APPENDIX B. DETAILED ANALYSIS OF 2010 STEELHEAD MONITORING IN THE SAN LORENZO, SOQUEL, APTOS AND CORRALITOS WATERSHEDS

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SCOPE OF WORK

In fall 2010, 4 Santa Cruz County watersheds were evaluated for habitat quality and sampled for juvenile steelhead to compare with past results. Refer to maps in **Appendix A** that delineate reaches and sampling sites. The mainstem San Lorenzo River and 7 tributaries were sampled with a total of 19 sites. Seven half-mile segments were habitat typed to assess habitat conditions and select habitats of average quality to sample. In reaches that were not habitat typed, the same habitats were sampled in 2009 and 2010. Tributaries included Branciforte, Zayante, Lompico, Bean, Fall, Newell, Boulder and Bear creeks. Eight steelhead sites were sampled below anadromy barriers in Soquel Creek and its branches. In the Aptos Creek watershed, 2 sites in Aptos Creek and 2 sites in Valencia Creek were sampled. In the Corralitos sub-watershed of the Pajaro River drainage, 4 sites were sampled in Corralitos Creek, 2 sites were sampled in Shingle Mill Gulch and 2 sites were sampled in Browns Valley Creek along with 1 half-mile segment habitat typed in lower Shingle Mill Reach 1.

Annual monitoring of juvenile steelhead began in 1994 in the San Lorenzo and 1997 in Soquel Creek. The Corralitos sub-watershed was previously sampled in 1981, 1994, 2006─2009. Aptos Creek was previously sampled in 1981, 2006─2009.

For annual comparisons, fish were divided into two age classes and three size classes. Age classes were young-of-the-year (YOY) and yearlings and older. The size classes were Size Class I (<75 mm Standard Length (SL)), Size Class II (between 75 and 150 mm SL) and Size Class III (>=150 mm SL). Juveniles in Size Classes II and III were considered to be "smolt-sized," based on scale analysis of out-migrating smolts by Smith (**2005**), because most fish of that size would grow sufficiently in the following spring to smolt. Fish below that size very rarely smolt the following spring.

I-1. Steelhead and Coho Salmon Ecology

<u>Migration.</u> Adult steelhead in small coastal streams tend to migrate upstream from the ocean through an open sandbar after several prolonged storms; the migration seldom begins earlier than December and may extend into May if late spring storms develop. Many of the earliest migrants tend to be smaller than those entering the stream later in the season. Adult fish may be blocked in their upstream migration by barriers such as bedrock falls, wide and shallow riffles and occasionally log-jams. Man-made objects, such as culverts, bridge abutments and dams are often significant barriers. Some barriers may completely block upstream migration, but many barriers in coastal streams are passable at higher streamflows. If the barrier is not absolute, some adult steelhead are usually able to pass in most years, since they can time their upstream movements to match optimal stormflow conditions. We located partial migrational barriers in the San Lorenzo River Gorge caused by a wide riffle that developed below a bend in 1998 (Rincon riffle) and a large boulder field discovered in 1992 that created a falls (above Four Rock). Both of these impediments were probably passable at flows above approximately 50-70 cubic feet per second (cfs) as they were observed in 2002. A split channel had developed at the Rincon riffle by 2002 and in 2007 there existed a steep cascade where the channels rejoined, making adult steelhead passage up the main channel difficult. In 2008, the steep cascade was gone, offering much easier fish passage up the main channel. The boulder field at Four Rock was partially modified in 2008, though we have not examined the results. In most years these are not passage problems. However, in drought years and years when storms are delayed, they can be serious barriers to steelhead and especially coho salmon spawning migration. In the West Branch of Soquel Creek, there are Girl Scout Falls I and II that impede adult passage. Based on juvenile sampling, it appears that adult steelhead pass Girl Scout Falls I in most years but seldom pass Girl Scout Falls II.

Coho salmon often have more severe migrational problems because their migration period, November through early February, is often prior to the stormflows needed to pass shallow riffles, boulder falls and partial logjam barriers. Access is also a greater problem for coho salmon because they die at maturity and cannot wait in the ocean an extra year if access is poor due to failure of sandbar breaching during drought or delayed stormflow. In recent years until 2008, the rainfall pattern has generally brought early winter storms to allow for good coho access to the San Lorenzo system, though only a small number of apparent strays have been detected at the Felton fish ladder and trap.

Smolts (young steelhead and coho salmon which have physiologically transformed in preparation for ocean life) in local coastal streams tend to migrate downstream to the lagoon and ocean in March through early June. In streams with lagoons, young-of-the-year (YOY) and yearling fish may spend several months in this highly productive lagoon habitat and grow rapidly. In some small coastal streams, downstream migration can occasionally be blocked or restricted by low flows due primarily to heavy streambed percolation or early season stream diversions. Flashboard dams or sandbar closure of the stream mouth or lagoon are additional factors that adversely affect downstream migration. However, for most local streams, downstream migration is not a major problem except under drought conditions.

Spawning. Steelhead and coho salmon require spawning sites with gravels (from 1/4" to 3 1/2" diameter) having a minimum of fine material (sand and silt) and with good flows of clean water moving over and through them. Flow of oxygenated water through the redd (nest) to the fertilized eggs is restricted by increased fine materials from sedimentation and cementing of the gravels with fine materials. Flushing of metabolic wastes is also hindered. These restrictions reduce hatching success. In many local streams, steelhead appear to successfully utilize spawning substrates with high percentages of coarse sand, which probably reduces hatching success. Steelhead spawning success may be limited by scour from winter storms in some Santa Cruz County streams. Steelhead that spawn earlier in the winter are more likely to have their redds washed out or buried by the greater number of winter and spring storms that will follow. However, unless hatching success has been severely reduced, survival of eggs and alevins is usually sufficient to saturate the limited available rearing habitat in most small coastal streams and San Lorenzo tributaries. However, in the mainstem San Lorenzo River downstream of the Boulder Creek confluence, spawning success in the river may be an important limiting factor. The production of YOY fish is related to spawning success, which is a function of the quality of spawning conditions, the pattern of storm events and ease of spawning access to upper reaches of tributaries, where spawning conditions are generally better.

Rearing Habitat. In the mainstem San Lorenzo River, downstream of the Boulder Creek confluence, many steelhead require only one summer of residence before reaching smolt size. This is also the case in the Soquel Creek mainstem and lagoon. Except in streams with high summer flow volumes (greater than about 0.2 to 0.4 cubic feet per second (cfs) per foot of stream width), steelhead require two summers of residence before reaching smolt size. This is the case for most juveniles inhabiting tributaries of the San Lorenzo River and the mainstem upstream of the Boulder Creek confluence. This is also the case for most juveniles in the East and West Branches of Soquel Creek, as well as in the Aptos watershed (except its lagoon) and the Corralitos sub-watershed except in wetter years such as 2006. Juvenile steelhead are generally identified as YOY (first year) and yearlings (second year). The slow growth and often two-year residence time of most local juvenile steelhead indicate that the year class can be adversely affected by low streamflows or other problems (including over-wintering survival) during either of the two years of residence. Nearly all coho salmon, however, smolt after one year under most conditions, despite their smaller size.

Growth of YOY steelhead and coho salmon appears to be regulated by available insect food (determined by substrate conditions in fastwater habitat and insect drift rate), although escape cover (hiding areas, provided by undercut banks, large rocks which are not buried or "embedded" in finer substrate, surface turbulence, etc.) and water depth in pools, runs and riffles are also important in regulating juvenile numbers, especially for larger fish. Densities of yearling and smolt-sized steelhead in small streams, the upper San Lorenzo (upstream of the Boulder Creek confluence) and San Lorenzo tributaries, are usually regulated by water depth and the amount of escape cover during low-flow periods (July−October) and by over-winter survival in deep and/or complex pools. In most small coastal streams, availability of this "maintenance habitat" provided by depth and cover appears to determine the number of smolts produced (**Alley 2006a; 2006b; 2007; Smith 1982**). Abundance of food (aquatic insects and terrestrial insects that fall into the stream) and fast-water feeding positions for capture of drifting insects in "growth habitat" (provided mostly in spring and early summer) determine the size of these smolts. Study of steelhead growth in Soquel Creek has noted that growth is higher in winter-spring compared to summer-fall (**Sogard et al. 2009**). It was determined that in portions of a watershed that are capable of growing YOY juvenile steelhead to smolt size their first growing season (Size Class II =>75 mm Standard Length in fall), the density of YOY that obtain this size was positively associated with the mean monthly streamflow for May–September (**Alley et al. 2004**). Furthermore, it has been shown that the density of slower growing YOY in tributaries was positively associated with the annual minimum annual streamflow (**Alley et al. 2004**). Aquatic insect production is maximized in unshaded, high gradient riffles dominated by relatively unembedded substrate larger than about 4 inches in diameter.

Yearling steelhead growth usually shows a large increase during the period of March through June. Larger steelhead then may smolt as yearlings. For steelhead that stay a second summer, mid to late summer growth is very slight in many tributaries (or even negative in terms of weight) as flow reductions eliminate fast-water feeding areas and reduce insect production. A short growth period may occur in fall and early winter after leaf-drop of riparian trees, after increased streamflow from early storms, and before water temperatures decline below about 48ºF or water clarity becomes too turbid for feeding. The "growth habitat" provided by higher flows in spring and fall (or in summer for the mainstem San Lorenzo River) is very important, since ocean survival to adulthood increases exponentially with smolt size.

During summer in the mainstem San Lorenzo River downstream of the Boulder Creek confluence, steelhead use primarily fast-water habitat where insect drift is the greatest. This habitat is found in deeper riffles, heads of pools and faster runs. YOY and small yearling steelhead that have moved down from tributaries can grow very fast in this habitat if streamflows are high and sustained throughout the summer. The shallow riffle habitat in the upper mainstem is used almost exclusively by small YOY, although most YOY are in pools. In the warm mainstem Soquel Creek, downstream of Moores Gulch, juvenile steelhead utilize primarily heads of pools in all but the highest flow years, with some YOY using shallower runs and riffles. Upstream of Moores Gulch in summer on the mainstem and in the two Branches (East and West), juvenile steelhead use primarily pool habitat where cover is available and deeper step-runs. Riffles are used by primarily YOY and more so in the upper mainstem than the branches where they become more shallow.

Pools and step-runs are the primary habitat for steelhead in summer in San Lorenzo tributaries, the upper San Lorenzo River above the Boulder Creek confluence, the Aptos watershed and the Corralitos sub-watershed because riffles and runs are very shallow, offering limited escape cover. Primary feeding habitat is at the heads of pools and in deeper pocket water of step-runs. The deeper the pools, the more value they have. Higher streamflow enhances food availability, surface turbulence (as overhead cover) and habitat depth, all factors that increase steelhead densities and growth rates. Where found together, young steelhead use pools and faster water in riffles and runs/step-runs, while coho salmon use primarily pools, being poorer swimmers.

Juvenile steelhead captured during fall sampling included a smaller size class of juveniles less than (<) 75 mm (3 inches) Standard Length (SL); these fish would almost always require another growing season before smolting. The larger size class included juveniles 75 mm SL or greater (=>) and constituted fish that are called "smolt size" because a majority will likely out-migrate the following spring and because fish smaller than this very rarely smolt the following spring. Smolt size was based on scale analysis of out-migrant smolts captured in 1987-89 in the lower San Lorenzo River. This size class in fall may include fast growing YOY steelhead inhabiting the mainstems of the San Lorenzo River and Soquel Creek, lower reaches of larger San Lorenzo tributaries, and lower reaches of Corralitos and Aptos creeks. It also includes slower growing yearlings and older fish inhabiting all watershed reaches.

A basic assumption in relating juvenile densities to habitat conditions where they are captured is that juveniles do not move substantially from where they are captured during the growing season. This assumption is reasonable because at sites in close proximity, such as adjacent larger mainstem and smaller tributary sites, there are consistent differences in fish size, such as juveniles that are consistently larger in the mainstem sites where streamflow is greater and there is more food (**D. Alley pers. observation)**. In other cases, there are differences in fish size between sunny productive habitats and shady habitats where food is scarce. This indicates a lack of movement between sites. In addition, Davis (**1995**), during a study of growth rates in various habitat types, marked juvenile steelhead in June in Waddell Creek and recaptured the same fish in September in the same (or immediately adjacent) habitats where they had been marked. Evidence is lacking that would indicate ecologically significant juvenile movement upstream during the dry season, and the concern that summer flashboard dams without ladders may impede upstream movements of juvenile salmonids appears unfounded. Shapovalov and Taft (**1954**), after 9 consecutive years of fish trapping on Waddell Creek, detected very limited upstream juvenile steelhead movements; most of the relatively limited movement was in the winter.

Overwintering Habitat. Shelter for fish against high winter flows is provided by deeper pools, undercut banks, side channels, large unembedded rocks and large wood clusters. Over-wintering survival is usually a major limiting factor, since yearling fish are usually less than 10-20% as abundant as YOY. Extreme floods (i.e. 1982 and 1998) may make overwintering habitat the most critical for steelhead production. In the majority of years when bankfull or greater stormflows occur, these refuges are critical, and it is unknown how much refuge is needed. The remaining coho streams, such as Gazos, Waddell and Scott creeks, have considerably more instream wood than others (**Leicester 2005**).

I-2. Project Purpose and General Study Approach

The 2010 fall fish sampling and habitat evaluation included comparison of 2010 juvenile steelhead densities at sampling sites and rearing habitat conditions with those in 1997–2001 and 2003–2009 for the San Lorenzo River mainstem and 8 tributaries and with those in 1997−2009 for the Soquel Creek mainstem and branches. 2010 site densities were compared to multi-year averages. Trends in habitat conditions and steelhead densities were examined for mainstem and tributary sites having multi-year data. Habitat conditions were assessed primarily from measured streamflow, escape cover, water depth and consistent visual estimates of streambed composition and embeddedness.

Fall steelhead densities and habitat conditions in 2010 in the Corralitos Creek sub-watershed were compared to those in 1981, 1994 and 2006−2010. Fall 2010 steelhead densities and habitat conditions in the Aptos Creek watershed were compared to those in 1981 and 2006−2009. 2010 site densities were compared to multi-year averages.

In 2010, instream wood was inventoried in middle Bean Creek, middle Zayante Creek, East Branch Soquel Creek and Corralitos Creek to guide the County in choosing potential habitat enhancement projects.

DETAILED METHODS

M-1. Choice of Reaches and Vicinity of Sample Sites

Prior to 2006, juvenile steelhead densities were estimated by reach, an index of juvenile steelhead production was estimated by reach and by watershed. Indices of adult steelhead population size were also calculated from juvenile population indices. Since 2006, fish densities at average habitat quality sampling sites in previously determined reach segments have been compared to past years' fish densities. The proportion of habitat types sampled at each site within a reach was kept similar between years so that site densities could be compared between years for each reach. However, site density did not necessarily reflect fish densities for an entire reach because the habitat proportions sampled were not exactly similar to the habitat proportions of the reach. In most cases, habitat proportions at sites were somewhat similar to habitat proportions in the reach because sampling sites were more or less continuous and lengths of each habitat type were somewhat similar. However, in reaches where pools are less common, such as Reach 12a on the East Branch of Soquel Creek and Reach 2 in lower Valencia Creek, a higher proportion of pool habitat was sampled than exists in the respective reaches. More pool habitat was sampled because larger yearlings utilize, almost exclusively, pool habitat in small streams, and changes in yearling densities in pools are most important to monitor. In these two cases, site densities of yearlings were higher than reach densities. Prior to 2006, actual reach density and fish production could be compared between years and between reaches because fish densities by habitat type were extrapolated to reach density and an index of reach production with reach proportions of habitat types factored in.

The mainstem San Lorenzo was divided into 13 reaches, based on past survey work (**Table 1a; Appendix A map, Figure 2**). Much of the San Lorenzo River was surveyed during a past water development feasibility study in which general geomorphic differences were observed (**Alley 1993**). This work involved survey and determination of reach boundaries in the mainstem and certain tributaries, including Kings and Newell creeks (**Tables 1a-b; Appendix A map, Figure 2**). In past work for the San Lorenzo Valley Water District, Zayante and Bean creeks were surveyed and divided into reaches. Previous work for the Scotts Valley Water District required survey of Carbonera Creek and reach determination, although it has not been sampled since 2001. Considerations for reach boundaries in Lompico Creek were similar to those for other tributaries, including summer baseflows, past road impacts and bridge crossings, water diversion impacts and extent of perennial channel. The half-mile segment surveyed and sampled in Lompico Creek was mostly in the lowermost Reach 13e and included some of Reach 13f with two bridge crossings.

In each tributary and the upper mainstem of the San Lorenzo, the uppermost extent of steelhead use was approximated in past years to make watershed population estimates. For the upper San Lorenzo River, topographic maps were used with attention to change in gradient and tributary confluences to designate reach boundaries (**Table 1b; Appendix A map, Figure 2**). The uppermost reach boundaries for

Bean and Bear creeks were based on a steep gradient change seen on the topographic map, indicative of passage problems. The Deer Creek confluence was used on Bear Creek, although steelhead access continues somewhat further. Known barriers were upper reach boundaries in Carbonera, Fall, Newell, Boulder and Kings creeks. The extent of perennial stream channel in most years was used for setting boundaries on Branciforte, Zayante and Lompico creeks. Steelhead estimates in Zayante Creek stopped at the Mt. Charlie Gulch confluence in past years, although steelhead habitat exists above in Zayante Creek and Mt. Charlie Gulch in many years. Steelhead habitat in Lompico Creek was first sampled in 2006.

In 2010, sampled tributaries of the San Lorenzo included Zayante, Lompico, Bean, Fall, Newell, Boulder, lower Bear and lower Branciforte creeks. Refer to **Table 1c, Appendix A, Figure 2** and page 2 for a list of sampling sites and locations in 2010. Half-mile segments in the vicinity of sampling sites were habitat typed to select sampling sites with average habitat conditions. For reaches not habitat typed in 2010, the previous year's sampling site was replicated. Steelhead inhabit other tributaries, and in the past, 9 major tributaries were sampled, including Carbonera. Other tributaries known to contain steelhead from past sampling and observation include (from lower to upper watershed) Eagle Creek in Henry Cowell State Park, Lockhart Gulch, Mountain Charlie Gulch in the upper Zayante Creek drainage, Love Creek, Clear Creek, Two Bar Creek, Logan Creek tributary to Kings Creek and Jamison Creek (a Boulder Creek tributary). Other creeks likely to provide limited steelhead access and perennial habitat in some years for relatively low densities of steelhead include Glen Canyon and Granite creeks in the Branciforte system; Powder Mill Creek, Gold Gulch (lower mainstem San Lorenzo tributaries); and Ruins and Mackenzie creeks (2 small Bean Creek tributaries). This list is not exhaustive for steelhead. Resident rainbow trout undoubtedly exist upstream of steelhead migrational barriers in some creeks and especially upper Boulder Creek above the bedrock chute near the Boulder Creek Country Club.

In Soquel Creek, reach boundaries downstream of the East and West Branch confluence were determined from our habitat typing and stream survey work in September 1997. For reaches on the East and West branches, boundaries were based on observations made while hiking to sampling sites, observations made during previous survey work, and reach designations made by Dettman during earlier work (**Dettman and Kelley 1984**). Changes in habitat characteristics that necessitated reach boundary designation often occurred when stream gradient changed. Stream gradient often affects habitat type proportions, pool depth, substrate size distribution and channel type. Other important factors separating reaches are a change in tree canopy closure or significant tributary confluences that increase summer baseflow and/or may be locations of sediment input from tributaries in winter.

The 7.1 miles of Soquel Creek (excluding the lagoon) downstream of the East and West Branches were divided into 8 reaches (**Table 2a; Appendix A of watershed maps**). The lagoon was designated Reach 0. The 7 miles of the East Branch channel between the West Branch confluence and Ashbury Gulch were divided into 4 reaches. The upstream limit of steelhead in this analysis was considered Ashbury Gulch due to the presence of a bedrock falls and several boulder drops constituting Ashbury Falls immediately downstream. These impediments likely prevent adult access to areas above the falls in most years. Furthermore, the salmonid size distribution of previous years at Site 18 above Ashbury Falls (delineated in **Table 2b**) indicated that a higher proportion of larger resident rainbow trout was present in the population upstream of Reach 12b. The West Branch had 2 reliable steelhead reaches (13 and 14a). The upper West Branch reach was shortened in 2000 when a bedrock chute (Girl Scout Falls I) was observed upstream of Olson Road (formerly Olsen Road) near the Girl Scout camp. This chute is likely impassable during many stormflows. Therefore, juvenile steelhead population estimates for previous years were reduced to exclude potential juvenile production above this passage impediment. Sampling in 2003 and 2005 indicated that steelhead likely passed Girl Scout Falls I but not Girl Scout Falls II. Sampling in 2004 indicated that some steelhead might have passed Girl Scout Falls II, although young-of-the-year production above Girl Scout Falls II was approximately half what it was downstream. Sampling in 2005 and 2006 indicated that adult steelhead did not pass Girl Scout Falls II. After 2006, the sampling site upstream of Girl Scout Falls II was dropped from the scope.

In 2002, the upper West Branch was surveyed. Significant impediments to salmonid migration were found and used as reach boundaries. Reach 14b was designated between Girl Scout Falls I and Girl Scout Falls II. Reach 14c was designated between Girl Scout Falls II and Tucker Road (formerly Tilly's Ford). Reach 14d was designated between Tucker Road and Laurel Mills Dam.

Soquel Creek sites included 4 mainstem sites with one in Reach 1 (Site 1) upstream of the lagoon (downstream of Bates Creek), one in the lower mainstem below Moores Gulch in Reach 3 (Site 4), one in the upper mainstem in Reach 7 (Site 10) and one in the upper mainstem in Reach 8 (Site 12) (**Table 2b**). Half-mile segments encompassing these sites were habitat typed to determine sampling sites with average habitat quality, except 0.8 miles were habitat typed in Reach 1. Sampling sites were chosen to represent the lower East Branch Reach 9 (Site 13a) and the upper East Branch Reach 12a (Site 16) (**Table 2b**) in the upper Soquel Creek watershed where most of the spawning usually occurs. On the West Branch, one sampling site was chosen downstream of Girl Scout Falls I and Hester Creek in Reach 13 (Site 19). The reach between Girl Scout Falls I and II was habitat typed (Reach 14b) and sampled (Site 21) in 2009. Landowner objection in 2006 prevented our surveying and sampling of Reach 14a in the future.

In the Aptos Creek watershed, 2 sites were sampled in Aptos Creek, representing the low-gradient Reach 2 above the Valencia Creek confluence and the higher gradient Reach 3 in Nisene Marks State Park (**Appendix A map**). Two sites on Valencia Creek were sampled in the vicinity of historical sites previously sampled in 1981 (**Table 3**). Reach 2 was above passage impediments near Highway 1 where a new fish ladder was constructed. Reach 3 was above the passage impediment that has been retrofitted at the Valencia Road culvert crossing. Half-mile segments in the vicinity of historical sampling sites were habitat typed so that pools with average habitat quality could be chosen for sampling, along with adjacent fastwater habitat. Site numbers were consistent with 1981 numbering.

In the Corralitos Creek sub-watershed of the Pajaro River Watershed, sampling sites were chosen based on historical sampling locations (**Smith 1982; Alley 1995a**) and historical reach designations determined in 1994 (**Alley 1995a**). Reach delineations were based on previous stream survey work of streambed conditions, streamflow and habitat proportions by Alley of the extent of steelhead distribution in sub-watershed in 1981 and past knowledge of streamflow and sediment inputs from tributaries by Smith and Alley during drought and flood (**Table 4a; Appendix A**). Half-mile segments were habitat typed in the vicinity of the historical sampling sites to identify pools with average habitat quality and their adjacent fastwater habitat to sample. Site numbers were kept consistent with the original 1981 designations to prevent confusion.

In Corralitos Creek, 4 reaches were chosen: Reach 1 downstream of the water diversion dam (Site 1), Reach 3 downstream of Rider Creek as streamflow steadily increased toward the diversion dam (Site 3), Reach 6 upstream of Rider Creek (a historical sediment source) and the Eureka Canyon Road crossing at RM 2.95 (box culvert baffled in 2008) that is a partial passage impediment (Site 8) and Reach 7 upstream of Eureka Gulch, a historical sediment source (Site 9) (**Tables 4a and 4b; Appendix A map**).

In Shingle Mill Gulch, Reach 1 was chosen below the partial passage impediment at the second road crossing (Site 1) and Reach 3 above the second (approach modified in 2008) and third road crossings and the steep Reach 2. Reach 3 is a lower gradient, low flow reach downstream of Grizzly Flat (Site 3) (**Tables 4a and 4b; Appendix A map**).

In Browns Valley Creek, Sites 1 and 2 were chosen to represent the 2 reaches previously delineated there (**Tables 4a and 4b; Appendix A map**). The diversion dam demarcated the reach boundaries because of its potential effect on surface flow and a change in channel type. Other valuable steelhead habitat exists in Ramsey Gulch and Gamecock Canyon Creek (**Smith 1982**).

M-2. Classification of Habitat Types and Measurement of Habitat Conditions

In each watershed, ½-mile stream segments were habitat-typed using a modified CDFG Level IV habitat inventory method; with fish sampling sites chosen within each segment based on average habitat conditions. See sampling methods for more details. Habitat types were classified according to the categories outlined in the California Salmonid Stream Habitat Restoration Manual (**Flosi et al. 1998**). Some habitat characteristics were estimated according to the manual's guidelines, including length, width, mean depth, maximum depth, shelter rating and tree canopy (tributaries only in 1998). More data were collected for escape cover than required by the manual to obtain more detailed, biologically relevant information.

M-3. Measurement of Habitat Conditions

During habitat typing in 2010, as in past years, visual estimates of substrate composition and embeddedness were made. The observer looked at the habitat and made mental estimates based on what he saw with his trained eye. Therefore, these estimates are somewhat subjective, with consistency between data collectors requiring calibration from one to the other. An assumption is that the same data collector will be consistent in visual estimates. If more than one data collector contributed to the same study, the original observer trained the others to be consistent ("calibrated") on visual estimates. Changes in visual estimates of substrate abundance or embeddedness of about 10% or more between sites and years probably represent real changes in habitat quality. The previous years' data was not reviewed prior to data collection so as not to bias current data.

Fine Sediment. Fine sediment was visually estimated as particles smaller than approximately 0.08 inches. In the Santa Cruz Mountains, there is little gradual gradation in particle size between sand and larger substrate, making visual estimates of fines relatively easy. Annual consistency in data collecting personnel during habitat typing is important, however. Gravel-sized substrate is generally in short supply. The comparability of these visual estimates to data collection via pebble counts would depend on the skill of the visual estimator and the skill of the pebble count collectors. Untrained volunteers tend to select larger substrate to pick up and measure during pebble counts, resulting in an overestimate of particle size composition. The accuracy of pebble counts is also dependent on sample size. Neither the pebble count nor the visual estimate will provide data for substrate below the streambed surface. The McNeil Sampler may be used for core samples, and results from this method may not be comparable to the other methods. The substrate sampled with coring devices is restricted by the diameter of the sampler. Both pebble counting and core sampling are too labor intensive for habitat typing. We do not believe more in-depth estimates than those taken for percent fines are necessary for this fishery study.

Embeddedness. Embeddedness was visually estimated as the percent that cobbles and boulders larger than 150 mm (6 inches) in diameter were buried in finer substrate. Previous to 1999, the cobble range included substrate larger than 100 mm (4 inches). The change in cobble size likely had little effect on embeddedness estimates. The reason the cobble size was increased to 150 mm was because substrate smaller than that probably offered little benefit for fish escape cover, and embeddedness of smaller substrate was not a good indicator of habitat quality for fish.

Cobbles and boulders larger than approximately 150 mm in diameter provided good, heterogeneous habitat for aquatic insects in riffles and runs and some fish cover if embedded less than 25%. Cobbles and boulders larger than 225 mm provided the best potential fish cover if embedded less than 25%.

Tree Canopy Closure. Tree canopy closure was measured with a densiometer. Included in the tree canopy closure measurement were trees growing on slopes considerable distance from the stream. The percent deciduous value was based on visual estimates of the relative proportion of deciduous canopy closure provided to the stream channel. Tree canopy closure directly determines the amount of solar radiation that reaches the stream on any date of the year, but the relationship changes as the sun angle changes through the seasons and with stream orientation. Our measure of canopy closure estimated the percent of blue sky blocked by the vegetative canopy and was not affected by the sun angle.

Greater tree canopy inhibits warming of the water and is critically important in small tributaries. Increased water temperature increases the metabolic rate and food requirements of steelhead. Tree canopy in the range of 75-90% is optimal in the upper mainstem San Lorenzo River (Reaches 10-12) and tributaries because water temperatures are well within the tolerance range of juvenile steelhead and coho salmon. If reaches with low summer baseflow become unshaded, water temperature rapidly increases. Limited openings (10-15%) in the canopy provide some sunlight during the day for algal growth and visual feeding by fish. In the San Lorenzo River system, it is important that the tributaries remain well shaded so that tributary inflows to the mainstem are sufficiently cool to prevent excessively high water temperatures in the lower mainstem river (Reaches 1-5), where tree canopy is often in the 30-75% range. There is an inverse relationship between tree canopy and insect production in riffles, which allows faster steelhead growth in larger, mainstem reaches, especially downstream of the Zayante Creek confluence, having deeper, fastwater feeding areas, despite the elevated temperatures and steelhead metabolic rate (and associated food requirements.) In addition, very dense shading reduces visibility of drifting insect prey and reduces fish feeding efficiency. However, as fast-water feeding areas diminish in smaller stream channels with less streamflow further up the watershed, high water temperatures may increase steelhead food demands beyond the benefits of greater food production in habitat lacking in fast-water feeding areas. Here is where shade canopy must increase to maintain cooler water temperature and lowered metabolic rate and food requirements of juvenile steelhead.

Escape Cover– Sampling Sites. The escape cover index for each habitat type within sampled sites was quantitatively determined in the same manner in 1994-2001 and in 2003-2010. The importance of escape cover is that the more there is in a habitat, the higher the production of steelhead, particularly for steelhead => 75 mm SL. Water depth itself provides some escape cover when 2 feet deep and good escape cover when it is 3 feet deep (1 meter) or greater. Escape cover was measured as the ratio of the linear distance under submerged objects and undercut banks within the habitat type that fish at least 75 mm (3 inches) Standard Length (SL) could hide under, divided by the length of the habitat type. The summer escape cover (as unembedded cobbles, undercut banks and instream wood) also provides overwintering habitat in the tributaries. This allowed annual comparisons for the habitats at historical sites.

Escape Cover– Habitat Typing Method by Reach. Reach segment averages in 1997–2000, 2003, 2005–2010 for escape cover by habitat type were determined from habitat typed segments. Reach cover indices were determined for habitat types in reach segments for purposes of annual comparisons. The escape cover index for each habitat type in a half-mile segment was measured as the ratio of linear feet of cover under submerged objects that Size Class II and III juveniles could hide under for all of that habitat type in the segment divided by total feet of stream channel as that habitat type in the reach segment. Objects of cover included unembedded boulders, submerged woody debris, undercut banks, bubble curtains and overhanging tree branches and vines that entered the water. Man-made objects, such as boulder rip-rap, concrete debris and plywood also provided cover. Escape cover constituted areas where fish could be completely hidden from view. This was not a measure of the less effective overhead cover that may be caused by surface turbulence or vegetation hanging over the water but not touching. Steelhead habitat is illustrated in the following drawings.

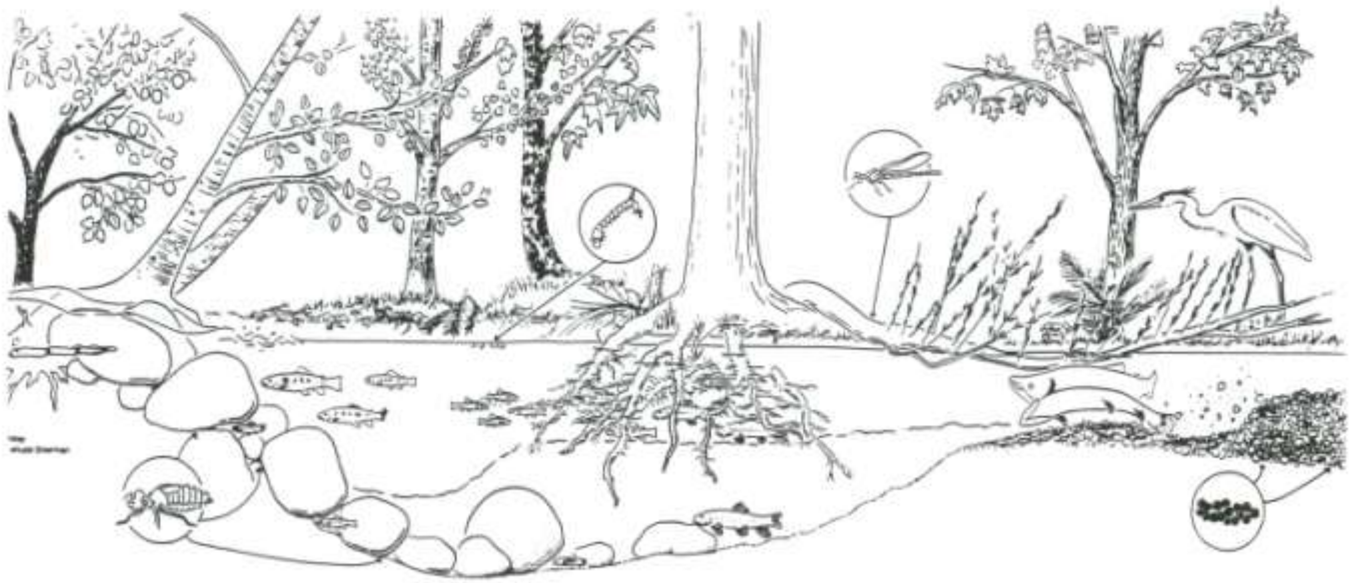

Illustration of pool habitat (stream flowing from left to right) showing escape cover under boulders and undercut bank with tree roots. Juvenile steelhead are feeding at the head of the pool. (Female steelhead covering her redd of eggs after spawning at the tail of the pool.)

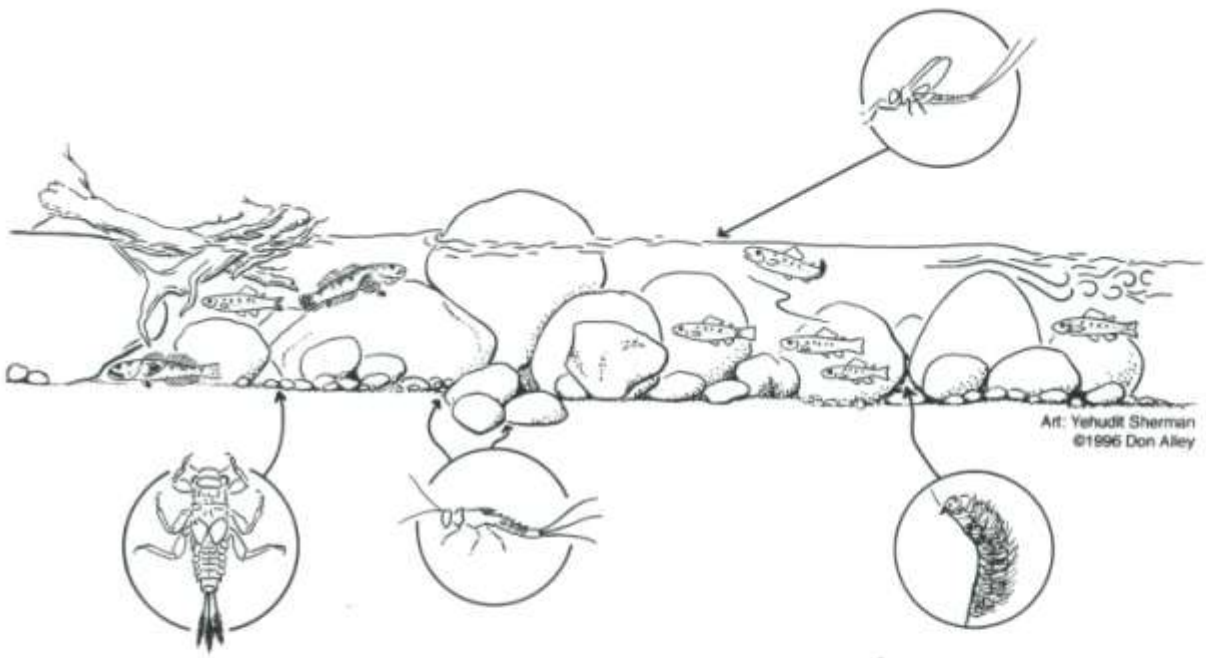

Illustration of riffle habitat (stream flowing from left to right) showing escape cover under rootwad and boulders. (Juvenile steelhead are holding feeding positions, facing upstream.)

<u>Water Depth, Channel Length and Width.</u> Water depth is important because deeper habitat is utilized more heavily by steelhead, especially by larger fish. Deeper pools are associated with scour objects that often provided escape cover. Mean depth and maximum depth were determined with a dip net handle, graduated in half-foot increments. Soundings throughout the habitat type were made to estimate mean and maximum depth. Annual comparisons of habitat depth were possible because measurements were taken in the fall of each year. Minimum depth was determined approximately one foot from the stream margin in earlier years. Stream length was measured with a hip chain. Width in each year was measured with the graduated dip net except in wider habitats of the mainstem. In wider habitats (greater than approximately 20 feet), a range finder was used to measure width.

<u>Streamflow.</u> For 1995 and 1998 onward, the Marsh McBirney Model 2000 flowmeter was more extensively used at most sampling sites. Streamflow measurement was beyond the project scope and budget in 2006−2009 but was added back in 2010. Even so, streamflow was measured in 2006 at historical sites in the San Lorenzo watershed in fall before any fall storms, as in past years. Mean column velocity was measured at 20 or more verticals at each cross-section. For 2007−2009, streamflow measurements made by Santa Cruz County staff were used for annual comparisons.

M-4. Choice of Specific Habitats to be Sampled Within Reaches

Based on the habitat typing conducted in each reach prior to fish sampling, representative habitat units were selected with average habitat quality values in terms of water depth and escape cover to determine fish densities by habitat type. In mainstem reaches of the lower and middle San Lorenzo River (Sites 1, 2, 4, 6 and 8), riffles and runs that were close to the average width and depth for the reach were sampled by electrofishing. Pools in these reaches were divided into long pools (greater than 200 feet long) and short pools (less than 200 feet) and at least one pool of each size class was either snorkel censused or electrofished. The exception was Reach 1, which had only one pool less than 200 ft long, which was not censused. Only a long pool was censused in Reach 1 (which historically consisted of a long pool and a short pool). In these mainstem reaches, most fish were in the fastwater habitat of riffles, runs and the heads of pools and fish were not using most of the pool habitat. Some of the pools are hundreds of feet long with very few juveniles, except for those at the heads of pools. The sampling site in Reach 0a between the levees was chosen in 2009 because it was the only location downstream of Highway 1 where a pool and adjacent fastwater habitat could be sampled by electrofishing. Much of the reach was lagoon habitat due to a closed sandbar that summer.

For all other reaches in this study, in the upper San Lorenzo River above the Boulder Creek confluence, all San Lorenzo tributaries and in the Aptos and Corralitos watersheds, the location of representative pools with average habitat quality in terms of water depth and escape cover determined the pool habitat to be sampled. Pools were deemed representative if they had escape cover ratios and water depths similar to the average values for all pools in the half-mile segment that was habitat typed within the reach. Therefore, pools that were much deeper or much shallower than average or had much less or much more escape cover than average were not sampled. Once the pools were chosen for electrofishing, adjacent riffles, step-runs, runs and glides were sampled, as well. In these smaller channel situations, these latter habitat types showed great similarity to most other habitats of the same type. Namely, all riffles had similar depth and escape cover; all runs had similar depth and escape cover; all step-runs had similar depth and escape cover; and all glides had similar depth and escape cover.

Sampled units may change from year to year since habitat conditions change, and locations of individual habitat units may shift depending on winter storm conditions. Our assumption is that fish sampling of mean habitat quality will reflect representative habitat for the reach and provide average fish densities for each habitat type in the reach. The assumption is that there is a correlation between fish density and habitat quality in that better habitat has more fish. Past modeling has indicated that increased densities of smolt-sized juveniles are positively associated with greater water depth and escape cover in small, low summer flow streams (**Smith 1984**). Site densities were determined by calculating the number of juveniles present in each sampled habitat from electrofishing and/or snorkel censusing and adding those to numbers of juveniles from other habitats. The total number of fish was divided by the total lineal feet sampled at the site.

The proportion of habitat types sampled at each site within a reach were kept similar between years so that site densities could be compared for each reach. However, site density did not necessarily reflect fish densities for the entire reach because the habitat proportions sampled were not necessarily similar to the habitat proportions of the reach. In most cases, habitat proportions at sites were similar to habitat proportions in the reach because sampling sites were more or less continuous. However, in reaches where pools were less common, such as Reach 12a on the East Branch of Soquel Creek and in Reach 2 of Valencia Creek, a higher proportion of pool habitat was sampled than existed in the respective reaches. In these two cases, site densities were higher than reach densities. Prior to 2006, actual reach density and fish production could be compared between years and between reaches because fish densities by habitat type were extrapolated to reach density and an index of reach production according to reach proportions of habitat types.

M-5. Consistency of Data Collection Techniques in 1994-2001 and 2003-2010

Habitat conditions of depth and escape cover were measured at the monitoring sites in 2010 consistent with methods used in 1981 and 1994-2001 and 2003−2010 in the San Lorenzo River and Soquel Creek watersheds. Donald Alley, the principal investigator and data collector in 1994−2001 and 2003−2010, had also collected the fish and habitat data at approximately half or more of the sites in the 1981 study for the County Water Master Plan that included the 4 watersheds in the current study, except for Aptos Creek (**Smith 1982**). His previous qualitative estimates of embeddedness, streambed composition and habitat types were calibrated to be consistent with those of Dr. Smith, the primary investigator for the 1981 sampling program. Mr. Alley's method of measuring escape cover for smolt-sized (=>75 mm SL) and larger steelhead was consistent through the years, although the escape cover index in 1981 was based upon linear cover per habitat perimeter and later escape cover indices were based on linear cover per habitat length. In 2006, Chad Steiner began assisting in habitat typing some reaches after being calibrated to be consistent with Mr. Alley's methods. During electrofishing from 1996 onward, block nets were used to partition off habitats at all electrofishing sites. This prevented steelhead escapement. A multiple-pass method was used in each habitat with at least three passes.

From 1998 onward, underwater visual (snorkel) censusing was incorporated with electrofishing so that pool habitat in the mainstem San Lorenzo River, which had been electrofished in past years, could be effectively censused despite it being too deep in 1998 (a high-flow year) for backpack electrofishing. Snorkel censusing was also used to obtain density estimates in deeper pools previously unsampled prior to 1998 at Sites 2, 3, 7, 8 and 9, in an effort to increase the accuracy of production estimates. A better juvenile production estimate and predictions of adult returns were made with snorkel-censusing of pool habitat in the mainstem San Lorenzo River for 1998–2005. In 2006−2010, deeper pools were snorkel-censused at Sites 1, 2, 4, 6 and 8 in the lower and middle mainstem San Lorenzo to determine site densities only. All other watersheds were sampled by electrofishing only.

The City of Santa Cruz funded a separate San Lorenzo watershed sampling effort in 2002. Their data were not included in this report except in graphs of total juvenile density at some sites because their methods were inconsistent with ours. The method used for choosing fish sampling sites was not stated in their report. For our review of their findings, please refer to our 2003 censusing report (**Alley 2004**).

M-6. Assessing Change in Rearing Habitat Quality

Change in rearing habitat quality was based on changes in reach segment habitat conditions, if the reach was habitat typed in successive years. If it was not, then habitat conditions in replicated sampling sites were compared between years. Elements of habitat change in the lower San Lorenzo mainstem (downstream of the Zayante Creek confluence) were assessed in fastwater habitat (runs and riffles) where most juvenile steelhead inhabited. In all other sites, primarily habitat conditions in pools were considered. Increased escape cover, increased habitat depth, increased baseflow, reduced embeddedness and reduced percent fines constituted positive change, in order of decreasing importance, except in the lower San Lorenzo mainstem where increased baseflow was considered most important. Spring and summer/fall baseflow were considered. Change in linear escape cover of 1 foot per 100 feet of stream channel (0.010) constituted significant habitat change. Change in average maximum pool depth was more significant than change in average mean pool depth in sites beyond the lower San Lorenzo mainstem. A change in 0.1−0.2 ft or more in either pool depth constituted significant habitat change. A change in 0.1 ft or more in fastwater habitat constituted significant habitat change in the lower San Lorenzo mainstem. Embeddedness and percent fines must have changed at least 10 percent to constitute change because these factors are visually estimated and less than 10% changes are difficult to detect visually. Decreased escape cover, habitat depth or baseflow indicated negative habitat change, along with increased embeddedness and increased fines. Assessment is more complex when some factors improve while others decline or remain similar between years. This is when order of importance plays a key role in judging overall habitat change.

Sometimes, habitat factors change together. Sometimes, pool depth will increase due to increased scour, which also may occur during a wet year with associated high baseflow. Greater scour may also reduce embeddedness and increase escape cover under boulders and instream wood. However, if high stormflows were associated with high erosion and sedimentation, pool depth and escape cover may diminish as embeddedness increases afterwards, despite higher baseflow. Sometimes during a mild winter, sedimentation is reduced and escape cover and pool depth may increase because sediment is removed from the streambed. Embeddedness and percent fines may be reduced in this scenario.

If YOY growth rate increased when YOY density was similar to or more than in the previous year, rearing habitat was assessed to have improved due to primarily increased baseflow (usually spring baseflow). However, if juvenile numbers =>75 mm SL were much less compared to the previous year, rearing habitat change could be negative if escape cover or pool depth decreased, even though YOY growth rate had increased. Rearing habitat quality was judged independent of juvenile steelhead densities.

Table 1a. Defined Reaches in the Mainstem San Lorenzo River.
Refer to Appendix A for map designations. Surveyed reach segments within reaches indicated by asterisk)

Reach #	Reach Boundaries	Reach Length (ft)
0	Water Street to Tait Street Diversion CM0.92 – CM1.92	5,277
1	Tait Street Diversion to Buckeye Trail Crossing CM1.92 - CM4.73	14,837
2*	Buckeye Trail Crossing to the Upper End of the Wide Channel Representation on the Felton USGS Quad Map CM4.73 - CM6.42	8,923
3	From Beginning of Narrow Channel Representation in the Gorge to the Beginning of the Gorge (below the Eagle Creek Confluence) CM6.42 - CM7.50	5,702
4	From the Beginning of the Gorge to Felton Diversion Dam CM7.50 - CM9.12	8,554
5	Felton Diversion Dam to Zayante Creek Confluence CM9.12 - CM9.50	2,026
6	Zayante Creek Confluence to Newell Creek Confluence CM9.50 - CM12.88	17,846
7	Newell Creek Confluence to Bend North of Ben Lomond CM12.88 - CM14.54	8,765
8*	Bend North of Ben Lomond to Clear Creek Confluence in Brookdale CM14.54 - CM16.27	9,138
9	Clear Creek Confluence to Boulder Creek Confluence CM16.27 - CM18.38	11,137
10	Boulder Creek Confluence to Kings Creek Confluence CM18.38 - CM20.88	13,200
11*	Kings Creek Confluence to San Lorenzo Park Bridge Crossing CM20.88 - CM24.23	17,688
12	San Lorenzo Park Bridge to Gradient Change, North of Waterman Gap CM24.23 - CM26.73	13,200
	TOTAL	136,293 (25.8 miles)

Table 1b. Defined Reaches in Major Tributaries of the San Lorenzo River.

Creek-Reach #	Reach Boundaries (Downstream to Upstream)	Reach Length (ft)
Zayante 13a	San Lorenzo River Confluence to Bean Creek Confluence CM0.0-CM0.61	3,221
13b	Bean Creek Confluence to Trib. Draining from S.Cruz Aggregate Quarry CM0.61-CM2.44	9,662
13c	Santa Cruz Aggregate Tributary to Lompico Creek Confluence CM2.44-CM3.09	3,432
13d*	Lompico Creek Confluence to Mt. Charlie Gulch Confluence CM3.09-CM5.72	13,886
Lompico 13e	Lompico Creekmouth to 1st Culvert Crossing CM0.0-CM0.5	4,265
Lompico 13f	1st Culvert Crossing to Carol Road Bridge CM0.5-CM1.77	5,077
Lompico 13g	Carol Road Bridge to Mill Creek Confluence CM1.77-CM2.35	3,046
Lompico 13h	Mill Creek Confluence to End of Perennial Channel CM2.35-CM3.73	7,311
Bean 14a	Zayante Creek Confluence to Mt. Hermon Road Overpass CM0.0-CM1.27	6,706
14b*	Mt. Hermon Road Overpass to Ruins Creek Confluence CM1.27-CM2.15	4,646
14c	Ruins Creek Confluence to Gradient Change Above the Second Glenwood Road Crossing CM2.15-CM5.45	17,424
Fall 15*	San Lorenzo River Confluence to Boulder Falls CM0.0-CM1.58	8,342
Newell 16*	San Lorenzo River Confluence to Bedrock Falls CM0.0-CM1.04	5,491
Boulder 17a*	San Lorenzo River Confluence to Foreman Creek Confluence CM0.0-CM0.85	4,488
17b	Foreman Creek Confluence to Narrowing of Gorge Adjacent Forest Springs CM0.85-CM2.0	6,072
17c	Narrow Gorge to Bedrock Chute At Kings Highway Junction with Big Basin Way CM2.0-CM3.46	7,709

Creek-Reach #	Reach Boundaries (Downstream to Upstream)	Reach Length (ft)
Bear 18a	San Lorenzo River Confluence to Unnamed Tributary at Narrowing of the Canyon Above Bear Creek Country Club CM0.0-CM2.42	12,778
18b	Narrowing of the Canyon to the Deer Creek Confluence CM2.42-CM4.69	11,986
Kings 19a	San Lorenzo River Confluence to Unnamed Tributary at Former Fragmented Dam Abutment Location CM0.0-CM2.04	10,771
19b	Tributary to Bedrock-Boulder Cascade CM2.04-CM3.73	8,923
Carbonera 20a	Branciforte Creek Confluence to Old Road Crossing and Gradient Increase CM0.0-CM1.38	7,293
20b	Old Road Crossing to Moose Lodge Falls CM1.38-CM3.39	10,635
Branciforte 21a*	Carbonera Creek Confluence to Granite Creek Confluence CM1.12-CM3.04	10,138
21b	Granite Creek Confluence to Tie Gulch Confluence CM3.04-CM5.73	14,203

	TOTAL	177,806 (33.7 miles)

Table 1c. Fish Sampling Sites in the San Lorenzo Watershed.
(2010 Sites Indicated by Asterisk.)

Reach #	Sampling Site # -Channel Mile	MAINSTEM SITES Location of Sampling Sites
0	*0a -CM1.6	Above Water Street Bridge
0	0b -CM2.3	Above Highway 1 Bridge
1	*1 -CM3.8	Paradise Park
2	*2 -CM6.0	Lower Gorge in Rincon Reach, Downstream of Old Dam Site
3	3 -CM7.4	Upper End of the Gorge
4	*4 -CM8.9	Downstream of the Cowell Park Entrance Bridge
5	5 -CM9.3	Downstream of Zayante Creek Confluence
6	*6 -CM10.4	Below Fall Creek Confluence
7	7 -CM13.8	Above Lower Highway 9 Crossing in Ben Lomond
8	*8 -CM15.9	Upstream of the Larkspur Road (Brookdale)
9	9 -CM18.0	Downstream of Boulder Creek Confluence
10	10 -CM20.7	Below Kings Creek Confluence
11	*11 -CM22.3	Upstream of Teilh Road, Riverside Grove
12	12a -CM24.7	Downstream of Waterman Gap and Highway 9
	12b -CM25.2	Waterman Gap Upstream of Highway 9

Table 1c. Fish Sampling Sites in the San Lorenzo Watershed (continued).

Reach #	Sampling Site # -Channel Mile	TRIBUTARY SITES Location of Sampling Sites
13a	*13a-CM0.3	Zayante Creek Upstream of Conference Drive Bridge
13b	13b-CM1.6	Zayante Creek Above First Zayante Rd crossing
13c	*13c-CM2.8	Zayante Creek downstream of Zayante School Road Intersection with E. Zayante Road
13d	*13d-CM4.1	Zayante Creek upstream of Third Bridge Crossing of East Zayante Road After Lompico Creek Confluence
13e	*13e-CM0.4	Lompico Creek upstream of the fish ladder and downstream of first bridge crossing.
14a	14a-CM0.1	Bean Creek Upstream of Zayante Creek Confluence
14b	*14b-CM1.8	Bean Creek Below Lockhart Gulch Road
14c	*14c-CM4.7	Bean Creek 1/2-mile Above Mackenzie Creek Confluence and Below Golpher Gulch Rd.
15	*15 -CM0.8	Fall Creek, Below Wooden Bridge
16	*16 -CM0.5	Newell Creek, Upstream of Glen Arbor Road Bridge
17a	*17a-CM0.2	Boulder Creek Just Upstream of Highway 9
17b	*17b-CM1.6	Boulder Creek Below Bracken Brae Creek Confluence
17c	17c-CM2.6	Boulder Creek, Downstream of Jamison Creek
18a	*18a-CM1.5	Bear Creek, Just Upstream of Hopkins Gulch
18b	18b-CM4.2	Bear Creek, Downstream of Bear Creek Road Bridge and Deer Creek Confluence
19a	19a-CM0.8	Kings Creek, Upstream of First Kings Creek Road Bridge
19b	19b-CM2.5	Kings Creek, 0.2 miles Above Boy Scout Camp and Upstream of the Second Kings Creek Road Bridge
20a	20a-CM0.7	Carbonera Creek, Upstream of Health Services Complex
20b	20b-CM1.9	Carbonera Creek, Downstream of Buelah Park Trail
21a	21a1-CM1.5	Branciforte Creek, Upstream of the Highway 1 Overpass
21a	*21a2-CM2.8	Branciforte Ck, Downstream of Granite Creek Confluence
21b	21b-CM4.6	Branciforte Ck, Upstream of Granite Crk Confl. and Happy Valley School

Table 2a. Defined Reaches on Soquel Creek.
(Refer to Appendix A for map designations. Surveyed reach segments indicated by asterisk.)

Reach #	Reach Boundaries (Downstream to Upstream)	Reach Length (ft)
0	Soquel Creek Lagoon	3,168
1*	Upper Lagoon's Extent to Soquel Avenue CM0.6 - CM1.41	4,449
2	Soquel Avenue to First Bend Upstream CM1.41 - CM1.77	2,045
3*	First Bend Above Soquel Avenue to Above the Bend Closest to Cherryvale Avenue CM1.77 - CM2.70	4,827
4	Above the Bend Adj. Cherryvale Ave to Bend at End of Cherryvale Ave CM2.70 – CM3.54	4,720
5	Above Proposed Diversion Site to Sharp Bend Above Conference Center CM3.54 - CM4.06	3,041
6	Sharp Bend Above Conference Center to the Moores Gulch Confluence CM4.06-CM5.34	6,640
7*	Moores Gulch Confluence to Above the Purling Brook Road Crossing CM5.34 - CM6.41	5,569
8*	Above Purling Brook Road Crossing to West Branch Confluence CM6.41 - CM7.34	5,123
	Subtotal	39,582 (7.5 miles)
9a*	West Branch Confluence to Mill Pond Diversion CM7.34 - CM9.28	10,243
9b	Mill Pond Diversion to Hinckley Creek Confluence CM9.28 - CM9.55	1,425
10	Hinckley Creek Confluence to Soquel Creek Water District Weir CM9.55 - CM10.66	5,856
11	Soquel Creek Water District Weir to Amaya Creek Confluence CM10.66 - CM11.79	5,932
12a*	Amaya Creek Confluence to Gradient Increase CM11.79 – 12.56	4,062
12b	Gradient Increase to Ashbury Gulch Confluence CM12.56 - CM14.38	9,647
	SUBTOTAL	76,747 (14.5 miles)

Table 2a. Defined Reaches on Soquel Creek (continued).

Reach #	Reach Boundaries (Downstream to Upstream)	Reach Length (ft)
13*	West Branch Confluence to Hester Creek Confluence on West Branch CM0.0 - CM0.98	5,173
14a	Hester Creek Confluence to Girl Scout Falls I CM0.98- CM2.26	6,742
	SUBTOTAL	88,662 (16.8 miles)
14b*	Girl Scout Falls I to Girl Scout Falls II CM2.26 – CM2.89	3,311
14c	Girl Scout Falls II to Tucker Road (Tilly's Ford) CM2.89 – CM4.07	6,216
14d	Tucker Road (Tilly's Ford) to Laurel Mill Dam-1,465 ft Below Confluence of Laurel and Burns Creeks on West Branch CM4.07 - CM6.56	13,123
	TOTAL	111,312 (21.1 miles)

Table 2b. Locations of Sampling Sites by Reach on Soquel Creek.
(An asterisk indicates sampling in 2009.)

Reach #	Site # –Channel Mile	Location of Sampling Sites
1	*1 –CM1.2	Below Grange Hall
2	2 –CM1.6	Near the USGS Gaging Station
3	3 –CM2.1	Above Bates Creek Confluence
3	*4 –CM2.7	Upper Reach 3, Adjacent Cherryvale Ave Flower Fields
4	5 –CM2.9	Near Beach Shack (Corrugated sheet metal)
4	6 –CM3.4	Above Proposed Diversion Site
5	7 –CM3.9	Upstream to Proposed Reservoir Site, End of Cherryvale
6	8 –CM4.2	Adjacent to Rivervale Drive Access
6	9 –CM4.8	Below Moores Gulch Confluence, Adjacent Mountain School
7	*10 –CM5.5	Above Moores Gulch Confluence and Allred Bridge
7	11 –CM5.9	Below Purling Brook Road Ford
8	*12 –CM7.0	Below and Above Soquel Creek Road Bridge
9a	*13a-CM8.9	Below Mill Pond
9b	13b-CM9.2	Below Hinckley Creek Confluence
10	14 –CM9.7	Above Hinckley Creek Confluence
11	15 –CM10.8	Above Soquel Creek Water District Weir
12a	*16 –CM12.3	Above Amaya Creek Confluence
12b	17 –CM13.0	Above Fern Gulch Confluence
	18 –CM15.2	Above Ashbury Gulch Confluence One Mile
13	*19 –CM0.2	West Branch below Hester Creek Confluence
14a	20 –CM2.0	West Branch Near End of Olson Road
14b	*21 –CM2.4	Above Girl Scout Falls I (Added in 2002)
14c	22 –CM3.0	Above Girl Scout Falls II (Added in 2002)

Table 3. Locations of Sampling Sites by Reach in the Aptos Watershed.
(An asterisk indicates sampling in 2006−2010.)

Reach #	Site # -Channel Mile	Location of Sampling Sites
Aptos Creek		
1	1 -CM0.4	Below Mouth of Valencia Creek
2	2 -CM0.5	Just Upstream of Valencia Creek Confluence
2	*3 -CM0.9	Above Railroad Crossing in County Park near Center
3	*4 -CM2.9	In Nisene Marks State Park, 0.3 miles above First Bridge Crossing
Valencia Creek		
1	1 -CM0.9	0.9 miles Up from the Mouth
2	*2 -CM2.85	Below Valencia Road Crossing and above East Branch
3	*3 -CM3.26	Above Valencia Road Crossing

Table 4a. Defined Reaches in the Corralitos Sub-Watershed.

(Refer to Appendix A for map designations. Reach segments surveyed within reaches are indicated by asterisk.)

Reach #	Reach Boundaries (downstream to upstream)	Reach Length (ft)
Corralitos Creek		
1*	Browns Creek Confluence to 0.25 miles Below Diversion Dam CM0.00 – CM10.25	4,171
2	0.25 miles below Diversion Dam to Diversion Dam CM10.25.6 - CM10.5	1,320
3*	Diversion Dam to Rider Creek Confluence CM10.5 – CM11.77	6,706
4	Rider Creek Confluence to Box Culvert Crossing above Rider Creek Confluence CM11.77 – CM12.87	3,643
5*	First Bridge Crossing Above Rider Creek to Clipper Gulch Confluence CM12.46 – CM12.87	2,165
6*	Clipper Gulch Confluence to Eureka Gulch Confluence CM12.87 – CM13.33	2,429
7*	Eureka Gulch Confluence to Shingle Mill Gulch Confluence CM13.33 –CM13.98	3,432
Shingle Mill Gulch		
1	From Corralitos Creek Confluence to Second Eureka Canyon Road Crossing on Shingle Mill Gulch CM0.0 – CM0.35	1,848
2	From 2nd Eureka Canyon Road Crossing of Shingle Gulch to 3rd Road Crossing CM0.35 – CM0.62	1,420
3*	3rd Eureka Canyon Road Crossing of Shingle Mill Gulch to Beginning of Steep (Impassable) Gradient on Rattlesnake Gulch CM0.62 –CM1.35	3,858
	Total	30,992 (5.9 miles)
Browns Valley Creek *		
1*	First Bridge Crossing on Browns Valley Road below the Diversion Dam to the Diversion Dam	1,015
2*	From Diversion Dam to Redwood Canyon Creek Confl.	4,468
	Total	5,483 (1.04 miles)

* More steelhead habitat exists above Reach 2 in Browns Valley Creek and in Redwood Canyon Creek, Ramsey Gulch and Gamecock Canyon Creek. Varying amounts of perennial steelhead habitat exists downstream of Reach 1, depending on bypass flows from the diversion dam.

Table 4b. Locations of Sampling Sites by Reach in the Corralitos Sub-Watershed.
(An asterisk indicates sampling in 2010.)

Corralitos Creek

Reach #	Site # -Channel Mile	Location of Sampling Sites
1	*1 -CM10.1	Downstream of Diversion Pipe Crossing
2	2 -CM10.3	Below Diversion Dam to Around the Bend
3	3a-CM10.6	Just Upstream of Diversion Dam
	*3b-CM11.1	0.6 miles Upstream of Diversion Dam (above Las Colinas Drive)
	4 -CM11.3	Below Rider Creek Confluence below bridge crossing
	5 -CM11.4	Below Rider Creek confluence and upstream of bridge crossing
4	6 -CM11.4	Upstream of Rider Creek Confluence
5	7 -CM12.0	Upstream of First Bridge Crossing above Rider Creek Confluence
6	*8 -CM12.9	Downstream of Eureka Gulch near Clipper Gulch
7	*9 -CM13.6	0.4 miles Above Eureka Gulch Confluence

Shingle Mill Gulch

Reach #	Site # -Channel Mile	Location of Sampling Sites
1	*1 -CM0.3	Below Second Bridge on Shingle Mill Gulch
2	2 -CM0.5	Above Second Bridge on Shingle Mill Gulch
3	* 3 -CM0.9	At and Above Washed Out Check Dams below Grizzly Flat on Shingle Mill Gulch

Browns Valley Creek

Reach #	Site # -Channel Mile	Location of Sampling Sites
1	*1 -CM1.9	Between First Browns Valley Road Crossing and Diversion Dam Upstream
2	*2 -CM2.7	Above Diversion Dam but Below Redwood Canyon Creek Confluence

M-6. Juvenile Steelhead Densities at Sampling Sites - Methods

Electrofishing was used at sampling sites to determine steelhead densities according to two juvenile age classes and three size classes in all 4 watersheds. Block nets were used at all sites to separate habitats during electrofishing. A three-pass depletion process was used to estimate fish densities. If poor depletion occurred with 3 passes, a fourth pass was performed and the number of fish captured in 4 passes represented a total count for the habitat. Electrofishing mortality rate has been approximately 1% or less over the years. Snorkel-censusing was used in deeper pools that could not be electrofished at sites in the mainstem reaches of the San Lorenzo River, downstream of the Boulder Creek confluence. For the middle mainstem reaches included in Table 2 of Appendix C, underwater censusing of deeper pools was incorporated with electrofishing data from more shallow habitats to provide density estimates.

Visual censusing was judged inappropriate in other habitats because it would be inaccurate in fastwater habitat in the mainstem and in 80-90% of the habitat in tributaries. For example, 24 of 26 sampled tributary pools had more than 20 fish in 2005. Most tributary sites are well shaded and many pools have substantial escape cover, making it very difficult to count all of the juveniles, much less divide them into size and age classes. Dense shading in most tributaries reduces snorkeling effectiveness. Riffles, step-runs, runs and glides are typically too shallow to snorkel in tributaries.

In larger rivers of northern California, density estimates from electrofishing are commonly combined with those determined by underwater observation in habitats too deep for electrofishing. Ideally, underwater censusing would be calibrated to electrofishing data in habitat where capture approached 100%. Calibration was originally attempted by Hankin and Reeves (**1988**) for small trout streams. Their intent was to substitute snorkel censusing for electrofishing. However, attempts at calibration of the two methods of censusing in large, deep pools of the mainstem San Lorenzo River was judged impractical, beyond the scope of the study and probably inadequate.

Two divers were used in snorkel censusing. Visual censusing of deeper pools occurred prior to electrofishing of sites. In wide pools, divers divided the channel longitudinally into counting lanes, combining their totals after traversing the habitat in an upstream direction. Divers would warn each other of juveniles being displaced into the other's counting lane to prevent double- counting. For juveniles near the boundaries of adjacent counting lanes, divers would verbally agree to who would include them in their tallies. In narrower pools, divers would alternate passes through the pool to obtain replicates to be averaged. In most pools, three replicate passes were accomplished per pool. The relative proportions of steelhead in the three Size Classes obtained from electrofishing were considered in dividing visually censused steelhead into size and age classes. The average number of steelhead observed per pass in each age and size category became the density estimate. In Reaches 1−4, most juveniles were greater than 75 mm SL, and yearlings were considerably larger than YOY fish. It was relatively easy to separate fish into size and age classes. In Reaches 6−9, more juveniles are normally around 75 mm SL, leading to a small error in deciding division between Size Classes 1 and 2. Age classes were easily distinguished.

Steelhead were visually censused for two size classes of pools in the San Lorenzo. There were short pools less than approximately 200 feet in length and those more than approximately 200 feet. Juvenile densities in censused pools were extrapolated to other pools in their respective size categories. Steelhead were censused by size and age class, as in electrofishing. If less than 20 juveniles were observed in a pool, the maximum number observed on a pass was the estimate. When 20 or more fish were observed, the average of the three passes was the best estimate.

Visual censusing offered realistic density estimates of steelhead in deeper mainstem pools. It was the only practical way to inventory such pools, which were mostly bedrock- or boulder- scoured and had limited escape cover. Visibility was usually 10 feet or more, making the streambed and counting lanes observable. Relatively few steelhead used these pools in 1999-2001 and 2003-2010, compared to 1998 when mainstem baseflow was considerably higher (minimum of 30 cubic feet per second at the Big Trees Gage compared to approximately 20 cfs or less in later years).

M-7. Age and Size Class Divisions

With electrofishing data, the young-of-the-year (YOY) age class was separated from the yearling and older age class in each habitat, based on the site-specific break in the length-frequency distribution (histogram) of fish lengths combined into 5 mm groupings. Also, scale analysis was utilized in the past for fish captured at lower mainstem sites in the San Lorenzo River and Soquel Creek. Density estimates of age classes in each habitat type were determined by the standard depletion model used with multiple pass capture data. Densities were expressed in fish per 100 feet of channel and determined in the lowest baseflow period when juvenile salmonids remain in specific habitats without up or downstream movement. Density is typically provided per channel length by convention and convenience, and may be accurately measured quickly. Consistent density measurement allows valid annual comparisons.

Depletion estimates of juvenile steelhead density were applied separately to two size categories in each habitat at each site. The number of fish in Size Class 1 and combined Classes 2 and 3 were recorded for each pass. The size class boundary between Size Classes 1 and 2 was 75 mm Standard Length (SL) (3 inches) because smaller fish would almost always spend another growing season in freshwater before smolting and entering the ocean the following spring. Although some fish larger than 75 mm SL stayed a second year in the stream, the majority of fish captured during fall sampling that were larger than 75 mm SL were found to smolt the very next spring to enter the ocean. These assumptions are based on scale analysis, back-calculated annuli and standard length determinations by Smith of steelhead smolts captured in spring of 1987 and 1989 (**Smith unpublished**). He found that 97% of a random sample (n=248) of yearling smolts in spring were 76 mm SL or longer after their first growing season. In addition, about 75% of smolts that were 75 mm SL or larger at their first annulus (n=319) smolted as yearlings. All 2-year old smolts from a random sample (n=156) were larger than 75 mm SL after 2 growing seasons prior to smolting. Also, 95% of these 2-year olds were at least 60 mm SL after their first growing season, indicating that few YOY less than 60 mm SL after their first growing season survived to smolt.

The depletion method estimated the number of fish in each sampled habitat in two size categories; those less than (<) 75 mm SL (Class 1) and those equal to or greater than (=>) 75 mm SL (Classes 2 and 3). Then, the number of juveniles => 75 mm SL (Class 2) was estimated separately from the juveniles => 150 mm SL (Class 3). This was done by multiplying the proportion of each size class (Class 2 and 3 separately) in the group of captured fish by the estimate of fish density for all fish => 75 mm SL. A density estimate for each habitat type at each site was then determined for each size class. Densities in each habitat type were added together and divided by the total length of that habitat type at the sampling site to obtain a density estimate by habitat type.

The depletion method was also used to estimate the number of fish in each sampled habitat based on 2 age classes: young-of-the-year (YOY) and yearling and older (1+) age classes. Age classes in the mainstem San Lorenzo and mainstem Soquel Creek were determined by scale analysis of a spectrum of fish sizes in 2007. A total of 28 larger San Lorenzo juvenile steelhead and 10 larger Soquel Creek juveniles were aged by scale analysis, along with 20 juveniles from Soquel Lagoon. These limited results showed that the majority of fish => 75 mm SL in the mainstems and lagoon were YOY, but also included yearlings that moved into the mainstem after slow tributary growth in their first year. These data provided information for age class division for both watersheds. Scale analysis, along with past experience of growth rates, and breaks in fish length histograms were used to discern age classes at other sampling sites. Density estimates determined by size class and age class were not the same when YOY reached Size Class II by fall.

In 2010, as in previous years, the lower mainstems of the San Lorenzo River and Soquel Creek, many YOY steelhead reached Size Class 2 size in one growing season, as did a few in the middle mainstem San Lorenzo and upper mainstem of Soquel Creek. In this monitoring report, sampling site densities were compared for 13 years in the San Lorenzo system by size and age (1997−2001 and 2003−2010) and for 14 years in Soquel Creek (1997−2010). At each sampling site, habitat types were sampled separately, with density estimates calculated for each habitat. Then these density estimates were combined and divided by the stream length of the entire site to calculate annual site density.

DETAILED RESULTS

R-1. Capture and Mortality Statistics

For this study overall in 2010, 2,932 juvenile steelhead were captured by electrofishing among all 38 sites, with 10 mortalities (0.34% mortality rate). A total of only 267 juvenile steelhead were visually censused in pools at 5 San Lorenzo mainstem sites. Seven mainstem sites and 12 tributary sites were sampled in the San Lorenzo watershed in 2010, with a total of 1,792 juvenile steelhead captured and 6 mortalities (0.33%). A total of 506 juvenile steelhead were captured at 8 sites in the Soquel watershed in 2010 with 1 mortality (0.2%). A total of 307 juveniles steelhead were captured in the Aptos Watershed at 4 sites with no mortality. A total of 327 juveniles were captured in the Corralitos watershed at 8 sites with three mortalities (0.92%).

R-2. Habitat Change in the San Lorenzo River Mainstem and Tributaries, 2009 to 2010

Refer to **Appendix A** for maps of reach locations. A summary table of habitat change for all reaches is provided in **Table 37**. Weighing the relative importance of streamflow as an aspect of habitat quality with other habitat parameters in the fall is not clear cut, especially when exact fall streamflow measurements are limited and spring streamflows were not measured. Most juvenile steelhead growth occurs in the spring when baseflow is most important. All reaches had higher baseflow, especially during the important spring growth period, due to later storms in 2010. This provided more food and better growth rate in all reaches in 2010 (**Figures 53 and 56;** size histograms in **Appendix D**). In 2010, only Reach 2 was habitat typed in the mainstem. Therefore, evaluation of habitat quality in other reaches was based on changes at sampling sites. Overall habitat quality improved in Reach 2 primarily due to increased baseflow and resulting higher insect drift velocity and more fastwater habitat (**Table 5c**). Juvenile steelhead were observed during snorkel censusing in the faster glides that developed at pool tails in 2010, which were absent in 2009. The YOY density and Size Class II density at Site 2a were much higher in 2010 (**Tables 21 and 24**) and above average (**Figure 4**), consistent with better rearing habitat. Riffle habitat depth was similar between years, but run habitat was much deeper in 2010 to improve fastwater habitat (**Table 6a; Figure 42**). However, riffle escape cover in 2010 was slightly less than in 2009 (**Figure 43**) and embeddedness was increased (**Figure 45**).

Habitat improvement came from higher baseflow in all mainstem reaches and based on consistent changes in habitat conditions measured at sampling sites. Important fastwater feeding habitat in the lower and middle mainstem was consistently deeper, although some pool sedimentation was indicated at Sites 0a and 11, where pool habitat was important for rearing (**Table 6b**). Escape cover increased in 2010 fastwater habitat in all lower and middle mainstem sites except remaining similar at Site 4 in Henry Cowell Park (**Table 9b**).

In San Lorenzo River tributaries, of the 4 reaches monitored and compared between 2009 and 2010, Newell 15, had overall improved habitat quality in fall 2010 (deeper, less sediment, similar embeddedness, similar escape cover, higher percent of YOY reaching Size Class II) (**Tables 6a, 7, 8, 12a and 13; Figure 17**). Zayante 13d had reduced habitat quality in fall (deeper primarily because shallow pools in 2009 were typed as runs in 2010, similar sediment but more embedded and half the escape cover) (**Figures 46-49**). Bean 14b had similar fall habitat quality (similar depth, similar embeddedness, less fines in pools, slightly more escape cover), as did lower Branciforte 21a-2 (similar depth, similar sediment and embeddedness except more in runs, similar escape cover). All tributary reaches likely had higher habitat quality in spring 2010 due to much higher baseflows for fish growth (**Figures 53 and 56**), as indicated by the percent of YOY reaching Size Class II in the first growing season (**Figure 17;** size histograms in **Appendix D**).

For tributary reaches where habitat conditions were measured at sampling sites only, it is sometimes problematic to extrapolate from site conditions to reach conditions, especially when embeddedness and percent fines were not measured. Sometimes the type of escape cover is site specific. Only if we consistent habitat changes between sites and reaches in the same tributary can we assume site conditions mirror reach conditions. We know that baseflow was consistently greater in 2010, giving a positive effect on habitat, in general. Zayante Site 13a improved (higher baseflow, deeper pools, slightly less pool cover) (**Tables 6b and 12b**). Fall Site 15 improved (deeper pools, more pool escape cover). Lompico Site 13e declined (shallower pools, less escape cover). Fall conditions in Boulder Site 17a remained similar (similar depth, similar pool escape cover), and Boulder Site 17b declined (similar depth, much less pool escape cover). However, spring growth conditions were better as indicated by a much higher percentage of YOY reaching Size Class II in 2010 with higher densities at 17a and similar densities at 17b (**Table 22; Figure 17**). We have no comparisons for Zayante 13c and Bear 18a because site locations changed in 2010. However, spring growth conditions were undoubtedly better in 2010 at both sites as indicated by a much higher percentage of YOY reaching Size Class II in 2010 with similar densities at Zayante 13c and twice the density at Bear 18a.

Table 5a. Fall STREAMFLOW (cubic feet/ sec) Measured by Flowmeter at SAN LORENZO Sampling Sites Before Fall Storms by D.W. ALLEY & Associates.

