These recovery criteria are taken from earlier recovery documents and are not intended as targets to be achieved. They are for example purposes only and are not recommended by the fish agencies.

The following restoration criteria are taken from the USFWS *Recovery Plan for the Sacramento/San Joaquin Delta Native Fishes* 1996 and the AFRP *A Plan to Increase Natural Production of Anadromous Fish in the Central Valley of California* 2001.

Sacramento Splittail Restoration Criteria

The splittail was proposed for listing as a threatened species on January 6, 1994. The restoration criteria listed here would represent appropriate recovery criteria should the species be listed. Splittail will be considered restored when they meet two out of three possible restoration criteria, developed from three independent surveys. The three possible criteria are: (1) FMWT numbers must be 19 or greater for 7 of 15 years; (2) Suisun Marsh catch per trawl must be 3.8 or greater AND catch of young-of-year must exceed 3.1 per trawl for 3 of 15 years; and (3) Bay Study otter trawl numbers must be 18 or greater AND catch of young-of-year must exceed 14 for 3 out of 15 years. Within each survey, if target criteria are not met at least once in 5 consecutive years, the restoration period for the failed survey will be re-started. Criteria depend on data collected by three independent surveys, two conducted by DFG (FMWT and Bay Study otter trawl) and one conducted by UCD (Suisun Marsh otter trawl). These studies were chosen because they sample most of the splittail range and contain the earliest continuous data on splittail abundance. When any two out of three criteria are reached, splittail will be considered restored.

Justification for using numbers from three surveys: Restoration criteria were built around three surveys to increase flexibility in how criteria are met. Splittail catches tend to be low in the long-term data sets available on the estuary, so using two out of three surveys to meet the criteria provides added protection for splittail as well as flexibility for managers. The Bay Study and Suisun Marsh sample downstream portions of splittail range, so meeting abundance criteria in either one of these surveys will ensure wide distribution for splittail in the estuary. Numbers were chosen rather than the index because there is a high correlation between numbers and the index ($r^2 = 0.83$, a relatively high coefficient of determination, for the FMWT). Furthermore, using numbers reduces confusion due to the widely published indices for striped bass and delta smelt. Numbers are also consistent with the rest of the recovery plan for other species.

Justification for using 1967-1983 for the pre-decline period: Graphs from the surveys were used to establish pre- and post-decline periods for splittail. As is the case for other species, especially delta smelt, the decline in splittail numbers actually occurred over a multi-year period from 1981-1985. Further, because splittail live for *5-7* years, drops in abundance are dampened by the presence of several year classes.

Length of restoration period: Because all splittail mature by three years, 15 years were chosen as the restoration period. Fifteen years represent five generations of splittail. Restoration criteria specify that numbers can not fall below the restoration target for five consecutive years. This is to protect splittail 76 from reproductive failure and is based on

These recovery criteria are taken from earlier recovery documents and are not intended as targets to be achieved. They are for example purposes only and are not recommended by the fish agencies.

historic FMWT data. Splittail numbers were very low from 1969-1974 and contributed to subsequent low numbers. Because splittail live from 5-7 years, a strong year class within this period is essential to sustain the species.

Restoration criteria: Restoration criteria are grouped and numbered by survey. When any two out of three restoration criteria are reached, splittail will be considered restored.

(1) Fall midwater trawl. The FMWT data set was filtered down to stations sampled in at least 3/4 of the years (6 of 24 years could be missed) in at least one month. Based on this reduced data set, average abundance of splittail from 1967- 1992 was 19 based on the FMWT (Table 4.1). In years prior to 1984, splittail abundance exceeded this number in 7 out of 15 years. Since 1983 abundance has fallen below this value in 7 out of 9 years.

Splittail will be considered restored when the FMWT exceeds 19 for 7 out of 15 years. If splittail fail to meet this restoration criterion for five consecutive years, the restoration period will start over.

