MONITORING PLAN
FOR
THE RUTHERFORD REACH RESTORATION OF THE NAPA RIVER
WITH SITE-SPECIFIC DETAIL FOR
Phase I (REACHES 1 and 2)
& Phase II (Reach 3)
& Phase III (Reach 4)

Per agreement No. 07-542-550-0
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INTRODUCTION

The purpose of this document is to establish a Monitoring Program for the Napa River Rutherford Reach Restoration Project. Key program elements include a monitoring framework and defined protocols for evaluating monitoring parameters that provide measures of long term restoration effectiveness. This document defines specific field protocols, schedules, and field data sheets to be used to evaluate monitoring parameters. This document is intended for review by resource agencies and application by the project monitoring team. Monitoring team members may include local landowners and/or their representatives and Napa County Resource Conservation (RCD) staff, under the supervision of a Napa District Flood Control and Water Conservation District (District) team leader. This Plan augments an original plan that was developed by Jones & Stokes in coordination with technical experts from Sonoma Ecology Center, Tessera Consulting, and the District for Phase 1(Reaches 1 and 2) in 2009, and a revised plan developed by ESA PWA and their subconsultant Horizon Water and Environment for Phase 2 (Reach 3) in 2010.

Project Setting

The Napa River Rutherford Reach Restoration Project is comprised of a 4.5-mile reach of the mainstem Napa River south of the City of Saint Helena between Zinfandel Lane and the Oakville Cross Road. This reach is comprised of approximately 40 parcels owned and managed by 29 different private entities. Historic changes in land use and management in the Napa River watershed have resulted in confinement of the river into a narrow channel, loss of riparian and wetland habitats, accelerated channel incision and bank erosion, and ongoing channel degradation. Properties along the Rutherford Reach have been subject to bank instability and failure leading to the loss of valuable vineyard land and costly repairs.

The Napa River Rutherford Reach Restoration is a landowner-initiated project that aims to reduce existing bank erosion and enhance riparian and aquatic habitats using a suite of approaches, including: setting back earthen berms from the top of the river bank; creating vegetated buffers between the river and adjacent land uses; excavating and planting inset floodplain benches (1.5- to 2-year flood recurrence interval); creating backwater habitat to provide high-flow refugia for native fish; removing non-native invasive and Pierce’s disease host species (e.g., Himalayan blackberry, periwinkle, giant reed, tree-of-heaven); planting native understory species; installing biotechnical bank stabilization to stabilize actively eroding banks; and, installing instream structures to improve aquatic habitat. The project also includes an annual maintenance program to proactively address debris, bank erosion, and inputs of fine sediments and to maintain the functions of the restoration features. Proposed maintenance activities include: debris removal; downed tree stabilization/relocation; in-channel vegetation management; planting native vegetation; invasive and Pierces’s Disease host plant removal; and, repairing (as needed) instream habitat structures and other constructed instream restoration features. All of this work is proposed for private lands along the study reach under the supervision of the District in concert with landowners and their representatives.

The Napa River is presently subject to a Clean Water Act Total Maximum Daily Load (TMDL) action due to excessive quantities of fine sediment degrading local water quality and beneficial uses. While sediment is a naturally-occurring input to the Napa River system, excessive amounts are considered a pollutant, and thus sediment load reductions mentioned in this report amount to ‘pollutant reductions’ in TMDL terms. The Rutherford Reach Restoration Project serves to support the TMDL objective of reducing fine sediment loads and as a result has been designated a regional priority by the San Francisco Bay Regional Water Quality Control Board responsible for TMDL development and implementation.

Project Objectives

This monitoring plan will evaluate and document the progress of the Napa River Rutherford Reach Restoration towards meeting its objectives using a system of monitoring methods, indicators, and performance standards. Project objectives driving the restoration design include the following:

- Reducing fine sediment loads due to accelerated rates of channel bed and bank erosion.
- Minimizing the need for piecemeal efforts at channel stabilization and berm construction on the part of local landowners.
- Rehabilitating natural river/floodplain interactions where possible within the new channel corridor.
- Increasing and enhancing riverine, riparian, and floodplain habitat value and complexity, particularly to support increased quality and quantity of habitat for Chinook salmon and California freshwater shrimp.
- Wherever possible, protecting existing high value riparian corridor habitat patches.
- Re-establishing geomorphic and hydrologic processes to support a continuous and diverse native riparian corridor.
- Removing invasive non-native vegetation and replanting with native vegetation that will not promote Pierce’s disease in vineyards.
- Working closely with landowners to address their interests with regard to adjacent farmland and property.
- Rehabilitating the river in a way that facilitates permitting agency approval.

Project Implementation

The 4.5 mile project reach has been defined by a stream stationing system and has been divided into nine subreaches extending from upstream to downstream, and is being constructed in phases. A preliminary project design was completed for all nine subreaches with Coastal Conservancy funding under the supervision of the RCD in 2008. A copy of the preliminary design, and final designs for Phases 1 and 2 are available at the Watershed Information Center and Conservancy (WICC) of Napa County website at http://www.napawatersheds.org/app_folders/view/3577 .

The Rutherford Reach Restoration Project will be constructed in phases over approximately the next 10 years contingent on available funding and landowner/District priorities. For each phase, the consulting engineer refines the preliminary design to a final design suitable for construction, based on more detailed topographic data, specific site conditions such as vegetation, current science, and consultations with landowners and permitting agency staff.

Phase 1 of project implementation, which treats river subreaches 1 and 2, was completed in 2010. Phase 1 is funded by the American Recovery and Reinvestment Act (stimulus funds) received through the State Water Resources Control Board, matched with Measure A funds provided by Napa County, and the project landowners. Phase 1 design was completed by ICF Jones & Stokes, with engineering subcontractors Riechers Spence & Associates, Inc, and Northwest Hydraulic Consultants, with consultation input from Prunuske Chatham Inc.

Phase 2 of project implementation, which treats river Subreach 3, was completed in 2010. Phase 2 funders include the State Water Resources Control Board, with match funding provided by Napa County (Measure A funds), and the project landowners. The Final Design was completed by the engineering firm ESA PWA (formerly Phil Williams Associates, Inc), based on the Conceptual Design of ICF Jones and Stokes.

Phase 3 of project implementation, which treats river Subreach 4, and Sequoia Grove in Reach 8, is planned for summer of 2011. ESA PWA is scheduled to complete the final design for both locations by February 2011. Permits are in progress and expected by March 2011. Partial implementation funding for Subreach 4 is provided by the California Department of Parks and Recreation Habitat Conservation Fund Salmonid Restoration Grant program. Grant applications are pending from the State Water Resources Control Board, the Environmental Protection Agency, the California Department of Parks and Recreation Habitat Conservation Fund Riparian Habitat Restoration Grant program, the Federal Natural Resources Conservation Service, and a development project which is subject to wetland mitigation requirements. Other grants are in progress.

Project implementation planning and construction is overseen by a Project Team that includes the Napa County Program Manager, Napa County Department of Public Workst Construction Managers, the Rutherford Dust Restoration Team Landowner Advisory Committee (LAC), with the benefit from input of a Project Strategy Team that includes technical experts and representatives from interested resource agencies.

Monitoring Program Overview

The Monitoring Program is aimed at evaluating the success of the Rutherford Reach Restoration Project. It has three main components: 1) an Annual Survey of the entire 4.5 mile reach, which is aimed at capturing both critical monitoring parameters and channel maintenance needs using rapid assessment formats; 2) qualitative evaluation and photomonitoring of the performance of the instream habitat structures at representative seasonal flows; and, 3) detailed Transects including topographic cross-sections and localized longitudinal profile surveys to be conducted following significant flow events to capture long term habitat response. These monitoring field survey elements are complemented with basic photo-monitoring at defined stations, detailed monitoring of revegetation sites conducted in phases as project areas are planted, and surveys of stakeholder participation. Refer to the Monitoring Protocols section below for a detailed description of the protocols that are to be conducted in each monitoring component.

We are employing a Before/After Control/Impact (BACI) approach for long term measuring change of geomorphic, aquatic and riparian habitat parameters (Roni 2005; Gerstein & Harris, 2005). Monitoring parameters have been chosen to measure changes in targeted resource categories in response to stream enhancements. Detailed Transects complement the Annual

Survey and are designed to balance the frequency and resolution of data collection in the most meaningful and yet cost-effective manner possible.

Specific resource categories keyed to project objectives include the following.

Sediment Load Reductions and Channel Morphology

Evaluating changes in basic stream channel geometry, bank condition, and resultant sediment loads in treated and untreated river reaches.

Aquatic Habitat

Evaluating changes in aquatic habitat quantity and quality associated with installed instream structures, including those aspects of active channel morphology that drive the creation and maintenance of habitat complexity.

Riparian Habitat

Evaluating increases in riparian habitat quantity and quality and planting survival in treated reaches, including the reduction in invasive plant species.

Stakeholder Participation

Evaluating success of stakeholder coordination in maintaining meaningful levels of participation.

The Annual Survey is conducted within the entire length of the bankfull channel every year in order to evaluate the status of constructed features and to rapidly assess effects on fine sediment loading, channel morphology, and habitat features. (The Annual Survey also serves the Maintenance Plan objectives by identifying any emerging new areas of management concern along the channel due to debris deposition or bank instability—see *Final Maintenance Plan for the Napa River Rutherford Reach Restoration Project* (Napa County Resource Conservation District, August 2008) for details.)

Seasonal evaluation of constructed instream habitat structures, including installed woody debris (LWD features), boulder clusters, riffle features, constructed alcoves and benches indicate whether the creation of high flow, low velocity, refugia habitat has been achieved as designed.

Transects provide greater resolution for selected habitat and channel morphology parameters at representative project locations and are timed to capture the effects of peak floods (with return intervals of approximately five years and higher). Transects will evaluate changes across the entire channel and adjacent portions of the floodplain by integrating topographic cross-section surveys with habitat mapping conducted concurrently. Transects may, as needed, be complemented with localized longitudinal channel thalweg surveys centered on the transect to measure detailed changes in geomorphic, aquatic, and riparian habitat parameters within the stream channel in response to instream structures. The specific parameters to be evaluated at each transect will be contingent on restoration technique applied. “Treatment” Transects will be complemented with “no treatment” Transects for comparison.

Photo-monitoring stations will be established and re-occupied in the course of monitoring surveys to provide a visual record of progress. Site-specific monitoring of riparian revegetation sites will capture rates of survival and establishment and quantities of native relative to non-native vegetation.

A stakeholder survey and ongoing documentation of participation levels will address the success of community engagement.

The project team will coordinate with partner agencies responsible for complementary water quality, fish, and wildlife monitoring including the Water Board, RCD, and others and will encourage an active exchange of data and findings.

The duration of the monitoring program is designed to coincide with the 20-year extent of the maintenance program.

Oversight and Coordination

The District is responsible for oversight of project maintenance and monitoring, as part of its responsibilities as lead construction agency and holder of regulatory permits, in concert with the LAC. The LAC has been established to help prioritize maintenance and to coordinate access required for the maintenance and monitoring program elements with local landowners and vineyard managers. The LAC requested that the District Board adopt a Special Benefit Zone Project, funded through a property tax assessment program under procedures established in the District Act, to conduct maintenance in the Rutherford reach of the Napa River. This Special Benefit Zone is referred to as the Rutherford Reach River Maintenance District (Maintenance District).

The LAC is comprised of landowner representatives and is supported by District staff. Participation in the LAC is open to any landowner, or their representative, who have river frontage within the Rutherford Reach. Voting is by majority of landowners at meetings. In the case of a tie, the LAC will select three (3) representatives from the LAC to represent the recommendations of the LAC to the District Board. The three representatives will be designated as the Chair, Co-Chair, and Secretary of the LAC, and will serve for a 2-year period. The LAC meets three times annulally to review, evaluate, and prioritize annual maintenance activities based on the Maintenance Surveys, landowner maintenance requests, and available funding, and to review and approve the annual maintenance report.

All maintenance and monitoring activities will be conducted in compliance with regulatory permits issued in conjunction with the Rutherford Reach Restoration Project, with oversight by the District.

Grant Requirements

Development of this program was originally funded by the 2005-2006 Consolidated Grants Proposition 40-50 Agricultural Water Quality program under Agreement Number 06-282-552-01, administered by the State Water Resources Control Board (Water Board) to the County of Napa as grantee. Match funding is provided by Napa County Measure A funds, and covers 50% of project implementation costs. Maintenance and monitoring costs are financed by match funding provided by project landowners via the Maintenance District. All of the deliverables herein are fulfill specific requirements of the Water Board grant and/or 401 certification.

MONITORING FRAMEWORK

The monitoring program framework links project objectives to proposed monitoring elements based on our understanding of process-based relationships between existing conditions and restoration techniques aimed at achieving desired outcomes. For each desired outcome we have defined specific performance indicators and standards. Project success will be evaluated by quantifying progress towards meeting performance standards over the life of the projectTable 1 provides a summary of performance indicators, standards, and monitoring activities, and monitoring frequency organized by monitoring category.

The following section addresses existing conditions, restoration treatments, desired outcomes, monitoring indicators, and performance standards for each resource category. See **Appendix A** for a detailed breakdown by subreach for site-specific treatments matched to desired outcomes for subreaches 1-9. (For greater analytic detail on data used as a basis for evaluating existing conditions and on geomorphic, engineering, and vegetation and wildlife design criteria applied to project design, please refer to *Final Basis of Design Report for the Napa River Rutherford Reach Restoration Project*, Napa County RCD, October 2008. Alpha-numeric design criteria labels referred to here are more fully explained in that report.)

Table 1. Monitoring Parameter Protocols, References, and Frequency by Category

Sediment Load Reductions and Channel Morphology

Monitoring Parameter	Protocols	Reference Sources	Frequency
Sediment Delivery to the Channel: Length and Height (Surface Area) of Actively Eroding Banks (Failing graded slopes, mass wasting, slumps, flows, etc)	Mapping and Measurement of Height and Length of Actively Eroding Streambanks, Photodocumentation	Gerstein and Harris (2005) Harrelson et al. (1994) Nossaman et al. (2007)	Annually
Channel Adjustment / Incision: Bed Deposition or Scour in Control Versus Treated Reaches	Cross Section Transects, Local Longitudinal Thalweg Survey, Photodocumentation	Flosi et al / CDFG. (1998) Gerstein (2005) Harrelson et al (1994) Gerstein (2005) Harrelson et al (1994)	Pre-and Post-Construction, and/or Post Significant Channel Forming Event
Bankfull Width to Depth Ratio: Entrenchment	Cross Section Transects	Fitzpatrick et al (1998) Rosgen (1996)	Pre-and Post-Construction, and/or Post Significant Channel Forming Event
Flood Stage / High Water Mark	Cross Section Transects	Fitzpatrick et al (1998)	Pre-and Post-Construction, and/or Post Significant Channel Forming Event
Bank Stability *(Rates of Widening at reference vs. restored cross sections)*	Cross Section Transects	Gerstein and Harris (2005) Nossaman et al. (2007)	Pre-and Post-Construction, and/or Post Significant Channel Forming Event
Channel Planform Network (Primary and Secondary Channels)	Photodocumentation of Constructed Alcoves Air Photo Analysis (As Available)	Fitzpatrick et al (1998)	Post Significant Channel Forming Event; As Available

Aquatic Habitat

Monitoring Parameter	Protocols	Reference Sources	Frequency
Large Woody Debris Logs and Jams (>12 inch diameter, or clump of >4 pieces)	Mapping and Categorization of LWD by geomorphic unit, salmonid habitat function, and risk to bank stability; Photodocumentation	Gerstein (2005) Flosi et al / CDFG. (1998)	Annually
Channel Geomorphic Heterogeneity: Riffle Habitat Frequency and Distribution	Mapping of Riffle Crests with GPS		Annually
Installed Habitat Structure (LWD/Boulder/Other) Affect on Increasing Pool Depth and Habitat Complexity	Measurement of Residual Pool Depth at Locations of Installed Habitat Structures (LWD/Boulder/Other)	Lisle (1987)	Annually
Installed Habitat Structure Persistence (LWD/Boulder/Other)	Evaluation of Persistence and Status at Locations of Installed Habitat Structures	Lisle (1987)	Annually
Areas requiring trash removal	Mapping, Photodocumentation		Annually
Channel Geomorphic Heterogeneity: Riffle, Pool and Glide Habitat Distribution	Cross Section Transects, Local Longitudinal Thalweg Survey or Habitat Unit Mapping at Locations of Installed Structures.	Flosi et al / CDFG (1998) Gerstein (2005) Harrelson et al. (1994); USDA R-5s Bulletin Number One	Pre-and Post-Construction, and Post Significant Channel Forming Event
Spawning Gravel Recruitment: Channel Substrate Size Distribution / Riffle Median Grain Size (D50)	Modified Wolman Pebble Count, and/or Grid Pebble Count at Riffle Crests near Cross Section Transects	Bunte & Abt (2001) Cover et al (2008) Fitzpatrick et al (1998) USDA (2003) Wolman (1954)	Pre-and Post-Construction, and Post Significant Channel Forming Event
Area of Low Velocity High Flow Refugia Within Bankfull at Constructed Alcoves and Bankfull Benches	Habitat Unit Mapping and/or Sketch of River Flow Pattern; Narrative Description of Restoration Feature Affect on River Flow Pattern and Relative Velocity; Photodocumentation; Velocity Flow Measurements in Accessible Areas of High Flow Refugia Habitat in Constructed Alcoves and Bankfull Benches	USDA (2003) Gerstein (2005) Flosi et al / CDFG. (1998) Fisheries Biologist Expert Opinion	Representational Seasonal River Flow Stages (Winter and Spring)

Riparian Habitat

Monitoring Parameter	Protocols	Reference Sources	Frequency
Areas requiring weed control, including infestations of Pierce's disease host species	Mapping, Photodocumentation, Land Owner Request Forms	Harris (1999, 2005) Herrick et al (2005 a) Interagency Technical Reference (1996)	Annually
Areas requiring trash removal	Mapping, Photodocumentation		Annually
Riparian Vegetation Buffer Width	Cross Section Transects, Vegetation Surveys Air Photo Analysis (As Available)	Harris (1999, 2005)	Pre-and Post-Construction, and/or Post Significant Channel Forming Event
Riparian Vegetation Buffer Width for first five years after planting	Cross Section Transect Vegetation Survey; Air Photo Analysis (As Available)	Harris (1999, 2005)	Establishment Years, 1,2,3 by contractor; Years 5 and 7 by Maintenance Assessment District
Number of Pierce Disease Host Plant Infestations for first five years after planting	Area Mapping Vegetation Survey; Direct Count Vegetation Survey; Photodocumentation	Herrick et al (2005 a) Interagency Technical Reference (1996)	Establishment Years, 1,2,3 by contractor; Years 5 and 7 by Maintenance Assessment District
Restoration Planting Survival (80% in first five years after planting)	Cross Section Transect Vegetation Survey; Direct Count Vegetation Survey; Photodocumentation	Nossaman et al. (2007) Harris (1999, 2005) Gaffney (2008)	Establishment Years, 1,2,3 by contractor; Years 5 and 7 by Maintenance Assessment District

Stakeholder Participation

Monitoring Parameter	Protocols	Reference Sources	Frequency
Landowner participation in adaptive monitoring and management	Landowner maintenance requests and access agreements	FISRWP (2001)	As Events Occur
Landowner Advisory Committee (LAC) participation	Meeting minutes; Surveys of participation; Opinion surveys of effectiveness	FISRWP (2001)	As Events Occur

Sediment Load Reductions and Channel Morphology

Existing Conditions

Changes in land use and land cover types, construction of earthen berms, and filling of historic distributary channels has resulted in increased flow volumes and velocities within the Rutherford Reach leading to channel incision, and streambank erosion and failure. In addition, inputs of fine sediments to the channel from eroding streambanks and other sources within the watershed has led to a reduction in the quality and quantity of instream habitat for salmonids and other native fish in the Rutherford Reach.

Length of Eroding Banks

To better quantify the effects of these changes and to identify areas requiring treatment as part of the restoration project, actively eroding streambanks were mapped and bank instability was assessed throughout the Rutherford Reach. During the first annual stream survey in 2009, 14,674 linear feet of eroding banks were mapped in the Rutherford Reach. Comparison of eroding banks mapped during the first two annual channel maintenance surveys, shows that eroding bank length was reduced in the Project Reach by 44% from 14,674 to 8,201 feet from June 2009 to 2010. Approximately 1,900 feet of this reduction was due to restoration construction in Phase 1 Subreaches 1 and 2 in 2009. Phase 2 treated an additional X feet of eroding banks mapped during the 2010 survey in Subreaches 1-3. During the 2010 annual monitoring survey, 1,788 feet of eroding banks mapped were mapped in the Phase 3 Reach 4, which will be stabilized through a combination of biotechnical and grading techniques in Phase 3.

Bank Erosion Rates

Completion of the first two Phases of restoration construction in 2009 and 2010 (Reaches 1 through 3combined) made a one-time removal of 79,300 metric tons (58,000+21,300 metric tons) (49,563 cubic meters) (64,826 cubic yards) of fine sediment from the system from grading eroding banks (Assuming soil bulk density of 1.6 metric tons per cubic meter), and an estimated average reduction in bank erosion rates of 750 metric tons/mile/year thereafter. Over 20 years, implementation **Phases 1-2 combined will reduce sediment loading by 5,165 metric tons/year [3,965+(750*1.6 miles)], or 27% of the total target reduction for the Napa River watershed from channel incision sources.**

The target goal is to reduce the surface area of eroding banks in the Rutherford Reach by 75%, which is measured annually under the channel monitoring survey conducted by Napa County each June. From 2009 to 2010, measured eroding bank length has been reduced in the Project (Reaches 1-9) by 44% from 14,674 to 8,201 feet.

Post-construction surveys of channel geometry will be conducted within 5 years or after a channel forming flow event to evaluate whether restored areas have performed to reduce erosion and channel incision.

Phase 3 West will make a one-time removal of 38,100 metric tons (23,813 cubic meters) (31,146 cubic yards) of fine sediment from the system from grading eroding banks (Assuming soil bulk density of 1.6 metric tons per cubic meter), and an estimated average annual reduction in bank erosion rates of 750 metric tons/mile/year thereafter. **Over the life of the Project (20 years), implementation of Phase 3 West will reduce sediment loading by 2,505 metric tons/year [1,905+(750*.8 miles)], or 13% of the total annual target reduction for the watershed from channel erosion.**

Completion of the first three Phases of restoration construction combined (Reaches 1 through 4 West) will have made a one-time removal of 117,400 metric tons (58,000+21,300+38,100 metric tons) (73,375 cubic meters) (95,971 cubic yards) of fine sediment from the system from grading eroding banks, and an estimated average reduction in bank erosion rates of 750 metric tons/mile/year thereafter. Over 20 years, implementation of **Phases 1-3 West combined will reduce sediment loading by 7,670 metric tons/year**

[5,870+(750*2.4 miles)], or 40% of the total target reduction for the Napa River watershed from channel incision sources.

Channel Incision

Additionally, a comparison of the channel invert profile from data collected in 1972 and 2005/2007 shows that the channel bed has degraded from approximately 5 feet in the lower half of the reach to approximately 15 ft in the upper half of the reach during this 35 year period. Channel incision rates will be measured in Project reaches a minimum of once every five years following construction or after a channel forming flood event.

Desired Outcomes

The desired outcomes for this category focus on reducing contributions of fine sediment to the Napa River by reducing rates of channel bank erosion and bed incision and creating a more stable long term channel configuration.

The goals/desired outcomes for sediment load reduction and channel morphology are as follows.

- Decrease the total surface area of eroding streambanks
- Reduce rates of bank retreat and stabilize severely eroding banks.
- Reduce rates of channel incision.
- Create inset bankfull (1.5 year flood elevation) and mid-level terraces.
- Create sustainable geometries for setback channel banks and berms.
- Minimize the need for ongoing channel stabilization and maintenance work.

To achieve these desired outcomes, the project design employs a suite of treatments described below.

