UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
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San Francisco, CA 94105

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**TECHNICAL SUPPORT MEMORANDUM**

# Review of State of California Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary Under Section 303 of the Federal Clean Water Act

## Introduction

This memorandum provides a technical analysis of the provisions of the State of California's Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary (1995 WQCP). This plan was adopted by the California State Water Resources Control Board (SWRCB or State Board) on May 22, 1995, was approved by the California Office of Administrative Law pursuant to state law on July 17, 1995, and was submitted to EPA for its review under Section 303 of the federal Clean Water Act on July 28, 1995.

Under Section 303 of the Clean Water Act and EPA's implementing regulations, states are to establish designated uses for waterbodies, and must adopt water quality criteria sufficient the protect those designated uses. EPA is to review and approve or disapprove all state-adopted water quality standards. In reviewing water quality criteria, EPA considers whether the criteria contain sufficient parameters to protect the designated uses.

This review of the 1995 WQCP pertains only to those parameters included in that plan, and does not include a review of the provisions of any other related State or Regional Board water quality plans applicable to the waters of the Bay/Delta. In keeping with our past practice, this review is considering the 1995 WQCP's "beneficial uses" and "objectives" as "designated uses" and "water quality criteria", respectively, under the Clean Water Act. To avoid confusion, this memorandum will use the terminology employed in the Clean Water Act.

Substantial information about the scientific background of the Bay/Delta, as well as a discussion of the procedural and regulatory context of the State's 1995 WQCP, are included in the proposed and final EPA promulgations of water quality criteria for the Bay/Delta, and this information will not be repeated here. See 59 FR 810 (January 6, 1994) and 60 FR 4664 (January 24, 1995).

The 1995 WQCP does not make any substantive changes to the revisions to the designated uses in the Bay/Delta (1995 WQCP, p. 12), nor does it include substantive revisions to the water quality criteria protecting municipal and industrial or agricultural designated uses (1995 WQCP, p. 14). The new and revised water quality criteria in the 1995 Plan all address protection of the fish and wildlife designated uses (1995 WQCP, p. 14-15).

In its review, EPA has considered the various changes to the State's criteria primarily in terms of the protection of four different designated uses: the Estuarine Habitat use, the Fish Migration use (now renamed the Migration of Aquatic Organisms use), the Warm Water Fish Spawning use (now renamed the Spawning, Reproduction, and/or Early Development use), and the uses that rely on the Suisun Marsh, including especially the Wildlife Habitat and Rare, Threatened, or Endangered Species uses.

As state above, the fundamental question in reviewing the 1995 WQCP is whether the State's criteria protect the designated uses. This document describes the reasons that EPA has approved the 1995 WQCP as protective of the above-listed designated uses in the Bay/Delta. Further, this document describes data and information that will be collected under the 1995 WQCP that will be considered by EPA during its next triennial review.

## CHAPTER ONE

## Protection of Estuarine Habitat Use

### BACKGROUND

This chapter specifically discusses the provisions of the 1995 WQCP that protect the Estuarine Habitat designated use.

### EPA'S ESTUARINE HABITAT CRITERIA

The Estuarine Habitat criteria in EPA's final rule require maintenance of the 2 ppt isohaline at or downstream of one of three monitoring sites in Suisun Bay during the February through June period. The final criteria require a 2 ppt salinity value at the Confluence of the Sacramento and San Joaquin rivers between February through June in all years. The 2 ppt salinity value is to be met at Chipps Island for a specified number of days, depending on the amount of precipitation. The greater the precipitation, the higher the number of days the criteria must be attained. The 2 ppt salinity value must be met at Roe Island only if it is triggered by precipitation sufficient to push the 2 ppt salinity value downstream to Roe Island during the last half of the previous month. Once triggered, the 2 ppt salinity value is to be met at Roe Island for a specified number of days, depending on precipitation.

EPA based the number of days of compliance on a "sliding scale" or "smooth function" that states the correlation between precipitation and the number of days of the 2 ppt value. For example, the sliding scale requires fewer number of days for a <u>dry</u> "above normal" year than for a <u>wet</u> "above normal" year. The final criteria base the current month's requirements only on the previous month's hydrological conditions. EPA used the 1968 "level of development" - the baseline water management infrastructure for diversion and storage that existed in 1968 - as a surrogate for the late 1960's to early 1970's reference period when the estuary attained its designated uses. Finally, EPA stated that attainment of the final criteria could be measured at the Roe Island and Chipps Island monitoring sites by any of (1) the daily salinity value, (2) the 14-day average salinity, or (3) the "flow equivalence" of the salinity value, as predicted in the Contra Costa Water District (CCWD) model. For reasons that are peculiar to that model, attainment at the Confluence monitoring site could be measured by either of the first two of these approaches only.

### ESTUARINE HABITAT PROTECTION UNDER THE 1995 WQCP

The 1995 WQCP protects estuarine habitat for the critical February through June period through requirements for net delta outflow and alternative requirements based on the location of the 2 ppt isohaline (1995 WQCP, page 19 and footnote 14, with associated table on page 26). In most years when the projects will

be operating to meet water quality criteria in these months (as opposed to years when flood control operations take precedence) the stated delta outflow requirements will be in excess of outflows resulting from other requirements in the plan. Thus, direct protection of estuarine habitat will receive little, if any, augmentation from these other requirements.

## COMPARISON OF FEDERAL AND STATE CRITERIA

### In General

The State's 1995 WQCP is identical to EPA's Estuarine Habitat criteria in its reliance on the location of the 2 ppt isohaline as the operative criteria, its use of the same three compliance locations to define applicable number of days of compliance with the 2 ppt criteria, and in its use of the previous month's precipitation to determine the current month's number of days when the 2 ppt isohaline is required to be downstream of one or both of the downstream compliance locations.

The 1995 WQCP differs from EPA's promulgation primarily in six ways:

1. The 1995 WQCP uses the 1971.5 "level of development" rather than the 1968 "level of development."

2. The 1995 WQCP includes several other measures that, although not explicitly included as estuarine habitat criteria, affect the level of protection of that designated use. EPA's analysis of the State plan gauges the effect of these other measures.

3. The 1995 WQCP relaxes requirements under extremely dry conditions.

4. The 1995 WQCP uses a table of values to represent to the "sliding scales" stating the number of days of compliance with the 2 ppt criteria, instead of the EPA approach of using algebraic equations.

5. The 1995 WQCP uses slightly different coefficients in the operative equations defining the "sliding scale" for the Roe Island requirement in February.

6. The 1995 WQCP uses a flow equivalence measure for compliance at the confluence.

This chapter evaluates each of these differences in terms of their technical differences in requirements and their likely biological impacts. For most of this analysis, the historical hydrology from 1906 to 1992 was used as the study period to compare the two sets of standards. Where specified below, hydrological

data from the DAYFLOW database were also used. This chapter concludes that despite the differences in the state and federal standards, the provisions of the 1995 WQCP discussed below are protective of the estuarine habitat designated use.

**Detailed Analysis**

1. 1968 v. 1971.5 targeted level of development

To assess the difference in requirements resulting from the differences in targeted level of development[1] (the State's 1971.5 level of development v. EPA's 1968 level of development), EPA has translated the different requirements into the actual number of days of 2 ppt would be attained at each of the two downstream compliance locations (Chipps and Roe Islands). EPA also calculated the overall monthly mean location of the 2 ppt isohaline for the February-June period that would have occurred in each year between 1906 and 1992,[2] using criteria calculated at the original EPA 1968 level of development compared to criteria calculated using the SWRCB 1971.5 level of development.

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[1]As stated above, the "level of development" refers to the baseline water management infrastructure for diversion and storage that existing at particular times. For more detail on how EPA uses the "level of development" concepts in constructing the applicable criteria, please refer to the preamble to the final EPA rule.

