# North Bay Fisheries Monitoring Program

Prepared for members of the North Bay Watersheds Association
by the
Center for Ecosystem Management and Restoration

June 2010

## Figures



## Tables

# Summary

This document presents a proposed fisheries monitoring program for three watersheds located in the northern portion of the San Francisco Bay Area. The North Bay Fisheries Monitoring Program (NBFMP) was prepared under the auspices of the North Bay Watersheds Association (NBWA) on behalf of several of the association's member organizations and other groups that will implement the program.

The monitoring program is being proposed primarily to aid in the understanding and management of steelhead trout populations in the study area, with special reference to the anadromous life history form of steelhead. This emphasis exists for two reasons: the Endangered Species Act listing status of steelhead and the paucity of information regarding steelhead spawning locations and smolt production. Data regarding the outmigration of juvenile steelhead are virtually absent for watersheds tributary to the San Francisco Estuary, with the notable exception of information gathered recently by the Napa County Resource Conservation District (RCD). The proposed program is intended to inform the processes of identifying and prioritizing rehabilitation projects, determining needed changes to land and water resources policies and their implementation, and measuring the status of salmonid populations and the effectiveness of restoration efforts.

The program's initial time frame is one year, after which the program will be continued and/or expanded depending on the availability of funding. Monitoring will be performed using outmigrant traps at sites in: Marin County's Corte Madera Creek; Carriger and upper mainstem Sonoma creeks in the Sonoma Creek watershed, Sonoma County; and three Napa River watershed locations selected from possible sites in Napa, Redwood, Milliken, and Carneros creeks. Mainstem Napa River also will be sampled by rotary screw trap, continuing on-going efforts.

Monitoring sites have been selected for their location downstream from areas of known high quality salmonid spawning and rearing habitat and for their suitability for trap installation. Outmigrants potentially captured during sampling would reflect production in the streams noted above or in any of several smaller tributaries. For example, the Corte Madera Creek trap location was selected specifically to capture smolts from the San Anselmo Creek sub-watershed, which is assumed to be relatively productive based on past observations of spawning adults and juvenile steelhead.

The program is expected to cost approximately $363,000. Of this figure, about $21,000 will be expended by participating agencies and other organizations through ongoing budgetary mechanisms. The value of the in-kind service and volunteer effort components of the program is expected to be $31,000, and funding in the amount of $30,000 has been secured. The remaining $281,000 will be sought from outside funding sources.

# Introduction

Members of the North Bay Watersheds Association, or NBWA, have established goals to improve salmonid habitat and increase production, and now seek to implement a monitoring program to inform restoration and management. The study area for this program comprises the San Francisco Bay-draining basins of Marin, Sonoma, and Napa counties (Figure 1). Reviews of historical records and recent surveys indicate that several study area watersheds supported coho salmon (*Oncorhynchus kisutch*) and steelhead (*O. mykiss*), although coho appears to be extirpated from this portion of its historical range (Leidy *et al*. 2005a; Leidy *et al*. 2005b). While the historical record is less revealing about the distribution of Chinook salmon (*O. tshawytscha*), this species has consistently and successfully spawned in streams of the study area since the 1980s.[1] *Oncorhynchus mykiss* populations in streams of the study area are included in the Central California Coast Steelhead Distinct Population Segment (DPS) and are listed as threatened for purposes of the federal Endangered Species Act (Good *et al*. 2005).

While substantial information is available regarding observations of steelhead/rainbow trout in streams of the study area, the preponderance of the data concerns only juvenile *O. mykiss*. Systematic sampling efforts and surveys regarding the occurrence and location of spawning or the presence and extent of smolt production have not been performed in North Bay streams, with the notable exception of an outmigrant monitoring program conducted in the Napa River in 2009. Implementing the monitoring program described here would provide natural resources managers, restoration advocates, landowners, and other interested parties with the requisite context to make informed decisions about managing steelhead and steelhead habitat in the immediate future.

# Program Objectives

The need for population monitoring is broadly accepted, and it is a priority recovery action listed by both the National Marine Fisheries Service (NMFS) and the Department of Fish and Game (DFG) (NMFS 2007; McEwan and Jackson 1996). In its 1996 Steelhead Plan, DFG states that monitoring is an essential restoration action to "collect baseline information, assess population trends, and evaluate success of restoration activities" (DFG 1996, p. 11). The proposed monitoring program also would address recommendations from the Regional Water Quality Control Board (RWQCB) to collect current, statistically valid data on steelhead and salmon populations (Napolitano *et al*. 2007).

This report recognizes the value of collecting, analyzing, and reporting information in a manner that can be easily integrated with ongoing or planned monitoring programs for the region. A goal of the program is to maximize its compatibility with related processes

[1] Studies to determine ancestry of the Chinook populations of the North Bay are ongoing.

and attract funders interested in expanding the scope of salmonid monitoring in the watersheds of the San Francisco Estuary. In particular, the NBFMP acknowledges and will inform NMFS' steelhead (*Oncorhynchus mykiss*) recovery planning process under the federal Endangered Species Act (ESA) and the RWQCB's ability to measure progress toward achieving aquatic habitat goals expressed in the Basin Plan. Although a steelhead recovery plan under the federal ESA has not been released for the Central Coast planning area, it is expected, and the NBFMP should comprise an important contribution to the plan's adaptive management and monitoring program. (The salmon recovery plan for the Puget Sound region deemed this component to be, "The key to this plan's success…")

In short, the NBWA seeks to establish a monitoring program that will advance the multiple processes related to conservation and management of salmonids and their habitat. The current program also reflects the desire of NBWA members to take a proactive role in watershed planning and to base funding and policy decisions on sound scientific information. Lastly, the program is intended to provide the basis for collaborations between the many stakeholders who necessarily will be involved in restoration actions in the coming years.

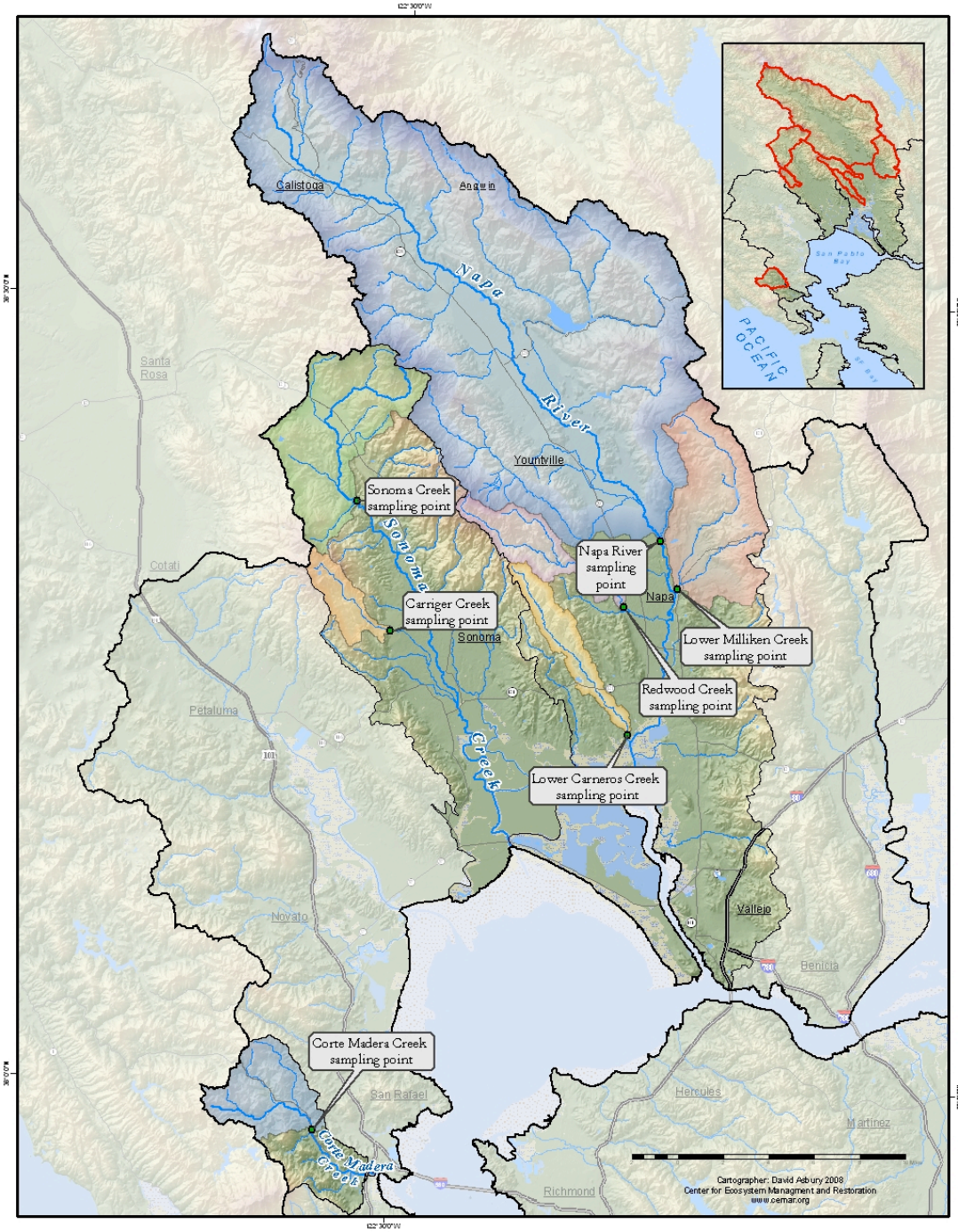
Trapping performed in 2009 in mainstem Napa River yielded, for the first time, an exhaustive description of the species composition of the Napa River fishery, including relative proportions of native and non-native species; size range of juvenile *O. mykiss* outmigrants (important in understanding marine survival rates); extensive genetics samples that can be used to characterize the population; and baseline data for estimating the watershed's smolt production potential (with the incorporation of data from future trapping). The first-year results also revealed that steelhead spawning occurs in the lowest reaches of the non-tidal Napa River.