Restoration Treatments

Restoration treatments to reduce sediment load and stabilize channel morphology include:

- Increase Riparian Buffer Width, and Where “Levees” Exist, Berm Set-back and Replacement

The overall aim here is to maximize channel width and counteract confinement and concentration of flows in the channel. This technique aims to satisfy design criteria that include: establish a minimum 50’ buffer between the active floodplain (defined by the 2-yr return interval flow) to allow for future widening; establish replacement berm elevations based on estimated maximum water surface elevations and define an shallow back slope to minimize scour due to overtopping (minimum 3:1 slope, target 8:1 slope). Since the current piecemeal berm system was assembled in a haphazard, undocumented manner, replacement of berm structures to a consistent engineering standard reduces risks of catastrophic berm/bank blow outs.

- Channel Reconfiguration

This approach focuses on grading/recontouring of streambanks to counter oversteepening and installation of inset flood terraces to reduce the effect of flow shear on bed and banks. Applied design criteria include: create floodplain bench cuts (at or below an elevation equal to the 2-year recurrence interval flood) in locations of active erosion to widen the channel and reduce local velocities, stabilize incised river sections by grading back channel banks from bench cuts to top of bank, with a preferred side slope of 3:1.

- Bank Stabilization

Where width does not permit application of an inset bench cut, other stabilization methods have been applied. Relevant design criteria include: when feasible, utilize soft engineering techniques such as willow plantings, placement of geotextiles, and appropriate grading to control moderate bank erosion and to reduce fine sediment loading; where softer methods are not feasible, install rock protection where significant erosion threatens structures or infrastructure.

- Grade Control Boulders and Weirs

These measures are the least frequently applied, and focus on locations of active incision. The relevant design criteria is: install grade control structures (e.g. constructed riffles, boulder weirs) in shallow runs to prevent future incision of the channel, limit the hydraulic drop to less than 1' and the longitudinal slope to less than 12.5% (8:1).

Summary Hypotheses

Historic patterns of channel confinement and incision have served to destabilize stream banks, a significant source of fine sediment impairing the water quality and supported beneficial uses of the Napa River. Since it is not feasible to restore the river to its full historic width, a suite of treatments are proposed based on opportunities and constraints, in the following order of priority. Wherever feasible, channel width should be increased by setting back bank top berm/levees or banks to reduce shear forces on bed and banks by reducing flow depths. If berm setback includes re-engineering the replacement berm to a standard geotechnical and hydraulic standard, risks of catastrophic blowouts due to berm failure will be reduced. Where feasible, bank recontouring/grading to establish a two-stage channel (described as an "inset floodplain) can reduce flow shear on banks and bed by reducing total bank height and alleviating pressure at flow "choke points." Reducing bank slopes of terrace features and elsewhere to greater than 3:1 can reduce the risk of mass failure triggered by undermining of bank toe materials. In cases of severely eroding banks adjacent to restrictive land uses (structures, etc) biotechnical bank stabilization can serve to reinforce the bank toe to prevent further fluvial entrainment and consequent mass failure.

Performance Indicators

Performance indicators for sediment load reductions and channel morphology are listed below (units in parentheses):

- Length of actively eroding streambanks over the project reach (LxH or %L);
- Rates of bed deposition and scour at representative cross-sections (L or Vol/T);
- Bankfull width to depth ratio (W/D) at representative treatment cross-sections (dimensionless).

Progress towards the desired outcome will result in an overall reduction in estimated fine sediment loading from actively eroding banks and an incising channel bed within the Rutherford Reach. Annual Surveys will identify, map, and evaluate areas of actively eroding streambanks on an annual basis. Data will be collected for basic channel morphology indicators (erosion rates and W/D as part of Transect surveys at the representative locations.

Performance Standards

The performance standard for reducing sediment loads and improving channel morphology is:

- A 75% reduction in the length, or surface area, of actively eroding streambanks in the entire project reach and on a subreach basis. (Instead of specific numeric performance targets for bed and bank erosion rates and width to depth ratios, successful performance will be defined as positive trends in reductions in bed and bank erosion rates; and increases in bankfull channel width to depth ratios as measured using repeat Transect surveys at representative cross-section locations).

Aquatic Habitat

Existing Conditions

Aquatic habitat within the Rutherford Reach consists of long runs and glides, with fewer deep pools, and occasional riffles. Pool depths typically exceed 3 feet and occasionally reach a maximum depth of approximately 9 feet. When present, cover in the pools consist of deep water, undercut banks, instream woody material, and overhead cover in the form of low growing riparian vegetation. In general, less cover and fewer cover types are present in runs and riffles compared to pools. Cover in these habitats consists of undercut banks, overhead cover from riparian vegetation, and instream woody material. The predominant substrate in the reach is gravels and sand-sized particles, although more sand than gravel is commonly present. Finer substrates, such as clay- and silt-sized particles, are generally absent. Average particle size (D_{50}) on the bars and riffles sampled in 2005 varied from approximately 8mm to 50mm, with an average of 23mm. In comparison, preferred spawning habitat for Chinook salmon typically consists of bed material ranging from 25 to 102 mm in size.

In summary, the diversity and abundance of native fish (including salmonids) in the Rutherford Reach is limited by a combination of factors including: the lack of winter and spring high flow refugia (low velocity flow areas); lack of suitable fall and winter spawning habitat (riffles and coarse gravel), lack of habitat complexity (pool, riffle, glide variability); high percentage of predatory fish habitat (deep pools and glides); and lack of instream and overhead cover.

Desired Outcomes

The goals/desired outcomes for aquatic habitat quality on the Napa River Rutherford Reach are as follows:

Overall

- Increase habitat velocity flow complexity by increasing variability in pool, riffle and glide habitats.
- Decrease percentage of deep pool and glide habitats that function as predatory fish habitat, and increase percentage of shallow pool and riffle habitat.

Summer Steelhead and Chinook Rearing

- Increase summer rearing habitat and cover by inducing lateral pool scour associated with installed habitat structures (LWD).

Fall and Winter Steelhead Rearing

- Increase and establish of high flow(>500 cfs) low velocity (<6 fps) bankfull refugia areas to increase fall and winter rearing habitat for 0-1+ Steelhead, and immigrating/emigrating salmonids.

Fall and Winter Steelhead and Chinook Spawning

- Increase of suitable fall and winter spawning habitat by increasing the frequency and length of riffle habitat, and increasing the recruitment of coarser spawning gravel by inducing sorting of bed and bar material, resulting in increased deposition of spawning-sized sediments and decreases in percentages of fines covering riffle crests / pool tails.
- Increase fall and winter spawning habitat and cover by inducing lateral pool scour associated with installed habitat structures (LWD).

Annual Steelhead 0-1+ Rearing

- Increase and establish of high flow (>500 cfs) low velocity (<6 fps) bankfull refugia areas to increase spring rearing habitat for 0+ Steelhead, and immigrating/emigrating salmonids.
- Increase quantity of high velocity feeding lanes, by creating relatively high velocity riffle habitat, and breaking up low velocity flat-water pool habitat. Induce local velocity accelerations and complexity and channel flow constrictions with installed habitat structures (LWD/Boulders).
- Enhance and encourage coarse sediment trapping for establishing riffle habitat and subsequent invertebrate production (i.e., create fish food habitat).

Spring Chinook Juvenile Rearing

- Increase and establish spring flow backwater pool habitat areas to increase spring rearing habitat for juvenile Chinook, and immigrating/emigrating salmonids.

- Increase summer rearing habitat by enhancing pool habitat complexity, depth, and shelter/canopy cover.

A summary of examples of seasonal habitat needs for different life stages of anadromous salmonids is provided in the **Tables 2 and 3** below adapted from the *USDA Forest Service Pacific Southwest Region. Stream Habitat Classification and Inventory Procedures for Northern California. FHR Currents…R-5's Fish Habitat Relationships Technical Bulletin Number One.* http://www.fs.fed.us/biology/fishecology/currents/currents01.pdf. The first section of each table is text, and the second section illustrates the habitat types. Table 2 lists critical habitat needs for salmonids, while Table 3 lists habitat restoration goals for the Napa River Rutherford Reach.

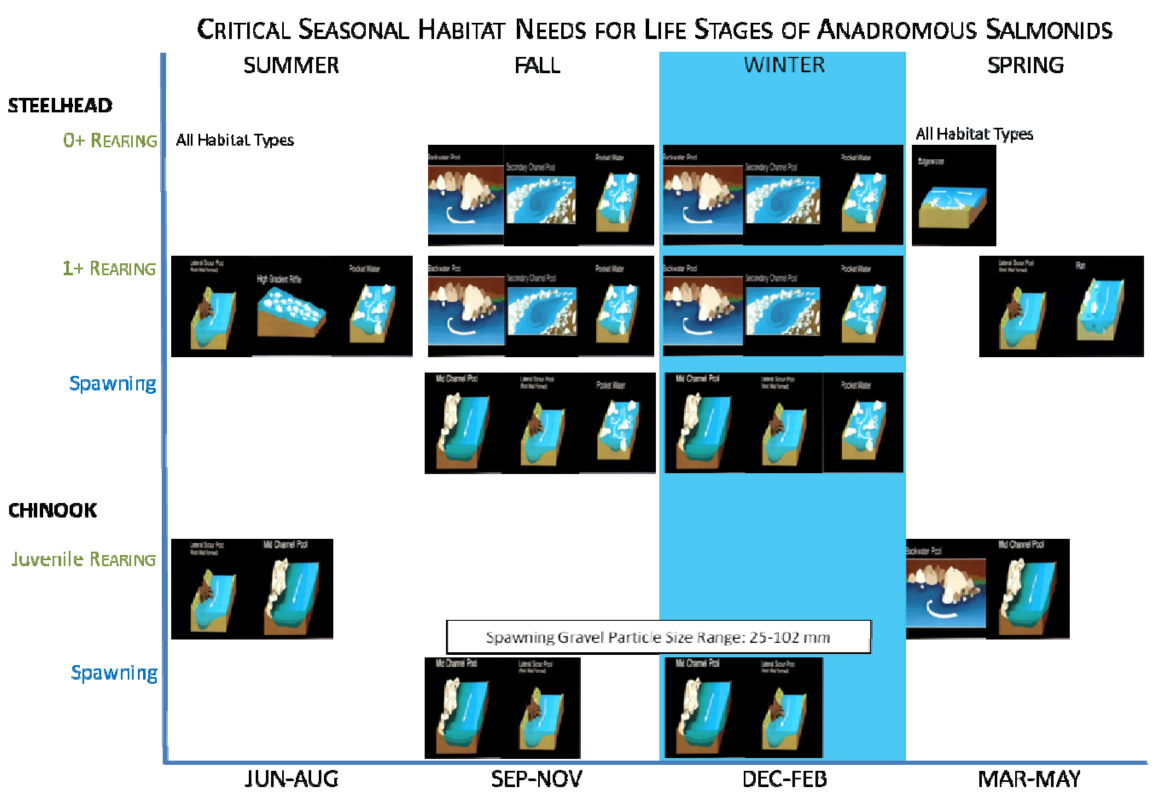
To achieve these desired outcomes, the project design employs a suite of treatments described below.

Table 2. Critical Seasonal Habitat Needs for Life Stages of Anadromous Salmonids

Critical Seasonal Habitat Needs for Life Stages of Anadromous Salmonids

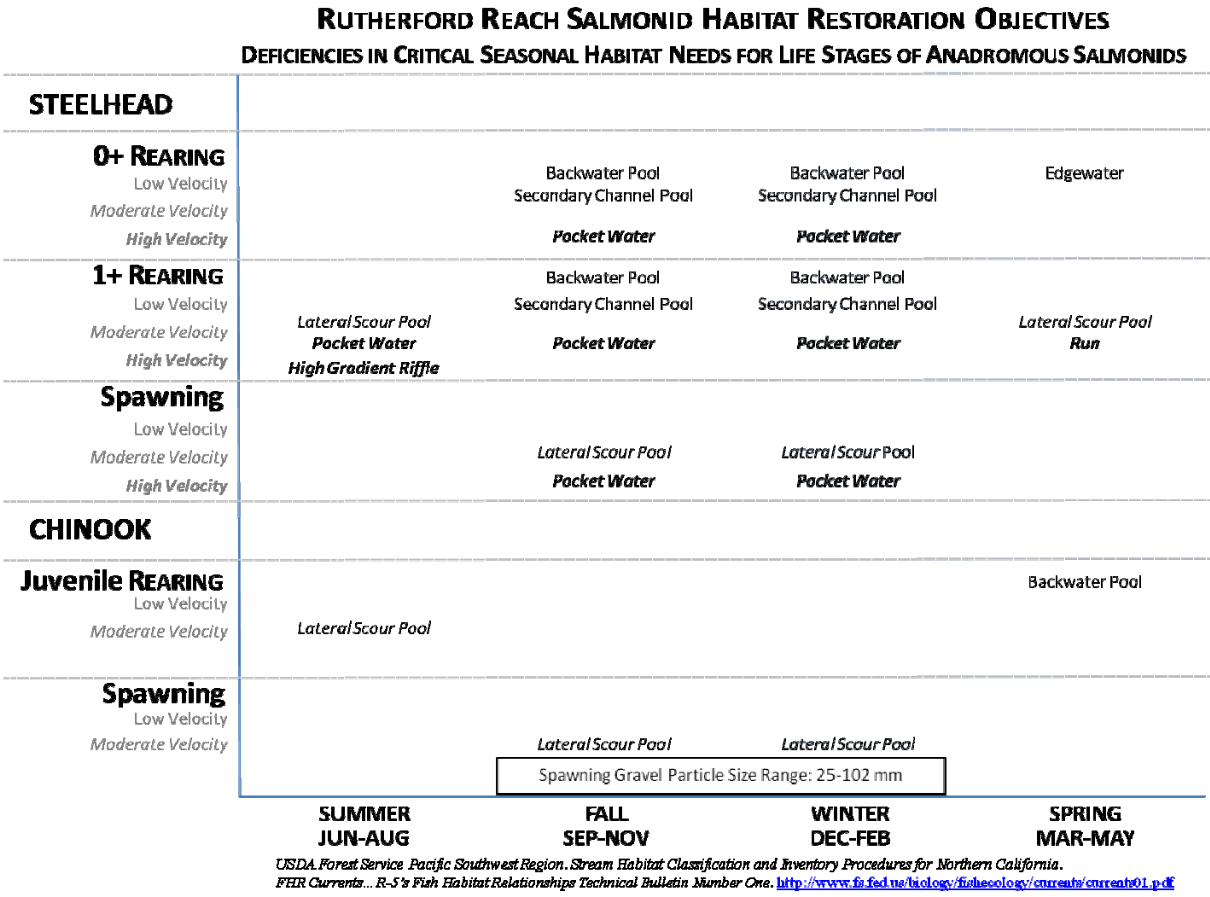
	Summer Jun-Aug	Fall Sep-Nov	Winter Dec-Feb	Spring Mar-May
STEELHEAD				
0+ Rearing (Low Velocity / *Moderate Velocity* / ***High Velocity***)	All Habitat Types	Backwater Pool Secondary Channel Pool ***Pocket Water***	Backwater Pool Secondary Channel Pool ***Pocket Water***	Edgewater All Habitat Types
1+ Rearing (Low Velocity / *Moderate Velocity* / ***High Velocity***)	*Lateral Scour Pool* ***Pocket Water*** ***High Gradient Riffle***	Backwater Pool Secondary Channel Pool ***Pocket Water***	Backwater Pool Secondary Channel Pool ***Pocket Water***	*Lateral Scour Pool* ***Run***
Spawning (Low Velocity / *Moderate Velocity* / ***High Velocity***)		Mid-Channel Pool *Lateral Scour Pool* ***Pocket Water***	Mid-Channel Pool *Lateral Scour* Pool ***Pocket Water***	
CHINOOK				
Juvenile Rearing (Low Velocity / *Moderate Velocity*)	Mid-Channel Pool *Lateral Scour Pool*			Backwater Pool Mid-Channel Pool
Spawning (Low Velocity / *Moderate Velocity*)		Mid-Channel Pool *Lateral Scour Pool* Spawning Gravel Particle Size Range: 25-102 mm	Mid-Channel Pool *Lateral Scour Pool*	

USDA Forest Service Pacific Southwest Region. Stream Habitat Classification and Inventory Procedures for Northern California.
FHR Currents... R-5's Fish Habitat Relationships Technical Bulletin Number One. http://www.fs.fed.us/biology/fishecology/currents/currents01.pdf



USDA Forest Service Pacific Southwest Region. Stream Habitat Classification and Inventory Procedures for Northern California. FHR Currents... R-5's Fish Habitat Relationships Technical Bulletin Number One.

Table 3. Rutherford Reach Salmonid Habitat Restoration Objectives



RUTHERFORD REACH SALMONID HABITAT RESTORATION OBJECTIVES
DEFICIENCIES IN CRITICAL SEASONAL HABITAT NEEDS FOR LIFE STAGES OF ANADROMOUS SALMONIDS

	SUMMER JUN-AUG	FALL SEP-NOV	WINTER DEC-FEB	SPRING MAR-MAY
STEELHEAD				
0+ REARING — Low Velocity		Backwater Pool Secondary Channel Pool	Backwater Pool Secondary Channel Pool	Edgewater
Moderate Velocity				
High Velocity		***Pocket Water***	***Pocket Water***	
1+ REARING — Low Velocity		Backwater Pool Secondary Channel Pool	Backwater Pool Secondary Channel Pool	
Moderate Velocity	*Lateral Scour Pool*			*Lateral Scour Pool*
High Velocity	***Pocket Water*** ***High Gradient Riffle***	***Pocket Water***	***Pocket Water***	***Run***
Spawning — Low Velocity				
Moderate Velocity		*Lateral Scour Pool*	*Lateral Scour Pool*	
High Velocity		***Pocket Water***	***Pocket Water***	
CHINOOK				
Juvenile REARING — Low Velocity				Backwater Pool
Moderate Velocity	*Lateral Scour Pool*			
Spawning — Low Velocity				
Moderate Velocity		*Lateral Scour Pool*	*Lateral Scour Pool*	

Spawning Gravel Particle Size Range: 25-102 mm

USDA Forest Service Pacific Southwest Region. Stream Habitat Classification and Inventory Procedures for Northern California.
FHR Currents... R-5's Fish Habitat Relationships Technical Bulletin Number One. http://www.fs.fed.us/biology/fishecology/currents/current01.pdf

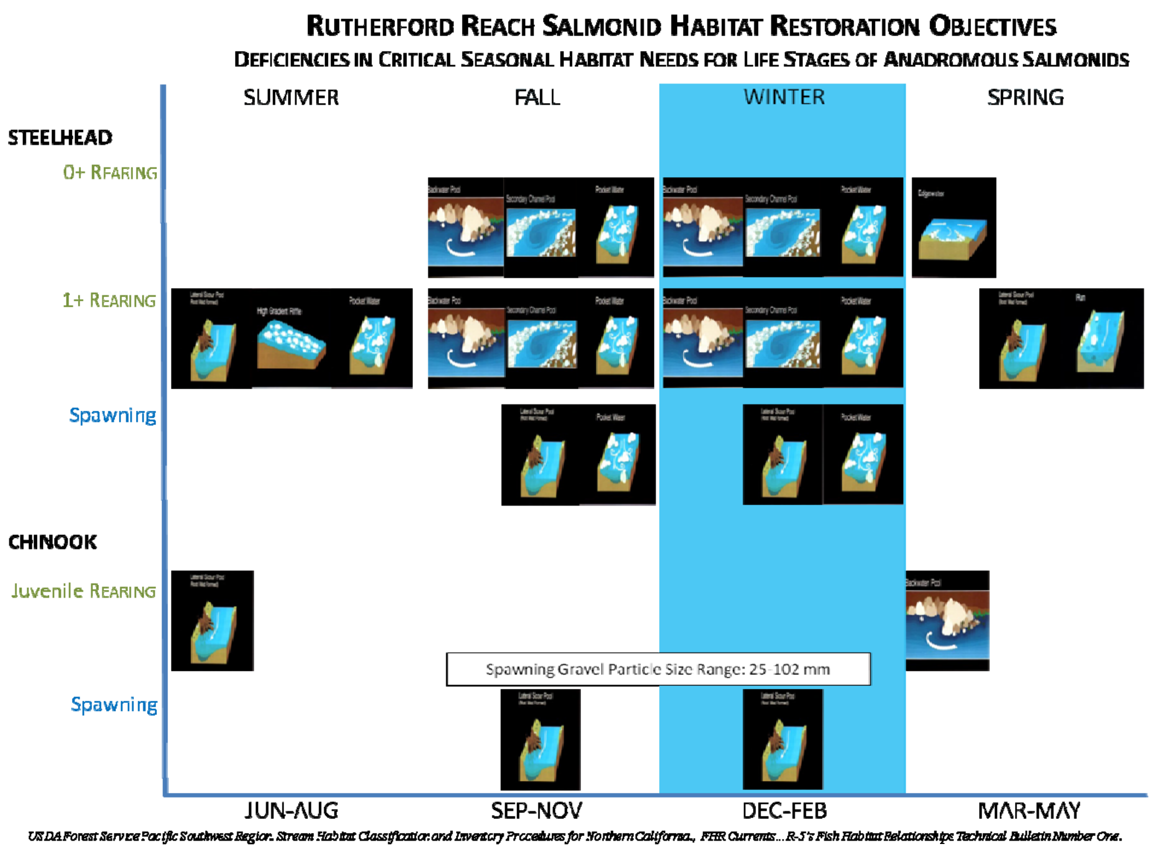


Table 2 & 3. Definitions

High Velocity Habitat

High Gradient Riffles

Steep reaches (>4%) of moderately deep and very turbulent water. High relative amount of exposed substrate. Substrate is boulder dominated. Water velocity is high.

Pocket Water

A section stream containing numerous boulders or other large obstructions which create eddies or scour hole pockets behind the obstructions. Water velocity is high.

Run

Reaches with little surface agitation and no major flow obstructions. Often appears as flooded riffles. Substrate varies from gravel to cobble and boulders. Water velocity is high.

Moderate Velocity Habitat

Lateral Scour Pool– Boulder / Root Wad / Log / Bedrock Formed

Pool formed by flow impinging against one stream bank or against a partial channel obstruction, such as rootwads, woody debris, boulders and bedrock. The associated scour is confined to <60% of the wetted channel width. Water velocity is moderate.

Low Velocity Habitat

Mid-Channel Pool

Large pools formed by mid-channel scour encompassing more than 60% of the wetted channel. Substrate is highly variable. Water velocity is low.

Backwater Pool – Boulder / Root Wad / Log Formed

Pool along channel margins and caused by eddies around obstructions such as boulders, rootwads, or woody debris. Pools are usually shallow and dominated by fine-grained substrates. Water velocity is low.

Edgewater

Quiet, shallow area found along the margins of the stream, typically associated with riffles. Substrate varies from cobbles to boulders. Water velocity is low and sometimes lacking.

Secondary Channel Pool

Pools formed outside of the average wetted channel, which are dry, or nearly dry in summer. Mainly associated with gravel bars. Substrates vary from silt, to sand and gravel. Velocity is low.

Restoration Treatments

Restoration treatments to improve aquatic habitat include:

- Installed In-Channel Features

A variety of in-stream structures are proposed to created channel irregularities capable of creating flow velocity accelerations that in turn cause bar deposition or pool scour, cause bed material sorting (coarsening of riffles), and provide instream cover.

Large Woody Debris, Spider Logs, and other Log-Boulder Structures
Install large woody debris structures along channel margins to create lateral pool scour habitat and increase cover. Install instream habitat structures to narrow the low flow channel by ¼ to 1/3 of its original width to create pocket water and high-velocity feeding lanes, promote coarser spawning gravel deposition, reduce fine sediment deposition. Install large woody debris on constructed instream benches to create high flow (>500 cfs) low velocity (<6 fps) backwater pool bankfull refugia habitat for steelhead and Chinook juvenile rearing.

Plant Material: Native Willow Cuttings, Off-Bench Branch Cover, Branch Bundles.
Plant soft structures such as willow cuttings and branch cover/bundles to create in-stream cover needed for salmonids to evade predation, as well as edgewater habitat critical for steelhead spring 0+ rearing.

Constructed Riffles
Place large rock in constructed grade control structure to add hydraulic and geometric complexity to the channel, create pocket water and high gradient riffle habitat for steelhead spawning and rearing.

