2009 Monitoring and Evaluation Study Plan for the Robles Fish Passage Facility and Related Studies

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1.0 INTRODUCTION

As described in the Biological Opinion (BO) for the Robles Fish Passage Facility (NMFS 2003), the annual monitoring and evaluation study plan is intended to identify the activities, or other activities associated with the Robles Facility, to be accomplished for a given year. The 2009 study plan includes activities related to the physical conditions in the Ventura River and the biological responses to those conditions. Approximate timeline for all activities are identified in Table 1.

The monitoring, evaluations, and activities related to the modifications of the Robles Facility, as outlined in the BO, were intended to achieve three main objectives:

I. Monitor Fish Passage Facility operations and performance.

II. Determine if the Fish Passage Facility functions and operates in such a fashion that migrating steelhead:
    a. Successfully navigate into and through the facility, and
    b. Move through the facility in good physical condition.

III. Determine if the operations at the Robles Diversion are enhancing the opportunity for:
    a. Adult steelhead to migrate upstream to the Robles Facility, and
    b. Smolts and kelts to migrate downstream through the Robles Reach.

Table 1. Activities and associated time periods for the 2009 Monitoring and Evaluation Study Plan.

Activity	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Impediment Evaluation	X	X	X	X	X	X	X	X	X	X	X	X
Sandbar Monitoring	X	X	X	X	X	X	X	X	X	X	X	X
Post-Construction Performance Evaluation	X	X	X	X	X	X						
Fish Attraction Evaluation	X	X	X	X	X	X	X					
Basin Fish Surveys	X	X	X	X	X	X	X	X	X	X	X	X
Spawning Surveys	X	X	X	X	X	X						
Video Monitoring Pilot Study	X	X	X	X	X	X	X	X	X	X	X	X
Stranding Surveys	X	X	X	X	X	X						
Downstream Fish Passage Evaluation	X	X	X	X	X	X						
Robles Reach Downstream Passage Evaluation	X	X	X	X	X	X						
Monitor Robles Facility Operations	X	X	X	X	X	X	X	X	X	X	X	X
Fish Passage Monitoring	X	X	X	X	X	X						
Water Quality	X	X	X	X	X	X	X	X	X	X	X	X
Photographic Index Monitoring			X						X			

2.0 UPSTREAM FISH MIGRATION IMPEDIMENT EVALUATION

The objective of the fish migration impediment evaluation is to assess physical factors that may impede a steelhead's ability to migrate to the Robles Facility (NMFS 2003). The first activity was to conduct a physical stream survey from the Ventura River mouth to the Robles Facility (Figure 1), which was completed during 2008 (CMWD 2009). The survey methodology used followed Moore et al. (2002) and is equivalent to a level IV survey as described in the California Salmonid Stream Habitat Restoration Manual (Flosi et al. 2002). The stream survey was conducted at river discharges ranging from a target of about 20 cfs up to about 100 cfs.

Critical passage features were initially selected using an impediment metric (CMWD 2009) and were representative of the Robles Reach. The Robles Reach was defined in the BO as the reach extending downstream 4 miles from the Robles Facility. However, for this study plan, the Robles Reach will be defined as the reach extending downstream to the confluence of San Antonio Creek, a distance of approximately 10.5 km (Figure 1). Each site was selected and prioritized based on the data from the habitat survey and included: streambed slope; habitat depth and length; and general channel morphology. These sites were distributed systematically through the reach to capture longitudinal differences that may be the result of variable subsurface hydrology. Representative sites are also located in the lower Ventura River reach from Foster Park to the mouth. The total number of sites selected for intensive evaluations was 15. Ten of the sites are located within the Robles Reach.

After discussions with the Biological Committee, NMFS and CDFG believed that this method of site selection could be missing important potential sites for monitoring. Therefore, an alternative method of selecting sites was used to determine the final sites for future impediment evaluations, beginning in 2010. A detailed description on the method and final sites selected will be included in the 2009 progress report and 2010 study plan, since 2010 will be the first study year that the sites will be monitored.

