APPENDIX B. DETAILED ANALYSIS OF 2012 STEELHEAD MONITORING IN THE SAN LORENZO, SOQUEL, APTOS AND CORRALITOS WATERSHEDS.

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SCOPE OF WORK

In fall 2012, 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 21 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 2011 and 2012. Tributaries included Branciforte, Zayante, Lompico, Bean, Fall, Newell, Boulder and Bear creeks. Seven steelhead sites were sampled below anadromy barriers in Soquel Creek and its branches, and 4 half-mile reach segments were habitat typed. In the Aptos Creek watershed, 2 sites in Aptos Creek and Aptos Lagoon/Estuary were sampled. The lower ½-mile segment of Aptos Creek was habitat typed. In the Corralitos sub-watershed of the Pajaro River drainage, 4 sites were sampled in Corralitos Creek with 3 half-mile reach segments habitat typed, 2 sites were sampled in Shingle Mill Gulch and 2 sites were sampled in Browns Valley Creek. Pajaro Lagoon was also sampled.

Annual monitoring of juvenile steelhead began in 1994 in the San Lorenzo and 1997 in Soquel Creek (also sampled in 1994). The Corralitos sub-watershed was previously sampled in 1981, 1994, 2006─2011. Aptos Creek was previously sampled in 1981, 2006─2011. Fall streamflow was measured at 19 locations in the 4 sampled watersheds.

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

Migration. 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, 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. YOY fish production is related to spawning success, which is a function of the spawning habitat quality, 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 baseflows (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 San Lorenzo River tributaries 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, 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.

Growth of yearling steelhead 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 reduced flow eliminates fast-water feeding areas and reduces insect production and drift. A short growth period may occur in fall and early winter after leaf-drop from 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 primarily by YOY and more so in the upper mainstem than the branches where they 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 fastwater 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.

The lower San Lorenzo mainstem below Zayante Creek typically has sufficient baseflow every year to grow a high proportion of YOY to smolt size in one year, as does lower Soquel Creek below Moores Gulch. In these lower reaches with high growth potential, factors that determine YOY densities are important in determining soon-to-smolt densities, such as number of adult spawners, spawning success and/or recruitment of YOY from nearby tributaries.

There is a group of sites with intermediate YOY growth potential which may produce a higher proportion of YOY that reach potential smolt size by fall in addition to yearlings if streamflow is high and/or YOY densities are low. These reaches include the middle mainstem San Lorenzo between Boulder and Zayante creek confluences, upper Soquel mainstem above the Moores Gulch confluence, lower East Branch Soquel, Aptos Creek mainstem and lower Corralitos below Rider Creek confluence. In above average baseflow years, these reaches are relatively productive for soon-to-smolt-sized YOY unless large, late stormflows reduce YOY survival or insufficient adults spawn after the late storms to saturate habitat with YOY.

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. During the Sogard et al. (**2009**) work, many juveniles that had been PIT tagged early in the growing season were recaptured in the same habitats later in the fall, and we detected very few of their marked fish in other downstream sites through the years of tagging, with most being captured in close proximity of where they were originally tagged. 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 2012 fall fish sampling and habitat evaluation included comparison of 2012 juvenile steelhead densities at sampling sites and rearing habitat conditions with those in 1997–2001 and 2003–2011 for the San Lorenzo River mainstem and 8 tributaries and with those in 1997−2011 for the Soquel Creek mainstem and branches. 2012 site densities were compared to multi-year averages. 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 2012 in the Corralitos Creek sub-watershed were compared to those in 1981, 1994 and 2006−2011. Fall 2012 steelhead densities and habitat conditions in the Aptos Creek watershed were compared to those in 1981 and 2006−2012, and the Aptos Lagoon/estuary was inventoried for the second time to compare to the 2011 lagoon population estimate. Findings in Pajaro Lagoon will be compared to future sampling results.

In 2012, instream wood was inventoried in Branciforte Creek Reach 21a-2, Soquel Creek Reach 7 and Corralitos Creek Reach 5/6 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, and an index of juvenile steelhead production was estimated by reach to obtain an index of juvenile population size for each watershed. Indices of returning 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 their 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 2012, 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 2012. 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 2012, 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 sub-watershed; 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, streambed 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.

Sampled 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 in some years, 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 in 2009 (Reach 14b) and last sampled (Site 21) in 2011. Landowner objection in 2006 prevented our surveying and sampling of Reach 14a since then.

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 last sampled in 2010 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 in some years. Site numbers were kept consistent with the original 1981 designations to prevent confusion.

In Corralitos Creek, 4 reaches were chosen to be sampled: 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 upstream of 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 reworked in 2011) 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 <u>California Salmonid Stream Habitat Restoration Manual</u> (**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 detailed data were collected for escape cover than required by the manual to obtain biologically relevant information.

M-3. Measurement of Habitat Conditions

During habitat typing in 2012, 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 despite the elevated temperatures and steelhead metabolic rate (and associated food requirements). This is especially true downstream of the Zayante Creek confluence where deeper, fastwater feeding areas exist. 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 2003-2011. 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. Escape cover was identified in areas where fish could be completely hidden from view. It 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. Water depth also provides some escape cover when 2 feet deep and good escape cover when it is 3 feet deep (1 meter) or greater. The summer escape cover (as unembedded cobbles, undercut banks and instream wood) also provides overwintering habitat in the tributaries. Objects of cover may include unembedded boulders, submerged woody debris, undercut banks, bubble curtains and overhanging tree branches and vines that enter the water. Man-made objects, such as boulder riprap, concrete debris and plywood also provide cover. 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. Measurement of escape cover at sampling sites allowed annual comparisons for the habitats at historical sites.

Escape Cover– Habitat Typing Method by Reach. Reach segment averages in 1997–2000, 2003, 2005–2012 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.)

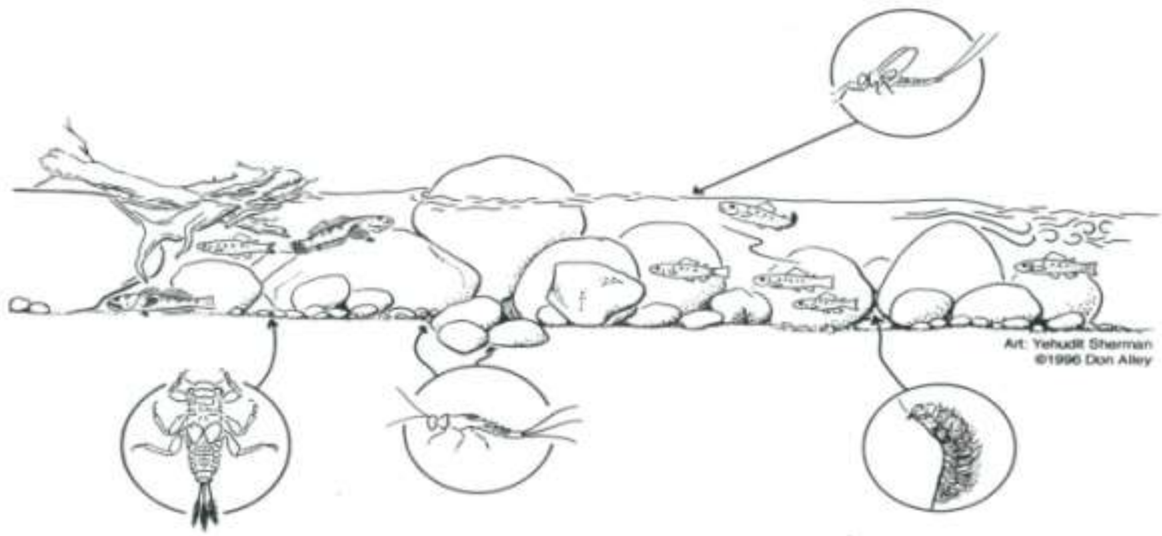

Illustration of riffle habitat (stream flowing from left to right) showing escape cover under rootwad and boulders. (Juvenile steelhead are holding feeding positions, facing upstream.)

Water Depth, Channel Length and Channel Width. 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.

Streamflow. Streamflow is an important aspect of habitat because it contributes to habitat depth and water velocity. Greater depth offers better rearing habitat. Faster water velocity offers better feeding habitat and higher growth rate. Assessment of streamflow at only established gages is insufficient to compare annual differences in streamflow throughout a watershed because streamflow decline in each tributary is not necessarily proportional to decline at a downstream gage, especially when specific aquifers are drawn down at variable municipal pumpage rates or specific tributary surface water is diverted at variable rates, which impact summer baseflow differently in wet versus dry years.

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 2010−2012. 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 2007−2011, 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. 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, including the upper San Lorenzo River above the Boulder Creek confluence, all San Lorenzo tributaries and in the Aptos and Corralitos watersheds, representative pools with average habitat quality in terms of water depth and escape cover were 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, runs and glides had similar depth and escape cover within their own habitat type designations.

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 typical, 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 more 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 2003-2012

Habitat conditions of depth and escape cover were measured at the monitoring sites in 2012, consistent with methods used in 1981 and 1994-2001 and 2003−2011 in the San Lorenzo River and Soquel Creek watersheds. Donald Alley, the principal investigator and data collector in 1994−2001 and 2003−2012, 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 2006−2012, 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 (**H.T. Harvey & Associates (HTH) 2003**). Much of their data were not included in this report because their methods were different from ours. The method used for choosing nonrandom fish sampling sites was not provided in their report. Their size class divisions of juvenile steelhead differed from ours, thus preventing annual comparisons by size class. Therefore, only 2002 total densities were graphed in this report. HTH did not compute densities by age class. In 2002, HTH sampled random and nonrandom sites in the middle mainstem San Lorenzo and compared. HTH found good correlation for juvenile densities between random and nonrandom sampling sites, especially in riffles and runs. HTH found higher steelhead densities in some mainstem pools than our earlier sampling. However, this may have been an artifact of HTH eliminating about 20% of the pools for inventory because they were judged to be too deep or had too much cover for censusing, creating a bias toward short, shallow pools that misrepresented typical mainstem pool habitat and that would yield higher densities. In typical mainstem pools, juvenile steelhead inhabit primarily the fastwater habitat at the heads of pools which typically span hundreds of feet in length, with the majority of the pool length being unused and yielding low overall steelhead pool density. HTH's 2002 juvenile densities in the San Lorenzo system were generally above average compared to other years, which was consistent with D.W. ALLEY & Associates findings in Soquel Creek in 2002. For a more detailed review of HTH 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.
(2012 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 -CM22.1	Downstream 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 2012.)

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 2012.)

Reach #	Site # -Channel Mile	Location of Sampling Sites
Aptos Creek		
0	*0 -CM0.0	Lagoon/Estuary
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 2011.)

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

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

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

Pajaro River Lagoon

1	*1 -CM0.0-CM3.0	From beach to 0.8 miles upstream of Thurwachter Bridge.

M-7. 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 habitats other than deep mainstem San Lorenzo pools because it would be inaccurate in heavily utilized fastwater habitat in the mainstem and in 80-90% of the habitat in tributaries. Shallow depth and poor visibility prevent most all habitats in tributary reaches and fastwater riffles of the mainstem reaches from being effectively censused by snorkeling. In Santa Cruz Mountain watersheds, tributaries to mainstems often flow through steep-walled canyons, consisting of densely shaded pools with undercut banks and other cover complexity, along with shallow fastwater habitat usually averaging 0.5 feet in depth or less. Mainstem riffles, where juvenile densities are especially high, usually average less than a foot in depth. Furthermore, our level of data analysis requires dividing juveniles into size and age classes to adequately evaluate the composition of juvenile populations with regard to potential smolt size and annual growth rates, which cannot be effectively accomplished by snorkeling unless juvenile densities are very low. However, as is typical, 24 of 26 sampled tributary pools in the San Lorenzo system (typically 50-100 feet long) had more than 20 juvenile steelhead in 2005. And densities are typically between 50 and 100 juveniles per 100 feet at sampling sites (**Figure 23**). Inventory by size class requires actual measurement of individuals with rulers.

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 2003-2011, 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 2011, as in previous years, the lower mainstems of the San Lorenzo River and Soquel Creek, a high proportion of 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 14 years in the San Lorenzo system by size and age (1997−2001 and 2003−2011) and for 15 years in Soquel Creek (1997−2011). 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.

M-8. Sampling of Aptos Lagoon/Estuary

Initially on 20 September 2012, steelhead were sampled from 5 seine hauls with a 106-ft long bag seine (6 feet high by 5/16-inch mesh) in the main estuary (**refer to illustration and photos**). Steelhead were placed in a holding pin until all seine hauls were completed. All steelhead were measured to Standard Length and Fork Length. Half of one pelvic fin was clipped on each steelhead as all steelhead were released back into the estuary. There were no steelhead mortalities. Other fish species were identified and counted.

In addition on 20 September, the periphery of the estuary, east of the rock jetty, was sampled for tidewater goby and other small fishes with 7 seine hauls, using a 30-foot long beach seine (4 feet high by 1/8-inch mesh). The margin along the jetty could not be seined effectively because it lacked smooth, gradual shorelines where the seine could be adequately beached. However, we ran the seine along the east side of the jetty as best we could and beached it on the sand periphery. Each seine haul was inspected for tidewater goby, and the fish species composition was determined for the seine hauls, combined.

On 27 September 2012, steelhead were again sampled with 3 seine hauls with a 106-ft long bag seine in the main estuary. All steelhead were measured to Standard and Fork Length and checked for fin clips. Scale samples were taken from 12 steelhead greater than 150 mm Standard Length for purposes of determining their age (young-of-the-year or older). No steelhead head mortalities occurred. Other species captured with the long seine were identified and counted.

In addition on 27 September, tidewater gobies were sampled for with the 30-foot long beach seine with 9 seine hauls around the estuary periphery (6 hauls east of the rock jetty and 3 hauls west of the jetty and downstream of the walk bridge. Each seine haul was inspected for tidewater goby, and the fish species composition was determined for the seine hauls, combined.

M-9. Sampling of Pajaro Lagoon

On 2 October 2012, two sites were sampled for steelhead in upper Pajaro Lagoon, upstream of the Watsonville Slough confluence. The lagoon was very full, and these were the only locations where the 106-ft long bag seine (6 feet high by 5/16-inch mesh) could be adequately beached after being set with a boat. Three seine hauls were made at each site. Species of fish were identified, counted and released without mortality. Water quality (oxygen concentration, temperature, salinity and conductivity) was measured at each site along the lagoon periphery. One site was adjacent to the model airplane landing strip (1.8 miles upstream of Watsonville Slough and 0.3 miles downstream of Thurwachter Bridge (N36.87689; W121.79555)). The other site was under the Thurwachter Bridge (2.1 miles upstream of Watsonville Slough (N36.88023; W121.79328)).

On 3 October 2012, lower Pajaro Lagoon was sampled at 8 sites with the 106-foot long seine set by boat. The seine was set 150-200 feet out into the lagoon and beached along the inner sandbar that separated the lagoon from the Bay. The sandbar was closed. Seining locations extended from approximately 200 meters east of Watsonville Slough confluence to the eastern end of the lagoon in approximately evenly spaced intervals. Seining included a deeper area near the central extent of the lower lagoon. Species of fish were identified, counted and released without mortality, except for striped bass, which were dispatched.

On the morning of 4 October 2012, lower Pajaro Lagoon was sampled for tidewater gobies at 6 sites, using a 30-foot long beach seine (4 feet high by 1/8-inch mesh) and one site adjacent to the Pajaro Dunes development in Watsonville Slough, 100 meters from its confluence with Pajaro Lagoon. Fish species were identified, counted and released without mortality. After seine hauls, water quality was measured at a maximum depth (0.75−1.0 meter depths) as far out from shore as could be waded at sites 1, 4 and 6 in Pajaro Lagoon. GPS readings were taken at each seining site.

On the afternoon of 4 October 2012, upper Pajaro Lagoon was sampled with the 30-foot long beach seine at the only site that could be found where wading was possible out from a shoreline that was unobstructed with vegetation. Other locations had either very steeply sloped streambeds from shore and/or overhanging vegetation that made beaching of the seine impossible. The sampling site was at a canoe ramp at the park beyond the sewage treatment plant, 0.8 miles upstream of Thurwachter Bridge. As with the morning seine hauls, fish species were identified, counted and released without mortality. After the seine haul, water quality was measured at the maximum depth (1.0 meter) as far out from shore as could be waded. A GPS reading was taken at the canoe ramp site.

DETAILED RESULTS

R-1. Capture and Mortality Statistics

For the overall sampling activities in 2012, 3,180 juvenile steelhead were captured by electrofishing at 38 sites, with 28 mortalities (0.88% mortality rate). 124 juvenile steelhead were captured on 2 days at Aptos Lagoon/Estuary with no mortalities. No steelhead were captured in Pajaro Lagoon. A total of 59 juvenile steelhead were visually censused in pools at 5 San Lorenzo mainstem sites. Eight mainstem sites and 13 tributary sites were sampled in the San Lorenzo watershed in 2012, with a total of 1,836 juvenile steelhead captured and 14 mortalities (0.78%). A total of 597 juvenile steelhead were captured at 7 sites in the Soquel watershed in 2012 with 4 mortalities (0.67%). A total of 221 juveniles steelhead were captured in the Aptos Watershed at 2 Aptos sites with 2 mortalities (0.90%). A total of 526 juveniles were captured in the Corralitos watershed at 8 sites with 4 mortalities (0.76%). Small YOY steelhead were numerous in 2012, and they were more vulnerable to electrofishing mortality than larger fish.

R-2. Habitat Change in the San Lorenzo River Mainstem and Tributaries, 2011 to 2012

Refer to **Appendix A** for maps of reach locations. Summary tables of habitat change for all reaches are provided in **Tables 13b and 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 and early summer when baseflow is higher and most important. Unlike in the wet 2011 year, all reaches in 2012 had slightly below the median daily statistic for baseflow from May through the summer (**Figures 33 and 34**). Late storms in spring 2012 created flows above the median statistic in March and April (**Figure 35**). Spring and summer baseflows were higher in 2011 because of greater rainfall, and aquifers had recovered somewhat from the dry years of 2007-2009 (**Table 5a; Figure 42**). Lower baseflow in 2012 provided less food (lower insect drift velocity and reduced fastwater habitat) and reduced growth rate in all reaches, especially with the higher total fish densities in 2012 caused by higher YOY densities and likely late spawning (**Figures 21 and 23;** fish size histograms in **Appendix D**). Slower YOY growth was exemplified by the lower percent of YOY reaching Size Class II in 2012 compared to the wetter year of 2011 at all but 2 sites (**Figure 17**). In 2012, only Reaches 2, 11 and 12b were habitat typed in the mainstem. Therefore, other reaches were evaluated according to habitat changes at sampling sites.

Overall habitat quality improved only at Site 0a of in the San Lorenzo mainstem from 2011 to 2012, despite reduced streamflow in Reach 0a. Habitat quality improved in Reach 0a due to deeper pool habitat with more escape cover, less fine sediment and less embeddedness (**Tables 5a, 5b, 6a-b, 7a-b, 8a-b, 9a-b, 12a-b and 13b**). Consistent with improved habitat at Site 0a, density of large YOY was greater there than in 2011 and much above average (**Tables 18 and 21; Figures 2 and 4**). In tributaries, habitat quality improved only at Branciforte Site 21a-2 with increased pool depth, less fines and embeddedness and more escape cover. Habitat quality likely improved in Reach 21b in upper Branciforte Creek since 2001 because percent fines and embeddedness were substantially reduced in

2012. In other reaches and sites, habitat quality declined with generally decreased habitat depth and reduced baseflow, while the majority had similar or less percent fines and embeddedness compared to 2011 conditions. Despite reduced habitat quality in most reaches and sites, 2012 YOY densities were higher at 5 of 7 mainstem sites and 8 of 12 tributary sites (**Table 23**) compared to 2011. Late spawning during late storms created more and smaller YOY in 2012. Yearling densities were similar or slightly less at mainstem sites between years (**Table 19**) and higher at 9 of 12 tributary sites in 2012 compared to 2011, indicating that more survived to spend another season after a milder winter.

Table 5a. Fall STREAMFLOW (cubic feet/ sec) measured by flowmeter at SAN LORENZO sampling sites before fall storms (or in 2011 when summer baseflow had resumed after early storm) by D.W. ALLEY & Associates.

Site # / Location	1995	1996	1998	1999	2000	2001	2003	2004	2005	2006	2010	2011	2012
1- SLR/ Paradise Pk	22.9	25.5	34.3	26.2	21.7	19.6				26.2	18.7	27.6	17.2
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 Zay.			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		2.8
9- SLR/ Below Bould.	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	1.10	0.40
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	7.2	4.4
13b/ Zayante above Bean			3.9	2.9	2.8	1.9	2.1	1.7	3.2	2.8			
14b/Bean bel Lockhart G	1.5		1.1	1.1	1.0	1.1	1.1	0.77	1.0	1.1			
14c/Bean abv MacKenzie											0.03	0.11	dry
15/ Fall	2.0		3.4	2.2	1.7	1.7							
16/ Newell	1.6				0.51						1.2	0.92	0.78
17a/ Boulder	2.0		2.2		1.1	1.0	1.25	0.9	1.6	1.7	1.6	2.2	1.1
18a/ Bear				0.45	0.61	0.34	0.6	0.51	0.90	1.1	0.68	1.3	0.23
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	0.81	0.32

*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 2006−2012 and from Stream Gages; Measurements by D.W. ALLEY & Associates; 2010 (September), 2011 (October), 2012 (October) at fall baseflow conditions, County Staff (Date stipulated).

Location	2006	2007	2008	2009	2010	2011	2012
SLR at Santa Cruz Gage	14 (30 Oct)	0.6 (4 Sep)	0.3 (3 Sep)	0.6 (3 Sep)	5.5 (2 Oct)	12 (23 Sep)	5.2 (19 Oct)
SLR at Sycamore Grove	34.8	14.6	14.2	−	18.7 Paradise P. (DWA)	27.6 Paradise P. (DWA)	17.2 Paradise P. (DWA)
SLR at Big Trees Gage	21 (30 Oct)	11 (4 Sep)	11 (3 Sep)	12 (3 Sep) 11 (11 Oct)	15 (2 Oct)	22 (23 Sep)	15 (9 Oct); 16 (19 Oct)
SLR above Love Cr	13.14	5.4 After*	3.8	−	6.7 (9/7)		
SLR below Boulder Cr	7.49	2.9 After	3.1	−	5.9 (9/7)		
SLR @ Two Bar Cr	1.8	0.78	0.39	−	2.0 (8/4)	2.4 (8/16)	1.46 (8/1)
SLR @ Teihl Rd					0.97 (DWA)	1.1 (DWA)	0.40 (DWA)
Zayante @ SLR	6.5	3.80	−	−	4.9 Below Bean (DWA)	7.2 Below Bean (DWA); 9.1 (8/3)	4.4 Below Bean (DWA); 5.1 (9/16)
Zayante below Lompico Cr	1.2	0.96	0.41	0.43	1.51 (8/24)		
Lompico Creek @ Carrol Ave						0.3 (8/10)	0.39 (6/13)
Bean adjacent Mt. Hermon	2.6	1.9	2.1	2.2	3.1 (9/2)	3.5 (8/25)	
Bean Below Lockhart Gulch	1.4	0.72	0.79	0.89	0.68 (9/2)		
Newell Cr @ Rancho Rio	1.2	1.2	1.1	−	1.17 (DWA)	0.92 (DWA); 1.6 (8/17)	0.78 (DWA); 1.14 (11/4)
Boulder Cr @ SLR	2.19	0.84	1.0	0.97	1.6 (DWA)	2.2 (DWA); 2.6 (8/17)	1.3 (DWA)
Bear Cr above Hopkins Gulch					0.68 (DWA)	1.3 (DWA)	0.23 (DWA)
Bear Cr @ SLR	1.9	0.37	0.27	−	1.6 (8/4)	2.0 (8/16)	0.69 (8/1)
Branciforte @ Isabel Lane			0.3	0.25	0.42 (8/26)		0.57 (8/22)
Soquel above Lagoon					2.3(DWA)	4.9 (DWA)	1.8 (DWA)
Soquel Cr at USGS Gage	6.6**	1.4**	0.65**	1.2**	3.4**	5.8**	1.8**
Soquel Cr @ Bates Cr	5.73	-	1.08		4.2 (9/1)	7.3 (8/31)	2.0 (9/19)
Soquel above Moores Gulch					2.16 (DWA)	4.3 (DWA)	2.0 (DWA)
W. Branch Soquel @ Old S.J. Road Olive Springs Bridge	2.2	1.75 After	−	−	1.2 @ Mouth (DWA)	2.2 @ Mouth (DWA); 3.0 (8/31)	1.1 @ Mouth (DWA); 1.21 (9/05)
W. Branch above Hester Creek (SCWD Weir/ Kraeger-prelim.)	1.5 (15 Sep)	1.0 (15 Sep)	−	−	−	−	−
E. Branch Soquel @ 152 Olive Springs Rd.	-	1.0 After	−	−	0.77 @ Mouth (DWA)	2.1 @ Mouth (DWA); 2.7 (8/31)	0.54 @ Mouth (DWA); 0.43 (9/05)
E. Branch below Amaya and above Olive Springs Quarry (SCWD Weir/ Kraeger-prelim.)	1.5 (15 Sep)	0.43 (15 Sep)	−	−	−	−	
E. Branch Soquel above				Trickle	0.44 (DWA)		

Amaya Creek				(DWA)			
Aptos @ Valencia Cr	2.5	1.2 After	0.77	0.53	0.85 (9/1)		0.87 (DWA); 1.10 (9/05)
Aptos above Valencia Cr					0.97 (DWA)	1.6 (DWA)	
Valencia Cr @ Aptos Cr			0.007	0.34 (May)	0.09 Adj. School (DWA)	0.8 Adj. School (7/27)	0.20 (9/05)
Valencia below Valencia Rd					0.22 (DWA)		
Corralitos Cr below Browns Valley Road Bridge	15.9 (May)	0.49 (May)	dry	1.71 (May)	0.47 (9/2)	0.2 (9/8)	
Corralitos above Los Casinos Road Bridge					2.0 (DWA)	2.6 (DWA)	2.0 (DWA)
Corralitos Cr @ Rider Cr	3.35	2.5 After	1.44	–	2.4 (9/2)		1.73 (9/13)
Corralitos above Eureka Gulch					0.63 (DWA)	0.71 (DWA)	0.23 (DWA)
Browns above diversion dam	0.96	0.30 After	0.32	–	0.41 (DWA)	0.79 (DWA); 0.5 (9/8)	0.30 (DWA); 0.14 (9/13)

*   After 2 early October storms that increased baseflow.

** Estimated from USGS Hydrographs for September 1.

Table 5c. Habitat Proportions of Pools, Riffles and Run/Step-runs in Habitat-Typed Reaches of the San Lorenzo, Soquel, Aptos and Corralitos Watersheds in 2012 and Most Recent Preceding Year.

Reach	2012 Pool Habitat In Feet/ Percent / # Habitats	2011 Pool Habitat In Feet/ Percent / # Habitats	2012 Riffle Habitat Feet/ Percent / # Habitats/ Riffle Width (ft)	2011 Riffle Habitat Feet/ Percent / # Habitats/ Riffle Width (ft)	2012 Run/Step-run/ Glide Habitat Feet/ Percent / # Habitats/ Width (ft)	2011 Run/ Step-run Habitat Feet/ Percent / #Habitats/ Width (ft)
Low. San Lorenzo #2	1912/55%/ 9	1711/52%/ 9	1065/ 31%/ 14/ 29 ft	773/ 24%/ 13/ 39 ft	493/ 14%/ 10/ 26 ft	781/ 24%/ 7/ 31 ft
Upper San Lorenzo # 11	2414/73%/ 21	(2009) 2066/66%/ 23	377/ 11%/ 18/8.5 ft	(2009) 279/9%/ 12/9 ft	510/ 15%/ 13/11 ft	(2009) 801/25%/ 16/ 11 ft
Upper San Lorenzo # 12	1498/ 58% /34	(2000 downstream) 1167/ 59%/ 24	444/ 17%/ 16/ 7 ft	(2000 downstream) 393/ 20%/ 13/	641/ 25%/ 15/ 13 ft	(2000 downstream) 419/ 21%/ 12/
Zayante #13d	1587/61%/ 31	1553/61%/ 30	262/ 7%/ 10/ 7 ft	232/ 9%/ 7/ 10 ft	740/ 29%/ 16/ 12 ft	776/ 30%/ 21/ 16 ft
Bean #14b	2130/71%/ 32	1743/64%/ 26	541/ 18%/ 18/ 8 ft	511/15%/ 18/ 10 ft	314/ 11%/ 6/ 13 ft	666/21%/ 14/ 12 ft
Bear #18a	2604/ 77%/ 25	2327/70%/ 19	352/ 10% 13/ 8 ft	427/13%/ 11/ 14 ft	405/ 12%/ 10/ 10 ft	581/17%/ 11/ 15 ft
Branciforte #21b	1122/ 64%/ 21	(2000) 1113/ 61%/ 20	184/ 11%/ 14/ 9 ft	(2000) 154/ 8%/ 10/	445/ 25%/ 9/ 9 ft	(2000) 547/ 30%/ 16/
Soquel #1	3774/ 85%/ 15	(2009) 3583/82%/ 16	433/ 10%/ 12	(2009) 465/11%/ 11	250/ 6%/ 5	(2009) 341/8%/ 8
Soquel #7	2383/ 64%/ 17	(2009) 2599/63%/ 18	782/ 21%/ 15/ 19 ft	(2009) 588/14%/ 15	586/ 16%/ 10/ 20 ft	(2009) 906/22%/ 13
Soquel #12a	973/ 38%/ 18	882/34%/ 17	303/ 12%/ 9/ 8 ft	297/12%/ 9/ 11 ft	1312/ 51%/ 18/ 10 ft	1402/54%/ 20/ 12 ft
Aptos #3	2025/ 78%/ 20	(2009) 2154/80%/ 21	374/ 14%/ 15/ 15 ft	(2009) 406/15%/ 21	182/ 7%/ 7/ 9 ft	(2009) 138/5%/ 5
Corralitos #3	1192/ 42%/ 18	1040/39%/ 20	863/ 31%/ 18/ 14 ft	907/34%/ 22/ 14 ft	766/ 27%/ 12/ 13 ft	752/28%/ 18/ 14 ft
Corralitos #5/6	1288/ 43%/ 21	1181/41%/ 20	416/ 14%/ 13/ 12 ft	800/27%/ 20/ 12 ft	1325/ 44%/ 23/ 11 ft	935/32%/ 17/ 12 ft
Corralitos #7	1010/ 38%/ 33	1044/39%/ 29	269/ 10%/ 18/ 6 ft	329/12%/ 14/ 7 ft	1388/ 52%/ 25/ 8 ft	1313/49%/ 27/ 11 ft

Table 6a. Averaged Mean and Maximum WATER DEPTH in SAN LORENZO Reaches Since 2006.

Reach	Pool 2006	Pool 2007	Pool 2008	Pool 2009	Pool 2010	Pool 2011	Pool 2012	Riffle 2006	Riffle 2007	Riffle 2008	Riffle 2009	Riffle 2010	Riffle 2011	Riffle 2012	Run/Step Run 2006	Run/Step Run 2007	Run/Step Run 2008	Run/Step Run 2009	Run/Step Run 2010	Run/Step Run 2011	Run/Step Run 2012
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		2.5/4.1	2.6/5.1	2.5/4.4	2.7/4.9	2.9/5.4 Seg.Δ	2.5/5.0		0.9/1.4	0.8/1.3	0.8/1.4	0.8/1.4	1.1/1.7 Seg.Δ	1.1/1.7		1.4/2.2	1.3/1.9	1.3/2.3	1.7/2.7	1.6/2.5 Seg.Δ	**1.6/2.3**
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	2.2/4.3	1.7/3.4	1.6/3.1					0.8/1.3	0.6/1.0	0.55/0.9					1.3/1.85	0.9/1.3	0.8/1.1				
7-M. Main																					
8-M. Main	2.7/5.5	2.3/4.3	2.3/4.7	2.8/5.1				1.1/1.6	0.6/1.0	0.45/0.7	0.65/1.0				1.3/2.25	0.8/1.2	0.8/1.2	0.7/1.0			
9-M. Main																					
10-U. Main																					
11-U. Main	1.1/2.1	1.0/1.9	0.9/1.8	1.05/1.8			1.1/2.0	0.5/0.8	0.2/0.4	0.25/0.5	0.25/0.4			0.3/0.5	0.6/1.1	0.4/0.6	0.4/0.7	0.4/0.75			**0.5/0.7**
12b-U. Main							1.1/1.9							0.3/0.7							**0.5/0.8**
Zayante 13a	1.6/2.6	1.4/2.2	1.5/2.5					0.6/0.9	0.5/0.8	0.4/0.8					0.85/1.2	0.6/1.0	0.6/0.9				
Zayante 13b																					
Zayante 13c		1.2/2.2	1.2/2.2		1.3/2.2	1.5/2.4			0.2/0.5	0.2/0.6		0.4/0.7	0.5/0.8			0.5/0.9	0.4/0.8		0.6/1.0	0.7/1.1	
Zayante 13d	1.35/2.1	1.0/1.5	1.0/1.55	0.9/1.5	1.2/2.0	1.3/2.0	1.1/1.8	0.45/0.8	0.3/0.5	0.2/0.5	0.25/0.5	0.4/0.6	0.45/0.8	0.3/0.6	0.9/1.4	0.6/1.0	0.5/0.9	0.55/0.9	0.7/1.1	0.8/1.2	**0.6/1.0**

Reach	**Pool 2006**	**Pool 2007**	**Pool 2008**	**Pool 2009**	**Pool 2010**	Pool 2011		**Rif-fle 2006**	**Rif-fle 2007**	**Rif-fle 2008**	**Rif-fle 2009**	**Rif-fle 2010**	Rif-fle 2011		**Run/Step Run 2006**	**Run/Step Run 2007**	**Run/ Step Run 2008**	**Run/ Step Run 2009**	**Run/ Step Run 2010**	Run/Step Run 2011	
Lom-pico 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																					
Bean 14b		1.1/1.8	1.0/1.8	1.2/1.9	1.15/2.0	1.2/2.0	1.2/2.1		0.2/0.4	0.2/0.4	0.2/0.4	0.2/0.4	0.3/0.6	0.3/0.5		0.4/0.8	0.4/0.65	0.4/0.6	0.4/0.6	0.5/0.8	**0.4/0.9**
Bean 14c	1.0/1.8	0.8/1.5	0.9/1.7		0.9/1.6	1.0/1.8		0.2/0.3	0.03/0.1	0.03/0.1		0.1/0.2	0.2/0.4		0.35/0.5	0.1/0.2	0.06/0.1		0.2/0.4	0.3/0.5	
Fall 15			0.9/1.4	0.9/1.4		1.3/1.9				0.4/0.8	0.35/0.75		0.6/1.05				0.6/0.9	0.5/1.0		0.8/1.25	
Newell 16	1.6/2.8			1.3/2.4	1.5/2.5	1.4/2.3		0.3/0.5			0.25/0.45	0.3/0.5	0.3/0.5		0.6/0.9			0.4/0.7	0.4/0.8	0.5/0.8	
Boul-der 17a	2.0/3.1	1.7/2.7	1.6/2.6	1.8/2.9				0.6/1.0	0.4/0.7	0.4/0.7	0.35/0.7				0.9/1.4	0.6/1.0	0.6/0.95	0.65/1.05			
Boul-der 17b	1.7/2.8	1.6/2.7	1.5/2.7					0.6/1.0	0.4/0.75	0.3/0.6					0.8/1.4	0.6/1.1	0.55/0.95				
Boul-der 17c																					
Bear 18a	2.0/3.35	1.4/2.4	1.3/2.55				1.4/2.2	0.6/0.9	0.2/0.4	0.2/0.4				0.2/0/4	0.8/1.25	0.4/0.7	0.35/0.7				**0.4/0.7**
Bear 18b																					
Branci-forte 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				
Branci-forte 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		
Branci-forte 21b							1.1/1.9							0.2/0.45							**0.4/0.8**

Table 6b. Averaged Mean and Maximum WATER DEPTH (ft) at REPLICATED San Lorenzo Sampling Sites in 2009−2012.

Site	Pool 2009	Pool 2010	Pool 2011	Pool 2012	Riffle 2009	Riffle 2010	Riffle 2011	Riffle 2012	Run/Step Run 2009	Run/Step Run 2010	Run/Step Run 2011	Run/Step Run 2012
0a	1.8/ 3.2	1.2/ 2.2	1.6/ 2.0	1.3/ 2.5	0.15/ 0.2	0.75/ 0.9	1.1/ 1.8	0.6/ 0.9	0.4/ 0.8	0.95/ 1.8	1.0/ 1.8	–
1					0.8/ 1.1	0.9/ 1.45	1.15/ 1.6	0.9/ 1.5	1.2/ 1.7	1.3/ 1.9	1.6/ 2.1	**1.1/ 1.7**
2							1.3/ 1.5	1.1/ 1.5			1.7/ 2.95	**1.9/ 2.6**
4					0.55/ 0.9	0.55/ 0.9	0.85/ 1.1	0.6/ 1.0	0.8/ 1.35	1.1/ 2.2	1.55/ 2.0	**1.2/ 1.65**
6					0.5/ 0.7	0.65/ 0.8	0.65/ 1.0	0.6/ 1.05	0.6/ 1.1	0.6/ 1.2	0.7/ 1.2	**0.7/ 1.1**
8					0.65/ 0.9	0.8/ 1.0	0.9/ 1.2	0.7/ 1.1	0.85/ 1.0	0.95/ 1.2	1.0/ 1.3	**0.8/ 1.2**
11	0.95/ 1.75	1.0/ 1.6	0.9/ 1.5	1.2/ 1.75	0.1/ 0.2	0.2/ 0.35	0.3/ 0.45	Δ riffle	0.4/ 0.8	0.6/ 0.8	0.6/ 1.1	**0.4/ 0.5**
Zayante 13a	1.8/ 2.9	2.1/ 3.4	1.8/ 3.8	1.9/ 3.7	0.15/ 0.4	0.2/ 0.5	0.5/ 0.8	0.4/ 0.7	0.65/ 1.0	0.75/ 1.3	0.9/ 1.5	**0.7/ 1.05**
Zayante 13c			1.1/ 1.85	1.1/ 1.75			0.6/ 0.9	0.3/ 0.7			0.7/ 0.95	0.5/ 0.75
Zayante 13d				1.1/ 1.95				–				0.75/ 1.0
Lompico 13e	0.85/ 1.75	1.2/ 1.6	1.25/ 1.75	1.2/ 1.65	0.1/ 0.15	0.1/ 0.3	0.2/ 0.4	0.2/ 0.5	0.3/ 0.5	0.45/ 0.75	0.5/ 0.8	**0.35/ 0.9**
Bean 14b	1.0/ 2.0	0.9/ 2.0	1.4/ 2.4	1.3/ 2.05	0.2/ 0.4	0.25/ 0.4	0.25/ 0.8	0.35/ 0.6	0.2/ 0.4	0.5/ 0.6	0.5/ 0.7	**0.5/ 0.8**
Bean 14c			0.8/ 1.65	0.8/ 1.45 Went dry			0.2/ 0.3	0.1/ 0.2 Went dry			0.3/ 0.5	**0.25/ 0.35 Went dry**
Fall 15			1.1/ 1.85	1.15/ 1.65			0.7/ 1.4	0.45/ 0.8			0.9/ 1.4	**0.6/ 1.1**
Newell 16	1.15/ 1.95	1.25/ 1.9	1.15/ 1.85	1.05/ 1.8	0.2. 0.5	.25/ .55	0.4/ 0.5	0.35/ 0.45	0.3/ 0.5	0.5/ 0.9	0.4/ 0.6	**0.3/ 0.5**
Boulder 17a	1.05/ 1.8	1.2/ 1.75	1.35/ 1.95	1.2/ 1.8	0.4/ 0.8	0.7/ 1.1	–	0.5/ 1.0	0.7/ 1.1	0.9/ 1.2	1.1/ 1.4	**0.8/ 1.2**
Boulder 17b	1.4/ 2.4	1.45/ 2.2	1.2/ 1.85	1.3/ 1.9	0.5/ 1.0	0.6/ 1.1	0.7/ 1.2	0.65/ 1.1	0.5/ 0.9	0.7/ 0.9	0.8/ 1.4	**0.6/ 1.2**
Bear 18a		1.35/ 2.6	1.35/ 2.2	1.1/ 1.85		0.3/ 0.6	0.3/ 0.6	0.3/ 0.6		0.7/ 0.9	0.65/ 1.0	**0.45/ 0.9**
Branciforte 21a-2	1.15/ 1.9	1.25/ 2.05	1.0/ 2.0	1.2/ 1.9	0.1/ 0.2	0.1/ 0.2	0.25/ 0.5	0.1/ 0.3	0.4/ 0.6	0.5/ 1.2	0.35/ 0.6	**0.4/ 0.6**
Branciforte 21b				1.2/ 1.95				0.3/ 0.6				**0.5/ 0.85**

Table 7a. Average PERCENT FINE SEDIMENT* IN SAN LORENZO REACHES Since 2006.

Reach	Pool 2006	Pool 2007	Pool 2008	Pool 2009	Pool 2010	Pool 2011	Pool 2012	Riffle 2006	Riffle 2007	Riffle 2008	Riffle 2009	Riffle 2010	Riffle 2011	Riffle 2012	Run/ Step Run 2006	Run/ Step Run 2007	Run/ Step Run 2008	Run/ Step Run 2009	Run/ Step Run 2010	Run/ Step Run 2011	Run/ Step Run 2012
1	80	65	77					20	15	20					40	46	46				
2		42	54	48	48	47	44		10	13	13	10	8	9		26	23	26	40	13	**17**
4	75	46	47					20	13	10					50	42	37				
6	75	61	68					25	17	12					38	18	23				
7																					
8	60	41	47	44				20	7	6	12				25	11	16	25			
9																					
10																					
11	40	32	52	40			25	25	10	9	12			8	15	24	14	14			**17**
12b							27							4							**9**
Zayante 13a	65	59	62					35	22	19					40	36	31				
Zayante 13b																					
Zayante 13c		45	47		41	43			9	12		10	14			27	34		19	19	
Zayante 13d	50	38	44	46	42	40	26	15	13	13	12	19	14	14	40	21	29	28	27	28	**19**
Lompico 13e	50	49	54					20	15	20					30	24	29				
Bean 14a																					
Bean 14b		67	66	67	55	61	49		18	9	13	13	32	10		58	34	34	28	72	**25**
Bean 14c	65	42	37		54	51		15	6	6		14	9		40	28	10		26	19	
Fall 15			64	69		57				30	34		19				48	50		37	
Newell 16	25			46	22	22		5			11	6	3		20			19	12	4	
Boulder 17a	35	31	27	28				5	12	9	11				20	17	13	11			
Boulder 17b	35	31	32					10	5	5					15	12	14				
Boulder 17c																					
Bear 18a	60	41	46		41		38	15	7	11		13		9	25	13	13		19		**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							**56**							**24**							**43**

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

Table 7b. Average PERCENT FINE SEDIMENT* IN SAN LORENZO SITES Since 2011.

Reach	Pool 2011	Pool 2012	Riffle 2011	Riffle 2012	Run/ Step Run 2011	Run/ Step Run 2012
0a	50	50	30	5	25	**15**
1	NA	NA	10	15	15	**20**
2	NA	NA	10	15	20	**25**
4	NA	NA	15	10	38	**30**
6	NA	NA	15	15	15	**15**
8	NA	NA	15	15	20	**30**
11	35	20	5	NA	5	**NA**
12b	45 (2001)	35	23 (2001)	5	20 (2001)	**5**
Zayante 13a	80	50	1	5	15	**30**
Zayante 13c	15	10	15	10	10	**13**
Zayante 13d	33	22	NA	NA	23	**25**
Lompico 13e	45	40	NA	20	25	**20**
Bean 14b	70	60	10	10	35	**25**
Bean 14c	38	10	5	2	15	**10**
Fall 15	50	68	20	20	25	**35**
Newell 16	18	28	5	2	5	**2**
Boulder 17a	20	30	5	15	15	**10**
Boulder 17b	25	25	0	2	10	**10**
Bear 18a	28	33	5	15	20	**20**
Branciforte 21a-2	75	48	2	NA	25	**20**
Branciforte 21b	73 (2001)	**53**	15 (2001)	**10**	45 (2001)	**20**

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

Table 8a. Average EMBEDDEDNESS IN SAN LORENZO Reaches Since 2006.

Reach	Pool 2006	Pool 2007	Pool 2008	Pool 2009	Pool 2010	Pool 2011	Pool 2012	Riffle \2006	Riffle 2007	Riffle 2008	Riffle 2009	Riffle 2010	Riffle 2011	Riffle 2012	Run / Step Run 2006	Run / Step Run 2007	Run / Step Run 2008	Run / Step Run 2009	Run / Step Run 2010	Run / Step Run 2011	Run / Step Run 2012
1	59	50	52					31	23	26					49	48	48				
2		26	38	36	37	49	39		13	18	16	25	20	19		23	25	32	27	**28**	**38**
3																					
4	64	43	45					37	19	33					47	37	42				
5																					
6	56	45	51					31	18	21					41	34	39				
7																					
8	56	40	46	33				28	18	30	19				35	28	26	32			
9																					
10																					
11	48	34	47	48			46	33	22	30	22			14	27	31	43	33			**30**
12b							35							32							**53**
Zayan-te 13a	54	44	51					23	25	30					50	36	47				
Zayan-te 13b																					
Zayan-te 13c		36	49		49	48			19	28		29	31			31	44		36	**56**	
Zayan-te 13d	51	55	49	49	57	53	53	37	30	33	43	39	45	49	42	39	37	41	51	**40**	**43**
Lompi-co 13e	55	52	47					42	16	19					46	37	32				
Bean 14a																					
Bean 14b		45	44	44	53	51	59		22	14	16	25	32	48		36	22	35	30	**55**	**53**
Bean 14c	62	39	42		60	53		36	8	15		42	31		52	25	29		43	**46**	
Fall 15			48	52		46				25	28		18				40	41		**42**	
Newell 16	36			42	39	53		12			20	24	31		33			31	34	**43**	
Boul-der 17a	48	37	37	38				29	18	21	18				33	27	31	27			
Boul-der 17b	43	33	35					24	22	17					34	33	34				
Boulder 17c																					
Bear 18a	54	33	48		49		60	35	28	34		25		44	41	36	43		34		**50**
Branc21a-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							48							18							**35**

Table 8b. Average EMBEDDEDNESS IN SAN LORENZO SITES Since 2011.

Reach	Pool 2011	Pool 2012	Riffle 2011	Riffle 2012	Run/ Step Run 2011	Run/ Step Run 2012
0a	60	40	30	20	**35**	**35**
1	NA	NA	25	30	**50**	**40**
2	NA	NA	15	20	**30**	**30**
4	NA	NA	15	20	**50**	**50**
6	NA	NA	20	30	**30**	**30**
8	NA	NA	30	25	**35**	**45**
11	40	50	5	NA	**5**	**NA**
12b	43 (2001)	55	35 (2001)	30	**35 (2001)**	**45**
Zayante 13a	60	65	20	30	**35**	**40**
Zayante 13c	30	45	45	45	**35**	**35**
Zayante 13d	43	53	20	NA	**45**	**45**
Lompico 13e	50	40	NA	30	**45**	**30**
Bean 14b	45	60	20	45	**35**	**70**
Bean 14c	53	10	10	25	**40**	**30**
Fall 15	38	60	25	50	**30**	**45**
Newell 16	65	33	15	15	**35**	**15**
Boulder 17a	40	38	25	40	**35**	**25**
Boulder 17b	30	35	10	10	**30**	**25**
Bear 18a	38	65	25	60	**35**	**60**
Branciforte 21a-2	53	48	20	NA	**60**	**40**
Branciforte 21b	42 (2001)	48	40 (2001)	20	**40 (2001)**	**30**

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	2011	2012
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	0.126 Seg. Δ	0.116
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			0.031
12	0.086	0.022	0.036	-	0.044							0.014

*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 2009−2012.