Backwater Alcoves on Created Instream Benches and Historic Secondary Channels
Grade secondary channel pool habitat features into constructed instream benches to simulate confluence conditions with historic secondary channels and provide steelhead fall and winter rearing habitat. Grade benches with a gradient of at least .005 to maintain drainage towards channel to prevent fish stranding.

Grade backwater alcoves into historic secondary channel confluences to create backwater pools for fall and winter steelhead and spring Chinook rearing habitat.

Create Instream Benches on Alternating Banks
Promote hydraulic flow variations to create geomorphic complexity; increase frequency of riffle habitat; break up existing flat-water habitat and deep pools providing predatory fish habitat.

Summary Hypotheses

Processes of channel confinement and incision have reduced aquatic habitat complexity by creating a “plane bed” morphology due to increases in shear forces acting on the bed. Project gains in channel width alone will be insufficient to restore habitat complexity, and there is no indication that the channel would be capable of reclaiming its original width under a “no-action “

alternative in less than a century. Installation of in-stream structures will create variations in hydraulic forces by creating obstructions to flow and creating irregular channel roughness elements. Hydraulic complexity will increase deposition and sorting of bar-sized sediments in transport, resulting in increased area of bar and riffle features and deeper pools. Large woody debris and live plant material placed within the channel will provide much needed cover to avoid predation, especially during the summer rearing season. Created backwater habitats and constructed riffles will increase winter rearing value by creating low-velocity refugia during peak floods.

Performance Indicators

Progress toward the goals/desired outcomes for aquatic habitat quality improvements will be based on (units in parentheses):

- Channel substrate size distribution (median statistic values for size frequency distribution, % fine sediment)
- Riffle length and frequency
- Residual pool depth;
- Large woody debris structure persistence (# years, % persisting);
- Riparian/overhead cover (%);
- Area of high-flow refugia in constructed alcoves and bankfull instream benches (A);
- Flow velocities in constructed high-flow refugia areas (v)

Progress toward the desired outcomes for aquatic habitat structures will in part be based on the persistence/long-term viability of the installed structures. Field surveys, conducted as part of the maintenance program, will evaluate the integrity of the structures on an annual basis. Data will be collected for the other indicators as part of the permanent cross section transect and local longitudinal profile surveys (described below).

Performance Standards

The performance standards for aquatic habitat quality are:

- A statistically significant increase in riffle median grain size (D50 mm);
- A statistically significant reduction in riffle substrate percentage of fines (<2mm);
- A 30% increase in riffle length or riffle frequency in treated locations;
- A 25% increase in residual pool depth in treated locations;
- A 75% persistence of installed instream habitat enhancement structures;
- A 40% increase in seasonal refugia cover
- Creation of high flow refugia with (velocities less that 6 fps) for flows 500 cfs and above at constructed alcoves and instream bankfull benches.

A performance standard was not established for area of high-flow refugia, since there are no baseline values for comparison; however, data from successive monitoring periods will be compared to identify and evaluate changes in high-flow refugia habitat resulting from graded or installed restoration features.

Riparian Habitat

Existing Conditions

The species composition and the width and extent of the riparian corridor vary considerably throughout the Rutherford Reach depending on channel width, bank steepness, and adjacent land uses . In general, Reaches 1, 2, 3, and 5 support the largest intact stands of mature riparian vegetation. Valley oak (*Quercus lobata*), coast live oak (*Quercus agrifolia),* and California walnut (*Juglans hindisi*) are the dominant species in these reaches. Reaches 3, 5, 6 and 7, where the wider channel permits development of bars and inset floodplain benches, support extensive stands of Fremont cottonwood (*Populus fremontii*), white alder (*Alnus rhombifolia*), red willow (*Salix laevigata*), arroyo willow (*Salix lasiolepis*), yellow willow (*Salix lutea*), and sandbar willow (*Salix exigua*). Overstory vegetation is relatively sparse in Reach 4 consisting of small stands or individual valley and coast live oaks. California bay (*Umbellularia californica*), blue elderberry (*Sambucus mexicana*), and California buckeye (*Aesculus californica*) are also found within the project area. The width of the riparian corridor (including vegetated areas along both banks) is greatest in Reach 1 (600 to 800 feet). The riparian corridor in Reaches 3, 5, 6, and 7 is also relatively wide, ranging from 250 to 400 feet in width. Reaches 2, 4, 8, and 9, which are confined by levees and adjacent land use, support narrow bands of riparian vegetation (150 feet or less).

In many portions of the Rutherford Reach, the riparian understory is dominated by non-native species including Himalayan blackberry (*Rubus discolor*), periwinkle (*Vinca major*), and wild grape (*Vitis* sp.). Other non-native invasive species such as giant reed (*Arundo donax*) are also pervasive throughout the project area. However, other areas support substantial patches of native understory species including snowberry (*Symphoricarpos albus*), Santa Barbara sedge (*Carex barbarae*), creeping wild rye (*Leymus triticoides*), and California rose (*Rosa californica*). In these reaches, it is not unusual to find areas dominated by native overstory and understory species. These areas of high native diversity are primarily a result of invasive species removal and revegetation projects implemented by local landowners to control Pierce's disease, and by the District to control giant reed.

In general, the extent and diversity of riparian habitat found within the project area is limited by the morphology of the channel. In most reaches the confined nature of the channel prevents the establishment of inset floodplain benches and bars that would enable recruitment and establishment of riparian species. Additionally, channel incision has increased channel capacity and decreased the frequency of overtopping leading to the development of a more xeric mix of plant species (e.g., oaks) along the top of the river bank.

Desired Outcomes

The goals/desired outcomes for riparian habitat quality are as follows:

- Increase and enhance riparian and floodplain habitat value and complexity, with secondary benefits of improving bird and wildlife diversity.
- Create a self-sustaining native riparian corridor.

- Decrease invasive non-native and Pierce’s Disease host plants.
- Increase diversity of native plant species.
- Maintain expanded riparian buffer width.

To achieve these desired outcomes, the project design employs a suite of treatments described below.

Restoration Treatments

Restoration treatments to improve riparian habitat include:

- Non-Native Vegetation Removal
  Remove dense patches (greater than .01 acre) of invasive exotic and non-native Pierce’s Disease (PD) host plants and replant with native under and overstory plants (VW-6)

- Native Restoration Plantings
  Relevant design criteria include: establish planting zones based on water surface elevations and distance from channel (VW-3); establish a minimum 50’ buffer to reduce disturbance to native wildlife and encourage migration (VW-4); fill existing canopy gaps < 25’ in length (VW-5); increase plant diversity and structure to improve quality for resident and migrant wildlife, especially riparian-dependent birds (VW-7); obtain all plant material from Napa River watershed (VW-10); salvage native plant material for transplanting onto newly excavated benches and slopes (VW-11); irrigate all newly established plant material (VW-13); stabilize exposed soils using a hydromulch consisting of a native (or sterile) seed mix (VW-14).

Summary Hypotheses

Interruption of historic patterns of disturbance due to flooding has reduced riparian corridor width and interrupted succession processes critical to recruitment and survival of native riparian vegetation species and communities. Absent significant change in the geomorphic regime (outside the scope of this project), the riparian community will continue to decline as older trees die and recruitment is impaired due to numerous factors (lack of suitable geomorphic surfaces for colonization, competition with invasive plan species, seed/seedling predation by introduced species, etc). Artificial creation of inset flood terraces and bank setback and grading increases the area suitable for riparian recruitment. In particular in terms of created flood terraces, designing terraces for inundation at approximately the two-year return interval event creates new disturbance zones where future recruitment may be self-sustaining, assuming invasives continue to be controlled as part of project maintenance.

Performance Indicators

Progress toward the goals/desired outcomes for riparian habitat quality improvements will be based on (units in parentheses):

- Area successfully treated (acres)
- Plant survival at revegetation sites (%)
- Percent native vegetative cover: Absence/presence natural recruitment (no units).

Vegetation monitoring data will be collected at specific revegetation sites by the landscape contractor under District supervision and at Transects (which may contain both sites with no vegetation treatment and treatment sites) by the District-led monitoring team (see protocols for details).

Performance Standards

The performance standards for riparian habitat quality are:

- A minimum 20 acres over the life of the Rutherford Reach project (acres)
  - Phase 1: a minimum of 6.00 acres riparian habitat established
  - Phase 2:, a minimum of 1.43 acres riparian habitat established
- A 75% survival of native plants at revegetation sites;
- Greater than 90% native cover (less than 10% total non-native);
- Evidence of successful natural recruitment by year 5 at revegetation sites;

Photomonitoring will complement field surveys with a visual record of progress.

Stakeholder Participation

Existing Conditions

The Rutherford Dust Restoration project is a landowner-initiated project. This leadership has been central to the success of the project. Maintaining Landowner buy-in and active participation will remain a key element of project viability. Through community outreach, this private-public partnership can serve as a model for other communities.

Performance Indicators

The performance standards for stakeholder participation are:

- Landowner participation in adaptive monitoring and management
- Landowner Advisory Committee participation

Performance Standards

- Continuation of at least 90% landowner participation in the project.

- Continued landowner leadership, as evidenced via the Landowner Advisory Committee (LAC) and willingness to fill offices (Chair, Vice-Chair, Secretary).
- Ongoing access granted for team members, including Napa County Flood District and the Napa County Resource Conservation District.

SCHEDULE

As of the writing of this document, the anticipated schedule for the construction of the project is as follows:

Phase	Subreaches	Year
Phase 1-east bank	Subreaches 1 and 2	2009
Phase 1-west bank	Subreaches 1 and 2	2010
Phase 2	Subreach 3	2010
Phase 3	Subreaches 4 and 8 west	2011
Phase 4	Subreaches 7 and 8	2014
Phase 5	Subreaches 5, 6 and 9	2017

Table 4 provides a summary of performance indicators, standards, and monitoring activities organized by monitoring frequency.

Stream maintenance and monitoring surveys commenced in summer 2009 and will continue annually through the 20-year duration of the River Maintenance District.

Repeated transect surveys are scheduled before and after the construction of each phase. The cross section transects in each phase will be surveyed pre-construction, and within two years post-construction, thereafter at least once every five years. Cross section transects may be also resurveyed after a significant channel forming flood event, or as deemed necessary by findings during the annual stream reach survey. Transects will be re-occupied and surveyed in the event of a channel changing flood event to re-establish baseline surveys before the construction of a phase, as well as to monitor changes in constructed project reaches. Transects will be re-occupied and surveyed at least once every 5 years in the absence of a channel forming event, unless annual stream surveys indicate minimal change.

A baseline monumented longitudinal thalweg survey of the Rutherford Reach will be completed by 2010. Repeated local surveys can be conducted to assess changes in thalweg elevation and channel incision.

Re-vegetated riparian areas will be monitored in the first three establishment years by the contractor that installed them. Thereafter vegetation monitoring and management in restored areas will be done by the Napa County Flood Control and Water Conservation District under the Maintenance Assessment District program. Photomonitoring will be incorporated into the annual stream reach survey, repeated cross section transect surveys, and phased vegetation establishment surveys. Photomonitoring of project progress will be conducted at least once every three years.

As air photos become available, and as the project budget allows, the riparian buffer width and stream network will be assessed and incorporated in the spatial database.

Evaluation of stakeholder participation in events will take place as those events occur.

Table 4. Monitoring Parameter Protocols, References, and Category by Frequency

Annual Stream Reach Survey

Monitoring Parameter	Protocols	Reference Sources	Category
Sediment Delivery to the Channel: Length and Height (Surface Area) of Actively Eroding Banks (Failing graded slopes, mass wasting, slumps, flows, etc)	Mapping and Measurement of Height and Length of Actively Eroding Streambanks, Photodocumentation	Gerstein and Harris (2005) Harrelson et al. (1994) Nossaman et al. (2007)	Sediment Load Reductions & Channel Morphology
Large Woody Debris Logs and Jams (>12 inch diameter, or clump of >4 pieces)	Mapping and Categorization of LWD by geomorphic unit, salmonid habitat function, and risk to bank stability; Photodocumentation	Gerstein (2005) Flosi et al / CDFG. (1998)	Aquatic Habitat Quality
Channel Geomorphic Heterogeneity: Riffle Habitat Frequency and Distribution	Mapping of Riffle Crests with GPS		Aquatic Habitat Quality
Installed Habitat Structure (LWD/Boulder/Other) Affect on Increasing Pool Depth and Habitat Complexity: Residual Pool Depth (Change in Pool Storage of Fines)	Measurement of Residual Pool Depth at Locations of Installed Habitat Structures (LWD/Boulder/Other)	Lisle (1987)	Aquatic Habitat Quality
Installed Habitat Structure Persistence (LWD/Boulder/Other)	Evaluation of Persistence and Status at Locations of Installed Habitat Structures	Lisle (1987)	Aquatic Habitat Quality
Areas requiring weed control, including infestations of Pierce's disease host species	Mapping, Photodocumentation, Land Owner Request Forms	Harris (1999, 2005) Herrick et al (2005 a) Interagency Technical Reference (1996)	Riparian / Floodplain Habitat Quality
Areas requiring trash removal	Mapping, Photodocumentation		Aquatic & Riparian Habitat Quality

Seasonal Aquatic Habitat Surveys of Constructed Alcoves and Bankfull Instream Benches

Monitoring Parameter	Protocols	Reference Sources	Category
Area of Low Velocity High Flow Refugia Within Bankfull at Constructed Alcoves and Bankfull Benches	Habitat Unit Mapping and/or Sketch of River Flow Pattern; Narrative Description of Restoration Feature Affect on River Flow Pattern and Relative Velocity; Photodocumentation; Velocity Flow Measurements in Accessible Areas of High Flow Refugia Habitat in Constructed Alcoves and Bankfull Benches	USDA (2003) Gerstein (2005) Flosi et al / CDFG. (1998) Fisheries Biologist Expert Opinion	Aquatic Habitat Quality

Repeated Channel Transect Surveys and Local Longitudinal Profiles

Monitoring Parameter	Protocols	Reference Sources	Category
Channel Adjustment: Bed Deposition or Scour in Control Versus Treated Reaches	Cross Section Transects, Local Longitudinal Thalweg Survey, Photodocumentation	Flosi et al / CDFG. (1998) Gerstein (2005) Harrelson et al (1994) Gerstein (2005) Harrelson et al (1994)	Sediment Load Reductions & Channel Morphology
Bankfull Width to Depth Ratio: Entrenchment	Cross Section Transects	Fitzpatrick et al (1998) Rosgen (1996)	Sediment Load Reductions & Channel Morphology
Flood Stage / High Water Mark	Cross Section Transects	Fitzpatrick et al (1998)	Sediment Load Reductions & Channel Morphology
Bank Stability *(Rates of Widening at reference vs. restored cross sections)*	Cross Section Transects	Gerstein and Harris (2005) Nossaman et al. (2007)	Sediment Load Reductions & Channel Morphology
Channel Planform Network (Primary and Secondary Channels)	Photodocumentation of Constructed Alcoves, Local Longitudinal Thalweg Profile; Velocity Profile; Photodocumentation Air Photo Analysis (As Available)	Fitzpatrick et al (1998)	Sediment Load Reductions & Channel Morphology
Channel Geomorphic Heterogeneity: Riffle, Pool and Glide Habitat Distribution	Cross Section Transects, Local Longitudinal Thalweg Survey or Habitat Unit Mapping at Locations of Installed Structures.	Flosi et al / CDFG (1998) Gerstein (2005) Harrelson et al. (1994); USDA R-5s Bulletin Number One	Pre-and Post-Construction, and Post Significant Channel Forming Event
Spawning Gravel Recruitment: Channel Substrate Size Distribution / Riffle Median Grain Size (D50)	Modified Wolman Pebble Count, and/or Grid Pebble Count at Riffle Crests near Cross Section Transects	Bunte & Abt (2001) Cover et al (2008) Fitzpatrick et al (1998) USDA (2003) Wolman (1954)	Aquatic Habitat Quality
Riparian Vegetation Buffer Width	Cross Section Transects, Vegetation Surveys Air Photo Analysis (As Available)	Harris (1999, 2005)	Riparian / Floodplain Habitat Quality

Phased Vegetation Establishment Years 1,2,3,5 and 7

Monitoring Parameter	Protocols	Reference Sources	Category
Riparian Vegetation Buffer Width for first five years after planting	Cross Section Transect Vegetation Survey; Air Photo Analysis (As Available)	Harris (1999, 2005)	Riparian / Floodplain Habitat Quality
Number of Pierce Disease Host Plant Infestations for first five years after planting	Area Mapping Vegetation Survey; Direct Count Vegetation Survey; Photodocumentation	Herrick et al (2005 a) Interagency Technical Reference (1996)	Riparian / Floodplain Habitat Quality
Restoration Planting Survival (80% in first five years after planting)	Cross Section Transect Vegetation Survey; Direct Count Vegetation Survey; Photodocumentation	Nossaman et al. (2007) Harris (1999, 2005) Gaffney (2008)	Riparian / Floodplain Habitat Quality

As Air Photos Become Available

Monitoring Parameter	Protocols	Reference Sources	Category
Channel Planform Network (Primary and Secondary Channels)	Photodocumentation of Constructed Alcoves Air Photo Analysis	Fitzpatrick et al (1998)	Stream Channel Geometry, Capacity, & Stability
Riparian Vegetation Buffer Width	Cross Section Transects, Vegetation Surveys Air Photo Analysis	Harris (1999, 2005)	Riparian / Floodplain Habitat Quality

As Events Occur

Monitoring Parameter	Protocols	Reference Sources	Category
Landowner participation in adaptive monitoring and management	Landowner maintenance requests and access agreements	FISRWP (2001)	Stakeholder Participation
Landowner Advisory Committee (LAC) participation	Meeting minutes; Surveys of participation; Opinion surveys of effectiveness	FISRWP (2001)	Stakeholder Participation

MONITORING PROTOCOLS

Annual Stream Reach Survey

Objectives

The objectives of the Annual Stream Reach Survey are to:

- Identify and prioritize maintenance actions, including vegetation management, large woody debris (LWD) realignment and/or relocation, debris/large trash removal, and biotechnical stabilization;
- Identify infestations of non-native invasive and Pierce's disease host plant species, and define control treatments to the extent practicable.
- Evaluate the persistence, status of, steps needed to maintain the function of constructed instream habitat enhancement structures;
- Quantify the surface area of eroding banks and consequent sediment source delivery to the channel;
- Evaluate the effect of installed instream structures on channel morphology; specifically on the formation of pools and distribution of riffles.

The District will work with the LAC to develop standard data sheets for the Annual Stream Reach Survey, which will be conducted concurrently with the Maintenance Survey. Data sheets, aerial photographs, and GPS units will be used to document the nature and extent of the problem, and to identify recommended treatments or remedial actions. Photos will also be taken to document each problem site. The results of the survey will be compiled into a report and presented to the LAC for review. Reports will be archived with the Napa County Resource Conservation District.

Flood District staff, in coordination with the LAC, will conduct these routine (at least once a year) surveys to identify and assess issues of concern relative to the program objectives. It may also be necessary to conduct interim river surveys shortly after large storm events (< 10-year flood event) to identify areas that may require immediate treatment to prevent additional streambank failure, and to protect existing infrastructure and environmental resources. The Annual Stream Reach Survey will also be used as a tool to determine when more in-depth long term monitoring cross section transect surveys are required.

Monitoring Parameters by Category

The Annual Stream Reach Survey will along the entire length of the 4.5 mile Rutherford Reach. The parameters to be identified, mapped and assessed in the Annual Stream Reach Survey are presented in Table 4.

In addition to determining maintenance needs for the treated areas of the project, the following stream assessment parameters will be evaluated during the annual survey:

- Surface area of Actively Eroding Banks (Failing graded slopes, mass wasting, slumps, etc)
- Large Woody Debris Logs and Jams (>12 inch diameter, or clump of >4 pieces); and their effect on channel morphology;
- Residual Pool Depth associated with Installed Instream Structures;
- Distribution and frequency of riffle crests to measure habitat unit complexity;
- Areas requiring weed control.

Monitoring Parameter Methods

The following protocols will be used to assess the above parameters:

- Survey of Actively Eroding Streambanks; and Bank Erosion Factors
- Assessment of Streambank Stabilization Structures
- Survey of Large Woody Debris and Geomorphic Function
- Assessment of Aquatic Habitat Instream Structures, and Geomorphic Function
- Measurement of Residual Pool Depth Associated with Instream Structures
- Mapping of Riffle Crests
- Weed Infestations
- Photodocumentation
- Land Owner Request Forms

The methods for conducting these protocols are discussed individually below.

Survey of Actively Eroding Stream Banks

Objectives

The length of actively eroding channel banks will be measured during the Annual Stream Reach Survey to assess the effectiveness of bank stabilization treatments in reducing sediment loads to the stream.

Methods

The survey of actively eroding streambanks will measure and assess:

- Length and height of actively Eroding Streambanks
- Streambank Stability

Prior to construction, Jones and Stokes conducted a survey of eroding streambanks based on definitions of bank conditions in the U.S. Forest Service Region 5 *Stream Condition Inventory Technical Guide, Pacific Southwest Region* (USDA, 2005): http://www.fs.fed.us/r5/publications/water_resources/sci/techguide-v5-08-2005-a.pdf. During the Annual Stream Reach Survey, record only unstable and potentially unstable stream banks on the Annual Stream Reach Form. During the Annual Stream Survey inventory areas of excessive vegetation growth, trash, large woody debris or other factors contributing to streambank erosion.

The term 'bank instability' refers to stream banks that are either actively retreating or have the potential to retreat in the near future. Bank instability was assessed in all previously surveyed areas (i.e., the PWA survey), and any other areas with unstable or potentially unstable banks. The purpose of assessing this indicator is to identify fluvial erosion (erosion associated with flowing water) and bank failure (erosion associated with gravitational forces and weakening processes). In brief, weakening processes are any bank or near-bank processes that act to erode or prepare banks for further erosion (Lawler, 1992). Fluvial erosion is closely related to boundary shear stress, which can be loosely approximated by unit stream power variations, and bank failure is collapse of all or part of the bank in situ (Lawler, 1995).

Bank stability is defined as a natural streambank that has stable groundcover. Stable ground cover includes rooted trees, shrubs, herbaceous plants, and naturally occurring rocky substrates. The terms defined in Table 3 were used to describe observed bank instability conditions in the initial survey. Instability codes have been updated to correlate with Collins (2008) Qualitative Monitoring Feature Codes.

Qualitative Monitoring Feature Codes

http://ftp.dfg.ca.gov/public/FRGP/Qualitative_Monitoring_Forms/2008%20Implementation_Monitoring/Supporting_Documents/Checklist_Letter_Codes_2008.pdf

Photograph unstable banks and banks requiring maintenance on the Photo Data Sheet.

Table 3. Terms Describing Bank Stability Conditions [a]

Category	Term	Definition
Banks	Stable bank	Has 75% or more cover of live plants and/or other stability elements that are not easily eroded and has no instability elements
	Potentially unstable bank	Has 75% or more cover but has 1 or more instability element(s)[b]
	Unstable bank	Has less than 75% cover of live plants and/or other stability elements and/or 1 or more instability element(s) (unstable banks are often bare or nearly bare banks composed of noncohesive soil that is susceptible to fluvial erosion; particle size may vary depending on bank material)
Stability elements	Live plants	Perennial herbaceous species, such as grasses, sedges, rushes; woody shrubs, such as willows; broadleaf trees, such as cottonwood and alder; conifer trees; and plant roots that are on or near the surface of the bank and provide substantial binding strength to the bank material
	Rock	Boulders, bedrock, and cobble/boulder aggregates that are combined to form a stable mass
	Downed wood	Logs firmly embedded in banks
	Erosion-resistant soil	Hardened conglomerate or cohesive clay/silt banks
Instability elements	HIG - Bank height	Moderately high to high bank height relative to surrounding banks
	SMP - Fracturing, blocking, or slumping	Cracks near the top of the bank, slumping banks, and blocks of soil/plant material that have fallen off or slid down the bank
	LDS- Landslides & Mass movement	Bank failure from landslides and gravity erosion of oversteepened bank slopes
	UND - Undercutting	Frequent or continuous scour; significant to severe undercutting

[a] Based on definitions of bank conditions in the U.S. Forest Service Region 5 *Stream Condition Inventory Guidebook.*

[b] Exception: Bank will be classified as stable if bank height is the only instability element present.

