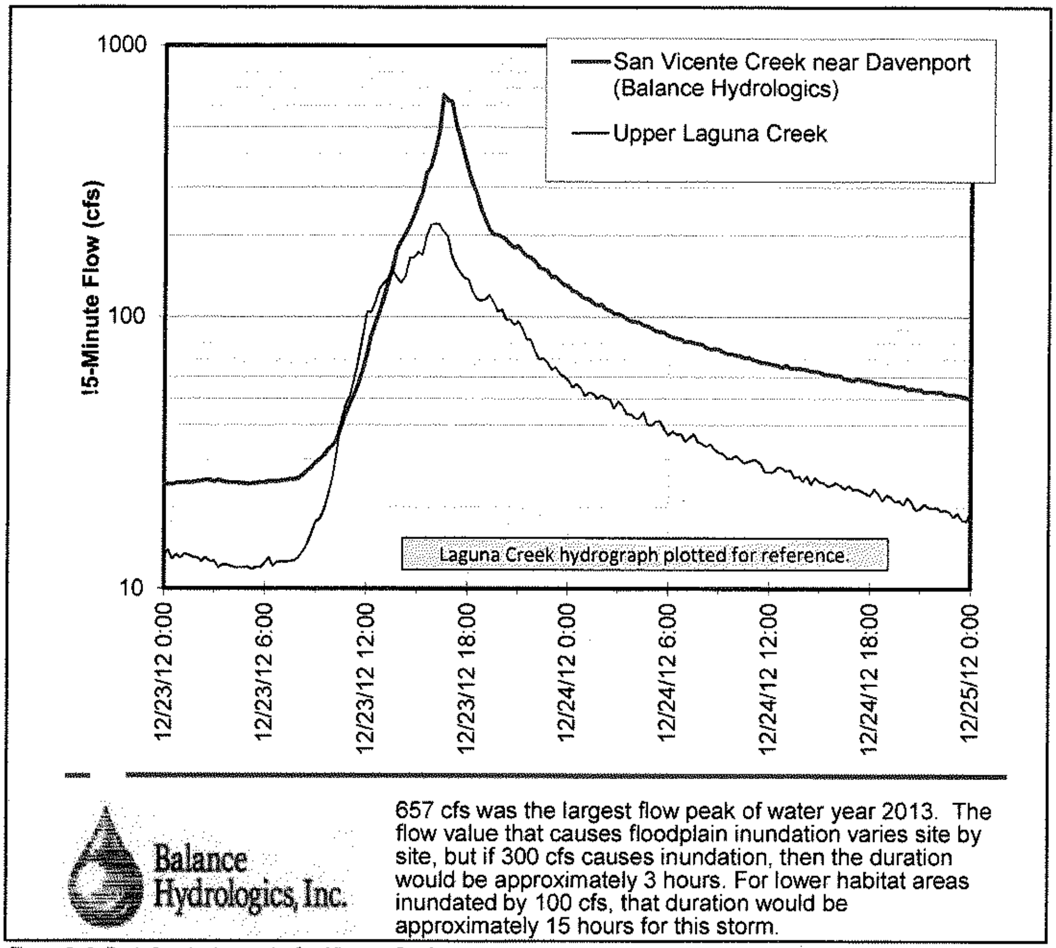


Figure 3-9. Peak flow hydrograph: San Vicente Creek, water year 2013

However because San Vicente is a small and steep watershed, flood durations last only for short periods, so many complex habitat features may best be viewed as short-term high-flow refuge unless they are well connected to the creek at low flow.

Floodplain-to-Creek Connectivity Findings

» Overall, the degree of floodplain connectivity does not seem to be closely associated with specific reaches below Mill Creek; the good and marginal sites occurred only in reaches 2 and 4, although more sites would need to be surveyed to make that a general conclusion. Also, we do not expect that notable floodplains would be present above Mill Creek, in both the San Vicente mainstem and Mill Creek, because of the steep canyon morphology.

» Floodplain connectivity seems to vary quite locally. Some well-connected locations only last for approximately 100 feet or less longitudinally, and can also transition quickly from poorly connected to marginally connected. We did not observe long longitudinal stretches of well-connected floodplain, although we did observe long longitudinal stretches of poorly-connected floodplain.

» Over time, with less human disturbance, we expect floodplain connectivity to gradually (or with occasional large changes during the largest flows) improve site by site as wood jams and floods erode creek banks and form new floodplains. This process can be accelerated with restoration projects that lower floodplains (or raise the creek bed) and increase channel complexity.

» We found a small number of complex floodplain and complex habitat features. Complex floodplains and channels provide more high-flow refuge for fish, as well as more trapping capacity for large wood and sorted patches of sediment. Complex features that connect to the creek or are lower than the rest of the floodplain would have longer periods of inundation and would be more beneficial to fish. Strategically adding large wood (or wood structures) can improve and maintain complex habitat features by focusing high-velocity storm flow to locally scour sediment.

FINDINGS

A. Although the degree of sediment sources in San Vicente Creek are low relative to other Santa Cruz Mountain streams, on-going and planned road-drainage improvements should provide additional reductions of fine sediment to salmonid habitats.

B. Because the quarry appears to function as a sink for upper watershed coarse sediment, and because dynamics of sediment moving through bedrock tunnels in and near the quarry is poorly understood, additional study may be required to better understand sediment dynamics through the quarry, such as repeat surveys of sediment deposits in the quarry, or paired bedload measurements above and below the quarry tunnel over a range of events. However, access to these locations is difficult and may be infeasible during wet conditions.

C. There is potential to reduce fine sediment in the creek system by repairing, stabilizing, and revegetating some of fine sediment sources identified in this study. Steep and remote terrain in may be the most limiting factor for implementing channel restoration or mitigation measures. Alternatively, fine sediment can be address through more passive approaches. This may include restoration elements in downstream reaches that encourage overbank deposition.

D. Introduction of instream wood in Reach 2 seems to be trapping and storing gravel-sized sediment, but the cumulative and long-term effects of introduced wood on reducing fines to downstream reaches is unknown. This approach of adding large wood could be expanded to a larger-scale pilot study to evaluate its effect on reducing fine sediment to the stream.

E. Gravels comprised a range between 15 percent and 46 percent of riffles in San Vicente Creek, which may be considered low-to-moderate abundance for salmonids. Gravel augmentation has been suggested as a possibility for enhancing gravel abundance in San Vicente Creek; however, our assessment cannot conclude whether such efforts are feasible or needed. We suggest that a separate study be undertaken to review the feasibility of gravel augmentation for the lower reaches of San Vicente Creek.

F. Fines less than 8mm comprised between ten and 45 percent of 12 riffles examined at part of this assessment. Coho typically have lower rates of survivability when riffles include 30 percent or more of fines. While only two riffles exceeded 30 percent fines, the average percent of fines approached 25 percent and suggests that fines may be a limiting factor in salmonid spawning habitat. We suggest that a combined effort of fine sediment source reductions and/or floodplain enhancement are undertaken to minimize additional fines.

G. Measurements for embeddedness suggest San Vicente Creek exhibits a moderate level of embeddedness (22 percent across all riffles), but only slightly less than value considered as detrimental by the CDFW (25 percent). We recommend that efforts to reduce fine sediment to San Vicente Creek should be sought to maintain or improve substrate conditions.

H. Floodplain re-activation projects have potential in the four reaches downstream of the Mill Creek confluence. Within those reaches, locations need to be evaluated on a site-specific basis because there is frequent variability over short distance. Avoiding reach 1 may be desired due to the potential for backwatering and resulting sedimentation due to potential clogging of the Highway 1 tunnel during high flows (as occurred during 1998).

I. Because we did not find long stretches of well-connected floodplains, restoration efforts could focus on connecting short sections of well-connected floodplain that are close to each other. This could be designed by creating low-elevation backwater channels instead of- or in addition to- lowering large swathes of floodplain.

J. Improving floodplain connectivity can be performed by lowering the floodplain (such as by mechanical removal of vegetation and soil), or by raising the channel bed of the creek (such as by adding large wood that fully spans the channel). Locations where the floodplain has marginal connectivity should be considered as candidates for raising the bed of the channel with large wood (probably limited to half the diameter of available wood). Projects that use large wood that fully crosses the creek channel will also likely help retain gravel-sized sediment.

K. Because there are limited locations with good creek-to-floodplain connectivity, natural areas of good floodplain-to-creek connectivity (sites 3 and 7) should be used as analogs for designing complex floodplain re-activation projects. These sites have examples of complex habitat features such as low floodplains, backwater channels, undercut banks, and creek wood.

Chapter 4: Fisheries

OBJECTIVES

During a 2003 smolt outmigration study conducted in the lower San Vicente Creek watershed (ESA, 2003), over 1,000 coho salmon smolts were documented migrating to the ocean. However, by the time RCD submitted a grant application for the preparation of the *San Vicente Creek Watershed Restoration Plan for Salmonid Recovery* in early 2011, coho salmon populations throughout the Central California Coast (CCC) Evolutionarily Significant Unit (ESU) of the species had plummeted and it was unclear whether a self-sustaining population of coho salmon remained within the watershed. Consequently, RCD initially proposed to conduct a comprehensive, life-stage based assessment of coho salmon presence and distribution within the watershed, including spawner surveys, juvenile distribution surveys, and smolt outmigration surveys. Shortly after grant application submittal, however, both federal and State fisheries agencies began to direct significant attention and resources toward coho salmon extinction prevention and recovery in this small but productive watershed, initiating a comprehensive broodstock reintroduction and evaluation project, including extensive juvenile distribution and annual spawner surveys. As such, the goal of the fisheries assessment shifted from an independent species presence/absence assessment to collaborative support of ongoing NMFS/NOAA and CDFW efforts.

The three main objectives of the fisheries assessment were to: a) collect smolt outmigration data related to population size and composition, while also collecting comparative data on survival of different broodstock release life stages as part of long-term research being conducted by NOAA's Southwest Fisheries Science Center (SWFSC); (b) conduct spawner surveys to determine adult spawning locations and abundances; and (c) conduct juvenile distribution surveys to identify primary rearing reaches and associated habitat elements within the watershed. To address these objectives, CDFW staff conducted spawner surveys during the 2011/2012 and 2012/2013 spawning seasons; SWFSC staff began conducting frequent snorkel and electrofishing surveys in 2011 in support of strategic releases of different life stages of broodstock coho salmon; and RCD staff, in collaboration with SWFSC staff, conducted a smolt outmigration study during the spring of 2013. In addition, CDFW staff conducted a detailed habitat typing effort in 2010.

The purpose of these assessments was to begin answering a number of questions regarding coho salmon and steelhead utilization of the watershed, and to identify potential limiting factors to salmonid survival and productivity. It should be noted, however, that assessments conducted under this grant project are part of a larger long-term study, and answers to some of these questions will not be available for some time.

» Where within the watershed do adult salmonids spawn? Are suitable spawning sites limiting salmonid populations? Do wild (i.e., non-broodstock) coho salmon adults still return to spawn in San Vicente Creek?

» Where within the watershed do juvenile salmonids rear? Are suitable rearing sites limiting salmonid populations? What are the survival and productivity rates of different life stages of broodstock coho salmon releases?

» What are the rates of juvenile-to-smolt survival in San Vicente Creek? What is the condition of outmigrating smolts?

This report summarizes the findings to date of these collaborative efforts. In conjunction with the findings and recommendations of the hydrology, geomorphology, large woody debris, and invasive species assessments conducted under this grant, the findings of the various fisheries assessments represent our current understanding of salmonid population and habitat conditions in the San Vicente Creek watershed and will help guide future habitat restoration and species recovery efforts.

INTRODUCTION

San Vicente Creek is a small, third order coastal stream in northern Santa Cruz County, California, supporting coho salmon (*Oncorhynchus kisutsch*) and steelhead (*Oncorhynchus mykiss*). Its headwaters are located at an elevation of approximately 2,600 feet and its main stem flows for about 9.3 miles before emptying into the Pacific Ocean just south of the town of Davenport. The 11.1 square mile watershed also includes 11.3 miles of tributary streams, the most significant of which is Mill Creek (CDFG, 1998). San Vicente Creek does not have a lagoon because the mouth of the creek was diverted through a 245-foot long manmade bedrock tunnel when railroad tracks were constructed over the creek in 1906 (ESA, 2001) and the presumably historic lagoon was filled in by the railroad grade. Approximately 65 feet upstream of the bedrock bore, the creek passes through a 142-foot long concrete box culvert underneath Highway 1. Depending on tidal elevations, the creek exits the tunnel either on the north side of San Vicente Beach or directly into the Pacific Ocean. Due to the lack of a sandbar, adult coho salmon and steelhead migration into the watershed is never blocked at the mouth of the creek. However, a defunct mining tunnel at stream mile 3.4 of San Vicente creek presents a permanent barrier to fish migration and thus marks the upstream extent of accessible main stem anadromous salmonid habitat. Water diversion dams located at stream miles 0.5 and 0.75 on Mill Creek prevent fish from utilizing the upper watershed of that tributary (CDFG, 1998). In addition to coho salmon and steelhead, San Vicente Creek supports populations of prickly sculpin (*Cottus asper*), coastrange sculpin (*C. aleuticus*), and threespine stickleback (*Gasterosteus aculeatus*) (ESA, 2003). A single occurrence of a non-native green sunfish (*Lepomis cyanellus*) has been documented within the watershed (ESA, 2003).

Mean annual rainfall in the watershed ranges from about 24 inches at the mouth to upwards of 60 inches in the headwaters along Empire Grade (CDFG, 1998). The geology and precipitation are such that San Vicente Creek sustains summer minimum baseflows of about 1 cubic feet per second (cfs) in nearly all years —a large flow by regional standards and a criticallyimportant attribute in restoring coho salmon and steelhead populations (Stamm et al., 2008). The hydrology and geology of the watershed are discussed in detail in chapters one and two, respectively, of this report.

Although redwood forest dominates the watershed, the lower reaches of the creek support a narrow riparian zone dominated by alders (*Alnus spp.*) and willows (*Salix spp.).* Timber harvesting, water diversions, and rural residential development occur in the upper watershed. Open pit mining historically occurred in the upper watershed, but was recently terminated. Cattle grazing and agricultural water diversions historically occurred in the lower watershed but were gradually phased out over the past decade.

History, Previous Studies or Projects

Salmonid Populations

The historic presence and abundance of salmonid populations in San Vicente Creek are fairly well documented. A newspaper article dating back to 1866 placed San Vicente Creek at the top of the county's fisheries streams:

> *"The best [trout fishing] stream probably, is the San Beicente [San Vicente], ten miles up the coast, a large creek emptying into the sea. In this stream, trout bite as rapid and as strong as in Eastern streams, and [are] even more abundant and delicious. The largest trout caught (by Mr. Begelow, the insurance agent), being over 22 inches long and weighing about four pounds. In this stream the largest average from ten to fifteen inches."* (Sentinel 1/13/1866)

In addition to steelhead trout, museum specimens of coho salmon from San Vicente Creek dating back to 1895, prior to the first known stocking of coho salmon south of San Francisco Bay, provide strong evidence that the species historically occurred in the watershed (Spence et al., 2011). However, recreational and industrial pressures on these populations were already significant at the time, as indicated by the following reports:

> *"Messrs. Tom Dakan and Rob Dudley whipped the San Vicente for trout Sunday with immense results. Eight hundred and fifty is the record they are willing to make their affidavit on, and all caught with a hook."* (Surf 6/2/1891)

> *"The San Vicente Creek, beloved of the angler and the artist, has its mouth stopped by a vast dyke, and its throat choked into a tunnel, a saloon on its border, and its bed for miles denuded of the granite cobbles and sand beds. A sawmill is swiftly cutting out the timber and dirt and debris defile the pools and clog the riffles where lurked the gamey trout."* (Surf 2/02/1906)

In 1934, CDFW staff surveyed San Vicente Creek and noted both the presence of steelhead and past steelhead stocking. Natural propagation was said to be "good in normal years" (DFG, 1953). A CDFW (DFG, 1953) report states, "...the upper portion of this creek is a beautiful trout creek."

Coho salmon occurrences in San Vicente Creek have been documented a number of times over the past three decades, including in 1981 by Harvey & Stanley Associates (1982), in 1991 by McGinnis (1991), and in 1996 by CDFW (DFG, 1998). Steelhead have consistently been documented in San Vicente Creek throughout these and more recent survey efforts. By the late 1990's, CDFW considered the San Vicente Creek coho salmon population to be near extinction (DFG, 1998). However, a smolt outmigrant study conducted for NMFS and the Coast Dairies Land Company in the spring of 2003 captured over 1,000 coho salmon smolts and over 2,000 juvenile steelhead (ESA, 2003).

Subsequent randomized snorkel surveys, performed by SWFSC staff in 2008, observed a total of 188 juvenile coho salmon in the watershed. While this is a relatively small number from a population viability perspective, it represented the highest coho salmon abundance of any sampled watershed south of San Francisco Bay at that time (NMFS, 2012). San Vicente Creek has been identified by NMFS biologists as one of the highest priority anadromous fishery creeks south of the Golden Gate (Best, pers. comm.).

CDFW staff conducted spawning surveys in San Vicente Creek (excluding Mill Creek) and other drainages in Santa Cruz and San Mateo counties during the 2011-2012 spawning season1 to estimate regional escapement and general run timing (Jankovitz, 2012). The surveys were conducted at 10 to 14 day recurrence intervals and generally followed a protocol designed for monitoring salmonids along the north coast of California outlined by Gallagher and Knechtle (2005). However, while the protocol calls for surveys of randomly selected stream reaches, mainstem San Vicente Creek was surveyed in its entirety due to ease of access, short extent of anadromy, and the importance of the system to coho salmon recovery efforts. CDFW staff observed a total of 22 live broodstock coho salmon (see discussion of the broodstock program below), four broodstock carcasses, two ocean return coho salmon of unknown hatchery origin2, and 14 coho salmon redds between January 24 to March 1, 2012 (Jankovitz, 2012). All observations were made between the mouth of San Vicente Creek and the confluence of Mill Creek. The two ocean return coho of unknown hatchery origin were observed spawning in lower San Vicente Creek on February 17, 2012 and the resulting redd was observed and measured on February 28. This was the only pair of coho known to have returned from sea and successfully spawned in the entire Santa Cruz/San Mateo survey area3 during the

1 Spawning surveys were again conducted during the 2012-2013 spawning season, but results were not available at the time of report preparation.

2 The two adult coho salmon had clipped adipose fins, indicating they were hatchery releases, but did not contain any tags identifying the hatchery from which they were released (Jankovitz, 2012).

3 The survey area consisted of 21 randomly selected sampling reaches within

season (Jankovitz, 2012). Broodstock coho salmon constructed an additional thirteen redds in San Vicente Creek during the season. In addition, CDFW staff also identified a total of 55 steelhead redds (Jankovitz, 2012).

Broodstock Program

Recognizing the impending threat of regional extirpation of coho salmon south of San Francisco Bay, NOAA's SWFSC, in collaboration with the non-profit Monterey Bay Salmon and Trout Project (MBSTP), adopted a captive rearing strategy (captive broodstock program) in 2001 to protect the genetic legacy of southern coho salmon and provide future opportunities to reestablish coho salmon in regional streams from which they have been extirpated. Until 2011, broodstock raised by the program were only released in Scott Creek, a costal stream entering the Pacific Ocean approximately three miles north of the mouth of San Vicente Creek. However, San Vicente Creek has been identified by the inter-agency Priority Action Coho Team (Recovery and Captive Rearing Technical Work Group) as a high priority site for coho salmon reintroduction in the Santa Cruz Mountains diversity stratum, and broodstock releases to San Vicente Creek were initiated by SWFSC in 2011.

Consistent with the goals of the captive broodstock program, multiple life-stages of coho salmon have been released into San Vicente Creek since 2011 (Table 4-1) and researchers at SWFSC are conducting targeted experiments to quantify the relative success of each release strategy (e.g., release location, time of year, and life-stage). Preliminary results of this effort indicate that adult broodstock fish released into San Vicente Creek successfully spawned and produced offspring in both 2012 and 2013. The subsequent planting of 4,000 and 6,000 unfed fry across multiple release sites in April 2012 and March 2013, respectively, has further augmented the juvenile (young-of-year) coho population in the basin. The release of several hundred smolts in 2011 and April 2013 were aimed at increasing subsequent returns of broodstock adults imprinted to San Vicente Creek and matured in the ocean.

Table 4-1. Outplanting of coho salmon from the NOAA captive broodstock program into San Vicente Creek, 2011-2013.

	(year)		
Life Stage	**2011**	**2012**	**2013**
Fry (unfed)	0	4,000	6,000
Parr	0	0	0
Smolt	300	0	497
Adult	0	27	19

11 coastal watersheds, as well as seven non-randomly selected reaches within two coastal watersheds (San Vicente Creek and Gazos Creek) of San Mateo and Santa Cruz counties. Specific sampling locations are provided by Jankovitz (2012).

Habitat Quality

CDFW conducted comprehensive habitat inventories of San Vicente Creek in 1996 (DFG, 1996) and 2010 (CDFW, 2013) pursuant to standard methodologies presented in the *California Salmonid Stream Habitat Restoration Manual* (Flosi et al., 1998). The primary purpose of this type of habitat inventory is to provide a watershed or drainage-wide overview of existing habitat availability and conditions, and to develop generalized recommendations for potential habitat enhancement approaches. Due to randomized subsampling used in the assessments, as well as inherent sampler bias, these habitat inventories are generally not used as a monitoring tool aimed at documenting fine scale changes over time. However, a qualitative comparison of the 1996 and 2010 assessment results does provide valuable insights into potential basin-wide changes that may have occurred over the 14-year period between the two assessments. This section provides such a comparison. The reader is referred to the *California Salmonid Stream Habitat Restoration Manual* (Flosi et al., 1998) for detailed descriptions of assessment methodology and habitat parameters.

In 1996, broadly defined habitat types (i.e., Level II) in San Vicente Creek occurred with a frequency of 43% pool units, 16% riffle units, 40% flatwater units, and 1% culvert units. In 2010, the frequencies of Level II habitat type occurrences were 36% pool units, 35% riffle units, 27% flatwater units, 2% culvert units. These results suggest the frequency of pool units has decreased somewhat over 14 years, which is consistent with anecdotal evidence from the assessment team over the past decade. The large discrepancy between riffle and flatwater units between the two assessments, however, is somewhat surprising. It should be noted that the correct identification of riffle and flatwater units is subject to observer error to a greater extent than other habitat units. Higher stream flows and concomitant increases in stage can inundate some riffles to the extent that they appear as flatwaters. In fact, the *California Salmonid Stream Habitat Restoration Manual* indicates that run habitats, the most common flatwater unit type, "[o]ften appear as flooded riffles." Streamflow during the 1996 assessment was measured at approximately 8 cubic feet per second (cfs) while streamflow during the 2010 assessment was 6 cfs. It is therefore likely that at least some habitat units identified as flatwater during the 1996 assessment were identified as riffles during the 2010 assessment. Lastly, the discrepancy between culvert units between the two assessments is minor and likely a reflection of rounding effects. The assessment team is not aware of any new culverts having been constructed in the lower San Vicente Creek watershed during the past decade.

In 1996, fourteen individual Level IV habitat types were identified. Based on percent occurrence, the most frequent habitat types were mid-channel pool units (28%), step runs (28%), and low gradient riffles (12%). Based on percent total stream length, step runs comprised 70%, mid-channel pools 10%, and runs 5% in 1996. In 2010, a total of eighteen Level IV habitat types were identified. The most frequent habitat types by percent occurrence were low gradient riffle units (19%), run units (19%), and mid-channel pool units (15%). Based on percent total length, there were 21% run units, 18% low gradient riffle units, 16% high gradient riffle units. These results again suggest an overall reduction in pool habitat units, both in terms of frequency of occurrence and percent total stream length, between 1996 and 2010.

A total of 70 individual pool units were identified in 1996 under a random subsampling protocol (i.e., not all pools were quantified), with main channel pools being the most abundant (64%) pool habitat unit type, comprising 69% of the total length of pools. The 2010 assessment included quantification of all pool units and identified a total of 123 individual pools, with scour pools as the most frequently encountered at 53%, comprising 51% of the total length of all pools. Due to the different sampling intensities used for the two assessments, these numbers are not directly comparable.

Pool quality for salmonids increases with depth, particularly if instream shelter is present within the pool. Twenty-one of the 70 pools (30%) identified in 1996 had a residual depth of three feet or greater, while only 13 of the 123 pools (11%) had a residual depth of three feet or greater in 2010. Residual pool depth is a measure that is independent of streamflow or stage, and therefore provides a useful comparison tool. The residual pool depth data for 1996 and 2010 appear to indicate that pool depths have decreased considerably over 14 years. Coho salmon are known to prefer deep pools and relatively slow water velocities while steelhead generally reside in the more shallow and fast-flowing areas of a channel (e.g., Roni, 2002). As such, the apparent loss of deep pool habitat availability in San Vicente Creek has likely affected coho salmon disproportionately.

The depth of cobble embeddedness was estimated at pool tail-outs. This habitat parameter is rated on a scale of 1 to 5, with a value of 1 indicative of the best spawning conditions and a value of 4 representing the worst. A value of 5 is assigned to tail-outs that are deemed unsuited for spawning due to inappropriate substrate such as bedrock, log sills, boulders, or other such features. Of the 70 pool tail-outs measured in 1996, one had a value of 1 (1%), 12 had a value of 2 (17%), 51 had a value of 3 (73%), one had a value of 4 (1%), and five had a value of 5 (7%). Of the 123 pool tail-outs measured in 2010, 13 had a value of 1 (11%), 78 had a value of 2 (63%), 8 had a value of 3 (7%), none had a value of 4, and 24 had a value of 5 (20%). As such, a total of 74% of measured pool tail-outs had embeddedness ratings (1 or 2) generally considered suitable for salmonid spawning in 2010, while only 18% of tail-outs contained embeddedness levels suitable for spawning in 1996. Based on this analysis alone, fine sediment levels in San Vicente Creek may have decreased over time. This observation is consistent with the results of a sediment source inventory conducted for this report (chapter 2) that "identified very few active sediment sources that currently may impair spawning/rearing habitat."

Available instream cover was evaluated using a standard shelter rating for each habitat unit. The proportion of each habitat unit that is influenced by some type of shelter is estimated as a percentage of the total surface area of the unit, and a standard qualitative shelter value of 0 (none), 1 (low), 2 (medium), or 3 (high) is assigned according to the complexity of the cover. The shelter rating is calculated for each fully-described habitat unit by multiplying shelter value and percent cover. Thus, shelter ratings can range from 0-300 and are expressed as mean values by habitat types within a stream. A pool shelter rating of approximately 100 is desirable for salmonids. For San Vicente Creek, the mean shelter ratings for riffle and flatwater habitat types were very low (ratings of 10 or less) and similar to each other in 1996 and 2010. However, the mean shelter rating value for pools increased from 12 in 1996 to 35 in 2010. The dominant overall cover type was boulders during both assessment years. Within pools, the dominant cover types were root masses and boulders in 1996, but terrestrial vegetation and small woody debris in 2010. More importantly, large woody debris (LWD) accounted for only 7% of measured pool cover in 1996, but for 16% in 2010. These values may be indicative of marginal increases in large woody debris (LWD) loading in San Vicente Creek over the past 14 years. A detailed discussion of current LWD loading and recruitment potential is provided in chapter 5 of this report.

Channel substrate size suitability for salmonid spawning was evaluated differently in 1996 (sampled in low gradient riffles) and 2010 (sampled in pool tail-outs). During the former assessment, 100% of low gradient riffles contained large cobble as the dominant substrate size, which is generally considered unsuitable for spawning. In 2010, gravel substrate was dominant in 34% of pool tail-outs and small cobble substrate was dominant in 31% of pool tail-outs in 2010. Gravel and small cobble substrates are generally considered to provide suitable spawning conditions. No comparative conclusions can be drawn from the data presented for the two assessments, other than a potential indication that low gradient riffles in San Vicente Creek may not provide suitable spawning conditions (at least in 1996) while the majority of pool tail-outs appear to provide spawning opportunities (at least in 2010).

The mean percent canopy density for the surveyed length of San Vicente Creek was 87% in 1996 and 92% in 2010. In 1996, 75% of canopy cover was provided by hardwood trees, 12% by conifers, and 13% of the survey reach was classified as open (i.e., no canopy cover). In 2010, 78% of canopy cover was provided by hardwood trees, 14% by conifers, and only 8% of the survey reach was classified as open. Similar trends were observed in the percentage of vegetated streambanks, with 73% and 76% of the right and left banks, respectively, vegetated in 1996; and 77% and 80% of the right and left banks, respectively, vegetated in 2010. Although individual canopy cover and bank vegetation values for 1996 and 2010 are very similar, the data suggest that a gradual trend toward increased canopy cover has occurred since 1996.

In conclusion, the two habitat inventories indicate that pool habitat availability and quality has been decreasing while riparian canopy cover and LWD loading has been increasing slightly. Suitable spawning habitat is generally available in most pool tail-outs, and embeddedness ratings are relatively low. As depicted in Figure 4.7, coho salmon redds observed during the 2001-2012 spawner surveys were generally concentrated in reaches containing multiple pools.

METHODOLOGY

Smolt Outmigration

An outmigrant trap was installed in San Vicente Creek on March 1, 2013 and operated daily through June 15, 2013 to assess current population size, size of fish, migration timing, and freshwater survival. The outmigrant trap was installed immediately downstream of a boulder weir associated with the inlet structure for the Lower San Vicente Pond restoration site. This site was selected based on ease of access and security. The trapping site is located approximately 775 feet upstream of the Highway 1 culvert. Thus, outmigrating smolts from a small portion of the overall watershed locate downstream of the trap were not sampled in this study.

Study methodologies were consistent with the *California Coastal Salmonid Monitoring Plan* (CMP) as presented in Fish Bulletin 180 (DFG, 2011), but expanded upon to collect additional data in support of ongoing SWFSC broodstock reintroduction and research efforts. The trap consisted of a 2-foot diameter, 7-ring, 2-chamber hoop net with a 0.25-inch mesh size. Seine wings attached to both sides of the trap opening were used in an attempt to block the entire wetted width of the channel to achieve 100% trapping efficiency. Due to the design of the trap with seine side wings, upstream migration of adult salmonids was not impeded as these individuals were able to easily swim over the top of the seine, as was observed on two occasions. The trap was operated 24 hours per day, 7 days per week and checked daily, at a minimum. Trapped fish were transferred into a 20-gallon holding bucket filled with stream water. All non-salmonid species were returned to the stream. Coho salmon and steelhead were anesthetized in a short MS-222 bath. Forklengths of juvenile salmonids were recorded to the nearest millimeter using standard plastic rulers. Wet weights were measured to the nearest 0.1 grams using an Ohaus Scout II electronic scale with a 400-gram capacity. Evidence of fish diseases (e.g., black spot disease) and other noteworthy observations were also recorded. Adult steelhead captured in the trap were estimated for length and released immediately downstream of the trap.

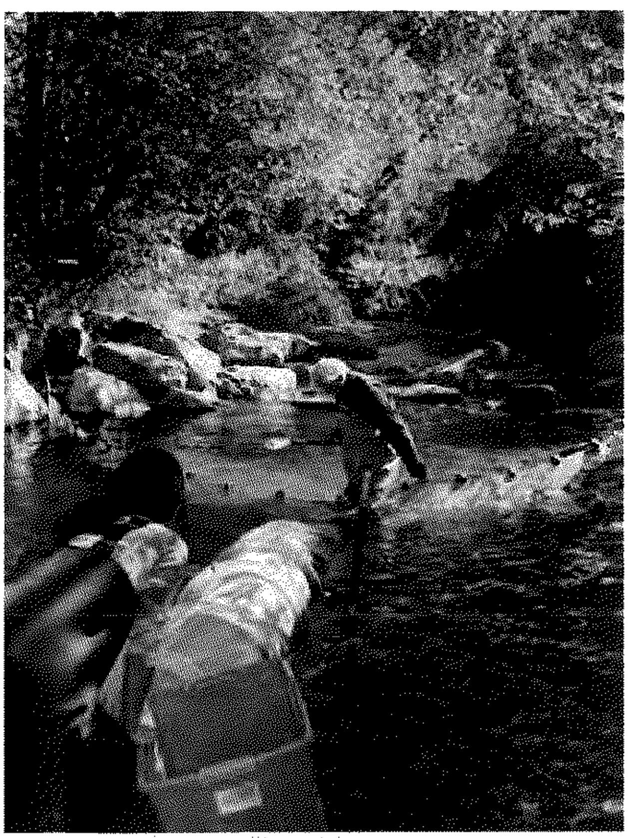


Figure 4-1. Smolt trap in San Vicente Creek, Spring 2013.

All juvenile salmonids were scanned for passive integrated transponder (PIT) tags using a Biomark 601 handheld reader, and all PIT tag codes were recorded. On April 23, 2013, SWFSC staff released 497 broodstock coho salmon smolts fitted with coded wire tags (CWT) in San Vicente Creek upstream of the outmigrant trap. Subsequent to this release, all captured coho salmon were also scanned for CWTs using a Northwest Marine Technology T-Wand CWT detector. Coho salmon containing a CWT were recorded and released immediately downstream of the trap without obtaining length or weight measurements.

All captured juvenile coho salmon that had not previously been tagged with a PIT tag or CWT were implanted with a 12 millimeter half duplex (HDX) PIT tag manufactured by Oregon RFID. The PIT-tagging techniques used were consistent with methodologies described by the Columbia Basin Fish and Wildlife Authority PIT Tag Steering Committee (CBFWA, 1999). The PIT tags were implanted into the body cavity between the posterior tip of the pectoral fin and the anterior point of the pelvic girdle using syringes fitted with 12-gauge veterinary-grade needles. Scale and DNA (fin-clip) samples were also collected from all previously untagged coho salmon using standard salmonid research protocols.

After handling, fish were placed into 5-gallon holding bucket containing stream water and an aerator, and allowed to recover from the anesthesia for approximately 10-20 minutes. All recovered fish were released into a deep and calm pool located approximately 50 feet downstream of the trap.

Based on guidelines presented in the CMP, trap efficiency was assessed using a simple mark-recapture protocol. SWFSC staff operated the outmigrant trap once a week (Wednesdays). Starting on April 3, 2013, NOAA staff selected a subset of all trapped fish each Wednesday for the mark-recapture study. Selected fish were issued a PIT tag (unless one was present already) and marked with a caudal fin clip for identification.

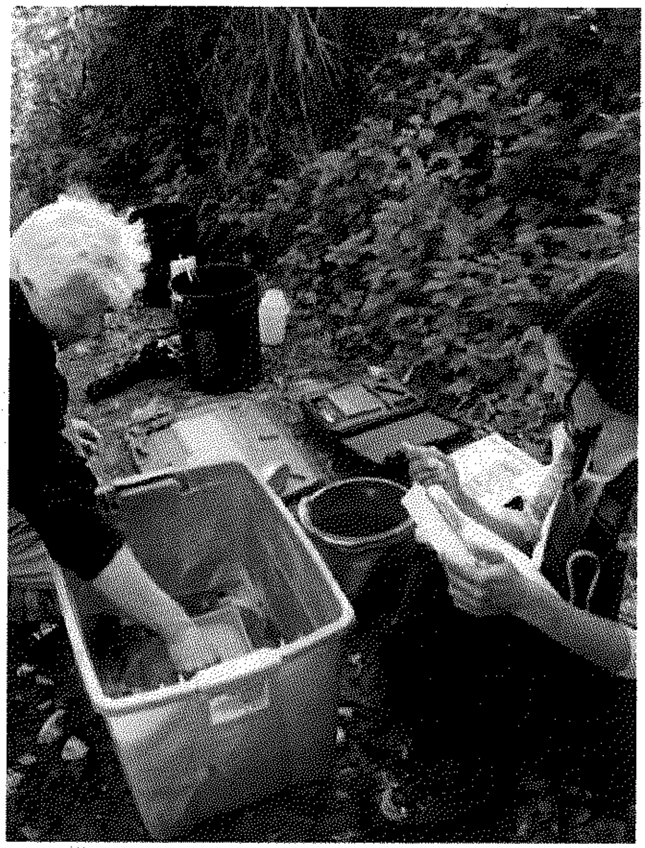


Figure 4-2. Processing of juvenile salmonids captured in San Vicente Creek, Spring 2013

Marked fish were released approximately 200 feet upstream of the outmigrant trap. PIT tag codes were used to identify and quantify marked and subsequently recaptured fish.

Outmigrant traps typically need to be removed from the stream during high flow events. However, water year 2013 proved to be a drought year along the central coast of California and no significant storm events occurred during the trapping period. As such, the trap remained in place and operational during the entire outmigrant study.

Juvenile Distribution

In July 2012, SWFSC staff conducted snorkel surveys in mainstem San Vicente Creek to document the distribution and abundance of juvenile coho salmon. The snorkel survey extended approximately 3.4 miles from the confluence with the Pacific Ocean to the quarry tunnel representing the upstream limit of anadromy. Procedurally, two snorkelers equipped with dive lights worked side-by-side to cover the width of the stream and slowly proceeded in an upstream direction. The survey was limited to pool habitat units and every pool encountered was sampled via a single pass. Based on methodologies previously employed by SWFSC staff (Spence, unpublished data), pools were defined as habitat units of at least 2.0 m^2 (21.5 ft^2) in surface area, widths at least one-half the wetted-width of the channel, and maximum depths exceeding 0.3 m (1 ft). For each pool, only the number of juvenile coho salmon was recorded; steelhead were not enumerated. Physical habitat information including location, total pool length, pool width, maximum pool depth, and pool tail depth were also recorded for each unit surveyed.

FINDINGS

Smolt Outmigration

Coho Salmon

A total of 329 juvenile coho salmon were captured in the outmigrant trap between March 2 and June 15, 2013. Of this total, 196 fish were marked with CWT, indicating that they were broodstock smolts released into the system on April 23, 2012. Of these totals, one non-CWT and three CWT coho were recaptures (see below). Furthermore, two of juvenile coho salmon captured toward the end of the trapping period were age 0+ fish (based on forklength). One of these was marked with a red visible implant elastomer (VIE) tag, indicating it was broodstock fish previously released as a fry; the other fish had no visible mark, suggesting it may have been the offspring of instream spawning. As such, the total tally of individual captured juvenile coho salmon was 130 non-CWT smolts, 193 CWT smolts, one VIE fry, and one non-VIE fry. In comparison, the 2003 trapping study (ESA, 2003) captured 703 smolts in mainstem San Vicente Creek and 319 smolts migrating from the Lower San Vicente Pond off-channel habitat feature[4], for a total of 1,022 smolts.

A total of five juvenile coho salmon were found dead upon arrival at the traps. Two of these mortalities were CWT-marked broodstock smolts and external fungus was observed on two others. Fungus infections were noted on a total of thirteen juvenile coho salmon, but twelve of these were CWT-marked broodstock smolts. Minor to moderately severe black spot (*Neascus sp.*) infestations were observed on only six captured coho salmon, none of which were broodstock CWT-marked broodstock smolts. One additional juvenile coho salmon mortality occurred during PIT-tagging.

Trap efficiency tests were inconclusive. On one hand, we felt that the positioning of the trap assured that essentially 100% of the channel width and depth were blocked by the trap and wing seines, and the absence of significant storm events enable us to operate the trap continuously without the trap being bypassed, over-topped, or removed. On the other hand, however, recapture success was low. A total of 26 coho salmon smolts (22 CWT broodstock smolts, 4 non-CWT smolts) captured in the trap were marked and released upstream. Of these, only four (three CWT broodstock smolts, one non-CWT smolt) were subsequently recaptured in the trap. These results suggest a low trap efficiency of approximately 15%. However, the recapture rate for non-broodstock smolts

4 The Lower San Vicente Pond site became hydrologically disconnected from San Vicente Creek in 2012. Therefore, no fish occupied this habitat in 2013.

was higher at 25%. Based on the fact that only 193 individual broodstock smolts of a total of 497 released by SWFSC staff were captured in the trap, survival of broodstock smolts appears to have been relatively low at approximately 39%. Alternatively, genetic cues for outmigration may have been weak in broodstock smolts. Considering that the majority (85%) of coho salmon smolts used for the trap efficiency study were broodstock smolts, the low recapture rates may be a reflection of poor survival and/or low migration rates rather than trapping inefficiencies. It is also important to note that it took an average of 22.5 days (min = 10 days; max = 36 days) for marked coho salmon to be recaptured in the trap. As such, it appears that the trapping study may have delayed outmigration through trap recognition and avoidance.

The average forklength of non-CWT coho salmon smolts was 116 mm (standard deviation, SD, ± 13 mm), and the average wet weight of non-CWT coho salmon smolts was 15.8 g (SD ± 5.4 g) (Table 4-2). The condition factor (k = 100,000 wet weight / length^3) is frequently used by fisheries biologists as an indicator of the health of a fish population, with high k values (*i.e.*, > 1.0) indicative of adequate food supplies (Moyle and Cech, 1988). The average condition factors for non-CWT coho salmon smolts was 0.98 (SD ± 0.08).

By comparison, average forklengths of coho salmon smolts captured in San Vicente Creek and Lower San Vicente Pond in 2003 were 99 mm (SD ± 10 mm) and 121 mm (SD ± 7 mm), respectively, and average wet weights were 10.1 g (SD ± 2.8 g) and 18.2 g (SD ± 2.8 g), respectively (Table 4-2). As such, average sizes of coho salmon smolts in 2013 were larger than those trapped in the mainstem in 2003, but smaller than those captured inthe off-channel habitat in 2003. Condition factors in 2003 were slightly higher at 1.02 at both trapping sites.

Steelhead

A total of 1,668 juvenile steelhead and 23 adult steelhead were captured in the creek trap during the 15-week study. Of this total, 47 juvenile steelhead were recaptures (see below). As such, the actual number of individual juvenile steelhead captured was 1,644. Smolts and presmolts (based on coloration) accounted for 407 of the total juvenile catch, with 23 of these being recaptures. As such, the actual number of individual steelhead smolts/presmolts captured was 384, or 23.4% of the total number of individual juvenile steelhead encountered in the trap. It is important to note, however, that while the use of coloration is the only available non-lethal method of distinguishing smolts from other juvenile steelhead, it is an imprecise measure of whether or not a juvenile fish will migrate to the ocean during the study period, particularly during the early part of the season when many eventual smolts captured in the trap had not yet entered the smoltification process. As such, the presented smolt numbers are likely artificially low.

A total of 18 juvenile steelhead were found dead upon arrival at the creek trap. Moderate to severe external fungus infections were noted on 10 of these mortalities. In all, fungal infections were observed on 36 juvenile steelhead and five adult steelhead. By comparison, blackspot infestations were observed on only six juveniles.

A total of 121 juvenile steelhead were marked with PIT tags and fin clips, and released upstream of the trap. Of this total, 47 juveniles (38.8%) were subsequently recaptured. Of the total number of marked fish, 51 were identified as smolts, and 23 (45.1%) of these were subsequently recaptured. It is not surprising that the rate of recapture among smolts was higher than the total juvenile recapture rate since smolts are genetically cued, and physiologically ready, to outmigrate and therefore more

Table 4-2. Coho Salmon and Steelhead Smolt Abundance, Length, Weight, and Condition in San Vicente Creek, 2013 and 2003

	(year)		
	2013	2003 (creek)	2003 (pond)
Coho (non-CWT smolts only)			
Total # trapped	130	703	319
Average forklength, mm (±SD)	116 (13)	99 (10)	121 (7)
Average wet weight, g (±SD)	15.8 (5.4)	10.1 (2.8)	18.2 ((2.8)
Average condition factor, k (±SD)	0.98 (0.08)	1.02 (0.06)	1.02 (0.05)
Steelhead (smolts/presmolts only)			
Total # trapped	384	542	34
Average forklength, mm (±SD)	164 (22)	152 (21)	163 (24)
Average wet weight, g (±SD)	42.2 (20.4)	34.3 (15.2)	42.5 (21.8)
Average condition factor, k (±SD)	0.92 (0.07)	0.93 (0.07)	0.92 (0.10)

likely to reattempt outmigration (with subsequent recapture) after being marked than non-smolts that may have initially been captured during redistribution, but did not down-migrate again after being marked. However, as discussed above, trapping efficiency qualitatively appeared to be close to 100% and the reasons for the relatively low recapture rates are not known. It is interesting to note that even though the majority (n = 27, 52.9%) of marked fish were recaptured within one day of being marked and released, the average time to recapture was 7.2 days and the maximum time was 68 days. Given the considerable delay in recapture observed in many marked fish, trap recognition and avoidance, particularly in light of the high underwater visibility (due to a lack of runoff-induced turbidity) that prevailed during most of the study period, may have been an important factor in the low number of recaptures. Predation may have also affected recapture rates.

The average forklength of steelhead smolts was 164 mm (standard deviation, SD, ± 22 mm), and the average wet weight of steelhead smolts was 42.2 g (SD ± 20.4 g) (Table 4-2). The average condition factors for steelhead smolts was 0.92 (SD ± 0.07).

By comparison, average forklengths of steelhead smolts captured in San Vicente Creek and Lower San Vicente Pond in 2003 were 152 mm (SD ± 21 mm) and 163 mm (SD ± 24 mm), respectively, and average wet weights were 34.3 g (SD ± 15.2 g) and 42.5 g (SD ± 21.8 g), respectively (Table 4-2). As such, average sizes of steelhead smolts in 2013 were larger than those trapped in the mainstem in 2003, and similar in size to those captured exiting the off-channel habitat in 2003. Condition factors in 2003 were similar at 0.93 (creek) and 0.92 (pond).

Outmigration timing

Coho smolt migration timing along the central California coast has been studied in some detail. The results of a 9-year coho salmon and steelhead study on Waddell Creek show that the great majority of coho smolts enter the ocean during the months of April and May, with over 95% of the migration occurring during the 9-week period of April 8 through June 9 (Shapovalov and Taft, 1954). In 2013, 99% of all coho salmon smolts were captured in the outmigrant trap during that period, and the peak of the outmigration occurred during a 3-week period extending from May 3 through May 23 (Figure 4-3) during which 57% of the migration occurred. The peak of the steelhead smolt downstream migration occurred approximately one month earlier during the 3-week period of April 5 through April 25 (Figure 4-3), during which 63% of the migration occurred.

The timing of the peak smolt outmigration in San Vicente Creek was very similar during 2013 and 2003 for coho salmon (Figure 4-4). For steelhead, the migration timing as depicted in Figure 4-5 suggests that the 2013 migration peaked approximately one week earlier than in 2003, but as described in ESA (2003), the trap was non-operational for a total of three days during the week of April 12 through April 18, 2003. This weekly period had the highest number of steelhead smolt captures in 2013, and may have also had the highest number of outmigrants in 2003 if the trap could have been operated during the entire period.

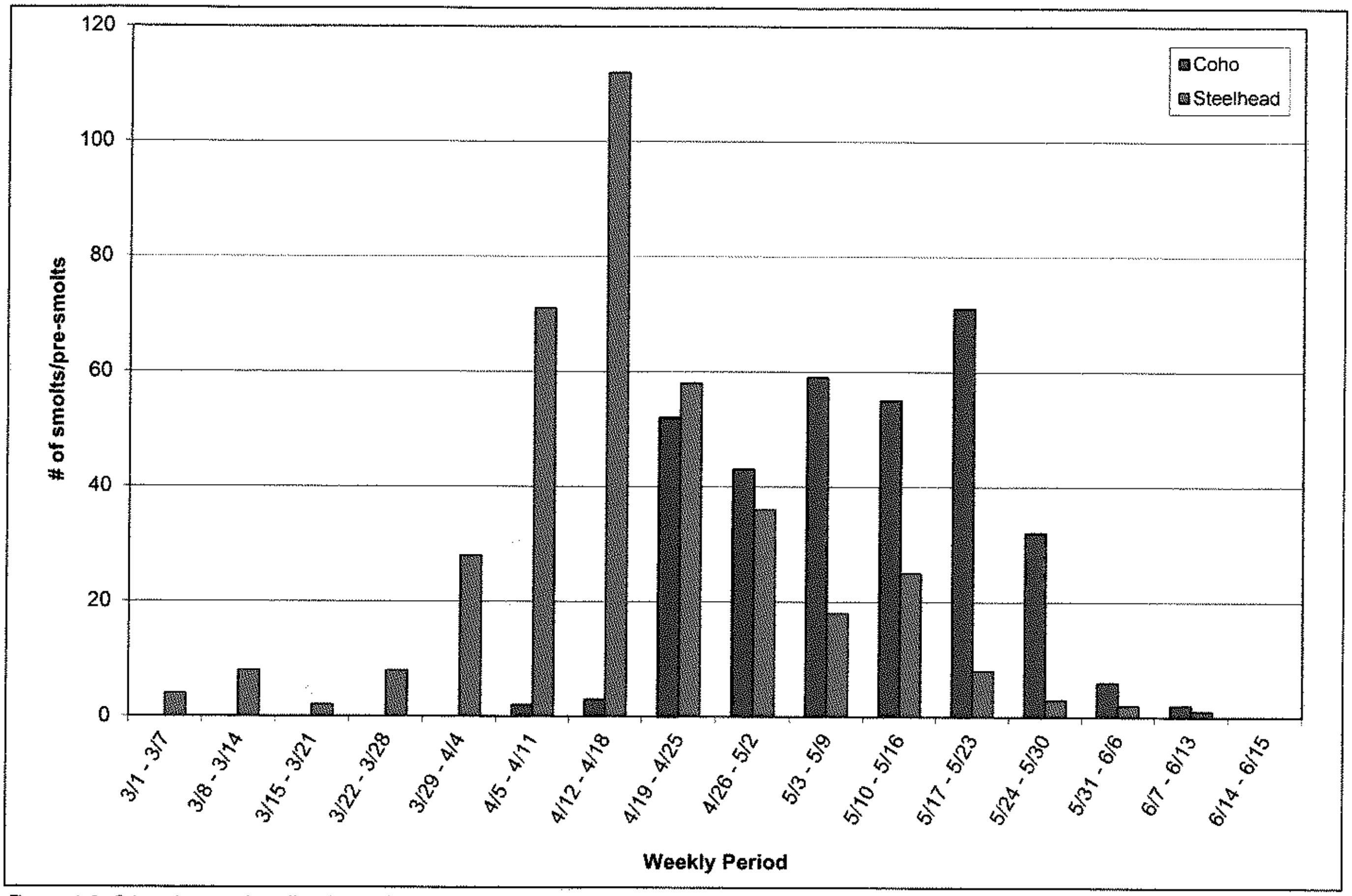
Juvenile Distribution

Of the 131 pool habitat units surveyed by SWFSC staff, 66 (50%) contained one or more juvenile coho salmon (Figure 4-6). Notably, only 5 individuals were observed above stream mile 1.9 where a large debris jam restricted passage by adult salmon the previous winter. No redds or live adults were observed upstream of this point during the 2011-2012 spawner surveys (Jankovitz, 2012). Consequently, coho salmon were absent from nearly 1.5 miles (45 suitable pool habitat units; Figure 4-7) of potential rearing habitat in the mainstem during the summer of 2012.