[2]The preamble to EPA's criteria explains the derivation of the historical record of hydrological conditions. Using this information, EPA computed how the State and federal criteria would have been implemented under each year's hydrology. It then used these results to construct Table 1 and summarize its findings both in terms of the number of days of compliance with the EPA criteria at Roe and Chipps Island, and in terms of the monthly mean location of the 2 ppt isohaline. In accordance with standard practice in the Bay/Delta, monthly mean location is stated as a certain number of kilometers upstream from the Golden Gate Bridge.

| | 1968 level | 1971.5 level | difference |
|---|---|---|---|
| Mean number of days required at Chipps Island | 118 days | 112 days | 6 days |
| Mean number of days required at Roe Island | 63 days | 59 days | 4 days |
| Mean 2 ppt location | 71.3 km | 71.8 km | .5 km |
| Maximum change in number of days required at Chipps Island | 67 days | 37 days | 30 days |
| Maximum change in number of days required at Roe Island | 103 days | 93 days | 10 days |
| maximum upstream location of 2 ppt | 72.7 km | 74.5 km | 1.7 km |

Table 1. Mean and maximum changes in daily requirements and in monthly mean location of the 2 ppt isohaline under the 1971.5 and 1968 targeted levels of development. These results do not reflect other differences between SWRCB and EPA methodologies that are described under other headings.

The difference in overall mean 2 ppt for the two levels of development (i.e., between the federal criteria and State plan) is .5 kilometer, which is hydrodynamically trivial in the face of a tidal excursion of 5 to 10 kilometers. The biological correlations used in the development of the EPA criteria suggest that changes in the mean location of 2 ppt of less than several kilometers would have no perceptible biological effect.

Of potentially greater significance than change in the overall mean location is the extent of the largest single difference in the number of days of compliance with the 2 ppt criteria in a given year (that is, the largest spread in the number of days of compliance in a year between the 1968-based criteria and the 1971.5-based criteria). As shown in the preamble to the final EPA rule, the monthly logistic model equations used to generate the daily requirements for each month in both the EPA and State criteria can be represented by curves. A small shift on the curve will generally have little effect on the required number of days of compliance in most cases, but can have a large impact in cases that fall on the part of the curve with a very steep slope. This is especially true of the equations for Chipps Island, which have generally steeper slopes for both coefficients than those for Roe Island.

The steeper slopes for Chipps Island result in larger differences in the number of days required in various months and more frequent differences in the number of days required at Chipps Island under the SWRCB's 1971.5 targeted level of development than under EPA's 1968 target (Table 2).

| Days of difference | Chipps Island (% of years with the stated difference) | Roe Island (% of years with the stated difference) |
|---|---|---|
| 2 | 31% | 17% |
| 4 | 20% | 35% |
| 6 | 19% | 38% |
| 8 | 10% | 8% |
| 10 | 5% | 2% |
| 12 | 0% | 0% |
| 14 | 1% | 0% |
| 16 | 0% | 0% |
| 18 | 0% | 0% |
| 20 | 2% | 0% |
| 22 | 1% | 0% |
| 24 | 1% | 0% |
| 26 | 1% | 0% |
| 28 | 0% | 0% |
| 30 | 8% | 0% |

Table 2. Percentage of years in the historical period having the indicated decrease in the number of days of compliance with the 2 ppt criteria at the applicable compliance site under the 1995 WQCP compared to the EPA criteria. EXAMPLE: Out of the 89 years in the record, the 1995 WQCP would require 10 fewer days of the 2 ppt requirement at Chipps Island in 5% of the years, and would require 10 fewer days of compliance with the 2 ppt requirement at Roe Island in 2% of the years, as compared with the EPA criteria. These results do not reflect other differences between State and EPA methodologies that are described under other headings.

These differences represent a small, occasionally measurable, decrease in the quality of estuarine habitat protected by the 2 ppt requirements when compared to the EPA rule. However, when combined with the other expected effects of the 1995 WQCP, as discussed below, this marginal change caused by the change in targeted level of development is not expected to

adversely affect protection of the designated estuarine habitat use.

2. Interaction between WQCP estuarine habitat criteria and related measures

In developing its estuarine habitat criteria, EPA did not make any assumptions about related measures that would affect estuarine habitat resources. Therefore, EPA assumed that the high mortality associated with water export activities would continue to reduce the suitability of estuarine habitat within the delta. The 1995 WQCP, however, includes other beneficial measures, including especially a substantial reduction in export rates during the February through June period. EPA's analysis of whether the 1995 WQCP protects the designated uses therefore considers the combined impact of reducing the estuarine habitat through a more lenient 1971.5 target (as discussed above) and improving fish conditions upstream where fish are subject to entrainment from the export operations. The following is this combined analysis.

A significant element of the 1995 WQCP is the restriction of exports in the February through June period. The export restrictions for most of this period are limited to no more than 35% of total delta inflow, independent of hydrological conditions. In February, reduced precipitation can trigger an increase in export rate up to 45%. For the period from April 15 to May 15, export limitations are reduced (as compared to the recent historical period) to 100% of San Joaquin riverflow.[3] In the following analysis an overall average export rate of 35% is assumed.

To evaluate the impact on estuarine habitat of export restrictions alone, EPA first concluded that there is an excellent correlation of (1) the "level of development," and (2) the unimpaired flow measured by the 8-River Index, with (3) the percentage of flow diverted for export.[4] Then, by using the 1995 WQCP's 35% export limitation and holding unimpaired flow constant, EPA determined that the export restrictions alone improved habitat

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[3]It may seem counterintuitive to view the export of 100% of the San Joaquin River flow as a "reduction" in exports. However, given the configuration of the delta and the location of the export pumps, water exported through the southern delta includes not only San Joaquin River flows but significant flows from the Sacramento River and other minor tributaries to the delta. In high export periods, the pumps can export significantly more water than the San Joaquin River alone provides.

[4]This relationship is similar to and approximately as strong as the relationship relied upon by EPA's estuarine habitat criteria, which correlated (1) the "level of development," and (2) unimpaired flow, with (3) the location of the 2 ppt isohaline. For a discussion of EPA's methodology and computations, see EPA, Memorandum of B. Herbold, September 20, 1995.

conditions to those that existed under a 1981 level of development (as compared with a 1992 level of development or the approximate current level of development).

As indicated above, the 1995 WQCP estuarine habitat criteria slightly reduces estuarine habitat protection by changing the targeted level of development from 1968 to 1971.5. However, given the improvement in overall habitat conditions caused by the new export restrictions (an improvement that is represented above by the almost 10-year shift in the level of development), EPA finds that the combination of elements in the 1995 WQCP protects the designated estuarine habitat criteria.

3. Dry condition relaxation provisions

The 1995 WQCP allows the estuarine habitat criteria to be relaxed in exceptionally dry conditions, as follows:

> (1) If the February 8-River index flow measurement is less than 500 TAF, the Operations Group established under the CALFED Framework Agreement will be allowed to recommend relaxing the criteria in March.
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> Historically, in the 89 years of the historical period, only 1977 and 1991 would have satisfied this extremely low-flow condition. With such a small sample size of these occurrences in the historical record, it is not entirely known how best to address fisheries protection during these periods.[5] The State Board approach of giving the Operations Group an active review and relaxation authority may be the best available approach under these conditions. As EPA is a member of the Operations Group, EPA can assure that any such relaxation will still provide for protection of the designated uses consistent with the requirements of the Clean Water Act. Given this oversight, it is unlikely that the rare instances of relaxing the protection of estuarine habitat for March (just one month of the five month period of biological concern) will have substantial negative biological impacts.
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> (2) If the projected total projected annual Sacramento River Index is less than 8.1 MAF, then minimum flows of 7100 cfs are reduced to 4000 cfs in May and June.
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> Historically, only 4 of the historical period's 89 years satisfy this condition (1924, 1931, 1976, and 1977). When total precipitation to the Sacramento Valley is less than 8.1

[5]Maintaining the 2 ppt isohaline requirements during these extreme periods not only may affect consumptive uses of water, but may adversely affect the ability of the system to meet other fish and wildlife concerns as well, such as meeting carryover storage requirements necessary to protect Sacramento salmon runs.

million acre-feet, minimum springtime flows through the estuary would still be 2 million acre-feet under the relaxed criteria. Given those reduced outflows, the 2 ppt isohaline would migrate upstream to about 85 km (above the Golden Gate) in May and to about 86.5 km in June. During the 1987-1992 drought, the mean May 2 ppt isohaline was downstream of 85 km for the first three years, but reached 90 km in 1991. The mean June 2 ppt isohaline location during the drought was further upstream than 86 km in four of the six years. Thus, the State's proposed relaxation provision will still be an improvement over recent conditions. The interplay of the 1995 WQCP requirements for estuarine habitat protection and its limitations on delta exports (to a % of inflow) should enhance habitat protection even when the lower flows are in effect, given that exports will simultaneously be reduced (as discussed below).