Sampling Site	2009	2010	2011	2012
Santa Cruz Levees 0a	0.211	0.298	0.205	0.403
Paradise Park 1	0.155	0.183	0.128	0.106
Rincon 2			0.129	0.117
Henry Cowell 4	0.537	0.479	0.374	0.308
Below Fall Creek 6	0.113	0.230	0.109	0.088
Below Clear Creek 8	0.082	0.194	0.154	0.163
Above Kings Creek Near Teihl Rd 11	0.0	0.024	0.036	–

***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	2011	2012
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	0.158 Seg. Δ	0.180
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			0.013
12	0.031	0.069	0.126	-	0.048							0.030

*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	2011	2012
1	-	-	0.271	0.186	0.205				
2	-	-		0.076	0.058	0.046	0.049	0.061 Seg. Δ	0.043
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			0.040
12	-	0.178							0.179

*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	2011	2012
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	0.075	
Zayante 13d	0.145	0.191	0.132	0.237	0.269	0.126	0.117	0.118	0.181	0.091	0.167	**0.102**
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	0.225	**0.162**
Bean 14c	0.259	0.093	0.100	0.142	0.141	0.131	0.142	0.131		0.135	0.115	
Fall 15	0.380		0.330					0.375	0.295		0.429	
Newell 16	0.285		0.325			0.120			0.125	0.111	0.083	
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		**0.064**
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							**0.156**

*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 and the Mainstem Teihl and Waterman Gap Sites in 2009–2012.

Site (Reach)	Pool Escape Cover 2009	Pool Escape Cover 2010	Pool Escape Cover 2011	Pool Escape Cover 2012
Mainstem @ Teihl 11	0.058*	0.094	**0.033**	**0.039**
Mainstem @ Waterman Gap 12b				**0.091**
Zayante 13a	0.140	0.103	**0.167**	**0.222**
Zayante 13c			**0.120**	**0.178**
Zayante 13d	0.285	0.113	**0.168**	**0.135 Site Δ**
Lompico 13e	0.154	0.092	**0.061**	**0.072**
Bean 14b	0.145	0.120	**0.165**	**0.175**
Bean 14c			**0.098**	**0.094**
Fall 15	0.302	0.571	**0.429**	**0.500**
Newell 16	0.150	0.118	**0.101**	**0.154**
Boulder 17a	0.066	0.094	**0.110**	**0.092**
Boulder 17b	0.356	0.266	**0.258**	**0.461**
Bear 18a		0.138	**0.101**	**0.050 Site Δ**
Branciforte 21a-2	0.051	0.068	**0.040**	**0.107**
Branciforte 21b				**0.158**

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

Table 13a. 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	2011	2012
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	0.007	
Zayante 13d	0.050	0.098	0.143	0.223	0.297	0.071	0.101	0.130	0.136	0.103	0.134	**0.072**
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	0.084	**0.016**
Bean 14c	-	0.018	0.023	0.015	0.012	0.009	0.0	0.0		0.0	0.018	
Fall 15								0.110	0.092		0.045	
Newell 16	0.072		0.129			0.020			0.065	0.018	0.040	
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				**0.022**
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							**0.026**

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

Table 13b. Habitat Change in the SAN LORENZO MAINSTEM AND TRIBUTARIES from 2011 to 2012, Based on Reach Data Where Available and Site Data, Otherwise.

Reach Comparison or (Site Only)	Fall Baseflow (Most Import. Parameter)	Pool Depth / Fastwater Habitat Depth in Mainstem below Boulder Cr.	Fine Sediment	Embed-dedness	Pool Escape Cover/ Fastwater Habitat Cover in Mainstem below Boulder Creek	Overall Habitat Change
(Mainstem 0a)	−	+ / −	+	+	+	+ (despite low flow)
(Mainstem 1)	−	NA / −	Similar	+	/−	−
Mainstem 2	−	− / Similar	Similar	Similar	/−	−
(Mainstem 4)	−	NA / −	Similar	Similar	/−	−
(Mainstem 6)	−	NA / −	Similar	− (run)	/−	−
(Mainstem 8)	−	NA / −	− (run)	− (run)	/Similar	−
(Mainstem Near Teihl 11)	−	+	+	−	Similar	− (due to low flow)
(Zayante 13a)	−	Similar	+ (pool) − (run)	Similar	+	− (due to low flow)
(Zayante 13c)	−	Slightly −	Similar	−	+	− (due to low flow)
Zayante 13d	−	−	+	Similar	−	−
(Lompico 13e)	−	−	Similar	+	+ (slightly)	−
Bean 14b	−	Slightly +	+	−	−	−
(Bean 14c)	− (Went dry In 2012)	−	+	+	Similar	−
(Fall 15)	−	−	−	−	+	−
(Newell 16)	−	−	−	+	+	−
(Boulder 17a)	−	−	−	− (riffle)	−	−
(Boulder 17b)	−	Slightly +	Similar	Similar	+	− (due to low flow)
Bear 18a	−	−	Similar	−	−	−
(Branciforte 21a-2)	−	+	+	+	+	+
Branciforte 21b	− Compared to 2001	NA	+ Compared to 2001	+ Comp. to 2001	NA	+ (despite lower flow)

***NA = Not available.**

R-3. Habitat Change in Soquel Creek and Its Branches, 2009 to 2012

Refer to **Appendix A** for maps of reach locations. Summary tables of habitat change for all sites are provided in **Tables 15g and 37**. Three reaches were compared to 2009 conditions; one reach was compared to 2011 (Reach 12a) and 3 replicated sites were compared to 2011 conditions. Weighing the relative importance of streamflow as an aspect of fall habitat quality with other habitat parameters is not clear cut. Most steelhead growth occurs in spring and early summer before baseflow decreases. All reaches had lower baseflow in spring/summer/fall 2012 than in 2011, though 2012 had late spring stormflows that maintained streamflow above median flow rate statistic until mid-May (**Table 5b; Figures 36‒38; 42**). All reaches had higher baseflow than in 2009. A pattern developed in the East Branch and upper mainstem with reduced pool depth in reaches and sites and reduced escape cover in reaches that were habitat typed. This may have resulted from sedimentation from erosion at the massive, still active Highland Way slide.

Two of the 4 reaches (Reaches 1 and 13) had improved habitat compared to 2009 due to higher baseflow and deeper pool habitat. Two reaches had reduced habitat quality (Reach 7 compared to 2009 conditions and Reach 12a compared to 2011 conditions, with reduced pool depth and escape cover and more embeddedness). All 3 replicated sites (Sites 4 (mainstem Reach 3), 12 (mainstem Reach 8) and Site 13a (East Branch Reach 9a)) had improved habitat compared to 2011 due to increased escape cover from less embedded boulders or larger instream wood clusters (**Tables 15e-f**). Pool depth increased in 2012 compared to another dry year, 2009, in Reaches 1 and 13 and at Site 4 (Reach 3) (**Tables 14a-b**). The majority of reaches and sites had similar or reduced fine sediment (**Tables 15a-b**). The majority had similar or increased embeddedness (**Tables 15c-d**).

Reduced baseflow in 2012 provided less food and less YOY growth in all reaches compared to 2011 (**Figure 18;** size histograms in **Appendix D**), especially when YOY abundance and competition for food were greater in 2012 at 6 of 7 sites and close to average at all sites except at Site 16 in the SDSF, where it was very low (**Figure 6**). Slower YOY growth was exemplified by the lower percent of YOY reaching Size Class II in 2012 compared to the wetter year of 2011 at all sites. As in the San Lorenzo watershed, despite negative habitat change in 4 of 7 reaches in 2012 (**Table 15e**), YOY in Soquel Creek were more numerous from likely better YOY survival than in 2011, though smaller from late spawning. Yearling densities were also higher at 4 of 7 sites compared to 2011 and showed a similar pattern as YOY densities (close to average) when compared to average densities (**Figure 7**). As in the San Lorenzo watershed, more yearlings apparently survived to stay another growth period after a milder winter compared to 2011.

Table 14a. Averaged Mean and Maximum WATER DEPTH (ft) of Habitat in SQOUEL CREEK Reaches* Since 2006.

Reach	Pool 2006	Pool 2007	Pool 2008	Pool 2009	Pool 2011	Pool 2012	Riffle 2006	Riffle 2007	Riffle 2008	Riffle 2009	Riffle 2011	Riffle 2012	Run/ Step Run 2006	Run/ Step Run 2007	Run/ Step Run 2008	Run/ Step Run 2009	Run/ Step Run 2011	Run/ Step Run 2012
1		1.2/ 2.7	1.2/ 2.8	1.15 / 2.7		**1.35/ 3.6**		0.3/ 0.4	0.2/ 0.4	0.25 / 0.45		**0.35/ 0.6**		0.4/ 0.5	0.3/ 0.5	0.35/ 0.5		**0.5/ 0.8**
2																		
3	1.4/ 2.5	1.4/ 2.3	1.2/ 2.3	1.4/ 2.35	1.6/ 3.0		0.5/ 0.8	0.3/ 0.5	0.2/ 0.4 *	0.25/ 0.4	0.45/ 0.75		0.7/ 1.0 *	0.4/ 0.6 *	0.3/ 0.6 *	0.45/ 0.7	0.7/ 1.1	
4																		
5																		
6																		
7	1.3/ 2.3	1.2/ 2.1	1.2/ 2.2	1.35 /2.4		**1.2/ 2.5**	0.5/ 0.8	0.3/ 0.6	0.3/ 0.5	0.35 /0.55		**0.4/ 0.7**	0.8/ 1.2	0.3/ 0.6	0.4/ 0.7	0.5/ 0.8		**0.6/ 1.0**
8		1.5/ 2.9	1.4/ 2.5	1.6/ 2.8	1.9/ 3.5			0.4/ 0.6	0.2/ 0.4	0.3/ 0.45	0.6/ 0.9			0.5/ 0.9	0.4/ 0.7	0.5/ 0.75	0.9/ 1.3	
9	1.5/ 2.5	1.3/ 2.2	1.2/ 2.3	1.45 /2.3	1.6/ 2.7		0.4/ 0.6	0.2/ 0.4	0.2/ 0.4	0.2/ 0.45	0.5/ 0.7		0.6/ 1.0	0.4/ 0.6	0.4/ 0.6	0.5/ 0.75	0.6/ 0.85	
10																		
11																		
12a	1.3/ 2.05	0.8/ 1.4	0.6/ 1.1	1.0/ 1.5	1.0/ 1.7	**0.9/ 1.5**	0.45 / 0.8	0.1/ 0.2	0.02 /0.1	0.25 / 0.45	0.4/ 0.7	**0.3/ 0.6**	0.7/ 1.2	0.3/ 0.7	0.2/ 0.5	0.45/ 0.8	0.6/ 1.05	**0.5/ 0.9**
12b																		
13		1.1/ 2.2	1.1/ 2.3	1.25 /2.3		**1.3/ 2.5**		0.3/ 0.5	0.3/ 0.5	0.3/ 0.5		**0.3/ 0.5**		0.5/ 0.8	0.4/ 0.7	0.5/ 0.8		**0.55/ 0.9**
14a	1.4/ 2.4						0.5/ 0.8						0.6/ 1.0					
14b	1.6/ 2.9	1.4/ 2.4	1.3/ 2.4	1.35 / 2.5			0.4/ 0.6	0.2/ 0.4	0.2/ 0.4	0.25 / 0.5			0.7/ 1.0	0.5/ 0.8	0.4/ 0.7	0.5/ 0.8		
14c																		

*Partial, ½-mile segments habitat typed in 2006–2009 and 2011−2012. Previously, the entire reach was habitat typed.

Table 14b. Averaged Mean and Maximum WATER DEPTH (ft) of Habitat at Replicated SQOUEL CREEK Sampling Sites in 2009− 2012.

Site (Reach)	Pool 2009	Pool 2010	Pool 2011	Pool 2012	Riffle 2009	Riffle 2010	Riffle 2011	Riffle 2012	Run/ Step Run 2009	Run/ Step Run 2010	Run/ Step Run 2011	Run/ Step Run 2012
1 (1)	1.0/ 2.8	1.0/ 2.8	0.9/ 3.2	**1.65/ 3.5 Site Δ**	0.4/ 0.5	0.5/ 0.75	0.5/ 0.8	**0.4/ 0.6 Site Δ**	0.2/ 0.3	0.35/ 0.8	0.8/ 1.1	**0.6/ 0.9 Site Δ**
4 (3)	1.6/ 2.9	2.0/ 4.3	1.2/ 2.5	**1.7/ 2.6**	0.4/ 0.6	0.55/ 0.8	0.6/ 0.9	**0.3/ 0.5**	0.5/ 0.8	0.7/ 1.0	0.7/ 1.0	**0.5/ 0.9**
10 (7)		1.4/ 2.8	1.4/ 3.0	**1.1/ 2.05 Site Δ**	0.55/ 0.9	0.6/ 1.2	0.65/ 0.9	**0.5/ 0.9 Site Δ**	0.5/ 0.9	0.6/ 1.2	0.9/ 1.2	**0.8/ 0.9**
12 (8)			2.2/ 2.8	**1.8/ 2.6**			0.9/ 1.2	**0.45/ 0.95**			1.0/ 1.5	**0.8/ 1.1**
13a (9a)			1.65/ 2.4	**1.2/ 1.9**			0.5/ 0.7	**0.3/ 0.6**			0.7/ 0.9	**0.75/ 1.1**
16 (12a)			1.2/ 1.85	**1.25/ 2.05 Site Δ**				**0.2/ 0.4 Site Δ**			0.55/ 0.95	**0.4/ 0.9 Site Δ**
19 (13)	1.0/ 2.0	1.1/ 2.1	0.9/ 2.9	**1.0/ 1.9**	0.5/ 0.7	0.5/ 0.9	0.45/ 0.6	**0.4/ 0.8**	0.5/ 0.9	0.6/ 1.1	0.7/ 1.1	**0.5/ 1.1**
21 (14b)	1.5/ 3.55	1.8/ 3.85	1.9/ 3.75		0.3/ 0.5	0.4/ 0.55	0.3/ 0.7		0.7/ 1.8	0.6/ 1.3	0.4/ 1.3	

Table 15a. Average PERCENT FINE SEDIMENT in Habitat-typed Reaches* in SOQUEL CREEK Since 2006.

Reach	Pool 2006	Pool 2007	Pool 2008	Pool 2009	Pool 2011	Pool 2012	Riffle 2006	Riffle 2007	Riffle 2008	Riffle 2009	Riffle 2011	Riffle 2012	Run/ Step Run 2006	Run/ Step Run 2007	Run / Step Run 2008	Run/ Step Run 2009	Run/ Step Run 2011	Run/ Step Run 2012
1		59	64	59		**62**		18	13	14		8		29	16	16		**24**
2																		
3	62	55	57	58	59		14	17	15	8	11		29	29	20	19	14	
4																		
5																		
6																		
7	69	52	59	70		51	21*	20	23	16		11	33	25	25	20		**21**
8		46	56	58	63			14	15	5	11			25	64	28	23	
9	62	47	49	42	58		12	13	10	6	6		30	24	26	19	24	
10																		
11																		
12a	40	29	34	35	42	34	12	6	10	12	8	8	21 (S.run)	20 (S.run)	21 (S.run)	19 (S.run)	15	**14**
12b																		
13		64	75	58		57		26	18	11		9		29	26	20*		**18**
14a	66						14						28 (run)					
14b	51	40	55	52			15	9	10	8			35 (run)	26 (run)	20 (run	20 (run)		
14c																		

*Partial, ½-mile segments habitat typed in 2006–2009 and 2011−2012 where previously, the entire reach was habitat typed.

Table 15b. Average PERCENT FINE SEDIMENT in SOQUEL CREEK SAMPLING SITES Since 2011.

Site (Reach)	Pool 2011	Pool 2012	Riffle 2011	Riffle 2012	Run/ Step Run 2011	Run/ Step Run 2012
1 (1)	85	**85**	5	10	10	**20**
4 (3a)	45	70	10	5	10	**15**
10 (7)	70	38	15	NA	20	**25**
12 (8)	25	30	10	NA	15	**15**
13a (9)	50	40	15	20	25	**15**
16 (12a)	50	50	NA	15	NA	**15**
19 (13)	60	70	15	10	40	**25**

Table 15c. Average EMBEDDEDNESS in Pool and Fastwater (Riffle and Run) Habitat of SOQUEL CREEK REACHES Since 2005 .

Reach	Pool 2005	Pool 2006	Pool 2007	Pool 2008	Pool 2009	Pool 2011	Pool 2012	Riffle 2005	Riffle 2006	Riffle 2007	Riffle 2008	Riffle 2009	Riffle 2011	Riffle 2012	Run / Step Run 2005	Run / Step Run 2006	Run / Step Run 2007	Run / Step Run 2008	Run / Step Run 2009	Run / Step Run 2011	Run / Step Run 2012
1	57		48	35	37		54	25		22	18	19		30	35		29	29	23		**39**
2	56							34							46						
3	58	55*	40*	39*	37*	40*		27	27*	17*	22*	19*	13*		42	46*	28*	33*	23*	24*	
4	61							31							48						
5	55							27							42						
6	53							28							40						
7	53	56*	42*	44*	41*		52	30	25*	25*	23*	23*		32	43	39*	35*	39*	38*		**43**
8	60		44*	43*	45*	60*		29		25*	17*	17*	28*		45		35*	48*	33*	50*	
9	59	54	47	44	50	59		34	26	18	22	26	28		45	50	37	47	42	50	
10																					
11																					
12a	53	53	55	54	59	57	61	29	30	41	45	34	28	42	37 (S.run)	38 (S.run)	47 (S.run)	39 (S.run)	46 (S.run)	38 (S.run)	**43 (S.run)**
12b	59							30							47						
13			50*	42*	53*		50*			26*	23*	22*		27*			39*	29*	37*		**33***
14a	58	57						47	18						59 (run)	34 (run)					
14b		57	47	44	44				32	17	19	16				46 (run)	25 (run)	27 (run)	38 (run)		
14c																					

*Partial, ½-mile segments habitat typed in 2006–2009 and 2011−2012 where previously, the entire reach was habitat typed.

Table 15d. Average EMBEDDEDNESS in Pool and Fastwater (Riffle and Run) Habitat of SOQUEL CREEK SAMPLING SITES Since 2011 .

Site (Reach)	Pool 2011	Pool 2012	Riffle 2011	Riffle 2012	Run/ Step Run 2011	Run/ Step Run 2012
1 (1)	55	**60**	35	**30**	25	**35**
4 (3a)	40	**40**	25	**25**	30	**50**
10 (7)	50	**50**	25	**NA**	35	**35**
12 (8)	30	**55**	35	**35**	35	**50**
13a (9)	60	**40**	35	**35**	35	**40**
16 (12a)	63	**58**	NA	**45**	NA	**40**
19 (13)	60	**60**	15	**25**	40	**30**
21 (14b)	60	**Not Sampled**	40	**Not Sampled**	45	**Not Sampled**

Table 15c. POOL ESCAPE COVER Index (Habitat Typing Method*) in SOQUEL CREEK, Based on Habitat Typed Segments.

Reach	Pool 2000	Pool 2003	Pool 2005	Pool 2006	Pool 2007	Pool 2008	Pool 2009	Pool 2011	Pool 2012
1	0.091	0.103	0.107		0.147	0.134	0.116		**0.099**
2	0.086	0.055	0.106						
3	0.085	0.092	0.141	0.178 * **	0.177 **	0.131 **	0.112 **	0.069 **	
4	0.041	0.071	0.086						
5	0.061	0.023	0.075						
6	0.082	0.102	0.099						
7	0.089	0.101	0.129	0.141 **	0.164 **	0.170 **	0.089 **		**0.071**
8	0.047	0.036	0.060		0.070 **	0.071 **	0.037 **	0.052 **	
9	0.146		0.101	0.086	0.117	0.147	0.100	0.128	
10	0.100								
11	0.068								
12a	0.113		0.222	0.175	0.121	0.097	0.143	0.169	**0.082**
12b	0.129		0.158						
13	0.077				0.081 **	0.069 **	0.060 **		**0.064**
14a	0.064			0.048					
14b		0.051 (2002)		0.058	0.076	0.080	0.069		
14c		0.068 (2002)							

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

** Partial, ½-mile segments habitat typed in 2006–2009 and 2011−2012 where previously, the entire reach was habitat typed.

Table 15d. POOL ESCAPE COVER Indices (Habitat Typing Method*) in SOQUEL CREEK, at Replicated Sampling Sites in 2009− 2012.

Site (Reach)	Pool Escape Cover 2009	Pool Escape Cover 2010	Pool Escape Cover 2011	Pool Escape Cover 2012
1 (1)	0.101	0.132	0.104	**0.117 Site Δ**
4 (3)	0.102	0.067	0.085	**0.191**
10 (7)		0.124	0.254	**0.096 Site Δ**
12 (8)			0.092	**0.231 (Wood cluster)**
13a (9a)			0.101	**0.164 (Wood cluster)**
16 (12a)			0.079	**0.064 Site Δ**
19 (13)	0.041	0.080	0.131	**0.060**
21 (14b)	0.029	0.017	0.021	**Not Sampled**

Table 15e. Habitat Change in SOQUEL CREEK WATERSHED Reaches (2009 to 2012 or 2011-2012) or Replicated Sites (2011 to 2012).

Reach Comparison or (Site Only)	Baseflow	Pool Depth	Fine Sediment	Embeddedness	Pool Escape Cover	Overall Habitat Change
Reach 1	+	+	Similar	−	−	+ (Compared to 2009)
Site 4 (Reach 3a)	−	+	−	− (Runs Only)	+ (large)	+
Reach 7	+	−	+	−	−	− (Compared to 2009)
Site 12 (Reach 8)	−	−	Similar	−	+ (Wood Cluster)	+ (due to wood)
Site 13a (Reach-9a)	−	−	+	+	+ (Wood Cluster)	+ (due to wood)
Reach 12a	+	−	Similar	− (Riffles Only)	− (large decrease)	− (Compared to 2011)
Reach 13	+	+	Similar	Similar	Similar	+ (Compared to 2009)

*** NA = Not available.**

R-4. Habitat Change in Aptos Creek, 2011 to 2012

Refer to **Appendix A** for maps of reach locations. Summary tables of habitat change for all sites are provided in **Tables 16c and 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 on Aptos Creek and 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 higher and more important. Based on hydrographs from stream gages in other watersheds (**Figures 33-41**), it is likely that this watershed also had similarly lower baseflow in 2012 compared to 2011, probably near the median streamflow statistic in spring and slightly less than the median statistic in summer. This provided less food and slower growth rate in all reaches in 2012 compared to the 2 previous wetter years. Measured streamflow in fall in lower Aptos Creek confirmed significantly lower baseflow in 2012 than 2011 (**Table 5b**).

Habitat conditions deteriorated at the lower Reach 2 in Aptos Creek from 2009, despite higher baseflow, due to much less escape cover (**Table 16c summarized from Tables 5b, 16a−b**). The upper Aptos Reach 3 in Nisene Marks had reduced habitat quality compared to 2011, based on conditions at Site 4. Baseflow was less, pool depth decreased substantially and fine sediment increased compared to 2011. The one improvement at Site 4 was more escape cover from more instream wood that collected (**Table 16c**).

As occurred at the majority of sites in other watersheds, despite habitat quality reduction, YOY and yearling densities increased at both Aptos sites in 2012 (**Tables 32−33**). YOY and yearling densities were above average at Site 4, while at Site 3 the YOY density was below average and the yearling density was above average (**Figures 10−11**). Like in other watersheds, YOY were smaller from a later spawn in 2012 with likely better survival. Yearlings survived better over a milder winter and more stayed another season compared to 2011. Less YOY growth in 2012 was exemplified by the lower percent of YOY reaching Size Class II in 2012 at both Aptos sites (**Figure 19**) compared to the wetter year of 2011.

Table 16a. AVERAGE POOL HABITAT CONDITIONS FROM HABITAT TYPING IN REACHES of APTOS, VALENCIA, CORRALITOS, SHINGLE MILL and BROWNS Creeks in 2007–2009 and 2011−2012.

Reach #/ Sampling Site #	Mean Depth/ Maximum Depth					Escape Cover*					Embeddedness					Percent Fines				
	2007	2008	2009	2011	**2012**	2007	2008	2009	2011	**2012**	2007	2008	2009	2011	**2012**	2007	2008	2009	2011	**2012**
Aptos #2/#3- in County Park	1.1/2.3	1.1/2.1	1.0/2.1		**1.1/2.2**	0.133	0.172	0.155		0.105	49	47	48		**55**	76	60	53		**59**
Aptos #3/#4- Above Steel Bridge Xing (Nis. Marks)	1.2/2.2	1.1/2.2	1.2/2.3	1.2/2.3		0.102	0.132	0.127	0.107		59	57	56	54		62	63	57	66	
Valencia #2/#2- Below Valencia Road Xing	0.8/1.4	0.6/1.3	0.6/1.2			0.148	0.131	0.143			70	45	51			98	88	79		
Valencia #3/#3- Above Valencia Road Xing	0.9/1.6	0.7/1.4	0.8/1.5			0.154	0.210	0.217			56	55	53			78	79	76		
Corralitos #1/#1- Below Dam	1.25/1.95	1.3/2.0	1.5/2.1			0.106	0.152	0.123			35	44	49			37	50	54		
Corralitos #3/#3- Above Colinas Drive	1.3/2.3	1.1/2.0	1.2/2.0	1.3/2.0	1.1/2.0	0.191	0.172	0.121	0.175	**0.161**	41	46	52	50	**63**	38	50	53	32	**42**
Corralitos #5-6/#8- Below Eureka Gulch	1.1/1.9	1.0/1.8	1.1/1.9	1.2/2.0	**1.0/1.8**	0.084	0.090	0.093	0.052	**0.072**	42	45	58	58	**58**	35	48	56	29	**29**
Corralitos #7/#9- Above Eureka Gulch	1.0/1.6	0.9/1.5	1.0/1.5	1.0/1.5	**0.9/1.35**	0.185	0.171	0.125	0.119	**0.146**	37	40	45	54	**63**	30	29	41	20	**28**
Shingle Mill #1/#1- Below 2nd Road Xing	0.8/1.3	0.8/1.3				0.198	0.214				58	58				33	26			
Shingle Mill #3/#3- Above 3rd Road Xing	0.9/1.4	0.8/1.3	0.9/1.5			0.196	0.223	0.264			62	62	59			38	34	45		
Browns Valley #1/#2- Below Dam	1.1/1.8	1.2/1.9	1.2/1.9			0.127	0.156	0.185			60	56	57			40	35	38		
Browns Valley #2/#2- Above Dam	1.0/1.7	1.0/1.6	1.0/1.6			0.161	0.155	0.198			59	56	54			36	32	35		

* Habitat typing method = total feet of linear pool cover divided by total habitat typed channel length as pool habitat in ½-mile reach segments.

Table 16b. POOL HABITAT CONDITIONS FOR REPLICATED SAMPLING SITES IN APTOS, VALENCIA, CORRALITOS, SHINGLE MILL and BROWNS Creeks in 2009‒2012.

Reach #/ Sampling Site #	Avg Mean/ Maximum Pool Depth-2009	Avg Mean/ Maximum Pool Depth-2010	Avg Mean/ Maximum Pool Depth-2011	Avg Mean/ Maximum Pool Depth-2012	Pool Escape Cover Index-2009	Pool Escape Cover Index-2010	Pool Escape Cover Index-2011	Pool Escape Cover Index-2012
Aptos #2/#3- in County Park	1.2/ 2.5	1.25/ 2.6	1.0/ 2.4	**1.0/ 2.5 (Site Δ)**	0.164	0.183	0.055	**0.080 (Site Δ)**
Aptos #3/#4- Above Steel Bridge Xing (Nisene Marks)			1.35/ 3.25	**1.1/ 2.05**			0.156	**0.177**
Valencia #2/#2- Below Valencia Road Xing	0.6/ 1.5	0.45/ 1.05	Not Sampled	**Not Sampled**	0.138	0.156	Not Sampled	**Not Sampled**
Valencia #3/#3- Above Valencia Road Xing	1.0/ 1.8	0.9/ 1.45	Not Sampled	**Not Sampled**	0.200	0.250	Not Sampled	**Not Sampled**
Corralitos #1/#1- Below Dam	1.05/ 1.65	0.85/ 1.5	0.9/ 1.25	**1.05/ 1.4**	0.106	0.087	0.120	**0.156**
Corralitos #3/#3- Above Colinas Drive	1.1/ 2.0	0.7/ 1.6	0.95/ 1.95	**1.35/ 2.2 (Site Δ)**	0.186	0.173	0.231	**0.121 (Site Δ)**
Corralitos #5-6/#8- Below Eureka Gulch	1.35/ 1.95	0.55/ 0.9	1.0/ 1.85	**0.7/ 1.05**	0.120	0.048	0.033	**0.061**
Corralitos #7/#9- Above Eureka Gulch			1.0/ 1.8	**1.0/ 1.6**			0.112	**0.148**
Shingle Mill #1/#1- Below 2nd Road Xing		0.9/ 1.3	0.9/ 1.4	**0.8/ 1.3**		0.296	0.310	**0.357**
Shingle Mill #3/#3- Above 3rd Road Xing	0.8/ 1.2	0.6/ 0.9	1.0/ 1.5	**0/9/ 1.4**	0.151	0.139	0.173	**0.145**
Browns Valley #1/#2- Below Dam	1.0/ 1.55	1.25/ 2.0	1.3/ 2.05	**1.1/ 1.6**	0.160	0.125	0.187	**0.201**
Browns Valley #2/#2- Above Dam	1.05/ 1.7	1.15/ 1.85	1.35/ 1.85	**1.25/ 1.8**	0.130	0.243	0.203	**0.272**

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

Table 16c. Habitat Change in APTOS Reaches (2009 to 2012) AND CORRALITOS WATERSHED Reaches (2011 to 2012) and Replicated Sites (2011 to 2012).

Reach Comparison or (Site Only Comparison)	Baseflow	Pool Depth	Fine Sediment	Embeddedness	Pool Escape Cover	Overall Habitat Change
Aptos 2	+ (compared to 2009)	+ (slightly)	Similar	Similar	− (large)	−
(Aptos 4)	−	−	−	Similar	+	− (Site)
(Corralitos 1)	−	+	+	Similar	+	+ (Site)
Corralitos 3	−	−	−	−	−	−
Corralitos 5/6	−	−	Similar	Similar	+	−
Corralitos 7	−	−	Similar	Similar	+	+ (due to more cover)
(Shingle Mill 1)	−	−	NA (Construction Turbidity in 2011)	NA (Construction Turbidity in 2011)	+	− (Site)
(Shingle Mill 3)	−	−	Similar	Similar	−	− (Site)
(Browns 1)	−	−	−	−	+	− (Site)
(Browns 2)	−	−	Similar	−	+	+ (due to more cover)

*** NA = Not Available.**

R-5. Habitat Change in Corralitos, Shingle Mill and Browns Valley Creeks, 2011 to 2012

Refer to **Appendix A** for maps of reach locations. Summary tables of habitat change for all reaches are provided in **Tables 16c and 37**. Weighing the relative importance of streamflow 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 higher and most important. All reaches had lower spring and summer/fall baseflow in 2012 compared to 2011, though late spring storms occurred in 2012 (**Table 5b; Figures 39−41**). Lower baseflow provided less food and slower growth rate in all reaches. Slower YOY growth was exemplified by the lower percent of YOY reaching Size Class II in 2012 at most sites compared to the wetter year of 2011 (**Figure 20**). Three of 8 reaches were habitat typed in 2012 to determine habitat quality. Changes in habitat quality in the other reaches was based on conditions at repeated sampling sites. Despite diminished habitat quality in 5 of 8 reaches in 2012 (**Table 16c: summarized from Tables 16a-b**), YOY and yearling steelhead densities increased at 6 of 8 sites compared to 2011 (**Tables 32−33**). This pattern was similar to other sampled watersheds. However, YOY and yearling densities were substantially above average at only 3 of 8 sites (**Figures 14−15**). Reduced streamflow was consistent with reduced pool depth in all reaches except Reach 1. Percent fines and embeddedness were either similar or worse in all reaches in 2012 compared to 2011, except less fine sediment in Reach 1. Fortunately, escape cover increased in 6 of 8 reaches.

ANNUAL COMPARISON OF JUVENILE STEELHEAD ABUNDANCE

R-6. 2012 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 2012 the most sites (20 of 38) in 4 sampled watersheds were rated "Good" and "Very Good" in the last 7 years, based on densities of Size Class II and III juveniles and their average sizes at each site (**Table 41**). However, in the San Lorenzo River drainage, densities of all size and age classes were below average at most sites (**Figures 1-4**), although densities of yearlings and YOY were significantly higher, statistically, in 2012 compared to 2011 (**Table 42**). This was due to higher YOY densities in 2012 and better survival of yearlings over a mild winter and fewer opting to smolt early (**Tables 18, 19, 23 and 24**). However, a smaller proportion of YOY reached Size Class II in the relatively fast-growth reaches of the lower mainstem in 2012 compared to 2011 due to reduced baseflow (**Figures 17, 33 and 34**).

Site densities of YOY in the mainstem below the Boulder Creek confluence have been low from 1999 onward (**Table 18**). YOY densities increased at 5 of 7 repeated mainstem sites in 2012 compared to 2011 (except Sites 2a and 11) but were still below average at 6 of 8 sites (**Figure 2**). The higher YOY densities resulted in higher total juvenile densities at 5 of 7 repeated mainstem sites in 2012 compared to 2011 (**Table 17**) but below average densities at 5 of 7 sites (**Figure 1**). 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 such high baseflow that steelhead were in high densities at the heads of pools and even further back in pools 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 densities of smolt-sized juveniles there. Yearling densities at mainstem sites continued to be similarly low in 2012 as in 2011, with slightly greater than average numbers at Site 0a and 12b (**Table 19; Figure 3**).

It was the winter of 1999 when substantial sediment entered the middle mainstem from erosion in upstream tributaries that had occurred from the 1998 high peak-flow event (19,400 cfs at Big Trees). The 1999 water year had a low peak flow (3,200 cfs at Big Trees) that apparently moved sediment from the tributaries into the mainstem but 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 consisting of primarily sand and fine gravel.

Densities of larger Size Class 2 and 3 juvenile were higher in 2012 at 4 of 7 mainstem sites (**Table 21**) but still below average at 6 of 8 sites (**Figure 4**). Their density at 0a was much above average due to the deep pool with good escape cover that had developed in the site. Regarding small YOY in the Size Class 1 category, densities were greater at 5 of 7 mainstem sites in 2012 compared to 2011 due to late spawning and slower growth rate under lower baseflow conditions (**Table 20**).

Table 17. Density of Juvenile Steelhead for ALL SIZES at MAINSTEM SAN LORENZO RIVER Monitoring Sites (Excluding Lagoon) in 1997-2001 and 2003-2012.

Sample Site	1997	1998	1999	2000	2001	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Avg.
0a				5.4								2.4	20.4	2.1	26.9	11.4
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	2.7	7.6	10.8
2a	74.9	21.4	4.6	3.9	13.5					14.8	20.6	9.2	28.4	11.2	6.7	19.0
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	4.1	17.5	32.6
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	9.1	16.7	16.5
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	9.2	14.2	38.9
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	9.1	4.5	27.2
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							17.5	43.5

*** 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 2003-2012.

Sample Site	1997	1998	1999	2000	2001	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Avg.
0a				2.2								1.2	19.0	2.1	23.4	9.6
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	1.9	6.6	9.7
2a	66.3	19.2	3.2	2.7	11.0					13.7	19.0	8.1	27.6	8.6	6.4	19.0
2b				21.2	12.1											20.1
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	3.5	17.2	30.8
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	8.1	15.8	15.5
7	143.5	19.8	5.7	3.6	12.0	9.7	38.0	11.2								30.4
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	5.8	13.7	36.9
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								25.9
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	8.4	3.7	24.2
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							6.2	33.9

***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 2003-2012.

Sample Site	1997	1998	1999	2000	2001	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Avg.
0a				2.2								1.2	1.7	0	3.9	1.8
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	0.5	1.0	0.9
2a	7.9	1.5	0.9	1.2	1.5					0.9	0.4	1.0	0.5	2.2	0.4	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	0.6	0.2	1.7
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	1.2	0.3	0.9
7	6.0	2.5	6.3	4.8	3.6	0.4	0.3	3.0								3.4
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	0.2	0.3	1.9
9	4.3	8.1	2.5	1.0	0.6	0.8	1.9	2.5								2.7
10	3.3	6.4	4.6	5.5	4.1	6.8	2.7	4.7								4.8
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	0.6	0.8	4.1
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							10.7	9.5

***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 2003-2012.

Sample Site	1997	1998	1999	2000	2001	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Avg.
0a				0								0	0.6	0	0	0.1
0b				0	0											0
1	3.3*	0.2	2.2	0	0.7				0	0.3	2.1	0	1.1	0.1	0	0.8
2a	7.9	1.3	0.4	0.2	2.5					3.7	8.4	1.2	6.0	0	0.1	2.9
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	0.4	8.6	17.3
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	3.4	13.5	11.8
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	5.8	12.2	32.5
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	1.3	1.6	22.0
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							6.2	31.9

*** 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 2003-2012.

Sample Site	1997	1998	1999	2000	2001	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Avg.
0a				5.4								2.4	19.8	2.1	26.9	11.3
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	2.6	7.6	10.0
2a	67.0	20.1	4.2	3.7	11.0					11.1	12.2	8.0	22.4	11.2	6.6	16.1
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	3.7	8.9	15.4
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	5.3	3.3	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	3.4	2.0	6.4
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	7.9	2.9	6.5
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							11.3	11.6

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

At mainstem sites, 2012 soon-to-smolt ratings were the same as in 2011 at 3 of 7 sites. The rating continued to be "Below Average" at Site 4 (upper Henry Cowell), "Very Poor" at Site 8 (Brookdale) and "Poor" at Site 11 (Teilh Road). They worsened from "Good" to "Fair" at Site 2 (Rincon) and from "Poor" to "Very Poor" at Site 6 (Below Fall Creek). Worse ratings resulted from fewer YOY reaching Size Class II after a late spawn, reduced baseflow and slower growth.

In tributaries of the San Lorenzo River, total and YOY juvenile steelhead densities increased at most sites in 2012; 9 of 12 sites for total density and 8 of 12 sites for YOY (**Tables 22 and 23**). However, densities for both categories were above average at only 3 of 13 sites (Boulder 17b with increased instream wood, upper Bean 14c and Fall 15) (**Figures 1 and 2**). Later in the fall, Bean 14c went dry to eliminate those fish. At all sites, YOY were dominated by much smaller YOY than the previous year, presumably due to late spawning during the late March and April stormflows, followed by slower growth rate from less baseflow. Yearling densities increased at 8 of 12 tributary sites (slightly at Newell 16) (**Table 24**), while they were above average at only 3 of 13 sites (Zayante 13d, Fall 15 and Branciforte 21b) (**Figure 3**). High spring stormflows and baseflows in 2012 may have encouraged some yearlings to immigrate early and may have caused reduced YOY survival as presumably occurred to a greater extent in 2011, with its much larger stormflows late in the season (**Figures 33 and 35**). Peak flows on March 23, 24 and 26 in 2011 at the Big Trees Gage were approximately 2,500, 11,500 and 3,800 cfs, respectively. Peak flows on January 21, March 17, 28 and April 13 in 2012 were 1,570, 2,660, 1,770 and 1,330 cfs, respectively. The 17 March 2012 flow approached the bankfull event. From previous calculations, bankfull at the Big Trees gage was between 2,800 and 4,300 cfs, corresponding to the 1.3 and 1.5 year recurrence intervals, respectively (**Alley 1999**).

With the juvenile steelhead population in 2012 in tributaries being dominated by small YOY at mostly below average densities and yearlings at mostly below average densities, Size Class II and III densities were less than 2011 at 10 of 12 repeated sites and below average at 8 of 13 sites (2 of which only slightly below average) (**Table 25; Figures 4 and 24**). It was positive to see that the lower Zayante 13a density had rebounded (due to larger wood cluster that had formed for cover), that Zayante 13c continued to produce relative high densities, and that our added site at upper Branciforte 21b had much above average densities (compared to pre-2002 sampling; good undercut banks for cover). The overall low densities of tributary yearlings and larger juveniles were consistent with the lowest YOY densities ever detected at some of these sites in 2011 (**Table 23**). Soon-to-smolt ratings were similar in 2012 compared to 2011 at tributary sites with only 2 of 12 sites declining (Bean 14c (which later went dry) and Newell 16) (**Table 40**). Ratings at four sites improved over 2011 due to greater retention of large yearlings (Zayante 13a, Zayante 13d, Bean 14b and Branciforte 21a-2). Tributary soon-to-smolt ratings were “Fair” or “Good” at all sites except “Below Average” at Lompico 13e and Newell 16 and “Very Good” at Branciforte 21b. This high rating at Branciforte 21b was likely due to high yearling survival plus a resident salmonid component.

Table 22. TOTAL DENSITY of Juvenile Steelhead at SAN LORENZO TRIBUTARY Monitoring Sites in 1997-2001 and 2003-2012.

Sample Site	1997	1998	1999	2000	2001	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Avg.
Zay 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	5.2	26.3	55.1
Zay 13b	74.9*	50.7	74.9	24.9	38.0	70.0	65.1	53.3								56.5
Zay 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	54.0	62.4	67.4
Zay 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	29.1	70.6	99.8
Lomp 13e									26.2	108.3	27.8	123.3	23.1	16.6	54.8	54.3
Bean 14a		44.2	45.9	17.0	38.0	50.9	31.9	54.0								40.3
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	18.2	10.5	59.0
Bean 14c		78.2	22.7	87.5	36.8	41.3	99.6	87.4	66.0	18.2	Dry		58.8	29.1	95.2 Went dry	44.7
Fall 15	84.5	82.7	85.0	55.0	59.8						84.0	48.7	46.1	78.5	101.5	72.6
Newell 16	94.9	76.3	40.5	28.8	40.3				26.0			18.6	32.5	13.4	37.7	40.9
Boul 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	19.0	19.6	54.6
Boul 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	48.7	108.7	65.9
Boul 17c		42.8	33.9	36.0	39.4	75.8	81.5	67.4								53.8
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	30.0	22.2	61.4
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
Carb 20a	13.4	21.0	18.9	9.7	19.6											16.5
Carb 20b		53.4	51.7	45.2	45.2											48.9
Branc 21a-1										6.6	3.3					5.0
Branc 21a-2	70.0	60.2	47.1	65.2	45.2				29.5	49.1	33.0	20.0	15.7	25.0	31.4	41.0
Branc 21b		67.8	57.6	59.6	57.5			20.4							50.7	52.3

*** 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 2003-2012.

Sample Site	1997	1998	1999	2000	2001	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Avg.
Zay 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	2.6	21.9	50.6
Zay 13b	64.9*	43.5	60.6	7.7	31.2	60.4	58.7	48.1								46.9
Zay 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	43.4	58.1	59.7
Zay 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	25.6	62.2	85.8
Lomp 13e									24.2	96.9	21.4	118.4	14.4	14.2	52.5	48.9
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	14.3	8.3	50.1
Bean 14c		71.8	6.9	76.6	18.1	23.0	87.4	81.5	61.1	5.6	0 (Dry)		55.7	27.2	58.1 Went dry	36.8
Fall 15	79.6	74.8	68.1	45.1	45.4						68.2	30.6	33.5	71.7	86.2	60.3
Newell 16	77.1	67.6	17.7	19.9	35.6				20.1			15.0	31.2	13.1	37.1	33.4
Boul 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	17.0	13.5	47.1
Boul 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	46.4	98.1	57.7
Boul 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	29.0	19.1	51.3
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
Carb 20a	9.1	17.2	13.2	5.6	16.5											12.3
Carb 20b		50.9	40.3	29.7	33.4											38.6
Branc 21a-1										2.8	2.7					2.8
Branc 21a-2	64.6	54.1	35.5	47.2	34.2				30.6	47.6	27.3	12.5	11.2	21.5	22.2	34.0
Branc 21b		60.1	44.2	45.8	49.4			9.1							23.4	38.7

*** 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 2003-2012.

Sample Site	1997	1998	1999	2000	2001	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Avg.
Zay 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	1.4	4.0	4.3
Zay 13b	10.0 *	7.2	14.3	17.2	6.8	9.6	6.4	5.2								9.6
Zay 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	10.1	2.1	7.6
Zay 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	1.5	8.3	13.8
Lomp 13e									1.9	11.3	6.4	4.9	8.7	3.3	2.3	5.5
Bean 14a		0.8	3.9	5.9	2.0	4.5	1.9	3.1								3.2
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	3.9	2.9	8.9
Bean 14c		6.4	15.8	10.9	18.7	18.3	12.2	5.9	4.1	5.4	0 Dry		3.1	1.8	2.6 Went dry	7.3
Fall 15	4.9	7.9	16.9	9.9	14.4						15.8	18.0	12.3	6.5	14.5	12.1
Newell 16	17.8	8.7	22.8	8.9	4.7				5.4			3.9	1.5	0.6	1.2	7.6
Boul 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	2.9	6.3	7.6
Boul 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	1.8	10.6	8.1
Boul 17c		5.2	18.6	8.5	8.7	11.8	11.8	6.1								10.1
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	0.7	3.2	8.7
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
Carb 20a	4.3	3.8	5.7	4.1	3.1											4.2
Carb 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	3.4	9.2	7.0
Branc 21b		7.6	13.4	11.1	8.1			11.3							27.3	13.1

*** 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 2003-2012.

Sample Site	1997	1998	1999	2000	2001	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	Avg.
Zay 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	4.8	14.2	11.1
Zay 13b	11.7	14.9	19.9	17.2	7.1	9.6	6.4	17.3								13.0
Zay 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	29.2	20.0	14.5
Zay 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	11.7	8.6	15.6
Lomp 13e									5.7	11.3	6.4	4.9	8.7	7.8	2.3	6.7
Bean 14a		2.1	3.9	5.9	2.0	4.5	1.9	12.0								4.6
Bean 14b	13.7	11.3	33.1	7.1	5.3	9.1	8.2	39.4	11.9	8.9	4.7	10.9	8.4	7.4	10.1	12.6
Bean 14c		6.4	15.8	10.9	18.4	18.3	12.2	12.4	17.1	5.4	0 Dry		6.7	8.8	5.2 Went Dry	9.5
Fall 15	8.2	13.3	16.9	9.9	13.0						15.8	18.7	14.3	14.7	13.0	13.8
Newell 16	23.6	14.9	22.8	8.9	4.7				16.2			4.4	24.7	13.1	7.3	14.1
Boul 17a	22.8	21.9	17.8	9.1	5.2	16.9	7.3	9.0	18.2	6.8	7.2	5.5	11.8	10.6	7.2	11.8
Boul 17b	9.7	11.5	13.3	9.1	12.9	14.5	6.2	8.2	13.7	9.8	3.8	10.7	12.7	13.6	10.6	10.7
Boul 17c		5.2	18.6	8.5	8.7	11.8	11.8	8.4								10.4
Bear 18a	18.3	13.0	18.1	21.0	8.0	11.8	11.1	13.7	13.6	5.7	5.1	2.5	9.5	9.4	4.1	11.0
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	4.5	6.2	12.8	6.0	10.0											7.9
Carb 20a		11.5	5.7	4.1	3.1											6.1
Carb 20b		11.4	11.4	15.5	11.8											12.5
Branc 21a-1										3.9	0.5					2.2
Branc 21a-2	4.3	8.5	11.6	18.0	10.8				10.8	1.5	5.7	7.5	12.6	13.6	12.3	9.8
Branc 21b		14.8	13.4	11.1	8.1			16.0							27.3	15.1

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

R-7. 2012 Densities in Soquel Creek Compared with Those Since 1997

As was the pattern in the San Lorenzo watershed, total and YOY densities in 2012 increased from 2011 at all 7 sites (**Tables 26 and 27**). However, the pattern of 2012 juvenile densities compared to average densities in Soquel Creek was different from the San Lorenzo in that total and YOY densities were near average at 5 of 7 sites instead of mostly below average, except at East Branch Site 16 in the SDSF where they were much below average (**Figures 5 and 6**). This was the second year in a row in which YOY and total densities at that site were alarmingly low, as indicated in the trend in total numbers (**Figure 25**). 2012 yearling densities showed the same pattern as YOY with regard to long term averages except yearling densities were nearly twice the average at Site 16 (**Figure 7**), and were slightly greater than in 2011 at 4 of 7 sites (**Table 28**). The relative high yearling survival/retention at Site 16 was consistent with similar higher densities at that site during other dry years of 2007–2009. Increased total and YOY densities in 2012 compared to 2011 were statistically significant (**Table 44**).