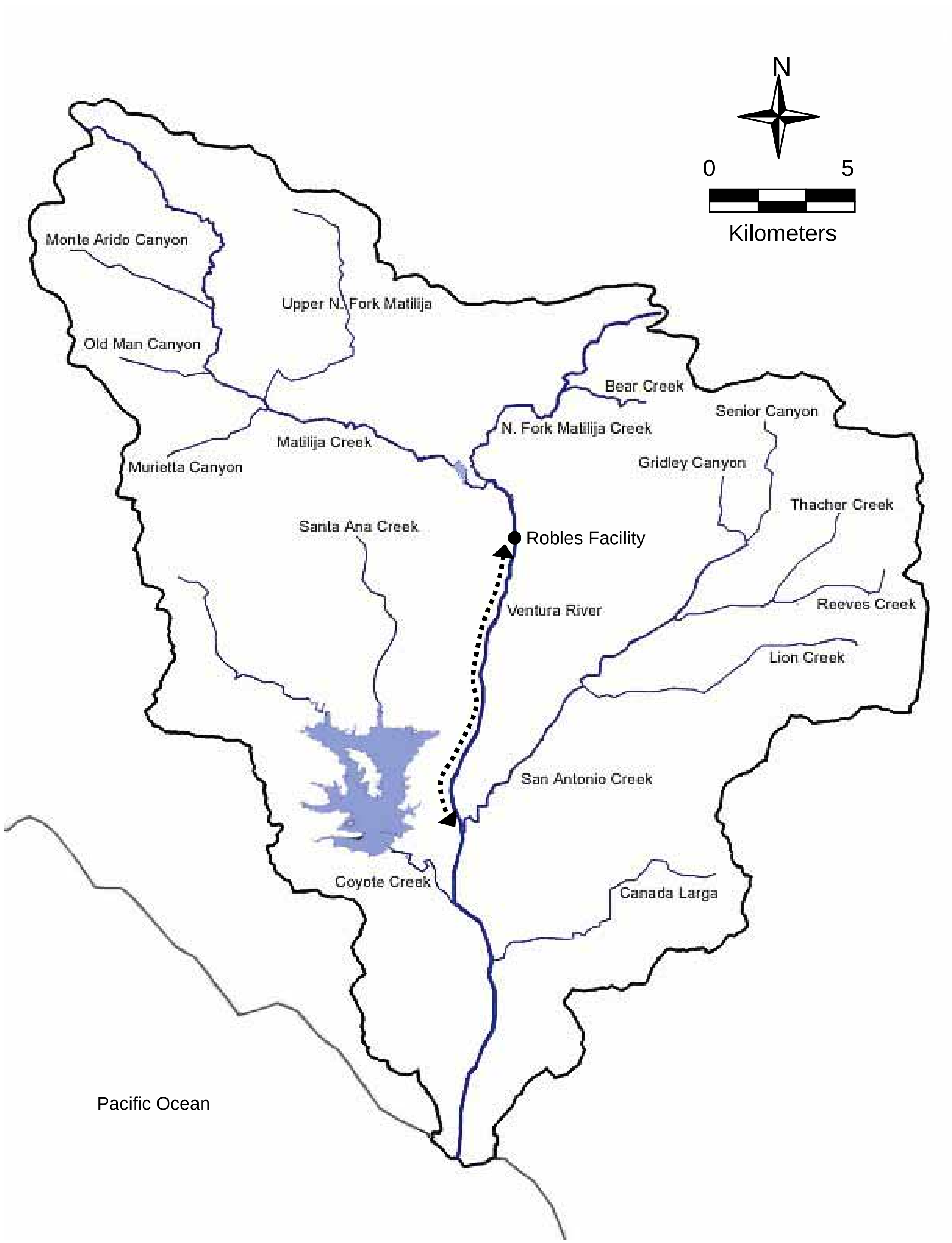

Figure 1. Basin map of the Ventura River. The Robles Fish Passage Facility is identified by the round black dot and the Robles Reach is identified by the dashed line downstream of the Robles Facility.

The selected critical passage features will be surveyed multiple times during the fish migration season to determine water depth, velocity, and discharge, if sufficient runoff occurs. The method used to estimate stream discharge will be the velocity-area method and will generally follow the USGS methods in Nolan and Shields (2000). The selected sites will be surveyed over a range of discharges from approximately 20-100 cfs (the upper limit will depend on the ability to safely conduct the surveys). The number of re-surveys will be dependent on the frequency of significant rain events, ease of access to sites, and time constraints due to other aspects of the monitoring and evaluation program. These surveys will most likely be conducted over a period of 2-3 years and will be dependent on wet and dry climatic cycles. The selected sites will be surveyed as many times as needed to develop a statistically rigorous data set that could be used to evaluate fish passage.

An initial assessment of potential passage impediments in relation to river discharge was completed by Entrix (1999); seven sites were identified in the Robles Reach. The physical characteristics of the seven potential impediments were compared to the Thompson (1972) passage criteria. The Thompson (1972) passage criteria for adult steelhead at critical riffles is a water depth of 0.6 ft for 25% of the total transect width and a continuous portion equal to 10% of the width. The impediments were also evaluated for criteria of 0.5 ft and 0.6 ft depth for 25% width and a total of 8 ft width for both depths. The resulting discharge required was estimated to be between 40 and 65 cfs. There have been several modifications to the Thompson passage criteria by other researchers; Dettman and Kelly (1986) on the Carmel River used a 0.6 depth over a 5 ft continuous section, on the Santa Ynez River a criteria of 0.6 ft depth over an 8 ft section was used (SYRTAC 1999), and Harrison et al. (2006) used a criteria of 0.6 ft depth over a 10 ft section on the Santa Clara. Thompson's (1972) depth criterion was based on fish body measurements and not on actual migration observations, and it has been observed that salmonids can successfully move through shallower riffles (Mosley 1982). The final evaluation of potential impediments will use one of the aforementioned criteria or a yet to be determined criteria that will be developed through the Cooperative Decision Making Process as described in the BO.

During 2009, an attempt will be made to locate all of the Entrix sites to determine their current status. Since there has been numerous bed-mobilizing runoff events since the study was completed, the present status of the sites needs to be determine and how they may have changed over time.