(2) Suisun Marsh criteria. Splittail catch per trawl (otter trawl)has declined steadily in Suisun Marsh since 1979 from a high of 20.3 in 1979, to fewer than 1 for each year since 1984 (Table 4.1, Figure 4.2). The average catch per trawl from 1979-1992 was 3.8. Splittail catches in Suisun Marsh were greater than this in all but one year of the pre-decline period (4 out of *5* years). Since 1984 catch per trawl has fallen below this value for all years except one. Suisun Marsh criteria are important to the restoration of splittail because shallow, unriprapped backwaters of the marsh are preferred habitat of splittail, indicated by high catches taken there (over 11,800 fish in 14 years). Splittail recruitment in the marsh has been poor since 1984. From 1980-1983, average abundance of splittail young was 3.1 per trawl (Figure 4.2). Splittail young abundance has fallen below that value in every year since 1984 except 1986 (Figure 4.2). Because splittail live for 5-7 years, a successful year class is necessary at least every five years to reduce the probability of extinction.

Splittail will be considered restored when Suisun Marsh catch per trawl exceeds 3.8 for *7* out of 15 years AND when splittail young abundance exceeds 3.1 per trawl for at least 3 out of 15 years. Splittail young abundance can be used to make up total abundance *(i.e.,* 3.1 young per trawl can be applied to meet the 3.8 target). If these target criteria (both young and overall) are not met for 5 consecutive years, the restoration period will begin again.

(3) Bay Study. The average number of splittail captured by Bay Study otter trawls from 1980-1992 is 18 (Table 4.1). In the pre-decline years, this *77* number was met half the time. After the decline, these numbers were met a third of **the** time. **In wet years,** which are highly correlated with strong splittail year classes, young-of-year make up more than half of the Bay Study's catches (Figure 4.3). Splittail young catch per unit effort must exceed 14 in at least 3 of **15** years.

These recovery criteria are taken from earlier recovery documents and are not intended as targets to be achieved. They are for example purposes only and are not recommended by the fish agencies.

Splittail will be considered restored when Bay Study otter trawl numbers exceed 18 for 7 out of 15 years AND when splittail young numbers exceed 14 for 3 out of 15 years. Young-of-year numbers can be applied to meet overall criterion. If these targets, including both young-of-year and overall criteria, are not met for five consecutive years, the restoration period will be re-started.

Delta Smelt Recovery Objective

The objective of this part of the Delta Native Fishes Recovery Plan is to remove delta smelt from the Federal list of threatened species through restoration of its abundance and distribution. Recovery of delta smelt should not be at the expense of other native fishes. The basic strategy for recovery is to manage the estuary in such a way that it is a better habitat for native fish in general and delta smelt in particular. Improved habitat will allow delta smelt to be widely distributed throughout the Delta and Suisun Bay, recognizing that areas of abundance change with season. Recovery of delta smelt will consist of two phases, restoration and delisting. Separate restoration and delisting periods were identified because it is possible that restoration criteria can be met fairly quickly in the absence of consecutive extreme outflow years *(i.e.,* extremely wet or dry years).

However, without the population being tested by extreme outflows there is no assurance of long-term survival for the species. Thus, restoration is defined as a return of the population to pre-decline levels, but delisting is not recommended until the population has been tested by extreme outflows. Delta smelt will be considered restored when its population dynamics and distribution pattern within the estuary are similar to those that existed in the 1967-1981 period. This period was chosen because it includes the earliest continuous data on delta smelt abundances and was a period in which populations stayed reasonably high in most years (see below for a more detailed justification). The species will be considered recovered and qualify for delisting when it goes through a five-year period that includes two sequential years of extreme outflows, one of which must be dry or critically dry. Delta smelt will be considered for delisting when the species meets recovery criteria under stressor conditions comparable to those that led to listing and mechanisms are in place that insures the species' continued existence.

