was the data source The Bay Institute used to generate their Figure 3. In addition to showing the number of Chinook salmon for each year, the data were averaged for three time periods, 1952-2003, 1988-1992, and 2000-2003 and displayed as a single line in Figure 1. This analysis shows that average returns over the 2000-2003 period may have been slightly higher than the 1952-2003 average although a 4-year time period is too short to know if this difference is significant. The average during the five-year period from 1988-1992 appears to be substantially lower. These averages show how misleading a "snapshot" of such a short-time period may be for a species that has cyclical trends over a longer time period.

The Bay Institute claims that higher Vernalis flows during the March-June period, when juvenile salmon migrate downstream to the ocean, correspond to larger numbers of adult salmon returning to spawn in San Joaquin Basin tributaries 2.5 years later (Figure 5, p.5). The Bay Institute claims this statistically significant relationship (based on 47 years of data) has continued to be strong during the years since the Bay-Delta Plan was implemented (see Figure 5, open symbols).

Good conditions for outmigration on the San Joaquin are strongly driven by huge, unmanaged flow events such as floods that occurred in 1955, 1969, 1983, 1986, 1995, 1997 and 1998. Any Vernalis flow over 10,000 cfs is indicative of Wet water year conditions and therefore unmanaged flows. Removal of these flows events, because they are not managed flows, eliminates the portrayed overall correlation.

Baker and Morhardt (2001) looked at the effects of flow at Vernalis by examining escapement as a function of flows when the escapees were smolts (assuming smolt emigration occurred 2.5 years earlier). They found that

> *…there is a clear relationship when high flows are included in the analysis, but at flows below 10,000 cfs there is very little correlation between flows at Vernalis and escapement, and there is a very large amount of scatter in the data.* (Baker and Morhardt 2001, p. 180).

Baker and Morhardt (2001) conclude

> *Smolt survival through the Delta may be influenced to some extent by the magnitude of flows from the San Joaquin River, but this relationship has not been well quantified yet, especially in the range of flows for which such quantification would be most useful. Salvage records show clearly that export-related smolt mortality is a major problem, but no relationship between export rate and smolt mortality, suitable for setting day-to-day operating levels, has been found.* (Baker and Morhardt 2001, p. 181)

