APPENDIX B. DETAILED ANALYSIS OF 2014 STEELHEAD MONITORING IN THE SAN LORENZO, SOQUEL, APTOS AND CORRALITOS WATERSHEDS.

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SCOPE OF WORK

In fall 2014, 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 24 sites. Nine 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 2014 included Sites 10 in the mainstem San Lorenzo and Site 15a in lower Fall 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, 2 sites in Valencia Creek and Aptos Lagoon 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 2 half-mile reach segment habitat typed above the diversion dam (Reaches 3 and 7). Two sites were sampled in Shingle Mill Gulch and 2 sites were sampled in Browns Valley Creek. Pajaro Lagoon was also sampled.

Annual monitoring of juvenile steelhead began in 1994 in the San Lorenzo and 1997 in Soquel Creek (also sampled in 1994). There was a gap in our sampling in the San Lorenzo in 2002. The Corralitos sub-watershed was previously sampled in 1981, 1994, 2006─2013. Aptos Creek was previously sampled in 1981, 2006─2013. Fall streamflow was measured at 18 locations in the 4 sampled watersheds under this contract. Half-mile segments were surveyed for riparian and instream wood in lower Fall 15a in the San Lorenzo watershed, Aptos 4 in the Aptos watershed and Corralitos 7 in the Corralitos sub-watershed. Wood survey 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 “soon-to-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, though no data were collected to confirm this. 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. The steep cascade reappeared at the end of the Rincon riffle by 2014. 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.

<u>Spawning</u>. 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 2014 in the Corralitos Creek sub-watershed were compared to those in 1981, 1994 and 2006−2013. Fall 2014 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 fourth time to compare to previous lagoon population estimates. Findings in Pajaro Lagoon were compared with 2013 sampling results.

In 2014, instream wood was inventoried in Fall Creek Reach 15a, in Aptos Creek Reach 3 and Corralitos Creek Reach 7 to guide the County in choosing potential habitat enhancement projects.

DETAILED METHODS

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

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.

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 2014. 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. The Tucker Road ford has since been replaced with a bridge.

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 2014 (Reach 14b) and sampled (Site 21) after a 2-year break. 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 3 in 2014. Two sites on Valencia Creek were last sampled in 2014 after a break since 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 previously so that pools with average habitat quality could be chosen for sampling, along with adjacent fastwater habitat. Site numbers were consistent with 1981 numbering. The 2010 sites were re-sampled in 2014.

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 from the diversion dam to Rider Creek confluence, with streamflow steadily increasing toward the diversion dam (Site 3), Reach 5/6 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) to Eureka Gulch confluence (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– Methods

In each watershed, ½-mile stream segments were habitat-typed within each reach, 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**). Habitat characteristics that were estimated according to the manual's guidelines included 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– Methods

During habitat typing, 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 (D. Alley and C. Steiner) requiring calibration from one to the other. An assumption is that the same data collector will be consistent in visual estimates. Alley trained Steiner to be consistent ("calibrated") on visual estimates with himself. Reach segments previously habitat typed by either Alley or Steiner were repeated by the same data collector in future years for consistency. Changes in visual estimates of substrate abundance or embeddedness of about 10% or more between sites and years probably represent real differences 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– Fish 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 onward. 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 was 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 habitats at historical fish sampling sites.

Escape Cover– Habitat Typing Method by Reach. Reach segment averages in 1997–2000, 2003, 2005 and onward 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 from surface turbulence 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 at least 75 mm (3 inches) Standard Length (SL) could be completely hidden from view. This was not a measure of the less effective overhead cover that may be caused by surface turbulence without white water 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 is covering her redd of eggs after spawning at the tail of the pool.)

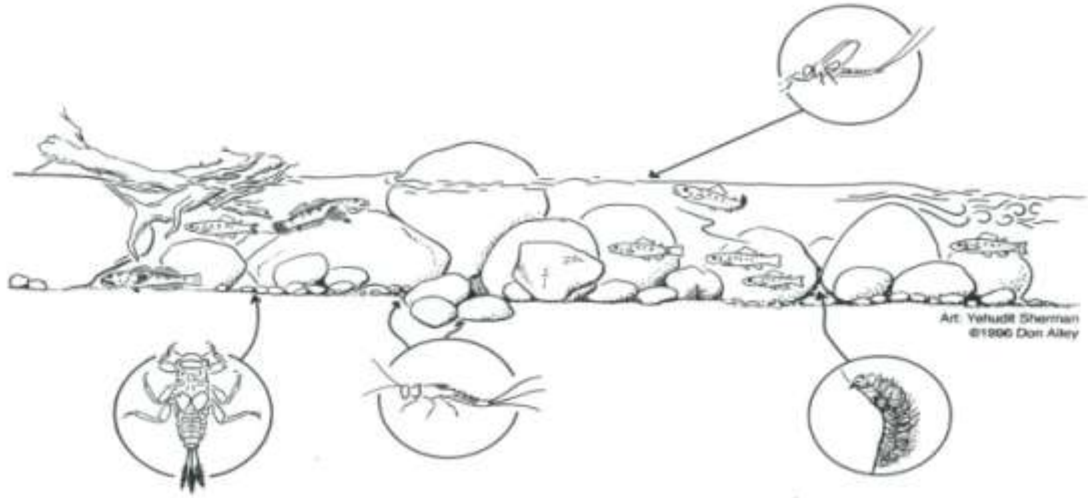


Illustration of riffle habitat (stream flowing from left to right) showing escape cover under rootwad and boulders. (Juvenile steelhead are holding feeding positions, facing upstream.)

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 and onward. 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 2007−2014, streamflow measurements made by Santa Cruz County staff were used for annual comparisons.

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

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, 8 and 9), 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. That site has been re-sampled since.

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 Onward− Methods

Habitat conditions of depth and escape cover were measured at the monitoring sites, consistent with methods used in 1981 and 1994-2001 and 2003 onward in the San Lorenzo River, Soquel Creek, Aptos Creek and Corralitos Creek watersheds. Donald Alley, the principal investigator and data collector in 1994−2001 and 2003 onward, 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 of the middle mainstem 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 a short portion of fastwater habitat at the heads of long 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− Methods

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 Represen-tation 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 Conflu-ence CM9.12 - CM9.50	2,026
6	Zayante Creek Confluence to Newell Creek Con-fluence 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 Con-fluence CM16.27 - CM18.38	11,137
10*	Boulder Creek Confluence to Kings Creek Con-fluence 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-1	Ruins Creek Confluence to Mackenzie Creek Confluence CM2.15-CM3.83 (typically dry)	8,895
14c-2	Mackenzie Creek Confluence to Gradient Change Above the Second Glenwood Road Crossing CM3.83-CM5.45	8,529
Fall 15a*	San Lorenzo River Confluence to SLVWD Diversion CM0.0-CM0.46	2,420
15b*	San Lorenzo River Confluence to SLVWD Diversion CM0.46-CM1.58	5,922
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

Creek-Reach #	Reach Boundaries (Downstream to Upstream)	Reach Length (ft)
17c	Narrow Gorge to Bedrock Chute At Kings Highway Junction with Big Basin Way CM2.0-CM3.46	7,709
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 Vinehill Road Bridge CM5.73-CM6.55	4,322

Table 1c. Fish Sampling Sites in the San Lorenzo Watershed.
(2014 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 Location of Sampling Sites	TRIBUTARY 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.
15a	*15a-CM0.3	Fall Creek, Below SLVWD Fish Ladder and Diversion
15b	*15b-CM1.0	Fall Creek, Above 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 2014.)

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 2014.)

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 CM9.46 – CM10.25	4,171
2	0.25 miles below Diversion Dam to Diversion Dam CM10.25 - 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 2014.)

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 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 graduated 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− Methods

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 2014, the lowest baseflow year since sampling began, 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 when juveniles were well represented. 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). Newell and Bear Creek had YOY reaching the larger size class, but YOY juveniles were nearly absent at both sites. In the sunny middle Reach 13c of Zayante Creek, very few YOY (7%) 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 2014, with the majority of YOY being less than 75 mm SL at Site 1. Of the few YOY present at sunny Site 4, the majority did reach Size Class II. The upper mainstem Sites 10 and 12 had no YOY reaching Size Class II. In this monitoring report, sampling site densities were compared for 17 years in the San Lorenzo system by size and age (1997−2001 and 2003 onward) and for 18 years in Soquel Creek (1997 onward). At each sampling site, habitat types were sampled separately, with density estimates calculated for each habitat type. Then these density estimates were combined and divided by the stream length of the entire site to calculate annual site density.

M-8. Index of Abundance of Size Class II and III Steelhead by Watershed– Methods

Indices of watershed abundance (production) of Size Class II and III steelhead for sampled reaches were calculated to compare annual differences with reach lengths incorporated with site densities. 2010 abundance was compared to 2014 abundance to contrast production in a year with a near median statistic of baseflow in late spring through fall (2010) with production in a critically dry year (2014). This contrast would better describe the extreme reduction in abundance in a critically dry year more so than just comparing site densities.

In each sampled watershed, an index of reach abundance was calculated for Size Class II and III juveniles (soon-to-smolt fish) in all reaches sampled. Then reach abundances were added together to obtain a watershed index of these larger juveniles for the reaches sampled. Indices of reach abundances were calculated by multiplying density estimates determined by electrofishing and snorkeling for Size Class II and III juveniles for each habitat type at the sampling site within the reach by the total distance of that habitat type estimated for the entire reach. Habitat percentages were estimated in the reach segments that were habitat typed. If the reach segment was not habitat typed for the year in which an abundance index was being calculated, the most recent habitat typing data for that reach segment was used to determine habitat percentage. For example, for Zayante Creek Reach 13d, the reach length was estimated to be 13,886 feet. In 2010, pool habitat was estimated as 57% in the habitat typed reach segment. The soon-to-smolt density for pool habitat was estimated to be 0.066 per foot, based on electrofishing at the representative site for Zayante Reach 13d. To get the index of reach abundance of soon-to-smolt juveniles for pool habitat in this reach, the product was calculated as follows; 13,886 feet for total reach length estimated from the USGS topography map, multiplied by 0.57 for the reach percentage of pool habitat determined by habitat typing the reach segment, multiplied by 0.066 for the density per foot of pool habitat, equaling 522.39 Size Class II and III juveniles for pool habitat in the reach. The same calculations were made for other habitat types, including riffles (6%) and runs/step-runs (37%). Then numbers of fish were then added together for all habitat types to obtain a reach abundance index. For 2010, the reach abundance index for Zayante 13d was 1,314 Size Class II and III juveniles for all habitat types combined. Then the reach abundances for each sampled reach were added together to obtain a watershed abundance index for that year for those sampled reaches. Watershed indices of abundance for different years were then compared for the same reaches, based on the habitat proportions determined by reach from habitat typing in those years or the most recent years prior to index calculation.

M-9. Sampling of Aptos Estuary– Methods

Initially on 18 September 2014, steelhead were sampled from 7 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 18 September, the periphery of the estuary, east of the rock jetty and adjacent to it, was sampled by Alley and Kittleson for tidewater goby and other small fishes from 9 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. 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.

On 25 September 2014, steelhead were again sampled from 8 seine hauls with the larger bag seine in the main estuary. Steelhead were measured to Standard and Fork Length and checked for fin clips. 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.

M-10. Sampling of Pajaro Estuary– Methods

On 3 October 2014, the main lagoon along the beach and Watsonville Slough near its mouth were sampled for steelhead with the 106-foot bag seine (9 seine hauls). On 6 October 2014, the main lagoon along the beach (5 seine hauls) and the upper lagoon (3 seine hauls), oriented perpendicular to the beach, were sampled for tidewater goby. On 7 October 2014, the upper lagoon was sampled for steelhead with the 106-foot seine (2 seine hauls) at the model airport and Thurwachter Bridge (3 seine hauls).

On 6 October during tidewater goby sampling in the lower (mid-channel) and upper lagoon (along margin), the water temperature, salinity and oxygen were measured through the water column at 0.25 meter intervals at 5 stations. On 7 October during steelhead sampling at the model airport and Thurwachter Bridge in the upper lagoon, water quality was measured through the water column, mid-channel from a boat (2 sites).

DETAILED RESULTS

R-1. Capture and Mortality Statistics

For the overall sampling activities in 2014, a total of 1,913 juvenile steelhead were captured by electrofishing at 44 electrofishing sites and 2 lagoon sites, with 22 mortalities (1.15% mortality rate). In Aptos Lagoon/Estuary, only 6 juvenile steelhead were captured on 2 days with no mortality. No steelhead were captured in Pajaro Lagoon. A total of 7 juvenile steelhead were visually censused in pools at 6 San Lorenzo mainstem sites. Ten mainstem sites and 14 tributary sites were sampled in the San Lorenzo watershed in 2014, with a total of only 1,255 juvenile steelhead captured and 12 mortalities (0.95%). A total of 378 juvenile steelhead were captured at 7 sites in the Soquel watershed in 2014 with 7 mortalities (1.8%). A total of 116 juveniles steelhead were captured by electrofishing in the Aptos Watershed at 2 Aptos sites and 2 Valencia sites with 1 mortality (0.86%). A total of 178 juveniles were captured in the Corralitos watershed at 8 sites with 2 mortalities (1.1%). A high proportion of YOY steelhead were small in 2014, and they were more vulnerable to electrofishing mortality than larger fish.

R-2. Habitat Change in the San Lorenzo River Mainstem and Tributaries, 2013 to 2014

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 were 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 2014 were much below the median daily statistic for baseflow from May through the summer, the lowest in 18 years of calculations (**Figure 45**), and they were less than in the previous two dry years of 2012 and 2013 (**Figures 33a-b, 34a−b; Appendix E**). Only 4 small stormflows, peaking between 150 and 850 cfs at Big Trees gage (well below bankfull), occurred between 1 February and 1 April 2014 with little after (**Figures 37a and 38**). Very low baseflow in 2014 provided less food (lower insect drift velocity and reduced fastwater habitat) and reduced growth rate at most sites compared to even the dry year of 2013 except where YOY and total densities were much less in 2014, thus reducing competition for food (**Figures 21 and 23**). The average mean monthly streamflow for May−September in 2014 at the Big Trees gage was the lowest in 18 years of calculations (7.9 cfs with an 18-year average of 36 cfs) (**Figure 45**). Slower YOY growth was exemplified by the lower percent of YOY reaching Size Class II in 2014 compared to those in other relatively dry years of 2012 and 2013 and wetter 2011, except where YOY and total densities were very low in 2014 (Sites 8, 16 and 18b) (**Figures 17a and 17b**).

In 2014, habitat typing occurred in segments of Reaches 1, 2, 8 and 10 in the mainstem and Reaches 13d, 14b, 15a, 15b, and 21a-2 in the tributaries. Therefore, other reaches were evaluated according to habitat changes at sampling sites. Rearing habitat quality declined at all sites in 2014 (except Branciforte 21b) due to decreased streamflow (less food), shallower habitat (except Waterman Gap (12b) and middle Branciforte (21b) and often less escape cover (11 of 21 reaches/sites) (summary **Table 13b based on**

Tables 5a-c; 6a-b; 7a-b; 8a-b; 9a-b; 10, 11, 12a-b; 13a). Habitat conditions at Branciforte 21b was considered improved, despite reduced streamflow, because pools deepened and escape cover improved considerably. Percent fines were mostly similar or improved in the mainstem. Embeddedness in the mainstem was mostly increased or similar. Percent fines were mostly similar or improved in tributaries except for middle Zayante 13c and Newell 16. Embeddedness in tributaries remained mostly similar to 2013. It worsened in pools at Lompico 13e and Bean 14b. It improved in pools in Zayante 13c, Newell 16 and Bear 18a. Erosion was likely minimized in a drought winter.

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

Site # / Location	1995	1996	1998	1999	2000	2001	2003	2004	2005	2006	2010	2011	2012	2013	2014
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	8.0
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					3.7
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	0.95
9- SLR/ Below Bould.	4.6		7.2	3.5		3.0	3.7	2.1	5.8						0.80
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	0.13
12a- SLR/Lower Waterman G			1.0	0.7										0.33	0.10
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	3.2
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	Dry
15/ Fall	2.0		3.4	2.2	1.7	1.7									1.0 (Balance)
16/ Newell	1.6				0.51						1.2	0.92	0.78	0.78	0.08
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	0.76 (Balance)
18a/ Bear				0.45	0.61	0.34	0.6	0.51	0.90	1.1	0.68	1.3	0.23	0.16	0.03
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 2006−2014 and from Stream Gages; Measurements by D.W. ALLEY & Associates; 2010 (September), 2011−2014 (October) at fall baseflow conditions, County Staff (Date specified).

Location	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
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	0.6−7.1 (17 Oct) 1.2 (19 Oct)
SLR at Sycamore Grove		34.8	14.6	14.2	−	18.7 Paradise P. (DWA)	27.6 Paradise P. (DWA)	17.2 Paradise P. (DWA)	12.9 Paradise P. (DWA)	8.0 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)	7.8 (17 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)	0.80 (DWA)
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)	0.11(8/6)
SLR @ Teihl Rd						0.97 (DWA)	1.1 (DWA)	0.40 (DWA)	0.38 (DWA)	0.13 (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)	3.2 Below Bean (DWA) 3.1 (10/23)
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)	0.06 (8/20)
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)	1.75 (10/23)
Bean Cr Below Lockhart Gulch		1.4	0.72	0.79	0.89	0.68 (9/2)			0.83 (8/13)	0.56 (10/16)
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)	0.08 (DWA) 0.23 (8/20)
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)	0.76 (10/2) (Balance Hydrologics) 0.55 (8/21)
Bear Cr above Hopkins Gulch						0.68 (DWA)	1.3 (DWA)	0.23 (DWA)	0.16 (DWA)	0.03 (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)	0.12 (8/6)
Branciforte @ Isabel Lane				0.3	0.25	0.42 (8/26)		0.57 (8/22)	0.59 (6/20)	0.31 (8/7)
Soquel Cr above Lagoon						2.3(DWA)	4.9 (DWA)	1.8 (DWA)	0.33 (DWA)	0.19 (DWA) (Walnut St.)
Soquel Cr @ USGS Gage	5.0**	6.6**	1.4**	0.65**	1.2**	3.4**	5.8**	1.8**	0.36**	0.35**
Soquel Cr @ Bates Cr		5.73	-	1.08		4.2 (9/1)	7.3 (8/31)	2.0 (9/19)	0.95 (9/11)	0.22 (9/17)
Soquel Cr above Moores Gulch						2.16 (DWA)	4.3 (DWA)	2.0 (DWA)	1.26 (DWA)	0.72 (7/16) 0.80 (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)	0.80 (9/16) 0.74 @ Mouth (DWA)

Location	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
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)	0.0 (7/16) Trickle @ Mouth; Dry above (DWA)
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)	Dry (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) (Valencia Cr. dry)	0.47 (9/16)
Aptos Cr above Valencia Cr						0.97 (DWA)	1.6 (DWA)			0.63 (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.	0.51 (9/11) Below Browns Cr.
Corralitos Cr above Los Cosinos Road Br						2.0 (DWA)	2.6 (DWA)	2.0 (DWA)	1.54 (DWA)	1.29 (DWA)
Corralitos Cr @ Rider Cr		3.35	2.5 After	1.44	–	2.4 (9/2)		1.73 (9/13)	1.12 (9/5)	1.24 (9/11)
Corralitos above Eureka Gulch						0.63 (DWA)	0.71 (DWA)	0.23 (DWA)	0.16 (DWA)	0.07 (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)	0.33 (DWA) 0.21 (9/11)

* 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 2014 and Most Recent Preceding Year.

Reach	2014 Pool Habitat In Feet/ Percent / # Habitats	2013 Pool Habitat In Feet/ Percent / # Habitats	2014 Riffle Habitat Feet/ Percent / # Habitats/ Riffle Width (ft)	2013 Riffle Habitat Feet/ Percent / # Habitats/ Riffle Width (ft)	2014 Run/Step-run/ Glide Habitat Feet/ Percent / # Habitats/ Width (ft)	2013 Run/ Step-run Habitat Feet/ Percent / #Habitats/ Width (ft)
Low. San Lorenzo #1	1778/57%/8	1948/63%/6 (2008)	438/ 14%/ 9/ 22 ft	501/16%/8/ 26 ft (2008)	908/ 29%/ 12/ 25 ft	634/21%/6/ 38 ft (2008)
Low. San Lorenzo #2	1831/56%/11	1879/57%/ 10	762/ 23%/ 14/ 20 ft	853/ 26%/ 13/ 29 ft	668/ 21%/ 6/ 19 ft	554/ 17%/ 7/ 28 ft
Middle San Lorenzo #8	2974/83%/15	3467/84%/13 (2009)	317/9%/ 7/ 11 ft	262/6%/ 7/ 17 ft (2009)	277/ 8%/ 6/ 15 ft	392/10%/ 8/ 19 ft (2009)
Upper San Lorenzo #10	3609/ 87%/ 21	2361/ 79%/ 12 (1999)	214/5%/ 7/ 6 ft	434/15%/ 12/ 18 ft (1999)	330/8%/ 10/ 5 ft	194/6%/ 4/ 14 ft (1999)
Zayante #13d	2189/ 86%/ 43	1901/75%/ 38	111/ 4%/ 6/ 3 ft	135/ 5%/ 6/ 5 ft	236/ 9%/ 9/ 5 ft	503/ 20%/ 14/ 8 ft
Bean #14b	2017/ 67%/ 30	2036/69%/ 26	500/ 17%/ 17/ 8 ft	424/14%/ 15/ 11 ft	477/ 16%/ 10/ 9 ft	503/17%/ 7/ 12 ft
Fall #15a	565/ 25%/ 18		1131/ 50%/ 27/ 9 ft		562/ 25%/ 14/ 8 ft	
Fall #15b	731/ 24%/ 31	523/20%/ 21 (2011)	1823/ 61%/ 31/ 12 ft	1821/71%/25/ 16 ft (2011)	456/ 15%/ 13/ 9 ft	237/9%/ 9/ 16 ft (2011)
Branciforte #21a-2	2298/ 84%/ 30	2075/ 75% 23 (2010)	271/ 10%/ 22/ 9 ft	312/11%/18/ 9 ft (2010)	162/ 6%/ 7/ 8 ft	380/14%/ 13/ 9 ft (2010)
Soquel #1	3216/81%/15	3774/85%/15 (2012)	415/10%/15 13 ft	433/10%/12 21 ft (2012)	356/9%/ 8/ 11 ft	250/6%/ 5 19 ft (2012)
Soquel #7	2149/63%/20	2383/64%/17 (2012)	467/14%/11 12 ft	782/21%/15/ 19 ft (2012)	784/23%/12 14 ft	586/16%/10/ 20 ft (2012)
Soquel #9a	1461/61%/20	1580/ 55%/ 17	277/11%/12 7 ft	213/ 7%/ 10/ 7 ft	665/28%/12 8 ft	1059/37%/14/ 11 ft (2012)
Soquel #14b	2351/73%/33	2366/73%/29 (2009)	374/12%/18/ 8 ft	179/5%/12 7 ft (2009)	502/15%/15 7 ft	711/22%/16 10 ft (2009)
Aptos #4	1741/67%/25	1854/70%/21 (2011)	496/19%/23 12 ft	322/12%/16 13 ft (2011)	346/13%/9 13 ft	485/18%/11 12 ft (2011)
Corralitos #3	1479/53%/22	1192/42%/18 (2012)	673/24%/17 16 ft	863/31%/18/ 14 ft (2012)	644/23%/13 18 ft	766/27%/12/ 13 ft (2012)
Corralitos #7	1528/55%/51	1010/38%/33 (2012)	396/14%/24 5 ft	269/10%/18/ 6 ft (2012)	864/31%/21 5 ft	1388/52%/25/ 8 ft (2012)

Table 6a. Averaged Mean and Maximum WATER DEPTH in SAN LORENZO Reaches Since 2008.

Reach	Pool 2008	Pool 2009	Pool 2010	Pool 2011	Pool 2012	Pool 2013	Pool 2014	Riffle 2008	Riffle 2009	Riffle 2010	Riffle 2011	Riffle 2012	Riffle 2013	Riffle 2014	Run/ Step Run 2008	Run/ Step Run 2009	Run/ Step Run 2010	Run/ Step Run 2011	Run/Step Run 2012	Run/Step Run 2013	Run/Step Run 2014
1- L. Main	1.85/ 3.4						1.9/ 3.1	0.7/ 1.2						0.6/ 0.9	0.9/ 1.35						**0/9 1.4**
2- L. Main	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	2.2/ 3.9	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	0.8/ 1.3	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**	**1.3/ 1.95**
3- L. Main																					
4- L. Main	2.0/ 3.6							0.5/ 1.0							0.9/ 1.5						
5- L. Main																					
6- M. Main	1.6/ 3.1							0.55/ 0.9							0.8/ 1.1						
7- M. Main																					
8- M. Main	2.3/ 4.7	2.8/ 5.1					2.4/ 4.0	0.45/ 0.7	0.65/ 1.0					0.4/ 0.7	0.8/ 1.2	0.7/ 1.0					**0.6/ 1.0**
9- M. Main						1.8/ 3.5							0.4/ 0.7							**0.5/ 0.9**	
10- U. Main							1.2/ 2.4							0.1/ 0.3							**0.2/ 0.3**
11- U. Main	0.9/ 1.8	1.05/ 1.8			1.1/ 2.0			0.25/ 0.5	0.25/ 0.4			0.3/ 0.5			0.4/ 0.7	0.4/ 0.75			**0.5/ 0.7**		
12b- U. Main					1.1/ 1.9							0.3/ 0.7							**0.5/ 0.8**		
Zayante 13a	1.5/ 2.5							0.4/ 0.8							0.6/ 0.9						
Zayante 13c	1.2/ 2.2		1.3/ 2.2	1.5/ 2.4				0.2/ 0.6		0.4/ 0.7	0.5/ 0.8				0.4/ 0.8		0.6/ 1.0	0.7/ 1.1			
Zayante 13d	1.0/ 1.55	0.9/ 1.5	1.2/ 2.0	1.3/ 2.0	1.1/ 1.8	1.0/ 1.6	0.8/ 1.4	0.2/ 0.5	0.25/ 0.5	0.4/ 0.6	0.45/ 0.8	0.3/ 0.6	0.3/ 0.5	0.2/ 0.35	0.5/ 0.9	0.55/ 0.9	0.7/ 1.1	0.8/ 1.2	**0.6/ 1.0**	**0.5/ 0.9**	**0.3/ 0.5**

Reach	Pool 2008	Pool 2009	Pool 2010	Pool 2011	Pool 2012	Pool 2013	Pool 2014	Riffle 2008	Riffle 2009	Riffle 2010	Riffle 2011	Riffle 2012	Riffle 2013	Riffle 2014	Run/ Step Run 2008	Run/ Step Run 2009	Run/ Step Run 2010	Run/ Step Run 2011	Run /Step Run 2012	Run/Step Run 2013	Run/Step Run 2014
Lom-pico 13e	1.0/ 1.7							0.1/ 0.3							0.3/ 0.5						
Bean 14a																					
Bean 14b	1.0/ 1.8	1.2/ 1.9	1.15/ 2.0	1.2/ 2.0	1.2/ 2.1	1.0/ 1.9	0.9/ 1.5	0.2/ 0.4	0.2/ 0.4	0.2/ 0.4	0.3/ 0.6	0.3/ 0.5	0.3/ 0.5	0.3/ 0.5	0.4/ 0.65	0.4/ 0.6	0.4/ 0.6	0.5/ 0.8	**0.4/ 0.9**	**0.4/ 0.7**	**0.4/ 0.6**
Bean 14c	0.9/ 1.7		0.9/ 1.6	1.0/ 1.8				0.03/ 0.1		0.1/ 0.2	0.2/ 0.4				0.06/ 0.1		0.2/ 0.4	0.3/ 0.5			
Fall 15a							0.7/ 1.1							0.3/ 0.6							**0.4/ 0.8**
Fall 15b	0.9/ 1.4	0.9/ 1.4		1.3/ 1.9			0.8/ 1.2	0.4/ 0.8	0.35/ 0.75		0.6/ 1.05			0.3/ 0.6	0.6/ 0.9	0.5/ 1.0		0.8/ 1.25			**0.5/ 0.7**
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	1.6/ 2.6	1.8/ 2.9				1.4/ 2.4		0.4/ 0.7	0.35/ 0.7				0.4/ 0.7		0.6/ 0.95	0.65/ 1.05				**0.6/ 1.0**	
Boul-der 17b	1.5/ 2.7					1.4/ 2.4		0.3/ 0.6					0.4/ 0.8		0.55/ 0.95					**0.55/ 1.0**	
Boul-der 17c																					
Bear 18a	1.3/ 2.55				1.4/ 2.2			0.2/ 0.4				0.2/ 0/4			0.35/ 0.7				**0.4/ 0.7**		
Bear 18b																					
Branci-forte 21a-1	1.35/ 2.3							0.2/ 0.3							0.3/ 0.6						
Branci-forte 21a-2	0.9/ 1.7	1.0/ 1.8	1.0/ 1.9				0.95/ 1.6	0.2/ 0.35	0.2/ 0.35	0.2/ 0.4				0.25/ 0.5	0.45/ 0.65	0.45/ 0.65	0.5/ 0.8				**0.5/ 0.7**
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 2009−2014.

Site	Pool 2009	Pool 2010	Pool 2011	Pool 2012	Pool 2013	Pool 2014	Riffle 2009	Riffle 2010	Riffle 2011	Riffle 2012	Riffle 2013	Riffle 2014	Run/Step Run 2009	Run/Step Run 2010	Run/Step Run 2011	Run/Step Run 2012	Run/Step Run 2013	Run/Step Run 2014
0a	1.8/ 3.2	1.2/ 2.2	1.6/ 2.0	1.3/ 2.5	2.2/ 3.5	1.2/ 1.9	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**	**0.6/ 1.2**
1							0.8/ 1.1	0.9/ 1.45	1.15/ 1.6	0.9/ 1.5	0.9/ 1.4	0.5/ 0.9	1.2/ 1.7	1.3/ 1.9	1.6/ 2.1	**1.1/ 1.7**	**1.3/ 1.9**	**1.0/ 1.5**
2									1.3/ 1.5	1.1/ 1.5	1.0/ 1.8	0.9/ 1.4			1.7/ 2.95	**1.9/ 2.6**	**1.9/ 2.5**	**1.5/ 2.2**
4							0.55/ 0.9	0.55/ 0.9	0.85/ 1.1	0.6/ 1.0	0.6/ 0.9	0.5/ 0.7	0.8/ 1.35	1.1/ 2.2	1.55/ 2.0	**1.2/ 1.65**	**1.3/ 1.6**	**1.05/ 1.45**
6							0.5/ 0.7	0.65/ 0.8	0.65/ 1.0	0.6/ 1.05	0.5/ 0.9	0.4/ 0.6	0.6/ 1.1	0.6/ 1.2	0.7/ 1.2	**0.7/ 1.1**	**0.75/ 1.05**	**0.5/ 0.9**
8							0.65/ 0.9	0.8/ 1.0	0.9/ 1.2	0.7/ 1.1	0.6/ 1.1	0.6/ 0.8	0.85/ 1.0	0.95/ 1.2	1.0/ 1.3	**0.8/ 1.2**	**0.8/ 1.0**	**0.65/ 1.0**
9							0.9/ 1.4 (2005				0.4/ 0.7	0.4/ 0.85	1.0/ 1.3 (2005)				**0.6/ 1.0**	**0.5/ 0.7**
10						1.3/ 2.5						0.1/ 0.15						**0.3/ 0.5**
11	0.95/ 1.75	1.0/ 1.6	0.9/ 1.5	1.2/ 1.75	1.05/ 1.7	1.1/ 1.85	0.1/ 0.2	0.2/ 0.35	0.3/ 0.45	0.45/ 0.6 Δ riffle	0.4/ 0.7	0.15/ 0.4 (glide)	0.4/ 0.8	0.6/ 0.8	0.6/ 1.1	**0.4/ 0.5**	**0.3/ 0.5**	**0.2/ 0.5**
12b				1.05 / 2.0	0.95/ 1.35	0.9/ 1.8				0.45/ 0.8	0.5/ 0.8	0.3/ 0.6				**0.55/ 0.9**	**0.5/ 0.9**	**0.5/ 0.95**
Zayante 13a	1.8/ 2.9	2.1/ 3.4	1.8/ 3.8	1.9/ 3.7	1.7/ 3.0	1.4/ 2.9	0.15/ 0.4	0.2/ 0.5	0.5/ 0.8	0.4/ 0.7	0.6/ 1.0	0.35/ 0.6	0.65/ 1.0	0.75/ 1.3	0.9/ 1.5	**0.7/ 1.05**	**0.8/ 1.2**	**0.75/ 1.1**
Zayante 13c			1.1/ 1.85	1.1/ 1.75	1.05/ 1.85	0.95/ 1.75			0.6/ 0.9	0.3/ 0.7	0.3/ 0.5	0.2/ 0.5			0.7/ 0.95	0.5/ 0.75	0.55/ 0.85	0.4/ 0.5
Zayante 13d				1.1/ 1.95	0.8/ 1.2 Δ Site	0.7/ 1.45 Δ Site										0.75/ 1.0	0.3/ 0.5	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	1.0/ 1.75	0.1/ 0.15	0.1/ 0.3	0.2/ 0.4	0.2/ 0.5	0.05 / 0.3	0.05/ 0.2	0.3/ 0.5	0.45/ 0.75	0.5/ 0.8	**0.35/ 0.9**	**0.4/ 0.9**	**0.4/ 0.7**

Site	Pool 2009	Pool 2010	Pool 2011	Pool 2012	Pool 2013	Pool 2014	Riffle 2009	Riffle 2010	Riffle 2011	Riffle 2012	Riffle 2013	Riffle 2014	Run/Step Run 2009	Run/ Step Run 2010	Run/ Step Run 2011	Run/ Step Run 2012	Run/ Step Run 2013	Run/ Step Run 2014
Bean 14b	1.0/ 2.0	0.9/ 2.0	1.4/ 2.4	1.3/ 2.05	1.1/ 2.5	1.1/ 2.0	0.2/ 0.4	0.25/ 0.4	0.25/ 0.8	0.35/ 0.6	0.1/ 0.2	0.15/ 0.2	0.2/ 0.4	0.5/ 0.6	0.5/ 0.7	**0.5/ 0.8**	**0.5/ 0.7**	**0.4/ 0.5**
Bean 14c			0.8/ 1.65	0.8/ 1.45 Went dry	Dry	Dry			0.2/ 0.3	0.1/ 0.2 Went dry	Dry	Dry			0.3/ 0.5	**0.25/ 0.35 Went dry**	**Dry**	**Dry**
Fall 15a						0.7/ 0.95						0.25/ 0.5						**0.45/ 0.8**
Fall 15b			1.1/ 1.85	1.15/ 1.65	0.8/ 1.3	0.9/ 1.2 Δ Site			0.7/ 1.4	0.45/ 0.8	0.3/ 0.6	0.35/ 0.55			0.9/ 1.4	**0.6/ 1.1**	**0.45/ 0.8**	**0.4/ 0.5**
Newell 16	1.15/ 1.95	1.25/ 1.9	1.15/ 1.85	1.05/ 1.8	1.2/ 2.1	0.95/ 1.75	0.2. 0.5	.25/ .55	0.4/ 0.5	0.35/ 0.45	0.4/ 0.7	0.03/ 0.1	0.3/ 0.5	0.5/ 0.9	0.4/ 0.6	**0.3/ 0.5**	**0.4/ 0.55**	**0.2/ 0.5**
Boulder 17a	1.05/ 1.8	1.2/ 1.75	1.35/ 1.95	1.2/ 1.8	1.05/ 1.8	1.0/ 1.75	0.4/ 0.8	0.7/ 1.1	–	0.5/ 1.0	0.5/ 0.7	0.35/ 0.6	0.7/ 1.1	0.9/ 1.2	1.1/ 1.4	**0.8/ 1.2**	**0.85/ 1.0**	**0.7/ 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	1.15/ 1.75	0.5/ 1.0	0.6/ 1.1	0.7/ 1.2	0.65/ 1.1	0.5/ 0.6	0.3/ 0.6	0.5/ 0.9	0.7/ 0.9	0.8/ 1.4	**0.6/ 1.2**	**0.4/ 0.85**	**0.4/ 0.7**
Bear 18a		1.35/ 2.6	1.35/ 2.2	1.1/ 1.85	1.3/ 2.3	1.2/ 1.95		0.3/ 0.6	0.3/ 0.6	0.3/ 0.6	0.3/ 0.5	0.2/ 0.4		0.7/ 0.9	0.65/ 1.0	**0.45/ 0.9**	**0.4/ 0.6**	**0.35/ 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	1.15/ 1.45 Δ Site	0.1/ 0.2	0.1/ 0.2	0.25/ 0.5	0.1/ 0.3	0.1/ 0.3	0.35/ 0.5	0.4/ 0.6	0.5/ 1.2	0.35/ 0.6	**0.4/ 0.6**	**0.35/ 0.6**	**0.5/ 0.7**
Branciforte 21b				1.2/ 1.95	1.05/ 1.75 Δ site	1.05/ 1.65				0.3/ 0.6	0.4/ 0.6	0.2/ 0.4				**0.5/ 0.85**	**0.5/ 0.7**	**0.5/ 0.8**
Branciforte 21c					1.2/ 2.35	1.4/ 2.5					0.1/ 0.15	0.05/ 0.1					**0.3/ 0.4**	**0.2/ 0.4**

Table 7a. Average PERCENT FINE SEDIMENT* IN SAN LORENZO REACHES Since 2008.

Reach	Pool 2008	Pool 2009	Pool 2010	Pool 2011	Pool 2012	Pool 2013	Pool 2014	Riffle 2008	Riffle 2009	Riffle 2010	Riffle 2011	Riffle 2012	Riffle 2013	Riffle 2014	Run / Step Run 2008	Run / Step Run 2009	Run / Step Run 2010	Run / Step Run 2011	Run / Step Run 2012	Run / Step Run 2013	Run / Step Run 2014
1	77						60	20						5	46						**31**
2	54	48	48	47	44	50	38	13	13	10	8	9	6	6	23	26	40	13	**17**	**9**	**8**
4	47							10							37						
6	68							12							23						
7																					
8	47	44					37	6	12					6	16	25					**8**
9						46							9							**23**	
10							44							4							**6**
11	52	40			25			9	12			8			14	14			**17**		
12b					27							4							**9**		
Zayan-te 13a	62							19							31						
Zayan-te 13b																					
Zayan-te 13c	47		41	43				12		10	14				34		19	19			
Zayan-te 13d	44	46	42	40	26	31	19	13	12	19	14	14	6	6	29	28	27	28	**19**	**16**	**13**
Lompi-co 13e	54							20							29						
Bean 14a																					
Bean 14b	66	67	55	61	49	64	60	9	13	13	32	10	13	13	34	34	28	72	**25**	**34**	**56**
Bean 14c	37		54	51				6		14	9				10		26	19			
Fall 15a							28							19							**23**
Fall 15b	64	69		57			40	30	34		19			13	48	50		37			**47**
Newell 16		46	22	22					11	6	3					19	12	4			
Boul-der 17a	27	28				59		9	11				13		13	11				**19**	
Boulder 17b	32					22		5					3		14					**7**	
Boul-der 17c																					
Bear 18a	46		41		38			11		13		9			13		19		**19**		
Branci. 21a-1	62							10							16						
Branci. 21a-2	42	38	43				40	8	8	9				6	21	13	22				**14**
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	Pool 2014	Riffle 2011	Riffle 2012	Riffle 2013	Riffle 2014	Run/ Step Run 2011	Run/ Step Run 2012	Run/ Step Run 2013	Run/ Step Run 2014
0a	50	50	NA	25	30	5	NA	10	25	15	NA	10
1	NA	NA	NA	NA	10	15	5	5	15	20	40	25
2	NA	NA	NA	NA	10	15	5	15	20	25	5	20
4	NA	NA	NA	NA	15	10	5	5	38	30	35	30
6	NA	NA	NA	NA	15	15	5	10	15	15	10	15
8	NA	NA	NA	NA	15	15	15	5	20	30	15	5
9	NA (2005)		NA	NA	10 (2005)		13	8	35 (2005)		45	23
10	60 (2001)			30	25 (2001)			1	40 (2001)			20
11	35	20	33	33	5	NA	5	1	5	NA	15	10
12b	45 (2001)	35	30	28	23 (2001)	5	5	2	20 (2001)	5	5	10
Zayante 13a	80	50	75	60	1	5	10	10	15	30	50	50
Zayante 13c	15	10	5	15	15	10	2	NA	10	13	10	NA
Zayante 13d	33	22	30	17	NA	NA	NA	NA	23	25	20	15
Lompico 13e	45	40	45	50	NA	20	10	2	25	20	30	30
Bean 14b	70	60	80	95	10	10	10	20	35	25	25	25
Bean 14c	38	10	Dry	Dry	5	2	Dry	Dry	15	10	Dry	Dry
Fall 15a				32				15				13
Fall 15b	50	68	40	28	20	20	15	23	25	35	60	25
Newell 16	18	28	8	20	5	2	2	1	5	2	10	5
Boulder 17a	20	30	60	38	5	15	10	10	15	10	15	15
Boulder 17b	25	25	18	18	0	2	2	1	10	10	5	2
Bear 18a	28	33	43	45	5	15	5	5	20	20	10	15
Branciforte 21a-2	75	48	65	43	2	NA	15	5	25	20	20	10
Branciforte 21b	73 (2001)	53	28	50	15 (2001)	10	10	5	45 (2001)	20	20	15
Branciforte 21c			80	55			15	5			15	10

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

Table 8a. Average EMBEDDEDNESS IN SAN LORENZO Reaches Since 2008.

