Fisheries Implementation Plan 2009-2010

January 12, 2010 Draft

Fisheries Management Work Group

Table of Contents

Figures

Tables

Executive Summary

After more than 18 years of litigation, the lawsuit known as *NRDC et al. v. Kirk Rodgers et al.*, reached a Stipulation of Settlement (Settlement) was reached. On September 13, 2006, the Settling Parties agreed on the terms and conditions of the Settlement, which was subsequently approved by the U.S. Eastern District Court of California on October 23, 2006. The Settlement established Restoration and Water Management Goals. The Restoration Goal was to restore fish populations in "good condition" below Friant Dam to the confluence of the Merced River. The San Joaquin River Restoration Program (SJRRP) will implement the Settlement.

The SJRRP Fisheries Management Plan (FMP) was created to provide a roadmap to adaptively manage efforts to restore and maintain naturally reproducing and self-sustaining populations of Chinook salmon and other fishes in the San Joaquin River between Friant Dam and the confluence with the Merced River. The FMP identified the fisheries management of the SJRRP on a program level. This document includes workplans addressing site-specific studies that are related to the goals and objectives of the FMP.

The Fish Management Work Group prioritized study proposals that were then elevated to workplans. Proposals were prioritized based on: implementation date, phase status, and whether or not agencies had work related to the proposal in progress. Workplans included in this document received very high or high priority status by the FMWG for 2010. This document is a working draft, and other plans will be included as the program progresses.

Introduction

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 the Central Valley Project (CVP) Friant Division (FD) contractors. After more than 18 years of litigation of this lawsuit, known as *NRDC et al. v. Kirk Rodgers et al.*, a Stipulation of Settlement (Settlement) was reached. On September 13, 2006, the Settling Parties, including NRDC, Friant Water Users Authority (FWUA), and the U.S. Departments of the Interior (Interior) and Commerce, agreed on the terms and conditions of the Settlement, which was subsequently approved by the U.S. Eastern District Court of California 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 FD long-term contractors that may result from the Interim Flows and Restoration Flows provided for in the Settlement.

The Settlement establishes a framework for accomplishing the Restoration and Water Management goals that will require environmental review, design, and construction of projects over a multiple-year period. To achieve the Restoration Goal, the Settlement requires a combination of channel and structural modifications along the San Joaquin River below Friant Dam, releases of water from Friant Dam to the confluence of the Merced River (Figure 1), and the reintroduction of Chinook salmon. To achieve the Water Management Goal, the Settlement requires the downstream recapture of Restoration Flows to replace reductions in water supplies to Friant Division long-term contractors resulting from the release of the Restoration Flows, establishes a Recovered Water Account, and allows the delivery of surplus water supplies to Friant Division long-term contractors during wet hydrologic conditions.

For additional information regarding the Settlement and the San Joaquin River Restoration Program (SJRRP), the reader is referred to the Implementing Agencies guidance document known as the Program Management Plan (PMP) (www.restoresjr.net).

The SJRRP Fisheries Management Plan (FMP) was created by the Fisheries Management Work Group (FMWG) to provide a roadmap to adaptively manage efforts to restore and maintain naturally reproducing and self-sustaining populations of Chinook salmon and other fishes in the San Joaquin River between Friant Dam and the confluence with the Merced River (Restoration Area). The FMP addresses the SJRRP *on a programatic level* and refers to how the Settlement will be implemented from a fisheries perspective. Whereas the FMP describes the adaptive management approach of the SJRRP, associated workplans addressing site-specific monitoring and research studies are included in this document. Below is a list of the program's goals (qualitative) and objectives (quantitative) since these are related to the FMWG workplans. The reader is referred to the FMP for justification of these goals and objectives.

Program Goals and Objectives

The five population goals are:

- Establish natural populations of spring-run and/or fall-run Chinook salmon that are specifically adapted to conditions in the upper San Joaquin River. Allow natural selection to operate on the population to produce a strain that has its timing of upstream migration, spawning, outmigration, and physiological and behavioral characteristics adapted to conditions in the San Joaquin River. In the case of spring-run Chinook salmon, the initial population would likely be established from Sacramento River Basin stock. For fall-run Chinook salmon, the nature of the Settlement flow regime indicates it may be desirable to establish late-spawning (November to December), fall-run Chinook salmon from tributaries of the San Joaquin River (e.g., Merced or Tuolumne rivers).

- Establish populations of spring-run and/or fall-run Chinook salmon that are genetically diverse so they are not subject to the genetic problems of small populations, such as founder's effects, inbreeding, and high risk of extinction from catastrophic events. The minimum population threshold established in the Settlement was set with this goal in mind and suggests genetic and population monitoring will be required.

- Establish populations of spring-run and fall-run Chinook salmon that are demographically diverse in any given year, so returning adults represent more than two age classes. Given the vagaries of ocean conditions, the likelihood of extreme droughts, and other factors that can stochastically affect Chinook salmon numbers in any given year, resiliency of the populations requires that multiple cohorts be present. Chinook salmon populations in the Central Valley are dominated by 3-year-old fish, plus 2-year-old jacks, partly as the result of the effect of fisheries harvest. Both population resiliency and genetic diversity require that 4-, 5-, and even 6-year-old Chinook salmon be part of the population each year.

- Each population (spring-run, fall-run) should show no substantial signs of hybridizing with the other. In addition, each population (spring-run, fall-run) should show no substantial signs of genetic mixing with non-target hatchery stocks.

- Establish a balanced, integrated, adaptive community of fishes having a species composition and functional organization similar to what would be expected in the Sacramento-San Joaquin Province.

The following habitat goals focus on Chinook salmon and other native fishes:

- Restore a flow regime that (1) maximizes the duration and downstream extent of suitable rearing and outmigration temperatures for Chinook salmon and other native fishes, and (2) provides year-round river habitat connectivity throughout the Restoration Area.

- Provide adequate flows and necessary structural modifications to ensure adult and juvenile passage during the migration periods of both spring-run and fall-run Chinook salmon.

- Provide suitable habitat for Chinook salmon holding, rearing and outmigration during a variety of water year types, enabling an expression of a variety of life-history strategies. Suitable habitat will encompass appropriate holding habitat, spawning areas and seasonal rearing habitat.

- Provide water-quality conditions suitable for Chinook salmon and other native fishes completing their life cycle without lethal or sublethal effects.

- Reduce predation losses in all reaches by reducing the extent and suitability of habitat for nonnative predatory fish.

- Restore habitat complexity, functional floodplains, and diverse riparian forests that provide habitat for spawning and rearing by native resident species during winter and spring.

The SJRRP population objectives are listed below.

1. A 3-year target of a minimum of 2,500 naturally produced adult spring-run Chinook salmon and 2,500 naturally produced adult fall-run Chinook salmon.

2. Each year, a minimum of 500 naturally produced adult spring-run and adult fall-run Chinook salmon each should be in adequate health to spawn successfully. Thus, the minimum annual effective population target would be 500 adult Chinook salmon of each run. The expectation is that there will be a 50-percent sex ratio. Additional objectives related to genetics are identified in Exhibit E of the FMP and will be further described in the Genetics Management Plan.

3. Ten years following reintroduction, less than 15 percent of the Chinook salmon population should be of hatchery origin. Additional objectives related to genetics are identified in Exhibit E of the FMP and will be further described in the Genetics Management Plan.

4. A Growth Population Target of 30,000 naturally produced adult spring-run Chinook salmon and 10,000 naturally produced fall-run Chinook salmon (Table 3-1).

5. Prespawn adult Chinook salmon mortality related to any disease should not exceed 15 percent.

6. Mean egg production per spring-run female should be 4,200, and egg survival should be greater than or equal to 50 percent.

7. A minimum annual production target of 44,000 spring-run Chinook salmon juveniles and 63,000 fall-run Chinook salmon juveniles and maximum production target of 1,575,000 spring-run Chinook salmon juveniles and 750,000 fall-run juveniles migrating from the Restoration Area. Juvenile production includes fry, subyearling smolts, and age 1+ yearling smolts. Estimated survival rate from fry emergence until they migrate from the Restoration Area should be greater than or equal to 5 percent. Ten percent of juvenile production for spring-run Chinook should consist of age 1+ yearling smolts.

8. The incidence of highly virulent diseases should not exceed 10 percent in juvenile Chinook salmon.

9. A minimum growth rate of 0.4 grams per day (g/d) during spring and 0.07 g/d during summer should occur in juvenile Chinook salmon in the Restoration Area.

10. Document the presence of the following fish assemblage structures in the Restoration Area: rainbow trout assemblage (Reach 1), pikeminnow-hardhead-sucker assemblage (Reaches 2 through 5), and deep-bodied fish assemblage (Reaches 2 through 5).

11. Over 50% of the total target river length should be estimated to be in good condition (benthic index of biotic integrity (B-IBI) = 61-80) or very good condition (B-IBI=81-100). In addition, none of the study sites should be in "very poor condition" (B-IBI=0-20).

Development of the Implementation Plan

Background

The FMWG comprises representatives from the U.S. Bureau of Reclamation (Reclamation), U.S. Fish and Wildlife Service (USFWS), National Marine Fisheries Service (NMFS), California Department of Fish and Game (DFG), California Department of Water Resources (DWR), and consultants and was organized to write the FMP, and then follow up with an Implementation Plan consisting of workplans related to the goals and objectives of the program (as outlined in the FMP).

Following completion of the FMP, the FMWG began working on the Implementation Plan. The development of the Implementation Plan was a four-step process. First, the FMWG reviewed the program's goals and specific objectives. The objectives were matched to the Settlement timeline, and members of the FMWG were assigned to write general study proposals to address aspects of the FMP viewed to be possible priorities for 2010. Next, proposals were reviewed by FMWG members to ensure objectives of the proposals matched objectives of the FMP. The third step was a FMWG review of each draft, and suggested revisions to the author (the agency responsible for specific proposals made the final determination regarding which revisions to accept or decline). Finally, revised proposals were prioritized based on: implementation date, phase status, and agency priorities (details are included in the following section). Study proposals receiving high or very high priorities were elevated to workplans (Table 1), meaning the author/agency responsible for that proposal would develop the specifics of how the study would be completed. Workplans (included as appendices to this document) were elevated to the Bureau of Reclamation for funding. These workplans were determined by the FMWG to be necessary for the success of the fisheries adaptive management program; however, not all workplans received funding due to other funding priorities. Details of the prioritization process for the development of workplans are described below.

Prioritizing Proposals

Revised proposals were prioritized based on: implementation date, phase status, and work plan status (Figure 2). Proposals having a tentative implementation date of 2009 or 2010 received the highest priority. Second priority was assigned to those proposals with Phase I actions (improvements dictated as necessary under the Settlement, that must be completed by December 2013) listed in the Settlement that were not covered under the 2009 and 2010 criteria. Third priority went to study proposals that were associated with work in progress by an agency, and in the following order: 1. Hills Ferry Barrier, 2. Sediment Plan, and 3. Filling of the mining pits. The lowest priorities were those plans with Phase II actions (improvements dictated as necessary under the Settlement, that must be completed by December 2016) or with timelines of 2014 or later (items related to hydrograph flexibility).

Table 1. Workplans prioritized by the FMWG. Bold workplans are those selected by management (Bureau of Reclamation) for fall 2010 implementation. Italicized items were funded by other sources (i.e., California Department of Fish and Game, NMFS).

Proposal	Workplan	Description	Chapter 5 FMP Objective	2010 Priority
Genetics	Captive Rearing	Captive Rearing experiments with fall-run Chinook salmon	**I**	High
	Genetic Research	**UC Davis genetics contract**	**I**	**High**
	Stock Selection	*Methods for assessing donor stock*	**I**	High
	Permitting	*Genetic management planning to support reintroduction permit and HGMP*	**I**	High
Habitat Assessment	*Habitat Assessment*	*Characterization of major riverine habitat types in Restoration Area*	**L, N, O, Q**	High
Hills Ferry Barrier	**Hills Ferry Barrier Effectiveness Evaluation**	**Hills Ferry Barrier management investigation to assess potential use during spring flows**	**E, L**	**Very High**
Macroinvertebrate	*Benthic macroinvertebrate study*	*Macroinvertebrate study using SWAMP methodology*	**R**	Medium
Entrainment/passage	*Passage Assessment*	*Fish Migration Assessment*	**D, F**	High
Peer Review	Fisheries Management Plan Peer Review	Peer review of public draft of FMP	Not applicable	High
Sediment	Spawning Gravel Assessment	Spawning gravel quantity and quality assessment in Reach 1	**O**	Medium
Water Quality	**Water Quality Constituents**	**Measurement of select constituents in the Restoration Area**	**J**	**Very High**
Water Temperature	**Water Temperature Monitoring**	**Water temperature conditions in the Restoration Area**	**G, H**	**Very High**

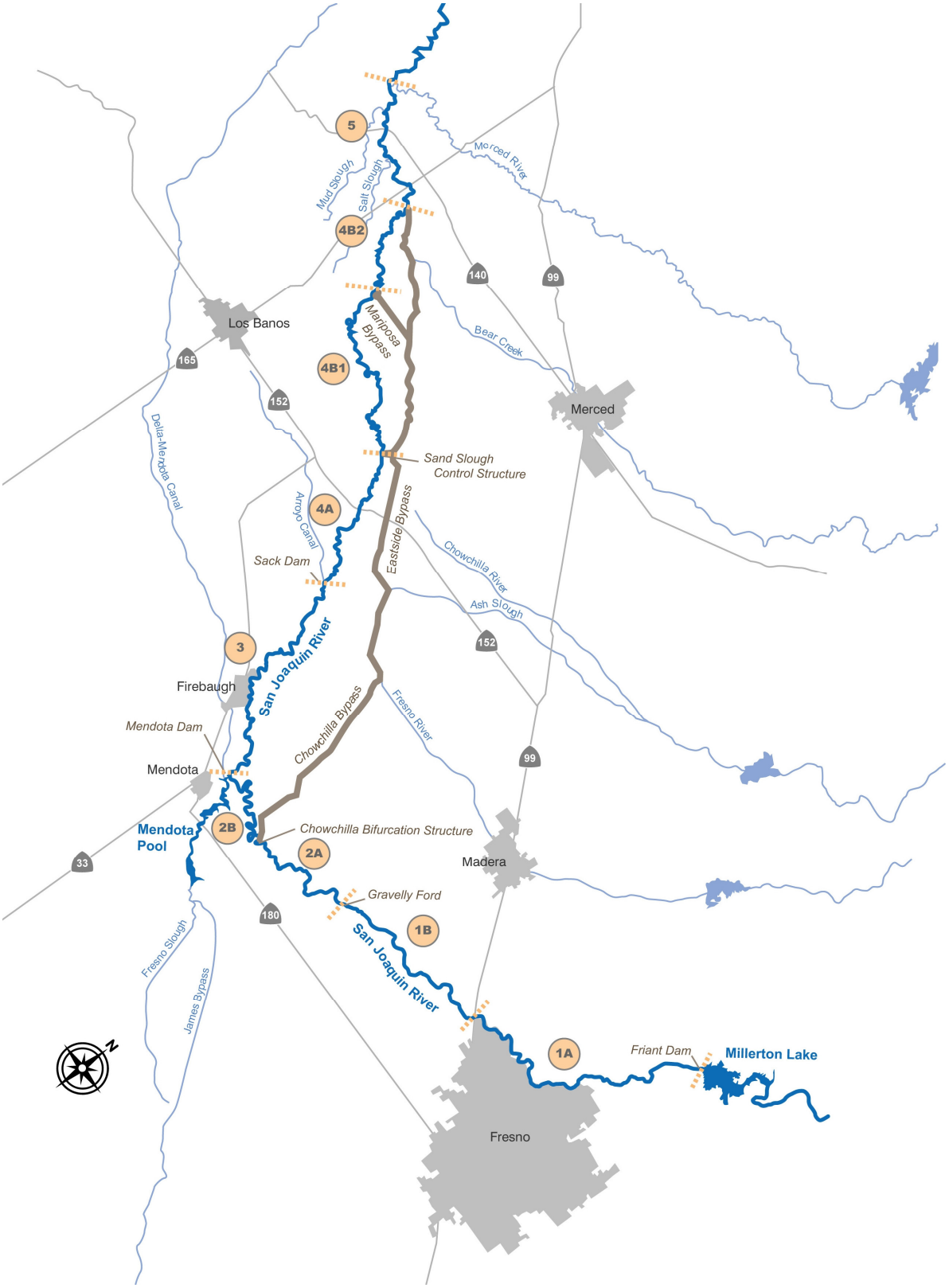


Figure 1. Restoration area of the San Joaquin River from Friant Dam to the confluence with the Merced River.

Figure 2. Flow chart depicting the process used by the FMWG to develop workplans to include in the Implementation Plan.

Workplans

Workplans included in this document received a high or very high priority by the FMWG for 2010 (other plans will be included as the SJRRP progresses). The workplans were submitted by various agencies and are, therefore in a variety of formats. Workplans are in the form presented to the FMWG, and are included as appendices to this document. A summary of each workplan is included below (alphabetical order).

Workplan Summaries

Genetics, Captive Rearing (Appendix A)**:** The Genetics Subgroup of the SJRRP has concluded that the use of a properly operated conservation hatchery is appropriate to increase the chance of successfully reintroducing a self-sustaining population of spring- and fall- run Chinook to the San Joaquin River. The Department of Fish and Game is currently completing necessary pre-planning for development of such a facility. The facility would be designed to provide maximum flexibility to accommodate future management actions for fish propagation. However, full-scale hatchery construction will likely not be completed before summer 2013. Therefore, an Interim Facility is proposed for conducting near-term fish research and fish reintroduction while full-scale facilities are constructed. This workplan proposes completion of the following objectives in order to develop the Interim Facility: 1.Complete modifications to Friant Dam hatchery water supply and the San Joaquin Hatchery aeration tower to allow sufficient quantities of water to flow from Friant Dam to SJH for salmon recovery projects, and 2. Design and construct an Interim Salmon Reintroduction facility that emphasizes the latest techniques and infrastructure to improve juvenile salmon behavioral traits and fitness that better reflects those of naturally produced juveniles.

Genetics, Research (Appendix B)**:** Reduced genetic viability may limit the success of Chinook salmon restoration. A description of the potential impact of reduced genetic viability and the objectives and associated actions for reducing this limiting factor are described in the Fisheries Management Plan. In addition, spring- run Chinook salmon genetic information is needed to adequately apply to NMFS for the ESA Section 10(A)1(a) permit for reintroduction and for artificial propagation planning purposes. The FMWG developed a genetics workplan describing genetics work needed to maintain the Programs schedule (through alternative contracting mechanisms).

Genetics, Stock Selection (Appendix C): The Settlement requires the reintroduction of spring run Chinook salmon to the San Joaquin River. A description of methods to maintain a naturally reproducing, self-sustaining population over the long-term are needed. Successful long-term maintenance of spring-run will require methods that promote and protect genetic diversity in the reintroduced population. A draft workplan was developed describing the appropriate methods to establish a viable population of spring run Chinook salmon and includes a list of decisions needed to select the founding population(s), alternative reintroduction strategies, innovative monitoring protocols and adaptive management principles as the population becomes established.

Genetics, Permitting (Appendix D): To meet the requirements of the Settlement and the San Joaquin River Restoration Act in terms of the designation of an experimental population of spring-run Chinook salmon in the San Joaquin River, a draft workplan was developed. The workplan details the specific steps necessary for the application and subsequent ESA 10(j) experimental designation and introduction of Central Valley spring-run Chinook into the Restoration Area.

Habitat Assessment (Appendix E): *currently under revision by DFG*

Hills Ferry Barrier Evaluation (Appendix F): The objectives of the Hills Ferry Barrier Evaluation are 1. Evaluate barrier effectiveness under a variety of flow conditions; 2. Collect data for detectable fish that arrive at the barrier, and; 3. Identify problems, limitations and improvements in operation and evaluate structural and non-structural barrier modifications and/or locations that may increase barrier effectiveness. A dual frequency identification sonar (DIDSON) will be deployed to help visually estimate the number and species of fish at the barrier and identify structural defects in the barrier that may reduce effectiveness. A trap will be installed on the barrier to collect detailed information about fish arriving at the barrier. Tissue samples will be collected for genetic analyses and fish will be marked and released to evaluate survival. Information will be collected about conditions through the operational season and problems encountered to evaluate potential changes and/or design improvements. The barrier will be evaluated under as many flow conditions as possible enabling a qualitative assessment of passage for native species. Results from this evaluation are expected to provide a better understanding of what anadromous and resident species encounter the barrier, and how to improve operation of the barrier. Additionally, this will provide methods to test potential barriers at mud and salt sloughs.

Macroinvertebrate Assessment (Appendix G)**:** The main objective of the benthic macroinvertebrate (BMI) assessment is to establish baseline measures to estimate the impact of restoration flows and other San Joaquin River Restoration Program (Program) actions on the ecological integrity and water quality conditions, as indicated by changes in BMI assemblages in the Restoration Area. To meet this objective, we propose to delineate survey transects and determine ancillary water quality parameters followed by BMI collection at designated sampling locations. These measurements will help evaluate physical habitat conditions as they relate to the status of BMI assemblages. The proposed study will provide information associated to physical habitat objectives set forth by the Fisheries Management Plan that, in conjunction with population objectives, will help evaluate overall Program success.

Passage (Appendix H)**:** Barriers to migration for anadromous fish in the restoration area encompass a wide range of both adult and juvenile passage impediments. Passage for anadromous fishes in the San Joaquin River has been completely blocked in the Restoration Area since the 1940s when the river was dewatered below Sack Dam except during uncontrolled flow releases in wet years. The FMWG developed a draft workplan with the goal to identify and prioritize fish passage barriers in the Restoration Area in an effort to minimize migration delays, stranding, and mortality of juvenile and adult salmon and other native fish. This information is needed to validate draft conceptual models of stressors and limiting factors for Chinook salmon, and to help build the Ecosystem Diagnosis and Treatment (EDT) model framework. In addition, this information will be critical to the decision making loop of Adaptive Management as described in the Fisheries Management Plan and in adequately informing restoration actions and priorities.

Peer Review (Appendix I): In order to assist the FMWG and the San Joaquin River Restoration Program in evaluating the overall adequacy of the Fisheries Management Plan, an independent peer review is needed including members who are selected for their expertise and reputation regarding fisheries management, salmonid biology, adaptive management, large-scale restoration, and performance monitoring. One review panel member will serve as the lead reviewer conducting the same review as the others, and in addition, facilitate and coordinate the completion of the reviews. The lead reviewer will also complete a synthesis of the review panel comments. The peer review panel will provide a written

review that focuses on the strengths and weaknesses of the FMP and its exhibits. The Fisheries Management Plan Peer Review draft charge, including specific questions and procedures is in Appendix I.

Spawning Gravel Assessment (Appendix J): The main objective of the spawning gravel assessment is to quantify available spawning habitat to determine if a minimum amount of quality functioning spawning gravel exists in Reach 1 for spring-run Chinook salmon. This plan recommends regular and systematic monitoring during each summer-fall low-flow season and opportunistic measurements and sampling during the winter-spring periods, when high flows are likely. Information on spawning habitat availability will determine the need for gravel augmentation and/or channel modification. If spawning habitat is insufficient, the Fisheries Management Plan recommends full implementation of actions to augment suitable gravel at existing riffles and other suitable locations in Reach 1. Moreover, the San Joaquin River Restoration Program would need to evaluate other alternatives including side-channel habitat creation and/or channel shape modification in Reach 1.

Water Quality Constituents (Appendix K)**:** The objectives of the water quality constituents study are: 1. to determine water quality conditions at holding pools to help provide or maintain a minimum of 30,000m^2 of high-quality spring-run Chinook salmon holding habitat; 2. to monitor selenium levels to ensure that they do not exceed 0.020 mg/L or a 4-day average of 0.005 mg/L in the Restoration Area; 3. to monitor dissolved oxygen levels to ensure that they remain above 0.5mg/L when Chinook salmon are present; and 4. to monitor total ammonia nitrogen to ensure that concentrations do not exceed 30-day average of 2.43 mg N/L when juvenile salmon are present or exceed a 1-hour average of 5.62 mg N/L when Chinook salmon are present. Field measurements of water quality in holding pools will rely on salmonid habitat features identified by macrohabitat monitoring. Selenium monitoring activities will be coordinated in collaboration between the Grassland Bypass Project, U.S. Bureau of Reclamation and the Central Valley Water Quality Control Board (Regional Board). Real-time oxygen monitoring data will be relayed by sensors distributed throughout the Restoration Area. Finally, the Regional Board would continue to measure ammonia nitrogen in the Restoration Area on a monthly basis. The implementation plan for evaluating water quality constituents accommodates approved changes or amendments to water quality requirements, as determined by the Regional Board. In addition, the Fisheries Management Plan states that water quality should meet minimum requirements for protection of aquatic resources to meet the Restoration Goal. Therefore, the San Joaquin River Restoration Program needs to incorporate other programs to monitor water quality at identified monitoring sites and ensure compliance with existing water quality objectives.

Water Temperature Monitoring (Appendix L): The objectives of the temperature monitoring study are: 1. Collect reliable water temperature data to document thermal response of upper San Joaquin River Basin water operations in conjunction with environmental conditions; 2. Develop and calibrate a model capable of simulating the water temperatures in Millerton reservoir and river reaches of the upper San Joaquin River basin in response to water management operations; 3. Evaluate how discharge released from Millerton Reservoir impact water temperatures in the San Joaquin River; 4. Investigate water management alternatives for improving habitat for Chinook salmon and steelhead by decreasing water temperatures; 5. Identify warm water sources that potentially increase water temperature; 6. Evaluate the ability of restoration flows to protect and provide habitat for all life stages of Chinook salmon and other native fishes. Data loggers will be placed at predetermined intervals, and other locations (warm-water sources, biologically significant habitat), to document the temperature regime of the San Joaquin River. In addition, Millerton Reservoir temperature profiles and meteorological data on the San Joaquin River will be collected. Temperature monitoring data will be used to validate draft conceptual models of stressors

and limiting factors for Chinook salmon and will be prepared for inclusion into the EDT (Ecosystem, Diagnosis, and Treatment) model and, potentially, other models. Analysis of temperature monitoring will be used to evaluate the relative importance of the various factors that combine to produce the observed stream temperatures, and to evaluate what impact changes in stream shade, channel geomorphology, and flow may have on the stream temperature regime.

Appendices

Appendix A. Genetics – Captive Rearing

Title: **Interim Pilot-scale Salmon Recovery Facility**

Principal Investigator(s): Paul Adelizi

Contact Info. Of Principal Investigator(s): (559) 243-4014 ext. 250

Proposed Staff: To be determined

County(ies) affected by Study: Fresno

I. Management

A. Description

1. Background

A. This Work Plan details the development of an Interim Pilot-scale Salmon Recovery Facility (Interim Facility) for investigations in the captive rearing of Chinook salmon and for other San Joaquin River Restoration Program (Program) related fish research projects. The Work Plan will provide the ability to conduct fish research while full-scale hatchery facilities are in development. The Program recognizes that long-term captive rearing may be required to achieve the Restoration Goal of restoring self sustaining populations of wild Spring- and Fall-run Chinook salmon to the San Joaquin River. To achieve this Goal, priority will be given to the use of wild populations of Chinook salmon as donor fish, as "there has been considerable concern expressed regarding potential effects of hatchery propagation on the genetic characteristics and diversity of salmonids within the Central Valley" (SJRRP 2007). However, the few stocks of spring run Chinook that persist in California are federally listed under the Endangered Species Act, which will significantly limit the ability of the Program to use wild stocks for restoration.

Therefore, in order to amplify the contribution of wild genes in the restored population, the Fisheries Management Work Group (FMWG) proposes the use of captive rearing, a propagation method that has been used successfully to increase depleted numbers of wild sockeye salmon (Hebdon *et al*. 2004), is currently employed by the CDFG's Coho Recovery Program and is recommended by CDFG when extirpation of a salmon population is imminent (CDFG 2004). This approach will be used in combination with other reintroduction strategies to assist in achieving the Restoration Goal.

The disadvantage of utilizing captive rearing is the threat of hatchery induced selection during the restoration process. To protect against reduced genetic viability, the Program's Fisheries Management Work Group (FMWG) drafted action "I2" (Fisheries Management Plan [FMP] 2009) to ensure incorporation of "conservation practices in artificial propagation" of fish targeted for restoration. This will be accomplished through the development of pre-emptive Hatchery Operations and Genetic Management Planning.

The CDFG's San Joaquin Fish Hatchery (SJH) is the proposed location of the Interim Facility and is the planned location of the Program's full-scale Salmon Recovery Hatchery. The SJH is a prime location for the proposed hatchery because of its proximity to Restoration Area, and offers existing infrastructure, access to a gravity-fed water supply, complimentary staffing and security, and available construction space that allows for infill development and cost savings. In its present condition, SJH does not have sufficient rearing space to accommodate the Recovery Hatchery or an adequate design to prevent possible disease transfer between the existing hatchery stock and the introduced salmon. Additionally, the TAC has recommended against the use of traditional concrete raceways utilized at SJH (SJRRP 2008).

The CDFG is currently completing the necessary pre-planning for developing the Recovery Hatchery. Spending authority for hatchery development is in review and funds for full-scale hatchery development will be available no sooner then the beginning of the 2010/2011 fiscal year. Full-scale hatchery construction will not be completed before the summer of 2013. This late completion date will complicate Program's ability to achieve the Restoration Goal of reintroducing salmon to the San Joaquin River by December 31, 2012 and provides little time for critical preliminary research as recognized and stated by the TAC; "The early phase of restoration implementation is expected to be experimental and designed to test basic hypotheses and provide information useful in refining the reintroduction strategy under an adaptive management framework" (2007). As a propagation method, captive rearing is considered technically challenging and merits early investigation and experimentation. Therefore, it is prudent to develop an appropriate interim facility for preliminary investigations. Upon completion of the new hatchery, fish will be transferred from the interim facility to the new facility. The interim facility could then be available for other Program related fish research activities including propagation of other salmonids such as Fall-run Chinook, steelhead, fish marking/tagging studies, etc.

B. Site Description

San Joaquin Hatchery is located along the San Joaquin River in town of Friant approximately 1 mile down stream of Friant Dam. The interim facility will be developed at an appropriate location down stream of existing hatchery operations to provide physical separation for purposes of disease control. Hatchery water supplies originate from Millerton Lake and are conveyed through a gravity-fed pipeline from Friant Dam and through a hydropower unit that is operated by Orange Cove Irrigation District (OCID). The water flows from the dam through two pipelines that draw water from different depths and different water temperature. This allows mixing of the two fractions for temperature control. Currently, the hatchery receives 35 cfs flow, which is the maximum that OCID releases according to their federal license.

2. Purpose

A. Goals

The goal of the Work Plan is to develop an Interim Facility for conducting near-term fish research while the full-scale Recovery Hatchery is constructed. The two main objectives for the Work Plan are to:

1. Complete appropriate modifications to Friant Dam and SJH to allow increased water flow to the project area that is sufficient to meet the needs of the Interim Facility and the final Recovery Hatchery; and

2. Complete the necessary tasks that result in the final design and construction of the Interim Facility.

The opportunity to receive a supply of gravity-fed water for the project provides considerable long-term cost savings for operational costs. However, two restrictions to water flow have been identified at the River Outlet Penstocks on Friant Dam and at the inflow Aeration Tower at SJH that limit the amount of water available for the project. The United States Bureau of Reclamation (Reclamation) currently diverts a continuous flow of 35 cfs to SJH from the Friant Dam penstocks through the Fishwater Release Powerplant owned by OCID. The flows are delivered to the Fishwater Release Powerplant through two separate pipelines: a 24-inch diameter pipeline that taps two Friant Dam penstocks, and a 30-inch diameter pipeline that takes water from the Friant-Kern Canal penstock near the left dam abutment. After the Powerplant, the flows are conveyed to SJH through a mile long 44" pipeline that is capable of handling significantly more flow. The pipelines that feed the Powerplant could accommodate additional flow increases; however, it would result in very high velocities in the 24-inch line from the River Outlet penstocks and cause high head losses, accelerate wear on the pipeline and substantially reduce power generation at the Fishwater Release Powerplant (Provost and Pritchard 2009, see attached). It is proposed that an additional 270-foot long 24-inch diameter line be constructed parallel to the existing line to convey the minimum of an additional 15 cfs flow to the hatchery.

In addition, preliminary tests indicate that a second flow restriction occurs at SJH that requires modification to accommodate the additional flow. The restriction occurs at the facility's aeration towers where the 44" main water line feeds seven 12" pipes that lead to individual aeration columns. Currently, an additional flow of approximately 12 cfs is capable of passing through the aeration structure, which is considerably less than what is capable of being conveyed to SJH by the 44" water main. Modifications to both the Friant Dam penstocks and the SJH aeration tower will be necessary to accommodate the planned full-scale Salmon Recovery Hatchery; and therefore, it is necessary that both of these projects be completed independent of the Interim Facility project but the interim facility cannot operate without it.

Concurrent to modifying the flow structures at Friant Dam and SJH, the Interim Facility will be designed and constructed. As recommended by the TAC, the facility will "emphasize the latest techniques and infrastructure to improve juvenile salmon behavioral traits and fitness that better reflect those of naturally produced juveniles" (SJRRP 2008). Flagg and Nash (1999) identified major culture strategies for the management and operation of conservation hatcheries in the Pacific Northwest and stressed the importance of emphasizing issues associated with:

- Inbreeding, Outbreeding, Domestication Selection, and other Genetic Considerations
- Broodstock Sourcing
- Broodstock Maturation and Reproduction
- Enriched Environments
- Growth Rate Modulation

- Rearing Density
- Anti-Predator Conditioning
- Release Size
- Release Time and Volitional Release
- Imprinting and Homing
- Habitat Carrying Capacity

These issues will be investigated and addressed appropriately in the project. In addition, the following objectives will be incorporate in the design of the facility:

- Adequate bio-security (predation, genetics, invasive species, fish pathogens, quarantine, escapement, site security)
- Ability to provide for flexibility in approaches to propagation
- Ability to meet production goals
- Evaluation of water supply quality relative to both process supply and effluent
- Attention to human health and safety (traffic ingress/ egress and building codes)
- Cost-effective solutions for site improvements
- Attention to environmental concerns

B. Objectives:

1. Request for contractor proposals will be made to provide preliminary design, permitting and approval, final design, project bidding, construction, preparation of record drawings, etc. CDFG is currently negotiating with Reclamation (Renewal Contract No. 14-06-200-879R) and the California Regional Water Quality Control Board, Central Region to amend agreements to allow the required flows.

2. Determine feasibility, needs, appropriate design features, etc. based on issues associated with project cost, biosecurity, amount of time to complete construction, and benefit to the Program. Alternative locations will be investigated (ongoing) for conducting captive rearing and other Program related fish research. Alternative facilities include the CDFG's San Joaquin Fish Hatchery, Mokelumne River Hatchery or Silverado Fisheries Base, UC Davis' Bodega Marine Laboratory or Center for Aquatic Biology and Aquaculture (CABA) or other appropriate locations. The Scope of Work will be developed by CDFG in cooperation with the FMWG and the Genetics Subgroup and will emphasize the latest techniques and infrastructure to improve juvenile salmon behavioral traits and fitness that better reflect those of naturally produced juveniles (SJJRP 2008). The conceptual design of the facility will be completed by an aquaculture engineering contractor in consultation with the CDFG, the Genetics Subgroup, and the FMWG. If deemed appropriate, the conceptual design will include a site master plan that will illustrate the future location of the Interim Facility as well as the location of the final Recovery Hatchery and its associated infrastructure. The design of the Interim Facility will emphasize the incorporation of "conservation practices in artificial propagation" to protect against reduced genetic viability.

B. Organization and Responsibilities

1. Person(s) Responsible:

Paul Adelizi, CDFG

Project Lead

Department of Fish and Game

1234 E. Shaw Ave.

Fresno, CA 93710

(559) 243-4014, ext. 250

padelizi@dfg.ca.gov

2. Collaborators:

A. Gerald Hatler, CDFG – Project supervisor and coordination with FMWG and program management

B. Margarita Gordus, CDFG – Genetics management plan

C. Dale Stanton, CDFG – Engineering consulting, conceptual design

D. Michael Lacy, CDFG – Conceptual design, operations management plan, genetics management plan

E. Greg Kollenborn, CDFG – Conceptual design, coordination with DFG Hatchery Operations Committee, operations management plan

F. Mark Adkison, CDFG – Conceptual design, disease and biosecurity management

G. Josh Israel (Molly Stephens, Melinda Baerwald), UC Davis – Conceptual design, genetics management plan, operations management plan

H. Shirley Witalis, NOAA Fisheries – Conceptual design, hatchery and genetic management plan, coordination with NOAA Fisheries

I. Kim Webb (Michelle Workman), USFWS – Conceptual design, hatchery and genetic management plan, coordination with USFWS

C. Design

D. Resource Needs

Detailed cost projections will be developed during the preliminary design phase of the project. Some preliminary costs have been provided by Provost and Pritchard for modifications associated with Friant Dam (see attached). Preliminary costs estimates for Objective One (Source Water Augmentation) is approximately $150,000 to $250,000 and includes $30,000 for preliminary design. Preliminary Cost estimates for Objective Two (Facility Design and Construction) is $150,000 and $250,000 and includes $30,000 to $50,000 for preliminary design and alternatives analysis. Final costs will depend on the size of the facility and the extent of water treatment

required. Currently, CDFG anticipates not having funding for the full-scale project until July, 2010.

