Executive Summary

Evaluating the Success of Spawning Habitat Enhancement on the Merced River, Robinson Reach

Large-scale river restoration projects are presently underway in California on three different rivers, the Merced and Tuolumne Rivers in the San Joaquin River drainage, and Clear Creek in the upper Sacramento River drainage. These projects, funded in large part by CALFED, are to restore channel and floodplain function under the present constraints of encroachment and flow regulation, and to increase populations of endangered and threatened fish, specifically Chinook salmon, by increasing spawning and rearing habitats. To assess the use of new spawning habitat constructed as part of the Merced River Salmon Habitat Enhancement Project (MRSHEP), a three-year monitoring plan is proposed. We will determine the location and number of redds in the Robinson Reach and to assess the quality of spawning habitat based on level of use within the Robinson Reach. Four different variants of design were distributed among twelve riffles built on the Robinson Reach and this study will help elucidate those constructed features of a riffle that increases the number of redds that are excavated within a newly constructed spawning riffle.

This study will create a knowledge base and will contribute to the improvement of designs for future phases of MRSHEP and the results from this study could be applied to salmon restoration projects in other rivers of similar size and fluvial character. As such, this study is part of the MRSHEP's adaptive management strategy to evaluate results and to revise or reinforce current methods used to restore Chinook salmon spawning habitat

Evaluating the Success of Spawning Habitat Enhancement on the Merced River, Robinson Reach

A. Project Description: Project Goals and Scope of Work

1. Problem

Large-scale river restoration projects are presently underway in California on three different rivers, the Merced and Tuolumne Rivers in the San Joaquin River drainage, and Clear Creek in the upper Sacramento River drainage. These projects generally require movement and redesign of the rivers' channel and meander as well as extensive grading to restore floodplain. One of the universal goals of these projects is to restore channel and floodplain function under the present constraints of encroachment and flow regulation. The driving force of this goal is to increase populations of endangered and threatened fish, specifically Chinook salmon, by increasing spawning and rearing habitats. To this end, all these projects include the addition of riffles with appropriately sized gravel and hydraulic conditions for spawning by Chinook salmon.

The addition of spawning riffles in these projects involves choosing and grading gravel for its suitability as spawning substrate, as well as for its ability to be transported downstream at certain design flows. The riffles are shaped and sloped to achieve the depths and velocities recommended by USFWS (US Fish and Wildlife Service 1982, 1986, and 1997; as cited in California Department of Water Resources 2001), but are otherwise devoid of features on the channel bottom.

While it is expected that geomorphic processes will create various features on the channel bottom after mobilizing flows, these flows may not take place right after construction. With the possibility of low rainfall years or even extended droughts, mobilizing flows may not take place for many years, and for that period whatever features are placed in spawning riffles during construction will remain. Given that during this time salmonid populations would be under the greatest environmental stress, it would be advantageous to design riffles that contain those features that salmon prefer to spawn in. Unfortunately, while there is a great deal of anecdotal information that suggests heterogeneity at the riffle scale improves spawning habitat, there is little data on design parameters that can be given to design engineers involved in river restoration or enhancement. To begin to address this problem, it is important that project designers experiment with design features that increase heterogeneity, that do not interfere with geomorphic function that is integral to sustaining and maintenance of habitat quality, and fit within regulatory constraint. It is also important that the quality of spawning habitat being created by these projects is assessed and results compared to begin to determine where methods of restoration can be improved. The proposed study will begin to address this problem.

When the Robinson Reach was restored, there were twelve riffles in three different gradients created. In an attempt to add to the heterogeneity, humps were added to simulate the sort of topography where fish have been observed spawning on other

riffles (Carl Mesick, personal communication). Hump design is simplistic, easily implemented, and intended as an experiment.

The goal of this study is to assess the use of spawning habitat within the Robinson Reach of the Merced River Salmon Habitat Enhancement Project (MRSHEP). The objectives are to determine the location and number of redds in the Robinson Reach and to assess the quality of spawning habitat based on level of use. The study is designed to assess and determine the following:

- location and number of redds in the Robinson Reach
- suitability of spawning habitat based on level of use
- features of a riffle that increases the number of redds that are excavated within a newly constructed spawning riffle

This study will create a knowledge base that can be used to improve the design features of future phases of MRSHEP and that can be applied to other restoration efforts on rivers of similar scale and fluvial character. The scope of this study is limited to determining the utilization of created riffles by spawning adults within the restored project area as compared to unaltered adjacent areas. It will not address long term or river wide population changes and causes, though information gathered in this study could add some understanding to the causes of these changes.

This study is also to be integrated into a larger and long term monitoring program on MRSHEP and the whole Merced River. This monitoring program is in planning stages and proposals will be submitted in fall 2003. Present monitoring programs and this proposed program will be integrated into this more comprehensive monitoring effort.

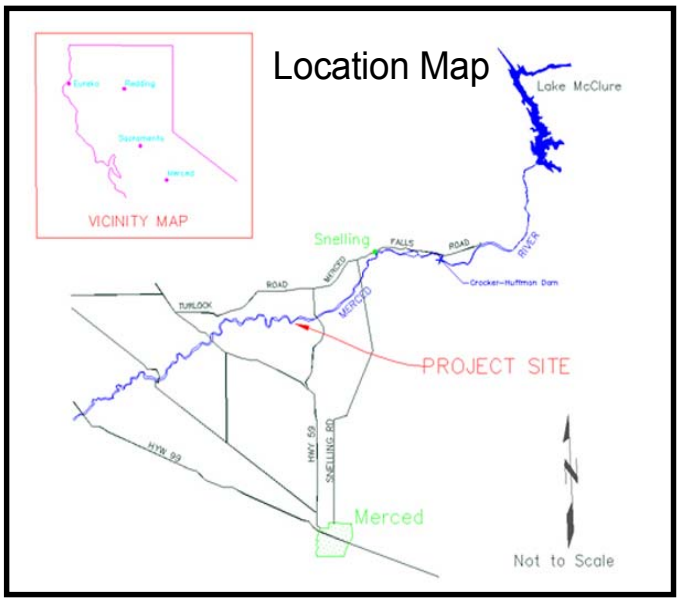
Background of the Merced River Salmon Habitat Enhancement Project

The MRSHEP is a multi-phased project to restore salmonid habitat and channel/floodplain function and sustainability to 4.5 miles of the Merced River between river miles 40.0 and 44.5 near the town of Snelling (figure 1). MRSHEP is a multi-agency cooperative effort to address historical impacts on the river that have had deleterious effects on salmon populations. Partners include the Department of Water Resources (CDWR), Department of Fish and Game (CDFG), CALFED Bay Delta Program, U.S Fish and Wildlife Service (USFWS), U.S. Bureau of Reclamation (USBR), and the Robinson Cattle Company.

The Merced River has undergone extensive modification over the years to provide agricultural and municipal water supply, flood control, and power generation, as well as raw materials such as gravel products and gold. As early as the 1870's, large canal systems were built to divert Merced River water for agricultural uses. Several dams were built to regulate flows, the largest being New Exchequer Dam (completed in 1967) that can store up to 1,032,000 acre-feet of water in its reservoir. Mining for gold and

aggregate downstream of the dams has been extensive, leaving tailings and numerous pits within the river corridor.

