UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION IX
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AUG 3 1 1994

Wayne S. White
State Supervisor
U.S. Fish and Wildlife Service
2800 Cottage Way
Sacramento, California 95825

James H. Lecky
Director, Protected Species Management Division
501 W. Ocean Blvd., Suite 4200
Long Beach, California 90802

Re: Section 7 Consultations on EPA Water Quality Standards - Updated Project Description

Dear Mr. White and Mr. Lecky:

This letter follows up on EPA's request for consultations on the potential impact of the Environmental Protection Agency's (EPA's) water quality standards promulgation on threatened and endangered species in the San Francisco Bay/Delta.

Background

EPA initiated formal consultations under the Endangered Species Act (ESA) with the Services in August 1993. To coordinate our actions in the "Club FED" process, we suspended formal consultations in the fall of 1993 as each of our agencies moved towards proposals for actions in the Bay/Delta. On January 6, 1994, as part of the coordinated Federal actions, EPA proposed certain water quality standards for the Bay/Delta. 59 FR 810. In June 1994, we agreed to reactivate the formal consultation process, so as to meet the consultation requirements on EPA's final promulgation of water quality standards. As you know, EPA will take final action on these standards on or before December 16, 1994.

The "project description" for EPA's action is most clearly summarized in the proposed rule published on January 6. The preamble to that proposal provides a detailed description of the regulatory and scientific background for the proposal. To respond to comments received on its proposal, and to account for new analyses prepared by EPA staff, EPA is contemplating a number of

changes to the proposed rule. The purpose of this letter is to summarize these changes for you, so that you can incorporate them into the "project description" under Section 7 of the ESA.

Proposed Changes

EPA proposed three sets of criteria on January 6, 1994: an Estuarine Habitat criteria protecting the salinity regime in the estuary, a Fish Migration criteria protecting migrating salmon smolts, and a Fish Spawning criteria on the lower San Joaquin River. In the final rule, EPA envisions publishing four sets of criteria. These are:

(1) Revised Estuarine Habitat criteria. The revised criteria are explained in the attached Memorandum from B. Herbold to P. Wright dated August 31, 1994.

(2) Revised Fish Migration criteria. The revised criteria are explained in the attached paper by Susan Hatfield entitled "Alternative Formulation of the Salmon Smolt Survival Index Criteria".

(3) Fish Spawning criteria on the lower San Joaquin River. EPA does not intend to make any changes to this criteria, so the Services can treat the description in the Proposed Rule as the current "project description".

(4) Narrative criteria for the Suisun Marsh. The need for these criteria was explained in the Proposed Rule. A draft of the probable language for the narrative criteria is attached.

The revisions outlined in the attached documents are, of course, preliminary, in that they represent staff recommendations only and have not received final management approval. Under the Clean Water Act, these revised criteria would become effective only upon the final approval by the Administrator. Nevertheless, EPA Region IX believes that these revised criteria constitute the best available "project description" for the Section 7 consultations. In the event that substantive changes are made to any of these criteria, EPA will inform the Services.

If you have any questions about the material contained in the attachments, please contact Patrick Wright at (415) 744-1993.

Sincerely,

Harry Seraydarian
Director
Water Management Division

Attachments

MEMORANDUM

SUBJECT: Estuarine Habitat Criteria for Bay/Delta - Discussion of Revisions to Proposed Rule

FROM: Bruce Herbold

TO: Patrick Wright

DATE: August 31, 1994

This memorandum summarizes the changes we are considering for the Estuarine Habitat criteria in the Bay/Delta, and presents a restatement of those criteria based on these changes.

a. Proposed Rule

The Proposed Rule included salinity criteria to protect the Estuarine Habitat and other designated fish and wildlife uses in the estuary. The criteria specified the location and number of days of required compliance. EPA's specific proposed criteria are shown in Table [1]. They included 2 ppt salinity criteria[1] at Roe Island, Chipps Island, and at the Sacramento/San Joaquin River confluence from February through June. The criteria replicated the average number of days on which the 2 ppt isohaline occurred at or downstream from each of these locations during the historical period 1940-1975, inclusive, classified by water year type. Because no critically dry years occurred in the period from 1940 to 1975, the required number of days for critically dry years was based on an extrapolation of the data.

The proposed criteria were to be measured using a 14-day moving average. The use of a 14-day moving average allowed the mean location to be achieved despite the varying strength of tidal currents during the lunar cycle because any 14 day period would include the full range of spring and neap tidal conditions.

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[1] EPA's Estuarine Habitat criteria are stated as a certain number of days when the near-bottom salinity at each of three locations in the estuary is less than 2 parts per thousand. This salinity is approximately equivalent to electrical conductivity less than 2694 mmhos when corrected to a temperature of 25.

Table 1. Proposed 2 ppt Salinity Criteria*

Year type	Roe Island [km 64]	Chipps Island [km 74]	Confluence [km 81]
wet	133 days	148 days	150 days
above normal	105 days	144 days	150 days
below normal	78 days	119 days	150 days
dry	33 days	116 days	150 days
critically dry	0 days	90 days	150 days

*Numbers indicate required number of days (based on a 14-day moving average) at or downstream from each location for the 5-month period from February through June. The water year classifications are identical to those included in the 1991 Bay/Delta Plan for the Sacramento River Basin. Roe Island salinity shall be measured at the salinity measuring station maintained by the USBR at Port Chicago (km 64). Chipps Island salinity shall be measured at the Mallard Slough station, and salinity at the Confluence shall be measured at the Collinsville station, both of which are maintained by the California Department of Water Resources. The Roe Island number represents the maximum number of days, based on the adjustment described below.

The Proposed Rule also included a "trigger" that limited the applicability of the Roe Island criteria. Under the Proposed Rule, the criteria of number of days for a given year type at Roe Island would not apply unless and until the average daily salinity at Roe Island attained the 2 ppt level through natural uncontrolled flows. Following the occurrence of such an event, the 14 day average salinity at Roe Island could not exceed 2 ppt for the number of days specified in Table [1]. Therefore, the number of days listed under Roe Island represented the maximum of the number of days that could be required. In effect, this adjustment provided that the additional water needed to move the isohaline downstream to Roe Island would come from natural storms rather than from reservoir releases or export restrictions. This approach better reflected the natural variability in timing and quantity of runoff and significantly reduced the water supply impacts of the proposed criteria relative to criteria that do not account for this variability.

In the Proposed Rule, EPA specifically requested public comment on a number of issues associated with the proposed Estuarine Habitat criteria, including the desirability of stating

the criteria as a "sliding scale" rather than by water year categories, the appropriate compliance measurement period, and the appropriate reference period for criteria target levels. EPA has incorporated many of the comments received on these and other issues in its revisions to the Proposed Rule.

b. Specific changes to the Estuarine Habitat criteria

(1) Sliding scale. The Proposed Rule outlined the rationale for moving from criteria varying by the five water year types to criteria stated as a sliding scale or a smooth function varying with changes in unimpaired flow. The comments EPA received on the Proposed Rule were generally supportive of this change in approach. (California Urban Water Agencies (CUWA) 1994, California Department of Water Resources (California DWR) 1994, Natural Heritage Institute (NHI) 1994, and Kimmerer 1994) Both written comments and the discussions at the CUWA scientific workshops offered several suggestions as to how the sliding scale function should be formulated.

EPA has concluded that the Estuarine Habitat criteria should be stated as a logistic equation defining the sliding scale. Dr. Wim Kimmerer, in his comments on the Proposed Rule (Kimmerer 1994), noted that the logistic model is "appropriate for a relationship between a dichotomous variable (i.e. compliance or no compliance) and a continuous variable." A logistic model cannot require fewer than 0 or more than the number of days available in the month, whereas linear equations (such as one included in written comments of Contra Costa Water District (CCWD)(CCWD 1994) or quadratic equations (such as the one EPA suggested in the Proposed Rule) can result in unrealistic extrapolations. Kimmerer suggested a sliding scale that set the percentage of the 5 month period that would be required at each control point as a function of the five months of unimpaired flow data and the desired level of protection. An example of these equations for Roe Island is shown in Figure [1]. As discussed below, however, EPA has revised the logistic equations to reflect monthly computations of compliance.

(2) Reference period/level of development. EPA received substantial comment about its choice of an historical reference period to define the targeted level of protection for the Estuarine Habitat criteria. One group of comments criticized the choice of the years included in the reference period. Various other historical periods were discussed by different commenters as alternatives. (Bay Institute 1994, California DWR 1994, and NHI 1994). A second set of comments raised a more fundamental problem with the use of an historical reference period. These comments argued that the choice of a particular historical reference period was inherently suspect, because this approach necessarily reflected, but could not distinguish between, hydrological conditions in the reference period and the

"level of development" (the existing water diversion and storage facilities) in the reference period. (California DWR 1994).

This issue was discussed in depth at the CUWA scientific workshops, and EPA believes that a reformulation of the "reference period" is appropriate. In the final rule, EPA is establishing Estuarine Habitat criteria that replicate the "level of development" existing in 1968. The use of individual calendar years appears to be a reasonable surrogate for the level of development, at least up to the time of the late 1970's when new water facility development declined and regulation by the State Water Resources Control Board began to control the operations of water projects.

The intent of these criteria is to protect the Estuarine Habitat and related fish and wildlife designated uses to the same degree that these uses would have been protected under the level of development present in 1968. To calculate these criteria, EPA and others developed regression equations that explained the variability in the location of the 2 ppt isohaline as a function of two variables: calendar year as a surrogate for the level of development and unimpaired flow as a measure of precipitation. (Kimmerer 1994). This procedure allows EPA to separate the effects of year to year variability in precipitation from the effects of increased levels of upstream storage and diversion. At a given level of development, then, the regression equations can predict the position of the 2 ppt isohaline from a given pattern of precipitation.

This process of developing a sliding scale is shown graphically in Figure [2]. The response surface or curved plane generated in Figure [2] shows how the number of days of 2 ppt salinity reflects the changing level of development over different hydrological conditions. A single sliding scale equation can be derived by taking a "slice" of the curved plane at the 1968 level of development. This 1968 curve shows how the number of 2 ppt days would have varied during different hydrological conditions at the 1968 level of development. Historically, of course, 1968 experienced only one hydrological scenario; the purpose of the regression equation for the 1968 level of development is to show how that particular level of development would have influenced the position of the 2 ppt isohaline over the entire range of possible hydrological conditions.