2. Personnel needs

   Personnel needs for the maintenance of the facility will be met by one permanent employee (50%) and two temporary employees (both 25-50%). Duties include sourcing fish, fish husbandry and tagging.

3. Equipment needs

   Equipment needs will be determined during the development of the Operations Management Plan. Possible equipment needs include Ultrasound equipment for tracking gamete development, water quality analysis equipment, fish transport equipment, feed delivery equipment and fish tagging equipment.

4. Coordination needs

   The project will be coordinated with CDFG, NOAA Fisheries, USFWS, FMWG, PMT, TAC and Reclamation.

E. Compliance Considerations

   All actions will be coordinated with appropriate State and Federal fish agency staff to ensure compliance with the California Endangered Species Act (CESA) and Federal Endangered Species Act (FESA) and California Environmental Quality Act (CEQA) and National Environmental Policy Act (NEPA).

   Take will be fully addressed and appropriately coordinated in development of the Hatcheries Operation Plan.

G. Due Dates and Products

   Objective 1 – Water Supply Augmentation

   Complete modifications to Friant Dam River outlet penstocks (see attached proposal) and the SJH aeration tower to allow sufficient quantities of water to flow from Friant Dam to SJH for salmon recovery projects. Feasibility and alternatives analysis – 1 month

   a. Preliminary design, permitting and approval – 3 months
   b. Final design – 3 months
   c. Project bidding – 2 months
   d. Construction and preparation of record drawings – 3 months

   Estimated Project Timeline: 11 months

   Objective 2 – Facility Design and Construction

   Design and construct an Interim Salmon Recovery facility that emphasizes the latest techniques and infrastructure to improve juvenile salmon behavioral traits and fitness that better reflect those of naturally produced juveniles. Timeline and costs are provided as early estimates.

a. Site Master Plan (Optional), feasibility and alternatives analysis (ongoing) – 3 months
b. Preliminary design, permitting and approval – 3 months
c. Final design – 3 months
d. Project bidding – 3 months
e. Construction (including construction over site, preparation of record drawings, system startup) – 3 to 7 months

Estimated Project Timeline: 12-16 months

References:

Flagg, T. A., and C. E. Nash (editors). 1999. A Conceptual Framework for Conservation Hatchery Strategies for Pacific Salmonids. U.S. Dep. of Commerce, NOAA Tech. Memo. NMFS-NWFS-38.

Hebdon, J. L., P. Kline, D. Taki, and T. A. Flagg. 2004. Evaluating Reintroduction Strategies for Redfish Lake Sockeye Salmon Captive Broodstock Progeny. American Fisheries Society Symposium 44:401-413.

San Joaquin River Restoration Program (SJRRP) Technical Advisory Committee (TAC). 2007. Recommendations on Restoring Spring-run Chinook Salmon to the Upper San Joaquin River. Prepared for the San Joaquin River Restoration Program Restoration Administrator.

San Joaquin River Restoration Program (SJRRP) Fisheries Management Work Group (FMWG). 2009. Draft Fisheries Management Plan: A Framework for Adaptive Management for the San Joaquin River Restoration Program.

Appendix B. Genetics – Genetics Research

Study Title: San Joaquin River Salmonid Genetics Research and Management Planning

Purpose: This contract is undertaken by the Department of Fish and Game (Department) and the University of California, Davis Genomic Variation Laboratory (Contractors) (collectively referred to herein as "Parties") to provide genetic research concerning three native California salmonid species: (i) Spring-run Chinook salmon, (ii) Fall-run Chinook salmon, and (iii) coastal rainbow trout (collectively referred to herein as "study species"). All of the study species are key native populations which historically occurred within the San Joaquin River basin. All three populations are essential targets of major and expensive restoration actions now being undertaken, as below.

The contracted work will include and involve analysis of: (i) the study species' natural background genetics, (ii) laboratory genetic analysis of field-collected tissue samples from the three populations, (iii) research and analysis of the genetic relationships associated with different geographic populations which may be utilized as restoration source populations, and (iv) production of formal reports, including: published technical material, Genetic Management Plans, and Hatchery Genetic Management Plans for three study species.

Background: The San Joaquin River is the subject of a major restoration program being pursued by five Federal and State agencies. The San Joaquin Restoration Program (Restoration Program) was initiated in response to a Settlement Agreement formed between litigant parties in a long-standing lawsuit, NRDC v. Rodgers. The Settlement Agreement mandates restoration of Spring-run and Fall-run Chinook salmon and other fish species within the reach of the San Joaquin River from the Merced River confluence, upstream to Friant Dam. The Settlement Agreement incorporates a separate State-Federal Memorandum of Understanding that identifies the respective roles of the state and federal fisheries agencies, including the Department, which has statutory fisheries stewardship responsibility. The Department has participated in the five-agency Restoration Program intended to accomplish the above restoration objectives.

A primary objective of the Restoration Program is to restore and maintain fish populations in the main-stem of the San Joaquin River below Friant Dam to the confluence of the Merced River. Restoration efforts will be aimed at developing self-sustaining and naturally reproducing populations of the Chinook salmon *(Oncorhynchus tshawytscha*) and other native species, including anadromous coastal steelhead trout *(O. mykiss irideus)*. The Restoration Program provides a unique opportunity for restoring populations of these anadromous fishes, which were extirpated from the river in 1950. Though Chinook salmon are one of the most cultured salmonid species in the world, managers have had very limited success in establishing viable Chinook salmon populations. A high level of uncertainty surrounds the management actions necessary to transition a managed population into a viable population, and many of the unknowns are species- and site-specific. In order for the study species' populations to be successfully reintroduced and established, it will be necessary to make a series of decisions regarding the selection of founding source populations, alternative reintroduction strategies, innovative monitoring protocols, and adaptive management of the populations which become established. To make these decisions, it will be necessary to have or develop: (i) up-to-date genetic information about potential founding populations and proximate San Joaquin River salmon and steelhead populations and (ii) genetic management and monitoring plans to assure that founding populations are not adversely impacted and that established populations within the San Joaquin River above the Merced River are of sufficient genetic breadth to remain viable and adapt in this managed environment. Each of these elements will depend upon the genetics research, as included herein.

Use of hatcheries is considered necessary by the Restoration Program Management Team (PMT) and Technical Advisory Committee (TAC) for initial establishment of founding populations and population support during anticipated periods of drought and other climatic processes that pose significant risks to the viability of the reintroduced populations. However, some past evaluations have determined that hatcheries, if improperly operated, can adversely affect the genetic characteristics, physiology, morphology, behavior, and health of propagated fish populations. Given the identified risks associated with uninformed hatchery operations, genetics research is considered essential by the PMT and TAC to provide the fundamental information needed to plan and operate hatcheries, while assuring the preservation of restored populations with sufficient adaptive potential to remain viable in the face of climatic and human alteration to the aquatic environment.

Hatchery Genetic Management Plans (HGMP) and Genetic Monitoring Plans are essential guidance documents in the reintroduction and restoration of populations, when it is determined that hatcheries are a strategy to be used for recovering a population. These planning efforts identify and evaluate the potential risks and benefits of hatchery activities and can prescribe hatchery operations protocols intended to protect both the founding and supplemented populations. Recent scientific research has aimed to develop principles and recommendations, so hatchery techniques can be used to help conserve naturally spawning salmon populations and support sustainable fisheries. An early effort to develop a framework for production strategies, which can propagate fish with wild-type phenotypes necessary for recovering depleted stocks, was led by scientists at the NMFS Northwest Fisheries Science Center (Flagg and Nash 1999). More recently, a congressionally-appropriated evaluation of more than 200 hatcheries in the Pacific Northwest was undertaken by a panel of agency and independent scientists (Hatchery Science Review Group 2004). This effort developed tools, questionnaires, and checklists, which could be asked of every hatchery program to enable the program to better meet the objective of conserving the founding and supplemented populations. Development of guidance documents using these already developed tools will be highly beneficial to efforts aimed at reintroducing and conserving naturally-spawning populations of the study species in the San Joaquin River. Use of these tools will be dependent upon the research findings and other deliverables as herein required.

Scope of Work:

The genetic research and management planning study will include three general phases, as follows.

Phase I: Baseline genetic research of the study species within the San Joaquin River basin and potential founding populations considered for the Restoration Program.

Phase II: Development and peer review of research-based Genetic Management Plans for study species with recommendations on management and monitoring actions needed to maintain and protect the genetic integrity of both source and reintroduced populations.

Phase III: Integration of genetic research and Genetic Management Plans to develop agency-reviewed and approved Hatchery Genetic Management Plans, Hatchery Operational Plans, and Genetic Monitoring Plans.

Contractors will perform the following tasks and services under each Phase:

Note: Deliverables' timetables as included below are intended only as target dates. Parties understand that Contractors will make reasonable effort to deliver products by these appointed timetables. However,

the Parties recognize that the production and approval of some of the deliverables is dependent upon circumstances outside the control of either Parties. As such, the deliverable dates may be varied or modified, as appropriate, subject to mutual written agreement of the Parties. Any such modification will be approved by the DFG Regional Manager and UCD Contract Manager, and be properly documented in the Contract Administration File.

Phase I: Research and Establishment of San Joaquin Salmonid Genetic Baselines

Task 1. Early identification of field tissue or data collection needs (field samples to be collected by the SJRMP agencies, as appropriate) and timetables/priorities for Fall 2008 and Spring and Fall 2009 to provide sufficiently comprehensive tissue or other samples needed to enable genetic research products/deliverables during 2009 and into the future.

Task 2. A Summary of published and unpublished genetic information, concerning the San Joaquin River populations of study species to inform Restoration Program planning efforts.

Task 3. Preliminary laboratory research/analysis of collected or archived field samples of study species to increase knowledge on genetic composition of study species.

Task 4. Synthesis of the results from Tasks 1, 2, and 3 above, to advise the state and federal fishery agencies in identifying the appropriate data platform(s) for studying genetic stocks to be considered for stock founding of Chinook salmon and *O. mykiss* in the San Joaquin River. Information will describe and compare the availability, efficiency and efficacy associated with use of microsatellite and/or Single Nuclear Polymorphism (SNP) markers for differentiating potential founding populations from contemporary San Joaquin Chinook salmon and assessing the genetic composition of source populations.

Phase I Deliverables:

Item 1. A Data Collection and Genetic Sampling Report identifying the field data gathering and field tissue sampling, which is necessary to facilitate development of a sufficiently clear and comprehensive genetic baseline description (see Item 2 below).

Completion: October 31, 2008. Draft by August 1, 2008 for fishery jurisdictional agency review.

Item 2. A San Joaquin River Salmonid Genetic Baseline Report, detailing the results of Tasks 2, 3 and 4 above, and including preliminary assessment of the benefits or impacts of inclusion of identified prospective source populations for Spring-run and Fall-run Chinook.

Completion: December 31, 2009. Draft by August 2009 for fishery jurisdictional agency review.

Phase II: Genetic Management Plans

Task 1: Development and preparation of research-based Genetic Management Plans (Reports) for each of the study species. These plans will be suitable for use by the 5-agency Program Management Team, Technical Advisory Committee and Restoration Administrator, to make recommendations and decisions concerning fish reintroduction actions. This deliverable will include the Contractors' recommendations concerning advisability of prospective hatchery deployment in reintroduction and restoration of Chinook populations.

Phase II Deliverables:

Item 1. Genetic Management Plan (Report) for San Joaquin River Spring-run Chinook salmon, including: (i) comparative analysis of reintroduction strategies and available Spring-run source populations for stock founding (ii) analysis of effects of removal of individuals from source populations, (iii) assessment of potential hatchery deployment options, including: rear and haul, trap and haul, instream artificial incubation, and these operations benefits or impacts to salmon genetic integrity, (iv) research and development of quantifiable objectives and recommendations for establishing and maintaining appropriate gene-pool breadth, defining acceptable introgression rates, and providing appropriate genetic management, and (v) monitoring protocols and methodologies. .

Completion: June 30, 2010. Draft Plan by March 31, 2010 for fishery jurisdictional agency review.

Item 2. Genetic Management Plan (Report) for San Joaquin River Fall-run Chinook salmon, including: (i) comparative analysis of reintroduction strategies and available Fall- and Late Fall-run source populations for stock founding (ii) analysis of effects of removal of individuals from source populations, (iii) analysis of San Joaquin River Fall-run chinook salmon genetics in context with management of the subject Friant reach with Fall-run or Late Fall-run chinook (iv) research and assessment of potential for hatchery use, rear and haul, trap and haul, and these operations benefits or impacts upon genetic integrity, (v) research and development of quantifiable objectives and recommendations for establishing and maintaining appropriate gene-pool breadth, defining acceptable introgression rates, and providing appropriate genetic management, and (vi) monitoring protocols and methodologies.

Completion: December 31, 2010 – Draft by June 30, 2010 for fishery jurisdictional agency review

Item 3. Genetics Management Plan (Report) or San Joaquin anadromous coastal rainbow trout, including: (i) comparative analysis of reintroduction and restoration strategies with analysis of available wild and/or hatchery steelhead stocks/populations for stock founding (ii) analysis of effects of removal of individuals from source populations, (iii) analysis of managed steelhead genetics in context with other San Joaquin Basin *O. mykiss* natural population genetics, (iv) research and assessment of potential for hatchery brood-stock development for production of native trout for use in stocking operations in upstream(non-anadromous) reaches of San Joaquin river tributaries, and associated benefits or impacts upon genetic integrity, (v) research and development of quantifiable objectives and recommendations for establishing and maintaining appropriate gene-pool breadth, defining appropriate introgression rates, and providing appropriate genetic management, and (vi) monitoring protocols and methodologies.

Completion: December 31, 2010. Draft Plan by October 31, 2010 for fishery jurisdictional agency review.

Item 4. Establishment of a tissue collection repository, containing archived samples from each of the above populations, for future research (archive location to be determined).

Item 5. Management of an objective, external peer review for the Final Draft Plans/Reports (Items 1,2,3 above), including review by outside geneticists, agency genetic laboratories, and outside fishery scientists with experience in managing anadromous salmonids on the west coast of North America.

Completion: April 1, 2011

Item 6. Preparation of a Report that includes final Genetic Management Plans and summaries of peer review comments.

Completion: December 31, 2011

Phase III: Salmon and Steelhead Hatchery Deployment

Research and analysis of genetics benefits or effects associated with various hatchery deployment strategies, including (for Fall-run and Spring-run chinook salmon): (i) short- or long-term hatchery rearing and hauling of wild and/or hatchery juveniles, (ii) short- or long-term wild trapping and movement of adult spawners, (iii) short- or long-term spawning of wild adults and hatchery rearing of eggs with release and/or hauling of juveniles, (iv) other prospective strategies. Regarding coastal rainbow trout, the analysis should include benefits and impacts associated with various husbandry approaches, including establishment of a domestic CRT brood-stock for use in anadromous and non-anadromous populations. This Phase will include contractor's recommendations for hatchery genetics management and long-term monitoring and maintenance.

Task 1. Modify Hatchery Scientific Review Group's(HSRG) *Operational Guidelines*, *Monitoring and Evaluation Criteria*, *Regional Information Key Questions Form*, and *Benefit/risks Tool* form for use in developing HGMP and Genetic Monitoring Plans for study species, as applicable.

Task 2. Lead workshops (i.e., Fresno and Sacramento) with Department Biologists and Hatchery staff and Restoration Program Management Team representatives to gain input regarding San Joaquin River hatcheries using modified HSRG forms.

Task 3. Develop HGMP and Genetic Monitoring Plan based on NOAA-Fisheries format.

Task 4. Circulate HGMP and Genetic Monitoring Plan for review to appropriate management agencies.

Phase III Deliverables:

Item 1. Development of separate HGMPs for each of the three study species, which are acceptable to the three state and federal fishery agencies and approved by the jurisdictional agencies. The HGMPs must include all of the components required by NOAA Fisheries at the time.

Completion: December 31, 2010 for Spring-run Chinook, June 30, 2011 for Fall-run Chinook and *O. mykiss*.

Item 2. Development of a Hatchery Operations Plan for three populations of study species detailing the genetic selection and management best management practices and recommendations on the quantitative aspects of hatchery involvement, in context with natural population establishment, maintenance and protection.

Completion: June 30, 2011 for Spring-run Chinook and December 31, 2011 for Fall-run Chinook and *O. mykiss*.

Appendix C. Genetics- Stock Selection

Study Title: Stock Selection and Reintroduction Strategy – Spring Run Chinook

Region or Division and Branch:

Principal Investigator(s): Margarita Gordus, Genetics subgroup

Contact Info. Of Principal Investigator(s): mgordus@dfg.ca.gov

Proposed Staff: Genetics subgroup

County(ies) affected by Study: Restoration Area

II. Study Management

A. Study Description

1. History or Background

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 lawsuit, known as *NRDC et al. v. Kirk Rodgers et al.*, reached a Stipulation of Settlement (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.

The Settlement establishes a framework for accomplishing the Restoration and Water Management goals that will require environmental review, design, and construction of projects over a multiple-year period. To achieve the Restoration Goal, the Settlement calls for a combination of channel and structural modifications along the San Joaquin River below Friant Dam, releases of water from Friant Dam to the confluence of the Merced River, and the reintroduction of Chinook salmon, *Oncorhynchus tshawytscha*.

In response to the Settlement, 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 and associated Work Groups to begin work implementing the Settlement. For additional information related to the Implementing Agency approach, the reader is referred to the Program Management Plan available on the San Joaquin River Restoration Program (SJRRP) Website, www.restoresjr.net. Related to the Settlement, President Obama signed the San

Joaquin River Restoration Act (Act) on March 30, 2009, giving the Department of Interior full authority to implement the SJRRP. The SJRRP will implement the Settlement and Act.

This study workplan was developed by the multiagency Fisheries Management Work Group (FMWG) and describes the fish passage monitoring program.

a. General project background discussion.

The San Joaquin River Restoration Program Settlement calls for reintroduction of spring run Chinook salmon and long term maintenance of a naturally reproducing, self-sustaining population. To achieve this goal it will be necessary for the Program to promote and protect genetic diversity in the reintroduced population. Spring run Chinook display some very important traits such as distinctive use of diverse aquatic habitats, timing of spawning, migration, breeding and natal fidelity. There is also likely a significant potential for evolution of traits to occur as a result of the novel selective pressures that will be placed on the fish in the upper San Joaquin River.

Spring run Chinook populations were extirpated from the San Joaquin basin following the completion of dams and major water diversion facilities. Currently independent spring run populations can be found in Deer, Mill and Butte Creeks and the Feather River in the Sacramento River basin. Spring run also occupy spawning habitats in numerous other tributaries in the Central Valley, though these populations are small and subject to gene flow from the larger independent populations in the valley.

b. Describe the evolution of the study.

The Fish Management Plan for the San Joaquin River Restoration Program lists 5 fish population goals. These goals include, establishing natural populations of spring and/or fall run Chinook salmon (Oncorhynchus tswaytscha) that are locally adapted to conditions in the SJR, genetically diverse, demographically diverse on an annual basis, and show no signs of hybridization between the runs (FMWG 2009b). Reduced genetic viability may limit the success of Chinook salmon restoration efforts. A description of the potential impact of reduced genetic viability and the objectives and associated actions for reducing this limiting factor are described in the conceptual models for Chinook salmon (FMWG 2009a) and in the Fisheries Management Plan (FMWG 2009b).

c. Why is the study necessary?

This information is needed to determine the most effective and efficient methods to use to meet the Restoration Goal with regards to spring run Chinook. Careful evaluation of all available information will ensure we develop a strategy to move forward with the fundamental element of this program – reintroduction of spring run Chinook. Since uncertainty is extremely high in the endeavor, we will be implementing all aspects of stock selection and reintroduction as experiments, during which we will closely monitor and evaluate outcomes, revise our approaches and implement revised strategies. v

d. Identify and analyze any previous similar studies.

McBain & Trush (2002) inventoried physical barriers in the Restoration Area including in the San Joaquin River and bypass system (see page 7-62), and identified approximately 18 potential and probable barriers to migration. California Department of Water Resources (2005) inventoried passage barriers in the San Joaquin River below Friant Dam and tallied more than 20 passage impediments and in addition 30 gravel pits. Evaluations on the Merced River (Stillwater Sciences 2002) and on the Tuolumne River (McBain & Trush 2000) have completed restoration plans with fish passage impediment descriptions. In addition, California Department of Water Resources (2005) inventoried fish passage barriers. Lastly, in 2007, DWR (2007) completed a detailed fish barrier assessment on the Calaveras River that could be useful as a reference.

2. Site Description

Following is a brief description of the Restoration Area, including San Joaquin River and bypass characteristics. For additional detail, the reader is referred to FMWG (2009b), or the SJRRP PEIS/R.

a. Location of the study (include maps, geographic data, etc.).

This study is located in the San Joaquin River Restoration Program (SJRRP) Restoration Area. The Restoration Area is approximately 153 miles long, extending from Friant Dam at the upstream end near the town of Friant, downstream to the confluence of the Merced River, and includes an extensive flood control bypass system (Figure 1). Five river reaches have been defined to address the different river characteristics throughout each reach. For more information regarding the Restoration Area, see FMWG (2009b), and the SJRRP PEIS/R.

b. Describe the environmental setting for the study.

Reach 1 begins at Friant Dam and continues approximately 37 miles downstream to Gravelly Ford. This reach conveys continuous flows through an incised, gravel-bedded channel. Reach 1 typically has a moderate slope, and is confined by periodic bluffs and terraces. The reach is divided into two subreaches: 1A and 1B. Reach 1A, which extends down to State Route (SR) 99, has the most gravel, and supports continuous riparian vegetation except where the channel has been disrupted by gravel mining and other development. Invasive woody species are common in Reach 1A (Moise and Hendrickson 2002). Reach 1B continues from SR 99 to Gravelly Ford where it is more narrowly confined by levees. Woody riparian species occur mainly in narrow strips immediately adjacent to the river channel in Reach 1B. Reach 1 has been extensively mined for instream gravel and is sediment limited. Gravel mining and agriculture are the primary land uses in Reach 1B.

Reach 2 starts at Gravelly Ford, extends downstream to Mendota Dam, and is a meandering, low-gradient channel. Reach 2 is characterized by seasonal drying of the channel in the summer and fall. In most years, the Reach 2 channel is dry except under flood release conditions from Gravelly Ford to Mendota Dam. Mendota Pool is formed by the Mendota Dam at the confluence of the San Joaquin River and Fresno Slough. The primary source of water to the Mendota Pool is conveyed from the Delta through the Delta-Mendota Canal (DMC).

Reach 2 is subdivided at the Chowchilla Bypass Bifurcation Structure into two subreaches, Reach 2A and Reach 2B, which have confining levees protecting adjacent agricultural land. Reach 2A and Reach 2B are intermittent and sand-bedded. Reach 2A is subject to extensive seepage losses and accumulates sand due to backwater effects of the Chowchilla Bypass Bifurcation Structure and the low gradient of the reach. Riparian vegetation in Reach 2A is sparse or absent due to the usually dry conditions of the river and groundwater overdrafting (McBain and Trush 2002). Reach 2A vegetation has abundant grassland/pasture and large stands of nonnative plants (Moise and Hendrickson 2002). Reach 2B has a sandy channel with limited conveyance capacity and a thin strip of riparian vegetation, primarily native species, which borders the channel. A portion of Reach 2B is perennial because of the backwater of Mendota Pool.

Reach 3 extends from Mendota Dam at the upstream end to Sack Dam at the downstream end and receives continuous flows from the DMC. At Sack Dam, flow releases are diverted into the Arroyo Canal. The river is confined by local dikes and canals on both banks. The sandy channel meanders through a predominantly agricultural area, except where the City of Firebaugh borders the river's west bank. The river at this location has a low stage but is perennial and supports a narrow riparian corridor along the edge of the river channel.

Reach 4, located between Sack Dam and the confluence with Bear Creek and the Eastside Bypass, is sand-bedded and usually dewatered because of the diversion at Sack Dam. The upstream portion of Reach 4 is bounded by canals and local dikes down to the confluence with the Mariposa Bypass at the San Luis National Wildlife Refuge. Levees that begin at the Mariposa Bypass continue downstream on both banks (McBain and Trush 2002). Reach 4 is subdivided into three distinct subreaches: 4A, 4B1, and 4B2.

Reach 4A, from Sack Dam to the Sand Slough Control Structure, is confined within a narrow channel. This subreach is dry in most months with negligible flows that are diverted at Sack Dam. The floodplain of Reach 4A is broad, with levees set back from the active channel. The subreach is sparsely vegetated, with a thin and discontinuous band of vegetation along the channel margin. This subreach has the fewest functioning stream habitat types and the lowest ratio of natural vegetation per river mile in the Restoration Area.

Reach 4B1 extends from the Sand Slough Control Structure to the confluence with the Mariposa Bypass. Reach 4B1 has been dry, for the most part, for more than 40 years. The only exception occurs when the channel receives varying amounts of agricultural-return flows. Water reaching the Sand Slough Control Structure is diverted to the bypass system via the Sand Slough Bypass. As a result, the Reach 4B1 channel is poorly defined with dense vegetation and other fill material. The riparian corridor upstream of the Mariposa Bypass is narrow, but nearly unbroken.

Reach 4B2 begins at the confluence of the Mariposa Bypass, where flood flows in the bypass system rejoin the mainstem of the San Joaquin River, and extend to the confluence of the Eastside Bypass. Reach 4B2 contains wider floodplains than upstream reaches and vast areas of natural vegetation.

Reach 5 extends from the confluence of the Eastside Bypass downstream to the Merced River confluence. Reach 5 is perennial because it receives varying amounts of agricultural return

flows from Mud and Salt sloughs. Reach 5 is more sinuous than other reaches and contains oxbows, side channels, and remnant channels (McBain and Trush 2002). Reach 5 is bounded on the west by levees downstream to the Salt Slough confluence and on the right bank to the Merced River confluence. Reach 5 has a broad floodplain; however, levees generally dissociate the floodplain from the mainstem San Joaquin River (McBain and Trush 2002). Less agricultural land conversion has occurred in Reach 5, with a majority of the land held in public ownership and managed for wildlife habitat.

The natural habitat surrounding Reach 5 includes large expanses of grassland with woody riparian vegetation in the floodplain. Remnant riparian tree groves are concentrated on the margins of mostly dry secondary channels and depressions or in remnant oxbows. The mainstem has a patchy riparian canopy (McBain and Trush 2002).

The bypass system consists of a series of dams, bifurcation structures, bypasses, levees, and portions of the main river channel. The bypass system is managed to maintain flood-conveyance capacity. Descriptions of primary components of the bypass system follow.

Fresno Slough, also known as James Bypass, conveys flood flows regulated by Pine Flat Dam from the Kings River system in the Tulare Basin to Mendota Pool.

The Chowchilla Bifurcation Structure, at the head of Reach 2B, regulates the flow split between the San Joaquin River and the Chowchilla Bypass. The Chowchilla Bypass extends to the confluence of Ash Slough, and is approximately 22 miles long, leveed, and 600 to 700 feet wide. Sand deposits are dredged from the bypass, as needed, and vegetation is periodically removed from the channel.

The Eastside Bypass extends from the confluence of Ash Slough and Chowchilla Bypass to the confluence with the San Joaquin River at the head of Reach 5 and is subdivided into three reaches. Eastside Bypass Reach 1 extends from Ash Slough to the Sand Slough Bypass confluence and receives flows from the Chowchilla River. Eastside Bypass Reach 2 extends from Sand Slough Bypass to the head of the Mariposa Bypass. Eastside Bypass Reach 3 extends from the head of the Mariposa Bypass to the head of Reach 5 and receives flows from Deadman, Owens, and Bear creeks.

The lower 10 miles of the Eastside Bypass are similar to the Chowchilla Bypass. Upland vegetation at the Eastside Bypass consists of grassland and ruderal vegetation. In the Grasslands Wildlife Management Area, riparian trees and shrubs have a patchy distribution along the banks of the Eastside Bypass. The lower Eastside Bypass has some side channels and sloughs that support remnant patches of riparian vegetation.

2. Study purpose

a. Statement of study goals.

Goal: Identify the appropriate methods to use **t**o establish a viable population of spring run Chinook salmon in the San Joaquin River, from a reintroduced population, through a series of decisions from selection of founding population(s), alternative reintroduction strategies,

innovative monitoring protocols and adaptive management of the population as it becomes established.

b. List the objectives of the study

1. Identify appropriate methods of stock selection and reintroduction.
2. Develop a plan to facilitate obtaining and reintroducing spring run Chinook.
3. Develop an adaptive management process to ensure appropriate levels of monitoring, analysis and evaluation inform future activities.
4. Implement plan to reintroduce spring run Chinook and monitor results.

c. Describe study milestones. Identify products and timelines.

1. **Task 1:** Identify potential stock selection criteria to be used in evaluation of potential stocks. Produce list of potential criteria.
2. **Task 2:** Identify potential methods of stock selection including ranking, prioritization, rating, and experimental methods, incorporating measurements of the levels of uncertainty. Produce list of methods.
3. **Task 3**: Develop a prioritized list of information needs and recommendations for how to fill those needs.
4. **Task 4:** Develop discussion papers documenting and evaluating alternative methods of reintroduction.
5. **Task 5:** Identify potential reintroduction strategies.
6. **Task 6:** Develop discussion papers documenting and evaluating alternative methods of reintroduction.
7. **Task 7:** Develop a plan to facilitate obtaining and reintroducing spring run Chinook.
8. **Task 8:** Develop monitoring plan designed to collect data, and analyze/evaluate each aspect of the reintroduction plan and provide an appropriate process for revision.
9. **Task 9:** Implement reintroduction plan and monitoring plan.

3. Study Approach (describe conceptual approach to study and include uncertainties).

1. **Task 1:** In order to complete Task 1, the Genetics subgroup will compile the preferred criteria for stock selection from the literature and expert opinion of work group members.
2. **Task 2:** In order to complete task 2, The Genetics subgroup will compile and discuss the potential alternative methods available for selecting stock(s).
3. **Task 3**: As the Genetics subgroup works through Tasks 1 and 2, they will be identifying information needs that may be essential for stock selection. An outcome of Task 3 will be to develop and recommend ways to fill the knowledge gaps.
4. **Task 4**: Discussion paper(s) will be developed to document the results of Task 1-3 and provide justification for the direction recommended for stock selection.
5. **Task 5**: Potential reintroduction strategies will be identified and investigated.
6. **Task 6**: Discussion paper(s) will be developed to document the alternative reintroduction strategies, pros and cons, and provide justification for recommended strategies.

7. **Task 7**: Develop a reintroduction implementation plan that will to incorporate the recommendations for stock selection and reintroduction into a plan of action.
8. **Task 8**: Develop a monitoring plan to accompany the implementation plan. The monitoring plan will be designed to assure an appropriate level of data collection, analysis and evaluation will occur as implementation progresses.
9. **Task 9**: Implement reintroduction and monitoring plans, including pilot work to evaluate reintroduction techniques.

4. What are the management or policy implications of the study?

The Fisheries Management Plan (FMWG 2009b) identifies a number of potential actions to provide passage including modifications to the Sand Slough Control Structure and the Reach 4B headgate (paragraph 11 projects), retrofit of Sack Dam (paragraph 11 project), construction of Mendota Pool Bypass (paragraph 11 project), ensuring sufficient fish passage measures at all other structures and potential barriers, and the implementation of trap and haul in the event passage conditions are not suitable (FMWG 2009b). Effective passage for salmon and other native fish is critical to the success of the SJRRP.

B. Study Organization and Responsibilities

1. Person(s) responsible (names, title, phone numbers, addresses, e-mail) and role.

Margarita Gordus, Department of Fish and Game

2. Collaborators

Agency collaborators:

U.S. Fish and Wildlife Service (Kim Webb, Michelle Workman)

Department of Fish and Game (Mike Lacy, Paul Adelizi),

National Marine Fisheries Service (Shirley Witalis, Rhonda Reed, Carlos Garza, Anthony Clemento)

Other collaborators:

U.C. Davis (Josh Israel, Melinda Baerwald, Molly Stephens)

4. Are there considerations protecting the Department's public trust and stewardship obligations that are kept in trust for the public now and in the future? These may include but are not limited to: The Department has the ownership and control rights for all of the products including data, metadata, images, video, research protocols, analyses, etc.; attribution, acknowledgement, and proper representation of the Department's scientific and coordination role; the Department should hold first American print rights.

C. Study Design

1. List the specific *research questions* (state them clearly as a null or positive hypothesis) to be answered by this study, including methodology:

a. If the study includes sampling, describe the sampling design and measurement variables. Be specific: describe the sampling unit, independent variables, dependent variables, and tests or techniques to be used. Explain how bias will be avoided in selection of sampling units. For hypothesis tests, state the null hypothesis and alternative hypotheses.

Not yet developed

b. Describe the experimental design and necessary sample sizes. For manipulative experiments, describe the table of treatments and number of replicates, and how experimental units will be grouped or blocked.

Not yet designed

c. Describe biological detection capability. For field observational studies, describe the variation in measurement variables necessary to detect. (Historical data often can be used to predict the kind and quantity of data that will be required to achieve a stated resolution, or to estimate the resolution of a stated study design. If historical data pertinent to this question are available, apply power analyses).

Not yet designed

d. Using feedback in ongoing studies, is an augmentation or reduction of previous sampling effort appropriate (i.e. can the data be collected with less field effort and still achieve the same level of significance)? After data become available, estimate the power of the existing sampling effort.

Not applicable

e. Describe the contingency plans to assure the question is resolved: (Depending on the question being addressed, such plans may include (a) planned routine collection of more than the minimum data required at each regular interval, (b) logistical contingency plans to make up for missed field observations, or repeat incomplete manipulative experiments, or (c) alternate statistical methods if not all data are obtained. Use of alternate statistical methods will likely weaken the power of the study to answer the question or force redefinition of the question, and should be a last resort.

Not yet designed

2. How will sampling bias(es) from different samplers or methods (e.g. training, standardized protocols) be minimized?

Not determined

D. Study Resource Needs

1. Detailed budget: Tasks 1-6 will be addressed by the Genetics subgroup members through March 2010. Tasks 7-8 may require additional staff and funding beginning in April 2010. Not yet determined. Task 9 will begin NLT fall 2012. If permitting can be expedited, we would prefer to begin pilot work with experimental reintroduction strategies NLT spring 2010.

2. Personnel needs

   a. Field activities – spring 2010 optimal

   b. Laboratory and office activities – cover with existing staff if BOR, NMFS and additional FWS staff are brought on board.

   c. Travel (in-state only) fuel and per diem

   d. Temporary help (estimated number of hours) FY2010: 800, FY2011: 1400, FY2012: 1800

3. Equipment needs

   a. Boats/vehicles/major sampling equipment – to be determined

   b. What major equipment – to be determined, much of it can be borrowed, but some will be purchased.

4. Coordination needs

   a. Once we have developed an implementation plan, we will need to coordinate and collaborate with others. It is likely additional funding will be required to cover the collection, health evaluations, holding and transport of fish.

5. Has access to study site(s) been arranged? No.

E. Compliance Considerations

1. Will study result in, or have the possibility of, take of federally- or state-listed threatened, endangered or species of special concern?

   Yes,

2. If so, estimate the number by species/race that will be taken and the estimated mortality.

   To be developed.

3. Will the "take" or capture of any state- or federally-listed species be covered by an existing Biological Opinion?

   No

4. If no BO exists, how will compliance be achieved?

   Through permits.

F. Invasive Species: What measures will be taken to ensure field staff does not spread invasive plants or animals to new sites during the study?

HACCP Plans will be developed and followed.

G. Due Dates and Products

1. Describe the timeline for the study, with due dates for deliverables, including drafts (this should relate to section I.A.2.c).

Deliverable	Date
Tasks 1 & 2 Summary	September 30, 2009
Tasks 3 & 4 Papers and Summary	October 31, 2009
Tasks 5 & 6 Papers and Summary	January 31, 2010
Tasks 7 & 8 Plans	April 30, 2010
Task 9	December 31, 2012 (NLT)

2. Will any new databases be created for or added to for this study?
Yes.

3. If data is to be uploaded to a centralized data server, by what date?

Need server developed.

4. If product includes a report, does it need to meet Americans with Disability Act format requirements (e.g. if the final document is made available on the internet)?

Yes.

5. Will spatial data be submitted to BIOS? If so, submission must be in accordance with minimum BIOS and FGDC metadata standards.
(http://bios.dfg.ca.gov/metadata.asp)

(http://www.fgdc.gov/metadata/documents/workbook 0501 bmk.pdf)

II. Study Measurement and Data Acquisition

A. Sample Site Selection

Description of study area and sample sites, with map.

To be determined.