2.1 *Sandbar Monitoring*

The primary objective of the sandbar monitoring at the mouth of the Ventura River will be to determine if criteria for initiation of the fish passage augmentation season have been met (NMFS 2003). This will be done by observing the timing and frequency of sandbar breaching during the augmentation season. The BO states the fish passage augmentation season will run from January 1st through June 30th of each year and will commence after the sandbar has been breached at least once during the current year's fish flow operations season.

The Ventura River, like many other California rivers, typically develops a seasonal sandbar at the mouth during the late spring or summer that is breached by higher river flows in the late fall or winter. However, during 2005, 2006, and 2007 the sandbar did not fully form during the fish augmentation season, or any other time during this period, and the Ventura River remained connected to the Pacific Ocean. The sandbar only closed briefly in April of 2007. In 2008, the sandbar was closed from August into December (CMWD 2009). If a sandbar does develop, a typical lagoon that forms can provide important rearing habitat for steelhead juveniles, due to the abundant food resources available that can facilitate the physiological and behavioral changes associated with smoltification (Cannata 1998).

Beginning in mid-December, weekly surveys will be conducted to determine the status of the river/ocean connection. This will be done to anticipate the conditions prior to the start of the fish passage augmentation season. If the sandbar has been breached as of January 1st, signaling the start of the fish passage augmentation season, the sandbar will be monitored once every two weeks for the remainder of the fish passage season. If the sandbar has not been breached by January 1st, it will also be monitored once every two weeks until a storm event (as defined in the BO) occurs. At that time, the sandbar will be monitored daily to determine when it is has been breached. If the sandbar does not breach following a storm event, it will again be monitored every two weeks until the next storm event occurs. If the storm event breaches the sandbar, it will be monitored once every two weeks for the remainder of the fish passage season. From July 1st through December 31st, the sandbar will be monitored at least once per month to determine the status of the river/ocean connection; this would provide information to better understand the variation within and among years.

During each occasion the sandbar is monitored, data recorded will be: date, time, status of the sandbar, tidal state, water temperature, discharge from the USGS gage at Foster Park (station # 11118500), discharge at the Robles Facility, and the number and location of open channels if the sandbar has been breached. An index count of the relative number and species of fish-eating birds will be conducted during each occasion.

Periodically, discharge measurements will be taken over a range of river flows, which can be safely done, to determine the correlation between the USGS gage station, or any other upstream gage station, and the discharge at the mouth. Discharge from the Ojai Valley Sanitary District treatment plant will be included in calculations to account for the additional water added to the lower river reach. These measurements will be taken to better understand what determines the timing and frequency of the sandbar breaching and forming events. Measurements will also be collected periodically of the estuary/lagoon surface area and depth to correlate with breaching and discharge; this may be useful to determine potential steelhead rearing capacity.

3.0 EVALUATE FISH MOVEMENT THROUGH THE PASSAGE FACILITY

3.1 *Water Velocity and Depth Validation Evaluation*

The intent of the water velocity and depth validation evaluation program is to determine if the conditions throughout the Robles fish passage facility are suitable for upstream and downstream migrating steelhead (NMFS 2003). The post-construction performance evaluation study plan (Rodgers 2006) has been completed and is anticipated to begin during 2009, if adequate river flows occur.

3.2 *Fish Attraction Evaluation*

The objective of the fish attraction evaluation is to determine if any adult or smolt steelhead are holding in close proximity to the fish ladder entrance during the fish passage augmentation season (NMFS 2003). The primary area of interest will be the reach immediately downstream of the Robles Facility. This reach will begin with the pool at the fish ladder entrance and extend downstream to the pool that is upstream the lower most rock weir, a total of approximately 185 m.

The fish attraction surveys will be conducted on a weekly basis during the fish passage season. The particular survey methodology used will be determined by water visibility, river discharge, and targeted steelhead life stage at the time of the survey. From January through March, which is when the vast majority of adults are expected to be migrating upstream (Shapovalov and Taft 1954), bank surveys will be the predominant method used. Beginning in March through the remainder of the fish passage season, snorkel surveys will be the predominant method used, which is when steelhead smolts are expected to migrate downstream (Shapovalov and Taft 1954). Bank surveys will be conducted by one or two surveyors in an upstream direction. The surveyors will wear polarized glasses to reduce water surface reflection. Snorkel surveys will be conducted by one or two surveyors in an upstream direction. All fish species will be identified and enumerated to the greatest extent possible that the river conditions and fish densities will allow at the time of the surveys.

After discussions with the Biological Committee, NMFS and CDFG did not believed that this method could not achieve the objectives of the evaluation as outlined in the BO. Therefore, NMFS and CDFG requested a change in the survey methodology. In general, the changes will include frequent observations for steelhead immediately following a storm event for a discrete period of time. Full details will be outlined in the 2010 study plan, which is when the new methods will be able to be implemented, after a thorough review and discussion through the Cooperative Decision Making Process of the Biological Committee

3.3 *Stranding Surveys*

When discharge through the Robles Fish Facility is lowered from 50 cfs to the 30 cfs, as described in the BO for between storm events, a bank survey will be conducted in the Robles Reach after the transition has been made. This survey will be done to determine if any steelhead are stranded, or may become stranded, and help determine steelhead migration success through the Robles Reach. Habitat surveys (as described in section 2.0) will help to first identify potential holding areas where steelhead may become stranded and will decrease the time to complete the stranding survey. It is anticipated the stranding survey will take approximately 1-2 days to complete.