Overall, the program produced critical information for managing resources and to allow tracking ecological responses to ongoing habitat restoration activities. It further bolstered the position that North Bay watersheds are among the most important in the region in terms of steelhead production potential. While additional data is needed to refine population estimates, it appears possible that the Napa River spawning run constitutes the most robust run among San Francisco Estuary tributaries and one of the most populous in the central coast region. Providing analogous information for the Corte Madera Creek and Sonoma Creek watersheds and expanding the understanding of the Napa River basin fishery are over-riding objectives of the NBFMP.

## Watershed Information

This section provides information specific to the NBFMP study area that includes the Bay-draining portions of Marin and Sonoma counties, and Napa County (Figure 1). For each county, we describe: 1) salmonid resources and restoration context, 2) monitoring goals and proposed methods, and 3) other program considerations. General program

Figure 1. Study Area



features including task descriptions and are detailed in the following section, followed by detailed budgets for each county's monitoring effort and an evaluation of the program's total costs.

## *Marin County*

### Salmonid resources and restoration context

At least 18 streams in five Bay-draining Marin County watersheds have supported steelhead/rainbow trout populations[2] over time (Leidy *et al*. 2005a). A review of the published information regarding these watersheds indicates that the Arroyo Corte Madera del Presidio and Corte Madera Creek systems likely historically supported the largest populations. Reproduction by *O. mykiss* is well documented in the Miller and Novato creeks watersheds, although evidence of steelhead spawning was not found in a recent review (Leidy *et al*. 2005a).

In a 1960 report, staff from the California Department of Fish and Game (DFG) relayed residents' estimates of a spawning run of 500 to 1,000 individuals in the Corte Madera Creek watershed (Allen 1960). An estimate of the historical steelhead run into Arroyo Corte Madera del Presidio is not available. Currently, small numbers of adult spawners are observed in the Corte Madera Creek watershed in typical years (Guldman pers. comm.). While it is assumed that steelhead spawn in streams of the Arroyo Corte Madera del Presidio watershed, evidence was not found to determine the recent ancestry of juvenile *O. mykiss* observed in the system.

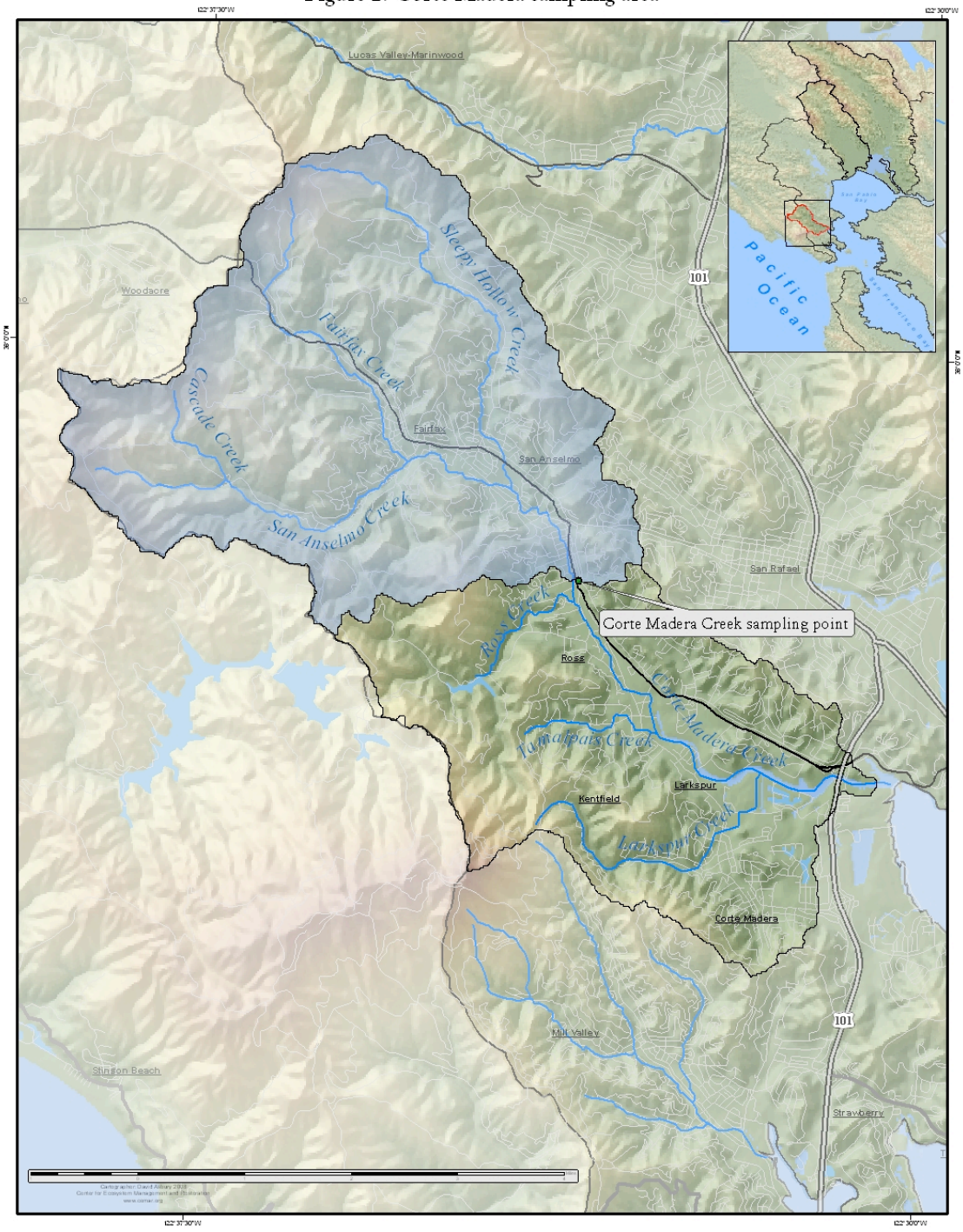
As staff and financial resources to monitor salmonid populations are limited, the monitoring program will incorporate sampling in only the areas of San Francisco Bay-draining Marin County most likely to produce steelhead smolts. Consistent with the historical record, a recent study noted that the Corte Madera Creek watershed contained the greatest amount of available *O. mykiss* rearing habitat in the area (*i.e*., more than 40 percent), with the bulk (more than 50 percent) located in San Anselmo Creek (Becker *et al*. 2007). The latter finding is supported by a DFG estimate that about 75 percent of the juvenile *O. mykiss* in the basin reared in San Anselmo Creek (Jones 1969).

*Oncorhynchus mykiss* juveniles are noted consistently in mainstem Corte Madera Creek and in Ross, Sleepy Hollow, San Anselmo, Fairfax, and Cascade creeks (Figure 2). While spawning steelhead have been observed in San Anselmo and Fairfax creeks, the degree to which successful reproduction, rearing, and out-migration occur is undetermined. The NBFMP will provide information regarding these features that is critical to advancing restoration in the watershed.

Steelhead restoration activities in the Corte Madera Creek watershed focus largely on passage barrier mitigation. Friends of Corte Madera Creek and consulting engineers have

[2] The NBFMP focuses on characterizing anadromous *O. mykiss*. However, we attempt to provide any potentially relevant information about *O. mykiss* distribution here, as relationships between "resident rainbow trout" and "steelhead" populations have not been established for the study area.

Figure 2. Corte Madera sampling area



examined current fish passage conditions in "Unit 3 and Unit 4" of the Corte Madera Creek Flood Control Project located in Kentfield and Ross and developed alternatives for improving steelhead passage. Improvements to the fishway in this reach are expected to be constructed in 2013 (Guldman pers. comm.).

Conceptual designs for treating fish passage barriers on San Anselmo Creek at Saunders Avenue, Lansdale Station, and Pastori Avenue have been prepared. Environmental review and permitting are under way for the two downstream locations, Saunders Avenue and Lansdale Station. Another proposed project would produce a conceptual design for modifying about 1,500 lineal feet of stream channel upstream of the Pastori Avenue crossing in San Anselmo Creek to reduce erosion and improve habitat value.[3] Temperature studies are underway in Phoenix Lake and Ross Creek to determine the potential for Phoenix Lake releases to aid smolt out-migration.

## Monitoring goals and proposed methods

The initial goal of monitoring in the Corte Madera Creek watershed is to demonstrate that smolt out-migration occurs and establish baseline conditions from which to measure future trends. Data collected through the monitoring program will be used to estimate smolt production from the watershed. With this information additional, future monitoring will help determine the relative contributions of various tributaries and reaches to smolt production for purposes of evaluating and prioritizing restoration actions. The monitoring also is expected to characterize the size range of steelhead outmigrants, informing understanding of the extent of high growth-rate habitat in the watershed as well as expectations for marine phase survival rates.

A smolt trap is proposed for a site near the fire station in Ross, consisting of a weir and collection device.[4] Conditions at the site appear near ideal by virtue of the channel having a wide and shallow profile with stable substrate consisting of gravel or small cobble as well as near vertical stream banks without undercut (Zimmerman and Zabkar 2007). Site security seems acceptable.

Sampling at this location offers the potential to represent smolt production from about 16 square miles, or almost 60 percent of the watershed area. Additionally, the important rearing habitat areas of San Anselmo, Cascade, Sleepy Hollow, and Ross creeks are upstream of this site. The site also is advantageous due to the presence of a telemetered stream gauge with a recently updated rating curve in the immediate vicinity that will allow two important activities: relating sampling results to streamflow and remote monitoring of conditions that determine when the trap can be checked and serviced in relation to high-flow events.

---

[3] Please contact Gordon Becker at CEMAR for more information regarding the "San Anselmo Creek Reach Scale Restoration Project."

[4] Expert opinion will inform the choice of trap design (*e.g.*, fyke net, funnel trap, or resistance board weir type design). The Alaska Department of Fish and Game produced a construction manual for a resistance board weir (Stewart 2002) that may be obtained by contacting CEMAR.