Start Station		Stream Name:				Date:	Surveyors:	
		Annual Stream Reach Survey - Eroding Banks, Weed Control, LWD						
GPS PT	**FROM +US/-DS**	**Length**	**Height**	**Bank**	**Problem Feature**	**Description**	**Recommendation**	**Priority**
	(feet)	(feet)	(feet)	Right, Left, Channel	Unstable or Potential Unstable Eroding Bank; Weed Control Site; Erosive LWD; Trash	Location Description; Height or Area Dimension; Bank Instability Element (HIG-Bank Height, SMP-Slump or Fractured Bank, LDS-Landslide or Mass Movement; UND-Undercut) , Problem; Type of Weed; Pierce Disease; LWD Accumulations and Jams with High Erosion Potential		High, Medium, Low

Record the following information about eroding banks, and maintenance issues on the field data form, or into a GPS with the following data fields:

Eroding Banks
DATE
RIVER STATION (US start)
LENGTH (feet)
BANK LOCATION
Right
Left
Other
BANK_EROS_LOCATION
Top of Bank
Base of Bank
Whole Bank
AVG_ERODING_BANK_HT
BANK CONDITION
Treated Bank
Unstable Bank
Other
TREATMENT_ELEMENT
Erosion BMP
Live Plantings
Rock/Boulder
Rip Rap
Bio Engineered
Armored
Downed Wood
Other
INSTABILITY ELEMENT_DESC_BANK
HIG High Bank
SMP Slump-Fractured Bank
LDS Landslide-Mass Movement
Undercutting
Un-Vegetated
Other
RECOMMENDATION
open edit field
PRIORITY
H
M
L
NOTES
DATE
RIVER STATION (US start)
WP
NUM_OF_PHOTOS
NOTES

For further information on assessing bank stability, see the Bank Stability Line Intercept Transect protocol and data sheet outlined in Gerstein and Harris (2005) *Monitoring the Effectiveness of Bank Stabilization Restoration*, and updated by Nossaman (2007), *Quantitative Effectiveness Monitoring of Bank Stabilization and Riparian Vegetation Restoration: A Field Evaluation of Protocols*.

Sampling Locations

The entire length of the Rutherford Reach, between stream channel stations 0 and 24,900, will be assessed to determine the length of actively eroding streambanks.

Phase 1: Reaches 1 and 2

The annual stream survey of eroding banks in Phase 1 (Reaches 1 and 2) will be conducted between river stations 18,600 and 24,900.

Phase 2: Reach 3

The annual stream survey of eroding banks in Phase 2 (Reach 3) will be conducted between river stations 16,000 and 18,600.

Phase 3: Reach 4

The annual stream survey of eroding banks in Phase 2 (Reach 3) will be conducted between river stations 12,000 and 16,000.

Sampling Schedule

The Annual Stream Reach Survey will be conducted each spring.

Phase 1: Reaches 1 and 2

Construction on Phase 1: Reaches 1 and 2 began in summer 2009, and will be completed in 2010. The post-construction annual stream survey will commence in spring 2010.

Phase 2: Reach 3

Phase 3: Reach 3 pre-project baseline surveys were conducted in fall 2009. It is anticipated that construction will occur in spring 2010, and the post-construction annual stream survey will commence in spring 2011.

Phase 2: Reach 3

Phase 3: Reach 4 pre-project baseline surveys were conducted in fall 2010. It is anticipated that construction will occur in spring 2011, and the post-construction annual stream survey will commence in spring 2012.

Protocol References and Data Forms

Flosi, G., S. Downie, J. Hopelain, M. Bird, R. Coey, and B. Collins / CDFG (1998)
California Salmonid Stream Habitat Restoration Manual, Third Edition. Sacramento, California, California Department of Fish and Game, Inland Fisheries Division. http://www.dfg.ca.gov/nafwb/pubs/1998/manual3.pdf

Gerstein, J.M. and R.R. Harris. (2005)
Protocol for Monitoring the Effectiveness of Bank Stabilization Restoration. University of California, Center for Forestry, Berkeley, CA. 24 pgs. http://www.cnr.berkeley.edu/forestry/comp_proj/DFG/Monitoring%20the%20Effectiven ess%20of%20Bank%20Stabilization%20Restorati.pdf

Nossaman, S., M. Lennox, D. Lewis, P. Olin. (2007)
Quantitative Effectiveness Monitoring of Bank Stabilization and Riparian Vegetation Restoration: A Field Evaluation of Protocols. University of California Cooperative Extension.
http://ucce.ucdavis.edu/files/filelibrary/2161/36783.pdf

USDA (2005) Frazier, J.W., et al
Stream Condition Inventory Technical Guide. USDA Forest Service, Pacific Southwest Region – Ecosystem Conservation Staff. Vallejo, CA 111pp.
http://www.fs.fed.us/r5/publications/water_resources/sci/techguide-v5-08-2005-a.pdf

Washington State Department of Natural Resources (2007, November)
Watershed Analysis Manual Version 4.0.

http://www.dnr.wa.gov/Publications/fp_wsa_manual_section06.pdf

Washington State Department of Natural Resources (2008)
Forest Practices Board Watershed Analysis Manual
http://www.dnr.wa.gov/ResearchScience/Topics/WatershedAnalysis/Pages/fp_watershed_analysis_manual.aspx

Weed Survey

Objectives

The objective of the annual weed survey is to identify locations where weeds, invasive plants, and Pierce disease host plants require removal to allow for the successful recruitment of native vegetation and prevent the spread of Pierce Disease.

Methods

During the Annual Stream Survey inventory areas requiring weed control, including weeds, invasive plant species, and Pierce disease plants. On the Annual Stream Reach Survey form record the station of the site requiring removal of invasive weeds. Record the GPS waypoint number. Record whether the location is on the right or left bank. Provide a written description of the location of the site on the bank, approximate area requiring treatment, and other relevant observations. Describe the type of weed to be removed, and whether it is a Pierce Disease Plant. Indicate whether it is a high, medium, or low priority.

Photograph areas requiring weed control on the Photo Data Sheet. These observations will be complemented by Landowner Maintenance Requests to deal with floodplain infestations.

Record the following information about weed and Pierce Disease host plant infestations, and maintenance issues on the field data form, or into a GPS with the following data fields:

Maintenance		
DATE		
RIVER STATION (US start)		
BANK	Unknown	tamarix
Right	Blue elderberry	tree tobacco
Left	brassbuttons	tree-of-heaven
Channel	Brazilian pepper-tree	wild artichoke
Other	bull thistle	wild radish
PROBLEM	Californian thistle	yellow locust
Weed Site	calla lily	yellow star thistle
Trash	Cape broom	black locust
Other	Cape weed	vinca major
INVASIVE_PLANT	castorbean	saltbush
(See Species List at right)	denseflower cordgrass	Russian thistle
PIERCE HOST	giant reed	French broom
Yes	Himalaya blackberry	date palm
No	iceplant	hogbite
Unknown	fountaingrass	hottentot fig
RECOMMENDATION	mustard	Italian thistle
PRIORITY	onionweed	knotweed
H	pampas grass	knapweed
M	parrot feather	spurge
L	pennyroyal	pampasgrass
NOTES	poison hemlock	waterprimrose
PATCHSIZE_FT	Portugese broom	Fennel
PICTURE_ID	purple starthistle	curly dock
Photodocumentation	ragwort	Harding grass
DATE	salt cedar	Filaree
RIVER STATION (US start)	Spanish broom	Spurge sp.
WP	spotted knapweed	water milfoil
NUM_OF_PHOTOS	St. John's wort	Eucalyptus
NOTES	stinkwort	Scotchbroom

Start Station			Stream Name:			Date:	Surveyors:	
			Annual Stream Reach Survey - Eroding Banks, Weed Control, LWD					
GPS PT	**FROM +US/-DS**	**TO +US/-DS**	**Length**	**Bank**	**Problem Feature**	**Description**	**Recommendation**	**Priority**
	(feet)	(feet)	(feet)	Right, Left, Channel	Unstable or Potential Unstable Eroding Bank; Weed Control Site; Erosive LWD; Trash	Location Description; Height or Area Dimension; Bank Instability Element (HIG-Bank Height, SMP-Slump or Fractured Bank, LDS-Landslide or Mass Movement; UND-Undercut) , Problem; Type of Weed; Pierce Disease; LWD Accumulations and Jams w ith High Erosion Potential		High, Medium, Low

Sampling Locations

The locations of invasive weeds and Pierce Disease Plants requiring removal will be mapped along the entire Rutherford Reach, between stream channel stations 0 and 24,900, and ranked according to their potential to cause bank erosion and propagate larger or new infestations.

Phase 1: Reaches 1 and 2

The annual stream reach survey of invasive weeds and Pierce Disease Plants in Phase1 (Reaches 1 and 2) will be conducted between river stations 18,600 and 24,900.

Phase 2: Reach 3

The annual stream reach survey of invasive weeds and Pierce Disease Plants in Phase 2 (Reach 3) will be conducted between river stations 16,000 and 18,600.

Sampling Schedule

The Annual Stream Reach Survey started in spring 2009, and will be conducted each spring for at least the following 19 years. The locations of invasive weeds and Pierce Disease Plants requiring removal will also be examined upon notification by a landowner of a problem.

Phase 1: Reaches 1 and 2

Construction on Phase 1: Reaches 1 and 2 began in summer 2009, and will be completed in 2010. The post-construction annual stream survey will commence in spring 2010.

Phase 2: Reach 3

Phase 2: Reach 3 pre-project baseline surveys were conducted in fall 2009. It is anticipated that construction will occur in spring 2010, and the post-construction annual stream survey will commence in spring 2011.

Large Woody Debris Survey

Objectives

An inventory of large woody debris and log jams will be made annually along the Rutherford Reach to identify locations where woody debris is adversely affecting channel bank stability, and to evaluate LWD function on channel geomorphology and aquatic habitat.

Methods

Use the LWD form to record

- The location of LWD
- The potential for bank erosion due to LWD
- Habitat complexity provided by LWD

Map the location of LWD by river station, GPS waypoint, bedform association, and position in channel. Document the geomorphic function provided by the LWD. Document the potential for bank erosion due to LWD.

For LWD configurations that consist of more than one piece (A or J), and have a high probability of contributing to bank erosion (High), document the channel width, debris type, species class, age class, recruitment mechanism, and dimensions of the jam. Indicate the location of LWD requiring maintenance on the Annual Stream Reach Survey form.

We created a LWD inventory form that is compatible with the data gathered and codes used in the LWD forms by Gerstein (2005), Flosi et al /CDFG (1998) and Washington State Department of Natural Resources (2008). We have also used three letter CDFG CRMEP Qualitative Monitoring Codes by Collins (2008), which will be incorporated into Flosi et al / CDFG (1998) Chapter 8. http://ftp.dfg.ca.gov/public/FRGP/Qualitative_Monitoring_Forms/2008%20Implementation_Monitoring/Supporting_Documents/Checklist_Letter_Codes_2008.pdf

Photograph LWD accumulations and jams with a high potential for bank erosion or requiring maintenance on the Photo Data Sheet.

For newly installed LWD structures, observe and document functioning for salmonid habitat (record age class and type of fish present in/near each (if possible).

Record the following information about LWD on the data form, or using a GPS with the following data fields:

LWD
DATE
RIVER STATION (US start)
LENGTH (feet)
BEDFORM ASSOC
Pool
Riffle Crest
Terrace
Cut Bank
Side Channel
Tributary Channel
Other
Gravel Bar
LWD_LOCATION_CHANNEL
Right of channel
Left of Channel
Mid Channel
Island
Full Channel
Other
Over Channel
LWD_FUNCTION (7 Fields of Same)
Back Water
Pool Scour
Spawning Gravel Entrainment
Summer Refugia
Winter High Flow Refugia
Other
CONFIGURATION NUMBER
Single
Accumulation 2 < 9
Jam > 10
BANK EROSION POTENTIAL
Yes
No
LWD_TYPE
Live/Dead/Artificial
RECRUITMENT
Placed in Channel - Restoration
Dislocated Restoration
Bank Erosion
Intercepted by Restoration
Flood Deposited
Other
DBH
12"-84"
NOTES
PICTURE_ID

Record the following information to measure residual pool depth at locations of installed LWD using a GPS with the following data fields:

Residual Pool Depth
DATE
RIVER STATION (Installed LWD)
POOL MAX DEPTH
RIFFLE CREST DEPTH

Start Station Stream Name: Date: Surveyors:

Large Woody Debris Inventory and Associated Geomorphology

GPS PT	FROM +US/-DS (feet)	TO +US/-DS (feet)	Bedform	Location in Channel	LWD Function	Config /Pieces	Bank Erosion Potential	LWD Accumulations and Jams with High Bank Erosion Potential						
								Channel Width @ LWD Elev	Type	Species Class	Age Class	Recruit-ment	Length (10s of feet)	DBH(feet)

Start Station		Stream Name:			Date:		Surveyors:	
		Annual Stream Reach Survey - Eroding Banks, Weed Control, LWD						
GPS PT	**FROM +US/-DS**	**TO +US/-DS**	**Length**	**Bank**	**Problem Feature**	**Description**	**Recommendation**	**Priority**
	(feet)	(feet)	(feet)	Right, Left, Channel	Unstable or Potential Unstable Eroding Bank; Weed Control Site; Erosive LWD; Trash	Location Description; Height or Area Dimension; Bank Instability Element (HIG-Bank Height, SMP-Slump or Fractured Bank, LDS-Landslide or Mass Movement; UND-Undercut) , Problem; Type of Weed; Pierce Disease; LWD Accumulations and Jams w ith High Erosion Potential		High, Medium, Low

Sampling Locations

The locations of LWD will be mapped along the entire Rutherford Reach, between stream channel stations 0 and 24,900, and ranked according to their potential to cause bank erosion.

Phase 1: Reaches 1 and 2

The annual stream reach survey of LWD in Phase1 (Reaches 1 and 2) will be conducted between river stations 18,600 and 24,900.

Phase 2: Reach 3

The annual stream reach survey of LWD in Phase 2 (Reach 3) will be conducted between river stations 16,000 and 18,600.

Sampling Schedule

The Annual Stream Reach Survey started in spring 2009, and will be conducted each spring for at least the following 19 years. The locations of LWD with the potential to exacerbate bank erosion will also be examined for damage after large flood events (>5year recurrence interval), or upon notification by a landowner of a problem.

Phase 1: Reaches 1 and 2

Construction on Phase 1: Reaches 1 and 2 began in summer 2009, and will be completed in 2010. The post-construction annual stream survey will commence in spring 2010.

Phase 2: Reach 3

Phase 2: Reach 3 pre-project baseline surveys were conducted in fall 2009. It is anticipated that construction will occur in spring 2010, and the post-construction annual stream survey will commence in spring 2011.

Protocol References and Data Forms

Flosi, G., S. Downie, J. Hopelain, M. Bird, R. Coey, and B. Collins / CDFG (1998) California Salmonid Stream Habitat Restoration Manual, Third Edition. Sacramento, California, California Department of Fish and Game, Inland Fisheries Division. http://www.dfg.ca.gov/nafwb/pubs/1998/manual3.pdf

Gerstein , J.M. (2005) *Monitoring the Effectiveness of Instream Habitat Restoration.* http://forestry.berkeley.edu/comp_proj/DFG/Monitoring%20the%20Effectiveness%20of %20Instream%20Habitat%20Restoration.pdf

Washington State Department of Natural Resources (2008)

Forest Practices Board Watershed Analysis Manual, Watershed Analysis Appendices E-Stream Channel Assessment Version 4.0 E-95 November 1997 http://www.dnr.wa.gov/ResearchScience/Topics/WatershedAnalysis/Pages/fp_watershed_analysis_manual.aspx;

Washington State Department of Natural Resources (2007, November) *Watershed Analysis Manual Version 4.0.*

http://www.dnr.wa.gov/Publications/fp_wsa_manual_section06.pdf

Washington State Department of Natural Resources (2008) Forest Practices Board Watershed Analysis Manual http://www.dnr.wa.gov/ResearchScience/Topics/WatershedAnalysis/Pages/fp_watershed_analysis_manual.aspx

Streambank Stabilization Structure Status Assessment

Objectives

The objective for assessing the status of installed streambank stabilization structures is to determine whether they require maintenance, and whether they are functioning to curb bank erosion.

Methods

The status of installed streambank stabilization structures will be assessed during the Annual Stream Reach Survey per the protocol outlined in the *California Salmonid Stream Habitat Restoration Manual, Part VIII, Project Evaluation and Monitoring* (Flosi et al / CDFG, 1998). To record streambank stabilization structure data use the *Stream habitat Enhancement Project Evaluation Individual Structure or Site Form* located on page VIII-17. The structure objective code for watershed and streambank stability improvement treatments is “2”. The form allows for the recording of the location, condition, and recommendations for repairing the structure. Use stream stationing for the reference point. Add a GPS waypoint number. While recording the status of restoration structures, simultaneously record data on associated habitat type.

Supplement the Flosi et al /CDFG form with the CB-Channel Reconstruction & Bank Stabilization Post-Treatment Evaluation Form by Collins (2008), which will be incorporated in to Flosi et al / CDFG (1998) in 2009. Use the codes from Collins (2008) to fill out the forms.

Post-Treatment Form (Collins 2008)

http://ftp.dfg.ca.gov/public/FRGP/Qualitative_Monitoring_Forms/2008%20Effectiveness_Monitoring/Checklists/2b%20CB_Post_ChannelBankReconstruction_2008.pdf

Qualitative Monitoring Feature Codes

http://ftp.dfg.ca.gov/public/FRGP/Qualitative_Monitoring_Forms/2008%20Implementation_Monitoring/Supporting_Documents/Checklist_Letter_Codes_2008.pdf

Treatment Types

http://ftp.dfg.ca.gov/public/FRGP/Qualitative_Monitoring_Forms/2008%20Implementation_Monitoring/Supporting_Documents/Treatment_Type_Codes_2008.pdf

Photograph and log the photo description of streambank stabilization structures requiring maintenance or of interest on the Photo Data Sheet.

c

Maintenance
DATE
RIVER STATION (US start)
BANK
Right
Left
Channel
Other
PROBLEM
Installed Structure
RECOMMENDATION
PRIORITY
H
M
L
NOTES
PICTURE_ID

STREAM HABITAT ENHANCEMENT PROJECT EVALUATION
INDIVIDUAL STRUCTURE OR SITE FORM

STREAM HABITAT ENHANCEMENT PROJECT EVALUATION
INDIVIDUAL STRUCTURE OR SITE FORM

STREAM: DRAINAGE: PAGE of

DATE:____/____/____ STREAM PNAME:____________________ PNAME CODE:__________

EVALUATOR(s) :________________________ CONTRACT NO.:__________ FY:____/____

REFERENCE POINT:____________________ LAT:____._______ (DECIMAL DEGREES) LONG:_____._______ (DECIMAL DEGREES)

FEET FROM REFERENCE POINT: **UP DN** CHANNEL TYPE:

RESTORATION OBJECTIVE: 1 2 3 (circle one) TYPE OF STRUCTURE: ________________

HOW WELL IS STRUCTURE MEETING HABITAT OBJECTIVE ? (circle number)

1 (EXCELLENT) _______ **2 (GOOD)**_______ **3 (FAIR)**_______ **4 (POOR)**_______ **5 (NO VALUE)**________

COMMENTS:____

CONDITION OF STRUCTURE - consider structural integrity only (circle number):

1 (EXCELLENT)_______ **2 (GOOD)**_______ **3 (FAIR)**_______ **4 (POOR)**_______ **5 (NOT VISIBLE)**_______

COMMENTS:____

STRUCTURE PROBLEMS (check appropriate items):

1. ANCHOR FAILURE_______,
2. CABLE FAILURE_______,
3. CHANNEL SHIFT_______,
4. BOULDER/LOG SHIFT_______,
5. UNDERMINED_______,
6. BURIED BY BEDLOAD_______,
7. UNDERBUILT_______,
8. LOGS/BOULDERS STRANDED OUT OF CHANNEL_______,
9. BANK EROSION AT SITE AND/OR DOWNSTREAM _______,
10. CREATED SEDIMENT TRAP_______,
11. POOR DESIGN_______,
12. POOR PLACEMENT_______,
13. EX-FENCE FAILURE_______,
14. OTHER_______.

COMMENTS:____

Repair recommended: Yes No Enhancement to improve cover or effectiveness recommended: Yes No

HABITAT TYPE (associated with structure) __________ BANKFULL STREAM WIDTH________FT.

MAXIMUM POOL DEPTH__________FT. DEPTH OF POOL TAIL CREST_________FT.