Recovery Criteria

Restoration of delta smelt should be assessed when the species satisfies distributional and abundance criteria. Distributional criteria include: (1) catches of delta smelt in all zones 2 of consecutive years, (2) in at least two zones in 1 of the remaining 3 years, and, (3) in at least one zone for the remaining 2 years. Abundance criteria are: delta smelt numbers or total catch must equal or exceed 239 for 2 out of 5 years and not fall below 84 for more than two years in a row. Distributional and abundance criteria can be met in different years. If abundance and distributional criteria are met for a five-year period the species will be considered restored. Delta smelt will meet the remaining recovery criteria and be

These recovery criteria are taken from earlier recovery documents and are not intended as targets to be achieved. They are for example purposes only and are not recommended by the fish agencies.

considered for delisting when abundance and distributional criteria are met for a five-year period that includes two successive extreme outflow years, with one year dry or critical. Delisting is contingent on the placement of legal mechanisms and interagency agreements to manage the CVP, SWP, and other water users to meet these criteria. Both criteria depend on data collected by DFG during the FMWT, during September and October.

Distributional criteria: Distributional criteria were developed on the basis of number of stations in each zone where delta smelt were captured during the pre decline period (Tables 2.2, 2.3, Figures 2.7 and 2.8). Each zone has the following criteria: (1) in Zone A, delta smelt must be captured in 2 of11 sites; (2) in Zone B (includes B 1 and B2), delta smelt must be captured in 5 of9 sites; and (3) in Zone C, delta smelt must be captured in 6 of 15 sites. Criteria for all zones need to be met in all years. Criteria for recovery are as follows: (1) site criteria must be met in all zones 2 of 5 consecutive years, (2) in at least two zones in 1 of the remaining 3 years, and, (3) in at least one zone for the remaining 2 years. A failure in all zones in any year will result in the start of a new 5-year evaluation period for the distributional criteria. Failure to meet these criteria in consecutive years should be avoided because such conditions will place the species in danger of extinction. These distributional criteria will be met in concert with the abundance criteria.

Abundance criteria: Abundance of delta smelt constituting **recovery is based on** pre-decline delta smelt numbers from the FMWT (Table 2.3). Two numbers were identified that had to be met during the five-year recovery period: (1) a low number below which abundance can not fall for more than two years in a row and, (2) a high number to be reached or exceeded in two out of five years. A low number was chosen to protect delta smelt from the risk of extinction during prolonged droughts or extremes of outflow. The lowest two-year running average of abundance in the pre-decline years was used for the low number. A running average was used because of the great degree of variability in delta smelt abundance. The high number is the median of delta smelt abundance in pre-decline years, in other words, abundance of delta smelt half of the time in the pre-decline period. To meet recovery criteria, delta smelt abundance must meet or exceed 239 in two out of five years and the two-year running average must never fall below 84. If any of these conditions are not met, the five-year recovery period will start again.

Length of restoration and recovery period: Delta smelt generation time and frequency of occurrence of very dry and very wet years were used to determine appropriate length of the restoration period. Because delta smelt live only a year, a five-year recovery period would include five generations of delta smelt; five generations is comparable to the period used in recovery plans for other fishes. A five-year restoration period has a reasonable probability of including years with extreme outflow. The 40:30:301 Sacramento River Indices (SRI) from 1906-1992 was used for this analysis. The goal was to identify a period that had a high probability of including two extreme outflow years, preferably back-to-back. This method was chosen because when two extreme years occur together, delta smelt are at risk of extinction. Because extremes in outflow led to the

These recovery criteria are taken from earlier recovery documents and are not intended as targets to be achieved. They are for example purposes only and are not recommended by the fish agencies.

