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SCOPE OF WORK

In fall 2013, 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 22 sites. Eight 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 2013. San Lorenzo tributaries included Branciforte, Zayante, Lompico, Bean, Fall, Newell, Boulder and Bear creeks. Sites added in 2013 included Site 9 in the mainstem San Lorenzo and Site 21c in upper Branciforte Creek. Site 14c in Bean Creek could not be sampled because it went dry. In Soquel Creek and its branches, seven steelhead sites were sampled below anadromy barriers, 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 upper 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 1 half-mile reach segment habitat typed below the diversion dam. Two sites were sampled in Shingle Mill Gulch and 2 sites were sampled in Browns Valley Creek with both half-mile reach segments habitat typed. 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─2012. Aptos Creek was previously sampled in 1981, 2006─2012. Fall streamflow was measured at 19 locations in the 4 sampled watersheds. Two half-mile segments were surveyed for riparian and instream wood in the San Lorenzo watershed and one was surveyed in the Soquel watershed. Results may be found in separate report.

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 logjams. 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 challenges 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 fastwater 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 fastwater 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 fastwater 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 "soon-to-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 occurred in 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 2013 fall fish sampling and habitat evaluation included comparison of 2013 juvenile steelhead densities at sampling sites and rearing habitat conditions with those in 1997–2001 and 2003–2012 for the San Lorenzo River mainstem and 8 tributaries and with those in 1997−2012 for the Soquel Creek mainstem and branches. 2013 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 2013 in the Corralitos Creek sub-watershed were compared to those in 1981, 1994 and 2006−2012. Fall 2013 steelhead densities and habitat conditions in the Aptos Creek watershed were compared to those in 1981 and 2006−2013, and the Aptos Lagoon/estuary was inventoried for the third time to compare to previous lagoon population estimates. Findings in Pajaro Lagoon were compared with 2012 sampling results.

In 2013, instream wood was inventoried in Zayante Creek Reaches 13a and 13d and in Soquel Creek Reach 3 to guide the County in choosing potential habitat enhancement projects.

DETAILED METHODS

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

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, 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. 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 2013, sampled tributaries of the San Lorenzo included Zayante, Lompico, Bean, Fall, Newell, Boulder, lower Bear and Branciforte creeks. Refer to **Table 1c, Appendix A, Figure 2** and page 2 for a list of sampling sites and locations in 2013. 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 2013, 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**). A half-mile segment was habitat typed in Reach 1 in 2013. 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 California Salmonid Stream Habitat Restoration Manual (**Flosi et al. 1998**). Some habitat characteristics were estimated according to the manual's guidelines, including length, width, mean depth, maximum depth, shelter rating and tree canopy (tributaries only in 1998). More 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 2013, 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 fastwater 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 fastwater 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, 2005−2013 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 riprap, 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.

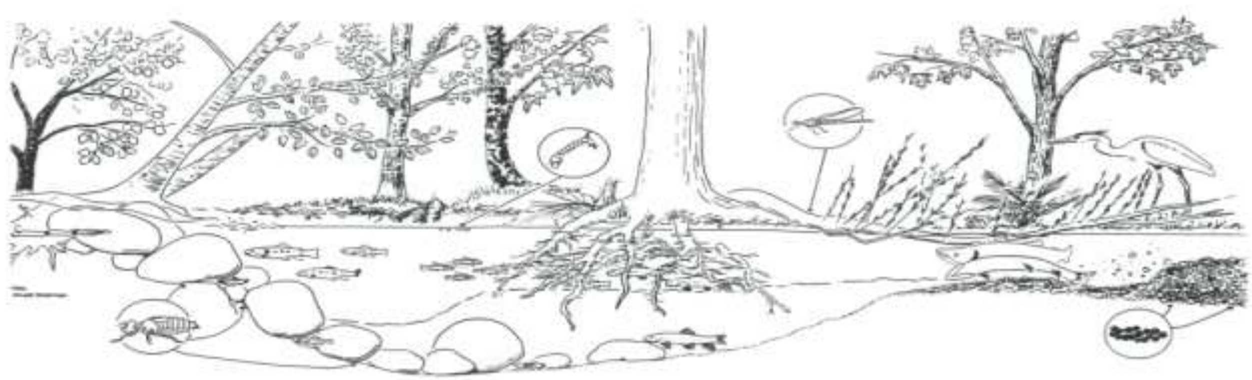


Illustration of pool habitat (stream flowing from left to right) showing escape cover under boulders and undercut bank with tree roots. Juvenile steelhead are feeding at the head of the pool. (Female steelhead covering her redd of eggs after spawning at the tail of the pool.)

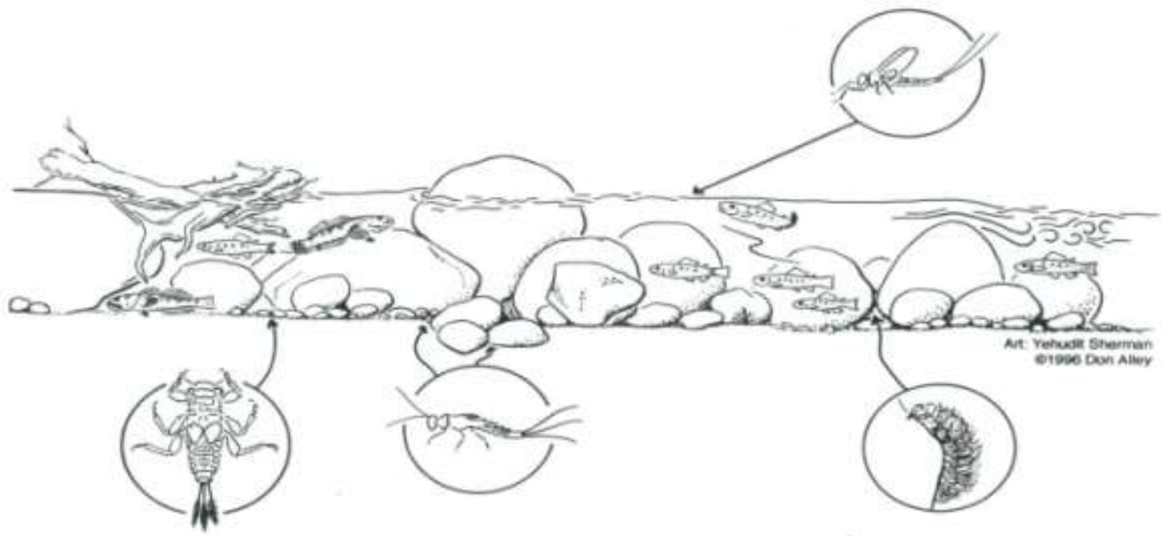


Illustration of riffle habitat (stream flowing from left to right) showing escape cover under rootwad and boulders. (Juvenile steelhead are holding feeding positions, facing upstream.)

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 2010−2013. 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 2003-2013

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 results from both methods. 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 either to be too deep or had too much cover for censusing, creating a bias toward short, shallow pools that would yield higher densities and misrepresent typical long mainstem pool habitat with fewer steelhead. 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 depth constituted significant habitat change in the lower/middle San Lorenzo mainstem below the Boulder Creek confluence. 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 characteristics 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 Steelhead 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 Steelhead 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)

Branciforte 21c*	Tie Gulch Confluence to	

Table 1c. Fish Sampling Sites in the San Lorenzo Watershed.
(2013 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 Gopher 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
21c	*21c-CM5.9	Branciforte Ck, Upstream of Tie Gulch Confluence (resident rainbow trout- steelhead not likely)

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 2013.)

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 2013.)

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 2013.)

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 2003-2013, 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 the lowest baseflow year since sampling began, 2013, only the lower mainstem Sites 0, 1 and 2 of the San Lorenzo River had a high proportion of YOY steelhead reaching Size Class 2 size in one growing season. At Site 4 below Zayante Creek, most YOY were less than 75 mm SL. Only a few YOY reached 75 mm SL in the middle mainstem San Lorenzo (Sites 6, 8 and 9). In the sunny middle Reach 13c of Zayante Creek, very few YOY reached Size Class II, though more than 30% did in the wetter years of 2010 and 2011. The lower mainstem of Soquel Creek showed similar slow growth in 2013, with the majority of YOY being less than 75 mm SL at Sites 1 and 4. The upper mainstem Sites 10 and 12 had only a small proportion of YOY reaching Size Class II. In this monitoring report, sampling site densities were compared for 16 years in the San Lorenzo system by size and age (1997−2001 and 2003−2013) and for 17 years in Soquel Creek (1997−2013). 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 Estuary

Initially on 12 September 2013, steelhead were sampled from 6 seine hauls with a 106-ft long bag seine (6 feet high by 3/8-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 12 September, the periphery of the estuary, east of the rock jetty, was sampled by Alley and Kittleson for tidewater goby and other small fishes with 3 seine hauls, using a 30-foot long beach seine (4 feet high by 1/8-inch mesh). Each seine haul was inspected for tidewater goby, and the fish species composition was determined for the seine hauls, combined. No tidewater goby mortality occurred.

On 19 September 2013, steelhead were again sampled with 7 seine hauls with a 106-ft long bag seine in the main estuary. Steelhead were measured to Standard and Fork Length and checked for fin clips. Scale samples were taken from 4 steelhead greater than 150 mm Standard Length for purposes of determining their age (young-of-the-year or older). Two steelhead escaped after their fins were checked but before they could be measured. No steelhead mortalities occurred. Other species captured with the long seine were identified and counted.

In addition on 19 September, tidewater gobies were sampled by Alley and Kittleson with the 30-foot long beach seine with 5 seine hauls around the estuary periphery (3 hauls east of the rock jetty and 2 hauls west of the jetty and downstream of the walk bridge. 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. No tidewater goby mortality occurred.

M-9. Sampling of Pajaro Estuary

On 4 October 2013, lower Pajaro Estuary was sampled at 8 sites with the 106-foot long seine set by boat. The seine was set 150-200 feet out into the estuary and beached along the inner sandbar that separated the estuary from the Bay. The sandbar was open. Seining locations extended from approximately 50 meters east of Watsonville Slough confluence to the eastern end of the lagoon in approximately evenly spaced intervals. Seining included a relatively deeper area near the confluence of Watsonville Slough and the Pajaro River. Species of fish were identified, counted and released without mortality. GPS readings were taken at 2 of the sites.

On the morning of 7 October 2013, lower Pajaro Estuary was sampled for tidewater gobies at 7 sites along the barrier beach sandbar, using a 30-foot long beach seine (4 feet high by 1/8-inch mesh). The westernmost seine haul was approximately 200 meters east of the Pajaro Dunes development. An eighth seine haul was made at the 2012 sampling location at the boat ramp 0.8 miles upstream of Thurwachter Bridge and 2.9 miles from the beach. Fish species were identified, counted and released without mortality. After seine hauls, water quality was measured at a maximum depth (0.85−1.0 meter depths) as far out from shore as could be waded at sites 1, 4, 7 and 8 in Pajaro Lagoon.

On the morning of 7 October 2013, lower Pajaro Estuary was sampled for tidewater gobies at 7 sites along the barrier beach sandbar, using a 30-foot long beach seine (4 feet high by 1/8-inch mesh). GPS was taken at each site. The westernmost seine haul was approximately 200 meters east of the Pajaro Dunes development. An eighth seine haul was made at the boat ramp 0.8 miles upstream of Thurwachter Bridge and 2.9 miles from the beach (N36.88450; W121.78142). Fish species were identified, counted and released without mortality. After seine hauls, water quality was measured at a maximum depth (0.85−1.0 meter depths) as far out from shore as could be waded at sites 1, 4, 7 and 8 in Pajaro Lagoon.

On 8 October 2013, sampling for steelhead was attempted at the 2 sites used in 2012 in the upper Pajaro Lagoon, upstream of the Watsonville Slough confluence. The lagoon was relatively full, and these were the only locations where the 106-ft long bag seine (6 feet high by 3/8-inch mesh) could be adequately beached after being set with a boat. Three seine hauls were made at the lower site. This 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).Species of fish were identified, counted and released without mortality. Water quality (oxygen concentration, temperature, salinity and conductivity) was measured in the center of the channel from the boat at this site. One seine haul was attempted at the upper site. However, the volume of detritus collected in the seine made it impossible to beach effectively. The decision was made to discontinue sampling at this site. It was located under the Thurwachter Bridge (2.1 miles upstream of Watsonville Slough (N36.88023; W121.79328)).

DETAILED RESULTS

R-1. Capture and Mortality Statistics

For the overall sampling activities in 2013, a total of 4,352 juvenile steelhead were captured by electrofishing at 39 sites, with 40 mortalities (0.92% mortality rate- less than 1%). In Aptos Lagoon/Estuary, 33 juvenile steelhead were captured on 2 days with no mortality. No steelhead were captured in Pajaro Lagoon. A total of 38 juvenile steelhead were visually censused in pools at 6 San Lorenzo mainstem sites. Nine mainstem sites and 13 tributary sites were sampled in the San Lorenzo watershed in 2013, with a total of 2,692 juvenile steelhead captured and 29 mortalities (1.08%). A total of 1,004 juvenile steelhead were captured at 7 sites in the Soquel watershed in 2013 with 8 mortalities (0.80%). A total of 134 juveniles steelhead were captured by electrofishing in the Aptos Watershed at 2 Aptos sites without mortality. A total of 522 juveniles were captured in the Corralitos watershed at 8 sites with 3 mortalities (0.57%). Small YOY steelhead were numerous in 2013, and they were more vulnerable to electrofishing mortality than larger fish.

R-2. Habitat Change in the San Lorenzo River Mainstem and Tributaries, 2012 to 2013

Refer to **Appendix A** for maps of reach locations. Summary tables of habitat change for all reaches are provided in **Tables 13b and 40**. 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 2013 were much below the median daily statistic for baseflow from May through the summer, the lowest 17 years of calculations (**Figure 42**), and they were less than in the dry 2012 year (**Figures 33, 34a−b**). Two major stormflows (well above bankfull) occurred in December 2012 (7,340 and 12,100 cfs at Big Trees gage) with only three very minor stormflows (less than 200 cfs at Big Trees gage) after that in March through early May (**Figure 35**). Lower baseflow in 2013 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 2013 (**Figures 21 and 23**). The average mean monthly streamflow for May−September in 2013 at the Big Trees gage was the lowest in 17 years of calculations (16 cfs with a 17-year average of 38 cfs) (**Figure 42**). High total densities of relatively small fish were caused by higher YOY densities at some sites and likely some late spawning (**Figures 2;** fish size histograms in **Appendix D**). Slower YOY growth was exemplified by the lower percent of YOY reaching Size Class II in 2013 compared to those during the relatively dry 2012 at sites with comparable YOY densities (**Figure 17a**) and during the wetter year of 2011 year (**Figure 17b**).

In 2013, habitat typing occurred only in Reaches 2 and 9 in the mainstem and Reaches 13d, 14b, 17a, 17b, and 21b in the tributaries. Therefore, other reaches were evaluated according to habitat changes at sampling sites. Rearing habitat quality declined at the majority of sites in 2013 due to decreased streamflow (less food), shallower habitat and often less escape cover. Exceptions to the shallowing trend occurred where good scour objects existed and sediment was transported out by the large December storms, except for Site 0a between the levees where the hydraulic control changed. Of the 21 sites/reaches examined in the San Lorenzo drainage, 6 had deeper pool habitat than the previous data collection time, despite lower baseflow. This occurred in the mainstem *San Lorenzo 0a* site (change in hydraulic control), *Lompico 13e* site (bedrock scour), middle *Bean 14b* reach (large wood scour), *Newell 16* site (scour from large wood and large boulders), *Bear 18* site (bedrock scour), *Branciforte 21b* reach (boulder and bedrock scour.

Overall habitat quality improved in Reach 0a due to deeper pool habitat with a major change in geomorphology and hydraulic control. More escape cover was created by floating vegetative mats, although baseflow during spring/early summer was low and fastwater habitat was reduced (**Figures 34a−b, 35; Tables 6a-b, 7a-b, 8a-b, 9a-b and 13b**). Inconsistent with improved habitat at Site 0a, density of large YOY was less than in 2012 and below average (**Tables 18 and 21; Figures 2 and 4**). Not all YOY reached Size Class II at Site 0a, unlike previous years. The shortage of fastwater habitat may have contributed to slower growth of some YOY and lower steelhead density there (**Figure 17a**). In San Lorenzo tributaries, habitat quality improved at the following sites despite lower baseflow (except similar baseflow at Newell 16 below the dam); Lompico 13e, Newell 16, Bear 18a and Branciforte 21a-2 (**Tables 5a−b, 12a−b, 13a−b**). In other reaches and sites, habitat quality declined with generally decreased habitat depth and reduced baseflow (**Table 13b**). Percent fine sediment was similar or increased in the mainstem and eastside tributaries. The same was true for fines in west side tributaries except improvement in pools at the Newell and Fall creek sites. There was substantially more fine sediment in pools of both reaches in Boulder Creek since 2008 and 2009. Generally, embeddedness was similar or improved in 2013except for pools in Newell Creek and fastwater habitat in the middle San Lorenzo (Sites 6 and 8).

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	2013
1- SLR/ Paradise Pk	22.9	25.5	34.3	26.2	21.7	19.6				26.2	18.7	27.6	17.2	12.9
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	1.7
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	0.38
12a- SLR/Lower Waterman G			1.0	0.7										0.33
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	3.9
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	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	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	1.1
18a/ Bear				0.45	0.61	0.34	0.6	0.51	0.90	1.1	0.68	1.3	0.23	0.16
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	0.29

*Streamflow in lower Zayante Creek done 3 weeks earlier in 2006 than usual and before other locations.

Table 5b. Fall/Late Summer STREAMFLOW (cubic feet/ sec) Measured by Santa Cruz County Staff in 2006−2013 and from Stream Gages; Measurements by D.W. ALLEY & Associates; 2010 (September), 2011−2013 (October) at fall baseflow conditions, County Staff (Date stipulated).

Location	2005	2006	2007	2008	2009	2010	2011	2012	2013
SLR at Santa Cruz Gage	13 (25 Oct)	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)	5.6 (23 Oct) 9.1 (27 Oct) 3.2 (7 Jan 14
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)	12.9 Paradise P. (DWA)
SLR at Big Trees Gage	22 (25 Oct)	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)	11.0 (27 Oct)
SLR above Love Cr		13.14	5.4 After*	3.8	–	6.7 (9/7)			4.68 (8/14)
SLR below Boulder Cr		7.49	2.9 After	3.1	–	5.9 (9/7)			1.75 (8/15)
SLR @ Two Bar Cr		1.8	0.78	0.39	–	2.0 (8/4)	2.4 (8/16)	1.46 (8/1)	0.32 (10/10)
SLR @ Teihl Rd						0.97 (DWA)	1.1 (DWA)	0.40 (DWA)	0.38 (DWA)
Zayante Cr @ 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)	3.9 Below Bean (DWA) 4.9 (10/10)
Zayante Cr below Lompico Cr		1.2	0.96	0.41	0.43	1.51 (8/24)			0.47 (8/15)
Lompico Cr @ Carrol Ave							0.3 (8/10)	0.39 (6/13) 0.26 (8/2)	0.18 (6/13)
Bean Cr adjacent Mt. Hermon		2.6	1.9	2.1	2.2	3.1 (9/2)	3.5 (8/25)		2.27 (8/13)
Bean Cr Below Lockhart Gulch		1.4	0.72	0.79	0.89	0.68 (9/2)			0.83 (8/13)
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)	0.78 (DWA) 1.05 @ mouth (10/9)
Boulder Cr @ SLR		2.19	0.84	1.0	0.97	1.6 (DWA)	2.2 (DWA); 2.6 (8/17)	1.3 (DWA)	1.1 (DWA) 0.81 (10/10)
Bear Cr above Hopkins Gulch						0.68 (DWA)	1.3 (DWA)	0.23 (DWA)	0.16 (DWA)
Bear Cr @ SLR		1.9	0.37	0.27	–	1.6 (8/4)	2.0 (8/16)	0.69 (8/1)	0.19 (10/10)
Branciforte @ Isabel Lane				0.3	0.25	0.42 (8/26)		0.57 (8/22)	0.59 (6/20)
Soquel Cr above Lagoon						2.3(DWA)	4.9 (DWA)	1.8 (DWA)	0.33 (DWA)
Soquel Cr @ USGS Gage	5.0**	6.6**	1.4**	0.65**	1.2**	3.4**	5.8**	1.8**	0.36**
Soquel Cr @ Bates Cr		5.73	-	1.08		4.2 (9/1)	7.3 (8/31)	2.0 (9/19)	0.95 (9/11)
Soquel Cr above Moores Gulch						2.16 (DWA)	4.3 (DWA)	2.0 (DWA)	1.26 (DWA)
W. Branch Soquel Cr @ 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)	0.91 @ Mouth (DWA) 1.73 (5/14)

Location	2005	2006	2007	2008	2009	2010	2011	2012	2013
W. Branch Soquel Cr above Hester Creek (SCWD Weir/ Kraeger- prelim.)		1.5 (15 Sep)	1.0 (15 Sep)	–	–	–	–	–	–
E. Branch Soquel Cr @ 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)	0.16 @ Mouth (DWA) 2.0 (5/14)
E. Branch Soquel Cr below Amaya and above Olive Springs Quarry (SCWD Weir/ Kraeger- prelim.)		1.5 (15 Sep)	0.43 (15 Sep)	–	–	–	–		
E. Branch Soquel Cr above Amaya Creek					Trickle (DWA)	0.44 (DWA)			0.03 (DWA)
Aptos Cr below Valencia Cr		2.5	1.2 After	0.77	0.53	0.85 (9/1)		0.87 (DWA); 1.10 (9/05)	0.75 (DWA) 0.84 (9/11)
Aptos Cr 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)	0.105 (9/11)
Valencia Cr 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)		0.10 (9/5) Below Browns Cr.
Corralitos Cr above Los Casinos Road Bridge						2.0 (DWA)	2.6 (DWA)	2.0 (DWA)	1.54 (DWA)
Corralitos Cr @ Rider Cr		3.35	2.5 After	1.44	–	2.4 (9/2)		1.73 (9/13)	1.12 (9/5)
Corralitos above Eureka Gulch						0.63 (DWA)	0.71 (DWA)	0.23 (DWA)	0.16 (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)	0.10 (DWA) 0.21 (9/5)

* 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 2013 and Most Recent Preceding Year.

Reach	2012 Pool Habitat In Feet/ Percent / # Habitats	2013 Pool Habitat In Feet/ Percent / # Habitats	2012 Riffle Habitat Feet/ Percent / # Habitats/ Riffle Width (ft)	2013 Riffle Habitat Feet/ Percent / # Habitats/ Riffle Width (ft)	2012 Run/Step-run/ Glide Habitat Feet/ Percent / # Habitats/ Width (ft)	2013 Run/ Step-run Habitat Feet/ Percent / #Habitats/ Width (ft)
Low. San Lorenzo #2	1912/55%/ 9	1879/57%/ 10	1065/ 31%/ 14/ 29 ft	853/ 26%/ 13/ 29 ft	493/ 14%/ 10/ 26 ft	554/ 17%/ 7/ 28 ft
Middle San Lorenzo # 9	2414/73%/ 21	2525/83%/ 10	372/ 12%/ 7/ 14 ft	372/ 12%/ 7/ 14 ft	510/ 15%/ 13/ 11 ft	160/5%/ 3/ 20 ft
Zayante #13d	1587/61%/ 31	1901/75%/ 38	262/ 7%/ 10/ 7 ft	135/ 5%/ 6/ 5 ft	740/ 29%/ 16/ 12 ft	503/ 20%/ 14/ 8 ft
Bean #14b	2130/71%/ 32	2036/69%/ 26	541/ 18%/ 18/ 8 ft	424/14%/ 15/ 11 ft	314/ 11%/ 6/ 13 ft	503/17%/ 7/ 12 ft
Boulder #17a	(2009) 1489/52%/ 17	1769/ 64%/ 18	(2009) 234/ 8%/ 9	251/ 9%/ 12/ 14 ft	(2009) 1136/40%/ 15	759/ 27%/ 12/ 20 ft
Boulder #17b	(2008) 1554/ 66%/ 25	1749/ 74%/ 28	(2008) 127/ 5%/ 6	243/ 10%/ 10/ 10 ft	(2008) 682/ 37%/ 13	360/ 15%/ 8/ 14 ft
Branciforte #21b	1122/ 64%/ 21	1422/ 53%/ 20	184/ 11%/ 14/ 9 ft	520/ 20%/ 23/ 8 ft	445/ 25%/ 9/ 9 ft	722/ 27%/ 18/ 8 ft
Branciforte #21c		1919/ 67%/ 28		501/ 17%/ 17/ 4.5 ft		452/ 16%/ 10/ 7 ft
Soquel #3	(2011) 2407/66%/ 14	2524/71%/ 14	(2011) 480/13%/ 12/ 18 ft	604/ 17%/ 15/ 16 ft	(2011) 783/21%/ 8/ 19 ft	404/ 11%/ 8/ 16 ft
Soquel #8	(2011) 1729/61%/ 9	2007/ 70%/ 13	(2011) 576/20%/ 14/ 19 ft	483/ 17%/ 11/ 10 ft	(2011) 507/18%/ 6/ 15 ft	357/ 13%/ 5/ 14 ft
Soquel #9a	(2011) 1575/55%/ 14	1580/ 55%/ 17	(2011) 774/27%/ 15/ 16 ft	213/ 7%/ 10/ 7 ft	(2011) 487/17%/ 9/ 18 ft	1059/ 37%/ 14/ 11 ft
Soquel #12a	973/ 38%/ 18	1431/ 57%/ 30	303/ 12%/ 9/ 8 ft	187/ 7%/ 8/ 5 ft	1312/ 51%/ 18/ 10 ft	911/ 36%/ 15/ 6 ft
Aptos #3	2025/ 78%/ 20	2108/ 79%/ 22	374/ 14%/ 15/ 15 ft	332/ 12%/ 18/ 16 ft	182/ 7%/ 7/ 9 ft	231/ 9%/ 7/ 11 ft
Corralitos #1	(2009) 1135/ 59%/ 17	1418/ 71%/ 22	(2009) 483/ 25%/ 17/ 11 ft	388/ 20%/ 17/ 12 ft	(2009) 321/ 16%/ 5/ 18 ft	181/ 9%/ 6/ 15 ft
Browns #1	(2009) 1512/ 58%/ 31	1580/ 61%/ 32	(2009) 539/ 21%/ 24/ 8 ft	420/ 16%/ 22/ 9 ft	(2009) 556/ 21%/ 15/ 9 ft	276/ 11%/ 13/ 11 ft
Browns #2	(2009) 1655/ 63%/ 42	1638/ 68%/ 39	(2009) 537/ 20%/ 31/ 7.5 ft	505/ 21%/ 30/ 7 ft	(2009) 441/ 17%/ 21/ 7 ft	276/ 11%/ 13/ 8 ft

Table 6a. Averaged Mean and Maximum WATER DEPTH in SAN LORENZO Reaches Since 2007.

Reach	Pool 2007	Pool 2008	Pool 2009	Pool 2010	Pool 2011	Pool 2012	Pool 2013	Riffle 2007	Riffle 2008	Riffle 2009	Riffle 2010	Riffle 2011	Riffle 2012	Riffle 2013	Run/ Step Run 2007	Run/ Step Run 2008	Run/ Step Run 2009	Run/ Step Run 2010	Run/ Step Run 2011	Run/Step Run 2012	Run/Step Run 2013
1- L. Main	1.8/ 3.0	1.85/ 3.4						0.8/ 1.2	0.7/ 1.2						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	2.6/ 4.6	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	0.9/ 1.5	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**	**1.5/ 2.4**
3- L. Main																					
4- L. Main	1.9/ 3.8	2.0/ 3.6						0.7/ 1.2	0.5/ 1.0						1.4/ 2.1	0.9/ 1.5					
5- L. Main																					
6- M. Main	1.7/ 3.4	1.6/ 3.1						0.6/ 1.0	0.55/ 0.9						0.9/ 1.3	0.8/ 1.1					
7- M. Main																					
8- M. Main	2.3/ 4.3	2.3/ 4.7	2.8/ 5.1					0.6/ 1.0	0.45/ 0.7	0.65/ 1.0					0.8/ 1.2	0.8/ 1.2	0.7/ 1.0				
9- M. Main	1.9/ 3.5 (2005)						1.8/ 3.5	0.7/ 1.1 (2005)						0.4/ 0.7	1.0/ 1.4 (2005)						**0.5/ 0.9**
10- U. Main																					
11- U. Main	1.0/ 1.9	0.9/ 1.8	1.05/ 1.8			1.1/ 2.0		0.2/ 0.4	0.25/ 0.5	0.25/ 0.4			0.3/ 0.5		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**	
Zayan- te 13a	1.4/ 2.2	1.5/ 2.5						0.5/ 0.8	0.4/ 0.8						0.6/ 1.0	0.6/ 0.9					
Zayan- te 13b																					
Zayan- te 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		
Zayan- te 13d	1.0/ 1.5	1.0/ 1.55	0.9/ 1.5	1.2/ 2.0	1.3/ 2.0	1.1/ 1.8	1.0/ 1.6	0.3/ 0.5	0.2/ 0.5	0.25/ 0.5	0.4/ 0.6	0.45/ 0.8	0.3/ 0.6	0.3/ 0.5	0.6/ 1.0	0.5/ 0.9	0.55/ 0.9	0.7/ 1.1	0.8/ 1.2	**0.6/ 1.0**	**0.5/ 0.9**

Reach	Pool 2007	Pool 2008	Pool 2009	Pool 2010	Pool 2011	Pool 2012	Pool 2013	Rif-fle 2007	Rif-fle 2008	Rif-fle 2009	Rif-fle 2010	Rif-fle 2011	Riffle 2012	Riffle 2013	Run/ Step Run 2007	Run/ Step Run 2008	Run/ Step Run 2009	Run/ Step Run 2010	Run/ Step Run 2011	Run/Step Run 2012	Run/Step Run 2013
Lom-pico 13e	0.8/ 1.5	1.0/ 1.7						0.15 /0.4	0.1/ 0.3						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	1.0/ 1.9	0.2/ 0.4	0.2/ 0.4	0.2/ 0.4	0.2/ 0.4	0.3/ 0.6	0.3/ 0.5	0.3/ 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**	**0.4/ 0.7**
Bean 14c	0.8/ 1.5	0.9/ 1.7		0.9/ 1.6	1.0/ 1.8			0.03 /0.1	0.03/ 0.1		0.1/ 0.2	0.2/ 0.4			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			1.3/ 2.4	1.5/ 2.5	1.4/ 2.3					0.25/ 0.45	0.3/ 0.5	0.3/ 0.5					0.4/ 0.7	0.4/ 0.8	0.5/ 0.8		
Boul-der 17a	1.7/ 2.7	1.6/ 2.6	1.8/ 2.9				1.4/ 2.4	0.4/ 0.7	0.4/ 0.7	0.35/ 0.7				0.4/ 0.7	0.6/ 1.0	0.6/ 0.95	0.65/ 1.05				**0.6/ 1.0**
Boul-der 17b	1.6/ 2.7	1.5/ 2.7					1.4/ 2.4	0.4/ 0.75	0.3/ 0.6					0.4/ 0.8	0.6/ 1.1	0.55/ 0.95					**0.55/ 1.0**
Boul-der 17c																					
Bear 18a	1.4/ 2.4	1.3/ 2.55				1.4/ 2.2		0.2/ 0.4	0.2/ 0.4				0.2/ 0/4		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	1.0/ 1.7	0.9/ 1.7	1.0/ 1.8	1.0/ 1.9				0.2/ 0.4	0.2/ 0.35	0.2/ 0.35	0.2/ 0.4				0.4/ 0.7	0.45/ 0.65	0.45/ 0.65	0.5/ 0.8			
Branci-forte 21b						1.1/ 1.9	1.2 2.0						0.2/ 0.45	0.3/ 0.5						**0.4/ 0.8**	**0.4/ 0.7**

Table 6b. Averaged Mean and Maximum WATER DEPTH (ft) at REPLICATED San Lorenzo Sampling Sites in 2009−2013.

Site	Pool 2009	Pool 2010	Pool 2011	Pool 2012	Pool 2013	Riffle 2009	Riffle 2010	Riffle 2011	Riffle 2012	Riffle 2013	Run/Step Run 2009	Run/Step Run 2010	Run/Step Run 2011	Run/Step Run 2012	Run/Step Run 2013
0a	1.8/ 3.2	1.2/ 2.2	1.6/ 2.0	1.3/ 2.5	2.2/ 3.5	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	–	**1.8/ 3.0**
1						0.8/ 1.1	0.9/ 1.45	1.15/ 1.6	0.9/ 1.5	0.9/ 1.4	1.2/ 1.7	1.3/ 1.9	1.6/ 2.1	**1.1/ 1.7**	**1.3/ 1.9**
2								1.3/ 1.5	1.1/ 1.5	1.0/ 1.8			1.7/ 2.95	**1.9/ 2.6**	**1.9/ 2.5**
4						0.55/ 0.9	0.55/ 0.9	0.85/ 1.1	0.6/ 1.0	0.6/ 0.9	0.8/ 1.35	1.1/ 2.2	1.55/ 2.0	**1.2/ 1.65**	**1.3/ 1.6**
6						0.5/ 0.7	0.65/ 0.8	0.65/ 1.0	0.6/ 1.05	0.5/ 0.9	0.6/ 1.1	0.6/ 1.2	0.7/ 1.2	**0.7/ 1.1**	**0.75/ 1.05**
8						0.65/ 0.9	0.8/ 1.0	0.9/ 1.2	0.7/ 1.1	0.6/ 1.1	0.85/ 1.0	0.95/ 1.2	1.0/ 1.3	**0.8/ 1.2**	**0.8/ 1.0**
9						0.9/ 1.4 (2005				0.4/ 0.7	1.0/ 1.3 (2005)				**0.6/ 1.0**
11	0.95 / 1.75	1.0/ 1.6	0.9/ 1.5	1.2/ 1.75	1.05 / 1.7	0.1/ 0.2	0.2/ 0.35	0.3/ 0.45	0.45/ 0.6 Δ riffle	0.4/ 0.7	0.4/ 0.8	0.6/ 0.8	0.6/ 1.1	**0.4/ 0.5**	**0.3/ 0.5**
12b				1.05/ 2.0	0.95 / 1.35				0.45/ 0.8	0.5/ 0.8				**0.55/ 0.9**	**0.5/ 0.9**
Zayante 13a	1.8/ 2.9	2.1/ 3.4	1.8/ 3.8	1.9/ 3.7	1.7/ 3.0	0.15/ 0.4	0.2/ 0.5	0.5/ 0.8	0.4/ 0.7	0.6/ 1.0	0.65/ 1.0	0.75/ 1.3	0.9/ 1.5	**0.7/ 1.05**	**0.8/ 1.2**
Zayante 13c			1.1/ 1.85	1.1/ 1.75	1.05 / 1.85			0.6/ 0.9	0.3/ 0.7	0.3/ 0.5			0.7/ 0.95	0.5/ 0.75	0.55/ 0.85
Zayante 13d				1.1/ 1.95	0.8/ 1.2 Δ Site				–					0.75/ 1.0	0.3/ 0.5
Lompico 13e	0.85 / 1.75	1.2/ 1.6	1.25 / 1.75	1.2/ 1.65	1.2/ 2.0	0.1/ 0.15	0.1/ 0.3	0.2/ 0.4	0.2/ 0.5	0.05/ 0.3	0.3/ 0.5	0.45/ 0.75	0.5/ 0.8	**0.35/ 0.9**	**0.4/ 0.9**
Bean 14b	1.0/ 2.0	0.9/ 2.0	1.4/ 2.4	1.3/ 2.05	1.1/ 2.5	0.2/ 0.4	0.25/ 0.4	0.25/ 0.8	0.35/ 0.6	0.1/ 0.2	0.2/ 0.4	0.5/ 0.6	0.5/ 0.7	**0.5/ 0.8**	**0.5/ 0.7**
Bean 14c			0.8/ 1.65	0.8/ 1.45 Went dry	Dry			0.2/ 0.3	0.1/ 0.2 Went dry	Dry			0.3/ 0.5	**0.25/ 0.35 Went dry**	**Dry**
Fall 15			1.1/ 1.85	1.15/ 1.65	0.8/ 1.3			0.7/ 1.4	0.45/ 0.8	0.3/ 0.6			0.9/ 1.4	**0.6/ 1.1**	**0.45/ 0.8**
Newell 16	1.15 / 1.95	1.25 / 1.9	1.15 / 1.85	1.05/ 1.8	1.2/ 2.1	0.2. 0.5	.25/ .55	0.4/ 0.5	0.35/ 0.45	0.4/ 0.7	0.3/ 0.5	0.5/ 0.9	0.4/ 0.6	**0.3/ 0.5**	**0.4/ 0.55**

Site	Pool 2009	Pool 2010	Pool 2011	Pool 2012	Pool 2013	Riffle 2009	Riffle 2010	Riffle 2011	Riffle 2012	Riffle 2013	Run/Step Run 2009	Run/Step Run 2010	Run/Step Run 2011	Run/Step Run 2012	Run/Step Run 2013
Boulder 17a	1.05/ 1.8	1.2/ 1.75	1.35/ 1.95	1.2/ 1.8	1.05/ 1.8	0.4/ 0.8	0.7/ 1.1	–	0.5/ 1.0	0.5/ 0.7	0.7/ 1.1	0.9/ 1.2	1.1/ 1.4	**0.8/ 1.2**	**0.85/ 1.0**
Boulder 17b	1.4/ 2.4	1.45/ 2.2	1.2/ 1.85	1.3/ 1.9	1.05/ 1.85 Δ Site	0.5/ 1.0	0.6/ 1.1	0.7/ 1.2	0.65/ 1.1	0.5/ 0.6	0.5/ 0.9	0.7/ 0.9	0.8/ 1.4	**0.6/ 1.2**	**0.4/ 0.85**
Bear 18a		1.35/ 2.6	1.35/ 2.2	1.1/ 1.85	1.3/ 2.3		0.3/ 0.6	0.3/ 0.6	0.3/ 0.6	0.3/ 0.5		0.7/ 0.9	0.65/ 1.0	**0.45/ 0.9**	**0.4/ 0.6**
Branciforte 21a-2	1.15/ 1.9	1.25/ 2.05	1.0/ 2.0	1.2/ 1.9	0.8/ 1.65	0.1/ 0.2	0.1/ 0.2	0.25/ 0.5	0.1/ 0.3	0.1/ 0.3	0.4/ 0.6	0.5/ 1.2	0.35/ 0.6	**0.4/ 0.6**	**0.35/ 0.6**
Branciforte 21b				1.2/ 1.95	1.05/ 1.75 Δ site				0.3/ 0.6	0.4/ 0.6				**0.5/ 0.85**	**0.5/ 0.7**

Table 7a. Average PERCENT FINE SEDIMENT* IN SAN LORENZO REACHES Since 2007.

Reach	Pool 2007	Pool 2008	Pool 2009	Pool 2010	Pool 2011	Pool 2012	Pool 2013	Riffle 2007	Riffle 2008	Riffle 2009	Riffle 2010	Riffle 2011	Riffle 2012	Riffle 2013	Run/ Step Run 2007	Run / Step Run 2008	Run / Step Run 2009	Run / Step Run 2010	Run / Step Run 2011	Run / Step Run 2012	Run / Step Run 2013
1	65	77						15	20						46	46					
2	42	54	48	48	47	44	50	10	13	13	10	8	9	6	26	23	26	40	13	**17**	**9**
4	46	47						13	10						42	37					
6	61	68						17	12						18	23					
7																					
8	41	47	44					7	6	12					11	16	25				
9	58 (2005)						46	14 (2005)						9	28 (2005)						**23**
10																					
11	32	52	40			25		10	9	12			8		24	14	14			**17**	
12b						27							4							**9**	
Zayan-te 13a	59	62						22	19						36	31					
Zayan-te 13b																					
Zayan-te 13c	45	47		41	43			9	12		10	14			27	34		19	19		
Zayan-te 13d	38	44	46	42	40	26	31	13	13	12	19	14	14	6	21	29	28	27	28	**19**	**16**
Lompi-co 13e	49	54						15	20						24	29					
Bean 14a																					
Bean 14b	67	66	67	55	61	49	64	18	9	13	13	32	10	13	58	34	34	28	72	**25**	**34**
Bean 14c	42	37		54	51			6	6		14	9			28	10		26	19		
Fall 15		64	69		57				30	34		19				48	50		37		
Newell 16			46	22	22					11	6	3					19	12	4		
Boul-der 17a	31	27	28				59	12	9	11				13	17	13	11				**19**
Boulde r 17b	31	32					22	5	5					3	12	14					**7**
Boul-der 17c																					
Bear 18a	41	46		41		38		7	11		13		9		13	13		19		**19**	
Branci. 21a-1	65	62						7	10						30	16					
Branci. 21a-2	50	42	38	43				12	8	8	9				35	21	13	22			
Branci. 21b						**56**	45						**24**	18						**43**	**41**
Branci-forte 21c							73							14							**50**

* 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	Pool 2013	Riffle 2011	Riffle 2012	Riffle 2013	Run/ Step Run 2011	Run/ Step Run 2012	Run/ Step Run 2013
0a	50	50	NA	30	5	NA	25	**15**	**NA**
1	NA	NA	NA	10	15	5	15	**20**	**40**
2	NA	NA	NA	10	15	5	20	**25**	**5**
4	NA	NA	NA	15	10	5	38	**30**	**35**
6	NA	NA	NA	15	15	5	15	**15**	**10**
8	NA	NA	NA	15	15	15	20	**30**	**15**
9	NA (2005)		NA	10 (2005)		13	35 (2005)		**45**
11	35	20	33	5	NA	5	5	**NA**	**15**
12b	45 (2001)	35	30	23 (2001)	5	5	20 (2001)	**5**	**5**
Zayante 13a	80	50	75	1	5	10	15	**30**	**50**
Zayante 13c	15	10	5	15	10	2	10	**13**	**10**
Zayante 13d	33	22	30	NA	NA	NA	23	**25**	**20**
Lompico 13e	45	40	45	NA	20	10	25	**20**	**30**
Bean 14b	70	60	80	10	10	10	35	**25**	**25**
Bean 14c	38	10	Dry	5	2	Dry	15	**10**	**Dry**
Fall 15	50	68	40	20	20	15	25	**35**	**60**
Newell 16	18	28	8	5	2	2	5	**2**	**10**
Boulder 17a	20	30	60	5	15	10	15	**10**	**15**
Boulder 17b	25	25	18	0	2	2	10	**10**	**5**
Bear 18a	28	33	43	5	15	5	20	**20**	**10**
Branciforte 21a-2	75	48	65	2	NA	15	25	**20**	**20**
Branciforte 21b	73 (2001)	**53**	28	15 (2001)	**10**	10	45 (2001)	**20**	**20**
Branciforte 21c			80			15			**15**

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

Table 8a. Average EMBEDDEDNESS IN SAN LORENZO Reaches Since 2007.

Reach	Pool 2007	Pool 2008	Pool 2009	Pool 2010	Pool 2011	Pool 2012	Pool 2013	Riffle 2007	Riffle 2008	Riffle 2009	Riffle 2010	Riffle 2011	Riffle 2012	Riffle 2013	Run/ Step Run 2007	Run / Step Run 2008	Run / Step Run 2009	Run / Step Run 2010	Run / Step Run 2011	Run / Step Run 2012	Run / Step Run 2013
1	50	52						23	26						48	48					
2	26	38	36	37	49	39	33	13	18	16	25	20	19	20	23	25	32	27	**28**	**38**	**31**
3																					
4	43	45						19	33						37	42					
5																					
6	45	51						18	21						34	39					
7																					
8	40	46	33					18	30	19					28	26	32				
9	39 (2005)						48	25 (2005)						26	31 (2005)						**63**
10																					
11	34	47	48			46		22	30	22			14		31	43	33			**30**	
12b						35							32							**53**	
Zayante 13a	44	51						25	30						36	47					
Zayante 13b																					
Zayante 13c	36	49		49	48			19	28		29	31			31	44		36	**56**		
Zayante 13d	55	49	49	57	53	53	56	30	33	43	39	45	49	41	39	37	41	51	**40**	**43**	**51**
Lompico 13e	52	47						16	19						37	32					
Bean 14a																					
Bean 14b	45	44	44	53	51	59	38	22	14	16	25	32	48	25	36	22	35	30	**55**	**53**	**36**
Bean 14c	39	42		60	53			8	15		42	31			25	29		43	**46**		
Fall 15		48	52		46				25	28		18				40	41		**42**		
Newell 16			42	39	53					20	24	31					31	34	**43**		
Boulder 17a	37	37	38				58	18	21	18				27	27	31	27				**39**
Boulder 17b	33	35					33	22	17					26	33	34					**34**
Boulder 17c																					
Bear 18a	33	48		49		60		28	34		25		44		36	43		34		**50**	
Branc-21a-1	60	58						31	24						55	41					
Branc-21a-2	62	46	49	53				30	28	28	30				36	33	28	41			
Branc-21b						48	**48**						18	**25**						**35**	**36**
Branc-21c							**15**							**10**							**13**

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

Reach	Pool 2011	Pool 2012	Pool 2013	Riffle 2011	Riffle 2012	Riffle 2013	Run/ Step Run 2011	Run/ Step Run 2012	Run/ Step Run 2013
0a	60	40	NA	30	20	**NA**	**35**	**35**	**NA**
1	NA	NA		25	30	**20**	**50**	**40**	**40**
2	NA	NA		15	20	**25**	**30**	**30**	**25**
4	NA	NA		15	20	**20**	**50**	**50**	**50**
6	NA	NA		20	30	**40**	**30**	**30**	**40**
8	NA	NA		30	25	**45**	**35**	**45**	**45**
9				15 (2005)		**25**	**25 (2005)**		**65**
11	40	50	53	5	NA	**15**	**5**	**NA**	**30**
12b	43 (2001)	55	55	35 (2001)	30	**35**	**35 (2001)**	**45**	**45**
Zayante 13a	60	65	45	20	30	**30**	**35**	**40**	**40**
Zayante 13c	30	45	50	45	45	**30**	**35**	**35**	**40**
Zayante 13d	43	53	55	20	NA	**NA**	**45**	**45**	**65**
Lompico 13e	50	40	38	NA	30	**25**	**45**	**30**	**35**
Bean 14b	45	60	35	20	45	**15**	**35**	**70**	**35**
Bean 14c	53	10	Dry	10	25	**Dry**	**40**	**30**	**Dry**
Fall 15	38	60	45	25	50	**20**	**30**	**45**	**30**
Newell 16	65	33	60	15	15	**35**	**35**	**15**	**40**
Boulder 17a	40	38	58	25	40	**20**	**35**	**25**	**20**
Boulder 17b	30	35	35	10	10	**35**	**30**	**25**	**30**
Bear 18a	38	65	50	25	60	**65**	**35**	**60**	**60**
Branciforte 21a-2	53	48	53	20	NA	**25**	**60**	**40**	**30**
Branciforte 21b	42 (2001)	48	50	40 (2001)	20	**20**	**40 (2001)**	**30**	**35**
Branciforte 21c			20			**35**			**15**

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	2013
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	0.101
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**								**0.043**
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 Since 2009.

Sampling Site	2009	2010	2011	2012	2013
Santa Cruz Levees 0a	0.211	0.298	0.205	0.403	2.000
Paradise Park 1	0.155	0.183	0.128	0.106	0.045
Rincon 2			0.129	0.117	0.100
Henry Cowell 4	0.537	0.479	0.374	0.308	0.307
Below Fall Creek 6	0.113	0.230	0.109	0.088	0.183
Below Clear Creek 8	0.082	0.194	0.154	0.163	0.148
Below Boulder Creek 9	0.133 (2005)				0.035
Above Kings Creek Near Teihl Rd 11	0.0	0.024	0.036	–	0.041
Waterman Gap 12b				0.000	0.031

***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	2013
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	0.132
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**								**0.047**
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	2013
1	-	-	0.271	0.186	0.205					
2	-	-		0.076	0.058	0.046	0.049	0.061 Seg. Δ	0.043	0.021
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**								**0.021**
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	2013
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**	**0.086**
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**	**0.146**
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				**0.026**
Boulder 17b	0.129	0.141	0.164	-	0.232	0.100	0.140	0.155					**0.062**
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**	**0.211**
Branciforte 21c													**0.158**

*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 Since 2009.