Reach	Pool 2008	Pool 2009	Pool 2010	Pool 2011	Pool 2012	Pool 2013	Pool 2014	Riffle 2008	Riffle 2009	Riffle 2010	Riffle 2011	Riffle 2012	Riffle 2013	Riffle 2014	Run / Step Run 2008	Run / Step Run 2009	Run / Step Run 2010	Run / Step Run 2011	Run / Step Run 2012	Run / Step Run 2013	Run / Step Run 2014
1	52						52	26						23	48						**44**
2	38	36	37	49	39	33	50	18	16	25	20	19	20	21	25	32	27	**28**	**38**	**31**	**30**
3																					
4	45							33							42						
5																					
6	51							21							39						
7																					
8	46	33					56	30	19					36	26	32					**38**
9						48							26							**63**	
10							57							28							**35**
11	47	48			46			30	22			14			43	33			**30**		
12b					35							32							**53**		
Zayante 13a	51							30							47						
Zayante 13b																					
Zayante 13c	49		49	48				28		29	31				44		36	**56**			
Zayante 13d	49	49	57	53	53	56	63	33	43	39	45	49	41	43	37	41	51	**40**	**43**	**51**	**54**
Lompico 13e	47							19							32						
Bean 14a																					
Bean 14b	44	44	53	51	59	38	50	14	16	25	32	48	25	26	22	35	30	**55**	**53**	**36**	**41**
Bean 14c	42		60	53				15		42	31				29		43	**46**			
Fall 15a							48							30							**37**
Fall 15b	48	52		46			53	25	28		18			26	40	41		**42**			**46**
Newell 16		42	39	53					20	24	31					31	34	**43**			
Boulder 17a	37	38				58		21	18				27		31	27				**39**	
Boulder 17b	35					33		17					26		34					**34**	
Boulder 17c																					
Bear 18a	48		49		60			34		25		44			43		34		**50**		
Branc-21a-1	58							24							41						
Branc-21a-2	46	49	53				53	28	28	30				30	33	28	41				**34**
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	Pool 2014	Riffle 2011	Riffle 2012	Riffle 2013	Riffle 2014	Run/ Step Run 2011	Run/ Step Run 2012	Run/ Step Run 2013	Run/ Step Run 2014
0a	60	40		45	30	20		25	35	35		25
1				65	25	30	20	25	50	40	40	40
2	55	35	33	58	15	20	25	35	30	30	25	30
4					15	20	20	15	50	50	50	38
6					20	30	40	50	30	30	40	50
8				65	30	25	45	35	35	45	45	25
9			55		15 (2005)		25	38	25 (2005)		65	60
10				45				15				20
11	40	50	53	68	5	NA	15	15	5	NA	30	40
12b	43 (2001)	55	55	58	35 (2001)	30	35	35	35 (2001)	45	45	40
Zayante 13a	60	65	45	50	20	30	30	30	35	40	40	50
Zayante 13c	30	45	50	28	45	45	30	35	35	35	40	60
Zayante 13d	43	53	55	73	20				45	45	65	75
Lompico 13e	50	40	38	58	NA	30	25	60	45	30	35	50
Bean 14b	45	60	35	60	20	45	15	45	35	70	35	35
Bean 14c	53	10	Dry		10	25	Dry		40	30	Dry	
Fall 15a				43				30				43
Fall 15b	38	60	45	58	25	50	20	48	30	45	30	50
Newell 16	65	33	60	20	15	15	35	25	35	15	40	15
Boulder 17a	40	38	58	50	25	40	20	30	35	25	20	45
Boulder 17b	30	35	35	40	10	10	35	35	30	25	30	30
Bear 18a	38	65	50	50	25	60	65	60	35	60	60	45
Branciforte 21a-2	53	48	53	63	20		25		60	40	30	40
Branciforte 21b	42 (2001)	48	50	53	40 (2001)	20	20	25	40 (2001)	30	35	30
Branciforte 21c			20	35			35	10			15	30

Table 9a. ESCAPE COVER Indices (Habitat Typing Method*) in RIFFLE HABITAT in MAINSTEM Reaches of the SAN LORENZO Since 1998, Based on Habitat Typed Segments.

Reach	1998	1999	2000	2003	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1	0.187	0.244	0.084	-	-	0.270	0.257	0.200						0.076
2	-	0.503	0.260	-	-		0.228	0.287	0.132	0.109	0.126 Seg. Δ	0.116	0.101	0.133
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**					**0.038**
9	**0.038**	**0.080**	**0.043**	**0.066**	**0.161**								**0.043**	
10	0.011	0.039	0.012	0.018	0.040									0
11	0.025	0.020	0.017	-	0.056	0.014	0.005	0.010	0.027			0.031		
12b	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 MAINSTEM SAN LORENZO SAMPLING SITES Since 2009.

Sampling Site	2009	2010	2011	2012	2013	2014
Santa Cruz Levees 0a	0.211	0.298	0.205	0.403	2.000 Floating veg.	0.182
Paradise Park 1	0.155	0.183	0.128	0.106	0.045	0.073
Rincon 2			0.129	0.117	0.100	0.141
Henry Cowell 4	0.537	0.479	0.374	0.308	0.307	0.320
Below Fall Creek 6	0.113	0.230	0.109	0.088	0.183	0.141
Below Clear Creek 8	0.082	0.194	0.154	0.163	0.148	0.054
Below Boulder Creek 9	0.133 (2005)				0.035	0.060
Below Kings Creek 10						0
Above Kings Creek Near Teihl Rd 11	0.0	0.024	0.036	–	0.041	0
Waterman Gap 12b				0.000	0.031	0.038

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

Table 10. ESCAPE COVER Indices (Habitat Typing Method*) in RUN HABITAT in MAINSTEM Reaches of the SAN LORENZO Since 1998, Based on Habitat Typed Segments.

Reach	1998	1999	2000	2003	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1	0.273	0.130	0.064	-	-	0.131	0.120	0.151						0.014
2	0.228	0.136	0.100	-	-		0.282	0.226	0.196	0.252	0.158 Seg. Δ	0.180	0.132	0.139
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**					**0.081**
9	**0.138**	**0.051**	**0.036**	**0.046**	**0.098**								**0.047**	
10	0.072	0.041	0.081	0.062	0.057									0
11	0.026	0.016	0.022	-	0.021	0.0084	0.0068	0.014	0.032			0.013		
12b	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 Since 2003, Based on Habitat Typed Segments.

Reach	2003	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
1	-	-	0.271	0.186	0.205						0.109
2	-	-		0.076	0.058	0.046	0.049	0.061 Seg. Δ	0.043	0.021	0.077
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**					**0.027**
9	**0.037**	**0.070**								**0.021**	
10	0.054	0.051									0.033
11	0.054 (2000)	0.059	0.031	0.034	0.035	0.042			0.040		
12b	-	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	2014
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**	**0.073**
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**	**0.199**
Bean 14c	0.259	0.093	0.100	0.142	0.141	0.131	0.142	0.131		0.135	0.115			
Fall 15a														**0.081**
Fall 15b	0.380		0.330					0.375	0.295		0.429			**0.209**
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				**0.180**
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 Since 2009, Including the Mainstem Teihl and Waterman Gap Sites.

Site	Pool Escape Cover 2009	Pool Escape Cover 2010	Pool Escape Cover 2011	Pool Escape Cover 2012	Pool Escape Cover 2013	Pool Escape Cover 2014
Mainstem below Kings Cr. 10						**0.026**
Mainstem @ Teihl 11	0.058*	0.094	**0.033**	**0.039**	**0.081**	**0.085**
Mainstem @ Waterman Gap 12b				**0.091**	**0.124**	**0.155**
Zayante 13a	0.140	0.103	**0.167**	**0.222**	**0.122**	**0.060**
Zayante 13c			**0.120**	**0.178**	**0.164**	**0.186**
Zayante 13d	0.285	0.113	**0.168**	**0.135 Site Δ**	**0.135 Site Δ**	**0.073 Site Δ**
Lompico 13e	0.154	0.092	**0.061**	**0.072**	**0.098**	**0.057**
Bean 14b	0.145	0.120	**0.165**	**0.175**	**0.137**	**0.181**
Bean 14c			**0.098**	**0.094**	**Dry**	**Dry**
Fall 15a						**0.170**
Fall 15b	0.302	0.571	**0.429**	**0.500**	**0.357**	**0.174 Site Δ**
Newell 16	0.150	0.118	**0.101**	**0.154**	**0.142**	**0.033**
Boulder 17a	0.066	0.094	**0.110**	**0.092**	**0.060**	**0.041**
Boulder 17b	0.356	0.266	**0.258**	**0.461**	**0.088 Site Δ**	**0.138**
Bear 18a		0.138	**0.101**	**0.050 Site Δ**	**0.068**	**0.034**
Branciforte 21a-2	0.051	0.068	**0.040**	**0.107**	**0.070**	**0.173 Site Δ**
Branciforte 21b				**0.158**	**0.184 Site Δ**	**0.254**
Branciforte 21c					**0.252**	**0.286**

***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 Since 1998.

Reach	1998	1999	2000	2003	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014
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 13	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	**0.042**
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	**0.094**
Bean 14c	-	0.018	0.023	0.015	0.012	0.009	0.0	0.0		0.0	0.018			
Fall 15a														**0.021**
Fall 15b								0.110	0.092		0.045			**0.061**
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				**0.065**
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 2013 to 2014, 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)	−	− / −	NA	NA	−/−	−
Mainstem 1	−	− (Since 2008)	+ (Since 2008)	Similar (Since 2008)	−/− (Since 2008)	−
Mainstem 2	−	− / −	−	Similar	− (pools)/ + riffles	−
(Mainstem 4)	−	NA / −	Similar	+ (run)	/Similar	−
(Mainstem 6)	−	NA / −	Similar	− (fastwater)	/−	−
Mainstem 8	−	− / − (Since 2009)	Similar pools/ + (riffles) (Since 2009)	− (pools)/ − (fast water) (Since 2009)	− (pools)/ − (riffles) (Since 2009)	−
(Mainstem 9)	−	− (fastwater) Similar in pools	+ (run)	− (riffle)	NA/+	−
(Mainstem Near Teihl 11)	−	Similar	Similar	− (pool and run)	Similar/−	−
(Mainstem Waterman Gap 12b)	−	+ (pool) − (run)	Similar	Similar	+/+	−
(Zayante 13a)	−	−/−	+ (pool)	− (run)	−	−
(Zayante 13c)	−	Similar	− (pool)	+ (pool) − (run)	+ (slightly)	−
Zayante 13d	−	−/−	+ (pool)	Similar	Similar	−
(Lompico 13e)	−	−/−	Similar	−	−	−
Bean 14b	−	−/−	− (run)	− (pools)	+	−
(Bean 14c)						Dry
Fall 15b	−	−/− (Since 2009/2011)	+ (pool) − (run) (Since 2011)	Similar (Since 2011)	− (Since 2009/ 2011)	−
(Newell 16)	−	−/−	− (pool)	+	−	−
(Boulder 17a)	−	Similar- pool −(fastwater)	+ (pool)	− (fastwater)	_	−
(Boulder 17b)	−	Similar- pool −(fastwater)	Similar	Similar	+	−
(Bear 18a)	−	−/−	Similar	+ (run)	−	−
Branciforte 21a-2	−	− (pool) (Since 2009/2010)	Similar (Since 2010)	Similar (Since 2010)	Similar (Since 2010)	−
(Branciforte 21b)	−	+ (pool)	− (pool)	Similar	+ (substantial)	− (flow)
(Branciforte 21c)	−	+ (pool)	+ (pool)	−	+	− (flow)

***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 15g and 40**. Reaches 1 and 7 were compared to 2012 conditions. Reach 9a was compared to 2013 conditions. Reach 14b was compared to 2009 conditions. The studied segment in Reach 12a in the SDSF was dry in 2014, though YOY and yearling steelhead were present in lower Reach 12a near the Amaya Creek confluence in July and relocated before a segment of it was dewatered for a road repair project. Sites in other reaches (3, 9 and 13) were compared to 2013 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 2014 than in 2013 (**Table 5b; Figures 36a-b; 37a-b; and 38**). As for the San Lorenzo watershed, there were 4 small storms in the Soquel watershed in 2014, peaking at flows between 40 and 320 cfs, well below bankfull stormflows. The average mean monthly streamflow for May−September in 2014 at the Soquel Village gage was the lowest in 18 years of calculations (1.0 cfs with an 18-year average of 8.9 cfs) (**Figure 45**).

With habitat typed Reaches 1, 7, 9a and 21b there was pool shallowing and reduced fastwater habitat depth since previous habitat typing (**Tables 14a and 15g**). Average maximum pool depth in branch reaches declined from 0.15 to 0.3 feet, and in mainstem reaches it declined from 0.5 to 0.9 feet. Pools at replicated Sites 4 (Reach 3), 12 (Reach 8) and 19 (Reach 13) also shallowed since 2013 (**Tables 14b and 15g**). Average maximum pool depth declined from 0.2 to 0.3 feet at replicated sites. Soquel Lagoon maintained most of its depth from 2013 conditions (**Alley 2015**). Escape cover improved in mainstem reaches/sites in 2014 (**Tables 15e-g**), it being increased by more overhanging vegetation and fallen trees. In the branches, escape cover declined in Reaches 9a (below Mill Pond) and 14b (between the 2 Girl Scout Falls), with it remaining similar at Site 19 (lower West Branch).

Percent fines were mostly similar or lessened in 2014, except in pools at mainstem Site 12 and West Branch Site 19 (**Tables 15a-b; 15g**). Percent fines in pools were in the 25-95% range. In riffles it was in the 2-20% range. In runs/step-runs it was in the 5-30% range. Embeddedness was mostly similar in mainstem reaches/sites except more in riffles at Site 12 (**Tables 15c-b; 15g**). Embeddedness worsened in Reaches 9a (compared to 2013) and 14b (compared to 2009). Embeddedness in pools generally was in the 45-65% range. It was in the 25-50% range in riffles and in the 40-55% range in runs/step-runs.

Reduced baseflow in 2014 provided less food and less YOY growth in all reaches compared to 2011 (wet year), as exemplified by lower percent of YOY reaching Size Class II in 2014 compared to 2011 (**Figure 18a;** size histograms in **Appendix D; Alley 2014**). Growth was still reduced in 2014 compared to 2013 (**Figure 18b**) despite the reduced YOY abundance at all 7 sites (**Table 27**). Yearling densities remained low and close to average, consistent with poor over-winter survival as in past years (**Figure 7**). 2014 yearling densities were low but above average after the mild winter, except where Site 16 (SDSF) was dry and at the middle West Branch Site 21b, where YOY densities may have been low the previous year above Girl Scout Falls I.

Table 14a. Averaged Mean and Maximum WATER DEPTH (ft) of Habitat in SQOUEL CREEK Reaches* Since 2008.

Reach	Pool 2008	Pool 2009	Pool 2011	Pool 2012	Pool 2013	Pool 2014	Riffle 2008	Riffle 2009	Riffle 2011	Riffle 2012	Riffle 2013	Riffle 2014	Run/ Step Run 2008	Run/ Step Run 2009	Run/ Step Run 2011	Run/ Step Run 2012	Run/ Step Run 2013	Run/ Step Run 2014
1	1.2/ 2.8	1.15/ 2.7		1.35/ 3.6		1.0/ 2.7	0.2/ 0.4	0.25/ 0.45		0.35/ 0.6		0.1/ 0.2	0.3/ 0.5	0.35/ 0.5		0.5/ 0.8		**0.3/ 0.5**
2																		
3	1.2/ 2.3	1.4/ 2.35	1.6/ 3.0		1.2/ 2.4		0.2/ 0.4 *	0.25/ 0.4	0.45/ 0.75		0.3/ 0.6		0.3/ 0.6 *	0.45/ 0.7	0.7/ 1.1		0.5/ 0.7	
4																		
5																		
6																		
7	1.2/ 2.2	1.35/ 2.4		1.2/ 2.5		1.1/ 2.0	0.3/ 0.5	0.35/ 0.55		0.4/ 0.7		0.3/ 0.5	0.4/ 0.7	0.5/ 0.8		0.6/ 1.0		**0.4/ 0.7**
8	1.4/ 2.5	1.6/2 .8	1.9/ 3.5		1.1/ 2.1		0.2/ 0.4	0.3/ 0.45	0.6/ 0.9		0.3/ 0.6		0.4/ 0.7	0.5/ 0.75	0.9/ 1.3		0.5/ 0.85	
9	1.2/ 2.3	1.45/ 2.3	1.6/ 2.7		1.0/ 1.8	0.8/ 1.5	0.2/ 0.4	0.2/ 0.45	0.5/ 0.7		0.2/ 0.3	0.15/ 0.3	0.4/ 0.6	0.5/ 0.75	0.6/ 0.85		0.3/ 0.6	**0.2/ 0.45**
10																		
11																		
12a	0.6/ 1.1	1.0/ 1.5	1.0/ 1.7	0.9/ 1.5	0.6/ 1.0	Dry	0.02/ 0.1	0.25/ 0.45	0.4/ 0.7	0.3/ 0.6	0.15/ 0.3	Dry	0.2/ 0.5	0.45/ 0.8	0.6/ 1.05	0.5/ 0.9	0.3/ 0.6	**Dry**
12b																		
13	1.1/ 2.3	1.25/ 2.3		1.3/ 2.5			0.3/ 0.5	0.3/ 0.5		0.3/ 0.5			0.4/ 0.7	0.5/ 0.8		0.55/ 0.9		
14a																		
14b	1.3/ 2.4	1.35/ 2.5				1.3/ 2.35	0.2/ 0.4	0.25/ 0.5				0.2/ 0.4	0.4/ 0.7	0.5/ 0.8				**0.4/ 0.7**
14c																		

*Partial, ½-mile segments habitat typed in 2006–2009 and 2011−2014. Previously, the entire reach was habitat typed.

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

Site (Reach)	Pool 2009	Pool 2010	Pool 2011	Pool 2012	Pool 2013	Pool 2014	Riffle 2009	Riffle 2010	Riffle 2011	Riffle 2012	Riffle 2013	Riffle 2014	Run/ Step Run 2009	Run/ Step Run 2010	Run/ Step Run 2011	Run/ Step Run 2012	Run/ Step Run 2013	Run/ Step Run 2014
1 (1)	1.0/ 2.8	1.0/ 2.8	0.9/ 3.2	1.65/ 3.5 Site Δ	1.65/ 3.6	1.3/ 3.1 Site Δ	0.4/ 0.5	0.5/ 0.75	0.5/ 0.8	0.4/ 0.6 Site Δ	0.05/ 0.3	0.2/ 0.4 Site Δ	0.2/ 0.3	0.35/ 0.8	0.8/ 1.1	0.6/ 0.9 Site Δ	0.25/ 0.4	0.3/ 0.4 Site Δ
4 (3)	1.6/ 2.9	2.0/ 4.3	1.2/ 2.5	1.7/ 2.6	1.4/ 2.2	1.35/ 2.0	0.4/ 0.6	0.55/ 0.8	0.6/ 0.9	0.3/ 0.5	0.3/ 0.7	0.3/ 0.5	0.5/ 0.8	0.7/ 1.0	0.7/ 1.0	0.5/ 0.9	0.6/ 1.0	**0.3/ 0.5**
10 (7)		1.4/ 2.8	1.4/ 3.0	1.1/ 2.05 Site Δ	1.55/ 2.35	0.9/ 1.6 Site Δ	0.55/ 0.9	0.6/ 1.2	0.65/ 0.9	0.5/ 0.9 Site Δ	0.35/ 0.9	0.3/ 0.45 Site Δ	0.5/ 0.9	0.6/ 1.2	0.9/ 1.2	0.8/ 0.9	0.5/ 0.85	0.3/ 0.9 Site Δ
12 (8)			2.2/ 2.8	1.8/ 2.6	0.9/ 2.0 Site Δ	0.7/ 2.3			0.9/ 1.2	0.45/ 0.95	0.3/ 0.5	0.3/ 0.5			1.0/ 1.5	0.8/ 1.1	0.6/ 0.8	**0.45/ 0.7**
13a (9a)			1.65/ 2.4	1.2/ 1.9	0.95/ 1.95 Site Δ	0.7/ 1.8 Site Δ			0.5/ 0.7	0.3/ 0.6	0.1/ 0.3	0.3/ 0.4 Site Δ			0.7/ 0.9	0.75/ 1.1	0.35/ 0.5	**0.1/ 0.15** Site Δ
16 (12a)			1.2/ 1.85	1.25/ 2.05 Site Δ	0.5/ 0.85 Site Δ	Dry				0.2/ 0.4 Site Δ	0.1/ 0.15	Dry			0.55/ 0.95	0.4/ 0.9 Site Δ	0.3/ 0.8	**Dry**
19 (13)	1.0/ 2.0	1.1/ 2.1	0.9/ 2.9	1.0/ 1.9	0.9/ 2.5	0.8/ 2.2	0.5/ 0.7	0.5/ 0.9	0.45/ 0.6	0.4/ 0.8	0.35/ 0.6	0.3/ 0.5	0.5/ 0.9	0.6/ 1.1	0.7/ 1.1	0.5/ 1.1	0.5/ 1.0	**0.4/ 0.95**
21 (14b)	1.5/ 3.55	1.8/ 3.85	1.9/ 3.75			1.55/ 2.5 Site Δ	0.3/ 0.5	0.4/ 0.55	0.3/ 0.7			0.4/ 0.6 Site Δ	0.7/ 1.8	0.6/ 1.3	0.4/ 1.3			**0.35/ 0.6** Site Δ

Table 15a. Average PERCENT FINE SEDIMENT in Habitat-typed Reaches* in SOQUEL CREEK Since 2008.

Reach	Pool 2008	Pool 2009	Pool 2011	Pool 2012	Pool 2013	Pool 2014	Riffle 2008	Riffle 2009	Riffle 2011	Riffle 2012	Riffle 2013	Riffle 2014	Run/ Step Run 2008	Run/ Step Run 2009	Run/ Step Run 2011	Run/ Step Run 2012	Run/ Step Run 2013	Run/ Step Run 2014
1	64	59		62		64	13	14		8		7	16	16		24		**16**
2																		
3	57	58	59		60		15	8	11		19		20	19	14		38	
4																		
5																		
6																		
7	59	70		51		31	23	16		11		4	25	20		21		**14**
8	56	58	63		68		15	5	11		5		64	28	23		15	
9a	49	42	58		50	49	10	6	6		3	10	26	19	24		14	**19**
10																		
11																		
12a	34	35	42	34	24	Dry	10	12	8	8	5	Dry	21 (S.run)	19 (S.run)	15	14	20	**Dry**
12b																		
13	75	58		57			18	11		9			26	20*		18		
14a																		
14b	55	52				27	10	8				3	20 (run	20 (run)				**11**
14c																		

*Partial, ½-mile segments habitat typed in 2006–2009 and 2011−2014 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	Pool 2014	Riffle 2011	Riffle 2012	Riffle 2013	Riffle 2014	Run/ Step Run 2011	Run/ Step Run 2012	Run/ Step Run 2013	Run/ Step Run 2014
1 (1)	85	85	75	75	5	10	10	3	10	20	5	**30**
4 (3a)	45	70	70	70	10	5	20	20	10	15	25	**5**
10 (7)	70	38	28	30	15	NA	5	5	20	25	10	**2**
12 (8)	25	30	80 Site Δ	95	10	NA	5	2 Site Δ	15	15	15	**5** Site Δ
13a (9)	50	40	40 Site Δ	95 Site Δ	15	20	2	15 Site Δ	25	15	15	**25** Site Δ
16 (12a)	50	50	20 Site Δ	Dry	NA	15	5	Dry	NA	15	25	**Dry**
19 (13)	60	70	70	90	15	10	15	10	40	25	30	**30**
21 (14b)	70			20 Site Δ	2			5 Site Δ	10			**15** Site Δ

Table 15c. Average EMBEDDEDNESS in Pool and Fastwater (Riffle and Run) Habitat of SOQUEL CREEK REACHES Since 2007.

Reach	Pool 2007	Pool 2008	Pool 2009	Pool 2011	Pool 2012	Pool 2013	Pool 2014	Riffle 2007	Riffle 2008	Riffle 2009	Riffle 2011	Riffle 2012	Riffle 2013	Riffle 2014	Run/ Step Run 2007	Run/ Step Run 2008	Run/ Step Run 2009	Run/ Step Run 2011	Run/ Step Run 2012	Run/ Step Run 2013	Run/ Step Run 2014
1	48	35	37		54		58	22	18	19		30		32	29	29	23		39		**40**
2																					
3	40*	39*	37*	40*		50*		17*	22*	19*	13*		31*		28*	33*	23*	24*		38*	
4																					
5																					
6																					
7	42*	44*	41*		52		49	25*	23*	23*		32		24	35*	39*	38*		43		**40**
8	44*	43*	45*	60*		52*		25*	17*	17*	28*		24*		35*	48*	33*	50*		43*	
9a	47	44	50	59		45	59	18	22	26	28		30	47	37	47	42	50		45	**54**
10																					
11																					
12a	55	54	59	57	61	65	Dry	41	45	34	28	42	38	Dry	47 (S.run)	39 (S.run)	46 (S.run)	38 (S.run)	43 (S.run)	51 (S.run)	**Dry**
12b																					
13	50*	42*	53*		50*			26*	23*	22*		27*			39*	29*	37*		33*		
14a																					
14b	47	44	44				60	17	19	16				29	25 (run)	27 (run)	38 (run)				**46**
14c																					

***Partial, ½-mile segments habitat typed in 2006–2009 and 2011−2014 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	Pool 2014	Riffle 2011	Riffle 2012	Riffle 2013	Riffle 2014	Run/ Step Run 2011	Run/ Step Run 2012	Run/ Step Run 2013	Run/ Step Run 2014
1 (1)	55	60	70	60 Site Δ	35	30	25	25	25	35	**40**	**40**
4 (3a)	40	40	50	45	25	25	35	30	30	50	**30**	**30**
10 (7)	50	50	40	50 Site Δ	25	NA	25	30	35	35	**35**	**30**
12 (8)	30	55	65 Site Δ	65	35	35	15	30	35	50	**35**	**35**
13a (9)	60	40	50	60 Site Δ	35	35	15	18	35	40	**55**	**60**
16 (12a)	63	58	65	Dry	NA	45	45	Dry	NA	40	**75**	**Dry**
19 (13)	60	60	30	NA	15	25	40	35	40	30	**45**	**30**
21 (14b)	60	-	-	65 Site Δ	40	-	-	20	45	-	**-**	**35**

Table 15e. POOL ESCAPE COVER Index (Habitat Typing Method*) in SOQUEL CREEK by REACH Since 2000, 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	Pool 2014
1	0.091	0.103	0.107		0.147	0.134	0.116		0.099		**0.108**
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		**0.092**
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	**0.069**
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	**Dry**
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				**0.045**
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 2011−2014 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	Pool Escape Cover 2014
1 (1)	0.101	0.132	0.104	0.117 Site Δ	0.178	**0.140** Site Δ
4 (3)	0.102	0.067	0.085	0.191	0.086	**0.094**
10 (7)		0.124	0.254	0.096 Site Δ	0.152	**0.097** Site Δ
12 (8)			0.092	0.231 (Wood cluster)	0.059 Site Δ	**0.089** (more wood)
13a (9a)			0.101	0.164 (Wood cluster)	0.127 Site Δ	**0.111**
16 (12a)			0.079	0.064 Site Δ	0.093 Site Δ	**Dry**
19 (13)	0.041	0.080	0.131	0.060	0.143	**0.146**
21 (14b)	0.029	0.017	0.021	–	–	**0.048** Site Δ

Table 15g. Habitat Change in SOQUEL CREEK WATERSHED Reaches (2011 to 2014, 2012-2014 or 2013-2014) or Replicated Sites (2013 to 2014).

Reach Comparison or Site Only	Baseflow	Pool Depth	Fine Sediment	Embeddedness	Pool Escape Cover	Overall Habitat Change
Reach 1	**–**	**–**	**Similar**	**Similar**	**+**	**–**
Site 4 (Reach 3a)	**–**	**–**	**+ (run)**	**Similar**	**+**	**–**
Reach 7	**–**	**–**	**+ (pool)**	**Similar**	**+**	**–**
Site 12 (Reach 8)	**–**	**–**	**– (pool) + (run)**	**– (riffle)**	**+**	**–**
Reach 9a	**–**	**–**	**Similar**	**–**	**–**	**–**
Reach 12a	**Dry**					**–**
Site 19 (Reach 13)	**–**	**–**	**– (pool)**	**+ (run)**	**Similar**	**–**
Reach 14b	**–**	**–**	**+ (pool)**	**–**	**–**	**–**

R-4. Habitat Change in Aptos Creek

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 than later in the dry season. Based on hydrographs from stream gages in other watersheds (**Figures 36-41**), it is likely that the Aptos watershed also had similarly low baseflow in 2014 compared to 2011−2013, and considerably below the median streamflow statistic in spring and summer. There was undoubtedly less food and slower growth rate in all reaches in 2014 compared to the previous 3 years. Measured streamflow in fall in lower Aptos Creek confirmed lower baseflow in 2014 than 2012 or 2013 (dry years) and much lower than in 2011 (**Table 5b**). However fall baseflow in 2014 was not substantially less than in 2013, as was observed in San Lorenzo and Soquel watersheds.

Habitat quality was reduced at both the lower Aptos Site 3 above Valencia Creek confluence and in the upper Aptos Reach 3 (with Site 4) in Nisene Marks due to reduced baseflow and pool depth in both and reduced escape cover in Reach 3 (**Tables 16a-c**). Substrate conditions regarding percent fines and embeddedness were similar to previous measured conditions. Habitat conditions at both Valencia Creek sites had declined drastically since 2010, with no pool habitat left at Site 2 and much reduced pool depth at Site 3 (**Table 16b**). The escape cover index of habitat remaining at Site 2 was much less than pool habitat in 2010. Pool escape cover at Site 3 was greatly reduced in 2014 due to the loss of instream wood. The percent of YOY reaching soon-to-smolt-size, as an indicator of YOY growth rate, showed much higher percent and YOY growth rate in the wet 2011 with higher baseflow and food supply compared to 2013 and 2014 (**Tables 19a-b**). The 2013 to 2014 comparison indicated slower YOY growth rate at the lower Site 3 but similar growth rate at Site 4, with much lower YOY density at Site 3 and slightly lower YOY density at Site 4 in 2014 (**Table 32**).

Table 16a. AVERAGE POOL HABITAT CONDITIONS FROM HABITAT TYPING IN REACHES of APTOS, VALENCIA, CORRALITOS, SHINGLE MILL and BROWNS Creeks in 2009; 2011-2014.

Reach #/ Sampling Site #	Mean Depth/ Maximum Depth					Escape Cover*					Embeddedness					Percent Fines				
	2009	2011	2012	2013	2014	2009	2011	2012	2013	2014	2009	2011	2012	2013	2014	2009	2011	2012	2013	**2014**
Aptos #2/#3- in County Park	1.0/ 2.1		1.1/ 2.2	1.0/ 1.8		0.155		0.105	0.141		48		55	52		53		59	59	
Aptos #3/#4- Above Steel Bridge Xing (Nis. Marks)	1.2/ 2.3	1.2/ 2.3			1.0/ 1.7	0.127	0.107			0.091	56	54			59	57	66			**60**
Valencia #2/#2- Below Valencia Road Xing	0.6/ 1.2					0.143					51					79				
Valencia #3/#3- Above Valencia Road Xing	0.8/ 1.5					0.217					53					76				
Corralitos #1/#1- Below Dam	1.5/ 2.2			1.1/ 1.9		0.133			0.080		49			43		54			43	
Corralitos #3/#3- Above Colinas Drive	1.2/ 2.0	1.3/ 2.0	1.1/ 2.0		1.0/ 2.0	0.121	0.175	0.161		0.172	52	50	63		52	53	32	42		44
Corralitos #5-6/#8- Below Eureka Gulch	1.1/ 1.9	1.2/ 2.0	1.0/ 1.8			0.093	0.052	0.072			58	58	58			56	29	29		
Corralitos #7/#9- Above Eureka Gulch	1.0/ 1.5	1.0/ 1.5	0.9/ 1.35		0.7/ 1.2	0.125	0.119	0.146		0.093	45	54	63		63	41	20	28		**12**
Shingle Mill #1/#1- Below 2nd Road Xing																				
Shingle Mill #3/#3- Above 3rd Road Xing	0.9/ 1.5					0.264					59					45				
Browns Valley #1/#2- Below Dam	1.2/ 1.9			1.35/ 2.0		0.185			0.208		57			56		38			29	
Browns Valley #2/#2- Above Dam	1.0/ 1.6			1.3/ 1.9		0.198			0.250		54			38		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	Avg Mean/ Maximum Pool Depth- 2014	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	Pool Escape Cover Index- 2014
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)	0.8/ 1.55	0.164	0.183	0.055	0.080 (Site Δ)	0.179 (Site Δ)	**0.186**
Aptos #3/#4- Above Steel Bridge Xing (Nisene Marks)			1.35/ 3.25	1.1/ 2.05	0.85/ 2.4	0.85/ 1.45 (Site Δ)			0.156	0.177	0.170	**0.064** (Site Δ)
Valencia #2/#2- Below Valencia Road Xing	0.6/ 1.5	0.45/ 1.05	–	–	–	No pool habitat	0.138	0.156	–	–	–	**0.015 mostly run**
Valencia #3/#3- Above Valencia Road Xing	1.0/ 1.8	0.9/ 1.45	–	–	–	0.35/ 0.8	0.200	0.250	–	–	–	**0.049 less wood**
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)	0.9/ 1.65	0.106	0.087	0.120	0.156	0.083	**0.111**
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	0.85/ 2.1 (Site Δ)	0.186	0.173	0.231	0.121 (Site Δ)	0.128	**0.206** (Site Δ)
Corralitos #5-6/#8- Below Eureka Gulch	1.35/ 1.95	0.55/ 0.9	1.0/ 1.85	0.7/ 1.05	0.45/ 0.95	0.5/ 0.9	0.120	0.048	0.033	0.061	0.053	**0.067**
Corralitos #7/#9- Above Eureka Gulch			1.0/ 1.8	1.0/ 1.6	0.9/ 1.3	0.6/ 1.3 (Site Δ)			0.112	0.148	0.133	**0.092** (Site Δ)
Shingle Mill #1/#1- Below 2nd Road Xing		0.9/ 1.3	0.9/ 1.4	0.8/ 1.3	0.8/ 1.2	0.8/ 1.2		0.296	0.310	0.357	0.397	**0.220**

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	0.9/ 1.4	0.151	0.139	0.173	0.145	0.168	**0.233**
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)	1.35/ 2.05	0.160	0.125	0.187	0.201	0.283 (Site Δ)	**0.219**
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)	0.9/ 1.9	0.130	0.243	0.203	0.272	0.210 (Site Δ)	**0.213**

* 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 (2011 or 2013 to 2014) AND CORRALITOS WATERSHED Reaches (2012 or 2013 to 2014) and Replicated Sites in Both Watersheds (2013 to 2014).

Reach Comparison or (Site Only Comparison)	Baseflow	Pool Depth	Fine Sediment	Embeddedness	Pool Escape Cover	Overall Habitat Change
(Aptos Site 3)	−	−	Similar	Similar	Similar	−
Aptos 4	−	−	Similar	Similar	−	−
(Corralitos Site 1)	−	Similar	−	Similar	+	−
Corralitos 3	−	Similar	Similar	− (riffle and run)	+	−
(Corralitos Site 8)	−	Similar	+	+	+	−
Corralitos 7	−	−	Similar	−	−	−
(Shingle Mill Site 1)	−	Similar	Similar	+	−	−
(Shingle Mill Site 3) above fault line	−	−	+	+	+	−
(Browns Site 1)	−	−	Similar	+	−	− (spring/early summer flow)
(Browns Site 2)	−	+	Similar	Similar	Similar	− (spring/early summer flow)

R-5. Habitat Change in Corralitos, Shingle Mill and Browns Valley Creeks, 2013 to 2014

Refer to **Appendix A** for maps of reach locations. Summary tables of habitat change for all reaches are provided in **Tables 16c and 42**. Weighing the relative importance of streamflow with other habitat parameters is not clear cut, especially when exact streamflow measurements are limited. Segments in both reaches in Browns Creek and Reach 1 in Corralitos Creek of the 8 reaches were habitat typed in 2013 to compare habitat quality to replicated sites in 2014. Segments in Reaches 3 and 7 were habitat typed in 2014 to compare to reach conditions in 2012. Habitat conditions in Reach 5/6 of Corralitos and the 2 reaches in Shingle Mill were compared at replicated sites. Most juvenile steelhead growth occurs in the spring-early summer when baseflow is higher and most important. Based on hydrographs at the Freedom gage on Corralitos Creek (**Figures 43a−b and 44**), the Corralitos watershed also had lower baseflow in spring and earlier summer in 2014 compared to 2012 and 2013, and considerably below the median streamflow statistic in spring and summer. Corralitos Creek went dry at Freedom. CA in mid-April 2014 but flow continued until mid-May in 2013 (**Figure 42c**). There was undoubtedly less food and slower growth rate in all reaches in 2014 in spring-early summer compared to the previous 3 years. Measured streamflow in fall in Corralitos Creek confirmed lower baseflow in 2014 than 2012 or 2013 (dry years) and much lower than in 2011 (**Table 5b**). However fall baseflow in 2014 was not substantially less than in 2013, unlike the annual flow reductions observed in the San Lorenzo and Soquel watersheds. And fall baseflow measured in Browns Creek above the diversion dam was slightly higher in 2014 than 2013.

Overall habitat quality declined in all reaches of the Corralitos-Browns-Shingle Mill sub-watershed in 2014, primarily due to lower baseflow in spring and early summer (**Table 16a-c**). Non-flow aspects of habitat improved in the lower 3 Corralitos sites/reaches in that escape cover increased and pool depth remained similar to 2013 despite reduced baseflow. However, Corralitos Reach 7 above Eureka Gulch experienced negative change in pool depth, embeddedness and escape cover in 2014, with very low baseflow (**Table 5b**). Lower Browns 1 had shallower pool depth and less escape cover. Most non-flow aspects of habitat were similar at upper Browns 2 in 2014 to 2013 except for increased pool depth in 2014. And October baseflow was slightly higher than in 2013 (**Table 5b**).

Despite some reaches/sites having similar or improved conditions in 2014, the Corralitos sub-watershed had much reduced YOY densities at all 8 sites and much below the average YOY density (**Table 32; Figure 14**). Poor adult access to Browns and Corralitos creeks led to low YOY densities in 2014, with limited migratory opportunities during probably only 1 stormflow event at the end of February when the sandbar was open. Then, of the eggs that were laid, mortality may have been high with low winter and spring flows. Shallow conditions in spawning glides likely forced adults to spawn further upstream into sandy pools to further limit water percolation through the redds of eggs.
2014 yearling densities were closer to 2013 densities and the long term average than YOY densities because of the higher yearling survival over the mild winter and likely insufficient growth in spring to leave early (**Table 33; Figure 15**).

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 2014, 30 of 39 sites were rated "below average" (14), "poor" (10) and "very poor" (6), based on densities of Size Class II and III juveniles and their average sizes (**Tables 40 and 41**) and two sites were dry . The remainder of sites were rated "fair" (7) and "good" (2). These were the lowest ratings since the dry years of 2007 and 2008. 21 of the 39 sampled sites with surface water declined in ratings since 2013. Ratings were much better in 2012 when most sites (20 of 38) were rated "good" and "very good."

R-6. 2014 Juvenile Steelhead Densities in the San Lorenzo Drainage Compared to 2013 and Averages Since 1997

In 2014, all but 2 of 23 sites repeated from 2013 and having streamflow had below average total densities, with 2 sites likely having resident rainbow trout (**Figure 1**). Sites SLR 12b and Branciforte 21c likely had resident rainbow trout and not steelhead. The lowest total densities recorded since 1997 occurred at Sites 2, 6, 9, 10, Newell 16, Boulder 17a, Boulder 17b and Bear 18a (8 of 22 sites; 36%) (**Tables 17 and 22**). Zayante 13d and Branciforte 21a-2 had above average total densities. Looking at the trend in total densities, 2014 had the lowest 5-mainstem site average (6.1 juveniles/ 100 ft) since 1997 (**Figure 21**). 2014 also had the lowest 4 to 7-tributary site average (30.4 juveniles/ 100 ft) since 1997 (**Figure 23**).

The lowest YOY densities recorded since 1997 occurred at Sites 2, 8, 9, 10, Newell 16, Boulder 17a, Boulder 17b and Bear 18a (8 of 22 steelhead sites; 36%) (**Tables 18 and 23**). Nineteen of 22 steelhead sites had below average YOY densities, with only 2 sites having above average YOY densities; Zayante 13d and Fall 15b (**Figure 2**). Nineteen of 22 steelhead sites had below average densities of yearlings (**Figure 3**) and 20 of 22 steelhead sites had below average densities of Size Class II and III steelhead (**Figure 4**). The lowest soon-to-smolt (=> 75 mm SL) densities recorded since 1997 occurred at Sites 2, 9, 10, Zayante 13c, Bean 14b, Fall 15b, Newell 16, Bear 18a and Branciforte 21b (since 1998) (9 of 22 sites; 41%) (**Tables 21 and 25**). Regarding the trend in soon-to-smolt-densities, 2014 was the third year of decline, with the second lowest 5-mainstem site average (2.1 fish/ 100 ft) since 1997 (**Figure 22**). 2014 also had the lowest 4 to 7-tributary site average (6.1 fish/ 100 ft) since 1997 (**Figure 24**). A relatively smaller percentage of the much reduced YOY population reached soon-to-smolt size in 2014 with such small baseflows, a shortage of insect drift and slow growth rate (**Figures 17a and 17b**).