EPA chose the 1968 level of development because of a widespread perception that at that time there was adequate estuarine habitat to sustain most aquatic populations in the Bay/Delta. As explained in the Proposed Rule, EPA and the Federal fisheries agencies have frequently called for a level of protection equal to that which existed in the late 1960's and early 1970's. EPA believes that the fish population data summarized in the San

Francisco Estuary Project's Status and Trends Report document the precipitous and unreversed decline of the most abundant species beginning in 1970. (Herbold et al. 1992). This downward trend is also apparent in the population data for winter run Chinook salmon. (Herbold et al. 1992).

(3) Use of entire basin unimpaired flow. The Proposed Rule stated flow as measured by the Sacramento Basin Water Year Type classification. This was done primarily to simplify calculations and to reflect the dominant role of Sacramento River flows in the Bay/Delta estuary. Nevertheless, in some circumstances, the omission of the San Joaquin River basin flows could significantly over or understate the actual hydrological conditions in the estuary. Further, one of the reasons EPA chose the three locations for compliance (all at or downstream of the confluence of the Sacramento and San Joaquin Rivers) was to give the State Board maximum flexibility in determining the source of flows to meet the Estuarine Habitat criteria. To reflect the importance of the San Joaquin river basin, the final criteria are stated in reference to unimpaired flow of both the Sacramento River basin (Sacramento, Feather, Yuba, and American rivers) and the San Joaquin River basin (Stanislaus, Tuolumne, Merced and San Joaquin rivers). EPA believes that the Sacramento/San Joaquin Unimpaired Flow Index described by CUWA is the best statement of how this unimpaired flow should be computed.[2]

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[2]As stated on page 3 of Appendix 1 to the California Urban Water Agencies "Recommendations to the State Water Resources Control Board for a Coordinated Estuarine Protection Program for the San Francisco Bay-Sacramento and San Joaquin River Delta Estuary" dated August 25, 1994, the Sacramento/San Joaquin Unimpaired Flow Index "shall be computed as the sum of flows at the following stations:

1. Sacramento River at Band Bridge, near Red Bluff
2. Feather River, total inflow to Oroville Reservoir
3. Yuba River at Smartville
4. American River, total inflow to Folsom Reservoir
5. Stanislaus River, total inflow to New Melones Reservoir
6. Tuolumne River, total inflow to Don Pedro Reservoir
7. Merced River, total inflow to Exchequer Reservoir
8. San Joaquin River, total inflow to Millerton Lake."

(4) Modeling salinity and flows. The Proposed Rule relied on certain correlations to describe the relationship between biological responses and salinity. In developing these correlations, the Proposed Rule used a model of the relationship between salinity and flow to estimate salinity conditions in those limited instances when salinity data were unavailable. EPA also used this model to estimate salinity conditions for earlier historical periods when flows were measured but salinity was not. This model, which was used by the San Francisco Estuary Project (SFEP 1993), was considered at that time to be the most accurate available for this purpose. Since the Proposed Rule was published, a new model correlating salinity and flow has been developed by CCWD. (Denton, R.A. 1993, and Denton, R.A. 1994.) The participants at the CUWA scientific workshops generally agreed the CCWD model is a more appropriate model to use in developing the Estuarine Habitat criteria, and EPA agrees. The final rule will use this new CCWD model to estimate the number of days that salinities have been less than 2 ppt historically at each of the compliance monitoring stations.

(5) Previous month flow index. The Proposed Rule stated that the target number of days of compliance at Chipps and Roe Island would vary according to the Sacramento Basin Water Year Type. EPA has received comments (California DWR 1994) and participated in discussions at the CUWA scientific workshops raising concerns over the use of the standard water year classifications as the measure of hydrological conditions in the estuary. In essence, these comments suggested that the requirements to protect estuarine habitat ought to be stated solely, or largely, in reference to the patterns of precipitation that could directly affect estuarine habitat during the period intended for protection. For example, criteria that are designed to protect conditions in the February-June period should reference only the unimpaired flows of February-June (or, possibly, January-June). Including precipitation in other months or the amount of carryover storage in reservoirs from previous years (both of which are included in the Sacramento Basin Water Year Type calculation) could lead to inaccuracies in the criteria that could unnecessarily affect water project operations or inadequately protect the designated uses.

A related issue created by the Proposed Rule is the need to develop compliance strategies for a given year based on a forecast of hydrological conditions expected during the following months. This forecasting is notoriously inaccurate, especially for the critical February and March months which are typically the months of most variable precipitation. Sliding scales such as Figure [1] (for Roe Island), which apply to the entire February to June period of protection, still require the project operators to forecast future hydrological conditions to meet the expected number of required days of compliance with the 2 ppt criteria. As such, the modeling approach suggested by Kimmerer

and shown for Roe Island in Figure [1] would not address the issue of unreliable forecasts.

Analysis by EPA staff indicated that the required number of days of compliance with the 2 ppt criteria in a given month could be quite accurately predicted from logistic models using unimpaired flows of the current month, the previous month, the previous two months or the previous and current month. Inclusion of the actual unimpaired flows of the current month did not reliably improve model performance and, of course, the actual unimpaired flow of the current month cannot be known accurately until the month is over. EPA has, therefore, recast the criteria using the model suggested by Kimmerer, but only for one month at a time based on the preceding month's unimpaired flow. For example, the measured unimpaired flow in January would be used to set the number of days of compliance with the 2 ppt criteria at the Chipps and Roe island locations. Similarly, measured unimpaired flow in February is used to set the next month's requirement. This approach has been labeled the "Previous Month's Index" (PMI) approach. To make this approach work, the sliding scales exemplified (for Roe Island) in Figure [1] have been transformed into monthly sliding scales. These monthly logistic equations for both Chipps and Roe islands are shown graphically in Figure [3].

One additional refinement should be considered when the implementation plan is developed for these criteria. The river flow data used in the monthly calculation of the PMI are generally not available until the 10th day of the following month. To assist in the timing of compliance, it may be appropriate to allow the period for meeting the required number of 2 ppt days to extend forward 10 days into the subsequent month. For example, if the PMI computation at the end of January indicates that 28 days of compliance with the 2 ppt criteria are required at Chipps Island in February, this number could be satisfied on any of the days between February 10 and March 10. Any such implementation flexibility would have to assure that days of compliance are not "double counted", and that the critical period of early February is still protected. However, it would be appropriate for the implementation plan to flexibly address this issue.

(6) Revised "trigger" for Roe Island criteria. As a result of the above changes to the Estuarine Habitat criteria, the "trigger" for the Roe Island location must be revised. The Proposed Rule stated, in effect, that if the salinity dropped below 2 ppt at Roe Island due to uncontrolled hydrologic conditions, the Roe Island requirements were "triggered" for the remainder of the February to June compliance period. In the final rule, the "trigger" is evaluated on a monthly basis. If the 14-day average salinity at Roe Island falls below 2 ppt on any day during the last 14 days of a month, compliance with the

Roe Island criteria would be "triggered" for the following month. For example, assume that the PMI for January indicates 18 days of compliance in February, and that the 14-day average salinity in the last part of January is below 2 ppt at Roe Island. This would trigger the applicability of the Roe Island criteria in February. Assume then that the system is operated to meet the 18 days in February, but that a large storm in mid-February results in the salinities of less than 2 ppt at Roe Island for the entire month of February. This would "trigger" Roe Island criteria in March. If the PMI-based calculation required 31 days of compliance at Roe Island in this scenario, compliance for April (for 13 days, for example) would also be triggered. If April is a dry month, the 2 ppt criteria could be met for the required 13 days early in the month, and the Roe Island criteria would not be triggered for May at all.

Although somewhat complicated, this monthly triggering mechanism is essential to assure that the criteria applicable to a given month reflect the actual distribution of storm events throughout the compliance period. As explained in more detail in the preamble to the Proposed Rule, accounting for the natural hydrologic cycles assures protection of the designated uses without unnecessarily affected water project operations.

(7) Measuring compliance. Implementation measures for these Estuarine Habitat criteria will be developed by the State Board. In the Proposed Rule, EPA indicated that it believed an implementation plan that relied on the salinity-flow models, without making additional allowances for "confidence intervals", would adequately protect the designated uses. EPA's further review of the comments and continued discussions with the project operators has confirmed this belief. This would allow project operators to meet the criteria by providing the modeled "flow equivalent" of a particular salinity target. In addition, EPA believes that the designated fish and wildlife uses would be protected if the Estuarine Habitat criteria are directly measured as either a daily salinity value or as a 14-day average salinity value. This means that the State Board could adopt an implementation providing that project operators would be in compliance with the criteria in any one of three ways: (1) the daily salinity value meets the requirement, (2) the 14-day average salinity meets the requirement, or (3) the system is operated on that day so as to meet the "flow equivalent," using the model, of the stated salinity requirement. EPA notes that under most circumstances, the most efficient approach (in terms of water usage) to meeting the criteria would be to satisfy the specified salinity value rather than the alternative flow equivalent.

c. Revised Estuarine Habitat Criteria

In order to reflect the changes listed above, the Estuarine Habitat criteria have been revised. The revised Estuarine Habitat criteria provide that salinity shall not exceed 2 ppt (measured on a 14-day moving average) at Roe Island (if triggered) and Chipps Island for the number of days each month in the February to June period computed by reference to the following formula.

$$\text{\# of days required in Month X} = \text{Total \# of days in Month X} * (1-1/(1+e^{K}))$$

where

K = A + (B*natural logarithm of the previous month's 8-river index)

and A and B are determined by reference to Table [2] for the Roe Island and Chipps Island locations.

Month X	Chipps Island		Roe Island (if triggered)	
	A	B	A	B
Feb	-*	-*	-14.36	+2.068
Mar	-105.16	+15.943	-20.79	+2.741
Apr	-47.17	+6.441	-28.73	+3.783
May	-94.93	+13.662	-54.22	+6.571
June	-81.00	+9.961	-**	-**

Table 2. Constants appropriate to each of the monthly equations to determine monthly requirements described. *Coefficients for A and B are not provided at Chipps Island for February, because the 2 ppt criteria must be maintained at Chipps Island throughout February under all historical PMI values for January. **Coefficients for A and B are not provided at Roe Island for June, because under the equations used the 2 ppt criteria will never be required at Roe Island in June, regardless of the PMI value for May. This is true even if the Roe Island criteria are triggered earlier in the spring.

Examples of the required number of compliance days resulting from the computation of these equations across a range of previous monthly 8-river index (PMI) values are presented in Table [3].