Site (Reach)	Pool Escape Cover 2009	Pool Escape Cover 2010	Pool Escape Cover 2011	Pool Escape Cover 2012	Pool Escape Cover 2013
Mainstem @ Teihl 11	0.058*	0.094	**0.033**	**0.039**	**0.081**
Mainstem @ Waterman Gap 12b				**0.091**	**0.124**
Zayante 13a	0.140	0.103	**0.167**	**0.222**	**0.122**
Zayante 13c			**0.120**	**0.178**	**0.164**
Zayante 13d	0.285	0.113	**0.168**	**0.135 Site Δ**	**0.135 Site Δ**
Lompico 13e	0.154	0.092	**0.061**	**0.072**	**0.098**
Bean 14b	0.145	0.120	**0.165**	**0.175**	**0.137**
Bean 14c			**0.098**	**0.094**	**Dry**
Fall 15	0.302	0.571	**0.429**	**0.500**	**0.357**
Newell 16	0.150	0.118	**0.101**	**0.154**	**0.142**
Boulder 17a	0.066	0.094	**0.110**	**0.092**	**0.060**
Boulder 17b	0.356	0.266	**0.258**	**0.461**	**0.088 Site Δ**
Bear 18a		0.138	**0.101**	**0.050 Site Δ**	**0.068**
Branciforte 21a-2	0.051	0.068	**0.040**	**0.107**	**0.070**
Branciforte 21b				**0.158**	**0.184 Site Δ**
Branciforte 21c					**0.252**

*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	2013
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**	**0.030**
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**	**0.062**
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				**0.024**
Boulder 17b	0.116	0.156	0.137	-	0.194	0.102	0.114	0.105					**0.104**
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**	**0.032**
Branciforte 21c													**0.000**

*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 2012 to 2013, Based on Reach Data Where Available and Site Data, Otherwise.

Reach Comparison or (Site Only)	Baseflow (Most Important 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)	Similar (in fall)	+ / +	Similar	Similar	+/+	+
(Mainstem 1)	−	NA / Similar	− (run)	+ (riffle)	/−	−
Mainstem 2	−	− / −	Similar	Similar	−/−	−
(Mainstem 4)	−	NA / −	Similar	Similar	/Similar	−
(Mainstem 6)	−	NA / −	Similar	−	/+	− (lower flow)
(Mainstem 8)	−	NA / −	− (run)	− (riffle)	/−	−
Mainstem 9 (2005 to 2013)	−	− (fastwater) Similar in pools	+ (pool)	−	−	−
(Mainstem Near Teihl 11)	Similar (in fall)	−	−	Similar	−	−
(Mainstem Waterman Gap 12b)	NA	−	Similar	Similar	+	−
(Zayante 13a)	−	−	− (pool) − (run)	+ (pool)	−	−
(Zayante 13c)	−	Similar	Similar	+ (riffle)	− (slightly)	− (lower flow)
Zayante 13d	−	−	Similar	Similar	−	−
(Lompico 13e)	−	+	+ (riffle) − (run)	Similar	+	+
Bean 14b	−	+	−	+	−	−
(Bean 14c)	(Went dry sooner in 2013)					Dry both years
(Fall 15)	−	−	+ (pool) − (run)	+	−	−
(Newell 16)	Same (in fall)	+	+ (pool)	−	− (slightly less)	+
Boulder 17a	Same (in fall)	− (since 2009)	− (pool) (since 2009)	− (pool) (since 2009)	− (since 2009)	−
Boulder 17b	Similar (in fall)	− (since 2008)	− (pool) (since 2008)	Similar (since 2008)	− (pool) (since 2008)	−
(Bear 18a)	−	+	− pool) + (fastwater)	+ (pool)	+	+
(Branciforte 21a-2)	Similar (in fall)	−	− (pool)	Similar	+	−
Branciforte 21b	NA	+	Similar	Similar	+	+

***NA = Not available.**

R-3. Habitat Change in Soquel Creek and Its Branches

Refer to **Appendix A** for maps of reach locations. Summary tables of habitat change for all sites are provided in **Tables 15e and 40**. Three reaches (3, 8 and 9a) were compared to 2011 conditions (wet year). Reach 12a in the SDSF was compared to 2012 conditions. Three replicated sites in Reaches 1, 7 and 13 were compared to 2012 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 2013 than in 2012, which had late spring stormflows that maintained streamflow above median flow rate statistic until mid-May (**Table 5b; Figures 37a−b; 38**). As for the San Lorenzo watershed, two large, above bankfull stormflows occurred in December 2012 (peak flows at Soquel Village USGS Gage of 4,800 and 6,470 cfs), with only two very small stormflows in March and early April 2013 with peak flows of less than 60 cfs. The average mean monthly streamflow for May−September in 2013 at the Soquel Village gage was the second lowest in 17 years of calculations (2.4 cfs with a 17-year average of 9.3 cfs) (**Figure 42**). With habitat typed Reaches 3, 8 and 9a there was significant pool filling and reduced fastwater habitat depth since 2011 (**Table 14a**). The same thing occurred for Reach 12 a since 2012, although some step runs in 2012 may have been typed as pools in 2013due to the very low streamflow, thus reducing the average pool depth. Pools at replicated Site 4 (Reach 3) also shallowed from 2012 (**Table 14b**). However, Sites 1, 10 (Reach 7) and 19 (Reach 13 on West Branch) maintained their depths or were scoured to deeper conditions in 2013 compared to 2012, despite lower baseflow. In addition, Soquel Lagoon was the deepest in 23 years of monitoring and 0.75 m (2 ft) deeper than 2012 at Stockton Bridge from scour and net sediment transport out.

Although the important habitat parameters of pool depth and escape cover remained similar or improved substantially in 2013 at Sites 1, 10 and 19 compared to 2012, overall habitat quality was judged reduced due to much lower baseflow (**Tables 5b, 14b, 15d, 15f and 15g**). The 3 habitat typed reaches had reduced overall habitat quality due to reduced baseflow and shallower conditions compared to reach data from 2011 (**Tables 14a, 15a, 15c, 15e and 15g**). Reach 3 had substantially more escape cover as overhanging vegetation. Substrate remained similar or improved in all 3 reaches.

Reduced baseflow in 2013 provided less food and less YOY growth in all reaches compared to 2012 and 2011 (wet year), as exemplified by lower percent of YOY reaching Size Class II in 2013 compared to 2012 (dry year) and 2011 (wet year) at all sites (**Figures 18a−b;** size histograms in **Appendix D**). Growth was also reduced from added competition for food when YOY abundance was greater in 2013 at all 7 sites (**Table 27**) and above average at Sites 10, 12, 13a and 19, although at Site 16 in the SDSF, YOY density continued to be very low (**Figure 6**). As in the San Lorenzo watershed, despite negative habitat change in all 7 reaches in 2013 (**Table 15g**), YOY in Soquel Creek were more abundant likely due to better YOY survival than in 2012, though smaller from late spawning and low baseflow. Yearling densities remained low and close to average, consistent with poor over-winter survival as in past years (**Figure 7**). As in the San Lorenzo watershed, few yearlings remained after the large December storms.

Table 14a. Averaged Mean and Maximum WATER DEPTH (ft) of Habitat in SQOUEL CREEK Reaches* Since 2007.

Reach	Pool 2007	Pool 2008	Pool 2009	Pool 2011	Pool 2012	Pool 2013	Riffle 2007	Riffle 2008	Riffle 2009	Riffle 2011	Riffle 2012	Riffle 2013	Run/ Step Run 2007	Run/ Step Run 2008	Run/ Step Run 2009	Run/ Step Run 2011	Run/ Step Run 2012	Run/ Step Run 2013
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/ 2.3	1.2/ 2.3	1.4/ 2.35	1.6/ 3.0		1.2/ 2.4	0.3/ 0.5	0.2/ 0.4 *	0.25/ 0.4	0.45/ 0.75		0.3/ 0.6	0.4/ 0.6 *	0.3/ 0.6 *	0.45/ 0.7	0.7/ 1.1		**0.5/ 0.7**
4																		
5																		
6																		
7	1.2/ 2.1	1.2/ 2.2	1.35/ 2.4		1.2/ 2.5		0.3/ 0.6	0.3/ 0.5	0.35/ 0.55		0.4/ 0.7		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		1.1/ 2.1	0.4/ 0.6	0.2/ 0.4	0.3/ 0.45	0.6/ 0.9		0.3/ 0.6	0.5/ 0.9	0.4/ 0.7	0.5/ 0.75	0.9/ 1.3		**0.5/ 0.85**
9	1.3/ 2.2	1.2/ 2.3	1.45/ 2.3	1.6/ 2.7		1.0/ 1.8	0.2/ 0.4	0.2/ 0.4	0.2/ 0.45	0.5/ 0.7		0.2/ 0.3	0.4/ 0.6	0.4/ 0.6	0.5/ 0.75	0.6/ 0.85		**0.3/ 0.6**
10																		
11																		
12a	0.8/ 1.4	0.6/ 1.1	1.0/ 1.5	1.0/ 1.7	0.9/ 1.5	0.6/ 1.0	0.1/ 0.2	0.02/ 0.1	0.25/ 0.45	0.4/ 0.7	0.3/ 0.6	0.15/ 0.3	0.3/ 0.7	0.2/ 0.5	0.45/ 0.8	0.6/ 1.05	0.5/ 0.9	**0.3/ 0.6**
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																		
14b	1.4/ 2.4	1.3/ 2.4	1.35/ 2.5				0.2/ 0.4	0.2/ 0.4	0.25/ 0.5				0.5/ 0.8	0.4/ 0.7	0.5/ 0.8			
14c																		

*Partial, ½-mile segments habitat typed in 2006–2009 and 2011−2013. Previously, the entire reach was habitat typed.

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

Site (Reach)	Pool 2009	Pool 2010	Pool 2011	Pool 2012	Pool 2013	Riffle 2009	Riffle 2010	Riffle 2011	Riffle 2012	Riffle 2013	Run/ Step Run 2009	Run/ Step Run 2010	Run/ Step Run 2011	Run/ Step Run 2012	Run/ Step Run 2013
1 (1)	1.0/ 2.8	1.0/ 2.8	0.9/ 3.2	1.65/ 3.5 Site Δ	**1.65/ 3.6**	0.4/ 0.5	0.5/ 0.75	0.5/ 0.8	0.4/ 0.6 Site Δ	**0.05/ 0.3**	0.2/ 0.3	0.35/ 0.8	0.8/ 1.1	0.6/ 0.9 Site Δ	**0.25/ 0.4**
4 (3)	1.6/ 2.9	2.0/ 4.3	1.2/ 2.5	1.7/ 2.6	**1.4/ 2.2**	0.4/ 0.6	0.55/ 0.8	0.6/ 0.9	0.3/ 0.5	**0.3/ 0.7**	0.5/ 0.8	0.7/ 1.0	0.7/ 1.0	0.5/ 0.9	**0.6/ 1.0**
10 (7)		1.4/ 2.8	1.4/ 3.0	1.1/ 2.05 Site Δ	**1.55/ 2.35**	0.55/ 0.9	0.6/ 1.2	0.65/ 0.9	0.5/ 0.9 Site Δ	**0.35/ 0.9**	0.5/ 0.9	0.6/ 1.2	0.9/ 1.2	0.8/ 0.9	**0.5/ 0.85**
12 (8)			2.2/ 2.8	1.8/ 2.6	**0.9/ 2.0** Site Δ			0.9/ 1.2	0.45/ 0.95	**0.3/ 0.5**			1.0/ 1.5	0.8/ 1.1	**0.6/ 0.8**
13a (9a)			1.65/ 2.4	1.2/ 1.9	**0.95/ 1.95** Site Δ			0.5/ 0.7	0.3/ 0.6	**0.1/ 0.3**			0.7/ 0.9	0.75/ 1.1	**0.35/ 0.5**
16 (12a)			1.2/ 1.85	1.25/ 2.05 Site Δ	**0.5/ 0.85** Site Δ				0.2/ 0.4 Site Δ	**0.1/ 0.15**			0.55/ 0.95	0.4/ 0.9 Site Δ	**0.3/ 0.8**
19 (13)	1.0/ 2.0	1.1/ 2.1	0.9/ 2.9	1.0/ 1.9	**0.9/ 2.5**	0.5/ 0.7	0.5/ 0.9	0.45/ 0.6	0.4/ 0.8	**0.35/ 0.6**	0.5/ 0.9	0.6/ 1.1	0.7/ 1.1	0.5/ 1.1	**0.5/ 1.0**
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 2007.

Reach	Pool 2007	Pool 2008	Pool 2009	Pool 2011	Pool 2012	Pool 2013	Riffle 2007	Riffle 2008	Riffle 2009	Riffle 2011	Riffle 2012	Riffle 2013	Run/ Step Run 2007	Run/ Step Run 2008	Run/ Step Run 2009	Run/ Step Run 2011	Run/ Step Run 2012	Run/ Step Run 2013
1	59	64	59		62		18	13	14		8		29	16	16		24	
2																		
3	55	57	58	59		60	17	15	8	11		19	29	20	19	14		**38**
4																		
5																		
6																		
7	52	59	70		51		20	23	16		11		25	25	20		21	
8	46	56	58	63		68	14	15	5	11		5	25	64	28	23		**15**
9a	47	49	42	58		50	13	10	6	6		3	24	26	19	24		**14**
10																		
11																		
12a	29	34	35	42	34	24	6	10	12	8	8	5	20 (S.run)	21 (S.run)	19 (S.run)	15	14	**20**
12b																		
13	64	75	58		57		26	18	11		9		29	26	20*		18	
14a																		
14b	40	55	52				9	10	8				26 (run)	20 (run	20 (run)			
14c																		

*Partial, ½-mile segments habitat typed in 2006–2009 and 2011−2013 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	Pool 2013	Riffle 2011	Riffle 2012	Riffle 2013	Run/ Step Run 2011	Run/ Step Run 2012	Run/ Step Run 2013
1 (1)	85	85	75	5	10	10	10	20	**5**
4 (3a)	45	70	70	10	5	20	10	15	**25**
10 (7)	70	38	28	15	NA	5	20	25	**10**
12 (8)	25	30	80 Site Δ	10	NA	5	15	15	**15**
13a (9)	50	40	40 Site Δ	15	20	2	25	15	**15**
16 (12a)	50	50	20 Site Δ	NA	15	5	NA	15	**25**
19 (13)	60	70	70	15	10	15	40	25	**30**

Table 15c. Average EMBEDDEDNESS in Pool and Fastwater (Riffle and Run) Habitat of SOQUEL CREEK REACHES Since 2006.

Reach	Pool 2006	Pool 2007	Pool 2008	Pool 2009	Pool 2011	Pool 2012	Pool 2013	Riffle 2006	Riffle 2007	Riffle 2008	Riffle 2009	Riffle 2011	Riffle 2012	Riffle 2013	Run/ Step Run 2006	Run/ Step Run 2007	Run/ Step Run 2008	Run/ Step Run 2009	Run/ Step Run 2011	Run/ Step Run 2012	Run/ Step Run 2013
1		48	35	37		54			22	18	19		30			29	29	23		**39**	
2																					
3	55*	40*	39*	37*	40*		50*	27*	17*	22*	19*	13*		31*	46*	28*	33*	23*	24*		**38***
4																					
5																					
6																					
7	56*	42*	44*	41*		52		25*	25*	23*	23*		32		39*	35*	39*	38*		**43**	
8		44*	43*	45*	60*		52*		25*	17*	17*	28*		24*		35*	48*	33*	50*		**43***
9	54	47	44	50	59		45	26	18	22	26	28		30	50	37	47	42	50		**45**
10																					
11																					
12a	53	55	54	59	57	61	65	30	41	45	34	28	42	38	38 (S.run)	47 (S.run)	39 (S.run)	46 (S.run)	38 (S.run)	**43 (S.run)**	**51 (S.run)**
12b																					
13		50*	42*	53*		50*			26*	23*	22*		27*			39*	29*	37*		**33***	
14a	57							18							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 2011–2013 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	Pool 2013	Riffle 2011	Riffle 2012	Riffle 2013	Run/ Step Run 2011	Run/ Step Run 2012	Run/ Step Run 2013
1 (1)	55	60	70	35	30	25	25	35	**40**
4 (3a)	40	40	50	25	25	35	30	50	**30**
10 (7)	50	50	40	25	NA	25	35	35	**35**
12 (8)	30	55	65 Site Δ	35	35	15	35	50	**35**
13a (9)	60	40	50	35	35	15	35	40	**55**
16 (12a)	63	58	65	NA	45	45	NA	40	**75**
19 (13)	60	60	30	15	25	40	40	30	**45**
21 (14b)	60	-	-	40	-	-	45	-	**-**

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

Reach	Pool 2000	Pool 2003	Pool 2005	Pool 2006	Pool 2007	Pool 2008	Pool 2009	Pool 2011	Pool 2012	Pool 2013
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 **		**0.143 ** **
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 **		**0.032**
9a	0.146		0.101	0.086	0.117	0.147	0.100	0.128		**0.114**
10	0.100									
11	0.068									
12a	0.113		0.222	0.175	0.121	0.097	0.143	0.169	0.082	**0.067**
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 2011−2013 where previously, the entire reach was habitat typed.

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

Site (Reach)	Pool Escape Cover 2009	Pool Escape Cover 2010	Pool Escape Cover 2011	Pool Escape Cover 2012	Pool Escape Cover 2013
1 (1)	0.101	0.132	0.104	0.117 Site Δ	**0.178**
4 (3)	0.102	0.067	0.085	0.191	**0.086**
10 (7)		0.124	0.254	0.096 Site Δ	**0.152**
12 (8)			0.092	0.231 (Wood cluster)	**0.059** Site Δ
13a (9a)			0.101	0.164 (Wood cluster)	**0.127** Site Δ
16 (12a)			0.079	0.064 Site Δ	**0.093** Site Δ
19 (13)	0.041	0.080	0.131	0.060	**0.143**
21 (14b)	0.029	0.017	0.021	–	–

Table 15g. Habitat Change in SOQUEL CREEK WATERSHED Reaches (2011 to 2013 or 2012-2013) or Replicated Sites (2012 to 2013).

Reach Comparison or Site Only	Baseflow	Pool Depth	Fine Sediment	Embeddedness	Pool Escape Cover	Overall Habitat Change
Site 1 (Reach 1)	**–**	**Similar**	**+**	**– (pool)**	**+**	**– (lower flow)**
Reach 3a	**–**	**–**	**–**	**– (pool) + (run)**	**+ (large)**	**–**
Site 10 (Reach 7)	**–**	**+ (pool)**	**+**	**+ (pool)**	**+**	**– (lower flow)**
Reach 8	**–**	**–**	**Similar**	**Similar**	**–**	**–**
Reach 9a	**–**	**–**	**+ (run)**	**+ (pool)**	**–**	**–**
Reach 12a	**–**	**–**	**+ (pool)**	**Similar**	**–**	**–**
Site 19 (Reach 13)	**–**	**+**	**Similar**	**+ (pool) – (fastwater)**	**+**	**– (lower flow)**

R-4. Habitat Change in Aptos Creek, 2012 to 2013

Refer to **Appendix A** for maps of reach locations. Summary tables of habitat change for all sites are provided in **Tables 16c and 40**. 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 is higher and more important. Based on hydrographs from stream gages in other watersheds (**Figures 33-41**), it is likely that the Aptos watershed also had similarly low baseflow in 2013 compared to 2011 and 2012, and considerably below the median streamflow statistic in spring and summer. This provided less food and slower growth rate in all reaches in 2013 compared to the previous 2 years. Measured streamflow in fall in lower Aptos Creek confirmed lower baseflow in 2013 than 2012 (dry year) and much lower than in 2011 (**Table 5b**).

Habitat had reduced quality in the lower Reach 2 in Aptos Creek from 2012 due primarily to lower baseflow and shallower pools, though escape cover rebounded to 2011 levels in 2013 (**Table 16c summarized from Tables 5b, 16a−b**). Most escape cover was undercut banks. The upper Aptos Reach 3 in Nisene Marks had reduced habitat quality compared to 2012, based on conditions at Site 4. Baseflow was less, though maximum pool depth increased somewhat while average mean depth lessened. Escape cover was similar as was embeddedness, while percent fines increased. The wood cluster at the lower pool had become lessened in 2012 with significant sedimentation, which had been partially scoured out in 2013.

Unlike the increased abundance observed at some sites in the San Lorenzo and Soquel watersheds, below average YOY densities (only increased slightly at the lower Aptos 3 site and decreased significantly at the upper Aptos 4 site) were consistent with reduced habitat quality (**Tables 32−33**). Like in other watersheds, YOY were smaller at least at the lower site from likely late spawning and low baseflow (**Appendix D**). Reduced YOY growth in 2013 was exemplified by the much lower percent of YOY reaching Size Class II in 2013 at the upper Aptos site compared to 2012 and 2011 (**Figures 19a−b**). Consistent with reduced habitat quality and declines in the San Lorenzo and Soquel Watersheds, yearling densities were down and below average in 2013. Lack of overwintering cover may have prevented yearlings from staying after the large December stormflows.

Table 16a. AVERAGE POOL HABITAT CONDITIONS FROM HABITAT TYPING IN REACHES of APTOS, VALENCIA, CORRALITOS, SHINGLE MILL and BROWNS Creeks in 2008–2009; 2011-2013

Reach #/ Sampling Site #	Mean Depth/ Maximum Depth					Escape Cover*					Embeddedness					Percent Fines				
	2008	2009	2011	**2012**	**2013**	2008	2009	2011	**2012**	**2013**	2008	2009	2011	**2012**	**2013**	2008	2009	2011	**2012**	**2013**
Aptos #2/#3- in County Park	1.1/2.1	1.0/2.1		**1.1/2.2**	**1.0/1.8**	0.172	0.155		0.105	**0.141**	47	48		**55**	52	60	53		**59**	**59**
Aptos #3/#4- Above Steel Bridge Xing (Nis. Marks)	1.1/2.2	1.2/2.3	1.2/2.3			0.132	0.127	0.107			57	56	54			63	57	66		
Valencia #2/#2- Below Valencia Road Xing	0.6/1.3	0.6/1.2				0.131	0.143				45	51				88	79			
Valencia #3/#3- Above Valencia Road Xing	0.7/1.4	0.8/1.5				0.210	0.217				55	53				79	76			
Corralitos #1/#1- Below Dam	1.3/2.0	1.5/2.2			**1.1/1.9**	0.152	0.133			**0.080**	44	49			**43**	50	54			**43**
Corralitos #3/#3- Above Colinas Drive	1.1/2.0	1.2/2.0	1.3/2.0	1.1/2.0		0.172	0.121	0.175	**0.161**		46	52	50	**63**		50	53	32	**42**	
Corralitos #5-6/#8- Below Eureka Gulch	1.0/1.8	1.1/1.9	1.2/2.0	**1.0/1.8**		0.090	0.093	0.052	**0.072**		45	58	58	**58**		48	56	29	**29**	
Corralitos #7/#9- Above Eureka Gulch	0.9/1.5	1.0/1.5	1.0/1.5	**0.9/1.35**		0.171	0.125	0.119	**0.146**		40	45	54	**63**		29	41	20	**28**	
Shingle Mill #1/#1- Below 2nd Road Xing	0.8/1.3					0.214					58					26				
Shingle Mill #3/#3- Above 3rd Road Xing	0.8/1.3	0.9/1.5				0.223	0.264				62	59				34	45			
Browns Valley #1/#2- Below Dam	1.2/1.9	1.2/1.9			**1.35/2.0**	0.156	0.185			**0.208**	56	57			**56**	35	38			**29**
Browns Valley #2/#2- Above Dam	1.0/1.6	1.0/1.6			**1.3/1.9**	0.155	0.198			**0.250**	56	54			**38**	32	35			**22**

* 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 Since 2009.

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	Avg Mean/ Maximum Pool Depth- 2013	Pool Escape Cover Index- 2009	Pool Escape Cover Index- 2010	Pool Escape Cover Index- 2011	Pool Escape Cover Index- 2012	Pool Escape Cover Index- 2013
Aptos #2/#3- in County Park	1.2/ 2.5	1.25/ 2.6	1.0/ 2.4	1.0/ 2.5 (Site Δ)	0.85/ 1.75 (Site Δ)	0.164	0.183	0.055	0.080 (Site Δ)	**0.179** (Site Δ)
Aptos #3/#4- Above Steel Bridge Xing (Nisene Marks)			1.35/ 3.25	1.1/ 2.05	0.85/ 2.4			0.156	0.177	**0.170**
Valencia #2/#2- Below Valencia Road Xing	0.6/ 1.5	0.45/ 1.05	–	–	–	0.138	0.156	–	–	**–**
Valencia #3/#3- Above Valencia Road Xing	1.0/ 1.8	0.9/ 1.45	–	–	–	0.200	0.250	–	–	**–**
Corralitos #1/#1- Below Dam	1.05/ 1.65	0.85/ 1.5	0.9/ 1.25	1.05/ 1.4	0.85/ 1.7 (Site Δ)	0.106	0.087	0.120	0.156	**0.083**
Corralitos #3/#3- Above Colinas Drive	1.1/ 2.0	0.7/ 1.6	0.95/ 1.95	1.35/ 2.2 (Site Δ)	1.4/ 2.25	0.186	0.173	0.231	0.121 (Site Δ)	**0.128**
Corralitos #5-6/#8- Below Eureka Gulch	1.35/ 1.95	0.55/ 0.9	1.0/ 1.85	0.7/ 1.05	0.45/ 0.95	0.120	0.048	0.033	0.061	**0.053**
Corralitos #7/#9- Above Eureka Gulch			1.0/ 1.8	1.0/ 1.6	0.9/ 1.3			0.112	0.148	**0.133**
Shingle Mill #1/#1- Below 2nd Road Xing		0.9/ 1.3	0.9/ 1.4	0.8/ 1.3	0.8/ 1.2		0.296	0.310	0.357	**0.397**
Shingle Mill #3/#3- Above 3rd Road Xing	0.8/ 1.2	0.6/ 0.9	1.0/ 1.5	0.9/ 1.4	1.0/ 1.7	0.151	0.139	0.173	0.145	**0.168**
Browns Valley #1/#2- Below Dam	1.0/ 1.55	1.25/ 2.0	1.3/ 2.05	1.1/ 1.6	1.5/ 2.3 (Site Δ)	0.160	0.125	0.187	0.201	**0.283** (Site Δ)
Browns Valley #2/#2- Above Dam	1.05/ 1.7	1.15/ 1.85	1.35/ 1.85	1.25/ 1.8	1.3/ 1.75 (Site Δ)	0.130	0.243	0.203	0.272	0.210 (Site Δ)

* 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 (2012 to 2013) AND CORRALITOS WATERSHED Reaches (2009 to 2013) and Replicated Sites (2012 to 2013).

Reach Comparison or (Site Only Comparison)	Baseflow	Pool Depth	Fine Sediment	Embeddedness	Pool Escape Cover	Overall Habitat Change
Aptos 2	−	−	Same	Similar	+ (large rebound)	− (lower baseflow)
(Aptos 4)	−	+	−	Similar	Similar	−
Corralitos 1 (2009 to 2013)	−	Similar	+	Similar	Similar	−
Site 3 (Corralitos 3)	−	−	Similar	− (riffle and run)	Similar	−
Site 8 (Corralitos 5/6)	−	−	Similar	−	Similar	−
Site 9 (Corralitos 7)	−	−	Similar	−	−	−
Site 1 (Shingle Mill 1)	−	Similar	Similar	Similar	+	Similar
Site 3 (Shingle Mill 3) (above fault line)	−	+	Similar	−	+	− (lower baseflow)
Browns 1 (2009 to 2013)	−	+	Similar	Similar	+	− (lower baseflow)
Browns 2 (2009 to 2013)	−	+	+	+	+	− (lower baseflow)

*** NA = Not Available.**

R-5. Habitat Change in Corralitos, Shingle Mill and Browns Valley Creeks, 2012 to 2013

Refer to **Appendix A** for maps of reach locations. Summary tables of habitat change for all reaches are provided in **Tables 16c and 40**. Weighing the relative importance of streamflow with other habitat parameters is not clear cut, especially when exact streamflow measurements are limited. Both reaches in Browns Creek of the 8 reaches were habitat typed in 2013 to compare habitat quality to that in 2009. Changes in habitat quality in the other reaches were based on conditions at repeated sampling sites. Most juvenile steelhead growth occurs in the spring-early summer when baseflow is higher and most important. Habitat quality declined in 7 of 8 reaches (**Table 16c**). All reaches had lower spring-summer-fall baseflow in 2013 compared to 2012 and much below the median statistic (**Table 5b; Figures 39−41**). As a result, pool depth at sites in Corralitos Creek shallowed in all sites/ reaches except Corralitos 1. Escape cover was similar except it declined at Corralitos 9. The two sites in

Shingle Mill Creek had similar or deeper pool habitat and more escape cover despite lower baseflow, with net habitat being judged similar for Shingle Mill 1 between 2012 and 2013. Although pool depth and escape cover increased in both Browns Creek reaches from 2009 to 2013, habitat quality was judged to be reduced due to the much reduced baseflow. Lower baseflow provided less food and slower growth rate in all reaches. Slow YOY growth was exemplified by the lower percent of YOY reaching Size Class II in 2013 at all sites as was the case in 2012 and even less so than in the wetter 2011 (**Figures B-20a−b**).

Percent fines and embeddedness were similar to past measurements or improved in upper Shingle Mill 3 and in both Browns creek reaches (compared to 2009). Fine sediment was similar between 2013 and 2012 in the middle 3 reaches of Corralitos Creek above the dam, while embeddedness increased. Consistent with diminished habitat quality in 7 of 8 reaches in 2013 (**Table 16c: summarized from Tables 16a-b**), YOY densities decreased at 6 of 8 sites and was above average at only Site 3. Unlike in the San Lorenzo and Soquel watersheds where yearling steelhead densities were down, densities increased slightly at 4 of 8 sites in the Corralitos sub-watershed and were above average at 4 sites compared to 2012 (**Tables 32−33**).

ANNUAL COMPARISON OF JUVENILE STEELHEAD ABUNDANCE

All figures presented within the text may be found in color in the FIGURES section after the REFERENCES AND COMMUNICATIONS. In the 4 watersheds sampled in 2013, 21 of 38 sites were rated “very poor” (5), “poor” (6) and “very poor” (10), based on densities of Size Class II and III juveniles and their average sizes (**Tables 40 and 41**) . The remainder of sites were rated “fair” (9), “good” (7) and “very good” (1). These were the lowest ratings since the dry years of 2007 and 2008. Ratings were much better in 2012 when most sites (20 of 38) were rated “good” and “very good.”

R-6. 2013 Densities in the San Lorenzo Drainage Compared with Those Since 1997

In the San Lorenzo River drainage in 2013, about half of the sites had below average total and YOY densities, though sites in Zayante, Fall and Boulder creeks were above average (**Figures 1−2**). About three-quarters of the sites had below average densities of yearlings and Size Class II and III steelhead (**Figures 3−4**). Yearlings likely immigrated early or did not survive during the two large storms in December 2013. Below average densities of larger juveniles were left after most yearlings were gone and few YOY grew into the larger size class with the much reduced baseflow and food availability in 2013. No trend in changes in densities of the different age and size classes was found to be statistically significant (**Tables 42 and 43**). The Waterman Gap Site 12b was considered a resident rainbow trout site and was not included in statistical analysis.

Site densities of YOY in the mainstem below the Boulder Creek confluence have been low from 1999 onward and at Site 11 from 2011 onward after past wet winters of 1998 and 2006 (**Table 18**). YOY densities increased at 5 of 9 mainstem sites up to Waterman Gap in 2013 compared to 2012 (compared to 2005 at Site 9) but were still below average at 8 of 9 sites (just above average at Site 6) (**Figure 2**). The higher YOY densities resulted in higher total juvenile densities at 5 of 9 mainstem sites (**Table 17**), but below average densities at 8 of 9 sites (**Figure 1**). YOY densities were especially high in the mainstem in 1997 and 1998. 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 2013, as in past years, and below average at 6 of 9 sites (**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 lower in 2013 than 2012 at all 9 mainstem sites (**Table 21**) and below average (**Figure 4**). Their densities were much below average at the 4 lower mainstem sites below the Zayante Creek confluence. Relatively low densities of the important soon-to-smolt fish in these high growth reaches was due to below average densities of YOY and the reduced percent that grew into Size Class II in a low baseflow year with less drifting food compared to 2012 and 2011 (**Figures 17a−b**). Upstream of Zayante Creek, densities of the small YOY in the Size Class 1 category mirrored YOY density (**Tables 18 and 20**).

Table 17. Density of Juvenile Steelhead for ALL SIZES at MAINSTEM SAN LORENZO RIVER Monitoring Sites (Excluding Lagoon) in 1997-2001 and 2003-2013.

Sample Site	1997 E-M	1998 L-W	1999 L-W	2000 E-W	2001 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	2013 E-D	Avg.
0a				5.4								2.4	20.4	2.1	26.9	4.6	10.3
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	4.2	10.3
2a	74.9	21.4	4.6	3.9	13.5					14.8	20.6	9.2	28.4	11.2	6.7	8.1	18.1
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	21.3	31.7
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	20.6	16.8
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	30.7	38.4
9	126.8	77.3	27.6	12.0	29.6	17.4	10.9	17.1								20.9	35.7
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	5.7	25.9
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	42.4	43.4

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

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 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 2003-2013.

Sample Site	1997 E-M	1998 L-W	1999 L-W	2000 E-W	2001 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	2013 E-D	Avg.
0a				2.2								1.2	19.0	2.1	23.4	4.6	8.8
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	4.1	9.3
2a	66.3	19.2	3.2	2.7	11.0					13.7	19.0	8.1	27.6	8.6	6.4	8.1	18.1
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	19.9	30.0
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	20.5	15.8
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	30.1	36.5
9	119.9	69.7	23.4	11.0	28.9	17.6	10.0	15.4								20.8	35.2
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	3.4	22.9
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	32.5	33.7

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

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 19. Density of Juvenile Steelhead for YEARLINGS AND OLDER at MAINSTEM SAN LORENZO RIVER Monitoring Sites in 1997-2001 and 2003-2013.

Sample Site	1997 E-M	1998 L-W	1999 L-W	2000 E-W	2001 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	2013 E-D	Avg.
0a				2.2								1.2	1.7	0	3.9	0	1.5
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	0.1	0.8
2a	7.9	1.5	0.9	1.2	1.5					0.9	0.4	1.0	0.5	2.2	0.4	0	1.6
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	0.2	1.6
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	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	0.5	1.8
9	4.3	8.1	2.5	1.0	0.6	0.8	1.9	2.5								0.2	2.4
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	2.3	4.0
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	10.0	9.6

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

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 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 2003-2013.

Sample Site	1997 E-M	1998 L-W	1999 L-W	2000 E-W	2001 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	2013 E-D	Avg.
0a				0								0	0.6	0	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	0.8
2a	7.9	1.3	0.4	0.2	2.5					3.7	8.4	1.2	6.0	0	0.1	1.9	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	14.6	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	18.6	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	28.8	32.5
9	102.2	57.5	18.5	6.2	28.4	15.4	9.6	12.2								18.6	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	3.4	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	32.5	31.9

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

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 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 2003-2013.

Sample Site	1997 E-M	1998 L-W	1999 L-W	2000 E-W	2001 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	2013 E-D	Avg.
0a				5.4								2.4	19.8	2.1	26.9	4.1	10.1
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	3.4	9.5
2a	67.0	20.1	4.2	3.7	11.0					11.1	12.2	8.0	22.4	11.2	6.6	6.2	15.3
2b				23.6	8.7												16.1
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	6.7	14.7
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	2.0	4.3
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	1.9	6.2
9	24.6	19.8	9.1	5.8	1.2	2.0	1.3	4.9								2.3	7.9
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	2.3	6.3
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	10.0	11.4

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

At mainstem sites, 2013 soon-to-smolt ratings were the same as in 2012 at 1 of 8 sites (**Table 40**). That was at Site 12b in Waterman Gap with a rating of "good" both years. However, Site 12b may not have been accessible to steelhead. All other sites were rated between "very poor" and "below average," with 4 of 8 decreasing in rating. Worse ratings resulted from fewer YOY reaching Size Class II after a late spawn, reduced baseflow and slower growth. Three sites had "very poor" ratings due to below average YOY densities and small size of the category II fish (<=75 mm SL).

In tributaries of the San Lorenzo River, total and YOY juvenile steelhead densities increased at Zayante, Bean, lower Boulder and upper Branciforte sites in 2013; 7 of 12 sites increased for total density and 6 of 12 sites increased for YOY compared to 2012 (**Tables 22 and 23**). Densities for both age categories were above average at 8 of 13 sites (**Figures 1 and 2**). The lowest YOY density and near absence of YOY (1.3 YOY/ 100 ft) was Bear Site 18a, likely due to a log jam that developed at a dam remnant below the Lanktree Road Bridge. Bean 14c went dry before fall sampling, as it did after sampling in 2012, to eliminate typically high densities of steelhead inhabiting the area. At 6 of 13 tributary sites in 2013, YOY were dominated by smaller YOY than the previous year. Exceptions were Lompico 13e (similarly small), Fall 15 (similarly small), Newell 16 (larger and similar density), Boulder 17b (similarly small), Bear 18a (larger but nearly absent in 2013), Branciforte 21a-2 (larger but much lower density in 2013) and Branciforte 21b (similarly small), with typical small size presumably due to late spawning, followed by slower growth rate from less baseflow. The unusually larger YOY found in Newell Creek may have resulted from artificially provided, unnaturally high and consistent baseflow from dam releases in summer and fall in both years and possibly earlier spawning with improved habitat and equivalent survival in 2013. The city of Santa Cruz has a minimum bypass of 1 cfs throughout the year from Loch Lomond dam.

On the whole, yearling densities in 2013 were relatively low in tributaries and mostly less than in 2012. Yearling densities increased at 5 of 12 tributary sites in 2013 (only slightly higher at Zayante 13c, Newell 16 and Boulder 17b) (**Table 24**), while they were above average at 4 upper tributary sites of 12 sites (Zayante 13d, Lompico 13e, Boulder 17b and Branciforte 21b) (**Table 24; Figure 3**).

Size Class II and III densities (soon-to-smolt sized fish) were less than in 2012 at 8 of 12 tributary sites and below average at 8 of 12 sites (1 of which was average and 4 within 2 fish/ 100 ft of average) (**Table 25; Figures 4 and 24**). The poor showing in tributaries occurred because the juvenile steelhead population in 2013 was dominated by small YOY at mostly below average densities and yearlings at mostly below average densities. The largest increase in density was at Newell Site 16, resulting from a high proportion of YOY reaching Size Class II. With its relatively high survival of yearlings at Zayante Site 13d, Size Class II densities were high, though they were down at Zayante Site 13c with slow YOY growth and very low at Zayante 13a with the dispersal of wood at the formerly large wood cluster and slow YOY growth. Soon-to-smolt ratings declined at 9 of 12 tributary sites in 2013, with improvements at Zayante 13d, Lompico 13e and Newell 16 (**Table 40**). Ratings were “poor” at lower Zayante 13a and “below average” at middle Zayante 13c, lower Boulder 17a and lower Bear 18a. Ratings were “fair” at 4 tributary sites (Bean 14b, Fall 15, Boulder 17b, and Branciforte 21a-2 and 21b). Ratings were “good” at Lompico 13e (relatively high survival of yearlings) and Newell 16 (good YOY growth rate) and “very good” at Zayante 13d (relatively high of yearlings).

Table 22. TOTAL DENSITY of Juvenile Steelhead at SAN LORENZO TRIBUTARY Monitoring Sites in 1997-2001 and 2003-2013.

Sample Site	1997 E-M	1998 L-W	1999 L-W	2000 E-W	2001 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	2013 E-D	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	91.7	55.5
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	189.4	75.5
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	169.7	104.5
Lomp 13e									26.2	108.3	27.8	123.3	23.1	16.6	54.8	56.3	54.6
Bean 14a		44.2	45.9	17.0	38.0	50.9	31.9	54.0									40.3

Sample Site	1997 E-M	1998 L-W	1999 L-W	2000 E-W	2001 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	2013 E-D	Avg.
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	27.7	57.0
Bean 14c		78.2	22.7	87.5	36.8	41.3	99.6	87.4	66.0	18.2	0 Dry	0 Dry	58.8	29.1	0 (95.2 before Went dry)	0 Dry	41.7
Fall 15	84.5	82.7	85.0	55.0	59.8						84.0	48.7	46.1	78.5	101.5	92.6	74.4
Newell 16	94.9	76.3	40.5	28.8	40.3				26.0			18.6	32.5	13.4	37.7	36.8	40.5
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	73.2	55.8
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	90.3	67.4
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	3.3	57.8
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	10.9	38.7
Branc 21b		67.8	57.6	59.6	57.5			20.4							50.7	69.9	54.8
Branc 21c																15.7	15.7

*** Density in number of fish per 100 feet of stream.**
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 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 2003-2013.

Sample Site	1997 E-M	1998 L-W	1999 L-W	2000 E-W	2001 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	2013 E-D	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	72.2	50.7
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	187.6	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	151.2	85.8
Lomp 13e									24.2	96.9	21.4	118.4	14.4	14.2	52.5	47.7	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	26.9	50.1
Bean 14c		71.8	6.9	76.6	18.1	23.0	87.4	81.5	61.1	5.6	0 (Dry)	0 (Dry)	55.7	27.2	0 (58.1 B4 dry)	0 (Dry)	36.8
Fall 15	79.6	74.8	68.1	45.1	45.4						68.2	0 30.6	33.5	71.7	86.2	84.3	60.3
Newell 16	77.1	67.6	17.7	19.9	35.6				20.1			15.0	31.2	13.1	37.1	33.7	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	70.0	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	79.6	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	1.3	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	10.0	34.0
Branc 21b		60.1	44.2	45.8	49.4			9.1							23.4	56.7	38.7
Branc 21c																5.7	5.7

*** Density in number of fish per 100 feet of stream.**
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 24. Density of Juvenile Steelhead for YEARLING and OLDER Fish at SAN LORENZO TRIBUTARY Monitoring Sites in 1997-2001 and 2003-2013.

Sample Site	1997 E-M	1998 L-W	1999 L-W	2000 E-W	2001 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	2013 E-D	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	0.3	4.0
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	2.9	7.3
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	18.5	14.1
Lomp 13e									1.9	11.3	6.4	4.9	8.7	3.3	2.3	8.7	5.9
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	1.1	8.4
Bean 14c		6.4	15.8	10.9	18.7	18.3	12.2	5.9	4.1	5.4	0 Dry	0 (Dry)	3.1	1.8	0 (2.6 B4 dry)	0 (Dry)	6.8
Fall 15	4.9	7.9	16.9	9.9	14.4						15.8	18.0	12.3	6.5	14.5	8.3	11.8
Newell 16	17.8	8.7	22.8	8.9	4.7				5.4			3.9	1.5	0.6	1.2	2.8	7.2
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	3.2	7.3
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	10.7	8.3
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	2.0	8.3
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	1.5	6.6
Branc 21b		7.6	13.4	11.1	8.1			11.3							27.3	13.3	13.1
Branc 21c																10.0	10.0

*** Density in number of fish per 100 feet of stream.**
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 25. Density of Juvenile Steelhead for SIZE CLASS II/III (=>75 mm SL) Fish at SAN LORENZO TRIBUTARY Monitoring Sites in 1998-2001 and 2003-2013.

Sample Site	1997 E-M	1998 L-W	1999 L-W	2000 E-W	2001 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	2013 E-D	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	2.7	10.5
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	8.4	14.2
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	18.5	15.8
Lomp 13e									5.7	11.3	6.4	4.9	8.7	7.8	2.3	8.7	7.0
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	12.5	12.6
Bean 14c		6.4	15.8	10.9	18.4	18.3	12.2	12.4	17.1	5.4	0 Dry	0 Dry	6.7	8.8	0 (5.2 B4 Dry)	0 (Dry)	8.8
Fall 15	8.2	13.3	16.9	9.9	13.0						15.8	18.7	14.3	14.7	13.0	12.1	13.6
Newell 16	23.6	14.9	22.8	8.9	4.7				16.2			4.4	24.7	13.1	7.3	23.7	15.0
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	3.2	11.3
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	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	2.6	10.5
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 0a		11.5	5.7	4.1	3.1												6.1
Carb 0b		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	6.0	9.5
Branc 21b		14.8	13.4	11.1	8.1			16.0							27.3	13.3	14.8
Branc 21c																10.0	10.0

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

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-7. 2013 Densities in Soquel Creek Compared with Those Since 1997

Total densities increased in 2013 at 6 of 7 sites, and YOY densities increased at all 7 sites compared to 2012 (**Tables 26 and 27**). Site 12 in Reach 8 of the upper mainstem was abundant with small YOY (134 YOY/ 100 ft). Total and YOY densities were above average at 6 of 7 sites, with Site 16 in the SDSF much below average, as it has been since 2010 (**Figures 5 and 6**). Apparently, there were insufficient spawners to seed the SDSF site with YOY in 2013 after December 2012, and YOY survival was likely poor due to very low baseflows through the summer (**Table 5b**; **Figure 37b**). The trend in total densities (consisting of mostly YOY) for the watershed showed another increase in 2013 (**Figure 25**). 2013 yearling densities showed a similar pattern to those in the San Lorenzo, with a decline at 4 of 7 sites, generally low yearling densities throughout and near average at all sites (**Table 28; Figure 7**). The high survival/retention of yearlings in the mild winter of 2012 was not repeated in 2013 in which two large December stormflows occurred (4,500+ cfs and 6,000+ cfs) (**Figure 37a**). Increased total and YOY densities and decreased Size Class II/III densities in 2013 compared to 2012 were statistically significant (**Table 44**).

Despite the higher density of YOY's at all sites in 2013, the trend in Size Class II and III densities declined precipitously in Soquel Creek to a low level not seen since the dry year of 2008 (**Figure 26**). This was because few YOY grew into these soon-to-smolt size classes compared to past years and few yearlings remained in the watershed due to the high stormflows in December (**Figure 18a and 18b**). 2013 densities of Size Class II and III juveniles were less than in 2012 and below average at all 7 sites (**Table 30; Figure 8**). Spring and early summer baseflows were substantially below median statistic to hinder YOY from growing into the soon-to-smolt size class (**Figure 37)**. The juvenile steelhead population consisted primarily of an above average abundance of little Size Class 1 steelhead at all sites except Site 16 in the SDSF (**Table 29**). Soon-to-smolt density ratings declined at 6 of 7 sites, while 6 sites were rated between "very poor and "below average" (**Table 40**). Only Site 19 in the West Branch was rated as good as "fair." This was likely because a wood cluster existed at the sampling site and a few larger yearling steelhead were retained there to increase the rating from "below average" to "fair."

Table 26. TOTAL Juvenile Steelhead SITE DENSITIES (fish/ 100 ft) at Monitoring Sites in SOQUEL CREEK in 1997–2013.
(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	2013 E-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	10.7	6.1
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	20.4	19.4
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	54.9	32.8
11- Below Purling Br	81.9	13.1	10.5	13.1	31.6	-	-	-	-	-	-	-						30.0
12- Near Soquel Ck Bridge	83.5	19.5	17.4	12.0	34.4	65.5	20.1	48.5	21.3	-	50.7	61.8	37.4	12.3	6.0	33.8	133.8	41.1
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	61.2	47.6
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	42.2	106.6
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	58.2	36.5
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 1997–2013. (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	2013 E-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	9.6	5.0
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	19.1	17.5
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	54.0	31.0
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	133.1	39.1
13a- Below Mill Pond	75.3	57.4	20.9	24.5	24.0	73.4	30.9	109.9	41.7	2.5	34.6	55.0	21.4	35.2	8.3	37.8	56.6	41.7
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	36.0	99.0
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	55.5	35.2
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 1997–2013.
(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	2013 E-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	0.4	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	1.2	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	0.7	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	1.1	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	4.0	2.4
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	6.2	7.6
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	2.7	1.5
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 1997–2013.
(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	2013 E-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	8.9	2.1
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	18.3	10.3
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	49.6	23.7
11- Below Purling Br	60.5	0.9	4.1	2.8	29.1	-	-	-	-	-	-	-						19.5
12- Near Soquel Ck Rd Br	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	130.8	33.0
13a- Below Mill Pond	60.2	30.4	13.0	16.4	23.1	138.3	29.8	109.9	20.8	0	31.8	53.9	11.6	4.3	0.7	22.5	54.4	36.0
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 *	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	36.0	96.2
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	54.8	30.3

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 Fall II	-	-	-	-	-	56.2	24.7	50.9	0.3	3.9	-	-						27.2

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

Table 30. SITE DENSITIES (fish/ 100 ft) of Juvenile Steelhead by SIZE CLASS II/III at Monitoring Sites in SOQUEL CREEK in 1997–2013.
(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	2013 E-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	1.8	4.0
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	2.1	9.1
5-Adj. Beach Shack	18.1	20.6	7.8	8.1	6.4	-	-	-	-	-	-	-						12.2
6-End of Cherry-vale	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	5.2	9.0
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	3.1	8.1
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	6.8	11.0
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	6.2	10.3
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	3.4	6.4

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 2013 Densities in Aptos Creek with Previous Years

The Aptos Watershed's sampling sites did not indicate higher YOY and total densities in 2013 as occurred at some sites in the San Lorenzo and Soquel watersheds, yet they were below average (**Tables 31b and 32; Figures 9 and 10**). Both sites followed the pattern in these other watersheds with below average yearling densities that were less than in 2012 (**Table 33; Figure 27**). With the lower survival of yearlings and a lower percent of YOY reaching Size Class II (low baseflow unlike 2011), the Size Class II and III densities were below average and less than in 2012 at both sites (**Table 35; Figures 11 and 19a–b**). In Aptos Creek, average Size Class II and III density increased from 2008 to 2010, but declined steadily after that to a 2013 low level, the lowest thus far calculated (**Figure 28**). This low soon-to-smolt density likely resulted from many yearlings being lost of forced to immigrate early from the large December storms, poor YOY production and then poor growth of YOY fish at the lower site due to low baseflow in spring and early summer.