Mild spring stormflows and above median baseflows in spring may have encouraged some yearlings to immigrate early except at the upper East Branch Site 16. But they were insufficient to cause sufficient YOY mortality to reduce YOY densities below average at most sites (**Figures 37 and 38**). Apparently, there were insufficient late spawners to seed the SDSF site with YOY in 2012 after the March 16 storm. Peak flows at the Soquel Village Gage on March 16, March 28 and April 13 were 2,360, 706 and 794 cfs, respectively. The 16 March flow was likely somewhat above bankfull in magnitude and may have reduced YOY survival from earlier spawners. YOY mortality was also probably high in 2011 when peak flows on March 23, 24 and 26 in 2011 were approximately 850, 5,700 and 1,800 cfs, respectively. The 24 March 2011 storm was likely at least twice the bankfull, and the 26 March storm was likely near bankfull.

With yearling densities higher in 2012 than 2011 at 4 of 7 sites and a higher density of YOY's at all sites with a portion growing into Size Class II at some sites (**Figure 18**), the trend in Size Class II and III densities rebounded in 2012 to 2010 levels on average (**Figure 26**). 2012 densities of Size Class II and III juveniles were above average at 5 of 7 sites and greater than in 2011 at 5 of 7 sites (**Table 30; Figure 8**). This was unlike in the San Lorenzo watershed where the majority of tributary sites had below average Size Class II densities that were less than in 2011. Spring and early summer baseflows were above or near the median statistic (**Figure 37**), allowing some YOY to reach Size Class II despite the apparent late spawning that occurred, as indicated by the higher density of small YOY in Size Class I (**Table 29**). Soon-to-smolt density ratings improved at 3 of 7 sites to "Good" at Site 10 (above Moores Gulch) and Site 16 (SDSF) and "Fair" at Site 1 (Capitola) (**Table 40**). This was due to retention of large yearlings after a mild winter and sufficient baseflow for some of the average density of YOY to reach Size Class II in the lower mainstem. Only West Branch Site 19 declined to a "Below Average" rating. This was due to reduced yearling density at the sampling site as a result of loss of instream wood and escape cover over the winter. East Branch Site 13a remained in the "Good" range, while Site 4 and Site 12 remained "Fair."

Table 26. TOTAL Juvenile Steelhead SITE DENSITIES (fish/ 100 ft) at Monitoring Sites in SOQUEL CREEK in 1997–2012.
(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	2011 L-W	2012 L-D	Avg
1- Near Grange Hall	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	2.7	4.2	5.8
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 Field	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	5.3	13.5	19.3
5-Adj. Beach Shack	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	-	-	-					34.1
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	5.8	37.1	31.4
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	6.0	33.8	34.9
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	11.2	41.1	46.8
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	37.8	43.0	110.6
17- Above Fern Gulch*	138.3	104.2	170.9	93.8	96.3	129.5	102.4	117.2	157.3	-	-	-					123.3
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	24.3	48.7	34.7
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	13.7		70.6
22- Above GS Falls II	-	-	-	-	-	65.5	27.5	58.1	5.5	8.6	-	-					33.0

*** 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 27. SITE DENSITIES (fish/ 100 ft) of Juvenile Steelhead by YOUNG-OF-THE-YEAR AGE CLASS at Monitoring Sites in SOQUEL CREEK in 1997–2012.
(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	2011 L-W	2012 L-D	Avg
1- Near Grange Hall	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	1.8	3.0	4.7
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 Field	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	3.9	12.6	17.4
5-Adj. Beach Shack	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	-	-	-	-	-	-					17.4
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	5.2	34.3	29.6
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	4.3	31.4	32.8
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	8.3	37.8	40.8
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	32.8	29.2	102.9
17- Above Fern Gulch*	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	22.6	48.7	33.5
20- Above Hester Ck	-	30.6	36.3	34.3	26.2	49.2	45.3	84.9	49.4	21.5	-	-					42.0
21- Above GS Falls I	-	-	-	-	-	107.2	104.0	93.7	98.7	42.7**	63.2**	-	44.9	20.8	11.9		65.2
22- Above 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 1997–2012.
(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	2011 L-W	2012 L-D	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	0.9	1.2	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 Field	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	1.4	1.0	1.3
5-Adj. Beach Shack	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	–	–	–	–	–	–					1.2
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	0.6	2.5	1.5
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	1.7	2.3	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	2.7	2.6	2.3
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	5.1	13.8	7.7
17- Above Fern Gulch*	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	2.4	1.0	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	2.1		5.2
22- Above 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 1997–2012.
(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	2011 L-W	2012 L-D	Avg.
1- Near Grange Hall	1.7	0.2	0	0	0.5	3.5	0.3	0.5	0	-	9.2	4.9	2.6	1.6	0	0.2	1.7
2- Adj. USGS Gage	0.9	0.2	0	0	2.2	3.5	1.7	1.9	0	-	-	-					1.2
3- Above Bates Ck	1.8	0	0	0.9	4.0	10.4	-	-	0	-	-	-					2.4
4- Adj. Flower Field	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	0	2.4	9.8
5-Adj. Beach Shack	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	0	21.2	22.1
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	0.4	20.7	26.5
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	0.7	22.5	34.8
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	22.5	29.2	100.0
17-Above Fern Gulch*	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	7.4	43.8	28.1
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 Fall I	-	-	-	-	-	107.2	103.1	91.8	90.0	30.1 **	61.3 **	-	43.1	8.7	1.2		59.6
22-Above GS FallII	-	-	-	-	-	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 1997–2012.
(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	2011 L-W	2012 L-D	Avg
1-Near Grange	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	2.7	4.0	4.1
2-Adj. USGS Gage	3.6	9.4	0.8	5.9	5.5	–	2.4	1.6	4.2	–	–	–					4.1
3-Above Bates Ck	11.4	50.6	7.6	1.3	4.4	4.4	–	–	7.9	–	–	–					12.5
4-Adj. Flower Field	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	5.3	11.1	9.5
5-Adj. Beach Shack	18.1	20.6	7.8	8.1	6.4	–	–	–	–	–	–	–					12.2
6-End of Cherryvl	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 Riverval	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	5.8	16.0	9.2
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	5.6	13.1	8.4
13a- below MillPond	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	10.1	18.6	11.3
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 C*	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	15.4	13.8	10.6
17-Above Fern G*	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 C	2.2	1.3	8.7	3.1	1.2	–	–	–	–	4.7	4.8	5.7	14.1	11.6	16.9	6.1	6.7
20- Above Hester C	–	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	12.4		11.1
22-Above GSFallII	–	–	–	–	–	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-8. Comparison of 2012 Densities in Aptos Creek with Previous Years

The lower Aptos Watershed's sampling Site 3 followed the pattern of consistently below average total and YOY densities in 2012 that was observed in the San Lorenzo watershed, but the upper Site 4 was much above average, likely due to the increased instream wood found at the site (**Tables 31 and 32; Figures 9 and 10**). Both sites followed the pattern in other watersheds with increased YOY, yearling and total juvenile densities in 2012 compared to 2011 (**Table 33; Figure 27**). With the higher retention of yearlings, the Size Class II and III densities were near average at both sites (**Table 35; Figure 11**). However, the reduced baseflow compared to 2011 did not allow YOY's to reach Size Class II at Site 4 in 2012 (**Figure 19**), and Size Class II densities were much higher in 2011 at that site because such a high percentage of YOY reached Size Class II that year. YOY densities were higher at Site 4 in 2012 (**Table 32**), but they were nearly all small Size Class I fish (**Table 34**). The reduced Size Class II densities at Site 4 in 2012 in Aptos compared to 2011 followed the pattern seen in San Lorenzo tributary sites but not because of reduced yearling densities as found in San Lorenzo tributaries. The increased Size Class II density at Site 3 in Aptos in 2012 compared to 2011 followed the pattern seen at most Soquel sites and for the same reasons; more yearling retention in 2012 and some proportion of the higher YOY density growing into Size Class II.

In Aptos Creek, average Size Class II and III density increased in 2008−2010, but declined slightly after that to a 2012 level that was less than in 2006 and 2007 (**Figure 28**). However, differences between sites are typically great because YOY growth rate is higher at the lower site. Both Aptos sites had "Good" smolt ratings in 2012, having improved at Aptos #3 due to improved yearling survival/retention. It declined at Aptos #4 due to lack of YOY reaching Size Class II after a late spawn but remained "Good" due to high yearling survival/retention at the site, which had a larger instream wood cluster and more escape cover than in 2011.

R-9. Steelhead Population Estimate for the Aptos Lagoon/Estuary and Tidewater Goby Use in 2012

Aptos estuary/lagoon in fall 2012 had a significant juvenile steelhead population with relatively rapid growth rate compared to those captured in stream habitat. We suspect that a substantial percent of returning adults spent residence time in the estuary/lagoon. Soquel Lagoon is also habitat for a sizeable juvenile steelhead population, as indicated by 20 years of population censusing there for the City of Capitola. A small population of tidewater goby still existed in Aptos estuary/lagoon in fall 2012, despite an artificial breaching straight out across the sandbar in March that caused the estuary to drain and likely artificial breaching in fall prior to fish sampling. Tidewater gobies are typically found along freshwater lagoon margins having aquatic algae and other aquatic vegetation. They were most abundant along the jetty and along the western estuary margin, 30 feet downstream from the bridge.

Steelhead were sampled on 20 September from 5 seine hauls with a 106-ft long bag seine (6 feet high by 3/8-inch mesh) in the main estuary. On 27 September 2012, steelhead were again sampled with 3 seine hauls with a 106-ft long bag seine in the main estuary. On 20 September 2012, 48 juvenile steelhead were captured with the 106-ft bag seine, along with staghorn sculpin, prickly sculpin, threespine stickleback and 94 topsmelt. On 27 September 2012, 76 juvenile steelhead were captured with the larger seine, along with 73 topsmelt. There were 26 steelhead recaptures and no steelhead mortalities (estimated population size of 140). No bimodal distribution of juvenile steelhead lengths occurred in 2012 as had been detected in 2011 (**Figures 43 and 44**). The 2012 population estimate was a third of the 2011 estimate of 423.

In addition, on 20 September 2012, the periphery of the estuary east of the jetty was sampled for tidewater goby and other small fishes from 7 seine hauls with a 30-foot long beach seine (4 feet high by 1/8-inch mesh). The eastern margin of the jetty was seined. There was no dead end finger present near the residences as had been present in 2011 (**see illustration**). On 27 September 2012, an additional 6 seine hauls east of the jetty and 3 seine hauls west of the jetty were made with the 30-foot long beach seine. The western margin of the jetty, concrete walls and riprap could not be seined effectively because these areas lacked smooth, gradual shorelines where the seine could be adequately beached. Each seine haul was inspected for tidewater goby, and the fish species composition was determined for the seine hauls, combined.

Species captured with the 30-foot beach seine on 20 September 2012 included 68 tidewater gobies. Threespine sticklebacks and staghorn sculpins were present. An additional 9 tidewater gobies were captured with the steelhead seine that day. Species captured with the 30-foot beach seine on 27 September 2012 included 71 tidewater gobies. Threespine sticklebacks were abundant and staghorn sculpins were present. An additional 2 tidewater gobies were captured with the steelhead seine that day. No tidewater goby mortalities occurred.

It is typical for the creek outlet to rise in elevation and meander laterally across the beach as streamflow declines and the sandbar builds up in summer at Central Coast stream outlets. Enlargement and deepening of the estuary/lagoon resulted through the summer from progressive elevational increase of the outlet through the sandbar as stream inflow to the estuary diminished, it being enhanced by recent tidal overwash between 20 and 27 September. The estuary was open to the ocean during both samplings, with saline conditions in the lower water column. The estuary was nearly 0.5 meter deeper on 27 September than 20 September due to tidal overwash. The upper 0.5 meter of the water column was close to freshwater on 20 September, while only the upper 0.25 meter was fresh on 27 September.

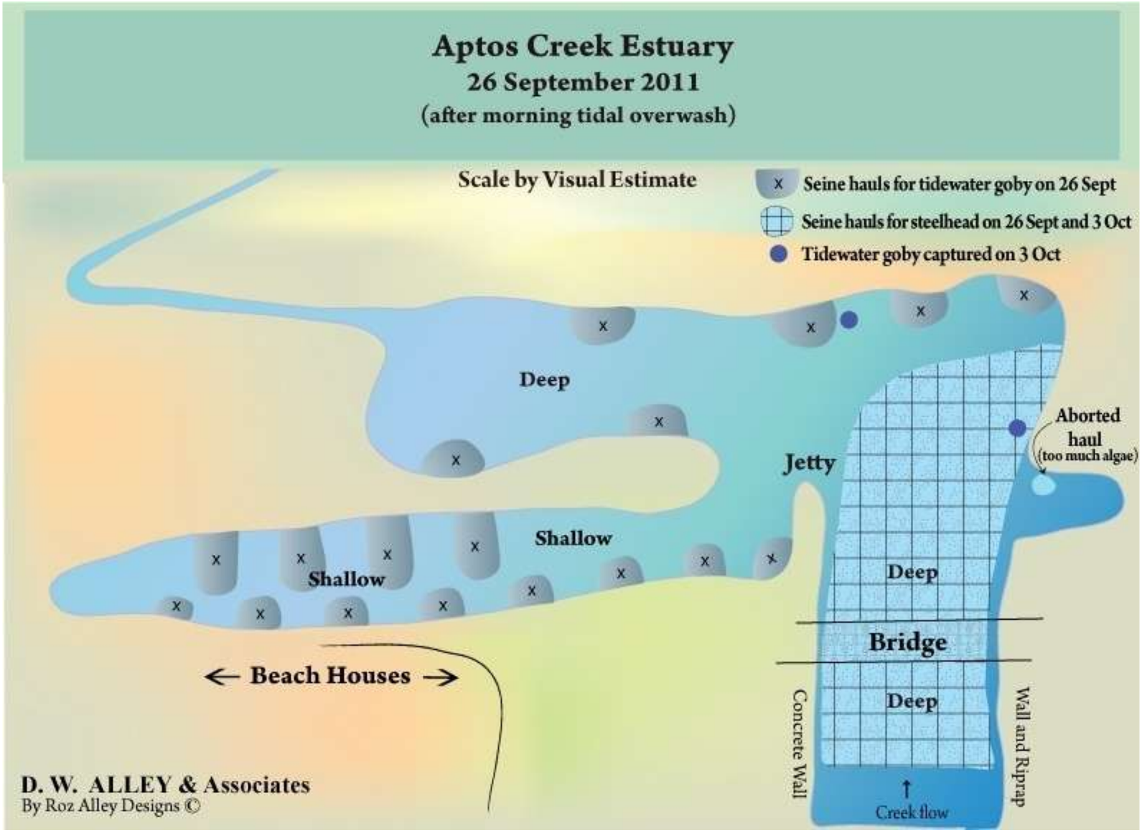
Aptos Creek Estuary
26 September 2011
(after morning tidal overwash)
Scale by Visual Estimate
Seine hauls for tidewater goby on 26 Sept
Seine hauls for steelhead on 26 Sept and 3 Oct
Tidewater goby captured on 3 Oct
Deep
Jetty
Aborted haul (too much algae)
Shallow
Shallow
Deep
Bridge
Deep
Concrete Wall
Wall and Riprap
Creek flow
Beach Houses
D. W. ALLEY & Associates
By Roz Alley Designs ©

Table 31. TOTAL DENSITY of Juvenile Steelhead at Monitoring Sites in APTOS, VALENCIA, CORRALITOS, SHINGLE MILL and BROWNS VALLEY Creeks, 1981, 1994 and 2006–2012.

Sample Site	1981	1994	2006	2007	2008	2009	2010	2011	2012	Avg.
Aptos #3- in County Park	35.2*	–	26.2	61.7	45.4	8.5	39.4	10.3	24.5	31.4
Aptos #4- above steel Bridge Xing Nisene Marks	43.0	–	38.6	26.8	89.3	8.0	21.7	21.6	65.5	38.8
Valencia #2- Below Valencia Road Xing	33.1	–	28.3	43.0	38.5	22.7	25.1	–	–	31.8
Valencia #3- Above Valencia Road Xing	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	16.2	65.4	38.7
Corralitos #3- Above Colinas Dr	39.1	18.6	35.5	42.1	35.9	14.9	6.2	16.2	60.2	29.9
Corralitos #8- Below Eureka Glch	81.9	28.6	49.0	52.9	55.9	51.9	20.1	34.0	27.6	44.7
Corralitos #9- Above Eureka Glch	86.1	29.9	87.1	38.5	61.7	73.2	33.6	38.7	49.2	55.3
Shingle Mill #1- Below 2nd Road Xing	24.5	30.0	33.9	16.2	18.8	6.7	11.9	22.0	25.2	21.0
Shingle Mill #3- Above 2nd Road Xing	32.6	–	22.9	12.7	24.5	21.8	33.1	22.3	24.8	24.3
Browns Valley #1- Below Dam	54.3	22.5	101.6	35.4	36.5	25.6	24.9	45.6	52.2	44.3
Browns Valley #2- Above Dam	71.6	18.5	99.5	79.0	44.8	54.9	41.4	49.2	69.1	58.7

*** 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, 2006–2012.

Sample Site	1981	1994	2006	2007	2008	2009	2010	2011	2012	Avg.
Aptos #3- in County Park	24.4*	–	23.7	54.0	43.4	3.3	37.3	8.9	17.5	26.6
Aptos #4- above steel Bridge Xing Nisene Marks	37.1	–	35.2	9.8	84.6	3.9	20.1	20.7	52.4	33.0
Valencia #2- below Valencia Road Xing	16.6	–	24.5	26.6	27.5	8.9	16.4	–	–	20.1
Valencia #3- Above Valencia Road Xing	16.6	–	20.5	4.7	41.5	7.8	25.6	–	–	19.5
Corralitos #1- Below Dam	–	–	–	27.0	61.2	26.5	9.1	14.8	57.5	32.7
Corralitos #3- Above Colinas Dr	33.9	10.2	24.6	30.6	27.6	9.8	5.2	14.2	38.5	21.6
Corralitos #8- Below Eureka Gulch	59.7	14.3	45.0	44.0	46.6	39.3	19.0	29.4	18.2	35.1
Corralitos #9- Above Eureka Gulch	55.8	16.7	78.4	31.3	44.6	54.0	30.7	33.5	36.9	42.4
Shingle Mill #1- Below 2nd Road Xing	14.3	5.7	25.1	2.9	13.2	0	7.0	15.7	21.0	11.7
Shingle Mill #3- Above 2nd Road Xing	18.6	–	19.5	6.0	23.9	18.4	25.2	14.3	19.1	18.1
Browns Valley #1- Below Dam	26.9	7.0	96.6	15.3	25.0	8.9	21.4	41.8	34.6	30.8
Browns Valley #2- Above Dam	66.1	12.8	94.7	47.0	32.2	43.0	38.8	45.2	48.9	47.6

*** 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 2006–20112

Sample Site	1981	1994	2006	2007	2008	2009	2010	2011	2012	Avg.
Aptos #3- in County Park	10.8*	–	3.1	7.6	2.3	5.2	1.9	1.4	6.4	4.8
Aptos #4- above steel Bridge Xing Nisene Marks	5.9	–	3.0	17.1	4.9	3.9	1.0	2.8	8.9	5.9
Valencia #2- below Valencia Road Xing	16.5	–	3.8	16.4	11.0	13.8	8.9	–	–	11.7
Valencia #3- Above Valencia Road Xing	13.2	–	12.9	11.5	14.0	18.5	14.2	–	–	14.1
Corralitos #1- Below Dam	–	–	–	9.1	8.7	6.9	1.3	1.3	7.3	5.8
Corralitos #3- Above Colinas Dr	5.2	8.4	10.8	11.5	8.3	5.3	1.1	1.8	20.5	8.1
Corralitos #8- Below Eureka Gulch	22.2	14.3	4.0	9.0	9.4	13.2	1.1	3.9	9.4	9.6
Corralitos #9- Above Eureka Gulch	30.3	13.2	9.5	7.2	17.1	19.2	2.8	5.1	12.2	13.0
Shingle Mill #1- Below 2nd Road Xing	10.2	24.3	9.0	13.3	5.6	6.7	5.6	6.3	4.2	9.5
Shingle Mill #3- Above 2nd Road Xing	14.0	–	3.4	6.7	0.7	7.2	6.1	8.0	5.7	6.5
Browns Valley #1- Below Dam	27.4	15.5	4.3	19.6	11.5	12.9	3.7	4.5	17.6	13.0
Browns Valley #2- Above Dam	5.5	7.7	2.8	32.0	12.6	11.9	2.0	4.3	20.2	11.0

*** 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, 2006–2012.

Sample Site	1981	1994	2006	2007	2008	2009	2010	2011	2012	Avg.
Aptos #3- in County Park	24.4*	–	7.2	50.8	39.4	3.3	22.2	3.2	12.9	20.4
Aptos #4- above steel Bridge Xing Nisene Marks	37.1	–	28.5	9.0	83.8	0	12.0	4.9	51.9	28.4
Valencia #2- below Valencia Road Xing	16.6	–	24.5	26.6	27.5	8.9	16.4	–	–	20.1
Valencia #3- Above Valencia Road Xing	16.6	–	20.5	5.7	41.5	7.8	24.6	–	–	19.5
Corralitos #1- Below Dam	–	–	–	27.0	61.2	20.5	1.7	8.6	56.8	29.3
Corralitos #3- Above Colinas Dr	33.9	10.2	16.2	30.6	27.6	5.6	0.7	9.6	36.0	18.9
Corralitos #8- Below Eureka Gulch	59.7	14.3	35.8	43.0	46.6	36.6	14.1	21.7	18.2	32.2
Corralitos #9- Above Eureka Gulch	55.8	16.7	45.5	31.3	44.6	53.5	22.4	24.2	36.5	36.7
Shingle Mill #1- Below 2nd Road Xing	14.3	5.7	17.7	2.9	13.2	0	5.6	15.0	21.0	10.6
Shingle Mill #3- Above 2nd Road Xing	32.4	–	19.5	6.0	23.9	18.4	25.2	14.3	19.1	19.9
Browns Valley #1- Below Dam	26.9	7.0	84.6	18.1	25.0	8.9	14.8	31.4	34.6	27.9
Browns Valley #2- Above Dam	66.1	12.8	82.6	48.8	32.2	43.0	32.0	35.9	48.9	44.7

*** 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 2006–2012.

Sample Site	1981	1994	2006	2007	2008	2009	2010	2011	2012	Avg.
Aptos #3- in County Park	10.8*	–	19.0	10.9	6.0	5.2	17.2	7.1	11.6	11.0
Aptos #4- above steel Bridge Xing Nisene Marks	5.9	–	10.1	17.8	5.5	8.0	9.7	16.7	9.6	10.4
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	–	–	14.0
Corralitos #1 Below Dam	–	–	–	9.1	8.7	13.7	8.7	7.6	8.7	9.4
Corralitos #3- Above Colinas Dr.	5.2	8.4	19.3	11.5	8.3	9.3	5.5	6.6	24.2	10.9
Corralitos #8- Below Eureka Gulch	22.2	14.3	13.2	9.9	9.4	15.3	6.0	12.3	9.4	12.4
Corralitos #9- Above Eureka Gulch	30.3	13.2	41.6	7.2	17.1	19.7	11.2	14.5	12.7	18.6
Shingle Mill #1- Below 2nd Road Xing	10.2	24.3	16.2	13.3	5.6	6.7	6.3	7.0	4.2	10.4
Shingle Mill #3- Above 2nd Road Xing	4.0	–	3.4	6.7	0.7	7.2	6.1	8.0	5.7	5.2
Browns Valley #1- Below Dam	27.4	15.5	17.0	17.4	11.5	12.9	10.1	14.2	17.6	16.0
Browns Valley #2- Above Dam	5.5	5.7	16.9	30.2	12.6	11.9	9.4	13.3	20.2	14.0

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

R-10. Comparison of 2012 Steelhead Densities in the Corralitos Sub-Watershed

In 2012, Corralitos Creek was still recovering from the Summit fire of 2008 that caused high sedimentation over the 2009-2010 winter to Corralitos Creek, mostly downstream of Shingle Mill Gulch and not in Browns Creek. In 2012, YOY densities at the lower 2 Corralitos sites were above average, but the upper 2 Corralitos sites were still below average, with lower Shingle Mill Site 1 above average and upper Shingle Mill Site 3 and Browns sites being near average (**Table 32; Figure 14**). Yearling densities were either near average or above average at 7 of 8 sites. Total juvenile densities followed a similar pattern to YOY densities. However, with higher survival/retention of yearlings in 2012 at all but Shingle Mill sites, the total 2012 densities increased above average at Browns Creek sites, as well (**Tables 31 and 33; Figures 13 and 15***)*. Spring stormflows were apparently mild enough to reduce yearling mortality or failed to allow yearlings to grow sufficiently to leave early or be flushed out, unlike what probably occurred in 2011. No changes in densities of size or age classes were statistically significant (**Tables 45 and 46**).

In 2012, Size Class II densities were notably above average at Corralitos #3 and Browns #2 sites due to high yearling densities there (**Table 35; Figure 16**). The other 6 sites had near average or below average densities. This was similar to the pattern in San Lorenzo tributary sites. Size Class II densities increased at 4 of 8 sites in the Corralitos sub-watershed in 2012 compared to 2011, with increases at the lower 2 Corralitos sites and the 2 Browns Creek sites. Increased densities at Corralitos Site 1 and Browns Site 2 were consistent with improved habitat conditions at those sites (**Tables 16b-c**). But density was slightly less at Corralitos Site 9 in 2012 despite more escape cover being present. There was slightly lower YOY density at that site in 2011, but there was sufficient baseflow to allow nearly 1/3 to reach Size Class II (**Figure 20**). Size class II densities were more at Corralitos Site 3 despite less escape cover, though maximum depth was nearly 3 feet in one sampled pool and escape cover was ample. At Corralitos Site 3, yearling density was greater (10x) and YOY density was higher (>2x) in 2012 compared to 2011, with 10% of the YOY reaching Size Class II. This resulted in 3.7x the Size Class II density in 2012 compared to 2011 at that site.

With reduced baseflow and continuing sediment abundance, pool depth declined in all 3 reaches habitat typed in Corralitos Creek and at all sites sampled except Corralitos Site 3. Fine sediment and embeddedness were either similar to 2011 or worse in 2012 except for less sediment at Corralitos Site #1. So, Corralitos Creek has not recovered from the fire in 2012, and added sedimentation was occurring in Browns Creek. On a positive note, during wood survey work in December in Corralitos Creek, spawning gravel appeared more abundant than in recent years since the fire.

With regard to adult steelhead passage above the Corralitos Creek diversion dam between Corralitos Sites #1 and #3, passage conditions through the fish ladder should have been adequate during the protracted rainy season of 15 March−15 April. YOY densities of nearly 40 fish/ 100 feet above the dam at Site #3 (above average YOY density) and at Site #9 indicated that adults negotiated the fish ladder to spawn upstream.

R-11. Rating of Rearing Habitat in 2012, Based on Site Densities of Soon-to-Smolt-Sized Steelhead

Habitat was rated at sampling sites, based on soon-to-smolt-sized (=>75 mm SL and likely to smolt the following spring) steelhead density according to the rating scheme developed by Smith (**1982**) (**Table 39**). In this scheme, the average standard length for soon-to-smolt-sized fish was calculated for each site. If the average was less than 89 mm SL, then the density rating assigned by 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 to 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. This was highly unlikely in 2012.

For 2011 and 2012, smolt-sized juvenile ratings for sampling sites were tabulated and summarized (**Tables 40 and 41**). Four of 8 sites had improved smolt ratings to "Good" at Corralitos #1, Browns #1 and Browns #2 and "Very Good" at Corralitos #3 due to increased yearling survival/retention. The two Shingle Mill sites registered at "Below Average" ratings, with the upper site being down-graded in 2012. Corralitos #8 in the still highly sedimented reach below Eureka Gulch also declined from "Fair" to "Below Average" because of low yearling density and poor pool habitat.

Table 39. Rating of Steelhead Rearing Habitat For Small, Central Coastal Streams.*
(From Smith 1982.)

<u>Very Poor</u> - less than 2 smolt-sized fish per 100 feet of stream.**			
<u>Poor</u>* - from 2 to 4**	"	"	"
<u>Below Average</u> - 4 to 8	"	"	"
<u>Fair</u> - 8 to 16	"	"	"
<u>Good</u> - 16 to 32	"	"	"
<u>Very Good</u> - 32 to 64	"	"	"
<u>Excellent</u> - 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 40. 2012 Sampling Sites Rated by Potential Smolt-Sized Juvenile Density (=>75 mm SL) and Their Average Size in Standard Length Compared to 2011, with Physical Habitat Change from 2011 Conditions.

Site	2012 Potential Smolt Density (per 100 ft)/ Avg Pot. Smolt Size SL (mm)	2012 Smolt Rating (With Size Factored In)	2011 Potential Smolt Density (per 100 ft)/ Avg Pot. Smolt Size SL (mm)	2011 Smolt Rating (With Size Factored In)	Physical Habitat Change by Reach/Site Since 2011
Low. San Lorenzo #0a	26.9/ 135 mm	*Very Good*	2.1/ 124 mm	Below Average	+
Low. San Lorenzo #1	7.6/ 119 mm	Fair	2.6/ 148 mm	Below Average	–
Low. San Lorenzo #2	6.6/ 111 mm	Fair	11.2/ 142 mm	*Good*	–
Low. San Lorenzo #4	8.9/ 87 mm	Below Average	3.7/ 103 mm	Below Average	–
Mid. San Lorenzo #6	3.3/ 86 mm	Very Poor	5.3/ 85 mm	Poor	–
Mid. San Lorenzo #8	2.0/ 81 mm	Very Poor	3.4/ 82 mm	Very Poor	–
Up. San Lorenzo #11	2.9/ 101 mm	Poor	7.9/ 84 mm	Poor	–
Up. San Lorenzo #12b	11.3/ 112 mm	*Good*	No data	No data	No data
Zayante #13a	14.2/ 107 mm	*Good*	4.8/ 116 mm	Fair	–
Zayante #13c	20.0/ 90 mm	*Good*	29.2/ 95 mm	*Good*	–
Zayante #13d	8.6/ 127 mm	*Good*	11.7/ 97 mm	Fair	–
Lompico #13e	2.3/ 127 mm	Below Average	7.8/ 95 mm	Below Average	–
Bean #14b	10.1/ 122 mm	*Good*	7.4/ 127 mm	Fair	–
Bean #14c	5.2/ 120 mm Went Dry	Fair Went Dry	8.8/ 104 mm	*Good*	–
Fall #15	13.0/ 113 mm	*Good*	14.7/ 115 mm	*Good*	–
Newell #16	7.3/ 93 mm	Below Average	13.1/ 99 mm	Fair	–
Boulder #17a	7.2/ 131 mm	Fair	10.6/ 101 mm	Fair	–
Boulder #17b	10.6/ 104 mm	*Good*	13.6/ 106 mm	*Good*	–
Bear #18a	4.1/ 115 mm	Fair	9.4/ 98 mm	Fair	–
Branciforte #21a-2	12.3/ 114 mm	*Good*	13.6/ 100 mm	Fair	–
Branciforte #21b	27.3/ 96 mm	*Very Good*	No data	No data	No data
Soquel #1	4.0/ 115 mm	Fair	2.7/ 135 mm	Below Average	–
Soquel #4	11.1/ 101 mm	Fair	5.3/ 118 mm	Fair	+
Soquel #10	16.0/ 94 mm	*Good*	5.8/ 107 mm	Fair	–
Soquel #12	13.1/ 93 mm	Fair	5.6/ 109 mm	Fair	+
East Branch Soquel #13a	18.6/ 94 mm	*Good*	10.1/ 112 mm	*Good*	+
East Branch Soquel #16	13.8/ 105 mm	*Good*	15.4/ 100 mm	Fair	–
West Branch Soquel #19	6.1/ 91 mm	Below Average	16.9/ 95 mm	Fair	–
Aptos #3	11.6/ 103 mm	*Good*	7.1/ 101 mm	Below Average	–
Aptos #4	9.6/ 120 mm	*Good*	16.7/ 104 mm	*Very Good*	–
Corralitos #1	8.7/ 108 mm	*Good*	7.6/ 100 mm	Fair	+
Corralitos #3	24.2/ 114 mm	*Very Good*	6.6/ 123 mm	Fair	–
Corralitos #8	9.4/ 100 mm	Fair	12.3/ 109 mm	*Good*	–
Corralitos #9	12.7/ 105 mm	*Good*	14.5/ 104 mm	*Good*	+
Shingle Mill #1	4.2/ 101 mm	Below Average	7.0/ 100 mm	Below Average	–
Shingle Mill #3	5.7/ 91 mm	Below Average	8.0/ 98 mm	Fair	–
Browns #1	17.6/ 98 mm	*Good*	14.2/ 100 mm	Fair	–
Browns #2	20.2/ 97 mm	*Good*	13.3/ 101 mm	Fair	+

Table 41. Summary of Sampling Site Ratings in 2006–2012, 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=39)	0	1	9	16	12	1
2011 (n=37)	1	2	7	18	8	1
2012 (n=38)	2	1	6	9	17	3

R-12. Steelhead Population Estimate for the Pajaro Lagoon and Tidewater Goby Use in 2012

No steelhead were captured in Pajaro Lagoon in fall 2012. A small population of tidewater goby still existed there. However, its future is uncertain due to potential conflicts between maintaining fish habitat and flood control.

Methods

The sandbar was closed in fall 2012, and the lagoon was extensive and extended more than 3 miles upstream from the beach. The upper lagoon, oriented perpendicular to the beach, was sampled on 2 October (6 seine hauls in two locations) (**Table 36**). The lower lagoon, oriented parallel to the beach, was sampled on 3 October (8 seine hauls in 8 locations along the full extent) (**Table 37**). The 106-foot bag seine (3/8-inch mesh) was used on 2 and 3 October to capture steelhead. On October 4, the periphery of the lower lagoon along the beach berm (6 seine hauls), Watsonville Slough (1 seine haul) and the upper lagoon (1 seine haul) were sampled with the smaller seine (**Table 38**). The 30-foot goby seine (1/8-inch mesh) was used on 4 October. Captured fish were identified, counted and released without mortality.

Water Quality

On sunny 2 October during the warmest days of the dry season, air temperature was 25.2 C at 1430 hr. Slight salinity stratification was detected along the steep LAGOON MARGIN under the Thurwachter Bridge. Salinity and water temperature went from 4.5 ppt and 23.6 C at the surface to 8.9 ppt and 22.8 C at the bottom of 0.75 m (oxygen concentration above 8.7 mg/l throughout). At the model airport at 1500 hr, salinity and water temperature along the steep LAGOON MARGIN went from 4.3 ppt and 23.4 C at the surface to 9.8 ppt and 22.6 C at the bottom at 0.75 m (oxygen concentration above 10.7 mg/l throughout).

On initially overcast 4 October, the lower LAGOON'S MARGIN was uniformly moderate in salinity at about 9 ppt to the bottom at one meter depth, with a water temperature between 18.1 and 18.4 C between 1000 hr and 1300 hr (oxygen concentration above 8 mg/l at 1000 hr and above 11.3 mg/l by 1300 hr throughout the water column), with air temperature between 16 and 18 C. Approximately 3 miles upstream of the Watsonville Slough confluence at 1430 hr, water temperature, salinity and oxygen stratification were detected with 1.8 ppt salinity, 19.1 C water temperature and 5.9 mg/l oxygen at the surface and 12.5 ppt salinity, 24.4 C water temperature and 1.5 mg/l oxygen at the bottom of 1 meter along the LAGOON MARGIN. The air temperature was 21.1 C at 1430 hr, after the cloud layer had burned off.

Sampling Results for Pajaro Lagoon

Table 36. Fish capture results from sampling Upper Pajaro Lagoon with the 106-foot bag seine (3/8-inch mesh), 2 October 2012.

Date	Location	Seine Haul	Tide-water Goby	Yellow fin goby	Hitch	Prickly sculpin	Sac. sucker	Smelt (jack and top)	Staghorn Sculpin	Three-spine Stickle-back
2 Oct 2012 Large Seine	Model Airport- 0.3 miles down-stream of Thurwachter Bridge	1						5	3	2
	Same	2	1					1	1	5
	Same	3				1		14	1	8
	Thurwachter Bridge	1	1		2				8	5
	Same	2			7		1	14	3	
	Same	3			3	1		22	11	2
Total			**2**		**12**	**2**	**1**	**56**	**27**	**22**

Table 37. Fish capture results from sampling lower Pajaro Lagoon with the 106-foot bag seine (3/8-inch mesh), 3 October 2012.

Date	Location	Seine Haul	Tide-water Goby	Arrow goby	Yellow fin goby	Pacific herring	Bay pipe-fish	Shiner Surf-perch	Smelt (jack and top)	Staghorn Sculpin	Striped Bass	Three-spine stickle-back
3 Oct 2012 Large Seine	East of Watsonville Slough confluence	1				53		1	35			3
	East of #1	2				6		4	62			3
	East of #2	3			1	38		1	104			
	East of #3	4	4	12			6		46	13		2
	East of #4	5				4	1	2	39	2	4	
	East of #5	6				4			23			
	East of #6	7				65	2		73	1		2
	Eastern end of lagoon	8				64			17			2
Total			**4**	**12**	**1**	**234**	**9**	**8**	**399**	**16**	**4**	**12**

Table 38. Fish capture results from sampling the periphery of lower Pajaro Lagoon, Watsonville Slough and upper Pajaro Lagoon with the 30-foot seine (1/8-inch mesh), 4 October 2012.

Date	Location	Seine Haul	Tide-water Goby	Arrow goby	Yellow fin goby	Gam-busia	Hitch	Bay pipe-fish	Smelt (jack and top)	Staghorn Sculpin	Three-spine stickle-back
4 Oct 2012 Small Seine	Approx. 200 m east of Pajaro Dunes Complex	1	4	25						1	Present
	East of #1	2	1	6							Present
	East of #2	3	9	25				4		9	Present
	East of #3	4	15	39				2	4	3	Present
	East of #4	5	13	49	1			3			Present
	East of #5	6	4					2	4		Present
	Watsonville Slough- 100m from Pajaro confluence	7	1			1				1	Present
	0.8 miles upstream of Thurwachter Bridge and 2.9 miles upstream of Watsonville Slough confl.	8	58			1	3				Present
Total			**105**	**144**	**1**	**2**	**3**	**11**	**8**	**14**	**Present**

Conclusions- Pajaro Lagoon

An expansive lagoon had formed behind the closed sandbar in summer 2012. It extended upstream past Highway 1, more than three miles from the beach. No steelhead were detected in Pajaro Lagoon in 2012, although sampling of the upper lagoon was difficult because of the limited landing areas for the seine. A small population of tidewater goby still existed in Pajaro Lagoon in fall 2012. The highest density was at the uppermost site, 3 miles upstream of Watsonville Slough. The closed lagoon had not converted to freshwater after a below average rainfall winter. However, water quality was adequate for both species' (steelhead and tidewater goby) survival at the time of sampling, which was the warmest period of the 2012 dry season. Water quality measurements along the lagoon margin detected some stratification between 2 and 3 miles upstream of Watsonville Slough and oxygen depletion at the bottom, 2.9 miles upstream from the Slough. We suspect that if deeper areas of the lower lagoon had been measured for water quality, stratification would have been detected there, as well. However, oxygen concentrations and water temperature were adequate for steelhead in the upper water column at all locations. The lagoon was eutrophic, with an algal bloom observed. As was indicated on 2 October, in the less saline upper lagoon where steelhead were most likely to inhabit, water temperatures reached 23.6 C near the surface and remained above 22.8 C down 0.75 m, below which oxygen may have been depleted.

After 15 years of water quality monitoring and fish sampling of Santa Rosa Creek Lagoon near Cambria and 20+ years at Soquel Creek Lagoon in Capitola, the following were recommendations to insure steelhead habitation.

- *The 7-day rolling average water temperature within 0.25 m of the bottom should be 19°C or less.*

- *Maintain the daily maximum water temperature below 25ºC (77°F).*

- *If the maximum daily water temperature should reach 26.5ºC (79.5ºF), it may be lethal and should be considered the lethal limit.*

- *Water temperature at dawn near the bottom for at least one monitoring station should be 16.5°C (61.7°F) or less on sunny days without morning fog or overcast and 18.5°C (65.3°F) or less on days with morning fog or overcast.*

- *Maintain the daily dissolved oxygen concentration near the bottom at 5milligrams/liter or greater, though it does not become critically low and potentially lethal until it is less than 2 mg/l throughout the water column for several hours, with the daily minimum occurring near dawn or soon after.*

Recommendations- Pajaro Lagoon

The sandbar should be allowed to close naturally as flows decline in the summer. Artificial breaching should be prohibited in summer. Spatial heterogeneity should be protected in the Pajaro Lagoon/estuary. Slackwater areas with overhanging riparian vegetation should be allowed to form to provide rearing and breeding habitat for tidewater goby during the dry season. Tule beds are valuable rearing habitat and provide winter refuge. Natural training of the Pajaro River outlet channel to the east, as occurs at other local creek mouths, results in a long lateral extent of the summer lagoon to the east of Watsonville Slough. This is significant summer habitat along the beach berm for tidewater goby and arrow goby. There is a long history of emergency breaching of the sandbar which potentially reduces tidewater goby numbers. Emergency breaching of the sandbar for flood control should be minimized. Breaching should be done so that lagoon draining is as slow as possible and with a maximum residual backwater depth in the estuary after draining. Breaching at high tide will encourage this. Elevation of Beach Street, the access road to Pajaro Dunes, would reduce the need to artificially breach the lagoon for flood control. Access roads within the Pajaro Dunes complex could be elevated as well to alleviate flooding of essential infrastructure there. If the levees that border the lagoon are reconstructed, tidewater gobies should be relocated from lagoon margins along affected reaches prior to disturbance, and wetted work area should be isolated from fish.

R-13. Statistical Analysis of Annual Difference in Juvenile Steelhead Densities

The trend in fish densities between 2011 and 2012 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 2011 and 2012 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 2012 were compared to 2011, such that a positive difference indicated that the densities in 2011 were larger than in 2011 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 2011 and 2012 densities. The 95% confidence limits are standard and a p-value of < 0.05 is considered significant.

With 18 comparable sites in the San Lorenzo drainage, the increases in total density and YOY density in 2012 were statistically significant (**Table 42**). With 7 comparable sites in the San Lorenzo mainstem only, no increases in density were found to be statistically significant (**Table 43**). With 6 comparable sites in the Soquel watershed, increases in total density and YOY density in 2012 were statistically significant (**Table 44**). With only 2 comparable sites in Aptos watershed, no statistical tests were made. With 7 comparable sites in the Corralitos sub-watershed, no increases in density were found to be statistically significant (**Table 45**). With 6 comparable sites in Corralitos and Shingle Mill creeks only, the no changes in density were found to be statistically significant (**Table 46**).

Table 42. Paired T-test for the Trend in Steelhead Site Densities by Size Class and Age Class at All Replicated Sampling Sites in the SAN LORENZO Watershed (2012 to 2011; n=18).

Statistic	s.c. 2	a.c. 1-YOY	a.c. 2	All Sizes
Mean difference	-0.24	12.37	1.34	15.51
Df	17	17	17	17
Std Error	1.83	3.91	0.91	5.06
t Stat	-0.13	3.17	1.47	3.06
P-value (2-tail)	0.90	0.006	0.16	0.007
95% CL (lower)	-4.10	4.12	-0.58	4.83
95% CL (upper)	3.63	20.61	3.26	26.19

Table 43. Paired T-test for the Trend in Steelhead Site Densities by Size Class and Age Class at All Replicated MAINSTEM SAMPLING SITES ONLY In the SAN LORENZO Watershed (2012 to 2011; n=7).

Statistic	s.c. 2	a.c. 1-YOY	a.c. 2	All Sizes
Mean difference	3.14	6.91	0.23	6.67
Df	6	6	6	6
Std Error	3.93	3.37	0.68	3.88
t Stat	0.80	2.05	0.34	1.72
P-value (2-tail)	0.45	0.09	0.752	0.137
95% CL (lower)	-6.48	-1.34	-1.43	-2.84
95% CL (upper)	12.77	15.16	1.89	16.15

Table 44. Paired T-test for the Trend in Steelhead Site Densities by Size Class and Age Class at All Replicated Sampling Sites In the SOQUEL Watershed (2012 to 2011; n=6).

Statistic	s.c. 2	a.c. 1-YOY	a.c. 2	All Sizes
Mean difference	3.75	20.28	0.15	20.52
Df	5	5	5	5
Std Error	3.16	4.97	0.45	5.12
t Stat	1.19	4.08	0.33	4.01
P-value (2-tail)	0.29	0.01	0.75	0.01
95% CL (lower)	-4.38	7.50	-1.00	7.36
95% CL (upper)	11.88	33.06	1.30	33.67

Table 45. Paired T-test for the Trend in Steelhead Site Densities by Size Class and Age Class at All Repeated Sampling Sites in the CORRALITOS Sub-Watershed (2012 to 2011; n=7).

Statistic	s.c. 2	a.c. 1-YOY	a.c. 2	All Sizes
Mean difference	0.22	5.93	6.17	12.21
Df	6	6	6	6
Std Error	1.42	6.60	2.60	6.87
t Stat	0.16	0.90	2.37	1.78
P-value (2-tail)	0.87	0.40	0.055	0.13
95% CL (lower)	-3.25	-10.23	-0.19	-4.60
95% CL (upper)	3.71	22.08	12.54	29.03

Table 46. Paired T-test for the Trend in Steelhead Site Densities by Size Class and Age Class at All Repeated CORRALITOS/SHINGLE MILL CREEK SITES Only, Within the Corralitos Creek Watershed (2012 to 2011; n=6).