(3) The requirement that salinity be less than 2 ppt at the confluence for at least one day in the first 14 days of February may be relaxed following an extremely dry January by a unanimous recommendation of the Operations Group.

As EPA is a member of the Operations Group, EPA can assure that any such relaxation will still provide for protection of the designated uses consistent with the requirements of the Clean Water Act.

Finally, EPA's consideration of the 1995 WQCP relaxation provisions in exceptionally dry years should include an acknowledgment that the 1995 WQCP changes (for the better) some of the background conditions which EPA assumed in developing its final criteria. In particular, restrictions on export rates (page 19) have the potential to improve the suitability of low salinity habitat above the confluence of the Sacramento and San Joaquin Rivers to serve as estuarine habitat. EPA's criteria viewed the confluence as the upstream limit of low salinity habitat in the critical period, partly because evidence in the Biological Assessment for delta smelt had shown that the entrainment of delta smelt at the export pumps tended to increase when the 2 ppt isohaline was upstream of the confluence. However, by restricting exports, the 1995 WQCP would also reduce mortality rates of delta smelt when 2 ppt is upstream of the confluence by reducing fish exposure to entrainment at the operating pumps. The new plan may thereby increase the ability of shallow habitat in the delta to serve as estuarine habitat in drier years. See also discussion of exports in Section 2, above.

In the future, the amount of shallow habitat in the delta upstream of the confluence (which is currently too fragmented to serve as estuarine habitat) is likely to increase from restoration activities of the California Department of Water Resources, the U.S. Corps of Engineers, the Category III process established in the Bay/Delta Accords, and the CVPIA. Although these improvements

are expected, none of the changes in background conditions are sufficient to affect evaluation of adequate levels of protection at this time. Future triennial reviews will need to examine habitat use and mortality rates of estuarine species within the delta above the confluence to determine how changes in the assumptions about current conditions affect measures needed to protect the designated uses.

4. Tables v. equations

The new 1995 WQCP states its required number of days of compliance at the various compliance locations in a table format (table for footnote 14 of Table 3 (p. 26)), rather than by reference to the actual underlying "sliding scale" equations as was done in the EPA criteria. EPA has determined that this approach results in no significant difference in protection of the estuarine habitat designated use. As noted above, the State's target values are based on a different targeted level of protection than EPA's. Thus, to compare the 1995 WQCP table versus the EPA equations, it is necessary to set the EPA's equations to a target of 1971.5, and then compare the resulting values to those in the SWRCB table. This process isolates the differences in the two approaches (table v. equations) from the differences caused by the different level of development discussed above. A comparison of the 1995 WQCP table and the outputs from EPA's set of equations (rounded to the nearest whole day), reveals three types of differences:

- In two cases, rounding errors are the most likely reasons for differences of one day. In both cases the 1995 WQCP calls for one more day than use of the EPA equation would indicate.

- All of the table entries for Roe Island in February are marginally greater than the EPA equations would suggest. As discussed below, this appears to be caused by the State's use of slightly different coefficients in the equations defining the "sliding scales" for this month at this site.

- Most of the table entries for June at Roe Island are greater by one day than the equations would suggest. This likely results from some difference in the rounding algorithm used.

The remaining entries in the 315 cells of the 1995 WQCP's Table 3 are identical to the outputs of the EPA equations. Since none of the values in the table are less than those that would arise from use of the EPA equations, no reduction in the protection of aquatic resources arises from the SWRCB's tabulation of requirements.

5. Revised coefficients in model equations

The EPA criteria include equations with coefficients that vary by month. These coefficients are used in the equations to ...

construct the "sliding scales" correlating hydrological conditions and days of compliance each month. The 1995 WQCP appears to have used slightly different equations in developing its tables of the required number of days of compliance. Discussions with Austin Nelson (formerly of Contra Costa Water District), the California Urban Water Agencies engineer whose analysis was the basis for the 1995 WQCP, indicated that slight differences in the coefficients appear to be a result of different algorithms in the different statistical packages that were used by EPA and the State. These differences in coefficients result in differences in requirements only for Roe Island in February. Interestingly, Mr. Nelson's model does not include calendar year as a significant variable in setting the criteria at Roe Island, so requirements at Roe Island are unaffected by the change in targeted level of protection (i.e., the 1968 v. 1971.5 level of development). The coefficients used by Mr. Nelson and the 1995 WQCP for the February Roe Island requirements result in several more days of compliance with the 2 ppt requirement during drier hydrological periods than are required in the EPA criteria. Since these differences arise only under very dry conditions when the Roe Island criterion is extremely unlikely to be triggered (see the discussion of the Roe Island trigger in the preamble to the final EPA rule), the somewhat greater numbers in the 1995 WQCP are unlikely to have any significant impact on the designated uses.

6. Use of "flow equivalence" for salinity values

In its final rule, EPA concluded that the use of a "flow equivalence" approach to satisfying the 2 ppt criteria at Chipps Island and Roe Island required an assumption that the 2 ppt salinity value was actually being attained at the upstream confluence compliance site. See the preamble to the final rule for more discussion of this issue (60 F.R. 4680). The purpose of this provision in EPA's rule was to assure that the assumption in the model that the 2 ppt isohaline was at or near the confluence near the beginning of the spring runoff period in early February was satisfied.

The 1995 WQCP allows project operators to meet the 2 ppt criteria at the confluence using the flow equivalence method. EPA believes that this approach is still protective of the estuarine habitat designated use because the State plan ensures the validity of EPA's underlying assumption by requiring that the 2 ppt isohaline be attained at the confluence for at least one day between February 1 and February 14. See Footnote 14 to Table 3 in the 1995 WQCP (p. 21). This requirement assures that the 2 ppt isohaline will be located at or near the "starting point" assumed in the flow equivalence model.

**Conclusion**

The 1995 WQCP's provisions explicitly protecting estuarine habitat (namely, the minimum flow requirements and related 2 ppt

requirements) result in generally minor, changes in the level of protection compared to EPA's estuarine habitat criteria. However, when combined with the 1995 WQCP's export restrictions, the State plan not only protects estuarine habitat in Suisun Bay, but also substantially reduces expected mortality rates of species in the upper estuary (upstream of Suisun Bay). Effectively, this improves the quality of total estuarine habitat in the delta, even at times when aquatic resources downstream may receive marginally less protection. Overall, therefore, the 1995 WQCP protects the designated estuarine habitat uses.

**Triennial Review**

EPA expects to learn more about protecting designated uses in the Bay/Delta as the future responses of aquatic resources of the estuary during drier conditions unfold. Biological knowledge and models used in the development of both the EPA and the State criteria strongly suggest that the increased protection of estuarine habitat will ensure that populations of a number of important species will survive.

Future triennial reviews of the adequacy of any State Board plan will likely rest upon analysis of how well future indices of species abundance match the predictive regression models. If future abundances are distributed both above and below the regression lines and within the confidence intervals, the measures will have achieved the targets. However, if all future points are below the regression line or below the confidence limits, the Board should re-evaluate the models and improve protection measures.

Protection of rare species, and of sport and commercial fisheries, could likely be improved through greater levels of protection of estuarine habitat, higher river flows, and other measures. Included in such other measures are those identified by the Category III process established under the December 1994 Bay/Delta Accords. These Category III measures include reductions of toxic loading, elimination of important unscreened diversions, and habitat restoration, and any other impacts on aquatic resources that are not direct effects of delta outflow. For listed species, improved protection would doubtless be directed by the appropriate fish and wildlife agencies, but the State Board and EPA should anticipate broader ecosystem needs. Habitat restoration and Category III actions, when coordinated with adequate in-stream conditions, could be expected to result in future abundances consistent with or exceeding the modeled expectations.