The manipulation of the river has led to loss and degradation of native habitat. With the building of dams, access to spawning grounds upstream has been lost and gravel recruitment is greatly reduced in reaches below the dams. The large in-stream ponds left by mining create habitat for introduced predator fish species that prey upon juvenile salmon. In an effort to better understand those problems influencing salmon production in the Merced River, CDFG biologists have identified several factors that, in concert, seem to have contributed to the decline of San Joaquin fall-run Chinook salmon. Among those identified factors are degraded channel, poor gravel composition, low flows, high water temperatures, low intragravel oxygen content, predation on outmigrating juvenile salmon by warmwater fish such as large and smallmouth bass, and insufficient spawning habitat (CDFG, November 1993; CDFG Memo September 6, 1991, CDFG Memo November 23, 1987). Specific to the MRSHEP site, Extreme high flows in 1997 combined with previous mining impacts resulted in the loss of several prime salmon spawning riffles and much of the existing nursery habitat in the Robinson reach. CDFG biologists estimate that 25 percent of the annual Merced River natural salmon spawning and production historically occurred within the “Robinson” site and another 65% upstream (B. Loudermilk, personal communication) which made this reach a priority for restoring spawning habitat and improving passage.



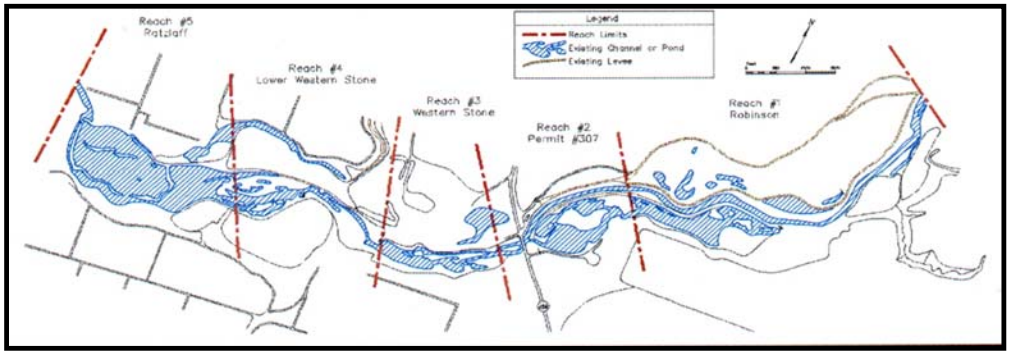


Figure 1. Map of the Merced River Salmon Habitat Enhancement Project Reach, showing location and channel conditions prior to 1997. The sections above the J59 Bridge are known as the Robinson Reach (Reach #1 and #2).

Robinson Reach

The Robinson Reach is the upper most section between river miles 42.5 and 44.5 (figure 1). Before the January 1997 flood event, this reach showed little evidence of channel bed degradation, although gravel mining activities had constrained the channel behind non-engineered berms. As much as 25 percent of the Merced River's Chinook salmon spawning took place in the project reach (Pers. Comm. Bill Loudermilk, DFG, 1999). During the 1997 flood, the river breached the mining berms which had confined it to the historic channel; as a result, the river abandoned the historic channel in favor of a gravel pit with an invert approximately six feet lower (figure 2). When the river abandoned the channel, all of the spawning riffles and much of the existing nursery habitat were lost. Prior to 2001 construction, the project site consisted of a wide, flat, shallow upstream section devoid of proper channel characteristics with several in-stream ponds in the downstream portion of the reach, which harbored habitat for non-native fish that prey on young salmon. The river alignment bypassed much of the original channel in favor of low-lying mined areas and, therefore, much of the coarse sediment that provided for salmon spawning and rearing habitat was left dry.

To construct the MRSHEP – Robinson Reach, heavy equipment was used to re-shape the heavily disturbed channel and floodway into a configuration that would improve salmon habitat and foster river and floodplain function under the current post-dam flow regime. The creation of the channel and grading of the floodplain was accomplished by manipulating 1.5 million tons of material that was within the bounds of the active floodplain. The constructed channel includes a meander, riffles and pools. It was designed to allow bed movement at flows at or above 1,700 cfs and to ensure the availability of suitable salmon spawning habitat. Revegetation of the floodplain with native herbaceous and woody riparian plant species began in February 2002 and will continue over the next few years. The planted areas will be irrigated for 2-4 years and will be dependent on groundwater and flood-flows thereafter.

The design parameters, such as depth, velocity, and gravel size for spawning habitat in the Robinson Reach was developed by examining existing habitat suitability studies for the lower Merced River (California Department of Water Resources 2001). To experiment with enhancing other hydraulic characteristics that may attract spawning salmon, six of the twelve constructed riffles in the Robinson Reach were manipulated by piling gravel to form one, two or three uniform humps at set intervals along the riffles' length. Figure 3a - 3d depict the designs of the riffle/spawning areas constructed along the Robinson Reach. The features were constructed to induce transitions in depth and velocity, and increase intragravel flow, upwelling, and downwelling. It is assumed that functionally equivalent features would form naturally over time on constructed riffles that are initially flat and homogeneous, given that the correct channel form and substrate are present. However, a flow event significant enough to create features that improve a constructed riffle's potential as salmon spawning habitat may take years to occur because of controlled releases from the system of dams upstream of the project reach, and the need for consecutive years of normal or above normal precipitation.