B. Sampling Procedure (Standard Operating Procedures, SOPs)

1. Parameters to be measured with units defined
    a. Frequency that each parameter will be measured (SOP)
    b. Will replicate samples be taken? (SOP)
2. Methodology (with references) and SOP
    a. Sample preservation, transportation, storage and disposal (SOP)
    b. Preparation of equipment: cleaning, reagents, supplies (SOP)
    c. Sample and data collection (SOP)
    d. Sample and data acceptability (SOP)
3. Personnel training (SOP)
4. Personnel safety (SOP), in both field and laboratory

C. Sample Custody for Field and Laboratory

1. Identify custodians and site for long-term storage (if appropriate)
2. Tracking forms (if appropriate)
3. Sample records (if appropriate)

D. Calibration Procedures and Frequency

1. Instrument and sample calibration (referenced).
2. Frequency and timing of calibration: analytical system, instruments, devices, etc. (SOP).
3. Documentation of calibration checks.
4. Instrument, equipment and supplies inspection and maintenance, including periodicity.

E. Sample Processing and Analysis

1. Reference standard methods and appropriateness for measurements
2. Describe non-standard methods and validation procedures
3. Describe SOPs

F. Data Reduction, Analysis and Reporting

1. Who will conduct the data reduction (transformation of raw data) and analysis?

2. What quality control procedures will be used to assure the validity of statistical results?

3. Who is responsible for preparing peer-reviewed articles and/or reports?

4. Will the data be archived in a central repository, like BIOS, FISH, etc.?

III. DATA ASSESSMENT AND OVERSIGHT

A. Quality Control Data Checks

1. What procedure will be used for data checks?

2. What criteria will be used to check data?

3. Who will conduct the data checks and how will the results be \ documented?

B. Field and laboratory performance and systems audit

1. How will the audit be conducted?

2. What criteria will be used?

3. Who will conduct the audit and how will the results be documented?

C. Corrective action

1. If errors are encountered in items A and B above, who will determine and implement corrective action(s)?

IV. DATA VALIDATION AND USABILITY

A. Error checking of raw data (data review)

1. What protocol will be used to check for errors?

2. What criteria will be used?

3. Who will conduct the checking?

4. How will the results be documented?

B. Data limitations

1. Describe the limitations of the data, such as periodicity, seasonality, etc.

V. STUDY FEEDBACK TO MANAGEMENT:

A. Study should contain the following:

1. Periodic review by a designated science advisory panel or individual; could be part of the reporting milestones at set times.
2. Integration of feedback to study design and methodologies.
3. Study completion and reporting (publication).
4. Presentation to leadership by deadline.

REFERENCES:

FMWG. 2009a. Conceptual models of stressors and limiting factors for San Joaquin River Chinook salmon. 178 pages. June 2009.

FMWG. 2009b. Fisheries management plan: A framework for adaptive management in the San Joaquin River Restoration Program.

Exhibit a: Guidance for Determining Implementation Objectives

Implementation Objective(s)

Examples: Monitor X for three years to determine success of a management action, survey Population Y for one year to determine current abundance, range, sex ratio, and age class structure, etc. If the study monitors the results of an event or a management strategy, what qualitative or quantitative threshold or degree of change defines a significant change or success? Examples:

- Maintain at least 50 individuals of Species B in the Willow Creek Unit.
- No more than 3 patches of Weed B in the Willow Creek Unit by 2010.
- Do not exceed Cover Class 3 (10 – 30% by visual estimate) by any of the target weed species in more than 2 of the 10 macroplots established in the Willow Creek Unit.

If monitoring involves sampling, how certain do you want to be of your results:

Example:

- Management Objective: Maintain a population of Species A in the Willow Creek Preserve with at least 100 individuals from 2009 ─ 2012.
- Sampling Objective: Be 95% confident that estimates are within ± 10% of the true value.

Examples of objectives adapted from Elzinga, C.L.;Salzer, D.W. and J.W. Willoughby. 1998. Measuring and Monitoring Plant Populations. U.S. Department of the Interior. Bureau of Land Management. Report #BLM/RS/ST-98/005+1730; BLM Technical Reference # 1730-1.

Appendix D. Genetics- Permitting

Study Plan Title: Experimental Population Permitting

Principal Investigator(s): NMFS, USFWS

Principal Investigator(s): [Jeff McLain, Rhonda Reed, Elif Fehm-Sullivan, Gerald Hatler]

Proposed Staff: [Jeff McLain, Stephanie Theis]

County(ies) affected by Study: [Fresno, Madera, Merced]

III. Study Management

C. Study Description

1. History or Background

See background provided in other workplans

This study workplan was developed in collaboration with the multiagency Fisheries Management Work Group (FMWG).

e. General project background discussion.

Experimental population status is required for successful reintroduction of Chinook salmon into the Restoration Area of the San Joaquin River. The purpose of this Workplan is to help identify the necessary steps for the application and permitting process to complete the experimental designation and introduction of Central Valley spring-run Chinook into the Restoration Area.

Under section 10(j), the Secretary of the Department of Commerce can designate reintroduced populations established outside the species' current rage, but within its historical range as 'experimental.' Section 10(j) allows flexibility in managing an experimental population as threatened, regardless of its designation elsewhere in its range. In addition, experimental populations are classified as either 'essential' or nonessential.' Experimental populations considered to be 'essential' are those that are required for the continued existing of the species and are treated as a threatened species, and special rules may allow take. Experimental populations considered 'nonessential' are also treated as a threatened species, but if the species is located outside a National Wildlife Refuge or a National Park, it is treated as a species proposed for listing.

Since spring-run Chinook salmon are also listed under the California Endangered Species Act (CESA) as threatened, they are subject to sections 2080 and 2081 of the California Fish and Game Code. There currently is no identified DFG process to permit the introduction of an experimental population that is CESA listed. There are currently two options identified to comply with CESA: 1) DFG makes a consistency determination that the findings within a Federal Biological Opinion/Incidental Take

Statement (BO/ITS) are consistent with CESA under section 2080.1 or 2) DFG issues a formal take permit under section 2081.

f. Describe the evolution of the study.

Not applicable.

g. Why is the study necessary?

Paragraph 14 of the San Joaquin River Litigation Settlement (Settlement) indicates that the Restoration Goal of the Settlement shall include the reintroduction of spring-run Chinook salmon to the San Joaquin River between Friant Dam and the confluence of the Merced River. Because spring-run Chinook salmon are listed as Federally threatened, it is subject to Endangered Species Act (ESA) requirements. In addition, the San Joaquin River Restoration Act indicates that spring-run Chinook salmon are to be reintroduced into the San Joaquin River pursuant to Section 10(j) of the Endangered Species Act, provided that the Secretary of Commerce "finds that a permit for the reintroduction of California Central Valley spring Run Chinook salmon may be issued pursuant to section 10(a)1(A) of the Endangered Species Act." Furthermore, it indicates that the Secretary of Commerce is to issue a final rule pursuant to Section 4(d) of the ESA governing incidental take.

Section 10 of the ESA allows the establishment and maintenance of experimental populations. The Secretary may authorize the release (and the related transportation) of any population (including eggs, propagules, or individuals) of an endangered species or a threatened species outside the current range of such species if the Secretary determines that such release will further the conservation of such species. Before authorizing the release of any experimental population, the Secretary must identify the population and determine, on the basis of the best available information, whether or not such population is essential to the continued existence of an endangered species or a threatened species.

h. Identify and analyze any previous similar studies.

To date, NMFS has prepared several 10(a)1(A) permits, however has never issued a 10(j) rule. The USFWS has issued several 10(j) rules, including a rule for four fishes in the Tellico River, TN. These populations were classified as nonessential experimental populations (NEPs), which means these populations are not required for the continued survival of the species, and are treated as a species proposed for listing. In this process, a letter requesting NEP status was submitted in 1998. In 2001, a proposed rule was submitted and a 60-day comment period was opened. The final rule was issued and published in the Federal Register in 2002 (67 FR 52420, August 12, 2002).

In 2008, the USFWS issued a 10(j) rule to list a portion of the grey wolf populations as experimental populations, while other populations were listed as endangered and others as threatened. The special rules used for the 10(j) rule included the 50 CFR 17.84 (k), which are special rules for vertebrates.

Specific populations of Colorado squawfish and woundfin were identified as experimental, nonessential populations with a special rule under section 17.84(b). The boulder darter in Shoal Creek, TN was identified as a nonessential experimental population with a special rule under section 17.84(o). The slender chub and the pygmy madtom were both identified as having nonessential experimental populations and were identified in special rule 17.84 (s) and 17.84(t) respectively.

For DFG to permit and be consistent with the ESA 10(A)1(a) collection permit, a DFG scientific collection permit is needed (2081.(A)). This work plan identifies agency roles and responsibilities as a deliverable which may or may not lead to the development of an MOU to help clarify agency roles and responsibilities. There are currently no known examples of CESA compliance for Federally designated experimental populations. Four potential possibilities exist for state consistency regarding the experimental designation including: 1) changing the CESA, 2) issuance of individual permit 2081.b, 3) consistency determination, or 4) safe harbor legislation. Given the uncertainty related to the process required to achieve CESA compliance of the experimental population, a key deliverable identified in this work plan is an identification of the process and agency roles and responsibilities.

2. Site Description

a. Location of the study (include maps, geographic data, etc.).

Not applicable

b. Describe the environmental setting for the study.

Not applicable

2. Study purpose

d. Statement of study goals.

To meet the requirements of the Settlement and the San Joaquin River Restoration Act in terms of the designation of an experimental population of spring-run Chinook salmon in the San Joaquin River.

e. List the objectives of the study

5. Develop experimental designation strategy;
6. Develop technical review process;
7. Identify the specific process for designating the experimental population of spring-run, and;
8. Identify data gaps and information needs for the USFWS permit application for reintroduction.

f. Describe study milestones. Identify products and timelines.

Task 1: Experimental designation strategy developed in collaboration with NMFS. July 2009.

Task 2: Identified technical review process.

Task 3: Detailed list of agency roles and responsibilities, including timelines and deliverables. October 31, 2009.

Task 4: A detailed list of information needs for the USFWS permit application for reintroduction. Due December 31, 2009.

Task 5: Submit completed permit application to NMFS by April 30, 2010

3. Study Approach (describe conceptual approach to study and include uncertainties).

Not Applicable

4. What are the management or policy implications of the study?

If a 10(j) rule cannot be issued prior to April 30, 2012, the Restoration Goal will not be met on the timeline designated by the Settlement and the Act.

D. Study Organization and Responsibilities

1. Person(s) responsible (names, title, phone numbers, addresses, e-mail) and role.

2. Chain of command (if appropriate).

3. Collaborators (agencies, NGOs, academia, etc.) and contact persons:

Is an MOU and/or contract already established with the collaborator(s)?

Agency collaborators:

- National Marine Fisheries Service (Rhonda Reed, Elif Fehm-Sullivan)
- U.S. Fish and Wildlife Service (Jeff McLain, Michelle Workman)
- Department of Fish and Game (Gerald Hatler, John Battistoni),

2. Are there considerations protecting the Department's public trust and stewardship obligations that are kept in trust for the public now and in the future?

Not applicable

C. Study Design

Not applicable

H. Study Resource Needs

A Fisheries Reintroduction Regulatory Team was established on September 24, 2009. This team is projected to meet biweekly for at least several months. The team consists of 3 representatives from NMFS, 1 from USFWS, 1 from Reclamation, 2 from DFG, and 1 consultant. Additional staff may be needed as the process continues.

2. Detailed budget

This work plan is funded with program funds supporting SJRRP staff. No additional funds are identified at this time.

I. Due Dates and Products

6. **Describe the timeline for the study, with due dates for deliverables, including drafts (this should relate to section I.A.2.c).**

   Deliverable Date

   Experimental designation strategy – October 31, 2009

   Identified technical review process – October 31, 2009

   Detailed list of agency roles and responsibilities, - April 2010

   List of permit information needs - April 2010

7. **Will any new databases be created for or added to for this study?**

No

8. **If data is to be uploaded to a centralized data server, by what date?**

Not applicable

9. **If product includes a report, does it need to meet Americans with Disability Act format requirements (e.g. if the final document is made available on the internet)?**
10. **Will spatial data be submitted to BIOS? If so, submission must be in accordance with minimum BIOS and FGDC metadata standards.**
    (http://bios.dfg.ca.gov/metadata.asp)
    (http://www.fgdc.gov/metadata/documents/workbook 0501 bmk.pdf)

II. Study Measurement and Data Acquisition

Not Applicable

III. DATA ASSESSMENT AND OVERSIGHT

Not Applicable

IV. DATA VALIDATION AND USABILITY

Not Applicable

V. STUDY FEEDBACK TO MANAGEMENT:

A. Study should contain the following:

- Periodic review by a designated CDFG science advisory panel or individual; could be part of the reporting milestones at set times.
- Integration of feedback to study design and methodologies.
- Study completion and reporting (publication).
- Presentation to leadership by deadline.

REFERENCES:

Appendix E. Habitat Assessment *(currently under revision by DFG)*

Study Title: **Habitat Assessment**
Principal Investigators: Matt Bigelow, Eric Guzman
Contact Info. Of Principal Investigators: (559) 243-4014
Proposed Staff: CDFG and SJRRP staff
Counties affected by Study: Fresno, Madera, Merced

1. Study Management

A. Study Description

1. Background

a. Biological Considerations

Suitable habitat for all salmonid life stages may be a key limiting factor for successful spawning, egg incubation and juvenile rearing and outmigration throughout the Restoration Area. Without sufficient habitat quantity and quality for all life stages, the Program's salmonid population goals will not be met.

Adult salmon require sufficient spawning gravel areas to build redds and lay eggs. Spawning gravel must be of adequate size and be composed of an appropriate mixture of gravel and contain minimal fine-grained material. The surface water head elevation differences just upstream and downstream of each redd drives Intra-gravel flow. This flow provides oxygen to the incubating eggs and carries off generated waste. Depth and velocity also need to be suitable in order to carry fine-grained material from each redd during construction. Emerging fry require calm shallow water having sufficient cover in order to feed and grow to their juvenile stage when they require shallow water along the fringe or in floodplain areas with abundant food supplies to feed without over-competing in order to mature as they move along the river and smoltify. As the juveniles and smolts outmigrate through the system, they require suitable depth, velocity and cover to successfully make it to the confluence with the Merced River.

b. Previous Similar Studies

Based upon existing temperature and habitat data, it is likely that Reach 1 (Reaches 1A and 1B) will provide the most suitable salmonid spawning and rearing habitat. However, a detailed assessment of this reach has not been conducted for several years. CDFG evaluated this reach in 2003-2005, but this information must be updated following recent high-flow flood events. The habitat in the remaining reaches to the confluence with the Merced River also need to be assessed.

c. Location of the study

This study is located in the San Joaquin River Restoration Program (SJRRP) Project Area. The Restoration Area is approximately 153 miles long, extending from Friant Dam at the upstream end near the town of Friant, downstream to the confluence with the Merced River, and includes an extensive flood control bypass system (Figure 1). Five river reaches have been defined to address the different river characteristics. For more information regarding the Restoration Area, see FMWG (2009b).

2. Study Purpose

   a. Goals:

      To evaluate the extent of existing habitat types, identify which types are abundant and those that appear inadequate to meet the Settlement's salmonid reintroduction goals based upon detailed habitat information sufficient to guide restoration actions and evaluate effectiveness.

   b. Objectives:

      1) Provide data for habitat distribution (mesohabitat);

      2) Understand how the restoration flows will affect distribution, abundance and availability of aquatic habitat resources (mesohabitat tracking through time);

      3) Provide detailed data on fish habitat quantity and quality for native and non-native species while placing an emphasis on all life stage requirements for both Spring and Fall-run Chinook salmon (physical microhabitat data); and,

      4) Aid in assessing needs and provide information to make recommendations for restoration actions and evaluate restoration success (comparison of mesohabitat/microhabitat data to known physical requirements for fish and standards for habitat abundance and quality).

      Habitat monitoring should be able to characterize existing habitat conditions with enough detail so that informed decisions can be made as to how suitable existing habitat is likely to be for restored fish populations. Furthermore, it is expected that the temporal scale of monitoring will be able to document changes in habitat resulting from restoration actions such that it will be possible to determine if those actions are beneficial, detrimental or likely to have a negligible effect. Detailed fish habitat data will provide enough information to determine how environmental conditions will likely effect fish species on a reach by reach basis. Analysis of detailed data is not expected to model changes in direct response to flows but will provide ongoing measurements of specific environmental variables that may be used subsequently in predictive modeling efforts. These data will, however, provide a direct indication of the suitability of environmental conditions and

provide the means to track how they and overall habitat conditions may change with time and in response to restoration actions (including flows).

c. Milestones:

1) Evaluate the distribution of habitat by targeting Program Interim flows occurring October 1 – November 20, 2009 for reach 1A and continuing with the remaining reaches during the interim flow period February 1 – December 1, 2010; and,
2) Evaluate detailed physical conditions as soon as reasonably possible but with the expectation that this work will be initiated during the interim flow period February 1 – December 1, 2010; and,
3) Incorporate data collected into an annual Program monitoring report.

3. Study Approach:

a. Data collection efforts will focus on two different scales of measurement; one measuring the spatial extent and distribution of habitat classified with distinguishing features on a mesohabitat scale with the second based upon several physical condition measurements within these habitats (microhabitat). Classifications are based upon the system originally developed by P.A. Bisson, et al. (1982) and later expanded by others as described in CDFG's Salmonid Stream Habitat Restoration Manual (1998).

b. Mesohabitat units will be mapped using site measurements (GPS, etc.) and incorporated into a Geographical Information Systems (GIS) database for further analysis. Habitat unit measurements will be updated regularly to document temporal changes.

c. Detailed physical information will be documented within the habitat units at selected sites.

B. Study Organization and Responsibilities

1. Persons responsible:

a. Gerald Hatler
Senior Environmental Scientist
1234 E. Shaw Avenue
Fresno, CA 93710
(559) 243-4014, ext. 259
(559) 341-1814 Mobile
(559) 243-3004 Fax
ghatler@dfg.ca.gov

b. Principle Investigators:

Matt Bigelow
Environmental Scientist
1234 E. Shaw Avenue
Fresno, CA 93710

(559) 243-4014, ext. 258
(559) 246-0877 Mobile
(559) 243-3004 Fax
mbigelow@dfg.ca.gov

Eric Guzman
Environmental Scientist
1234 E. Shaw Avenue
Fresno, CA 93710
(559) 243-4014, ext. 260
(559) 417-7494 Mobile
(559) 243-3004 Fax
eguzman@dfg.ca.gov

2. Collaborators:

    a. Department of Water Resources
    b. NOAA Fisheries
    c. United States Bureau of Reclamation
    d. United States Fish and Wildlife Service

C. Study Design

1. Hypothesis: (H_1): Existing and future developed habitat in the San Joaquin River does not support all life history requirements for restored runs of Spring and Fall-run Chinook salmon. Information resulting from this study will be able to test this hypothesis for the following reasons:
   a) Mesohabitat inventories will document existing and future conditions sufficiently such that changes (or no change) in general habitat conditions will be observed.
   b) Microhabitat conditions will be documented sufficiently such that an understanding of existing and future environmental conditions (temperature, dissolved oxygen, substrate, etc.) and how those conditions relate to life history needs can be analyzed and deemed detrimental or beneficial to sustaining a restored fishery.
2. Sampling Design:

   The Program divides the San Joaquin River project area into reaches and sub-reaches according to similarities within each reach and landmarks that divide the river into manageable segments. Similarities are in terms of different physical processes occurring within the system (figure 1). This study will provide detail for each reach by describing individual habitat units according to habitat type and the physical properties measured within them. Data will be collected utilizing a combination of methods described in the CDFG Salmonid Stream Habitat Restoration Manual (1998) and Stream Channel Reference Sites (USDA 1994).

    a. Mesohabitat methods:

Habitat data collection will consist of an inventory of the different habitat units present and how they are distributed throughout the system. Habitat units will be described according to a modified classification system which is a variation of the system originally developed by P.A. Bisson, et al. (1982) and later expanded by others. For each habitat unit encountered, the location and spatial area occupied by the unit will be measured and mapped utilizing several field documentation methods and GIS. Water surface elevations along the thalweg and wetted channel width at the top, middle and bottom of each habitat unit reach will be measured as well.

Habitat units are described according to the following list:

RIFFLE	
Low Gradient Riffle	(LGR)
High Gradient Riffle	(HGR)
CASCADE	
Cascade	(CAS)
Bedrock Sheet	(BRS)
FLATWATER	
Pocket Water	(POW)
Glide	(GLD)
Run	(RUN)
Step Run	(SRN)
Edgewater	(EDW)
MAIN CHANNEL POOL	
Trench Pool	(TRP)
Mid-Channel Pool	(MCP)
Channel Confluence Pool	(CCP)
Step Pool	(STP)
SCOUR POOL	
Corner Pool	(CRP)
L. Scour Pool - Log Enhanced	(LSL)
L. Scour Pool - Root Wad Enhanced	(LSR)
L. Scour Pool - Bedrock Formed	(LSBk)
L. Scour Pool - Boulder Formed	(LSBo)
Plunge Pool	(PLP)
BACKWATER POOLS	
Secondary Channel Pool	(SCP)
Backwater Pool - Boulder Formed	(BPB)
Backwater Pool - Root Wad Formed	(BPR)
Backwater Pool - Log Formed	(BPL)
Dammed Pool	(DPL)
ADDITIONAL UNIT DESIGNATIONS	
Dry	(DRY)
Culvert	(CUL)
Not Surveyed	(NS)
Not Surveyed due to a marsh	(MAR)

b. Microhabitat:

1) Sample Site Selection

Chosen sites will be maintained as reference sites that will be monitored for changes over time and will document physical responses to restoration flows. For example, substrate data will indicate bed mobility and document how material may move in response to specific flows.

CDFG's Salmonid Stream Habitat Restoration Manual Appendix O (1998) describes a 10% sampling protocol (included in appendix A) for habitat inventories. While this method is recommended as being satisfactory for basin level planning, obtaining descriptive microhabitat detail may be served well by this systematic approach for the following reasons:

a) A full inventory of the study area will be accomplished and mesohabitat conditions will be well-understood.

b) It is expected that reach conditions will be consistent enough such that a 10% subsample should characterize other similar habitat units within reaches adequately.

Choosing a systematic method for site selection is problematic because field conditions tend to be restrictive as land and river access is typically inconsistent. Furthermore, systematic random sampling may force investigators to analyze a unit that may be similar enough to other habitat units to be classified the same but may not, in the opinion of experienced investigators, reasonably represent other units within the subreach (unit may be unusually small or have been difficult to ascertain mesohabitat classification). Additionally, limitations of personnel and time would make a full systematic study impossible for a large system like the study area in question. It is likely that habitat in Reach 1 would require a more intensive effort owing to the likely presence of multiple life stage critical conditions and less homogenous conditions than, perhaps, lower reaches. It is likely that the methods employed may be a combination of subjective site selection and systematic approaches.

Microhabitat data may be useful for further analysis such as habitat/flow modeling and channel typing using systems developed by David Rosgen (1985 rev. 1994) and others to better inform restoration actions.

2) Methods

A challenge arises between sampling when conditions are wadeable and non-wadeable. Methods outlined in the CDFG Salmonid Stream Habitat Restoration Manual (1998) and Stream Channel Reference Sites (USDA 1994) are for wadeable conditions. However, with refinement, data collection will be able to document physical conditions under non-wadeable conditions with wadeable surveys being restricted to riffle habitat units.

Monumented cross-sections will be developed at the top, middle and bottom of each site which will also provide a reference for longitudinal profiles.

For each cross-section the following data will be collected:

a) Flow: Measured in cubic feet per second (cfs) to calculate discharge and delineate channel form and, in particular, calculating bankfull discharge (Qbf). This will be accomplished with an acoustic doppler current profiler and can be operated under non-wadeable conditions or, as necessary and conditions permitting, using traditional wading methods.

b) Substrate: This will generate information regarding the geomorphic nature of riffles and measure the following conditions:

Substrate composition will range from silt/clay sized particles to boulders and bedrock elements using the following criteria:

Code	Type	Particle Size (inches)
0.1	Sand/Silt	< 0.1
1	Small Gravel	0.1 – 1
1.2	Medium Gravel	1 – 2
1.3	Medium/Large Gravel	1 – 3
2.3	Large Gravel	2 – 3
2.4	Gravel/Cobble	2 – 4
3.4	Small Cobble	3 – 4
3.5	Small Cobble	3 – 5
4.6	Medium Cobble	4 – 6
6.8	Large Cobble	6 – 8
8	Large Cobble	8 – 10
9	Boulder/Bedrock	> 12
10	Large Cobble	10 – 12

A minimum of 100 substrate samples will be collected randomly across each riffle.

Substrate composition data will also evaluate embeddedness. The depth of embeddedness of the cobbles in pool tail-outs will be measured by estimating the percent of cobble surface area that is surrounded or buried by fine sediment from the average of five randomly selected samples. The values will be recorded using the following ranges:

0 - 25%	(value 1)
26 - 50%	(value 2)
51 - 75%	(value 3)
76 - 100%	(value 4)

Additionally, a value of 5 is assigned to tail-outs deemed unsuitable for spawning due to inappropriate substrate particle size, having a bedrock tail-out, or other considerations.

The percentage of bottom substrate that is exposed above the water surface will be recorded as well.

In all habitat units, dominant and sub-dominant substrate elements will be visually estimated using the list below of seven size classes and will be recorded as one or two dominant classes present. Subsequent changes in dominant classes may serve as an indicator of changes within the channel.

1) Silt/Clay
2) Sand
3) Gravel
4) Small Cobble
5) Large Cobble
6) Boulder
7) Bedrock

c) Water quality: water quality parameters will be recorded utilizing a portable sampler. Samples will be taken within one foot of the water surface. Temperature will be recorded to augment permanent temperature recorders throughout the study area and will also record pH, turbidity, conductivity, dissolved oxygen (DO) and salinity. More specific measures of subsurface DO and temperature will be taken within the head of each riffle via a perforated tube buried in the substrate.

d) Instream Shelter: The composition of elements within the channel that that may provide protection from predation, reduce water velocities for fish rest areas, and allow separation of territorial units to reduce density related competition, etc. will be documented and used to calculate a shelter rating value. The shelter rating is calculated by multiplying the shelter value and percent cover which are determined as indicated below. Shelter ratings can range from 0-300 and are expressed as mean values by habitat types within a stream.

1) Shelter Value:

Standard shelter values will be assigned to each unit which is a relative measure of shelter quantity and composition:

0 =

- No shelter.

1 =

- One to five boulders.
- Bare undercut bank or bedrock ledge.
- Single piece of large wood (>12" diameter and 6' long defined as large woody debris (LWD).

2 =

- One or two pieces of LWD associated with any amount of small wood (<12" diameter) defined as small woody debris (SWD).
- Six or more boulders (> 10” diameter) per 50 feet.
- Stable undercut bank with root mass, and less than 12" undercut.
- A single root wad lacking complexity.
- Branches in or near the water.
- Limited submersed vegetative fish cover.
- Bubble curtain.

3 =

Combinations of (must have at least two cover types):

- LWD/boulders/root wads.
- Three or more pieces of LWD combined with SWD.
- Three or more boulders combined with LWD/SWD.
- Bubble curtain combined with LWD or boulders.
- Stable undercut bank with greater than 12" undercut, associated with root mass or LWD.
- Extensive submersed vegetative fish cover.

2) Percentage Cover:

Percentage cover will be based upon a visual estimate of the percentage of the shelter value descriptions below that occupy the habitat unit. The sum of percentage cover estimates should be equal to 100%.

a) Undercut bank
b) Small woody debris
c) Large woody debris
d) Root mass
e) Terrestrial vegetation
f) Aquatic vegetation
g) Bubble curtain
h) Boulders
i) Bedrock ledges

e) Canopy: Canopy density will be estimated using handheld spherical densiometers at the center of the habitat unit. Canopy density will be related to the amount of stream that could be shaded from the sun. An estimate of percentage of the wetted area of the habitat unit influenced by shade will be made. Additionally, the percentage of coniferous or deciduous trees contributing to shade will be estimated.

f) Bank Composition and Vegetation: Bank composition elements range from bedrock to bare soil. However, stream banks are usually covered with grass, brush, or trees. These factors influence the ability for stream banks to withstand higher flows. The dominant composition type (see list below) and the dominant vegetation type (see list below) of both the right and left banks will be estimated at the bankfull discharge and 20 feet upslope of bankfull discharge level for each unit.

1) Dominant Composition:

a) Bedrock
b) Boulder
c) Cobble/Gravel
d) Silt/Clay/Sand

2) Dominant Vegetation:

a) Grass
b) Brush
c) Deciduous trees
d) Coniferous trees
e) No vegetation

Additionally, the percent of each bank covered by vegetation will be estimated and recorded for bankfull elevation and 20 feet upslope.

g) A site sketch with photographs will further document overall conditions including but not limited to land use, structures (bridges, diversions, etc.), and large observational changes such as slides or other features that may influence the stream.

D. Study Resource Needs
1. Personnel Needs:
   a. Field Activities – Field work will be done by a crew of 2-6 people of which will include at least one principle investigator.
   b. Travel – efforts to keep overnight travel to a minimum will be made. However, given the length of the project area such travel will occur. Mendota Pool will be considered the cutoff point for over night travel. Any work done upstream of Mendota Pool will be within day trip travel range conversely anything downstream will probably require an overnight stay for crews leaving Fresno.
   c. Temporary Help – Temporary help need is estimated to be 416 hours per year per employee. This represents 2 weeks in the field 4 times a year working 8 hour days for

approximately 320 hours in the field. There will also be office time which will be three days for each of the two week periods described above for 96 hours per employee per year.

d. Training – Training will be provided to any staff new to habitat crews. During the course of the study at least one of the principle investigators will be in the field and participate in assessment and data collection to maintain continuity and decrease bias. This includes training for equipment use watercraft such as kayaks, canoes and other boats.
e. Safety – All personnel involved in the field portion of this study is expected to be familiar with the CDFG field safety manual and Injury and Illness Prevention Program.

2. Coordination Needs:
   Access to sampling sites will be a challenge in the lower reaches and opportunities for collaboration will be sought to fulfill development of a complete habitat analysis of the restoration area.
3. Access:
   a. Reach 1– Publicly owned lands are prevalent in this reach and access restrictions are typically relaxed for CDFG personnel.
   b. Reach 2 – There are insufficient access points at this time to fully survey this reach.
   c. Reach 3 – There are insufficient access points at this time to fully survey this reach.
   d. Reach 4 – There are insufficient access points at this time to fully survey this reach.
   e. Reach 5 – There are publicly owned lands within this reach but limitations for access are not entirely understood at this point..
   f. Bypasses – There are no access points at this time to permit surveys within this reach

References:

Bisson, P.A., J.L. Nielsen, R.A. Palmson, and L.E. Grove. 1982. A system of naming habitat types in small streams with examples of habitat utilization by salmonids during low stream flow. Symposium on acquisition and utilization of aquatic habitat inventory information. Western Division, American Fisheries Society. Bethesda, Maryland.

Bunte, Kristin; Abt, Steven R. 2001. Sampling surface and subsurface particle-size distributionsin wadable gravel- and cobble-bed streams for analyses in sediment transport, hydraulics, andstreambed monitoring. Gen. Tech. Rep. RMRS-GTR-74. Fort Collins, CO: U.S. Departmentof Agriculture, Forest Service, Rocky Mountain Research Station. 428 p.

California Salmonid Stream Habitat Restoration Manual, 3rd edition, Sections I - VIII. Flosi, G., Downie, S., Hopelain, J., Bird, M., Coey, R., and B. Collins. 1998. California Department of Fish and Game, Inland Fisheries Division. 497 pages.

Harrelson, Cheryl C; Rawlins, C. L.; Potyondy, John P. 1994. Stream channel reference sites: an illustrated guide to field technique. Gen. Tech. Rep. RM-245. Fort Collins, CO: U.S. Department of Agriculture, Forest Service, Rocky Mountain Forest and Range Experiment Station. 61 p.

Hawkins, C. P., J. L. Kershner, P. A. Bisson, M. D. Bryant, L. M. Decker, S. V. Gregory, D. A. McCullough, C. K. Overton, G. H. Reeves, R. J. Steedman, and M. K. Young. 1993. A hierarchial approach to classifying stream habitat features. Fisheries 18(6):3-12.

Appendix A
TEN PERCENT SAMPLING PROTOCOL FOR HABITAT INVENTORY SURVEYS

Since 1990 numerous anadromous salmonid streams in California have been inventoried for fish habitat utilizing fish habitat typing methods described by Flosi and Reynolds (1994). Habitat typing involves the identification, description, and measurement of distinct fish habitats within the wetted channel. Surveyors usually begin at the mouth of a stream and proceed upstream. They identify each fish habitat type and record up to 35 individual measurements or observations for each habitat type unit. Typically, this method is applicable in first through fourth order streams with an average wetted width of less than 75 feet. These streams can usually be waded. A team of two experienced surveyors are able to complete about one-half mile of stream (or about 100 habitat units) per day. The primary use of fish habitat typing data by the Department of Fish and Game, and others, is to identify and prioritize streams or stream reaches in need of restoration. The resulting stream descriptions are considered a general "basin level" view for planning purposes and not a rigorous "project level" view that describes site specific details. For example, a stream might reveal a lower than expected frequency of pools throughout the survey area, which indicates a potential restoration opportunity of deploying pool-forming structures.

Past practice has been to determine and record all characteristics of each habitat unit as called for on the Habitat Inventory Data Form. However, experience in analyzing over 200 stream habitat inventory data sets has indicated that adequate stream descriptive detail for “basin level” planning can be accomplished with a sampling level of about 10 percent. Possible strategies for subsampling habitat type units in streams or stream reaches at about a 10 percent level included:

1) a systematic sample with a random start of every tenth unit,
2) a systematic sample stratified by habitat type, where each habitat type was sampled at a pre-determined interval,
3) a 10% random sample of all habitat units,
4) a random sample within every 10 consecutive habitat units.

Each proposed sampling strategy has some drawbacks. The systematic random sample with a random start was perceived to be too non-random, except for the start. Both complete and systematic random sampling of habitat types requires prior knowledge of the population of habitat types available and is impractical for field application. A random sample of all habitat units is perhaps statistically the most sound, but might not reflect land use or ownership differences if a particular random sample allowed for no samples in some areas. Because of the desire to have samples selected throughout the entire stream reach, to avoid possible sampling gaps in some watershed ownership parcels, the stratified sampling method (strategy No. 4) was selected as the preferred sampling strategy. This sampling strategy was modified by adding to the randomly selected habitat type set, a sample set that included the first occurrence of each habitat type. This modification ensured that all habitat types were represented at least once in the entire sample.

RECOMMENDATIONS

1. Segment the stream into sub-reaches consisting of 10 consecutive habitat units. The Habitat Inventory Data Form contains spaces for 10 habitat units per page. Habitat unit numbers begin at the downstream end of the survey and continue sequentially upstream to the end of the survey area.
2. Obtain a random number table or a 10-sided die.
3. Randomly select a number from one through ten by tossing a die or using the random number table.
4. The number selected is the first randomly sampled habitat unit within the first 10 habitat units. Mark this habitat unit on Form 1 of the Habitat Inventory Data Form. Now, randomly select another number from one to ten. This is the habitat unit to randomly sample in the second set of 10 habitat units. If the number is "3", select the 3rd habitat unit on Form 2, or habitat unit No. 13. Mark this

number on Form 2 of the Habitat Inventory Data Form. Continue selecting random numbers and marking forms to indicate random habitat units until you have enough forms for the day.
Hint: use a felt tipped marking pen to highlight the entire column of the randomly selected unit.
5. Begin the survey at the downstream end of a stream, reach or stream channel type change.
6. The actual survey involves:

a. Walk and measure the entire stream length.

1). Identify every habitat unit by type.

2). Measure the length of each unit.

b. Record all measurements and observations (complete sample) for each first time encounter of each habitat type found in a stream channel type reach.

c. Record all measurements and observations (complete sample) for every randomly selected habitat unit number. Optimizing pool habitat is a high priority for restoration projects. To enable these survey data to function as a crude monitoring tool of pool scour and deposition dynamics, including relative quality of spawning substrate in pool tail crests, the following parameters are recommended for each pool habitat:

d. Measure maximum depth, pool tail crest depth and pool tail embeddedness in all pool habitat types. Another high priority restoration prescription is improvement of riparian canopy density. To enable graphic display and analysis of canopy densities linearly along a stream reach, the following is recommended:

e. Determine canopy density in at least every third habitat unit.

Appendix F. Hills Ferry Barrier Assessment

Principal Investigators: Matt Bigelow

Contact Info. Of Principal Investigators: (559) 243-4014

Proposed Staff: CDFG and SJRRP staff

Counties affected by Study: Fresno, Madera, Merced, Stanislaus

2. Study Management

A. Study Description

3. Background

Prior to 1992, an estimated 38% of Merced River fall-run Chinook salmon strayed beyond their natal Merced River upstream into the San Joaquin River during their spawning migration journey. These fish continued up the mainstem San Joaquin River into Salt and Mud sloughs, and their distributaries. These sloughs and distributaries convey poor quality water and have no suitable salmon spawning habitat.