Many factors determine juvenile salmonid rearing habitat site selection, but the 2012 distribution data suggest that coho salmon rearing in San Vicente Creek is concentrated within reaches containing abundant and large pools. Furthermore, juvenile coho salmon in San Vicente Creek appear to remain relatively close to spawning sites. Juvenile coho salmon have been shown to migrate considerable distances from their natal reaches, but this tendency is typically thought to be a response to rising summer water temperatures forcing juveniles to seek out cooler rearing habitat elsewhere in the watershed. Relatively cool and stable summer water temperatures in San Vicente Creek likely reduce or eliminate the need for significant juvenile redistribution. It should be noted, however, that the lowermost reaches of the stream also show a concentration of coho salmon rearing, even though no redds were observed in this area during spawner surveys. A certain amount of downstream redistribution of juveniles occurs in most drainages.

Conclusions

As described above, the fisheries portion of this Existing Conditions assessment was initially envisioned to provide an evaluation of the current status of salmonids in general, and coho salmon in particular, within the watershed. The overall goal was to determine whether coho salmon were still utilizing San Vicente Creek. However, the focus of the assessment shifted after NOAA's SWFSC, in collaboration with MBSTP, embarked on a concerted coho salmon broodstock reintroduction and research effort. As such, the coho salmon population within the watershed is currently being artificially supplemented. Available data from a 2011-2012 spawner surveys, a July 2012 juvenile distribution survey, and a spring 2013 smolt outmigration study indicate that limited spawning is occurring, and at least a portion of the offspring and/or broodstock juveniles are successfully rearing and subsequently migrating to the ocean. The proportion of the wild versus broodstock coho salmon in San Vicente Creek is currently unknown, but this information will become available once the genetic samples that have been collected over the past two years are analyzed.



Figures 4-3. Coho salmon and steelhead smolt/presmolt migration timing, San Vicente Creek, March 1–June 15, 2013.

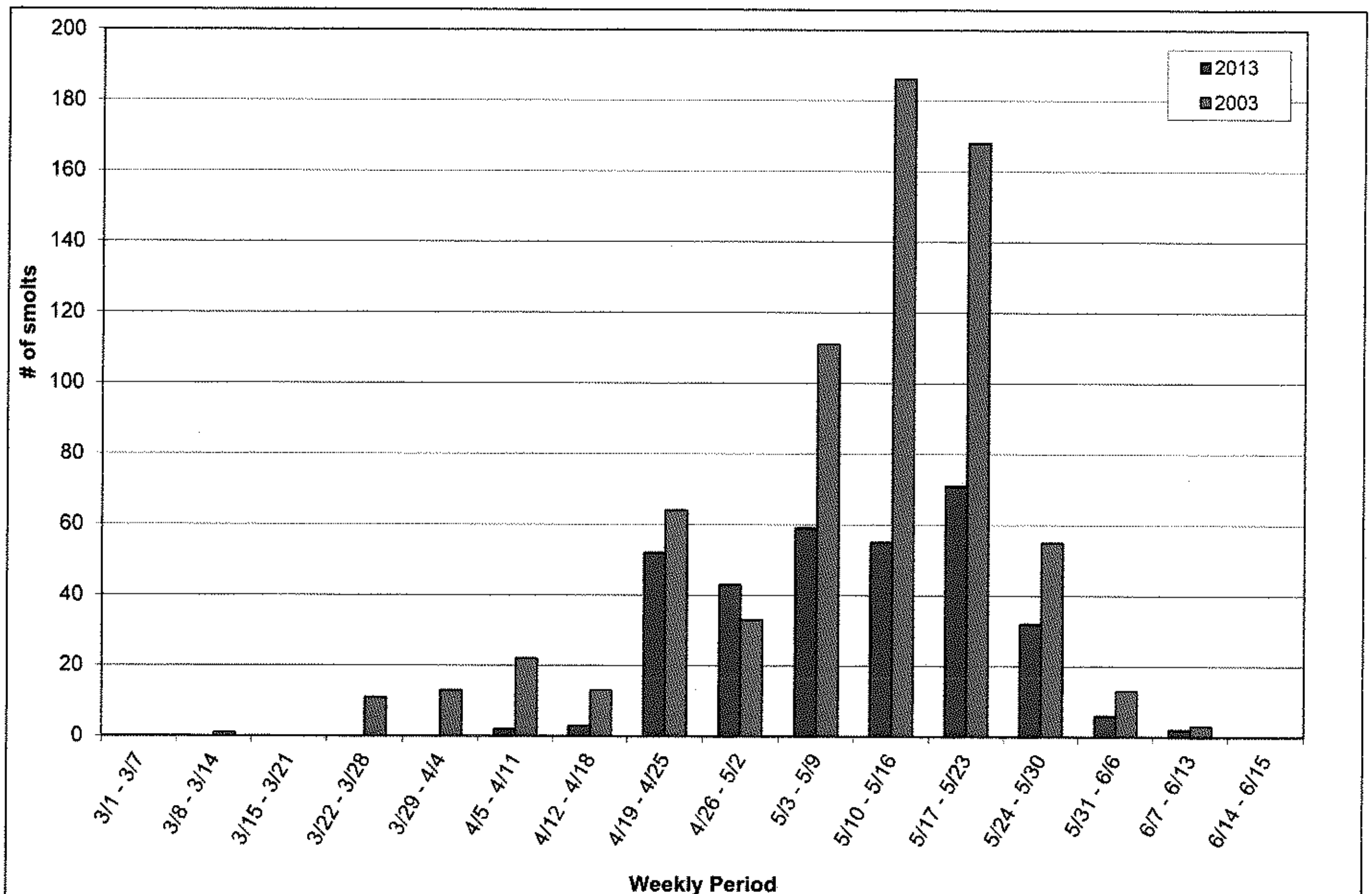


Figure 4-4. Coho salmon smolt migration timing, San Vicente Creek, March 1 –June 15, 2013 and 2003.

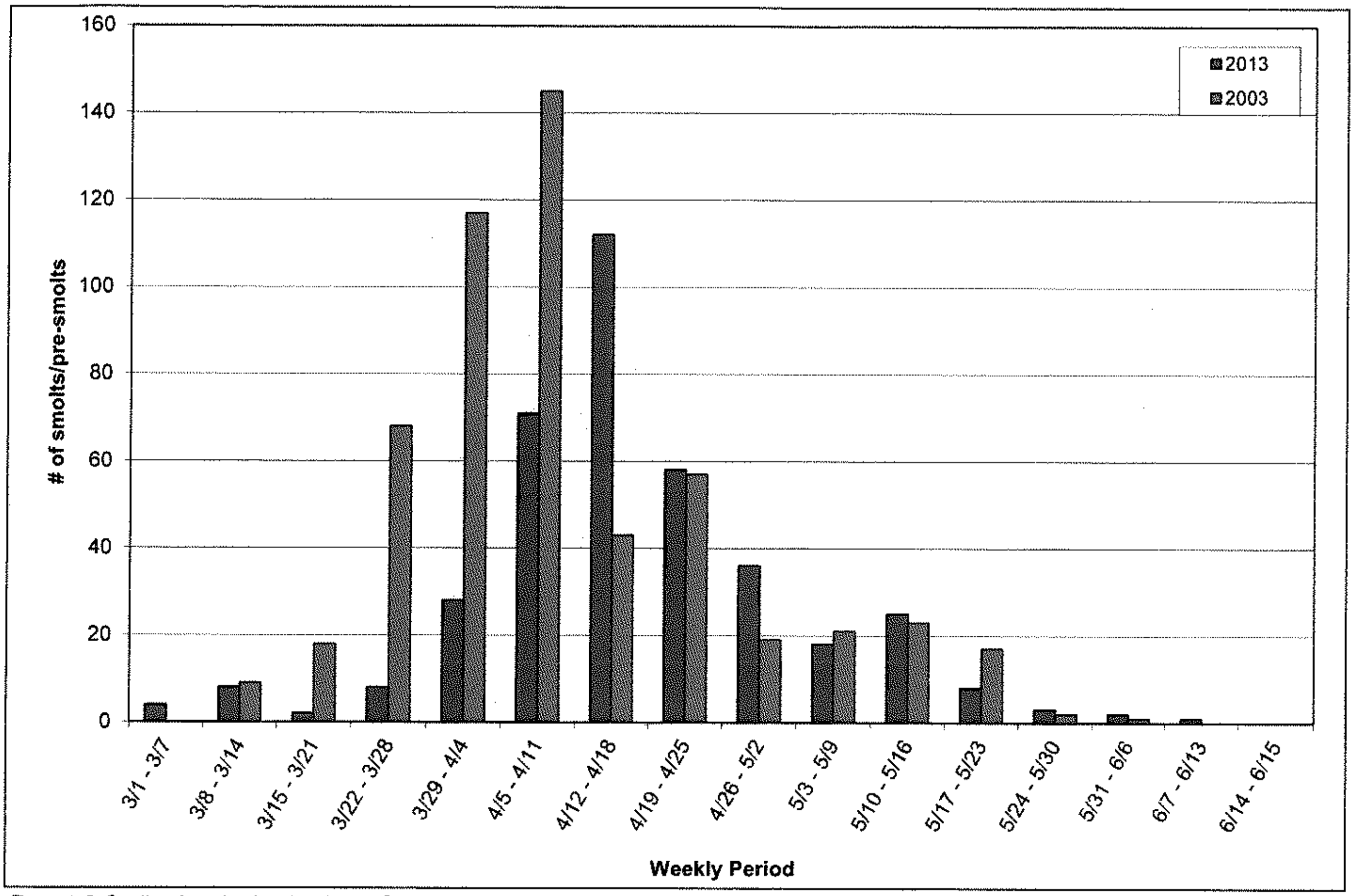


Figure 4-5. Steelhead smolt migration timing, San Vicente Creek, March 1–June 15, 2013 and 2003.

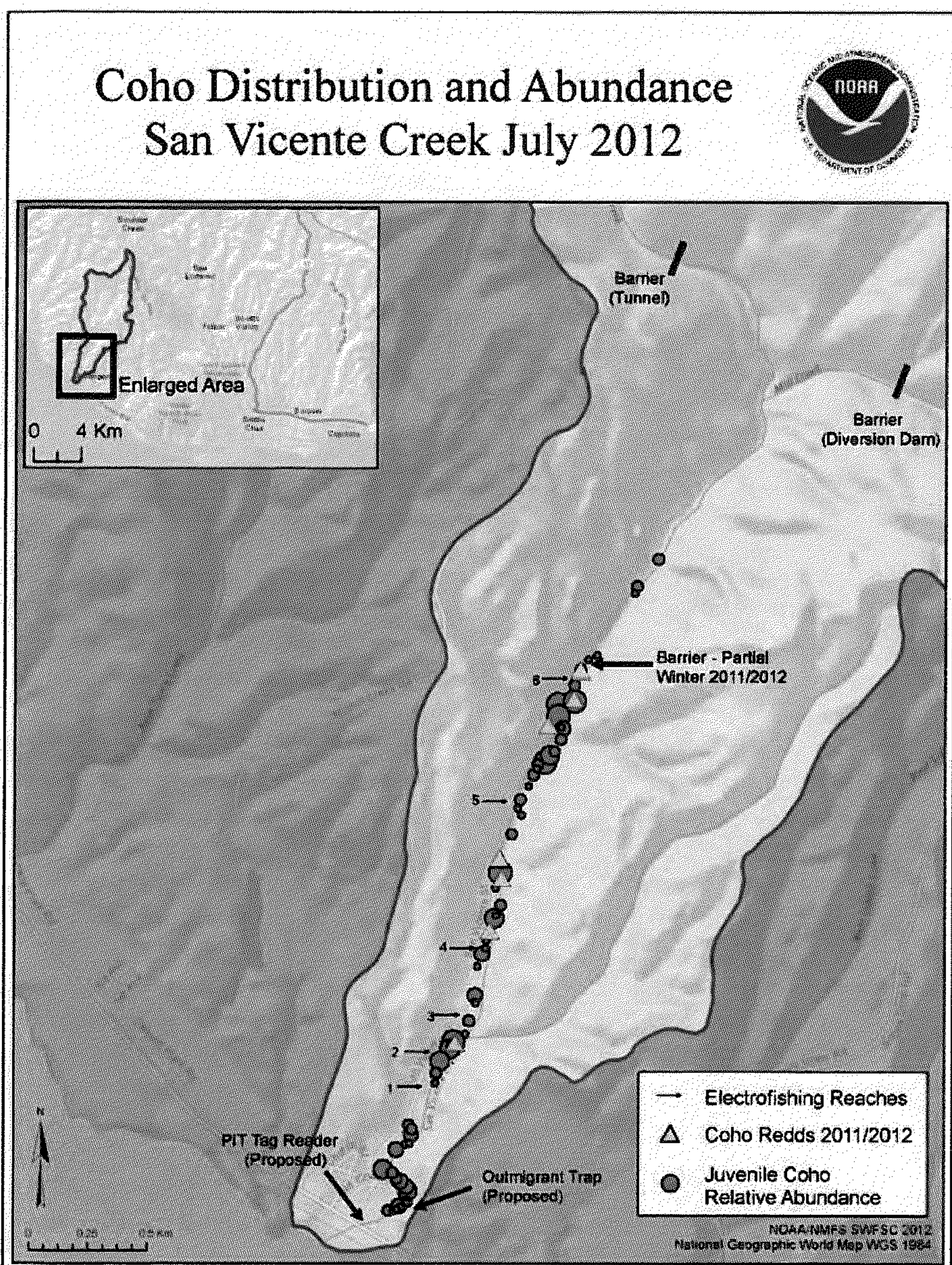


Figure 4-6. Spatial distribution and relative abundance of juvenile coho salmon in San Vicente Creek.

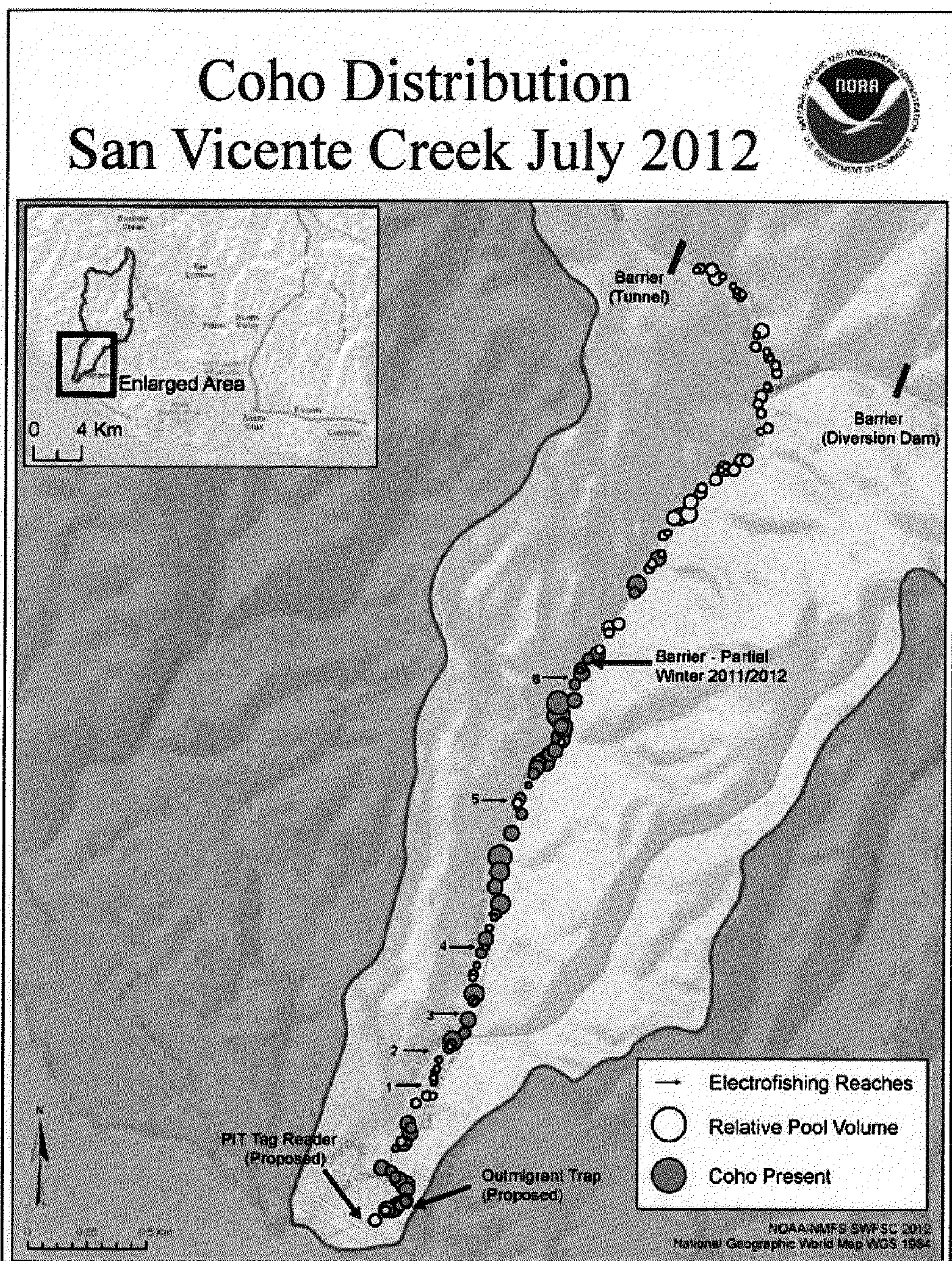


Figure 4-7. Spatial distribution of pool habitat units identified, relative pool volume, and juvenile coho salmon presence within pool habitat units.

Chapter 5: Large Woody Debris

OBJECTIVES

The goal of this project was to determine current Large Woody Debris (LWD) availability and natural recruitment potential in San Vicente Creek Watershed to help guide future management efforts. Lack of LWD, habitat complexity, and shelter in the anadramous reaches of San Vicente Creek are highlighted as a key limiting factors for salmonid recovery in the Central California Coast Coho Recovery Plan (National Marine Fisheries Service, 2012).

The main objectives of the LWD assessment were to: conduct an *LWD Stream and Riparian Inventory* based on the protocol described in Part III of DFG's California Salmonid Stream Habitat Restoration Manual and adaptations recommended by Leicester (2005), evaluate wood recruitment potential in San Vicente and Mill Creek based on inventory results, evaluate the presence of in-channel wood on pool and backwater habitats based on inventory results, and develop recommendations for future LWD enhancement projects, if warranted. To address these objectives, the following questions were kept in mind:

» What is the extent of recruitable wood in the stream system? Where is located?

» Which is more dominant within the stream system, hardwood or conifer species?

» How do the presence of in-channel hardwood and conifer LWD influence pool and backwater formation? Is there a difference?

» Are there geographic limitations to where LWD enhancement projects might be feasible based on challenges with equipment access, private property, slope/gradient, etc?

INTRODUCTION

The importance of large woody debris (LWD) in the development of a stream's morphology and biological productivity has been well documented in the literature since the 1980's. Work by Bilby (1984) and Rainville et al. (1985) found that in nearly 80 percent of the pools surveyed in small streams, LWD was the structural agent forming the pool or associated with the pool. Gurnell et al (2002) and Gregory et al, (2003) found in their studies that LWD provides habitat for a broad range of aquatic species and can strongly affect the geomorphic and ecological processes and conditions such as erosion, transport and deposition of bed material and nutrient cycling. The importance of LWD has also been touted in a publication by the National Research Council (1996) that documents that researchers consistently characterize LWD as one of the most important habitat elements for anadramous salmonids. Opperman and Merenlander (2007) summarizes the state of scientific knowledge on the value of wood for fish noting that:

> *"wood in streams and rivers provides critical habitat features for fish through a variety of mechanisms including pool formation (Montgomery et al., 1995), cover from predators (Shirvell, 1990), refuge during high flows (Tschaplinkski and Hartman, 1983), substrate for invertebrate prey (Benke and Wallace, 2003), promotion of riparian regeneration (Abbe and Montgomery, 1996), and deposition and storage of spawning gravels (Crispin et al., 1993) and organic matter (Bilby and Likens, 1980)."*

In addition to establishing the central role that LWD can play in the ecological and geomorphic processes that create and sustain aquatic habitats, significant research has been conducted over the past 20 years to better understand optimal rates of wood loading, the effects of different alignments and distribution of instream wood on channel forms and processes, the longevity and transport of wood, and the value of living LWD versus non-living LWD (Hildebrand et al., 1998; Bragg et al., 2000; Lassettre, 2001; Faustini and Jones, 2003; Opperman and Merenlender, 2007; Whol and Jaeger, 2009; and Thompson, 2012). Collectively, these studies not only provide a solid scientific foundation for assessing the quantity and quality of LWD in a given stream system, but also provide significant insights and guidance on designing and implementing LWD enhancement projects.

The National Marine Fisheries Service's (NMFS) recovery plan for the Central California Coast (CCC) ESU of coho salmon (NMFS, 2012) highlights the critical importance of LWD and the ecological and geomorphic role it can play in facilitating recovery of this species. According to the Recovery Plan, the habitat requirements for coho salmon in most streams in the Central CCC ESU are not at properly functioning conditions and their abundance has decreased, in large part, because the natural rates of critical watershed processes (e.g., sediment delivery, hydrology, wood recruitment, temperature regulation, etc.) have been substantially altered by human activities (NMFS, 2012). When in freshwater, optimal habitats for successful rearing include adequate quantities of:

1. Deep complex pools formed by large woody debris,
2. Adequate quantities of water,
3. Cool water temperatures,
4. Unimpeded passage to spawning grounds (adults) and back to the ocean (smolts),
5. Adequate quantities of clean spawning gravel, and
6. Access to floodplains, side channels and low velocity habitat during high flow events.

Numerous other requirements exist (e.g., adequate quantities of food, dissolved oxygen, low turbidity, etc.), but in many respects these other needs are generally met when the six freshwater habitat requirements listed above are at a properly functioning conditions.

In many streams, these essential pool and complex habitats have been altered or lost due to reduced water flows, historic logging, LWD removal activities from landowners and adjacent residents, increased rates of sedimentation, and loss, alteration, and simplification of riparian forests which leads to a lack of significant large wood recruitment. In San Vicente Creek, specifically, contributing factors are likely historical grazing adjacent to and within the riparian corridor and flood control methods in the community of Davenport (RCD, 2010). The deficiency of pools is indicative of the current and past land use practices and associated removal of LWD from riparian areas and streams within the channel.

Lack of recruitment is due in large part to the much younger age of current riparian forests which generally lack older, larger trees that fall into the stream as they age and die. The absence of large wood in the stream, in particular, has major impacts on coho salmon because of its role in physical habitat formation, in sediment and organic-matter storage, and in maintaining a high degree of spatial heterogeneity (habitat complexity) in stream channels. Instream pools provide an increase in the volume of rearing habitat and, as such, data indicates that stream reaches with a high density of deep cool pools allow for a greater density of juvenile coho than an equivalent length of stream with limited pool habitats (NMFS, 2012). Decreases in coho abundances following LWD removal or loss have been widely documented and are often linked to loss of pool habitat for summer rearing and for winter refuge. Maintaining pool habitats, reversing the mechanisms leading to their loss, and adding wood will be critical to ensuring adequate summer and winter rearing habitat in streams designated by the California Department of Fish and Wildlife (CDFW) and/or the NMFS for recovery of endangered central California coast coho salmon (NMFS, 2012).

While the NMFS Recovery Plan (2012) notes that water quality, fish passage and migration, stream temperature and water quality as being "good" or "very good", habitat complexity for San Vicente Creek is listed as "poor" for LWD and the shelter rating. To address these, NMFS priorities actions include:

1. Improve over-winter survival by increasing the frequency and functionality of off-channel habitat (Recovery Action 2),
2. Increase shelter ratings to optimal conditions (>80 pool shelter value) in mainstem San Vicente Creek (Recovery Action 3),
3. Increase large wood frequency (Recovery Action 4), and
4. Increase pool frequency to achieve optimal conditions (>40% of pools meet primary pool criteria (>2.5 feet deep in 1st and 2nd order streams; >3 feet in third order or larger streams) (Recovery Action 3).

Past Actions: A severe paucity of large woody debris and subsequent lack of pool habitat within San Vicente Creek Watershed has been noted by many biologists, ecologists, and planners over the past few decades, including the County of Santa Cruz (County of Santa Cruz, 2000) and RCD (2010). In response to this lack of pool frequency, abundance and depth, the County of Santa Cruz installed 18 complex large wood habitat structures in 1999 within a reach extending from approximately one mile above the mouth of San Vicente Creek to the confluence of San Vicente and Mill Creek at stream mile 2.5. A total of 106 pieces of large wood and root balls were installed. Natural stream meander has since rendered a number of these structures nonfunctional, but some remain in or along the channel and continue to provide refugia for anadramous fish through maintenance of pools and slack water and increased instream cover (RCD, 2010).

While reconnaissance level stream surveys conducted by the RCD and its partners for the Bureau of Land Management (BLM) in 2010 revealed greater frequency and complexity of LWD features (compared to observations in 2008) in a small reach below the lower pond outlet (RCD, 2010), this study noted that a quantitative assessment of current LWD loading was needed for the entire watershed. The RCD's work for this assessment focused on identifying near-future opportunities for LWD augmentation projects within an approximately 1-mile reach of lower San Vicente Creek extending from the inlet to the Lower San Vicente Pond upstream to the first bridge across the creek. This particular focus area was chosen based on the following criteria;

» The channel slope, substrate and proximal floodplains create natural conditions for LWD structure to develop, persist, and have maximum benefit for pool creation, sediment sorting, and reconnection of high flows with floodplains,

» Historic and current NMFS snorkeling surveys noting that juvenile coho salmon in San Vicente Creek have generally been observed using small pockets of habitat in the lower most 1 mile of the creek,

» LWD augmentation projects had previously been installed upstream of the bridge by the County, and

» The channel downstream of the Lower San Vicente Creek Pond outlet is geomorphically unstable (due to periodic backwatering effects of the Highway 1 culvert), in close proximity to residential development, and currently contains a number of smaller, naturally occurring LWD structures composed of a mix of live and dead alders, willows, and other material.

Based on the findings of the reconnaissance surveys, the RCD, with funding and support from CDFW, NMFS, and the Natural Resources Conservation Service (NRCS), installed eight LWD structures in 2011 in the focus area reach of in an effort to improve rearing and sheltering habitat for salmonids (RCD, 2010). Seventeen redwood and Douglas fir trees were sourced from the Santa Cruz Mountains, keeping the majority of their rootballs intact. These logs were buried into the banks of San Vicente Creek with the root wads placed directly into the creek itself. Each structure was designed with a different configuration to encourage recruitment of additional smaller woody debris, increase Instream habitat complexity, activate the adjacent floodplain and provide higher quality rearing and cover habitat for juvenile salmonids. Two-ton boulders and bolts were used to anchor each structure in place. Based on post-construction monitoring data and observations by the RCD and partners, each of these installed structures has affected stream geomorphology and resulted in changes in the channel conditions. Most importantly, however, data from NOAA's Southwest Fisheries Science Center indicates that juvenile coho and possibly steelhead are preferentially using these structures as cover habitat with the highest densities of juveniles in and around these structures (Kiernan, J., pers comm.). Additional information on fisheries is discussed in detail in chapter 4 of this report. The project is intended to enhance steelhead and coho salmon rearing habitat by increasing channel complexity, and reactivating nearby floodplains while the natural LWD recruitment process recovers. It is anticipated that the LWD structures will reactivate the floodplain, deepen pools, promote substrate sorting, enhance riffles, create gravel bars and provide cover, winter refuge and summer rearing for coho salmon and steelhead trout.

The existing abundance and complexity of LWD within San Vicente Creek is understood to be low, but no formal surveys have been completed for the entire reach of anadromy in recent years. Understanding the current state of large woody debris within the channel, as well as possible future recruitment within the watershed, will allow future LWD augmentation efforts to be better targeted towards LWD-poor reaches where constraints to project implementation are relatively minor.

Many stream restoration projects are implemented without information about the amount of wood that historically occurred or the natural rates of wood recruitment. The Large Woody Debris assessment conducted as part of this *San Vicente Creek Watershed Restoration Project* will take inventory of large woody debris in San Vicente Creek to inform specific recommendations for locations within the watershed that are lacking LWD and identify where LWD enhancement projects are needed and feasible.

METHODOLOGY

A LWD Stream and Riparian Inventory was conducted between July 15 and October 20, 2013 on San Vicente Creek and Mill Creek utilizing a method outlined in the California Salmonid Stream Restoration Manual (Flosi et al., 1998) with adaptations used by Leicester (2005).

Table 5- 1. Reach lengths (feet), number of samples per reach, and Rosgen channel classification types.

Reach	Length (ft)	Number of Samples	Rosgen Channel Type
1	5,932	6	F3
2	1,628	2	C3
3	4,888	4	B3
4	3532	3	F4
5	2683	2	A5
6	2347	2	B3

The inventory was conducted by two people walking in the stream channel, proceeding upstream. Stream distances were measured using a hipchain. Slopes were measured using a clinometer at all slope breaks (bankfull, riparian, upslope) and given as a percentage as measured from the thalweg. Where satellite reception was available, a GPS unit measured starting and ending coordinates for the sample reaches. Average bankfull channel depths were measured at the thalweg using a stadia rod and bankfull widths, tree diameter and widths were measured using a tape measure.

San Vicente Creek was divided into five reaches by stream channel types based on Rosgen's methodology, as documented in CDFW's Stream Habitat Assessment Report for San Vicente Creek (2010). Mill Creek was divided into two reaches by stream channel types using Rosgen's methodology, as documented in CDFW's Stream habitat Assessment Report for Mill Creek (2010). Reaches were surveyed to the extent of anadromy, with all five reaches of San Vicente Creek surveyed to the tunnel and Reach 1 of Mill Creek surveyed to the historic Davenport intake dam. Reach 1 of Mill Creek is hereafter referred to as Reach 6. (see Figure 5-1f). See Table 5-1 for the length and channel classification of each reach. This assessment does not consider wood recruitment potential above the quarry on San Vicente Creek or above the water intake system on Mill Creek, nor does it consider the disruption of wood transport created by these barriers.

Data were collected in 200-foot segments every 1000 feet for each of the 6 reaches. The segments were randomly selected by numbering the 200-foot sections and tossing a dice to determine which segment to begin. The first 200-ft section was labeled Sample Area 1 (see Figures 5-1). See Table 5-1 for the number of samples per reach. One LWD Inventory Form was completed for each 200-foot section. After conducting the survey in this initial segment, the surveyors proceeded upstream 800 feet from the upper end of Sample Area 1 and inventoried the next 200 feet as Sample Area 2. Sample Area 3 began 800 feet upstream from the upper end of Sample Area 2, etc. This procedure was followed for each of the channel types.

Data were collected using a "Large Woody Debris Inventory Form", adapted by Leicester (2005). The form is designed so that the right and left streambank are defined looking downstream. One surveyor observed LWD, estimates sizes, and tallied LWD on one bank and LWD within the stream channel, while the other observer tallied the opposite bank.

At the beginning of each day, prior to categorizing and recording LWD, field personnel selected several pieces of LWD for sight calibration. Diameter ranges were estimated and then verified by measuring with a diameter tape. Also, sight estimates of 6, 20, and 50 feet were calibrated with length measurement verifications. Standing tree diameter was determined at breast height (54") above the ground measured from the

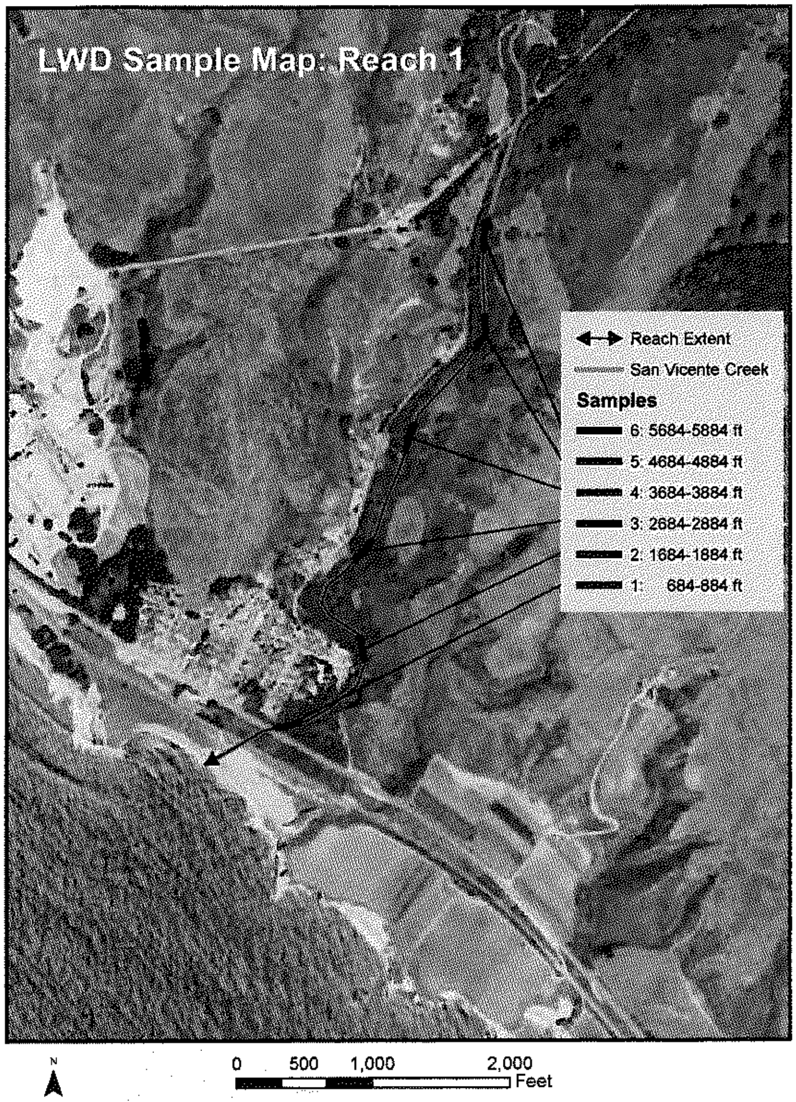


Figure 5-1a. Reach 1 LWD sample map

upslope side of the tree. Diameter of downed logs was the largest diameter anywhere along the log. During the survey in each 200-foot sample area, the surveyors periodically confirmed size, dimensions, and distances for accuracy and calibration. This ongoing calibration effort kept the surveyors' estimates more accurate.

Leicester's (2005) protocol requires identifying trees and LWD to the species level, as coniferous LWD is more decay resistant then hardwood and likely to persist in the channel longer. Secondly, as the probability of a tree falling into the stream decreases from the channel upslope, Leicester separates habitats into perched, riparian, and upslope zones to further evaluate recruitment potential. Perched applies to standing live or dead trees within the stream channel or to trees or downed wood at the edge of bankfull (active) channel, which are likely to be recruited at high flows. Riparian designates an area beginning at the edge of the bankfull channel and dominated by deciduous riparian trees. Upslope designates an area beyond the riparian zone that still falls within 75 ft of the bankfull channel. However, downed wood that cannot be observed has little chance of making it to the stream and thus, is not tallied. Slopes were measured for the riparian and upslope zones separately. Thirdly, four categories are used within the bankfull channel to indicate the effects of LWD on habitat features: a) lowflow/pool for LWD pieces in the lowflow channel which are creating or enhancing a pool, b) lowflow/extra for pieces in the low flow channel present but not creating pool habitat, c) bankfull/backwater for pieces in the remainder of the stream channel which were creating or enhancing backwater or high water refugium, and d) bankfull/extra for pieces in the bankfull channel which were present but not contributing to the creation or enhancement of backwater or refuge habitat. Bankfull width and depth were also measured.

For this assessment, Leicester's protocol was further refined to address specific conditions associated with the San Vicente Creek watershed. Wood recruitment potential was documented as less than 75 feet, if the edge of an access road was located within the 75 feet. This is because past observations show that when trees fall across the road, they are cut up with a chain saw for road access and are removed from the system as possible LWD.

In addition, Leicester (2005) noted a deficiency in the survey method of LWD debris jams as they often occurred outside sample boundaries and were not tallied. As the location of LWD structures vary in distribution they may not be included in the 200 foot sample sections and a significant portion of the total in channel LWD present in the stream may not be recorded. As this underrepresentation of wood accumulation could affect not only the documented health of the stream system, but also influence future recommendations, all LWD structures were noted during stream surveys and the findings are discussed separately in the following section.

All LWD and trees located within the sample areas and which measured greater than 6 feet (1.8 m) in length and 1 foot (30 cm) in diameter were identified to species and recorded with their sizes, locations, positions in the channel and association with any habitat structures (pool or backwater). The form categorizes trees, logs, and stumps in the bankfull channel or adjacent to the channel by length [6-20 feet (2-6 m), >20 feet (>6 m), diameter [in 1-foot (30 cm) increments from 1 foot (30 cm) to >4 feet (120 cm)], and location (bankfull channel, "perched" at the edge of the bankfull channel, or upslope; on the left or right bank). All trees within the channel and/or 75 feet (23 m) up the bank on either side were recorded by diameter as live or dead. Out-of-channel trees and logs are also recorded as conifer or deciduous. Root wads and stumps are also differentiated. Stumps are fully rooted in the ground and are at distances far enough from the stream that there is

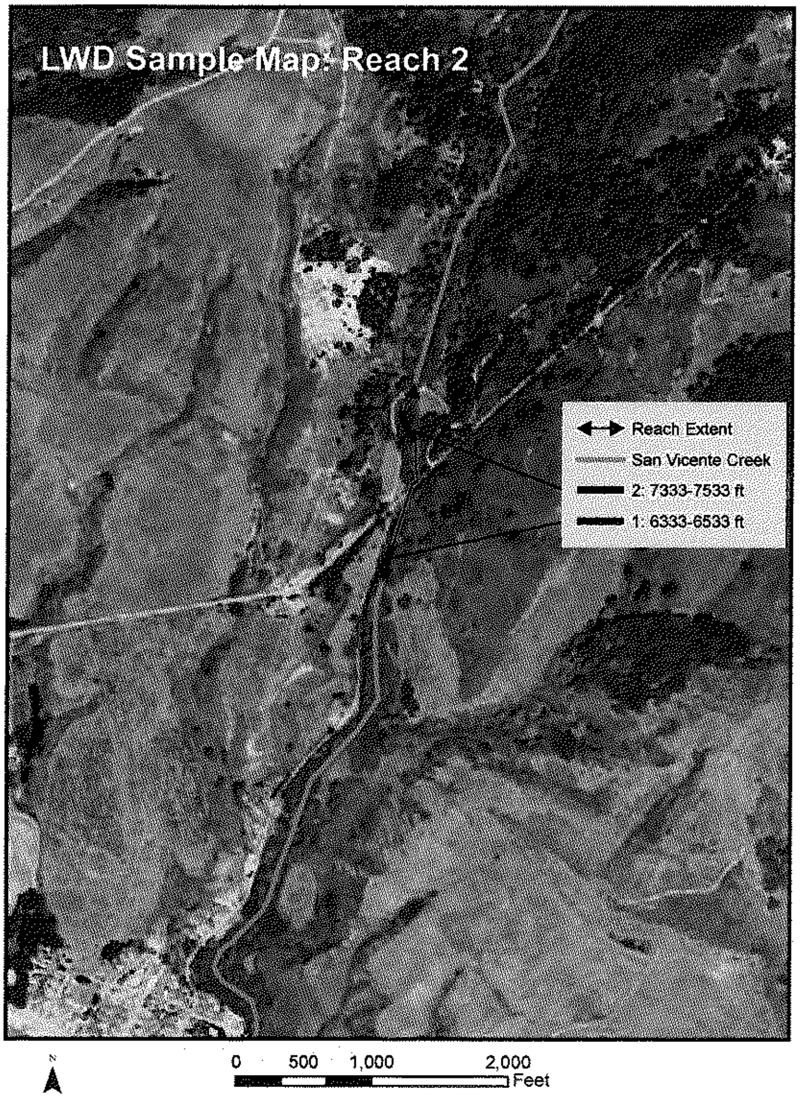


Figure 5-1b. Reach 2 LWD sample map.

little or no potential of them being uprooted and entering the instream zone. Root wads have a high potential for reaching the stream channel. Root wads classified as dead/down are anchored in the ground by less than 25 percent of their root system, or are already "loose" and free to be moved, or are already in the channel. Root wads classified as dead/standing are anchored in the ground by at least 25 percent of their root system and have a good likelihood of being moved from the recruitment zone (bank) to the stream channel, or may already be in the stream channel. Root wads classified as "perched" are on the bank, and their movement into the stream channel is imminent. There is no classification for "live" root wads. If a root wad was sprouting, it was classified as a live tree and categorized based on diameter of the sprouting stem.

Field tallies were organized by reach and total LWD counts were recorded and analyzed using Microsoft Excel 2007. Data within sample reaches was then extrapolated to the entire reach to estimate the actual density of wood for recruitment based on data collected for each 200 ft sample. Data was further standardized by factoring reach length to evaluate number of trees or logs per linear foot of stream reach.

If LWD, due to length or positioning, was located and/or functioned in more than one category within the active channel and/or in upslope areas, LWD was tallied on the form to indicate that it occurred in multiple different categories by making a hatch mark representing the root, and drawing a line representing the trunk through all areas in which the LWD occurred. For example, if a downed tree had its root in the riparian dead/down category and its crown in the bankfull channel/extra category, a hatch mark would be made in the riparian dead/down column on the form, and a connecting line drawn to the bankfull/extra column on the form, to accurately indicate the position of the downed tree. Where LWD was found to be located in two or more areas of the active channel or upslope areas, it was classified as being located in the most biologically valuable category in terms of habitat formation. For example, a piece tallied as being located in both "bankfull/ extra" and "bankfull/backwater" would be classified for analysis as being only in the "bankfull/ backwater" category because structure-forming LWD is more biologically valuable due to the habitat it creates (see Appendix D to view LWD Survey Data).

FINDINGS

Stream Characteristics

San Vicente Creek within Reach 1 has a gentle slope (<1.5%) and a bankfull width of approximately 27 ft with a fairly extensive but inactive floodplain is located on the left (east) bank. Residential development (Davenport) is located close to the right (west) bank for the lower portion of this reach. Alders are the dominant hardwood in the reach (48%), followed by Willow (33%) and Maple (17%).

Reach 2 has a gentle slope (<1.5%) and a bankfull width of approximately 29 feet. The floodplain within this reach is generally narrow due to steeper topography on the right bank and the proximity of San Vicente Street within 50 to 75 feet of the right bank. Alders are the dominant hardwood in the reach (71%), followed by Maple (18%) and Tan oak (10%).

Reach 3 narrows slightly and increases in slope with a private access road visible along the left bank. Alders are the dominant hardwood species (92%) and redwood is the dominant conifer species (91%), followed by Doug Fir (9%).

Reach 4 has a 3 to 6% slope and becomes slightly wider with a bankfull width of approximately 28 feet. The private access road is visible for most of the reach along the right bank. Alders are the dominant hardwood species (90%). Redwood is the dominant conifer species (67%), followed by Doug Fir (50%).

Reach 5 has as >6.5% slope and a bankfull width of approximately 24 feet. The private access road

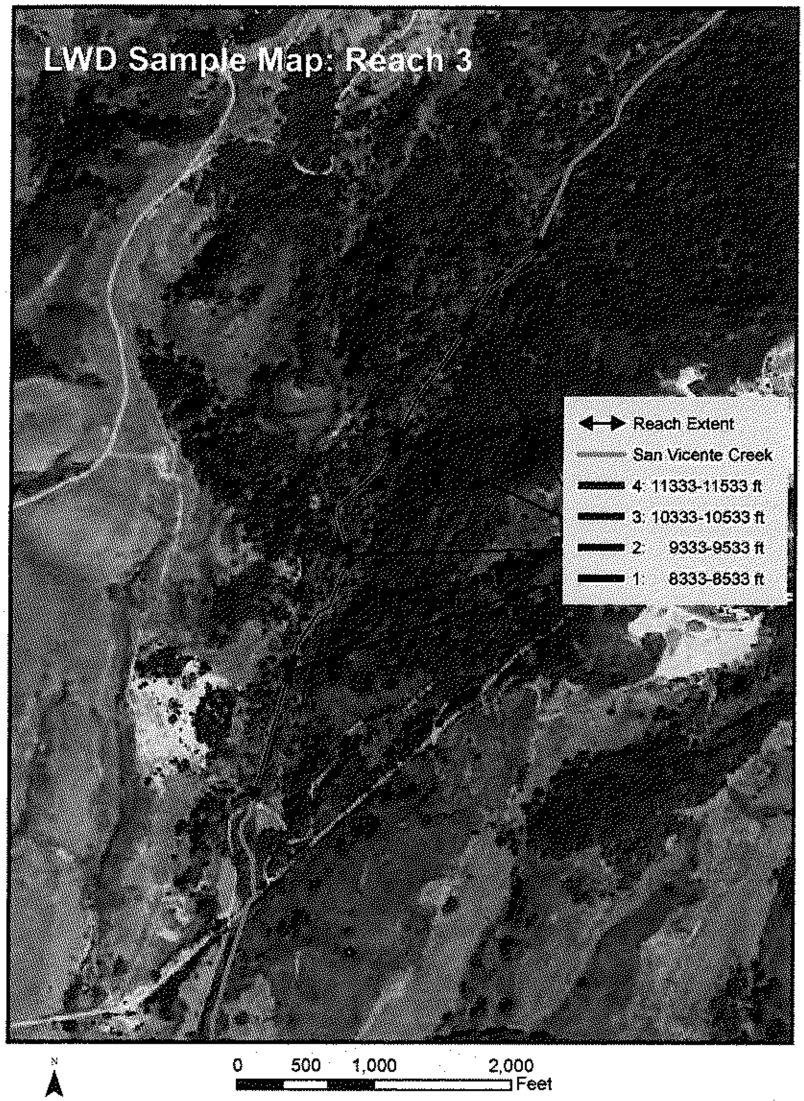


Figure 5-1c. Reach 3 LWD sample map

remains visible on the right bank. Doug Fir is the dominant species within this reach (87%).

Reach 6 has a bankfull width of approximately 11 feet. This is the steepest (>7%), most incised reach and is dominated by Redwood (65%), followed by Doug fir (34%). A private access road is visible for a portion of the reach on the right bank.

Wood Distribution

Recruitment of large pieces of wood to streams is a dynamic process consisting of episodic disturbances, chronic riparian forest mortality, and stream erosion processes (Lienkaemper and Swanson, 1987; Benda et al., 2003). Wood recruitment into streams occurs either as a result of individual tree mortality or as a consequence of fine to coarse scale disturbances affecting multiple trees in the riparian forest (Benda et al., 2002). While individual tree mortality, caused by forces such as windthrow, contributes wood to the stream system, larger disturbance are responsible for the majority of wood recruitment. As streams meander onto broad floodplains, they create scour and cause shallow rooted trees (e.g., Alder) to fall into the stream, as well as remobilize stored wood. Likewise, during larger storm events as the water levels rise, streambank erosion can occur, undercutting trees in perched and riparian areas. These trees may fall directly into the stream or be deposited onto the streambank and recruited during future high flow events.

The width of floodplains and riparian areas influences the amount of wood readily available for recruitment. McDade et al. (1990) looked at LWD recruitability as a function of distance from the stream and found that 70% of wood originates from within 65 feet of the stream channel. To determine the recruitment potential from the perched and riparian areas in San Vicente Creek, the width of the riparian area was considered. Overall, the riparian area was widest in the downstream reaches where a broad, inactive floodplain has been noted for the left bank and gentle slopes allowed the stream to historically meander (see Table 5-2 and Figure 5-2). The widest riparian (mean) width was recorded for Reach 1 (61.7 feet), where the stream would have historically meandered (prior to construction of Highway 1) in this lower, flatter area before emptying into the Pacific Ocean. In Reach 4, the stream channel widens and flattens out (discussed as plane-bed in chapter 3) before steepening and becoming higher gradient and narrowing in the upper reaches, particularly for Reach 6 (Mill Creek), which had the lowest mean width (<17.5 feet). The riparian area is further confined in the upper reaches by the private access road, which was constructed adjacent to the stream channel. If wood recruitment occurs within 65 feet of the stream, most of the wood recruitment in the lower reaches of San Vicente Creek will be from the riparian area, whereas in Mill Creek, most of wood recruitment will occur in the upslope areas.