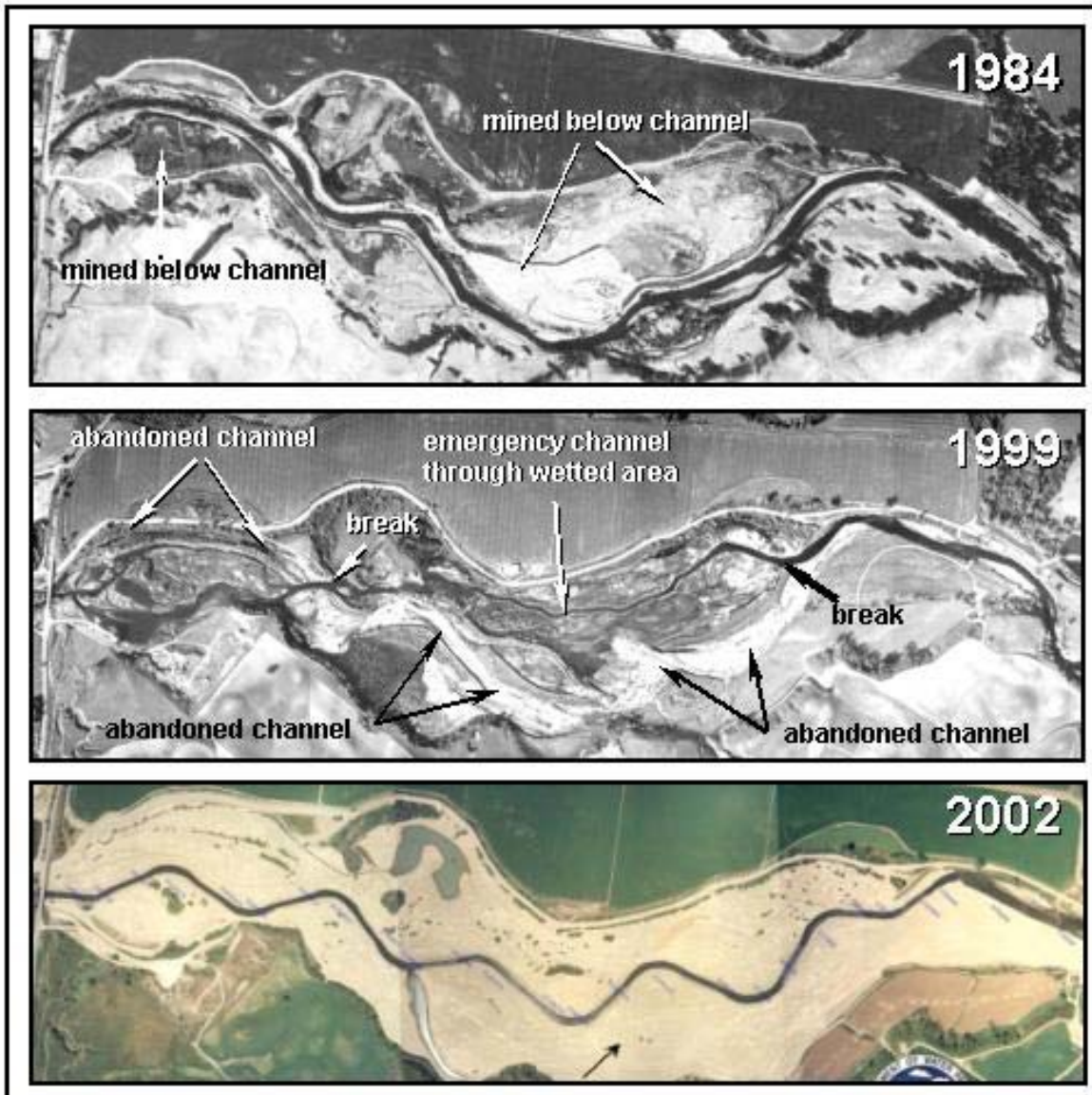


Figure 2. Changes in project area channel morphology. Top: aggregate extraction created large areas mined below the river's grade separated from the channel by non-engineered berms. Middle: area after the 1997 high flows had broken through the berms and captured the low areas. An emergency channel was excavated by DFG to allow salmon to migrate through shallow sheetflow. Bottom: reconstructed channel and floodplain. Channel sinuosity, bankfull and floodplain inundation is scaled for dam-regulated flows

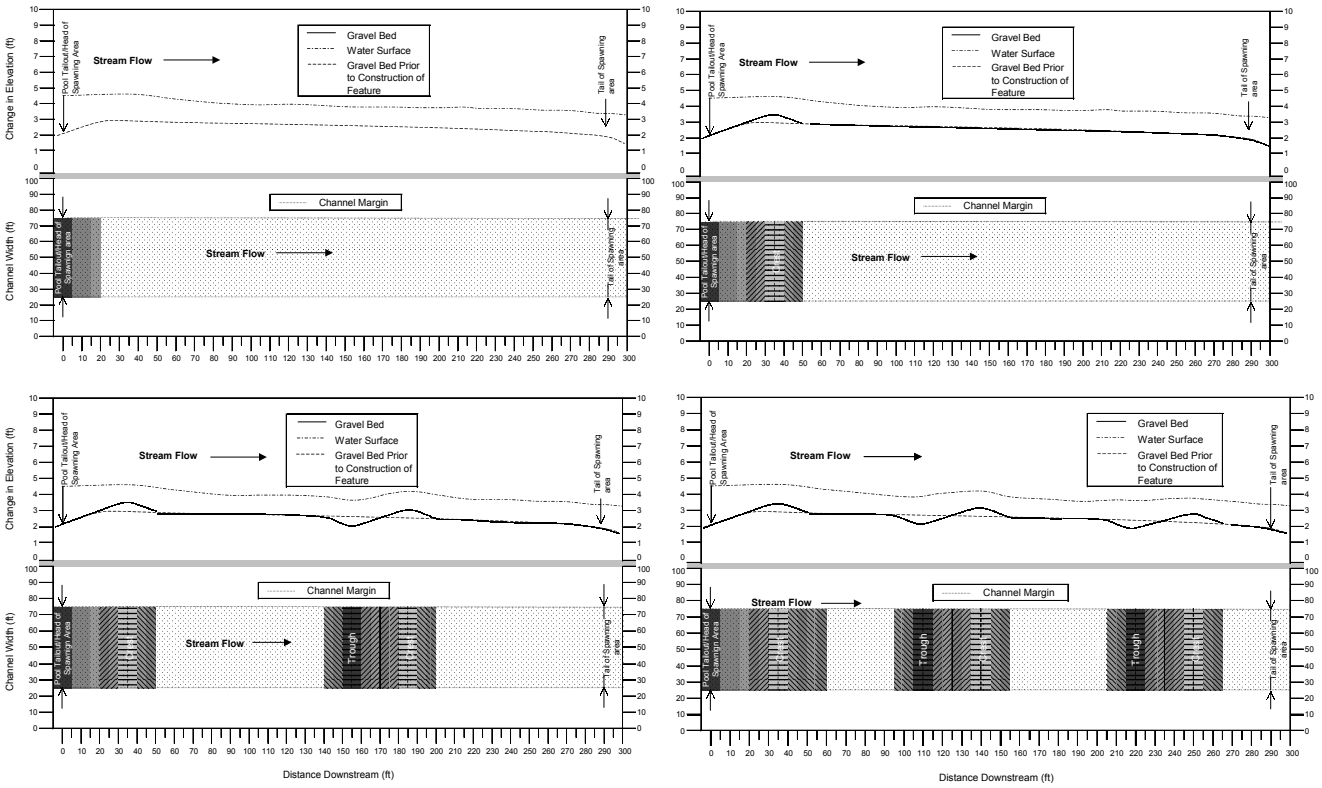


Figure 3. Spawning riffle designs. a. originally designed flat riffle; b. one hump riffle; c. two hump riffle; d. three hump riffle.

Studies similar to this one have been conducted on the Stanislaus River (Mesick 2002), a tributary to the San Joaquin River. However, a thorough assessment of spawning use that would help identify successful and poor performing design features was not originally part of the Robinson monitoring plan or budget. The CDFG does perform annual spawning surveys on the Merced River, but these are designed to identify river-wide annual trends and would provide only a course analysis of spawning habitat use within the Robinson Reach. In addition, CDFG was contracted, as part of the project monitoring, to perform tagged release studies of smolts to determine effectiveness of passage improvements from the MRSHEP.

To determine if the MRSHEP – Robinson Reach increased salmon habitat, a study is currently being conducted by the USFWS (2001) to quantify the amount of spawning and rearing habitat available for chinook salmon over a range of flow conditions based on compound suitability predicted by the River2D model. The study will infer changes in Chinook salmon habitat by predicting physical habitat quality based on water depth, velocity, adjacent velocity, cover and substrate. The USFWS study and the proposed study will both evaluate the success of the project and its design features. However, the USFWS study will rely on physical habitat parameters to evaluate the project, whereas the study described herein will rely on actual use by spawning salmon. USFWS will be collecting spawning use data to validate the River2D model. The USFWS study should

be completed in 2004 and we will have 2 years of data by then. Depending on the data produced by each study, results will be integrated through the adaptive management process below to evaluate success of MRSHEP in increasing salmon spawning in the reach. By comparing the results of these two evaluation studies, we will be able to 1) verify the efficacy of the 2D model's predictive power, 2) measure the increase of spawning habitat created by the project quantitatively and qualitatively, and 3) further develop efficient and accurate monitoring methods for measuring spawning habitat.