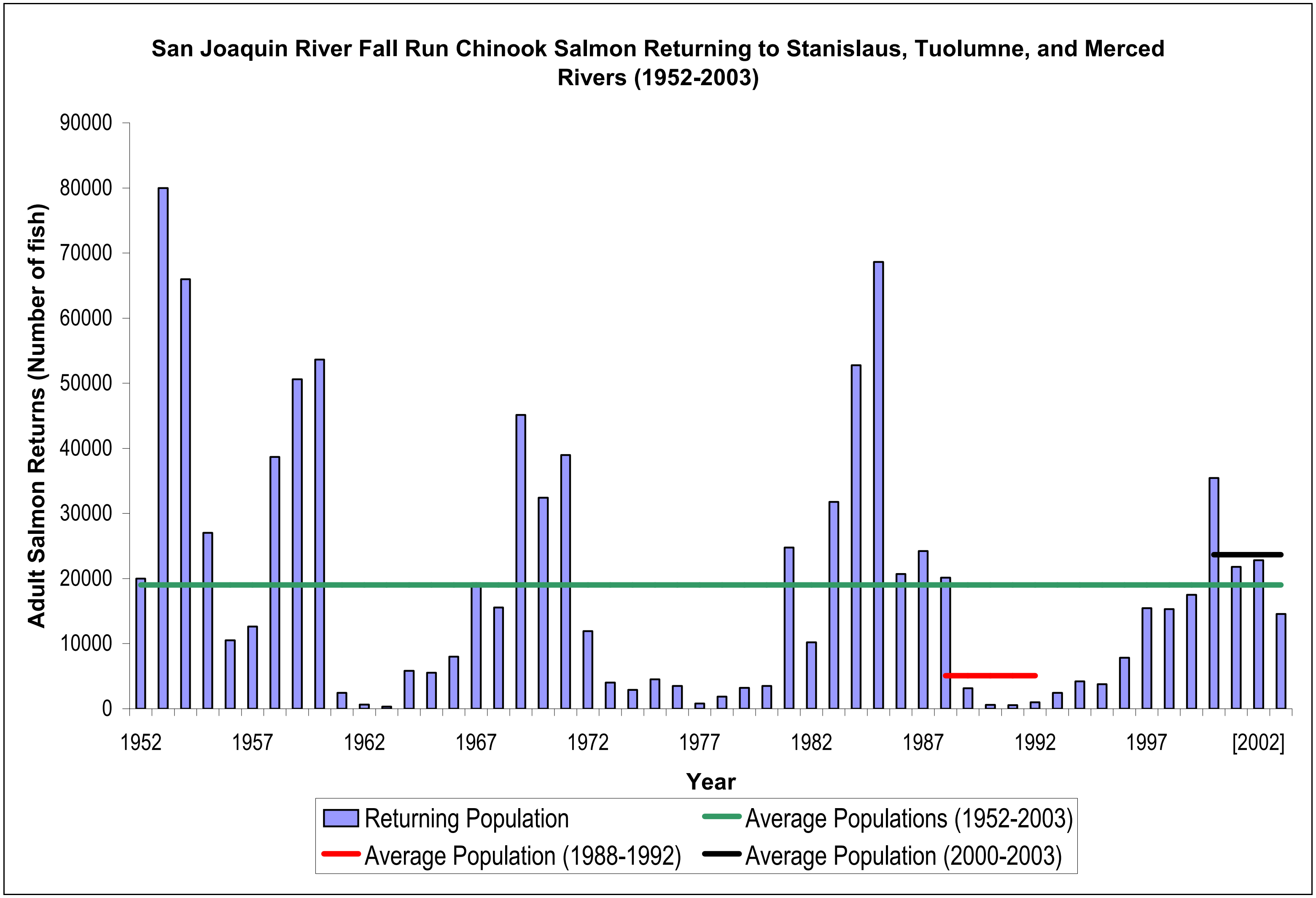

Figure 1. Number of adult fish Chinook salmon returning to the Stanislaus, Tuolumne, and Merced Rivers from 1952 to 2003 (hatchery and naturally spawned fish). Numbers are averaged for three time periods: 1952-2003, 1988-1992, and 2000-2003. Data source: California Department of Fish and Game, "Grandtab".

In actuality, **e**scapement is not a direct measure of upstream or downstream migration success. A "statistically significant relationship" does not indicate a cause and effect relationship. Year-class survival is affected by a complex suite of factors, some of which may be correlated with flows at Vernalis (e.g. water year type). In The Bay Institute analysis, potential effects of factors other than flows at Vernalis are not even acknowledged. In addition to flow-related factors, emigrating juveniles face a suite of issues such as poor water quality, entrainment both along the San Joaquin River and in the Delta, and assemblages of predators exacerbated by the introduction of exotic fishes. Water diverted at the State Water Project and Central Valley Project pumps in the southern Delta causes flow reversal in the lower San Joaquin River confusing migrating salmon and causing delays or otherwise contributing to mortality (Kjelson and Brandes 1989, FWS 1995, Baker and Morhardt 2001).

> *Smolt survival in the San Joaquin Delta is known to be poor, and there are many factors that could plausibly be manipulated to the benefit of survival. Foremost among these are the "usual suspects" in inland fisheries problems: flows, diversions, and water quality.* (Baker and Morhardt 2001, p. 170).

Inflow from the San Joaquin River tributaries does not resolve the root-cause of export-related mortality and should not be used as mitigation for the effects of pumping from the State Water Project and Central Valley Project.

Assumptions based on correlations between flow at Vernalis and salmon population trends presented in Figures 5 through 8 are overly simplified. One such assumption is that river flows per se have a direct and overriding influence on smolt year-class survival and subsequent adult abundance. Population fluctuations in The Bay Institute's Figure 3 appear to occur in 7 to 9-year cycles, and are likely influenced by water year type, which would affect not only flow at Vernalis, but a range of habitat factors in the entire watershed. Peaks in population numbers shown in Figure 3 are often associated with the wettest of water years, while decreases are associated with drier conditions. A number of factors affecting year class survival are likely to be affected by water year type, such as spawning and rearing habitat in tributaries, or dilution of agricultural runoff.

The 60-20-20 San Joaquin Basin Indices for Water Year 1998 through 2000 are Wet or Above Normal, while for 2001 through 2004 are Dry or Below Normal. This indicates that during the recent years since implementation of the Bay-Delta Plan, drier conditions are likely to have contributed to decreasing population trends. Full implementation of the 1995 plan began in 1998, which does not allow quite enough time for two salmon life cycles to have occurred. It will take a longer time frame to properly observe and assess the effects on salmon populations of implementation of the 1995 Bay-Delta Plan.

Analyses presented in Figures 5 through 8 of The Bay Institute analyses and conclusions are based on CDFG data that have faulty assumptions. A key assumption is that escapement can be tied to smolt downstream migration presumed to have occurred 2.5 years earlier. This assumption is based on an assumed age of three years for a consistent proportion of males within a specified size range. Gender was not verified and age was not confirmed by scale or otolith samples. Between 1981 and 1997 the age and sex composition of runs varied widely in the Tuolumne River. In six of the years two-year olds were most abundant while three-year olds were most abundant in 11 of the years. Four-year olds were less than a third of each run (Ford and Brown 2001). The percent of females ranged from 25% to 67% during the 17-year period and the sex ratio varied with the age composition (Ford and Brown 2001). To date, CDFG has presented no confirmation of size and age relationships assumed in the Bay Institute's analysis. Access to CDFG's datasets is needed to fully evaluate the analyses and to assess the validity of assumptions made with these data.