In 1988, drought conditions resulted in reduced flows and warmer water down the Merced River. Chinook salmon were attracted to the larger flows in the San Joaquin River originating from west side agricultural runoff. The Department of Fish and Game (DFG), in an attempt to save the straying salmon, began a trapping and egg salvage effort in the San Luis Canal adjacent to the Los Banos Wildlife Area. Electronic weirs were used to help guide stray salmon to a Denil fish ladder and eventually to a trap in the San Luis Canal near Henry Miller Road. During the spawning season, trapped salmon were spawned and the eggs transported to the Merced River Hatchery near Snelling, California, for incubation and rearing. Some adults were transported to the hatchery the first year, but this approach was abandoned due to the stress on the fish causing direct mortality of the adults, egg mortality, and poor quality of the resulting gametes from the few that survived. The trapping effort continued with modifications in location and design until discontinued in 1991 as the percentage of egg to smolt survival had dropped to 5.8%.

During the 1992 spawning season, DFG personnel constructed and tested an electrical fish barrier made by Smith-Root Incorporated. Department of Water Resources funded this effort, pursuant to the DPFPA. The barrier was placed in the San Joaquin River just upstream of the Merced River confluence approximately 3.5 miles northeast of the town of Newman. Rather than trapping the stray salmon after they had migrated well upstream near Los Banos, DFG used the electrical barrier to deter their migration up the San Joaquin River so that as Merced River flows increased, the salmon would instead be attracted to suitable spawning habitat in the Merced River. A secondary physical barrier was placed 50 yards upstream of the electrical barrier to act as a backup, and to help evaluate the effectiveness of the electrical barrier.

After evaluating their 1992 efforts, DFG determined the electrical barrier was not the best approach at this location due to heavy corrosion occurring in one season caused by high

conductivity of the San Joaquin River water corroding the electrical cables and the highly mobile stream bed developing gaps or covering the barrier rendering it less effective. During the 1993 spawning season, DFG constructed an "Alaska Weir" type barrier at this location, just upstream of the Merced River confluence. This design is also referred to as a resistance board weir (RBW), similar to a weir operated on the lower Stanislaus River near Riverbank. This design, anchored to the stream bed with the top floating on the surface, allowed the few boaters that encountered the weir greater ease of passage and most importantly the heavy debris that can often consume time or damage previous designs continued floating downstream. Unfortunately, salmon were able to detect the barrier at the surface and jump to continue migrating upstream. DFG continued modifying the barrier to prevent salmon passage and accommodate the highly mobile stream bed.

The current structure, first used in 2003, incorporates several wooden tripod structures with cables spanning the river providing top and bottom support to attach aluminum channels with 1" holes punched through to allow lengths of ¾" electrical conduit to be placed vertically through the aluminum channels and into the stream bottom. The conduit is oriented vertically and is spaced tightly to prevent salmon from swimming through the gaps but allows smaller fish and some debris to pass. This design's biggest advantage over previous designs is it allows the conduit to remain bedded into the mobile sandy stream bottom. This design is referred to as a sliding pipe weir (SPW). Two-thirds of the 2003 weir was of the RBW type and one third was of the SPW type. DFG encountered both construction and operational challenges by attempting to incorporate the two designs. After the 2003 season, DFG decided to use only the SPW design.

The barrier is usually installed and operated from mid-September through December each year. It takes two to three days to erect and disassemble and is usually constructed with a crew of four. The barrier is staffed 24-hrs per day to visually monitor its success, remove accumulated debris and assist boaters in passing the structure.

The barrier has been highly effective at redirecting salmon, but is not without limitations. The barrier's effective sustained flow capacity is 1,000 cfs, with the ability to withstand short-duration flows up to 1,500 cfs. Flows greater than 1,750 cfs will totally submerge the barrier. Interim Flows will begin October 1st and continue through November 20th, 2009, with Friant Dam releases ranging from 350-700 cfs. After November 20th, the flows will decrease to "normal" and will not likely impact barrier operations. It remains unknown whether Friant releases will reach the Merced River confluence during this Interim Flow period, especially since releases will be based on a "Dry" hydrologic water year type.

DFG leases private land each year to gain access to the site and house personnel for the 24-hr per day operation and maintenance activities. The current agreement allows for DFG to access the site beginning September 1 of each year to begin the site set-up and must be out by December 31st of each year but, does allow for site clean-up through January. The current agreement would not allow the barrier to be operated in the spring.

Conditions at the site are challenging as water quality is very poor and corrosive to metals and trash and debris floating down the river is collected by the barrier putting strain on the supports and conduit. This requires a significant amount of maintenance. The fine, sandy,

river bottom substrate frequently moves, scouring gaps beneath the support structures, requiring sandbags be placed to maintain a relatively "fish tight" barrier. The highly mobile streambed and the temporary nature of the barrier will likely be a continual problem regardless of the type of barrier used.

4. Study Purpose

A. Goals:

To evaluate barrier effectiveness and the nature of fish that arrive at the barrier.

B. Objectives:

1. Evaluate barrier effectiveness under a variety of flow conditions;

2. Collect data for detectable fish that arrive at the barrier, and;

3. Identify problems, limitations and improvements in operation and evaluate structural and non-structural barrier modifications and (or) locations that may increase barrier effectiveness.

C. Implementation Objectives:

1. Install a high-definition acoustic camera upstream of the barrier to detect and identify fish that may make it past the barrier.

2. Install a trap on the barrier to collect data on fish that arrive at the barrier and potentially use fish for experimental purposes.

3. Study Milestones:

1. DFG will continue operating the barrier each fall.

2. Data collected will be incorporated into an annual Program monitoring report.

4. Study Approach:

1. The San Joaquin River's high turbidity makes fish detection at the site difficult. A dual frequency identification sonar (DIDSON) will be deployed to help visually estimate the number and species of fish that may move past the barrier and identify structural defects in the barrier that may reduce effectiveness. Barrier defects are often the result of debris load, over topping of the barrier, erosion around the base or broken conduit.

2. A trap will be installed on the barrier to collect detailed information about fish that arrive at the barrier. Fish may also be used to collect tissue

samples for genetic analysis and fish may be marked and released to evaluate survival.

3. Information will be collected about conditions through the operational season and problems encountered to evaluate changes or potential operational and design improvements.

B. Study Organization and Responsibilities

3. Persons responsible:

Gerald Hatler
Senior Environmental Scientist
1234 E. Shaw Avenue
Fresno, CA 93710
(559) 243-4014, ext. 259
(559) 341-1814 Mobile
(559) 243-3004 Fax
ghatler@dfg.ca.gov

2. Principle Investigators:

Matt Bigelow
Environmental Scientist
1234 E. Shaw Avenue
Fresno, CA 93710
(559) 243-4014, ext. 258
(559) 246-0877 Mobile
(559) 243-3004 Fax
mbigelow@dfg.ca.gov

Dale Gates
Fish Habitat Assistant
LaGrange, CA
(209) 853-9136
(209) 610-6406 cell
(209) 853-2075 fax
dgates@dfg.ca.govv

4. Collaborators:

    A. Department of Water Resources

    B. NOAA Fisheries

    C. United States Bureau of Reclamation

    D. United States Fish and Wildlife Service

C. Study Design

3. Hypothesis: (H_1): The Hills Ferry Barrier effectively protects Chinook salmon from migration upstream of the Merced River confluence.

4. Sampling Design:

    A. Barrier Effectiveness:

    A hydroacoustic dual frequency identification sonar unit will be installed at a suitable location immediately upstream of the barrier. Deployment will attempt to monitor a cross-sectional area that may also provide visual monitoring of the barrier itself. The unit will be connected to an onsite trailer that will record and store data for analysis.

    Data collected (with limitations) will include:

        1. Number of fish detected

        2. Timing of fish detected

        3. Species determination

        4. Observations related to the barrier (when and where fish may move past the barrier or identify features for maintenance or improvement)

    B. Trap Operation:

    1. A trap will be installed and fish will be measured and potentially tagged to estimate survival (recapture rates) for fish that will be released downstream of the barrier.

    2. Tissue samples (fin clip) may be taken for Chinook salmon and steelhead for genetic assessment, not to exceed take limits. Take limits currently allow non-lethal take of up to ten (10) Central Valley steelhead.

        a. Tissue Collection Methods (Attachment A)

        b. Sample Custody

        For proper handling, field samples will be dried and sent to:

Margarita Gordus, Environmental Scientist
California Department of Fish and Game
1234 E. Shaw Avenue
Fresno CA 93710

C: Operational Considerations:

Problems that will be documented may include: broken panels, debris jams and debris load, erosion, etc. and trap issues. Operational challenges and limitations as they relate to flow conditions will be thoroughly documented and evaluated.

D. Study Resource Needs

1. Estimated Equipment Budget (Attachment B)
2. Personnel Needs:

A. Field Activities – Field work will two-person crews. In the morning they will check the barrier for holes, breaks, debris load, and if trap is present, process the fish for release in the Merced River. This process will be repeated for the evening check.

B. Lab and Office Activities - Office activities will include data entry, quality assurance/quality control, creation of graphs, charts and reports. Data entry will be conducted by 1-2 scientific aid(s) and will be checked by the principle investigator or designee. The creation of charts, graphs and reports will be done by the principle investigators and edited by the current supervisor or designee. Possible tissue samples collected will be sent to the DFG's Salmonid Tissue Archive for long term storage and for future use by the San Joaquin River Restoration Project.

C. Travel – efforts will be made to minimize overnight travel. However, given the distance from region 4 headquarters to the project area such travel will occur. There will be coordination with the DFG, LaGrange field office on staffing and sampling for the work at Hill Ferry Barrier to help with travel. These logistics are to be worked out at a later time after the specific needs at the site have been analyzed.

D. Temporary Help –The amount of hours worked by temporary help is estimated to be 700 hours per year per employee. This amounts to 12 weeks in the field working 8-hour days for approximately 672 hours in the field plus a 5% contingency. These estimates are subject to revision.

3. Access:

Access is available from mid September to the end of December and access agreements are in place with a private land owner and are renewed annually. Any changes to this operational timeframe have uncertain conditions or limitations.

E. Compliance Considerations

1. The Hills Ferry Barrier is currently operated in the fall (mid September to mid December) by DFG to ensure survival of Merced River Fall-run Chinook salmon. The barrier is a protective feature for Chinook salmon in the San Joaquin River tributaries and all operational considerations will ensure that this objective is met.

2. During the operational history of the barrier, the presence of Spring-run Chinook salmon, Central Valley steelhead and green sturgeon have not been documented. However, based upon historic accounts and what is understood about these species, it is expected that they could be present under favorable conditions.

3. Take authorization under the federal Endangered Species Act 4(d) rule is in place for the 2009 calendar year. (Attachment C)

Attachment A. Tissue Collection Methods

FISH DNA SAMPLE COLLECTION PROTOCOL

Based on the Genomic Variation Laboratory Protocol

1) **Collecting tissue from the fish:** Cut a small piece of fin tissue from the caudal (preferred) or adipose fin of a live fish or fresh carcass fish using clean scissors or a scalpel blade. Hands of the collector should be cleaned of mucus and scales between handling fish, and scissors/knife should be rinsed between samples. Tissue size should be at a minimum 5 sq. mm. which is about the size of a hole punch, however a larger sample is preferred (see below †),. If the fin is too small to collect this size sample, take a portion of a pelvic fin.

2) **Transferring tissue to storage container:** Each tissue sample is stored separately in individual containers: coin envelopes for dry fin clips.

a. ***Dry fin clips***: It is critical that samples be completely dry in order for DNA extraction in the lab to be successful.

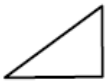
(1) Label a standard scale envelope (unbleached kraft paper) with all relevant details (date, water body, location (latitude and longitude or UTMs if available), species, individual fish identification number, length, weight, hatchery-origin, etc.). **OR** Label the scale envelope with the fish ID number being used to identify individual fish on the datasheet (i.e. metal tag #), so the above information can be linked to an individual fish.

(2) Air dry the samples on filter/blotter paper until all mucus and moisture in the fin has evaporated and the tissue is dry to the touch. Place the fin clip in the envelope and loosely close the envelope. **Do not seal the envelope,** as air and moisture should be allowed to escape to help the fin sample dry out. **Do not rubber-band envelopes together until samples inside are <u>completely dry</u>**.

3) **Recording data:** The date of collection, detailed locality information (accurate description of locality is critical – include GPS info if possible), collector(s) name, species, subspecies, type of collection (e.g. fin clip), fork length, and sex, should be written on data sheets. **OR** If you are collecting the above information as part of another survey/study (i.e. carcass surveys) then make sure the envelope labeling method can be used to link the tissue sample to the above information.

4) **Storing samples:** Samples must be kept out of extreme sun/heat (e.g. dashboards, hot warehouses), as this may damage the DNA.

5) **Shipping samples:** Repackage dried fin clips separately and attach field notes for shipping or a query of the database. Dry samples can be sent surface mail with no special packaging.

† *approximate* size of fin cli 

Attachment B

Estimated Equipment Budget

(For the 2009 operational year)

Description	**Amount**
Fish tagging equipment	$2,000
Miscellaneous equipment	$1,500
Maintenance materials	$3,500
Sontec current velocity meter	$8,500
Hydrolab ms 5 with surveyor	$13,000
Trap/Barrier construction	$22,000
DIDSON™	$80,000
Total	**$130,500**

Appendix G. Macroinvertebrate Study

Benthic Macroinvertebrate Assessment

Principal Investigator(s): Karen Dulik, Kevin Faulkenberry, Gerald Hatler, James Harrington

Contact Information of Principal Investigator(s):

Karen Dulik
Senior Environmental Scientist
California Department of Water Resources
South-Central Regional Office
3374 E. Shields Avenue
Fresno, California 93726
Telephone: (559) 230-3361
Fax: (559) 230-3363
E-mail: kdulik@water.ca.gov

Kevin Faulkenberry
California Department of Water Resources
South-Central Regional Office
3374 E. Shields Avenue
Fresno, California 93726
Telephone: (559) 230-3320
Fax: (559) 230-3363
E-mail: faulkenb@water.ca.gov

Gerald Hatler
Senior Environmental Scientist
Fisheries Supervisor
San Joaquin River Restoration
California Department of Fish and Game
1234 E. Shaw Ave
Fresno, California 93710
Phone: (559) 243-4014 Ext. 259
Fax: (559) 243-4020
Mobile: (559) 341-1814
Email: ghatler@dfg.ca.gov

James (Jim) Harrington

California Department of Fish and Game

Office of Spill Prevention and Response

Fish and Wildlife Water Pollution Control Laboratory

2005 Nimbus Road

Rancho Cordova, CA 95670

Email: jharring@ospr.dfg.ca.gov

Proposed Staff: [Margarita Gordus, James (Jim) Kitch, Abimael León]

County (ies) affected by Study: [Fresno, Madera, and Merced]

IV. Study Management

E. Study Description

1. History or Background

See introduction to other workplans

This study workplan describes a benthic macroinvertebrate assessment for the San Joaquin River Restoration Area.

i. General project background discussion.

Benthic macroinvertebrate communities, the subject of this study, are both bioindicators of stream condition and a food resource for fish. The main purpose of assessing the biological condition of aquatic communities is to determine how well a water body supports aquatic life (Barbour et al. 1996). Biological communities comprise the effects of different pollutant stressors such as increased temperature, toxic chemicals, excessive nutrients and sediment loading. Therefore, they provide an overall measure of the combined impact of these stressors. In addition, benthic macroinvertebrates (BMI) are a key food source for the native and potentially reintroduced fish in the San Joaquin River.

We do not know whether or not the Interim Flows will improve water quality conditions or elicit a change in the abundance and diversity of BMIs which are an indicator of water quality. Degraded water quality is identified as a potential limiting factor for all life stages of Chinook salmon and other native fishes in the Restoration Area (FMWG 2009a, 2009b). Urban and agricultural wastes may alter water quality parameters such as dissolved oxygen and turbidity, creating unsuitable habitat for Chinook salmon. As portions of the river are restored and vegetated, it is also likely that the BMIs will change, resulting in a more diverse population. Knowing the BMI community that inhabits the river and different areas of the river will help assess water quality conditions and potential food sources for juvenile salmon.

j. Describe the evolution of the study.

Use of information about ambient biological communities, assemblages, and populations to protect, manage, and even exploit water resources has been developing and evolving for the past 150 years (Davis 1995). Despite this long history, it has only been in the last decade that a widely accepted technical framework has evolved for using biological assemblage data to assess water resources (Barbour et al. 1996, Barbour and Hill 2003).

In 1993, the CDFG's Water Pollution Control Laboratory in Rancho Cordova developed and promoted standardized field and laboratory protocols, known as California Stream Bioassessment Procedure (CSBP), for assessing biological integrity in wadeable streams and rivers. Presently, bioasssessment is used as an additional tool to National Pollutant Discharge Elimination System (NPDES) and stormwater permitting to supplement the chemical and toxicological information obtained to address chemical standards. In the proposed study, bioassessment data will provide information about the ecological integrity of the San Joaquin River system during the Interim Flow period.

k. Why is the study necessary?

Interim Flows should be sufficient in condition to provide habitat that meets life history requirements of Chinook salmon, and other native fishes, in the San Joaquin River. These requirements include habitat characteristics such as good water quality and availability of food resources. When attempting to restore a river and its extirpated fishery, a key part of the habitat is the benthic macroinvertebrate assemblage, as it can be used to indicate water quality and is a primary food source for fish. Thus, biological assessment of the benthic community can be used as a tool in the San Joaquin River restoration process to evaluate the impact of restoration flows on salmonid riverine habitat.

l. Identify and analyze any previous similar studies.

While the impact of Interim Flows on existing water quality conditions is unknown, a study by Henson and others (2007) showed that a pulse flow event similar to the Interim Flows can affect downstream fish and macroinvertebrate habitat quality.

Invertebrate production plays a key role between primary producers and higher trophic levels (Rader, 1997). Differences in invertebrate biomass contribute to some of the variation in growth and survival of salmonids between rivers (Cada et al, 1987; Filbert and Hawkins, 1995). Even though salmonids feed primarily in the drift, studies have shown that their diets are correlated with both benthic and drift invertebrate abundance (Esteban and Marchetti, 2004). Results of the proposed bioassessment study, will help fisheries biologists in the San Joaquin River Restoration Program gain an understanding on the prey base and abundance.

2. Site Description

Following is a brief description of the Restoration Area, including San Joaquin River and bypass characteristics. For additional detail, the reader is referred to FMWG (2009b), or the SJRRP PEIS/R.

a. Location of the study (include maps, geographic data, etc.).

This study is located in the San Joaquin River Restoration Program (SJRRP) Restoration Area. The Restoration Area is approximately 153 miles long, extending from Friant Dam at the upstream end near the town of Friant, downstream to the confluence of the Merced River, and includes an extensive flood control bypass system (Figure 1). Five river reaches have been defined to address the hydrological variation throughout the Restoration Area. For more information regarding the Restoration Area, see FMWG (2009b), and the SJRRP PEIS/R.

b. Describe the environmental setting for the study.

Reach 1 begins at Friant Dam and continues approximately 37 miles downstream to Gravelly Ford. This reach conveys continuous flows through an incised, gravel-bedded channel. Reach 1 typically has a moderate slope, and is confined by periodic bluffs and terraces. The reach is divided into two subreaches: 1A and 1B. Reach 1A, which extends down to State Route (SR) 99, has the most gravel, and supports continuous riparian vegetation except where the channel has been disrupted by gravel mining and other development. Invasive woody species are common in Reach 1A (Moise and Hendrickson 2002). Reach 1B continues from SR 99 to Gravelly Ford where it is more narrowly confined by levees. Woody riparian species occur mainly in narrow strips immediately adjacent to the river channel in Reach 1B. Reach 1 has been extensively mined for instream gravel and is sediment limited. Gravel mining and agriculture are the primary land uses in Reach 1B.

Reach 2 starts at Gravelly Ford, extends downstream to Mendota Dam, and is a meandering, low-gradient channel. Reach 2 is characterized by seasonal drying of the channel in the summer and fall. In most years, the Reach 2 channel is dry except under flood release conditions from Gravelly Ford to Mendota Dam. Mendota Pool is formed by the Mendota Dam at the confluence of the San Joaquin River and Fresno Slough. The primary source of water to the Mendota Pool is conveyed from the Delta through the Delta-Mendota Canal (DMC).

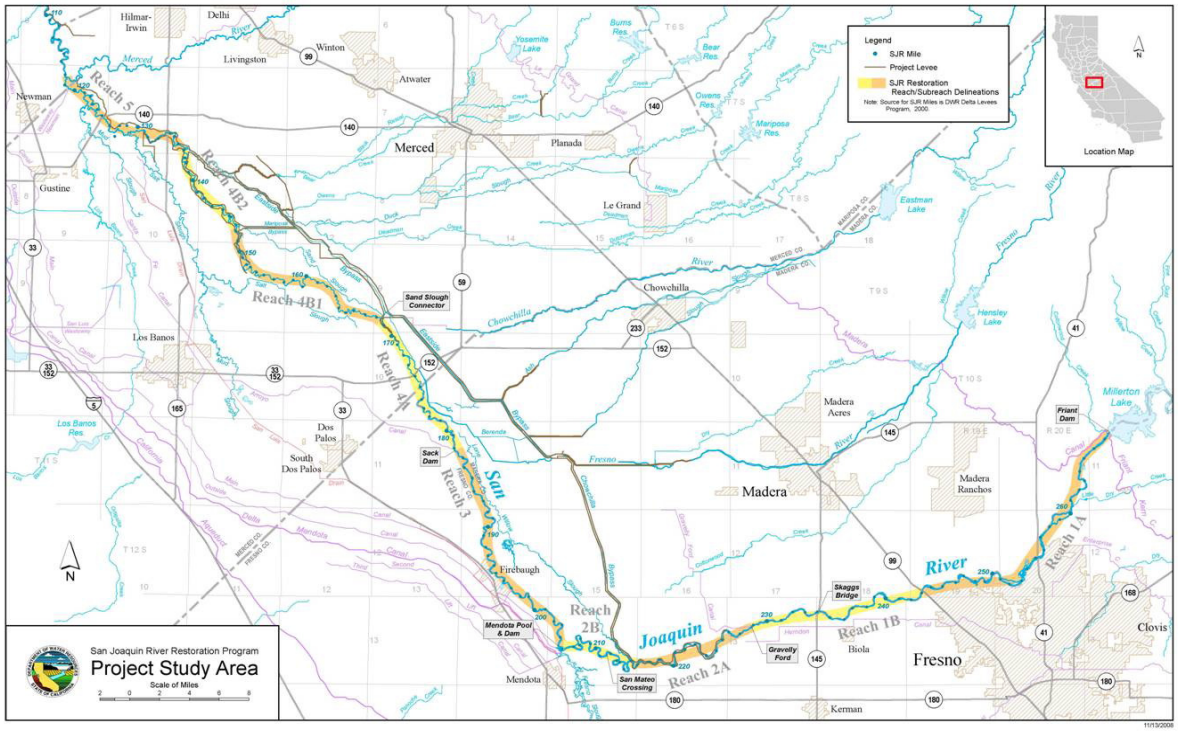


Figure 1. Macroinvertebrate survey area in the upper San Joaquin River below Friant Dam

Reach 2 is subdivided at the Chowchilla Bypass Bifurcation Structure into two subreaches, Reach 2A and Reach 2B, which have confining levees protecting adjacent agricultural land. Reach 2A and Reach 2B are intermittent and sand-bedded. Reach 2A is subject to extensive seepage losses and accumulates sand because of backwater effects of the Chowchilla Bypass Bifurcation Structure and the low gradient of the reach. Riparian vegetation in Reach 2A is sparse or absent because of to the usually dry conditions of the river and groundwater overdrafting (McBain and Trush 2002). Reach 2A vegetation has abundant grassland/pasture and large stands of nonnative plants (Moise and Hendrickson 2002). Reach 2B has a sandy channel with limited conveyance capacity and a thin strip of riparian vegetation, primarily native species, which borders the channel. A portion of Reach 2B is perennial because of the backwater of Mendota Pool.

Reach 3 extends from Mendota Dam at the upstream end to Sack Dam at the downstream end and receives continuous flows from the DMC. At Sack Dam, flow releases are diverted into the Arroyo Canal. The river is confined by local dikes and canals on both banks. The sandy channel meanders through a predominantly agricultural area, except where the City of Firebaugh borders the river's west bank. The river at this location has a low stage but is perennial and supports a narrow riparian corridor along the edge of the river channel.

Reach 4, located between Sack Dam and the confluence with Bear Creek and the Eastside Bypass, is sand-bedded and usually dewatered because of the diversion at Sack Dam. The upstream portion of Reach 4 is bounded by canals and local dikes down to the confluence with the Mariposa Bypass at the San Luis National Wildlife Refuge. Levees that begin at the Mariposa Bypass continue downstream on both banks (McBain and Trush 2002). Reach 4 is subdivided into three distinct subreaches: 4A, 4B1, and 4B2. Reach 4A, from Sack Dam to the Sand Slough Control Structure, is confined within a narrow channel. This subreach is dry in most months with negligible flows that are diverted at Sack Dam. The floodplain of Reach 4A is broad, with levees set back from the active channel. The subreach is sparsely vegetated, with a thin and discontinuous band of vegetation along the channel margin. This subreach has the fewest functioning stream habitat types and the lowest ratio of natural vegetation per river mile in the Restoration Area.

Reach 4B1 extends from the Sand Slough Control Structure to the confluence with the Mariposa Bypass. Reach 4B1 has been dry, for the most part, for more than 40 years. The only exception occurs when the channel receives varying amounts of agricultural-return flows. Water reaching the Sand Slough Control Structure is diverted to the bypass system via the Sand Slough Bypass. As a result, the Reach 4B1 channel is poorly defined with dense vegetation and other fill material. The riparian corridor upstream of the Mariposa Bypass is narrow, but nearly unbroken.

Reach 4B2 begins at the confluence of the Mariposa Bypass, where flood flows in the bypass system rejoin the mainstem of the San Joaquin River, and extend to the confluence of the Eastside Bypass. Reach 4B2 contains wider floodplains than upstream reaches and vast areas of natural vegetation.

Reach 5 extends from the confluence of the Eastside Bypass downstream to the Merced River confluence. Reach 5 is perennial because it receives varying amounts of agricultural return flows from Mud and Salt sloughs. Reach 5 is more sinuous than other reaches and contains oxbows, side channels, and remnant channels (McBain and Trush 2002). Reach 5 is bounded on the west by levees downstream to the Salt Slough confluence and on the right bank to the Merced River confluence. Reach 5 has a broad floodplain; however, levees generally dissociate the floodplain from the mainstem San Joaquin River

(McBain and Trush 2002). Less agricultural land conversion has occurred in Reach 5, with a majority of the land held in public ownership and managed for wildlife habitat. The natural habitat surrounding Reach 5 includes large expanses of grassland with woody riparian vegetation in the floodplain. Remnant riparian tree groves are concentrated on the margins of mostly dry secondary channels and depressions or in remnant oxbows. The mainstem has a patchy riparian canopy (McBain and Trush 2002).

The bypass system consists of a series of dams, bifurcation structures, bypasses, levees, and portions of the main river channel. The bypass system is managed to maintain flood-conveyance capacity.

3. Study purpose

g. Statement of study goals.

The goal is to conduct a benthic macroinvertebrate assessment within the San Joaquin River Restoration Area using the approach described in California's Surface Water Ambient Monitoring Program (SWAMP) Bioassessment Procedures.

h. List the objectives of the study

1. Identify and quantify benthic macroinvertebrates in the Restoration Area during the Interim Flow Period.

2. Establish baseline measures to document the impact of restoration flows and other SJRRP actions on the ecological integrity and water quality conditions as indicated by changes in the benthic macroinvertebrate community in the Restoration Area.

3. Adapt the sampling schedule in this work plan to account for observed changes in the benthic macroinvertebrate community.

i. Describe study milestones. Identify products and timelines.

1. **Task 1**: Delineate survey transects (Figure 2) and determine ancillary water quality parameters before entering the stream to sample benthic macroinvertebrates (BMIs). This work will begin during spring 2010 and will be coordinated with BMI sample collection. Deliverables include a report on physical habitat conditions.

2. **Task 2**: Collect benthic macroinvertebrates in the designated sampling locations within the Restoration Area, with an emphasis on upper reaches of the San Joaquin River. Increase sampling effort according to flow augmentation in the Restoration Area. This work will begin during spring 2010 Interim Flows and continue until spring 2012. Deliverables include a report on the potential effects of restoration actions on BMI characteristics.

3. Study Approach (describe conceptual approach to study and include uncertainties).

Habitat conditions will be determined by reach delineation and ancillary water quality measurements. These measurements will help evaluate physical habitat conditions as they relate to the status of benthic macroinvertebrates. Physical habitat evaluation requires coordination with benthic macroinvertebrate collection and will be expanded as river connectivity increases as a result of flow augmentation.

4. What are the management or policy implications of the study?

This study will provide baseline data on the response of macroinvertebrates to changing habitat conditions that can also determine the success of salmon reintroduction in the San Joaquin River. In addition, results from this study will inform adaptive management of restoration actions by the FMWG and other fisheries scientists of the SJRRP.

We anticipate that results of the bioassessment will characterize the ecological integrity of the instream habitat within the Restoration Area. Ecological integrity measures, such as the benthic-index of biotic integrity (see Rehn and Ode 2005), could be quantified during the Interim Flow period of the San Joaquin River Restoration process (Figure 3). Specifically, data from this study will be used to estimate changes in community structure and abundance of BMI. These data will indicate species richness, responses to perturbation, tolerance/ intolerance to environmental conditions, and habitat measures. In addition, physical and chemical measures may provide insight on water quality issues such as point pollution sources in the Restoration Area.

F. Study Organization and Responsibilities

1. Person(s) responsible (names, title, phone numbers, addresses, e-mail) and role.

Bioassessment will be possible with combined efforts from the California Department of Fish and Game (CDFG), and the California Department of Water Resources (DWR). Field and laboratory tasks required by this work plan would be performed by staff from both State agencies.

James (Jim) Harrington

Staff Environmental Scientist

Aquatic Bioassessment Laboratory, Director

Quality Assurance Officer

California Department of Fish and Game

Office of Spill Prevention and Response

Fish and Wildlife Water Pollution Control Laboratory

2005 Nimbus Road

Rancho Cordova, CA 95670

Email: jharring@ospr.dfg.ca.gov

The San Joaquin River Restoration Program (SJRRP) will ensure that BMI monitoring continues and should have access to results.

2. Chain of command (if appropriate).

Not applicable

3. Collaborators (agencies, NGOs, academia, etc.) and contact persons:

Is an MOU and/or contract already established with the collaborator(s)?

Agency collaborators: California Department of Water Resources (Karen Dulik, Kevin Faulkenberry, James Kitch, Abimael León), California Department of Fish and Game (James Harrington, Gerald Hatler, Margarita Gordus)

* MOU, contract or written agreement pending

4. **Are there considerations protecting the Department's public trust and stewardship obligations that are kept in trust for the public now and in the future?**

   Such considerations may include: The Department has the ownership and control rights for all of the products including data, metadata, images, video, research protocols, analyses, etc.; attribution, acknowledgement, and proper representation of the Department's scientific and coordination role; the Department should hold first American print rights.

C. Study Design

1. **List the specific *research questions* (state them clearly as a null or positive hypothesis) to be answered by this study, including methodology:**

   a. **If the study includes sampling, describe the sampling design and measurement variables. Be specific: describe the sampling unit, independent variables, dependent variables, and tests or techniques to be used. Explain how bias will be avoided in selection of sampling units. For hypothesis tests, state the null hypothesis and alternative hypotheses.**

   Hypothesis 1: Invertebrate species diversity (total number of taxa) will change with increased instream flows in the San Joaquin River;

   Hypothesis 2: Community composition (EPT taxa) of benthic macroinvertebrates will vary among the river segments because of changes in physical habitat and water chemistry;

   Hypothesis 3: Benthic macroinvertebrate data will provide appropriate biocriteria [Benthic-Index of Biological Integrity (B-IBI)] to evaluate the success of management actions to restore the San Joaquin River.

   b. **Describe the experimental design and necessary sample sizes. For manipulative experiments, describe the table of treatments and number of replicates, and how experimental units will be grouped or blocked.**

   Reach layout and general documentation:

At each sample site, the crews will take and record GPS coordinates at each end of the reach. If the stream width is greater than 10m, we will use a 250m long reach. Alternately, we will use a 150m long reach, if the stream width is 10m or less. Starting at the downstream end, the crews will establish 11 main transects every 15 or 25 m along the bank and mark inter-transects equidistant from main transects (Figure 2). The crews will measure and record water chemistry (pH, temperature, salinity, conductivity, turbidity, and dissolved oxygen) and take a minimum of four photos at the downstream end facing upstream, in the midreach facing both directions, and at the upstream end facing downstream. The groups will record dominant land use and cover within 50m of either side of the river. In addition, the groups will record evidence of recent disturbance such as flooding, fire, or anything else that may influence the bioassessment sample. We will document if flow conditions have been affected by recent rainfall, as this can cause significant undersampling of BMI diversity.

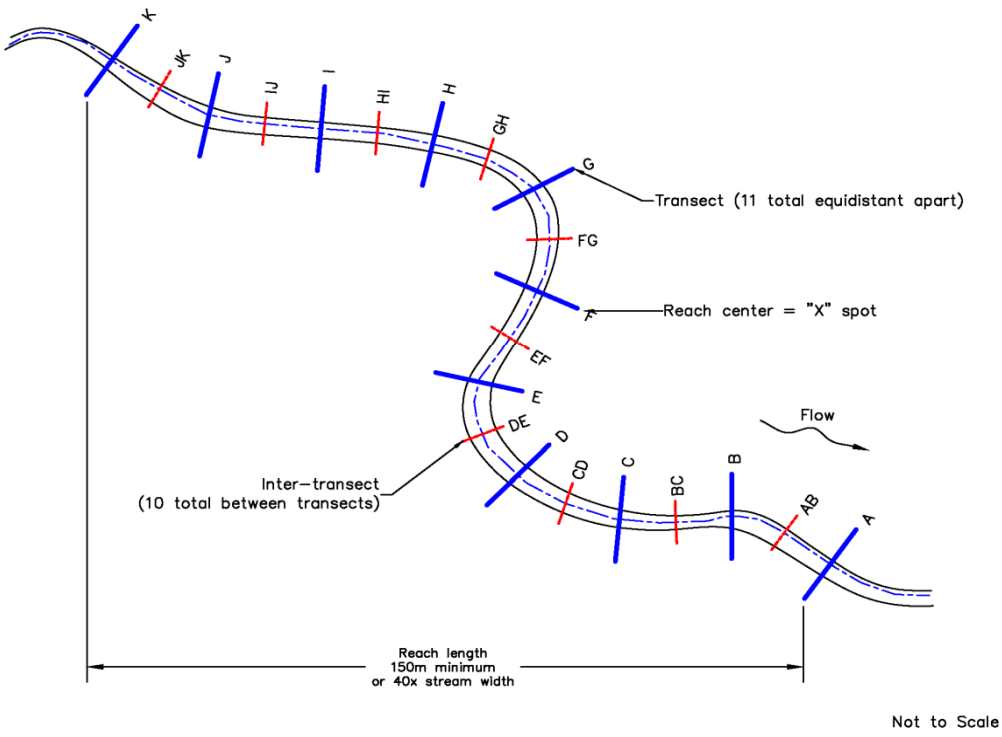


Figure 2. River transects and inter-transects for the Reachwide Benthos (Multihabitat) Procedure (Ode, 2007).

c. Describe biological detection capability. For field observational studies, describe the variation in measurement variables necessary to detect. (Historical data often can be used to predict the kind and quantity of data that will be required to achieve a stated resolution, or to estimate the resolution of a stated study design. If historical data pertinent to this question are available, apply power analyses).

Historical data are not available.

Samples collected during this study will be identified according to the Standard Taxonomic Effort (STE) Level 2 of the Southwestern Association of Freshwater Invertebrate Taxonomists (SAFIT), and using a fixed-count of 600 organisms per sample. Level 2 entails identification down to species for the more important indicator species and genus or higher taxonomic level for other species such as some nonarthropod invertebrates.

d. Using feedback in ongoing studies, is an augmentation or reduction of previous sampling effort appropriate (i.e. can the data be collected with less field effort and still achieve the same level of significance)? After data become available, estimate the power of the existing sampling effort.

-

Not applicable

-

e. Describe the contingency plans to assure the question is resolved: (Depending on the question being addressed, such plans may include (a) planned routine collection of more than the minimum data required at each regular interval, (b) logistical contingency plans to make up for missed field observations, or repeat incomplete manipulative experiments, or (c) alternate statistical methods if not all data are obtained. Use of alternate statistical methods will likely weaken the power of the study to answer the question or force redefinition of the question, and should be a last resort.

-

Not applicable

2. How will sampling bias(es) from different samplers or methods (e.g. training, standardized protocols) be minimized?

Not applicable

J. Study Resource Needs

3. Detailed budget –Refer to Appendix A

2. Personnel needs

a. Field activities

Ideally, two crews of three people, consisting of CDFG and DWR employees, will perform the bioassessment. The Quality Assurance Management Plan (CDFG, 2008) provides guidance for training field personnel.

b. Laboratory and office activities

Method performance criteria for all laboratory procedures are listed in Appendix I of the SOP entitled "Protocol for Internal Laboratory Quality Control" (CDFG 2008).

c. Travel (in-state and out-of-state)

Out-of-state travel is not necessary.

