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.

## *(b) San Joaquin River Fish Migration Criteria*

On the San Joaquin River, the criteria index values vary according to unimpaired San Joaquin river flow. The actual index values have been 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 taggedfish release results indicate that these or equivalent management measures are necessary to protect the Fish Migration designated use on the San Joaquin.

(I) Using Unimpaired Flow at Vernalis as the Independent Variable for the Criteria. In the Proposed Rule, San Joaquin River criteria varied according to water year types reflecting precipitation in the San Joaquin River basin. Using the water year type as the "independent variable" allowed EPA to match the criteria index values with the natural variation in precipitation. Further analysis has confirmed that water flow at Vernalis shows a significant correlation with survival indices representing total survival through the Delta,37 suggesting that criteria index values should vary with the natural hydrology. That is, the criteria index values should reflect higher survival during wetter years with

more precipitation and lower survival during drier years. This variation replicates the natural hydrological cycles affecting Fish Migration through the estuary.

The Proposed Rule varied criteria index values according to the five water year types, and in that way reflected natural hydrological cycles. In the final rule, however, EPA is using the 60–20– 20 unimpaired San Joaquin flow index <sup>38</sup> as a readily-available estimate of natural hydrology. When used in a continuous function (as described below), the 60–20–20 index allows a much more precise statement of the natural hydrology than the five water year categories.

(II) Establishing Criteria Index Values. To establish the actual values included in the San Joaquin River Fish Migration criteria, EPA first developed survival values associated with the implementation of management measures proposed by USFWS (USFWS 1992a). These USFWS measures include export limits at certain times, a barrier at Old River during April and May, and minimum flows at Vernalis, and are summarized in Table 5.39 As indicated in the Proposed Rule, EPA believes that implementation of these management measures would provide conditions protecting the designated Fish Migration 1150

Modifying management measures. As explained below, EPA has revised its assessment of some of the USFWS management measures (notably, those involving the Upper Old River barrier). Accordingly, the final rule used the following management measures: (1) A one month (April 15 to May 15), instead of USFWS's 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 USFWS's 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 year index, rather than using the USFWS proposal to vary measures by water year type. EPA's measures (stated as averages for each water year type) are also shown in Table 4.

EPA revised the management measures recommended by USFWS because recent discussions with USFWS and others, as well as information developed in hydrological modeling for the South Delta Barriers Project (California DWR 1993), raised concerns that an Upper Old River barrier might increase reverse flows in the central Delta. Such an increase has the potential to draw fish into poor habitat and to increase entrainment of fish 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 Upper Old River barrier is an important implementation measure. However, in order to prevent an increase in detrimental central Delta reverse flows, EPA is revising the USFWS management measures to include only one month with the barrier in place, rather than the two months initially recommended by USFWS.40

through the Delta may have been better than the index indicates for those releases.

<sup>38</sup> The San Joaquin water year index (denoted the San Joaquin Valley Index in the final rule language) 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.

<sup>39</sup> As explained above, the index values shown in Table 6 (both USFWS and EPA values) have been "scaled" by dividing by 1.8. This scaling allows a direct comparison with the Proposed Rule index values, which were also scaled. EPA's final criteria index values have not been scaled, to facilitate measurement of attainment through actual experiments as discussed below.

<sup>&</sup>lt;sup>37</sup> EPA considered water temperature at release, smolt size at release, and water flow at Vernalis as potential independent variables affecting survival. Based on the studies done to date, it appears that neither water temperature at release nor smolt size show a significant correlation with the smolt survival indices representing smolt survival through the San Joaquin Delta (P. Fox, Data summary presented at CUWA workshop on June 29, 1994). Note that results from upstream site releases (at Snelling and on the lower Stanislaus and Tuolumne Rivers) were included in this correlation between flow and survival index values in order to supplement data from wetter years. This approach assumed that the mortality between the upstream release sites and the downstream 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

<sup>&</sup>lt;sup>40</sup> As in the Proposed Rule, EPA assumed that exports would be reduced to no more than 1500 cfs while the barrier is in place, to help alleviate hydrological problems caused by the barrier. Minimum flows during the time the barrier is in place are assumed to be 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, thereby further reducing potential problems caused by reverse flows. Management measures assumed in developing the criteria values also included export restrictions during the times in April and May when the barrier is not in place. These maximum export rates are: in critically dry years, 2000 cfs; dry years, 3000 cfs; below normal years, 4000 cfs; above normal years, 5000 cfs; and wet years, 6000 cfs.