## CHAPTER TWO

### Protection of Migration of Aquatic Organisms Use

This chapter of the technical support document describes why EPA has approved the new 1995 WQCP as protective of the fish migration designated use.[6]

### EPA'S FISH MIGRATION CRITERIA

EPA stated its criteria generally, measuring the success of salmon in migrating through the Delta. That is, EPA stated goals that (1) called for a certain percentage of salmon to be able to survive their passage through the Delta, and (2) that could be achieved by any of a number of different management measures. In this way, the State Board would have maximum latitude to find combinations of management measures that would attain the salmon survival goal. EPA called these criteria "fish migration criteria." For each of the Sacramento and San Joaquin River systems, the criteria provided a fish migration index equation and a set of index values to be attained. The index equation for each river quantified and predicted the survival of salmon migrating through the Delta.

On the Sacramento River, the federal criteria index values vary according to the water temperature at Miller Park at the time of the tagged fish release. "Ceiling" and "floor" criteria index values are included to reflect the fact that at very high water temperatures, the Fish Migration use needs additional protection, and at very low water temperatures, temperature is unlikely to affect fish migration. The actual index values were set to replicate the survival values that would be attained if the Delta Cross-Channel were closed during the critical spring migration period. The Sacramento River tagged-fish release results indicate that, except in very high temperature periods, those periods in which the Delta Cross-Channel is closed provide aquatic conditions allowing for the protection of the Fish Migration designated use.

On the San Joaquin River, the federal criteria index values vary according to unimpaired San Joaquin river flow. The actual index values were set to approximately replicate the survival values that would be attained if a series of management measures (flow requirements, export restrictions, barriers, etc.) recommended by the USFWS were implemented. The tagged-fish release results indicate that these or equivalent management measures are necessary to protect the Fish Migration designated use on the San

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[6]Although EPA recognizes that the names of some of the designated uses have been revised in the 1995 WQCP, we believe that it is less confusing to use the nomenclature included in both EPA's rule and in the earlier State plans, rather than continuously switching back and forth between the old and new names.

Joaquin.

## FISH MIGRATION CRITERIA UNDER THE 1995 WQCP

The 1995 WQCP improves protection of salmon smolt passage through six elements:

1. A narrative criterion that calls for water quality conditions, together with other actions in the watershed, to achieve a doubling of natural production of chinook salmon compared to the average production in a 1967 to 1991 baseline period [p. 18].

2. Closure of the Delta Cross Channel (DCC) for up to 45 days from November through January, with complete closure from February through May 20 and an additional 14 days of closure from May 21 to June 15 [p. 19 & footnotes 26 and 27]. The Operations Group is to determine actual closures during the early and late periods, depending on real time monitoring of fish migration patterns.

3. Augmentation of San Joaquin River flows for 31 days during April and May [p. 19].

4. Export restrictions on project pumping from the delta during the February through June period (a) to no more than 35% of total delta inflow, and (b) to no more than the greater of the San Joaquin flow (measured at Vernalis) and 1,500 cfs. [p. 19 & footnote 22].

5. Modification of Delta Cross Channel (DCC) operations and export restrictions through the CALFED operations coordination group ("Ops Group") in order to maximize protection of aquatic resources [footnotes 21, 22, 26, and 27].

6. Changes to delta hydraulics and other conditions due to actions directed toward the protection of other species (e.g., measures to maintain Suisun Bay salinity in the 2 ppt range pursuant to protection of the estuarine habitat designated use) [pages 18 through 22].

## COMPARISON OF FEDERAL AND STATE CRITERIA

### 1. 1995 WQCP Narrative Criteria

EPA promulgated criteria that stated the goals or targets numerically as survival index values applicable to the Sacramento and San Joaquin Rivers. The 1995 WQCP instead adopted a narrative criterion calling for water quality conditions and other actions that achieve a doubling of natural production of chinook salmon compared to a 1967-1991 baseline period.

In the preamble to its final criteria, EPA compared its criteria index value graph lines to graph lines representing a doubling of recent survival values. See 60 F.R. 4664, 4687 and 4694 (January 24, 1995). Although these lines are not identical,

EPA believes that the EPA criteria lines are roughly equivalent, and consistent with, these doubling lines. Given this similarity, EPA finds that the 1995 WQCP approach of stating the doubling goal narratively sufficiently protects the fish migration designated use. As stated in EPA's water quality standards guidance (Water Quality Standards Handbook, 2d Edition, August 1994, Chapter 3), narrative criteria may serve as the underpinnings of state planning and regulatory programs that fully protect the relevant resources.

At the same time, however, EPA recognizes that the terms used in the State's narrative criteria are, as narrative criteria, inherently imprecise. For this reason, EPA is also reviewing the probable impacts of the combination of other elements included in the 1995 WQCP to determine whether the 1995 WQCP as a whole protects the fish migration designated use. In addition, EPA notes that the 1995 WQCP states an intention to evaluate achievement of the narrative criteria and to develop numeric criteria to replace it as part of its ongoing triennial review process. EPA strongly supports this review effort and, ultimately, the development of numeric criteria to replace the narrative criteria protecting the fish migration designated use.

Protection of fish migration must address different needs on the two principal rivers of the estuary, the Sacramento and the San Joaquin. As discussed above, EPA's final rule established goals of salmon smolt survival from Sacramento to Chipps Island on the Sacramento River and from Mossdale on the San Joaquin River downstream to Chipps Island just below the Confluence of the two rivers. In its final rule, EPA identified many of the actions that are included in the 1995 WQCP as possible implementation mechanisms to achieve the specified goals. EPA's survival goals varied with water temperature at Sacramento for Sacramento smolts and with unimpaired flows on the tributary streams for San Joaquin smolts. The period of protection for Sacramento smolts extends from April through June while the period of protection for San Joaquin River smolts is from April through May. A comparison of the State and federal approaches to fish migration protection is discussed below for each river system.

**2. Sacramento River salmon outmigrant protection**

EPA's final rule is essentially a performance standard that specifies salmon smolt survival rates through the delta from Sacramento to Chipps Island. Survival goals on the Sacramento River vary linearly with temperature across most of the range of temperatures encountered during the April to June period when smolts are migrating through the delta. 'Floor' and 'ceiling' values set bounds on the required goals outside of this normal range.

Importance of the Delta Cross Channel. USFWS recently identified several parameters that are negatively associated with salmon passage through the delta, including the percentage of flow

diverted into the central delta through the Delta Cross Channel (DCC) and Georgiana Slough, the low or negative net flow at Jersey Point in the western delta (QWEST[7]), and high temperature.[8] EPA concluded in its final rule that the most critical component of successful migration was closing the DCC to prevent diversion of migrating salmon out of the mainstem Sacramento River into the central delta where they would be subject to adverse conditions. Accordingly, the EPA criteria index values were set to replicate survival values that would be attained if the DCC were closed from April through June. EPA specified that direct experimental measurements of salmon survival through the delta would be used to estimate attainment of the criteria.

The 1995 WQCP requires intermittent closure of the DCC for up to 45 days from November through January, complete closure from February through May 20, and an additional 14 days of intermittent closure from May 21 to June 15. To address the beneficial use associated with recreational boating in the delta, the 1995 WQCP allows opening the DCC prior to the end of the usual salmon smolt outmigration season in late June. The 1995 WQCP provides that the Interagency Operations Group ("Ops Group") established in the 1994 Framework Agreement will determine the actual gate operation schedule during the intermittent closure periods.

In that the 1995 WQCP requires DCC closure through May 20 (consistent with the measures upon which EPA based its criteria), the only difference between the federal and state criteria is the likely impact on the designated use of opening the DCC during portions of the migration period after May 20, given the other measures included in the plan. This chapter discusses why the increased export restrictions, increased baseline flows, and Ops Group responsibilities to tailor management measures to specific information about salmon migration in a given year, contained in the 1995 WQCP are sufficient to protect the fish migration designated use.