SHELTER COMPLEXITY: **0 1 2 3** x SHELTER % COVER:__________ = SHELTER RATING:__________

OBSERVED SALMONIDS NO.: 0+______, 1+______, 2+______, ADULTS_________, REDDS_________
COMMENTS:____

REVEGETATION: RIPARIAN______ UPSLOPE______ BOTH_____ (Photo required for reveg.) DESCRIBE DENSITY:
____

PHOTO NO. PRINT: ROLL________ FRAME________, SLIDE: ROLL_______ FRAME________

COMMENTS:____

CB - CHANNEL RECONSTRUCTION & BANK STABILIZATION POST-TREATMENT

Grant #: **Project title:**

Date : **Evaluator:** **Site ID:** page ___ of ___

	Project Feature Number			
	Feature Type Code			
#	1. Length of treated channel and/or streambank monitored: (ft)			
	a. Length of instream habitat improved: (ft)			
	2. Was bioengineering used at this feature? If Y, use RT also.			
Structure	3. Feature condition: Excl, Good, Fair, Poor, Fail			
	4. Are problems with the feature visible?			
	a. Type: ANC, BBB, CRF, MAT, SHF, STR, SWA, UND, UNS, WSH, OTH			
	5. Is the feature still in its original location, position & orientation?			
Shleter	6. If an objective, was instream shelter and habitat improved?			
	7. Large woody debris count in treatment area: (D >1', L 6-20' / D >1', L >20')	/	/	/
	8. If an objective, did the feature increase LWD count in the treatment area?			
	a. LWD recruitment methods: ANC, EXC, EXH, INT, RPR, UNA, OTH			
Channel	9. Stream channel problems within the treatment area: AGG, BRD, FLO, GRC, HDC, INC, NAR, SCU, STT, WID, NON, OTH			
	10. If an objective, did the treatment lead to the targeted channel conditions?			
	a. Conditions: AGG, FPD, GRC, INC, NAR, SIN, STB, TOG, WID, OTH			
	11. If an objective, was active channel width reduced within the treatment area?			
	a. Average active channel width in the treatment area: (ft)			
	12. If an objective, was the frequency or length of dry stream decreased?*			
	13. Did the residual maximum water depth in the treatment area increase?			
	a. Maximum residual water depth in treatment area: (ft)			
	14. 1st/2nd dominant substrate: SLC, SND, GRV, COB, BOL, BED, OTH	/	/	/
	15. Was there sediment deposition at the feature?			
	a. Did sediment deposition at the feature narrow the stream channel?			
	b. Did sediment deposition at the feature fill in a side channel?			
	16. Were there any unintended effects on the stream channel? If Y, comment.			
Streambanks	17. Is there bank erosion or instability in the vicinity of the treatment area?			
	a. Locations: UPS, DNS, WIN and LBK, RBK			
	b. Apparent causes: BAR, CNR, EMG, GRZ, HYD, RDS, UND, USG, OTH			
	18. If an objective, was streambank instability and/or bank erosion reduced?			
	a. Length of streambank stabilized: (ft)			
	b. Length of treated bank that is still unstable: (ft)			
	19. Average bank angle at treatment site: (degrees)			
	20. If an objective, did the feature reduce the bank angle?			
	a. Did the feature create ≤ the targeted bank angle?			
	21. Were there any unintended effects on the banks? If Y, comment.			
Rating	**22. Feature Effectiveness Rating: Excl, Good, Fair, Poor, Fail**			
	23. Does this feature need: DEC, ENH, MNT, REP, NON, OTH			
	24. Are additional restoration treatments recommended at this location?			
Comments				

☐ **Comment on back.** * If for fish passage, use FB also. **Y**=Yes, **N**=No, **P**=Partially, **D**=Don't know, **A**=Not Applicable. CRMEP 08/05/08 Draft

CDFG CRMEP 08/05/08 Draft Qualitative Monitoring Code List 2008

ABA	Artificial barrier	**CRF**	Cable/rebar failure
ACQ	Habitat/land acquisition	**CRL**	Controlled release
AFD	Armored fill - dry	**CRN**	Crowned
AGG	Aggradation	**CRS**	Crushed
ALN	Alignment	**CSP**	Chemical spray
ANC	Anchoring/anchored placement	**CUL**	Culvert
ANG	Multiple angles	**CUT**	Cut bank
APP	Approach	**CVX**	Convex
AFW	Armored fill - wet	**DBB**	Debris barrier
ARM	Armoring	**DBF**	Debris flow/torrent
ARZ	Arizona Crossing	**DBR**	Debris
BAC	Bottomless arch culvert	**DEC**	Decommissioning
BAR	Bare area devoid of vegetation	**DFG**	CA Dept. of Fish & Game
BBB	Buried by bedload	**DIT**	Ditch
BED	Bedrock	**DIV**	Diversion of flow
BFC	Bankfull channel	**DNS**	Downstream
BIO	Bioengineering (live vegetation)	**DOX**	Dissolved oxygen
BLD	Bank building (LU-Building)	**DPD**	Diversion prevention ditch
BNK	Bank	**DRC**	Ditch relief culverts
BOL	Boulder	**DRT**	Dirt
BRD	Channel braiding	**DRY**	Dry channel
BRI	Bridge	**DSP**	Downspouts
BRM	Berm	**DVP**	Diversion potential
BRN	Burn/burning	**DWR**	Dept of Water Resources
BRW	Barbed wire	**EAS**	Conservation Easement
BUB	Bubble curtain	**EFL**	Earthflows and large, slow moving landslides
BUR	Buried or "keyed in"	**ELC**	Electric
CAN	Canal	**EMG**	Emergent groundwater
CBL	Cabled	**ENH**	Enhancement
CCV	Concave	**EOC**	Emergency overflow culvert (pipe)
CDP	Critical dip	**ERO**	Erosion
CGA	Culvert gravel absent	**EXC**	Excavated/excavation
CGR	Controlled grazing	**EXH**	Exhumed/unburied
CHB	Channel bed	**FAB**	Fabric
CHL	Chain link	**FIL**	Fill material
CHN	Channel/channel bed	**FJH**	Fish jump height
CHS	Chiseled	**FLA**	Flared
CNR	Concentrated runoff	**FLD**	On floodplain
COB	Cobble	**FLO**	Flow obstructions
COM	Compacting	**FLS**	Floating segments
COM	Complete barrier	**FLT**	Flatwater or flat Surface
CON	Concrete	**FPD**	Floodplain deposition
COR	Corrosion	**FRM**	Farming
CRD	Cross road drains	**FSL**	Fill slope

FUL	Full recontour
GRA	Grasses
GRC	Grade control
GRV	Gravel
GRZ	Grazing/Grazing Animal
GUL	Gully
HAN	Hand Crew
HDC	Headcut
HIG	High
HRB	Herbaceous
HTW	High tensile wire
HUM	Humboldt Crossing
HYD	Hydrologic processes
IMS	Impassable structures
INC	Incision
INL	Inlet
INS	Inslope
INT	Interception
IRS	Irrigation system
IST	Instability/unstable
JUV	Juvenile
LAN	Landing failures
LBK	Left bank
LDA	Large debris accumulation
LDS	Landslide
LEA	Habitat/land lease
LNG	Length
LOW	Low
LWD	Large woody debris
MAC	Machine/heavy Equipment
MAT	Materials failure
MDC	Mid-channel
MEC	Mechanical failure
MED	Medium
MIG	Lateral migration
MIT	Mitered culvert inlet
MNT	Maintenance
MOD	Moderate
MTL	Metal
MUL	Multiple angles
NAR	Narrowing
NAT	Natural causes
NBA	Natural barrier
NCA	Natural channel adjustment
NNS	Non-native species
NRG	Non-road gullying
NRL	Non-road (hillslope) debris landslides
NRP	No resting pool
NTM	Native mulching
NTR	Native rock
NTS	Native species
NUM	Nutrient movement
NUT	Nutrients
OFR	Off-site rock
OTH	Other
OTL	Outlet
OUT	Outslope
OVF	Overland flow
OVS	Oversteepened
OVT	Overtopped
PAR	Partial barrier or recontour
PAV	Paved
PCA	Poor channel alignment
PIP	Piping
PLA	Plastic
PLG	Plugged
PLN	Planting
PPT	Poor profile transition
POO	Pool
PRL	Parallel to bank/ floodplain
PRM	Perched material
PRP	Perpendicular to bank/floodplain
RBK	Right bank
RCP	Road construction practices
RDS	Roads/Road surface
REB	Rebar
REP	Repair
RIF	Riffle
RIL	Rilling
RIP	Ripping
RLD	Rolling dips
RMP	DFG Riparian Area Management Plan Agreement
ROC	Rock
RPR	Riparian recruitment
RRG	Other road-related Gullying
RTW	Root wads
SBE	Streambank erosion
SBL	Streambank landslides

SCU	Side cutting	**TEM**	Temporal barrier or seasonal exclusion
SCW	Stream crossing washouts (gullies)	**TIE**	Tied
SDC	Side-channel	**TMB**	Timber
SDS	Side slope or slope	**TMP**	Temperature
SBM	Substrate movement	**TNC**	Tension crack
SCR	Scar or scarp	**TOG**	To grade
SEE	Seeding	**TOT**	Total barrier
SET	Settling basins	**TRE**	Tree
SFE	Surface erosion	**TRW**	Time release water packs
SHF	Shifting	**TUR**	Turbidity
SHR	Shrub	**UAF**	Unarmored fill Crossing
SIN	Sinuosity	**UBE**	Undercutting by Excavation
SIZ	Size	**UCB**	Undercut banks as habitat
SLA	Slope angle	**UCR**	Under crossing
SLC	Silt/clay	**UCT**	Undercut toe
SLF	Silt fence	**UEF**	Unexcavated fill
SLT	Slotted	**UNA**	Unanchored placement
SMP	Slump	**UND**	Undercut/ Undermined
SND	Sand	**UNS**	Undersized
SQR	Square	**UPL**	Upland
SOP	Soil pedestals	**UPS**	Upstream
SPN	Spanning	**USG**	Unstable soils/geology
SPS	Suspended segments	**VEG**	Vegetation
STA	Stable angle	**VOI**	Void
STB	Stability	**WDG**	Wedged
STG	Stream gauge	**WGW**	Wingwalls
STK	Staked	**WID**	Width/Widening
STM	Straw mulching	**WIN**	Within
STR	Stranding	**WOO**	Wood, wooden
STT	Straight/ straightening	**WSH**	Washout
SUB	Substrate	**WTB**	Water bars
SWA	Stranded out of water (vertically)	**WTD**	Water depth
SWD	Small woody Debris	**WTR**	Water
TCU	Through cut	**WTV**	Water velocity

Sampling Locations

All streambank stabilization structures installed along the Rutherford Reach, between stream channel stations 0 and 24,900, will be assessed during the Annual Stream Reach Survey.

Phase 1: Reaches 1 and 2

In 2009, streambank stabilization structures are anticipated to be installed in discontinuous subreaches in Phase1: Reaches 1 and 2. Phase 1 spans from river station 18,600 to 24,900.

Phase 2: Reach 3

Phase 2 spans from river station 16,000 to 18,600.

Sampling Schedule

The Annual Stream Reach Survey started in spring 2009, and will be conducted each spring for at least the following 19 years. Streambank stabilizations structures will also be examined for damage after large flood events (>5year recurrence interval), and upon notification by a landowner that the structure has failed.

Phase 1: Reaches 1 and 2

Construction on Phase 1: Reaches 1 and 2 began in summer 2009, and will be completed in 2010. The post-construction annual stream survey will commence in spring 2010.

Phase 2: Reach 3

Phase 2: Reach 3 pre-project baseline surveys were conducted in fall 2009. It is anticipated that construction will occur in spring 2010, and the post-construction annual stream survey will commence in spring 2011.

Protocol References and Data Forms

Collins, B. (2008)

Coastal Restoration Monitoring and Evaluation Program Qualitative Monitoring Forms. California Department of Fish and Game, Fort Bragg, California. http://ftp.dfg.ca.gov/public/FRGP/Qualitative_Monitoring_Forms/

(Will be incorporated into Flosi et al. CDFG Stream Restoration Manual Chapter 8)

Channel Bank Reconstruction and Bank Stabilization (CB)

Pre-Treatment Form
http://ftp.dfg.ca.gov/public/FRGP/Qualitative_Monitoring_Forms/2008%20Effectiveness_Monitoring/Checklists/2a%20CB_Pre_ChannelBankReconstruction_2008.pdf

Implementation Form
http://ftp.dfg.ca.gov/public/FRGP/Qualitative_Monitoring_Forms/2008%20Implementation_Monitoring/Checklists/2%20CB_Imp_ChannelBankReconstruction_2008.pdf

Post-Treatment Form
http://ftp.dfg.ca.gov/public/FRGP/Qualitative_Monitoring_Forms/2008%20Effectiveness_Monitoring/Checklists/2b%20CB_Post_ChannelBankReconstruction_2008.pdf

Flosi, G., S. Downie, J. Hopelain, M. Bird, R. Coey, and B. Collins / CDFG (1998) California Salmonid Stream Habitat Restoration Manual, Third Edition. Sacramento, California, California Department of Fish and Game, Inland Fisheries Division. http://www.dfg.ca.gov/nafwb/pubs/1998/manual3.pdf

Harris, R.R., S.D. Kocher, J.M. Gerstein and C. Olson. (2005) Monitoring the Effectiveness of Riparian Vegetation Restoration. University of California, Center for Forestry, Berkeley, CA. 33 pp. http://www.cnr.berkeley.edu/forestry/comp_proj/DFG/Monitoring%20the%20Effectiven ess%20of%20Riparian%20Vegetation%20Restorat.pdf

Aquatic Habitat Structure Status Assessment

The status of installed streambank aquatic habitat structures will be assessed during the Annual Stream Reach Survey per the protocol outlined in *Monitoring the Effectiveness of Instream Habitat Restoration* (Gerstein, 2005). Data on the persistence, habitat function and maintenance needs of each installed structure will be recorded.

The affect of installed aquatic habitat structures on stream channel morphology and aquatic habitat quality will be assessed seasonally during the year to capture the effectiveness in creating seasonal habitat functions for different life stages of salmonids. Some assessments will be conducted during the annual stream survey, while others will be conducted at representative winter and spring high flows. Additional surveys will be conducted after significant channel forming events.

Annual Stream Survey

To measure the affect of installed structures on creating increased geomorphic, habitat, and velocity flow heterogeneity, during the annual stream survey in June, residual pool depth associated with installed instream structures will be measured, and riffle crest locations will be mapped throughout the Rutherford Reach. Installed structures include Large Woody Debris (LWD) installed at the edge of constructed instream benches that extend into the low flow channel to create lateral scour pools; Spider logs installed in the channel to create scour pools and cover; lateral LWD installed along the base of banks to create later scour pools, cover, and to create high velocity feeding lanes; and Boulders installed to create high velocity feeding lanes.

A unique identifier will be assigned to each instream structure based on the protocol in the LWD survey, which includes the river station at the center of the feature and GPS location.

Installed Large Woody Debris (LWD) aquatic habitat structures will be evaluated for their function as part of the LWD assessment. Additional measurements will be taken of residual pool depth associated with installed LWD. Use the following GPS fields to enter information to record residual pool depth.

Residual Pool Depth
DATE
RIVER STATION (Installed LWD)
POOL MAX DEPTH
RIFFLE CREST DEPTH

Use the following GPS fields to map the distribution of riffle crests, to measure increases in habitat unit complexity associated with installed instream structures.

Riffle Crest
DATE
RIVER STATION (US start)
REDD MAPPED in Previous Season
Yes
No

Seasonal High Flow Refugia Habitat Assessments

A fisheries biologist will conduct habitat assessments at the constructed alcoves and instream bankfull bench locations during one winter and one spring representative high flow event each year to evaluate the area of backwater and secondary channel pool habitat been created for instream rearing habitat. The constructed alcove and instream bankfull benches will be assessed during two high flow events: in December or January, to characterize winter steelhead rearing, and steelhead and Chinook spawning habitat conditions; in March or April, to characterize spring steelhead and juvenile Chinook rearing habitat conditions. At each high flow refugia site, a sketch will be made depicting the extent of the alcove, or bankfull bench, installed LWD (if visible), the distribution of slow water habitat units. The sketch will include an indication of channel flow directionality to characterize eddy formation associated with the constructed or installed feature. Alternatively, a field base map created from an aerial photograph and/or the restoration design CAD files, could be used to map the habitat units and direction of flow. The design file will be helpful in determining the location and influence of submerged LWD installations that are not visible at high flows. A fisheries biologist will prepare a narrative description of the habitat function provided by the constructed instream feature, along with a description of the life stage of the anadromous salmonid which the habitat is supporting. Where installed large woody debris (LWD) structures can be identified and mapped in high flow conditions, the GPS protocol utilized during the annual stream survey will be applied to assess location, status, and habitat function of the installed structure (See LWD mapping protocol). Photos of the alcove and bankfull benches will be taken.

In addition to the parameters measured above, velocity of flow will be measured at a maximum of three created high flow refugia locations during one winter and one spring high flow event each year, depending accessibility and budget. The locations where velocity measurements were taken will be recorded on the field sketch map depicting the flow patterns in the alcove or bankfull bench.

A unique identifier will be assigned to each constructed alcove and instream bankfull bench structure. Distinguish whether the feature is a constructed alcove (AL) or instream bankfull bench (B) structure. Indicate the river station location in the center of the feature. Indicate whether the structure is on the left bank (L) or right bank (B). For example, an alcove number would be "AL-center river station –R".

Periodic Surveys

Periodically after significant channel forming events, changes in habitat unit distribution will be assessed via long profile surveys in the vicinity of installed structures, and phased cross section surveys accompanied by pebble counts of at associated riffle crests.
All data collection will be accompanied by photodocumentation.

Gerstein, J.M. (2005)
Monitoring the Effectiveness of Instream Habitat Restoration. University of California, Center for Forestry, Berkeley, California. 45 pgs.
http://forestry.berkeley.edu/comp_proj/DFG/Monitoring%20the%20Effectiveness%20of %20Instream%20Habitat%20Restoration.pdf

USDA Forest Service Pacific Southwest Region.
Stream Habitat Classification and Inventory Procedures for Northern California. FHR Currents…R-5's Fish Habitat Relationships Technical Bulletin Number One.
http://www.fs.fed.us/biology/fishecology/currents/currents01.pdf

Instream Habitat and Bank Restoration (IN)

Instream Habitat and Bank Restoration – Post-Treatment Form Instructions

http://ftp.dfg.ca.gov/public/FRGP/Qualitative_Monitoring_Forms/2008%20Effectiveness_Monitoring/Instructions/1b%20IN_Post_Checklist_Instructions_2008.pdf

Post-Treatment Form

http://ftp.dfg.ca.gov/public/FRGP/Qualitative_Monitoring_Forms/2008%20Effectiveness_Monitoring/Checklists/1b%20IN_Post_InstreamHab_2008.pdf

Qualitative Monitoring Feature Codes

http://ftp.dfg.ca.gov/public/FRGP/Qualitative_Monitoring_Forms/2008%20Implementation_Monitoring/Supporting_Documents/Checklist_Letter_Codes_2008.pdf

Treatment Types

http://ftp.dfg.ca.gov/public/FRGP/Qualitative_Monitoring_Forms/2008%20Implementation_Monitoring/Supporting_Documents/Treatment_Type_Codes_2008.pdf

STREAM HABITAT ENHANCEMENT PROJECT EVALUATION
INDIVIDUAL STRUCTURE OR SITE FORM

STREAM: DRAINAGE: PAGE of

DATE:____/____/____ STREAM PNAME:________________________________ PNAME CODE:__________

EVALUATOR(s) :______________________________________ CONTRACT NO.:__________ FY:____/____

REFERENCE POINT:________________________________ LAT:____.________ LONG:______.________
(DECIMAL DEGREES) (DECIMAL DEGREES)

FEET FROM REFERENCE POINT: **UP DN** CHANNEL TYPE:

RESTORATION OBJECTIVE: 1 2 3 (circle one) TYPE OF STRUCTURE: ____________________

HOW WELL IS STRUCTURE MEETING HABITAT OBJECTIVE ? (circle number)

1 (EXCELLENT) ________ 2 (GOOD)_______ 3 (FAIR)________ 4 (POOR)_______5 (NO VALUE)__________

COMMENTS:____

CONDITION OF STRUCTURE - consider structural integrity only (circle number):

1 (EXCELLENT)________ 2 (GOOD)________ 3 (FAIR)________ 4 (POOR)________ 5 (NOT VISIBLE)_________

COMMENTS:____

STRUCTURE PROBLEMS (check appropriate items):

1. ANCHOR FAILURE_______,
2. CABLE FAILURE______,
3. CHANNEL SHIFT_______,
4. BOULDER/LOG SHIFT_______,
5. UNDERMINED_______,
6. BURIED BY BEDLOAD_______,
7. UNDERBUILT_______,
8. LOGS/BOULDERS STRANDED OUT OF CHANNEL_______,
9. BANK EROSION AT SITE AND/OR DOWNSTREAM ______,
10. CREATED SEDIMENT TRAP_______,
11. POOR DESIGN_______,
12. POOR PLACEMENT________,
13. EX-FENCE FAILURE_______,
14. OTHER_______.

COMMENTS:____

Repair recommended: Yes No Enhancement to improve cover or effectiveness recommended: Yes No

HABITAT TYPE (associated with structure) ____________ BANKFULL STREAM WIDTH_________FT.

MAXIMUM POOL DEPTH___________FT. DEPTH OF POOL TAIL CREST__________FT.

SHELTER COMPLEXITY: **0 1 2 3** x SHELTER % COVER:__________ = SHELTER RATING:____________

OBSERVED SALMONIDS NO.: 0+______, 1+_______, 2+_______, ADULTS____________, REDDS___________
COMMENTS:____

REVEGETATION: RIPARIAN______ UPSLOPE______ BOTH_____ (Photo required for reveg.) DESCRIBE DENSITY:
____

PHOTO NO. PRINT: ROLL________ FRAME________, SLIDE: ROLL_______ FRAME_________

COMMENTS :____

Sampling Locations

All aquatic habitat structures installed along the Rutherford Reach, between stream channel stations 0 and 24,900, will be assessed during the Annual Stream Reach Survey.

Phase 1: Reaches 1 and 2

In 2009, aquatic habitat enhancement structures are anticipated to be installed in discontinuous subreaches in Phase1: Reaches 1 and 2. Phase 1 spans from river station 18,600 to 24,900.

Sampling Schedule

The Annual Stream Reach Survey started in spring 2009, and will be conducted each spring for at least the following 19 years. Aquatic habitat enhancement structures will also be examined for damage after large flood events (>5year recurrence interval), and upon notification by a landowner that the structure has failed.

Phase 1: Reaches 1 and 2

Construction on Phase 1: Reaches 1 and 2 began in summer 2009, and will be completed in 2010. The post-construction annual stream survey will commence in spring 2010.

Phase 2: Reach 3

Phase 2: Reach 3 pre-project baseline surveys were conducted in fall 2009. It is anticipated that construction will occur in spring 2010, and the post-construction annual stream survey will commence in spring 2011.

Protocol References and Data Forms

Collins, B. (2008)
Coastal Restoration Monitoring and Evaluation Program Qualitative Monitoring Forms. California Department of Fish and Game, Fort Bragg, California. http://ftp.dfg.ca.gov/public/FRGP/Qualitative_Monitoring_Forms/

(Will be incorporated into Flosi et al. CDFG Stream Restoration Manual Chapter 8)

Flosi, G., S. Downie, J. Hopelain, M. Bird, R. Coey, and B. Collins / CDFG (1998)
California Salmonid Stream Habitat Restoration Manual, Third Edition. Sacramento, California, California Department of Fish and Game, Inland Fisheries Division. http://www.dfg.ca.gov/nafwb/pubs/1998/manual3.pdf

Harris, R.R., S.D. Kocher, J.M. Gerstein and C. Olson. (2005)
Monitoring the Effectiveness of Riparian Vegetation Restoration. University of California, Center for Forestry, Berkeley, CA. 33 pp. http://www.cnr.berkeley.edu/forestry/comp_proj/DFG/Monitoring%20the%20Effectiven ess%20of%20Riparian%20Vegetation%20Restorat.pdf

Photodocumentation of Annual Changes

Objectives

The objective of photodocumentation is to provide a visual record to augment data collected in the field.

Methods

Photodocument eroding stream banks, areas requiring weed control, LWD Accumulations and Jams contributing to stream erosion, and bank stabilization and aquatic habitat enhancement structures requiring maintenance. Record the GPS point, stream station, photographer location (in-channel, at a monument pin or tag), and direction of photograph on the Photo Form. Where directionality in relation to the stream is not obvious, record the compass bearing of the direction in which the photo is taken. Record the subject of the photograph.

Sampling Locations

Photodocumentation of problem sites will occur along the Rutherford Reach, between stream channel stations 0 and 24,900, during the Annual Stream Reach Survey.

Phase 1: Reaches 1 and 2

Project construction of Phase 1: Reaches 1 and 2, which spans from river station 18,600 to 24,900, is expected to be completed in 2010.

Sampling Schedule

The Annual Stream Reach Survey started in spring 2009, and will be conducted each spring for at least the following 19 years. Photodocumentation will occur concurrently with assessment of eroding stream banks, areas requiring weed control, LWD, and bank stabilization and aquatic habitat enhancement structures. These features will also be examined for damage after large flood events (>5year recurrence interval), and upon notification by a landowner of a bank erosion problem.

Phase 1: Reaches 1 and 2

Construction on Phase 1: Reaches 1 and 2 began in summer 2009, and will be completed in 2010. The post-construction annual stream survey will commence in spring 2010.

Phase 2: Reach 3

Phase 2: Reach 3 pre-project baseline surveys were conducted in fall 2009. It is anticipated that construction will occur in spring 2010, and the post-construction annual stream survey will commence in spring 2011.

Record the following information about eroding banks, and maintenance issues on the field data form, or into a GPS with the following data fields:

Photodocumentation
DATE
RIVER STATION (US start)
WP
NUM_OF_PHOTOS
NOTES

Accompanied by a field data sheet with the following information

Date

River Station

Starting Photo Number

Ending Photo Number

Photographer Location

- Left Bank
- Right Bank
- Channel
- Monument or Tag Number
- Other

Photo Directionality Relative to Stream

- Upstream
- Downstream
- Right Bank
- Left Bank

Compass Bearing

Subject

Notes

Start Station	Stream Name:	Date:	Surveyors:

Photodocumentation

GPS PT	FROM +US/-DS	TO +US/-DS	Photo No.	Photographer Location, Monument Pin or Tag Number	Direction of Photo Relative to Stream	Compass Bearing	Subject / Feature / View / Notes
	(feet)	(feet)	#	LB, RB, CH, etc	US, DS, RB, LB	Degrees	

DS-Downstream US-Upstream LB-Left Bank RB-Right Bank CH-Channel TOP-Top of Bank Pin MID-Mid Bank Pin BTM – Base of Bank Pin

Protocol References and Data Forms

Gerstein, J.M. and S.D. Kocher. (2005)
Photographic Monitoring of Salmonid Habitat Restoration Projects. University of California, Center for Forestry, Berkeley, CA. 21 pp. http://www.cnr.berkeley.edu/forestry/comp_proj/DFG/Photographic%20Monitoring%20 of%20Salmonid%20Habitat%20March%202005.pdf

Hayes, G. et al (2008)
Napa River, Rutherford Reach, Restoration Phase 1, Reaches 1 and 2, Pre-Project Monitoring Survey, Prepared for the Napa County Resource Conservation District, December 3, 2008. 33 pp.