2. Justification

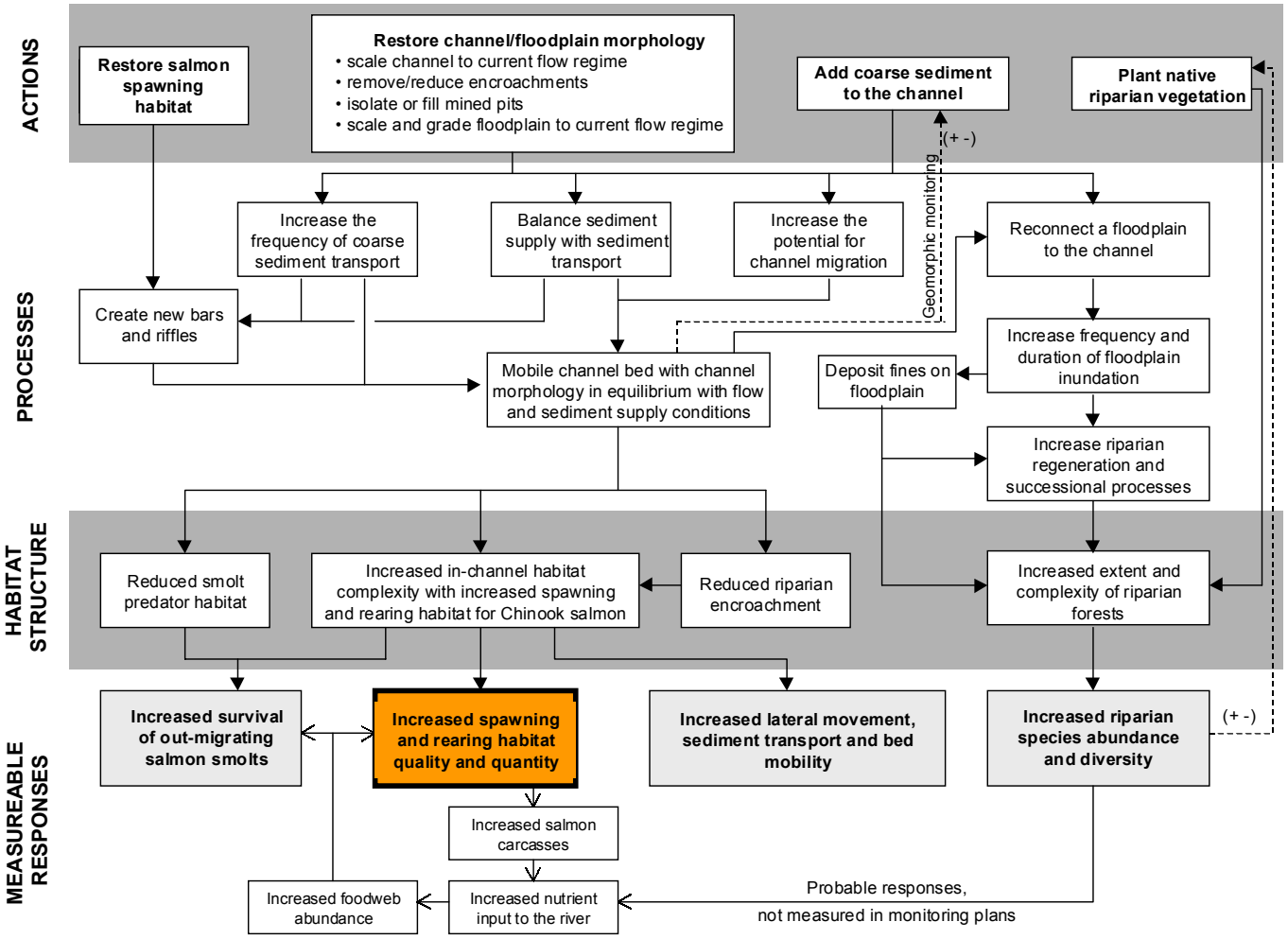
Channel and floodplain restoration projects that reverse the effects of dams and gravel mining require the movement of thousands of tons of gravel, sand, and soil, and are very costly. Therefore, an evaluation of this type is important for helping inform decisions on future projects by gauging the success of the project in respect to enhancing spawning habitat for Chinook salmon.

This proposed monitoring program is one part of a MRSHEP Comprehensive Monitoring Plan that is being formulated that will integrate monitoring currently being undertaken by DWR, DFG and USFWS for the different phases of the project. Biotic, geomorphic and hydraulic responses to the restoration efforts will be evaluated throughout the project reach by an interagency monitoring group and personnel from UC Davis and Fresno State College.

Conceptual Model

The conceptual model for the MRSHEP is illustrated in figure 4. Actions taken through MRSHEP include restoring salmon habitat, channel/floodplain morphology, adding coarse sediment to the channel, and planting native riparian vegetation. Through various processes illustrated in the figure, a mobile channel bed with channel morphology in equilibrium with flow and sediment supply conditions was created. This in turn has created a habitat structure that has increased in-channel habitat complexity with increased spawning and rearing habitat for salmon, reduced smolt predator habitat, reduced riparian encroachment, and increased complexity of riparian vegetation. Measurable responses to this change in habitat structure include increased survival of out-migrating salmon smolts, increased spawning and rearing habitat quality and quantity, increased lateral movement of the channel, sediment transport and bed mobility, and increased riparian species abundance and diversity. Of these measurable responses, this study is focusing on measuring spawning and rearing habitat quality and quantity (highlighted). The channel restoration undertaken in the Robinson Reach resulted in changes to depths, velocities, substrate and cover. These changes, in turn, altered the amount of habitat area for adult spawning. Changes in the amount or quality of habitat for adult spawning could affect reproductive success through alterations in the amount of redd superposition and hatching rates. These alterations in reproductive success and/or survival could ultimately affect changes in salmonid populations. By

directly measuring the intensity of use by spawning adults, some measure of the increase in habitat quality can be determined.



Conceptual model of habitat restoration actions on the Merced River Salmon Habitat Enhancement Project.

Figure 4. Conceptual model of habitat restoration actions under the Merced River Salmon Habitat Enhancement Project and the response component (highlighted) addressed by this study (adapted from Merced River Corridor Restoration Plan, 2002).

Objectives and Hypotheses

The objective of the study is to determine the location and number of redds in the Robinson Reach and to assess the suitability of spawning habitat based on level of use. Included in this objective is to identify riffle features that increase the number of redds excavated by salmon within a newly constructed spawning riffle. This study will create a knowledge base that can be used to improve the design features of future phases of MRSHEP and that can be applied to other restoration efforts on rivers of similar scale and fluvial character. The following research hypotheses will be investigated to accomplish the objective:

1. Chinook salmon redd densities will be higher in the constructed portion of the Robinson Reach than in the adjacent upstream and downstream natural spawning sites.
    a. Chinook salmon redd densities will increase over time in the constructed reach compared to those in the adjacent natural spawning sites.

2. Chinook salmon redd densities will be equal to or higher in the constructed portion of the Robinson Reach than those that occurred in the Robinson Reach prior to the reach altering flows of 1997.