Statistic	s.c. 2	a.c. 1-YOY	a.c. 2	All Sizes
Mean difference	-1.74	9.00	2.84	11.80
Df	5	5	5	5
Std Error	0.74	8.96	2.07	9.73
t Stat	-2.36	1.00	1.37	1.21
P-value (2-tail)	0.08	0.37	0.24	0.29
95% CL (lower)	-3.79	-15.88	2.92	-15.21
95% CL (upper)	0.31	33.88	8.60	38.81

R-14. Adult Trapping Results at the Felton Dam's Fish Ladder and 2012 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, 20 days in 2008-2009 and 8 days in 2009-2010. During the winter of 2010-2011, steelhead were trapped on 19 different days between 20 January and 16 March 2011. The 2011-2012 trapping was done by volunteers from the Monterey Bay Salmon and Trout Project for 21 days from 15 March to 5 April 2012 (all but 4 April). The 2012 trapping (as the previous four years) encompassed major stormflows of the winter/spring but was late for trapping coho salmon (**Figure 34**). In 2012, a total of 174 adult steelhead =>14 inches (35 cm) Fork Length were captured; 57 (33%) were hatchery clipped (**Table 47**). Two steelhead were less than 35 cm Fork Length (presumably subadults). No coho were recorded at the trap, and 35 steelhead were retained for hatchery propogation. In 2011, a total of 55 adult steelhead =>14 inches (35 cm) Fork Length were captured; 30 (55%) steelhead were hatchery clipped (19 nonconsecutive days). One coho salmon were trapped in 2011 **(T. Umstead personal communication).** In 2010, a total of 53 adult steelhead were captured; 44 (83%) steelhead were hatchery clipped (10 days in early March). No coho salmon were captured in 2010. 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.

In early April, steelhead smolts (16.33/ pound and 170 pounds), with the San Lorenzo as the source, were planted at the following location:

San Lorenzo River at Highlands Park (2,776 juveniles; 1 April 2011).

Table 47. 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 20 Mar	12 Feb- (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
2008-09	18 Feb-27 Mar (20 days)	145 Steelhead 1 Coho	SLV High School-Felton Diversion
2009-10	2-11 Mar	53 Steelhead	SLV High School- Felton Diversion
2010-11	20 Jan-16 Mar (19 days)	55 Steelhead 1 Coho	MBST Project- Felton Diversion Dam
2011-12	15 Mar-5 Apr (21 days)	174 Steelhead	MBST Project- Felton Diversion Dam

(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 2012 RESULTS

D-1. Causal Factors for Continued Below Average 2012 YOY Steelhead Densities at Many Sites

Although we have no estimates of adult returns for the 4 watersheds that were sampled, it would appear that there were insufficient adult steelhead returns after late stormflows, 15 March−15 April, to saturate reaches with redds and egg production after the spring stormflows passed. This would explain the below average YOY densities at many sites in the San Lorenzo drainage and specific sites in the other drainages. There were only 4 major storms in the 2011-2012 winter, and they were all most likely less than bankfull, based on bankfull estimates for the San Lorenzo River at the Big Trees gage in 1999. Adult access to uppermost sites may have been limited, explaining the below average YOY densities at Zayante 13d, Branciforte 21b, East Branch Soquel 16, Corralitos 8 and Corralitos 9 sites. The total 2012 adult returns may have been up slightly from 2011, as indicated by adult counts in the Carmel River and the estimate in Scott Creek. Adult returns to the Carmel River increased in 2012, as detected at the San Clemente Dam on the Carmel River. Recent counts for 2006−2012 were 368, 222, 412, 95, 157, 452 and 470, respectively (**Urquhart, 2012**). Trapping data from Scott Creek indicated increased adult returns in winter 2011-2012, where adult escapement estimates in water years 2006─2012 were 219, 259, 293, 126 , 109 and 214, respectively (**Sean Hayes, NOAA Fisheries personal communication**). The pattern of returning adults to our watersheds may have been similar to that on the Carmel River. In the Carmel River in 2012, most adult steelhead entered the River during March storms (78% of the adults (366) passed the San Clemente Dam counter in March; 72 in February after San Clemente Dam filled and 32 in April) (**Urquhart 2012**)).

Some 2012 sites had high densities of small YOY, indicating sporadically good spawning success in March and April (**Table 46**). They include the San Lorenzo (3 of 21 sites; Fall #15, Bean #14c and Boulder #17b), Aptos (1 of 2 sites; Aptos #4) and Corralitos (1 of 7 sites; Corralitos #1) watersheds. Unfortunately, Bean Creek Site #14c went dry by October. All sites in 2012 were dominated by small YOY except headwater sites SLR 12b (in Waterman Gap above a difficult passage impediment at the Highway 9 culvert and apron) and Branciforte 21b (above a potential passage impediment at the old City of Santa Cruz dam abutment having wood accumulation). These latter two sites may have a significant resident salmonid component. The stormflow pattern in 2005-2006 was similar to 2010-2011 in that late storms were large. Late stormflows also occurred in 2012, but they were much smaller. Similar to 2011, YOY densities were depressed in 2006 but not quite as much in 2012. The stormflow pattern in WY2009 and WY2010 included late stormflows, as well, but not as prominent as in WY2006, WY2011 and WY2012. YOY densities were below average in 2010 in tributaries of the San Lorenzo drainage and the Soquel drainage, but small YOY were present at more sites in the San Lorenzo than in 2006 and 2011, indicating more successful late spawning (**Tables 23, 29 and 32; Table 48**). WY2012 had the highest small YOY densities of the 4 years in the Soquel and Corralitos watersheds (and the upper Aptos #4 site) and had similar densities to WY2009 (a dry year) in the San Lorenzo.

Table 48. Presence of Small YOY at Sampling Sites, Indicating Late Spawning After Late Stormflows in 2006, 2010−2012.

Site	At least 30% of the YOY < 75 mm SL and More than 10 in Number/ At least One Habitat 2006	At least 30% of the YOY < 75 mm SL and More than 10 in Number/ At least One Habitat 2010	At least 30% of the YOY < 75 mm SL and More than 10 in Number/ At least One Habitat 2011	At least 30% of the YOY < 75 mm SL and More than 10 in Number/ At least One Habitat 2012
Low. San Lorenzo #0a	NA	−	−	−
Low. San Lorenzo #1	−	−	−	−
Low. San Lorenzo #2	NA	+	−	−
Low. San Lorenzo #4	−	+	−	+
Mid. San Lorenzo #6	+	+	−	+
Mid. San Lorenzo #8	+	+	+	+
Up. San Lorenzo #11	−	+	−	−
Up. San Lorenzo #12b	NA	NA	NA	−
Zayante #13a	+	+	−	+
Zayante #13c	−	+	+	+
Zayante #13d	+	+	+	+
Lompico #13e	+	−	−	+
Bean #14b	−	+	+	−
Bean #14c	+	+	−	+ (Went Dry)
Fall #15	NA	+	+	+
Newell #16	−	+	−	+
Boulder #17a	+ (barely)	+	−	−
Boulder #17b	+	+	+	+
Bear #18a	+	+	+	+
Brancifor. 21a-2	+	−	+	+
Branciforte #21b	NA	NA	NA	+
Soquel #1	−	−	−	−
Soquel #4	−	−	−	−
Soquel #10	−	−	−	+
Soquel #12	NA	−	−	−
East Br. Soq. #13a	−	−	−	+
East Br. Soquel #16	+	+	+	+
West Br. Soquel #19	−	−	+ (barely)	+
West Br. Soquel #21	+	+ (barely)	−	NA
Aptos #3	−	+	−	+
Aptos #4	+	+	−	+
Valencia #2	+	+	NA	NA
Valencia #3	+ (barely)	+	NA	NA
Corralitos #1	NA	−	+ (barely)	+
Corralitos #3	+	−	+	+
Corralitos #8	+	+ (barely)	+	+
Corralitos #9	+	+	+	+
Shingle Mill #1	+ (barely)	−	−	−
Shingle Mill #3	+	+	−	+
Browns #1	+	+	+	+
Browns #2	+	+	+	+
# Positives	21	27	16	26

In the Aptos system, the continued below average YOY density at the lower Aptos site is attributable to sporadic spawning effort by a potentially small adult steelhead population. The lagoon's juvenile population estimate was only a third the size of the 2011 estimate, indicating possibly lower YOY production in the lower watershed.

In the Corralitos system, Corralitos Creek was still recovering from the substantial sedimentation that occurred after the Summit Fire. Habitat data for 2 reaches below Eureka Gulch in 2009 (pre-fire impacts) and 2012 (post-fire impacts) indicated that habitat conditions had not recovered there. Pool depth was still less in both reaches, and fine sediment and embeddedness were still worse in one. However, improvement was observed in the reach above Eureka Gulch with more cover, yet pool depth was still less. The lowermost Site #1 below the dam showed habitat improvement with deeper pools, less fine sediment and more escape cover. Despite limited habitat recovery, YOY densities were the highest since the fire except at Site 8, just below Eureka Gulch, where habitat was still the most sedimented. As in other watersheds, the adult spawning steelhead population entering the Corralitos watershed when passage flows were available in March and April may have been small in 2012. This may have lead to insufficient reproduction to saturate reaches with redds and egg production after the spring stormflows passed.

D-2. Causal Factors for Size Class II Densities in Each Watershed

San Lorenzo Watershed

The below average densities of larger juveniles in most sites in the San Lorenzo drainage were due to below average densities of yearlings in the tributaries (resulting from a small YOY population in 2011) and slow growth of a small population of YOY in the mainstem after a late spawn under median or less baseflow conditions. A smaller proportion of YOY reached Size Class II in the mainstem than occurs during a wetter spring and early summer (**Figure 17**). There were insufficient YOY produced in the tributaries to saturate the rearing habitat in the fast-growth reaches of the lower mainstem, downstream of the Zayante Creek confluence.

Soquel Watershed

The above average densities of larger juveniles at 5 of 7 sites in the Soquel drainage were due to average densities of YOY in 2012 in the relative fast-growth reaches of the Soquel mainstem (YOY densities much below average in 2011), with sufficient baseflow to allow some YOY to reach Size Class II (**Figure 18**), and the above average yearling densities at 2 mainstem sites and, especially, upper East Branch Site 16. Winter/Spring stormflows were mild enough to allow above average overwinter survival of yearlings from a small YOY population in 2011.

Aptos Watershed

Near average densities of larger juveniles in both Aptos sites resulted from above average densities of yearlings in a year when few YOY reached Size Class II. YOY were spawned late without high enough baseflows to allow a portion of them to grow rapidly into Size Class II at the upper site (**Figure 19**). Above average densities of yearlings survived after mild winter/spring stormflows, despite a below average size YOY population in 2011 for recruitment to yearlings in 2012.

Corralitos Sub-Watershed

Above average densities of larger juveniles at some sites (Corralitos #3 and Browns #2) resulted from survival and retention of relatively high numbers of yearlings. Above average yearling survival occurred after a mild winter/spring, being recruited from a below average YOY population in 2011. Near average or below average densities of larger juveniles at most sites corresponded directly to yearling densities in a year when YOY were spawned late and could not grow into Size Class II at most sites (**Figure 20**).

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

YOY steelhead densities in 2012 continued to be below average at most sites in Gazos (**Figure 45;** data from **Smith 2013**), Waddell and Scott (**Figure 46;** data from **Smith 2013**) creeks, although they increased slightly from 2011 densities in Gazos and Waddell, on average (**Smith 2013**). Below average YOY densities in Scott, Waddell and Gazos creeks were consistent with below average YOY densities at a majority of sites in the San Lorenzo watershed and the upper East Branch Soquel site. However, 1 of 9 sampling sites on Scott Creek and 1 of 7 sites on Gazos Creek had above average YOY densities as occurred sporadically at some San Lorenzo sites.

In Scott Creek, average YOY steelhead site densities for 2007─2012 were 49, 20, 24, 45, 41 and 33 fish/ 100 ft, respectively, with a 22-year average to 2012 of 53 (**Figure 49** data from **Smith 2013**). The average Waddell Creek YOY site densities for 2007─2012 were 13, 23, 10, 13, 8 and 13 fish/ 100 ft and much below the 22-year average of 36. The average Gazos Creek YOY site densities for 2007 and 2009─2012 were 21, 17, 16, 28 and 30 fish/ 100 ft and below the 19-year average to 2012 of 35. YOY densities in Gazos may have remained similar to 2011 due to continued adult spawning access through two large logjams and two smaller logjams in 2012.

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. Smith noted that in 2011, YOY densities in the West Branch were similarly as low as site densities on the East Branch below Last Chance, and YOY densities below the branches were even lower. Smith stated that insufficient adults may have returned to saturate the creek with young.

Densities of 1+/2+ juveniles were above average at most sites in Gazos Creek in 2012 (**Figure 47;** data from **Smith 2013**), while densities were near average or above average in Soquel, Aptos and Corralitos watersheds that we sampled. However, in Scott (**Figure 48;** data from **Smith 2013**) and Waddell (**Smith 2013**) creeks they were below average, as was the case in the San Lorenzo watershed that we monitored. Average 1+/2+ densities in Scott Creek for 2007─2012 were 14, 8, 7, 7, 2 and 4 fish/ 100 feet, with a 22-year average of 8.4 fish/ 100 feet and a sizeable standard error (**Figure 49;** data from **Smith 2013**). Average 1+/2+ density in Waddell Creek for 2007─2012 were 2, 1, 2, 1, 0.4 and 1 fish/

100 ft, with a 22-year average being 5.2 fish/ 100 ft. Average 1+/2+ density in Gazos Creek for 2007 and 2009−2012 were 4, 9, 4, 6 and 9 fish/ 100 ft, with 19-year average being 7.6 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 and Waddell creek sites in 2012 were similar to poorer sites in our 4 watersheds, such as lower and middle San Lorenzo mainstem sites (4, 6 and 8), upper San Lorenzo mainstem Site 11, Lompico 13e and lower mainstem Soquel Site 1 in 2012. Average Size Class II abundance at Waddell Creek sites were less than densities at all sample sites in our four watersheds.

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 needs to be restored to 2000 levels. In 2000 in the San Lorenzo River drainage, 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, more accurate indices of juvenile and adult steelhead population sizes were possible. By 2009−2012, 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 and 2011. Accurate population indices were not possible after 2001 in the San Lorenzo watershed or after 2005 in the Soquel watershed. 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.

The mainstem San Lorenzo River should be surveyed for passage impediments between the Boulder Creek confluence and Teihl Road Bridge. Steelhead densities at Site 11 near Teihl Road have been very low in recent years.

Fish and habitat monitoring in Soquel Creek should be restored to 2004 levels to obtain an accurate estimate of juvenile steelhead population size. 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, increased to 8 sites (8 reaches) in 2009−2011 and reduced to 7 sites in 2012. 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, and 2 mainstem reaches (1 mile) and 2 Branch reaches (1 mile) were habitat typed in 2011. Fortunately, 4 reaches were habitat typed in 2012.

Instream wood inventories should be expanded to other reaches. 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 reach segments among 3 watersheds were inventoried for wood in 2010, and 3 reaches were inventoried in 2 watersheds in 2011. Three reaches were inventoried in 3 watersheds in 2012.

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).

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FIGURES

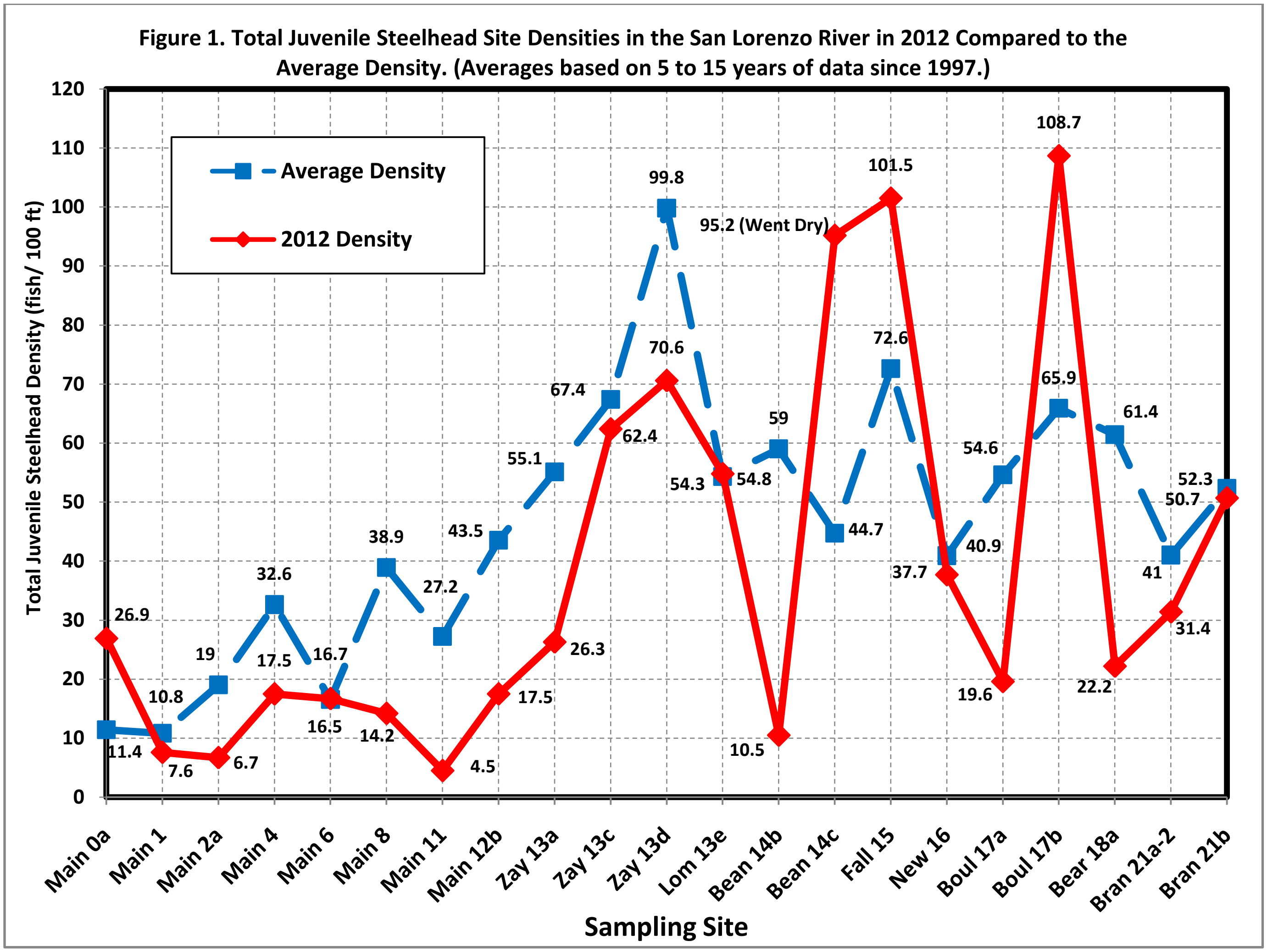


Figure 1. Total Juvenile Steelhead Site Densities in the San Lorenzo River in 2012 Compared to the Average Density. (Averages based on 5 to 15 years of data since 1997.)
Average Density
2012 Density
Total Juvenile Steelhead Density (fish/ 100 ft)
Sampling Site
Main 0a
Main 1
Main 2a
Main 4
Main 6
Main 8
Main 11
Main 12b
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
Bran 21b
95.2 (Went Dry)
11.4
10.8
19
32.6
16.7
38.9
27.2
43.5
55.1
67.4
99.8
54.8
59
44.7
72.6
40.9
54.6
65.9
61.4
41
52.3
26.9
7.6
6.7
17.5
16.5
14.2
4.5
17.5
26.3
62.4
70.6
54.3
10.5
101.5
37.7
19.6
108.7
22.2
31.4
50.7

Figure 2. Young-of-the-Year Steelhead Site Densities in the San Lorenzo River in 2012 Compared to Average Density. (Averages based on 5 to 15 years of data.)

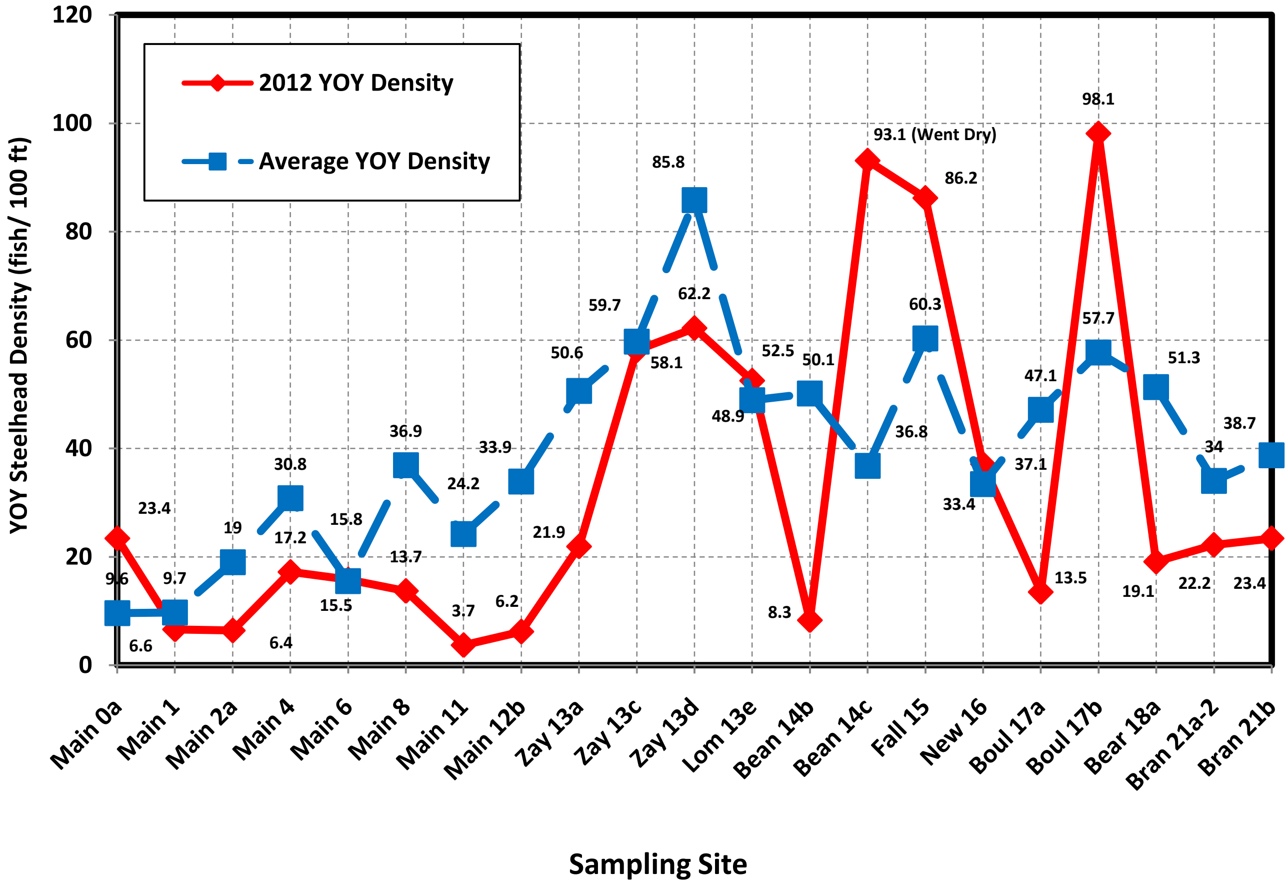
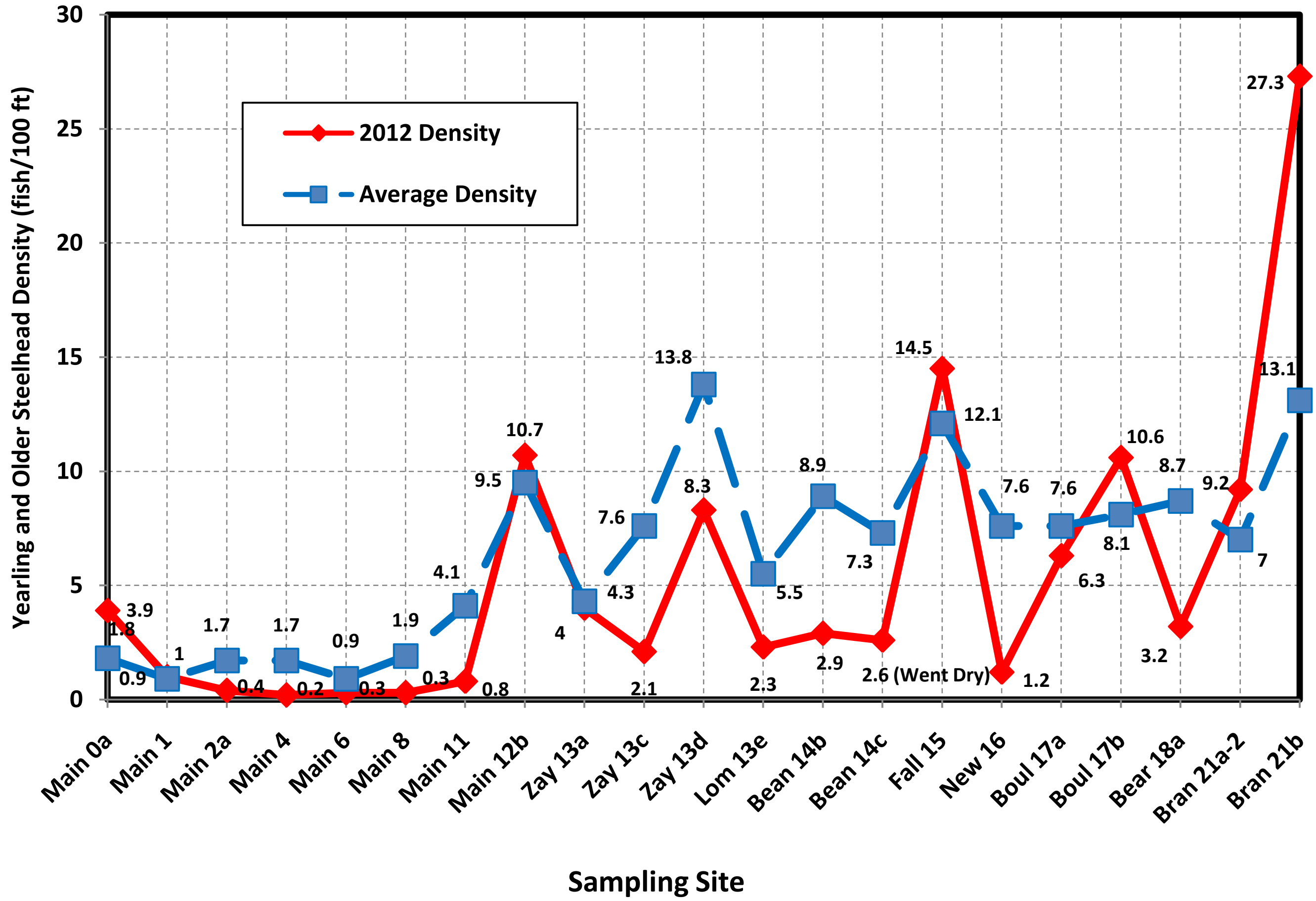


Figure 3. Yearling and Older Steelhead Site Densities in the San Lorenzo River in 2012 Compared to Average Density. (Averages based on 5 to 15 years of data.)



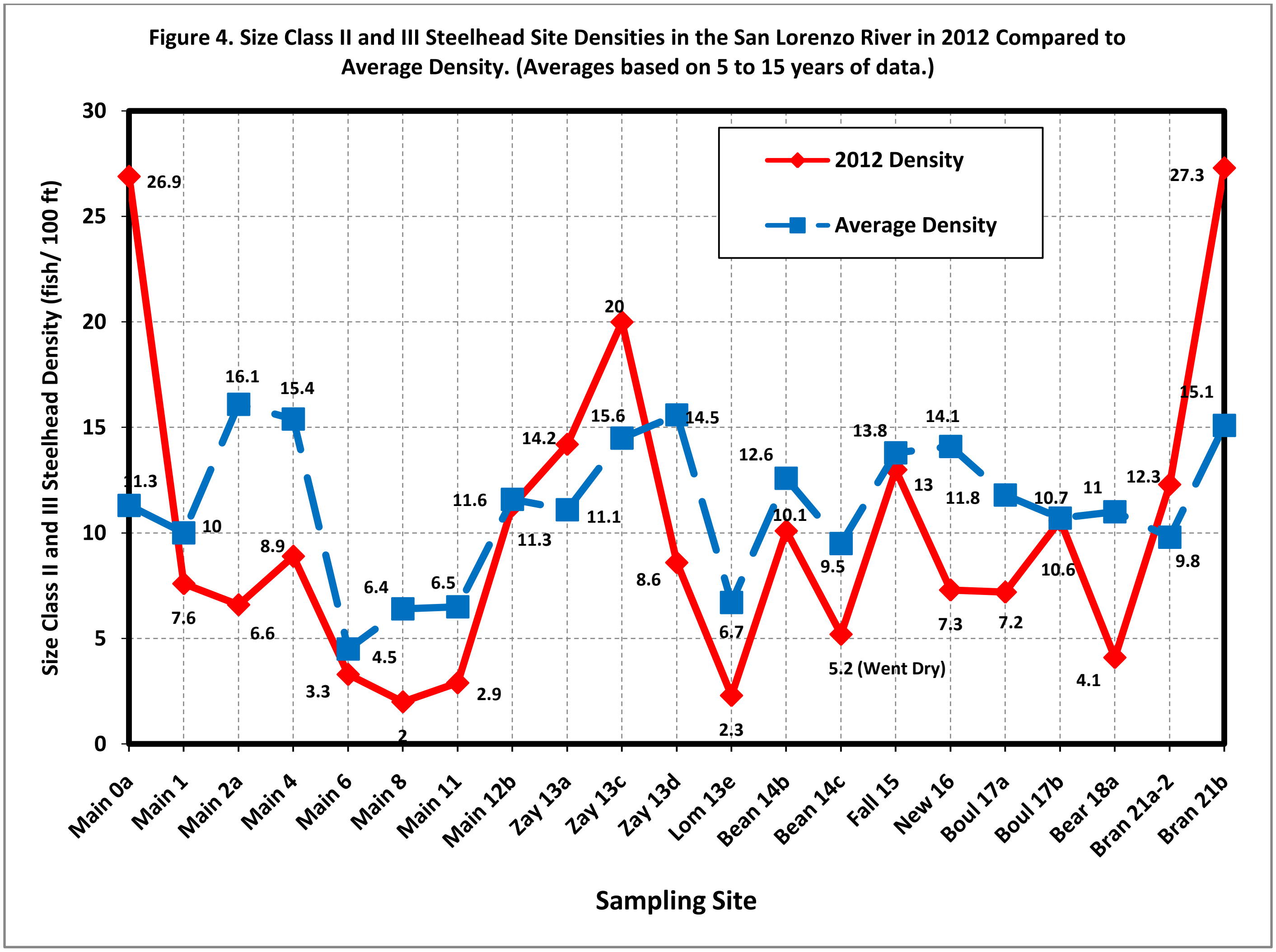


Figure 4. Size Class II and III Steelhead Site Densities in the San Lorenzo River in 2012 Compared to Average Density. (Averages based on 5 to 15 years of data.)
2012 Density
Average Density
Size Class II and III Steelhead Density (fish/ 100 ft)
Sampling Site
Main 0a
Main 1
Main 2a
Main 4
Main 6
Main 8
Main 11
Main 12b
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
Bran 21b
5.2 (Went Dry)

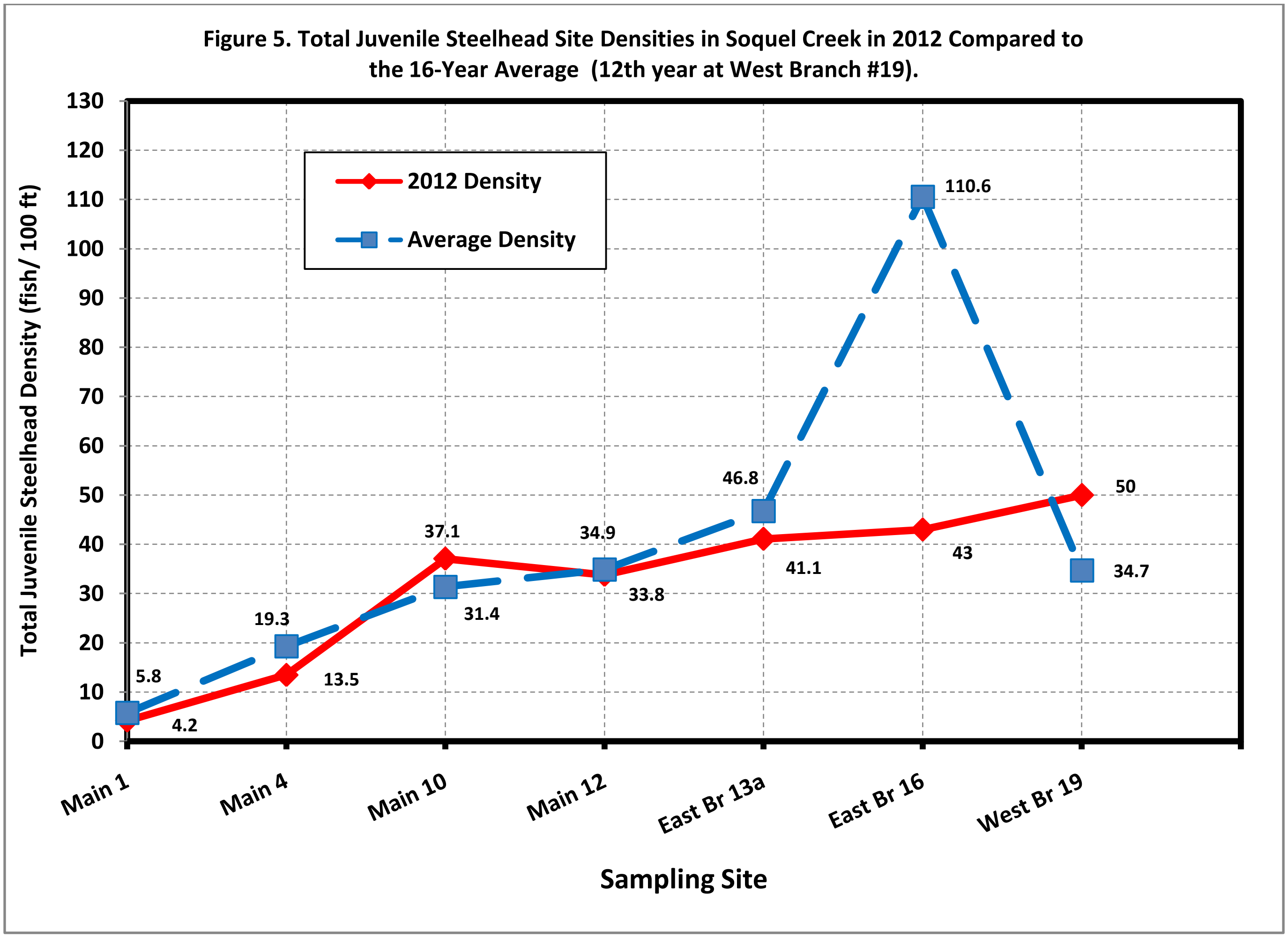


Figure 5. Total Juvenile Steelhead Site Densities in Soquel Creek in 2012 Compared to the 16-Year Average (12th year at West Branch #19).
2012 Density
Average Density
Total Juvenile Steelhead Density (fish/ 100 ft)
Sampling Site
0
10
20
30
40
50
60
70
80
90
100
110
120
130
Main 1
Main 4
Main 10
Main 12
East Br 13a
East Br 16
West Br 19
5.8
4.2
19.3
13.5
37.1
31.4
34.9
33.8
46.8
41.1
110.6
43
50
34.7

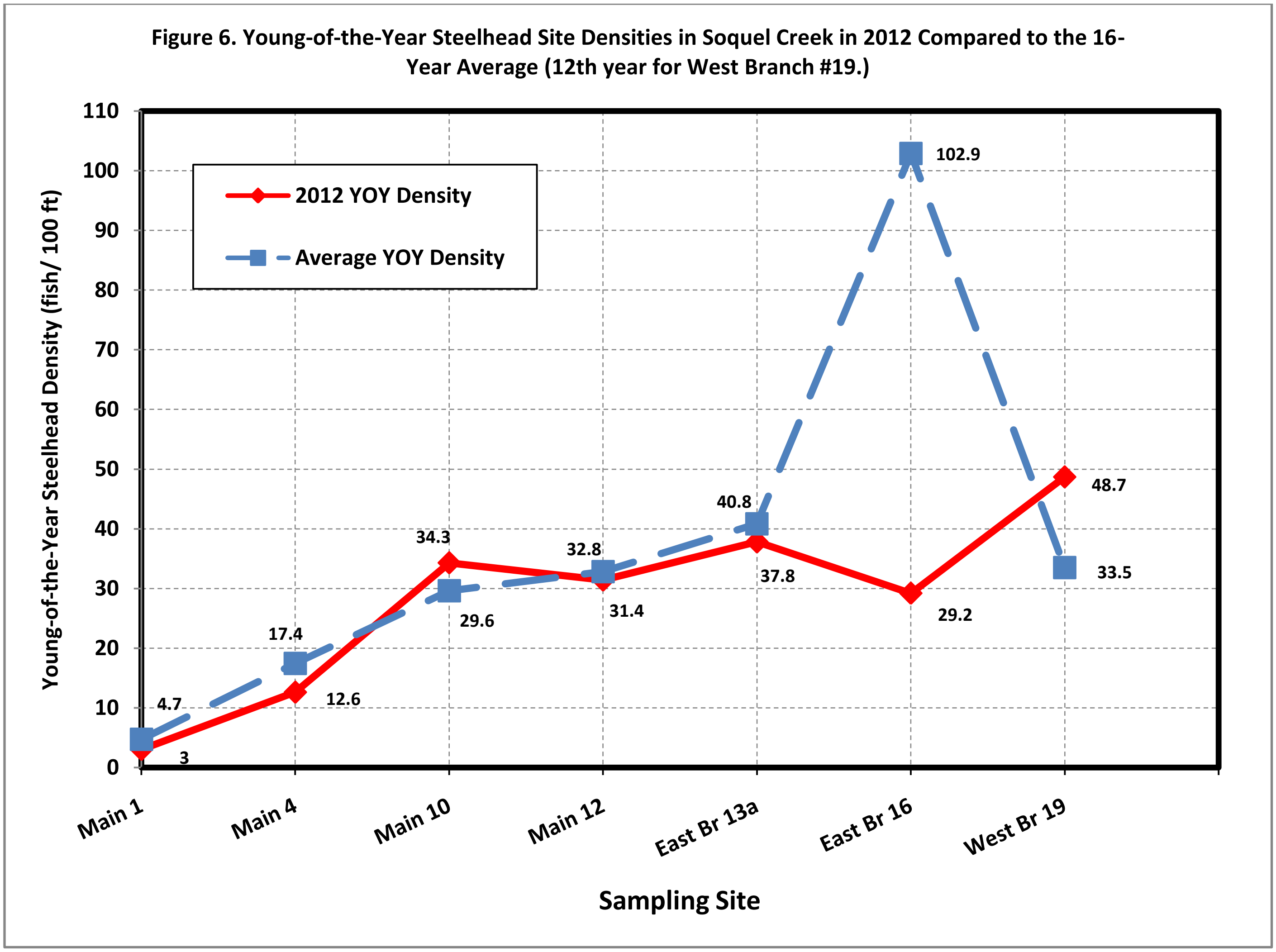


Figure 6. Young-of-the-Year Steelhead Site Densities in Soquel Creek in 2012 Compared to the 16-Year Average (12th year for West Branch #19.)
2012 YOY Density
Average YOY Density
Young-of-the-Year Steelhead Density (fish/ 100 ft)
0
10
20
30
40
50
60
70
80
90
100
110
4.7
3
17.4
12.6
34.3
29.6
32.8
31.4
40.8
37.8
102.9
29.2
48.7
33.5
Main 1
Main 4
Main 10
Main 12
East Br 13a
East Br 16
West Br 19
Sampling Site

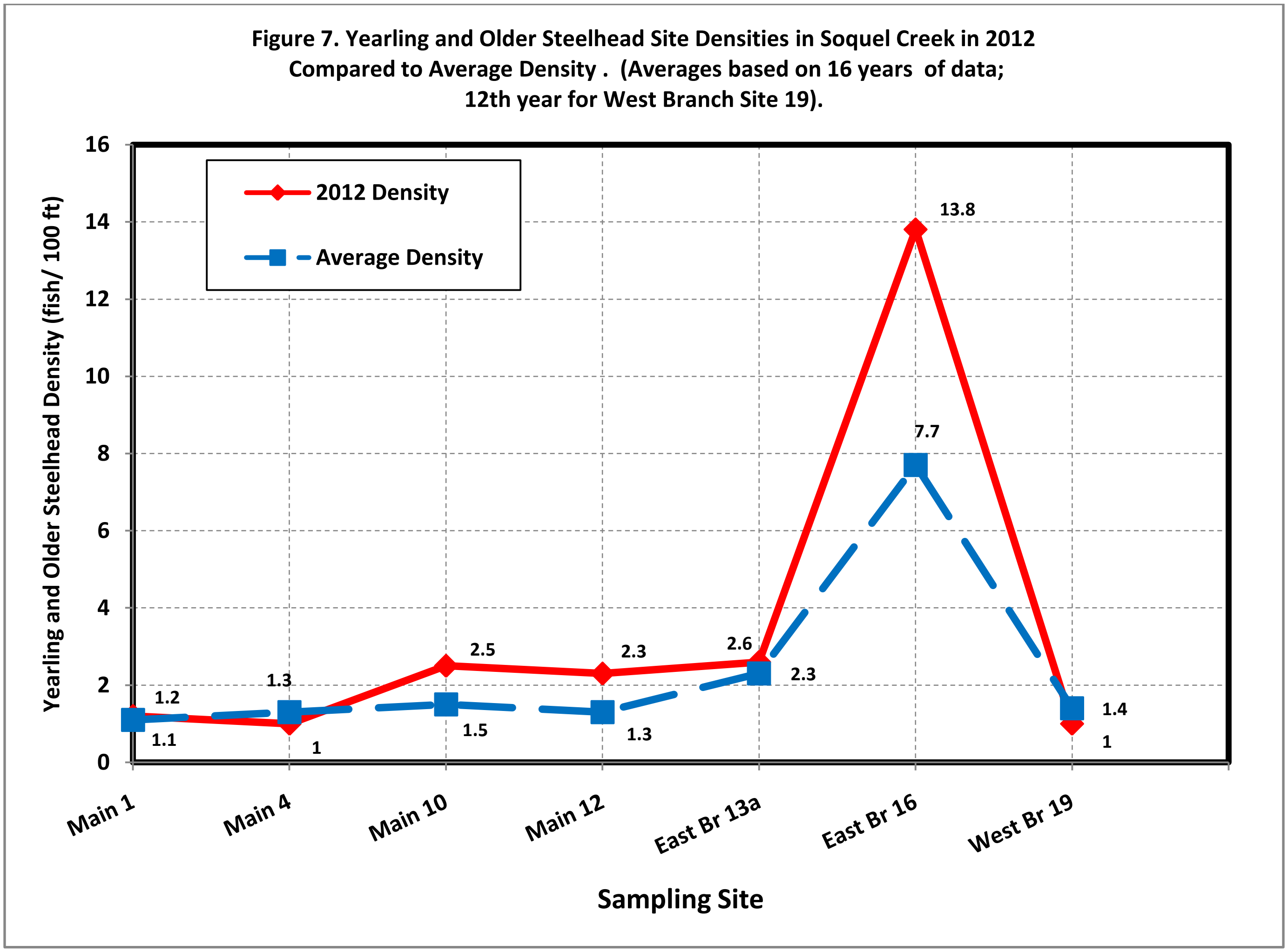
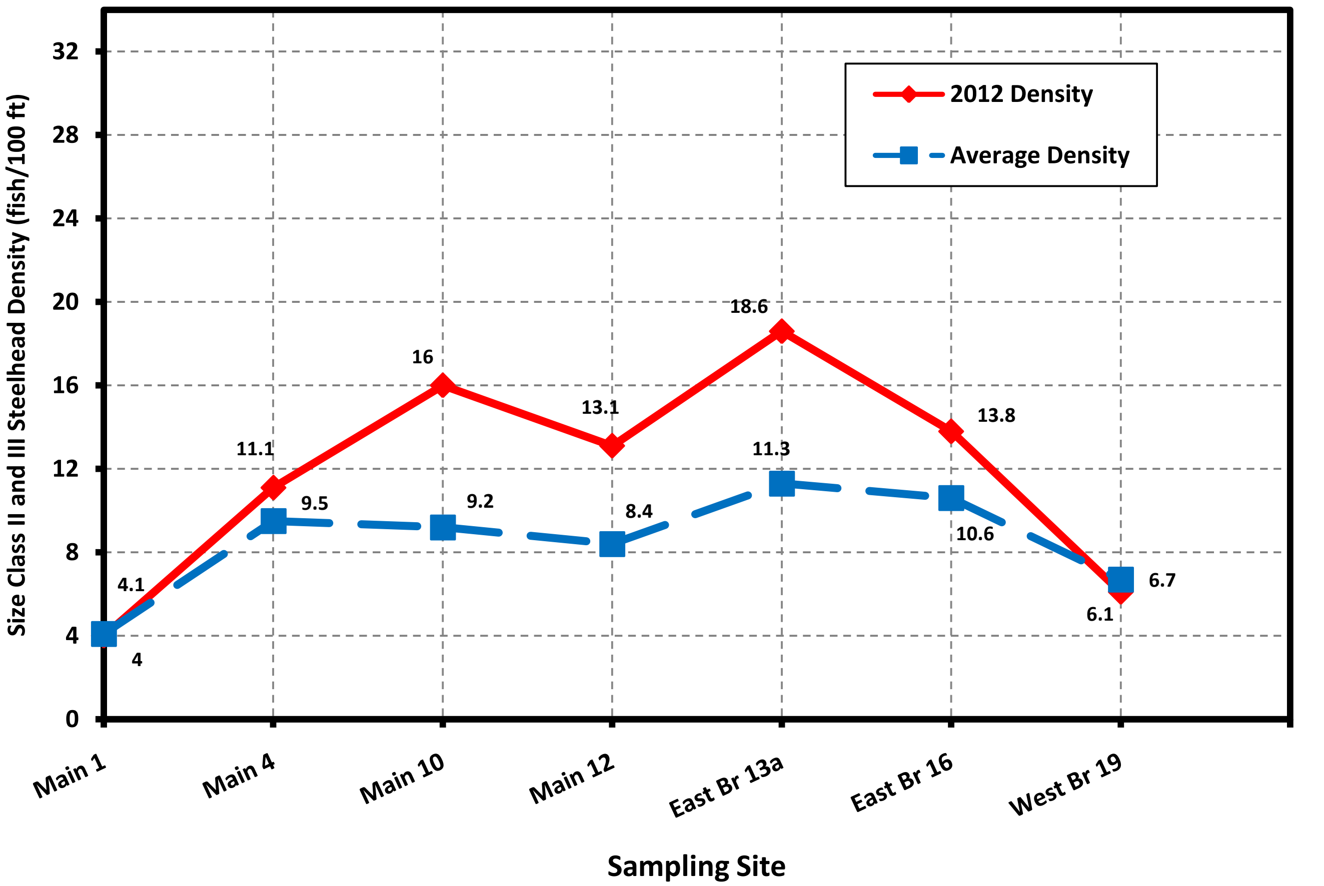


Figure 7. Yearling and Older Steelhead Site Densities in Soquel Creek in 2012
Compared to Average Density . (Averages based on 16 years of data;
12th year for West Branch Site 19).
2012 Density
Average Density
Yearling and Older Steelhead Density (fish/ 100 ft)
0
2
4
6
8
10
12
14
16
1.2
1.1
1.3
1
2.5
1.5
2.3
1.3
2.6
2.3
13.8
7.7
1.4
1
Main 1
Main 4
Main 10
Main 12
East Br 13a
East Br 16
West Br 19
Sampling Site

Figure 8. Size Class II and III Steelhead Site Densties in Soquel Creek in 2012 Compared to the 16-Year Average (12 th year for West Branch #19.)



