release and recapture experiments measuring and comparing salmon smolt survival under a number of different physical conditions of varying migration pathways, water temperatures, flow rates, and rates of water exports from the Delta. On the Sacramento River, over the past 14 years, USFWS has performed a series of studies, releasing coded-wire tagged smolts at Sacramento and using recapture data to estimate an index of their survival to Chipps Island. Similarly, on the San Joaquin River, between 1982 and the present, the USFWS has conducted a series of experimental releases and captures of tagged salmon smolts in the San Joaquin River system, and has used the data collected in these experiments to develop a smolt survival index model for that basin (Brandes 1994).34 EPA believes that the smolt survival indices from these releases do in fact represent the pattern of smolt survival through the Delta, and this belief was generally confirmed by the scientific workshops sponsored by CUWA (Kimmerer 1994b). As noted above, USFWS and the EPA Proposed Rule both "scaled" the index values by dividing experimental release results by 1.8.

In the Proposed Rule, the index values contained in the criteria varied according to the standard five water year types. The proposed criteria index values were stated in tabular form as in Table 3, below. The index values were to be attained by implementing management measures affecting the variables included in the index equations. For the Sacramento River, the index equation stated a relationship between smolt survival and three variables: water temperature, water diversion out of the mainstem Sacramento River, and water export rates. For the San Joaquin, the variables were river flows rates, water diversion into the Upper Old River, and export rates.

The Preamble to the Proposed Rule discussed in detail how the actual criteria index values in Table 3 were determined. To protect the designated uses, the Proposed Rule included index values representing the modeled results

of the management measures proposed by USFWS based on the work of the Delta Team of the Five Agency Chinook Salmon Committee, with the exception of certain recommendations regarding the Georgiana Slough. The management measures consisted of export limits, minimum flows, channel gate closures, etc., during critical periods in the year. As explained in the preamble to the Proposed Rule (59 FR 825), EPA was concerned that the Delta Team recommendation to close the Georgiana Slough would have deleterious effects on the Delta smelt and other aquatic life in the central Delta, and possibly on adult salmon returning upstream. Thus, the management measures underlying the recommended criteria index values did not assume that the Slough would be closed. EPA concluded that these management measures, if implemented by the State, would lead to the protection of the designated Fish Migration use.

EPA then evaluated the effects of these management measures on the variables contained in the models, and calculated the criteria index values using the model's equations. The result was criteria index values that reflect effects on survival as a result of implementing the recommended management measures.

Although the criteria index values were set by reference to the protective management measures, the resulting criteria index values were also consistent with the recommendations of the Interagency Statement of Principles signed by EPA, NMFS, and USFWS which called for a level of protection for aquatic resources equivalent to the level existing in the late 1960's to early 1970's. To make this comparison, EPA compared its proposed criteria index values with the index values attained historically on the two river systems. The historical index values were developed by the USFWS. See USFWS, 1992c (WRINT-USFWS-8); also 59 FR 824. The proposed Sacramento River criteria index values represented overall protection for the Fish Migration use at approximately the 1956-1970 historical level, whereas the proposed San Joaquin River criteria index values represented slightly better protection than the 1956-1970 historical level. Both sets of criteria index values represented better protection than the 1956–1970 historical period in drier years, and less protection in wetter years. These proposed criteria index values were intended to reflect more consistent smolt survival and help avoid situations where extraordinary measures would be necessary to preserve runs, particularly in the San Joaquin River tributaries.

## TABLE 3.—PROPOSED SALMON SMOLT CRITERIA

Sacramento River		San Joaquin River	
Water year type	Cri- teria value	Water year type	Cri- teria value
Wet	.45	Wet	.46
Above Nor- mal.	.38	Above Nor- mal.	.30
Below Nor- mal.	.36	Below Nor- mal.	.26
Dry	.32	Dry	.23
Critical	.29	Critical	.20

Finally, the Proposed Rule also relied on the criteria index equations to determine whether the criteria were being attained. In effect, attainment would be assumed if the State adopted an implementation plan with a set of measures (export restrictions, flow requirements, etc.) that, when computed in the index equations, resulted in the criteria index value. This approach assumed that the criteria index equations included all of the important variables determining smolt survival and correctly stated the interrelationship of those variables, so that actual measurement of attainment would be unnecessary.

The final Fish Migration criteria reflect the following changes from the Proposed Rule: (i) the methodology for establishing the criteria index values has been revised, (ii) the criteria have been restated as sliding scales or continuous functions, and (iii) direct experimental measurements of salmon survival will be used to measure attainment of the criteria.

## (i) Revised Method of Selecting Criteria Index Values

As discussed in the materials referenced in EPA's Notice of Availability (59 FR 44095), EPA has revised its approach to stating and developing the criteria index values used in the final criteria. The primary change in the final rule is that EPA has revised the underlying management measures used to generate the criteria index values. On the Sacramento River, available information indicates that closing the Delta Cross Channel during the spring migration period is the most important factor in the protection of the Fish Migration designated use, primarily because closing the Channel prevents migrating fish from being pulled into the inner Delta where survival is significantly lower. Accordingly, the criteria index values were based on tagged-fish release results for migration periods when the Delta Cross Channel was closed. Similarly,

<sup>&</sup>lt;sup>34</sup> Since the Proposed Rule was published, and as described in the alternative formulation of the Fish Migration criteria made available in EPA's Notice of Availability (59 FR 44095), 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.