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Analysis of Restoration Options for Cañada de Santa Anita
Santa Barbara County, California

Group Project Proposal
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1.0 ABSTRACT

The southern California steelhead (*Oncorhynchus mykiss*) is listed as endangered by the National Marine Fisheries Service (NMFS). Barriers to upstream migration are currently the primary limitation on access to riverine habitat for the southern steelhead. Cañada de Santa Anita is situated on Hollister Ranch, which is located on the Gaviota coast in Santa Barbara County, California. The Hollister Ranch Conservancy has designated steelhead restoration as a top priority, in conjunction with the protection of other endangered and threatened species such as the California red-legged frog and tidewater goby. Cañada de Santa Anita contains a dam, estimated to be 20 to 25 feet high, that prevents upstream migration of southern steelhead. An understanding of possible dam removal options, in addition to the physical, chemical, and biological habitat characteristics of the creek, is necessary for a successful restoration plan. Furthermore, other engineered and regulatory barriers need to be assessed, given their potential to influence the restoration process. Various options exist for the restoration of Cañada de Santa Anita and this project aims to analyze these scenarios. It is our hope that these restoration options, if implemented, will result in a healthy, self-sustaining stream and riparian habitat that will encourage steelhead population growth within southern California.

2.0 EXECUTIVE SUMMARY

The federally endangered southern California steelhead (*Oncorhynchus mykiss*) currently face threats that jeopardize the viability of sustainable population levels (F&WS, 1997). Among these, obstacles that impede upstream migration to spawning habitat pose the most significant limitation (Stoecker et al., 2002). Hollister Ranch and its Conservancy, located on the Gaviota coast, have designated steelhead restoration as a priority. In addition, protecting other endangered and threatened species, such as the California red-legged frog and tidewater goby has also been identified for conservation purposes (Draft Conservation and Restoration Plan for the Hollister Ranch, 2006). Cañada de Santa Anita, located on Hollister Ranch, is identified as having potential for steelhead recovery due to limited anthropogenic development in its watershed (Stoecker et al., 2002). However, a dam on the creek, estimated to be about 20 to 25 feet high, prevents upstream migration of steelhead. Various options exist for the restoration of southern steelhead in Cañada de Santa Anita and this project aims to analyze these scenarios.

Southern California steelhead, as an anadromous species, spend time both in marine and freshwater environments. They require sufficient levels of dissolved oxygen and streamflow and gravels of 0.2 to 4.0 inches in diameter for spawning (Bovee, 1978; Reiser and Bjornn, 1979; as cited in McEwan and Jackson, 1996). Southern steelhead prosper from habitat that has overhanging banks, instream vegetation and boulders that obstruct flow for rest and cover (Stoecker, 2002).

The California red-legged frog, another threatened species historically observed along Cañada de Santa Anita, requires breeding and non-breeding aquatic habitat, as well as upland and dispersal habitat (F&WS, 2005a). The frogs' habitat consists of dense riparian vegetation associated with deep, still or slow-moving water, which allows for food consumption, reproduction and refuge (Hayes and Jennings, 1988, as cited in F&WS 1996). In addition, the tidewater goby, an endangered species inhabiting Cañada de Santa Anita estuary, requires still to slow-moving aquatic habitat, sand and silt for burrows and reproduction, submerged vegetation for protection from predators and sandbars along the mouth of the estuary to reduce wave energy and to facilitate stable salinity levels (F&WS, 2006a).

The dam on Cañada de Santa Anita and the sediment that it impounds pose a barrier to southern steelhead upstream migration. However, simple dam removal could damage estuarine habitat, and the species that inhabit the estuary through sediment erosion, transport, and deposition (Pizzuto, 2002). In order to minimize the effects of dam removal, sediment may be stabilized in place with vegetation or hard surfaces (Harbor, Kanehl, as cited by Pizzuto, 2002), exported off the site with heavy equipment (NOAA, 2007), or carried off naturally by letting the creek transport the impounded fill (Pizzuto, 2002). Moreover, dam removal can take place all at once or gradually over time (Pizzuto, 2002). Worthy examples of dam removal projects considering similar sediment management options include the nearby Matilija Dam and Washington State Elwa Dam (NOAA, 2007).

In this project, we seek 1) to identify physical and biological conditions that constitute favorable stream and riparian habitat for endangered and threatened species in and along Cañada de Santa Anita, 2) to understand the factors that limit the creek's current state as productive habitat and 3) to evaluate options for restoration that encourage native biodiversity along Cañada de Santa Anita. These steps will be completed by gathering background information, conducting a field analysis at Cañada de Santa Anita, synthesizing our findings, and creating a list of restoration options specific to Hollister Ranch but also transferable to other local creeks. It is our hope that these restoration options, if implemented, will result in a healthy, self-sustaining stream and riparian habitat that will encourage steelhead population growth within southern California.

3.0 PROJECT OBJECTIVES

3.1 Problem

The southern California steelhead (*Oncorhynchus mykiss*) was listed as endangered by the National Marine Fisheries Service (NMFS) in 1997 and 2006. Barriers to upstream migration currently block their access to potential habitat in small streams draining the Santa Ynez Mountains to the Santa Barbara Channel. Cañada de Santa Anita, located on Hollister Ranch (the Ranch), may offer habitat opportunities for southern steelhead, but their migration is presently obstructed by engineered barriers. Also, physical, chemical, and biological characteristics may influence the prospect of steelhead usage of the creek. Furthermore, regulatory barriers may prevent restoration efforts from occurring. Despite these obstacles, the Hollister Ranch Conservancy (the Conservancy) has identified steelhead restoration as a priority. In addition to its potential as steelhead habitat, Cañada de Santa Anita may also support habitat for several other threatened and endangered species, a fact that could impact restoration efforts.

3.2 Research Questions

The Group Project will address the following specific questions:

1) What are the physical and biological conditions that constitute favorable stream and riparian habitat for steelhead, tidewater goby, and red-legged frogs that are reported to inhabit Cañada de Santa Anita?
2) What factors impair the creek's current state as productive habitat?

3) What management and restoration options are viable to encourage native biodiversity along Cañada de Santa Anita?

3.3 Purpose

To assess, evaluate, and propose feasible restoration options for Cañada de Santa Anita that, if implemented, would result in a healthy, self-sustaining stream and riparian habitat, and encourage anadromous steelhead in the stream.

4.0 PROJECT SIGNIFICANCE

4.1 Significance to Society

This project will focus on the restoration and sustainability of channel habitat along a small stream. Rather than focusing on the needs of only one species, this analysis will place an emphasis on protecting biodiversity. Southern steelhead are a component of this restoration project because they are an important indicator species for the health and habitat of coastal freshwater streams and are tied to other species within the food web. By offering options for the restoration of steelhead habitat in Cañada de Santa Anita, our project will contribute to the protection of a species upon whose existence society is beginning to place value. Restoration of the creek to enhance steelhead production is likely to have collateral benefits for other aquatic and riparian species. Moreover, other private landowners may apply the same methods and guidelines used in this project as a template for their own restoration efforts.

4.2 Significance to Science

This project will merge physical, chemical, biological, and economic understanding as well as regulatory policy into one restoration effort. By systematically detailing specific requirements for each component of the restoration project, the final product will link seemingly unrelated issues and result in a comprehensive analysis. Moreover, the final analysis will not only be relevant to Cañada de Santa Anita, but will also have the potential for transfer to other creeks with similar riparian and stream characteristics and anthropogenic barriers to fish migration.

The technical community involved in restoration will benefit from this project because dam removal studies are limited in number and scope. This study, especially with an interdisciplinary focus, will provide further insight into the proper ways to cost effectively remove large obstacles from a creek while achieving restoration goals. Likewise, this project plans to address the effects of restoration over time, by encouraging simple forms of post-restoration monitoring to document project successes and failures for use within an adaptive management framework.