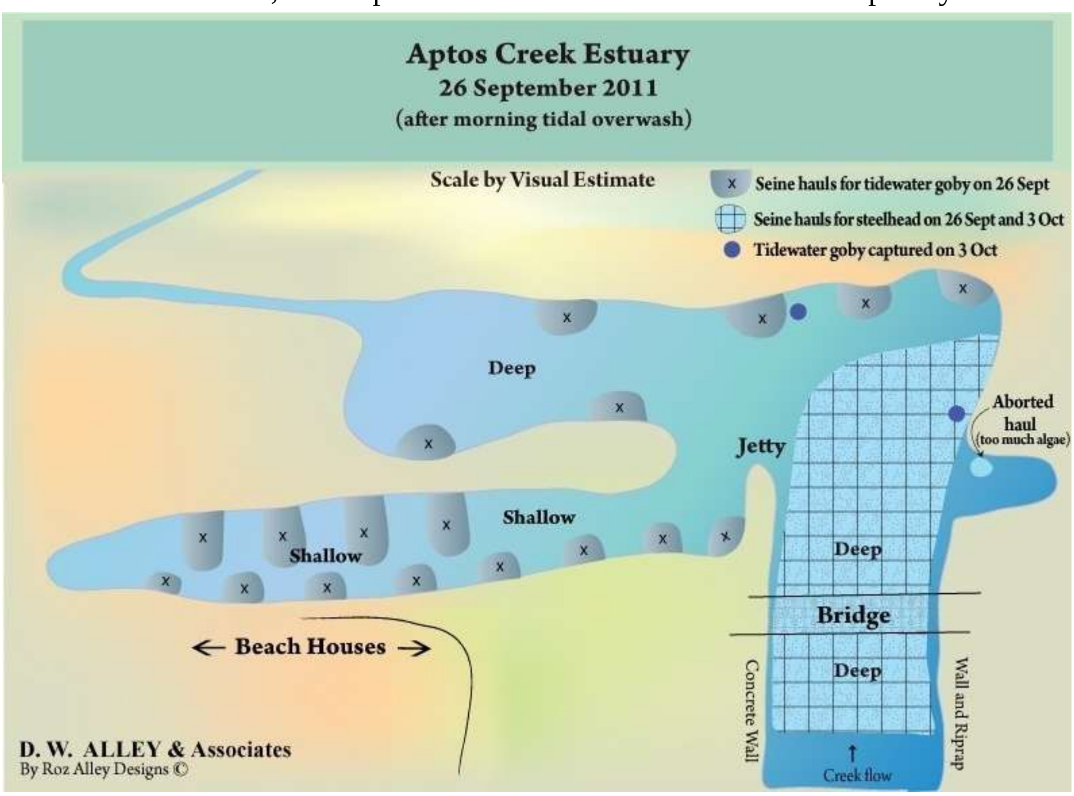
R-9. Steelhead Population Estimate for the Aptos Lagoon/Estuary and Tidewater Goby Use in 2013

Aptos estuary/lagoon in fall 2013 had a much smaller juvenile steelhead population than the two previous years, with the typical rapid growth rate compared to those captured in stream habitat. Poor water quality in the lagoon may have forced juveniles to avoid the lower estuary in 2013. We suspect that a substantial percent of out-migrating smolts and returning adults spend residence time in the estuary/lagoon in most years. Soquel Lagoon is also habitat for a sizeable juvenile steelhead population, as indicated by our long-term population censusing for the City of Capitola. A small population of tidewater goby still existed in Aptos estuary/lagoon in fall 2013, despite an open sandbar in fall during fish sampling. Tidewater gobies are typically found along freshwater lagoon margins having aquatic algae and other aquatic vegetation. In 2013, tidewater gobies were most abundant along the jetty and along the western estuary margin, 30 feet downstream from the bridge, as was the case in previous years.

Steelhead were captured on 12 September from 6 seine hauls with a 106-ft long bag seine (6 feet high by 3/8-inch mesh) in the main estuary. On 19 September 2013, steelhead were again sampled with 7 seine hauls with the bag seine in the main estuary. On 12 September 2013, 27 juvenile steelhead were captured and marked, along with capturing and releasing 1 staghorn sculpin (*Leptocottus armatus*) and numerous smelt (*Atherinops spp.*). On 19 September 2013, only 6 juvenile steelhead were captured with the larger seine (5 recaptures), along with smelt. There were no steelhead mortalities (estimated population size of ***32*** in 2013 compared to ***140*** in 2012 and ***423*** in 2011). A bimodal distribution of juvenile steelhead lengths occurred as had been detected in 2011 (**Figures 43 and 44b**).

In addition, on 12 and 19 September 2013, the periphery of the estuary east and west of the jetty was sampled for tidewater goby and other small fishes. Three seine hauls were made on 12 September and 5 seine hauls were made on 19 September 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 separate dead end finger present in 2013 near the residences, as occurred in 2011 (**see illustration below**). 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. A total of 170 tidewater gobies were captured from 11 seine hauls east and west of the jetty on the two days of seining. Other species captured included 6 pipefish (*Syngnathus leptorhynchus),* 2 prickly sculpin (*Cottus asper*), 24 smelt and numerous threespine sticklebacks (*Gasterosteus aculeatus*).

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. This occurred at Aptos Lagoon/Estuary. 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. The gage height increased nearly a foot from 3.76 ft on 12 September to 4.64 ft on 19 September due to ensuing tidal overwash. The estuary was open to the ocean during both fish samplings, with poor water quality below 0.75 meters, resulting from well-defined stratification in salinity, temperature and oxygen through the water column (**Table 31a**). We would have expected a closed sandbar under such low stream inflow rate to the estuary, based on 15+ years of monitoring sandbar dynamics on other similar sized streams, San Simeon and Santa Rosa Creek lagoons near Cambria, California. Therefore, we suspect that the sandbar was maintained open by artificial means.



(No presence of isolated estuary finger adjacent to beach houses in 2013.
Sand peninsula between finger and deep zone in 2011 was absent in 2013.)

Table 31a. Water Quality on 12 and 19 September 2013 at Aptos Estuary, Prior to Fish Sampling.

Gage ht. 3.76 ft	Air temp. 18.9° C	0759 hr	12 Sep 2013		Gage ht. 4.64 ft	Air temp. 10.8° C	0745 hr	19 Sep 2013
	Walk- bridge over Aptos Estuary				**Walk-bridge over Aptos Estuary**			
Depth	**Temp**	**Salin**	**O2**	**Cond**	**Temp**	**Salin**	**O2**	**Cond**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	17.0	1.8	9.51	2967	17.6	4.6	10.24	7150
0.25	18.3	1.9	9.55	3062	17.8	4.7	10.29	7172
0.50	20.7	6.4	11.63	10466	17.8	4.7	10.51	7193
0.75	23.1	8.4	12.64	13925	22.1	6.9	10.74	11367
1.00	24.1	15.2	10.08	25277	24.9	8.4	13.34	14480
1.25	25.6	25.6	5.74	32148	27.5	14.6	11.34	25247
1.50	26.6	26.2	1.16	39620	27.9	16.4	5.25	28335
1.75 b	26.7	26.5	0.11	42809	28.6	18.0	0.36	31288
2.00 b					29.2	23.0	0	40715
2.25								

Table 31b. TOTAL DENSITY of Juvenile Steelhead at Monitoring Sites in APTOS, VALENCIA, CORRALITOS, SHINGLE MILL and BROWNS VALLEY Creeks, 1981, 1994 and 2006–2013.

Sample Site	1981	1994	2006	2007	2008	2009	2010	2011	2012	2013	Avg.
Aptos #3- in County Park	35.2*	–	26.2	61.7	45.4	8.5	39.4	10.3	24.5	25.9	30.8
Aptos #4- above steel Bridge Xing Nisene Marks	43.0	–	38.6	26.8	89.3	8.0	21.7	21.6	65.5	23.5	36.9
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	41.1	39.0
Corralitos #3- Above Colinas Dr	39.1	18.6	35.5	42.1	35.9	14.9	6.2	16.2	60.2	44.1	31.3
Corralitos #8- Below Eureka Glch	81.9	28.6	49.0	52.9	55.9	51.9	20.1	34.0	27.6	30.7	43.3
Corralitos #9- Above Eureka Glch	86.1	29.9	87.1	38.5	61.7	73.2	33.6	38.7	49.2	43.4	54.1
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	8.9	19.8
Shingle Mill #3- Above 2nd Road Xing	32.6	–	22.9	12.7	24.5	21.8	33.1	22.3	24.8	20.7	23.9
Browns Valley #1- Below Dam	54.3	22.5	101.6	35.4	36.5	25.6	24.9	45.6	52.2	35.5	43.4
Browns Valley #2- Above Dam	71.6	18.5	99.5	79.0	44.8	54.9	41.4	49.2	69.1	33.4	56.2

*** 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, 2006–2013.

Sample Site	1981	1994	2006	2007	2008	2009	2010	2011	2012	2013	Avg.
Aptos #3- in County Park	24.4*	–	23.7	54.0	43.4	3.3	37.3	8.9	17.5	22.4	26.1
Aptos #4- above steel Bridge Xing Nisene Marks	37.1	–	35.2	9.8	84.6	3.9	20.1	20.7	52.4	18.6	31.4
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	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	30.4	32.4
Corralitos #3- Above Colinas Dr	33.9	10.2	24.6	30.6	27.6	9.8	5.2	14.2	38.5	34.7	22.9
Corralitos #8- Below Eureka Gulch	59.7	14.3	45.0	44.0	46.6	39.3	19.0	29.4	18.2	28.9	34.5
Corralitos #9- Above Eureka Gulch	55.8	16.7	78.4	31.3	44.6	54.0	30.7	33.5	36.9	32.9	41.5
Shingle Mill #1- Below 2nd Road Xing	14.3	5.7	25.1	2.9	13.2	0	7.0	15.7	21.0	2.0	10.7
Shingle Mill #3- Above 2nd Road Xing	18.6	–	19.5	6.0	23.9	18.4	25.2	14.3	19.1	14.7	17.7
Browns Valley #1- Below Dam	26.9	7.0	96.6	15.3	25.0	8.9	21.4	41.8	34.6	17.4	29.5
Browns Valley #2- Above Dam	66.1	12.8	94.7	47.0	32.2	43.0	38.8	45.2	48.9	23.1	45.2

*** 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 2006–2013.

Sample Site	1981	1994	2006	2007	2008	2009	2010	2011	2012	2013	Avg.
Aptos #3- in County Park	10.8*	–	3.1	7.6	2.3	5.2	1.9	1.4	6.4	3.5	4.7
Aptos #4- above steel Bridge Xing Nisene Marks	5.9	–	3.0	17.1	4.9	3.9	1.0	2.8	8.9	5.1	5.8
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	10.7	6.5
Corralitos #3- Above Colinas Dr	5.2	8.4	10.8	11.5	8.3	5.3	1.1	1.8	20.5	9.6	8.3
Corralitos #8- Below Eureka Gulch	22.2	14.3	4.0	9.0	9.4	13.2	1.1	3.9	9.4	1.8	8.8
Corralitos #9- Above Eureka Gulch	30.3	13.2	9.5	7.2	17.1	19.2	2.8	5.1	12.2	10.5	12.8
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	6.9	9.2
Shingle Mill #3- Above 2nd Road Xing	14.0	–	3.4	6.7	0.7	7.2	6.1	8.0	5.7	6.9	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	18.0	13.5
Browns Valley #2- Above Dam	5.5	7.7	2.8	32.0	12.6	11.9	2.0	4.3	20.2	10.4	10.9

*** 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, 2006–2013.

Sample Site	1981	1994	2006	2007	2008	2009	2010	2011	2012	2013	Avg.
Aptos #3- in County Park	24.4*	–	7.2	50.8	39.4	3.3	22.2	3.2	12.9	20.8	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	17.4	27.2
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	29.0	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	33.4	20.5
Corralitos #8- Below Eureka Gulch	59.7	14.3	35.8	43.0	46.6	36.6	14.1	21.7	18.2	28.9	31.9
Corralitos #9- Above Eureka Gulch	55.8	16.7	45.5	31.3	44.6	53.5	22.4	24.2	36.5	32.9	36.3
Shingle Mill #1- Below 2nd Road Xing	14.3	5.7	17.7	2.9	13.2	0	5.6	15.0	21.0	2.0	9.7
Shingle Mill #3- Above 2nd Road Xing	32.4	–	19.5	6.0	23.9	18.4	25.2	14.3	19.1	17.6	19.6
Browns Valley #1- Below Dam	26.9	7.0	84.6	18.1	25.0	8.9	14.8	31.4	34.6	17.4	26.9
Browns Valley #2- Above Dam	66.1	12.8	82.6	48.8	32.2	43.0	32.0	35.9	48.9	23.7	42.6

*** 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 2006–2013.

Sample Site	1981	1994	2006	2007	2008	2009	2010	2011	2012	2013	Avg.
Aptos #3- in County Park	10.8*	–	19.0	10.9	6.0	5.2	17.2	7.1	11.6	5.1	10.3
Aptos #4- above steel Bridge Xing Nisene Marks	5.9	–	10.1	17.8	5.5	8.0	9.7	16.7	9.6	6.1	9.9
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	12.1	9.8
Corralitos #3- Above Colinas Dr.	5.2	8.4	19.3	11.5	8.3	9.3	5.5	6.6	24.2	10.7	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	1.8	11.3
Corralitos #9- Above Eureka Gulch	30.3	13.2	41.6	7.2	17.1	19.7	11.2	14.5	12.7	10.5	17.8
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	6.9	10.1
Shingle Mill #3- Above 2nd Road Xing	4.0	–	3.4	6.7	0.7	7.2	6.1	8.0	5.7	3.1	5.0
Browns Valley #1- Below Dam	27.4	15.5	17.0	17.4	11.5	12.9	10.1	14.2	17.6	18.0	16.2
Browns Valley #2- Above Dam	5.5	5.7	16.9	30.2	12.6	11.9	9.4	13.3	20.2	9.6	13.6

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

R-10. Comparison of 2013 Steelhead Densities in the Corralitos Sub-Watershed and Pajaro Lagoon

In 2013, Corralitos Creek was still recovering from the Summit fire of 2008 that caused high sedimentation to Corralitos Creek over the 2009-2010 winter, mostly downstream of Shingle Mill Gulch and not in Browns Creek. In 2013, YOY densities were generally below average or close to average in this sub-watershed and less than in 2012 at 7 of 8 sites (**Table 32; Figure 14**). The two Browns Creek sites were the most below average and had low measured fall baseflow (0.1 cfs above the Browns Creek dam) (**Table 5b**). YOY densities above and below the Corralitos dam were similar, indicating successful adult fish passage through the fish ladders. Yearling densities varied widely at sites, with half being above average and the majority being less than in 2012 (**Table 33; Figure 15**). Total juvenile densities followed a similar pattern to YOY densities. However, with higher survival/retention of yearlings at the lower Browns Creek site brought total density closer to average (**Table 31b; Figures 13***)*. The decrease in total juvenile densities at sites was statistically significant (**Table 45**).

In 2013, Size Class II densities were less than those in 2012 at 6 of 8 sites and below average at 5 of 8 sites and close to average at the others (**Table 35; Figure 16**). Relatively high survival of yearlings at Browns Site 1 gave it the highest density of soon-to-smolt fish (18 fish/ 100 ft). Average or below average densities of yearlings at other sites, along with the absence of YOY reaching Size Class II (low baseflow (**Table 5b**)) lead to relatively low densities of the larger fish compared to 2012 when more yearlings were retained and compared to the wetter 2011 that allowed faster growth rate (**Figures 20a−20b**).

The mostly below average densities of YOY and Size Class II steelhead and the reductions from 2012 were consistent with lower baseflow that reduced habitat quality. Pool depth and escape cover had improved since 2009 according to reach-wide habitat typing, and fine sediment and embeddedness had also improved above the Browns creek dam (**Table 16c**). These improved non-flow-related habitat improvements were consistent with higher yearling survival at the Browns Site 1 (**Table 33**), which had more depth and escape cover than the previously used, representative site (**Table 16b**). The extremely low yearling density at Corralitos Site 8 near Clipper Gulch was consistent with poor pool development (shallow pool depth) and limited escape cover in a reach that was still badly sedimented (**Table 16b**) from the 2008 fire.

R-11. Sampling Results for the Pajaro River Estuary in 2013

No steelhead were captured in Pajaro River Estuary in fall 2013, as was the case in fall 2012. A small population of tidewater goby still existed in 2013. However, its future is uncertain due to potential conflicts between maintaining fish habitat and flood control.

<u>Methods</u>

The purpose of sampling was to determine presence/absence and distribution of tidewater goby and steelhead. The barrier beach sandbar was slightly open. The 106-foot bag seine (3/8-inch mesh) was used on 4 and 8 October to capture steelhead. The lower lagoon, oriented parallel to the beach, was sampled on 4 October (8 seine hauls in 8 locations along the full extent) (**Table 36**). The upper lagoon, oriented perpendicular to the beach, was sampled on 8 October (3 successful seine hauls adjacent the model airport; 1 unsuccessful haul under Thurwachter Bridge) (**Table 37**). A thick layer of detrital ooze on the bottom prevented seining under the Thurwachter Bridge where it was done in 2012. On 7 October, the periphery of the lower lagoon (7 seine hauls) and the upper lagoon (1 seine haul) were sampled with the smaller, 30-foot goby seine with 1/8-inch mesh (**Table 38**).

<u>Water Quality</u>

On overcast 7 October during goby sampling along the beachfront of the lower lagoon, the salinity was uniformly high, ranging from a minimum of 22.9 ppt at the surface to a maximum of 27.4 ppt at the bottom at one meter depth, with a water temperature between a minimum of 15.8°C at the surface and a maximum of 18.9°C at the bottom between 1005 hr and 1344 hr (oxygen concentration ranging from 14.7 mg/l at the surface to 4.0 mg/l at the bottom nearest Pajaro Dunes and ranging between 10.3 and 18.1 mg/l through the water column in late morning/ early afternoon at sites further east).

On 8 October, the station at the model airport below Thurwachter Bridge on October 8 was cooler at the surface at 1020 hr (air temperature of 15.5˚C) than upstream the previous day. However, salinity stratification was very evident, with oxygen dropping from 16.3 mg/l at the surface to 4.5 mg/L at 0.5 meters down to 0.3 mg/l at the bottom (1 meter) and temperature increasing from 19˚ C at the surface steadily to 24˚ C at the bottom.

Approximately 3 miles upstream of the Watsonville Slough confluence at 1520 hr on 7 October, water temperature, salinity and oxygen stratification were measured at the surface to be 6.4 ppt salinity, 23.4° C water temperature and 31.9 mg/l oxygen (very supersaturated) and at the bottom to be 25.6 ppt salinity, 24.4° C water temperature and 0.2 mg/l oxygen at the bottom of 0.85 meter, approximately 30 meters out from the estuary margin. The cloud layer had burned off by this time.

Fish Sampling Results for Pajaro Estuary

Results of sampling the lower lagoon on 4 October with the large beach seine, oriented parallel to the beach, yielded 9 native fish species (**Table 36**). Species absent in the 2013 catch which were present in 2012 included hitch, Sacramento suckers, yellowfin goby and striped bass. Smelt and crabs were more common in 2013. One purple octopus was captured. Results of sampling the upper lagoon near the model airport yielded tidewater gobies, despite the 3/8-inch mesh size (**Table 37**). Our tidewater goby sampling on 7 October yielded low densities along the periphery of the lower lagoon and high abundance at the boat ramp in the upper lagoon (**Table 38**).

Table 36. Fish capture* results from sampling lower Pajaro Lagoon *with the 106-foot bag seine (3/8-inch mesh)*, 4 October 2013.

Date	**Location**	**Seine Haul**	**Tide-water Goby**	**Arrow goby**	**Pacific herring**	**Bay pipe-fish**	**Shiner Surf-perch**	**Smelt (jack and top)**	**Staghorn Sculpin**	**Three-spine stickle-back**	**Prickly sculpin**
4 Oct 2013	East of Watsonville Slough Confluence	1			1	1	1	311	8		
	East of #1	2						120			
	East of #2	3				1		107			
	East of #3	4	3	1				235	2	36	
	East of #4	5					1	147			
	East of #5	6						53		6	
	East of #6	7						14			
	Adj. mouth of Watsonville Slough	8					1	461	1	5	4
Total			**3**	**1**	**1**	**2**	**3**	**1,448**	**11**	**47**	**4**

*Crabs (likely Dungeness and another species) captured in every seine haul (n= 300+). 1 purple octopus captured in seine haul #8.

Table 37. Fish capture results from sampling Upper Pajaro Lagoon *with the 106-foot bag seine (3/8 inch (3/8-inch mesh)*, 8 October 2013.

Date	**Location**	**Seine Haul**	**Tide-water Goby**	**Smelt (jack and top)**	**Three-spine Stickle-back**
8 Oct 2013	Model Airport- 0.3 miles downstream of Thurwachter Br	1		220	20+
	Same	2		18	20+
	Same	3	32	170	20+
Total			**32**	**408**	**60+**

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)*, 7 October 2013.

Date	Location	Seine Haul	Tide-water Goby	Arrow goby	Bay pipe-fish	Smelt (jack and top)	Staghorn Sculpin	Three-spine stickle-back
7 Oct 2013	Approx. 200 m east of Pajaro Dunes Complex	1	10				1	
	East of #1	2	5		4		5	1
	East of #2	3	18		2	38	6	
	East of #3	4	13	1		50	2	
	East of #4	5	23	13			1	25+
	East of #5	6	1					
	East of #6	7	10	12				5
	0.8 miles upstream of Thurwachter Bridge and 2.9 miles upstream of Watsonville Slough confl.	8	321					200+
Total			**401**	**26**	**6**	**88**	**15**	**231+**

*Crabs (likely Dungeness and another species) captured on 6 seine hauls, not easternmost #7 or upper estuary #8.

Conclusions- Pajaro Estuary

An expansive estuary had formed behind the sandbar with its shallow opening to the Bay in summer 2013. It extended upstream past Highway 1, more than three miles from the beach. The estuary was eutrophic, with an algal bloom observed. No steelhead were detected in Pajaro Estuary in 2013, although sampling of the upper lagoon was difficult because of the limited landing areas for the seine and heavy detritus on the bottom. A small population of tidewater goby still existed in Pajaro Lagoon in fall 2013. The highest density was at the uppermost site, 3 miles upstream of Watsonville Slough. The open estuary 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. Water quality measurements detected stratification of salinity, temperature and oxygen between 2 and 3 miles upstream of Watsonville Slough and oxygen depletion down the water column. Stratification was also detected near the confluence with Watsonville Slough, but not as extreme as further upstream. East of Watsonville Slough in the shallow main estuary, salinity was uniformly high through the water column with a 3 degree C increase from top to bottom. Oxygen remained high throughout the water column. Oxygen concentrations and water temperature were tolerable for steelhead in the upper water column at all locations.

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-12. Rating of Rearing Habitat in 2013, 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. Assumptions included that spawning rarely limited juvenile steelhead abundance and that sufficient yearlings survived overwinter to saturate the rearing habitat. This was highly unlikely in 2013.

For 2012 and 2013, smolt-sized juvenile ratings for sampling sites were tabulated and summarized (**Tables 39 and 40**). Three sites in the San Lorenzo drainage improved substantially. Zayante 13d went from "good" to "very good" and Lompico 13e went from "below average" to "good" due to higher yearling densities. Newell 16 went from "below average" to "good" due to higher YOY densities with better YOY growth into Size Class II, perhaps resulting from earlier successful spawning in 2013 that gave YOY a longer growth period. Some sites remained in the "good" range in 2013, including Branciforte 21b, Corralitos 1, Corralitos 3, Corralitos 9 and Browns 1. These sites all had good yearling survival, unlike most other sites. Twenty-four of 38 sites (63%) had rating reductions primarily due to reduced YOY growth rate and/or fewer yearlings surviving in 2013. The most substantial declines were at mainstem San Lorenzo 0a (very good to below average), mainstem San Lorenzo 1 (fair to poor), mainstem San Lorenzo 2 (fair to very poor), Zayante 13a (good to poor), Zayante 13c (good to below average), Soquel 1 (fair to poor), Soquel 10 (good to poor), Soquel 12 (fair to very poor), East Soquel 16 (good to below average) and Corralitos 8 (fair to poor). San Lorenzo 9 also had a "very poor" rating because few YOY grew into Size Class II and yearlings were absent.

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

Very Poor - less than 2 smolt-sized** fish per 100 feet of stream.			
Poor*** - from 2 to 4	"	"	"
Below Average - 4 to 8	"	"	"
Fair - 8 to 16	"	"	"
Good - 16 to 32	"	"	"
Very Good - 32 to 64	"	"	"
Excellent - 64 or more	"	"	"

* Drainages sampled included the Pajaro, Soquel and San Lorenzo systems, as well as other smaller Santa Cruz County coastal streams. Nine drainages were sampled at over 106 sites.

** Smolt-sized fish were at least 3 inches (75 mm) Standard Length at fall sampling and would be large enough to smolt the following spring.

***The average standard length for smolt-sized fish was calculated for each site. If the average was less than 89 mm SL, then the density rating according to density alone was reduced one level. If the average was more than 102 mm SL, then the rating was increased one level.

Table 40. 2013 Sampling Sites Rated by Potential Smolt-Sized Juvenile Density (=>75 mm SL) and Their Average Size in Standard Length Compared to 2012, with Physical Habitat Change Since 2012 Conditions.

Site	2012 Potential Smolt Density (per 100 ft)/ Avg Pot. Smolt Size SL (mm)	2012 Smolt Rating (With Size Factored In)	2013 Potential Smolt Density (per 100 ft)/ Avg Pot. Smolt Size SL (mm)	2013 Smolt Rating (With Size Factored In)	Physical Habitat Change by Reach/Site Since 2012
Low. San Lorenzo #0a	26.9/ 135 mm	*Very Good*	4.1/ 94 mm	**Below Average**	+
Low. San Lorenzo #1	7.6/ 119 mm	Fair	3.4/ 96 mm	**Poor**	–
Low. San Lorenzo #2	6.6/ 111 mm	Fair	6.2/ 88 mm	**Very Poor**	–
Low. San Lorenzo #4	8.9/ 87 mm	**Below Average**	6.7/ 81 mm	**Very Poor**	–
Mid. San Lorenzo #6	3.3/ 86 mm	**Very Poor**	2.0/ 108 mm	**Below Average**	–
Mid. San Lorenzo #8	2.0/ 81 mm	**Very Poor**	1.9/ 90 mm	**Poor**	–
Mid. San Lorenzo #9	–	–	2.3/ 86 mm	**Very Poor**	
Up. San Lorenzo #11	2.9/ 101 mm	**Poor**	2.3/ 114 mm	**Below Average**	–
Up. San Lorenzo #12b (may not be steelhead)	11.3/ 112 mm	*Good*	10.0/ 111 mm	*Good*	–
Zayante #13a	14.2/ 107 mm	*Good*	2.7/ 98 mm	**Poor**	–
Zayante #13c	20.0/ 90 mm	*Good*	8.4/ 87 mm	**Below Average**	–
Zayante #13d	8.6/ 127 mm	*Good*	18.5/ 105 mm	*Very Good*	–
Lompico #13e	2.3/ 127 mm	**Below Average**	8.7/ 104 mm	*Good*	+
Bean #14b	10.1/ 122 mm	*Good*	12.5/ 90 mm	Fair	–
Bean #14c	5.2/ 120 mm	Fair (**went dry**)	**Dry**	**Dry**	**Dry both years**
Fall #15	13.0/ 113 mm	*Good*	12.1/ 98 mm	Fair	–
Newell #16	7.3/ 93 mm	**Below Average**	23.7/ 89 mm	*Good*	+
Boulder #17a	7.2/ 131 mm	Fair	3.2/ 118 mm	**Below Average**	–
Boulder #17b	10.6/ 104 mm	*Good*	10.7/ 96 mm	Fair	–
Bear #18a	4.1/ 115 mm	Fair	2.6/ 115 mm	**Below Average**	+
Branciforte #21a-2	12.3/ 114 mm	*Good*	6.0/ 106 mm	Fair	+
Branciforte #21b	27.3/ 96 mm	*Good*	13.3/ 100 mm	Fair	+
Soquel #1	4.0/ 115 mm	Fair	1.8/ 94 mm	**Poor**	–
Soquel #4	11.1/ 101 mm	Fair	2.1/ 110 mm	**Below Average**	–
Soquel #10	16.0/ 94 mm	*Good*	5.2/ 87 mm	**Poor**	–
Soquel #12	13.1/ 93 mm	Fair	3.1/ 82 mm	**Very Poor**	–
East Branch Soquel #13a	18.6/ 94 mm	*Good*	6.8/ 106 mm	Fair	–
East Branch Soquel #16	13.8/ 105 mm	*Good*	6.2/ 92 mm	**Below Average**	–
West Branch Soquel #19	6.1/ 91 mm	**Below Average**	3.4/ 105 mm	**Below Average**	–
Aptos #3	11.6/ 103 mm	*Good*	5.1/ 103 mm	Fair	+
Aptos #4	9.6/ 120 mm	*Good*	6.1/ 120 mm	Fair	–
Corralitos #1	8.7/ 108 mm	*Good*	12.1/ 110 mm	*Good*	–
Corralitos #3	24.2/ 114 mm	*Very Good*	10.7/ 105 mm	*Good*	–
Corralitos #8	9.4/ 100 mm	Fair	1.8/ 130 mm	**Poor**	–
Corralitos #9	12.7/ 105 mm	*Good*	10.5/ 108 mm	*Good*	–
Shingle Mill #1	4.2/ 101 mm	**Below Average**	6.9/ 94 mm	**Below Average**	**Similar**
Shingle Mill #3	5.7/ 91 mm	**Below Average**	3.1/ 86 mm	**Very Poor**	–
Browns #1	17.6/ 98 mm	*Good*	18.0/ 96 mm	*Good*	–
Browns #2	20.2/ 97 mm	*Good*	9.6/ 101 mm	Fair	–

Table 41. Summary of Sampling Site Ratings in 2006−2013, based on Potential Smolt-Sized Densities.

Year	Very Poor	Poor	Below Average	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
2013 (n=38)	5	6	10	9	7	1

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

The trend in fish densities between 2012 and 2013 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 (Total, AC1, AC2, 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 2012 and 2013 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 2013 were compared to 2012, such that a positive difference indicated that the densities in 2013 were larger than in 2012 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 2012 and 2013 densities. The 95% confidence limits are standard and a p-value of < 0.05 is considered significant.

With 16 comparable sites in the San Lorenzo drainage, none of the differences in density in 2013 were statistically significant (**Table 42**). SLR Site 12b was excluded from the analysis because it was judged to resident rainbow trout and not steelhead. Zayante Site 13d was excluded because the sampling location changed. With 7 comparable sites in the San Lorenzo mainstem only, no changes 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 and decreases in Size Class II/III density in 2013 were statistically significant (**Table 44**). With only 2 comparable sites in Aptos watershed, no statistical tests were made. With 6 comparable sites in the Corralitos sub-watershed, the decrease in total density was found to be statistically significant (**Table 45**). Since sampling locations changed for the Browns Creek sites, they were excluded from the analysis.

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 (2013 to 2012; n=16).

Statistic	s.c. 2	a.c. 1-YOY	a.c. 2	All Sizes
Mean difference	-2.24	13.28	-0.63	13.67
Df	16	16	16	16
Std Error	2.11	9.44	0.72	9.61
t Stat	-1.06	1.41	-0.87	1.42
P-value (2-tail)	0.31	0.180	0.397	0.176
95% CL (lower)	-6.73	-6.84	-2.15	-6.82
95% CL (upper)	2.25	33.39	0.90	34.16

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 (2013 to 2012; n=7).

Statistic	s.c. 2	a.c. 1-YOY	a.c. 2	All Sizes
Mean difference	-4.51	0.56	-0.41	0.16
Df	6	6	6	6
Std Error	3.09	3.96	0.65	4.40
t Stat	-1.46	0.14	-0.64	0.04
P-value (2-tail)	0.195	0.893	0.546	0.973
95% CL (lower)	-12.08	-9.13	-2.00	-10.62
95% CL (upper)	3.05	10.25	1.17	10.93

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	-7.35	10.87	-1.15	10.00
Df	5	5	5	5
Std Error	1.66	2.65	1.40	3.17
t Stat	-4.43	4.09	-0.82	3.15
P-value (2-tail)	0.007	0.009	0.448	0.025
95% CL (lower)	-11.62	4.04	-4.74	1.85
95% CL (upper)	-3.08	17.69	2.44	18.15

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 (2013 to 2012; n=6; excluding unrepeated Browns Creek sites).

Statistic	s.c. 2	a.c. 1-YOY	a.c. 2	All Sizes
Mean difference	-3.30	-7.93	-2.15	-10.58
Df	5	5	5	5
Std Error	2.61	5.42	2.39	4.10
t Stat	-1.26	-1.46	-0.90	-2.58
P-value (2-tail)	0.263	0.203	0.410	0.049
95% CL (lower)	-10.02	-21.87	-8.31	-21.11
95% CL (upper)	3.42	6.01	4.01	-0.05

R-14. Adult Trapping Results at the Felton Dam's Fish Ladder and 2013 Planting Records

The trap in the fish ladder at the City of Santa Cruz Felton Diversion dam was operated by volunteers from the Monterey Bay Salmon and Trout Project for 46 days during the winter of 2012-2013 (20 days in December, 11 days in January, 5 days in February, 9 days in March and 1 day in April). The 2013 trapping (as the previous 5 years) encompassed stormflows of the winter/spring (**Figure 34a**). In 2013, a total of 341 adult steelhead were captured; 57 (17%) were hatchery clipped (**Table 47**). One adult male coho was captured on 18 December at the trap, and 109 steelhead were retained for hatchery propagation during the winter/spring season. One coho salmon were trapped in 2011 **(T. Umstead personal communication).** No coho salmon were captured in 2010. In 2009, one adult coho salmon was captured on the first day of trapping. No coho salmon were captured in 2007 or 2008, likely due to the late trapping period. In 2006, 2 coho salmon captured in 2 months from mid-January to late March. But trapping was over much shorter periods in 2007 and 2008. In 2005, 18 adult coho captured, 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. Usually, in milder winters the trapping numbers increase because more fish use the ladder, which has the fish trap.

R-15. Planting Records from the Big Creek Hatchery in 2013

San Lorenzo River Steelhead

Date	Inventory	Weight (lbs)	Release Location
3/27/2013	4,829	550.0	San Lorenzo River @ Highland County Park
3/28/2013	4,851	300.0	San Lorenzo River @ Lomond Street bridge crossing
4/3/2013	4,704	250.0	San Lorenzo River @ Lomond Street bridge crossing
4/4/2013	4,741	525.0	San Lorenzo River @ Highland County Park
Totals	**19,125**	**1,625.0**	

Table 46. Adult Steelhead Trapping Data from the San Lorenzo River With Adult Return Estimates. (Trapping totals ARE NOT estimates of steelhead runs for the year. Trapping is sporadic and not all fish use the fish ladder.)

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 Juveniles 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 Juveniles only
1997-98		1,784 (estimate)	Alley Estimate from 1995 Mainstem Juveniles only
1998-99		1,541 (estimate)	Alley Revised Estimate from 1996 Mainstem 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
2012-13	3 Dec-1 Apr (46 days, mostly Dec and Jan)	341 Steelhead 1 Coho	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 2013 RESULTS

D-1. Causal Factors for Continued Below Average 2013 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 the large December stormflows to saturate reaches with redds and egg production after these greater than bankfull flows passed. This would explain the below average YOY densities at many sites in the mainstem San Lorenzo (0a−9), middle Bean Creek 14b and lower Branciforte Creek 21a-2. The low YOY densities in the middle and lower mainstem may indicate that insufficient spawning success occurred in the tributaries to supply the mainstem with the numbers of YOY that they once did. Low YOY densities at the upper San Lorenzo Site 11 since 2010, Bear Site 18a and lower Branciforte Site 21a-2 may suggest that adult steelhead passage to these sites was problematic. In fact, a log cluster had collected on a remnant dam on Bear Creek, downstream of the Lanktree Road Bridge. We recommend that any wood that has collected on the dam and obstructs the dam opening for adult steelhead passage be removed until the walls of the remnant dam are removed. Examine the potential for constructing a downstream rock weir to lessen the jump height at the dam.

The low YOY densities in the upper mainstem San Lorenzo since 2006 leads one to believe that a passage impediment periodically develops after especially wet years, perhaps logs collecting on dam remnants or difficulties in adults negotiating the flat, concrete sill at the dam remnant location downstream of Teihl Road and Either Way and our sampling site. Similarly low YOY densities occurred at this site in 1998, which was a very wet winter. It appears that YOY densities have been lower after milder winters since 1998 at this site. We recommend that Reaches 10 and 11 be surveyed for any additional passage impediments and that any found be modified to improve passage. We recommend that the sill at the dam remnant below Either Way Bridge be modified to improve adult salmonid passage.

The salmonid population at the upper Waterman Gap Site 12b appears to be resident rainbow trout, with its high proportion of larger individuals found there. The concrete apron below the culvert crossing of Highway 9 is a passage impediment. We recommend that this apron be modified to improve adult salmonid passage.

On Branciforte Creek, the mile-long, concrete flood control channel at its mouth was likely a passage impediment in 2013 with so few stormflows after December 2012. We recommend that this flood control channel be made more passable to adult salmonids. Fish captured at the upper Site 21c were likely resident rainbow trout, based on the high proportion of larger fish. A dam was removed downstream recently that may improve steelhead access to this site.

The below average YOY density at the middle Bean Creek Site 14b may be caused by much more of upper Reach 14b above going dry in low flow years, thus eliminating YOY recruitment to lower Reach 14b from the typically productive upper Reach 14b when it is more perennial. (A large portion of upper Reach 14b above Ruins Creek confluence goes dry every year. However, in some years, such as the last two in 2012 and 2013, the dry section has extended beyond the MacKenzie Creek confluence into Reach 14c.) This rational would help explain low YOY densities at Site 14b in 2007, 2009, 2012 and 2013. However, YOY densities were above average in 2008, which was also a dry year, and YOY densities were also below average in 2010 and 2011, which were wetter years. It appears that YOY densities at this site have been consistently low since 2006, which was a wet year. Another possibility is that spawning conditions in Bean Creek have deteriorated since 2006 to reduce spawning success. Substrate is very sandy in Bean Creek. Erosion control projects are recommended on this tributary to improve habitat.

The total 2013 adult returns may have been down substantially compared to 2012, as indicated by adult counts in the Carmel River and the estimate in Scott Creek. Adult returns to the Carmel River decreased in 2013, as detected at the San Clemente Dam on the Carmel River. Recent counts for 2006–2013 were 368, 222, 412, 95, 157, 452, 470 and 249, respectively (**Chaney, 2013**). Trapping data from Scott Creek indicated decreased adult returns in winter 2012-2013, where adult escapement estimates in water years 2006–2013 were 219, 259, 293, 126 , 109, 214 and 167, respectively (**Sean Hayes, NOAA Fisheries personal communication**). The pattern of adults returning to our watersheds may have been similar to that on the Carmel River. In the Carmel River in 2013, most adult steelhead entered the River in March (46% of the adults (115) passed the San Clemente Dam counter in March; 18 in December, 46 in January, 47 in February, 115 in March, 23 in April, and 0 in May (**Chaney 2013**)).

Some 2013 sites had high densities of small YOY, indicating sporadically good spawning success after December 2012. In the San Lorenzo system, Zayante Site 13c had the highest YOY density measured during the last 15 years of monitoring, nearly all YOY being in Size Class I (**Table 23**). Zayante Site 13d had the second highest YOY density in the last 15 years of monitoring, all YOY being in Size Class I. In the Soquel drainage, upper mainstem Site 12 had the highest YOY density measured in the last 17 years of monitoring, and Site 10 had the highest density in the last 5 years (**Table 27**). However, despite these high densities of small YOY at some sites, few YOY reached Size Class II in either watershed and few yearlings apparently survived the large December storms. The result was that densities of the important Size Class II that would most influence the number of adult returns were below average (**Figures 4 and 8**) and statistically less in 2013 compared to 2012 in Soquel (**Table 44**). Most San Lorenzo sites had a high proportion of Size Class I YOY except for 5 of 22 sites; Mainstem #0a and #1 (faster YOY growth into SC II), and #11 (low YOY density), Bear #18 (low YOY density) and Branciforte 21a-2 (low YOY density). All 7 sites in Soquel and both sites in Aptos had a high proportion of Size Class I YOY. All sites in the Corralitos sub-watershed had a high proportion of small YOY except Shingle Mill #1 and Browns #1 (both due to low densities of YOY). Unfortunately, Bean Creek Site #14c went dry for the second year in a row in 2013. At a few sites, the majority of YOY reached Size Class II due to faster growth rates. Those were SLR Sites #0a, #1, #2, Bean #14b and Newell #16. Bear #18a, Branciforte #21a-2 and Branciforte #21c had very low YOY densities and therefore had a few large YOY at each site.

Table 47. Presence of Small YOY Steelhead at Sampling Sites, Indicating Late Spawning After Late Stormflows in 2006, 2010−2013.

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	At least 30% of the YOY < 75 mm SL and More than 10 in Number/ At least One Habitat 2013
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	+	+	+	+	+
Mid. San Lorenzo #9					+
Up. San Lorenzo #11	−	+	−	−	−
Up. San Lorenzo #12b	NA	NA	NA	− (likely resident rainbow trout)	+ (likely resident rainbow trout)
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	+	+	+	+	−
Branc. 21a-2	+	−	+	+	−
Branc. #21b	NA	NA	NA	+	+
Branc. #21c	NA	NA	NA		+ (likely resident rainbow trout)
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	NA
Aptos #3	−	+	−	+	+
Aptos #4	+	+	−	+	+
Valencia #2	+	+	NA	NA	NA
Valencia #3	+ (barely)	+	NA	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**	**32**

In the Aptos system, the continued below average YOY density at both stream sites is attributable to sporadic spawning effort by a potentially small adult steelhead population. The estuary's juvenile population estimate of only 32 juveniles was less than 25% of the 2012 estimate of 140 and less than 10% of the 2011 estimate of 423, indicating possibly much lower YOY production in the lower watershed to supply the lagoon with YOY. The small 2013 estuary estimate may also have been attributed to the poor water quality in a badly stratified estuary that never converted to freshwater.

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 Below Average Size Class II Densities in Each Watershed

San Lorenzo Watershed

The below average densities of larger juveniles in all sites in the mainstem resulted from poor survival/retention of yearlings after the large December storms, but primarily due to below average YOY densities and a smaller proportion of YOY reaching Size Class II due to slow YOY growth from less food associated with low baseflow. The averaged mean monthly streamflow for May−September in the San Lorenzo was the lowest in the past 17 years (**Figure 42**). 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.

Below average densities of larger juveniles at some tributary sites (Zayante 13a, Zayante 13c, Boulder

17a, Branciforte 21a-2) resulted from poor survival/retention of yearlings. The two large stormflows in December (7,000+ cfs and 12,000+ cfs) may have caused overwinter mortality in yearlings or encouraged others to emigrate early (**Figure 34a**). With good water clarity throughout most of the spring with the absence of stormflow, feeding efficiency was likely high and may have allowed more yearlings to smolt in spring rather than stay over another season until fall sampling. 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**). Some sites maintained near average or above average densities of Size Class II fish because they were headwater sites that retained yearlings (Zayante 13d, Lompico 13e, Fall 15, Boulder 17b and Branciforte 21b). Some sites maintained average Size Class II densities because they had relatively high, sustained baseflow that allowed a higher proportion of YOY to reach Size Class II from moderate YOY densities (Bean 14b and Newell16).

Soquel Watershed

The below average densities of larger juveniles at all sites in the Soquel drainage were due to 1) typical poor survival/retention of yearlings (or low recruitment from a below average YOY population in the case of Site 16 (SDSF) from 2012) and 2) the relatively small proportion of YOY that grew into Size Class II due to reduced food from low baseflow and relatively high YOY density and competition at upper mainstem sites. The averaged mean monthly streamflow for May−September in Soquel Creek was the second lowest in the past 17 years (**Figure 42**).

Aptos Watershed

The below average densities of larger juveniles in both Aptos sites resulted from slightly below average yearling densities and the continued small proportion of YOY reaching Size Class II from below average YOY densities. The very low estuary density of these Size Class II fish likely resulted from poor YOY recruitment from the lower stream reaches and poor water quality in the estuary.

Corralitos Sub-Watershed

The below average densities of larger juveniles at some upper sites (Corralitos 8, Corralitos 9, Shingle Mill 1, Shingle Mill 2 and Browns 2) resulted from low survival/retention of yearlings and/or the relatively low proportion of YOY that reached Size Class II in a year with less food associated with very low baseflow. Some lower sites managed to maintain near average or slightly above average densities of Size Class II juveniles (Corralitos 1, Corralitos 3 and Browns 1) because they had better yearlings survival/retention.

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

YOY steelhead densities in 2013 continued to be below average at all sites in Gazos, especially at the upper two sites (**Figure 45;** data from **Smith 2013**) and at all sites in Scott (near average in Big Creek at Swanton Road) (**Figure 46;** data from **Smith 2013**). Their YOY densities averaged for all sites continued to decline in 2013 from 2012 (**Figure 49; data from Smith 2013**). The average YOY density for Waddell Creek increased from 2012 to 2013. Below average YOY densities in Scott and Gazos creeks were consistent with below average YOY densities at San Lorenzo mainstem sites and some lower tributary sites in the San Lorenzo watershed, the upper East Branch Soquel site, both sites in Aptos Creek and 6 of 8 sites in the Corralitos sub-watershed.

In Scott Creek, average YOY steelhead site densities for 2007─2013 were 49, 20, 24, 45, 41, 33 and 27 fish/ 100 ft, respectively, with a 23-year average to 2013 of 51 (**Figure 49** data from **Smith 2013**). The average Waddell Creek YOY site densities for 2007─2013 were 13, 23, 10, 13, 8, 13 and 20 fish/ 100 ft and much below the 23-year average of 36. The average Gazos Creek YOY site densities for 2007 and 2009─2013 were 21, 17, 16, 28, 30 and 17 fish/ 100 ft and below the 19-year average to 2013 of 34. YOY densities in Gazos may have been much lower than the two previous years because adult spawning access through existing and new logjams may have been more difficult, if not impossible, in 2013 (**Smith 2013**).

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 most years 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 in 2011. According to Smith (**2013**), the source of the toxic pollution appeared to have been upstream of Last Chance Creek with low steelhead densities above its confluence, but below the falls ¼ mile upstream. In Smith's words, "a major effort should be made to track down and eliminate the toxic sources of the kills, which may sometimes originate in the Last Chance Creek watershed. Eliminating the kills could also significantly benefit restoration of coho. Expanding redd counts in the Waddell Creek watershed and summer long observations on juvenile steelhead distribution and abundance may aid in determining the timing and source of the kills."

Densities of yearling juveniles were below average at 7 of 8 sites in Gazos Creek in 2013 (**Figure 47;** data from **Smith 2013**), consistent with poor survival/retention of yearlings in all but headwater sites in the San Lorenzo, the typical poor survival/retention of yearlings in Soquel Creek and slightly below average yearling densities in Aptos Creek. However, in Scott Creek the yearling densities were above average at some and below average at other sites (**Figure 48;** data from **Smith 2013**), consistent with the Corralitos sub-watershed. Average 1+/2+ densities in Scott Creek for 2007─2013 were 14, 8, 7, 7, 2, 4 and 6 fish/ 100 feet, with a 23-year average of 8.3 fish/ 100 feet (**Figure 50;** data from **Smith 2013**). Average 1+/2+ density in Waddell Creek for 2007─2013 were 2, 1, 2, 1, 0.4, 1 and 1.5 fish/ 100 ft, with a 23-year average being 5.1 fish/ 100 ft. Average 1+/2+ density in Gazos Creek for 2007 and 2009−2013 were 4, 9, 4, 6, 9 and 3.7 fish/ 100 ft, with 20-year average being 7.4 fish/ 100 ft.

In these 3 creeks' sites, yearlings were likely the only fish reaching Size Class II. So, the very low Size Class II and III densities in all of these creeks of less than 6 fish/ 100 ft were similar to poorer sites in our 4 watersheds in 2013, such as San Lorenzo mainstem sites (0a−11) and lower tributary sites in

Boulder, Zayante and Branciforte. Their site densities were similar to Size Class II densities in all sites in Soquel and Aptos creeks in 2013 but only 1 site in the Corralitos sub-watershed.

D-4. Data Gaps

Annual monitoring of steelhead needs to continue through drought periods and beyond to assess the extent of population recovery or decline. The level of fish monitoring and habitat analysis needs to be restored to 2000 levels so that accurate indices of juvenile and adult steelhead population sizes were possible. 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 2010–2013. 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. Fortunately, the Waterman Gap Site 12 b as added in 2012, and a new Branciforte Site 21c has been added. 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. Two reaches in San Lorenzo tributaries and one reach in the mainstem Soquel were inventoried in 2013.