The criteria at Roe Island shall be required for any given month only if the 14-day average salinity at Roe Island falls below 2 ppt on any of the last 14 days of the previous month.

As in the Proposed Rule, the final rule provides that salinity at the Confluence of the Sacramento and San Joaquin Rivers (Collinsville Continuous Monitoring Station C-2) shall not exceed 2 ppt throughout the period February 1 through June 30.

PMI	Chipps Island					Rock Island (if triggered)			
	Feb	Mar	Apr	May	Jun	Feb	Mar	Apr	May
250	0	0	0	0	0	1	0	0	0
500	28	0	0	0	0	5	1	0	0
750		18	0	0	0	9	2	1	0
1000		31	2	0	0	13	4	2	0
1250			7	0	0	17	7	4	0
1500			15	0	0	19	10	8	0
1750			21	0	0	21	13	11	0
2000			26	1	0	22	16	15	0
2500			29	16	1	24	20	21	2
3000			29	29	7	25	24	25	5
4000			30	31	25	26	27	28	18
5000					29	27	29	29	26
6000					30	28	30	30	29

Table 3. Examples of required number of days of compliance for each month across a range of possible values of the 8-river index for the prior month (PMI).

REFERENCES

Bay Institute 1994. Comments on the proposed Rule for Water Quality Standards in the Bay/Delta, 1 p., plus three appendices and three enclosures.

California Department of Water Resources 1994. Comments on the Water Quality Standards for the Bay and Delta, 2 pp., plus 88+ pp. comment booklet and 7 appendices.

California Urban Water Agencies 1994. Comments on the Water Quality Standards for the Bay and Delta, 3 pp., plus 5 pp. supplementary comments and 12 draft technical appendices.

Contra Costa Water District 1994. Comments on the Water Quality Standards for the Bay and Delta, 5 pp., plus 2 attachments.

Denton, R.A. 1993. Accounting for Antecedent Conditions in Seawater Intrusion Modeling - Applications for the San Francisco Bay/Delta Hydraulic Engineering 93, vol 1, pp 448-453.

Denton, R.A. 1994. Minor Modifications to the G-Model Fit of Electrical Conductivity Versus Antecedent Outflow. Internal CCWD report, 8 pp.

Herbold, B., A.D. Jassby, P.B. Moyle, 1992. San Francisco Estuary Project Status and Trends Report on Aquatic Resources in the San Francisco Estuary. March 1992. 257 pp.

Kimmerer, W. 1994. A sliding scale for the EPA salinity standard. 12 p.

Natural Heritage Institute, 1994. Comments on the proposed rule for water quality standards in the Bay/Delta, 1 p., plus 42+ pp. of comments and Attachments A-F.

SFEP, 1993. Managing Freshwater Discharge to the San Francisco Bay/Sacramento-San Joaquin Delta Estuary: The Scientific Basis for an Estuarine Standard. 17 pp. + appendices.

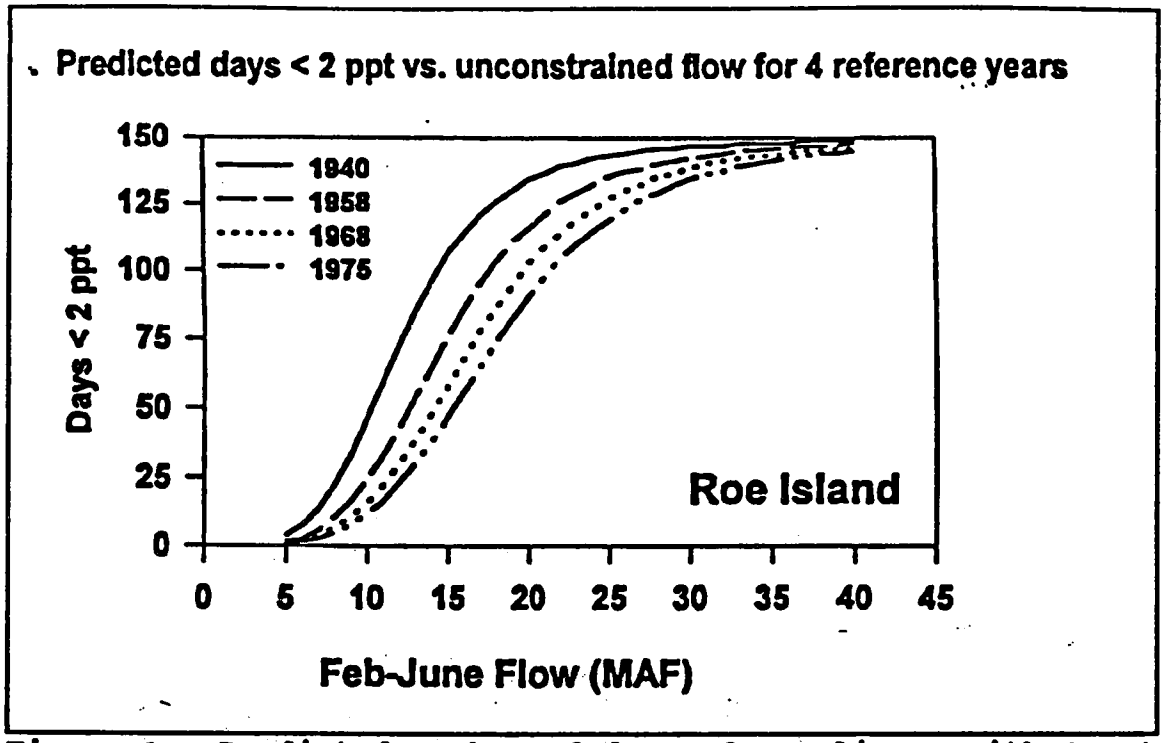

Figure 1. Predicted number of days of compliance with 2 ppt criteria during February to June at four levels of development across a range of unimpaired flows.

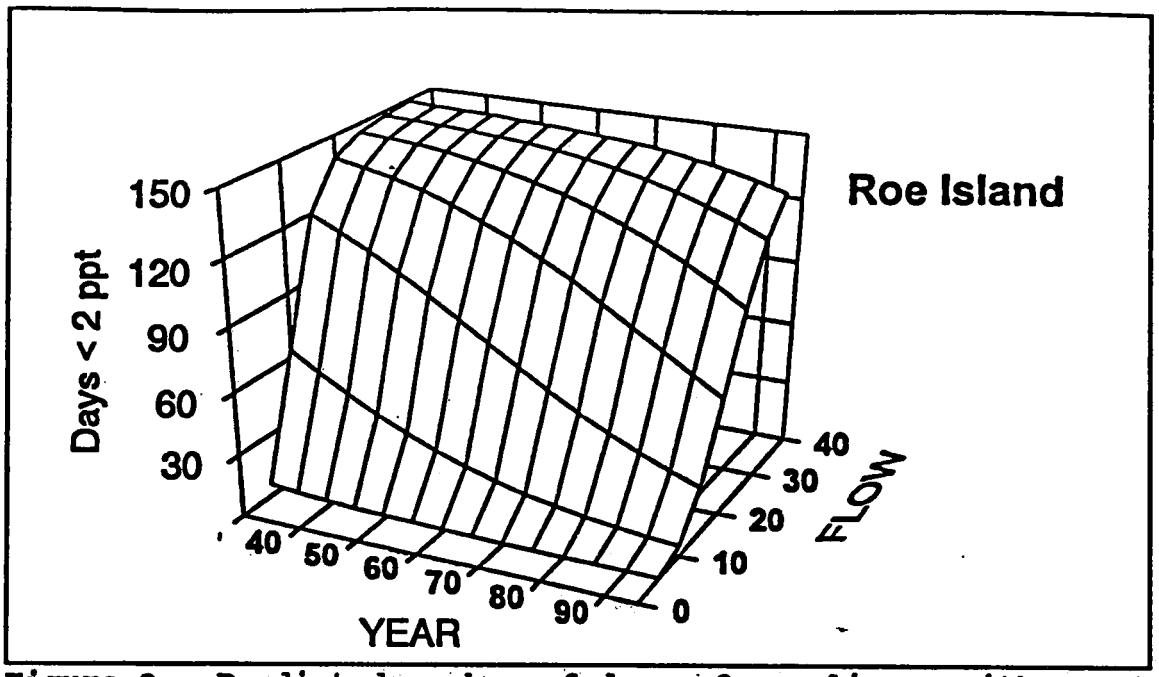

Figure 2. Predicted number of days of compliance with 2 ppt criteria during Feb-Jun period, showing relationship to (1) increasing level of development represented by calendar year and (2) unimpaired flow.