USDA (2005) Frazier, J.W., et al
Stream Condition Inventory Technical Guide. USDA Forest Service, Pacific Southwest Region – Ecosystem Conservation Staff. Vallejo, CA 111pp. http://www.fs.fed.us/r5/publications/water_resources/sci/techguide-v5-08-2005-a.pdf

Repeated Channel Transects and Local Longitudinal Profiles

Objectives

The objectives of the Repeated Channel Transect and Local Longitudinal Profile surveys are to:

- Evaluate long term changes in stream channel geometry, capacity and stability in treated and untreated river reaches.
- Evaluate long term changes in aquatic habitat quality associated with installed instream structures.

While longitudinal monitoring data will be collected for the entire reach on an annual basis during the Maintenance Survey, less frequent cross-section transects will be surveyed to measure changes in the relationship between the channel, its floodplain, and associated habitats. We are employing a Before/After Control/Impact of Treatment (BACI) approach for measuring change (Roni, P, 2005ed.). Monitoring cross sections in control and treatment reaches is an effective strategy for differentiating between natural and project-related changes, and therefore for evaluating project effectiveness.

The general strategy for surveying the transects and local longitudinal profiles is to:

- Identify treatment and control reaches to perform a BACI monitoring strategy.
- Establish, monument, and survey cross section transects along Rutherford Reach of the Napa River in these treatment and control reaches to characterize channel geometry, capacity and stability.
- Perform pebble counts at the closest riffle crest to each of these cross sections in order to characterize the channel substrate for aquatic habitat quality.
- Gather information on the distribution of riparian vegetation communities along the cross sections to assess function of riparian vegetation zones.
- Provide reference documentation for re-occupying the cross sections for future monitoring surveys.
- Photodocument the survey for re-occupation of monuments and to discern changes over time in geomorphology and vegetation.
- Survey local longitudinal thalweg profiles upstream and downstream of the cross sections as needed to assess changes in channel geomorphology and associated aquatic habitat quality.

These variables will be surveyed pre-and post-construction, and thereafter post-significant channel forming flood event.

The data from the monitoring transect surveys performed may be also used to calibrate hydraulic models.

Monitoring Parameters by Category

The parameters to be identified, mapped and assessed in the Long Term Monitoring Program are presented in Table 1 organized by monitoring category.

The following parameters will be evaluated as part of the Long Term Monitoring Plan survey:

- Channel Adjustment: Bed Deposition or Scour
- Bankfull Width to Depth Ratio: Entrenchment
- Flood Stage / High Water Mark
- Bank Stability (Rates of widening at control versus treated cross sections)
- Channel Planform Network (Primary and Secondary Channels)
- Channel Substrate Size Distribution / Riffle Median Grain Size (D50) on Riffles
- Area of High Flow Refugia within Bankfull at Constructed Alcoves
- Riparian Buffer Width

Monitoring Parameter Methods

The following protocols will be used to assess the above parameters:

- Cross Section Transects
- Local Longitudinal Stream Surveys
- Grid Pebble Counts at Riffle Crests Nears Cross Section Transects
- Photodocumentation
- Air Photo Analysis

The methods for conducting these protocols are discussed individually below.

Cross Section Transects

Objectives

Cross section transect surveys will be conducted to record changes in channel morphology (e.g., bed and bank erosion), riparian vegetation buffer width, and general riparian vegetation community distribution.

Methods

District staff will coordinate cross-section transect surveys in cooperation with team partners, including the Napa County Resource Conservation District (RCD), their resource specialists, and landowner representatives.

The following parameters will be evaluated from the comparing pre- and post-construction, and post-flood surveys:

- Channel Adjustment: Bed Deposition or Scour
- Bank Stability: Rates of Widening at Reference vs. Treatment Reaches
- Bankfull Width to Depth Ratio: Entrenchment
- Flood Stage/ High Water Mark
- Elevation Ranges of Vegetation Communities
- Riffle and Pool Habitat Location Changes
- Riparian Vegetation Buffer Width
- Riparian Vegetation Elevation Zones

Label cross sections by river station. This allows for the addition of new monitoring and monument locations without necessitating the re-ordering or re-naming of existing cross sections. This labeling system also allows for quick slope gradient estimation between cross sections when NGVD thalweg and water surface elevations are known.

Tie the surveys into control points previously established for the Rutherford Restoration Project. Collect all survey data in the California State Plan Coordinate System (Zone 2, NAD 83) using the NAVD 88 vertical datum. Record riparian and aquatic habitat characteristics (e.g, plant species, percent native cover, substrate type) along each transect.

Monumentation

Rebar Pins

Monument each of the ten cross sections with a minimum of four rebar pins. Two pins should be located on the levees near the vineyard access roads, one each on the left and right banks of the Napa River. For ease of re-surveying, two pins should be located at the base of the banks on either side the channel. Wide cross sections should be monumented with additional pins midway up the channel bank. The pins located on the levees have a higher likelihood of surviving high river flow events and therefore survey re-occupation than those located next to the channel. The lower pins, however, allow for rapid re-surveying of the portion of the cross section most likely to experience measurable change in morphology. It is recommended that each cross section be monumented with a third set of pins midway up the bank, above the calculated bankfull level, to allow for a higher probability of pin re-occupation and a means for rapid re-surveying.

The pins should be labeled according to channel bank and location along the bank. All labeling assumes facing the downstream direction, which on the Napa River, is southerly.

LB - Leftbank
RB - Rightbank

TOP - Top of Channel Bank, Near Levee Road
MID - Midway up Channel Bank
BTM - Bottom, or Base, of Channel Bank

US - Upstream
DS - Downstream

In the field, flag the pins and label with the GPS waypoint number for the cross section as well as with the river station number. Include these placemark identifiers in the report. Cross reference previous, and preliminary stationing with new cross section labels in an identification table. It is recommended that small permanent signs displaying cross section labels by river station be installed along the levee roads for ease of re-occupying the cross sections. Additional signage might include river stations every 1000 feet. Linear distances along the levee roads will be shorter that distances between river mile stations measured along the stream channel.

Dense vegetation at each cross section may necessitate clearing of sight lines to facilitate the survey. Survey efforts should allocate approximately three to four hours per cross section for line of site vegetation clearing after re-locating the rebar monument pins. Refer to the field equipment check list for suggested clearing tools, including a ladder for surmounting dense blackberry thickets. Use of a metal detector, GPS device, monument location table, and photodocumentation is recommended for re-locating rebar pins.

Metal Tags

For ease of re-locating cross sections, metal monument tags should be mounted to stationary sites along the levee roads, such as trees and telephone poles, in the vicinity of the cross sections. The monument tags from the 2004 baseline survey are silver-colored, a few inches wide, and are stamped with identification numbers. In 2004, twenty-six tags were installed and numbered individually from 186 to 200 and from 222 to 239. Compass bearings and distances were tabulated from each of the monument tags to nearby cross sections pins, and vice versa. Photographs of the monument pins and metal tags were taken in relation to one another.

Monument Location Documentation

Geographic Positioning System (GPS) Coordinates

Record the map coordinates of the monument pins and tags with Geographic Positioning System instrument. Map the monument points on the project plans.

Relative Distances from Fixed Reference Points

For assistance in locating cross sections in the field without a GPS, or in the event that the GPS is not adequately accurate, record the linear distance from a known fixed point to the cross section endpoint monument pins.

For example, in 2004, for the cross sections downstream of the Rutherford Cross Road, the approximate linear distance, from the O-ring on top of the power box next to the large grey pump pipe, and across the dirt levee road from the wooden power pole (Monument Tag 186) near the leftbank pin of cross section RXRD+4.2DS, to the top cross section monument pins on the left bank, was measured with a tape stretched along the west edge of the left bank levee road (Pump Box +/- feet upstream / downstream). A schematic reference key was used to show the relative location of the cross sections and reference points along the river.

Cross Section Survey

Geomorphology

Survey cross section topography with a level and rod, or with a total station. Use a twenty-five foot rod to reduce the required number of survey instrument turning points. Survey points at changes in slope, substrate, and vegetation cover.

CROSS SECTION DATA FORM

Contract #:	Contract Name:	Implementation Mo/Yr:
Site Name:		**Stream/Drainage:**
Date:	**Phase:** (*Pre-treatment* or *Post-treatment*) **Project Feature #/Name:**	**XS#:**
Crew: Level	Stadia Rod	Recorder

Description of Survey (include BM & XP locations):

Total Survey Length (ft & tenths):

Station	(+) BS	HI	(-) FS	Elevation	Comments (record geomorphic features, substrate, vegetation and other factors of interest at each station)

Codes: BM = Benchmark, **HI** = Height of Instrument, **FS** = Foresight, **BS** = Backsight, **XP** = Cross Section Endpoint, **LB** = Left Bank, **RB** = Right Bank, **UPS** = Upstream, **DNS** = Downstream, **FP** = Floodplain, **LT/MT/HT** = Low/Middle/High Terrace, **LEW/REW** = Left/Right Edge Water, **BKF** = Bankfull, **PB** = Point Bar, **TP** = Turning Point, ‖ = Parallel, ⊥ = Perpendicular

Additional Comments:

Cross Section Substrate and Ground Cover

Indicate the distribution of substrate size classes along the cross section transects by coloring the cross section plot according to relative gravel size determined by eye during the survey.

brown	-	silt, soil	(<.062mm median diameter)
yellow	-	sand	(.062-2 mm median diameter)
orange	-	gravel	(2-64 mm median diameter)
red	-	cobble and boulder	(>64 mm median diameter)
purple	-	bedrock	
grey	-	rip-rap	
green		roots	

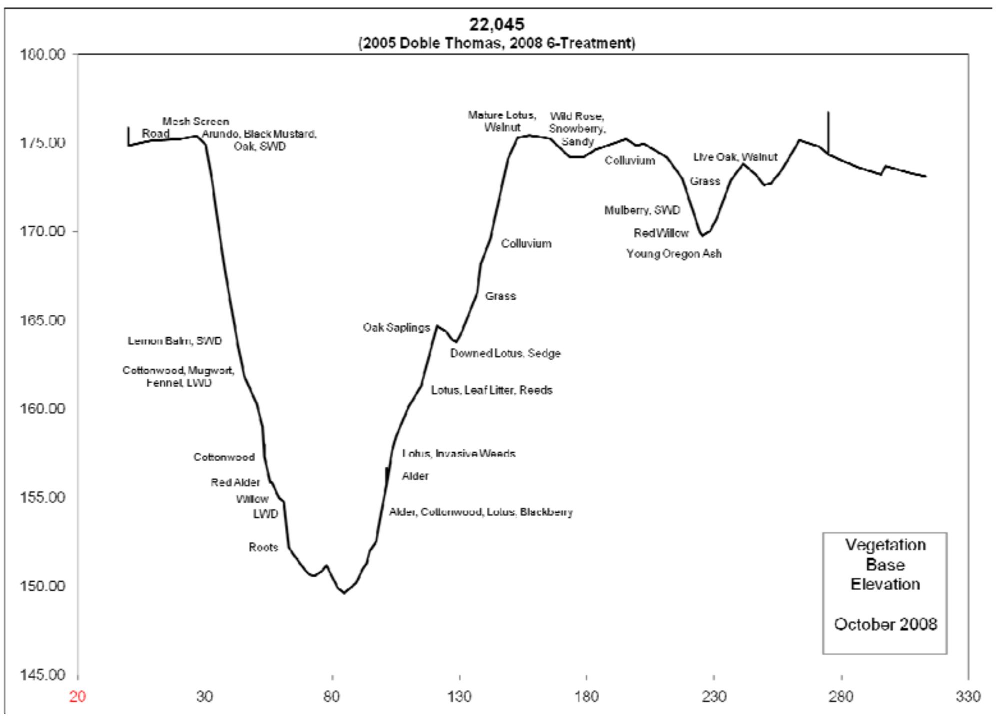
Riparian Vegetation

Record vegetation changes at stations along the cross section to identify the general elevation and extent of riparian zones along the cross section. This protocol is not interchangeable with a vegetation green line, or cross section transect intercept survey, which has a more specific protocol for vegetation monitoring purposes. Rather, this data will supplement the more specific data collected by those methods, by providing elevation establishment data for riparian species, and riparian buffer width.

Collect vegetation data along the cross section to indicate the starting and ending station elevation of general vegetation communities on and nearby the cross section in both the upstream and downstream direction. Include information such as tree lines by species, locations of woody debris, groundcover zones, and areas that are heavily rooted. In some cases, this vegetation information will help to explain the geomorphology along the cross section. For example, heavily rooted channel banks are often steeper than those that are not. Woody debris piles indicate flood level and may have served to prevent bank erosion at that part of the channel bank. Woody debris in the channel may be the cause of incision or deposition on the cross section.

Record the distribution of types of riparian vegetation, tree canopy type, and extent along each cross section surveyed. Record distances upstream and downstream to prominent trees, vegetation communities, and other attributes in reference to specific stations along each cross section. This data assists in the accurate relocating of cross sections in the event that monument pins are lost, as well as in the characterization of the distribution of riparian vegetation communities in relation to the stream channel.

Tabulate and graph the vegetation data along the cross section plot, including location and depth of large woody debris (LWD) piles. It is recommended that the vegetation, LWD, culvert and other attribute data be depicted on the cross section to the extent practicable.



Recommended Tasks

Install small permanent signs displaying cross section labels by river station along the levee roads for ease of re-occupying the cross sections. Include additional signage indicating river station every 1000 feet.

Data Management and Analysis

Continue to standardize all cross section labeling to correspond to river mile station.

Plot the riparian vegetation cover and canopy, large woody debris, culvert and other attribute data that was collected during the survey on the cross section graphs.

Create reference maps in a GIS with the following layers:

- River stationing
- Locations of previous cross sections by year surveyed
- Cross section monument pin locations
- Metal Monument tag and fixed reference point locations
- Access, ingress, egress and parking locations
- Culvert outlet locations
- Reaches of stream where long profile thalweg was surveyed
- Create an exhibit that depicts cross section graphs and zoomed in aerial photographs on the same page for each cross section.
- Long Profile and Water Surface Elevation Surveys
- Plot the long profile survey data.
- Tie the surveyed long profile reaches into each other and into the NGVD elevation coordinate system.
- Determine the slope of the entire study reach when all cross sections are tied together, and/or to NGVD elevation.
- Update the cross section plots to reflect relative and/or NGVD elevations using the long profile survey data.
- Survey in the elevation of the most recent high water mark (HWM).
- Mark and survey in the elevation of the high water mark (s).
- Mark and survey in the elevation of the high water marks and determine WSE slope and corresponding discharge for that storm event.

Access Information

Compile comprehensive list of property owner contacts for, and copies of Right of Entry forms, for future use to include in reference materials.

Create a reference map in a GIS with access, ingress, egress and parking locations.

Cross Section Transect Survey History

Baseline longitudinal and cross-section transect surveys of the Rutherford Reach were conducted in 2004, 2005 and 2007. Baseline longitudinal and cross-section transect surveys of the Rutherford Reach were conducted in 2004, 2005 and 2007.

- 2004 RDRT Baseline Survey (3 cross sections in Reaches 1 and 2; 10 cross sections in total, long profile sections)
- 2005 Doble Thomas Survey
- 12/31/2005 100 Year Flood Event
- 2007 Doble Thomas Survey
- 2008 Determine new baseline and determine channel change since 100-year flood event in Reaches 1 and 2.

Sampling Locations

A series of permanent cross section transects will be established at key locations within the restoration area to measure changes in channel morphology, substrate composition, vegetation structure and diversity, and other aquatic and riparian habitat quality performance indicators. Permanent transects will be established in areas where habitat features (i.e., inset floodplain benches, large woody debris structures) have been constructed to monitor the effectiveness of the features. Additional transects will be established in areas without constructed habitat features to help identify/control for reach-wide changes/trends that are not a result of constructed features. Permanent re-bar monuments will be installed at each location to mark each end of the cross section.

A minimum of one control cross section will be monitored per mile of project reach. Control cross sections will be located in areas where no channel treatments have been done. Control cross sections will be located, to the extent practicable, and in areas that represent the dominant channel type in that reach and provide representative coverage of the channel.

A minimum of two cross sections in treated areas will be monitored per mile of project reach. Treatment area cross sections will be located in areas that are expected to have the most change from instream enhancements, and that can be readily re-occupied. Monitoring cross sections will be spaced to monitor channel changes over a variety of channel types.

Cross sections were surveyed throughout the Rutherford Reach in 2004, 2005 and 2007 to establish a baseline for the survey. In each Project Phase, a subset of these cross sections will be chosen for long-term monitoring. A minimum of one cross section per half mile of river reach will be established for the purpose of long term effectiveness monitoring. Cross section will be selected in treatment and control areas. At least three monitoring cross sections will be established per reach: Two cross sections in treated portions of the reach, and one in a control portion of the reach. The baseline cross sections located in the treatment reaches will be re-occupied and re-surveyed after construction. Thereafter, the control and treatment cross section transects will be re-occupied following a large flood event (>5 years recurrence interval), or at least once every 5 years. Ideally, the Annual Stream Reach Survey will inform adaptations to the long term monitoring program.

Phase 1: Reaches 1 and 2

Phase 1 (Reaches 1 and 2) will be constructed by 2010. The monitoring cross sections in the treatment reaches, which will be re-surveyed post-construction, are located at river stations: 22,045 and 18,960. The monitoring cross sections in the control areas are located at river stations: 21,600, 21,200, and 20,600.

Phase 2: Reaches 3

Phase 2: Reach 3 pre-project baseline surveys were conducted in fall 2009. The monitoring cross section in a treatment location, which will be re-surveyed post-construction, is located at river stations 16,420 and 18,960. The monitoring cross section in a control area is located at river station 15, 17,890.

Sampling Schedule

The cross section transects in each phase will be surveyed pre-construction, and within two years post-construction, thereafter at least once every four years. Cross sections may be also resurveyed after a significant channel forming flood event or as deemed necessary by findings during the annual longitudinal stream survey.

For evaluation of project effectiveness, the cross section transects will be re-occupied based on a number of variables:

- Grant and regulatory requirements, including once within the grant timeline for Phase I implementation.
- The discretion of the survey team based on a major disturbance or change identified during the annual Maintenance Survey rapid assessment (ie. tree falling, failed instream structure, significant bank erosion, etc.).
- The occurrence of a significant channel forming flood event (likely to be at or above a 5-year recurrence interval).
- At least once within a five year period following construction in the absence of a significant flood event.
- Available budget.

Phase 1: Reaches 1 and 2

Construction on Phase 1: Reaches 1 and 2 began in summer 2009, and will be completed in 2010. The post-construction annual stream survey will commence in spring 2010. Two monitoring cross sections in the treatment reaches will be surveyed in 2009 (within grant timeline). Thereafter, monitoring cross sections in both the control and treatment reaches will be surveyed at least once every five years or following a channel forming event, based on recurrence interval and field evidence gathered in the course of the annual longitudinal survey.

Phase 2: Reach 3

Phase 2: Reach 3 pre-project baseline surveys were conducted in fall 2009. It is anticipated that construction will occur in spring 2010, and the post-construction annual stream survey will commence in spring 2011.

Protocol References and Data Forms

Fitzpatrick et al. (1998)
Revised Methods for Characterizing Stream Habitat in the National Water-Quality Assessment Program
http://water.usgs.gov/nawqa/protocols/WRI98-4052/wri98-4052.pdf

SWAMP (2008)
Reconnaissance and Evaluation of Field Sites for Suitability for Use in Monitoring Programs
www.swrcb.ca.gov/swamp/docs/qamp/appxd_guidelines.doc

Gerstein, J.M. (2005)
Monitoring the Effectiveness of Instream Habitat Restoration. University of California, Center for Forestry, Berkeley, California. 45 pgs.
http://forestry.berkeley.edu/comp_proj/DFG/Monitoring%20the%20Effectiveness%20of %20Instream%20Habitat%20Restoration.pdf

Gerstein and Harris (2005)
Protocol for Monitoring the Effectiveness of Bank Stabilization Restoration
http://www.cnr.berkeley.edu/forestry/comp_proj/DFG/Monitoring%20the%20Effectiveness%20of%20Bank%20Stabilization%20Restorati.pdf

Harrelson et al. (1994)
Stream channel reference sites: an illustrated guide to field technique
http://www.fs.fed.us/rm/pubs_rm/rm_gtr245.pdf

Hayes, G. et al (2008)
Napa River, Rutherford Reach, Restoration Phase 1, Reaches 1 and 2, Pre-Project Monitoring Survey, Prepared for the Napa County Resource Conservation District, December 3, 2008. 33 pp.

Nossaman, et al (2007)
Quantitative Effectiveness Monitoring of Bank Stabilization and Riparian Vegetation Restoration: A Field Evaluation of Protocols

http://ucce.ucdavis.edu/files/filelibrary/2161/36783.pdf

Rosgen, D.L. (1996)
Applied River Morphology

USDA (2005) Frazier, J.W., et al
Stream Condition Inventory Technical Guide. USDA Forest Service, Pacific Southwest Region – Ecosystem Conservation Staff. Vallejo, CA 111pp.
http://www.fs.fed.us/r5/publications/water_resources/sci/techguide-v5-08-2005-a.pdf

Local Longitudinal Thalweg Survey

Objectives

Conduct local longitudinal thalweg topography surveys to assess changes in channel geomorphology and associated aquatic habitat quality in control and treated reaches.

Methods

Survey the local longitudinal thalweg profile with a total station, transit, or hand level (+/- 1 meter accuracy) in vicinity of cross sections located in expected response reaches, as well as in control reaches. Record points along the stream to capture the following attributes:

- Habitat Units
- Riffle Crests
- Pool Forming Factors
- Pool Maximum Depth
- Residual Pool Depth: Change in pool storage of fines
- Frequency and Extent of Habitat Units: Channel Complexity; Riffle Habitat Length
- Channel Adjustment: Bed Deposition or Scour associated with Instream Structures
- Channel Planform Network
- Connectivity of Secondary Channels and High Flow Refugia at Constructed Alcoves
- Gravel Bar Characteristics

Note the stations of installed instream structures along the survey. Measure bankfull width associated with installed structures to evaluate how the structures affect channel bank erosion.

In 2004, three separate, discontinuous longitudinal reaches along the Rutherford Reach were surveyed to capture the stream profile where the 2004 control survey cross section transects were clustered. In total, 8,598 feet of river thalweg was surveyed, using 142 reference point observations.

The RCD and Flood Control District possess a GIS layer of the riffle locations identified along the Rutherford Reach in 2004.

Record bankfull depth data on the *Stream Habitat Enhancement Project Evaluation Individual Structure or Site Form* located on page VIII-17, of the California Salmonid Stream Habitat Restoration Manual, Part VIII, Project Evaluation and Monitoring (Flosi et al / CDFG, 1998).

To simultaneously record the status of restoration structures and data on associated habitat type, use the Habitat Monitoring Form on page 16 of *Monitoring the Effectiveness of Riparian Vegetation Restoration,* (Harris et al ,2005), http://www.cnr.berkeley.edu/forestry/comp_proj/DFG/Monitoring%20the%20Effectiveness%20of%20Riparian%20Vegetation%20Restorat.pdf.

Map all riffle crest locations with a GPS.

Sampling Locations

Anchor the long profile to contain at least two riffles or 10 bankfull channel lengths up and downstream from the monitoring cross sections in the control and treatment areas. Note the beginning and ending river station of the profile. Monument survey endpoints so that they can be seen from the channel. Photodocument the survey.

Note the stations of installed instream structures along the survey.

Sampling Schedule

In 2009 a baseline longitudinal thalweg profile of the Rutherford Reach was surveyed between Zinfandel Lane and the Rutherford Cross Road. The thalweg survey will be completed from the Rutherford Cross Road to the Oakville Cross Road in 2010. Subsequent local longitudinal profiles will be surveyed in control and treatment reaches in the vicinity of instream structures pre- and post-construction, and following a flood event (>5year recurrence interval), or at least once every 5 years.