While McDade et al. (1990) considered proximity to the stream channel as a function of wood recruitment, it could also be hypothesized that a wider riparian corridor would have a greater tree density and thus a higher recruitment potential. Reaches 1, 3, and 4, which had the widest riparian areas when left and bank mean widths were averaged (56, 38, and 48 feet respectively), had the highest density of trees and logs within the riparian area per reach (490, 623, and 589 respectively) (see Figure 5-3). Reach 2, which had the same riparian width as Reach 3 (38.8 feet) had the lowest density of trees (90). Reaches 5 and 6, which had narrower riparian widths (35 and 16.3 feet respectively), had the lowest density of trees and logs within the riparian area per reach (148 and 217 respectively). When the values were standardized to eliminate the skew created by

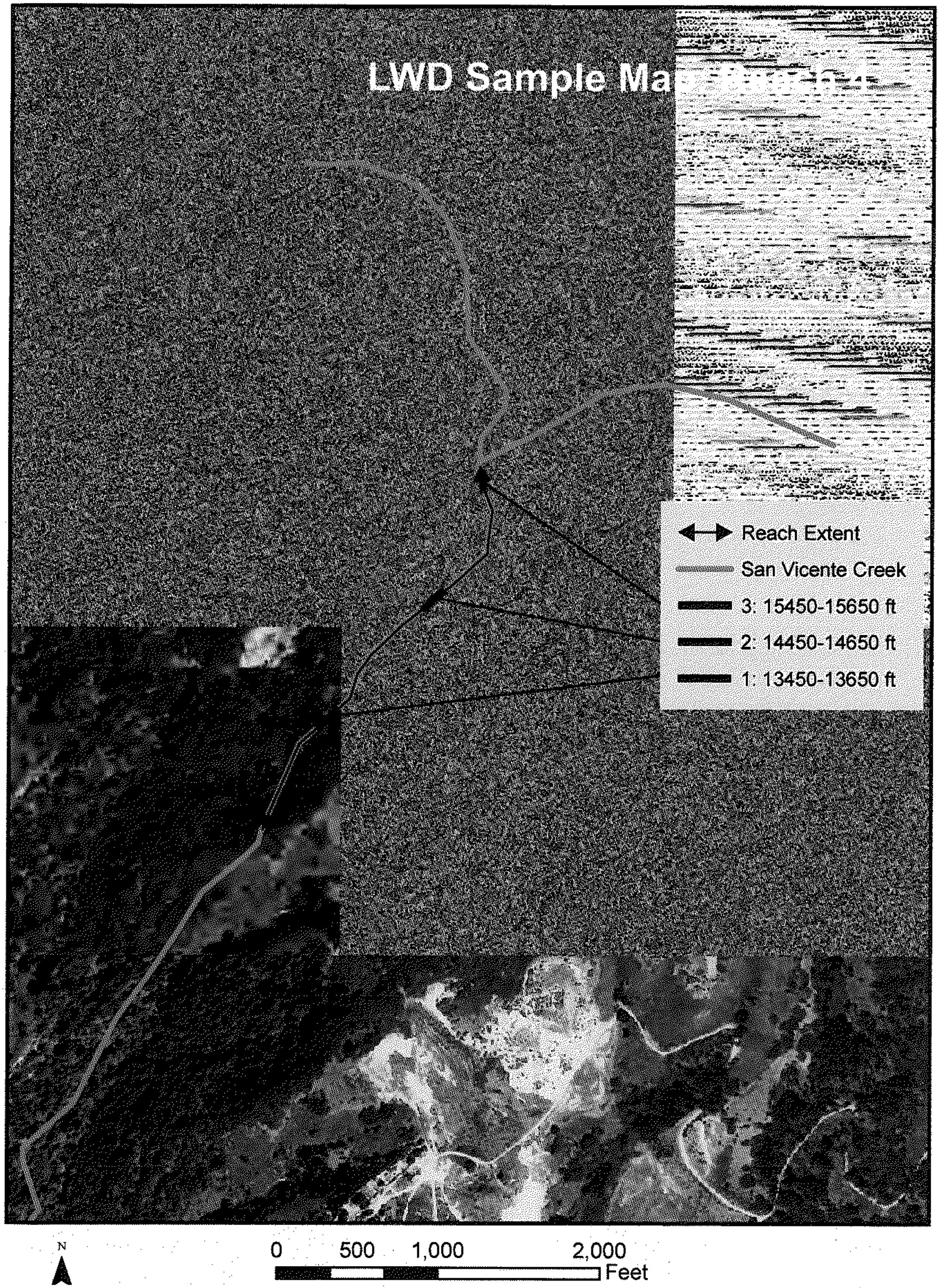


Figure 5-1d. Reach 4 LWD sample map.

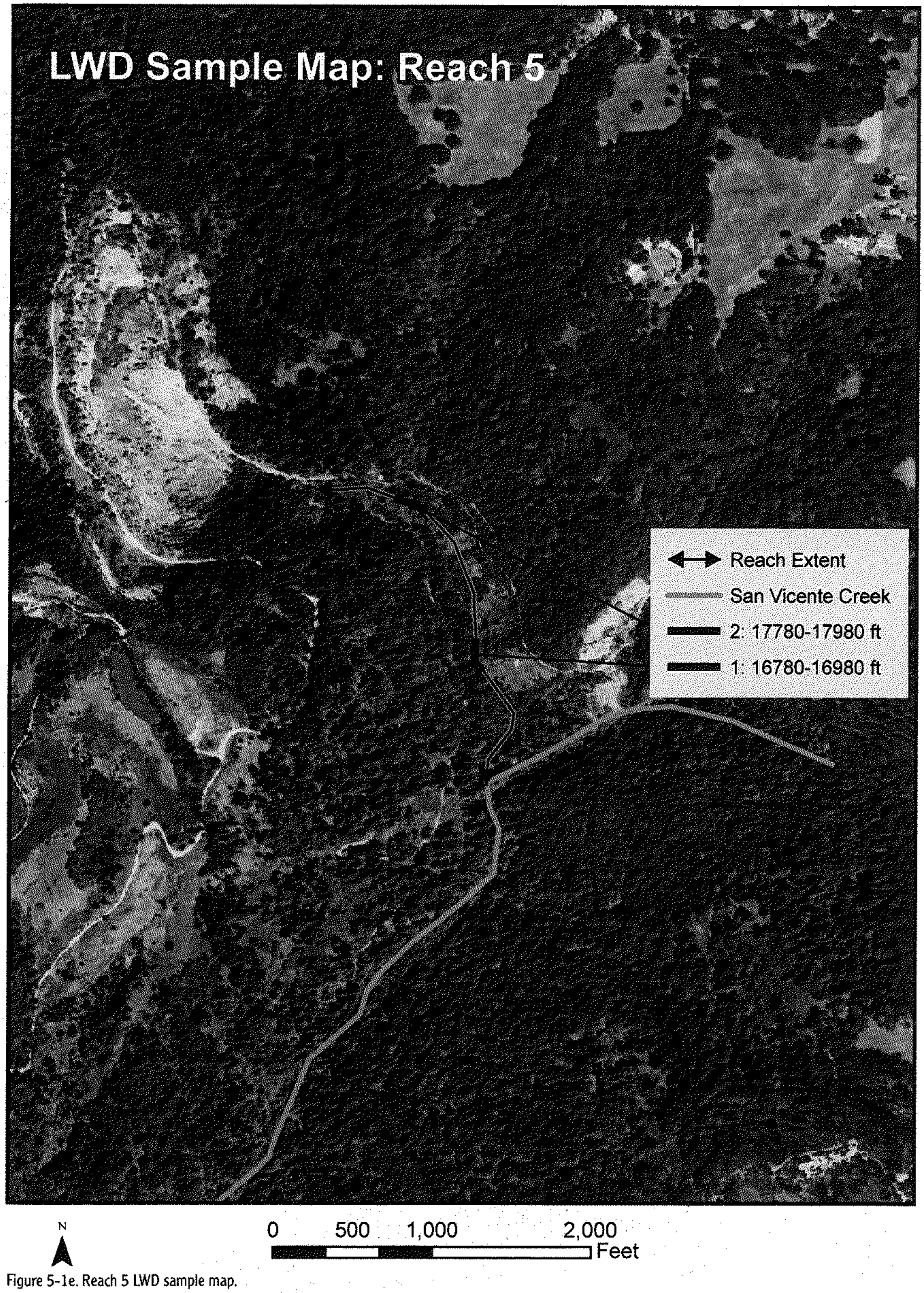


Figure 5-1e. Reach 5 LWD sample map.

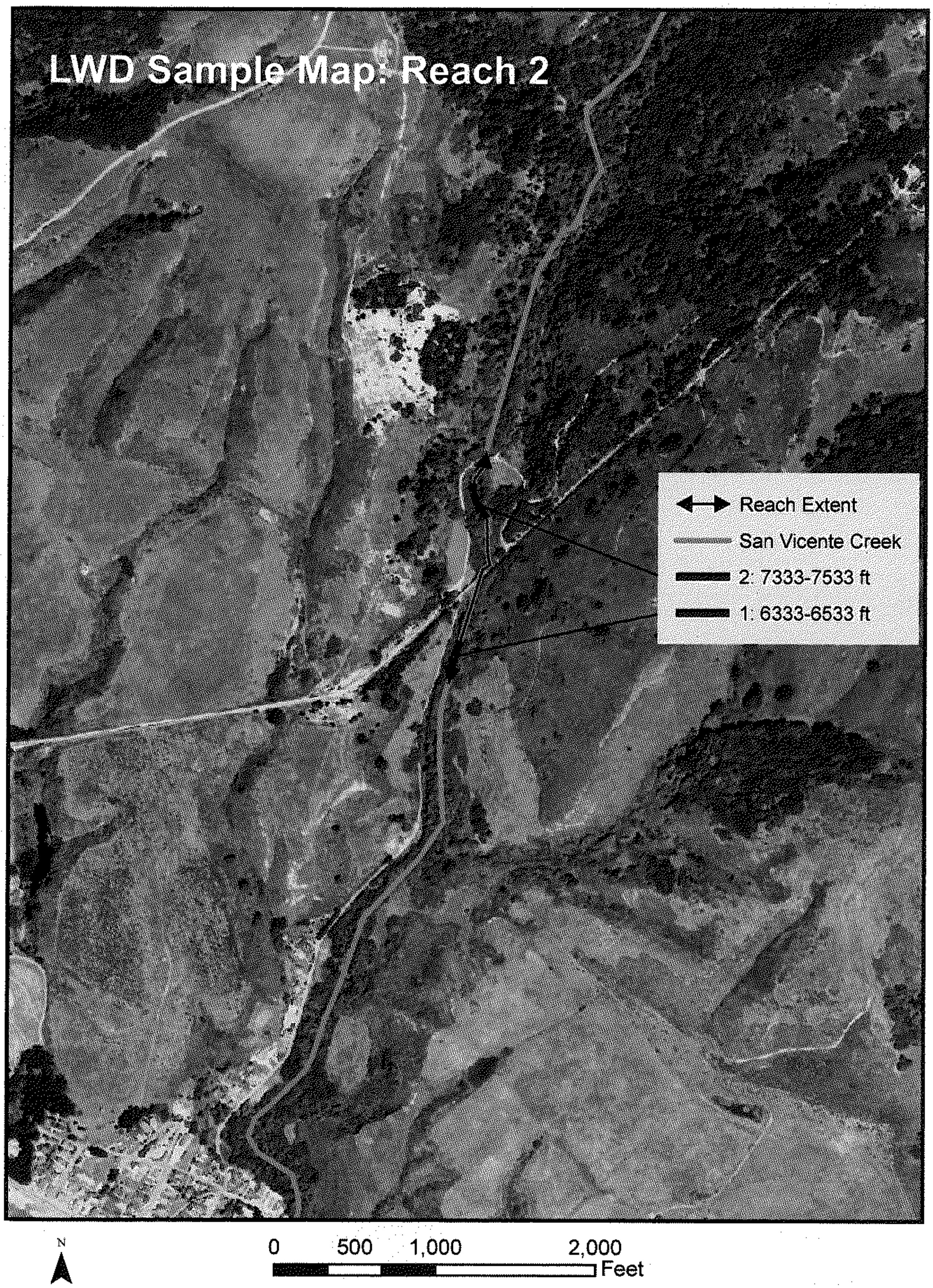


Figure 5-1f. Reach 6 LWD sample map.

Table 2. Reach lengths (feet), number of samples per reach, and Rosgen channel classification types.

	Riparian Width (ft)				Slope (%)							
	Left Bank		Right Bank		Left Bank Upslope		Left Bank Riparian		Right Bank Riparian		Right Bank Upslope	
Reach	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range
1	61.7	20-75	50.8	25-75	32.5	29-37	28.7	13-45	22.8	11-42	21.3	9-30
2	50.0	50.0	27.5	25-30	43.5	36-51	16.5	15-18	26.0	23-29	35.0	35.0
3	45.0	40-60	32.5	20-40	30.0	30.0	19.5	9-29	18.0	8-34	65.0	25-90
4	48.3	40-60	48.3	45-50	51.7	35-64	24.3	13-43	19.7	19-20	53.0	53.0
5	42.5	35-50	27.5	25-30	65.0	65	27.5	20-35	40.0	35-45	56.0	47-65
6	17.5	ID	15.0	ID	40.0	35-45	19.5	14-25	47.5	40-50	42.5	15-70

varying reach lengths, reaches with the widest riparian area (Reaches 1, 3, and 4) were still found to support the highest amount of riparian trees (see Figure 5-4). While, Reach 2, which had the shortest reach length (1,628 feet), shows a higher density of trees with standardization (0.06 trees per linear foot), this is still substantially lower in terms of potential wood recruitment than the other reaches. Reach 6, which had the narrowest riparian area (17.5 feet), also shows a higher density of trees with standardization (0.09 trees per linear foot), which is slightly higher than Reach 1.

As floodplain re-activation will be critical to restoring stream function and wood recruitment processes in San Vicente Creek, wide riparian areas will be a plentiful source of wood in the future, particularly in those areas with gentle slopes. Reaches 1, 3 and 4 have both the widest riparian areas and the gentlest slopes when looking at the ranges for both the left and right banks (see Table 5-2). While Reach 6 may have adequate wood recruitment potential, the narrow channel will likely limit the transport of this wood material downstream to valuable coho habitat.

As the stream exerts erosive forces on the bank over time, a wider riparian area with a corresponding increase in tree density has a greater potential to have perched trees. Similar to the riparian areas, there was a pattern of an increase in

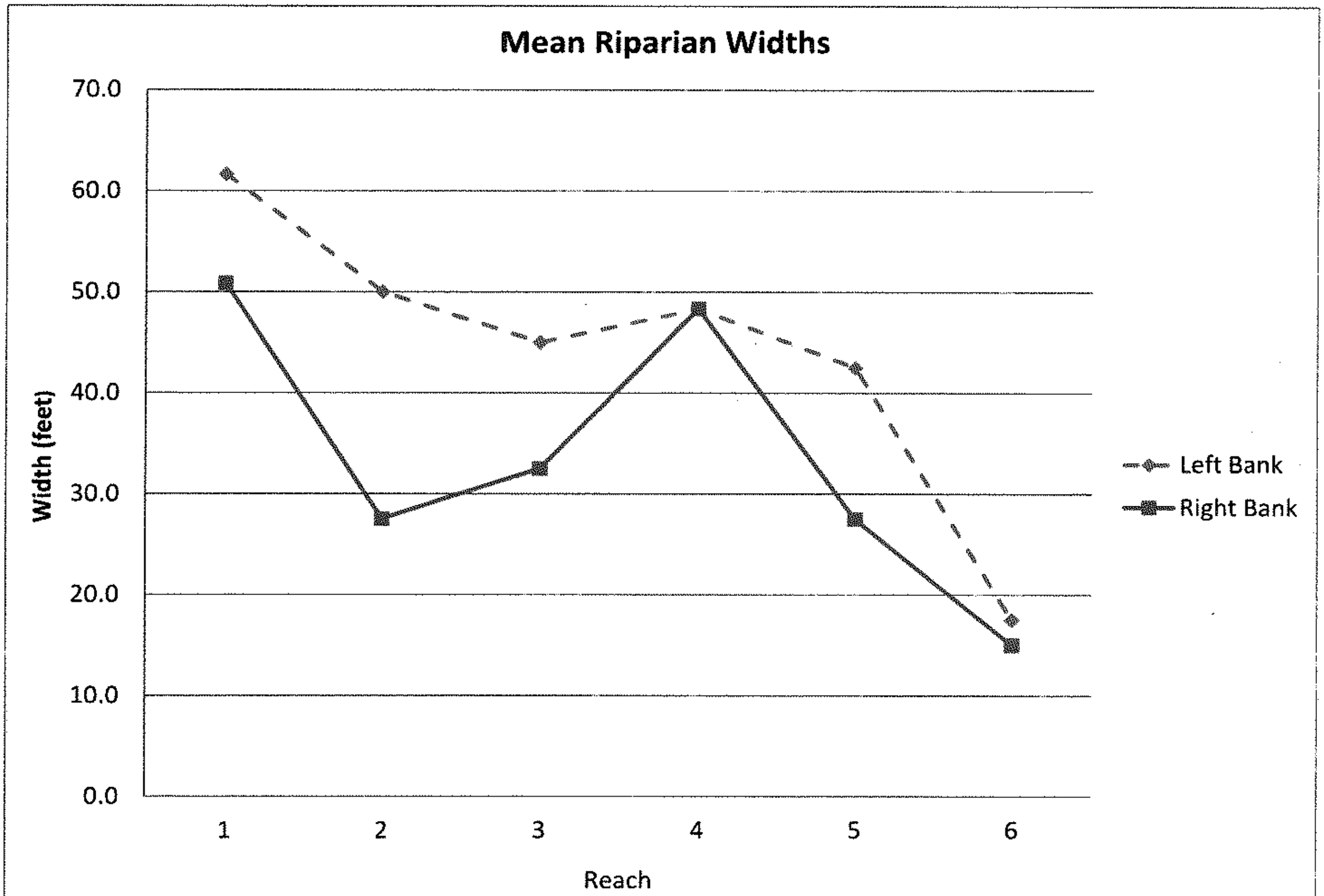


Figure 5-2.

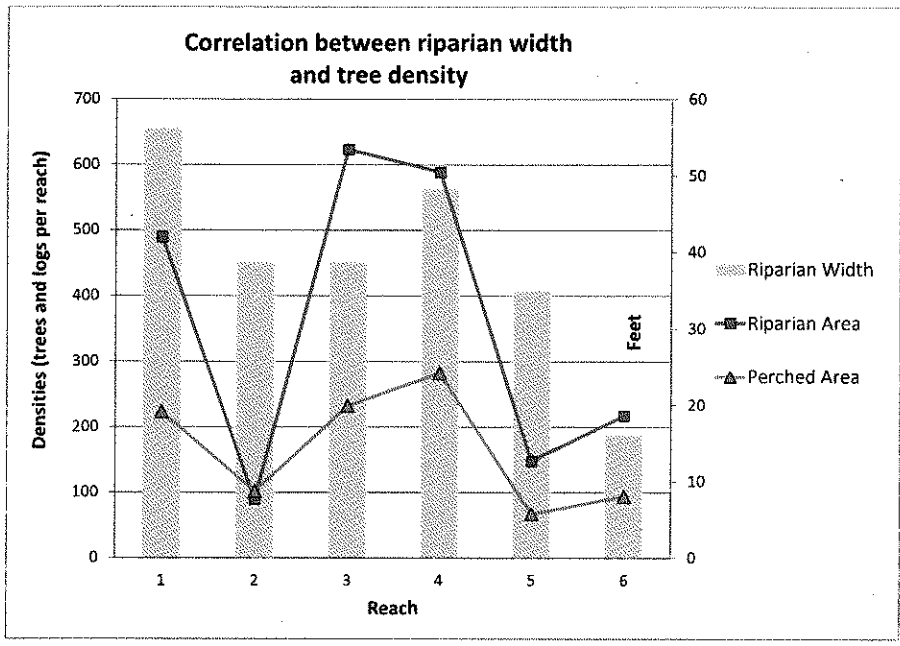


Figure 5-3.

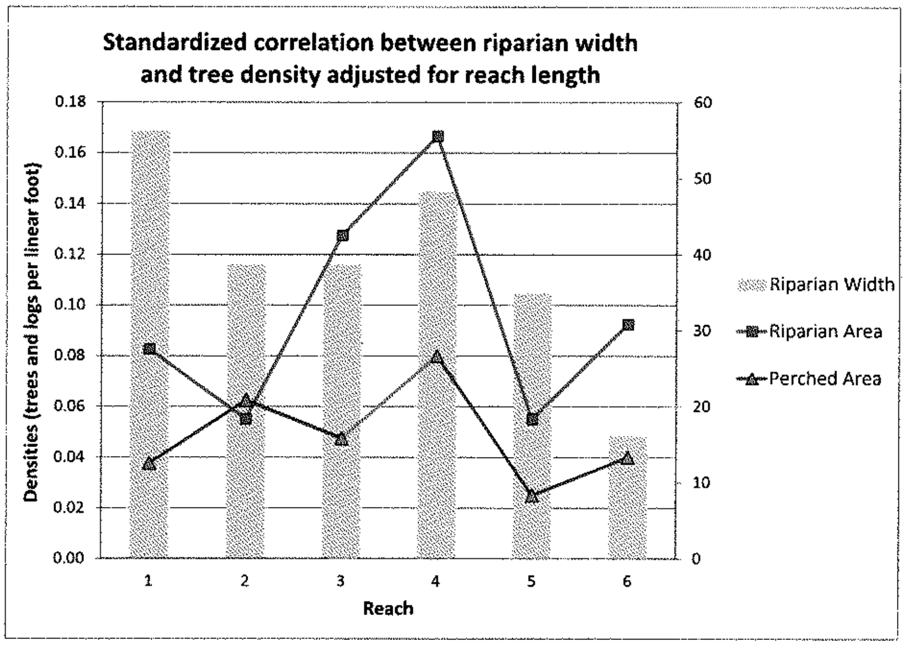


Figure 5-4.

the density of trees within the perched (edge of bankfull) zone with an increase in riparian width. Reaches 1, 3, and 4, which had the widest riparian areas, also had a higher density of perched trees (223, 232, and 283 respectively, see Figure 5-3). A corresponding decrease in the density of perched trees with decreasing riparian width can be seen for Reaches 5 and 6 (see Figure 5-3). However, when the values were standardized to eliminate the skew created by varying reach lengths, Reaches 2 and 4 had the highest density of trees and logs per reach (see Figure 5-4). It appears that Reach 2, while short in length, has a potential to contribute wood to the stream from the perched area.

When combined, the riparian and perched areas account for over 75% of the total vegetation (see Figure 5-5). Reach 3 has the highest density (855), followed by Reach 4 (872), and Reach 1 (713). Reach 6 has the next highest density of logs and trees (248), but delivery of this wood to downstream habitat, as previously mentioned, may be limited.

Because only 75 feet of bank on either side of the channel was included in sampling, densities of trees tallied in upslope areas depend largely on how much of that 75 feet fell within the riparian area. There is a weak correlation between increasing riparian width and an increase in riparian vegetation and a decrease in the density of upslope trees (see Table 5-3). Reach 1, which had the widest riparian width (56 feet), supported the greatest amount of riparian trees (69% based on the total tree density in the reach) and had the second lowest density of trees in the upslope habitat (15%). Reach 6, which had the narrowest riparian width (16 feet), had the lowest density of riparian vegetation (41%) and the highest density of upslope vegetation (42%). Wood recruitment from wider upslope areas will likely depend on large, episodic events for wood contribution rather than smaller storm events.

Wood Type

Because the residence time of wood in the stream has been linked to wood type (i.e. hardwood versus conifer), the type of trees growing in the perched, riparian and upslope areas was considered as part of this assessment. Generally, species that decay more slowly will remain in the stream longer and will therefore have a longer term impact on standing stocks of large wood (Benda et al., 2002). Hyatt and Naiman (2001) found that even large-diameter hardwoods, when dead, are broken down into small pieces and flushed from the channel more quickly than conifers of equal diameter. That said, Opperman and Merenlander (2007) found in their research on small coastal streams in California that over 40% of channel spanning large wood jams contained a living piece as the key piece. Their research also found that living wood within a jam was, "geomorphically functional at smaller dimensions than dead wood." This research is particularly interesting

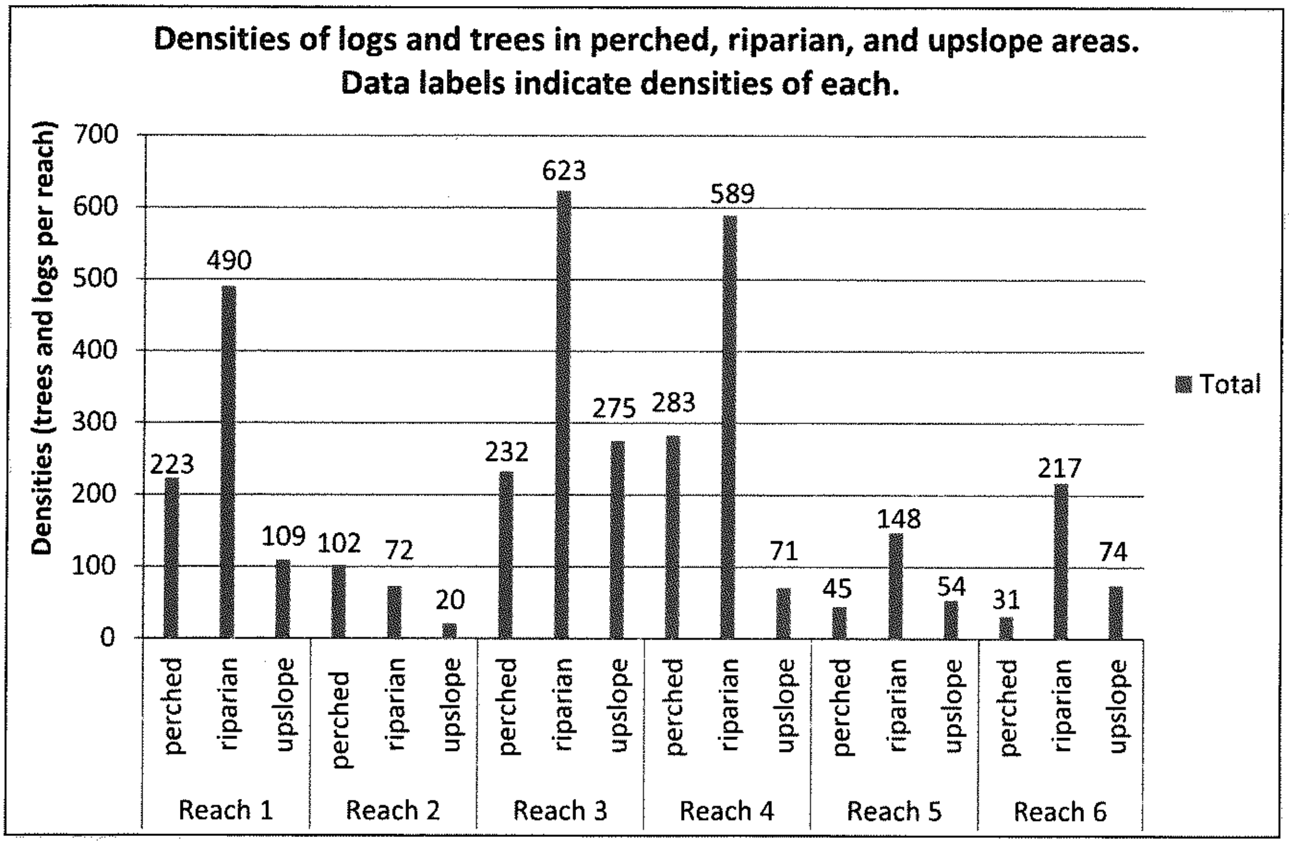


Figure 5-5.

as this assessment showed that the majority of recruitable wood along the floodplain is hardwood.

Riparian vegetation type was roughly linked to riparian width, with the wider, downstream reaches dominated by hardwood riparian forests and the narrower upstream riparian areas having more abundant conifers (see Figure 5-6). Reach 1 had almost 500 hardwood trees compared to less than 55 hardwoods in Reaches 5 and 6. Likewise Reaches 1 and 2 had fewer than 10 conifers, while Reaches 5 and 6 had greater than 125. When the values were standardized to eliminate the skew created by varying reach lengths, the wider downstream reaches were still dominated by hardwood riparian forests (4 to 9 trees per linear foot), while the upper reaches had a higher proportion of conifers (5 to 7 trees per linear foot) (see Figure 5-7). Reach 4 has the highest density of conifers (0.03 trees per linear foot) and second highest density of hardwoods (0.05 trees per linear foot).

Similar to the riparian zones, the perched area was dominated by hardwoods (see Figure 5-8 and Figure 5-12). As the "perched" category is defined as a hardwood-dominated transition area, it makes sense that it is dominated by hardwood species. As perched trees are the result of bank undercutting and erosion, these hardwood species are more likely to be recruited to the stream channel during flood events and thus contribute to the high proportion of hardwood within San Vicente Creek. While Reaches 1, 2, and 3 were still dominated by hardwoods, when the values were standardized to eliminate the skew created by varying reach lengths, there is an inverse relationship

Table 5-3. Correlation between riparian width and density of vegetation. The percent given represent the number of trees within the perched, riparian, or uplsope areas based on the total number of trees per reach.

Reach	Riparian Width*	Percent of Total , Riparian	Upslope Width*	Percent of Total, Upslope
1	56	69	19	15
2	39	42	36	10
3	39	55	36	24
4	48	63	27	27
5	35	52	40	24
6	16	41	59	42

*width has been rounded to a whole number.

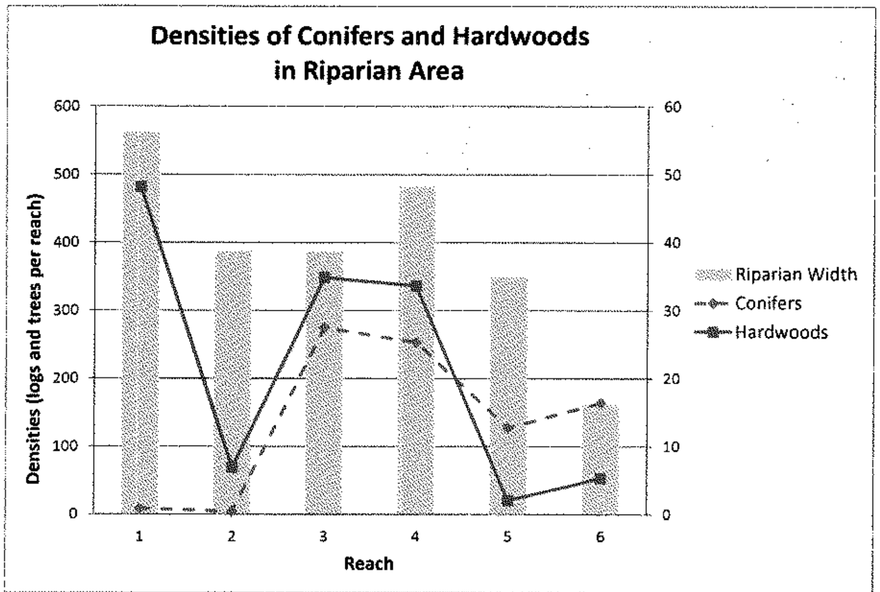


Figure 5-6.

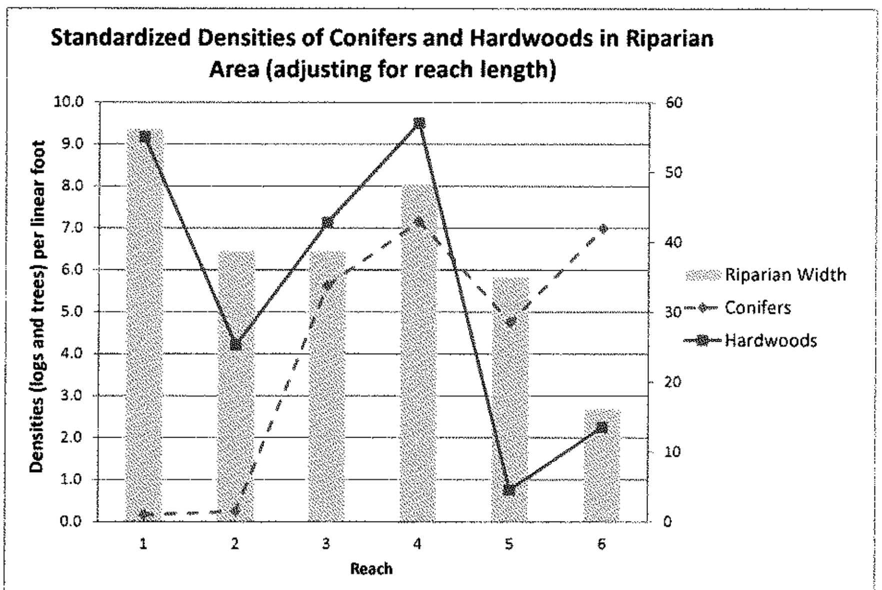


Figure 5-7.

(see Figure 5-9). Reaches 1 and 3, which are the longest reaches (5,932 feet and 4,888 feet, respectively), show a lower value of perched trees per linear foot (<0.03 trees per linear foot), while Reach 2, which is the shortest reach (1,628 feet), shows an increase in perched hardwoods (0.05 trees per linear foot). Regardless of the density, the lower reaches are dominated by hardwood species, which are likely to decay faster when recruited as LWD than conifer species.

The upslope areas were dominated by conifer species in all reaches except Reach 1 and Reach 2 (see Figure 5-10 and Figure 5-12). Reach 3 had the highest number of conifers. Reach 1 had over 100 hardwood trees in the upslope area, but no conifers were noted. When the values were standardized to eliminate the skew created by varying reach lengths, a similar pattern was seen (see Figure 5-11). While Andrus et al. (1993) speculated that there was a significantly greater percentage of pieces that should move toward the stream on steep slopes than on gentle slopes, McDade et al. (1990) found no significant difference between source distance on steep and gentle slopes. While no discernible correlation between slope and wood delivery was noted in the analysis, it will be valuable to monitor wood recruitment and slope in the future.

In Reach 1, Alder is the predominant vegetation type at followed by Willow and Maple. Willow represents the largest density of vegetation in the upslope area. A number of larger willows located in the upslopes was noted during field surveys. This is perhaps due to the meander patterns of the lower reach and changes to the stream configuration during the construction of Highway 1. Alders remain the dominant vegetation in Reach 2. While the presence of Redwoods increases dramatically in Reach 3, particularly in the riparian and upslope areas, alders are the dominant hardwood in the perched area. In Reach 4, Alders remain the dominant riparian and perched species, but Doug fir is seen in the upslope areas, followed by Redwood. In Reach 5, Doug fir is the predominant species in the riparian area. In Reach 6, Redwood is the dominant species in all areas.

As previously mentioned, the trees in the riparian and perched areas are mostly Willow and Alder (see Figure 5-13). While this wood is not as decay resistant as conifer, nor as likely to persist in the channel, it can provide an abundance of short lived wood in a shorter time period with the potential to catch larger, conifer pieces from the upper reaches. Reach 3 and 4 have both a high proportion of hardwood and conifer species and have the potential to contribute substantial amount of wood to the stream from the riparian and perched zones. The upper reaches have a lower density of trees, but it is predominantly conifer which can provide long term habitat forming processes as the wood makes it way down the channel.

In-Channel LWD Distribution and Abundance

In-channel LWD is an important component of stream systems. Collins and Montgomery (2002) noted that wood increases channel roughness, improves bed and bank stability and increases pool depth and frequency. In San Vicente Creek, in-channel LWD was looked at to understand the distribution and abundance of wood and to document its influence on the creation of pool and backwater habitat. Combined with

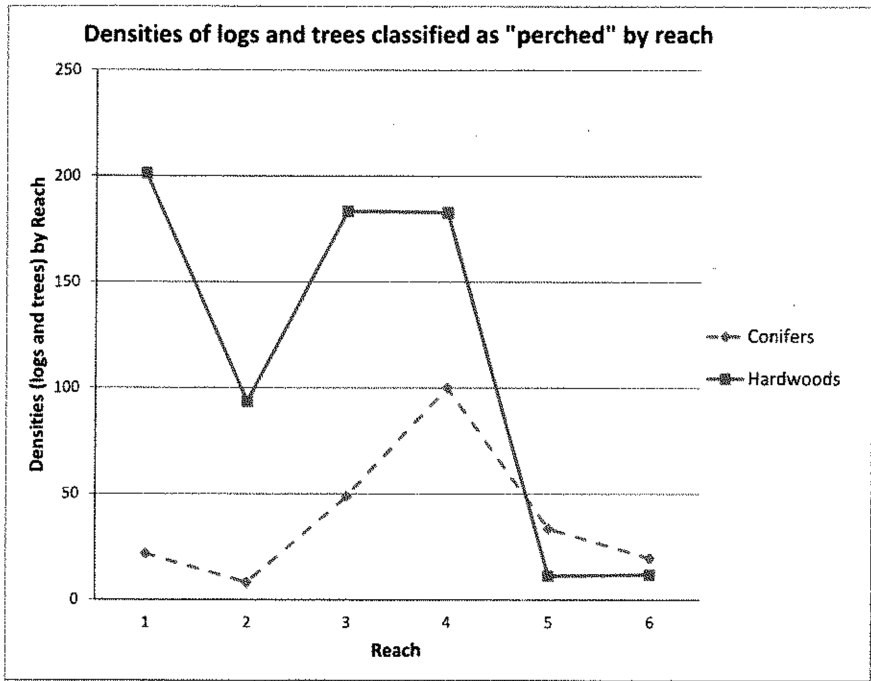


Figure 5-8.

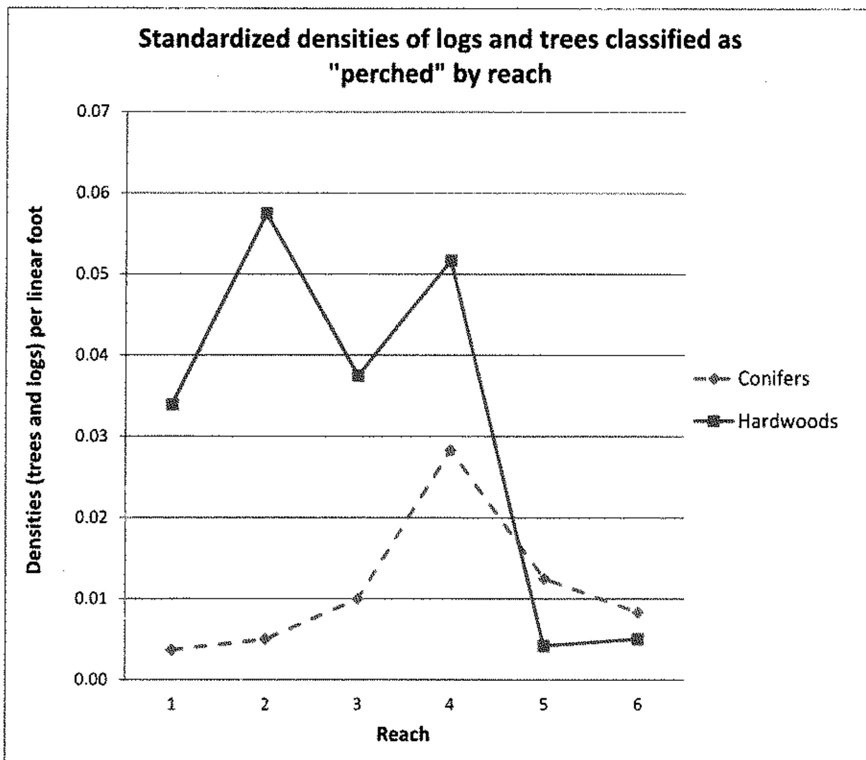


Figure 5-9.

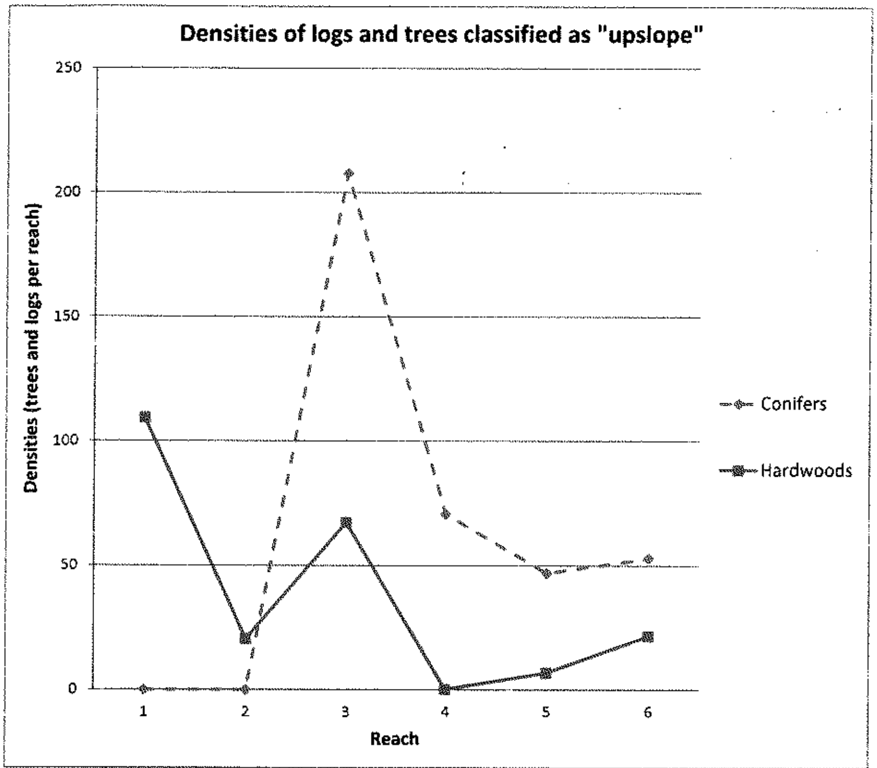
the previous section on potential wood recruitment, noting the current LWD distribution and abundance will guide recommendations for future wood recruitment projects.

Overall, there were only 102 pieces of in-channel LWD documented within the sample reaches (see Figure 5-14). Reach 1 had the highest overall in-channel density (62 pieces) . Reach 4 had the second highest density (19 pieces), followed by Reach 3 (15 pieces). The same pattern is seen when the values were standardized to account for the number of samples per reach. The high density in Reach 1 is likely due to the position in the watershed and lower gradient of the channel and that 4 of the 8 LWD structures implemented in 2011 by the RCD and NRCS occurred within Reach 1. The higher density of in-channel wood in Reach 3 was attributed to the LWD structures installed by the County of Santa Cruz as the area surveyed was less than 75 feet due to the presence of an access road. As previously mentioned, downed trees that had fallen across the road are often cut to restore vehicle access and as such, this wood does not make its way to the stream. Such activities were evident for Reach 3 during field surveys. As such, much of the wood which would have been accounted for in the upslope area was not tallied. The larger quantity of wood in Reach 4 may be attributed to its position (at the confluence of Mill Creek) or the low gradient of the stream in this area. All other reaches had less than 10 pieces.

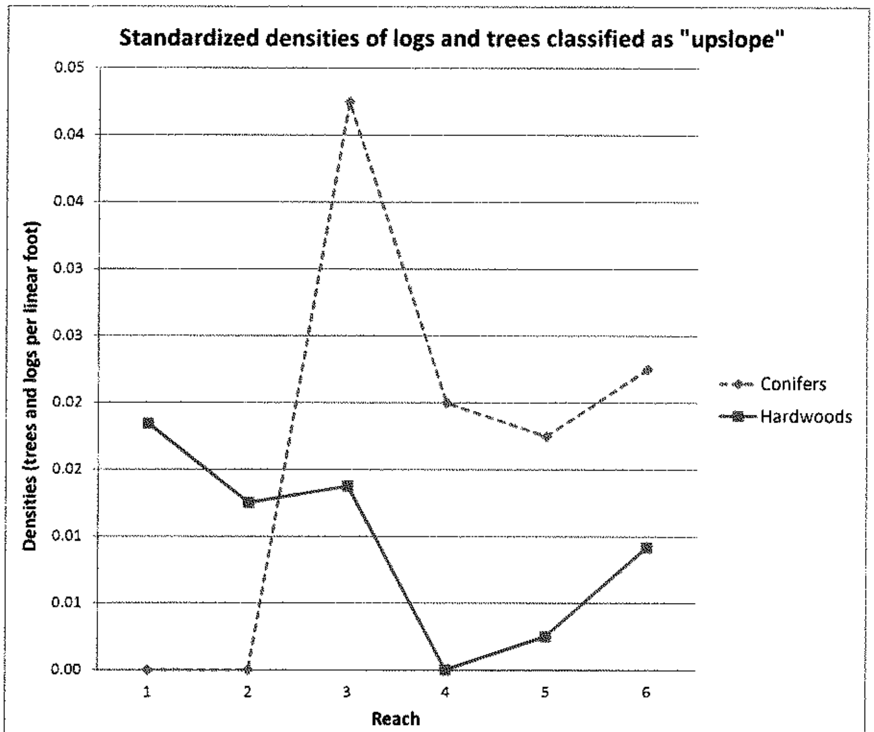
The Conservation Action Planning (CAP) Viability Results noted in NMFS' Coho Recovery Plan (2012), rated San Vicente Creek as "poor" for habitat complexity for adult, summer rearing juveniles and winter rearing juvenile coho with <4 key pieces per 100 meters biologically function wood (BFW) 0-10 meters) and < 1 key piece per 100 meters (BFW 10-100 meters). The desired criteria in NMFS' Coho Recovery Plan is listed as 6 to 11 key pieces per 100 meters, and 1.3 to 4 key pieces per 100 meters for the above listed indicators. This assessment confirmed that San Vicente severely deficient in meeting the desired criteria. Reach 1 had 4 pieces per 100 meters, Reach 4 had 2 pieces per 100 meters, and Reaches 2 and 3 had 1 piece per 100 meters.

However, Leicester (2005) noted a deficiency in the survey method in that debris jams outside the sample boundaries were not tallied. As jams are spotty in distribution, they are likely to occur outside of the 200-foot sample sections. This could result in a significant portion of the total in channel LWD present in the stream not being recorded. To achieve a more accurate estimation, all in-channel LWD was documented and analyzed in this assessment.

When LWD outside of the sample areas was considered, the density of in-channel LWD



5-10.



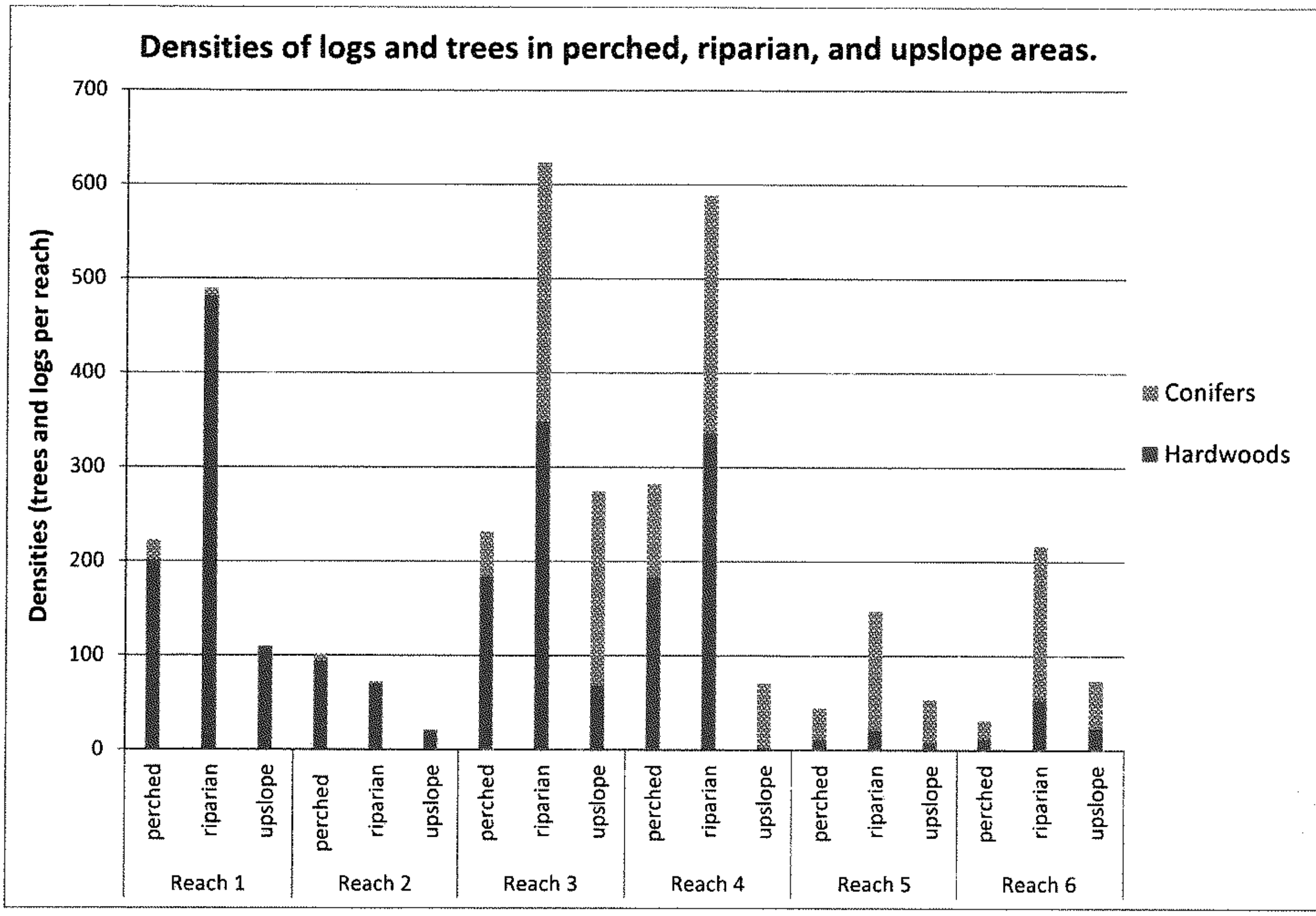
5-11.

doubled, increasing to 208 pieces (see Figure 5-15). While Leicester (2005) found that most of the in-channel would was accounted for within her sample reaches, this significant increase in LWD indicates that a large percentage occurred outside of the sample areas in San Vicente Creek. Reach 4 had the highest overall in-channel density (82 pieces). Reach 1 had the second highest density (68 pieces), followed by Reach 3 (54 pieces). The same pattern is seen when the values were standardized to account for variations in reach length. When the additional in-channel LWD pieces are compared to NMFS' desired criteria, Reach 1 and 2 still had 4 and 1 pieces per 100 meters, respectively, however, Reach 3 increased from 1 to 3 piece per 100 meters and Reach 4 increased from 2 to 7 pieces per 100 meters.