Site # / Location	1995	1996	1998	1999	2000	2001	2003	2004	2005	2006	2010
1- SLR/ Paradise Pk	22.9	25.5	34.3	26.2	21.7	19.6				26.2	18.7
2- SLR/ Rincon				24.0	21.1	17.2					
3-SLR Gorge	23.3	20.5									
4-SLR/Henry Cowell	18.7		32.7	23.3	21.8	15.5				24.1	
5- SLR/ Below Zayante			31.9								
6- SLR/ Below Fall	14.6		23.4	12.8	11.6	9.4	10.6	8.8	18.9	14.3	
7- SLR/ Ben Lomond	5.8				5.4	3.7	5.4	3.7	8.1		
8- SLR/ Below Clear	4.2		10.3	4.9	4.2	3.1	4.2	2.7	7.1	6.4	4.0
9- SLR/ Below Boulder	4.6		7.2	3.5		3.0	3.7	2.1	5.8		
10- SLR/ Below Kings				3.0	1.1	1.3	0.6	0.52	1.4		
11- SLR/ Teihl Rd			1.7	0.8	0.8	0.4	0.9	0.63	1.5		0.94
12a- SLR/Lower Waterman G			1.0	0.7							
13a/ Zayante below Bean			8.5	6.3	5.2	4.7	5.4	5.1	7.4	7.8*	4.9
13b/ Zayante above Bean			3.9	2.9	2.8	1.9	2.1	1.7	3.2	2.8	
14b/ Bean below Lockhart G	1.5		1.1	1.1	1.0	1.1	1.1	0.77	1.0	1.1	
14c/ Bean above MacKenzie											0.03
15/ Fall	2.0		3.4	2.2	1.7	1.7					
16/ Newell	1.6				0.51						1.17
17a/ Boulder	2.0		2.2		1.1	1.0	1.25	0.9	1.6	1.7	1.58
18a/ Bear				0.45	0.61	0.34	0.6	0.51	0.90	1.1	0.68
19a/ Lower Kings			1.1	0.11	0.17	0.02					
20a/ Lower Carbonera	0.33	0.36									
21a-2/ Branciforte			0.80								0.44

*Streamflow in lower Zayante Creek done 3 weeks earlier than usual and before other locations.

Table 5b. Fall/Late Summer STREAMFLOW (cubic feet/ sec) Measured by Santa Cruz County Staff in 2006−2010 and from Stream Gages; 2010 Measurements by D.W. ALLEY & Associates (September), County Staff and from Stream Gages.

Location	2006	2007	2008	2009	2010
SLR at Sycamore Grove	34.8	14.6	14.2	−	18.7 Paradise P. (DWA)
SLR at Big Trees Gage	26	11	12	13	15
SLR above Love Cr	13.14	5.42 After*	3.8	−	6.97 (9/7)
SLR below Boulder Cr	7.49	2.87 After	3.1	−	5.93 (9/7)
SLR @ Two Bar Cr	1.81	0.78	0.39	−	2.02 (8/4)
Zayante @ SLR	6.51	3.80	−	−	4.9 Below Bean (DWA)
Zayante below Lompico Cr	1.21	0.96	0.41	0.43	1.51 (8/24)
Bean adjacent Mt. Hermon	2.6	1.9	2.1	2.2	3.1 (9/2)
Bean Below Lockhart Gulch	1.37	0.72	0.79	0.89	0.68 (9/2)
Newell Cr @ Rancho Rio	1.18	1.16	1.11	−	1.17 (DWA)
Boulder Cr @ SLR	2.09	0.84	1.04	0.97	1.58
Bear Cr above Hopkins Gulch					0.68 (DWA)
Bear Cr @ SLR	1.87	0.37	0.27	−	1.64 (8/4)
Branciforte @ Isabel Lane			0.3	0.25	0.42 (8/26)
Soquel above Lagoon					2.31(DWA)
Soquel Cr at USGS Gage	6.6**	1.4**	0.65**	1.2**	3.4**
Soquel Cr @ Bates Cr	5.73	-	1.08		4.19 (9/1)
Soquel above Moores Gulch					2.06 (DWA)
W. Branch Soquel @ Old S.J. Road Olive Springs Bridge	2.17	1.75 After	−	−	1.21 (DWA) @ Mouth
W. Branch above Hester Creek (SCWD Weir/ Kraeger-prelim.)	1.48 (15 Sep)	1.04 (15 Sep)	−	−	−
E. Branch Soquel @ 152 Olive Springs Rd.	-	1.01 After	−	−	0.77 (DWA) @ Mouth
E. Branch below Amaya and above Olive Springs Quarry (SCWD Weir/ Kraeger- prelim.)	1.53 (15 Sep)	0.43 (15 Sep)	−	−	−
E. Branch Soquel above Amaya				Trickle (DWA)	0.44 (DWA)
Aptos @ Valencia	2.48	1.21 After	0.77	0.53	0.85 (9/1)
Aptos above Valencia (County Park)					0.97 (DWA)
Valencia Cr @ Aptos Cr			0.007	0.34 (May)	0.09 Adj. School (DWA)
Valencia below Valencia Rd Bridge					0.22 (DWA)
Corralitos Cr below Browns Valley Road Bridge	15.94 (May)	0.49 (May)	dry	1.71 (May)	0.47 (9/2)
Corralitos above Los Casinos Road Bridge					2.01 (DWA)
Corralitos Cr @ Rider Cr	3.35	2.50 After	1.44	−	2.41 (9/2)
Corralitos above Eureka Gulch					0.63 (DWA)
Browns @ 621 Browns Valley Rd	0.96	0.30 After	0.32	−	0.41 (DWA)

* After 2 early October storms that increased baseflow.
** Estimated from USGS Hydrographs for September 1.

Table 5c. Habitat Proportions in Habitat-Typed Reaches of the San Lorenzo, Soquel, Aptos and Corralitos Watersheds in 2009 and 2010.

Reach	2010 Pool Habitat In Feet/ Percent / # Habitats	2009 Pool Habitat In Feet/ Percent / # Habitats	2010 Riffle Habitat Feet/ Percent / # Habitats/ Riffle Width (ft)	2009 Riffle Habitat Feet/ Percent / # Habitats/ Riffle Width (ft)	2010 Run/Step-run/ Glide Habitat Feet/ Percent / # Habitats/ Width (ft)	2009 Run/ Step-run Habitat Feet/ Percent / #Habitats/ Width (ft)
Low. San Lorenzo #2	2006/61%/ 9	2194/65%/ 10	787/ 24%/ 10/ 26 ft	696/ 21%/ 9/ 21 ft	474/ 15%/ 10/ 30 ft	490/ 14%/ 6/ 27 ft
Zayante #13c	2038/69%/ 19		550/ 19%/ 16/10 ft		370/ 12%/ 10	
Zayante #13d	1517/57%/ 30	1840/71%/ 36	143/ 6%/ 7/ 8 ft	124/ 5%/ 8/ 6 ft	987/ 37%/ 24/ 15 ft	636/ 24%/ 15/ 11 ft
Bean #14b	2040/67%/ 28	1804/64%/ 27	560/ 18%/ 18/ 11 ft	433/15%/ 18/ 9 ft	445/ 15%/ 15/ 13 ft	588/21%/ 15/ 11 ft
Bean #14c	1765/ 66%/ 31		323/ 12% 15/ 6 ft		594/ 22%/ 16/ 7 ft	
Newell #16	1431/59%/ 17	1565/64%/ 15	638/20%/ 15/ 12 ft	481/20%/ 15/ 12 ft	412/21%/ 9/ 14 ft	396/16%/ 11/ 13 ft
Bear #18a	2327/ 70%/ 19	2393/73%/ 22 (2008)	427/ 13%/ 11/14 ft	213/ 6%/ 7/ 11 ft (2008)	581/ 17%/ 11/ 15 ft	374/ 11%/ 6/ 10 ft (2008)
Branciforte #21a-2	2075/ 75% 23	2152/77%/ 26	312/ 11%/ 18/ 9 ft	239/ 9%/ 18/ 9 ft	380/ 14%/ 13/ 9 ft	403/ 14%/ 13/ 9 ft
Shingle Mill #1	950/ 45%/ 50		344/ 16%/ 31		789/ 38%/ 26	

Table 6a. Averaged Mean and Maximum WATER DEPTH in SAN LORENZO Reaches Since 2003.

Reach	Pool 2003	Pool 2005	Pool 2006	Pool 2007	Pool 2008	Pool 2009	Pool 2010	Riffle 2003	Riffle 2005	Riffle 2006	Riffle 2007	Riffle 2008	Riffle 2009	Riffle 2010	Run/ Step-Run 2003	Run/ Step Run 2005	Run/ Step Run 2006	Run/ Step Run 2007	Run/ Step Run 2008	Run/ Step Run 2009	Run/ Step Run 2010
1- L. Main			2.5/ 4.4	1.8/ 3.0	1.85/ 3.4					1.1/ 1.5	0.8/ 1.2	0.7/ 1.2					2.4/ 3.1	1.0/ 1.5	0.9/ 1.35		
2- L. Main	3.0/ 5.2 (2000			2.5/ 4.1	2.6/ 5.1	2.5/ 4.4	**2.7/ 4.9**	1.2/ 2.0 (2000			0.9/ 1.4	0.8/ 1.3	0.8/ 1.4	**0.8/ 1.4**	1.7/ 2.4 (2000			1.4/ 2.2	1.3/ 1.9	1.3/ 2.3	**1.7/ 2.7**
3- L. Main																					
4- L. Main			2.6/ 4.4	1.9/ 3.8	2.0/ 3.6					0.9/ 1.5	0.7/ 1.2	0.5/ 1.0					1.6/ 2.2	1.4/ 2.1	0.9/ 1.5		
5- L. Main																					
6- M. Main	1.9/ 3.5	1.9/ 3.4	2.2/ 4.3	1.7/ 3.4	1.6/ 3.1			0.6/ 0.9	0.9/ 1.4	0.8/ 1.3	0.6/ 1.0	0.55/ 0.9			1.2/ 1.9	1.1/ 2.1	1.3/ 1.85	0.9/ 1.3	0.8/ 1.1		
7- M. Main	1.8/ 3.7	2.0/ 3.5						0.6/ 1.0	0.7/ 1.1						0.9/ 1.4	1.1/ 1.4					
8- M. Main	2.5/ 5.2	2.6/ 5.8	2.7/ 5.5	2.3/ 4.3	2.3/ 4.7	2.8/ 5.1		0.6/ 1.0	1.0/ 1.5	1.1/ 1.6	0.6/ 1.0	0.45/ 0.7	0.65/ 1.0		1.0/ 1.4	1.3/ 2.1	1.3/ 2.25	0.8/ 1.2	0.8/ 1.2	0.7/ 1.0	
9- M. Main	1.7/ 3.0	1.9/ 3.5						0.6/ 1.1	0.7/ 1.1						0.8/ 1.2	1.0/ 1.4					
10- U. Main	1.4/ 2.9	1.4/ 2.8						0.3/ 0.5	0.4/ 0.7						0.5/ 0.9	0.7/ 1.0					
11- U. Main		1.1/ 2.0	1.1/ 2.1	1.0/ 1.9	0.9/ 1.8	1.05/ 1.8			0.4/ 0.7	0.5/ 0.8	0.2/ 0.4	0.25/ 0.5	0.25/ 0.4			0.5/ 1.0	0.6/ 1.1	0.4/ 0.6	0.4/ 0.7	0.4/ 0.75	
12b- U. Main		1.3/ 2.2							0.3/ 0.6							0.5/ 0.8					
Zayante 13a	1.1/ 2.1	1.5/ 2.5	1.6/ 2.6	1.4/ 2.2	1.5/ 2.5			0.7/ 1.1	0.6/ 0.9	0.6/ 0.9	0.5/ 0.8	0.4/ 0.8			0.7/ 1.2	0.8/ 1.1	0.85/ 1.2	0.6/ 1.0	0.6/ 0.9		
Zayante 13b	1.5/ 2.4	1.7/ 2.9						0.5/ 0.7	0.5/ 0.9						0.8/ 1.1	0.7/ 1.2					
Zayante 13c	1.2/ 2.2	1.35/ 2.4		1.2/ 2.2	1.2/ 2.2		**1.3/ 2.2**	0.4/ 0.7	0.5/ 0.8		0.2/ 0.5	0.2/ 0.6		**0.4/ 0.7**	0.5/ 1.0	0.7/ 1.0		0.5/ 0.9	0.4/ 0.8		**0.6/ 1.0**
Zayante 13d	1.1/ 1.7	1.1/ 2.1	1.35/ 2.1	1.0/ 1.5	1.0/ 1.55	0.9/ 1.5	**1.2/ 2.0**	0.4/ 0.6	0.5/ 0.7	0.45/ 0.8	0.3/ 0.5	0.2/ 0.5	0.25/ 0.5	**0.4/ 0.6**	0.8/ 1.3	0.8/ 1.4	0.9/ 1.4	0.6/ 1.0	0.5/ 0.9	0.55/ 0.9	**0.7/ 1.1**
Lompico 13e			1.1/ 1.8	0.8/ 1.5	1.0/ 1.7					0.3/ 0.6	0.15 /0.4	0.1/ 0.3					0.45/ 0.8	0.35/ 0.65	0.3/ 0.5		
Bean 14a	0.8/ 1.6	1.0/ 1.9						0.4/ 0.7	0.4/ 0.7						0.6/ 1.2	0.7/ 1.1					

Reach	Pool 2003	Pool 2005	Pool 2006	Pool 2007	Pool 2008	Pool 2009	Pool 2010	Riffle 2003	Riffle 2005	Riffle 2006	Riffle 2007	Riffle 2008	Riffle 2009	Riffle 2010	Run/ Step-Run 2003	Run/ Step Run 2005	Run/ Step Run 2006	Run/ Step Run 2007	Run/ Step Run 2008	Run/ Step Run 2009	Run/ Step Run 2010
Bean 14b	0.9/ 1.5	1.0/ 1.9		1.1/ 1.8	1.0/ 1.8	1.2/ 1.9	**1.15/ 2.0**	0.3/ 0.6	0.3/ 0.5		0.2/ 0.4	0.2/ 0.4	0.2/ 0.4	**0.2/ 0.4**	0.6/ 0.9	0.6/ 0.8		0.4/ 0.8	0.4/ 0.65	0.4/ 0.6	**0.4/ 0.6**
Bean 14c	1.0/ 1.7	1.0/ 1.7	1.0/ 1.8	0.8/ 1.5	0.9/ 1.7		**0.9/ 1.6**	0.1/ 0.3	0.1/ 0.3	0.2/ 0.3	0.03 /0.1	0.03/ 0.1		**0.1/ 0.2**	0.25/ 0.4	0.2/ 0.5	0.35/ 0.5	0.1/ 0.2	0.06/ 0.1		**0.2/ 0.4**
Fall 15	1.0/ 1.8 (2000				0.9/ 1.4	0.9/ 1.4		0.2/ 0.5 (2000				0.4/ 0.8	0.35/ 0.75		0.4/ 0.6 (2000				0.6/ 0.9	0.5/ 1.0	
Newell 16			1.6/ 2.8			1.3/ 2.4	**1.5/ 2.5**			0.3/ 0.5			0.25/ 0.45	**0.3/ 0.5**			0.6/ 0.9			0.4/ 0.7	**0.4/ 0.8**
Boulder 17a		1.8/ 2.9	2.0/ 3.1	1.7/ 2.7	1.6/ 2.6	1.8/ 2.9			0.5/ 0.9	0.6/ 1.0	0.4/ 0.7	0.4/ 0.7	0.35/ 0.7			0.7/ 1.2	0.9/ 1.4	0.6/ 1.0	0.6/ 0.95	0.65/ 1.05	
Boulder 17b		1.7/ 2.8	1.7/ 2.8	1.6/ 2.7	1.5/ 2.7				0.4/ 1.0	0.6/ 1.0	0.4/ 0.75	0.3/ 0.6				0.7/ 1.2	0.8/ 1.4	0.6/ 1.1	0.55/ 0.95		
Boulder 17c		1.9/ 2.9							0.4/ 0.8							0.9/ 1.5					
Bear 18a	2.0/ 3.4	2.0/ 3.4	2.0/ 3.35	1.4/ 2.4	1.3/ 2.55			0.4/ 0.7	0.4/ 0.7	0.6/ 0.9	0.2/ 0.4	0.2/ 0.4			0.6/ 0.9	0.7/ 1.1	0.8/ 1.25	0.4/ 0.7	0.35/ 0.7		
Bear 18b																					
Branciforte 21a-1				1.2/ 2.2	1.35/ 2.3						0.15 /0.3	0.2/ 0.3						0.3/ 0.5	0.3/ 0.6		
Branciforte 21a-2			1.1/ 1.9	1.0/ 1.7	0.9/ 1.7	1.0/ 1.8	**1.0/ 1.9**			0.3/ 0.5	0.2/ 0.4	0.2/ 0.35	0.2/ 0.35	**0.2/ 0.4**			0.5/ 1.0	0.4/ 0.7	0.45/ 0.65	0.45/ 0.65	**0.5/ 0.8**
Branciforte 21b		1.1/ 1.7							0.4/ 0.7							0.3/ 0.6					

Table 6b. Averaged Mean and Maximum WATER DEPTH (ft) at Replicated San Lorenzo Sampling Sites in 2009 and 2010.

Site	Pool 2009	Pool 2010	Riffle 2009	Riffle 2010	Run/Step Run 2009	Run/Step Run 2010
0a	1.8/ 3.2	**1.2/ 2.2**	0.15/ 0.2	**0.75/ 0.9**	0.4/ 0.8	**0.95/ 1.8**
1			0.8/ 1.1	**0.9/ 1.45**	1.2/ 1.7	**1.3/ 1.9**
2	2.5/ 5.7	**2.45/ 5.6**	0.8/ 1.5	**1.0/ 1.6**	1.4/ 2.9	**1.8/ 3.2**
4			0.55/ 0.9	**0.55/ 0.9**	0.8/ 1.35	**1.1/ 2.2**
6			0.5/ 0.7	**0.65/ 0.8**	0.6/ 1.1	**0.6/ 1.2**
8			0.65/ 0.9	**0.8/ 1.0**	0.85/ 1.0	**0.95/ 1.2**
11	0.95/ 1.75	**1.0/ 1.6**	0.1/ 0.2	**0.2/ 0.35**	0.4/ 0.8	**0.6/ 0.8**
Zayante 13a	1.8/ 2.9	**2.1/ 3.4**	0.15/ 0.4	**0.2/ 0.5**	0.65/ 1.0	**0.75/ 1.3**
Zayante 13c		**1.45/ 2.75**		**0.4/ 0.6**		**0.35/ 0.5**
Zayante 13d	1.15/ 1.9	**1.2/ 1.65**			0.7/ 1.0	**0.8/ 1.2**
Lompico 13e	0.85/ 1.75	**1.2/ 1.6**	0.1/ 0.15	**0.1/ 0.3**	0.3/ 0.5	**0.45/ 0.75**
Bean 14b	1.0/ 2.0	**0.9/ 2.0**	0.2/ 0.4	**0.25/ 0.4**	0.2/ 0.4	**0.5/ 0.6**
Fall 15	0.95/ 1.3	**0.9/ 1.6**	0.3/ 0.8	**0.5/ 0.8**	0.35/ 1.0	**0.5/ 0.9**
Newell 16	1.15/ 1.95	**1.25/ 1.9**	0.2. 0.5	**.25/ .55**	0.3/ 0.5	**0.5/ 0.9**
Boulder 17a	1.05/ 1.8	**1.2/ 1.75**	0.4/ 0.8	**0.7/ 1.1**	0.7/ 1.1	**0.9/ 1.2**
Boulder 17b	1.4/ 2.4	**1.45/ 2.2**	0.5/ 1.0	**0.6/ 1.1**	0.5/ 0.9	**0.7/ 0.9**
Bear 18a		**1.35/ 2.6**		**0.3/ 0.6**		**0.7/ 0.9**
Branciforte 21a-2	1.15/ 1.9	**1.25/ 2.05**	0.1/ 0.2	**0.1/ 0.2**	0.4/ 0.6	**0.5/ 1.2**

Table 7. Average PERCENT FINE SEDIMENT* IN SAN LORENZO Reaches Since 2003.

Reach	Pool 2003	Pool 2005	Pool 2006	Pool 2007	Pool 2008	Pool 2009	Pool 2010	Riffle 2003	Riffle 2005	Riffle 2006	Riffle 2007	Riffle 2008	Riffle 2009	Riffle 2010	Run / Step Run 2003	Run / Step Run 2005	Run / Step Run 2006	Run / Step Run 2007	Run / Step Run 2008	Run / Step Run 2009	Run / Step Run 2010
1			80	65	77					20	15	20					40	46	46		
2	70 (2000			42	54	48	**48**	25 (2000			10	13	13	**10**	50 (2000			26	23	26	**40**
4			75	46	47					20	13	10					50	42	37		
6	70	70	75	61	68			25	20	25	17	12			35	40	38	18	23		
7	70	70						25	20						50	40					
8	55	65	60	41	47	44		25	20	20	7	6	12		40	25	25	11	16	25	
9	70	60						25	15						30	30					
10	60	70						20	15						25	35					
11	55	35	40	32	52	40		40	15	25	10	9	12		45	25	15	24	14	14	
12b	50	35						35	35						40	10					
Zayante 13a	85	65	65	59	62			40	25	35	22	19			70	50	40	36	31		
Zayante 13b	65	65						30	30						45	30					
Zayante 13c	50	45		45	47		**41**	25	10		9	12		**10**	30	20		27	34		**19**
Zayante 13d	40	40	50	38	44	46	**42**	25	25	15	13	13	12	**19**	25	25	40	21	29	28	**27**
Lompico 13e			50	49	54					20	15	20					30	24	29		
Bean 14a	80	70						40	25						70	35					
Bean 14b	85	80		67	66	67	**55**	45	15		18	9	13	**13**	80	45		58	34	34	**28**
Bean 14c	70	60	65	42	37		**54**	25	5	15	6	6		**14**	40	30	40	28	10		**26**
Fall 15	74 (2000				64	69		50 (2000				30	34		63 (2000				48	50	
Newell 16			25			46	**22**			5			11	**6**			20			19	**12**
Boulder 17a		30	35	31	27	28			20	5	12	9	11			15	20	17	13	11	
Boulder 17b		30	35	31	32				5	10	5	5				15	15	12	14		
Boulder 17c		25							5							5					
Bear 18a	55	50	60	41	46		**41**	15	15	15	7	11		**13**	25	20	25	13	13		**19**
Branciforte 21a-1				65	62						7	10						30	16		
Branciforte 21a-2			75	50	42	38	**43**			40	12	8	8	**9**			55	35	21	13	**22**
Branciforte 21b		55							15							65					

* Fine sediment was visually estimated as particles less than approximately 2 mm (0.08 inches).

Table 8. Average EMBEDDEDNESS IN SAN LORENZO Reaches Since 2003.

Reach	Pool 2003	Pool 2005	Pool 2006	Pool 2007	Pool 2008	Pool 2009	Pool 2010	Riffle 2003	Riffle 2005	Riffle \2006	Riffle 2007	Riffle 2008	Riffle 2009	Riffle 2010	Run / Step Run 2003	Run/ Step Run 2005	Run / Step Run 2006	Run / Step Run 2007	Run / Step Run 2008	Run / Step Run 2009	Run / Step Run 2010
1			59	50	52					31	23	26					49	48	48		
2				26	38	36	**37**	30* (2000			13	18	16	**25**	30* (2000			23	25	32	**27**
3																					
4			64	43	45					37	19	33					47	37	42		
5																					
6	52	49	56	45	51			27	31	31	18	21			38	46	41	34	39		
7	53	54						34	27						49	40					
8	49	53	56	40	46	33		32	25	28	18	30	19		44	29	35	28	26	32	
9	52	39						32	25						40	31					
10	38	39						32	27						32	34					
11		58	48	34	47	48			30	33	22	30	22			45	27	31	43	33	
12b		58							27							45					
Zayante 13a	44	45	54	44	51			33	29	23	25	30			41	44	50	36	47		
Zayante 13b	44	46						36	25						43	39					
Zayante 13c	48	48		36	49		**49**	29	25		19	28		**29**	33	38		31	44		**36**
Zayante 13d	41	47	51	55	49	49	**57**	35	48	37	30	33	43	**39**	33	43	42	39	37	41	**51**
Lompico 13e			55	52	47					42	16	19					46	37	32		
Bean 14a	46	45						32	21						49	37					
Bean 14b	35	41		45	44	44	**53**	35	20		22	14	16	**25**	41	29		36	22	35	**30**
Bean 14c	49	50	62	39	42		**60**	19	27	36	8	15		**42**	43	46	52	25	29		**43**
Fall 15	47 (2000)				48	52						25	28		44 (2000)				40	41	
Newell 16			36			42	**39**			12			20	**24**			33			31	**34**
Boulder 17a		34	48	37	37	38			24	29	18	21	18			30	33	27	31	27	
Boulder 17b		36	43	33	35				14	24	22	17				29	34	33	34		
Boulder 17c		31							18							13					
Bear 18a	48	42	54	33	48		**49**	28	22	35	28	34		**25**	47	30	41	36	43		**34**
Branc 21a-1				60	58						31	24						55	41		
Branc 21a-2			68	62	46	49	**53**			41	30	28	28	**30**			59	36	33	28	**41**
Branc 21b		41							28							32					

* Data from sampling sites and not reach segments.

Table 9a. ESCAPE COVER Indices (Habitat Typing Method*) in RIFFLE HABITAT in MAINSTEM Reaches of the SAN LORENZO, Based on Habitat Typed Segments.

Reach	1998	1999	2000	2003	2005	2006	2007	2008	2009	2010
1	0.187	0.244	0.084	-	-	0.270	0.257	0.200		
2	-	0.503	0.260	-	-		0.228	0.287	0.132	**0.109**
3	0.250	0.216	0.257	-	-					
4	0.125	0.078	0.109	-	-	0.183	0.354	0.141		
5	0.032	0.001	0.222	-	-					
6	**0.099**	**0.093**	**0.042**	**0.027**	**0.152**	**0.101**	**0.072**	**0.082**		
7	**0.148**	**0.146**	**0.050**	**0.130**	**0.187**					
8	**0.335**	**0.173**	**0.124**	**0.080**	**0.320**	**0.241**	**0.123**	**0.036**	0.156	
9	**0.038**	**0.080**	**0.043**	**0.066**	**0.161**					
10	0.011	0.039	0.012	0.018	0.040					
11	0.025	0.020	0.017	-	0.056	0.014	0.005	0.010	0.027	
12	0.086	0.022	0.036	-	0.044					

*Habitat Typing Method = linear feet of escape cover divided by habitat typed channel length as riffle habitat.

Table 9b. ESCAPE COVER Indices (Habitat Typing Method*) in RIFFLE AND RUN HABITAT at Replicated MAINSTEM SAN LORENZO SAMPLING SITES in 2009 and 2010.

Sampling Site	2009	2010
Santa Cruz Levees 0a	0.211	0.298
Paradise Park 1	0.155	0.183
Rincon 2	0.170	0.205
Henry Cowell 4	0.537	0.479
Below Fall Creek 6	0.113	0.230
Below Clear Creek 8	0.082	0.194

***Habitat Typing Method = linear feet of escape cover divided by habitat typed channel length as riffle and run habitat.**

Table 10. ESCAPE COVER Indices (Habitat Typing Method*) in RUN HABITAT in MAINSTEM Reaches of the SAN LORENZO, Based on Habitat Typed Segments.

Reach	1998	1999	2000	2003	2005	2006	2007	2008	2009	2010
1	0.273	0.130	0.064	-	-	0.131	0.120	0.151		
2	0.228	0.136	0.100	-	-		0.282	0.226	0.196	**0.252**
3	0.186	0.113	0.144	-	-					
4	0.234	0.159	0.091	-	-	0.125	0.204	0.221		
5	0.071	0.249	0.261	-	-					
6	**0.145**	**0.107**	**0.044**	**0.068**	**0.098**	**0.101**	**0.049**	**0.044**		
7	**0.038**	**0.030**	**0.023**	**0.165**	**0.074**					
8	**0.129**	**0.152**	**0.131**	**0.154**	**0.164**	**0.103**	**0.168**	**0.087**	0.079	
9	**0.138**	**0.051**	**0.036**	**0.046**	**0.098**					
10	0.072	0.041	0.081	0.062	0.057					
11	0.026	0.016	0.022	-	0.021	0.0084	0.0068	0.014	0.032	
12	0.031	0.069	0.126	-	0.048					

*Habitat Typing Method = linear feet of escape cover divided by habitat typed channel length as run habitat.

Table 11. ESCAPE COVER Indices (Habitat Typing Method*) in POOL HABITAT in MAINSTEM Reaches of the SAN LORENZO, Based on Habitat Typed Segments.

Reach	2003	2005	2006	2007	2008	2009	2010
1	-	-	0.271	0.186	0.205		
2	-	-		0.076	0.058	0.046	**0.049**
3	-	-					
4	-	-	0.203	0.275	0.290		
5	-	-					
6	**0.077**	**0.077**	**0.044**	**0.083**	**0.088**		
7	**0.134**	**0.105**					
8	**0.026**	**0.027**	**0.039**	**0.057**	**0.030**	0.049	
9	**0.037**	**0.070**					
10	0.054	0.051					
11	0.054 (2000)	0.059	0.031	0.034	0.035	0.042	
12	-	0.178					

*Habitat Typing Method = linear feet of escape cover divided by habitat typed channel length as pool habitat.

Table 12a. ESCAPE COVER Indices (Habitat Typing Method*) for POOL HABITAT in TRIBUTARY Reaches of the SAN LORENZO.

Reach	1998	1999	2000	2003	2005	2006	2007	2008	2009	2010
Zayante 13a	0.320	0.069	0.056	0.169	0.081	0.074	0.071	0.086		
Zayante 13b	0.150	0.093	0.072	0.130	0.087					
Zayante 13c	0.114	0.110	0.095	0.110	0.109		0.102	0.099		**0.073**
Zayante 13d	0.145	0.191	0.132	0.237	0.269	0.126	0.117	0.118	0.181	**0.091**
Lompico 13e						0.089	0.082	0.095		
Bean 14a	0.248	0.143	0.186	0.124	0.155					
Bean 14b	0.378	0.280	0.205	0.288	0.212		0.231	0.171	0.179	**0.207**
Bean 14c	0.259	0.093	0.100	0.142	0.141	0.131	0.142	0.131		**0.135**
Fall 15	0.380		0.330					0.375	0.295	
Newell 16	0.285		0.325			0.120			0.125	**0.111**
Boulder 17a	0.131	0.051	0.061	-	0.108	0.064	0.076	0.058	0.047	
Boulder 17b	0.129	0.141	0.164	-	0.232	0.100	0.140	0.155		
Boulder 17c	0.250	0.072	0.057	-	0.143					
Bear 18a	0.069	-	0.103	0.119	0.114	0.074	0.088	0.087		**0.104**
Branciforte 21a-1							0.140	0.136		
Branciforte 21a-2						0.121	0.134	0.151	0.164	**0.188**
Branciforte 21b	0.147	0.083	0.102	-	0.189					

*Habitat Typing Method = linear feet of escape cover divided by habitat typed channel length as pool habitat.

Table 12b. POOL ESCAPE COVER Indices (Habitat Typing Method*) at Replicated San Lorenzo Tributary Sites in 2009 and 2010.

Site (Reach)	Pool Escape Cover 2009	Pool Escape Cover 2010
Zayante 13a	0.140*	**0.103**
Zayante 13c		**0.056**
Zayante 13d	0.285	**0.113**
Lompico 13e	0.154	**0.092**
Bean 14b	0.145	**0.120**
Bean 14c		**0.093**
Fall 15	0.302	**0.571**
Newell 16	0.150	**0.118**
Boulder 17a	0.066	**0.094**
Boulder 17b	0.356	**0.266**
Bear 18a		**0.138**
Branciforte 21a-2	0.051	**0.068**

*Habitat Typing Method = linear feet of escape cover divided by habitat typed channel length as pool habitat.

Table 13. ESCAPE COVER Indices (Habitat Typing Method*) for RUN/STEP-RUN HABITAT in TRIBUTARY Reaches of the SAN LORENZO.

Reach	1998	1999	2000	2003	2005	2006	2007	2008	2009	2010
Zayante 13a	0.127	0.059	0.059	0.065	0.031	0.038	0.027	**0.009**		
Zayante 13b	0.060	0.127	0.087	0.152	0.103					
Zayante 13c	0.116	0.095	0.070	0.016	0.070		0.051	**0.074**		**0.124**
Zayante 13d	0.050	0.098	0.143	0.223	0.297	0.071	0.101	**0.130**	**0.136**	**0.103**
Lompico 13e						0.001	0.042	**0.020**		
Bean 14a	0.060	0.058	0.092	0.051	0.086					
Bean 14b	0.045	0.048	0.041	0.107	0.050		0.138	**0.141**	**0.056**	**0.080**
Bean 14c	-	0.018	0.023	0.015	0.012	0.009	0.0	**0.0**		**0.0**
Fall 15								**0.110**	**0.092**	
Newell 16	0.072		0.129			0.020			**0.065**	**0.018**
Boulder 17a	0.188	0.093	0.170	-	0.135	0.169	0.138	**0.113**	**0.100**	
Boulder 17b	0.116	0.156	0.137	-	0.194	0.102	0.114	**0.105**		
Boulder 17c	0.019	0.122	0.107	-	0.114					
Bear 18a	0.073	-	0.177	0.063	0.088	0.063	0.027	**0.030**		
Branciforte 21a-1							0.087	**0.040**		
Branciforte 21a-2						0.028	0.045	**0.037**	**0.045**	**0.101**
Branciforte 21b	0.138	0.014	0.087	-	0.133					

*Habitat Typing Method = linear feet of escape cover divided by habitat typed channel length as run habitat.

R-3. Habitat Change in Soquel Creek and Its Branches, 2009 to 2010

Refer to **Appendix A** for maps of reach locations. A summary table of habitat change for all sites is provided in **Table 37**. No Soquel watershed reaches were habitat typed in 2010. Weighing the relative importance of streamflow as an aspect of fall habitat quality against other habitat parameters is not clear cut. Most steelhead growth occurs in the late winter-spring when baseflow is most important. All reaches had higher baseflow in 2010 than 2009, especially in the spring due to later storms in 2010 (**Figures 54 and 57**). This provided more food and better growth rates in all reaches (**Figure 18;** size histograms in **Appendix D**), especially when YOY abundance was below average (**Figure 6**). Changes in habitat conditions were based on sampling site comparisons and were likely representative of reach changes because of consistent changes. Of the 8 sampling sites examined, all had overall positive habitat change based on more streamflow, greater water depth at all sites and generally more pool escape cover (6 of 8 sites). In the **lower mainstem,** Site 1 (Reach 1) improved with similar pool depth, deeper fastwater habitat and more pool escape cover (30% more) (**Tables 14 and 15**). Site 4 (Reach 3) improved although having reduced pool escape cover (40%) but much deeper habitat along with higher baseflow. In the **upper mainstem**, Site 10 (Reach 7) improved with regard to higher baseflow, deeper pools and 20% more pool escape cover. Site 12 (Reach 8) improved with higher baseflow, slightly deeper habitat and similar pool escape cover. In the **lower East Branch**, Site 13a (Reach 9a) improved with slightly deeper pool habitat and 50% more pool escape cover. In the **upper East Branch**, Site 16 (Reach 12a) improved with increased baseflow, deeper habitat and nearly twice the pool escape cover. In the **lower West Branch**, Site 19 (Reach 13) improved with more baseflow, slightly deeper habitat and twice the pool escape cover. In the **middle West Branch**, Site 21 (Reach 14b) improved with higher baseflow, deeper pool habitat but similar pool escape cover.

Table 14. Averaged Mean and Maximum WATER DEPTH (ft) of Habitat at Replicated SQOUEL CREEK Sampling Sites in 2009 and 2010.

Site (Reach)	Pool 2009	Pool 2010	Riffle 2009	Riffle 2010	Run/Step Run 2009	Run/Step Run 2010
1 (1)	1.0/ 2.8	**1.0/ 2.8**	0.4/ 0.5	**0.5/ 0.75**	0.2/ 0.3	**0.35/ 0.8**
4 (3)	1.6/ 2.9	**2.0/ 4.3**	0.4/ 0.6	**0.55/ 0.8**	0.5/ 0.8	**0.7/ 1.0**
10 (7)	1.4/ 2.1	**1.4/ 2.8**	0.55/ 0.9	**0.6/ 1.2**	0.5/ 0.9	**0.6/ 1.2**
12 (8)	1.9/ 3.5	**1.8/ 3.8**	0.3/ 0.6	**0.6/ 0.9**	0.6/ 0.9	**0.7/ 1.0**
13a (9a)	1.05/ 1.75	**1.0/ 1.8**	0.3/ 0.6	**0.4/ 0.6**	0.4/ 1.0	**0.45/ 0.8**
16 (12a)	1.05/ 1.65	**1.1/ 1.8**	0.3/ 0/5	**0.4/ 0.5**	0.6/ 0.9	**0.5/ 0.95**
19 (13)	1.0/ 2.0	**1.1/ 2.1**	0.5/ 0.7	**0.5/ 0.9**	0.5/ 0.9	**0.6/ 1.1**
21 (14b)	1.5/ 3.55	**1.8/ 3.85**	0.3/ 0.5	**0.4/ 0.55**	0.7/ 1.8	**0.6/ 1.3**

Table 15. POOL ESCAPE COVER Indices (Habitat Typing Method*) in SOQUEL CREEK, at Replicated Sampling Sites in 2009 and 2010.

Site (Reach)	Pool Escape Cover 2009	Pool Escape Cover 2010
1 (1)	0.101	**0.132**
4 (3)	0.102	**0.067**
10 (7)	0.109	**0.124**
12 (8)	0.037	**0.041**
13a (9a)	0.099	**0.151**
16 (12a)	0.099	**0.194**
19 (13)	0.041	**0.080**
21 (14b)	0.029	**0.017**

R-4. Habitat Change in Aptos and Valencia Creeks, 2009 to 2010

Refer to **Appendix A** for maps of reach locations. A summary table of habitat change for all sites is provided in **Table 37**. The January 1982 storm caused severe streambank erosion and landsliding throughout the Santa Cruz Mountains, and streams have been recovering since. The 1997-98 winter also brought significant stormflow and sedimentation into some watersheds by 1999, such as the San Lorenzo River (**Alley 2000**). Weighing the relative importance of streamflow as an aspect of habitat quality with other habitat parameters is not clear cut, especially when no stream gage exists and exact streamflow measurements are very limited. In 2010, we began measuring fall baseflow in this watershed. Most juvenile steelhead growth occurs in the spring-early summer when baseflow is most important. Based on hydrographs from stream gages in other watersheds (**Figures 53-58**), it is likely that this watershed also had higher baseflow, especially in the spring due to later storms in 2010. This provided more food and better growth rate in all reaches in 2010. From 2009 to 2010, habitat improved in Aptos Creek with higher baseflow, slightly deeper habitat and 10-20% more escape cover at both Sites 3 and 4 (**Table 16**). Habitat also improved in Valencia Creek with higher baseflow and 13-25% more pool escape cover at Sites 2 and 3, although pools were shallowed by sedimentation. In this small, heavily shaded, sediment-laden tributary with already shallow pools, escape cover is more important than pool depth in determining steelhead density. And at least two-year residency is necessary to reach smolt size.

Table 16. POOL HABITAT CONDITIONS and ESCAPE COVER INDICES for Replicated Sampling Sites in APTOS, VALENCIA, CORRALITOS, SHINGLE MILL and BROWNS Creeks in 2009 and 2010.

Reach #/ Sampling Site #	Avg Mean/ Maximum Pool Depth- 2009	Avg Mean/ Maximum Pool Depth- 2010	Pool Escape Cover Index- 2009	Pool Escape Cover Index- 2010
Aptos #2/#3- in County Park	1.2/ 2.5	**1.25/ 2.6**	0.164	**0.183**
Aptos #3/#4- Above Steel Bridge Xing (Nisene Marks)	1.2/ 2.3	**1.2/ 2.45**	0.130	**0.155**
Valencia #2/#2- Below Valencia Road Xing	0.6/ 1.5	**0.45/ 1.05**	0.138	**0.156**
Valencia #3/#3- Above Valencia Road Xing	1.0/ 1.8	**0.9/ 1.45**	0.200	**0.250**
Corralitos #1/#1- Below Dam	1.05/ 1.65	**0.85/ 1.5**	0.106	**0.087**
Corralitos #3/#3- Above Colinas Drive	1.1/ 2.0	**0.7/ 1.6**	0.186	**0.173**
Corralitos #6/#8- Below Eureka Gulch	1.35/ 1.95	**0.55/ 0.9**	0.120	**0.048**
Corralitos #7/#9- Above Eureka Gulch	1.1/ 1.45	**0.8/ 1.45**	0.147	**0.151**
Shingle Mill #3/#3- Above 3rd Road Xing	0.8/ 1.2	**0.6/ 0.9**	0.151	**0.139**
Browns Valley #1/#2- Below Dam	1.0/ 1.55	**1.25/ 2.0**	0.160	**0.125**
Browns Valley #2/#2- Above Dam	1.05/ 1.7	**1.15/ 1.85**	0.130	**0.243**

* Habitat typing method = total feet of linear pool cover divided by total habitat typed channel length as pool habitat.

R-5. Habitat Change in Corralitos, Shingle Mill and Browns Valley Creeks, 2009 to 2010

Refer to **Appendix A** for maps of reach locations. A summary table of habitat change for all reaches is provided in **Table 37**. Weighing the relative importance of streamflow as an aspect of habitat quality with other habitat parameters is not clear cut, especially when exact streamflow measurements are limited. Most juvenile steelhead growth occurs in the spring-early summer when baseflow is most important. All reaches had higher baseflow, especially in the spring due to later storms in 2010 (**Figures 55 and 58**). This provided more food and better growth rate in all reaches, especially with the low density of steelhead in Corralitos Creek. Faster growth is exemplified by the higher percent of YOY reaching Size Class II in 2010 (**Figure 20**). Only Reach 1 in Shingle Mill Gulch was habitat typed in 2010. Habitat changes are based on changes at sampling sites, otherwise. Consistently more shallow pools at the replicated sampling sites in Corralitos and Shingle Mill indicate stream-wide sedimentation and habitat degradation (**Table 16; Figure 50**). Pool escape cover was generally slightly reduced except less than half as much at the badly sedimented Site 8 downstream of Eureka Gulch and similar at the site above (**Figure 51**). Pool length also decreased at Site 8 with conversion to shallow glide.

Site 1 (Reach 1) below the Corralitos diversion dam continued to experience higher summer baseflow than in 2007 due to increased bypass from the diversion dam. Site 1 had declined slightly in habitat quality due to slightly reduced pool depth and escape cover (**Table 16; Figures 50 and 51**), though conditions for growth were likely better in spring 2010 than the previous year. Site 3 (Reach 3) on Corralitos Creek below Rider Creek had reduced habitat quality due to much shallower pool depth, though escape cover was similar and baseflow was more. Site 8 (Reach 6) above the box culvert and below Eureka Gulch had much reduced habitat quality due to substantial pool shallowing, loss of pool habitat and substantial loss of pool escape cover. The cause was high sedimentation. Site 9 (Reach 7) had slightly reduced habitat quality, despite higher baseflow and similar poor escape cover, due to reduced average pool depth (sedimentation) and less step-run escape cover.

In Shingle Mill Gulch, baseflow was improved in 2010, with only Reach 1 habitat typed but not the previous year. The sampling site was relocated to match average habitat conditions, so no habitat comparisons with 2009 were possible in Reach 1. Compared to 2008, Reach 1 conditions improved with higher baseflow, average and maximum pool depths increased by 0.2 feet and pool escape cover indices improving from 0.214 to 0.286, although percent fines in pools was greatly increased from 26 to 49%. At Site 3 (Reach 3), fall habitat quality declined with much reduced pool depth and similar pool escape cover (**Table 16; Figures 50 and 51**).

Unlike in Corralitos Creek, habitat conditions improved in Browns Creek in 2010, with regard to increased baseflow and scour indicated by pools deepening and escape cover increasing at the upper site (**Table 16; Figures 50 and 51**). Site 1 (Reach 1) below the water diversion dam improved in habitat quality due to much deeper pools that offered escape cover as water depth to offset the loss in escape cover under objects. Site 2 (Reach 2) also improved due to increased baseflow, deeper pools and substantially more pool escape cover.

ANNUAL COMPARISON OF JUVENILE STEELHEAD ABUNDANCE

R-7. 2010 Densities in the San Lorenzo Drainage Compared with Those Since 1997

All figures presented within the text may be found in color in the FIGURES section after the REFERENCES AND COMMUNICATIONS. In the mainstem San Lorenzo River, total juvenile steelhead densities were mostly higher in 2010 than 2009 (6 of 7 sites) (statistically significant- **Table 40**), above average at the lower 3 and below or near average at the upper 4 (**Figure 1; Table 17**). This was due to higher young-of-the-year (YOY) densities in 2010 (statistically significant- **Table 40**) than 2009 (6 of 7 sites), above average YOY density at the lower 3 and below or near average at the upper 4 (**Figure 2; Table 18**). Yearling densities between years were similarly low both years and slightly below average at 6 of 7 sites (**Figure 3; Table 19**). Yearling densities have been consistently low in the mainstem, downstream of the Boulder Creek confluence since monitoring began in 1994, with a slight downward trend since 1998 (**Table 19**). Size Class II densities were mostly greater in 2010 (6 of 7 sites) (statistically significant- **Table 40**) and near average at 5 of 7 sites (**Table 20**). Densities of Size Class II (>75 mm SL) (mostly fast-growing YOY) were mostly higher than in 2009 (6 of 7 sites) but below average at 4 of 7 sites (**Figure 4; Table 21**). Since densities of larger juveniles in the lower and middle mainstem are determined primarily by YOY densities and their growth rates, the increased densities detected in Reaches 1, 2, 6 and 8 were due to more YOY present and faster growth rates resulting from higher spring and summer baseflow and deeper fastwater habitat. Despite the higher YOY densities at most mainstem sites in 2010, a similar or higher percent of YOY reached Size Class II compared to 2009 (**Figure 17**). Smolt ratings increased at 5 of 7 sites in 2010 (**Table 37**) However only 3 sites had “Fair” or better ratings.

Site densities of YOY in the mainstem below the Boulder Creek have been low from 1999 onward (**Figure 22; Table 18**). However, Sites 1, 2 and 8 have shown a modest rebound in 2010. YOY densities also rebounded in 2008 at Site 4 in Henry Cowell Park. The year 1997 was unusual with considerable rain prior to 1 March with little afterwards, resulting in very stable spawning conditions after March 1 and baseflows near the average median flow. 1998 was a very wet year with so much baseflow that steelhead were in high densities at the heads of pools and even further back where water velocity was still high, unlike other years when they primarily reared in runs and riffles. YOY recruitment into the mainstem from tributaries has apparently been minimal from 1999 onward, except for possibly at Site 4 in 2008 from lower Zayante Creek. The mainstem will need more YOY recruitment from tributaries, improved spawning gravel and higher baseflow to greatly increase the smolt ratings there.

It was the winter of 1999 when substantial sediment entered the middle mainstem from erosion in upstream tributaries that occurred from the 1998 high peak-flow event (19,400 cfs at Big Trees), followed by the 1999 water year that had a relatively low peak flow (3,200 cfs at Big Trees) that apparently could not transport the sediment out of the system. Despite the fact that substrate conditions have improved in riffles and runs in terms of reduced fine sediment and embeddedness since then, substrate in glides where spawning occurs apparently has not, and spawning habitat in the mainstem remains poor in quality and primarily sand and fine gravel.

Table 17. Density of Juvenile Steelhead for ALL SIZES at MAINSTEM SAN LORENZO RIVER Monitoring Sites (Stream Habitat) in 1997-2001 and 2003-2010.

Sample Site	1997	1998	1999	2000	2001	2003	2004	2005	2006	2007	2008	2009	2010	Avg.
0a				5.4								2.4	20.4	9.4
0b				4.3	5.2									4.8
1	34.2*	26.9	17.6	3.4	7.6				1.2	1.9	7.0	3.4	16.4	12.0
2a	74.9	21.4	4.6	3.9	13.5					14.8	20.6	9.2	28.4	21.3
2b				24.8	15.4									20.1
3	83.9	73.5	29.0	33.0	36.0									51.1
4	86.9	37.8	39.6	12.0	33.1				16.6	21.3	71.2	28.4	23.1	37.0
5		133.8	46.2	4.5	23.6									52.0
6	45.4	46.0	14.1	4.0	10.9	4.7	8.7	6.7	4.5	24.0	21.4	13.2	17.4	17.0
7	149.3	21.7	11.8	7.6	15.5	29.4	38.9	11.0						35.7
8	158.6	140.1	48.2	11.2	21.4	32.3	21.6	20.3	13.7	5.5	33.0	18.0	36.7	40.0
9	126.8	77.3	27.6	12.0	29.6	17.4	10.9	17.1						39.8
10	69.1	17.9	10.9	18.4	19.7	51.9	44.6	21.9						31.8
11	73.0	10.9	33.4	28.7	5.1	57.2	45.7	32.3	3.0	21.3	47.6	6.8	29.1	30.3
12a	56.8	30.8	21.1	39.9	49.8									39.7
12b		32.2	25.9	43.5	30.4	51.9	48.4	98.2						47.2

*** Density in number of fish per 100 feet of stream.**

Table 18. Density of Juvenile Steelhead for the YOUNG-OF-THE-YEAR Age Class at MAINSTEM SAN LORENZO RIVER Monitoring Sites (Stream Habitat) in 1997-2001 and 2003-2010.

Sample Site	1997	1998	1999	2000	2001	2003	2004	2005	2006	2007	2008	2009	2010	Avg.
0a				2.2								1.2	19.0	7.5
0b				3.3	2.3									2.8
1	32.3*	25.6	12.6	1.8	6.8				1.2	1.6	7.0	2.7	16.0	10.8
2a	66.3	19.2	3.2	2.7	11.0					13.7	19.0	8.1	27.6	19.0
2b				21.2	12.1									16.7
3	84.3	68.2	24.7	29.4	29.6									47.2
4	86.2	32.9	34.2	10.5	30.5				13.9	20.7	69.8	26.5	22.5	34.7
5		132.4	38.5	3.5	22.8									49.3
6	42.0	44.4	13.2	3.3	10.6	4.4	8.5	5.9	4.2	23.4	20.6	11.1	16.7	16.1
7	143.5	19.8	5.7	3.6	12.0	9.7	38.0	11.2						32.9
8	152.0	135.3	44.2	10.9	21.0	30.5	20.9	18.7	11.6	5.5	31.2	16.3	35.4	41.0
9	119.9	69.7	23.4	11.0	28.9	17.6	10.0	15.4						37.0
10	65.8	11.7	6.5	13.4	5.9	45.1	40.5	18.4						27.2
11	64.2	6.8	27.6	16.4	21.8	49.8	34.5	29.6	1.5	20.8	46.1	4.4	26.8	27.0
12a	50.9	27.9	5.4	34.4	37.3									31.2
12b		24.2	14.3	37.9	15.8	44.4	39.3	89.1						37.9

***Density in Number of Juveniles per 100 feet of Stream.**

Table 19. Density of Juvenile Steelhead for YEARLINGS AND OLDER at MAINSTEM SAN LORENZO RIVER Monitoring Sites in 1997-2001 and 2003-2010.

Sample Site	1997	1998	1999	2000	2001	2003	2004	2005	2006	2007	2008	2009	2010	Avg.
0a				2.2								1.2	1.7	1.7
0b				1.0	2.9									2.0
1	1.6*	1.4	2.9	1.9	0.5				0	0.3	0	0.7	0.4	1.0
2a	7.9	1.5	0.9	1.2	1.5					0.9	0.4	1.0	0.5	1.7
2b				2.4	2.0									2.2
3	5.2	5.3	3.9	4.4	6.6									5.1
4	7.6	4.7	2.2	1.2	0.5				2.4	0.2	0.3	0.4	0.6	2.0
5		2.9	5.4	1.0	0.8									2.5
6	4.6	2.2	0.8	0.7	0.5	0.3	0.2	0.8	0.3	0.7	0.03	0	0.5	0.9
7	6.0	2.5	6.3	4.8	3.6	0.4	0.3	3.0						3.0
8	5.4	4.2	4.1	0.3	0.4	2.0	2.6	2.4	1.6	0	2.0	1.5	1.0	2.1
9	4.3	8.1	2.5	1.0	0.6	0.8	1.9	2.5						2.5
10	3.3	6.4	4.6	5.5	4.1	6.8	2.7	4.7						4.7
11	8.8	3.9	6.5	11.2	4.7	7.4	3.0	7.1	1.5	0.6	1.1	2.5	2.4	4.7
12a	5.9	3.2	15.7	5.5	12.9									8.6
12b		6.8	12.6	5.5	14.3	7.5	9.1	9.3						9.3

***Density in Number of Juveniles per 100 feet of Stream.**

Table 20. Density of Juvenile Steelhead for SIZE CLASS I (<75 mm SL) at MAINSTEM SAN LORENZO RIVER Monitoring Sites (Stream Habitat) in 1997-2001 and 2003-2010.

Sample Site	1997	1998	1999	2000	2001	2003	2004	2005	2006	2007	2008	2009	2010	Avg.
0a				0								0	0.6	0.2
0b				0	0									0
1	3.3*	0.2	2.2	0	0.7				0	0.3	2.1	0	1.1	1.0
2a	7.9	1.3	0.4	0.2	2.5					3.7	8.4	1.2	6.0	3.5
2b				1.2	6.7									4.0
3	47.7	9.4	3.7	5.9	18.1									17.0
4	63.0	8.6	6.8	3.1	17.6				0.5	15.4	58.1	14.5	10.5	19.8
5		19.1	5.2	0	8.1									8.1
6	35.1	20.5	11.2	1.8	8.4	4.1	8.3	4.7	2.2	22.8	19.2	10.7	11.3	12.3
7	126.7	11.7	2.9	1.5	8.6	23.6	35.0	4.9						26.9
8	138.6	118.7	37.4	8.0	20.5	27.9	19.9	13.2	7.9	4.8	29.4	14.5	28.5	36.2
9	102.2	57.5	18.5	6.2	28.4	15.4	9.6	12.2						31.3
10	65.8	9.6	4.4	10.1	12.2	45.1	39.8	17.6						25.6
11	64.2	4.1	26.9	15.6	18.7	49.8	34.5	19.3	0	20.8	44.9	3.7	24.4	25.1
12a	50.9	26.2	5.4	34.4	40.3									31.4
12b		19.5	4.1	37.0	17.4	44.4	39.3	87.6						35.6

*** Density in number of fish per 100 feet of stream.**

Table 21. Density of Juvenile Steelhead for SIZE CLASS II/ III (=>75 mm SL) at MAINSTEM SAN LORENZO RIVER Monitoring Sites (Stream Habitat) in 1997-2001 and 2003-2010.

Sample Site	1997	1998	1999	2000	2001	2003	2004	2005	2006	2007	2008	2009	2010	Avg.
0a				5.4								2.4	19.8	9.2
0b				4.3	5.2									4.8
1	30.9*	26.7	15.4	3.4	6.9				1.2	1.6	4.9	3.4	15.3	11.0
2a	67.0	20.1	4.2	3.7	11.0					11.1	12.2	8.0	22.4	17.7
2b				23.6	8.7									16.2
3	36.2	64.1	25.3	27.1	17.9									34.1
4	23.8	29.2	32.8	8.9	15.5				16.2	6.0	13.2	13.9	12.6	17.2
5		114.7	41.0	4.5	15.5									43.9
6	10.3	25.5	2.9	2.2	2.5	0.6	0.4	2.0	2.3	1.2	2.2	0.5	6.1	4.5
7	22.6	10.0	8.9	6.1	6.9	5.8	3.9	6.1						8.8
8	20.0	21.4	10.8	3.2	0.9	4.4	1.7	7.1	5.8	0.7	3.6	3.5	8.2	7.0
9	24.6	19.8	9.1	5.8	1.2	2.0	1.3	4.9						8.6
10	3.3	8.3	6.5	8.3	7.5	6.8	4.8	4.3						6.2
11	8.8	6.8	6.5	13.1	6.4	7.4	11.2	13.0	3.0	0.6	2.8	3.1	4.7	6.7
12a	5.9	4.6	15.7	5.5	9.5									8.2
12b		12.7	21.8	6.5	13.0	7.5	9.1	10.6						11.6

*** Density in number of fish per 100 feet of stream.**

In tributaries of the San Lorenzo River, no overall trend occurred between 2009 and 2010 regarding total or YOY juvenile steelhead densities. Sites where they increased were lower Zayante 13a, middle Bean 14b, Newell 16 and Bear 18a (**Tables 22 and 23**). Sites where they decreased decidedly were upper Zayante 13d and Lompico 13e. Other sites had similar densities between years. All tributary sites except for those in Zayante and upper Bean 14c in 2010 still had much below average total and YOY densities (**Figures 1 and 2**). 2010 yearling densities in tributaries were generally similar to or less than 2009 and generally much below average (**Figure 3; Table 24**). Only in Lompico 13e and Fall 15 sites, where growth rate is especially slow, were yearling densities near average. High spring baseflows may have encouraged yearlings to immigrate early. High stormflows in January may have reduced yearling survival. ***The peak flow of the 2010 water year was…….compared to the 1.3 and 1.5 year bankfull storms of 2,800 and 4,300 cfs, respectively. (need data)***

Size Class II densities in 2010 tributaries were generally similar to or greater than (at 9 of 11 sites) those in 2009 (**Table 25**), and the increase was statistically significant for the watershed (**Table 39**). Increases in Zayante 13a and 13c, Newell 16 and Bear 18a were attributed to more YOY reaching Size Class II despite more competition between YOY in 2010 and similar or greater percentages of YOY reaching Size Class II compared to 2009 (**Figure 17**). Size Class II densities were much above average at Zayante 13a, Zayante 13c and Newell 16 for these reasons and the highest in the watershed (**Figure 4**). High spring-early summer baseflows likely stimulated YOY growth in these cases (**Figure 56**). The much below average densities in Bean 14b and 14c were likely due to low 2009 YOY recruitment to yearlings. Zayante 13d had below average Size Class II density with fewer yearlings and insufficient growth rate to bring YOY into Size Class II. Smolt ratings improved in 2010, with 10 of 12 sites rated "Fair" or better and only 2 sites rated "Below Average" (Bean 14b and 14c) (**Table 37**).

Continued low yearling and Size Class II and III densities in middle Bean 14b, lower Boulder Creek 17a and lower Bear Creek 18a may have resulted from low YOY recruitment from 2009, poor overwinter survival of yearlings and early yearling out-migration associated with higher spring-early summer growth rates with high water clarity between stormflows. YOY density the previous fall were very low and much below average at these sites (**Table 23**). Rearing habitat conditions at replicated sites in Bean 14b and Boulder 17a were similar to 2009 conditions. Bear Creek comparisons were not possible because sampling sites changed.

Yearling and Size Class 2 and 3 densities in upper Zayante 13d and Fall 15 continued to be relatively high in 2010, presumably due to better rearing habitat and better overwintering survival than other sites. Escape cover and overwintering cover were higher at Zayante 13d due to higher incidence of larger, unembedded boulders and at Fall 15 due to higher incidence of instream wood.

Table 22. TOTAL DENSITY of Juvenile Steelhead at SAN LORENZO TRIBUTARY Monitoring Sites in 1997-2001 and 2003-2010.

Sample Site	1997	1998	1999	2000	2001	2003	2004	2005	2006	2007	2008	2009	2010	Avg.
Zayante 13a		83.0	104.0	46.6	54.8	68.3	69.9	53.6	17.0	66.9	84.8	29.9	61.4	61.7
Zayante 13b	74.9*	50.7	74.9	24.9	38.0	70.0	65.1	53.3						56.5
Zayante 13c		69.0	61.9	25.8	40.0	123.6	63.4	78.2	18.0	94.4	112.2	74.1	66.6	68.9
Zayante 13d		82.2	105.0	57.5	84.1	243.8	145.3	99.7	69.8	80.5	131.7	105.5	91.9	100.0
Lompico 13e									26.2	108.3	27.8	123.3	23.1	61.7
Bean 14a		44.2	45.9	17.0	38.0	50.9	31.9	54.0						45.4
Bean 14b	73.0	115.6	92.1	48.3	65.5	146.4	78.5	103.5	13.1	8.9	67.6	11.2	32.8	65.9
Bean 14c		78.2	22.7	87.5	36.8	41.3	99.6	87.4	66.0	18.2	Dry		58.8	59.6
Fall 15	84.5	82.7	85.0	55.0	59.8						84.0	48.7	46.1	68.2
Newell 16	94.9	76.3	40.5	28.8	40.3				26.0			18.6	32.5	44.8
Boulder 17a	134.2	149.2	68.5	32.0	61.1	60.0	38.6	40.1	30.7	62.7	69.9	13.6	19.2	60.0
Boulder 17b	100.7	74.9	49.5	43.0	51.8	98.6	54.2	70.2	57.6	45.1	97.8	44.0	43.4	63.9
Boulder 17c		42.8	33.9	36.0	39.4	75.8	81.5	67.4						53.9
Bear 18a	118.5	81.2	76.0	33.6	58.8	86.8	87.7	87.9	52.9	47.3	69.6	20.7	47.6	66.9
Bear 18b		69.5	116.1	67.6	63.5									79.2
Kings 19a		10.8	0.5	8.4	7.6									6.8
Kings 19b	52.7	22.9	44.9	37.5	41.6									39.9
Carbonera 20a	13.4	21.0	18.9	9.7	19.6									16.5
Carbonera 20b		53.4	51.7	45.2	45.2									48.9
Branciforte 21a-1										6.6	3.3			5.0
Branciforte 21a-2	70.0	60.2	47.1	65.2	45.2				29.5	49.1	33.0	20.0	15.7	33.3
Branciforte 21b		67.8	57.6	59.6	57.5			20.4						52.1

*** Density in number of fish per 100 feet of stream.**

Table 23. Density of Juvenile Steelhead for YOUNG-OF-THE-YEAR Fish (and Size Class I Juveniles in Most Years) at SAN LORENZO TRIBUTARY Monitoring Sites in 1997-2001 and 2003-2010.

Sample Site	1997	1998	1999	2000	2001	2003	2004	2005	2006	2007	2008	2009	2010	Avg.
Zayante 13a		80.0	96.4	29.0	52.9	64.4	68.3	50.1	14.6	62.1	82.3	26.1	58.3	57.1
Zayante 13b	64.9*	43.5	60.6	7.7	31.2	60.4	58.7	48.1						46.9
Zayante 13c		66.9	50.2	9.4	30.9	112.9	53.2	74.2	17.1	85.1	109.4	65.0	59.4	61.1
Zayante 13d		77.4	77.7	41.9	67.0	220.6	130.0	88.5	68.0	63.1	107.0	88.6	83.3	92.7
Lompico 13e									24.2	96.9	21.4	118.4	14.4	55.0
Bean 14a		43.4	42.0	11.1	36.0	46.4	30.0	50.9						37.1
Bean 14b	60.7	104.3	59.0	41.3	60.2	137.3	70.3	84.7	10.9	0	63.0	4.9	31.7	56.1
Bean 14c		71.8	6.9	76.6	18.1	23.0	87.4	81.5	61.1	5.6	0 (Dry)		55.7	49.2
Fall 15	79.6	74.8	68.1	45.1	45.4						68.2	30.6	33.5	55.6
Newell 16	77.1	67.6	17.7	19.9	35.6				20.1			15.0	31.2	38.5
Boulder 17a	119.2	141.5	50.7	22.9	55.9	45.6	31.3	36.5	25.3	55.9	64.9	9.3	16.3	52.0
Boulder 17b	91.8	68.0	36.2	33.9	38.9	84.1	48.0	62.0	56.1	35.1	94.1	33.3	39.6	55.5
Boulder 17c		37.6	15.3	27.5	30.7	64.0	69.7	61.3						43.7
Bear 18a	100.2	72.4	57.9	12.6	50.8	75.0	76.6	75.2	51.0	41.7	64.5	19.1	24.2	57.0
Bear 18b		66.6	89.2	58.3	48.1									65.6
Kings 19a		9.8	0	6.6	6.0									5.6
Kings 19b	48.2	20.8	32.1	31.5	28.5									32.2
Carbonera 20a	9.1	17.2	13.2	5.6	16.5									12.3
Carbonera 20b		50.9	40.3	29.7	33.4									38.6
Branciforte 21a-1										2.8	2.7			2.8
Branciforte 21a-2	64.6	54.1	35.5	47.2	34.2				30.6	47.6	27.3	12.5	11.2	36.5
Branciforte 21b		60.1	44.2	45.8	49.4			9.1						41.7

*** Density in number of fish per 100 feet of stream.**

Table 24. Density of Juvenile Steelhead for YEARLING and OLDER Fish at SAN LORENZO TRIBUTARY Monitoring Sites in 1997-2001 and 2003-2010.

Sample Site	1997	1998	1999	2000	2001	2003	2004	2005	2006	2007	2008	2009	2010	Avg.
Zayante 13a		3.0	7.6	17.7	1.9	3.9	1.6	3.5	3.2	4.9	2.1	2.6	2.9	4.6
Zayante 13b	10.0*	7.2	14.3	17.2	6.8	9.6	6.4	5.2						13.2
Zayante 13c		2.1	11.7	16.4	9.1	10.7	10.2	4.0	1.0	8.8	2.9	9.1	7.6	7.8
Zayante 13d		4.7	27.3	15.6	17.1	23.2	15.3	11.2	1.7	17.4	24.0	16.9	8.6	15.2
Lompico 13e									1.9	11.3	6.4	4.9	8.7	6.6
Bean 14a		0.8	3.9	5.9	2.0	4.5	1.9	3.1						4.6
Bean 14b	12.3	11.3	33.1	7.0	5.3	9.1	8.2	18.8	2.0	8.9	3.7	5.6	0.8	9.8
Bean 14c		6.4	15.8	10.9	18.7	18.3	12.2	5.9	4.1	5.4	0 (Dry)		3.1	9.4
Fall 15	4.9	7.9	16.9	9.9	14.4						15.8	18.0	12.3	12.5
Newell 16	17.8	8.7	22.8	8.9	4.7				5.4			3.9	1.5	9.2
Boulder 17a	15.0	7.7	17.8	9.1	5.2	14.4	7.3	3.6	5.9	6.8	5.8	4.1	2.8	8.2
Boulder 17b	8.9	6.9	13.3	9.1	12.9	14.5	6.2	8.2	1.1	9.8	3.8	10.7	3.6	8.4
Boulder 17c		5.2	18.6	8.5	8.7	11.8	11.8	6.1						10.4
Bear 18a	18.3	7.8	18.1	21.0	8.0	11.8	11.1	12.7	1.6	5.7	5.1	2.0	3.5	9.8
Bear 18b		2.9	26.9	9.3	15.4									13.6
Kings 19a		1.0	0.5	1.8	1.6									1.2
Kings 19b	4.5	2.1	12.8	6.0	13.1									7.7
Carbonera 20a	4.3	3.8	5.7	4.1	3.1									4.2
Carbonera 20b		2.5	11.4	15.5	11.8									10.3
Branc. 21a-1										3.9	0.5			2.2
Branc. 21a-2	5.4	6.1	11.6	18.0	11.0				0	1.5	5.7	7.5	4.4	7.1
Branc. 21b		7.6	13.4	11.1	8.1			11.3						12.7

*** Density in number of fish per 100 feet of stream.**

Table 25. Density of Juvenile Steelhead for SIZE CLASS II/III (=>75 mm SL) Fish at SAN LORENZO TRIBUTARY Monitoring Sites in 1998-2001 and 2003-2010.

Sample Site	1998	1999	2000	2001	2003	2004	2005	2006	2007	2008	2009	2010	Avg.
Zayante 13a	12.3*	13.5	17.7	1.9	3.9	1.6	31.4	11.7	4.9	6.3	12.1	18.8	11.3
Zayante 13b	14.9	19.9	17.2	7.1	9.6	6.4	17.3						13.2
Zayante 13c	14.7	16.8	16.4	9.5	10.7	10.2	15.0	12.6	8.8	4.4	10.4	24.5	12.9
Zayante 13d	10.7	27.3	15.6	17.1	23.2	5.3	15.7	17.3	17.4	22.5	16.9	9.1	17.4
Lompico 13e								5.7	11.3	6.4	4.9	8.7	7.4
Bean 14a	2.1	3.9	5.9	2.0	4.5	1.9	12.0						4.6
Bean 14b	11.3	33.1	7.1	5.3	9.1	8.2	39.4	11.9	8.9	4.7	10.9	8.4	13.3
Bean 14c	6.4	15.8	10.9	18.4	18.3	12.2	12.4	17.1	5.4	0 (Dry)		6.7	12.4
Fall 15	13.3	16.9	9.9	13.0						15.8	18.7	14.3	14.6
Newell 16	14.9	22.8	8.9	4.7				16.2			4.4	24.7	13.8
Boulder 17a	21.9	17.8	9.1	5.2	16.9	7.3	9.0	18.2	6.8	7.2	5.5	11.8	11.5
Boulder 17b	11.5	13.3	9.1	12.9	14.5	6.2	8.2	13.7	9.8	3.8	10.7	12.7	10.5
Boulder 17c	5.2	18.6	8.5	8.7	11.8	11.8	8.4						10.4
Bear 18a	13.0	18.1	21.0	8.0	11.8	11.1	13.7	13.6	5.7	5.1	2.5	9.5	11.2
Bear 18b	6.2	26.9	9.3	13.2									13.9
Kings 19a	6.2	0.5	1.8	1.6									2.5
Kings 19b	6.2	12.8	6.0	10.0									8.8
Carbonera 20a	11.5	5.7	4.1	3.1									6.1
Carbonera 20b	11.4	11.4	15.5	11.8									12.5
Branciforte 21a-1									3.9	0.5			2.2
Branciforte 21a-2	8.5	11.6	18.0	10.8				10.8	1.5	5.7	7.5	12.6	6.9
Branciforte 21b	14.8	13.4	11.1	8.1			16.0						12.7

*** Density in number of fish per 100 feet of stream.**

R-8. 2010 Densities in Soquel Creek Compared with Those Since 1997

The pattern of 2010 juvenile densities compared to average densities in Soquel Creek was similar to the pattern in San Lorenzo tributaries. Total densities were generally below average, YOY densities were generally below average (but even more so), yearling densities were similar or slightly below average (but not as much), while Size Class II densities were much above average at some sites where YOY growth rate was sufficient to bring YOY into Size Class II (mainstem Site 10, lower East Branch 13a and lower West Branch 19) (**Figures 5−8; Tables 26−30**).

In Soquel Creek in 2010, total juvenile steelhead densities were much lower than in 2009 (8 of 8 sites) (**Figure 4; Table 31**), and the decline was statistically significant (**Table 41**). This was due to much lower YOY densities in 2010 (6 of 8 sites) (**Table 27**). 2010 yearling densities remained similarly low as in 2009 and near or below average, with density cut in half at the upper East Branch 16 site (**Table 28 and Figure 7**), similar to the upper Zayante 13d in the San Lorenzo watershed. Size Class I densities were much reduced in 2010 because of the fewer YOY and faster growth rate (**Table 29**). There was no trend in differences in Size Class II and III juvenile densities from 2009 to 2010, with sites that showed high YOY densities and good growth rate of YOY having greater Size Class II densities (mainstem 10, East Branch 13a and West Branch 21) (**Table 30; Figure 18**). These faster YOY growth rates were evident throughout the watershed (except in upper East Branch 16a in the Soquel Demonstration State Forest) because of reduced juvenile densities, less competition and higher spring and summer baseflow (**Figures 54 and 57**). Due to faster YOY growth, 5 of 8 sites had above average Size Class II and III densities (**Figure 8**). Of the 8 sampling sites rated according to Size Class II and III (smolt) densities, 5 of 8 sites in 2010 had improved ratings over 2009, with both East Branch sites and the upper West Branch sites rated "Good" (**Table 37**). These improved ratings were consistent with positive physical habitat change and increased baseflow. Apparently, the lower overall juvenile densities and increased baseflow allowed sufficient increased growth rates of YOY into Size Class II to overcome the lower YOY densities at many sites. The fewer yearlings that remained at East Branch 16a were of sufficient size to increase the rating to "Good."

Table 26. TOTAL Juvenile Steelhead SITE DENSITIES (fish/ 100 ft) at Monitoring Sites in SOQUEL CREEK in 1997–2010.
(Resident rainbow trout likely present at Sites 18 and 22).

Sample Site	1997 E-M	1998 L-W	1999 L-W	2000 E-W	2001 E-D	2002 E-D	2003 L-W	2004 E-D	2005 L-W	2006 L-W	2007 E-D	2008 E-D	2009 E-D	2010 L-W	Avg
1- Near GrangeHall	2.9	5.6	3.0	2.4	3.5	7.4	2.5	1.7	9.5	-	15.8	8.7	7.7	9.5	6.3
2- Adj. USGS Gage	4.5	9.4	1.2	5.9	7.7	-	4.1	3.5	4.2	-	-	-			5.1
3- Above Bates Ck	13.2	50.6	7.6	2.2	8.4	14.8	-	-	7.9	-	-	-			15.0
4- Adj. Flower Fld	49.6	20.7	6.8	5.5	23.0	33.3	7.7	20.1	9.2	3.2	23.5	63.0	18.6	5.3	20.6
5-Adj. Beach Shk	50.3	20.6	8.1	9.2	28.0	-	-	-	-	-	-	-			23.2
6- End of Cherryvale	24.7	9.4	2.6	5.3	5.7	47.6	15.9	13.1	16.1	-	-	-			15.6
7- Adj. Orchard	96.6	14.0	5.6	2.0	27.5	-	-	-	-	-	-	-			29.1
8- Below Rivervale	21.0	10.7	4.1	4.9	12.4	59.2	-	-	-	-	-	-			18.7
9- Adj. Mt. School	61.6	18.4	5.1	7.9	20.7	94.8	26.2	45.8	26.8	-	-	-			28.2
10- Above Allred	54.2	11.9	9.1	9.2	15.5	70.7	19.9	37.2	26.2	12.1	54.3	105.8	18.0	15.0	32.8
11- Below Purling Br	81.9	13.1	10.5	13.1	31.6	-	-	-	-	-	-	-			30.0
12- Near Soquel Ck Bridge	83.5	19.5	17.4	12.0	34.4	65.5	20.1	48.5	21.3	-	50.7	61.8	37.4	12.3	37.2
13a- Below Mill Pond	79.4	57.6	21.5	22.8	26.2	142.0	33.3	110.5	46.9	3.2	35.0	57.9	22.8	37.1	49.7
13b- Below Hinckley	-	-	17.0	24.4	47.3	110.6	-	-	-	-	-	-			49.8
14- Above Hinckley	49.6	47.7	23.6	18.5	37.7	107.6	86.0	78.0	39.5	-	-	-			54.2
15- Below Amaya Ck	137.9	79.9	55.4	39.0	38.3	91.6	-	-	-	-	-	-			73.7
16- Above Amaya Ck*	153.2	179.7	283.5	122.6	85.7	121.9	134.6	98.7	127.3	69.4	57.0	76.0	107.2	71.4	120.
17- Above Fern Glch*	138.3	104.2	170.9	93.8	96.3	129.5	102.4	117.2	157.3	-	-	-			123.
18- Above Ashbury G*	44.1	24.5	53.0	-	-	-	-	-	-	-	-	-			40.5
19- Below Hester Ck	62.3	21.7	32.1	27.6	37.8	-	-	-	-	8.3	26.5	70.7	43.1	13.0	30.4
20- Above Hester Ck	-	28.2	36.9	37.7	28.3	52.1	49.1	87.2	50.2	22.9		-			43.6
21- Above GS Falls I	-	-	-	-	-	119.0	112.9	99.4	102.0	44.2**	68.3**	-	49.9	26.2	77.7
22- Abv GS Falls II	-	-	-	-	-	65.5	27.5	58.1	5.5	8.6	-	-			33.1

*** Raw data obtained from the Soquel Demonstration State Forest, 1997–1999.**
**** Raw Data obtained from NOAA Fisheries in 2006 and 2007.**

Table 27. SITE DENSITIES (fish/ 100 ft) of Juvenile Steelhead by YOUNG-OF-THE-YEAR AGE CLASS at Monitoring Sites in SOQUEL CREEK in 1997–2009.

(Resident rainbow trout likely present at Sites 18 and 22).