We propose grouping together the sampling sites in clusters as to minimize the travel distance between sites and maximize efficiency. In addition, we will ensure that roads are open and accessible before traveling to the designated sites.

d. Temporary help (estimated number of hours) – not applicable

3. Equipment needs

a. Boats/vehicles/major sampling equipment – what is necessary and for what period? **– Refer to Appendix B**

b. What major equipment (>$1000) is necessary (purchased, borrowed, or leased leased)? **– Refer to Appendix A**

4. Coordination needs

   a. If another study or agency is participating in collection of samples, is coordination plan, including funding, in place?

      California Department of Water Resources (DWR) and California Department of Fish and Game (CDFG) will collect and analyze bioassessment data and compare results. Both agencies need to coordinate funding responsibilities.

5. Has access to study site(s) been arranged?

   Agencies will seek access agreements, if necessary.

K. Compliance Considerations

5. **Will study result in, or have the possibility of, take of federally- or state-listed threatened, endangered or species of special concern?**
   No

6. **If so, estimate the number by species/race that will be taken and the estimated mortality.**
   Not applicable

7. **Will the "take" or capture of any state- or federally-listed species be covered by an existing Biological Opinion?**
   No

8. **If no BO exists, how will compliance be achieved?**
   No take is anticipated

L. Invasive Species: What measures will be taken to ensure field staff does not spread invasive plants or animals to new sites during the study?

All gear, including sampling equipment and waders will be thoroughly inspected and cleaned after sampling each day.

M. Due Dates and Products

11. **Describe the timeline for the study, with due dates for deliverables, including drafts (this should relate to section I.A.2.c).**

Critical project activities and the time frame for their implementation are listed in Table 1. The field activities which include portions of the reconnaissance and sample collection are subject to ambient weather conditions. The BMI project timeframe and task schedule are summarized in figures 3 and 4, respectively.

Deliverable	Date
BMI Progress Report(s)	January 31, 2011
	January 31, 2012
Final BMI Report	January 31, 2013

Table 1. Critical project activities and time frame [Taken from Table 2 in CDFG (2008)]

Critical Project Activity	Time Frame
Desk-top reconnaissance	January-March
Field visit reconnaissance	March-May
Sample collection	April-September
Laboratory analysis	April-March
Database entry	May-April
Data analysis	April-August (following year)
Report Writing	September-January (following year)

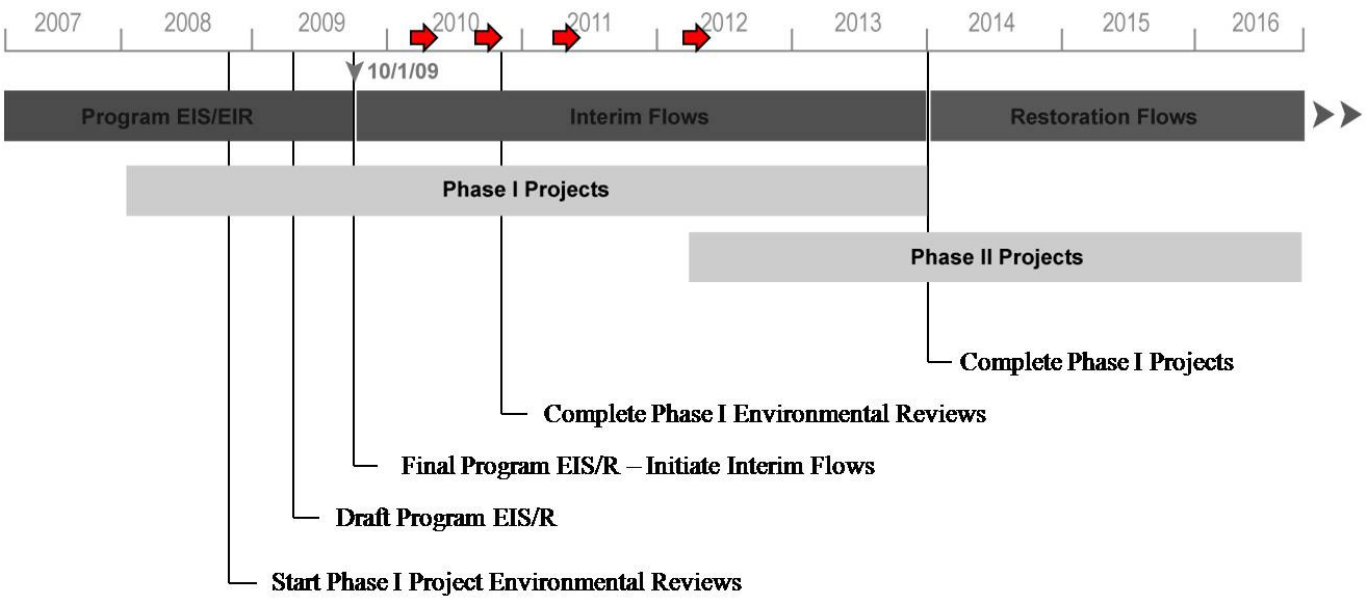


Figure 3. Proposed project timeframe and San Joaquin River Restoration Program timeline. Red arrows indicate BMI sampling periods.

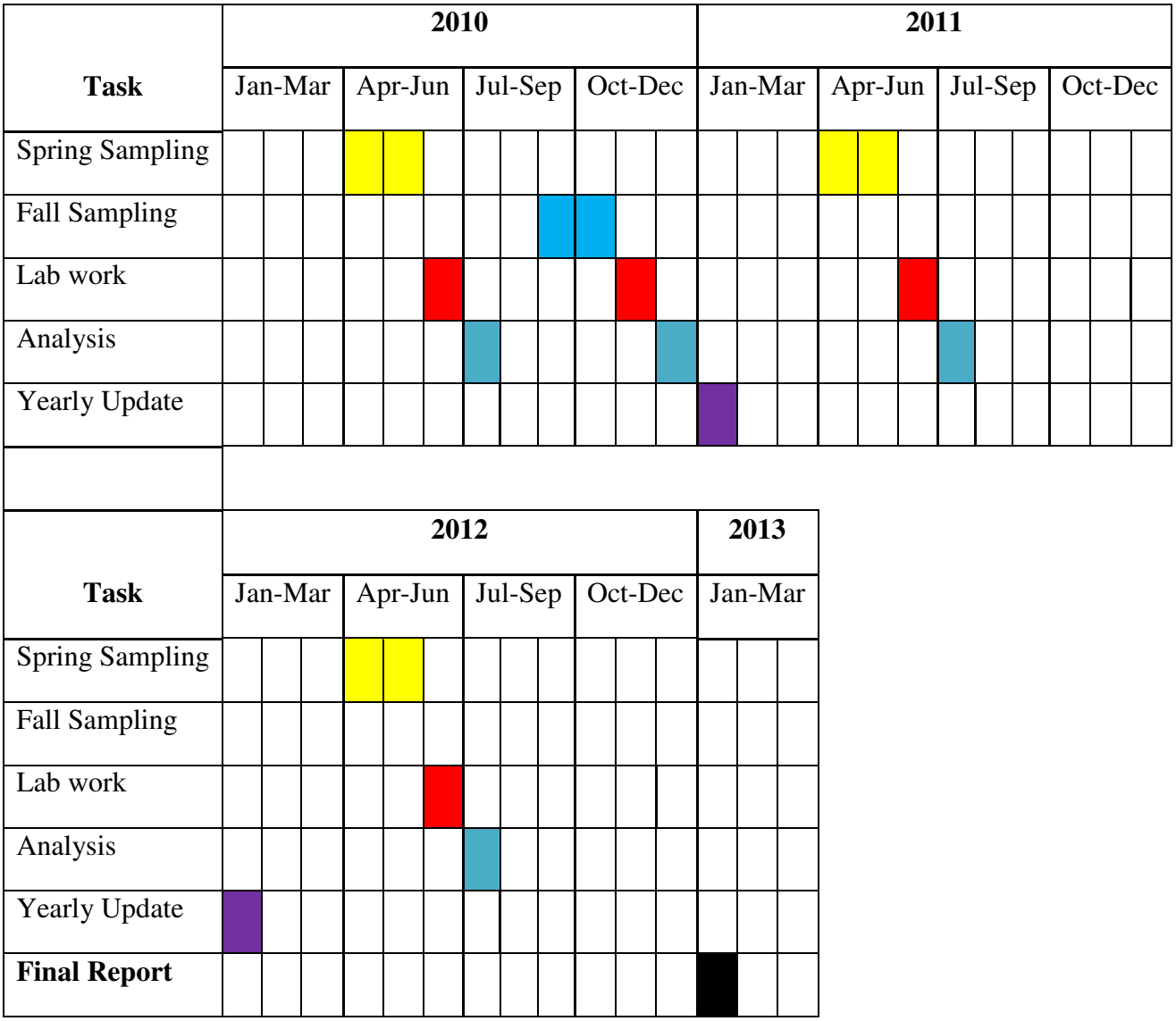


Figure 4. Task schedule for benthic macroinvertebrate project. The amount of time it will take to conduct the lab work is unknown at this time.

12. **Will any new databases be created for or added to for this study?**

All data collected are recorded on standardized field data entry forms and are stored at the Aquatic Bioassessment Laboratory (ABL) indefinitely. Electronic versions of the data are stored in CalEDAS, an Access© database which functions as the central repository for all data collected by the ABL.

13. **If data is to be uploaded to a centralized data server, by what date?**

-
- Sample log-in procedures are described in Appendix D of the Quality Assurance Management Plan (CDFG, 2008).
-

14. **If product includes a report, does it need to meet Americans with Disability Act format requirements (e.g. if the final document is made available on the internet)?**

Not applicable

-

15. **Will spatial data be submitted to BIOS? If so, submission must be in accordance with minimum BIOS and FGDC metadata standards.**
(http://bios.dfg.ca.gov/metadata.asp)
(http://www.fgdc.gov/metadata/documents/workbook 0501 bmk.pdf)

Not applicable

II. Study Measurement and Data Acquisition

A. Sample Site Selection

1. Description of study area and sample sites, with map.

Refer to Figure 1 of this document for a map of the study area and sample sites.

2. Statistical and scientific rationale for choosing sites (why was a site chosen?).

The procedure for collecting macroinvertebrates is known as the Reachwide Benthos (Multihabitat) Procedure (Ode, 2007). The Multihabitat Procedure includes an objective method for selecting sampling sites based on 11 transects that are also used for physical habitat measurements. Since transects define the sampling sites, these sites may fall within a number of different erosional or depositional environments.

Each season the US Environmental Protection Agency (EPA) will randomly generate locations for the wadeable sites along Reach 1 and 2, which will be used as the midpoint of each sample site. The EPA will also generate back up points for sites that are dry or too deep for sampling. The other ten sites will be located between Mendota Pool and the confluence with the Merced River (Reaches 3-5). Access to these sites will depend on the increasing continuity of restoration flows in the lower reaches of the Restoration Area.

Site selection can also be informed by habitat surveys conducted by CDFG during the WY2010 Interim Flow period.

3. Sample site – parameter matrix (what parameters will be measured at each site).

Sample parameters measured include:

Benthic macroinvertebrate samples to determine diversity (species, genus or higher taxonomic order)

Physical habitat: Riparian vegetation, instream habitat complexity, water velocity, bank stability, human influence

Water Chemistry:

Temperature

Specific conductance

Salinity

pH

Alkalinity

Dissolved oxygen (DO)

Turbidity

Chlorophyll

B. Sampling Procedure (Standard Operating Procedures, SOPs)

The sampling procedure described in this section is an abridged version of the State Water Board's Surface Water Ambient Monitoring Program (SWAMP) standard operating procedures for collecting macroinvertebrate samples and associated physical and chemical data for ambient bioassessment in California (Ode, 2007).

1. Parameters to be measured with units defined

a. Frequency that each parameter will be measured (SOP)

The assessments will be performed twice on the first year and once yearly thereafter for two years. Sampling frequency can be adjusted based on recommendations from preliminary reports.

b. Will replicate samples be taken? (SOP)

We will sample 40 sites. Thirty wadeable sites will be located within Reach 1 and 2 of the San Joaquin River. Each site consists of a reach of 150 or 250 m, depending on wetted width. Each sample site will consist of 11 transects. Each transect will be considered a subsample of the entire site; all 11 will be combined to comprise the sample.

2. Methodology (with references) and SOP

Bioassessment will include:
1) …the collection of macroinvertebrate samples.
2) …measurements of physical/habitat parameters.
3)… laboratory analysis of macroinvertebrate samples.
4) …incorporation of quality assurance measuring both field and laboratory procedures; and
5) …reporting of biological and physical habitat data.

a. Sample preservation, transportation, storage and disposal (SOP)

Benthic macroinvertebrate samples will be preserved and stored in 95% ethanol after collection.
When the sampling season is completed, all the samples will be sent to the Aquatic Bioassessment Lab, in Rancho Cordova, for identification by taxonomists.
Appendix D of the Quality Assurance Management Plan (CDFG, 2008) provides instructions for submitting benthic samples to the California Fish and Game Aquatic Bioassessment Lab.

b. Preparation of equipment: cleaning, reagents, supplies (SOP)

Refer to CDFG (2008)

c. Sample and data collection (SOP)

Sample and data collection will occur twice on the first year and annually for the next two years; for a total study period of three years.
The initial time frames will be April/May and September/October. Once restoration flows are established, other previously dewatered sites may be sampled to assess restoration progress.
At the designated sampling locations, we place a 500µ net in the water perpendicular to flow and facing upstream. After placing the net in the water, we will collect all BMIs from rocks, substrate, and bed in a one square foot quadrat. Since the mouth of the net is one foot wide, the quadrat is one net width by one net width. After the quadrat has been sampled, we will move upstream to the next subsampling location, keeping organisms in the net. If the net gets too full of organisms, we will empty the contents into a labeled jar with 95% ethanol.
While two people are conducting the sampling, a third person will characterize the habitat. They will measure wetted width, bankfull dimensions, canopy cover, gradient, and sinuosity. In addition, they will make visual estimates of human influence, instream habitat, and riparian vegetation and collect water chemistry measurements.

d. Sample and data acceptability (SOP)

The California Department of Fish and Game (CDFG) Aquatic Bioassessment Laboratory (ABL) currently has a Quality Assurance Project Plan for the California Stream Bioassessment Procedure (2008). The crew will follow the Quality Assurance (QA) procedures in the plan as it pertains to the collection of field data. Sampling QA will be performed by James Harrington of the ABL, California Department of Fish and Game, in Rancho Cordova.

3. Personnel training (SOP)

The field crews will be comprised of agency staff that has received training from James Harrington, director of the Aquatic Bioassessment Laboratory, to ensure compliance with the SWAMP protocols, and all field staff will attend a procedure review session prior to the beginning of each sampling season. Refer to Section A8 in CDFG (2008).

4. Personnel safety (SOP), in both field and laboratory

Personnel safety guidelines will be observed at all times.

C. Sample Custody for Field and Laboratory

1. Identify custodians and site for long-term storage (if appropriate)
2. Tracking forms (if appropriate)
3. Sample records (if appropriate)

D. Calibration Procedures and Frequency

1. Instrument and sample calibration (referenced).
2. Frequency and timing of calibration: analytical system, instruments, devices, etc. (SOP).

The Hydrolabs will be calibrated (as per manufacturer's specifications) at the beginning of each field season and at two-week intervals.

3. Documentation of calibration checks.

A Hydrolab multiprobe calibration logbook will be kept for each instrument, which will contain pre- and post-calibration data, and maintenance and troubleshooting notes.

4. Instrument, equipment and supplies inspection and maintenance,

   including periodicity.

An inspection and maintenance log will be kept for the field sampling equipment. All equipment will be inspected prior to each sampling event.

E. Sample Processing and Analysis

1. Reference standard methods and appropriateness for measurements

CDFG (2008) Appendix E: Protocol for Processing Quantitative Benthic Macroinvertebrate Samples

CDFG (2008) Appendix F: Protocol for Taxonomic Identification of Benthic Macroinvertebrates

CDFG (2008) Appendix G: Protocol for Preparing Benthic Macroinvertebrate Microscope Slides

2. Describe non-standard methods and validation procedures – N/A

3. Describe SOPs – Refer to CDFG (2008)

F. Data Reduction, Analysis and Reporting

1. Who will conduct the data reduction (transformation of raw data) and analysis?

All data sheets will be reviewed at the end of the field day prior to leaving the site; the field lead will write, “field reviewed” and initial the first page, and the crew members will resolve any discrepancies prior to the end of the field day.

The raw data will also be reviewed, prior to data entry, by a trained crew member who was not present at the sampling site.

2. What quality control procedures will be used to assure the validity of statistical results?

Refer to CDFG (2008) Appendix H: Protocol for Reporting Benthic Macroinvertebrate Data

3. Who is responsible for preparing peer-reviewed articles and/or reports?

These data will be fit for publication in peer reviewed journals. Participating agencies will prepare reports for the San Joaquin River Restoration Program and reports for scientific journals.

4. Will the data be archived in a central repository, like BIOS, FISH, etc.?

All samples and completed field forms will be stored at (DWR or CDFG?), where the Chain of Custody Records will be stored and maintained.
Refer to CDFG (2008) Appendix C: Chain of Custody Record
Electronic versions of the data will be stored in CalEDAS, an Access© database which functions as the central repository for all data collected by the ABL.

III. DATA ASSESSMENT AND OVERSIGHT

A. Quality Control Data Checks

1. What procedure will be used for data checks?
2. What criteria will be used to check data?
3. Who will conduct the data checks and how will the results be documented?

Refer to CDFG (2008) Appendix I: Protocol for Internal Quality Control

B. Field and laboratory performance and systems audit

1. How will the audit be conducted?

Audits will be performed annually to ensure continued compliance with the protocols.

2. What criteria will be used?

Ten percent (10%) of all sites will be randomly sampled twice each season. This will function as a statistical test of the study.

With proper quality assurance in place, the San Joaquin River BMI data can be compared to EPA studies of streams around the state and country.

3. Who will conduct the audit and how will the results be documented?

James Harrington and/or designated trained staff will perform field audits at random times throughout the field season addressing all aspects of the SOP and additional pre and post sampling event activities. All observations and comments are recorded on the Field Audit Form (Appendix J: SWAMP SOP Field Audit Form; CDFG 2008) and kept on file at the Rancho Cordova ABL facility.

C. Corrective action

1. If errors are encountered in items A and B above, who will determine and implement corrective action(s)?

   The audit lead performs an assessment of the field and laboratory activities and makes recommendations to the SJRRP.

IV. DATA VALIDATION AND USABILITY

* Refer to CDFG (2008) Sections D1 and D2.

A. Error checking of raw data (data review)

1. What protocol will be used to check for errors?
2. What criteria will be used?
3. Who will conduct the checking?
4. How will the results be documented?

B. Data limitations

1. Describe the limitations of the data, such as periodicity, seasonality, etc.

V. STUDY FEEDBACK TO MANAGEMENT:

A. Study should contain the following:

1. Periodic review by a designated science advisory panel or individual; could be part of the reporting milestones at set times.
2. Integration of feedback to study design and methodologies.
3. Study completion and reporting (publication).
4. Presentation to leadership by deadline.

* Refer to CDFG (2008) Appendix H: Protocol for Reporting Benthic Macroinvertebrate Data

REFERENCES:

Barbour, M. T., J.M. Diamond, and C. O. Yoder. 1996. Biological assessment strategies: Applications and Limitations. Pages 245-270 *in* D.R. Grothe, K.L. Dickson, and D.K. Reed-Junkins, editors). Whole effluent toxicity testing: An evaluation of methods and prediction of receiving system impacts, SETAC Press, Pensacola, Florida.

Barbour, M. T. and C. Hill. 2003. The Status and Future of Biological Assessment for California Streams. Prepared for the California State Water Resources Control Board, Division of Water Quality.

Cada, G.F., J.M. Loar, and M.J. Sale. 1987. Evidence of food limitation of rainbow and brown trout in Southern Appalachian soft-water streams. Transaction of the American Fisheries Society 116:692-702.

CDFG. 2008. Quality Assurance and Management Plan for the California Department of Fish and Game's Aquatic Bioassessment Laboratory: Field and Laboratory Procedures for Conducting Freshwater Bioassessment. California Department of Fish and Game. Office of Spill Prevention and Response. Fish and Wildlife Water Pollution Control Laboratory. August 2008.

Davis, W. S. 1995. Biological assessment and criteria: Building on the past. Pages 15-29 *in* W. S. Davis and T. P. Simon (editors). 1995 *Biological assessment and criteria: Tools for water resource planning and decision making.* Lewis Publishers, Boca Raton, Florida.

Esteban, E.M. and M.P. Marchetti. 2004. What's on the menu? Evaluating a food availability model with young-of-the-year Chinook salmon in the Feather River, California. Transactions of the American Fisheries Society 113:777-788.

Filbert, R. B., and C.P. Hawkins. 1995. Variation in condition of rainbow trout in relation to food, temperature, and individual length in the Green River, Utah. Transactions of the American Fisheries Society 124:824-835.

FMWG. 2009a. Conceptual models of stressors and limiting factors for San Joaquin River Chinook salmon. 178 pages. June 2009.

FMWG. 2009b. Fisheries management plan: A framework for adaptive management in the San Joaquin River Restoration Program.

Henson, S. S., D. S. Ahearn, R. A. Dahlgren, E. V. Nieuwenhuyse, K. W. Tate and W. E. Fleenor. 2007. Water quality response to a pulse-flow event on the Mokelumne River, California. River Research and Applications 23:185-200.

McBain, S., and W. Trush. 2002. San Joaquin River restoration study background report. Prepared for Friant Water Users Authority, Lindsay, California and Natural Resources Defense Council, San Francisco, California. Arcata, California. December.

Moise, G.W. and B. Hendrickson. 2002. Riparian vegetation of the San Joaquin River. Technical Information Record SJD-02-1. California Department of Water Resources, San Joaquin District. Fresno, California.

Ode, P. R. 2007. Standard operating procedures for collecting macroinvertebrate samples and associated physical and chemical data for ambient bioassessments in California. California State Water Resources Control Board Surface Water Ambient Monitoring Program (SWAMP) Bioassessment SOP 001.

Rader, R.B. 1997. A functional classification of the drift: traits that influence invertebrate availability to salmonids. Canada Journal of Fisheries and Aquatic Sciences 54:1211-1234.

Rehn, A.C. and P.R. Ode. 2005. Development of a benthic index of biotic integrity for wadeable streams in Northern Coastal California and its application to regional 305(b) assessment. Draft report.

SJRRP. 2007. Program Management Plan. May 1, 2007. Accessed on September 2009.

	2010							2011-2012
	Spring						Fall	Spring (2 seasons)
LABOR COSTS	Unit cost	# Crew	Hrs per day	# days	Hours	Total[a]	Total[a]	Total per season[a]
Sampling	$113	6	8	22	1,056	$119, 328	$119, 328	$119, 328
Travel	$113	6	2	22	264	$29,832	$29,832	$29,832
Preparation	$113	2	1	22	44	$4,972	$4,972	$4,972

Total hours = 1,364 Estimated average hourly rate for ESS staff = $113/h

Labor Sub-Totals = $ 154,132.00 X 4 sampling seasons

[a] The California Department of Water Resources (DWR) and the California Department of Fish and Game (DFG) will share labor costs.

LAB COSTS	2010				2011-2012
	Spring			Fall	Spring (2 seasons)
	Unit cost	Quantity	Total	Total	Total per season
	$500	44	$22,000	$22,000	$22,000

Lab Totals = $22,000.00 X 4 sampling seasons

[b] DFG will cover the costs of laboratory analysis.

MATERIALS COSTS[c]	2010		2011-2012
	Spring	Fall	Spring (2 seasons)

	Unit cost	Quantity	Total	Total	Total per season
*Hydrolab with surveyor and cable	$14,600	2	$29,200	$0	$0
*Wildco D-frame net with bucket	$492	4	$1,968	$0	$0
*Digital camera: Canon ELPH	$300	2	$600	$0	$0
*Current velocity meter (Swoffer Flowmeter 3000 LX)	$2,415	2	$4,830	$0	$0
*KVH rangefinders	$459	2	$918	$0	$0
*Dry bag for GPS/phone (REI)	$24.95	4	$99.80	$0	$0
*Densiometer	$101	2	$202	$0	$0
*100 m measuring tape:	$71.50	4	$286	$0	$0
*Brunton clinometer	$241.50	2	$483	$0	$0
*Sorting tray	$7.35	2	$14.70	$0	$0
[d]Water proof paper	$24.95	2	$49.90	$49.90	$49.90
[d] Ethanol (20L)	$100.00	1	$100	$100	$100
[d] *Case of (12) 500 ml jars	$28.90	6	$173.40	$173.40	$173.40

Materials Sub-Totals = $38,601.50 + $323.30 X 4 sampling seasons

Grand Total = $744,422.70

*One time purchase

[c] DWR and DFG will share the cost of materials, unless otherwise indicated (d)

[d] DWR will purchase these items for the duration of the project.

Attachment B – Equipment needs

Field Equipment and Supplies

* See also Table 5, on CDFG (2008), page 27.

Physical Habitat

- GPS receiver
- Topographic maps
- Measuring tape (150 m)
- Small metric ruler or gravelometer
- Random number generator
- Stadia rod
- Clinometer
- Autolevel (for slopes >1%)
- Current velocity meter
- Convex spherical densitometer
- Flags/flagging tape
- Rangefinder
- Sounding rod (boatable surveys)
- Depth finder (boatable surveys)

BMI Collection

- D-frame kick net with 500 µ mesh
- Standard #35 sieve (500 µ mesh)
- Wide-mouth 500ml or 1000 ml plastic jars
- White sorting pan (enamel or plastic)
- 95% ethanol
- Fine tipped forceps
- Waterproof paper and tape for labels
- 10-20 L bucket for sample elutriation
- Preprinted waterproof labels (Rite-in-the-Rain®)
- Disposable gloves/ elbow length insulated gloves

General/ Water Chemistry

- SWAMP Bioassessment Procedure
- Waders
- Field forms printed on waterproof paper
- Clipboard and pencils
- Digital camera
- Hydrolab (measures pH, DO, conductivity, and temperature)

Attachment C: Guidance for Determining Implementation Objectives

Implementation Objective(s)

Examples: Monitor X for three years to determine success of a management action, survey Population Y for one year to determine current abundance, range, sex ratio, and age class structure, etc. If the study monitors the results of an event or a management strategy, what qualitative or quantitative threshold or degree of change defines a significant change or success? Examples:

- Maintain at least 50 individuals of Species B in the Willow Creek Unit.
- No more than 3 patches of Weed B in the Willow Creek Unit by 2010.
- Do not exceed Cover Class 3 (10 – 30% by visual estimate) by any of the target weed species in more than 2 of the 10 macroplots established in the Willow Creek Unit.

If monitoring involves sampling, how certain do you want to be of your results:

Example:

- Management Objective: Maintain a population of Species A in the Willow Creek Preserve with at least 100 individuals from 2009 ─ 2012.
- Sampling Objective: Be 95% confident that estimates are within ± 10% of the true value.

Examples of objectives adapted from Elzinga, C.L.;Salzer, D.W. and J.W. Willoughby. 1998. Measuring and Monitoring Plant Populations. U.S. Department of the Interior. Bureau of Land Management. Report #BLM/RS/ST-98/005+1730; BLM Technical Reference # 1730-1.

Appendix H. Passage Assessment

Study Title: Fisheries Passage Assessment

Region or Division and Branch:

Principal Investigator(s): G. Hatler

Contact Info. Of Principal Investigator(s): [xx]

Proposed Staff: [Dale Stanton, George Heise, Kevin Faulkenberry]

County(ies) affected by Study: [Fresno, Madera, Merced]

The intent of this proposal is to complete a fish passage evaluation of the San Joaquin River restoration project area (Restoration Area). The results of the study will be used to develop alternatives for implementation to improve conditions on the river to allow for unimpeded fish passage. The timelines for the scope of work is to complete the study to allow enough time to implement and complete construction on priority projects by the initial 2014 salmon run. The background and criteria of this summary was developed from existing information provided by the Fisheries Management Work Group (FMWG), internal DWR documents, and published works.

The goal is to identify and prioritize fish passage barriers in the Restoration Area in an effort to minimize migration delays, stranding, and mortality of juvenile and adult salmon and other native fish. The objectives of the study include:

9. Identify potential channel and structural barriers that may impede juvenile and adult fish passage in the Restoration Area;
10. Evaluate passage impairment of potential barriers using common passage criteria (i.e., depth, velocity, and discharge) under a variety of flow conditions;
11. Develop a prioritized list of channel and structural barriers;
12. Provide a preferred alternative for fish passage improvements at priority fish passage barriers.

Background

Barriers to migration for anadromous fish in the Restoration Area encompass a wide range of both adult and juvenile passage impediments. Passage for anadromous fishes in the San Joaquin River has been completely blocked in the Restoration Area since the 1940s, when the river was dewatered below Sack Dam except during uncontrolled flow releases in wet years. The 2002 San Joaquin River Restoration Study Background Report (McBain & Trush 2002) identified numerous potential barriers to fish migration in the Restoration Area. The Settlement prescribes

restoring passage at a number of structures that may impede the passage of adult Chinook salmon through the Restoration Area, and additionally requires screening a number of currently unscreened diversions to protect juveniles; however, a preliminary assessment of additional passage impediments is needed. Passage may be impeded for migrating adults and juveniles if design, operation and maintenance at some facilities and locations do not afford passage under a range of flows (FMWG 2009). Vertical, velocity, and depth barriers can block or impede fish movement. In addition, passage can be impaired by lack of water, poor water quality, poor habitat, natural occurrences, waterfalls, boulder cascades, and other structures. Impacts of fish barriers may include impaired passage and injury to fish, resulting in reduced numbers of fish reaching suitable spawning areas and low survival for juvenile life stages. If and to what extent adults, juveniles, smolts and yearling salmon fail to access suitable habitat because of physical or physiological barriers, entrainment risk and false pathways need to be determined. Restoration actions are expected to enable passage, and reduce entrainment* and stranding risk in the Restoration Area; however, a preliminary inventory and qualitative assessment of the passage conditions in the Restoration Area is needed.

*The term 'fish passage' is commonly used to describe issues relating to migrating adults while 'entrainment' is commonly used to describe the unintended diversion of fish into an unsafe passage route (NMFS 2008) and generally applies to juvenile fish migration.

Study Area

This study is located in the San Joaquin River Restoration Program (SJRRP) Restoration Area. The Restoration Area is approximately 153 miles long, extending from Friant Dam at the upstream end near the town of Friant, downstream to the confluence of the Merced River, and includes an extensive flood control bypass system. Five river reaches have been defined to address the different river characteristics throughout each reach.

The Fisheries Management Plan (FMP) identifies a number of potential actions, consistent to those recommended in the settlement, to provide passage including modifications to the Sand Slough Control Structure and the Reach 4B headgate, retrofit of Sack Dam, construction of Mendota Pool Bypass, ensuring sufficient fish passage measures at all other structures and potential barriers, and the implementation of trap and haul in the event passage conditions are not suitable (FMWG 2009). The FMP also identifies a number of potential actions to reduce entrainment, consistent to those recommended in the settlement, including the screening of Arroyo canal, construction of Mendota Pool Bypass, modification of Chowchilla Bypass, the filling and isolation of gravel pits, the consolidation of diversion locations, and an assessment of entrainment risk at other diversions (FMWG 2009). This proposal describes the need to collect

basic passage information, and information on entrainment and stranding risks during the Interim Flow period to inform future restoration needs.

Existing Data

Jones & Stokes (2001) identified 16 potential barriers to migrating steelhead and Chinook salmon in the San Joaquin River and bypass system. McBain & Trush (2002) inventoried physical barriers in the Restoration Area, including the San Joaquin River and bypass system (see page 7-62), and identified approximately 18 potential and probable barriers to migration. California Department of Water Resources (2005) inventoried passage barriers in the San Joaquin River below Friant Dam and tallied more than 20 passage impediments and 30 gravel pits.

Tributaries to the San Joaquin River also had assessments for fish passage. Evaluations on the Merced River (Stillwater Sciences 2002) and on the Tuolumne River (McBain & Trush 2000) have completed restoration plans with fish passage impediment descriptions. In addition, California Department of Water Resources (2005) inventoried fish passage barriers. Lastly, in 2007, DWR (2007) completed a detailed fish barrier assessment on the Calaveras River that could be useful as a reference.

Criteria

When evaluating the channel and structures, the primary attributes to be considered are velocity, depth, and drop or jump. These attributes can block or impede fish movement so all other attributes are related to, or dependent on, these attributes. In addition, turbulence, depth, and fall can injure or disorient fish, increasing their vulnerability to predation and disease. Cumulative effects of these barriers may decrease the physical abilities of individual fish to migrate (Jones & Stokes 2001). The criteria for the primary attributes are described as velocity and vertical barriers as provided in the Migration Report by Jones & Stokes. Criteria specific to the San Joaquin River and potential fish passage barriers identified in the initial survey will need to be developed.

Velocity Barriers

Elevated water velocities may occur at water control structures, road crossings, and culverts, and can create a barrier to the movement of adult and juvenile fish. Culverts are characteristically uniform and designed to optimize flow efficiency. The velocity a fish can overcome in moving through a culvert also depends on the length of the culvert. The longer the culvert, the lower the velocity must be for a fish to pass successfully. Maximum design swim velocities shown in Table 1 are further reduced when structure length exceeds 60 feet. The presence of a large scour

pool at the downstream end of a culvert is a good indicator that velocity may be a barrier to fish passage, especially at high flow (Washington Department of Fish and Wildlife 1999). Table 1 identifies the average velocity and culvert length that steelhead and Chinook salmon, of all life stages, can pass through. For the purpose of fish passage, the distinction between bridge, culvert or low water crossings is not as important as the effect the structure has on the form and function of the stream. The following criteria conceptually apply to bridges and low water crossings, as well as culverts.

Table 1. Average Velocity for Steelhead and Chinook Salmon Passage through Culverts as a Function of Culvert Length

Culvert Length (ft)	Average Velocity* (ft/s), Non-Anadromous Adults	Average Velocity* (ft/s), Anadromous Adults	Average Velocity* (ft/s), Juveniles[1]
0–60	4.0	6.0	≤1.0
61–100	4.0	5.0	≤1.0
101–200	3.0	4.0	≤1.0
201–300	2.0	3.0	≤1.0
301 or greater	2.0	2.0	≤1.0

*Average velocity refers to the calculated average of velocity within the culvert.
[1] Juveniles require 1 ft/s or less for upstream passage for any length culvert at their High Fish Passage Design Flow, 1% exceedence flow. (NMFS 2001). Juvenile fish passage analysis should include calculating average water velocity for the 50% exceedence flow for the time period corresponding to juvenile upstream passage (NMFS 2008).
Sources: National Marine Fisheries Service 2001; Raleigh et al. 1984.

The Department of Water Resources conducted a fish passage evaluation of culverts along State Route highways and freeways in the State where anadromous fish spawn (mostly along coastal regions). The Department used FishXing software to identify any fish passage impediments. FishXing is an interactive software package that integrates a culvert design and assessment model for fish passage. The software models organism capabilities against culvert hydraulics across a range of expected stream discharges. Water surface profiles can be calculated for a variety of culvert shapes using gradually varied flow equations. The program then compares the flows, velocities and leap conditions with the swimming abilities of the fish species of interest. The output includes tables and graphs summarizing the water velocities, water depths, and outlet conditions, then lists the limiting fish passage factors and flows for each culvert. The guidelines used in the FishXing software are considered an industry standard. The following table from the CDFG 2003 report summarizes recommendations for criteria to evaluate structures with FishXing software.

Table 2. Minimum water depth requirements and swimming and leaping ability inputs for FishXing.

Species or Lifestage	Minimum Water Depth (ft)	Prolonged Swimming Mode		Burst Swimming Mode		
		Maximum Swim Speed (fps)	Time to Exhaustion (min.)	Maximum Swim Speed (fps)	Time to Exhaustion (sec)	Maximum Leap Speed (fps)
Adult Anadromous Salmonids	0.8	6.0	30	10.0	5.0	15.0
Resident Trout and Juvenile Steelhead >6"	0.5	4.0	30	5.0	5.0	6.0
Juvenile Salmonids <6"	0.3	1.5	30	3	5.0	4.0

(These values are used to assist in prioritizing stream crossing for treatment and do not represent whether or not a stream crossing currently meets DFG or NMFS passage criteria).

For non-embedded culverts, those with no channel substrate within, a design recommendation for minimum depths of 1.0 foot for adult salmonids and 0.5 feet for juveniles is standard. For embedded culverts, some amount of stable channel substrate within, the minimum depth must meet or exceed conditions found in the adjacent natural channel. These are not significantly different than the criteria for FishXing software but will make a significant difference when identifying issues with passage.

Table 3. Maximum Average Water Velocity and Minimum Depth of Flow

Species/Lifestage	Maximum Average Water Velocity (fps)	Minimum Flow Depth (ft)
Adult Anadromous Salmonids	See Table 1	1.0
Adult Non-Anadromous Salmonids	See Table 1	0.67
Juvenile Salmonids	1	0.5
Native Non-Salmonids Non-Native Species	Species-specific swimming performance data are required for the use of the hydraulic design option for non-salmonids. Hydraulic design is not allowed for these species without this data.	