It is well documented that hardwood-derived LWD is less decay-resistant, not as persistent in the channel, and not as likely to form habitat as conifer-derived LWD (McHenry et al., 1998; Hyatt and Naiman, 2001). When only the sample reaches were considered, sixty-five (65) percent of the in-channel LWD noted within the sample reaches was hardwood (see Figure 5-14). However, when the entire survey reach is considered, this number is reduced to 48% and the density of conifer increased from 35 to 52% (see Figure 5-15). As to where this increase is occurring within the stream system, there was no to little change in Reaches 1 and 2 (see Figure 5-14 and Figure 5-15). However, in Reach 3 the density of hardwood LWD approximately doubled and the density of conifer LWD increased 6-fold. Likewise for Reach 4, the density of both hardwood and conifer increased 4-fold. As previously mentioned, there was an increase in conifer tree density beginning in Reach 3 and continuing upstream. Whether this in-channel LWD is being recruited from the reach itself or transported downstream is unknown.

As approximately 50% of the in-channel LWD and 61% of the trees in the perched, riparian and upslope areas are hardwood, this provides an interesting management challenge for San Vicente Creek. Bilby and Ward (1991) noted, deciduous or hardwood LWD does not offset the losses from the day of coniferous LWD, resulting in a net loss over time. However, Leicester (2005) determined that hardwoods can potentially serve as valuable LWD if certain conditions are met: 1) they are sufficient diameter and length in proportion to the channel width, 2) have a root wad; and c) are alive. In Reach 1, 20% of the hardwoods, particularly alder and willows, were noted as alive.

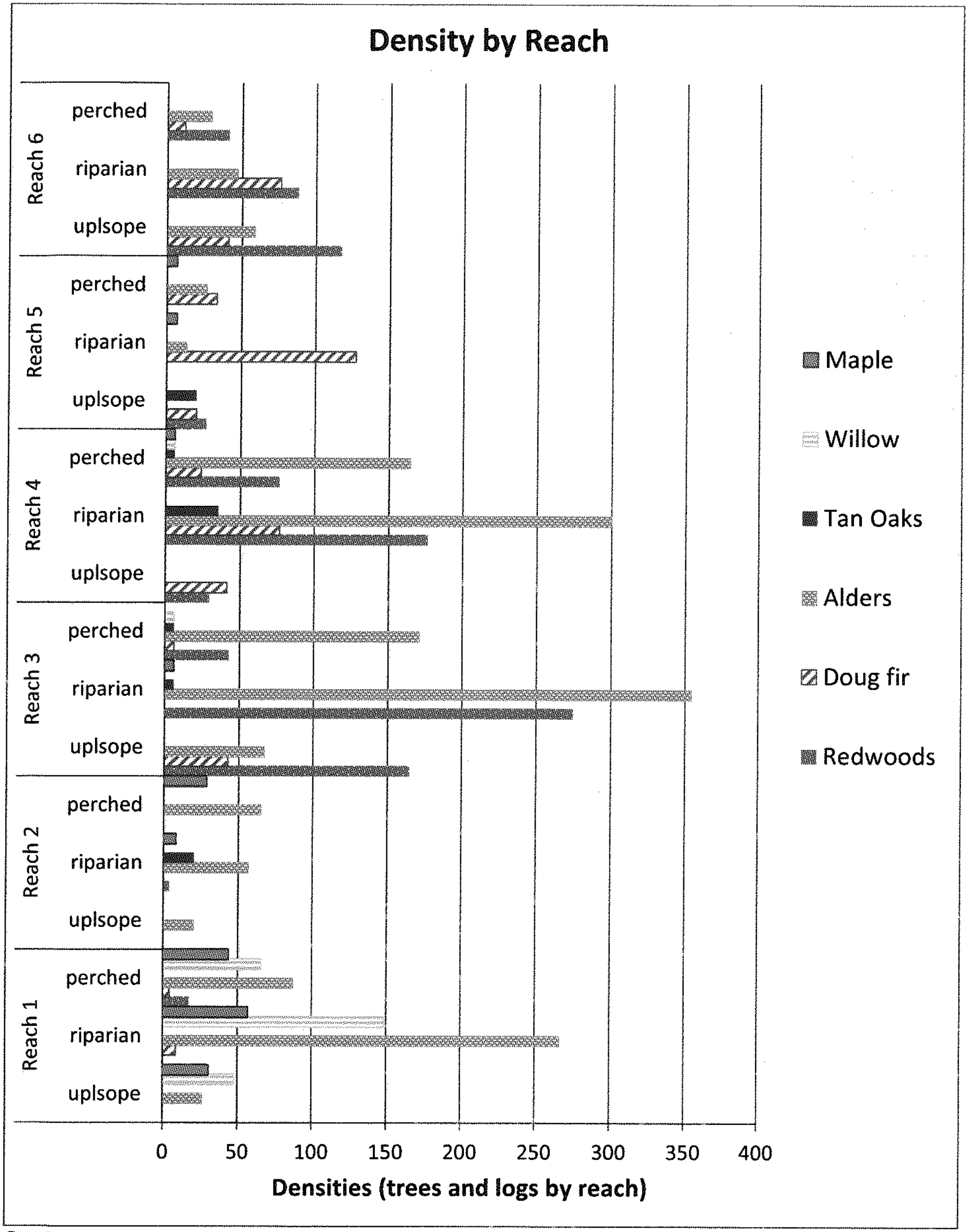
To consider whether in-channel hardwood LWD resulted in the formation of valuable pool or backwater habitat in San Vicente



5-12.

Creek, all in-channel LWD was considered. Overall, LWD formed in-channel 56% of the time. It's important to note that while pools and backwater habitat was noted with conifer LWD 45% of the time, 69% of the time that hardwood was observed, it was associated with a pool or backwater structure (see Figure 5-16). This small, high decaying wood seems to have a large impact on the creation of pools and aquatic habitat within the stream system. Whether the LWD resulted in the creation of pool or backwater habitat varied depending on the reach. In Reach 1, the presence of wood resulted in pool or backwater habitats 75% of the time and the predominance of this was from hardwood species. In Reach 2, the presence of wood resulted in pool or backwater habitat 100% of the time, but the sample size was small (5 pieces). In Reach 3, the presence of LWD resulted in an Instream structure (pool or backwater) 44% of the time. In Reach 4, LWD resulted in an Instream structure only 34% of the time. The formation of pools was closely observed within the first year for all 8 structures installed by the RCD in Reach 1. All LWD structures formed pools and most were recorded between 2 and 3 feet in depth. It is important to note that while LWD tallied and classified as "extra" is not currently contributing to habitat structures or their formation, it has the potential to become mobile during storm events and become associated with debris jams. Bilby (1984) and Swanson et al. (1984) found that, while the largest pieces of LWD were more stable and likely to create habitat, smaller pieces associated with debris jams could also contribute to habitat formation, since they become mobile during floods. If more large-diameter logs were added to the stream to serve as "catcher" logs, much of the smaller "extra" LWD may have a chance to be incorporated in a debris jam and begin to form habitat, rather than being rinsed out of the system,.Larger "extra" LWD also provides opportunities for habitat enhancement if it can be moved within the channel to more productive configurations or locations (Leicester, 2005).

Keim and Skaugset (2002) found that a piece of LWD with a rootwad attached was far more likely to form a pool or be a key piece in a log jam than a piece without a rootwad. For the in-channel LWD noted in San Vicente Creek watershed, 26 trees had rootwads. Of these, 88% were redwood. The remaining 12% were alder. However, 50% of these were associated with past project implemented by the County of Santa Cruz or RCD. Approximately 60% of the time, trees with rootwads occurred on the left bank; 70% of the in-channel wood was noted to be located on the left bank.



Density by Reach
Reach 6
perched
riparian
uplsope
Reach 5
perched
riparian
uplsope
Reach 4
perched
riparian
uplsope
Reach 3
perched
riparian
uplsope
Reach 2
perched
riparian
uplsope
Reach 1
perched
riparian
uplsope
0
50
100
150
200
250
300
350
400
Densities (trees and logs by reach)
Maple
Willow
Tan Oaks
Alders
Doug fir
Redwoods

Figure 5-13.

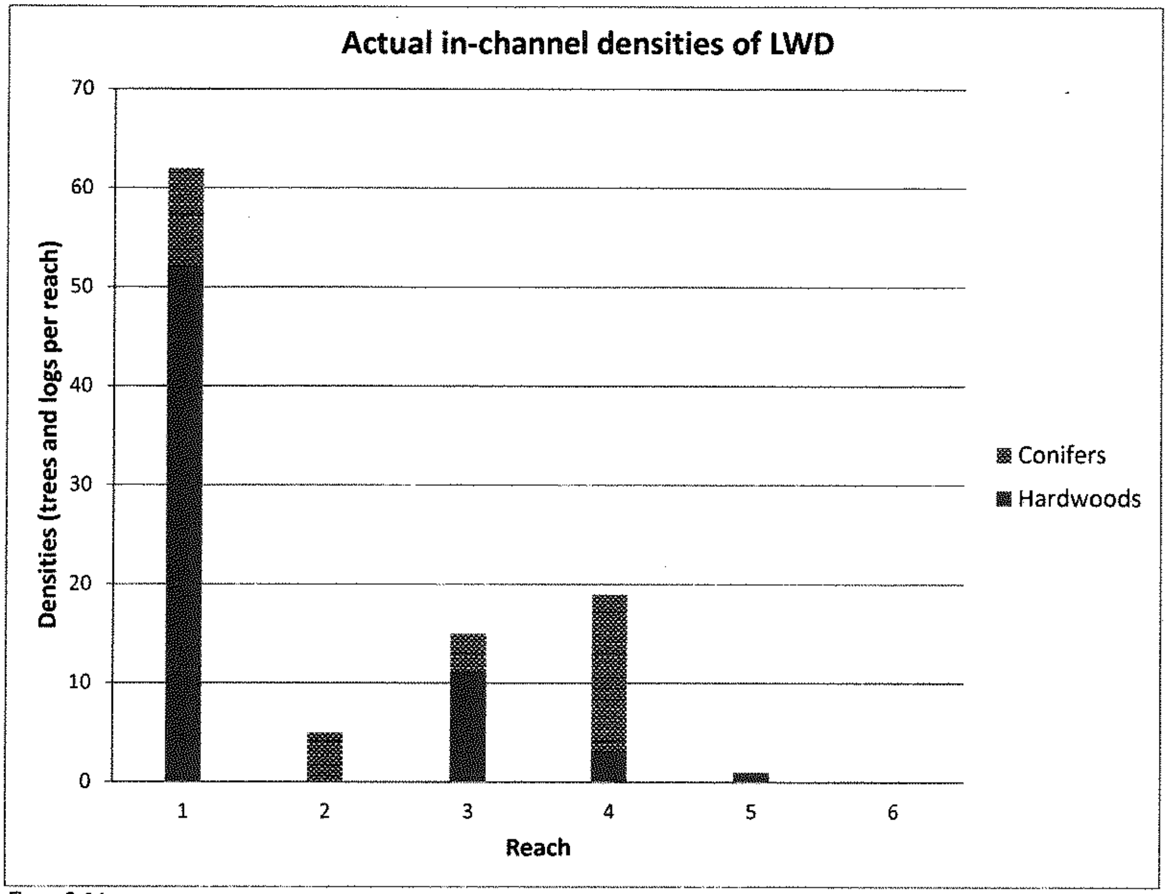


Figure 5-14.

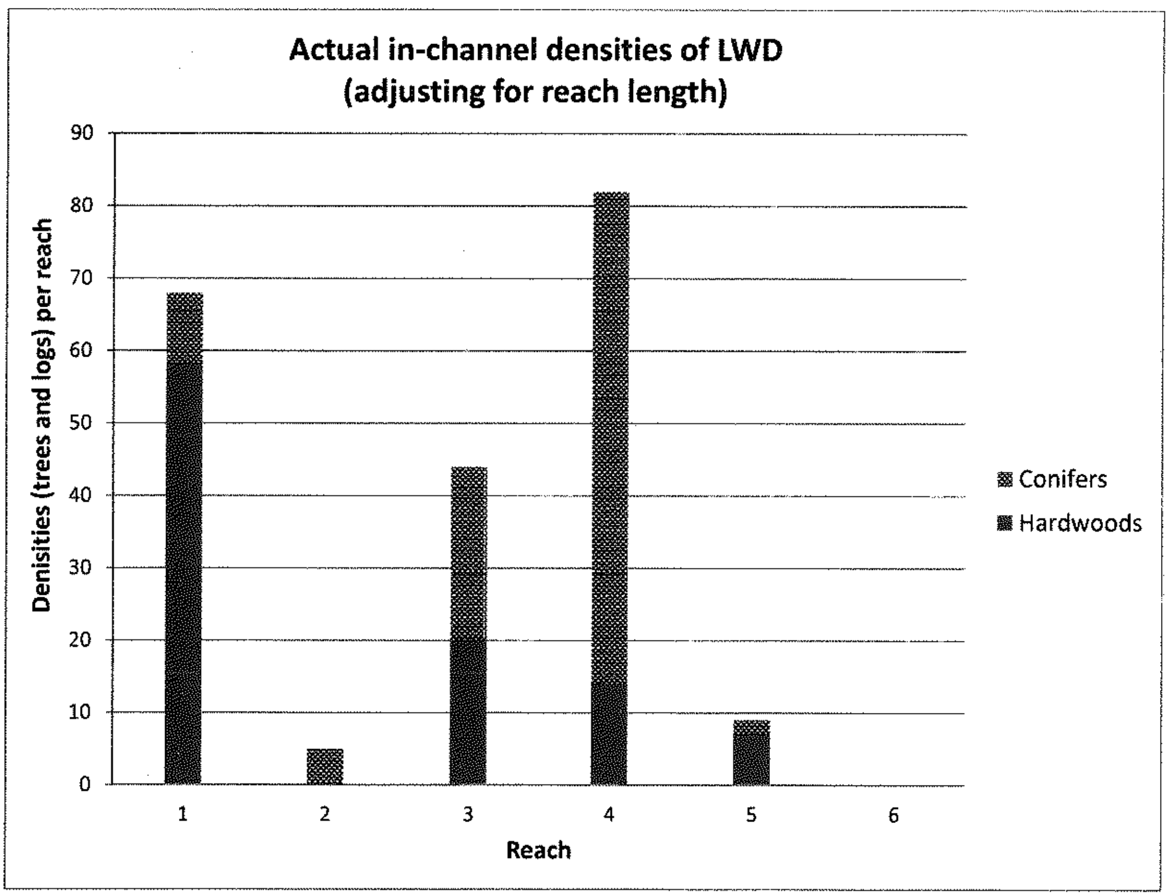


Figure 5-15.

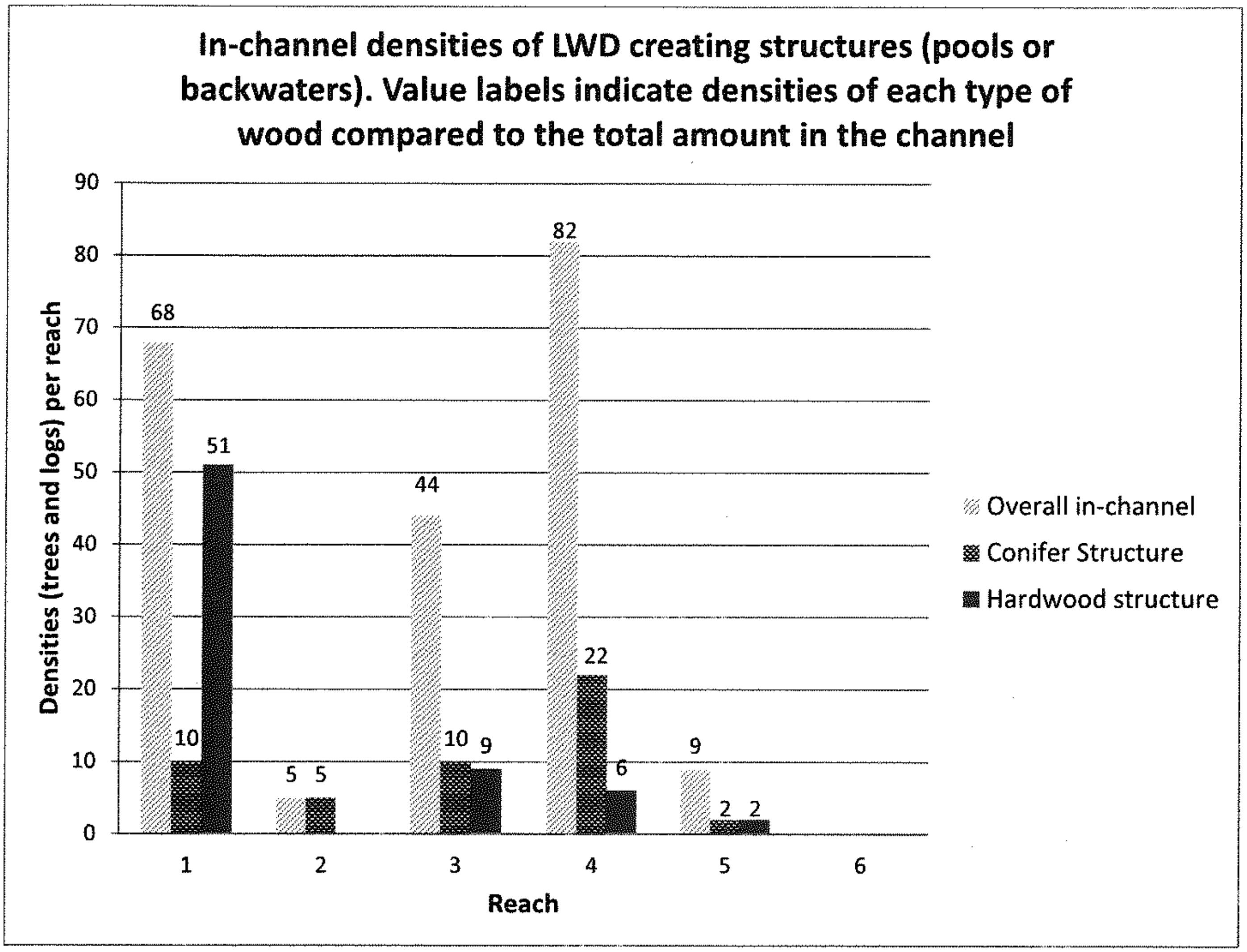


Figure 5-16.

Effects of LWD Size Classes on Formation of In-Channel Structures

LWD tallied for all reaches was greatest in the 1 to 2 foot diameter range, with the >4 foot range next (see Figure 5-17 and Table 5-4). However, all size classes were likely to form an in-channel structure with 92% of LWD forming structure for the 2 to 3 foot range and 80% for the >4 foot diameter range. Smaller wood (1 to 2 foot in diameter) was associated with a pool or backwater feature 83% of the time. Bilby and Ward (1989) found that LWD in the 1-foot range produced smaller pools (<15 sq ft), while LWD in the 2-foot ranged produced larger pools (over 42 sq ft), which could make them more valuable in terms of habitat. Unfortunately, depth was the only measurement taken for pool habitat in this assessment.

The majority of in channel LWD tallied for conifer species was Redwood, which accounted for 90% of the conifer LWD (see Table 5-4). "Old" redwood only accounted 5% of the total redwood species, most likely due to past logging practices in the upper watershed. The majority of in-channel hardwood tallied was alder, which accounted for 46%. The remaining hardwood LWD was predominantly willow. In-channel LWD, for both conifer and hardwood species, appears to be either larger trees (>4 foot) or smaller trees (1-2 foot). Riparian forest conditions and past land use activities heavily influence riparian LWD loading. More mature and intact the adjacent riparian forest has a greater the likelihood of sustained LWD delivery (Bragg et al., 2000). This corresponds to NMFS' Recovery Plan (2012) that found that younger riparian forests often lack trees of sufficient size and decadence that can act as keystone pieces to create habitat complexity after they fall into a stream. Past land uses within the watershed have altered the historic delivery of wood to San Vicente Creek and as a result, small (1-2 foot) material is the dominant wood currently accumulating as LWD in the stream.

Opperman and Merenlander's (2007) work indicates that hardwoods are most effective for LWD when they are downed, but living, while Leicester (2005) noted that hardwoods can potentially serve as valuable LWD if they are sufficient diameter and length in proportion to the channel width. Longer wood can create larger pools due to its ability to become lodged within the stream system and accumulate addition wood. Benda et al.

(2002) found that large pieces of wood exceeding the width of the bankfull channel are more likely to remain stable and act as a trap for smaller pieces of wood, resulting in reduced large wood export. In San Vicente Creek, which had a mean bankfull width of 25 feet, shorter wood (<20 feet) was more plentiful in all reaches and was the largest contributor to the creation of in-channel structure (see Figure 5-18). LWD (less < 20 feet in length), was structure forming 95% and 84% of the time for LWD 1-2 foot and > 4-foot diameter, respectively. Longer LWD (> 20 feet in length) was structure forming 45% and 63% of the time for LWD 1-2 foot and > 4-foot diameter, respectively. Note: Because wood length was not documented for all LWD outside of the sample reaches, the data was not included in Figure 5-18. However, for the data that was collected, 61% of the in-channel wood was < 20 feet and a pool was noted in association with this wood 69% of the time, compared to 31% of the time for wood > 20 feet.

Various characteristics, including the shape and density of individual wood pieces, affect their potential to be mobilized and transported or to be retained as can the quantity, position and orientation of the wood pieces within the stream channel (Gurnell, et al., 2002). As only size and length has been considered as part of this assessment, it is challenging to determine the movement of recruited wood in San Vicente Creek. It is equally challenging to determine the effect of a predominance of hardwood species within the system on long-term pool and backwater development. However, the results suggest that the presence of both hardwood and conifer species greater than 1 foot in diameter will result in a pool and backwater habitat at least for a short time. Long term LWD debris jam formation and wood accumulation will be annually monitored.

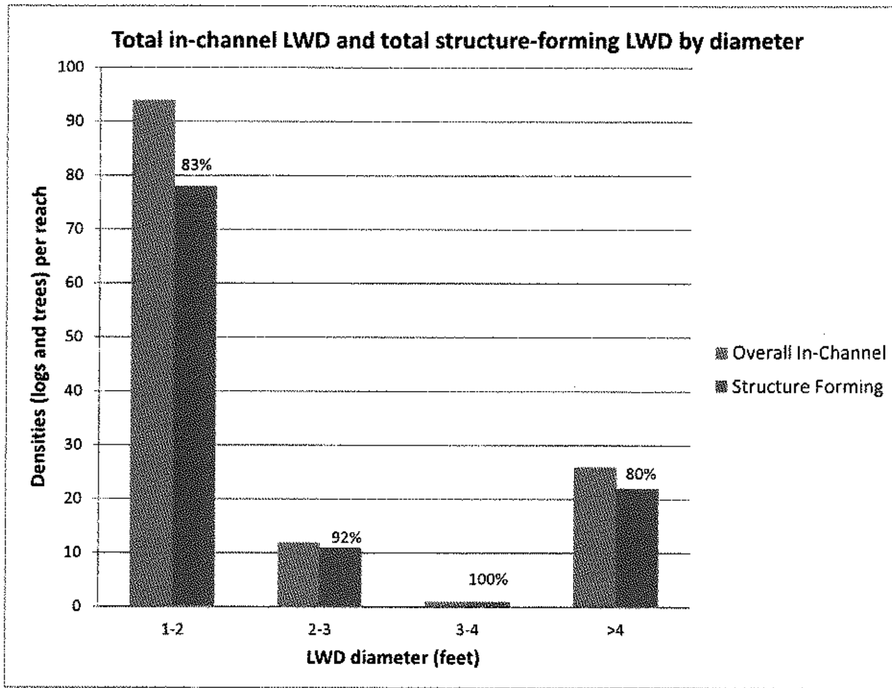


Figure 5-17.

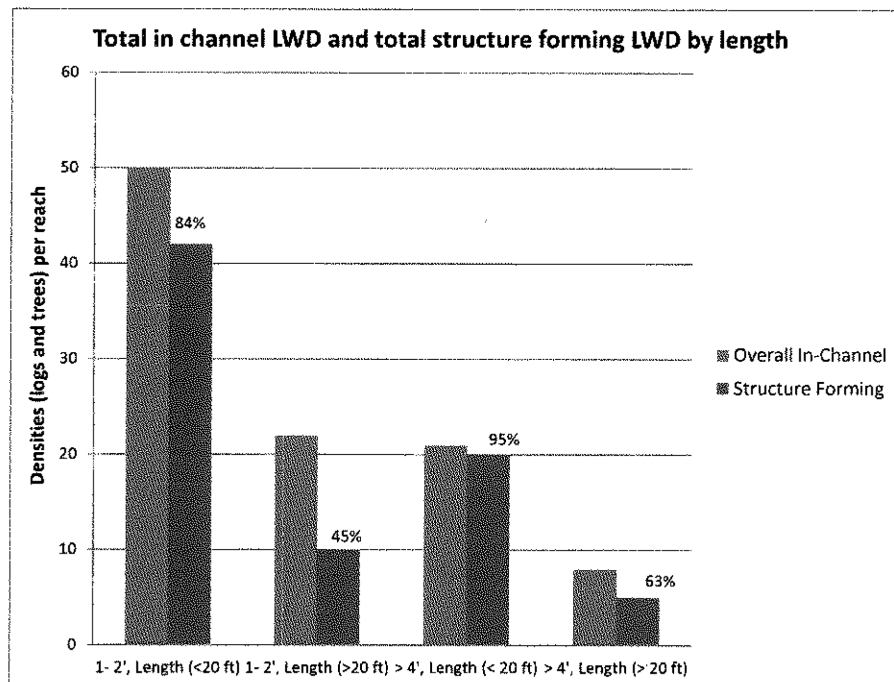


Figure 5-18.

Table 5-4. Amounts of in-channel LWD by diameter, channel location, function, and species. CF=conifer, HW=hardwood

Diameter (feet)		Structure		Extra		Totals	Percent
		Pool	Backwater	Lowflow	Bankfull		
1-2	Total CF	27	1	9	11	48	
1-2	Redwood	25	1	8	11	45	94
1-2	"Old" Redwood	0	0	0	0	0	
1-2	Total HW	26	2	16	2	46	
1-2	Alders	12	2	9	2	25	54
2-3	Total CF	8	0	0	1	9	
2-3	Redwood	8	0	0	1	9	100
2-3	"Old" Redwood	0	0	0	0	0	
2-3	Total HW	3	0	0	0	3	
2-3	Alders	1	0	0	0	1	33
3-4	Total CF	1	0	0	0	1	
3-4	Redwood	1	0	0	0	1	100
3-4	"Old" Redwood	0	0	0	0	0	
3-4	Total HW	0	0	0	0	0	
3-4	Alders	0	0	0	0	0	
>4	Total CF	4	0	0	0	4	
>4	Redwood	1	0	0	0	1	25
>4	"Old" Redwood	3	0	0	0	3	75
>4	Total HW	16	1	5	3	25	
>4	Alders	5	1	2	0	8	32
Total	**Total CF**	40	1	9	12	62	
	Redwood	35	1	8	12	56	90
	"Old" Redwood	3	0	0	0	3	5
	Total HW	45	3	21	5	74	
	Alders	18	3	11	2	34	46

Chapter 6: Invasive Species

OBJECTIVES

The goal of this project was to evaluate riparian health related to the Cape ivy infestation, and other non-native species to a lesser extent, in San Vicente Creek. This goal builds directly off of Priority 1: Threat Abatement Action articulated in NOAA's 2012 CCC Coho Recovery Plan which focuses on removal of exotic vegetation from riparian zones in lower San Vicente Creek.

The main objectives of the invasive species assessment was to conduct reconnaissance to determine the extent of cape ivy within the watershed, consider how cape ivy is impacting salmonid habitat, and develop recommendations on methods and schedule of activities for control.

To address these objectives, the following questions were kept in mind:

» Is the presence of cape ivy impairing salmonid habitat directly or through modification of vegetative or morphologic structure?

» How will the presence of other non-native species influence control/eradication methodology recommendations?

» Will the presence of cape ivy influence the prioritization of restoration activities?

INTRODUCTION

After decades of neglect and abuse, riparian zones are now recognized as critical components of aquatic and terrestrial ecosystems (Bragg et al., 2000). Riparian ecosystems, defined as the transitional zone between terrestrial and aquatic ecosystems, provide many beneficial functions including flood attenuation, groundwater recharge, stream temperature regulation, improved water quality, wildlife cover and food, and large woody debris production. Riparian communities are characterized by highly diverse, disturbance dependent, early seral vegetation that reflect environmental heterogeneity. However, riparian zones are susceptible to invasive by non-indigenous plant species (Masters and Sheley, 2001) and can become a homogeneous blanket, degrading riparian habitat by out competing native plants and reducing biodiversity.

Aquatic systems depend on the riparian ecosystems for recruitment of leaves, woody debris, and other detrital matter for habitat and food resources. Changes in leaf litter inputs due to the presence of non-native vegetation may result in substantial impacts on aquatic communities and food-web dynamics. Changes in terrestrial leaf inputs may further influence stream organic matter processing, nutrient cycling, and light availability within streams (Benbow et al., 2013).

Changes in light availability can impact drifting macroinvertebrates, which comprise the vast majority of the food resources for juvenile salmonids (Chapman and Bjornn, 1969; Elliot, 1973). Canopy cover can have a strong influence on invertebrate production and salmonid growth (Behmer and Hawkins, 1986; Hill et al., 1995; Quinn et al., 1997; Poole and Berman, 2001). In addition, riparian canopy intercepts solar radiation, buffering salmonids from changing stream temperatures. Juveniles, in particularly cannot persist in streams with high summer temperatures or highly fluctutating temperatures. Increasing stream temperatures can influence salmonid survival directly and habitat by changing the structure of plant and invertebrate communities (Bisson and Davis, 1976).

Changing plant communities can also result in less bank stability and an increase in turbidity level. Sediment can directly reduce salmonid breeding by covering spawning gravels and reducing light available for primary production (Kirk, 1985; Davies-Colley and Smith, 2001). An increase in turbidity also has been shown to affect salmonid behavior, as well as density and growth (NMFS, 2012).

The riparian ecosystem plays an important function in stream and salmonid health. However, like many of the coastal stream systems in California, San Vicente Creek hosts a number of invasive, non-native species that can prevent the growth and establishment of other plant species. For the past five years, Cape ivy has been noted in the lower watershed and recognized as by far the largest invasive infestation responsible for degrading riparian habitat due to its expansive coverage and known ecological impacts. Thus, a large part of this assessment was focused specifically on Cape ivy.

However, field reconnaissance in 2012-2013 identified the presence of a non-native species, which had previously escaped notice by field researchers. Identified as *Clematis vitalba* (Moore, pers. comm., West, pers. comm.), this plant has not been previously found in Santa Cruz County and is known from only one other occurrence in California, San Francisco County. While the original intent of this assessment was to discuss management recommendations for Cape ivy, this newly identified Clematis has the potential to be of even greater threat to the health and function of San Vicente Creek and thus will also be discussed.

Cape ivy

Cape ivy (*Delairea odorata*) is an aggressive, invasive, non-native plant. Cape ivy can form dense vegetative groundcover that smothers other vegetation and can prevent seeding of native plants. Cape ivy forms stands of close to 100% cover and competes with other plants for water and nutrients. Native plant species richness can be reduced up to 90% (McMenamin, pers. comm.) with greater short-term impacts on annual than on woody perennial species. In the long-term, impacts on woody species can be significant.

Cape ivy readily climbs to the top of mature trees, depriving them of light, increasing limb loss and causing them to fall due to weakened conditions, including added weight and the increased effects of wind forces. The loss of tree canopy results in changes in stream temperature and modification of instream structure and the aquatic food chain (Cal IPC, 2013). The suppression of native herbaceous and perennial, woody seedlings, limits the future potential for the natural large woody debris recruitment process and the plants required for the macroinvertebrates that are necessary during all salmonid life stages.

In addition, Cape ivy is not a food source for most animals and insects because of toxic alkaloids, xanthones and a noxious smell that the plant produces. (Stelljes et al., 1991, Catalano et al., 1996). The organic compounds found in Cape ivy foliage and flowers are known to be toxic to mammals, spiders and Cape ivy foliage contains compounds that decrease fish survival (Bossard, 1998). Cape ivy may use allelopathy to suppress competitors, similar to California sagebush (*Artemisia californica)* and Eucalyptus (*Eucalyptus globules*).

Originally from South Africa, Cape ivy is a perennial vine with shiny, five- to six-pointed leaves, waxy cuticles, and often two small stipule-like lobes (Cal-IPC, 2013). There is one leaf at each node. Foliage is green to yellow-green and has a distinct odor. Plants have extensive waxy stolons running above and below ground. Below-ground stems are purple. Each flower is a yellow, round discoid head the size of a dime. Flowers are arranged in groups of twenty or more. While Cape ivy flowers extensively in California from December to February, it has been assumed that ivy forms non-viable seeds and thus spreads solely by vegetative means. However, recent laboratory analysis has shown reproduction from seeds, although this has not been confirmed in the field (Robinson, 2006). Vegetative reproduction can occur at any time when the nodes of the stem, stolon, or leaf petiole are in contact with the soil including a leaf node, which will sprout readily - even after sitting on dry ground for months. Cape ivy readily moves downstream with high winter flows, which can begin new infestations.

Cape ivy was introduced in the 1850s as an ornamental in the eastern United States and to California by the 1950s (Elliot, 1994). By the 1960s, it had become prolific in Golden Gate Park, San Francisco, and Marin County (Archbald, 1995; Howell, 1970). The Invasive Plant Council (Cal-IPC) lists the species on its High List: Species with severe ecological impacts on ecosystems, plant and animal communities, and vegetational structure (Cal-IPC, 2013). Cape ivy's spread in California is a concern because it invades wildland areas and once established is extremely difficult to eradicate (Alvarez, 1997; Bossard et al., 2000).

Clematis

As mentioned in the previous section, the presence of Clematis (*Clematis vitalba*) within Santa Cruz County is undocumented (Moore, pers. comm.; West, pers. comm.). Little is known of it from its singular documented occurrence in California (Moore, pers. comm.), but the most recent edition of the Flora of North America documents that the non-native has become naturalized in northwestern Oregon to Puget Sound (West, pers. comm.). With limited information about it's' presence and growth patterns, the following description of the species is solely based on literature review and personal communication with local botanists and ecologists. As we begin to learn more about this species, much of this preliminarily information may change.

This variety of Clematis appears to be an aggressive, vine-like plant that is noted to be invasive plant in most places, including many in which it is native (CAB International, 2013). It is a very serious environmental weed in New Zealand undergoing eradication (CAB International, 2013). As many professional have walked San Vicente Creek over the past decade and the plant went unnoticed until 2012, it is likely that this species may spread even more rapidly than cape ivy. There is a severe infestation in the upper reaches of San Vicente Creek and individual patches exist throughout San Vicente Creek almost down to Highway 1. Like Cape ivy, Clematis both blankets the ground, smothering herbaceous and woody plants and climbs into the tree canopy. It has been noted to bring down tall trees and reduce standing forests to impenetrable low-growing infestations of the vine (CAB International, 2013). Clematis noticeably hangs down from the trees into the water (see Figure 6-1).

The plant spread both by seed and vegetatively (Moore, pers. comm.). West (1991) notes that this variety of Clematis is a deciduous, woody climber that can live for 40 years or more, can grow to over 10 meters in length, and can reach 15 to 20 cm in diameter. However, its growth rate and pattern in San Vicente Creek is unknown.

Figure 6-1. Clematis hangs down from the trees.

The Clematis in San Vicente Creek is likely a garden escapee from the Bonny Doon community above the watershed. Given its rarity, there is no information published on methods for control in California, but methodology and tools for control should be similar to English ivy (Moore, pers. comm.).

METHODOLOGY

To address the Coho Recovery Plan (NMFS, 2012), which calls for the removal of invasive exotic vegetation from riparian zones in the lower San Vicente watershed (Recovery action 14.1.1), it is important to understand the direct impacts of Cape ivy on habitat and riparian function in San Vicente Creek. Site reconnaissance was conducted in fall/winter of

2012. Additional reconnaissance was done between April 1 and October 31, 2013. The intent was to determine the spatial extent and infestation of Cape ivy and to a lesser extent other specific invasive species within the riparian corridor and then develop specific recommendations on methods, priorities, timing and schedule of related activities for invasive control and management.

For field reconnaissance observations, San Vicente Creek was divided into three reaches for discussion and recommendations for control and eradication within riparian habitat. Reach 1 extends from the Highway 1 crossing (684 ft upstream from the confluence of San Vicente Creek and the Pacific Ocean) to the 1st gate, which is located 3,670 ft upstream of Highway 1. Reach 2 extends north of the 1st gate to the conveyor below (5,260 ft upstream from the Highway 1). Reach 3 extends north from the conveyor belt to the tunnel on San Vicente Creek (15,470 ft upstream of Highway 1) and from the confluence of San Vicente Creek and up Mill Creek to the 1st dam (15,240 ft upstream from Highway 1)(see Figure 6-2).

To systematically collect data, a one-page Occurrence Sheet was developed (see Figure 6-3). The sheet included a description of location (GPS was unreliable due to canopy cover), a description of specific invasive species present and percent cover, limited documentation of specific native species presence, and also information on access and priority based on potential for spreading, ease of control, and presence of native species. Photos were also collected at each occurrence location (see Appendix E) Invasive Mapping Reconnaissance for completed documents and map).

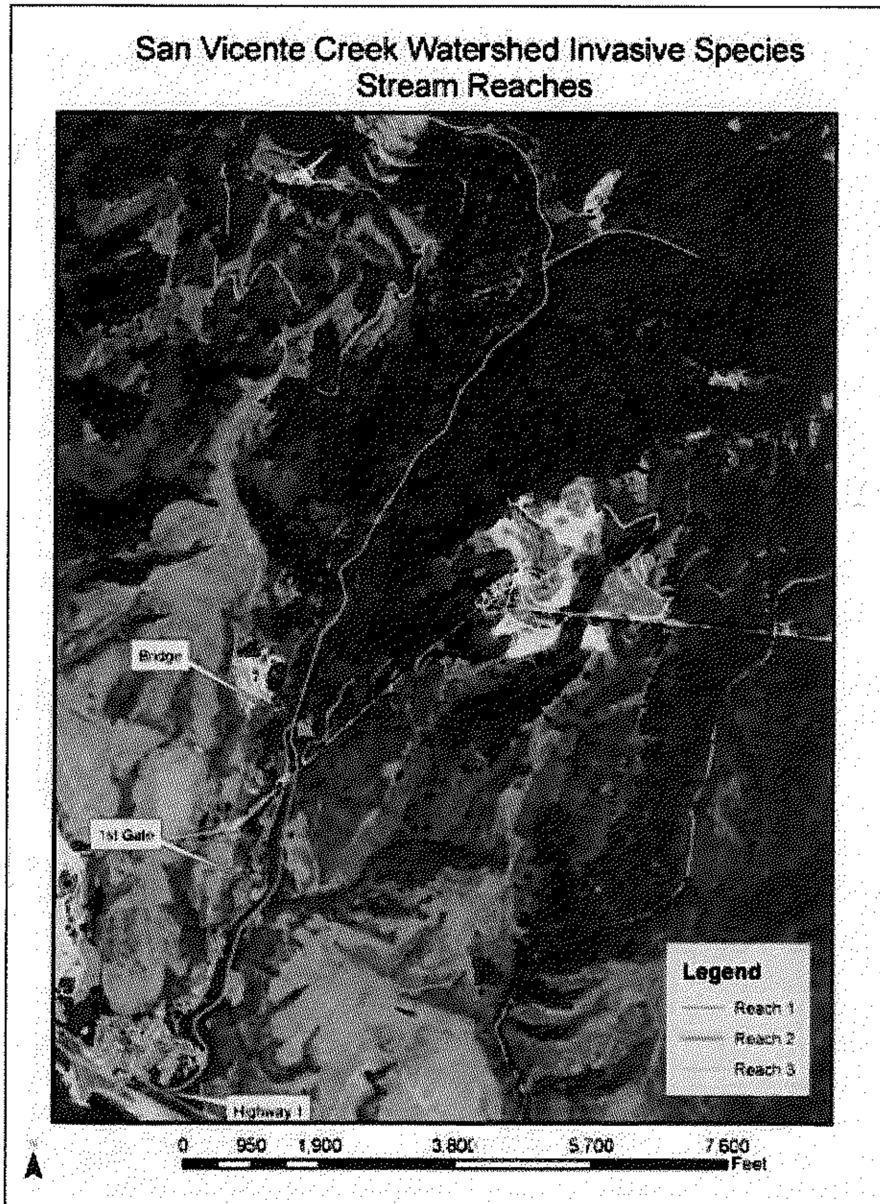


Figure 6-2. San Vicente Creek Watershed Invasive Species Stream Reaches Map

While the Occurrence Sheets provided basic information on the location of invasive species, infestation severity, and impact to habitat quality, a more in-depth procedure was developed for Reach 2, which was found to consist of five well defined patches of Cape ivy. As it is important to treat these patches before they spread and become a larger patch, which will result in the loss of native species, and greater time and expense for eradication, additional focus was given in this area. In Reach 2, assessments were conducted in fall/winter, 2012, when Cape ivy is easiest to identify and in April, July and October of 2013. The assessments included walking along San Vicente Street to identify Cape ivy on the west side of the stream and then walking the stream to identify Cape ivy on both the west and east sides of San Vicente Creek. Once Cape ivy was identified, the boundaries of each infestation were walked and recorded with an accuracy of approximately 1 meter. Information was recorded for each infestation Area, including an approximation of percent invasive and native cover, predominant native and non-native trees, shrub and herbaceous species, the distance from the road and stream, approximate size and density of the infestation, and predominance of Cape ivy in tree canopy (see Appendix E and Figure 6-4). This data was then hand drawn onto aerial photos. The hand drawn data was used to develop a GIS data layer (see Figure 6-5).

FINDINGS

The following invasive plants, with critical ecosystem impacts, were identified within the project area and are considered to be of management concern for San Vicente Creek and Mill Creek.

Reach 1

Reach 1 was historically modified to allow grazing on adjacent areas, as evident from historic off-channel ponds, and was straightened to reduce flooding (Smith pers. comm., 2012). This anthropogenic disturbance has resulted in a predominantly solid mass of Cape ivy (>50-90%) on both sides of the stream and approximately 100 ft up the rock cliff on the south side. Below the rock weir structure installed by the National Marine Fisheries Service and RCD in 2008, Cape ivy currently spans across the creek covering downed wood and debris. Directly above the weir structure, the Cape ivy infestation is heavier on the right bank, on what is likely a historic floodplain. Cape ivy is present in about 50% of mature native trees, which predominantly include alders (*Alnus sp.*) and willows (*Salix sp.*).

Clematis is found in Reach 1, beginning approximately 1250 ft upstream from Highway 1 with small multiple patches identified from San Vicente Creek. While the species is likely to continue spreading to Highway 1, its expansion into the riparian buffer is unknown.

Jubata grass (*Cortaderia jubata*) is present along Highway 1 and predominant adjacent to the concrete weir structure and within the constructed diversion channel to the lower pond. A few plants are found sporadically throughout the reach, but potential expansion is limited due to shade provided by tree canopy.

Hemlock (*Conium maculatum*) and fennel (*Foeniculum vulgare*) are present near Highway 1 and along Coast Road/San Vicente Street. Other noted invasive species within the reach include forget-me-nots (*Myosotis sp.*), occurring on gravel beds and within the active flood channel, French broom (*Genista monspessulana*) along the road edge and bare, sunny locations, and a small patch of English ivy (*Hedera helix*) on the left bank. In addition, nasturtium (*Nasturium sp.*) and morning glory are present on the left bank near residences and along San Vicente Street. These last two invasive species represent a significant threat in the short-term future, particularly after restoration disturbance (McMenamin, pers. comm.).

Noted native species include California blackberry (*Rubus ursinus*), California Bee Plant (*Scrophularia californica*), Stachys (*Stachys sp.*), Coffeeberry (*Rhamnus californica*), Red elderberry (*Sambucus racemosa*), Dogwood (*Cornus sp.*), *Ribes sp.*, Bracken fern (*Pteridium aquilinum*), Five finger fern (*Adiantum pedatum aleuticum*), Horsetail (*Equisetum arvense*), and Stinging nettle (*Urtica dioica*). There is good access along Reach 1 for treat-

Point: ________________ **Compass:** __________ **Distance from GPS:** __________ **Lat/Long:** ________________________

Access:
[ ] Heavy Equip.
[ ] Crew

Adjacent to Floodplain?
[ ] Yes
[ ] No

Slope:
Outerbank :
Innerbank :

Solar Radiation: _______

Photo Description	Photo #s:
North	
South	
East	
West	

Notes:

Invasive Species	Cover < 50%	Cover > 50%	In Trees?	Mixed w/ Natives?	Isolated?
DEOD					
HEHE					
CALYSTEGIA					
COJU					
RUDI					
VIMA					
GEMO2					
AGAD					
COMA					
BRASSICA					
RHSA					
HIIN					
CAPY					
CIVU					
CULTIVAR					
ACACIA					
CARPOBROTUS					
FOENICULUM					
ERHARTA					

Dominant Natives	Present?	Size Class / Tree Count
ACMA		
ACNE		
ATFE		
AECA		
ARCA		
ARDO		
COSE		
COCO		
FRVE		
HELA		
JUEF		
JUPA		
PEPA		
PLRA		
POMU		
POTR		
Quercus		
RHCA		
RIME		
RISA		
ROCA		
RUPA		
SAME		
SCCA		
SESM		
STACHYS		
SYAL		
WOFI		

Date: ___________ Time: __________ Observers: ______________________________________

Figure 6-3. Occurence Sheet.

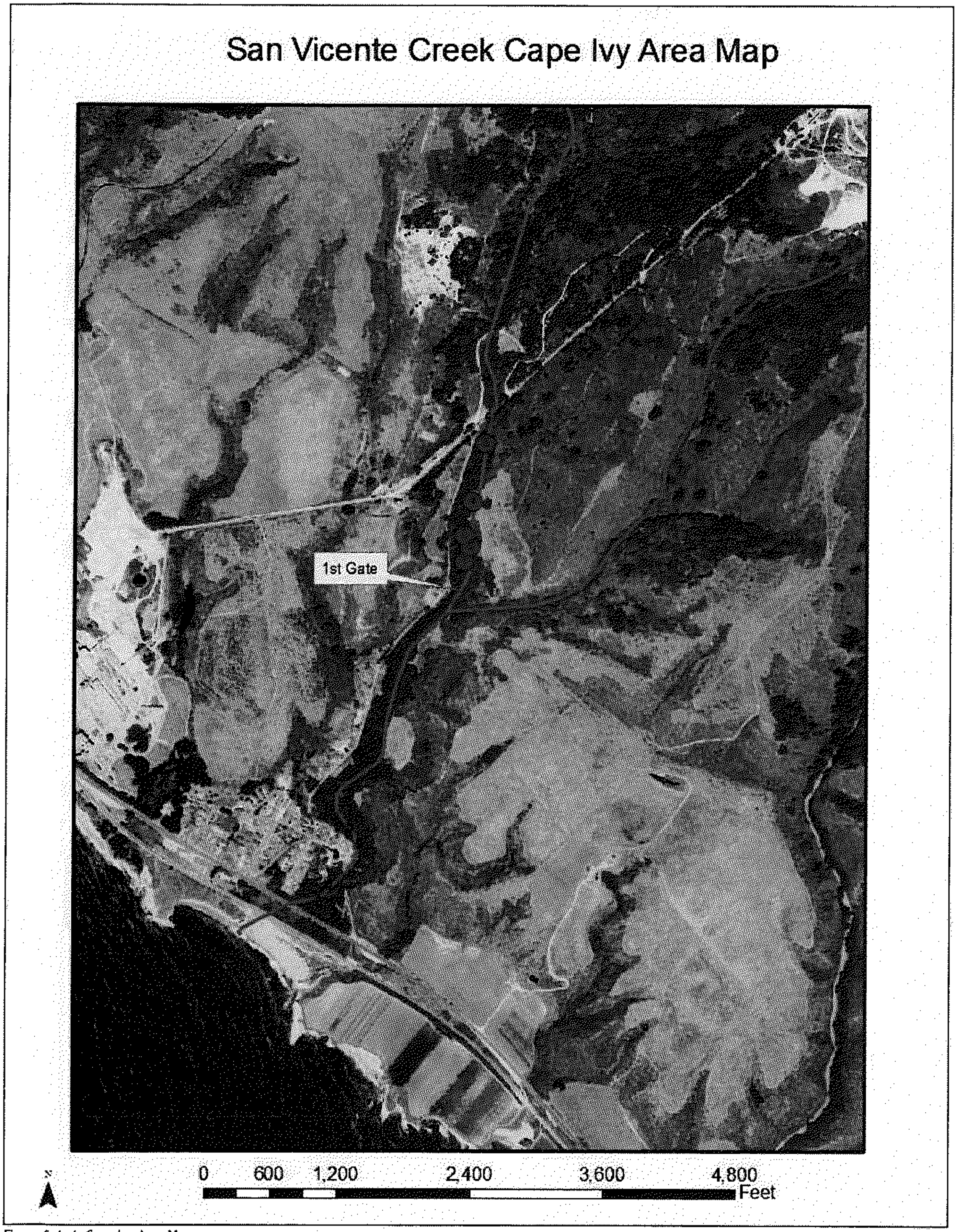


Figure 6-4 4. Cape Ivy Area Map

Figure 6-5. Cape ivy patch map

ment, but coordination with the adjacent landowners will be needed.