3.4 *Downstream Fish Passage Evaluation*

There are two main objectives for the downstream fish passage evaluation. The first objective is to determine if steelhead are successfully passing downstream through the Robles Facility. The second objective is to capture and examine steelhead smolts and kelts and determine if they sustained any injuries that may have been caused by downstream passage through the Robles Facility (NMFS 2003).

A weir trap will be placed and operated approximately 100 m downstream of the Robles Facility. This location will be between the fish ladder entrance and the access road crossing. The weir trap will consist of a live-box with an internal fyke situated near the bank. A fence will extend approximately 3/4 of the way into the river channel from the live-box and will be constructed out of plastic fencing with 3-cm diagonal openings. The fence will extend 12 m upstream from the live-box at about a 60° angle (from the left bank, facing upstream). The lead fence will extend approximately 70% across river channel and allow adult steelhead passage upstream by the trap location in the remaining 30%. Alternative trap locations will be discussed through the Cooperative Decision Making Process as described in the BO for inclusion into the 2010 study plan. Since the vast majority of downstream steelhead migrants are expected to be captured from mid-March through mid-June (Shapovalov and Taft 1954; Dettman and Kelley 1986), the trap would be operated from mid-March through mid-June, or until water temperatures exceeded a 5-day mean of 22 °C, which could negatively impact captured fish (SYRTAC 2000).

The trap will be operated only at lower river flows when it would be effective at capturing downstream migrants. The upper limit of river flow operation would be determined after the first year of full operation, if flow conditions exist. Because base flow conditions are more likely to be used for downstream passage by steelhead (NMFS 2003), a weir trap was chosen as the method for this evaluation rather than a rotary screw trap. After assessing some representative hydrographs from previous years, evaluating potential screw trap sites, and the potential for capturing downstream migrants with a screw trap at the higher discharges, a screw trap was determined to be much less effective at gathering data that would help address the objectives of the downstream passage evaluation.

When the trap is operational, it will initially be checked twice per day (in the morning and late afternoon) to determine necessary frequency. Data collected would include: fork length (mm), weight (g), and a subsample of scale and tissue samples for aging and genetic analysis. Fish that are to be handled will be put into an aerated container with a solution of tricaine methanesulfonate (MS-222) and Stress Coat®. The anesthesia MS-222 is a registered US Food and Drug Administration for use with food fish (Summerfelt and Smith 1990). The level of anesthesia needed will generally be a stage 2-4, which is a deep sedation to a total loss of equilibrium (Summerfelt and Smith 1990). To achieve a short induction time of 3-4 minutes, as recommended by Summerfelt and Smith (1990), a concentration of 60-100 mg/L of MS-222 will be used. This concentration will allow for a recovery time of less than 5 minutes (Summerfelt and Smith 1990), but from previous experience, anesthetized steelhead it will most likely recover in less than 3 minutes. Stress Coat® is a synthetic slime coating that replaces the natural secreted slime that is lost during capture and handing of fish. It will be added to both the anesthetizing and recovery containers at the manufacture recommended concentration of 0.25 ml/L.

Scale loss will be assessed by examining captured fish and estimating scale loss over three zones on each side of the fish. The three zones will be: 1) The caudal zone will include above and below the lateral line from the caudal fin to the posterior end of the dorsal fin, 2) the dorsal zone will include the area anterior of the caudal zone to the operculum and above the lateral line, and 3) the ventral zone that includes the area anterior of the caudal zone to the operculum and below the lateral line (Marine and Gorman 2005). The percentage of scale loss in each zone will be estimated and then weighted by each zone's area proportional to the total area of all six zones. Summing of the resulting weighted scale loss will yield the total area of each fish with scale loss. Any physical injury will be noted and categorized among the fins, skin, eyes, and head. Within each anatomical category, there will be from four to six types of injuries. In general, the scale loss and physical injury methods will follow those of Marine and Gorman (2005) and McNabb et al. (1998). Only one weir trap will be used initially to first determine if there is any significant scale loss or other physical injuries are occurring. If significant scale loss or physical injuries are occurring, and the Robles Biological Committee deems is necessary, then a second trap will be installed and operated the following year upstream of the Robles Facility. If conducted in the future, steelhead will be captured, marked, and released before they enter the Robles Facility and then recaptured in a trap downstream of the facility to determine if the injuries were the result of passage through the facility.

4.0 DOWNSTREAM FISH MIGRATION THROUGH THE ROBLES REACH

The purpose of the downstream migration evaluation is to determine how successfully smolts are migrating through the Robles Reach (NMFS 2003). Because of the limited number of steelhead smolts most likely passing downstream through the facility at this time, a pilot study using radio telemetry is proposed for further evaluations.