Sample Site	1997 E-M	1998 L-W	1999 L-W	2000 E-W	2001 E-D	2002 E-D	2003 L-W	2004 E-D	2005 L-W	2006 L-W	2007 E-D	2008 E-D	2009 E-D	2010 L-W	Avg
1- Near GrangeHall	6.1	4.3	1.0	0.9	2.8	6.7	1.7	1.2	8.6	-	14.6	8.0	6.1	8.1	5.4
2- Adj. USGS Gage	4.1	8.3	0.4	5.3	6.3	-	4.9	3.5	2.6	-	-	-			4.4
3- Above Bates Ck	11.7	48.0	5.6	2.0	8.2	14.1	-	-	6.7	-	-	-			13.8
4- Adj. Flower Fld	45.7	18.2	6.2	3.5	19.9	28.8	7.1	19.4	8.7	2.4	22.2	61.4	14.4	4.2	18.7
5-Adj. Beach Shk	54.0	19.2	5.8	7.6	27.2	-	-	-	-	-	-	-			22.8
6- End of Cherryvale	21.1	8.3	2.4	4.4	5.1	46.4	15.8	12.8	12.9	-	-	-			14.4
7- Adj. Orchard	94.0	13.6	5.2	1.6	26.4	-	-	-	-	-	-	-			28.2
8- Below Rivervale	18.9	9.9	3.9	1.7	11.4	57.2	-	-	-	-	-	-			17.2
9- Adj. Mt. School	53.4	16.0	4.5	4.9	18.8	92.5	22.7	43.6	22.2	-	-	-			31.0
10- Above Allred	52.2	10.8	7.8	7.9	12.9	68.8	17.2	36.3	22.3	11.8	51.9	105.3	17.1	12.3	29.1
11- Below Purling Br	78.3	12.4	9.5	10.2	31.7	-	-	-	-	-	-	-			28.4
12- Near Soquel Ck Rd Bridge	79.8	18.7	14.4	11.2	33.1	65.1	19.7	48.6	9.3	-	49.2	61.5	33.5	12.3	35.1
13a- Below Mill Pond	75.3	57.4	20.9	24.5	24.0	73.4	30.9	109.9	41.7	2.5	34.6	55.0	21.4	35.2	43.4
13b- Below Hinckley	-	-	16.2	22.0	45.9	109.5	-	-	-	-	-	-			48.4
14- Above Hinckley	46.9	46.6	24.7	14.6	37.2	104.6	83.7	76.8	36.7	-	-	-			52.4
15- Below Amaya Ck	139.0	76.9	49.6	35.8	35.4	87.1	-	-	-	-	-	-			70.6
16- Above Amaya Ck*	148.6	171.9	271.6	123.8	77.6	113.9	131.1	96.4	122.4	65.8	37.1	67.3	93.5	63.9	113.1
17- Above Fern Glch*	131.9	101.3	159.4	84.7	8.1	112.4	4.4	10.1	147.9	-	-	-			113.4
18- Above Ashbury G*	29.4	24.8	33.3	-	-	-	-	-	-	-	-	-			29.2
19- Below Hester Ck	60.6	5.7	30.8	27.0	36.6	-	-	-	-	8.3	24.9	70.4	38.3	12.5	31.5
20- Above Hester Ck	-	30.6	36.3	34.3	26.2	49.2	45.3	84.9	49.4	21.5	-	-			41.9
21- Above GS Falls I	-	-	-	-	-	107.2	104.0	93.7	98.7	42.7**	63.2**	-	44.9	20.8	71.9
22- Abv GS Falls II	-	-	-	-	-	56.2	24.7	53.2	1.0	6.1	-	-			28.2

*** Raw data obtained from the Soquel Demonstration State Forest, 1997–1999.**
**** Raw data obtained from NOAA Fisheries in 2006 and 2007.**
E=early large stormflows before March 1, L=late large stormflows after March 1, M=near median baseflow, D="dry"-below median baseflow, W="wet"-above median baseflow

Table 28. SITE DENSITIES (fish/ 100 ft) of Juvenile Steelhead by YEARLING AND OLDER AGE CLASS at Monitoring Sites in SOQUEL CREEK in 1997–2010.
(Resident rainbow trout likely present at Sites 18 and 22).

Sample Site	1997 E-M	1998 L-W	1999 L-W	2000 E-W	2001 E-D	2002 E-D	2003 L-W	2004 E-D	2005 L-W	2006 L-W	2007 E-D	2008 E-D	2009 E-D	2010 L-W	Avg.
1- Near Grange Hall	1.2	1.5	1.0	1.9	0.7	0.6	0.9	0.5	1.0	–	1.0	0.7	1.6	1.9	1.1
2- Adj. USGS Gage	0.6	1.2	0.4	0.5	1.4	–	0	0	1.3	–	–	–			0.7
3- Above Bates Ck	2.5	2.6	2.0	0.5	0.2	0.5	–	–	1.3	–	–	–			1.4
4- Adj. Flower Fld	2.2	1.5	0.9	2.0	0.7	2.6	0.6	0.7	0.6	0.7	2.2	1.6	1.9	0.7	1.3
5-Adj. Beach Shk	2.8	1.4	2.0	1.6	0.5	–	–	–	–	–	–	–			1.7
6- End of Cherryvale	3.2	1.7	0.7	1.0	0.5	1.3	0	0.3	3.1	–	–	–			1.3
7- Adj. Orchard	2.2	0.5	0.4	0.4	1.1	–	–	–	–	–	–	–			0.9
8- Below Rivervale	1.0	0.9	0.7	3.1	1.4	1.6	–	–	–	–	–	–			1.5
9- Adj. Mt. School	3.4	1.7	1.3	4.7	1.7	2.6	3.6	2.3	4.5	–	–	–			2.9
10- Above Allred	1.3	1.1	1.3	1.1	0.9	1.8	3.0	0.2	2.9	0.4	4.3	0.4	0.7	0.7	1.3
11- Below Purling Br	2.7	0.6	2.2	4.1	0.3	–	–	–	–	–	–	–			2.0
12- Near Soquel Ck Rd Bridge	3.6	0.5	2.0	1.1	0.9	0.3	0.5	0	1.9	–	1.5	0.3	3.2	0	1.3
13a- Below Mill Pond	7.1	0	1.1	2.9	2.1	2.6	2.1	0.6	5.3	0.7	0.7	2.9	1.6	1.9	2.2
13b- Below Hinckley	–	–	1.1	4.7	1.4	2.0	–	–	–	–	–	–			2.3
14- Above Hinckley	2.6	1.0	1.6	4.8	1.9	2.9	1.4	0.6	2.8	–	–	–			2.2
15- Below Amaya Ck	0	2.5	6.7	4.0	2.9	4.3	–	–	–	–	–	–			3.4
16- Above Amaya Ck*	3.6	5.4	11.6	2.8	8.1	8.0	3.5	2.3	4.4	3.5	20.0	11.0	13.1	7.5	7.5
17- Above Fern Gch*	5.7	3.1	11.5	6.9	18.2	17.0	7.8	7.1	9.6	–	–	–			9.7
18- Above Ashbury G*	13.8	9.6	19.8	–	–	–	–	–	–	–	–	–			14.4
19- Below Hester Ck	1.2	0.4	1.6	1.2	1.2	–	–	–	–	0.3	1.6	0.4	4.6	0.4	1.4
20- Above Hester Ck	–	0.3	0.3	3.0	2.1	2.9	3.8	2.3	1.0	0.6	–	–			1.8
21- Above GS Falls I	–	–	–	–	–	11.9	8.8	5.3	2.1	1.2**	5.1**	–	4.9	5.7	5.6
22- Abv GS Falls II	–	–	–	–	–	9.3	2.8	4.9	4.5	2.5	–	–			4.8

*** Raw data obtained from the Soquel Demonstration State Forest, 1997–1999.**
**** Raw Data obtained from NOAA Fisheries in 2006 and 2007.**
E=early large stormflows before March 1, L=late large stormflows after March 1, M=near median baseflow, D="dry"-below median baseflow, W="wet"-above median baseflow

Table 29. SITE DENSITIES (fish/ 100 ft) of Juvenile Steelhead by SIZE CLASS I at Monitoring Sites in SOQUEL CREEK in 1997–2010.
(Resident rainbow trout likely present at Sites 18 and 22).

Sample Site	1997 E-M	1998 L-W	1999 L-W	2000 E-W	2001 E-D	2002 E-D	2003 L-W	2004 E-D	2005 L-W	2006 L-W	2007 E-D	2008 E-D	2009 E-D	2010 L-W	Avg.
1- Near GrangeHall	1.7	0.2	0	0	0.5	3.5	0.3	0.5	0	-	9.2	4.9	2.6	1.6	2.0
2- Adj. USGS Gage	0.9	0.2	0	0	2.2	3.5	1.7	1.9	0	-	-	-			0.9
3- Above Bates Ck	1.8	0	0	0.9	4.0	10.4	-	-	0	-	-	-			2.4
4- Adj. Flower Fld	20.1	1.5	0	0.5	7.6	20.0	4.4	13.8	0	0.4	17.2	58.1	10.5	0.4	11.0
5-Adj. Beach Shk	38.2	0	0.3	1.1	21.6	-	-	-	-	-	-	-			12.2
6- End of Cherryvale	14.3	0	0	0	2.8	42.9	13.7	12.5	0.4	-	-	-			9.6
7- Adj. Orchard	71.6	1.0	1.6	0.4	21.5	-	-	-	-	-	-	-			19.2
8- Below Rivervale	11.7	0.2	1.0	0.2	6.3	49.6	-	-	-	-	-	-			11.5
9- Adj. Mt. School	36.7	1.1	0.4	0.5	6.6	79.7	12.7	27.1	2.1	-	-	-			18.5
10- Above Allred	43.2	0	3.3	0	9.4	60.8	13.8	34.7	3.5	5.8	43.0	102.7	11.8	1.0	23.8
11- Below Purling Br	60.5	0.9	4.1	2.8	29.1	-	-	-	-	-	-	-			19.5
12- Near Soquel Ck Rd Bridge	68.1	3.8	9.2	5.9	28.9	60.1	16.3	44.0	4.5	-	45.9	60.4	25.5	4.3	29.0
13a- Below Mill Pond	60.2	30.4	13.0	16.4	23.1	138.3	29.8	109.9	20.8	0	31.8	53.9	11.6	4.3	38.8
13b- Below Hinckley	-	-	3.2	15.8	43.9	105.1	-	-	-	-	-	-			42.0
14- Above Hinckley	27.4	26.9	11.8	3.5	24.3	101.7	78.9	76.1	17.8	-	-	-			40.9
15- Below Amaya Ck	130.4	64.1	38.2	30.5	35.4	84.9	-	-	-	-	-	-			63.9
16- Above Amaya Ck*	143.3	164.8	267.8	114.7	77.6	113.9	131.1	96.4	118.2	60.3	37.1	66.0	94.1	63.4	110.7
17- Above Fern Glch*	130.3	90.1	151.7	82.4	78.1	112.4	94.4	110.1	130.9	-	-	-			108.9
18- Above Ashbury G*	29.2	20.6	33.2	-	-	-	-	-	-	-	-	-			27.7
19- Below Hester Ck	60.1	20.4	23.4	24.5	36.6	-	-	-	-	3.6	21.7	65.0	29.0	1.4	28.6
20- Above Hester Ck	-	20.6	33.2	32.4	26.2	49.2	45.3	84.9	47.3	17.1	-	-			39.6
21- Above GS Falls I	-	-	-	-	-	107.2	103.1	91.8	90.0	30.1**	61.3**	-	43.1	8.7	66.9
22- Abv GS Falls II	-	-	-	-	-	56.2	24.7	50.9	0.3	3.9	-	-			27.2

*** Raw data obtained from the Soquel Demonstration State Forest, 1997–1999.**
**** Raw data obtained from NOAA Fisheries in 2006 and 2007.**
E=early large stormflows before March 1, L=late large stormflows after March 1, M=near median baseflow, D=”dry”-below median baseflow, W=”wet”-above median baseflow

Table 30. SITE DENSITIES (fish/ 100 ft) of Juvenile Steelhead by SIZE CLASS II/III at Monitoring Sites in SOQUEL CREEK in 1997–2010.
(Resident rainbow trout likely present at Sites 18 and 22).

Sample Site	1997 E-M	1998 L-W	1999 L-W	2000 E-W	2001 L-D	2002 E-D	2003 L-W	2004 E-D	2005 L-W	2006 L-W	2007 E-D	2008 E-D	2009 E-D	2010 L-W	Avg
1- Near GrangeHall	1.2	5.4	3.0	2.4	3.0	3.9	2.3	1.2	9.5	-	6.6	3.8	5.1	7.9	4.2
2- Adj. USGS Gage	3.6	9.4	0.8	5.9	5.5	-	2.4	1.6	4.2	-	-	-			4.2
3- Above Bates Ck	11.4	50.6	7.6	1.3	4.4	4.4	-	-	7.9	-	-	-			12.5
4- Adj. Flower Fld	29.5	19.2	6.8	5.0	15.4	13.3	3.3	6.3	9.2	2.8	6.3	4.9	8.1	4.9	9.7
5-Adj. Beach Shk	18.1	20.6	7.8	8.1	6.4	-	-	-	-	-	-	-			12.2
6- End of Cherryvale	10.4	9.4	2.6	5.3	2.9	4.7	2.2	0.6	15.7	-	-	-			6.0
7- Adj. Orchard	25.0	13.0	4.0	1.6	6.0	-	-	-	-	-	-	-			9.9
8- Below Rivervale	9.3	10.5	3.1	4.7	6.1	9.6	-	-	-	-	-	-			7.2
9- Adj. Mt. School	24.9	17.3	4.7	7.4	14.1	15.1	13.5	18.7	24.7	-	-	-			15.6
10- Above Allred	11.0	11.9	5.8	9.2	6.1	9.9	6.1	2.5	22.7	6.3	11.3	3.1	6.2	14.0	9.1
11- Below Purling Br	21.4	12.2	6.4	10.3	2.5	-	-	-	-	-	-	-			10.6
12- Near Soquel Ck Rd Bridge	15.4	15.7	8.2	6.1	5.5	5.4	3.8	4.5	16.8	-	4.8	1.5	11.9	8.0	8.3
13a- Below Mill Pond	19.2	27.2	8.5	6.4	3.1	3.7	3.5	0.6	26.1	3.2	3.1	4.0	11.2	32.8	10.9
13b- Below Hinckley	-	-	13.8	8.6	3.4	5.5	-	-	-	-	-	-			7.8
14- Above Hinckley	22.2	20.8	11.8	15.0	13.4	5.9	7.1	1.9	21.7	-	-	-			13.3
15- Below Amaya Ck	7.5	15.8	17.2	8.5	2.9	6.7	-	-	-	-	-	-			9.8
16- Above Amaya Ck*	9.9	14.9	15.7	7.9	8.1	8.0	3.5	2.3	9.1	9.1	20.0	10.0	13.1	8.0	10.1
17- Above Fern Glch*	8.0	14.1	19.2	11.4	18.2	17.1	8.0	7.1	26.4	-	-	-			14.4
18- Above Ashbury G*	14.9	3.9	19.8	-	-	-	-	-	-	-	-	-			12.9
19- Below Hester Ck	2.2	1.3	8.7	3.1	1.2	-	-	-	-	4.7	4.8	5.7	14.1	11.6	5.8
20- Above Hester Ck	-	7.6	3.7	5.3	2.1	2.9	3.8	2.3	2.9	5.8	-	-			4.0
21- Above GS Falls I	-	-	-	-	-	11.8	9.8	7.6	12.0	14.1 **	7.5**	-	6.8	17.5	10.9
22- Above GS Falls II	-	-	-	-	-	9.3	2.8	7.2	5.2	4.7	-	-			5.8

*** Raw data obtained from the Soquel Demonstration State Forest, 1997–1999.**
****Raw data obtained from NOAA Fisheries in 2006 and 2007.**
E=early large stormflows before March 1, L=late large stormflows after March 1, M=near median baseflow, D="dry"-below median baseflow, W="wet"-above median baseflow

R-9. Comparison of 2010 Densities in Aptos and Valencia Creeks with Previous Years

The Aptos Watershed sampling sites did not clearly follow the pattern of consistently below average total and YOY densities in 2010 that were observed in the Soquel and San Lorenzo watersheds. The lower site in Aptos and the upper site in Valencia had slightly above average densities of both categories, although the other two sites were below average (**Figures 9 and 10**). Below average yearling and older densities in the Aptos watershed followed the pattern found in the other two watersheds except the upper Valencia site, which remained average (**Figure 11**), analogous to Fall Creek in the San Lorenzo system which also likely has resident trout. Yearling abundance was less than in 2009 at all 4 sites (Table 33). Size Class II densities in the Aptos sites were near or above average because of the high YOY growth rate in 2010 (**Figure 12**). Size Class II densities in the Valencia sites were below average at the lower site and near average at the upper site, mirroring the yearling and older densities in a tributary where YOY cannot grow into Size Class II.

Unlike in Soquel Creek, total densities increased in the Aptos watershed in 2010 from very low densities in 2009, resulting from much higher YOY densities in 2010 (statistically significant- **Table 42**) (**Tables 31 and 32**). As in the San Lorenzo and Soquel watersheds, yearling and older densities decreased in 2010 (statistically significant- **Table 42**), which was consistent with very poor recruitment of 2009 YOY (**Tables 31 and 33**).

Of the four sampling sites rated by densities of Size Class II and III juveniles (smolt-sized), the lower and upper sites in Aptos Creek were rated “Good” and “Fair” (**Table 37**). The lower and upper sites in Valencia Creek were rated “Fair” and “Good.” The fish in this category were primarily fast growing YOY in Aptos and slow growing yearlings in Valencia, and a higher proportion of pool habitat was sampled in lower Valencia than exists in the reach, thus elevating the site density of larger fish above the likely reach density.

Table 31. TOTAL DENSITY of Juvenile Steelhead at Monitoring Sites in APTOS, VALENCIA, CORRALITOS, SHINGLE MILL and BROWNS VALLEY Creeks, 1981, 1994 and 2006–2010.

Sample Site	1981	1994	2006	2007	2008	2009	2010	Avg.
Aptos #3- in County Park	35.2*	–	26.2	61.7	45.4	8.5	39.4	36.1
Aptos #4- above steel Bridge Xing (Nisene Marks)	43.0	–	38.6	26.8	89.3	8.0	21.7	37.9
Valencia #2- below Valencia Road Crossing	33.1	–	28.3	43.0	38.5	22.7	25.1	31.8
Valencia #3- Above Valencia Road Crossing	29.8	–	33.4	23.0	55.5	26.3	39.4	34.6
Corralitos #1- Below Dam				36.2	69.9	34.2	10.4	37.7
Corralitos #3- Above Colinas Drive	39.1	18.6	35.5	42.1	35.9	14.9	6.2	27.5
Corralitos #8- Below Eureka Gulch	81.9	28.6	49.0	52.9	55.9	51.9	20.1	48.6
Corralitos #9- Above Eureka Gulch	86.1	29.9	87.1	38.5	61.7	73.2	33.6	58.6
Shingle Mill #1- Below 2nd Road Crossing	24.5	30.0	33.9	16.2	18.8	6.7	11.9	20.3
Shingle Mill #3- Above 2nd Road Crossing	32.6	–	22.9	12.7	24.5	21.8	33.1	24.6
Browns Valley #1- Below Dam	54.3	22.5	101.6	35.4	36.5	25.6	24.9	43.0
Browns Valley #2- Above Dam	71.6	18.5	99.5	79.0	44.8	54.9	41.4	58.5

*** Density in number of fish per 100 feet of stream.**

Table 32. YOUNG-OF-THE-YEAR Steelhead Density at Monitoring Sites in APTOS, VALENCIA, CORRALITOS, SHINGLE MILL and BROWNS VALLEY Creeks, 1981, 1994, 2006–2010.

Sample Site	1981	1994	2006	2007	2008	2009	2010	Avg.
Aptos #3- in County Park	24.4*	–	23.7	54.0	43.4	3.3	37.3	29.8
Aptos #4- above steel Bridge Xing (Nisene Marks)	37.1	–	35.2	9.8	84.6	3.9	20.1	34.1
Valencia #2- below Valencia Road Crossing	16.6	–	24.5	26.6	27.5	8.9	16.4	20.8
Valencia #3- Above Valencia Road Crossing	16.6	–	20.5	4.7	41.5	7.8	25.6	18.2
Corralitos #1 Below Dam				27.0	61.2	26.5	9.1	38.2
Corralitos #3- Above Colinas Drive	33.9	10.2	24.6	30.6	27.6	9.8	5.2	22.8
Corralitos #8- Below Eureka Gulch	59.7	14.3	45.0	44.0	46.6	39.3	19.0	41.6
Corralitos #9- Above Eureka Gulch	55.8	16.7	78.4	31.3	44.6	54.0	30.7	46.8
Shingle Mill #1- Below 2nd Road Crossing	14.3	5.7	25.1	2.9	13.2	0	7.0	10.2
Shingle Mill #3- Above 2nd Road Crossing	18.6	–	19.5	6.0	23.9	18.4	25.2	17.3
Browns Valley #1- Below Dam	26.9	7.0	96.6	15.3	25.0	8.9	21.4	30.0
Browns Valley #2- Above Dam	66.1	12.8	94.7	47.0	32.2	43.0	38.8	49.3

*** Density in number of fish per 100 feet of stream.**

Table 33. YEARLING AND OLDER Juvenile Steelhead Density at Monitoring Sites in APTOS, VALENCIA, CORRALITOS, SHINGLE MILL and BROWNS VALLEY Creeks, 1981, 1994 and 2006–2010.

Sample Site	1981	1994	2006	2007	2008	2009	2010	Avg.
Aptos #3- in County Park	10.8*	–	3.1	7.6	2.3	5.2	1.9	5.2
Aptos #4- above steel Bridge Xing (Nisene Marks)	5.9	–	3.0	17.1	4.9	3.9	1.0	3.9
Valencia #2- below Valencia Road Crossing	16.5	–	3.8	16.4	11.0	13.8	8.9	11.7
Valencia #3- Above Valencia Road Crossing	13.2	–	12.9	11.5	14.0	18.5	14.2	14.0
Corralitos #1 Below Dam				9.1	8.7	6.9	1.3	6.5
Corralitos #3- Above Colinas Dr.	5.2	8.4	10.8	11.5	8.3	5.3	1.1	7.3
Corralitos #8- Below Eureka Gulch	22.2	14.3	4.0	9.0	9.4	13.2	1.1	10.4
Corralitos #9- Above Eureka Gulch	30.3	13.2	9.5	7.2	17.1	19.2	2.8	14.2
Shingle Mill #1- Below 2nd Road Crossing	10.2	24.3	9.0	13.3	5.6	6.7	5.6	10.7
Shingle Mill #3- Above 2nd Road Crossing	14.0	–	3.4	6.7	0.7	7.2	6.1	6.7
Browns Valley #1- Below Dam	27.4	15.5	4.3	19.6	11.5	12.9	3.7	13.6
Browns Valley #2- Above Dam	5.5	7.7	2.8	32.0	12.6	11.9	2.0	10.7

*** Density in number of fish per 100 feet of stream.**

Table 34. SIZE CLASS I (<75 mm SL) Steelhead Density at Monitoring Sites in APTOS, VALENCIA, CORRALITOS, SHINGLE MILL and BROWNS VALLEY Creeks, 1981, 1994, 2006–2010.

Sample Site	1981	1994	2006	2007	2008	2009	2010	Avg.
Aptos #3- in County Park	24.4*	–	7.2	50.8	39.4	3.3	22.2	24.6
Aptos #4- above steel Bridge Xing (Nisene Marks)	37.1	–	28.5	9.0	83.8	0	12.0	28.4
Valencia #2- below Valencia Road Crossing	16.6	–	24.5	26.6	27.5	8.9	16.4	20.1
Valencia #3- Above Valencia Road Crossing	16.6	–	20.5	5.7	41.5	7.8	24.6	19.4
Corralitos #1 Below Dam				27.0	61.2	20.5	1.7	29.3
Corralitos #3- Above Colinas Drive	33.9	10.2	16.2	30.6	27.6	5.6	0.7	15.1
Corralitos #8- Below Eureka Gulch	59.7	14.3	35.8	43.0	46.6	36.6	14.1	35.8
Corralitos #9- Above Eureka Gulch	55.8	16.7	45.5	31.3	44.6	53.5	22.4	38.6
Shingle Mill #1- Below 2nd Road Crossing	14.3	5.7	17.7	2.9	13.2	0	5.6	8.5
Shingle Mill #3- Above 2nd Road Crossing	32.4	–	19.5	6.0	23.9	18.4	25.2	21.0
Browns Valley #1- Below Dam	26.9	7.0	84.6	18.1	25.0	8.9	14.8	26.5
Browns Valley #2- Above Dam	66.1	12.8	82.6	48.8	32.2	43.0	32.0	45.4

*** Density in number of fish per 100 feet of stream.**

Table 35. SIZE CLASS II/III (=>75 mm SL) Steelhead Density at Monitoring Sites in APTOS, VALENCIA, CORRALITOS, SHINGLE MILL and BROWNS VALLEY Creeks, 1981, 1994 and 2006–2010.

Sample Site	1981	1994	2006	2007	2008	2009	2010	Avg.
Aptos #3- in County Park	10.8*	–	19.0	10.9	6.0	5.2	17.2	11.5
Aptos #4- above steel Bridge Xing (Nisene Marks)	5.9	–	10.1	17.8	5.5	8.0	9.7	9.5
Valencia #2- below Valencia Road Xing	16.5	–	3.8	16.4	11.0	13.8	8.7	11.7
Valencia #3- Above Valencia Road Xing	13.2	–	12.9	10.5	14.0	18.5	14.8	14.1
Corralitos #1 Below Dam				9.1	8.7	13.7	8.7	10.1
Corralitos #3- Above Colinas Dr.	5.2	8.4	19.3	11.5	8.3	9.3	5.5	9.6
Corralitos #8- Below Eureka Gulch	22.2	14.3	13.2	9.9	9.4	15.3	6.0	12.9
Corralitos #9- Above Eureka Gulch	30.3	13.2	41.6	7.2	17.1	19.7	11.2	20.0
Shingle Mill #1- Below 2nd Road Xing	10.2	24.3	16.2	13.3	5.6	6.7	6.3	11.8
Shingle Mill #3- Above 2nd Road Xing and check dams	4.0	–	3.4	6.7	0.7	7.2	6.1	4.7
Browns Valley #1- Below Dam	27.4	15.5	17.0	17.4	11.5	12.9	10.1	15.9
Browns Valley #2- Above Dam	5.5	5.7	16.9	30.2	12.6	11.9	9.4	13.2

*** Density in number of fish per 100 feet of stream.**

R-10. Comparison of 2010 Densities in the Corralitos Sub-Watershed

In 2010, densities of size classes and age classes in the Corralitos watershed compared to average densities followed a similar pattern as in the Soquel watershed and San Lorenzo tributaries, except YOY and yearling densities were much further below average. Total densities were generally below average (7 of 8 sites and statistically significant for Corralitos-only sites- **Table 44**); YOY and Size Class I densities were generally below average (but even more so at 7 of 8 sites); and yearling densities were much below average (7 of 8 sites with the upper Shingle Mill 3 site having near average densities and statistically significant for Corralitos-only sites- **Table 44**) (**Tables 32–34; Figures 14 and 15**). However, the pattern changed for Size Class II densities where they were also mostly below average (7 of 8 sites and statistically significant for Corralitos-only sites- **Table 44**) (**Table 35; Figure 38**) because either insufficient fast-growing YOY or too few yearlings remained in the watershed to bring 2010 densities up to average except at the upper Shingle Mill 3 site, which probably had older resident trout. Judging from the 2010 hydrograph, the mid-October stormflow was quite large (mean daily discharge of 700+ cfs at Freedom CA) and may have been responsible for substantial sediment transport, sediment deposition and yearling displacement and mortality (**Figure 58**).

In the Corralitos Creek watershed, total, YOY, yearling and Size Class II juvenile steelhead densities were lower in 2010 than 2009 at all 4 mainstem Corralitos-only sites, and declines were statistically significant in each case (**Tables 31-35 and 43; Figures 39-41**). For all 8 watershed sites analyzed together, declines in Size Class II and yearling densities were also statistically significant (**Table 43**). 2010 total and YOY densities were less than in 2009 at all sites except in Shingle Mill Gulch (6 of 8 sites), but the negative differences were less pronounced in Browns Creek. Size Class II densities declined at all 8 watershed sites, with less pronounced declines in Shingle Mill and Browns Creeks. Extreme sedimentation was detected in Corralitos Creek and less so in Shingle Mill Gulch, greatly shallowing pools and eliminating pool escape cover particularly downstream of Eureka Gulch confluence (**Figures 50 and 51**). Reduced spawning and rearing habitat quality likely caused reduced spawning success, a smaller YOY year class in spring, reduced YOY and yearling survival. High spring baseflows may have encouraged early yearling emigration to the Bay (**Figure 58**). However, yearling and older juvenile densities declined less in Shingle Mill Creek, analogous to Fall Creek in the San Lorenzo drainage that is suspected to have a resident component and slower yearling growth rate.

Of the 8 sampling sites rated according to Size Class II and III (smolt) densities in 2010, the ratings actually improved in the two Browns Creek sites to "Good", and the Corralitos Site 9 above Eureka Gulch remained "Good." Smolt densities were not as high as 2009, but average sizes were larger than in 2009 (**Table 37**). Ratings of the middle mainstem Sites 3 and 8 declined in 2010 to "Fair and "Below Average," respectively, in the heavily sedimented reach of the Creek. All but Corralitos 8 and Shingle Mill 3 were rated "Fair" or better.

With regard to adult steelhead passage above the Corralitos Creek diversion dam between Corralitos Site 1 and Site 3, passage conditions should have improved in 2010 with higher winter stormflows than

2009 (**Figures 55 and 58**). However, the sedimentation factor and exceptionally low YOY densities detected in the fall throughout the Corralitos Branch of the watershed showed no evidence of it. However, the upper Corralitos sites had the highest YOY densities in 2010, indicating that some adult steelhead successfully spawned upstream of the dam (**Table 32**).

R-11. Rating of Smolt Rearing Habitat in 2010, Based on Site Densities of Smolt-Sized Fish

Smolt habitat was rated at sampling sites, based on smolt-sized (=>75 mm SL) fish density according to the rating scheme developed by Smith (**1982**) (**Tables 41 and 42**). In this scheme, the average standard length for smolt-sized fish was calculated for each site. If the average was less than 89 mm SL, then the density rating according to density alone was reduced one level. If the average was more than 102 mm SL, then the rating was increased one level. (Note: the rating scale was applied to all sites, and lower San Lorenzo sites were rated very good and excellent in 1981.) This scheme assumed that rearing habitat was usually near saturation with smolt-sized juveniles, at least at tributary sites, and that spawning rarely limited juvenile steelhead abundance.

Table 36. Rating of Steelhead Rearing Habitat For Small, Central Coastal Streams.*
(From Smith 1982.)

Very Poor - less than 2 smolt-sized** fish per 100 feet of stream.

Poor*** - from 2 to 4 " " "

Below Average - 4 to 8 " " "

Fair - 8 to 16 " " "

Good - 16 to 32 " " "

Very Good - 32 to 64 " " "

Excellent - 64 or more " " "

* Drainages sampled included the Pajaro, Soquel and San Lorenzo systems, as well as other smaller Santa Cruz County coastal streams. Nine drainages were sampled at over 106 sites.
** Smolt-sized fish were at least 3 inches (75 mm) Standard Length at fall sampling and would be large enough to smolt the following spring.
***The average standard length for smolt-sized fish was calculated for each site. If the average was less than 89 mm SL, then the density rating according to density alone was reduced one level. If the average was more than 102 mm SL, then the rating was increased one level.

Table 37. 2010 Sampling Sites Rated by Potential Smolt-Sized Juvenile Density (=>75 mm SL) and Their Average Size in Standard Length, with Physical Habitat Change from 2009 Conditions.

Site	2010 Potential Smolt Density (per 100 ft)/ Avg Smolt Size SL (mm)	2010 Smolt Rating (With Size Factored In)	2009 Potential Smolt Density (per 100 ft)/ Avg Smolt Size SL (mm)	2009 Smolt Rating (With Size Factored In)	Physical Habitat Change by Reach/Site Since 2009
Low. San Lorenzo #0a	19.8/ 106 mm	Very Good	2.4/ 124 mm	Below Average	+
Low. San Lorenzo #1	15.3/ 98 mm	Fair	3.4/125 mm	Below Average	+
Low. San Lorenzo #2	22.4/ 91 mm	Good	8.0/105 mm	Very Good	+
Low. San Lorenzo #4	12.6/ 87 mm	Below Average	13.9/85 mm	Below Average	+
Mid. San Lorenzo #6	6.1/ 80 mm	Poor	0.5/ 76 mm	Very Poor	+
Mid. San Lorenzo #8	8.2/ 88 mm	Below Average	3.5/ 95 mm	Poor	+
Up. San Lorenzo #11	4.7/ 93 mm	Below Average	3.1/ 99 mm	Poor	+
Zayante #13a	18.8/ 89 mm	Fair	12.1/ 85 mm	Below Average	+
Zayante #13c	24.5/ 90 mm	Good	10.4/ 91 mm	Fair	NA
Zayante #13d	9.1/ 101 mm	Fair	16.9/ 97 mm	Good	−
Lompico #13e	8.7/ 96 mm	Fair	4.9/ 92 mm	Below Average	−
Bean #14b	8.4/ 87 mm	Below Average	10.9/ 101 mm	Fair	=
Bean #14c	6.7/ 99 mm	Below Average	-	-	NA
Fall #15	14.3/ 118 mm	Good	18.7/ 111 mm	Very Good	+
Newell #16	24.7/ 86 mm	Fair	4.4/94 mm	Below Average	+
Boulder #17a	11.8/ 89 mm	Fair	5.5/ 98 mm	Below Average	=
Boulder #17b	12.7/ 90 mm	Fair	10.7/ 96 mm	Fair	−
Bear #18a	9.5/ 99 mm	Fair	2.5/ 88 mm	Very Poor	NA
Branciforte #21a-2	12.6/ 105 mm	Good	7.5/ 117 mm	Fair	=
Soquel #1	7.9/ 108 mm	Fair	5.1/ 93 mm	Below Average	+
Soquel #4	4.9/ 98 mm	Below Average	8.1/ 96 mm	Fair	+
Soquel #10	14.0/ 96 mm	Fair	6.2/ 80 mm	Poor	+
Soquel #12	8.0/ 88 mm	Below Average	11.9/ 86 mm	Below Average	+
East Branch Soquel #13a	32.8/ 88 mm	Good	11.2/ 88 mm	Below Average	+
East Branch Soquel #16	8.0/ 106 mm	Good	13.1/ 98 mm	Fair	+
West Branch Soquel #19	11.6/ 93 mm	Fair	14.1/ 92 mm	Fair	+
West Branch Soquel #21	17.5/ 99 mm	Good	6.8/ 97 mm	Below Average	+
Aptos #3	17.2/ 90 mm	Good	5.2/ 120 mm	Fair	+
Aptos #4	9.7/ 96 mm	Fair	8.0/ 99 mm	Fair	+
Valencia #2	8.7/ 100 mm	Fair	13.8/ 94 mm	Fair	+
Valencia #3	14.8/ 105 mm	Good	18.5/ 95 mm	Good	+
Corralitos #1	8.7/ 99 mm	Fair	13.7/ 96 mm	Fair	−
Corralitos #3	5.5/ 116 mm	Fair	9.3/ 112 mm	Good	−
Corralitos #8	6.0/ 90 mm	Below Average	15.3/ 105 mm	Good	−
Corralitos #9	11.2/ 104 mm	Good	19.7/ 102 mm	Good	−
Shingle Mill #1	6.3/ 104 mm	Fair	6.7/ 103 mm	Fair	NA
Shingle Mill #3	6.1/ 99 mm	Below Average	7.2/ 85 mm	Poor	−
Browns #1	10.1/ 103 mm	Good	12.9/ 98 mm	Fair	+
Browns #2	9.4/ 104 mm	Good	11.9/ 98 mm	Fair	+

For 2006−2010, smolt-sized juvenile ratings for sampling sites was summarized (**Table 38**). Ratings indicated substantial improvement in 2010 for 4 watersheds combined, compared to the 3 previous dry years, with 35% of the sites in the "Good" to "Very Good" range in 2010 compared to 16-19% in 2007−2009. 2010 improvement occurred most in the lower mainstem San Lorenzo, lower and middle Zayante, Newell, East and West Branches of Soquel and lower Aptos.

Table 38. Summary of Sampling Site Ratings in 2006−2010, based on Potential Smolt-Sized Densities.

Year	Very Poor	Poor	Below Avg	Fair	Good	Very Good
2006 (n=34)	1	6	5	11	10	1
2007 (n=37)	5	2	12	12	6	0
2008 (n=36)	5	6	9	10	6	0
2009 (n=37)	2	4	11	13	6	1
2010 (n=37)	0	2	8	14	12	1

R-12. Statistical Analysis of Annual Difference in Juvenile Steelhead Densities

The trend in fish densities between 2009 and 2010 was analyzed by using a paired t-test (**Snedecor and Cochran 1967; Sokal and Rohlf 1995; Elzinga et al. 2001**). Comparisons were made for total density, age class densities and size class densities (AC1, AC2, SC1, SC2). The paired t-test is among the most powerful of statistical tests, where the difference in mean density (labeled "mean difference" in the analysis) is tested. This test was possible because the compared data were taken at the same sites between years with consistent average habitat conditions between years, as opposed to re-randomizing each year. The null hypothesis for the test was that among all compared sites, the site-by-site difference between years 2009 and 2010 was zero. The non-random nature of the initial choice of sites was necessary for practical reasons and does not violate the statistical assumptions of the test; the change in density is a randomly applied effect (i.e. non-predictable based on knowledge of the initial sites) that does not likely correlate with the initial choice of sites. So, the mean difference is a non-biased sample.

The null hypothesis was that the difference in mean density was zero. Results from 2010 were compared to 2009, such that a positive difference indicated that the densities in 2010 were larger than in 2009 on average. A p-value of 0.05 meant that there was only a 5% probability that the difference between densities was zero and a 95% probability that it was not zero. A 2-tailed test was used, meaning that an increase or a decrease was tested for. The confidence limits tell us the limits of where the true mean difference was. The 95% confidence interval indicated that there was a 95% probability that the true mean difference was between these limits. If these limits included zero, then it could not be ruled out that there was no difference between 2009 and 2010 densities. The 95% confidence limits are standard and a p-value of < 0.05 is considered significant.

With 15 comparable sites in the San Lorenzo drainage, the increase in Size Class II and III density was statistically significant (**Table 39**). With 7 comparable sites in the San Lorenzo mainstem only, increases in total density, YOY density and Size Class II and III density were statistically significant (**Table 40**). With 8 comparable sites in the Soquel watershed, decrease in total density was statistically significant (**Table 41**). With only 4 comparable sites in Aptos watershed, the increase in YOY density and the decrease in yearling density were still statistically significant (**Table 42**). With 8 comparable sites in the Corralitos sub-watershed, decreases in yearling and Size Class II and III densities were statistically significant (**Table 43**). With 4 comparable sites in Corralitos Creek only, decreases in YOY, yearling and Size Class II and III densities were all statistically significant (**Table 44**).

Table 39. Paired T-test for the Trend in Steelhead Site Densities by Size Class and Age Class at All Replicated Sites In the SAN LORENZO Watershed (2010 to 2009; n=14).

Statistic	s.c. 2	a.c. 1-YOY	a.c. 2	All Sizes
Mean difference	5.80	3.50	-1.49	1.72
Df	13	13	13	13
Std Error	2.14	8.73	0.89	8.50
t Stat	2.71	0.40	-1.68	0.20
P-value (2-tail)	0.02	0.69	0.12	0.84
95% CL (lower)	1.17	-15.35	-1.08	20.09
95% CL (upper)	10.42	22.35	2.68	3.57

Table 40. Paired T-test for the Trend in Steelhead Site Densities by Size Class and Age Class at All Replicated MAINSTEM SITES ONLY In the SAN LORENZO Watershed (2010 to 2009; n=7).

Statistic	s.c. 2	a.c. 1-YOY	a.c. 2	All Sizes
Mean difference	7.75	13.39	-0.03	12.87
Df	6	6	6	6
Std Error	2.62	3.56	0.16	3.76
t Stat	2.96	3.76	-0.17	3.42
P-value (2-tail)	0.03	0.01	0.87	0.01
95% CL (lower)	1.34	4.66	-0.43	3.66
95% CL (upper)	14.27	22.11	0.37	22.08

Table 41. Paired T-test for the Trend in Steelhead Site Densities by Size Class and Age Class at All Replicated Sites In the SOQUEL Watershed (2010 to 2009; n=8).

Statistic	s.c. 2	a.c. 1-YOY	a.c. 2	All Sizes
Mean difference	3.53	7.49	-1.34	-14.36
Df	7	7	7	7
Std Error	3.30	6.15	0.71	6.16
t Stat	1.07	1.22	-1.89	-2.33
P-value (2-tail)	0.32	0.26	0.10	0.05
95% CL (lower)	-4.27	-7.05	-3.01	-28.92
95% CL (upper)	11.32	22.03	0.34	0.20

Table 42. Paired T-test for the Trend in Steelhead Site Densities by Size Class and Age Class at All Replicated Sites In the APTOS Watershed (2010 to 2009; n=4).

Statistic	s.c. 2	a.c. 1-YOY	a.c. 2	All Sizes
Mean difference	1.23	18.88	-3.85	15.03
Df	3	3	3	3
Std Error	3.88	5.53	0.46	5.89
t Stat	0.32	3.42	-8.42	2.55
P-value (2-tail)	0.77	0.04	0.004	0.08
95% CL (lower)	-11.12	1.29	-5.31	-3.73
95% CL (upper)	13.57	36.46	-2.39	33.78

Table 43. Paired T-test for the Trend in Steelhead Site Densities by Size Class and Age Class at All Repeated Sites In the CORRALITOS Sub-Watershed (2010 to 2009; n=7).

Statistic	s.c. 2	a.c. 1-YOY	a.c. 2	All Sizes
Mean difference	-4.71	-7.21	-8.35	-15.26
Df	6	6	6	6
Std Error	1.17	5.20	1.94	6.73
t Stat	-4.01	-1.39	-4.29	-2.27
P-value (2-tail)	0.01	0.21	0.01	0.06
95% CL (lower)	-7.59	-19.93	-13.12	-31.73
95% CL (upper)	-1.84	5.50	-3.59	1.21

Table 44. Paired T-test for the Trend in Steelhead Site Densities by Size Class and Age Class at All Repeated MAINSTEM CORRALITOS CREEK SITES Only In the Corralitos Creek Watershed (2010 to 2009; n=4).

Statistic	s.c. 2	a.c. 1-YOY	a.c. 2	All Sizes
Mean difference	-6.65	-16.40	-9.58	-25.97
Df	3	3	3	3
Std Error	1.33	4.11	2.85	6.60
t Stat	-4.99	-3.99	-3.36	-3.94
P-value (2-tail)	0.02	0.03	0.04	0.03
95% CL (lower)	-10.89	-29.49	-18.65	-46.98
95% CL (upper)	-2.41	-3.31	-0.50	-4.97

R-13. Adult Trapping Results at the Felton Dam's Fish Ladder and 2010 Planting Records

The trap in the fish ladder at the City of Santa Cruz Felton Diversion dam was operated by Terry Umstead (aquaculture teacher), San Lorenzo Valley High School students and other volunteers for 10 days during the winter of 2006-2007 and 2007-2008 and 20 days in 2008-2009. During the winter of 2009-2010, it was used for 8 days (2−6 March and 9−11 March). The 2010 trapping (as the previous three years) encompassed major stormflows of the winter but was late for trapping coho salmon (**Figure 56**). **In 2010, a total of 53 adult steelhead =>14 inches Fork Length were captured; 44 (83%) steelhead were hatchery clipped.** In 2009 during 20 nonconsecutive days encompassing major stormflows during the period 18 February−27 March, a total of 145 adult steelhead =>14 inches Fork Length and one adult coho salmon were captured; 79 (54%) steelhead were hatchery clipped. The coho salmon was captured on the first day of trapping in 2009. In 2008 during the period 5−15 February, a total of 78 adult steelhead =>14 inches Fork Length were captured; 20 (26%) were hatchery clipped. In 2007 during a similar period (15−21 February), a total of 53 adult steelhead =>18 inches Fork Length were captured; 17 (32%) were hatchery clipped. No coho salmon were captured in 2007 or 2008, likely due to the late trapping period. More adult steelhead were trapped in 2006, with 247 adult steelhead and 2 coho salmon captured in 2 months from mid-January to late March. But trapping was over much shorter periods in 2007 and 2008. The 2006 total was less than the 371 adult steelhead and 18 adult coho captured in 2005 over a longer time period, but trapping began and ended later in the 2006 season than in 2005 and began after several storm events in 2006. Since in all years the trap has operated for only a small portion of the adult migration period, no comparisons among years can be used to estimate adult abundance or trends.

Non-smolt juvenile steelhead were planted in January 2010 from the MBSTNAF Hatchery with the San Lorenzo as the source. This was due to concern that the hatchery's water quality might become compromised after the Bonny Doon Fire the previous summer. An estimated 25,000 juvenile steelhead (1,250 pounds) were planted on 7 and 14 January 2010 at the following locations:

San Lorenzo River at Highlands County Park in Ben Lomond (5,000 juveniles; 7 Jan 2010)
San Lorenzo River at Highlands County Park in Ben Lomond (5,000 juveniles; 14 Jan 2010)
San Lorenzo River at Henry Cowell Park Bridge in Felton (5,000 juveniles; 7 January 2010)
San Lorenzo River at Henry Cowell Park Bridge in Felton (5,000 juveniles; 14 January 2010)
San Lorenzo River at Henry Cowell Park Bridge in Felton (5,000 juveniles; 14 January 2010)

Later in March 2010, additional steelhead smolts (9/ pound and 585 pounds) with the San Lorenzo as the source were planted at the following location:

San Lorenzo River at Paradise Park office hole (5, 267 juveniles; 30 March 2010).

Table 45. Adult Steelhead Trapping Data from the San Lorenzo River With Adult Return Estimates.

Trapping Year	Trapping Period	Number of Adults	Location
1934-35	?	973	Below Brookdale (1)
1938-39	?	412	Below Brookdale (1)
1939-40	?	1,081	Below Brookdale (1)
1940-41	?	671	Near Boulder Ck (2)
1941-42	Dec 24 - Apr 11	827	Near Boulder Ck (2)
1942-43	Dec 26 - Apr 22	624	Near Boulder Ck (3)
1976-77	Jan-Apr	1,614	Felton Diversion (4)
1977-78	Nov 21 - Feb 5	3,000 (Estimate)	Felton Diversion (4)
1978-79	Jan-Apr	625 (After drought)	Felton Diversion (4)
1979-80	Jan-Apr ?	496 (After drought)	Felton Diversion (4)
1982-83		1,506	Alley Estimate from 1981 Mainstem Juve-niles only
1994-95	6 Jan- 21 Mar (48 of 105 days-Jan-15 Apr)	311 (After drought)	Felton Diversion (5) Monterey Bay Salmon & Trout Project
1996-97		1,076 (estimate)	Alley Estimate from 1994 Mainstem Juve-niles only
1997-98		1,784 (estimate)	Alley Estimate from 1995 Mainstem Juve-niles only
1998-99		1,541 (estimate)	Alley Revised Esti-mate from 1996 Main-stem Juveniles only
1999-2000	17 Jan- 10 Apr	532 (above Felton)	Monterey Bay Salmon & Trout Project
1999-2000		1,300 (estimate)	Alley Index from 1997 Mainstem Juveniles only
2000-01	12 Feb- 20 Mar (above Felton)	538	Monterey Bay Salmon & Trout Project
2000-01		2,500 (estimate)	Alley Index from 1998 Juveniles in Mainstem and 9 Tributaries
2001-02		2,650 (estimate)	Alley Index from 1999 Juveniles in Mainstem and 9 Tributaries
2002-03		1,650 (estimate)	Alley Index from 2000 Juveniles in Mainstem and 9 Tributaries
2003-04		1,600 (estimate)	Alley Index from 2001 Juveniles in Mainstem and 9 Tributaries
2003-04	28 Jan- 12 Mar	1,007 Steelhead 14 Coho	SLV High School-Felton Diversion Dam
2004-05	12 Dec 29 Jan	371 Steelhead 18 Coho	SLV High School-Felton Diversion Dam
2005-06	17 Jan- 24 Mar	247 Steelhead 2 Coho	SLV High School-Felton Diversion Dam
2006-07	15 Feb- 21 Feb	54 Steelhead	SLV High School-Felton Div. Dam
2007-08	05 Feb- 15 Feb	78 Steelhead	SLV High School-Felton Diversion Dam
2008-09	18 Feb- 27 Mar	145 Steelhead 1 Coho	SLV High School-Felton Diversion
2009-10	2-11 Mar	53 Steelhead	SLV High School- Felton Diversion

(1) Field Correspondence from Document # 527, 1945, Div. Fish and Game.
(2) Field Correspondence from Document #523, 1942, Div. Fish and Game.
(3) Inter-office Correspondence, 1943, Div. Fish and Game.
(4) Kelley and Dettman (1981). (5) Dave Strieg, Big Creek Hatchery, 1995.

DISCUSSION OF 2010 RESULTS

D-1. Effect of Cooler Water Temperature on YOY Growth Rate in the Lower Mainstem San Lorenzo

In 2010, stream water temperature was likely 2−3°F cooler at most sites in the 4 watersheds compared to 2009, as indicated by comparisons at sites in the Soquel mainstem and San Lorenzo tributaries (**Figures 59−66**). Cooler water temperature appeared to offset the faster YOY growth rate at the San Lorenzo mainstem Site 4 that was expected from higher 2010 baseflow (May−September daily average of 37 cfs compared to 19 cfs in 2009 at nearby Big Trees Gage (**Figure 52**)). At Site 4 where total and YOY abundance was slightly less in 2010 than in 2009 (**Tables 17 and 18**), the percent of YOY reaching potentially smolt size from sampled fastwater habitat was approximately equal between years and average size of potentially smolt-sized steelhead was approximately equal (**Table 37**), despite substantially higher baseflow in 2010. The estimated cooler water temperature was based on continuously monitored water temperature upstream of Soquel Lagoon in 2009 and 2010 (**Alley 2010a**).

D-2. Causal Factors for Continued Below Average 2010 YOY Steelhead Abundance at Most Sites

Although we have no estimates of adult returns, it would appear that reduced adult steelhead returns with reduced spawning, combined with poor egg and YOY survival best explain the much below average YOY densities at most sites in all 4 watersheds. Substantial sedimentation of Corralitos Creek and modest sedimentation of upper Zayante Creek likely contributed to poor egg survival and YOY survival during a spring with late stormflows. Two tributary sites with especially low YOY densities for the sites, Lompico 13e and Boulder 17a, may have had other factors involved. There may have been poor spawning access to Lompico Creek. There may have been fishing pressure in lower Boulder Creek, where a popular human gathering place existed with a fishing pole and empty bait containers found streamside.

Exceptions to the below average YOY density pattern included mainstem San Lorenzo, Zayante and Aptos Creek sites, which produced near-average YOY densities, perhaps indicating successful late spawning in lower watershed reaches made possible by later spring storms.

Below average yearling and older juvenile densities across the 4 watersheds may have partially resulted from high spring baseflows that allowed young yearlings to have faster growth rates and early immigration. In addition, there may have been poorer overwinter survival of yearlings during more frequent winter stormflows than occurred during previous drought years. It may have been the former more than the latter in the San Lorenzo, Soquel and Aptos watersheds because at some upper watershed sites where there were presumed resident trout and slower growth rates, the densities of yearling and older sized fish remained relatively high, such as in Fall, upper Valencia and upper Shingle Mill creeks. The uppermost sites on East and West Branch Soquel Creek, Sites 16 and 21, also had near-average yearling densities. However, in the Corralitos branch of that sub-watershed, the especially high stormflow in mid-October (700+ cfs at Freedom CA) combined with significant sediment transport and deposition may have displaced and/or caused significant yearling mortality.

Three consecutive years with poor ocean conditions related to the decadal oscillation of ocean currents likely contributed somewhat to poor juvenile survival in the ocean and poor adult returns, although steelhead move north after reaching the ocean. The 2009-2010 returning adults were primarily from Size Class II and III juveniles in the streams/ lagoons in 2007. The likely poor lagoon conditions in the San Lorenzo and Aptos Creek in 2007 may have significantly reduced smolt numbers, along with slow growth rates of YOY into smolt size by spring 2008 throughout those watersheds, leading to low adult returns in WY2010. Low freshwater inflow is typical for the San Lorenzo Lagoon in dry years, which slows freshwater conversion, along with occasional artificial breaching that prevents freshwater conversion and poor water quality. Aptos Lagoon is subject to frequent artificial summer breaching in all years, reducing water quality and steelhead survival, as was found during previous sampling by NOAA Fisheries. Presumed low adult numbers in WY2010 in Soquel Creek, as indicated by low abundance of YOY, cannot be explained by poor lagoon conditions or low lagoon abundance of large fish. Very large lagoon populations of steelhead were measured in Soquel Lagoon in 2007 and 2008, which should have resulted in high adult numbers in WY 2010, whether returning adults were one or two years in the ocean. Trapping data from Scott Creek indicated continued relatively low adult returns in winter 2009-2010, where adult escapement estimates in water years 2006─2010 were 219, 259, 293, 126 and 109, respectively (**Sean Hayes, NOAA Fisheries personal communication**). Sean Hayes believes that abundance of lagoon fish in Scott Creek is the primary driver of adult returns, and he attributes poor adult returns to previously poor juvenile production in the lagoon. The same relatively low 2010 returns were detected at the San Clemente Dam on the Carmel River for those years, where counts were 368, 222, 412, 95 and 157, respectively (**Kevan Urquhart, personal communication**).

The generally lower 2010 YOY densities than in 2009 in San Lorenzo tributaries, Soquel watershed and Corralitos Creek sites may be a partial reflection of even fewer WY2010 adult returns than in WY2009. The Aptos watershed was the exception, though 2009 YOY densities were extremely low, and the two sites that were above average in 2010 were not much above. So, continuing relatively low adult returns may have occurred in the Aptos watershed. The highest spawning success and YOY production in the San Lorenzo watershed was all reaches of Zayante, upper Bean Creek and upper Boulder creeks. In the Soquel watershed it was East Branch Soquel sites with apparently the highest spawning success with the highest YOY abundance. In the Aptos watershed, greatest spawning success and YOY production occurred in lower Aptos and upper Valencia. In the Corralitos Watershed, it was upper sites in Corralitos, Shingle Mill and Browns creeks. The higher YOY densities at upper sites indicated adequate adult spawning access, with perhaps resident trout spawning contributions in upper Shingle Mill and Valencia creeks.

From the generally low YOY densities in the 4 watersheds, it appeared that insufficient spawning and/or egg survival occurred in WY2010 to fully seed most sites. Exceptions may have been upper Bean 14c, which had very low baseflow, and mainstem Corralitos sites which had much reduced rearing habitat due to high sedimentation. There may have been higher egg mortality in 2010 than 2009 because stormflows continued on through mid-April in 2010, after many nests were in the streambed and subject to scour. However, this is likely not the primary factor because YOY densities in lower Zayante, lower Aptos and the lower and middle mainstem San Lorenzo were near average or better. At least in 2010 there was a month and a half in March and April which provided higher flows for successful late spawning.

Above median baseflow in 2010, particularly in spring (**Figures 25 and 26**), likely provided more rearing habitat for YOY than more average and drier years, resulting in relatively lower YOY mortality from starvation and predation than during the 3 previous dry years. However, baseflow was higher in 2010 than 2008, and YOY densities were consistently higher in 2008 in all 4 sampled watersheds, except at some lower and middle mainstem San Lorenzo sites and Browns Creek sites. A decline in rearing habitat quality was not a cause for continued YOY density in the San Lorenzo, Soquel or Aptos watersheds because overall habitat quality generally increased. It was only mainstem Corralitos sites where rearing habitat quality declined and was likely a major factor.

D-3. Annual Trend in YOY and Yearling Abundance Compared to Other Coastal Streams

YOY steelhead densities in 2010 continued to be below average at most sites in Scott (**Figure 67**) Waddell, Gazos (**Figure 68**) and creeks, although it rebounded in Scott Creek where it doubled compared to 2009 (**Smith 2010**). Data from Waddell and Gazos creeks were consistent with below average YOY densities at a majority of sites in the San Lorenzo, Soquel and Corralitos watersheds. Density data from Scott Creek were more similar to what we found in Aptos Creek.

In Scott Creek, average YOY steelhead site densities for 2007─2010 were 49, 20, 24.2 and 45 fish/ 100 ft, respectively with YOY densities in 2010 closer to the 20-year average of 54 (**Smith 2010**). The average Waddell Creek YOY site densities for 2007─2010 were 13, 23, 10.4 and 13 fish/ 100 ft and much below the 20-year average of 39. Fall baseflow in Scott was similar to 2009 and YOY sizes were not greater in 2010. YOY were larger in Waddell and Gazos creeks where baseflow was higher than in 2009. The average Gazos Creek YOY site densities for 2007 and 2009─2010 were 21, 17 and 16 fish/ 100 ft and much below the 14-year average of 35 (years when at least 5 sites were sampled). Low YOY densities in Gazos were at least partially attributed by Smith to be poor spawner access due to two large logjams and two smaller logjams.

YOY densities in Waddell Creek have been especially low since 1999, assumedly due to toxic pollution from Last Chance Creek on the East Branch. Smith suspects that lightweight solvents (not usually affecting sculpins) are the cause, originating in the Last Chance Creek sub-watershed. Surprisingly, the highest YOY density in Waddell Creek in 2009 was in the East Branch, downstream of Last Chance. We noted that in 2010, YOY densities in the West Branch were similar to some site densities on the East Branch below Last Chance and in the mainstem below the East Branch confluence but higher than others. No sampling was done above Last Chance confluence on the East Branch in 2010. The lowest 2010 YOY densities were in the mainstem below the branch confluences. We agree with Smith that the adult steelhead population may be much smaller now, resulting in low YOY densities throughout the watershed. A close look at habitat conditions would be helpful for assessing causal factors for low YOY densities in Waddell Creek.

The low YOY densities in Waddell and Gazos creeks in 2010 were most similar to those found in the sediment-laden sites of Valencia 2, Corralitos 1, 3 and 8 and Branciforte 21a-2, as well as in mainstem Soquel sites, some mainstem San Lorenzo sites (0a, 1 and 6) and Lompico 13e. Higher YOY densities in Scott Creek in 2010 were more similar to those in San Lorenzo tributary sites, Soquel branch sites, lower Aptos 3 and upper Browns 2 sites.

Densities of 1+/2+ juveniles were below average at most sites in Scott (**Figure 69**), Waddell and Gazos creeks (**Figure 70**) and less than in 2009 (**Smith 2010**), consistent with general findings in our 4 sampled watersheds. Average 1+/2+ densities in Scott Creek for 2007─2010 were 14, 8, 7 and 5 fish/ 100 feet, with a 20-year average of 9 fish/ 100 feet and a sizeable standard error of 5.5 (**Figure 71**). Average 1+/2+ density in Waddell Creek for 2007─2010 were 2, 1, 2 and 1 fish/ 100 ft, with a 20-year average being 5.7 fish/ 100 ft. Average 1+/2+ density in Gazos Creek for 2007 and 2009−2010 were 4, 9 and 4 fish/ 100 ft, with 17-year average being 8 fish/ 100 ft. In these creek sites, these age classes were likely the only fish reaching Size Class II. So, the very low Size Class II and III densities in Scott, Waddell and Gazos creek sites in 2010 were similar to low densities at middle San Lorenzo mainstem Site 6, upper San Lorenzo mainstem Site 11, upper Bean 14c, lower Soquel mainstem Site 4, sediment-laden Corralitos sites 3 and 8, and both Shingle Mill sites (1 and 3).

Average Size Class II abundance at Waddell and Gazos creek sites in 2010 were less than densities in all sites sampled in our four watersheds. The Scott Creek average was less than all sites except for the mainstem San Lorenzo Site 6 below Fall Creek and the mainstem Soquel Site 4 near the flower fields.

D-4. Data Gaps

Annual monitoring of steelhead needs to continue through the next drought period and beyond to assess the extent of population recovery. The level of fish monitoring and habitat analysis was greatly reduced after 2000 in the San Lorenzo River drainage, a year in which the mainstem was sampled at 16 sites (13 reach segments habitat typed), and 9 tributaries were sampled at 20 sites (20 reach segments habitat typed). At that time, indices of juvenile and adult steelhead population sizes were possible. By 2009 and 2010, sampling was reduced to less than half that of 2000 and 2001, while habitat typing was reduced to less than 1/3 in 2009 and even more so in 2010. In 2010, 7 mainstem sites (1 reach segments habitat typed) and 8 tributaries were sampled at 12 sites (8 reach segments habitat typed). Population indices were not possible after 2001. Many upper mainstem and upper tributary sites were discontinued. Carbonera and Kings creeks are no longer sampled. While site densities are valuable, the relative contributions of mainstem reaches and tributaries to total juvenile population size are lost when only site densities are reported, rather than the total production of the reaches that the sites represent. The relative importance of mainstem reaches compared to tributaries in production of large juveniles is lost when only site densities are considered. Calculation of an *index of adult returns* is the most meaningful way to compare the value of the annual juvenile population because it weighs the juveniles according to size categories and size-dependent ocean survival rates. Although the index may not precisely predict actual adult numbers, it reflects *relative* juvenile contribution to adult returns between reaches and between years.

Sampling in Soquel Creek was reduced from 19 sites (14 reaches) in 2004 to 15 sites (14 reaches) in 2005 to 6 sites (6 reaches) in 2006 and increased to 8 sites (8 reaches) in 2009 and 2010. After 2005, annual estimation of juvenile steelhead population size and calculation of adult indices from juvenile population size ceased in Soquel Creek for the first time since 1994. This is a significant loss in monitoring information. Recent data gaps in the heavily impacted mainstem of Soquel Creek have occurred. In 2008 and 2009, 2.5 miles of mainstem were habitat typed, when all 7.2 miles were habitat typed in the past to assess habitat quality. No reaches were habitat typed in the watershed in 2010.

With the change in County management guidelines for large instream wood, incidence of large instream wood should be annually monitored. The wood survey completed in 2002 on Soquel Creek (**Alley 2003c**) could be repeated periodically for comparison purposes. Five reaches among 3 watersheds were inventoried for wood in 2010. Wood inventories should be expanded to other reaches.

There is a shortage of streamflow data on the San Lorenzo River mainstem and tributaries. More stream gages should be established and maintained in the watershed to better correlate streamflow with habitat conditions and fish densities and to detect insufficient streamflow. Mainstem locations for additional gages would include Waterman Gap, above and below the Boulder Creek confluence on the mainstem. Tributaries that need better gaging include Zayante Creek (above and below the Bean Creek confluence), Bean Creek (below Lockhart Gulch and just below the Mackenzie Creek confluence), Fall Creek above the water diversion and Boulder Creek (near the mouth).

There is no stream gage in the Aptos watershed. It would be beneficial to have stream gages on lower Valencia Creek and Aptos Creek near the lagoon. Any future management of Aptos Lagoon would benefit from continuous streamflow data in relation to sandbar manipulation. It is a valuable tool on Soquel Creek with the USGS gage in Soquel Village. The only stream gage data for the Corralitos watershed is at Freedom. This is below the City of Watsonville diversions and is in a percolating reach that is dry in summer. It would be beneficial to install stream gages at the diversion dams on Browns and Corralitos Creeks. Then streamflow above and below the diversions could be monitored. If stream gaging proves prohibitively expensive, streamflow should be annually measured in mid-May and mid-September at the proposed gage locations in Valencia, Aptos, Corralitos and Browns Creeks. In addition, it would be enlightening to measure streamflow downstream of the Rider Creek confluence with Corralitos Creek, downstream of the Eureka Gulch confluence with Corralitos Creek and upstream of the Eureka Gulch confluence.

If stream gaging proves prohibitively expensive, streamflow should be annually measured in mid-April and mid-September at the proposed gage locations in the San Lorenzo watershed, as well as in the mainstem at Paradise Park, at the Henry Cowell Park bridge, downstream of the Fall Creek confluence (under Graham Hill Road bridge), downstream of the Clear Creek confluence (near Larkspur Bridge), downstream of the Boulder Creek confluence (along Erwin Way), and in the upper valley near the Mountain Store (downstream of Kings Creek) and at the Teihl Road bridge. Streamflow should also be measured in Bear Creek below Hopkins Gulch and in Newell Creek (Glen Arbor Road Bridge).

TRENDS IN JUVENILE STEELHEAD ABUNDANCE AND HABITAT CONDITIONS IN THE SAN LORENZO RIVER, 1997−2010

Trend in Juvenile Abundance in the Lower and Middle Mainstem San Lorenzo River

The lower San Lorenzo mainstem (downstream of the Zayante Creek confluence) and middle mainstem (between the Boulder and Zayante creek confluences) have become less productive for juvenile steelhead in total abundance, YOY age class and the Size Class II and III categories from 1999 onward (**Figures 21−23**). However, with the high growth rate of YOY in 2010, Size Class II and II abundance improved. Fall YOY densities are very sensitive to timing of stormflow events, with higher YOY densities occurring when larger stormflows are absent after approximately March 1, adequate passage flows exist before March 1, and spawners are in sufficient numbers. This indicates that redds are scoured by later storms of sufficient magnitude and/or small YOY are washed away by later storms. 1997, 1998, 2002 and 2008 were years with primarily early winter spawning flows, and total abundance and YOY densities were generally higher in those years in the San Lorenzo and Soquel watersheds (**Figures 21−22 and 27−28**). Total and YOY densities were less in other years. No data were available from the HTH report (**2003**) regarding YOY or Size Class II and III densities in 2002 in the San Lorenzo. However, HTH found that total juveniles densities increased in 2002, and most fish were likely YOY. Comparison of 2002 densities with other years was also difficult because H.T. Harvey & Associates (HTH) (**2003**) employed different methods in choosing sampling sites. However, we detected the same increased densities in Soquel Creek in 2002 as did HTH in the San Lorenzo to strengthen the comparison.

Trends in Size Class II and III abundance are less correlated to winter storm patterns or yearling and older abundance. This is because after a wet winter and high spring streamflow, the YOY density may be relatively low. Yet abundance of Size Class II and III may be relatively high by fall sampling because a higher proportion of YOY have grown into this larger size class than in years with few late winter storms and high YOY abundance, yielding relatively high Size Class II densities. This occurred in 2005 and 2010 in the San Lorenzo (**Figures 25−26**) and Soquel watersheds (**Figure 29 and 32**).

The years 1998 and 2006 had similarly wet winters prior to fall sampling, making them good for comparison. However, the mainstem had substantially higher juvenile densities in 1998 than 2006. It does not appear that declines in rearing habitat conditions could fully explain the diminished juvenile densities in 2006. Detailed habitat comparisons between these two years may be found in **Alley 2010b**. We suspect that there were fewer adult spawners in 2006 than 1998 and/or reduced spawning success in 2006 to mostly explain the decline in juvenile densities between 1998 and 2006. Fewer tributary YOY likely seeded the mainstem in 2006 than 1998.

A comparison of habitat conditions in Reach 2 since 2000 indicated reduced habitat quality with percent fines similar while riffle embeddedness increased and riffle depth and escape cover declined (**Figures 42−45**). Trend analysis if Reach 4 to 2008 and Reach 8 to 2009 are in **Alley 2010b**. Substrate conditions improved in both reaches since 1999 (after the 1998 high stormflow) but were better in 1997.

Densities of Size Class II and III juvenile in the lower and middle mainstem were higher in the years 1997−1999 than later years, with relatively low densities from 2000 until 2009 and a slight rebound in 2010, and 2007 having the lowest densities measured in the last 14 years (**Figure 23**). The 5-site average shows this trend. Sites 1, 6 and 8 had been at less than 7 smolt-sized juveniles per 100 feet, 2003−2009 and 6-15 in 2010 compared to 10-24 per 100 feet in 1997, 21-29 per 100 feet in 1998 and 3-16 in 1999. Site 4 below the Zayante Creek confluence showed a similar pattern, just with relatively higher fish densities each year compared to the other sites and similar densities in the last 3 years at 12-14 per 100 ft. Later wet years of 2005 and 2006 (and 2010 at least in the spring) did not bring higher densities of these larger juveniles as occurred after the wet 1997-1998 winter. The lower and middle mainstem have become less important in producing larger juveniles in recent years. In order for adult returns to increase substantially, the mainstem will need to again support at least the densities of Size Class II and III juveniles that were present in 1997−99. Fish abundance will likely increase if instream wood does.

Ecological Considerations for the Lower and Middle Mainstem

The density and size of juvenile steelhead in the lower and middle mainstem San Lorenzo River is dependent upon a number of factors; 1) number of spawning adults, 2) spawning effort in these segments after large, sediment-moving, redd-scouring storms are over for the wet season, 3) spawning success (survival rate from egg to emerging fry), 4) the number of juveniles that enter the lower and middle mainstem from tributaries, 5) survival of emerging YOY in spring and 6) the rearing habitat quality primarily in fastwater habitat (riffles, runs and heads of pools) in the spring and summer (higher baseflow in spring and summer increases juvenile growth rate and size of YOY). The lower and middle mainstem are inhabited by primarily fast growing YOY with much fewer yearlings. In relatively drier winter/springs, more spawning effort usually occurs in the lower and middle mainstem and less in the tributaries due to more limited access to the upper watershed reaches. In the last 14 years, 2001, 2002 2004, 2007, 2008 and 2009 were relatively dry, based on averaged mean monthly streamflow (May–September) (**Figure 52**). Spawning success is likely greater in drier years in the lower and middle mainstem because fewer storms are likely to destroy spawning redds after spawning. However, shallow water depth in spawning glides may make it more difficult for adults to spawn, and water percolates more slowly through the gravels to buried eggs in drier years to provide less adequate oxygen and slower removal of metabolic wastes, which may reduce egg and sac-fry survival rates. 2010 was a wetter year than the 3 previous dry ones, and stormflows began in mid-January and continued sporadically until mid-April, which was relatively late (**Figure 56**). The distribution of YOY was typical in 2010 for a wetter year, with higher YOY densities in the upper watershed sites compared to lower sites (**Figures 22 and 25**). YOY abundance increased throughout the watershed, despite the higher stormflows in the lower mainstem sites where YOY densities were higher than 2006, 2007 and 2009. Apparently, in 2010 there was sufficient stormflow for adults to access upper sites, but some late spawning adults had success in the lower watershed, as well. Also, there may have been much fewer adults spawning over the WY2009 winter, making spawning effort and YOY densities more spotty than in WY2010. Years in which most of the larger winter storms occur early in the winter, and they are of sufficient number to maintain a high but steady decline in the hydrograph through the late winter and spring with the help of smaller stormflows, will have maximum spawning success later in the spawning season and maximum juvenile survival after emergence in the lower and middle mainstem. The years of 1997, 2002 and 2008 were examples of this hydrologic pattern (**Appendix E**). The year 2007 had few late winter storms but also had few early winter storms, as well, it being the driest of the last 14 years.

In wetter years, more spawning effort occurs in the upper reaches of the watershed, namely in the upper mainstem and the tributaries. Relatively wet years included 1997, 1998, 1999, 2000, 2005 and 2006 (**Appendix E**). Spawning success and survival of emerging YOY may be reduced in the lower and middle mainstem in these years due to later storms that destroy redds and wash away emerging YOY (except in 1997 when stormflow nearly ceased after 1 March). There may be fewer of the large yearlings in those mainstem segments because either growth rate may have been substantial in early spring to encourage yearlings to smolt. Large storms may also reduce overwinter survival of yearlings, as well. However, after wetter winters, the baseflow will be higher, and growth rate of YOY in the lower and middle mainstem will be substantial. The density of Size Class II and III juveniles may be relatively higher in the fall following the high baseflow spring and summer due to a higher proportion of YOY reaching this smolt size their first summer, as reflected in higher Size Class II densities in 1997−1999 and 2005 (**Figures 23 and 26**). Abundance of these larger juveniles rebounded in 2010 despite fewer yearlings than in 2009 because of as high a percent of YOY reaching Size Class II in mainstem sites despite higher densities and a higher percent in tributaries compared to 2009 where spring baseflows were higher (**Figure 17**).

Habitat quality will need to improve substantially in the lower and middle mainstem to increase adult returns. Retention of more large, instream wood will promote scour to deepen pools, create patches of coarser spawning gravel and provide escape cover for juvenile steelhead rearing and overwinter survival. Better retention of winter storm runoff, especially in Scotts Valley and other developed communities such as Felton, will reduce stormflow flashiness that increases streambank erosion and sedimentation leading to poorer spawning and rearing conditions. Better retention of storm runoff will also increase winter recharge of aquifers to increase spring and summer baseflow, which will increase YOY steelhead growth into Size Classes II and III in the lower mainstem. Capture of a portion of high winter flows and injection into groundwater aquifers may improve spring and summer baseflow and improve steelhead growth rates.

Trends in Juvenile Abundance in San Lorenzo River Tributaries and the Upper Mainstem

Looking for overall trends in juvenile densities for all of the tributaries combined would be time prohibitive. Each tributary drains a sub-watershed with its own climate, geology, gradient, habitat proportions, residential density and level of human activities (logging, bridge building, road and bridge maintenance and water extraction). Adult spawning access and habitat conditions do not necessarily fluctuate annually in parallel between sub-watersheds. Some sub-watersheds are accessible to spawning steelhead in most years while others are difficult to pass in drier winters. Some sub-watersheds are more stable regarding sedimentation while others are more erosive. Some have high annual variability in baseflow while others are stable. The relative size of each sub-watershed affects the level of summer/fall baseflow in each.

The Zayante Creek sub-watershed, along with other sub-watersheds on the east side of the San Lorenzo watershed is more heavily developed, has more roads and bridges, is most impacted by well-pumping, is lower gradient with more meandering, less shaded channels dominated by pools, is more accessible to steelhead and is more sediment-laden because erosive shale and Santa Margarita sandstone dominate the geology. The Boulder Creek sub-watershed is smaller, along with other sub-watersheds on the west side of the San Lorenzo watershed, is less developed with less roads and bridges, is most impacted by surface water diversions, is steeper gradient with a cooler, more canyon-like and shaded channel having more fastwater step-runs and riffles, is less accessible to steelhead with steep, boulder riffles and is less erosive because of its granitic geology. Although conifers dominate the streamside vegetation more so in western sub-watersheds, the upper reaches of eastern sub-watersheds are highly coniferous, with the entire watershed being impacted by historical and contemporary logging.

Most of the juvenile population in tributaries consists of YOY. YOY abundance at tributary sites is influenced by several factors; 1) number of adults returning to the respective tributaries, 2) spawning effort, 3) spawning success, 4) survival of emerging YOY in late winter and spring and 5) rearing habitat quality in primarily pools. Spawning conditions are better in the tributaries than the mainstem, but late stormflows may be very successful in destroying many spawning redds because of the high percentage of fines in spawning glides in nearly all tributary spawning sites. Water velocities from late stormflows may also wash newly emerged YOY away, with high mortality in the face of little instream wood to provide velocity shelter.

For tributary sites and the upper mainstem (above the Boulder Creek confluence as represented by Reach 11), there was a general decline in total and YOY abundance from 1997 to 2000, with a general increase from 2000 to 2003, followed by a general decline from 2003 to 2007, a rebound in 2008 followed by an overall decline in 2009 that continued in 2010 at Zayante sites but not others which rebounded slightly (**Figures 24 and 25**). The extremely high juvenile density measured in 2002 at Site 11 by HTH (**2003**) seemed highly unusual, considering our 16 other years of sampling experience with Reach 11 in the upper mainstem. Although there were no YOY data available in 2002, we can guess that YOY densities followed the same trend as total densities. YOY densities fluctuated greatly through the years at certain sites. YOY density at Site 14c in upper Bean Creek fluctuated the most. This reach is greatly impacted by well pumping, with the segment partially dry in 2007 and completely dry in 2008 (Alley 2009) and 2009 (C. Berry pers. comm. 2011). During the 2003–2009 period, Site 14b in middle Bean Creek surprisingly had no YOY in 2007 and very low densities in 2009, presumably because a long segment of the creek upstream of the site was dry and prevented YOY recruitment. YOY densities rebounded at Site 14b in 2010, with more wetted channel in Reach 14c above.

YOY density at Site 13c on Zayante Creek annually fluctuated up and down and had the greatest steelhead abundance in the watershed in 2008−2010 resulting from high YOY abundance. Site 13d on Zayante Creek declined significantly in YOY and total densities in 2007, with its 2007 densities the second lowest in 14 years. However, it rebounded in 2008 and declined somewhat in 2009 and 2010. The 2007 sampling site in Reach 13d had been upstream of a major landslide that had created a steep boulder cluster in the channel during the winter of 2005−2006. This boulder cluster may have been a passage impediment in 2007 that resulted in reduced spawning and juvenile recruitment upstream. This possible impediment was modified in 2008. The 2009 and 2010 sampling sites were above this modified boulder cluster.

