# Reintroduction Strategies

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# 1.0 Introduction

## *1.1 Reintroduction Strategies Development Process*

### 1.1.1 Purpose and Goal

This document is part of a multi-step process to reintroduce spring-run Chinook salmon to the San Joaquin River. The effort is part of the San Joaquin River Restoration Program (SJRRP) whose charge is to execute a legal settlement from the lawsuit, *NRDC et al. v. Kirk Rodgers et al*.; whereby in 1988, a coalition of environmental groups, led by the Natural Resources Defense Council (NRDC), filed a lawsuit challenging the renewal of long-term water service contracts between the United States and California's Central Valley Project Friant Division contractors. After more than 18 years of litigation, the Settling Parties reached a Stipulation of Settlement Agreement (Settlement). The Settling Parties, including NRDC, Friant Water Users Authority, and the U.S. Departments of the Interior and Commerce, agreed on the terms and conditions of the Settlement, which was subsequently approved on October 23, 2006. The Settlement establishes two primary goals:

Restoration Goal – To restore and maintain fish populations in "good condition" in the mainstem San Joaquin River below Friant Dam to the confluence with the Merced River, including naturally reproducing and self-sustaining populations of salmon and other fish.

Water Management Goal – To reduce or avoid adverse water supply impacts to all of the Friant Division long-term contractors that may result from the Interim Flows and Restoration Flows provided for in the Settlement.

Related to the Settlement, President Obama signed the San Joaquin River Restoration Act on March 30, 2009, giving the Department of Interior full authority to implement the SJRRP. The implementing agencies, consisting of the U.S. Department of Interior, Bureau of Reclamation (Reclamation) and U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), California Department of Fish and Game (DFG), and California Department of Water Resources (DWR) organized a Program Management Team (PMT) and associated Technical Work Groups to begin work implementing the Settlement. As a result, the PMT published a draft Fisheries Management Plan (FMP, 2009) to describe the Program's approach to Restoration.

The reintroduction of Chinook salmon to the San Joaquin River under the settlement requires the USFWS to submit an application to NMFS for an ESA Section 10(a)(1)(A) permit for scientific research or to enhance the propagation and survival of the species. NMFS responsibility is then to create an experimental population designation under a ESA 10j decision making process. To develop the information that would inform this permit process the Genetics Subgroup (a subgroup of the Fisheries Management Work Group (FMWG)) prepared a Stock Selection Strategy Document to identify and describe potential donor stocks for reintroduction. The group, through a DFG contract with

University of California, Davis, developed a Hatchery and Genetics Management Plan to describe the manner in which donor stock would be propogated. This document, the Reintroduction Strategy, is another document developed to support this permit application.  The Genetics Subgroup focuses on genetic issues related to protecting the genetic integrity of the reintroduced stock, stock selection strategies, reintroduction strategies, development of the Hatchery and Genetics Management Plan, and other hatchery related issues. This subgroup is composed of State and Federal fisheries scientists and academic researchers. This document is guided by an adaptive management approach as described in the FMP. The development of the Reintroduction Strategy will guide the methods of reintroduction of stocks described in the Stock Selection Strategy. The Stock Selection Strategy identified the need to rely primarily on the three most abundant stocks of spring-run Chinook salmon in the Central Valley; Feather River, Butte Creek, and the Deer and Mill creek Complex, and secondarily to obtain stray spring-run opportunistically from the San Joaquin River tributaries, as the best approach to achieve the Restoration Goal and to achieve the population goals and objectives described in the FMP. This document provides a description of a suite of appropriate methods for collection from each donor stock, and a suite of reintroduction methods utilizing various life stages of the donor stocks, various reintroduction techniques, and various levels of conservation hatchery techniques.

While extensive analysis and expertise is used to guide the development of these reintroduction efforts it is recognized that these methods are potentially fallible due to the numerous variables associated with the massive scale of this project. A key aspect to this decision making process is the use of adaptive management as described by Williams *et al*. (2009), which recognizes and embraces this uncertainty.

> *"Making a sequence of good management decisions is more difficult in the presence of uncertainty, an inherent and pervasive feature of managing ecological systems (16, 17). Uncertainties arise with incomplete control of management actions, sampling errors, environmental variability, and an incomplete understanding of system dynamics, each affecting the decision making process.  An adaptive approach provides a framework for making good decisions in the face of critical uncertainties, and a formal process for reducing uncertainties so that management performance can be improved over time."*

For more information about the adaptive management process used here, refer to Chapter 1 of the SJRRP's 2010 Daft Fisheries Management Plan.

The Public Draft Recovery Plan for the Evolutionarily Significant Units (ESU) of Sacramento River winter-run Chinook salmon and Central Valley spring-run Chinook salmon and the Distinct Population Segment of Central Valley Steelhead (NMFS 2009) describes both long-term and short-term strategies to achieve recovery of the above mentioned populations.  As part of the recovery strategy the Plan incorporates viability at ESU and population levels of existing stocks, prioritizes currently occupied watersheds, and prioritizes currently unoccupied watersheds for reintroductions. The San Joaquin

River from Friant Dam to the Merced River confluence (the Restoration Area) is prioritized as a primary focus for recovery for spring-run Chinook salmon in the Southern Sierra Nevada Diversity Group (NMFS 2009). While reintroduction of spring-run Chinook salmon into the Restoration Area will meet the Settlement as stated above, an additional, unstated, goal of the program is to ultimately contribute to the recovery of spring-run Chinook salmon viability in the Central Valley by addressing this recovery priority.
Existing literature provides much background into rearing programs specific to spring-run Chinook salmon (Gallinat et al., 2009; Venditti, 2003), conservation hatchery practices (Flagg and Nash 1999), and reintroduction and translocation methods for Pacific salmonids (Murdoch and Tonseth 2006, Conrad et al. 2004, Wunderlich and Parlaleo 1995). Lessons learned from these programs, strategies, and culture methods used have been incorporated into the reintroduction planning effort for the SJRRP.

### 1.1.2 General Locations of Action

There are four specific actions associated with the Reintroduction Strategy: donor stock collection, rearing/culture of these stocks, reintroduction/release of these stocks, and post introduction monitoring of donor stock populations and reintroduced populations.

Figure 1.1 shows the general location of each of these efforts. Collections will be primarily focused on the three identified donor stock watersheds, with secondary emphasis on SRO adults from various watersheds identified further in this document, and Delta salvage operations, both combined with genetic evaluations. Fish releases to the San Joaquin River will be made primarily in the uppermost reach, Reach 1A, of the Restoration Area, with the possibility of releases further downstream to avoid potential predator and/or passage constraints that may be identified in the system early in the reintroduction effort before Settlement mandated channel modifications are completed.

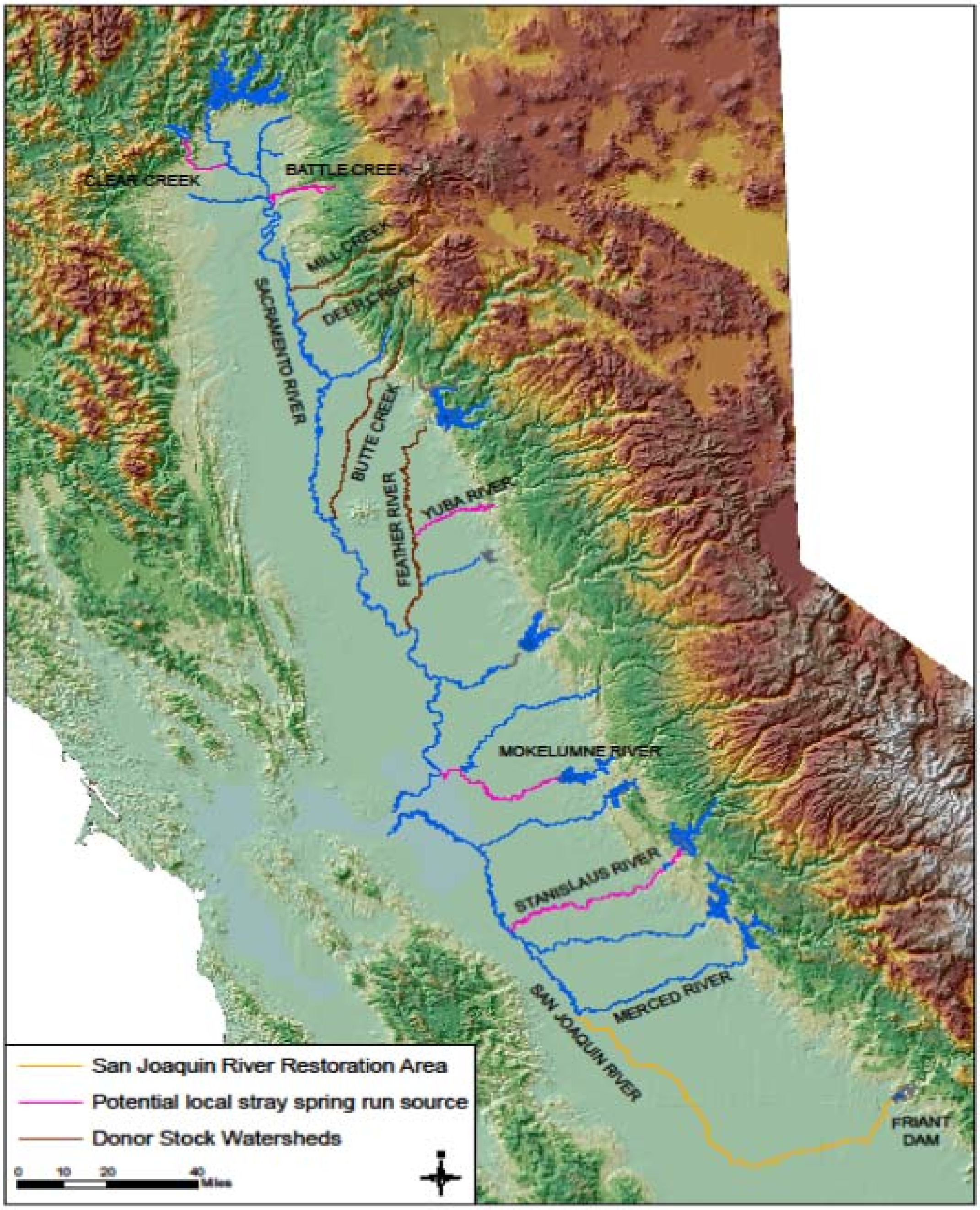
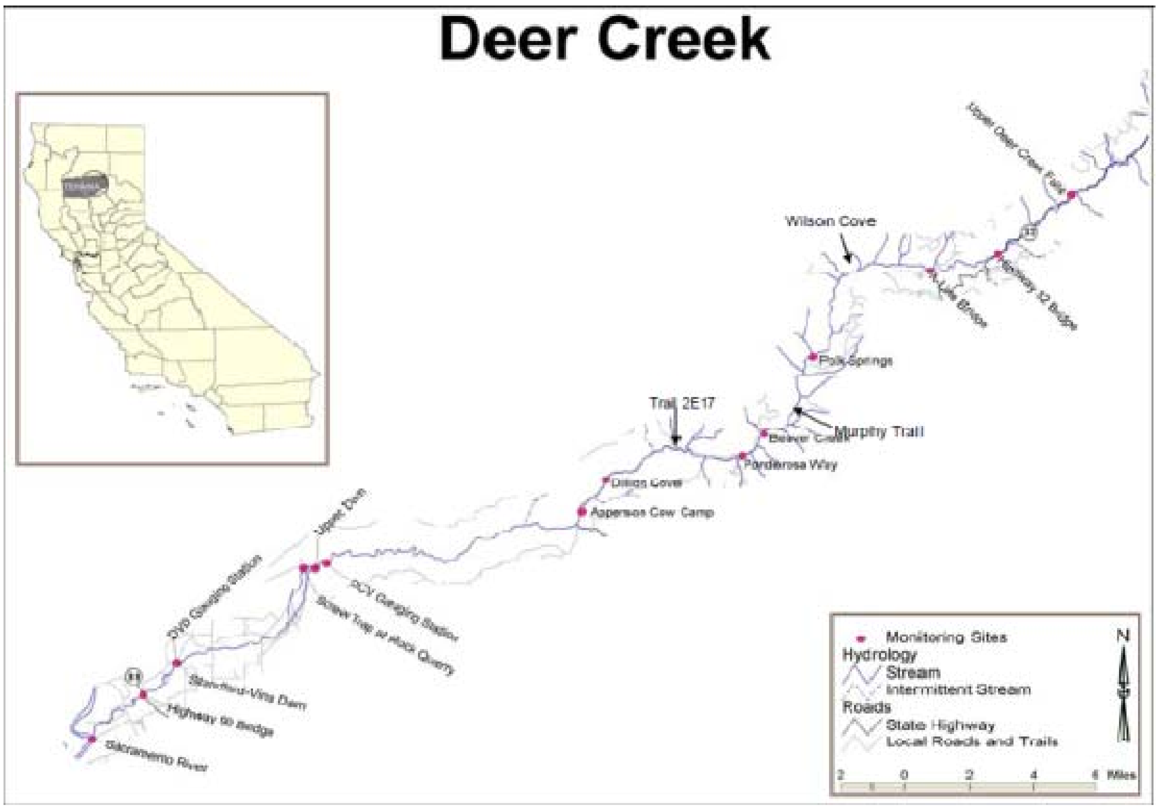



**Figure 1.1 General Locations For Donor Stock Collections and Reintroductions for the San Joaquin River Salmon Conservation and Research Program (SJRSCRP)**

The three identified donor stocks for spring run Chinook salmon collections are 1) the populations in the Deer/Mill creek complex, 2) Butte Creek population and 3) the Feather River population. General collection locations within the donor watersheds will be coordinated with current ongoing surveying, monitoring, and other management activities related to spring-run Chinook salmon populations in these watersheds.

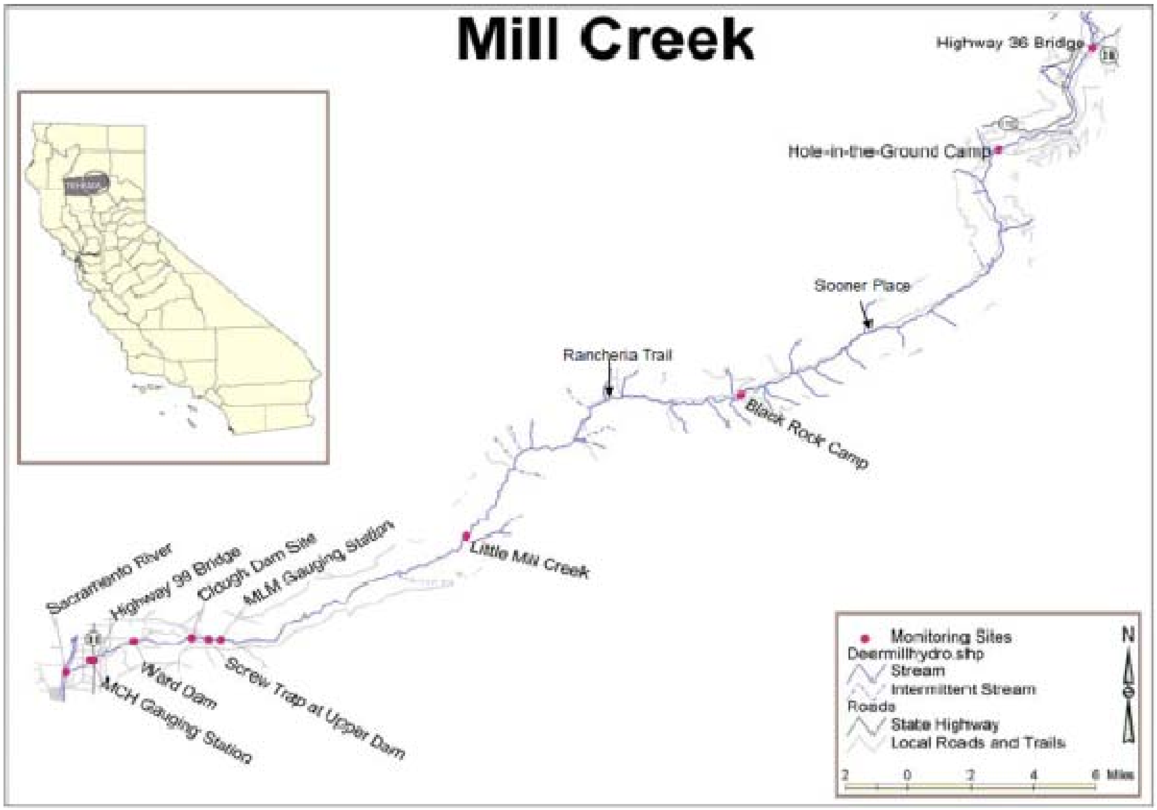
Figures 1.2, 1.3, and 1.4 below identify the general geographic area on Deer Creek, Mill Creek, and Butte Creek identified as spring run Chinook salmon habitat and in which monitoring for spring run Chinook salmon populations occur. The Feather River population will be accessed through the Feather River Fish Hatchery site (RM 66) due to spatial and temporal overlap of spring- and fall-run Chinook salmon populations on this River.

**Figure 1.2 Map depicting general location of Deer Creek spring run Chinook salmon habitat**



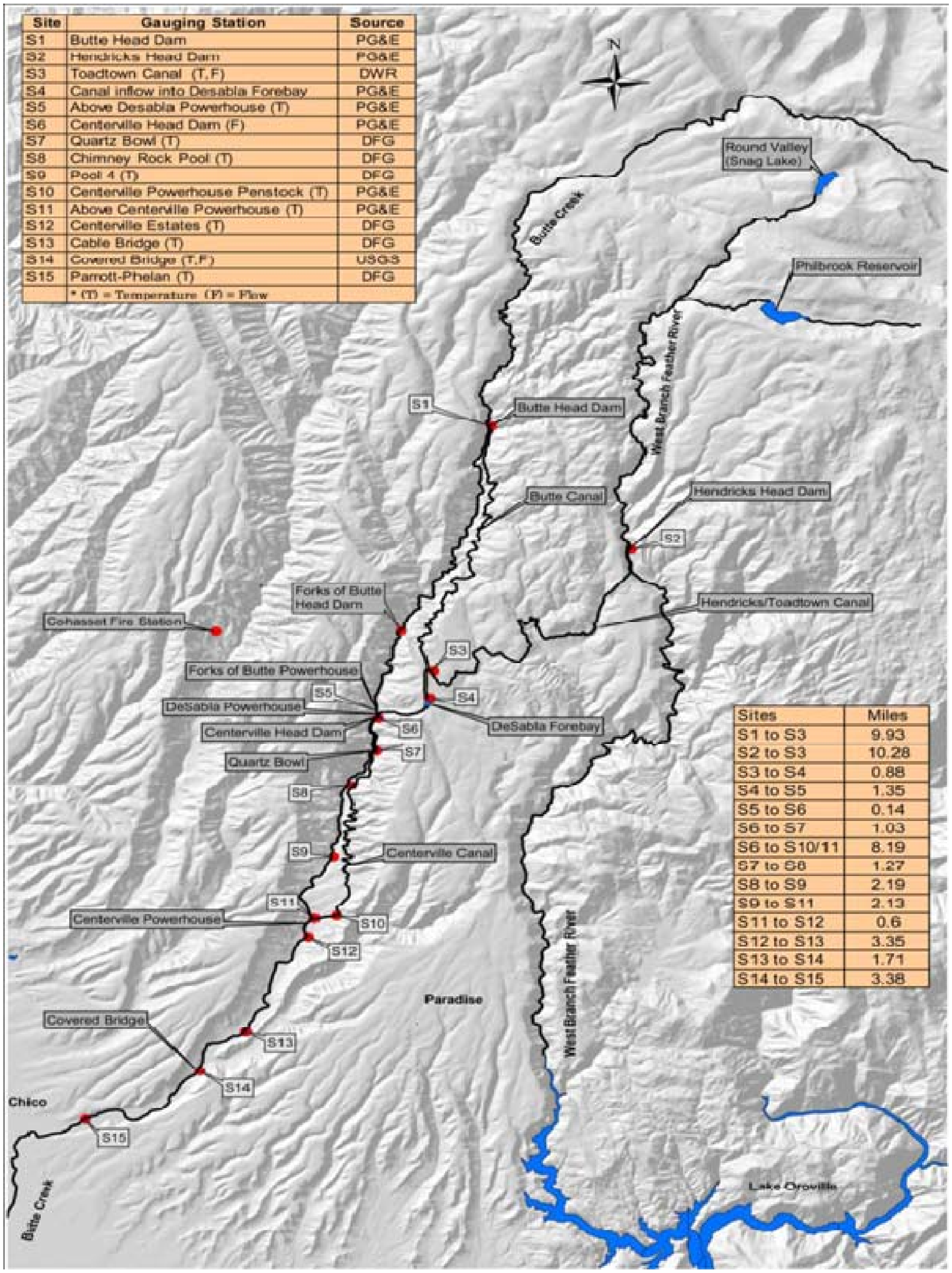

*Source: Harvey-Arrison 2008*

**Figure 1.3 Map depicting general location of Mill Creek spring run Chinook salmon habitat**




*Source: Harvey-Arrison 2008*

**Figure 1.4 Map depicting general location of Butte Creek spring run Chinook salmon habitat**



Additional collection locations outside of recognized streams with spring-run Chinook salmon would also be used for source stock collection activities.  These would include DFG/USFWS trawling stations in the Sacramento-San Joaquin Delta that have been established as part of the Interagency Ecological Program (IEP); salvage operations at the Tracy Fish Collection Facility (CVP) and the John Skinner Fish Protection Facility (SWP) located in the south delta; SRO populations located throughout the Central Valley including Clear and Battle Creeks, and the Yuba, Mokelumne and Stanislaus Rivers. As SRO populations are identified in other watersheds, these populations would be targeted as well.  Currently collection could occur at collection weirs and/or hatchery facilities that currently exist on these rivers, or alternatively collection facilities would need to be developed.