Reach 2

Reach 2 appears to have been less modified historically. Interestingly, the infestation of invasive species is less severe and occurs in isolated patches in Reach 2 rather than as a homogenous community. Whether this is directly linked to the lack of disturbance could not be confirmed through field observation or analysis of historic aerial images. The Cape ivy patches have established within approximately a 1,450 ft linear stretch of the riparian zone and appear to be located only on the western side of San Vicente Creek. With the exception of the upper most area (Area 5), all areas appear to have spread from the streambank towards the road. Area 5 is also the largest patch of Cape ivy. This suggests that Area 5 may have been the initial infestation site and that Cape ivy has since been spreading downstream during winter rain events.

As previously mentioned, within Reach 2, five Cape ivy areas were intensively mapped, documenting current boundaries, distance between patches, and the presence of specific herbaceous natives that may need to be protected.

Note: The information listed below, describing the five Cape ivy areas in Reach 2 is accurate prior to any treatments that occurred in July, August and September, 2013. After treatment, some changes will have occurred.

Area 1 is located 340 feet north of Gate 1 (measured on the road). The stream distance is approximately 250'. The area is between 400 and 600 sq. ft. in size with an overall density of Cape ivy less than 50%. Cape ivy can be found in 5 to 10 trees up to heights of 30'. A low density of Cape ivy is found on the northeastern streambank.

Area 2 is located 75 feet north of Area 1, along the stream. The stream distance is approximately 340'. The area is between 450 and 550 sq. ft. The Cape ivy density is greater than 50%. Cape ivy can be found in 5 to 10 trees up to heights of 30'. While there is not usable access for this area from the road at this time, due to a Yellow Jacket nest, access will be created through Area 3, in the future. The distance between area 2 and area 3 along the stream is approximately 20'.

Area 3 is located 459 north of Gate 1(measured on the road) and 410' north (stream distance). This area is approximately 4000 to 5000 sq. ft. in size with an overall density of Cape ivy of 70% to 80%. Cape ivy can be found in 10 to 30 trees up to heights of 30'. There are significant patches of desirable native plant species within the area.

Area 4 is located 993 ft north of Gate 1. This area is 225 to 300 sq. ft. with a density of 40% to 60%. The Cape ivy is in a few trees to a height of 15'. This is the only patch of Cape ivy within a 325 linear foot section of habitat between Area 3 and Area 5. There is also an isolated 500 to 600 sq. ft. patch of Vinca (*Vinca major*) directly adjacent to the Cape ivy, along the stream. Also, there is a tiny (15 sq. ft.) patch of Wandering Jew (*Tradescantia fluminensis*) approximately 70 ft upstream. As of July 2013, there is access for this area from the road.

Area 5 has to road access points. The southern access is located 1179 ft north of Gate 1. The northern access is located 1425 ft. north of Gate 1. This is the largest patch of Cape ivy (15,000 to 17,000 sq. ft.). It runs north to south for 246 linear feet of the road. This area represents the furthest known upstream, northern extent of the Cape ivy. This is also the only patch in Reach 2 that stretches from San Vicente Creek to the road. The height in the trees ranges from 15 to 30 ft. The width of this patch is 75 ft at the upstream edge and 78 ft at the downstream edge. As the creek bends in this stretch there is a narrowed section running east to west, with a width of approximately 45 ft. This was likely the initial point of infestation in Reach 2.

Other non-native species occur in small patches, including a few single jubata grass plants, a few French broom and Clematis within the stream channel and along both sides of the stream, although more dominantly established on the left bank. Italian thistle (*Carduus pycnocephalus*) has been observed along San Vicente Road (McMenamin, pers. comm.).

Noted native species include California blackberry (*Rubus ursinus*), California Bee Plant (*Scrophularia californica*), Stachys, Coffeeberry, Red elderberry (*Sambucus racemosa*), Dogwood (*Cornus sp.*), *Ribes sp.*, Bracken fern (*Pteridium aquilinum*), Five finger fern, Horsetail, Scirpus (*Scirpus sp.*) and Stinging nettle.

Reach 3

While Reach 3 is devoid of Cape ivy, the riparian habitat is dominated by Clematis, particularly in areas where the canopy is less dense and more sunlight is available. In the upper extent of this reach, Clematis blankets the ground (>70%) and is present in California Redwood (*Sequoia sempervirens*) and Alder trees up to heights of 30 feet. Clematis forms a solid wall in some areas and native herbaceous plants are limited in these areas (see Figure 6-6).

Two large patches of jubata grass exist on the right bank (facing upstream) in the upper extent of Reach 3, near the tunnel on San Vicente Creek. They are fairly close together and appear to have colonized on old landslides/scarps (see Figure 6-7).

In addition, English ivy appears to have been planted near a historic building on to the left of San Vicente Creek (facing upstream). The ivy now occurs on covers both stream banks near the tunnel (Figure 6-8).

Acacia (*Acacia sp.*) trees were observed near the lower dam on Mill Creek (Moore, pers. comm.). There were removed in November, 2013.

A small amount of English ivy and individual jubata plants also exists in most of this reach, although a large patch of jubata is present near the tunnel. French broom has colonized small, sunny disturbed areas, although expansion is minimal due to heavy canopy and groundcover.

Small but frequent patches of *Tradescantia fluminensis* can be found in Mill Creek, predominantly on the gravel beds and on the left bank of the channel.

Native vegetation in Reach 3 includes Tan oak (*Lithocarpus densiflorus*), and Douglas Fir (*Pseudotsuga menziesii*), California Redwood, Alder, Willow, California blackberry, Bracken fern, thimbleberry (*Rubus parviflorus*), Five finger lady fern, and stinging nettle.

In addition, there is a small patch of Purple starthistle (*Centaurea calcitrapa*) (< 30 sq ft) near the conveyor belt, where the road forks (McMenamin, pers. comm.). There may be more plants in the fields across the road, but this area has not been surveyed.

Actions to Date

Since 2011, the RCD has been planning and coordinating the removal of small areas of Cape ivy within Reach 1 and 2. In 2012, Cape ivy was hand pulled from a 10,000 sq. ft area located directly adjacent to and just south of the first gate (Reach 1). Roughly 95% of the ivy was removed, with the remaining 5% being comprised of sub-surface root systems that were missed by the hand crews. Follow up removal is a high priority and will be completed this fall.

In 2013, Cape ivy was almost completely (95%+) removed from the trees in Reach 2, Areas 1, 4, and 5. Removal from the trees in Area 2 and Area 3 was limited, due to the presence of a Yellow Jacket nest.

Two passes of hand removal were made to remove Cape ivy in Area 1. Very little new Cape ivy growth has been observed on the ground and a success rate of approximately 90% has been achieved to date. There are medium Clematis vines on the ground in Area 1, but after the vines were cut in July, much of the Clematis in the trees is dead, with limited seed production. The Coffeeberry and *Ribes sp.* in the area has new growth since the removal of the Cape ivy and Clematis, due to increased sunlight exposure.

Of all the Areas, Area 2 had most remaining ground contact with Cape ivy in the trees. Where possible, this contact was broken to a height of 4 to 6 feet to allow the Cape ivy to desiccate in the trees. However, significant levels of Cape ivy remain in the trees as it is too high up to successfully be removed and due to the close proximity to the Yellow Jacket nest. Desiccation levels for remaining Cape ivy in the trees is not as high here as elsewhere, likely due to shade and greater mass. A large Cape ivy mass remains in the trees, but is too high for access, as of 2013. The largest Clematis vines found in Reach 2 are located along the stream in Area 2 and remain on the ground with mostly live vines remain in the trees. Proximity to a Yellow Jacket nest limits further removal work in Area 2, at this time.

For Area 3, all ground contact for Cape ivy in the large Alder was broken to a height of at least 6 feet and significant amounts in the tree were removed and left on the ground.

Figure 6-6. Clematis blankets the ground in the upper reaches of San Vicente Creek.

Figure 6-7. Two large patches of jubata grass are near the tunnel on San Vicente Creek.

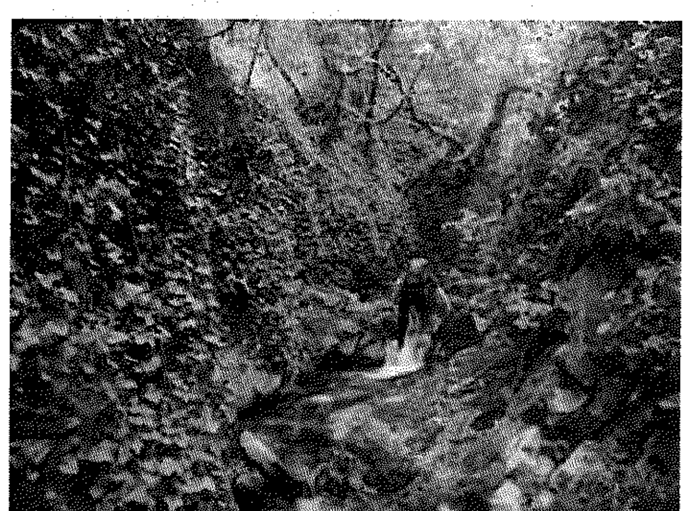


Figure 6-8. English ivy near the tunnel on San Vicente Creek.

The Cape ivy appears to be desiccating and will likely be dead prior to winter. More than half of the upstream edge of Cape ivy was cleared from native trees and shrubs and a limited amount was pulled adjacent to the stream bank to limit downstream transport and establishment. Due to the presence of native herbaceous plants, care was taken to limit damage to the desirable plant species. The yellow jacket nest limits work in the area.

An access path was cleared to reach Area 4 and Cape ivy was carefully hand pulled to 99%+. No further ivy has been observed on the ground and the little Cape ivy which remained high in the trees has desiccated further and is highly likely to be dead by the first rains. A small patch of *Vinca major* was removed to 97%+, with only a few roots remaining on the stream bank. The *Tradescantia* was not removed yet, as a path will be required to access this small infestation. The two Clematis seedlings found in Area 4 were left undisturbed for further observation and will be hand pulled this fall or winter. A small San Francisco dusky-footed Woodrat nest is found in Area 4 and was left undisturbed during removal activities.

Area 5 was too large to attempt large scale eradication in 2013 due to limited resources, but a permanent north and south border was established by carefully hand pulling the ivy to create an easily monitored and defensible border and prevent future infestation upstream and downstream. Desiccation for Cape ivy in the few remaining trees is not as high as elsewhere, likely due to shade and greater mass.

The small patch of purple starthistle was hand removed in 2012 prior to seed set.

Most of the plant species found within the project area are listed by the CDFA and Cal-IPC, as noxious weeds and invasive species. Table 6-1 lists these species and the invasive threat ranking based on the CDFA ranking, Cal-IPC ranking, and field observations.

Methods of Control

There are various management techniques used to treat/eradicate the non-native species identified as resource concerns in the San Vicente watershed, including heavy equipment, the use of specific hand power equipment, hand tools, hand removal, grazing, and herbicide application. Specific bio-control agents are presently going through the field testing process for approved use in California for use with Cape ivy and may be available a few years down the line. The most effective control techniques consider species' growth patterns, reproduction characteristics, the species location within the project area, weather, type of and proximity of desirable species, and the level of infestation. Below provides a summary of those methods, as well as their growth patterns (see Table 6-1). Also taken into account are the species' flowering and seed production periods (see Table 6-2). The selected method of control may vary from location to location within the habitat for a given species based on extent, presence of natives, distance from stream, soil and moisture conditions, time of year, amount of solar radiation, etc.

Italian thistle (*Carduus pycnocephalus*) readily colonizes any area removed of dense groundcover and recently disturbed (Harradine, 1985). However, it does not readily establish in shaded moist environments and so is a limited threat to riparian restoration. Potential removal techniques include:

1. Hand pull.
2. Carefully timed weed whacking
3. Graze with sheep or goats.

Purple starthistle (*Centaurea calcitrapa*) readily colonizes recently disturbed areas and roadsides (Bossard et al., 2000). However, unlike Italian thistle which can be dispersed long distances by wind, purple starthistle seeds are primarily deposited below or near the parent plant. Thus, it will be most important to continue to remove new plants prior to seed set to eventually deplete the seed bank. Potential removal techniques include:

1. Hand pulling, digging, or grubbing prior to seed set.

Clematis (*Clematis vitalba*) growth patterns and rate of reproduction in San Vicente Creek is currently unknown. As previously mentioned, the potential removal techniques are based on experience in English ivy removal (Moore, pers. comm.) and include:

1. For climbing vines, cut a 4-5 ft swath around the trees with loppers and/or hedge trimmers to kill the Clematis in the tree canopy. Larger stems are common and will require hand saws. Minimize damage to the bark of the host tree.
2. For groundcover:
   - » Re-cut tree root in spring and apply an herbicide approved for use in riparian areas.
   - » Apply foliar application of herbicide approved for use in riparian areas with backpack sprayers in areas with high density Clematis and limited native species.
   - » Use a small skidster/loader to remove surface mass and follow up with spot treatment of herbicide in areas with large infestations. Requires a skilled operator.

Poison hemlock (*Conium maculatum*) can spread quickly after the rainy season to areas that have been cleared or disturbed. The combination of a long seed dispersal period, seed dormancy, and non-specific germination requirements enable poison hemlock seedlings to emerge almost every month of the year (Roberts, 1979). Given its broad infestation and prolific nature, only low level management of this non-native will be possible. Potential removal techniques include:

1. Hand pull or grub plants before seeds set. Removing the entire root mass is not necessary, but repeating this procedures for multiple years will be required.
2. Apply a post emergent herbicide, like glyphosate with a surfactant.
3. Flame in wet season, late winter.

Table 6-1. Invasive Weeds of Management Concern and Invasive Rankings

Common Name	Scientific Name	Habitat	Cal-IPC Ranking	Growth Habit
Italian thistle	*Carduus pycnocephalus*	Widely distributed in disturbed open sites, roadsides, pastures, annual grasslands, and disturbed wildlands.	Moderate[1]	Annual; spread by seeds; seeds can disperse by animals, vehicles; by wind an average of 75 feet from the parent plant and can travel more than 325 feet in strong winds. A single plant can produce 20,000 seeds in one season (Wheatley and Collett, 1981).
Purple starthistle	*Centaurea calcitrapa*	Fields, roadsides, disturbed open sites, grasslands, overgrazed range-lands, and logged areas in the northern and central coast ranges of California.	Moderate	Annual, biennial or perennial; spread by seeds but close to the parent plant; longevity of seed is unknown (Bossard, et. al, 2000).
Clematis	*Clematis vitalba*	Agricultural areas, coastland, natural forests, planted forests, range/grasslands, riparian zones, ruderal/disturbed, scrub/shrublands, urban areasC. vitalba typically occupies forest margins and gaps and can invade open spaces	Unlisted	Perennial; airborne seeds; damaged or cut stems can re-sprout so plants can spread vegetatively as well.
Poison hemlock	*Conium maculatum*	Commonly found in dense patches along roadsides and fields. It also thrives in meadows and pastures and is occasionally found in riparian forests and flood plains, but prefers disturbed areas	Moderate	Annual, biennial; reproduced by seed which is dispersed by water, wind, mud, animal and humans (Bossard, et al., 2000).Can germinate any time of year. Approximataly 90% of the seed is dispersed between September and December. Seed can remain viable in seed bank for up to three years (Baskin and Baskin, 1990).
Jubata grass	*Cortaderia jubata*	Favors dunes, bluffs, coastal shrublands and marshes, inland riparian areas, and disturbed areas	High	Perennial; spreads by wind blown seed that can travel over 20 miles under windy conditions. Can flower twice in a year. An individual inflorescence can produce a million or more seeds (Bossard, et al., 2000).
Cape ivy	*Delairea odorata*	Predominant in coastal riparian areas, as well as inland riparian areas, moist forests, and oak woodlands	High	Perennial; presently appears to spreads vegetatively in California; can root at each node along the stem; viability of seeds in wildlands is unknown,but has been found viable under lab conditions .
Fennel	*Foeniculum vulgare*	Grasslands, coastal scrub, riparian, and wetland communities	High	Perennial; reproduces from root crown and seed (Bossard, et al., 2000); dispersed by water, vehicles, and humans; birds and rodents eat the seeds and may also cause dispersion (Bossard, et al., 2000); seeds may persist in soil for several years before germinating; can germinate any time of year.
French broom	*Genista monspessulana*	Common on coastal plains, mountain slopes and in disturbed places such as streambanks, roads cuts. It can colonize grassland and open canopy forest.	High	Perennial; Spread by seeds; seeds viable 30+ years; plants can re-sprout from cut stumps. Can flower twice a year at some locations (Bossard et al., 2000).
English ivy	*Hedera helix*	Found in open, deciduous forests, particularly near residences.	High	Perennial; plant reproduces vegetatively; can root at each node along the stem.
Forget-me-nots	*Myosotis sylvatica*	Prefer moist habitat, wetlands and riparian areas.	Limited	Annual or perennial
Wild Radish	*Raphanus sativus*	Grasslands and open/disturbed areas, including roadsides in California. Wild radish may also be found in wetland areas.	Limited	Annual, but can occasionally be perennial; spreads by seed
Wandering Jew	*Tradescantia fluminensis*	Damp shaded habitats, especially disturbed and previously grazed forest, shrubland, streams, alluvial terraces, wetlands, and anywhere downstream or adjacent to existing infestations.	Unlisted	Perennial
Vinca	*Vinca major*	Coastal counties, foothill woodlands, the Central Valley, and even desert areas.Riparian zones are particularly sensitive.	Moderate	Perennial; Spreads vegetatively only in this area. water can transport broken stem fragments downstream where it resprouts.

1 - Species has a pest rating of "C" by CDFA.)

Jubata grass (*Cortedaria jubata*) is a very invasive weed in the coastal area of Santa Cruz County. It readily colonizes disturbed soils and produces an abundance of seed that can disperse widely. It persists under dense canopy, but does not readily produce seed under shaded conditions. Potential removal techniques include:

1. Hand removal with the use of pulaski, prior to seeding.
2. Apply a post emergency herbicide, such as glyposate at a 2% solution.
3. Removal with heavy equipment or pull out with a truck and chain

Cape ivy (*Delaireia odorata*) is one of the priority species for removal in the watershed and methods for removal will vary greatly based on site conditions and financial resources available. Success will always require specific methodologies following carefully prioritized steps and long term monitoring. Potential removal techniques include:

1. Hand Grubbing:
   - » Break ground contact for all Cape ivy in trees for 3-6 feet. If practical remove all the Cape ivy from the trees. If removal is not practical, ground contact should be broken as soon as possible after the rainy season.
   - » Establish easy maintained borders/ buffer zones around the edge of each patch if it is not going to be treated to 95%+ eradication level in any given year. Monitor and remove any Cape ivy growing into the border areas/buffer zones.
   - » Hand pull, follow up with second pass to remove all above ground Cape ivy to 90+ % and third pass to remove all Cape ivy rhizomes and roots to 95+%.
2. Grazing is an option for large areas and minimal native species.
3. Mechanical removal with heavy equipment.
4. Herbicide treatment with an herbicide approved for use in riparian areas.

Fennel (*Foeniculum vulgare*) thrives on disturbance (including control techniques). Control techniques include either minimizing disturbance or increasing disturbance to promote fennel seed germination. Because the species readily colonizes disturbed sites and can have dormant seeds for several years, fennel control will be crucial to control seed dispersal on recently disturbed sites. Potential removal techniques include:

1. With small stands, dig out the whole plant. Do not cut plant as this disperses seeds.

French broom (*Genista monspessulana*) is an aggressive shrub that readily colonizes disturbed sites and roadsides, particularly sunny locations. It produces long-lived seeds (over 30 years) and requires a long term commitment to be removed. Control of this plant will also be critical to ensure that it does not colonize sites after another invasives are removed. Potential removal techniques include:

1. Hand pull and pull with weed wrenches, removing entire mature plant; repeat yearly for 5-6 years. Apply multiple treatments each year to speed up depletion of the seed bank.
2. Apply foliar herbicide spray to mature plants during active growth and after flower formation.
3. Use a flaming method on young seedlings and seeds in winter months.

Table 6-2. Typical Flowering Period of Invasive Weeds

Common Name	Scientific Name	Jan	Feb	Mar	Apr	May	Jun	July	Aug	Sept	Oct	Nov	Dec
Italian thistle	*Carduus pycnocephalus*					■	■	■	■				
Purple starthistle	*Centaurea calcitrapa*							■	■	■	■		
Clematis	*Clematis vitalba*					■							
Poison hemlock	*Conium maculatum*				■	■	■	■					
Jubata grass	*Cortaderia jubat*					■	■						
Cape ivy	*Delairea odorata*	■	■										■
Fennel	*Foeniculum vulgare*				■	■	■	■					
French broom	*Genista monspessulana*			■	■	■	■						
English ivy	*Hedera helix*	■	■										■
Forget-me-nots	*Myosotis sylvatica*				■	■	■	■					
Wild radish	*Raphanus sativus*		■	■	■	■	■						
Wandering Jew	*Tradescantia fluminensis*				■	■	■	■					
Vinca	*Vinca major*	■	■	■	■	■							

English Ivy (*Hedera helix*) exists in small patches within the project area. Due to the presence of more aggressive, herbaceous plants, expansion of this non-native has been limited. Removal of English ivy alongside Clematis and Cape ivy will limit its potential for spread. Potential removal techniques include:

1. For climbing vines cut plant to kill upper portions and treat the remainder of the plant as ground cover. Try to minimize damage to the bark of the host tree. Use a large screw driver or forked garden tool to pry and snap the vines away from the tree trunks and cut using a pruning saw for larger vines or a pruning snips for smaller stems.
2. For groundcover:

» Apply foliar herbicide.

» Use mechanical equipment to remove the mass of ivy and follow with hand crews.

Forget-me-nots (*Myosotis sylvatica*) are limited in the current extent in the watershed, but have the potential to pose a serious threat to the understory and native herbaceous vegetation due its highly successful seed dispersal. Potential removal techniques include:

1. Hand pull

Wild radish (*Raphanus sativa*) has limited potential for degrading habitat within the riparian corridor, but can readily become a problem along riparian and roadsides, like San Vicente Street. Potential removal techniques include:

1. Pull younger plants by hand.
2. For follow up spot treatments use a foliar spray of glyphosate on the leaves before the plant flowers. Do not use glyphosate for broad treatments due to the development of resistance.

Wandering Jew (*Tradescantia fluminensis*) exists in small patches within the project area and could be easily controlled while the extent is limited. The key to successful control of *T. fluminensis* is to reduce light availability by improving canopy cover that also reduces invasion by other weeds as gaps left from removal are likely to be colonized by other invasive species. Potential removal techniques include:

1. Hand pull (remove all fragments).

Vinca (*Vinca major*) exists in small patches within the project area and its spread may be limited due to the dense riparian canopy. Under the right conditions and once established, vinca has the potential to form a dense groundcover. Potential removal techniques include:

1. Hand pull. Monitor and hand pull resprouts.

Chapter 7: Plan for Salmonid Recovery

INTRODUCTION

Over the past two years, the RCD team has completed a number of key technical assessments with the collective goals of enabling development of a comprehensive and multidisciplinary set of recommendations to support recovery of listed salmonids in the San Vicente Watershed. The previous 6 chapters of this Plan both set the context for the intrinsic value and uniqueness of this particular watershed, and articulate the objectives and findings from these assessments. While these assessments contain invaluable data and insights, there are two external factors which make this document and the technical information it presents so valuable. First, the technical team and the review committee have been working collaboratively in this watershed for over a decade (and some folks for upwards of half of century). During this time, we have walked, talked, observed, discussed, and experimented in this watershed; learning all the time and shaping the assessment conducted as part of this effort. Second, our landowner partners (particularly the Trust for Public Land/Coast Dairies, US Bureau of Land Management, CEMEX, and Living Landscape Initiative) have provided us with unprecedented access to nearly 90% of the watershed and to their internal archives and data. This level of cooperation and access has significantly enriched and informed both the objectives and methods for the assessments as well as interpretation and ground-truthing of the findings.

This effort was explicitly funded in order to develop specific recommendations to promote recovery of listed salmonids in the San Vicente Creek Watershed and this section aims to accomplish that stated goal. That said, through a process of critical review, robust discussion and a long history of observation, the RCD technical team has developed a list of recommended actions that we believe are at their core ecological, interconnected, synergistic, and holistic. As such, the recommendations not only specifically address listed salmonids but address ecological uplift and resilience across the watershed, amongst different habitat types and niches, and through both short and long term time scales. For a purely ecological perspective, the recommendations contained in this section address the foundational ecological concepts of:

Food: via enhancing and protecting the ability of the system to create allochthonous productivity (insects and food sources from outside of the stream such as leaf litter fall from riparian trees and material washed in from floodplains) and autochthonous productivity (insects and food sources produced in the stream such as benthic macroinvertebrates that rely on clean gravels and cobbles);

Shelter: via enhancing and restoring the processes that create a mosaic of shelter for both adult and juvenile salmonids such as large wood to provide refuge, force scour pools, and promote channel aggradation and flow redirection to enable floodplain activation and recreate slack water habitat; and

Successful Reproduction and Rearing: via reestablishment of natural geomorphic processes that would recruit and sort spawning sized gravels, removal of barriers to sediment transport, remediation of areas contributing fine sediments, and protection of instream flows to allow fish to access high quality spawning habitat, migrate through and feed in shallow riffles, and hide in deep, cool pools.

In addition to framing and developing recommendations that support the overt goal of salmonid recovery, we also emphasize the more subtle and foundational goal of enhancing and restoring the key ecological processes that maintain the watershed. All of the recommendations discussed in this chapter also address one or more of the following watershed objectives:

1. Improve conditions that facilitate natural geomorphic function;
2. Improve riparian health;
3. Floodplain connectivity;
4. Improve instream habitat suitability and quality for salmonids; and
5. Consider all actions within the context of adaptive management.

Finally, it should be noted that the recommendations articulated below are also intertwined with the on-going efforts of the local captive broodstock coho recovery program and are focused on increasing carrying capacity and improving the ecological health of the watershed to increase the value and effectiveness of this broodstock program. These recommendations have been developed in a collaborative fashion, have been reviewed by the Steering Team and modified based on substantive feedback.

Please note, for the purpose of this report, the implementation timeline provided for all recommended practices is defined in the following manner: Short-term (0-5 years), medium-term (4-10 years), and long-term (10+ years).

CONCLUSION

As mentioned above, this plan is the culmination of decades of experience, familiarity and commitment by this team and watershed partners. This plan is a living document that will not collect dust by sitting on the shelf, but rather guide our actions over the next decade to improve riparian health and restore ecosystem function.

While ambitious, the recommendations in the plan are implementable. They build on previous efforts in the watershed under the auspices of IWRP and by partners and the RCD, and can be permitted through the Santa Cruz Countywide Partners in Restoration (PIR) Permit Coordination Program. The PIR program facilitates the implementation of small-scale, environmentally beneficial projects through the issuance of programmatic permits rather than permitting projects on an individual basis. Projects are designed based on criteria set forth by the Natural Resources Conservation Service (NRCS) and environmental guidelines and protection measures set forth by the program partners, including the County of Santa Cruz, Regional Water Quality Control Board (RWQCB), Army Corps of Engineers (ACOE), National Marine Fisheries Service (NMFS), US Fish and Wildlife Service (USFWS), California Department of Fish and Wildlife (CDFW).

RECOMMENDATIONS

Table 7.1. Strategies and actions proposed for San Vicente Creek Watershed

Recommendations						
	Recommendation	Detailed Description	Location Description	Dependencies/ Linkages	Issue or Limitation Addressed	Objective/ Ecological Concept
Recovery Objective: Improve, enhance and protect summer base flow and minimizing any chance of further deterioration in quality or quantity of summer base flow and/or modifications to the natural flood hydrograph						
1	Synoptic measurements	Recommend taking synoptic measurements 2 times per year to monitor magnitudes of flow and provide a set of on-going flow measurements that can be used as a basis of comparison to determine if, and how much, flows vary based on water year.	Throughout the lower watershed as per methodology described in the hydrologic assessment chapter		Instream flow	Instream habitat
2	Maintain existing continous streamflow/stage gauge	Recommend continuing the current flow record through funding and operation of the flow and temperature gauge installed in lower San Vicente Creek.	Current gauge locations		Instream flow	Instream habitat
3	Outreach and technical assistance ito reduce fine sediment transport and protect high percolation areas	Recommend outreach and technical assistance in Bonny Doon community to reduce fine sediment transport. Need to protect Santa Margarita sands in the upper Mill Creek area, which are subject to higher levels of development, prone to erosion and have large water storage capacity.	Bonny Doon		Instream flow and Fine sediment transport	Instream habitat
4	Coordinate with landowners and project partners on protecting water resources	Support the County Sanitation Districts efforts to upgrade the existing diversion facilities for the town of Davenport's water supply to reduce water loss and improve system flexibility and efficiency.	CEMEX/Davenport Diversions		Instream flow	Instream habitat
5		Consider conjunctive water supply options for the town of Davenport (e.g use of groundwater, surface water, recycled water and new storage) that would allow the town to reduce withdrawals from SVC during the dry season (especially during drought), provide a higher level of municipal water supply reliability, and protect critical summer baseflows for salmonids.	Watershed and beyond		Instream flow	Instream habitat
6		Identify opportunities for flow protection and enhancement such as relocating existing instream and near stream water diversions/wells and/or using section 1707 of the Ca Water Code to dedicate water rights to fish and wildlife resources.	Mill Creek Subwatershed and San Vicente Watershed downstream of the Quarry		Instream flow	Instream habitat
7	Implement projects to reduce or avoid impacts to instream flows	In coordination with voluntary landowner action, design and permit at least 1 project to relocate or dedicate flows from an existing water diversion to protect instream summer baseflows.	Mill Creek Subwatershed and San Vicente Watershed downstream of the Quarry	#6	Instream flow	Instream habitat
8	Support karst protection efforts	Recommend supporting the County's protection efforts for karst protection zones. Data needs around streamflow measurements could be tiered and correlated to high priority karst areas.	Watershed		Instream flow	Instream habitat
9	Work with county on protection efforts or Santa Margarita Sandstone	Recommend working with the county on a parallel effort to the karst protection effort to protect areas underlain by Santa Margarita sandstones from impacts related to impervious surfaces and altered runoff patterns.	Watershed		Instream flow/water quality	Instream habitat

Implementation

*Timeline: Short term = 0-5, Medium Term = 4-10, Long Term = 9+

Timeline*	Priority	Estimated Budget	Identified Partners
Short-term and Ongoing (recommend 10 year data set)	Medium	$5,000/year	RCDSCC, BLM and Technical Consultant, FRGP, IWRP, Sanitation District
Ongoing	High	$15,000/year	FRGP, Sanitation District, NOAA, and/or BLM.
Short-term	Medium	Unknown	RCDSCC, Bonny Doon Fire Safe Council, Rural Bonny Doon Association and NRCS
Short-term	High	None	County Sanitation Department, Davenport residents, IRWM, CEMEX
Medium and long-term	Medium	Unknown	County Sanitation Department, Davenport residents, IRWM, CEMEX, Resource Agencies, many others
Medium-term	Medium	Unknown	RCDSCC, BLM, Bonny Doon Fire Safe Council, Rural Bonny Doon Association and NRCS
Short-term	High	Unknown	BLM, Sanitation Department, private landowners, RCDSCC, NRCS
Short-term	Medium	Unknown	County
Medium-term	Medium	Unknown	County

	Recommendations					
	Recommendation	Detailed Description	Location Description	Dependencies/ Linkages	Issue or Limitation Addressed	Objective/ Ecological Concept
10	Address issues of homeless encampment and potential for poaching and water quality impacts to lower San Vicente and to the Pond	Recommend BLM wardens remove current homeless encampment from lower pond site, clean the site of refuse, and investigate ways to make the site less accessible and attractive to homeless encampments. Ideally, this can and should be accomplished regardless of the time scale for implementation of any adaptive management actions for the area. It is possible that the design of a new floodplain could make the site less attractive for an encampment (eg if the site is flooded more regularly and less visually protected by the current levees/ spoils that disconnect the mainstem from the pond).	Lower pond	#20 & #21	Water quality and poaching	Geomorphic function and Instream habitat
11	Prevent illegal water diversions	Suggest the Bureau of Land Management (BLM) enforcement and Living Landscape Initiative Partners (CEMEX) address illegal land uses, including water diversions for marijuana or other illicit operations that rely on diversion on their property.	Watershed		Instream flow/water quality	Instream habitat
Recovery Objective: Improve channel complexity in terms of pools, shelter and refuge and increase frequency and duration of flooding on undeveloped floodplains						
12	Implement Significant LWD loading projects along San Vicente Creek	Use Large Woody Debris Assessment (chapter 5) and Geomorphology Assessment (chapter 3) to identify specific trees and specific locations for LWD loading and floodplain reconnection (see recommendations below)	Throughout the watershed with particular focus on sections adjacent/ near floodplains 3, 4, 7, 9, 10 and 11		Lack of pools, pool depth, channel complexity, and floodplain connectivity	Geomorphic function, instream habitat and floodplain connectivity
13		Recommend placing 4-6 anchored/engineered LWD structures within the creek channel and identifying local trees for felling or excavation/ pushing, and anchoring	Lower watershed in areas near floodplains in section 3 and 4.		Lack of pools, pool depth, channel complexity, and floodplain connectivity	Geomorphic function, instream habitat and floodplain connectivity
14		Recommend selecting and directionally felling and/or partial rootball excavation/pushing whole conifers into the creek channel to create LWD structures, load the channel for future recruitment, and facilitate channel aggradation and flow deflection onto currently disconnected floodplain areas. Loading densities should strive to meet NMFS's criteria of 6-11 key pieces/100 meters. Trees need to be large enough (3-4 times bankfull) to avoid significant downstream movement AND be put in areas where shade and canopy impacts will be minimal. While use of trees 3-4 times bankfull should reduce the potential for significant movement, installing "backstop" structures upstream of bridges should provide additional protection from loaded LWD for those structures	Middle watershed (bounded by Mill Creek confluence on the upstream to the lower bridge on at downstream) with concentration near or adjacent to floodplains 7, 9, 10 and 11.		Lack of pools, pool depth, channel complexity, and floodplain connectivity	Geomorphic function, instream habitat and floodplain connectivity
15		Recommend experimenting with partial rootball excavation and direction "pushing" of local hardwoods (eg older alders) for LWD structures to determine longevity and potential for creating living LWD structures through mimicking "tipped" hardwood structures naturally occuring on San Vicente Creek and elsewhere along the California coast.	Throughout the watershed with particular focus on sections adjacent/ near floodplains 3, 4, 7, 9, 10 and 11		Lack of pools, pool depth, channel complexity, and floodplain connectivity	Geomorphic function, instream habitat and floodplain connectivity

Implementation

*Timeline: Short term = 0-5, Medium Term = 4-10, Long Term = 9+

Timeline*	Priority	Estimated Budget	Identified Partners
Immediate	High	$5,000-$10,000 for eviction, clean-up and fencing/signage	BLM
Short-term and ongoing	High	Unknown	BLM, Living Landscapes Initiative, County Sheriff
Short-term	High	Unknown	IWRP, RCDSCC, BLM, IWRP TAC
Short-term	High	Unknown	IWRP, RCDSCC, BLM, IWRP TAC
Short-term	Highest	Unknown	IWRP, RCDSCC, BLM, IWRP TAC
Short-term	Highest	Unknown	IWRP, RCDSCC, BLM, IWRP TAC

Recommendations

	Recommendation	Detailed Description	Location Description	Dependencies/ Linkages	Issue or Limitation Addressed	Objective/ Ecological Concept
16	Connect floodplains to the main channel	Follow recommendations in the Geomorphology Assessment for re-establishing floodplain connectivity in areas with high potential for success with increased frequency and duration of flooding.	Particular focus on sections adjacent/ near floodplains 3, 4, 7, 9, 10 and 11	#12- #15	Reconnect floodplains and reestablish natural geomorphic processes	Geomorphic function and floodplain connectivity
17		Review the potential for and develop concept sketch for re-design of the lower pond site as a significant floodplain restoration project (See recommendation #18 and #19 below)	Lower Pond	#20 and #21	Reconnect floodplains and reestablish natural geomorphic processes	Geomorphic function and floodplain connectivity
18	Remove Cape Ivy (*Delairea odorata*) from existing and/ or reconnected floodplains to faciliate natural geomorphic processes	As per recommendations below, implement a full watershed eradication effort for cape ivy to reduce potential impacts to natural geomorphic processes on floodplain areas resulting from complete cover of cape ivy and impacts to health and longevity of floodplain trees (see recommendation #20 below).	Watershed	#27 and #28	Reconnect floodplains and reestablish natural geomorphic processes	Geomorphic function and riparian enhancement
19	Roughen floodplains	Suggest roughening floodplains with downed wood to reduce flow velocities, encourage deposition sediment, and increase the frequency and duration of activation and inundation.	Link these actions to areas where floodplain reconnection and LWD loading are to occur.	#11-#17	Reconnect floodplains and reestablish natural geomorphic processes	Geomorphic function and floodplain connectivity
20	Address significant shortcoming in the current function of the lower pond restoration project	Recommend further analysis and design to rethink the lower pond project based on the past five years of observations and information developed from the geomorphic and hydrologic assessments. The original design team (Balance Hydrologics and the IWRP TAC) have discussed numerous options for either repair and/ or rethinking this project and the current thinking is the natural geomorphic and hydrologic context for the area lends itself to one of the highest priority and largest opportunities for floodplain restoration.	Lower pond	#17	Geormorphic function, floodplain connectivity, increasing carrying capacity	Geomorphic function, instream habitat and floodplain connectivity
21		Permit and implement the preferred alternative developed through action #17. Depending on technical studies, this project could include removal of the existing concrete water control structure, notching of the natural upstream banks, significant sediment removal and grading between the channel and the pond to restore floodplain function, circulation, and connectivity. Any analysis and design would need to incorporate future sea-level rise and impacts/opportunities associated with these changes.	Lower Pond	#20	Geormorphic function, floodplain connectivity, increasing carrying capacity	instream habitat and floodplain connectivity

Implementation

*Timeline: Short term = 0-5, Medium Term = 4-10, Long Term = 9+

Timeline*	Priority	Estimated Budget	Identified Partners
Short-term	High	Unknown	IWRP, RCDSCC, BLM, IWRP TAC
Short-term	Medium	Unknown	IWRP, RCDSCC, BLM, IWRP TAC
Medium-term and ongoing	High	Unknown	RCDSCC, George McMenamin, BLM and NRCS
Short-term	Medium	Unknown	IWRP, RCDSCC, BLM, IWRP TAC
Short-term	Medium	$30,000-$40,000 (for designs and studies)	IWRP, RCDSCC, BLM Caltrans, CEMEX (possible use of sediment for reclamation)
Medium-term	Medium	$50-200,000	IWRP, RCDSCC, BLM, IWRP TAC

	Recommendation	Detailed Description	Location Description	Dependencies/ Linkages	Issue or Limitation Addressed	Objective/ Ecological Concept
22	Restore capacity and improve functionality of the upper pond	Recommend a focused investigation to determine the origin of the current sediment slug that was deposited in the pond in 2010.There are a few potential sources including a natural landslide or debris slide, agricultural activities on the terrace upstream of the tributary that drains into the pond and potential impacts from the CEMEX quarry at and adjacent to the headwaters of the tributary.	Tributary to Upper Pond		Geomorphic function, floodplain connectivity, increasing carrying capacity	Geomorphic function, instream habitat and floodplain connectivity
23		Recommend suction dredging 120-150 cy of material from the pond to clean it out and regain depth for fish and frogs,, plant sedges/rushes in the upper area of the pond to keep suspended matter down, and knocking down some small alders to get additional sunlight.	Upper pond	#21	Geomorphic function, floodplain connectivity, increasing carrying capacity	Instream habitat and floodplain connectivity
24	Monitor effectiveness of restoration actions	Sustain, enhance and support existing effectiveness monitoring protocols developed and implemented by NOAA's Southwest Fisheries Science Center to determine/identify/quantify effects of restoration actions on physical AND biological response via fisheries population, density and abundance.	Throughout anadramous reaches of the Watershed	#13-#23	Lack of monitoring and evaluating success of restoration projects/ recovery strategies	Geomorphic function, instream habitat and floodplain connectivity
25		Recommend monitoring LWD projects for scour, hardwood sprouting, longevity of wood, how species differ, ability to redirect flows and aggrade the channel bed to facilitate floodplain inundation, etc.	Throughout the watershed at implementation sites.	#13-#15	Lack of monitoring and evaluating success of LWD projects/ strategies	Geomorphic function, instream habitat and floodplain connectivity
26		In addition to monitoring effectiveness for fisheries, conduct annual monitoring of restoration sites for other species such as California red-legged frog	Throughout anadramous reaches of the Watershed	#24	Lack of monitoring and evaluating success of "watershed process-based" projects/ strategies on other listed species	Geomorphic function, instream habitat and floodplain connectivity

Implementation

*Timeline: Short term = 0-5, Medium Term = 4-10, Long Term = 9+

Timeline*	Priority	Estimated Budget	Identified Partners
Short-term	Medium	$2,000-$4,000	RCDSCC, IWRP, BLM, Techincal Consultant
Short-term	High	$10,000-30,000	RCDSCC, IWRP, BLM
Ongoing	High	Unknown	NOAA Fisheries SWFSC, DFW, FRGP, RCDSCC, BLM
Ongoing	High	Unknown	IWRP, RCDSCC, BLM, IWRP TAC, NOAA Fisheries SWFSC
Medium -term	Medium	Unknown	USFWS, DFW, RCDSCC, BLM, Living Landscapes Initiative

	Recommendation	Detailed Description	Location Description	Dependencies/ Linkages	Issue or Limitation Addressed	Objective/ Ecological Concept
Recovery Objective: Control and, if possible, eradicating known invasive and ecologically damaging plant species populations in the watershed to improve riparian health and ecosystem function						
27	Remove Cape Ivy (*Delairea odorata*)	Recommend prioritizing cape ivy removal identified in reach 2 due to the limited extent of five distinct patches in this area	Reach 2 (as identified in Chapter 6)		Invasive species and Geomorphic Processes	Riparian health
28		Recommend implementing a larger eradication effort throughout the watershed with regular maintenance twice a year and ongoing monitoring and maintenance after restoration efforts. This is the priority weed identified for eradication/control and current patch size and distribution make this effort possible.	All mapped patches starting from upstream and moving downstream	#17	Invasive species and Geomorphic Processes	Riparian health
29	Identify and remove prevalence of Clematis	Due to the unknown nature of this emerging threat, further investigation is needed to identify the geographic extent of clematis within the watershed and the most effective method of eradication (greater presence in the upper watershed).	Throughout San Vicente watershed (greater presence in the upper watershed)		Invasive species	Riparian health and adaptive management
30	Prevent new colonization of invasive species	Recommend preventing new colonization of invasive species within project sites, removing existing invasive species prior to project implementation, and continuing to track new invasions (i.e. spider wort population near lowest dam on Mill Cr).	Throughout San Vicente watershed		Invasive species	Riparian health
Recovery Objective: Increase understanding of and address potential impacts to natural sediment transport and delivert into the anadramous reaches of San Vicente Creek.						
31	Conduct study at abandoned quarry to identify/ quantify potential interruption to coarse sediment transport downstream creek reaches. Depending on findings, implement projects to mitigate impacts.	Conduct study at abandoned quarry to identify and quantify potetial impacts of the site to the natural sediment transport regime and develop viable alternatives to mitigate impacts, if necessary.	Quarry on Mainstem San Vicente		Geomorphic Function and improved spawning conditions	Geomorphic function and instream habitat
32		Pending results of this study implement options for mitigating impacts (if any exist) to coarse sediment transport and delivery to key anadramous reaches of San Vicente Creek.	Quarry on Mainstem San Vicente	#31	Geomorphic Function and improved spawning conditions	Geomorphic function and instream habitat

Implementation

*Timeline: Short term = 0-5, MediumTerm = 4-10, LongTerm = 9+

Timeline*	Priority	Estimated Budget	Identified Partners
Short-term and ongoing	High	$40,000-$60,00	RCDSCC, George McMenamin, BLM and NRCS
Medium-term and ongoing	Medium	$200,000-$300,000	RCDSCC, George McMenamin, BLM and NRCS
Short-term and ongoing	High	$150,000-$200,000	RCDSCC, Living Landscape Initiative Partners, BLM, NRCS
Short-term and ongoing	Low	$50,000	Watershed Stewards Project members, RCDSCC Interns, BLM, Living Landscape Initiative Partners, private landowners
Short-term	Medium	$2500-$5,000	Living Landscapes Initiative Partners, RCDSCC, IWRP,Technical consultant
Medium -term	Medium	Unknown	Living Landscapes Initiative Pamers, RCDSCC, IWRP,Technical consultant

	Recommendations					
	Recommendation	Detailed Description	Location Description	Dependencies/ Linkages	Issue or Limitation Addressed	Objective/ Ecological Concept
33	Assess material behind the lower dam on Mill Creek, determine feasibility and value of removal and implement (preferred action).	Recommend further investigation on the defunct lower dam on Mill Creek to asses the type and size of sediment stored behind the dam and develop a risk analysis related to impacts to the stream from an uncontrolled breach (recent observations indicate that structural integrity at the dam site is a real issue for the foreseeable future).	Mill Creek		Geomorphic function, improved spawning conditions, and passage	Geomorphic function and instream habitat
34		Based on findings from sediment assessment, consider various options for shoring the dam, removing accumulated sediment (currently assumed to be infeasible due to lack of access) or facilitating a controlled breach of the dam (eg concrete cutting or explosio, possibly prior to an expected large storm event to naturally and effectively transport material downstream). Note: any recommendation for transporting sediments downstream is based on the ability to implement significant LWD and floodplain projects prior to faciliating transport in order to ensure the system can process, sort and effectively store the transported material.	Mill Creek	#12-#17, #33 (so system can handle the sediment)	Geomorphic function, improved spawning conditions, and passage	Geomorphic function and instream habitat
35	Identify sediment sources originating from the Mill Creek subdrainage	Recommend further study and identification of fine sediment sources originating from the Mill Creek subwatershed.	Mill Creek subwatershed		Geomorphic function, improved spawning and rearing conditions	Instream habitat
	Recovery Objective Consider major long-term restoration efforts that would significantly restore the natural geomorphic and biologic functions of San Vicente Creek from headwaters to mouth					
36	Work with Caltrans and the Regional Transporation Commission to assess the viability of replacing the existing tunnel and bore with a clear span bridge to restore a more natural beach/lagoon/ coastal marsh system.	While the current conditions provide unique physical conditions for anadromous fish to migrate in and out of San Vicente Creek year round, this current infrastructure could (a) be prone to significant coastal erosion with sea level rise and (b) may reduce the reslience of San Vicente Creek to adjust to climate change. The current condition with the mouth devoid of a bar-built estuary maybe one of the most important characteristics of the system for coho recovery in the near future due the lack of a natural sand barrier and concerns about breaching. That said, as recovery gains a foothold and planners look toward the future, naturalization of the mouth/ lagoon could be a viable and valuable action.	Lower watershed		Geomorphic function and improved rearing conditions	Geomorphic function and instream habitat

Implementation

*Timeline: Short term = 0-5, MediumTerm = 4-10, LongTerm = 9+

Timeline*	Priority	Estimated Budget	Identified Partners
Short-term	Medium	$500	RCDSCC, County Sanitation Department and/or Public Works.
Medium-term	Medium	Unknown	RCDSCC and County Department of Sanitation and/or Public Works.
Medium-term	Medium	Unknown	Technical consultant, County, IWRP, RCDSCC, BLM, Living Landscape Initiative Partners
Long-term	Low	Millions	Caltrans, RTC, NMFS, NOAA Science Center, DFW, RWQCB, ACOE, USFWS, BLM.