Importance of QWEST. USFWS identified a positive QWEST value as one of the major factors enhancing fish migration on the Sacramento River.[9] The 1995 WQCP contains outflow requirements and

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[7]Roughly defined, QWEST is the net delta outflow, calculated as inflows into the central delta minus the amounts used and exported from the central delta.

[8]See USFWS, Measures to Improve the Protection of Chinook Salmon in the Sacramento/San Joaquin River Delta. WRINT-USFWS-7, 1992. See also Letter Dated November 17, 1994 from Pat Brandes (USFWS) to Greg Gartrell (Contra Costa Water District).

[9]The general form of this relationship was also used by NMFS in developing its ESA biological opinion to the water projects to protect winter-run salmon. Data analysis contained in a letter dated November 17, 1994 from Pat Brandes (USFWS) to Greg Gartrell (Contra Costa Water District) indicates a linear relationship between QWEST, when QWEST is less than 2000 cfs, and

restrictions on exports that result in substantial beneficial changes in average QWEST values.

California's Department of Water Resources used its DWRSIM model to simulate the expected effects of the measures in the 1995 WQCP during the historical record of 71 years of hydrologies. The DWRSIM model only considers average monthly conditions. These model results show two patterns of changes to QWEST when comparing the former State plan (D-1485) to the new 1995 WQCP:

1. Under D-1485, June exports were limited to a monthly average of 3000 cfs, whereas under the 1995 WQCP exports are limited to 35% of total inflow. Thus, when total inflows in June exceed 8500 cfs, the 1995 WQCP allows higher export rates than were previously allowed. Because of this relaxation, QWEST values in wet years are often reduced under the 1995 WQCP compared to what they would have been under D-1485. These sporadic large decreases in QWEST in wet years are probably of small biological importance. This is because the DCC is apt to be closed more often (for flood control purposes rather than salmon protection purposes) in wet years, so that the beneficial effects of closing the DCC noted above would outweigh adverse impacts of the lower QWEST. Further, these lowered values of QWEST in occasional wet years is an issue that the Ops Group should be able to address (as discussed below).

2. Under D-1485, QWEST values tended to be very low in dry and critical years because the allowed level of export comprised a large percentage of the water entering the delta. The new 1995 WQCP provision increasing flows and limiting exports to 35% of total inflow drastically increases QWEST relative to D-1485. Table 1 shows modeled QWEST values for June for the years when QWEST was negative under conditions of D-1485 and the comparable QWEST values under the 1995 WQCP. As noted above, USFWS identified a positive QWEST value as one of the major factors enhancing fish migration on the Sacramento River. In most years, the 1995 WQCP results in positive values of QWEST whereas the previous plan led to substantial negative values. The overall averages of June QWEST is -437 cfs under D-1485 compared to +113 cfs under the 1995 WQCP.

These improvements in QWEST in very dry, negative QWEST years as a result of the 1995 WQCP's increased flows and limited exports offsets somewhat the decrease in protection caused by opening the DCC periodically after May 20. The model of smolt mortality referenced in footnote 9 suggests that changes to QWEST on average under the 1995 WQCP would decrease salmon smolt mortality in the western delta by about 12% in the dry

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fall-run smolt mortality indices in the Sacramento River below the DCC. The model for this relationship is: mortality index = .531-0.000106*QWEST.

water years.

| Year | D-1485 | 1995 WQCP | Improvement in QWEST |
|---|---|---|---|
| 1931 | -232 | 280 | 512 |
| 1933 | -341 | 396 | 737 |
| 1934 | -200 | 280 | 480 |
| 1939 | -577 | -38 | 539 |
| 1976 | -562 | -43 | 519 |
| 1987 | -580 | -19 | 561 |
| 1988 | -690 | 156 | 846 |
| 1990 | -688 | -55 | 633 |
| 1991 | -61 | 61 | 122 |
| Mean mortality | .57 | .51 | 12% |

Table 1. Values of June QWEST modeled under D-1485 and under the 1995 WQCP. Years included are those which under D-1485 yielded negative values of QWEST.

This discussion of the probable beneficial effects on salmon survival caused by 1995 WQCP measures in effect after May 20 suggests that the overall impacts of the plan from May 21 to June 15 in drier years rest on two components. First, the 1995 WQCP's closure of the DCC for 14 of the 25 days results in an improvement of overall survival of 14/25=56%, assuming (as the EPA computations in the preamble to its rule indicate) that closure alone doubles survival during those ~14 days. Second, changes in flow requirements and export restrictions in the 1995 WQCP, without regard to closure of the DCC, results in an improvement of about 12%, if the significant relationship reported by USFWS between QWEST and survival in drier years is correct[10]. Thus, the sum of these impacts suggests that under the 1995 WQCP Sacramento River salmon passage through the delta from May 21 to June 15 will be approximately 68% better than under the earlier State plan.

While this combined result falls somewhat short of the survival index criteria values for Sacramento salmon smolt passage included in EPA's final criteria, the ability of the operations group to change DCC operations and export conditions in response to real-time needs of salmon passage (see below) are expected to make the level of protection greater than that calculated from these general conditions.

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[10]See model discussed in footnote 9, above.

Importance of the Ops Group. The Ops Group is charged, under the 1995 WQCP, with modifying export and gate operations to protect salmon outmigration. This group can use current information about fish migration in a given year to take protective measures (including closing the DCC) at particular times. This approach will be at least as effective, if not more effective, in protecting the designated use than general water quality standards that are designed to encompass a broader period to ensure protection generally for all years. For example, in past years, as much as 40% of the outmigrating salmon smolts have passed through the delta after May. If such late migrations occur in wet years, the DCC is likely to be closed for flood protection, and no additional management measures would be necessary to protect these migrations. If a late migration occurs in a dry year, however, the Ops Group will need to respond rapidly to information about salmon passage so that it can modify DCC gate operations and keep the DCC closed during sufficient periods of the late migration so as to prevent salmon from being diverted into the adverse habitat conditions of the central delta. As discussed below, such real time monitoring was successfully used for the first time in 1995 on the San Joaquin River, and plans are under development to continue these efforts in the future on both river systems.

In addition, Ops Group decisions can also be used as adaptive management experiments to determine which actions are effective, whereas water quality standards must use the best currently available science to establish requirements for an indefinite number of future years. For example, recent USGS research (Richard Oltman, USGS, pers. comm.) has demonstrated that diversions of salmon through an open DCC are greatest during a rising tide. Studies at the nearby Georgiana Slough have also indicated that salmon passage into the central delta is greatest during a rising tide (Charles Hanson, Hanson Environmental). These two recent observations strongly suggest that operating the DCC more precisely in response to tidal cycles could achieve many of the survival objectives expected for a complete DCC closure. Alternatively, because smolts appear to migrate most rapidly at night in riverine areas, much of the value of closing DCC might be derived from closing it at night, when little conflict with boat traffic would exist. Thus, Ops Group actions have considerable potential to achieve adequate salmon migration rates.

In addition to the Ops Group activities, which are specifically referenced in the 1995 WQCP, actions of other parties may facilitate achievement of adequate salmon passage in the delta. Both the Central Valley Project Improvement Act and the so-called "Category III" effort arising out of the December 1994 Accords are intended to improve conditions for aquatic resources. Both efforts are examining opportunities to increase shading and bathymetry of river channels in order to improve salmon smolt survival. Success of these efforts in the delta could greatly increase the likelihood of achieving intended salmon passage rates.

Sacramento River summary. EPA finds that the 1995 WQCP is protective of the fish migration use in the February through May 20 period because the 1995 WQCP, like the EPA criteria, relies on closing the DCC so as to prevent diversion of migrating salmon out of the mainstem river. EPA further finds that the measures in the 1995 WQCP affecting migration after May 20 - which rely on the value of improved QWEST in dry years and on the effectiveness of the Ops Group in accommodating the individual year conditions - are protective of the designated use.