# 2.0 Describe Multi-stock and Multi-strategies approach

There is a high level of uncertainty attached to the likelihood of success of the three primary spring-run Chinook salmon source stocks in a San Joaquin River reintroduction project. This uncertainty encompasses genetic differences in source stocks, environmental conditions in the Restoration Area, and the ability of source stocks to adapt to these conditions over time. There is a large amount of genetic data available to evaluate the genetic aspects and the genetic status of the different stocks. However there is remaining uncertainty in predicting fitness, adaptability, and success of each individual stock.

The multi-stock approach includes incorporation of all available known Central Valley (CV) spring-run Chinook salmon stocks in the reintroduction effort, as well as SRO Chinook salmon populations and fish captured in the Sacramento-San Joaquin Delta either through IEP trawling activities or salvage from the Delta pumping facilities. The latter groups would include genetic verification as spring-run Chinook salmon before use as a donor source.  The benefits associated with this multi-stock approach include an increase in overall genetic diversity and reduction in inbreeding risk, flexibility, and availability of diverse reintroduction methods. The risks include outbreeding depression, fall-run Chinook salmon phenotype expression, and challenges in monitoring the independent success of each source population's establishment in the Restoration Area due to the high likelihood of introgression. On strategy is the use of a captive propagation program, the San Joaquin River Salmon Conservation and Research Facility (Conservation Facility). The level of threat from these risks will be closely monitored in the Conservation Facility, and breeding matrices will be utilized to minimize these risk factors.  Additionally, marks, tags and genetic analyses will be used to monitor the independent success of each source population's establishment in the RA and appropriate adjustments in breeding matrices will follow these assessments.

Each of the three CV spring-run Chinook salmon lineages has biological characteristics that might be favorable for a successful reintroduction project and each also has unfavorable characteristics. Spring-run Chinook salmon vary in a number of important traits like distinctive use of diverse aquatic habitats, timing of spawning migration and breeding, and natal fidelity. Conditions on the San Joaquin River will likely provide strong, novel selection pressure that may result in the potential for evolution of traits to occur. If it is determined that the risks to the source stock(s) is too high, it is likely the SJRRP will limit the source stock to the utilization of two stocks. In the worst case scenario, the SJRRP will use only one stock, since spring-run Chinook salmon must be reintroduced by December 31, 2012.

Strategies used for reintroduction will include reintroduction of cultured fish originally collected from available donor stocks, reintroduction of offspring of cultured fish originally captured from available donor stocks and reared to broodstock age, and reintroduction of donor stocks of various life stages directly into the San Joaquin River Restoration Area (i.e., translocation). Because of the necessity to utilize the multi-strategy approach to facilitate adaptive management and increase potential for success, there will be a number of monitoring tools used to evaluate the reintroduction strategies employed by the Program. These include genetic evaluations of donor stocks and resulting broodstocks as well as monitoring of in-river biotic and abiotic parameters including temperature, dissolved oxygen, water quality constituents, discharge, habitat availability, prey availability, predator abundance and their relation to diet, growth, survival (egg to fry, fry to smolt), and survival to adult of various releases.

Adaptive Management will guide the simultaneous multiple stock and multiple strategy reintroduction process. Genetic evaluation and other methods will be used to evaluate the relative fitness and success of fish from the different stocks at various life stages following the reintroduction. These evaluations will inform progress in the reintroduction effort.

Short-term and long-term population goals and objectives for spring- run Chinook salmon in the San Joaquin River have been developed in the FMP (FMWG 2009), and through the Technical Advisory Committee Recommendations (Meade 2007, 2008). The goals set forth in the FMP (paraphrased as they relate to spring-run Chinook salmon reintroductions only): establishing natural populations that are adapted to conditions in the San Joaquin River; establish genetically diverse populations; establish demographically diverse populations, so that any one year represents more than two age classes; and minimize hybridization/interbreeding with non-target hatchery stocks.

Some specific targets developed in the FMP include a minimum target of 2,500 naturally produced adults in the three years following reintroduction, an annual minimum effective population size of 500 naturally spawning adults, with a 50% sex ratio, and a long-term growth target of 30,000 naturally produced adults. (FMWG 2009)

## *2.1 Collection Targets*

The total number of fish or eggs collected from each population, over the course of the reintroduction, will depend on the adult escapement from those stocks. While the escapement will likely limit the number collected, collection targets here are based on the number of fish necessary to capture the genetic diversity of the source stocks, not based on source population parameters. Because all three populations represent distinct populations, all three must be considered independently when setting collection goals. Additionally, collections from SRO Chinook salmon populations need to be considered independently as well in determining population targets for the San Joaquin River experimental population.

The total number collected from each population will determine the effective population size of the founding population ($N_e$), which in turn determines the amount of genetic diversity from the source population that is represented in the new population. Further discussion on the genetic basis for collection numbers can be found in the San Joaquin River Conservation and Research Program Hatchery and Genetic Management Plan (HGMP, Appendix 9.3) (Bork and Adelizi 2010).

The number of fish needed for the reintroduction effort are also developed using the adult population targets from the FMP (FMWG 2009) and the Restoration Administrator's (RA) Recommendations (Meade 2007, 2008). There are several issues to consider when determining the number of fish needed to achieve the Restoration Goals (estimated survival by lifestage, rate of return and/or straying, inbreeding and outbreeding risk, to name a few), and balancing those needs with potential risk to donor stocks, and maintaining the appropriate level of genetic diversity and fitness in the restored population to ensure long term sustainability of the population. A captive rearing program has the ability to amplify the donor stocks contributions to the reintroduced population (i.e. higher juvenile survival rates). This rearing program is a critical component of a successful reintroduction strategy. However, cultured fish have been shown to exhibit reduced fitness from their wild counterparts (Araki et al 2008), so inclusion of direct reintroductions (commonly referred to as translocations) to the river to achieve the Restoration Goals is an integral part of the plan to achieve long term sustainability.

There is natural variability in survival of various life stages of Chinook salmon in the wild, conventional hatcheries, and conservation hatchery facilities. . The survival rates of eggs to the fry stage for fall-run in the lower Tuolumne River have been estimated at 40 percent (EA 1992) when water temperatures were suitable for adult migration (<18ºC) and egg incubation (<13ºC). This estimate includes mortality from non-viable gametes as well as mortality of fertilized eggs. In contrast, survival of eyed eggs would be expected to be higher, approaching 70 percent, particularly when planted in egg incubation boxes with clean gravel (Carl Mesick Consultants and KDH Environmental Services 2009). The estimated mean percentage of fry that survive to the parr-smolt stage (≥56 mm FL) and migrate is about 5 percent, as suggested from rotary screw trap (RST) data on the Stanislaus River during dry and normal year spring flow releases (not flood control releases) (C. Mesick, Pers. Comm. USFWS. 9/15/2010). However, the estimate of 5 percent does not factor in the mortality of fry that may occur before the upstream RST, thus a range of 3-5 percent for the survival rate of fry to parr-smolt stage may be more suitable (C. Mesick Pers. Comm. USFWS. 9/15/2010). Of these parr-smolt stage fish (≥56 mm FL) that migrated from the Stanislaus River and returned to spawn, it has been estimated that survival rates were approximately 3.6 percent (C.

Mesick, Pers. Comm. USFWS. 9/15/2010). However, the true estimate could be as low as 2.5 percent because of uncertainty in the estimated number of natural spawners (versus strays) in the Stanislaus River, thus a range of 2.5-3.6 percent would be appropriate (C. Mesick, Pers. Comm. USFWS. 9/15/2010). Although falling slightly beyond this range, Petrosky et al. (2001) calculated 1-5 percent for the transition from smolt to adult on the Snake River. Smolt to adult returns to the Merced River hatchery, tributary to the San Joaquin, for brood year 1998 smolt releases were 1.25% (CDFG/NMFS Hatchery Review report 2001, CDFG GrandTab 2009).

The number of fish needed for successful reintroduction is also based on the ability to use all three primary donor stocks simultaneously. In years where it is not feasible to collect from all stocks, donor fish will be collected only from those populations where collection is considered sustainable, but total numbers would need to compensate for the loss of potential donor stocks.

### 2.1.1 Optimal Number of Fish

The optimal number of fish to collect is directly related to the life stage at collection, survival rates to adult, and additionally related to the need to maximize the genetic diversity of the population to reduce the risk of founder's effect, inbreeding, and the high risk of extinction from catastrophic events often encountered with small population sizes. The following tables represent the optimal numbers for donor stock collection for the Conservation Facility and direct Translocation efforts.

Table 2.1 shows the anticipated numbers needed to conduct the captive rearing program to ensure and maximize genetic diversity and long-term sustainability of the reintroduced population, and to meet the population targets as determined by the Program.

| | **Source** | **Age** | **Minimum Harvest** | **Anticipated Spawning Females** |
|---|---|---|---|---|
| **Year 1-3** | Butte Creek | Eggs or Juvenile | 100-200 | 16-34 |
| | Feather River Hatchery | Eggs or Juvenile | 100-200 | 16-34 |
| | Deer Creek | Eggs or Juvenile | 50-100 | 9-16 |
| | Mill Creek | Eggs or Juvenile | 50-100 | 9-16 |
| | **Total Target** | Eggs or Juvenile | 300-600 | 50-100 |
| | **Source** | **Age** | **Minimum Harvest** | **Anticipated Spawning Females** |
| **Year 4 - 8** | Butte Creek | Eggs or Juvenile | 300-900 | 50-150 |
| | Feather River Hatchery | Eggs or Juvenile | 300-900 | 50-150 |
| | Deer Creek | Eggs or Juvenile | 150-450 | 25-75 |
| | Mill Creek | Eggs or Juvenile | 150-450 | 25-75 |
| | **Total Target** | Eggs or Juvenile | 900-2700 | 150-450 |

**Table 2.1 Target broodstock collection levels for the Conservation Facility Program**

Direct river to river introductions, translocations, are also being considered to help achieve Program Goals. Meeting the population targets described in the FMP through translocations alone would not be viable based on the status of existing stocks. However, translocating enough individuals to initiate a non-hatchery influenced portion of the population is worth investigating. Density dependent mechanisms contribute to predator avoidance, feeding behavior, migration patterns, and survival in juvenile salmonids, so care needs to be taken to translocate enough individuals to minimize alteration of natural behaviors and to achieve a detectable level of adult returns from the effort. Based on the survival rates cited above, the number of eggs required to produce approximately 50 returning pairs (assuming a 50% sex ratio) would be approximately 400,000 eggs in total. The number of juveniles to produce the same number of adults would be approximately 10,000 (Table 2.2). While these numbers may not be sustainable in the donor populations, they are minimums to achieve a detectable return rate and support juvenile schooling behavior, and taking less than that for river to river reintroductions may not add value to the reintroduction effort. In years where these numbers are not sustainable in any combination, the benefits of translocation efforts may not be worth the risk to the donor populations. Lower numbers of translocations may be warranted for targeted study purposes as determined valuable to the Program by interagency agreement.

| | **Source** | **Age** | **Optimal Harvest** | **Anticipated Spawning Females** |
|---|---|---|---|---|
| **Year 1-8** | Butte Creek | Eyed Eggs or Parr-Smolts | 62,000 eggs or 1,300 parr-smolts | 16 |
| | Feather River Hatchery | Eyed Eggs or Parr-Smolts | 62,000 eggs or 1,300 parr-smolts | 16 |
| | Deer Creek | Eyed Eggs or Parr-Smolts | 35,000 eggs or 750 parr-smolts | 9 |
| | Mill Creek | Eyed Eggs or Parr-Smolts | 35,000 eggs or 750 parr-smolts | 9 |
| | **Total Target** | Eyed Eggs or Parr-Smolts | 194,000 eggs or 4,100 parr-smolts | 50 |

**Table 2.2 Target broodstock collection levels for direct river introductions**

In specified, rare cases when donor stream populations are high and there is a Program need, adult spring-run Chinook salmon may be removed from selected donor populations for remote site egg-taking, or for direct adult transfers to the San Joaquin River. Up to 100 adults may be taken in these rare cases, and decisions on this take method would come from interagency agreement on an annual basis.

| | Source | Age | Females | Males |
|---|---|---|---|---|
| **Year 1-8** | Butte Creek | Adult | 26 | 26 |
| | Deer Creek | Adult | 12 | 12 |
| | Mill Creek | Adult | 12 | 12 |
| | **Total Target** | Adult | 50 | 50 |

**Table 2.3 Number of adults that may be removed from selected donor populations for remote-site egg-taking or direct adult transfer.**

## *2.2 Reintroduction Timelines*

The timeline in Figure 2.1 is based upon the proposed Conservation Facility timeline. As indicated above, approval would not support full-scale reintroduction levels by the Settlement deadline of 2012. However, there is an advantage of this timeline to the Program in that it would permit more time to complete channel modifications and implement full Restoration Flows before introducing restoration stocks. If channel improvements are not complete by the time reintroduced fish needed to migrate either in or out of the Restoration Area, it will require trucking and releasing fish around barriers until channel modifications are complete. The Stipulation of Settlement states that adults will be monitored for seven years following reintroduction and determine if they fall below 500 fish in any year. This would presumably conclude in 2019 which is also the earliest anticipated date for returns of restoration stocks reared at the according to the proposed Conservation Facility effort timeline. Due to the timeline presented below, and the dates when a significant level of reintroduction may occur, this monitoring timeline will likely need to be extended. The proposed timeline has been developed using the best available information and professional judgment of both State and Federal experts for West Coast conservation hatchery practices.

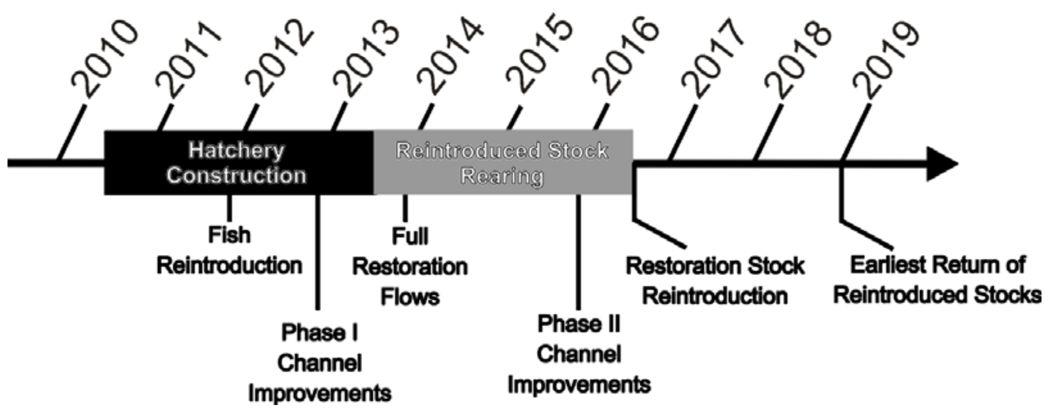



**Figure 2.1 Proposed Conservation Facility Timeline**

## *2.3 In-river Introduction*

The RA recommendations regarding reintroduction of salmon to the San Joaquin River include, in part, the concepts of using a mixture of reintroduction strategies including strategies at least partly based on maximizing learning potential and informing adaptive management decisions. Direct in-river introductions meet the intent of these recommendations.

Additionally, the RA recommendations state:

> "A number of alternative strategies exist for reintroduction that could range from complete reliance on in-river natural reproduction to complete human intervention through hatchery propagation (e.g., spawning and rearing wild stocks in a hatchery with planting in the river). The TAC recommends that in the early stages of the reintroduction, a blended strategy be used that relies on a wide variety of techniques offering a diversified approach to reintroduction while avoiding the use of hatchery rearing, if at all possible. The goal of this approach is to diversify the approaches and actions supporting reintroduction to maximize the likelihood of success and to increase genetic diversity within the founding stock. The recommended approach includes a phased reintroduction strategy that includes greater intervention (e.g., trap and haul, use of hatch boxes and stream-side incubators, etc.) in the early years until the stock has been established and local adaptation begins to occur, followed by a phasing out of the level of intervention and a greater reliance on a self-sustaining, in-river, naturally reproducing population"

The RA suggests strategies for developing a naturally reproducing population focus on non-hatchery fish during the reintroduction and interim period (Meade 2009, Meade 2008). While hatchery fish may be included as originators of this group, the objectives are developed to minimize the influence of hatchery origin fish on this group and maximize the influences of natural origin broodstock fishes on survival and adaptation of natural fish in the Restoration Area. This group of fish is likely to undergo the greatest natural selection pressures and any local adaptation should increase fitness in this group.

Monitoring of the naturally reproducing fish in the Restoration Area will inform management actions for reestablishment, artificial propagation, and allowable straying among non-target fish. A monitoring framework that permits biologists to collect biological data during multiple life history stages is required to evaluate the possible influence of genetic variability and adaptation on the survival and fitness of this group of fish. A monitoring framework that includes static sites, which will remain identical throughout the term of the SJRRP, for collecting biological data and a genetic sample (e.g., fin clip) will allow identification of individuals and their biological status (e.g. growth, weight, and condition factor). This pedigree information and biological information can be combined with genetic study of adaptive traits to demonstrate selection for specific traits and local adaptation to the upper San Joaquin River's environment.