4.3 Significance to the Hollister Ranch Conservancy

The Conservancy represents a community of landowners committed to the conservation of Gaviota coast natural resources as indicated by its Covenants, Conditions and Restrictions. The restoration of steelhead and other threatened and endangered species is one of the primary objectives of the Conservancy. This project will lay a framework from which our client can address stream restoration projects. The information gained through this study will identify the restoration options for Cañada de Santa Anita and contribute to the overall Hollister Ranch Watershed Management Plan. At the same time, this project will promote stewardship through restoration among private property owners and further improve the working relationship between Hollister Ranch, the community of Santa Barbara, and state and local oversight agencies.

5.0 BACKGROUND

5.1 Hollister Ranch

Cañada de Santa Anita is located on the historic Hollister Ranch along the rugged Gaviota coast of California. The Ranch's unique geographic location encompasses the convergence of northern and southern California ecosystems and provides a diverse mixing of flora and fauna, including habitat for many endangered and threatened species (Hollister Ranch Conservancy, May 5, 2007). These diverse native habitats remain relatively intact because of the Ranch's large 14,500 acre size, remote location, and strict development rules outlined in the Covenants, Conditions, and Restrictions, which are structured to preserve the natural environment (Ward, 2004). The Ranch was subdivided in the early 1970s with intentions to create a new type of development that preserved a 200 year tradition of cattle ranching as well as the unspoiled character of the land. The Ranch is one of the largest natural areas remaining along southern California's coast and is recognized to be critical for the preservation of ecological communities now rare in the rest of California (Ward, 2004).

The Conservancy operates under a charter of the Hollister Ranch Owners Association, with the purpose to protect and enhance the natural environment. The stated goals of the Conservancy are to study, manage, and conserve the Ranch's environment while providing access programs for scientific and educational purposes (Draft Conservation and Restoration Plan for the Hollister Ranch, 2006). In January 2006, the Hollister Ranch Owners Association asked the Conservancy to develop a comprehensive plan for conservation and restoration of the Ranch's natural environment (Draft Conservation and Restoration Plan for the Hollister Ranch, 2006). Of the many potential projects, steelhead restoration was recognized as one of the Conservancy's top priorities. Cañada de Santa Anita was identified by the Conservancy as the site with the highest potential for steelhead restoration on the Ranch (Pers. Comm. Anne Coates, April 23, 2007), based on local knowledge and scientific studies (NOAA and Stoecker, 2002).

The 2.58 mile-long riparian corridor of Cañada de Santa Anita holds favorable habitat for southern steelhead, however several engineered barriers prohibit fish passage and prevent migration to middle and upper reaches of the creek (Stoecker, 2002). Previous studies identified these barriers and categorized them by levels of impassability (Stoecker, 2002). These engineered structures include a dam, several culverts, and three Arizona crossings, with the dam completely preventing steelhead migration. Restoring connectivity through the riparian corridor for migrating steelhead is the stated goal of the Conservancy. However, removing the barriers—particularly the dam—presents significant engineering, biological, physical, and regulatory challenges that need to be clarified.

5.2 Southern Steelhead Trout

5.2.1 *Background*

Steelhead are of the Salmonidae family with a North America coastal range running from Alaska to Baja, Mexico. However, the current population distribution of steelhead is much smaller than historical levels. Currently, known spawning populations in California are found from Smith

River near the Oregon border, to Malibu Creek, near Los Angeles. Steelhead are anadromous fish, that is, they live most of their lives in the ocean but migrate back to freshwater streams for spawning (McEwan and Jackson, 1996). Much research and technical data have been compiled on the steelhead; however, most is focused on northern populations. Literature is limited on the ecological requirements of the southern California steelhead. To contrast the two regions: the northern steelhead rivers are generally large and may be glacial fed, are usually perennial, and often are hundreds of miles long. Southern streams can be spring fed, much warmer, intermittent in stretches, and frequently only a few miles long. Due to the specific ecological requirements and behaviors of the southern steelhead, it is currently the most endangered steelhead population in the state and likely in all of North America (Stoecker, 2002).

While inland and anadromous trout are the same species in California, resident *O. mykiss* are generally referred to as rainbow trout and anadromous life forms are referred to as steelhead (Federal Registrar no. 53 03-19-1998). Often the two forms exist in the same stream system. Yet they are separated from each other by an impassible migration barrier such as a waterfall or manmade structure (NMFS, 1996).

The Southern California Steelhead Recovery Coalition calls the southern steelhead the most charismatic of fish because of its strength, size and steel-blue coloring, valued for its beauty and speed. Healthy runs of steelhead reflect healthy rivers and streams. Although not considered a "keystone species," it is considered an important watershed "indicator species" because steelhead inhabit entire river ecosystems and require clean, cool, well oxygenated water year round (Finney and Edmonston, N.D.).

5.2.2 *Lifecycle, Migration, & Spawning*

Steelhead usually spend one to two years feeding and growing in the ocean before migrating to their natal stream to spawn for the first time (Shapovalov and Taft, 1954). Some proportion of returning steelhead may also stray into non-natal streams in response to variable climate conditions and/or human-related activities. Additionally, steelhead can spawn more than once, although usually only the female spawns more than twice (Stoecker, 2002). Steelhead generally migrate upstream when streamflows rise during winter storms and after sandbars across streams are breached (Shapovalov and Taft, 1954). Depending on rainfall and streamflow, spawning usually takes place from December through April. After finding their way upstream—usually close to headwaters to find cooler waters—females will hollow out a depression in the gravel called a redd. The male simultaneously defends the redd from intruders and fertilizes the eggs. The female then covers them with a shallow layer of gravel for protection (Shapovalov and Taft, 1954). The duration and success of egg incubation is highly variable and depends largely on factors including water temperature, dissolved oxygen concentration, the risk of scour by high flows, predation, and suspended sediment deposition (Stoecker, 2002).

Roughly four weeks after the eggs hatch, the young fry leave the gravel nest and school together along the protected areas of the bank. As the fry grow, the schools break up and individuals move into riffle areas and become territorial. As growth continues, they move into the deeper runs and pools where they live for a year or more. Smolting takes place, which allows them to migrate from freshwater into the ocean where they feed and gain most of their growth, and obtain the blue-back coloration from which their name is derived (NMFS, 1996).

5.2.3 *Desired Habitat*

According to the NMFS, the habitat needs of southern steelhead are critically important and complex (NMFS, 2006). "Spawning gravels must be [between] 0.2 to 4 inches and free of sediment to allow successful incubation of the eggs. Eggs [and alevins] also require cool, clean, well oxygenated waters for proper development. Juveniles need abundant food sources, including insects, crustaceans, and other small fish. They need places to hide from predators (mostly birds and bigger fish), such as under logs, root wads and boulders in the stream, and beneath overhanging vegetation. They also need places to seek refuge from periodic high flows (side channels and off channel areas) and from warm summer water temperatures (coldwater springs and deep pools). Returning adults … also require cool water and places to rest and hide from predators. During all life stages steelhead require cool water that is free of contaminants."

5.2.3.a *Water Parameters (Depth, Temperature, Dissolved Oxygen, Flow)*

- Sufficient depth for: overcoming barriers, clearing passageways to and from estuaries, and 6 to 36 inches for spawning (Bovee, 1978; as cited in Stoecker, 2005)
- Temperatures of 0 to 28 degrees Celsius
- Dissolved oxygen (DO) concentrations of around 80% of saturation. Concentrations of less than 7.2 milligrams per liter (mg/L) can cause total mortality (Reiser and Bjornn, 1979; as cited in Stoecker, 2005)
- Water movement between 0.5 and 3.5 feet per second

5.2.3.b *Channel characteristics (Gravels, Banks, Debris, Shade, Pools and Riffles)*

- Gravels of 0.2 to 4.0 inches in diameter for spawning, with less than 5% sand and silt (Bovee, 1978; Reiser and Bjornn, 1979; as cited in McEwan and Jackson, 1996)
- Undercut banks and instream riparian vegetation for temperature regulation and security
- Boulders or woody debris to break current for rest and cover
- Pools, runs, and riffles are all desirable for different stages of development and capture of prey (Stoecker, 2002)

5.2.4 *Food Sources*

Steelhead fry feed primarily on benthic macroinvertebrates, such as zooplankton. As growth and development continue juveniles and adults tend toward aquatic and terrestrial insects, mollusks, crustaceans, fish eggs, minnows, and other small fish, including trout (NMFS, 2006).

