BIOLOGICAL EXPLANATION OF THE JOINT WATER USERS PROPOSED BAY-DELTA STANDARDS

Submitted by

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The Joint Water Users proposal also includes the development and implementation of a comprehensive monitoring program (Step 5). This program is focused on evaluating each of the flow and operational measures specified in the Joint Water Users proposal (following implementation) relative to its effectiveness in achieving intended benefits. This will provide a feedback loop via the Triennial Review in which necessary adjustments and modifications can be considered to various components of the program to better achieve balanced protection of the aquatic resources. In some cases, additional measures may be warranted, in others, the monitoring may indicate that certain operational measures are having no influence on the resource and may therefore be removed from the program. The existing monitoring programs have not been designed to specifically address the effectiveness of flow and operational measures. It is in the interest of all users and resource managers of the Bay-Delta system to better understand the aquatic ecosystem and its major influencing factors (flow and non-flow related). The Proposal recognizes this and has placed special emphasis on biological monitoring with the understanding that it is the only way in which to develop the necessary scientific data from which to evaluate specific flow and operational measures. A description of the Joint Water Users proposed Monitoring Program is presented in Section 2.3.

2.2 THE JOINT WATER USERS PROPOSAL - BENEFITS AND SCIENTIFIC BASIS

This section contains a description of the logic and rationale for each of the proposed measures, its biological objective and intended benefits, and to the extent possible, a discussion of the scientific basis supporting the development of such measures. The overall Joint Water Users proposal is presented in Table 2-1. The discussion in this section is organized by season, but is limited to flow and operational measures; no discussion is provided for proposed water quality (salinity based) measures, since these largely reflect the measures existing under the 1991 Water Quality Control Plan.

2.2.1 SPRING PERIOD (FEBRUARY 1-JUNE 30)

Spring is a critical time for most biological resources using the Bay-Delta. During this time, many species are spawning, eggs are incubating, and juvenile fish, such as chinook salmon smolts, are emigrating through the estuary. Because this time is so critical, a major focus of the Joint Water Users' Proposal has been on the spring period. We have attempted to protect those life history stages and those activities important to the biological resources of the Bay-Delta during this period. The proposed standards therefore provide for the greatest reduction in exports, the highest transport flows, and the highest flows for improving estuarine habitat conditions during this period. We have also provided minimum outflows, beyond those which might have occurred using the X2/sliding scale approach, in critical and dry water-year types. Figure 2-2 presents the life history periodicity chart for important Bay-Delta fish species.

affect smolt survival. Consensus of biologists at a recent Salmon Smolt Workshop (co-sponsored by CUWA; Kimmerer, 1994) was that flows in San Joaquin River during smolt outmigration periods are important; however, it was also recognized that the existing flow:survival relationships are useful to identify management strategies, but are not adequate to become the basis for specific standards.

The proposed standard will establish minimum flow levels during the period of primary smolt outmigration. These recommended minimum flows are greater than flows which have historically occurred in many years, particularly critically dry years, upon comparison to historical conditions, the proposed minimum flows, in concert with the proposed direct export limits during the 31-day flow period (exports may be additionally limited by the export/inflow restriction described in Section 2.2.1.4, will improve smolt survival. When the flow standards and export limits are enhanced by the proposed closure of Old River during the 31-day flow period, significant, additional improvement of smolt survival is anticipated (see Figure 1-5 for illustration of calculated smolt survival indices for historical and anticipated conditions).

The standards proposed in this section along with the comprehensive standards provided by the Joint Proposed are likely consistent with actions that will be required to achieve the yet-to-be-established objectives of Anadromous Fish Restoration Program.

Although stated in terms of a 31-day uniform pulse flow, it is intended that an equivalent volume of water may be distributed differently in time (e.g., two seven-day pulses of flow greater than 2,000 cfs during a critical year). Short-duration flow fluctuations, adequately separated in time, have shown to be effective in cuing smolts into outmigration. Effective planning and management of a combination of base flow and pulsed flow fluctuations can improve smolt survival efficiently. This alternative management of the flow volume would be based on coordination of San Joaquin River tributary and Delta conditions.

The recommended standard represents an improvement over historical conditions and therefore should prove beneficial to the resource.

2.2.1.4 Export/Inflow Ratio Limits

(a) Measure: February 1-28 -- limit pumping to 65% of Delta inflow. March 1-June 30 -- limit pumping to 30% Delta inflow (35% if monitoring program indicates that fish are disproportionately distributed away from the pumps); minimum 1,500 cfs pumping in all year types.

(b) Measure: Shift exports between CVP and SWP pumps depending on which facility has the lowest density of fish during periods when fish are present (spring) to times when fish are less susceptible to pumping.