listing of the delta smelt, the period identified for recovery differs from restoration and includes a stressor period. Delta smelt will be considered for delisting when abundance and distributional criteria have been met over a five-year period that includes two sequential years of extreme outflows. However, delisting may not take place until there is reasonable assurance that long term solutions to delta problems are in place. One of the extreme years must be dry or critically dry (SRI ~ 6.0); the other can be wet SRI =11.2). Other indices can be used to identify dry, critically dry, and wet years, if appropriate. Dry conditions are included because delta smelt losses increase in dry and critical years due to high proportions of outflow diverted, which results in habitat loss and increased entrainment in water projects. Analysis of the historical hydrograph indicated that there is about a 24 percent chance that two extreme years (one being dry or critical) will occur in a five-year period. There is a 48 percent chance (based on the historical hydrograph) that the period of time required to delist delta smelt could be 10 years. According to existing records, the longest amount of time required to delist delta smelt is 38 years.

Longfin Smelt Restoration Criteria

Restoration of longfin smelt will be achieved when the species satisfies distributional and abundance criteria. Distributional criteria are: (1) longfin smelt must be captured in all zones 5 of 10 years, (2) in two zones for an additional year, and (3) at least one zone for 3 of the 4 remaining years, with no failure to meet site criteria in consecutive years. Abundance must be equal to or greater than predicted abundance for 5 of 10 years. Distributional and abundance criteria can be met in different years. If abundance and distributional criteria are met for a ten-year period, the species will be considered restored. Both criteria depend on data collected by DFG with the FMWT, during September and October. Justification for using FMWT numbers: The FMWT covers most of the range of longfin smelt distribution and provides one of the best measures of longfin smelt abundance (R. Baxter, personal communication). September and October numbers were chosen, because these are the months that were sampled most consistently in all years. Weather conditions are also more stable in September and October. The more frequent storms of November and December produce conditions that result in more variability in fish-capture numbers. There is a high correlation between September and October sampled fish numbers and total numbers (r = 0.95). Longfin smelt sampled fish numbers rather than the abundance index were used for restoration criteria. Sampled fish numbers represent actual fish captured during the FMWT; the index represents sampled fish captured multiplied by a factor representing the volume of the area sampled. Using numbers for longfin smelt simplifies the assumptions of the criteria and there is a close correspondence between numbers and the abundance index for longfin smelt (r2 = 0.94)(a statistical abbreviation for the coefficient of determination, the square of the correlation coefficient). Furthermore, use of numbers reduces confusion; the public is familiar with the overall abundance index, but restoration criteria are derived from of a subset of the data, so the restoration index will differ from the overall index.

These recovery criteria are taken from earlier recovery documents and are not intended as targets to be achieved. They are for example purposes only and are not recommended by the fish agencies.

Distributional criteria: Distributional criteria were developed on the basis of number of stations in each zone where longfin smelt were captured during the predecline period (Table 3.1, Figures 3.5 and 3.6). Zones A and Bi (North Central Delta and the Sacramento River) were excluded from the distributional criteria because presence of longfin smelt in these zones does not contribute to restoration. Longfin smelt only occur in Zones A and B 1 during dry and critical years when abundances are very low and when they are in these zones, are vulnerable to entrainment (Meng 1993). For each zone, criteria are as follows: (1) in Zone B2 longfin smelt must be captured in 2 of4 sites; and (2) in Zone C longfin smelt must be captured in 12 of 16 sites; and (3) in Zone D longfin smelt must be captured in 1 of 4 sites. The criteria for all zones do not need to met in all years. Criteria for restoration are as follows: (1) site criteria must be met in all zones S of 10 years, (2) in two zones for an additional year, with no failure to meet site criteria in consecutive years, and (3) in at least one of the zones for 3 of the 4 remaining years. These distributional criteria will be met in concert with the abundance criteria.
Abundance criteria: The abundance of longfin smelt that will constitute restoration is based on pre-decline longfin smelt numbers from the FMWT. Because there is a strong relationship between longfin smelt abundance and spring outflow (r2 = 0.66), abundance criteria were based on the February-May outflow longfin smelt abundance regression, using a subset of FMWT stations. The equation for the regression is: number of longfin smelt captured by the FMWT equals 1.64 times February-May outflow, in cubic feet per second (cfs), minus 10.6 (Y = I.64X - 10.6). Both number of longfin smelt and February-May outflow are base-ten logs. For example, using Figure 3.1 to predict the~catch (Y) in a particular year (1977), if the outflow is 35,000 cfs, then 1.64 (log 10 35 cfs)-l0.6 = log10 26 longfin smelt (or 26,000 longfin smelt). Unfortunately, in the past 10 years, February through May outflows have been much lower then 35,000 cubic feet per second, averaging about 10,000 cubic feet per second. Additionally, from 1987-1993, the actual numbers of longfin smelt taken by the FMWT has fallen below the abundance predicted by this relationship. From 1987-1992, longfin smelt abundance dropped by 50 percent each year (Meng 1993). Therefore, longfin smelt abundance must be equal to or greater than that predicted by the above equation for S of 10 years of the restoration period to satisfy restoration criteria.