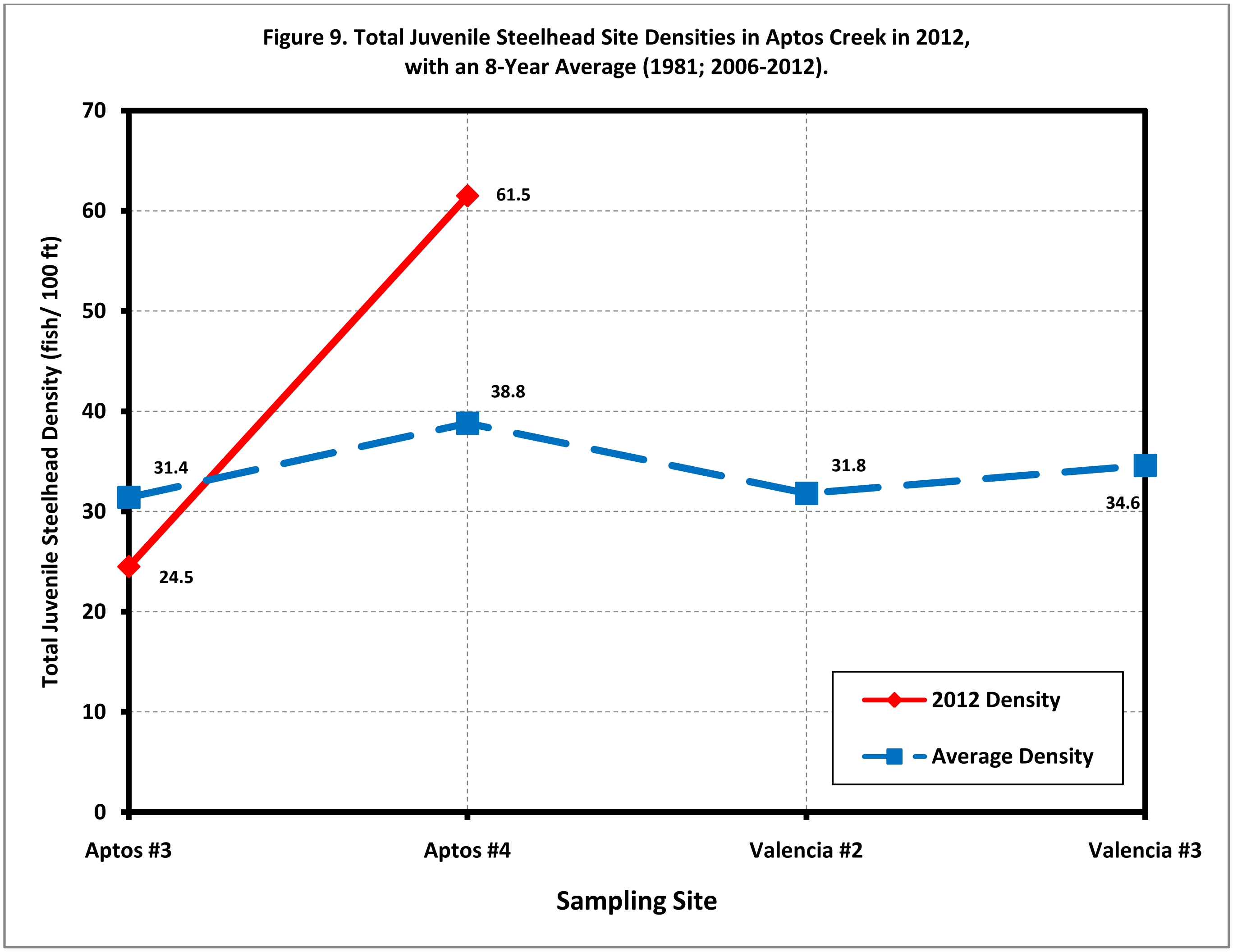


Figure 9. Total Juvenile Steelhead Site Densities in Aptos Creek in 2012,
with an 8-Year Average (1981; 2006-2012).
Total Juvenile Steelhead Density (fish/ 100 ft)
70
60
50
40
30
20
10
0
61.5
38.8
31.4
31.8
34.6
24.5
2012 Density
Average Density
Aptos #3
Aptos #4
Valencia #2
Valencia #3
Sampling Site

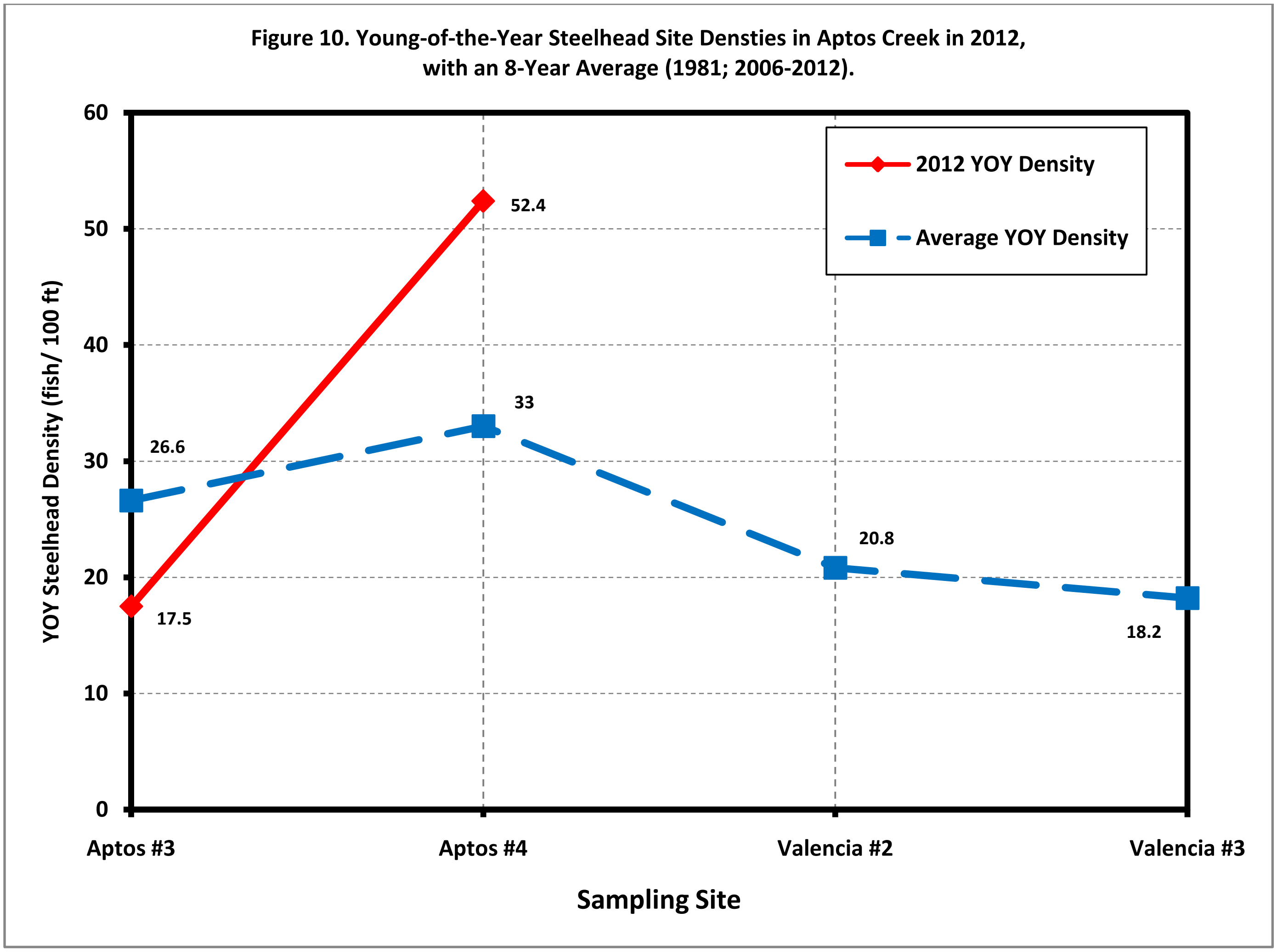


Figure 10. Young-of-the-Year Steelhead Site Densties in Aptos Creek in 2012,
with an 8-Year Average (1981; 2006-2012).
2012 YOY Density
Average YOY Density
YOY Steelhead Density (fish/ 100 ft)
0
10
20
30
40
50
60
52.4
33
26.6
20.8
17.5
18.2
Aptos #3
Aptos #4
Valencia #2
Valencia #3
Sampling Site

Figure 11. Yearling and Older Juvenile Steelhead Site Densities in Aptos Creek in 2012, with an 8-Year Average (1981; 2006-2012).

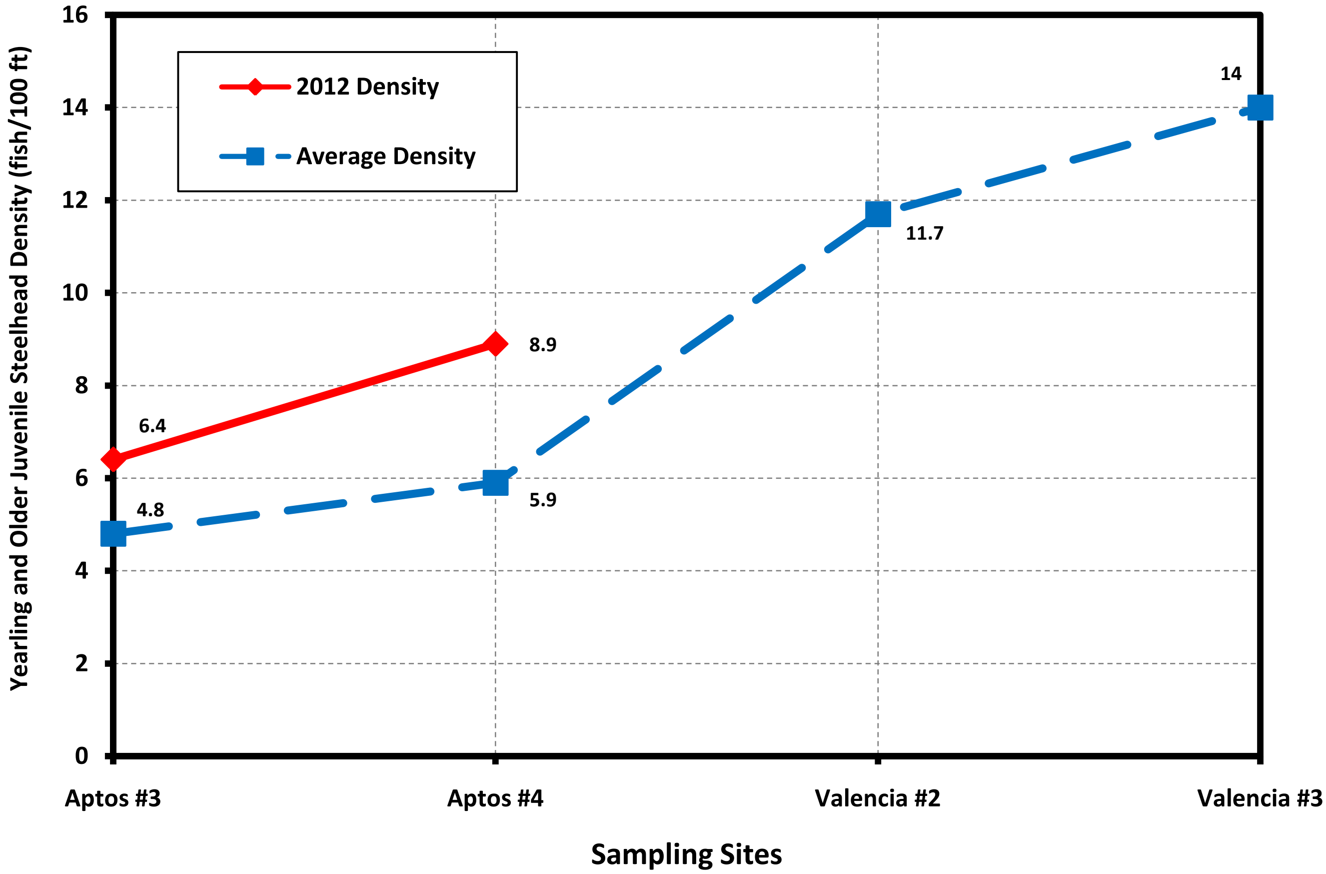


Figure 12. Size Class II and III Steelhead Site Densities in Aptos and Valencia Creeks in 2012, with an 8-Year Average (1981; 2006-2012).

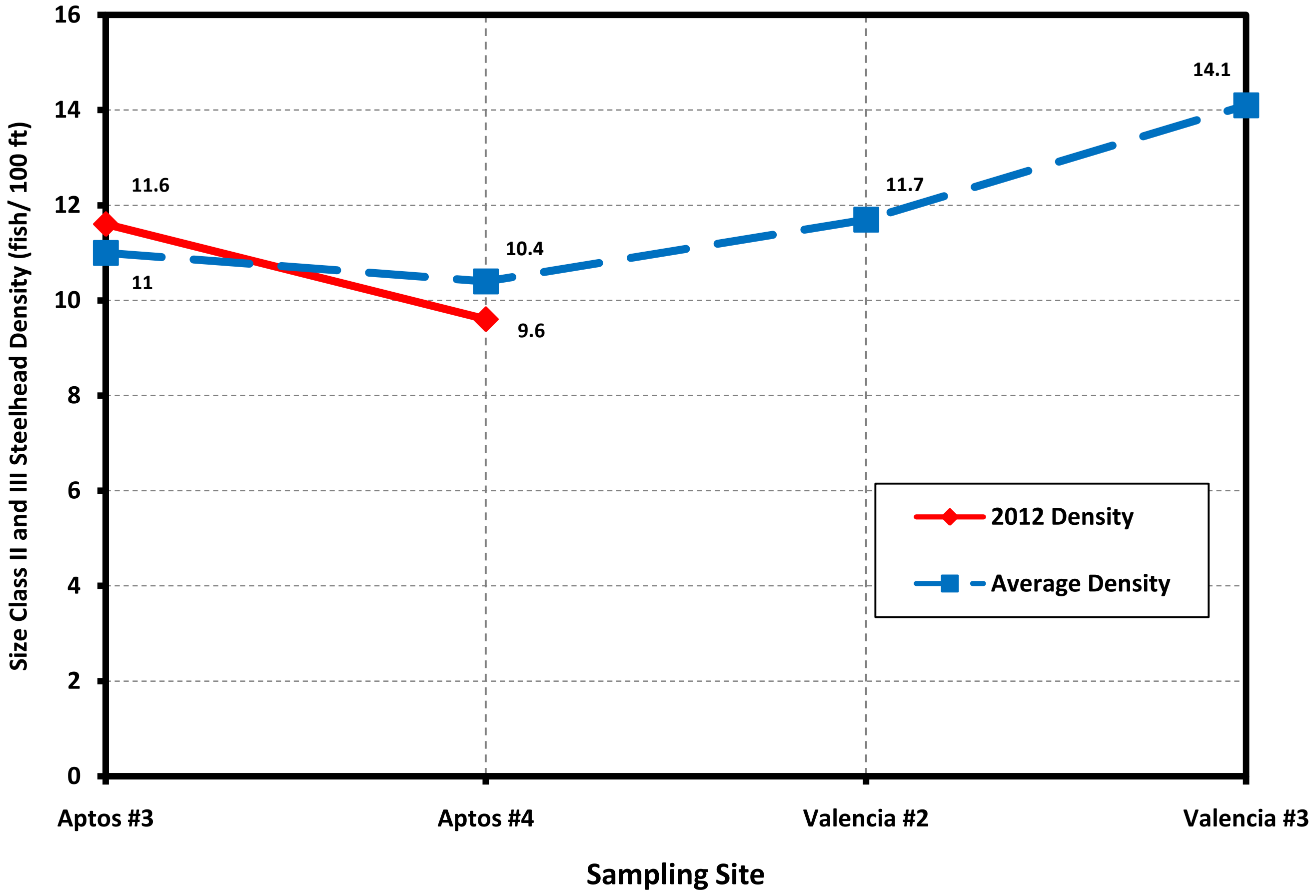


Figure 13. Total Juvenile Steelhead Site Densities in Corralitos, Shingle Mill and Browns Creeks in 2012, with a 9-Year Average (1981; 1994; 2006-2012).

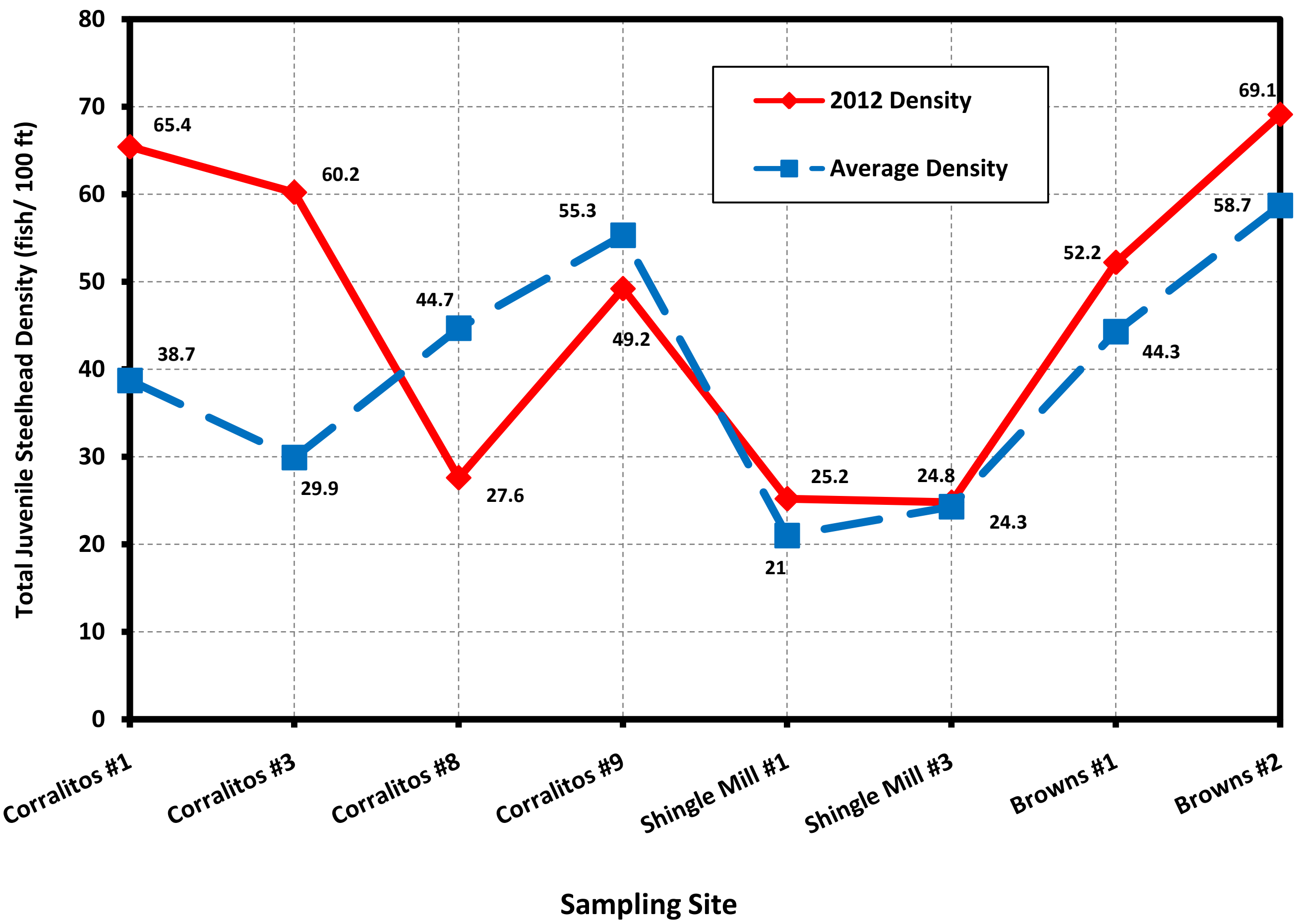


Figure 14. Young-of-the-Year Steelhead Site Densities in Corralitos, Shinglemill and Browns Creeks in 2012, with a 9-Year Average (1981; 1994; 2006-2012).

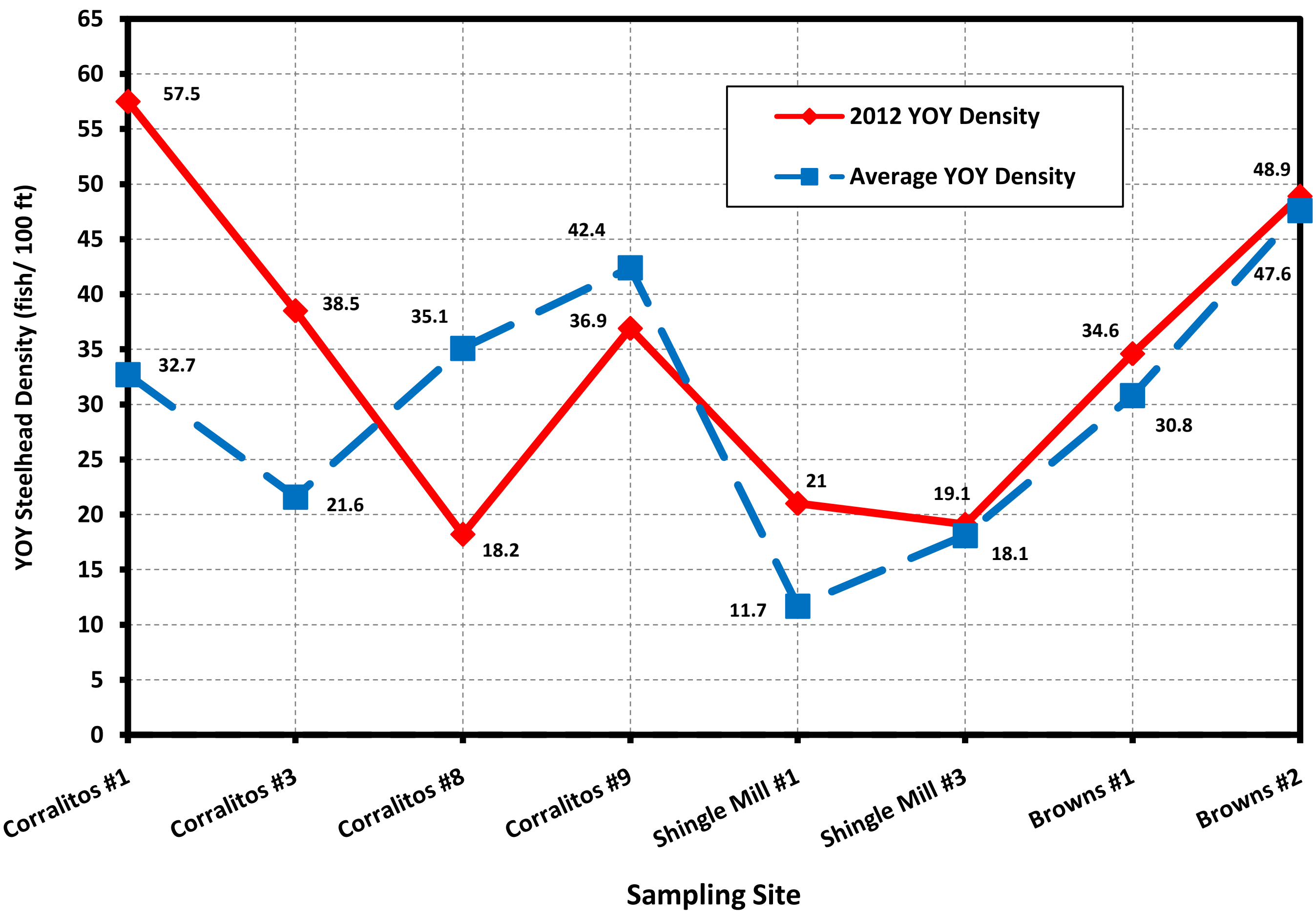


Figure 15. Yearling and Older Steelhead Site Densities in Corralitos, Shingle Mill and Browns Creeks in 2012, with a 9-Year Average (1981; 1994; 2006-2012).

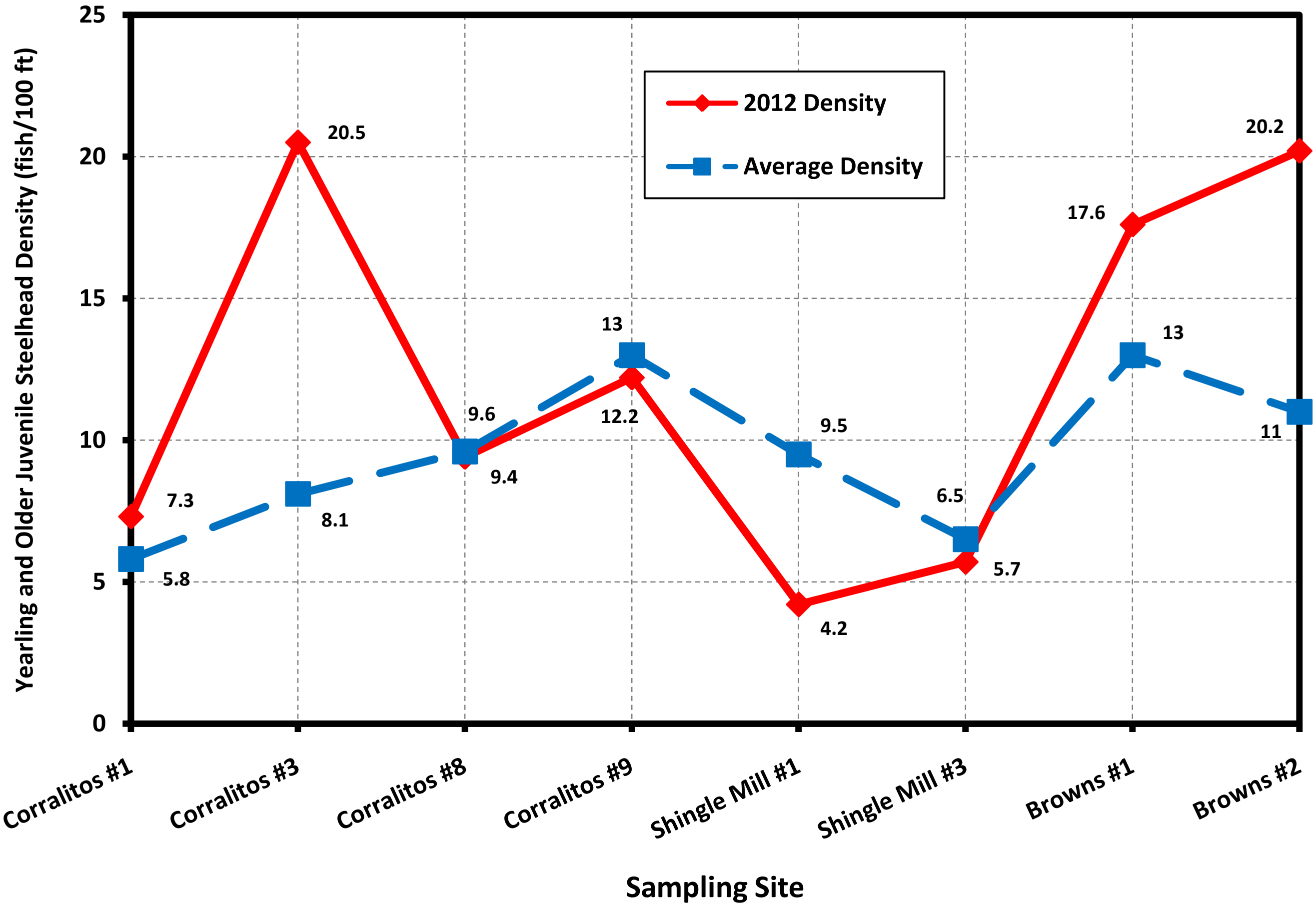
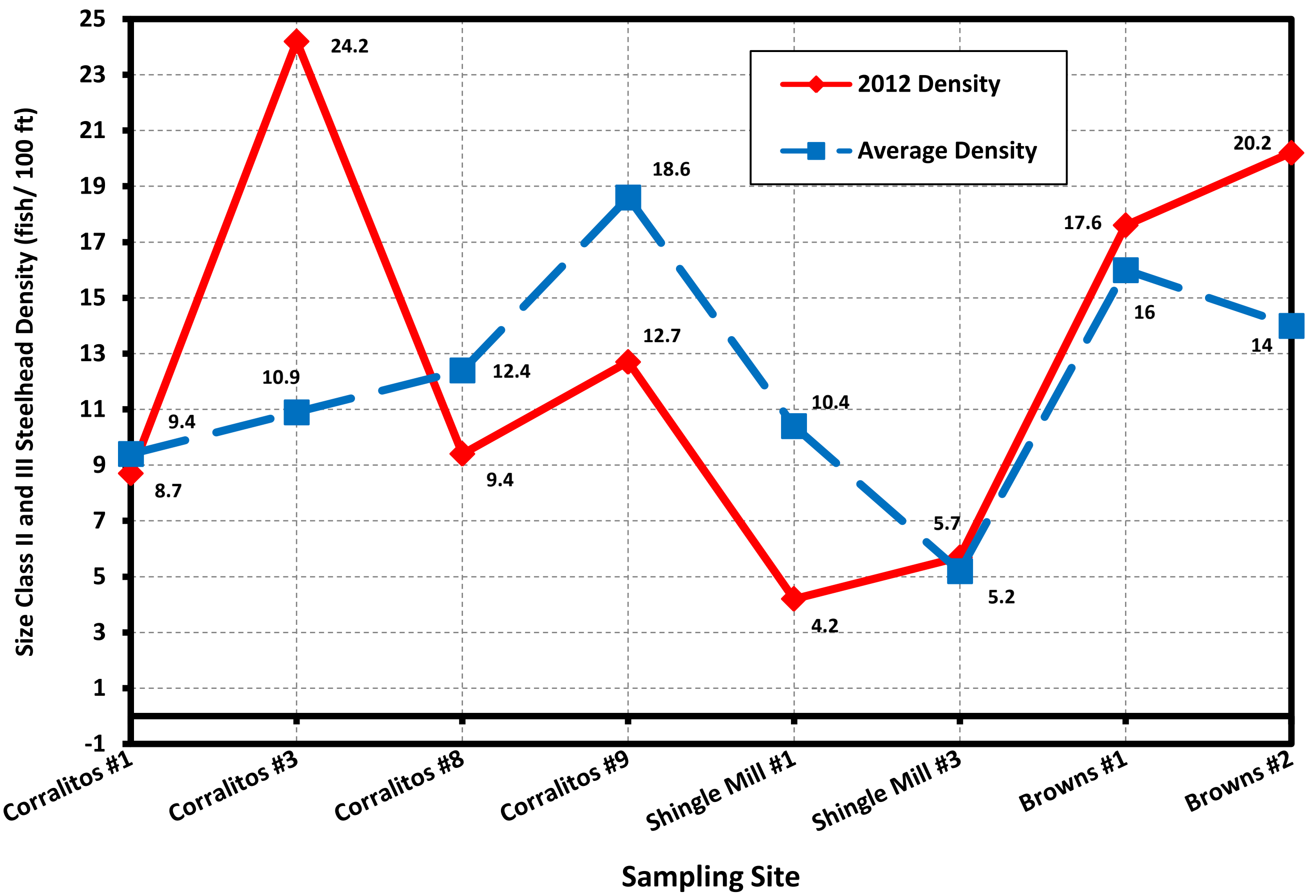


Figure 16. Size Class II and III Steelhead Site Densities in Corralitos, Shingle Mill and Browns Creeks in 2012, with a 9-Year Average (1981; 1994; 2006-2012).



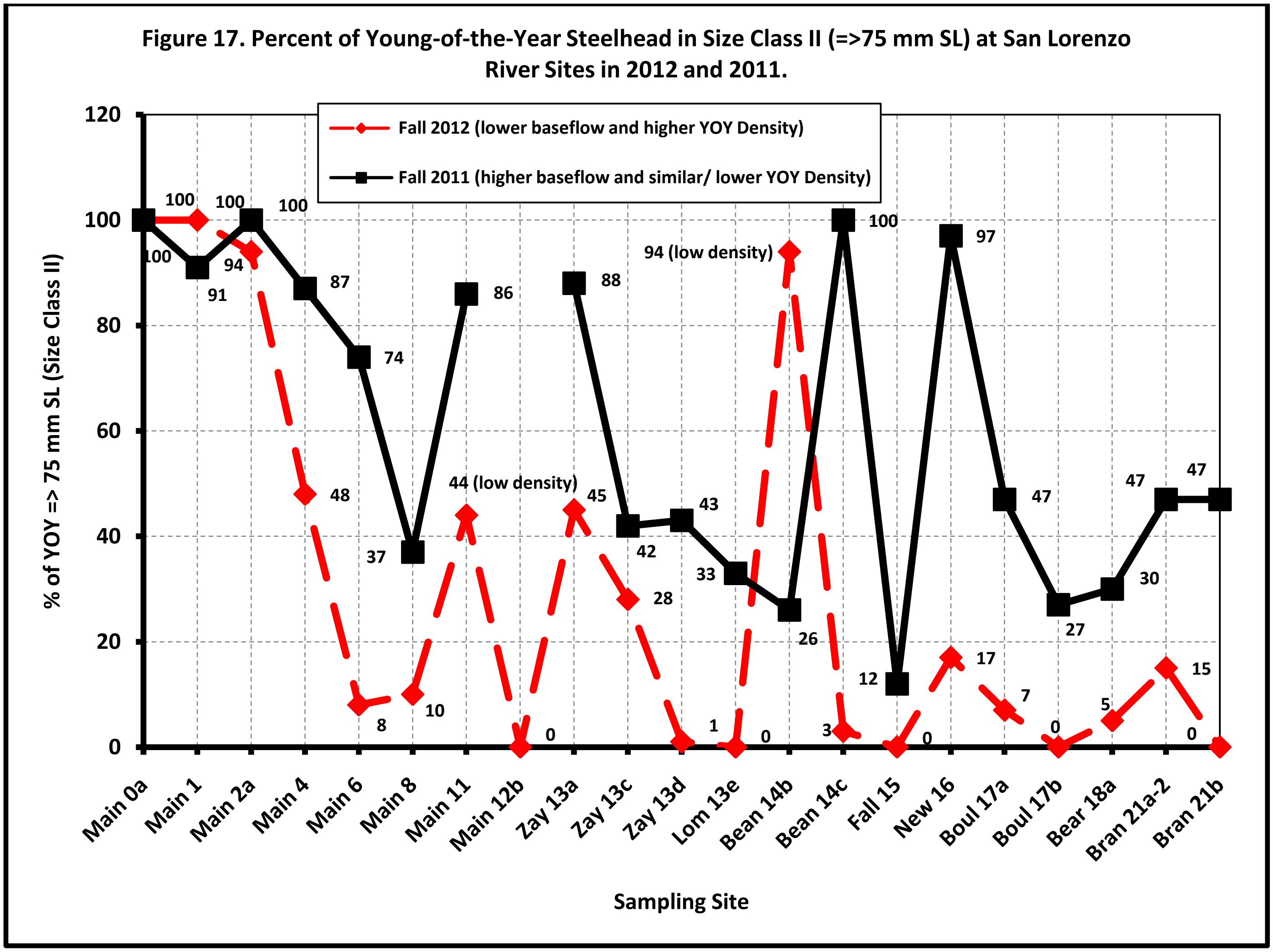
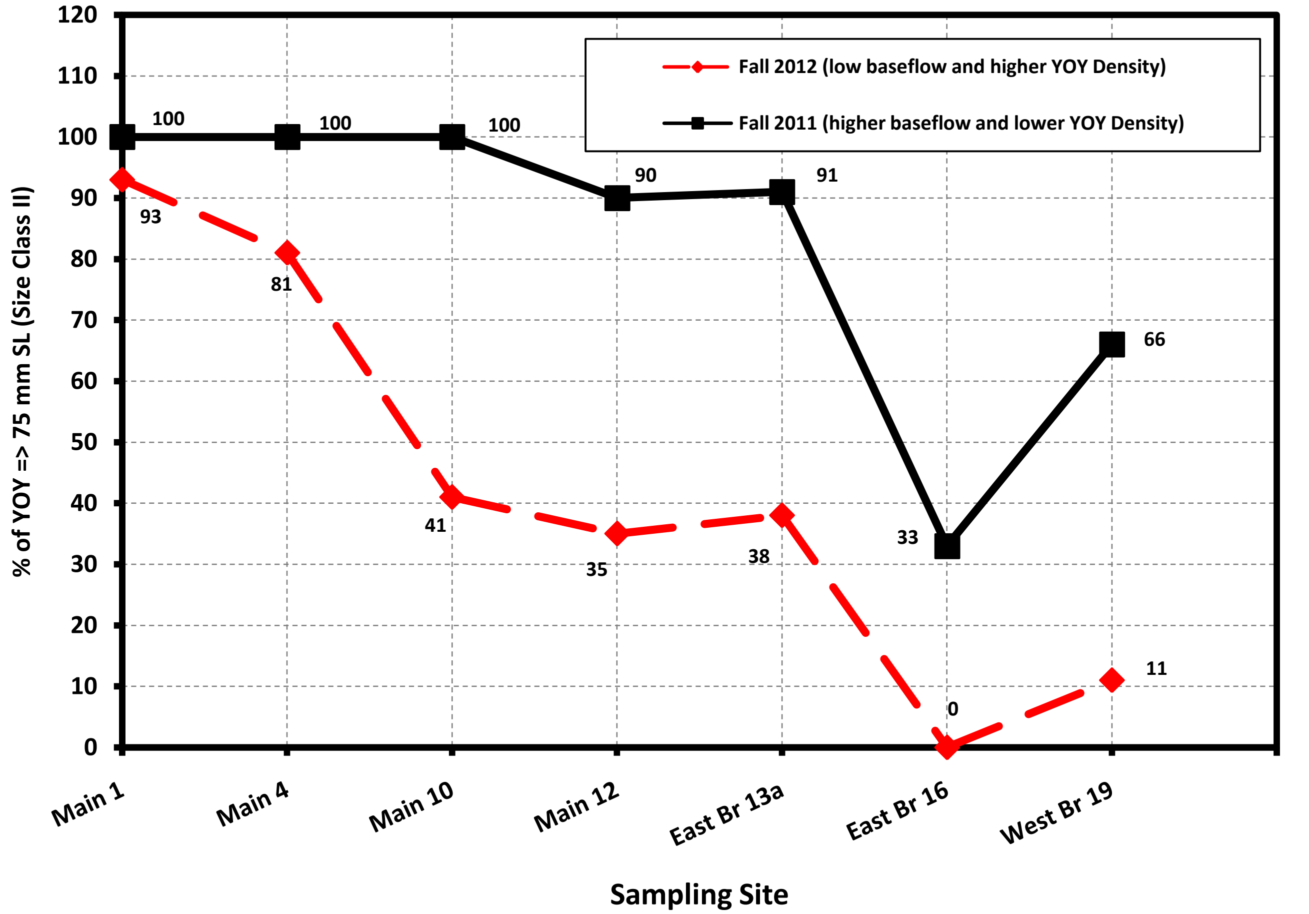


Figure 17. Percent of Young-of-the-Year Steelhead in Size Class II (=>75 mm SL) at San Lorenzo River Sites in 2012 and 2011.
Fall 2012 (lower baseflow and higher YOY Density)
Fall 2011 (higher baseflow and similar/ lower YOY Density)
% of YOY => 75 mm SL (Size Class II)
Sampling Site
0
20
40
60
80
100
120
Main 0a
Main 1
Main 2a
Main 4
Main 6
Main 8
Main 11
Main 12b
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
Bran 21b
44 (low density)
94 (low density)

Figure 18. Percent of Young-of-the-Year Steelhead in Size Class II (=>75 mm SL) at Soquel Creek Sites in 2012 and 2011.



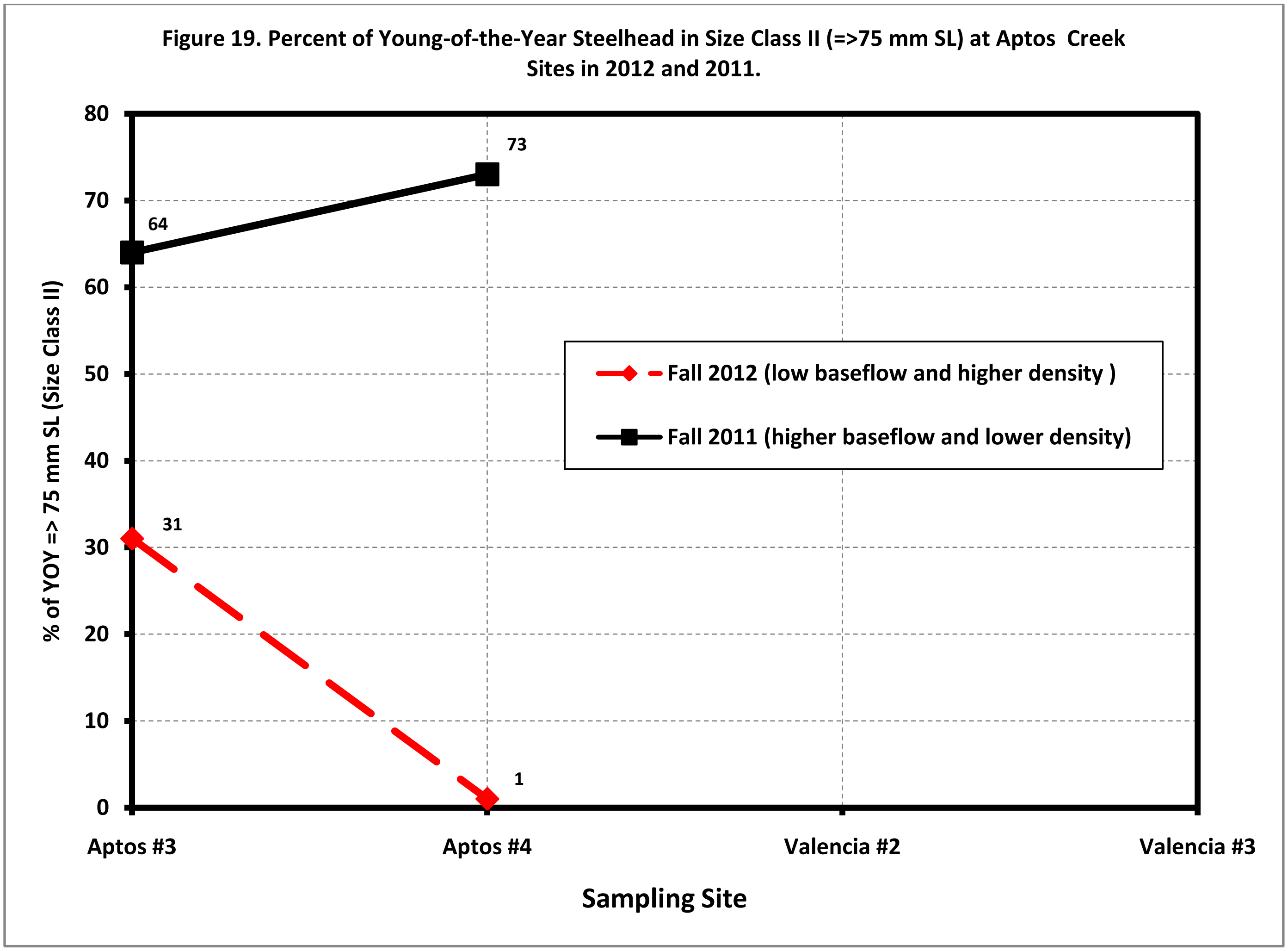
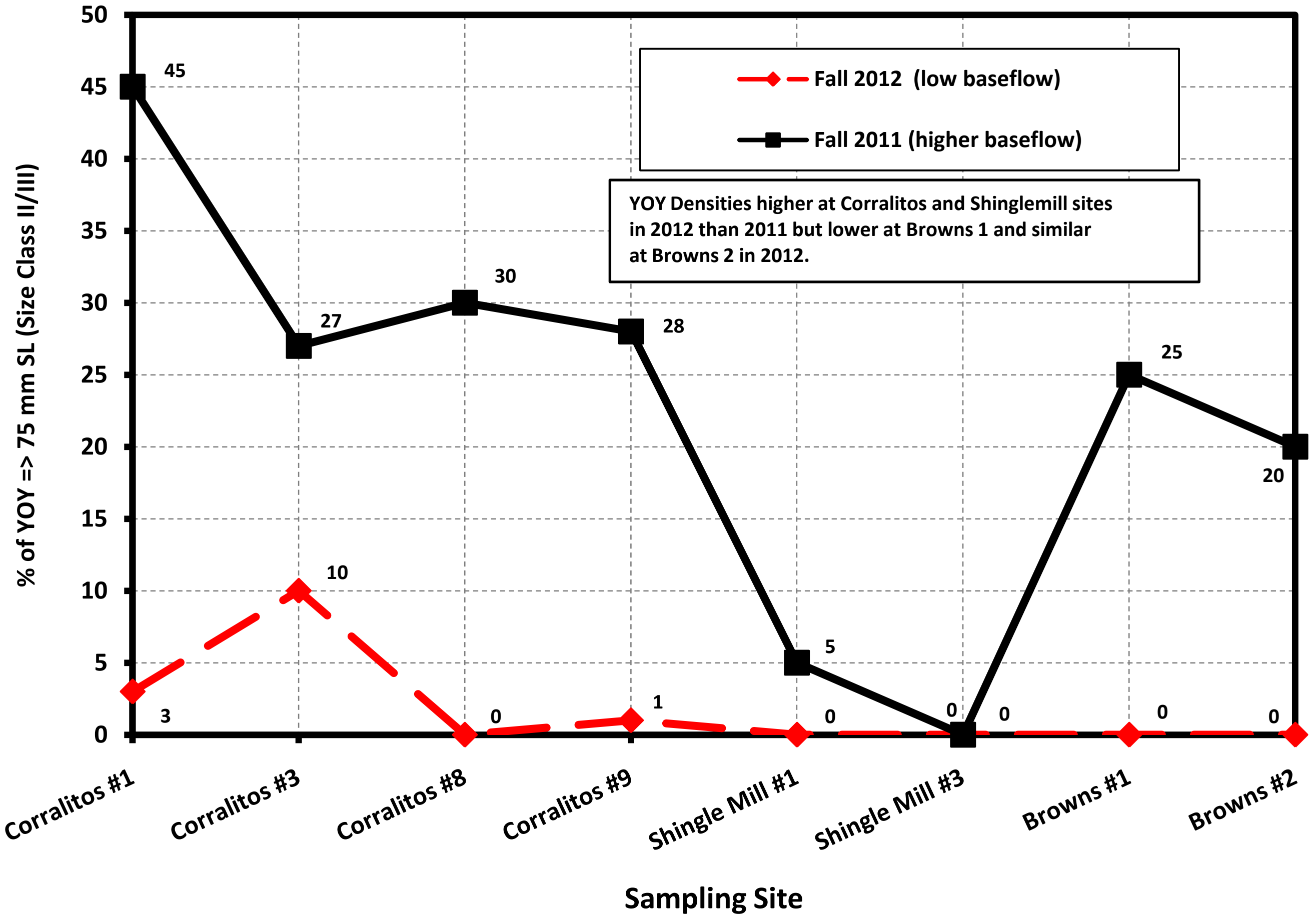


Figure 19. Percent of Young-of-the-Year Steelhead in Size Class II (=>75 mm SL) at Aptos Creek Sites in 2012 and 2011.
80
70
60
50
40
30
20
10
0
73
64
31
1
% of YOY => 75 mm SL (Size Class II)
Fall 2012 (low baseflow and higher density)
Fall 2011 (higher baseflow and lower density)
Aptos #3
Aptos #4
Valencia #2
Valencia #3
Sampling Site

Figure 20. Percent of Young-of-the-Year Steelhead in Size Class II (=>75 mm SL) at Corralitos Watershed Sites in 2012 and 2011.