**San Joaquin River salmon outmigrant protection**

Protection of salmon smolt outmigration in the San Joaquin River has been strongly associated with three physical features: restricting diversion of water out of the mainstem of the river at its junction with Old River, flows in the river at Vernalis, and temperature at Jersey Point. Consistent with its approach on the Sacramento River, EPA's final rule specifies survival goals for salmon smolts on the San Joaquin River, but leaves the implementation methods for achieving those goals up to the State.

Old River Barrier. The evidence strongly suggests that a control structure at the head of Old River is necessary to restrict the diversion of migrating salmon from the main San Joaquin River channel and towards the export pumping facilities. The signatories to the December 15, 1994 Bay/Delta Accords also recognized the importance of the barrier, and specified inclusion of the Old River barrier in their consensus measures dealing with resource protection in the delta. Although the 1995 WQCP does not absolutely mandate an Old River barrier, it does recognize the critical importance of this mechanism. The 1995 WQCP states:

> The DWR and the USBR, in consultation with the DFG, USFWS, and NMFS, should: (1) test the use of barriers at the head of Old River and at other strategic locations within the lower San Joaquin River and Delta as a means of improving survival of migrating chinook salmon in the spring and fall; and (2) evaluate the advisability of closing Georgiana Slough by using either a physical barrier or an acoustic barrier. The barriers should be constructed if it is determined that they are effective and will neither harm other species, such as Delta smelt, nor have other significant adverse effects on the environment. If construction of barriers makes compliance with the water quality objectives in this water quality control plan problematic, the DWR or the USBR should request a change in this water quality control plan. (1995 WQCP, page 36).

As the 1995 WQCP indicates, if the barrier cannot be constructed to protect San Joaquin salmon smolts, a re-evaluation of the measures needed to protect this designated use will be necessary.

Modeled effects of flow measures, etc. The importance of the barrier is illustrated below in model estimates of the overall effects of the 1995 WQCP measures on survival in the San Joaquin. The models of salmon smolt survival rates indicate levels of protection far below EPA criteria index values in the absence of a barrier. The 1995 WQCP's monthly average flow and export restrictions without a barrier shows some improvement in survival rates compared to results for the previous D-1485 requirements without the barrier, especially in dry, above normal, and below

normal years. However, inclusion of a barrier under either set of requirements (the 1995 WQCP and the previous D-1485) roughly triples the respective survival rates. These models suggest that combining an Old River barrier with the 1995 WQCP flow and export requirements is the only scenario identified to date that substantially meets the criteria index values set out in EPA's final rule.[11]

| | D-1485 Condition | | | 1995 WQCP | | | EPA criteria |
|---|---|---|---|---|---|---|---|
| Year Type | without Barrier | with Barrier | half-time barrier | without Barrier | with Barrier | half-time barrier | |
| Wet | .177 | .490 | .334 | .201 | .515 | .358 | .49 |
| Above Normal | .058 | .181 | .119 | .113 | .312 | .213 | .35 |
| Below Normal | .046 | .140 | .093 | .087 | .245 | .166 | .28 |
| Dry | .037 | .122 | .080 | .072 | .222 | .146 | .22 |
| Critical | .036 | .140 | .088 | .055 | .202 | .128 | .22 |

Table 2. Modeled survival indices over April and May under the D-1485 requirements and under 1995 WQCP requirements for flow conditions and export limitations, both with and without a barrier. Leftmost column gives comparable level of survival based on EPA's final rule.

Use of the models. There are some limitations on the accuracy of the models on the San Joaquin. The modeling analysis fails to address the actual level of protection most outmigrating smolts are likely to encounter because it is based on monthly averages for April and May, whereas protections under the 1995 WQCP are stated as a total of 31 days in April and May. Thus, the average flows and exports used in the above analysis include flows and export rates that would occur outside the time period specified for protection. On one hand this is appropriate because outmigrating San Joaquin smolts have been identified throughout the entire two month period. On the other hand, however, the bulk of smolts have usually been observed in the delta during the specified protection period.

Similarly, model results of salmon smolt survival in the San Joaquin must also be cautiously interpreted because the required

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[11]The modeled survival index values shown in Table 2 do not yield identical values for the 1995 WQCP measures with the barrier in place as compared to the EPA criteria index values. Considering the inherent imprecision of these models, especially given the factors discussed in the text below, EPA believes that these two sets of values are substantially equivalent for purposes of this analysis, and that meeting either set of survival index values would be protective of the designated use.

flow and export conditions in the 1995 WQCP are outside the range of conditions upon which that the model is based. Historically, the large amount of upstream storage on tributary streams has resulted in reduced flows at Vernalis of about 1000 cfs in all but extremely wet years. Simultaneously, higher demands in dry years have increased export rates as much as five times the Vernalis inflow rate. In contrast, the 1995 WQCP mandates flows at Vernalis of 3110 cfs to 8620 cfs and limits exports to no more than the flow rate at Vernalis.

Temperature impacts. The higher flows required under the 1995 WQCP on both rivers in drier years may also affect temperatures in the San Joaquin. USFWS models of San Joaquin smolt survival through the delta identify temperature at Jersey Point as a significant model parameter. EPA is unaware of any models that can predict temperature at Jersey Point over a range of flows in the Sacramento and San Joaquin rivers, but it seems likely that temperature will decrease, and therefore smolt survival will improve, as a result of greater freshwater flows. These new conditions will provide valuable new data on the relative impacts of flows, exports and temperature that have previously been difficult to separate. New models can be developed once data from dry years with higher flows and reduced exports are gathered.

Importance of the Ops Group. As described above, the Ops Group is charged under the 1995 WQCP with modifying export restrictions and other operations to protect salmon outmigration. For example, the Ops Group is charged in footnote 22 of the 1995 WQCP with varying the flow and export restrictions in April and May as needed to protect fish resources. The Ops Group can use recently gathered information to focus protection on particular times or in specific ways more effectively than can general water quality standards which must encompass a broader period to ensure protection in all years. In past years, the exact timing of smolt outmigration has varied within the months of April and May. The 1995 WQCP plan recognizes a need for flexibility in applying protection:

> "This time period may be varied based on real-time monitoring. One pulse, or two separate pulses of combined duration equal to the single pulse, should be scheduled to coincide with fish migration in San Joaquin River tributaries and the Delta. The time period for this 31-day flow requirement will be determined by the operations group established under the Framework Agreement." 1995 WQCP footnote 18.

Real time monitoring was successfully used for the first time in 1995 when export rates were held to only 20% of Vernalis flows during the smolt outmigration period. Plans are under development to continue these efforts in the future.

San Joaquin River summary. On the San Joaquin, the 1995 WQCP

contains flow and operational constraints that will protect the fish migration designated use if a gate or other barrier is installed at the head of Old River, at least during drier years. During years when flows may be too great to allow construction or maintenance of a barrier at the head of Old River, the Ops Group is likely to be able to compensate by reducing export rates when salmon are found in the vicinity. Under lower flow conditions, if a barrier is not used, the Ops Group may improve fish passage by adjusting export rates and flows, etc., but data at this time indicate that it is unlikely to provide adequate protection for the designated fish migration use.

## CHAPTER THREE

## Protection of Spawning, Reproduction, and/or Early Development Use

This memorandum specifically discusses the provisions of the 1995 WQCP that protect the Warm Water Fish Spawning (now the Protection of Spawning, Reproduction, and/or Early Development Use) designated use in the lower San Joaquin River.

### EPA'S WARM WATER FISH SPAWNING CRITERIA

In the San Joaquin River system, striped bass spawn primarily in the less saline segments of the river. To protect this designated use, the State Board's 1991 Bay/Delta Plan established objectives of 1.5 mmhos/cm EC at Antioch and 0.44 mmhos/cm EC at Prisoners Point in April and May. EPA disapproved the 1991 Bay/Delta Plan spawning criteria for primarily two reasons. First, these criteria were not based on sound science. The State Board explained that the 1.5 mmhos/cm EC criteria at Antioch was intended to protect spawning habitat upstream of Antioch (near Jersey Point), not at the Antioch location itself. The State Board acknowledged that "the use of 1.5 [mmhos/cm] EC at Antioch appears not to be generally appropriate, and proposed that a thorough review of this [criterion] be undertaken at the next triennial review" (1991 Bay/Delta Plan, p. 5-32). EPA found this unproven approach of setting criteria downstream in hopes of attaining different criteria upstream deficient, and disapproved it. Second, EPA disapproved the 1991 State plan objectives because they are not adequate to protect spawning habitat in the reach farther upstream between Prisoners Point and Vernalis.