5.2.5 *Endangered Species Status*

The southern California steelhead Distinct Population Segment (DPS) was listed as endangered by the NMFS on August 18, 1997, and its endangered status was reaffirmed on January 5, 2006. A DPS, which is comparable to the Evolutionary Significant Unit (ESU), is a population that is primarily isolated in reproduction and also represents the evolutionary legacy of the species (Di Silvestro, 1997). Of all 15 population segments of steelhead, the only species listed with the highest risk of extinction as "endangered" is the southern steelhead. The southern steelhead DPS extends from the Santa Maria River in San Luis Obispo County, California to the U.S.-Mexico Border (NOAA, 2007). The southern steelhead DPS habitat consists of four major rivers systems, including the Santa Maria, Santa Ynez, Ventura, and Santa Clara Rivers. National Oceanic Atmospheric Administration (NOAA) assigned southern steelhead with a Recovery Priority Number of three. This ranking indicates that they face a high magnitude of threat, moderate recovery potential, conflict with future anthropogenic development and disturbance, and population extirpation through their historical range (NOAA, 2007).

5.2.6 *Population History*

Historical (pre-1960) runs of southern steelhead populations are estimated to have been 32,000 to 46,000 individuals along the southern California coast (Carpinteria Watershed Plan, 2005). Currently, southern steelhead populations, including both anadromous and landlocked fish, do not exceed more than 200 individuals (F&WS, 1997). Therefore, less than 1% of the southern steelhead historical population currently exists (Stoecker et al., 2002). During the twentieth century, 23 indigenous, naturally reproducing steelhead populations were lost in California and 43 current stocks experience moderate to high level risks of extinction (Di Silvestro, 1997). Such a dramatic decrease in population increases the threat of extinction due to unstable dynamics of demographic and genetic variability in small populations (F&WS, 1997). The extensive loss of steelhead populations can be attributed to urbanization, channelization of rivers and creeks, wetland loss, grazing, forestry, invasive species and agricultural runoff. However, the greatest threat to steelhead success is barriers to fish migration along creeks, which prevent access to prime spawning and rearing habitat in the upstream habitat (Stoecker et al., 2002).

5.2.7 *Threats to Survival*

The U.S. Fish and Wildlife Service (F&WS) categorizes southern steelhead threats into the following broad categories.

1. Present or Threatened Destruction, Modification, or Curtailment of its Habitat or Range
    - Agriculture and urbanization have degraded and fragmented ideal steelhead habitat (F&WS, 1997)
    - Sedimentation from land use activities has degraded steelhead habitat (F&WS, 1997)
2. Over-utilization for Commercial, Recreational, Scientific, or Educational Purposes
    - Due to the dependence of steelhead on naturally variable precipitation rates and streamflow, recreational activities may severely impact steelhead populations during times of naturally low water availability (F&WS, 1997)
3. Disease or Predation
    - Steelhead are subjected to many bacterial, protozoan, viral, and parasitic organisms throughout their life-cycle which are enhanced by stress during migration (F&WS, 1998)
    - Although steelhead and marine mammals have coexisted for a significant amount of time, an increase in hatchery salmonids has caused an increase in these predator populations in river systems. This increase in predators, although noticeable, is not a major cause of the large declines in west coast steelhead populations (F&WS, 1997)
    - Freshwater fish and avian species prey upon juvenile salmonids and may reduce localized steelhead populations (F&WS, 1998)

In Cañada de Santa Anita, the possible factors that may negatively impact southern steelhead include:

- The dam that prevents upstream migration to suitable spawning habitat
- The culverts along the stream making fish passage inaccessible

- Potential low levels of dissolved oxygen
- Potential high water temperature
- Insufficient amounts of gravel for spawning
- Potential excessive nutrients
- Potential lack of healthy benthic macroinvertebrate community
- Susceptibility to sedimentation
- Potential high concentrations of metals

5.2.8 *Conservation and Management Considerations*

In order to achieve a successful restoration of southern steelhead in Cañada de Santa Anita, more information must be analyzed than just an assessment of habitat. Other factors, including the presence of dams and a complete instream life-cycle understanding of the fish are crucial for constructing a comprehensive restoration plan (Good, 2003). Also, the restoration plan must note that certain habitat requirements are specific to the southern steelhead DPS. For example, southern steelhead depend more strongly on rainfall and streamflow than northern populations, given that southern California receives less precipitation than the northern areas (F&WS, 1997).

5.3 The Dam

5.3.1 *Barrier*

A dam with an estimated height of 20 to 25 feet, poses the most significant impediment to steelhead migration within Cañada de Santa Anita. Though the dam does not significantly influence the water discharge, it cannot be surmounted by fish. Since the dam was installed, an attempt was made to notch a “fish-ladder” up the dam’s face, but it does not serve its intended purpose. This failure is due to low flow, narrow steps, lack of step-pools of sufficient depth, insufficient height of the ladder, and reeds growing within the steps making passage impossible (field observations and personal communications with Orrin Sage, April 27, 2007). Due to the height of the dam face, no other option is present for steelhead to traverse this obstacle.

5.3.2 *History*

Construction of the dam was completed in 1975 for aesthetic purposes. After its construction, two El Niño events (1978 and 1983) filled it with sediment. As a result, an artificially low gradient has replaced a portion of the previously existing channel. Since then, it no longer serves its intended purpose (personal communication Kim Kimbell, April 27, 2007). The impounded material within this reach predominantly consists of fine sediments (silt, clay, and fine sand) that otherwise may have been transported through the estuary (field observations, April 27, 2007).

5.3.3 *Management Considerations*

The Ranch is considering steelhead restoration efforts on Cañada de Santa Anita, therefore removing or making adjustments to the dam is a necessary consideration. However, it is important to understand the different methods available and to evaluate dam removal options in order to optimize the creek’s physical and biological functions. Though there are many cases where dam removal has taken place, the effects have rarely been studied. Furthermore, examples of dam removal effects in an environment that resembles Cañada de Santa Anita’s, including climate, precipitation patterns, and ecological conditions, are non-existent. Potential future examples, such as the recent Horse Canyon Dam removal in the Sisquoc watershed of Santa

Barbara County, and proposed removal of Matilija Dam (NOAA, 2007) on Matilija Creek and the Rindge Dam on Malibu Creek (Heinz Center, 2002) may someday provide useful examples of management concerns associated with dam removal. Until then, most expectations are based on general fluvial geomorphology and hydrology studies that are applied to post-dam removal conditions (Heinz Center, 2002 and Pizzuto, 2002). Below is an analysis of the current understanding regarding potential effects of removing a dam, similar to the one on Cañada de Santa Anita.

5.4 Impounded Sediment Management

5.4.1 *Background*

Of the many challenges related to dam removal, sediment erosion, transport, and deposition are likely to present the greatest threat to the intended biological and physical functions of the creek. Any dam removal option will affect the existing extent and nature of the impounded sediments. In addition, mobilized sediment transported downstream will further affect the nature of downstream morphology and creek processes (Pizzuto, 2002). Where the sediment deposits and in what sort of landform is a concern that requires understanding prior to making management decisions. Fine sediments will increase turbidity downstream, and eventually may deposit in the creek, estuary, or coastal areas where they may be transported further by ocean currents. Coarse sediments also may be mobilized from the impounded sediments, but they are likely to travel shorter distances (Heinz Center, 2002).