3. Spawning is clustered in areas along the Robinson Reach and is not spread evenly or randomly throughout the reach.

4. The quantity of spawning is significantly different among spawning area designs.
    a. Chinook salmon redd densities are correlated with the number of hydraulic controls (a.k.a., humps) per riffle.

Comparisons between sites within the Robinson Reach (hypothesis 4) will help determine if the extra expense required to manipulate the bed material to create features intended to increase suitability for spawning salmon is warranted when improving spawning habitat is the objective. Construction of the Robinson Reach project provides a rare opportunity to replicate and compare different methods for manipulating the channel bed to improve conditions for spawning Chinook salmon. The Robinson Reach accommodated the construction of twelve consecutive riffle/pool sequences of similar plan form, cross section, and longitudinal dimensions, and thus similar base environmental conditions within each. Beyond comparing the manipulated riffles, the density and location data from this study can be used to identify areas for further study to help better define attributes that influence nest site selection by Chinook salmon.

Also, this study provides a comparison between pre- and post-project redd densities within the Robinson Reach and adjacent reference areas (hypotheses 1 & 2), and thus, provide an indicator of the project's success to help determine if there is need for improvement. The study will contribute to the improvement of designs for future phases of MRSHEP and the results from this study could be applied to salmon restoration

projects in other rivers of similar size and fluvial character. As such, this study is part of the MRSHEP's adaptive management strategy to evaluate results and to revise or reinforce current methods used to restore Chinook salmon spawning habitat (figure 5). Utilization of spawning riffles is a key component of the MRSHEP monitoring plan and will be used to assess and evaluate the efficacy of this large scale habitat enhancement approach to increase salmon populations in the Merced River and San Joaquin River basin.

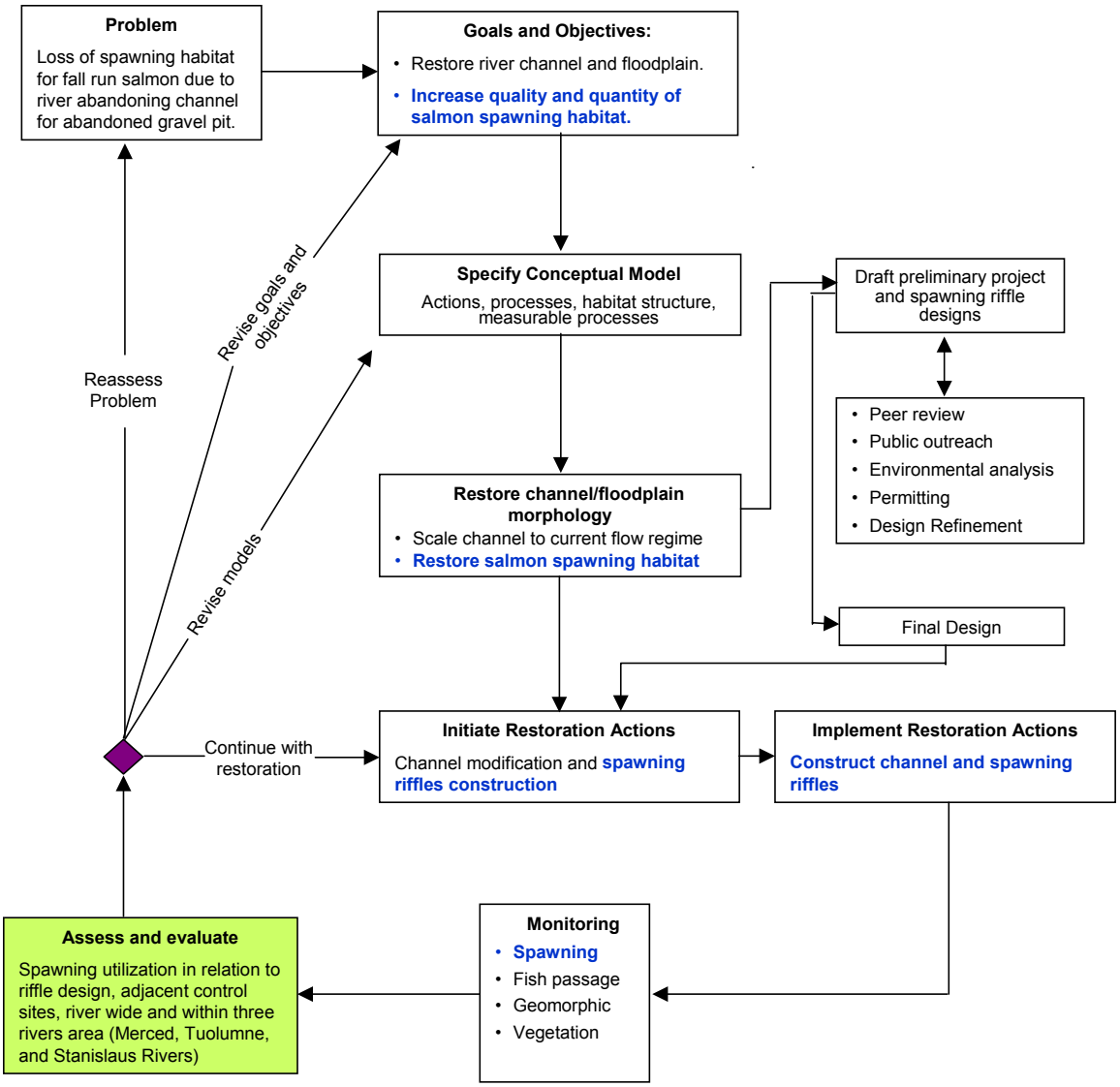


Figure 5. Adaptive management process for MRSHEP. Project elements (spawning) that directly concern this study are highlighted.

3. Approach

To test the hypotheses, annual redd surveys will be conducted within the reach and at natural upstream and downstream sites. Surveys will occur during the spawning season, October through November. For this study, it is assumed that adult salmon, given the choice of various habitats and riffle conditions, will utilize that area where conditions are most conducive to survival to hatch of their eggs. The spawning salmon's choice of habitat is the ultimate indicator of suitable spawning habitat.

Data Collection and Redd Density Calculation

Preliminary results from redd surveys conducted in 2002 by DWR staff indicate that the survey approach described below to locate redds and measure habitat variables is feasible. Preliminary results also indicate that salmon spawn on the constructed riffles and within the chosen reference areas. A total of 201 redds were located on the constructed riffles and in the reference areas. Of these, 130 redds were on the newly constructed riffles, 31 in the upstream reference area, and 40 in the downstream reference area. Figure 6 shows the location of the constructed portion of the Robinson Reach channel and the upstream and downstream reference sites