Biological Objective: Reduce fish, egg, and larvae entrainment and mortality at the pumps through export restrictions and intensive real-time monitoring/response designed to detect presence of fish in areas adjacent to the pumps.

Intended Benefits: Development of the export/inflow concept was founded on two basic principals which include (1) exports may increase during periods when higher volumes of fresh water are flowing through the Delta without increasing the risk of adverse biological effects and, correspondingly, exports should decrease during those years when fresh water inflow to the Delta is decreased and a larger percentage of fish and other aquatic organisms are geographically distributed further upstream where their susceptibility to export losses is increased, and (2) the percentage of water diverted in recent years, particularly during the spring, has increased substantially above diversion levels (expressed as a ratio of exports to inflow) during earlier years when aquatic resources inhabiting the Bay-Delta system were at more acceptable levels. An analysis was performed using inflow and export data from DWR Dayflow to investigate the inflow/export ratios during the spring (March 1-June 30) for various water year types during two historic periods. Data were reviewed for the period from 1970 to 1983 representing a period when both the SWP and CVP facilities were in operation and when fisheries populations inhabiting the Bay-Delta system were characterized by higher levels of abundance than presently exist for most species. Data from 1984 to 1990 were selected to characterize export/inflow ratios for various water year types during a period when most biological indices reflect declining populations for many of the fish and invertebrates inhabiting the system. Results of these analyses for the spring (March-June), which were considered to be the most significant for affecting aquatic resources are summarized below:

	Water Year Type	Percentage Inflow Diverted (March 1-June 30)		
		Average	Minimum	Maximum
1970-1983	C	35	8	51
	D	29	12	46
	BN	38	27	46
	AN	14	11	41
	W	15	2	40
1984-1990	C	44	25	70
	D	39	25	48
	BN	--	--	--
	AN	--	--	--
	W	23	2	35

Results of these analyses show an increase in the percentage of inflow exported during the spring during more recent years, coincident with the period of decline for many aquatic resources. Based on consideration of these data it was concluded that a reduction in the percentage of inflow exported during the spring was appropriate and would offer substantial biological protection when compared with more recent conditions. The average percentage of inflow exported during dry and critical springs, considered to be the most critical period, between 1970 and 1983 were 29 and 35 percent, respectively. Using these data the joint water user proposal limits spring exports to 30% of inflow unless it can be demonstrated that significant fisheries losses are not occurring at the SWP and CVP diversion facilities under which case exports may be increased to 35% of inflow in all water year types. These export limits, in combination with other elements of the proposed program, offer substantial protection and enhancement for aquatic resources when compared with recent historic conditions.

Imposing the greatest export restrictions during these months should proportionally reduce the numbers of fish potentially entrained within and salvaged at the pumps. Such measures, coupled with increased transport flows, real-time monitoring/response (designed to detect when fish are present/absent in the vicinity of the pumps) should provide increased protection to the fish resources within the Delta.

Scientific Basis: The overall proposed export/inflow limits (those proposed during the summer, fall, and winter) were developed with consideration for balancing fish protection with water supply needs. Thus, relatively low export/inflow ratios were specified during the spring (<30%) when fish are especially vulnerable to entrainment at the pumps, with a general increase in allowable exports (35% in July; 55% from August -September; 65% from October - February) during other times when fish are less vulnerable to diversion losses. Each of the March-September levels likewise has a complementary trigger mechanism (based on real-time monitoring/response) which would allow additional exports upon demonstration that low proportions of known populations of fish are present near the pumps. The specific export limits (and brief statements of benefits and scientific basis) are presented under the flow and operational measures described for the summer, fall, and winter.

State Water Project fish salvage records are available for use in evaluating the seasonal distribution in susceptibility and loss resulting from water project operations (Brown, 1992). Review of salvage data shows that the seasonal distribution of losses varies among species. Salvage data was compiled for data from Brown (1992) for striped bass, chinook salmon, American shad, Sacramento splittail, longfin smelt, and delta smelt to characterize the seasonal distribution in fisheries losses. For these species overall average losses were greatest in April (10%), May (23%), June (24%), and July (16%). Over 70% of the combined average losses for these species occurred between April and July. Average monthly losses ranged from 2 to 6 percent between August and March. In addition to salvage losses relatively large numbers of fish eggs and larvae, which are not accounted for in salvage data, are susceptible to entrainment losses during the spring (April-June).

2.2.1.5 Direct Export Limits

(a) Measure: Direct export limits during the period April 15-May 15, consisting of an amount of water no greater than Vernalis flows, coupled with installation of a barrier at head of Old River. If the decision is made to provide pulse flows for a shorter duration and higher magnitude, then the maximum export rates shall not exceed the Vernalis flow rates shown in Section 2.2.1.2.