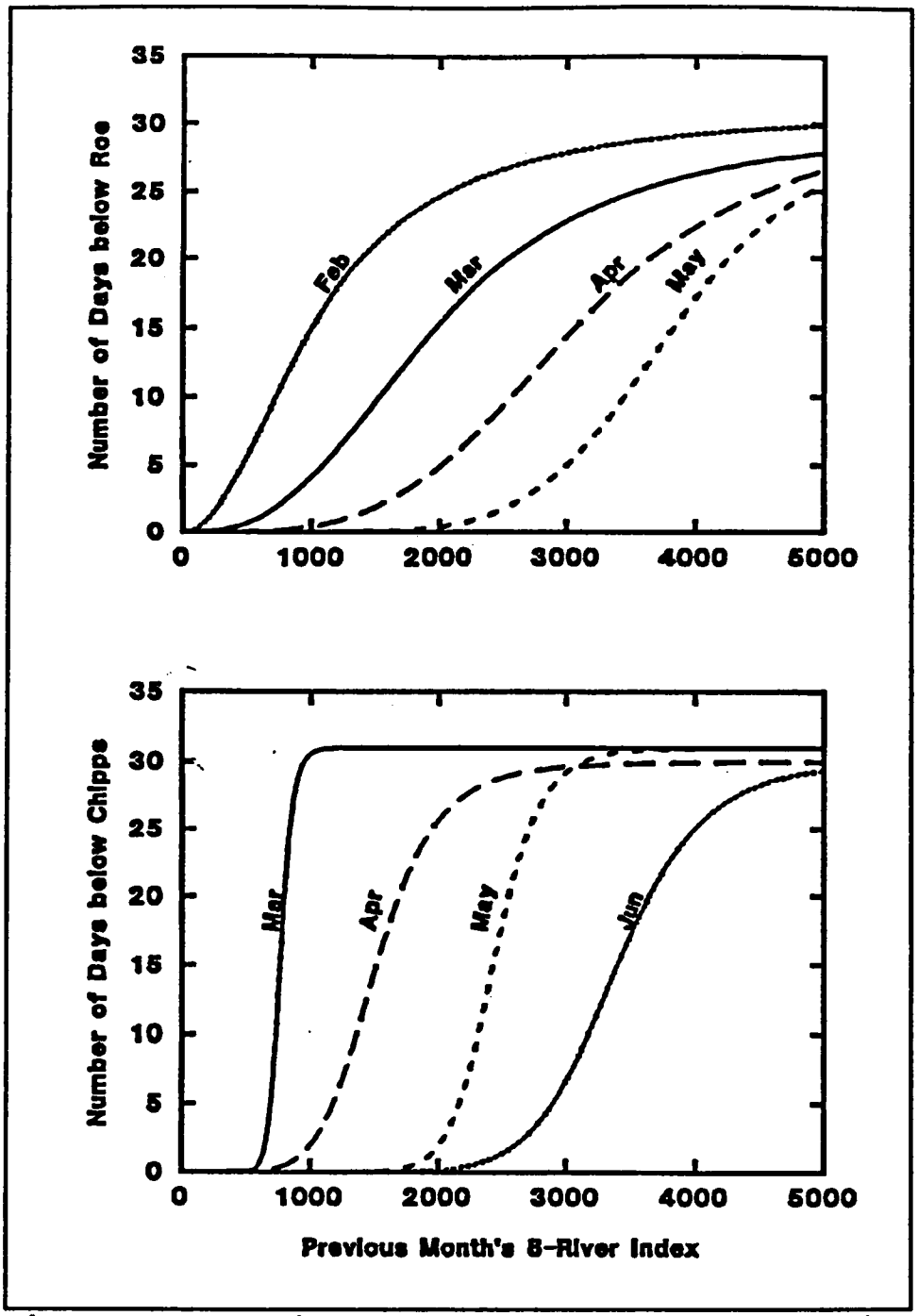

Figure 3 Equations for separate months relating previous month's unimpaired flow to current month requirement.

ALTERNATIVE FORMULATION

OF

SALMON SMOLT SURVIVAL INDEX CRITERIA

Susan Hatfield
U.S. Environmental
Protection Agency
August 1994

BACKGROUND

This paper summarizes an alternative approach to the salmon smolt survival index criteria proposed in EPA's January 6, 1994, Federal Register notice. This alternative proposal was developed in response to formal comments received on the Proposed Rule, and also draws on discussions at a series of workshops sponsored by the California Urban Water Agencies (CUWA) and a number of environmental groups. These workshops reviewed in depth the formal comments submitted by CUWA. The overall substance of these workshops is reported in a summary prepared by the workshop facilitator. EPA participated in these workshops at a staff level, and found them extremely useful, but the workshop summary does not necessarily entirely reflect the positions of the participating EPA staff or of the Agency generally.

1. Proposed Rule

To protect fish migration and cold freshwater habitat uses of the estuary, the Proposed Rule (59 FR 810) included "salmon smolt survival criteria." These criteria consisted of two sets of index values, one for each of the Sacramento and San Joaquin River systems, to be attained through the management of certain variables included in the index equations. The index values varied according to the standard five water year types. The criteria were stated in tabular form as in Table 1.

The indices were to be computed and compliance was to be measured by using the salmon smolt survival models developed by the Stockton office of the U.S. Fish and Wildlife Service (USFWS). These models were stated as the following equations:

Sacramento River Index (SRI):

$$\begin{aligned} SRSI = {} & 1 - (-2.45925 + .0420748T) \\ & + (-0.5916024 + .017968T + .0000434E)(P_1) \\ & + (-1.613493 + .0420748T)(P_2) \\ & - (-2.45925 + .0420748T) * \\ & \quad (-.5916024 + .017968T + .0000434E) * P_1 \\ & - (-2.45925 + .0420748T) * (-1.613493 + .0420748T) * P_2 \end{aligned}$$

where

SRSI = Sacramento River Salmon Index value
T = Average Water Temperature in Fahrenheit at Freeport
E = Average State Water Project plus Central Valley Project Exports in cubic feet/second (cfs) (from DAYFLOW)

P_1 = proportion water diverted into Delta Cross-Channel at Walnut Grove
P_2 = proportion water remaining in Sacramento River at Walnut Grove

San Joaquin River Index (SJRI):

$$SJSI = (0.341271 - 0.000025E + 0.000067F)/1.8$$

where
SJSI = San Joaquin River Salmon Index value
E = Average Central Valley Project plus State Water Project exports measured in cfs
F = Mean daily flow in cfs in San Joaquin River at Stockton, calculated as Old River flow subtracted from San Joaquin River flow at Mossdale. Old River flow is calculated from ratio of Brandt Bridge flow to exports.

The Preamble to the Proposed Rule discusses in detail how the actual target index values in Table 1 were determined. To protect the designated uses, the Proposed Rule included target values representing the modeled results of the management measures developed by the Delta Team of the Five Agency Chinook Salmon Committee. EPA believes that implementation of these measures would result in the protection of the designated cold freshwater habitat and fish migration uses. EPA revised these modeled results to address concerns over the Delta Team proposal to close the Georgiana Slough, and the recommended target values did not assume that the Slough would be closed.

2. Formal Comments and Workshops

During the comment period on the Proposed Rule, EPA received a number of substantive critiques of the salmon smolt survival index criteria. Among the more detailed analyses were those submitted by CUWA. In addition, EPA staff attended a series of workshops sponsored by CUWA, the Bay Institute of San Francisco, Environmental Defense Fund, Natural Heritage Institute, and Save San Francisco Bay Association. The purpose of these workshops was to consider the formal comments filed by CUWA. A summary of these workshops was prepared by Dr. Kimmerer, the facilitator and reporter of the workshops.

The reformulation of the salmon smolt survival index criteria described below relies in large part on the formal comments and workshop discussions. In addition, EPA has engaged in further discussions with USFWS's Stockton office and with its Endangered Species Act coordinators in Sacramento.

ALTERNATIVE FORMULATION

1. In General

EPA has developed the following alternative approach for establishing protective criteria for salmon smolt migration through the Delta. There are three principal differences between the Proposed Rule's approach and the new alternative.

- Measuring Attainment Through Actual Test Results

The Proposed Rule relied on the USFWS models to determine whether the criteria were being attained. In effect, attainment would be assumed if the State's implementation plan adopted a combination of measures stated in the model that added up (using the model equation) to the target survival value.

Under this revised alternative, direct experimental measurements of survival through the Delta will be used to estimate attainment of the criteria, instead of relying on modeled estimates. This approach assures that any possible biological factors that are not included in the model will be reflected in survival measurements. This more direct approach gives the State greater latitude to develop implementation measures outside of the model parameters. It also insures that the implementation measures are actually providing the intended protection.

- Use of Continuous Function

The second principal difference in this new alternative is to move away from criteria varying according to the five water year types, and instead to state the criteria as a "continuous function" or "sliding scale." The rationale for using the continuous function approach is explained in detail in the preamble to the Proposed Rule in the context of the Estuarine Habitat criteria (2 ppt isohaline), and that same rationale is applicable to these salmon smolt survival index criteria. In the Proposal, EPA suggested index values that varied according to the five standard water year categories.[1] EPA believes that the continuous function approach provides the same degree of protection for the designated uses, but provides a more precise approximation of hydrological conditions and facilitates implementation and compliance. The derivations of the actual functions for the Sacramento and San Joaquin River systems are explained below.

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[1] These categories are wet, above normal, below normal, dry and critically dry water years.

- Alternative Method of Selecting Target Values

Largely as a result of the above changes in the approach to the criteria, a new method of developing the target values must also be used. The Proposed Rule relied in part on estimates of historical period index values, and that approach requires reliance on a model such as the USFWS model to estimate the index values from historical conditions because salmon smolt survival was not measured prior to 1978. The alternative approach to setting target index values is detailed below. On the Sacramento River, the target values were developed based on the experimental data associated with times in which the Delta Cross-channel was closed during the appropriate migration period. On the San Joaquin River, the target values were derived from the modeled values associated with adjusted management measures recommended by USFWS. These values are consistent with the discussions of the workshop participants.

These alternative approaches to developing target index values should also address some of the concern about the models raised in the workshops. University of California at Berkeley statistician Dr. John Rice reviewed the models for CUWA, and was concerned about their use in target value development. He believes that the basic statistical structure of the models, i.e. multiplying separate water segment regression equations to estimate an overall survival index through the entire Delta, results in too much uncertainty about the statistical reliability of the models. The revised alternative reduces this problem on the Sacramento River because it relies on observed experimental data rather than the model to develop target values for the criteria.

2. Sacramento River Salmon Smolt Survival Criteria

Developing the Criteria

Over the past 14 years, a series of studies have been performed by USFWS, releasing coded-wire tagged smolts at Sacramento and using recapture data to estimate an index of their survival to Chipps Island. These data form the basis for the alternative formulation of the salmon smolt survival criteria. They quantify the impact of meteorological conditions on smolt survival, and indicate the range of survival index values achieved over the last 14 years.

The data suggest that temperature is a dominant factor controlling salmon smolt survival in the Sacramento River. Temperature alone is significantly related to salmon smolt survival (Letter from P. Fox to L. Hoag dated July 13th, 1994). Because water temperature in the Delta has a large uncontrollable component, the alternative salmon smolt survival criteria vary based on water temperature. This is consistent with the comments of the workshop participants.[2]

In the Proposed Rule, EPA based its criteria on the modeled salmon smolt survival index values representing survival levels that occurred in the late 1960's to early 1970's, modified to reflect achievable implementation measures recommended by USFWS, National Marine Fisheries Service (NMFS) and California Department of Fish and Game (CDFG). EPA concluded that the survival index values attained through the use of these implementation measures were consistent with protecting the designated fisheries uses on the Sacramento River system. In that there were no direct experimental results during this period, EPA is using a slightly different approach to establish the target in this alternative formulation. This approach relies on the recommendation by USFWS that the Delta cross-channel should be closed at critical times. Work by USFWS indicates that closure of the cross-channel is the most important controllable factor in the survival of smolts on the Sacramento River. (USFWS, Abundance and Survival of Juvenile Chinook Salmon in the Sacramento-San Joaquin Estuary, 1991 Annual Progress Report, June 1992; also known as WRINT-USFWS-9.) The experimental release data support this hypothesis, in that data points derived from periods with the cross-channel closed show a consistent improvement in survival compared to periods when it is

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[2] If the results of ongoing temperature modelling studies identify controllable factors, or if future water development or land use practices alter the relationship of water temperature and the uncontrollable factors that currently determine water temperature, these criteria may need to be revised.

open.[3] Based on this correlation, EPA is suggesting a target index level, stated as a continuous function or line, that approximates[4] the experimental survival index values observed in Sacramento releases during periods in which the channel is closed. This target appears to be an achievable level for criteria that would protect the fish migration designated use. This target index line can be stated as 6.96 - .092 * Fahrenheit temperature.