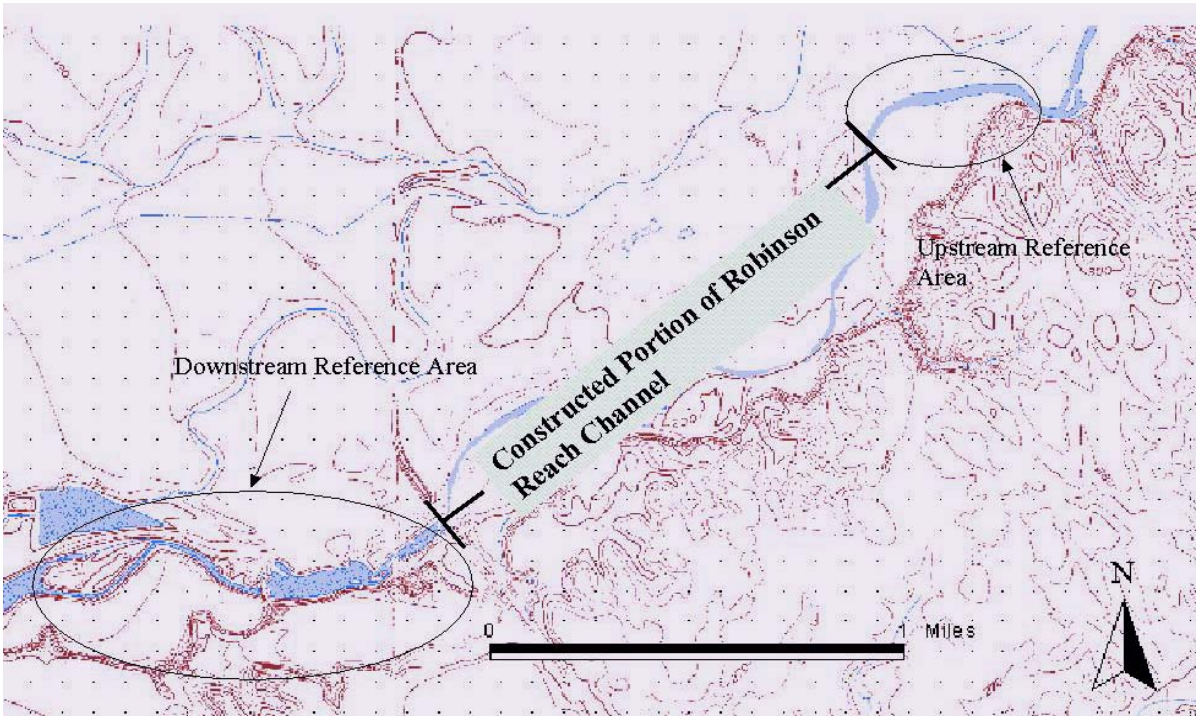


Figure 6. Location of the upstream and downstream reference areas and the constructed portion of the Robinson Reach channel.

Surveys will commence shortly after the first redds are sighted in the reach by CDFG, and repeated every ten days until new redd construction has ceased or nearly ceased within the reach. This will likely require from 3 to 4 survey visits per area, though possibly more. If there is a high degree of spawning, surveys will be repeated at shorter intervals. In order to count all redds in the project reach and upstream and downstream reference areas, two surveyors will walk the edge of the stream channel with polarized glasses to scan the entire riverbed for redds. Pit locations will be mapped on recent high-resolution (600 dpi) color photos at 1:1000 scale to an accuracy of 2-4 meters. The stream bank location perpendicular to the redd will be flagged so that redds are not recounted on subsequent surveys and superimposition can be monitored. The closest engineering station, distance from closest bank, and a GPS location will be noted to further assist with relocating redds. For each redd, the size as gauged by length (small 3-5 feet, medium 6-10 feet, large 11-15 feet), the presence or absence of salmon at the redd, and the cleanliness of the gravel (level of periphyton re-growth) will be noted. Qualitative estimates of depth, velocity and gravel size will also be recorded to choose redds for later measurement of these variables. Percent tree or shrub cover perpendicular and adjacent to the redd will also be noted.

To determine the density of redds on a riffle, the boundaries of spawning habitat will need to be determined. The spawning habitat on the constructed riffles within the project area are easily delineated as they are similar in gravel size, depth and configuration. The amount of spawning habitat in adjacent reaches is more difficult to delineate. The range of values for gravel size, gravel embeddedness, depth and mean column velocity at flows typical of the spawning period (about 180 –230 cfs at the Snelling gage) will be taken from studies of spawning habitat on the Merced River used to develop habitat suitability criteria (USFWS 1997). These values will be compared to the measurements taken at redds and around the perimeter of riffles to delineate the extent of spawning habitat. At redds, data for these variables will be collected at a point 0.5 meter upstream and adjacent to the lip of the pit in an area undisturbed or influenced by redd construction. Depth and velocity measurements will be taken with a top setting wading rod and a velocity meter equipped with a current meter digitizer. The number of redds in a riffle will be divided by spawning habitat area to get the riffle's redd density to be used in statistical analysis.

Comparison to Historical Data

River wide redd counts for the Merced River conducted by CDFG will be used to make comparisons between the current level of spawning use within the Robinson reach and historical use. Past year's spawning use within the Robinson Reach relative to use in the upstream and downstream reaches in the same year would be compared to the post project use relative to upstream and downstream use. Floating surveys by DFG will also be used as data quality control of walking spawning surveys conducted by DWR staff. Pre-project data from 1975 to 1997 will be used to make comparisons before the reach altering event of January 1997 and the data from 1998 to 2000 will be used to make comparisons of use following the event.

Historical data from surveys previous to 1975 will also be compared to better understand long term trends and effects of the restoration efforts of MRSHEP on salmon populations.

Riffle Design Experiment

A randomized block design was used to guide the assignment of a spawning area design (designs B, C, and D) to six of the twelve riffles. The three riffle designs were randomly distributed in two sections within six consecutive riffles. Originally, all twelve of the riffles were to be manipulated, but due to the demands of the construction schedule, only the six were incorporated. The remaining six riffles have beds that are flat between the head of the riffle and its tailout (design A). Figure 7 depicts the constructed portion of the Robinson Reach and the location and type of spawning area design constructed on each riffle. Differences among the spawning riffles will be tested by two way ANOVA (GLM, SAS).

Each replicate of a riffle design has approximately the same dimensions. The riffles are between 250 feet and 300 feet in length. Among the manipulated riffles relative location along the reach, and slope are similar. Average depths and velocities will be analyzed for significant differences between riffles to assess differences in spawning use that may be due to these habitat variables. Data for these variables will be measured at three points along three perpendicular transects within the riffles. The habitat suitability work being done concurrently by USFWS, and groundwater monitoring and hydraulic modeling being done by CDWR on the reach will also be consulted to help with the assessment habitat variability and suitability. Sediment conditions and bank cover are fairly uniform in the constructed reach and can be assumed to be the same, unless anomalies are observed. Redd densities per riffle will be calculated using the methods described above.

The constructed gravel bed features and the geometry and planform of the bed are not designed to be permanent. Based on the overall project design, it is assumed that gravel movement will occur at high flows that will erode the engineered bed features into a more natural configuration as a result of normal river processes. Gravel movement by spawning salmon will also alter the bedform. Differences in patterns of use between years that seem to occur along with annual changes in bed form will be qualitatively described in the results.