Results confirming the presence of outmigrating smolts from the Corte Madera Creek system will provide the baseline datum for a long-term monitoring program at the site. Ideally, spring smolt trapping will be performed annually for a period of at least three years. Data collected during this time would provide important context for understanding the relationship between water year type and steelhead production, and for detecting possible biological response to the multiple restoration actions underway in the basin.

The proposed monitoring would occur under a research permit provided through NMFS. Implementation of the smolt trapping project would be supervised by Greg Andrews of the Marin Municipal Water District (MMWD) staff, while installation and maintenance of the trap, as well as data collection and management, would be performed by a team consisting of MMWD staff, consultants, staff from the Marin County Public Works Agency, and by volunteers from Friends of Corte Madera Creek, the North Bay chapter of Trout Unlimited, and other local conservation groups. Protocols followed for fish handling are provided in Appendix A of this report.

## Cost and other program considerations

The cost for smolt trapping in the Corte Madera Creek watershed is estimated to be approximately $109,000 (Table 1). Staff from Marin Municipal Water District and volunteers from Trout Unlimited and Friends of Corte Madera Creek have offered to participate in the program, resulting in substantial cost savings. Matching funds represented by these efforts amount to about $26,000, leading to a funding requirement of slightly more than $83,000 for the program.

While a monitoring program element that captures spawning information is desirable to further inform restoration planning for the Corte Madera Creek watershed, it is not proposed at this time due to cost and other factors (*e.g.*, access). Various projects are underway that should improve passage opportunities, after which spawning surveys, redd surveys, or other approaches to measuring escapement will be proposed for the program.[5] It is expected that information developed through smolt trapping will lead to greater interest on the part of resource agency personnel and the public at large in improving habitat conditions in the watershed and in dedicating resources to additional data collection.

[5] The presence of a fishway at the upper end of the flood control channel does, however, offer the opportunity for an interim inmigrant monitoring element in the NBFMP.

Table 1. North Bay Fisheries Monitoring Program - Corte Madera Creek Watershed

**Detailed Task Budget**

| | | *TASK - Estimated Hours* | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Personnel and Expense Description | Rate | Project Management | Site Selection / Access | Equipment Acquisition | Trap Install/Decommission | Trap Processing/Maintenance | Data Analysis/Reporting | Outreach | **TOTALS** |
| Sr. Consulting Biologist | $120.00 | 24 | 6 | 4 | 16 | 112 | 16 | | 178 |
| Consulting Biologist | $105.00 | 16 | 6 | 8 | 16 | 168 | 16 | | 230 |
| Program Coordinator | $100.00 | 40 | 6 | 8 | 16 | 112 | 24 | 8 | 214 |
| Coordinator Support | $65.00 | | | | 8 | 56 | 16 | 8 | 88 |
| Coordinator GIS | $75.00 | | | | | | 16 | | 16 |
| Coordinator Administration | $45.00 | 24 | | | | | 8 | 8 | 40 |
| **STAFF TOTALS** | | $9,640 | $1,950 | $2,120 | $5,720 | $45,920 | $8,600 | $1,680 | **$75,630** |
| *Soft Match (includes salaries of funded employees)* | | | | | | | | | |
| MMWD Sr. Biologist | $80.60 | 16 | | | 8 | 16 | 6 | 2 | 48 |
| MMWD Biologist | $67.00 | 16 | | | 8 | 16 | 6 | 2 | 48 |
| MMWD Seasonal Aide | $31.70 | | | 4 | 16 | 56 | 8 | 4 | 88 |
| Marin County PWA 1 | $95.00 | 8 | | | | 40 | 4 | 4 | 56 |
| Marin County PWA 2 | $57.00 | 8 | | | | 60 | 6 | 6 | 80 |
| Napa County RCD | $86.00 | 4 | | | | | 4 | | 8 |
| Southern Sonoma County RCD | $69.00 | 4 | | | | | 4 | | 8 |
| **SOFT MATCH TOTALS** | | $3,854 | $0 | $127 | $1,688 | $11,357 | $2,137 | $1,144 | **$20,306** |
| *Hard Match (includes equipment, materials, and volunteer hours)* | | | | | | | | | |
| Volunteer Coordinator (shared by 3) | $25 | 16 | | | 24 | 112 | 16 | 40 | 208 |
| Volunteers | $25 | | | 8 | 24 | 200 | | | 232 |
| **HARD MATCH TOTALS** | | $400 | $0 | $200 | $624 | $3,000 | $400 | $1,000 | **$5,624** |
| **TOTAL COST SHARE** | | **$4,254** | **$0** | **$327** | **$2,312** | **$14,357** | **$2,537** | **$2,144** | **$25,930** |
| *Equipment / Expenses* | *Rate* | | | | | | | | |
| Field supplies | $800 | | | $800 | | | | | **$800** |
| Anesthetic | $100 | | | | | $100 | | | **$100** |
| Smolt trap | $850 | | | $1,000 | | | | | **$1,000** |
| Installation supplies | $800 | | | | $800 | | | | **$800** |
| Storage box | $250 | | | $250 | | | | | **$250** |
| Dipnets/Buckets/Pumps | $450 | | | | | $450 | | | **$450** |
| Printing / Mailing / Copying | | | | | | | | $105 | **$105** |
| Coordinator indirect expense | | | | | | | | | **$0** |
| Mileage | 0.55/mi | | | $44 | $66 | $2,200 | | | **$2,310** |
| **EXPENSE TOTALS** | | $0 | $0 | $3,986 | $866 | $2,750 | $0 | $105 | **$7,707** |
| **TASK TOTALS** | | $13,894 | $1,950 | $6,433 | $8,898 | $63,027 | $11,137 | $3,929 | **$109,267** |

| | | | |
|---|---|---|---|
| **TOTAL GRANT FUNDS** | **$83,337** | | |
| **TOTAL COST SHARE** | **$25,930** | **23.7%** | |
| Hard Match | $5,624 | 21.7% | |
| Soft Match | $20,306 | 78.3% | |

**PROJECT TOTAL**

## *Sonoma County*

### Salmonid resources and restoration context

Historical steelhead runs have been noted in the three Bay-draining watersheds of Sonoma County (Leidy *et al*. 2005a). While the Petaluma River system historically supported steelhead, its importance to the regional steelhead fishery is substantially less than that of the Sonoma Creek system to the east. Schell Creek (east of Sonoma Creek) also supports *O. mykiss* populations but is not a candidate for the NBFMP at this time due to its relatively small size and lesser habitat resources. The following reviews the steelhead resources of the Sonoma Creek watershed with particular emphasis on the portions of the watershed most likely to contain rearing habitat that will support the high growth rate critical to smolt production.

Reports of DFG stream surveys in the Sonoma Creek watershed are available from 1946 and have been supplemented by habitat studies and *O. mykiss* sampling by other parties, particularly between 1993 and 2002 (see Leidy *et al*. 2005a). The earliest available steelhead run size estimate for the Sonoma Creek system suggests a run of about 500 individuals annually (with great variation) (Rockwood 1966). The historical record shows that steelhead largely spawned and reared in the upper portions of mainstem Sonoma Creek, and in important tributaries like Carriger, Agua Caliente, and Calabazas creeks (see Leidy *et al*. 2005a). Anecdotal information from multiple sources suggests that far fewer steelhead spawn in the Sonoma Creek watershed in a typical year than did in the 1960s, with adult observations occurring relatively rarely.

Becker *et al*. (2007) used the presence of rearing habitat (based on observation of juvenile *O. mykiss*) as a criterion to evaluate the relative importance of Sonoma Creek tributaries for restoration. The authors identified mainstem Sonoma Creek (and the headwater tributary Bear Creek) as containing the most important rearing habitat resources, with other important tributaries including Carriger, Agua Caliente, Hooker, Asbury, Calabazas, and Stuart creeks (Figure 3).

According to a recent analysis, passage barriers, sedimentation, water temperatures, and instream flows limit the *O. mykiss* population in Sonoma Creek (SEC 2006a). The study hypothesizes a "bottleneck" in steelhead production in the watershed consisting of limited rearing habitat (SEC 2006a). Therefore, the Sonoma Ecology Center (SEC) identified restoration measures that enhance rearing habitat along with a relatively small number of passage improvement projects as highest priority. Also recently, a sediment source analysis was completed for Sonoma Creek that states, "Dramatic increases in loads [from pre-European settlement levels] are evident in many tributary watersheds and in most cases are attributable to intensified stream bed and bank erosion" (SEC *et al.* 2006b, p. 46).

The SEC has completed an inventory and ranking of the passage barriers in the Sonoma Creek watershed that lists the 20 most important barriers in the watershed (Katopothis *et al.* 2005). The SEC has received funding to modify one of these, a total barrier at Dunbar Road on Calabazas Creek, and is participating in designing fixes at four additional locations. For example, an engineering analysis, conceptual design, and cost estimate for modifying a total passage barrier on Stuart Creek was prepared recently.[6] Other barriers currently being examined include the Warms Springs Creek location on Yulupa Creek, and the Grove Street location and Grove Street "#1 DST" on Carriger Creek. The Glen Oaks Dam location on Stuart Creek appears on the list as an unaddressed important passage project (Katopothis *et al.* 2005). Various projects intended to reduce sediment input into Sonoma Creek and its tributaries also are expected to be implemented during the next several years (Micheli pers. comm.).

## Monitoring goals and proposed methods

Relatively recent sampling information documents the presence of *O. mykiss* in many watershed locations as well as density and size distribution. However, little is known about the ancestry of these fish and the relative contribution of anadromous individuals to the watershed's *O. mykiss* population. Accordingly, the primary goal of monitoring under the NBFMP is to confirm the presence of outmigrating smolts in the Sonoma Creek system and to establish baseline conditions. Data collected through the monitoring program can be used to estimate smolt production from the watershed.