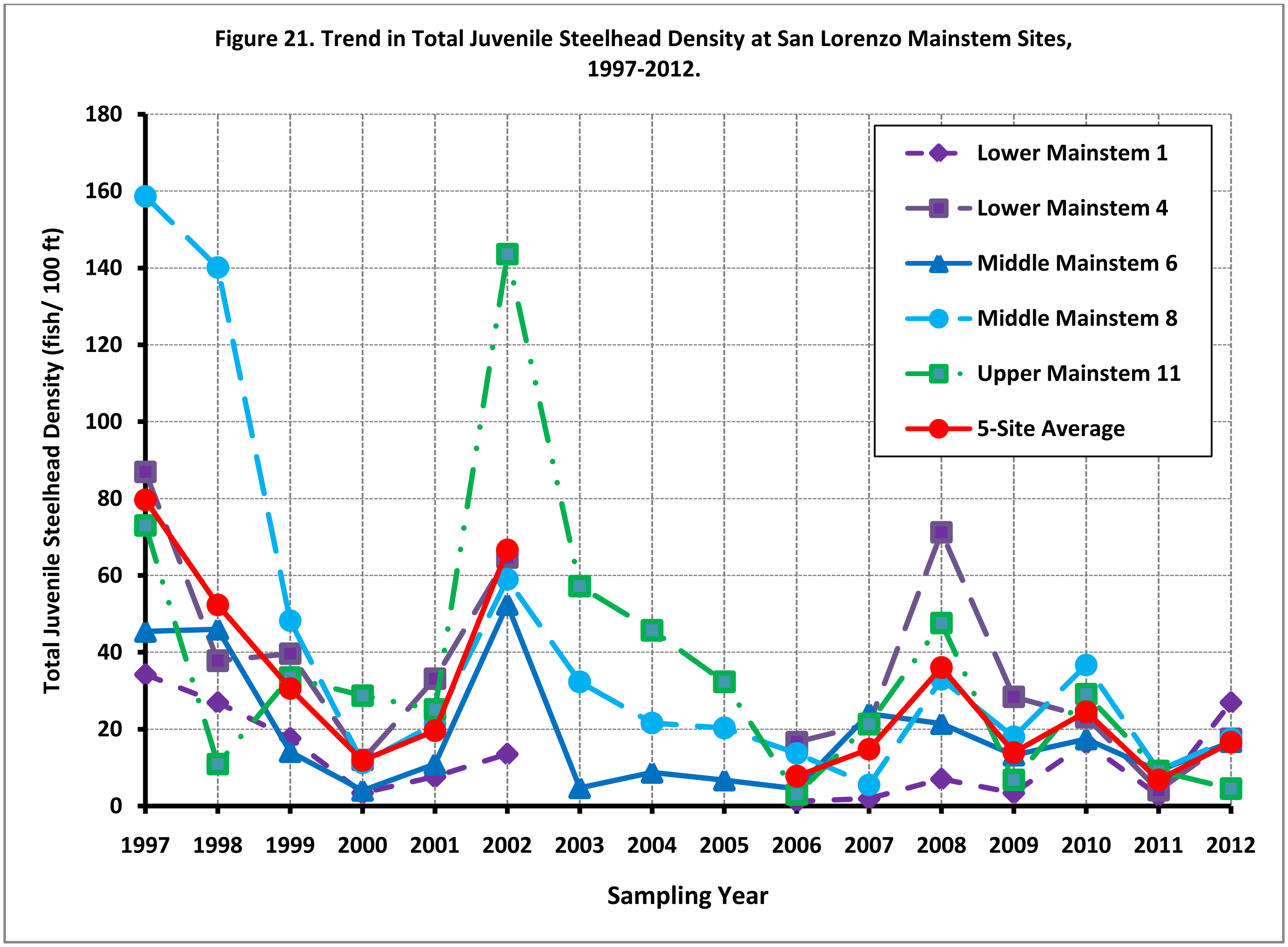


Figure 21. Trend in Total Juvenile Steelhead Density at San Lorenzo Mainstem Sites, 1997-2012.
Total Juvenile Steelhead Density (fish/ 100 ft)
180
160
140
120
100
80
60
40
20
0
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
Sampling Year
Lower Mainstem 1
Lower Mainstem 4
Middle Mainstem 6
Middle Mainstem 8
Upper Mainstem 11
5-Site Average

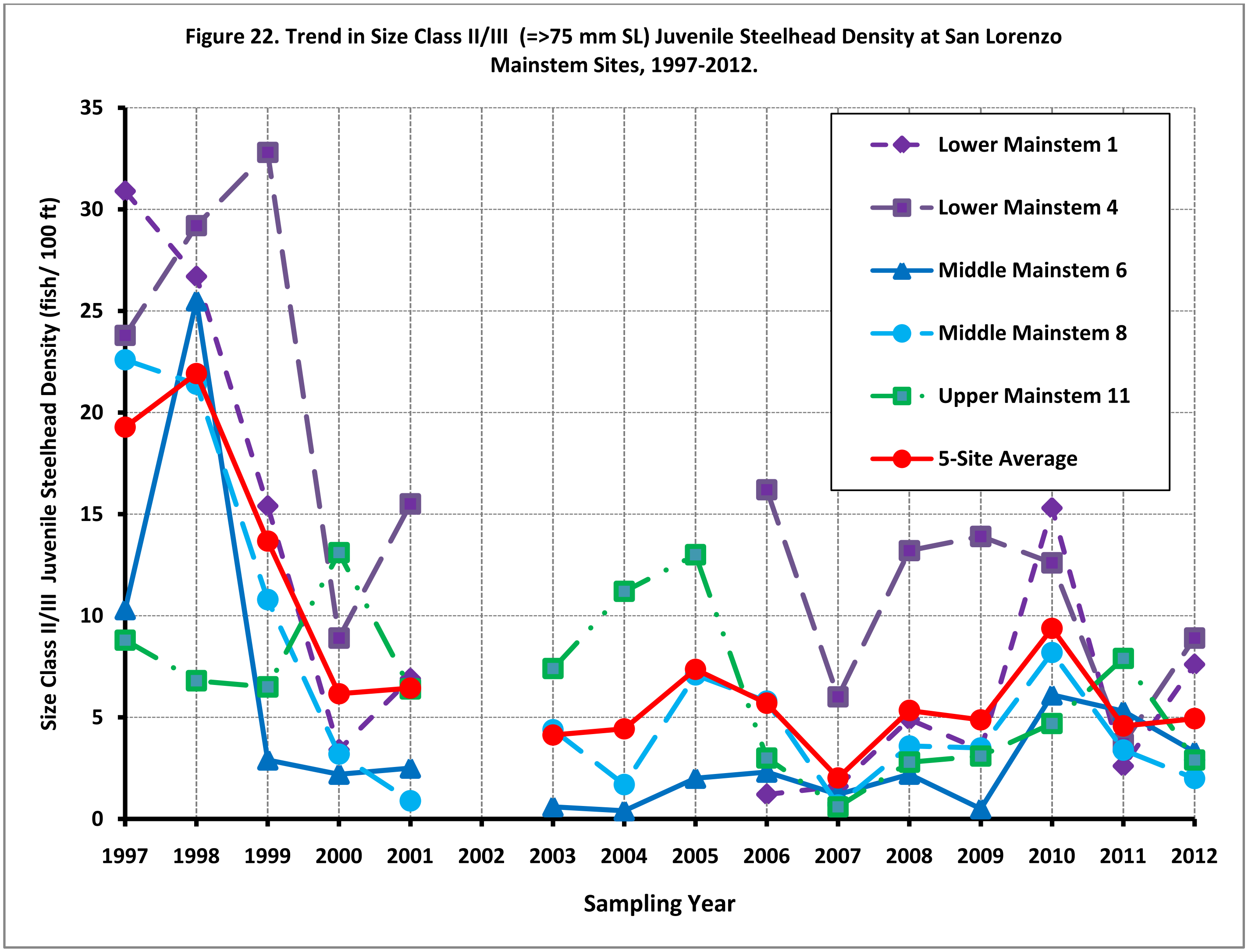
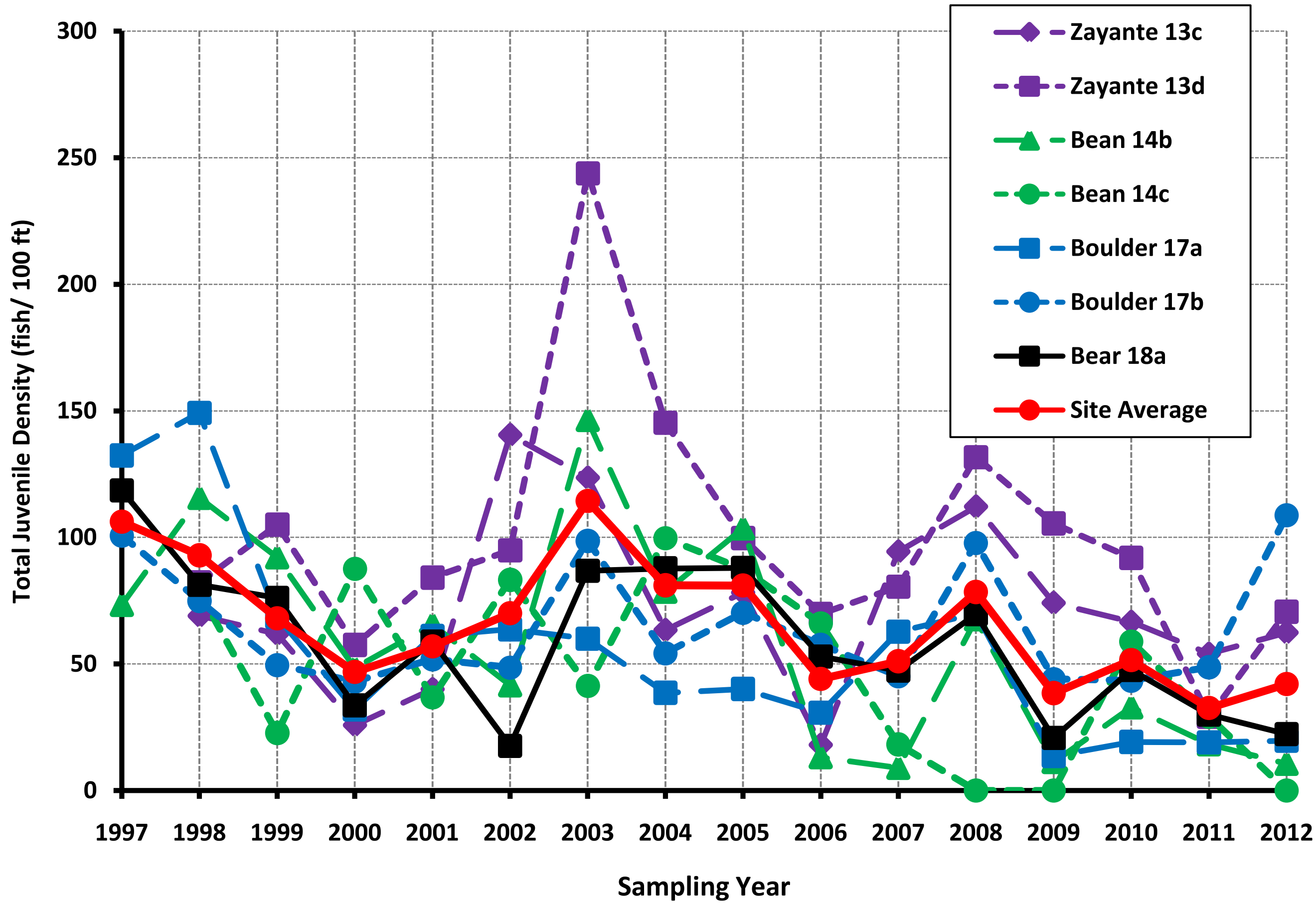


Figure 22. Trend in Size Class II/III (=>75 mm SL) Juvenile Steelhead Density at San Lorenzo Mainstem Sites, 1997-2012.
Size Class II/III Juvenile Steelhead Density (fish/ 100 ft)
0
5
10
15
20
25
30
35
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
Sampling Year
Lower Mainstem 1
Lower Mainstem 4
Middle Mainstem 6
Middle Mainstem 8
Upper Mainstem 11
5-Site Average

Figure 23. Trend in Total Juvenile Steelhead Density at San Lorenzo Tributary Sites, 1997-2012.



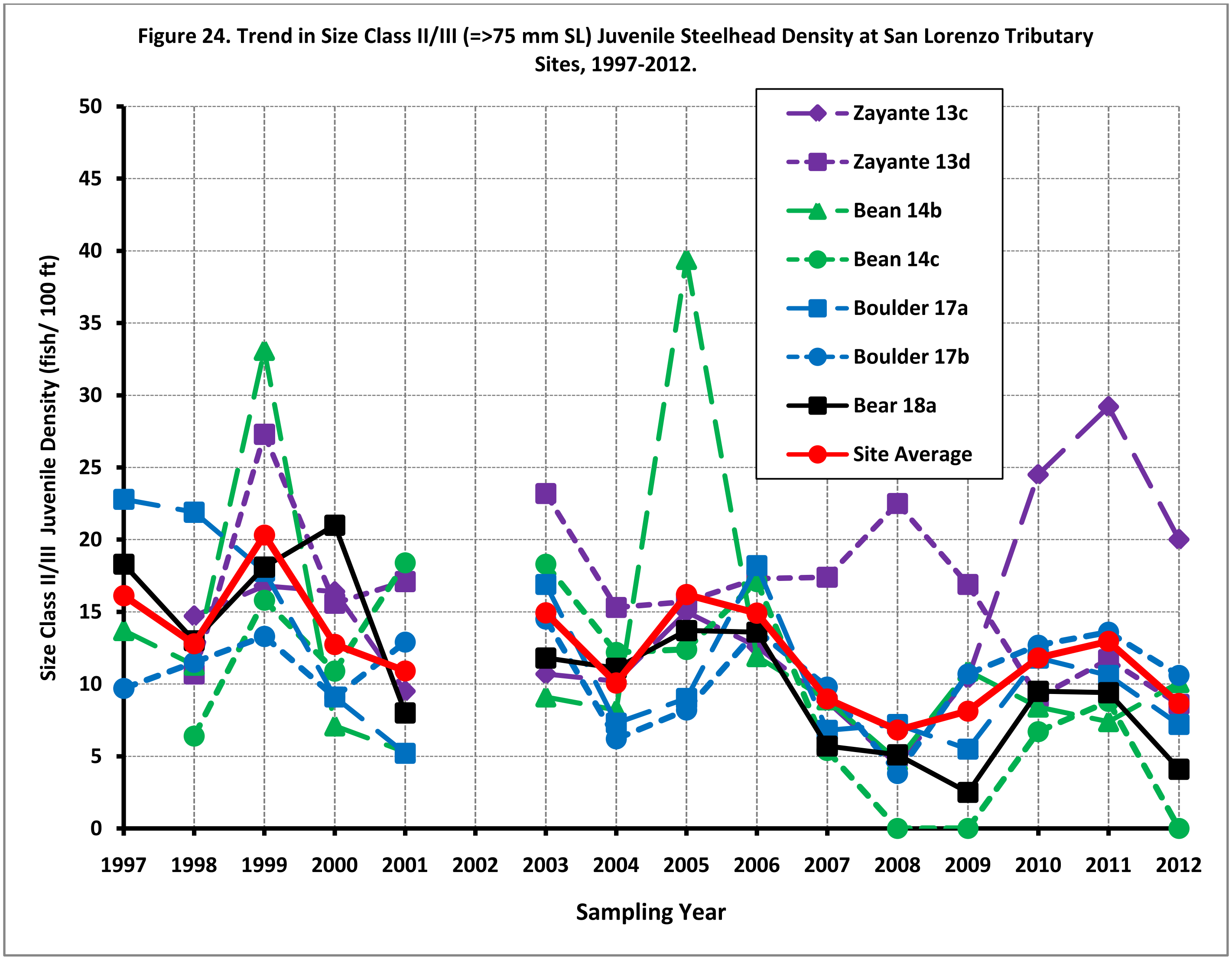
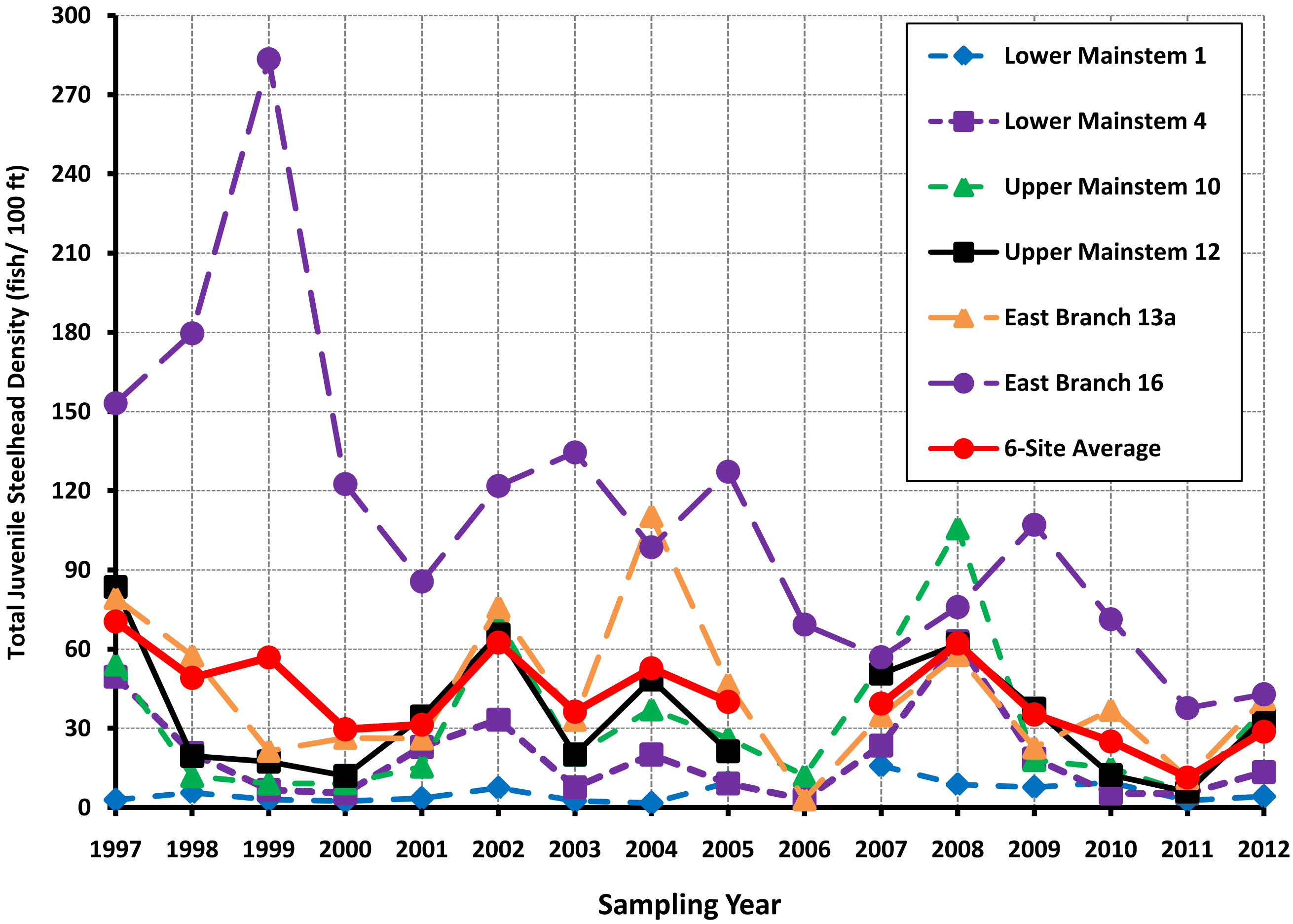


Figure 24. Trend in Size Class II/III (=>75 mm SL) Juvenile Steelhead Density at San Lorenzo Tributary Sites, 1997-2012.
Size Class II/III Juvenile Density (fish/ 100 ft)
Sampling Year
Zayante 13c
Zayante 13d
Bean 14b
Bean 14c
Boulder 17a
Boulder 17b
Bear 18a
Site Average
0
5
10
15
20
25
30
35
40
45
50
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012

Figure 25. Trend in Total Juvenile Steelhead Density at Soquel Creek Sites, 1997-2012.



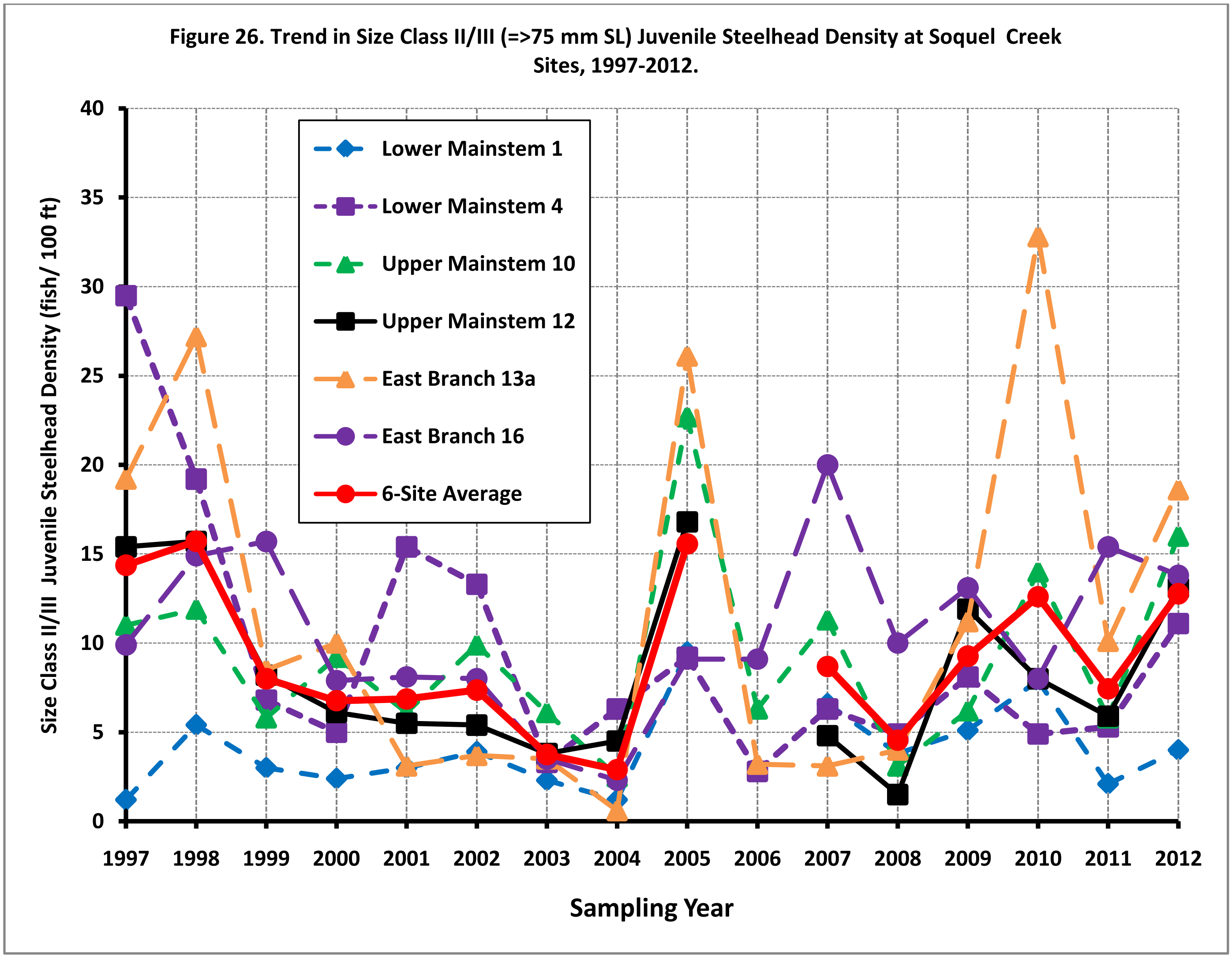


Figure 26. Trend in Size Class II/III (=>75 mm SL) Juvenile Steelhead Density at Soquel Creek Sites, 1997-2012.
Size Class II/III Juvenile Steelhead Density (fish/ 100 ft)
Sampling Year
Lower Mainstem 1
Lower Mainstem 4
Upper Mainstem 10
Upper Mainstem 12
East Branch 13a
East Branch 16
6-Site Average
0
5
10
15
20
25
30
35
40
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012

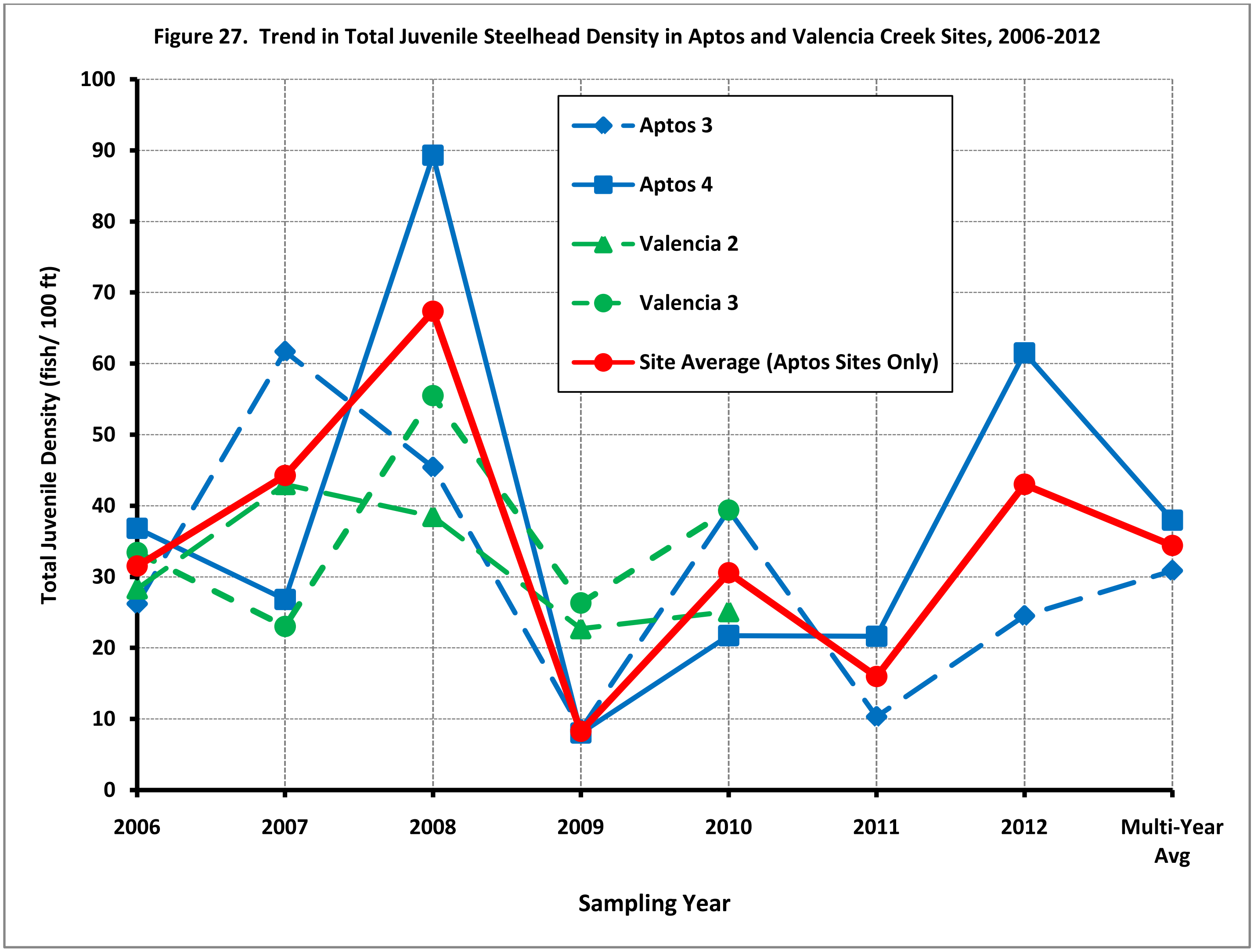
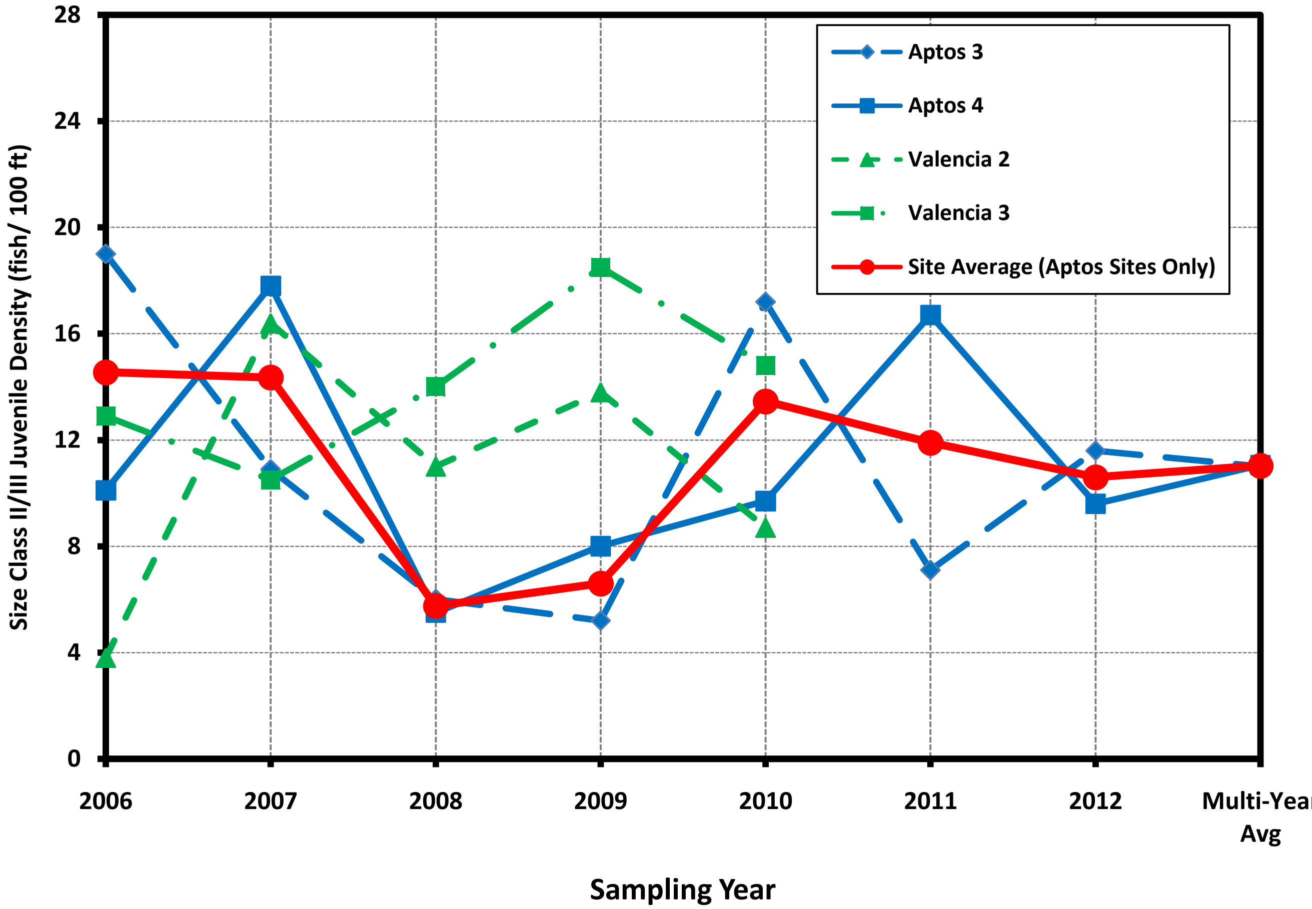


Figure 27. Trend in Total Juvenile Steelhead Density in Aptos and Valencia Creek Sites, 2006-2012
Total Juvenile Density (fish/ 100 ft)
100
90
80
70
60
50
40
30
20
10
0
Aptos 3
Aptos 4
Valencia 2
Valencia 3
Site Average (Aptos Sites Only)
2006
2007
2008
2009
2010
2011
2012
Multi-Year Avg
Sampling Year

Figure 28. Trend in Size Class II/III Juveniles Steelhead Density at Aptos and Valencia Creek Sites, 2006-2012.



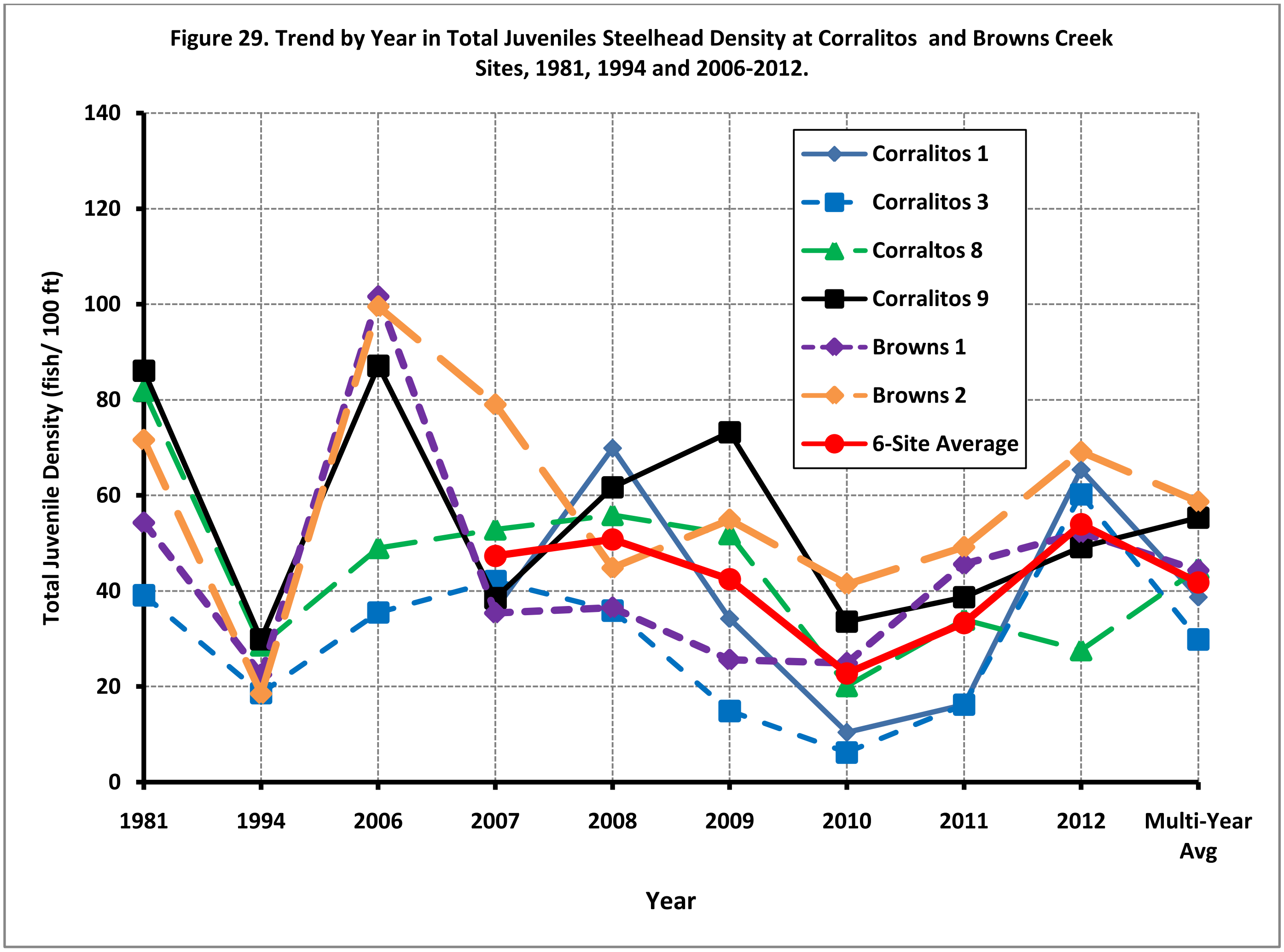


Figure 29. Trend by Year in Total Juveniles Steelhead Density at Corralitos and Browns Creek Sites, 1981, 1994 and 2006-2012.
Total Juvenile Density (fish/ 100 ft)
140
120
100
80
60
40
20
0
1981
1994
2006
2007
2008
2009
2010
2011
2012
Multi-Year Avg
Year
Corralitos 1
Corralitos 3
Corraltos 8
Corralitos 9
Browns 1
Browns 2
6-Site Average

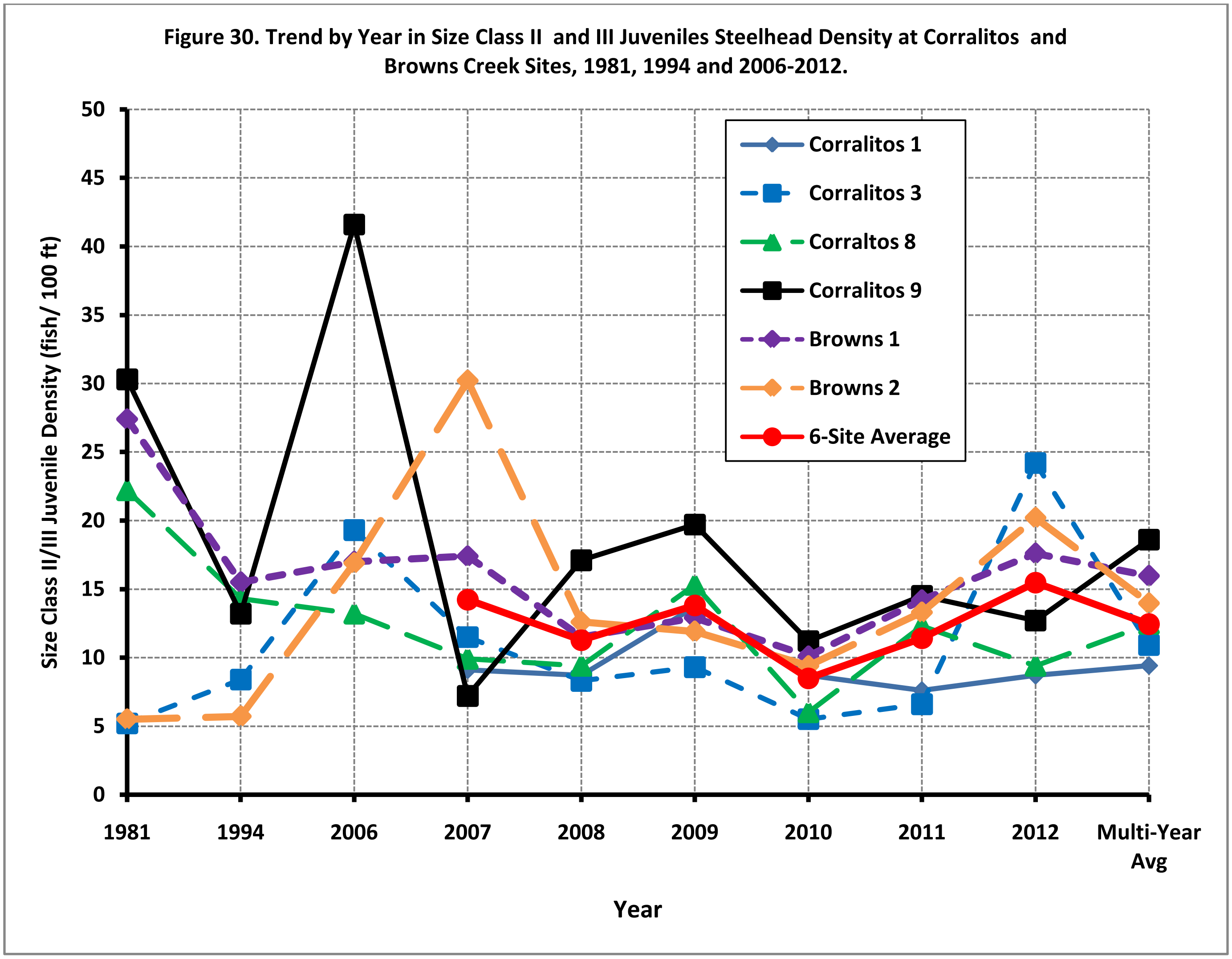


Figure 30. Trend by Year in Size Class II and III Juveniles Steelhead Density at Corralitos and Browns Creek Sites, 1981, 1994 and 2006-2012.
Size Class II/III Juvenile Density (fish/ 100 ft)
50
45
40
35
30
25
20
15
10
5
0
1981
1994
2006
2007
2008
2009
2010
2011
2012
Multi-Year Avg
Year
Corralitos 1
Corralitos 3
Corraltos 8
Corralitos 9
Browns 1
Browns 2
6-Site Average

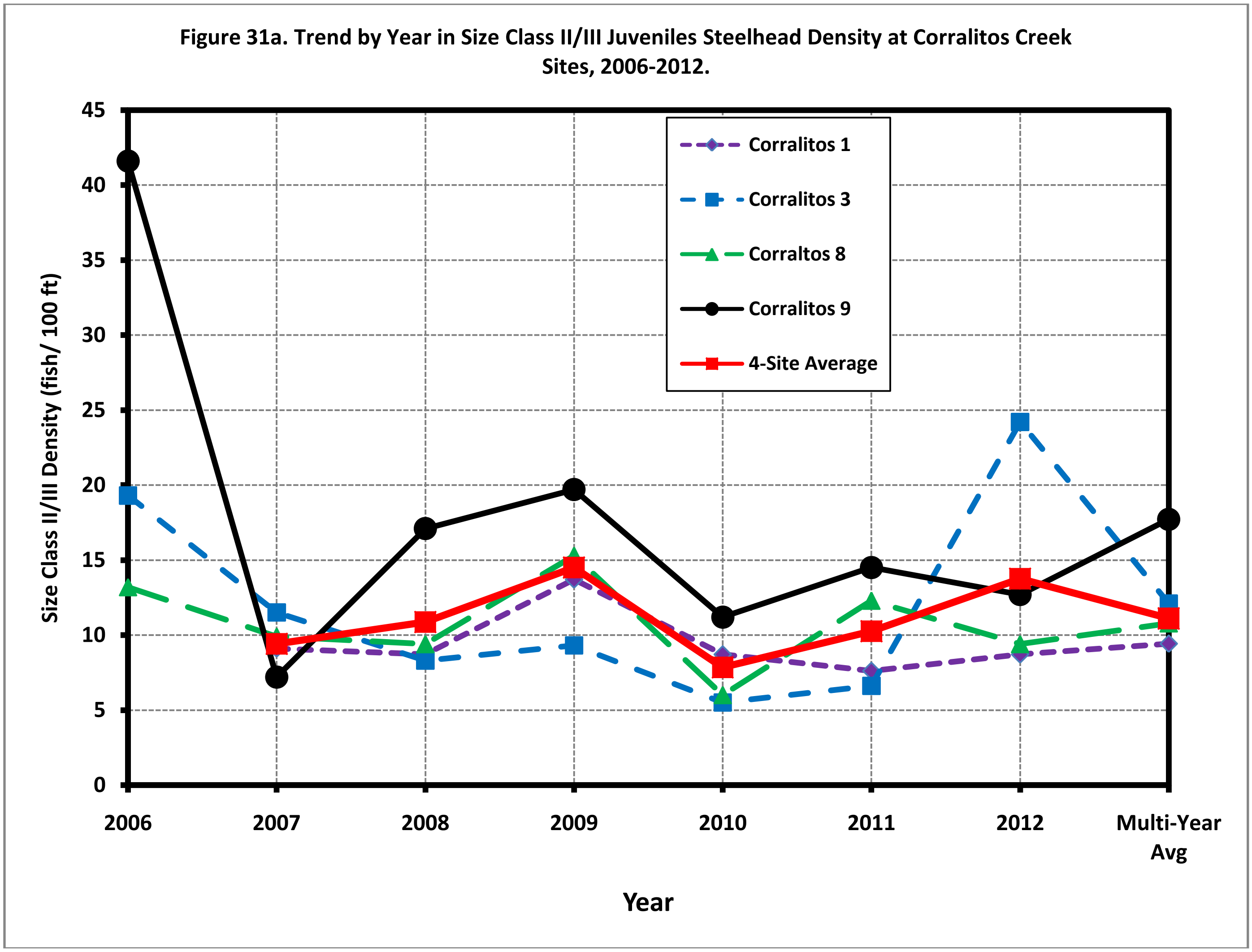


Figure 31a. Trend by Year in Size Class II/III Juveniles Steelhead Density at Corralitos Creek Sites, 2006-2012.
Corralitos 1
Corralitos 3
Corraltos 8
Corralitos 9
4-Site Average
Size Class II/III Density (fish/ 100 ft)
45
40
35
30
25
20
15
10
5
0
2006
2007
2008
2009
2010
2011
2012
Multi-Year Avg
Year

Figure 32. Site Trend by Year in Size Class II/III Steelhead Density at Corralitos, Shingle Mill and Browns Creek Sites, 2006-2012.

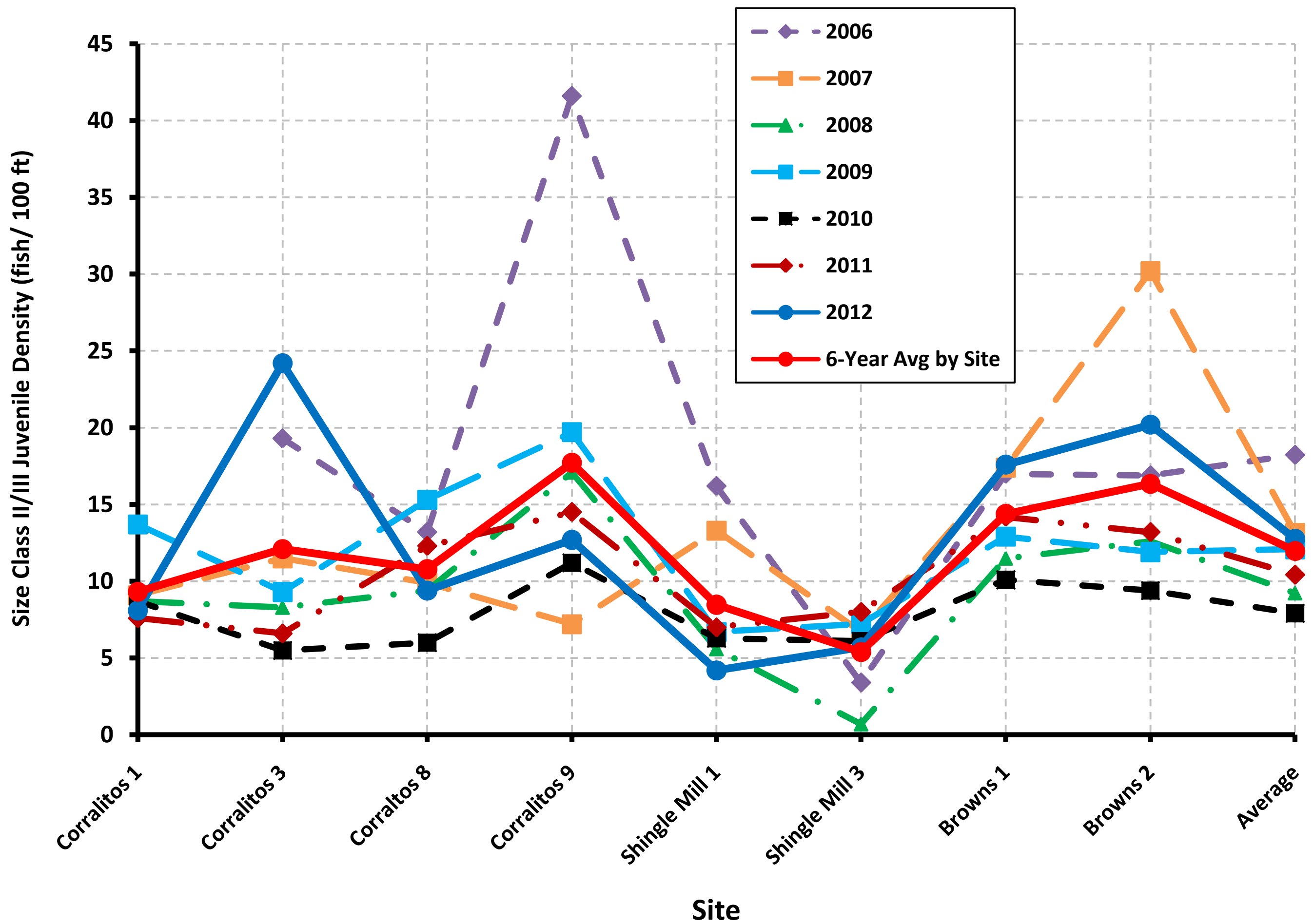


Figure 33. The 2011 Daily Average Discharge and Median Daily Flow of Record for the USGS Gage On the San Lorenzo River at Big Trees.