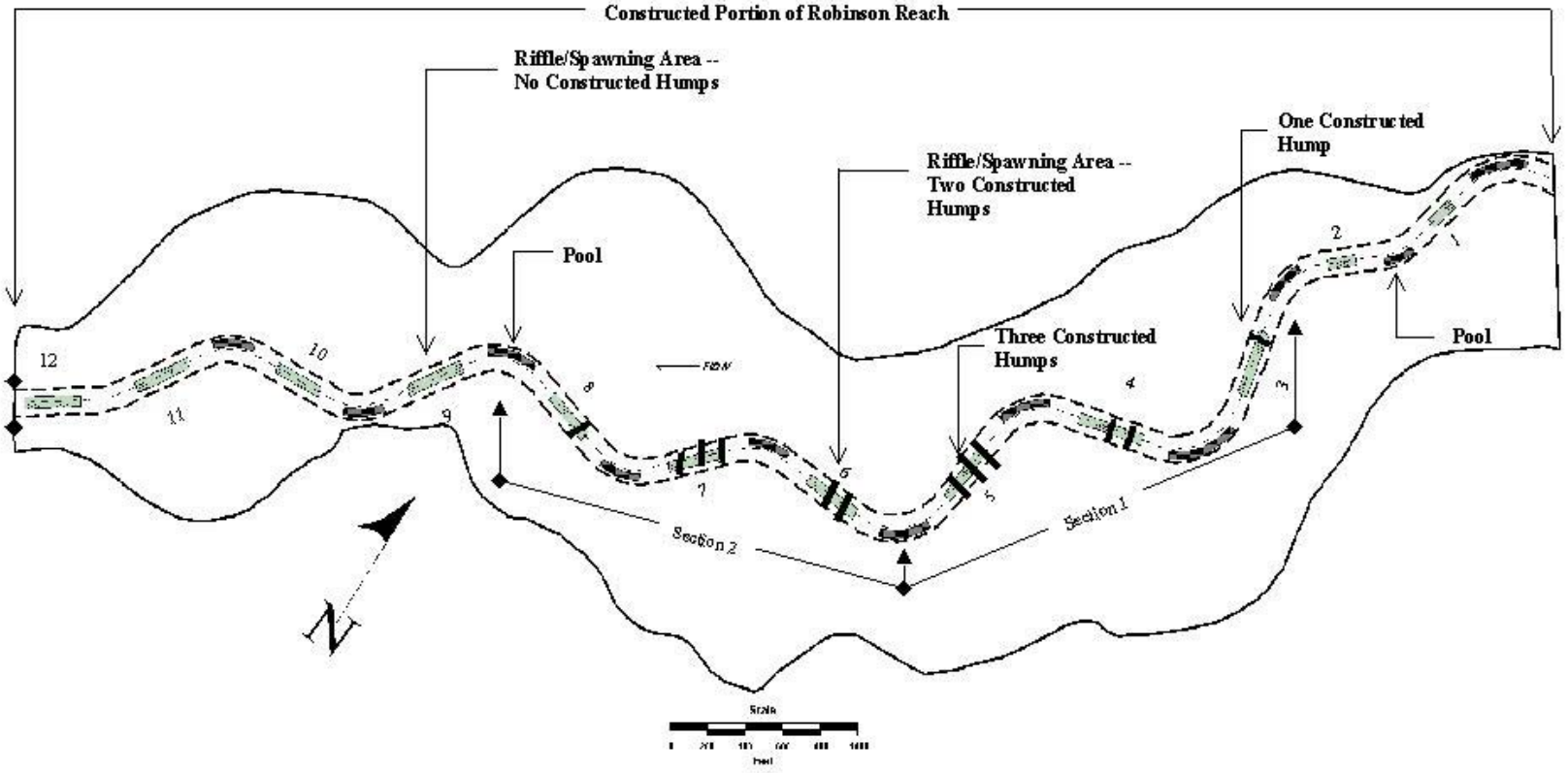
Reporting

Tabular data will be entered into a database to aid analysis and for storage. Location and habitat delineation data will be entered into a GIS that includes recent aerial photos of the site to display data and to determine densities. The data will then be used to test the hypotheses described earlier using analysis of variance within and between riffles. Reports will be produced annually that describe and document the analysis and depict the survey results, including a final report that summarizes the results and makes recommendations. These reports will be circulated to all appropriate agencies and

through the Merced River Stakeholders Group. A manuscript will also be submitted for publication in a peer-reviewed journal.

Wherever feasible, the proponents of this study will coordinate with other monitoring and evaluation efforts on the Merced River and other San Joaquin River Tributaries to learn and share results, techniques, and data.

Figure 7. Planform of the constructed channel of the MRSHEP – Robinson Reach project, showing the location of the riffles/spawning areas and pools



4. Feasibility

A pilot study was conducted in 2002 by the proponents to develop methods for this study. Preliminary results indicate the approach to accurately count redds and measure habitat variables is feasible for the budget and time proposed. Access to the property for study purposes is included in the easement between CDFG and the Robinson Cattle Company for the MRSHEP Robinson Reach project. The proponents also have permission to access the Calaveras Materials property downstream. This study is enthusiastically supported by the landowners.

5. Performance Measures

The proponents performance will primarily be based on their ability to complete redd and habitat surveys, process the data, and produce understandable and meaningful reports about what the data indicates and where further study may be warranted. Making the results known and available to others that are interested through reports and manuscripts in peer reviewed journals is also an important measure of performance and is a purpose of this project.

6. Data Handling and Storage

The data will be held in an Access database, and in ESRI GIS format at CDWR (3251 S St, Sacramento, CA). The data will be made available upon request and in the annual reports. Annual reports will be produced by June of each year using Microsoft software and stored in hardcopy and electronically in Adobe Acrobat pdf format, made available on compact disk and posted on the San Joaquin District's (DWR) web site.

7. Expected Products/Outcomes

Annual reports made available June 1, presentations will be made where possible (CALFED Science Conference, American Fisheries Society, Salmon Restoration Federation, Society for Ecological Restoration), manuscripts submitted to CALFED Science Journal, Fish and Game, and a final report with recommendations that will aid decisions on funding, implementing, and designing salmon spawning habitat restoration projects.

Results of this study will also be included in reports of the MRSHEP Comprehensive Monitoring Program (under development).

8. Work Schedule

Annual schedule includes preparation for the spawning season in late October with spawning surveys beginning sometime in late October or early November. By mid-December, spawning activity should be finished and surveying terminated. Data

processing and analysis will occur in January and February. Report preparation, presentations at conferences and preparation of manuscripts will occur March-June.

TASK	*Oct*	*Nov*	*Dec*	*Jan*	*Feb*
Redd & Habitat Surveys					
Analysis/Reporting					

B. Applicability to CALFED ERP and Science Program Goals and Implementation Plan and CVPIA Priorities

1. ERP, Science Program and CVPIA Priorities

This project is in accordance with the CALFED ERP goal of achieving recovery of at-risk species and the CVPIA priority of restoring anadromous fish populations by evaluating the degree to which a restoration project and its design features increase spawning habitat suitability for fall-run chinook salmon.

The CALFED Science Program has stressed the importance of adaptive management as a necessary part of a successful restoration effort. This study is part of the MRSHEP's adaptive management strategy to evaluate results and to revise or reinforce current methods used to restore Chinook salmon spawning habitat. This study has been reviewed at the Adaptive Management Forum in 2001and has undergone revision in response to comments by the AMF committee.

The Merced River Adaptive Management Forum Report stated that the restoration team for MRSHEP needed to make a stronger commitment to monitoring. In response, this study, a groundwater modeling study, and expanded vegetation monitoring program have been started or expanded. Efforts are underway to coordinate and combine data of these and other in-place programs into a singular, comprehensive monitoring program for the MRSHEP area.