During the estimated smolt migration period of mid-March through mid-June, 15 steelhead smolts captured in the weir trap downstream of the Robles Facility will be tagged with radio transmitters and released downstream of the weir trap. Only steelhead smolts that exhibit steelhead smolt characteristics and are in good physical condition (e.g., no significant scale loss) will be tagged. The smolting characteristics include: increased skin reflectance, larger heads, slimmer bodies, longer caudal peduncle, loss of parr marks, and darker margin of the dorsal fin Beeman et al 1995; Haner et al. 1995; Ando et al. 2005). These characteristics have been used in southern California to identify steelhead smolts migrating downstream (Spina et al. 2005). It is anticipated that the smolts will be tagged throughout the migration season so a range of discharges will be encountered by the smolts. The radio transmitters used for the study will be manufactured by Advanced Telemetry Systems (ATS) and have transmitter radio frequencies ranging from 149.000 to 150.999 MHz and a pulse rate of 30 per minute and a pulse width of 18 ms. Each tag will have a unique radio frequency so that individual fish can be tracked during their downstream migration. The transmitters will weigh 0.85 g and have an expected operational life of about 48 days. The dimensions of ATS tags (model number F1435) will be 14 mm long and have a diameter of 7 mm. The ratio of tag weight to steelhead weight in the air will be less than 5%, which will ensure that physiological stress will be minimized (Jepsen et al. 2001) and swimming performance will not be altered (Brown et al. 1999). Based on the expected sizes of captured smolts; estimated from steelhead smolts capture in the Santa Clara River

(ENTRIX 2000), the maximum tag-to-weight ratio will be closer to approximately 3%. The steelhead will be anesthetized with a solution of MS-222 and placed on a Stress Coat® soaked foam pad ventral side up so the tags can be gastrically inserted (Adams et al. 1998). The tag will be gently inserted through the mouth and into the stomach using a ridged small-diameter tube and the tag will be lubricated with food-grade glycerin to prevent abrasion (Adams et al. 1998; Hockersmith et al. 2000). Each tagging procedure is expected to take less than 1 minute from the time a fish is taken out of the water to the time it will be returned. The fish will be allowed to fully recover to assure they are behaving normally before they are released downstream for migration tracking; typical recovery occurs in approximately 3 minutes. The estimated time for tagging and recovery are based on previous radio telemetry studies with steelhead smolts (Lewis 2001, 2002, and 2003).

After tagging and recovery, the steelhead will be released downstream of the weir trap. Tagged steelhead will be located on a daily basis as they migrate downstream for the first week after release and then at least weekly until the batteries die. Mobile tracking will be done using an ATS radio telemetry receiver (model R2100) and 3- and 4-element Yagi antennae. Initial broad scanning will be accomplished with the 4-element Yagi mounted to a vehicle driven on roads near the Ventura River. Once a general location of a tagged steelhead has been found, final location will be determined on foot with the 3-element Yagi. This method will yield locations of $\pm$ 10 m (Lewis 2001). If access to a detectable tagged smolt is very difficult, triangulation may also be used to estimate location. All determined locations will be recorded on a map and datasheet. At least once during their downstream migration, a subsample of tagged steelhead will be tracked on a 24-hour basis to determine diel behavior. This additional tracking will be done at a time when the greatest number of tagged steelhead are migrating in the Robles and lower Ventura River reaches. The actual number will depend on initial smolt tagging frequency during the migration period and smolt migration rate. This will be done by relocating as many tagged steelhead as possible on a continuous basis for a 24-hour period. If a tagged steelhead appears to have stopped migrating for more than a week, an attempt will be made to locate the tagged fish by snorkeling in the general area of the transmitter. Every reasonable effort will be made to determine the ultimate final location of each radio tagged steelhead and if any mortality occurs, the cause of the mortality will be determined if possible. It is estimated, that at the most, one tag will be lost due to regurgitation during the study period; Hockersmith et al. (2000) measured a short-term regurgitation rate of 1.3% using the gastric method, Adams et al. (1998) measured a regurgitation rate of 4.2%, and Jepson et al. (2001) measured a 5.0% regurgitation rate.

Using the method of radio telemetry to monitor migration through the Robles Reach will provide more usable information while using fewer fish to gather that information; compared to using an additional trap at the downstream end of the Robles Reach. It is estimated that no more than one steelhead mortality will occur using this method and this initial sample size. Hockersmith et al. (2000) measured a mortality rate of 2.4% using the gastric method. Gastric implanted fish also have similar survival rates, overall health, and similar physiological stress as fish with surgically implanted radio or PIT tags (Adams et al. 1998; Hockersmith et al. 2000; Jepsen et al. 2001). When the number of fish to be handled is a concern, such as with an endangered species, the method of radio telemetry can be a useful method over others like extensive trapping (Hockersmith et al. 2000). Telemetry migration information of steelhead smolts in the Ventura River would allow for the determination of survival, travel time and rates through select reaches, migration relative to river discharge, habitat use, and passage success through critical riffles. By tracking the fish until the batteries die, it is anticipated that downstream migration can be monitored all the way to the Ventura River estuary/lagoon, which could provide important data on estuary rearing.

5.0 LONG-TERM MONITORING COMPONENTS

5.1 *Monitor Robles Facility Operations*

To document that the Robles Diversion Dam and Fish Passage Facility are operated as outlined in the BO (NMFS 2003), data will be collected using built-in automated sensory equipment for the Robles forebay elevation, diversion flow, fish ladder flow, auxiliary water flow, and spill flow.