## *2.4 Use of a Conservation Artificial Propagation Facility*

Given the goal of the SJRRP to achieve a naturally reproducing viable spring-run Chinook salmon population in the Restoration Area, several pathways might be considered to achieve this goal. One pathway is the use of a conservation artificial propagation facility. Propagation facilities can generally be classified as supplementation facility or conservation facility. Traditional supplementation facilities have a low likelihood of achieving this goal without detrimental genetic impacts to the reintroduced population. Allowing only natural recolonization is problematic for spring-run Chinook salmon, given the lack of geographically proximal spring-run Chinook salmon populations. The numbers of donor fish needed to support in-river reintroductions is likely too high to be supported by any or all of the potential donor stocks. Therefore, on-site or off-site artificial propagation will likely be necessary for achieving restoration goals.

Conservation facility models emphasize not only producing desired numbers of fish for release, but also reducing genetic and ecological impacts of release on wild fish (Flagg and Nash, 1999). The proposed conservation facility is based upon adaptive, multi-strategy concepts that are intended to support an eventual population that will have genetic integrity and be functionally self-sustaining. Methods will be employed based upon the best available information and research developed within the Program conservation hatchery. Conservation hatchery practices being developed for the proposed facility are considered critical to the propagation of reintroduced stocks.

The draft Hatchery and Genetic Management Plan (HGMP) (Appendix 9.4) presents information on the San Joaquin River Salmon Conservation and Research Facility (Conservation Facility). The Conservation Program consists of two phases based on facility availability, an interim phase during construction of the full-scale facility and then a full-scale operational phase, commencing with the hatchery's full-scale operation in 2014. The Conservation Facility will be located on the grounds of the current San Joaquin River Fish Hatchery, but will be completely independent of the existing facility. The facilities for each phase are described below.

### 2.4.1 Interim/temporary Facility

A small-scale, interim facility will begin operation in fall 2010 with fall-run Chinook salmon to allow hatchery personnel to familiarize themselves with the rearing of juvenile Chinook in the new conservation facilities before working with Endangered Species Act (ESA) listed fish. Once capital funding has been secured, construction on the full-scale hatchery facility will begin, ideally in 2012, although delays in the state budget process or delays in allocation of the funding may delay construction. In 2011, the permit to work with listed spring-run Chinook salmon will still be under review, and the hatchery will continue its work with fall-run Chinook salmon. Information gained from the interim facility will be used to improve the design features of the full-scale Conservation Facility.

### 2.4.2 Full Scale Conservation Facility

The Conservation Facility will play a key role in restoring a spring-run Chinook salmon population in the San Joaquin River, as mandated by the 2006 Settlement. The historical San Joaquin River spring-run Chinook salmon populations have become extinct, and remaining CV spring-run Chinook salmon populations are at varying risk of extinction. The Conservation Facility may only expect limited transfers from any CV spring-run Chinook salmon population and will depend on artificial propagation via a broodstock, by captive rearing, to attain sufficient fish numbers for reintroduction.

Conservation facility practices being developed for the proposed facility are considered critical to the propagation of reintroduced stocks. Nevertheless, the soonest restored stocks, from the Conservation facility, could be reintroduced would be 2016. The Conservation Facility will generally embrace the population goals and objectives set forth by the RA and the FMWG. For more information regarding these goals read Section 1.8 of the HGMP (Appendix 9.4).

#### 2.3.2.1 Phase out of artificial propagation

The goal of the Conservation Facility is to restore naturally reproducing, viable spring run Chinook salmon populations, and so its success is marked by the ability to ultimately phase out hatchery production of fish. This will reduce the negative influences that continued hatchery supplementation can have on the re-established spring run Chinook salmon populations. Modification of spring run Chinook salmon hatchery production should be determined by an adaptive management approach given the likely uncertainty of initial restoration phases. Genetic accommodation of the natural population, quantitative natural population targets (e.g. $N_e$, census size, and genetic diversity), and other community and ecosystem indicators of reintroduction success will be derived and periodically evaluated to phase out hatchery production. Hatchery production phase-out is further detailed in the HGMP (Appendix 9.4). Additionally, uncertainties such as local habitat change, climate change, and others, should be given consideration in phase-out determinations.

# 3.0 Analysis of Collection Methods

Successful broodstock collection will encapsulate the genetic diversity found in the source population(s) to hopefully provide reintroduced Chinook salmon with a high level of genetic fitness for adaptation to changing environmental conditions. Ideally, the broodstock should be compromised of a large number of unrelated individuals, which, as a collective group, contain the majority of genetic variation detected in the source population(s). It is recommended that individuals are collected from multiple locations throughout the broodstock's native habitat to capture genetic diversity for distinct special spawning (adults and possibly eggs) or rearing (juveniles) preferences. It is also advisable to not preferentially select only the largest fish, but randomly collect individuals that may have a range of diverse phenotypes, with the exception of visibly diseased or deformed fish. Individuals should be collected throughout spawning (adults and eggs) or outmigration (juveniles) periods to ensure that temporal preferences are maintained in the reintroduced population. Collecting throughout space and time will also help to ensure that the broodstock is not compromised of a large fraction of related individuals. The particular life stage chosen for collection (e.g., adults, juveniles, eggs, or a combination of life stages) will impact the employed collection strategies. The collection methods described below will be considered.

## 3.1 *Pros and Cons of different collection methods*

### 3.1.1 Eggs

In salmonid populations, the egg lifestage contains the most individuals. Therefore, if collection methods can achieve a high survival rate of collected eggs, then eggs offer the potential for the greatest number of fish obtained with the least effect on the donor stock. However, in order to achieve genetic diversity (and minimize the number of siblings) within the founding population on the San Joaquin River, a small number of eggs from several redds would need to be collected. The process of collecting eggs from a redd has the potential to negatively impact the survivorship of the remaining eggs in a redd (see section 3.1.1). Obtaining eggs from the donor stocks in Mill, Deer, and Butte Creeks entails risk. The timing of spring-run Chinook salmon adult presence (i.e. holding and spawning) coincides with warmer air and water temperatures, and the lowest streamflows of the year generally occur during the spawning period. In Mill, Deer, and Butte Creeks spring-run Chinook salmon eggs can be obtained directly from adult fish or from within redds after spawning occurs. Obtaining eggs from Feather River fish is easier and presents less risk of loss of individuals with the presence of the hatchery.

Approximately 5,000 eggs are available from each female, but in order to obtain the desired genetic diversity for the San Joaquin River population, eggs need to be obtained from several individuals. The desired method for acquiring eggs depends on the number of eggs needed and the number of unique individual females and males needed to achieve adequate genetic diversity. Methods for obtaining eggs from donor populations are described below.

#### 3.1.1.1 Obtain live spawned eggs from in-river (Redd Extraction)

***Hand-digging redd extraction***

This method will consist of carefully hand-digging into the tailspill of identified spring-run Chinook salmon redds to obtain live fertilized eggs. Collection locations will be selected from areas of shallower water and gentle velocities to facilitate obtaining eggs without loss. Redds will be selected to provide spatial and temporal diversity by sampling multiple spawning locations, from our pre-determined collection locations, during different times of the spawning season. Eggs will be obtained approximately 20 to 30 days after spawning occurs. Eggs are most resistant to disturbance after 200 accumulated temperature units (ATUs in degrees C). This period occurs 20 days post-spawning at $10^{o}$ C. Eggs will be obtained prior to 480 ATUs, which is the point at which hatching can be beginning in Chinook salmon eggs. Spawning surveys will need to be conducted roughly weekly during the spawning season and redds marked with the approximate date of spawning. Redd locations will be marked after the redd is completed and the female is no longer present. Iron rods will be driven into the streambed along the central axis of the redd, and a GPS unit will be used to triangulate the location of the redd. Water temperatures will be monitored, by deploying thermographs in collection locations, to assess the stage of development of eggs. This will enable egg collection activities to occur during the desired stage of development to maximize survival of the eggs removed from the source population and of those left to incubate in the redd. Approximately 10 to

40 eggs will be removed from each redd. This results in a maximum take of about 1% of the eggs from an individual female assuming a fecundity of 4,200 eggs. Egg to fry survival in naturally spawned eggs generally ranges between 25-50% (29% calculated for winter-run Chinook salmon on average). Therefore, a take of 1% of the eggs from a female at this lifestage should be sustainable as long as survival of the non-taken eggs can be maintained.

The hand-digging egg removal method consists of the following:

- Gravel will be carefully removed from the tailspill of the redd by hand until eggs are reached. The digging process will proceed slowly so that a clear view of the excavated area can be maintained throughout the process. Snorkel gear will be used to get a clear underwater view of the excavated area.
- A fine mesh dipnet will be used to retrieve the eggs.
- Eggs will be counted and placed into a five-gallon bucket of river water, maintained at or below the temperature of the river, as they are removed from the gravel. The eggs will be kept covered in the bucket to prevent mortality due to exposure to direct sunlight.
- Once the correct number of eggs are removed from the redd, gravel will be carefully replaced into the area from which it was removed until the pre-disturbance substrate contour is re-created.
- Following collection, eggs will be placed into coolers with equal volumes of eggs and river water.

For transportation, ice will placed in a separate compartment of the cooler such that it is in contact with the water but not with the eggs. The ideal temperature for transport is in the 5 – 10$^{o}$ C range. (Note: There may be a better packing method but the key is to keep the eggs cool and clean.) The eggs will be disinfected with an iodophore at 100 parts per million (ppm) of free iodine.

- prior to release into the river.

### *Redd Pumping*

Redd pumping removes eggs by probing the redd using an aluminum pipe. Redd pumping may also be considered and used on Butte and Deer/Mill Creeks. Egg to adult survival rates is anticipates to exceed 50 percent. Redd pumping will be initiated when eggs are in the relatively hardy eyed stage. Pre-eyed and post hatch collections will be aborted due to the sensitivity off these stages to handling. Eggs will be collected from redds using a backpack style hydraulic egg injector (ARED, Wrangell, AK). Both water and air are gently injected into the redd until eggs begin to appear at the surface where they are trapped in an enclosure and removed. Redds will be skirted with collection netting and the egg injector tube will be inserted into the gravel within a redd and water will be pulsed into redd until 10-50 are ejected from each redd. Total egg take will depend on redd availability and Lindley et al.'s forth coming viability analysis. Excess eggs will be re-injected into the redd by using the hydraulic egg planter. Eggs will be transported on ice according to standard hatchery operating procedures and sent to the hatchery facilities for disinfection with an iodophore at 100 parts per million (ppm) of free iodine.

Several programs in the Pacific Northwest use redd pumping since it is a low impact option for egg extraction. While there doesn't appear to be published studies on the impacts to the eggs left behind in the redds, fisheries managers in the Pacific Northwest agreed that if appropriate techniques were used, the impact would likely be low. Egg survival is typically high for the eggs that are extracted from the redds, often exceeding 90% (Hopley 2002, Murdoch and Tunsel 2005, Andrew R. Murdoch, Pers. Comm.). This method would allow for quicker collection of eggs, than hand-digging, and it can be less invasive. Redd pumping occurs at the farthest downstream portion of the tailspill, at the very outer edge of the redd to avoid disturbing the remaining eggs. However, since there are no published reports in the scientific literature regarding the impact redd pumping would have on the other incubating eggs the impact to the existing redd cannot be quantified.


A. Example of hydraulic sampling gear. B. Example of collection net used.

**Figure 3-1**
**Redd Pumping**

## 3.1.1.2 Adult egg takes in the wild

This method consists of capturing natural origin adults in the wild in Butte Creek, Mill Creek, and/or Deer Creek. This would require removal of all eggs from each female adult taken from the donor stock, and using all the eggs for the introduction. Approximately 100 adults (50:50 sex ratio) will need to be taken to meet genetic diversity needs. Generally, remote site egg takes involve capturing pre-spawn adults in the river and holding them in a pen until ripe and ready to spawn. The water temperatures during the spring-run Chinook salmon spawning period, which approach 16$^{o}$ C, probably preclude holding wild adults in the river for any amount of time because significant holding mortality is likely to occur. In addition, the capture process will stress the non-captured fish holding in the same area, potentially resulting in additional take.

The remote egg take operation method consists of the following:

- Adults will be captured using a tangle net. A tangle net is essentially of the same design as a gill net (floats on top and sinking line on bottom) except that the mesh size is too small for the target salmon species to become gilled. The fish instead become tangled, generally by swimming into the net and a tooth or fin catching on the net. The fish becomes entangled as it twists trying to escape. Mortality is much less than with gill nets because the fish can still breath when tangled and can be removed from the net without harm. The tangle net for this type of capture would be actively fished by dragging through an area of holding fish in the same manner as with a seine, except the top and bottom of the area would be blocked with tangle nets to ensure quick capture and avoid stress to fish. The area to be netted needs to be relatively free of snags on the bottom. If dragging the net through a holding area is not feasible the net can be strung across an area of stream and fish herded into the net, such as by a person in the water snorkeling. This works initially, however once a few captures occur in a group of fish the remaining fish learn to stay clear of the net.
- Fish will be immediately removed from the net as they are captured. As fish are captured the sex will be determined and they will be placed in a holding pen. As a fish is placed in the holding pen it will be revived if needed and examined for ripeness.
- Temperature can be limiting during the pre-spawning period for spring–run Chinook salmon. Netting should not occur at water temperatures above 16 $^{o}$ C and the operation ideally should be conducted below about 13 $^{o}$ C. Broodstock collection would occur until the appropriate number of males and females were collected. This number would be dependent on the number of stocks available for use annually (see Table 2.3).
- Once adults are ripe (they likely will not all be ripe at the same time) they would be spawned on-site, water hardened for two hours, and the eggs immediately transferred to the San Joaquin River destination, either in-river or hatchery.

A holding cage consisting of plastic mesh (approximately ¼” holes) on a two by four frame would be anchored in the center of a pool to hold fish until ripe and ready to be spawned. Should this approach be chosen, the recommendation is to use the process in 2010 and/or 2011 on fall Chinook to perfect the method for this specific application, from fish capture to introduction to the San Joaquin River.

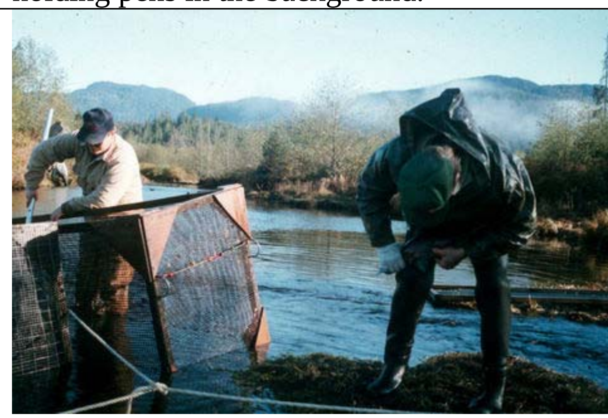
An alternative to capturing and holding pre-spawn fish would be to wait until a female begins to dig a redd and target capturing specific ripe female and male fish that could be immediately spawned. This reduces potential losses of fish during holding for “ripening” and yields the benefit of natural mate selection. By placing nets above and below spawning riffles, specific fish identified on a spawning riffle could be targeted for capture depending on redd distribution, risk to non-target adults may be of concern, and should be one evaluation criteria for use of this method on a watershed specific level. Angling or snagging specific fish could also be tried, however, these methods are untested.

The following photo series displays a remote area egg take operations.


1 - Adult capture in tangle net.


2 - Adult capture using a tangle net with holding pens in the background.


3- Two holding pens secured in the river.


4 - Removing adults from holding pens and checking for ripeness.


5 - Adult salmon (coho in this case) ready for gamete removal.


6 - Stripping eggs from female salmon at a remote site.

7 - Green eggs transported in plastic bags. ***may want to fertilize onsite due to travel time to Fresno****

8 - Bags of eggs transported in a cooler.

9 - Milt placed into plastic bags for transport.

10 - Eggs emptied into plastic buckets for fertilization at the hatchery

**Figure 3-2**
**Remote area egg take station**

### 3.1.1.3 Hatchery Egg Takes

The Feather River Hatchery offers a convenient source of eggs for the reintroduction program from either natural or hatchery origin adult spring run Chinook. Gametes could be taken from a desired number of males and females during the normal hatchery spawning operation. Approximately 100 adults (50:50 sex ratio) will need to be taken to meet genetic diversity needs. Fertilization could occur on-site and eggs destined for the San Joaquin River could be incubated on-site to the eyed stage. At that point, when they are relatively hardy, they could be transferred to the San Joaquin River for in-river or hatchery incubation. The hatchery egg-take option allows a specific number of eggs to be taken from each fish with no additional impact to the source population besides the removal of those eggs. Table 3.1 compares pros and cons of the described egg collection methods.

**Table 3.1 Pros and cons of different methods for collecting gametes from donor populations**

| Collection Method | Pros | Cons | Mortality risk |
|---|---|---|---|
| Obtain incubating eggs from in-river | • Most abundant lifestage<br>• Does not remove spawners from population | • Could affect survival of 'non-taken' eggs in a redd<br>• Requires disturbing multiple redds | Low/moderate |
| Adult egg takes in the wild – from holding pools | • Allows for all incubation to occur in San Joaquin system. | • Removes spawners from source population<br>• Requires take of multiple adults<br>• Can stress non-taken fish<br>• Requires holding in pens susceptible to tampering or being washed out. | High |
| Adult egg takes in the wild – active spawners | • Allows for all incubation to occur in San Joaquin system.<br>• Allows natural mate selection to be incorporated into spawning | • Removes spawners from source population<br>• Requires take of multiple adults<br>• Difficult to target specific ripe fish<br>• Can stress non-target fish | Moderate |
| Hatchery egg takes | • Can easily take gametes from multiple adults<br>• No effect on fish or eggs that are not taken | • Feather River is the only applicable spring-run Chinook salmon stock<br>• Requires use of multiple adults | Low |

### 3.1.2 Juveniles

Collection of juveniles from donor stocks offers several advantages over the use of eggs or adults. Use of juveniles maximizes genetic diversity while minimizing impacts to donor stocks. Juveniles from the donor stock(s) are the progeny of many mating pairs in the population and therefore reduce the potential of siblings being present in the released group. One would have to collect a greater number of adults to release in the San Joaquin River to spawn to capture the genetic variation already present in juveniles in the donor stocks.

Selecting a method for collecting juveniles in rivers depends on requirements for specific project goals, number of samples, target fish size, duration of sampling period, habitat conditions, funding availability, capture efficiencies of gear, and lethal impacts to fish (see pros and cons in Table 3.2). Most methods proposed here to collect and transport juveniles result in low mortality and are evaluated in Table 3.2 and Appendix 9.2. Specific methods that are being considered for collection of spring-run Chinook salmon juveniles from donor stocks are described in further detail below.

#### 3.1.2.1 Seine

Seines are nets that hang vertically in the water with weights along the bottom (lead line) and buoys on the top (floats). They are most effective when used in relatively shallow water with few obstructions, where fish are in high concentration. Seining permits the sampling of large areas in short periods of time. Sites with irregular bottom topography, significant accumulations of debris or larger rocks, or dense stands of aquatic vegetation may not be suitable for seining due to net snagging or lifting. Seining has been recommended for collection of spring-run Chinook salmon on Deer and Mill Creeks by personnel (Colleen Harvey-Arrison, CDFG) with local expertise in collecting fish on these rivers.