Biological Objective: Minimize entrainment and salvage losses of outmigrating juvenile (smolts and some fry) fall-run chinook salmon from the San Joaquin River.

Intended Benefits: Limiting exports to not exceed flows at Vernalis, coupled with a barrier at the head of Old River, should substantially reduce the potential for salmon smolts and fry outmigrating from the San Joaquin River to be drawn to and lost to the pumps. This will increase the probability of smolt outmigration survival from the San Joaquin River to the estuary and should increase the numbers of returning adult salmon.

Scientific Basis: Results of coded wire tagging of salmon smolts conducted by the USFWS (Kjelson et al., 1990) have indicated that smolts outmigrating from the San Joaquin River are susceptible to entrainment at the pumps due to false attraction down the

Old River channel near Mossdale. The peak of outmigration typically occurs in the spring during the period April 15-May 15; direct export limits are therefore proposed for this period. It should be noted that the flow at Vernalis is only one component of the flow in the lower San Joaquin River, which includes flows from eastside tributaries as well as agricultural return flows, and that limiting exports to Vernalis flows ensures a net flow into the lower San Joaquin River.

2.2.2 SUMMER PERIOD (JULY 1-AUGUST 31)

Summer usage of the Bay-Delta is primarily of concern to resident species, although some late spawning of striped bass and splittail has been reported in some locations. A comparison of life stage periodicity data for several species (Figure 5-2) indicates a window of inactivity during July and in particular, August for the species listed. Measures proposed for this period are focused on maintenance of estuarine health and biological processes.

2.2.2.1 Delta Outflow

(a) Measure: July 1-31 – provide monthly average net Delta outflow consistent with the following water year type requirements:

YEAR CLASS	*Delta Outflow (cfs)*
Critical	*4,000*
Dry	*5,000*
Below Normal	*6,500*
Above Normal	*8,000*
Wet	*8,000*

Biological Objective: Provide outflow to the estuary during summer months; maintenance of biological communities in preparation for fall transition period.

Intended Benefits: Maintain suitable habitat in the Delta which is important for continued rearing of juvenile and adult fish (delta smelt, striped bass and others); also, reduce seawater intrusions into the estuary to prevent the colonization of undesirable organisms in the Delta (e.g., *Potamocorbula, Mya* sp. and others). This represents an improvement from previous water rights standards.

Scientific Basis: Although many of the important estuarine species of fish (e.g., delta smelt, longfin smelt) have spawned by June, several others, including striped bass and Sacramento splittail have been reported to continue spawning into July (Figure 2-2). Additionally, larvae and early juveniles of delta smelt and other species remain in the

system and warrant conditions conducive to their survival; i.e., flows to transport larvae to suitable habitats. The derivation of the recommended flows is not based on the results of quantitative habitat or population studies, rather on scientific judgment. The effectiveness of the recommended flows for benefitting the resource will be evaluated as part of the detailed monitoring/response program.

(b) Measure: August 1-31 -- provide monthly average net Delta outflow index consistent with the following water year type requirements:

YEAR CLASS	*Delta Outflow (cfs)*
Critical	*3,000*
Dry	*3,500*
Below Normal	*4,000*
Above Normal	*4,000*
Wet	*4,000*

Biological Objective: Provide outflow to the estuary during summer months; maintenance of biological communities in preparation for fall transition period.

Intended Benefits: Promote continuation of conditions conducive to production of estuarine fish and invertebrate species.

Scientific Basis: *Based on biological judgment.* No definitive studies have been completed to support this specific flow proposal. Both D-1485 and draft D-1630 recommended an August flow of 1,000 cfs at Rio Vista on the Sacramento River based on upstream adult migrations.

2.2.2.2 Export/Inflow Ratio Limits

(a) Measure: July 1-31 – limit pumping to ≤35% Delta inflow (≤55% if monitoring program indicates that fish are disproportionately distributed away from the pumps).

Biological Objective: Reduce overall entrainment of organisms at pumps; regulate in concert with real-time monitoring/response program at locations adjacent to pumps.

Intended Benefits: Transition period during which Delta export/inflow ratios can begin to increase, as biologically sensitive periods pass; i.e., majority of spawning and egg and larvae transport is completed by July.

Scientific Basis: Based on reviews of salvage data which indicate that historically, the highest percentages of salvage occurred during April - June period. The proposed export/inflow ratios are based on shifting periods of high exports to less biologically sensitive periods.