In its federal criteria, EPA included salinity criteria of 0.44 mmhos/cm EC in the lower San Joaquin River in the reach from Jersey Point to Vernalis in wet, above normal, and below normal water years. In dry and critical water years, EPA required the 0.44 mmhos/cm criteria for only the reach from Jersey Point to Prisoners Point. In all years, the effective period for these criteria was April through May.

### WARM WATER FISH SPAWNING PROTECTION UNDER THE 1995 WQCP

The 1995 WQCP protects warm water fish spawning habitat in the San Joaquin River within the delta for the critical April through May period through requirements on the maximum 14 day running average of mean daily EC (1995 WQCP, page 18 and footnote 6). Criteria directly protecting spawning habitat are augmented by requirements of minimum San Joaquin River flows for 31 days between April 15 and May 15 (page 19). Protection during the remainder of the April and May period is augmented by other mandated minimum San Joaquin River flows (page 19), although these flows are generally less than are already likely to occur as a result of existing

criteria protecting agricultural uses in the south delta. As stated in the record for EPA's final rule, the beneficial effects of increased flows on spawning habitat in the San Joaquin River would likely be increased by the presence of a barrier at the head of Old River. Although not mandating this barrier, the 1995 WQCP recommends that the State and federal water projects should examine and, if advisable, construct this barrier. Finally, the 1995 WQCP clearly expects increases in freshwater flow to be used to satisfy the criteria in the short term (page 29), but it also addresses many of the measures that are expected to result in reduced loadings of salt in the future (pages 29-33).

## COMPARISON OF FEDERAL AND STATE APPROACHES

### In General

The 1995 WQCP replaces the disapproved Antioch requirement with specific criteria at and between Prisoners Point and Jersey Point. By doing so, the new plan addresses EPA's concern that the 1991 plan improperly set criteria downstream in hopes of attaining different criteria upstream.

The 1995 WQCP further explicitly requires appropriate salinities at and between Prisoner's Point and Jersey Point in all but critically dry water years. This is not identical to the EPA criteria, which explicitly cover a larger stream segment (Jersey Point to Vernalis, in wet, above normal, and below normal water years) and also provide for protection in critically dry years. In evaluating whether the 1995 WQCP provides protection for the designated fish spawning use, the following aspects of the State plan have been evaluated:

1. Eliminating explicit protection in critically dry water years;

2. Eliminating explicit protection for the upstream segment of the river from Prisoner's Point up to Vernalis in all water years; and

3. Likely impacts on the warm water fish spawning designated use of other 1995 WQCP requirements that alter salinity and hydrodynamics of the San Joaquin River and delta.

### Elimination of critically dry water year protections

The discussion below concludes that the combination of measures included in the 1995 WQCP will generally provide salinity conditions for striped bass spawning that are very close to the conditions required under EPA's criteria. Accordingly, taken as a whole, the 1995 WQCP protects the warm water fish spawning designated use. The 1995 WQCP, by eliminating explicit criteria in critically dry water years, uses a more biologically defensible

approach to protecting the fish spawning designated use than was used in the disapproved 1991 plan.[12] Simply eliminating the protection in critically dry years is a recognition of that the ecosystem on the San Joaquin has always included experienced natural variability. Conceptually, it is reasonable to assume that under the undisturbed natural hydrology, conditions in some critically dry years would fail to provide adequate salinities for striped bass spawning. However, as discussed below, related measures in the 1995 WQCP should provide protection of the designated use on the San Joaquin.

**Elimination of upstream protections**

The 1995 WQCP does not provide explicit salinity criteria for the San Joaquin River upstream of Prisoners Point. Nominally, this is substantial reduction of the river segment where the spawning designated use is protected, as compared to the EPA rule. Nevertheless, the discussion below explains that the cumulative effects of the related measures in the 1995 WQCP will in fact provide salinity conditions in San Joaquin that provide protection for the designated use.

**Impacts of related measures**

Additional measures in the new 1995 WQCP substantially improve the background conditions on the lower San Joaquin river, and EPA is taking those other measures into account when it analyzes the expected efficacy of the explicit .44 mmhos/cm EC requirement. For example, the Board's 1991 WQCP concluded that the salinities specified for striped bass spawning in the delta could probably be controlled by releasing Sacramento River water into the delta cross channel and on into the central delta. The new 1995 WQCP, however, requires the delta cross channel to be closed constantly (primarily for the benefit of salmon) for most of the critical spawning period, so a much smaller fraction of Sacramento River water will enter the central delta. This means that the water flows on the San Joaquin are relatively more critical to the warm water fish spawning designated use. Therefore, to enhance San Joaquin flow, the 1995 WQCP requires flows on the San Joaquin River at Vernalis from April 15 to May 15 to be 3 to 5 times their recent historical levels. Simultaneously, export rates at the state and federal pumps during this period are severely restricted by the new plan. These measures will increase San Joaquin River flows beneficial to

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[12]The simple elimination of protective criteria in critically dry water years is more biologically defensible that the SWRCB's earlier approach of arbitrarily relaxing the criteria in those years. Neither the relaxed salinity value (.55 mmhos/cm EC) nor the deficiency in deliveries to water users (which indirectly determine the water year categories on the San Joaquin), both of which were measures included in the earlier plan, is particularly relevant to the biology of striped bass.

the spawning designated use. In addition, EPA recognizes that the Bay/Delta Accords signed in December 1994 call for construction of a barrier at the head of Old River, near Vernalis. These actions, in concert, will result in major improvements in the water movement patterns and improve spawning conditions for warm water fish in the San Joaquin River.

Comments received by EPA in response to its proposed rule suggest that these various management measures may in fact be more important to protecting the warm water fish spawning designated use than merely maintaining the salinity regime as under the EPA criteria. See, for example, Letter of March 11. 1994 from Boyd Gibbons, Director California Department of Fish and Game to EPA on draft promulgation of warm water fish spawning criteria; see also WRINT-DFG-8. Summary and Recommendations of the Department of Fish and Game's Testimony on the Sacramento-San Joaquin Estuary. Testimony to SWRCB in hearings preparatory to draft Decision 1630.

The magnitude of physical changes represented by the new criteria, new implementation measures and new proposed barrier operation have been modeled to compare their collective effects on the flow-salinity regime in the San Joaquin. California's Department of Water Resources (DWR) used its computer models (DWRSIM) to calculate the salinities expected at Vernalis as part of its computer analysis of the impacts of the new flows mandated in the 1995 WQCP. Despite some reservations about the continued accuracy of these models under the new conditions, EPA recognizes that these models represent the best currently available science.

A review of the DWR models results reveals the following: The DWRSIM model runs compare expected salinities over the 71 years of historical hydrologies under both the "base" conditions (i.e., under the hydrological conditions reflecting the 1978 water quality plan) and under the "alternative" conditions (the 1995 WQCP). Only 45 of these 71 modeled years are important, given that the EPA rule is the same as the new 1995 WQCP at Vernalis for all of the dry and critically dry water years.

Under the State's 1978 water quality plan, the model suggests that EPA's salinity requirements would not have been met at Vernalis in 35 of the 45 applicable years. However, using the alternative conditions that reflect the measures included in the 1995 WQCP, the models indicate that EPA's salinity criteria at Vernalis would have been met in all but 8 of the 45 years. Further, in 4 of the 8 non-attainment years, the Vernalis salinity requirement would be met in April but not in May, so that the warm water fish spawning use would have been protected for at least a significant part of the critical spawning period. Finally, the models suggest that during these 8 non-attainment years the monthly average salinity never exceeds .50 mmhos. Given that these are monthly averages, it is likely that values slightly in exceedence of the .44 mmhos criteria would reflect substantial times within

the month when salinity would be appropriate for spawning. Especially during the April 15 to May 15 period it is very likely that salinities from Vernalis to Prisoners Point will be less than .44 mmhos/cm EC.