Vertical Barriers

As a general criterion, structures are considered to be vertical barriers when the ratio of the staging pool depth to barrier height is less than 1.5 or when the height and length of the jump required to clear the structure exceeds the jumping abilities of the migrating fish (Robison et al. 1999, Stuart 1962, USDA Forest Service 1977). The maximum jumping height is 11.2 feet (ft) for steelhead and 7.9 ft for chinook salmon (U.S. Army Corps of Engineers 2001). However, jumping ability is greatly affected by the jump angle and the horizontal distance of the leap (Powers and Orsborn 1985, Reiser and Peacock 1985). Table 4 identifies the maximum leaping height and horizontal distance for steelhead and chinook salmon, depending on the angle of exit from the staging pool. A conservative vertical limit for adult fish is 4.5 ft for steelhead and 3.0 ft for chinook salmon. Clearance of the vertical limit assumes a minimum staging pool depth of 6.8 ft for steelhead to 4.5 ft for chinook salmon. The horizontal limit is a distance of less than 19.7 ft (Powers and Orsborn 1985, Reiser and Peacock 1985; Stuart 1962; USDA Forest Service 1977).

Table 4. **Maximum Leaping Height and Horizontal Distance for Steelhead and Chinook Salmon as Determined by the Angle of Exit from the Water and Pool Depth**

Angle of Exit from Water (degrees)	Minimum Pool Depth (ft)	Height of Leap (ft)	Distance of Leap (ft)
Steelhead			
40	6.8	4.5	21.0
60	12.0	8.0	18.4
80	15.9	10.6	7.3
Chinook salmon			
40	4.5	3.0	15.2
60	8.7	5.8	13.1
80	11.4	7.6	5.4

Sources: Powers and Orsborn 1985; Reiser and Peacock 1985

Nonembedded culverts should have a minimum water depth of 1.0 ft for adults and 0.5 ft for juveniles (National Marine Fisheries Service 2001). Hydraulic drops between the water surface and the water surface in the structure should not exceed 1.0 ft for adults or 0.5 ft for juveniles (National Marine Fisheries Service 2001). If a hydraulic drop occurs at the culvert outlet, a jump pool of 2.0 ft should be provided (National Marine Fisheries Service 2001). The CDFG recommends that hydraulic drops be avoided, but where fish passage is required and a hydraulic drop is unavoidable, it should not exceed the values shown in Table 5.

The design maximum fall from the structure water surface into a 2 foot pool is given in the following table and should be considered at all flows (CDFG 2002 and CDFG 2003). The NMFS 2000 report also recommends a minimum pool depth of 1.5 times the jump height, but not less than 2.0 feet.

Table 5. Maximum Drop at Culvert Outlet

Species/Lifestage	Maximum Drop (ft)
Adult Anadromous Salmonids	1
Adult Non-Anadromous Salmonids	1
Juvenile Salmonids	0.5
Native Non-Salmonids Non-Native Species	Where fish passage is required for native non-salmonids, no hydraulic drop shall be allowed at the culvert outlet unless data is presented which will establish the leaping ability and leaping behavior of the target species of fish.

The primary factors that determine the extent to which fish passage will be impacted by the construction of a crossing are: 1) the degree of constriction the crossing has on the stream channel; 2) the degree to which the streambed is allowed to adjust vertically; 3) the length of stream channel impacted by the crossing, and; 4) the degree to which the stream velocity has been increased by the crossing. For unimpaired fish passage, it is desirable to have a crossing that is a large percentage of the channel bankfull width, allows for a natural variation in bed elevation, and provides bed and bank roughness similar to the upstream and downstream channel (CDFG 2002).

Tasks & Timelines

10. **Task 1:** Identify passage impediments that impede migration of juvenile and adult salmon and other native fish. This work would be completed during fall 2009 and spring 2010 Interim Flows. Deliverables include an exhaustive description and list of possible structural passage impediments. New passage information will be incorporated in conceptual and quantitative models.
    a. Gather existing data that identify potential fish passage impediments. This work will include reviewing studies from Jones & Stokes (2001), McBain & Trush (2002), and DWR (2005) that have evaluated and listed passage problems within the restoration area. These studies can be used to compile an initial list of obstructions including physical descriptions and assessments.
    b. Develop a GeoDatabase with the locations of the structural barriers. The database can be used to display these locations and to attach attributes

(e.g. latitude/longitude, dimensions, pictures, permits) that are gathered for each location. The database can be used to compare the previous data with the new 2008 LiDAR images to confirm existing impediments and identify any new potential fish passage issues.

c. Develop field assessment procedures and protocols for the initial field survey. As part of the procedures, a detailed field data sheet needs to be developed that will insure that all the information required for the physical description and prioritization is collected. (This initial field survey is not intended to gather all the information for modeling.) This work will require coordination between fisheries expertise to identify preliminary passage capability, and engineering expertise to measure, describe, and model the function of the barriers.
d. Conduct initial field work to document the barriers.
e. Prepare a preliminary fish passage report on the initial evaluation of any fish passage impediments. The report will include a ranking of severity of fish passage impediments to help identify the locations where detailed evaluation is a priority.

-

11. **Task 2:** Detailed evaluation of channel and structural impediments including hydraulic modeling over the range of Settlement Restoration Flows. This work would be completed during fall 2009, spring 2010 and 2011 Interim Flows. Deliverables include passage ratings of structural barriers for juvenile and adult salmon and other native fish.
    a. Identify the locations where detailed evaluation of channel and structural impediments is necessary to complete a hydraulic model over a range of restoration flows (based on the preliminary fish passage report).
    b. Refine the fish passage barrier criteria for those locations, identified in the first pass, that are not possible for evaluation with the FishXing software.
    c. Develop field assessment procedures and protocols for collecting the detailed information to complete the hydraulic modeling. As with the first task, a more detailed field data sheet needs to be developed to insure that the information required is collected.
    d. Evaluate and model the passage impediments over the range of Settlement Restoration Flows to estimate the severity of the passage problem. Work will be based on data collected during the initial and final field visit. This information will be entered into a HEC-RAS model to generate results for input into the FishXing software.
    e. Provide the results to the fisheries management workgroup so they can refine an Ecosystem Diagnosis and Treatment (EDT) model for each identified location. The results from the EDT can be merged with the priorities developed by engineering for the final prioritization of fish passage impediments.
    f. The preliminary fish passage report can be updated to include a final assessment of fish passage ratings of the channel and structural fish passage barriers for juvenile and adult salmon and other native fish. Report will include recommendations of the highest priority structures.

12. **Task 3:** Prioritize passage activities and draft recommended fish passage improvements for implementation. This work would be completed during 2012. Deliverables include a prioritized list of channel and structural fish passage improvement projects and alternative implementation projects for unimpeded fish passage.
    a. Prioritize locations for fish passage improvement projects and a comprehensive prioritized list of barrier modification needs. This can be developed based on barrier impact, route probabilities (San Joaquin River vs. bypasses), Settlement priority, feasibility, etc.
    b. Provide alternatives for design improvements to improve fish passage at each high priority location including cost estimates to aid in selection of the desirable alternative.
    c. Complete a final report that includes the prioritization process and final list with recommended improvement alternatives.

Table 6. Timeline

Task	2009	2010				2011				2012			
	Q4	*Q1*	*Q2*	*Q3*	*Q4*	*Q1*	*Q2*	*Q3*	*Q4*	*Q1*	*Q2*	*Q3*	*Q4*
Task 1													
Identify Passage Impediments													
Preliminary Passage Report													
Task 2													
Detailed Passage Evaluation													
Passage Analysis Report													
Task 3													
Barrier Prioritization													
Action Plan													

Summary

The final report generated from this study will be primarily focused on the channel and structural fish barriers and prioritization may need to be coordinated with efforts and data from other groups and agencies. Studies that include non-structural barriers, entrainment and false pathways may need to be coordinated with the construction of channel and structural improvements for the maximum benefit for unimpeded fish passage.

References

California Department of Fish and Game 2002. Culvert Criteria for Fish Passage.

California Department of Fish and Game (CDFG), Chapter IX. 2003. California Salmonid Stream Habitat Restoration Manual.

California Department of Water Resources (DWR). 2005. Bulletin 250: Fish Passage Improvement. Sacramento, California.

DWR. 2007. Calaveras River Fish Migration Barriers Assessment. 299 pages.

Jones & Stokes. 2001. Technical Memorandum on the Potential Barriers to Migrating Steelhead and Chinook Salmon on the San Joaquin River.

McBain & Trush. 2002. San Joaquin River Restoration Study, Background Report.

National Marine Fisheries Service (NMFS). 2000. Guidelines for Salmonid Passage at Stream Crossings. May 2000.

National Marine Fisheries Service (NMFS). 2001. Guidelines for Salmonid Passage at Stream Crossings. September 2001.

NMFS. 2008. Anadromous Salmonid Passage Facility Design. NMFS, Northwest Region, Portland, Oregon.

Robison, E. G., A. Mirait, and M. Allen. 1999. *Oregon road/stream crossing Restoration guide: Spring 1999*. June 8, 1999.

SJRRP, Fisheries Management Plan 2009. A Framework for Adaptive Management in the San Joaquin River Management Program.

U.S. Department of Transportation, Federal Highway Administration. 1990. Fish Passage Through Culverts. Report No. FHWA-FL-90-006

McBain & Trush. 2000. Habitat Restoration Plan for the Lower Tuolumne River Corridor. Prepared for the Tuolumne River Technical Advisory Committee. 240 pages.

Moise, G.W. and B. Hendrickson. 2002. Riparian vegetation of the San Joaquin River. Technical Information Record SJD-02-1. California Department of Water Resources, San Joaquin District. Fresno, California.

Powers, P. D., and J. F. Orsborn. 1985. Analysis of barriers to upstream fish migration, an investigation of the physical and biological conditions affecting fish passage success at culverts and waterfalls. Washington State University, Department of Civil Engineering, Albroook Hydraulics Lab, Pullman, WA.

Raleigh, R. F., T. Hickman, R.C. Solomon, and P.C. Nelson. 1984. Habitat suitability information: rainbow trout. U.S. Fish and Wildlife Service Biological Report 82/10.60. Washington DC. 64 pp.

Reiser, D. W. and R. T. Peacock. 1985. A technique for assessing upstream fish leaping passage problems at small-scale hydropower developments. Pages 423–432 in F. W. Olson, R. G. White, and R. H. Hamre, editors. Symposium on small hydropower and fisheries. American Fisheries Society. Bethesda, MD.

Stillwater Sciences. 2002. Merced River Corridor Restoration Plan. Stillwater Sciences, Berkeley, California. 243 pages.

U.S. Army Corps of Engineers. 2001. Implementation plan for Stuart, T. A. 1962. The behavior of salmon and trout at falls and obstructions. Department of Agriculture and Fisheries for Scotland, Freshwater and Salmon Fisheries Research Report 28. Edinburgh.

the Guadalupe River mitigation and monitoring plan. January. Administrative draft. In cooperation with Santa Clara Valley Water District, San Jose, CA. With technical assistance form **Jones** & Stokes, Sacramento, CA.

USDA Forest Service. 1977. Fish migration and fish passage. A practical guide to solving fish passage problems. Report prepared by W. A. Evans in collaboration with F. B. Johnston, USDA Forest Service, Region 5.

Washington Department of Fish and Wildlife. 1999. *Fish passage design at road culverts: A design manual for fish passage at road crossings*. March 3. Habitat and Lands Program, Environmental Engineering Division.

Appendix I. Plan Peer Review

Study Title: Charge for Peer Review of the Draft Fisheries Management Plan San Joaquin River Restoration Program

Background

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 the Central Valley Project (CVP) Friant Division (FD) contractors. After more than 18 years of litigation, the lawsuit, known as *NRDC et al. v. Kirk Rodgers et al.*, reached a Stipulation of Settlement (Settlement) in 2006. 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. 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 FD long-term contractors that may result from the Interim Flows and Restoration Flows provided for in the Settlement.

The Settlement establishes a framework for accomplishing the Restoration and Water Management goals that will require environmental review, design, and construction of projects over a multiple-year period. To achieve the Restoration Goal, the Settlement calls for a combination of channel and structural modifications along the San Joaquin River below Friant Dam, releases of water from Friant Dam to the confluence of the Merced River, and the reintroduction of spring-run Chinook salmon, *Oncorhynchus tshawytscha*. To achieve the Water Management Goal, the Settlement calls for the downstream recapture of Restoration Flows to replace reductions in water supplies to Friant Division long-term contractors resulting from the release of the Restoration Flows, establishes a Recovered Water Account, and allows the delivery of surplus water supplies to Friant Division long-term contractors during wet hydrologic conditions.

The Fisheries Management Work Group (FMWG), composed of representatives from the U.S. Department of Interior, Bureau of Reclamation, U.S. Fish and Wildlife Service, National Marine Fisheries Service, California Department of Fish and Game, California Department of Water Resources, and consultants was tasked with the development of the Fisheries Management Plan (FMP) as a first step in the Restoration Goal planning process. The FMP is not intended to be an implementation plan for program-level or site-specific-level projects. The FMP provides a roadmap to adaptively manage efforts to restore and maintain naturally reproducing and self-sustaining populations of Chinook salmon and other fish in the San Joaquin River between Friant Dam and the confluence with the Merced River (Restoration Area). The FMP will be revised as needed, reflecting changes in implementation strategy as a result of the adaptive management approach.

Peer Review Charge

The goal of this peer review is to assist the FMWG and the San Joaquin River Restoration Program in evaluating the overall adequacy of the FMP, and its conclusions and recommendations. The peer review panel will provide a written review that focuses on the strengths and weaknesses of the FMP and its exhibits.

The Review Panel will focus on the following subject areas and questions:

1. **Fisheries Management Plan:** Does the FMP successfully function as a programmatic fisheries management plan? Does the FMP appear appropriate considering the stage and current phase of the San Joaquin River Restoration Program?

2. **Adaptive Management Process:** Does the overall structure and logic of the FMP follow the adaptive management approach successfully? Is the FMP appropriately structured to fit the adaptive management framework? Does the adaptive management framework allow for active and passive adaptive management? Does it provide a process to change as new information becomes available? What are the weaknesses of the FMP adaptive management process?

3. **Conceptual Models of Limiting Factors:** Do the conceptual models of limiting factors adequately provide baseline context for the FMP? Is the limiting factors analysis appropriate? Has the appropriate scientific information been used in developing the Conceptual Models? Is there missing information?

- The review panel will also provide specific focus on the following areas:

1. **Goals**: Do the fish goals appropriately interpret the Settlement Restoration Goal? Is there missing information?

2. **Objectives:** Has the most appropriate scientific information been used in developing the objectives? Do the objectives appear reasonable and measurable? Are there any missing objectives?

3. **Conceptual and Quantitative Models:** Is the conceptual and quantitative modeling approach appropriate? Are the modeling tools adequately linked with the FMP? Are there missing modeling tools?

4. **Action Routing:** Does the action routing process present a clear and transparent decision process? Are the definitions and "instructions" in the Action Routing section clear? Does it allow for the routing of active and passive actions? Is the overall routing approach feasible?

5. **Actions:** Given the Settlement requirements, do the passive and active actions in the FMP appear appropriate? Are the actions routed properly? Are there gaps?

6. **Monitoring and Evaluation of Program Objectives:** Does the identified monitoring appear to adequately evaluate the population and habitat objectives of the Program? Is there any information missing?

7. **Program Assessment and Evaluation:** Does the monitoring adequately evaluate the success of the Program? Is the short-term and long-term evaluation appropriate?

8. **Review Process:** Is the review process described in the FMP adequate?

- **Review Panel Members**

- The review panel will consist of 4 nationally renowned fisheries management specialists with sufficient breadth and expertise to evaluate the FMP on its adaptive management and fisheries merits. The panel will include members who are selected for their expertise and reputation regarding fisheries management, salmonid biology, adaptive management, large-scale restoration, and performance monitoring. One review panel member will serve as the lead reviewer conducting the same review as the others, and in addition, facilitate and coordinate the completion of the reviews. The lead reviewer will also complete a synthesis of the review panel comments.

- **Review Schedule and Products**

Early August 2009: Peer review charge, FMP, and supporting information (hard and electronic copies) received by peer review panel. Peer review panel convenes teleconferences as needed.

Late August 2009: Lead reviewer receives reviews from review panel and convenes teleconference with panel as needed.

Early September 2009: Lead reviewer provides final review comments including synthesis summary from lead reviewer and attached peer reviews from panel members to FMWG. Lead reviewer will travel to Sacramento and present summary of findings to FMWG.

Late-September 2009: Final peer review synthesis and individual reports posted to public website.

Appendix J. Spawning Gravel

Study Title: Spawning Gravel Assessment

Region or Division and Branch: N/A

Principal Investigator(s): David (Dave) Encinas, Thomas Dunne

Contact Info. Of Principal Investigator(s):

David (Dave) Encinas
River Restoration Section
CA Department of Water Resources
South-Central Regional Office
3374 E. Shields Avenue
Fresno, California 93726
Telephone: (559) 230-3355
Fax: (559) 230-3363
E-mail: dencinas@water.ca.gov

Thomas Dunne
Bren School of Environmental Science & Management
Department of Earth Science
University of California-Santa Bárbara

Proposed Staff: [Matthew Meyers, Lee Harrison, Dale Stanton]

County (ies) affected by Study: [Fresno]

V. Study Management

G. Study Description7

1. History or Background

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 lawsuit, known as *NRDC et al. v. Kirk Rodgers et al.*, reached a Stipulation of Settlement (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.

The Settlement establishes a framework for accomplishing the Restoration and Water Management goals that will require environmental review, design, and construction of projects over a multiple-year period. To achieve the Restoration Goal, the Settlement calls for a combination of channel and structural modifications along the San Joaquin River below Friant Dam, releases of water from Friant Dam to the confluence of the Merced River, and the reintroduction of Chinook salmon, *Oncorhynchus tshawytscha*.

In response to the Settlement, 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 and associated Work Groups to begin work implementing the Settlement. For additional information related to the Implementing Agency approach, the reader is referred to the Program Management Plan available on the San Joaquin River Restoration Program (SJRRP) Website, www.restoresjr.net. Related to the Settlement, President Obama signed the San Joaquin River Restoration Act (Act) on March 30, 2009, giving the Department of Interior full authority to implement the SJRRP. The SJRRP will implement the Settlement and Act.

This study workplan was developed by the multiagency Fisheries Management Work Group (FMWG) and describes the spawning gravel assessment program.

m. General project background discussion.

Friant Dam serves as a barrier to gravel recruitment and may have significantly reduced the quantity and quality of gravel for Chinook salmon spawning in Reach 1. Furthermore, primary land uses in Reach 1 include extensive mining for gravel and sand. While Reach 1 is expected to provide all suitable spawning habitat, the condition of existing gravel or the ability for the system to adequately distribute suitable gravel in this segment of the San Joaquin River is not well-understood (FMWG 2009b). The San Joaquin River Restoration Program (Program) needs to determine if spawning habitat quality and quantity is sufficient to meet long-term population goals. If spawning habitat is insufficient, the Fisheries Management Plan recommends full implementation of actions to augment suitable gravel at existing riffles and other suitable locations in Reach 1.

n. Describe the evolution of the study.

Gravel availability was identified as a limiting factor for Chinook salmon in the Restoration Area by the Fisheries Management Workgroup (FMWG 2009a, 2009b). Two hypotheses concerning how to best implement these actions are: the "creation of side-channels for spawning habitat" and "modification of channel shape to improve the quality and quantity of spawning habitat in existing channels". Implementation of these actions has medium worth, involves medium risk, would have moderate

magnitude, and high uncertainty. Since Chinook salmon usually spawns in pool tails and riffle habitats, it is unknown if they will use the newly created spawning habitat. The creation of spawning habitat by means of channel modification is likely cost prohibitive in terms of reversibility and could have uncertain impacts on existing or downstream habitat. For these reasons, we propose an initial evaluation of the need to modify the channel to provide spawning habitat. Overall, the FMP recommends small-scale implementation of channel modification actions to provide spawning habitat for salmon.

o. Why is the study necessary?

This study is necessary to quantify the area of potentially suitable habitat for salmonid spawning. If spawning habitat is insufficient, the Fisheries Management Plan recommends full implementation of actions to augment suitable gravel at existing riffles and other suitable locations in Reach 1.

p. Identify and analyze any previous similar studies.

A 2002 survey mapped gravel beds in Reach 1A that are potentially suitable for salmonid spawning (cited in McBain and Trush 2003b 7-59). These gravel beds were described to occur in 65 riffles, 39 of which were upstream of Lanes Bridge (Hwy 41, RM 255.2). The total suitable spawning gravel bed surface area was calculated to total approximately 357,000 ft^2 (33,166 m^2) within the reach, of which approximately 79% or 281,000 ft^2 (26,106m^2) is upstream of Lanes Bridge. Riffles mapped by Stillwater Sciences were presented in their Restoration Strategies report (Stillwater, 2003a Appendix B). Figures 1 through 4 show locations of these identified riffles and the USGS river mile marks.

The Fisheries Management Plan (FMP) assumes an average redd size of 5.2m^2, with a mean growth population target ("escapement target") of 30,000 spring-run Chinook salmon and a 50-percent sex ratio. The FMP states that, under these conditions, spring-run Chinook salmon would require 78,000m^2 of spawning gravel (FMWG 2009b). In addition to quantifying spawning habitat, monitoring geomorphological conditions, such as depths and velocities, will inform on the integrity of existing habitat on Reach 1 and downstream on the following years.

2. Site Description

Following is a brief description of the Restoration Area, including San Joaquin River and bypass characteristics. For additional detail, the reader is referred to FMWG (2009b), or the SJRRP PEIS/R.

a. Location of the study (include maps, geographic data, etc.).

This study is located in the San Joaquin River Restoration Program (SJRRP) Restoration Area. The Restoration Area is approximately 153 miles long, extending from Friant Dam at the upstream end near the town of Friant, downstream to the confluence of the Merced River, and includes an extensive flood control bypass system (Figure 1). Five river reaches have been defined to address the different river characteristics throughout each reach. For more information regarding the Restoration Area, see FMWG (2009b), and the SJRRP PEIS/R.

b. Describe the environmental setting for the study.

Reach 1 begins at Friant Dam (RM 267.5) and continues approximately 37 miles downstream to Gravelly Ford (RM 229.0). Gravelly Ford is the historical terminus of the gravel bedded portion of the San Joaquin River. This reach conveys continuous flows through an incised, gravel-bedded channel. Reach 1 typically has a moderate slope, and is confined by periodic bluffs and terraces. The reach is divided into two subreaches: 1A and 1B. Reach 1A, which extends down to State Route (SR) 99, is the steepest reach and has the most gravel, and supports continuous riparian vegetation except where the channel has been disrupted by gravel mining and other development. Invasive woody species are common in Reach 1A (Moise and Hendrickson 2002). Reach 1B continues from SR 99 to Gravelly Ford where it is more narrowly confined by levees. Woody riparian species occur mainly in narrow strips immediately adjacent to the river channel in Reach 1B. Reach 1 has been extensively mined for instream gravel and is sediment limited. Gravel mining and agriculture are the primary land uses in Reach 1B.

2. Study purpose

j. Statement of study goals.

The goal is to assess spawning gravel availability and suitability to provide sufficient quantity and quality of spawning habitat for Chinook salmon in Reach 1.

k. List the objectives of the study

1. Quantify spawning habitat available to determine if a minimum amount of quality functioning spawning gravel exists in Reach 1 for spring-run Chinook salmon. If additional spawning habitat is necessary, augment gravel at existing riffles and other suitable locations in Reach 1.

2. If necessary, create side-channel habitat in Reach 1 to improve spawning habitat.

3. Modify channel shape in Reach 1 to increase the amount of spawning habitat.

l. Describe study milestones. Identify products and timelines.

13. **Task 1:** Substantiate and, if necessary, augment existing lists of riffles. All identified riffles and potential riffles will be evaluated during the fall 2010 Interim Flow Period. This work could be completed during fall and spring 2010 Interim Flows. The proposed study involves regular and systematic monitoring during each summer-fall low-flow season and opportunistic measurements and sampling during the winter-spring periods when high flows are likely. Deliverables include a comprehensive description and list of riffles that comprise the potential spawning habitat in Reach 1A. Information on spawning habitat availability will determine the need to pursue tasks 2 and 3.

14. **Task 2:** Task 2 involves altering the availability of redd-building bed material through the creation of side-channel habitat and gravel augmentation. The need for gravel augmentation on existing riffles or by side-channel creation in Reach 1 depends on the estimated amount and quality of spawning gravel available.

15. **Task 3:** Tasks 3 involves altering the availability of redd-building bed material through modification of channel shape to increase the amount of spawning habitat. This work depends on the results of Task 1 implementation which will follow an adaptive management process.

3. Study Approach (describe conceptual approach to study and include uncertainties).

10. **Task 1:** In order to complete the first task of evaluating riffles, several characteristics will be measured in this assessment, including riffle slope, length, and total riffle area. Water depths and velocities during low and high flow seasons, gravel size and depth, and sand content will be used to determine the availability of functional spawning habitat. In addition, the measurements will evaluate the permeability of substrates impregnated with fine sediment. Identified riffles will be assessed as to their existing value to Chinook salmon as a spawning bed. If a riffle is determined to have spawning potential we will note what action may be taken to maximize spawning area. Those riffle areas that have a higher ratio of spawning potential to existing spawning will be rated higher in the assessment.

11. **Task 2:** In order to complete task 2, a detailed assessment of riffles (Task 1) will help determine the need to create side-channel habitat in Reach 1 to improve spawning habitat. Data from Task 1 will allow to compare the size distributions with the spawning requirements of Chinook salmon in terms of both coarse and fine particle content to obtain an estimate of the extent of spawning gravel in the Reach (Kondolf and Wolman 199, Kondolf 2000).

12. **Task 3**: In order to complete task 3, a detailed assessment of riffles (Task 1) will help determine the need to modify channel shape in Reach 1 to increase the amount of spawning habitat. Priorities may change due to water year type, costs and property access.

4. What are the management or policy implications of the study?

Actions prescribed by the Settlement that will change discharge, depths and velocities in Reach 1 will likely influence the suitability of spawning habitat for Chinook salmon in this reach. It is likely that discharge increases will also increase available spawning habitat until discharge reaches an unknown threshold

(FMWG 2009b). Therefore, this study can be used to determine gravel quantity and/or quality changes as a result of Flushing Flows, Interim Flows, Restoration Flows and other Program actions that will impact discharge in Reach 1. Moreover, flow actions or other actions that improve the quantity and quality of spawning habitat could potentially help ameliorate or minimize other limiting factors identified in the FMP, such as, excessive redd superimposition and excessive hybridization.

Studies that provide information about the availability and suitability of spawning habitat will enhance our ability to meet the Restoration Goal. Other Program efforts to collect sediment transport information (DWR 2009, SJRRP 2008) support the objectives of the proposed study. Coordination between these monitoring efforts is crucial to optimize resources and avoid duplication of studies.

H. Study Organization and Responsibilities

1. Person(s) responsible (names, title, phone numbers, addresses, e-mail) and role.

David (Dave) Encinas
CA Department of Water Resources
South-Central Regional Office
3374 E. Shields Avenue
Fresno, California 93726
Telephone: (559) 230-3355
Fax: (559) 230-3363
E-mail: dencinas@water.ca.gov

2. Chain of command (if appropriate).

Not applicable

3. Collaborators (agencies, NGOs, academia, etc.) and contact persons:

Is an MOU and/or contract already established with the collaborator(s)?No.

Agency collaborators:

California Department of Water Resources (David Encinas),

California Department of Fish and Game (Dale Stanton)

Dale Stanton
Hydraulic Engineer
California Department of Fish and Game
1234 E. Shaw Ave
Fresno, California 93710
Phone: (559) 243-4014
Fax: (559) 243-4020

University of California, Santa Barbara (Thomas Dunne, Matthew Meyers, Lee Harrison)

4. Are there considerations protecting the Department's public trust and stewardship obligations that are kept in trust for the public now and in the future? These may include but are not limited to: The Department has the ownership and control rights for all of the products including data, metadata, images, video, research protocols, analyses, etc.; attribution, acknowledgement, and proper representation of the Department's scientific and coordination role; the Department should hold first American print rights.

C. Study Design

1. List the specific *research questions* (state them clearly as a null or positive hypothesis) to be answered by this study, including methodology:

   a. If the study includes sampling, describe the sampling design and measurement variables. Be specific: describe the sampling unit, independent variables, dependent variables, and tests or techniques to be used. Explain how bias will be avoided in selection of sampling units. For hypothesis tests, state the null hypothesis and alternative hypotheses.

   Not applicable

   b. Describe the experimental design and necessary sample sizes. For manipulative experiments, describe the table of treatments and number of replicates, and how experimental units will be grouped or blocked.

   Not applicable

   c. Describe biological detection capability. For field observational studies, describe the variation in measurement variables necessary to detect. (Historical data often can be used to predict the kind and quantity of data that will be required to achieve a stated resolution, or to estimate the resolution of a stated study design. If historical data pertinent to this question are available, apply power analyses).

   Not applicable

   d. Using feedback in ongoing studies, is an augmentation or reduction of previous sampling effort appropriate (i.e. can the data be collected with less field effort and still achieve the same level of significance)? After data become available, estimate the power of the existing sampling effort.

   Not applicable

e. Describe the contingency plans to assure the question is resolved: (Depending on the question being addressed, such plans may include (a) planned routine collection of more than the minimum data required at each regular interval, (b) logistical contingency plans to make up for missed field observations, or repeat incomplete manipulative experiments, or (c) alternate statistical methods if not all data are obtained. Use of alternate statistical methods will likely weaken the power of the study to answer the question or force redefinition of the question, and should be a last resort.

Not applicable

2. How will sampling bias(es) from different samplers or methods (e.g. training, standardized protocols) be minimized?

Not applicable

N. Study Resource Needs

4. Detailed budget

2 years beginning 09/01/09

Salaries and Stipends

T. Dunne 1 mo/yr

Lee Harrison 1 mo/yr

Matt Meyers, Graduate Student Researcher (GSR) 12 mo/yr plus student fees

Field assistants (at going rate for Bren Masters students) 1000 hours/year

Fieldwork expenses

Car mileage for travel to Fresno area and return 8 times per year

40 days living expenses for two people

Meeting travel expenses

2 people 1 trip per year to Bay or Sacramento area with 3 days of hotel and per diem each

2. Personnel needs

a. Field activities

- Float entire reach – ½ day

- Survey riffles – 2 weeks

- Flow measurement at riffles – 2 weeks

- Collect and analyze bulk samples – 1 week

- Collect pebble count data – 2weeks

Total days of field work for a two person team is estimated to be about 41.5 days.

b. Laboratory and office activities

Aerial photography review – ½ day

c. Travel (in-state and out-of-state)

d. Temporary help (estimated number of hours)

3. Equipment needs

a. Boats/vehicles/major sampling equipment – what is necessary and for what period?

b. What major equipment (>$1000) is necessary (purchased, borrowed, or leased)?

Stand pipe equipment for permeability measurements

Tools and field supplies

4. Coordination needs

a. If another study or agency is participating in collection of samples, is coordination plan, including funding, in place?

5. Has access to study site(s) been arranged?

Access agreements will need to be obtained for those areas that are deemed necessary for surveying gravel beds and riffles. Properties where permission to access has not been granted will be noted prior to performing field activities.

O. Compliance Considerations

9. Will study result in, or have the possibility of, take of federally- or state-listed threatened, endangered or species of special concern?

No

10. If so, estimate the number by species/race that will be taken and the estimated mortality.

11. Will the "take" or capture of any state- or federally-listed species be covered by an existing Biological Opinion?

No

12. If no BO exists, how will compliance be achieved?

No take is anticipated

P. Invasive Species: What measures will be taken to ensure field staff does not spread invasive plants or animals to new sites during the study?

All gear, including sampling equipment, boats and trailers, waders, etc., will be thoroughly inspected and cleaned after sampling each day.

Q. Due Dates and Products

16. **Describe the timeline for the study, with due dates for deliverables, including drafts (this should relate to section I.A.2.c).**

Deliverable	Date
Preliminary Spawning Gravel Assessment Report	March 31, 2010
Preliminary Spawning Gravel Assessment Report	March 31, 2011
Final Spawning Gravel Assessment Report	August 31, 2011

17. Will any new databases be created for or added to for this study?

N/A

18. If data is to be uploaded to a centralized data server, by what date?

Results will be reported to CDWR

19. If product includes a report, does it need to meet Americans with Disability Act format requirements (e.g. if the final document is made available on the internet)?

20. Will spatial data be submitted to BIOS? If so, submission must be in accordance with minimum BIOS and FGDC metadata standards.
(http://bios.dfg.ca.gov/metadata.asp)

(http://www.fgdc.gov/metadata/documents/workbook 0501 bmk.pdf)

II. Study Measurement and Data Acquisition

A. Sample Site Selection

1. Description of study area and sample sites, with map.

See Figure 1 for general map of the study area.

Statistical and scientific rationale for choosing sites (why was a site chosen?).

Aerial photography will be reviewed to locate potential riffles within the reach. Subsequently, the property ownership of sites adjacent to the river will be determined. Properties that are privately owned will require permission for access.

3. Sample site – parameter matrix (what parameters will be measured at each site).

Several characteristics will be measured at each site during the spawning habitat assessment including riffle slope, length, and total riffle area, water depths, gravel size and depth, and sand content. These measurements will help identify those riffle areas that have a higher ratio of spawning potential to existing spawning. Since no spawning currently exists, the "existing spawning" value will be determined based on current riffle conditions as they compare to spawning habitat on other Central Valley rivers.

I. Sampling Procedure (Standard Operating Procedures, SOPs)

Reference: Kondolf, G. M. 2000. Assessing salmonid gravel quality. Transactions of the American Fisheries Society 129:262-281.

1. Parameters to be measured with units defined

a. Frequency that each parameter will be measured (SOP)

b. Will replicate samples be taken? (SOP)

Spawning conditions will be assessed according to spawning habitat requirements detailed in the Background Report (McBain and Trush, 2003b B-30, B-46). Chinook salmon spawning depths of 4 to 78 inches and velocities of 0.5 to 3.3 ft/s are considered acceptable, and gravel sizes with D50 of 10.8 to 78mm are considered within their spawning range. These criteria will be used to identify areas with conditions that are potentially suitable as salmonid spawning habitat.

2. Methodology (with references) and SOP

a. Sample preservation, transportation, storage and disposal (SOP)

b. Preparation of equipment: cleaning, reagents, supplies (SOP)

To determine the total spawning area that will require investigation, we propose to float the entire reach to identify all potential spawning riffles. Canoes will be used to float the reach while taking detailed notes and mapping of gravel bed and riffle locations and dimensions. After locating significant riffles within the reach they will be surveyed to further determine the characteristics of each riffle area. Benchmarks will be established at locations expected to be undisturbed for the foreseeable future. These benchmarks will be located using GPS to determine

latitude, longitude, and elevation to a precision provided by such equipment. A total station will be used to survey location and elevation of the riffles. The survey data will be used to determine riffle dimensions and slopes.

c. Sample and data collection (SOP)

An acoustic Doppler velocimeter (ADV) will be used to collect flow measurements at the riffles and help determine stream flow velocities and depths. The depth average flow will be estimated by performing measurements at 60% of the stream depth at each location measured. In order to discount turbulence, each location will be measured over a time period of at least 1.5 minutes. Each velocity measurement location will be surveyed and plotted on a base map.

Bulk samples of the bed material will be collected at some riffles using a shovel and 5 gallon bucket. Each sample will be labeled with an identification code. In addition, each sample will be noted and its ID marked on a base map. The samples will be sieved and the particle size distribution will be recorded.

Pebble count data will be collected at each riffle to determine the particle size distribution of the surface sediment from riffles. Transects will be located perpendicular to banks across relatively homogenous flows and stream-bottoms. Particles will be chosen at random via a not looking, first touch method to minimize selection bias. Bedrock, organic debris, and human produced debris will not be counted. Particle measurements are based on their intermediate axis (b-axis). Measurements will be made based on whether the intermediate axis of the particles fits through the smallest of the following square hole screen sizes: 4 mm, 5.7 mm, 8 mm, 11.3 mm, 16 mm, 22.6 mm, 32 mm, 45 mm, 64 mm, 90 mm, 128 mm, 180 mm, or 256 mm. Particles with an intermediate axis less than 4 mm will be noted on field data sheets and plotted on a base map.

d. Sample and data acceptability (SOP)

3. Personnel training (SOP)

4. Personnel safety (SOP), in both field and laboratory

C. Sample Custody for Field and Laboratory -

1. Identify custodians and site for long-term storage (if appropriate)

2. Tracking forms (if appropriate)

3. Sample records (if appropriate)

Each sample will be noted and its ID marked on a base map. The samples will be sieved and the particle size distribution will be recorded.

D. Calibration Procedures and Frequency

1. Instrument and sample calibration (referenced).

2. Frequency and timing of calibration: analytical system, instruments,

devices, etc. (SOP).