Many yearlings likely smolted early in the spring with good feeding visibility instead of holding over the summer or did not survive the winter, despite mild stormflows (**Figure 37a**). The sites having above average yearlings or older juvenile densities were headwater mainstem or upper tributary sites (SLR 12b (resident), Zayante 13d, Lompico 13e, Boulder 17b and Branciforte 21c (resident)). This was because most yearlings were gone from other sites, and few YOY grew into the larger size class with the low habitat quality attributed to much reduced baseflow, shallower conditions and reduced food in 2014. Decreased total, YOY and Size Class II/III juvenile densities from 2013 to 2014 were statistically significant (**Tables 44 and 45**). The Waterman Gap Site 12b and Branciforte Site 21c were likely resident rainbow trout sites and 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 8 of 10 mainstem sites up to Waterman Gap in 2014 compared to 2013 (compared to 2005 at Site 10) and were below average at all mainstem sites (**Figure 2**). The low YOY densities resulted in decreased total juvenile densities at 8 of 10 mainstem sites in 2014(**Table 17**) and below average densities at all mainstem 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 and 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 mainstem 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 soon-to-smolt-sized juveniles. Yearling densities at mainstem sites continued to be similarly low in 2014 as in past years except at Waterman Gap 12b, which likely had included older residents (**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 II and III juveniles were lower in 2014 than 2013 at 8 of 10 mainstem sites except 0a and 12b (**Table 21**) and below average at all but Site 12b (**Figure 4**). Relatively low densities of these important soon-to-smolt fish in these high growth potential reaches (1−9) was due to low densities of YOY and the reduced percent that grew into Size Class II at Sites 4 and 6 in a low baseflow year with less drifting food compared to 2012 and 2011 (**Figures 17a−b**). The trend in the mainstem 5-site average of these larger juveniles has declined steadily since 2010 to the second lowest value since 1997 (2.1 fish/ 100 ft), the lowest occurring in 2007 (**Figure 22**). Spring and early summer baseflows in 2014 were substantially below the median statistic (**Figure 38**), as they had been in 2013 (**Figure 36b**), and the 5-month mean monthly streamflow (May−September) was the lowest in the last 18 years (**Figure 45**). Reduced streamflow with associated reduced food supply hindered YOY from growing into the soon-to-smolt Size Class II).

Table 17. Density of Juvenile Steelhead for ALL SIZES at MAINSTEM SAN LORENZO RIVER Monitoring Sites (Excluding Lagoon) in 1997-2001 and 2003-2014. (Resident rainbow trout likely present at Site 12b).

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-M/D	2013 E-D	2014 E-D	Avg.
0a				5.4								2.4	20.4	2.1	26.9	4.6	6.2	9.7
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	1.8	7.8
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	2.9	16.9
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	12.0	30.4
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	4.6	16.0
7	149.3	21.7	11.8	7.6	15.5	29.4	38.9	11.0										35.7
8	158.6	140.1	48.2	11.2	21.4	32.3	21.6	20.3	13.7	5.5	33.0	18.0	36.7	9.2	14.2	30.7	5.7	36.5
9	126.8	77.3	27.6	12.0	29.6	17.4	10.9	17.1								20.9	2.1	34.2
10	69.1	17.9	10.9	18.4	19.7	51.9	44.6	21.9									0.7	28.3
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	6.5	24.7
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	35.7	42.6

*** 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 2003-2014. (Resident rainbow trout likely present at Site 12b).

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-M/D	2013 E-D	2014 E-D	Avg.
0a				2.2								1.2	19.0	2.1	23.4	4.6	5.1	8.2
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	1.4	6.9
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	2.7	15.1
2b				21.2	12.1													16.7
3	84.3	68.2	24.7	29.4	29.6													
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	11.4	47.2
5		132.4	38.5	3.5	22.8													
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	4.5	15.1
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	4.9	34.6
9	119.9	69.7	23.4	11.0	28.9	17.6	10.0	15.4								20.8	1.9	31.9
10	65.8	11.7	6.5	13.4	5.9	45.1	40.5	18.4									0.7	23.1
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	4.9	21.8
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	14.4	31.8

***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 2003-2014.
(Resident rainbow trout likely present at Site 12b).

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-M/D	2013 E-D	2014 E-D	Avg.
0a				2.2								1.2	1.7	0	3.9	0	1.1	1.4
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	0.4	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	0.2	1.4
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	0.7	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	0.8
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	0.6	1.7
9	4.3	8.1	2.5	1.0	0.6	0.8	1.9	2.5								0.2	0.2	2.2
10	3.3	6.4	4.6	5.5	4.1	6.8	2.7	4.7									0	4.2
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	1.6	3.9
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	21.3	10.7

***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 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 2003-2014.
(Resident rainbow trout likely present at Site 12b).

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-M/D	2013 E-D	2014 E-D	Avg.
0a				0								0	0.6	0	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	0.6
2a	7.9	1.3	0.4	0.2	2.5					3.7	8.4	1.2	6.0	0	0.1	1.9	0.5	2.6
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	4.4	16.2
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	3.2	11.7
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	4.3	30.6
9	102.2	57.5	18.5	6.2	28.4	15.4	9.6	12.2								18.6	1.5	27.0
10	65.8	9.6	4.4	10.1	12.2	45.1	39.8	17.6									0.7	22.8
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	4.9	19.9
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	14.4	30.2

*** 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 2003-2014. (Resident rainbow trout likely present at Site 12b).

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-M/D	2013 E-D	2014 E-D	Avg.
0a				5.4								2.4	19.8	2.1	26.9	4.1	6.2	9.6
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	1.8	7.2
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	2.4	14.3
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	4.4	14.0
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	1.4	4.2
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	1.4	5.9
9	24.6	19.8	9.1	5.8	1.2	2.0	1.3	4.9								2.3	0.6	7.2
10	3.3	8.3	6.5	8.3	7.5	6.8	4.8	4.3									0	5.5
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	1.6	6.0
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	21.3	12.4

*** 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, 2014 soon-to-smolt ratings were the same as in 2013 at 2 of 9 sites (**Table 40**). Site 1 in Paradise Park was rated “poor” in both years, and Site 12b in Waterman Gap was rated “good” both years. However, as stated earlier, Site 12b may not have been accessible to steelhead. Other mainstem sites downstream of Zayante Creek (Sites 0a, 2 and 4) had improved 2014 ratings because YOY densities were so low that more of the few that were there grew to soon-to-smolt size greater than 102 mm SL, which increased ratings. Still, 7 of 10 mainstem sites were rated “poor” or “very poor.” Site 0a between the levees had the highest rating at “fair,” and none of the fish had PIT tags from the lagoon/estuary.

In tributaries of the San Lorenzo River, after increases in total and YOY juvenile steelhead densities at Zayante, Bean, lower Boulder and upper Branciforte sites in 2013, densities then decreased in 2014 at all tributary sites except for Branciforte 21a-2 (**Tables 22 and 23**). There has been a downward trend in total juvenile densities in tributaries since 2003, overall, as indicated by the 7-site average values that began in 1999 (**Figure 23**). Bean 14c going dry and Bear 18a becoming inaccessible to adult spawners has brought the average down in the last 3 years. Densities for YOY and all juveniles combined were below average at 11 of 13 sites (**Figures 1 and 2**). Zayante 13d had above average YOY and total densities. Fall 15 b had above average YOY density. Branciforte 21a-2 had above average total density. The lowest YOY densities in 2014 were in Newell and Bear creeks. Newell Creek streamflow was less than 0.1 cfs in the fall and intermittent in places during fish sampling instead of the typical near 1 cfs that was maintained in previous years. Spawning success must have been very low in Newell Creek the previous winter/spring. Adult steelhead access to Bear 18a was apparently unsuccessful due to a log jam that developed at a dam remnant below the Lanktree Road Bridge in December 2012 and which had been partially removed in summer 2014. Bean 14c went dry before fall sampling, as it had in 2013 and after sampling in 2012, to eliminate typically high densities of steelhead inhabiting the area. No YOY were detected at the Branciforte 21c site, presumably upstream of anadromy.

All tributary sites were dominated by very small YOY in 2014 except Newell 16 and Bear 18a, where YOY were nearly absent (size histograms in **Appendix C**). Very few YOY reached soon-to-smolt-size in 2014 in tributaries due to low baseflow and very limited insect drift (**Figure 17a**). At tributary sites in 2014, yearling densities were relatively low, similar to those in 2013 and below average at 10 of 12 sites, except at Zayante 13d and Boulder 17b (**Table 24; Figure 3**).

In tributaries, Size Class II and III densities (soon-to-smolt sized fish) were less than in 2013 at 8 of 12 tributary sites and below average at 10 of 12 sites (**Table 25; Figures 4 and 24**). The poor showing in smolt densities in tributaries occurred because the juvenile steelhead population in 2014 was dominated by small YOY at mostly below average densities and yearlings at mostly below average densities. This was the same pattern that was observed in 2013, only worsened. The overall trend in average Size Class II and III densities has declined in tributaries since 1999, as indicated by the site average values graphed since 1997 (**Figure 24**). Bean 14c going dry and Bear 18a becoming inaccessible to adult spawners has brought the average down in the last 3 years. With its relatively high survival of yearlings at Zayante Site 13d, Size Class II densities were high, though they were way down at Zayante Site 13c with slow YOY growth and very low at Zayante 13a with the removal of wood at the formerly large wood cluster and slow YOY growth rate. Soon-to-smolt ratings declined at 9 of 12 tributary sites in 2014 (as they had done from 2012 to 2013), with no improvements (**Table 42**). Ratings ranged from "very poor" (Zayante 13c, which has very high ratings in wetter years) to "poor" (Zayante 13a, Bean 14b, Boulder 17a and Bear 18a) to "below average" (Lompico 13e, Fall 15a, Newell 16, Branciforte 21a-2 and Branciforte 21b) to "fair" (Fall 15b and Boulder 17b) to "good" (Zayante 13d). Average size of juveniles in the larger size class was less in 2014 than 2013 in Zayante, Lompico, Boulder and Branciforte creeks, indicating reduced yearling growth rate in 2014.

Table 22. TOTAL DENSITY of Juvenile Steelhead at SAN LORENZO TRIBUTARY Monitoring Sites in 1997-2001 and 2003-2014.

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-M/D	2013 E-D	2014 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	22.8	55.4
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	40.1	73.3
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	116.0	105.2
Lomp 13e									26.2	108.3	27.8	123.3	23.1	16.6	54.8	56.3	44.2	53.4
Bean 14a		44.2	45.9	17.0	38.0	50.9	31.9	54.0										40.3
Bean 14b	73.0	115.6	92.1	48.3	65.5	146.4	78.5	103.5	13.1	8.9	67.6	11.2	32.8	18.2	10.5	27.7	20.4	54.9
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 dry	0 dry	0 dry	39.1
Fall 15a																	32.9	32.9
Fall 15b	84.5	82.7	85.0	55.0	59.8						84.0	48.7	46.1	78.5	101.5	92.6	50.4	72.4
New 16	94.9	76.3	40.5	28.8	40.3				26.0			18.6	32.5	13.4	37.7	36.8	3.8	37.5
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	8.1	52.9
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	26.8	65.0
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	1.6	54.5
Bear 18b		69.5	116.1	67.6	63.5													79.2
King 19a		10.8	0.5	8.4	7.6													6.8
King 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
Bran21a-1										6.6	3.3							5.0
Bran21a-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	44.6	39.1
Bran 21b		67.8	57.6	59.6	57.5			20.4							50.7	69.9	22.6	50.8
Bran 21c																15.7	13.3	14.5

*** 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 2003-2014.

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-M/D	2013 E-D	2014 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	20.4	44.3
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	38.9	66.4
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	92.4	90.3
Lomp 13e									24.2	96.9	21.4	118.4	14.4	14.2	52.5	47.7	39.5	47.7
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	17.6	46.8
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 dry	0 dry	0 dry	32.2
Fall 15a																	28.5	28.5
Fall 15b	79.6	74.8	68.1	45.1	45.4						68.2	30.6	33.5	71.7	86.2	84.3	42.2	34.3
Newell 16	77.1	67.6	17.7	19.9	35.6				20.1			15.0	31.2	13.1	37.1	33.7	2.3	28.5
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	4.3	60.8
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	13.9	30.9
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	1.0	45.9
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
Bran 21a-1										2.8	2.7							2.8
Bran 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	40.0	56.4
Bran 21b		60.1	44.2	45.8	49.4			9.1							23.4	56.7	15.3	43.7
Bran 21c																5.7	0	45.4

*** 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 24. Density of Juvenile Steelhead for YEARLING and OLDER Fish at SAN LORENZO TRIBUTARY Monitoring Sites in 1997-2001 and 2003-2014.

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-M/D	2013 E-D	2014 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	2.1	3.9
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	1.0	6.9
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	23.5	14.7
Lomp 13e									1.9	11.3	6.4	4.9	8.7	3.3	2.3	8.7	9.5	6.3
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	2.8	8.0
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 dry	0 dry	0 dry	6.4
Fall 15a																	2.9	2.9
Fall 15b	4.9	7.9	16.9	9.9	14.4						15.8	18.0	12.3	6.5	14.5	8.3	7.7	11.4
Newell 16	17.8	8.7	22.8	8.9	4.7				5.4			3.9	1.5	0.6	1.2	2.8	1.5	6.7
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	3.8	7.2
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	13.0	8.5
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	0.7	7.8
Bear 18b		2.9	26.9	9.3	15.4													13.6
Kings 19a		1.0	0.5	1.8	1.6													1.2
Kings 19b	4.5	2.1	12.8	6.0	13.1													7.7
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
Bran21a-1										3.9	0.5							2.2
Bran 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	4.6	6.4
Bran 21b		7.6	13.4	11.1	8.1			11.3							27.3	13.3	7.3	12.4
Bran 21c																10.0	13.3	11.7

*** 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 25. Density of Juvenile Steelhead for SIZE CLASS II/III (=>75 mm SL) Fish at SAN LORENZO TRIBUTARY Monitoring Sites in 1998-2001 and 2003-2014.

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-M/D	2013 E-D	2014 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	2.4	9.7
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	3.7	13.5
Zay 13d		10.7	27.3	15.6	17.1	23.2	5.3	15.7	17.3	17.4	22.5	16.9	9.1	11.7	8.6	18.5	22.1	16.2
Lomp 13e									5.7	11.3	6.4	4.9	8.7	7.8	2.3	8.7	6.7	6.9
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	2.8	12.0
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 dry	0 dry	0 dry	8.3
Fall 15a																	2.7	2.7
Fall 15b	8.2	13.3	16.9	9.9	13.0						15.8	18.7	14.3	14.7	13.0	12.1	7.3	13.1
New 16	23.6	14.9	22.8	8.9	4.7				16.2			4.4	24.7	13.1	7.3	23.7	3.1	14.0
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	3.8	10.8
Boul 17b	9.7	11.5	13.3	9.1	12.9	14.5	6.2	8.2	13.7	9.8	3.8	10.7	12.7	13.6	10.6	10.7	13.0	10.8
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	0.7	9.9
Bear 18b		6.2	26.9	9.3	13.2													13.9
King 19a		6.2	0.5	1.8	1.6													2.5
King 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
Bran21a-1										3.9	0.5							2.2
Bran21a-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	4.6	9.1
Bran 21b		14.8	13.4	11.1	8.1			16.0							27.3	13.3	7.3	13.9
Bran 21c																10.0	13.3	11.7

*** 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

R-7. 2014 Juvenile Steelhead Densities in Soquel Creek Compared to 2013 and Averages Since 1997

2014 total juvenile steelhead densities decreased from 2013 at 6 sampling sites and increased at Site 21b since 2012 (**Table 26**). Site 16 (Reach 12a) in the SDSF went dry by July. 2014 total site densities were below average at 5 of 7 sampled sites (**Figure 5**). The trend in total densities (consisting of mostly YOY) for the watershed showed a decrease in 2014, with the second lowest 6-site average since 1997 (19.8 fish/ 100 ft) (**Figure 25**). Total densities have steadily declined through the years at the SDSF Site 16 to zero in 2014, when the reach went dry. The 2014 average was less than half the 2013 average (54.9 fish/ 100 ft) and similar to densities occurring in the wet year of 2011, the difference being that in wet years a high proportion of the juveniles are fast growing YOY in the soon-to-smolt size class. In 2014, the juvenile steelhead population in Soquel Creek consisted primarily of little Size Class 1 steelhead, whose densities were below average except at Sites 10 and 12 in the mainstem (**Table 29**).

2014 YOY densities decreased at 6 sampling sites compared to 2013 and was the same density at Site 21b as in 2012 (**Table 27**). However, the decrease was not statistically significant (**Table 44**).YOY densities were below average at 5 of 7 sites, plus Site 16 in the SDSF was dry (**Figure 6**). Lower Reach 12a in the SDSF had surface flow in July and good densities of YOY (134 YOY/ 100 ft on 17 July), indicating that adult steelhead reached the SDSF despite limited winter stormflow. However, the segment typically sampled in Reach 12a was dry by this time, as was the reach. Three-quarters of lower East Branch Reach 9a was also dry.

2014 yearling densities increased slightly at 6 of 7 wetted sites from 2013 and were above average at 5 of 7 sampled sites (**Table 28; Figure 7**). However, the increase was not statistically significant (**Table 44**). Overwinter retention/survival of yearlings may have been improved in 2014 after a very mild winter, though yearling density was very low at all sites (maximum of 4.7 yearlings/ 100 ft at Site 21b).

Densities of Size Class II and III juveniles decreased at 6 of 7 sites in 2014 and were below average at 7 of 7 sites (**Table 30; Figure 8**). However, the decrease was not statistically significant (**Table 44**). This was partly because few YOY were present (**Figure 6**) to grow into the soon-to-smolt size class in the lower mainstem compared to past years and few yearlings (**Figure 7**) remained in the watershed despite only mild winter stormflows (**Figures 40a−b**). Also, spring and early summer baseflows were substantially below the median statistic (less food) (**Figure 41**) to hinder YOY from growing into the soon-to-smolt size class in the upper mainstem and lower branch sites compared to wetter years (**Figures 18a and 18b**). The trend in Size Class II and III (soon-to-smolt) densities has fluctuated through the years, mostly depending on the percent of YOY reaching soon-to-smolt size, which is positively related to streamflow. The trend continued to decline since 2012 to the lowest 6-site average (2.5 fish/ 100 ft) since 1997 (**Figure 26**). Based on soon-to-smolt size densities, 3 of 6 sampled sites decreased in ratings compared to 2013, and Site 16 was dry (**Table 42**). The 7 sampled sites ranged in ratings from “very poor” to “below average.”

Table 26. TOTAL Juvenile Steelhead SITE DENSITIES (fish/ 100 ft) at Monitoring Sites in SOQUEL CREEK in 1997–2014.
(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-M/D	2013 E-D	2014 E-D	Avg
1- Near Grange	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	2.4	5.9
2- Adj. USGS Gage	4.5	9.4	1.2	5.9	7.7	-	4.1	3.5	4.2										5.1
3- Above Bates Ck	13.2	50.6	7.6	2.2	8.4	14.8			7.9										15.0
4- Adj. Flower Fld	49.6	20.7	6.8	5.5	23.0	33.3	7.7	20.1	9.2	3.2	23.5	63.0	18.6	5.3	5.3	13.5	20.4	12.1	18.9
5-Adj. Beach Shk	50.3	20.6	8.1	9.2	28.0														23.2
6- End of Cherryvale	24.7	9.4	2.6	5.3	5.7	47.6	15.9	13.1	16.1										15.6
7- Adj. Orchard	96.6	14.0	5.6	2.0	27.5														29.1
8- Below Rivervale	21.0	10.7	4.1	4.9	12.4	59.2													18.7
9- Adj. Mt. School	61.6	18.4	5.1	7.9	20.7	94.8	26.2	45.8	26.8										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	38.0	33.1
11- Below Purling Br	81.9	13.1	10.5	13.1	31.6														30.0
12- Near SoqCk Br	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	134	44.3	41.3
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	22.8	46.3
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	71.4	37.8	43.0	42.2	0	100.6
17- Above Fern Glch*	138.3	104.2	170.9	93.8	96.3	129.5	102.4	117.2	157.3										123
18- Above Ashbury G*	44.1	24.5	53.0																40.5
19- Below Hester Ck	62.3	21.7	32.1	27.6	37.8					8.3	26.5	70.7	43.1	13.0	24.3	48.7	58.2	25.1	35.6
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			16.6	65.2
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 1997–2014.
(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-M/D	2013 E-D	2014 E-D	Avg
1- Near Grange	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	1.7	5.1
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 Fd	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	8.5	17.0
5-Adj. Shack	54.0	19.2	5.8	7.6	27.2														22.8
6- End of Cherryval	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. Schl	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	35.2	31.3
11- Below Purlin Br	78.3	12.4	9.5	10.2	31.7														28.4
12- Near SoqCkRd B	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	41.6	39.2
13a- Belo 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	18.5	40.4
13b- Belo 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	0 dry	93.5
17- Above Fern Gch*	131.9	101.3	159.4	84.7	8.1	112.4	4.4	10.1	147.9										113.4
18- Above Ashbry 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	22.7	33.2
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			11.9	59.9
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 1997–2014.
(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-M/D	2013 E-D	2014 E-D	Avg.
1- Near Grange	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	0.7	1.0
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	3.5	1.4
5-Adj. Beach Shck	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	2.8	1.5
11- Below Purling Br	2.7	0.6	2.2	4.1	0.3														2.0
12- Near SoqCkRd B	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	2.8	1.4
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	4.3	2.5
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	0 dry	7.2
17- Above Fern Gch*	5.7	3.1	11.5	6.9	18.2	17.0	7.8	7.1	9.6										9.7
18- Above Ashbury G*	13.8	9.6	19.8																14.4
19- Below Hester Ck	1.2	0.4	1.6	1.2	1.2					0.3	1.6	0.4	4.6	0.4	2.4	1.0	2.7	2.4	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			4.7	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 1997–2014.
(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-M/D	2013 E-D	2014 E-D	Avg.
1- Near Grange	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	1.7	2.1
2- Adj. USGS Gge	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 F	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	7.8	10.2
5-Adj Bech Shk	38.2	0	0.3	1.1	21.6														12.2
6-End of Cherryval	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.Schl	36.7	1.1	0.4	0.5	6.6	79.7	12.7	27.1	2.1										18.5
10- Abov 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	35.2	24.4
11- Belo Purlin Br	60.5	0.9	4.1	2.8	29.1														19.5
12- Near SoqCkRdBr	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	131	41.6	33.6
13a-Belo Mill Pd	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	18.5	35.5
13b-Belo 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	165	267.8	114.7	77.6	113.9	131	96.4	118.2	60.3	37.1	66.0	94.1	63.4	22.5	29.2	36.0	0 dry	90.0
17-Abov Fern Gh*	130.3	90.1	151.7	82.4	78.1	112.4	94.4	110.1	130.9										109
18-Above Ashbry G*	29.2	20.6	33.2																27.7
19-Belo Hester C	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	22.7	29.6
20- Abov Hester C		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	91.8	90.0	30.1 **	61.3 **		43.1	8.7	1.2			11.9	39.6
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 1997–2014.
(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-M/D	2013 E-D	2014 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	0.7	3.8
2-Adj. USGS G	3.6	9.4	0.8	5.9	5.5		2.4	1.6	4.2										4.1
3-Above Bates C	11.4	50.6	7.6	1.3	4.4	4.4			7.9										12.5
4-Adj. FlowerFld	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	4.2	8.8
5-Adj. Beach Shk	18.1	20.6	7.8	8.1	6.4														12.2
6-End of Cherryval	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. Schl	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	2.8	8.7
11-Below Purlin Br	21.4	12.2	6.4	10.3	2.5														10.6
12- Near SoqCkRdBr	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	2.8	7.8
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	4.3	10.7
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	0 dry	9.7
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 AshbryG*	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	2.4	6.2
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			4.7	10.4
22-Above GS Falls II						9.3	2.8	7.2	5.2	4.7									5.8

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

R-8. Comparison of 2014 to 2013 and Average Steelhead Densities in Aptos Creek

The Aptos watershed's sampling sites indicated that YOY and total densities decreased in 2014, as occurred at most sites in the San Lorenzo and Soquel watersheds, and they were below average (**Tables 31b and 32; Figures 9 and 10**). Aptos Site #3 had the lowest YOY and total densities in the past 10 years of sampling. The two Valencia Creek sites had the lowest YOY and total densities in the past 7 years of sampling. The trend in total densities declined to a 9-year low (9.2 juveniles/ 100 ft), with the low Valencia Creek densities averaged in (**Figure 27**).

Yearling densities also declined in 2014 from the most recent past sampling and were below average at all 4 sites (just slightly less at Aptos #3) (**Table 33; Figure 11**). With low yearling densities 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 2013 (Aptos sites) and 2010 (Valencia sites) (**Table 35; Figures 12 and 19a−b**). In Aptos Creek, the trend in average Size Class II and III density increased from 2008 to 2010, but declined steadily after that to a 2013 low level (5.6 fish/ 100 ft), the lowest thus far calculated (**Figure 28**). With Valencia sites averaged into the 4-site average for 2014, the trend increased slightly (to 6 fish/ 100 ft) in 2014 with the higher Aptos 4 density being offset by low Valencia 2 and 3 densities. Average soon-to-smolt density increased in 2014, despite averaging in the very low densities in Valencia Creek. The low soon-to-smolt density detected in the Aptos watershed is due to few YOY being produced (likely few adult spawners), poor overwinter retention of yearlings and poor growth of YOY fish into Size Class II in a year with low baseflow.

R-9. Steelhead Population Estimate for the Aptos Lagoon/Estuary and Tidewater Goby Use in 2014

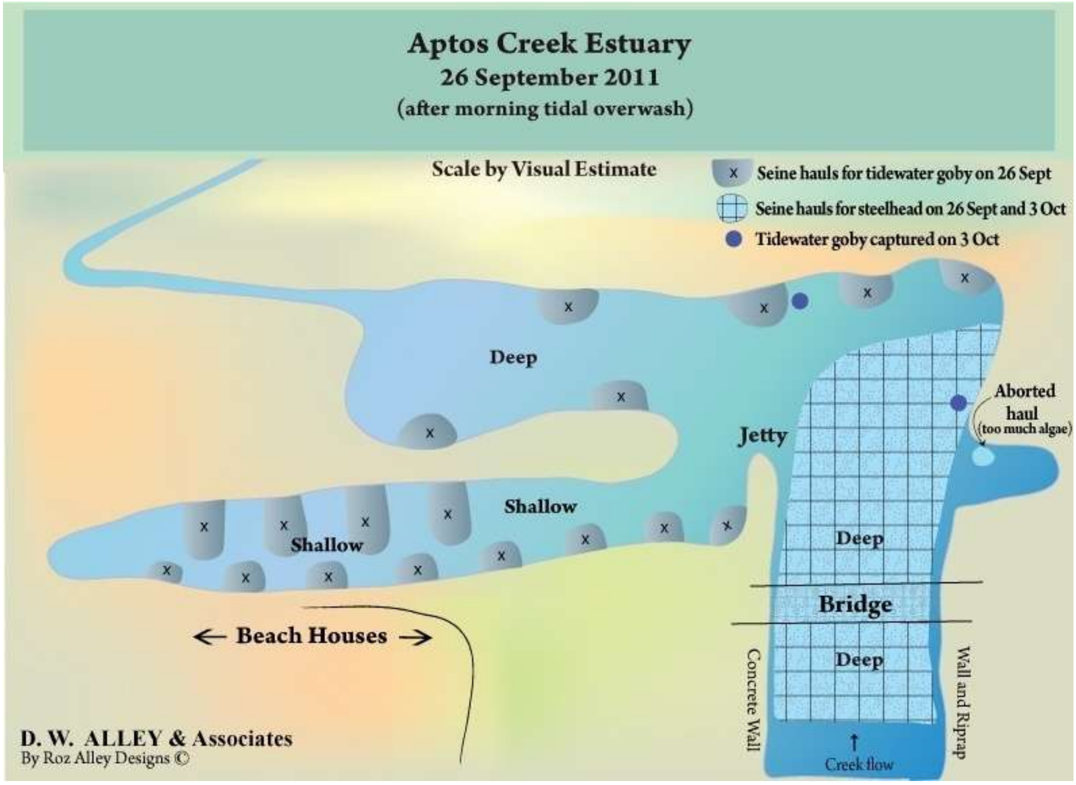
Aptos estuary/lagoon in fall 2014 had a much smaller juvenile steelhead population than the three previous years, with the typical rapid growth rate compared to those captured in stream habitat. However, only 6 juveniles were captured in 2 days of sampling. Poor water quality in the lagoon may have forced juveniles to avoid the lower lagoon in 2014. 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. However, only 10 juveniles were captured in Soquel Lagoon in 2014. A small population of tidewater goby still existed in Aptos estuary/lagoon in fall 2014, with a closed sandbar and substantial tidal overwash during fall fish sampling. Tidewater gobies are typically found along freshwater to brackish water lagoon margins having aquatic algae and other aquatic vegetation. In 2014, tidewater gobies were most abundant along the jetty, as in past years, and were also captured in the lagoon, east and west of the jetty.

Only 4 juvenile steelhead were captured on 18 September from 7 seine hauls with a 106-ft long bag seine (6 feet high by 3/8-inch mesh) in the main estuary. Other fishes captured included 1 prickly sculpin (*Cottus asper*), 6 staghorn sculpin (*Leptocottus armatus*) hundreds of smelt (*Atherinops spp.*)

and 22 tidewater gobies (*Eucyclogobius newberryi*). On 25 September 2014, only 2 more steelhead were captured with 8 seine hauls with the bag seine in the main estuary. Other fishes captured included 2 staghorn sculpins, 50 threespine stickleback (*Gasterosteus aculeatus*), less than 100 smelt and 21 tidewater gobies. Tidewater gobies must have been abundant in the western lagoon because usually, the bag seine with its coarse mesh does not capture tidewater gobies. There were no steelhead or tidewater goby mortalities. The steelhead appeared in poor condition. No steelhead recaptures occurred, and no population estimate was possible in 2014. Population estimates in previous years were ***32*** in 2013 compared to ***140*** in 2012 and ***423*** in 2011). Size histograms were graphed for steelhead captured each year (**Figures 46 and 47a−c**).

In addition, on 18 September 2014, the periphery of the estuary east of the jetty was sampled for tidewater goby and other small fishes. Nine seine hauls were made 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 2014 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. The small goby seine was not used west of the jetty because the larger seine had picked up gobies previously. Each seine haul was inspected for tidewater goby, and the fish species composition was determined for the seine hauls, combined. A total of 158 tidewater gobies were captured from 9 seine hauls, east of the jetty on the one day of seining with the small seine. In addition, 43 tidewater gobies were captured with the larger seine on two days of sampling, west of the jetty. Other species captured with the small seine included only 13 threespine sticklebacks.

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 in 2014 with the sandbar becoming closed. Enlargement and deepening of the estuary/lagoon likely resulted through the early summer from progressive elevational increase of the outlet through the sandbar as stream inflow to the estuary diminished until the sandbar closed. The gage height decreased 0.36 feet from 5.02 feet on 18 September after substantial tidal overwash to 4.64 feet on 25 September. The previous fall with an open sandbar, the gage height was 3.76 ft on 12 September but increased to 4.64 ft on 19 September due to ensuing tidal overwash. The estuary was open to the ocean during both fish samplings in 2013, whereas the sandbar was closed in 2014. Cool, oxygenated saltwater disrupted any stratification of water temperature and oxygen on 18 September (**Table 31a**). However, a week later, stratification was well-developed. Salinity went from 4.4 ppt at the surface to 22.4 ppt at the bottom. Water temperature had increased above 25˚C in early afternoon at 0.5 meter from the surface and increased at greater depth. Oxygen dropped from 10.15 mg/ l to 1 mg/l at 0.75 meter, and conditions were nearly anoxic at greater depth. With such poor water quality, steelhead were likely restricted to a 0.5 meter layer at the surface or less in the afternoon and early evening and perhaps down to 0.75 meters in late night and early morning, at best.



(No presence of isolated estuary finger adjacent to beach houses in 2013 or 2014. Sand peninsula between finger and deep zone in 2011 was absent in 2013 and 2014.)

Table 31a. Water Quality on 18 and 25 September 2014 at Aptos Lagoon.

Gage ht. 5.02 ft	Air temp. 19.8° C	1737 hr	18 Sep 2014		Gage ht. 4.64 ft	Air temp. 20.0° C	1354 hr	25 Sep 2014
	Walk- bridge over Aptos Lagoon				**Walk-bridge over Aptos Lagoon**			
Depth	**Temp**	**Salin**	**O2**	**Cond**	**Temp**	**Salin**	**O2**	**Cond**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	24.6	1.7	11.37	3260	23.7	4.4	10.15	7831
0.25	24.6	3.6	11.12	6496	23.7	4.5	9.91	7865
0.50	24.6	3.6	11.21	6533	25.8	7.5	5.91	13297
0.75	26.2	5.8	10.85	10522	26.4	11.2	1.03	17256
1.00	24.9	10.0	8.25	16949	27.5	18.3	0.08	30692
1.25	25.4	16.5	3.45	27197	27.3	21.6	0.06	35970
1.40b					27.1	22.4	0.05	37053
1.50b	25.3	22.2	0.76	35520				

Table 31b. TOTAL DENSITY of Juvenile Steelhead at Monitoring Sites in APTOS, VALENCIA, CORRALITOS, SHINGLE MILL and BROWNS VALLEY Creeks, 1981, 1994 and 2006–2014.

Sample Site	1981	1994	2006	2007	2008	2009	2010	2011	2012	2013	2014	Avg.
Aptos #3- in County Park	35.2*		26.2	61.7	45.4	8.5	39.4	10.3	24.5	25.9	9.8	28.7
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	18.5	35.7
Valencia #2-Below Valencia Road Xing	33.1		28.3	43.0	38.5	22.7	25.1				3.0	27.7
Valencia #3- Above Valencia Road Xing	29.8		33.4	23.0	55.5	26.3	39.4				5.4	30.4
Corralitos #1-Below Dam				36.2	69.9	34.2	10.4	16.2	65.4	41.1	10.1	35.4
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	13.3	29.6
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	6.1	39.9
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	8.8	50.0
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	7.0	18.6
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	15.6	23.1
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	7.2	40.1
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	19.4	52.8

*** 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, 2006–2014.

Sample Site	1981	1994	2006	2007	2008	2009	2010	2011	2012	2013	2014	Avg.
Aptos #3- in County Park	24.4*		23.7	54.0	43.4	3.3	37.3	8.9	17.5	22.4	5.2	24.0
Aptos #4- above steel Bridge Xing Nisene Mks	37.1		35.2	9.8	84.6	3.9	20.1	20.7	52.4	18.6	15.3	29.8
Valencia #2- below Valencia Road Xing	16.6		24.5	26.6	27.5	8.9	16.4				2.7	17.6
Valencia #3- Above Valencia Road Xing	16.6		20.5	4.7	41.5	7.8	25.6				2.5	17.0
Corralitos #1-Belo Dam				27.0	61.2	26.5	9.1	14.8	57.5	30.4	3.9	28.8
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	10.3	21.8
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	2.4	31.5
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	3.2	38.0
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	2.8	10.0
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	5.8	16.6
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	2.9	27.1
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	11.7	42.1

*** 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 2006–2014.

Sample Site	1981	1994	2006	2007	2008	2009	2010	2011	2012	2013	2014	Avg.
Aptos #3- in County Park	10.8*		3.1	7.6	2.3	5.2	1.9	1.4	6.4	3.5	4.6	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	3.0	5.6
Valencia #2- below Valencia Road Xing	16.5		3.8	16.4	11.0	13.8	8.9				0.3	10.1
Valencia #3- Above Valencia Road Xing	13.2		12.9	11.5	14.0	18.5	14.2				3.0	12.5
Corralitos #1- Below Dam				9.1	8.7	6.9	1.3	1.3	7.3	10.7	6.1	6.4
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	3.8	7.8
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	3.7	8.4
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	5.6	12.1
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	4.2	8.8
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	5.8	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	4.2	12.7
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	7.7	10.6

*** 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, 2006–2014.

Sample Site	1981	1994	2006	2007	2008	2009	2010	2011	2012	2013	2014	Avg.
Aptos #3- in County Park	24.4*		7.2	50.8	39.4	3.3	22.2	3.2	12.9	20.8	5.2	18.9
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	13.7	25.8
Valencia #2- below Valencia Road Xing	16.6		24.5	26.6	27.5	8.9	16.4				2.7	17.6
Valencia #3- Above Valencia Road Xing	16.6		20.5	5.7	41.5	7.8	24.6				2.5	17.0
Corralitos #1- Below Dam				27.0	61.2	20.5	1.7	8.6	56.8	29.0	1.8	25.8
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	1.3	18.6
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	0	29.0
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	0.5	33.1
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	2.8	9.1
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	10.4	18.7
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	0.6	24.5
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	12.3	39.8

*** 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 2006–2014.

Sample Site	1981	1994	2006	2007	2008	2009	2010	2011	2012	2013	2014	Avg.
Aptos #3- in County Park	10.8*		19.0	10.9	6.0	5.2	17.2	7.1	11.6	5.1	4.7	9.8
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	4.7	9.4
Valencia #2- below Valencia Road Xing	16.5		3.8	16.4	11.0	13.8	8.7				0.3	10.1
Valencia #3- Above Valencia Road Xing	13.2		12.9	10.5	14.0	18.5	14.8				3.0	12.4
Corralitos #1 Below Dam				9.1	8.7	13.7	8.7	7.6	8.7	12.1	8.3	9.6
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	12.1	11.0
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	6.1	10.9
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	8.3	16.9
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	4.2	9.5
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	5.2	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	6.6	15.3
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	7.2	13.0

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

R-10. Comparison of 2014 to 2013 and Average Steelhead Densities in the Corralitos Sub-Watershed and Pajaro Lagoon

Fall baseflow in Corralitos Creek was less in 2014 than 2013 but not reduced as much as in the San Lorenzo and Soquel watersheds compared to 2013 (**Table 5b**). Measured baseflow in Browns Creek was higher in October 2014 (0.3 cfs) than in October 2013 (0.1 cfs). However, spring and early summer baseflows in 2014 were likely lower than 2013, based on the observation that the flow at the Freedom gage stopped in mid-April 2014 (**Figure 44**) but continued until mid-May in 2013 (**Figure 42c**). Furthermore, 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 Eureka Gulch. Browns Creek had missed the sedimentation.

In 2014, YOY densities were very low and well below average at all sites in this sub-watershed and less than in 2013 all steelhead sites (**Table 32; Figure 14**). 2014 YOY densities were the lowest measured in 7−10 years of monitoring at all sites except for Corralitos 3 (slightly less in dry year 1994). We suspect that adult steelhead did not access Shingle Mill sites in 2014. The upper Browns Creek site had the highest YOY density (only 11.7 YOY/ 100 ft). The slight increase in YOY densities at Shingle Mill 3 may have resulted from resident rainbow trout spawning in the headwaters. Decreased YOY juvenile densities at sites from 2013 to 2014 were statistically significant (**Table 47**).

Total juvenile densities followed the same pattern to YOY densities in comparison to 2013 densities and long term average densities (**Table 31b; Figure 13**). Total densities were the lowest measured in 7-10 years of monitoring at Corralitos Sites 1, 8 and 9 and Browns Sites 1 and 2. The trend in total densities for the 6 Corralitos and Browns creek sites continued to decline in 2014 since 2012 to its lowest in the 11 years of monitoring (**Figure 29**). Decreased total juvenile densities from 2013 to 2014 were statistically significant (**Table 47**).

Yearling densities varied between 3.7 and 7.7 fish/ 100 feet (**Table 33; Figure 15**). 2014 yearling densities were less than in 2013 at all sites and below average at all 8 sites. Decreased yearling densities from 2013 to 2014 were statistically significant (**Table 47**).

In 2014, Size Class II densities were less than those in 2013 at 5 of 8 sites, were below average at 6 of 8 sites and were close to average at the 2 other sites (**Table 35; Figure 16**). The trend in soon-to-smolt densities had declined since 2012, with the 8-site average (7.8 fish/ 100 ft) being the lowest in 11 years of monitoring but very similar to the 2010 average (**Figure 32**). The highest density of soon-to-smolt fish in 2014 was at Corralitos 3 above the dam (11.7 fish/ 100 ft). Near average or below average densities of yearlings at all sites, along with the small number of YOY reaching Size Class II (low baseflow (**Table 5b**), lead to relatively low densities of the larger fish compared to 2013. More yearlings were retained in 2013 compared to 2014 or the wetter 2011, a year that allowed a high proportion of YOY to reach Size Class II despite much higher densities of YOY (**Figures 20a−20b**). Sampling site ratings based on soon-to-smolt densities declined at 5 of 8 sites in 2014 (**Table 42**). Four sites had "below average" ratings and 4 had "fair" ratings. The "fair" sites were rated "good" in 2013. Corralitos 9 typically is rated "good" but dropped to "fair" in 2014.