YOY densities in San Lorenzo tributaries may be relatively higher in years like 1997 and 2002 because of no large, late storms but smaller late storms sufficient to promote spawning through the winter and spring (**Figure 25**). YOY densities in tributaries may also be higher in wet years, such as 1998, which had high winter flows for good spawning access and high baseflows later on for good rearing habitat, with no large stormflows occurring between March and June but still adequate spawning flows for late spawners (**Appendix E**). 1999 had relatively large stormflows in April and May that may have reduced YOY survival, which may have also been the case in 2006, 2009 and 2010. The year 2000 had multiple large stormflows from January through early March, making egg survival likely difficult, followed by rapid decline in baseflow with no storms except for a small one in late April. In addition, it was hypothesized that there were reduced adult returns in 2000 associated with the El Niño storm pattern and associated ocean conditions. There was likely high mortality of smolts in winter of 1997-1998 due to large flood flows. These smolts would have contributed to the 2000 adult return. The El Niño period began in summer 1997 and persisted through spring and summer of 1998. Warm water, low macronutrient levels and low chlorophyll and primary production along the continental shelf characterized the event. Poor smolt survival in the ocean may have resulted from high competition for food under warm water conditions, contributing to low adult returns in 2000.

The drier-to-moderate rainfall years of 2001–2004 and 2008 likely allowed for relatively higher egg and young YOY survival, with enough small storms to allow adult access to tributaries and the largest storms occurring in early winter. Years 2004, 2005 and 2008 produced similar YOY densities as 1999 with very different hydrographs (**Appendix E**). The years 2004 and 2008 had no significant storms after early March and below average baseflows after that. The year 2005 had periodic stormflows throughout March, April and early May, with above average baseflows through the summer. YOY densities declined in 2006 with periodic stormflows through mid-May as in 2005, but the storms were of larger dimension and lasted longer in 2006, thus likely leading to poor egg and young YOY survival (**Appendix E**). The year 2007 had only very small storms in January, providing limited access to tributaries and only two moderate stormflows in March, providing access and flows conducive to spawning in tributaries (**Appendix E**). Limited stormflows likely limited spawning effort in tributaries. Egg survival was likely good but competition for food associated with low baseflow in April−May likely reduced YOY survival in 2007. The low 2009 YOY densities likely had four causal factors involved, including 1) fewer spawners after 3 previous years with poor ocean conditions and low smolt-sized juvenile abundance in 2006, 2) low spawning flows in early winter, 3) followed by the principle stormflows occurring later in the winter/early spring in a short time frame to scour previous redds and wash away emerging YOY, 4) but a below-average baseflow in late spring to limit rearing habitat (**Figure 54**). The continued low YOY abundance in 2010 had three likely causal factors, including 1) likely few spawners after previous poor ocean conditions affecting smolts that would return as adults, and 2) likely poor lagoon production of smolts due to poor water quality in 2007 after insufficient stream inflow to convert it to freshwater and 3) low YOY survival during late stormflows occurring into April (**Figure 56**). However, YOY densities rebounded in 2010 with relatively high spring baseflow to stimulate YOY growth and survival after the rainy season as indicated by increased averaged mean monthly streamflow for May−September 2010 after 3 previous dry years (**Figure 52**). However, summer baseflow declined rapidly to median levels because of the 3 antecedent dry years still affecting water tables and baseflow.

Tributary abundance of larger Size Class II and III juveniles in fall (almost entirely yearlings except in years with high spring baseflow) is determined mainly by 1) over-wintering survival from the previous winter, 2) growth rate in spring that may allow early smolting of yearlings their first spring while allowing some YOY to reach Size Class II and 3) rearing habitat quality through the summer that affects survival.

Tributary abundance of Size Class II and III (smolt size) showed no general trend, though as a group their annual average density was relatively low in 2007−2009 at mainstem and tributary sites (**Figures 23 and 26**). Years that had overall low tributary site densities of larger juveniles were 2001, 2004, 2007─2009, all of which had relatively low averaged mean monthly streamflow for May−September over the last 14 years and below the median daily flow for the years of record (**Figure 52 and Appendix E**). After wetter winters, densities of larger juveniles generally increased the most, as occurred in 1998, 1999, 2003, 2005 and 2006. Densities were similar between 1997 and 1998 but generally increased in 1999 to a 14-year high, particularly in Zayante, upper Boulder and Bear creeks. In 1999, the winter had only 1 peak flow that was near bankfull in early February, and it continued to rain through April for a relatively wet winter but without creating bankfull flow intensity to move sediment and scour redds (**Appendix E**). Spring and summer baseflow in 1999 was above the median. Densities of larger juveniles declined at all studied sites in the drier years of 2007─2008, except Zayante Creek 13d increased in 2008 to the highest in the watershed. In 2009, densities increased at some tributary sites and continued to plummet at others during a third consecutive dry year, remaining low on average. They rebounded in 2010 at mainstem and tributary sites due to faster YOY growth to Size Class II, resulting from high spring baseflow and near median baseflow soon after.

The highest overall Size Class II and III densities at most tributary sites occurred in 1999, which was a relatively wet year without stormflows that continued through April with only one possibly reaching bankfull streamflow (2,800– 4,300 cfs at Big Trees; (**Alley 1999a**) in early February at 3,200 cfs. The averaged mean monthly streamflow for May−September was intermediate for the last 13 years (**Figure**

25). 1999 had a much above median daily baseflow for May−September (**Appendix E**). When one takes a less detailed look at the changes in larger juvenile densities at tributary sites, there has been little overall change except in 2007─2009. In these 3 dry years, they mostly declined substantially, compared to earlier years. If adult returns are to substantially improve, densities of these larger, soon to smolt, juveniles must greatly increase from much improved tributary habitat quality.

Trends in Abundance of Large Juveniles at the upper Zayante Site 13d

Annual trends in Size Class II and III densities at the upper Zayante Site 13d (**Figure 24**) did not correlate well with changes in reach-wide pool depth for the years of available data (**Figure 46**). However, no reach data were available for drier years of 2001, 2002 or 2004. Changes in large juvenile fish density were associated with changes in sampling site escape cover in pools until densities began to level out for 2004−2009 (except for a blip in 2008), despite reduced escape cover from 2006 onward (**Table 12b and Alley 2010b**). They may have remained constant because of higher baseflow in 2006 and higher over-winter survival in 2007─2009 after mild winters. However, reduced large juvenile abundance was correlated with the halving of pool escape cover in 2010. Densities increased in 2008 as escape cover remained similar to 2007 at Site 13d but declined somewhat despite increased escape cover in 2009. Density changes also coincided well with changes in reach-wide escape cover in 1998–2000 and 2003 and 2010 (**Figure 47**). However, somewhat higher reach-wide escape cover in 2005 did not correspond to high Size Class II and III fish density in that year, presumably because escape cover at sampled pools remained similar between 2004 and 2005. The decline in step-run percent fines was only positively associated with increased densities from 2001 to 2003, but pool escape cover was also relatively high in 2003 to encourage higher fish densities (**Figure 48**). Reduced Size Class II and III abundance at Site 13d was correlated with increased step-run embeddedness in 2010 (**Figure 49**). Step-run embeddedness had remained similar in 2005−2009 and was substantially higher in 2010 (51%) than in 2003 (33%), indicating a trend in more highly sedimented conditions.

Analysis of continued reach-wide habitat change with associated change in Size Class II and III abundance in the important western tributary reach, Boulder Creek, was not possible in 2010 because no habitat typing was done there. Trend in habitat change through 2009 may be found in **Alley 2010b**.

Trends in Abundance of Large Juveniles at the lower Boulder Creek Site 17a

Annual trends in density of Size Class II and III juveniles at the lower Boulder Creek Site 17a were correlated with reach-wide changes in pool depth for most years of data (1998–2000 and 2005–2008) until 2009 when smolt densities remained low despite increased pool depth (**Table 6a; Figure 26**). In 2010, Size Class II and III abundance rebounded with deeper pools and more escape cover at Site 17a compared to 2009 (**Tables 6b and 12b**). This may be because a higher percent of YOY reached this size class in 2010 (54%) compared to 2009 (14%) (**Figure 17**). Changes in potential smolt density were not well correlated with changes in escape cover in sampled pools or with reach-wide changes in pool escape cover prior to 2010 (**Alley 2010b**). The poor correlation may result from no consideration of step-run escape cover and depth in a reach where step-runs are a large proportion of the habitat and deep enough to be inhabited by larger juveniles. Also, except for 1997 and 2007, the annual differences in pool escape cover were small in sampled pools that generally lacked much escape cover. Therefore, other factors may have played larger roles in determining densities. The 2007 density was much less than the 2006 density, despite increased pool escape cover in 2007. However, large yearlings from the previous wet year may have smolted and out-migrated in spring 2007 prior to fall sampling, leading to small fall yearling densities. Densities were at times positively correlated with increased percent fines in step-runs, though percent fines did not increase substantially except from 1998 to 1999 (**Alley 2010b**). This is the opposite of what was expected because increase in percent fines indicates a decline in habitat quality. Apparently the negative effect of increased percent fines measured in 1999 and 2006 were overcome by relatively high streamflow and water velocity, greater water depth in step-runs and better feeding stations in step-runs and the heads of pools.

Habitat Trends in the Lower and Middle Mainstem of the San Lorenzo River

In the lower mainstem (downstream of the Zayante Creek confluence) habitat conditions in Reach 2 (in the Rincon area below the gorge and the Felton water diversion) were analyzed in detail in 1999─2000 and 2007−2010, with no habitat typing in the years between. Habitat in riffles was focused on in the lower and middle mainstem because warm water temperatures there will increase energy requirements of juvenile steelhead, forcing them to select fastwater habitat where water velocity and insect drift are maximized. Riffle habitat conditions have worsened in Reach 2 between 1999 and 2010 primarily due to shallower conditions with much less escape cover. Riffle depth has been fairly constant in 2007−2010 but much shallower than in 2000 (**Figure 42**). Part of the difference may be the above median baseflows in 2000 than in the 3 dry years and median year of 2010 (**Appendix E**). Some deeper runs of recent years may have been classified as riffles in 2000 with higher flows, as well. However, the deeper riffle conditions indicated by the graph for 2000 are likely real. Escape cover in riffles has also declined substantially since 1999 and 2000, which may be partially explained by higher baseflows in the earlier years (**Figure 43**). However, with nearly 5 times the escape cover measured in 1999 compared to 2010, conditions were certainly better in 1999. Percent embeddedness has increased significantly since 2007 while percent fines have remained similarly low (**Figures 44 and 45**).

In the lower mainstem (downstream of the Zayante Creek confluence) habitat conditions in Reach 4 (above the gorge and below the Felton water diversion) were analyzed in detail in 1997─2008, with no habitat typing in 2009 or 2010 (**Alley 2010b**). General channel instability occurred in upper Reach 4 (Henry Cowell Park) of the lower mainstem after the 1997/1998 winter, causing substantial streambank erosion and washing large sycamores into the active channel (**Alley 1999a**). In summary, although rearing habitat conditions in Reach 4 riffles in 2008 have improved since 1999 regarding more escape cover and reduced percent fines, 1997 riffle conditions were better with regard to habitat depth, and riffles in 1999 were also deeper and had similar embeddedness compared to 2008. Riffle habitat conditions declined from 2007 to 2008 regarding shallower depth, much less escape cover and higher embeddedness.

In the middle mainstem (between the Zayante and Boulder creek confluences) habitat conditions in Reach 8 (from upper Ben Lomond to Brookdale past the Alba Creek confluence and ending at the Clear Creek confluence) were analyzed in detail for 1997−2009 (**Alley 2010b**). Riffle habitat was focused on because under warm water conditions in the middle mainstem, juvenile steelhead are found primarily in fastwater habitat. Habitat conditions in Reach 8 were best in the wet year of 1998 (highest baseflow, greatest depth, fastest water velocity and most escape cover). Overall rearing habitat conditions in 2007 were not as good as in 1997 with regard to depth, though percent fines and embeddedness were similar. Escape cover in 2009 was half that in 1998 or 2005, indicating reduced habitat quality in that regard (**Table 9a**). If baseflows had been the same in 1997 and 2009, habitat conditions in Reach 8 riffles would have been better in 1997 due to more escape cover then. In 2010 conditions improved, with the sampled riffle in Reach 8 having more than twice the escape cover as 2009 (**Table 9b**) and increased depth consistent with increased baseflow (**Table 6b**).

Habitat Trends in San Lorenzo Tributaries

In general, in comparing sub-watersheds on the west side of the drainage (largest being Fall and Boulder) with those on the east side, those on the west side are steeper in gradient, are from granitic origin (rather than shale and sandstone) and generally with larger boulders present in their lower reaches, they flow through deeper and narrower canyons without floodplains, are relatively more shaded and cooler and are impacted by primarily surface water diversions and logging. The sub-watersheds from the east (largest being Branciforte-Carbonera, Zayante-Bean, Newell, Bear and Kings) are generally lower gradient, are mostly from shale and sandstone origin (except Branciforte-Carbonera), have reaches that do not always flow through narrow canyons, are sporadically less shaded by primarily deciduous trees, and they are warmer.

Streamside vegetation plays little role in pool formation in Boulder Creek on the west side but plays an important role in Fall Creek. The flatter sub-watersheds of the eastern tributaries are more impacted than the western tributaries by higher residential and urban density, more human activities (more paved surfaces, quarrying, logging and business- and road-generated chemical pollution) and greater water extraction primarily from wells (except Lompico Creek, which has a surface diversion). The upper mainstem has a mix of substrate influences from western and eastern tributaries but is generally low gradient with short riffles and long pools, except where gradient increases in the upper reaches beginning near Waterman Gap.

In Zayante Creek, the largest eastern sub-watershed of the San Lorenzo system, habitat trends were analyzed in Reach 13d since 1998, when habitat typing of tributary reaches began. This was the uppermost reach under study and downstream of Mountain Charlie Gulch. Pool habitat was focused on for depth and escape cover parameters because in tributary channels, most juvenile steelhead inhabit pools, with important Size Class II and III juveniles restricted to primarily pools and step-runs.

Rearing habitat conditions improved in Zayante Reach 13d from 1998 to 2009 and then declined in 2010. In Reach 13d, annual changes in pool depths paralleled annual changes in averaged mean monthly streamflow record at Big Trees gage (May–September) except for additional shallowing from 2000 to 2003, caused by streambed filling despite increased baseflow in 2003 (**Figures 46 and 52**). Although it appeared that pools were deeper in 1998, this was likely caused by step-runs in 1998 being typed as pools in 2009, a year with much reduced baseflow. The same likely occurred in 2010 with higher baseflow, making it appear that pools deepened from 2009 to 2010. With higher baseflow in 1998, the proportion of pools in the reach was 50%, and the proportion of step-runs was 40% compared to 71% pools and 23% step-runs in 2009 (**Alley 1999a**). In 2010, pools reduced to 57% and step-runs increased to 37% of the habitat (**Table 5c**). The important reach-wide pool escape cover showed improvement from 1998 to 2005 but had substantial reduction in 2006 and continued low in 2007 and 2008 and 2010 (9 ft per 100 ft of stream), with a temporary rebound in 2009 (18 ft per 100 ft of stream) (**Figure 47**). Pool escape cover was less in 2010 than 1998 (14.5 ft per 100 ft of stream). (Escape cover and depth in sampled pools mirrored, as much as possible, annual reach-wide changes to sample average habitat conditions but should not be used to detect reach-wide trends.) Percent fines in step-runs declined substantially through the period to 2007, only to increase substantially in 2008 and continue in 2009 (30%) with slight improvement in 2010 (25%) (**Figure 48**). Percent fines in step-runs in 2007 were at a 13-year low (13%) and continued to be less in 2010 than in 1998 (35%). Run/step-run embeddedness increased significantly from 2009 (41%) to 2010 (51%) to its highest since 2003 (**Figure 49**).

In Boulder Creek, the largest western sub-watershed of the San Lorenzo system, habitat trends were analyzed in detail in Reach 17a for 1998−2009 (**Alley 2010b**). The reach was not habitat typed in 2010. Overall rearing habitat quality in Boulder Reach 17a has declined from 1997 to 2008 (as it had in Reach 13d) due to reach-wide pool filling and reduced pool escape cover. Pools had deepened in 2009, but escape cover continued to be low in both pools and step-runs, indicating slightly improved habitat conditions over those in 2008.

Annual changes in reach-wide pool depths of lower Boulder Reach 17a did not parallel annual changes in averaged mean monthly streamflow record at Big Trees gage (May–September) in 1998–2000 but did so in 2005–2009 (**Figure 52**). Reach-wide pool escape cover was highest in 1998, declined considerably in 1999, rebounded in 2005 but declined in 2006 and remained low in 2007─2009. High escape cover at the sampled pool habitat in 1997 (27 ft/ 100 ft of stream) in the same vicinity of later sampling offered evidence that escape cover was once much higher than in 2009 and 2010 (9.5 ft/ 100 ft of stream) (**Table 12b**). Escape cover was generally less in lower Boulder Creek 17a than in Zayante Reach 13d over the 12-year period, 1998−2009 (**Table 12a**), and continued to be at sampling sites in 2010. Percent fines in Boulder Reach 17a were generally less than in the Zayante Reach 13d (**Table 7**). Embeddedness was generally higher in pools and run/step-runs in Zayante Reach 13d than in Boulder Reach 17a with similar riffle embeddedness (**Table 8**).

TRENDS IN JUVENILE STEELHEAD ABUNDANCE IN SOQUEL CREEK, 1997−2010

Trends in Juvenile Steelhead Abundance in the Soquel Creek Mainstem

At the 4 mainstem sites tracked for the past 14 years, annual trends in total and YOY juvenile densities mostly paralleled each other (**Figures 27 and 28**). Because the juvenile population in the mainstem is largely YOY, spawning effort, spawning success and early YOY survival largely dictate total juvenile densities. In drier years with milder winter stormflows (or mostly early stormflows and few late stormflows) and reduced baseflow, total and YOY juvenile steelhead densities were relatively higher in the Soquel Creek mainstem than in wetter years (**Appendix E**). The years of highest YOY and total juvenile density corresponded to years with the lowest averaged mean monthly streamflow (May–September), indicating the drier years or at least years with few late winter and spring storms (**Figure 26**). 2009 did not fit this pattern because although it was dry, the storms came later and were in a short time frame. 2010 did fit the pattern with its later spring stormflows. Drier years are also typically the years when the lagoon population of juveniles is the greatest, although 2009 did not fit the typical pattern because the lagoon population was small despite an overall mild winter (**Alley 2010a**). 2010 did follow the pattern with a below average population size and a wet spring (**Alley 2011**). The typical inverse relationship may be explained by reasoning that during milder winters, adult spawners probably have limited access to the upper watershed, having more shallow riffles and other impediments to pass. Thus they expend more spawning effort in the mainstem. Also, in drier years, survival of eggs and emerging YOY may be increased without substantial late stormflows to scour or smother redds and wash away YOY. We learned from our spawning gravel study, which involved streambed coring and particle size analysis, that spawning gravel conditions in the mainstem were reasonably good in 2002, a year that was likely without large bankfull stormflows that would move considerable sediment (**Alley 2003c**). Exceptions to this inverse relationship were 2001 and 2009, when YOY and total juvenile densities were relatively low despite mild winters (except for the uppermost mainstem site with densities all increasing from 2000 to 2001). Higher YOY and total densities occurred in 1997, 2002, 2004, 2007 and 2008. YOY densities were generally low throughout the watershed in 2010, with very low mainstem YOY densities and higher ones in the Branches.

The pattern of densities of larger Size Class II and III juveniles in relation to baseflow is more complex than for YOY. In wetter years, there may be less spawning effort and spawning success in the mainstem until late in the spawning season. However, above median daily baseflow results in faster water velocity, increased insect drift and deeper feeding stations in fastwater habitat, at least in the spring. All of these factors promote faster growth rate, leading to a higher proportion of YOY reaching Size Class II in their first year and higher densities of larger juveniles. The higher percent of YOY reaching Size Class II is much higher in 2010 than 2009, with its wetter spring (**Figure 18**). In these wet years there may be relatively low YOY densities, yet relatively high Size Class II densities. The wet years of 1998 and 2005 are in this category for the mainstem and East Branch sites (**Figures 28−29 and 31−32**). However, 2006 was very wet but did not generate high Size Class II and III densities. This was likely because YOY densities were so low in the mainstem (many large storms occurred in April and May (**Appendix E**) to destroy mainstem steelhead redds, and spawning access to the upper watershed was good even in late spring), that faster growth rate could not make up for the fewer YOY juveniles in the mainstem. We see from 2009 to 2010 that where YOY abundance decreased at some sites but Size Class II and III abundance increased to near 2009 levels in 2010 (Sites 12 and 19) or surpassed it at sites where YOY were similar (Sites 1 and 13a) or where YOY were even less in 2010 (Sites 21) due to a higher percent of YOY reaching Size Class II in 2010 (**Tables 27 and 30; Figure 18**). Yearling abundance was similar or less at most sites in 2010 so that increases in larger juveniles was attributed to fast growing YOY (**Table 28**).

The other year having especially high densities of larger juveniles besides the wet years of 1998 and 2005 in the mainstem was 1997 (**Figure 29**), which had large storms before 1 February to boost the baseflow and virtually nothing after that. However, with two antecedent wet years, baseflow remained at median levels in 1997 (**Appendix E**). Very stable conditions for spawning, YOY emergence and yearling overwinter survival were created. That year had high YOY densities and a high proportion of YOY reached Size Class II, presumably because spawning effort and success were likely high in early February. This would allow early emergence and early spring growth despite the lower baseflow later on. In addition, yearling densities were generally average or better to add to the Size Class II and III abundance (**Table 28**). The year 2002 had a similar hydrograph pattern to 1997 in that the larger stormflows came early (but they were smaller than in 1997), and a series of smaller storms came in February and March (**Appendix E**). Most spawning may have occurred later in 2002 than 1997, leaving primarily late emerging YOY that would have less time to grow to Size Class II than in 1997, before baseflow diminished in late spring. So, 2002 had high densities of YOY in the mainstem, but not as many reached Size Class II as in 1997. In addition, 1997 had much more escape cover for larger juveniles than 2002, as indicated in Reaches 1 and 7 (**Alley 2010b**). Instream wood was common in 1997, and escape cover was relatively high in all mainstem reaches after high peak flows in January 1995 and December 1996 (**Alley 2003b**). The years 2004, 2007 and 2008 had previously mild winters (**Appendix E**), likely had heavy spawning in the mainstem, and produced relatively high densities of YOY. However, baseflow was insufficient to grow many to Size Class II, leading to low mainstem densities of larger juveniles. The rebound in potential smolt-sized juveniles from 2008 to 2009 in the mainstem likely resulted from less competition between YOY due to their very low density in 2009, allowing a higher proportion to reach smolt-size the first growing season (**Figure 29**). Continued improvement in 2010 came from an even higher percent of YOY reaching smolt size (**Figure 18**).

Since 1997, rearing habitat quality in the lower mainstem (as indicated by Reach 1) improved to 2009 with regard to increased average maximum pool depth and has declined with regard to reduced escape cover (**Alley 2010b**). At the replicated sampled pool in 2010, depth remained constant and escape cover increased (**Tables 14 and 15**). During the instream wood survey in 2002, this reach was noted for its lack of large wood (**Alley 2003c**). However, with reduced embeddedness, riffle conditions for aquatic insects and steelhead food supply have improved. In the lower mainstem, densities of larger juveniles were not well associated with rearing habitat conditions. Spring and summer baseflow and associated growth rate of YOY appeared to overshadow non-flow related habitat conditions to determine densities of larger juveniles. This was partly a result of extremely low yearling densities in the mainstem. After two winters with the lowest peak flows since sampling began, 1994 (900 cfs) and 2007 (614 cfs), slightly higher densities of yearlings were detected at some mainstem sites compared to other years. This may indicate that if more overwintering shelter was present (large instream wood), survival of yearlings might increase in the mainstem of Soquel Creek (**Alley 1995a; 2008**).

In summary, since 1997 in Reach 1, rearing habitat quality had improved to 2009 with increased average maximum pool depth and had declined with regard to reduced escape cover, although escape cover increased in the sampled pool in 2010. However, riffle conditions for aquatic insects and steelhead food supply had improved. During the instream wood survey in 2002, this reach was noted for its lack of large wood (**Alley 2003c**).

In the upper mainstem (upstream of the Moores Gulch confluence in Reach 7), densities of larger juveniles (Size Class II and III) (**Figure 29**) were not associated with reach-wide changes in pool depth or escape cover, except for escape cover in 1997 (**Alley 2010b**). However, fluctuations in larger juveniles were consistent with fluctuations in pool escape cover at sampling sites (except 2004 and 2009), but the amplitude of fluctuations was inconsistent. Spring and summer baseflow and associated growth rate of YOY appeared to overshadow non-flow related habitat conditions to determine densities of larger juveniles. This was partly a result of low yearling densities in the mainstem. In 2009, there were so few YOY at Site 10 that the reduced competition allowed a higher proportion to grow into Size Class II than in 2008 despite the low baseflow of a drier year. In 2010, YOY abundance was even less than in 2009, but Size Class II densities continued to increase (**Figures 28 and 29**). However, at Site 12 the 2010 decline in YOY was too great to maintain Size Class II density at the 2009 level.

Trends in Juvenile Steelhead Abundance in the East Branch Soquel Creek

In the East Branch of Soquel Creek, trends in juvenile steelhead densities were tracked since 1997 at Sites 13a (Reach 9a) and 16 (Reach 12a in the Soquel Demonstration State Forest (SDSF). Site 13a is located downstream of the Amaya Creek confluence, the quarry water diversion, the Hinckley Creek confluence and the Mill Pond water diversion and outfall (under new ownership prior to the 2006 sampling) (Map in **Appendix A**). Site 13a is in a geomorphically unstable reach where streambank erosion and fallen trees are common, and streambed rocks are poorly sorted by size (**Barry Hecht, personal observation**). Habitat conditions in Reach 9a may change considerably during high winter stormflows. Site 16 is located in the Soquel Demonstration State Forest (SDSF) and above permanent water diversions. During and after drier winters, spawning access and summer baseflow are usually much less at Site 16 than Site 13a. Usually, less than 10% of the juveniles at these sites were larger yearlings. After wetter winters with high spring baseflows, a sizeable portion of the YOY reach Size Class II at Site 13a as indicated in 2010 (**Figure 18**). YOY growth rate is less at Site 16, with only a few YOY reaching Size Class II after the wettest winters. A higher proportion of YOY reach Size Class II in wetter years because more food is available during higher spring baseflow.

In East Branch Soquel Creek, total and YOY densities annually fluctuated in a dissimilar fashion in the lower East Branch (Site 13a) compared to the upper East Branch (Site 16), except they increased at both locations from 2001 to 2002 and decreased at both locations in 2006 (**Figures 30 and 31**). After reaching a 14-year high in 2004, total and YOY abundance at Site 13a declined in 2005 and then again in 2006 to almost zero but rebounded in 2007 and 2008, only to decline again as was the pattern at other downstream sites in 2009. In 2010, their abundance increased at Site 13a a little despite declines at downstream sites. Higher YOY densities in most dry years in the lower East Branch may have resulted from 1) greater spawning effort than in wetter years, 2) more spawning success and 3) higher survival of YOY after emergence. In wetter years, more adult steelhead likely continued further up the East Branch into the SDSF. Though 2008 and 2009 had relatively low baseflows (especially 2008) because of few winter storms, there were storms in excess of 2,000 cfs peak flow that were absent in 2007 to provide better spawning access than 2007. These sizeable stormflows brought correspondingly higher YOY density at Site 16 in the SDSF in 2008 and 2009. 2010 was unusual in that passage was better to Site 16 but YOY densities declined, perhaps indicating fewer adult spawners in 2010 along with lower YOY densities at 6 of 8 sampling sites (**Table 27**). The 2009 baseflow appeared to be elevated due to the 2008 fire upstream of Site 16. It appeared higher in 2010 and was measured at 0.44 cfs in September (**Table 5b**). With the streambed instability of the lower East Branch, redd (nest) scour or burial in sediment may have been more common in winters with higher stormflows. During the instream wood inventory in 2002, this reach was identified as one with small quantities of large instream wood (**Alley 2003c**). In 2010, instream and streamside trees and wood were inventoried in a half-mile segment of this Reach 9a. If the incidence of large instream wood were to increase substantially, rearing habitat quality and improved over-winter survival in intermediate to wetter years may play more important roles in increasing Size Class II and III densities.

At Site 13a, annual densities of Size Class II and III juveniles (**Figure 24**) were not associated with changes in pool escape cover at sampling sites except in 2010 when densities increased with more escape cover (**Table 15; Alley 2010b**). Insufficient years of data were available for reach-wide changes in pool depth, escape cover or percent fines in run and step-run habitat to make comparisons with trends in juvenile densities. Size Class II and III juveniles steadily declined from 1998 to very low levels in 2004, followed by a large blip in 2005 and then very low abundance in 2006−2008 and improvement the last two years to the highest ever in 2010. Densities of larger juveniles increased in 2009 despite reduced pool escape cover and increased considerably again in 2010 without pool deepening. This may have happened because more YOY reached Size Class II in 2009 and 2010 with reduced competition between few YOY and much more cover in 2010 (15 ft/ 100 ft of stream compared to 10 ft/ 100 ft) (**Figure 18**).

The typical disconnect between non-streamflow related rearing habitat conditions and Size Class II and III densities in the lower East Branch indicated that rearing habitat quality within the observed range in the last 14 years was overshadowed by poor over-winter survival of yearlings in years that were not wet enough to grow many YOY to Size Class II or by the added potential for growth of some YOY to Size Class II in intermediate to wet years, or even drier years if YOY density was low, such as 2009.

Over-winter survival did not appear good in any year. The years with highest densities of Size Class II and III juveniles in the lower East Branch occurred in 1998, 2005 and 2010 (**Figure 32**), three years with relatively wet springs (**Figure 57; Appendix E**) and low to moderate YOY densities (**Figure 31**). There had been a steady decline in densities of large juveniles from 1998 to a low in 2004. Higher YOY growth rate during these high spring-baseflow years of 1998, 2005 and 2010 allowed a higher proportion of YOY to reach Size Class II (**Figure 18**), leading to higher densities of larger juveniles.

In summary, data indicated that overall rearing habitat quality in 2009 in Reach 9a of the lower East Branch was similar to 2000 conditions with regard to pool depth but worse with less pool escape cover. However, escape cover increased greatly at the sampled pool in 2010. Other factors related to the turbidity and thin silt layer on the substrate observed at the sampling site in 2006 and 2007 may indicate lower habitat quality in the upper part of the reach, though it was more localized in 2008 and absent in 2009 and 2010. During the instream wood inventory in 2002, this reach was identified as one with small quantities of large instream wood (**Alley 2003c**). Retention of more instream wood would enhance overwintering survival of yearling steelhead and rearing habitat.

In the upper East Branch at Site 16 in the SDSF, Size Class II and III abundance (nearly all yearlings) increased in 1997–1999, with a steady decline to less than one-fifth the 1999 level by 2004. Then from 2005 the density increased to the highest density in 14 years in the dry year of 2007 (**Figure 32**). The relatively high density of Size Class II and III juveniles (20/ 100 ft) was likely due to at least moderate numbers of YOY in 2006 and good overwinter survival of yearlings during a mild winter. However, the yearling density declined substantially in 2008 to reduce the density of larger juveniles. This was partially due to low recruitment of YOY from 2007 (**Figure 31**), poor rearing conditions with very low baseflows and likely a bankfull event during the 2007/2008 winter that flushed some yearlings downstream. Then Size Class II and III densities increased slightly in 2009 with higher baseflow after a fire, higher YOY densities in 2008 for higher recruitment to yearlings and a milder winter to allow greater overwinter survival than 2008. In 2010 this larger size class declined again after a wetter winter and reduced yearling retention (**Table 28**). Only one YOY grew into Size Class II in 2010.

The three highest Size Class II and III densities in the upper East Branch did not correspond to any hydrologic category. They were 1998 (very wet year), 1999 (intermediate rainfall year with relatively mild peak flow) and 2007 (very dry year). Both 1998 and 1999 had sufficient spring baseflows to grow some YOY to Size Class II. 2007 likely had very good overwinter survival of yearlings, although rearing conditions worsened. In addition, adult access may have been hampered in the dry 2006/2007 winter, causing reduced YOY production and reduced competition for food to benefit yearlings. Retrieval of PIT-tagged juveniles has indicated very limited movement of tagged individuals from their original locations (Sogard et al. 2009). If the incidence of large instream wood increased substantially in East Branch Soquel Creek, improved rearing habitat and overwinter survival of yearlings may play increase Size Class II and III densities. A survey of wood and trees was performed in 2010 to quantify instream wood present and the potential for recruitment.

At Site 16, annual densities of Size Class II and III juveniles (usually primarily yearlings) were not positively correlated with changes in pool escape cover at sampling sites, except in 2008 and 2009 (**Alley 2010b**). In fact, densities were the lowest in 2004 when pool escape cover at sampling sites was the highest. Densities increased from 2004 to 2007 despite a decline in pool escape cover at sampling sites. Densities decreased in 2010 despite higher baseflow and better rearing habitat at the sampling site (deeper pools and more escape cover (**Tables 14 and 15**). Insufficient years of data were available for reach-wide changes in pool depth and escape cover or in percent fines in run and step-run habitat for comparison to trends in juvenile densities. However, the decline in these potential smolt sized fish in 2008 did correlate with decreased pool depth and escape cover (**Alley 2010b**). But it also coincided with low YOY densities in 2007 for low recruitment as yearlings. Smolt-sized juvenile densities increased in 2009 with increased pool depth and escape cover but also coincided with a larger YOY density in 2008 to recruit from compared to 2007. The density decline in 2000–2004 was associated with relatively high percent embeddedness in riffles and step-runs at sampling sites except for the less embeddedness in 2003. Densities increased in 2005 with less embeddedness.

The apparent disconnect between rearing habitat conditions and Size Class II and III densities at Site 16 except in 2008 when baseflow was a trickle and 2009 when baseflow was likely enhanced by previous forest fire, indicated that rearing habitat quality within the observed range in most of the last 14 years was overshadowed by 1) poor overwinter survival of yearlings in years that were not wet enough to grow many YOY to Size Class II, 2) the potential for growth of some YOY to Size Class II in intermediate to wet years and 3) high overwinter survival of yearlings in mild dry years. If the incidence of large instream wood were to increase substantially, rearing habitat quality and improved over-winter survival in intermediate to wetter years may play more important roles in increasing Size Class II and III densities.

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FIGURES

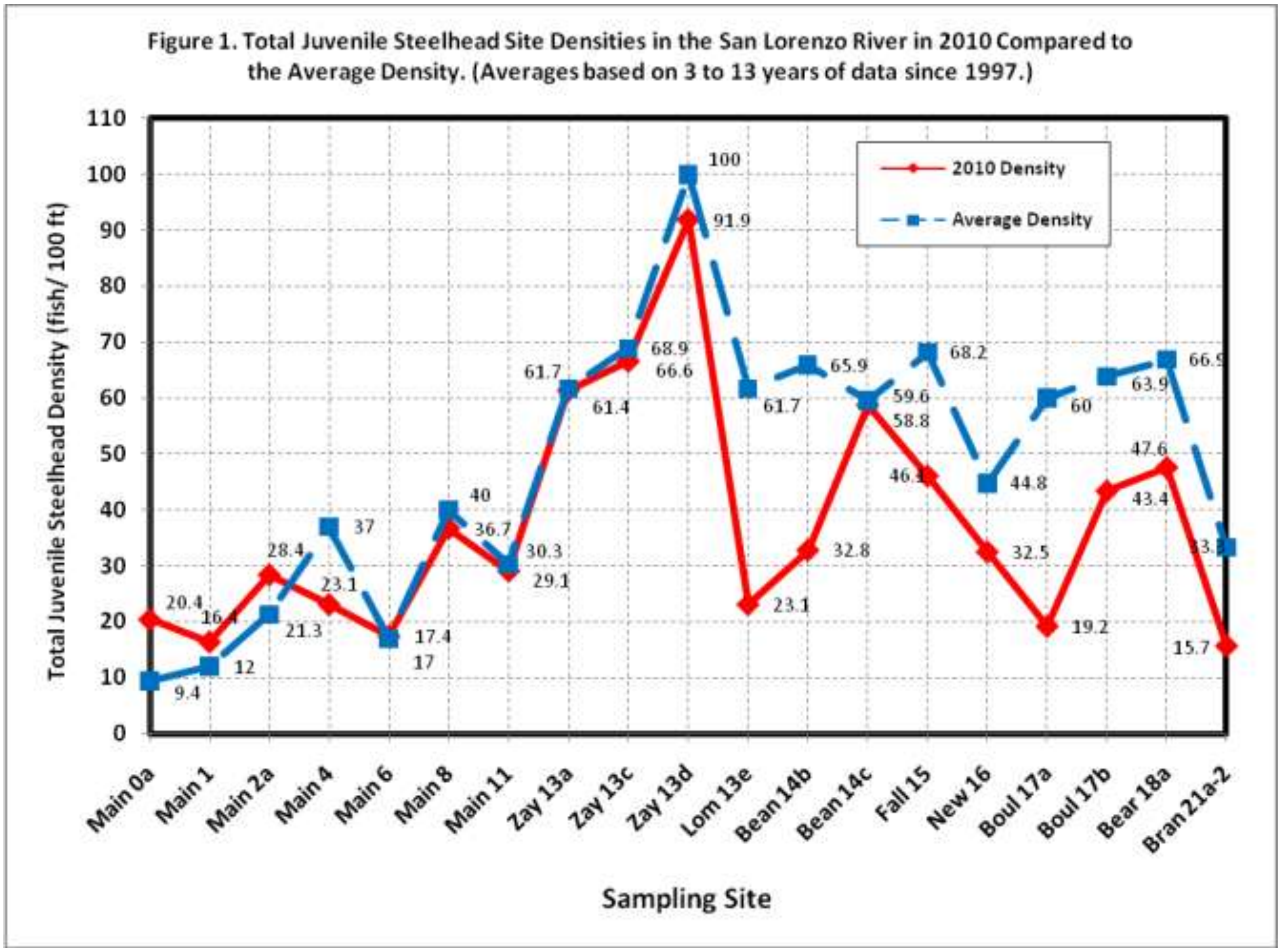
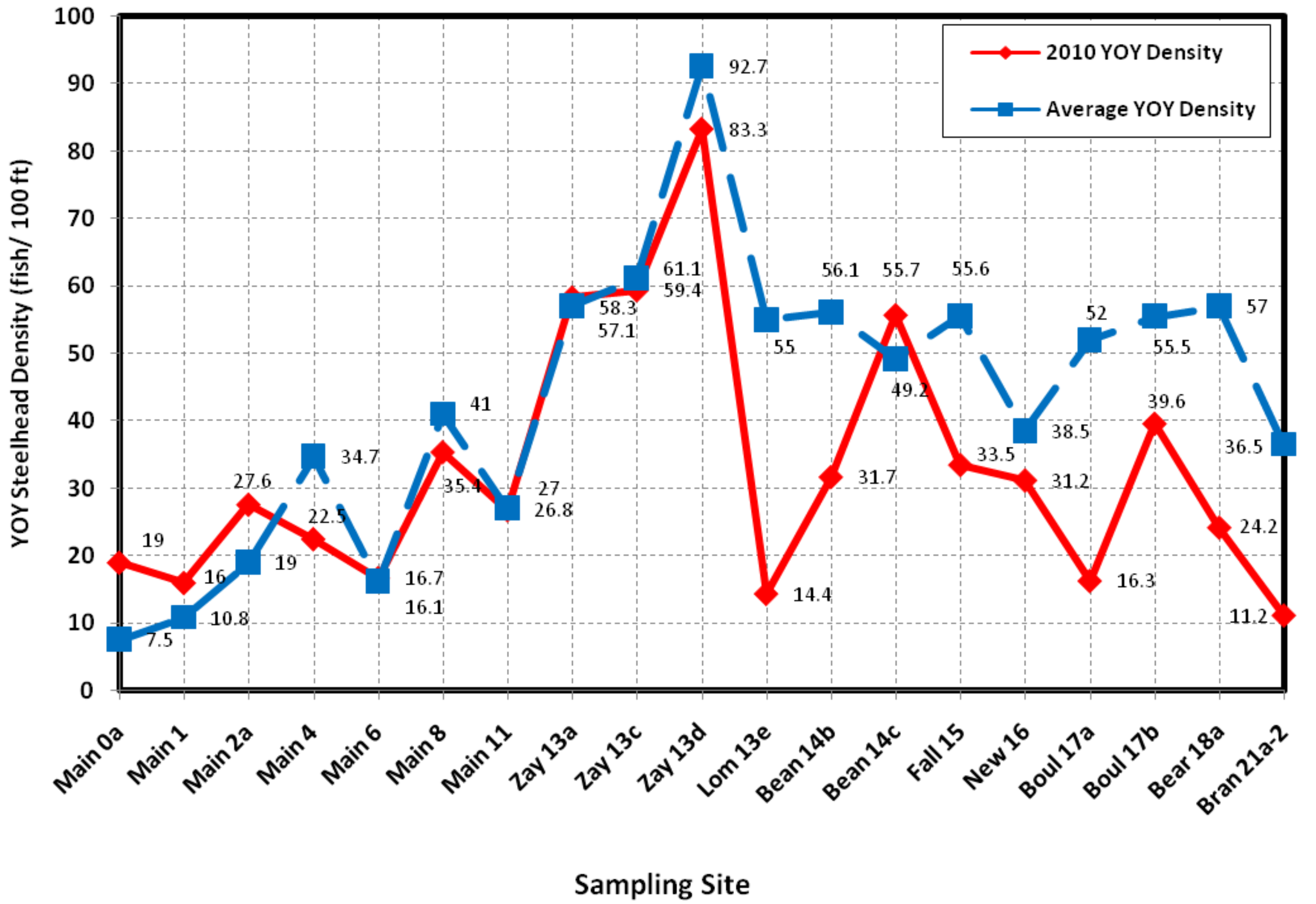


Figure 1. Total Juvenile Steelhead Site Densities in the San Lorenzo River in 2010 Compared to the Average Density. (Averages based on 3 to 13 years of data since 1997.)
2010 Density
Average Density
Total Juvenile Steelhead Density (fish/ 100 ft)
Sampling Site
Main 0a
Main 1
Main 2a
Main 4
Main 6
Main 8
Main 11
Zay 13a
Zay 13c
Zay 13d
Lom 13e
Bean 14b
Bean 14c
Fall 15
New 16
Boul 17a
Boul 17b
Bear 18a
Bran 21a-2

Figure 2. Young-of-the-Year Steelhead Site Densities in the San Lorenzo River in 2010 Compared to Average Density. (Averages based on 3 to 13 years of data.)



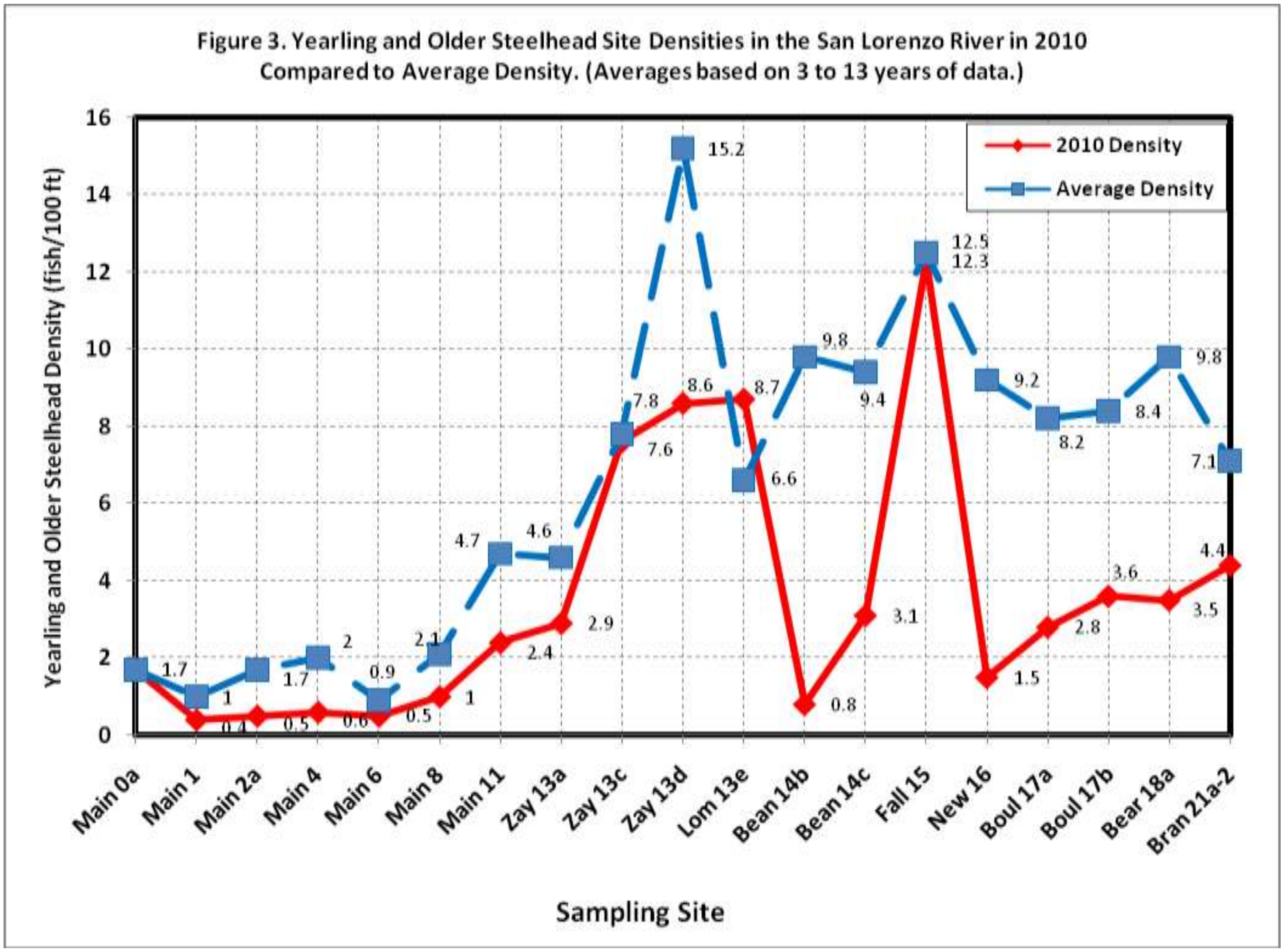


Figure 3. Yearling and Older Steelhead Site Densities in the San Lorenzo River in 2010
Compared to Average Density. (Averages based on 3 to 13 years of data.)
Yearling and Older Steelhead Density (fish/100 ft)
Sampling Site
2010 Density
Average Density
Main 0a
Main 1
Main 2a
Main 4
Main 6
Main 8
Main 11
Zay 13a
Zay 13c
Zay 13d
Lom 13e
Bean 14b
Bean 14c
Fall 15
New 16
Boul 17a
Boul 17b
Bear 18a
Bran 21a-2

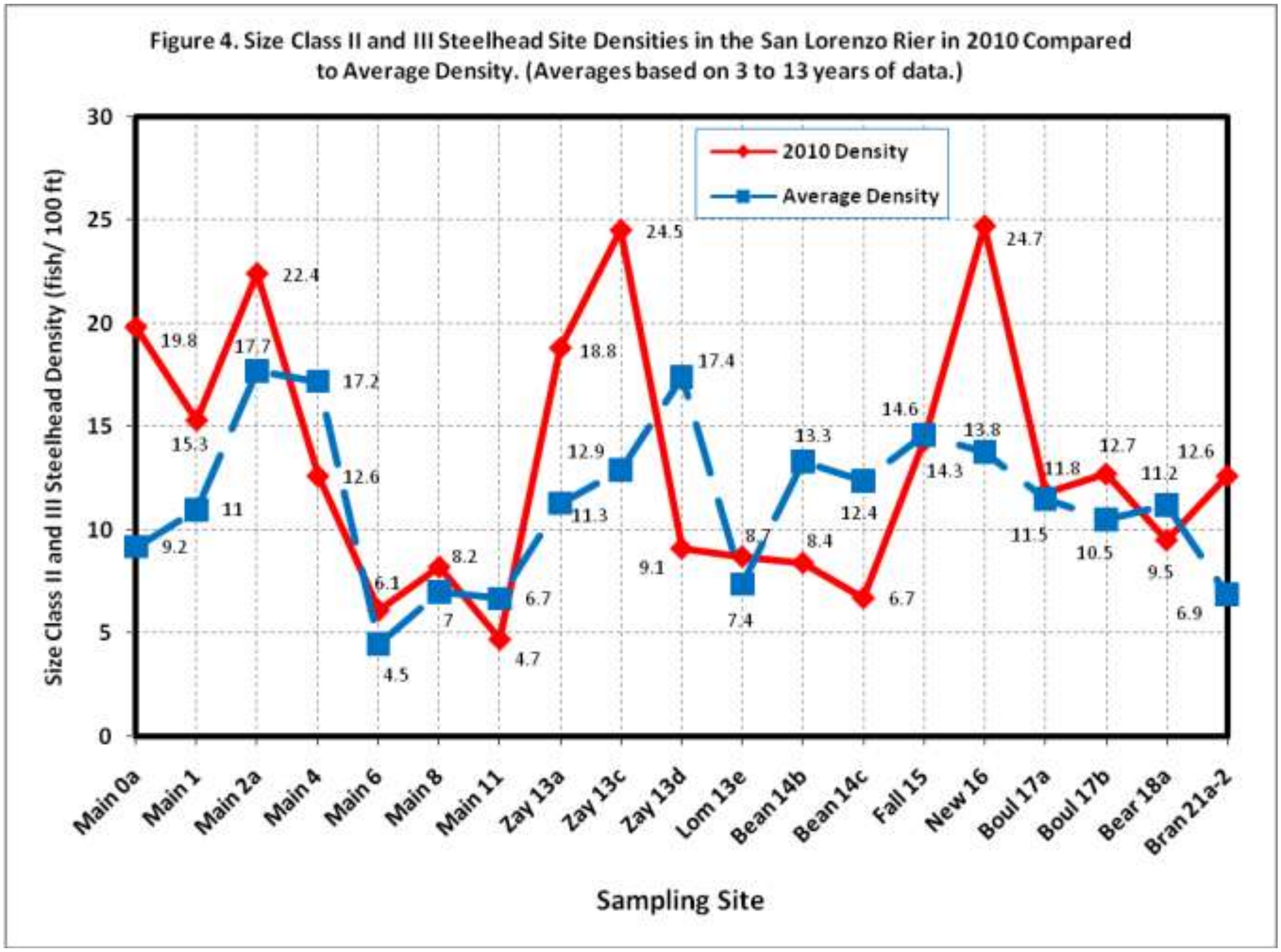


Figure 4. Size Class II and III Steelhead Site Densities in the San Lorenzo Rier in 2010 Compared to Average Density. (Averages based on 3 to 13 years of data.)
2010 Density
Average Density
Size Class II and III Steelhead Density (fish/ 100 ft)
Sampling Site
Main 0a
Main 1
Main 2a
Main 4
Main 6
Main 8
Main 11
Zay 13a
Zay 13c
Zay 13d
Lom 13e
Bean 14b
Bean 14c
Fall 15
New 16
Boul 17a
Boul 17b
Bear 18a
Bran 21a-2
19.8
15.3
22.4
12.6
6.1
8.2
4.7
18.8
24.5
9.1
8.7
8.4
6.7
14.3
24.7
11.8
12.7
9.5
12.6
9.2
11
17.7
17.2
4.5
7
6.7
11.3
12.9
17.4
7.4
13.3
12.4
14.6
13.8
11.5
10.5
11.2
6.9

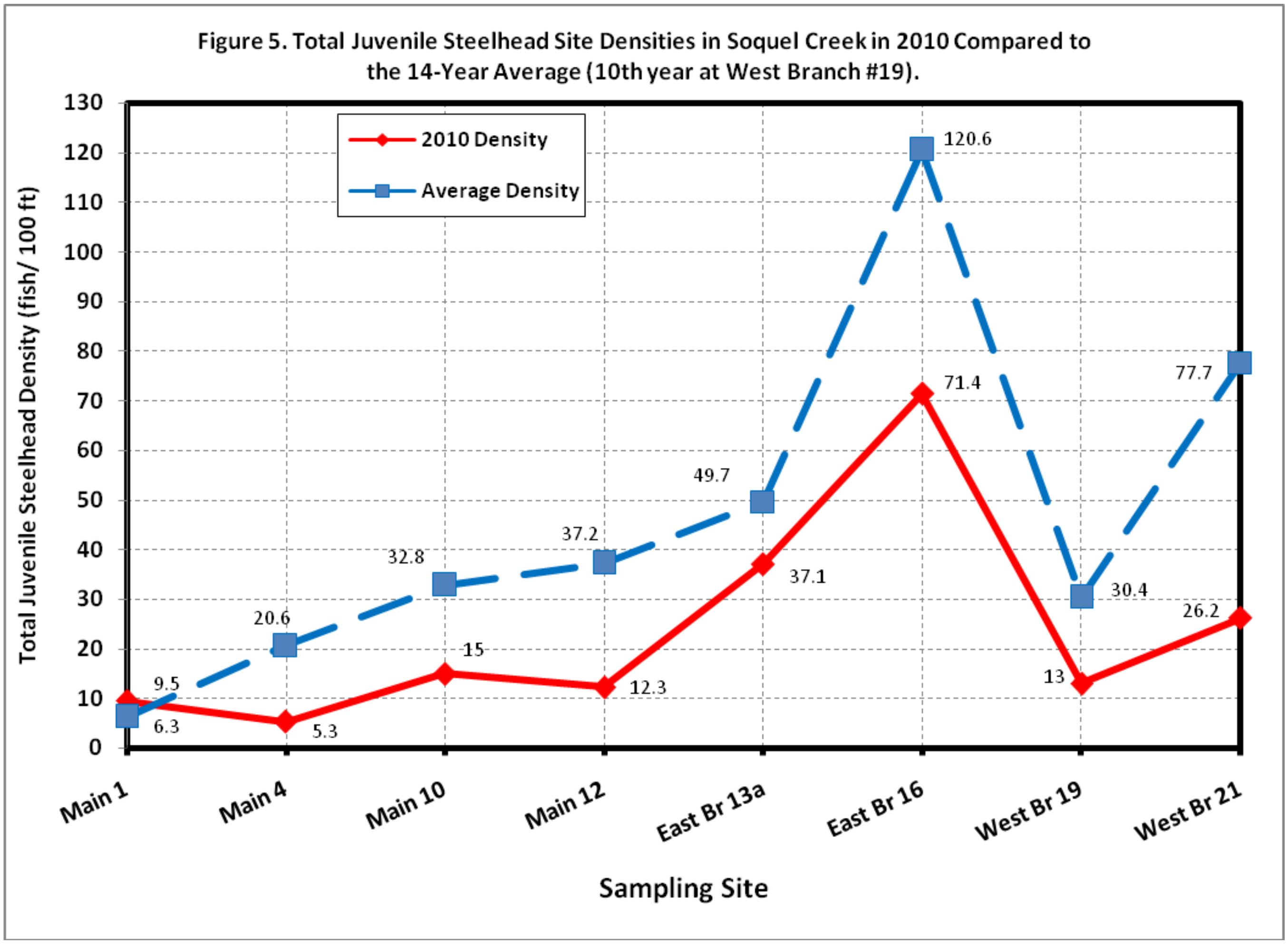


Figure 5. Total Juvenile Steelhead Site Densities in Soquel Creek in 2010 Compared to the 14-Year Average (10th year at West Branch #19).
Total Juvenile Steelhead Density (fish/ 100 ft)
0
10
20
30
40
50
60
70
80
90
100
110
120
130
2010 Density
Average Density
9.5
6.3
20.6
5.3
32.8
15
37.2
12.3
49.7
37.1
120.6
71.4
30.4
13
77.7
26.2
Main 1
Main 4
Main 10
Main 12
East Br 13a
East Br 16
West Br 19
West Br 21
Sampling Site

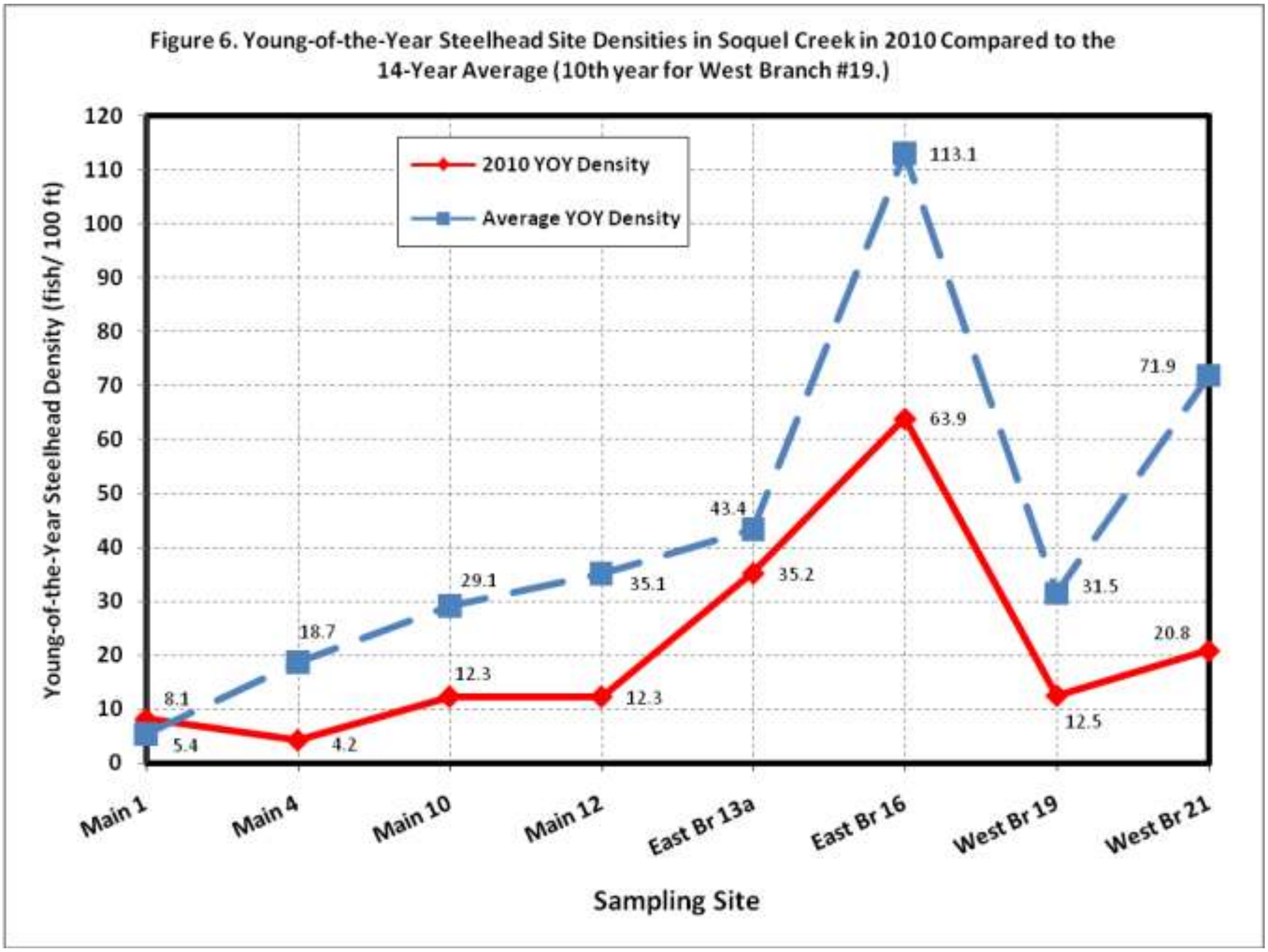


Figure 6. Young-of-the-Year Steelhead Site Densities in Soquel Creek in 2010 Compared to the 14-Year Average (10th year for West Branch #19.)
2010 YOY Density
Average YOY Density
Young-of-the-Year Steelhead Density (fish/ 100 ft)
120
110
100
90
80
70
60
50
40
30
20
10
0
8.1
5.4
18.7
4.2
29.1
12.3
35.1
12.3
43.4
35.2
113.1
63.9
31.5
12.5
71.9
20.8
Main 1
Main 4
Main 10
Main 12
East Br 13a
East Br 16
West Br 19
West Br 21
Sampling Site

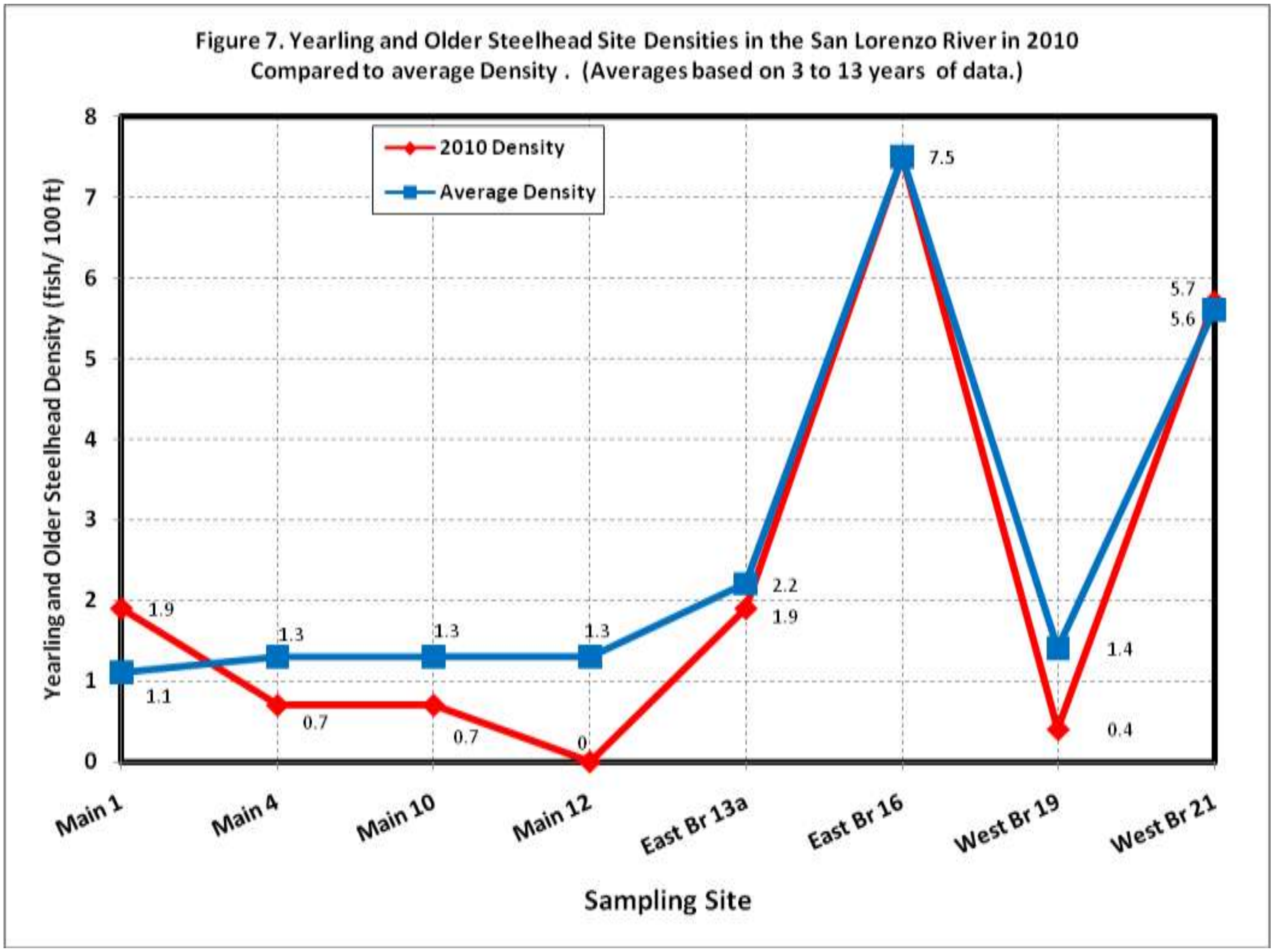


Figure 7. Yearling and Older Steelhead Site Densities in the San Lorenzo River in 2010
Compared to average Density . (Averages based on 3 to 13 years of data.)
2010 Density
Average Density
Yearling and Older Steelhead Density (fish/ 100 ft)
Sampling Site
Main 1
Main 4
Main 10
Main 12
East Br 13a
East Br 16
West Br 19
West Br 21
0
1
2
3
4
5
6
7
8
1.9
1.1
1.3
0.7
1.3
0.7
1.3
0
2.2
1.9
7.5
1.4
0.4
5.7
5.6

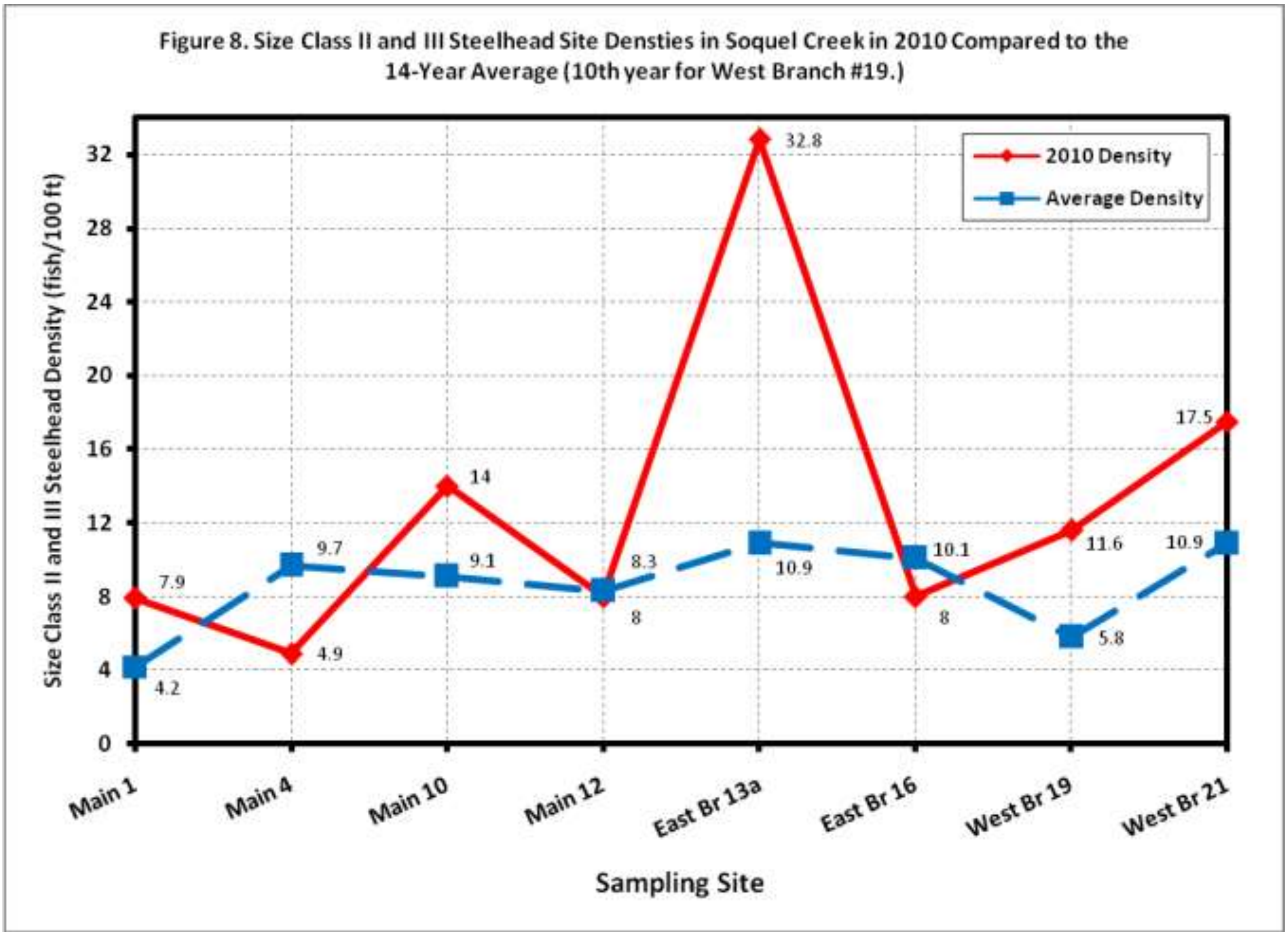


Figure 8. Size Class II and III Steelhead Site Densties in Soquel Creek in 2010 Compared to the
14-Year Average (10th year for West Branch #19.)
Size Class II and III Steelhead Density (fish/100 ft)
0
4
8
12
16
20
24
28
32
2010 Density
Average Density
7.9
4.2
9.7
4.9
14
9.1
8.3
8
32.8
10.9
10.1
8
11.6
5.8
17.5
10.9
Main 1
Main 4
Main 10
Main 12
East Br 13a
East Br 16
West Br 19
West Br 21
Sampling Site

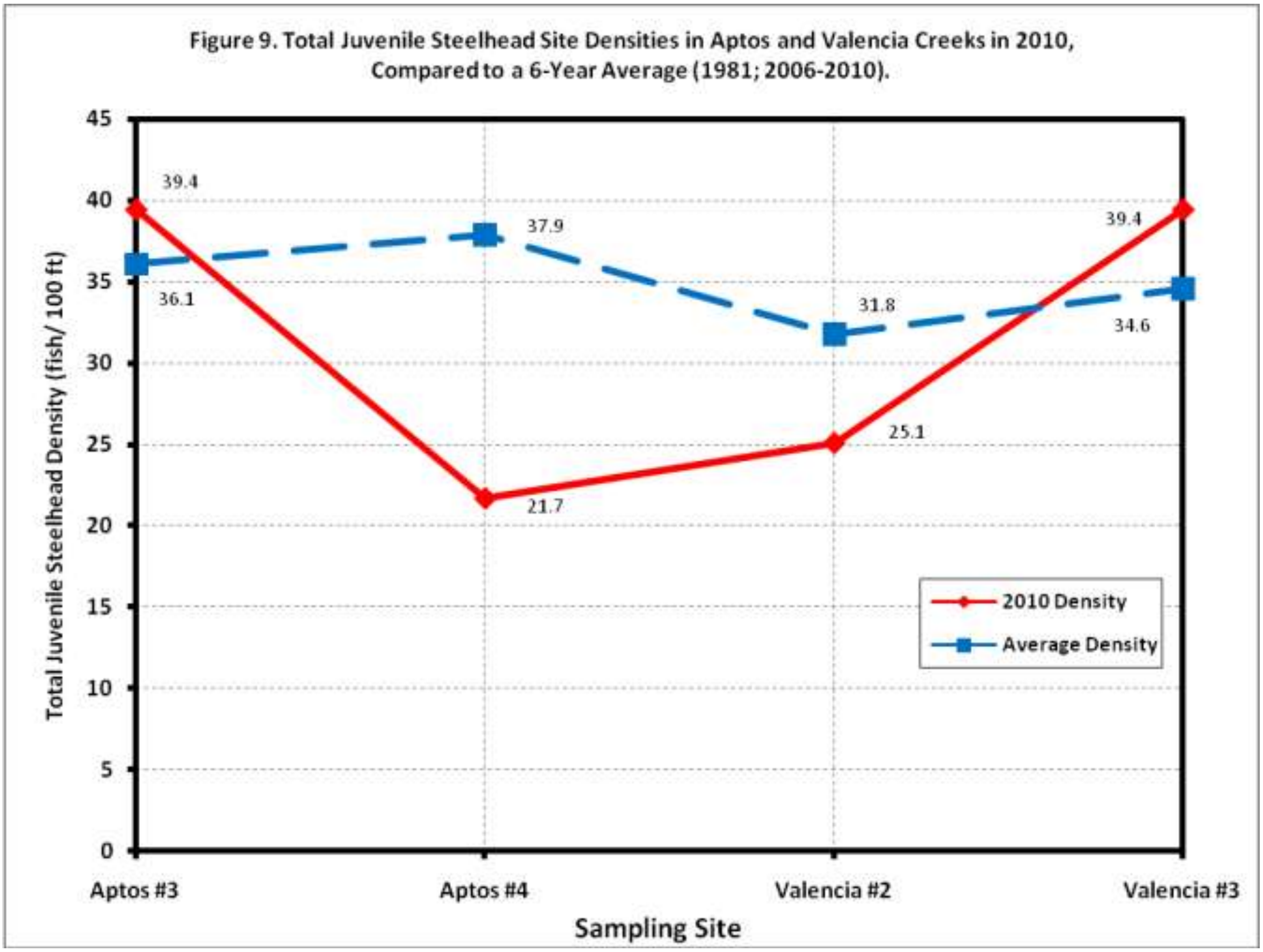


Figure 9. Total Juvenile Steelhead Site Densities in Aptos and Valencia Creeks in 2010, Compared to a 6-Year Average (1981; 2006-2010).
Total Juvenile Steelhead Density (fish/ 100 ft)
45
40
35
30
25
20
15
10
5
0
39.4
37.9
39.4
36.1
31.8
34.6
25.1
21.7
2010 Density
Average Density
Aptos #3
Aptos #4
Valencia #2
Valencia #3
Sampling Site

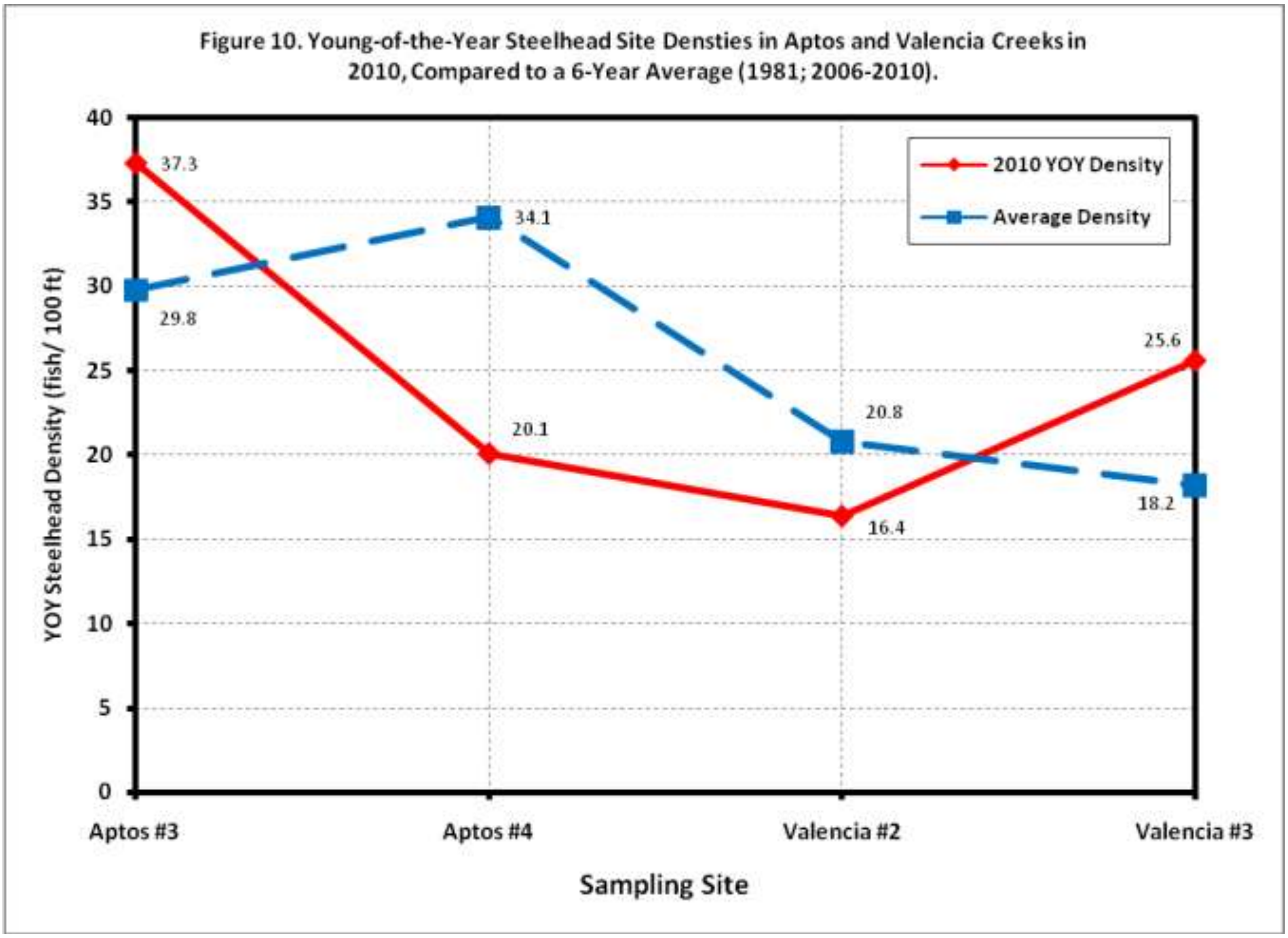


Figure 10. Young-of-the-Year Steelhead Site Densties in Aptos and Valencia Creeks in 2010, Compared to a 6-Year Average (1981; 2006-2010).
YOY Steelhead Density (fish/ 100 ft)
40
35
30
25
20
15
10
5
0
37.3
34.1
29.8
25.6
20.8
20.1
18.2
16.4
2010 YOY Density
Average Density
Aptos #3
Aptos #4
Valencia #2
Valencia #3
Sampling Site

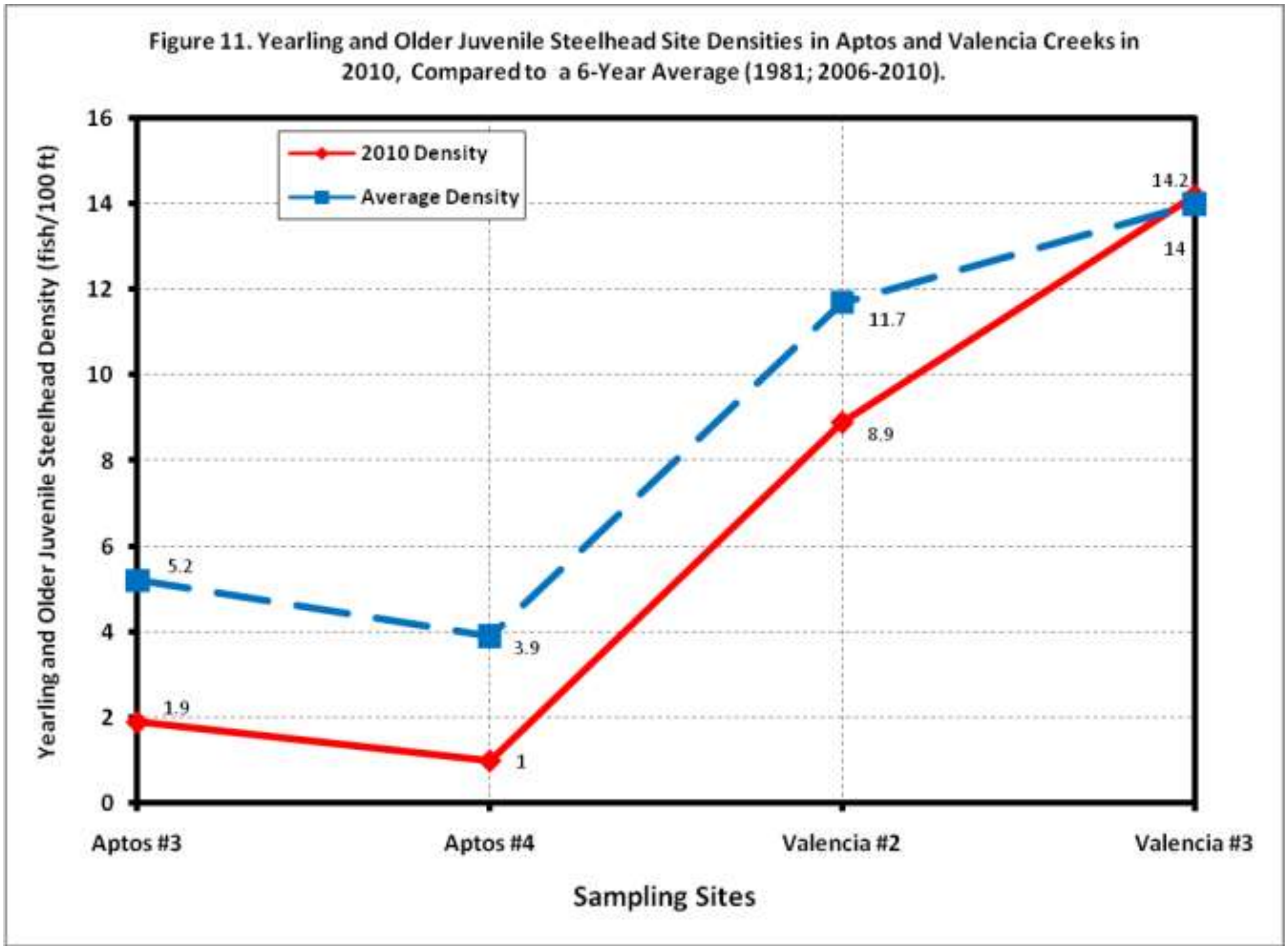
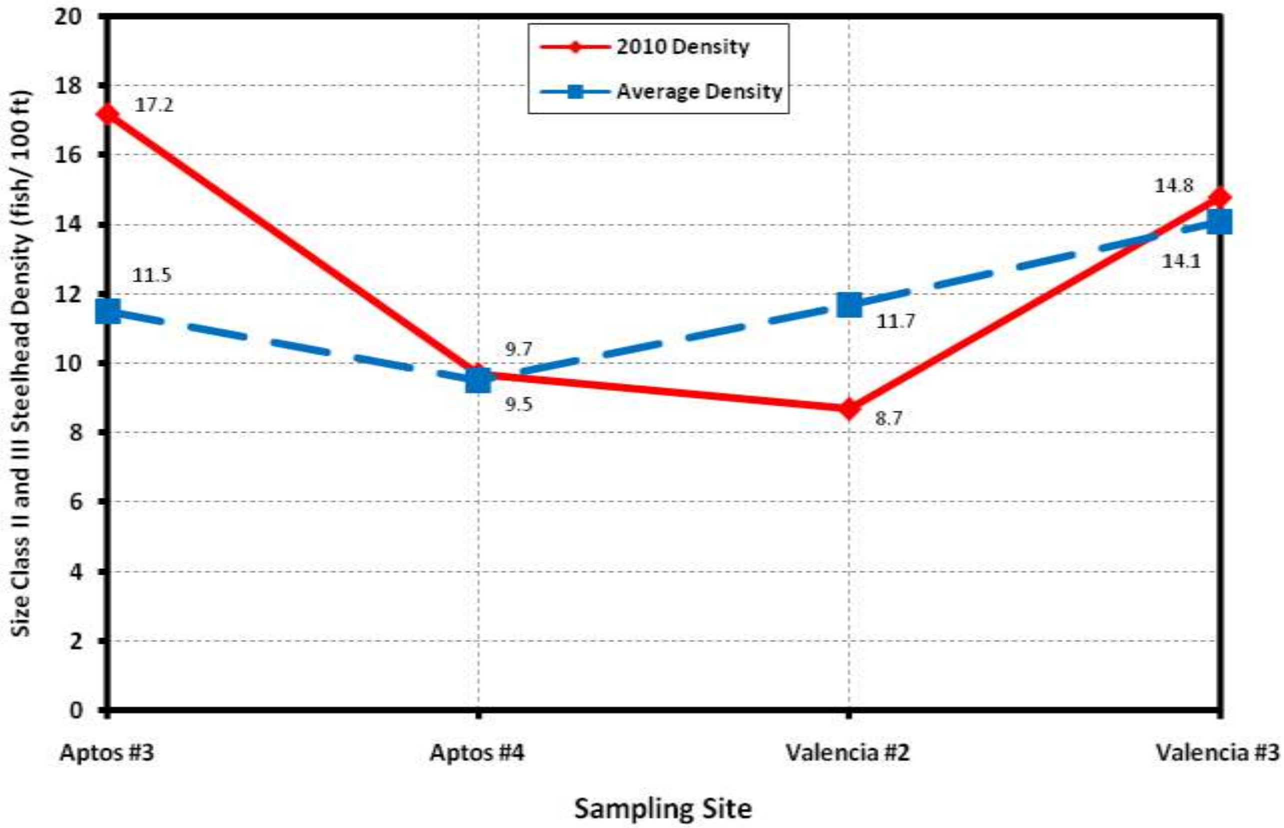


Figure 11. Yearling and Older Juvenile Steelhead Site Densities in Aptos and Valencia Creeks in 2010, Compared to a 6-Year Average (1981; 2006-2010).
2010 Density
Average Density
Yearling and Older Juvenile Steelhead Density (fish/100 ft)
16
14
12
10
8
6
4
2
0
5.2
3.9
11.7
14
14.2
1.9
1
8.9
Aptos #3
Aptos #4
Valencia #2
Valencia #3
Sampling Sites

Figure 12. Size Class II and III Steelhead Site Densities in Aptos and Valencia Creeks in 2010, Compared to a 6-Year Average (1981; 2006-2010).