The proposed target index line very closely approximates the line created by doubling the historical survival measured at times that the Delta cross-channel is open. These different lines, and the underlying data, are summarized in Figure 1. Although not intentional, the near-coincidence of the proposed target line and the doubling line provides an independent policy rationale for adopting the proposed target index, in that the Central Valley Project Improvement Act mandates a "doubling" goal for anadromous fish.

If this alternative approach to setting target criteria is used, EPA still believes that historical information can help support the Sacramento basin target criteria, in that the target values developed in this alternative are consistent with the modeled index values representing conditions in the late 1960's to early 1970's. As stated by EPA in the Proposed Rule, the level of protection in this historical period is consistent with the protection of the fisheries designated uses.

Two refinements need to be added to this alternative, both of which involve temperature. At lower temperatures, the salmon smolt survival index likely approaches a maximum at some point. The highest survival index recorded was 1.48 and coincides with the lowest temperature recorded during salmon smolt survival experiments. Below this temperature, it is unlikely that lower water temperatures would lead to a substantially increased survival. This suggests that the index should include a "ceiling" value.

At higher temperatures (those above 72 degrees), measured salmon smolt survival index approaches zero, and is below the detection level of the USFWS studies. The diversity in natural spawners is likely to result in smolt passage throughout the April-June period. Protective measures should be used to increase survival of smolts during this period, even at times of high

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[3]This is particularly true for release studies at Sacramento. Release studies at Courtland showed less dramatic improvement with the cross-channel closed, suggesting that other factors such as those included in the USFWS model are also at work.

[4]Approximating this line was done through a standard "best fit" computation.

temperature. EPA believes, and the workshop participants generally concurred, that a "floor" to the index is appropriate so as to encourage efforts to protect salmon during these periods of high temperature. To this end, USFWS has recommended actions to restrict passage of fish into the central Delta, such as gate operations and export restrictions. EPA believes that these measures can be used to reduce the serious degradation in migration conditions occurring during high temperature periods.

Alternative Sacramento Salmon Smolt Survival Criteria

The alternative criteria are stated in reference to water temperature. As explained above, use of this equation appears inappropriate at both high and low temperatures, so the criteria must specify a ceiling on the index values at low temperature and a floor for high temperature conditions. Incorporation of these conclusions and comments leads to alternative salmon smolt survival criteria of:

At temperatures below 61 F:
SRSI = 1.48

At temperatures between 61 and 72 F:
SRSI = 6.96 - .092 * Fahrenheit temperature

At temperatures above 72 F:
SRSI = 0.48

These alternative criteria are shown in Figure 2.

Implementation

EPA expects the USFWS Sacramento smolt survival model will be used to predict measures necessary to implement the criteria. There are a number of base conditions underlying the model. For example, USFWS recommended a base Sacramento River flow to insure that overall conditions do not deteriorate. The State should protect these base conditions as it develops an implementation plan.

Monitoring compliance with these criteria will need to focus on both within-year measures and across-year comparisons. During each year monitoring of salmon smolt survival should occur throughout the months of April, May and June with particular emphasis during times of temperature change or at times of change in water project operation. It is likely that this monitoring will reveal a large variability in survival at different times and under different conditions within each year. EPA anticipates that at the time of the next triennial review enough monitoring data over a range of temperatures will be available for a preliminary determination of whether the state's implementation actions attain the criteria.

3. San Joaquin River Salmon Smolt Survival Criteria

Developing the Criteria

Between 1982 and the present, fisheries biologists have conducted a series of experimental releases and captures of tagged salmon smolts in the San Joaquin River system. A general conclusion of the workshop participants was that the smolt survival indices resulting from these releases do in fact represent the pattern of smolt survival through the Delta. The workshop participants explored a number of ways of characterizing these results, with the aim of designing survival criteria which take into account the major uncontrollable factor(s) affecting survival. As in the case of the Sacramento River criteria, the controllable factors can then be addressed through the State's implementation plan to achieve a target level of protection. In the absence of any evidence of a relationship between uncontrollable factors and survival indices, the criteria would presumably be a single number.

Workshop participants considered temperature at release, smolt size at release, and flow at Vernalis. Although all three of these factors are controllable to a certain extent, they each have an uncontrollable component. Based on the studies done to date, it appears that neither temperature at release nor smolt size show a significant correlation with smolt survival indices representing smolt survival through the San Joaquin Delta. (P. Fox, Data summary presented at workshop on June 29, 1994). Flow at Vernalis, however, does show a significant correlation with survival indices representing total survival through the Delta (Table 2, Figure 3), suggesting that criteria should vary with the natural hydrology. Results from upstream releases were included in this correlation between flow and survival index values in order to supplement data from wetter years having higher flows. This approach assumes that the mortality between the upstream release sites and the Mossdale, Dos Reis and Upper Old River release sites (all close together) is negligible. If incorrect, this assumption may bias the correlation downward, and survival through the Delta may have been better than the index indicates for those releases.

Most of the release studies have been performed at flows below 5,000 cfs, and it is clear from the relation between survival indices and experimental flow conditions that these conditions are very poor for smolt survival. The average survival index for these low flow conditions is 0.09, representing approximately 5 recoveries from a release of 50,000 fish at Mossdale, 55 miles upstream of the smolt recovery site at Chipps Island.

Although there are fewer data points at higher flows, the experimental results do indicate that survival has been substantially higher under these conditions. The average survival index at these higher flows is 0.48 (n=4). It is important to

realize that these numbers are not survival estimates, but only indices, and that these indices have ranged up to 1.8 on the Sacramento and 1.5 on the San Joaquin (a Jersey Point release).

The workshop participants agreed that one option for setting survival criteria would be to characterize current (recent) survival indices separately under low and high flow conditions to provide a base for each separate set of conditions. Differentiating between low and high flow conditions also is consistent with the perception of workshop participants that substantially increased flows (and corresponding survival improvement) are relatively more achievable in drier years. Target index values for protecting the designated use could then be set by increasing the survival indices representing these two conditions (high and low flows) by a chosen incremental amount to provide increased protection, and scaling the goal to the 60-20-20 unimpaired San Joaquin water year flow index.[5]

In choosing the target criteria values for the San Joaquin, EPA relied in part on refining the target values included in the Proposed Rule, and in part on the workshop methodology outlined above.

EPA first developed a continuous function survival index target by refining the target values included in the Proposed Rule. To do so, EPA developed modeled index values associated with the implementation of protection measures proposed by USFWS. (USFWS, Measures to Improve the Protection of Chinook salmon in the Sacramento/San Joaquin River Delta, 1992; also known as WRINT-USFWS-7.) As indicated in the Proposed Rule, EPA believes that implementation of these measures is consistent with the protection of the designated fisheries uses. As explained below, however, EPA has revised its assessment of some of the implementation measures that are likely to be achievable, and this revision creates corresponding changes to the modeled index values. In addition, consistent with the findings of the workshop and with EPA's conclusions in the Proposed Rule, EPA increased protective measures in the drier years, and this increased protection is reflected in the modeled index values. Means of these modeled index values for each water year type are shown in Table 3. To translate these discrete index values into a continuous function, two lines of "best-fit" were created, one for the drier years (dry and critically dry) and one for the wetter years (wet, above normal, and below normal). By connecting these two lines, EPA created a

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[5] The San Joaquin water year index is the commonly-accepted method for assessing the hydrological conditions in the San Joaquin basin. It is also frequently referred to as the 60-20-20 index, reflecting the relative weighting given to the three terms (current year April to July runoff, current year October to March runoff, and the previous year's index) that make up the index.

single continuous function that can serve as the target criteria on the San Joaquin.

This alternative represents a larger increase in survival over current survival rates in dry and critical years (compared to wetter years) so as to protect salmon populations from declining to the critically low levels of recent years (Figure 3). At the same time, it is particularly important in the San Joaquin basin to protect salmon during periods of higher flow conditions. The years of higher flows have been the only times recently when salmon populations have recovered somewhat, and protection in these productive years is important for buffering the population against permanent loss of salmon runs when conditions are poor. On average, these alternative criteria should increase wet year survival by a factor of 1.8 and critical year survival by a factor of 4.

EPA is aware of the concerns expressed by some workshop participants about using the USFWS models to establish target criteria values. At the same time, however, the target values outlined above are fully consistent with the workshop findings. The workshop participants developed a consensus, based not on the modeled values but on their independent scientific judgment, that an increase in measured survival index values of two to three times recently observed values would be appropriate in critical years. Kimmerer, Setting Goals for Salmon Smolt Survival n the Delta, August 10, 1994 at p. 9. As stated above, the workshop participants also endorsed relatively higher protection in drier years as opposed to wetter years. EPA agrees with these scientific judgments, and believes that measured survival index values in these ranges must be attained to protect the designated uses on the San Joaquin.

EPA believes that the target index values stated as a continuous function in Figure 5, even though developed with the assistance of the USFWS model, are wholly consistent with the findings of the workshop participants. In addition, these target values are consistent with the CVPIA goal of doubling anadromous fish populations.

Alternative San Joaquin Salmon Smolt Survival Criteria

The proposed alternative criteria to protect salmon smolt migration through the San Joaquin Delta are:

For years in which the SJWYIndex is > 2.5:
SJSI = (-0.012) + 0.184*SJWYIndex

In other years: SJSI = 0.205 + 0.0975*SJWYIndex

where SJSI is the San Joaquin salmon smolt survival index, and SJWYIndex is the 60-20-20 San Joaquin water year index in million acre feet (MAF)

Implementation

Since the Proposed Rule was published, USFWS has developed a revised version of the San Joaquin River model. This model relates the survival of San Joaquin basin smolts migrating through the Delta to: (1) San Joaquin River flow at Vernalis, (2) proportion of flow diverted from the mainstem San Joaquin River, (3) exports, and (4) temperature at Jersey Point. The revised San Joaquin model structure overall is very similar to that of the Sacramento basin model. This revised model should be more useful than the previous version for analyzing alternative implementation measures.