5.2 *Fish Passage Monitoring*

Upstream and downstream migrating fish will be monitored through the Robles Fish Facility using a Vaki Riverwatcher® (Riverwatcher). The Riverwatcher will be operated in the fish bypass channel, which is located between the fish ladder and the fish screens. The Riverwatcher consists of two scanner plates with light diodes that send infrared light beams through the water to the corresponding receiver plate. When a fish swims through the infrared light beams, it breaks the light signal and a silhouette of the fish will be recorded on a computer. In addition, the scanner triggers an underwater camera to record a 10 second video clip (25 frames/sec). Presently, only fish swimming upstream can be recorded in the Riverwatcher system because the camera is on the upstream side of the scanner and it was only designed for one camera. An additional camera was added in 2008 so that downstream fish can be captured on video. This camera is independent of the Riverwatcher and has to be reviewed separately for downstream detections and was very time consuming. The operation of this camera will continue to be improved during 2009. Other data recorded when the scanner is triggered will be: date and time, length of the fish (from a length/height ratio), swimming speed (m/sec), and direction of the fish movement (upstream or downstream). The scanner will be positioned in the center of an aluminum frame covered with 1/2 inch aluminum bars, spaced 1 1/2 inches on center resulting in 1 inch spacing between the bars, which funnels the fish and directs them to swim through the scanner. The Riverwatcher will be operated during the entire flow augmentation season as long as sufficient water elevations in the fish bypass are present and also that debris and turbidity are low enough so that the crowder will not be damaged and the Riverwatcher will function.

Calibration data will be collected throughout the 2009 season to improve the detection and estimation of fish passing through the facility. This will entail determining the upper detection limit of the Riverwatcher in relation to water turbidity. This will be done using a continuous turbidity probe installed in the fish bypass to record ambient turbidity levels that will then be used to determine the detection limits of the Riverwatcher and the video recording system. A comparison of the length and number of fish captured in the weir trap to fish detected passing downstream through the Riverwatcher would also be done to improve fish length estimation of downstream migrating fish. This comparison would also help to determine the detection efficiency of the Riverwatcher for downstream migrating smolts.

6.0 ADDITIONAL MONITORING STUDIES

6.1 *Oncorhynchus mykiss Presence/Absence Surveys*

In addition to the fish attraction monitoring, *O. mykiss* presence/absence surveys will be conducted in the Ventura River mainstem between the Robles Facility and the Ventura River mouth. Surveys will also be conducted upstream of the Robles Facility in Matilija Creek, North Fork Matilija Creek, and San Antonio Creek. These additional sites will be surveyed using both bank and snorkeling methods (depending on water conditions and expected life history stage) but will be conducted primarily after storm events for adults and during March through June for smolts. A total of 13 sites will be monitored and both pool and riffle habitat at each site will be included. These additional surveys will be done in an attempt to determine whether adult steelhead are entering the Ventura River, migrating upstream and to what locations, where they may be holding on their upstream migration, and if they are successfully passing through the Robles Facility. During the fall before significant winter rain occurs, the estuary/lagoon will be snorkel surveyed monthly, if conditions allow, from October through December to determine if any juveniles have moved downstream to use the potential rearing before migrating to the ocean.

The sites will initially be selected based on easy of access, coverage of basin, and presumed chance of detecting *O. mykiss*. However, after all habitat surveys have been completed, site selection will be based on quantitative measurements that will identify high-quality habitats that may be used for *O. mykiss* juvenile rearing and adult holding.

6.2 *Adult Spawning Surveys*

6.2.1 *Index Spawning Surveys*

Spawning surveys will be conducted using two different methods throughout the Ventura Basin that is accessible to adult steelhead. The first method will be to survey 15 spawning index sites subjectively selected with small to medium size gravel that are suitable for steelhead spawning (Shapovalov and Taft 1954; Orcutt et al. 1961). During 2008, the location of spawning index sites selected were initially distributed broadly within the basin to capture general spawning locations and timing. These same sites will be used in 2009 and better sites added if observed. This initial information will be used to establish long-term index sites to capture population trends. The spawning surveys will be conducted biweekly from January through June and observations will be made at sites to identify and count *O. mykiss* redds; redds will be identified by typical characteristics (Orcutt et al. 1961; Chapman 1988). Once a redd has been identified, physical measurements will be collected to characterize it, similar to Zimmerman and Reeves (2000). Redd length and width will be measured from the upstream end of the pit to the downstream end of the tailspill and width will be measured at the widest point at between the pit and tailspill (Figure 2). Water depth will be measured at four locations: in the pit, on the side of the pit, upstream of the pit, and at the tailspill. Water velocity at the side and upstream of the pit will be measured at 60% of the depth. The predominate surface substrate size adjacent to the redd and on the tailspill will be estimated for all redds observed. All side measurements will be taken on the thalweg side of the redd. The surface substrate size will be estimated from gravel samples that randomly measure the first 30 substrate diameters at the surface. Photos and GPS locations will also be recorded for all redds identified. This information will help determine steelhead spawning habitat selection characteristics. The sites selected for the spawning surveys will initially be determined subjectively, but after all habitat surveys have been completed, sites with the highest potential for spawning will be selected as future index sites.