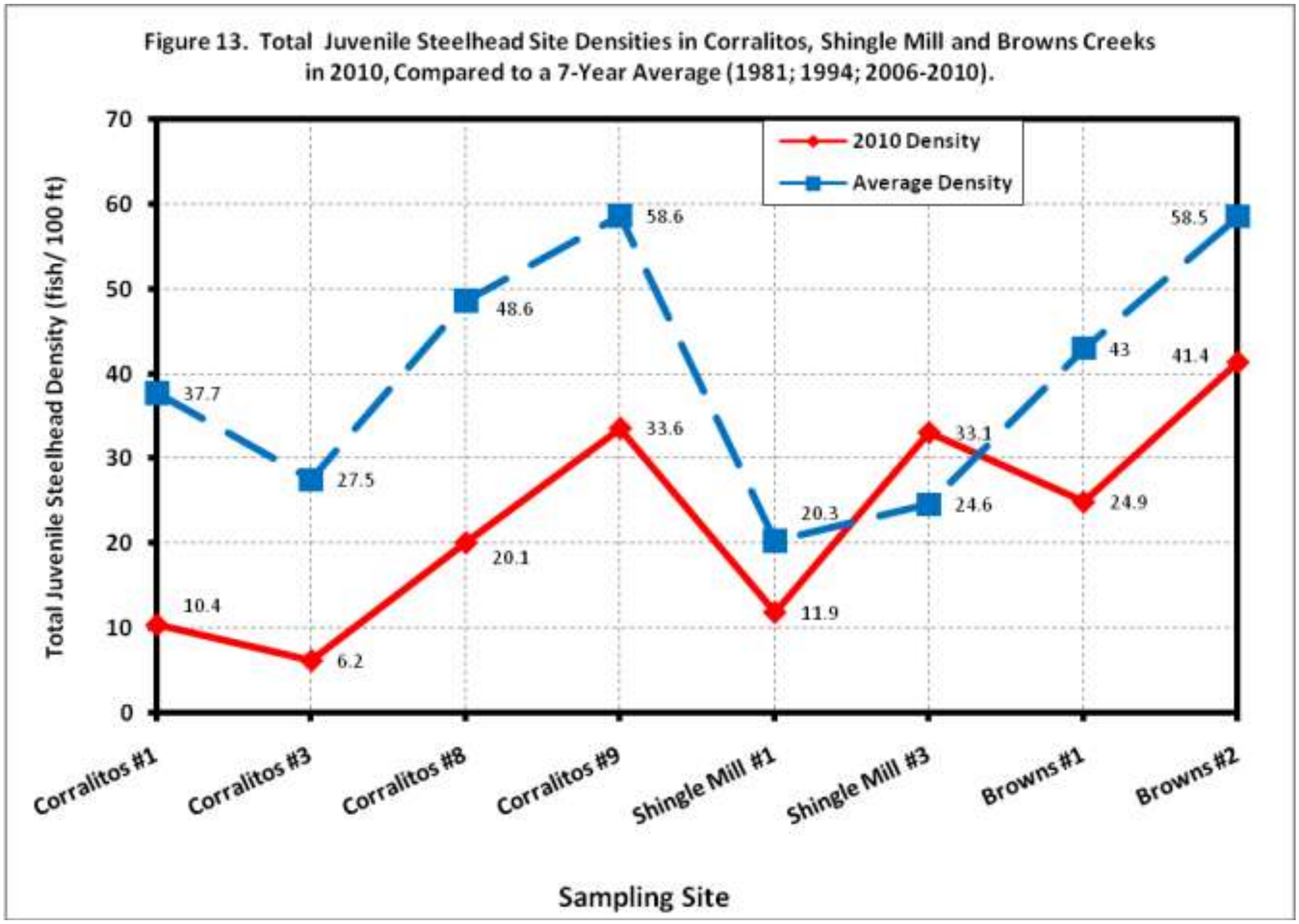


Figure 13. Total Juvenile Steelhead Site Densities in Corralitos, Shingle Mill and Browns Creeks in 2010, Compared to a 7-Year Average (1981; 1994; 2006-2010).
2010 Density
Average Density
Total Juvenile Steelhead Density (fish/ 100 ft)
0
10
20
30
40
50
60
70
37.7
27.5
48.6
58.6
20.3
24.6
43
58.5
10.4
6.2
20.1
33.6
11.9
33.1
24.9
41.4
Corralitos #1
Corralitos #3
Corralitos #8
Corralitos #9
Shingle Mill #1
Shingle Mill #3
Browns #1
Browns #2
Sampling Site

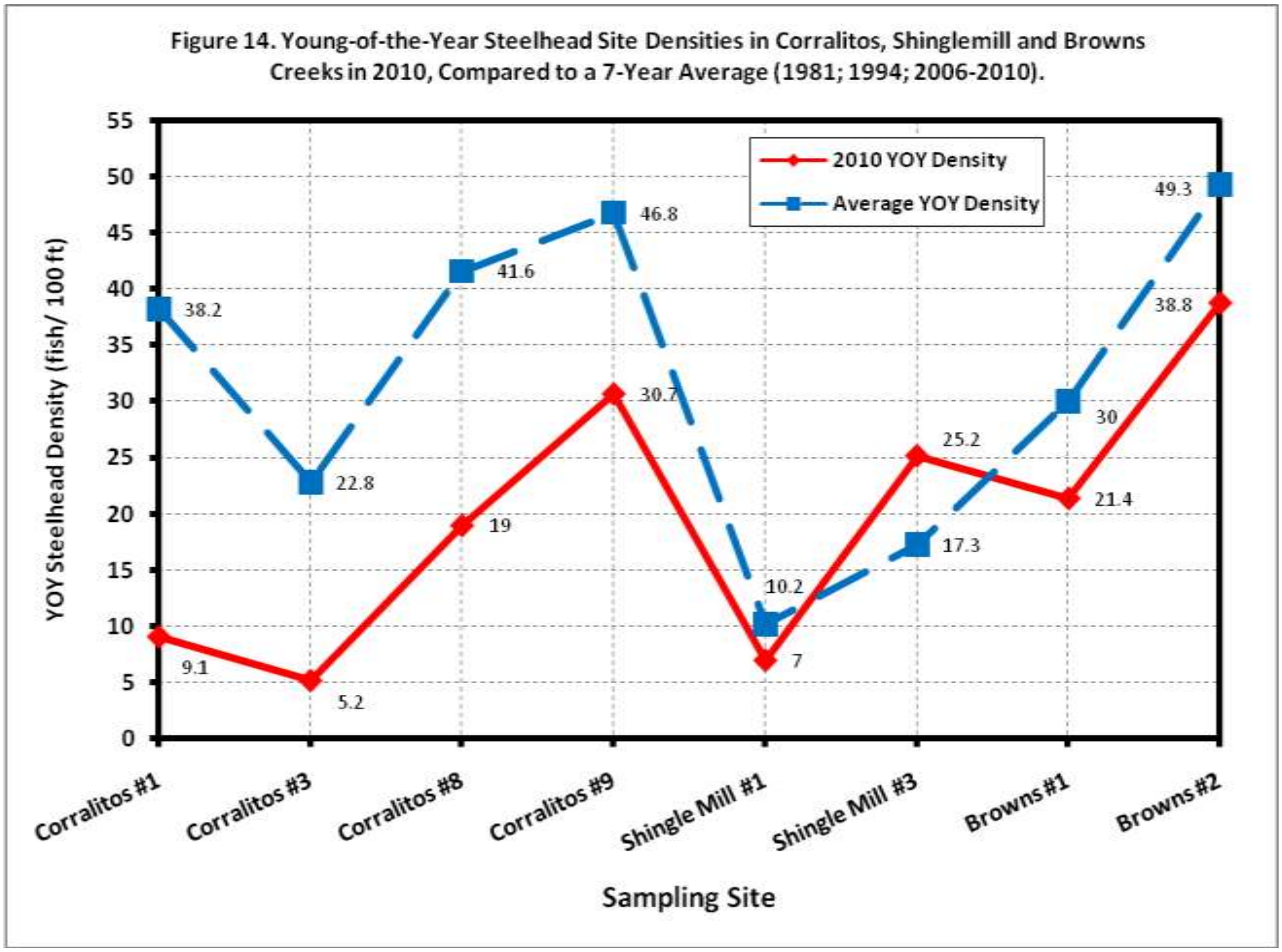


Figure 14. Young-of-the-Year Steelhead Site Densities in Corralitos, Shinglemill and Browns Creeks in 2010, Compared to a 7-Year Average (1981; 1994; 2006-2010).
2010 YOY Density
Average YOY Density
YOY Steelhead Density (fish/ 100 ft)
Sampling Site
Corralitos #1
Corralitos #3
Corralitos #8
Corralitos #9
Shingle Mill #1
Shingle Mill #3
Browns #1
Browns #2
38.2
22.8
41.6
46.8
10.2
17.3
30
49.3
9.1
5.2
19
30.7
7
25.2
21.4
38.8

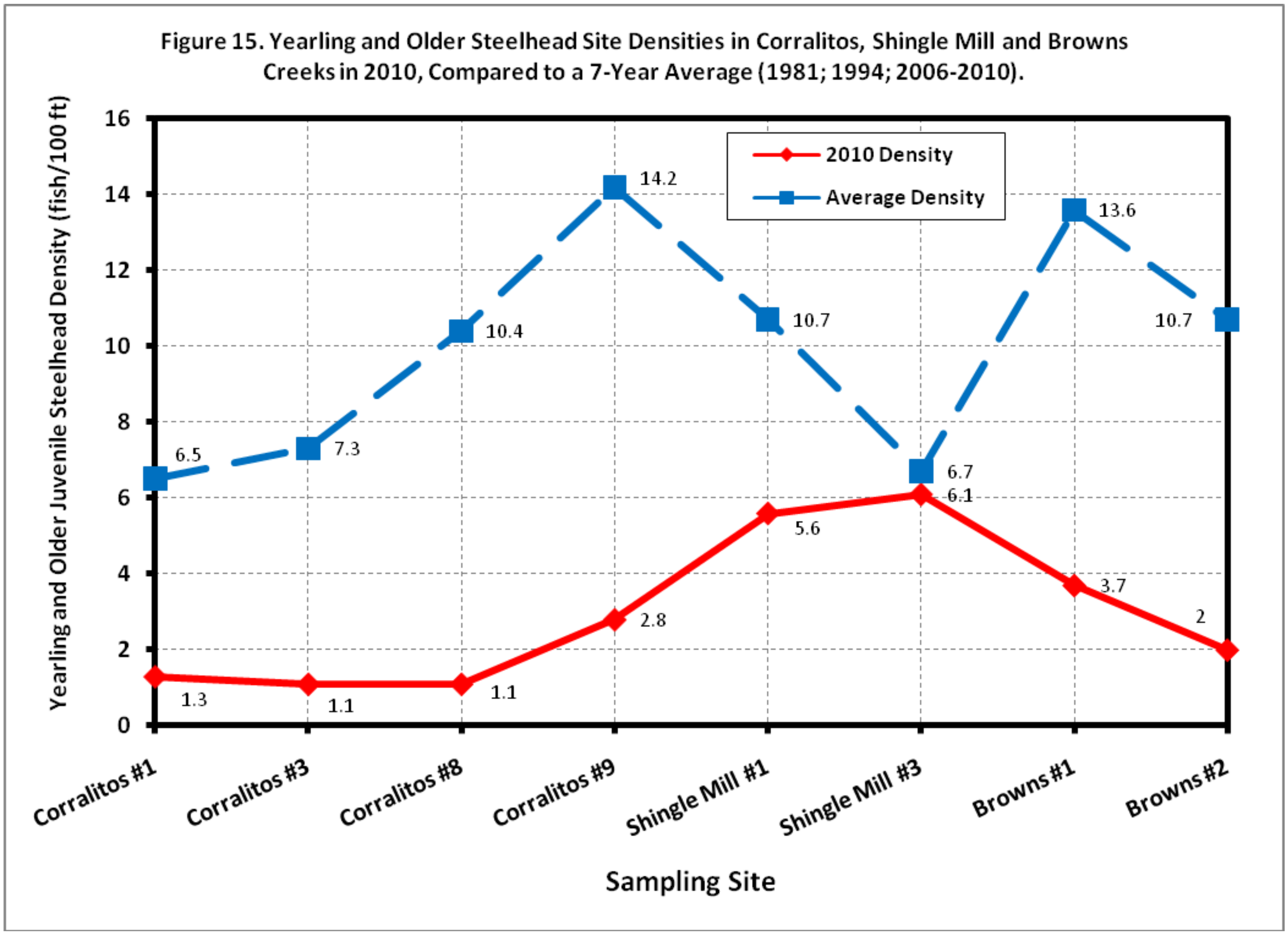


Figure 15. Yearling and Older Steelhead Site Densities in Corralitos, Shingle Mill and Browns Creeks in 2010, Compared to a 7-Year Average (1981; 1994; 2006-2010).
Yearling and Older Juvenile Steelhead Density (fish/100 ft)
2010 Density
Average Density
0
2
4
6
8
10
12
14
16
6.5
7.3
10.4
14.2
10.7
6.7
13.6
10.7
1.3
1.1
1.1
2.8
5.6
6.1
3.7
2
Corralitos #1
Corralitos #3
Corralitos #8
Corralitos #9
Shingle Mill #1
Shingle Mill #3
Browns #1
Browns #2
Sampling Site

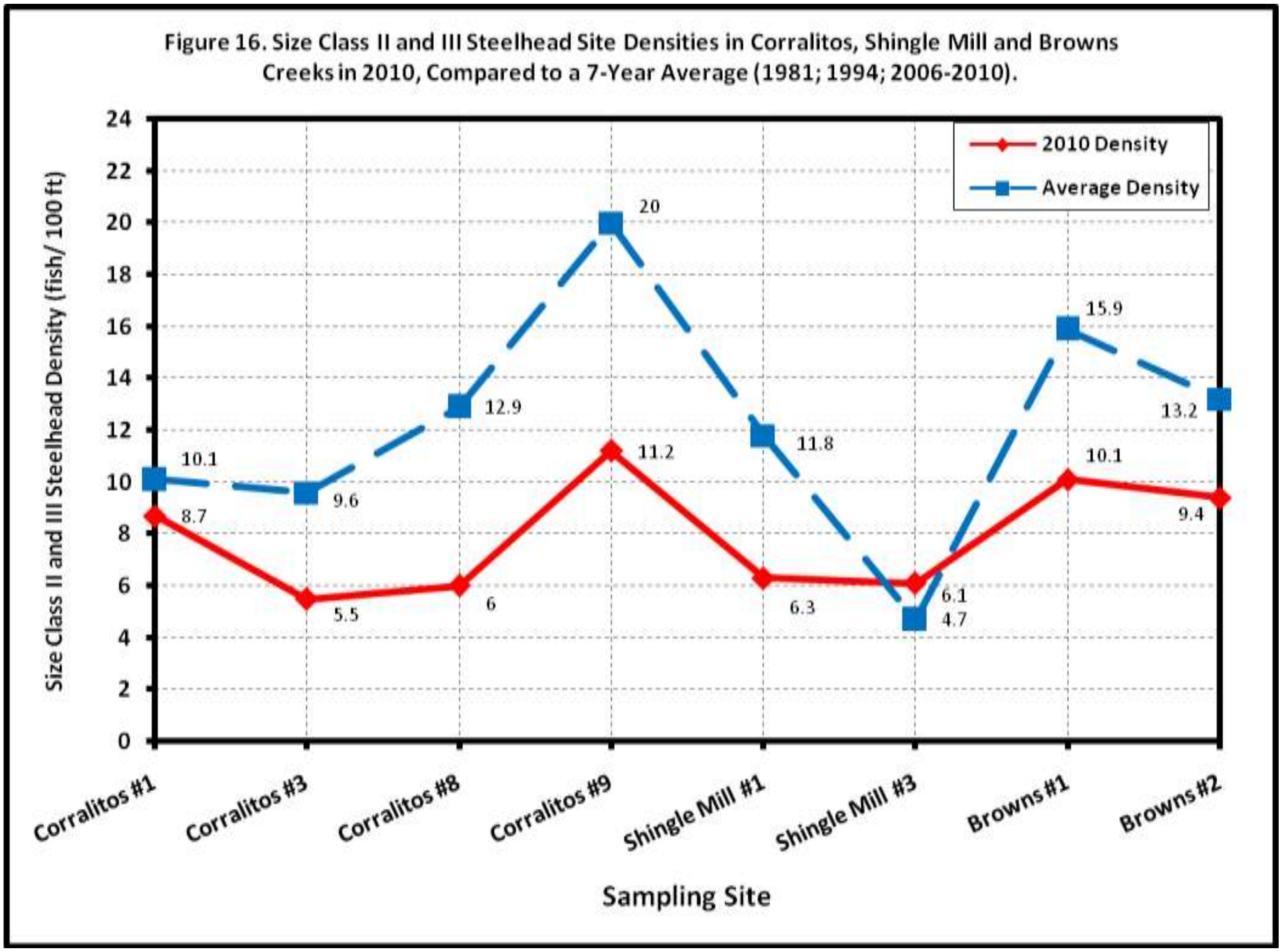
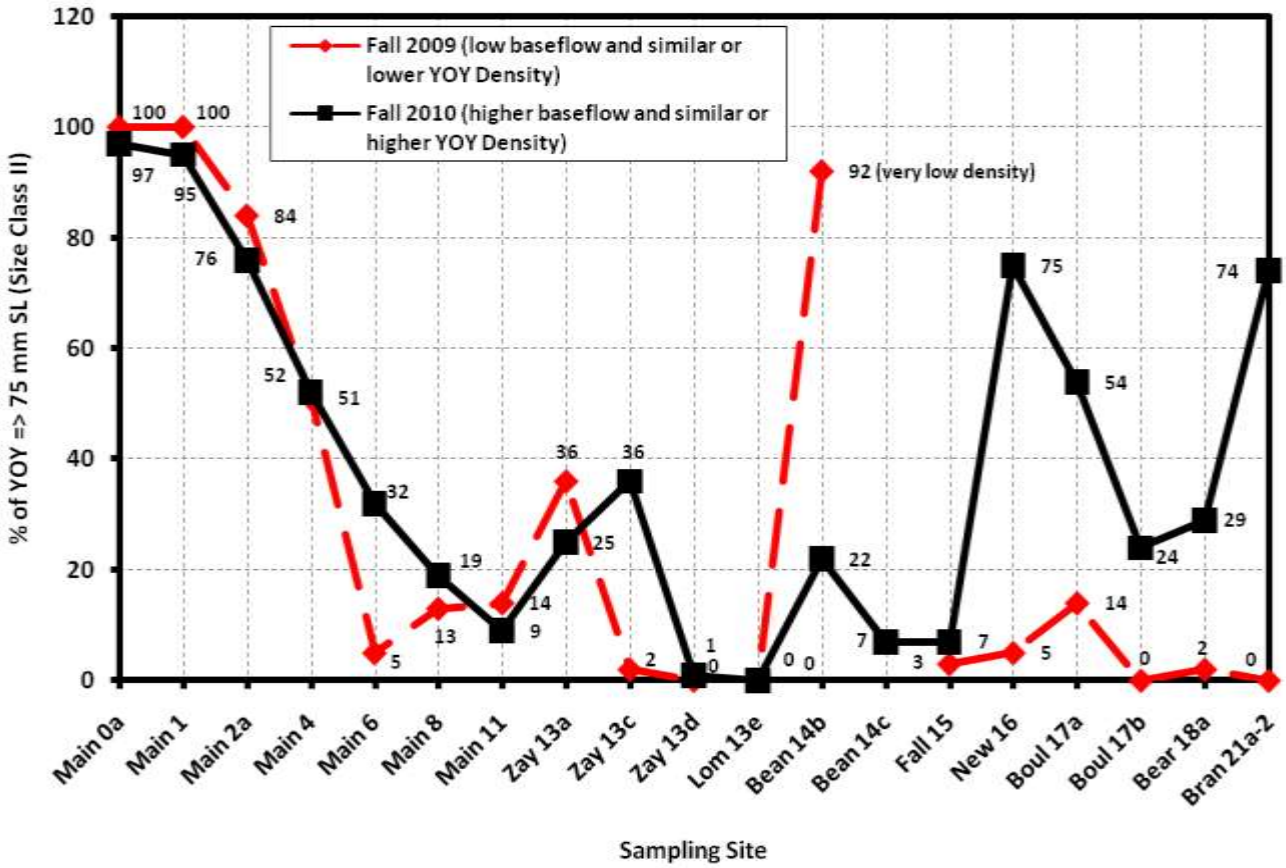


Figure 16. Size Class II and III Steelhead Site Densities in Corralitos, Shingle Mill and Browns Creeks in 2010, Compared to a 7-Year Average (1981; 1994; 2006-2010).
2010 Density
Average Density
Size Class II and III Steelhead Density (fish/ 100 ft)
Sampling Site
Corralitos #1
Corralitos #3
Corralitos #8
Corralitos #9
Shingle Mill #1
Shingle Mill #3
Browns #1
Browns #2
10.1
8.7
9.6
5.5
12.9
6
20
11.2
11.8
6.3
6.1
4.7
15.9
10.1
13.2
9.4

Figure 17. Percent of Young-of-the-Year Steelhead in Size Class II (=>75 mm SL) at San Lorenzo River Sites in 2009 and 2010.



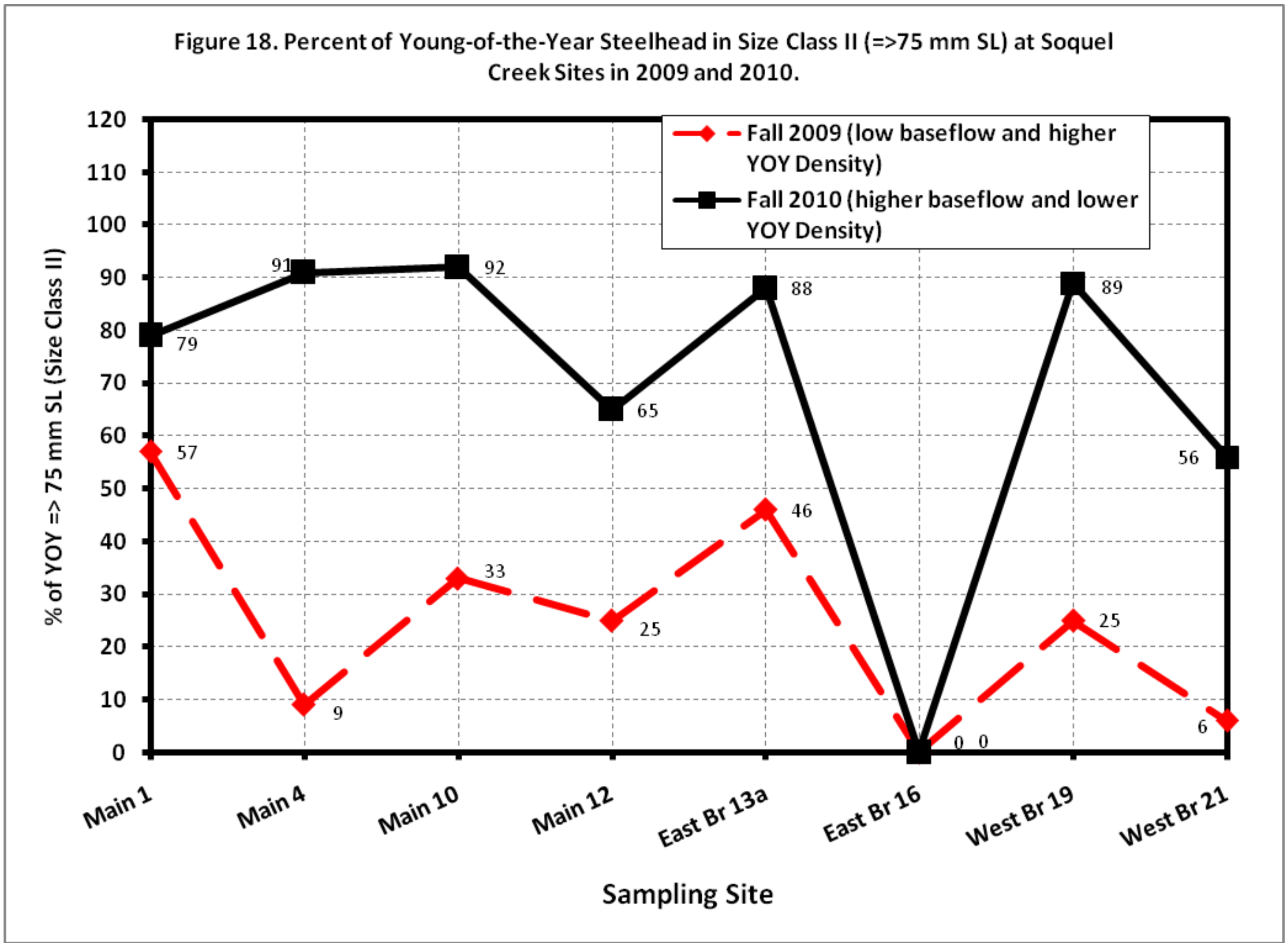


Figure 18. Percent of Young-of-the-Year Steelhead in Size Class II (=>75 mm SL) at Soquel Creek Sites in 2009 and 2010.
Fall 2009 (low baseflow and higher YOY Density)
Fall 2010 (higher baseflow and lower YOY Density)
% of YOY => 75 mm SL (Size Class II)
120
110
100
90
80
70
60
50
40
30
20
10
0
79
91
92
65
88
0
89
56
57
9
33
25
46
0
25
6
Main 1
Main 4
Main 10
Main 12
East Br 13a
East Br 16
West Br 19
West Br 21
Sampling Site

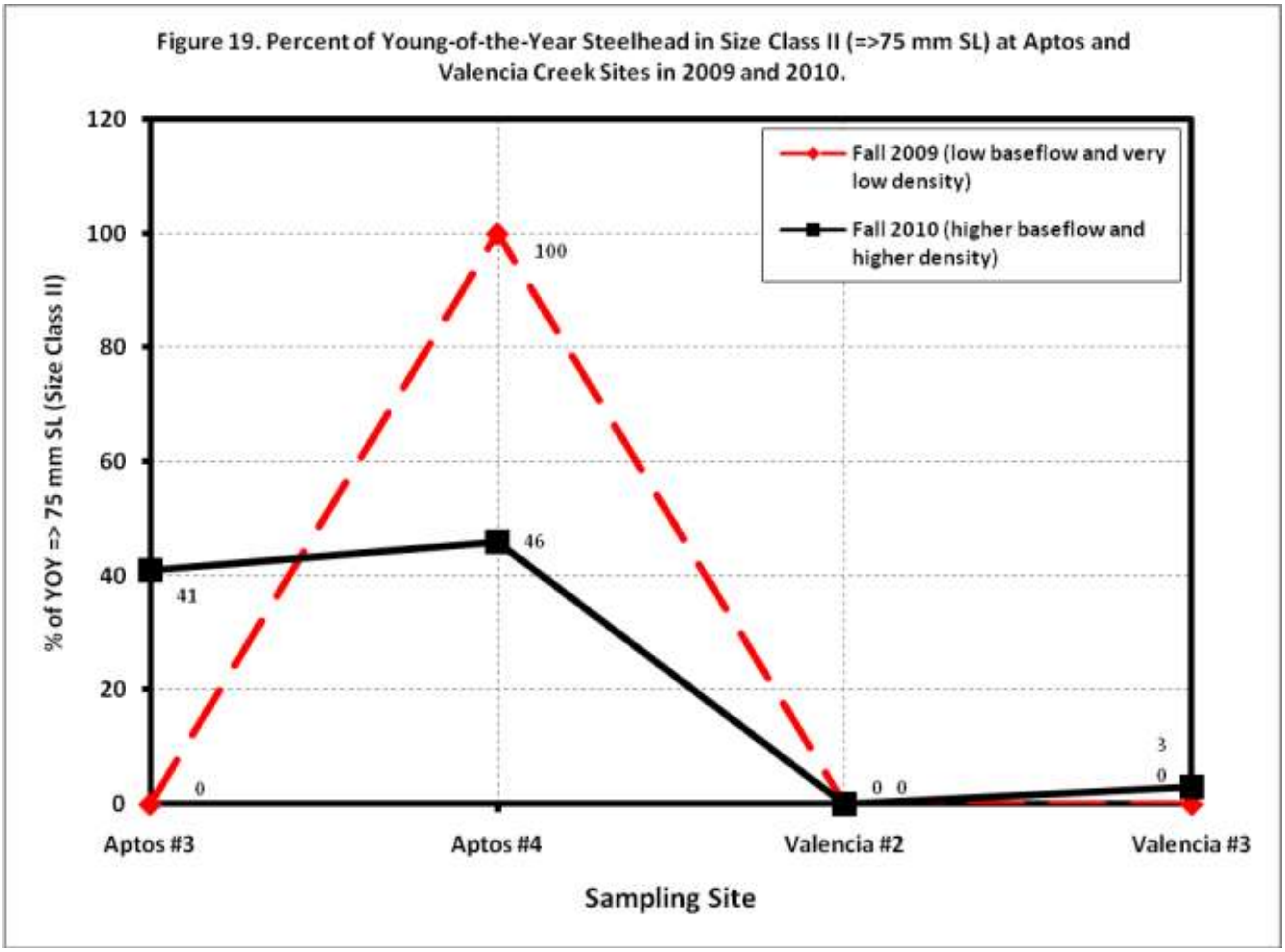
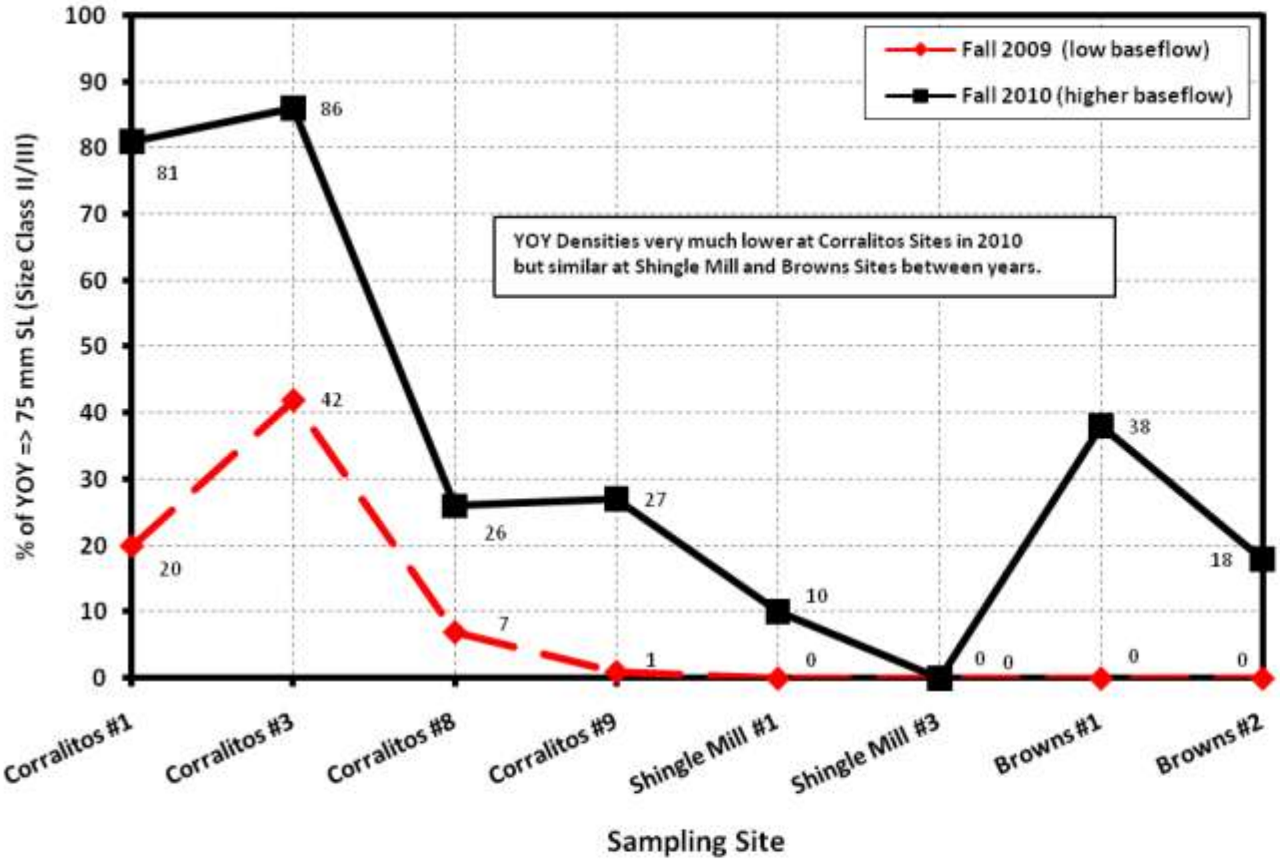


Figure 19. Percent of Young-of-the-Year Steelhead in Size Class II (=>75 mm SL) at Aptos and Valencia Creek Sites in 2009 and 2010.
Fall 2009 (low baseflow and very low density)
Fall 2010 (higher baseflow and higher density)
% of YOY => 75 mm SL (Size Class II)
Sampling Site
Aptos #3
Aptos #4
Valencia #2
Valencia #3
120
100
80
60
40
20
0
41
46
3

Figure 20. Percent of Young-of-the-Year Steelhead in Size Class II (=>75 mm SL) at Corralitos Watershed Sites in 2009 and 2010.



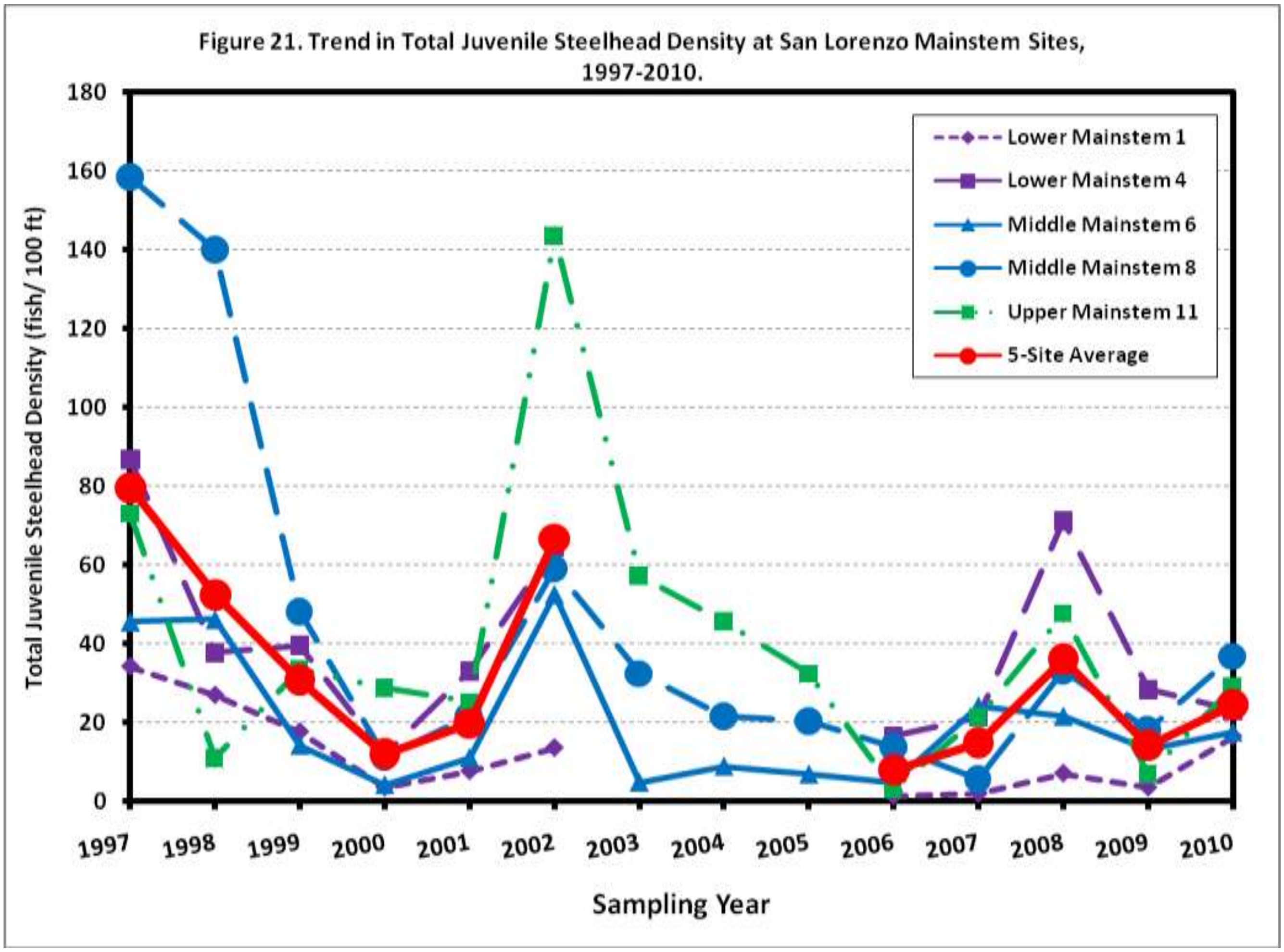


Figure 21. Trend in Total Juvenile Steelhead Density at San Lorenzo Mainstem Sites, 1997-2010.
Lower Mainstem 1
Lower Mainstem 4
Middle Mainstem 6
Middle Mainstem 8
Upper Mainstem 11
5-Site Average
Total Juvenile Steelhead Density (fish/ 100 ft)
0
20
40
60
80
100
120
140
160
180
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
Sampling Year

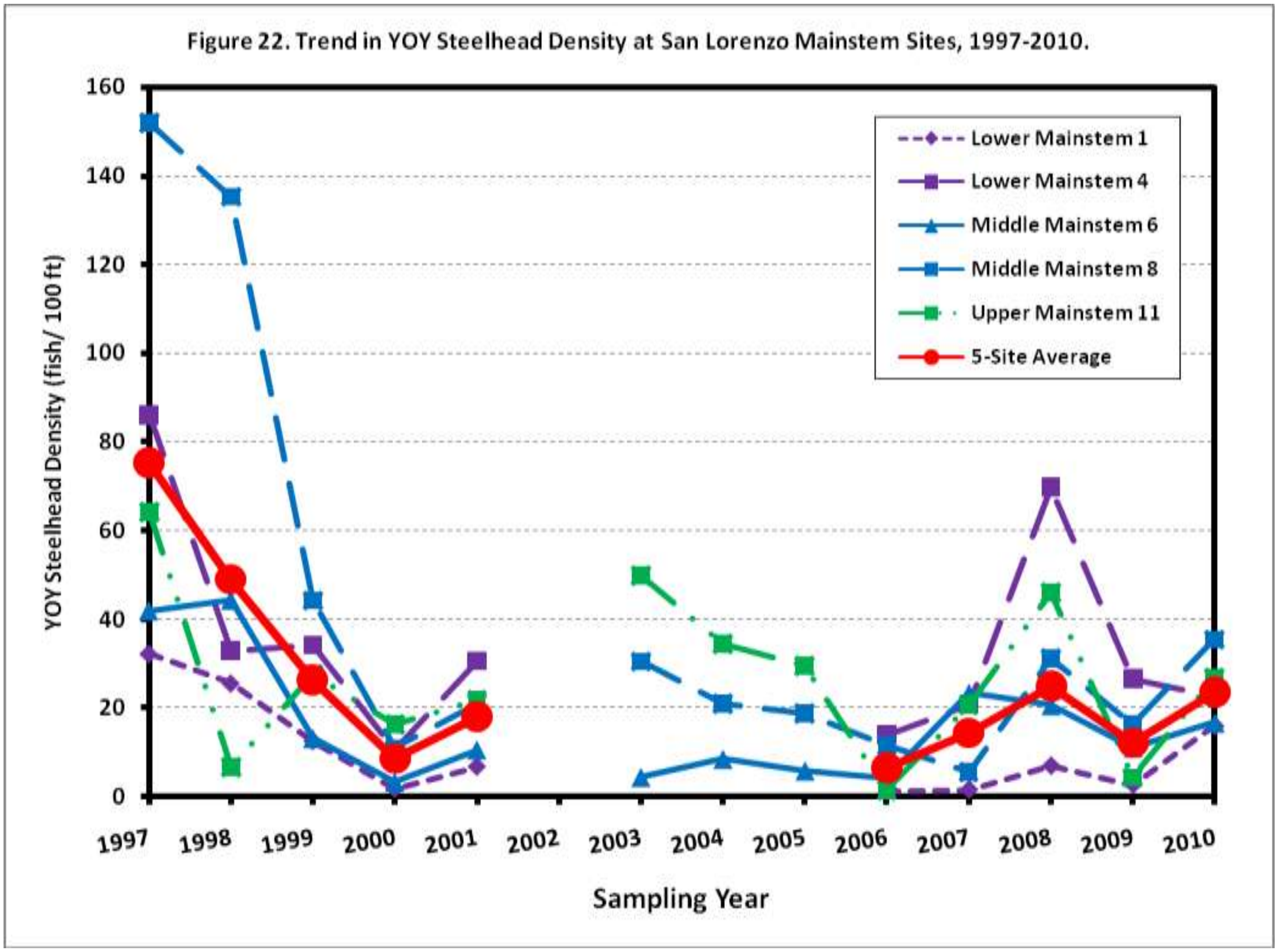


Figure 22. Trend in YOY Steelhead Density at San Lorenzo Mainstem Sites, 1997-2010.
YOY Steelhead Density (fish/ 100 ft)
Sampling Year
Lower Mainstem 1
Lower Mainstem 4
Middle Mainstem 6
Middle Mainstem 8
Upper Mainstem 11
5-Site Average
0
20
40
60
80
100
120
140
160
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010

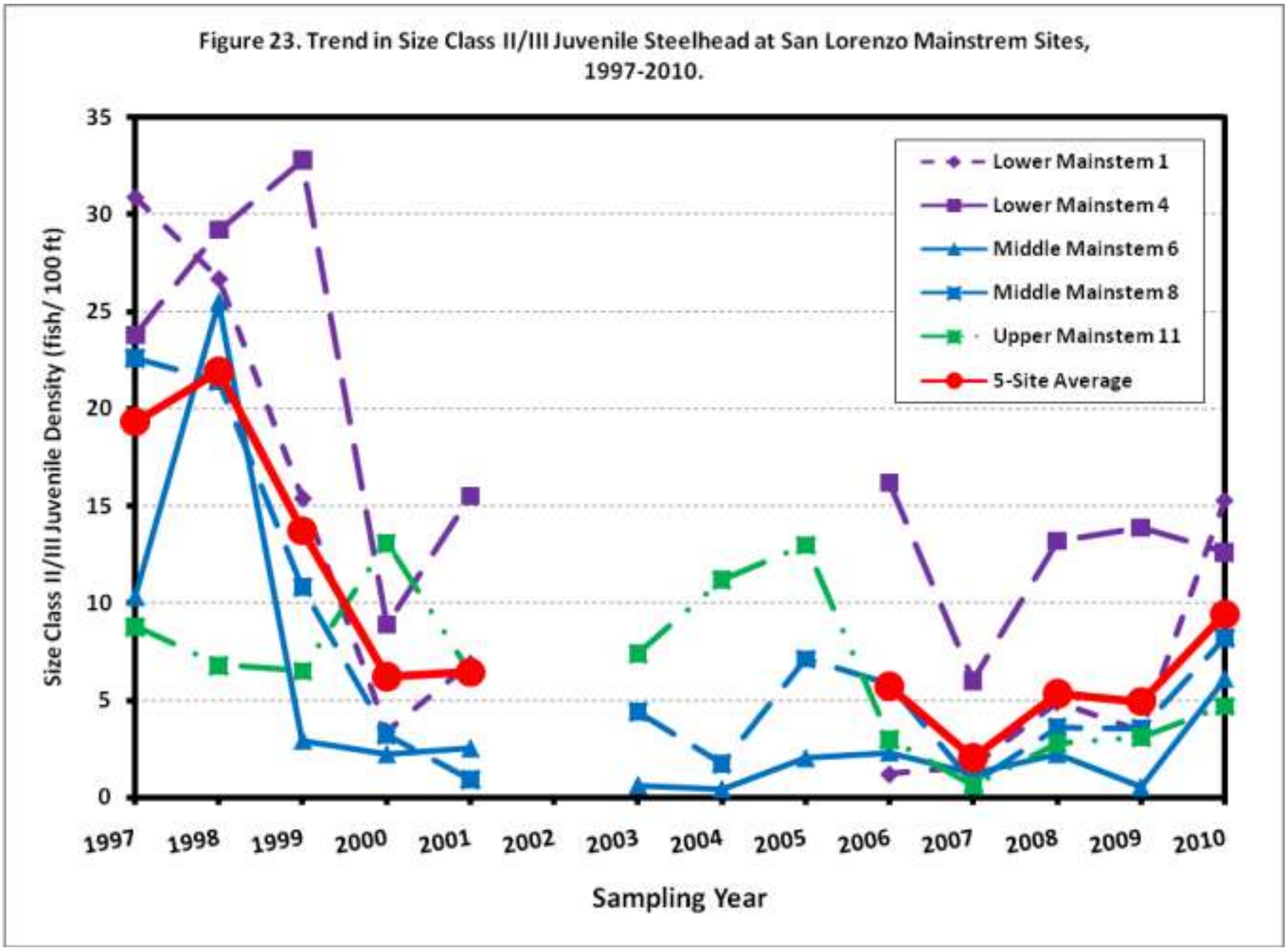


Figure 23. Trend in Size Class II/III Juvenile Steelhead at San Lorenzo Mainstrem Sites, 1997-2010.
Size Class II/III Juvenile Density (fish/ 100 ft)
Sampling Year
Lower Mainstem 1
Lower Mainstem 4
Middle Mainstem 6
Middle Mainstem 8
Upper Mainstem 11
5-Site Average
0
5
10
15
20
25
30
35
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010

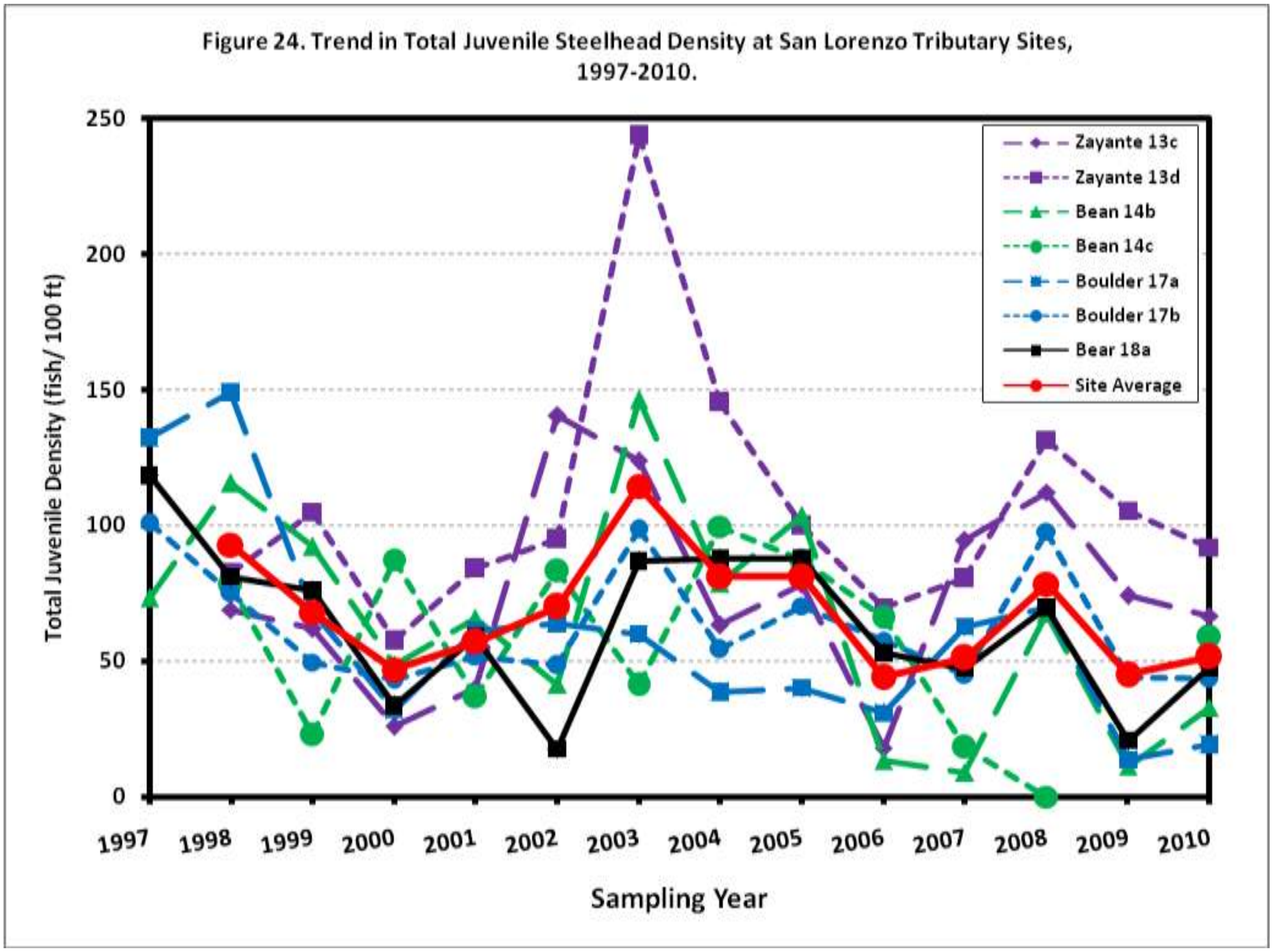


Figure 24. Trend in Total Juvenile Steelhead Density at San Lorenzo Tributary Sites, 1997-2010.
Total Juvenile Density (fish/ 100 ft)
250
200
150
100
50
0
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
Sampling Year
Zayante 13c
Zayante 13d
Bean 14b
Bean 14c
Boulder 17a
Boulder 17b
Bear 18a
Site Average

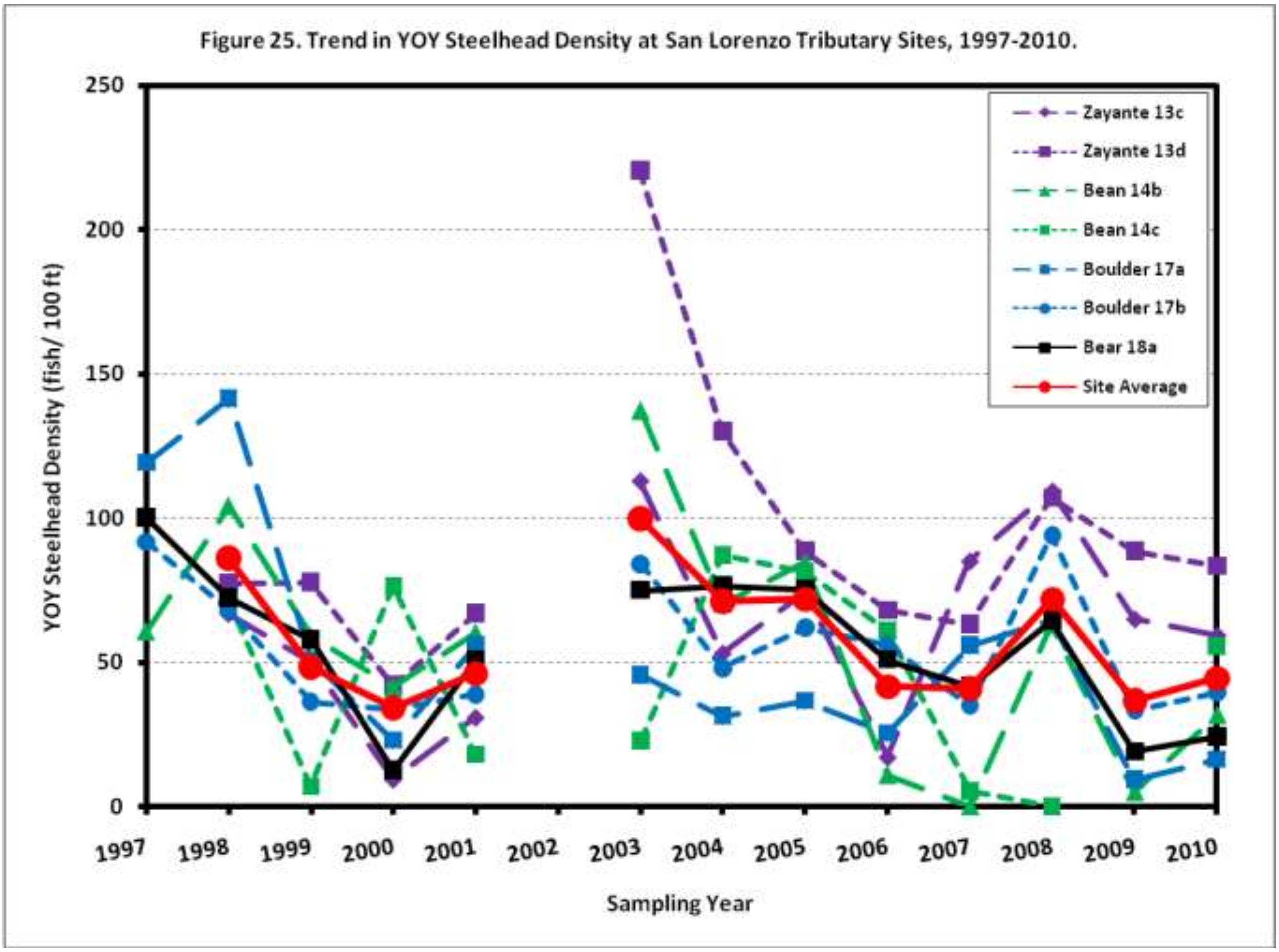


Figure 25. Trend in YOY Steelhead Density at San Lorenzo Tributary Sites, 1997-2010.
YOY Steelhead Density (fish/ 100 ft)
0
50
100
150
200
250
Zayante 13c
Zayante 13d
Bean 14b
Bean 14c
Boulder 17a
Boulder 17b
Bear 18a
Site Average
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
Sampling Year

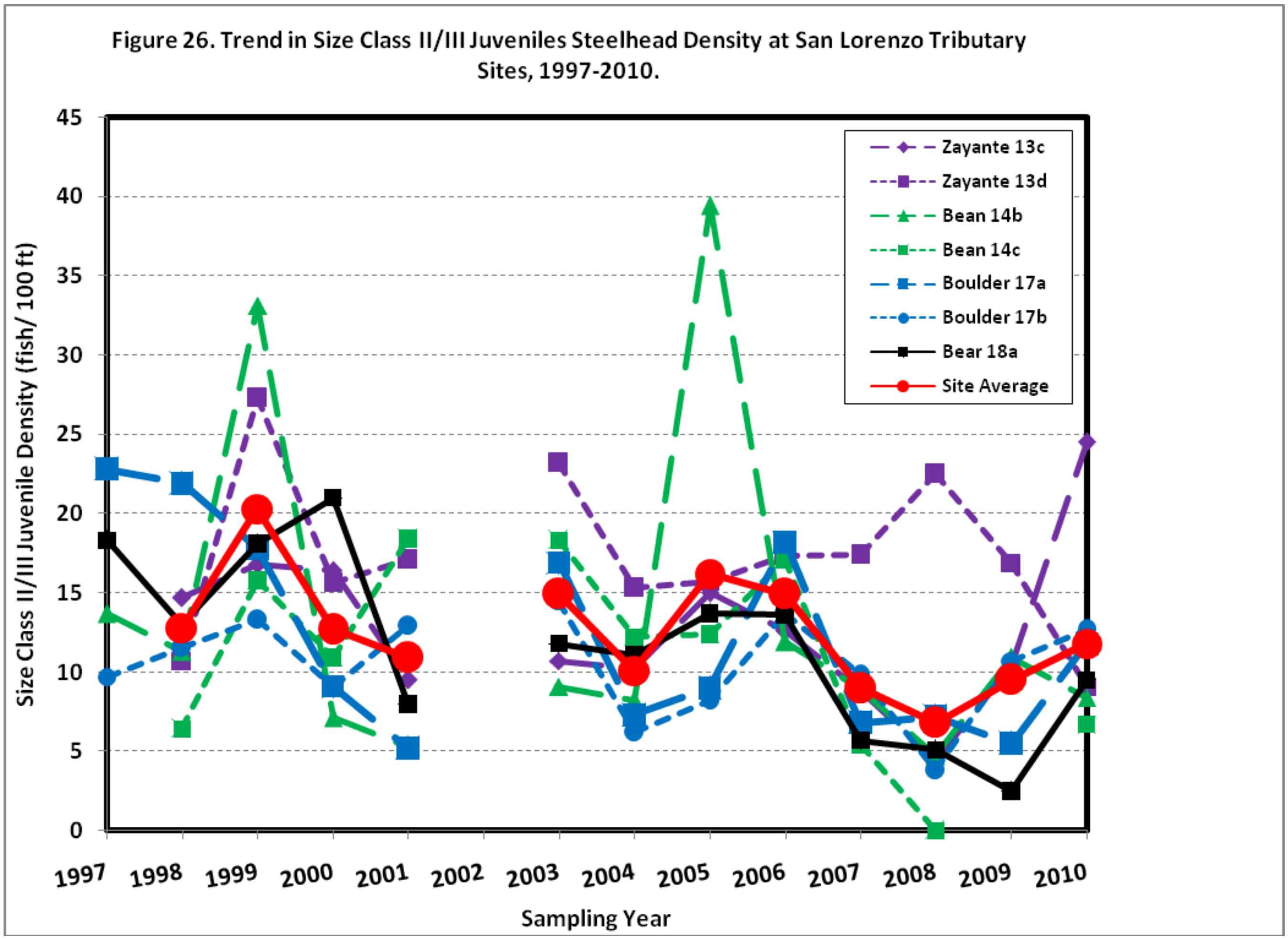


Figure 26. Trend in Size Class II/III Juveniles Steelhead Density at San Lorenzo Tributary Sites, 1997-2010.
Size Class II/III Juvenile Density (fish/ 100 ft)
45
40
35
30
25
20
15
10
5
0
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
Sampling Year
Zayante 13c
Zayante 13d
Bean 14b
Bean 14c
Boulder 17a
Boulder 17b
Bear 18a
Site Average

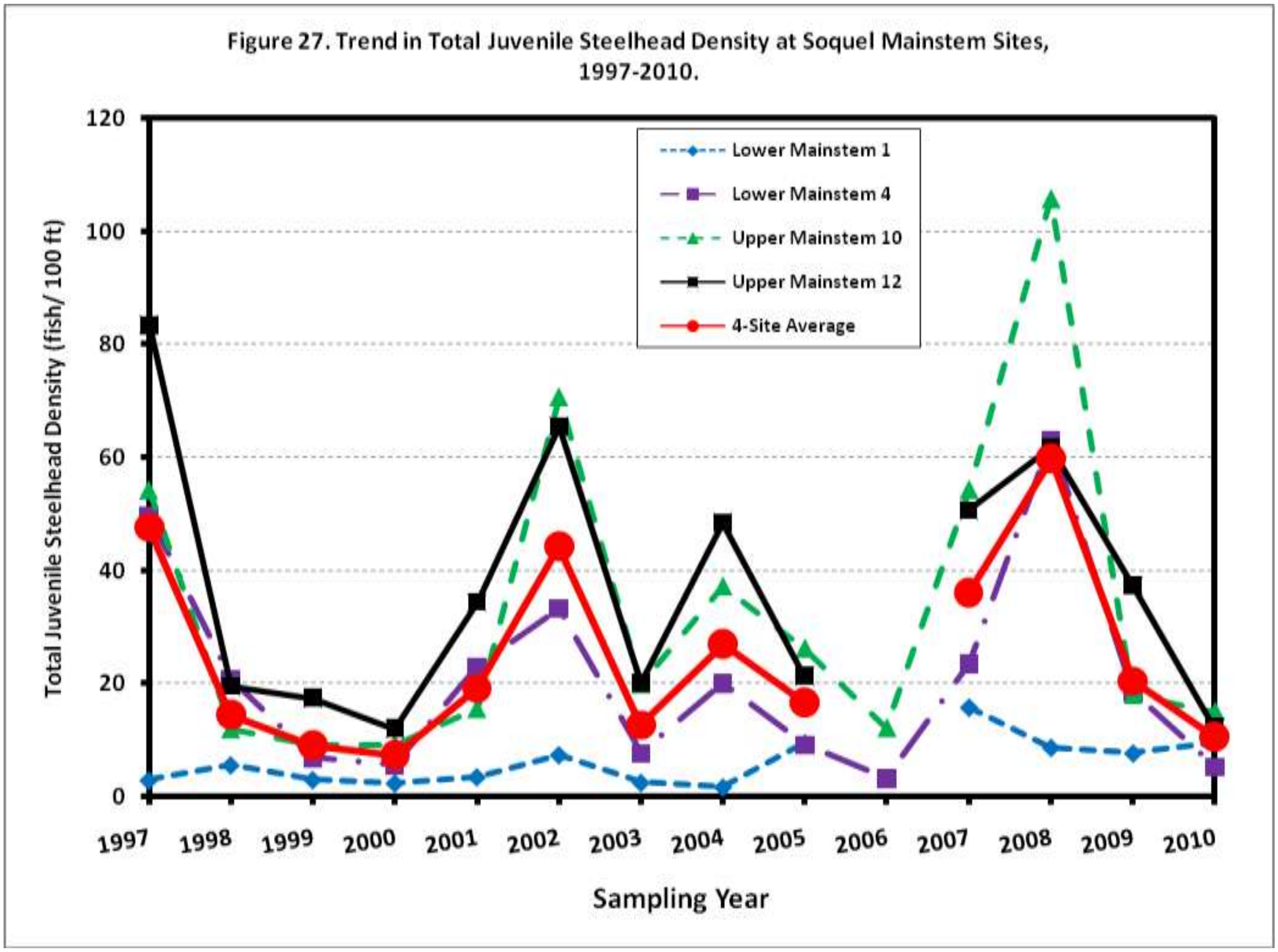


Figure 27. Trend in Total Juvenile Steelhead Density at Soquel Mainstem Sites, 1997-2010.
Total Juvenile Steelhead Density (fish/ 100 ft)
0
20
40
60
80
100
120
Lower Mainstem 1
Lower Mainstem 4
Upper Mainstem 10
Upper Mainstem 12
4-Site Average
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
Sampling Year

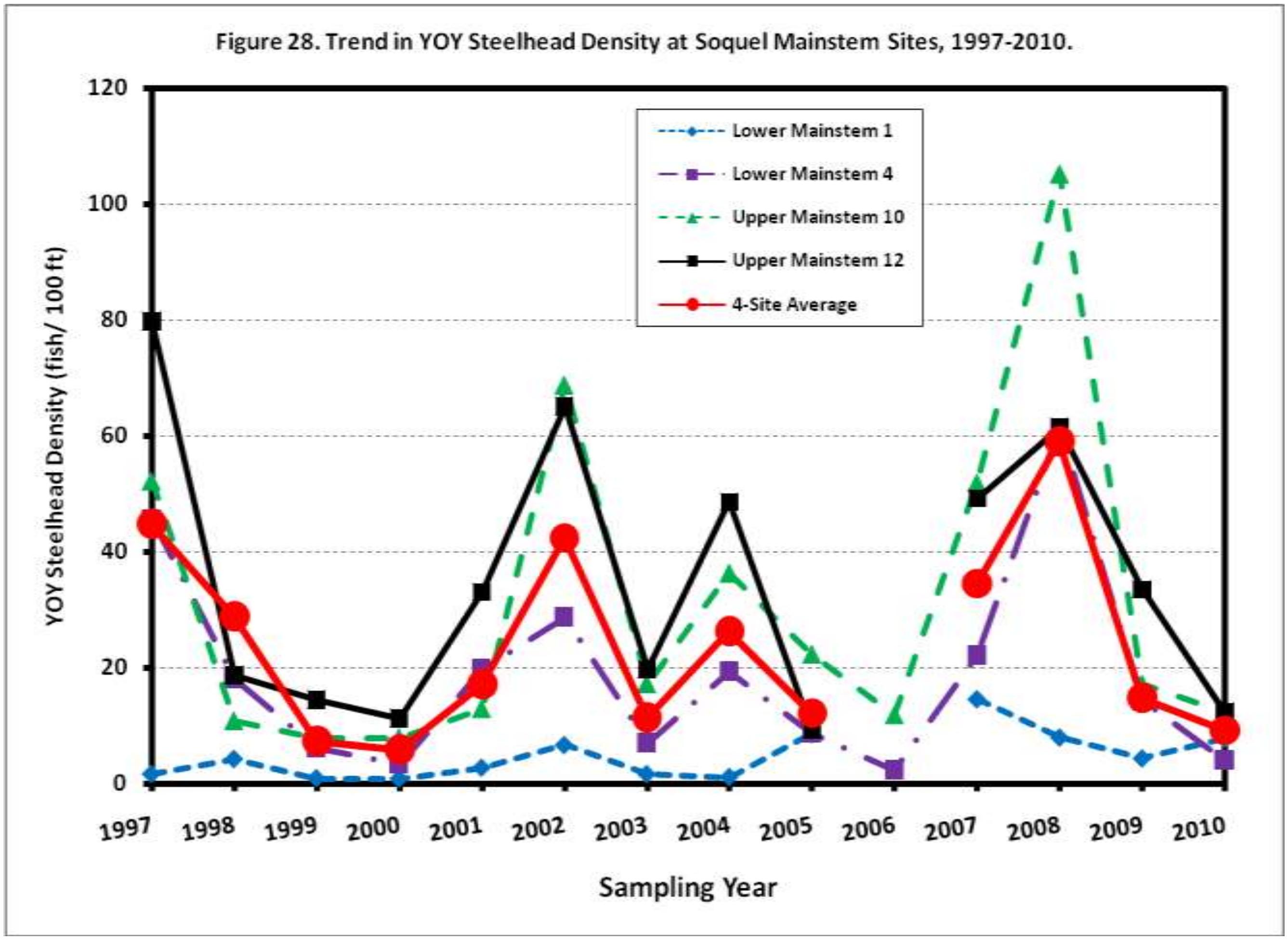


Figure 28. Trend in YOY Steelhead Density at Soquel Mainstem Sites, 1997-2010.
Lower Mainstem 1
Lower Mainstem 4
Upper Mainstem 10
Upper Mainstem 12
4-Site Average
YOY Steelhead Density (fish/ 100 ft)
0
20
40
60
80
100
120
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
Sampling Year

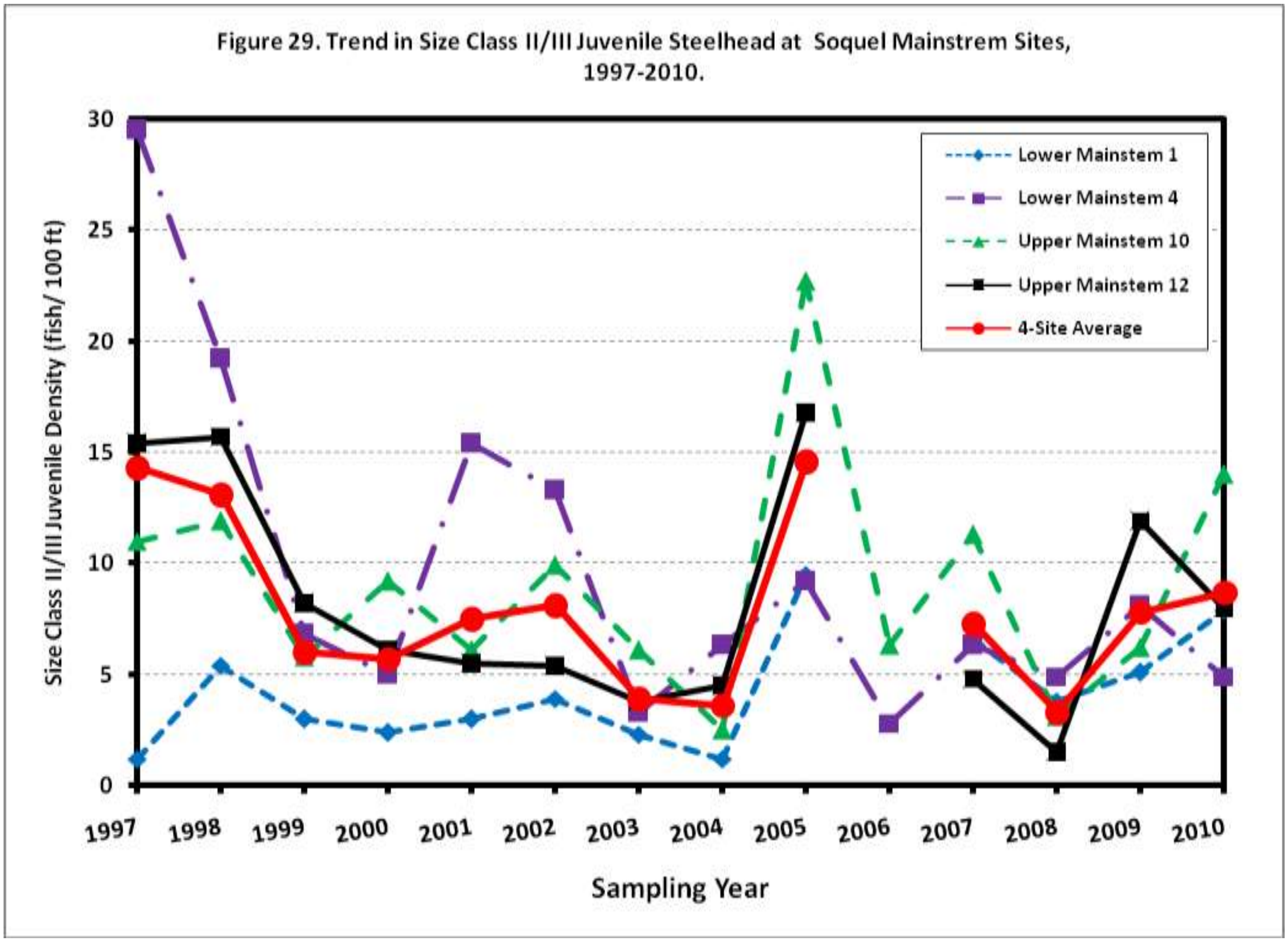


Figure 29. Trend in Size Class II/III Juvenile Steelhead at Soquel Mainstrem Sites, 1997-2010.
Size Class II/III Juvenile Density (fish/ 100 ft)
Sampling Year
Lower Mainstem 1
Lower Mainstem 4
Upper Mainstem 10
Upper Mainstem 12
4-Site Average
0
5
10
15
20
25
30
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010