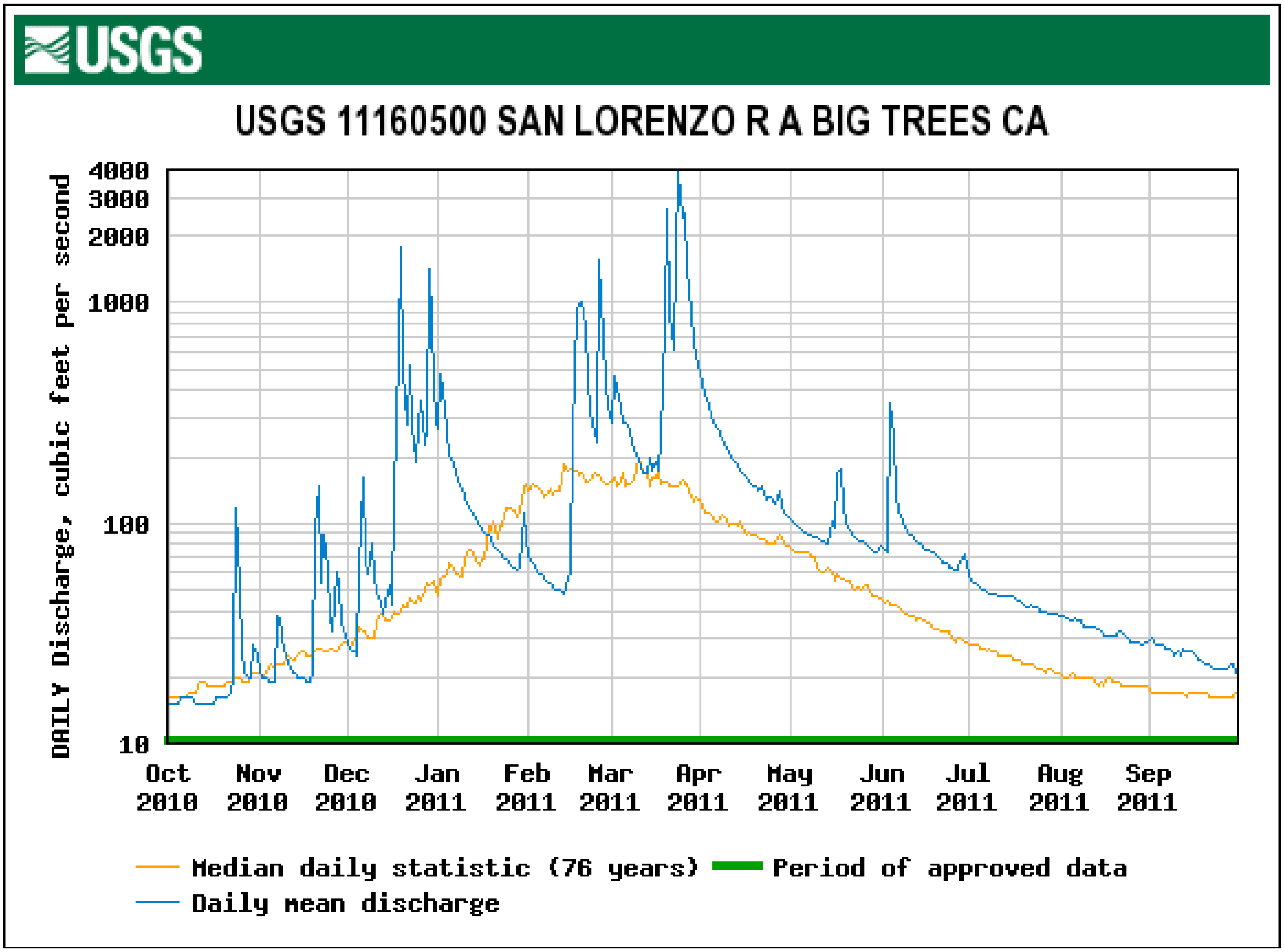


Figure 34. The 2012 Daily Average Discharge and Median Daily Flow of Record for the USGS Gage On the San Lorenzo River at Big Trees.

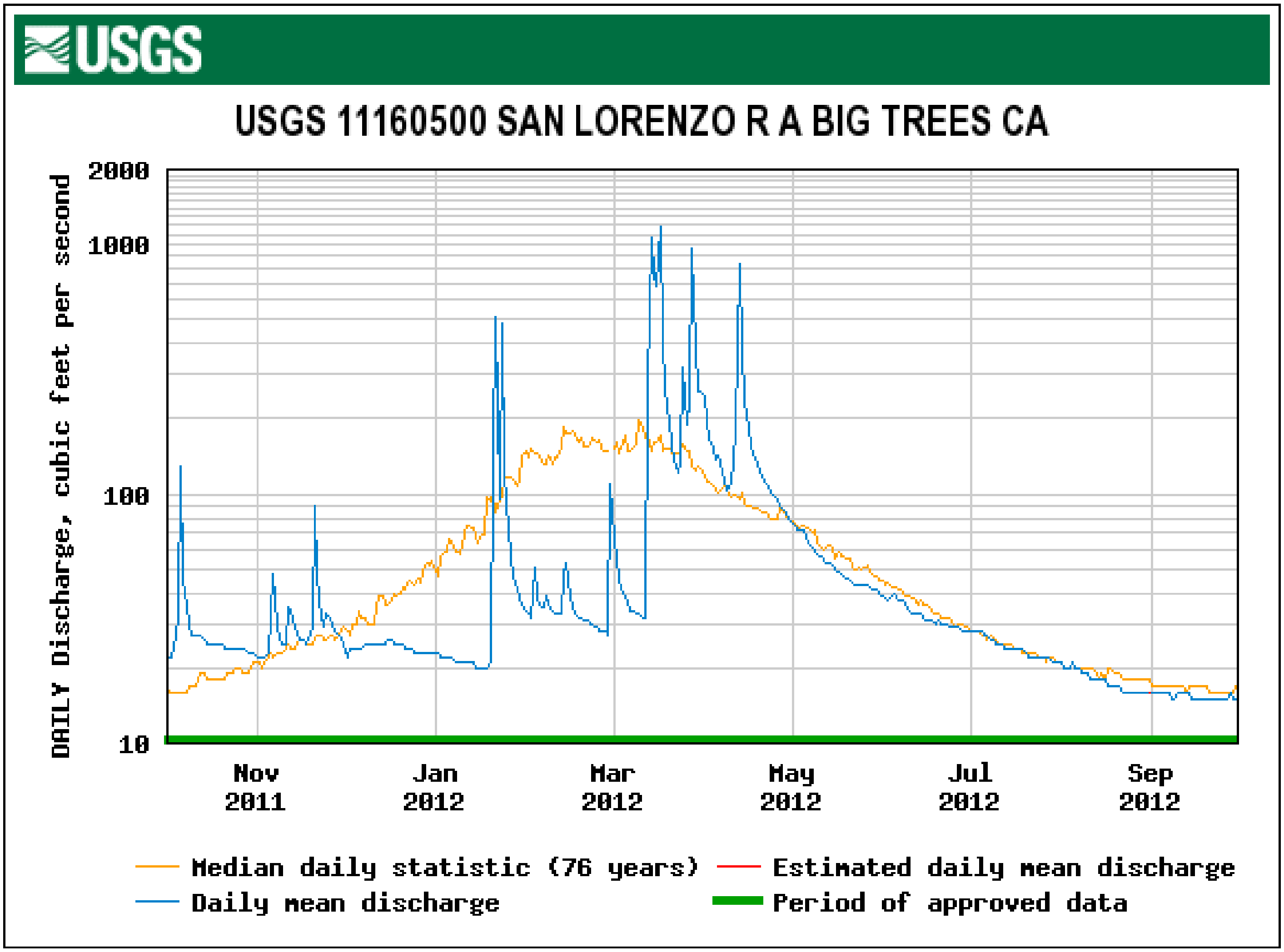


Figure 35. The March−April 2012 Discharge of Record for the USGS Gage On the San Lorenzo River at Big Trees.

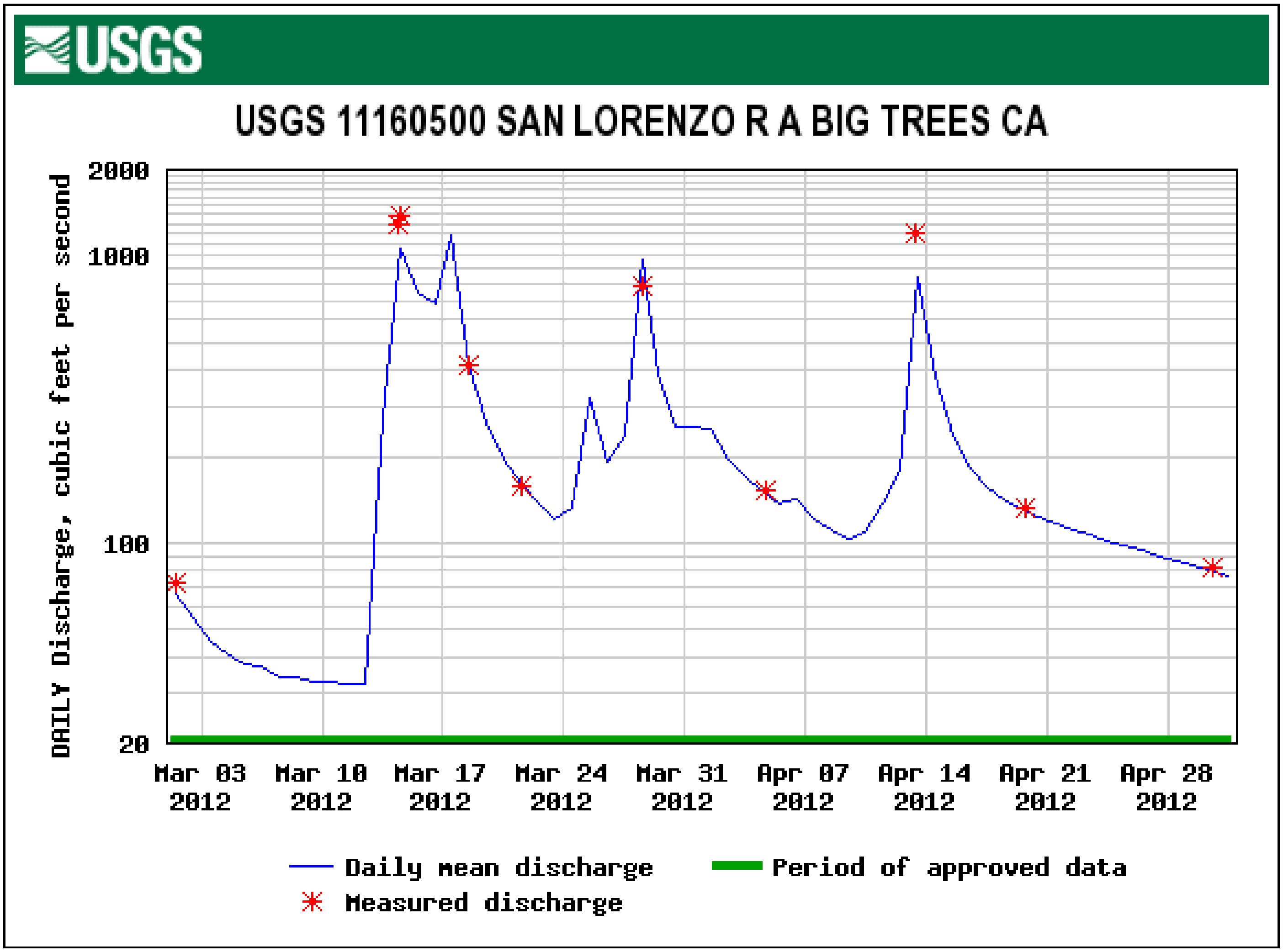


Figure 36. The 2011 Daily Mean and Median Flow at the USGS Gage on Soquel Creek at Soquel Village.

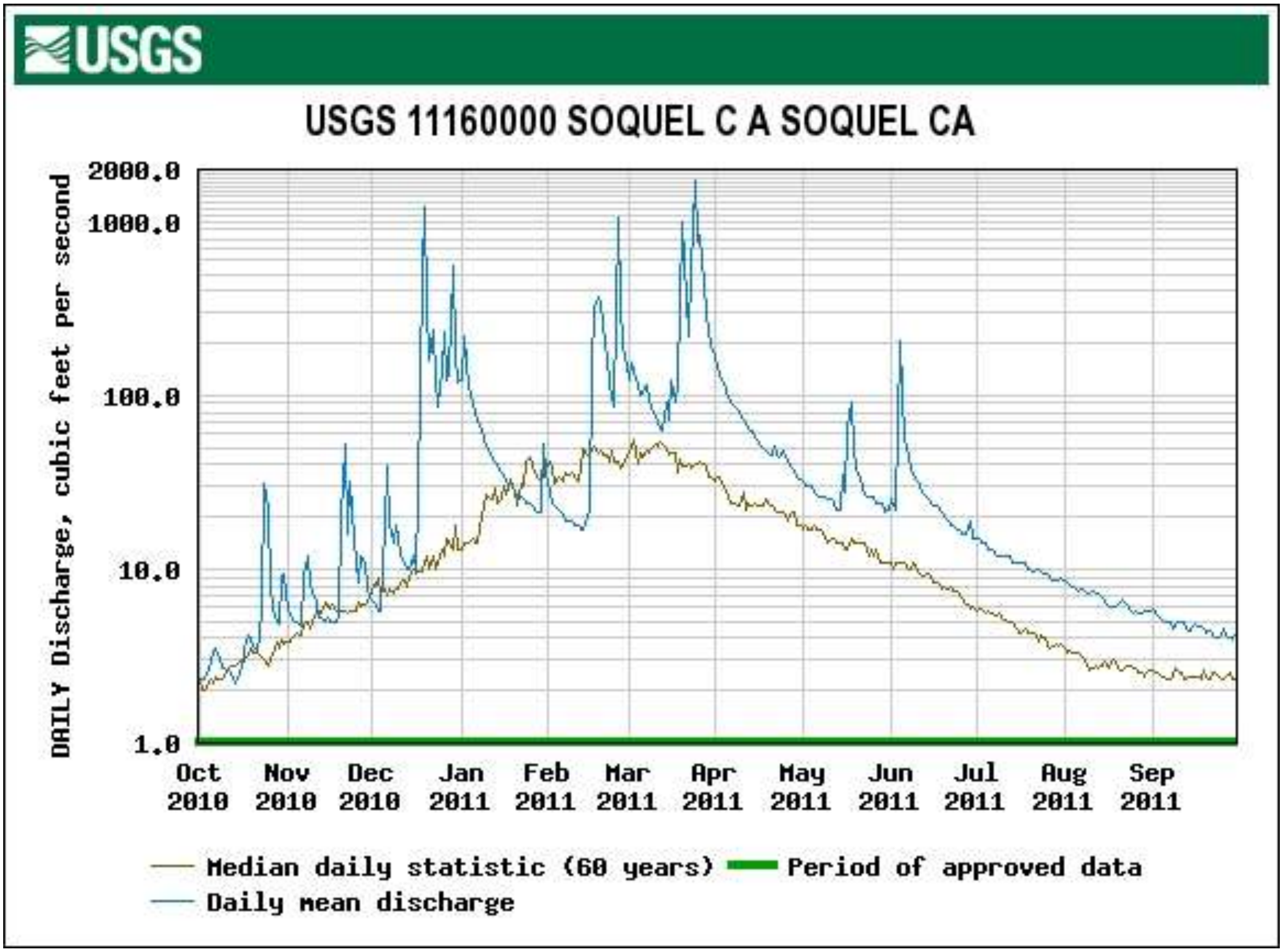


Figure 37. The 2012 Daily Mean and Median Flow at the USGS Gage on Soquel Creek at Soquel Village.

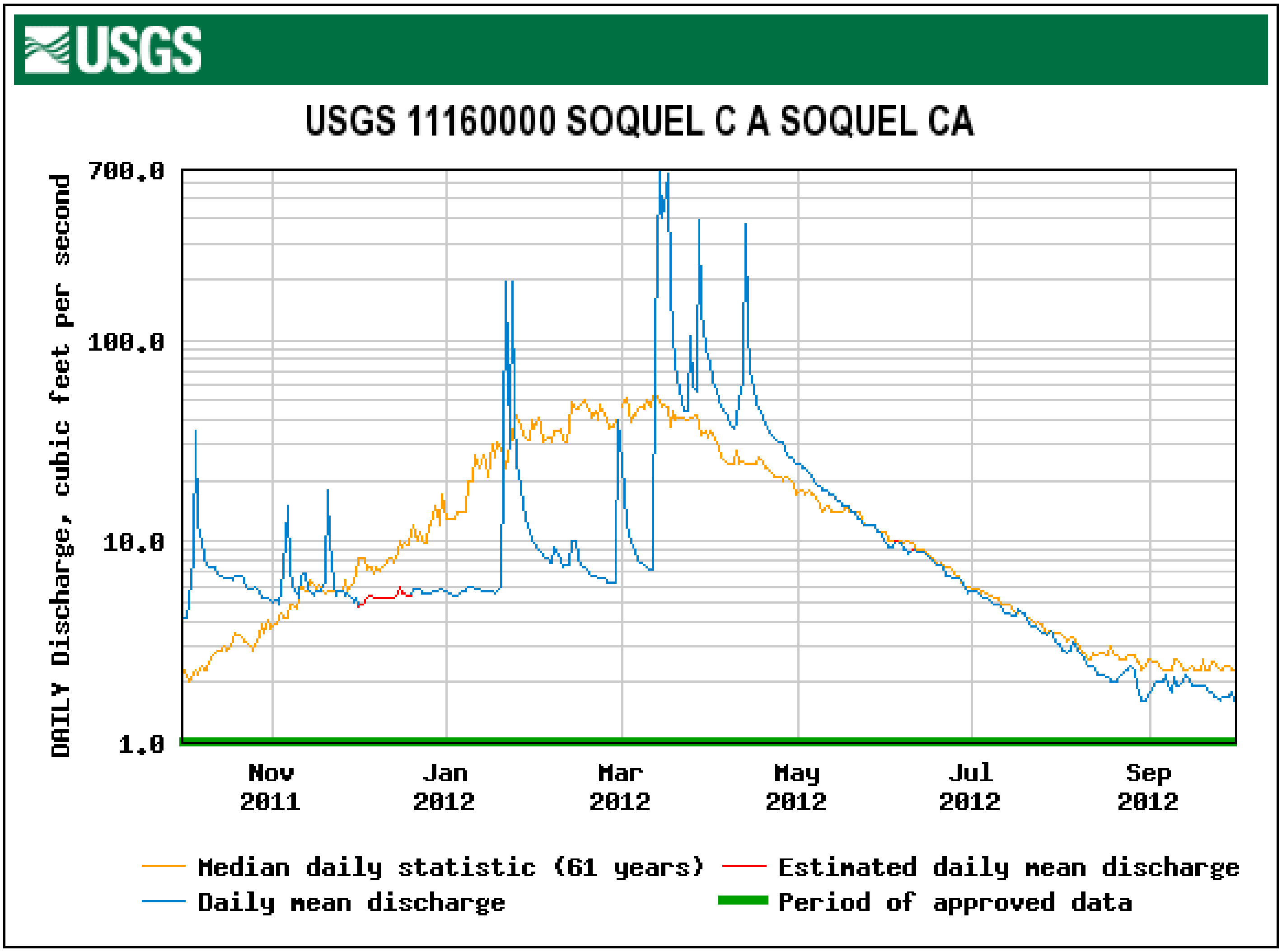


Figure 38. The March−April 2012 Discharge of Record for the USGS Gage on Soquel Creek at Soquel Village.

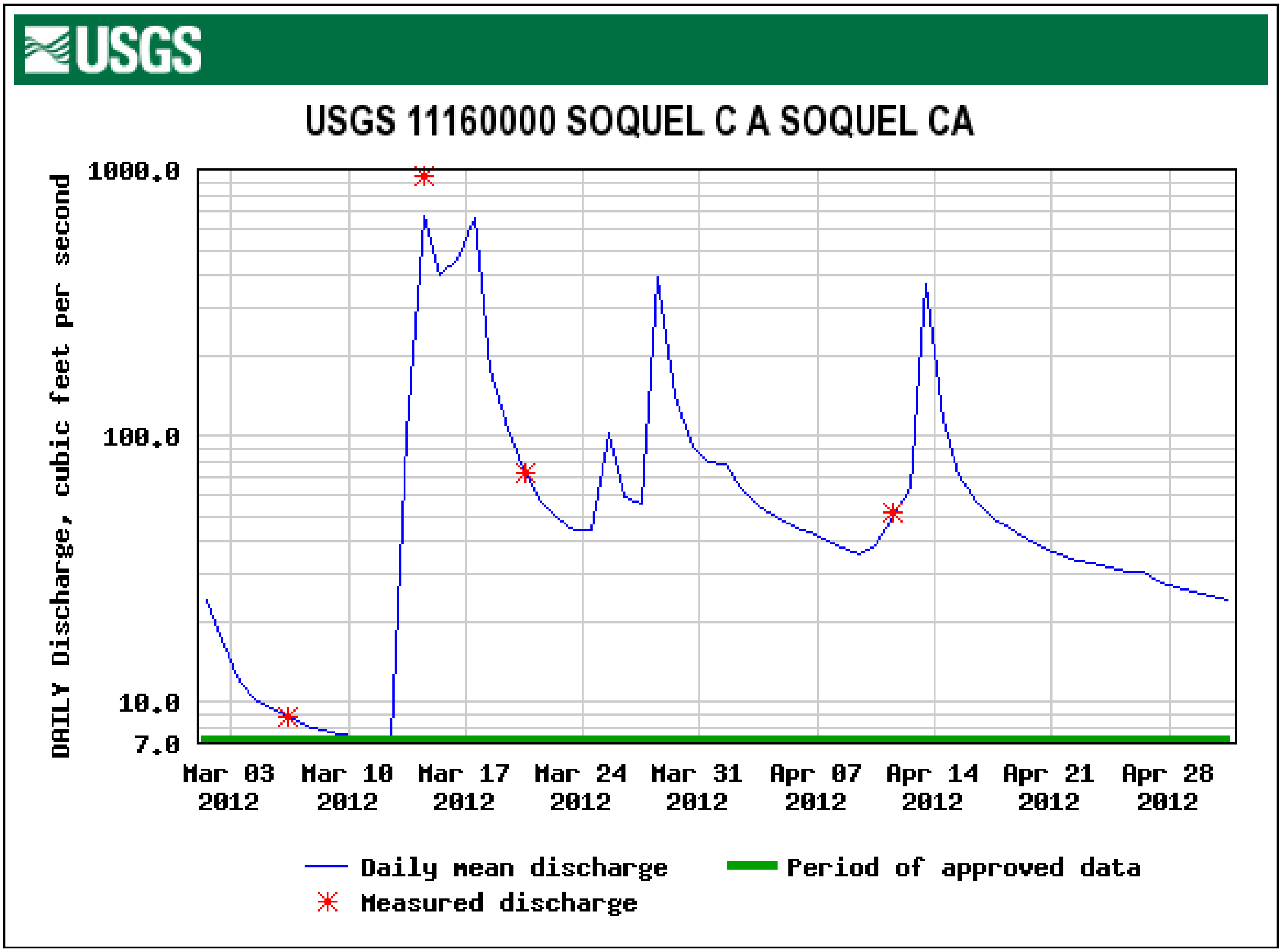


Figure 39. The 2011 Daily Mean and Median Flow at the USGS Gage on Corralitos Creek at Freedom. (USGS website would not provide a logarithmic scale of discharge).

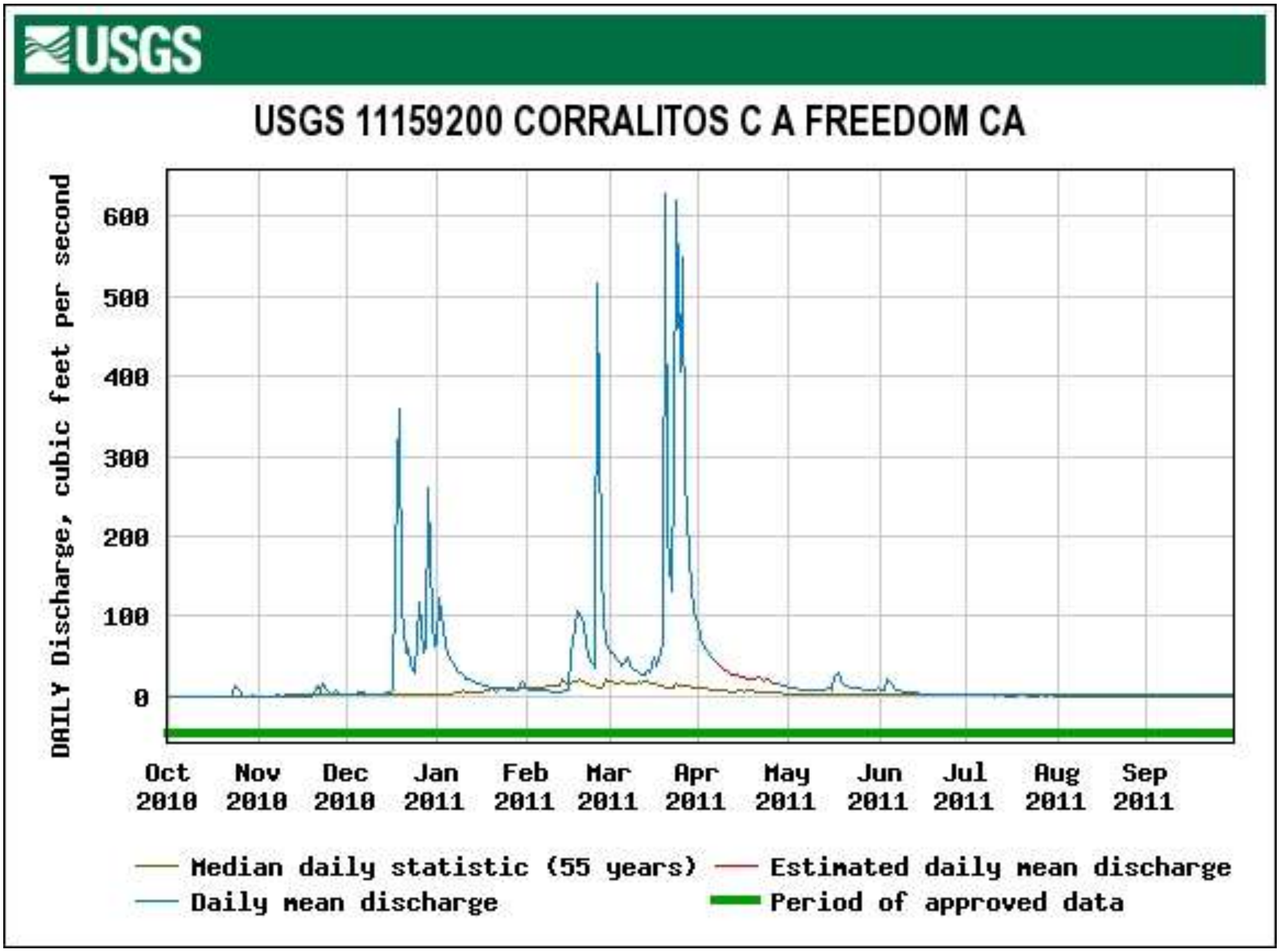


Figure 40. The 2012 Daily Mean and Median Flow at the USGS Gage on Corralitos Creek at Freedom. (USGS website would not provide a logarithmic scale of discharge).

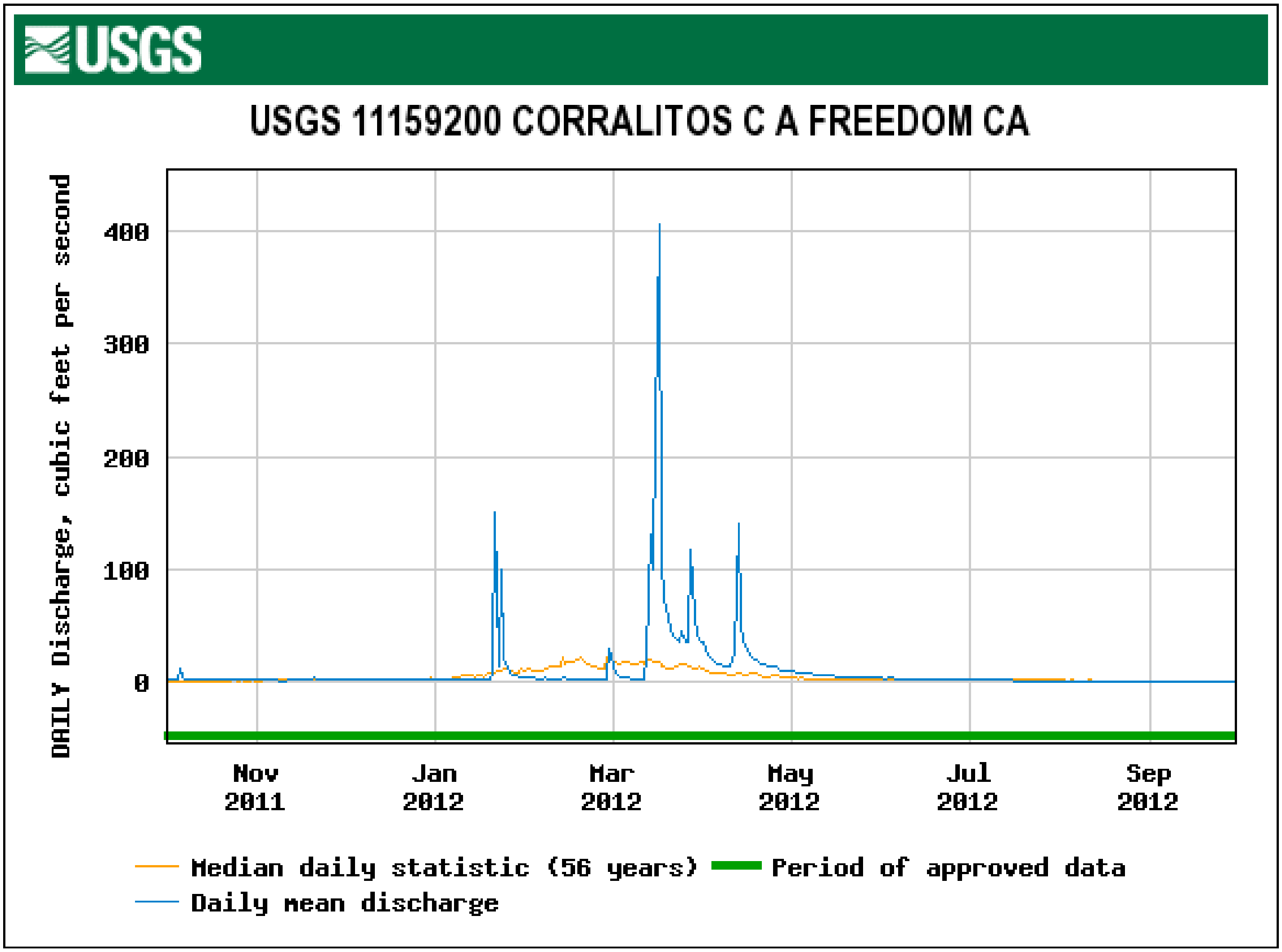
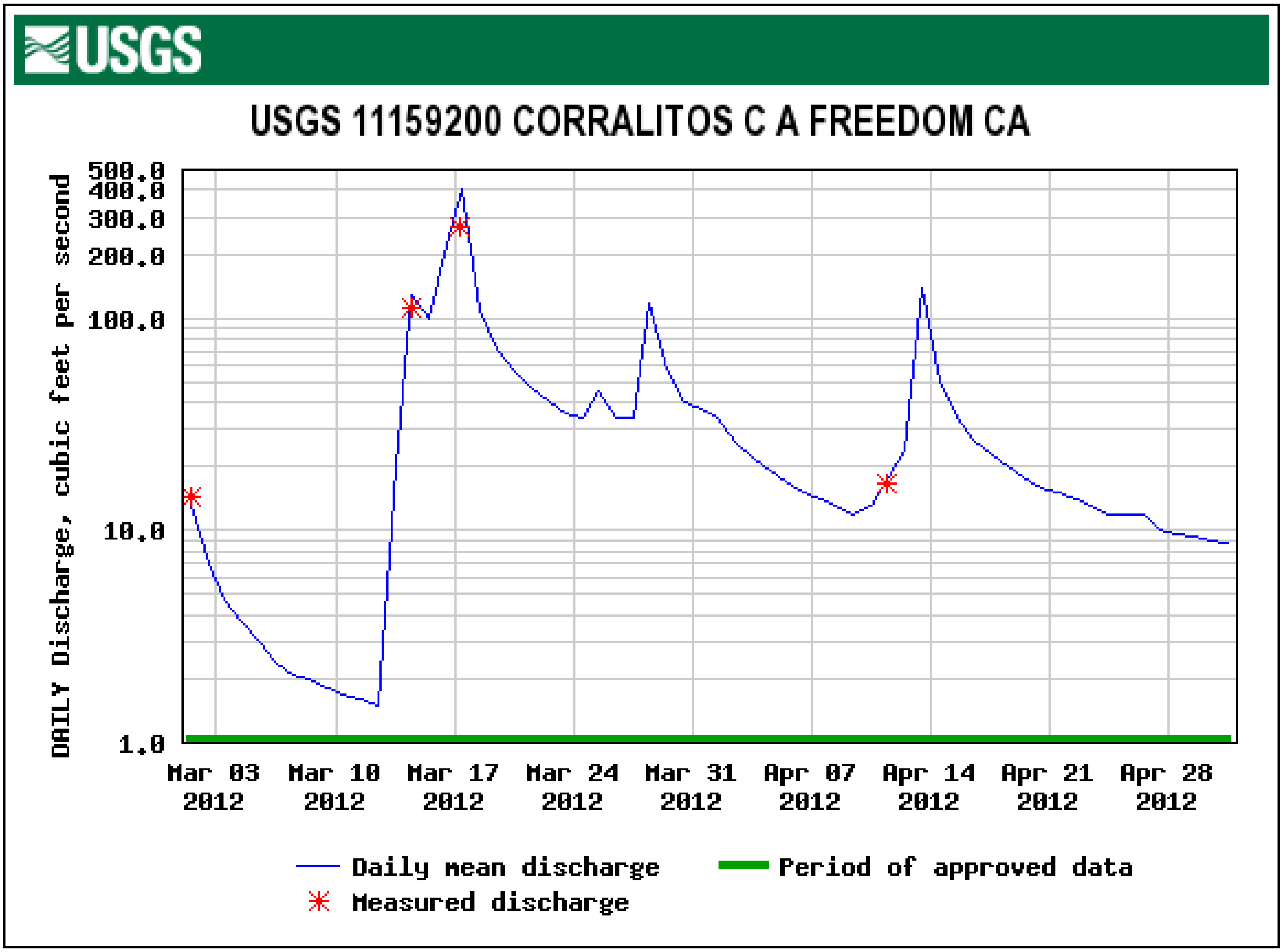


Figure 41. The March−April 2012 Discharge of Record for the USGS Gage on Corralitos Creek at Freedom.



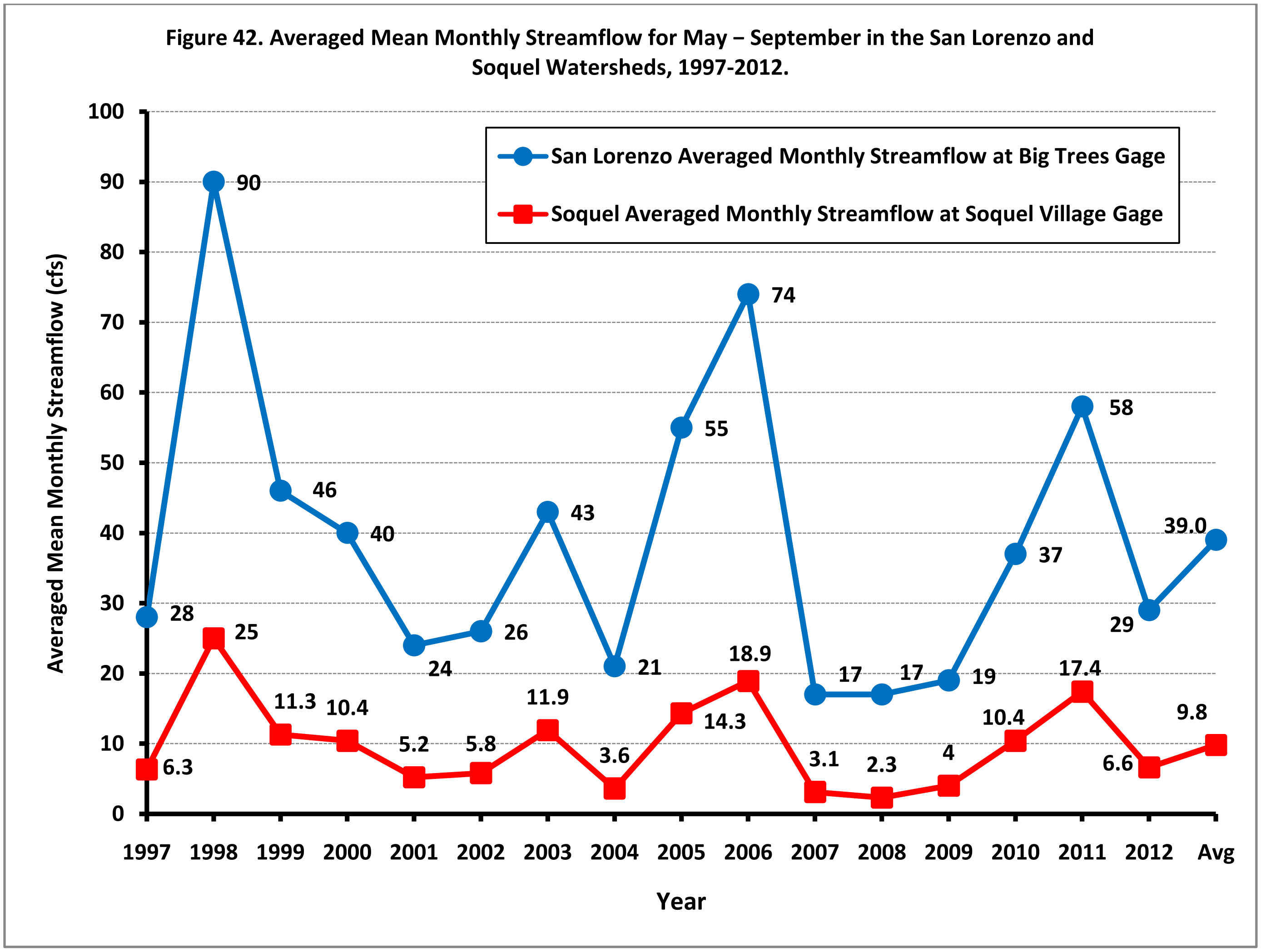


Figure 42. Averaged Mean Monthly Streamflow for May – September in the San Lorenzo and Soquel Watersheds, 1997-2012.
San Lorenzo Averaged Monthly Streamflow at Big Trees Gage
Soquel Averaged Monthly Streamflow at Soquel Village Gage
Averaged Mean Monthly Streamflow (cfs)
Year
0
10
20
30
40
50
60
70
80
90
100
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
2012
Avg
28
90
46
40
24
26
43
21
55
74
17
17
19
37
58
29
39.0
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
17.4
6.6
9.8

Figure 43. Size Frequency Histogram of Juvenile Steelhead Captured on 20 and 27 September 2012 in Aptos Lagoon/Estuary.

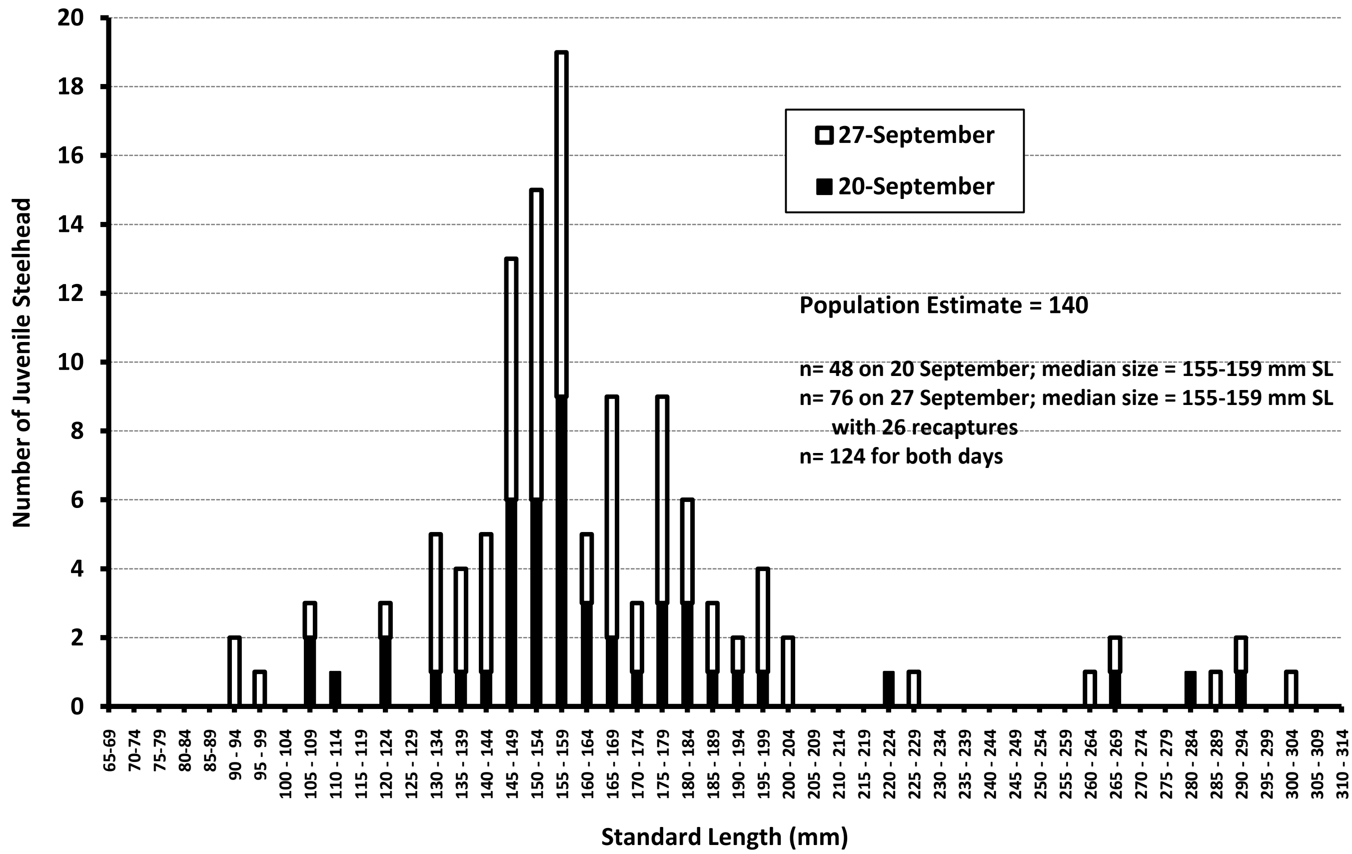
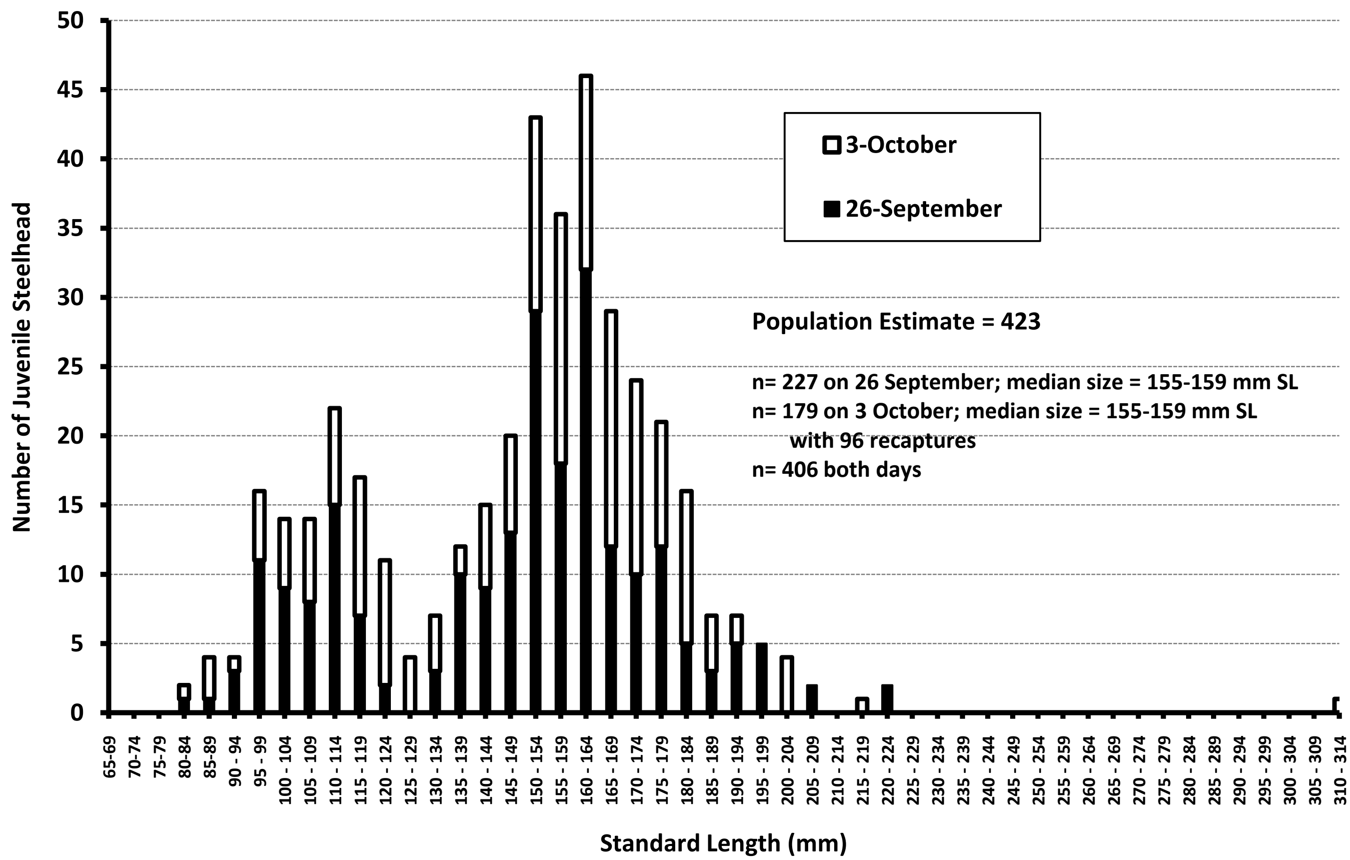


Figure 44. Size Frequency Histogram of Juvenile Steelhead Captured on 26 September and 3 October 2011 in Aptos Lagoon/Estuary.