Protocol References and Data Forms

Cover et al. (2008)
Quantitative linkages among sediment supply, streambed fine sediment, and benthic macroinvertebrates in northern California streams. University of California, Berkeley. J. N. Am. Benthol. Soc., 2008, 27(1):135–149,_ 2008 by The North American Benthological Society, DOI: 10.1899/07–032.1, Published online: 15 January 2008

Gerstein, J.M. (2005)
Monitoring the Effectiveness of Instream Habitat Restoration. University of California, Center for Forestry, Berkeley, California. 45 pgs. http://forestry.berkeley.edu/comp_proj/DFG/Monitoring%20the%20Effectiveness%20of %20Instream%20Habitat%20Restoration.pdf

Flosi, G., S. Downie, J. Hopelain, M. Bird, R. Coey, and B. Collins / CDFG (1998)
California Salmonid Stream Habitat Restoration Manual, Third Edition. Sacramento, California, California Department of Fish and Game, Inland Fisheries Division. http://www.dfg.ca.gov/nafwb/pubs/1998/manual3.pdf

Lisle, Thomas E. (1987)
Using "residual depths" to monitor pool depths independently of discharge. Res. Note PSW-394. Berkeley, CA: Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 4 p. http://www.fs.fed.us/psw/rsl/projects/water/Lisle87.pdf

Nossaman, S., M. Lennox, D. Lewis, P. Olin. (2007)
Quantitative Effectiveness Monitoring of Bank Stabilization and Riparian Vegetation Restoration: A Field Evaluation of Protocols. University of California

Cooperative Extension.
http://ucce.ucdavis.edu/files/filelibrary/2161/36783.pdf

USDA (2005) Frazier, J.W., et al
Stream Condition Inventory Technical Guide. USDA Forest Service, Pacific Southwest Region – Ecosystem Conservation Staff. Vallejo, CA 111pp.
http://www.fs.fed.us/r5/publications/water_resources/sci/techguide-v5-08-2005-a.pdf

Washington State Department of Natural Resources (2007, November)
Watershed Analysis Manual Version 4.0.

http://www.dnr.wa.gov/Publications/fp_wsa_manual_section06.pdf

Washington State Department of Natural Resources (2008)

Residual Pool Depth Measurement Associated with Instream Structures

Objectives

Residual pool depth is measured to assess the impact of instream structures on pool structure and reducing the deposition of fines in pools.

Methods

In treated reaches ameasure the residual pool depth associated with a subset installed structures to evaluate how the structures affect pool structure and the amount of fines stored in pools over time. Record residual pool depth data on the *Stream habitat Enhancement Project Evaluation Individual Structure or Site Form* located on page VIII-17, of the *California Salmonid Stream Habitat Restoration Manual, Part VIII, Project Evaluation and Monitoring* (Flosi et al / CDFG, 1998).

For an in-depth description of the protocol for measuring residual pool depth., consult Lisle, Thomas E. (1987), *Using "residual depths" to monitor pool depths independently of discharge,* http://www.fs.fed.us/psw/rsl/projects/water/Lisle87.pdf

Sampling Locations

Pools associated with installed instream structures in treated reaches will be mesured to determine change in fine sediment storage (V*). See Lisle (1987) for a description of V* rapid protocol methods.

Sampling Schedule

Residual pool depth associated with installed instream structures will be measured annually during the June river survey.

Protocol References and Data Forms

Cover et al. (2008)

Quantitative linkages among sediment supply, streambed fine sediment, and benthic macroinvertebrates in northern California streams. University of California, Berkeley. J. N. Am. Benthol. Soc., 2008, 27(1):135–149,_ 2008 by The North American Benthological Society, DOI: 10.1899/07–032.1, Published online: 15 January 2008

Gerstein, J.M. (2005)

Monitoring the Effectiveness of Instream Habitat Restoration. University of California, Center for Forestry, Berkeley, California. 45 pgs. http://forestry.berkeley.edu/comp_proj/DFG/Monitoring%20the%20Effectiveness%20of %20Instream%20Habitat%20Restoration.pdf

Flosi, G., S. Downie, J. Hopelain, M. Bird, R. Coey, and B. Collins / CDFG (1998)

California Salmonid Stream Habitat Restoration Manual, Third Edition. Sacramento, California, California Department of Fish and Game, Inland Fisheries Division. http://www.dfg.ca.gov/nafwb/pubs/1998/manual3.pdf

Lisle, Thomas E. (1987)
Using "residual depths" to monitor pool depths independently of discharge. Res. Note PSW-394. Berkeley, CA: Pacific Southwest Forest and Range Experiment Station, Forest Service, U.S. Department of Agriculture; 4 p. http://www.fs.fed.us/psw/rsl/projects/water/Lisle87.pdf

Nossaman, S., M. Lennox, D. Lewis, P. Olin. (2007)
Quantitative Effectiveness Monitoring of Bank Stabilization and Riparian Vegetation Restoration: A Field Evaluation of Protocols. University of California Cooperative Extension. http://ucce.ucdavis.edu/files/filelibrary/2161/36783.pdf

USDA (2005) Frazier, J.W., et al
Stream Condition Inventory Technical Guide. USDA Forest Service, Pacific Southwest Region – Ecosystem Conservation Staff. Vallejo, CA 111pp. http://www.fs.fed.us/r5/publications/water_resources/sci/techguide-v5-08-2005-a.pdf

Grid Pebble Counts at Riffle Crests Nears Cross Section Transects

Objectives

Pebble counts will be conducted to monitor changes in channel substrate median particle Size (D50) and (D84) at riffle crests in control and treatment reaches.

Per Bunte and Abt (2001):

> Pebble counts are used to determine the particle-size characteristics of gravel and cobble surface sediment and can be performed on dry beds as well as on inundated beds, as long as the streams are wadable. Percentile values of the cumulative particle-size frequency distribution and the percent fines are used for many applications including computations of incipient bedload motion, channel-bed roughness, stream morphology studies, cumulative watershed effects analysis, and stream habitat evaluation.

Methods

Conduct a grid pebble count at riffle crests located nearest to long-term monitoring cross section transects in treated and control reaches. Tabulate and graph the data to identify the median grain size (D50) and the 84th percentile grain size (D84) for each cross section. Follow the grid sampling method described in Bunte and Abt (2001) and USDA (2005) to reduce operator error and bias against fines.

Measure and record the distance from the long-term monitoring cross section to the sampled riffle crest. Calculate and note the river station of the sampled riffle crest.

Whereas Bunte and Abt (2001) recommend sampling from high flow bank to high flow bank, we will sample the active bed width of the incised channel as described in USDA (2005):

> Measurement is conducted on the stream bottom so that the streambed is sampled without incorporating bank materials. The stream bottom is the area of the stream that is practically bare of vegetation caused by the wash of waters of the stream from year to year. It is therefore at a level less than bankfull stage and excludes streambanks.

This width may correlate with the summer low flow channel.

Divide the bed width of the channel to be sampled into ten equal intervals. Have operators sample in a grid along a tape beginning at the riffle crest and working downstream. Make sure that the grid interval, or the spacing between sampled particles, exceeds the length of the *b*-axis of the D_{max} particle size of concern. This spacing is necessary in order to prevent double counting of large particles, which should be avoided because it causes a serially correlated sample and bias towards large particle sizes. (Bunt and Abt, 2001). Where an anomalously large particle is present use the largest dominant particle size in the riffle. For example, if a riffle is 70% gravel and 30% cobble but has one very large boulder, use the largest cobble as the minimum spacing guide (USDA, 2005). Make the grid interval equal to 1/10 of the width of the channel as determined by a taped stretched horizontally across the channel. Have operators use a scratch awl, and averted gaze, to sample the particle at each grid intersection. Sample a minimum of 100 particles at each bar. Measure the intermediate axis of each particle to the nearest millimeter. Record the actual measured particle size in the same grid pattern location in which the particle was sampled. Record whether the particle was located in water. In this way the notes will provide a visual representation of the particle size distribution as sampled. A gravelometer could be used instead of rulers for future pebble counts.

Tips for reducing operator bias and errors while surface sampling with pebble counts from Bunte and Abt (2001):

- Use a sampling frame when selecting particles to reduce operator preference for "handy" particles, or sample along a tape measure on dry beds.
- Sample along a strictly determined grid pattern that covers the sampling area to prevent operators from omitting "unappealing" streambed locations.
- Space sampling points by at least the D_{max} particle size in order to avoid counting large particles multiple times which results in a serially correlated sample.
- Record all particle sizes for each transect in sequential order (e.g., from left to right bank). Include the location of the current water line. Such a record helps to determine a systematic spatial variation of particle sizes and allows a deferred decision on whether particles from the high-flow bed are included or excluded from the study.
- One operator should select and retrieve all particles. A second person may assist by taking over the template measurements.
- The use of templates to measure particle sizes avoids measurement errors but requires that the size distribution approximates normality. Use calipers only if the measured range of particle sizes is small (less than 0.5 or 1 units), if particle sizes are definitely not normally distributed, or when measuring all particle axes for an analysis of particle shape.

Sampling Locations

Riffle crests located nearest to long-term monitoring cross section transects in treated and control reaches.

Sampling Schedule

Pebble counts will be conducted concurrent with re-surveying of the monitoring cross sections pre- and post-project construction, and post channel forming flood event.

Protocol References and Data Forms

Bunte, Kristin; Abt, Steven R. (2001)
Sampling surface and subsurface particle-size distributions in wadable gravel- and cobble-bed streams for analyses in sediment transport, hydraulics, and streambed monitoring.
http://www.fs.fed.us/rm/pubs/rmrs_gtr74.html

Cover et al. (2008)
Quantitative linkages among sediment supply, streambed fine sediment, and benthic macroinvertebrates in northern California streams. University of California, Berkeley. J. N. Am. Benthol. Soc., 2008, 27(1):135–149,_ 2008 by The North American Benthological Society, DOI: 10.1899/07–032.1, Published online: 15 January 2008.

USDA (2005) Frazier, J.W., et al
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http://www.fs.fed.us/r5/publications/water_resources/sci/techguide-v5-08-2005-a.pdf

Photodocumentation of Cross Section Transects

Objectives

The objective for photodocumenting cross section transects is to create a visual record to assess changes along the cross section in vegetation and channel geomorphology on the cross section, as well as upstream and downstream in the vicinity of the cross section. Photodocumentation of cross section monuments is also instrumental for relocating and re-occupying the survey cross section in the correct location.

Methods

At a minimum, photodocument each cross section from each endpoint monument and any monuments established along the cross section. Also photodocument from the center of the channel on the cross section. Take photographs in a minimum of four directions: facing downstream, towards the right bank, upstream, and towards the left bank from each point. Ideally, take eight photos to create a 360 degree record from each point. Take photos of other features of interest, making sure to describe the photopoint in relation to a monument, or distance and bearing from a station along the cross section. Indicate the river station corresponding to the photo location.

Where necessary to establish a new photopoint monument, record the distance and bearing from the monument to at least two fixed locations that can be re-located, such as tree tags installed for this purpose, or permanent landscape features, such as building corners, or fence posts. Describe the fixed points. Photograph these points from the photopoint for re-location purposes.

Record the GPS point, stream station, photographer location (in-channel, at a monument pin or tag), and direction of photograph on the Photo Form. Record the compass bearing of the direction in which the photo is taken. Record the subject of the photograph.

Sampling Locations

Each surveyed cross section will be photodocumented in a 360 degree manner at each permanent monument, at the center of the stream channel, and at other points deemed relevant in the field.

Sampling Schedule

Photodocumentation of cross sections and local longitudinal profiles will take place concurrent with the pre- and post- project surveys. Photodocumentation in the channel at each cross section will also be done during the Annual Stream Reach Survey. Photodocumentation of re-vegetated areas along the control and treatment monumented cross sections will also be done during the phased vegetation surveys.

Start Station			Stream Name:			Date:	Surveyors:
			Photodocumentation				
GPS PT	FROM +US/-DS	TO +US/-DS	Photo No.	Photographer Location, Monument Pin or Tag Number	Direction of Photo Relative to Stream	Compass Bearing	Subject / Feature / View / Notes
	(feet)	(feet)	#	LB, RB, CH, etc	US, DS, RB, LB	Degrees	

DS-Downstream US-Upstream LB-Left Bank RB-Right Bank CH-Channel TOP-Top of Bank Pin MID-Mid Bank Pin BTM – Base of Bank Pin

Protocol References and Data Forms

Gerstein, J.M. and S.D. Kocher. (2005)
Photographic Monitoring of Salmonid Habitat Restoration Projects. University of California, Center for Forestry, Berkeley, CA. 21 pp.
http://www.cnr.berkeley.edu/forestry/comp_proj/DFG/Photographic%20Monitoring%20of%20Salmonid%20Habitat%20March%202005.pdf

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Napa River, Rutherford Reach, Restoration Phase 1, Reaches 1 and 2, Pre-Project Monitoring Survey, Prepared for the Napa County Resource Conservation District, December 3, 2008. 33 pp.

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http://www.fs.fed.us/r5/publications/water_resources/sci/techguide-v5-08-2005-a.pdf

Phased Vegetation Establishment Surveys

Objectives

The objectives of the phased vegetation survey are to:

- Evaluate restoration planting survival and establishment success in treated reaches.
- Control target non-native invasive and Pierce's disease host plant species, to the extent practicable.

Vegetation monitoring in restored riparian planting areas is to be performed by the contractor responsible for plant installation for a period of three years after planting. Thereafter vegetation monitoring and management in restored areas will be performed by the Napa County Flood Control and Water Conservation District under the Maintenance Assessment District program. Photomonitoring will be incorporated into the annual stream reach survey, repeated cross section transect surveys, and phased vegetation establishment surveys. Photomonitoring of project progress will be conducted at least once every three years.

Information regarding vegetation community distribution and riparian buffer width will be collected along the cross section transects located in the control and treatment reaches. These cross sections are surveyed before and after construction, and then after large flood events. Riparian vegetation data will be supplemented with aerial photo analysis as budgets allow.

In order to assure consistency with CDFG protocols, use the plant species identification codes in Flosi et al (1997) for describing vegetation.

Monitoring Parameters by Category

The parameters to be identified, mapped and assessed in the Phased Vegetation Survey are presented in Table 1 organized by monitoring category.

The following riparian vegetation establishment success parameters will be evaluated:

Restoration Planting Survival

- Relative Abundance of Native versus Non-Native Plant Cover
- Number of Pierce Disease Plants
- Riparian Vegetation Buffer Width

Monitoring Parameter Methods

The following protocols will be used to assess the above parameters:

- Riparian Vegetation Cross Section Transects: Direct Count
- Photodocumentation
- Air Photo Analysis

Riparian Vegetation Cross Section Transects: Direct Count

Objectives

The objective of performing a direct count vegetation census is to assess species composition and survival of planted trees and shrubs in treated areas.

Methods

As of the writing of this draft (March 22, 2010) we are in the process of adapting the method outlined below to be more compatible with the baseline riparian vegetation survey performed by the California Land Stweardhsip Institute on the Oakville to Oak Knoll Reach of the Napa River.

To assess survivorship of planted trees and shrubs in treated areas, follow the Planted Tree Survival Assessment protocol in Harris et al (2005) utilizing the revised forms in Nossaman et al (2007). For detailed instructions on establishing a plot sampling strategy, refer to FIREMON's Integrated Sampling Strategy (2003a).

Complete the CRMEP Post-Treatment Checklist for Revegetation Treatments at each site surveyed (Collins, 2008).

> Post-Treatment Form Instructions
>
> http://ftp.dfg.ca.gov/public/FRGP/Qualitative_Monitoring_Forms/2008%20Effectiveness_Monitoring/Instructions/7b%20RT_Post_Checklist_Instructions_2008.pdf
>
> Post-Treatment Form
>
> http://ftp.dfg.ca.gov/public/FRGP/Qualitative_Monitoring_Forms/2008%20Effectiveness_Monitoring/Checklists/7b%20RT_Post_Revegetation_2008.pdf

In addition, photodocument the survey per the Photodocumentation protocol described below in the next section.

Instructions from Harris et al (2005) for the Planted Tree Assessment protocol are as follows:

> Survey techniques for evaluating the survival of planted trees are well established (Stein 1992). The method recommended here is appropriate for evaluating treatment areas with a relatively uniform distribution of single stem seedlings. This method is not appropriate for projects where seedlings are planted in single lines, randomly or in clumps. For those projects, it would be necessary to flag or otherwise identify planted seedlings in order to track survival. This method is also appropriate for evaluating survival of herbaceous plantings, willow baffles, willow mattresses, or similar projects.
>
> Control sites are not required for assessments of planting survival unless there is a desire to evaluate the effects of natural recruitment or of extreme events

(floods or droughts) on plantations. If it is desirable to separate planted from naturally recruited individuals of the same species, planted stock must be flagged or otherwise identified.

For evaluating survival of shrub and/or herbaceous plantings, other methods are required. Line intercept… is recommended to evaluate survival of vegetative clumps or shrubs within delineated treatment areas, within 50 feet of the channel or along banks. For plantings involving grasses or other small, individual plants, point intercept methods may be more appropriate. Texts on rangeland sampling should be consulted in the event that these kinds of projects must be assessed for survival.

Determination of Sample Size
Determine the extent and location of the project area(s) using polygon traverses, as outlined above or other information. Using GIS, planimeter, or dot grid determine the area(s) of the polygon(s) to be planted in acres.

Once the area has been determined for each polygon, the required number of 1/100-acre sample plots is determined as follows. If the polygon is less than 30 acres, two percent of the area should be sampled. If the area of the polygon is greater than 30 acres, one percent of the area should be sampled. In any event, a minimum of 5 sample plots should be surveyed. If the polygon is less than 0.25 acre, all seedlings should be counted.

Field Method
Determine locations of sample plots within the project area polygon(s). The plots need to be equally distributed. First, divide the number of acres in the project area by the number of plots that will be surveyed. This will give the portion of an acre that each plot represents. Multiply this number times the square feet in one acre: 43,560. Then calculate the square root of the result to provide a value in lineal feet. This will be the distance between lines and between plots on the line.

After the distance between plots and lines has been determined, these lines and plot locations are drawn onto the appropriately scaled map. All lines must be parallel to each other and the first line should be inset from the polygon boundary by one half the calculated distance between plots and lines (147.5/2 = 73.8 feet). After drawing the grid on the map, determine the distance and bearing to the first plot from a recognizable reference point (e.g., bridge, tributary junction, large snag, etc.)

Locate the reference point on a map or air-photo. Navigate to the first plot location using the bearing and distance calculated from the map or air-photo. After recording data for the first plot, navigate to all successive plots with a compass set to the bearing of the lines drawn on the map or air-photo. All distances between plots must be slope corrected.

After locating the plot center, measure out a distance of 11.4 feet due north. Search the plot in a clockwise direction for seedlings until arriving back at the due north starting point of your search. For every seedling within 11.4 feet of plot center record *species* and *vigor class* (live, dead, or dying). Record any observations regarding obvious causes of death (browsing, desiccation, competition, etc.) or other relevant observations in the comments section for the plot, not for each seedling.

Data Analysis
These data may be used to calculate: average number of trees per acre by species across all plots, percent of live versus dead seedlings observed and percent of plots with at least one live seedling. A confidence interval of survival rate at each site can be computed (if the treated area is less than 0.25 acres then the survival rate is known).

PLANTATION SURVIVAL DATA FORM

Contract #:_______________ Contract Name:____ Implementation Mo/Yr:__________
Site Name:____ Stream/Drainage:_______________________________
Evaluators:___________________________ Date:_________ Project Feature #/Name:________________________ Polygon #:____
Location:_______________________ Start Point:____

Streambank: (*Left* or *Right*) **Direction:** (*Upstream* or *Downstream*)

Plot #	Species	Vigor	Tally	Comments

Vigor Class = **L**ive, **D**ead, **P**oor Health, Vigorous Growth

Species Codes

Additional Comments:

Instructions for Completing the Planted Tree Survival Assessment Data Form General Information- section 1

1) Page ___ of ____—Number the page. For example, if this is page 2 out of 3 total pages, enter: Page 2 of 3.

2) Contract #—Enter in the contract number assigned to this project by the Department of Fish and Game.

3) Contract Name – Enter the name of the contract.

4) Stream Name—Enter in the name of the stream or road. If unnamed, use named stream or road to which it is tributary.

5) Date—Enter the date: *mm/dd/yy*

6) Crew—Enter the names of the crew members collecting the data using the following format: *last name, first initial*.

7) Drainage Name—Enter the name of the main drainage basin that the stream is a tributary to.

8) Polygon #/Location- Enter the number of the treatment polygon and locational information.

9) Start Point- Describe the location at which the survey began, using permanent reference points.

10) Streambank- Circle the stream bank being surveyed, if applicable.

11) Survey Direction- Circle the direction of travel taken by surveyors during data collection, if applicable.

Seedling Survey Data – section 2

13) Plot #- Enter the number of the plot where the data is collected.

14) Species- Enter the species of the seedlings found on the plot.

15) Vigor- Enter all possible vigor classes for seedlings of each species, live, poor health and dead.

16) Tally- For each species and vigor class, enter the number of seedlings found on that plot as a dot tally.

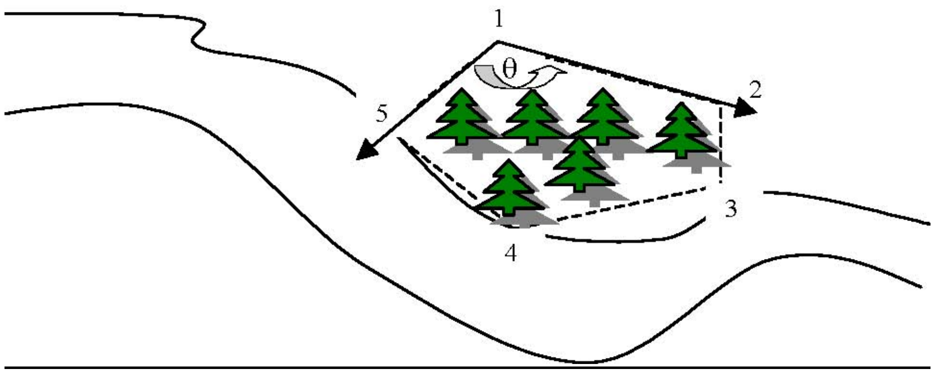
17) Comments- Enter any pertinent comments on the seedlings found in that plot.

Sampling Locations

Restoration planting survival of trees surveys will take place in sampled plots of revegetated riparian areas.

The protocol for delineating study areas from Harris et al (2005) is as follows:

> Study areas may be discrete areas or stream reaches. Stream reach study area locations are documented by stream station, and channel bank. Generally, stream reach study areas should begin and end with the limits of proposed treatments, even if the treatments are not continuous. For example, if a stream reach has 11 defined sites for riparian planting, the study area boundaries would begin with the most upstream treatment site and end with the most downstream treatment site.
>
> Control (untreated) stream reaches, if possible, should be located upstream of the treated area, or at least in their vicinity. Control reaches should be environmentally and ecologically comparable to the reaches that will be treated.
>
> In some cases, riparian restoration treatments are applied to relatively large, independent areas such as grazing exclusions, plantings on eroded sites, exotic plant eradications, etc. In such cases, it is necessary to establish the boundaries of the area proposed for treatment so that it may be properly sampled and relocated in the future:
>
> - Establish the location of one corner of the area relative to a known reference point. Flag the perimeter of the area to be treated.
> - At each polygon corner, record the bearing between the corners.
> - Using a hip chain or tape, record the length of each side of the polygon.
> - Sketch the polygon onto field form.
>
> In the example figure, points 1, 2, 3, 4, and 5 are corners of the treatment polygon. Record the length of each side (e.g., the distance between points one and two). Record the bearings between all corners. The angle theta at point one is the difference in degrees between the bearing on line 1 to 2 and the bearing on line 1 to 5.
>
> For more guidance on this procedure refer to *Documenting Salmonid Habitat Restoration Project Locations.*



Sampling Schedule

Restoration planting survival surveys will take place in the first 7 years after planting to evaluate establishment success.