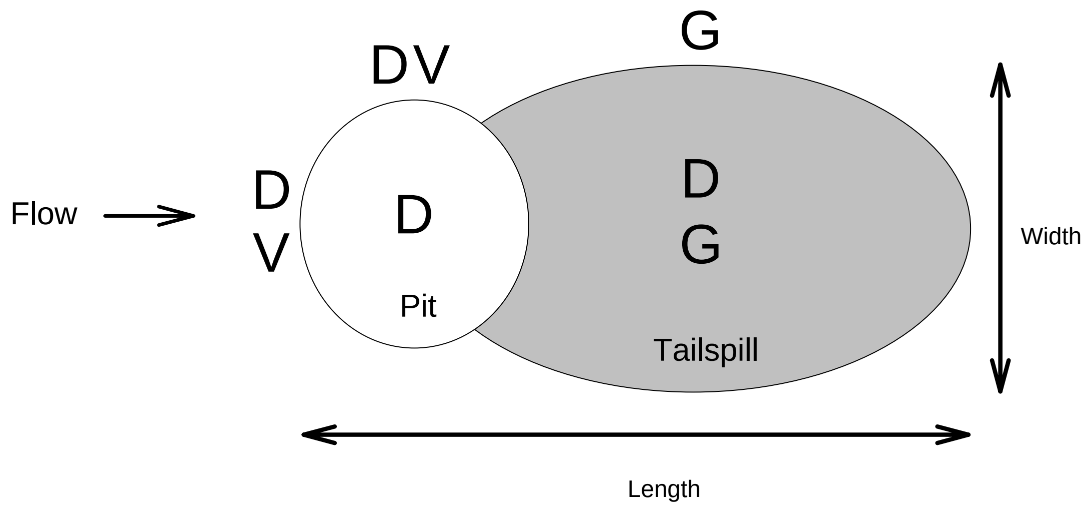

Figure 2. Diagram of measurements to be collect on all identified *O. mykiss* redds. (D) = locations of depth measurements, (V) = location of water velocity measurements, and (G) = location of gravel substrate sampling.

6.2.2 *Statistical Spawning Surveys*

The additional spawning survey methodology will be a stratified random sampling of the available habitat to steelhead (Gallagher and Gallagher 2005). This method will be more time consuming, but it will allow the total adult spawning population to be estimated. No estimate of the adult spawning population has been calculated for Ventura River steelhead. Therefore, conducting baseline population estimation is important to assessing this core population (Boughton et al. 2007). This adult survey will help determine spatial and temporal spawning distributions, general locations of suitable spawning areas, and further determine microhabitat selection criteria such as water depth, water velocity, and gravel selection.

The areas of the watershed that are currently accessible to the anadromous form of *O. mykiss* will be stratified into five reaches. The five study reaches will be 1) lower Ventura River from the mouth to the confluence with San Antonio Creek, 2) middle

Ventura River from the confluence with San Antonio Creek to the Robles Diversion, 3) upper Ventura River from the Robles Diversion to the Wheeler Gorge Campground on North Fork Matilija Creek, including Matilija Creek to Matilija Dam, 4) lower San Antonio Creek from the Ventura River to approximatly Fox Creek, and 5) upper San Antonio Creek that would extend upstream to the confluence of Senior and Gridley canyons and the confluence of Thacher and McAndrews creeks. Within each of the five strata, all 0.5 km subreaches will be identified, and from those, nine will be randomly selected for monitoring. Each 0.5 km sub-reach will be surveyed every two weeks from January 1st through May 31st. Observations at each site will be made to identify and count steelhead redds; redds will be identified by typical characteristics (Orcutt et al. 1961; Chapman 1988). Once a redd has been identified, physical measurements will be collected as described before. Each observed redd will be ranked according to its visibility according to being: a new redd, obvious and still measurable but not new, no longer measurable but still identifiable, no longer apparent, or test redd (Garrison 2002; Gallagher and Gallagher 2005). Total population estimates will be calculated by multiplying the mean density of redds in the selected 0.5 km sub-reaches of each strata and then summing for all five strata (Gallagher and Gallagher 2005). Dry reaches will be surveyed after a rain event and as soon as the turbidity is low enough to identify any potential redds.

6.3 *Underwater Video Monitoring*

A pilot study of an underwater video monitoring system will be conducted to determine if remote monitoring for adults or smolts is feasible within the Ventura River or tributaries. The monitoring system would be placed at selected locations when water conditions are suitable to record fish rearing, holding, or migrating. The system will consist of an underwater video camera attached to a VCR to record for 6-8 hours at a time. The system will be powered by a 12 volt DC battery so the system could be placed anywhere within the basin. The video tapes would be reviewed to determine presence or absence and relative numbers of steelhead, if present. If this pilot study is successful, it may be expanded and developed into a more quantitative monitoring tool.