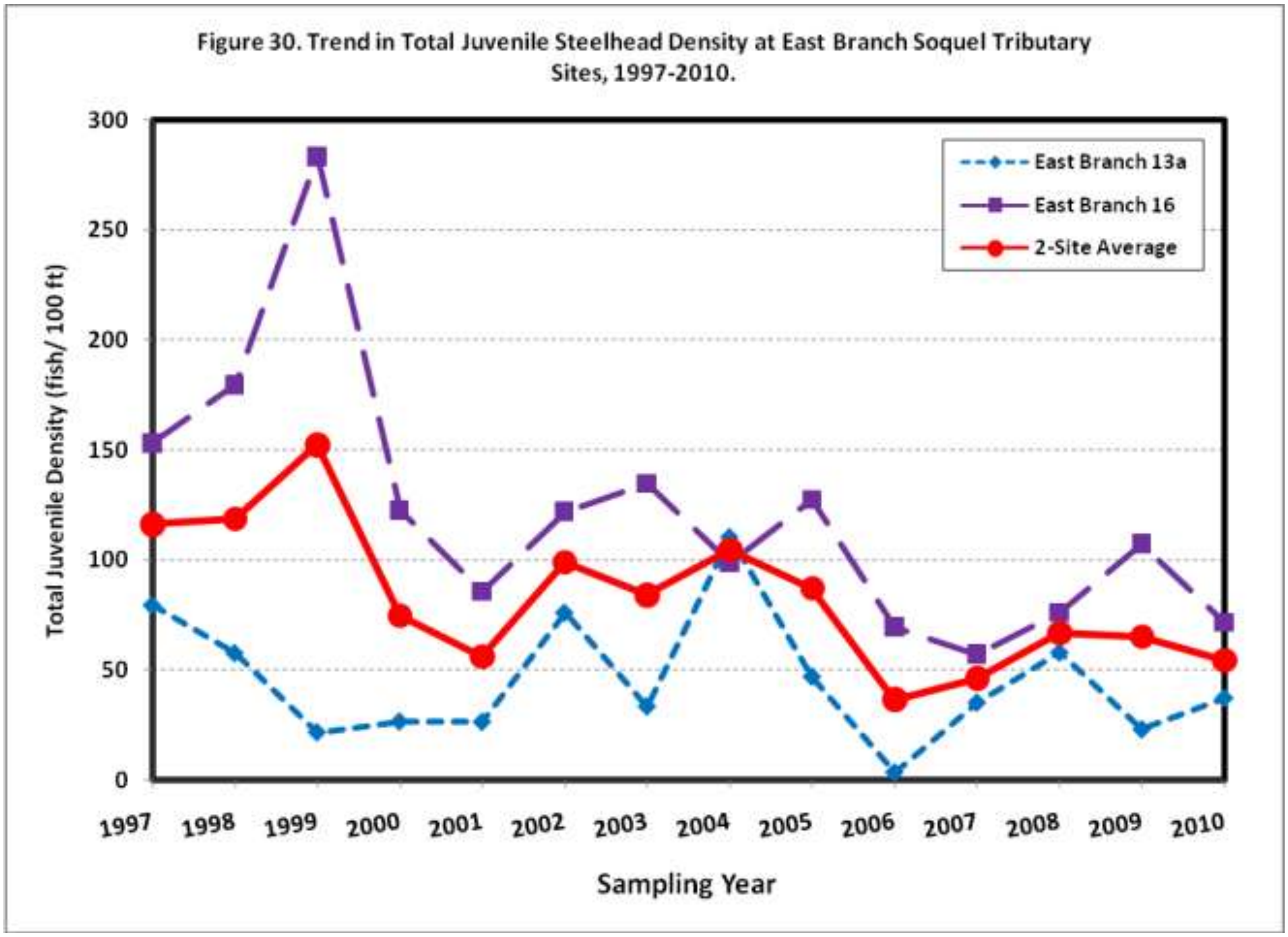


Figure 30. Trend in Total Juvenile Steelhead Density at East Branch Soquel Tributary Sites, 1997-2010.
East Branch 13a
East Branch 16
2-Site Average
Total Juvenile Density (fish/ 100 ft)
300
250
200
150
100
50
0
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
Sampling Year

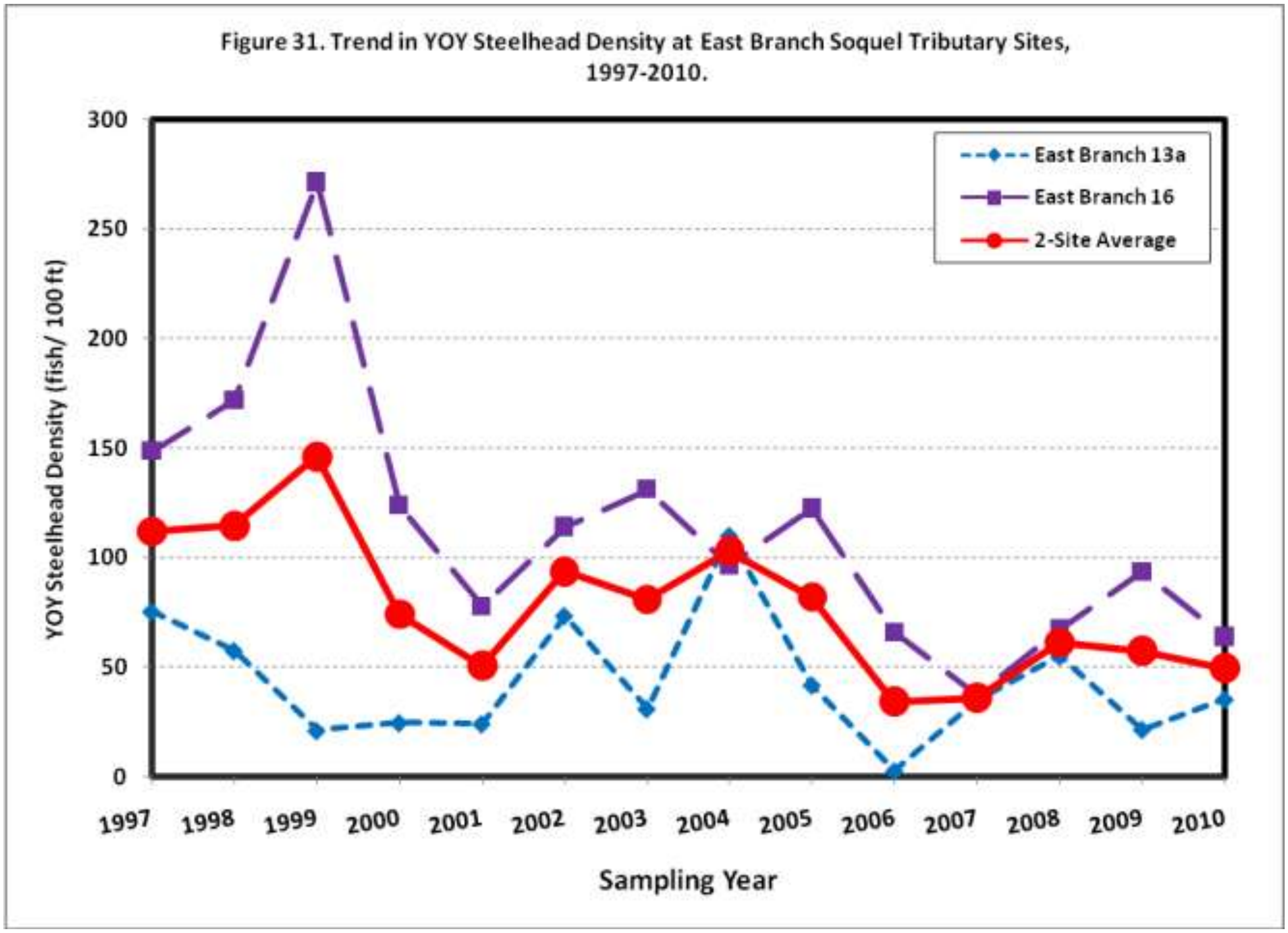


Figure 31. Trend in YOY Steelhead Density at East Branch Soquel Tributary Sites, 1997-2010.
YOY Steelhead Density (fish/ 100 ft)
300
250
200
150
100
50
0
East Branch 13a
East Branch 16
2-Site Average
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
Sampling Year

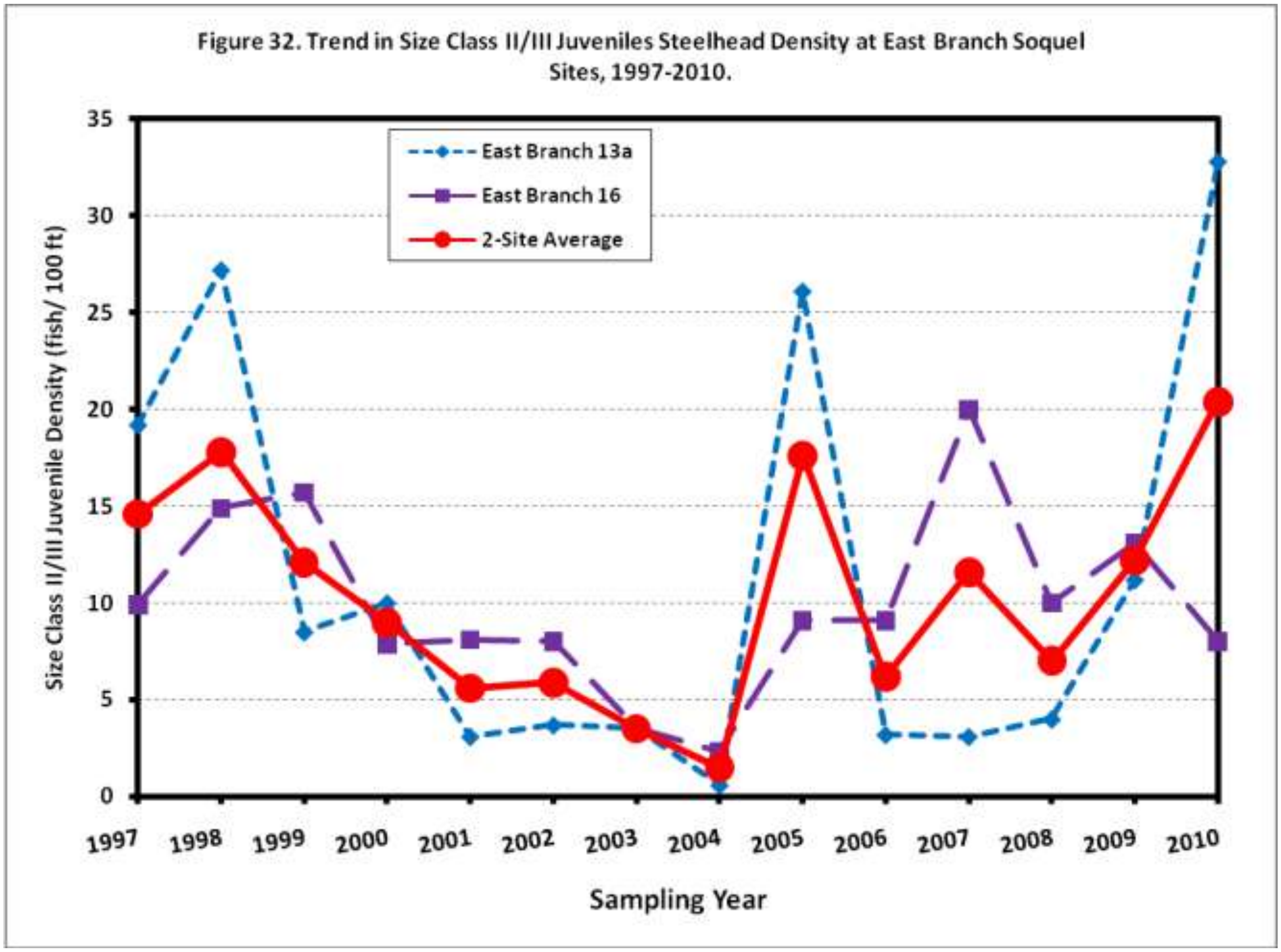


Figure 32. Trend in Size Class II/III Juveniles Steelhead Density at East Branch Soquel Sites, 1997-2010.
East Branch 13a
East Branch 16
2-Site Average
Size Class II/III Juvenile Density (fish/ 100 ft)
0
5
10
15
20
25
30
35
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
Sampling Year

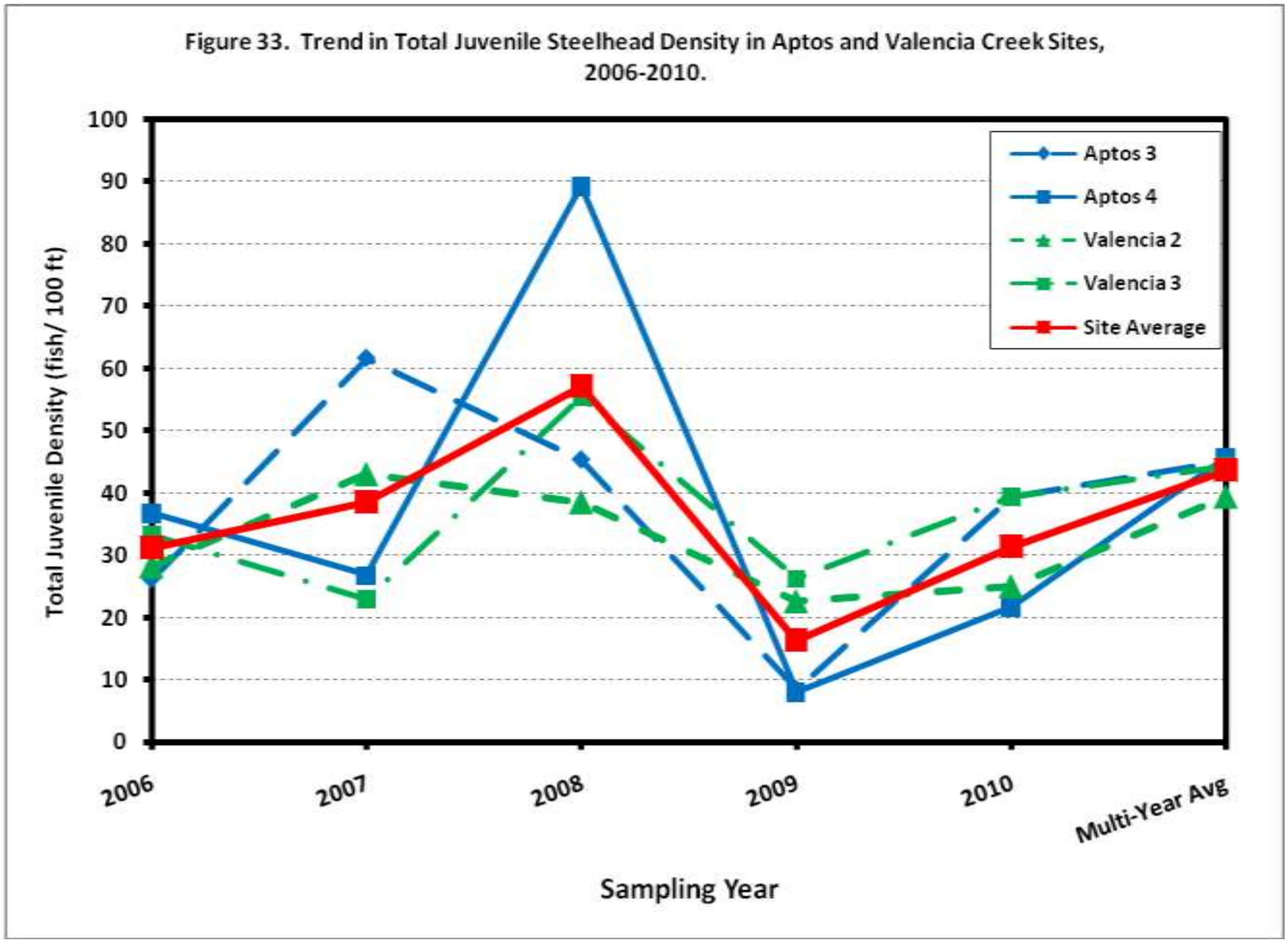


Figure 33. Trend in Total Juvenile Steelhead Density in Aptos and Valencia Creek Sites, 2006-2010.
Total Juvenile Density (fish/ 100 ft)
100
90
80
70
60
50
40
30
20
10
0
2006
2007
2008
2009
2010
Multi-Year Avg
Sampling Year
Aptos 3
Aptos 4
Valencia 2
Valencia 3
Site Average

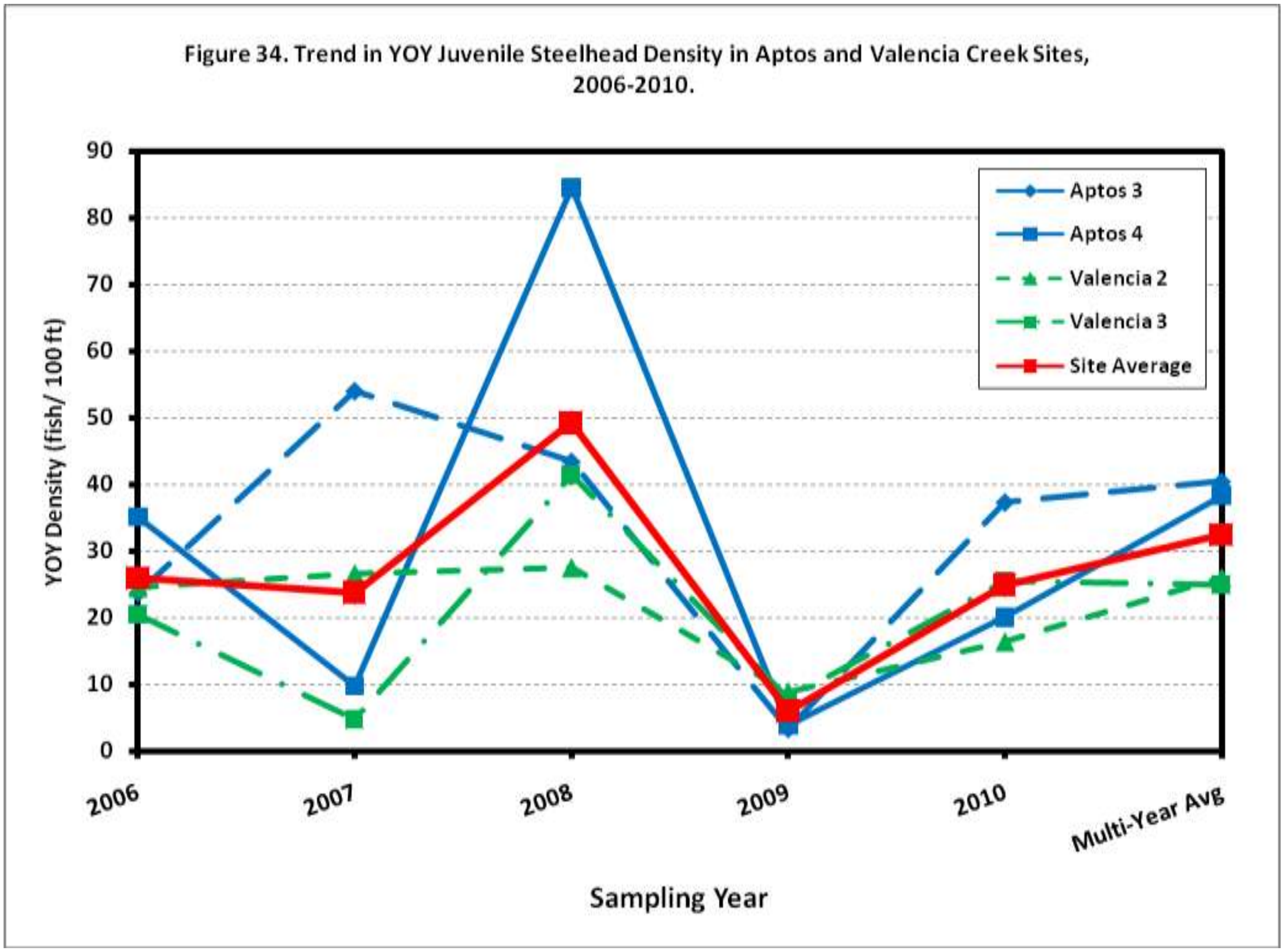


Figure 34. Trend in YOY Juvenile Steelhead Density in Aptos and Valencia Creek Sites, 2006-2010.
YOY Density (fish/ 100 ft)
0
10
20
30
40
50
60
70
80
90
Aptos 3
Aptos 4
Valencia 2
Valencia 3
Site Average
2006
2007
2008
2009
2010
Multi-Year Avg
Sampling Year

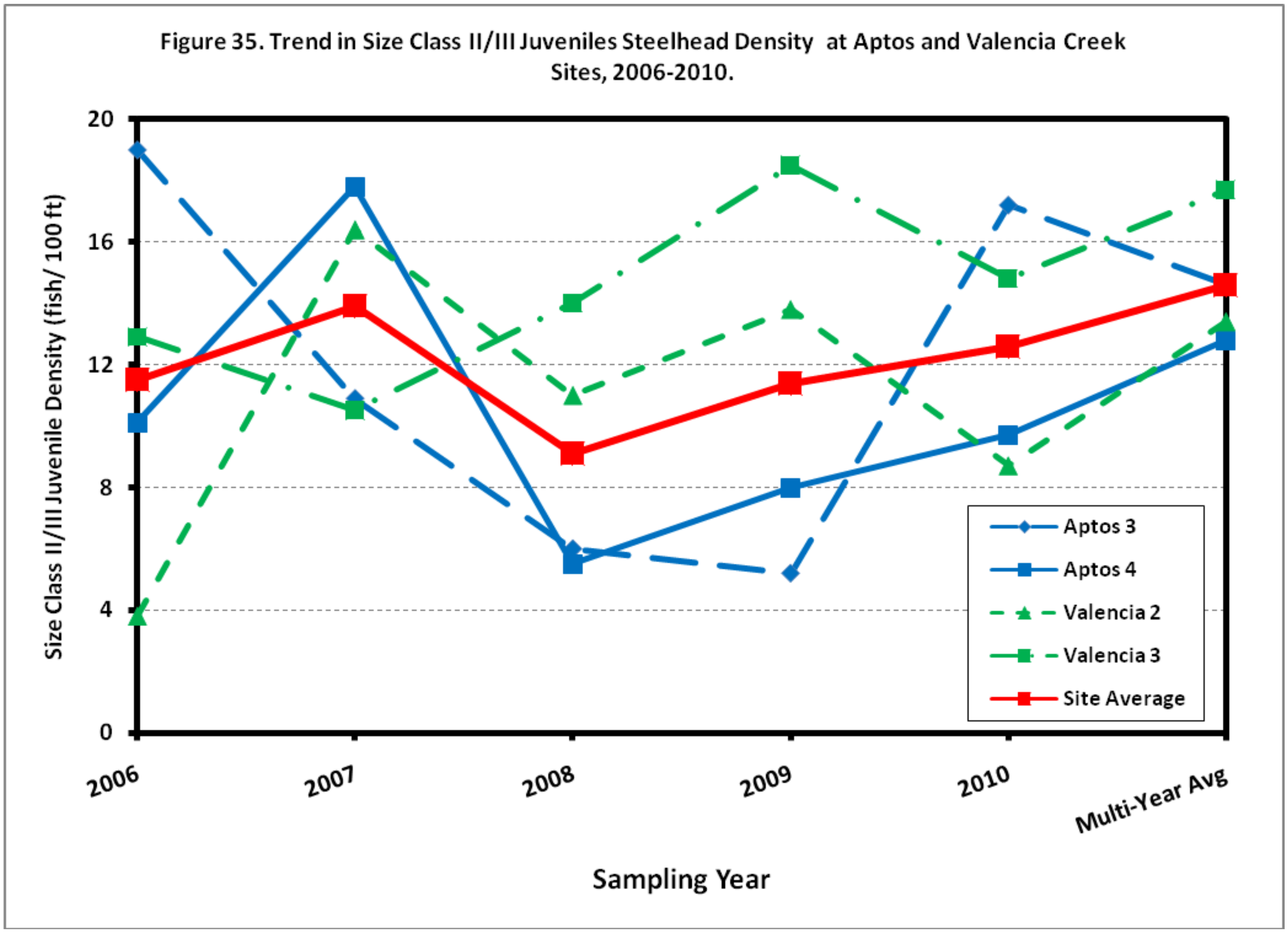
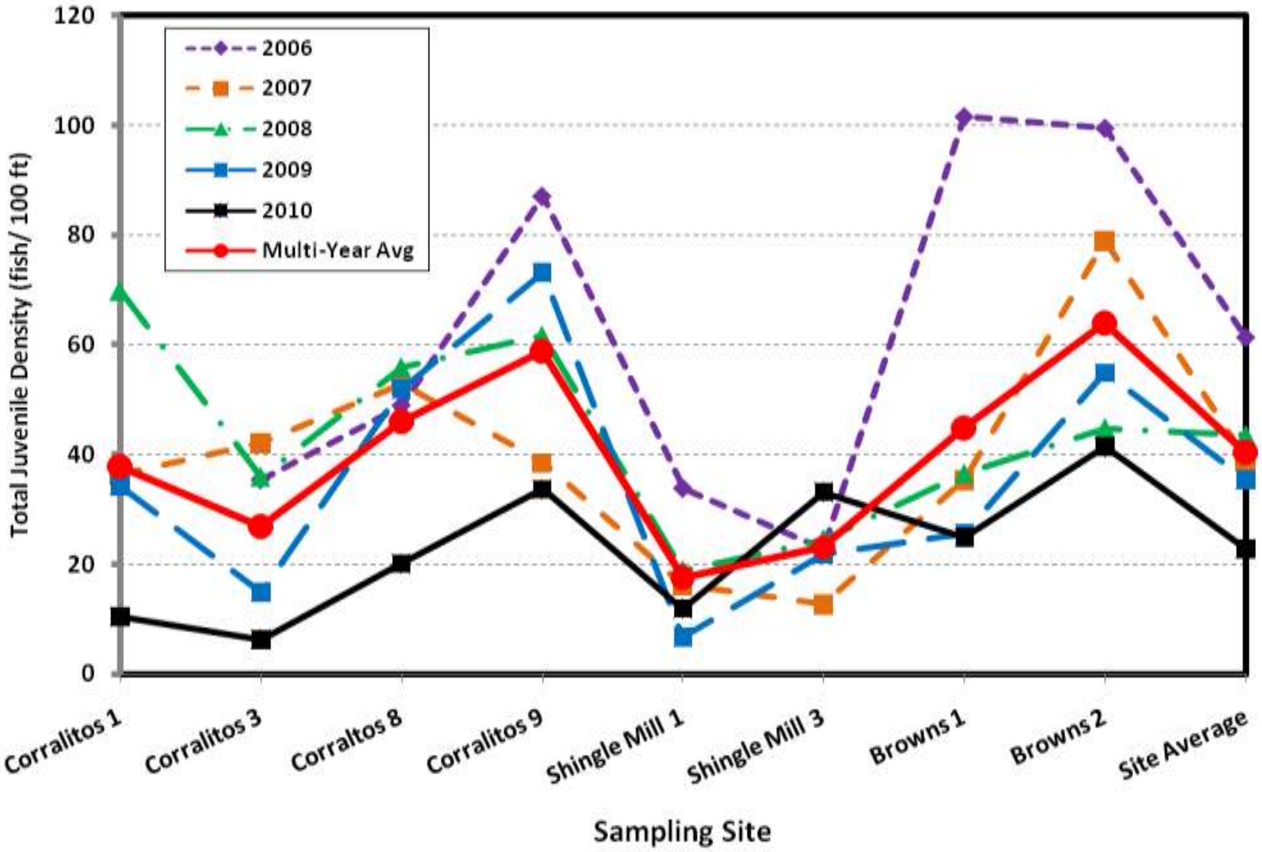


Figure 35. Trend in Size Class II/III Juveniles Steelhead Density at Aptos and Valencia Creek Sites, 2006-2010.
Size Class II/III Juvenile Density (fish/ 100 ft)
20
16
12
8
4
0
2006
2007
2008
2009
2010
Multi-Year Avg
Sampling Year
Aptos 3
Aptos 4
Valencia 2
Valencia 3
Site Average

Figure 36. Trend by Site in Total Juveniles Steelhead Density at Corralitos, Shingle Mill and Browns Creek Sites, 2006-2010.



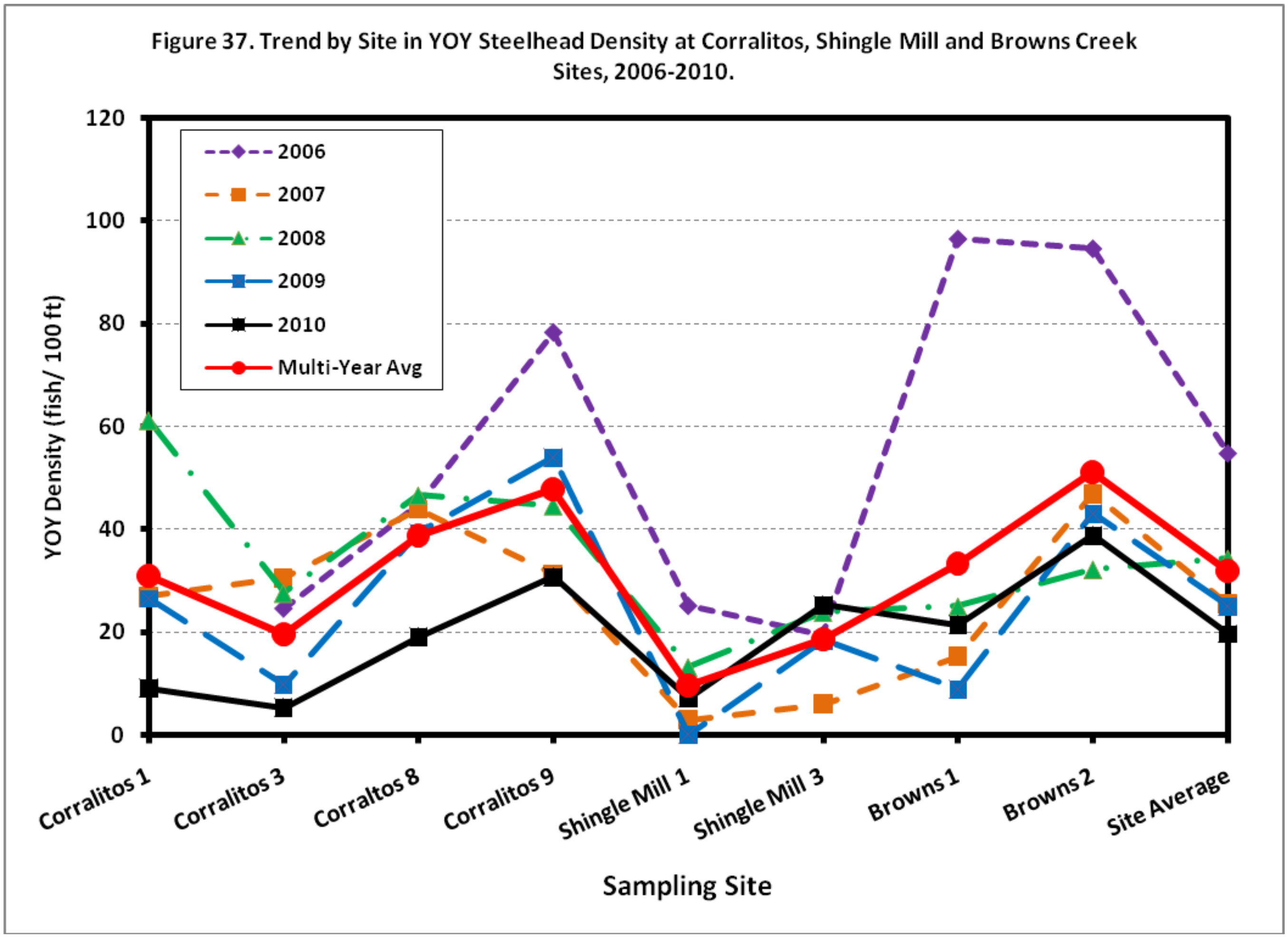


Figure 37. Trend by Site in YOY Steelhead Density at Corralitos, Shingle Mill and Browns Creek Sites, 2006-2010.
2006
2007
2008
2009
2010
Multi-Year Avg
YOY Density (fish/ 100 ft)
0
20
40
60
80
100
120
Corralitos 1
Corralitos 3
Corraltos 8
Corralitos 9
Shingle Mill 1
Shingle Mill 3
Browns 1
Browns 2
Site Average
Sampling Site

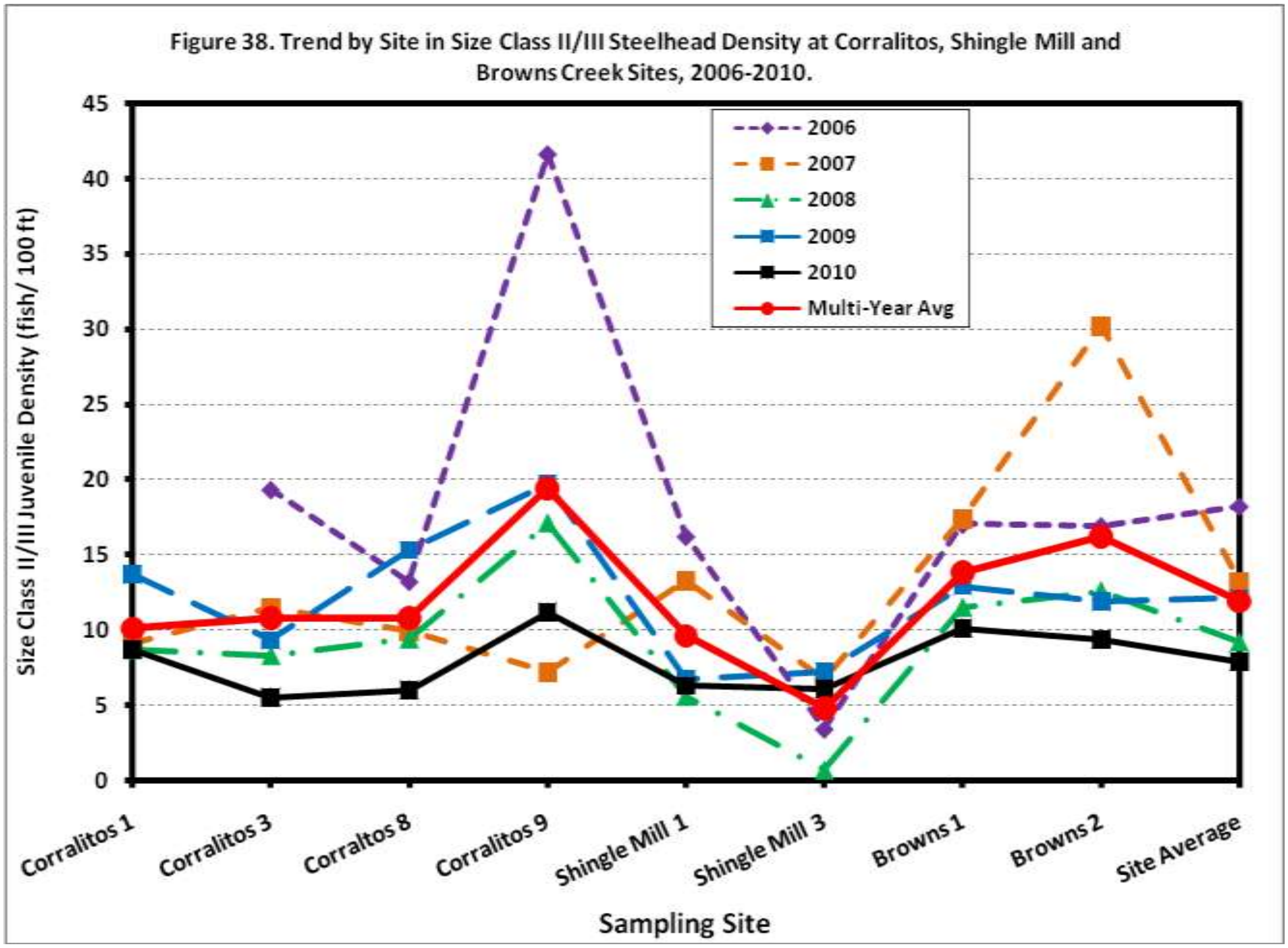


Figure 38. Trend by Site in Size Class II/III Steelhead Density at Corralitos, Shingle Mill and Browns Creek Sites, 2006-2010.
2006
2007
2008
2009
2010
Multi-Year Avg
Size Class II/III Juvenile Density (fish/ 100 ft)
0
5
10
15
20
25
30
35
40
45
Corralitos 1
Corralitos 3
Corraltos 8
Corralitos 9
Shingle Mill 1
Shingle Mill 3
Browns 1
Browns 2
Site Average
Sampling Site

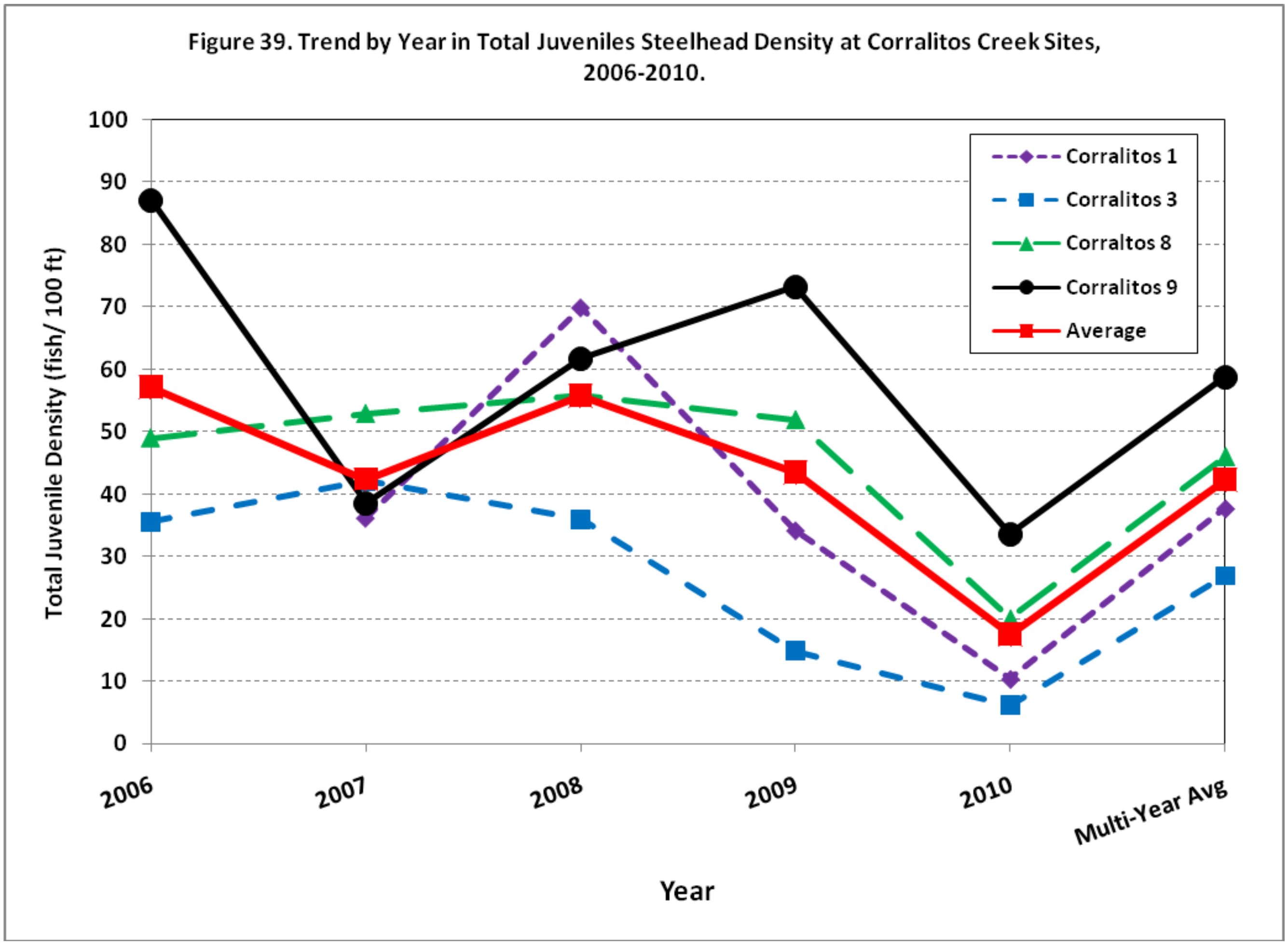


Figure 39. Trend by Year in Total Juveniles Steelhead Density at Corralitos Creek Sites, 2006-2010.
100
90
80
70
60
50
40
30
20
10
0
Total Juvenile Density (fish/ 100 ft)
Corralitos 1
Corralitos 3
Corraltos 8
Corralitos 9
Average
2006
2007
2008
2009
2010
Multi-Year Avg
Year

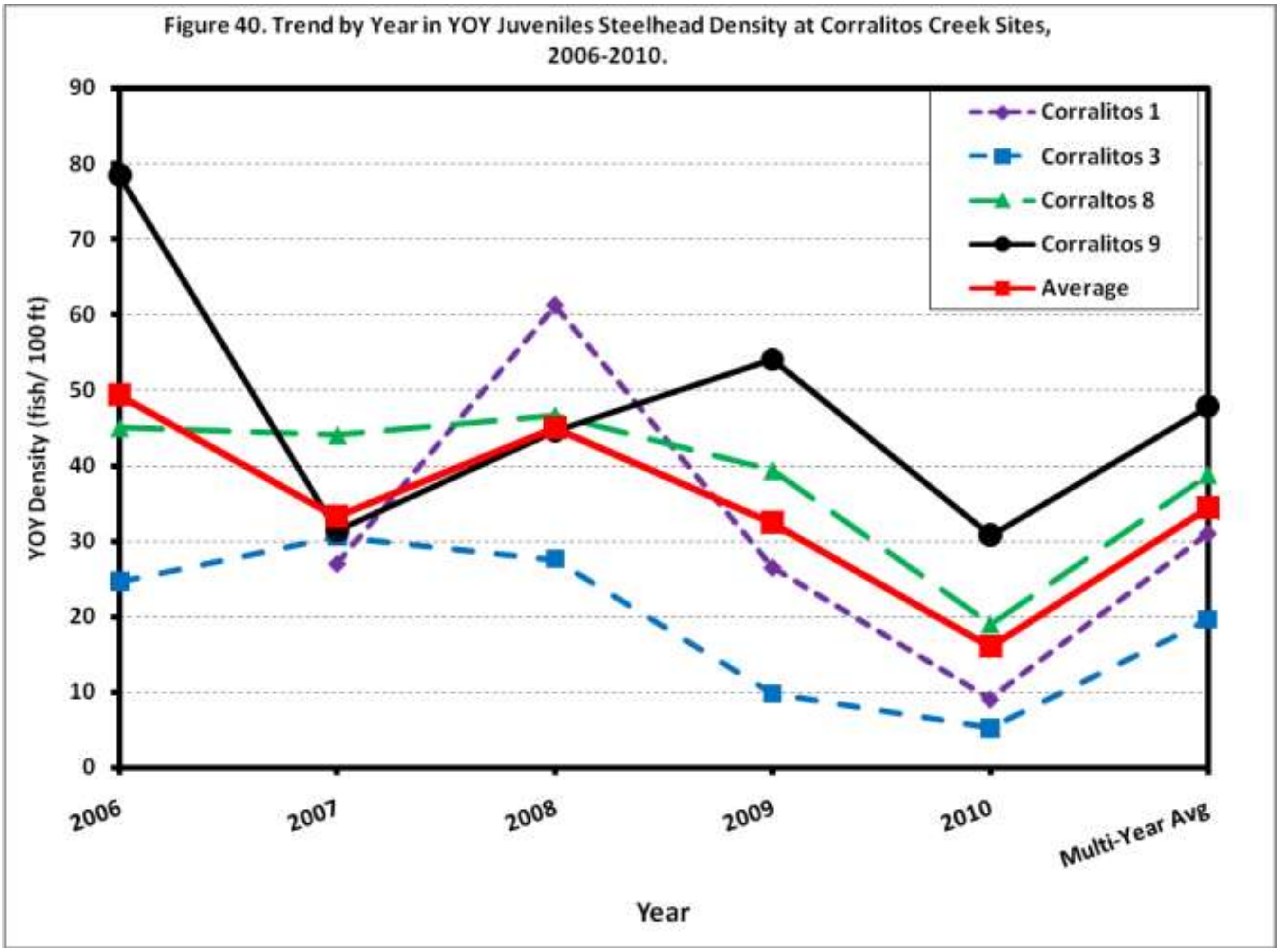


Figure 40. Trend by Year in YOY Juveniles Steelhead Density at Corralitos Creek Sites, 2006-2010.
YOY Density (fish/ 100 ft)
90
80
70
60
50
40
30
20
10
0
2006
2007
2008
2009
2010
Multi-Year Avg
Year
Corralitos 1
Corralitos 3
Corraltos 8
Corralitos 9
Average

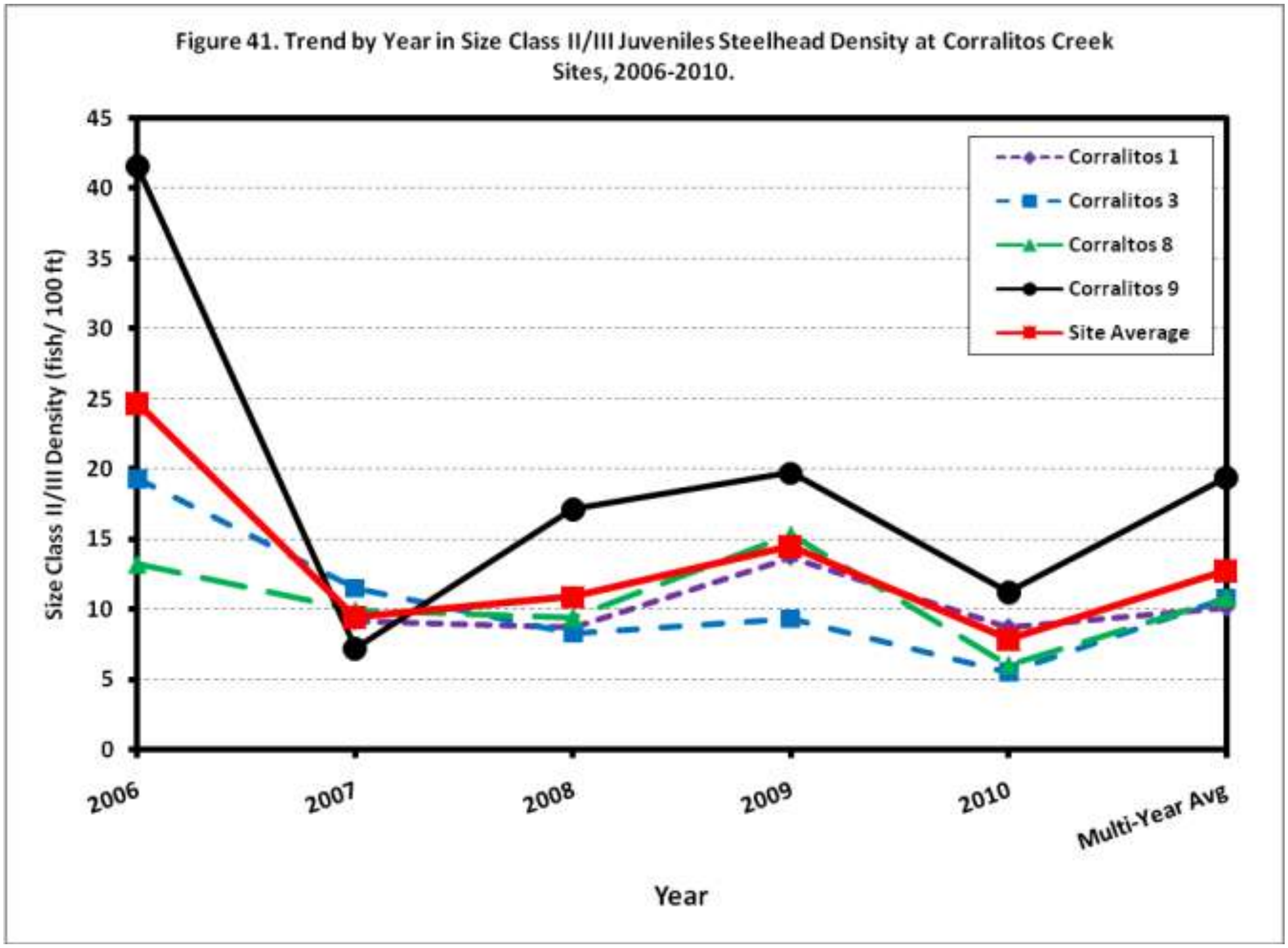


Figure 41. Trend by Year in Size Class II/III Juveniles Steelhead Density at Corralitos Creek Sites, 2006-2010.
Size Class II/III Density (fish/ 100 ft)
Year
2006
2007
2008
2009
2010
Multi-Year Avg
0
5
10
15
20
25
30
35
40
45
Corralitos 1
Corralitos 3
Corraltos 8
Corralitos 9
Site Average

Figure 42. Trend in Averaged Maximum and Mean Riffle Depth in Reach 2 of the Lower Mainstem San Lorenzo River, 2000 and 2007-2010.

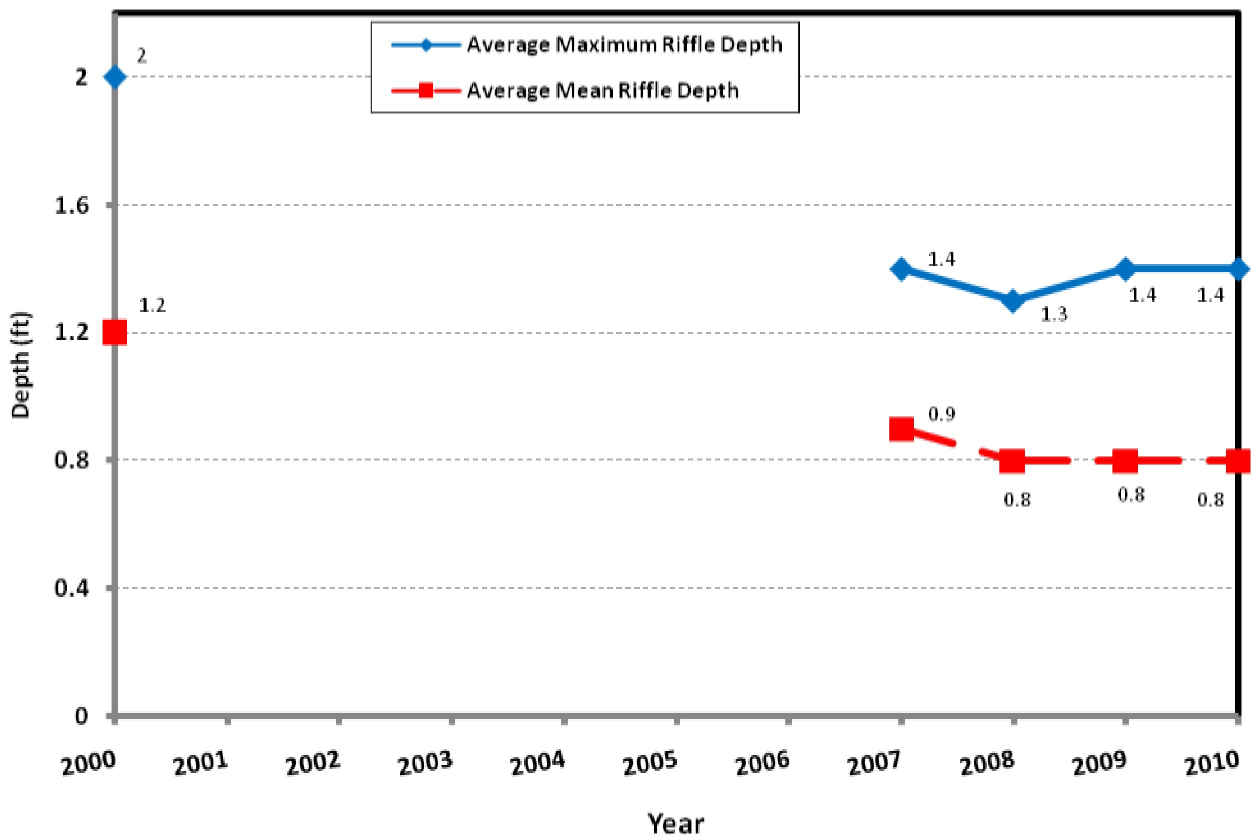
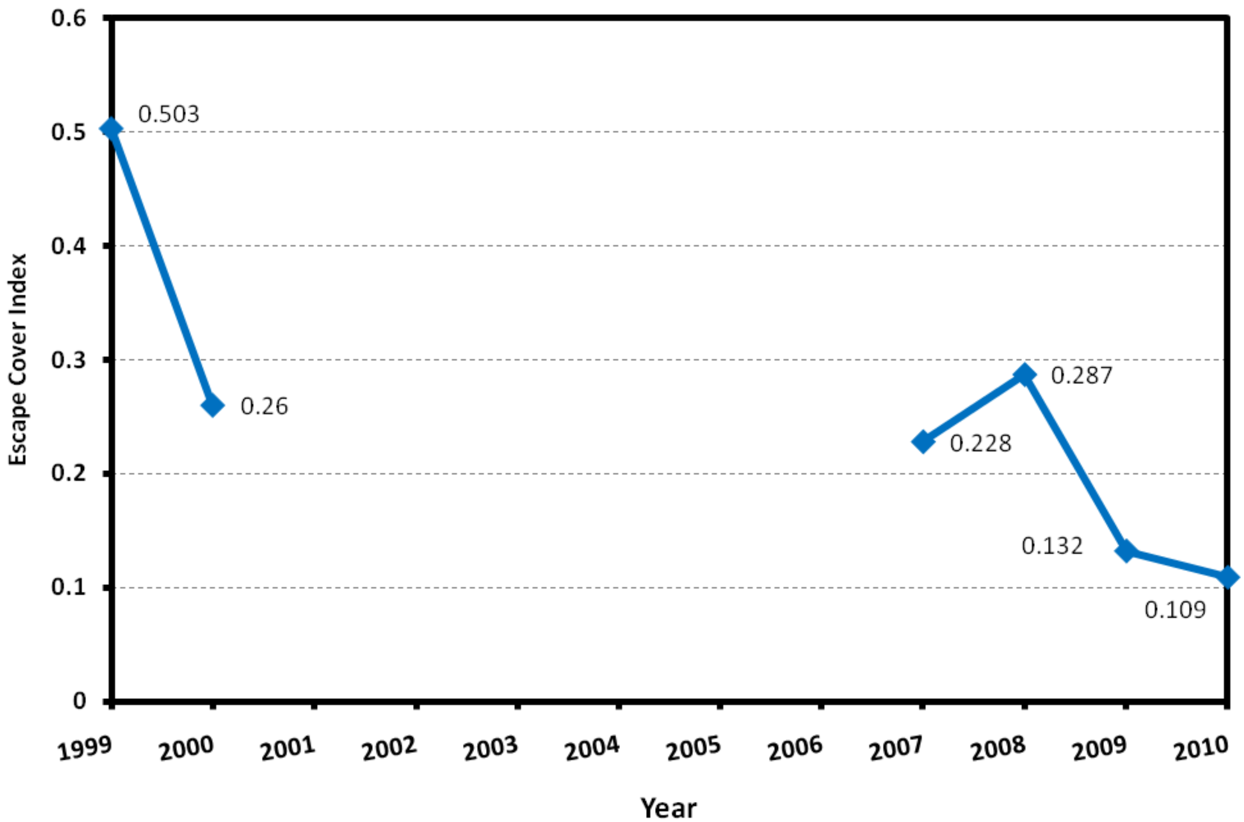


Figure 43. Trend in Escape Cover Index for Riffles in Reach 2 in the Lower Mainstem San Lorenzo River, 1999-2000 and 2007-2010.



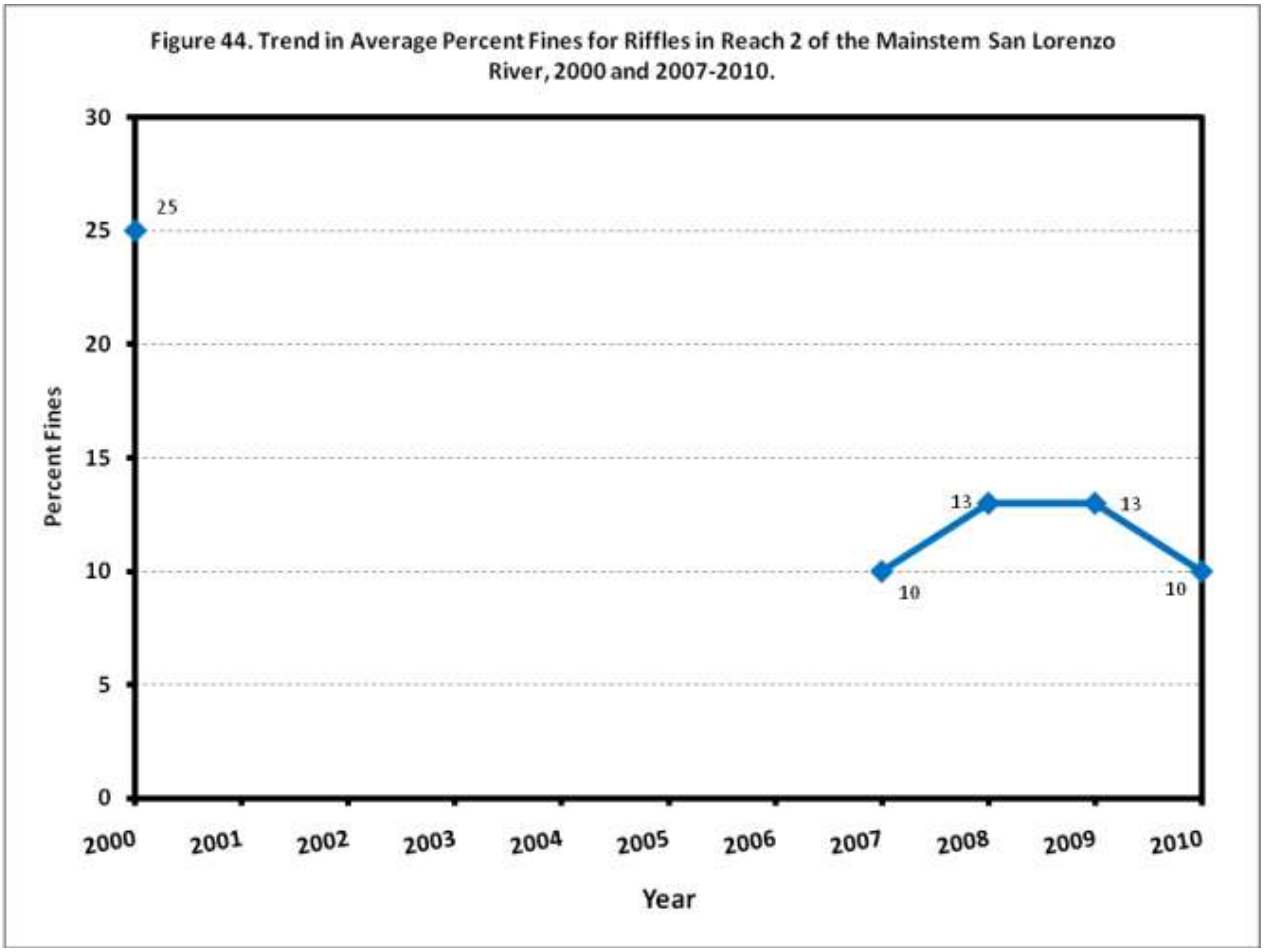


Figure 44. Trend in Average Percent Fines for Riffles in Reach 2 of the Mainstem San Lorenzo River, 2000 and 2007-2010.
Percent Fines
Year
30
25
20
15
10
5
0
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
25
13
13
10
10

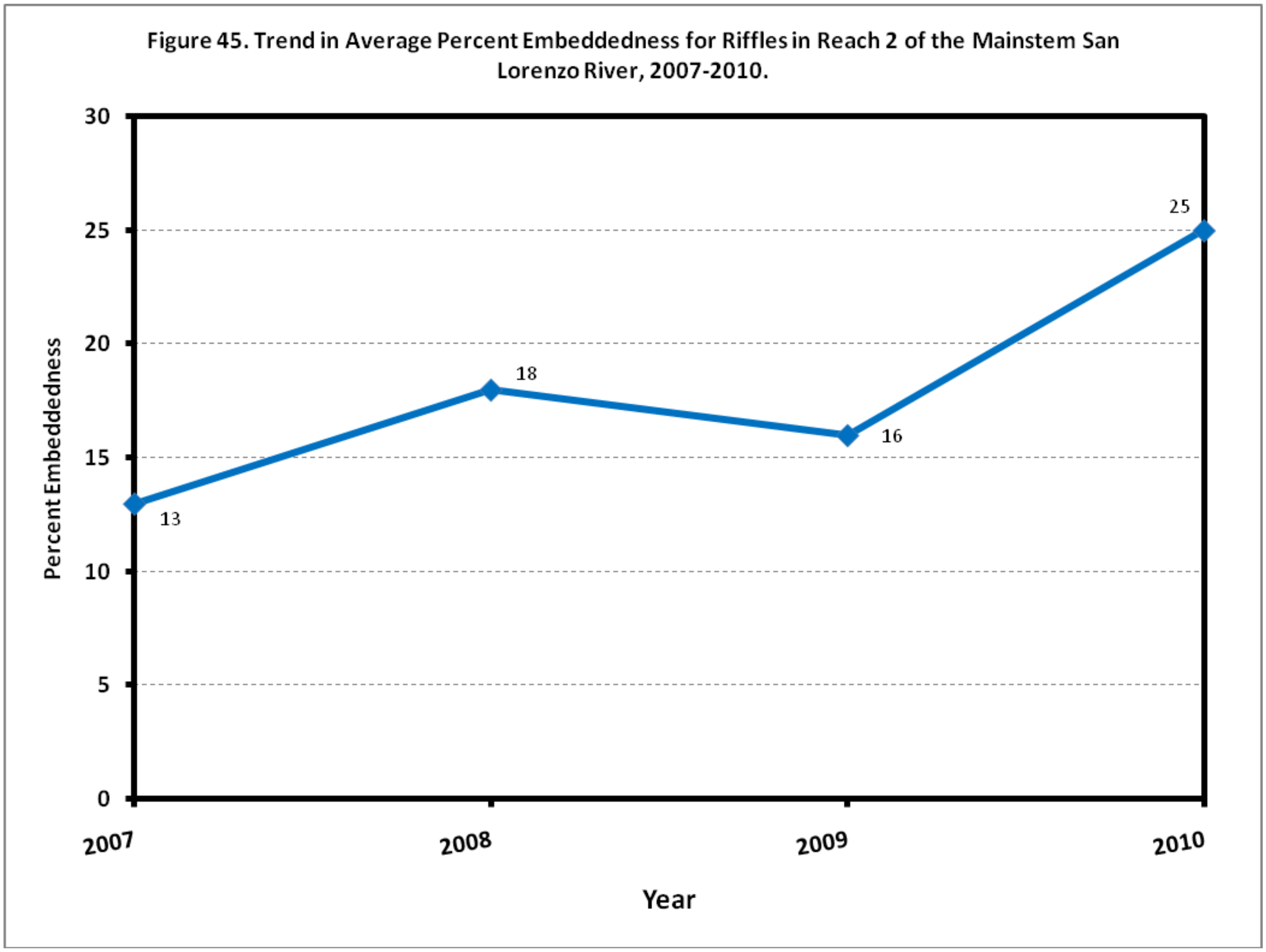


Figure 45. Trend in Average Percent Embeddedness for Riffles in Reach 2 of the Mainstem San Lorenzo River, 2007-2010.
Percent Embeddedness
Year
30
25
20
15
10
5
0
2007
2008
2009
2010
13
18
16
25

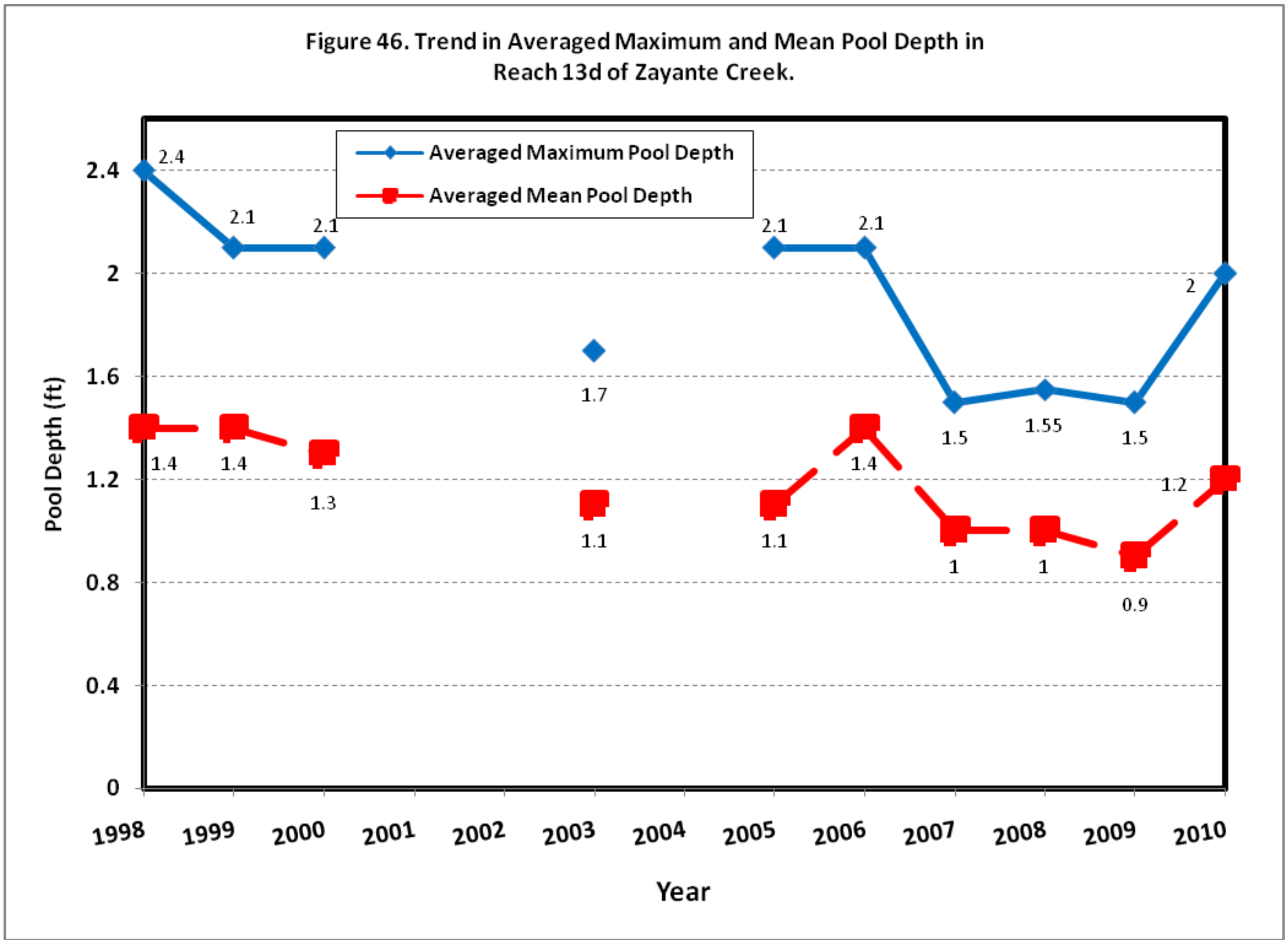


Figure 46. Trend in Averaged Maximum and Mean Pool Depth in
Reach 13d of Zayante Creek.
Averaged Maximum Pool Depth
Averaged Mean Pool Depth
Pool Depth (ft)
2.4
2
1.6
1.2
0.8
0.4
0
2.4
2.1
2.1
1.7
2.1
2.1
1.5
1.55
1.5
2
1.4
1.4
1.3
1.1
1.1
1.4
1
1
0.9
1.2
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
Year

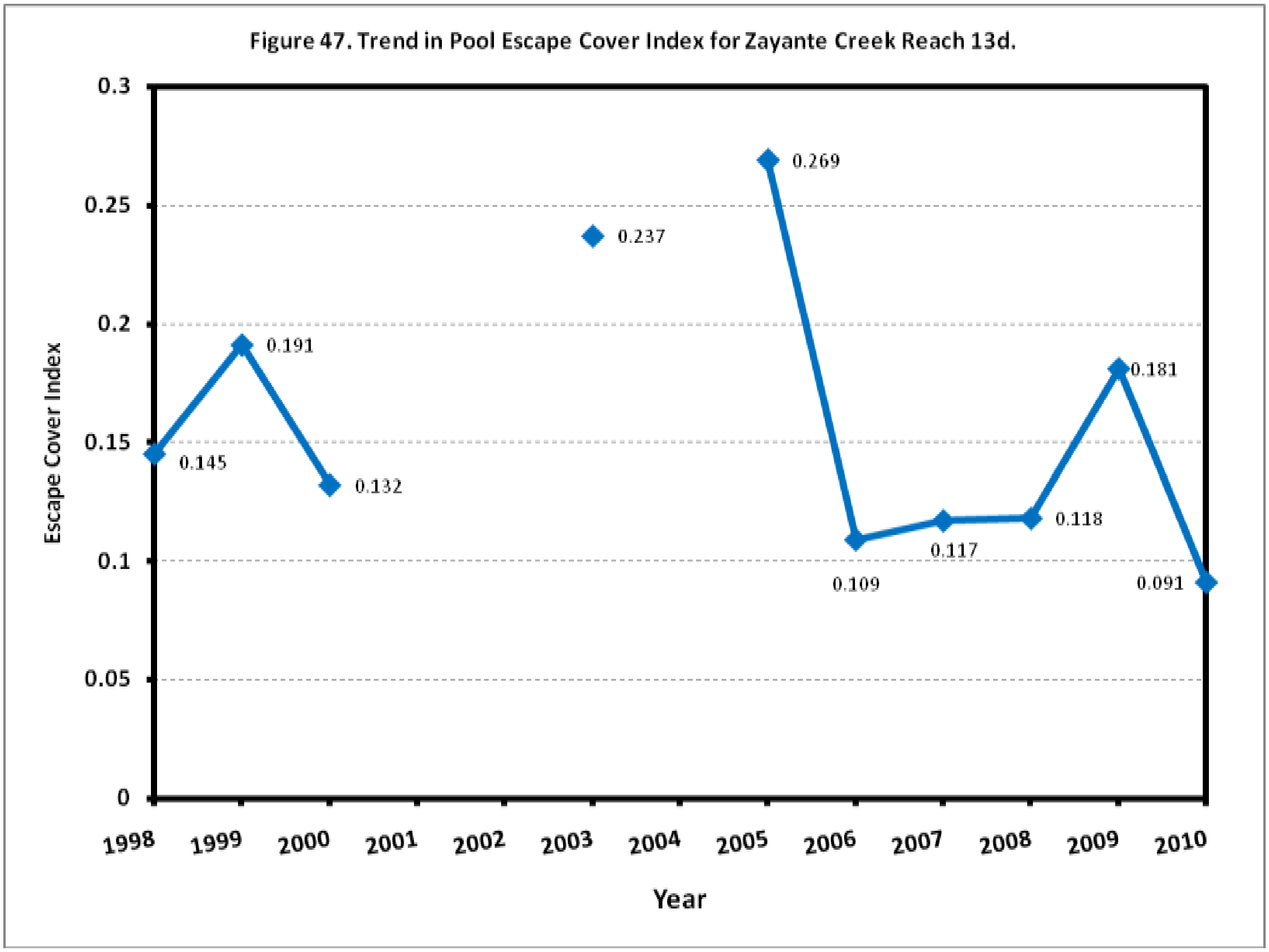


Figure 47. Trend in Pool Escape Cover Index for Zayante Creek Reach 13d.
Escape Cover Index
0.3
0.25
0.2
0.15
0.1
0.05
0
0.269
0.237
0.191
0.181
0.145
0.132
0.118
0.117
0.109
0.091
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
Year

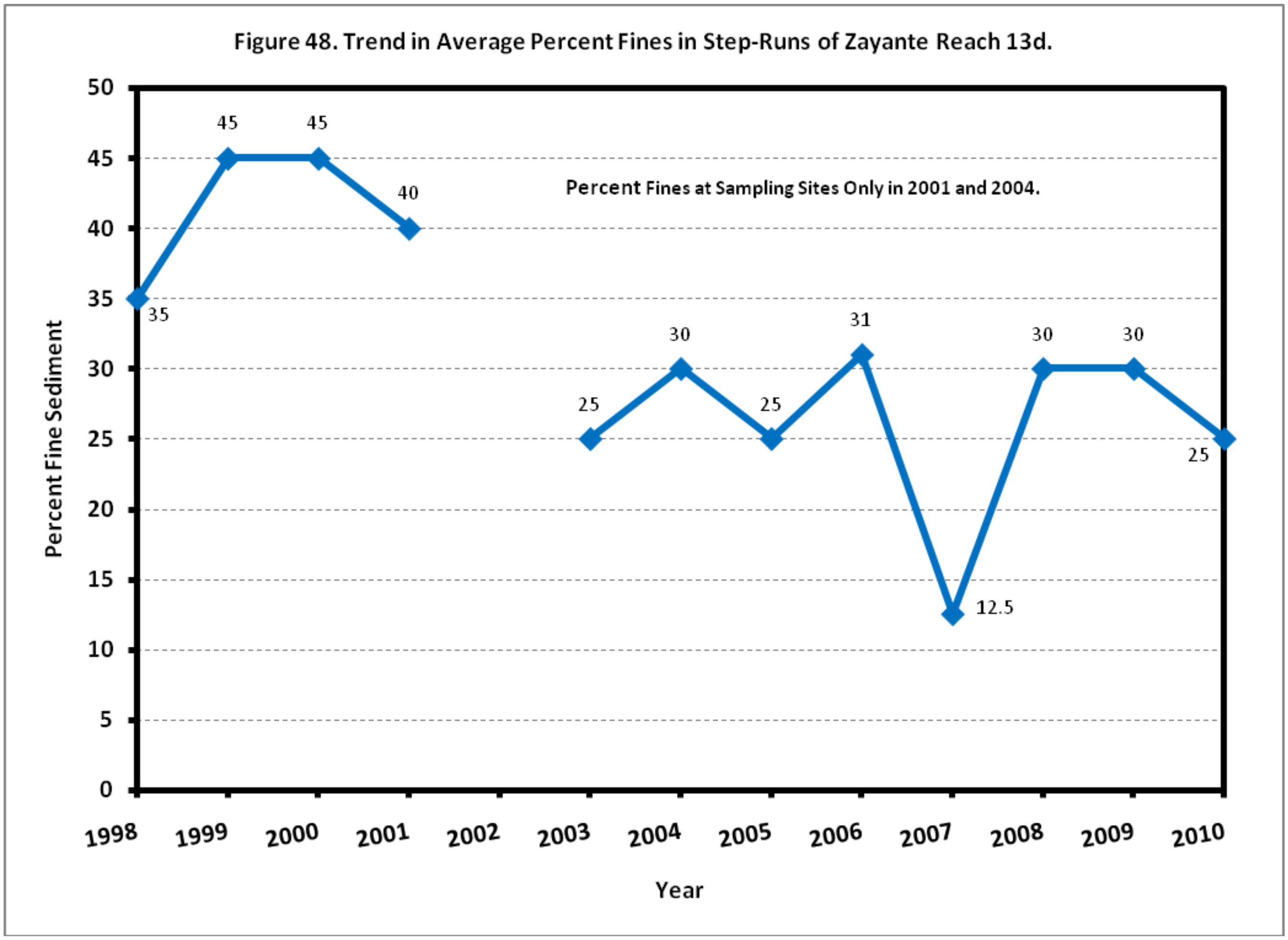
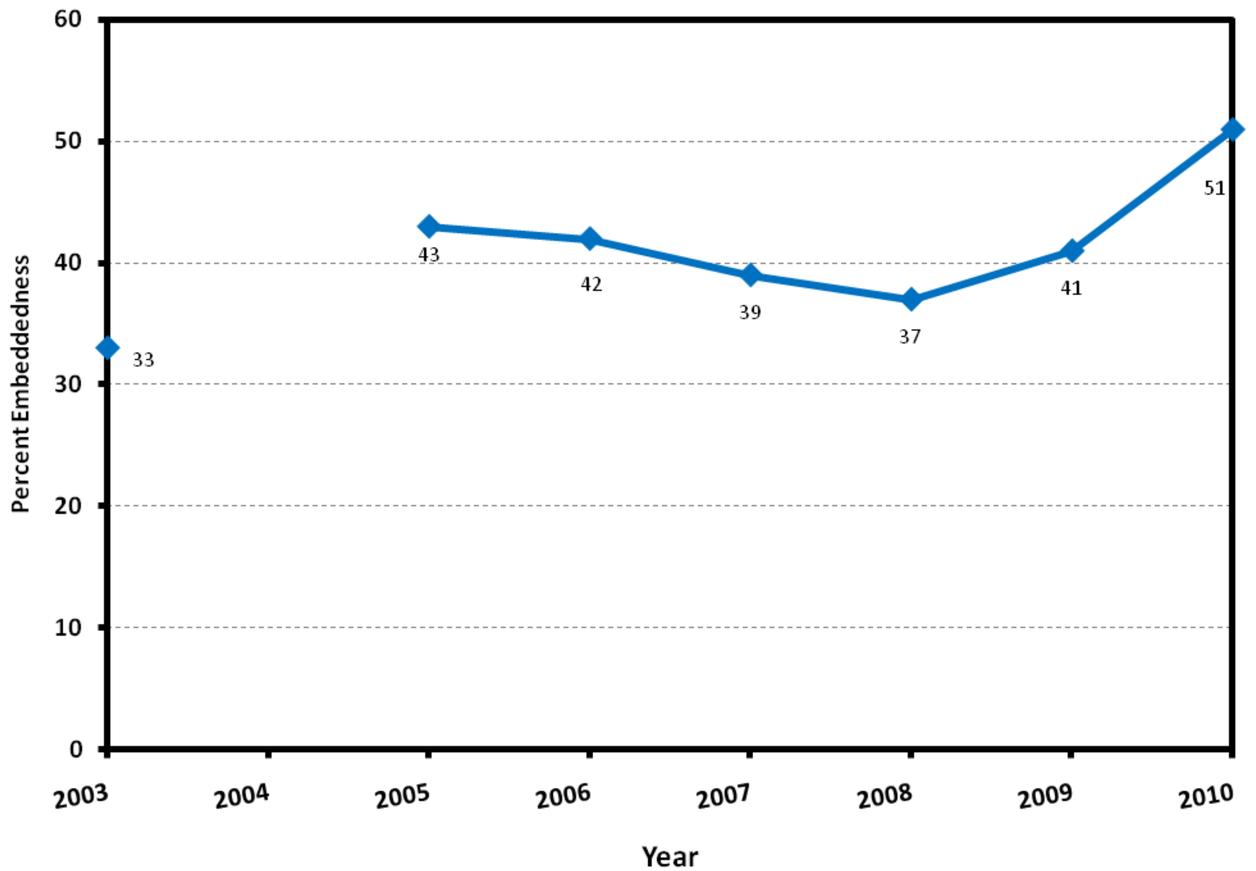


Figure 48. Trend in Average Percent Fines in Step-Runs of Zayante Reach 13d.
Percent Fines at Sampling Sites Only in 2001 and 2004.
Percent Fine Sediment
Year
50
45
40
35
30
25
20
15
10
5
0
45
45
40
35
30
31
25
25
30
30
25
12.5
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010

Figure 49. Trend in Run/Step-run Embeddedness in Zayante Creek Reach 13d.