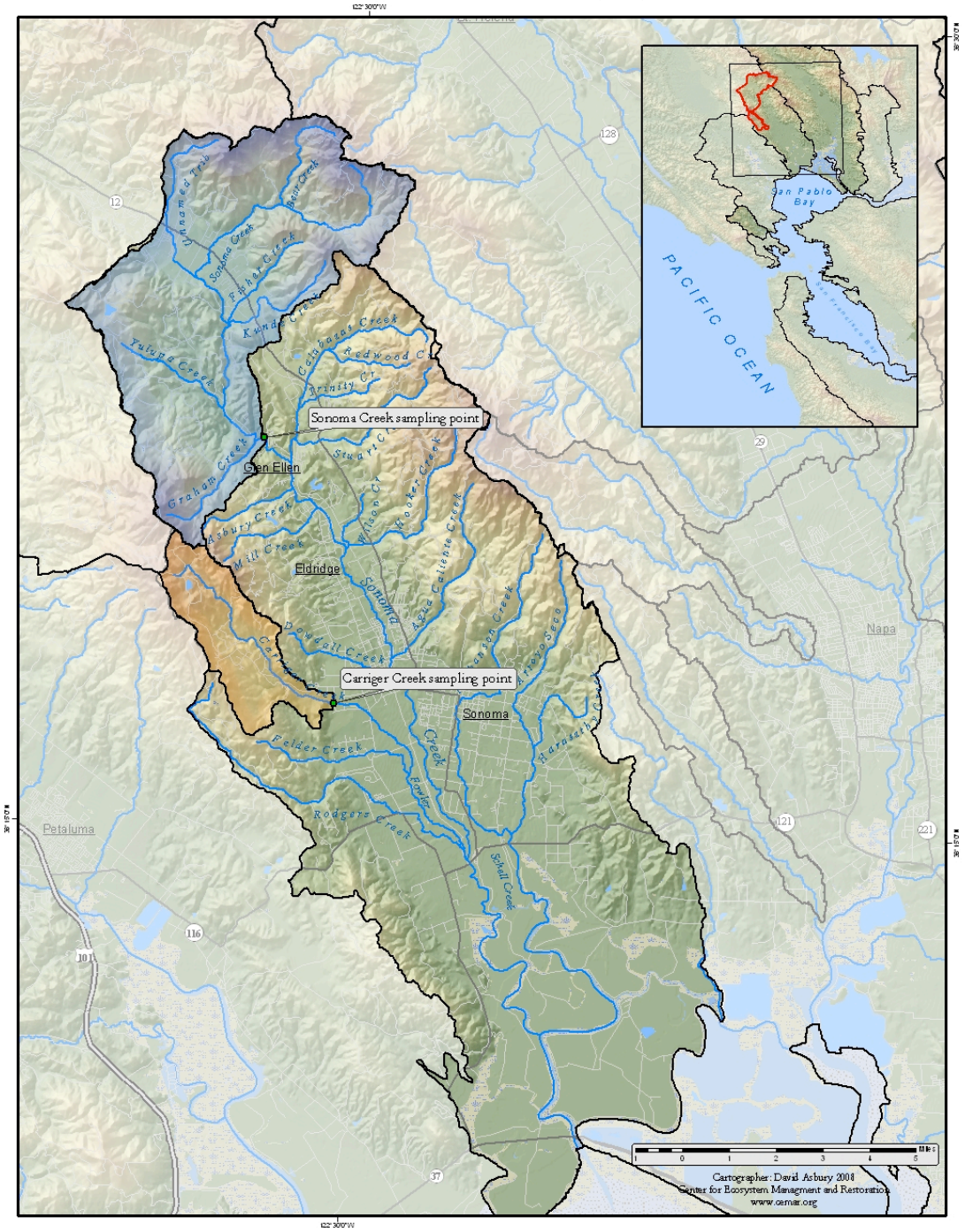
Monitoring will be involve installation and operation of smolt traps at two locations, one selected by virtue of being downstream of the largest area of known high quality rearing habitat in the watershed (*i.e.*, upper Sonoma Creek) and another in the tributary Carriger Creek, also known to contain extensive rearing habitat (Figure 3). The basin area upstream from the Sonoma Creek trap locations consists of about 32 square miles, whereas the Sonoma Creek watershed area is approximately 155 square miles. As noted in the previous section, however, this portion of the watershed contains important rearing habitat resources (~40 percent of available rearing habitat [based on Becker *et al*. 2007]). The smolt trap in Sonoma Creek will be operated during the spring outmigration season for a period of one year, with expansion of the program should funding become available. The second trap will be operated in Carriger Creek also during a one-year period.

The Sonoma Creek smolt trap will be located in the immediate vicinity of telemetered streamflow gauge, allowing accurate relationship between trapping results and the hydrograph. Additionally, the gauge allows for remote sensing of appropriate conditions for data collection and trap maintenance in relation to high flow events. Fish sampling equipment and handling protocols are provided in Appendix A of this report.

The proposed monitoring would occur under a research permit provided through NMFS. Implementation of the smolt trapping project would be supervised by Southern Sonoma County Resource Conservation District staff, while installation and maintenance of the

[6] Please contact CEMAR for a copy of the design report for the Stuart Creek barrier modification.

Figure 3. Sonoma Creek sampling areas



trap, as well as data collection and management, would be performed by a team consisting of staff from the Southern Sonoma County RCD, consultants, and volunteers, particularly from the pool of interested individuals developed through SEC's Stream Stewards Program. The Sonoma Creek element of the NBFMP would be administered through the SEC.

## Cost and other program considerations

The cost to monitor outmigrants at two sites in the Sonoma Creek watershed is estimated to be approximately $106,000 (Table 2). Staff from Southern Sonoma Resource Conservation District and the Sonoma Ecology Center have expertise in fisheries science, project management, and outreach that will allow for considerable cost savings in relation to a consultant-conducted program. The use of SEC's volunteer network in particular provides considerable savings in labor cost. Matching funds represented by this effort amounts to about $8,500, leading to a funding requirement of slightly more than $98,000 for the program.

Operating a smolt trap in Carriger and upper mainstem Sonoma creeks would allow initial characterization of smolt production from a substantial portion of the available rearing habitat in the watershed (based on Becker *et al*. 2007), but would neglect possible outmigration from other tributaries such as Agua Caliente, Hooker, Asbury and Calabazas creeks. After the first year of monitoring, it will be desirable to operate a smolt trapping program in other watershed areas or to expand the program, depending on available resources.

A monitoring program element that captures spawning information also is suggested to further inform restoration planning for the Sonoma Creek watershed, but is not proposed at this time due to cost and other factors (*e.g*., availability of staffing). It is expected that information developed through smolt trapping will lead to greater interest on the part of resource agency personnel and the public at large in improving habitat conditions in the watershed and in dedicating resources to additional data collection. Monitoring results from the initial phase of the NBFMP also will allow future spawning surveys, redd surveys, or other escapement-related studies to narrow their geographic focus and achieve greater cost efficiency.

Table 2. North Bay Fisheries Monitoring Program - Sonoma Creek Watershed

**Detailed Task Budget**

| | | *TASK - Estimated Hours* | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Personnel and Expense Description | Rate | Project Management | Site Selection / Access | Equipment Acquisition | Trap Install/Decommission | Trap Processing/Maintenance | Data Analysis/Reporting | Outreach | **TOTALS** |
| SSCRCD Biologist | $69.00 | 60 | 16 | 20 | 40 | 280 | 32 | 16 | 464 |
| SEC Manager | $95.00 | 40 | | | | | | | 40 |
| Senior Biologist | $95.00 | 8 | 8 | | 24 | 280 | 32 | | 352 |
| SSCRCD Director | $80.00 | 16 | | | | | | 8 | 24 |
| SEC Ourteach Coordinator | $80.00 | | | | | | | 40 | 40 |
| SEC Project Technician | $60.00 | | 8 | | 24 | 40 | 32 | 24 | 128 |
| Project Coordinator | $95.00 | 24 | 8 | | 24 | 40 | 8 | 8 | 112 |
| **STAFF TOTALS** | | $12,260 | $3,104 | $1,380 | $8,760 | $52,120 | $7,928 | $7,144 | **$92,696** |
| *Soft Match (includes salaries of funded employees)* | | | | | | | | | |
| NRCS | $70 | | | | | | | | 0 |
| RWQCB | $70 | | | | | | | | 0 |
| Southern Sonoma County RCD | $70 | | | | | | | | 0 |
| Napa County RCD | $86 | 8 | | | | | | | 8 |
| SEC | $56.72 | | | | | | | | 0 |
| | $84.20 | | | | | | | | 0 |
| **SOFT MATCH TOTALS** | | $688 | $0 | $0 | $0 | $0 | $0 | $0 | **$688** |
| *Hard Match (includes equipment, materials, and volunteer hours)* | | | | | | | | | |
| Citizen Volunteers (hours) | $25 | | 8 | | 24 | 200 | 40 | 40 | 312 |
| Hard Match ($) | - | | | | | | | | 0 |
| **HARD MATCH TOTALS** | | $0 | $200 | $0 | $600 | $5,000 | $1,000 | $1,000 | **$7,800** |
| **TOTAL COST SHARE** | | **$688** | **$200** | **$0** | **$600** | **$5,000** | **$1,000** | **$1,000** | **$8,488** |
| *Equipment / Expenses* | *Rate* | | | | | | | | |
| Cable/Rope | $150 | | | | $150 | | | | **$150** |
| Anesthetic | $100 | | | | | $100 | | | **$100** |
| Fyke Nets (2) | $1,000 | | | $2,000 | | | | | **$2,000** |
| Installation supplies | $300 | | | | $600 | | | | **$600** |
| Storage boxes | $250 | | | $500 | | | | | **$500** |
| Waders/Boots/Raingear | $800 | | | | $800 | | | | **$800** |
| Dipnets/Buckets/Pumps | $450 | | | | | $450 | | | **$450** |
| Envelops/Blotter Paper | | | | | | $100 | | | **$100** |
| Printing/Mailing/Copying | | $100 | $150 | | | | | $150 | **$400** |
| **EXPENSE TOTALS** | | $100 | $150 | $2,500 | $1,550 | $650 | $0 | $150 | **$5,100** |
| **TASK TOTALS** | | $13,048 | $3,454 | $3,880 | $10,910 | $57,770 | $8,928 | $8,294 | **$106,284** |

| | | |
|---|---|---|
| **TOTAL GRANT FUNDS** | **$97,796** | |
| **TOTAL COST SHARE** | **$8,488** | **8.0%** |
| Hard Match | $7,800 | 91.9% |
| Soft Match | $688 | 8.1% |

**PROJECT TOTAL**

## *Napa County*

### Salmonid resources and restoration context

A review of the historical record suggests that the Napa River historically supported the largest steelhead run of the various Bay Area watersheds (see Leidy *et al*. 2005a). Run size estimates from the late 1960s range widely, but suggest that some 1,000 individuals typically spawned in that era (Anderson 1969; USFWS 1968). Recent estimates of the run size are not available, though based on anecdotal evidence abundance appears to be a fraction of that estimated previously. Monitoring in 2009 led to capture of 119 steelhead smolts and 940 fry, with an estimated capture efficiency of 1.45 percent (NCRCD 2009).

