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Reducing Entrainment Losses from South Delta Exports During CALFED Stage 1

This is a short description of the challenges to finding a way to provide both improved fish protection and increased water supply reliability using the existing Delta facilities during CALFED Stage 1. The water supply target of 5 to 6 MAF requires that the Delta export pumping plants be operated for the majority of the time. However, efforts to further reduce fish entrainment effects would restrict the number of days with high export pumping.

Entrainment losses occur when a vulnerable life stage of a fish species of interest is directly diverted at the pumping facilities or indirectly drawn towards the vicinity of the pumping facilities. The daily entrainment loss is proportional to the density of fish in the south Delta water and the volume of water diverted. The existing fish salvage facilities were designed to effectively screen some of the larger fish life stages (i.e chinook and striped bass). These fish screening facilities may not be as effective for smaller fish (i.e. Delta smelt). The density of fish in the south Delta is governed by natural spawning and migration events, but may also be influenced by the hydrodynamic transport and mixing conditions that are controlled by the Delta inflow and south Delta pumping patterns. Changing the Delta inflow or south Delta pumping patterns may change the distribution of vulnerable fish within the Delta channels. Many of the existing Delta objectives (i.e. WQCP objectives such as the export/inflow ratio and X2 requirements) attempt to govern these basic Delta hydrodynamic conditions that are thought to influence entrainment losses. The distribution and abundance of each fish population is influenced by the hydrodynamic conditions within the Delta, but is also a function of habitat conditions important to the various life stages of each fish. Therefore, in addition to operating the existing fish salvage facilities and compying with current Delta flow and salinity objectives, the entrainment of fish in the Delta can be reduced with the following basic entrainment management "tools":

- Sacramento River inflow can be increased to control conditions along the migratory pathway for fish entering the Delta from the Sacramento River corridor, and to regulate Delta outflow and other hydrodynamic conditions.
- The Delta Cross Channel (DCC) gates can be closed to reduce the diversion of fish into the central Delta. The DCC directly influences hydrodynamic conditions in the central Delta (i.e. QWEST).
- San Joaquin River inflow can be increased to control conditions along the migratory pathway for fish entering the Delta from the San Joaquin River corridor, and to regulate central Delta hydrodynamic conditions.
- The temporary Head of Old River (HOR) barrier can be closed to reduce the diversion of fish into the south Delta channels. The HOR barrier directly influences hydrodynamic conditions in the south Delta (i.e. reverse flow from the central Delta).

- The Delta export pumping can be reduced to protect vulnerable life stages of fish species of interest during periods when high densities of these fish are observed in the south Delta or in central Delta habitat.

These entrainment management "tools" can be used in combination to increase Delta outflow or change other hydrodynamic conditions within the Delta. However, these are the only "tools" currently available for managing (i.e. reducing) entrainment at the beginning of CALFED stage 1.

Additional Tools for Reducing Entrainment

There are additional entrainment management "tools" that can be implemented during CALFED Stage 1. But these "tools" require the construction of new facilities or habitat restoration activities, and would not be available immediately:

- The temporary rock barrier at the head of Old River should be replaced with an operable tidal gate, similar to the Suisun Marsh salinity control structure in Montezuma Slough. This would give hydraulic control of the fraction of San Joaquin River water that is diverted into Old River. Opening the gate on flood tide would allow fish that may be migrating or trapped in south Delta channels to escape into the San Joaquin River.

- The fish screening facilities can be replaced with new facilities which will be more effective at diverting water without diverting vulnerable life stages of fish, and allowing more of the fish to remain in south Delta channels or to be more successfully "salvaged" and moved to another Delta location that is more isolated from the pumping facilities. These improved fish screening facilities are assumed by ERPP, and would be constructed during Stage 1.

- New screens can be installed on large agricultural diversions within the Delta or improved screens can be installed on the cooling water intakes for the Delta power plants.

- A new screened diversion channel at Hood (or screen facilities at DCC and Georgiana Slough) would allow more of the water from the Sacramento River to be diverted into the central Delta without also diverting vulnerable fish life stages (i.e. juvenile chinook). These screened facilities would allow greater hydrodynamic control than is presently available with DCC closure required to reduce fish diversions from the Sacramento River. The DCC gates should be automated to become operable tidal gates to allow more flexible operations for fish protection, water quality control, and recreation (boat) uses.

- New and restored habitat can be created throughout the Delta to increase the populations

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and shift the distributions of vulnerable life stages of fish species of interest. This will reduce the net effect of entrainment losses on fish populations, although the south Delta density of fish may actually increase as a result of larger fish populations. This habitat restoration effort is expected to follow the targets and priorities described by ERPP but will require longer than the seven years of CALFED Stage 1.

Water Supply Targets and Delta Export Constraints

The basic water supply targets (i.e. 1995 level of demands used by DWRSIM) require at least 6 million acre feet (MAF) of Delta exports. The demand follows a seasonal pattern with the majority of water needed in the summer months for agricultural purposes. The San Luis Reservoir capacity of 2 MAF, with an assumed carryover storage of 500 TAF, allows some (i.e. 1,500 TAF) of the water supply to be pumped in the winter period and stored until needed in the summer. However, the demands for the October-March period total about 1.8 MAF, so the pumping during these first six months cannot be more than about 3.3 MAF (with existing storage and demand patterns). The remainder of the pumping (2.7 MAF) must occur during the April-September period of high demands.