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). A gage was established in Fall Creek above the SLVWD diversion point in 2013, and another gage is planned for the mouth of Boulder Creek in 2014.

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

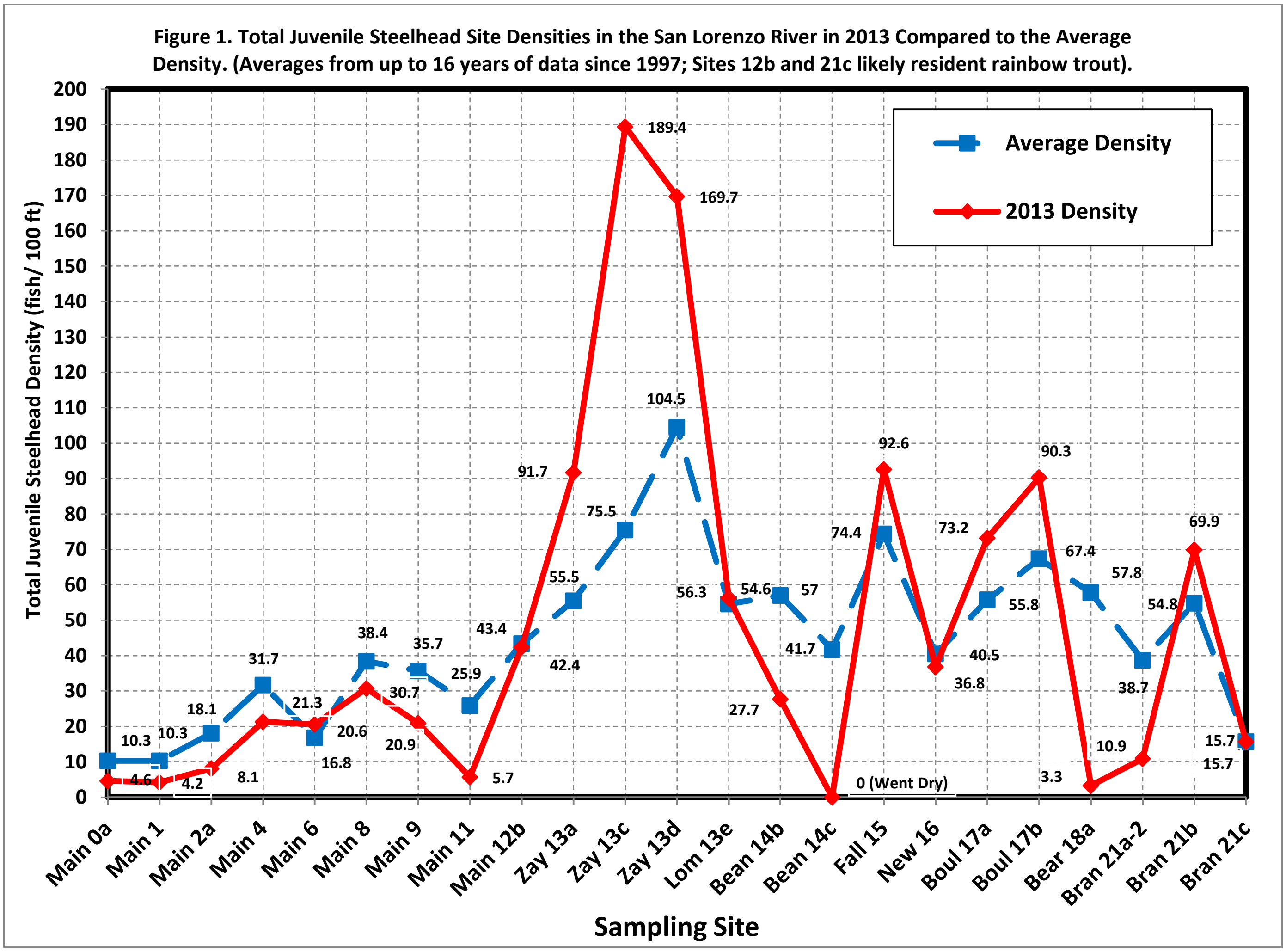


Figure 1. Total Juvenile Steelhead Site Densities in the San Lorenzo River in 2013 Compared to the Average Density. (Averages based on up to 16 years of data since 1997).

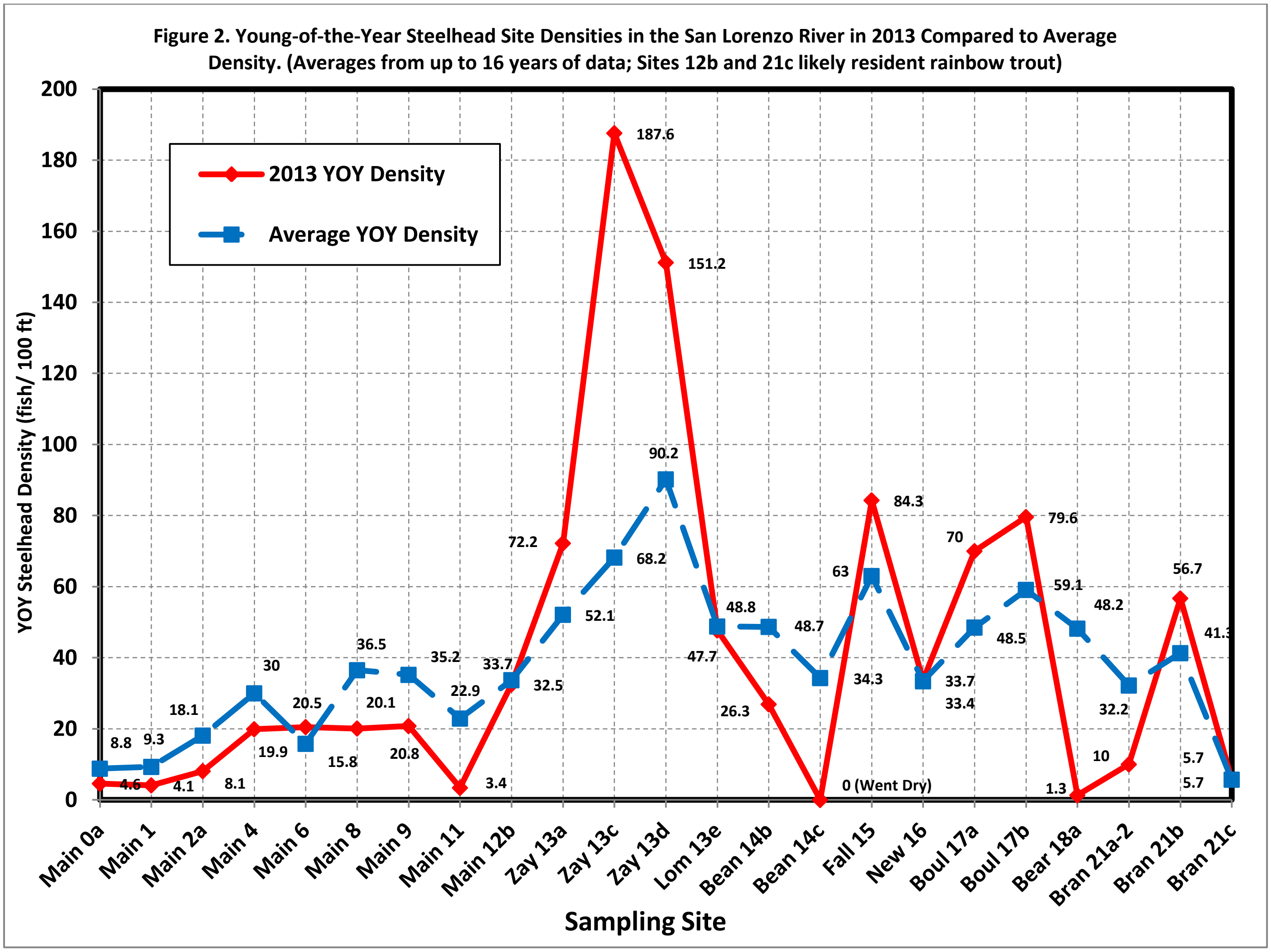


Figure 2. Young-of-the-Year Steelhead Site Densities in the San Lorenzo River in 2013 Compared to Average Density. (Averages based on up to 16 years of data.)

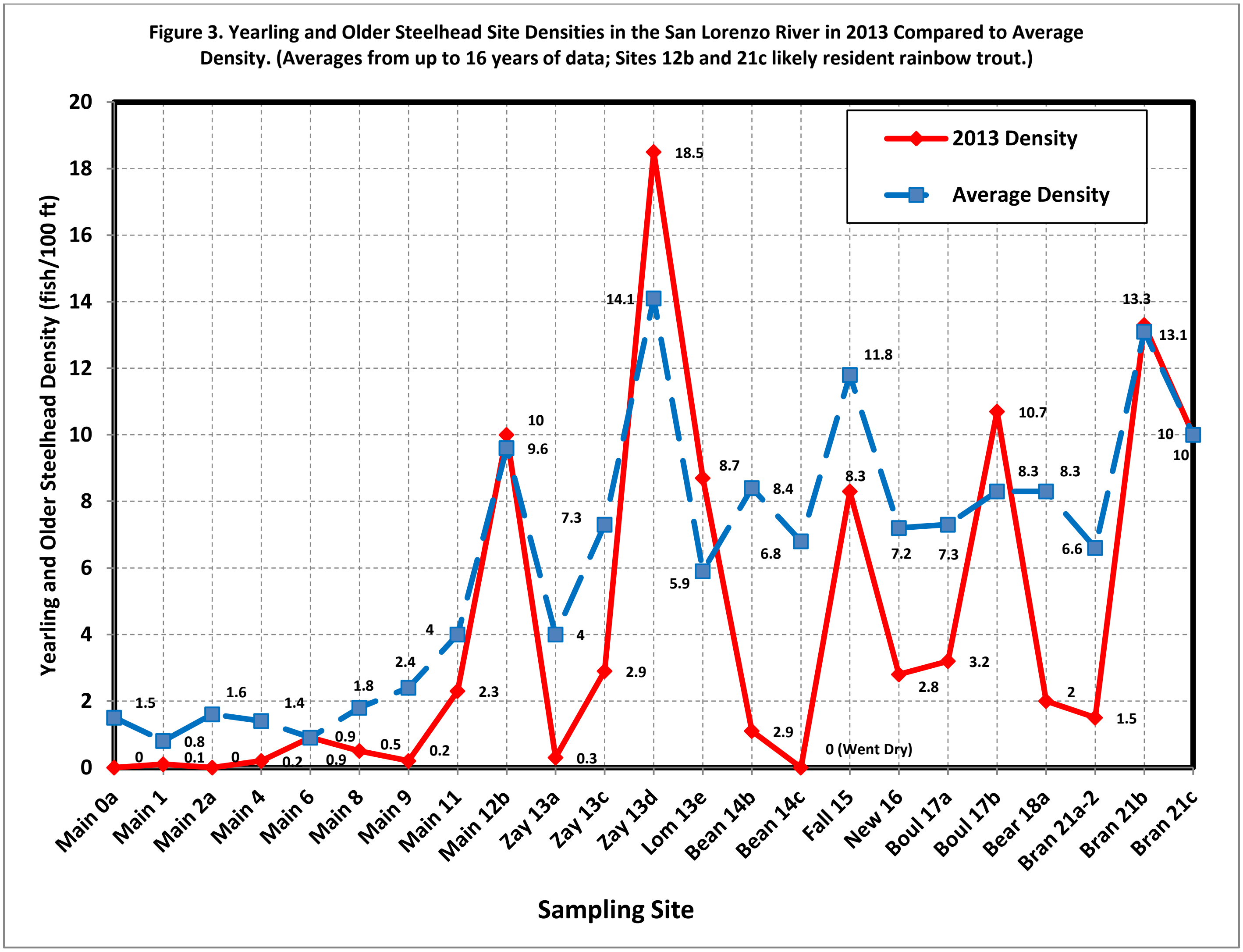


Figure 3. Yearling and Older Steelhead Site Densities in the San Lorenzo River in 2013 Compared to Average Density. (Averages based on up to 16 years of data.)

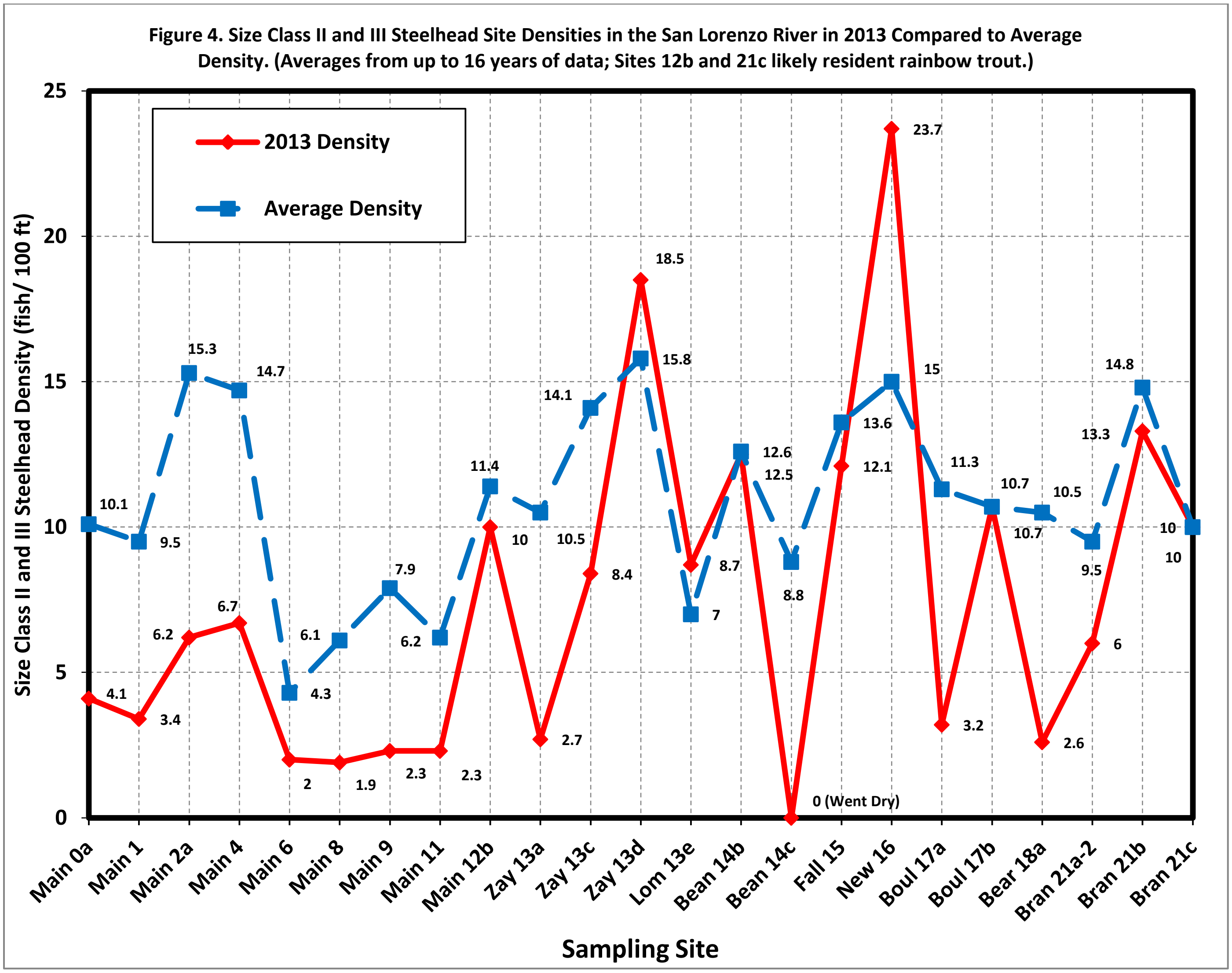


Figure 4. Size Class II and III Steelhead Site Densities in the San Lorenzo River in 2013 Compared to Average Density. (Averages based on up to 16 years of data.)

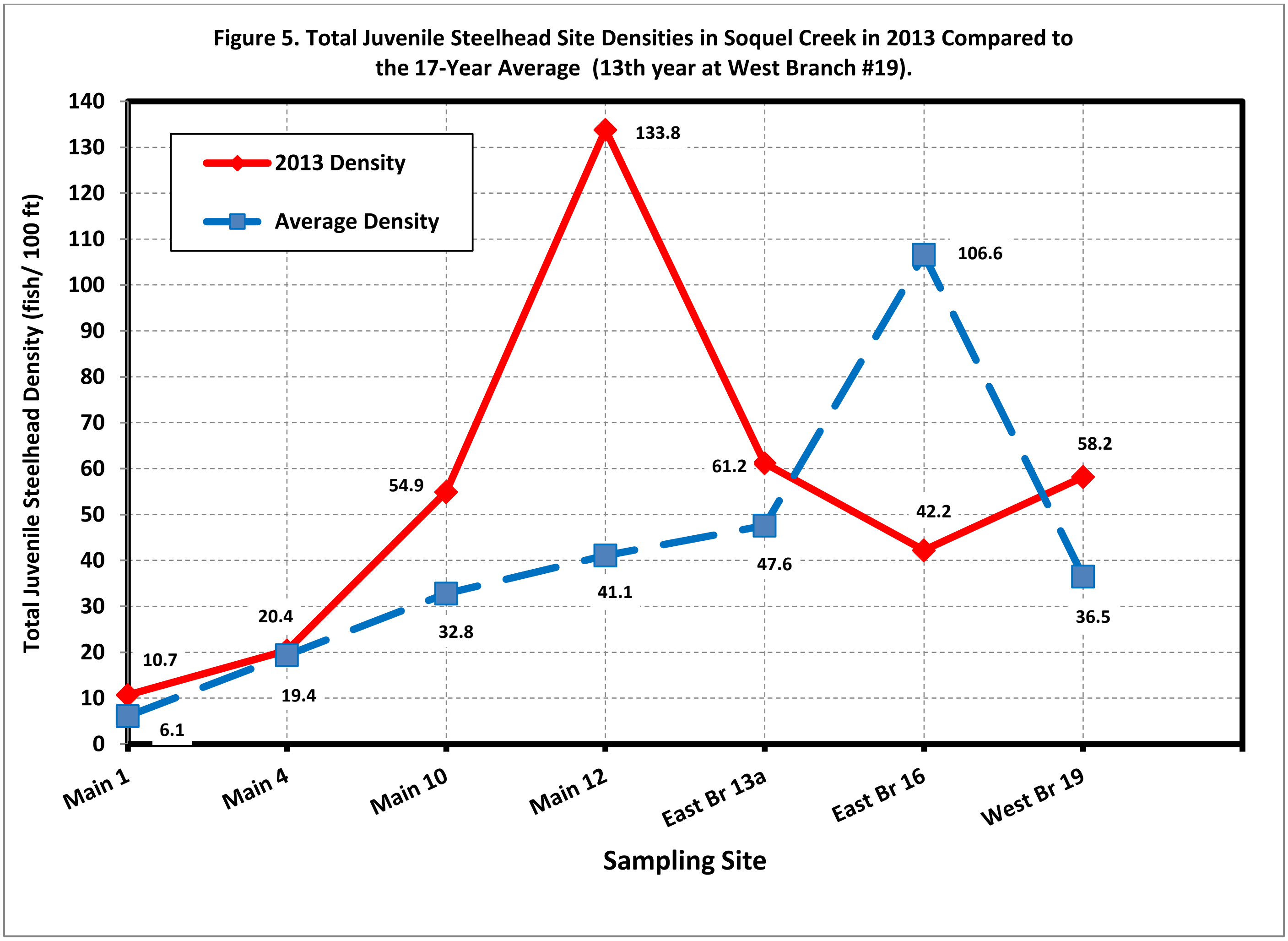


Figure 5. Total Juvenile Steelhead Site Densities in Soquel Creek in 2013 Compared to the 17-Year Average (13th year at West Branch #19).

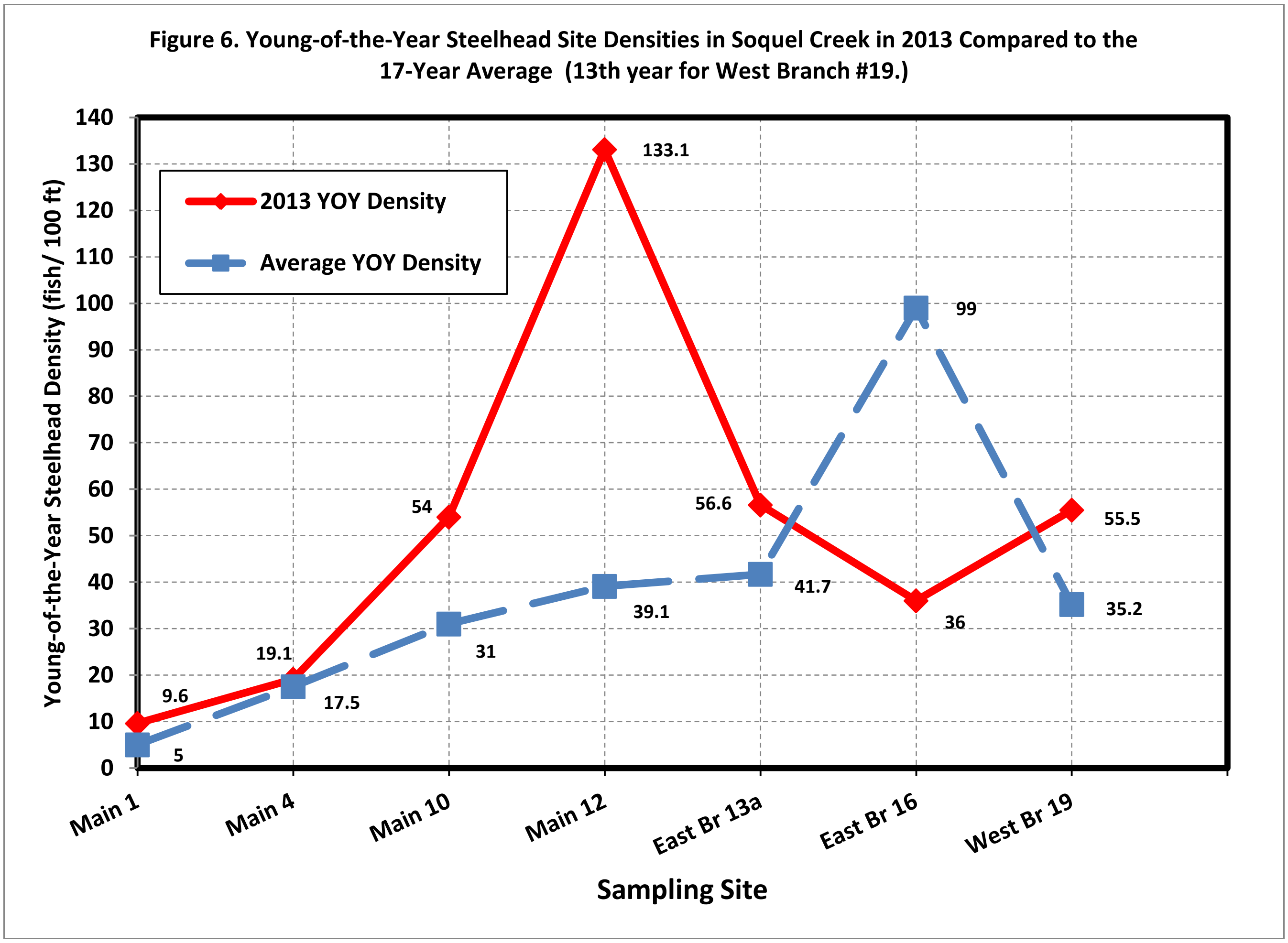


Figure 6. Young-of-the-Year Steelhead Site Densities in Soquel Creek in 2013 Compared to the 17-Year Average (13th year for West Branch #19.)

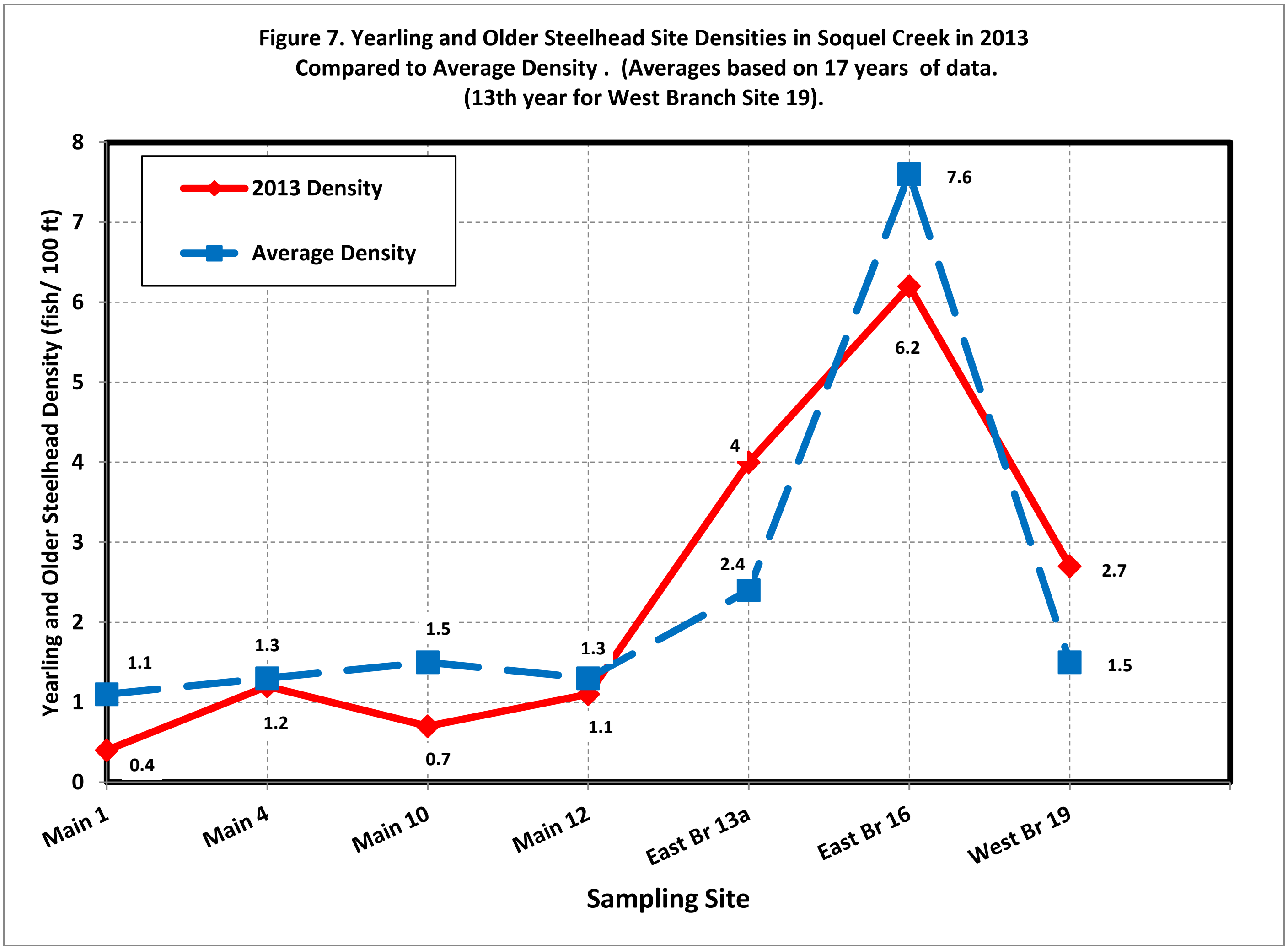


Figure 7. Yearling and Older Steelhead Site Densities in Soquel Creek in 2013 Compared to Average Density. (Averages based on 17 years of data. (13th year for West Branch Site 19).

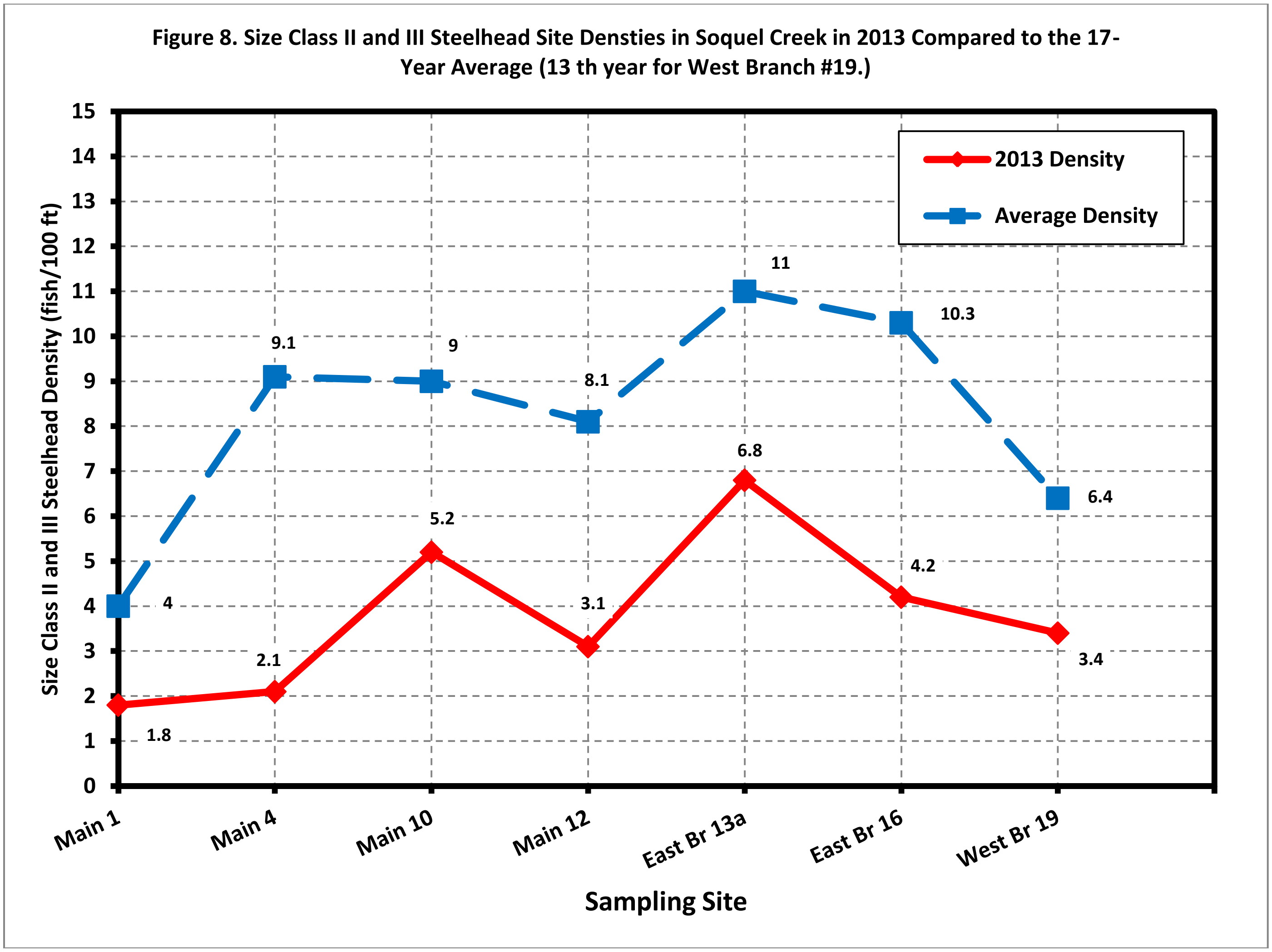


Figure 8. Size Class II and III Steelhead Site Densities in Soquel Creek in 2013 Compared to the 17-Year Average (13th year for West Branch #19.)

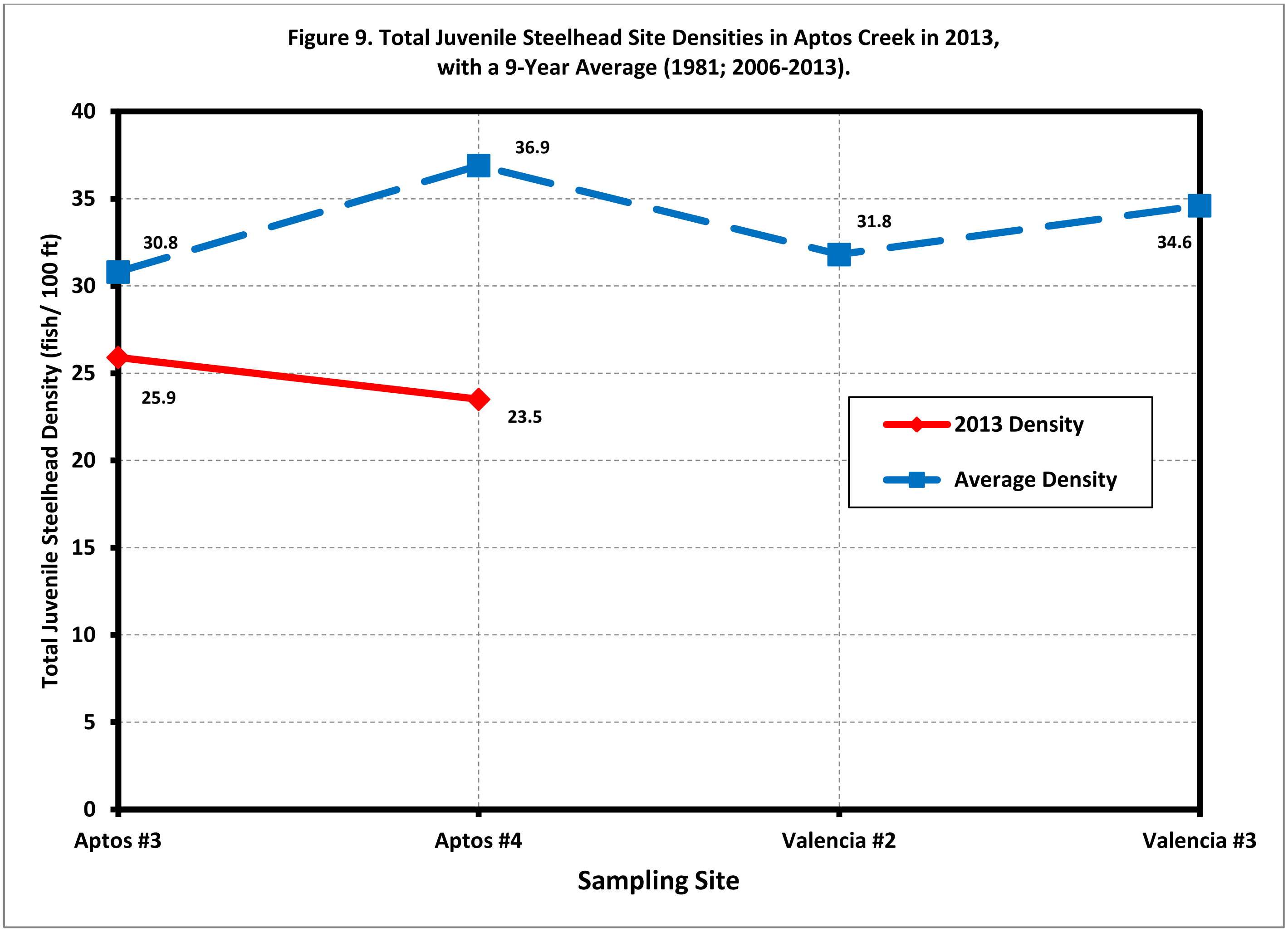


Figure 9. Total Juvenile Steelhead Site Densities in Aptos Creek in 2013, with a 9-Year Average (1981; 2006-2013).

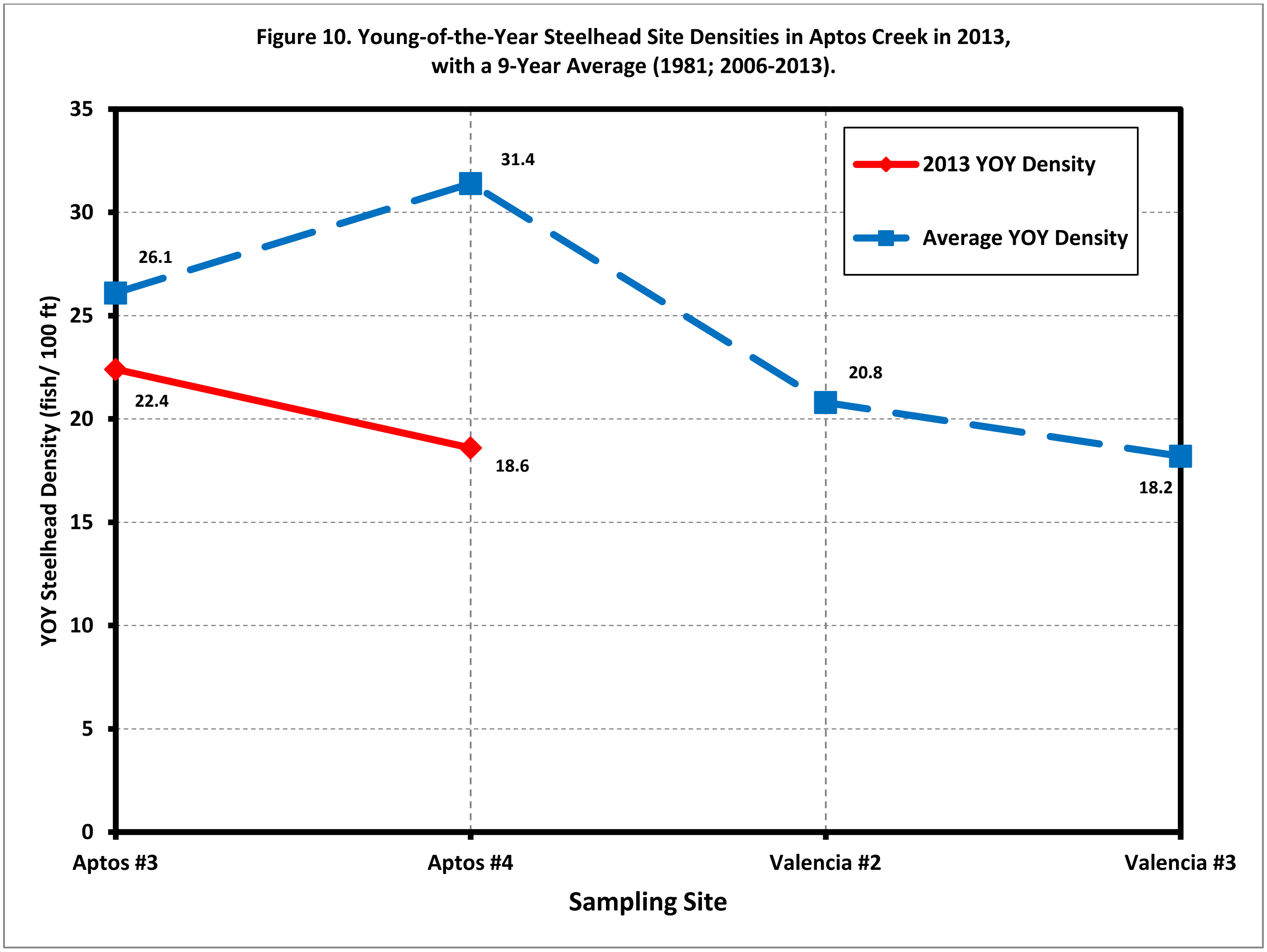


Figure 10. Young-of-the-Year Steelhead Site Densities in Aptos Creek in 2013, with a 9-Year Average (1981; 2006-2013).

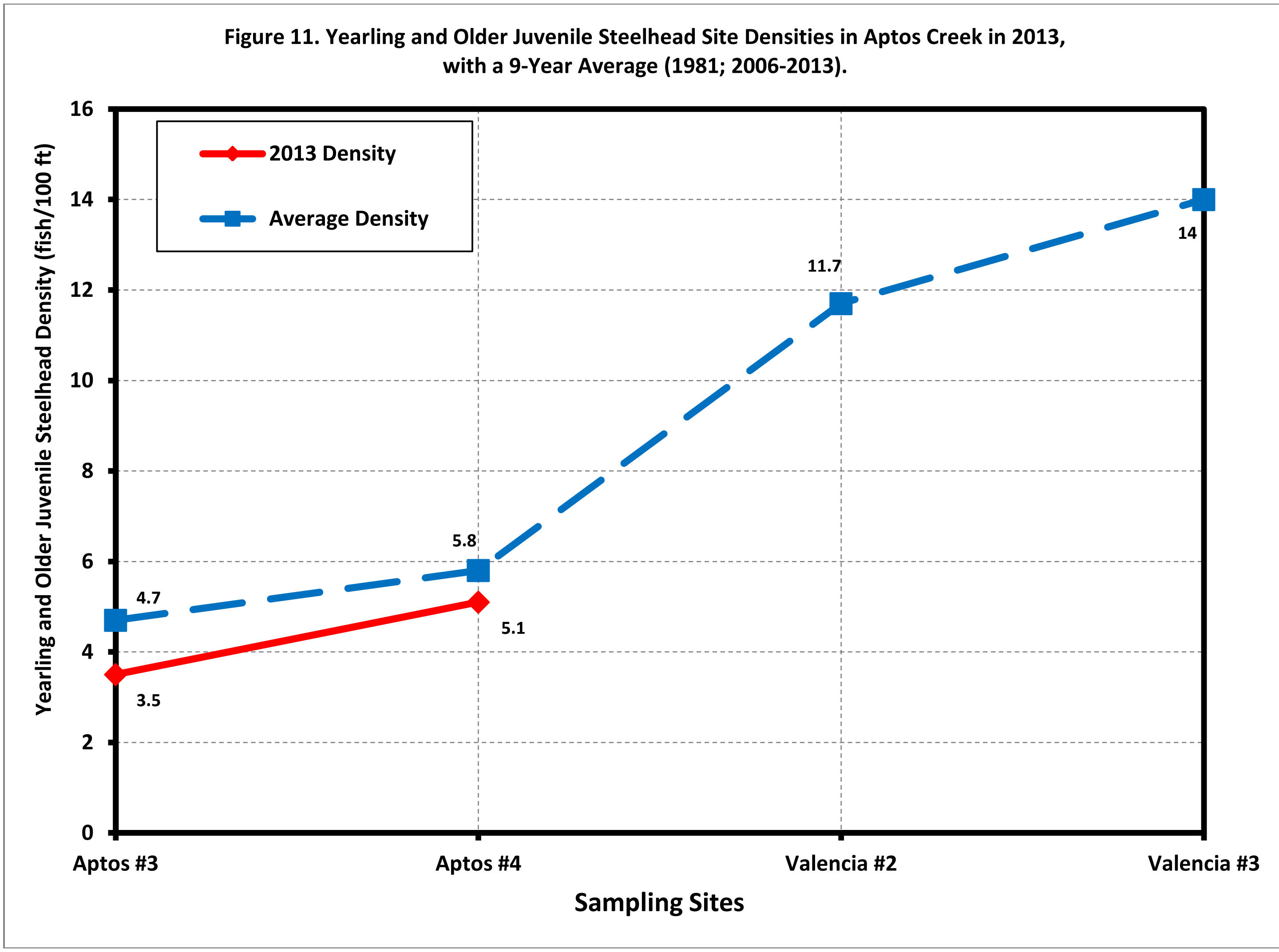


Figure 11. Yearling and Older Juvenile Steelhead Site Densities in Aptos Creek in 2013, with a 9-Year Average (1981; 2006-2013).

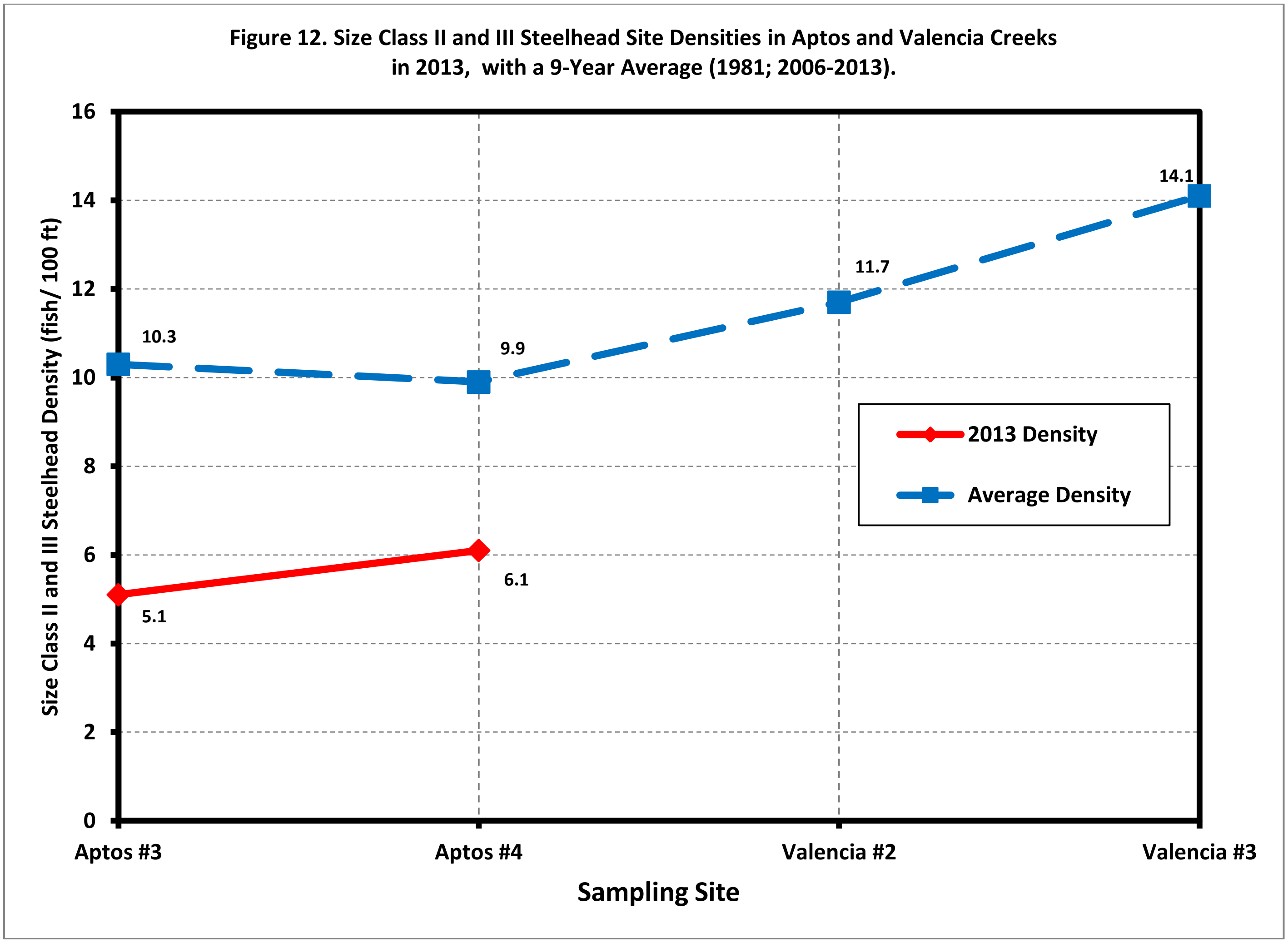


Figure 12. Size Class II and III Steelhead Site Densities in Aptos and Valencia Creeks in 2013, with a 9-Year Average (1981; 2006-2013).

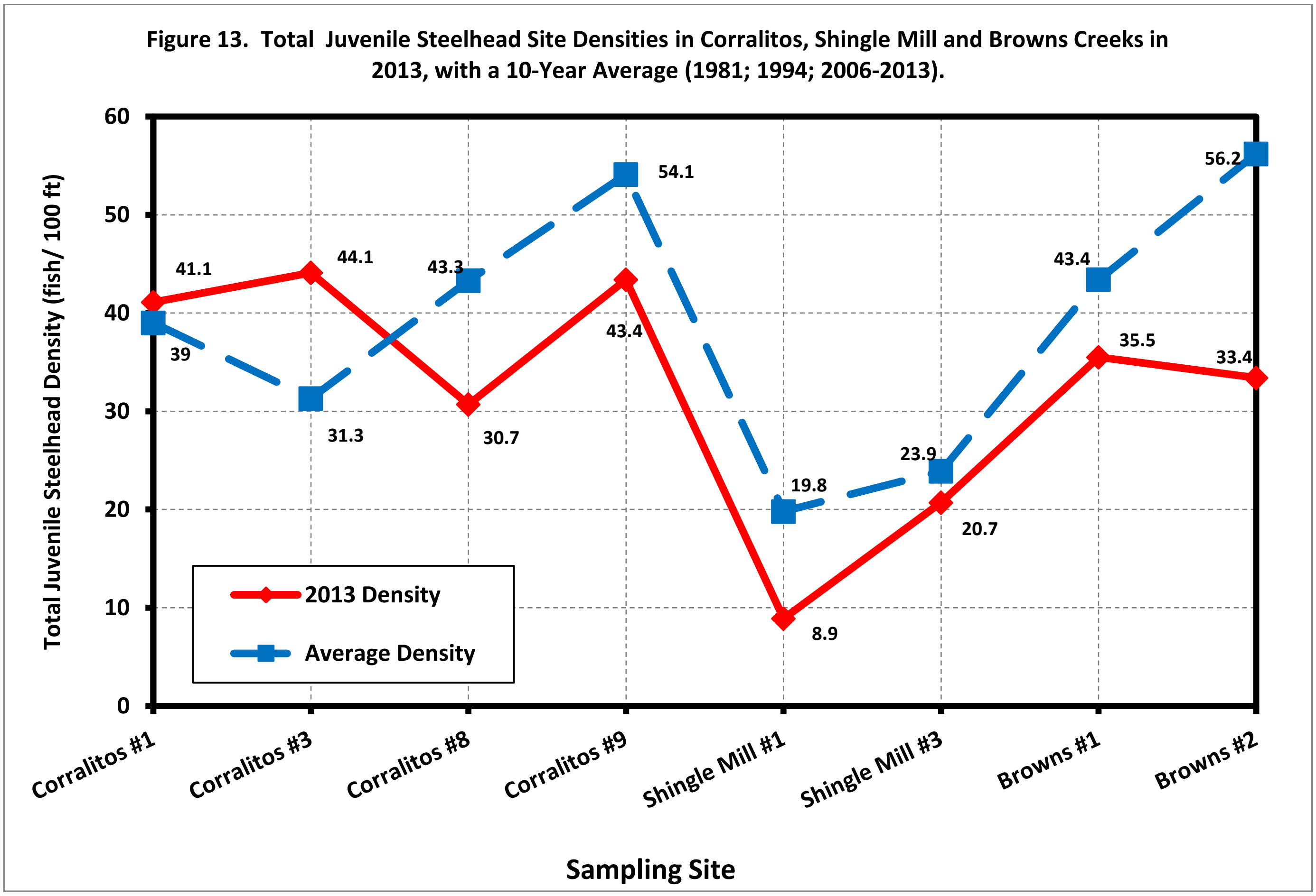


Figure 13. Total Juvenile Steelhead Site Densities in Corralitos, Shingle Mill and Browns Creeks in 2013, with a 10-Year Average (1981; 1994; 2006-2013).