(b) Measure: August 1-31 -- limit pumping to ≤ 55% Delta inflow (≤ 65% if monitoring program indicates that fish are disproportionately distributed away from the pumps).

Biological Objective: Same as above.

Intended Benefits: Continue transition in shifting increases in pumping to periods when biological activity is low.

Scientific Basis: Recommendations based on reviews of salvage data which indicate that potential for losses to pumps decreases during the late summer and early fall; no definitive studies or analysis completed to support these or alternative export/inflow restrictions.

2.2.3 FALL PERIOD (SEPTEMBER 1-OCTOBER 31)

The fall period marks the transition from the long, hot, dry months to periods of increased moisture and rainfall; water temperatures begin to decrease. Biologically, several species of fish, including fall run chinook salmon begin to migrate upstream into the Sacramento and San Joaquin rivers (and tributaries) in preparation for spawning. Adult and juvenile delta smelt and striped bass, and adult splittail continue to rear in portions of the Delta and therefore conditions promoting feeding and growth in preparation for spawning are important.

2.2.3.1 Net Delta Outflow

(a) Measure: September 1-30 -- provide monthly average net Delta outflow at Chipps Island of 3,000 cfs under all year types.

Biological Objective: Provide outflow for maintaining conditions conducive to growth and maintenance of resident and anadromous populations utilizing the Bay-Delta during this period. Provide attraction flows for fall-run chinook salmon.

Intended Benefits: Maintain healthy ecosystem during this period. Need conditions which allow growth and maturation of adult fish in preparation for spawning.

Scientific Basis: Based on biological judgment of life history and rearing requirements of species utilizing the Delta during this time period.

Scientific Basis: Returning adult salmon are rheophilic and rely on velocity cues for stimulating upstream migrations. Maintaining minimum Sacramento River flows will provide such cues for adult fall-run chinook salmon.

2.2.3.3 San Joaquin River Flow

(a) ***Measure: October 1-31 -- maintain minimum flow of 1,000 cfs at Vernalis in all water year types; provide additional pulse attraction flows of 28,000 acre-feet at Vernalis (actual release dates based on real-time monitoring/response) during all year types, except no two critical years in a row; this measure includes installation of barrier at head of Old River.***

Biological Objective: Provide pulse flows to allow attraction of adult fall-run chinook salmon into San Joaquin River.

Intended Benefits: Adult salmon returning to the San Joaquin River are faced with numerous channels on their migration to upstream natal spawning grounds. Provision of a pulse of water down the mainstem San Joaquin will provide additional velocity and olfactory cues which should direct salmon to the main river, and facilitate passage through the lower Delta.

Scientific Basis: Largely subjective; based on biological judgment and knowledge of behavior patterns and requirements of migrating adult salmon. The recommended standard represents an improvement over historical dry year conditions and therefore should prove beneficial to the resource.

2.2.3.4 Export/Inflow Ratio Limits

(a) ***Measure: September 1-30 -- limit pumping to $\leq$ 55% Delta inflow ($\leq$ 65% if monitoring program indicates that fish are disproportionately distributed away from the pumps).***

Biological Objective: Reduce overall entrainment of organisms at the pumps; regulate in concert with real-time monitoring/response program at locations adjacent to pumps.

Intended Benefits: Transition period during which export/inflow ratios can be higher since entrainment potential of fish is low during this period.

Scientific Basis: Based on reviews of salvage data which indicate that historically, the highest percentages of salvage (losses of fish to the pumps) occur during April - June period. The proposed export/inflow ratios are based on shifting periods of high exports to biologically less sensitive periods.

(b) Measure: October 1-31 -- limit pumping to ≤ 65% Delta inflow.

Biological Objective: Provide ability to reduce exports during most biologically sensitive periods.

Intended Benefits: Allowing highest exports during periods when fish densities are typically low at the pumps, while restricting exports during the spring when fish densities are high should reduce overall net losses of fish at the pumps and increase survival, while preventing disproportionate pumping in any period.

Scientific Basis: Based on reviews of salvage data which indicate that historically, the highest percentages of salvage occur during April-June period. The proposed export/inflow ratios are based on shifting periods of high exports to biologically less sensitive periods.

It should be noted that the pumping regime in this proposal was developed with consideration to the seasonal distribution of a variety of aquatic species. However, not all aquatic resources receive the same level of protection from the proposed plan. Indeed, the proposal may hamper fish restoration efforts on the Mokelumne River, because yearling salmon migrate downstream and adult salmon migrate through the Delta and into the Mokelumne River during the fall and winter, when the proposal provides less biological protection. Thus, the increased fall pumping that will occur under this proposal could potentially decrease the survival of yearling and straying adult salmon due to increased diversions, reversed flows, and increased flows through Old and Middle Rivers and the Delta portion of the lower Mokelumne River when the Delta Cross-Channel is open. On balance, however, the proposal provides substantial improvement in the protection of aquatic resources and should be adopted, with the recognition that some tradeoffs may be made between estuarine and upstream resource protection.