5.4.2 *Stabilization*

Options for controlling impounded sediment include partially stabilizing in place with vegetation, hard surfaces, and/or re-grading surfaces. Such methods may reduce the extent and rate of erosion (Harbor, Kanehl, as cited by Pizzuto, 2002). Vegetation binds soil through its roots and helps to resist erosion. In addition, the stems and leaf structures add hydraulic roughness to channel margins and floodplains. This roughness decreases flow velocities over the surface of the bank material thereby further reducing erosion. By leaving areas of large, dense vegetation in place and encouraging plant growth, restoration efforts stabilize material that would otherwise be eroded. In addition, canopy cover and woody debris habitat can also be gained from riparian vegetation.

Grading the sediment to match an anticipated channel width, gradient, bank height, and floodplain is another option that can affect erosion rates (Harbor, Kanehl, as cited by Pizzuto 2002). Unfortunately, predicting channel morphology is likely to be quite difficult. Prediction methods often include using existing channel dimensions from undisturbed portions of the stream or pre-dam aerial photos as a guide. However, the sediment within the impounded area is often different in type or composition and may have different riparian vegetation from the other reaches of the stream (Egan, Egan and Pizzuto, as cited by Pizzuto, 2002).

5.4.3 *Export*

Another option includes removing the sediment from the site. Removal methods might include using heavy equipment, such as trucks and excavators, or piping it as a slurry to be stored and/or used elsewhere. Such methods are known to be much more expensive than the other options presented here (NOAA, 2007). However, potential for the sediment to do unacceptable habitat damage can make this option the safest alternative. For example, if the sediment is contaminated such that it would negate the restoration potential for critical species, this option should be seriously considered. Additionally, if the material could be used as a cheap engineered fill source for local construction this method may prove to be an economically viable alternative (Smith, Wilcox, Egan and Pizzuto, as cited by Pizzuto, 2002).

5.4.4 *Post-Dam Removal Erosion Effects*

The third sediment management option involves letting the creek incise its channel and transport the impounded fill. This could be done in increments by notching the dam down over time or removing the dam all at once. In comparison with the other options, incremental lowering of the dam would allow a reduced sediment erosion rate over a relatively long period of time to disperse the impounded sediment.

Possible geomorphic outcomes resulting from erosion of upstream impounded sediment and its downstream deposition are numerous (Pizzuto, 2002). However, literature has described two distinct processes of erosion of a sediment slug. A dispersion transport model is generally accepted to describe how such a slug would be removed with time. This model suggests that the removal of particles via streamflow occurs at a greater rate than accumulation, thereby decreasing the mass of the slug with time (Lisle 1997, 2001, as cited by Pizzuto, 2002). A study supported this model by observing the erosion of a landslide dam with time in a stream in California (Ball as cited by Pizzuto, 2002). Another model describes slug erosion by translation. In this model, the slug migrates downstream without change in peak. Management decisions will depend on which of these two methods occurs. Translation could severely impact downstream habitats, creek system morphology, and/or engineered structures; however, the duration of the impact might be shorter if the slug passes quicker than the lingering effects of dispersion processes. Dispersion impacts should decrease in severity with time, but effects will last longer since the fine sediments will erode at a slower rate (Pizzuto, 2002).

5.4.4.a *Upstream*

Upstream from the dam, the channel is expected to incise into the accumulated fine fill material, assuming erosion occurs at a faster rate than deposition within the impounded area (i.e. no landslides or other mass wasting events occur upstream during this time). Research in the region has shown that over time incision of this sediment will eventually result in development of a channel that most of the time can transport much more sediment than will be supplied to it from the watershed. As a result, the channel bed will often be floored with bedrock and some patches of gravel and cobbles. The initial stages of this process involve down-cutting beginning at the leading steepened edge of sediment (known as the knick point) nearest the dam location. This knick point then migrates upstream. As the banks become over-steepened, channel bank erosion occurs leading to channel widening (Doyle, as cited by Pizzuto 2002). Conditions observed along local streams in Santa Barbara County display evidence of limited fine and granular material especially within the steeper reaches. Eventually we would expect that as the fine impounded sediment erodes, the channel will become bedded with cobble to boulder sized material. The rates at which these processes occur are difficult to predict because of the inter-annual variability of flows in local creeks. However, the rate is expected to depend on the type of sediment, its cohesiveness and saturation, and physical processes related to channel shape and flood magnitude, duration, and frequency.

5.4.4.b *Downstream*

"Because the volume of sediment supplied by channel incision will vary with time and because channel responses to changes in sediment supply are time dependent, the morphology and sediment character of the channel downstream will be highly transient (Simon, as cited by Pizzuto, 2002)." Similar to upstream conditions, as the sediment upstream is eroded and transported downstream we can expect a return to conditions that existed prior to dam construction. Once again though, inter-annual climatic variability will prevent a steady state equilibrium from developing in this highly transient environment. However, short term (years to decades) risks do exist and include:

- increased sediment and turbidity
- burial of coarse materials by fine materials in the channel
- aggradation of the channel bed
- widening of the channel
- dispersion versus translation of sediment (Pizzuto 2002)
- impacts to downstream culverts

5.4.4.c *Contamination*

Sediment or water accumulating behind dams has the potential to affect water quality both during impoundment and after breaching. This effect is caused by an alteration in the hydraulic behavior that changes the physical and chemical processes within the water and saturated sediment. More common changes include reduced DO. Shallow, slow moving water, with greater exposure to sunlight, increases in temperature. The increased temperature causes DO concentration to decrease. In addition, the stored water undergoes changes in other dissolved gas concentrations, water temperature, acidity, and reduction-oxidation (redox) potential and increased nutrient, heavy metal, and other contaminant concentrations in water and saturated sediment (Kelley, 2004). When water is stored behind a dam, dissolved and transported constituents settle out and are stored within the impounded sediment. When the dam is removed, these contaminated sediments are transported downstream in greater concentrations than they would have been otherwise. This results in a general decline in water quality that may negatively impact the desired outcome of a restoration effort (Petts, as cited by Heinz Center, 2002). However, it is not yet clear the degree to which these effects are problematic in Cañada de Santa Anita, and we will make observations to clarify them.

5.4.4.d *Coastal Effects*

The final destination of Cañada de Santa Anita is the Santa Barbara Channel. In the short term, dam removal activities will increase sediment that is transported to the coast. Upon reaching the ocean, the sediments' fate must be understood so as to prevent unintended consequences to marine habitat. Silt and clay particles will not settle in high energy environments such as beaches. As a result, they are carried further offshore by currents where eventually these sediments settle on the deep seafloor. Mudbelts occur offshore and in these areas fine sediments eventually settle. Most sand-sized sediment will remain in the coastal zone, and gradually be moved alongshore by currents in a process known as littoral drift. Sand along the coast of Santa Barbara County is generally transported via littoral cells from the north to the south. The source of Santa Barbara's sand is predominantly from watersheds that drain to the coast (99% or 2,167,000 $yards^3$/year, Patsch and Griggs, 2006). The remaining sands are believed to originate from eroding beach bluffs. However, Patsch and Griggs (2006) has estimated that anthropogenic reductions in sand supply to the Santa Barbara littoral cell are 41% (1,476,000 yards^3/year) from rivers and 19% (3,000 yards^3/year, Patsch and Griggs, 2006) from bluff erosion. The majority of the material transported by littoral drift is supplied to the cell during episodic events such as high surf conditions and high stream discharge events. El Niño events can provide approximately three to five times the sediment of an average year (Inman and Jenkins, as cited by Patsch and Griggs, 2006). Rates of littoral drift range from about 100,000 to 1,000,000 yards^3 per year along the California coast. Santa Barbara cell's sink is located at Magu Submarine Canyon off Oxnard and Malibu (Patsch and Griggs, 2006).