The currently permitted maximum combined CVP and SWP pumping rate is about 10,000 cfs, which allows a maximum of about 20 TAF of exports per day. The 6 MAF water supply target would require about 300 days of maximum permitted pumping. If full pumping capacity at SWP is allowed (i.e. about 15,000 cfs combined capacity), then a maximum of about 30 TAF can exported per day, and about 200 days of maximum capacity pumping could supply the 6 MAF water supply target.

To maintain water supply reliability, pumping restrictions to provide increased fish protection from south Delta entrainment must be limited to less than 65 days at permitted capacity (i.e. about 1.3 MAF of unused permitted capacity). The number of days with pumping restrictions to reduce entrainment could be increased if the permitted capacity was raised to equal the physical capacity. To fill San Luis reservoir by the end of March from an initial volume of 500 TAF and to meet the 1.8 MAF of demands would require 165 days of maximum permitted pumping. There cannot be more than 20 days of reduced pumping during this period. To meet the demands in the second half or the year would require 135 days of maximum pumping, leaving a maximum of about 45 days of reduced pumping for fish protection.

Maximum pumping is only allowed when Delta inflows are relatively high (i.e. to satisfy Delta outflow and E/I ratios). For example, during the winter and spring when the E/I ratio is 0.35, the inflow necessary to allow exports of 10,000 cfs would be about 28,500 cfs. During the summer and fall, with an E/I ratio of 0.65 and a required outflow of 5,000 cfs with a channel depletion of 4,000 cfs, the necessary inflow to allow 10,000 cfs of pumping would be about 19,500 cfs. Because these necessary inflows for full pumping are not available during all years, the allowable days of pumping restrictions for increased fish protection are reduced in those years when hydrologic conditions limit pumping at less than full capacity. The reduced pumping in dry years reduces entrainment effects, but there are very limited opportunities to further restrict pumping without causing a water supply reduction.

The basic challenge for entrainment reduction during CALFED Stage 1 is to adaptively manage the south Delta pumping to provide the greatest possible pumping in periods without substantial risk of entrainment and reduce pumping only when entrainment risk is greatest. The DNCT team has developed several different possible scenarios for accomplishing this task. One necessary component will be the fish distribution monitoring (i.e. real-time monitoring) that will alert the operators to the presence of high fish densiites. The second component is an Environmental Water Account (EWA) that is proposed to provide enough water supply to allow direct control over pumping restrictions to reduce entrainment. Whenever additional pumping is allowed beyond what is possible to comply with the currrent standards, the EWA account will be increased. The goal of the EWA is to provide a water supply bank to increase the opportunity for export pumping flexibility.

Potential Methods to Control Delta Export Pumping

There are five potential ways to control or limit the south Delta export pumping. These are:

- Pumping capacity can be limited by the physical size of the pumps (i.e. 15,000 cfs) , or by the Corps of Engineers permitted capacity (i.e. 11,280 + 1/3 SJR flow), or by the estimated interim hydraulic Clifton Court tidal gate capacity (i.e. about 8,500 cfs).

- Pumping can be limited by the requirements for Delta outflow, including the fixed monthly outflow objectives, X2 requirements in February-June, and salinity control for agricultural and M&I diversions (i.e. 250 mg/l chloride). A minimum ouitflow of about 4,000 cfs is required to maintain export salinity at 250 mg/l chloride. A minimum outflow of 5,000 cfs will reduce this chloride to 150 mg/l, providing a substantial water quality benefit.

- Pumping can be limited by the export/inflow ratio or by the export/SJR inflow ratio during the SJR pulse flow or VAMP period.

- Pumping could be limited by QWEST flow targets because export pumping reduces QWEST. The DCC closure for fish protection reduces the QWEST flow and therefore reduces allowable pumping. A screened Hood diversion would allow increased exports if QWEST targets were controlling.

- Pumping can be reduced by fish salvage density triggers, or by real time monitoring at Mossdale and Franks Tract that might provide early warming of high fish density. A combination of all availalbe information about fish population size and distributions within the Delta would be used to govern the need for additional pumping restrictions.

The relative magnitude of the these export limits changes with fluctuations in the Delta inflows and with observed fish distribution and density patterns. The effect of imposing new export restrictions or allowing relaxations in existing export limits can be visualized from the pumping limits chart that is produced by superimposing all of the applicable export pumping limits. One example of this chart is shown in the attached figure "Delta Export Limits".