Protocol References and Data Forms

Collins, B. (2008)

Coastal Restoration Monitoring and Evaluation Program Qualitative Monitoring Forms. California Department of Fish and Game, Fort Bragg, California. http://ftp.dfg.ca.gov/public/FRGP/Qualitative_Monitoring_Forms/

(Will be incorporated into Flosi et al. CDFG Stream Restoration Manual Chapter 8)

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Monitoring the Effectiveness of Riparian Vegetation Restoration. University of California, Center for Forestry, Berkeley, CA. 33 pp. http://www.cnr.berkeley.edu/forestry/comp_proj/DFG/Monitoring%20the%20Effectiven ess%20of%20Riparian%20Vegetation%20Restorat.pdf

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Department of Agriculture, Forest Service, Rocky Mountain Research Station, General Technical Report RMRS-GTR-47, April 2000, 49pp.

Photodocumentation of Riparian Vegetation

Objectives

The objective for photodocumenting riparian vegetation establishment is to create a visual record to assess changes in vegetation over time.

Methods

Before project construction, establish monument points from which to photograph restoration planting establishment, survival, and growth. Establish a set of permanent photomonitoring stations to document progress in restoration areas that are not selected for detailed surveys. Choose photomonitoring stations prior to implementation of each phase of the restoration project to document both pre- and post-project conditions. Mark station locations using metal T-posts, re-bar monuments, or relative distances from identified fixed points marked with metal id tags. Record GPS (Geographic Information System) coordinates at each station and document each location on a map of the project reach. The number and coverage of photographs taken at each station may vary, depending on the location of the station and the size and condition of the target feature. Record compass bearings for each photo. Record the subject of the photograph.

For each survey plot, photodocument the location from the corners of the polygonal sampling plot towards the center.

Sampling Locations

Photodocumentation of restoration planting survival will take place at monuments that are established before project construction, and at the corners of all sampled plots of revegetated areas. New permanent monument points may have to be established after project construction in the event that the pre-project monuments are not able to be re-occupied, or in the event that better vantage points can be established for long term documentation post-construction

Phase 1: Reaches 1 and 2

Project construction of Phase1 (Reaches 1 and 2), which spans from river station 18,600 to 24,900, is expected to be completed in 2009. Discontinuous riparian re-vegetation treatment areas are located along the left and right banks of the entire subreach.

Phase 2: Reach 3

Project construction of Phase2 (Reach 3), which spans from river station 16,000 to 18,600, is expected to be completed in 2010. Discontinuous riparian re-vegetation treatment areas are located along the left and right banks of the entire subreach.

Sampling Schedule

Photos will be taken pre-project at pre-established monument. Thereafter, photodocumentation of the restoration planting survival of riparian vegetation will take place 1,2,3,5 and 7 years after planting concurrent with vegetation surveys in the spring after vegetation has leafed out at those locations, and at additional vegetation survey polygon plot corners..

Phase 1: Reaches 1 and 2

Phase 1 (Reaches 1 and 2) are scheduled for construction in spring 2009, and the post-construction annual stream reach survey will commence in spring 2010.

Phase 2: Reach 3

It is anticipated that Phase 2: Reach 3 pre-project baseline surveys will be conducted in spring 2009, and that construction will occur in spring 2010, and the post-construction annual stream survey will commence in spring 2011.

Protocol References and Data Forms

Hayes, G. et al (2008)
Napa River, Rutherford Reach, Restoration Phase 1, Reaches 1 and 2, Pre-Project Monitoring Survey, Prepared for the Napa County Resource Conservation District, December 3, 2008. 33 pp

Start Station **Stream Name:** **Date:** **Surveyors:**

Photodocumentation

GPS PT	FROM +US/-DS	TO +US/-DS	Photo No.	Photographer Location, Monument Pin or Tag Number	Direction of Photo Relative to Stream	Compass Bearing	Subject / Feature / View / Notes
	(feet)	(feet)	#	LB, RB, CH, etc	US, DS, RB, LB	Degrees	

DS-Downstream US-Upstream LB-Left Bank RB-Right Bank CH-Channel TOP-Top of Bank Pin MID-Mid Bank Pin BTM – Base of Bank Pin

Air Photo Analysis

Objectives

The objectives of air photo analysis are to detect change over time in channel planform network and associated riparian habitat extent.

Methods

Document the width of the riparian buffer along the stream channel. Document the spatial extent of the stream channel network.

As aerial photos become available, measure the extent of the riparian buffer along the stream channel by outlining the riparian vegetation boundary along both sides of the channel. Subdivide these polygons by re-vegetated and pre-project vegetation areas. Use GIS analysis to compare changes in riparian vegetation extent through time. Note where other natural and physical disturbances to pre-existing vegetation cover have occurred.

As aerial photos become available, delineate the primary and secondary channel network. Compare the current and historic networks to detect change in drainage locations, stream length, and channel width.

Sampling Locations

Document the extent of the riparian buffer and the stream channel network along the entire length of the stream channel on both the right and left banks. Include secondary channels.

Sampling Schedule

Air photo analysis will be conducted as air photos become available and as the budget allows.

Stakeholder Participation Surveys

Objectives

The objective of conducting stakeholder participations surveys and ongoing documentation of participation levels is to document the success of community engagement.

Methods

- LAC participation in maintenance and monitoring oversight including holding office, maintenance requests and access provisions
- Minutes will be recorded of meetings of the LAC and details from those meetings will be included in an annual report.

Sampling Schedule

The participation of landowners will be recorded as events occur.

Protocol References and Data Forms

Federal Interagency Stream Restoration Working Group (FISRWP) (2001) *Stream Corridor Restoration: Principles, Processes, and Practices; Part II.* http://www.nrcs.usda.gov/technical/stream_restoration/newtofc.htm

REPORTING

As described in the *Napa River Rutherford Reach Restoration Project Maintenance Plan*, following completion of annual maintenance activities, the LAC will prepare a report documenting work completed that year, associated costs, remaining budget, and adequacy of funding to complete required maintenance. The results of streambank erosion and instream structure persistence monitoring conducted as part of the maintenance surveys will also be included in the annual maintenance program report. The results of the additional monitoring conducted to evaluate progress toward meeting the desired outcomes for aquatic and riparian habitat quality will be summarized in separate reports issued in the same year that monitoring of those features was conducted. The reports will document the year's monitoring activities; monitoring results; overall site progress; and any remedial actions taken during the year. It is anticipated that monitoring will occur in the late-spring or early-summer, after flows in the channel have receded and vegetation has leafed out. Monitoring reports will be completed and submitted to the agencies for review by November 1 of each year that additional monitoring has been conducted.

The Phase 1 and 2 monitoring report will include the following specific components.

- A cover and title page with the Corps permit number.
- An *Executive Summary*.
- An *Introduction* that provides background on the project and identifies restoration objectives, performance indicators, and performance standards.
- A summary of the monitoring methods and discussion of any modifications made to the monitoring methods since the previous monitoring period.
- A summary and analysis of the monitoring results, including an evaluation of conditions relative to success criteria and the overall development of restored areas.
- A discussion of remedial measures identified and implemented following the previous monitoring period and a summary of the effectiveness of the remedial measures that were implemented.

DATA MANAGEMENT

It is anticipated that the Flood District will function as the organizational sponsor for the archiving of digital and physical copies of all field data sheets, photodocumentation, GIS layers, and reports associated with the project.

All final reports shall also be filed with the Napa Watershed Information Center and Conservancy of Napa County (http://www.napawatersheds.org) for access through their website. The monitoring reports with also be linked to the San Francisco Bay Data Commons.

Monitoring data will be recorded on standardized data sheets developed by the District in coordination with the Napa County Resource Conservation District and landowner representatives. Data sheets, aerial photographs, and GPS units will be used to document monitoring results and identify the need for any remedial actions. The results of the survey will be compiled into a report and submitted to the resource and regulatory agencies for review.

REFERENCES

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Collins, B. (2008)
Coastal Restoration Monitoring and Evaluation Program Qualitative Monitoring Forms. California Department of Fish and Game, Fort Bragg, California. http://ftp.dfg.ca.gov/public/FRGP/Qualitative_Monitoring_Forms/

(Will be incorporated into Flosi et al. CDFG Stream Restoration Manual Chapter 8)

Channel Bank Reconstruction and Bank Stabilization (CB)

Pre-Treatment Form
http://ftp.dfg.ca.gov/public/FRGP/Qualitative_Monitoring_Forms/2008%20Effectiveness_Monitoring/Checklists/2a%20CB_Pre_ChannelBankReconstruction_2008.pdf

Implementation Form
http://ftp.dfg.ca.gov/public/FRGP/Qualitative_Monitoring_Forms/2008%20Imple

mentation_Monitoring/Checklists/2%20CB_Imp_ChannelBankReconstruction_2008.pdf

Post-Treatment Form
http://ftp.dfg.ca.gov/public/FRGP/Qualitative_Monitoring_Forms/2008%20Effectiveness_Monitoring/Checklists/2b%20CB_Post_ChannelBankReconstruction_2008.pdf

Instream Habitat and Bank Restoration (IN)

Pre-Treatment Form Instructions

http://ftp.dfg.ca.gov/public/FRGP/Qualitative_Monitoring_Forms/2008%20Effectiveness_Monitoring/Instructions/1a%20IN_Pre_Checklist_Instructions_2008.pdf

Pre-Treatment Form

http://ftp.dfg.ca.gov/public/FRGP/Qualitative_Monitoring_Forms/2008%20Effectiveness_Monitoring/Checklists/1a%20IN_Pre_InstreamHab_2008.pdf

Implementation Form Instructions

http://ftp.dfg.ca.gov/public/FRGP/Qualitative_Monitoring_Forms/2008%20Implementation_Monitoring/Instructions/1%20IN_Imp_Checklist_Instructions_2008.pdf

Implementation Form

http://ftp.dfg.ca.gov/public/FRGP/Qualitative_Monitoring_Forms/2008%20Implementation_Monitoring/Checklists/1%20IN_Imp_InstreamHab_2008.pdf

Instream Habitat and Bank Restoration – Post-Treatment Form Instructions

http://ftp.dfg.ca.gov/public/FRGP/Qualitative_Monitoring_Forms/2008%20Effectiveness_Monitoring/Instructions/1b%20IN_Post_Checklist_Instructions_2008.pdf

Post-Treatment Form

http://ftp.dfg.ca.gov/public/FRGP/Qualitative_Monitoring_Forms/2008%20Effectiveness_Monitoring/Checklists/1b%20IN_Post_InstreamHab_2008.pdf

Revegetation Treatments (RT)

Pre-Treatment Form Instructions

http://ftp.dfg.ca.gov/public/FRGP/Qualitative_Monitoring_Forms/2008%20Effectiveness_Monitoring/Instructions/7a%20RT_Pre_Checklist_Instructions_2008.pdf

Pre-Treatment Form

http://ftp.dfg.ca.gov/public/FRGP/Qualitative_Monitoring_Forms/2008%20Effectiveness_Monitoring/Checklists/7a%20RT_Pre_Revegetation_2008.pdf

Implementation Form Instructions

http://ftp.dfg.ca.gov/public/FRGP/Qualitative_Monitoring_Forms/2008%20Implementation_Monitoring/Instructions/7%20RT_Imp_Checklist_Instructions_2008.pdf

Implementation Form

http://ftp.dfg.ca.gov/public/FRGP/Qualitative_Monitoring_Forms/2008%20Implementation_Monitoring/Checklists/7%20RT_Imp_Revegetation_2008.pdf

Post-Treatment Form Instructions

http://ftp.dfg.ca.gov/public/FRGP/Qualitative_Monitoring_Forms/2008%20Effectiveness_Monitoring/Instructions/7b%20RT_Post_Checklist_Instructions_2008.pdf

Post-Treatment Form

http://ftp.dfg.ca.gov/public/FRGP/Qualitative_Monitoring_Forms/2008%20Effectiveness_Monitoring/Checklists/7b%20RT_Post_Revegetation_2008.pdf

Upslope Stabilization and Delivery Prevention (US)

Pre-Treatment Form

http://ftp.dfg.ca.gov/public/FRGP/Qualitative_Monitoring_Forms/2008%20Effectiveness_Monitoring/Checklists/14a%20US_Pre_UpslopeStabilization_2008.pdf

Post-Treatment Form

http://ftp.dfg.ca.gov/public/FRGP/Qualitative_Monitoring_Forms/2008%20Effectiveness_Monitoring/Checklists/14b%20US_Post_UpslopeStabilization_2008.pdf

Vegetation Control & Removal (VC)

Pre-Treatment Form

http://ftp.dfg.ca.gov/public/FRGP/Qualitative_Monitoring_Forms/2008 Effectiveness_Monitoring/Checklists/8a VC_Pre_VegetationControl_2008.pdf

Implementation Form

http://ftp.dfg.ca.gov/public/FRGP/Qualitative_Monitoring_Forms/2008%20Implementation_Monitoring/Checklists/8%20VC_Imp_VegetationControl_2008.pdf

Post-Treatment Form

http://ftp.dfg.ca.gov/public/FRGP/Qualitative_Monitoring_Forms/2008%20Effectiveness_Monitoring/Checklists/8b%20VC_Post_VegetationControl_2008.pdf

Implementation Monitoring

Annual Summary

http://ftp.dfg.ca.gov/public/FRGP/Qualitative_Monitoring_Forms/2008%20Implementation_Monitoring/Summary_Forms/4%20Annual_Imp_Monitoring_Summary_2008.pdf

General Form Instructions
http://ftp.dfg.ca.gov/public/FRGP/Qualitative_Monitoring_Forms/General%20Monitoring%20Instructions_2008.pdf

Summary Form Submission Instructions

http://ftp.dfg.ca.gov/public/FRGP/Qualitative_Monitoring_Forms/2008%20Implementation_Monitoring/Instructions/Imp_Mon_Instructions_08.pdf

Structure Rating Definitions

http://ftp.dfg.ca.gov/public/FRGP/Qualitative_Monitoring_Forms/2008%20Implementation_Monitoring/Supporting_Documents/Rating_Definitions_2008.pdf

Riparian-Instream Summary

http://ftp.dfg.ca.gov/public/FRGP/Qualitative_Monitoring_Forms/2008%20Implementation_Monitoring/Summary_Forms/2%20Riparian-Instream_SITE_Summary_2008.pdf

Monitoring Evaluation and File QA/QC

http://ftp.dfg.ca.gov/public/FRGP/Qualitative_Monitoring_Forms/2008%20Effectiveness_Monitoring/Summary_Forms/M&E_File_Checklist_2008.pdf

Forms

Photo Description

http://ftp.dfg.ca.gov/public/FRGP/Qualitative_Monitoring_Forms/2008%20Implementation_Monitoring/Supporting_Documents/Photo_Description_Form_2008.pdf

Restoration Site Sketch

http://ftp.dfg.ca.gov/public/FRGP/Qualitative_Monitoring_Forms/2008%20Implementation_Monitoring/Supporting_Documents/Site_Sketch_2008.pdf

Codes

Qualitative Monitoring Features

http://ftp.dfg.ca.gov/public/FRGP/Qualitative_Monitoring_Forms/2008%20Implementation_Monitoring/Supporting_Documents/Checklist_Letter_Codes_2008.pdf

Treatment Types

http://ftp.dfg.ca.gov/public/FRGP/Qualitative_Monitoring_Forms/2008%20Implementation_Monitoring/Supporting_Documents/Treatment_Type_Codes_2008.pdf

Vegetation Species

http://ftp.dfg.ca.gov/public/FRGP/Qualitative_Monitoring_Forms/2008%20Implementation_Monitoring/Supporting_Documents/Plant_Species_Codes_2008.pdf

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Appendix A – Field Forms

http://www.anr.state.vt.us/dec//waterq/rivers/docs/assessmenthandbooks/rv_apxaphase3fieldforms.pdf

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APPENDIX A: RESTORATION EVALUATION BY REACH

Reach 1

The aim of the Monitoring Plan is also to evaluate the success of these specific restoration goals in **Reach 1**:

Pollutant Load / Erosion Reduction

- Bank toe protection at high flows from installed toe logs.

Stream Channel Geometry, Capacity, & Stability

- Persistence of the created low-level bankfull (1.5 year flood) terraces.
- Improved geomorphic definition of the low-flow channel from installed toe logs.
- Narrowed low-flow channel from installed spider log structures.
- Inundation of the reconnected remnant side channel during the bankfull (1.5 year) flood event.
- Inundation of the reconnected side channel on the right (west) bank during the bankfull (1.5 year) flood event.

Aquatic Habitat Quality

- Increase in channel roughness from installed bench logs.
- Increase in sediment deposition from installed bench logs.
- Increased fisheries habitat quality from installed spider and toe logs.
- Increased bed material sorting from installed spider log structures.
- Increased hydraulic complexity from installed off-branch cover.
- Increased habitat complexity from installed spider and toe logs.

Riparian / Floodplain Habitat Quality

- Success of native riparian plantings on the created low-level terraces.
- Success of native riparian plantings on the graded terraces.
- Increased percent of native versus invasive plant species in re-vegetated areas.

Reach 2

The aim of the Monitoring Plan is also to evaluate the success of these specific restoration goals in **Reach 2**:

Pollutant Load / Erosion Reduction

- Increased bank stability by native riparian plantings between the top of the streambank and the toe of the new berm.
- Stabilization of the previously severely eroded and failing portions of the left (east) bank by bank protection treatments at the downstream end of Reach 2.

Stream Channel Geometry, Capacity, & Stability

- Persistence of the created low-level bankfull (1.5 year flood) terraces.
- Trace the migration of the thalweg knickpoint upstream through the Huichica saprolite channel bed.

Aquatic Habitat Quality

- Increased fisheries habitat quality from installed spider logs.
- Increased hydraulic complexity from rock placed to protect portions of the bank toe.
- Increased habitat complexity from installed spider logs.
- Increased instream and overhead cover from rock placed to protect portions of the bank toe.

Riparian / Floodplain Habitat Quality

- Success of native riparian plantings on the created low-level terraces.
- Success of native riparian plantings on the graded terraces.
- Success of native riparian plantings between the top of the streambank and the toe of the new earthen setback berm constructed on the west bank.
- Increased sediment deposition and recruitment of riparian vegetation by bank protection treatments installed on the east bank at the downstream end of Reach 2.

Reach 3

The aim of the Monitoring Plan is also to evaluate the success of these specific restoration goals in **Reach 3**:

Pollutant Load / Erosion Reduction

- Increased bank stability by native riparian plantings between the top of the streambank and the toe of the new berms.

Aquatic Habitat Quality

- Increased habitat complexity by breakup of existing flatwater habitat by the installed rock grade-control riffle.

Riparian / Floodplain Habitat Quality

- Success of native riparian plantings between the top of the streambank and the toe of the new earthen setback berms constructed on both banks

Reach 4

The aim of the Monitoring Plan is also to evaluate the success of these specific restoration goals in **Reach 4**:

Pollutant Load / Erosion Reduction

- Protection of an existing corporation yard located immediately adjacent to the channel on the right (west) bank by the approximately 350 linear feet of sheet-pile floodwall installed near the downstream portion of Reach 4.
- Stabilization of the channel invert by the installed toe log structures and rock grade control weirs in the upstream portion of Reach 4.

Stream Channel Geometry, Capacity, & Stability

- Persistence of the created low-level bankfull (1.5 year flood) terraces.
- Increased channel sinuosity of the low flow channel by installed branch bundles.
- Improved geomorphic definition of the low-flow channel from installed toe log structures and rock grade control weirs in the upstream portion of Reach 4.

Aquatic Habitat Quality

- Increased cover from installed branch bundles.
- Increased habitat complexity by breakup of existing flatwater habitat by the installed tow log structures and rock grade control weirs in the upstream portion of Reach 4.
- Increased sediment deposition upstream from installed branch bundles.
- Increased fisheries habitat quality from installed spider logs.
- Increased downstream hydraulic complexity from installed branch bundles.
- Increased habitat complexity from installed spider logs.
- Mimic of the cover provided by existing undercut banks by native logs installed parallel to the banks.

Riparian / Floodplain Habitat Quality

- Success of native riparian plantings on the created low-level terraces.
- Success of native riparian plantings between the top of the streambank and the toe of the new earthen setback berms constructed on both banks.

Reach 5

The aim of the Monitoring Plan is also to evaluate the success of these specific restoration goals in **Reach 5:**

Pollutant Load / Erosion Reduction

- Stabilization of the previously eroding meander bend at the upstream portion of Reach 5.

Stream Channel Geometry, Capacity, & Stability

- Persistence of the created low-level bankfull (1.5 year flood) terraces.

Riparian / Floodplain Habitat Quality

- Success of native riparian plantings on the created low-level terraces.
- Success of native riparian plantings on the upper portion of the previously eroding left (east) bank.

Reach 6

The aim of the Monitoring Plan is also to evaluate the success of these specific restoration goals in **Reach 6**:

Pollutant Load / Erosion Reduction

- Increased bank stability by installed toe log structures.
- Increased bank stability by native riparian plantings on the new terraces.

Stream Channel Geometry, Capacity, & Stability

- Persistence of the created mid-level terrace on the steep left (east) bank of the side channel
- Improved geomorphic definition of the low-flow channel from installed toe logs.
- Inundation of the existing side channel during the bankfull (1.5 year) flood event.

Aquatic Habitat Quality

- Increased fisheries habitat quality from installed spider logs.
- Increased habitat complexity from installed spider logs.
- Increased area of high-flow refugia for aquatic species by excavation of the existing side channel to approximately the 1-year flood level.

Riparian / Floodplain Habitat Quality

- Success of native riparian understory plantings on the new terrace.
- Percent preservation of the pre-existing mature riparian overstory.

Reach 7

The aim of the Monitoring Plan is also to evaluate the success of these specific restoration goals in **Reach 7**:

Pollutant Load / Erosion Reduction

- Increased bank stability by installed toe log structures.

Stream Channel Geometry, Capacity, & Stability

- Persistence of the created terraces.
- Increased flood conveyance capacity by slope re-contouring.

Aquatic Habitat Quality

- Increased riffle habitat by the installed rock weir at the downstream portion of Reach 7, extending into the uppermost portion of Reach 8.

Riparian / Floodplain Habitat Quality

- Success of native riparian plantings on the created terraces.
- Success of native riparian plantings along most of the west bank and a portion of the east bank.

Reach8

The aim of the Monitoring Plan is also to evaluate the success of these specific restoration goals in **Reach 8**:

Pollutant Load / Erosion Reduction

- Stabilization of banks from biotechnical installations.
- Increased bank stability from a bench excavated at the bankfull (1.5-year) flood level on the steep right (east) bank?
- Stabilization of a steeply incised, unstable segment of the right (west) bank in the upstream portion of the Reach 8, immediately downstream of the channel complexity improvements installed in Reach 7.
- Stabilization of the previously severely eroding upstream bend in the middle of Reach by bank recontouring.
- Stabilization of the outer side of the left (east) bank meander bend by biotechnical installations (rock armoring supporting native willow plantings).
- Stabilization of previously steep, at-risk on both sides of the main channel by bank stabilization techniques.
- Stabilization of channel incision by the installed rock grade control.
- Reduced bank erosion by removal of the disused concrete bridge abutments.

Stream Channel Geometry, Capacity, & Stability

- Increased channel sinuosity from the installed toe log structures in the upstream portion of Reach 8, immediately downstream of the habitat complexity improvements installed in Reach 7.
- Persistence of created terraces.
- Persistence of the created inset terrace on the right (west inner) meander bank, at approximately the 500-cfs (<1-year) level.
- Persistence of a multi-stage channel by excavation of a bankfull (1.5 year) flood terrace.
- Increase flood capacity by excavation of a bankfull (1.5 year) flood terrace.

Aquatic Habitat Quality

- Increased channel complexity from installed instream structures.

Riparian / Floodplain Habitat Quality

- Success of native riparian plantings in the created buffer.

Reach 9

The aim of the Monitoring Plan is also to evaluate the success of these specific restoration goals in **Reach 9**:

Stream Channel Geometry, Capacity, & Stability

- Persistence of the created low-level bankfull (1.5 year flood) terraces.

Aquatic Habitat Quality

- Increased fisheries habitat quality from installed rock weirs and toe logs in the downstream portion of the reach.

Riparian / Floodplain Habitat Quality

- Success of native riparian plantings on the created low-level terraces.
- Success of native riparian plantings on the top of bank along the new roads to create vegetated buffers.
- Increased percent of native versus invasive plant species in re-vegetated areas.