#### 3.1.2.2 Screw traps

Rotary screw traps (RSTs) are the most common gear used to collect and monitor the production of juvenile salmon in tributaries in the California Central Valley. This is because when placed properly and calibrated, they can provide calculated estimates of juvenile abundance over a season and across years. A RST consists of a funnel-shaped cone that is screened and suspended above the water between floating pontoons. The cone rotates as water flows past the trap, guiding the fish moving downstream into a live box that is attached to the rear of the trap cone. Rotary screw traps are usually installed at a fixed location and they can continuously sample during an extended period of time. Fish are confined to the live trap and therefore the RST needs to be checked frequently (at least two times per day) to process fish and remove debris making this method somewhat labor intensive. Juvenile spring-run Chinook salmon are currently being collected on rivers using this method (e.g., Butte Creek). When monitored at the appropriate time interval relative to the number of fish being collected, RSTs result in low mortality rates. Therefore, RSTs that are part of on-going monitoring programs would dovetail well with our collection of juveniles from those donor stocks.

#### 3.1.2.2 Minnow traps (or Fyke nets)

Minnow traps work well in a diversity of habitats (e.g., weeds, beach, and logs) that may be difficult to access by boat. Due to their small size and torpedo shape, they are ideal for sampling in areas with high debris accumulations that make electrofishing and seining impractical. They are cost effective and require low maintenance, unless several traps are deployed. Traps can be baited and deployed for varying amounts of time (one to several hours), but they generally have relatively low capture efficiency. Therefore, they are ideal for studies requiring a limited number of fish. Fyke/hoop nets are also passive fish traps. They consist of cylindrical or cone-shaped netting bags mounted on rings or other rigid structures. They can have wings or leaders, which guide the fish towards the entrance of the bags. These nets are fixed on the river bottom by anchors, ballast or stakes. They have high catch efficiencies when deployed in deep water close to shore. These methods could be useful for sampling juvenile spring-run Chinook salmon in headwater habitats on Deer and Mill Creeks, where spring-run Chinook salmon are spatially segregated from fall-run Chinook salmon juveniles. However, these habitats are difficult to access.

### 3.1.2.3 Electrofishing

Backpack electrofishing uses electricity to stun fish before they are collected. It is widely used in streams, rivers and lakes because of its catch efficiency and versatility in different aquatic habitats. Electrofishing gear is portable, so fish can be collected in areas that otherwise cannot be accessed by larger gear that is deployed at a fixed location (e.g., rotary screw trap). Electrofishing is a common scientific survey method used to sample fish populations to determine abundance, density, species composition, as well as to capture brood stock for hatcheries. Its effectiveness is influenced by a variety of biological (fish size), technical (pulse rate and electric field intensity), logistical (safety considerations), and environmental factors (water conductivity). While electrofishing has become a common capture technique, it is labor intensive, poses some increased safety hazards to gear operators, and its impacts to fish are not completely understood. For example, Cho et al. (2002) found significant spinal injuries in juvenile Chinook salmon that were collected using this method. Yet, other physiological variables (e.g., hematocrit, serum cortisol, and glucose) showed equivocal results (Cho et al. 2002). This method would be potentially useful for collecting juveniles in areas with hydrologic conditions that make them difficult to sample with traps, and where no existing sampling gear is installed.

### 3.1.3 Hatchery and Salvage Fish Facility collection methods

Collection of juvenile spring-run Chinook salmon from the Feather River Fish Hatchery is straightforward. The Feather River Hatchery HGMP describes their protocol for identifying and spawning spring-run Chinook salmon separately from fall-run Chinook salmon. The progeny of spring-run Chinook salmon parents are raised in cement race-ways where they could be netted and transported for released in-river in the San Joaquin River Restoration Area or raised at the San Joaquin hatchery facility as broodstock.

The Tracy Fish Collection Facility (CVP) and the John Skinner Fish Protection Facility (SWP) located in the south delta entrain spring-run fish from the Sacramento River populations. Currently, spring-run Chinook salmon are designated as spring-run based on their size in particular months and salvaged (e.g., transported for release into the San Francisco Bay). Genetic samples are currently being collected on a subsample of fish salvaged at these facilities to ground-truth the size by month criteria for run designation by CDFG. This may provide a good vehicle for collection of spring-run Chinook salmon broodstock for the San Joaquin River reintroduction program. Putative spring-run Chinook salmon would need to be individually marked and held (i.e. PIT tagged) until genetic information can be confirmed. Fish genetically identified as spring-run Chinook salmon could be incorporated as broodstock for the reintroduction program. Those not genetically confirmed as spring-run Chinook salmon would be salvaged. Genetic information would be collected on all broodstock samples. Therefore, these fish would have genotype information already available.

**Table 3-2**
**Pros and cons of different methods for collecting juveniles from donor populations**

| Collection Method | Pros | Cons | Mortality risk |
|---|---|---|---|
| Seine | • Samples large area in short time<br>• High catch rates<br>• Effective in relatively shallow water | • Damaged by debris<br>• Requires smooth substrate | Low |
| Rotary screw traps | • Reliable when placed properly<br>• Common on salmon rivers in CA<br>• Can continuously sample | • High maintenance (monitored frequently)<br>• Expensive to build | Low |
| Minnow trap & Fyke nets | • Effective in most habitats (high debris)<br>• Low maintenance and cost<br>• Passively samples<br>• No permanent deployment | • Low catch rates<br>• May require regular maintenance | Low |
| Electrofishing | • High catch rate<br>• Samples diverse habitats<br>• No permanent deployment | • Potential injury to fish<br>• Safety hazard<br>• No continuous sampling | Moderate/ high |
| Trawl | • Samples large area in short time | • Constrained to deeper water<br>• Requires boat<br>• High cost and labor | Moderate/ high |
| Salvage | Opportunistic<br>Ease of capture<br>Can continuously sample | • Genetic uncertainty of stock<br>• Impacts to populations<br>• Low catch rates | Low |
| Hatchery | Ease of Capture | • Reduced fitness | Low |

### 3.1.3 Adults

Collection of pre-spawn adult salmon from the donor stocks, to transfer to the San Joaquin River to spawn, is not as advantageous as collecting eggs or juveniles. Capturing and handling adult Chinook salmon is very stressful on the fish, which makes them more susceptible to pathogens and diseases. This susceptibility may lead to an increase in capture and post-capture myopathy (i.e., malfunction of muscle fibers). Adult fish must survive the capture, transport to the San Joaquin River (a minimum distance of 240 miles), release, and the summer holding period. The mortality of one pre-spawn adult fish is a substantial loss of reproductive potential. Therefore, it is not recommended to capture adult spring-run Chinook salmon for direct transfer to the San Joaquin River. However, there are two instances when collection of adults may be feasible.

There may be potential to take adult spring-run Chinook salmon from the Feather River Hatchery during a high return year. Chinook salmon returning to the Feather River Hatchery during the spring are floy tagged and release back into the river. This allows hatchery staff to identify spring-run Chinook salmon during the spawning season. Adult fish may be collected during the spring tagging season, quarantined for disease purposes, and then transported to the San Joaquin River and directly released into the river. Subsequently, spring-run Chinook salmon may also be collected at the Feather River Hatchery in the fall, however, since the fish will be close to spawning they will be even more susceptible to capture and post-capture myopathy.

Using adult SRO Chinook salmon from non-spring run watersheds either during the spring holding period, or prespawning/spawning period would allow the Program to analyze mortality rates and the successfulness of moving adult spring-run Chinook salmon to the San Joaquin River, without directly impacting natal spring run watershed populations. These fish could be collected as part of hatchery operations, as in the case of the Mokelumne River, or from weir trapping, as in the case of the Stanislaus River. However, the mortality risk is still expected to be moderate to high for these collection efforts.

For the remaining donor systems (Butte Creek and Deer/Mill Creeks) it is anticipated that no adult fish will be collected for direct transfer to the San Joaquin River due to the difficulty associated with collecting, holding and transporting adult wild Chinook salmon. However, there has been discussion of collecting fish during salvage operations (a.k.a. fish rescue operations); such as the ones that have occurred on Butte Creek. Salvage operations occur to "save" fish that are in imminent danger of mortality due to a variety of factors. Collecting fish during salvage operations amplifies the concerns and mortality risk associated with collecting adult fish since the fish are generally already stressed, and presumably already show signs of disease. Further, salvage operations occur during the summer months when air temperatures can reach over 100$^{o}$ F (38$^{o}$ C). This may pose a problem, and may increase mortality, during transportation of fish over 240 miles in the heat. The salvage operations that have occurred on Butte Creek are conducted to rescue fish that are unable to migrate upstream due to a thermal barrier. The salvage operation occurs in June or July, the fish rescued have been exposed to high water temperatures for an extended period, and these fish are generally stressed and show signs of disease. It is not recommended to use salvaged adult fish in our reintroduction efforts due to the concerns expressed above.

## *3.2 Preferred Collection methods*

Based on our analysis of collection methods the preferred life stages to collect are juveniles and/or eggs (gametes). The Program may collect fish from source population(s) over an 8-year period (see Table 6.1) and use multiple reintroduction strategies, thus, we will not focus on only collecting juveniles or eggs for the Program, but a combination of both. Further, each source population river is different, so one method may not be feasible in all systems.

The highest priority will be given for collection methods with low to moderate mortality risks (Tables 3.1, 3.2 and 3.3). Other factors to take into consideration are ease of collection, capturing enough genetic diversity, source population size, cost of operation, source river conditions and restored San Joaquin River conditions. At this time it is unknown how the restored San Joaquin River will function in 2012 and subsequent years, however, we do know issues that may impede reintroduction efforts. These include physical habitat conditions in the San Joaquin River within the Restoration Area, such as, fish passage, entrainment, elevated water temperatures, habitat conditions for each life history stage.), water-year type, and unscreened water diversions. Further, many of these collection techniques have not been tested in the source rivers, so it is unknown how successful they will be. It is recommended that all collection techniques are practiced on fall-run Chinook salmon prior to the use of these techniques on spring-run Chinook salmon.

Based on the above factors, collecting juveniles would be more feasible and allow for better adaptive management than the collection of eggs, for direct in-river introduction. Eggs must be introduced within Reach 1 because the primary spawning gravels are located there. If the San Joaquin River conditions are not adequate for juvenile rearing and outmigration then there is a high likelihood that reintroducing eggs will be unsuccessful. Juveniles can be released in all reaches, and in multiple locations in each reach. This allows for better adaptive management if flows, passage issues, habitat conditions, etc. become insufficient.

The collection of juveniles would best serve direct in-river introduction, however, for the purposes of the captive rearing program egg collection would be a necessary and feasible option. Captive rearing is generally considered a challenging venture and has been used both successfully and unsuccessfully in restoration efforts.  One of the more successful efforts include NMFS and Idaho Department of Fish and Game’s Redfish Lake sockeye Restoration Program. Fisheries managers who work on the Redfish Lake Restoration Program recommend collecting eggs for any captive rearing program (pers comm Paul Kline, July 30, 2010.), one went as far as saying they would not attempt a captive rearing program if they only had juveniles to use for captive rearing.

**Table 3.3**
**Summary of preferred collection methods from donor populations**

| Collection Method | Mortality Risk | Ease of Collection | Genetic Diversity |
|---|---|---|---|
| Seine | Low | • High catch rates<br>• Effective in relatively shallow water | • Can collect a few individuals from multiple locations<br>• Samples large area in short time |
| Minnow trap & Fyke nets | Low | • Effective in most habitats (high debris)<br>• Low catch rates | • Can collect a few individuals from multiple locations |
| Rotary screw traps | Low | • Reliable when placed properly<br>• Common on salmon rivers in CA<br>• High maintenance<br>• Must be monitored regularly | • High likelihood of collecting siblings..<br>• Continuous sampling.<br>• Mill/Deer Creek: will collect both spring- and fall-run Chinook salmon. |
| Obtain incubating eggs from in-river | Low/moderate | • Does not remove spawners form population | • Most abundant lifestage<br>• Multiple crosses can be collected.<br>• Several spawning areas can be targeted for collection<br>• Can collect a few individuals from each redd. |
| Electroshocking | Moderate/High | • High catch rate<br>• No permanent deployment<br>• Safety hazard | • Samples diverse habitats<br>• Can collect a few individuals from each habitat<br>• No continuous sampling |
| Adult egg takes in the wild – active spawners | Moderate/High | • Requires coordination among field biologists, spawning crew, and hatchery personnel. .<br>• Difficult to target specific ripe fish<br>• Stresses non-target fish | • Collect from known parents<br>• Collected individuals will be full siblings<br>• Allows for all incubation to occur in San Joaquin system. |

# 4.0 Analysis of Reintroduction Methods

Release strategies are equally important as the collection strategies during the reintroduction efforts. Natural survival in the riverscape during early life history stages greatly influences the genetic contribution of distinct release strategies to the next broostock generation. The appropriate stages of release (e.g., egg, fry, smolt, adult) is likely to depend not only on scientifically supported strategies, but also on the need to achieve a balance between the source broodstock outmigration pattern and what is logistically feasible given the environmental conditions in the San Joaquin River at particular points in the timeline.

The following strategies should be considered for the reintroduction methods:

1. Evaluate habitat suitability/conditions prior to release
2. Consider use of non-hatchery releases.
3. Screen all direct transfer, hatchery, and broodstock populations for disease prior to release
4. Evaluate proper life-stage and condition for release to minimize conservation hatchery influence
5. Release only marked fish (to identify hatchery-spawned from naturally reproducing fish and to ensure ability to determine impact of conservation hatchery releases on spring-run Chinook salmon populations in other watersheds)
6. Use appropriate size at release (e.g., smolts equal in size to those in the wild population)
7. Use volitional, on-site release of fish at the appropriate time (during natural downstream migration window)
8. Do not truck fish to locations outside the upper San Joaquin River, as trucking has had demonstrably negative effects on fall-run Chinook population genetic structure (Williamson and May 2005), and predation, habitat, and water pumping effects outside the Restoration Area will be difficult to quantify
9. Use repeated introductions over successive generations in initial phases of reintroduction; possibly utilize "pulses" (conservation hatchery-produced fish input into population for 2 generations, then cease and assess population response)
10. Minimize release sizes (number of fish) in secondary stages of reintroduction to minimize influence on in-river populations.
11. Use releases proportional to the natural habitat carrying capacity
12. Monitor and evaluate releases to determine success of various release strategies, detect potential mortality vortices, and allow for adaptive action

Assuming release recommendations have been followed to the maximum extent possible, some variables may have unknown causes. However, identifying the stage of failure, whether fish are not returning due to straying, mortality upon release, mortality after outmigration, etc. will aid in adaptive management of the release strategy itself.

Monitoring of the effectiveness of artificial propagation and management actions on the demographics of the natural re-establishing populations is essential for adaptive management. This population will require monitoring during all periods of the restoration program both within the Restoration Area, and through the Delta and Ocean phases, to ensure that the planned level of segregation/integration of hatchery fish is occurring. In

Reintroduction and Interim population phases (Meade 2007, 2008), genetic pedigree analyses (parentage based tagging, Anderson and Garza 2005) and well-designed propagation experiments should be conducted to evaluate which re-introduction method has the greatest success in returning adult spawners. The HGMP (Adelizi and Bork 2010) lists specific Performance Indicators for Program success. These Performance indicators are related to Conservation Facility operation, genetic performance, instream performance. Monitoring to evaluate these indicators, including specific research tasks is also included in the HGMP.

Progress toward completion of channel modification projects outlined in the San Joaquin Settlementis of significant concern in developing reintroduction strategies. Currently there are three major channel modification that are identified in Pargraph 11 of the Settlement. These projects are termed “Phase I actions” and are deemed necessary to achieve the Restoration Goal. These actions are listed below, and the current timeline is addressed for each.

The Mendota Pool Bypass and Reach 2B Channel Improvements Project includes creation of a bypass channel around Mendota Pool to ensure conveyance of at least 4,500 cubic feet per second (cfs) from Reach 2B to Reach 3. Additionally, channel capacity modifications that incorporate new floodplain and riparian habitat to ensure conveyance of at least 4,500 cfs in reach 2B between Chowchilla Bifurcation Structure and the new Mendota Pool bypass channel. Project planning has begun and construction is estimated to start in 2013, and be completed in 2015.

The Reach 4B, Eastside Bypass and Mariposa Bypass Low Flow Channel and Structural Improvements Project includes a number of modifications including; channel capacity, if necessary, to ensure 475 cfs through Reach 4B; modifications at Reach 4B headgate on the SJR channel for fish passage and to enable flow routing of between 500 cfs and 4,500 cfs into Reach 4B; Sand Slough modifications to ensure fish passage; modifications to structures in the Eastside and Mariposa Bypass channels to the extent needed to provide anadromous passage on an interim basis until completion of Phase 2 improvements; and modifications in the Eastside and Mariposa Bypass channels to establish a suitable low flow channel (if the Secretary of the Interior, in consultation with RA, determines it is necessary). Work began in September 2009; construction is anticipated to start in 2013 and be completed in 2015.

The Arroyo Canal Fish Screen and Sack Dam Fish Passage Improvements Project requires screening of Arroyo Canal water diversion upstream of Sack Dam to prevent entrainment of anadromous fish and modifications at Sack Dam for fish passage. Planning for this project began in 2009, and construction is anticipated to start in 2012 and be completed in 2014.

The Salt and Mud Slough Seasonal Barriers Modifications project is to enable deployment of seasonal barriers to prevent adult anadromous fish from entering false migration pathway in the area of Salt and Mud Sloughs. Planning was anticipated to begin for this project in late 2010, with construction estimated to start and be completed in 2013.

Planning and construction timelines have not been established for these actions. In the Settlement, these modifications were scheduled for completion by December 31, 2013, but all are still in the planning and/or permitting stage and considered significantly behind schedule. Given that the modifications to improve both passage and habitat quality in the River are significantly behind schedule, strategies to compensate for these conditions are incorporated into the evaluation of reintroduction strategies below.

## *4.1 Pros and Cons of different reintroduction methods*

### 4.1.1 Eggs

This section describes methods for using eggs as a source of fish for the San Joaquin River reintroduction program. The methods include using eggs as a source of fish for broodstock, utilizing streamside incubators, or introducing eggs directly into the river. Ideally the latter two methods should be tested on an unlisted stock of fish to perfect the techniques to be used to introduce spring-run Chinook salmon into the San Joaquin River. These methods were developed, and have been used, predominantly in cooler climates than the Central Valley.

#### 4.1.1.1 Develop a Captive Broodstock

Eggs would be transferred from the source population to hatchery incubators at the San Joaquin River Conservation Facility, hatched, and the juveniles raised to adult. The hatchery-reared adults would then be used as the source of juveniles or eggs for introduction into the river each year. In years when natural origin source stock are not available, a portion of the production may be held in the hatchery to provide the source for the next generation of broodstock. Although, to minimize risk of hatchery fish, this method would only be used as a contingency. Developing a captive broodstock entails a delay of three years between the time stock is obtained from the source population until offspring can be produced in the hatchery for reintroduction. Therefore this method will not meet the near-term 2012 goal for introduction of fish into the San Joaquin River. This is likely the preferred long-term method of reaching numeric fish goals while the restoration program is in the process of improving the habitat to provide sufficient in-river survival rates. Details of this method are described in the HGMP (Appendix 9.4)

#### 4.1.1.2 Streamside incubators

This method entails using portable incubators erected alongside the San Joaquin River. Eyed eggs would be incubated in the incubators and the fry released into the river immediately upon swimup (free-swimming stage). Release could occur volitionally onsite or fry could be transported to specific locations for release. A variety of design options could be utilized but this essentially involves piping a river water source, using gravity, through an incubator of incubating eggs. The water is piped into the bottom of the incubator and allowed to flow out the top. This method allows incubation to occur at various locations along the river to test survival at varied incubation temperatures and water quality. It requires establishment of the water intake pipe in a section of the thalweg of the river such that the coolest water passing the location is being utilized. An area of sufficient channel gradient is needed so that the water intake in the river is higher in elevation than the desired water level in the incubator. These incubators could be subject to vandalism and tampering in this urban area. Water temperature in streamside incubators could be an issue at times with the warm air temperatures that occur in the fall. Figure 4-1 shows three examples of streamside incubator setups.