	Recommendations					
	Recommendation	Detailed Description	Location Description	Dependencies/ Linkages	Issue or Limitation Addressed	Objective/ Ecological Concept
37	Work with the Living Landscape Initiative Partners to consider long-term benefits and options for reconnecting the watershed above and below the defunct CEMEX quarry.	The historic record is not clear on the duration or regularity with which San Vicente Creek maintained surface flows through the quarry reach and/or whether coho salmon would have been able to access some of the steeper headwater streams above the quarry. That said, watershed restoration and restoration of natural geomorphic processes could be greatly improved if large wood and gravel from the upper watershed were able to be naturally transported to the lower watershed . In addition, as climate change becomes a reality and both sea-levels and temperatures rise, the lower watershed may become more brackish , pushing juvenile fish further upstream. Higher temperatures may also push juvenile fish to seek the more densely shaded, redwood forest reaches upstream of the quarry. Lastly, as fisheries recover carrying capacity could become a limiting factor and opening up the entire upper watershed could be a critical action to provide more spawing and rearing habitat.	Upper Watershed	#31 and #33	Geomorphic function, improved spawning and rearing conditions	Geomorphic function and instream habitat

Implementation

*Timeline: Short term = 0-5, Medium Term = 4-10, Long Term = 9+

Timeline*	Priority	Estimated Budget	Identified Partners
Long-term	Low	Millions	Living Landscapes Initiative Pamers, RCDSCC, IWRP, NMFS, DFW, etc

Appendix A

APPENDIX A

San Vicente Resource Library Documents

Author	Year	Title
Abbe, T.B. and D.R Montgomery	1996	Large Woody Debris Jams, Channel Hydraulics and Habitat Formation in Large Rivers
Alvarez, M. E.	1997	Management of Cape-ivy (*Delairea odorata*) in the Golden Gate National Recreation Area
Andrus, C., B. Bilby, T. Nichelson, A. McKee and J. Boechler	1993	Modeling woody debris inputs and outputs
Archbald, G.	1995	Biology and control of German ivy
Becker, G.S., K.M. Smetak, and D.A. Asbury	2010	Southern Steelhead Resources Evaluation: Identifying Promising Locations for Steelhead Restoration in Watersheds South of the Golden Gate
Behmer, J. D. and C.P Hawkins	1986	Effects of overhead canopy on macroinvertebrate production in a Utah stream

Benbow, E.M, R. McEwan, R. McNeish and L. Schewart	2013	Invasive Plant Impacts on Riparian-Aquatic Linkages
Benda, L.E., D. Miller, J. Sias, D. Martin, R.E. Bilby, C. Veldhuisen, and T. Dunne	2003	Wood recruitment processes and wood budgeting
Benda, L.E., P. Bigelow and T.M Worsley	2002	Recruitment of wood to streams in old-growth and second-growth redwood forests, northern California, U.S.A.
Benke, A.C. and J.B Wallace	2003	Influence of Wood on Invertebrate Communities in Streams and Rivers
Bergendorf, D.	2002	The Influence of In-stream Habitat Characteristics on Chinook Salmon (Oncorhynchus tshawytscha)
Bilby, R.E.	1984	Removal of Woody Debris May Affect Stream Channel Stability
Bilby, R.E. and G.E. Likens	1980	Importance of Organic Debris Dams in the Structure and Function of Stream Ecosystems
Bilby, R. E. and J. W. Ward	1989	Changes in characteristics and function of woody debris with increasing size of streams in western Washington

Bilby, R.E. and J.W.Ward	1991	Characteristics and Function of Large Woody Debris in Streams Draining Old-Growth, C ear-Cut, and Second-Growth Forests in Southwestern Washington
Bisson, P. and G. Davis	1976	Production of juvenile chinook salmon (*Oncorhynchus tshawytscha*) in a heated model stream
Blodgett, C. J. and E.H Chin	1989	Flood of January 1982 in the San Francisco Bay Area, California.
Bossard, C.	1998	Effects of floating Cape ivy (Senecio mikanioides) foliage on golden shiners and crayfish
Bossard, C.C., M.J. Randall and C.M. Hoshovsky	2000	Invasive plants of California's wildlands
Bragg, D. C., J. L. Kershner and D. W. Roberts	2000	Modeling large woody debris recruitment for small streams of the central Rocky Mountains
Bryant, M. D. and D.N. Swanston	1998	Coho Salmon Populations in the Karst Landscape of North Prince of Wales Island, Southeast Alaska
Burnham, K.	2008	~285 km Since Before 11 Ma Vs. ~30 km Since ~3 Ma: The Hayward-Calaveras Faulat Outranks a part of the San Andreas Fault in Both Age and Offset Distance

California Coastal Commission	2008	Nonpoint Source Watershed Assessment : James Fitzgerald Marine Reserve Critical Coastal Area
California Department of Fish and Game (DFG)	1996	Stream Inventory Report San Vicente Creek
California Department of Fish and Game (DFG)	2007	Bonny Doon Limestone Quarry Boundary Expansion Project & Reclamation Plan Amendment Draft Environmental Impact Report
California Department of Fish and Game (DFG)	2011	FRGP Budget for the San Vicente Watershed Restoration Plan for Salmonid Recovery
California Department of Fish and Game (DFG)	2011	FRGP Grant Agreement for the San Vicente Watershed Restoration Plan for Salmonid Recovery
California Department of Fish and Wildlife (DFW)	2013	Stream Inventory Report Mill Creek (Surveyed 2010)
California Department of Fish and Wildlife (DFW)		Stream Inventory Report San Vicente Creek (Surveyed 1996)
California Department of Fish and Wildlife (DFW)	2013	Stream Inventory Report San Vicente Creek (Surveyed 2010)

California Department of Forestry and Fire Protection (CalFire)	2003	Timber Harvesting Plan
California Department of Forestry and Fire Protection (CalFire)	2009	Lockheed Fire: Post Fire Risk Assessment
California Regional Water Quality Control Board (CRWQCB)	2005	Fact Sheets Supporting Revision of the Section 303(d) List
Carter, K.	2005	The Effects of Temperature on Steelhead Trout, Coho Salmon, and Chinook Trout Biology and Function by Life Stage
Cartier, R.	1991	The Santa's Village Site Excerpt: *An Overview of Ohlone Culture*
Catalano, S., S. Luschi, G. Flamini, P. L. Cioni, E. M. Nieri, and I. Morelli	1996	A xanthone from Senecio mikanioides leaves
CEMEX	2006	Davenport Cement Centennial: Honoring Our Past, Building the Future
Chapman, D.W. and T.C. Bjornn	1969	Distribution of salmonids in streams, with special reference to food and feeding

Coast Dairies	2010	Coast Dairies Ferrari Creek Watershed Task 2 for BLM
Coast Dairies	2010	Coast Dairies Molino Creek Watershed Task 2 for BLM
Coast Dairies	2010	Coast Dairies Y Creek Watershed Task 2 for BLM
Coast Dairies	2010	Coast Dairies Yellowbank Creek Watershed Task 2 for BLM
Coast Dairies	2012	Grazing Management Task 4 for BLM
Coast Dairies	2013	San Vicente Creek Large Woody Debris Task 1 for BLM
Collins, B.D. and D.R. Montgomery	2002	Forest development, wood jams andrestoration of floodplain rivers in the Puget Lowland, Washington
County of Santa Cruz	2002, 2003	Davenport Water Turbidity Levels

County of Santa Cruz	1998	San Vicente Creek Enhancement Project Proposal
County of Santa Cruz	2000	San Vicente Creek Enahncement Project
County of Santa Cruz	1998	San Vicente Creek Habitat Enhancement Project Drawings
County of Santa Cruz	2004	Davenport Water & Surface Water Treatment Plant Monthly Report
County of Santa Cruz	2006	Winter Raw Water Supply
Creegan and D'Angelo	1984	Watershed Analysis, San Vicente Creek, Mill Creek, Liddel Creek
Crispin, V., R. House and D. Roberts	1993	Changes in instream habitat, large woody debris, and salmon habitat after restructuring of a coastal Oregon stream
Davies-Colley, R. J. and D. G. Smith	2001	TURBIDITY, SUSPENDED SEDIMENT, AND WATER CLARITY: A REVIEW

Davies-Colley, R. J., and D. G. Smith	2001	TURBIDITY SUSPENDED SEDIMENT, AND WATER CLARITY: A REVIEW
Elliott, J.M.	1973	The Diel Activity pattern, drifting and food of the Leech ERPOBDELLA OCTOCULATA (L.)(HIRUDINEA: ERPOBDELLIDAE) in a lake district stream
Elliot, W.	1994	German ivy engulfing riparian forests and heading for the uplands
Environmental Science Associates (ESA)	2001	Coast Dairies Long Term Resource Protection and Use Plan
Environmental Science Associates (ESA)	2003	San Vicente Pond and Creek Smolt Outmigrant Study
Faustini, J. M. and J.A Jones	2003	Influence of large woody debris on channel morphology and dynamics in steep, boulder-rich mountain streams, western Cascades, Oregon
Flosi, G., D. Downie, J. Hopelain, M. Bird, R. Corey and B. Collins	1998	California Salmonid Stream Habitat Restoration Manual.
Giacchino, A.	2006	Water Appropriation Protest

Gilchrist, J. et al.	1982	Fish Habitat Assessment for Santa Cruz County Streams
Gregory, S. V. et al.	2003	The ecology and management of wood in world rivers.
Gurnell, A. M., H. Piegay, F. J. Swanson and S.V. Gregorys	2002	Large Wood and Fluvial Processes.
Hagans, D.	2010	Testimony read into the record at the 04.04.2010 SWRCB hearing
Hamey, N.	2009	Support of delist San Vicente Creek from the RWQB 303(d) TMDL List
Hamman, R.	1996	140 Years of Railroadings in Santa Cruz County
Harradine, A.R.	1985	Dispersal and establishment of slender thistle, Carduus pycnocephalus, as effected by ground cover.
Hildebrand, R.H., A.D. Lemly, C.A. Dolloff, and K.L. Harpster	1998	Design Considerations for Large Woody Debris Placement in Stream Enhancement Projects

Hill, W. R., M.G. Ryon, and E. M. Schilling	1996	Light limitation in a stream ecosystem: responses by primary producers and consumers
Howell, J. T.	1970	Marin Flora
Hyatt, T. L. and R.J. Naiman	2001	The residence time of large woody debris in the Queets River, Washington
Jackson, D.	2004	Coast Dairies Draft Stream Gauging Report
Jankovitz, J.D.	2012	2011-2012 Escapement Estimates for Central California Coast Coho Salmon (Oncorhynchus kisutch) and Steelhead (Oncorhynchus mykiss) South of the Golden Gate
Kiem, R. F. and A.E. Skaugset	2002	Physical aquatic habitat I. errors associated with measurement and estimation of residual pool volumes.
Kirk, J.T.O.	1985	Effects of suspensoids (turbidity) on penetration of solar radiation in aquatic ecosystems
Kossack, D.	2008	Individual Conditional Waiver of Waste Discharge Requirements of Timber Harvest Plan

Lassettre, N.S.	2001	Large woody debris in channels for aquatic habitat: developing strategies for watershed scale management, Soquel Demonstration Forest.
Lehane, B.M., P.S. Giller, J. O'Halloran, C. Smith, and J. Murphy	2002	Experimental provision of large woody debris in streams as a trout management technique.
Leicester, M. A	2005	Recruitment and Function of Large Woody Debrs in Four California Coastal Streams
Lienkaemper, G. W. and F.J. Swanson.	1987	Dynamics of large woody debris in streams in old-growth Douglas-fir forests
Lonestar	1983	Fisheries Resouce
Masters, R. A. and R. L. Sheley	2001	Principles and practices for managing rangeland invasive plants
McDade, M.H., F.J. Swanson, W.A. McKee, J.F. Franklin, and J. VanSickle	1990	Source distance for coarse woody debris entering small streams in western Oregon and Washington
McGinnis, M.S.	1991	An Evaluation of the Anadromous Fish Spawning San Vicente Creek Systems

McHenry, M.L., E. Shott, R.H. Conrad, and G.B. Grette	1998	Changes in the quantity and characteristics of large woody debris in streams of the Olympic Peninsula, Washington, USA
Montgomery, D. R. and J.M. Buffington	1995	Pool spacing in forest channels.
Morgan, R.	2001	Botanical survey of THP area, RMC property, Ben Lomond Mountain.
Mull, K.E.	2005	Selection of Spawning Sites by Coho Salmon (*Onchorhynchus kisutch*) in Freshwater Creek, California
National Marine Fisheries Service (NMFS)	2008	San Vicente Watershed Characterization
National Marine Fisheries Service (NMFS).	2012	Recovery Plan for the Ecologically Significant Unit of Central California Coast Coho Salmon.
National Oceanic and Atmospheric Association (NOAA)	2012	San Vicente Creek
National Oceanic and Atmospheric Association (NOAA)		San Vicente Creek Threats and Associated Recovery Actions

National Oceanic and Atmospheric Association (NOAA)	2012	Stream Reach Data
North Coast Regional Water Quality Control Board (NCRWQCB)	2006	Desired Salmonid Freshwater Habitat Conditions for Sediment-Related
Opperman, J.J. and A.M Merenlender	2007	Living trees provide stable large wood in streams
Paul, G.	2007	California 2004-2006 Section 303(d) list-San Vicente Creek, Santa Cruz County
Poole, G.C. and C. H. Berman	2001	An Ecological Perspective on In-Stream Temperature: Natural Heat Dynamics and Mechanisms of Human-Caused Thermal Degradation
Quinn, J. M, A.B Cooper, M.J Stroud, and G.P Burrell	2007	Shade effects on stream periphyton and invertebrates: an experiment in streamside channels.
Rainville R.P., S.C. Rainville, and E.L. Lider	1985	Riparian silviculture strategies for fish habitat emphasis
Regional Water Quality Control Board (RWQCB)	2010	California 2010 Integrated Report (303(d) List 305(b) Report - FINAL and DRAFT

Reppert, H.	2002	Response to March 29 Comments by Davenport Sanitation District
Resource Conservation District of Santa Cruz County (RCDSCC)	2011	Fisheries Resource Grant Program Application Attachments
Resource Conservation District of Santa Cruz County (RCDSCC)	2011	Fisheries Resource Grant Application Form
Resource Conservation District of Santa Cruz County (RCDSCC)	2012	Fisheries Restoration Grant Program Large Woody Debris Progress Report 2
Resource Conservation District of Santa Cruz County (RCDSCC)	2011	Fisheries Restoration Grant Program.Large Woody Debris Invoice 2
RMC Pacific Materials	2001	Timber Harvesting Plan
Roberts, H.A.	1979	Periodicity of seedling emergence and seed survival in some Umbelliferae
Robison, R. A.	2006	Distribution, Growth Analysis, and Reproductive Biology of Cape Ivy (Delairea Odorata Lem. Syn Senecio Mikanioides Walp.) in California

Santa Cruz County	2009	San Vicente Recovery Issues
Santa Cruz County Environmental Health Service	2003, 2004, 2005, 2006, 2007	Surface Water Treatment Plant Monthly Report
Schmid, E.	1997	Resource Management Planning for Coast Dairies Property
Shirvell, C. S.	1990	Role of Instream Rootwads as Juvenile Coho Salmon (Oncorhynchus kisutch) and Steelhead Trout (O. myskiss) Cover Habitat Under Varying Streamflows.
Sierra Club	2004	Supplement to San Vicente 303d Listing
Sierra Club	2008	Support of not delisting
Sierra Club	2004	Inclusion of San Vicente Creeek Watershed on 2004 Clean Water Act Section 303(d) List
Spence, B. W.G. Duffy, J.C. Garza, B.C. Harvey, S.M. Sogard, L.A. Weitkamp, T.H.	2011	Historical occurrence of Coho salmon (*O, kisutch)* in streams of the Santa Cruz Mountain Region of California: Response to an endangered species act petition to delist Coho salmon south of the San Francisco Bay

State Water Resources Control Board (SWRCB)	2010	Draft California 2010 Integrated Report (303(d) List/305(b) Report) Supporting Information
State Water Resources Control Board (SWRCB)	2011	Order Approving Issuance of Permit of CEMEX Division of Water Rights
Stelljes, M. E., R.B Kelley, R.J Molyneux and J.N Seiber.	1991	GC-MS determination of pyrrolizidine alkaloids in four Senecio species
Swanson, F. J., M.D. Bryant, G.W. Lienkaemper and J.R. Sedell	1984	Organic Debris in Small Streams, Prince of Wales Island, Southeast Alaska.
Thompson, D. M.	2012	The challenge of modeling pool–riffle morphologies in channels with different densities of large woody debris and boulders
Titus, R.G., D.C Erman, and W.M Snider.	2012	History and status of steelhead in California Coastal drainages south of San Francisco Bay
Tschaplinski, P. J. and G.F Hartman.	1983	Winter Distribution of Juvenile Coho Salmon (Oncorhynchus kisutch) Before and After Logging in Carnation Creek, British columbia, and Some Implications for Overwinter Survival.
Tunheim, E.	2001	Stream Survey of Upper San Vicente Tributaries

UC:ANR: Hopland Research Extension and Center GIS Lab	2008	Description of Attributes in Tables produced in the Stream Summary Application
University of California Santa Cruz (UCSC)	2012	San Vicente Creek Coho reintroduction and monitoring program.FRGP Proposal Application Form
Watson, J., J. Casgrande and F. Watson.	2008	Central Coast Region South District Basin Planning & Habitat Mapping Project
Weppner, E.M., E. Richards and D. Hagans.	2009	Cemex THP 1-06-080SCR 2008 Phase 1 Road Assessment Project, San Vicente Creek Santa Cruz County, California
West, C.J.	1991	Literature review of the biology of Clematis vitalba (old man's beard)
West, J.A.	2012	A Journey through Scott's Creek Watershed
West, J.A.	2012	Traversing Swanton Road
Wohl E. and K. Jaeger.	2009	A conceptual model for the longitudinal distribution of wood in mountain streams

	2012	San Vicente NTU Data
	1998	California Salmonid Stream Habitat Restoration Manula Part II Preliminary Watershed Assessment
		Steelhead rainbow trout resources of Santa Cruz County
	2002, 2003	San Vicente Stage Data
	2012	San Vicente Redds Data
		San Vicente Water Intake Location
	1996	Upstream: Salmon and Society in the Pacific Northwest.
	1985	Proceedings

Appendix B

ANALYTICAL CHEMISTS
and
BACTERIOLOGISTS
Approved by State of California

SOIL CONTROL LAB

42 HANGAR WAY
WATSONVILLE
CALIFORNIA
95076
USA

TEL: 831-724-5422
FAX: 831-724-3188

Balance Hydrologics, Inc. (Santa Cruz)
224 Walnut Ave., Suite E
Santa Cruz, CA 95060
Attn: Denis Ruttenberg

October 17, 2013

RE: Project #/Name: 211024 / San Vincente Water Shed
Workorder: 3100329

Dear Denis Ruttenberg,

Enclosed is a copy of your laboratory report for test samples received by our laboratory on .

Unless otherwise noted in an attached project narrative, all samples were received in acceptable condition and processed in accordance with the referenced methods.

If you have any questions or require further information, please do not hesitate to contact me.

Sincerely,

Mike Galloway

Mike Galloway
Laboratory Manager
Enclosure(s)

Balance Hydrologics, Inc. (Santa Cruz)
224 Walnut Ave., Suite E
Santa Cruz, CA 95060
Attn: Denis Ruttenberg

Work Order #: 3100329
Reporting Date: October 17, 2013

SAMPLE SUMMARY

Laboratory ID	Client ID	Station ID	Matrix	Sampled	Received
3100329-01	SVC at Gage		Water	10/09/13 13:30	10/10/13 09:20
3100329-02	Mill Cr. At SVC		Water	10/09/13 14:15	10/10/13 09:20
3100329-03	SVC above Miller		Water	10/09/13 14:17	10/10/13 09:20

RL - are levels down to which we can quantify with reliability, a result below this level is reported as "ND" for Not Detected.

Balance Hydrologics, Inc. (Santa Cruz)
224 Walnut Ave., Suite E
Santa Cruz, CA 95060
Attn: Denis Ruttenberg

Work Order #: 3100329
Reporting Date: October 17, 2013

Date Received: October 10, 2013
Project # / Name: 211024 / San Vincente Water Shed
Sample Identification: SVC at Gage
Matrix: Water
Laboratory #: 3100329-01

	Results	Units	RL	Dilution Factor	Analysis Method	Date Analyzed	Flags
Carbonate as CO3	ND	mg/L	3.8	3.85	SM 2320B	10/10/13	
Bicarbonate as HCO3	180	mg/L	3.8	3.85	SM 2320B	10/10/13	
Total Alkalinity as CaCO3	150	mg/L	3.8	3.85	SM 2320B	10/10/13	
Hydroxide as OH	ND	mg/L	3.8	3.85	SM 2320B	10/10/13	

RL - are levels down to which we can quantify with reliability, a result below this level is reported as "ND" for Not Detected.

Balance Hydrologics, Inc. (Santa Cruz)
224 Walnut Ave., Suite E
Santa Cruz, CA 95060
Attn: Denis Ruttenberg

Work Order #: 3100329
Reporting Date: October 17, 2013

Date Received:	October 10, 2013
Project # / Name:	211024 / San Vincente Water Shed
Sample Identification:	Mill Cr. At SVC
Matrix:	Water
Laboratory #:	3100329-02

	Results	Units	RL	Dilution Factor	Analysis Method	Date Analyzed	Flags
Carbonate as CO3	ND	mg/L	4.5	4.55	SM 2320B	10/10/13	
Bicarbonate as HCO3	120	mg/L	4.5	4.55	SM 2320B	10/10/13	
Total Alkalinity as CaCO3	97	mg/L	4.5	4.55	SM 2320B	10/10/13	
Hydroxide as OH	ND	mg/L	4.5	4.55	SM 2320B	10/10/13	

RL - are levels down to which we can quantify with reliability, a result below this level is reported as "ND" for Not Detected.

Page 4 of 6

Balance Hydrologics, Inc. (Santa Cruz)
224 Walnut Ave., Suite E
Santa Cruz, CA 95060
Attn: Denis Ruttenberg

Work Order #: 3100329
Reporting Date: October 17, 2013

Date Received:	October 10, 2013
Project # / Name:	211024 / San Vincente Water Shed
Sample Identification:	SVC above Miller
Matrix:	Water
Laboratory #:	3100329-03

	Results	Units	RL	Dilution Factor	Analysis Method	Date Analyzed	Flags
Carbonate as CO3	ND	mg/L	3.8	3.85	SM 2320B	10/10/13	
Bicarbonate as HCO3	180	mg/L	3.8	3.85	SM 2320B	10/10/13	
Total Alkalinity as CaCO3	150	mg/L	3.8	3.85	SM 2320B	10/10/13	
Hydroxide as OH	ND	mg/L	3.8	3.85	SM 2320B	10/10/13	

RL - are levels down to which we can quantify with reliability, a result below this level is reported as "ND" for Not Detected.

Balance Hydrologics, Inc. (Santa Cruz)
224 Walnut Ave., Suite E
Santa Cruz, CA 95060
Attn: Denis Ruttenberg

Work Order #: 3100329
Reporting Date: October 17, 2013

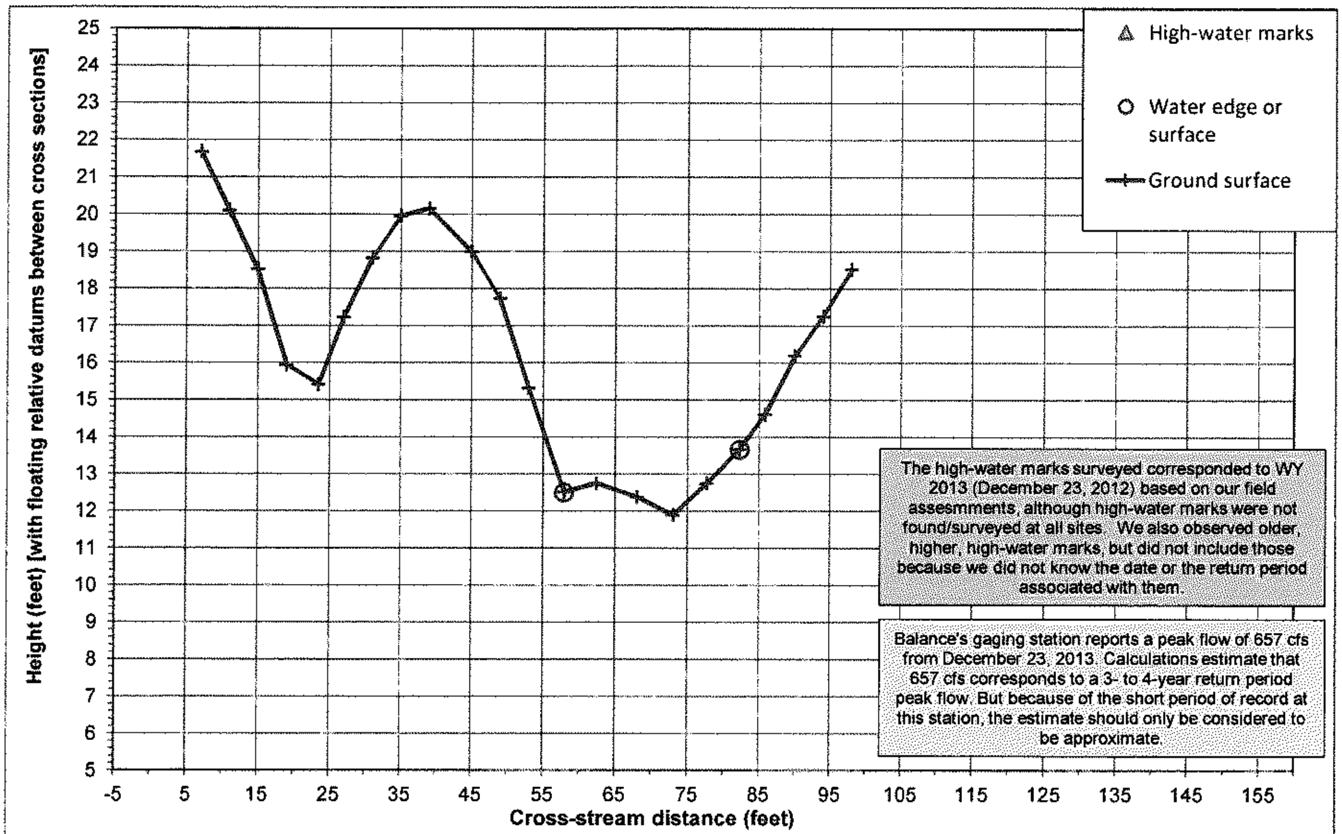
Classical Chemistry Parameters - Quality Control
Soil Control Lab

Analyte	Result	MDL	Reporting Limit	Units	Spike Level	Source Result	%REC	%REC Limits	RPD	RPD Limit	Notes
Batch PJ30109 - Default Prep GenChem											
Blank (PJ30109-BLK1)					Prepared & Analyzed: 10-Oct-13						
Total Alkalinity as CaCO3	2.120		1.0	mg/L							
Duplicate (PJ30109-Dup1)		**Source: 3100349-01**			Prepared & Analyzed: 10-Oct-13						
Total Alkalinity as CaCO3	276.2		2.0	mg/L		277.4			0.414	20	

RL - are levels down to which we can quantify with reliability, a result below this level is reported as "ND" for Not Detected.

Appendix C

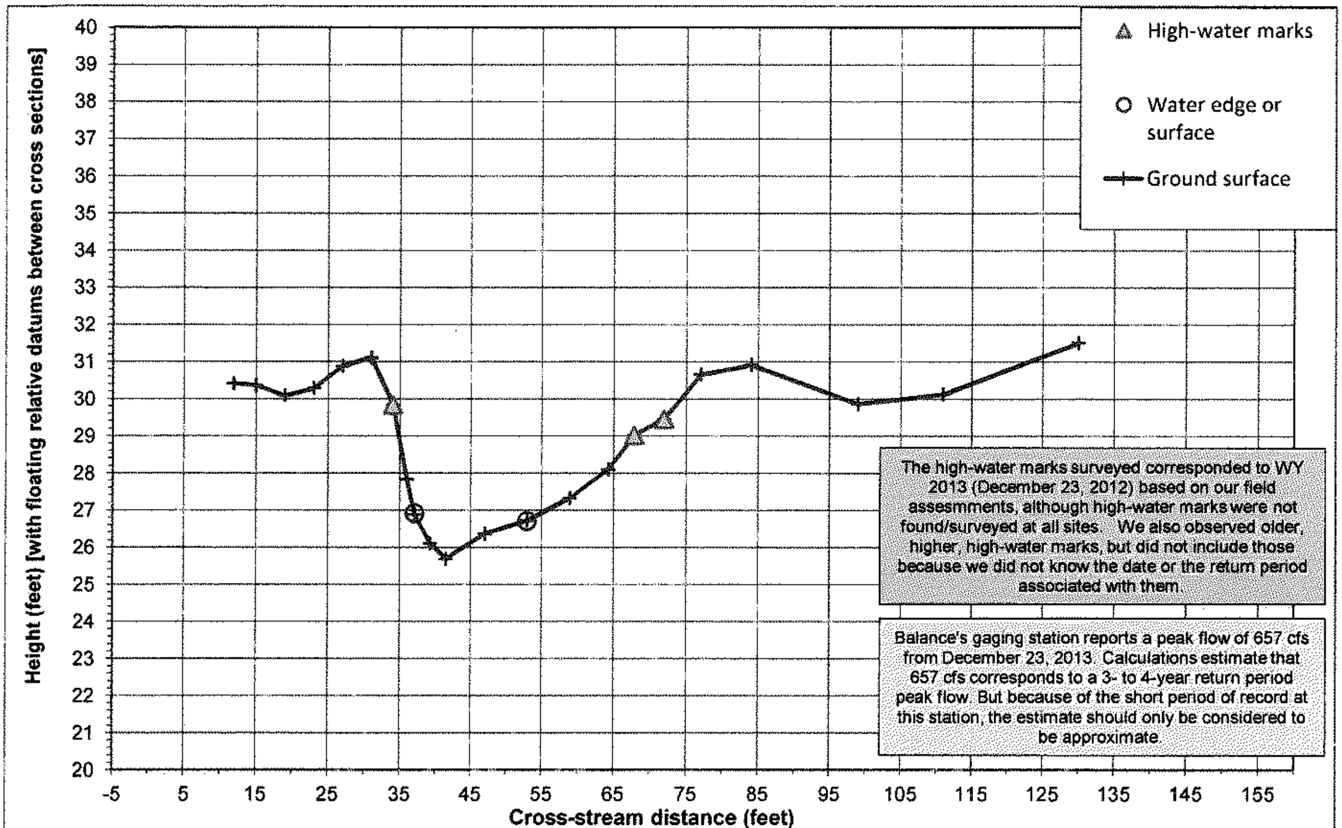
CROSS SECTION AND HIGH-WATER MARKS:
SAN VICENTE CREEK, JULY 2013



Balance Hydrologics, Inc.

Figure B.1. Cross-section 1 survey data: San Vicente Creek, July 2013. The cross-section surveys show varying degrees of floodplain connectivity. Well-connected floodplains would ideally be moderately inundated by the water year 2013 peak flow (indicated by high-water marks).

211024 SVC_Floodplain July 2013 JO.xlsx, Fig B1



Balance Hydrologics, Inc.

Figure B.2. Cross-section 2 survey data: San Vicente Creek, July 2013. The cross-section surveys show varying degrees of floodplain connectivity. Well-connected floodplains would ideally be moderately inundated by the water year 2013 peak flow (indicated by high-water marks).

211024 SVC_Floodplain July 2013 JO.xlsx, Fig B2

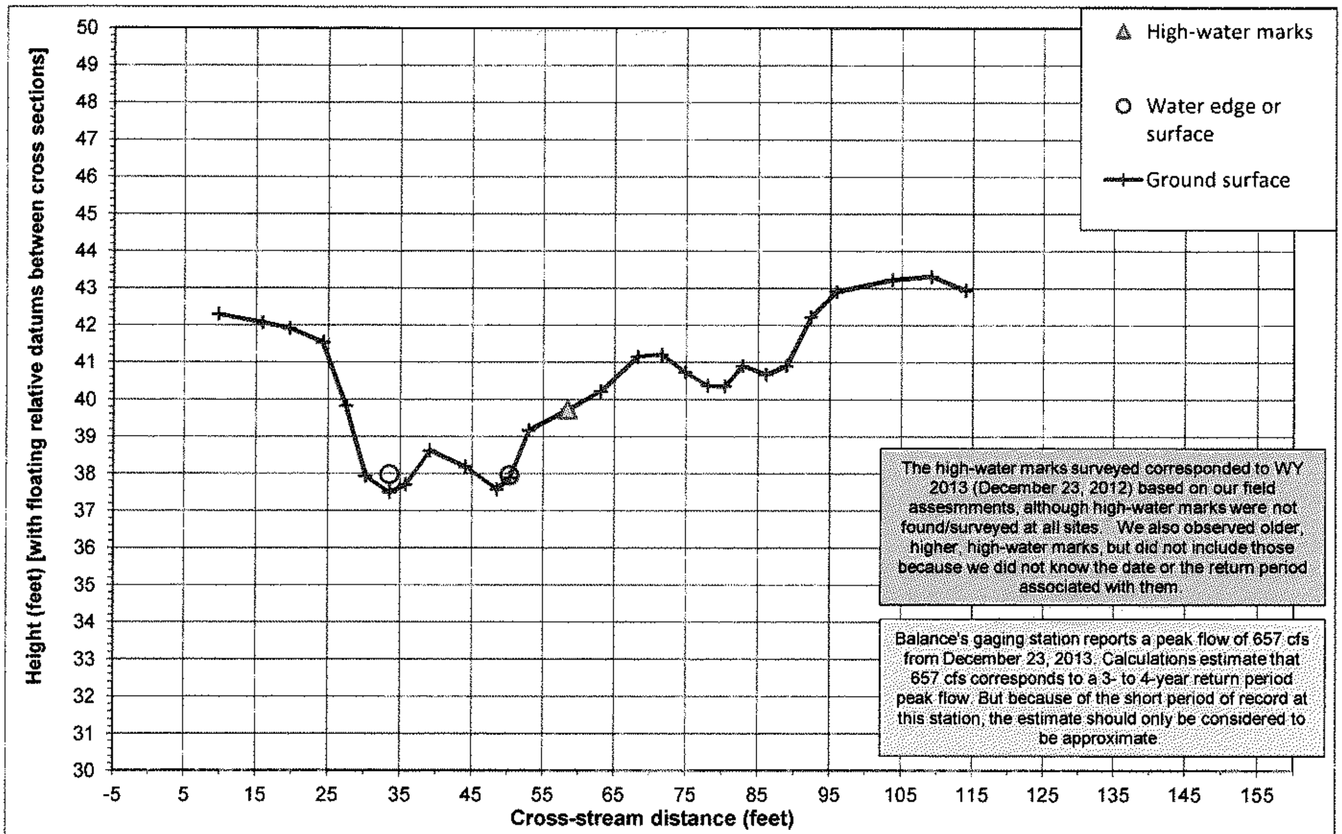
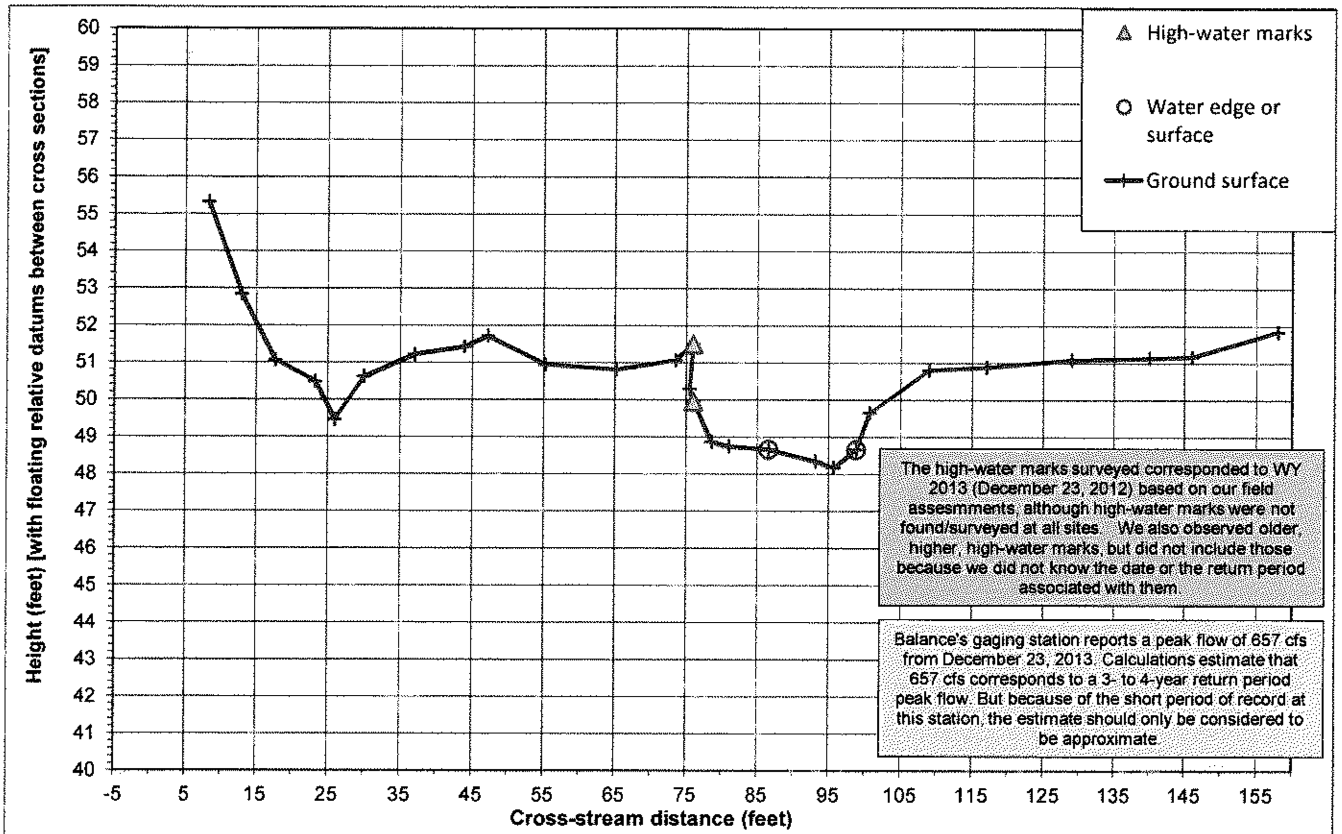


Figure B.3. Cross-section 3 survey data: San Vicente Creek, July 2013. The cross-section surveys show varying degrees of floodplain connectivity. Well-connected floodplains would ideally be moderately inundated by the water year 2013 peak flow (indicated by high-water marks).

Balance Hydrologics, Inc.

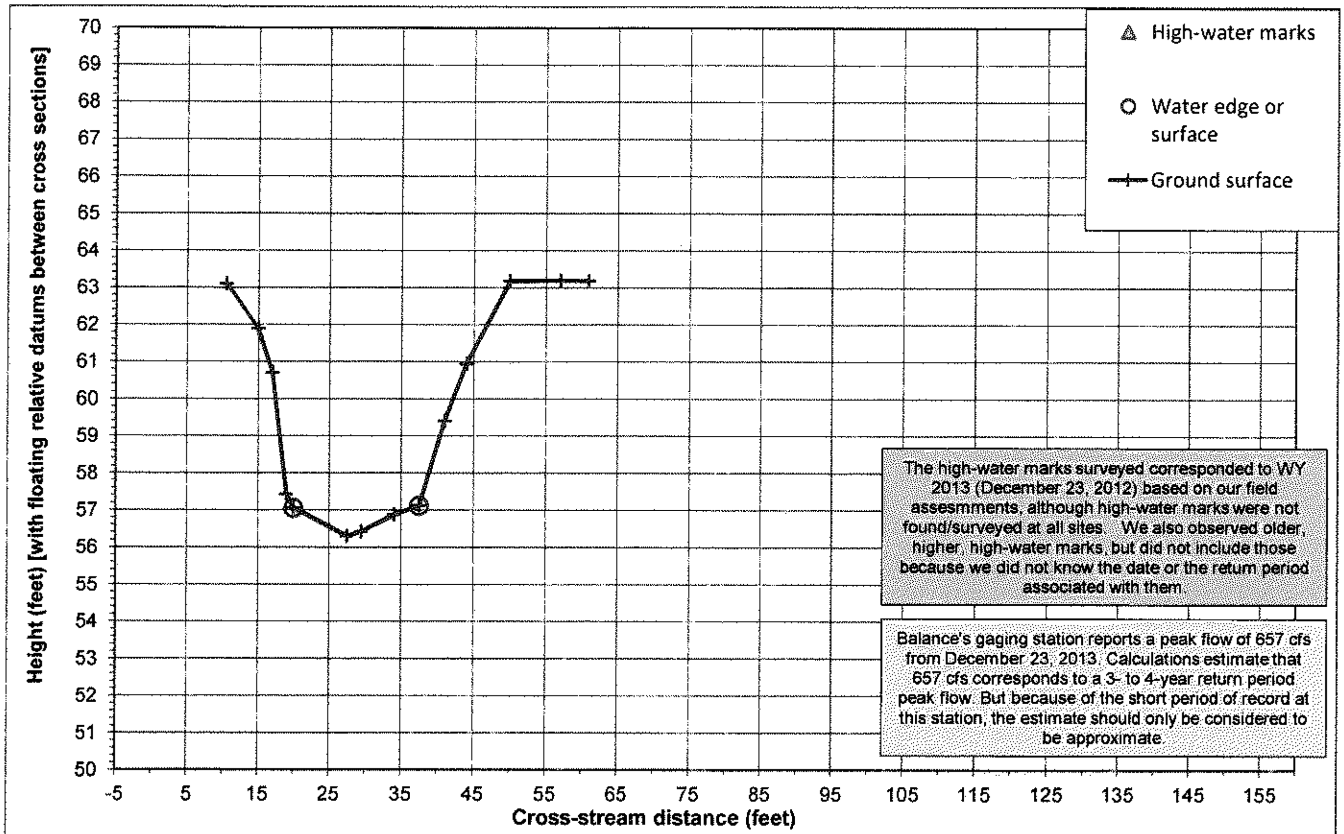
211024 SVC_Floodplain July 2013 JO.xlsx, Fig B3



Balance Hydrologics, Inc.

Figure B.4. Cross-section 4 survey data: San Vicente Creek, July 2013. The cross-section surveys show varying degrees of floodplain connectivity. Well-connected floodplains would ideally be moderately inundated by the water year 2013 peak flow (indicated by high-water marks).

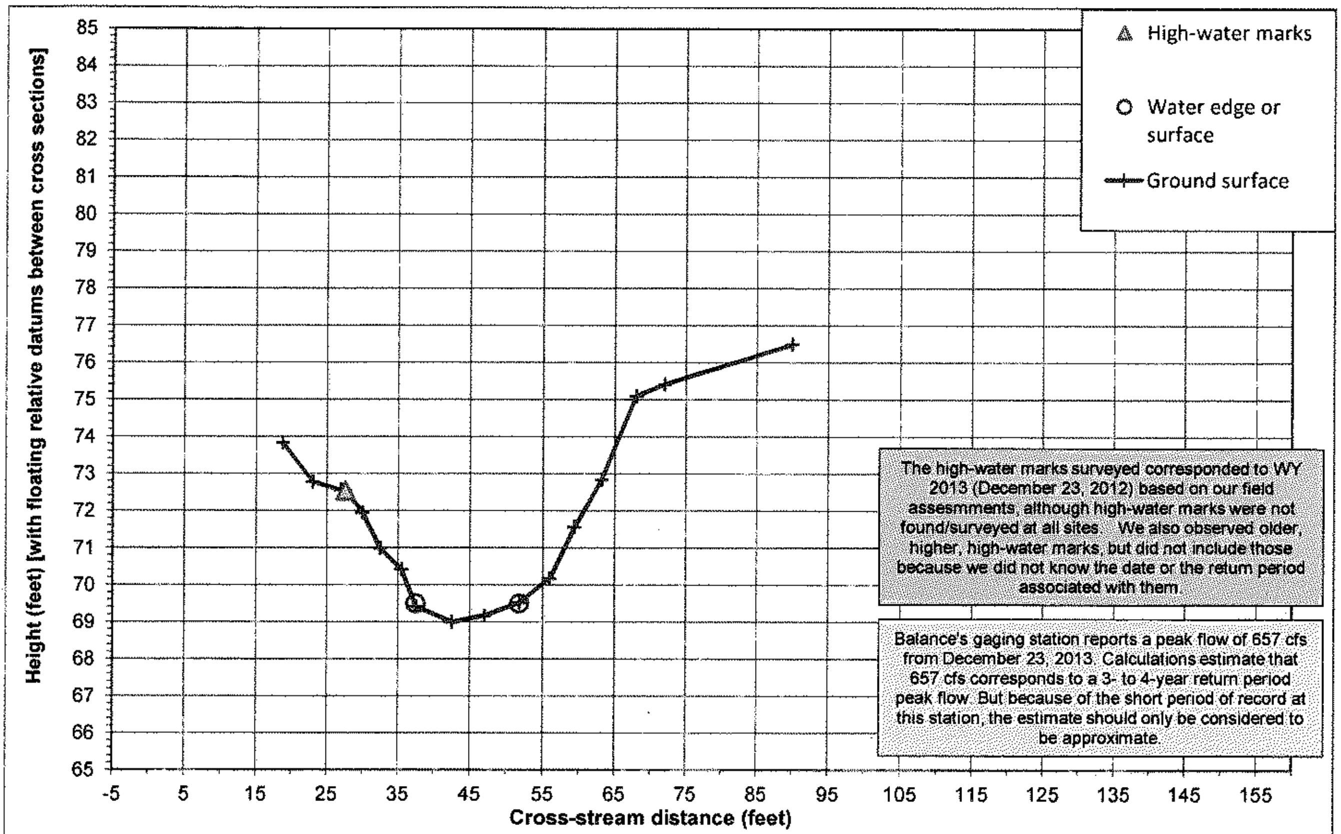
211024 SVC_Floodplain July 2013 JO.xlsx, Fig B4



Balance Hydrologics, Inc.

Figure B.5. Cross-section 5 survey data: San Vicente Creek, July 2013. The cross-section surveys show varying degrees of floodplain connectivity. Well-connected floodplains would ideally be moderately inundated by the water year 2013 peak flow (indicated by high-water marks).

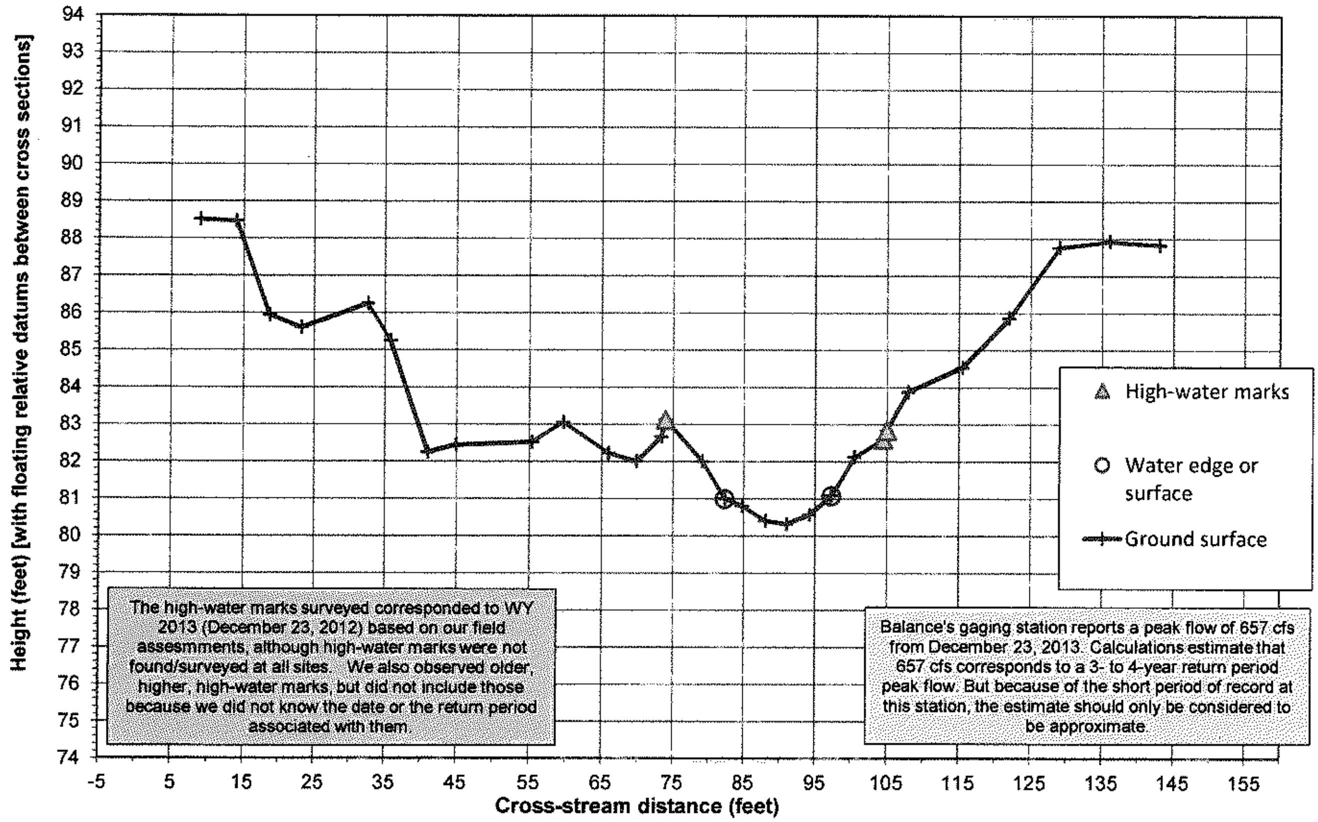
211024 SVC_Floodplain July 2013 JO.xlsx, Fig B5



Balance Hydrologics, Inc.

Figure B.6. Cross-section 6 survey data: San Vicente Creek, July 2013. The cross-section surveys show varying degrees of floodplain connectivity. Well-connected floodplains would ideally be moderately inundated by the water year 2013 peak flow (indicated by high-water marks).