The allowable pumping is shaded. The full pumping capacity was assumed to be available, and the historical inflow during 1985 would have been sufficient for full pumping under the WQCP objectives in the October-December period. However, there were substantial densities of chinook and delta smelt observed during 1985, and the simulated example fish triggers limited pumping during much of the high inflow period. Delta outflow requirements and the AFRP VAMP period of April 15-May 31 further reduced the allowable pumping in this example. Identifying periods when increased pumping could be allowed is more challenging than identifying periods when additional pumping restrictions are needed for fish protection. The EWA will increase the likelihood that this flexibility (i.e. increases to balance the reductions)

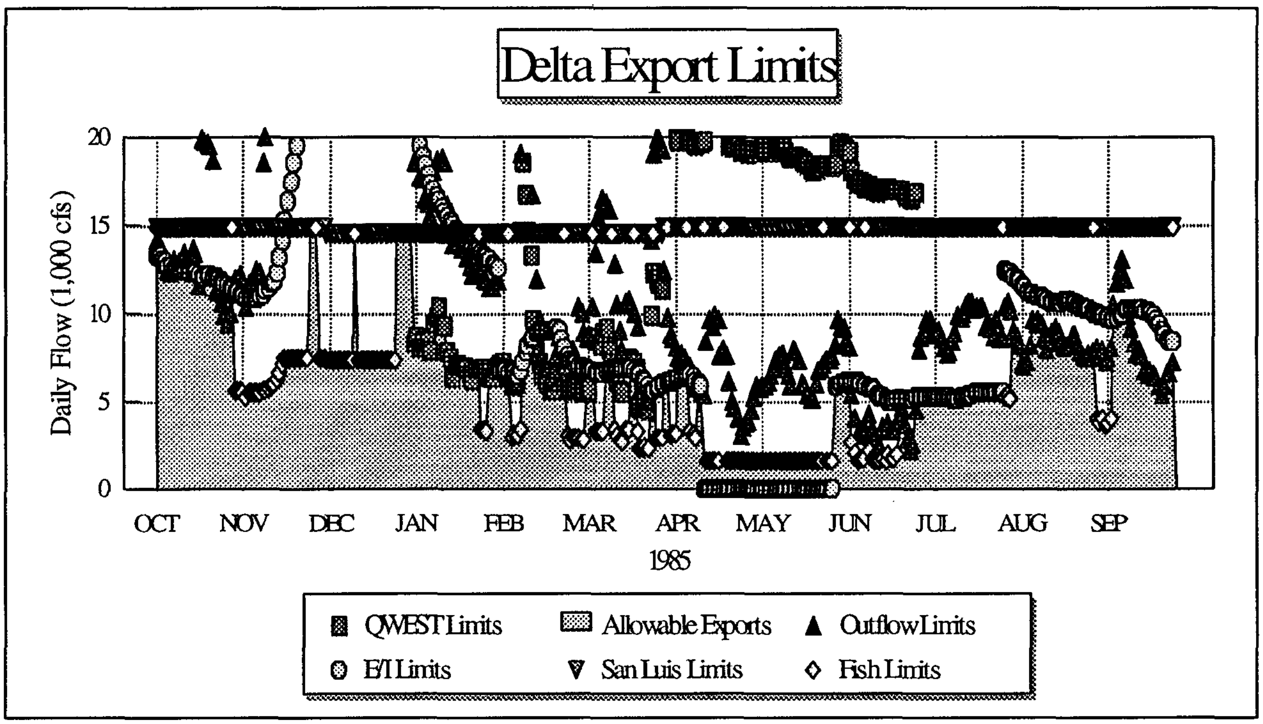

Figure 1. Example of Daily Limits on Delta Exports. Limits can be increased or decreased to shift exports from periods of high entrainment risk to periods of lower entrainment risk.

will be exercised.

Environmental Water Account

The EWA would be a combination of real water storage capacity and a water supply loan "collateral" to allow increased pumping during periods of low fish entrainment risk and corresponding reduced pumping during periods of high fish entrainment risk. The EWA is assumed to be a method for providing additional fish protection by allowing exports to be shifted to periods that have lower environmental effects, without reducing the net water supply exports.

In contrast, the recent series of Delta regulations have generally both shifted exports and reduced the allowable exports. For example, the 1994 Accord lowered the average allowable exports from about 5.8 MAF under D-1485 objectives to about 5.4 MAF under the WQCP objectives (i.e. based on DWRSIM model results). The 1997 in-Delta AFRP measures further shifted exports and lowered the allowable exports by about 250 TAF. The USFWS and NMFS have suggested additional Delta objectives that would provide increased ESA protection, but would require that allowable exports be reduced by another 250 TAF.

The EWA would provide an accounting method to shift a comparable amount of exports, but make-up these reductions with increased pumping during periods with lower entrainment risk, or by purchasing the reduced exports. The EWA puts definitive boundaries on the amount of water that can be used for entrainment reduction, and provides assurrances for the payback of any shortages that these reductions may cause. The EWA has the following advantages compared with the no action alernative (i.e. no further entrainment reduction measures) or compared with the likely alternative of imposing additional export restrictions using prescriptive (i.e. fixed) standards:

- EWA is based on flexibility- the ability to increase and decrease exports based on fish protection goals without constraints from fixed rules.

- The EWA will allow efficient use of water for environmental protection because only the water necessary for protection will be used, and the EWA manager will look for periods of increased exports to replenish the EWA.

Ron. Add the other advantages that were identified this morming here.

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