1- Example streamside incubation system using a plastic tub.

2 - Example streamside incubation system using five gallon buckets.

3 - Streamside incubator with Whitlock-Vibert boxes holding incubating eggs in an old freezer.

Source: XXXX

**Figure 4-1.**
**Examples of instream incubator systems**

### 4.1.1.3 In-river incubation - instream incubation box

The instream incubation box method involves incubating freshly fertilized or eyed eggs contained in wire or plastic boxes in the stream gravel. Donaghy and Verspoor (2000) describe an instream incubator consisting of three components: lidded trays for holding eggs, a basket for retaining the trays, and a lidded frame for securing the basket in the streambed. The box is filled with eggs and buried in the streambed in an area of spawning habitat (ie. appropriate water temperature, velocity, and substrate). Their design accommodates 4,000 eggs per box with a 170 $mm^2$ box size. This method allows eggs to mature within the streambed and the fry to emerge naturally. The boxes can be examined to assess survival at points throughout the incubation period. There is a lower risk of tampering with this device than with a streamside incubator. Whitlock-Vibert (W-V) boxes are a simpler variant of this method where eggs are placed in plastic rectangular slotted boxes and the boxes buried in the streambed. The absence of trays in W-V boxes makes examination for survival more difficult and fungus development from dead eggs is a reported problem. Sedimentation is a known issue in W-V boxes and they are commonly used to measure fine sedimentation rates in river substrate.

#### 4.1.1.4 In-river incubation – egg injection into the gravel

This method involves injecting eyed eggs into the gravel using a water pump. It attempts to simulate incubation in a natural redd within the gravel. Areas of the river with suitable spawning habitat (ie. appropriate water temperatures, velocities, and substrate size) are selected for egg injection. A simulated redd is prepared by first inserting a water pump pipe into the gravel and pumping water through to remove fine material, as would occur with natural salmonid spawning, prior to egg injection. Fine sediments can be pumped out to improve permeability. Eggs are then poured into the open top of the pipe and pumped into the gravel along with the stream water from the pump. The site is then left alone for the eggs to incubate and fry emerge naturally. This method could allow evaluation of various in-river egg incubation sites by thermal marking prior to the egg injection process. It avoids the risk of tampering associated with streamside incubators.

1 - The pump setup used for pumping eggs into the gravel for incubation.  Photos courtesy of Brian Allred.

2 - Pouring eggs into the pipe for injection into the gravel.

**Figure 4-2.**
**Egg Injection Techniques**

**Table 4.1**
**Pros and cons of egg reintroduction methods**

| Method | Pros | Cons | Expected egg to fry survival |
|---|---|---|---|
| Use to develop captive broodstock | • Only requires take from individuals from donor population for three years | • Requires larger hatchery facility to maintain a captive broodstock.<br>• Limited sampling of donor populations could lead to fairly rapid inbreeding of captive broodstock. | High |
| Streamside incubators | • Allows for experimental incubation using water from different areas of the river | • Subject to tampering/vandalism<br>• Potential water temperature concerns<br>• Requires instream water intake to be maintained | High/medium |
| Instream incubator box | • Newly fertilized or eyed eggs can be used<br>Sedimentation is limited<br>Egg survival can be determined | • Requires handling eggs in the outside environment when air temperature can be high | Medium |
| Egg planting | • Allows for natural in- | • Requires handling | Medium |

| | | | |
|---|---|---|---|
| | river incubation to occur<br>• Allows for evaluation of in-river egg to fry survival | eggs in the outside environment when air temperature can be high | |

### 4.1.2 Juveniles

Juveniles can be released at various ages and sizes from the donor watersheds or the Conservation Facility. Juveniles may be released over the same temporal window as collection or availability occurs, or placed in temporary holding pens for imprinting and acclimation to the San Joaquin River conditions. Release sites would be selected to provide appropriate water depth, velocity, substrate, and cover characteristics to promote juvenile growth and survival and promote successful emigration from the system. The reintroduction of juveniles into the San Joaquin River in the near-term has some challenges. Specifically, channel modification projects that support passage and habitat requirements are not anticipated to be completed until 2015-2016, yet salmon reintroduction will occur in 2012. This section describes potential methods for reintroducing juveniles from donor stocks, or captive reared juveniles either directly into the San Joaquin River or into holding pens, given these constraints. Transportation and handling of juveniles after collection and prior to release is described in Appendix 8.2.

#

#### 4.1.2.1 Direct Juvenile Releases into the San Joaquin River

Ideally, juveniles from the donor stocks would be collected over the entire rearing and outmigration season to capture the genetic diversity of the donor population(s). Direct release of juveniles collected from donor stocks into the San Joaquin River can be achieved on the same schedule as they are collected. This would simulate the same temporal distribution of rearing and outmigration observed by the donor source. One disadvantage of this method may be releasing too few fish at a given time disrupting densities, schooling behaviors, and outmigration cues experienced at their previous source location. The transportation and release of fish as they are collected on a daily or weekly basis also increases the frequency and complicates logistics in transporting and releasing fish to the San Joaquin River. Fish collected at donor streams could be held on site until a predetermined threshold number of fish for release is achieved to improve efficiency of the method. Releasing juveniles directly into the San Joaquin River may not provide the necessary time for juveniles to imprint on the San Joaquin River water necessary for successful navigation back to the San Joaquin River, depending on release location.

In relation to progress of Program required channel modification projects, options for direct release need to consider passage through the river. Given full passage is not achieved at the time of reintroductions, efforts have one of two options: 1) release the fish in the furthest upstream habitat close to Friant Dam, allow volitional movement downstream to the first channel blockage and recapture fish for trap and haul to passable habitat, or 2) conduct direct releases in the lower portion of the river, below all passage impediments.

Direct release of fish to the lower, fully passable, reaches of the river provides little or no time for imprinting to take place on San Joaquin River water released from Friant Dam. Potentially it also requires reintroduction into potentially inhospitable habitat (high temperatures, low DO, compromised water quality) depending on timing of release, or conversely release of smaller fish to the lower watershed earlier, potentially reducing survival through the lower River and Delta. Alternatively, releasing fish in the prime upstream habitat creates complications related to recapture efficiencies downstream, with the reality that 100% recapture of juveniles is likely not feasible for trucking fish around obstructions. Planned experiments using fall-run Chinook salmon prior to spring-run Chinook salmon releases will help inform these decisions.

An alternative to releasing fish from donor watersheds directly to the river is to utilize juveniles reared in the Conservation Facility reared specifically for the SJRRP. Captively reared juveniles can be allowed to volitionally release from the Facility, mimicking natural migration timing. They can also be subjected to forced releases wherein release locations and timing can vary to accommodate impacts such as predation, entrainment, and passage issues that have not been resolved in the San Joaquin River prior to reintroduction, as well as overall survival as a function of fish size.

Captively reared juveniles can exhibit reduced fitness due to hatchery effects, and releasing fish all at once and at one location (forced release) may contribute to failure of an entire cohort. Alternatively, they can be grown to larger size which may improve survival, be the result of specific mating crosses to maximize fitness, or used experimentally to test specific hypotheses surrounding reintroduction success.

As in the case of direct donor releases, consideration needs to be given to progress of channel modifications. While captive stock could be released volitionally in Reach 1A, there may be a need to release them downstream of passage obstructions or predation hazards and into the lower, passable reaches of the river.

## 4.1.2.2 Use of Holding Pens for Juvenile Releases

An alternative to direct release into the San Joaquin River is to temporarily hold juveniles in holding pens with recirculating San Joaquin River water to assist with imprinting. Temporarily holding fish in San Joaquin River water and releasing them in the San Joaquin River could maximize their likelihood of successfully navigating back to their reintroduced location. This does need to be balanced with release strategies occurring prior to the completion of river restoration actions (e.g., removal of fish barriers).

The use of temporary holding pens would allow the juveniles to acclimate before release, and thereby reduce the risk of predation (Fisheries Foundation 2009). Holding pens would also allow for collecting juveniles from donor stocks over a period of time until a group of fish have been amassed for release in a series of groups. Juvenile salmon outmigrate in groups, which may reduce mortality due to predation. Temporarily holding juveniles and releasing them in a series of groups may more closely resemble natural densities experienced during natural rearing and outmigration conditions and increase their survivorship. Finally, if smolt-sized juveniles from the Sacramento River Basin, or elsewhere out of basin, are released in the Restoration Area, holding the fish in pens temporarily may increase the likelihood that they imprint on the San Joaquin River and return to the Restoration Area to spawn as adults. Juvenile salmon learn odors associated with their home stream before seaward migration and use these odor memories for homing as adults (Dittman 1995). Numerous studies from the Pacific Northwest point to the value in developing olfactory cues for juvenile salmonids released outside of their natal streams, to improve homing to the river of release (Slatick et al 1988).

The use of holding pens can be for a number of reasons. Holding pens can be used to allow fish time to imprint on release waters, allow fish to acclimate to release water conditions and better prepare for predations, and other migration impediments, holding pens can also be used to conduct site specific experiments related to floodplain growth, impacts of water temperature, flow, etc. on survival. Captively reared juveniles, reared at the Conservation Facility will not need the benefit of imprinting time in holding pens, but holding pens may be useful in controlling release conditions and/or locations to improve survival.

**Table 4.2**
**Pros and cons of juvenile reintroduction methods**

| **Method** | **Pros** | **Cons** |
|---|---|---|
| Direct Releases (Donor) | • Reduced holding period<br>• Mimick natural timing | • Logistically challenging<br>• Reduced release densities impact survival<br>• No time for imprinting |
| Direct Releases (Captive Reared) | • Can grow to large size<br>• More control over release location/timing | • Reduced Fitness<br>• Risk of cohort failure |
| Holding Pens (Donor) | • Allows time for imprinting and acclimation | • Increased exposure to vandalism<br>• Increased holding |

| | | |
|---|---|---|
| | • Allows for larger release groups to alleviate predation impacts | time/stress |
| Holding Pens (Captive) | • More control over release location/timing<br>• Can be used for experimental purposes | • No need for imprinting. Added expense with little benefit |

### 4.1.3 Adults

While collection of adults for reintroduction efforts is given low priority in section 3.1.3 above, there are a few instances identified where collection of adults for reintroduction may be considered. Namely, those instances include, direct take from the Feather River Fish Hatchery when production targets are exceeded for the facility, SRO Chinook salmon that are likely to succumb to hybridization effects in non-spring run watersheds, and fish collected from rescue events that would be lost to mortality in their natal watershed Typically the latter occurs in the Butte Creek watershed, but could provide source stock wherever rescue would improve the chance of survival for these fish. The options listed below define how those adults would be reintroduced once collected from the identified opportunities.

## 4.1.3.1 Direct Transfer of Adults to San Joaquin River

There are basically two stages for adult reintroductions to the San Joaquin River for adult spring run Chinook salmon. These two stages are; the adult holding stage which could be reintroduced from March through June depending on collection source timing; and the adult spawning stage which could be reintroduced from August through October depending on collection source and timing. Spring run Chinook salmon, by definition migrate into freshwater as adults in the spring, then find deep cool pools to hold in while they develop and ripen into spawning condition. Spawning typically occurs from August through October depending on local conditions. In addition to the two stages for release, two ‘sources’ of adults for release can be grouped as “donor” source, and “captive reared” source. Independent of the source, the release methods have various attributes that are discussed below.

In the spring, fish are still healthy and robust and have not started to devote all of their energy into the process of gamete maturation. Releasing holding stage adults from donor watersheds will allow adults to acclimate to existing conditions in the San Joaquin River, and to choose appropriate spawning sites from those available. This also allows natural behaviors on spawning grounds, mimicking more natural mate selection, spawn site selection, etc.

Releasing holding stage adults, though, exposes them to poaching risk in the San Joaquin River for a longer period of time. Additionally, suitable conditions in holding habitat are necessary for proper gamete development and to prevent pre-spawn mortality from disease, temperature impacts, etc. Evaluation of the water quality in holding pools and habitat conditions of the existing holding habitat on the San Joaquin River need to be confirmed before this is a feasible reintroduction option to balance risk to the donor stock with the value of the method.

This method may be best tested using the SRO Chinook salmon populations identified earlier in this document, as well as in the Stock Selection Strategy document (SJRRP 2010). Use of these fish would allow an assessment of survival to spawning in holding habitat, while not directly impacting an identified spring run watershed population.

Releasing spawining stage donor adults into spawning grounds may reduce the increased oversummer mortality risk that may come with releasing holding adults. However, handling adult fish during this sensitive stage, when they are more susceptible to disease, may cause increases in prespawn mortality, or the premature release of eggs and/or milt, reducing the overall benefit of the method.

**Table 4.3**
**Pros and cons of adult reintroduction methods**

| Method | Pros | Cons |
|---|---|---|
| Holding Adult | • Fish are robust and healthy, fresh from the ocean<br>• Allows acclimation to local conditions | • Handling stress<br>• Risk of poaching, prespawn mortality |
| Spawning Adult | • | • High risk of handling stress, prespawn mortality, premature loss of eggs/milt |

**Table 4.4**
**Pros and cons of reintroduction methods by lifestage**

| Life History Stage | Pros | Cons |
|---|---|---|
| Captive Broodstock (all stages) | • Can control the relatedness of source stocks to maximize genetic diversity<br>• Lower number of source stocks needed to produce large numbers of individuals for reintroduction | • May not fit the settlement timeline<br>• Reduced fitness from hatchery practices |
| Eggs | • Can collect from various | • collection methods may |

| | | |
|---|---|---|
| | sources<br>• All local selection pressure (none from natal watershed)<br>• High relatedness | damage donor red integrity<br>• Typically low survival of egg-juvenile stage<br>• Methods relatively untested for release to river |
| Juveniles | • higher survival than eggs<br>• potential for controlled experimental releases<br>• more tolerant to thermal stress<br>• can be marked/tagged (CWT and PBT) prior to release<br>• less likely to be siblings<br>• Less potential for holding mortality than adults | • no information on egg survival gained<br>• less imprinting opportunity than eggs<br>• greater impact to donor stock than eggs |
| Adults | • can accommodate natural spawning pairs<br>• all selection on gametes occurs on the San Joaquin River | • high potential to holding/handling stress<br>• large impact to donor population |

### *4.2 Preferred Reintroduction methods*

Pacific Salmon populations have undergone numerous introduction, reintroduction, repatriation, translocation programs, across the Pacific Northwest and beyond (Quinn et al 2001, Young 1999, Wunderlich and Panteleo 1995, Krueger and May 1991). While fish introductions based on direct river release without supplementation have been successful and resulted in established populations, including salmonid and nonsalmonid introductions (Moyle 1986, Cordes et al 2004), the benefits of captive rearing of stocks in population restoration efforts are evident in the extensive collection of available published and grey literature on the subject (Bosch et al 2007, Venditti et al 2000, Conrad et al 2005, Gallinat et al 2009, Murdoch and Tonseth 2006, Hopley 2002). Direct river releases require large numbers of fish over multiple years to address natural mortality rates and to achieve population growth. Fish that aren't allowed to acclimate to the release watershed waters also show a significantly lower return to that watershed in a number of studies. Coho salmon recovery efforts in the Clearwater River that were mandated by settlement *(U.S. v. Oregon 1994)*, required outplanting of 550,000 smolts every year. These levels of release have occurred since 1998, from hatchery reared stocks in the Columbia River Basin, and resulted in a return of over 3,000 fish to Bonneville dam by 2004 (Nez Perc Tribe and Fish Pro 2004). Not all programs attain these results. Spring-run Chinook salmon recovery efforts using a captive rearing program in the Tucannon River have been unsuccessful in meeting program population goals (Gallinat 2009).

Because of the limitations of donor stock availability, low survival to adult in Chinook salmon in general, and the uncertainties in the conditions in the San Joaquin River in 2012, direct river to river reintroductions may be the least favorable option for long-term sustainable results. However, the use of direct river to river introductions on a smaller scale, may help inform long-term management decisions based on targeted research studies, and provide a reintroduction method more suited to meeting the requirements of the settlement. According to Stockwell and Leberg (2002) translocations (intentional release of either wild caught or captively reared individuals) provide unique opportunities to study the ecological requirements of targeted taxa, and information gathered from these activities are the essence of adaptive management.

Additionally, the captive broodstock will not be ready for large scale reintroduction numbers until approximately 2016, so some form of direct river reintroductions will precede captive broodstock offspring releases. In these cases, reintroducing juveniles provides a better opportunity than using eggs for marking/tagging. Marked or tagged stock identification can be used to address performance throughout the Restoration Area and survival to adult returns. than eggs, and temporary holding for imprinting purposes is preferred over direct juvenile releases.

Supplementation, through captive rearing has been deemed appropriate in two scenarios: (1) when short-term extinction risk for the population is high, and (2) in re-seeding vacant habitat that is unlikely to be colonized naturally within a reasonable time frame (Arkush and Siri 2001). For the SJRRP, the use of captive broodstock offers the best opportunity for amplifying our limited donor stock resources, and careful application to conservation hatchery techniques as described in Appendix 9.3 offers the best opportunity to meet our long-term program goals and establish a population that is genetically diverse enough to adapt to the conditions in the San Joaquin River. Progeny from captive broodstock, additionally, provides the flexibility to release fish at a number of life stages, including eggs, and juveniles from fry to smolt to yearling releases.

# 5.0 Recommended Actions

## *5.1 Optimal Number of Fish*

### 5.1.1 Egg

The optimal number of eggs to introduce to the river depends on the objective of the introduction. If the near term objective is to meet the near term escapement goal of the program (500-2,500 adults) then the number of eggs needed is a function of the survival from eggs to returning adults. The juvenile section below (5.1.2) describes calculation of numbers of juvenile Chinook salmon needed to meet program escapement goals. Figure 5.1 and Table 5-1 builds on the juvenile estimate using the same juvenile to returning adult survival but incorporates a range of egg to fry survival rates for in-river incubation (average of 29% for winter-run Chinook salmon egg to fry survival measured at Red Bluff emigration monitoring). Additionally, minimum numbers needed to produce as few as 100 returning adults is included in anticipation of multiple strategy utilization on an annual basis. Figure 5.1 and Table 5-1 display the number of females needed to provide the eggs at the specified egg to adult survival rates assuming average fecundity of 5,000 eggs per female.

These large egg introduction requirements are likely too high to obtain directly from Butte, Mill, or Deer Creeks combined. They may be feasible in higher escapement years from Feather River but cannot likely be relied upon to be available each year. Development of a hatchery broodstock would be the most reliable method in the early and late long term to obtain the required number of eggs. Even with a captive broodstock the number of females required to provide eggs for in-river egg plants is very high, up to 1,000 at low survival rates, so 2,000 total adults. Release of juveniles produced in the hatchery would require only about one-third the number of adults and eggs so fry or older lifestage hatchery production releases would likely be the preferred option. Fewer eggs would be required for experimental egg survival studies.