5.4.5 *Stream Functions*

Dam removals restore interconnectivity of the riparian corridor and stream system. By allowing the water and sediment to move downstream unimpeded, a gradient develops that will remove fine sediment and allow further transport of larger sized sediments such as gravels and cobbles (Heinz Center, 2002). Since the range between the highest and lowest flows is drastic on Cañada de Santa Anita, the creek channel is inundated during large storm events and their associated flash floods. This results in flushing fine grained, and to a lesser extent, larger grained materials further downstream (Heinz Center, 2002). During sedimentation of the reservoir sediment size may follow a specific distribution pattern. Most notably, coarse sediments (i.e. gravel, cobbles, and boulders) settle close to where they enter the reservoir (Heinz Center, 2002). Such coarse materials are useful in creek morphology. It has been demonstrated that during channel forming discharges, constrictions, such as those created by large boulders, aid in creating pool habitat (Harrison and Keller, 2003). Such pools may accumulate gravel beds and form an important habitat for steelhead (communications with Ed Keller, Ph.D., April 25, 2007).

5.4.6 *Management Questions*

Dam removal raises important management questions regarding the fate and quality of the sediments stored behind the dam. Such questions include:

- What is the volume of sediment presently impounded by the dam?
- How much of the impounded sediment will remain in place, and how much will be eroded?
- Will the majority of impounded sediments be washed away by the creek after the dam is removed?
    - If so, at what rate?
    - How many El Nino cycles will it take?
- How would further mass wasting within the drainage impact this erosion rate?
- Are there any contaminants in the sediment that will negatively impact restoration efforts for species of concern?
- What impacts will the eroded sediment have on downstream critical species and habitat, and infrastructure?

5.5 Additional Threatened and Endangered Species

Restoration efforts on Cañada de Santa Anita, especially removal of the dam, may affect threatened and endangered species other than the southern steelhead. The lagoon and estuary located at the mouth of Cañada de Santa Anita were recently identified as critical habitat for the endangered tidewater goby (*Eucyclogobius newberryi*) by the F&WS (2006a). While Cañada de Santa Anita was not specifically listed as critical habitat for the threatened California red-legged frog (*Rana aurora draytonii*), the creek is located between two officially designated California red-legged frog habitats (F&WS 2006b). We hope to determine to what extent restorative efforts aimed at improving southern steelhead habitat within the Cañada de Santa Anita watershed will affect the tidewater goby and California red-legged frog, as well as suggest restoration options that will meet agency requirements regarding these species.

5.5.1 *California Red-Legged Frog*

The California red-legged frog is one of two distinct subspecies of the red-legged frog (*Rana aurora*) found on the Pacific coast. The frog gains its name from the typically red or pink color of its posterior abdomen and hind legs and is suspected to be the species described by Mark Twain in 'The Celebrated Jumping Frog of Calaveras County.' It is brown to reddish brown and is the largest native frog in the western United States (U.S. Fish and Wildlife, 2005a).

5.5.1.a *Regulatory Status*

The California red-legged frog was listed as threatened within its remaining range by the F&WS in 1996. According to the Santa Barbara Museum of Natural History, the frog is present and breeds regularly at the Ranch, although it is rarely seen (Collins, 2005). While the Cañada de Santa Anita watershed is not located within designated critical habitat, it is between two officially designated units, Jalama Creek and Gaviota Creek. As such, the California red-legged frog habitat provided by Cañada de Santa Anita and its watershed may still be important for the recovery of the species, as explained by F&WS (2006b), "Critical habitat designations do not signal that habitat outside the designation is unimportant or may not be required for recovery."

5.5.1.b *Population Range*

The California red-legged frog was heavily exploited commercially for food causing it to become severely depleted by the turn of the century (Hayes & Jennings, as cited in Jennings & Hayes, 1995). The frog has sustained a 70 percent reduction in its geographic range in California as a result of several factors acting singly or in combination (Jennings et al.,1992, as cited in F&WS, 1996). The central coast region of California, especially Monterey, San Luis Obispo, and Santa Barbara Counties, supports the greatest number of occupied drainages (F&WS, 1996).

5.5.1.c *Habitat*

The California red-legged frog is endemic to California and Baja California, Mexico at elevations ranging from sea level to approximately 5,000 feet (F&WS, 2005a). The frog occupies both aquatic and riparian environments (Hayes and Jennings 1988, Jennings 1988b, as cited in F&WS,1996). Adults require dense, shrubby or emergent riparian vegetation closely associated with deep (> 2.2 feet) still or slow moving water (Hayes and Jennings, 1988, as cited in F&WS, 1996). Riparian vegetation that is structurally most suitable for the California red-legged frog includes the arroyo willow (*Salix lasiolepis*), cattails (*Typha* sp.), and bulrushes (*Scirpus* sp.) (Jennings, 1988b, as cited in Jennings and Hayes, 1995). Within the riparian corridor, well vegetated terrestrial areas provide important sheltering habitat during the winter (Jennings and Hayes, 1994b, as cited in F&WS , 1996). Habitat for the California red-legged frog consists of aquatic and riparian areas within the range of the species and, in the dry season, can include non-riparian landscape features within 200 feet of riparian areas which provide moisture and cover (F&WS, 2005a).

In accordance with the habitat requirements listed above, the F&WS (2005a) identified four Primary Constituent Elements (PCEs), or known physical and biological features that are essential to the conservation of the frog:

1. Aquatic breeding habitat: standing bodies of freshwater with salinities less than 7.0 parts per thousand (ppt) that typically become inundated during winter rains and hold water for a minimum of 15 weeks in all but the driest of years
2. Non-breeding aquatic habitat: freshwater habitats which may or may not hold water long enough for the species to hatch and complete its aquatic life cycle, but do provide for shelter, foraging, predator avoidance, and aquatic dispersal habitat for adults and juveniles. Non-breeding habitat allows the frogs to survive periods of drought
3. Upland habitat: areas within 200 feet of surrounding aquatic and wetland habitat or no further than the watershed boundary, comprised of various vegetational series which provide for shelter, shade, moisture, cooler temperatures, prey base, foraging opportunities and predator avoidance. The frogs often disperse from their breeding habitat to forage and when aquatic habitat is unavailable. They have been observed to be unconstrained by topographic constraints, except for vertical rock faces, scaling slopes up to 77% (Bulger, Scott, & Seymour, 2003)
4. Dispersal habitat: accessible areas located within the boundaries of the watershed between occupied habitats (maximum distance between habitats = 0.7 miles) that allow for movement between habitats and do not contain barriers to dispersal such as heavily traveled roads

Aquatic breeding habitat includes low gradient natural and manmade fresh water ponds, slow moving (roughly 0.1 feet per second) streams or pools within streams, and other ephemeral or permanent water bodies. Non-breeding aquatic habitat includes all aquatic breeding habitat and plunge pools within intermittent creeks, seeps, and springs of sufficient flow to withstand the summer dry period. Upland habitat consists of natural or manmade structures including, spaces under boulders, rocks, and organic debris. It also includes agricultural features and light construction debris including drains, watering troughs, abandoned sheds, stacks of hay, and brush piles. Finally, dispersal habitat includes various natural and altered habitats, including agricultural fields, which are used for migration between breeding habitats and non-breeding habitats, as well as for movement and establishment of home ranges by juvenile recruits (F&WS 2005a).

5.5.1.d *Threats*

Habitat loss and alteration are the primary factors that have negatively affected the California red-legged frog throughout its range. A large amount of the frog’s habitat now exists in the form of isolated patches along stream courses. Populations isolated in habitat fragments are vulnerable to extinction through stochastic environmental events or anthropogenic impacts (F&WS, 1996). Several factors continue to threaten the existence of the California red-legged frog.