It is overly simplistic to conclude, as the Bay Institute does, that average springtime Vernalis flows during each of the past four years have been insufficient to protect San Joaquin Basin Chinook salmon (see comments above). The fall-run escapement cycles presented in the Bay Institute's Figure 3 occur on larger time scales, and therefore it is clear that only four years of observations--particularly four years that have been classified as Dry or Below Normal Water Years--is an insufficient time period from which to draw such a conclusion.

If the open circles in the Bay Institute's Figure 7 (p. 20) represent years since implementation of the 1995 Bay-Delta Plan, it appears that in subsequent years there are more years when the return ratio of adult spawners in the San Joaquin River basin is greater than 1.0 than not. Specifically, the return ratio was greater than 1.0 (reflecting an increasing population) in all years when the San Joaquin River flow equaled or exceeded delta water exports (i.e. in 5 of 7 years since Bay-Delta Plan implementation).

Potential Contribution of Fry that Down-migrate early in the Year

The apparent focus of the Bay Institute's proposed flows in the March-June period implies an emphasis on larger juveniles and smolts as the primary contributors to the subsequent adult population. That emphasis on spring down-migrants does not consider the potentially significant contribution of the fry down-migration that occurs earlier during January-February. By ignoring fry downstream migration, which occurs earlier in the year than the Bay Institute's analyses address, a potentially important life history stage of the fall-run Chinook population is ignored. Historical (Hatton and Clark 1942) and recent (Demko et al. 1999) data indicate that substantial numbers of Chinook fry migrate downstream in the San Joaquin River basin in January and February. These fish may be an important life history component to the returning adult population. Fry movement occurs during mid-winter, when water is turbid and cold. Little is known about passage and survival of fry through the Delta, and of subsequent effects on escapement several years later. An analysis that focuses solely on the correlation between March-June Vernalis flows and adult escapement completely ignores a potentially important life-history stage of the fall-run Chinook salmon population and factors that may affect it.

Recent migrant trapping studies on the Stanislaus River showed that by far, most of the juvenile Chinook migrants passed the Oakdale trap site as fry (<45mm), although traps may need to be installed earlier to provide more complete sampling and to accurately determine the proportion of fry in the downstream migrants (Demko et al. 1999). Chinook fry migration peaked in January of 1999 and mid-February of 1996 and 1998, although sampling in 1996 and 1998 may have begun too late to document earlier peaks. The large number of fry moving through the Stanislaus River alone does not give an indication of the number of fry moving through the San Joaquin River toward the Delta, but does suggest the a large component of the Chinook salmon downstream migrants may be fry. The Bay Institute's analyses do not account for the possibly extensive movement of fry during the winter months from the tributaries into and through the lower San Joaquin River and delta.

Steelhead

Steelhead differ in some biological respects from fall-run Chinook salmon and it is, therefore, inappropriate to lump the environmental requirements of the two species together. As McEwan (2001, p. 21) stated,

> *It is often assumed that steelhead have been affected by the identified stressors to the same degree as chinook salmon; hence, it is a common perception that alleviation of the stressor to the level that it no longer affects a chinook salmon will result in steelhead population increases. However, some stressors cause greater effects to steelhead than they do to many chinook salmon populations. For example, high water temperatures affect juvenile steelhead to a greater degree than juvenile fall-run chinook salmon because most salmon have emigrated to the ocean by early summer before high water temperatures occur, whereas steelhead must rear through summer and fall when water temperatures are more likely to become critical.*

Management actions that increase flow in the lower San Joaquin River during the Chinook salmon outmigration season will not directly affect rearing habitat flows in the Stanislaus, Tuolumne, or Merced rivers for steelhead. Furthermore, increases in flow at Vernalis in the spring may affect the availability of water during other seasons for habitat restoration or maintenance actions.

Dissolved Oxygen Levels in the Stockton Ship Channel

The Bay Institute proposes that

> *iv. Required flows levels in all months and all water year types should be greater than or equal to 1500 cfs, a level that should be sufficient to provide tolerable dissolved oxygen conditions in the Stockton deep Water Ship Channel.* (Page 9).