The mostly below average densities of Size Class II consisting of few yearlings and a preponderance of YOY that reached Size Class II because their density was very low, were consistent with lower baseflow, limited spawning success and reduced habitat quality overall. There were indications of habitat improvement in 2014 regarding sedimentation problems caused by the previous fire. 2014 pool depth was similar to 2013 at Corralitos 1, 3 and 8 despite reduced baseflow (**Table 16c**). Pool escape cover also increased in Reach 3 and at sites in Reaches 1 and 8. Percent of fine sediment and embeddedness were both reduced at Site 8, which had been most impacted by fire-induced sedimentation downstream of Eureka Gulch in 2010. These improved non-flow-related habitat improvements were consistent with higher soon-to-smolt densities at Corralitos Site 3 and Site 8 compared to 2013 (**Table 35**). The reduced soon-to-smolt densities at Browns 1 and 2 were consistent with reduced streamflow, reduced pool depth and reduced or similar pool escape cover.

R-11. Comparison of Abundance Indices for Size Class II and III Juveniles in 2014 and 2010 for the San Lorenzo, Soquel and Corralitos Watersheds

When habitat proportions in reach segments were factored in with reach length and soon-to-smolt juvenile densities by habitat type in representative sampling sites within reach segments, then abundance indices were calculated for each sampled reach in each watershed. An overall watershed index of abundance for the sample reaches combined was then calculated. Indices were compared for 2010 (a wet baseflow year) and 2014 (a very dry year). Refer to the methods section for more details.

For the San Lorenzo watershed in 2010, the reach index total for 18 reaches (not including the lagoon) was 21,000 Size Class II and III juveniles (**Figure 33**). The reach index total in 2014 was 7,800, it being only 37% of the 2010 index. Since it is this size class of juveniles that will soon smolt and contribute most to adult returns, the potential for adult returns from juvenile production in 2014 from stream habitat was only about 1/3 that in 2010 for the San Lorenzo drainage. In 2010, 8 reaches contributed more than 1,000 larger juveniles to the total index. Another 7 reaches contributed between 500 and 1,000 larger fish. Only 3 reaches contributed less than 500. In 2014, only Zayante Reach 13d contributed more than 1,000 larger juveniles (3,012 fish), which was 39% of the total index. Only 3 reaches contributed between 500 and 1,000 larger fish in 2014. 13 reaches contributed less than 500 larger fish, and Bean 14c was dry in 2014. We see from 2010 reach indices that in a wet baseflow year the lower mainstem reaches, as well as SLR-6, Zayante 13d, Newell 16, Boulder 17b and Bear 18a were high contributors (more than 1,000 larger fish each; SLR Reach 2 contributing the most at 4,154). The lower mainstem reaches in 2010 had 2−10 times higher densities of YOY than in 2014 (**Table 18**), and still a sizeable percentage of YOY reaching Size Class II (**Figure 17c**). In 2014, larger juveniles as fast growing YOY and yearlings were scarce in lower mainstem reaches, and their reach indices were much reduced by 3−10 times the 2010 reach indices. It is important to note that while two reaches, Newell 16 and Bear 18a, contributed significantly to the total index in 2010, they were minor contributors in 2014. The decline in Bear 18a was because adult spawning had been severely restricted, if not prevented for 2 years prior by the flashboard dam abutment with log jam identified in lower Bear Creek below Lanktree Bridge. The decline in Newell 16a was likely because of poor spawning success below the dam in winter 2013-2014 when no releases were made during natural stormflows after December 2012 and because habitat quality was substantially reduced when bypass from the dam was reduced to 0.2 cfs from the previous minimum bypass of 1 cfs. Parts of Newell Creek went intermittent in Newell 16 in summer 2014. Newell Creek typically has an average of 30 YOY/ 100 ft and a sizeable portion reaching Size Class II with the 1 cfs minimum release. In 2014 the YOY density was only 2.3 YOY/ 100 ft (**Figure 2**). Yearlings that contribute to the soon-to-smolt index average 6.7 yearlings/ 100 ft in Newell 16. But yearling density was only 1.5 yearlings/ 100 ft in 2014.

The large increase in soon-to-smolt production in Zayante Reach 13d from 2010 to 2014 resulted from much below average 2010 densities of larger fish with few yearlings compared to above average 2014 densities with many more yearlings. Differences in habitat conditions did not explain the difference in yearling densities between years at Site 13d because habitat was better in 2010. In 2010, the escape cover was greatly reduced to half the 2009 amount in pools (**Table 12a**), and embeddedness was increased by more than 10%, indicating channel disturbance. However, pool escape cover was slightly less in 2014 and embeddedness was similar both years (**Table 8a**). Percent fines were much less in 2014 in all habitats (**Table 7a**), but pool habitat was substantially shallower in 2014 than in 2010 (partially because run habitat in a higher baseflow year becomes shallow pool habitat in a drought year, such as 2014) (**Table 6a**). More food was available in 2010 than in 2014 because baseflow was higher with more insect drift (**Table 5a**).The higher retention of yearlings in 2014 in upper Zayante Reach 13d may be attributed primarily to the milder winter/spring that resulted in slower yearling growth and less displacement downstream during stormflows. Similar yearling retention occurred in upper Boulder Reach 17b, likely for the same reasons and resulting in the second highest reach contribution to the total 2014 index. SLR Reach 1 was third highest with its fast growing YOY in riffles. Fall Reach 15 was fourth highest with some yearling retention, though lower densities than in 2010.

For the Soquel watershed in 2010, the reach index total for 8 reaches (not including the lagoon) was 3,800 Size Class II and III juveniles (**Figure 34**). The reach index total in 2014 was 900, it being only 24% of the 2010 index. Since it is this size class of juveniles that will soon smolt and contribute most to adult returns, the potential for adult returns from juvenile production in 2014 from stream habitat was only about 1/4 that in 2010 for the Soquel drainage. In 2010, Reach 13a (from the Mill Pond diversion down to the West Branch confluence and the longest reach sampled) was the highest contributor to the total index (1,018 fish). The next highest reach contributors in declining numbers were West Branch Soquel 13, mainstem Soquel 8 and East Branch Soquel 12 in the SDSF. All 8 reaches contributed more than 200 large fish to the total index in 2010. In 2014, all 8 reaches contributed less than 200 each. In 2014, Reach 12a was dry, only ½ mile of the 1.9 mile Reach 9a had surface flow and Reach 1 experienced near or possible intermittency on some summer nights due to water diversion. In 2014, Reaches 1 and 9a contributed about a tenth of the 2010 numbers to the total soon-to-smolt index. The negative difference in 2014 soon-to-smolt numbers compared to 2010 increases when lagoon production is considered. In 2010, the lagoon population estimate was about 1,200 soon-to-smolt size fish (**Alley 2014a**). In 2014, only 10 fish were captured during 2 sampling days, and no recaptures were made (**Alley 2015**). The 2014 lagoon population was likely less than 100.

For the Corralitos sub-watershed in 2010, the reach index total for 8 reaches was 3,300 Size Class II and III juveniles (**Figure 35**). The reach index total in 2014 was 2,300, it being 70% of the 2010 index. Since it is this size class of juveniles that will soon smolt and contribute most to adult returns, the potential for adult returns from juvenile production in 2014 from stream habitat was only about 2/3 that in 2010 for the Corralitos/Browns sub-drainage. In 2010, the lower 4 sampled reaches in Corralitos Creek all contributed equally to the index at about 600 larger fish per reach. In 2010, these soon-to-smolt fish consisted of both fast growing YOY (25−85% of YOY reaching Size Class II (**Figure 20c**) and yearlings. However, in 2014, 3 of 4 of these lower reaches contributed only 250−350 fish, with Reach 3 contributing more than 750 (more than in 2010). The decline was due to few YOY reaching Size Class II because few YOY were present and reach indices consisting of mostly yearlings at below average densities, except for Corralitos Reach 3 that had a significant portion of Size Class II YOY's (**Figures 14, 15 and 20a**). The total index in 2014 would have been much lower in comparison to 2010 if yearling densities had not been higher in 2014 than in 2010.

R-12. Sampling Results for the Pajaro River Estuary in 2014

No steelhead were captured in Pajaro River Estuary in fall 2014, as was the case in fall 2012 and 2013. A small population of tidewater goby still existed in 2014. However, its future is uncertain due to potential conflicts between maintaining fish habitat and flood control.

Methods

The purpose of sampling was to determine presence/absence and distribution of tidewater goby and steelhead. The barrier beach sandbar had been closed for some time. On 3 October 2014, the main lagoon along the beach and Watsonville Slough near its mouth were sampled for steelhead with the 106-foot bag seine (3/8-inch mesh) (9 seine hauls) (**Table 39**). On 6 October 2014, the main lagoon along the beach (5 seine hauls) and the upper lagoon (3 seine hauls), oriented perpendicular to the beach, were sampled for tidewater goby with a 30-foot seine with 1/8-inch mesh (**Table 38**). On 7 October 2014, the upper lagoon was sampled for steelhead with the 106-foot seine (2 seine hauls) at the model airport and Thurwachter Bridge (3 seine hauls) (**Table 37**).

On 6 October during tidewater goby sampling in the lower (mid-channel) and upper lagoon (along margin), the water temperature, salinity and oxygen were measured through the water column at 0.25 meter intervals at 5 stations. On 7 October during steelhead sampling at the model airport and Thurwachter Bridge in the upper lagoon, water quality was measured through the water column, mid-channel from a boat (2 sites).

Fish Sampling Results for Pajaro Estuary

Results of sampling the lower lagoon on 3 October with the large bag seine (106 ft long) yielded only 3 native fish species (Pacific herring, smelt and threespine stickleback) compared to 10 in 2013 (**Table 36**). The presumably early closure of the sandbar in 2014 separated the lagoon from many Bay species that were in the 2013 estuary in sufficient numbers to be captured. Results of sampling the upper lagoon near the model airport and Thurwachter Bridge on 7 October with the large seine yielded a tidewater goby, despite the 3/8-inch mesh size, and hitch (**Table 37**). Our tidewater goby sampling on 6 October yielded very low densities along the beach berm of the lower lagoon except near the confluence of Watsonville Slough and higher abundance at Thurwachter Bridge and the boat ramp in the upper lagoon (**Table 38**). Other species captured with the 30-foot long, fine-meshed seine (1/8-inch mesh) included arrow goby, mosquitofish and threespine stickleback.

Water Quality

On 6 October during tidewater goby sampling in the lower (mid-channel) and upper lagoon (along margin), the water temperature, salinity and oxygen were not stratified (**Table 39**). On 7 October during steelhead sampling at the model airport and Thurwachter Bridge in the upper lagoon, salinity stratification was not detected at mid-channel from a boat except for higher salinity at the bottom of 9.1 ppt (**Table 40**). The remainder of the water column was lightly saline at about 3.8 ppt. Water temperature was not stratified. Oxygen was not stratified except for depletion within 0.25 m of the bottom.

Table 36. Fish capture* results from sampling lower Pajaro Lagoon *with the 106-foot bag seine (3/8-inch mesh)*, 3 October 2014.

Date	Location	Seine Haul	Tide-water Goby	Arrow goby	Yellow fin goby	Pacific herring	Bay pipe-fish	Shiner Surf-perch	Smelt (jack and top)	Staghorn Sculpin	Striped Bass	Three-spine stickle-back	Prickly sculpin
3 Oct 2014	East of Watsonville Slough confluence	1				7			1			3	
	East of #1	2				25						5	
	East of #2	3				2						2	
	East of #3	4										1	
	East of #4	5										9	
	East of #5	6				2						1	
	East of #6	7										6	
	Adj. mouth of Watsonville Slough	8										1	
Total			**0**	**0**	**0**	**36**	**0**	**0**	**1**	**0**	**0**	**28**	**0**

*6 Crabs (likely Dungeness and another species) captured on 3 seine hauls.

Table 37. Fish capture results from sampling Upper Pajaro Lagoon *with the 106-foot bag seine (3/8 inch (3/8-inch mesh)*, 7 October 2014.

Date	Location	Seine Hauls	Tide-water Goby	Yellow fin goby	Hitch	Prickly sculpin	Sac. sucker	Smelt (jack and top)	Staghorn Sculpin	Three-spine Stickle-back
7 Oct 2014	Model Airport	1−3	1							
	Thurwachter Bridge	4−6			16					
Total			**1**	**0**	**16**	**0**	**0**	**0**	**0**	**0**

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)*, 6 October 2014.

Date	Location	Seine Haul	Tide-water Goby	Arrow goby	Yellow fin goby	Gam-busia	Hitch	Bay pipe-fish	Shiner Surf-perch	Smelt (jack and top)	Staghorn Sculpin	Three-spine stickle-back
6 Oct 2014	Approx. 200 m east of Pajaro Dunes Complex	1	4									4
	East of #1	2	200+									
	East of #2	3	2									
	East of #3	4	16									4
	East of #4	5										
	Airport- 0.3 miles down from Thurwachter Br	6	1	19		42						9
	Thurwachter Br.	7	100+									3
	Boat Ramp- 0.8 miles upstream of Thurwachter Bridge and 2.9 miles upstream of Watsonville Slough confl.	8	90			29						50+
Total			**413+**	**19**	**0**	**71**	**0**	**0**	**0**	**0**	**0**	**70+**

Table 39. Water quality measurements in the lower lagoon (Stations 2 and 4 in mid-channel) and the upper lagoon sites (along margin) during tidewater goby sampling, 6 October 2014.

			6-October 2014					
	Station 2 (lower lagoon)		0946 hr		**Station 4 (lower lagoon)**			1038 hr
Depth	**Temp 2**	**Salin 2**	**O2 2 (% sat.)**	**Cond 2**	**Temp 4**	**Salin 4**	**O2 4 (% sat.)**	**Cond 4**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	20.4	4.9	13.66	7987	20.5	5.2	11.32	8439
0.25	20.4	4.9	13.93	8013	20.6	5.2	10.81	8437
0.50	20.3	4.9	13.89	8009	20.5	5.2	10.99	8434
0.75	20.3	4.9	14.04	8029	20.5	5.2	10.59 (121)	8434
1.00	20.3	5.0	13.82 (158)	8036	20.5	5.2	10.72 (123)	8433
1.10b					20.4	5.2	10.25	8419
1.13b	20.3	5.0	12.98	8113				
	Model Airport			1228 hr	**Thurwachter Bridge**			1321 hr
Depth	**Temp**	**Salin**	**O2 (% sat.)**	**Cond**	**Temp**	**Salin**	**O2 (% sat.)**	**Cond**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**Umhos**
0.00	22.9	3.8	10.06	6571	23.3	3.1	8.43	5523
0.25	22.4	3.7	10.04	6491	23.1	3.1	8.47	5506
0.50	22.0	3.8	9.23	6472	21.6	3.1	7.95	5272
0.75	21.9	3.8	7.55 (88)	6529	21.9	3.1	7.57 (88)	5371
0.83b					21.9	3.3	7.68	5669
0.87b	21.5	3.9	6.17	6563				

Table 39 (continued). Water quality measurements in the lower lagoon (Stations 2 and 4) and the upper lagoon during tidewater goby sampling, 6 October 2014.

			6-October 2014					
	Boat Launch Ramp (above Thurwachter Br.)		1427 hr					
Depth	**Temp 2**	**Salin 2**	**O2 2 (%sat.)**	**Cond 2**				
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**				
0.00	22.6	1.5	7.54	2793				
0.25	22.2	1.5	6.90	2785				
0.50	20.3	1.5	6.77 (76)	2647				
0.75	21.1	1.7	11.15 (123)	2931				
1.00	22.5	5.2	0	8819				

Table 40. Water quality measurements in the upper lagoon during steelhead sampling, 7 October 2014.

			7-October 2014					
	Model Airport (mid-channel)			1005 hr	**Thurwachter Bridge** (mid-channel)			1346 hr
Depth	**Temp**	**Salin**	**O2 (%sat.)**	**Cond**	**Temp**	**Salin**	**O2 (%sat.)**	**Cond**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**Umhos**
0.00	21.5	3.8	8.78	6380	22.2	3.2	8.68	5625
0.25	21.5	3.7	8.94	6365	22.3	3.2	8.56	5637
0.50	21.4	3.8	9.02	6381	22.2	3.2	8.44	5633
0.75	21.4	3.8	8.80 (102)	6439	22.2	3.3	8.58 (100)	5654
1.00	21.4	3.8	7.09 (83)	6493	22.5	3.7	8.60 (102)	6365
1.18b					23.1	4.2	5.89	7350
1.25	21.4	3.8	3.89 (46)	6503				
1.50b	22.5	9.1	0.0	14642				

Conclusions- Pajaro Estuary

An expansive lagoon had formed behind the complete barrier beach in summer 2014, severe drought year. The lagoon extended more than three miles from the beach. A small population of tidewater goby still existed in Pajaro Lagoon in fall 2014. The highest densities were in the upper lagoon and along the beach within 300 m of Watsonville Slough. Water quality was adequate for this species' survival during the dry season. The absence of stratification, low salinity and good oxygen concentrations made the lagoon habitable for steelhead, though water temperature was warm. However, no steelhead were detected in Pajaro Lagoon in 2014, though sampling of the upper lagoon was difficult because of the limited landing areas for the seine and the thick layer of decomposing material on the bottom.

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

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

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

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

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

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

Recommendations- Pajaro Lagoon

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

R-13. Rating of Rearing Habitat in 2014, 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 41**). 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 2014.

For 2013 and 2014, soon-t-smolt-sized juvenile ratings for sampling sites were tabulated and summarized (**Tables 42 and 43**). Ratings for 3 sites in the San Lorenzo drainage improved; San Lorenzo 0a (below average to fair), San Lorenzo 4 (poor to below average) and Branciforte 21c (fair to good- resident rainbow trout). Eleven San Lorenzo watershed sites (46%) had decreased ratings in 2014. In the San Lorenzo drainage, 18 of 24 sampled sites (75%) were rated between very poor (5), poor (7) and below average (6). And Bean 14c was dry. Only 3 sites were rated fair; San Lorenzo 0a, Fall 15b and Boulder 17b. Only the two rainbow trout sites, San Lorenzo 12b and Branciforte 21c, and Zayante 13d were rated good due to the increased retention of yearlings after a mild winter.

In the Soquel drainage in 2014, no sites were rated fair or better. The ratings went from very poor (1) to poor (4) to below average (2). And Site 16 in the SDSF went dry. In the Aptos drainage in 2014, lower Aptos #3 had the highest rating of fair due to the larger size of yearlings. Aptos #4 was rated below average, with its low juvenile density and only 10% of its YOY reaching Size Class 2. Lower Valencia #2 was rated very poor with its absence of pool habitat. Upper Valencia #3 was rated below average, with its low steelhead density and few large older fish.

The Corralitos sub-watershed had the best overall ratings of the 4 watersheds sampled. Half the sites were rated below average (4), with the others rated fair (4); Corralitos #1, Corralitos #3, Corralitos #9 and Browns #1. Ratings were as high as they were because there was some retention of yearlings after a mild winter, and some of the few YOY reached Size Class II.

Table 41. 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 42. 2014 Sampling Sites Rated by Potential Smolt-Sized Juvenile Steelhead Density (=>75 mm SL) and Average Size in Standard Length Compared to 2013, with Physical Habitat Change Since 2013 Conditions.

Site	2014 Potential Smolt Density (per 100 ft)/ Avg Pot. Smolt Size SL	2014 Smolt Rating (With Size Factored In)	2013 Potential Smolt Density (per 100 ft)/ Avg Pot. Smolt Size SL	2013 Smolt Rating (With Size Factored In)	Physical Habitat Change by Reach/Site Since 2013
Low. San Lorenzo #0a	6.2/ 108 mm	Fair	4.1/ 94 mm	Below Average	–
Low. San Lorenzo #1	1.8/ 125 mm	Poor	3.4/ 96 mm	Poor	–
Low. San Lorenzo #2	2.4/ 98 mm	Poor	6.2/ 88 mm	Poor	–
Low. San Lorenzo #4	4.4/ 89 mm	Below Average	6.7/ 81 mm	Poor	–
Mid. San Lorenzo #6	1.4/ 80 mm	Very Poor	2.0/ 108 mm	Below Average	–
Mid. San Lorenzo #8	1.4/ 92 mm	Very Poor	1.9/ 90 mm	Very Poor	–
Mid. San Lorenzo #9	0.6/ 92 mm	Very Poor	2.3/ 86 mm	Very Poor	–
Up. San Lorenzo #10	None	Very Poor	–	–	–
Up. San Lorenzo #11	1.6/ 112 mm	Poor	2.3/ 114 mm	Below Average	–
Up.San Loren #12b (res. rt)	21.3/ 92 mm	*Good*	10.0/ 111 mm	*Good*	–
Zayante #13a	2.4/ 89 mm	Poor	2.7/ 98 mm	Poor	–
Zayante #13c	3.7/ 81 mm	Very Poor	8.4/ 87 mm	Below Average	–
Zayante #13d	22.1/ 93 mm	*Good*	18.5/ 105 mm	*Very Good*	–
Lompico #13e	6.7/ 94 mm	Below Average	8.7/ 104 mm	*Good*	–
Bean #14b	2.8/ 101 mm	Poor	12.5/ 90 mm	Fair	–
Bean #14c	Dry	Dry	Dry	Dry	Dry
Fall #15a	2.7/ 103 mm	Below Average	–	–	
Fall #15b	7.3/ 103 mm	Fair	12.1/ 98 mm	Fair	–
Newell #16	3.1/ 109 mm	Below Average	23.7/ 89 mm	*Good*	–
Boulder #17a	3.8/ 91 mm	Poor	3.2/ 118 mm	Below Average	–
Boulder #17b	13.0/ 90 mm	Fair	10.7/ 96 mm	Fair	–
Bear #18a	0.7/ 116 mm	Poor	2.6/ 115 mm	Below Average	–
Branciforte #21a-2	4.6/ 98 mm	Below Average	6.0/ 106 mm	Fair	–
Branciforte #21b	7.3/ 98 mm	Below Average	13.3/ 100 mm	Fair	–
Branciforte #21c (res. Rt)	13.3/103 mm	*Good*	10.0/ 100 mm	Fair	–
Soquel #1	0.7/ 102 mm	Very Poor	1.8/ 94 mm	Poor	–
Soquel #4	4.2/ 98 mm	Below Average	2.1/ 110 mm	Below Average	–
Soquel #10	2.8/ 89 mm	Poor	5.2/ 87 mm	Poor	–
Soquel #12	2.8/ 95 mm	Poor	3.1/ 82 mm	Very Poor	–
East Branch Soquel #13a	4.3/ 100 mm	Below Average	6.8/ 106 mm	Fair	–
East Branch Soquel #16	Dry	Dry	6.2/ 92 mm	Below Average	Dry
West Branch Soquel #19	2.4/ 92 mm	Poor	3.4/ 105 mm	Below Average	–
West Branch Soquel #21b	4.7/ 87 mm	Poor	–	–	- (Since 2009)
Aptos #3	4.7/ 117 mm	Fair	5.1/ 103 mm	Fair	–
Aptos #4	4.7/ 95 mm	Below Average	6.1/ 120 mm	Fair	–
Valencia #2	0.3/ 83 mm	Very Poor	-	-	–
Valencia #3	3.0/ 108 mm	Below Average	-	-	– (Since 2009)
Corralitos #1	8.3/ 97 mm	Fair	12.1/ 110 mm	*Good*	–
Corralitos #3	12.1/ 95 mm	Fair	10.7/ 105 mm	*Good*	–
Corralitos #8	6.1/ 97 mm	Below Average	1.8/ 130 mm	Poor	–
Corralitos #9	8.3/ 94 mm	Fair	10.5/ 108 mm	*Good*	–
Shingle Mill #1	4.2/ 97 mm	Below Average	6.9/ 94 mm	Below Average	–
Shingle Mill #3	5.2/ 84 mm	Below Average	3.1/ 86 mm	Very Poor	–
Browns #1	6.6/ 106 mm	Fair	18.0/ 96 mm	*Good*	–
Browns #2	7.2/ 92 mm	Below Average	9.6/ 101 mm	Fair	–

Table 43. Summary of Sampling Site Ratings in 2006−2014, based on Potential Smolt-Sized Steelhead Densities and Sizes.

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 (+ 1 dry)	6	9	10	6	0
2009 (n=37)	2 (+ 1 dry)	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 dry)	1	6	9	17	3
2013 (n=38)	5 (+ 1 dry)	6	10	9	7	1
2014 (n=39)	6 (+ 2 dry)	10	13	8	2	0

R-14. Statistical Analysis of Annual Difference in Juvenile Steelhead Densities

The trend in fish densities between 2013 and 2014 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 2013 and 2014 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. Sampling results from 2014 were compared to 2013, such that a positive difference indicated that the densities in 2014 were larger than in 2013 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 2013 and 2014 densities. The 95% confidence limits are standard and a p-value of < 0.05 is considered significant.

With 19 comparable sites in the San Lorenzo mainstem and tributaries, the decreases in densities of Size

Class II and III juveniles, YOY and all juveniles combined were statistically significant (**Table 44**). SLR Site 12b was excluded from the analysis because it was judged to be resident rainbow trout and not steelhead. Zayante Site 13d and Fall 15b were excluded because the sampling locations changed. With 8 comparable sites in the San Lorenzo mainstem only, decreases in YOY and all juveniles combined were statistically significant (**Table 45**). With just 4 comparable sites in the Soquel watershed, no changes in density were statistically significant (**Table 46**). However, YOY and total densities were less at all Soquel sampling sites in 2014. Soon-to-smolt densities in Soquel Creek were less in 2014 at 6 of 7 sites. With only 2 comparable sites in Aptos watershed, no statistical tests were made. With 8 comparable sites in the Corralitos sub-watershed, the decreases in densities of YOY and all fish combined were statistically very significant (**Table 47**).

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 SAN LORENZO Watershed (2014 to 2013; n=19).

Statistic	s.c. 2	a.c. 1-YOY	a.c. 2	All Sizes
Mean difference	-2.59	-27.68	0.28	-28.55
Df	18	18	18	18
Std Error	1.22	8.96	0.52	9.16
t Stat	-2.12	-3.09	0.55	1.42
P-value (2-tail)	0.048	0.006	0.589	0.006
95% CL (lower)	-5.15	--46.50	-0.80	-47.81
95% CL (upper)	-0.03	-3.09	1.37	-3.12

Table 45. 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 (2014 to 2013; n=8).

Statistic	s.c. 2	a.c. 1-YOY	a.c. 2	All Sizes
Mean difference	-1.14	-9.34	0.08	-9.29
Df	7	7	7	7
Std Error	0.60	3.43	0.23	3.45
t Stat	-1.89	-2.72	0.33	-2.69
P-value (2-tail)	0.101	0.030	0.750	0.031
95% CL (lower)	-2.56	-17.47	-0.46	-17.45
95% CL (upper)	0.29	-1.21	0.61	-1.13

Table 46. 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 (2014 to 2013; n=4).

Statistic	s.c. 2	a.c. 1-YOY	a.c. 2	All Sizes
Mean difference	-0.08	-35.79	1.00	-34.85
Df	3	3	3	3
Std Error	0.74	19.42	0.60	19.20
t Stat	-0.10	-1.84	1.66	-1.82
P-value (2-tail)	0.926	0.163	0.196	0.167
95% CL (lower)	-2.45	-97.50	-0.92	-95.94
95% CL (upper)	2.30	26.10	2.92	26.24

Table 47. 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 (2014 to 2013; n=8).

Statistic	s.c. 2	a.c. 1-YOY	a.c. 2	All Sizes
Mean difference	-1.84	-17.63	-3.21	-21.35
Df	7	7	7	7
Std Error	1.69	3.81	0.938	4.49
t Stat	-1.09	-4.63	-3.42	-4.76
P-value (2-tail)	0.313	0.002	0.011	0.002
95% CL (lower)	-5.84	-26.65	-0.99	-31.96
95% CL (upper)	2.16	-8.63	1.73	-10.74

R-14. Adult Trapping Results at the Felton Dam's Fish Ladder and 2014 Planting Records

San Lorenzo River Steelhead

Date	Origin Site	BY	Inven-tory	Weight (lbs)	Size (fish/lb)	Length (In.)	Length (mm)	Mark	Release Location
3/3/2014	Big Creek Hatchery	2013	4,474	456.1	9.81	6.57	166.79	AD-100	San Lorenzo River @ Lomond Street bridge crossing
3/5/2014	Big Creek Hatchery	2013	2,237	228	9.81	6.57	166.79	AD-100	San Lorenzo River @ Bear Creek/SLR confluence
3/5/2014	Big Creek Hatchery	2013	2,237	228	9.81	6.57	166.79	AD-100	San Lorenzo River @ Riverdale Road
3/10/2014	Big Creek Hatchery	2013	4,474	456.1	9.81	6.57	166.79	AD-100	San Lorenzo River @ Lomond Street bridge crossing
3/12/2014	Big Creek Hatchery	2013	4,474	456.1	9.81	6.57	166.79	AD-100	San Lorenzo River @ Highland County Park
3/17/2014	Big Creek Hatchery	2013	4,474	456.1	9.81	6.57	166.79	AD-100	San Lorenzo River @ Lomond Street bridge crossing
3/19/2014	Big Creek Hatchery	2013	4,414	449.9	9.81	6.57	166.79	AD-100	San Lorenzo River @ Henry Cowell State Park
3/26/2014	Powder Mill Tank	2013	5,329	743.2	7.17	7.29	185.17	AD-100	San Lorenzo River @ Powder Mill Creek/SLR confluence
Totals/Avg			32,113	3,473.50	9.25				

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 Juve-niles only
1994-95	6 Jan- 21 Mar (48 of 105 days-Jan-15 Apr)	311 (After drought)	Felton Diversion (5) Monterey Bay Salmon & Trout Project
1996-97		1,076 (estimate)	Alley Estimate from 1994 Mainstem Juve-niles only
1997-98		1,784 (estimate)	Alley Estimate from 1995 Mainstem Juve-niles only
1998-99		1,541 (estimate)	Alley Revised Esti-mate from 1996 Main-stem Juveniles only
1999-2000	17 Jan- 10 Apr	532 (above Felton)	Monterey Bay Salmon & Trout Project
1999-2000		1,300 (estimate)	Alley Index from 1997 Mainstem Juveniles only
2000-01 20 Mar	12 Feb- (above Felton)	538	Monterey Bay Salmon & Trout Project
2000-01		2,500 (estimate)	Alley Index from 1998 Juveniles in Mainstem and 9 Tributaries
2001-02		2,650 (estimate)	Alley Index from 1999 Juveniles in Mainstem and 9 Tributaries
2002-03		1,650 (estimate)	Alley Index from 2000 Juveniles in Mainstem and 9 Tributaries
2003-04		1,600 (estimate)	Alley Index from 2001 Juveniles in Mainstem and 9 Tributaries
2003-04	28 Jan- 12 Mar	1,007 Steelhead 14 Coho	SLV High School-Felton Diversion Dam
2004-05	12 Dec 29 Jan	371 Steelhead 18 Coho	SLV High School-Felton Diversion Dam
2005-06	17 Jan-	247 Steelhead	SLV High School-Felton Diversion

	24 Mar	2 Coho	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

D-1. Causal Factors for Below Average Size YOY Densities in All Watersheds

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 4 relatively small stormflows between 1 February and mid-April 2014 to saturate reaches of the 4 sampled watersheds with redds or egg production.

Four factors may explain the much below average YOY densities at most sites in all 4 watersheds sampled. The first factor may have been low adult returns to all 4 watersheds. Six of the last 8 years have been on the dry side, including 2012 and 2013, which has resulted in slower juvenile growth rates leading to smaller smolt populations and size of smolts entering the Bay. The cumulative effect of multiple dry years has likely reduced survival to adulthood and adult returns. Trapping data from Scott Creek indicated substantially decreased adult returns in winter 2013-2014, where adult escapement estimates in water years 2006─2014 were 219, 259, 293, 126, 109, 214, 140, 167 and 50, respectively (**Sean Hayes and Joe Kiernan, NOAA Fisheries personal communications**). No adult steelhead made it to San Clemente Dam on the Carmel River in water year 2014 due to limited surface flow (**Chaney 2014**). So, no annual index of adult returns was possible at the dam. Adult estimates at San Clemente Dam in 2006−13 were 368, 222, 412, 95, 157, 452, 470 and 249, respectively (**Chaney, 2013**).

The sporadic distribution of YOY in the San Lorenzo system in Fall 2014 indicated limited spawning activity by a reduced number of adults returning over the 2013-2014 winter (**Figure 2**). There were higher YOY densities at 2 upper sites in Zayante and Fall creeks and 1 site in lower Branciforte Creek, with well below average densities elsewhere. In the Soquel drainage, the only near to or above average YOY densities occurred at only 2 upper mainstem sites (**Figure 6**), indicating only sporadic spawning by a small adult steelhead population. In the Aptos system, the continued below average YOY density in 2014 at all 4 stream sites (**Figure 10**) is attributable to sporadic spawning effort by a potentially small adult steelhead population. YOY densities were very low at the lower Aptos site and both Valencia sites. An Aptos lagoon juvenile population estimate was not possible in 2014 because only 6 juveniles were captured with no recaptures, further indicating the presence of a very small steelhead population. Sporadic spawning of a very small adult population was also observed in the Corralitos sub-watershed, where much below average YOY densities were found at all sites and extremely low YOY densities at all sites except Corralitos 3 and Browns 2 (**Figure 14**).

A second factor contributing to low YOY densities in the San Lorenzo and other was likely that adult steelhead spawning passage was restricted to narrow windows of time in 2014. Several partial passage impediments likely became factors in either preventing adult steelhead passage or slowing it down. These low flow impediments may significantly inhibit coho recovery if not addressed, because entire year classes may be weakened if adult access to the watershed is largely prevented when early winter storms are lacking. The cold water refuges required for coho rearing are located in the upper mainstem and tributaries of the upper watershed, where access must be insured. At least 6 impediments that will impede adult salmonid passage during mild winters were present in the lower and middle mainstem San Lorenzo (**Alley et al. 2004**). They included the Rincon riffle, Four Rock boulder field (partially modified), the Huckleberry Island flashboard dam in Brookdale and the Barker's Dam between the Erwin Way bridges (**Alley et al. 2004**). At least 6 potentially significant impediments during mild winters were found in the upper mainstem above the Boulder Creek confluence (**Kittleson 2015a**). They included the flashboard dam abutment upstream of the Brimblecom Road Bridge, the collapsed flashboard dam abutment above the Kings Creek confluence, the concrete sill downstream of the Either Way Bridge, the San Lorenzo Woods remnant dam abutment just upstream of the Fern Drive Bridge, the Highway 9 culvert apron in Waterman Gap and the Waterman Gap road ford.

The low YOY densities in the upper mainstem San Lorenzo above the Boulder Creek confluence since 2006 leads one to believe that a passage impediment periodically develops after especially wet years, perhaps logs collecting on remnant flashboard dam abutments. 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. The near absence of YOY at the Bear Creek site in 2013 and 2014 indicates that the flashboard dam abutment on lower Bear Creek near Lanktree Bridge is a significant passage impediment.

As stated in the 2013 monitoring report, the salmonid population at the upper Waterman Gap Site 12b in 2014 continues to appear to be resident rainbow trout, with its high proportion of larger, older fish. The concrete apron below the culvert crossing of Highway 9 was likely a significant passage impediment. In 2014, the road ford upstream of Highway 9 but below Site 12b may also have been an additional passage impediment, with water flowing underneath the concrete ford. After downstream passage impediments are identified that apparently restrict access to Reaches 10 and 11 are removed, we recommend that the Highway 9 apron be modified to improve adult salmonid passage, and then the concrete ford be sealed up.

On Branciforte Creek, the one mile-long concrete flood control channel at its mouth was likely a passage impediment in winter/spring 2013-2014 with such small stormflows (**Figure 37a and 38**). The adult steelhead carcass that was discovered in Branciforte Creek above the flood control channel on 27 March 2014 by SCRCD staff and the 40 YOY/ 100 ft density at Branciforte 21a-2 during fall sampling indicated that some steelhead successfully spawned above the flood control channel in 2014. However, the YOY density at Branciforte 21b, above the old City of Santa Cruz diversion dam remnant was much below average, indicating that few adults made it past impediments to spawn. Fish captured at the upper Site 21c were likely resident rainbow trout, based on the absence of YOY fish and population consisting of larger fish in 2013 and 2014. In 2012, a dam was removed downstream of Site 21c that may improve steelhead access to this site in wet years. Other important passage impediments during mild winters included the the logjam at De Laveaga Park, the Santa Vida ford, the Happy Valley dam remnant #1, a collapsed bridge and the Casa de Montgomery rock dams (**Kittleson 2015b**).

The near absence of YOY at the Bear Creek site in 2013 and 2014 indicates that the flashboard dam abutment on lower Bear Creek near Lanktree Bridge is a significant passage impediment.

In the Soquel drainage, the primary passage impediments were Girl Scout Falls I and II on the West Branch. Limited adult access occurred above Girl Scout Falls I in 2014, as indicated by 1) the Girl Scout camp caretaker seeing adults above Girl Scout Falls I, 2) our observation of a steelhead redd just above Girl Scout Falls I during habitat typing of the reach between the falls and 3) low YOY densities measured below Girl Scout Falls II. We suspect that Girl Scout Falls II was a complete barrier to adult passage in most years, though no sampling occurred above that falls since 2006.

In the Aptos drainage, Valencia Creek had one potential passage impediment that may have narrowed the passage window of time to 2 small stormflows for adult passage in 2014. Refer to the Soquel Creek hydrograph as indicative of the pattern of stormflow in Aptos Creek (**Figure 40a**). The impediment was the baffled fishway near the mouth (under Highway 1). In 2014, baseflow receded to near summertime flow between storm events, making it questionable if the baffles worked at such low flows. The culvert under Valencia Road had been improved for fish passage and likely was more passable than the Highway 1 baffles. Furthermore, with extremely poor pool development after substantial sedimentation of Valencia Creek, with its long stretches of shallow run habitat below Valencia Road culvert, the stream channel, in general, may have been difficult for adult steelhead to pass.

Adult steelhead passage from the Bay to the monitored reaches of Corralitos and Browns creeks may have been restricted to just 1 short stormflow at the end of March. The first storm in February produced a peak flow of about 60 cfs at the Freedom gage in the town of Corralitos, downstream of the Browns Creek confluence (**Figures 43a-b**). However, the sandbar at Pajaro Lagoon remained closed during this storm event (**J. Smith pers. comm.**). The storm at the end of March provided a peak flow of about 175 cfs at the same location, with an open sandbar. In the Corralitos/Browns drainage, two different residents observed adult steelhead present in Browns Creek in two different locations (one below the dam and one above) over the previous winter. Resident sightings of adult steelhead in Browns Creek above its dam indicated that it was passable at some point during the winter. Consistent with adult sightings, YOY were detected in higher density at Browns Site 2 above the dam than below the dam. The relatively higher YOY density (compared to other sites in 2014) at Corralitos 3 above the Corralitos diversion dam indicated that it was passable also. However, the very low YOY densities at the uppermost Corralitos site indicated that bedrock cascade in Reach 7 may have been a passage impediment. The box culvert at the beginning of Reach 5 (CM12.46) may have had depth issues between storms but was likely passable during the end-of-March storm because it is baffled.

A third factor contributing to low YOY densities may have been insufficient winter/spring baseflow for much spawning success and good egg incubation, resulting in poor egg survival during rapid decline in streamflow after storms passed (streamflow in the 15−30 cfs range at Big Trees gage for much of the February−April incubation period; **Figures 37a-b; 38**). Between stormflows, streamflows declined to near summertime levels. Water percolation through spawning gravels to oxygenate eggs and remove metabolic wastes would have been much reduced at such low baseflows. Pool tail-outs have the best quality spawning gravel and fastest percolation rates just before their hydraulic breaks. But under the low streamflows in 2014, these areas were too shallow for spawning, and adult steelhead likely moved further upstream into the pools beyond the breaks to find sufficient depth in which to spawn. However, most pools in the Santa Cruz Mountains have a high sand component, and the spawning fish resort to spawning in more sandy substrate further upstream of the hydraulic break under these low flow conditions (**J. Smith pers. observation in 1988**). Also, the high sand component in the spawning gravels would further impede water percolation and oxygenation of eggs.

A fourth factor contributing to low YOY densities may have been reduced habitat quality resulting from reduced streamflow, shallower depth, reduced escape cover and less food for YOY, causing starvation of many where spawning was successful but competition was higher. The averaged mean monthly streamflow for May–September in the San Lorenzo and Soquel watersheds were the lowest in the past 18 years since 1997 (**Figure 45**). The preponderance of small YOY (except where their density was very low) (**Table 47**) and small, Size Class II yearlings throughout the watershed (**Table 42**) indicated slow growth rate in 2014. Furthermore, 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 Eureka Gulch. Although habitat in Reaches 5 and 6 was improving, pool scouring was still very limited due to still highly sedimented conditions. This contributed to poor rearing conditions for YOY survival, along with very low baseflows upstream of Rider Creek confluence.

Higher water temperature increased food requirements for steelhead in 2014 by increasing metabolic rate when less food was available in drift at slower velocities than if baseflow was higher. 2014 temperature monitoring in San Lorenzo tributaries (Boulder, Fall and Zayante creeks) and in the mainstem San Lorenzo downstream of Clear and Fall creek confluences indicated that summer water temperatures were 2–3˚C warmer than in the wetter Water Year of 2005. Habitat typing data in 2014 indicated a smaller proportion of riffle habitat per stream length and less surface area in riffles for insect production due to narrower stream channels associated with lower baseflow, further reducing food supply for steelhead.