- Present or potential destruction, modification, or curtailment of its habitat or range including, but not limited to, wetland alterations, clearing of aquatic vegetation, water diversions, roadway construction, stream channelization, large reservoir construction, activities that result in excess siltation in the stream, disturbance of the riparian zone by feral pigs, and off-road vehicle use

- Continued harvest for food
- Introduced predators including the bullfrog, red swamp crayfish (*Procambarus clarkia*), signal crayfish (*Pacifastacus leniusculus*), and several species of fish including bass, catfish (*Ictalurus spp.*), sunfish, and mosquitofish
- Inadequacy of existing regulatory mechanisms
- Natural factors including drought, wildfires, and extensive flooding

5.5.1.e *Conservation and Management Considerations*

When attempting to manage existing California red-legged frog populations, emphasis needs to be placed on retaining the dense riparian vegetation associated with deep water habitats used by the species. Water quality standards and natural flow regimes of sites need to be maintained. Furthermore, impacts such as additional withdrawals of surface and groundwater that modify existing flow regimes or can change water quality should be avoided (Jennings & Hayes, 1995). Judicious application of terrestrial buffer zones adjacent to small ponds and streams may often be an effective means of protecting and maintaining populations of California red-legged frogs (Bulger, Scott, and Seymour, 2003).

The F&WS recently changed its position on the threat potential of livestock grazing and stock pond development. It now officially recognizes that stock pond and small reservoir impoundments can provide suitable breeding habitat for the frog and that now, in many areas, the presence of the frog is due solely to the existence of these small pond habitats. It also recognizes that managed livestock grazing at low to moderate levels has a neutral or beneficial effect on California red-legged frog habitat. This effect occurs because managed grazing can facilitate an appropriate mix of open water habitat and emergent vegetation for the frog. The F&WS (2005a) also recognizes that unmanaged livestock grazing can pose a threat to the California red-legged frog when it leads to channel down cutting, lowered water tables, loss of plunge pools, and higher water temperatures due to a loss of vegetative cover.

Finally, research by Rathbun and Schneider (2001) suggests that California red-legged frogs translocated away from an area that is going to be restored may demonstrate homing instincts that repeatedly bring them back to their original pond with potentially serious consequences including death. This homing problem might be reduced in the Mediterranean climate of coastal California by moving the frogs during the dry summer months that coincide with the non-breeding season. Resource managers need to be aware that simply moving an individual animal from one place to another does not necessarily mean that it has been successfully “saved.” This misconception is especially the case if the action results in its death or a compromised population.

5.5.2 ***Tidewater Goby***

5.5.2.a *Regulatory Status*

The tidewater goby is a small (rarely exceeding 2 inches), grey-brown, benthic fish that is found primarily in waters of coastal lagoons, estuaries, and marshes (Swift, 1989). The goby was listed as endangered throughout its entire range by the F&WS in 1994 and is considered a Species of Special Concern (SSC) in the state of California (Moyle, Yoshiyama, Williams, &

Wikramanayake, 1995). It was confirmed that the goby occupied Cañada de Santa Anita estuary in 1989, 1994, and 2006 (Swift, Nelson, Maslow, & Stein 1989, F&WS 2006a).

5.5.2.b *Historical and Current Population Range*

The tidewater goby is endemic to California (F&WS 2005b). Although the extent of the goby's range has not changed much over time, its overall population has become patchy and fragmented along the coast. Of the 134 localities in which the tidewater goby has been documented to occur, 23 (17%) are considered extirpated, or have experienced local extinction, and 55 to 70 (41-52%) are naturally so small or have been so degraded over time that long term persistence is uncertain (F&WS 2005b).

5.5.2.c *Habitat*

Tidewater goby habitat is restricted to low-salinity waters in California's coastal wetlands (Moyle et. al 1995). Lagoons, estuaries, backwater marshes, and freshwater tributaries inhabited by the goby are subject to considerable fluctuations on a seasonal and annual basis as a result of inter-annual climatic variability and the seasonal opening and closing of lagoon or estuary mouths. In coastal areas of Santa Barbara County where the topography is steep and precipitation is relatively low, the habitats occupied by tidewater gobies may be a few acres in size and only extend a few hundred feet inland from the ocean (F&WS, 2006a). Tidewater gobies primarily feed on small animals including mysid shrimp, gamarid amphipods, ostracods, and aquatic insects, especially chironomid midge larvae (Swift et. al, 2006a), but they have been observed to have food requirements adaptable to a variety of habitats (Swenson & McCray, as cited in Swenson, 1999).

Six different phylogeographic groups of tidewater gobies have been identified (Dawson et. al 2002, as cited in F&WS, 2006a). Local populations of tidewater gobies are best characterized as a metapopulation. These populations are often separated from one another by the open ocean and/or extensive tracts of unsuitable habitat. Some populations experience intermittent extirpations due to climatic events including floods and droughts, while other populations persist on a continual basis. Extirpated habitats have been recolonized by extant source populations located within 6 miles of extirpated habitats (Lafferty, Swift, & Ambrose, 1999). These recolonization events suggest that tidewater goby populations exhibit metapopulation dynamics where some populations remain viable through recolonization events and the continuous exchange of individuals (F&WS, 2006a).

In its revised critical habitat plan for the tidewater goby, F&WS (2006a) identified four PCEs:

1. Persistent, shallow (ranging from 0.3 to 6.4 feet), still-to-slow moving, aquatic habitat approximately ranging in salinity from 0.5 to 12 ppt, which provides adequate space for population growth
2. Substrates, including sand, silt, and mud, suitable for the construction of burrows and reproduction
3. Submerged and emergent aquatic vegetation that provides protection from predators, such as *Potamogeton pectinatus* and *Ruppia maritime*
4. Presence of sandbars across the mouth of a lagoon or estuary during the late spring, summer, and fall that close or partially close, thereby providing relatively stable water and salinity levels

All four PCEs occur in the canyon through which Cañada de Santa Anita flows. However, at any particular time the precise location of PCE numbers 1 through 3 may change due to seasonal fluctuations in precipitation and tidal inundation. Because Cañada de Santa Anita contains all four PCEs, it is important to the conservation of the tidewater goby. As such, it allows for connectivity between source populations, supporting gene flow and metapopulation dynamics within the region (F&WS 2006a).

5.5.2.d *Threats*

Despite the fact that tidewater gobies are found in many lagoons and estuaries along the California coast, their potential for extinction is considerable due to the small size and relative isolation of individual populations and the continued anthropogenic alteration of coastal habitats. Ten primary threats have been identified for the tidewater goby species by the F&WS (2006a).

- Coastal development projects that result in the loss or alteration of coastal wetland habitat including: interruption of sediment flow by upstream barriers, anthropogenic breaching of lagoons and estuaries during the dry season, and stream diversions
- Water diversions and alterations of flows upstream of coastal lagoons and estuaries that negatively impact the species' breeding and foraging activities
- Groundwater over drafting
- Channelization of rivers
- Discharge of agricultural and sewage effluents
- Cattle grazing and feral pig activity that increases sedimentation of coastal lagoons and riparian habitats, removal of vegetative cover, increased ambient water temperatures, and elimination of plunge pools and undercut banks
- Introduced species that prey on the tidewater goby
- Inadequacy of existing regulatory mechanisms
- Drought conditions that result in the deterioration of coastal and riparian habitats;
- Competition with introduced species such as the yellowfin goby (*Acanthogobius flavimanus*) and chameleon goby (*Tridentiger trigonocephalus*)

5.5.2.e *Conservation and Management Considerations*

The tidewater goby holds several characteristics that favor its recovery. These include its euryhaline tolerances, rapid reproductive rate, and opportunistic feeding behavior. Conservation efforts should focus on protecting coastal marshes, estuaries, and lagoons, maintaining the natural flow regimes and sediment transport of coastal creeks, preventing artificial breaching of creek mouths (especially during the summer and fall when there is little freshwater inflow), and preventing the introduction of predatory fishes (Swenson, 1999).