2. Relationship to Other Ecosystem Restoration Projects

The study will contribute to the improvement of designs for the next phase of MRSHEP, the Western Stones Reach, and the results from this study could be applied to salmon restoration projects in other rivers of similar size and fluvial character. Within the San Joaquin Basin, spawning habitat restoration projects that use methods similar to those used to construct the Robinson Reach are being carried out on the Stanislaus and Toulumne Rivers.

In addition, the goals and objectives of the MRSHEP – Robinson Reach and this study are in accordance with those of the Merced River Corridor Restoration Plan (MRCRP; Stillwater Sciences 2002) funded by the CALFED ERP.

3. Requests for Next Phase Funding

This is not a request for next phase funding.

4. Previous Recipients of CALFED Program or CVPIA funding

The projects listed below have been implemented by DWR's Mitigation and Restoration Branch in cooperation with CDFG, USFWS, and USACE and were funded in part by CALFED and CVPIA programs:

1. Phase 2 – Merced River Salmon Habitat Enhancement: River Mile 42 to 43.5 (Robinson Ranch and Gravel Mining Permit #307 site) Project
   CALFED ERP Numbers: 2001 – C200, 98-C1009
   AFRP – In-kind contribution
   Project Status: Construction complete
   Accomplishments: After a significant planning effort, which included substantial review and input from stakeholders and restoration experts, the project was constructed and completed in February 2002.

2. Phase I – Merced River Salmon Habitat Enhancement: River Mile 40 to 40.5 (Robinson/Gallo Project – Ratzlaff Reach Site)
   CALFED ERP Number: 99B05
   AFRP Agreement – 114209J032
   Project Status: Project has been constructed and is being monitored for the achievement of benefits to salmon and riparian habitat, and improved river function, including more natural floodplain and geomorphic processes.
   Accomplishments: The project was successfully constructed on schedule and the channel and floodplain are performing as designed.

3. Prospect Island – Shallow Water Habitat/Wetland Restoration Plan
   CALFED ERP Number: 96-M02
   Project Status: Waiting to award contract for construction
   Accomplishments: Construction contract was not awarded and project is on hold, permits and Biological Opinions have been acquired, and Reclamation Board has given approval.

4. Prospect Island – Develop Monitoring Plan
   CALFED ERP Number: 96-M26
   Project Status: Project completed
   Accomplishments: Final monitoring plan

5. Prospect Island Habitat Protection Project
   CALFED ERP Number: 98-A01
   Project Status: Project complete
   Accomplishments: Repaired levee

6. Prospect Island Monitoring Program

CALFED ERP Number: 99A02
Project Status: On hold

7. Restoration of Eastern Delta Floodplain Habitats on Grizzly Slough in the Cosumnes River Watershed – Phase I
CALFED ERP Number: 2002 PSP reference number 25
Project Status: Contract development for Phase I – project planning phase

5. System-Wide Ecosystem Benefits

The results from this study could be applied to salmon habitat restoration projects for funding, planning, and design decisions on other rivers of similar size and fluvial character.

C. Qualifications

Randy Mager:
The P.I., Dr. Mager has a Ph.D. in Ecology (aquatic) and M.S. in Animal Science (aquaculture) from UC Davis and a B.S. in Psychobiology from UC Santa Cruz. He has been involved in research and habitat restoration for reproduction of threatened and endangered salmonids through UC Davis and Department of Water Resources since 1987. Within the Restoration and Mitigation branch at DWR, Dr. Mager is responsible for project management, development of restoration plans and monitoring programs. Dr. Mager has been involved with MRSHEP since 1999.

Aric Lester:
Mr. Lester has a BS in Biological Conservation. Aric has been in the field of habitat restoration for seven years, first as a Biologist for the USDA Forest Service then as an Environmental Scientist for CDWR with the Mitigation and Restoration Branch. Aric is also experienced in GIS and database management. Under the Mitigation and Restoration Branch, Mr. Lester is responsible for planning, implementing and monitoring stream, floodplain, and wetland restoration projects. Mr. Lester has been involved with the MRSHEP Robinson Reach project during all major planning and construction phases since 1999.

D. Cost

State Funds

Year 1											
Task Description Direct Labor Hours	**Direct Labor Hours**	**Salary (per year)**	**Benefits (per year)**	**Travel**	**Supplies and Expendibles**	**Services or Consultants**	**Equipment**	**Other Direct Costs**	**Total Direct Costs**	**Indirect Costs**	**Total Cost**
Preparation	45	2,059	457	500		0	5,000	0	8,016	1,313	9,329
Spawning Survey	160	7,322	1,624	1,000	500	0		0	10,446	4,669	15,114
Data Processing and Analysis	150	6,864	1,523						8,387	4,377	12,764
Reporting and Presentations	170	7,779	1,726	1,500					11,005	4,961	15,965
	525	24,024	5,329	3,000	500	0	5,000	0	37,853	15,320	53,172

Year 2											
Task Description Direct Labor Hours	**Direct Labor Hours**	**Salary (per year)**	**Benefits (per year)**	**Travel**	**Supplies and Expendibles**	**Services or Consultants**	**Equipment**	**Other Direct Costs**	**Total Direct Costs**	**Indirect Costs**	**Total Cost**
Preparation	42	1,899	421	500		0	250	0	3,070	1,211	4,281
Spawning Survey	160	7,322	1,624	1,000	500	0		0	10,446	4,669	15,114
Data Processing and Analysis	150	6,864	1,523						8,387	4,377	12,764
Reporting and Presentations	170	7,779	1,726	1,500					11,005	4,961	15,965
	522	23,864	5,293	3,000	500	0	250	0	32,907	15,217	48,124

Year 3											
Task Description Direct Labor Hours	**Direct Labor Hours**	**Salary (per year)**	**Benefits (per year)**	**Travel**	**Supplies and Expendibles**	**Services or Consultants**	**Equipment**	**Other Direct Costs**	**Total Direct Costs**	**Indirect Costs**	**Total Cost**
Preparation	42	1,909	423	500		0	250	0	3,083	1,217	4,300
Spawning Survey	160	7,322	1,624	1,000	500	0		0	10,446	4,669	15,114
Data Processing and Analysis	150	6,864	1,523						8,387	4,377	12,764
Reporting and Presentations	170	7,779	1,726	1,500					11,005	4,961	15,965
	522	23,874	5,295	3,000	500	0	250	0	32,919	15,224	48,143

GRAND TOTAL = 149,440

E. Local Involvement

The landowner has been an integral part of planning for the Robinson Reach Project as well as this study and enthusiastically supports it. Other landowners in the area who would like to see salmon runs increase are aware of our efforts and of this study and support it. The proponents will present the results to the Merced River Stakeholders Group. This group has been kept informed of the MRSHEP project and it's progress since the group's inception. A product of this group is the Merced River Corridor Restoration Plan. The goals and objectives of the MRSHEP – Robinson Reach and this study are in accordance with those of the MRCRP.

F. Compliance with Standard Terms and Conditions

The proponents will comply with all contracting terms required by CDWR and the USFWS/AFRP.

G. Literature Cited

CALFED Bay-Delta Program. 2000. Ecosystem restoration program plan, Appendix to CALFED Bay-Delta Program Final Programmatic Environmental Impact Statement/Report, July 2000. Sacramento, California.

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