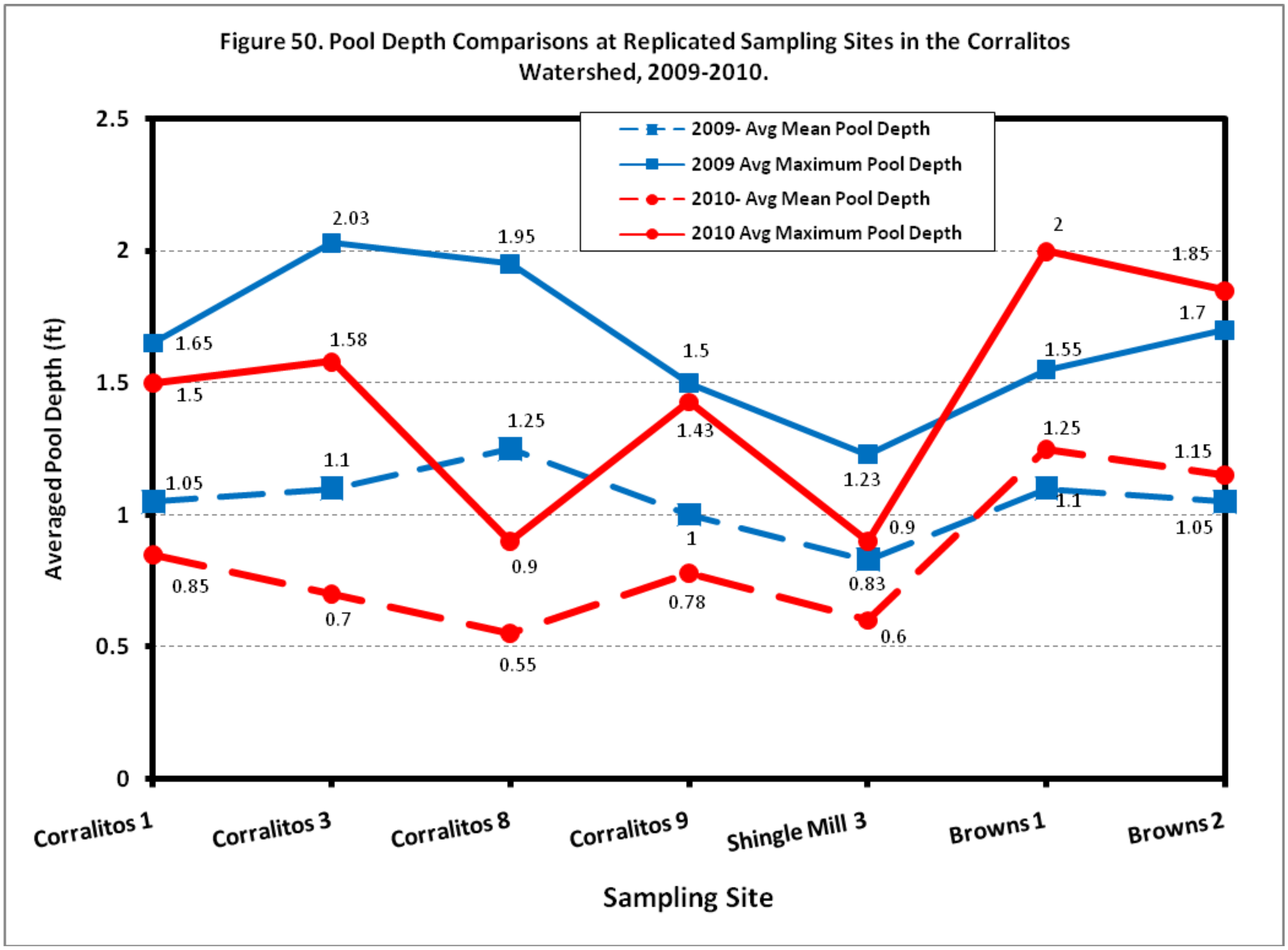


Figure 50. Pool Depth Comparisons at Replicated Sampling Sites in the Corralitos Watershed, 2009-2010.
2009- Avg Mean Pool Depth
2009 Avg Maximum Pool Depth
2010- Avg Mean Pool Depth
2010 Avg Maximum Pool Depth
Averaged Pool Depth (ft)
2.5
2
1.5
1
0.5
0
2.03
1.95
1.65
1.58
1.5
1.5
1.25
1.43
1.05
1.1
1.23
0.9
0.9
1
0.83
0.85
0.7
0.55
0.78
0.6
2
1.85
1.7
1.55
1.25
1.15
1.1
1.05
Corralitos 1
Corralitos 3
Corralitos 8
Corralitos 9
Shingle Mill 3
Browns 1
Browns 2
Sampling Site

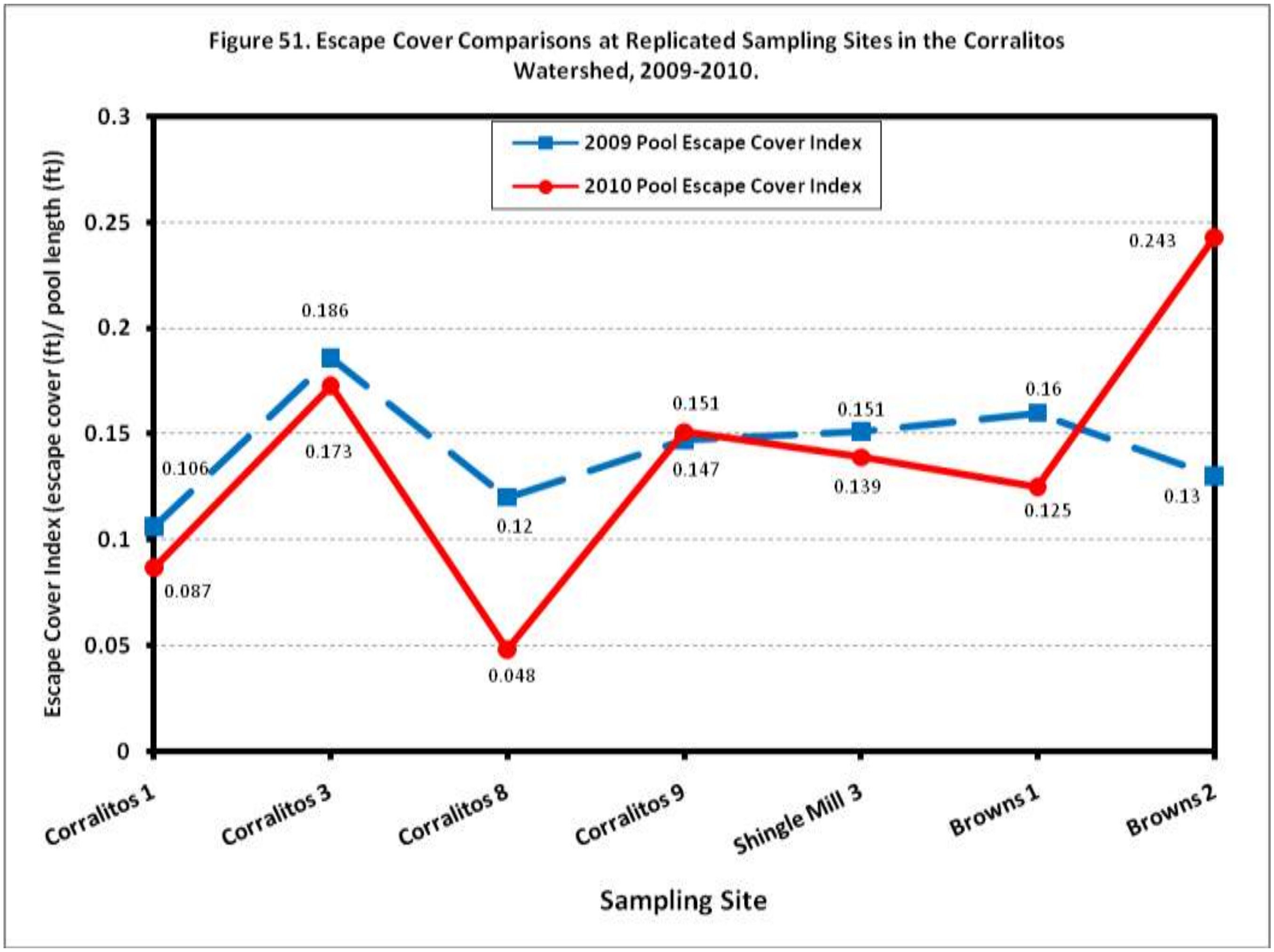


Figure 51. Escape Cover Comparisons at Replicated Sampling Sites in the Corralitos Watershed, 2009-2010.
2009 Pool Escape Cover Index
2010 Pool Escape Cover Index
Escape Cover Index (escape cover (ft)/ pool length (ft))
0.3
0.25
0.2
0.15
0.1
0.05
0
0.106
0.087
0.186
0.173
0.12
0.048
0.151
0.147
0.151
0.139
0.16
0.125
0.243
0.13
Corralitos 1
Corralitos 3
Corralitos 8
Corralitos 9
Shingle Mill 3
Browns 1
Browns 2
Sampling Site

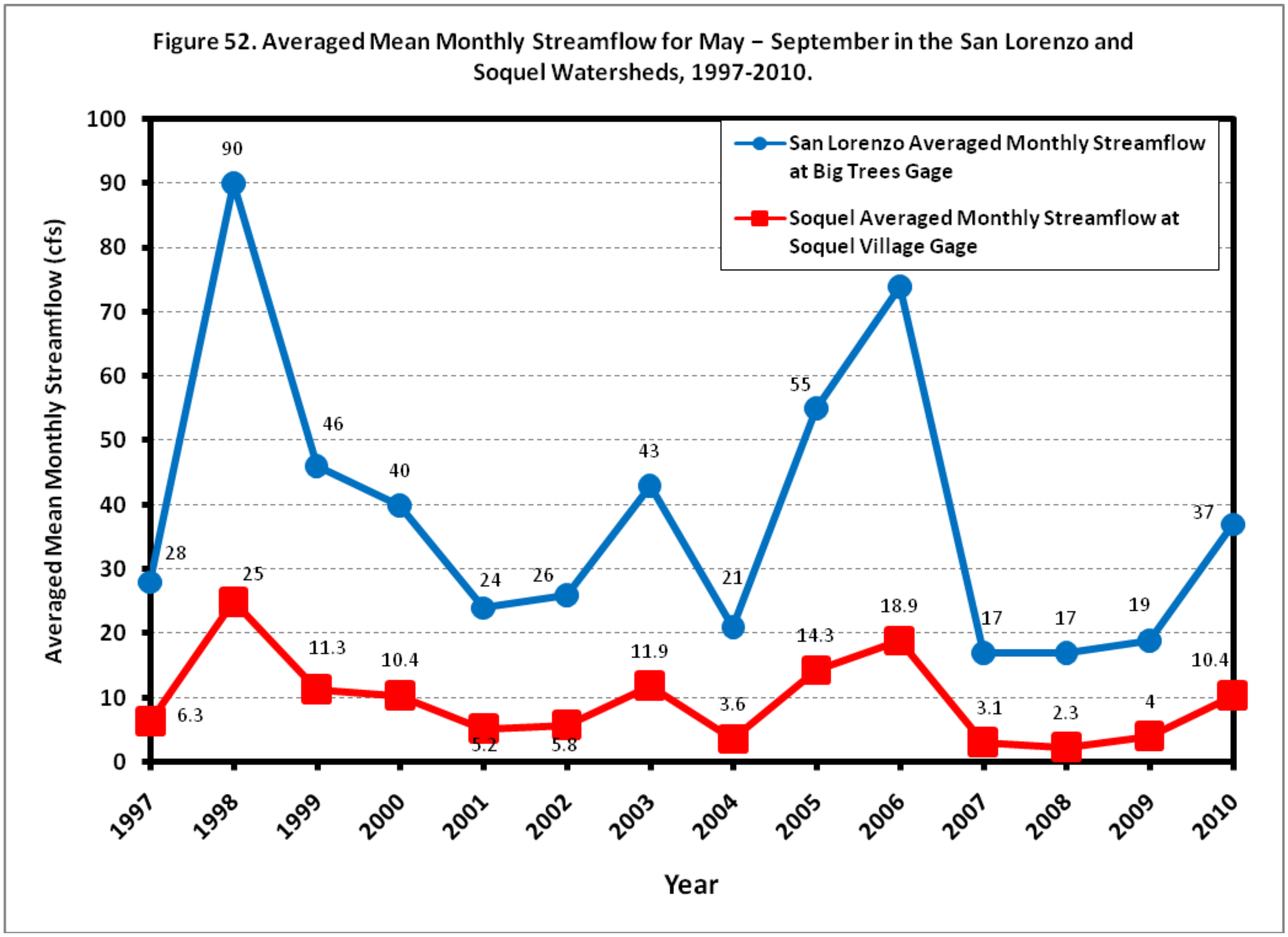


Figure 52. Averaged Mean Monthly Streamflow for May – September in the San Lorenzo and Soquel Watersheds, 1997-2010.
San Lorenzo Averaged Monthly Streamflow at Big Trees Gage
Soquel Averaged Monthly Streamflow at Soquel Village Gage
Averaged Mean Monthly Streamflow (cfs)
Year
0
10
20
30
40
50
60
70
80
90
100
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
28
90
46
40
24
26
43
21
55
17
17
19
37
6.3
25
11.3
10.4
5.2
5.8
11.9
3.6
14.3
18.9
3.1
2.3
4
10.4

Figure 53. The 2009 Daily Average Discharge and Median Daily Flow of Record for the USGS Gage On the San Lorenzo River at Big Trees.

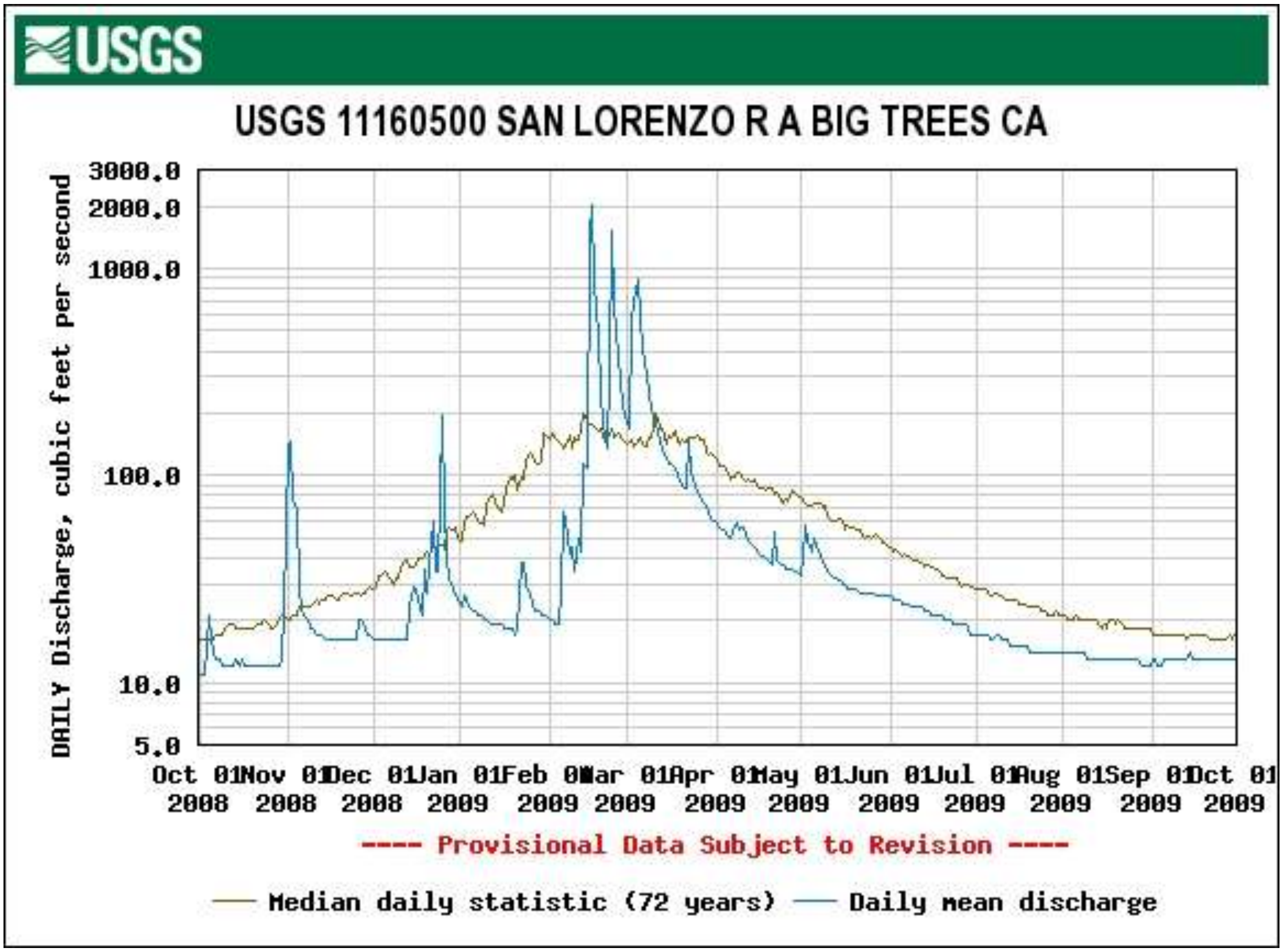


Figure 54. The 2009 Daily Mean and Median Flow at the USGS Gage on Soquel Creek at Soquel Village.

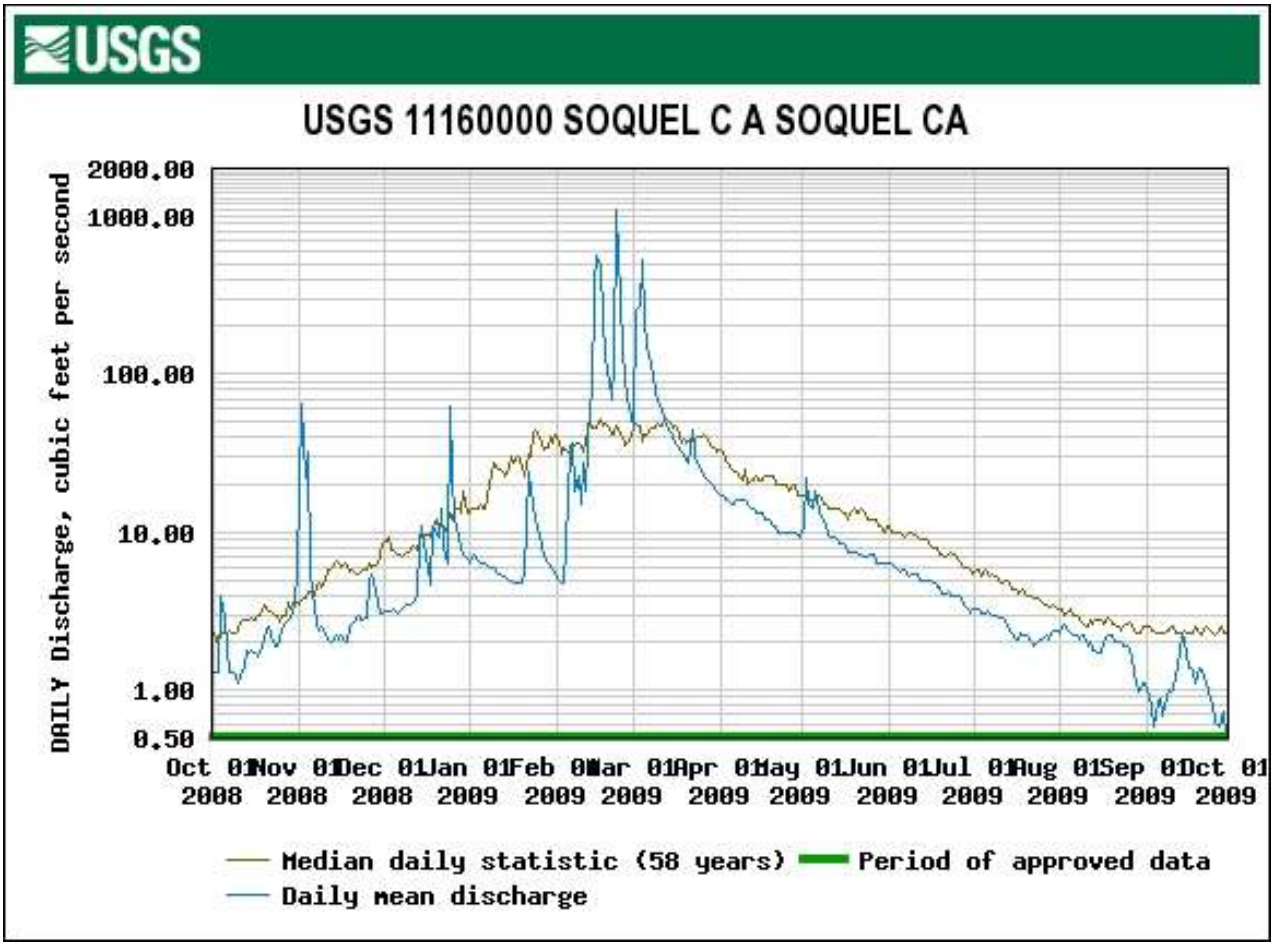


Figure 55. The 2009 Daily Mean and Median Flow at the USGS Gage on Corralitos Creek at Freedom. (USGS website would not provide a logarithmic scale of discharge).

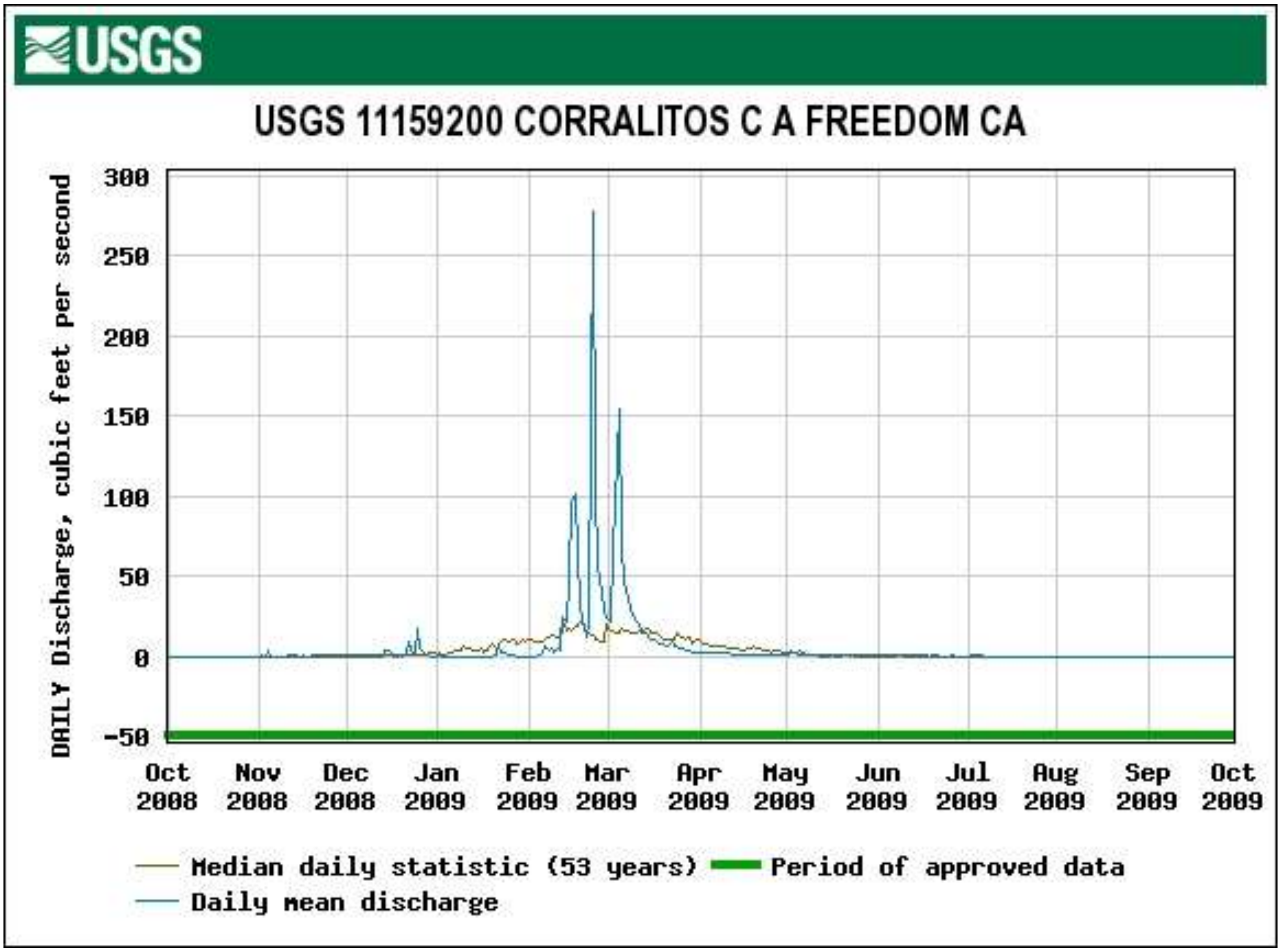


Figure 56. The 2010 Daily Average Discharge and Median Daily Flow of Record for the USGS Gage On the San Lorenzo River at Big Trees.

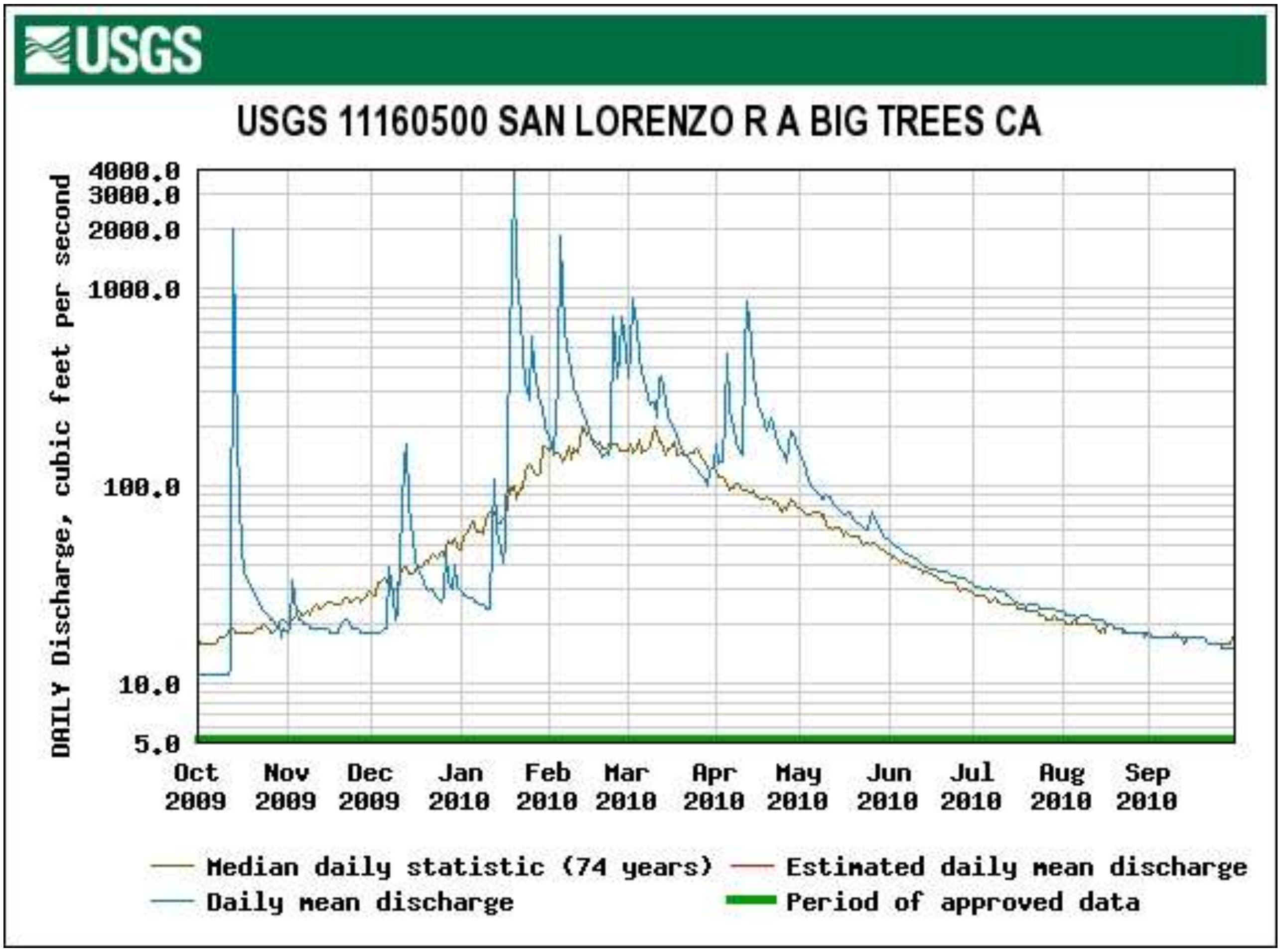


Figure 57. The 2010 Daily Mean and Median Flow at the USGS Gage on Soquel Creek at Soquel Village.

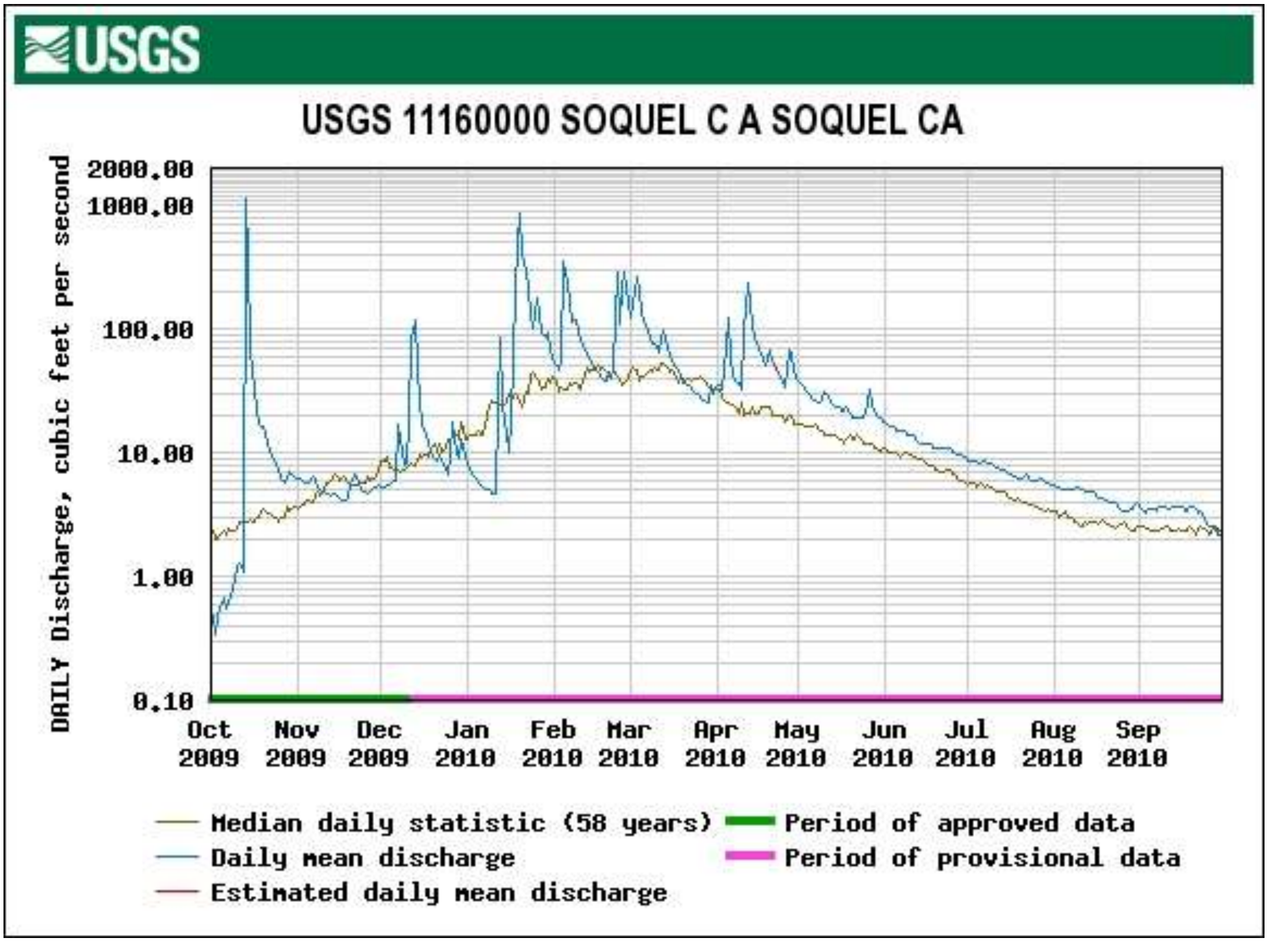


Figure 58. The 2010 Daily Mean and Median Flow at the USGS Gage on Corralitos Creek at Freedom. (USGS website would not provide a logarithmic scale of discharge).

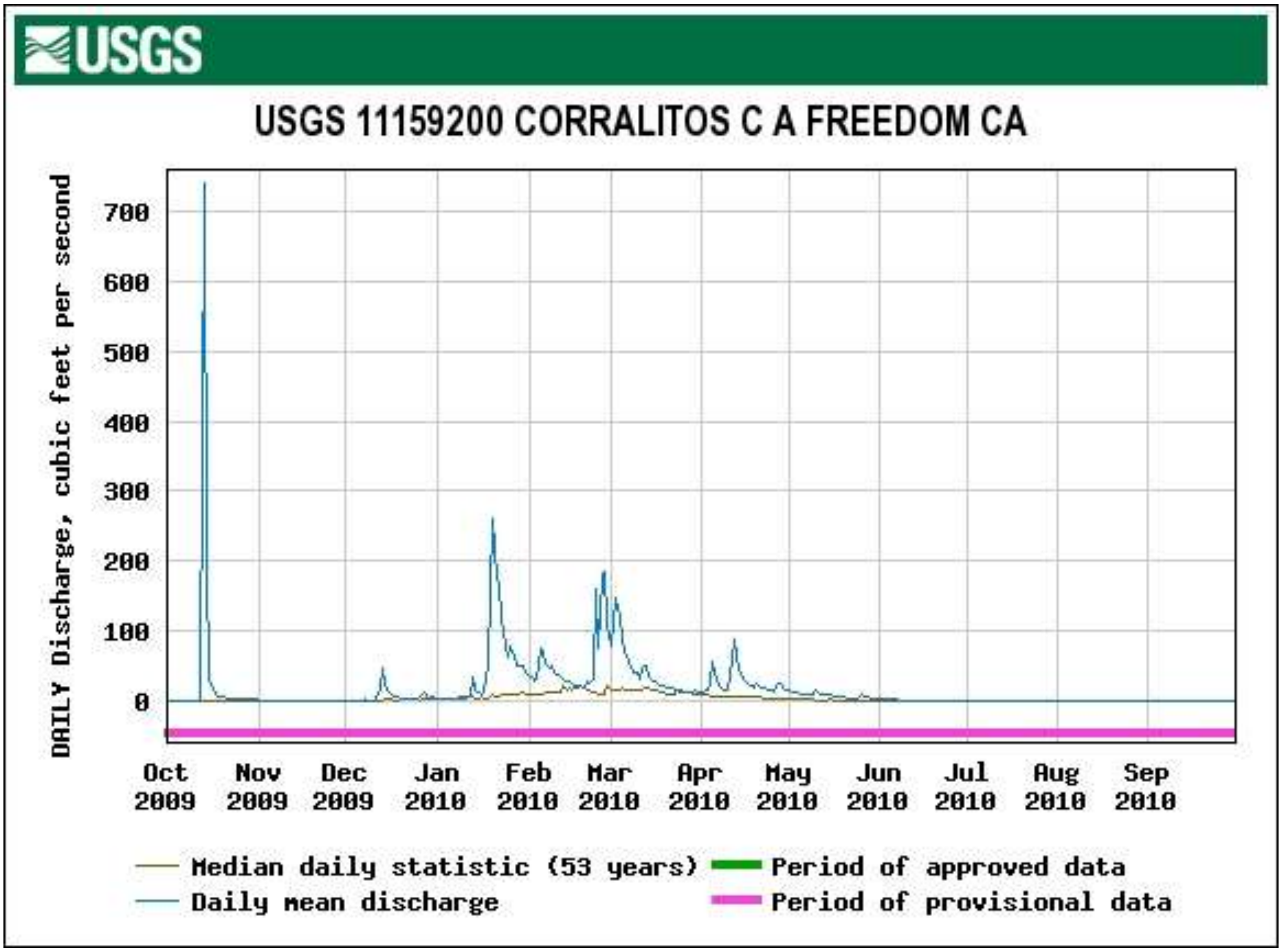


Figure 59. Water Temperature (*F) Above the Lagoon (Nob Hill) in Soquel Creek, 25 May - 4 October 2009 (30-minute interval).

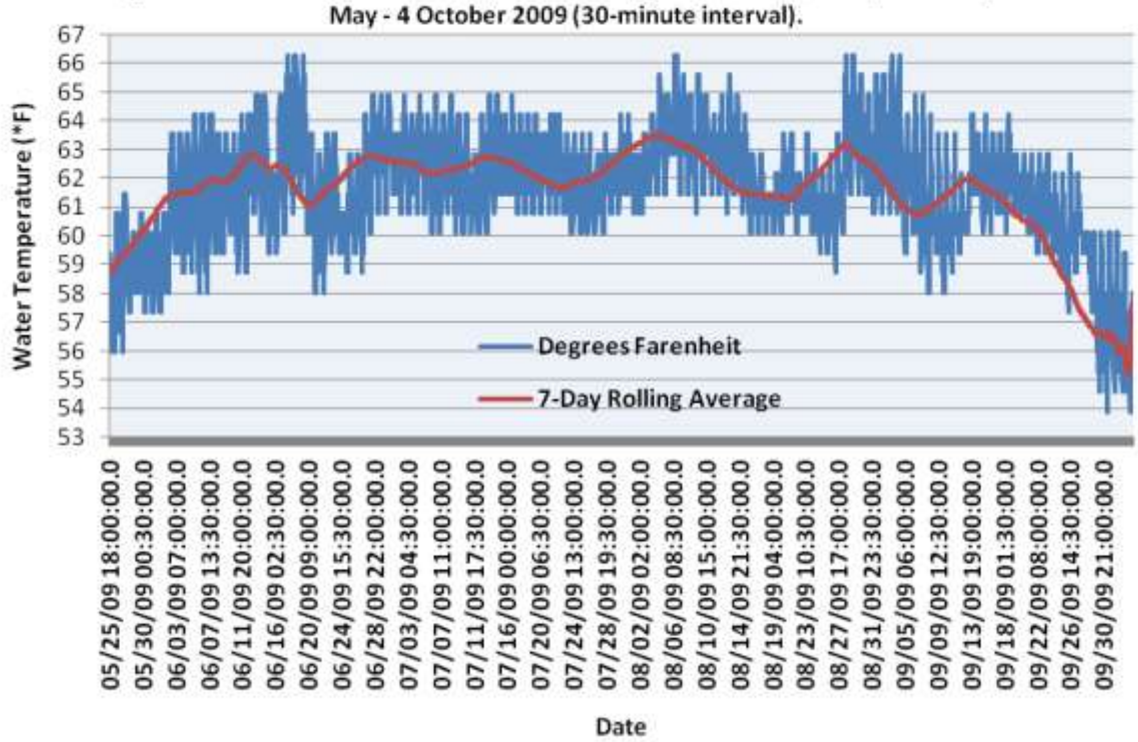


Figure 60. Water Temperature (*F) Above the Lagoon (Nob Hill) in Soquel Creek, 4 June - 9 October 2010 (30-minute interval).

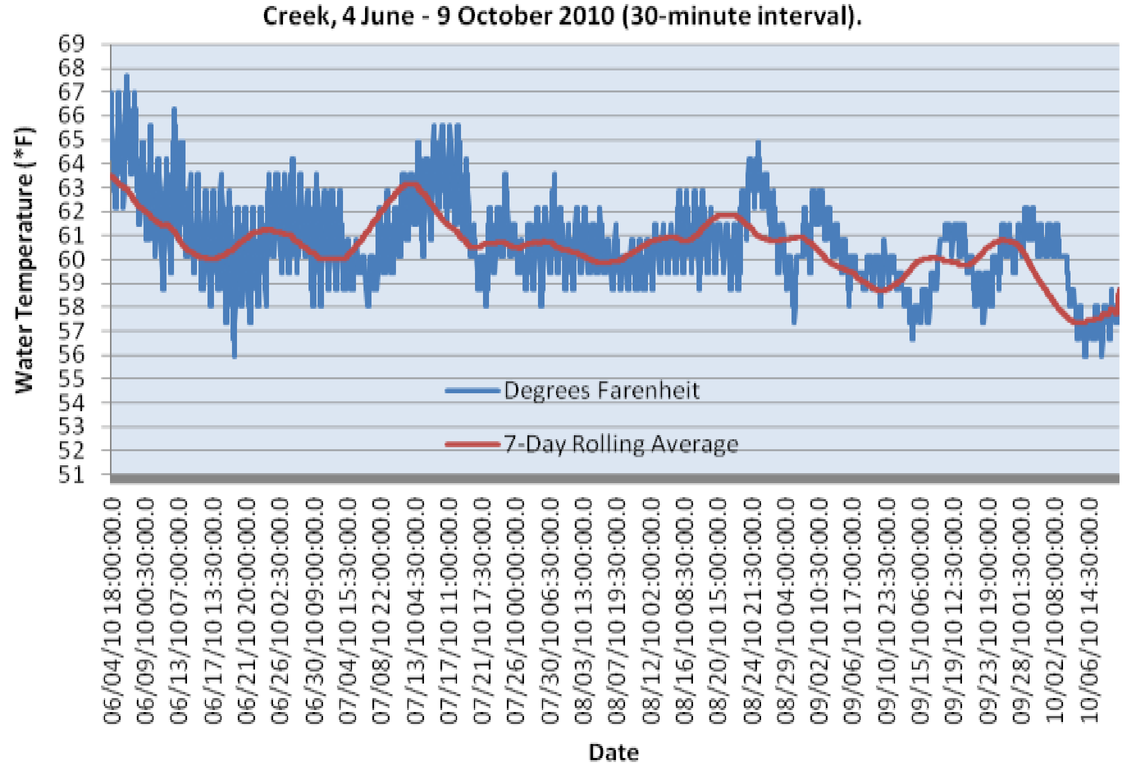


Figure 61. 2009 Water Temperature in Lower Zayante Creek at 30-minute Intervals with the 7-day Rolling Average, 5 August- 17 October.

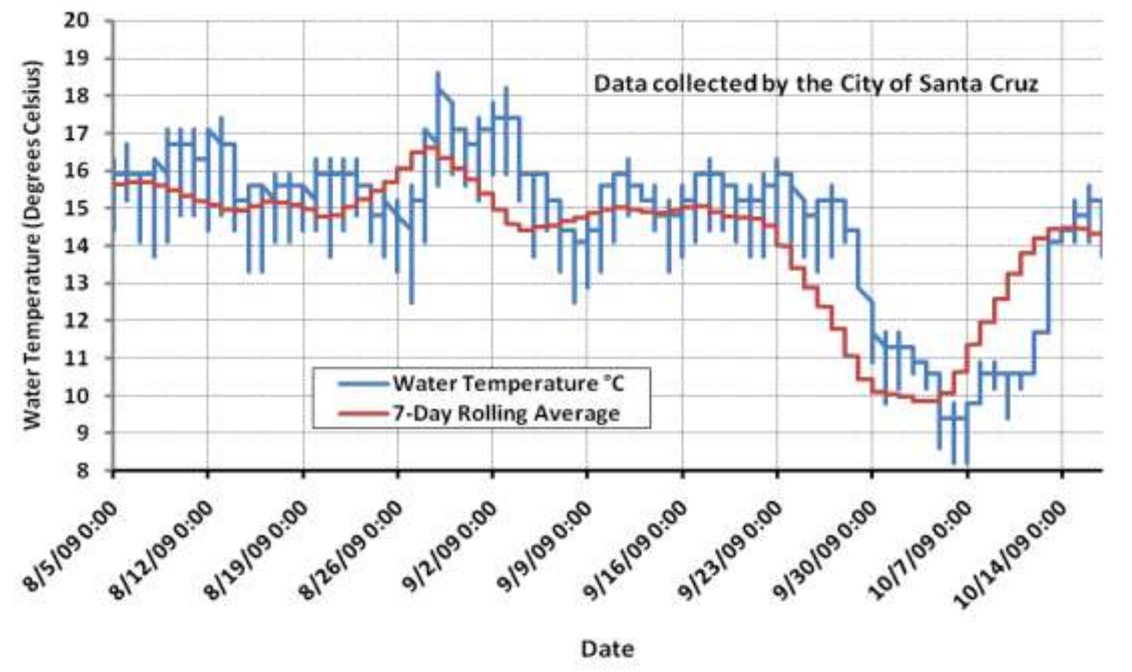


Figure 62. 2010 Water Temperature in Lower Zayante Creek at 30-minute Intervals with the 7-day Rolling Average, 26 May- 22 September .

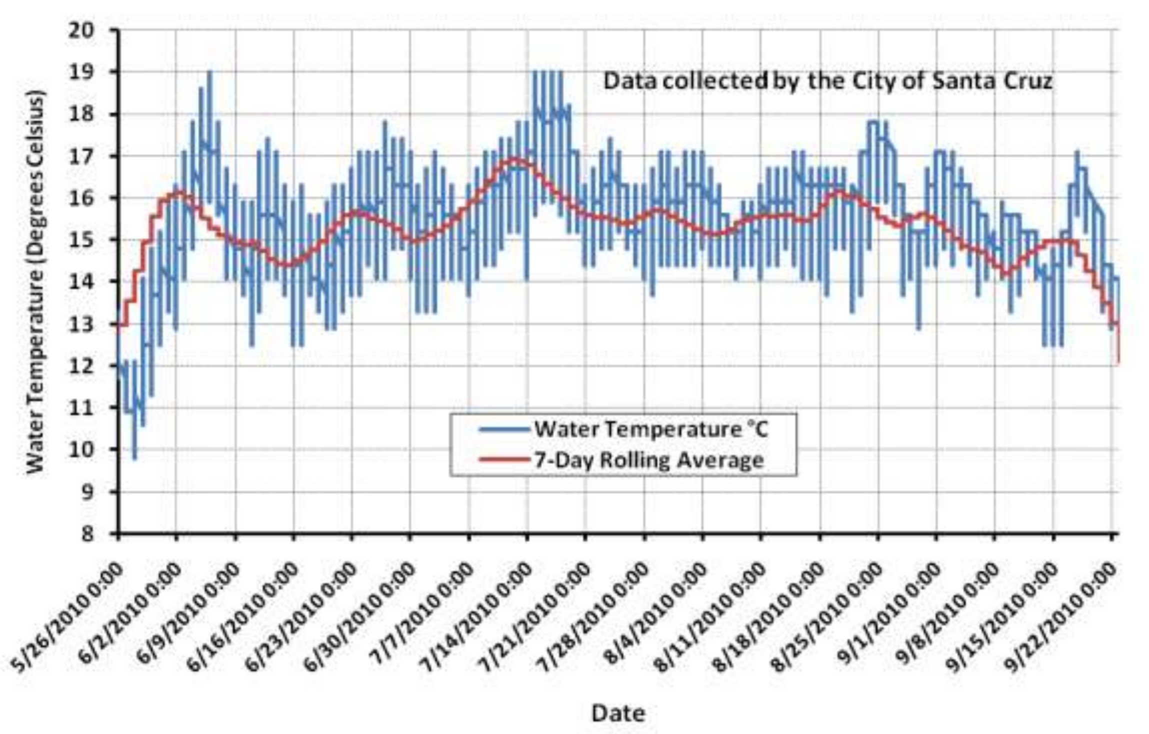


Figure 63. 2009 Water Temperature in Upper Bean Creek at 30-minute Intervals with the 7-day Rolling Average, 5 August- 18 October.

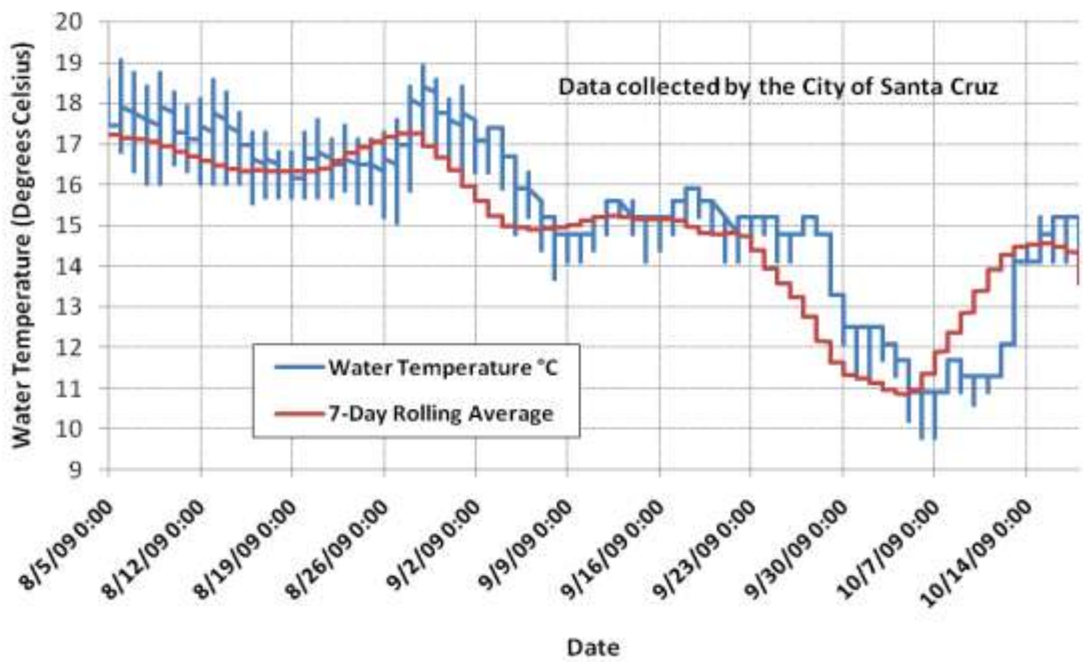
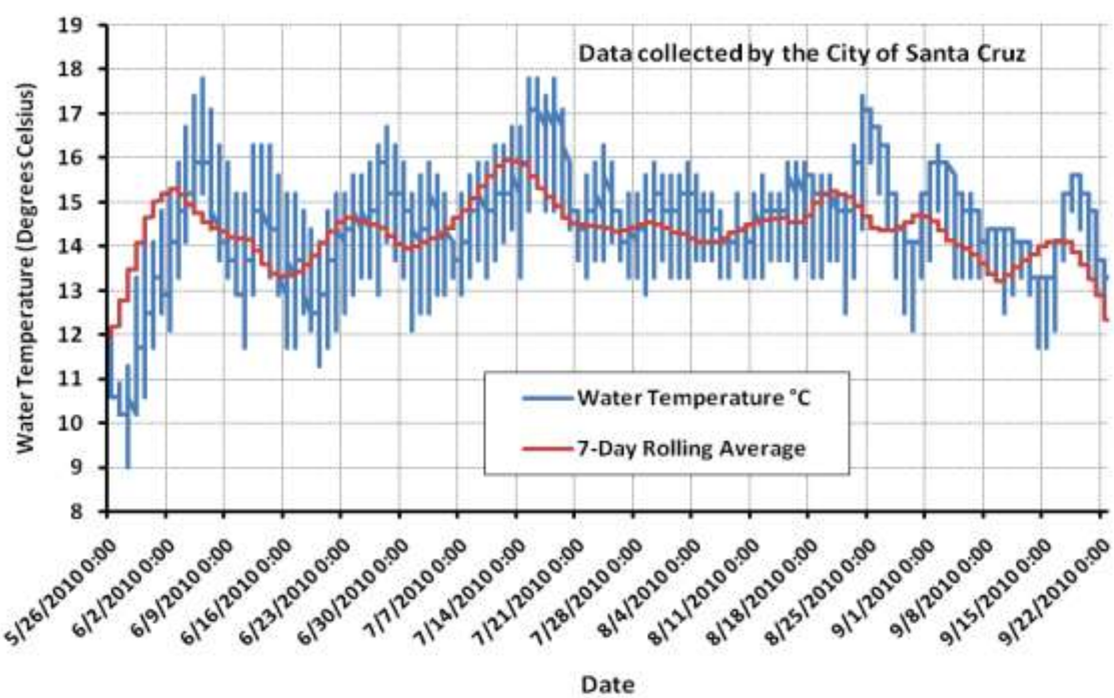


Figure 64. 2010 Water Temperature in Upper Bean Creek at 30-minute Intervals with the 7-day Rolling Average, 26 May- 22 September.



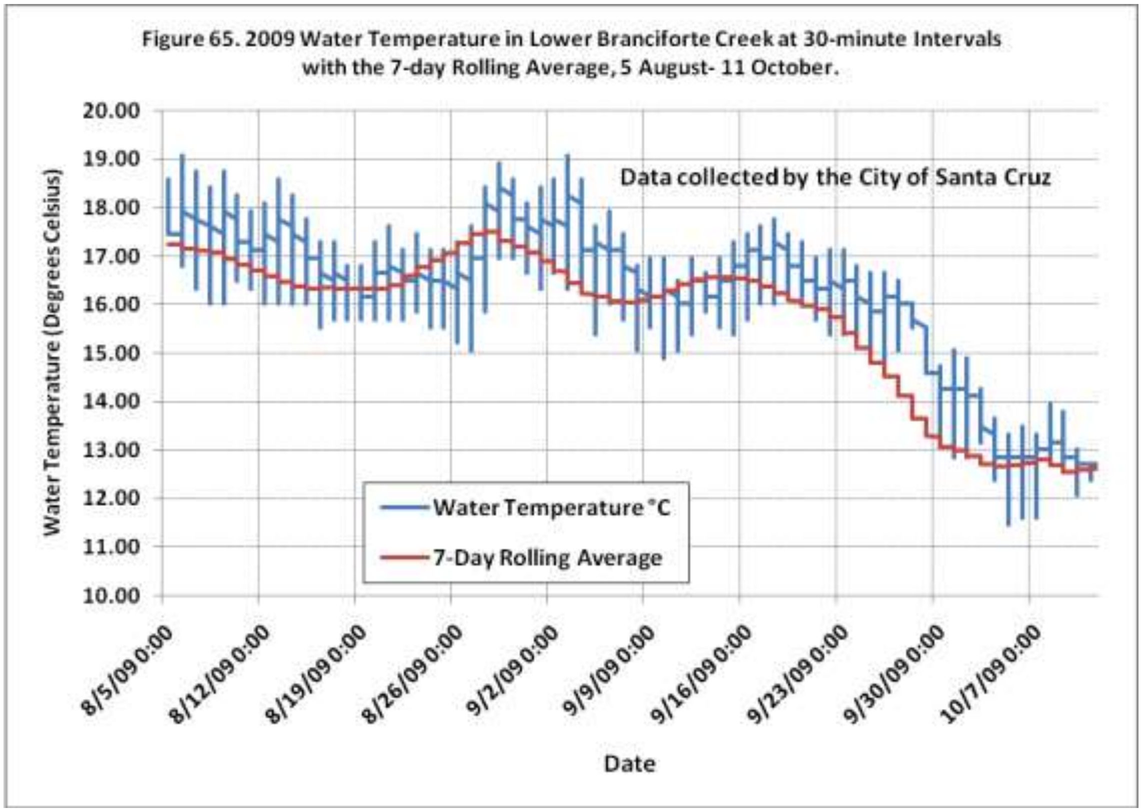


Figure 65. 2009 Water Temperature in Lower Branciforte Creek at 30-minute Intervals
with the 7-day Rolling Average, 5 August- 11 October.
Data collected by the City of Santa Cruz
Water Temperature (Degrees Celsius)
20.00
19.00
18.00
17.00
16.00
15.00
14.00
13.00
12.00
11.00
10.00
Water Temperature °C
7-Day Rolling Average
8/5/09 0:00
8/12/09 0:00
8/19/09 0:00
8/26/09 0:00
9/2/09 0:00
9/9/09 0:00
9/16/09 0:00
9/23/09 0:00
9/30/09 0:00
10/7/09 0:00
Date

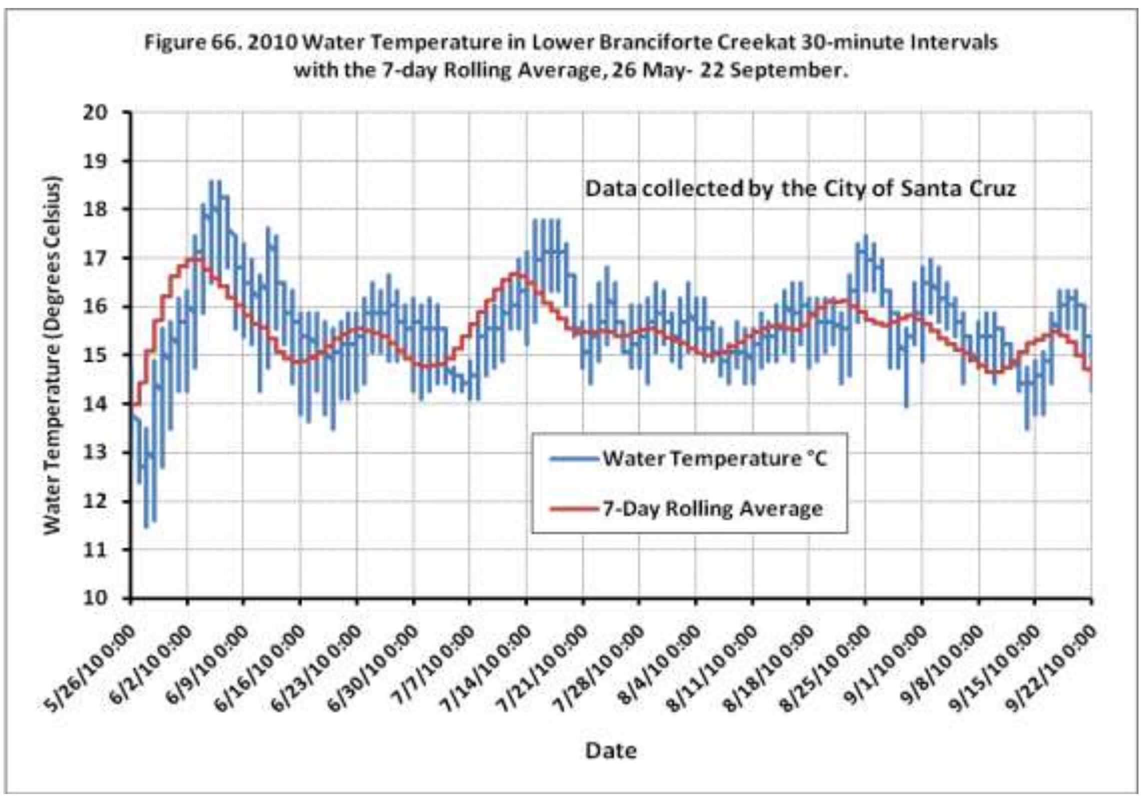


Figure 66. 2010 Water Temperature in Lower Branciforte Creekat 30-minute Intervals
with the 7-day Rolling Average, 26 May- 22 September.
Data collected by the City of Santa Cruz
Water Temperature (Degrees Celsius)
20
19
18
17
16
15
14
13
12
11
10
Water Temperature °C
7-Day Rolling Average
5/26/10 0:00
6/2/10 0:00
6/9/10 0:00
6/16/10 0:00
6/23/10 0:00
6/30/10 0:00
7/7/10 0:00
7/14/10 0:00
7/21/10 0:00
7/28/10 0:00
8/4/10 0:00
8/11/10 0:00
8/18/10 0:00
8/25/10 0:00
9/1/10 0:00
9/8/10 0:00
9/15/10 0:00
9/22/10 0:00
Date

Figure 67. Young-of-the-Steelhead Site Densities in Scott Creek in 2010 Compared to Multi-Year Averages.

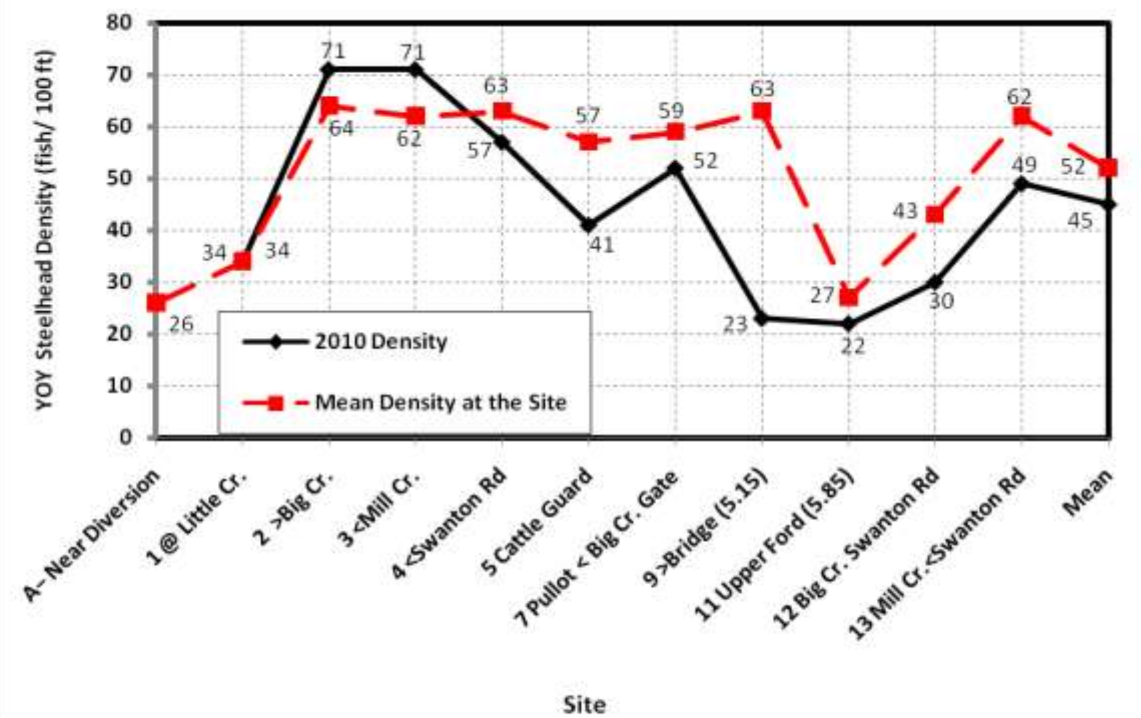
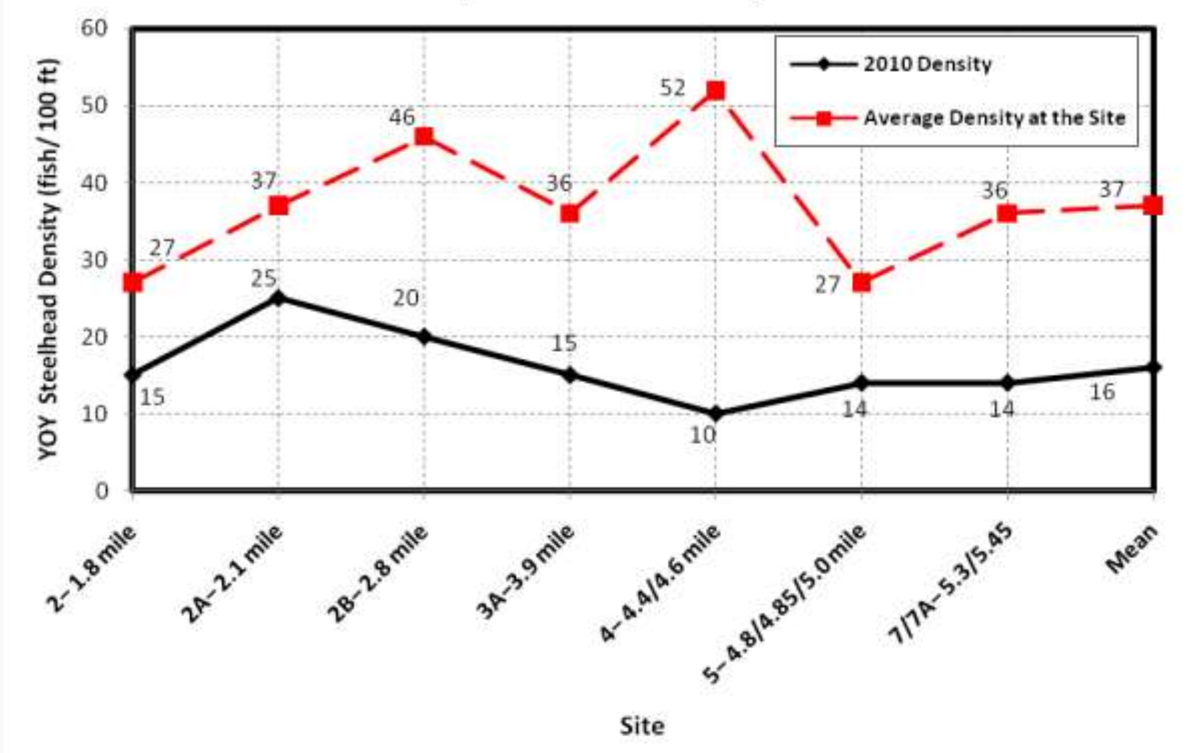


Figure 68. Young-of-the-Year Steelhead Site Densities in Gazos Creek in 2010 Compared to Multi-Year Averages.



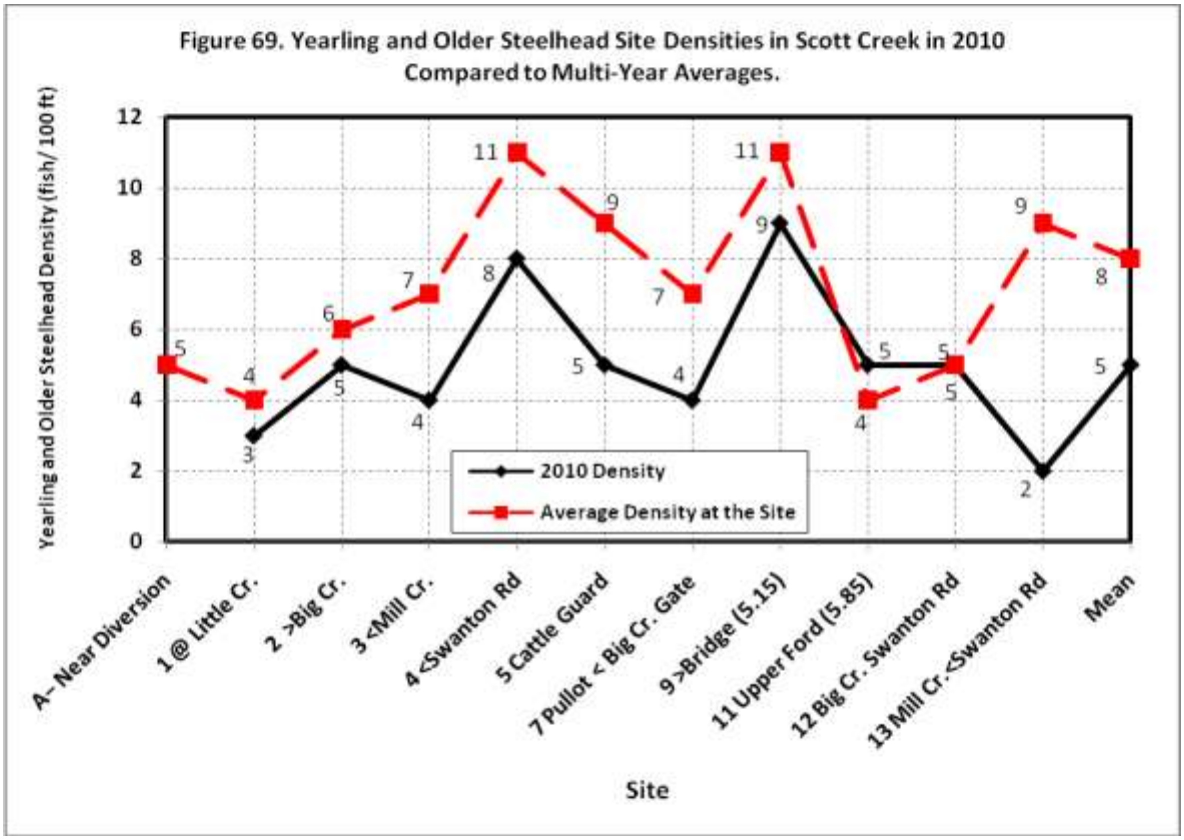


Figure 69. Yearling and Older Steelhead Site Densities in Scott Creek in 2010
Compared to Multi-Year Averages.
Yearling and Older Steelhead Density (fish/ 100 ft)
2010 Density
Average Density at the Site
A- Near Diversion
1 @ Little Cr.
2 >Big Cr.
3 <Mill Cr.
4 <Swanton Rd
5 Cattle Guard
7 Pullot < Big Cr. Gate
9 >Bridge (5.15)
11 Upper Ford (5.85)
12 Big Cr. Swanton Rd
13 Mill Cr.<Swanton Rd
Mean
Site

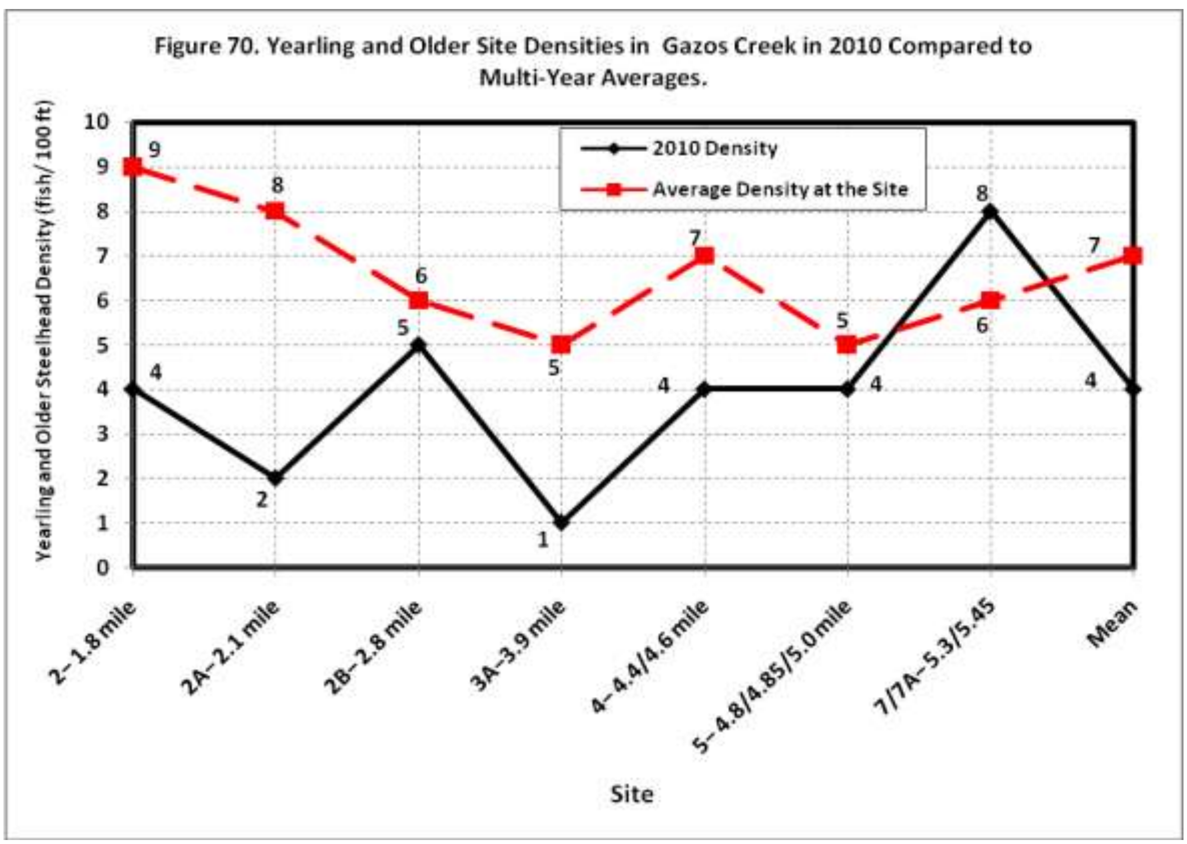


Figure 70. Yearling and Older Site Densities in Gazos Creek in 2010 Compared to
Multi-Year Averages.
Yearling and Older Steelhead Density (fish/ 100 ft)
2010 Density
Average Density at the Site
2- 1.8 mile
2A-2.1 mile
2B-2.8 mile
3A-3.9 mile
4- 4.4/4.6 mile
5- 4.8/4.85/5.0 mile
7/7A-5.3/5.45
Mean
Site

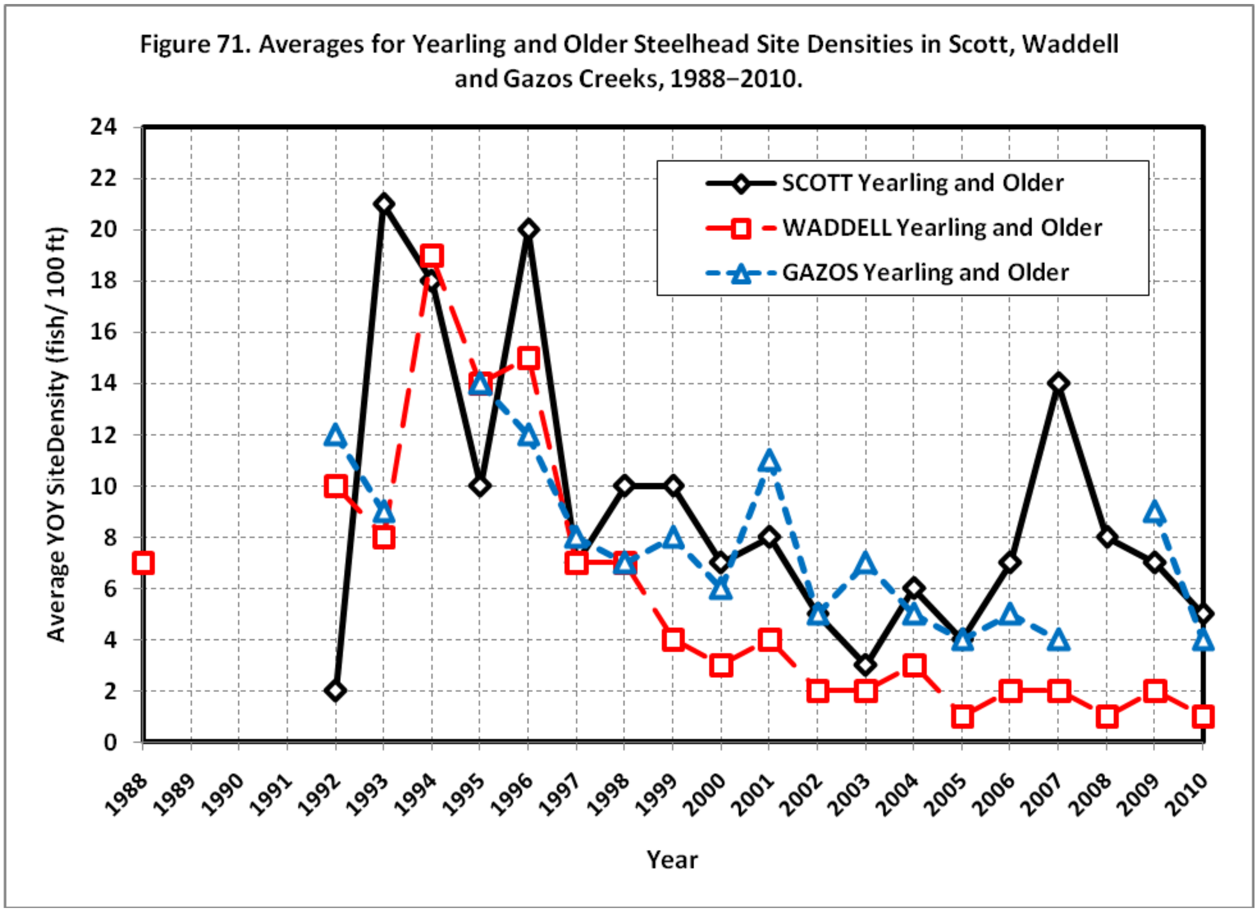


Figure 71. Averages for Yearling and Older Steelhead Site Densities in Scott, Waddell and Gazos Creeks, 1988–2010.
SCOTT Yearling and Older
WADDELL Yearling and Older
GAZOS Yearling and Older
Average YOY SiteDensity (fish/ 100 ft)
24
22
20
18
16
14
12
10
8
6
4
2
0
1988
1989
1990
1991
1992
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
Year

APPENDIX A. Watershed Maps.