Low dissolved oxygen conditions in the Stockton Deep Water Ship Channel is not an issue during the spring Chinook outmigration period. Poor water quality and anaerobic conditions near the mouth of the San Joaquin River (Lee 1999, Lee and Jones-Lee 2003) often temporarily impede adult salmon migration from the Sacramento-San Joaquin Delta to the San Joaquin River (Hallock et al. 1970, Mesick 2001). The approximately first seven miles of the San Joaquin River Deep Water Ship Channel (DWSC) near the Port of Stockton experiences summer and fall dissolved concentrations below the levels required by the CVRWQCB Basin Plan for water quality. Dissolved oxygen depletions below the water quality objective have been documented in the winter in some years (Lee and Jones-Lee 2003) but the low dissolved oxygen conditions are typically eliminated following the first major storm of the year. Lee and Jones-Lee (2003) synthesized available information on the causes and factors influencing these low dissolved oxygen levels and summarize information that can be used to formulate a management plan, including potential management options not related to flow management.

Estuarine Habitat and Native Resident Fishes

Given the number of factors that contribute to the presence of exotic species, it is unrealistic to suggest that flow at Vernalis is responsible for the presence of exotic species. A suite of factors likely has greater influence, such as ongoing and active management of exotic species including striped bass, catfish and largemouth bass. Past and continued introductions from multiple sources such as ballast water from shipping and bait bucket or other illegal introductions will continue to influence the local fish community. Ongoing land-use and water management practices also affect habitat conditions for newly introduced species. High flows may temporarily displace exotic species in riverine systems but this effect is short-lived with fish community differences during the spring that had disappeared by fall (Ford and Brown 2001). Reestablishing a natural hydrograph will not rid systems of introduced species but at best will favor some balanced mixture of native and non-native species.

In estuarine systems the natural hydrograph is strongly dominated by tidal action so reestablishment of a natural hydrograph on upstream rivers would have a noticeable effect only during large flood events. Baker and Morhardt (2001) say the basic fact that tidal flows are much larger than the tidally averaged, or "net" flow is important to emigrating smolts.

> *It would be difficult to exaggerate the difference in magnitude between net and tidal flows. From water year (WY) 1940 through WY 1991, the average flow at Vernalis was 4,550 cfs, and the highest annual average flow over this period was 21,281 cfs (WY 1983). In the San Joaquin River near Columbia Cut and the mouth of Middle River, typical summer flows swing from roughly 50,000 cfs westward to 50,000 cfs eastward, and back again, each day (DWR 1993). At the confluence of the San Joaquin and Sacramento rivers, the typical daily excursion in each direction exceeds 300,000 cfs.* (Baker and Morhardt 2001, p. 173).

Feyrer and Healey (2003) found that after factoring out the amount of variance explained by gear type, fish assemblages in sampled channels in the lower San Joaquin River basin were associated with flow and water temperature. Species that are adapted to high water velocities (splittail, tule perch, and Sacramento sucker) are more likely to dominate the habitat in Grant Line Canal (which is essentially a high-velocity diversion channel) and the lower San Joaquin River, while the Old River and Middle River are more likely to be colonized by species that require moderate to low water velocity habitat.

Substantial variation in sub-adult/adult Delta smelt abundance occurred over the period shown in the Bay Institute's Figure 9 (mid-1960s to present). Recovery criteria outlined in the Recovery Plan for the Sacramento / San Joaquin Delta Native Fishes (USFWS 1996) acknowledges that year-to-year variation will occur, and the Recovery Plan presents recovery criteria applied over a five-year period. The Bay Institute's interpretation of these data is not consistent with recovery guidelines presented in the Recovery Plan (USFWS 1996 p. 29-30), which states:

> *Abundance criteria are: delta smelt numbers or total catch must equal or exceed 239 for 2 out of 5 years and not fall below 84 for more than two years in a row. Distributional and abundance criteria can be met in different years. If abundance*

and distributional criteria are met for a five-year period the species will be considered restored. (USFWS 1996).

In the latest 5-year period presented in Figure 9, the 239 abundance criterion was met. It is not clear from Figure 9 whether the criterion of 84 for more than two years in a row was met, and no information is presented related to distributional criteria.

Conclusions

The Bay Institute has not provided justification for their assertion that an average of 5000 cfs at Vernalis for three consecutive months would provide a substantial benefit for Chinook salmon smolt outmigration. The analyses The Bay Institute presented are based on correlations between flow at Vernalis and flawed CDFG data. The analyses presented do not account for factors, some of which would also be correlated with flow that could affect population trends. Furthermore, the period of time since implementation of the Bay-Delta Plan, which includes mostly Dry or Below Normal water years, is insufficient to assess recent population trends. Correlations presented by The Bay Institute do not quantify potential effects of specific Vernalis flows on Chinook salmon outmigration or on estuarine habitat, and therefore do not provide justification for the Bay Institute's proposals.

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