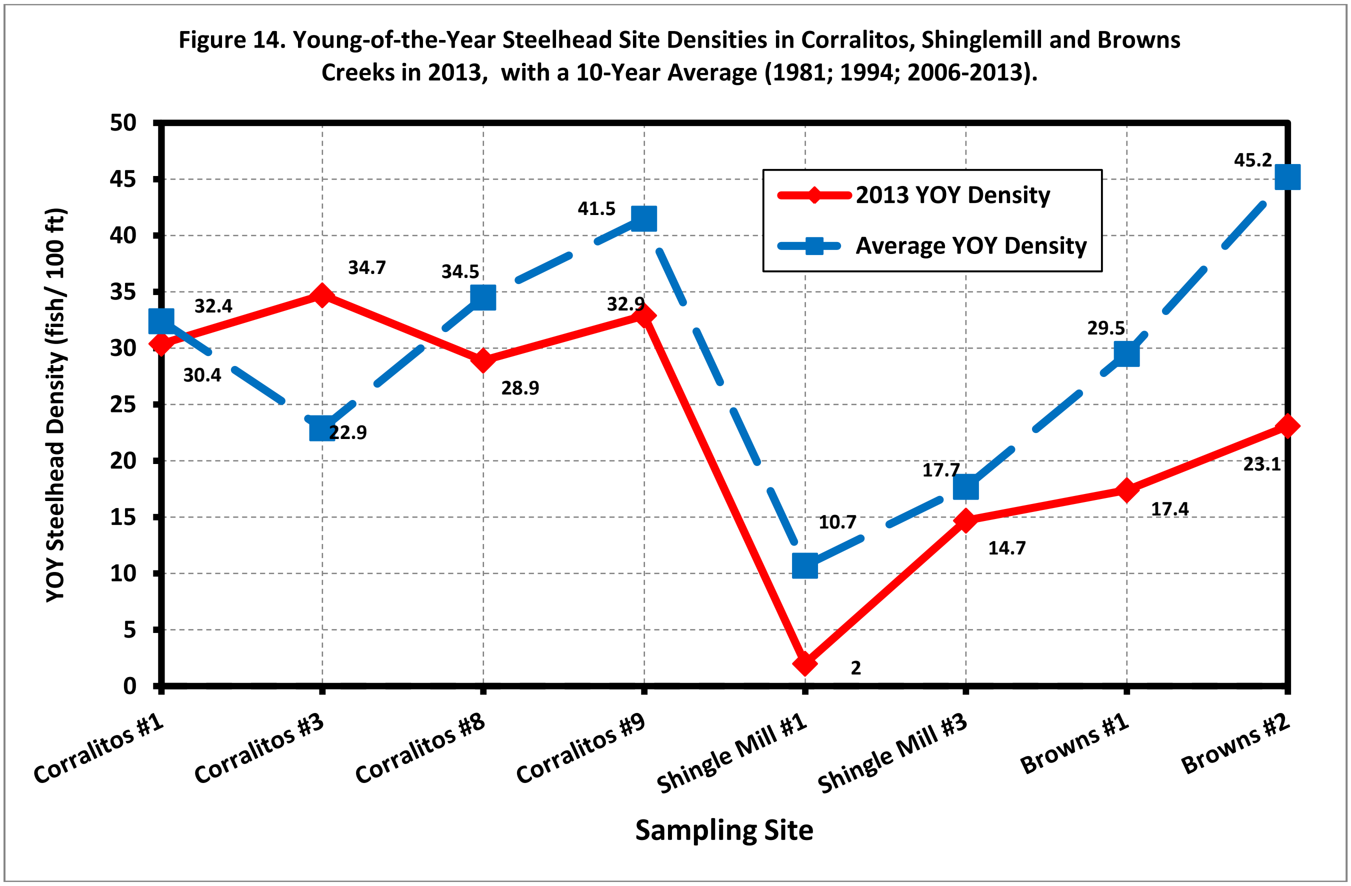


Figure 14. Young-of-the-Year Steelhead Site Densities in Corralitos, Shingle Mill and Browns Creeks in 2013, with a 10-Year Average (1981; 1994; 2006-2013).

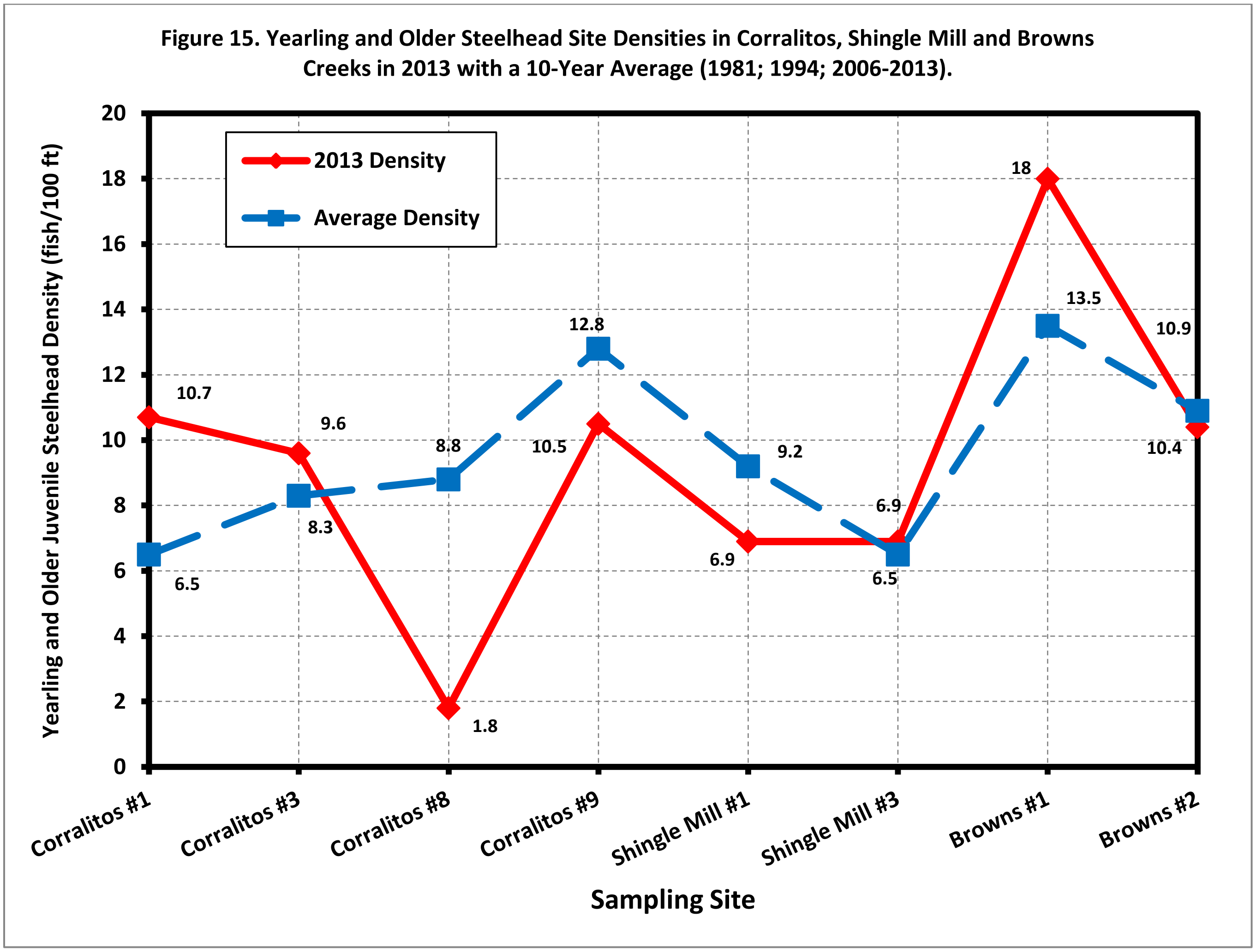


Figure 15. Yearling and Older Steelhead Site Densities in Corralitos, Shingle Mill and Browns Creeks in 2013 with a 10-Year Average (1981; 1994; 2006-2013).

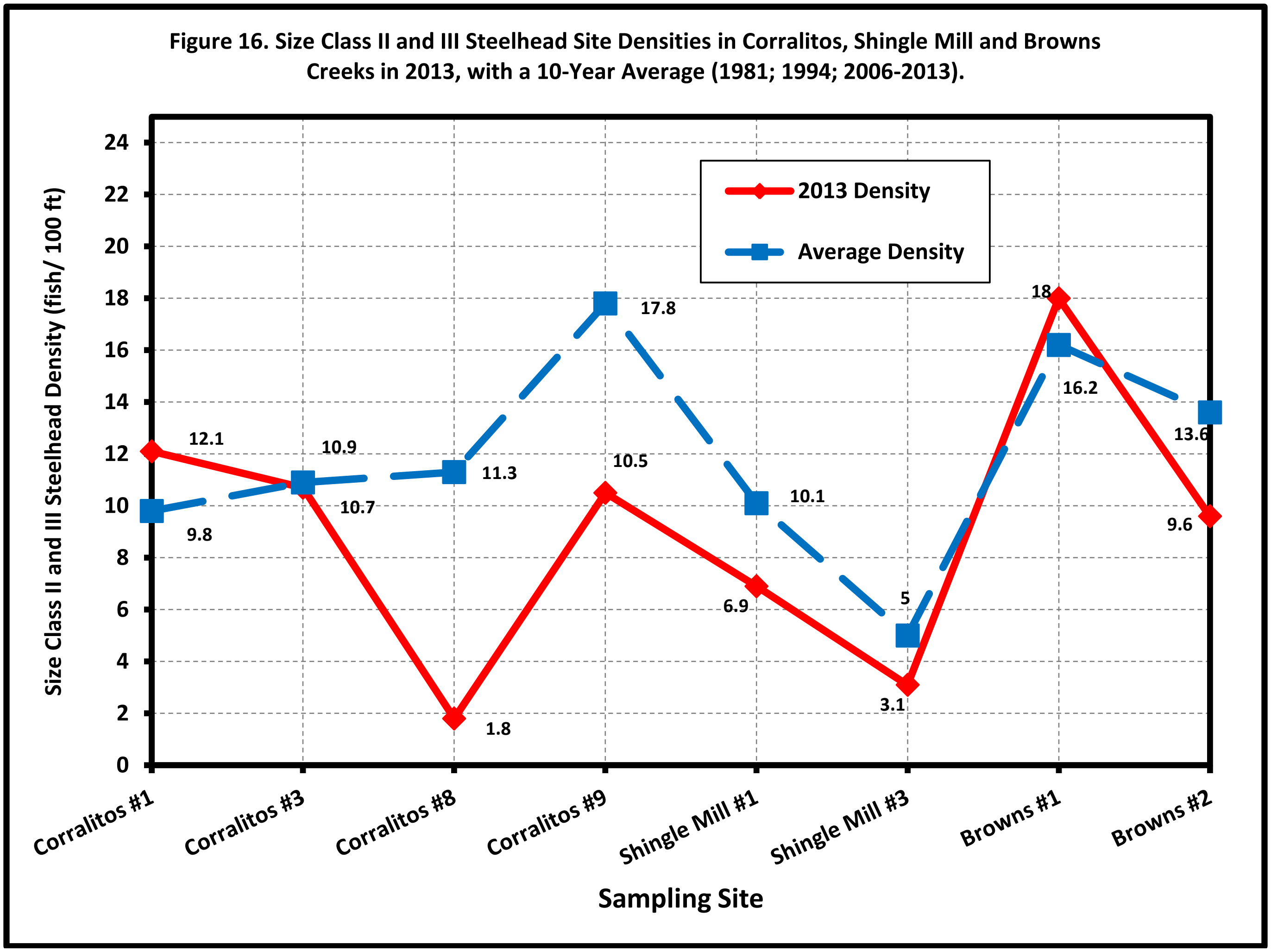


Figure 16. Size Class II and III Steelhead Site Densities in Corralitos, Shingle Mill and Browns Creeks in 2013, with a 10-Year Average (1981; 1994; 2006-2013).

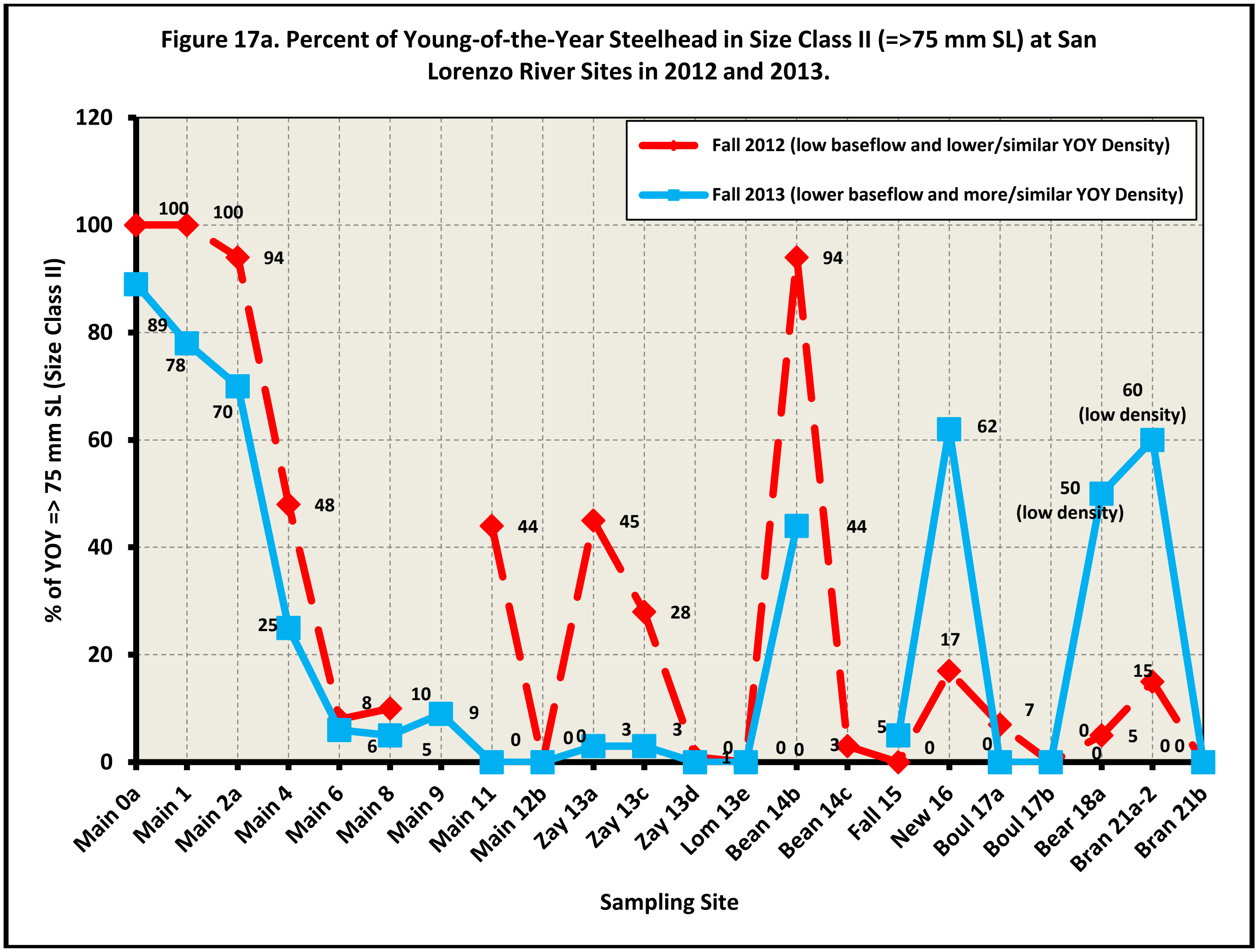


Figure 17a. Percent of Young-of-the-Year Steelhead in Size Class II (=>75 mm SL) at San Lorenzo River Sites in 2012 and 2013.

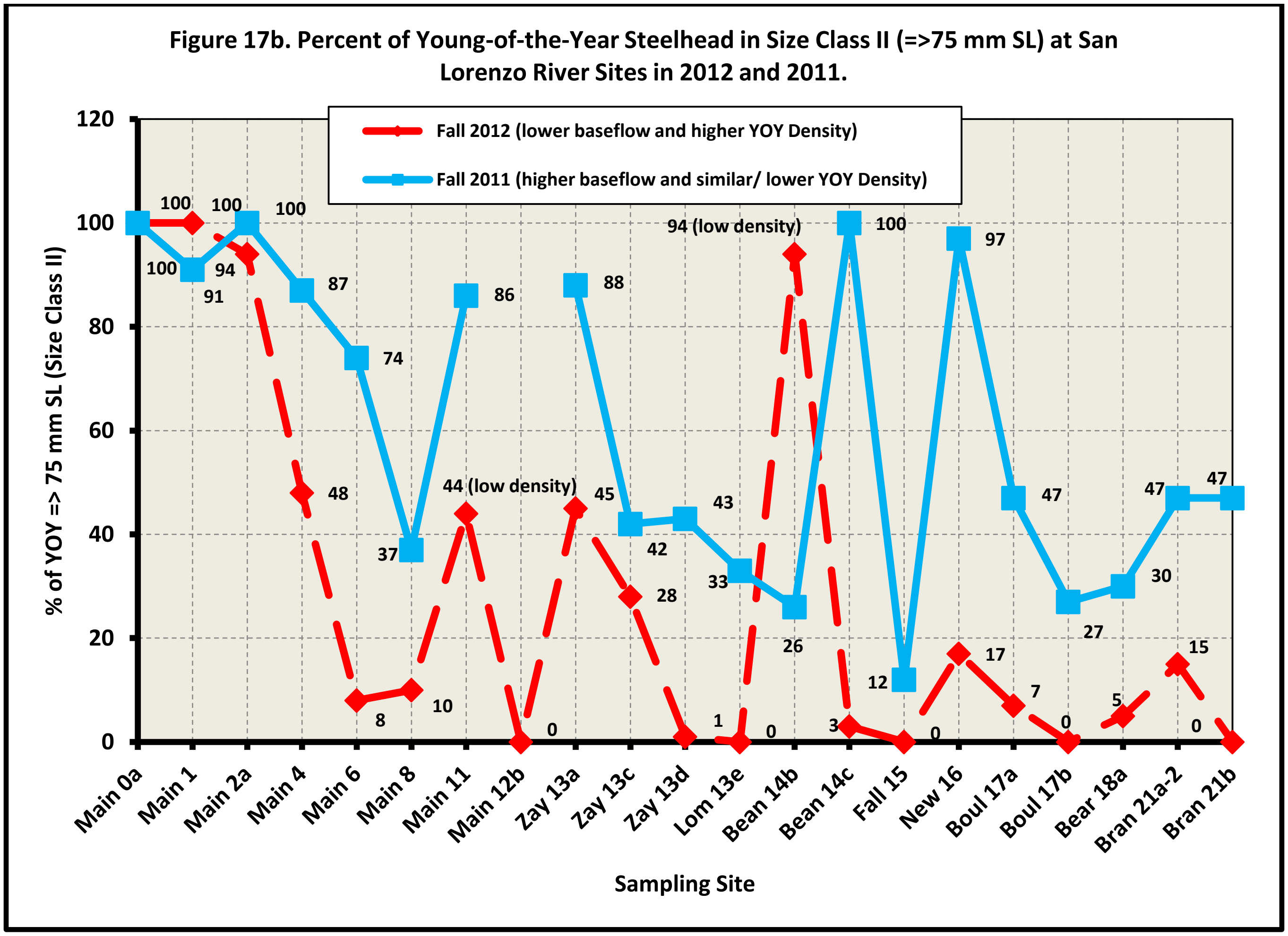


Figure 17b. Percent of Young-of-the-Year Steelhead in Size Class II (=>75 mm SL) at San Lorenzo River Sites in 2011 and 2012.

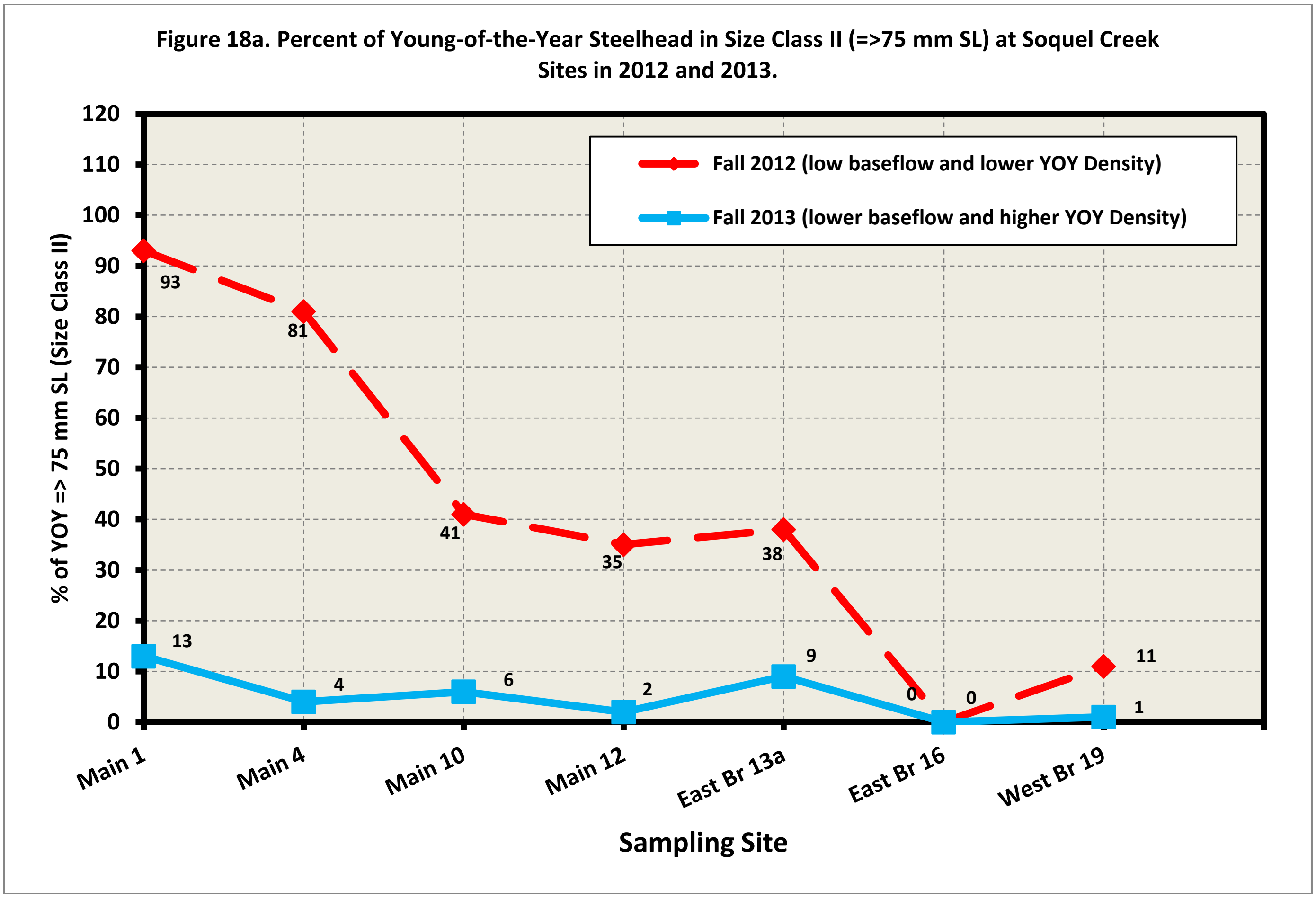


Figure 18a. Percent of Young-of-the-Year Steelhead in Size Class II (=>75 mm SL) at Soquel Creek Sites in 2012 and 2013.

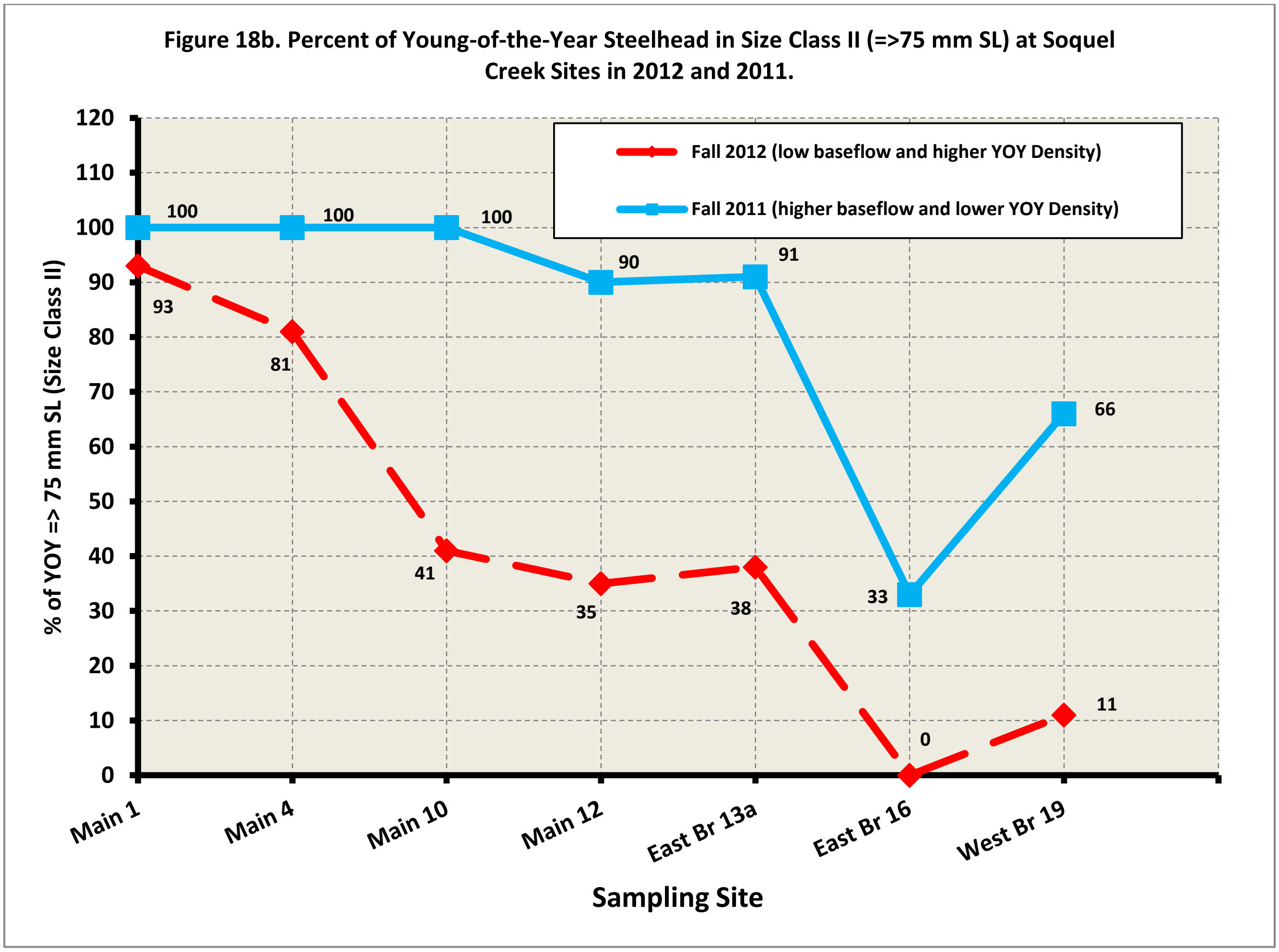


Figure 18b. Percent of Young-of-the-Year Steelhead in Size Class II (=>75 mm SL) at Soquel Creek Sites in 2011 and 2012.

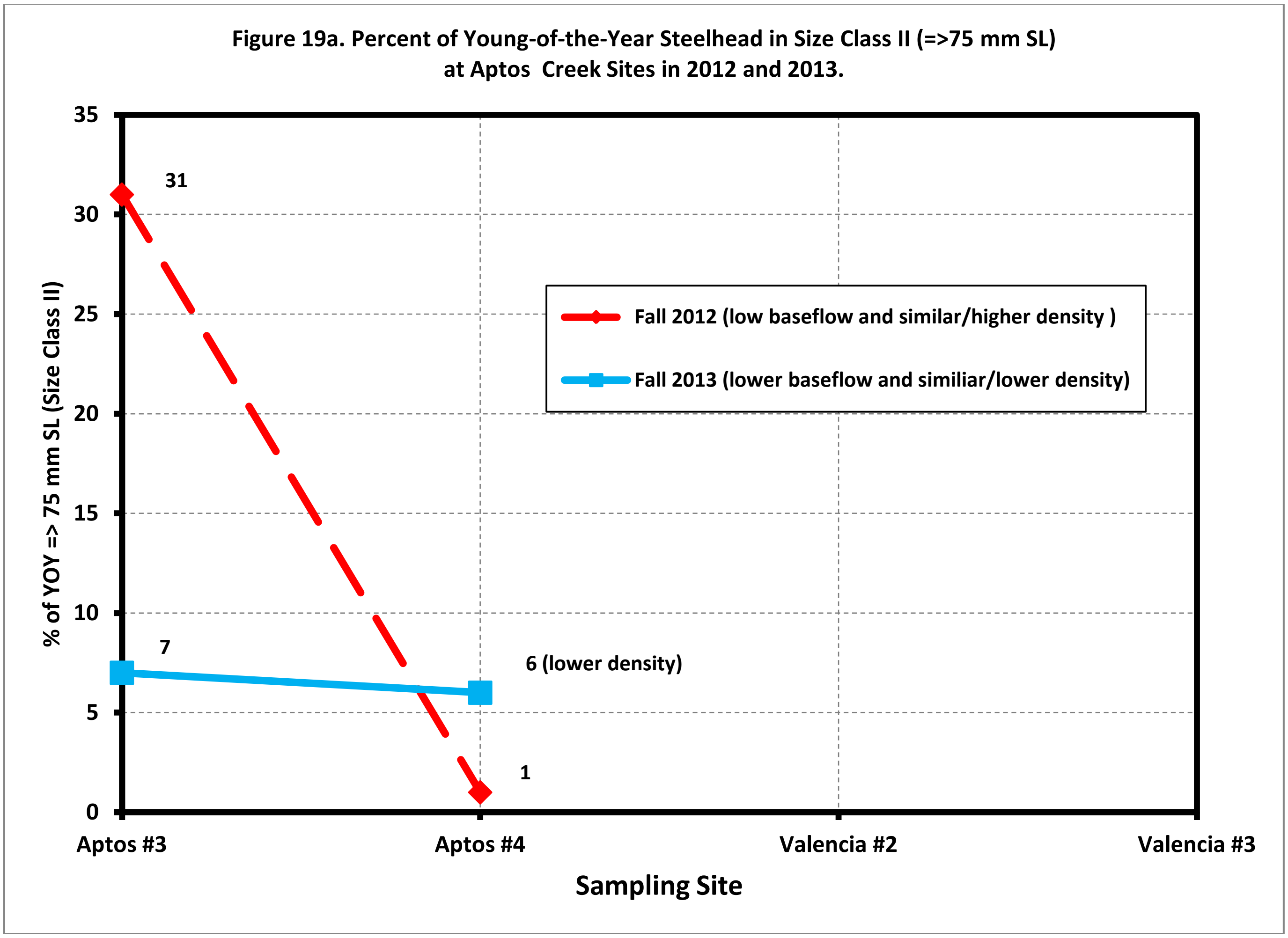


Figure 19a. Percent of Young-of-the-Year Steelhead in Size Class II (=>75 mm SL) at Aptos Creek Sites in 2012 and 2013.

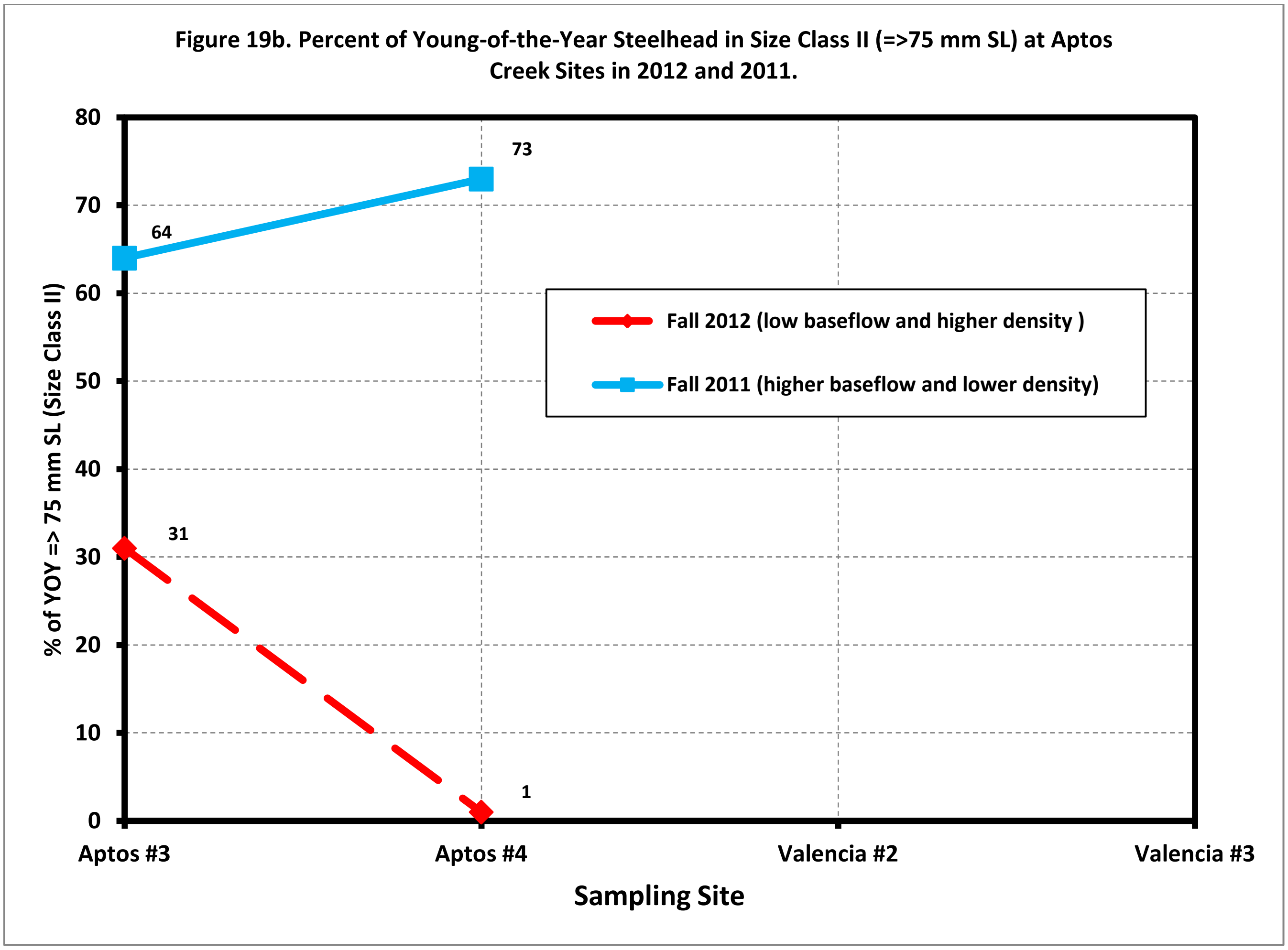


Figure 19b. Percent of Young-of-the-Year Steelhead in Size Class II (=>75 mm SL) at Aptos Creek Sites in 2011 and 2012.

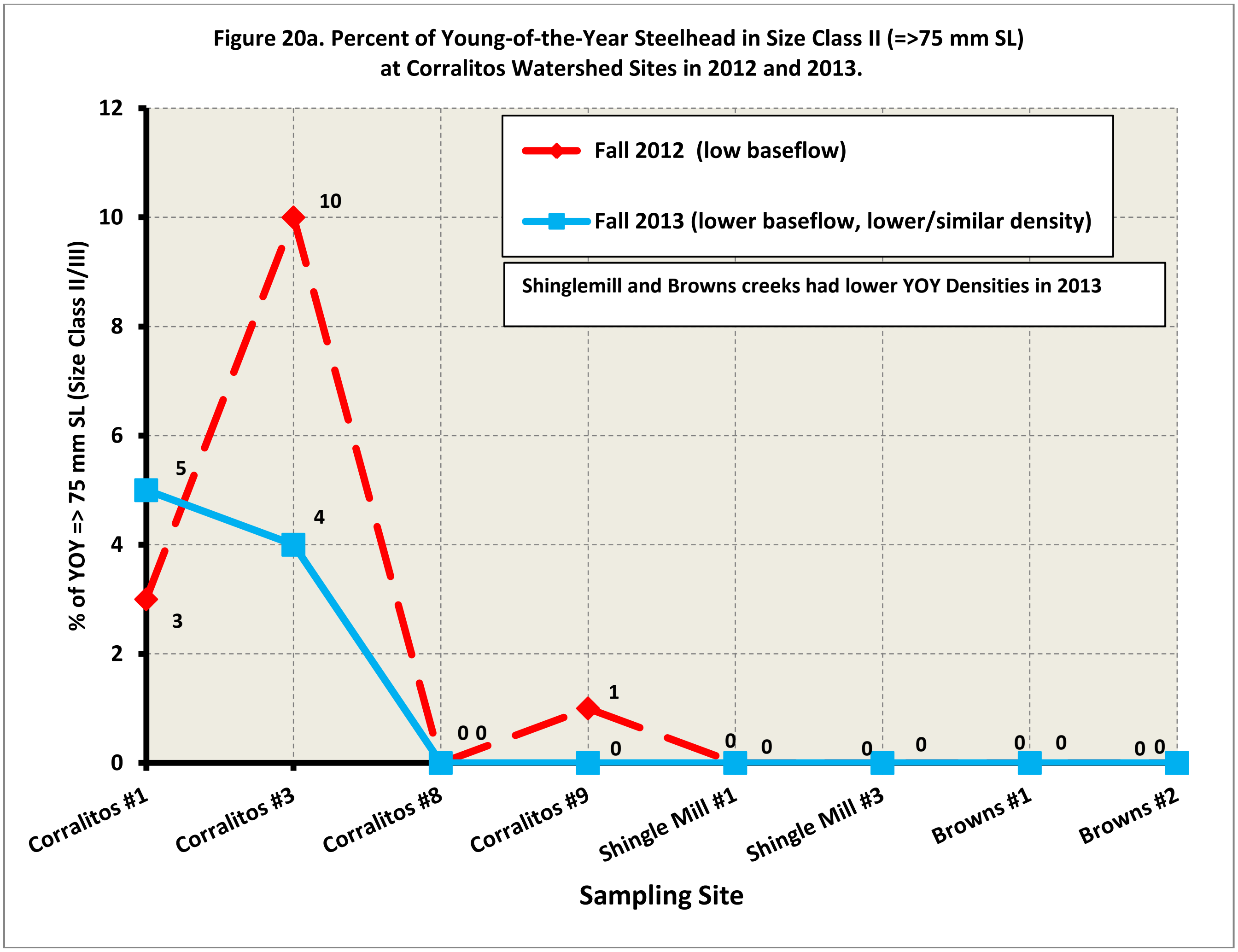


Figure 20a. Percent of Young-of-the-Year Steelhead in Size Class II (=>75 mm SL) at Corralitos Sub-Watershed Sites in 2012 and 2013.

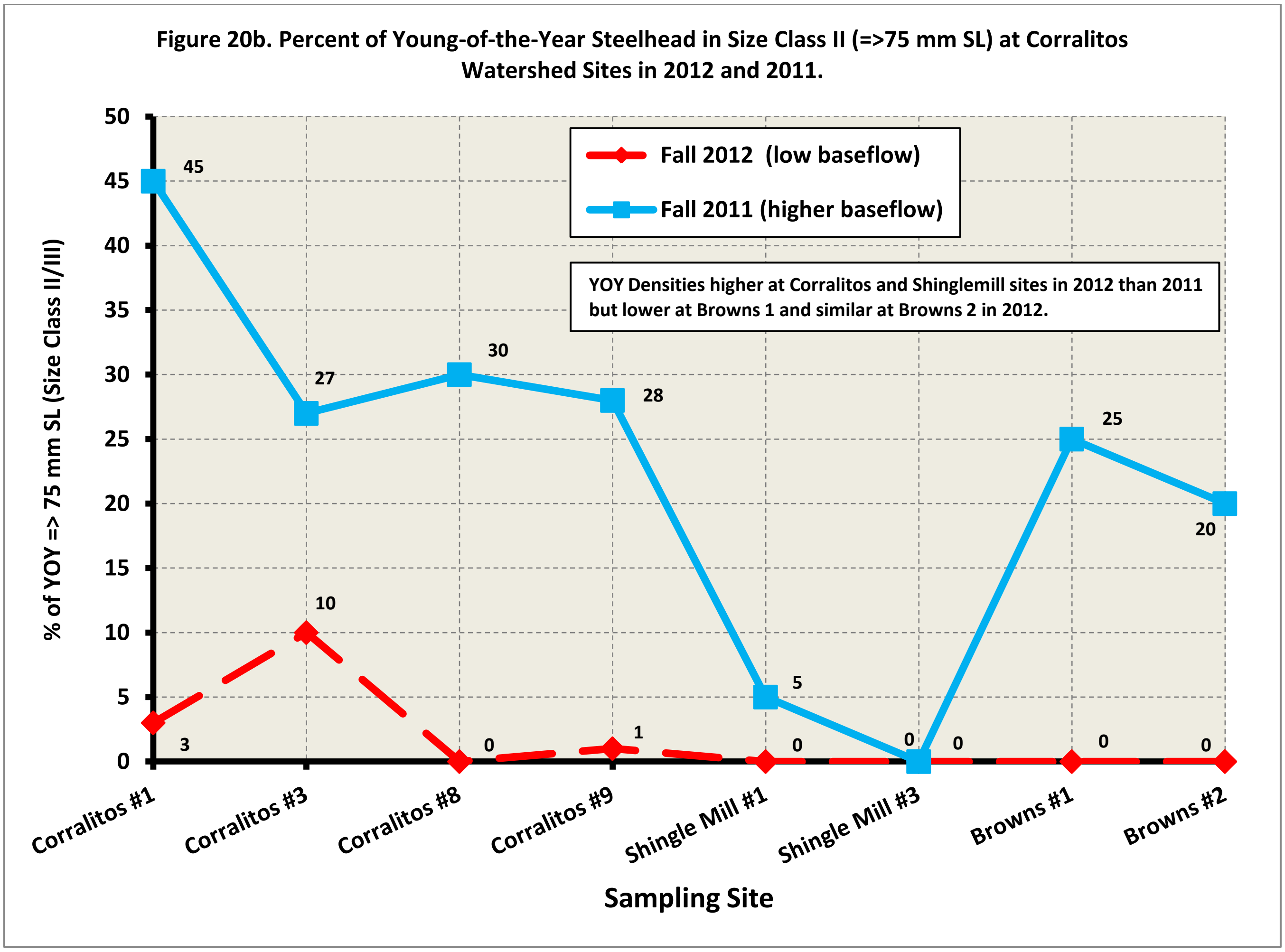


Figure 20b. Percent of Young-of-the-Year Steelhead in Size Class II (=>75 mm SL) at Corralitos Sub-Watershed Sites in 2011 and 2012.

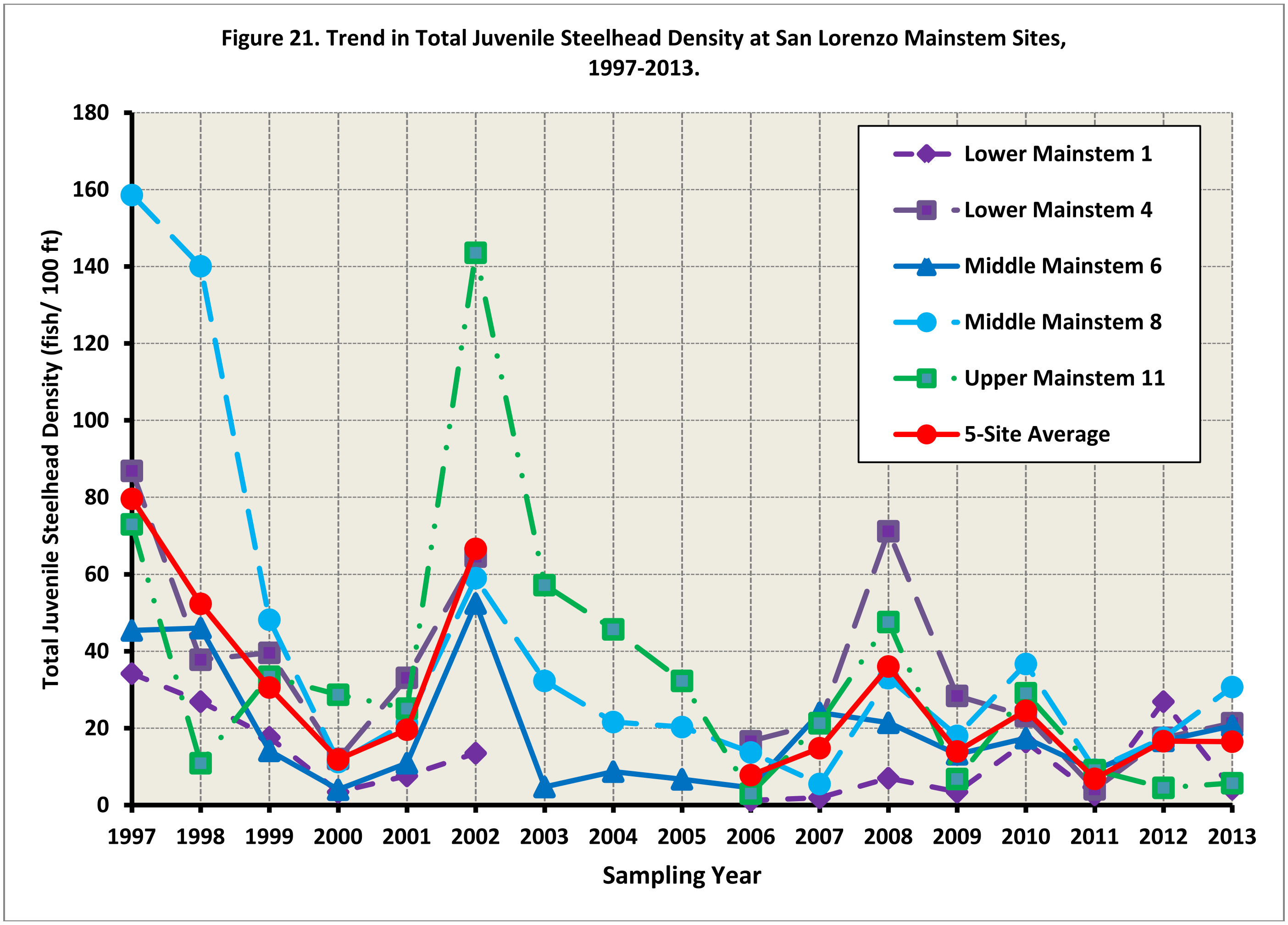


Figure 21. Trend in Total Juvenile Steelhead Density at San Lorenzo Mainstem Sites, 1997-2013.