Tidewater gobies have been successfully reintroduced into the wild following both captive breeding and translocation. Reintroduction can serve as a recovery tool, provided that reintroduced populations come from nearby locations in order to reconstitute the original genetic form as closely as possible (Swenson, 1999). Flooding may be an important natural cause for recolonization among tidewater goby populations. While studies have shown that tidewater goby populations can persist during extreme flood events, the recolonization of lagoons and estuaries previously uninhabited by tidewater gobies has also been documented to occur directly after large floods. It is hypothesized that tidewater gobies are flushed into the littoral zone during high streamflow events where they are carried to new habitats by longshore currents (Lafferty, Swift, & Ambrose, 1999).

6.0 APPROACH

In our efforts to propose feasible restoration options for Cañada de Santa Anita that will result in a healthy, self-sustaining stream and riparian habitat that would especially favor southern steelhead, we will utilize a four-step analytical process.

1. Gather background information from peer reviewed articles, technical reports, consultant reports, agency issued reports and protocols, and interviews with outside experts
2. Conduct a field-based analysis of habitat conditions and physical characteristics of Cañada de Santa Anita.
3. Synthesize our findings
4. Analyze restoration options

An explanation of each step is provided below:

1. Gather background information

   Gathering background information will help us answer our first research question—What physical and biological conditions constitute favorable stream and riparian habitat for steelhead and several other species that are reported to inhabit Cañada de Santa Anita?—and provide a better understanding of the regulatory umbrella under which our project falls. The primary information essential to our project can be classified into three main categories: physical, biological, and regulatory. The physical category is tied to Cañada de Santa Anita's hydrological and geomorphological features and processes, with a large emphasis on dam removal, channel morphology, and sediment management. The biological category focuses primarily on the habitat needs of the threatened and endangered species that inhabit the creek, including the southern steelhead, tidewater goby, and the California red-legged frog. The primary components of the regulatory category are the county, state, and federal agencies that protect threatened and endangered species and define how the restoration process must be conducted. Research for this component will identify the requirements of agencies responsible for restoration permitting, as well as any potential regulatory hurdles that may exist. We will obtain information through a review of the relevant literature, interviews with external advisors and other experts in the field, and a compilation of pre-existing data on Cañada de Santa Anita that has been created by the Hollister Ranch Conservancy and their consultants.

   Opportunities for interaction with the professional environmental community include:

   - Mauricio Gomez, Community Environmental Council. Aquatic biologist. Extensive steelhead experience and knowledge. Prior knowledge of needs and contact with client
   - Orrin Sage, Sage Associates Agricultural Consultants. Preparing watershed management plan for Hollister ranch. Wide-ranging knowledge of biological and ecological issues
   - Trudy Ingram, Partners in Restoration Program Sustainable Conservation. Works on beneficial permits pathway with private landowners. Prior knowledge of needs and contact with client

- Kim Kimbell, Hollister Ranch Conservancy, Chair. Coastal Ranches Conservancy, Board member. Strong knowledge of local issues regarding restoration and Hollister ranch
- Tom Lockhart, Cachuma Resource Conservation District. Developing a coordinated permit process for small restoration projects conducted mostly on agriculture land in Santa Barbara County. Worked on Carpenteria Watershed Management Plan
- Timothy Robinson, Cachuma Operations and Maintenance Board, Bren School Ph.D. graduate with experience in watershed and land use change
- Mary Root, United States Fish and Wildlife Service. Recommended contact at lead terrestrial regulatory agency
- Matt McGoogan, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. Bren MESM grad. Recommended steelhead contact at lead marine regulatory agency
- Mark Walters, Santa Barbara County Planning and Development Department. Recommended steelhead contact at county regulatory level
- Jeff Phillips, United States Fish and Wildlife Service. Bren MESM grad. Fish and wildlife biologist with special knowledge of the tidewater goby

2. Field-based analysis
   In our field-based analysis we hope to conduct a systematic physical and biological assessment of Cañada de Santa Anita in order to answer our second research question—What factors are impairing the creek's current state as productive habitat? Our level of analysis will include qualitative observations and quantitative surveys and is contingent upon available funding and allowable time. Components of this analysis include:
   - Analysis of the volume and characteristics of impounded sediment behind the dam (hand augering, sieve analysis, chemical analysis)
   - Analysis of barriers and fish passage
     - Fish passage will initially be assessed qualitatively through visual inspection of the creek and its barriers
     - We will conduct a hydraulic analysis of fish passage before and after barrier removal. This analysis may use the following tools, depending on their appropriateness to the situation and their feasibility: FishXing, Manning's equation, HEC-RAS, and Instream Flow Incremental Methodology (IFIM).
   - Physical, biological and chemical assessment of creek habitat
     - Fish count and mapping led by a biologist experienced in snorkel surveys
       - A survey conducted by an experienced biologist will strengthen our final report
       - Possible experienced biologists identified thus far include Tim Robinson and Scott Englblom from the Cachuma Conservation Release Board. Other experienced biologists to be considered will be from UCSB and private/nonprofit sector professionals. Otherwise, a more simple fish count might suffice for this preliminary study
     - Habitat identification and mapping conducted in accordance to the DFG protocol (California Salmonid Habitat Restoration Manuel, 2003)
     - Streamflow measurements will be collected from the downstream end of culverts

- Water quality parameters analysis (DO, temperature, and salinity)
    - These parameters will be collected in the estuary and several pools where steelhead are expected to inhabit
- Channel and barrier surveys for analysis of access under various flow conditions
- Field and aerial photography based stream mapping
    - Vegetation (shade production, native vs. non-native species)
    - Steelhead habitat requirements (pools, runs, riffles, spawning gravel)
- Photo-analysis of the creek corridor
    - Existing areas of endangered infrastructure (undermined roads) to document whether future damages were a result of restoration efforts or would have occurred anyway
    - Dam impounded sediment to note changes in channel and riparian vegetation
    - Creek characteristics (pools, runs, riffles, banks, estuary) to note changes resulting from barrier changes.

During this stage of our project, we will also research the feasibility and potential cost of removing the creek's engineered barriers, as well as potential geotechnical impacts of removal through contractor interviews and analysis of the barriers.

3. Synthesize our findings
   In this step we will compare the results of our field-based analysis to the knowledge we gained during the background information gathering step. Based on this comparison, we will examine options for improving steelhead access to the creek, the amount and condition of habitat that will be available to steelhead once access is reestablished, and the collateral effects on habitat for two other species of concern. In addition, a cost analysis will be performed that will evaluate dam removal options.

4. Analyze restoration options
   Based on our analysis, we will present options to Hollister Ranch Conservancy for the restoration of Cañada de Santa Anita. This analysis may compare barrier removal options and their associated costs, restoration options for steelhead habitat, and expectations about future developments in the creek.

7.0 DELIVERABLES

Our project will provide the following deliverables:

- Final report
- Project brief
- Project poster

The deliverables above will include the following:

- Habitat and species assessment of Cañada de Santa Anita
- Fish passage assessment
- Inventory of barriers
- Barrier removal assessment
- Project oriented GIS data
- Cost analysis of restoration options

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APPENDIX A
MANAGEMENT PLAN

The following management plan was created to better define and organize the group dynamics for the upcoming project. Group members have both shared and individual jobs, with their respective expectations outlined below. The management plan also addresses meeting structure, time management, conflict resolution, archiving information, interactions with clients and external advisors, and expectations of the faculty advisor and students.

Definitions of Shared Jobs

- Each individual in the group will update his or her respective Corporate Time schedules for the purpose of knowing the group members' availability for scheduling meetings.
- Group members are responsible for following the rubric for contacting outside sources and organizing the documented phone calls in its binder and shared directory on the server.