6.4 *Ambient Water Quality Monitoring*

In order to fully evaluate several aspects of the monitoring and evaluation program, water quality data will be collected throughout the Ventura River basin (Table 2). Water temperatures will be recorded at 12 locations throughout the Ventura River basin. The locations will include the Ventura River mouth and mainstem, Coyote Creek, San Antonio Creek, North Fork Matilija Creek, and Matilija Creek upstream and downstream of Matilija Dam. The recorders will record at 30-min intervals. Monthly grab samples will also be collected at the same locations with a multiprobe that will record: dissolved oxygen, pH, conductivity, salinity, TDS, and temperature. A monthly water quality profile will also be collected in the estuary/lagoon. The profile will be collected at approximately the mid-point of the estuary/lagoon and will have at least four depths recorded. A continuous turbidity probe will also be installed in the Robles Facility fish bypass near the Riverwatcher. It will record water turbidity at 1-hr intervals when the bypass is operational. Turbidity measurements will also be collected at several sites upstream, downstream, and within the Robles Facility to ensure the continuous probe is located in a position that will be representative of the turbidity in the Ventura River. All locations will be monitored if sufficient water is present.

6.5 *Photographic Index Sites*

Photographic index sites will be established throughout the Ventura River basin to monitor general changes of the stream channel morphology, water conditions, and riparian zones. There will be a total of 14 sites where an upstream and downstream photo will be taken (Table 3). The sites will be re-visited twice per year, during March and September.

Table 2. Water quality monitoring sites and sampling summary.

Site Number	Site Description	Site Location[a]	Sampling Method[b]	Sampling Type[c]	Frequency
1	Estuary	V 0.3 km	Multiparameter	Grab profile	Monthly
2	Main St. Bridge	V 1.0 km	Temperature Multiparameter	Continuous Grab	30 min Monthly
3	Foster Park	V 9.7 km	Temperature Multiparameter	Continuous Grab	30 min Monthly
4	Santa Ana Blvd Bridge	V 15.5 km	Temperature Multiparameter	Continuous Grab	30 min Monthly
5	Hwy 150 Bridge	V 18.7 km	Temperature Multiparameter	Continuous Grab	30 min Monthly
6	Robles Dam	V 23.5 km	Temperature Multiparameter Turbidity	Continuous Grab Continuous	30 min Monthly Hourly
7	North Fork Matilija	N 1.3 km	Temperature Multiparameter	Continuous Grab	30 min Monthly
8	Below Matilija Dam	M 1.0 km	Temperature Multiparameter	Continuous Grab	30 min Monthly
9	Above Matilija Dam	M 2.1 km	Temperature Multiparameter	Continuous Grab	30 min Monthly
10	Middle Matilija	M 8.5 km	Temperature Multiparameter	Continuous Grab	30 min Monthly
11	Lower San Antonio	S 0.3 km	Temperature Multiparameter	Continuous Grab	30 min Monthly
12	Middle San Antonio	S 9.5 km	Temperature Multiparameter	Continuous Grab	30 min Monthly
13	Lower Coyote	C 0.4 km	Temperature Multiparameter	Continuous Grab	30 min Monthly

[a]Site location is identified by the river system and kilometers from its confluence. C = Coyote Creek, M = Matilija Creek, N = North Fork Matilija Creek, S = San Antonio Creek, V = Ventura River.

[b]Temperature data will be collected using programmable loggers. Multiparameter water quality probe will collect water quality data including: temperature, dissolved oxygen, conductivity, salinity, pH, turbidity (separate meter). Turbidity data will be collected using a programmable logger.

[c]Continuous samples will be collected at the identified frequency. Grab samples are collected once at the identified frequency. Grab profile samples are collected once at the identified frequency at 0.5 m intervals from surface to bottom.

Table 3. Photographic monitoring sites within the Ventura River basin.

Site Number	Site Description	Site Location[a]	Photo Direction	Frequency
1	Train bridge in estuary, east bank	V 0.3 km	Downstream	Biannual
2	Train bridge in estuary, west bank	V 0.3 km	Upstream Downstream	Biannual
3	Main Street Bridge	V 1.0 km	Upstream Downstream	Biannual
4	Shell Road Bridge	V 5.2 km	Upstream Downstream	Biannual
5	Casitas Vista Road Bridge (Foster Park)	V 9.7 km	Upstream Downstream	Biannual
6	Santa Ana Boulevard Bridge	V 15.5 km	Upstream Downstream	Biannual
7	Highway 150 Bridge	V 18.7 km	Upstream Downstream	Biannual
8	Robles Diversion/Fish Passage Facility	V 23.5 km	Downstream	Biannual
9	Camino Cielo Road Bridge	V 25.7 km	Upstream Downstream	Biannual
10	Highway 33 Bridge at NF Matilija USGS Gauging Station	N 1.3 km	Upstream Downstream	Biannual
11	End of North Matilija Road	M 8.5 km	Upstream Downstream	Biannual
12	Highway 33 Bridge near Old Creek Road	S 0.3 km	Upstream Downstream	Biannual
13	Creek Road near Creek Lane	S 9.5 km	Upstream Downstream	Biannual
14	Santa Ana Road Bridge	C 0.4 km	Upstream Downstream	Biannual

[a]Site location is identified by the river system and kilometers from its confluence. C = Coyote Creek, M = Matilija Creek, N = North Fork Matilija Creek, S = San Antonio Creek, V = Ventura River.

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