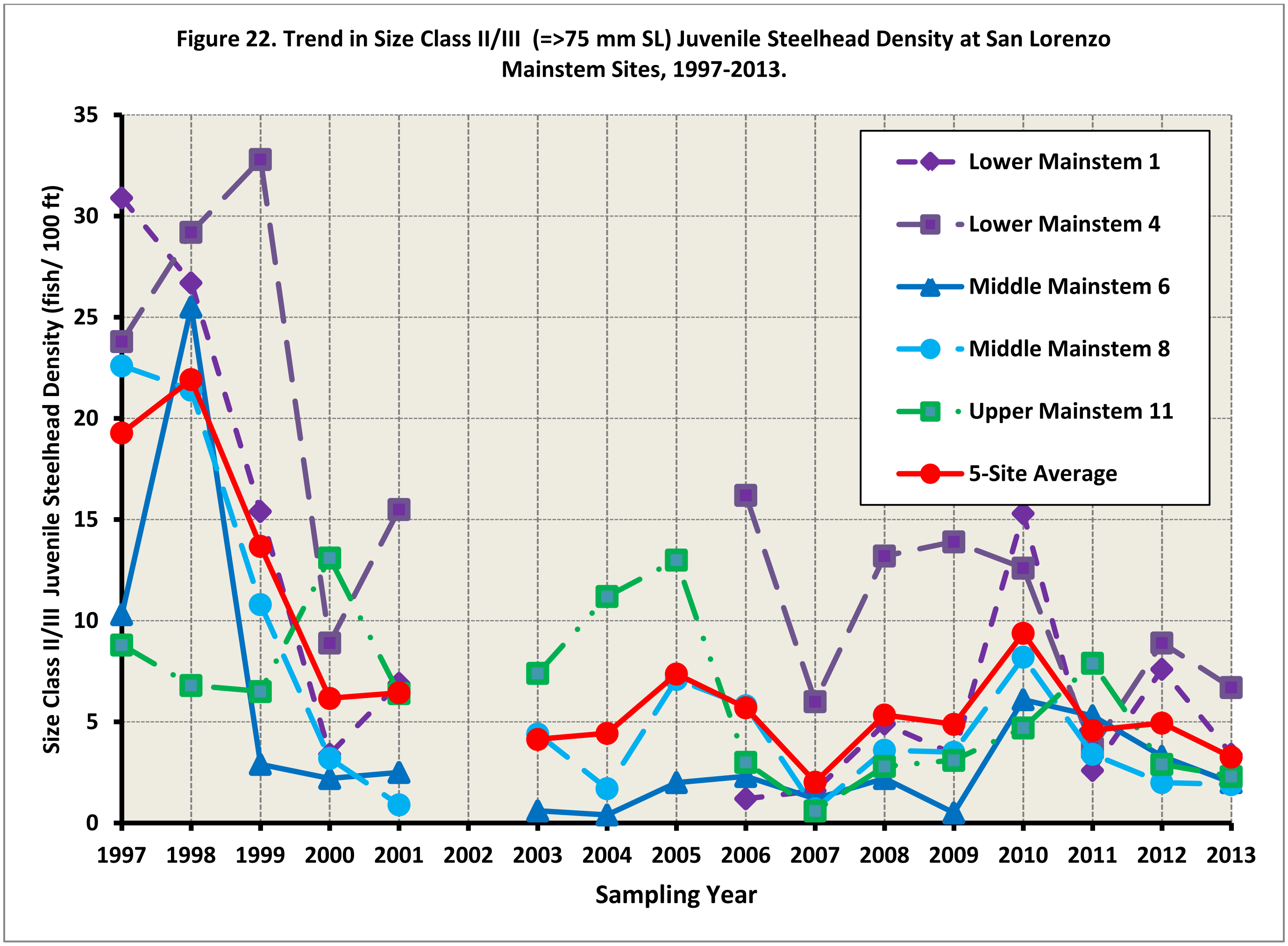


Figure 22. Trend in Size Class II/III (=>75 mm SL) Juvenile Steelhead Density at San Lorenzo Mainstem Sites, 1997-2013.

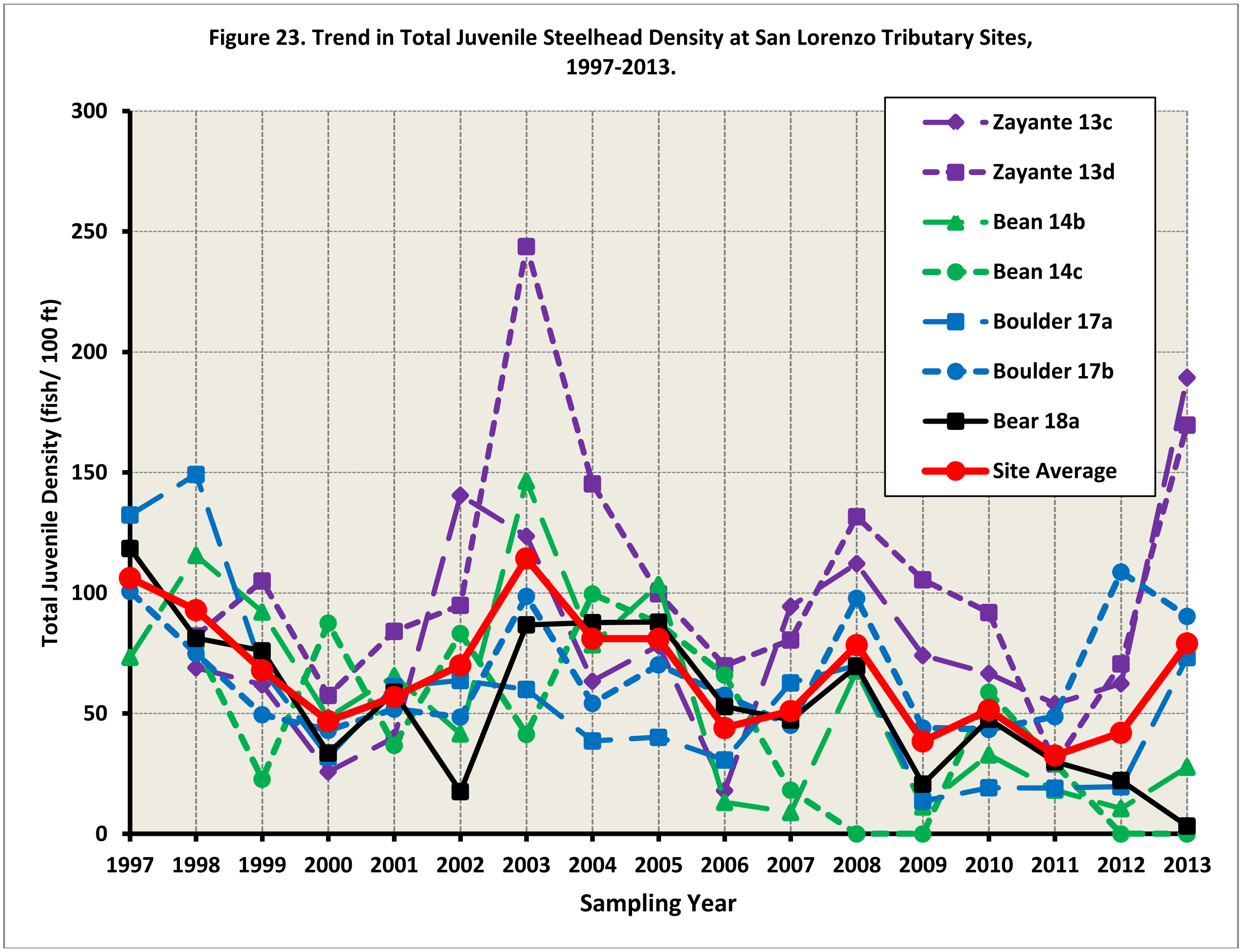


Figure 23. Trend in Total Juvenile Steelhead Density at San Lorenzo Tributary Sites, 1997-2013.

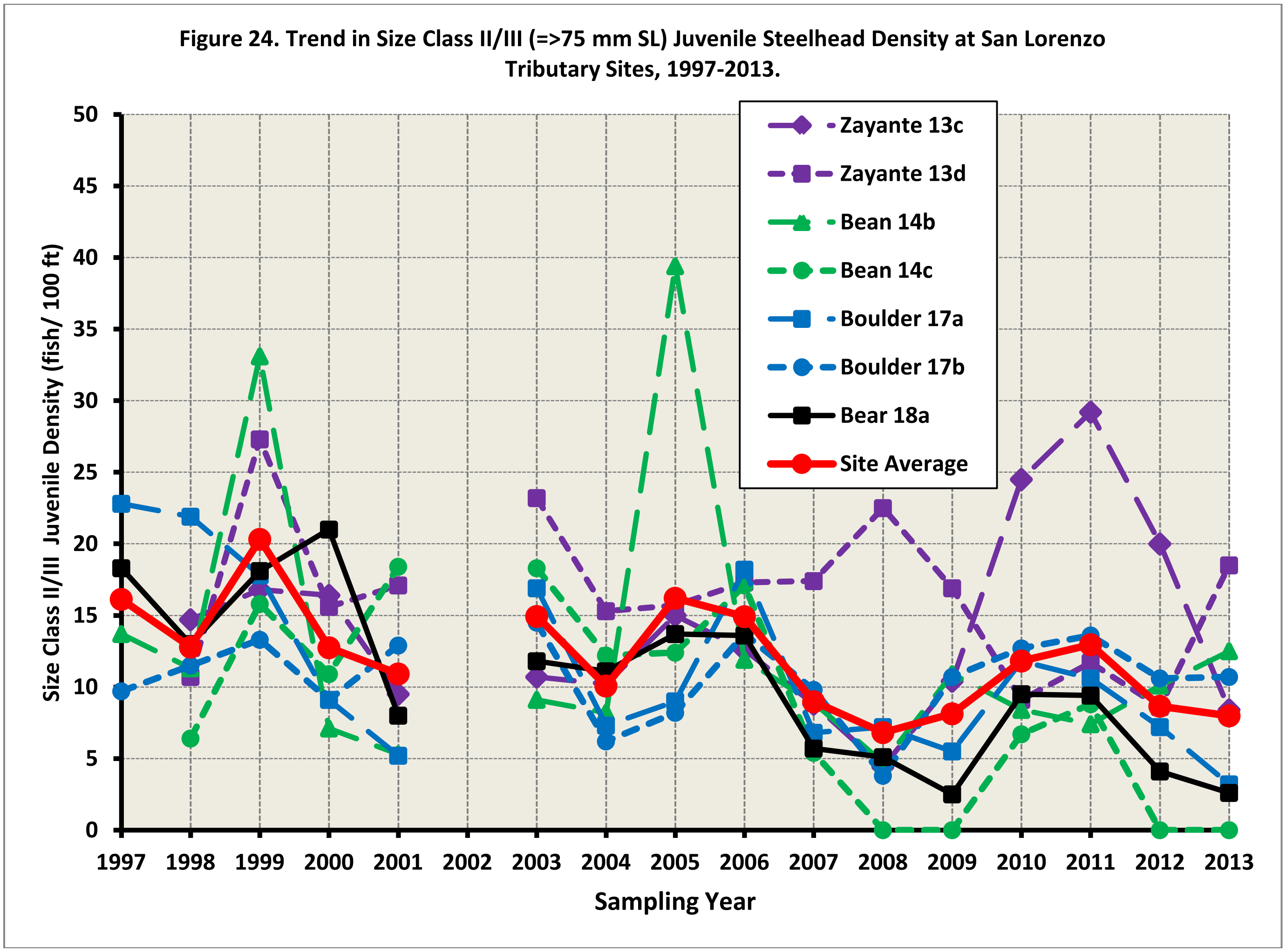


Figure 24. Trend in Size Class II/III (=>75 mm SL) Juvenile Steelhead Density at San Lorenzo Tributary Sites, 1997-2013.

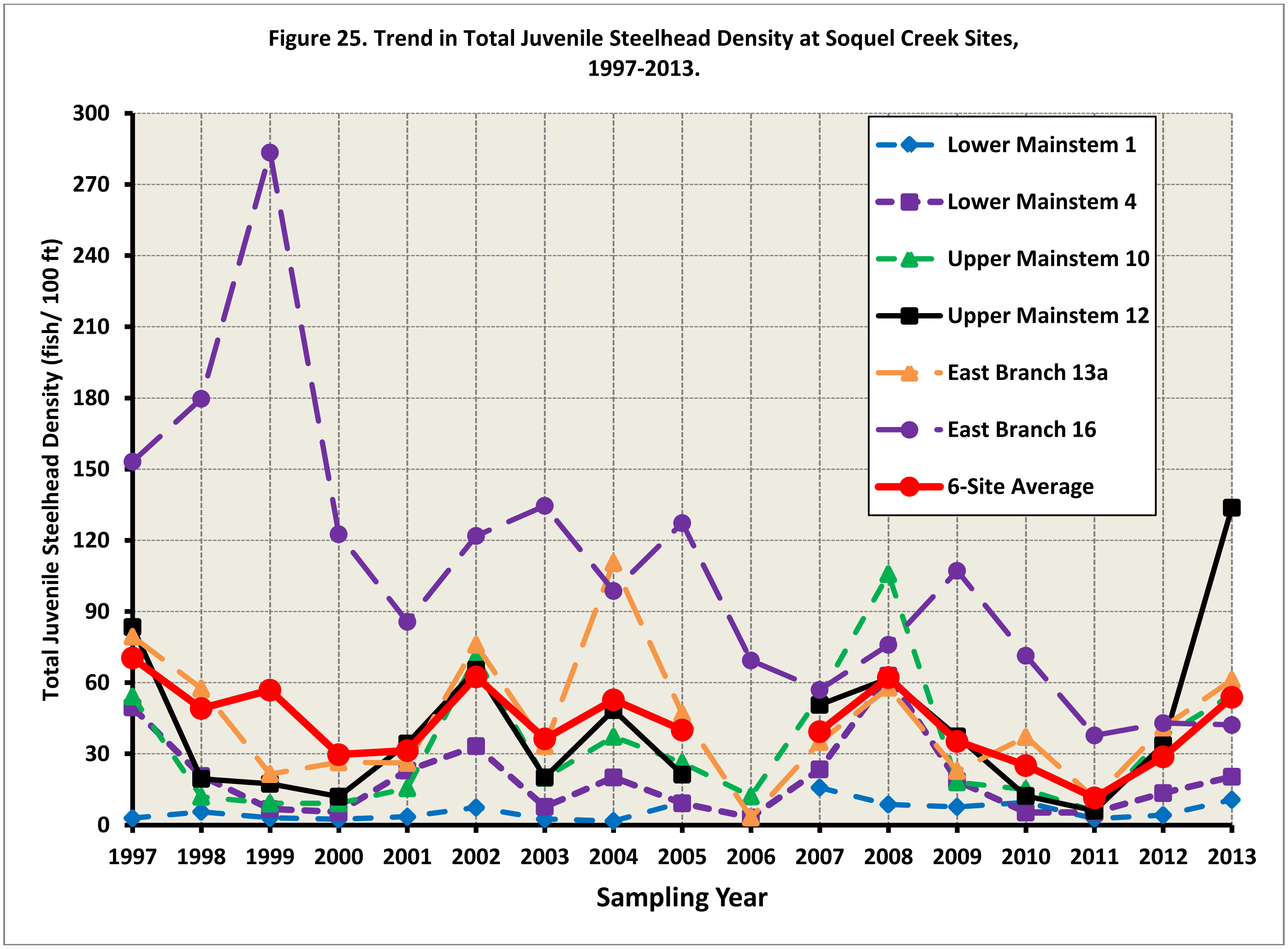


Figure 25. Trend in Total Juvenile Steelhead Density at Soquel Creek Sites, 1997-2013.

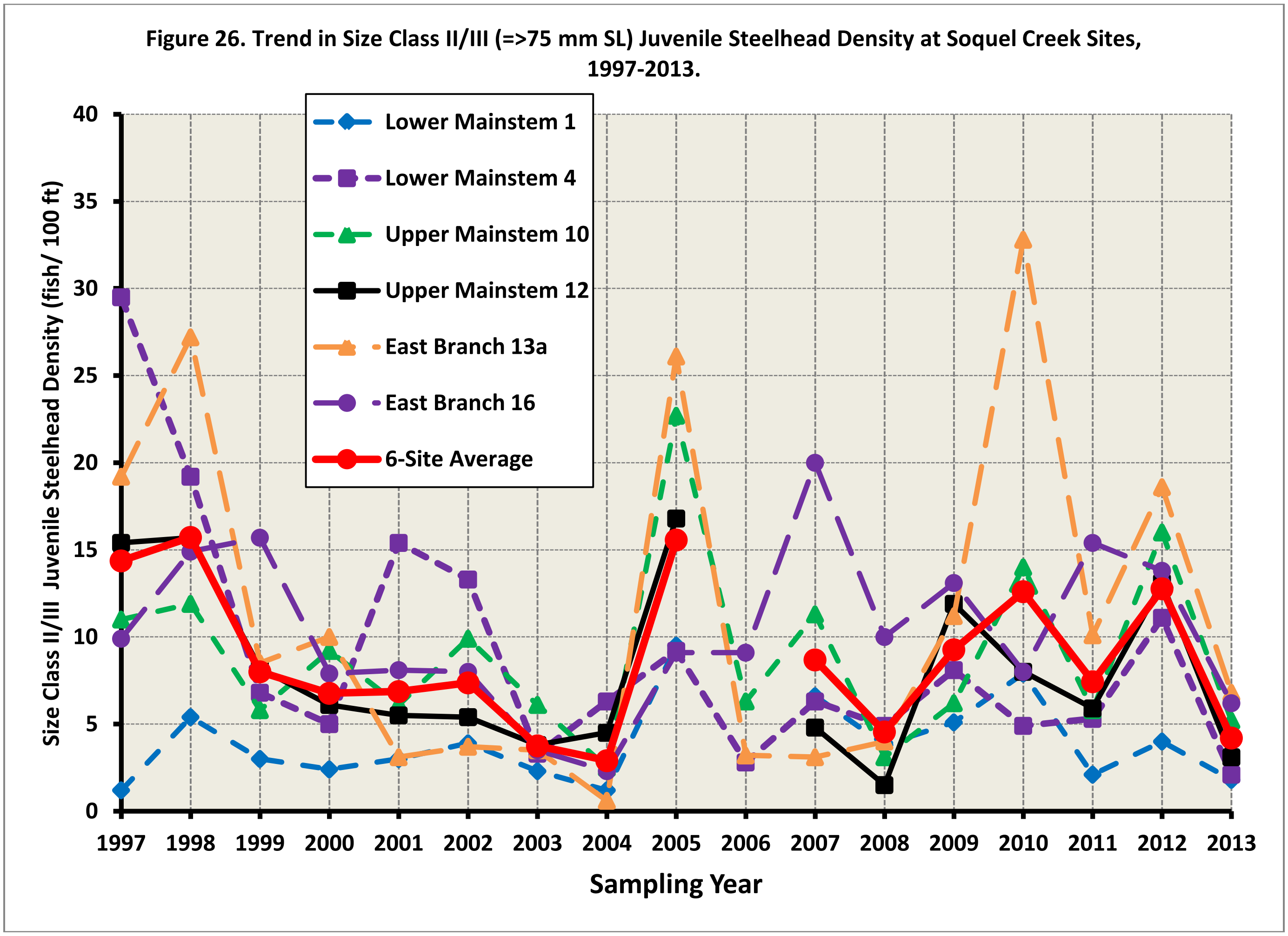


Figure 26. Trend in Size Class II/III (=>75 mm SL) Juvenile Steelhead Density at Soquel Creek Sites, 1997-2013.

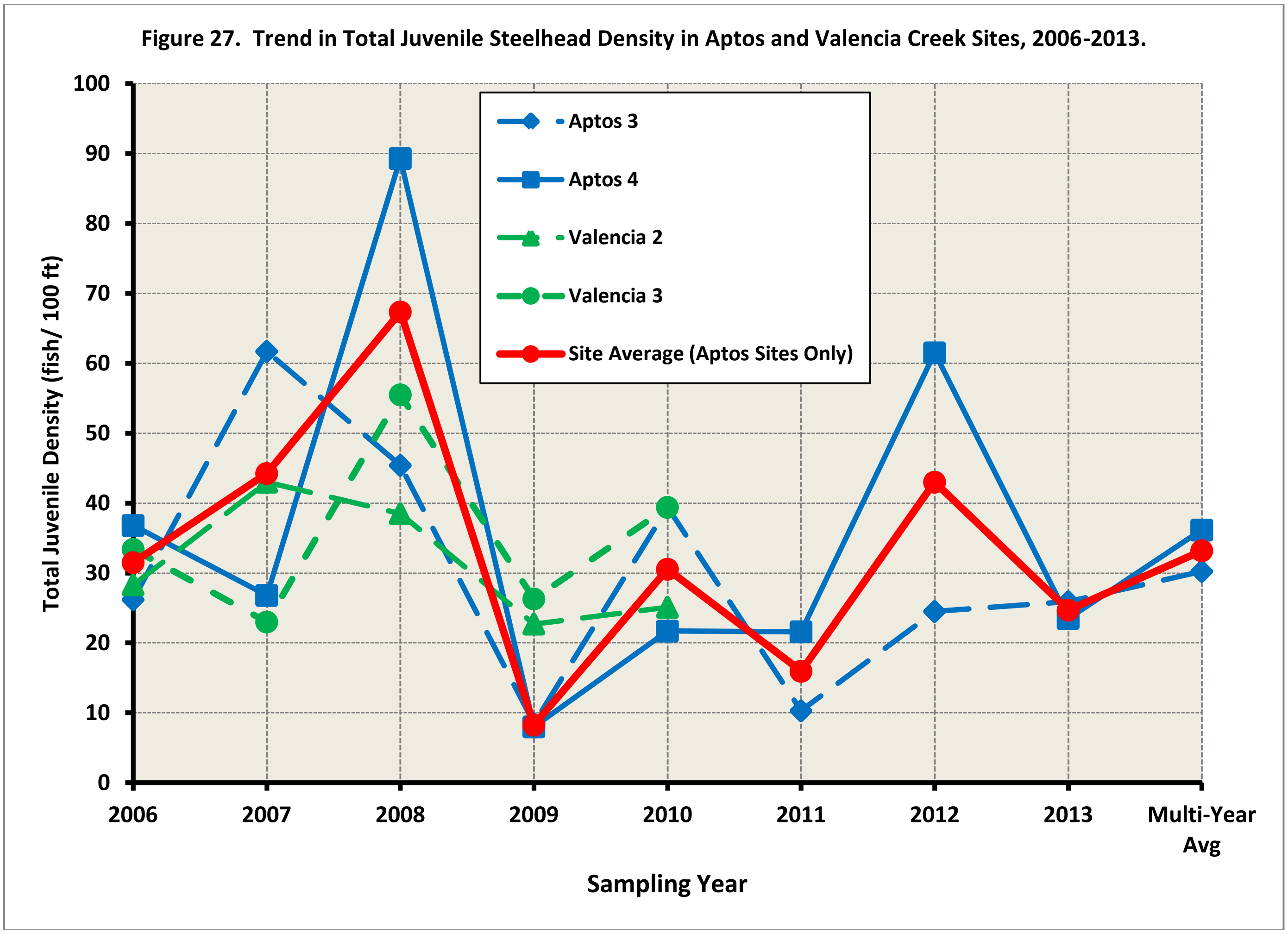


Figure 27. Trend in Total Juvenile Steelhead Density in Aptos and Valencia Creek Sites, 2006-2013.

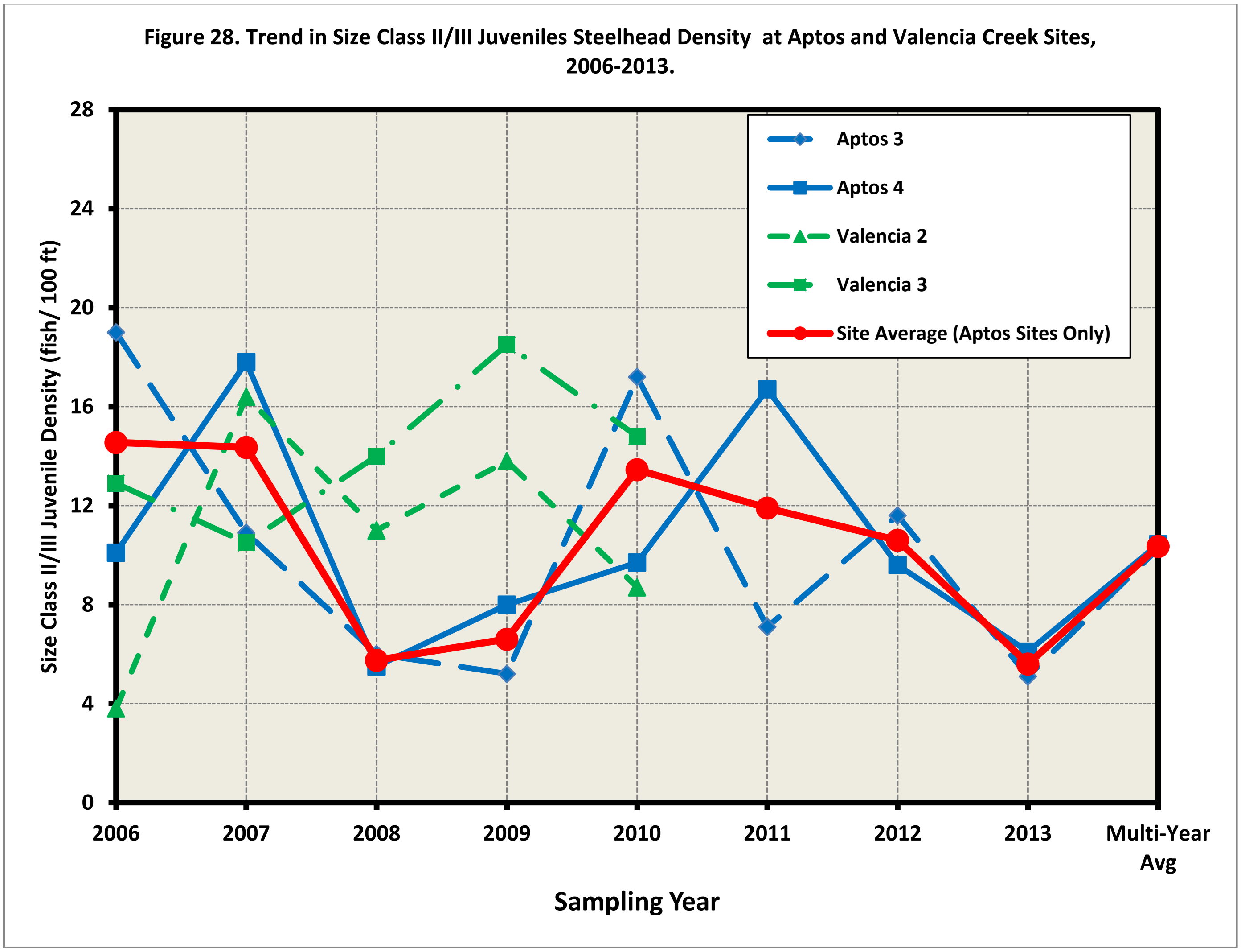


Figure 28. Trend in Size Class II/III Juveniles Steelhead Density at Aptos and Valencia Creek Sites, 2006-2013.

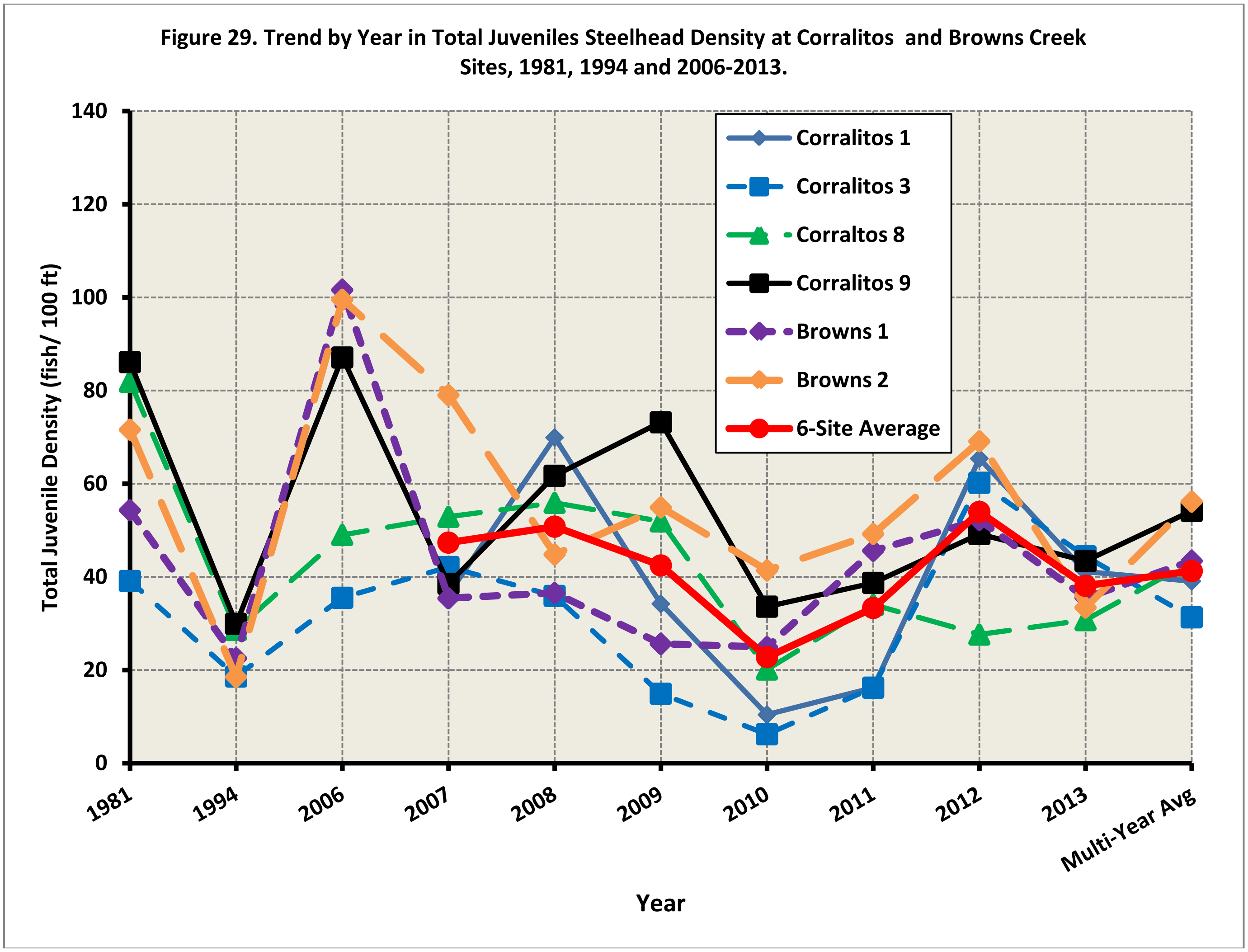


Figure 29. Trend by Year in Total Juveniles Steelhead Density at Corralitos and Browns Creek Sites, 1981, 1994 and 2006-2013.

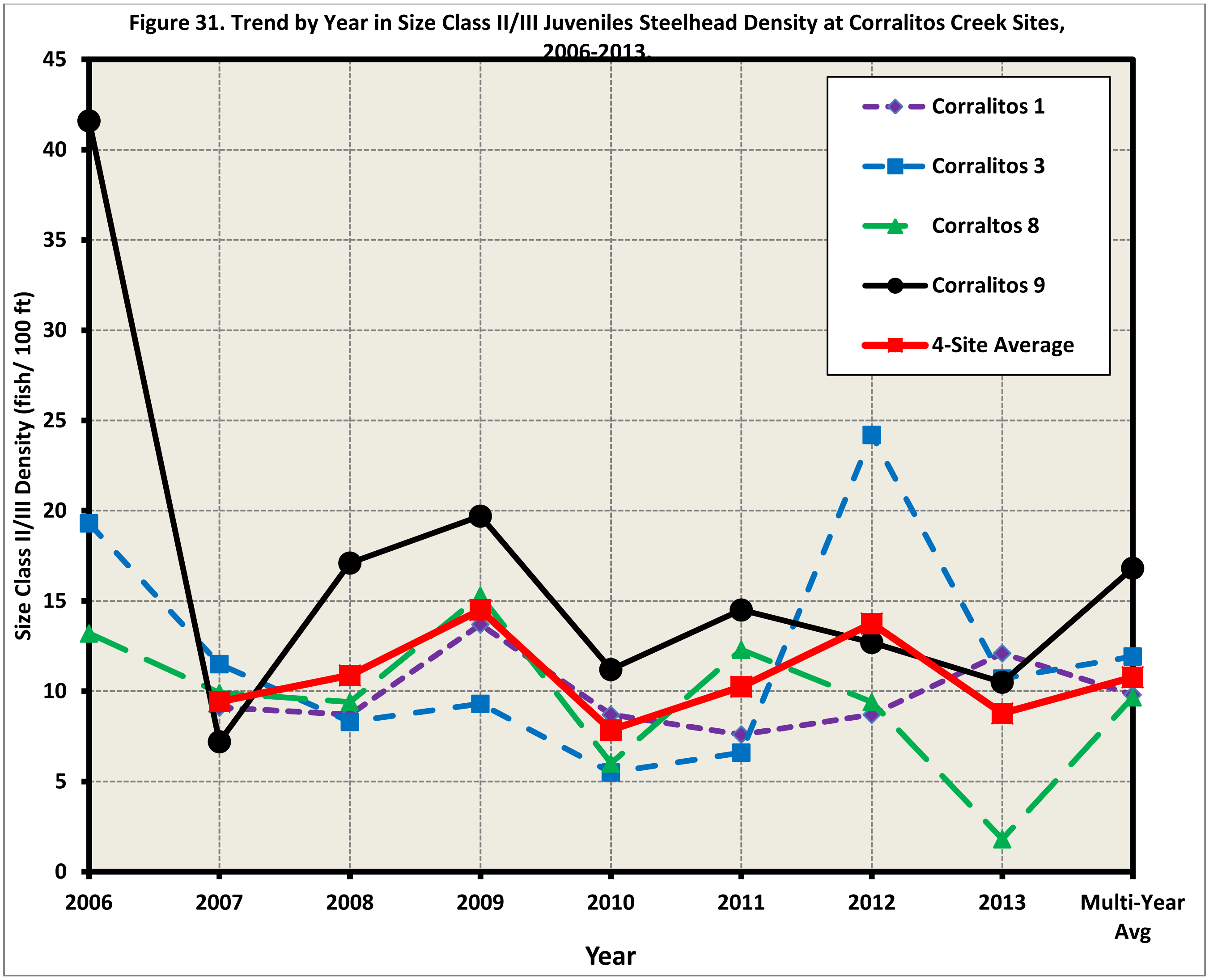


Figure 31. Trend by Year in Size Class II/III Juveniles Steelhead Density at Corralitos Creek Sites, 2006-2013.

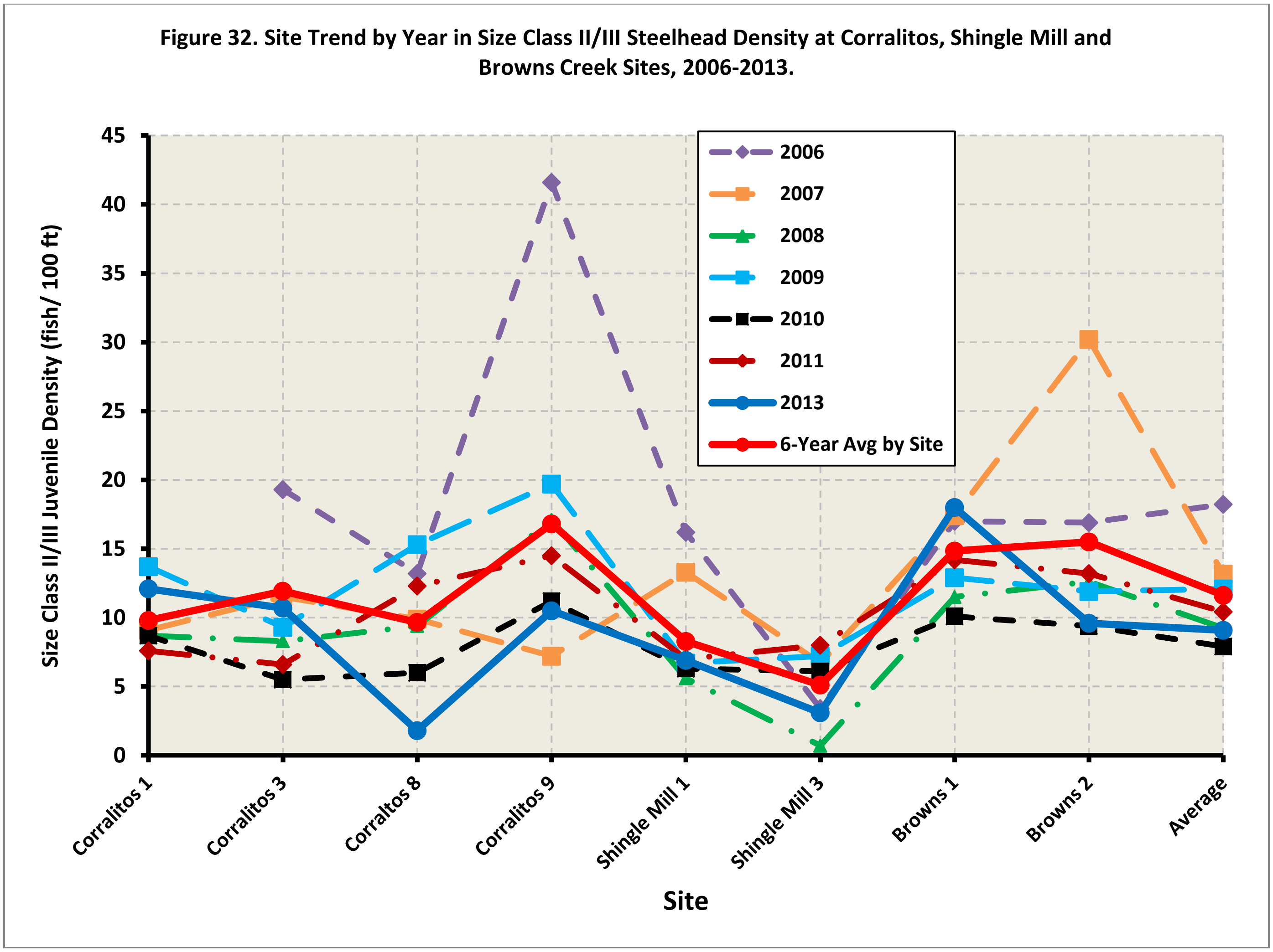


Figure 32. Site Trend by Year in Size Class II/III Steelhead Density at Corralitos, Shingle Mill and Browns Creek Sites, 2006-2013.

Figure 33. The 2012 Daily Average Discharge and Median Daily Flow of Record for the USGS Gage On the San Lorenzo River at Big Trees.

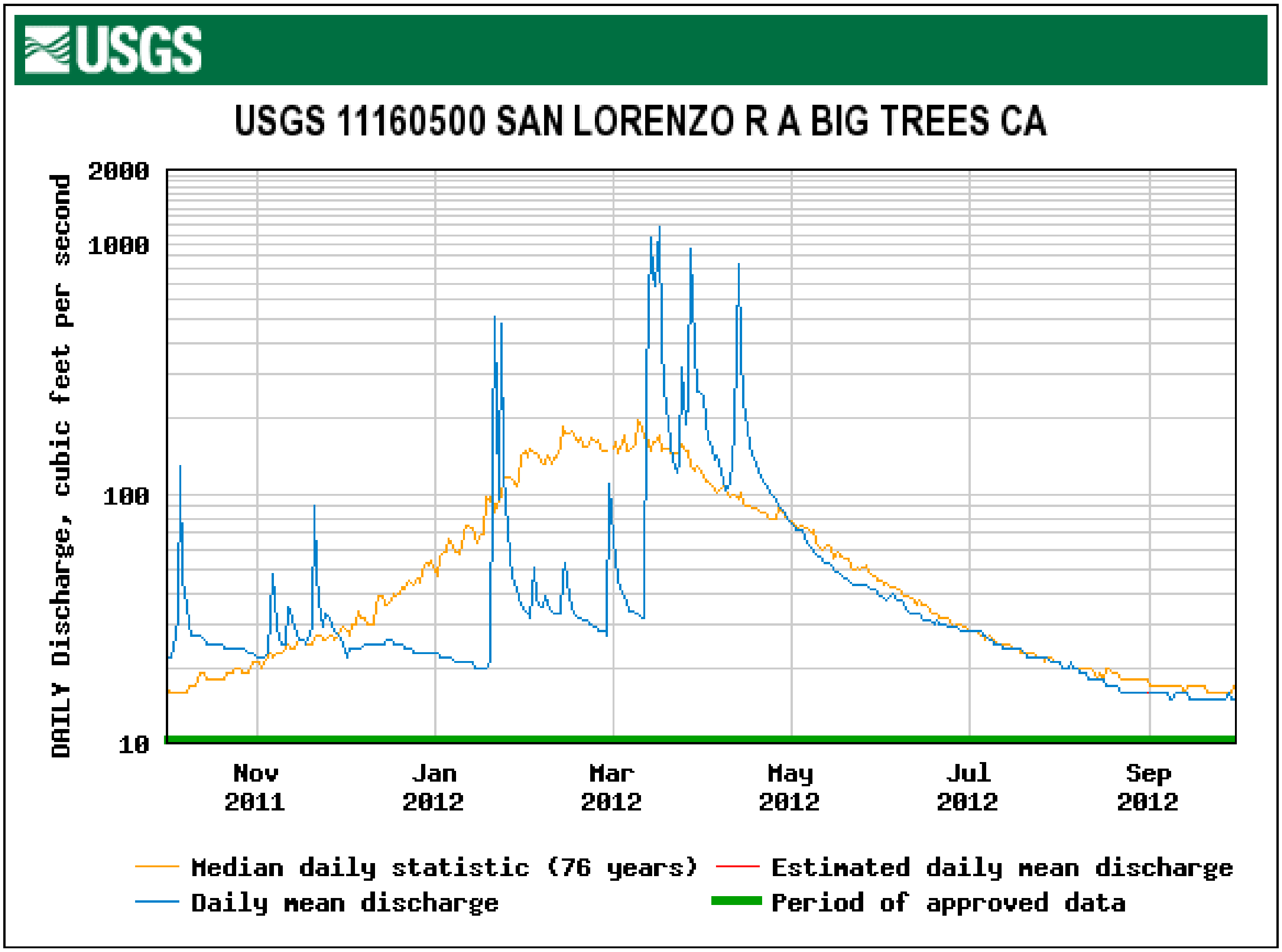


Figure 34a. The 2013 Discharge for the USGS Gage On the San Lorenzo River at Big Trees.

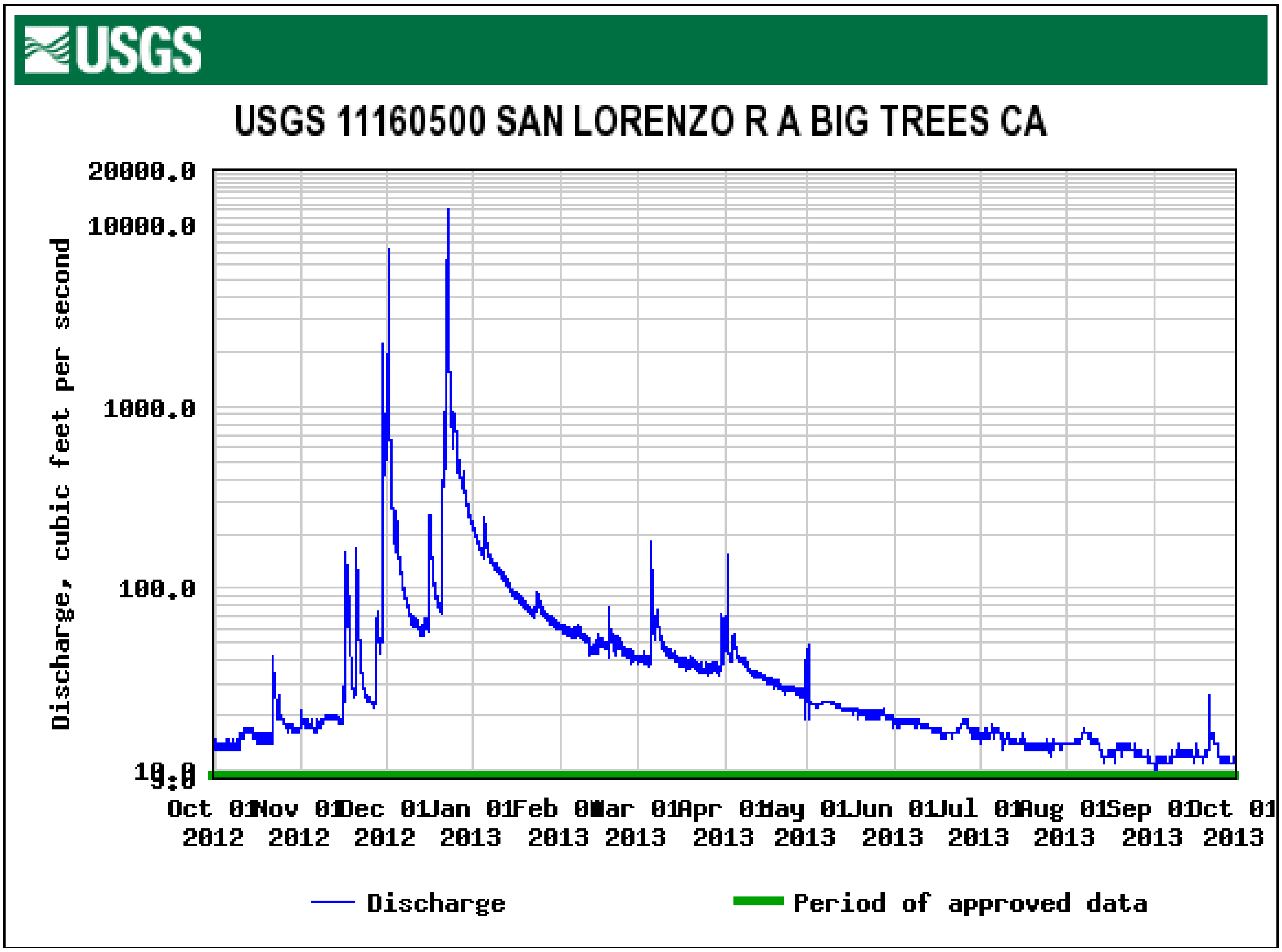


Figure 34b. The 2013 Daily Average Discharge and Median Daily Flow of Record for the USGS Gage On the San Lorenzo River at Big Trees.

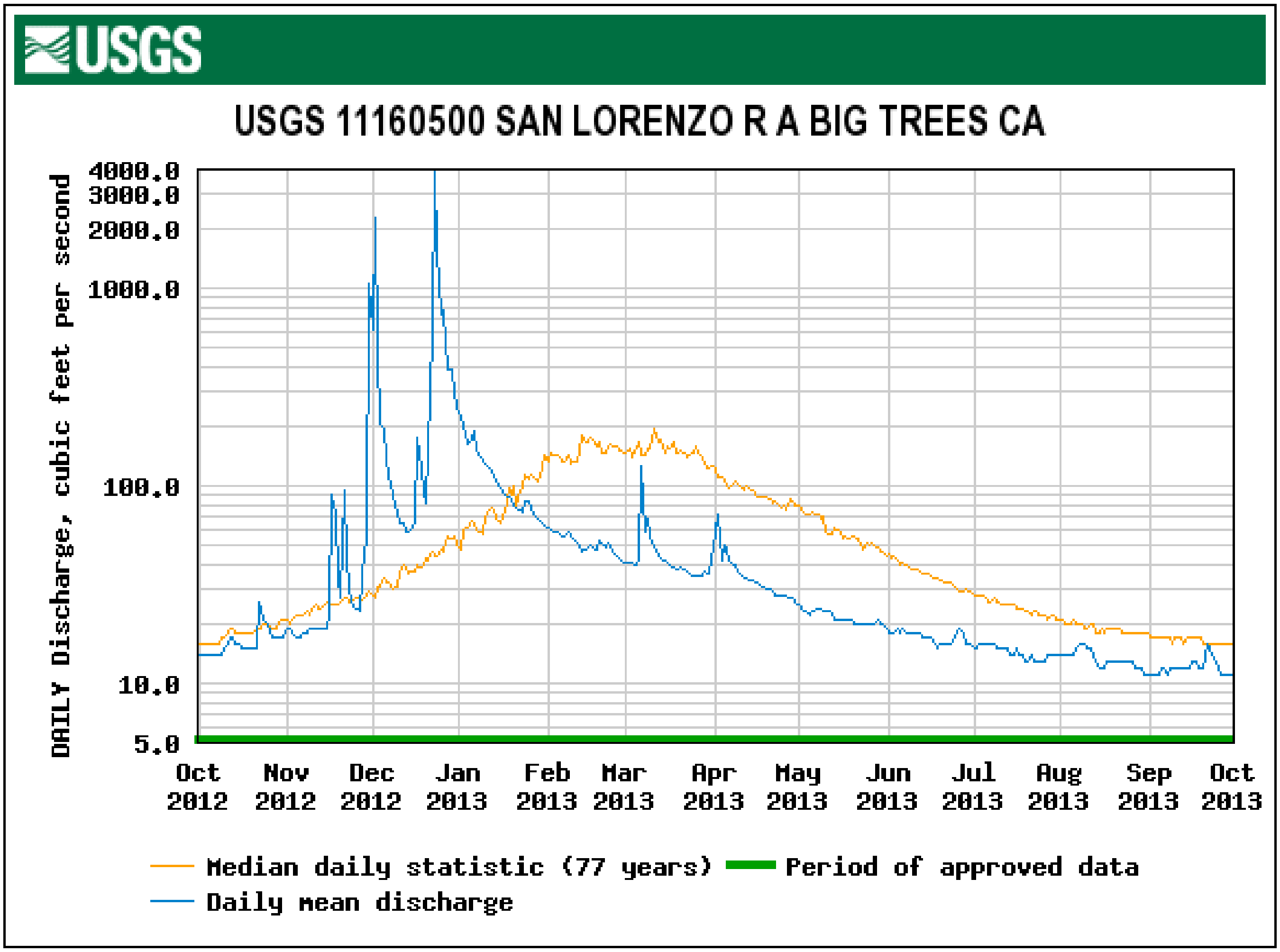


Figure 35. The March−May 2013 Discharge of Record for the USGS Gage On the San Lorenzo River at Big Trees.