Length of restoration: Longfin smelt generation time was used to determine appropriate length of the restoration period. Because longfin smelt live for two years, a ten-year restoration period would include five generations of longfin smelt; five generations is comparable to the period used in recovery plans for other fishes. Because longfin smelt decline occurred during a six-year period of very low outflows, the population should not be considered restored until it has been tested by consecutive dry or critical years. There is a 48 percent chance that the ten-year restoration period will include two consecutive years of extreme outflows (see Delta smelt section). Based on the historical hydrograph, the longest amount of time necessary to restore longfin smelt is 38 years.

These recovery criteria are taken from earlier recovery documents and are not intended as targets to be achieved. They are for example purposes only and are not recommended by the fish agencies.

Green Sturgeon Restoration Criteria

Green sturgeon will be considered restored in the Sacramento-San Joaquin estuary once the median population of mature individuals (over 1 meter [39 inches] total length) has reached 1,000 individuals (including 500 females over 1.3 meters [51 inches] total length) over a 50 year period or for five generations (10 years is the minimum age of sexual maturity). If population estimates are fewer than 1,000 fish for more than three years in a row, the restoration period will be restarted. This definition is subject to revision as more information becomes available. Restoration will be measured by determining population sizes from tagging programs or other suitable means. The present sturgeon tagging programs, which focus on white sturgeon, are inadequate for determining accurately the abundance of green sturgeon. Therefore, a median population goal of 1,000 fish over 1 meter (39 inches) total length (including 500 females over 1.3 meters [51 inches]) is achievable with numbers determined through a monitoring program that focuses specifically on green sturgeon. Thus, the first restoration criterion will be establishment of an adequate population determination through a monitoring program. Once that program is in place, the minimum population goal can be re-evaluated and a realistic, presumably higher, goal established. It may be desirable to have the numbers high enough to support the removal of a minimum of 50 fish over 1 meter (39 inches) total length per year by a fishery (assuming an exploitation rate of 5 percent is sustainable).

Spring Run Chinook Salmon Restoration Criteria

Sacramento spring Chinook will be regarded as restored when (1) self sustaining populations in excess of 500 spawners each are present in both Deer and Mill creeks; (2) the number of wild spawners in Sacramento River tributaries reaches a mean number of 8,000 fish and does not drop below 5,000 fish, for 15 years, three of which are dry or critical years and (3) when the smolt survival rates between Sacramento and Chipps Island approach pre-project levels when the• number of adults in the tributary streams is fewer than *5,000.* Restoration will be measured by three interacting criteria: (1) presence of self-sustaining spawning populations in Deer and Mill creeks; (2) total number of spawners in Deer, Mill, Antelope, Butte, Big Chico, Begum, South Fork Cottonwood, and Clear creeks and (3) smolt survival rates through the Delta. The number of spawners can be estimated by carcass and redd counts and counting from weirs at dams on Dear and Mill creeks, but smolt survival cannot yet be satisfactorily estimated. These restoration goals can be achieved only if there is simultaneously improvement in conditions in spawning and rearing streams, in the Delta for passage of juveniles and adults, and improved management of the fishery to allow for increased survivorship of adults during periods of low population size.