D-2. Causal Factors for Below Average Size Class II and III Densities in Each Watershed

San Lorenzo Watershed

The below average densities of larger juveniles at all sites in the lower mainstem downstream of Zayante Creek (**Figure 4**) resulted partially from retention of few yearlings being recruited from a small YOY age class in 2013 and despite a mild winter that would have improved overwinter survival. With limited turbidity in the spring due to lack of stormflow, feeding efficiency was likely high and some young yearlings may have grown sufficiently to immigrate early. But low soon-to-smolt sized steelhead densities in the lower mainstem sites in fall were primarily due to much below average YOY densities leading to fewer YOY reaching Size Class II. Most YOY reached Size Class II at Sites 0a, 1 and 2 (33% at Site 4) but there were much fewer YOY in 2014 (**Figure 17a**). For the middle and upper mainstem, there were few Size Class II fish because there were very few juvenile steelhead present, either YOY or yearlings.

Table 47. Presence of Small YOY Steelhead at Sampling Sites, Indicating Late Spawning After Late Stormflows in Wet Years or Slow YOY Growth Rate in Dry Years; 2006, 2010−2014.

Site	At least 30% of the YOY were < 75 mm SL and More than 10 in Number/ At least One Habitat 2006 (Wet)	At least 30% of the YOY were < 75 mm SL and More than 10 in Number/ At least One Habitat 2010 (Wet)	At least 30% of the YOY were < 75 mm SL and More than 10 in Number/ At least One Habitat 2011 (Wet)	At least 30% of the YOY were < 75 mm SL and More than 10 in Number/ At least One Habitat 2012 (Median)	At least 30% of the YOY were < 75 mm SL and More than 10 in Number/ At least One Habitat 2013 (Dry)	At least 30% of the YOY were < 75 mm SL and More than 10 in Number/ At least One Habitat 2014 (Dry)
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					+	Too few YOY
Up. San Lorenzo #11	−	+	−	−	−	Too few YOY
Up. San Lorenzo #12b	NA	NA	NA	− (resident Rt)	+ (resident Rt)	+ (resident Rt)
Zayante #13a	+	+	−	+	+	+
Zayante #13c	−	+	+	+	+	+
Zayante #13d	+	+	+	+	+	+
Lompico #13e	+	−	−	+	+	+
Bean #14b	−	+	+	−	+	+
Bean #14c	+	+	−	+ (Went Dry)	Dry	Dry
Fall #15	NA	+	+	+	+	+
Newell #16	−	+	−	+	+	Too few YOY
Boulder #17a	+ (barely)	+	−	−	+	Too few YOY
Boulder #17b	+	+	+	+	+	+
Bear #18a	+	+	+	+	−	Too few YOY
Branc. 21a-2	+	−	+	+	−	+
Branc. #21b	NA	NA	NA	+	+	+
Branc. #21c	NA	NA	NA	NA	+ (resident Rt)	No YOY (resident Rt)
Soquel #1	−	−	−	−	+	Too few YOY
Soquel #4	−	−	−	−	+	+
Soquel #10	−	−	−	+	+	+
Soquel #12	NA	−	−	−	+	+
East Br. Soq. #13a	−	−	−	+	+	+
East Br. Soquel #16	+	+	+	+	+	Dry
West Br. Soquel #19	−	−	+ (barely)	+	+	+
West Br. Soquel #21	+	+ (barely)	−	NA	NA	+
Aptos #3	−	+	−	+	+	Too few YOY
Aptos #4	+	+	−	+	+	+
Valencia #2	+	+	NA	NA	NA	Too few YOY
Valencia #3	+ (barely)	+	NA	NA	NA	Too few YOY

Corralitos #1	**NA**	**–**	**+ (barely)**	**+**	**+**	**Too few YOY**
Corralitos #3	**+**	**–**	**+**	**+**	**+**	**Too few YOY**
Corralitos #8	**+**	**+ (barely)**	**+**	**+**	**+**	**Too few YOY**
Corralitos #9	**+**	**+**	**+**	**+**	**+**	**Too few YOY**
Shingle Mill #1	**+ (barely)**	**–**	**–**	**–**	**Too few YOY**	**Too few YOY**
Shingle Mill #3	**+**	**+**	**–**	**+**	**+**	**+**
Browns #1	**+**	**+**	**+**	**+**	**–**	**Too few YOY**
Browns #2	**+**	**+**	**+**	**+**	**+**	**+**
# Negatives	**12**	**13**	**21**	**11**	**6**	**3**

*Indicates that the condition was not met.
**Indicates that the condition was met.

Low densities of Size Class II steelhead at many tributary sites (**Figure 4**) resulted from poor rearing habitat resulting from drought streamflow, low retention of yearlings and/or few YOY the previous year for yearling recruitment. The near-average or higher than average Size Class II densities at some steelhead sites (Zayante 13d, Lompico 13e and Boulder 17b) resulted from average or above average YOY densities in 2013 to recruit yearlings from and retention of high numbers of small yearlings (**Table 42**). These small yearlings had been small YOY the previous year in upper tributary sites and had survived the mild winter/spring wet season with sufficient overwinter cover. On the other hand, Zayante 13c had the highest YOY density in 2013 but very low yearling density in 2014, indicating that nearly all former YOY disappeared. This occurred either because they grew large enough during the spring with little turbidity to smolt early as young yearlings or they were flushed downstream by relatively small stormflows without overwinter cover in a largely bedrock reach with little instream wood. Overwinter survival of yearlings in Reach 13c may be improved significantly by installing wood projects there.

Soquel Watershed

The below average densities of Size Class II and III juveniles at all sites in the Soquel drainage again in 2014 as in 2013 (**Figure 8**) were due to 1) typical poor survival/retention of yearlings either because they were flushed out despite low winter stormflows or grew sufficiently in low turbidity water in spring to smolt early, 2) low yearling recruitment from a below average 2013 YOY population, 3) no YOY grew into Size Class II at upper mainstem sites due to reduced food from low baseflow and relatively high YOY density and competition (**Figure 18a**), unlike wetter years (**Figure 18b**) and no YOY reaching Size Class II at Site 1 and few YOY reaching Size Class II with above average yearlings numbers to compete with (**Figure 7**) . The averaged mean monthly streamflow for May–September in Soquel Creek was the lowest in the past 18 years, resulting in reduced riffle area and low insect drift for food (**Figure 45**).

Aptos Watershed

Below average densities of larger juveniles in Aptos sites in 2014 resulted from no YOY reaching Size Class II at Site 3 (**Figure 19a**) and below average yearling density (**Figure 11**) combined with only 10% of YOY reaching Size Class II at Site 4. Below average densities of larger juveniles in Valencia sites resulted from much below average yearling and older densities in 2014. Pool habitat had seriously deteriorated since 2010, with no pool habitat found at Site 2 and much shallower pool habitat at Site 3

(**Table 16b**), offering only limited habitat for yearlings. Also with limited adult passage flows after December 2012, adult access to Valencia Creek may have been limited in 2013, resulting in low YOY densities from which yearlings would be recruited in 2014.

Corralitos Sub-Watershed
The below average densities of larger juveniles at 6 of 8 sites (**Figure 16**) resulted from low densities of YOY (**Figure 14**) and few YOY reaching Size Class II, despite the high percentage that reached Size Class II (**Figure 20a**). The slightly above average densities of larger juveniles at Corralitos Site 3 and Shingle Mill Site 1 resulted from a good portion of YOY reaching Size Class II and relatively high YOY densities at the former and near average yearling density at the latter (**Figure 15**). The yearlings at these sites consisted of relatively small fish with high retention after a very mild winter without large stormflows that would displace overwintering yearlings (**Table 42**).

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

As in the watersheds we sampled in 2014, YOY densities were below average at all sampling sites in Gazos and Scott creeks (**Figures 48 and 49; from Smith 2014**), and the average YOY density for all sites combined in Waddell Creek declined to its lowest point since monitoring began in 1988 (**Figure 52; from Smith 2014**). Most of the YOY site densities in Gazos and Scott creeks were well below average. YOY average density for all sites combined has declined since 2010 in Scott Creek to a similarly low average density found in 2009. YOY average density for all sites combined increased slightly in Gazos Creek from 2013. But the 2014 Gazos YOY average density was still one of the 4 smallest since 1992.

Densities of yearling juveniles were near average or above average at 6 of 8 sites in Gazos Creek and 8 of 10 sites in Scott Creek in 2014 (**Figures 50 and 51;** data from **Smith 2014**). This above average survival of yearlings after a mild winter was inconsistent with poor survival/retention of yearlings in all but headwater and upper tributary sites in the San Lorenzo (**Figure 3**), 3 of 4 sites in the Aptos watershed (**Figure 11**) and 6 of 8 sites in the Corralitos sub-watershed (**Figure 15**). Gazos yearling densities near or above average was consistent with yearling densities in the Soquel watershed where they were near or above average at all sites that remained watered (**Figure 7**). However, yearling densities in Soquel Creek were generally less than in Gazos or Scott creeks. The overall downward trend in YOY densities (which mirrors a trend in total density) in Scott, Waddell and Gazos creeks (**Figure 52**) is consistent with the overall downward trend in total juvenile densities in San Lorenzo mainstem sites and tributary sites, averaged separately (**Figures 21 and 23**). The general downward trend in yearling densities since 1994 in Gazos to 2007 and in Scott and Waddell to 2011has shown up and down fluctuation in Gazos since 2007 and slight increases in Scott and Waddell since 2011 (**Figure 53**). Yearling densities in these streams with slow growth rate potential are most comparable to soon-to-smolt densities in the San Lorenzo. There has been an overall downward trend in mainstem sites and tributary sites, averaged separately, with no upswing since 2011, as occurred in Scott and Waddell (**Figures 22 and 24**). Soon-to-smolt densities have fluctuated at the Soquel stream sites, with them at a low point in 2014 (**Figure 26**). The same is true for Aptos and Corralitos stream sites (**Figures 28 and 32**).

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. In 2014, reach indices for soon-to-smolt juvenile densities were calculated in the San Lorenzo, Soquel and Corralitos watersheds in 2014 and 2010. Reach indices were totaled for each watershed. In this way we could evaluate the relative importance of each reach with its length factored in. We could compare indices for a wet year (2010) and a very dry year (2014). 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.

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. Three reaches have been inventoried each year since in the various watersheds.

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, other gages were established in Boulder Creek below Foreman confluence and Zayante Creek above Lompico confluence in 2014. As part of a monitoring program funded by the SLVWD, additional streamflow measurements were taken in the mainstem near the mouths of Boulder, Clear, Fall and Bull creeks and in Boulder, Lompico and Zayante creeks.

There is no stream gage in the Aptos watershed. It would be beneficial to have stream gages on lower Valencia Creek and Aptos Creek above 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.

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FIGURES

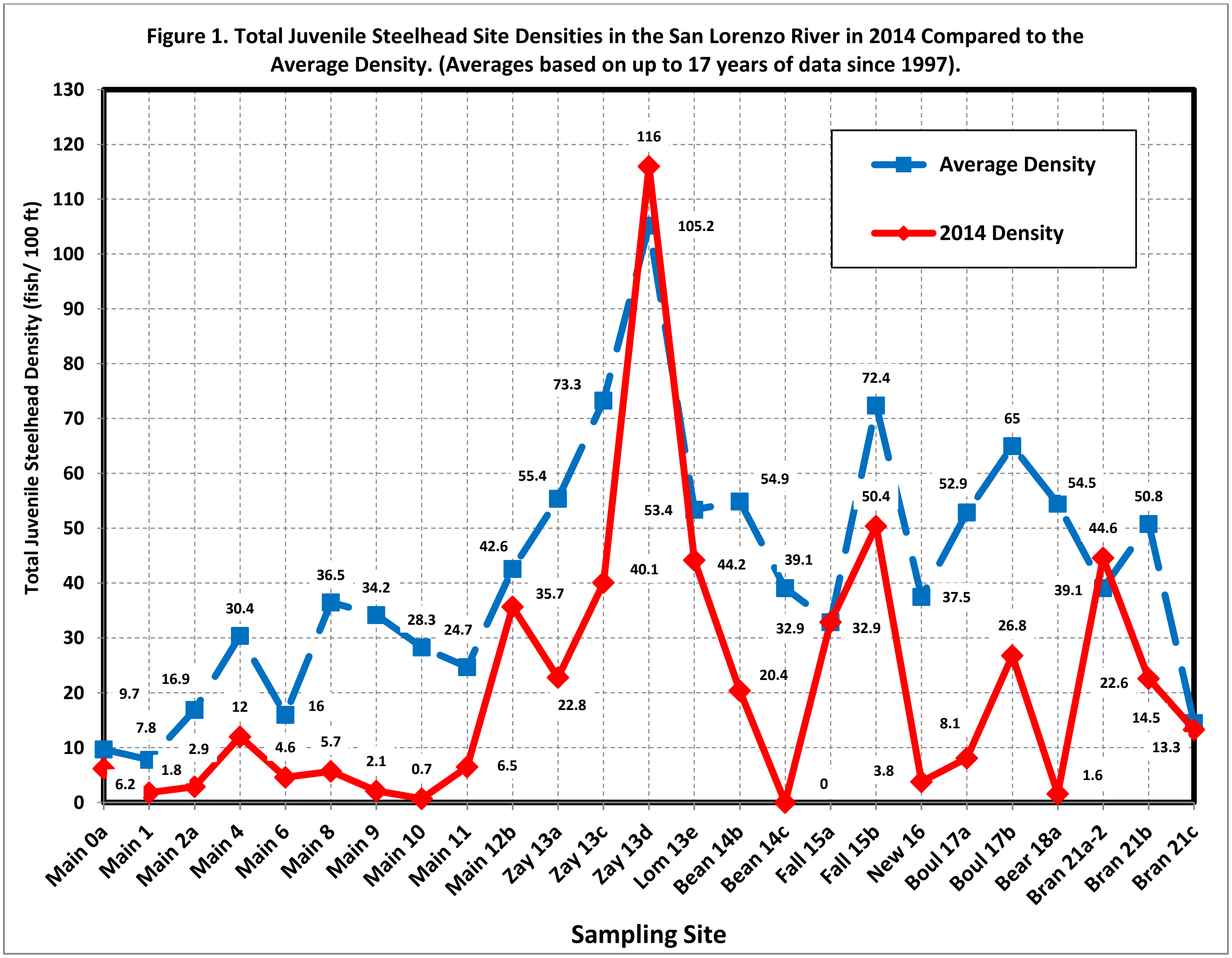


Figure 1. Total Juvenile Steelhead Site Densities in the San Lorenzo River in 2014 Compared to the Average Density. (Averages based on up to 17 years of data since 1997).

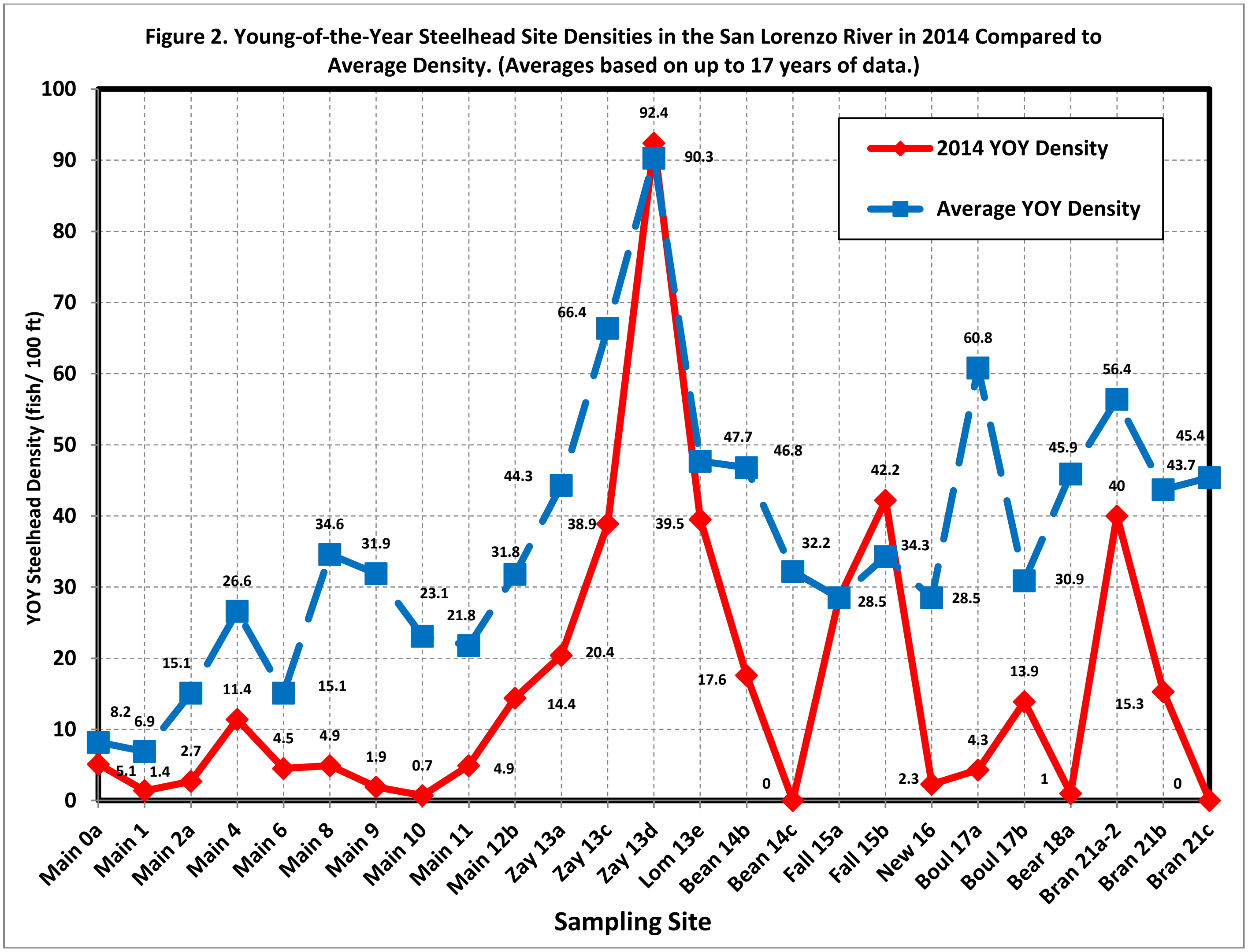


Figure 2. Young-of-the-Year Steelhead Site Densities in the San Lorenzo River in 2014 Compared to Average Density. (Averages based on up to 17 years of data.)

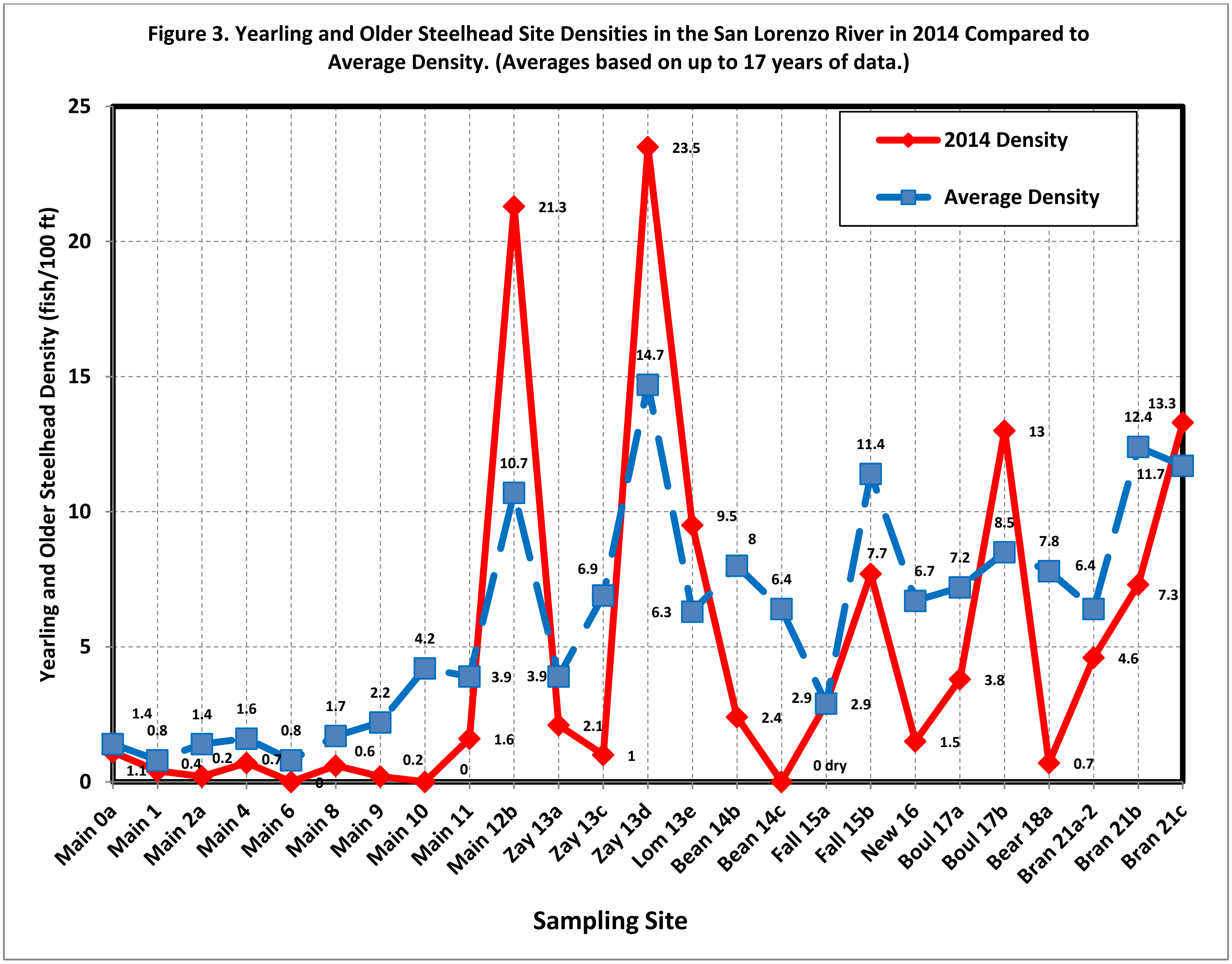


Figure 3. Yearling and Older Steelhead Site Densities in the San Lorenzo River in 2014 Compared to Average Density. (Averages based on up to 17 years of data.)

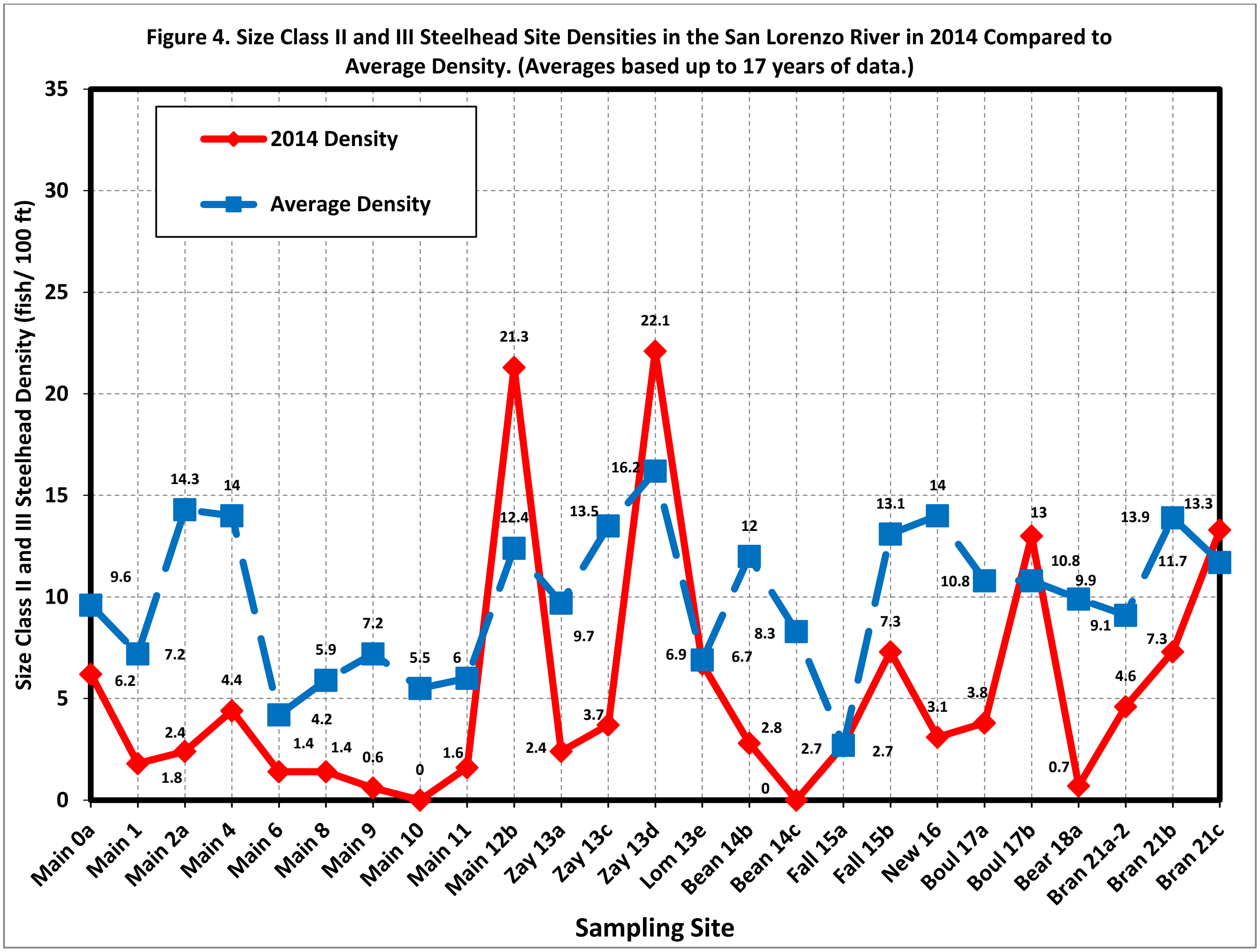


Figure 4. Size Class II and III Steelhead Site Densities in the San Lorenzo River in 2014 Compared to Average Density. (Averages based on up to 17 years of data.)

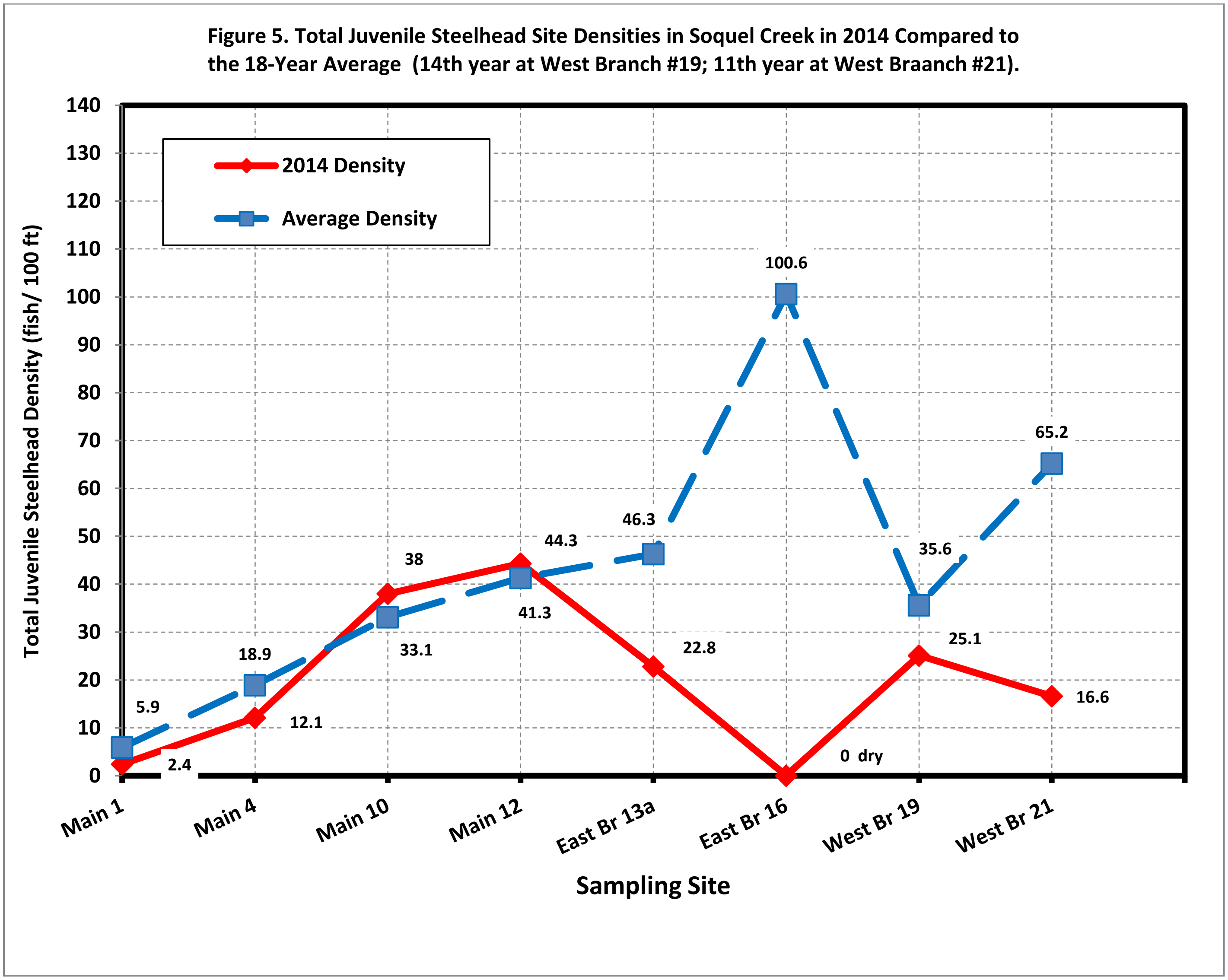


Figure 5. Total Juvenile Steelhead Site Densities in Soquel Creek in 2014 Compared to the 18-Year Average (14th year at West Branch #19).

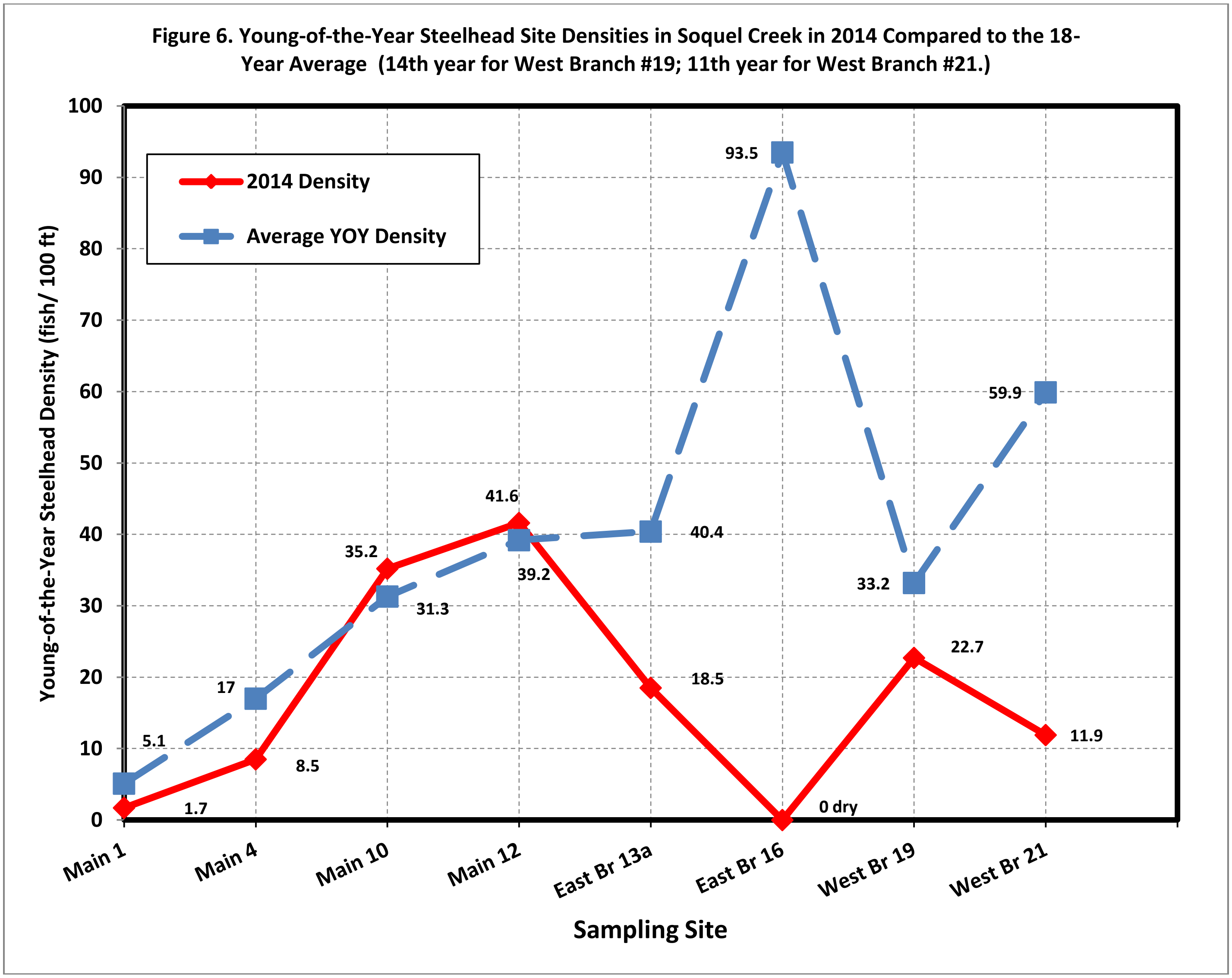


Figure 6. Young-of-the-Year Steelhead Site Densities in Soquel Creek in 2014 Compared to the 18-Year Average (14th year for West Branch #19.)

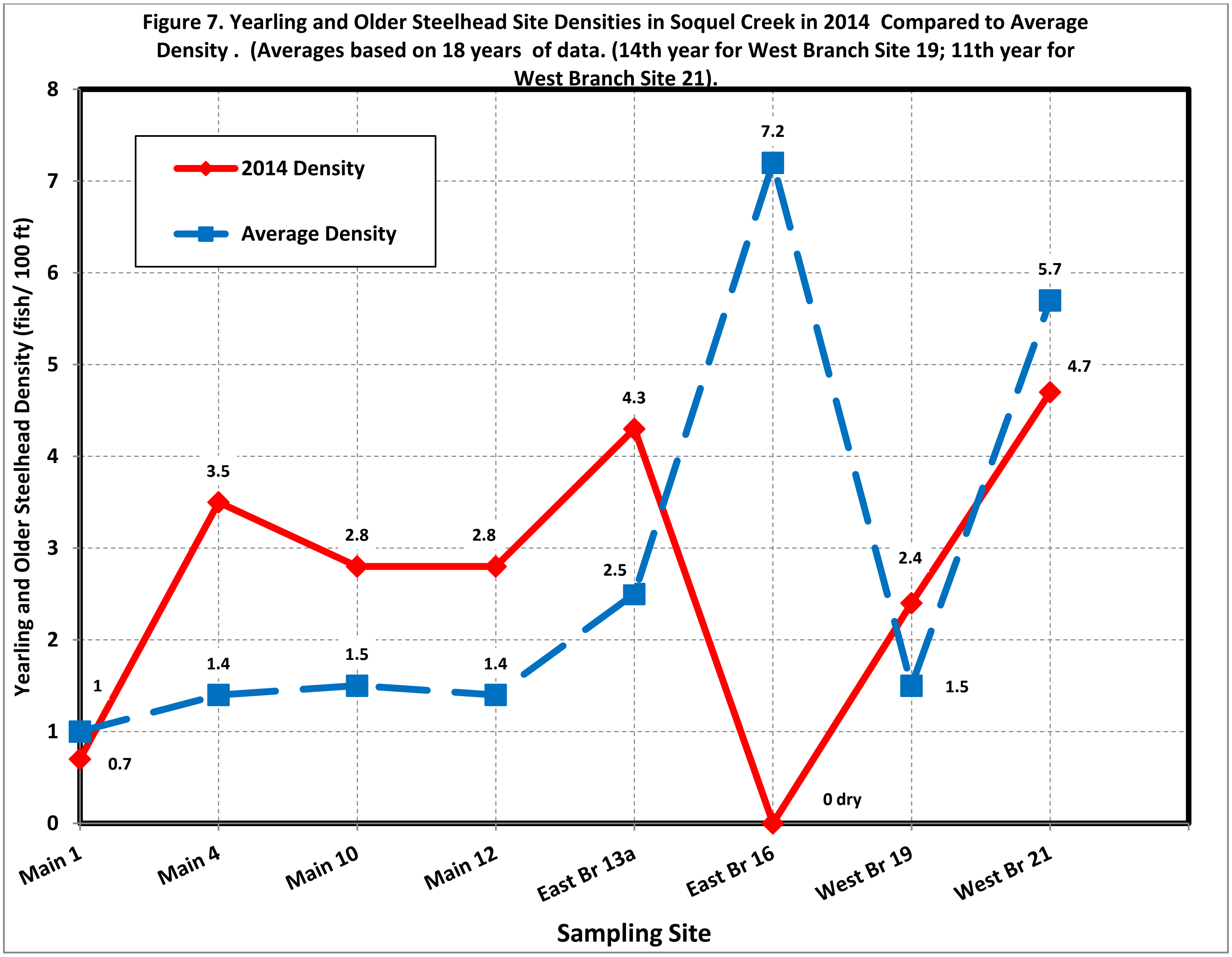


Figure 7. Yearling and Older Steelhead Site Densities in Soquel Creek in 2014 Compared to Average Density. (Averages based on 18 years of data. (14th year for West Branch Site 19).

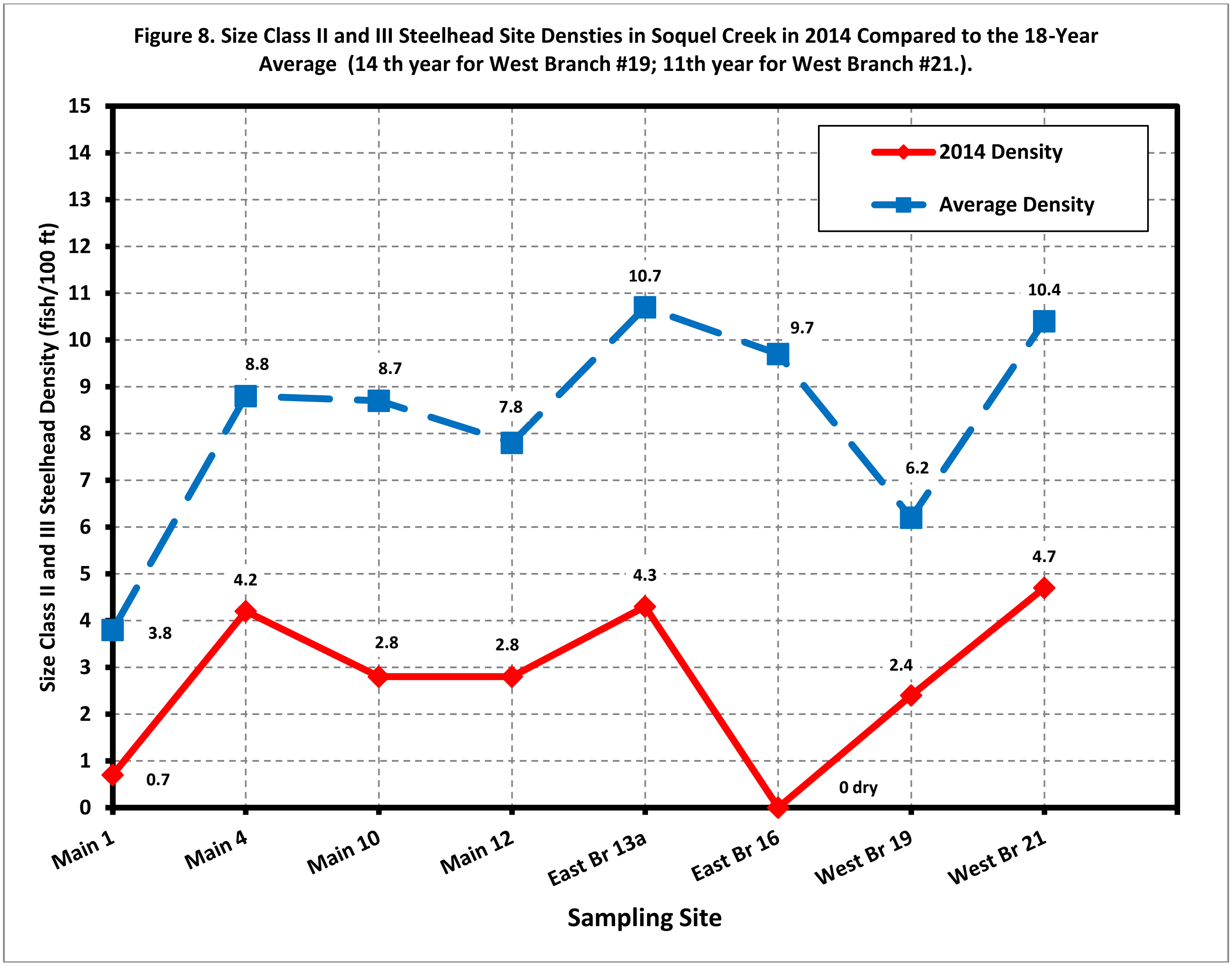


Figure 8. Size Class II and III Steelhead Site Densities in Soquel Creek in 2014 Compared to the 18-Year Average (14th year for West Branch #19.)