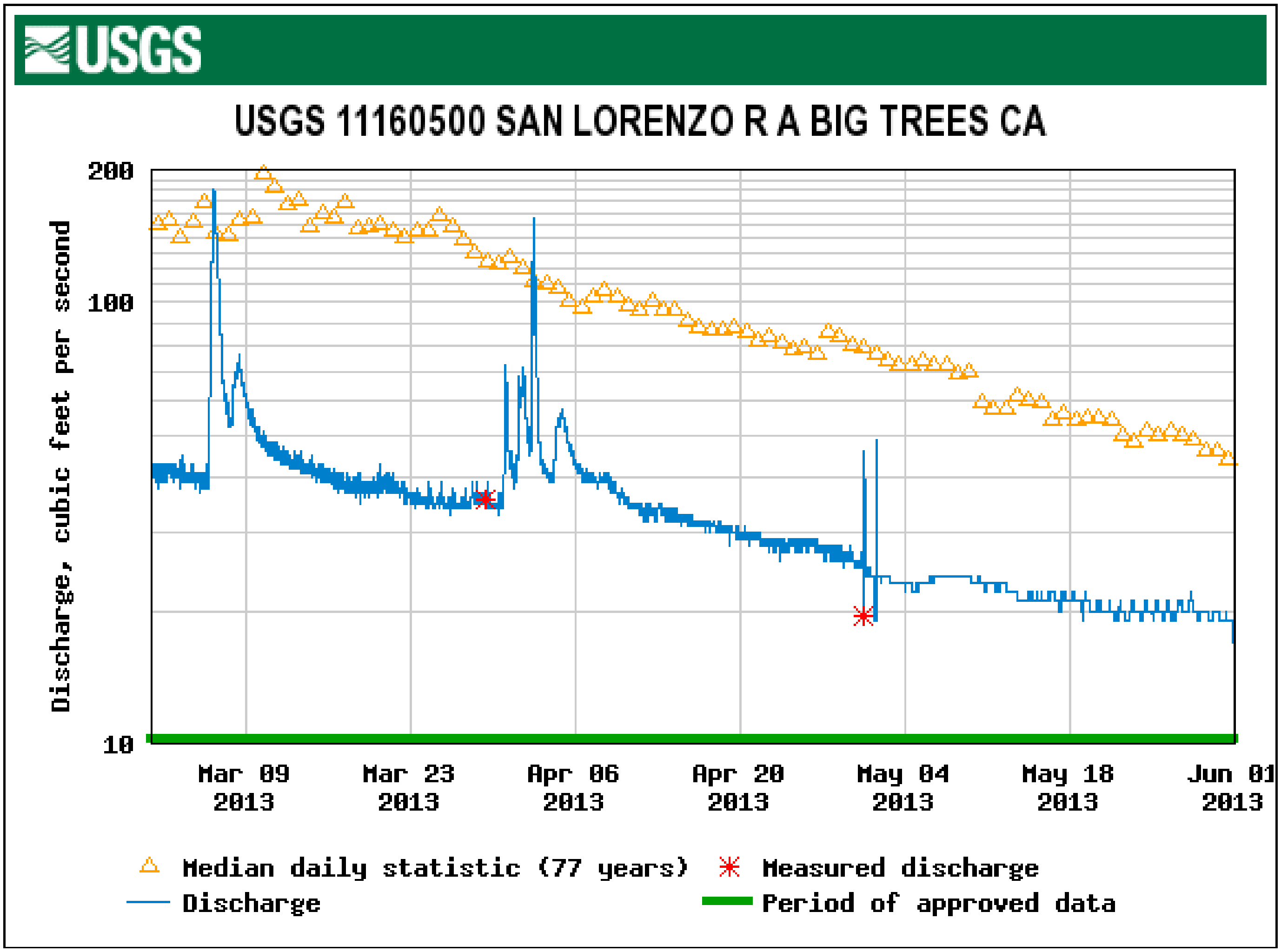


Figure 36. The 2012 Daily Mean and Median Flow at the USGS Gage on Soquel Creek at Soquel Village.

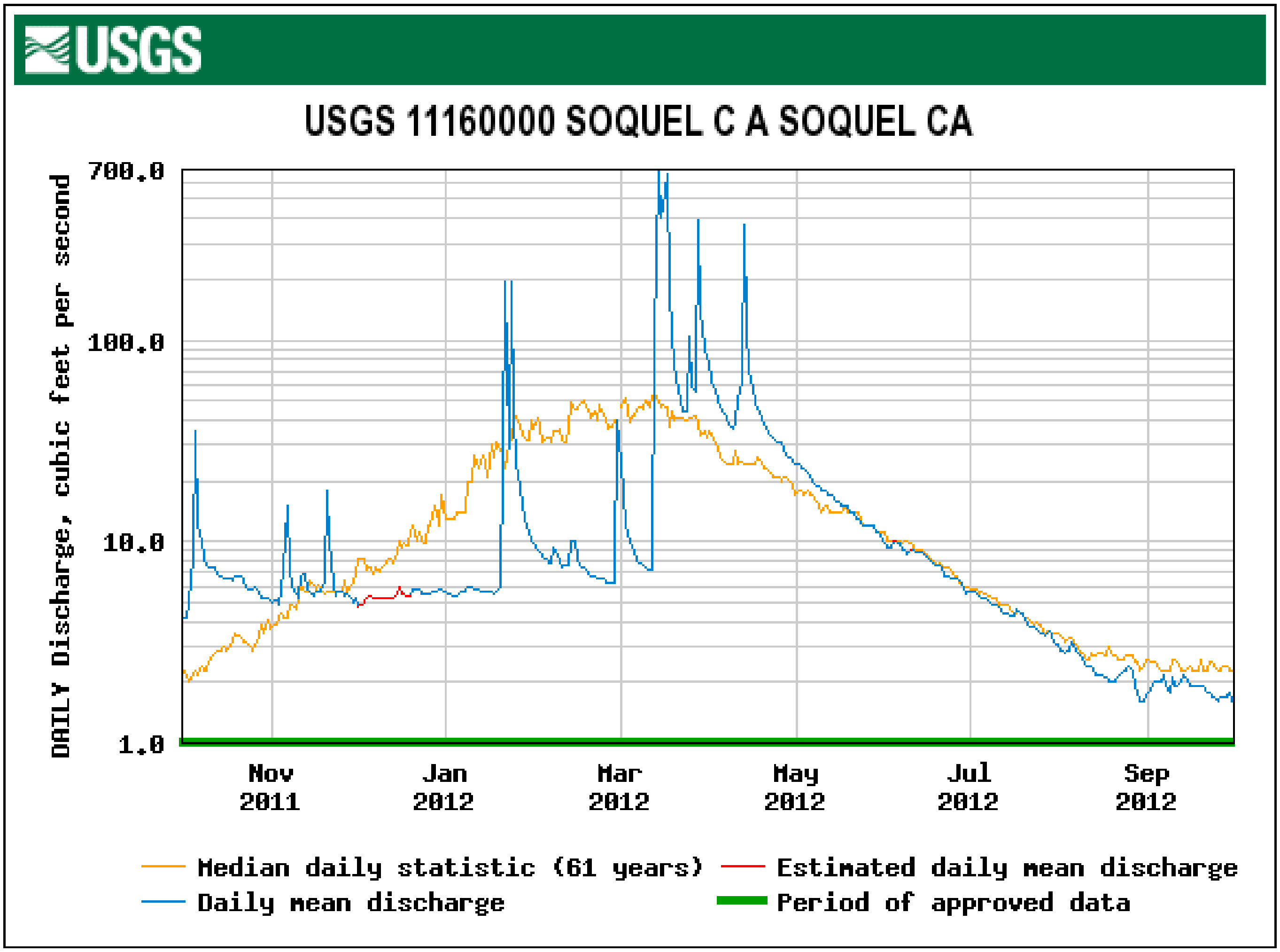


Figure 37a. The 2013 Discharge at the USGS Gage on Soquel Creek at Soquel Village.

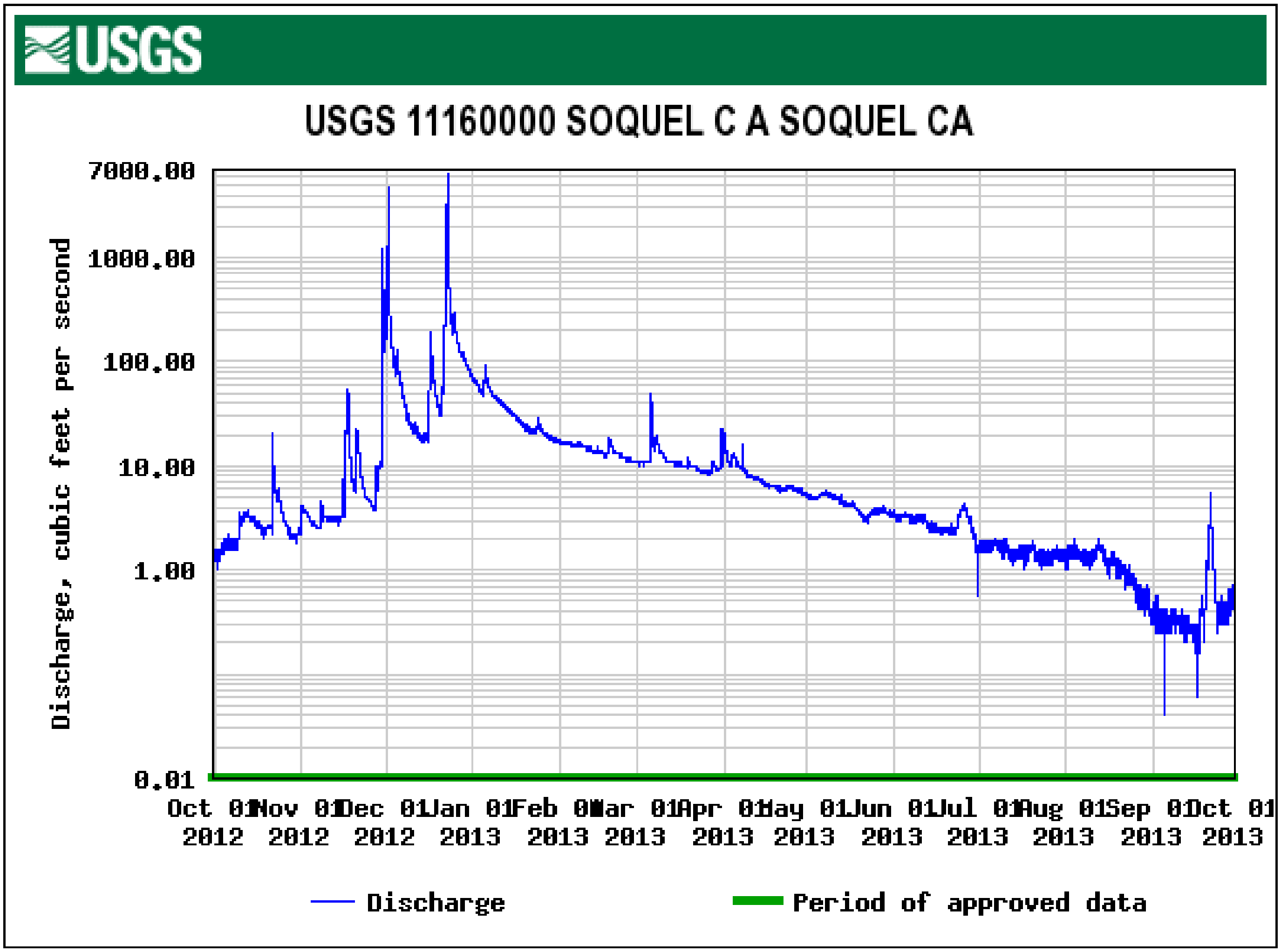


Figure 37b. The 2013 Daily Mean and Median Flow at the USGS Gage on Soquel Creek at Soquel Village.

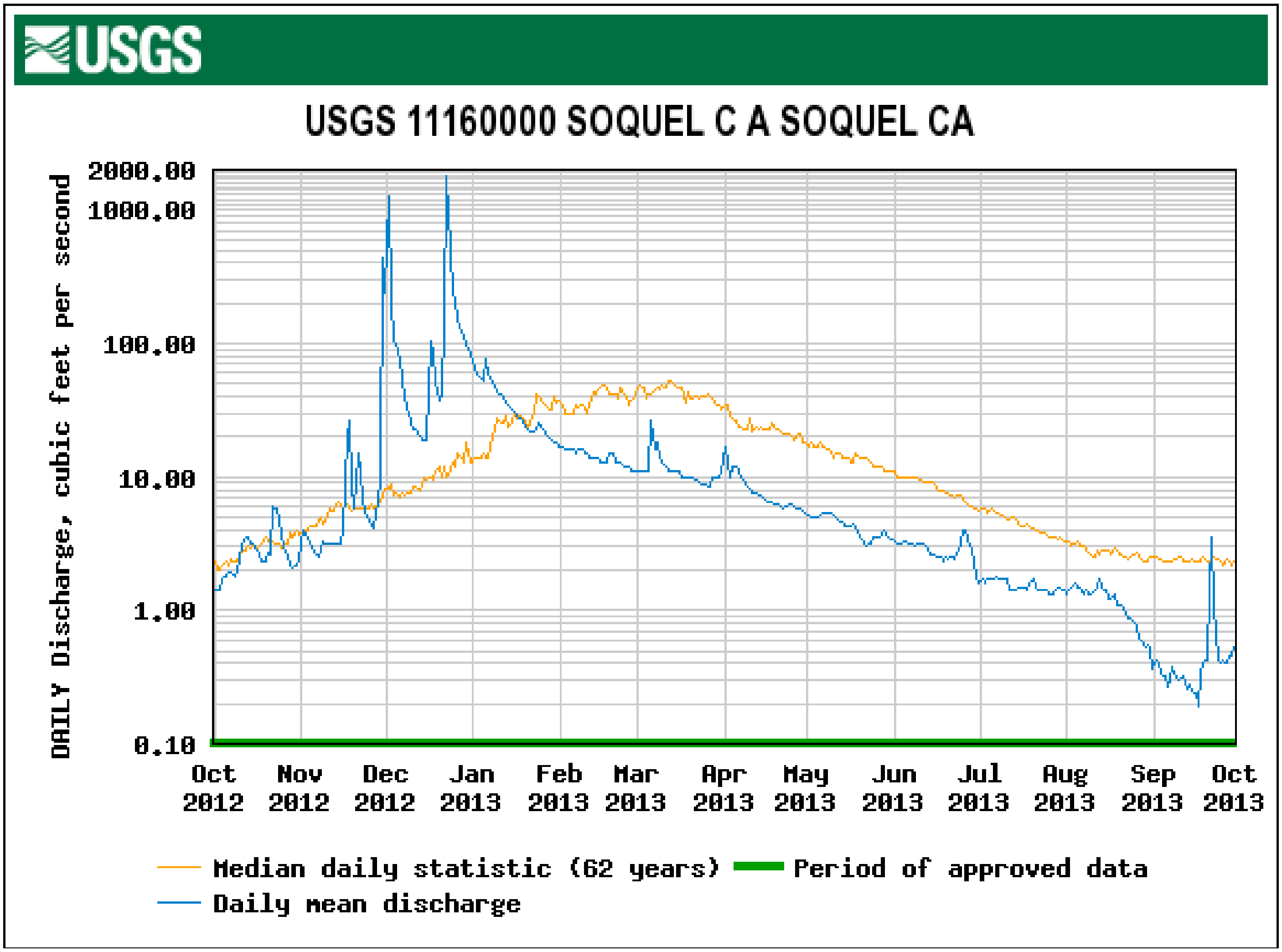


Figure 38. The March−May 2013 Discharge of Record for the USGS Gage on Soquel Creek at Soquel Village.

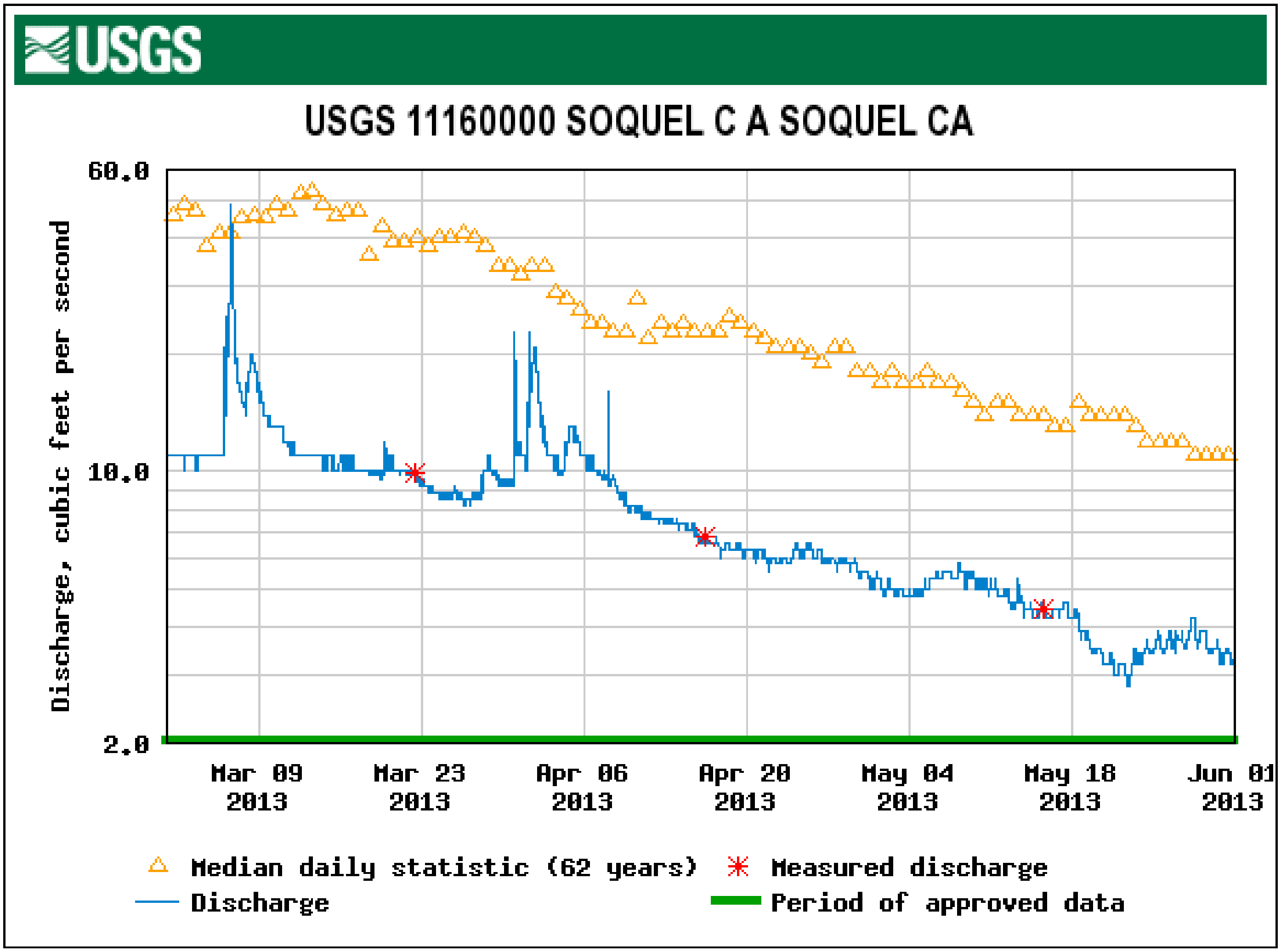


Figure 39. The 2012 Daily Mean and Median Flow at the USGS Gage on Corralitos Creek at Freedom. (USGS website would not provide a logarithmic scale of discharge).

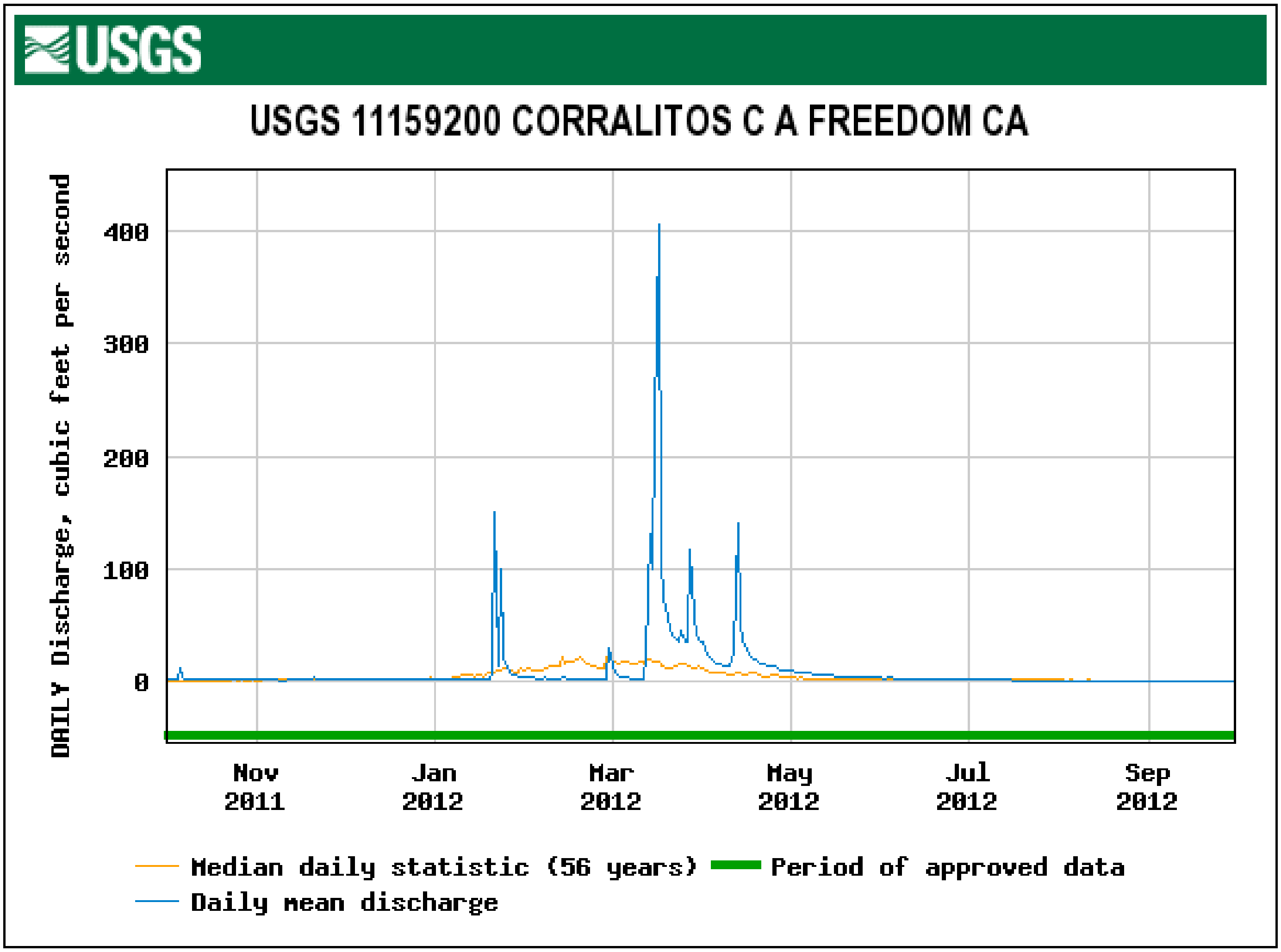


Figure 40a. The 2013 Discharge at the USGS Gage on Corralitos Creek at Freedom. (USGS website would not provide a logarithmic scale of discharge).

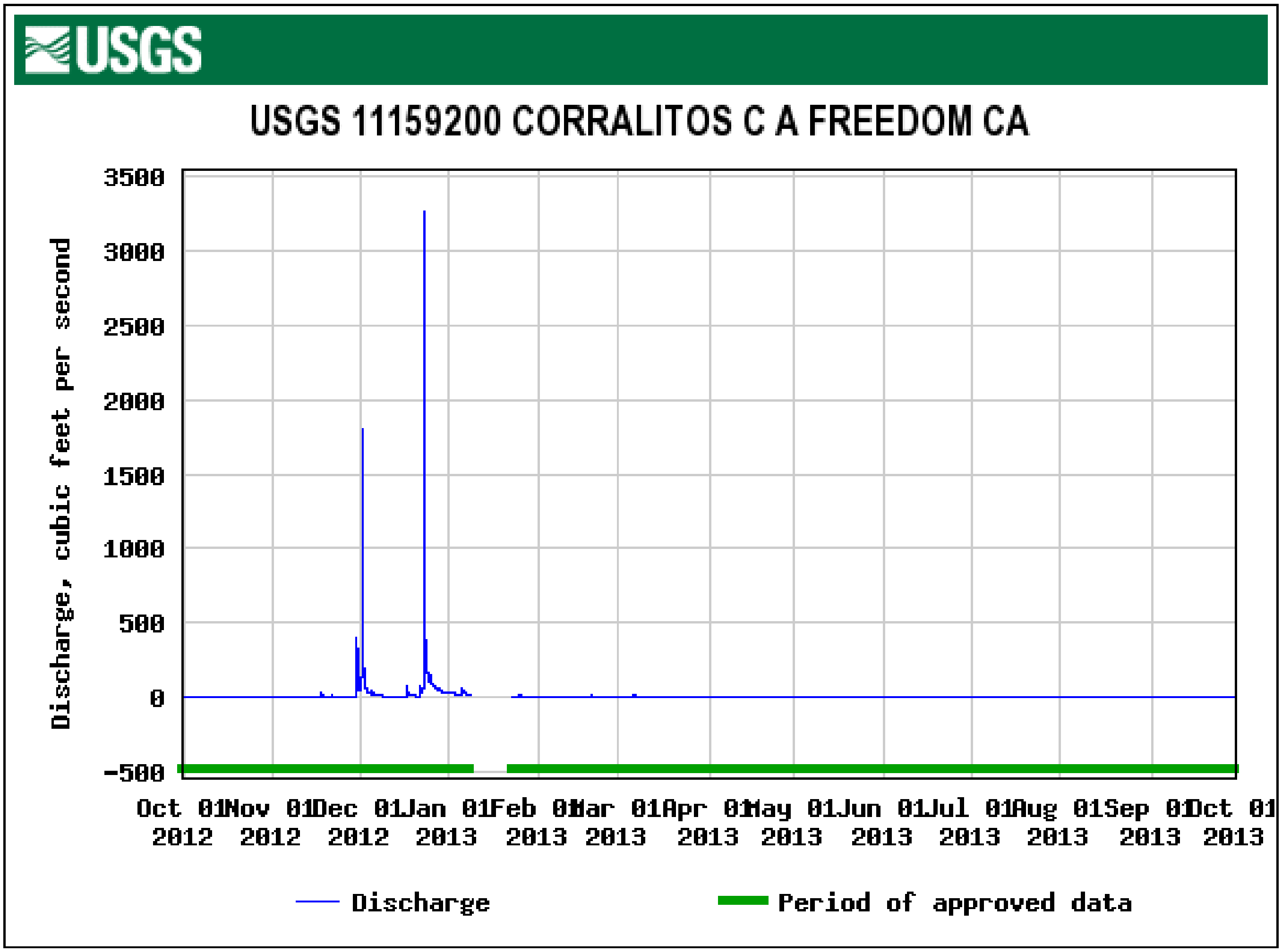


Figure 40b. The 2013 Daily Mean and Median Flow at the USGS Gage on Corralitos Creek at Freedom. (USGS website would not provide a logarithmic scale of discharge).

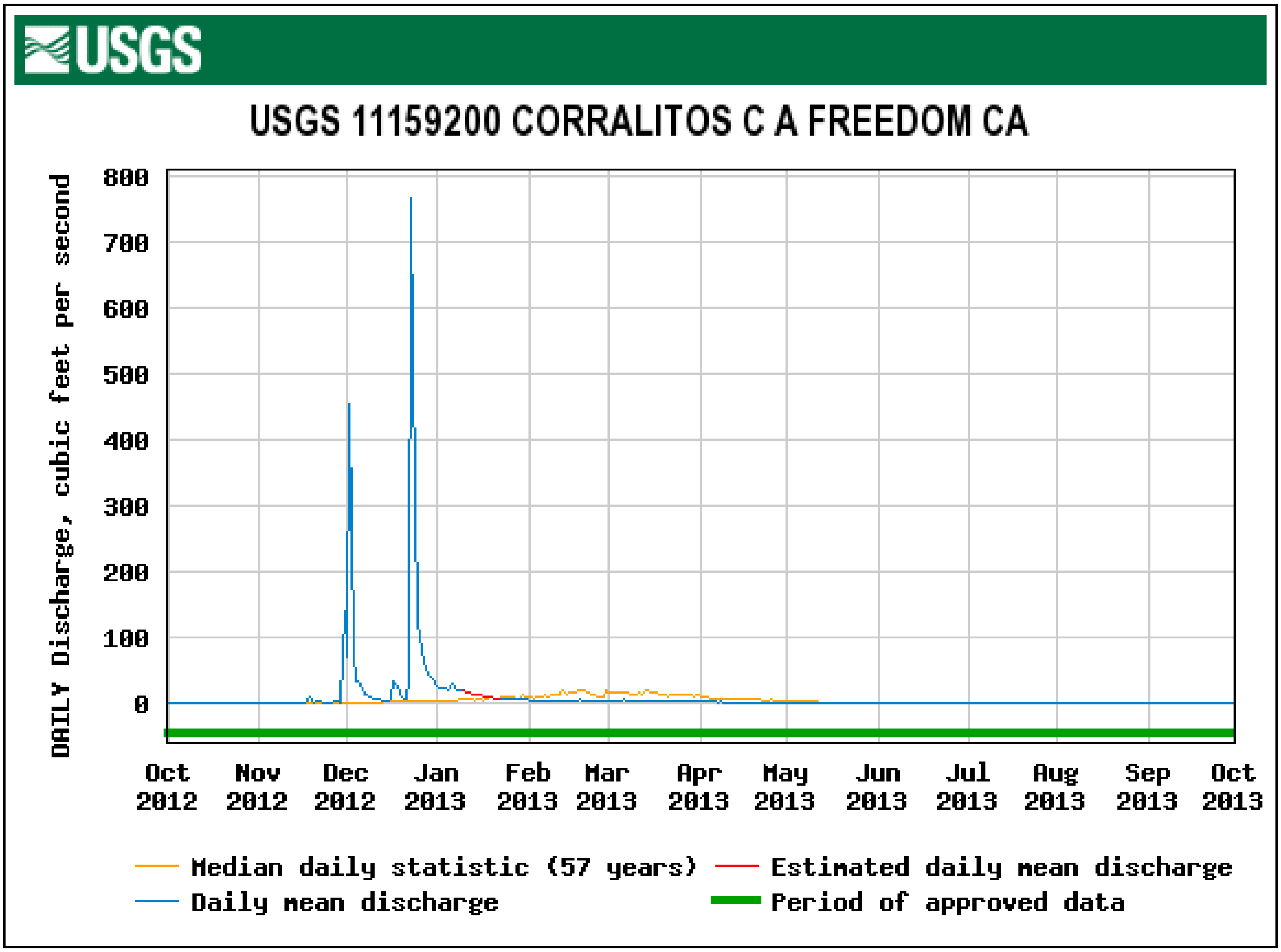
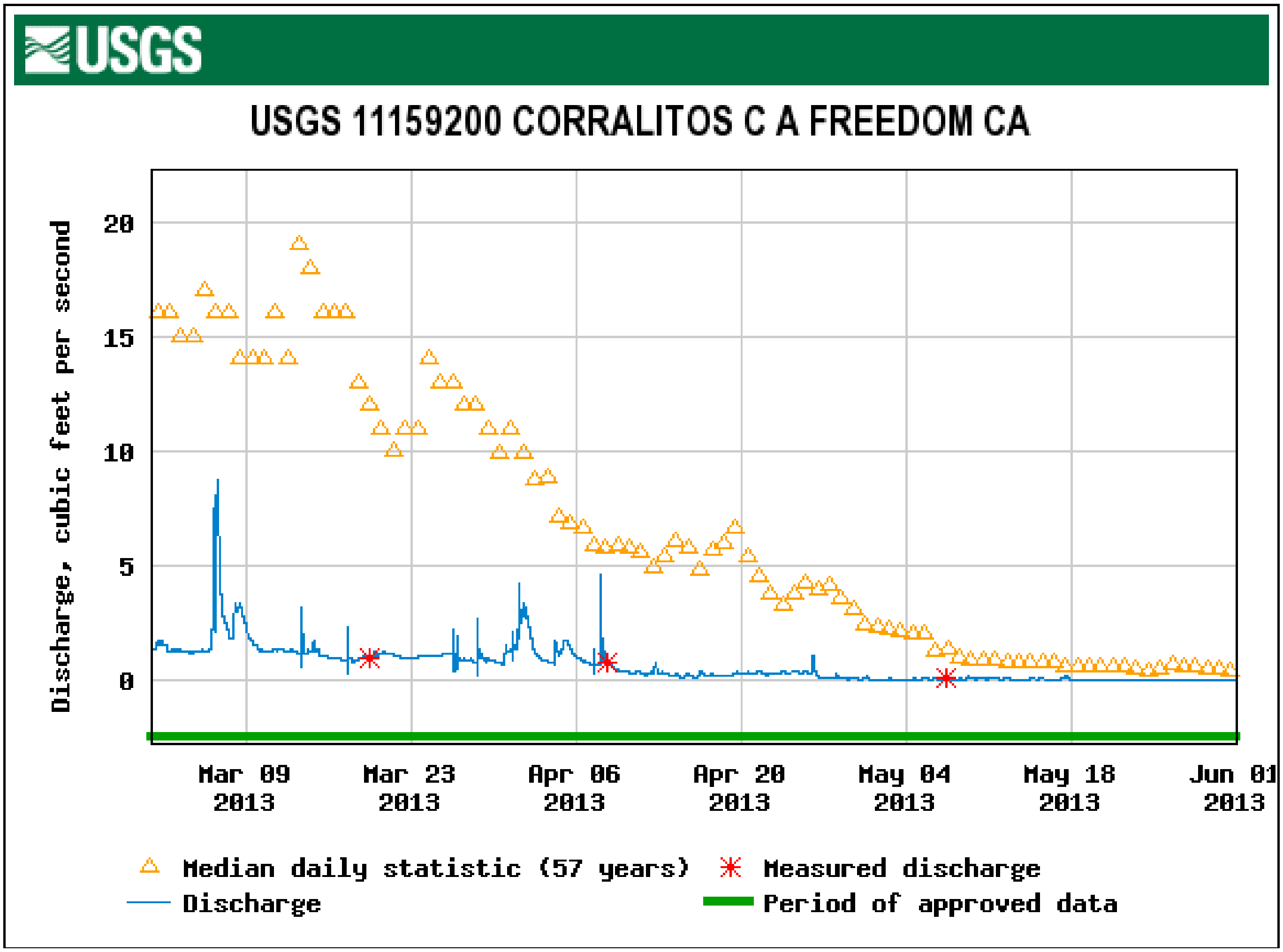


Figure 41. The March−May 2013 Discharge of Record for the USGS Gage on Corralitos Creek at Freedom.



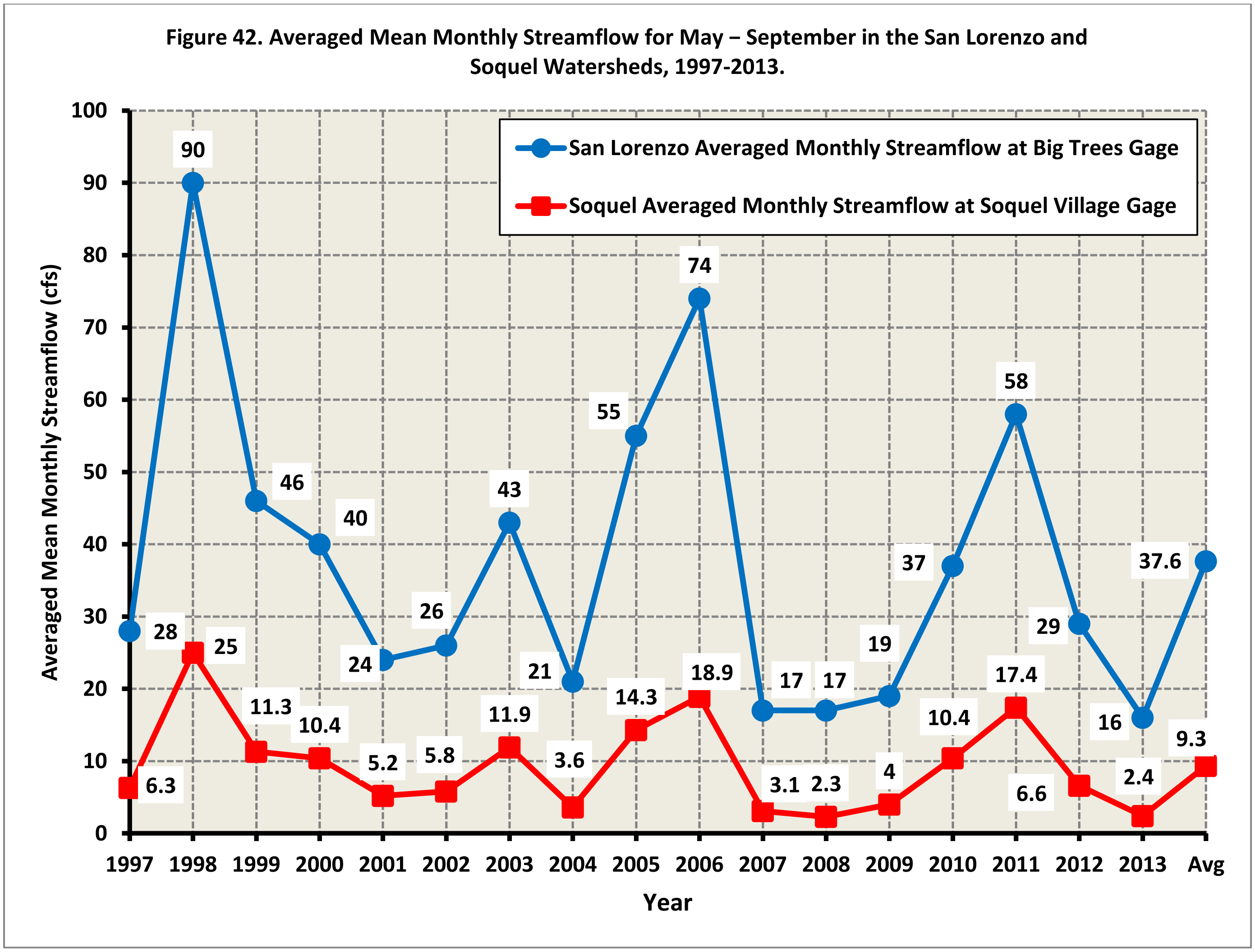


Figure 42. Averaged Mean Monthly Streamflow for May − September in the San Lorenzo and Soquel Watersheds, 1997-2013.

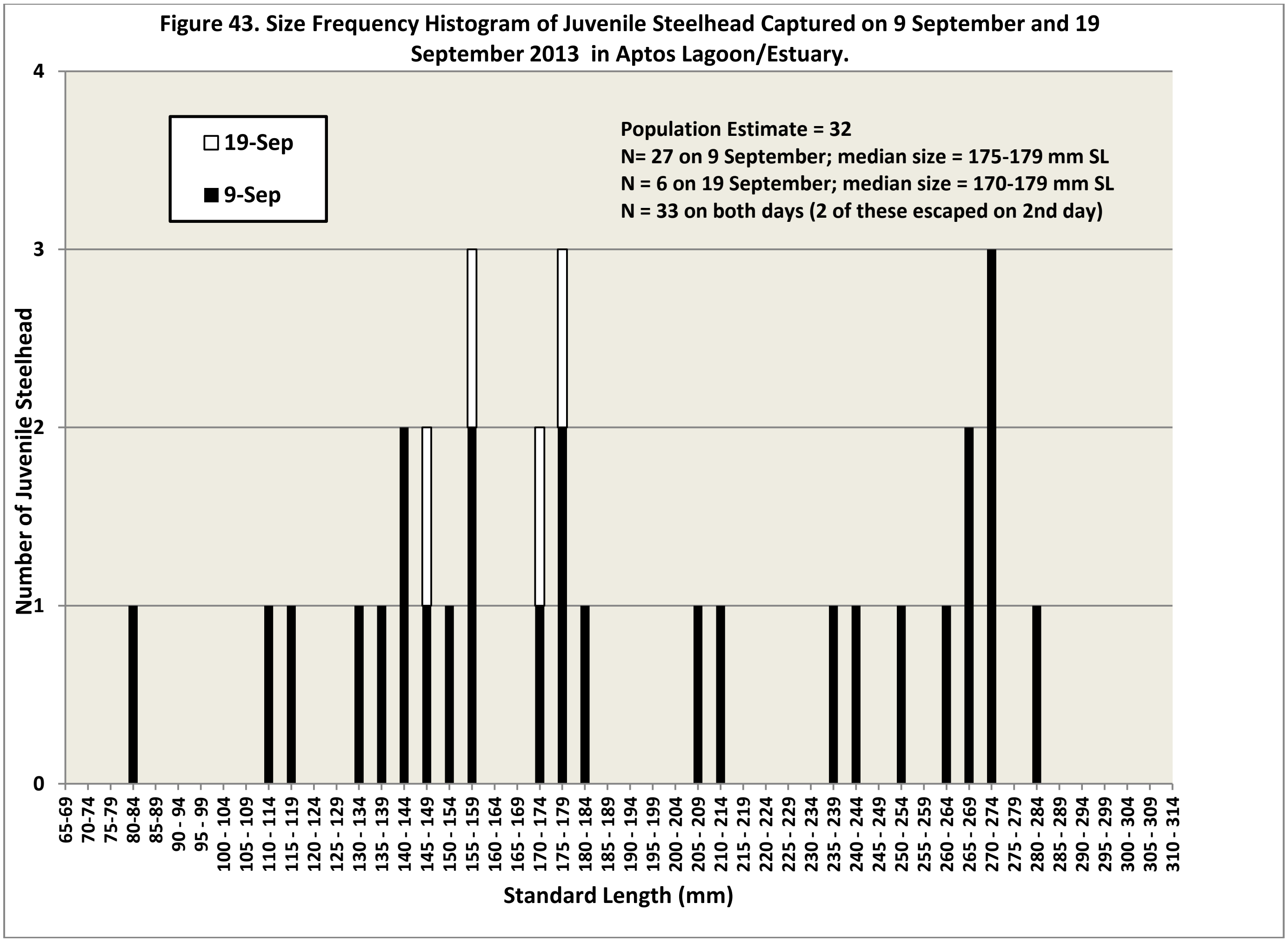


Figure 43. Size Frequency Histogram of Juvenile Steelhead Captured on 9 September and 19 September 2013 in Aptos Lagoon/Estuary.

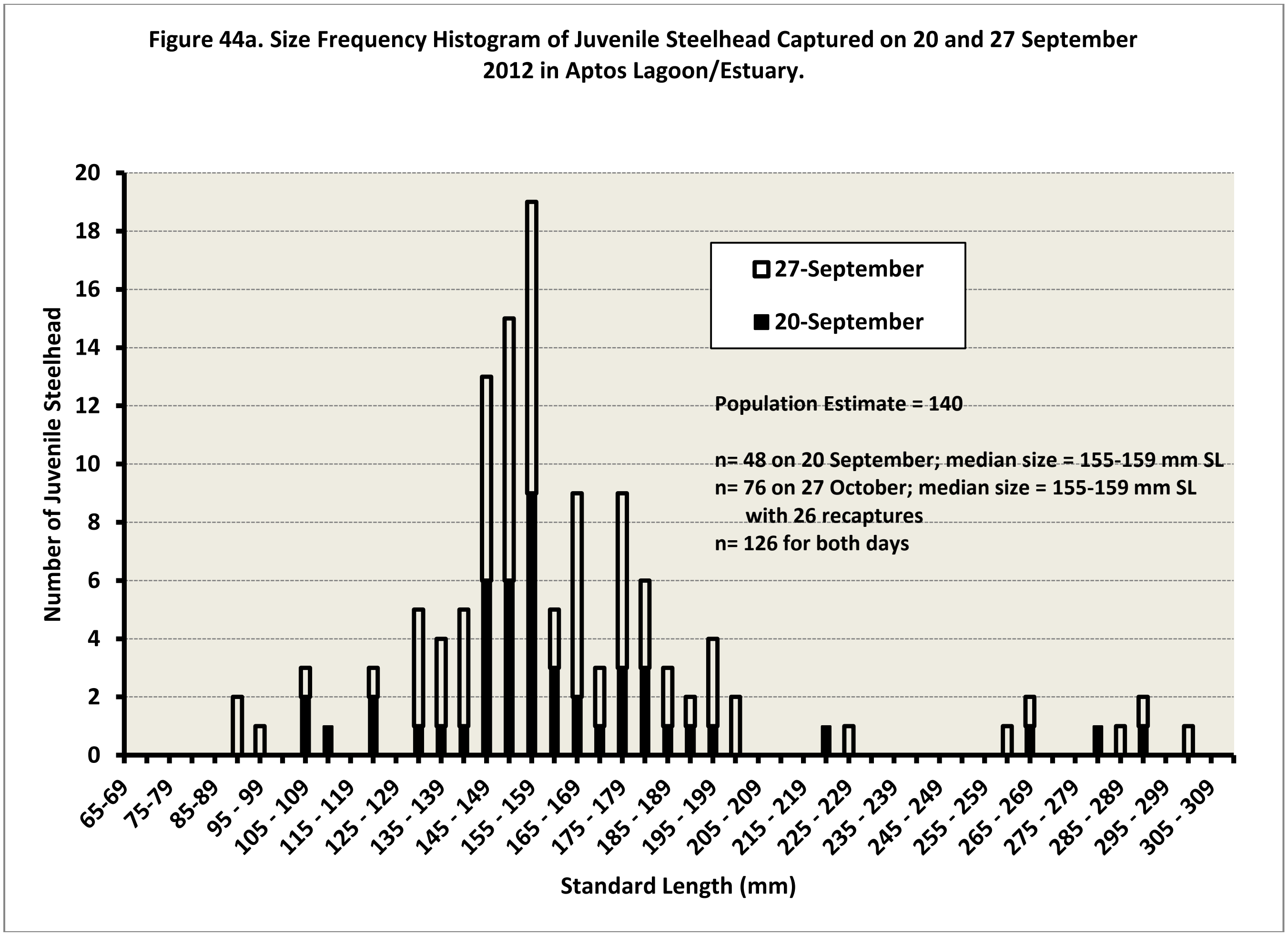


Figure 44a. Size Frequency Histogram of Juvenile Steelhead Captured on 20 and 27 September 2012 in Aptos Lagoon/Estuary.