Deer and Mill creeks: These two streams are largely unregulated streams that support the largest remaining populations of unquestioned wild spring-run Chinook. Thus these two populations must be maintained as self-sustaining entities to provide a minimum level of protection for the wild fish. Based on historic (pre-1976) records, the number of salmon in each stream should not drop below 500 fish, with a three-year running average

These recovery criteria are taken from earlier recovery documents and are not intended as targets to be achieved. They are for example purposes only and are not recommended by the fish agencies.

of no fewer than 1,000 fish (Table 6.1). While a fairly substantial population of salmon exists in Butte Creek, long-term sustainability of the population in a regulated stream is questionable, as is its relationship to the hatchery-maintained "spring" run population in the Feather River.

Number of spawners: Spring Chinook will be regarded as recovered when the number of spawners in tributary streams to the Sacramento drainage exceeds 5,000 fish each year over a 15-year period (five generations X three-year life cycle), with 3 of the 15 years being dry or critical years. The average number of natural spawners of wild origin over the 15-year period must not be fewer than 8,000 fish. If the Yuba River proves to still have a natural run of spring Chinook, this population goal should be raised by whatever number of spawners it is estimated that the stream can support. The total population goal assumes an equal (or nearly equal) sex ratio and that 90 percent or more of the females are age 3 or older. It does not include fish found in the Feather River or mainstem Sacramento River or those taken by the Feather River hatchery for artificial spawning. This number is a tiny fraction of the 500,000 to I million spring Chinook that once spawned in the Central Valley but represents a reasonable number of spawners that can be supported in Sacramento River tributaries (F. Fisher, personal communication).

Smolt survival rate: The principal means for measuring suitability of habitat conditions for juvenile Chinook salmon in the Delta is to have smolt survival rates between Sacramento and Chipps Island be equivalent to what they were prior to the present configuration of the CVP and SWP *(i.e.,* 1940s level of development, Service 1992). The 1994 Bay-Delta Accord should provide beneficial actions that benefit salmon. Accurately measuring smolt survival rates is extremely difficult, so this cannot be used as a criterion for restoration until adequate methods of estimating survival are developed (something which should be done as part of the restoration process). Ideally, the survival rate should be based on mark-recapture studies of smolts of similar size released during the principal outmigration period. Because many Deer and Mill creek outmigrants enter the Delta as yearlings during November through January, this time period will be the most important to evaluate. However, hatcheries do not release spring-run during this time period, so late fall-run hatchery production may need to be used as a surrogate for the mark-recapture studies. Until reliable measures of survival rates are developed, the principal means for measuring restoration will be distribution and number of spawning adults. Once the criterion is developed, it should be used primarily in conjunction with adult criteria. When adult numbers drop below 5,000, smolt survival rates through the Delta the following year should be higher than would be permitted when adult numbers are higher. If possible, a sliding scale of minimum survival rates based on adult numbers should be developed.

Late Fall Run Chinook Salmon Restoration Criteria

Sacramento late-fall Chinook will be regarded as recovered when (1) the number of wild spawners in the Sacramento River reaches a mean number of 22,000 fish and does not drop below 15,000 fish, for 15 years, three of which are dry or critical years and (2) when

These recovery criteria are taken from earlier recovery documents and are not intended as targets to be achieved. They are for example purposes only and are not recommended by the fish agencies.

the juvenile survival rates approach pre-project levels following years when adult populations are fewer than 15,000 fish in the Sacramento River. The number of spawners can be estimated by carcass and redd counts or enumerated through dam counts, while smolt survival cannot yet be satisfactorily estimated. The Team recognizes that these restoration goals can be achieved only if there is simultaneously improvement in conditions in the spawning and rearing streams, in the Delta for passage of juveniles, and improved management of the fishery to allow for increased survivorship of adults.