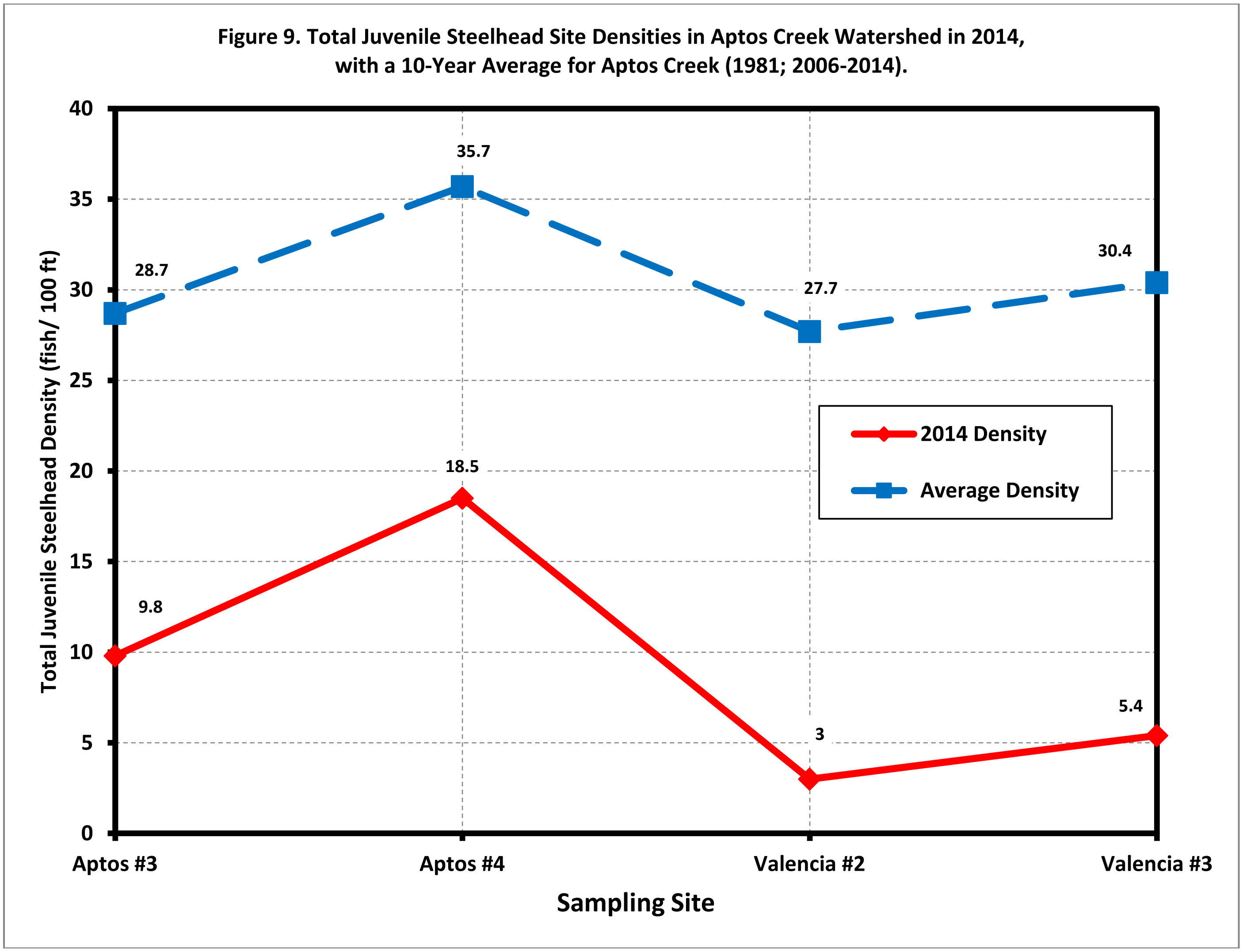


Figure 9. Total Juvenile Steelhead Site Densities in Aptos Creek in 2014, with a 10-Year Average (1981; 2006-2014).

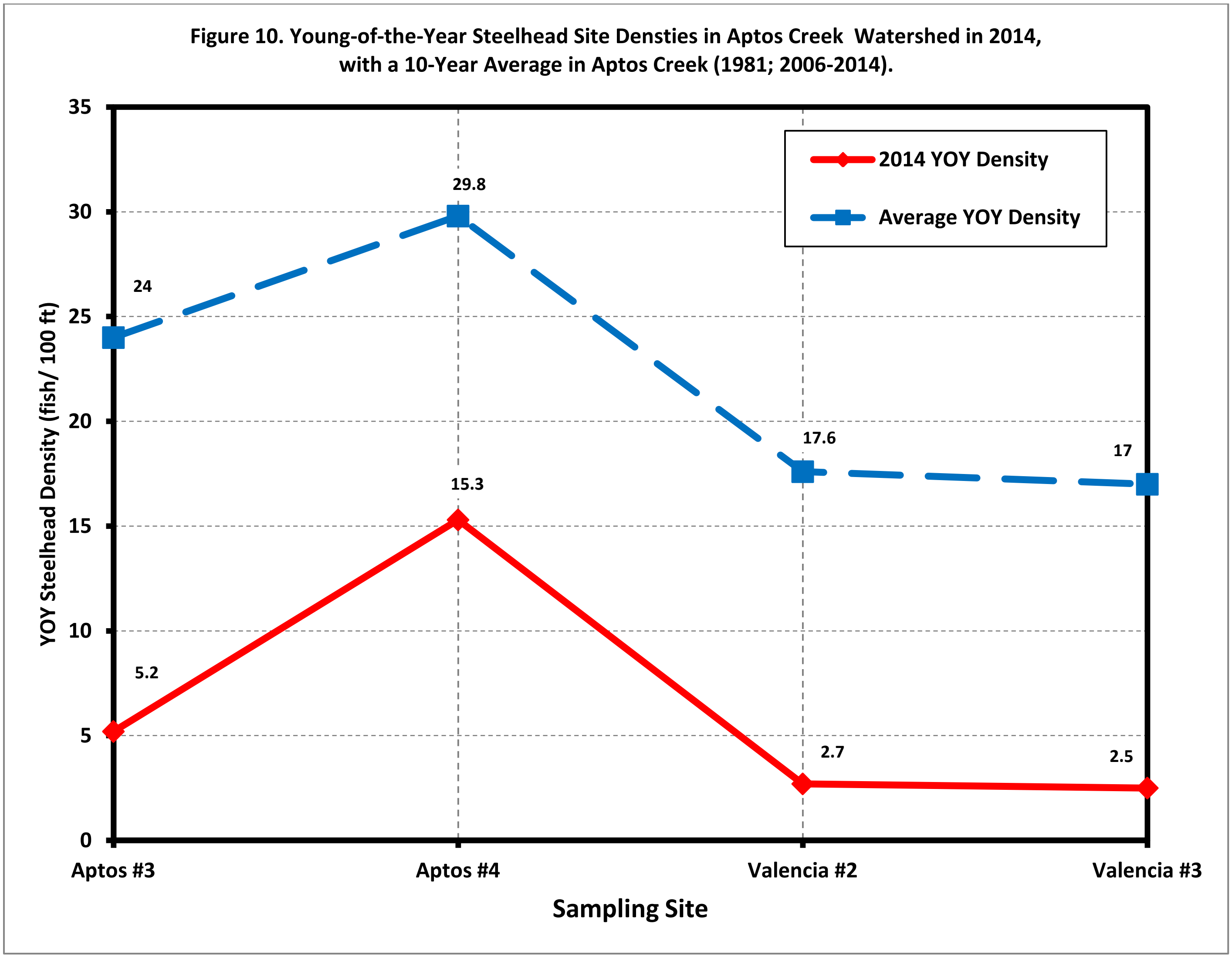


Figure 10. Young-of-the-Year Steelhead Site Densities in Aptos Creek in 2014, with a 10-Year Average (1981; 2006-2014).

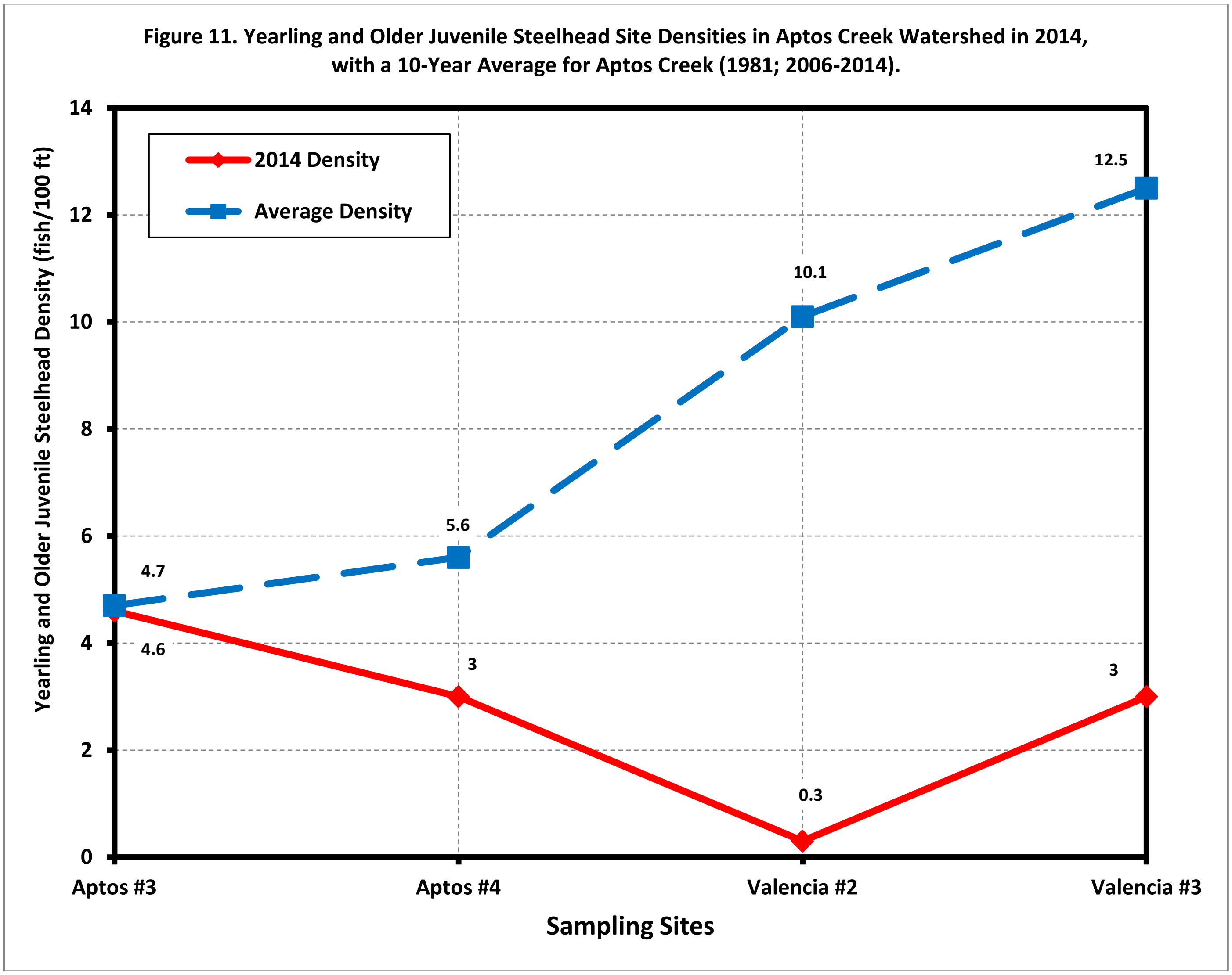


Figure 11. Yearling and Older Juvenile Steelhead Site Densities in Aptos Creek in 2014, with a 10-Year Average (1981; 2006-2014).

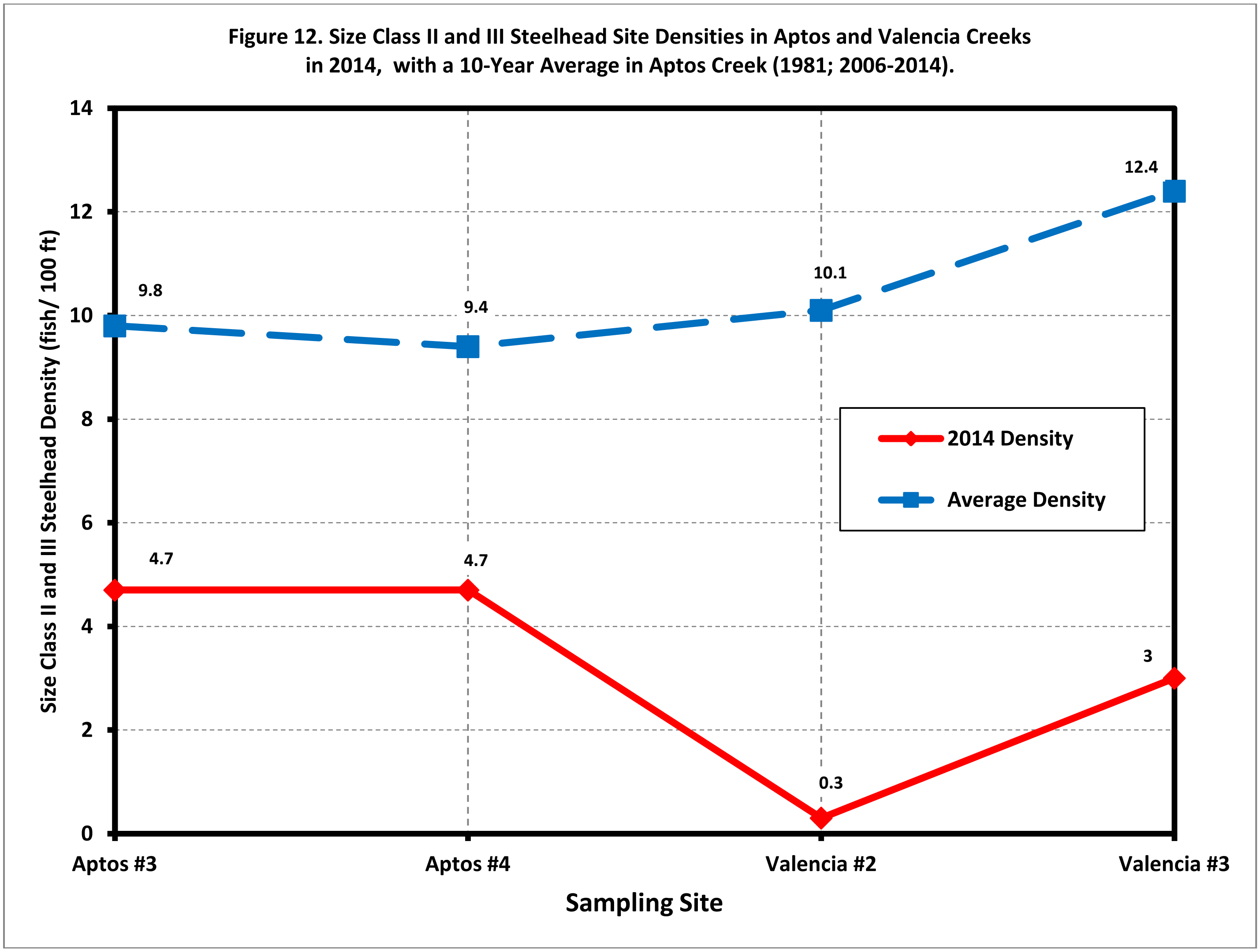


Figure 12. Size Class II and III Steelhead Site Densities in Aptos and Valencia Creeks in 2014, with a 10-Year Average (1981; 2006-2014).

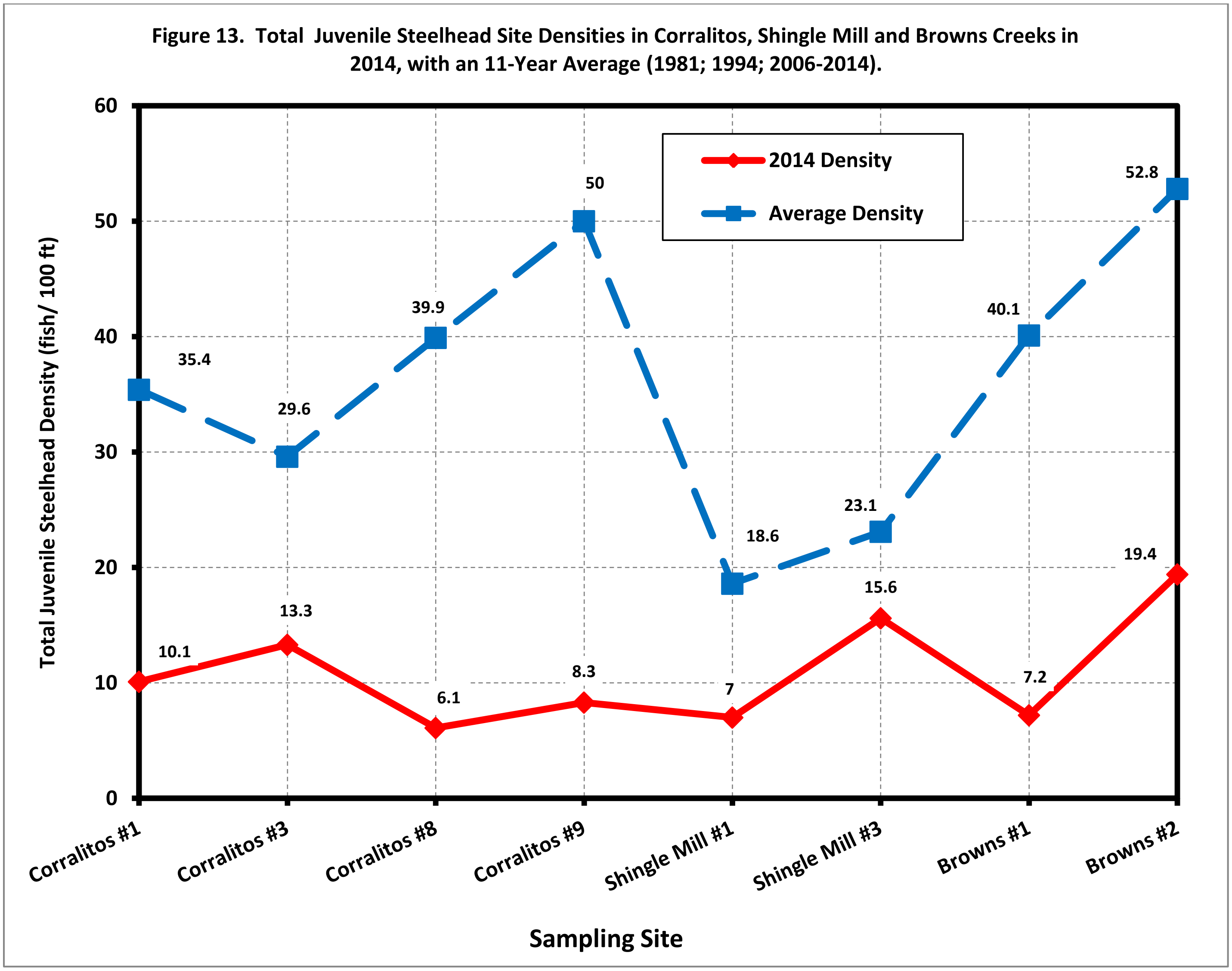


Figure 13. Total Juvenile Steelhead Site Densities in Corralitos, Shingle Mill and Browns Creeks in 2014, with an 11-Year Average (1981; 1994; 2006-2014).

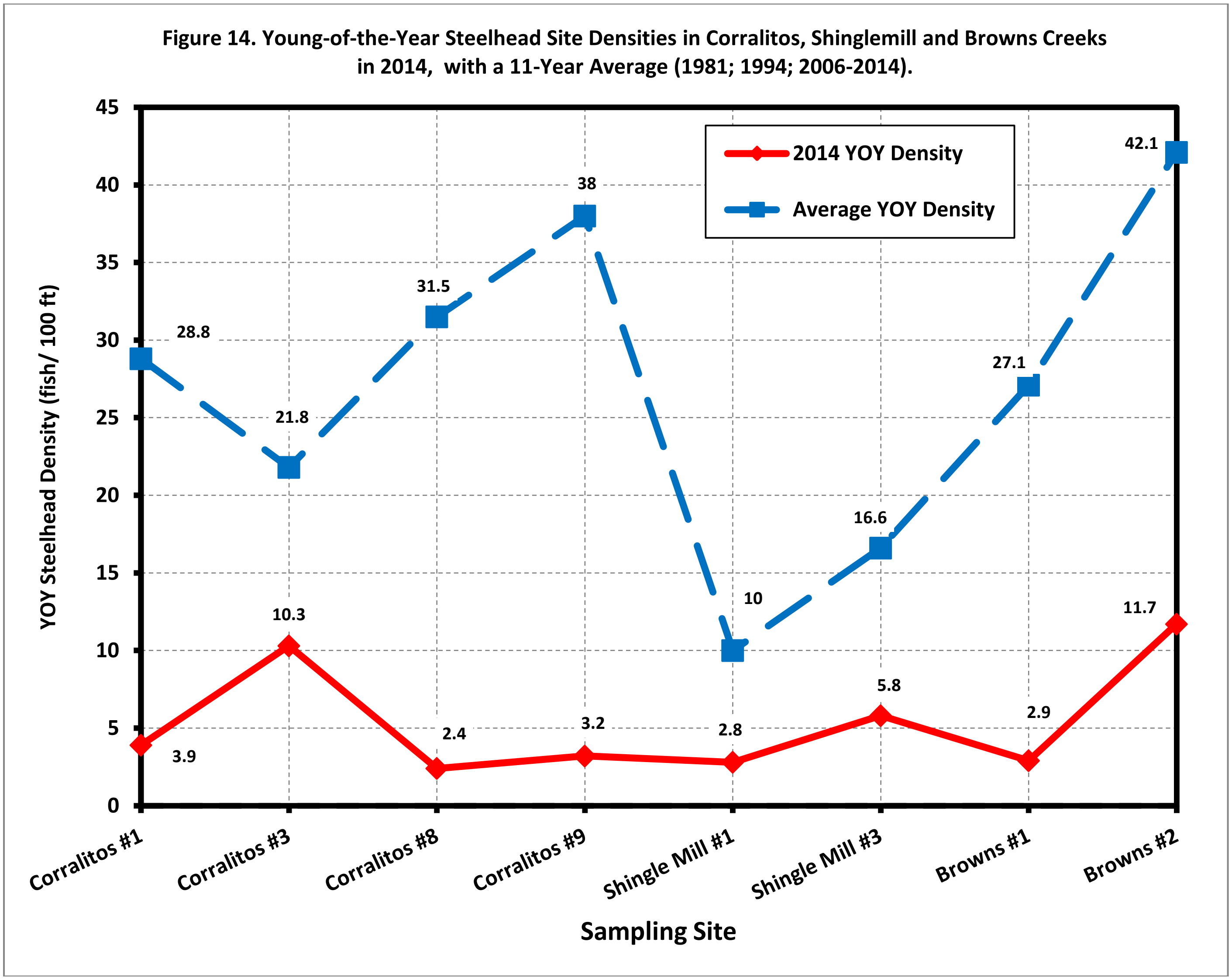


Figure 14. Young-of-the-Year Steelhead Site Densities in Corralitos, Shingle Mill and Browns Creeks in 2014, with an 11-Year Average (1981; 1994; 2006-2014).

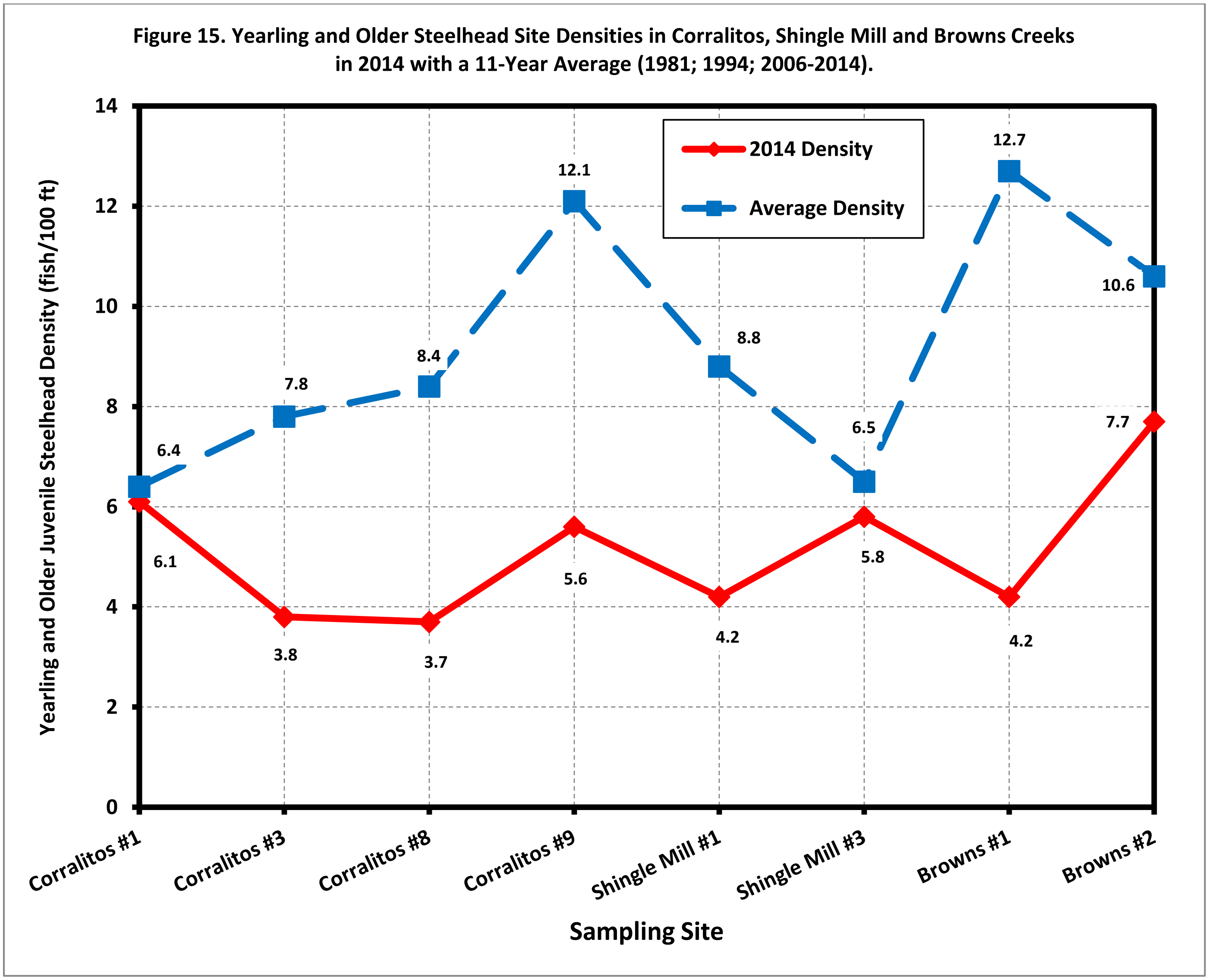


Figure 15. Yearling and Older Steelhead Site Densities in Corralitos, Shingle Mill and Browns Creeks in 2014 with an 11-Year Average (1981; 1994; 2006-2014).

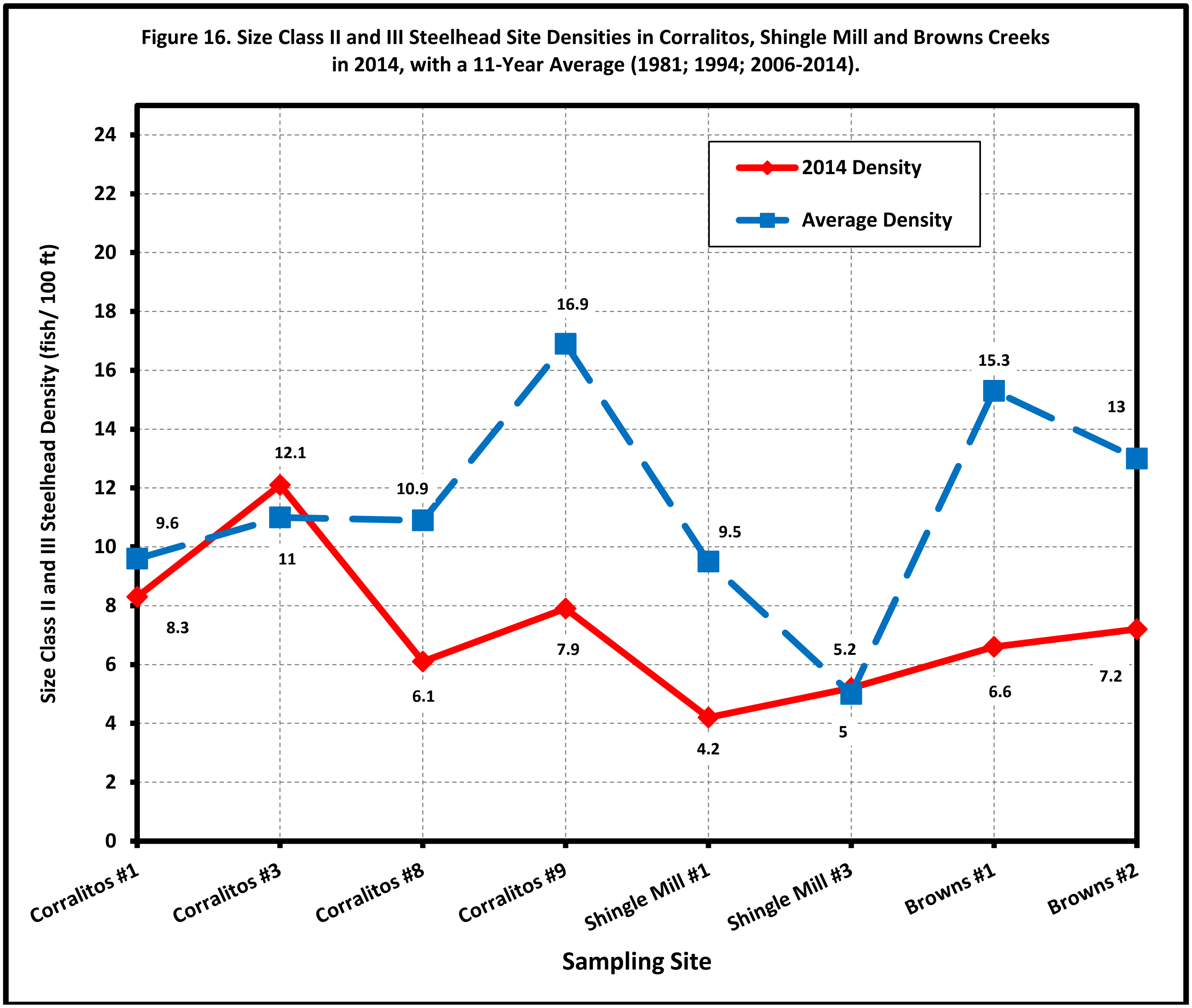


Figure 16. Size Class II and III Steelhead Site Densities in Corralitos, Shingle Mill and Browns Creeks in 2014, with an 11-Year Average (1981; 1994; 2006-2014).

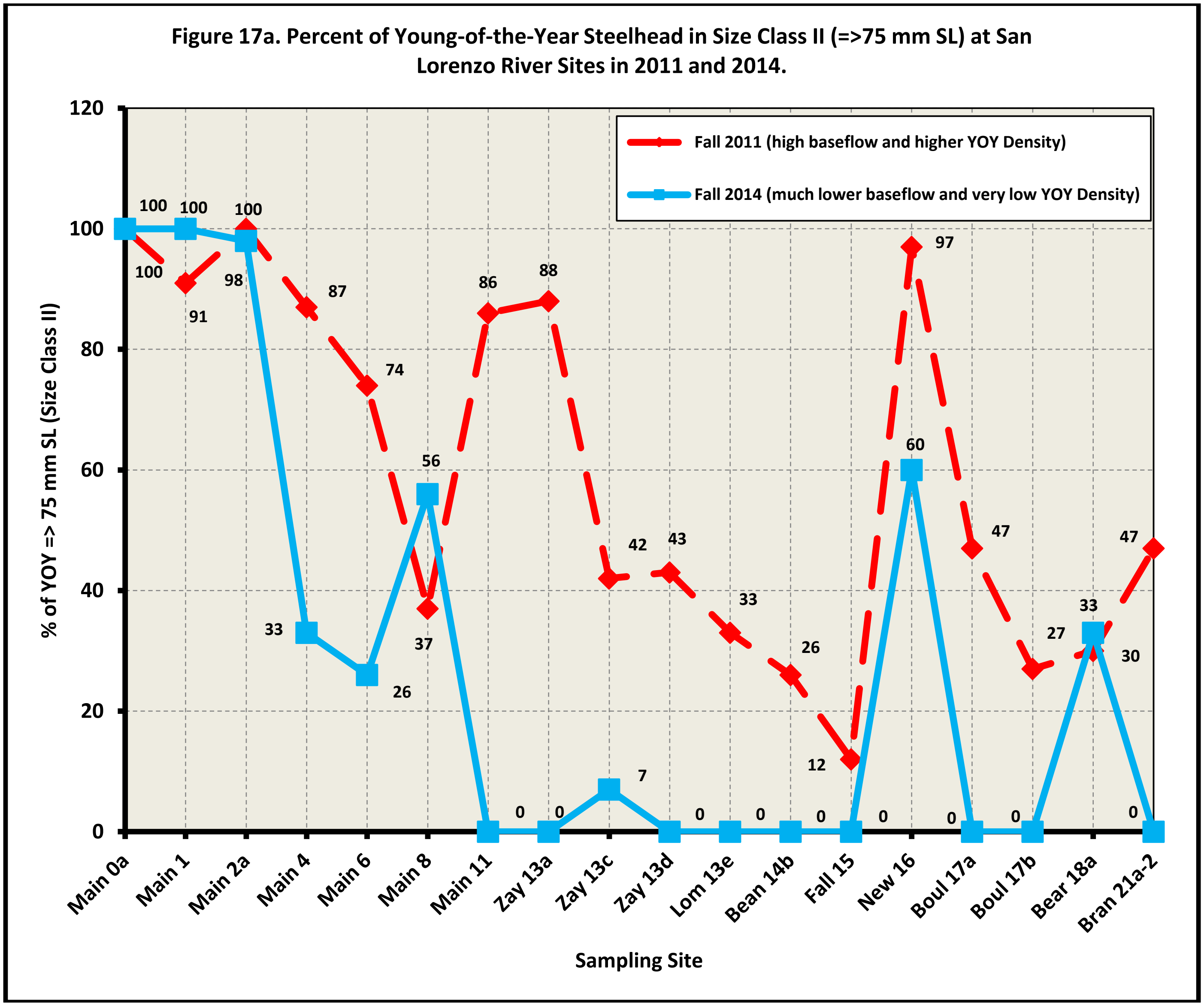


Figure 17a. Percent of Young-of-the-Year Steelhead in Size Class II (=>75 mm SL) at San Lorenzo River Sites in 2011 and 2014.

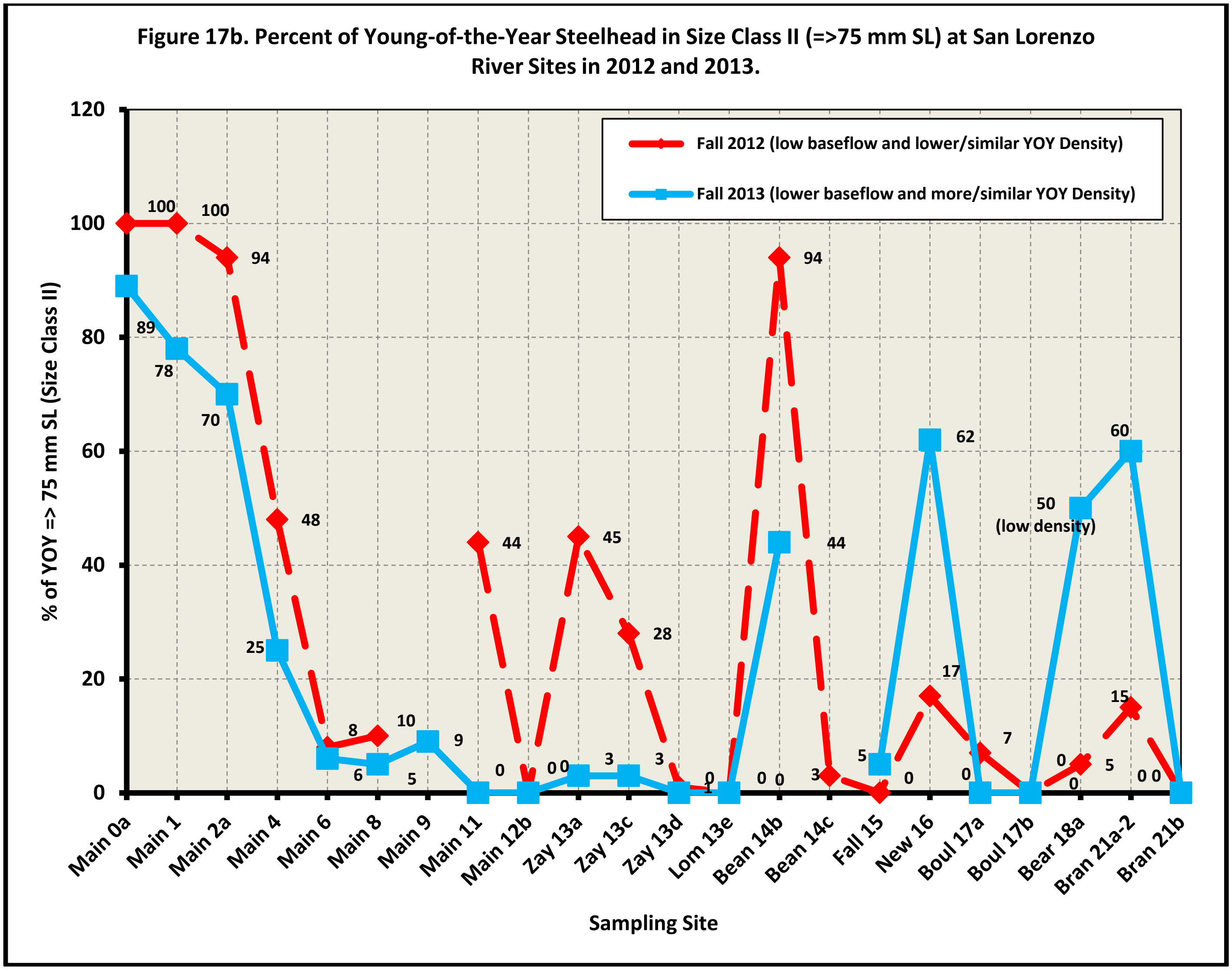


Figure 17b. Percent of Young-of-the-Year Steelhead in Size Class II (=>75 mm SL) at San Lorenzo River Sites in 2012 and 2013.

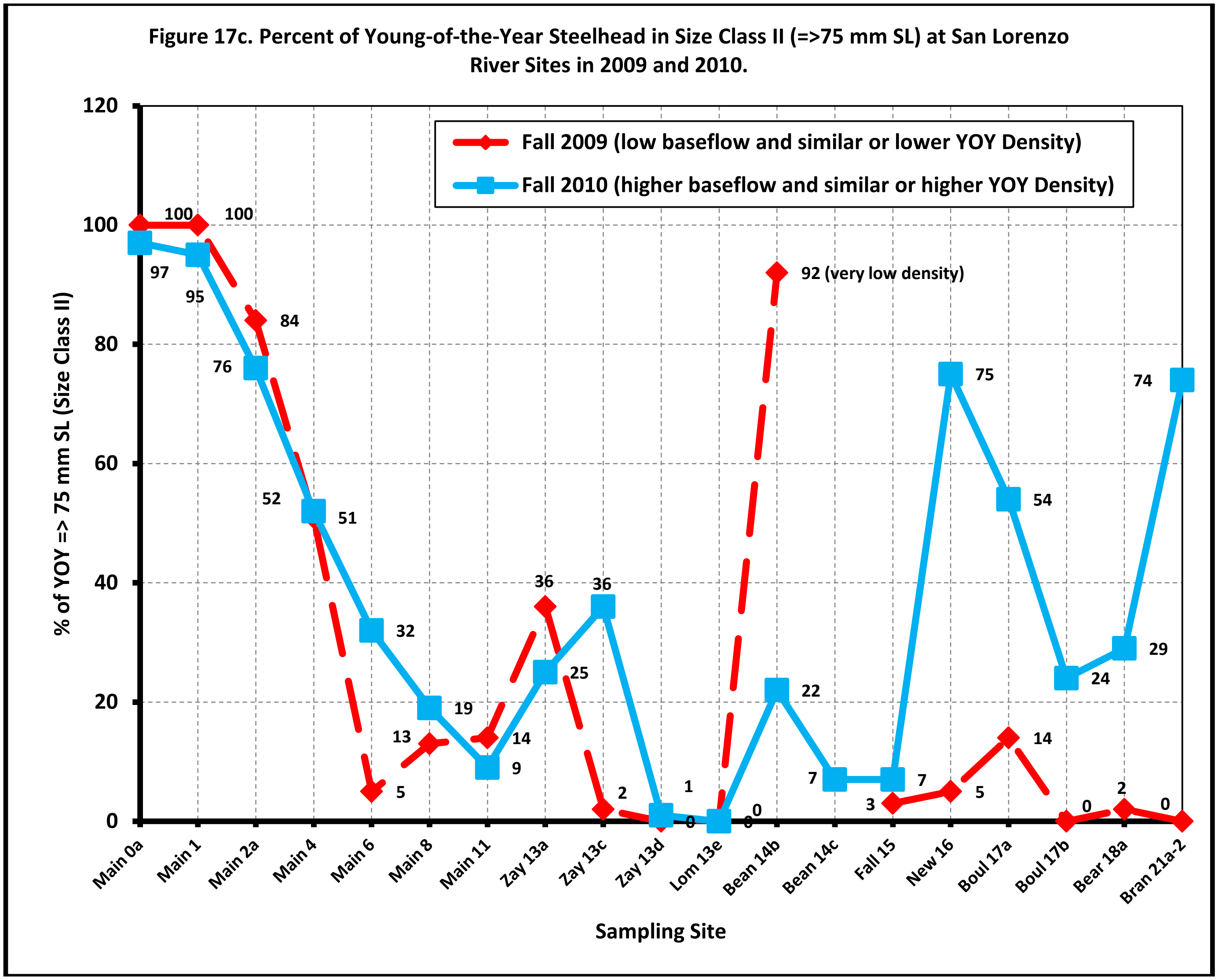


Figure 17b. Percent of Young-of-the-Year Steelhead in Size Class II (=>75 mm SL) at San Lorenzo River Sites in 2009 and 2010.