3. Documentation of calibration checks.

4. Instrument, equipment and supplies inspection and maintenance, including periodicity.

E. Sample Processing and Analysis

1. Reference standard methods and appropriateness for measurements

2. Describe non-standard methods and validation procedures

3. Describe SOPs

F. Data Reduction, Analysis and Reporting

1. Who will conduct the data reduction (transformation of raw data) and analysis?

2. What quality control procedures will be used to assure the validity of statistical results?

3. Who is responsible for preparing peer-reviewed articles and/or reports?

4. Will the data be archived in a central repository, like BIOS, FISH, etc.?

III. DATA ASSESSMENT AND OVERSIGHT

A. Quality Control Data Checks

1. What procedure will be used for data checks?

2. What criteria will be used to check data?

3. Who will conduct the data checks and how will the results be documented?

B. Field and laboratory performance and systems audit

1. How will the audit be conducted?

2. What criteria will be used?

3. Who will conduct the audit and how will the results be documented?

C. Corrective action

1. If errors are encountered in items A and B above, who will determine and implement corrective action(s)?

IV. DATA VALIDATION AND USABILITY

A. Error checking of raw data (data review)

1. What protocol will be used to check for errors?
2. What criteria will be used?
3. Who will conduct the checking?
4. How will the results be documented?

B. Data limitations

1. Describe the limitations of the data, such as periodicity, seasonality, etc.

V. STUDY FEEDBACK TO MANAGEMENT:

A. Study should contain the following:

1. Periodic review by a designated CDFG science advisory panel or individual; could be part of the reporting milestones at set times.
2. Integration of feedback to study design and methodologies.
3. Study completion and reporting (publication).
4. Presentation to leadership by deadline.

REFERENCES:

FMWG. 2009a. Conceptual models of stressors and limiting factors for San Joaquin River Chinook salmon. 178 pages. June 2009.

FMWG. 2009b. Fisheries management plan: A framework for adaptive management in the San Joaquin River Restoration Program.

Kondolf, G. M. 2000. Assessing salmonid gravel quality. Transactions of the American Fisheries Society 129:262-281.

Kondolf, G. M. and M. G. Wolman. 1993. The sizes of salmonid spawning gravels. Water Resources Research 29(7):2275-2285.

McBain, S. and W. Trush. 2002. San Joaquin River restoration study background report. Prepared for Friant Water Users Authority, Lindsay, California and Natural Resources Defense Council, San Francisco, California. Arcata, California. December.

Stillwater Sciences. 2003. Restoration Strategies for the San Joaquin River. Prepared by Stillwater Sciences, Berkeley, California for Natural Resources Defense Council, San Francisco, California and Friant Water Users Authority, Lindsay, California.

Exhibit c: Guidance for Determining Implementation Objectives

Implementation Objective(s)

Examples: Monitor X for three years to determine success of a management action, survey Population Y for one year to determine current abundance, range, sex ratio, and age class structure, etc. If the study monitors the results of an event or a management strategy, what qualitative or quantitative threshold or degree of change defines a significant change or success? Examples:

- Maintain at least 50 individuals of Species B in the Willow Creek Unit.
- No more than 3 patches of Weed B in the Willow Creek Unit by 2010.
- Do not exceed Cover Class 3 (10 – 30% by visual estimate) by any of the target weed species in more than 2 of the 10 macroplots established in the Willow Creek Unit.

If monitoring involves sampling, how certain do you want to be of your results:

Example:

- Management Objective: Maintain a population of Species A in the Willow Creek Preserve with at least 100 individuals from 2009 ─ 2012.
- Sampling Objective: Be 95% confident that estimates are within ± 10% of the true value.

Examples of objectives adapted from Elzinga, C.L.;Salzer, D.W. and J.W. Willoughby. 1998. Measuring and Monitoring Plant Populations. U.S. Department of the Interior. Bureau of Land Management. Report #BLM/RS/ST-98/005+1730; BLM Technical Reference # 1730-1.

Appendix K. Water Quality

Study Title: Water Quality Constituents

Region or Division and Branch: N/A

Principal Investigator(s): Stephen Lee, Gerald Hatler, Kevin Faulkenberry

Contact Info. Of Principal Investigator(s):

Stephen Lee
Hydrologist
South-Central California Area Office
U. S. Bureau of Reclamation
1243 N Street
Fresno, California 93721-1813
Telephone: (559) 487-5286
E-mail: slee@mp.usbr.gov

Gerald Hatler
Senior Environmental Scientist
Fisheries Supervisor
San Joaquin River Restoration
California Department of Fish and Game
1234 E. Shaw Ave
Fresno, California 93710
Phone: (559) 243-4014 Ext. 259
Fax: (559) 243-4020
Mobile: (559) 341-1814
Email: ghatler@dfg.ca.gov

Kevin Faulkenberry
California Department of Water Resources
South-Central Regional Office
3374 E. Shields Avenue
Fresno, California 93726
Telephone: (559) 230-3320
Fax: (559) 230-3363
E-mail: faulkenb@water.ca.gov

Proposed Staff: [Michael C. S. Eacock, Margarita Gordus, Abimael León]

County (ies) affected by Study: [Fresno, Madera, and Merced]

VI. Study Management

J. Study Description

1. History or Background

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 lawsuit, known as *NRDC et al. v. Kirk Rodgers et al.*, reached a Stipulation of Settlement (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.

The Settlement establishes a framework for accomplishing the Restoration and Water Management goals that will require environmental review, design, and construction of projects over a multiple-year period. To achieve the Restoration Goal, the Settlement calls for a combination of channel and structural modifications along the San Joaquin River below Friant Dam, releases of water from Friant Dam to the confluence of the Merced River, and the reintroduction of Chinook salmon, *Oncorhynchus tshawytscha*.

In response to the Settlement, 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 and associated Work Groups to begin work implementing the Settlement. For additional information related to the Implementing Agency approach, the reader is referred to the Program Management Plan available on the San Joaquin River Restoration Program (SJRRP) Website, www.restoresjr.net. Related to the Settlement, President Obama signed the San Joaquin River Restoration Act (Act) on March 30, 2009, giving the Department of Interior full authority to implement the SJRRP. The SJRRP will implement the Settlement and Act.

This study workplan was developed by the multiagency Fisheries Management Work Group (FMWG) and describes the water quality monitoring program.

q. General project background discussion.

Degraded water quality is identified as a potential limiting factor for all life stages of Chinook salmon and other native fishes in the Restoration Area (FMWG 2009). Urban and agricultural wastes may alter water quality parameters such as dissolved

oxygen and turbidity, creating unsuitable habitat for Chinook salmon. We do not know whether or not Interim Flows will improve water quality in the Restoration Area. Therefore, evaluation and management of water quality conditions are essential to successfully meet the Restoration Goal.

r. Describe the evolution of the study.

Monitoring activities should document the impact of Interim Flows on physical parameters, including water quality indicators, in the Restoration Area. Interim Flows are releases of water from Friant Dam consistent with Restoration Flow Schedules specified in the Settlement and commencing no later than October 1, 2009. Water quality monitoring is implicitly required to meet the goals of the Settlement (SJRRP 2008). Specifically, water quality data are required to verify that Interim Flows are sufficient in condition to meet life history requirements for the reintroduction of Chinook salmon in the San Joaquin River. Hence, the proposed study responds to a need to measure select constituents in the Restoration Area.

To meet the Restoration Goal, the Fisheries Management Plan states that water quality should meet minimum standards for protection of aquatic resources. The Central Valley Regional Water Quality Control Board defines water quality objectives for beneficial uses that can be used to establish water quality goals for the protection of the San Joaquin River fishery (FMWG 2009). The San Joaquin River Restoration Program needs to coordinate with other water quality programs to monitor water quality at identified monitoring sites and ensure compliance with existing water quality objectives.

s. Why is the study necessary?

Monitoring activities are essential to assess the performance of the San Joaquin River Restoration Program (SJRRP) and they are a critical component in the adaptive management process (FMWG 2009). Specifically, water quality monitoring supports the main beneficial uses of the SJRRP Restoration Area for the enhancement of fisheries resources: (1) cold freshwater habitat, (2) fish migration, and (3) spawning, reproduction and/or early development. Therefore, water quality monitoring data will be used to verify that Interim Flows are sufficient in condition to provide habitat that meets life history requirements of Chinook salmon, and other native fishes, in the San Joaquin River. These results can be used, in conjunction with flow data, to assess potential impacts of water quality on the health and survival of salmon and other native fishes.

Overall, this study will inform timely decision making related to Interim Flow releases as well as help evaluate the success of the Program and its objectives.

t. Identify and analyze any previous similar studies.

McBain & Trush (2002) concluded that the historical water quality of the San Joaquin River likely provided suitable conditions for native fish, including

anadromous salmonid populations. Moyle (2002) highlighted, however, that subsequent declines in water quality may be contributing to the decline of some native resident fish. While the capacity of Interim Flows to improve existing water quality conditions is unknown, a study by Henson and others (2007) showed that a pulse flow event similar to the Interim Flows could improve downstream fish and macroinvertebrate habitat quality.

Monitoring activities by the Central Valley Regional Water Quality Control Board (CVRWQCB 2006) suggest that the San Joaquin River above Friant Dam is not impaired and that the water quality on the Upper San Joaquin River is excellent. In contrast, water quality objectives for salinity have been routinely exceeded in downstream reaches (from Reaches 3 through 5), according to CVRWQCB reports. Furthermore, although most dissolved oxygen (DO) data are generally not indicative of water quality impairment, low DO levels have impaired the upstream end of the Stockton Deep Water Ship Channel since the 1970s and have been associated to high nutrient concentrations in other parts of the river.

Studies support that trace element concentrations in the San Joaquin River are a primary water quality concern. Saiki et al. (1992) found evidence of bio-accumulation of several trace elements from exposure to undiluted agricultural drainwater. Agricultural drainage water had been a source of selenium to Salt Slough, but selenium concentrations improved at this site after implementation of the Grasslands Bypass Project (GBP) in 1996 (Saiki et al. 2001). The GBP conveys agricultural drainwater to the San Joaquin River which is still regarded as impaired because of selenium. A study by Saiki et al. (2001) did not detect any adverse effects in fish that could be attributed to GBP operations. However, Beckon (2007) found that juvenile fall-run Chinook salmon died in the laboratory after eating selenium-contaminated invertebrates and prey fish over a 90-day period that were collected from the San Joaquin River basin.

The 303(d) list, a list of impaired water bodies maintained by the CVRWQCB and revised by the U.S. Environmental Protection Agency, identifies pesticide impairment in Reaches 3, 4 and 5 of the Restoration Area. The 303(d) listing process guides the CVRWQCB, the United States Geological Survey (USGS), and the State Department of Pesticide Regulation (DPR) to conduct cooperative synoptic and/or in-season sampling for pesticides, herbicides, and insecticides. Some of the sampling stations are within the Restoration Area.

Other water quality constituents of concern, such as turbidity, have not been extensively documented and need to be included in a water quality monitoring program to evaluate their potential effects on the San Joaquin River fishery.

2. Site Description

Following is a brief description of the Restoration Area, including San Joaquin River and bypass characteristics. For additional detail, the reader is referred to FMWG (2009b), or the SJRRP PEIS/R.

a. Location of the study (include maps, geographic data, etc.).

This study is located in the San Joaquin River Restoration Program (SJRRP) Restoration Area. The Restoration Area is approximately 153 miles long, extending from Friant Dam at the upstream end near the town of Friant, downstream to the confluence of the Merced River, and includes an extensive flood control bypass system (Figure 1). Five river reaches have been defined to address the different river characteristics throughout each reach. For more information regarding the Restoration Area, see FMWG (2009b), and the SJRRP PEIS/R.

b. Describe the environmental setting for the study.

Reach 1 begins at Friant Dam and continues approximately 37 miles downstream to Gravelly Ford. This reach conveys continuous flows through an incised, gravel-bedded channel. Reach 1 typically has a moderate slope, and is confined by periodic bluffs and terraces. The reach is divided into two subreaches: 1A and 1B. Reach 1A, which extends down to State Route (SR) 99, has the most gravel, and supports continuous riparian vegetation except where the channel has been disrupted by gravel mining and other development. Invasive woody species are common in Reach 1A (Moise and Hendrickson 2002). Reach 1B continues from SR 99 to Gravelly Ford where it is more narrowly confined by levees. Woody riparian species occur mainly in narrow strips immediately adjacent to the river channel in Reach 1B. Reach 1 has been extensively mined for instream gravel and is sediment limited. Gravel mining and agriculture are the primary land uses in Reach 1B.

Reach 2 starts at Gravelly Ford, extends downstream to Mendota Dam, and is a meandering, low-gradient channel. Reach 2 is characterized by seasonal drying of the channel in the summer and fall. In most years, the Reach 2 channel is dry except under flood release conditions from Gravelly Ford to Mendota Dam. Mendota Pool is formed by the Mendota Dam at the confluence of the San Joaquin River and Fresno Slough. The primary source of water to the Mendota Pool is conveyed from the Delta through the Delta-Mendota Canal (DMC).

Reach 2 is subdivided at the Chowchilla Bypass Bifurcation Structure into two subreaches, Reach 2A and Reach 2B, which have confining levees protecting adjacent agricultural land. Reach 2A and Reach 2B are intermittent and sand-bedded. Reach 2A is subject to extensive seepage losses and accumulates sand due to backwater effects of the Chowchilla Bypass Bifurcation Structure and the low gradient of the reach. Riparian vegetation in Reach 2A is sparse or absent due to the usually dry conditions of the river and groundwater overdrafting (McBain and Trush 2002). Reach 2A vegetation has abundant grassland/pasture and large stands of nonnative plants (Moise and Hendrickson 2002). Reach 2B has a sandy channel with limited conveyance capacity and a thin strip of riparian vegetation, primarily native

species, which borders the channel. A portion of Reach 2B is perennial because of the backwater of Mendota Pool.

Reach 3 extends from Mendota Dam at the upstream end to Sack Dam at the downstream end and receives continuous flows from the DMC. At Sack Dam, flow releases are diverted into the Arroyo Canal. The river is confined by local dikes and canals on both banks. The sandy channel meanders through a predominantly agricultural area, except where the City of Firebaugh borders the river's west bank. The river at this location has a low stage but is perennial and supports a narrow riparian corridor along the edge of the river channel.

Reach 4, located between Sack Dam and the confluence with Bear Creek and the Eastside Bypass, is sand-bedded and usually dewatered because of the diversion at Sack Dam. The upstream portion of Reach 4 is bounded by canals and local dikes down to the confluence with the Mariposa Bypass at the San Luis National Wildlife Refuge. Levees that begin at the Mariposa Bypass continue downstream on both banks (McBain and Trush 2002). Reach 4 is subdivided into three distinct subreaches: 4A, 4B1, and 4B2.

Reach 4A, from Sack Dam to the Sand Slough Control Structure, is confined within a narrow channel. This subreach is dry in most months with negligible flows that are diverted at Sack Dam. The floodplain of Reach 4A is broad, with levees set back from the active channel. The subreach is sparsely vegetated, with a thin and discontinuous band of vegetation along the channel margin. This subreach has the fewest functioning stream habitat types and the lowest ratio of natural vegetation per river mile in the Restoration Area.

Reach 4B1 extends from the Sand Slough Control Structure to the confluence with the Mariposa Bypass. Reach 4B1 has been dry, for the most part, for more than 40 years. The only exception occurs when the channel receives varying amounts of agricultural-return flows. Water reaching the Sand Slough Control Structure is diverted to the bypass system via the Sand Slough Bypass. As a result, the Reach 4B1 channel is poorly defined with dense vegetation and other fill material. The riparian corridor upstream of the Mariposa Bypass is narrow, but nearly unbroken.

Reach 4B2 begins at the confluence of the Mariposa Bypass, where flood flows in the bypass system rejoin the mainstem of the San Joaquin River, and extend to the confluence of the Eastside Bypass. Reach 4B2 contains wider floodplains than upstream reaches and vast areas of natural vegetation.

Reach 5 extends from the confluence of the Eastside Bypass downstream to the Merced River confluence. Reach 5 is perennial because it receives varying amounts of agricultural return flows from Mud and Salt sloughs. Reach 5 is more sinuous than other reaches and contains oxbows, side channels, and remnant channels (McBain and Trush 2002). Reach 5 is bounded on the west by levees downstream to the Salt Slough confluence and on the right bank to the Merced River confluence. Reach 5 has a broad floodplain; however, levees generally dissociate the floodplain from the mainstem San Joaquin River (McBain and Trush 2002). Less agricultural land

conversion has occurred in Reach 5, with a majority of the land held in public ownership and managed for wildlife habitat.

The natural habitat surrounding Reach 5 includes large expanses of grassland with woody riparian vegetation in the floodplain. Remnant riparian tree groves are concentrated on the margins of mostly dry secondary channels and depressions or in remnant oxbows. The mainstem has a patchy riparian canopy (McBain and Trush 2002).

The bypass system consists of a series of dams, bifurcation structures, bypasses, levees, and portions of the main river channel. The bypass system is managed to maintain flood-conveyance capacity. Descriptions of primary components of the bypass system follow.

Fresno Slough, also known as James Bypass, conveys flood flows regulated by Pine Flat Dam from the Kings River system in the Tulare Basin to Mendota Pool.

The Chowchilla Bifurcation Structure, at the head of Reach 2B, regulates the flow split between the San Joaquin River and the Chowchilla Bypass. The Chowchilla Bypass extends to the confluence of Ash Slough, and is approximately 22 miles long, leveed, and 600 to 700 feet wide. Sand deposits are dredged from the bypass, as needed, and vegetation is periodically removed from the channel.

The Eastside Bypass extends from the confluence of Ash Slough and Chowchilla Bypass to the confluence with the San Joaquin River at the head of Reach 5 and is subdivided into three reaches. Eastside Bypass Reach 1 extends from Ash Slough to the Sand Slough Bypass confluence and receives flows from the Chowchilla River. Eastside Bypass Reach 2 extends from Sand Slough Bypass to the head of the Mariposa Bypass. Eastside Bypass Reach 3 extends from the head of the Mariposa Bypass to the head of Reach 5 and receives flows from Deadman, Owens, and Bear creeks.

The lower 10 miles of the Eastside Bypass are similar to the Chowchilla Bypass. Upland vegetation at the Eastside Bypass consists of grassland and ruderal vegetation. In the Grasslands Wildlife Management Area, riparian trees and shrubs have a patchy distribution along the banks of the Eastside Bypass. The lower Eastside Bypass has some side channels and sloughs that support remnant patches of riparian vegetation.

2. Study purpose

a. Statement of study goals.

The goal is to monitor select water quality constituents to help provide and/or maintain suitable habitat for Chinook salmon and other native fishes of the San Joaquin River.

b. List the objectives of the study

1. Determine water quality conditions (i.e. electrical conductivity, alkalinity, pH, dissolved oxygen, turbidity and chlorophyll) at holding pools to help provide or maintain a minimum of 30,000 m^2 of high-quality spring-run Chinook salmon holding habitat.
2. Monitor selenium levels to ensure that they do not exceed 0.020 mg/L or a 4-day average of 0.005 mg/L in the Restoration Area.
3. Monitor dissolved oxygen levels to ensure that they remain above 5.0mg/L when Chinook salmon are present.
4. Monitor total ammonia nitrogen to ensure that concentrations do not exceed 30-day average of 2.43 mg N/L when juvenile Chinook salmon are present or exceed a 1-hour average of 5.62 mg N/L when Chinook salmon are present.
5. Adapt this work plan to accommodate approved changes or amendments to water quality requirements

c. Describe study milestones. Identify products and timelines.

1. **Task 1**: Determine general water quality conditions in holding pools. This work could be completed during fall and spring 2010 Interim Flows. Deliverables include a comprehensive report of habitat-specific water quality conditions in potential Spring-run Chinook salmon holding habitat. This information will supplement ongoing habitat assessments.
2. **Task 2**: Monitoring of selenium levels in the lower Reaches of the San Joaquin River Restoration Area. This work will be conducted during fall and spring 2010 and 2011 Interim Flows. Deliverables include reports from the Grasslands Bypass Project monitoring activities.

3. **Task 3**: Monitor dissolved oxygen in the Restoration Area to ensure that the levels remain above the minimum objective when Chinook salmon are present. This work would be ongoing during the Interim Flow period. Deliverables include real-time reports to enable adaptive management of the fishery.

4. **Task 4:** Monitor total ammonia nitrogen to ensure that concentrations do not exceed 30-day average of 2.43 mg N/L when juvenile Chinook salmon are present or exceed a 1-hour average of 5.62 mg N/L when Chinook salmon are present. This work could be conducted during the Interim Flow period. Deliverables include a final report and a database to search for possible exceedances during the sampling period.

3. Study Approach (describe conceptual approach to study and include uncertainties).

1. **Task 1**: In order to complete the first task of evaluating general water quality conditions in holding pools, a physical description of the habitat will be needed including the location of holding pools in Reach 1. The task requires coordination with and expansion of current water quality monitoring programs. Field measurements should concentrate on the habitat features that were previously identified in a habitat assessment.

2. **Task 2**: Task 2 requires laboratory analysis of grab samples and composite samples to determine selenium content. Selenium content could be monitored periodically in the Restoration Area below Mendota. The major source of selenium is subsurface agricultural return flows (tile drainage) from the Drainage Project Area (DPA) which is drained by the Grassland Bypass Project (GBP). Hence, selenium monitoring activities will be coordinated in collaboration between the GBP, Reclamation and the Regional Board.
Reclamation measures selenium daily in the Delta-Mendota Canal and Mendota Pool to ensure that Central Valley Project water meets the 2 ppb monthly objective for the Grasslands wetlands water supply channels. In addition, the Regional Board collects weekly grab samples from these channels and the river below Fremont Ford to support the Grassland Bypass Project.

3. **Task 3**: Task 3 is an extension of task 1. However, monitoring of dissolved oxygen requires real-time data collection and transmission to minimize response time in case of an emergency, such as an oxygen barrier to migration. An oxygen barrier, also known as "oxygen block", could impede upstream migration of adult Chinook salmon. Locations for oxygen monitoring with real-time sensors will be distributed along the river.

4. **Task 4**: Task 4 can be accomplished by periodic monitoring of ammonia close to potential sources such as local wastewater treatment plants, septic leaching and effluents from animal facilities. Targeted monitoring of such locations will help identify ammonia levels that may be acutely toxic to migrating subyearling smolts or rearing juveniles after exposures of short duration or levels that would significantly increase their susceptibility to disease. The Regional Board currently measures nitrate as nitrogen, ammonia, and total Kjedahl nitrogen on a monthly basis and every two weeks during the irrigation season (March through August) at Mud Slough (north), San Joaquin River at Fremont Ford, and San Joaquin River at Crows Landing.

4. What are the management or policy implications of the study?

The Fisheries Management Workgroup anticipates that monitoring for water quality constituents will inform decision-making and will ultimately help evaluate the success of the SJRRP in providing water of suitable quality for reintroduced Chinook salmon populations. The proposed monitoring activities will inform timely adjustments to flow releases to help meet water quality needs for fisheries within some portions of the Restoration Area according to Settlement flow guidelines.

K. Study Organization and Responsibilities

1. Person(s) responsible (names, title, phone numbers, addresses, e-mail) and role.

Chris C. S. Eacock, Project Manager for the Grassland Bypass Project (GBP)
(559) 487-5133, E-mail: ceacock@mp.usbr.gov

Water quality monitoring programs are currently underway in the Restoration Area with the combined efforts of the Bureau of Reclamation (Reclamation), the United States Geological Survey (USGS), the California Department of Fish and Game (DFG), the California Department of Water Resources (DWR), and the Central Valley Regional Water Quality Control Board (Regional Board). The field work required by this work plan could be conducted by staff from Reclamation and resource agencies.

The San Joaquin River Restoration Program (SJRRP) will ensure that monitoring continues and should provide access to results.

2. Chain of command (if appropriate).

Not applicable

3. Collaborators (agencies, NGOs, academia, etc.) and contact persons:

Is an MOU and/or contract already established with the collaborator(s)?

Agency collaborators:

California Department of Water Resources (Kevin Faulkenberry, Abimael León),

California Department of Fish and Game (Gerald Hatler, Margarita Gordus)

U. S. Department of the Interior, Bureau of Reclamation (Stephen Lee, Chris C. S. Eacock)

Central Valley Regional Water Quality Control Board (TJ Kopshy)

TJ Kopshy
SJR Watershed Unit
Grasslands Bypass Project Coordinator
Environmental Scientist
Regional Water Quality Control Board-Central Valley
Phone: (916) 464-4718
E-mail: tkopshy@waterboards.ca.gov

4. Are there considerations protecting the Department's public trust and stewardship obligations that are kept in trust for the public now and in the future?

Such considerations may include: The Department has the ownership and control rights for all of the products including data, metadata, images, video, research protocols, analyses, etc.; attribution, acknowledgement, and proper representation

of the Department's scientific and coordination role; the Department should hold first American print rights.

C. Study Design – Refer to SJRRP (2008)

2. List the specific *research questions* (state them clearly as a null or positive hypothesis) to be answered by this study, including methodology:

f. If the study includes sampling, describe the sampling design and measurement variables. Be specific: describe the sampling unit, independent variables, dependent variables, and tests or techniques to be used. Explain how bias will be avoided in selection of sampling units. For hypothesis tests, state the null hypothesis and alternative hypotheses.

Not applicable

g. Describe the experimental design and necessary sample sizes. For manipulative experiments, describe the table of treatments and number of replicates, and how experimental units will be grouped or blocked.

Not applicable

h. Describe biological detection capability. For field observational studies, describe the variation in measurement variables necessary to detect. (Historical data often can be used to predict the kind and quantity of data that will be required to achieve a stated resolution, or to estimate the resolution of a stated study design. If historical data pertinent to this question are available, apply power analyses).

Not applicable

i. Using feedback in ongoing studies, is an augmentation or reduction of previous sampling effort appropriate (i.e. can the data be collected with less field effort and still achieve the same level of significance)? After data become available, estimate the power of the existing sampling effort.

Not applicable

j. Describe the contingency plans to assure the question is resolved: (Depending on the question being addressed, such plans may include (a) planned routine collection of more than the minimum data required at each regular interval, (b) logistical contingency plans to make up for missed field observations, or repeat incomplete manipulative

experiments, or (c) alternate statistical methods if not all data are obtained. Use of alternate statistical methods will likely weaken the power of the study to answer the question or force redefinition of the question, and should be a last resort.

Not applicable

2. How will sampling bias(es) from different samplers or methods (e.g. training, standardized protocols) be minimized?

Not applicable

R. Study Resource Needs – Refer to SJRRP (2008)

5. Detailed budget

TBD

2. Personnel needs

a. Field activities

b. Laboratory and office activities

c. Travel (in-state and out-of-state)

d. Temporary help (estimated number of hours)

3. Equipment needs

a. Boats/vehicles/major sampling equipment – what is necessary and for what period?

b. What major equipment (>$1000) is necessary (purchased, borrowed, or leased leased)?

4. Coordination needs

a. If another study or agency is participating in collection of samples, is coordination plan, including funding, in place?

5. Has access to study site(s) been arranged?

S. Compliance Considerations

13. Will study result in, or have the possibility of, take of federally- or state-listed threatened, endangered or species of special concern?

No

14. If so, estimate the number by species/race that will be taken and the estimated mortality.

15. Will the "take" or capture of any state- or federally-listed species be covered by an existing Biological Opinion?

No

16. If no BO exists, how will compliance be achieved?

No take is anticipated

T. Invasive Species: What measures will be taken to ensure field staff does not spread invasive plants or animals to new sites during the study?

All gear, including sampling equipment, boats and trailers, waders, etc., will be thoroughly inspected and cleaned after sampling each day.

U. Due Dates and Products

21. Describe the timeline for the study, with due dates for deliverables, including drafts (this should relate to section I.A.2.c).

Deliverable	Date
Quarterly Water Quality Data Reports	December 31, 2010
Water Quality Annual Synthesis Reports	December 31, 2011

22. Will any new databases be created for or added to for this study?

The agencies responsible for data collection will also be responsible for its quality assurance (QA) verification according to Standard Operating Protocols set out by the United States Geological Survey (USGS). Real-time data will be posted on a website with interactive graphics.

The San Joaquin River Restoration Program (SJRRP) will ensure that monitoring continues and should provide access to results. Refer to the *Monitoring Plan for Physical Parameters* SJRRP (2008) for a list of websites that contain the databases.

23. If data is to be uploaded to a centralized data server, by what date?

The Monitoring work group of the San Joaquin River Restoration Program proposes to use an independent data manager to gather historic and contemporary data. Possible data managers include the Data Collection and Review Team of the Grasslands Bypass Project (GBP)

24. If product includes a report, does it need to meet Americans with Disability Act format requirements (e.g. if the final document is made available on the internet)?

25. Will spatial data be submitted to BIOS? If so, submission must be in accordance with minimum BIOS and FGDC metadata standards.
(http://bios.dfg.ca.gov/metadata.asp)

(http://www.fgdc.gov/metadata/documents/workbook 0501 bmk.pdf)

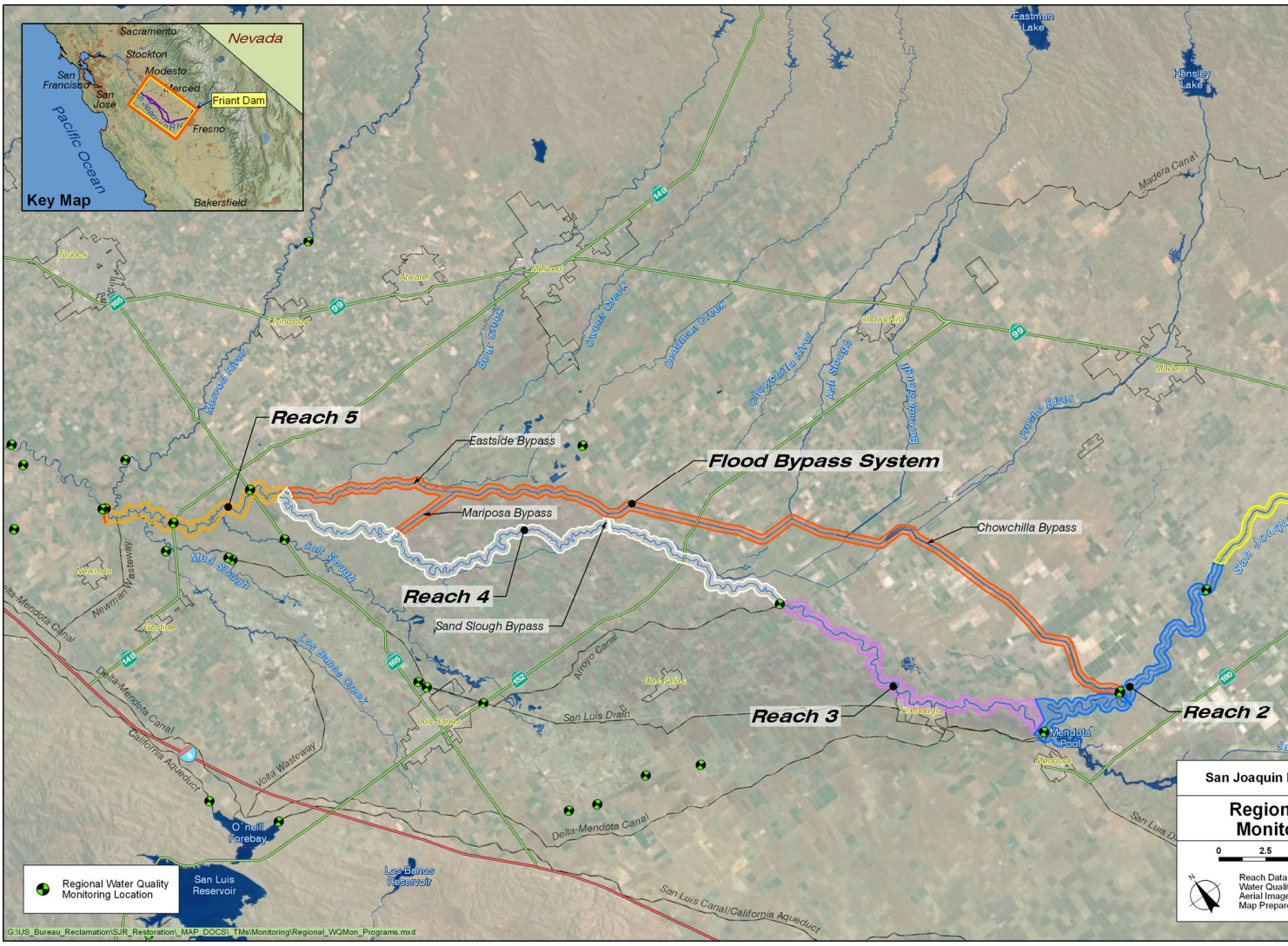
II. Study Measurement and Data Acquisition

A. Sample Site Selection

1. Description of study area and sample sites, with map.

The Settlement specifies the following Interim Flow and Restoration Flow Monitoring locations (modified from Table 4-1; SJRRP 2008):

Location	Station Identifier(s)	Responsible Agency
Friant Dam Release	Millerton Lake (MIL)	Reclamation
Gravelly Ford	San Joaquin River at Gravelly Ford (GRF)	Reclamation
Below Chowchilla Bifurcation Structure	Chowchilla Bypass below Bifurcation Structure (CBP), San Joaquin River below Bifurcation Structure (SJB)	Reclamation
Below Sack Dam	None	DWR
Top of Reach 4B	None	DWR
Merced River Confluence	None	USGS



Map 1. Existing Water Quality Stations in the San Joaquin Region

2. Statistical and scientific rationale for choosing sites (why was a site chosen?).

Many of the existing flow monitoring stations also monitor water quality. Most of the water quality monitoring stations were chosen because they are already established, funded, and with sufficient historical data. To maximize cost-effectiveness, we recommend that monitoring at these stations continues during the Interim Flow period. In any case, these stations are likely to continue operation for a minimum of ten more years (SJRRP 2008). Additional water quality monitoring locations will be established based on habitat features, such as presence of pool habitat or in response to changing conditions of the system.

3. Sample site – parameter matrix (what parameters will be measured at each site).

Water quality monitoring sites and measured parameters (modified from Table 4-3; SJRRP 2008)

Reach	Location	Responsible Agency	Parameters	Frequency	Sampling Method or Remarks
Reach 1	Friant Dam (Millerton)	Reclamation – South Central California Area Office (SCCAO)	EC, Temperature, pH, DO, Turbidity, Chlorophyll	Continuous	Multiple parameter sonde (new)
	San Joaquin River below Friant Dam	Reclamation-SCCAO	EC, Temperature, pH, DO, Turbidity, Chlorophyll	Continuous	Multiple parameter sonde
		Reclamation-Mid-Pacific Region, Environmental Monitoring Branch (MP157)	Selenium (new), CVP Baseline WQ monitoring program; full Title 22 organic and inorganic compounds,	Daily composite Quarterly	Autosampler (new) Grab sampler

			bacterial		
Reach 2	San Joaquin River near Mendota	Reclamation-SCCAO	EC, Temperature, pH, DO, Turbidity, Chlorophyll	Continuous	Multiple parameter sonde
		Reclamation-Mid-Pacific Region, Environmental Monitoring Branch (MP157)	Selenium (new), CVP Baseline WQ monitoring program (new); full Title 22 organic and inorganic compounds and bacterial (new)	Daily composite (new) Quarterly (new)	Autosampler (new) Grab sampler (new)
Reach 3	San Joaquin River below Sack Dam	TBD	EC, Temperature, pH, DO, Turbidity, Chlorophyll	Continuous (new)	Multiple parameter sonde (new)
Reach 4	San Joaquin River at top of Reach 4B	TBD	Conductivity (new), Dissolved oxygen (new), Turbidity (new)	Continuous (new)	Recommended using established site at Fremont Ford
Reach 5	Hills Ferry	Reclamation	EC, Temperature, pH, DO, Turbidity, Chlorophyll (new)	Continuous (new)	Multiple parameter sonde (new)

Sample parameters measured include:

Electrical conductivity (Salinity)

pH

Dissolved oxygen (DO)

Turbidity

Chlorophyll

B. Sampling Procedure (Standard Operating Procedures, SOPs)

Reference: Wagner, R. J., Boulger, R. W., Jr., Oblinger, C. J., and Smith, B. A. 2006. Guidelines and standard procedures for continuous water-quality monitors – Station operation, record computation, and data reporting: U. S. Geological Survey Techniques and Methods 1-D3, 51 p. +8 attachments; accessed April 10, 2006 at http://pubs.water .usgs.gov/tm1d3

1. Parameters to be measured with units defined
    a. Frequency that each parameter will be measured (SOP)
    b. Will replicate samples be taken? (SOP)
2. Methodology (with references) and SOP
    a. Sample preservation, transportation, storage and disposal (SOP)
    b. Preparation of equipment: cleaning, reagents, supplies (SOP)
    c. Sample and data collection (SOP)
    d. Sample and data acceptability (SOP)
3. Personnel training (SOP)
4. Personnel safety (SOP), in both field and laboratory

C. Sample Custody for Field and Laboratory

1. Identify custodians and site for long-term storage (if appropriate)
2. Tracking forms (if appropriate)
3. Sample records (if appropriate)

D. Calibration Procedures and Frequency

1. Instrument and sample calibration (referenced).
2. Frequency and timing of calibration: analytical system, instruments,

devices, etc. (SOP).