Number of spawners: Late fall-run Chinook will be regarded as restored when the number of spawners in the Sacramento drainage exceeds 15,000 fish each year **over** a 15-year period (five generations times three- year life cycle), with 3 of the 15 years being dry or critical years. The average number of spawners over the 15- year period must not be fewer than 22,000 fish (the 1967-1976 average). The total population goal assumes an equal (or nearly equal) sex ratio and that 90 percent or more of the spawning females are age 3 or older. It does not include those fish taken by the Coleman National Fish Hatchery for artificial spawning. This number is a small proportion of the several hundred thousand late-fall Chinook that once spawned in the upper Sacramento River drainage but represents the number offish that probably existed in river at the time Red Bluff Diversion Dam was constructed (F. Fisher, personal communication).

Smolt survival rate: The principal means for measuring the suitability of habitat conditions for juvenile Chinook salmon in the Delta is to have smolt survival rates between Sacramento and Chipps Island be equivalent to what they were prior to the present configuration of the CVP and SWP *(i.e.,* 1 940s level of development, Service 1992). Accurately measuring juvenile survival rates is extremely difficult, so this cannot be used as a criterion for restoration until adequate methods of estimating survival are developed (something which should be done as part of the restoration process). Ideally, the survival rate should be based on mark-recapture studies of juveniles of similar size released during the principal out migration or Delta residence period. Until reliable measures of survival rates are developed, the principal means for measuring restoration will be distribution and number of spawning adults. Once the criterion is developed, it should be used primarily in conjunction with adult criteria. When adult numbers drop below 15,000, juvenile survival rates through the Delta the following year should be higher than would be permitted when adult numbers are higher. If possible, a sliding scale of minimum survival rates based on adult numbers should be developed.

Restoration Criteria

San Joaquin fall-run Chinook salmon will be regarded as restored when (I) the number of naturally spawning fish in the Stanislaus, Tuolumne, and Merced Rivers reaches a median number of 20,000 fish and the three-year running average does not drop below 3,000 fish, for 15 years, three of which are dry or critical years and (2) when the smolt survival rates approach pre-project levels when adult numbers decline to fewer than 3,000 naturally spawning fish. The number of spawners can be estimated by carcass and redd counts. A model has been developed for estimating smolt survival through the Delta.

These recovery criteria are taken from earlier recovery documents and are not intended as targets to be achieved. They are for example purposes only and are not recommended by the fish agencies.

The smolt survival index is a calculated variable (Service 1992), based on on-going tagging studies, that is presumed to have a strong positive relationship to actual smolt survival rates. The model relies on the relationship between (1) salmon smolt survival and flows in the San Joaquin River, (2) rates of diversion into Old River, and (3) export rates at the CVP and SWP pumps. The model to set smolt survival criteria (Service 1992) was considered, but rejected due to lack of sufficient precision to set specific criteria. A revised model incorporating more data is now available and should be considered (P. Brandis, Service, personal communication). These restoration goals can be achieved only if there is simultaneously (1) improvement in conditions in the spawning and rearing streams, (2) improvement in conditions in the lower San Joaquin River and in the Delta, and (3) improved management of the fishery to allow for increased survivorship of adults during periods of low population size. Salmon taken by hatcheries for artificial spawning will not be counted toward meeting criteria.