These model results suggest that the combined effects of the various water management measures contained in the 1995 WQCP provide conditions that are protective of the designated warm water fish spawning use.

## CONCLUSION

The above discussion suggests that the 1995 WQCP as a whole provides protection for the warm water fish spawning designated use. This finding is based on a number of critical findings or assumptions.

1. That the management measures included in the 1995 WQCP, especially when combined with a barrier at the head of Old River, will yield the salinity regime described in the DWR modeling effort. Stated another way, this finding assumes that the modeled flow-salinity relationships are accurate under the newly-prescribed management conditions.

2. That water quality upstream of Vernalis (that is, water entering the lower San Joaquin from upstream) will not be significantly higher in salinity than the model assumptions. This is a reasonable assumption given that several related regulatory plans and programs (including the actions of the Central Valley Regional Water Quality Board, Category III measures under the Bay/Delta Accords, and measures required by the Central Valley Project Improvement Act) are all expected to reduce salt loading into the San Joaquin River.

Future triennial review of these criteria should examine how accurate each of these assumptions proves to be, as well as on the future trends in abundance of multiple species that spawn in the lower San Joaquin River.

**Further Thoughts on the Triennial Review.** Although EPA is finding that the 1995 WQCP protects the designated warm water fish spawning use, this finding is based on the available models and knowledge of the needs of the striped bass. It will be important to verify this finding during the next triennial review and to consider whether new information being developed on the Sacramento splittail requires any refinements in protecting the warm water fish spawning use. The .44 mmhos/cm EC was used as the numeric criterion in both the EPA rule and in the 1995 WQCP because spawning salinity requirements are, to date, best quantified by using available data about striped bass. Recent information being developed in the field suggests that the high water flows in 1995 have led to tremendous production of Sacramento splittail, a

candidate for federal listing as a threatened species, in the San Joaquin River above Prisoners Point. Sacramento splittail, therefore, may be one species that relies on protection of spawning conditions above Prisoner's Point. See generally Daily Reports of the Interagency Ecological Program's Real-time Monitoring Program (1995). EPA urges the SWRCB to reconsider the needs of multiple warm water fish species as scientific knowledge improves over the next three years.

## CHAPTER FOUR

### Protection of Designated Uses in Suisun Marsh

The 1995 WQCP includes a narrative criterion for the tidal marshes of Suisun Bay. This narrative criterion is identical to the narrative in the final EPA Rule. The 1995 WQCP directed the California Department of Water Resources and the U.S. Bureau of Reclamation to convene a Suisun Marsh Ecological Work Group to, among other tasks, identify specific measures to implement the narrative criterion for tidal brackish marshes of Suisun Bay and make recommendations to the SWRCB regarding achievement of the criterion and development of numeric criteria to replace the narrative criterion.

The 1995 WQCP also contains salinity criteria designed to protect the managed marsh. The managed portion of the marsh are those areas managed to provide waterfowl forage in the fall and attract ducks for hunting. Some areas are private duck clubs and other areas are wildlife refuges managed by the California Department of Fish and Game. The criteria are set as maximum monthly average high tide electrical conductivity (EC) values (Table 1).

Table 1

**EC in mmhos**

| | Eastern Marsh | Western Marsh | Deficiency Western Marsh |
|---|---|---|---|
| Oct. | 19.0 | 19.0 | 19.0 |
| Nov. | 15.5 | 16.5 | 16.5 |
| Dec. | 15.5 | 15.5 | 15.6 |
| Jan. | 12.5 | 12.5 | 15.6 |
| Feb. | 8.0 | 8.0 | 15.6 |
| Mar. | 8.0 | 8.0 | 15.6 |
| Apr. | 11.0 | 11.0 | 14.0 |
| May | 11.0 | 11.0 | 12.5 |

The 1995 WQCP criteria designed to protect the managed marsh areas for the eastern part of Suisun Marsh are unchanged from the D-1485 provisions adopted in 1978. These criteria were developed to achieve acceptable alkali bulrush seed production with good water management in the diked wetlands. The adopted criteria for the western part of Suisun marsh (compliance stations S-21, S-42, S-97 and S-35, see Figure 1) were changed to those levels agreed to by the four signatories of the Suisun Marsh Preservation Agreement (1987): DWR, USBR, DFG, and the Suisun Resource Conservation District. For the areas represented by these stations, there are "normal" criteria and "deficiency period" criteria. "Deficiency period" criteria are set for drier water years meeting certain hydrological conditions when there is less water available to the water projects, as follows: (1) the second consecutive dry water year following a critical year; (2) a dry water year following a year in which the Sacramento River Index was less than 11.35; or (3) a critical water year following a dry or critical water year.

The effective date for implementation of the criteria for the station S-21 is Oct. 1, 1993. The effective date for the other three western stations is Oct. 1, 1997. This is a change from the compliance dates of 1993 for S-97 and 1994 for S-35.

Modelling by DWR indicates that the hydrological conditions required to meet the Estuarine Habitat criteria (X2 or the 2 ppt) would have resulted in the Suisun Marsh criteria being met for most months in recent years (including the drought) if the Montezuma Slough tidal gates were in operation (DWR, 1994). However, even with gate operation, modelling indicates that additional facilities or augmented overland water supplies are likely needed to meet the criteria at S-35 and S-97, especially during the fall (SWRCB, 1995a; DWR, 1994).

Had they been in effect, the deficiency criteria would have required lower salinities than historical western marsh channel salinities during certain months of the recent drought (primarily in the fall; SWRCB, 1995b), and thus can be characterized as better than historical conditions. However, the deficiency criteria would have been in effect 5 years in a row during the recent drought. Such long periods of high salinity allowed by the deficiency period criteria are of concern. The evidence from the 1976 and 1977 drought indicates that two or more years of high salinity in the managed marshes can alter production of waterfowl food plants, reducing the food supply (DWR, 1984). At the same time, however, in the 1995 WQCP's Program of Implementation, the SWRCB states that the soil water salinity depends upon the irrigation practices used by the various property owners of the managed wetlands, and that management practices should be used that will promote adequate soil salinity levels. For this reason, and because other local water projects also can affect water quality in Suisun Marsh, the SWRCB has found that there is a need to review the appropriateness of the Suisun Marsh salinity criteria, and has prescribed this review in the 1995 WQCP. SWRCB Order WR 95-6 directs the permittees (DWR and USBR) to work with other interested groups and agencies to accomplish this review, and to report the results of this review to the SWRCB by August 1997. It will be important and necessary for protection of the managed portion of the marsh as feeding habitat for waterfowl, and as viable marsh habitat available to other species, to implement and assess management actions and water quality criteria together.

In addition, the SWRCB suggests that a sliding scale transitioning between the normal and deficiency criteria be developed for the western marsh. Such a sliding scale will promote more variable conditions in the marsh, and should help prevent long periods of consistently high salinity. It will be important take into account both Delta and local hydrology when developing this sliding scale, since both are important sources of freshwater to the marsh, particularly the western marsh.

The SWRCB expects DWR and USBR, working with the Suisun Marsh Ecological Work Group, to evaluate the success of the protective implementation actions, to advise the SWRCB on the types of actions necessary to protect the marsh ecosystems surrounding Suisun Bay, to help develop the sliding scale for the salinity criteria, and to identify specific measures to implement the narrative criterion for tidal brackish marshes of Suisun Bay and make recommendations to the SWRCB regarding achievement of the criterion and development of numeric criteria to replace it. It will be important for the SWRCB to work closely with this group, so that the criteria can receive adequate review and implementation will provide the expected protection. Based on the SWRCB's strong commitment to undertake these actions, EPA finds that the 1995 WQCP's narrative criterion in the tidal marshes and revised numeric criteria in the managed marshes of Suisun Marsh are protective of the designated uses in the Marsh.

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