Implementation measures likely to be necessary to attain the alternative criteria would be similar to those recommended by the USFWS for the State's hearings on Draft Water Right Decision D-1630. They include: (1) a one month (April 15 to May 15), instead of two month (April 1 to May 31), requirement for the Upper Old River barrier placement, (2) increased export restrictions (to 1500 cfs) during the time the Old River barrier is in place, (3) increased flow (to an average of 4000 cfs rather than 2000 cfs) in critical years when the barrier is in place, and (4) flows and exports varying each year according to the 60-20-20 water years index, rather than varying by water year type. These measures are displayed in tabular form in Table 3.

The implementation assumptions in this alternative are basically the same as in the Proposed Rule except in one major respect. Recent discussions with USFWS and others, as well as information developed in hydrological modeling for the South Delta Barriers Project, raised concerns about the effect of the Upper Old River barrier on reverse flows in the central Delta and their potential to draw fish into poor habitat and to entrainment at the project pumps. This is of particular concern for the threatened Delta smelt. Because the barrier is expected to provide greatly increased protection for migrating salmon smolts, EPA continues to believe, as it expressed in the Proposed Rule, that an Old River barrier is an important implementation measure. However, in order to balance the potentially competing requirements of Delta smelt and salmon, EPA is assuming that implementation will include only one month with the barrier in place, rather than the two months initially recommended by USFWS. The 1500 cfs export restrictions during pulse flows were implementation measures assumed for EPA's proposed rule. Restricted exports will help alleviate hydrological problems caused by the barrier. Flows have been increased to an average of approximately 4000 cfs during dry and critically dry years to provide an increased ratio of flows to exports in the lower San

Joaquin to protect vulnerable fish.

Implementation measures to attain the criteria would also include export restrictions during the time in April and May when the barrier is not in place. These would average 2000 cfs in critically dry years, 3000 in dry, 4000 in below normal, 5000 in above normal, and 6000 in wet years. With the sliding scale as currently formulated, the lowest flows (1977 hydrology) with the barrier in place would be approximately 2300 cfs if exports were kept at 1500 cfs.

One additional refinement to the implementation measures should be considered on the San Joaquin River. As discussed above, the Sacramento River criteria includes a ceiling value on the maximum salmon smolt survival. This was included because there appears to be a point where incrementally lower temperatures do not significantly increase salmon smolt survival. In theory, there may be a similar point on the San Joaquin River where incrementally higher flows in very wet years do not yield significantly higher salmon smolt survival. Nevertheless, the existing data do not suggest what those flow levels should be. EPA is considering another mechanism for dealing with this issue. EPA believes that in very wet years (those in which the flows exceed 10,000 cfs during the relevant period) it may be appropriate to require meeting the flow requirements associated with the targeted salmon smolt survival criteria index solely through natural storm events and restricted diversions, and not by upstream reservoirs releases. In other words, the implementation flows would be provided at these higher flow periods, if at all, by natural hydrology rather than by reservoir releases. In this way, the natural "flood events" that appear to be so beneficial to the salmon would be protected, but the water supply system would not have to bear the water costs of generating artificial flood events through reservoir releases.

As indicated above, the USFWS model is the best available model of salmon smolt survival through the Delta, and EPA encourages the State Board to use the recently revised USFWS San Joaquin model as guidance for setting implementation measures. Nevertheless, it is important to recognize that there may be constraints on the model's use. Further monitoring and experimental releases under the chosen implementation regime are essential to verify and refine the model, and will insure that the smolts are actually surviving at the expected level. In addition, it will be particularly important to protect the base conditions assumed in the model, such as flows during the time the barrier is not in place, flows at Jersey Point, and temperature. The expected survival index is unlikely to be achieved if these base conditions deteriorate. As in the case of the Sacramento River criteria, EPA anticipates that at the time of the next triennial review enough monitoring data over a range of hydrological conditions will be available for a preliminary

determination of whether the State's implementation plan is sufficient to attain the criteria.

The alternative survival index does not vary by temperature (as it does on the Sacramento River) because information from releases near the upstream edge of the Delta did not show a significant relationship between survival and temperature at release. However, temperature at Jersey Point is included in the revised USFWS San Joaquin model, and temperature has a fairly strong effect on modeled survival. This model prediction is the result of using a set of releases from Jersey Point. Although EPA believes that temperature control is important to protect the cold-water habitat use for salmon, it is unclear how much control is possible. At this point, EPA does not believe that establishing San Joaquin implementation measures that vary by temperature is appropriate. Average temperatures of 60 F in April and 65 F in May were assumed when using the model to predict survival for a set of implementation measures. These are averages from a set of temperature data at Jersey Point taken during the late 1950's and 1960's. The recent experimental release temperatures are within the range of this data. If monitoring shows that predicted survival is not as expected, and appears to be varying significantly with temperature, then temperature should be included in a reformulation of the criteria.

Finally, experimental releases have shown that survival is substantially less for those smolts migrating down Old River versus those traveling down the mainstem San Joaquin. This is the primary reason why many agency and planning groups proposed a barrier at Upper Old River. This last year, however, some parties expressed concern about the potential for flooding if the barrier is in place with flows higher than 4000 cfs. EPA would like comment on whether these concerns are justified and, if so, what alternatives are available to deal with the problem.

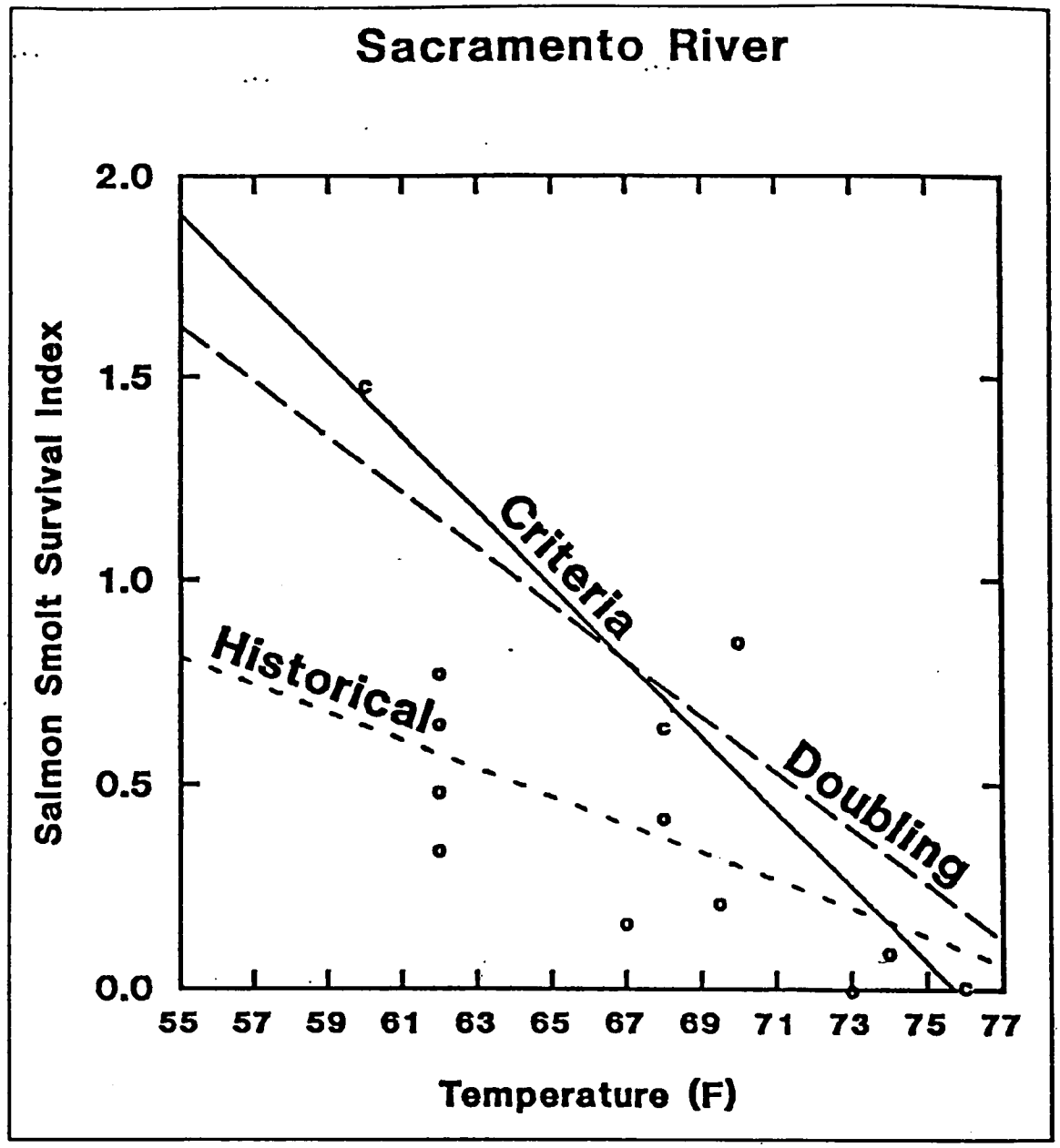

Figure 1. The line labeled 'Historical' is the line of best fit for the data from times when the Delta cross-channel was open (these data are represented with an 'o'). The 'Criteria' line is the line of best fit for data from times when the Delta cross-channel was closed (represented by 'c'). The line labeled 'Doubling' represents a simple doubling of the slope and intercept of the 'Historical' line.