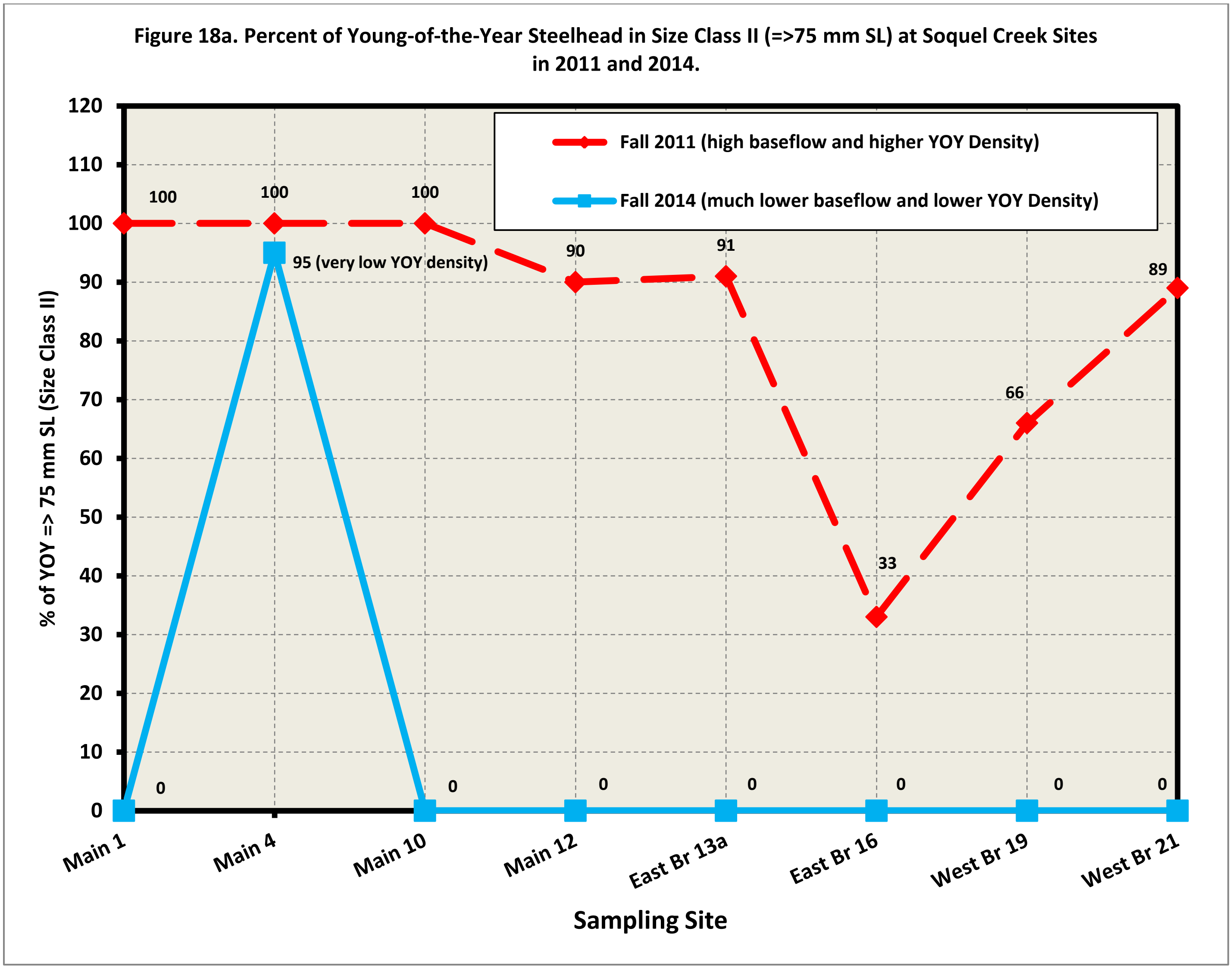


Figure 18a. Percent of Young-of-the-Year Steelhead in Size Class II (=>75 mm SL) at Soquel Creek Sites in 2011 and 2014.

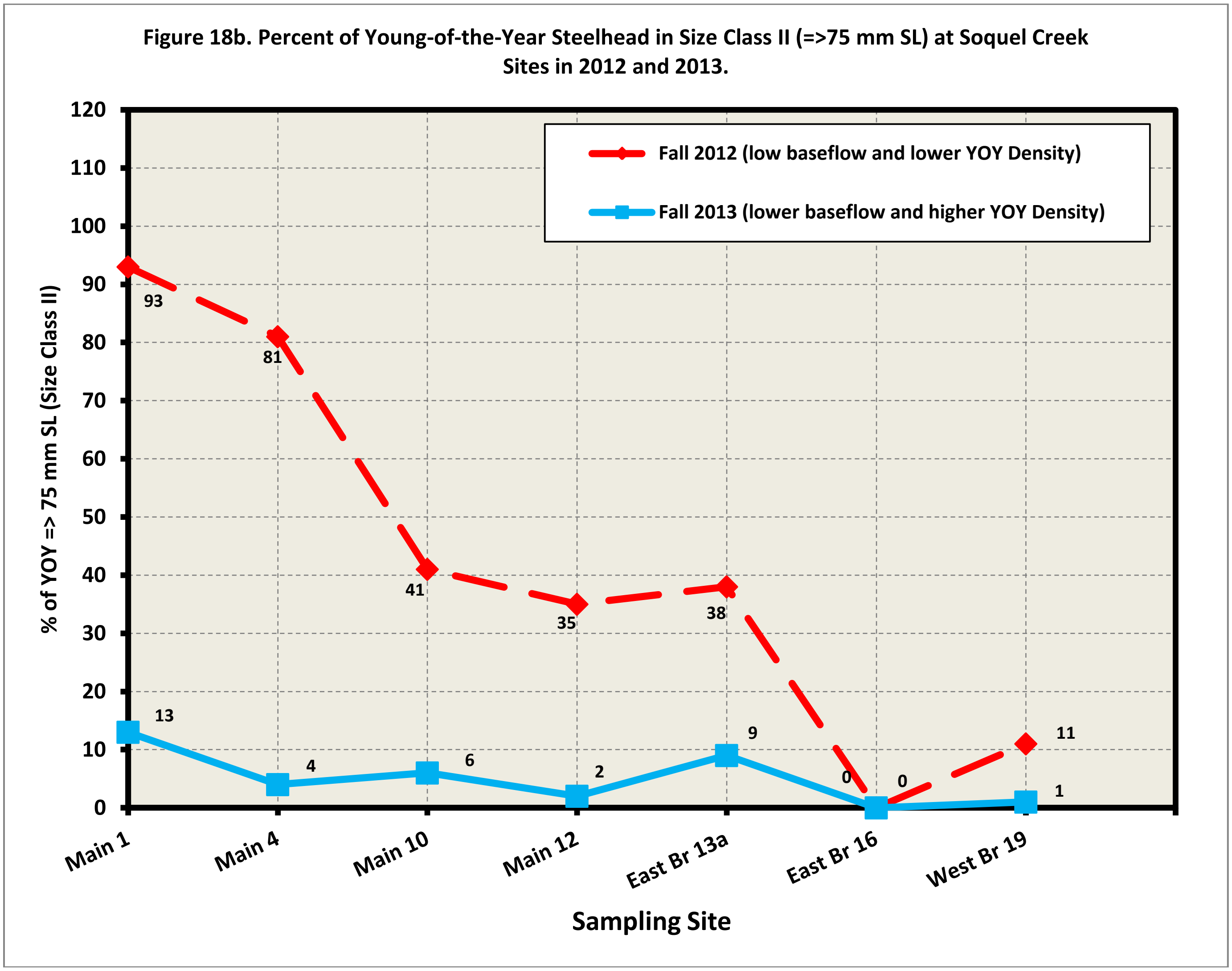


Figure 18b. Percent of Young-of-the-Year Steelhead in Size Class II (=>75 mm SL) at Soquel Creek Sites in 2012 and 2013.

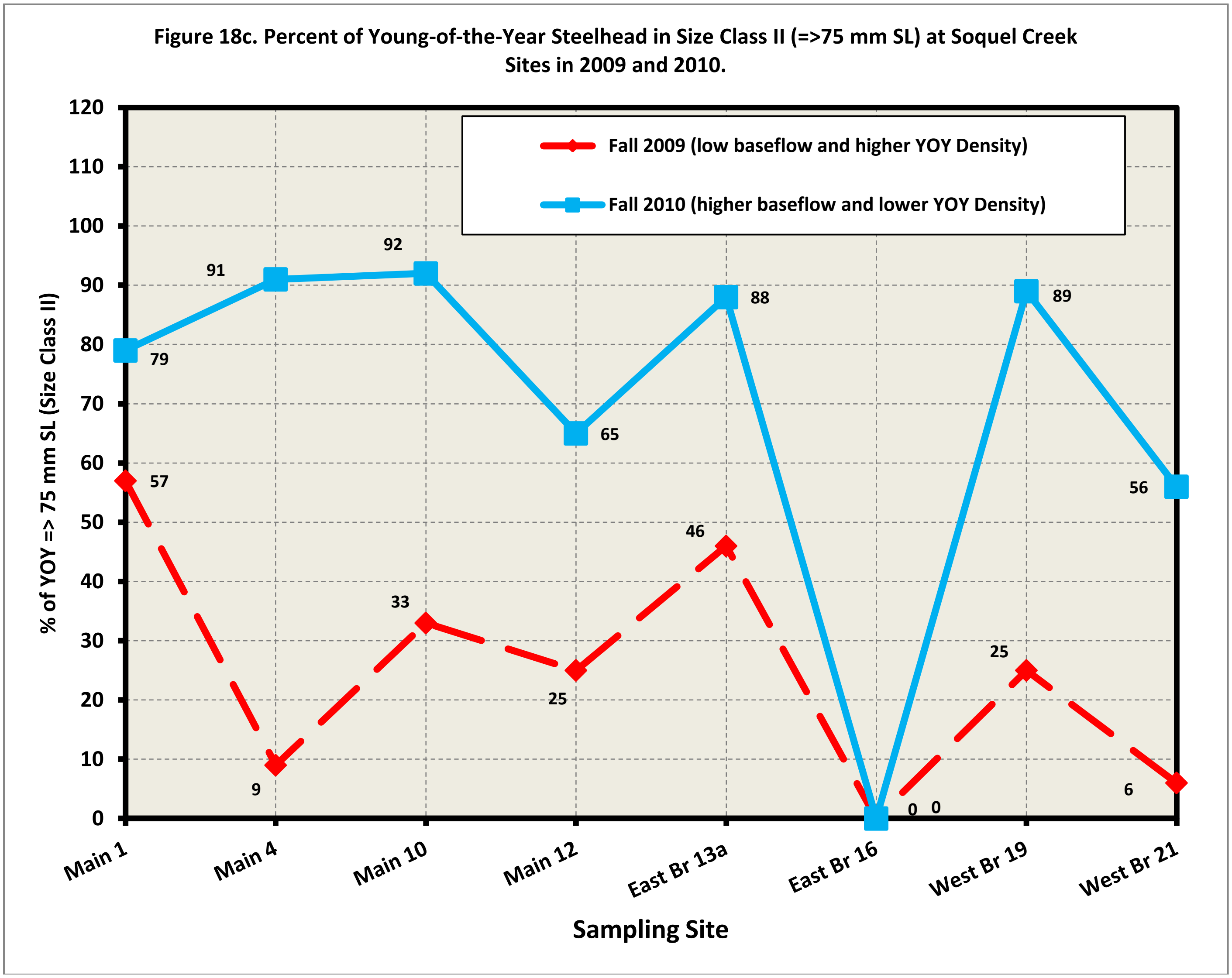


Figure 18c. Percent of Young-of-the-Year Steelhead in Size Class II (=>75 mm SL) at Soquel Creek Sites in 2009 and 2010.

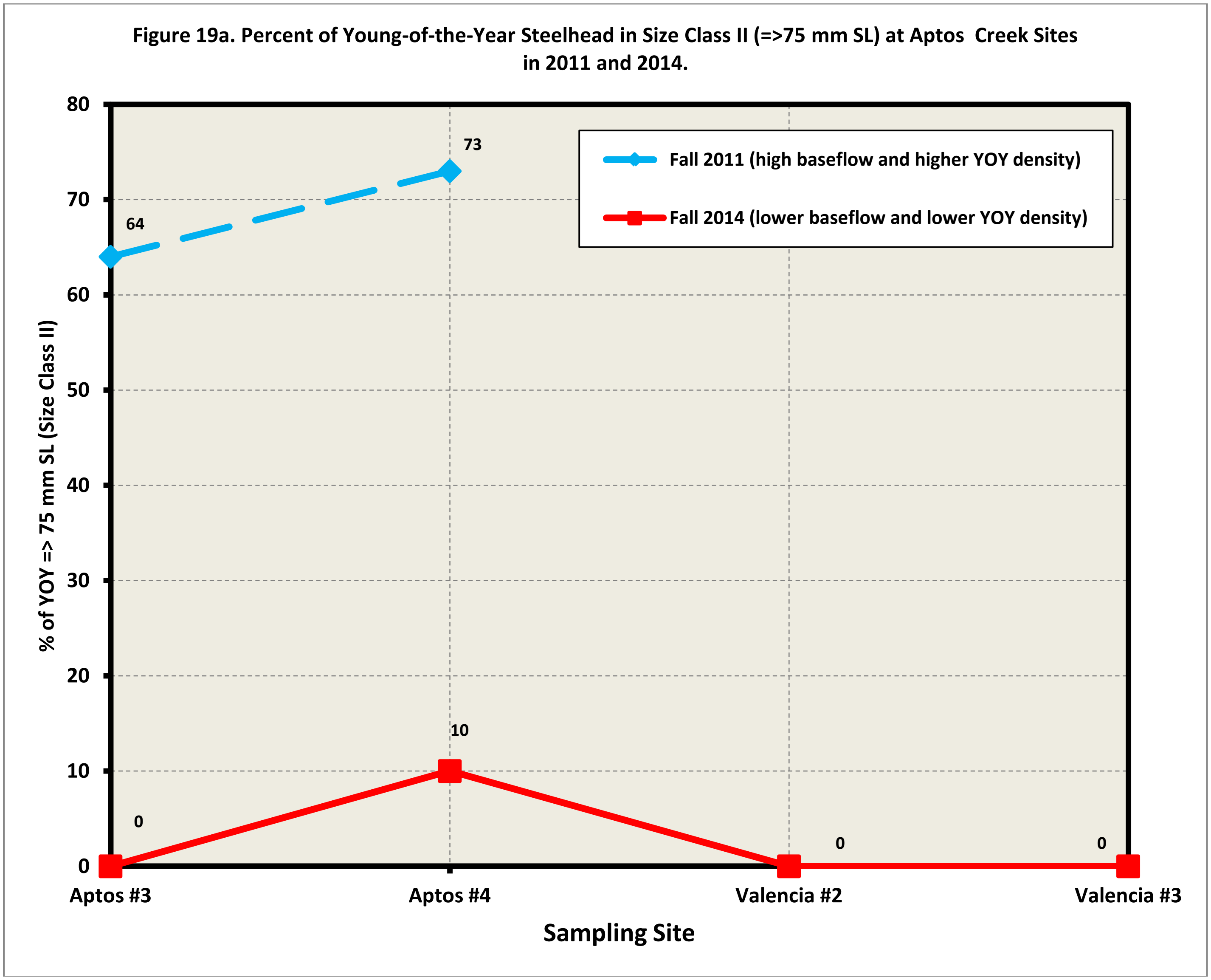


Figure 19a. Percent of Young-of-the-Year Steelhead in Size Class II (=>75 mm SL) at Aptos Creek Sites in 2011 and 2014.

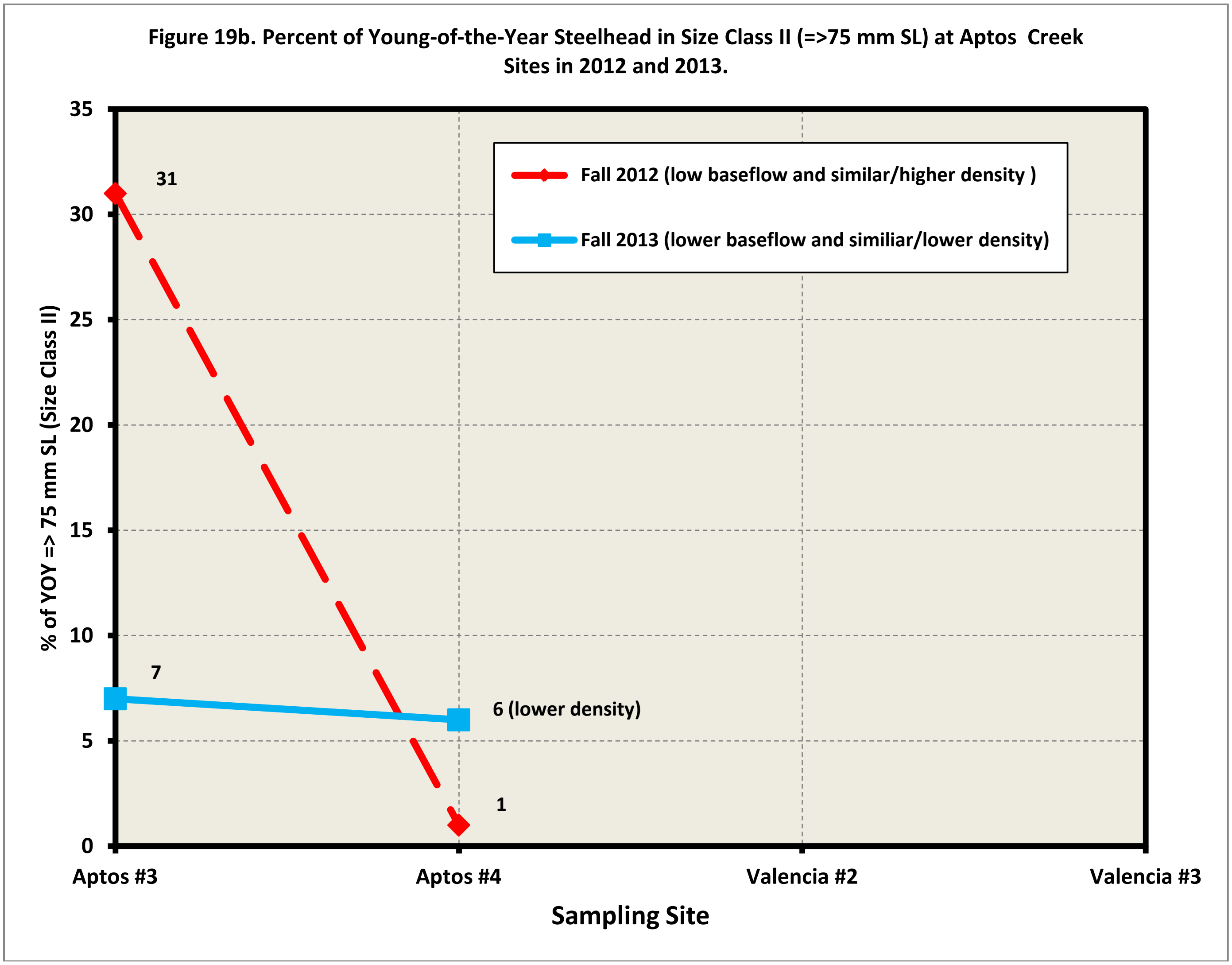


Figure 19b. Percent of Young-of-the-Year Steelhead in Size Class II (=>75 mm SL) at Aptos Creek Sites in 2012 and 2013.

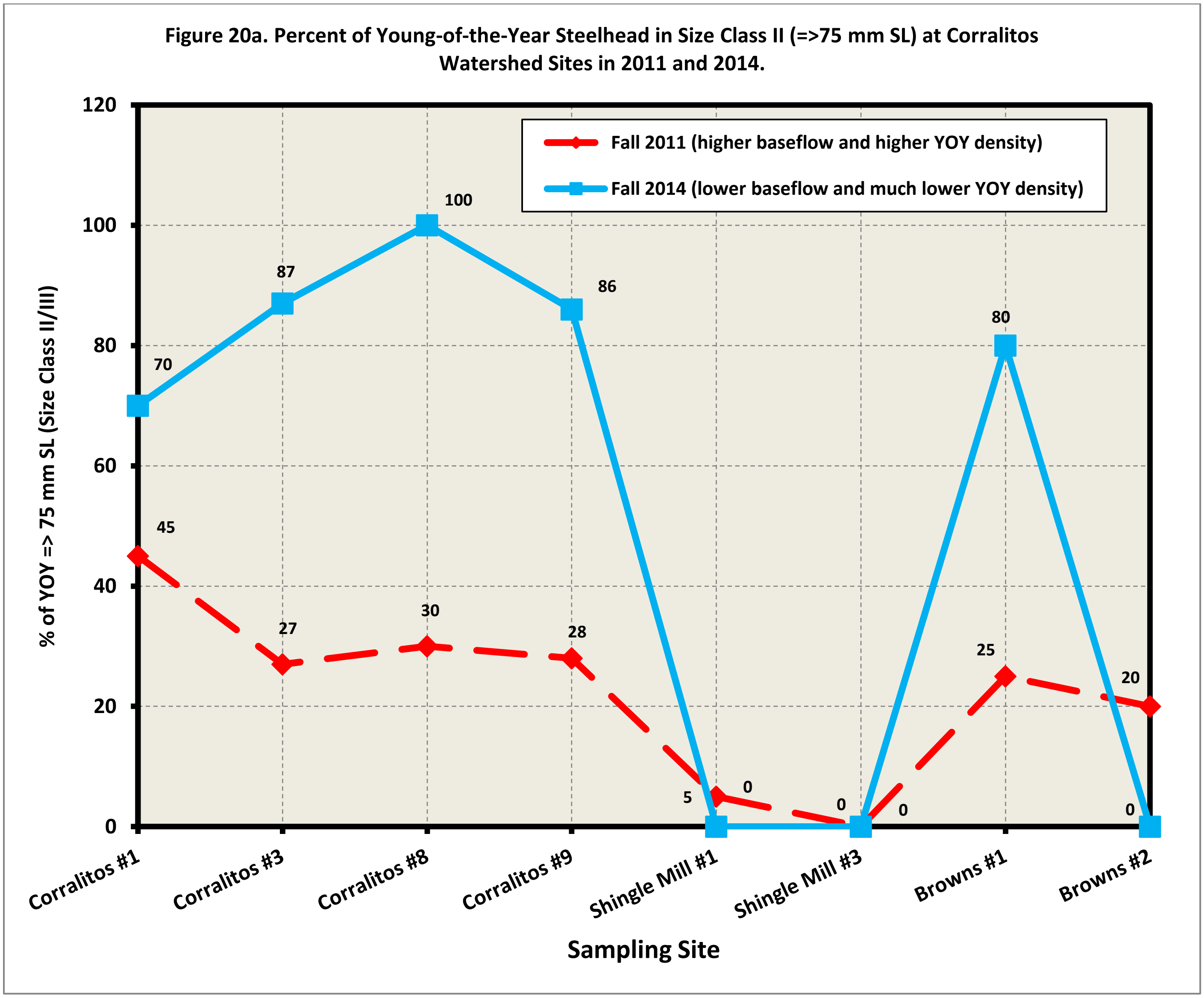


Figure 20a. Percent of Young-of-the-Year Steelhead in Size Class II (=>75 mm SL) at Corralitos Sub-Watershed Sites in 2011 and 2014.

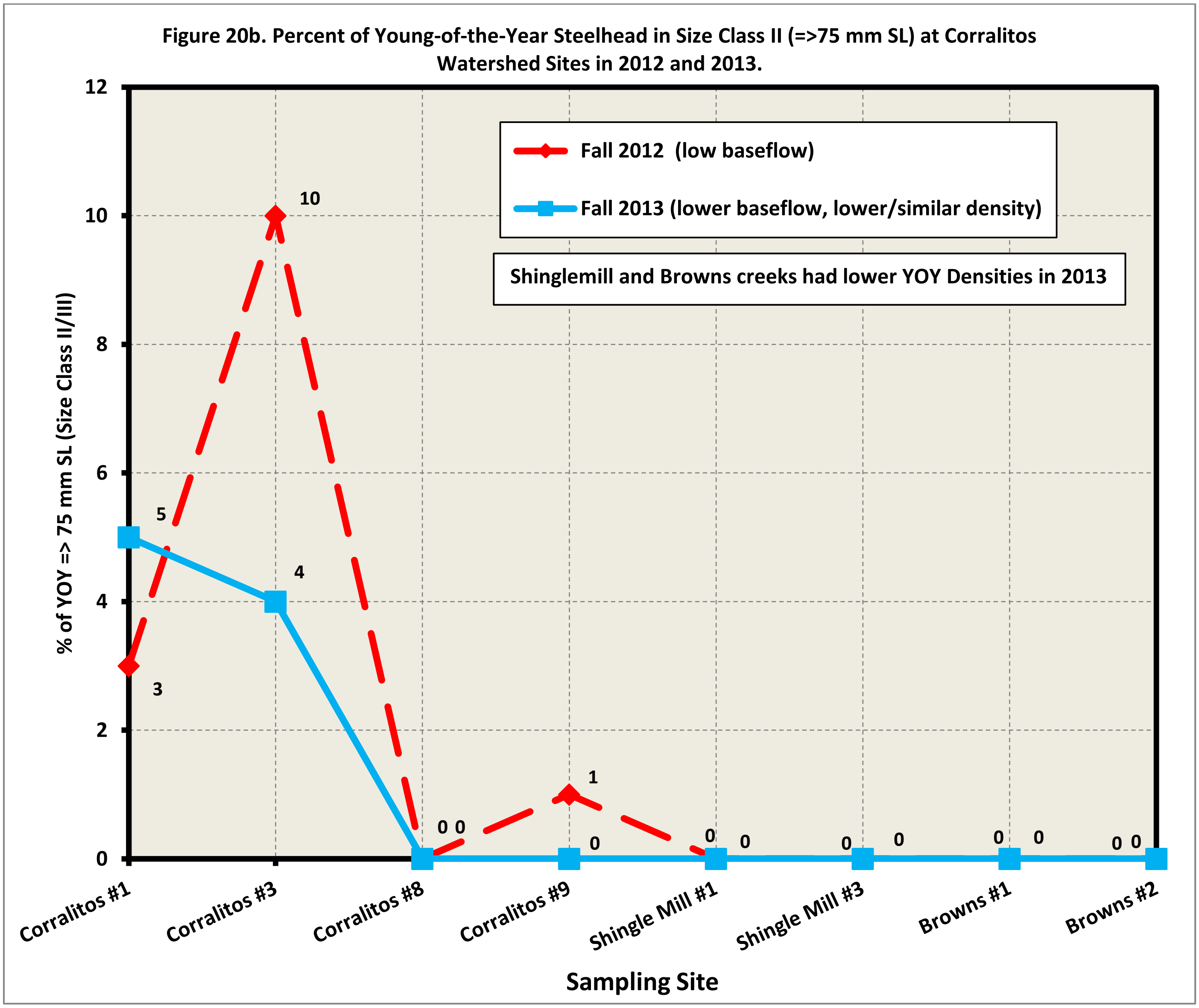


Figure 20b. Percent of Young-of-the-Year Steelhead in Size Class II (=>75 mm SL) at Corralitos Sub-Watershed Sites in 2012 and 2013.

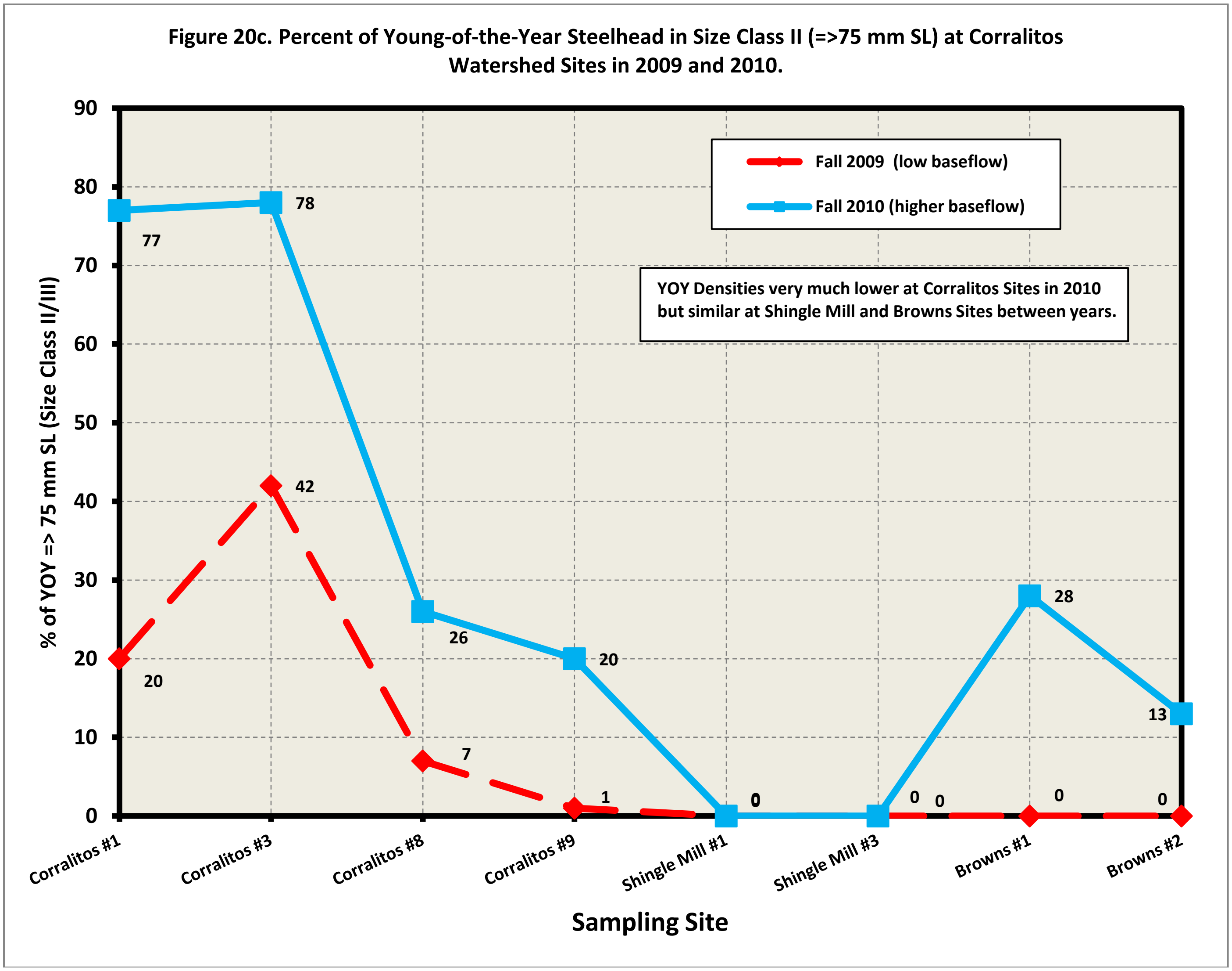


Figure 20c. Percent of Young-of-the-Year Steelhead in Size Class II (=>75 mm SL) at Corralitos Sub-Watershed Sites in 2009 and 2010.

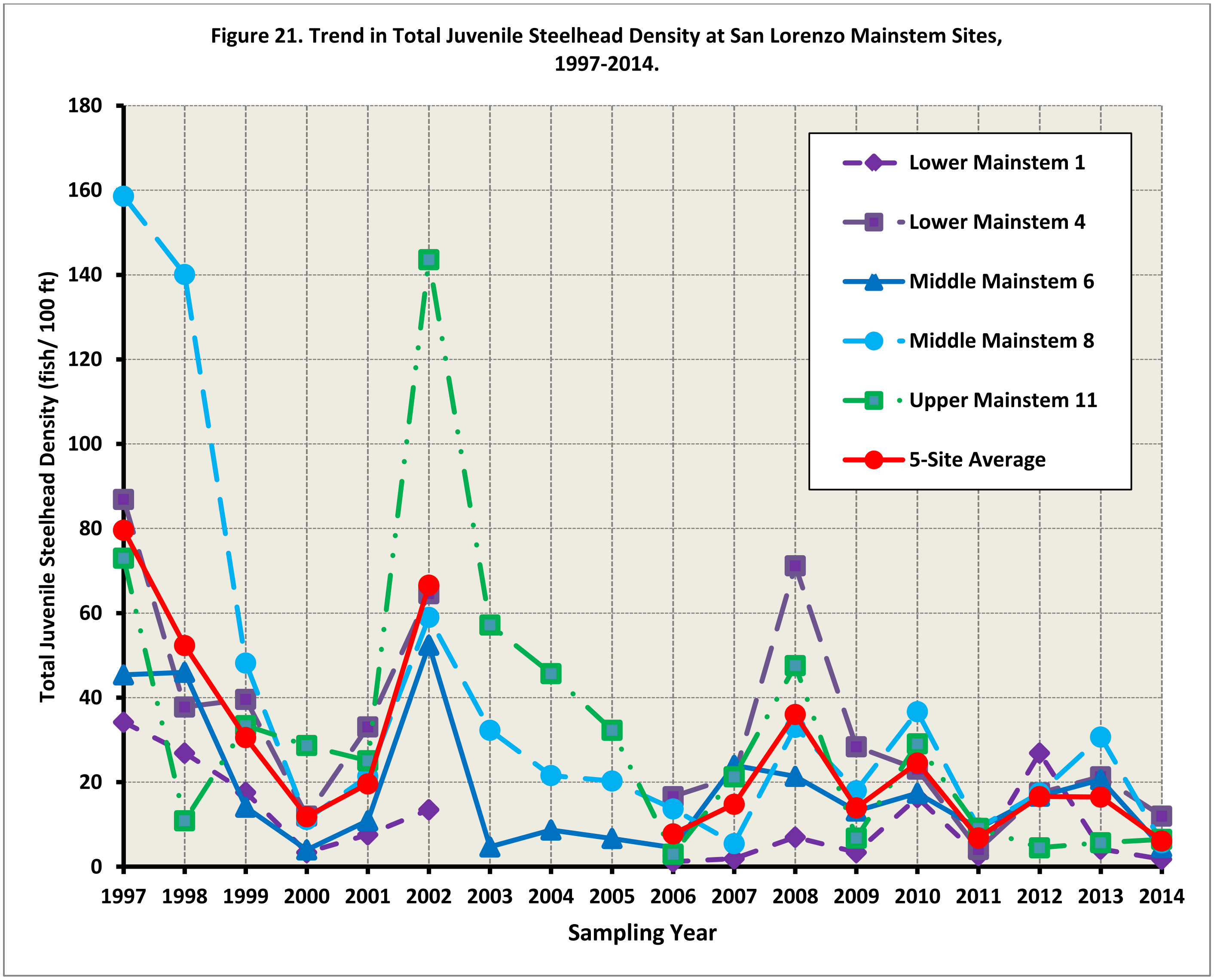


Figure 21. Trend in Total Juvenile Steelhead Density at San Lorenzo Mainstem Sites, 1997-2014.

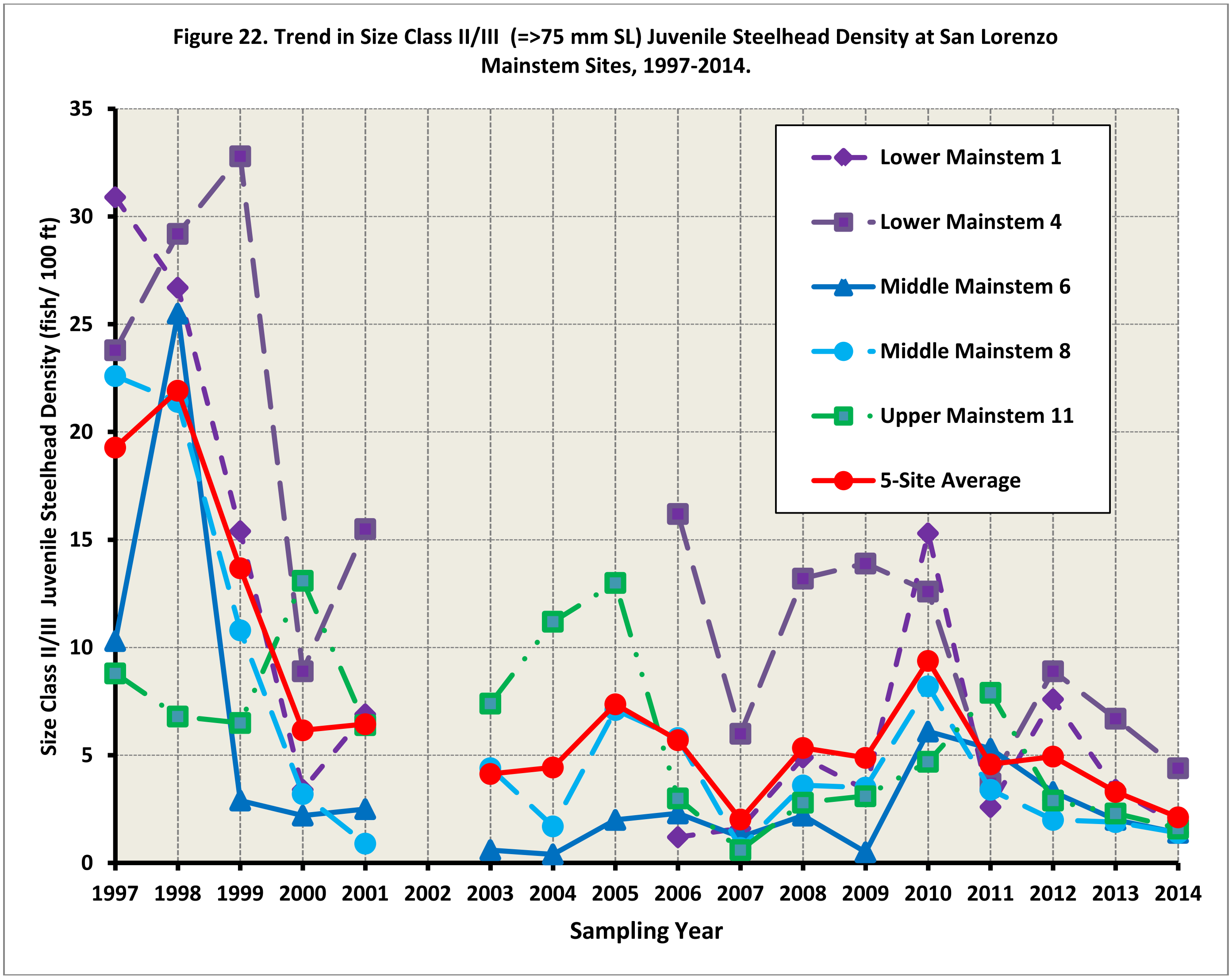


Figure 22. Trend in Size Class II/III (=>75 mm SL) Juvenile Steelhead Density at San Lorenzo Mainstem Sites, 1997-2014.