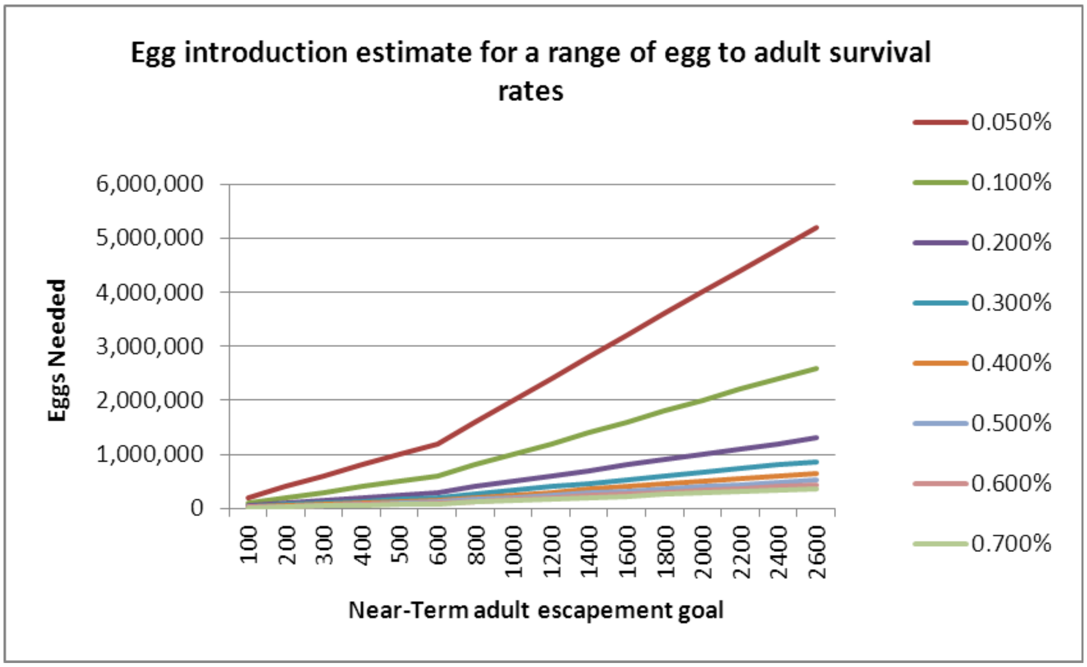



**Figure 5.1.**
**Estimated number of eggs needed to reach escapement goal for a range of likely egg to returning adult survival rates for in-river egg plants.**

**Table 5-1. Estimated number of eggs needed to reach escapement goal for a range of egg to returning adult survival rates (mid-range uses 29% egg to emigrating fry survival).**

| Adult Escapement Goal | 0.05% | 0.10% | 0.20% | 0.30% | 0.40% | 0.50% | 0.60% | 0.70% |
|---|---|---|---|---|---|---|---|---|
| 100 | 200,000 | 100,000 | 50,000 | 33,333 | 25,000 | 20,000 | 16,667 | 14,286 |
| 200 | 400,000 | 200,000 | 100,000 | 66,667 | 50,000 | 40,000 | 33,333 | 28,571 |
| 300 | 600,000 | 300,000 | 150,000 | 100,000 | 75,000 | 60,000 | 50,000 | 42,857 |
| 400 | 800,000 | 400,000 | 200,000 | 133,333 | 100,000 | 80,000 | 66,667 | 57,143 |
| 500 | 1,000,000 | 500,000 | 250,000 | 166,667 | 125,000 | 100,000 | 83,333 | 71,429 |
| 600 | 1,200,000 | 600,000 | 300,000 | 200,000 | 150,000 | 120,000 | 100,000 | 85,714 |
| 800 | 1,600,000 | 800,000 | 400,000 | 266,667 | 200,000 | 160,000 | 133,333 | 114,286 |
| 1000 | 2,000,000 | 1,000,000 | 500,000 | 333,333 | 250,000 | 200,000 | 166,667 | 142,857 |
| 1200 | 2,400,000 | 1,200,000 | 600,000 | 400,000 | 300,000 | 240,000 | 200,000 | 171,429 |
| 1400 | 2,800,000 | 1,400,000 | 700,000 | 466,667 | 350,000 | 280,000 | 233,333 | 200,000 |
| 1600 | 3,200,000 | 1,600,000 | 800,000 | 533,333 | 400,000 | 320,000 | 266,667 | 228,571 |
| 1800 | 3,600,000 | 1,800,000 | 900,000 | 600,000 | 450,000 | 360,000 | 300,000 | 257,143 |
| 2000 | 4,000,000 | 2,000,000 | 1,000,000 | 666,667 | 500,000 | 400,000 | 333,333 | 285,714 |
| 2200 | 4,400,000 | 2,200,000 | 1,100,000 | 733,333 | 550,000 | 440,000 | 366,667 | 314,286 |
| 2400 | 4,800,000 | 2,400,000 | 1,200,000 | 800,000 | 600,000 | 480,000 | 400,000 | 342,857 |
| 2600 | 5,200,000 | 2,600,000 | 1,300,000 | 866,667 | 650,000 | 520,000 | 433,333 | 371,429 |

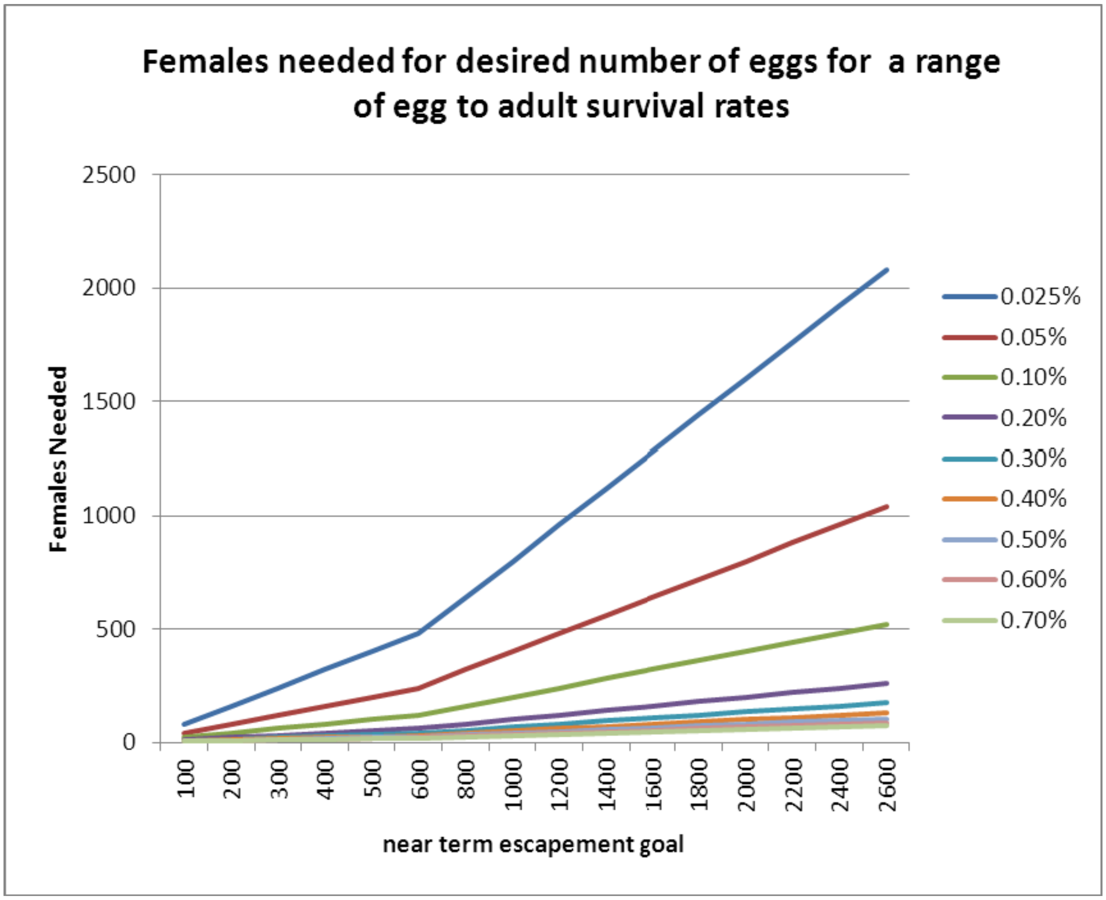



**Figure 5.2.**
**Number of females needed to meet egg take goals for a range of potential egg to adult survival rates for in-river egg plants**

**Table 5-2. Females needed to produce eggs for in-river introduction of incubating eggs.**

| Adult Escapement Goal | 0.025% | 0.05% | 0.10% | 0.20% | 0.30% | 0.40% | 0.50% | 0.60% | 0.70% |
|---|---|---|---|---|---|---|---|---|---|
| **100** | 80 | 40 | 20 | 10 | 7 | 5 | 4 | 3 | 3 |
| **200** | 160 | 80 | 40 | 20 | 13 | 10 | 8 | 7 | 6 |
| **300** | 240 | 120 | 60 | 30 | 20 | 15 | 12 | 10 | 9 |
| **400** | 320 | 160 | 80 | 40 | 27 | 20 | 16 | 13 | 11 |
| **500** | 400 | 200 | 100 | 50 | 33 | 25 | 20 | 17 | 14 |
| **600** | 480 | 240 | 120 | 60 | 40 | 30 | 24 | 20 | 17 |
| **800** | 640 | 320 | 160 | 80 | 53 | 40 | 32 | 27 | 23 |
| **1000** | 800 | 400 | 200 | 100 | 67 | 50 | 40 | 33 | 29 |
| **1200** | 960 | 480 | 240 | 120 | 80 | 60 | 48 | 40 | 34 |
| **1400** | 1120 | 560 | 280 | 140 | 93 | 70 | 56 | 47 | 40 |
| **1600** | 1280 | 640 | 320 | 160 | 107 | 80 | 64 | 53 | 46 |
| **1800** | 1440 | 720 | 360 | 180 | 120 | 90 | 72 | 60 | 51 |
| **2000** | 1600 | 800 | 400 | 200 | 133 | 100 | 80 | 67 | 57 |
| **2200** | 1760 | 880 | 440 | 220 | 147 | 110 | 88 | 73 | 63 |
| **2400** | 1920 | 960 | 480 | 240 | 160 | 120 | 96 | 80 | 69 |
| **2600** | 2080 | 1040 | 520 | 260 | 173 | 130 | 104 | 87 | 74 |

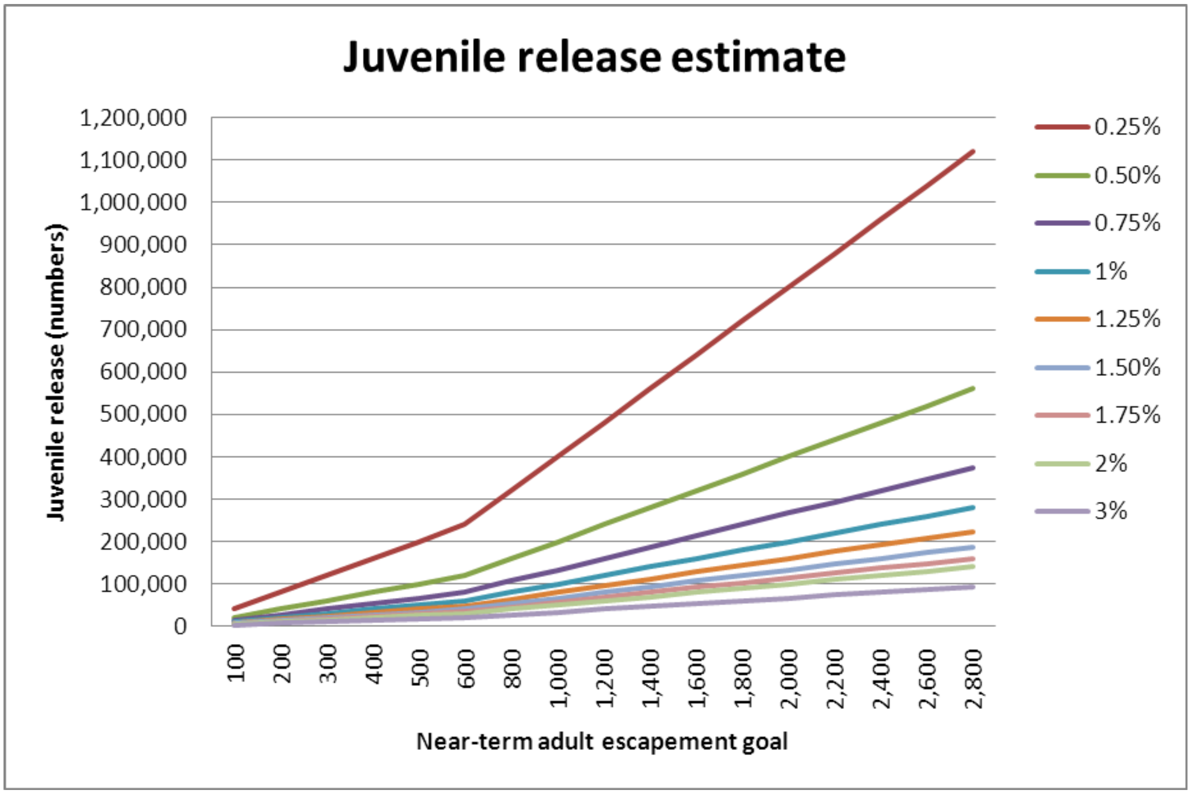
### 5.1.2 Juveniles

The optimal number of fish to release in-river is a function of survivorship of individuals between different life history stages and the adult escapement goals. To estimate the number of juveniles necessary to release to meet the near-term escapement goal of the SJRRP (500-2,500 adults), we first calculated survivorship estimates for fall-run Chinook salmon from the Merced River Fish Hatchery when the majority of fish were volitionally released in the Merced River. The Merced River Fish Hatchery is the most reasonable surrogate population for estimating survivorship of the reintroduced spring-run Chinook salmon to the San Joaquin River because they utilize the most similar outmigration route/habitat than any other population. In brood year 1998, Merced River Fish Hatchery released 913,329 smolts (CDFG/NMFS Hatchery Review report 2001). 10,844 three-year old adults from this release group returned to the Merced River and Merced River Fish Hatchery in 2001 (CDFG Grand Tab). Based on these estimates, we calculated that 1.2% of juvenile survived to adulthood. Since survivorship varies among years and is unknown for the upper San Joaquin RiverRestoration Area, we modeled the number of juveniles to release as a function of adult escapement goals and survivorship rates (Table 5.2; Figure 5.2). For example, since the river restoration projects will likely not be completed prior to initial reintroduction, we estimate low survivorship (0.25%). To reach the minimum number of adult returns, would require release 200,000 juveniles. To reach an adult escapement of 2,500 adults, approximately 1 million juveniles would need to be released. Given the likelihood of impacts to donor stocks of removing this number of juveniles, we recommend collecting a fewer number of juveniles from the donor stocks. They would be reared to reproductive maturity in the conservation hatchery, spawned and their progeny could be propagated to achieve the estimated number of juveniles necessary for in-river releases to achieve our population goals.

**Table 5-3. The estimated number of juveniles for release in-river as a function of near-term adult escapement goals and survivorship rates.**

| Adult escapement goal | 0.25% | 0.50% | 0.75% | 1% | 1.25% | 1.50% | 1.75% | 2% | 3% |
|---|---|---|---|---|---|---|---|---|---|
| **100** | 40,000 | 20,000 | 13,333 | 10,000 | 8,000 | 6,667 | 5,714 | 5,000 | 3,333 |
| **200** | 80,000 | 40,000 | 26,667 | 20,000 | 16,000 | 13,333 | 11,429 | 10,000 | 6,667 |
| **300** | 120,000 | 60,000 | 40,000 | 30,000 | 24,000 | 20,000 | 17,143 | 15,000 | 10,000 |
| **400** | 160,000 | 80,000 | 53,333 | 40,000 | 32,000 | 26,667 | 22,857 | 20,000 | 13,333 |
| **500** | 200,000 | 100,000 | 66,667 | 50,000 | 40,000 | 33,333 | 28,571 | 25,000 | 16,667 |
| **600** | 240,000 | 120,000 | 80,000 | 60,000 | 48,000 | 40,000 | 34,286 | 30,000 | 20,000 |
| **800** | 320,000 | 160,000 | 106,667 | 80,000 | 64,000 | 53,333 | 45,714 | 40,000 | 26,667 |
| **1,000** | 400,000 | 200,000 | 133,333 | 100,000 | 80,000 | 66,667 | 57,143 | 50,000 | 33,333 |
| **1,200** | 480,000 | 240,000 | 160,000 | 120,000 | 96,000 | 80,000 | 68,571 | 60,000 | 40,000 |
| **1,400** | 560,000 | 280,000 | 186,667 | 140,000 | 112,000 | 93,333 | 80,000 | 70,000 | 46,667 |
| **1,600** | 640,000 | 320,000 | 213,333 | 160,000 | 128,000 | 106,667 | 91,429 | 80,000 | 53,333 |
| **1,800** | 720,000 | 360,000 | 240,000 | 180,000 | 144,000 | 120,000 | 102,857 | 90,000 | 60,000 |
| **2,000** | 800,000 | 400,000 | 266,667 | 200,000 | 160,000 | 133,333 | 114,286 | 100,000 | 66,667 |
| **2,200** | 880,000 | 440,000 | 293,333 | 220,000 | 176,000 | 146,667 | 125,714 | 110,000 | 73,333 |
| **2,400** | 960,000 | 480,000 | 320,000 | 240,000 | 192,000 | 160,000 | 137,143 | 120,000 | 80,000 |
| **2,600** | 1,040,000 | 520,000 | 346,667 | 260,000 | 208,000 | 173,333 | 148,571 | 130,000 | 86,667 |

**Figure 5.3.**
**The estimated number of juveniles for release in-river as a function of near-term adult escapement goals and survivorship rates**




## *5.2 Fish Needed for Targeted Research/Monitoring*

Monitoring of stocks reintroduced into the San Joaquin River will be an integral part of assessing program success, and of the annual process to revisit collection numbers, release methods and locations. The studies below provide an overview of potential targeted studies to inform future management of the reintroduced population. Further description of these studies is provided in the HGMP for the Program (Adelizi and Bork 2010).

### 5.2.1 Eggs

#### 5.2.1.1 Spawning Gravel Hatching Study – Egg Survival

This study addresses several limiting factors (i.e., sedimentation, streamflow, temperature, and gravel quality and quantity) to the "Healthy Fry Production" life stage (via egg survival) of Chinook salmon (FMWG 2009a); and provides the necessary information on existing conditions to inform the reintroduction of salmon by 2012 by identifying factors that may contribute significant mortality to introduced salmonids. This study can be carried out using fall-run Chinook salmon eggs prior to an approved 10a1A permit being issued.

Incubating salmon eggs require appropriate conditions (temperature, spawning gravel size distribution, water quality including DO and pH, etc) to survive and hatch successfully. Field studies indicate there may be a significant amount of sand and other fine sediments in the areas perceived to be adequate spawning habitats. The infiltration of these materials into the redd, in addition to degraded water-quality conditions (in the hyporheic environment) including low dissolved oxygen, and high temperature, may result in decreased survival of eggs and prevent the SJRRP from meeting the targets identified in the FMP (FMWG 2009a).

The objective of this study will be to determine egg survival under current spawning conditions in the Restoration Area. Additionally, this work would indicate the relationship among egg survival and several environmental parameters in the restoration area (hyporheic environment). The outcome of the study will provide information required for determining successful reintroduction methods and lifestages in the early years of reintroduction. Additionally, it will provide the Program with critical information on the suitability of spawning habitat for egg survival in the Restoration Area. This information will also help the FMWG make decisions on how to best manage the perceived spawning areas in the Restoration Area.