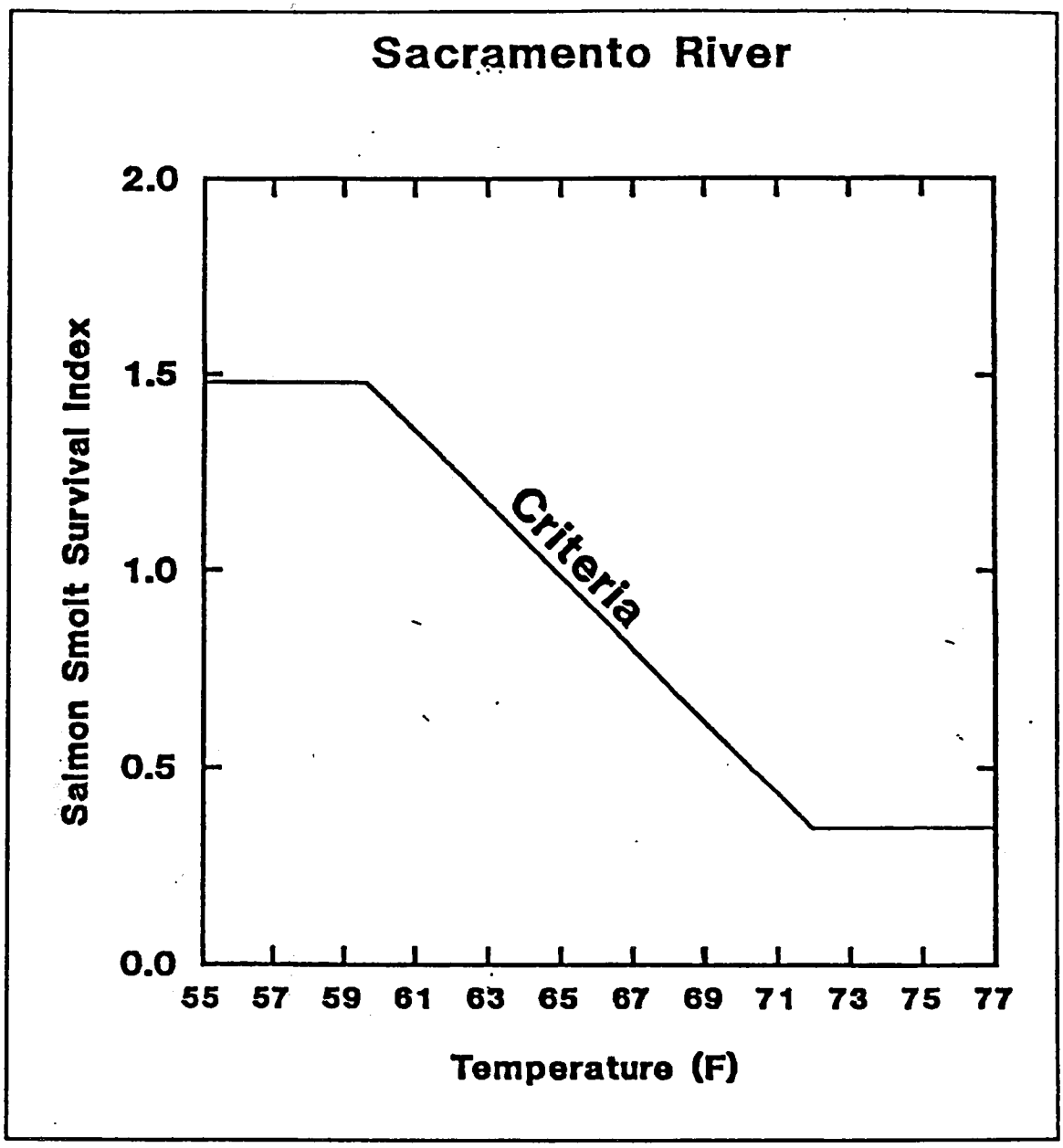

Figure 2. The 'criteria' line from figure 1 modified with a ceiling at 60 F and a floor at 72 F.

Figure 3. San Joaquin Salmon Smolt Survival Index vs Dayflow at Vernalis averaged over 10 Days after Release

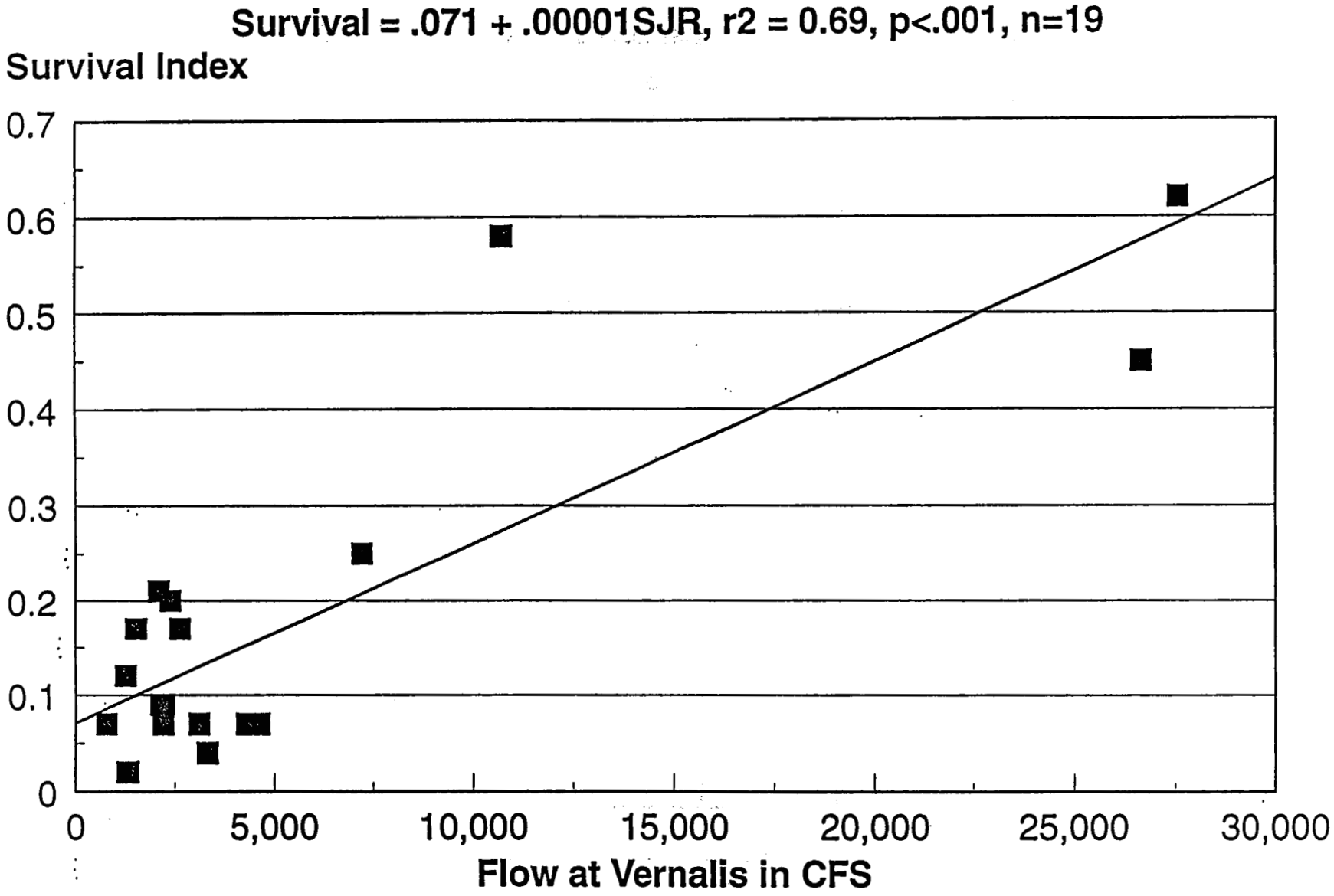

Figure 4. San Joaquin Salmon Smolt Survival Criteria Compared with Historical Experimental Release Results and Release Results Doubled