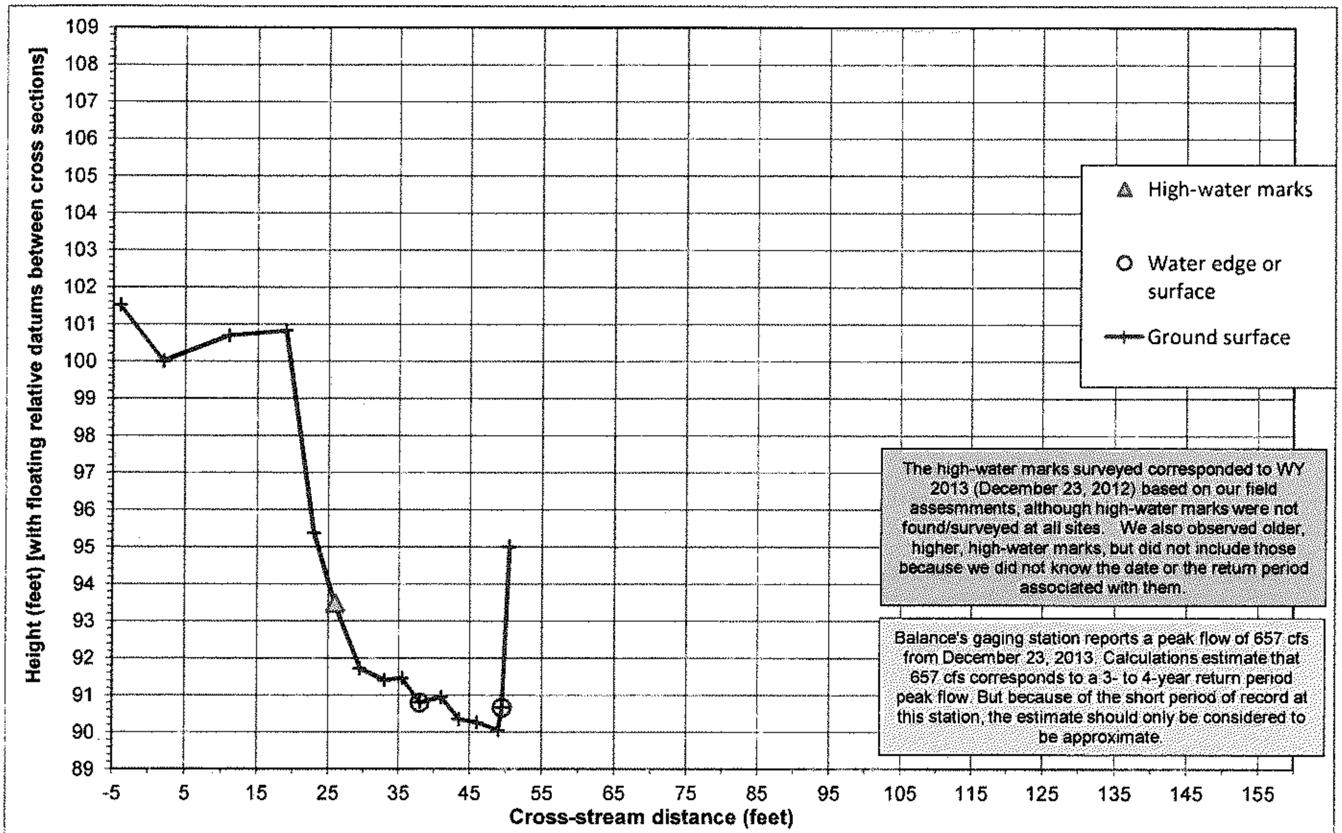
211024 SVC_Floodplain July 2013 JO.xlsx, Fig B6



Balance Hydrologics, Inc.

Figure B.7. Cross-section 7 survey data: San Vicente Creek, July 2013. The cross-section surveys show varying degrees of floodplain connectivity. Well-connected floodplains would ideally be moderately inundated by the water year 2013 peak flow (indicated by high-water marks).

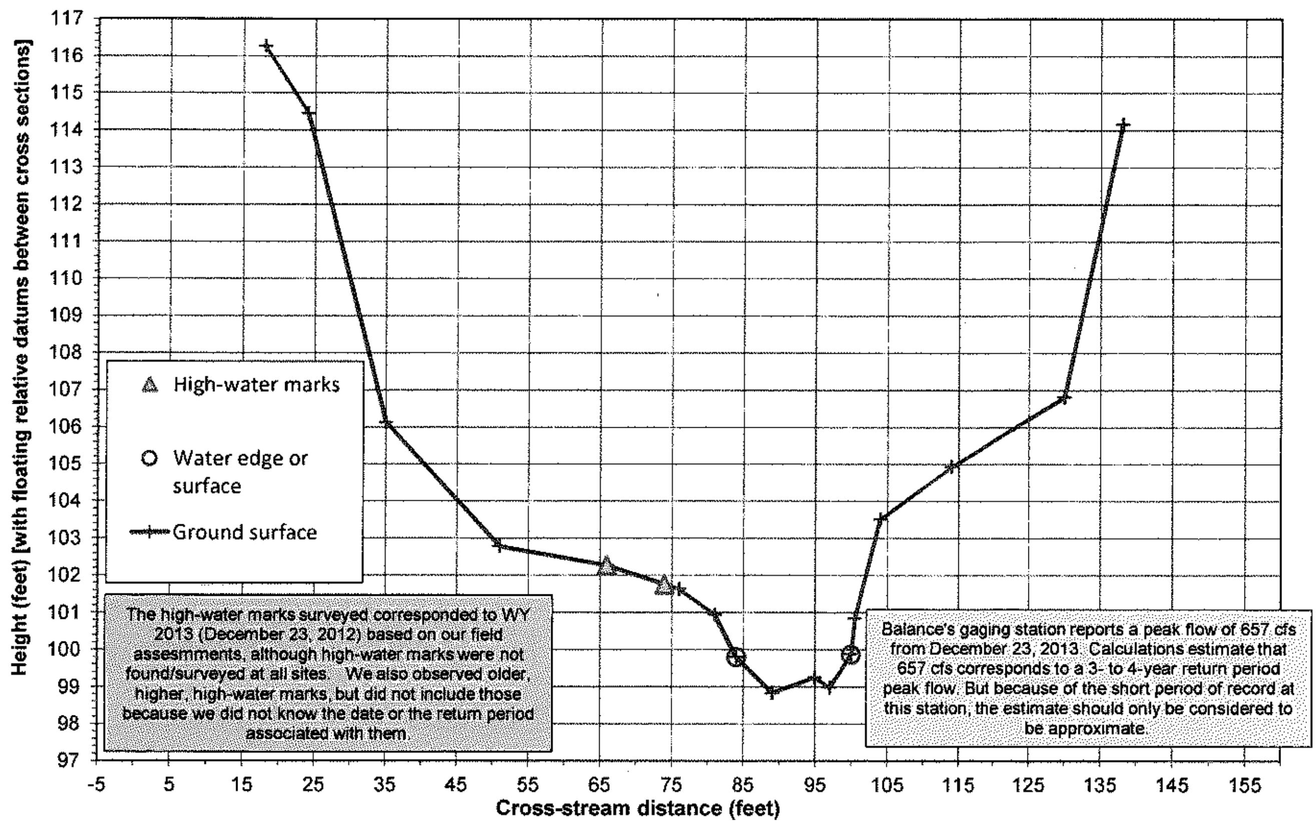
211024 SVC_Floodplain July 2013 JO.xlsx, Fig B7



Balance Hydrologics, Inc.

Figure B.8. Cross-section 8 survey data: San Vicente Creek, July 2013. The cross-section surveys show varying degrees of floodplain connectivity. Well-connected floodplains would ideally be moderately inundated by the water year 2013 peak flow (indicated by high-water marks).

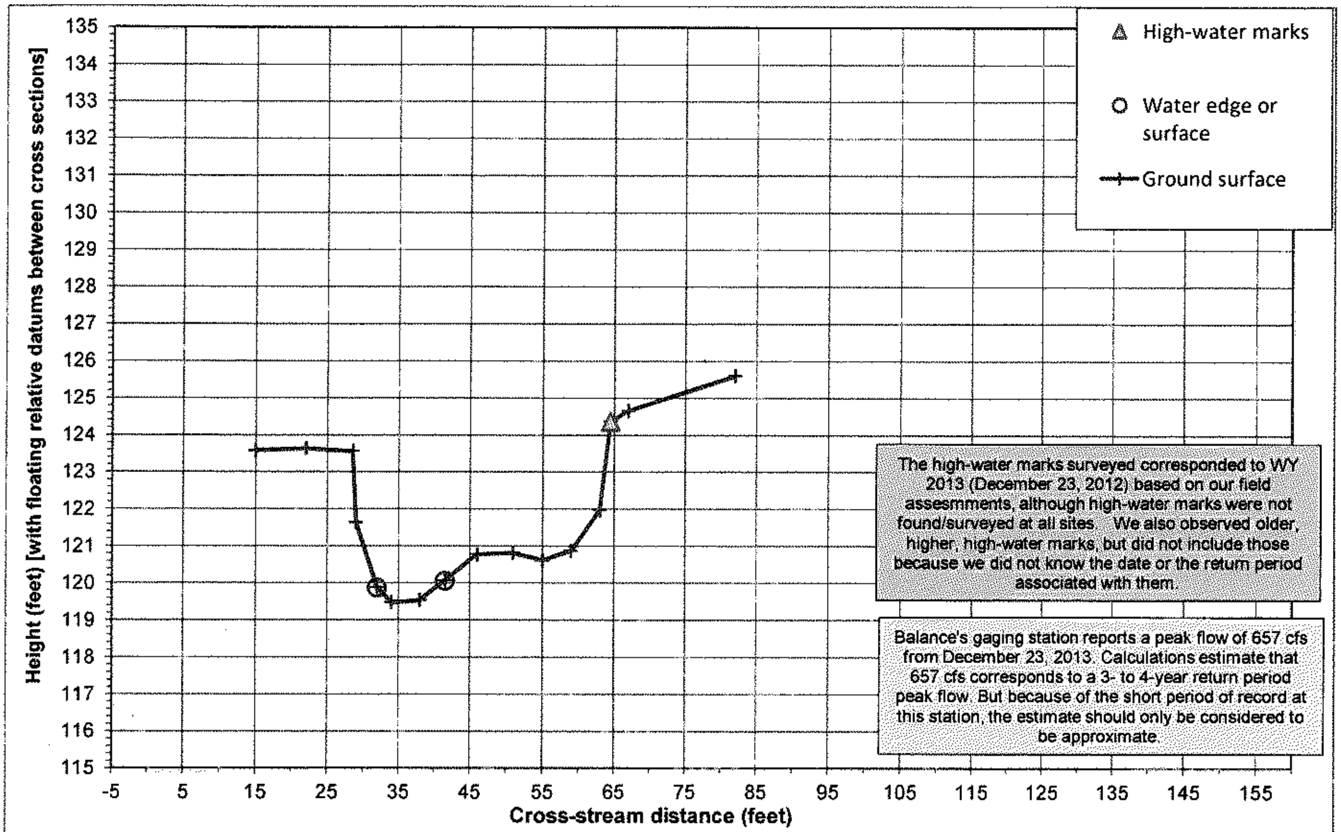
211024 SVC_Floodplain July 2013 JO.xlsx, Fig B8



Balance Hydrologics, Inc.

Figure B.9. Cross-section 9 survey data: San Vicente Creek, July 2013. The cross-section surveys show varying degrees of floodplain connectivity. Well-connected floodplains would ideally be moderately inundated by the water year 2013 peak flow (indicated by high-water marks).

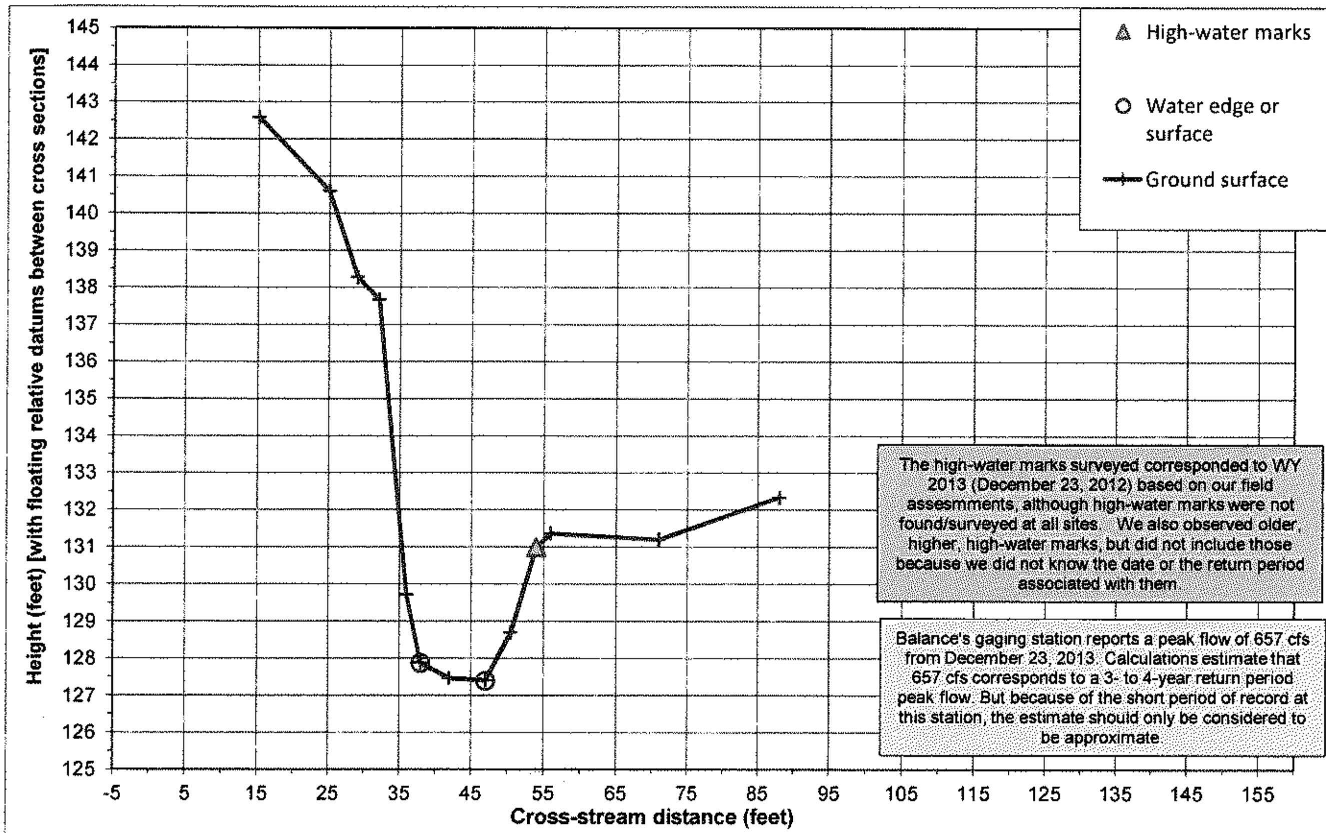
211024 SVC_Floodplain July 2013 JO.xlsx, Fig B9



Balance Hydrologics, Inc.

Figure B.10. Cross-section 10 survey data: San Vicente Creek, July 2013. The cross-section surveys show varying degrees of floodplain connectivity. Well-connected floodplains would ideally be moderately inundated by the water year 2013 peak flow (indicated by high-water marks).

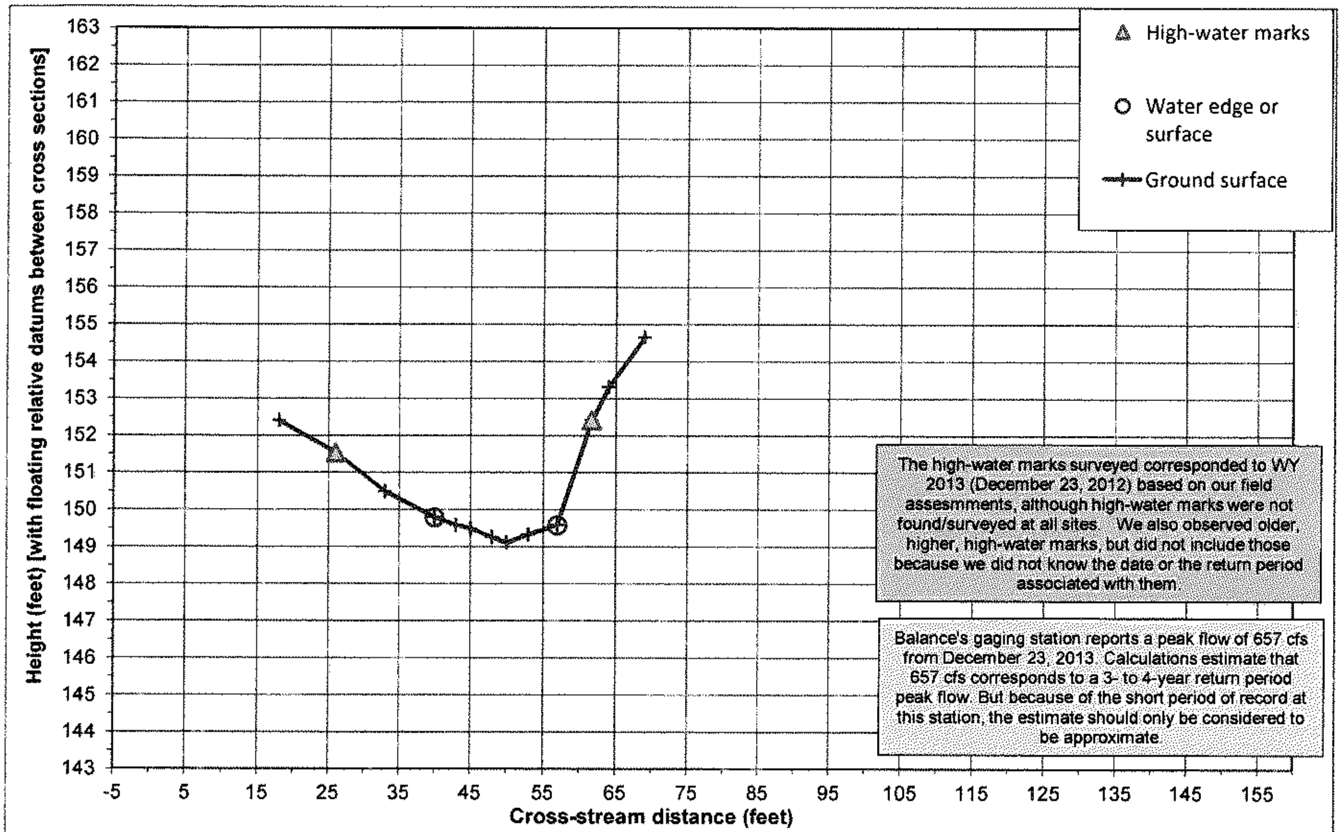
211024 SVC_Floodplain July 2013 JO.xlsx, Fig B10



Balance Hydrologics, Inc.

Figure B.11. Cross-section 11 survey data: Mill Creek, July 2013. The cross-section surveys show varying degrees of floodplain connectivity. Well-connected floodplains would ideally be moderately inundated by the water year 2013 peak flow (indicated by high-water marks).

211024 SVC_Floodplain July 2013 JO.xlsx, Fig B11



Balance Hydrologics, Inc.

Figure B.12. Cross-section 12 survey data: San Vicente Creek, July 2013. The cross-section surveys show varying degrees of floodplain connectivity. Well-connected floodplains would ideally be moderately inundated by the water year 2013 peak flow (indicated by high-water marks).

211024 SVC_Floodplain July 2013 JO.xlsx, Fig B12

Appendix D

LARGE WOODY DEBRIS SURVEY DATA SHEETS

Large Woody Debris Inventory Form

Date: 7/16/12	Surveyors: JM [illegible]	Stream: San Vicente Creek – Main Stem	Drainage: San Vicente Creek	Sample: 1 of [illegible]	Reach No: 1
Channel Type/ ~~B~~ F3	Ref pt: Confluence with Pacific Ocean	Sample Location (FT. FROM REF PT.): [illegible] to [illegible]	Reach Location (FT. FROM REF PT.): [illegible] to [illegible]		

	Right Bank (75') [illegible]									Stream				Left Bank (75')									
	Upslope Width: N/A Slope: [illegible]			Riparian Width: 75 Slope: [illegible]			Perched Slope: [illegible]			BF Width: [illegible] Depth: [illegible]				Perched Slope: [illegible]			Riparian Width: [illegible] Slope: [illegible]			Upslope Width: [illegible] Slope: [illegible]			
										LF Channel		BF Channel											
	DD	DS	Live	DD	DS	Live	DD	DS	Live	Pool	Extra	BW	Extra	DD	DS	Live	DD	DS	Live	DD	DS	Live
1-2'D 6-20'						A: HHT HHT II W HHT I			A:III	W:II W:II Aa:III As:III		Wo:I	WII			A III W I			A:I			W HHT A I
Root																						
1-2'D >20'										A:I W J A:I A:I	A:I	A:II W:II										
2-3'D 6-20'										A Q —						W:I			A:II			
Root																						
2-3'D >20'																						
3-4'D 6-20'																						
Root																						
3-4'D >20'																						
>4'D 6-20'																						
Root																						
>4'D >20'																						

Tree Codes: R – Redwood D – Doug Fir T - Tan Oak P - Monterey Pine N – Nutmeg M – Maple W – Willow B – Bay C – Cottonwood E – Box Elder A – Alder

Characteristics: X – Diameter, sum of mult trunks J – in logjam L – Leaning (into the channel) → - Source of recruited wood Circled – Old ⊥ - Downed tree with root wad (root)|— (trunk) * -Downed tree, alive

Comments:

Large Woody Debris Inventory Form

Date: 7-15-13	Surveyors: JM+GW	Stream: San Vicente Creek – Main Stem	Drainage: San Vicente Creek	Sample: 6 of 6	Reach No: 1
Channel Type: B3 F3	Ref pt: Confluence with Pacific Ocean		Sample Location (FT. FROM REF PT.): [illegible] to [illegible]	Reach Location (FT. FROM REF PT.): [illegible] to [illegible]	

	Right Bank (75')									Stream				Left Bank (75')								
	Upslope Width: 50 Slope: [illegible]			Riparian Width: [illegible] Slope: [illegible]			Perched Slope: [illegible]			BF Width: [illegible] Depth: [illegible] LF Channel		BF Channel		Perched Slope: [illegible]			Riparian Width: [illegible] Slope: [illegible]			Upslope Width: X Slope: X		
	DD	DS	Live	DD	DS	Live	DD	DS	Live	Pool	Extra	BW	Extra	DD	DS	Live	DD	DS	Live	DD	DS	Live
1-2'D 6-20'			W|||			A:HH W:|| W|||		A:||	W:|| A:|	W:|	A:||				W:|	W:| A:|		W:|	W:||| A:||			
Root																						
1-2'D >20'								A|														
2-3'D 6-20'			W||			A|| D||			AL||							W:| A:|			A:HH W:|			
Root																						
2-3'D >20'																						
3-4'D 6-20'																						
Root																						
3-4'D >20'																						
>4'D 6-20'																						
Root																						
>4'D >20'																						

Tree Codes: R – Redwood D – Doug Fir T - Tan Oak P - Monterey Pine N – Nutmeg M – Maple W – Willow B – Bay C – Cottonwood E – Box Elder A – Alder

Characteristics: X – Diameter, sum of mult trunks J – in logjam L – Leaning (into the channel) → - Source of recruited wood Circled – Old ⊥ - Downed tree with root wad (root)|— (trunk) – Downed tree, alive

Comments:

Large Woody Debris Inventory Form

Date: 7-16-13	Surveyors: JM + GW	Stream: San Vicente Creek – Main Stem	Drainage: San Vicente Creek	Sample: 3 of 6	Reach No: 1
Channel Type: B3	Ref pt: Confluence with Pacific Ocean	Sample Location (FT. FROM REF PT.): [illegible] to [illegible]	Reach Location (FT. FROM REF PT.): 0 to [illegible]		

F3

	Right Bank (75')									Stream				Left Bank (75')								
	Upslope Width: X Slope: X			Riparian Width: [illegible] Slope: [illegible]			Perched Slope: [illegible]			BF Width: [illegible] Depth: [illegible] LF Channel		BF Channel		Perched Slope: [illegible]			Riparian Width: 70 Slope: [illegible]			Upslope Width: X Slope: X		
	DD	DS	Live	DD	DS	Live	DD	DS	Live	Pool	Extra	BW	Extra	DD	DS	Live	DD	DS	Live	DD	DS	Live
1-2'D 6-20'			W:1			A:IIII				A:1 W:1		W:1		A:1 A:IIII		W:1 A:11 A:1			W:IIII A:III			
Root										A:1												
1-2'D >20'																						
2-3'D 6-20'									A:III										A:IIII			
Root																						
2-3'D >20'																						
3-4'D 6-20'																						
Root																						
3-4'D >20'																						
>4'D 6-20'																						
Root																						
>4'D >20'																						

Tree Codes: R –Redwood D – Doug Fir T - Tan Oak P - Monterey Pine N – Nutmeg M – Maple W – Willow B – Bay C – Cottonwood E – Box Elder A – Alder

Characteristics: X – Diameter, sum of mult trunks J – In logjam L – Leaning (into the channel) → - Source of recruited wood Circled – Old ⊥ - Downed tree with root wad (root)|— (trunk) ₐ –Downed tree, alive

Comments:

Large Woody Debris Inventory Form

Date: 7/10/13	Surveyors: JM & GW	Stream: San Vicente Creek – Main Stem	Drainage: San Vicente Creek	Sample: 4 of 6	Reach No: 1
Channel Type: F3	Ref pt: Confluence with Pacific Ocean	Sample Location (ft. from ref pt.): [illegible] to [illegible]		Reach Location (ft. from ref pt.): 0 to [illegible]	

	Right Bank (75') Upslope Width: [illegible] Slope: [illegible]			Riparian Width: [illegible] Slope: [illegible]			Perched Slope: [illegible]			Stream BF Width: [illegible] Depth: [illegible] LF Channel		BF Channel		Left Bank (75') Perched Slope: [illegible]			Riparian Width: [illegible] Slope: [illegible]			Upslope Width: X Slope:		
	DD	DS	Live	DD	DS	Live	DD	DS	Live	Pool	Extra	BW	Extra	DD	DS	Live	DD	DS	Live	DD	DS	Live
1-2'D 6-20'			W:1			A:IIII	A:1	W:1	W:III A:1	W:1		A:II				A:1						
Root										A:II									A:卌 卌 II W:II			
1-2'D >20'																						
2-3'D 6-20'																			A:III			
Root																						
2-3'D >20'																						
3-4'D 6-20'																						
Root												A:1										
3-4'D >20'																						
>4'D 6-20'																						
Root																						
>4'D >20'																						

Tree Codes: R – Redwood D – Doug Fir T – Tan Oak P - Monterey Pine N – Nutmeg M – Maple W – Willow B – Bay C – Cottonwood E – Box Elder A – Alder

Characteristics: X – Diameter, sum of mult trunks J – In logjam L – Leaning (into the channel) → - Source of recruited wood Circled – Old ⊥ - Downed tree with root wad (root)|--- (trunk) ₐ –Downed tree, alive

Comments:

Large Woody Debris Inventory Form

Date: 7/19/1[illegible]	Surveyors: JM & GW	Stream: San Vicente Creek – Main Stem	Drainage: San Vicente Creek	Sample: 3 of 6	Reach No: 1
Channel Type: F3	Ref pt: Confluence with Pacific Ocean		Sample Location (FT. FROM REF PT.): [illegible] to [illegible]	Reach Location (FT. FROM REF PT.): 0 to [illegible]	

	Right Bank (75')									Stream				Left Bank (75')								
	Upslope Width: 30 Slope: 30%-60			Riparian Width: 30 Slope: 40% [illegible]			Perched Slope: [illegible]			BF Width: [illegible] Depth: [illegible]				Perched Slope: 20%			Riparian Width: 15' Slope: [illegible]			Upslope Width: X Slope:		
										LF Channel		BF Channel										
	DD	DS	Live	DD	DS	Live	DD	DS	Live	Pool	Extra	BW	Extra	DD	DS	Live	DD	DS	Live	DD	DS	Live
1-2'D 6-20'			W:1			W:HHT			W:1 A:1	W:1						W:1 A:1	W:1	W:1	W:III A:1			
Root																						
1-2'D >20'																						
2-3'D 6-20'			W:HHT II W:1			A:1										A:1						
Root																						
2-3'D >20'																						
3-4'D 6-20'																						
Root																						
3-4'D >20'																						
>4'D 6-20'																						
Root																						
>4'D >20'																						

Tree Codes: R – Redwood D – Doug Fir T – Tan Oak P – Monterey Pine N – Nutmeg M – Maple W – Willow B – Bay C – Cottonwood E – Box Elder A – Alder

Characteristics: X – Diameter, sum of mult trunks J – In logjam L – Leaning (into the channel) → - Source of recruited wood

Circled – Old ⊥ - Downed tree with root wad (root)|—(trunk) ▲ –Downed tree, alive

Comments:

Large Woody Debris Inventory Form

Date: 7-19-1[illegible] Surveyors: JWC GW	Stream: San Vicente Creek – Main Stem	Drainage: San Vicente Creek	Sample: 6 of 6	Reach No: 1
Channel Type: B[illegible] F3 Ref pt: Confluence with Pacific Ocean	Sample Location (FT. FROM REF PT.): [illegible] to [illegible]	Reach Location (FT. FROM REF PT.): 0 to [illegible]		

	Right Bank (75')									Stream				Left Bank (75')								
	Upslope Width: X Slope:			Riparian Width: [illegible] Slope: 19.1 [illegible]			Perched Slope: [illegible]			BF Width: [illegible] Depth: [illegible]				Perched Slope: [illegible]			Riparian Width: [illegible] Slope: [illegible]			Upslope Width: X Slope:		
										LF Channel		BF Channel										
	DD	DS	Live	DD	DS	Live	DD	DS	Live	Pool	Extra	BW	Extra	DD	DS	Live	DD	DS	Live	DD	DS	Live
1-2'D 6-20'						A:卌 I				W:I		W:II				A:I			W:IIII A:I			
Root																						
1-2'D >20'												A:II										
2-3'D 6-20'						A:II			A:III B:I													
Root																						
2-3'D >20'																						
3-4'D 6-20'																						
Root																						
3-4'D >20'																						
>4'D 6-20'																						
Root																						
>4'D >20'																						

Tree Codes: R –Redwood D – Doug Fir T - Tan Oak P - Monterey Pine N – Nutmeg M – Maple W – Willow B – Bay C – Cottonwood E – Box Elder A – Alder

Characteristics: X – Diameter, sum of mult trunks J – In logjam L – Leaning (into the channel) → - Source of recruited wood Circled – Old ⊥ - Downed tree with root wad (root)|— (trunk) a -Downed tree, alive

Comments:

Large Woody Debris Inventory Form

Date: 7-19-[illegible]	Surveyors: [illegible]	Stream: San Vicente Creek – Main Stem	Drainage: San Vicente Creek	Sample: [illegible] of [illegible]	Reach No: [illegible]
Channel Type: [illegible]	Ref pt: Confluence with Pacific Ocean		Sample Location (ft. from ref pt.): [illegible] to [illegible]	Reach Location (ft. from ref pt.): [illegible] to [illegible]	

	Right Bank (75')									Stream				Left Bank (75')								
	Upslope Width: [illegible] Slope: [illegible]			Riparian Width: [illegible] Slope: [illegible]			Perched Slope: [illegible]			BF Width: [illegible] Depth: [illegible] LF Channel		BF Channel		Perched Slope: [illegible]			Riparian Width: [illegible] Slope: [illegible]			Upslope Width: [illegible] Slope:		
	DD	DS	Live	DD	DS	Live	DD	DS	Live	Pool	Extra	BW	Extra	DD	DS	Live	DD	DS	Live	DD	DS	Live
1-2'D 6-20'									A: IIII							A: II			A: 𝍸			
Root																						
1-2'D >20'																						
2-3'D 6-20'								A: I											TC: 𝍸			
Root																						
2-3'D >20'																						
3-4'D 6-20'																						
Root																						
3-4'D >20'																						
>4'D 6-20'																						
Root																						
>4'D >20'																						

Tree Codes: R – Redwood D – Doug Fir T - Tan Oak P - Monterey Pine N – Nutmeg M – Maple W – Willow B – Bay C – Cottonwood E – Box Elder A – Alder

Characteristics: X – Diameter, sum of mult trunks J – in logjam L – Leaning (into the channel) → - Source of recruited wood Circled – Old ⊥ - Downed tree with root wad (root)|--- (trunk) ⌞ –Downed tree, alive

Comments:

Large Woody Debris Inventory Form

Date: 1-19	Surveyors: [illegible]	Stream: San Vicente Creek – Main Stem	Drainage: San Vicente Creek	Sample: [illegible] of [illegible]	Reach No: 2
Channel Type: B2 (B3)	Ref pt: Confluence with Pacific Ocean		Sample Location (FT. FROM REF PT.): [illegible] to [illegible]	Reach Location (FT. FROM REF PT.): [illegible] to [illegible]	

	Right Bank (75')									Stream				Left Bank (75')								
	Upslope Width: 45' Slope: 36/50%			Riparian Width: 30' Slope: 31/35%			Perched Slope: [illegible]			BF Width: 40' Depth: 2.3'				Perched Slope: 15			Riparian Width: [illegible] Slope: 17			Upslope Width: X Slope:		
										LF Channel		BF Channel										
	DD	DS	Live	DD	DS	Live	DD	DS	Live	Pool	Extra	BW	Extra	DD	DS	Live	DD	DS	Live	DD	DS	Live
1-2'D 6-20'			A: UH			A: HHI			A: HHI			A: IIII A: II		A: I		A: II		A: I	A: I			
Root																						
1-2'D >20'																			A: I			
2-3'D 6-20'						A: I		A: I	A: II							A: III			A: I			
Root																						
2-3'D >20'																						
3-4'D 6-20'									A: II													
Root																						
3-4'D >20'																						
>4'D 6-20'																						
Root																						
>4'D >20'																						

Tree Codes: R – Redwood D – Doug Fir T - Tan Oak P - Monterey Pine N – Nutmeg M – Maple W – Willow B – Bay C – Cottonwood E – Box Elder A – Alder

Characteristics: X – Diameter, sum of mult trunks J – In logjam L – Leaning (into the channel) → - Source of recruited wood Circled – Old ⊥ - Downed tree with root wad (root)|— (trunk) ▲ -Downed tree, alive

Comments:

Large Woody Debris Inventory Form

Date: 7-19	Surveyors: Graham & Jess	Stream: San Vicente Creek – Main Stem	Drainage: San Vicente Creek
Sample: 1 of 12	Reach No: 3	Channel Type: B3	Ref pt: Confluence with Pacific Ocean
Sample Location (ft. from ref pt.): [illegible] to [illegible]	Reach Location (ft. from ref pt.): 7560 to 10249		

	Right Bank (75')									Stream				Left Bank (75')								
	Upslope Width: 75 Slope: 56% / 48%			Riparian Width: 90 Slope: 34% / 93			Perched Slope: 101% / 164			BF Width: [illegible] Depth: 3.06				Perched Slope: 137% / 164			Riparian Width: 40 Slope: 25% / 34			Upslope Width: 35 Slope: 36% / 30%		
										LF Channel		BF Channel										
	DD	DS	Live	DD	DS	Live	DD	DS	Live	Pool	Extra	BW	Extra	DD	DS	Live	DD	DS	Live	DD	DS	Live
1-2'D 6-20'			R:III			R:HHH HHH III R:II			R:HHH HHH III					R:I	R:I	R:I R:II			R:HHT HH R:I R:III			R:IIII
Root																						
1-2'D >20'																						
2-3'D 6-20'			R:I			R:I R:II			R:I										R:III			D:I R:II
Root																						
2-3'D >20'																						
3-4'D 6-20'			R:IIII																			
Root																						
3-4'D >20'																						
>4'D 6-20'																						
Root																						
>4'D >20'																						

Tree Codes: R – Redwood D – Doug Fir T - Tan Oak P - Monterey Pine N – Nutmeg M – Maple W – Willow B – Bay C – Cottonwood E – Box Elder A – Alder

Characteristics: X – Diameter, sum of mult trunks J – In logjam L – Leaning (into the channel) → - Source of recruited wood Circled – Old ⊥ - Downed tree with root wad (root)|— (trunk) ₒ –Downed tree, alive

Comments:

Large Woody Debris Inventory Form

Date: [illegible]	Surveyors: [illegible]	Stream: San Vicente Creek – Main Stem	Drainage: San Vicente Creek	Sample: [illegible] of [illegible]	Reach No: 3
Channel Type: B3	Ref pt: Confluence with Pacific Ocean		Sample Location (ft. from ref pt.): [illegible] to [illegible]	Reach Location (ft. from ref pt.): [illegible] to [illegible]	

	Right Bank (75')									Stream				Left Bank (75')								
	Upslope Width: [illegible] Slope: [illegible]			Riparian Width: [illegible] Slope: [illegible]			Perched Slope: [illegible]			BF Width: [illegible] Depth: [illegible]				Perched Slope: [illegible]			Riparian Width: [illegible] Slope: [illegible]			Upslope Width: [illegible] Slope: [illegible]		
										LF Channel		BF Channel										
	DD	DS	Live	DD	DS	Live	DD	DS	Live	Pool	Extra	BW	Extra	DD	DS	Live	DD	DS	Live	DD	DS	Live
1-2'D 6-20'			[illegible]			[illegible]										A: II	A: I [illegible]			[illegible]		
Root																						
1-2'D >20'																						
2-3'D 6-20'			R: II											[illegible]			A: I		R: I	R: I		
Root																						
2-3'D >20'																						
3-4'D 6-20'			R: I																			
Root																						
3-4'D >20'																						
>4'D 6-20'																						
Root																						
>4'D >20'																						

Tree Codes: R – Redwood D – Doug Fir T - Tan Oak P - Monterey Pine N – Nutmeg M – Maple W – Willow B – Bay C – Cottonwood E – Box Elder A – Alder

Characteristics: X – Diameter, sum of mult trunks J – in logjam L – Leaning (into the channel) → - Source of recruited wood Circled – Old ⊥ - Downed tree with root wad (root)|— (trunk) -Downed tree, alive

Comments:

Large Woody Debris Inventory Form

Date: 8/21/13	Surveyors: GW & JM	Stream: San Vicente Creek – Main Stem	Drainage: San Vicente Creek	Sample: 3 of 4
Channel Type: B3	Ref pt: Confluence with Pacific Ocean	Sample Location (FT. FROM REF PT.): [illegible] to [illegible]	Reach Location (FT. FROM REF PT.): [illegible] to [illegible]	Reach No: 3

	Right Bank (75')									Stream				Left Bank (75')								
	Upslope Width: 35 Slope: 65%			Riparian Width: 15' Slope: 14%			Perched Slope: 0%			BF Width: [illegible] Depth: [illegible] LF Channel		BF Channel		Perched Slope: 20%			Riparian Width: 40' Slope: 15%			Upslope Width: Slope:		
	DD	DS	Live	DD	DS	Live	DD	DS	Live	Pool	Extra	BW	Extra	DD	DS	Live	DD	DS	Live	DD	DS	Live
1-2'D 6-20'			[illegible] R:II			A:I			A:IIII I			A:III			A:I	A:III			A:[illegible] R:[illegible]			
Root																						
1-2'D >20'										R:I			R:I							ROAD		
2-3'D 6-20'			R:III							R:I			R:I						R:II			
Root															R:I							
2-3'D >20'																						
3-4'D 6-20'			R:I																R:II			
Root																						
3-4'D >20'																						
>4'D 6-20'																						
Root																						
>4'D >20'																						

Tree Codes: R – Redwood D – Doug Fir T - Tan Oak P - Monterey Pine N – Nutmeg M – Maple W – Willow B – Bay C – Cottonwood E – Box Elder A – Alder

Characteristics: X – Diameter, sum of mult trunks J – In logjam L – Leaning (into the channel) → - Source of recruited wood

Circled – Old ⊥ - Downed tree with root wad (root)|— (trunk) * –Downed tree, alive

Comments:

Large Woody Debris Inventory Form

Date: [illegible]	Surveyors: [illegible]	Stream: San Vicente Creek – Main Stem	Drainage: San Vicente Creek	Sample: [illegible] of [illegible]	Reach No: 3
Channel Type: B3	Ref pt: Confluence with Pacific Ocean		Sample Location (FT. FROM REF PT.): [illegible] to [illegible]	Reach Location (FT. FROM REF PT.): [illegible] to [illegible]	

	Right Bank (75')									Stream				Left Bank (75')								
	Upslope Width: [illegible] Slope: [illegible]			Riparian Width: [illegible] Slope: [illegible]			Perched Slope: [illegible]			BF Width: [illegible] Depth: [illegible]				Perched Slope: [illegible]			Riparian Width: [illegible] Slope: [illegible]			Upslope Width: ____ Slope: ____		
										LF Channel		BF Channel										
	DD	DS	Live	DD	DS	Live	DD	DS	Live	Pool	Extra	BW	Extra	DD	DS	Live	DD	DS	Live	DD	DS	Live
1-2'D 6-20'			[illegible]			[illegible]										[illegible]			[illegible]		[illegible]	
Root																						
1-2'D >20'																						
2-3'D 6-20'			[illegible]			[illegible]													[illegible]			
Root																						
2-3'D >20'																						
3-4'D 6-20'																						
Root																						
3-4'D >20'																						
>4'D 6-20'																						
Root																						
>4'D >20'																						

Tree Codes: R –Redwood D – Doug Fir T - Tan Oak P - Monterey Pine N – Nutmeg M – Maple W – Willow B – Bay C – Cottonwood E – Box Elder A – Alder

Characteristics: X – Diameter, sum of mult trunks J – in logjam L – Leaning (into the channel) → - Source of recruited wood Circled – Old ⊥- Downed tree with root wad (root)|— (trunk) ⸗ -Downed tree, alive

Comments:

Large Woody Debris Inventory Form

Date: [illegible]	Surveyors:	Stream: San Vicente Creek – Main Stem	Drainage: San Vicente Creek
Sample: 1 of 2	Reach No: 4		
Channel Type: [illegible]	Ref pt: Confluence with Pacific Ocean	Sample Location (ft. from ref pt.): [illegible] to [illegible]	Reach Location (ft. from ref pt.): [illegible] to [illegible]

	Right Bank (75')									Stream				Left Bank (75')								
	Upslope Width: / Slope:			Riparian Width: [illegible] Slope: [illegible]			Perched Slope: 15%			BF Width: [illegible] Depth: [illegible]				Perched Slope: [illegible]			Riparian Width: [illegible] Slope: [illegible]			Upslope Width: Slope:		
										LF Channel		BF Channel										
	DD	DS	Live	DD	DS	Live	DD	DS	Live	Pool	Extra	BW	Extra	DD	DS	Live	DD	DS	Live	DD	DS	Live
1-2'D 6-20'				[illegible]		[illegible]			[illegible]	[illegible]		[illegible]				[illegible]	[illegible]		[illegible]			
Root																						
1-2'D >20'												[illegible]										
2-3'D 6-20'						[illegible]										T: I			[illegible]			
Root																						
2-3'D >20'																						
3-4'D 6-20'																			R: I			
Root															[illegible]							
3-4'D >20'																						
>4'D 6-20'																						
Root																						
>4'D >20'																						

Tree Codes: R – Redwood D – Doug Fir T - Tan Oak P - Monterey Pine N – Nutmeg M – Maple W – Willow B – Bay C – Cottonwood E – Box Elder A – Alder

Characteristics: X – Diameter, sum of mult trunks J – In logjam L – Leaning (into the channel) → - Source of recruited wood
Circled – Old ⊥ - Downed tree with root wad (root)|— (trunk) ₐ –Downed tree, alive

Comments:

Large Woody Debris Inventory Form

Date: 9/12/13	Surveyors: GW + JM	Stream: San Vicente Creek – Main Stem	Drainage: San Vicente Creek
Sample: 2 of 3	Reach No: 4	Channel Type: [illegible]	Ref pt: Confluence with Pacific Ocean
Sample Location (FT. FROM REF PT.): 14150 to 14650	Reach Location (FT. FROM REF PT.): [illegible] to 17980		

	Right Bank (75')									Stream				Left Bank (75')								
	Upslope Width: ___ Slope: ___			Riparian Width: 50' Slope: 14%			Perched Slope: 14%			BF Width: 23'6" Depth: 2.4' LF Channel		BF Channel		Perched Slope: 30%			Riparian Width: 45' Slope: 13%			Upslope Width: ___ Slope: ___		
	DD	DS	Live	DD	DS	Live	DD	DS	Live	Pool	Extra	BW	Extra	DD	DS	Live	DD	DS	Live	DD	DS	Live
1-2'D 6-20'						A: III			R: ||||| |||||	R: II	R: I					R: III A: |||||			R: ||||| ||||| ||||| I			
Root									A: ||||| ||||| II										A: ||||| III			
1-2'D >20'												A: I	R: I									
2-3'D 6-20'						R: III			A: I													
Root																						
2-3'D >20'																						
3-4'D 6-20'																						
Root										R: I												
3-4'D >20'																						
>4'D 6-20'																						
Root																						
>4'D >20'										R: I												

Tree Codes: R – Redwood D – Doug Fir T - Tan Oak P - Monterey Pine N – Nutmeg M – Maple W – Willow B – Bay C – Cottonwood E – Box Elder A – Alder

Characteristics: X – Diameter, sum of mult trunks J – In logjam L – Leaning (into the channel) → - Source of recruited wood

Circled – Old ⊥ - Downed tree with root wad (root)|— (trunk) ⌄ –Downed tree, alive

Comments:

Large Woody Debris Inventory Form

Date: 8/8/13	Surveyors: GW + JM	Stream: San Vicente Creek – Main Stem	Drainage: San Vicente Creek
Channel Type: B3 F4	Ref pt: Confluence with Pacific Ocean	Sample: 3 of 3	Reach No: 4
Sample Location (FT. FROM REF PT.): 15450 to 15654	Reach Location (FT. FROM REF PT.): 14448 to 15980		

	Right Bank (75')									Stream				Left Bank (75')								
	Upslope Width: 30' Slope: 40%			Riparian Width: 45' Slope: 28%			Perched Slope: 3%			BF Width: 23'6" Depth: 2.4' LF Channel		BF Channel		Perched Slope: 22%			Riparian Width: 50' Slope: 43%			Upslope Width: 25' Slope: 50%		
	DD	DS	Live	DD	DS	Live	DD	DS	Live	Pool	Extra	BW	Extra	DD	DS	Live	DD	DS	Live	DD	DS	Live
1-2'D 6-20'			A: HHT			A: HHT HHT I			A: IIII	A: I						A: I I T: I			A: HHT HHT II T: HHT R: HHT			
Root																						
1-2'D >20'																						
2-3'D 6-20'			R: IIII						R: IIII										R: HHT			R: II
Root																						
2-3'D >20'																						
3-4'D 6-20'			R: I																			
Root																						
3-4'D >20'																						
>4'D 6-20'																						
Root																						
>4'D >20'																						

Tree Codes: R –Redwood D – Doug Fir T - Tan Oak P - Monterey Pine N – Nutmeg
M – Maple W – Willow B – Bay C – Cottonwood E – Box Elder A – Alder

Characteristics: X – Diameter, sum of mult trunks J – In logjam L – Leaning (into the channel) → - Source of recruited wood
Circled – Old ⊥ - Downed tree with root wad (root)|— (trunk) ⌄ -Downed tree, alive

Comments:

Large Woody Debris Inventory Form

Date: 10/16/13	Surveyors: Chris Loomis + John Drups	Stream: San Vicente Creek – Main Stem	Drainage: San Vicente Creek	Sample: 1 of 1	Reach No: 5
Channel Type: B3	Ref pt: Confluence with Pacific Ocean	Sample Location (FT. FROM REF PT.): [illegible] to [illegible]	Reach Location (FT. FROM REF PT.): [illegible] to [illegible]		

	Right Bank (75')									Stream				Left Bank (75')								
	Upslope Width: 50' Slope: 65%			Riparian Width: 25' Slope: 35%			Perched Slope: 22%			BF Width: 23' Depth: 18"				Perched Slope: 5%			Riparian Width: 35 Slope: 20%			Upslope Width: Slope:		
										LF Channel		BF Channel										
	DD	DS	Live	DD	DS	Live	DD	DS	Live	Pool	Extra	BW	Extra	DD	DS	Live	DD	DS	Live	DD	DS	Live
1-2'D 6-20'																						
Root																						
1-2'D >20'			R: III T: I Ma: II			D: IIII		A: I	A: II		A: I ⊥					A: I			Ma: I D: III			
2-3'D 6-20'																						
Root																						
2-3'D >20'																D: I			D: II			
3-4'D 6-20'																						
Root																		R: III				
3-4'D >20'																						
>4'D 6-20'																						
Root																						
>4'D >20'																						

Tree Codes: R – Redwood D – Doug Fir T – Tan Oak P – Monterey Pine N – Nutmeg M – Maple W – Willow B – Bay C – Cottonwood E – Box Elder A – Alder

Characteristics: X – Diameter, sum of mult trunks J – In logjam L – Leaning (into the channel) → - Source of recruited wood
Circled – Old ⊥ - Downed tree with root wad (root)|— (trunk) * – Downed tree, alive

Comments: Ma = Madrone

Large Woody Debris Inventory Form

Date: 10/16/13 | Surveyors: CL & JD | Stream: San Vicente Creek – Main Stem | Drainage: San Vicente Creek | Sample: 2 of 2 | Reach No: 5

Channel Type: B3 [illegible] | Ref pt: Confluence with Pacific Ocean | Sample Location (FT. FROM REF PT.): [illegible] to [illegible] | Reach Location (FT. FROM REF PT.): [illegible] to [illegible]