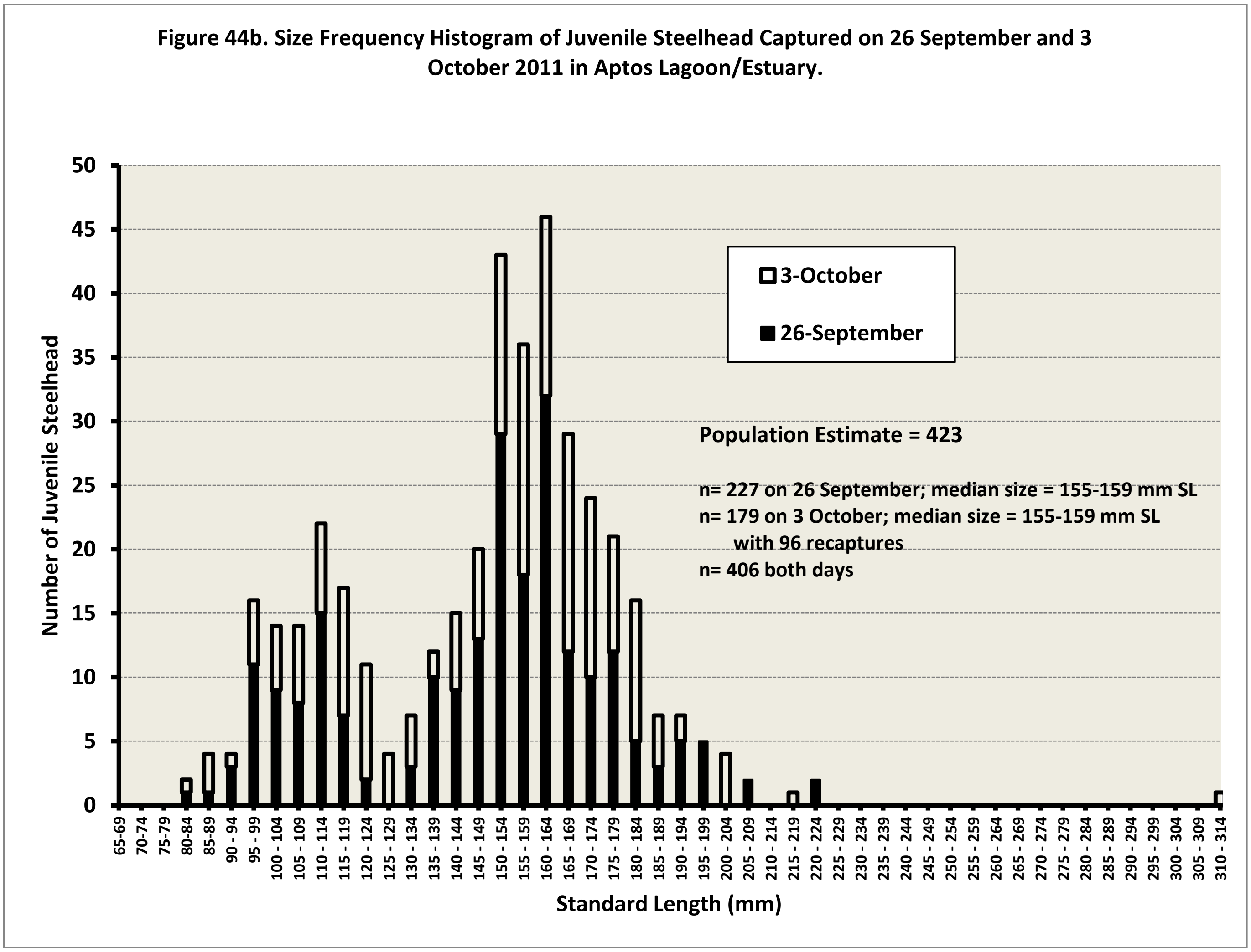


Figure 44b. Size Frequency Histogram of Juvenile Steelhead Captured on 26 September and 3 October 2011 in Aptos Lagoon/Estuary.

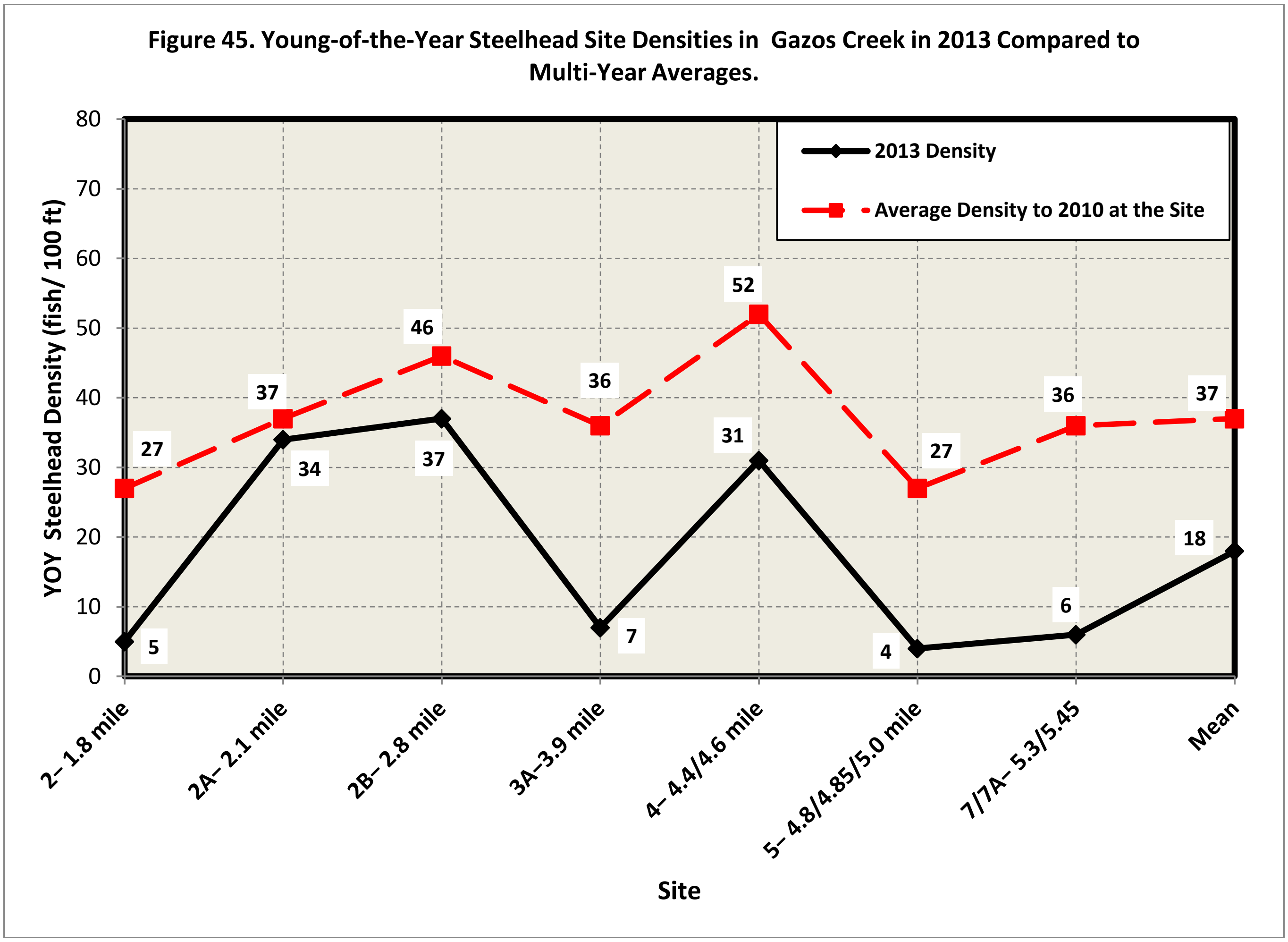


Figure 44. Size Frequency Histogram of Juvenile Steelhead Captured on 20 and 27 September 2012 in Aptos Lagoon/Estuary.

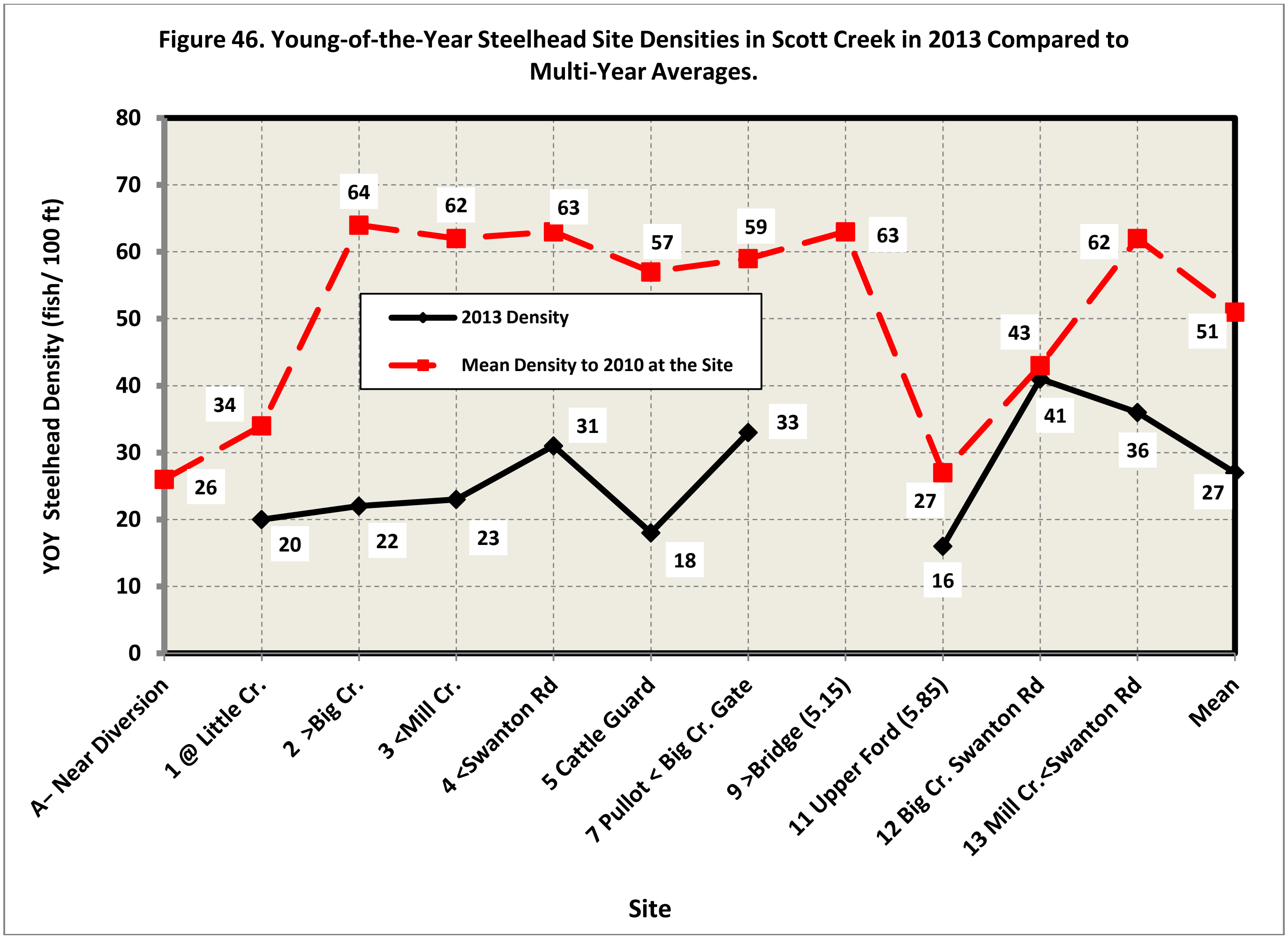


Figure 46. Young-of-the-Year Steelhead Site Densities in Scott Creek in 2013 Compared to Multi-Year Averages.

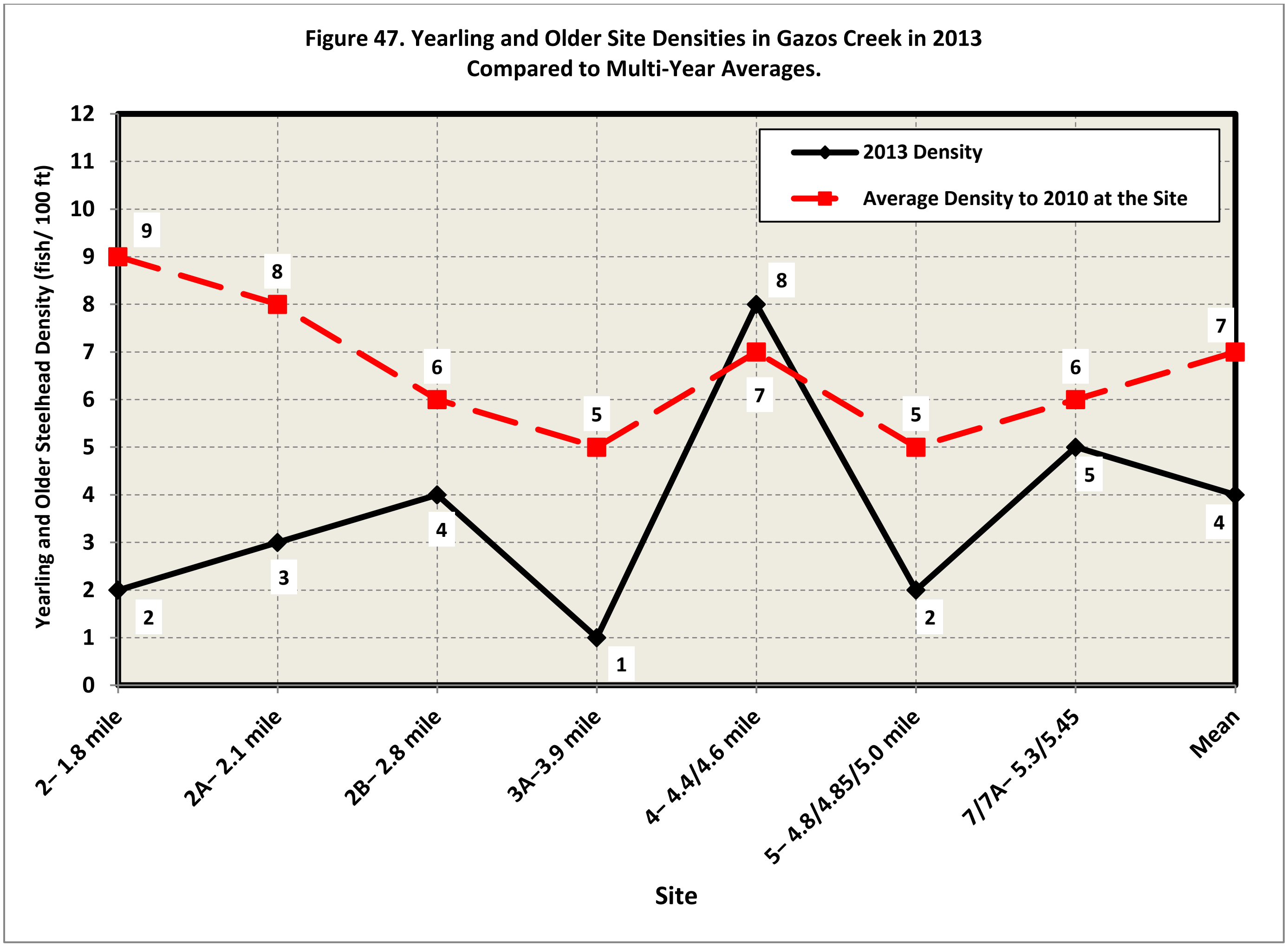


Figure 47. Yearling and Older Site Densities in Gazos Creek in 2013 Compared to Multi-Year Averages.

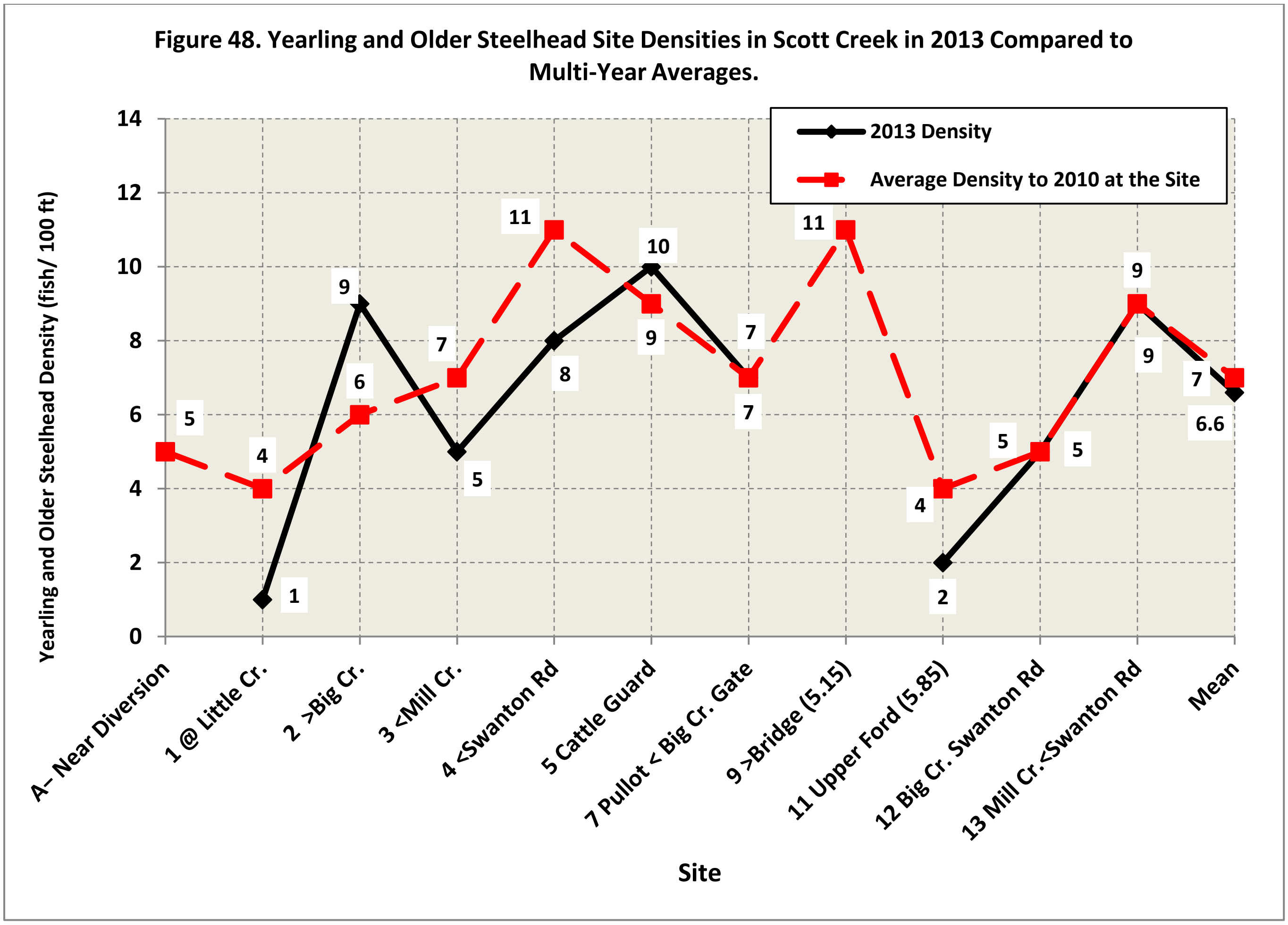


Figure 48. Yearling and Older Steelhead Site Densities in Scott Creek in 2013 Compared to Multi-Year Averages.

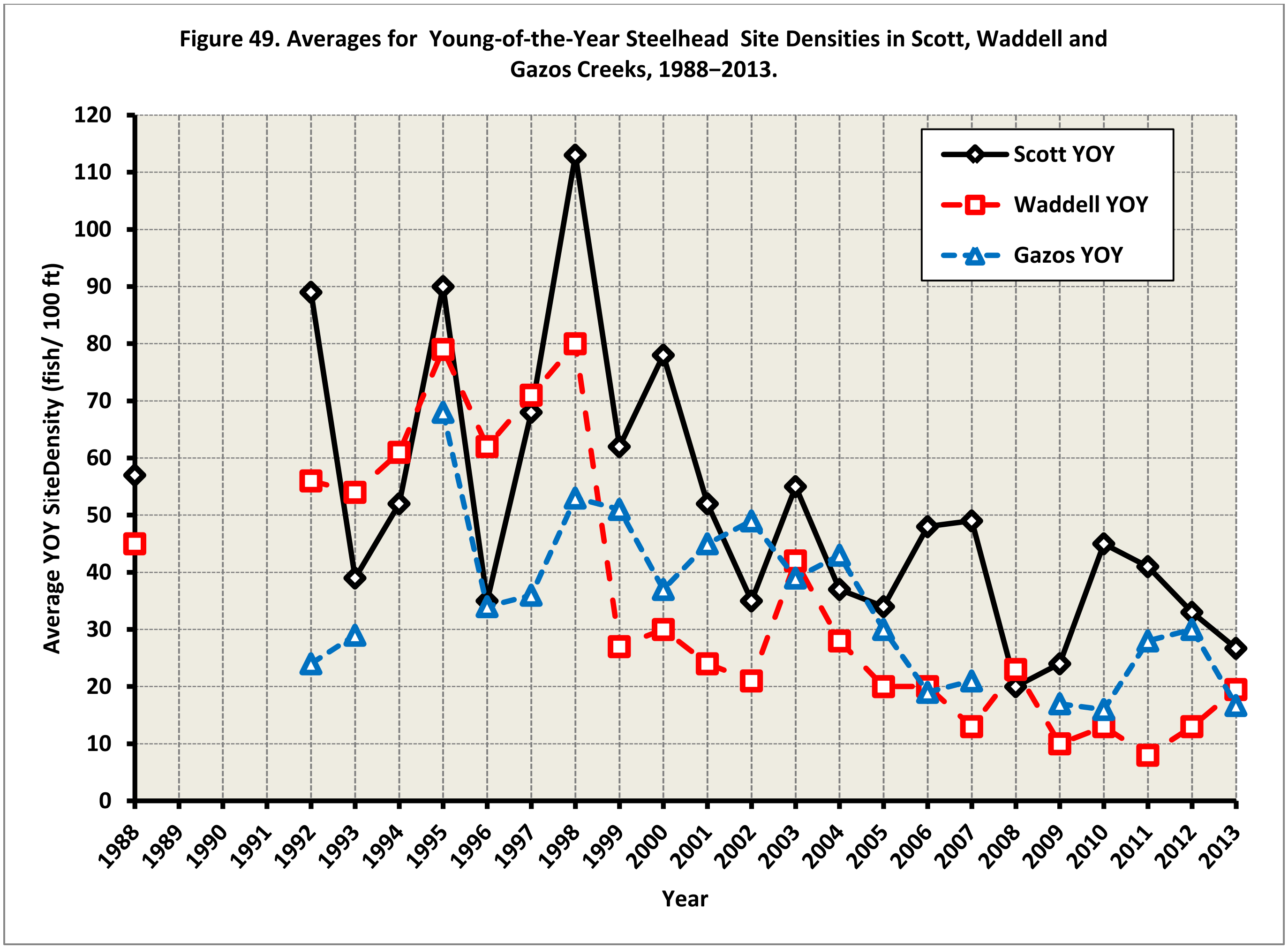


Figure 49. Averages for Young-of-the-Year Steelhead Site Densities in Scott, Waddell and Gazos Creeks, 1988–2013.

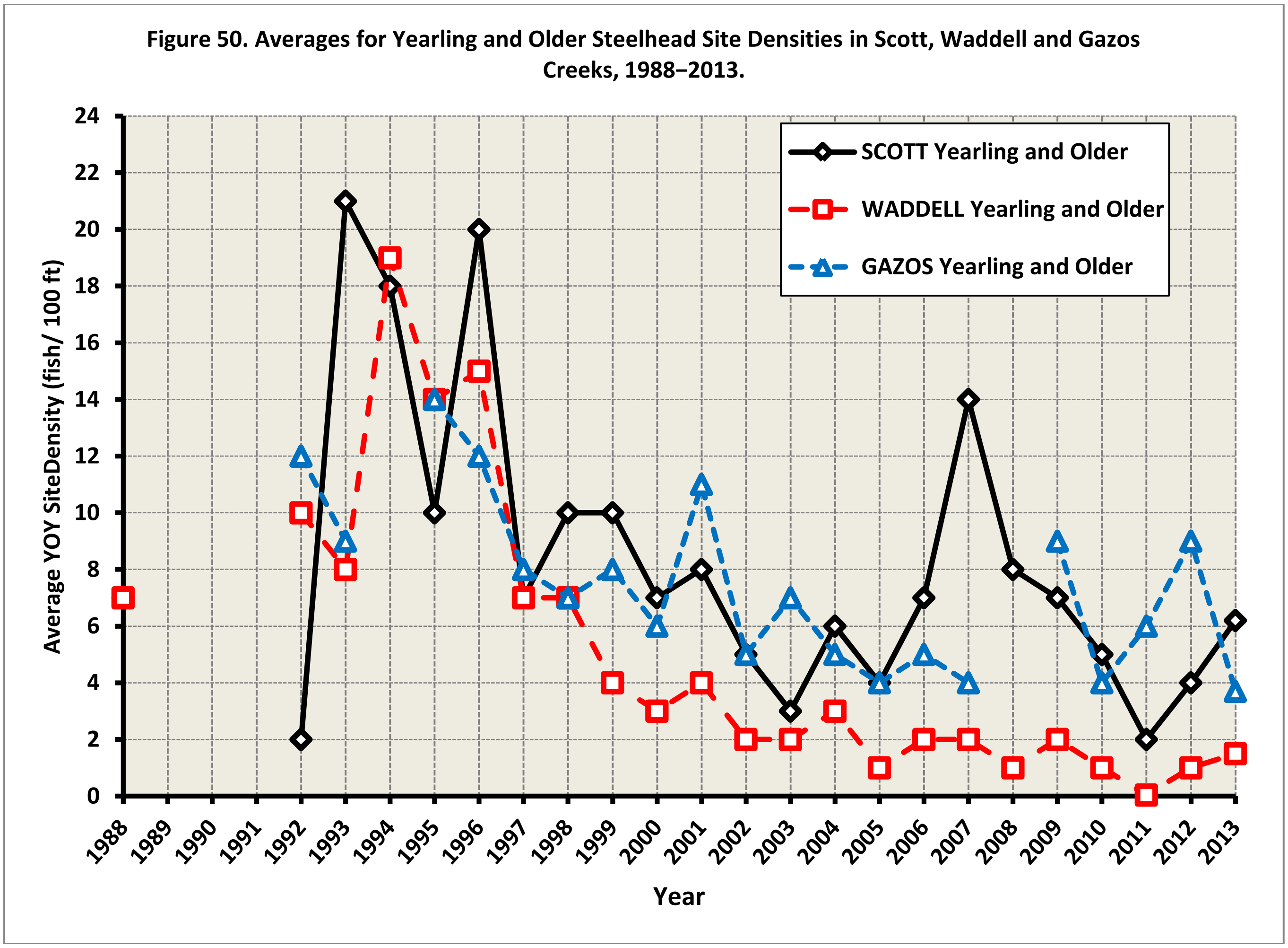


Figure 50. Averages for Yearling and Older Steelhead Site Densities in Scott, Waddell and Gazos Creeks, 1988–2013.

APPENDIX A. Watershed Maps.

Figure 1. Santa Cruz County Watersheds.

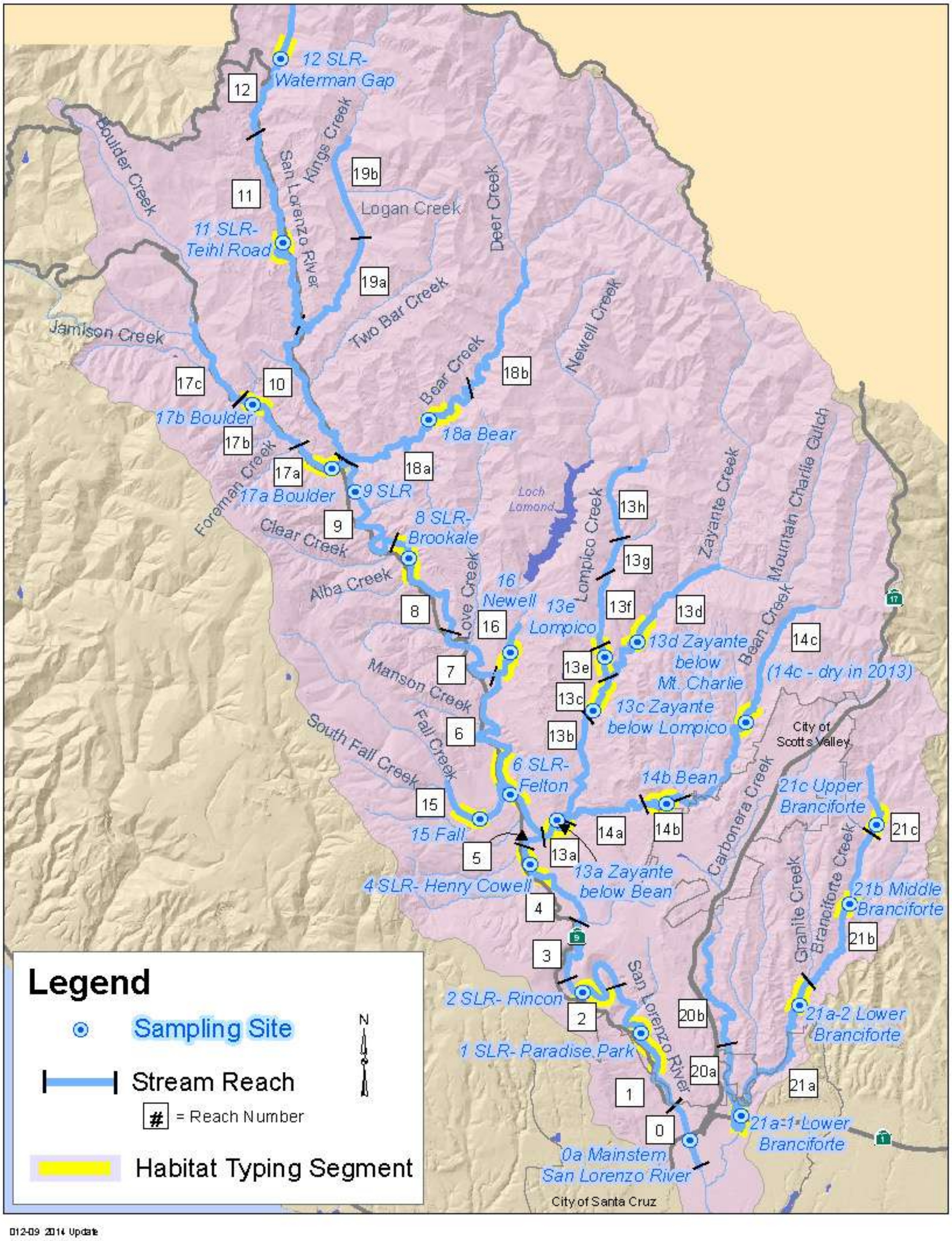


Figure 2. San Lorenzo River Watershed− Sampling Sites and Reaches.

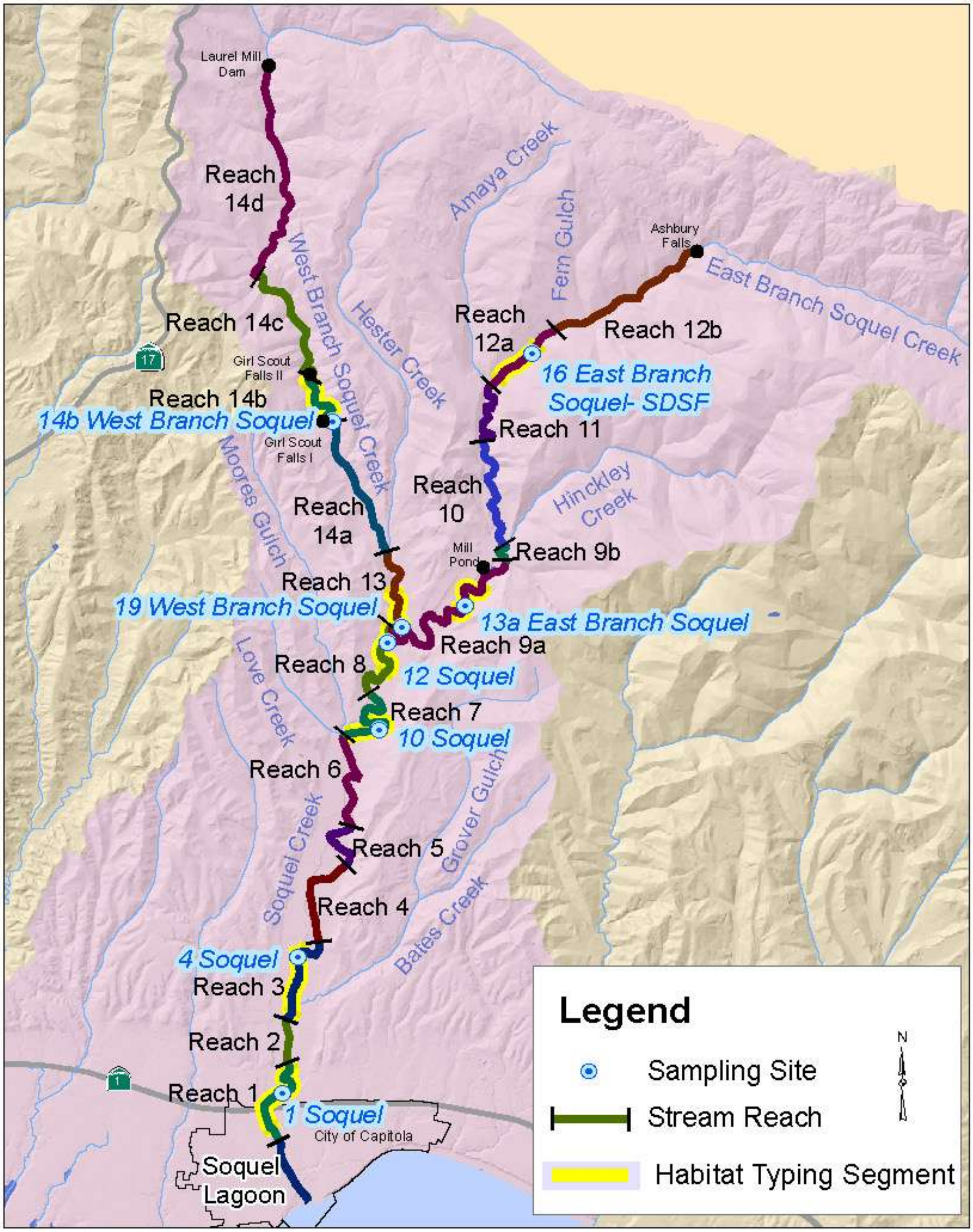


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Figure 3. Soquel Creek Watershed.

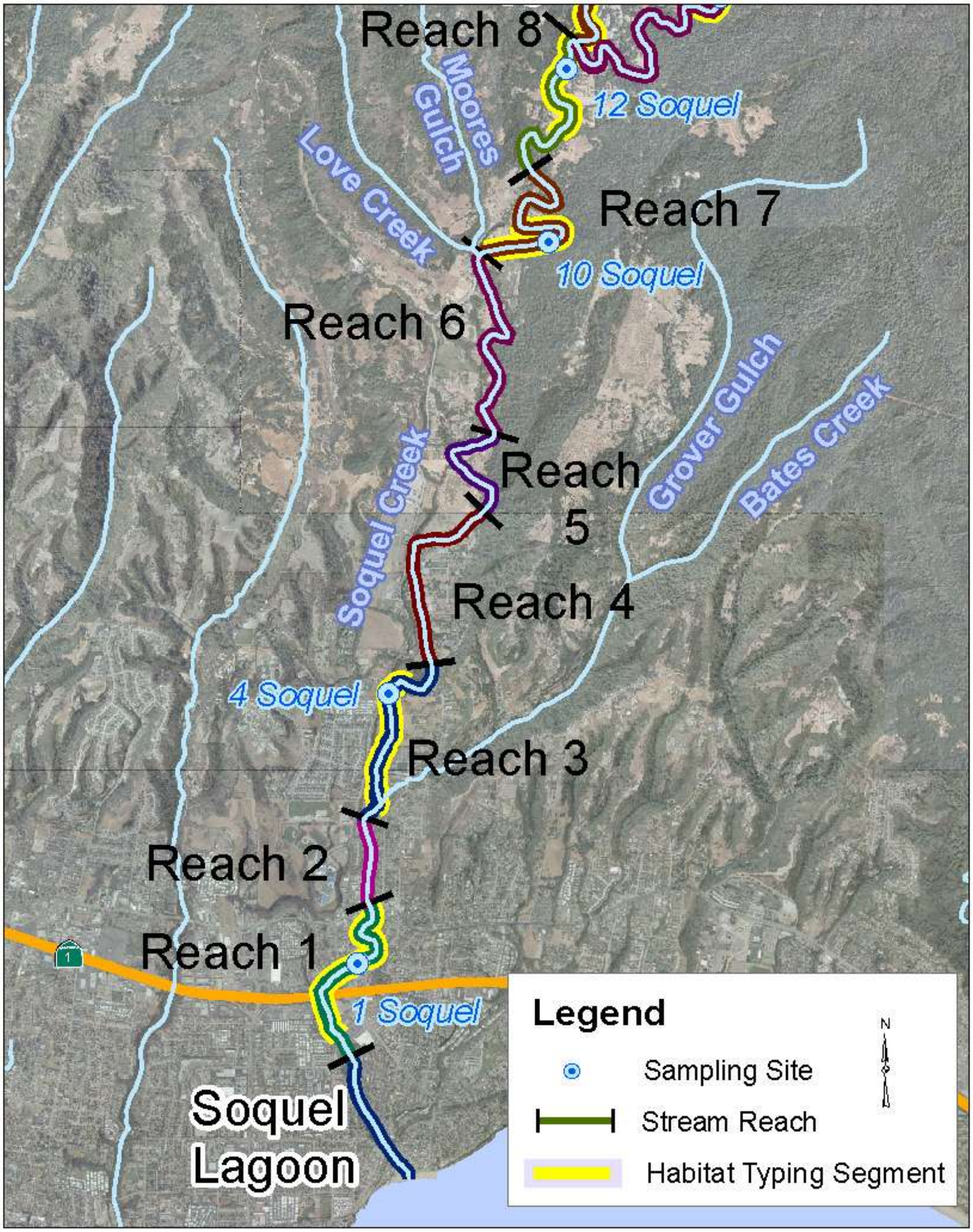

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Figure 4. Lower Soquel Creek (Reaches 1–8 on Mainstem).

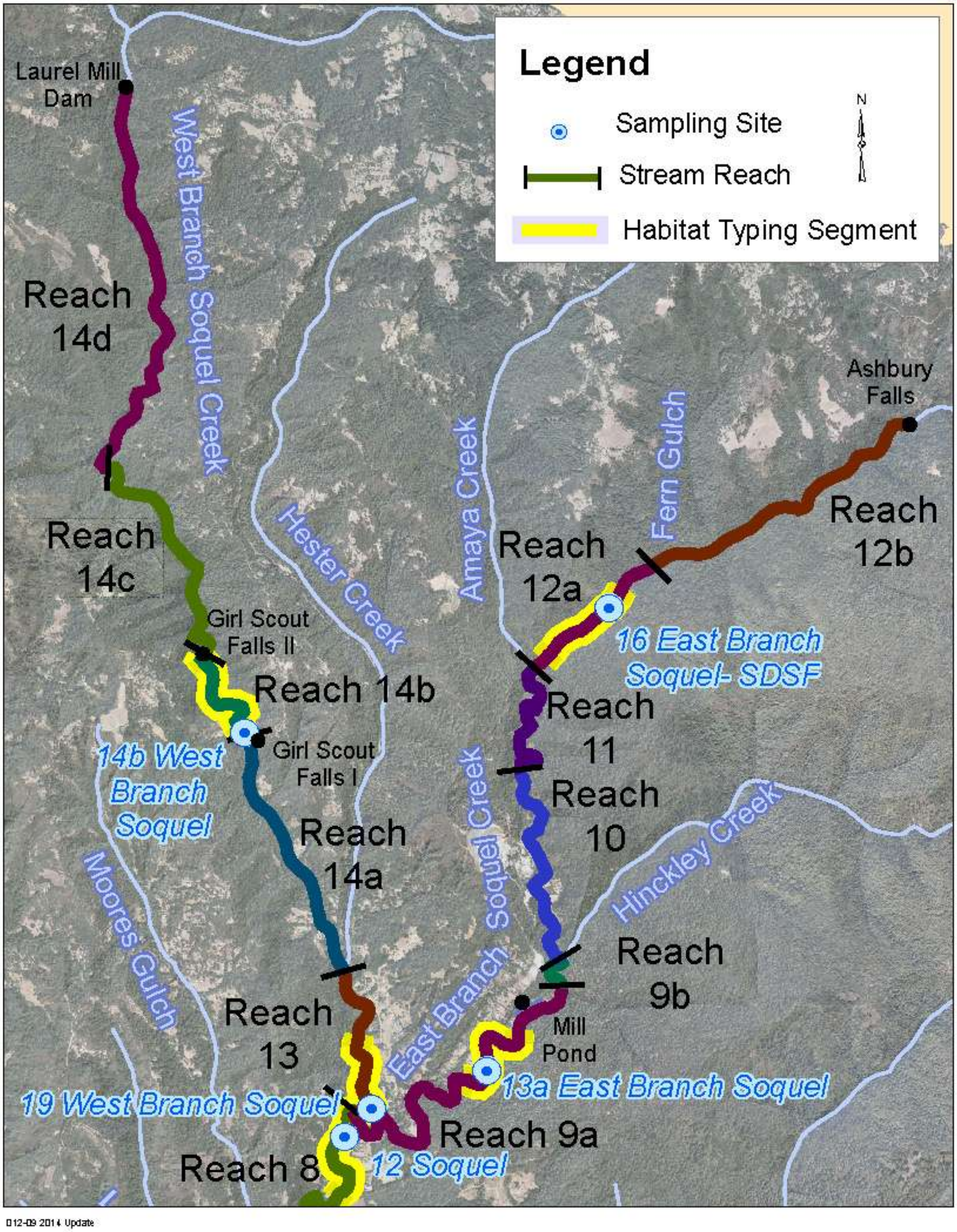

Figure 5. Upper Soquel Creek Watershed (East and West Branches).

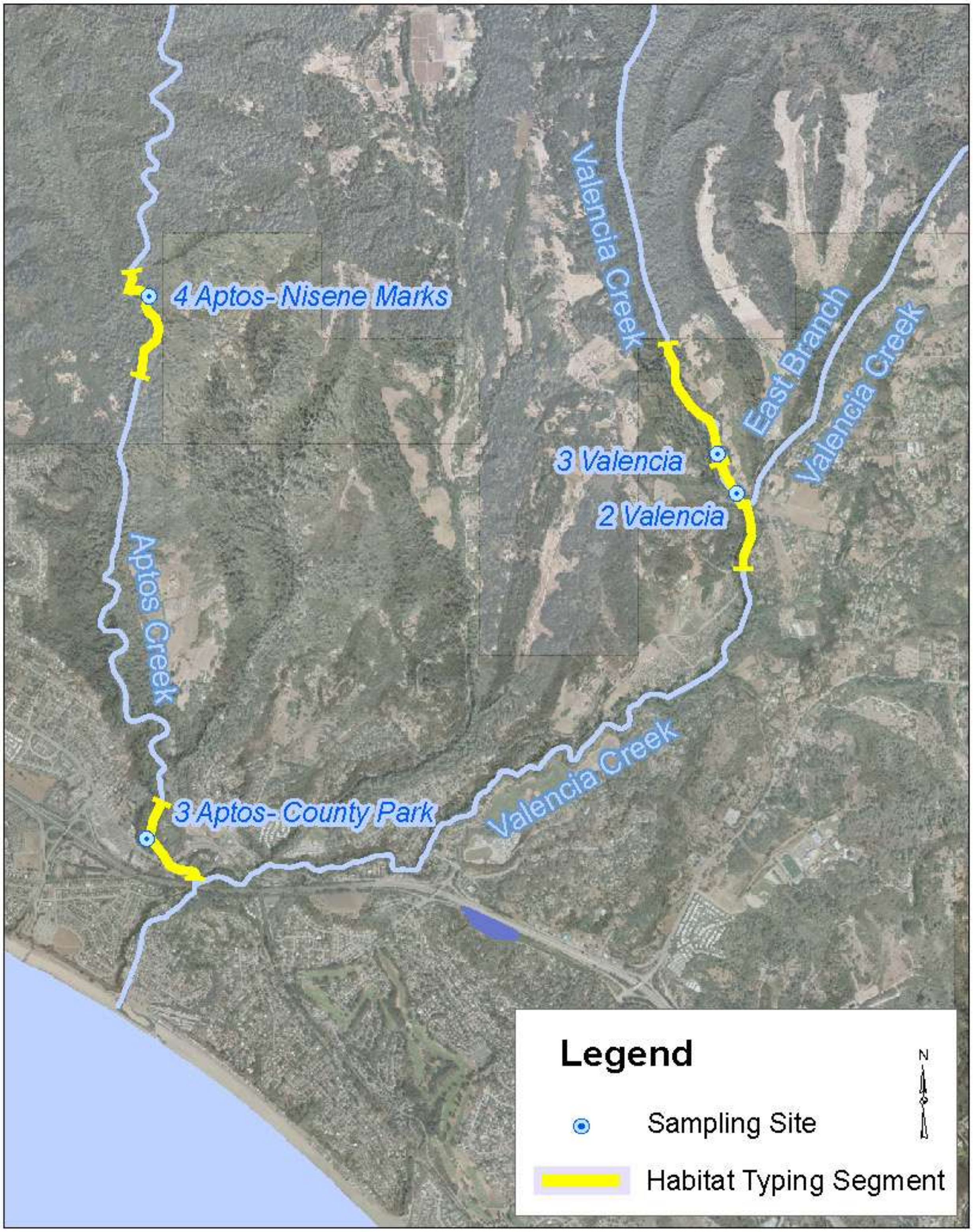

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Figure 6. Aptos Creek Watershed.

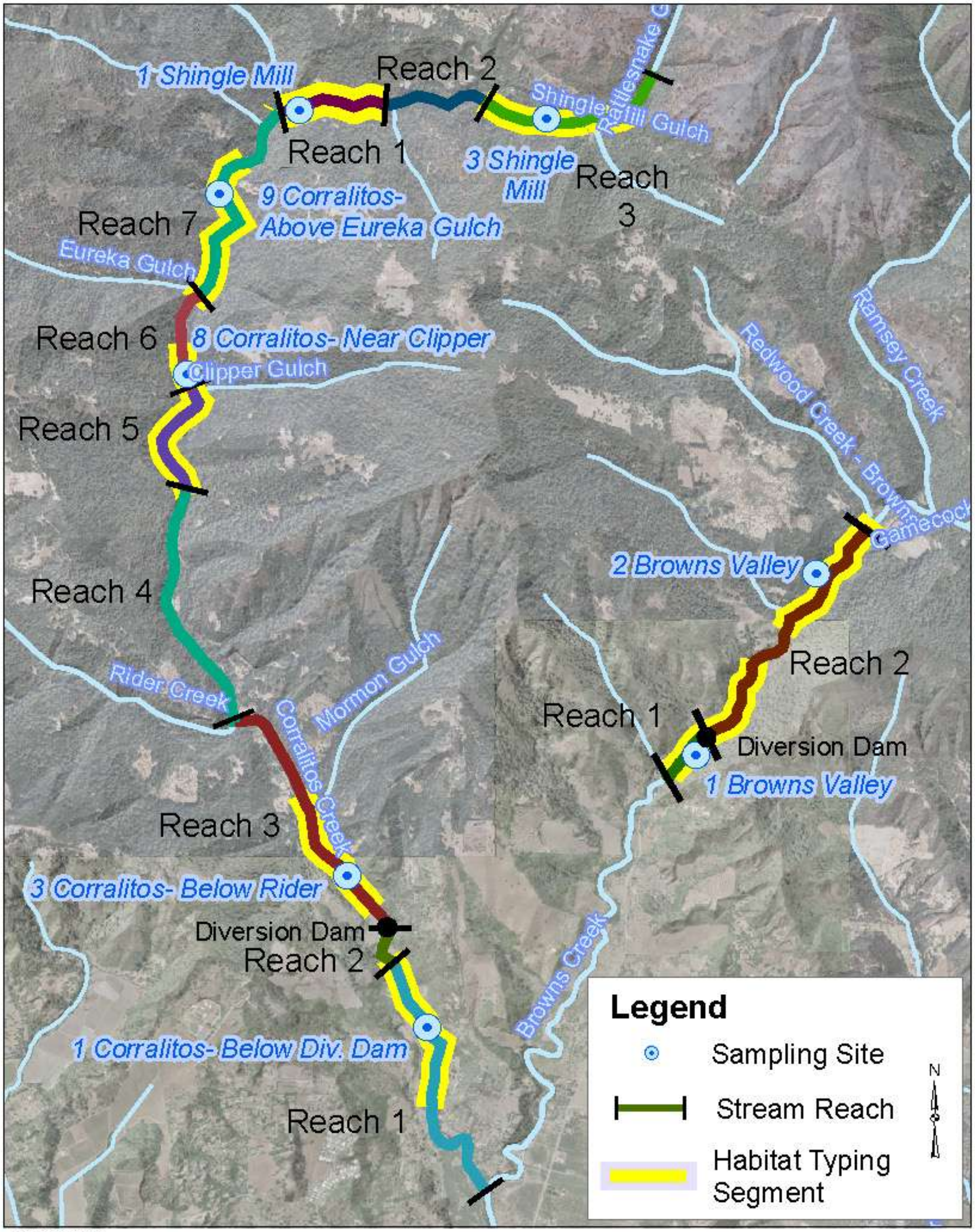

Figure 7. Upper Corralitos Creek Sub-Watershed of the Pajaro River Watershed

APPENDIX C. Summary of 2013 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 2013. 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 2013 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.)