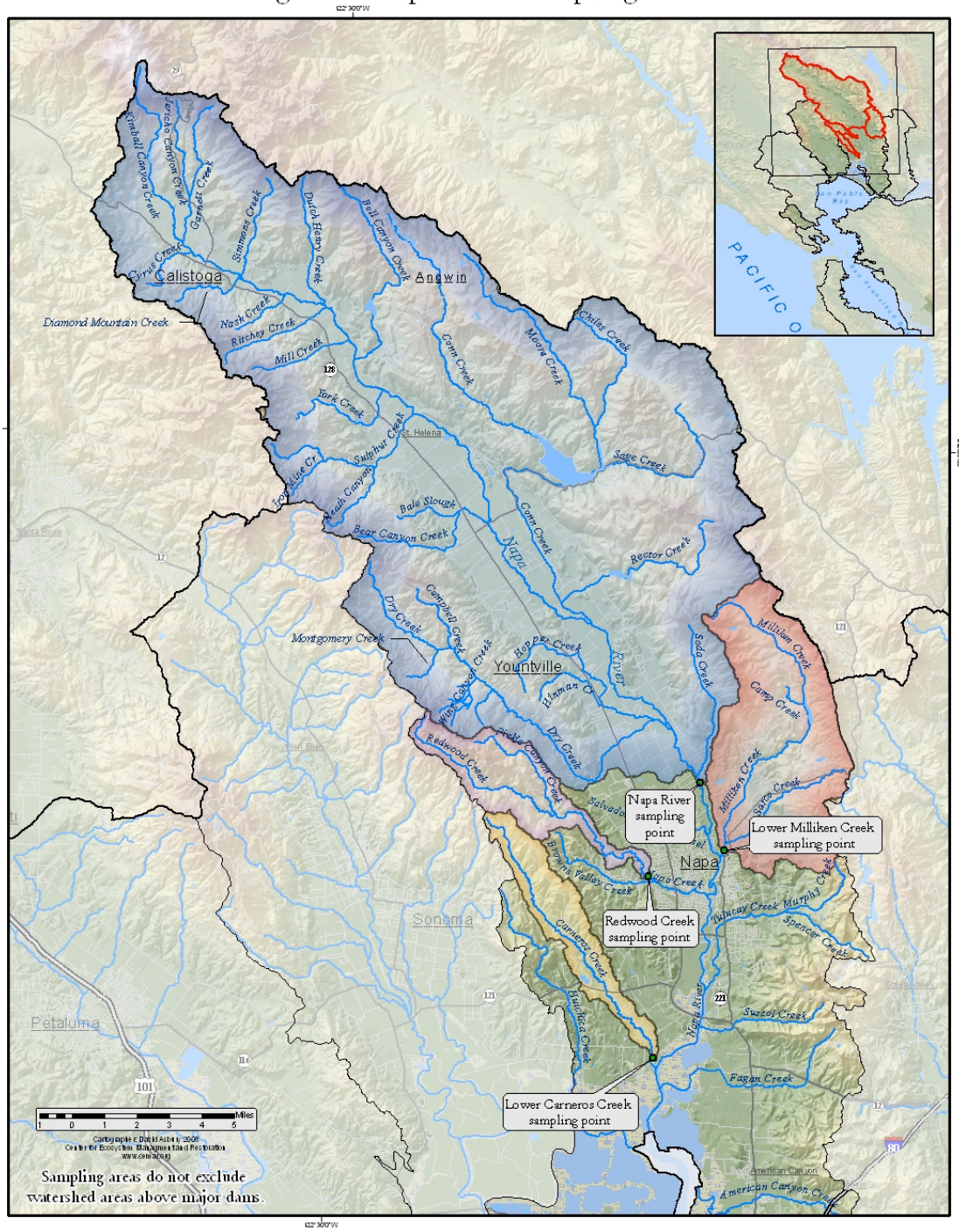
In addition, the Napa River system historically supported Chinook and coho salmon, although coho no longer occurs in the drainage (Leidy *et al*. 2005b). The historical record regarding Chinook salmon distribution and abundance is particularly incomplete. Based on analysis of natural channel form, hydrology, and ecology, researchers have concluded that the Napa River likely supported a large, sustainable population of Chinook salmon under historical conditions (Stillwater Sciences 2002). Chinook salmon have been regularly reported in the Napa River since the 1980s and since 2001, an estimated 400-600 fall-run Chinook have spawned each year in the mainstem Napa River and several tributary streams (Koehler 2005, 2006, 2007).

A review of available information regarding juvenile steelhead observations produced an estimate of available rearing habitat in the Napa River watershed by tributary. This analysis indicated that the Napa River mainstem, Carneros Creek, and the Dry, Redwood and Sulphur creeks systems (Figure 4) offer some of the most extensive habitat resources in the Bay Area (Becker *et al*. 2007). It also noted extensive *O. mykiss* rearing habitat resources in Tulucay, Napa, Milliken, and Ritchey creeks and additional habitat available in Soda, Conn, York, Dutch Henry, and Jericho Canyon creeks.

According to estimates, approximately 40 miles of suitable Chinook spawning habitat in the mainstem Napa River and low gradient reaches of several large tributaries (NCRCD 2005). The County Napa Resource Conservation District (RCD) began a limited salmon monitoring program in 2003 to track Chinook abundance and distribution within a five-mile reach of the Napa River near Rutherford. Successful Chinook reproduction has been documented via the capture of juveniles in spring 2005 and 2006, and visual observation of thousands of Chinook smolts during snorkel surveys in a nine-mile reach of the Napa River in spring 2007 (Koehler 2006; Koehler pers. obs. April 2007).

Efforts by Friends of the Napa River, the Napa County RCD, and various consultants have increased the understanding of steelhead resources and restoration needs dramatically in recent years. Sedimentation reduction plans and projects also are being developed due in part to the watershed's listing as impaired by the Regional Water

Figure 4. Napa River sampling areas



Quality Control Board. Decreasing siltation is a key element of a comprehensive restoration program for the basin. In 2007, an instream sill removal, channel and bank stabilization, and riparian re-vegetation project was completed in Dry Creek.

Restoration of a 4.5 mile reach of the Napa River called the "Rutherford Reach" is being planned through a stakeholder process managed by the RCD. The Oakville to Oak Knoll Restoration Project also is expected to benefit habitat in mainstem Napa River. Also, restoration planning for the Napa River is addressing instream flows provisions (especially for rearing) in selected tributaries, and the Napa County RCD has an on-going project to identify opportunities to coordinate agricultural diversion with habitat needs.

Important restoration activities in the Napa River basin include modifying the barrier at the Zinfandel Land bridge, replacement of a poorly functioning fishway on Sulphur Creek, modifying the concrete ford crossing on Rector Creek, modifying the concrete dam/weir structure on Wing Canyon Creek, instream sill removal, channel and bank stabilization, and riparian re-vegetation in Dry Creek, Murphy Creek channel improvements, and culvert and road crossing projects in Pickle, Suscul, and Huichica creeks. Also, priority projects related to riverine/riparian conditions and provision of instream flows include Milliken, Murphy, Dry, lower Ritchie, and Redwood creeks (Stillwater Sciences 2002; Koehler 2005; NCRCD 2009; Koehler pers. comm.).

## Monitoring goals and proposed methods

As previously stated, NCRCD's 2009 rotary screw trap monitoring produced important results for understanding Napa River fisheries including the size range of *O. mykiss* outmigrants, species composition and relative abundance (versus non-native species) of the native assemblage, and timing of outmigration and relationship to stream discharge. Additionally, the program revealed that steelhead spawning occurs in the lowest non-tidal reach of the Napa River and providing genetics samples for future characterization of the *O. mykiss* population.

Generating accurate baseline population estimates is among the highest priority monitoring goals for the watershed. Such estimates inform decision-making and resource management by state and federal agencies as well as local and regional planners. Also, the Napa River watershed element of the NBFMP is proposed to provide data that will useful in testing several hypotheses regarding steelhead smolt production, juvenile growth, reproductive success, and life history details, which form the basis of multiple local, state, and federal resource agency planning objectives (NMFS 2007; McEwan and Jackson 1996; Napolitano *et al*. 2007).

Three stream locations will be identified for new out-migrant trap sites based on recent field surveys by the RCD. They will be selected from candidate sites in Napa, Redwood, Milliken, Tulucay, Carneros, and Huichica creeks. Together with the sampling results from the mainstem Napa River monitoring location, new sampling results will account for production in approximately 95 percent of all spawning and rearing habitat available to salmonids below major barriers (Figure 4).