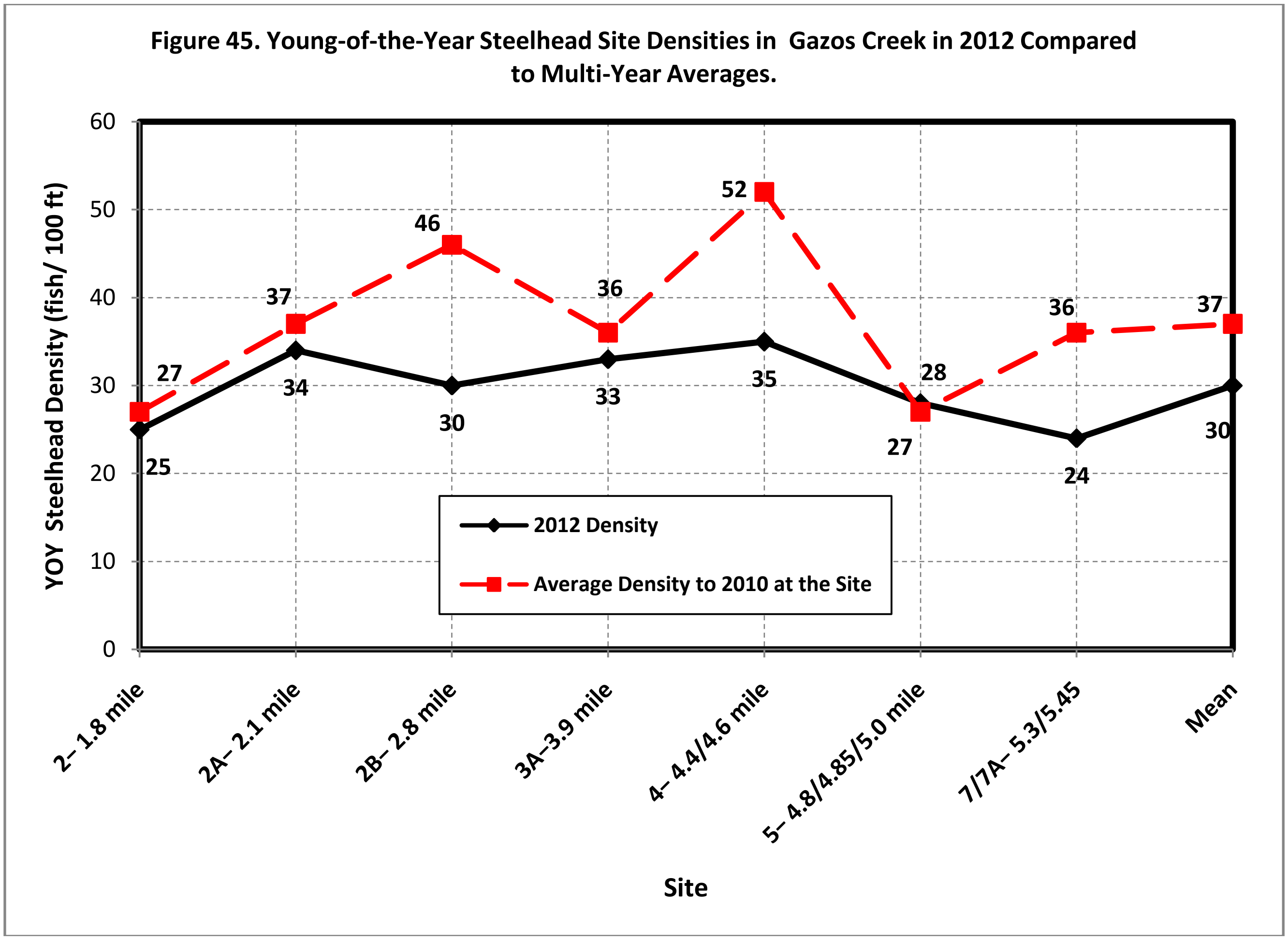


Figure 45. Young-of-the-Year Steelhead Site Densities in Gazos Creek in 2012 Compared to Multi-Year Averages.
YOY Steelhead Density (fish/ 100 ft)
0
10
20
30
40
50
60
27
37
46
36
52
28
36
37
25
34
30
33
35
27
24
30
2012 Density
Average Density to 2010 at the Site
2– 1.8 mile
2A– 2.1 mile
2B– 2.8 mile
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

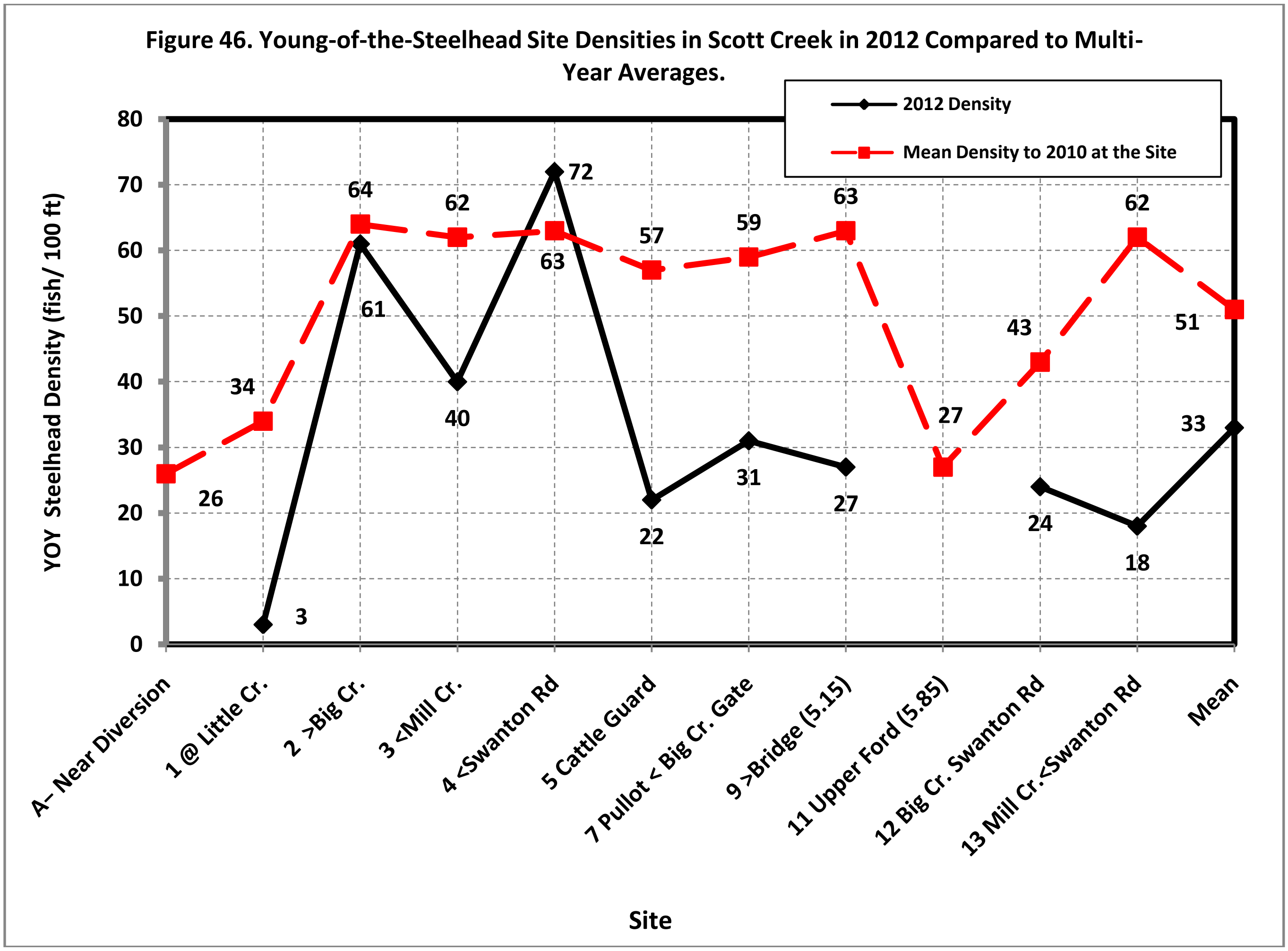


Figure 46. Young-of-the-Steelhead Site Densities in Scott Creek in 2012 Compared to Multi-Year Averages.
2012 Density
Mean Density to 2010 at the Site
YOY Steelhead Density (fish/ 100 ft)
80
70
60
50
40
30
20
10
0
26
34
3
64
61
62
40
72
63
57
22
59
31
63
27
27
43
24
62
18
51
33
A– Near Diversion
1 @ 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

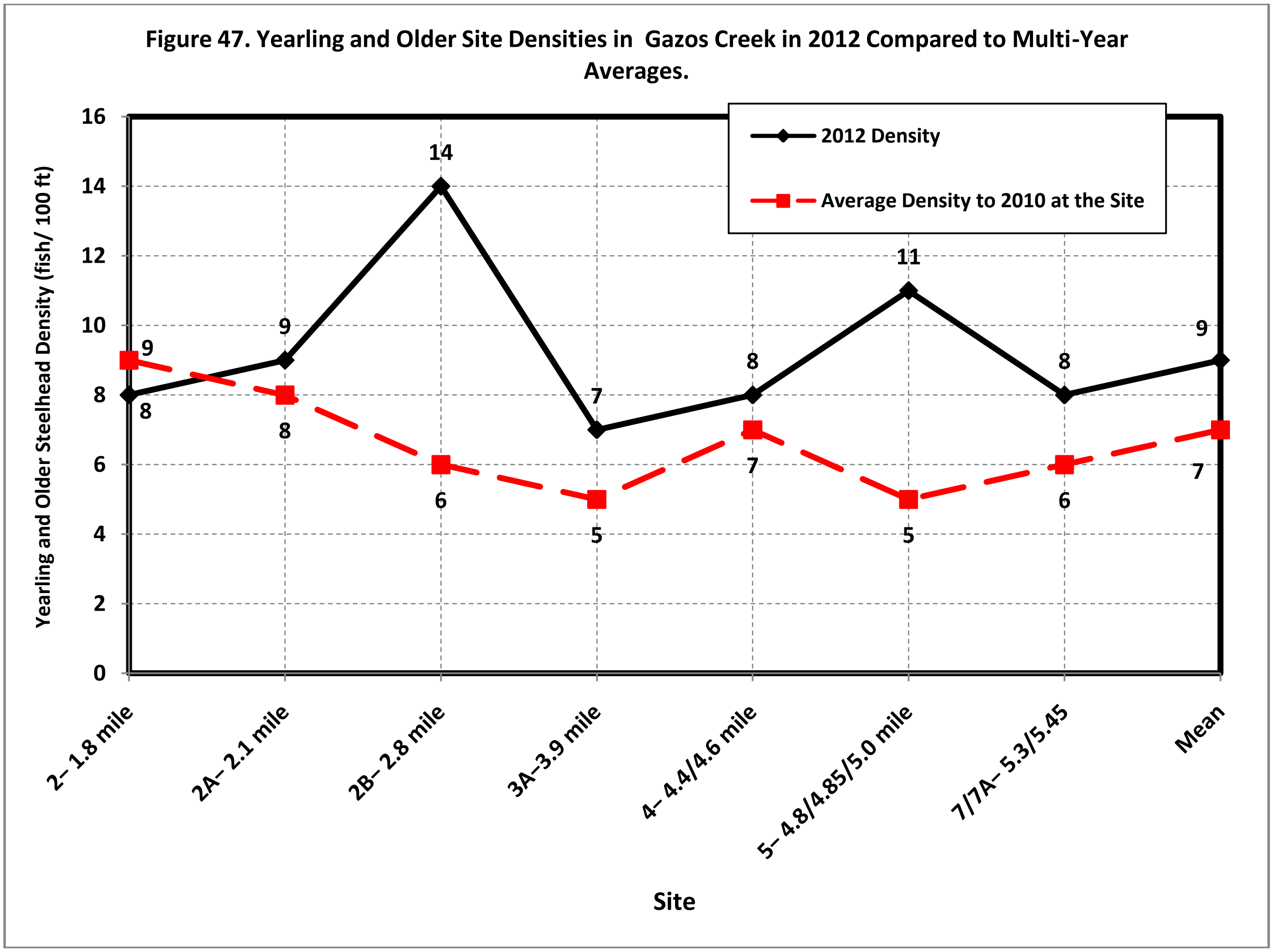


Figure 47. Yearling and Older Site Densities in Gazos Creek in 2012 Compared to Multi-Year Averages.
2012 Density
Average Density to 2010 at the Site
Yearling and Older Steelhead Density (fish/ 100 ft)
0
2
4
6
8
10
12
14
16
2– 1.8 mile
2A– 2.1 mile
2B– 2.8 mile
3A–3.9 mile
4– 4.4/4.6 mile
5– 4.8/4.85/5.0 mile
7/7A– 5.3/5.45
Mean
8
9
14
7
8
11
8
9
9
8
6
5
7
5
6
7
Site

Figure 48. Yearling and Older Steelhead Site Densities in Scott Creek in 2012 Compared to Multi-Year Averages.

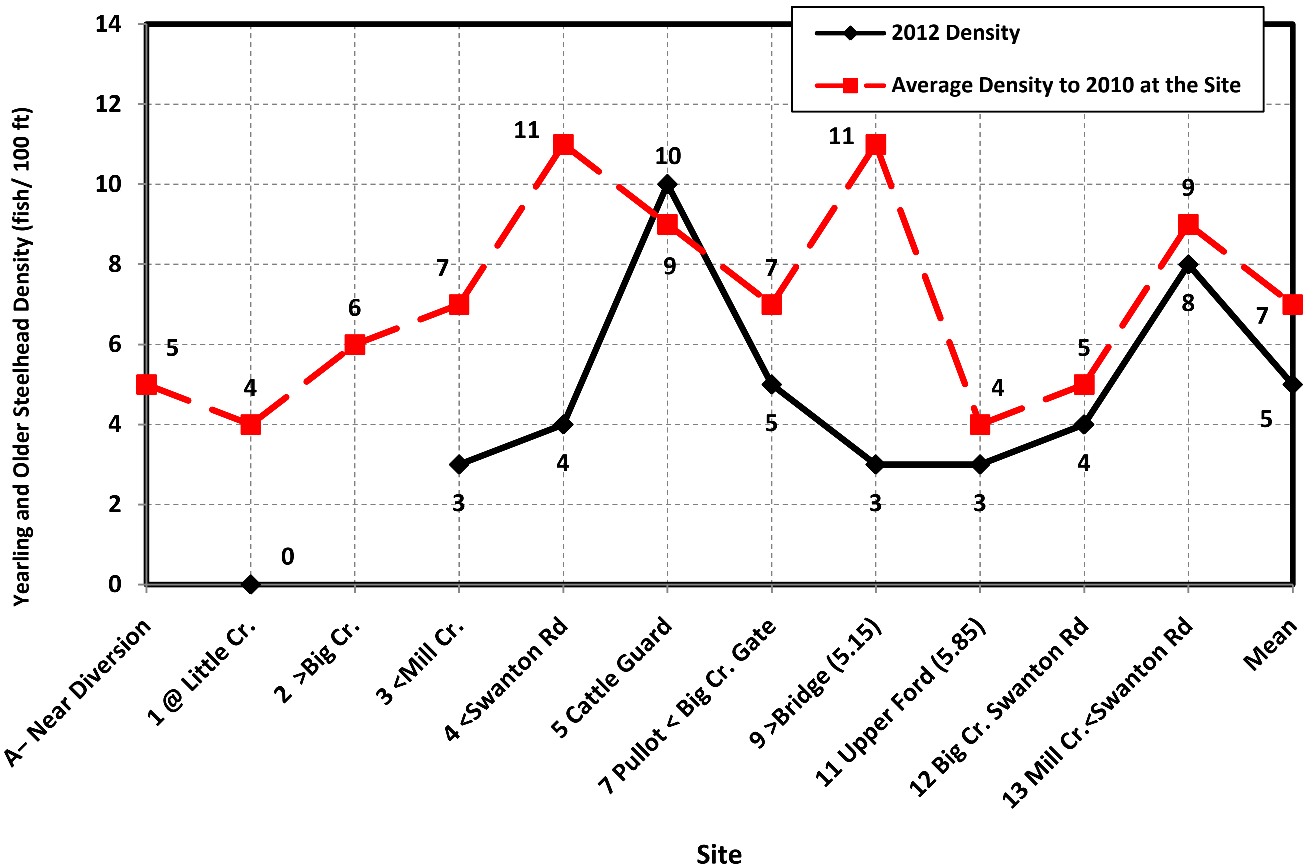


Figure 49. Averages for Young-of-the-Year Steelhead Site Densities in Scott, Waddell and Gazos Creeks, 1988–2012.

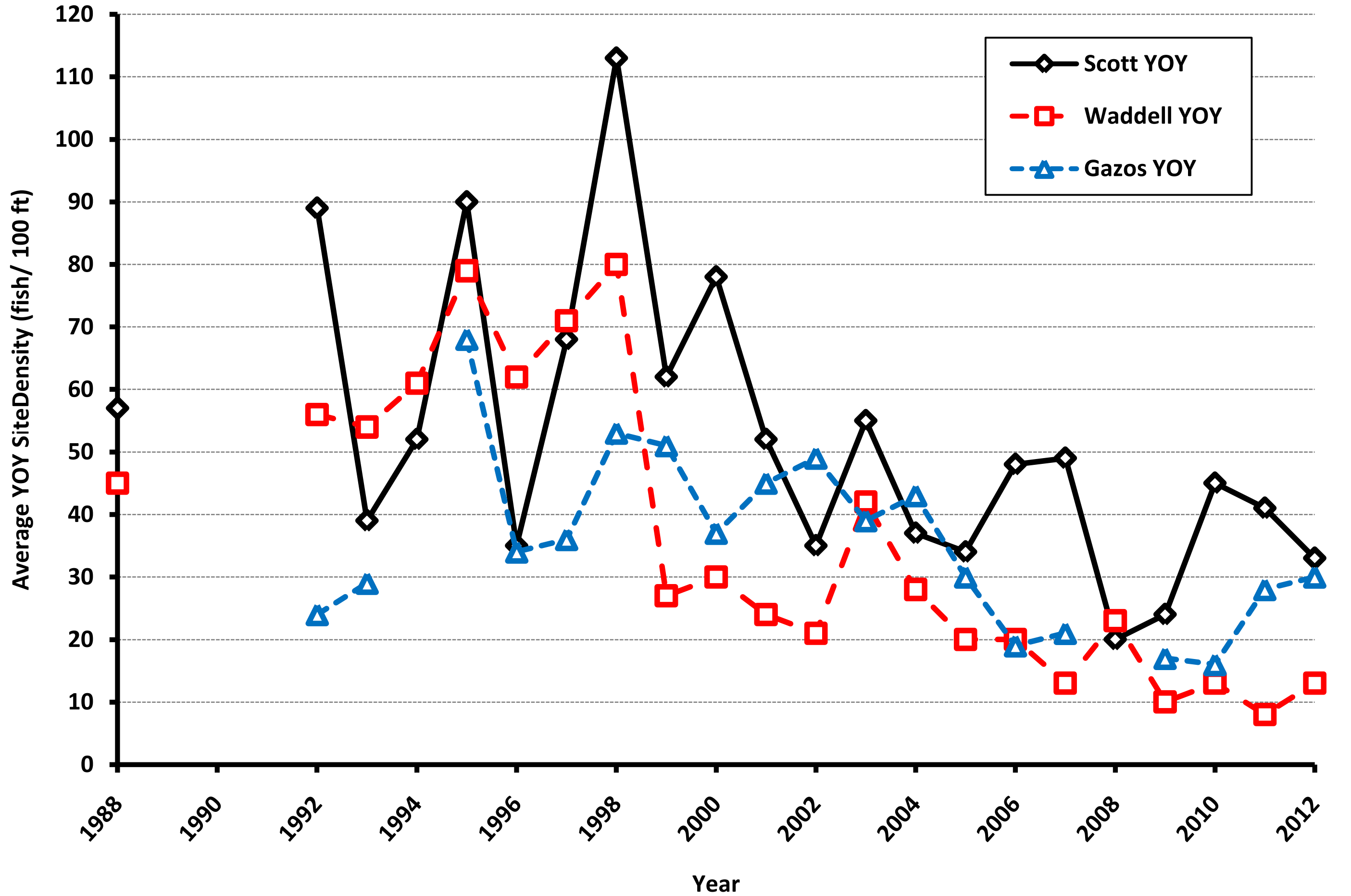
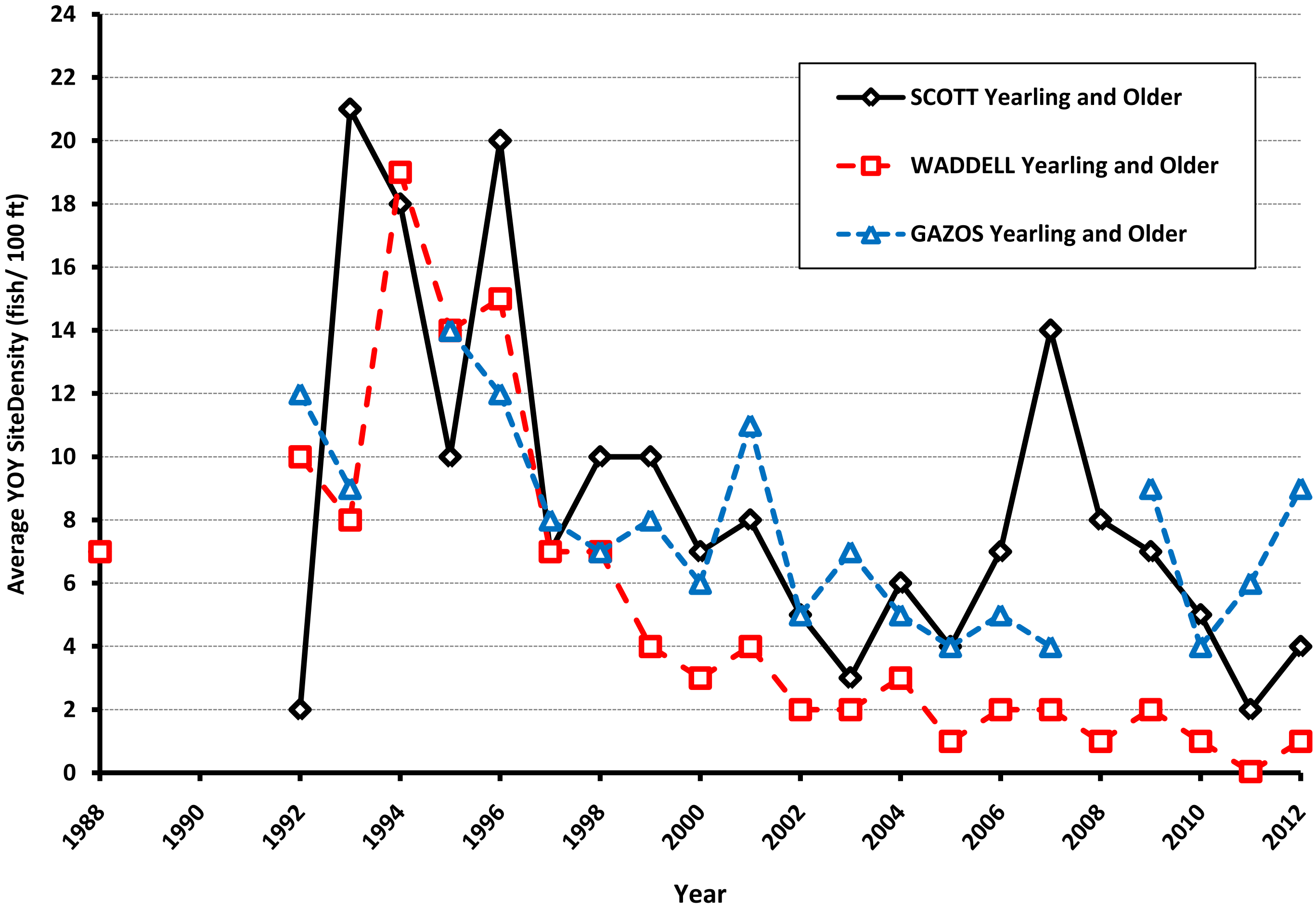


Figure 50. Averages for Yearling and Older Steelhead Site Densities in Scott, Waddell and Gazos Creeks, 1988–2012.



APPENDIX A. Watershed Maps.

Figure 1. Santa Cruz County Watersheds.

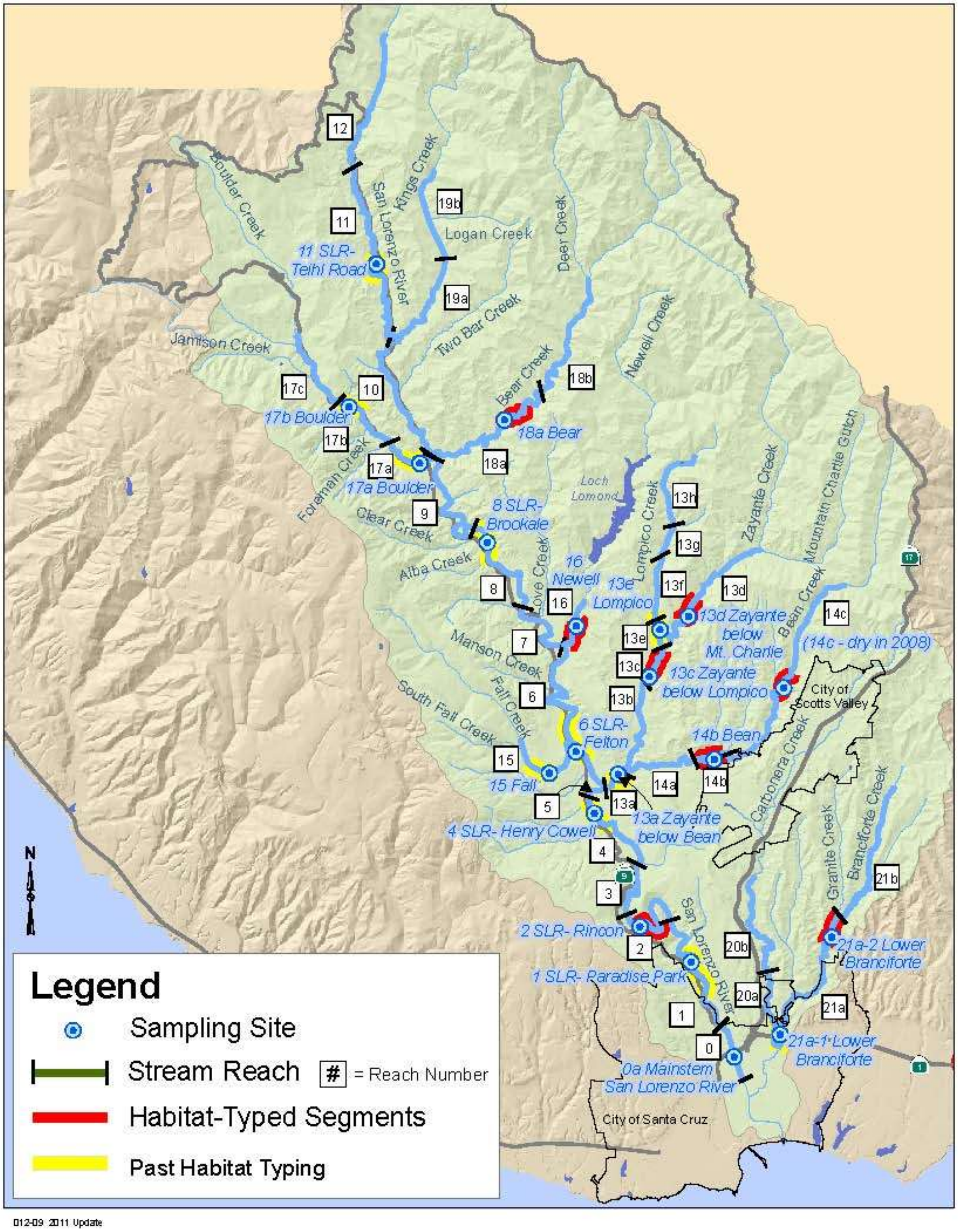
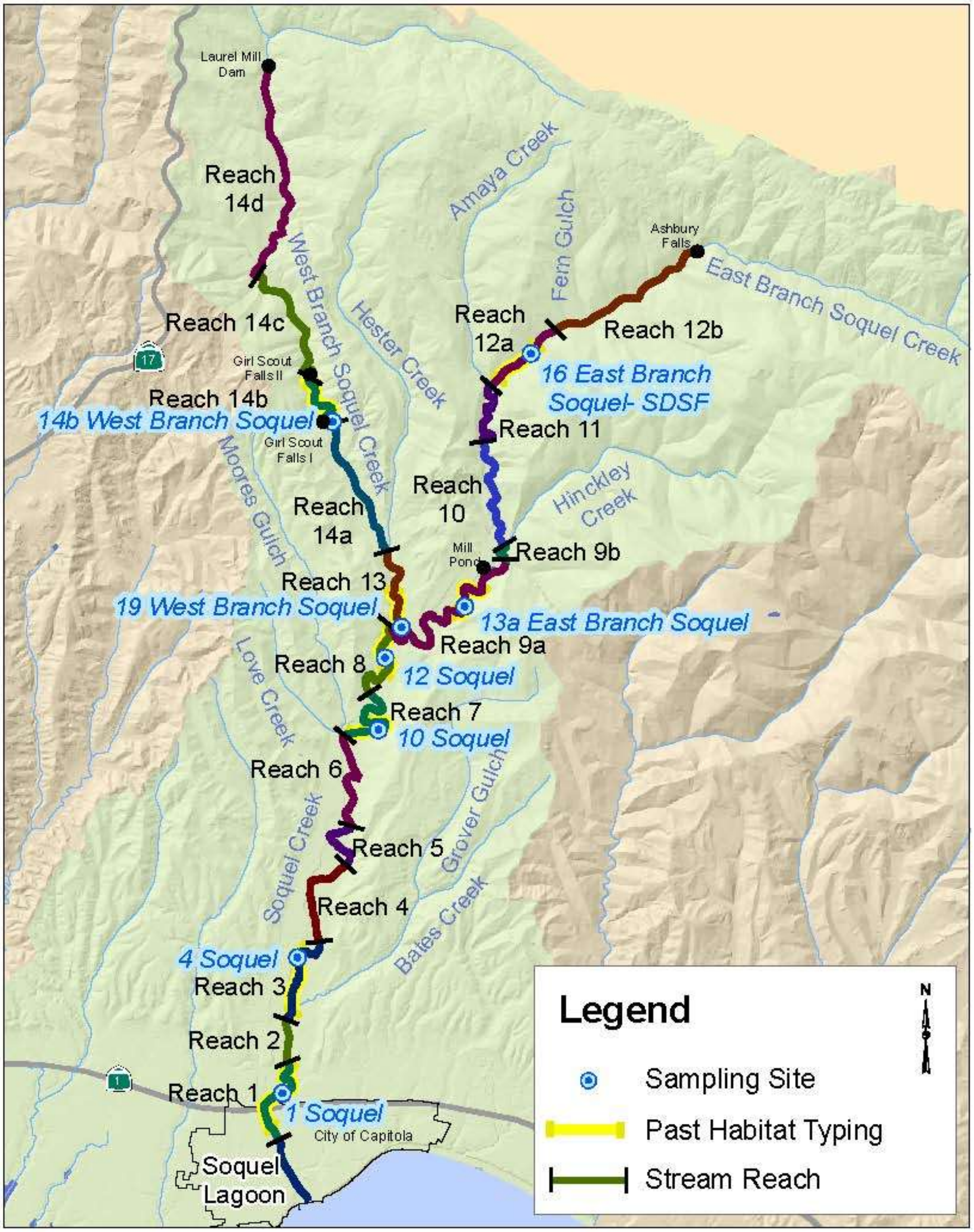
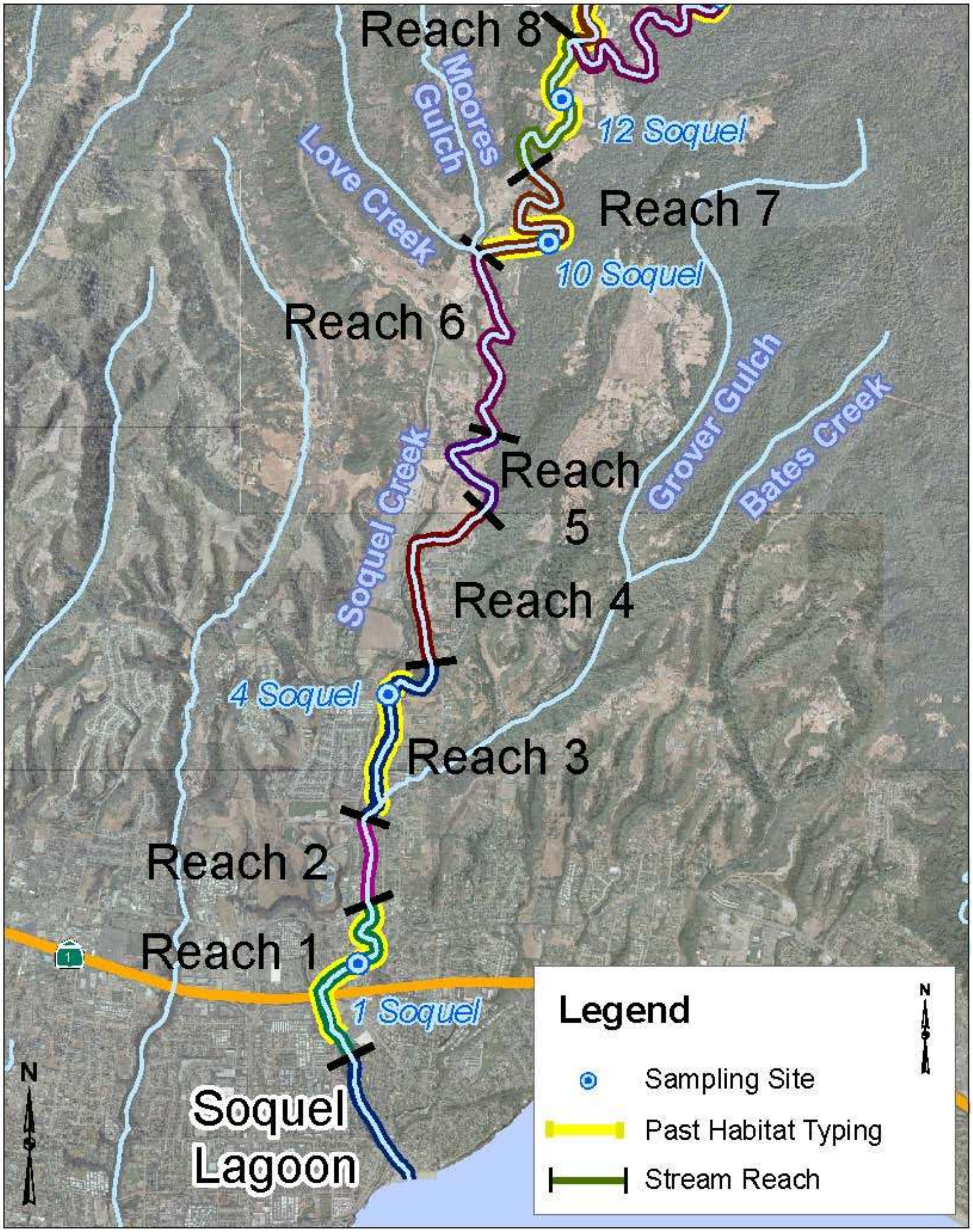


Figure 2. San Lorenzo River Watershed



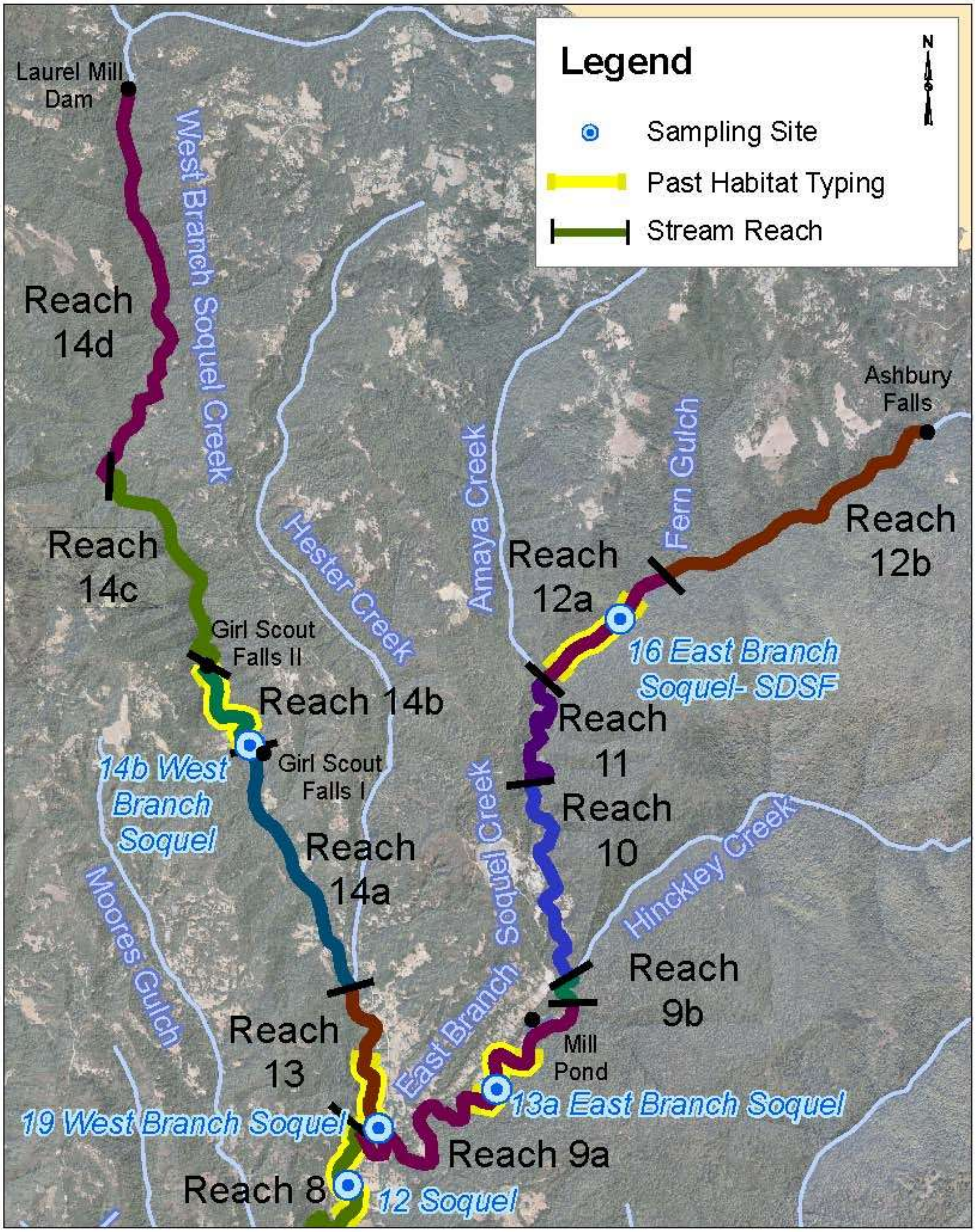
012-09 2011 Update

Figure 3. Soquel Creek Watershed.



012-09 2011 Update

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



012-09 2011 Update

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

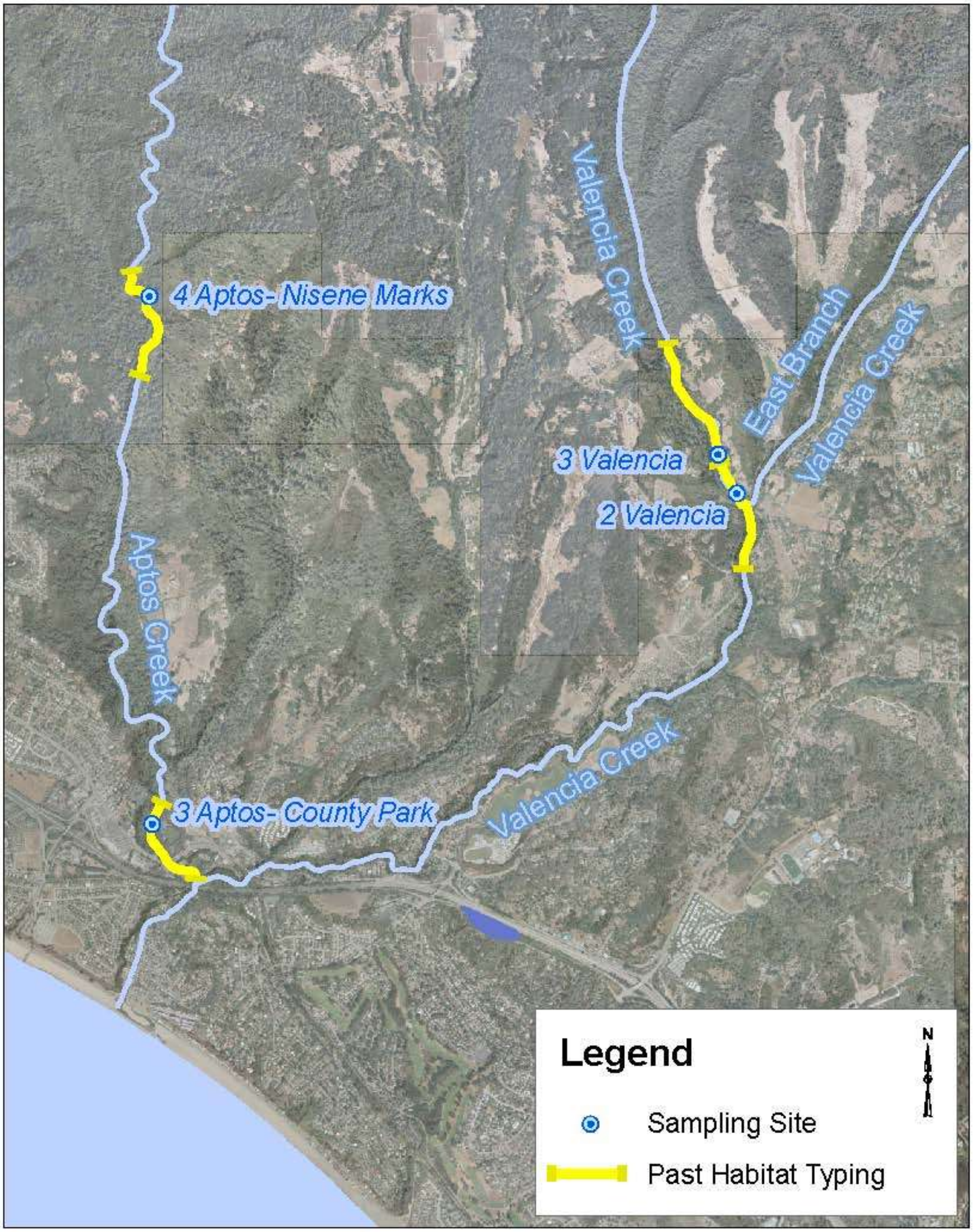


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Figure 6. Map from Smith (1982) with Site #3 designation on Valencia Creek at 2006 location.

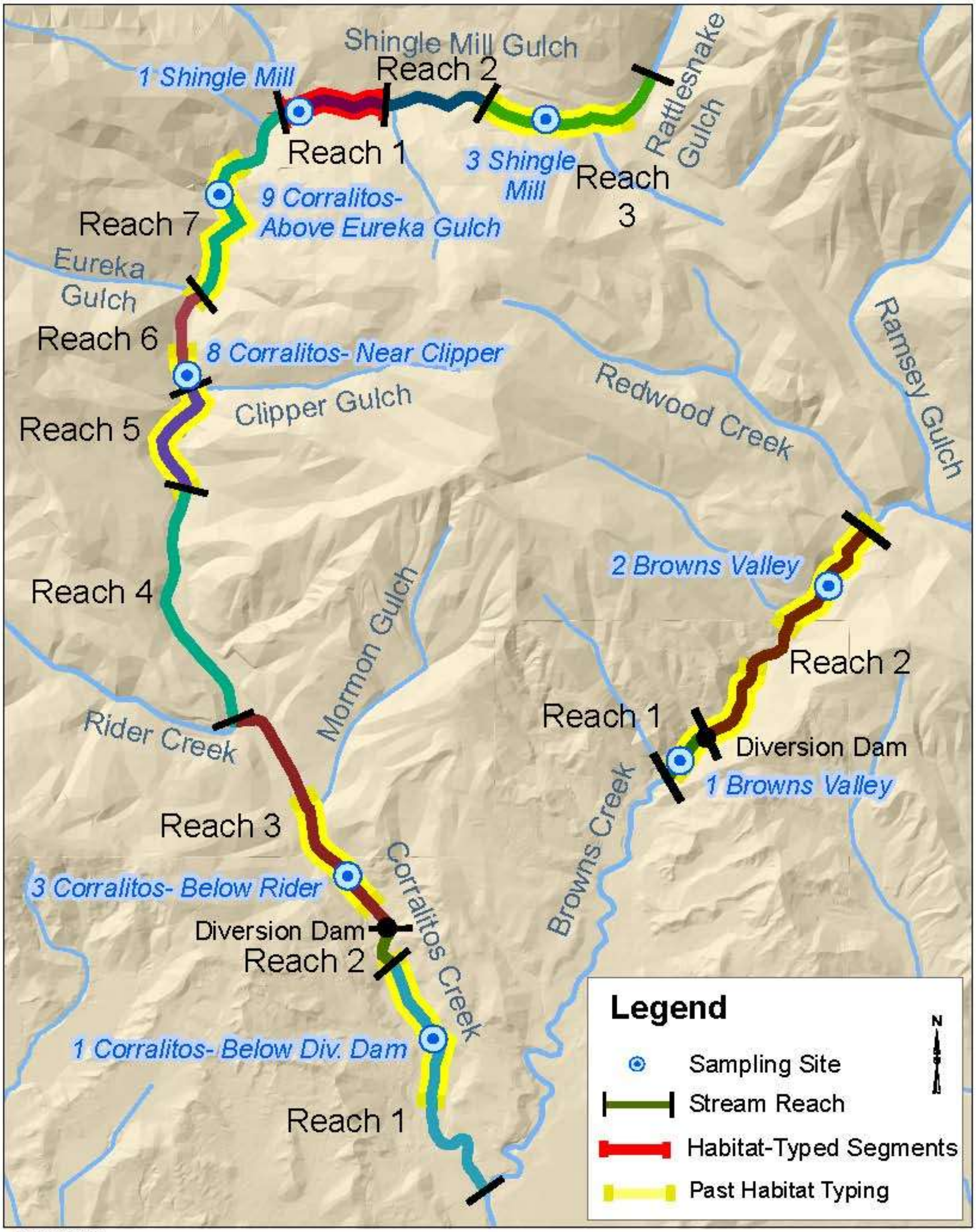

Figure 7. Upper Corralitos Creek Sub-Watershed of the Pajaro River Watershed.

APPENDIX C. Summary of 2012 Catch Data at Sampling Sites.
(Available separately as Excel Files.)

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 2012. 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 2012 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.

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.)