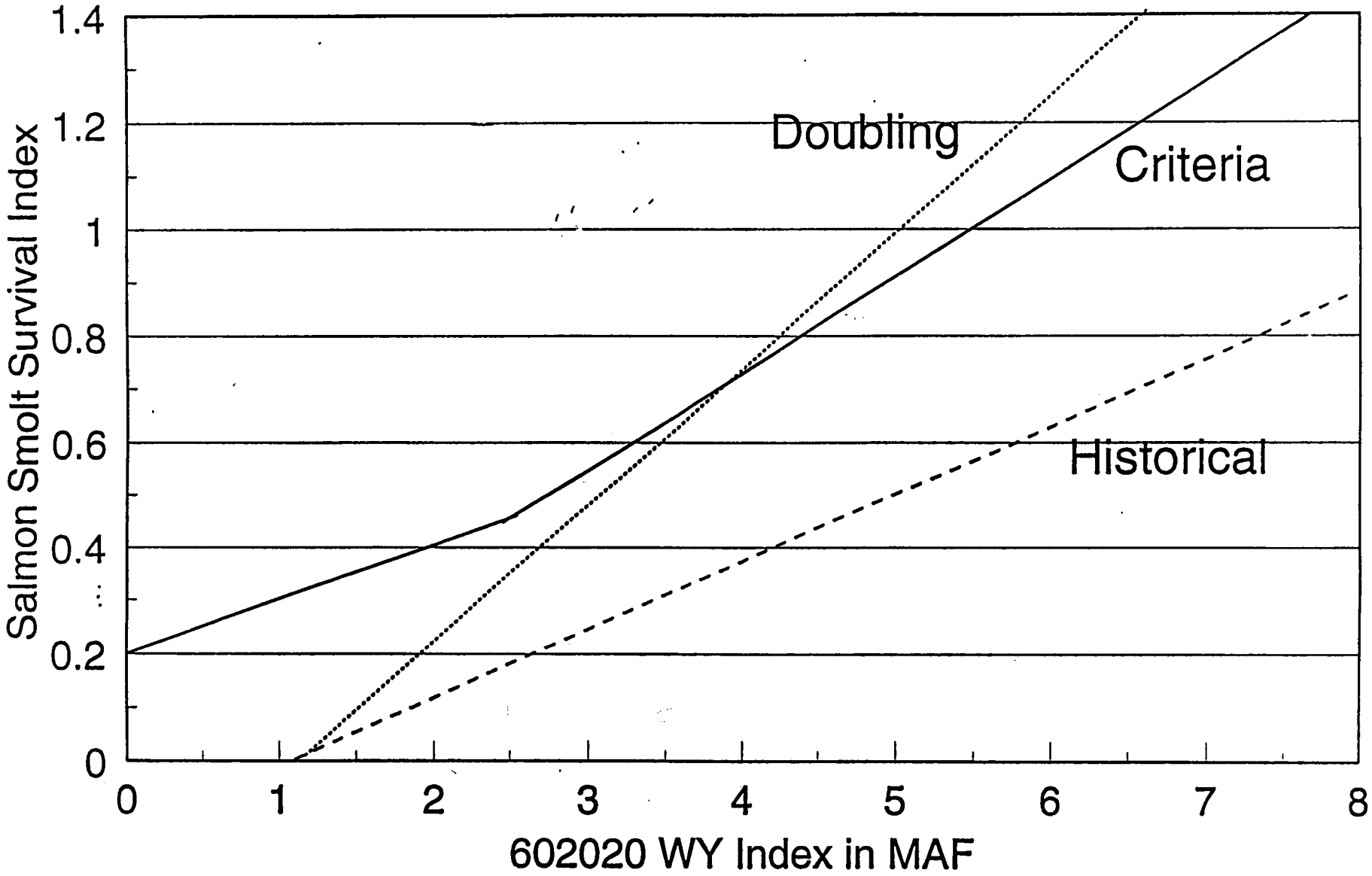

Figure 5. San Joaquin Salmon Smolt Survival Criteria

Goal for WY Index >2.5 MAF: SSSI = -0.012+ 0.184*SJWYIndex in MAF

Goal for <=2.5 MAF: SSSI = 0.205 +0 .0975*SJWYIndex in MAF

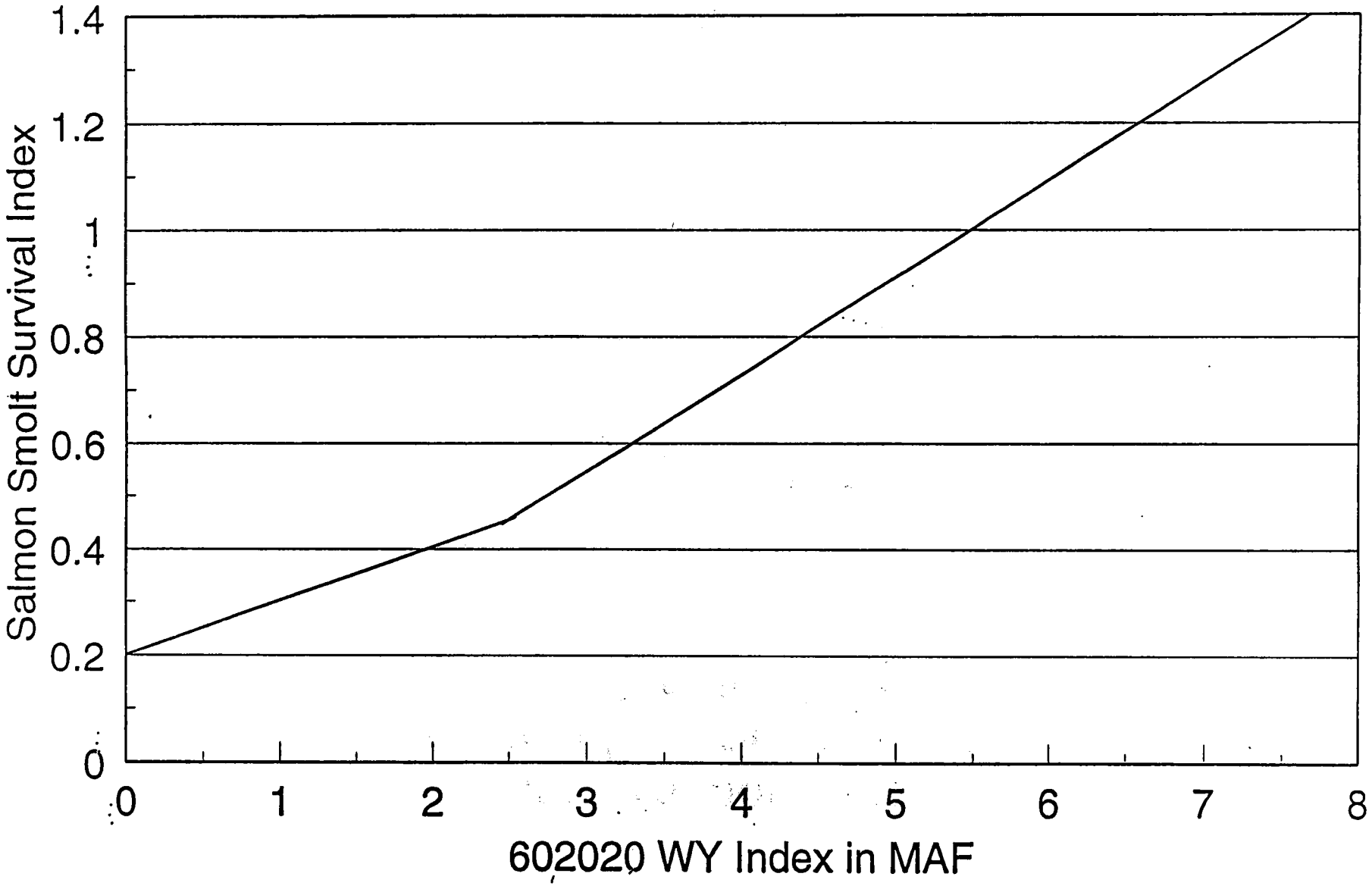

Table 1. Salmon smolt survival criteria.

Sacramento River		San Joaquin River	
Water Year Type	Index Value	Water Year Type	Index Value
Wet	.45	Wet	.46
Above Normal	.38	Above Normal	.30
Below Normal	.36	Below Normal	.26
Dry	.32	Dry	.23
Critical	.29	Critical	.20

Table 2. San Joaquin River Experimental Release Data

Release Location	Year	survival	10 day avg SJR Flow at Vernalis
DosRUoldR**	1982*	0.45	26670
DosRUoldR	1985	0.61	2370
DosRUoldR	1986	0.25	7215
DosRUoldR	1987	0.20	2386
DosRUoldR	April 1989	0.09	2148
DosRUoldR	May 1989	0.07	2203
DosRUoldR	April 1990	0.02	1342
DosRUoldR	May 1990	0.02	1325
DosRUoldR	1991*	0.07	799.2
Mossdale	April 1992	0.17	1530
Mossdale	April 1992	0.12	1274
Mossdale	April 1993	0.04	3321
Mossdale	April 1993	0.07	4630
Mossdale	May 1993	0.07	4309
Mossdale	May 1993	0.07	3111
Snelling	1982	0.62	27570
L Stanislaus	1986	0.58	10710
L Tuolumne	1987	0.17	2627
L Stanislaus	1988	0.09	2233
L Stanislaus	1989	0.21	2096

* 1982 and 1991 did not have a matching release in Upper Old River, therefore UOldR survival estimated by using average proportional survival for Upper Old River releases vs Dos Reis releases, excluding 1985, which is an outlier apparently because the marking method was dye rather than fin clip. Avg=0.43, range=0.64-0.25, n=5

** All DosRUoldR survivals estimated by weighting each reach survival by proportion of flow, and summing; others used directly

TABLE 3: San Joaquin Implementation Measures Compared

Alternative	Max Total CVP/SWP Exports in cfs	Barrier Upper Old River	Vernalis Flow	Fall Run SSSI on San Joaquin
EPA	4/15 to 5/15 1500 4/1 to 4/15 & 5/16 to 5/31 W[1] 6000 AN 5000 BN 4000 D 3000 C 2000	4/15 to 5/15 All Year Types	4/15 to 5/15 Minimum CFS W 10000 AN 8000 BN 6000 D 4000 C 4000 Other flows from 4/1 to 5/31 same as DWRSIM run used by USFWS for D-1630	W .49 AN .35 BN .28 D .22 C .22 Avg = .33
USFWS	4/15 to 5/15 W 6000 AN 5000 BN 4000 D 3000 C 2000	4/1 to 5/31 All Year Types	4/15 to 5/15 Minimum CFS W 10000 AN 8000 BN 6000 D 4000 C 2000 Other flows from 4/1 to 5/31 same as DWRSIM run used by USFWS for D-1630	W .49 AN .41 BN .40 D .35 C .32 Avg = .41

[1]Many of the implementation measures in Table 3 vary by the water year category. Those categories are wet (W), above normal (AN), below normal (BN), dry (D) and critically dry (C).

Narrative Standard for Protection of Tidal Marshes of Suisun Bay

In order to protect the Estuarine Habitat, Wildlife Habitat, Preservation of Rare and Endangered Species, and other designated fish and wildlife uses of the tidal marshes bordering Suisun Bay, EPA will include a narrative water quality criteria in its Final Rule. This narrative criteria was developed in response to comments received on EPA's Proposed Rule, and especially to comments responding to Question 8 in that Proposed Rule. The narrative criteria would read as follows:

> Water quality conditions sufficient to support a natural gradient in plant diversity and wildlife habitat characteristic of a brackish marsh throughout all elevations of the tidal marshes bordering Suisun Bay, to prevent conversion of brackish marsh to salt marsh, and to protect and maintain sustainable populations of those species vulnerable to increased mortality, loss of habitat, or permanent reduction in plant stature and percent cover from increased water or soil salinity or other water quality problems shall be maintained. Vulnerable species include those species that are presently listed under the Federal Endangered Species Act, including the salt-marsh harvest mouse (*Reithrodontomys raviventris*) and the California clapper rail (*Rallus longirostris obsoletus*). Vulnerable species also include both those rare plants that are candidates for listing under the Federal Endangered Species Act (including Mason's lilaeopsis (*Lilaeopsis masonii*), delta tule pea (*Lathyrus jepsonii*), Suisun slough thistle (*Cirsium hydrophilum* var. *hydrophilum*), Suisun aster (*Aster chilensis* var. *lentus*), soft-haired bird's beak (*Cordylanthus mollis* ssp *mollis*)) and dominant plant species such as the tules *Scirpus acutus, S. californicus* and *S. robustus*. Animal species include Federal candidate species Suisun song sparrow (*Melospiza melodia maxillaris*), California black rail (*Laterallus jamaicensis coturniculus*), tri-colored blackbird (*Agelaius tricolor*), saltmarsh common yellowthroat (*Geothylpis trichos sinuosa*), Suisun ornate shrew (*Sorex ornatus sinuosus*) and southwestern pond turtle (*Clemmys marmorata pallida*). Other vulnerable species include river otter (*Lutra canadensis*), beaver (*Castor canadensis*), nesting snowy egret (*Egretta thula*), nesting black-crowned night-heron (*Nycticorax nycticorax*), ducklings of breeding ducks such as mallard (*Anas platyrhynchos*), gadwall (*Anas strepera*) and cinnamon teal (*Anas cyanoptera*), marsh wren (*Cistothorus palustris*), American bittern (*Botaurus lentiginosus*), Virginia rail (*Rallus limicola*), sora (*Porzana carolina*), and common moorhen (*Gallinula chloropus*).