Fyke nets will be installed at the downstream end of each of the three target creeks. Operation of a rotary screw trap (RST) will be continued in the Napa River north of Trancas Avenue to capture migrating salmonids from all upstream tributaries. This site was surveyed by RCD staff and others in recent years and its original location was modified to be most favorable in relation to flow.

Trapping will be conducted for approximately 14 weeks during spring for one year with the expectation of continuing the program contingent upon receiving additional funding. Traps will be in place from about February 15 through June 1. Traps will be maintained and monitored daily by qualified biologists from the RCD or their surrogates during the sampling period, assisted by volunteers. Fish sampling equipment and handling protocols are provided in Appendix A of this report.

## Cost and other program considerations

The cost for smolt trapping at three new locations in the Napa River watershed is estimated to be $95,265 (Table 3). Staff from the Napa County Resource Conservation District have expertise in fisheries science, project management, and outreach that will allow for significant cost savings in relation to a program conducted by consultants. Also, previous sampling in the Napa River during 2009 involved developing an extensive volunteer network that will be tapped for the proposed new monitoring. This approach maintains costs at a minimum. Matching funds represented by this effort amounts to about $6,500, leading to a funding requirement of slightly less than $89,000 for the program.

The Napa County RCD has secured support to continue monitoring in the mainstem Napa River during 2010. Previous experience and capital outlays have led to efficiencies in this year's costs, which are estimated to be about $52,000 (Table 4). Secured funding in the amount of $30,000 and matching funds represented by the use of volunteer labor allow this element of the monitoring program to be supported with only about $11,000 of additional funding support.

The Napa River element of the NBFMP reflects the large size of the watershed and seeks to develop information needed to characterize salmonid resources on a relatively broad scale. Particularly with regard to the steelhead population, future monitoring likely will provide additional geographic focus into key spawning and rearing habitat areas. Data produced during the program’s initial phase will be evaluated to determine the relative importance of various portions of the watershed to smolt production, to help establish restoration priorities, and to design additional monitoring activities that can further inform restoration planning and the effectiveness of on-going restoration efforts.

Table 3. North Bay Fisheries Monitoring Program - Napa River Watershed

**Detailed Task Budget**

| | | *TASK - Estimated Hours* | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Personnel and Expense Description | Rate | Project Management | Site Selection / Access | Equipment Acquisition | Trap Installation/Removal | Trap Processing/Maintenance | Data Analysis/Reporting | Distribution and Outreach | **TOTALS** |
| Sr. Biologist (Project Manager) | $86.00 | 100 | 20 | 20 | 90 | 200 | 140 | 20 | 590 |
| Hydrologist/Co-investigator | $66.00 | | 20 | | 90 | 200 | | | 310 |
| RCD Seasonal Aide | $18.50 | | | | 90 | 400 | 100 | | 590 |
| | $65.29 | | | | | | | | 0 |
| | $56.72 | | | | | | | | 0 |
| **STAFF TOTALS** | | $8,600 | $3,040 | $1,720 | $15,345 | $37,800 | $13,890 | $1,720 | **$82,115** |
| *Soft Match (includes salaries of funded employees)* | | | | | | | | | |
| NRCS | $70 | | | | | | | | 0 |
| RWQCB | $70 | | | | | | | | 0 |
| Napa County Flood Dist. | $70 | | | | | | | | 0 |
| Napa County Planning Dept. | $70 | | | | | | | | 0 |
| RCD Biologist | $56.72 | | | | | | | | 0 |
| RCD Sr. Biologist | $84.20 | | | | | | | | 0 |
| **SOFT MATCH TOTALS** | | $0 | $0 | $0 | $0 | $0 | $0 | $0 | **$0** |
| *Hard Match (includes equipment, materials, and volunteer hours)* | | | | | | | | | |
| Citizen Volunteers (hours) | $25 | | | | 60 | 200 | | | $6,500 |
| Hard Match ($) | - | | | | | | | | $0 |
| **HARD MATCH TOTALS** | | $0 | $0 | $0 | $1,500 | $5,000 | $0 | $0 | **$6,500** |
| **TOTAL COST SHARE** | | **$0** | **$0** | **$0** | **$1,500** | **$5,000** | **$0** | **$0** | **$6,500** |
| *Equipment / Expenses* | *Rate* | | | | | | | | |
| Cable/Rope | $150 | | | | $150 | | | | **$150** |
| Tricaine Anesthetic | $100 | | | | | $100 | | | **$100** |
| Fyke Nets (3) | $1,000 | | | $3,000 | | | | | **$3,000** |
| Installation supplies (per site) | $300 | | | | $900 | | | | **$900** |
| Storage boxes (3) | $250 | | | $750 | | | | | **$750** |
| Waders/Boots/Raingear | $800 | | | | $800 | | | | **$800** |
| Dipnets/Buckets/Pumps | $450 | | | | | $450 | | | **$450** |
| Envelopes/Blotter Paper | | | | | | $100 | | | **$100** |
| Printing / Mailing / Copying | | $100 | $150 | | | | | $150 | **$400** |
| **EXPENSE TOTALS** | | $100 | $150 | $3,750 | $1,850 | $650 | $0 | $150 | **$6,650** |
| **TASK TOTALS** | | $8,700 | $3,190 | $5,470 | $18,695 | $43,450 | $13,890 | $1,870 | **$95,265** |

| | | | |
|---|---|---|---|
| **TOTAL GRANT FUNDS** | **$88,765** | | |
| **TOTAL COST SHARE** | **$6,500** | **7%** | |
| Hard Match | $6,500 | 100% | |
| Soft Match | $0 | 0% | **PROJECT TOTAL** |

Table 4. North Bay Fisheries Monitoring Program - Napa River RST

**2010 Estimated Budget**

| Personnel and Expense Description | 2010 Rate | *TASK - Estimated Hours* | | | | | | TOTAL |
|---|---|---|---|---|---|---|---|---|
| | | Trap and Site Prep | Trap Assembly/Removal | Daily Trap Processing | Data entry | Data Analysis | Summary Report | |
| Sr. Biologist | $86.00 | 30 | 10 | 100 | 10 | 80 | 80 | 310 |
| Hydrologist | $66.00 | 30 | 10 | 100 | | | | 140 |
| RCD Seasonal Aide | $18.50 | | 10 | 100 | 80 | | | 190 |
| | | | | | | | | **0** |
| **STAFF TOTAL** | | **$4,560** | **$1,705** | **$17,050** | **$2,340** | **$6,880** | **$6,880** | **$39,415** |
| *Soft Match (includes salaries of funded employees)* | | | | | | | | |
| NRCS | $0 | | | | | | | 0 |
| RWQCB | $0 | | | | | | | 0 |
| Napa County Flood Dist. | $0 | | | | | | | 0 |
| Napa County Planning Dept. | $0 | | | | | | | 0 |
| RCD Biologist | $0 | | | | | | | 0 |
| RCD Sr. Biologist | $0 | | | | | | | 0 |
| **SOFT MATCH TOTALS** | | $0 | $0 | $0 | $0 | $0 | $0 | $0 |
| *Hard Match (includes equipment, materials, and volunteer hours)* | | | | | | | | |
| Citizen Volunteers (hours) | $25 | 10 | 120 | 300 | | | | 430 |
| Hard Match ($) | $0 | | | | | | | 0 |
| **HARD MATCH TOTALS** | | $250 | $3,000 | $7,500 | $0 | $0 | $0 | $10,750 |
| **TOTAL COST SHARE** | | **$250** | **$3,000** | **$7,500** | **$0** | **$0** | **$0** | **$10,750** |
| *Equipment / Expenses* | | | | | | | | |
| 1/2" Cable | | $200 | | | | | | $200 |
| Cable clamps | | $100 | | | | | | $100 |
| Tricaine | | | | $100 | | | | $100 |
| Elastomer kit | | | | $500 | | | | $500 |
| Genetics supplies | | | | $200 | | | | $200 |
| Waders/field supplies | | | | $600 | | | | $600 |
| **EXPENSE TOTAL** | | **$300** | **$0** | **$1,400** | **$0** | **$0** | **$0** | **$1,700** |
| **TASK TOTAL** | | **$5,110** | **$4,705** | **$25,950** | **$2,340** | **$6,880** | **$6,880** | **$51,865** |
| **SECURED FUNDS** | | | | | | | | **$30,000** |
| Napa County | $25,000 | | | | | | | |
| City of Napa | $5,000 | | | | | | | |
| **TOTAL GRANT FUNDS** | | | | | | | | **$11,115** |

**Assumptions**

Conduct one year of monitoring March 1 - June 1, 2010 (~85 days)
Travel costs covered by NRCS vehicle usage
Daily checks = 2 hrs
Continuous trap efficiency releases throughout sampling period

# Summary of Tasks and Costs

While it is desirable to fund the NBFMP in its entirety, it may be necessary to fund the program through a collection of smaller grants. Therefore, the program's cost estimation is provided in detailed budgets (Tables 1-4) and total costs (Table 5) for flexibility in preparing funding proposals. The following describes tasks necessary to carry out the monitoring program in each of the subject watersheds. The tasks listed below correspond to rows in the detailed specific budget tables. Hours allocations for the tasks are expected to vary between the watersheds primarily due to the differing number of monitoring sites in each county.

Table 5. North Bay Fisheries Monitoring Program

Annual Cost Summary

| Element | Labor Cost | In-kind Staff Labor | Volunteer and Hard Match | ODC | Total | Total Grant | Total Match | Match % |
|---|---|---|---|---|---|---|---|---|
| Corte Madera Creek | $75,630 | $20,306 | $5,624 | $7,707 | $109,267 | $83,337 | $25,930 | 24% |
| Sonoma Creek | $92,696 | $688 | $7,800 | $5,100 | $106,284 | $97,796 | $8,488 | 8% |
| Napa River | $82,115 | $0 | $6,500 | $6,650 | $95,265 | $88,765 | $6,500 | 7% |
| Napa River RST | $39,415 | $0 | $10,750 | $1,700 | $51,865 | $11,115 | $40,750 | 79% |
| Total | $289,856 | $20,994 | $30,674 | $21,157 | $362,681 | $281,013 | $81,668 | 23% |

**Project management.** This program element involves several distinct responsibilities, each of which in necessary to ensure that the program is implemented on schedule and on budget, and that it produces the appropriate "deliverables." Responsibilities assumed under this task include administering the program funding, communicating with stakeholders, addressing staffing requirements, administering the permit-mandated endangered species handling protocols, and post-program evaluation.