Figure 1. Santa Cruz County Watersheds.

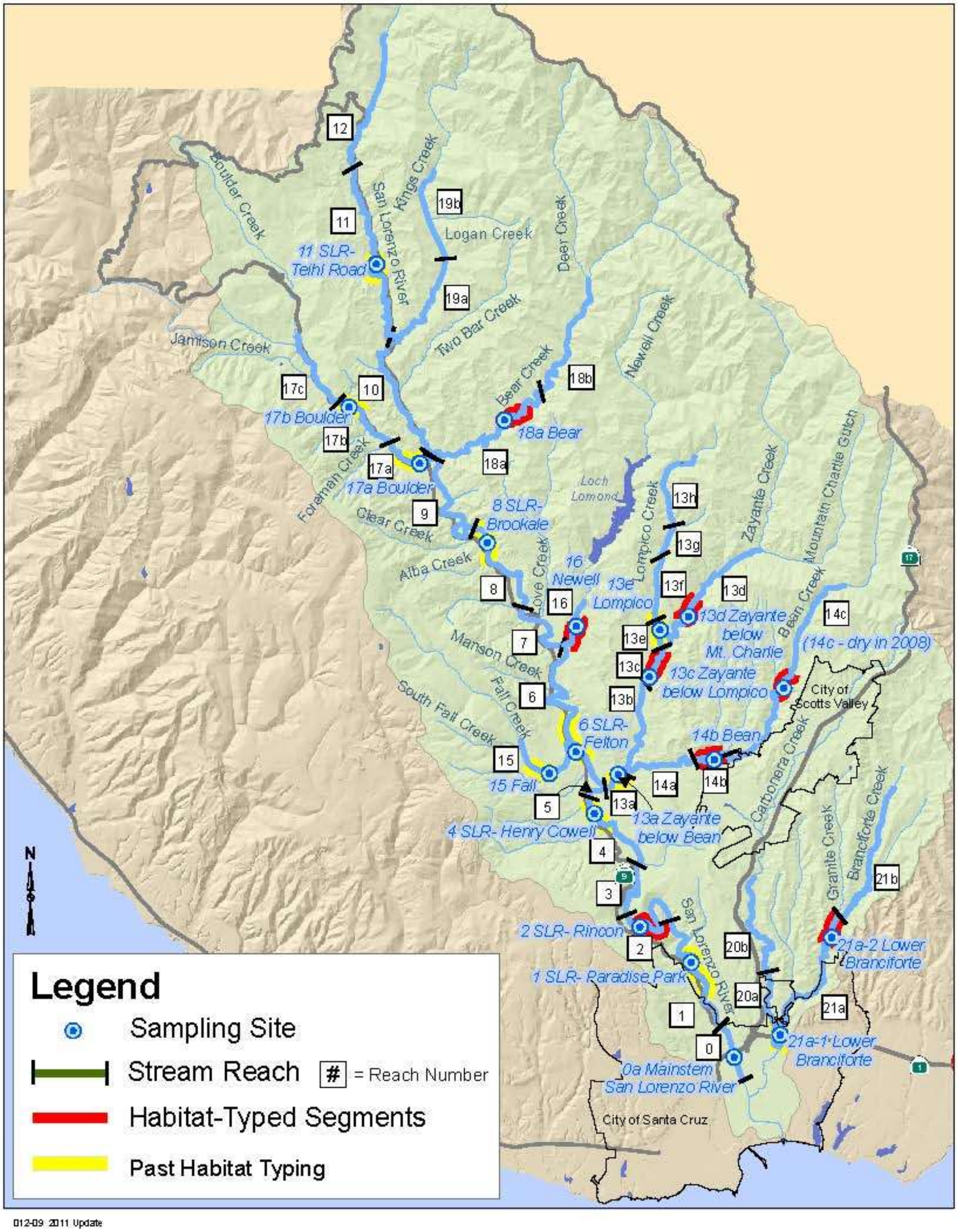


Figure 2. San Lorenzo River Watershed

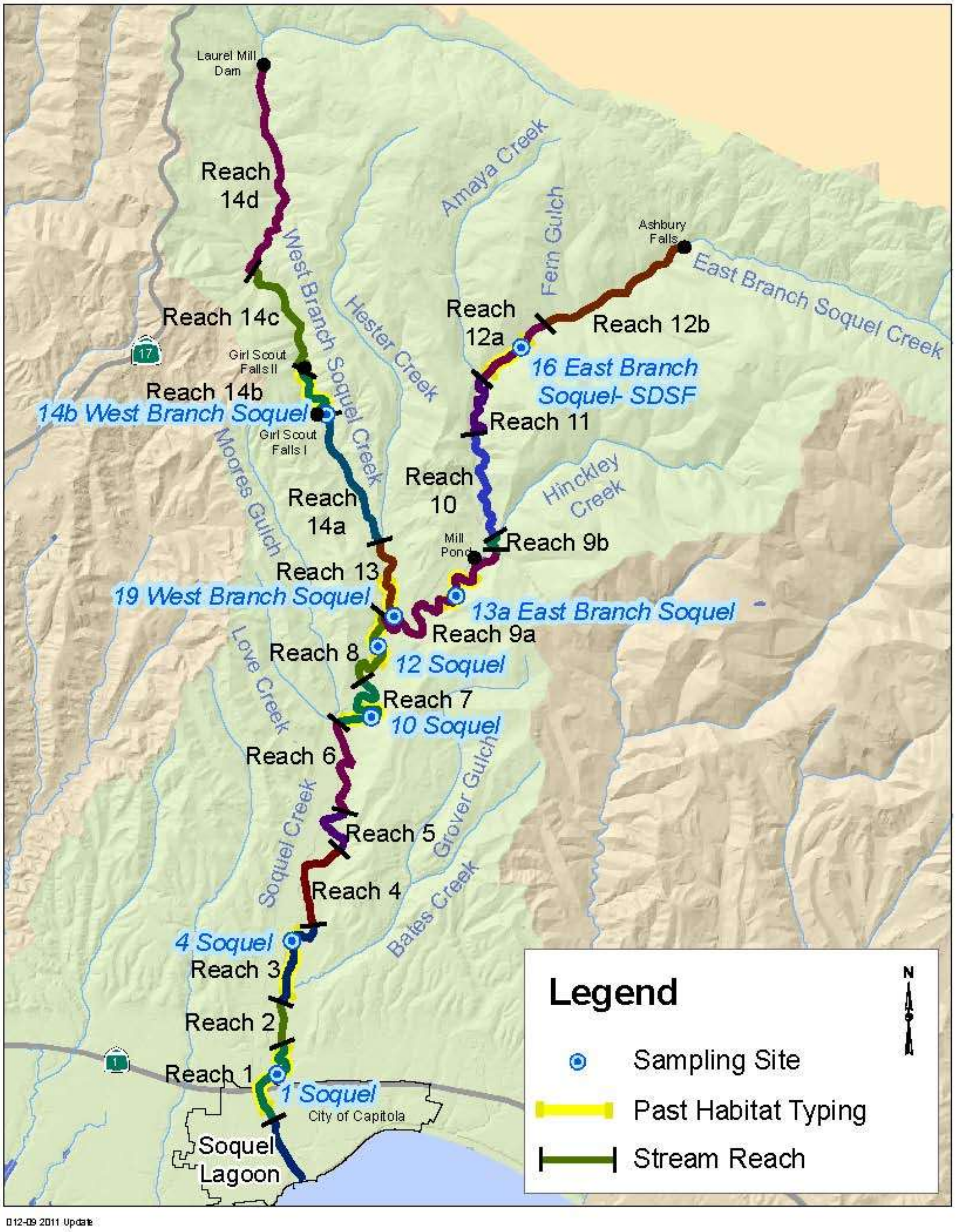


Figure 3. Soquel Creek Watershed.

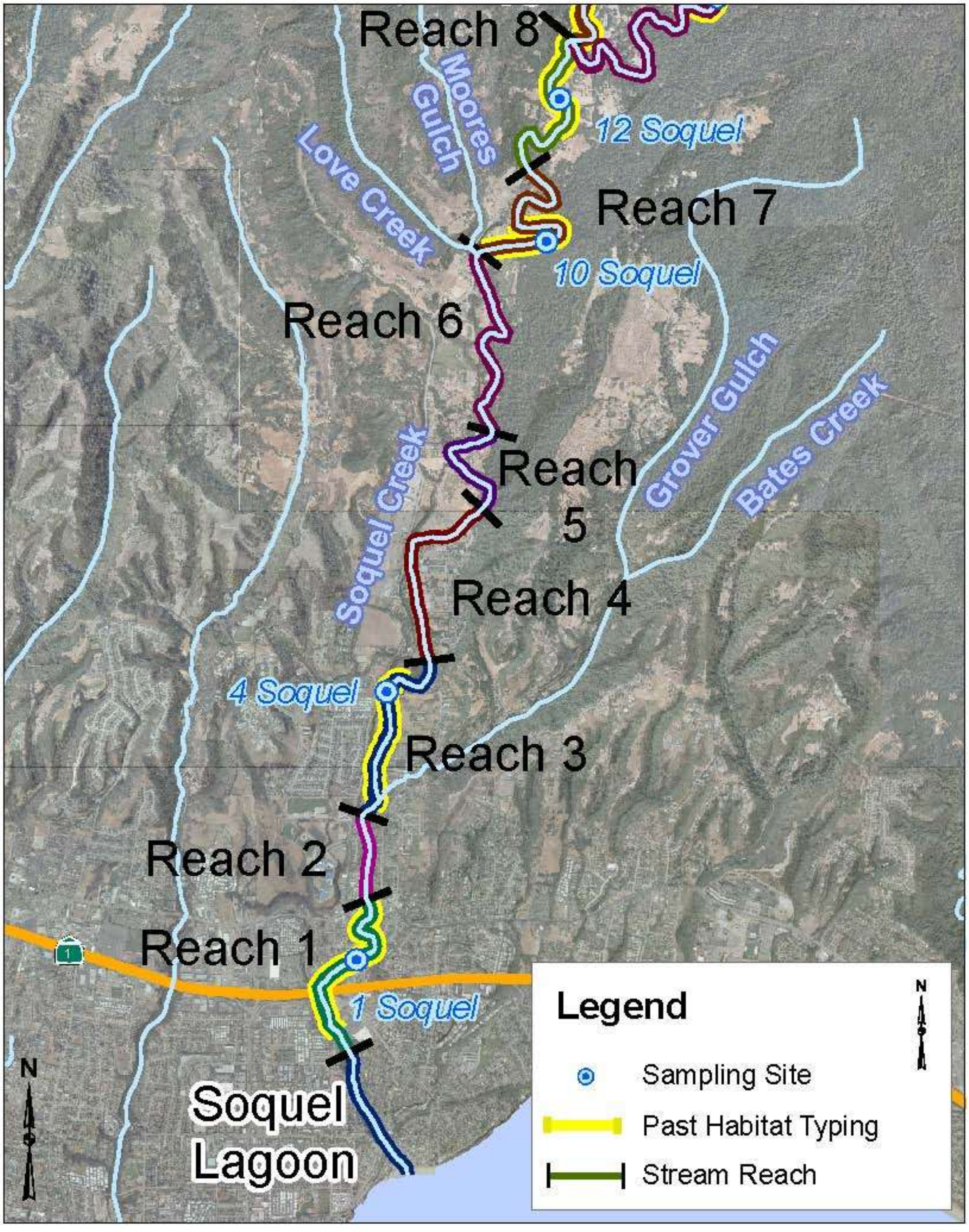


Figure 4. Lower Soquel Creek (Reaches 1–8 on Mainstem).

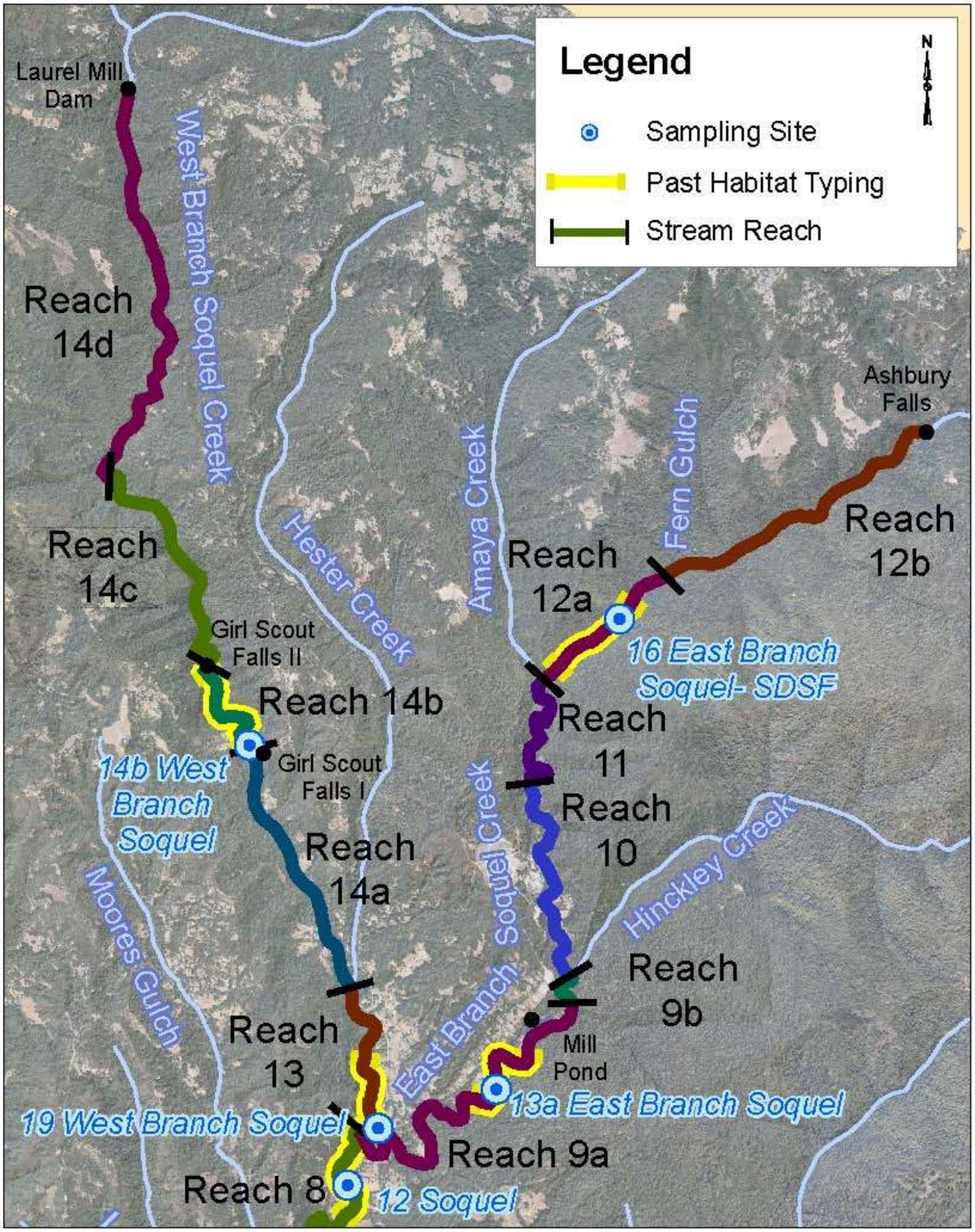
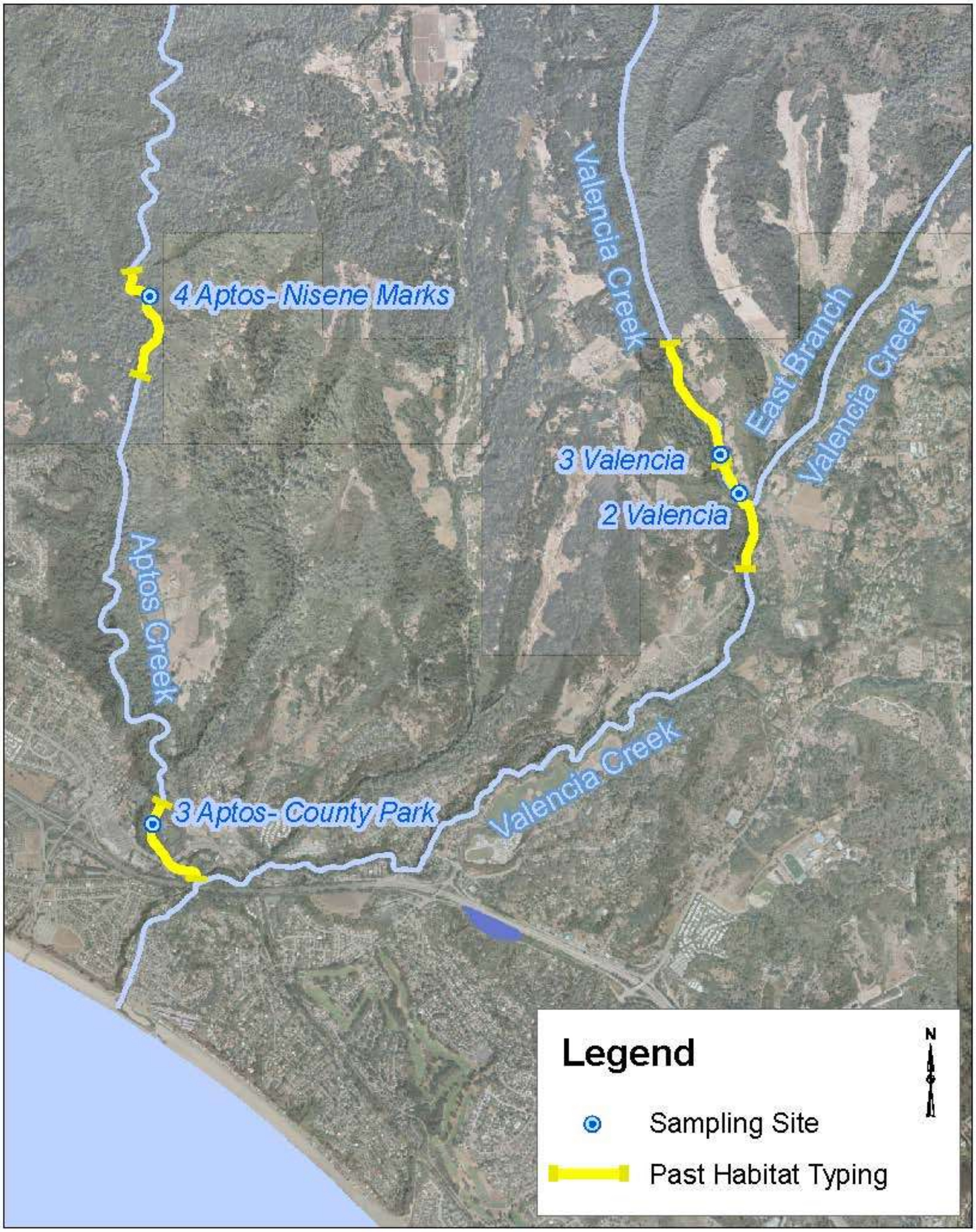


Figure 5. Upper Soquel Creek Watershed (East and West Branches).



012-09 2011 Update

Figure 6. Map from Smith (1982) with Site #3 designation on Valencia Creek at 2006 location.

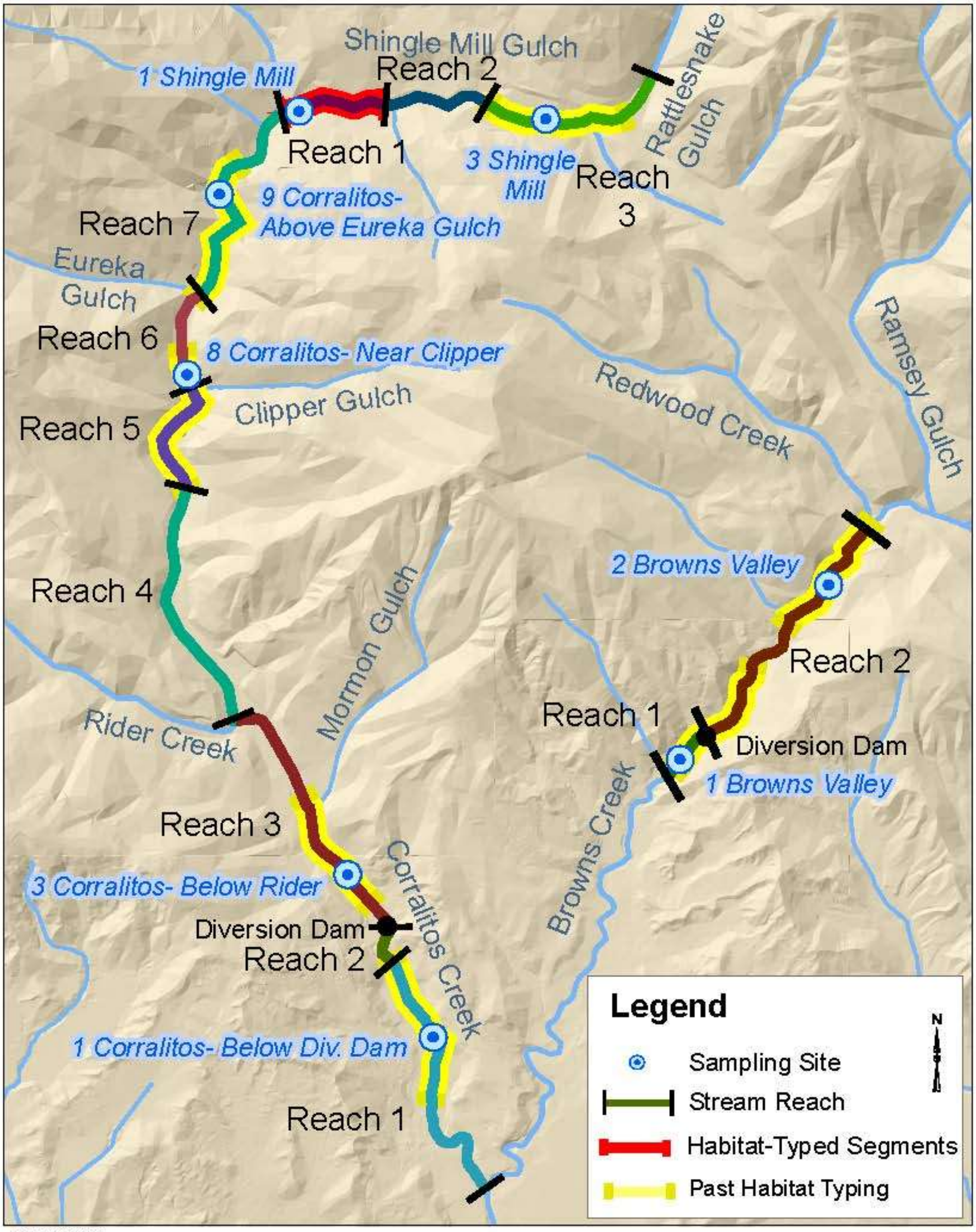


Figure 7. Upper Corralitos Creek Sub-Watershed of the Pajaro River Watershed.

APPENDIX C. Summary of 2010 Catch Data at Sampling Sites.

ORDER OF DATA ORGANIZATION IN THIS APPENDIX

The summary sheets for each sampling site were provided first as steelhead/coho sampling forms. Then the field data sheets for each sampling site were provided. The order of sampling sites corresponded to the numerical order presented in Tables 1-4 in the methods section.

EXPLANATION OF STEELHEAD/COHO SALMON SAMPLING FORMS

Electrofishing and snorkeling data were presented for each sampling site. All data pertained to steelhead because no coho salmon were captured in 2010. Snorkeled habitat is denoted. For electrofishing data, it was presented in successive passes. For underwater visual censusing data, fish counts for replicate passes were presented as passes. Density estimates for each electrofished habitat were obtained by the depletion method and regression analysis. Density estimates for mainstem pool habitats that were visually censused in 2010 were obtained by using the maximum number of steelhead seen per pass if less than 20 fish were counted and by using the average of three passes if more than 20 fish were counted.

For each pass, steelhead were divided into age and size class categories. YOY and 1+ refer to age classes. C-1, C-2 and C-3 refer to Size Classes 1, 2 and 3. For the data presented by pass, C-2 includes Size Classes 2 and 3 combined. Only in the population estimates are these two size classes differentiated.

Site densities at the bottom of the summary data forms were obtained by dividing total estimated number of fish in each size/age category by the total length of stream that was censused.

Steelhead Sampling Results

Date: 01Oct09 **Stream:** SLR **Sampled by:** Alley, Steiner, Wheeler

Sampling Site: 0a (Below Highway 1) **Water Temperature and Times:** 60.0° F @ 1520 hr, 01Oct09

Habitat type& Length (ft)	First Pass				Second Pass				Third Pass/ Fourth Pass				Number Est. / Density Est. per ft					
	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	C-3	Total
#1Riffle 17 ft	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
#2 Pool 85 ft	0	0	1	1	1	0	0	1	0/0	0/0	1/0	1/0	1	0	2	1	2	3
#3 Run 68 ft	0	0	0	0	0	0	0	0	1/0	0/0	0/0	1/0	1	0	0	1	0	1
All Habitats Combined 170 ft													2	0	2	2	2	4

Length of Stream Sampled (ft): 170 ft
Young-of-the-Year / Size Class 1 per Foot of Stream: 0.0118/ 0.0
Yearlings and 2+ / Size Classes 2 and 3 per Foot of Stream: 0.0118 /0.0235

Steelhead Sampling Results

Date: 20Sep09/30Sep09 Stream: SLR Sampled by: Alley, Steiner, Kittleson, Reis, Wheeler

Sampling Site: 1 (Paradise Park) Water Temperature and Times: 58.5° F @ 1620 hr, 30Sep09.

Habitat type& Length (ft)	First Pass				Second Pass				Third Pass/ Fourth Pass				Number Est. / Density Est. per ft					
	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	C-3	Total
#8 Riffle 71 ft	11	0	3	14	2	0	1	3	2	0	0	2	15.2	0	4.2	16.2	3	19.2
#7 Run 58 ft	2	0	0	2	1	0	0	1	0	0	0	0	3.3	0	0	3.3	0	3.3
#10a-b Pool Snorkel 622 ft	2	0 Three	1 Passes	3									2	0	1	3	0	3
All Habitats Combined 751 ft													20.5	0	5.2	22.5	3	25.5

Length of Stream Sampled (ft): 751 ft
Young-of-the-Year / Size Class 1 per Foot of Stream: 0.0273/ 0.0
Yearlings and 2+ / Size Classes 2 and 3 per Foot of Stream: 0.0069 /0.0340

Steelhead Sampling Results

Date: 27Sep09/1Oct09 Stream: SLR Sampled by: Alley, Steiner, Reis, Wheeler, Finstad

Sampling Site: 2a (Rincon) Water Temperature and Times: 54.0° F @ 1226 hr, 1Oct09.

Habitat type & Length (ft)	First Pass				Second Pass				Third Pass/ Fourth Pass				Number Est. / Density Est. per ft					
	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	C-3	Total
#22 Riffle 42 ft	14	2	1	13	10	2	0	8	5/5	0/2	1/0	6/3	34	6	2	28	2	36
#21 Run 71 ft	12	1	2	13	3	0	1	4	1/1	1/0	2/0	2/1	17	2	5	17	3	22
#14 Pool Snorkel 384 ft	1	0 Three	0 Passes	1									1	0	0	1	0	1
#17 Pool Snorkel 180 ft	3	0 Three	0 Passes	3									3	0	0	3	0	3
All Habitat Combined 677 ft													55	8	7	49	5	62

Length of Stream Sampled (ft): 677 ft
Young-of-the-Year / Size Class 1 per Foot of Stream: 0.0812/ 0.0118
Yearlings and 2+ / Size Classes 2 and 3 per Foot of Stream: 0.0103 /0.0798

Steelhead Sampling Results

Date: 20Sep09/30Sep09 **Stream:** SLR **Sampled by:** Alley, Steiner, Kittleson, Reis, Wheeler

Sampling Site: 4 (Henry Cowell Park) **Water Temperature and Times:** 54.0° F @ 1012 hr, 30Sep09.

Habitat type & Length (ft)	First Pass				Second Pass				Third Pass/Fourth Pass				Number Est. / Density Est. per ft					
	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	C-3	Total
#17 Riffle 43 ft	9	3	1	7	4	3	0	1	2	1	0	1	16.6	11.4	1	9	0	20.4
#20 Riffle 51 ft	59	22	0	37	23	9	0	14	14	9	0	5	104.6	49.5	0	59.2	0	108.7
#21 Run 27 ft	10	7	0	3	4	4	0	0	2	2	0	0	17.3	15.6	0	3	0	18.6
#22 Pool Snorkel 405 ft	1 Three	0 Passes	1	2									1	0	1	1	1	2
All Habitats Combined 526 ft													139.5	76.5	2	72.2	1	149.7

Length of Stream Sampled (ft): 526 ft
Young-of-the-Year / Size Class 1 per Foot of Stream: 0.2652/0.1454
Yearlings and 2+ / Size Classes 2 and 3 per Foot of Stream: 0.0038/0.1392

Steelhead Sampling Results

Date: 09Sep09/5Sep09 **Stream:** SLR **Sampled by:** Alley, Steiner, Wheeler, Kittleson

Sampling Site: 6 (below Fall Creek) **Water Temperature and Times:** None taken.

Habitat type & Length (ft)	First Pass				Second Pass				Third Pass/Fourth Pass				Number Est. / Density Est. per ft					
	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	C-3	Total
#8 Riffle 54 ft	22	20	0	2	9	9	0	0	4	4	0	0	37.7	36.3	0	2	0	38.3
#9 Run 79 ft	10	9	0	1	12	12	0	0	6/1	6/1	0	0	29	28	0	1	0	29
#17 Short Pool Snorkel 109 ft	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
#15 Long Pool Snorkel 357 ft	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
All Habitats Combined 599 ft													66.7	64.3	0	3	0	67.3

Length of Stream Sampled (ft): 599 ft
Young-of-the-Year / Size Class 1 per Foot of Stream: 0.1114/.1073
Yearlings and 2+ / Size Classes 2 and 3 per Foot of Stream: 0.0/0.0050

Steelhead Sampling Results

Date: 9Sep09/5Sep09 **Stream:** SLR **Sampled by:** Alley, Steiner, Kittleson, Wheeler

Sampling Site: 8 (below Clear Creek) **Water Temperature and Times:** 67.5° F @ 15360hr, 5Sep09. (Air temp. 68° F)

Habitat type & Length (ft)	First Pass				Second Pass				Third Pass/ Fourth Pass				Number Est. / Density Est. per ft					
	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	C-3	Total
#9a Riffle 21 ft	11	10	3	4	6	6	0	0	4	3	0	1	26.2	23.3	3	6	0	29.3
#11 Riffle 29 ft	20	17	1	4	8	7	1	2	3	3	0	0	33.1	29.1	3	6.7	0	35.8
#9b Run 48 ft	21	18	1	4	9	8	0	1	3	3	0	0	35.5	31.5	1	5.1	0	36.6
#15 Short Pool snorkel 163 ft	1	0	1	2	0	0	0	0	0	0	0	0	1	0	1	2	0	2
#24 Long Pool snorkel 326 ft	1	1	1	1	0	0	0	0	0	0	0	0	1	1	1	1	0	2
All Habitats Combined 587 ft													95.8	84.9	9	20.8	0	105.7

Length of Stream Sampled (ft): 587 ft
Young-of-the-Year / Size Class 1 per Foot of Stream: 0.1632/ 0.1446
Yearlings and 2+ / Size Classes 2 and 3 per Foot of Stream: 0.0153/ 0.0354

Steelhead Sampling Results

Date: 2Sep09 **Stream:** SLR **Sampled by:** Alley, Steiner, Reis

Sampling Site: 11 (above Teihl Rd) **Water Temp. and Times:** 65 F @ 1513 hr, 11Aug09.(Air temp. 71 F).

Habitat type & Length (ft)	First Pass				Second Pass				Third Pass/Fourth Pass				Number Est. / Density Est. per ft					
	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	C-3	Total
#21 Run- 48 ft	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
#23 Riffle- 10 ft	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
#24 Pool-51 ft	4	3	2	4	0	0	1	1	0	0	0	0	4	3	3	4	0	7
#21 Pool-52 ft	1	1	1	1	2	2	0	0	0	0	0	0	3	3	1	1	0	4
All Habitats Combined 161 ft													7	6	4	5	0	11

Length of Stream Sampled (ft): 161 ft
Young-of-the-Year / Size Class 1 per Foot of Stream: 0.0435/ 0.0373
Yearlings and 2+ / Size Classes 2 and 3 per Foot of Stream: 0.0248/ 0.0311

Steelhead Sampling Results

Date: 03Sep09 **Stream:** Zayante **Sampled by:** Alley, Steiner, Wheeler

Sampling Site: 13a (below Bean Creek) **Water Temperature and Times:** none taken.

Habitat type & Length (ft)	First Pass				Second Pass				Third Pass/Fourth Pass				Number Est. / Density Est. per ft					
	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	C-3	Total
#17 Riffle 10 ft	3	1	0	2	1	0	0	1	0	0	0	0	4.2	1	0	3.3	0	4.3
#19 Pool 133 ft	13	7	5	11	2	2	0	0	0	0	0	0	15.2	9.3	5	11	0	20.3
#20 Pool 56 ft	11	6	2	7	1	1	0	0	1	1	0	0	13	8.1	2	7	0	15.1
#18 Run 70 ft	26	18	0	8	7	5	0	2	4	3	0	1	37.9	26.8	0	11.2	0	38
All Habitats Combined 269 ft													70.3	45.2	7	32.5	0	77.7

Length of Stream Sampled (ft): 269 ft

Young-of-the-Year / Size Class 1 per Foot of Stream: 0.2613/ 0.1680

Yearlings and 2+ / Size Classes 2 and 3 per Foot of Stream: 0.0260/ 0.1208

Steelhead Sampling Results

Date: 04Sep09 **Stream:** Zayante **Sampled by:** Alley, Steiner, Wheeler

Sampling Site: 13c (below Lompico Ck) **Water Temp. and Times:** 64° F @ 1405 hr, 4Sep09.

Habitat type & Length (ft)	First Pass				Second Pass				Third Pass/Fourth Pass				Number Est. / Density Est. per ft					
	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	C-3	Total
#26-27 Riffle 22 ft	11	11	3	3	2	2	0	0	1	0	0	0	14	13	3	4	0	17
#28 Pool 28 ft	17	17	2	2	4	4	1	1	1	1	0	0	22.3	22.3	3.3	3.3	0	25.6
#29 Pool 100 ft	37	36	4	5	11	11	0	0	8	8	1	1	58.8	58	6	6.7	0	64.7
#32 Step-Run 52 ft	25	24	3	4	8	8	3	3	2	2	0	0	36.2	35.3	6	7	0	42.3
All Habitats Combined 202 ft													131.3	128.6	18.3	21	0	149.6

Length of Stream Sampled (ft): 202 ft
Young-of-the-Year / Size Class 1 per Foot of Stream: 0.65/ 0.6366
Yearlings and 2+ / Size Classes 2 and 3 per Foot of Stream: 0.0906/ 0.1040

Steelhead Sampling Results

Date: 10Sep08 **Stream:** Zayante **Sampled by:** Alley, Steiner, Wheeler

Sampling Site: 13d (below Mountain Charlie Gulch) **Water Temp. and Times:** 66° F @ 1602 hr, 13Aug09. (Air temp. 79° F).

Habitat type & Length (ft)	First Pass				Second Pass				Third Pass/ Fourth Pass				Number Est. / Density Est. per ft					
	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	C-3	Total
#38 Riffle 13 ft	1	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1
#29 Step-Run 38 ft	13	13	6	6	1	1	0	0	0	0	0	0	14	14	6	6	0	20
#37 Pool 60 ft	67	67	11	11	13	13	1	1	8	8	0	0	88.3	88.3	12	12	0	100.3
#39 Pool 48 ft	26	26	4	4	9	9	3	3	1	1	0	0	37.6	37.6	8.8	8.8	0	46.4
All Habitats Combined 159 ft													140.9	140.9	26.8	26.8	0	167.7

Length of Stream Sampled (ft): 159 ft

Young-of-the-Year / Size Class 1 per Foot of Stream: 0.8862/ 0.8862

Yearlings and 2+ / Size Classes 2 and 3 per Foot of Stream: 0.1686/ 0.1686

Steelhead Sampling Results

Date: 4Sep09 Stream: Lompico Sampled by: Alley, Steiner, Wheeler, Collins

Sampling Site: 13e (below turnout) Water Temp. and Times: 58° F @ 0935 hr, 4Sep09.

Habitat type & Length (ft)	First Pass				Second Pass				Third Pass/Fourth Pass				Number Est. / Density Est. per ft					
	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	C-3	Total
#42 Pool 68 ft	59	59	5	5	23	23	1	1	3	3	0	0	90	90	6.1	6.1	0	96.1
#44 Pool 46 ft	34	34	2	2	16	16	0	0	7	7	0	0	63.3	63.3	2	2	0	65.3
#43 Riffle 10 ft	2	2	0	0	2	2	0	0	0	0	0	0	4	4	0	0	0	4
#46 Step-run 40 ft	24	24	0	0	9	9	0	0	2	2	0	0	36.8	36.8	0	0	0	36.8
All Habitats Combined 164 ft													194.1	194.1	8.1	8.1	0	202.2

Length of Stream Sampled (ft): 164 ft
Young-of-the-Year / Size Class 1 per Foot of Stream: 1.1835/ 1.1835
Yearlings and 2+ / Size Classes 2 and 3 per Foot of Stream: 0.0494/ 0.0494

Steelhead Sampling Results

Date: 14Sep09 Stream: Bean Ck Sampled by: Alley, Steiner, Wheeler
Sampling Site: 14b (below Lockhart Gulch.) Water Temp. and Times: 61° F @ 1522hr, 8Aug09. (Air temp. 69° F).

Habitat type & Length (ft)	First Pass				Second Pass				Third Pass/Fourth Pass				Number Est. / Density Est. per ft					
	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	C-3	Total
#44 Riffle 58 ft	1	0	0	1	0	0	0	0	0	0	0	0	1	0	0	1	0	1
#43 Pool 95 ft	2	0	7	9	3	0	2	5	1	0	1	2	6	0	10.3	18.5	0	18.5
#45 Pool 89 ft	4	1	5	8	1	0	0	1	1	0	0	1	6.3	1	5	9	1	11
#49 Run 30 ft	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
All Habitats 272 ft													13.3	1	15.3	28.5	1	30.5

Length of Stream Sampled (ft): 272 ft
Young-of-the-Year/ Size Class 1 per Ft of Stream: 0.0489/ 0.0037
Yearlings and 2+/ Size Classes 2 and 3 per Ft of Stream: 0.0563/ 0.1085

Steelhead Sampling Results

Date: 10Sep09 Stream: Fall Ck Sampled by: Alley, Steiner, Reis

Sampling Site: 15 (above Highway 9) Water Temp. and Times: 60° F @ 1523 hr. 12Aug09. (Air temp. 72° F).

Habitat type & Length (ft)	First Pass				Second Pass				Third Pass/Fourth Pass				Number Est. / Density Est. per ft					
	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	C-3	Total
#25 Riffle 42 ft	4	4	4	4	2	2	0	0	2	2	0	0	11.3	11.3	4	4	0	15.3
#20 Pool 20 ft	4	3	5	6	2	2	1	1	0	0	1	1	6.7	6	7.2	5.1	3	14.1
#24 Pool 23 ft	6	6	9	9	2	2	0	0	1	1	1	1	9.4	9.4	10.3	8.2	2.1	19.7
#19 Step-Run 40 ft	7	7	1	1	3	3	0	0	0	0	0	0	10.8	10.8	1	1	0	11.8
All Habitats Combined 125 ft													38.2	37.5	22.5	18.3	5.1	60.9

Length of Stream Sampled (ft): 125 ft

Young-of-the-Year / Size Class 1 per Foot of Stream: 0.3056/0.3

Yearlings and 2+ / Size Classes 2 and 3 per Foot of Stream: 0.18/ 0.1872

Steelhead Sampling Results

Date: 11Sep09 **Stream:** Newell Ck **Sampled by:** Alley, Steiner, Wheeler

Sampling Site: 16 **Water Temp. and Times:** 59.5° F @ 1155hr. 10Aug09. (Air temp. 75° F).

Habitat type & Length (ft)	First Pass				Second Pass				Third Pass/Fourth Pass				Number Est. / Density Est. per ft					
	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	C-3	Total
#22 Riffle 19 ft	2	2	0	0	2	2	0	0	0	0	0	0	4	4	0	0	0	4
#21 Pool 77 ft	6	4	1	3	1	1	1	1	0	0	0	0	7.1	5.1	3	4.2	0	9.3
#28 Pool 107 ft	3	3	5	5	1	1	0	0	1	1	0	0	5.7	5.7	5	5	0	10.7
#20 Run 52 ft	15	15	2	2	4	4	0	0	2	2	0	0	21.4	21.4	2	2	0	23.4
All Habitats Combined 255 ft													38.2	36.2	10	11.2	0	47.4

Length of Stream Sampled (ft): 255 ft
Young-of-the-Year / Size Class 1 per Foot of Stream: 0.1498/0.1420
Yearlings and 2+ / Size Classes 2 and 3 per Foot of Stream: 0.0392/ 0.0439

Steelhead Sampling Results

Date: 10Sep09 Stream: Boulder Ck Sampled by: Alley, Steiner, Reis

Sampling Site: 17a (above Highway 9) Water Temp. and Times: 64° F @ 1531hr. 14Aug09. (Air temp. 67° F).

Habitat type & Length (ft)	First Pass				Second Pass				Third Pass/Fourth Pass				Number Est. / Density Est. per ft					
	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	C-3	Total
#4 Riffle 22 ft	1	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1
#5 Pool 133 ft	6	6	3	3	2	1	0	1	2	2	0	0	11.3	10.1	3	4.2	0	14.3
#8 Pool 41 ft	4	3	2	3	0	0	0	0	0	0	0	0	4	3	2	3	0	6
#7 Run 48 ft	4	3	4	5	1	1	1	1	1	1	0	0	6.3	5.7	5.1	6.1	0	11.8
All Habitats Combined 244 ft													22.6	19.8	10.1	13.3	0	33.1

Length of Stream Sampled (ft): 244 ft
Young-of-the-Year / Size Class 1 per Foot of Stream: 0.0926/0.0811
Yearlings and 2+ / Size Classes 2 and 3 per Foot of Stream: 0.0414/ 0.0545

Steelhead Sampling Results

Date: 10Sep09 Stream: Boulder Ck Sampled by: Alley, Steiner, Reis

Sampling Site: 17b (Bracken Brae) Water Temp. and Times: 58° F @ 1400 hr, 10Aug09.

Habitat type & Length (ft)	First Pass				Second Pass				Third Pass/Fourth Pass				Number Est. / Density Est. per ft					
	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	C-3	Total
#22 Step-run 32 ft	4	4	0	0	0	0	0	0	0	0	0	0	4	4	0	0	0	4
#31 Riffle/ Step-run 56 ft	7	7	1	1	2	2	0	0	0	0	0	0	9.3	9.3	1	1	0	10.3
#30 Pool 40 ft	15	15	10	10	4	4	2	2	5	5	0	0	26.9	26.9	12.2	12.2	0	39.1
#32 Pool 26 ft	9	9	2	2	1	1	1	1	1	1	0	0	11	11	3.3	3.3	0	14.3
All Habitats Combined 154 ft													51.2	51.2	16.5	16.5	0	67.7

Length of Stream Sampled (ft): 154 ft
Young-of-the-Year / Size Class 1 per Foot of Stream: 0.3325/0.3325
Yearlings and 2+ / Size Classes 2 and 3 per Foot of Stream: 0.1071/ 0.1071

Steelhead Sampling Results

Date: 2Sep09 Stream: Bear Ck Sampled by: Alley, Steiner, Reis

Sampling Site: 18a (above and below Hopkins Gulch) Water Temp. and Times: 66° F @ 1508 hr, 2Sep09. Air Temp. 75° F.

Habitat type & Length (ft)	First Pass				Second Pass				Third Pass/Fourth Pass				Number Est. / Density Est. per ft					
	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	C-3	Total
#10 Riffle 16 ft	1	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1
#11 Pool 109 ft	10	10	1	1	5	4	1	2	1	1	0	0	17.7	15.9	2	3	0	18.9
#13 Pool 23 ft	3	3	1	1	2	2	1	1	3/0	3/0	0/0	0/0	8	8	2	2	0	10
#14 Step-Run 53 ft	8	8	0	0	3	3	0	0	0	0	0	0	11.7	11.7	0	0	0	11.7
All Habitats Combined 201 ft													38.4	36.6	4	5	0	41.6

Length of Stream Sampled (ft): 201 ft
Young-of-the-Year / Size Class 1 per Foot of Stream: 0.1910/ 0.1821
Yearlings and 2+ / Size Classes 2 and 3 per Foot of Stream: 0.0199/ 0.0249

Steelhead Sampling Results

Date: 14Aug09 **Stream:** Branciforte Ck **Sampled by:** Alley, Steiner, Reis

Sampling Site: 21a-2 (below Granite Ck) **Water Temp. and Times:** 63° F @ 1542 hr, 11Aug09. (Air temp. 70° F).

Habitat type & Length (ft)	First Pass				Second Pass				Third Pass/Fourth Pass				Number Est. / Density Est. per ft					
	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	C-3	Total
#14 Riffle 8 ft	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
#15 Pool 46 ft	4	4	2	2	1	1	1	1	1	1	0	0	6.3	6.3	3.3	3.3	0	9.6
#19 Pool 60 ft	2	2	4	4	4	4	3	3	3	3	0	0	9	9	7	6	1	16
#25 Run 24 ft	2	2	0	0	0	0	0	0	0	0	0	0	2	2	0	0	0	2
All Habitats Combined 138 ft													17.3	17.3	10.3	9.3	1	27.6

Length of Stream Sampled (ft): 138 ft
Young-of-the-Year / Size Class 1 per Foot of Stream: 0.1254/ 0.1254
Yearlings and 2+ / Size Classes 2 and 3 per Foot of Stream: 0.0746 / 0.0746

Steelhead Sampling Results

Date: 16Sep09 **Stream:** Soquel Ck **Sampled by:** Alley, Steiner, Reis
Sampling Site: 1 below Grange **Water Temp. and Times:** 61° F @ 1004 hr. 25Aug09.
Air Temp. 57° F.

Habitat type & Length (ft)	First Pass				Second Pass				Third Pass/Fourth Pass				Number Est. / Density Est. per ft					
	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	C-3	Total
#19 Run 43 ft	1	0	0	1	0	0	0	0	0	0	0	0	1	0	0	1	0	1
#23 Riffle 34 ft	1	0	0	1	0	0	0	0	0	0	0	0	1	0	0	1	0	1
#18 Pool 494 ft	17	7	4	14	9	5	2	6	6/1	2/1	3/0	7/0	33	15	9	27	0	42
All Habitats Combined 571 ft													35	15	9	29	0	44

Length of Stream Sampled (ft): 571 ft
Young-of-the-Year / Size Class 1 per Foot of Stream: 0.0612/ 0.0263
Yearlings and 2+ / Size Classes 2 and 3 per Foot of Stream: 0.0158/ 0.0508

Steelhead Sampling Results

Date: 16Sep09   Stream: Soquel Ck Sampled by: Alley, Steiner, Reis
Sampling Site: 4 Adjacent Flower Field. Water Temp. and Times: 64 F @ 1755 hr 25Aug09. Air Temp. 63 F

Habitat type & Length (ft)	First Pass				Second Pass				Third Pass/Fourth Pass				Number Est. / Density Est. per ft					
	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	C-3	Total
#14 Run 25 ft	2	1	0	1	2	2	0	0	0	0	0	0	4	3	0	1	0	4
#16 Riffle 67 ft	10	10	1	1	2	2	0	0	1	1	0	0	13.0	13.0	1	1	0	14
#15 Pool 137 ft	7	4	2	5	5	4	1	2	1	0	0	1	16	8	3.3	8.6	0	16.6
All Habitats Combined 229 ft													33	24	4.3	18.6	0	34.6

Length of Stream Sampled (ft): 229 ft
Young-of-the-Year / Size Class 1 per Foot of Stream: 0.1441/ 0.1048
Yearlings and 2+ / Size Classes 2 and 3 per Foot of Stream: 0.0188/ 0.0812

Steelhead Sampling Results

Date: 17Sep09 **Stream:** Soquel Ck **Sampled by:** Alley, Steiner, Wheeler
Sampling Site: 10 (Above Allred) **Water Temp. and Times:** 63° F @ 1430 hr, 27Aug09 (air temp. 78° F)

Habitat type & Length (ft)	First Pass				Second Pass				Third Pass/Fourth Pass				Number Est. / Density Est. per ft					
	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	C-3	Total
#26 Run 50 ft	7	4	0	3	1	1	0	0	1	1	0	0	9	6.3	0	3	0	9.3
#27 Pool 211 ft	17	12	1	6	13	8	1	6	3	2	0	1	33	22	2	13	0	35
#28 Riffle 30 ft	6	4	0	2	0	0	0	0	1	1	0	0	7.5	6	0	2	0	8
All Habitats Combined 291 ft													49.5	34.3	2	18	0	52.3

Length of Stream Sampled (ft): 291 ft
Young-of-the-Year / Size Class 1 per Foot of Stream: 0.1701/ 0.1179
Yearlings and 2+ / Size Classes 2 and 3 per Foot of Stream: 0.0069/ 0.0619

Steelhead Sampling Results

Date: 18Sep09 **Stream:** Soquel Ck **Sampled by:** Alley, Steiner, Wheeler
Sampling Site: 12 Soquel Creek Rd **Water Temp. and Times:** 64° F @ 1717 hr.
27Aug09 **Air Temp.** 73° F.

Habitat type & Length (ft)	First Pass				Second Pass				Third Pass/Fourth Pass				Number Est. / Density Est. per ft					
	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	C-3	Total
#19 Run 37 ft	9	8	0	1	2	2	0	0	0	0	0	0	11.3	11.3	0	1	0	12.3
#20 Riffle 31 ft	5	4	0	1	2	2	0	0	0	0	0	0	7.5	6.7	0	1	0	7.7
#13 Pool 218 ft	53	35	5	23	8	8	4	4	12/4	8/4	0/0	4/0	77	55	9	31	0	86
All Habitats Combined 286 ft													95.8	73	9	34	0	106

Length of Stream Sampled (ft): 286 ft
Young-of-the-Year / Size Class 1 per Foot of Stream: 0.3350/ 0.2552
Yearlings and 2+ / Size Classes 2 and 3 per Foot of Stream: 0.0315/ 0.1189

Steelhead Sampling Results

Date: 18Sep09 Stream: E. Br. Soquel Ck Sampled by: Alley, Steiner, Wheeler
Sampling Site: 13a (Below Millpond) Water Temp. and Times: 69°F @ 1458 hr, 21Aug09 (air temp. 79°F).

Habitat type & Length (ft)	First Pass				Second Pass				Third Pass				Number Est. / Density Est. per ft					
	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	C-3	Total
#41 Riffle 46 ft	8	4	1	5	4	2	0	2	1	0	0	1	14.4	6.7	1	8.6	0	15.3
#39 Run 29 ft	2	1	0	1	0	0	0	0	0	0	0	0	2	1	0	1	0	2
#38 Pool 137 ft	18	11	2	9	4	4	0	0	2	1	0	1	24.2	16.8	2	10.3	0	27.1
#40 Pool 44 ft	9	4	2	7	4	1	0	3	0	0	0	0	14.1	5.1	2	10.8	0	15.9
All Habitats Combined 256 ft													54.7	29.6	4	30.7	0	60.3

Length of Stream Sampled (ft): 256 ft
Young-of-the-Year / Size Class 1 per Foot of Stream: 0.2137/ 0.1156
Yearlings and 2+ / Size Classes 2 and 3 per Foot of Stream: 0.0156/ 0.1119

Steelhead Sampling Results

Date: 21Sep09 Stream: E. Br. Soquel Ck Sampled by: Alley, Steiner, Reis
Sampling Site: 16 (Below Long Ridge Rd) Water Temp. and Times: 59° F @ 1307 hr, 26Aug09; (air temp. 68.2° F).

Habitat type & Length (ft)	First Pass				Second Pass				Third Pass				Number Est. / Density Est. per ft					
	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	C-3	Total
#28 Step-Pool 49 ft	17	17	9	9	11	11	3	3	0	0	0	0	33.3	33.3	12.6	12.6	0	45.9
#34 Pool 27 ft	20	21	5	5	5	5	0	0	1	1	0	0	26.5	27.4	5	5	0	32.4
#36 Step-run 70 ft	67	67	3	3	14	14	0	0	2	2	0	0	84	84	3	3	0	87
#35 Riffle 11 ft	3	3	0	0	0	0	0	0	0	0	0	0	3	3	0	0	0	3
All Habitats Combined 157 ft													146.8	147.7	20.6	20.6	0	168.3

Length of Stream Sampled (ft): 157 ft
Young-of-the-Year / Size Class 1 per Foot of Stream: 0.9350/ 0.9408
Yearlings and 2+ / Size Classes 2 and 3 per Foot of Stream: 0.1312/ 0.1312

Steelhead Sampling Results

Date: 17Sep09 Stream: W. Br. Soquel Ck Sampled by: Alley, Steiner, Wheeler
Sampling Site: 19 (below Hester) Water Temp. and Times: 63.5° F @ 1734 hr, 21Aug09 (air temp. 66° F)

Habitat type & Length (ft)	First Pass				Second Pass				Third Pass/Fourth				Number Est. / Density Est. per ft					
	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	C-3	Total
#17 Run 18 ft	11	9	0	2	0	0	0	0	0	0	0	0	11	9	0	2	0	11
#18 Riffle 52 ft	29	21	0	8	10	9	0	1	2	1	0	1	42.7	33.3	0	10	0	43.3
#19 Pool 193 ft	26	18	11	19	6	5	1	2	7/8	3/8	0/0	4/0	47	34	12	25	0	59
All Habitat 263 ft													100.7	76.3	12	37	0	113.3

Length of Stream Sampled (ft): 263 ft
Young-of-the-Year / Size Class 1 per Foot of Stream: 0.3829/ 0.2901
Yearlings and 2+ / Size Classes 2 and 3 per Foot of Stream: 0.0456/ 0.1407

Steelhead Sampling Results

Date: 18Sep09 **Stream:** W. Br. Soquel Ck **Sampled by:** Alley, Steiner, Wheeler
Sampling Site: 21 (above Girl Scout Falls I) **Water Temp. and Times:** 61° F @ 1248 hr, 21Aug09 (air temp. 66° F)

Habitat type & Length (ft)	First Pass				Second Pass				Third Pass/Fourth				Number Est. / Density Est. per ft					
	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	C-3	Total
#4 Step-Run 20 ft	9	9	1	1	0	0	0	0	0	0	0	0	9	9	1	1	0	10
#2 Riffle 8 ft	1	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1
#3 Pool 113 ft	28	25	4	7	13	13	3	3	6	6	2	2	52.2	50.5	11	12.5	1.1	64.1
#5 Pool 91 ft	31	29	1	2	13	12	0	1	2	2	0	0	55.9	52.8	1	3.3	0	56.1
All Habitat 232 ft													118.1	113.3	13	16.8	1.1	131.2

Length of Stream Sampled (ft): 263 ft
Young-of-the-Year / Size Class 1 per Foot of Stream: 0.4490/ 0.4308
Yearlings and 2+ / Size Classes 2 and 3 per Foot of Stream: 0.0494/ 0.0681

Steelhead Sampling Results

Date: 22Sep09 Stream: Aptos Ck Sampled by: Alley, Wheeler, Steiner, Kittleson
Sampling Site: 3 (Adj. County Park) Water Temp. and Times: 58° F @ 1402hr, 18Aug09; (air temp. 60° F).

Habitat type & Length (ft)	First Pass				Second Pass				Third Pass				Number Est. / Density Est. per ft					
	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	C-3	Total
#27 Pool 168 ft	2	2	12	12	1	1	0	0	0	0	0	0	3.3	3.3	12	11	1	15.3
#44 Run 48 ft	2	2	1	1	2	2	0	0	0	0	0	0	4	4	1	1	0	5
#26 Riffle 36 ft	1	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1
All Habitats Combined 252 ft													8.3	8.3	13	12	1	21.3

Length of Stream Sampled (ft): 252 ft
Young-of-the-Year / Size Class 1 per Foot of Stream: 0.0329/ 0.0329
Yearlings and 2+ / Size Classes 2 and 3 per Foot of Stream: 0.0516/ 0.0516

Steelhead Sampling Results

Date: 22Sep09 **Stream:** Aptos Ck **Sampled by:** Alley, Steiner, Wheeler
Sampling Site: 4 (Above Steel Bridge) **Water Temp. and Times:** 59° F@ 1645 hr, 19Aug09; (air temp. 61° F).

Habitat type & Length (ft)	First Pass				Second Pass				Third Pass				Number Est. / Density Est. per ft					
	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	C-3	Total
#35 Pool 133 ft	3	0	6	9	2	0	0	2	0	0	0	0	5	0	6	11.3	0	11.3
#37 Pool 97 ft	4	0	4	8	1	0	1	2	0	0	0	0	5.1	0	5.1	10.3	0	10.3
#36 Riffle 52 ft	2	0	0	2	0	0	1	1	0	0	0	0	2	0	1	3.3	0	3.3
#34 Run 31 ft	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
All Habitats Combined 313 ft													12.1	0	12.1	24.9	0	24.9

Length of Stream Sampled (ft): 313 ft
Young-of-the-Year / Size Class 1 per Foot of Stream: 0.0387/ 0.0
Yearlings and 2+ / Size Classes 2 and 3 per Foot of Stream: 0.0387/ 0.0796

Steelhead Sampling Results

Date: 23Sep09 Stream: Valencia Ck Sampled by: Alley, Steiner, Reis
Sampling Site: 2 (below road crossing) Water Temp. and Times: 61° F@ 1515 hr, 20Aug09; (air temp. 65° F).

Habitat type & Length (ft)	First Pass				Second Pass				Third Pass				Number Est. / Density Est. per ft					
	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	C-3	Total
#32 Pool 87 ft	5	5	9	9	1	1	3	3	0	0	0	0	6.1	6.1	12.6	12.6	0	18.7
#34 Pool 40 ft	4	4	7	7	0	0	0	0	0	0	0	0	4	4	7	7	0	11
#36 Pool 61 ft	5	5	12	12	2	2	4	4	0	0	3	3	7.5	7.5	20.2	20.4	0	27.9
Pools Combined 188 ft													17.6	17.6	32.8	32.8	0	50.4
#40 Run 47 ft	5	5	3	3	0	0	0	0	1/0	1/0	1/0	1/0	6	6	4	4	0	10
#33 Riffle 11 ft	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
#35 Riffle 20 ft	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
All Habitats Combined 266 ft													23.6	23.6	36.8	36.8	0	60.4

Length of Stream Sampled (ft): 266 ft
Young-of-the-Year / Size Class 1 per Foot of Stream: 0.0887/ 0.0887
Yearlings and 2+ / Size Classes 2 and 3 per Foot of Stream: 0.1383/ 0.1383

Steelhead Sampling Results

Date: 23Sep09 **Stream:** Valencia Ck **Sampled by:** Alley, Steiner, Reis
Sampling Site: 3 (Above road crossing) **Water Temp. and Times:** 61° F@ 1700 hr, 21Aug09; (air temp. 67° F).

Habitat type & Length (ft)	First Pass				Second Pass				Third Pass				Number Est. / Density Est. per ft					
	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	C-3	Total
#20 Pool 64 ft	3	3	10	10	1	1	3	3	0	0	0	0	4.2	4.2	13.5	13.5	0	17.7
#22 Pool 40 ft	3	3	9	9	1	1	2	2	0	0	0	0	4.2	4.2	11.3	11.3	0	15.5
#24 Pool 51 ft	4	4	5	5	1	1	2	2	0	0	2	2	5.1	5.1	11	11	0	16.1
Pools Combined 155 ft													13.5	13.5	35.8	35.8	0	49.3
Run 20 ft	1	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1
#19 Riffle 18 ft	0	0	0	0	0	0	0	0	1	1	0	0	1	1	0	0	0	1
#21 Riffle 6 ft`	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	1	0	1
All Habitats Combined 199 ft													15.5	15.5	36.8	36.8	0	52.3

Length of Stream Sampled (ft): 199 ft
Young-of-the-Year / Size Class 1 per Foot of Stream: 0.0779/ 0.0779
Yearlings and 2+ / Size Classes 2 and 3 per Foot of Stream: 0.1849/ 0.1849

Steelhead Sampling Results

Date: 24Sep09 **Stream:** Corralitos Ck **Sampled by:** Alley, Steiner, Wheeler. **Sampling Site:** 1 (below dam) **Water Temp. and Times:** 61° F @ 1400hr, 28Aug09; (air temp. 77°F)

Habitat type & Length (ft)	First Pass				Second Pass				Third Pass				Number Est. / Density Est. per ft					
	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	C-3	Total
#25 Pool 72 ft	17	11	8	14	8	7	0	1	2	2	0	0	29.5	23.8	8	15	0	38.8
#32 Pool 41 ft	5	4	4	5	2	2	0	0	0	0	0	0	7.5	6.7	4	5	0	11.7
#24 Riffle 29 ft	5	2	1	4	1	1	0	0	0	0	0	0	6.1	3.3	1	4	0	7.3
#26 Run (partial) 77 ft	12	9	2	5	2	1	0	1	1	1	0	0	15	11	2	6.1	0	17.1
All Habitats Combined 219 ft													58.1	44.8	15	30.1	0	74.9

Length of Stream Sampled (ft): 219 ft
Young-of-the-Year / Size Class 1 per Foot of Stream: 0.2653/ 0.2046
Yearlings and 2+ / Size Classes 2 and 3 per Foot of Stream: 0.0685/ 0.1374

Steelhead Sampling Results

Date: 24Sep09 Stream: Corralitos Ck Sampled by: Alley, Steiner, Wheeler
Sampling Site: 3 (above Colinas Drive) Water Temp. and Times: 64° F @ 1822 hr, 28Aug09; (air temp. 72° F).

Habitat type & Length (ft)	First Pass				Second Pass				Third Pass				Number Est. / Density Est. per ft					
	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	C-3	Total
#10 Pool 43 ft	7	6	2	3	0	0	0	0	0	0	0	0	7	6	2	3	0	9
#12 Pool 65 ft	7	2	2	7	0	0	1	1	0	0	0	0	7	2	3.3	8.1	0	10.1
#13 Pool 91 ft	4	1	4	7	1	1	3	3	1	1	0	0	6.3	3	8	10.8	0	13.8
#11 Riffle 11 ft	1	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1
#14 Riffle 13 ft	0	0	1	1	1	0	0	1	0	0	0	0	1	0	1	2	0	2
#9 Run 45 ft	4	3	0	1	0	0	0	0	0	0	0	0	4	3	0	1	0	4
All Habitats Combined 268 ft													26.3	15	14.3	24.9	0	39.9

Length of Stream Sampled (ft): 268 ft
Young-of-the-Year / Size Class 1 per Foot of Stream: 0.0981/ 0.0560
Yearlings and 2+ / Size Classes 2 and 3 per Foot of Stream: 0.0534/ 0.0929

Steelhead Sampling Results

Date: 25Sep09 **Stream:** Corralitos Ck **Sampled by:** Alley, Wheeler, Steiner
Sampling Site: 8 (above Clipper Gulch) **Water Temp. and Times:** 64° F @ 1410 hr, 30Aug09; (air temp. 73° F).

Habitat type & Length (ft)	First Pass				Second Pass				Third Pass				Number Est. / Density Est. per ft					
	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	C-3	Total
#49 Pool 39 ft	11	9	4	6	1	1	2	2	0	0	1	1	12	10.1	8	8.4	1	19.5
#52 Pool 99 ft	33	32	14	15	15	14	1	2	3	3	1	1	55.2	52.7	16	18	0	70.7
#53 Step-run 52 ft	8	8	3	3	2	2	0	0	0	0	0	0	10.3	10.3	3	3	0	13.3
#50 Riffle 15 ft	1	1	0	0	2	1	0	1	0	0	0	0	3	2	0	1	0	3
All Habitats Combined 205 ft													80.5	75.1	27	30.4	1	106.5

Length of Stream Sampled (ft): 205 ft
Young-of-the-Year / Size Class 1 per Foot of Stream: 0.3927/ 0.3663
Yearlings and 2+ / Size Classes 2 and 3 per Foot of Stream: 0.1317/ 0.1532

Steelhead Sampling Results

Date: 1Oct08 **Stream:** Corralitos Ck S**ampled by:** Alley, Wheeler, Steiner
Sampling Site: 9 (above Eureka Gulch) **Water Temp. and Time:** 64° F @ 1915 hr, 30Aug09; (air temp. 63° F)

Habitat type & Length (ft)	First Pass				Second Pass				Third Pass				Number Est. / Density Est. per ft					
	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	C-3	Total
#49 Step-Pool 61 ft	33	33	9	9	6	6	2	2	2	2	2	2	41.1	41.1	13.5	13.5	0	54.6
#50 Pool 38 ft	16	16	5	52	2	2	2	2	1	1	0	0	19	19	7.5	6.4	1.1	26.5
#52 Step-pool 34 ft	22	22	6	6	5	5	3	3	1	1	2	2	28.4	28.4	13.2	13.2	0	41.6
#51 Step-run 24 ft	4	4	1	1	2	2	1	1	0	0	0	0	6.7	6.7	2	2	0	8.7
#57 Step-run 47 ft	13	12	3	4	1	1	0	0	1	1	0	0	15	14	3	4	0	18
All Habitats Combined 204 ft													110.2	109.2	39.2	39.1	1.1	149.4

Length of Stream Sampled (ft): 204 ft

Young-of-the-Year / Size Class 1 per Foot of Stream: 0.5402/ 0.5353
Yearlings and 2+ / Size Classes 2 and 3 per Foot of Stream: 0.1922/ 0.1971

Steelhead Sampling Results

Date: 25Sep09 **Stream:** Shingle Mill Gulch **Sampled by:** Alley, Steiner, Wheeler

Sampling Site: 1 (below 2nd Road crossing) **Water Temp. and Times:** 60° F @ 1630hr, 25Sep09; (air temp.)

Habitat type & Length (ft)	First Pass				Second Pass				Third Pass				Number Est. / Density Est. per ft					
	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	C-3	Total
#30 Pool 36 ft	0	0	2	2	0	0	0	0	0	0	0	0	0	0	2	1	1	2
#32-33 Step-Pool 30 ft	0	0	2	2	0	0	0	0	0	0	0	0	0	0	2	2	0	2
#23 Riffle 14 ft	0	0	1	1	0	0	0	0	0	0	0	0	0	0	1	1	0	1
#31 Step-run 25 ft	0	0	2	2	0	0	0	0	0	0	0	0	0	0	2	2	0	2
#34 Step-run 30 ft	0	0	2	2	0	0	0	0	0	0	0	0	0	0	2	2	0	2
All Habitats Combined 135 ft													0	0	9	8	1	9

Length of Stream Sampled (ft): 135 ft

Young-of-the-Year / Size Class 1 per Foot of Stream: 0.0/ 0.0
Yearlings and 2+ / Size Classes 2 and 3 per Foot of Stream: 0.0667/ 0.0667

Steelhead Sampling Results

Date: 28Sep09 **Stream:** Shingle Mill Gulch **Sampled by:** Alley, Steiner, Wheeler

Sampling Site: 3 (above 3rd road crossing) **Water Temp. and Times:** 59° F @ 1747hr, 24Aug09; (air temp. 63° F)

Habitat type & Length (ft)	First Pass				Second Pass				Third Pass				Number Est. / Density Est. per ft					
	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	C-3	Total
#49 Pool 23 ft	2	2	1	1	0	0	2	2	0	0	0	0	2	2	3	3	0	5
#51 Pool 52 ft	7	7	4	4	2	2	0	0	1	1	0	0	10.3	10.3	4	4	0	14.3
#53 Pool 41 ft	7	7	4	4	4	4	0	0	1	1	0	0	13.7	13.7	4	4	0	17.7
#50 Riffle 19 ft	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
#59 Run 17 ft	1	1	0	0	1	1	0	0	0	0	0	0	2	2	0	0	0	2
All Habitats Combined 152 ft													28	28	11	11	0	39

Length of Stream Sampled (ft): 152 ft

Young-of-the-Year / Size Class 1 per Foot of Stream: 0.1843/ 0.1843
Yearlings and 2+ / Size Classes 2 and 3 per Foot of Stream: 0.0724/ 0.0724

Steelhead Sampling Results

Date: 28Sep09 Stream: Browns Valley Ck Sampled by: Alley, Steiner, Reis
Sampling Site: 1 (below diversion dam) Water Temp. and Times: 58° F @ 1218hr, 28Sep09; (air temp.).

Habitat type & Length (ft)	First Pass				Second Pass				Third Pass				Number Est. / Density Est. per ft					
	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	C-3	Total
#1 Pool 65 ft	1	1	13	13	2	2	2	2	1	1	0	0	4	4	15.2	14	1.2	19.2
#3 Pool 57 ft	7	7	10	10	2	2	0	0	0	0	0	0	9.3	9.3	10	10	0	19.3
#2 Run 16 ft	2	2	0	0	0	0	0	0	1/0	1/0	0/0	0/0	3	3	0	0	0	3
#4 Riffle-57 ft	1	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	1
All Habitats Combined 195 ft													17.3	17.3	25.2	24	1.2	42.5

Length of Stream Sampled (ft): 195 ft

Young-of-the-Year / Size Class 1 per Foot of Stream: 0.0887/ 0.0887
Yearlings and 2+ / Size Classes 2 and 3 per Foot of Stream: 0.1292/ 0.1292

Steelhead Sampling Results

Date: 28Sep09 **Stream:** Browns Valley Ck **Sampled by:** Alley, Wheeler, Steiner
Sampling Site: 2 (above diversion dam) **Water Temp. and Times:** 59° F @ 1505hr, 25Aug09; (air temp. 67° F).

Habitat type & Length (ft)	First Pass				Second Pass				Third Pass				Number Est. / Density Est. per ft					
	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	YOY	C-1	1+	C-2	C-3	Total
#32 Pool 67 ft	14	14	9	9	2	2	1	1	7/0	7/0	0/0	0/0	23	23	10	10	0	33
#38 Pool 37 ft	13	13	5	5	8	8	2	2	1	1	0	0	25.6	25.6	7.5	7.5	0	33.1
#31 Run 24 ft	4	4	0	0	1	1	0	0	3/0	3/0	0/0	0/0	8	8	0	0	0	8
#30 Riffle 27 ft	9	9	1	1	1	1	0	0	0	0	0	0	10.1	10.1	1	1	0	11.1
All Habitats Combined 155 ft													66.7	66.7	18.5	18.5	0	85.2

Length of Stream Sampled (ft): 155 ft

Young-of-the-Year / Size Class 1 per Foot of Stream: 0.4303/ 0.4303
Yearlings and 2+ / Size Classes 2 and 3 per Foot of Stream: 0.1194/ 0.1194

APPENDIX D. Habitat and Fish Sampling Data With Size Histograms.

(Included electronically in a separate PDF file.)

APPENDIX E. Hydrographs from San Lorenzo, Soquel and Corralitos Watersheds.

(Included electronically in a separate PDF file.)