2.2.4 WINTER PERIOD (NOVEMBER 1-JANUARY 31)

This is a less sensitive period for most estuarine biological resources. Certain fish species normally spawn during this period, including starry flounder and longfin smelt. While some migration occurs, this period is of lesser importance with respect to flow-related measures, since the estuary is at a natural production ebb and natural (unregulated) flows through the system are sufficient for support of biological functions in most years.

2.2.4.1 Net Delta Outflow

(a) Measure: Provide monthly average net Delta outflow index during the months of November and December (01 November through 31 December) consistent with the following year type requirements:

2.2.4.3 Sacramento River Flow

(a) Measure: Provide flows in Sacramento River at Rio Vista during the months of November and December (01 November through 31 December) consistent with the following water year requirements:

YEAR CLASS	*Delta Outflow (cfs)*
Critical	*3,500*
Dry	*4,500*
Below Normal	*4,500*
Above Normal	*4,500*
Wet	*4,500*

Biological Objective: Provide upstream migration cues for winter run and late fall run chinook salmon. Provide net Delta outflow for continued rearing of juvenile and adult fish.

Intended Benefits: Contributes to maintenance and continuing maturation of resident fish populations; provide upstream migration cues for late fall and winter run chinook salmon and longfin smelt.

Scientific Basis: No definitive scientific or other data to determine appropriate flow magnitudes and durations to produce intended benefits. Based on biological judgment of life history and rearing requirements of species utilizing the Delta during this time period.

2.2.4.4 Export/Inflow Ratio Limits

(a) Measure: limit pumping to ≤65% Delta outflow.

Biological Objective: Permit reduced exports during the most biologically sensitive periods.

Intended Benefits: Allowing highest exports during periods when fish densities are typically low at the pumps, while restricting exports during the spring when fish densities are high should reduce overall net losses of fish at the pumps and increase survival.

Scientific Basis: Based on reviews of salvage data which indicate that historically, the highest percentages of salvage occur during the April-June period. The proposed

export/inflow ratios are based on shifting periods of high exports to biologically less sensitive periods.

2.3 MONITORING PROGRAM

There is a very large body of technical information relating to the Bay-Delta estuary and the lower Sacramento and San Joaquin rivers. This technical information base is composed of numerous long term and short term studies conducted for a wide variety of purposes, as well as accounts and records of activities and events in the estuary and the Delta. The sheer mass of data and other information is daunting. At the same time, individual studies and other technical records vary tremendously in usefulness and relevance when it comes to making informed decisions regarding present status and future management of water, the estuary and associated biological resources.

In recent years, the IEP has given attention to an integrated approach, but studies under this program are often so highly focused that their usefulness in developing a comprehensive, integrated management program for the Delta and its biological and water resources is limited. The San Francisco Estuary Project attempted to pull together many of the biological threads and develop an integrated understanding of the workings of the Delta and the estuary, but the purposes of this project were frustrated to a significant degree by the lack of definitive, reliable science which could be brought to bear on the central issues of the health and workings of the estuary. There has never been a truly integrated approach in data gathering targeting specifically at an integrated solution package. For this reason, among others, solutions to Bay-Delta problems have been a patchwork of individual and sometimes conflicting measures rather than an integrated tapestry with an overall systematic approach.

Many of the studies, including monitoring studies, which make up a significant portion of the technical information base for the Delta and its biological resources were originally designed for narrow purposes, such as single species monitoring. In recent years, however, incidental catch data from these studies have been put to interpretive uses for other species far beyond the capability of the original sampling protocol to adequately address these new issues; sampling protocols have never been reconfigured to correspond to the interpretive uses to which incidental catch data are presently being put. For this reason, conclusions based on these data must be drawn with great care and attention to detail, and must be considered tenuous.

Many of the biological monitoring studies have focused primarily on egg and larval or young-of-year (YOY) life stages of species with much longer life spans, with little focused attention on later life stages, or on scientifically rigorous integration of information relating to various life stages. For this reason, quantitatively integrated life-cycle and basic biological information on special interest fish species indigenous to the Delta and the lower Sacramento and San Joaquin rivers is lacking.

Especially in recent years, existing studies and research programs have been almost entirely focused on two aspects of the health of the estuary and Delta: water exports and freshwater outflow. This has been at the expense of our understanding of other problems with which the