**Site selection and access.** A combination of specific and generalized locations have been developed for the seven NBFMP monitoring sites primarily based on their capacity to represent large proportions of rearing habitat in their respective watersheds and their suitability in terms of channel morphology and flow characteristics. Additional considerations include ease of access, proximity to gauging stations, and security. Final site selection will involve determining relative suitability of specific sites based on these criteria.

**Equipment acquisition.** During the first year of the program, equipment used in constructing the traps and implementing the program will need to be purchased or acquired from cooperating organizations. Materials used in constructing the smolt traps

will vary depending on trap design, but typically include fyke nets, rebar stakes, flagging, wing nets, hardware, plywood, and other related materials. Cost estimates provide in the program budget represent likely design selections and associated expenses. The RST used in the Napa River watershed monitoring program is owned by the Napa County RCD.

**Trap installation/decommissioning.** Out-migrant traps will be installed at the one Corte Madera Creek site, the two Sonoma Creek watershed sites, and the three non-RST sites in the Napa River watershed. Sites are being selected in part for the appropriateness of the channel configuration; excessive complications during installation are not expected. At the end of the sampling period, the traps will be decommissioned and the constituent materials transported to in-watershed locations for storage.

In the Napa River, the RST will be transported to the site, cleaned, and assembled in the river. Hand winches on the front of the trap are used to position the trap advantageously in relation to streamflow. At the end of the sampling period, the RST will be disassembled and removed from the river for dry storage. The trap will be power washed and put on a trailer for transport to the County of Napa's corporate yard in Yountville.

**Trap processing and maintenance.** Out-migrant traps will be checked daily during the sampling period. Captured fish will be measured for length and weight, identified to species, and released. The fish processing protocol is specified in Appendix A of this document.

During the sampling period, traps will be inspected and maintained as necessary to achieve the highest possible capture rates. While periods of trap non-operation are expected due to likely damage by high flows and/or debris (and associated delays in re-establishing the integrity of any non-functioning traps), the accessibility of the sites and frequent monitoring schedule should allow for a high proportion of the sampling period to be represented in the data collected.

Processing at the RST will be carried out according to the RCD's Rotary Screw Trap Protocol (Appendix A). Fish will be removed from the livebox every morning and processed. Salmonids will be released either downstream of the trap or upstream if part of a mark-recapture study. Non-target fish will be released downstream from the trap. The RST will be inspected daily and debris removed as needed. The RST will be tilted out of the water during high flows to avoid damage.

**Data analysis and reporting.** All data collected for the proposed program will be entered onto standardized forms developed in association with a NBFMP database. Data collected under each monitoring task will be checked for errors, catalogued, archived, and entered into a database maintained jointly by the Marin Municipal Water District or the project consultants, the Sonoma Ecology Center, and the Napa County RCD, with assistance from designated collaborators.

Data quality assurance/quality control procedures will be set forth in a Quality Assurance Project Plan (see Appendix A). Spatial data and associated metadata will be similarly

checked and archived prior to entry into the program's Geographic Information System (GIS). The GIS will be based on and fully compatible with the Napa County RCD's existing GIS, which contains data layers from multiple partner agencies including CDFG, Napa County, and others.

Genetic analysis will be conducted through a cooperative agreement between the NBWA and the NOAA Fisheries Southwest Science Center when funding sources are identified. Tissue samples will be catalogued and sent to the center.

The program will entail preparing monitoring results reports that include description of sampling conditions, quantitative results, and recommendations for sampling program adaptations and future research efforts. Each of the three results reports will be distributed to reviewers consisting of lead biologists for the remaining watersheds (*e.g.*, Corte Madera watershed reporting will be reviewed by Southern Sonoma and Napa County RCD staff), staff at the Regional Water Quality Control Board, DFG, and NMFS. After a comment period of approximately one month, reports will be finalized and posted to the corresponding Web sites for the study areas. Electronic versions of the reports also will be distributed to interested parties by request.

**Outreach.** Outreach will consist of: 1) volunteer recruitment, coordination, and training; and 2) distribution of information generated by the program. Trapping efforts in the Corte Madera Creek will be supported by volunteers associated with the North Bay Chapter of Trout Unlimited (Olrich pers. comm.) and Friends of Corte Madera Creek (Guldman pers. comm.). In the Sonoma Creek watershed sampling element, volunteer participation will be developed and organized by staff from the Sonoma Ecology Center from an existing, extensive network of volunteers (DiPietro pers. comm.). The program budget for Sonoma Creek therefore includes support for the associated outreach. The Napa County RCD expects to rely on a volunteer base developed through the district's 2009 RST sampling effort that included more than 30 participants.

# References

## *Publications*


Allen, J.T., CDFG. 1960. Stream Survey Corte Madera Creek. Report dated January 18.

Anderson, K.R., CDFG. 1969. Steelhead Resource, Napa River Drainage, Napa County. Report dated December 23.

Becker, G.S., I.J. Reining, D.A. Asbury and A. Gunther, Ph.D. 2007. San Francisco Estuary Watersheds Evaluation. Center for Ecosystem Management and Restoration. Oakland, CA.

Good, T.P., R.S. Waples, and P. Adams (editors). 2005. Updated status of federally listed ESUs of West Coast salmon and steelhead. U.S. Dept. Commer., NOAA Tech. Memo. NMFS-NWFSC-66, 598 p.

Johnson, D.H., B.M. Shrier, J.S. O'Neal, J.A. Knutzen, X. Augerot, T.A. O'Neil, and T.N. Pearsons. Salmonid field protocols handbook: techniques for assessing status and trends in salmon and trout populations. American Fisheries Society, Bethesda, Maryland.

Jones, W.E., CDFG. 1969. Memo to Region 3 Water Projects Files. Re: Corte Madera Creek, Marin County-Steelhead population survey. Dated November 25.

Katopothis, C., L. Micheli, M. Orme, C. Rossi and R. Branciforte. 2005. Fish Passage Barrier Assessment in Sonoma Creek Watershed-Final Report.

Koehler, J. 2005. Napa River Fisheries Study: The Rutherford Dust Society Restoration Reach, Napa County, California. NCRCD (Napa County Resource Conservation District).

Koehler, J. 2006. Napa River Salmon Monitoring Project Spawning Year 2005 Report. NCRCD (Napa County Resource Conservation District).

Koehler, J. 2007. Napa River Salmon Monitoring Project Spawning Year 2006 Report. NCRCD (Napa County Resource Conservation District).

Leidy, R.A., G.S. Becker, and B.N. Harvey. 2005a. Historical status and current distribution of steelhead/rainbow trout (*Oncorhynchus mykiss*) in streams of the San Francisco Estuary, California. Center for Ecosystem Management and Restoration. Oakland, CA.

Leidy, R.A., G.S. Becker, and B.N. Harvey. 2005b. Historical status of coho salmon in streams of the urbanized San Francisco Estuary, California. California Fish and Game 91(4): 219-254.

McEwan, D. and T. Jackson. 1996. Steelhead Restoration and Management Plan for California. California Department of Fish and Game.

[NMFS] National Marine Fisheries Service. 2007. Recovery of Salmon & Steelhead in California and Southern Oregon - Central California Coast Steelhead DPS - Priority Actions Needed. http://swr.nmfs.noaa.gov/recovery/Steelhead_CCCS.htm

Napolitano, M., S. Potter, and D. Whyte. 2007. Napa River Watershed Sediment TMDL and Habitat Enhancement Plan. Staff Report. California Regional Water Quality Control Board, San Francisco Bay Region, Oakland, CA.

[NCRCD] Napa County Resource Conservation District. 2005. Central Napa River watershed project, salmonid habitat form and function. Final Report. Prepared for California Department of Fish and Game, Contract P9985160. October.

[NCRCD] Napa County Resource Conservation District. 2009. Napa River steelhead and salmon smolt monitoring program: Annual Report - Year 1. Report dated July 2009. Contact Jonathan Koehler, Senior Biologist, Napa County RCD.

Rockwood, K., CDFG. 1966. A Reconnaissance Report of Proposed Water Projects in the Sonoma Creek Drainage, Sonoma County.

[SEC] Sonoma Ecology Center. 2006a. Sonoma Creek Limiting Factors Analysis. Prepared with Stillwater Sciences and UC Berkeley, Department of Earth and Planetary Sciences.

[SEC] Sonoma Ecology Center. 2006b. Sonoma Creek sediment source analysis. Prepared with Watershed Sciences, Marin Trso, P.G., Talon Associates, LLC, and Tessera Consulting.

Stewart, Robert, Alaska Department of Fish and Game. 2002. Resistance board construction manual. Regional Information Report No. 3A02-21.

Stillwater Sciences. 2002. Napa River Basin Limiting Factors Analysis.

[Taylor] Ross Taylor Ross Taylor and Assoc. 2003. Marin County stream crossing inventory and fish passage evaluation-final report. Prepared for County of Marin - Department of Public Works.

[USFWS] United States Fish and Wildlife Service. 1968. Analysis of fish habitat of Napa River and tributaries, Napa County, CA, with emphasis given to steelhead trout production. Report dated October 21.

Zimmerman, C.E. and L.M. Zabkar. 2007. Weirs. Pages 385-397 in D.H. Johnson, B.M. Shrier, J.S. O'Neal, J.A. Knutzen, X. Augerot, T.A. O'Neil, and T.N. Pearsons. Salmonid field protocols handbook: techniques for assessing status and trends in salmon and trout populations. American Fisheries Society, Bethesda, Maryland.