	Right Bank (75')									Stream				Left Bank (75')									
	Upslope Width: 45' Slope: 47%			Riparian Width: 30 Slope: 45%			Perched Slope: 35%			BF Width: 7'		Depth: 5'6"		Perched Slope: 15%			Riparian Width: 50' Slope: 35%			Upslope Width: 25' Slope: 65%		
										LF Channel		BF Channel										
	DD	DS	Live	DD	DS	Live	DD	DS	Live	Pool	Extra	BW	Extra	DD	DS	Live	DD	DS	Live	DD	DS	Live
1-2'D 6-20'																						
Root																						
1-2'D >20'			D: II			M: I			M: I										A: II			
2-3'D 6-20'																						
Root																						
2-3'D >20'			D: I						R: III					R: I								D: I✓
3-4'D 6-20'																						
Root																						
3-4'D >20'																						
>4'D 6-20'																						
Root																						
>4'D >20'																						

Tree Codes: R – Redwood D – Doug Fir T – Tan Oak P – Monterey Pine N – Nutmeg M – Maple W – Willow B – Bay C – Cottonwood E – Box Elder A – Alder

Characteristics: X – Diameter, sum of mult trunks J – In logjam L – Leaning (into the channel) → - Source of recruited wood Circled – Old ⊥ - Downed tree with root wad (root)|—(trunk) ₐ –Downed tree, alive

Comments:

Large Woody Debris Inventory Form

Date: 10/16/13	Surveyors: CL + JD	Stream: San Vicente Creek – ~~Main Stem~~ Mill Ck	Drainage: San Vicente Creek	Sample: 1 of 2	Reach No: 6
Channel Type: B3	Ref pt: Confluence ~~with Pacific Ocean~~ w/ San Vicente Ck	Sample Location (FT. FROM REF PT.): 400 to 600		Reach Location (FT. FROM REF PT.): 0 to 8347	

	Right Bank (75')									Stream				Left Bank (75')								
	Upslope Width: 45' Slope: 15%			Riparian Width: 30' Slope: 45%			Perched Slope: 85%			BF Width: 14' Depth: 8" LF Channel		BF Channel		Perched Slope: 5%			Riparian Width: 35' Slope: 85%			Upslope Width: 40' Slope: 45%		
	DD	DS	Live	DD	DS	Live	DD	DS	Live	Pool	Extra	BW	Extra	DD	DS	Live	DD	DS	Live	DD	DS	Live
1-2'D 6-20'																W: ll						
Root																						
1-2'D >20'						T: ull R: l			R: lll A: l							R: lll A: l		T: l	T: ll R: ull l			
2-3'D 6-20'																						
Root																						
2-3'D >20'																			R: lll			
3-4'D 6-20'																		R: lll				
Root																						
3-4'D >20'																						
>4'D 6-20'																						
Root																						
>4'D >20'																						

Tree Codes: R – Redwood D – Doug Fir T – Tan Oak P – Monterey Pine N – Nutmeg M – Maple W – Willow B – Bay C – Cottonwood E – Box Elder A – Alder

Characteristics: X – Diameter, sum of mult trunks J – In logjam L – Leaning (into the channel) → - Source of recruited wood Circled – Old ⊥ - Downed tree with root wad (root)|— (trunk) ⌞ - Downed tree, alive

Comments:

Large Woody Debris Inventory Form

Date: 10/16/14	Surveyors: CL & JD	Stream: San Vicente Creek – Main Stem (Mill Ck)	Drainage: San Vicente Creek	Sample: 2 of 2	Reach No: 5
Channel Type: B3	Ref pt: Confluence with Pacific Ocean SV Creek		Sample Location (ft. from ref pt.): 1400 to 1600	Reach Location (ft. from ref pt.): 0 to 2347	

	Right Bank (75')									Stream				Left Bank (75')									
	Upslope Width: 45' Slope: 70%			Riparian Width: 30' Slope: 50%			Perched Slope: 10%			BF Width: 8' Depth: [illegible]				Perched Slope: 0			Riparian Width: 25 Slope: 14%			Upslope Width: 70 Slope: 35%			
										LF Channel		BF Channel											
	DD	DS	Live	DD	DS	Live	DD	DS	Live	Pool	Extra	BW	Extra	DD	DS	Live	DD	DS	Live	DD	DS	Live
1-2'D 6-20'																						
Root																						
1-2'D >20'			R: ||||| || T: |||||			D: ||	T:									R:				R: ||||| ||||			T:	R:	
2-3'D 6-20'																						
Root																						
2-3'D >20'			R:							R: || D:								R: |||			R: |||| D:				R: |||
3-4'D 6-20'							D:																
Root							R:		R:														D:	R: |||
3-4'D >20'																						
>4'D 6-20'																						
Root																						
>4'D >20'																						

Tree Codes: R – Redwood D – Doug Fir T – Tan Oak P – Monterey Pine N – Nutmeg M – Maple W – Willow B – Bay C – Cottonwood E – Box Elder A – Alder

Characteristics: X – Diameter, sum of mult trunks J – in logjam L – Leaning (into the channel) → - Source of recruited wood Circled – Old ⊥ - Downed tree with root wad (root)|— (trunk) ‗ -Downed tree, alive

Comments:

Appendix E

LARGE WOODY DEBRIS SURVEY DATA SHEETS

Invasive Mapping Reconnaissance

Project Key

DEOD	Cape Ivy
FOVU	Fennel
SCCA	Bee Plant
STBU	Hedge Nettle
RHCA	Coffeeberry
SARA	Red Elderberry
COJU	Jubata Grass
GEMO	French Broom
HEHE	English Ivy
RUUR	California Blackberry
RUPA	Rubus Parviflorus
ALRH	White Alder
SESE	Coast Redwood

Occurrence 1

Date: 12/13/12 **Time:** 10:11AM **Observers:** Graham/Jessica
Description: This point is for the lower SVC pond to the road. Cape Ivy is present in the trees. There appears to be flooding as indicated by the vegetation. There are several large trees and a white alder (ALRH) forest. Hemlock is present.
Access: Hand Crew
Adjacent to floodplain: Yes

Invasive Species	Cover	In Trees	Mixed w/Natives	Isolated
DEOD (Cape Ivy)	> 50%	Yes	Yes	
FOVU (Fennel)	< 50%			

Dominant Natives
SCCA
STBU

Photos:

Picture 42: North

Picture 43: South

Picture 45: West

Picture 46: Channel

Occurrence 2:

Date: 12/13/12 **Time:** 10:24AM **Observers:** Graham/Jessica
Description: Semi-isolated patch below the lower pond, the native "horseshoe". There is a wooden post in the side channel at the top of the "shoe". Lots of natives – parsley, dogwood, native blackberry, lady fern, elderberry, 5 finger fern, willow and dogwood. Forget-me-nots (MYLA) will need to be treated. There is a slight slope that is not pertinent to management. Stream banks go east to west. Cape Ivy extends to the road, but decreases on the other side of Highway 1. Jubata (COJU) and thistle are present at the road's edge.
Access: Hand Crew
Adjacent to floodplain: Yes

Invasive Species	Cover	In Trees	Mixed w/Natives	Isolated
DEOD	<50%	Yes	Yes	Yes

Dominant Natives
RHCA
SARA
STBU

Photos:

Picture 47: Upstream

Picture 48: Downstream

Picture 49: Left Bank


Picture 50: Right Bank

Occurrence 3:

Date: 12/13/12 **Time:** **Observers:** Graham/Jessica
Description: At the rock weir. Cape ivy is in the trees and across the stream, running up the cliff. Cape Ivy is surrounding the flow control structure. Large alders are present.
Access: Hand Crew, Herbicide
Adjacent to floodplain: Yes
Slope: Greater than 1:1

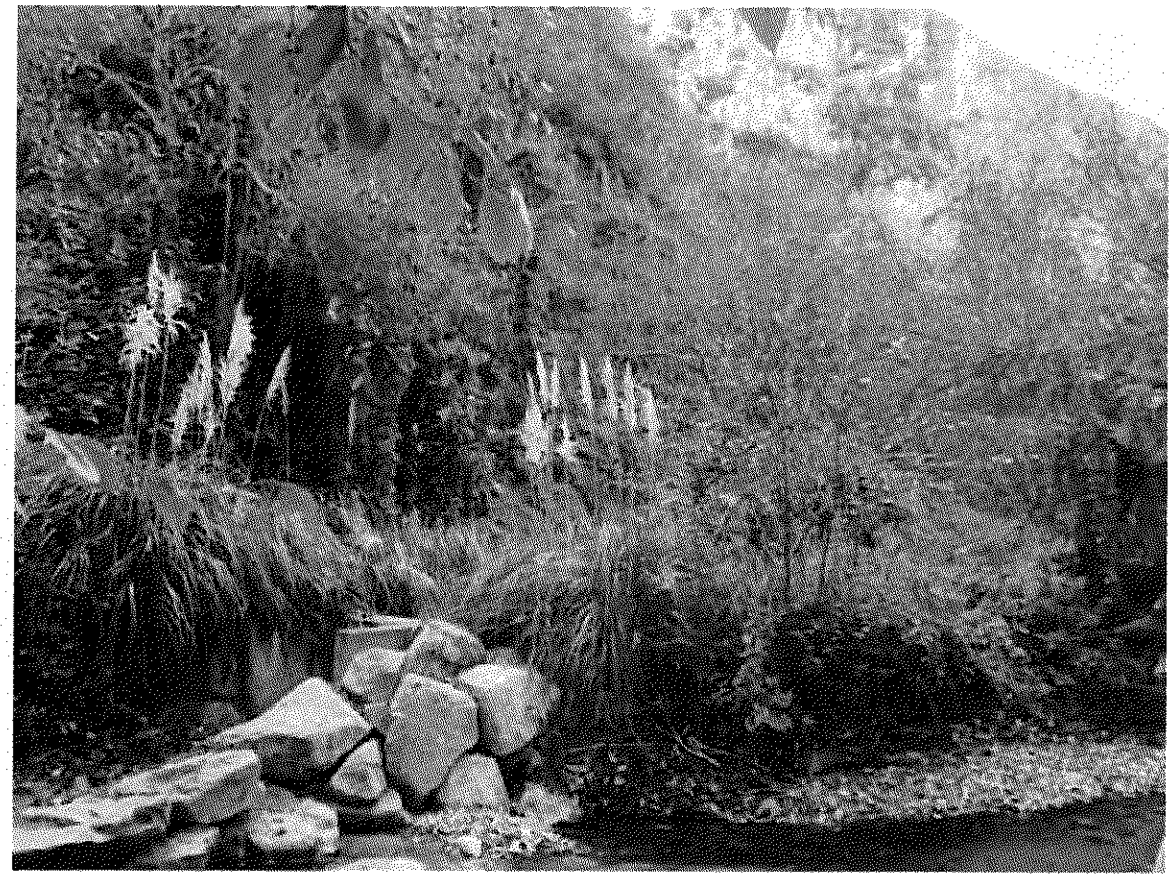
Invasive Species	Cover	In Trees	Mixed w/Natives	Isolated
DEOD	>50%	Yes		
COJU	< 50?			
GEMO	< 50%			
FOVU	<50%			

Photos:

Picture 51: Upstream


Picture: 52 Downstream


Picture 53: Left Bank



Picture 54: Right Bank

Picture 55: Right Bank, upstream

Occurrence 4:

Date: 12/13/12 **Time:** **Observers:** Graham/Jessica
Description: Large woody debris structure. Dense patch of nasturtium. Cape Ivy is a continuation of patch from Point 3, and is present 100ft up the cliff.
Access: Hand Crew
Adjacent to floodplain: Yes

Invasive Species	Cover	In Trees	Mixed w/Natives	Isolated
DEOD	> 50%	Yes		
HEHE	< 50%	Yes		Yes

Dominant Natives
STBU

Photos:

Picture 56: Upstream

Picture 57: Downstream

Picture 58: Left Bank

Picture 59: Right Bank

Occurrence 5:

Date: 12/13/12 **Time:** 12:45PM **Observers:** Graham/Jessica
Lat: 37 01' 07.772" N **Long:** 122 11' 15.008" W
Description: High priority area, adjacent to a large redwood tree. Fennel is present 15ft past this point.
Access: Hand Crew
Adjacent to floodplain: Yes
Slope: Innerbank 3:1

Invasive Species	Cover	In Trees	Mixed w/Natives	Isolated
DEOD	> 50%	Yes	Yes	Yes

Dominant Natives
STBU
RUUR

Photos:

Picture 61: Upstream

Picture 60: Downstream

Picture 63: Left Bank

Picture 62: Right Bank

The following points were taken from San Vicente Road, using the gate as a point of reference.

Occurrence 6:

Date: 12/13/12 **Time:** **Observers:** Graham/Jessica
Description: Large patch of cape ivy, about 200 ft along the stream
Access: 54 ft from road toward the stream, along a deer trail to the cape ivy patch.

Invasive Species	Cover	In Trees	Mixed w/Natives	Isolated
DEOD	> 50%	Yes		

Occurrence 7:

Date: 12/13/12 **Time:** **Observers:** Graham/Jessica
Lat: 37 01' 09.500" N **Long:** 122 11' 15.329" W
Description: Morning glory in trees (5% cover), 1 large French broom plant (15-18ft) doesn't seem to be mature. Geranium present
Distance from gate: 759ft

Invasive Species	Cover	In Trees	Mixed w/Natives	Isolated
Morning Glory	< 50%	Yes	Yes	Yes
GEMO	< 50%		Yes	

Dominant Natives
RHCA
RUPA

Occurrence 8:

Date: 12/13/12 **Time:** **Observers:** Graham/Jessica
Lat: 37 01' 12.801" N **Long:** 122 11' 13.946" W
Description: Sporadic french broom population on right and left banks for 77ft along stream.
Access: Hand Crew
Distance from gate: 958ft

Invasive Species	Cover	In Trees	Mixed w/Natives	Isolated
GEMO	< 50%		Yes	

Dominant Natives
RHCA
RUPA

The following points were taken from San Vicente Road, using the gate as a point of reference.

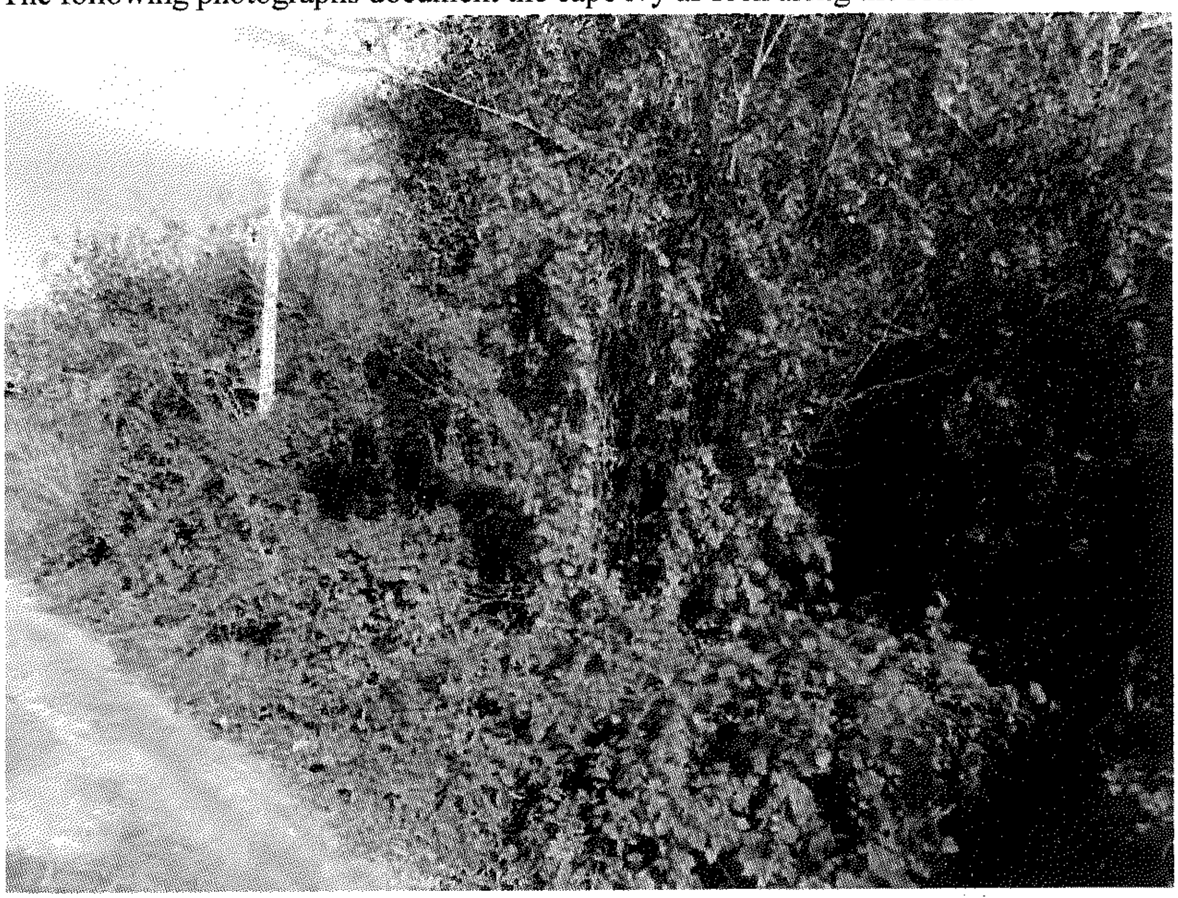
Occurrence 9:

Date: 12/13/12 **Time:** **Observers:** Graham/Jessica
Description: Large patch of ivy, extending 238 feet along the road and all the way to the stream. Only covers trees up to 15ft. 8 – 10 mature white alder and 1 large redwood 3-4 ft in diameter.
Distance from gate: 1361ft

Invasive Species	Cover	In Trees	Mixed w/Natives	Isolated
DEOD	> 50%	Yes	Yes	Yes

Dominant Natives
ALRH
SESE

Photos:
The following photographs document the cape ivy as seen along the road:



The following points were taken from San Vicente Road, using the gate as a point of reference.

The following points were taken from San Vicente Road, using the gate as a point of reference.

The following points were taken from San Vicente Road, using the gate as a point of reference.

The following points were taken from San Vicente Road, using the gate as a point of reference.

Occurrence 10:

Date: 12/13/12 **Time:** **Observers:** Graham/Jessica
Description: Underneath conveyor belt. Large and very tall patch of French broom, continues upstream.
Distance from gate: 1690ft

Invasive Species	Cover	In Trees	Mixed w/Natives	Isolated
GEMO	> 50%			Yes

Photos:

The following points were taken from San Vicente Road, using the gate as a point of reference.

Invasive Mapping Reconnaissance

Project Key

DEOD	Cape Ivy
FOVU	Fennel
SCCA	Bee Plant
STBU	Hedge Nettle
RHCA	Coffeeberry
SARA	Red Elderberry
COJU	Jubata Grass
GEMO	French Broom
HEHE	English Ivy
RUUR	California Blackberry
RUPA	Rubus Parviflorus
ALRH	White Alder
SESE	Coast Redwood

Description for Cape Ivy- Area 1						
Plant name	**Dist.**	**Dist.**	**Area (sq ft)**	**Density**	**Hgt in**	**# of**
	RD	**Strm**	**Length-along the Rd.**	**> %**	**Trees**	**Trees**
	Access		**or the creek**			
			Width- stream to Rd.			
	340	250	**40 x 25= 1000**	50	20	15-30
			or 33 x 25=825		1 tree 30'	~ 10
Notes						
Clear all ci from trees except for 1 tree with ci to 30'						
All hand work						
Best path weedwack Urtica sp. 15' from stream						
The **access point** is 10' passed the Redwood tree,						
along the road.						
Originally thought this was 40'x50', but CI appears to have infested inward from the creek,						
only part of the way towards the road.						
Little CI on the stream bank itself						

Description for Cape Ivy - Area 2						
						# of
Plant name	**Dist.**	**Dist.**	**Area (sq ft)**	**Density**	**Hgt in**	**Trees**
	RD	**Strm**		**> %**	**Trees**	
	Access					
	340	340	50 x 25' (maybe 30')	50	25-30	10+
			1250 - 1500 sq. ft			
Notes						
Maybe establish a inland border parallel to the stream and downstream to protect Cornus						
3 people- 2 hrs pruners, machete & weedwacker						
Some Poison Oak in border area						
Large non-native Clematis & CI under large alders at the stream.						
Access point same as Patch 1, go upstream to enter						
This is a patch along the stream only						
The gap between patch 2 & 3 is 20' along the creek						
Gap between patch 1 & 2 is 65' along the stream						

Description for Cape Ivy - Area 3						
						# of
Plant name	Dist.	Dist.	Area (sq ft)	Density	Hgt in	Trees
	RD	Strm		> %	Trees	
	Access					
	455	410	82 x 85 - 20%	40-80	20-30	10-30+
			Approx. 5600 sq. ft.			
Notes						
Yellow Jacket nest- downstream path near Redwoods						
Herbicide use:						
CI pull down from Alder and spray downstream wall of CI near YJ nest						
Spray 6' wide path along upstream section of path				~ 800 - 1000 sq. ft.		
No CI along the road. It begins around the large Alder 35' toward the stream						
There is a lot of Urtica in here and nice patches of Scrophularia and Stachys						

Description for Cape Ivy - Area 4						
						# of
Plant name	Dist.	Dist.	Area (sq ft)	Density	Hgt in	Trees
	RD	Strm		> %	Trees	
	Access					
	855		20 x 20= 400		15	a few
Notes						
Smaller Clematis at the stream near the building						
Access point 6' upstream from 3 transformer pole; walk upstream to within 45' of patch						
Cross stream for access road, 130' pass the power pole with 3 transformers						
There is a 1000 sq ft patch of Vinca along the stream & directly upstream from the CI patch						
There is a 15 sq foot patch of Tradescantia sp.(Wandering Jew) 70' upstream from the Vinca						

References Cited

CHAPTER 1:

Becker, G.S., K.M. Smetak, and Asbury, D.A. 2010. Southern Steelhead Resources Evaluation: Identifying Promising Locations for Steelhead Restoration in Watersheds South of the Golden Gate. Center for Ecosystem Management and Restoration.

County of Santa Cruz. 2012. Santa Cruz County Watersheds: San Vicente.

Department of Fish and Game (DFG). 1996. Stream Inventory Report: San Vicente Creek.

Environmental Science Associates (ESA). 2001. "Coast Dairies Long-Term Resource Protection and Land-use Plan: Existing Conditions Report for the Coast Dairies Property."

Griggs, G. and B. Haddad. 2011. City of Santa Cruz City Climate Change Vulnerability Assessment – Vulnerability Part One.

Hamman, R. 1996. 140 Years of Railroading in Santa Cruz County.

National Marine Fisheries Service (NMFS). 2012. Recovery Plan for the Evolutionarily Significant Unit of Central California Coast Coho Salmon: Executive Summary.

National Marine Fisheries Service (NMFS). 2008. Watershed Characterization: San Vicente Creek Watershed.

Regional Water Quality Control Board (RWQCB). 2010. Draft California 2010 Integrated Report 303(d) List/305(b) Report), San Vicente Creek: Santa Cruz County. Retrieved from http://www.waterboards.ca.gov/water_issues/programs/tmdl/2010state_ir_reports/00729.sh.

Regional Water Quality Control Board. (2010, October 20).

Santa Cruz County. 2009. San Vicente Creek Recovery Issues.

Smith, J. C. 2002. "Salmon and Steelhead Habitat Limiting Factors in WRIA 1, the Nooksack Basin." Washington State Conservation Commission.

Tihansky, B.A. and Knochenmus, A.L. 2003. Karst Features and Hydrogeology in West-Central Florida – A Field Perspective. U.S Geological Survey.

Weppner, E. M., E. Richards, E. and D. Hagans. (2009, January). CEMEX THP 1-06-080SCR 2008 Phase 1 Road Assessment Project, San Vicente Creek. Pacific Watershed Associates Report No. 08080501A.

CHAPTER 2:

Barton, J. 2012. Letter to John O'Hagan, State Water Resources Control Board. CEMEX Water Rights, Statements 8350 and 8351, Kossack Complaint.

Cayan, D.R., E.P. Maurer, Dettinger, M.D., M. Tyree, and K. Hayhoe. 2008. Climate change scenarios for the California region. Climatic Change (87), Suppl 1: S21-S42.

Coast Dairies, 2013. Coast Dairies Water Diversions. Report for Coast Dairies Task for BLM.

Creegan and D'Angelo. 1984. Watershed Analysis San Vicente Creek, Mill Creek, Liddell Creek, East Branch Liddell Creek. Consulting report prepared for Lone Star Industries.

Chartrand, S.M., B. Hastings, and B. Hecht. 2006. Neary Lagoon: Lagoon-specific sedimentation management plan, City of Santa Cruz, California. Consulting report prepared for the City of Santa Cruz Public Works Department. 38 p plus figures and tables.

Environmental Science Associates, 2001. Coast Dairies Long Term Resource Protection and Use Plan. Consulting report prepared for Trust for Public Land.

Hastings, B. and J. Owens. 2012. Sediment monitoring: Majors Creek upstream of Majors Creek dam, WY2008, 2009, 2010 and 2011, Santa Cruz County, California. Consulting report prepared for the City of Santa Cruz Water Department. 17 p plus figures and tables.

National Academies, 2012. Sea-Level Rise for the Coasts of California, Oregon, and Washington: Past, Present, and Future. Committee on Sea Level Rise in California, Oregon, and Washington; Board on Earth Sciences and Resources; Ocean Studies Board; Division on Earth and Life Studies; National Research Council. Available at: http://www.nap.edu/catalog.php?record_id=13389. 210 p.

National Marine Fisheries Service (NOAA Fisheries), 2012. Final recovery plan for central California coast coho salmon evolutionary significant unit. National Marine Fisheries Service, Southwest Region, Santa Rosa, California.

National Oceanic and Atmospheric Administration (2014). Comment letter on the draft San Vicente Creek Watershed Plan for salmonid recovery. West Coast Region Office, Santa Rosa, CA.

Nolan Associates, Johnson, N. M., 2007. Geologic, Hydrologic, and Hydrogeologic Technical Appendix F of the Bonny Doon Limestone Quarry Draft Environmental Impact Report. Consulting report prepared for TRA Environmental and the County of Santa Cruz Planning Department.

Parke, J., J. Owens, and S.M. Chartrand. 2013. Annual hydrologic record for Laguna Creek at Highway 1: draft data report. Consulting report prepared for the City of Santa Cruz Water Department.

P.E. LaMoreaux and Associates, Inc. (PELA). 2005. Karst investigation report – delineation of capture zone of Liddell Spring, Santa Cruz, California. Consulting report prepared for CEMEX. 82 p + appendices.

Rantz, S.E. 1982. Measurements and computation of streamflow, Volume 1, measurement of stage and discharge, USGS Water-Supply P-2175, Washington D.C., 284 p.

Reppert, H. 2002. Letter to Angela Petersen. Response to March 29 Comments by Davenport Sanitation District.

Santa Cruz County GIS. GISWEB-Mapping Application. Web tool available at: http://gis.co.santa-cruz.ca.us/PublicGISWeb/.

Scripps Institution of Oceanography. California Nevada Applications Program (CNAP). Data available at: http://cal-adapt.org/data/tabular/.

Stamm, J. S.M. S.M. Chartrand, and B. Hecht. 2008. Initial findings and preliminary design options, San Vicente pond, Santa Cruz County, California. Project memo prepared for the Resource Conservation District of Santa Cruz County and NOAA Western Region Restoration Center. 11 p plus figures and tables.

United States Geological Survey. 1982. Guidelines for determining flood flow frequency: Bulletin #17B of the hydrology subcommittee, interagency advisory committee on water data. U.S. Department of the Interior. 192 p.

CHAPTER 3:

Best, T. 2002. Road and trail erosion inventory: El Corte de Madera Creek Open Space Preserve: Draft consulting report prepared by Timothy Best, CEG for Duncan Simmons, Esq., Attorney for the Midpeninsula Regional Open Space District. November 27, 43 p.

Bjornn, T.C., and D.W. Reiser. 1991. Habitat requirements of salmonids in streams; American Fisheries Society Special Publication, v.19, pp. 83-138

Brabb, E.E.. 1989. Geologic map of Santa Cruz County, California, U.S. Geological Survey, Misc. Investigative Series, Map I-1905, 1:62,500.

Bunte, K., S.R. Abt, K.W. Swingle and J.P. 2009. Comparison of three pebble count protocols (EMAP, PIBO, and SFT) in two mountain gravel-bed streams, J. of the Amer. Water Res. Assoc.,

California Department of Fish and Wildlife. 2013. San Vicente Creek: Stream habitat assessment report, 35 p.

California Department of Fish and Wildlife. 1998. California salmonid stream habitat restoration manual, 3rd Edition. Inland Fisheries Division, California Department of Fish and Wildlife, Sacramento, CA. 495 p.

Clark, J.C. 1981. Stratigraphy, paleontology, and geology of the Central Santa Cruz Mountains, California Coast Ranges, U.S. Geological Survey Paper 1168, 51 p. + map.

Creegan and D'Angelo Consulting Engineers. 1984. Watershed analysis: San Vicente Creek, Mill Creek, Liddell Creek, East Branch Liddell Creek; consulting report prepared for Lone Star Industries, Santa Cruz California, 64 p.

Stephen E. D. and F. G. 1988. Landslides, floods, and marine effects of the storm of January 3-5, 1982, in the San Francisco Bay region, California. US Geological Survey Professional Paper.

Hastings, B., and S.M. Chartrand. 2011, Sediment monitoring, Laguna Creek, upstream of Laguna Creek Dam, water years 2008, 2009, 2010, and partial water year 2011, Balance Hydrologics consulting report prepared for the City of Santa Cruz Water Department, 19 p. + figures, tables, forms.

Kondolf, G.M. 2000. Assessing salmonid spawning gravel quality. Transactions of the American Fisheries Society, v.129, pp. 262-281.

Kondolf, G.M., and G. Wolman. 1993. The sizes of salmonid spawning gravel, Water Resources Research, v29, no. 7, pp 2275-2285.

Kondolf, G.M. 1988. Salmonid spawning gravels: A geomorphic perspective on their size distribution, modification by spawning fish, and criteria for gravel quality. PhD diss., John Hopkins University, Baltimore, MD, 396 p.

Montgomery, D.R., and J.M. Buffington. 1997. Channel-reach morphology in mountain drainage basins, GSA Bulletin v.109, no.5, pp. 596-611.

National Marine Fisheries Service (NMFS). 2008. Watershed characterization: San Vicente Creek, 22 p.

North Coast Regional Water Quality Control Board (NCRWQCB). 2008. Desired salmonid freshwater habitat conditions for sediment-related indices, 53 p.

Owens, J., B. Hastings, B. Hecht, and J. Gartner. Initial findings of sediment source survey and creek sedimentation, El Corte de Madera Creek, San Mateo County, California, Balance Hydrologics consulting report prepared for Midpeninsula Regional Open Space District, 29 p. + figures + tables.

P.E., LaMoreaux and Associates, Inc. (PELA). 2005. Karst investigation report—delineation of capture zone of Liddell Spring, based on data from the City of Santa Cruz, Santa Cruz, California; consulting report prepared for CEMEX, 82 p. + appendices.

Reid, L.M. and T. Dunne.1984, Sediment production from road surfaces, Water Resources Research, v.20, p. 1753-1761.

Santa Cruz County Resource Conservation District (RCD). 2013. Coast Dairies Task 1 for BLM: San Vicente Creek large wood debris, report prepared for BLM, 18 p.

Santa Cruz County. 2009. Coho recovery: San Vicente Creek (report incomplete).

Spittler, T. E., and E.L. Harps. Landslide features and other coseismic fissures triggered by the Loma Prieta earthquake, central Santa Cruz Mountains, California. The Loma Prieta (Santa Cruz Mountains), California earthquake of 17 (1989): 59-66.

Stamm, J., S.M. Chartrand, B. Hecht. 2008. Initial findings and preliminary design options, San Vicente pond, Santa Cruz County, California. Project memo prepared for the Resource Conservation District of Santa Cruz County and NOAA Western Region Restoration Center. 11 p plus figures and tables.

Sylte, T. and C. Fischenich. 2002. Techniques for measuring substrate embeddedness, EMRRP technical notes collection (ERDC TN-EMRRP-SR-36), U.S. Army Engineer Research and Development Center, Vicksburg, MS.

Tappel, P.D. and T.C. Bjornn. 1983. A new method of relating size of spawning gravel to salmonid embryo survival, N. American J. of Fisheries Management, v3, pp. 123-135.

Tunheim, E. 2001. Stream survey of upper San Vicente Creek tributaries, consulting report prepared for RMC Pacific Materials, 5 p. + maps and appendices

Weppner, E.M., E. Richards, and D .Hagans. 2009, Cemex THP 1-06-080SCR 2008 Phase 1 road assessment project, San Vicente Creek, Santa Cruz County, California. PWA consulting report prepared for Cemex, Inc., 20 p. + maps and appendices.

CHAPTER 4:

California Department of Fish and Game (DFG). 2011. California Coastal Salmonid Population Monitoring: Strategy, Design, and Methods. Fish Bulletin 180.

California Department of Fish and Game (DFG). 1998. Draft Strategic Plan for Restoration of the Endangered Coho Salmon South of San Francisco Bay.

California Department of Fish and Game (DFG). 1996. Stream Inventory Report – San Vicente Creek. Department files.

California Department of Fish and Wildlife (CDFW). 2013. Stream Inventory Report – San Vicente Creek, surveyed 2010, report completed 2013.

Columbia Basin Fish and Wildlife Authority (CBFWA). 1999. PIT Tag Marking Procedures Manual – Version 2.0, prepared by the PIT Tag Steering Committee.

Environmental Science Associates (ESA). 2003. San Vicente Creek and Pond Smolt Outmigramt Study, Spring 2003. Prepared for National Marine Fisheries Service on behalf of Coast Dairies & Land Company.

Environmental Science Associates (ESA). 2001. Coast Dairies Long-Term Resource Protection and Use Pan – Existing Conditions Report for the Coast Dairies Property. Prepared for the Trust for Public Land., San Francisco, CA.

Flosi, G., S. Downie, J. Hopelain, M. Bird, R. Coey, and B. Collins. 1998. California Salmonid Stream Habitat Restoration Manual. 3rd edition, California Department of Fish and Game, Inland Fisheries Division. Sacramento, CA.

Gallagher S. and M. Knechtle. 2005. Coastal Northern California Salmonid Spawning Survey Protocol. California Department of Fish and Game. Draft Oct. 19, 2005.

Jankovitz, J.D. 2012. 2011-2012 Escapement Estimates for Central California Coast Coho Salmon (Oncorhynchus kisutch) and Steelhead (Oncorhynchus mykiss) South of the Golden Gate. Pacific States Marine Fisheries Commission.

Moyle, P.B. and J. J. Cech, Jr. 1988. Fishes: An Introduction to Ichthyology. Second Edition, Prentice-Hall, Inc., NJ.

National Marine Fisheries Service (NMFS). 2012. Final Recovery Plan for Central California Coast coho salmon Evolutionarily Significant Unit. National Marine Fisheries Service, Southwest Region, Santa Rosa, CA.

Roni, P. 2002. Habitat use by fishes and Pacific giant salamanders in small western Oregon and Washington streams. Transactions of the American Fisheries Society 131:743–761.

Spence, B.C., W.G. Duffy, J.C. Garza, B.C. Harvey, S.M. Sogard, L.A. Weitkamp, T.H. Williams and D.A. Boughton. 2011. Historical occurrence of coho salmon (Oncorhynchus kisutch) in streams of the Santa Cruz Mountain region of California: Response to an endangered species act petition to delist coho salmon south of San Francisco Bay. National Oceanic and Atmospheric Administration (NOAA) Technical Memorandum NMFS-SWFSC-472.

Spence, B. NMFS Southwest Fisheries Science Center, Fisheries Ecology Division, unpublished data.

Shapovalov, L. and A. C. Taft. 1954. The Life Histories of the Steelhead Rainbow Trout (Salmo gairdneri gairdneri) and Silver Salmon (Oncorhynchus kisutch) with Special Reference to Waddell Creek, California, and Recommendations Regarding Their Management. State of California, Department of Fish and Game, Fish Bulletin No. 98.

Stamm, J., S.M. Chartrand, B. Hecht, E. Austensen and M. Podlech. 2008. Initial Findings and Preliminary Design Options, San Vicente Pond, Santa Cruz, California. Prepared for Resources Conservation District of Santa Cruz County by Balance Hydrologics, Inc.

CHAPTER 5:

Abbe, T. B. and D. R. Montgomery. 1996. Large woody debris jams, channel hydraulics, and habitat formation in large rivers. Regulated Rivers-Research and Management 12: 201–221.

Andrus, C., B. Bilby, S. Gregory, T. Nichelson, A. McKee, and J. Boechler. 1993. Modeling woody debris inputs and outputs. Unpublished, Oregon Department of Forestry as cited in Flosi, G., S. Downie, H. James, M. Bird, R. Coey, and B. Collins. State of California. Department of Fish and Game. California Salmonid Stream Habitat Restoration Manual. Sacramento: CA Department of Fish and Game Inland Fisheries Division, 1998.

Benbow, E.M, R. McEwan, R. McNeish and L. Schewart, 2013. Invasive Plant Impacts on Riparian-Aquatic Linkages. http://academic.udayton.edu/BenbowLab/Benbow_Lab/P3_Aquatic_Ecology/Entries/2010/1/22_Invasive_Plant_Impacts_on_Riparian-Aquatic_Linkages.html

Benda, L.E., D. Miller, J. Sias, D. Martin, R.E. Bilby, C. Veldhuisen, and T. Dunne. 2003. Wood recruitment processes and wood budgeting. In The ecology and management of wood in world rivers. Edited by S.V. Gregory, K.L. Boyer, and A.M. Gurnell. American Fisheries Society Symposium, 37. pp. 49–74.

Benda, L. E., P. Bigelow, and T. M. Worsley. 2002. Recruitment of wood to streams in old-growth and second-growth redwood forests, northern California, USA. Canadian Journal of Forest Research 32.8: 1460-1477.

Benke, A. C. and J. B. Wallace. 2003. Influence of wood on invertebrate communities in streams and rivers. In The Ecology and Management of Wood in World Rivers, Gregory, S., K. Boyer, A. Gurnell (eds). American Fisheries Society: Bethesda, MD; 149–177.

Bilby, R. E. 1984. Removal of woody debris may affect stream channel stability. Journal of Forestry 82: 609-613.

Bilby, R. E andG.E. Likens. 1980. Importance of organic debris dams in the structure and function of stream ecosystems. Ecology 61: 1107–1113.

Bilby, R. E. and J. W. Ward. 1991. Characteristics and function of large woody debris in streams draining old-growth, clear-cut, and second-growth forests in southwestern Washington. Canadian Journal of Fisheries and Aquatic Sciences 48.12: 2499-2508.

Bilby, R. E., and J. W. Ward. 1989. Changes in characteristics and function of woody debris with increasing size of streams in western Washington. Transactions of the American Fisheries Society 118.4 (1989): 368-378.

Bragg, D. C., J. L. Kershner and D. W. Roberts. 2000. Modeling large woody debris recruitment for small streams of the central Rocky Mountains. US Department of Agriculture, Forest Service, Rocky Mountain Research Station.

California Department of Fish and Wildlife. 2010. Stream Habitat Assessment Report Mill Creek.

California Department of Fish and Wildlife. 2010. Stream Habitat Assessment Report San Vicente Creek.

Crispin, V., R. House, and D. Roberts. 1993. Changes in instream habitat, large woody debris, and salmon habitat after restructuring of a coastal Oregon stream. North American Journal of Fisheries Management 13: 96–102.

Collins, B.D. and D.R. Montgomery. 2002. Forest development, wood jams and restoration of floodplain rivers in the Puget Lowland, Washington. Restoration Ecology 10, 237–247.

Faustini, J.M., and J.A. Jones. 2003. Influence of large woody debris on channel morphology and dynamics in steep, boulder-rich mountain streams, western Cascades, Oregon. Geomorphology 51: 187-205.

Flosi, G., S. Downie, H. James, M. Bird, R. Coey, and B. Collins. State of California. Department of Fish and Game. California Salmonid Stream Habitat Restoration Manual. Sacramento: CA Department of Fish and Game Inland Fisheries Division, 1998.

Gurnell, A. M., H. Piegay, F. J. Swanson and S.V. Gregorys. (2002). Large wood and fluvial processes. FRESHWATER BIOLOGY vol. 47, (4) 601-619.

Hildebrand, R.H., A.D. Lemly, C.A. Dolloff, and K.L. Harpster. 1998. Design considerations for large woody debris placement in stream enhancement projects. North American Journal of Fisheries Management, 18: 161-167.

Hyatt, T.L. and R.J. Naiman. 2001. The residence time of large woody debris in the Queets River, Washington. Ecological Applications 11(1):191-202

Keim, R.F., and A.E. Skaugset. 2002. Physical aquatic habitat I. errors associated with measurement and estimation of residual pool volumes. North American Journal of Fisheries Management 22:145-150.

Lassettre, N.S. 2001. Large woody debris in channels for aquatic habitat: developing strategies for watershed scale management, Soquel Demonstration Forest. Diss. University of California Berkeley.

Lehane, B.M., P.S. Giller, J. O'Halloran, C. Smith, and J. Murphy. 2002. Experimental provision of large woody debris in streams as a trout management technique. Aquatic Conservation: Mar. Freshwater Ecosystem., 12: 289–311.

Leicester, M.A. 2005. Recruitment and function of large woody debris in four California coastal streams. Masters Thesis Publication. 2772.

Lienkaemper, G.W. and F.J. Swanson. 1987. Dynamics of large woody debris in streams in old-growth Douglas-fir forests. Canadian Journal of Forestry Resources 17: 150–156

McDade, M.H., F.J. Swanson, W.A. McKee, J.F. Franklin, and J. VanSickle. 1990. Source distance for coarse woody debris entering small streams in western Oregon and Washington. Canadian Journal of Forestry Resources 20:326-330.

McHenry, M.L., E. Shott, R.H. Conrad, and G.B. Grette. 1998. Changes in the quantity and characteristics of large woody debris in streams of the Olympic Peninsula, Washington, USA (1982-1993). Canadian Journal of Fisheries and Aquatic Sciences. 55: 1395-1407. June.

Montgomery, D.R., J. M. Buffington, R.D. Smith, K.M. Schmidt, and G. Pess. 1995. Pool spacing in forest channels. Water Resources Research 31: 1097–1105.

National Research Council. 1996. Upstream: Salmon and Society in the Pacific Northwest. Committee on Protection and Management of Pacific Northwest Anadromous Salmonids /Board on Environmental Studies and Toxicology / Commission on Life Sciences. National Academy Press Washington, D.C.

Opperman, J. J. and A. M. Merenlender. 2007. Living trees provide stable large wood in streams. Earth Surface Processes and Landforms 32: 1229–1238.

Proceedings, 1985 Wildlife and Fish Ecology Working Group. Society of American Foresters. Bethesda, MD.

Rainville R.P., S.C. Rainville and E.L. Lider. 1985. Riparian silviculture strategies for fish habitat emphasis. Pages 186-189 in Silviculture for Wildlife and Fish: A Time for Leadership.

Shirvell, C.S. 1990. Role of instream rootwads as juvenile Coho salmon (Oncorhynchus kisutch) and Steelhead trout (O. mykiss) cover habitat under varying streamflows. Canadian Journal of Fisheries and Aquatic Sciences 47: 852–861.

Swanson, F. J., M. D. Bryant, G. W. Lienkaemper and J. R. Sedell. 1984. Organic debris in small streams. Prince of Wales Island, southeast Alaska. U.S. Forest Service General Technical Report. PNW-166.

Thompson, D. M. 2012. The challenge of modeling pool–riffle morphologies in channels with different densities of large woody debris and boulders. Earth Surface Processes and Landforms, 37: 223–239.

Tschaplinkski, P.J. and G. F. Hartman. 1983. Winter distribution of juvenile coho salmon (Oncorhynchus kisutch) before and after logging in Carnation Creek, British Columbia, and some implications for overwinter survival. Canadian Journal of Fisheries and Aquatic Sciences 40: 452–461.

National Marine Fisheries Service (NMFS). Recovery Plan for the Ecologically Significant Unit of Central California Coast Coho Salmon. Santa Rosa: NMFS, 2012.

Wohl E. and K. Jaeger. 2009. A conceptual model for the longitudinal distribution of wood in mountain streams. Earth Surface Processes and Landforms 34: 329–344.

CHAPTER 6:

Alvarez, M. E. 1 9 9 7. Management of Cape-ivy (Delairea odorata) in the Golden Gate National Recreation Area. Pages 91- 95 in M. Kelly, Wagner, E. and Warner, P., editor. California Exotic Pest Plant Symposium. California Exotic Pest Plant Council, Concord, California.

Archbald, G. 1995. Biology and control of German ivy. Report to California Department of Fish and Game, Pesticide Applications Seminar.

Behmer, J. D. and C. P. Hawkins. 1986. Effects of overhead canopy on macroinvertebrate production in a Utah stream. Freshwater Biology. 16: 287-300.

Bisson, P. and G. Davies. 1976. Production of juvenile chinook salmon (Oncorhynchus tshawytscha) in a heated model stream. FISHERIES BULLETIN. 74.4: 763-774.

Bragg, D. C., J. L. Kershner and D. W. Roberts. 2000. Modeling large woody debris recruitment for small streams of the central Rocky Mountains. US Department of Agriculture, Forest Service, Rocky Mountain Research Station.

Bossard, C.C., M.J. Randall and C.M. Hoshovsky. 2000. Invasive plants of California's wildlands. University of California Press.

Bossard, C. 1998. Effects of floating Cape ivy (Senecio mikanioides) foliage on golden shiners and crayfish. Report to Golden Gate National Park Association, January 1998, San Francisco, CA.

Bossard, C. Invasive Plants of California's Wildland: Delairea odorata. California Invasive plant Council (Cal-IPC). California Invasive plant Council, 2013. Web. 28 Jan 2014. http://www.cal-ipc.org/ip/management/ipcw/pages/detailreport.cfm@usernumber=41&surveynumber=182.php

Catalano, S., S. Luschi, G. Flamini, P. L. Cioni, E. M. Nieri, and I. Morelli. 1996. A xanthone from Senecio mikanioides leaves. Phytochemistry 42:1605–1607.

Chapman, D.W. and T.C. Bjornn. 1969. Distribution of salmonids in streams, with special reference to food and feeding. Pages 153-176 in T.G. Northcote, editor. Symposium on salmon and trout in streams. Institute of Fisheries, The University of British Columbia, Vancouver, Canada.

CAB International. 2013. "Datasheets > Clematis vitalba (old man's beard)." Invasive Species Compendium. Web. 28 Jan 2014. <http://www.cabi.org/isc/?compid=5&dsid=14280&loadmodule=datasheet&page=481&site=144>.

Davies-Colley, R. J. and D. G. Smith. 2001. TURBIDITY SUSPENDED SEDIMENT, AND WATER CLARITY: A REVIEW. JAWRA Journal of the American Water Resources Association 37.5: 1085-1101.

Elliott, J.M. 1973. The Diel Activity pattern, drifting and food of the Leech Erpobdella ocroculata (L.) (Hirdudunea: Erpobdellidae) in a lake district stream. Journal of Animal Ecology 42:449-459

Elliot, W. 1994. German ivy engulfing riparian forests and heading for the uplands. CalEPPC News. 2(1): 9.

Harradine, A.R. 1985. Dispersal and establishment of slender thistle, Carduus pycnocephalus, as effected by ground cover. Australian J. of Agricultural Research. 36:791-97.

Hill, W. R., M. G. Ryon and E. M. Schilling. 1995 Light limitation in a stream ecosystem: responses by primary producers and consumers. Ecology: 1297-1309.

Howell, J. T. 1970. Marin Flora, Second edition. University of California Press, Berkeley, CA.

Kirk, J.T.O. 1985. Effects of suspensoids (turbidity) on penetration of solar radiation in aquatic ecosystems. Perspectives in Southern Hemisphere Limnology. Springer Netherlands. 195-208.

Masters, R. A. and R. L. Sheley. 2001. Principles and practices for managing rangeland invasive plants. Journal of Range Management: 502-517.

National Marine Fisheries Service (NMFS). Recovery Plan for the Ecologically Significant Unit of Central California Coast Coho Salmon. Santa Rosa: NMFS, 2012.

Poole, G. C. and C. H. Berman. 2001. An Ecological Perspective on Instream Temperature: Natural Heat Dynamics and Mechanisms of Human-Caused Thermal Degradation. Environmental Management 27.6: 787-802.

Roberts, H.A. 1979. Periodicity of seedling emergence and seed survival in some Umbelliferae. J. of Applied Ecology. 16:195-201.

Robison, R. A., Distribution, Growth Analysis, and Reproductive Biology of Cape Ivy (Delairea Odorata Lem. Syn Senecio Mikanioides Walp.) in California. Diss. University of California, Davis, 2006.

Stelljes, M. E., R. B. Kelley, R. J. Molyneux and J. N. Seiber. 1991. GC-MS determination of pyrrolizidine alkaloids in four Senecio species. Journal of Natural Products, 54(3), 759-773.

Quinn, J. M., A. B. Cooper, M. J. Stroud and G. P. Burrell. 1997. Shade effects on stream periphyton and invertebrates: an experiment in streamside channels. New Zealand Journal of Marine and Freshwater Research 31: 665-684.

West, C.J. 1991. Literature review of the biology of Clematis vitalba (old man's beard). DSIR Land Resources vegetation report no. 725 (unpublished) 37 p.

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