This effort will be multi-agency and multidisciplinary. The efforts proposed here will supplement efforts currently being undertaken by DWR and Reclamation. We propose constructing several artificial redds and placing salmon eggs, either in egg tubes or in hyporheic pots, to document the impacts of conditions on the survival of those eggs.

### 5.2.2 Juveniles

#### 5.2.2.1 Acoustic Telemetry Study

A number of critical questions regarding habitat suitability, biological impacts, migration patterns, and rates can be addressed through the use of acoustic telemetry. Currently a large array of acoustic telemetry receivers is used throughout the Sacramento-San Joaquin River Tributaries, Delta and estuary to evaluate the movement of Chinook salmon, steelhead, and sturgeon. Recent advancements in technology have allowed for the successful tagging and tracking of young-of-year Chinook salmon through this technology. Before an approved Section 10a1A permit is issued, plans are to use fall-run Chinook salmon for telemetry studies on the San Joaquin River.

This study is intended to identify and characterize three limiting factors for juvenile Chinook salmon survival through the restoration area: predation, entrainment, and physical habitat. Knowledge of these limiting factors will determine the best approach for initial reintroduction efforts, assist in developing habitat enhancement projects, and prioritize and recommend actions for the reduction or elimination of predation, entrainment and habitat impacts to survival.

Fish habitat conditions in San Joaquin River within the Restoration Area have been highly altered. Interim Flows, which are now underway, provide an opportunity to understand how the river may function under improved flow conditions, specifically, how Chinook salmon will use the river once they are reintroduced. Chinook salmon are scheduled for reintroduction in 2012, which will likely occur prior to completion of the larger site specific physical habitat restoration activities, and will expose the reintroduced fish to less than optimal habitat conditions. In order to successfully reintroduce both fall-run and spring-run Chinook salmon, and reach the Settlement Goals, information must be gathered regarding potential sources of juvenile salmon mortality. The population goals as set forth in the FMP (FMWG 2009b) cannot be obtained unless we understand juvenile survival rates through the system. Acoustic telemetry technology is currently relied on heavily in the Sacramento-San Joaquin system to evaluate juvenile Chinook salmon survival (Perry et al. 2009, Vogel et al. 2008) and can allow investigators to evaluate reach-specific as well as through-project survival rates for juvenile Chinook salmon. In addition, data gathered from this acoustic telemetry study can determine the drivers for survival, i.e., which habitat conditions are most affecting successful migration. Initiating this study in the 2010-2011 Interim Flow period allows for two years to investigate existing river conditions and how those habitat conditions may affect salmon survival, prior to reintroduction.

Data will be used to determine areas that are contributing to salmon smolt mortality. This information will then inform the reach specific habitat designs, fish passage designs and identify entrainment areas that are in need of further study. In addition, this data will be used to estimate project-wide juvenile smolt survival rates allowing for refinement of the stock selection decisions related to how many adults are needed from the donor stocks, and the level of juvenile production necessary to meet the program population goals. Products: project survival rates, estimate travel time, identify areas of mortality and relate them to habitat conditions, predation, and entrainment.

Telemetry receivers will be deployed through reaches 1-5 of the Restoration Area. Receiver locations were determined based on a number of factors including: access, risk of vandalism, and value in assessing predation, entrainment and physical habitat features. Approximately 20 VEMCO 180kHz receivers will be deployed from the base of Friant Dam to the Confluence of the Merced River.

This study intends to place 1,000-1,200 juvenile fall run Chinook salmon, of which 200 will be fitted with telemetry tags, and the remainder will be fitted with Passive Integrated Transponder (PIT) tags to facilitate mark/recapture evaluation on the larger group while gaining specific information on the telemetered group.  The larger group also enables the fish to exhibit natural schooling behaviors typical of outmigrating juvenile salmonids. Tagging will be conducted in the interim Conservation Facility or the mobile processing trailer on loan to the SJRRP from the Anadromous Fish Restoration Program (AFRP). PIT tags will be injected subdermally on the ventral side of the fish. Telemetry tag placement will involve surgical techniques requiring an approximate ½ inch incision closed by suturing with standard absorbable suture material by staff experience in the procedure. Fish will be recovered for 24 hours to ensure no latent mortality from surgical implanting of tags effects tag results.

Transport/release operations for this study will take advantage of a  mobile fish processing trailer housed at the San Joaquin Fish Hatchery.  All fish will be handled following the fish handling procedures in the Draft HGMP for the SJRRP (Adelizi and Bjork 2010).

Telemetry receivers will be interrogated (downloaded) on a standard schedule, and additional sampling may be incorporated to conduct mark recapture estimation on the larger group (including seining and trapping methods), and/or mobile tracking of individual fish.

# 6.0 Phased Planning Approach

## *6.1 Reintroduction Phase (2012 – 2019)*

The Reintroduction Phase encompasses direct in-river release, the Interim Facility, and the full scale Conservation Facility (see Table 6-1). In the Reintroduction and Interim population phases (Meade 2007, 2008), genetic pedigree analyses (parentage based tagging, Anderson and Garza 2005) and well-designed propagation experiments should be conducted to evaluate which re-introduction method have the greatest success in returning adult spawners. Monitoring of the effectiveness of artificial propagation and management actions on the demographics of the natural re-establishing populations is essential for adaptive management. This population will require monitoring during all periods of the Restoration Program to ensure that the planned level of segregation/integration of hatchery fish is occurring.

## *6.2 Interim phase (2019 - 2025)*

During the Interim phase (Meade 2007, 2008), strategies with the greatest success should be continued. It is anticipated that San Joaquin River spring-run Chinook salmon returns will be high enough so collection of fish from source stocks will not be necessary. The Conservation Facility will also start ramping down hatchery operations during this phase.

## *6.3 Growth Phase (2025 – 2040)*

It is anticipated that the Conservation Facility will be phased out during the beginning of the Growth Phase; however, the research component of the Conservation facility will be ongoing. The Conservation Facility may be brought back online in certain circumstances, such as but not limited to, during periods of low returns, low water year types, and rescue operations.

**Table 6-1. Timeline of Activities for Reintroduction of Spring Run Chinook Salmon into the San Joaquin River.**

| Year | Goal | Facility | Number of Source Stock Collected for Broodstock | Number of Source Stock Collected for in-River Release | Source Stock Collection Methods | Reintroduction Method | Available Broodstock | Number of Fish Releases |
|---|---|---|---|---|---|---|---|---|
| 2010 | Obtain fall-run hatchery eggs for preparatory rearing and research | Interim Conservation Facility and UCD<br><br>Backup – MOH | None<br><br>500 fall-run MRH eggs to iCF | None<br><br>1,100 fall-run from MOK, MRH, or FRH releases for telemetry | Hatchery egg transfer | Possible fall-run release in Reach 1A for telemetry studies | None | Tentative - 1,100 fall-run yearlings for telemetry |
| 2011 | Collect wild MR fall-run eggs & juveniles for preparatory rearing and research | Interim Conservation Facility and UCD<br><br>Backup – MOH | 300 fall-run MR eggs to iCF<br>200 fall-run MR juv to iCF<br><br>1000 fall-run MRH eggs to UCD<br><br>**Target** - 50-100 adult pairs | Possible fall-run releases for telemetry studies | Redd extraction, juvenile seining, screw trap | Possible release of yearling fall-run in Reach 1A for telemetry studies | None | Tentative - 1,100 fall-run yearlings for telemetry |
| 2012 | Collect spring-run eggs & juveniles for captive rearing and in-river release<br><br>Possible collection of fall-run for research | Interim Conservation Facility and UCD<br><br>Backup – MOH | BC, FR, DC, MC – 300-900 eggs or juveniles<br><br>**Target** - 50-100 adult pairs | Up to annual allotment, minus broodstock needs | Redd extraction, juvenile seining, screw trap capture and egg transfers from FRH | Egg box or plate, gravel injection, streamside incubator, juvenile release | Fall-run jacks and precocious males only | None. Eggs may be placed directly into the river, pending permitting. |
| 2013 | Collect SS for captive rearing and in-river release<br><br>Spawn 2010 fall-run<br><br>Collect fall-run for research | Interim Conservation Facility<br><br>Backup – MOH | BC, FR, DC, MC – 300-900 eggs or juveniles | Up to annual allotment, minus broodstock needs | Redd extraction, juvenile seining, screw trap and egg transfers from FRH | Egg box or plate, gravel injection, streamside incubator, juvenile release | Spring-run jacks and precocious males only<br><br>≈ 30-60 fall-run pairs, offspring to MR | None. Eggs may be placed directly into nest boxes, pending permitting<br><br>Surplus yearling broodstock |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 2014 | Start new Hatchery<br>Collect spring-run eggs & juveniles for broodstock and in-river release<br>Spawn 2010/2011 fall-run<br>First opportunity to spawn spring-run broodstock | New Conservation Facility<br>Backup – Interim Conservation Facility | 900-2700 – eggs or juveniles<br>- Up to 10% (90-270 fish) from 2011 broodstock<br>- Balance from BC, FR, DC, MC<br>**Target** - 150-450 adult pairs | Up to annual allotment, minus broodstock needs<br>Surplus yearling broodstock | Redd extraction, juvenile seining, screw trap and egg transfers from FRH | Egg box or plate, gravel injection, streamside incubator, juvenile release | ≈ 5-15 spring-run pairs<br>≈ 50-100 fall-run pairs, offspring to MR | ≈ 6,000-18,000 hatchery smolts<br>Surplus yearling broodstock |
| 2015 | Collect spring-run eggs & juveniles for broodstock and in-river release<br>Increase spring-run broodstock spawning | Conservation Facility<br>Backup - iCF | 900-2700 – eggs or juveniles<br>- Up to 10% (90-270 fish) from broodstock<br>- Balance from BC, FR, DC, MC | Up to annual allotment, minus broodstock needs<br>Surplus yearling broodstock | Redd extraction, juvenile seining, screw trap and egg transfers from FRH | Egg box or plate, gravel injection, streamside incubator, juvenile release | ≈ 30-60 spring-run pairs<br>≈ 20-40 fall-run pairs, offspring to MR | ≈ 37,500-62,500 hatchery smolts<br>≈ 600-1,800 hatchery yearlings |
| 2016 | Collect spring-run eggs & juveniles for broodstock and in-river releases<br>Continue spring-run broodstock spawning | Conservation Facility<br>Backup - iCF | 900-2700 – eggs or juveniles<br>- Up to 10% (90-270 fish) from hatchery spawn<br>- Balance from BC, FR, DC, MC | Up to annual allotment, minus broodstock needs<br>Surplus yearling broodstock | Redd extraction, juvenile seining, screw trap and egg transfers from FRH | Egg box or plate, streamside incubator, juvenile release | ≈ 50-100 spring-run pairs | ≈ 60,000-125,000 hatchery smolts<br>≈ 3,000-6,000 hatchery yearlings |
| 2017 | Collect spring-run eggs & juveniles for broodstock and in-river releases<br>Increase spring-run broodstock spawning | Conservation Facility | 900-2700 – eggs or juveniles<br>- Up to 10% (90-270 fish) from hatchery spawn<br>- Balance from BC, FR, DC, MC | Up to annual allotment, minus broodstock needs<br>Surplus yearling broodstock | Redd extraction, juvenile seining, screw trap and egg transfers from FR | Egg box or plate, streamside incubator, juvenile release | ≈ 110-160 spring-run pairs | ≈ 130,000-200,000 hatchery smolts<br>≈ 6,000-12,000 hatchery yearlings |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 2018 | Collect spring-run eggs & juveniles for broodstock and in-river releases<br>Adult returns possible<br>Spawn broodstock and 10% of adult returns<br>Spawn potential adult returns | Conservation Facility | 900-2700 – eggs or juveniles<br>- Up to 10% (90-270 fish) of broodstock from SJR hatchery origin returns<br>- Balance from BC, FR, DC, MC | Up to annual allotment, minus broodstock needs<br>Surplus yearling broodstock | Redd extraction, juvenile seining, screw trap and egg transfers from FRH | Egg box or plate, streamside incubator, juvenile release<br>Possible hatchery adult releases | ≈ 150-450 spring-run pairs<br>Spawning up to 10% of SJR adult spring-run returns | ≈ 170,000-500,000 hatchery smolts (up to 1.5 mill with optimal results)<br>≈ 13,000-20,000 hatchery yearlings<br>Additional smolts from adult returns |
| 2019 | Collect spring-run eggs & juveniles for broodstock and in-river releases<br>Spawn broodstock and 10% of adult returns | Conservation Facility | 900-2700 – eggs or juveniles<br>- Up to 10% (90-270 fish) of broodstock from SJR hatchery origin returns, not to exceed 10% of returning population<br>- Balance from BC, FR, DC, MC | Up to annual allotment, minus broodstock needs<br>Surplus yearling broodstock | Redd extraction, juvenile seining, screw trap and egg transfers from FRH | Egg box or plate, streamside incubator, juvenile release<br>Possible hatchery adult releases | ≈ 150-450 spring-run pairs<br>Spawning up to 10% of SJR adult spring-run returns | ≈ 170,000-500,000 hatchery smolts (up to 1.5 mill with optimal results)<br>≈ 17,000-50,000 hatchery yearlings<br>Additional smolts from adult returns |
| 2020 | Last year of full collection of spring-run eggs & juveniles for broodstock and in-river releases<br>Spawn broodstock and 10% of adult returns | Conservation Facility | Final year of source stock collections<br>900-2700 – eggs or juveniles<br>- Up to 10% (90-270 fish) of broodstock from SJR hatchery origin returns<br>- Balance from BC, FR, DC, MC | Up to annual allotment, minus broodstock needs<br>Surplus yearling broodstock | Redd extraction, juvenile seining, screw trap and egg transfers from FRH | Egg box or plate, streamside incubator, juvenile release<br>Possible hatchery adult releases | ≈ 150-450 spring-run pairs<br>Spawning up to 10% of SJR adult spring-run returns | ≈ 170,000-500,000 hatchery smolts (up to 1.5 mill with optimal results)<br>≈ 17,000-50,000 hatchery yearlings<br>Additional smolts from adult returns |
| 2021 | Begin ramping down hatchery operations<br>First naturalized adult returns<br>Spawn broodstock and 10% of adult returns | Conservation Facility<br>Begin ramping down hatchery operations | No source stock collections | No source stock collections | No source stock collections | Egg box or plate, streamside incubator, juvenile release<br>Possible hatchery adult releases | ≈ 150-450 spring-run pairs<br>Spawning up to 10% of SJR adult spring-run returns | ≈ 170,000-500,000 hatchery smolts (up to 1.5 mill with optimal results)<br>≈ 17,000-50,000 hatchery yearlings<br>Additional smolts from adult returns |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| 2022 | Continue ramping down hatchery operations<br>Spawn broodstock and 10% of adult returns | Conservation Facility | No source stock collections | No source stock collections | No source stock collections | Egg box or plate, streamside incubator, juvenile release<br>Possible hatchery adult releases | ≈ 150-450 spring-run pairs<br>Spawning up to 10% of SJR adult spring-run returns | ≈ 170,000-500,000 hatchery smolts (up to 1.5 mill with optimal results)<br>≈ 17,000-50,000 hatchery yearlings<br>Additional smolts from adult returns |
| 2023 | Continue ramping down hatchery operations<br>Spawn broodstock and 10% of adult returns | Conservation Facility. | No source stock collections | No source stock collections | No source stock collections | Egg box or plate, streamside incubator, juvenile release<br>Possible hatchery adult releases | ≈ 150-450 spring-run pairs<br>Spawning up to 10% of SJR adult spring-run returns | ≈ 170,000-500,000 hatchery smolts (up to 1.5 mill with optimal results)<br>≈ 17,000-50,000 hatchery yearlings<br>Additional smolts from adult returns |
| 2024 | Continue ramping down hatchery operations<br>Spawn broodstock and 10% of adult returns | Conservation Facility | No source stock collections | No source stock collections | Continue rearing fish collected in 2020. | Egg box or plate, streamside incubator, juvenile release<br>Possible hatchery adult releases | ≈ 60-180 spring-run pairs (mainly 4 year old fish)<br>Spawning up to 10% of SJR adult spring-run returns | ≈ 70,000-200,000 smolts hatchery<br>≈ 17,000-50,000 hatchery yearlings<br>Additional smolts from adult returns |
| 2025 | Last year to spawn broodstock and 10% of adult returns | Conservation Facility | No source stock collections | No source stock collections | Probably no broodstock, though may continue spawning naturalized adults | Egg box or plate, streamside incubator, juvenile release<br>Possible hatchery adult releases | ≈ 15-45 spring-run pairs (last of the 5 year old fish)<br>Spawning up to 10% of SJR adult spring-run returns | ≈ 17,000-50,000 hatchery smolts<br>≈ 7,000-20,000 hatchery yearlings<br>Additional smolts from adult returns |

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# 8.0 Appendices

## *8.1 Contingency Planning*

Central to our reintroduction strategy is recognition that our plans (e.g. logistics, monitoring) will need to evolve as we implement and learn from our actions. We will rely on continued guidance from our technical team to make decisions to accommodate unforeseen circumstances. Here we outline some scenarios (not exhaustive) that have been formulated to build in flexibility to our reintroduction strategy to accommodate these possibilities.

### 8.1.1 Availability of donor stocks:

The genetic subcommittee recommends the use of multiple Chinook salmon spring-run stocks from the Sacramento River basin to re-establish a population on the San Joaquin River. Since spring-run salmon are listed as ‘threatened’ under the federal and state endangered species act, removing individuals from their native populations may cause demographic impacts to populations already at low abundances. We will rely on guidance from NMFS to determine the demographic parameters necessary for a putative donor stock to be used in our reintroduction program. These conditions may be satisfied in some, but not all years. As such, the specific donor stock(s) (or life stages) used in a given year will vary as a function of their availability. In future years, we aim to have information on the specific stock(s) or combination of stocks that successfully establish in the restoration area which may also influence our stock selection for future broodstock or releases into the river.

### 8.1.2 Condition of River

Some of the restoration actions associated with the Settlement will not be fully implemented prior to reintroduction of fish to the San Joaquin River in 2012. An assessment will be made regarding the likelihood of survival for introduced fish below Friant Dam. In the event that the river is not deemed hospitable by the technical team (Fisheries Management Work Group), alternate release locations (or release of fall-run fish) may be considered. This may involve trucking fish below areas that are deemed to be high risk to fish (to below barriers) or to downstream locations with temperatures or flows conducive to survival.

In some drier years, flows in the river may be limited and create challenges to fish migration and/or holding. In these cases, efforts may be made to trap and haul migrating adults upstream to more favorable spawning or holding habitat including the Conservation Facility.

### 8.1.3 Mortality of in-river spawners (adult rescues)

Once spring-run Chinook salmon return and spawn in-river (putatively a small initial population), efforts will be made to minimize prespawn mortality. If temperatures during the summer months are above physiological tolerance for adults or if fish health is determined to be compromised, these in-river adults may be retrieved from the river and brought in to the Conservation Facility to spawn, or adaptive management of flow releases can be used to improve temperature conditions.

### 8.1.4 No spring-run Chinook Salmon return

In the event that the abundance of spring-run Chinook salmon to the San Joaquin River does not reach sustainable levels after several generations of reintroduction efforts, Program efforts may shift to establishing viable fall-run Chinook salmon populations (fall-run ESU included in Settlement). All efforts would be made to determine the cause(s) of mortality that are preventing the success of spring-run Chinook salmon recruitment to the Restoration Area. If the technical team (Fisheries Management Work Group) determines that the stressors may not apply to the successful establishment of fall-run Chinook salmon (determined by the apparent success of fall-run Chinook salmon), then the reintroduction efforts may shift focus to fall-run populations.