## *Personal communications*

DiPietro, Diane, Sonoma Ecology Center. Communications in November 2009.

Guldman, Sandy, Friends of Corte Madera Creek. Communication in November 2008.

Koehler, Jonathan, Napa County Resource Conservation District. Communication in October 2009.

Micheli, Lisa, Sonoma Ecology Center (former). Communications in November 2008.

Olrich, Matt, Trout Unlimited North Bay Chapter. Communications in November 2009.

# Appendix A. Traps, fish handling, and QA/QC

## *Traps*

Smolt collection will be accomplished using either rotary screw, weir and pipe, resistance board weir, or fyke traps at the various sampling locations. The opening of the trap typically will be positioned at the upstream end of a riffle, while downstream run reaches will be used to locate the live cars. Stable streambanks will be sought in all trap locations.

A typical fyke trap is composed of a five-foot square metal frame onto which is tied a fyke net that tapers to a six-inch diameter cod end. The cod end transitions to a six-inch tube that enters a live car, consisting of a metal frame covered with fine (0.625 inch pore size) mesh. The live car may measure about four feet by two feet by two feet high.

The fyke net frame is installed in a weir composed of plywood and plastic sheeting that directs stream flow into the fyke. Plywood sheets are supported by t-posts imbedded into stream banks and have a downstream aspect that forces flow and fish into the fyke net. Sandbags and plastic tarps are used to close gaps between plywood weir and stream bottom, to tie into the banks, and to prevent scouring of substrate along plywood and fyke net openings. Flow can pass across the net, dissipating velocity, while fish are guided through the fyke net into the trap. A floating platform may be placed in the live car to allow a perching platform for toads, frogs, turtles, and waterfowl that may be captured in the trap.

Weir and pipe traps also may be used, and are comprised of a weir, a funnel, a pipe, and a live-car trap. In this system, an angled weir is created using two-inch square mesh fencing material supported by t-posts driven into the channel bed. The t-posts are spaced three to five feet apart so as to resist the force produced by high flows likely to be encountered during the trapping season. A mesh seine with one-eigth inch pore diameter is draped over the fence to prevent fish from passing through. The lower 12 inches of the fence is bent to form a collar on which are placed sandbags, precluding gaps between the weir and the stream bottom. Sandbags also are used at the interface of the weir and the banks to prevent scouring, and around the funnel and live-car to stablize these elements against high flows.

The weir guides fish to a plywood funnel containing a six-inch socket flange on its downstream face. The flange connects the funnel to a flexible pipe that leads to a trap. Tension straps are placed on the ends of the pipe and connected to t-post anchors to prevent the pipe from accidental disconnection during routine maintenance or high streamflow events.

The trap is constructed using one half inch diameter metal conduit for the frame and plywood panels forming solid top, bottom, and front surfaces. The sides and the rear of the trap are covered with one-eighth inch mesh seine to allow flow through the box. A

floating platform is placed in the trap to provide a platform for toads, frogs, turtles, and waterfowl that may be captured inadvertently.

A screw trap consists of a cone covered in perforated plate that is mounted on a pontton barge. The trap cone is oriented with the wide end facing upstream and uses the force of the river acting on tapered flights to rotate the cone about its axis. Downstream migrating fish are swept into the wide end of the cone and are gently augered into a live box at the rear of the trap. A winch is used to adjust the forward elevation of the screw, and an additinoal winch may be used to raise and lower the aft end of the screw if desired (Johnson *et al*. 2007).

Resistance board weirs are desirable in situations with highly variable flows, and particularly where floating debris is likely to damage alternative trap structures such as nets or rigid weirs. During high water, the resistance board weir will temporarily submerge when pressure created by water an debris loading reaches a point that would typically wash a rigid weir downstream. This flexibility requires less maintenance and also reducers the frequency of these occasions when the trap is non-operational.

Resistance board weirs consist of three main components: panels made of capped PVC pipe, a rail anchored to the substrate that attaches the panels to the river bottom, and a trap box or chute where fish are captured or counted. Electrical conduit is used because it resists breakdowns caused by UV light. Panels consist of multiple pipes supported by stringers that are spaced evenly lengthwise along the panel to provide rigidity to the flexible PVC. A resistance board is attached at the downstream end of the panel to deflect water flow downward, which causes lift and holds the downstream end of the panel above the surface of the water (Johnson *et al*. 2007).

## *Fish handling*

Traps will be checked daily for fish by a qualified fisheries technician and maintained to ensure full functionality. Maintenance involves removing debris and algae, and repairing portions of the trap damaged by high flows. Field notes will be recorded at every visit and will include the number of fish caught, collection and release times, temperature of stream and handling waters, and trap condition. Captured fish will be identified by species and handled according to the program protocol.

All steelhead/rainbow trout will be placed in aerated, chilled water in dedicated ice chests until release. Not more than ten juvenile fish will be kept simultaneously in a single ice chest. Not more than two adult steelhead will be kept in a single ice chest. Water will be chilled using refillable plastic freezer bottles filled with frozen river water. If water temperature exceeds 15 °C, the holding water will be chilled so that it is 3 to 5 °C cooler than the ambient temperature to reduce the risk of thermal shock to the fish, both after capture and upon release. Holding water will be aerated with $O_2$ and a diffuser to keep oxygen concentrations at saturation levels. While being held, the fish will be continually monitored for signs of stress such as rapid gilling, extreme agitation or loss of

equilibrium, and stressed individuals will be enumerated and released as quickly as possible without additional processing steps.

Each steelhead/rainbow trout captured will be given a unique identifier. Healthy individuals will be processed, starting with anesthetization using $CO_2$ to reduce stress. Fish will be removed from the anesthetic as soon as they lose their equilibrium. Processing includes measuring fork length to the nearest millimeter, scale sampling for age and life history determination, and a taking a fin clip (~2 $mm^2$) for possible future DNA analysis. Fish will be photographed and placed in a recovery area prior to release. Both holding and recovery water will be chilled and aerated using $O_2$, as described above.

At the completion of processing, fish will be released to an appropriate area downstream from the trap. If, following processing, a fish appears to have difficulty regaining its equilibrium, resuscitation will be attempted by holding the fish upright and moving it forward through the water to establish a flow of water over its gills. This should be continued for three to five minutes or until the fish is capable of swimming away on its own and maintaining its equilibrium.

If a fish dies during handling all data will be collected after all live fish have been processed and released. Mortalities will be labeled with the date and time of death, identification code, length, and all relevant data and placed individually in plastic bags. The fish will be frozen and NMFS and CDFG will be notified. The disposition of mortalities will be determined by consultation with agency staff.

Scale and DNA samples will be placed in tin foil or wax paper in a coin envelope. Coin envelopes will be labeled with trap location, the date and time of capture, the unique fish identification code, the fish length, and the type of sample. Scale samples will be stored in a designated location at the offices of the lead biologist. Fin clip samples will be stored in a freezer most conveniently accessed by the lead biologist. Photographs also will be associated with the sampling information.

Anadromous species (steelhead and lamprey) are released below the diversion after processing if there is continuous flow between the diversion and the ocean. If there is not continuous flow to the ocean, anadromous species are transported to the estuary or ocean after processing.

Threespine stickleback, *Gasterosteus aculeatus,* and other native fish species expected for the study area, are counted and returned to the river downstream of the trap. Non-native fish and invertebrates, such as the signal crayfish, *Pacifasticus leniusculus*, and red swamp crayfish, *Procambarus clarkii*, are removed from the sampling location.

A representative number of specimens (up to 10) of other species are measured for total length or fork length depending on the morphology of their caudal fin. The number of each species captured in the trap is recorded.

All fish data are to be recorded on fish data sheet. One sheet should be filled out for each sampling period. The sheet should be completed even if no fish are captured. Instructions for filling out the data sheet are provided with the stock of data sheets for each of the sampling areas, including the appropriate codes for specific fields. A separate line will be used for each rainbow trout or steelhead captured, and for individuals of all other species for which a length is collected. Lengths should be collected for every healthy rainbow trout and steelhead. For other species at least ten lengths should be collected if available. If there are more than ten fish of a given species, these lengths should be representative of the fish collected.

## *Fish Rescue Procedures*

In the event that there is not continuous flow between the trap location and the estuary, a fish rescue will be performed. Steelhead smolts will be transported in a large cooler filled with chilled, aerated water to the estuary for release. Prior to release, fish will be acclimated to brackish water in a large holding tank. This tank will be filled with water with a salinity of approximately ten parts per thousand, aerated and chilled. Fish to be released will be placed in this tank and held overnight. The following morning, these fish will be transported to designated locations and released.

## *Quality Assurance/Quality Control*

Prior to the initiation of trapping, a training session is required for all trap personnel. Training will be provided by experienced staff and cover fish identification, trap operation, fish measurement (fork lengths of juvenile salmonids), data recording, trap efficiency estimation, safety, and other general QA/QC procedures.

Trained trap operators will count the total number of fish trapped, and identify the species of each individual fish. On at least one trapping day every two weeks, the lead biologist (or designee) will verify identification and remeasure a 20 percent sample of captured salmonids. If greater than 1 percent error in identification or 10 percent error in measurement is found, the trap operator will receive additional review in identification and/or measurement techniques.

According to the QA/QC Plan, fish will not be handled when morning water temperatures exceed 68°F. The trap will not be operated and will remain non-operational until safe temperatures occur.

The traps will not be operated when high flows may cause water velocities within the live box to exceed the swimming capabilities of the smallest fish, which may result in mortalities greater than 5 percent. Live boxes will be checked and cleared of debris more than once a day during periods of high flow and/or in very windy conditions.

A weighted, five-gallon bucket with small holes in the live box will be provided as refuge for smaller fish. Traps and live boxes will be inspected daily during operation for damage. All dip nets will be inspected daily rips in the mesh. Fish holding buckets will be inspected

weekly for leaks, cracks, and sharp protrusions. Fish safety will be paramount, and information gathering will be considered secondary.