Definitions of Individual Jobs

- *Project Manager – Dakota Corey*
    - Prepares agendas before meetings
    - Keeps minutes during meetings, identifying decisions that were made, the process and reasoning behind conclusions, and "Action Items" for following meetings
    - Keeps meetings on track
    - Keeps track of the long-term picture and group project milestones
    - Maintains position until the end of the quarter
        - Group will vote on whether the project manager position should be switched at end of the spring quarter
- *Web Master – Matthew Meyers*
    - Designs and maintains project website
    - Acts as the interface between group and website viewers
- *Data Manager – Chris Helmer*
    - Manages group directory on (\\babylon\GroupProjects2008\santaanita) and files within
    - Acts as the interface between the group and Bren Compute Team
- *Finance Manager – Brandon Bunderson*
    - Leads budget creation process for the group
    - Tracks and records expenses
    - Provides budget updates
    - Acts as the interface between group and Bren staff on financial matters
- *Scheduler, Client Liaison and Editor – Amy Locke*
    - Schedules all meetings with group members and/or clients
    - Manages Corporate Time
    - Reserves meeting rooms and makes other necessary arrangements
    - Updates client on group project progress
    - Edits writing assignments for cohesion and flow

Meeting Structure

Meeting Schedule

Group members and the faculty advisor will meet for at least one hour on a weekly basis. Meetings without the faculty advisor may also be scheduled, depending on the workload and its relevance to the advisor. Additional meetings will be scheduled as necessary, including meetings with the client and external advisors.

Before Meetings

The Project Manager will send group members an e-mail with the agenda for the upcoming meeting, including topics for discussion and a reminder of individual assigned tasks.

During Meetings

Meetings will include these general topics:

- Updates from each member regarding individual tasks
- Updates on “Action-Items” as necessary
- Assignment of future tasks
- Reminders of long-term deadlines

After Meetings

The Project Manager will e-mail group members the meeting minutes, highlighting “Action-Items.”

System for Time Management and Meeting Deadlines

- Group project members will develop an overall project timeline with deadlines and milestones
- The Scheduler will place project deadlines (and 5-day reminders prior to the deadlines) into group members’ Corporate Time accounts
- The Scheduler will also send e-mails to remind group members and the faculty advisor about upcoming deadlines, as necessary
- Individual group members tasks and deadlines will be determined and tracked at weekly meetings

Conflict Resolution Process

Open communication and honesty will be heavily emphasized during this group project. Members will also be receptive to receiving constructive criticism with the knowledge that group members can work together to create the best product. Whenever possible, decisions will be made by consensus. In the event of a disagreement, a vote will be cast by each individual with the understanding that the majority wins. In terms of a more complicated, socially-based conflict that a simple vote cannot resolve, these steps will be taken:

1. Group members will attempt to talk out contentious matters by themselves and peacefully resolve conflict through discussion.
2. If group members cannot resolve a conflict, the problem at hand will be brought to the attention of the faculty advisor. The faculty advisor will then arbitrate differences among group members. A plan will be created for conflict resolution and recorded for everyone’s reference.

3. If one or more members do not follow the conflict resolution plan, other group members will record detailed accounts of the non-compliance actions.
4. If, after faculty arbitration, the group is still unable to resolve a conflict, the group may seek assistance from the Group Project Coordinator or the Chair of the Group Project Committee, who will consult with the Group Project Committee if appropriate. In addition, the campus ombuds office may be contacted to mediate the situation.
5. If the group has trouble with a member of the group, they must maintain written documentation of the problem. For example, if one member of the group is a "slacker" (not doing his or her share of work or not providing timely products or products of adequate quality), the other group members will document dates of specific incidences, what efforts were made to address the problem, and examples that support the allegation of "slacker". Under these circumstances it is possible for Group Project administrative personnel to intervene and assist in crafting a solution or dispensing a penalty.

In addition, meeting minutes can serve as backup by recording member actions, decisions, disagreements, and deadlines met or unmet. Though this is not the sole purpose of the meeting minutes, these notes will help with conflict resolution and "slackers".

Procedures for Cataloging, Documenting and Archiving Information

The Data Manager will be in charge of maintaining the organization and use of the shared directory (\\babylon\GroupProjects2008\santaanita). Each group member will have access to the shared computer drive and should continue to maintain an organized folder.

Minutes will be e-mailed out and added to the shared directory after each gathering by the Project Manager, for the purpose of detailing issues discussed at weekly meetings and the train of thought that produced decisions. Each group member will carefully review the minutes and add additional comments to the minutes in his or her respective color (Amy Locke – red, Brandon Bunderson – blue, Dakota Corey – orange, Chris Helmer – purple, Matt Meyers – green).

Guidelines for Interactions with Client and External Advisors

This project will involve stakeholders (the Hollister Ranch and its Conservancy, as well as individual parcel owners) who have a considerable interest in the project and the resulting data. There may be confidentiality, proprietary data, legal, intellectual property, and/or political issues that will need to be carefully addressed by the group. Students shall respect the privacy of these stakeholders in a professional manner.

Interacting and networking with the professional community are critical components of the Group Project process. Our group is expected to obtain the counsel of external advisors—individuals from government agencies, industry, non-profits, and private citizens—who may be interested in the project, data, or deliverables. We are responsible for identifying external advisors and maintaining professional contact with them for the duration of the project. In order to ensure confidentiality our group shall get pre-approval from the client in regards to selecting an external advisor. These pre-approvals will be coordinated through Anne Coates, our project contact.

Communications with third parties (e.g. individuals from government agencies, industry, non-profits, and private citizens) shall be pre-approved by the client prior to revealing specific (owner, location) details of the project. Specific contacts provided by the client will be understood to be pre-approved for group communications.

All communications will be documented for these reasons: future reference, quoting, the event that an individual group member is lost, prevention of memory loss, and duplication of work performed. This documentation is an important task that will prevent wasted time and effort and is therefore mandatory. For information gathering communications the group will organize a standard rubric of questions. Group members are responsible for following the rubric for communications and documenting and organizing the communications in the proper binder or directory on the server.

Expectations of Faculty Advisor

Faculty advisors are integral to the success of the group project. However, group members realize that this project is their own and that the faculty advisor has a specific role. These following points outline the expectations of the faculty advisor:

- Attend weekly meeting with group members
- Help keep project in line with its overall vision and keep the project focused
- Provide specific advice on project scope, progress and deliverables
- Edit written group work and provide constructive criticism
- Prepare written evaluations of team members at the end of each quarter

Expectations of Student Group Members

- A hard nosed analysis with a thorough and critical approach
- The project should have an enriching scope of work—contribute to something greater than just Cañada de Santa Anita
- Literature review should not be too long and should be related directly to the primary components of the project
- Group members run the show—Tom’s role is to watch and make sure that we don’t get too astray and offer help when requested

APPENDIX B
MILESTONES

Spring Quarter 2007	
4/1/2007	Primary Research
5/16/2007	Draft Proposal Due
5/24/2007	Final Proposal Due
5/29/2007	Proposal Review, Completed Website Due
6/2/2007	Hollister Ranch Conservancy Funding Proposal Meeting
6/8/2007	Report on Proposal Review Due, Self/Peer Evaluations Due
6/15/2007	Spring Quarter Ends
Summer Quarter 2007	
6/16/2007	Funding Approval Allows For Field Based Analysis
9/26/2007	Data Assimilation For Fall Quarter Synthesis
Fall Quarter 2007	
9/27/2007	Fall Quarter Begins
11/16/2007	Progress Reviews Due
11/30/2007	Project Reports Due, Self/Peer Evaluations Due
12/15/2007	Fall Quarter Ends
Winter Quarter 2008	
1/7/2008	Winter Quarter Begins
2/8/2008	Project Defenses Begin
2/11/2008	Draft Final Report Due
3/3/2008	Submit Information for Group Project Presentation Program
3/17/2008	Final Report Due, Project Brief Due, Submit Self/Peer Evaluations, Submit Faculty Advisor Evaluation.
3/21/2008	Spring Quarter Ends
Spring Quarter 2008	
3/31/2008	Spring Quarter Begins, 1 Week before Presentation Draft PowerPoint Presentation Due, and Poster Submitted to Printer for Production
4/3/2008	Few Days Prior to Presentations Optional Practice and Videotaping of Presentations
4/6/2008	Begin Public Presentations and Poster Display
4/9/2008	Give Poster to the Group Project Coordinator