### 8.1.5 Availability of Conservation Facility

The Conservation Facility will be initiated in phases. While the Program works to construct the full-scale conservation facility, an interim facility will be developed for practice captive rearing of non- ESA listed Chinook prior to working with spring-run Chinook in 2012 and be used to initiate spring-run Chinook captive rearing. The interim facility will be operated between 2010-2014, during full-scale conservation facility construction. In the event that the interim facility development is delayed, other facilities, such as UC Davis and Mokelumne River Hatchery may be used temporarily to hatch and captive rear fish for one to two years. Fish at UC Davis would be held at the Center for Aquatic Biology and Aquaculture. Fish at Mokelumne River Hatchery would be held in a segregated research area using two 10-ft diameter circular tanks. Once facility development is complete, the fish would be transferred and temporarily quarantined at the interim facility.

### 8.1.6 Mortality of hatchery brood (cohort failure):

Hatchery protocols minimize the spread of disease and several detailed procedures are outlined on how the hatchery anticipates reducing these risks (see HGMP section x). However, to the extent possible or feasible, we may consider rearing some individuals at an alternate facility in the event that failure of a(n) entire broodyear(s) occurs at the primary facility. This strategy has its tradeoffs. Not only can this be costly to maintain, but other conservation hatchery programs that have employed this back-up strategy have had difficulty in raising fish at the same developmental rate as the primary hatchery. This has limited the usefulness of the surrogate broodstock for use in the primary hatchery. Alternatively, in years where entire broodyears fail, juvenile spring-run Chinook salmon from the Feather River hatchery (or other donor stocks) could be released in-river in the relevant year to defray the impacts of the failed brood(s).

### 8.1.7 Flood conditions as it relates to hatchery brood

Flooding occurred at least once in recent history at the proposed hatchery grounds when in 1997 San Joaquin State Trout Hatchery was inundated by floodwater. At that time, many fish from the trout hatchery escaped to the adjacent San Joaquin River. However, approximately 20% of the trout remained in the uncovered raceways throughout the flood. In the event of future flooding, it is possible that fish from both facilities will again be released to the river. Measures will be taken to prevent fish loss during a flood event by netting the tops of fish tanks to prevent escape.

### 8.1.8 Funding

All of the restoration activities related to the reintroduction strategy require funds to implement. This includes funding for hatchery operations and all monitoring related activities. All primary responsibilities necessary to achieve the Settlement goals are contingent on funding availability (allocation). This poses the greatest challenge in anticipating what components of the reintroduction strategy, and fisheries management plan will be implemented.

## *8.2 Details of Transportation Method(s)*

Transportation of donor stock juveniles from donor watersheds to the Conservation Facility, or to the San Joaquin River will be accomplished by personnel from either the CDFG USFWS with previous experience transporting live fish, using one-ton 4-wheel drive Dodge Ram 3500, with heavy-duty suspension and a gross vehicle weight rating (GVWR) of 12,500 pounds equipped with a 500-gallon Aquaneering® fish transport tank. The single compartment tank is designed to be transported by, at minimum, a one-ton stake bed truck, or a heavy-duty transport trailer with gross vehicle weight rating of approximately 10,000 lbs. The tank is made of double-wall aluminum, insulated with 2 inch polyurethane foam, with the dimensions 46" wide x 84" long x 42" high. The tank is fitted with a 12" x 16" dump gate for easy release of large salmon and has a large 41" x 48" hinged lid to allow easy access to fish and the ability to stand in the tank while working with fish. Oxygen gas is supplied to the tank using compress oxygen gas cylinders and two Pointfour® micro-bubble diffusers. Additional oxygenation and $CO_2$ degassing is provided by two Fresh Flow®, 75 GMP, 12 volt, impeller-driven aerators. The aerators will be power by the vehicles 12-volt electrical system. A gas powered AC/DC generator will be available to operate aerators in the event of failure to the vehicle’s electrical system. Aerator indicator lights and oxygen gas flow meters will be viewable by the driver at all times for easy monitoring of the tank’s life-support system. The truck will be stopped after 30 minutes of transportation and each hour thereafter for visual inspection of the life-support system and fish health and wellbeing. Dissolved oxygen levels will be monitored and maintained near saturation during transport. Currently the CDFG contact for transport operations is Paul Adelizi, CDFG, 1234 E. Shaw Ave., Fresno, CA 93710 Addition qualified personnel will be hired in the coming months/years.

The tank will be filled with stream water immediately prior to transport using a portable, screened water pump. Transport water will be supplemented with sodium chloride to provide a physiologically isotonic concentration to minimize ionic disturbances. When possible, fish will be moved in and out of the transport truck using a water-filled vessel (i.e., water to water transfer) and without netting to minimize stress and loss of slime. Transport and holding times may exceed 4 hours but will be limited to 6 hours. Water will be tempered to the receiving water at the predetermined release location before transferring fish, by pumping receiving water directly into the transport tank until the temperature difference is two degrees Celsius or less.

#### 8.2.1 Quarantine Procedures

Quarantine procedures will be instituted for fish that are transported to the hatchery for temporary or long-term holding. Typically, fish introduced to the Conservation Facility will be treated with an eight hour oxytetracycline bath followed by a three day course consisting of a one hour formalin drip at 170 ppm. During the quarantine period, the fish will be screened for the presence of specific pathogens, and they will be treated as directed by the pathologists.

#### 8.2.2 Effluent Treatment

River water entering the Conservation Facility from donor watersheds will be considered to contain pathogens and will be only released to the quarantine tanks and treated as described above. Water not released at the hatchery will be released at a predetermined appropriate location on dry ground where there is no drainage to the hatchery or aquatic area.

#### 8.2.3 Disposition

The final disposition of broodstock collected will either be the Conservation Facility for rearing, or direct introduction to the San Joaquin River. For trap and haul operations, fish will be released back to the San Joaquin River at appropriate release locations. Mortalities from either transported donors or trap and haul fish will be necropsied and disposed of appropriately. Carcasses of mortalities will be frozen and generally disposed of through the hatchery solid waste disposal system, which involves ultimate disposal at the municipal disposal facilities. Carcasses derived from mortalities that have undergone adequate depuration following chemical treatment may be used to provide nutrient loading in streams.

#### 8.2.4 Indirect Mortality

The goal of the Program will be to maintain mortality between 0 - 0.5 percent during trap and haul operations. Fish will be monitored after release to identify post release mortality. If mortality exceeds 0.5 percent, collection and transportation methods will be modified.

#### 8.2.5 Emergency contingency plan

A gas powered AC/DC generator will be available to operate aerators in the event of failure to the vehicle’s electrical system. Aerator indicator lights and oxygen gas flow meters will be viewable by the driver at all times for easy monitoring of the tank’s life-support system. In the event that the vehicle becomes immobilized, a towing company will be used to tow the vehicle to the release location, or if the tank is used on the 14-ft trailer, a backup vehicle will be used to complete the delivery.

### *8.3 Details of Annual Donor Stock Selection Process*

### 8.3.1 Introduction

On September 30, 2010 the U.S. Fish and Wildlife Services applied for a *10(a)1(A), enhancement of species permit application for the reintroduction of Central Valley spring-run Chinook salmon into the San Joaquin River* (Permit), as per the Settlement. The Permit includes much of the information contained in the Reintroduction Strategies Document and Stock Selection Strategies; however, it also includes a planning and decision framework for donor collection. A summary of this process and associated decision matrix and reporting is outlined within this document.

The decisions regarding donor stock selections cannot be predicted *a priori* for each year during the duration of the permitted activity. The Program recognizes that conditions change (i.e. census size, donor stream conditions), the Conservation Facility is not completed, and the restoration of the San Joaquin River has not begun. The Program also recognizes that flexibility in donor stock collections will be required in order to reduce impacts on the population viability of the ESU and/or the populations within each potential source stream. For these reasons the Program proposed a donor stock collection planning process that will operate in real time, and be adaptive to population fluctuations and extant of habitat conditions. No specific decision on donor stock collection (i.e. numbers, method, location, etc.) will be made without an annual review process. The Donor Stock Collection Annual Decision Process is summarized below.

#### 8.3.1.1 Donor Stock Collection Annual Decision Process

A suite of collection methods across life stages are proposed subject to permit approval and an adaptive process that includes assessment of current population conditions, habitat characteristics, fish distribution, and spawning phenology. The donor stock collection decision process will be an interagency process, and will receive technical input from technical teams, such as the FMWG. The objective of this process is to adaptively manage annual collections within the context that assures no detrimental effects to the viability of each donor stream population. In addition, this process will ensure that specific collection locations and methods will follow best available practices to minimize take within the umbrella of the  reintroduction program.

The technical team will use real time information for planning and implementation. This information will include, but not limited to: population status, life stage(s) present, physical availability of donor stock, ease of capture method and its associated impact to individual (stress, injury, survival), Conservation Program status, benefits to the Conservation Program, and other pertinent information.. Potential impacts to donor populations will be assessed based on, but not limited to: induces stress to non-targets, negative effects from habitat disturbance, absolute numbers taken from donor populations, and the genetic implications for each method utilized. Other considerations may arise through further monitoring and research, and these may influence future planning.

This information, along with further data made available as knowledge from genetic studies, monitoring and method refinement (based in part as learning follows implementation of this study itself) will be critical to inform the specific details for future collections within refined stock selection strategies.

In addition, the interagency team will consider any updated numeric guidelines provided by NMFS to determine allowable collection limits with respect to current population trends (see Section 1.2 Decision Matrix).

Upon reviewing the available information, the team will confer and make a formal recommendation to the Service SJRRP Program Manager for stock selection for that year. The SJRRP Program Manager, or designated staff, will compile the information provided into an annual Donor Stock Collection Plan (DSC Plan), which will be submitted to NMFS and DFG in the form of a formal request.

#### 8.3.1.2 Decision Matrix

The Decision Matrix will function in real time and adapt to natural and population conditions, using best professional judgment of the FMWG and subject to guidance provide within the Permit application. This will allow the Program to adaptively manage annual collections within the context that assures no detrimental effects to the viability of each donor stream population.

NMFS's Southwest Science Center is working on criteria and guidance that should allow determination of appropriate collection levels by watershed. In the absence of this document, the Permit application includes basic guidelines following Lindley et al. (2007) results that are intended to place the proposed donor stock collections (a decision matrix to frame the DSC planning) within a population viability context. This process will be adaptive to incorporate improved and update analyzes that will serve as the guiding framework underpinning the adaptive process serving future DSC Plans and subsequent official requests from the Service to NMFS and DFG.

For each system, the Program will choose a metric upon which to base permissible collection limits. These metrics may vary due to the unique physical or biological characteristics of each stream, and available real-time abundance estimates. As an initial framework, the Program proposed a tiered decision approach that incorporates an established benchmark (extinction risk), and a methodology that is derived from the Lindley et al (2007) work within the context of the current trends evidence by existing monitoring programs. Appendix A of the Permit application further explains the decision matrix.

Once these criteria are known, the Program will be monitoring for those numeric thresholds and "triggers" to be achieved in respective watersheds, and implementing the donor stock collections commensurate with adult returns (and/or other monitoring data). Determination of when thresholds and "triggers" are met will be based on real-time survey and count information made available by various agencies, including DFG, over the duration of the collection season. Summary data on adult escapement values from the watersheds of interest will be available mid-January annually at the Project Work Team meeting (held by the biologists collecting escapement data on their respective rivers), which will further inform the Program if thresholds have been met and if collection can continue. Continual monitoring and evaluation of Program activities, consistent with implementation of the DSC Plan will occur, along with assessment of whether performance standards and performance indicators have been met.

The Program anticipates that NMFS and NMFS Southwest Science Center will establish biologically-relevant thresholds or “triggers” for donor stock collection that limit the detrimental effects on the “wild” populations, but allow collection activities to occur. In the Permit application the Program proposes possible criteria for this but were aware that the NFMS Southwest Science Center is also working on criteria.

#### 8.3.1.3 Donor Stock Collection Plan

The annual DSC Plan will be developed by a multi-agency technical team and will describe and evaluate the entire year’s field activities. Which include, at a minimum: the project impact to stocks, take totals, the full collection request (specific numbers, by lifestages, by collection method, by donor source), and the proposed annual timing for reporting the collection methods. Collection requests will include the rationale and justification for the specified numbers, sources, lifestages, and collection methods.

The DSC Plan will also include a summary of data evaluated by the interagency team, notes from the group’s deliberation from development to recommendations, and the Service’s rationale underlying the conditions of the permit and the FMWG technical recommendations through the permitting guidelines established through the 10(j) ruling. In addition, the DSC Plan will include any additional information NMFS requires for issuance of the Permit.

The DSC Plan will be submitted to NFMS and DFG for approval, according to the timeline outlined in the Permit. Since the Program is utilizing a multi-strategy approach, an interim/subsequent DSC Plan may be necessary at times to include request not submitted in the original plan, or to change a request based on real time information.

### 8.3.2 Details of Donor Stock Collection Plan

The sections below describe and list the information the Program anticipates NMFS will require be included in the DSC Plan. A DSC Plan outline/format is still under development, however, it is anticipated that the DSC Plan will include the flowing: collection targets (as a total, by donor stream, and by life stage), collection methods, collection locations, transportation methods, disposition of fish, and monitoring plan. Additional information may be included during the development of this document or if deemed necessary by State or Federal fishery jurisdictional agencies.

#### 8.3.2.1 Collection Targets

As mentioned above in Section 1.2 Decision Matrix, we anticipate that approval for annual collections will be vetted through the Decision Matrix still under development. The results of the decision matrix will be included in the DSC Plan. These results will be our collection targets.

#### 8.3.2.2 Collection Method(s)

Collection protocols will be developed and included in the DSC Plan. Collection methods may be implemented differently in each donor stream, or within each donor stream, and those differences will be clearly identified and included in the collection protocols. The DSC Plan will only contain collection protocols the Program anticipates using that year. Collection protocols may change or be refined in future DSC Plans as data, from future studies and monitoring, is made available. It is anticipated that the collection protocols will include detailed information on the following:

- Capture methods and gear that will be used.
- All samples and measurements that will be taken.
- Disposition of tissues (if tissue samples are taken)
- How species will be handled, including any anesthesia to be used.
- Measures to minimize effects to species
- How species will be cared for after capture
- Indirect mortality, percentage of indirect mortality expected due to action.
- Effects of research on the behavior and physiology of the fish, including probability of mortalities.
- Emergency Contingency Plan

Collection protocols may include additional information as deemed necessary by the Program or by State or Federal fishery jurisdictional agencies. During the course of collection, the Program will monitor and report the progress of collection activities to the Service (see Section 3.0).

##### *8.3.2.2.1 Collection Location(s)*

Collection locations will be identified by coordinating with fishery agency staff and managers who work on the donor systems. These locations will be included in the DSC Plan. It is anticipated that NMFS will require the following information:

- Describe location(s) of collection, and what collection method will be used.
- Fill out “Take Location #1 Description,” for each take location. See Table 9-1.
- Fill out “Detailed Take Table, Location #1,” for each take location. See Table 9-2.
- Map of collection locations

**Table 8-1. Take Location Table**

| **Take Location #1 Description** | |
|---|---|
| **State/Territory:** | |
| **Basin (4th Field HUC):** | |
| **Begin Mile:** | |

| | |
|---|---|
| **End Mile:** | |
| **Township, Range, Section, Latitude, Longitude, UTM Northing, and UTM Easting:** | |
| **Location Description:** | |

**Table 9-2 Detailed Take Table**

| Detailed Take Table, Location #1 | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| SPECIES | LISTING UNIT/STOCK | PRODUCTION/ORIGIN | LIFESTAGE | SEX | EXPECTED TAKE | INDIRECT MORTALITY | TAKE ACTION | OBSERVE/COLLECT METHOD | PROCEDURES | RUN | BEGIN DATE | END DATE |
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### 8.3.4 Transportation Method

A general description of transportation methods are included in Appendix 8.2. The Transportation appendix will be used as a starting point to develop the transportation protocols needed for the DSC Plan. Only transportation methods that will be utilized that year will be included in the DSC Plan. Transportation methods may change or be refined in future DSC Plans as data, from future studies and monitoring, is made available.

It is anticipated that NMFS will require the following information be included in the DSC Plan.

#### *Mode(s) of Transportation*

Describe the mode of transportation. Including a description of the vehicle(s) used to transport live fish and the name of the transportation company/agency, if applicable, and the qualifications of the common carrier to transport live fish. Specify whether a contractor will do the transportation, and include any relevant information.

#### *Transport Time*

Estimate the maximum amount of time fish may be in transport.

#### *Qualified transport personnel*

Give the name, affiliation, and contact information for each person.

#### *Destination*

If fish will be released in another body of water, provide details of the location. If the fish will be taken to a facility, provide details of the location.

#### *Containment methods*

Describe the containment system for the fish, quarantine procedures, and effluent treatment. Description of the container (e.g., tank) used to hold the fish during transit, including the material of the container and its dimensions. Include any special care procedures (e.g., medicines, aeration) to be administered during transport. The final disposition of the fish, for example, whether the fish will be released, sacrificed, or taken to the Conservation Facility (e.g., retain alive for six months, then release, sacrifice for tissue analysis).

#### *Emergency contingency plan*

Develop emergency contingency plans for anticipated failures that may occur (e.g. vehicle breaks down).

### 8.3.5 Reintroduction Method(s)

The Program needs to be sure about donor stock disposition with respect to hatchery operational status and/or habitat conditions in the mainstem San Joaquin River for reintroduced individuals. The Program recognizes that conditions change, the hatchery is not completed, and the restoration has not begun. Spring-run Chinook salmon which are relocated to the Conservation Hatchery will still be subject to the 10(a)1(A) provisions pursuant to the Permit application and HGMP. Spring-run Chinook salmon which are translocated to the San Joaquin River will be subject to the experimental 10(j) designation. At this time it unknown if the fishery jurisdictional agencies will require the same level of detail information regarding the in-river introduction methods as with the collection methods. If so, then the DSC Plan will include a reintroduction methods section that will include detailed protocols and associated monitoring, and be consistent with the collection protocols. It is anticipated that the reintroduction protocols would include the following:

- Release methods and gear that will be used.
- All samples and measurements that will be taken.
- Disposition of tissues (if tissue samples are taken)
- How species will be handled, including any anesthesia to be used.
- Measures to minimize effects to species
- Indirect mortality, percentage of indirect mortality expected due to action.
- Effects of research on the behavior and physiology of the fish, including probability of mortalities.
- Monitoring of released population
- Emergency Contingency Plan

Reintroduction protocols and monitoring may include additional information as deemed necessary by the Program or by State or Federal fishery jurisdictional agencies

### 8.3.6 Donor Stock Collection Monitoring Program

There will be ongoing monitoring during the course of the collection season(s). A donor stock collection monitoring program will be established. Staff responsible for collection, transport, rearing , and release activities will compile information covering all project activities, which will eventually comprise the annual tallies, monitoring, and rearing activities that shall be submitted to NMFS and DFG in an annual report of donor stock collection and hatchery operations. During the course of collection, the FMWG will monitor the progress of collection activities and report back to the Service throughout the course of collections.

Monitoring that is essential for reporting requirements and meeting performance standards will be included in the donor stock collection monitoring program, along with associated research and further investigations necessary to improve the performance of underling methodology. The monitoring program will be developed in conjunction with the DSC Plan.

In-stream monitoring of the San Joaquin River and experimental population will developed by the FMWG. This monitoring will be included in the DSC Monitoring Plan if deemed necessary by the State or Federal fishery jurisdictional agencies.