Number of spawners: The criterion for number of spawners is composed of two parts: (1) a median population size and (2) a minimum population size. A median population size of 20,000 spawning fall Chinook salmon should be maintained in the Stanislaus, Tuolumne, and Merced Rivers combined. This 20,000 figure is based on two independent estimates of the optimal number of spawners based on stock-recruit relationships (Reisenbichler 1986; EAEST 1992). This population size assumes an equal (or nearly equal) sex ratio and that 90 percent or more of the females are age 3 or older. It does not include fish taken by hatcheries for artificial spawning. A median was used due to the high degree of scatter in the data. The data contains many high and low numbers which are not addressed well through use of a mean. The minimum population size is based on an analysis of the three-year running average of San Joaquin fall Chinook for the period 1951-1972. This period was chosen because any contribution from pre-Friant Dam San, Joaquin River fish is excluded and it only includes years when pumping rates at the SWP were absent or low and presumably had minimal influence on the populations. The minimum three-year running average during this period was 1,143 fish, but this included the 1961-1963 period, which includes the two lowest counts in the period of record. Excluding these two years and treating the remaining years as a continuous data set gave a minimum running average of 4,560 fish. An intermediate value of 3,000 fish was selected as appropriate because it allows for significant variability in population size while protecting against extremely low population levels that have been associated with droughts under past and present conditions. Within the period 1951 to 1993, the population has only failed to meet a minimum three-year running average of 3,000 spawners during the periods 1963-1964, 1978-1980, and 1991-1993. All of these periods are associated with drought conditions in the drainage. The 3,000 number is achievable because of greater assurance of instream flows through regulatory processes. Both the median and minimum population levels must be met for a period of 15 consecutive years for restoration. This period represents five generations of a three-year life cycle. The choice of five generations is consistent with the other species included in this and other recovery plans. Three of the 15 years must be dry or critical years to insure that the population can withstand stressful conditions. Failure to meet the minimum population

These recovery criteria are taken from earlier recovery documents and are not intended as targets to be achieved. They are for example purposes only and are not recommended by the fish agencies.

level in any year will result in the start of a new 15-year evaluation period. The median level can be met in any period of 15 consecutive years.

Smolt survival index: The principal means for measuring the suitability of habitat conditions for juvenile San Joaquin fall Chinook in the Delta is to have smolt survival rates be equivalent to what they were prior to the closure of Friant Dam and the present configuration of the CVP and SWP *(i.e.,* I940s level of development). Accurately measuring smolt survival rates is extremely difficult, so it is not recommended as absolute criterion for restoration until the present model (Service 1994) is refined or more accurate models are developed (activities which are underway). Until reliable measures of smolt survival are available, the criteria for number of spawners will have precedence. When reliable survival criteria are developed, they should be used primarily in conjunction with the adult criteria. A drop in adult numbers to below 3,000 fish in any year should require higher smolt survival rates (near 1940s level) than permitted when adult numbers are higher. Such action should help avoid failure to meet the minimum three-year running average criterion of 3,000 naturally spawning fish. A schedule of minimum survival rates based on adult numbers should be developed if possible.

These recovery criteria are taken from earlier recovery documents and are not intended as targets to be achieved. They are for example purposes only and are not recommended by the fish agencies.

Race and river	Production targets
All races combined[a]	990,000
Fall run	750,000
Late-fall run	68,000
Winter run	110,000
Spring run	68,000
Sacramento River	
Fall run	230,000
Late-fall run	44,000
Winter run	110,000
Spring run	59,000
Clear Creek	7,100
Cow Creek	4,600
Cottonwood Creek	5,900
Battle Creek	
Fall run	10,000
Late-fall run	550
Paynes Creek	330
Antelope Creek	720
Mill Creek	
Fall run	4,200
Spring run	4,400
Deer Creek	
Fall run	1,500
Spring run	6,500
Miscellaneous creeks	1,100
Butte Creek	
Fall run	1,500
Spring run	2,000
Big Chico Creek	800
Feather River	170,000
Yuba River	66,000
Bear River	450
American River	160,000
Mokelumne River	9,300
Cosumnes River	3,300
Calaveras River Winter run	2,200*
Stanislaus River	22,000
Tuolumne River	38,000
Merced River	18,000

Figure 1 Salmon Production Goals By Stream. Taken from: A Plan to Increase Natural Production of Anadromous Fish in the Central Valley of California Final on January 9, 2001