3. Documentation of calibration checks.

4. Instrument, equipment and supplies inspection and maintenance, including periodicity.

E. Sample Processing and Analysis

1. Reference standard methods and appropriateness for measurements

2. Describe non-standard methods and validation procedures

3. Describe SOPs

F. Data Reduction, Analysis and Reporting

1. Who will conduct the data reduction (transformation of raw data) and analysis?

2. What quality control procedures will be used to assure the validity of statistical results?

3. Who is responsible for preparing peer-reviewed articles and/or reports?

4. Will the data be archived in a central repository, like BIOS, FISH, etc.?

III. DATA ASSESSMENT AND OVERSIGHT

A. Quality Control Data Checks

1. What procedure will be used for data checks?

2. What criteria will be used to check data?

3. Who will conduct the data checks and how will the results be documented?

B. Field and laboratory performance and systems audit

1. How will the audit be conducted?

2. What criteria will be used?

3. Who will conduct the audit and how will the results be documented?

C. Corrective action

1. If errors are encountered in items A and B above, who will determine and implement corrective action(s)?

IV. DATA VALIDATION AND USABILITY

A. Error checking of raw data (data review)

1. What protocol will be used to check for errors?
2. What criteria will be used?
3. Who will conduct the checking?
4. How will the results be documented?

B. Data limitations

1. Describe the limitations of the data, such as periodicity, seasonality, etc.

V. STUDY FEEDBACK TO MANAGEMENT:

A. Study should contain the following:

1. Periodic review by a designated CDFG science advisory panel or individual; could be part of the reporting milestones at set times.
2. Integration of feedback to study design and methodologies.
3. Study completion and reporting (publication).
4. Presentation to leadership by deadline.

REFERENCES:

Beckon, W. 2007. Selenium Risk to Salmonids with particular reference to the Central Valley of California. Poster presented at the American Fisheries Society 137th 15 Annual Meeting, San Francisco, California. September 2-6, 2007. U. S. Fish and Wildlife Service, Sacramento, California.

FMWG. 2009a. Conceptual models of stressors and limiting factors for San Joaquin River Chinook salmon. 178 pages. June 2009.

FMWG. 2009b. Fisheries management plan: A framework for adaptive management in the San Joaquin River Restoration Program.

Henson, S. S., D. S. Ahearn, R. A. Dahlgren, E. V. Nieuwenhuyse, K. W. Tate and W. E. Fleenor. 2007.
Water quality response to a pulse-flow event on the Mokelumne River, California. River Research and Applications 23:185-200.

McBain, S., and W. Trush. 2002. San Joaquin River restoration study background report. Prepared for Friant Water Users Authority, Lindsay, California and Natural Resources Defense Council, San Francisco, California. Arcata, California. December.

McBain & Trush. 2000. Habitat Restoration Plan for the Lower Tuolumne River Corridor. Prepared for the Tuolumne River Technical Advisory Committee. 240 pages.

Moise, G.W. and B. Hendrickson. 2002. Riparian vegetation of the San Joaquin River. Technical Information Record SJD-02-1. California Department of Water Resources, San Joaquin District. Fresno, California.

Moyle, P. 2002. Inland fishes of California: revised and expanded. University of California Press, Berkeley.

Saiki, M. K., M. R. Jennings, R.H. Wiedmeyer. 1992. Toxicity of agricultural subsurface drainwater from the San-Joaquin Valley, California, to juvenile Chinook salmon and Striped bass. Transactions of the America Fisheries Society 121: 78-93.

SJRRP (San Joaquin River Restoration Program). 2008. Monitoring Plan for Physical Parameters. Draft Technical Memorandum. September 2008.

Wagner, R. J., Boulger, R. W., Jr., Oblinger, C. J., and Smith, B. A. 2006. Guidelines and standard procedures for continuous water-quality monitors – Station operation, record computation, and data reporting: U. S. Geological Survey Techniques and Methods 1-D3, 51 p. +8 attachments; accessed April 10, 2006 at http://pubs.water .usgs.gov/tm1d3

Exhibit d: Guidance for Determining Implementation Objectives

Implementation Objective(s)

Examples: Monitor X for three years to determine success of a management action, survey Population Y for one year to determine current abundance, range, sex ratio, and age class structure, etc. If the study monitors the results of an event or a management strategy, what qualitative or quantitative threshold or degree of change defines a significant change or success? Examples:

- Maintain at least 50 individuals of Species B in the Willow Creek Unit.
- No more than 3 patches of Weed B in the Willow Creek Unit by 2010.
- Do not exceed Cover Class 3 (10 – 30% by visual estimate) by any of the target weed species in more than 2 of the 10 macroplots established in the Willow Creek Unit.

If monitoring involves sampling, how certain do you want to be of your results:

Example:

- Management Objective: Maintain a population of Species A in the Willow Creek Preserve with at least 100 individuals from 2009 ─ 2012.
- Sampling Objective: Be 95% confident that estimates are within ± 10% of the true value.

Examples of objectives adapted from Elzinga, C.L.;Salzer, D.W. and J.W. Willoughby. 1998. Measuring and Monitoring Plant Populations. U.S. Department of the Interior. Bureau of Land Management. Report #BLM/RS/ST-98/005+1730; BLM Technical Reference # 1730-1.

Appendix L. Water Temperature

Study Title: SJR Water Temperature Monitoring Study

Region or Division and Branch: Region 4 Central Region

Principal Investigator(s): Eric Guzman, Gerald Hatler

Contact Info. Of Principal Investigator(s): Eric Guzman, Environmental Scientist, DFG, Gerald Hatler, Senior ES Supervisor, DFG

Proposed Staff: Matt Bigelow, Margarita Gordus, Kevin Gipson, Laura Satterlee, Brook Bullock, Stephanie Houk, Sarah McCulloch, Haley Boehme, Dale Stanton, Dave Mooney,

County(ies) affected by Study: Fresno, Madera, Merced, Stanislaus

VII. Study Management

L. Study Description

1. History or Background

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 lawsuit, known as *NRDC et al. v. Kirk Rodgers et al.*, reached a Stipulation of Settlement (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's primary goals is 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.

In response to the Settlement, 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 and associated Work Groups to begin work implementing the Settlement. For additional information related to the Implementing Agency approach, the reader is referred to the Program Management Plan available on the San Joaquin River Restoration Program (SJRRP) Website, www.restoresjr.net. Related to the Settlement, President Obama signed the San Joaquin River Restoration Act (Act) on March 30, 2009, giving the Department of Interior full authority to implement the SJRRP. The SJRRP will implement the Settlement and Act.

This study workplan was developed by the multiagency Fisheries Management Work Group (FMWG) and describes the fish passage monitoring program.

u. General project background discussion.

Water temperature may be a key limiting factor for successful upstream migration, reproductive viability of adult fish and successful rearing and survival of juveniles and outmigrating smolts in the Restoration Area, especially in the driest years.

Egg maturation and survival to hatch are critical periods in the Chinook salmon life-history cycle. Water temperature may be a limiting factor for successful spawning and incubation and survival of juveniles and smolts,. Furthermore, water temperatures in sections of the Restoration Area may present thermal barriers to successful fish migrations resulting in stranding and increased mortality. The maintenance of suitable water temperatures to successfully meet the Restoration Goal will require consideration of the appropriate timing and duration of temperatures as well as determining the appropriate spatial extent of those temperatures. All life stages of Chinook salmon would be affected by this limiting factor.

v. Describe the evolution of the study.

Thermal conditions in migration, rearing, and spawning habitats along with potential factors that influence temperature are not well understood in the Restoration Area. The Fisheries Management Plan (FMP) identifies a number of potential actions including implementing settlement flow schedule, implementing hydrograph flexibility, buffer flows, use of additional purchased water, filling and isolating the highest priority mining pits, and modifying Friant and Madera canals to provide suitable water temperature releases from Friant Dam. These actions are intended assist the SJRRP in providing suitable water temperatures for upstream passage, spawning, egg incubation, rearing, and outmigrating smolts to the extent achievable considering hydrologic, climatic, and physical channel characteristics

Data collection and monitoring activities are intended to support studies and data needs consistent with the San Joaquin River Restoration Program (SJRRP) Fisheries Management Plan and Program recommendations. Long-term monitoring is expected to focus upon enabling informed decision making for making recommendations to improve and/or offset adverse impacts as they may be determined by interim flow period monitoring and subsequent measurements of Program success.

w. Why is the study necessary?

Temperature monitoring data will be used to validate draft conceptual models of stressors and limiting factors for Chinook salmon and will be prepared for inclusion into the EDT (Ecosystem, Diagnosis, and Treatment) model and potentially other models. The EDT model and other models will help distinguish between temperature exceedences that occur naturally and those that occur due to various human activities and will be capable of simulating the outcomes of alternative operations and discharge temperatures. Analysis of temperature monitoring will be used to evaluate the relative importance of the various factors that combine to produce the observed stream temperatures, and to evaluate what impact changes in stream shade, channel geometry morphology, flow, may have on the stream temperature regime.

Temperature monitoring evaluation will assist the SJRRP in developing TMDL standards and assist in making recommendations on specific actions relating to adaptive management of the SJRRP

x. Identify and analyze any previous similar studies.

Several monitoring sites on the San Joaquin River were established prior to 2005 (Figure 2). DFG currently has monitoring sites located upstream and downstream of tributary confluences, major inflows, diversions, and locations where thermal influences may occur. All current and previous water temperature monitoring sites that will provide data for the temperature study are listed in Table 1. The California Data Exchange Center (CDEC) has monitoring sites on the San Joaquin River that may also be utilized. DFG is currently conducting similar temperature monitoring studies on the SJR Tributaries.

2. Site Description

Following is a brief description of the Restoration Area, including San Joaquin River and bypass characteristics. For additional detail, the reader is referred to FMWG (2009b), or the SJRRP PEIS/R.

a. Location of the study (include maps, geographic data, etc.).

This study is located in the San Joaquin River Restoration Program (SJRRP) Restoration Area. The Restoration Area is approximately 153 miles long, extending from Friant Dam at the upstream end near the town of Friant, downstream to the confluence of the Merced River, and includes an extensive flood control bypass system (Figure 1). Five river reaches have been defined to address the different river characteristics throughout each reach. For more information regarding the Restoration Area, see FMWG (2009b), and the SJRRP PEIS/R.

b. Describe the environmental setting for the study.

Reach 1 begins at Friant Dam and continues approximately 37 miles downstream to Gravelly Ford. This reach conveys continuous flows through an incised, gravel-bedded channel. Reach 1 typically has a moderate slope, and is confined by periodic bluffs and terraces. The reach is divided into two subreaches: 1A and 1B. Reach 1A, which extends down to State Route (SR) 99, has the most gravel, and supports continuous riparian vegetation except where the channel has been disrupted by gravel mining and other development. Invasive woody species are common in Reach 1A (Moise and Hendrickson 2002). Reach 1B continues from SR 99 to Gravelly Ford where it is more narrowly confined by levees. Woody riparian species occur mainly in narrow strips immediately adjacent to the river channel in Reach 1B. Reach 1 has been extensively mined for instream gravel and is sediment limited. Gravel mining and agriculture are the primary land uses in Reach 1B.

Reach 2 starts at Gravelly Ford, extends downstream to Mendota Dam, and is a meandering, low-gradient channel. Reach 2 is characterized by seasonal drying of the

channel in the summer and fall. In most years, the Reach 2 channel is dry except under flood release conditions from Gravelly Ford to Mendota Dam. Mendota Pool is formed by the Mendota Dam at the confluence of the San Joaquin River and Fresno Slough. The primary source of water to the Mendota Pool is conveyed from the Delta through the Delta-Mendota Canal (DMC).

Reach 2 is subdivided at the Chowchilla Bypass Bifurcation Structure into two subreaches, Reach 2A and Reach 2B, which have confining levees protecting adjacent agricultural land. Reach 2A and Reach 2B are intermittent and sand-bedded. Reach 2A is subject to extensive seepage losses and accumulates sand due to backwater effects of the Chowchilla Bypass Bifurcation Structure and the low gradient of the reach. Riparian vegetation in Reach 2A is sparse or absent due to the usually dry conditions of the river and groundwater overdrafting (McBain and Trush 2002). Reach 2A vegetation has abundant grassland/pasture and large stands of nonnative plants (Moise and Hendrickson 2002). Reach 2B has a sandy channel with limited conveyance capacity and a thin strip of riparian vegetation, primarily native species, which borders the channel. A portion of Reach 2B is perennial because of the backwater of Mendota Pool.

Reach 3 extends from Mendota Dam at the upstream end to Sack Dam at the downstream end and receives continuous flows from the DMC. At Sack Dam, flow releases are diverted into the Arroyo Canal. The river is confined by local dikes and canals on both banks. The sandy channel meanders through a predominantly agricultural area, except where the City of Firebaugh borders the river's west bank. The river at this location has a low stage but is perennial and supports a narrow riparian corridor along the edge of the river channel.

Reach 4, located between Sack Dam and the confluence with Bear Creek and the Eastside Bypass, is sand-bedded and usually dewatered because of the diversion at Sack Dam. The upstream portion of Reach 4 is bounded by canals and local dikes down to the confluence with the Mariposa Bypass at the San Luis National Wildlife Refuge. Levees that begin at the Mariposa Bypass continue downstream on both banks (McBain and Trush 2002). Reach 4 is subdivided into three distinct subreaches: 4A, 4B1, and 4B2.

Reach 4A, from Sack Dam to the Sand Slough Control Structure, is confined within a narrow channel. This subreach is dry in most months with negligible flows that are diverted at Sack Dam. The floodplain of Reach 4A is broad, with levees set back from the active channel. The subreach is sparsely vegetated, with a thin and discontinuous band of vegetation along the channel margin. This subreach has the fewest functioning stream habitat types and the lowest ratio of natural vegetation per river mile in the Restoration Area.

Reach 4B1 extends from the Sand Slough Control Structure to the confluence with the Mariposa Bypass. Reach 4B1 has been dry, for the most part, for more than 40 years. The only exception occurs when the channel receives varying amounts of agricultural-return flows. Water reaching the Sand Slough Control Structure is

diverted to the bypass system via the Sand Slough Bypass. As a result, the Reach 4B1 channel is poorly defined with dense vegetation and other fill material. The riparian corridor upstream of the Mariposa Bypass is narrow, but nearly unbroken.

Reach 4B2 begins at the confluence of the Mariposa Bypass, where flood flows in the bypass system rejoin the mainstem of the San Joaquin River, and extend to the confluence of the Eastside Bypass. Reach 4B2 contains wider floodplains than upstream reaches and vast areas of natural vegetation.

Reach 5 extends from the confluence of the Eastside Bypass downstream to the Merced River confluence. Reach 5 is perennial because it receives varying amounts of agricultural return flows from Mud and Salt sloughs. Reach 5 is more sinuous than other reaches and contains oxbows, side channels, and remnant channels (McBain and Trush 2002). Reach 5 is bounded on the west by levees downstream to the Salt Slough confluence and on the right bank to the Merced River confluence. Reach 5 has a broad floodplain; however, levees generally dissociate the floodplain from the mainstem San Joaquin River (McBain and Trush 2002). Less agricultural land conversion has occurred in Reach 5, with a majority of the land held in public ownership and managed for wildlife habitat.

The natural habitat surrounding Reach 5 includes large expanses of grassland with woody riparian vegetation in the floodplain. Remnant riparian tree groves are concentrated on the margins of mostly dry secondary channels and depressions or in remnant oxbows. The mainstem has a patchy riparian canopy (McBain and Trush 2002).

The bypass system consists of a series of dams, bifurcation structures, bypasses, levees, and portions of the main river channel. The bypass system is managed to maintain flood-conveyance capacity. Descriptions of primary components of the bypass system follow.

Fresno Slough, also known as James Bypass, conveys flood flows regulated by Pine Flat Dam from the Kings River system in the Tulare Basin to Mendota Pool.

The Chowchilla Bifurcation Structure, at the head of Reach 2B, regulates the flow split between the San Joaquin River and the Chowchilla Bypass. The Chowchilla Bypass extends to the confluence of Ash Slough, and is approximately 22 miles long, leveed, and 600 to 700 feet wide. Sand deposits are dredged from the bypass, as needed, and vegetation is periodically removed from the channel.

The Eastside Bypass extends from the confluence of Ash Slough and Chowchilla Bypass to the confluence with the San Joaquin River at the head of Reach 5 and is subdivided into three reaches. Eastside Bypass Reach 1 extends from Ash Slough to the Sand Slough Bypass confluence and receives flows from the Chowchilla River. Eastside Bypass Reach 2 extends from Sand Slough Bypass to the head of the Mariposa Bypass. Eastside Bypass Reach 3 extends from the head of the Mariposa

Bypass to the head of Reach 5 and receives flows from Deadman, Owens, and Bear creeks.

The lower 10 miles of the Eastside Bypass are similar to the Chowchilla Bypass. Upland vegetation at the Eastside Bypass consists of grassland and ruderal vegetation. In the Grasslands Wildlife Management Area, riparian trees and shrubs have a patchy distribution along the banks of the Eastside Bypass. The lower Eastside Bypass has some side channels and sloughs that support remnant patches of riparian vegetation.

2. Study purpose

d. Statement of study goals.

The purpose of the temperature study is to collect sufficient data to develop and implement a systematic water temperature monitoring scheme capable of fully describing the water temperature conditions likely to be experienced by all life stages of spring- and fall-run Chinook salmon in the San Joaquin River Restoration Area (Restoration Area).

e. List the objectives of the study

1. Collect reliable water temperature data in both reservoir and stream environments at time and space intervals that sufficiently document thermal response of upper SJR basin water operations in conjunction with local meteorological conditions.
2. Develop and calibrate a model capable of simulating the water temperatures in Millerton reservoir and river reaches of the upper San Joaquin River basin in response to water management operations.
3. Evaluate how various flows released from Millerton Reservoir impact water temperatures in the SJR.
4. Investigate yet to be defined water management alternatives for improving habitat for Chinook salmon and steelhead by decreasing water temperatures.
5. Identify warm water sources that potentially increase water temperature and develop methods to ameliorate impacts.
6. Evaluate the ability of restoration flows to protect and provide habitat for all life stages of Chinook salmon

f. Describe study milestones. Identify products and timelines.

A full array of temperature sensors will be deployed before the interim flows commence in October 2009. Program Interim flows period occurs October 1 – November 20, 2009 and February 1 – December 1 2010. Subsequent monitoring will take place for the life of project. Data collected will be incorporated into an annual Program monitoring report.

3. Study Approach (describe conceptual approach to study and include uncertainties).

Monitoring sites will be expanded to augment existing monitoring as needed. Data loggers will be placed at predetermined intervals to best illustrate the temperature regime of the SJR. Loggers will also be placed in areas that may provide an evaluation of potential warm-water sources such as backwater areas, side channels, gravel pits associated with mining, wide/shallow areas, and areas lacking riparian shading, tributaries, and Friant Dam operations. Loggers will also be arrayed so that potentially suitable holding habitats, rearing habitats, spawning habitats, and migration pathways may be evaluated. In addition, Millerton Reservoir temperature profiles and meterological data on the SJR will be collected.

As water and air temperature data collection progresses, and modeling commences, the need for additional temperature loggers and/or weather stations, or re-deployment of existing temperature loggers and/or weather stations may be required.

There are several proposed locations that the SJRRP is interested in monitoring, however these location are located on private property, therefore access is not available at this time. The SJRRP is current pursuing obtaining TEP (Temporary Entry Permits) from private land owners. The Program will deploy new loggers and monitor the proposed locations once access becomes available.

4. What are the management or policy implications of the study?

DFG is currently managing for fall-run Chinook salmon in the Tributaries. Data collected in this study may be used to evaluate conditions and make management decisions for the fall-run Chinook population. Implementation of this temperature study will not result in implications of any DFG management or policies.

M. Study Organization and Responsibilities

a. Person(s) responsible (names, title, phone numbers, addresses, e-mail) and role.

DFG will be responsible for study organization, data collection and data management. Eric Guzman (Environmental Scientist, DFG) will be the lead for the Department under the supervision of Gerald Hatler (Senior Environmental Scientist, DFG).

Eric Guzman
Environmental Scientist
1234 E. Shaw Avenue
Fresno, CA 93710
(559) 243-4014, ext. 260
(559) 417-7494 Mobile
(559) 243-3004 Fax

eguzman@dfg.ca.gov

Gerald Hatler
Senior Environmental Scientist
1234 E. Shaw Avenue
Fresno, CA 93710
(559) 243-4014, ext. 259
(559) 341-1814 Mobile
(559) 243-3004 Fax
ghatler@dfg.ca.gov

2. Chain of command (if appropriate).

3. Collaborators (agencies, NGOs, academia, etc.) and contact persons:

Is an MOU and/or contract already established with the collaborator(s)?

Agency collaborators:

U.S. Fish and Wildlife Service (Jeff McLain, Michelle Workman)
Department of Water Resources (Kevin Faulkenberry, Abimael Leon-Cardona),
National Marine Fisheries Service (Rhonda Reed, Erin Strange)
Bureau of Reclamation (Doug DeFlitch, Dave Mooney)

4. Are there considerations protecting the Department's public trust and stewardship obligations that are kept in trust for the public now and in the future? These may include but are not limited to: The Department has the ownership and control rights for all of the products including data, metadata, images, video, research protocols, analyses, etc.; attribution, acknowledgement, and proper representation of the Department's scientific and coordination role; the Department should hold first American print rights.

C. Study Design

3. List the specific *research questions* (state them clearly as a null or positive hypothesis) to be answered by this study, including methodology:

H1: Are instream temperatures adequate to support all life-history needs for spring and fall-run Chinook salmon through the entire restoration area?

H2: How are instream temperatures affected by tributary flows, agricultural returns, etc.?

H3: What are the existing conditions for riparian vegetation impacts and river geomorphology upon instream temperature in the project area?

H4: What are the existing conditions for suitable holding pools and spawning habitat to support over-summering spring-run Chinook salmon?

H5: What are the existing conditions for suitable rearing habitat to support juvenile and outmigrating spring and fall-run Chinook salmon?

H6: What influence do instream and off-stream pools and mining pits have on increasing stream temperatures?

k. If the study includes sampling, describe the sampling design and measurement variables. Be specific: describe the sampling unit, independent variables, dependent variables, and tests or techniques to be used. Explain how bias will be avoided in selection of sampling units. For hypothesis tests, state the null hypothesis and alternative hypotheses.

Not applicable

l. Describe the experimental design and necessary sample sizes. For manipulative experiments, describe the table of treatments and number of replicates, and how experimental units will be grouped or blocked.

Not applicable

m. Describe biological detection capability. For field observational studies, describe the variation in measurement variables necessary to detect. (Historical data often can be used to predict the kind and quantity of data that will be required to achieve a stated resolution, or to estimate the resolution of a stated study design. If historical data pertinent to this question are available, apply power analyses).

Not applicable

n. Using feedback in ongoing studies, is an augmentation or reduction of previous sampling effort appropriate (i.e. can the data be collected with less field effort and still achieve the same level of significance)? After data become available, estimate the power of the existing sampling effort.

Not applicable

o. Describe the contingency plans to assure the question is resolved: (Depending on the question being addressed, such plans may include (a) planned routine collection of more than the minimum data required at each regular interval, (b) logistical contingency plans to make up for missed field observations, or repeat incomplete manipulative experiments, or (c) alternate statistical methods if not all data are obtained. Use of alternate statistical methods will likely weaken the

power of the study to answer the question or force redefinition of the question, and should be a last resort.

Not applicable

2. How will sampling bias(es) from different samplers or methods (e.g. training, standardized protocols) be minimized?

Not applicable

V. Study Resource Needs

1. Detailed budget
2. Personnel needs
   a. Field activities
   b. Laboratory and office activities
   c. Travel (in-state and out-of-state)
   d. Temporary help (estimated number of hours)
3. Equipment needs
   a. Boats/vehicles/major sampling equipment – what is necessary and for what period?
   b. What major equipment (>$1000) is necessary (purchased, borrowed, or leased)?
4. Coordination needs
   a. If another study or agency is participating in collection of samples, is coordination plan, including funding, in place?
5. Has access to study site(s) been arranged?

A detailed budget providing personnel, equipment, and coordination needs is listed in Table 2.

W. Compliance Considerations

17. Will study result in, or have the possibility of, take of federally- or state-listed threatened, endangered or species of special concern?

The study will not result in, or have the possibility of, take of federally- or state-listed threatened, endangered, fully protected, or species of concern.

18. If so, estimate the number by species/race that will be taken and the estimated mortality.

19. Will the "take" or capture of any state- or federally-listed species be covered by an existing Biological Opinion?

No take is anticipated

20. If no BO exists, how will compliance be achieved?

Not applicable

X. Invasive Species: What measures will be taken to ensure field staff does not spread invasive plants or animals to new sites during the study?

All gear, including sampling equipment, boats and trailers, waders, etc., will be thoroughly inspected and cleaned after sampling each day. The entire study will take place within the SJR basin, therefore the risk of spreading invasive plants or animals to new sites or introducing invasive species to the SJR watershed is low.

Y. Due Dates and Products

26. Describe the timeline for the study, with due dates for deliverables, including drafts (this should relate to section I.A.2.c).

A Program Monitoring Report will be required annually. This temperature monitoring study will take place for the life of the project. For a detailed project schedule see Table 3

27. Will any new databases be created for or added to for this study?

DFG has created an ACCESS data base that will be used to manage temperature data in the Restoration Area.

28. If data is to be uploaded to a centralized data server, by what date?

Are we going to have a centralized data server?

29. If product includes a report, does it need to meet Americans with Disability Act format requirements (e.g. if the final document is made available on the internet)?

30. Will spatial data be submitted to BIOS? If so, submission must be in accordance with minimum BIOS and FGDC metadata standards.

No spatial data will be submitted to BIOS.

II. Study Measurement and Data Acquisition

A. Sample Site Selection

1. Description of study area and sample sites, with map.

2. Statistical and scientific rationale for choosing sites (why was a site chosen?).

3. Sample site – parameter matrix (what parameters will be measured at each site).

Figure 2 is a map that indicates sensor locations, river temperature, reservoir profiles, weather station sites, and other program monitoring sites. Also indicated, are monitoring sites maintained by CDFG that have provided data for the EDT model. New sites have been added based upon input from the SJRRP Technical Advisory Committee (TAC) and the FMWG.

Data loggers will be placed at predetermined intervals to best illustrate the temperature regime of the SJR. Data loggers should be at locations that are concealed with sufficient depth and have good flow and a stout anchor (large boulder, tree or manmade structure). Loggers will be placed in areas that may provide an evaluation of potential warm-water sources such as backwater areas, side channels, gravel pits associated with mining, wide/shallow areas, areas lacking riparian shading, tributaries, and Friant Dam operations. Loggers will be arrayed so that potentially suitable holding, rearing, and spawning habitats may be evaluated. The locations will be selected to maximize ease of access and to minimize the potential for vandalism. Where possible, placement will be made within the thalweg of the stream, or in an area of the stream where there is adequate, year round flow and water coverage to avoid measurement bias from the warmer stream edges and from thermal stratification. Data loggers will be used to record air temperature at one location per reach.

B. Sampling Procedure (Standard Operating Procedures, SOPs)

1. Parameters to be measured with units defined

   a. Frequency that each parameter will be measured (SOP)

   b. Will replicate samples be taken? (SOP)

All data loggers will be programmed to record temperatures hourly on a continuous, year round, basis. Thermographs will be downloaded monthly when staffing and stream flow conditions permit but should not be less frequent than once every two months. A monthly check of each site will provide a timely opportunity to replace any missing or damaged thermographs due to vandalism, or to take corrective actions such as removing the thermograph from the sand if buried, returning the thermograph to the water if found on shore, or replacement of thermographs not working properly (i.e. battery dead or erroneous data). As water and air temperature data collection

progresses, and modeling commences, the need for additional weather stations, or re-deployment of existing stations may be required.

2. Methodology (with references) and SOP

   a. Sample preservation, transportation, storage and disposal (SOP)

   b. Preparation of equipment: cleaning, reagents, supplies (SOP)

   c. Sample and data collection (SOP)

   d. Sample and data acceptability (SOP)

Each data logger will be enclosed in a submersible case to prevent damage and anchored with stainless steel cable. Field data will be recorded at each logger location. Each site will be described in detail including: directions to the site from relatively permanent landmarks, method of access to the site, the GPS location, flow, channel width and depth, wetted width, bank full, riparian shading, substrate size category, channel morphology, a site map, photographs of the site, date, and time of the actual placement. An identification number will be assigned to each site logger. All data is downloaded into a HOBO waterproof shuttle and uploaded later into a field computer.

Variation for field sampling will be addressed with a field check of the instruments with a hand held thermometer at all thermograph sites upon deployment and retrieval.

Field auditing (e.g., data quality assurance and control) is done at each site visit. Field crews collecting the data take a water temperature reading at each sampling station using a thermometer. The thermometer should be placed in the stream near the thermograph. The water temperature and time is recorded in a field notebook and is used as a cross reference check for auditing the data. Comments are also recorded in the field and are used to help determine the validity of the data (i.e. thermograph out of the water or buried in sand) and or possibly a malfunctioning thermograph. If the latter is suspected, a second thermograph may be placed to cross reference the data, or the thermograph can be retrieved and recalibrated to find its accuracy using the same procedure.

Temperature loggers deployed in pools will require an ABS pipe housing drilled with ¼" holes to allow water to flow through freely. A threaded coupler will be used on one end with a galvanized steel plug that will function as a weight and allowed access to the sensor. The opposite end will be closed with an ABS cap. Loggers may be spaced on temperature profiling strings to continuously monitor temperature stratification

Data loggers recording air temperature will be attached to streamside vegetation. Locations for air temperature monitoring will be chosen where direct solar radiation is avoided, but where the units will be able to record air temperature.

Methods for deployment of temperature loggers in mining pits are described in the BOR guidelines. (Appendix A)

Methods for implementation procedures of the Millerton Reservoir temperature monitoring study are described in the Millerton Reservoir Temperature Monitoring Guidelines (BOR). (Appendix B)

3. Personnel training (SOP)

Personnel will be trained by experienced DFG staff.

4. Personnel safety (SOP), in both field and laboratory

The SJR project requires frequent site visits for monitoring and data collection. Site visits can include hiking, wading, boating, and driving. Field crews are subjected to various environmental conditions (e.g. changing stream flows and inclement weather) that require good judgment when determining where, when, and how to place monitoring equipment and collect data. Several actions have been taken to improve field crew safety awareness and include:

- Two or more members per field crew
- Monthly field safety meetings
- Cell phones are provided for field crews
- American Red Cross First Aide/CPR training course conducted by the CDFG
- Defensive driver training conducted by the CDFG
- Boater Safety Education course offered by the California Department of Boating and Waterways
- Informal field water craft training done by CDFG experienced water craft operators.
- Swift Water Rescue training

C. Sample Custody for Field and Laboratory

1. Identify custodians and site for long-term storage (if appropriate)
2. Tracking forms (if appropriate)
3. Sample records (if appropriate)

DFG will be responsible for data collection and management.

D. Calibration Procedures and Frequency

1. Instrument and sample calibration (referenced).
2. Frequency and timing of calibration: analytical system, instruments, devices, etc. (SOP).
3. Documentation of calibration checks.

4. Instrument, equipment and supplies inspection and maintenance, including periodicity.

HOBO U22 Water Temp Pro v2 from Onset are the data loggers being used by the CDFG for this project. The thermographs are calibrated using the Calibration and Standardization Procedure (need reference) adopted and modified from Lewis et al. 2000. This procedure tests each thermograph logger at room air temperature, room temperature water and cold water temperature against a National Institute of Standards and Technology (NIST) thermometer for precision and accuracy. All thermographs are calibrated before deployment using this procedure unless the manufacturer sends a certification of accuracy for each unit (Onset's Hobo Temp Pro); however, 10% of these certified units are being double-checked for calibration accuracy prior to deployment.

E. Sample Processing and Analysis

1. Reference standard methods and appropriateness for measurements
2. Describe non-standard methods and validation procedures
3. Describe SOPs

F. Data Reduction, Analysis and Reporting

1. Who will conduct the data reduction (transformation of raw data) and analysis?
2. What quality control procedures will be used to assure the validity of statistical results?
3. Who is responsible for preparing peer-reviewed articles and/or reports?
4. Will the data be archived in a central repository, like BIOS, FISH, etc.?

DFG will conduct the data reduction and analysis and the FMWG will be responsible for the preparation of program monitoring reports.

III. DATA ASSESSMENT AND OVERSIGHT

A. Quality Control Data Checks

1. What procedure will be used for data checks?
2. What criteria will be used to check data?
3. Who will conduct the data checks and how will the results be documented?

B. Field and laboratory performance and systems audit

1. How will the audit be conducted?

2. What criteria will be used?

3. Who will conduct the audit and how will the results be documented?

C. Corrective action

1. If errors are encountered in items A and B above, who will determine and implement corrective action(s)?

An important aspect of data collection and reporting is to ensure data integrity and validity. The structure of the local database and the characteristics of Microsoft Access usually enforce the integrity of the data. However, it is the responsibility of the CDFG staff to ensure valid data. To aid the staff in this task, the database is equipped with a QA/QC Utility to detect questionable data. The QA/QC Utility is designed to flag any data points that have a value in excess of a certain tolerance when compared with adjacent points. To minimize the possibility that erroneous data will migrate to other applications, the database will not allow the user to generate any reports or graphs until a QA/QC check is performed and all the data points tagged with QA/QC codes are cleared.

The QA/QC Utility enables the user to see what data has been tagged and provides the user with an editor to clear the data. The data are also graphed and visually inspected. Data that appear to be erroneous are either modified (accepted) or nullified (deleted). These edits are done in a second data column. The original data is always retained for review. Professional judgment is required to determine whether or not to accept (for example, by interpolating with other points) or to nullify the data. This decision is made on a case by case basis by the CDFG staff in concert with the modeling team who assesses the original and modified data.

Once processed, the data can be used for temperature model application purposes as well as to generate graphs and reports. An updated copy of the database is periodically sent to ICF Jones & Stokes Consultants for immediate use with the EDT Model. Updates are also exported to CDEC for inclusion in the global database.

Temperature monitoring data will be used to validate draft conceptual models of stressors and limiting factors for Chinook salmon and will be prepared for inclusion into the EDT (Ecosystem, Diagnosis, and Treatment) model and potentially other models. The EDT model and other models will help distinguish between temperature exceedences that occur naturally and those that occur due to various human activities and will be capable of simulating the outcomes of alternative operations and discharge temperatures. Analysis of temperature monitoring will be used to evaluate the relative importance of the various factors that combine to produce the observed stream temperatures, and to evaluate what impact changes in stream shade, channel geometry morphology, flow, may have on the stream temperature regime. Temperature monitoring evaluation will assist the SJRRP in developing TMDL standards and assist in making recommendations on specific actions relating to adaptive management of the SJRRP

IV. DATA VALIDATION AND USABILITY

A. Error checking of raw data (data review)

1. What protocol will be used to check for errors?
2. What criteria will be used?
3. Who will conduct the checking?
4. How will the results be documented?

DFG will delegate qualified staff to conduct error checking of raw data.

B. Data limitations

1. Describe the limitations of the data, such as periodicity, seasonality, etc.

V. STUDY FEEDBACK TO MANAGEMENT:

A. Study should contain the following:

1. Periodic review by a designated CDFG science advisory panel or individual; could be part of the reporting milestones at set times.
2. Integration of feedback to study design and methodologies.
3. Study completion and reporting (publication).
4. Presentation to leadership by deadline.

REFERENCES:

BOR (Bureau of Reclamation) Millerton Reservoir Temperature Monitoring Guidelines (need reference)

DFG (Department of Fish and Game). 2006. Lower San Joaquin River Basin-Wide Water Temperature Modeling Project Data Collection Protocol. 29 pages

FMWG. 2009a. Conceptual models of stressors and limiting factors for San Joaquin River Chinook salmon. 178 pages. June 2009.

FMWG. 2009b. Fisheries management plan: A framework for adaptive management in the San Joaquin River Restoration Program.

Exhibit e: Guidance for Determining Implementation Objectives

Implementation Objective(s)

Examples: Monitor X for three years to determine success of a management action, survey Population Y for one year to determine current abundance, range, sex ratio, and age class structure, etc. If the study monitors the results of an event or a management strategy, what qualitative or quantitative threshold or degree of change defines a significant change or success? Examples:

- Maintain at least 50 individuals of Species B in the Willow Creek Unit.
- No more than 3 patches of Weed B in the Willow Creek Unit by 2010.
- Do not exceed Cover Class 3 (10 – 30% by visual estimate) by any of the target weed species in more than 2 of the 10 macroplots established in the Willow Creek Unit.

If monitoring involves sampling, how certain do you want to be of your results:

Example:

- Management Objective: Maintain a population of Species A in the Willow Creek Preserve with at least 100 individuals from 2009 ─ 2012.
- Sampling Objective: Be 95% confident that estimates are within ± 10% of the true value.

Examples of objectives adapted from Elzinga, C.L.;Salzer, D.W. and J.W. Willoughby. 1998. Measuring and Monitoring Plant Populations. U.S. Department of the Interior. Bureau of Land Management. Report #BLM/RS/ST-98/005+1730; BLM Technical Reference # 1730-1.