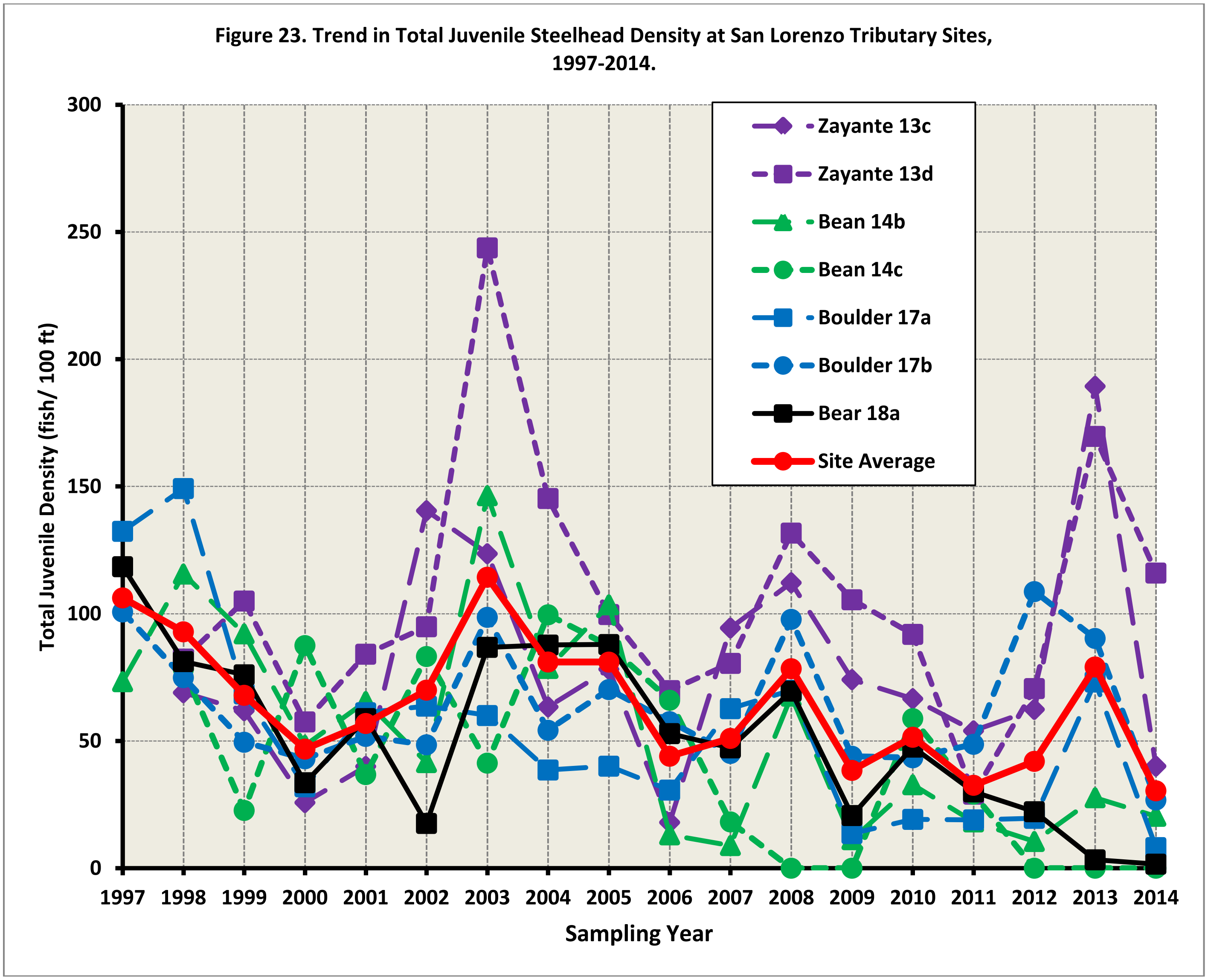


Figure 23. Trend in Total Juvenile Steelhead Density at San Lorenzo Tributary Sites, 1997-2014.

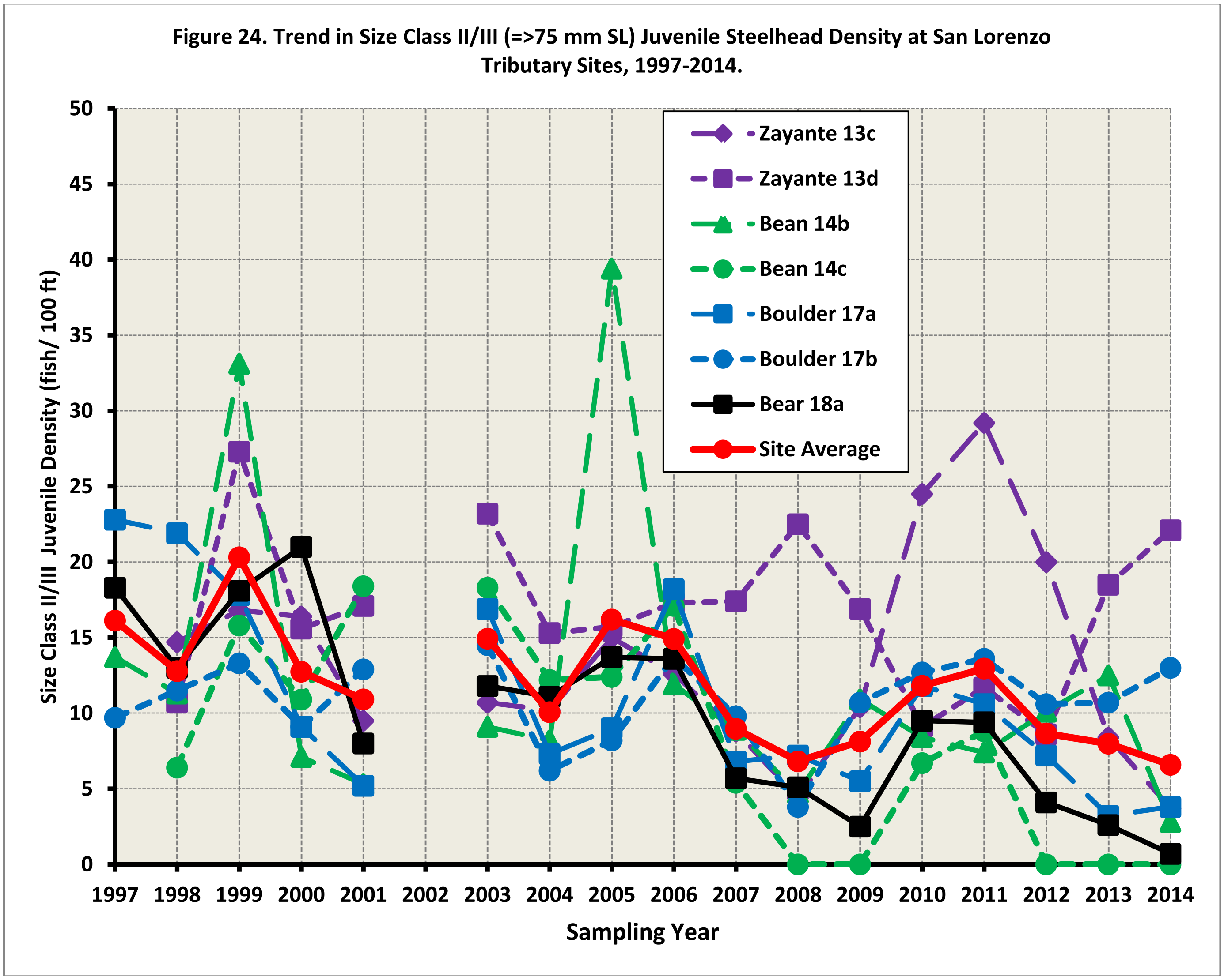


Figure 24. Trend in Size Class II/III (=>75 mm SL) Juvenile Steelhead Density at San Lorenzo Tributary Sites, 1997-2014.

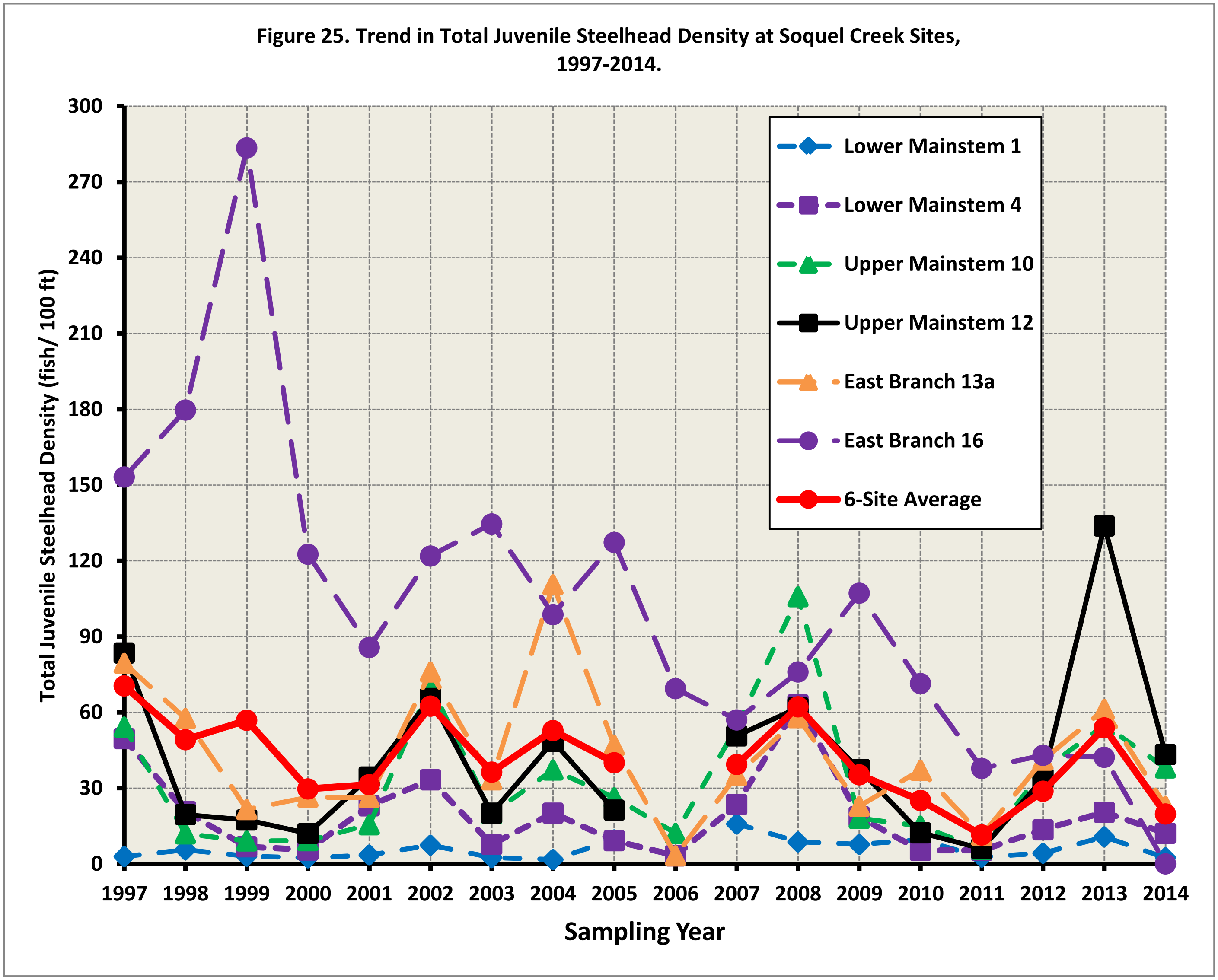


Figure 25. Trend in Total Juvenile Steelhead Density at Soquel Creek Sites, 1997-2014.

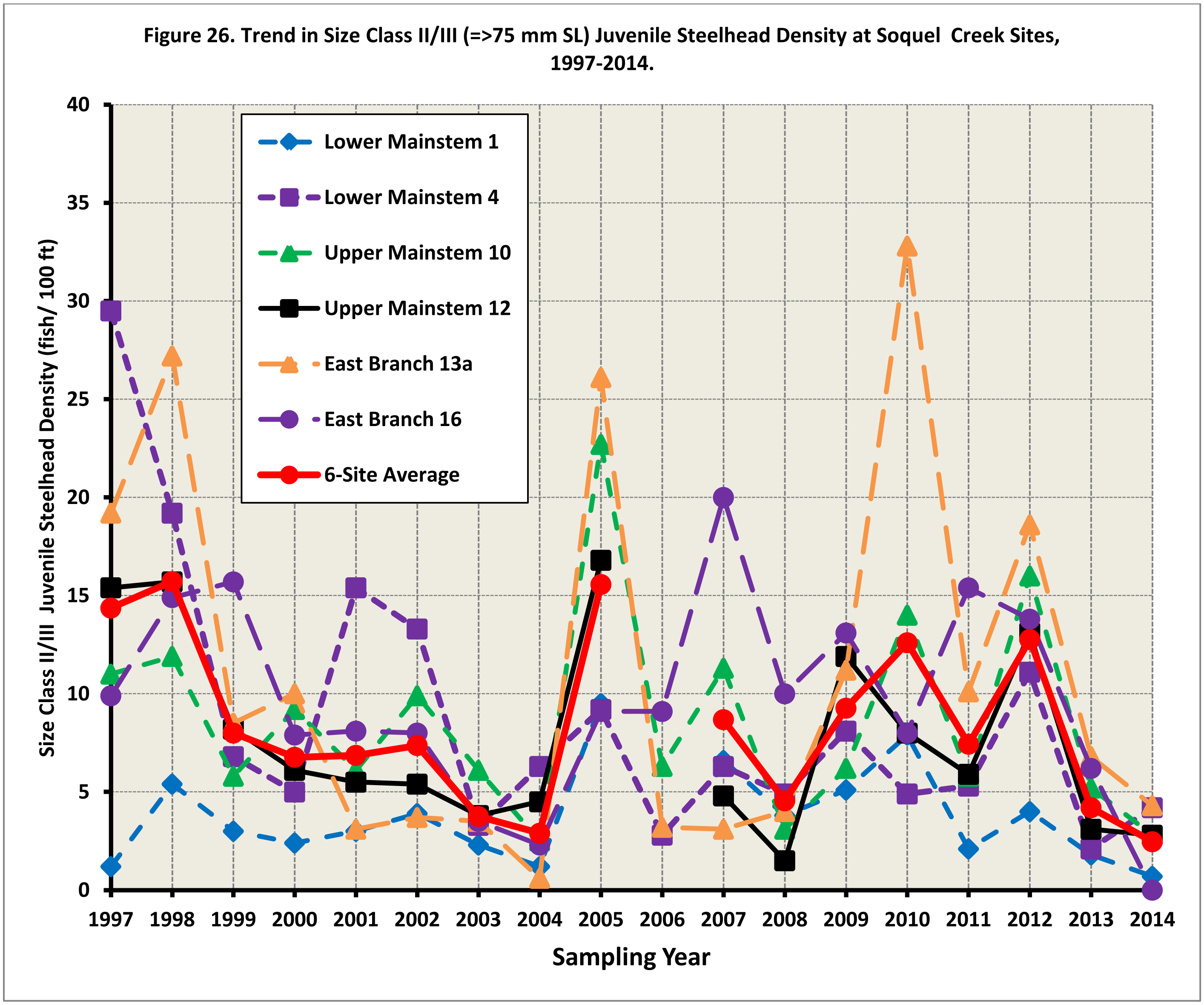


Figure 26. Trend in Size Class II/III (=>75 mm SL) Juvenile Steelhead Density at Soquel Creek Sites, 1997-2014.

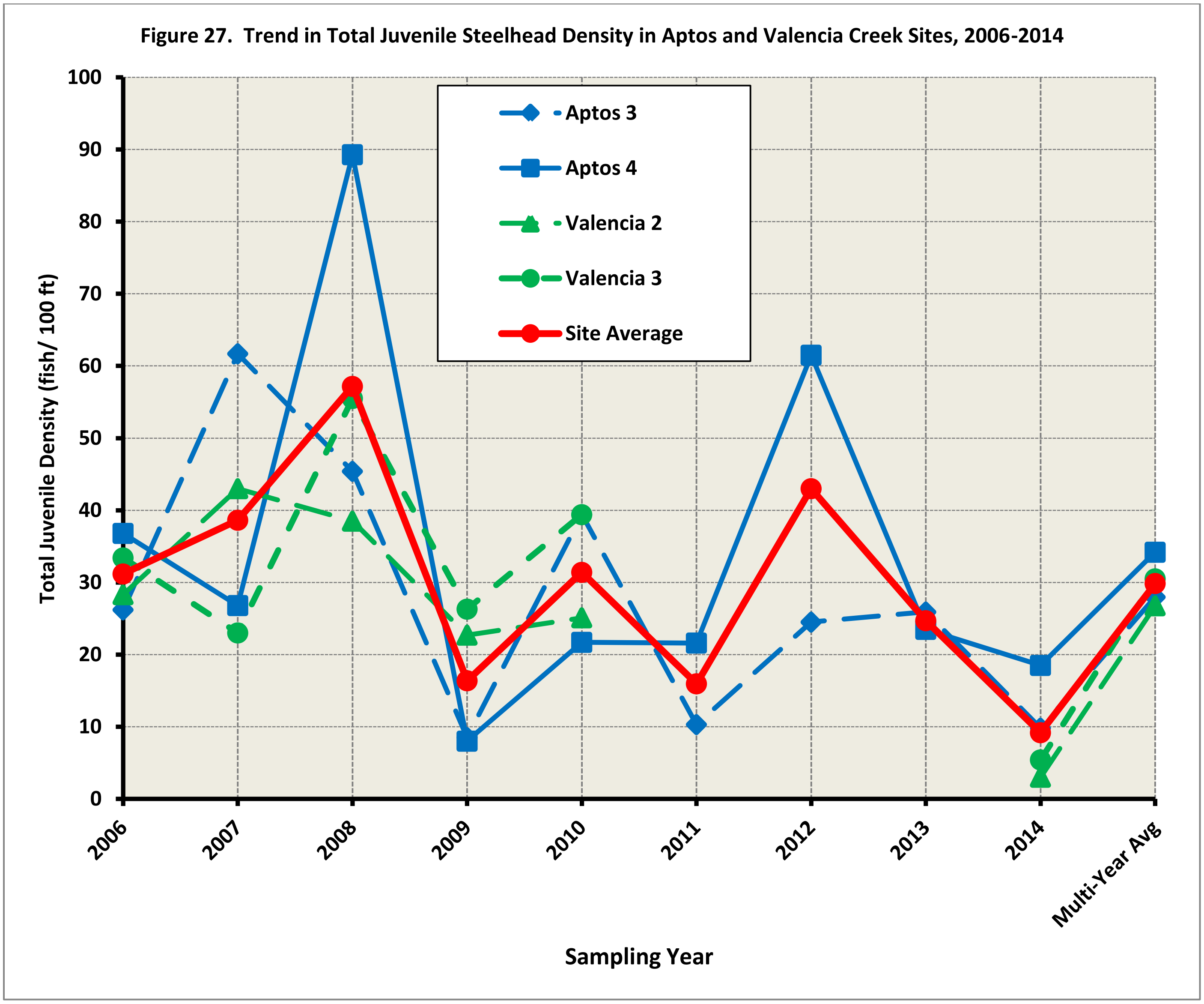


Figure 27. Trend in Total Juvenile Steelhead Density in Aptos and Valencia Creek Sites, 2006-2014.

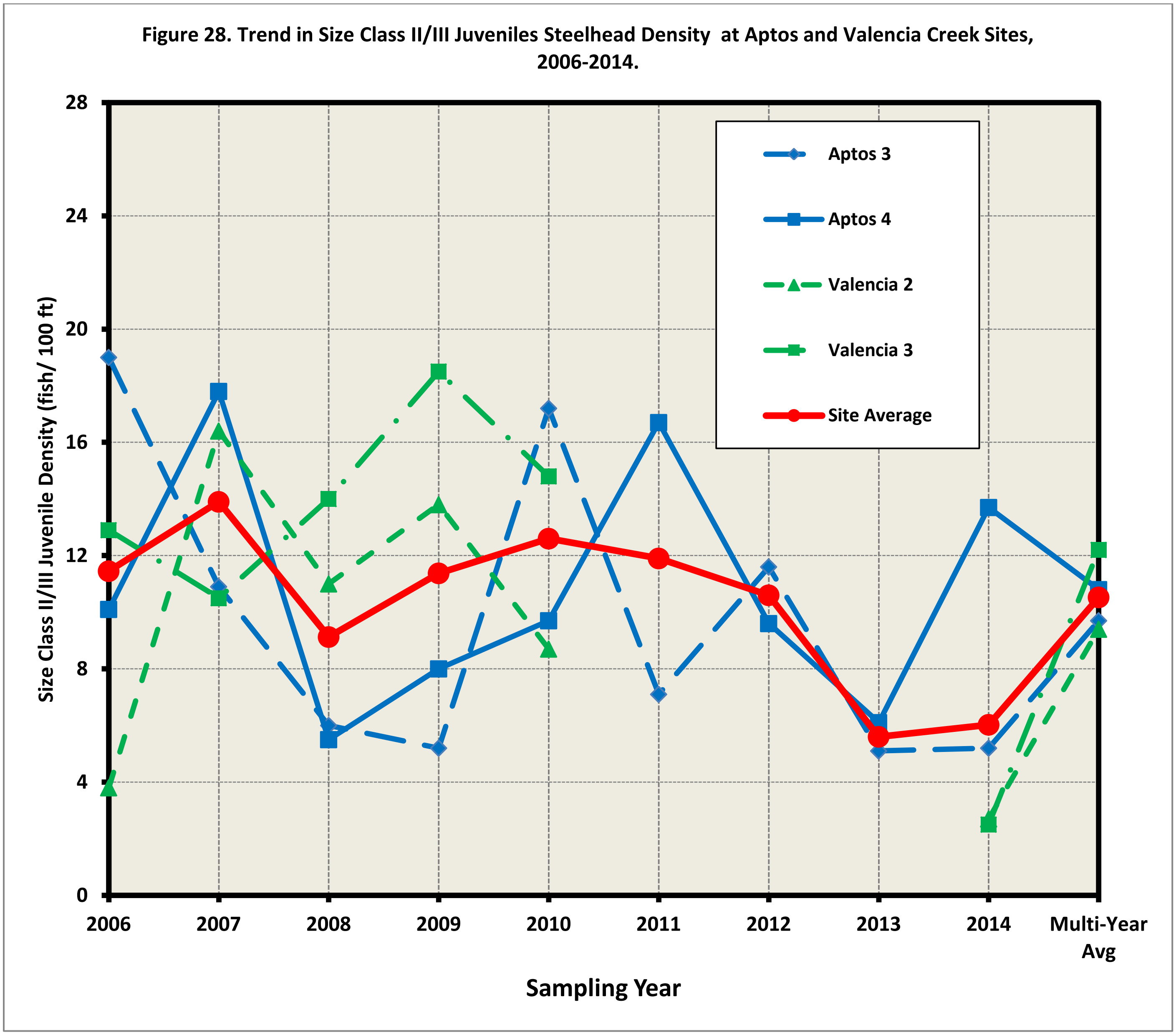


Figure 28. Trend in Size Class II/III Juveniles Steelhead Density at Aptos and Valencia Creek Sites, 2006-2014.

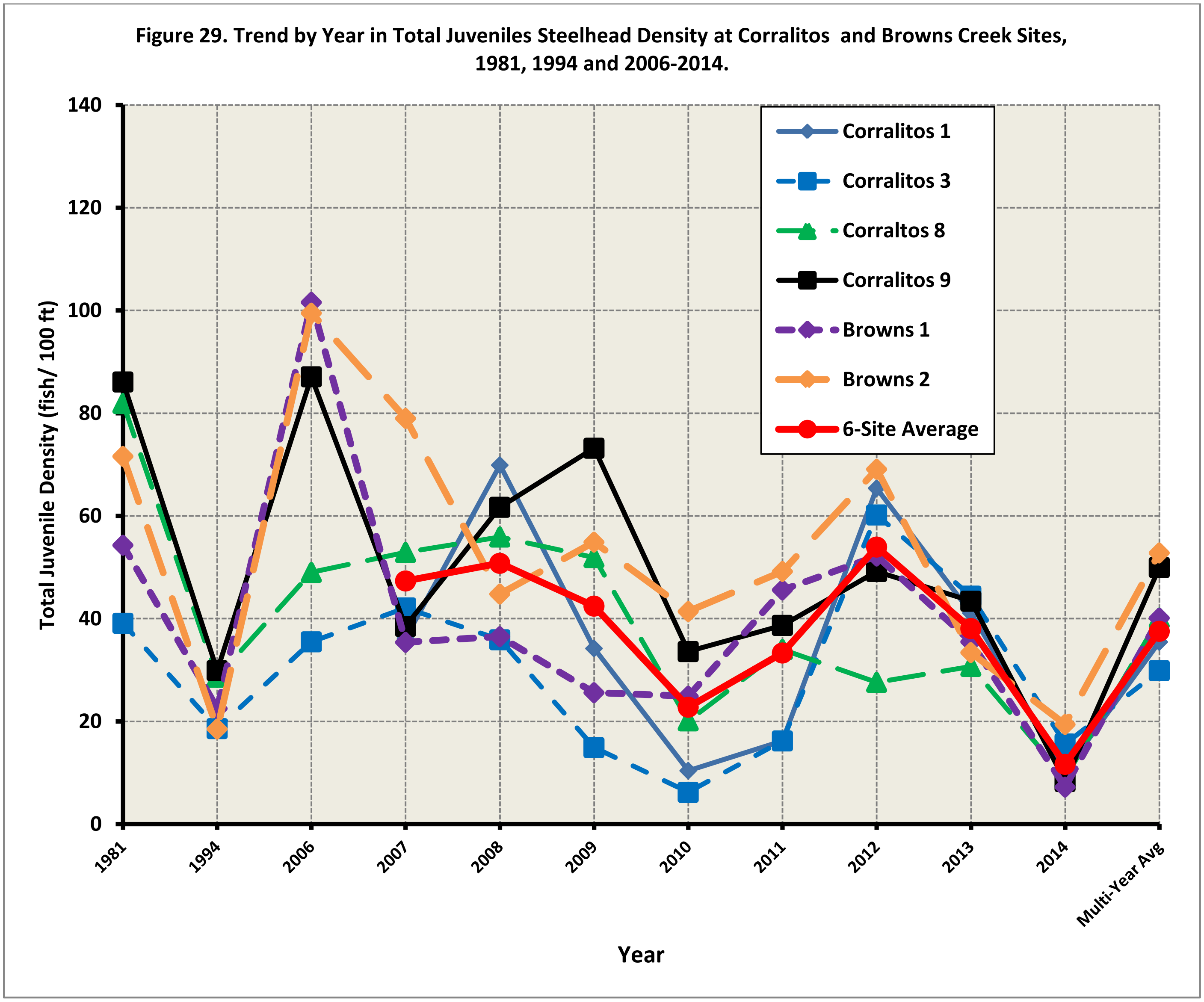


Figure 29. Trend by Year in Total Juveniles Steelhead Density at Corralitos and Browns Creek Sites, 1981, 1994 and 2006-2014.

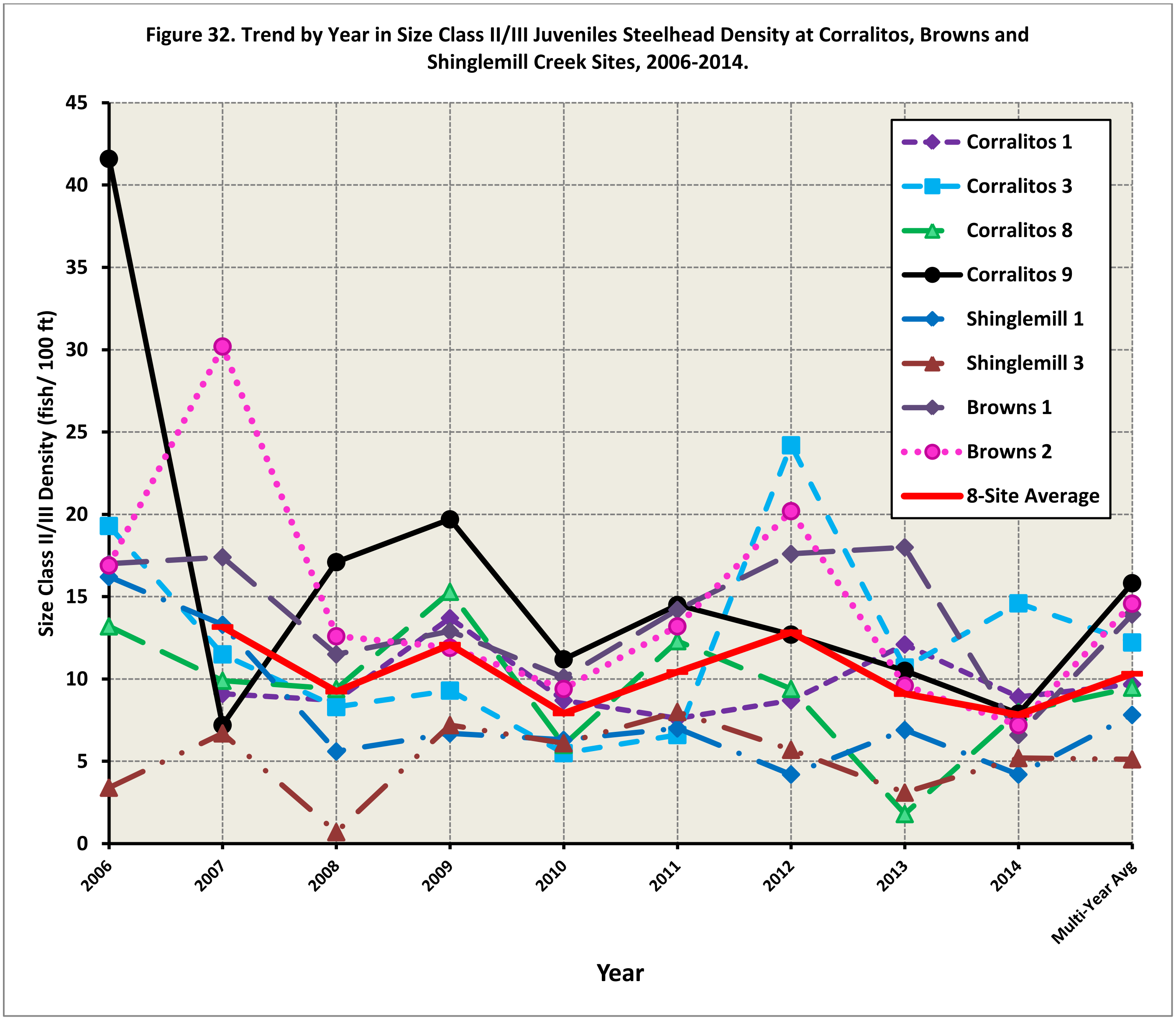


Figure 32. Trend by Year in Size Class II/III Juveniles Steelhead Density at Corralitos Creek Sites, 2006-2014.

Figure 33. San Lorenzo River Reach Indices of Soon-to-Smolt Steelhead Abundance, Comparing 2010 to 2014.

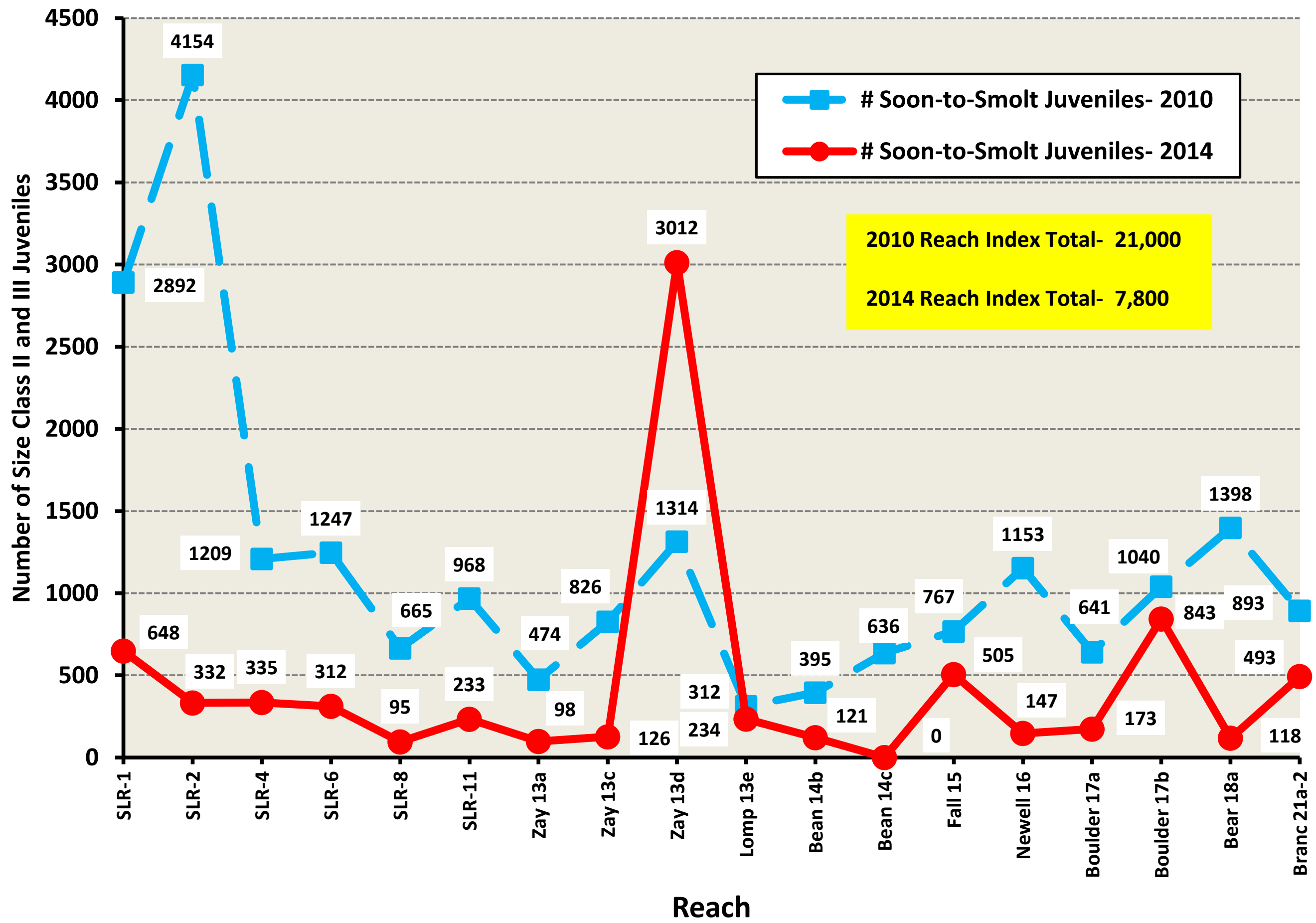


Figure 33. San Lorenzo River Reach Indices of Soon-to-Smolt Steelhead Abundance, Comparing 2010 to 2014.

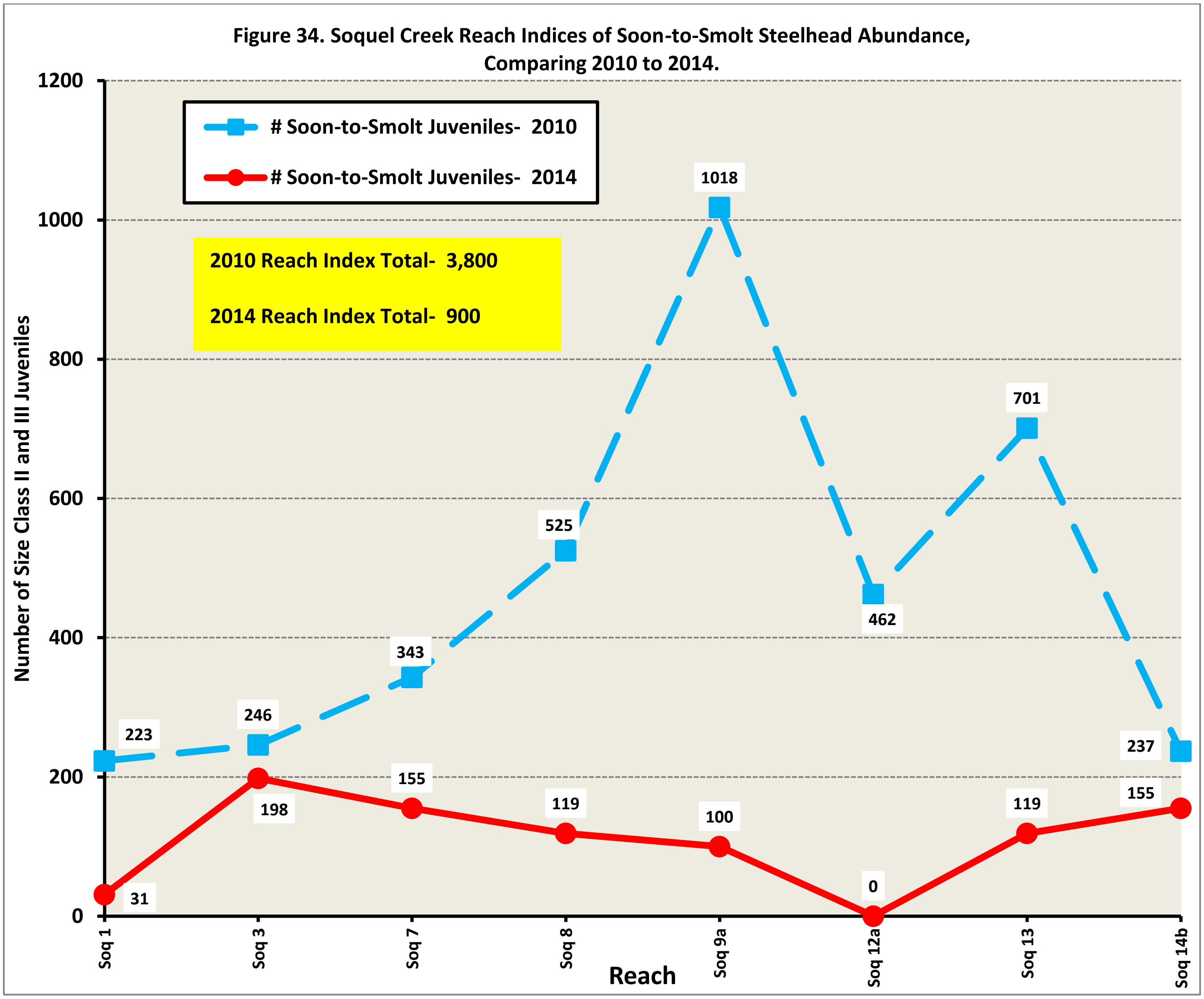


Figure 34. Soquel Creek Reach Indices of Soon-to-Smolt Steelhead Abundance, Comparing 2010 to 2014.

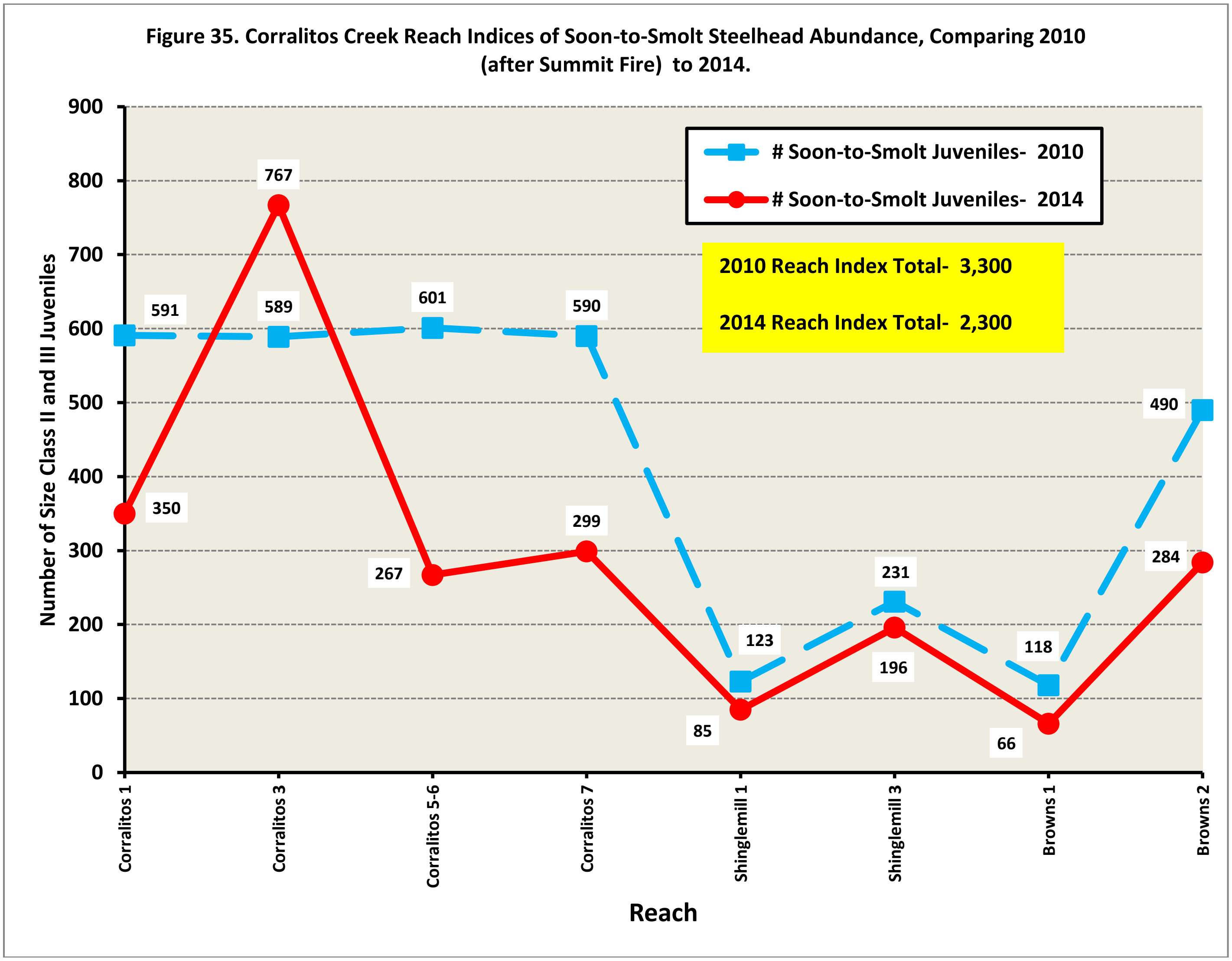


Figure 35. Corralitos Creek Reach Indices of Soon-to-Smolt Steelhead Abundance, Comparing 2010 to 2014.

Figure 36a. The 2013 Discharge Flow of Record for the USGS Gage On the San Lorenzo River at Big Trees.

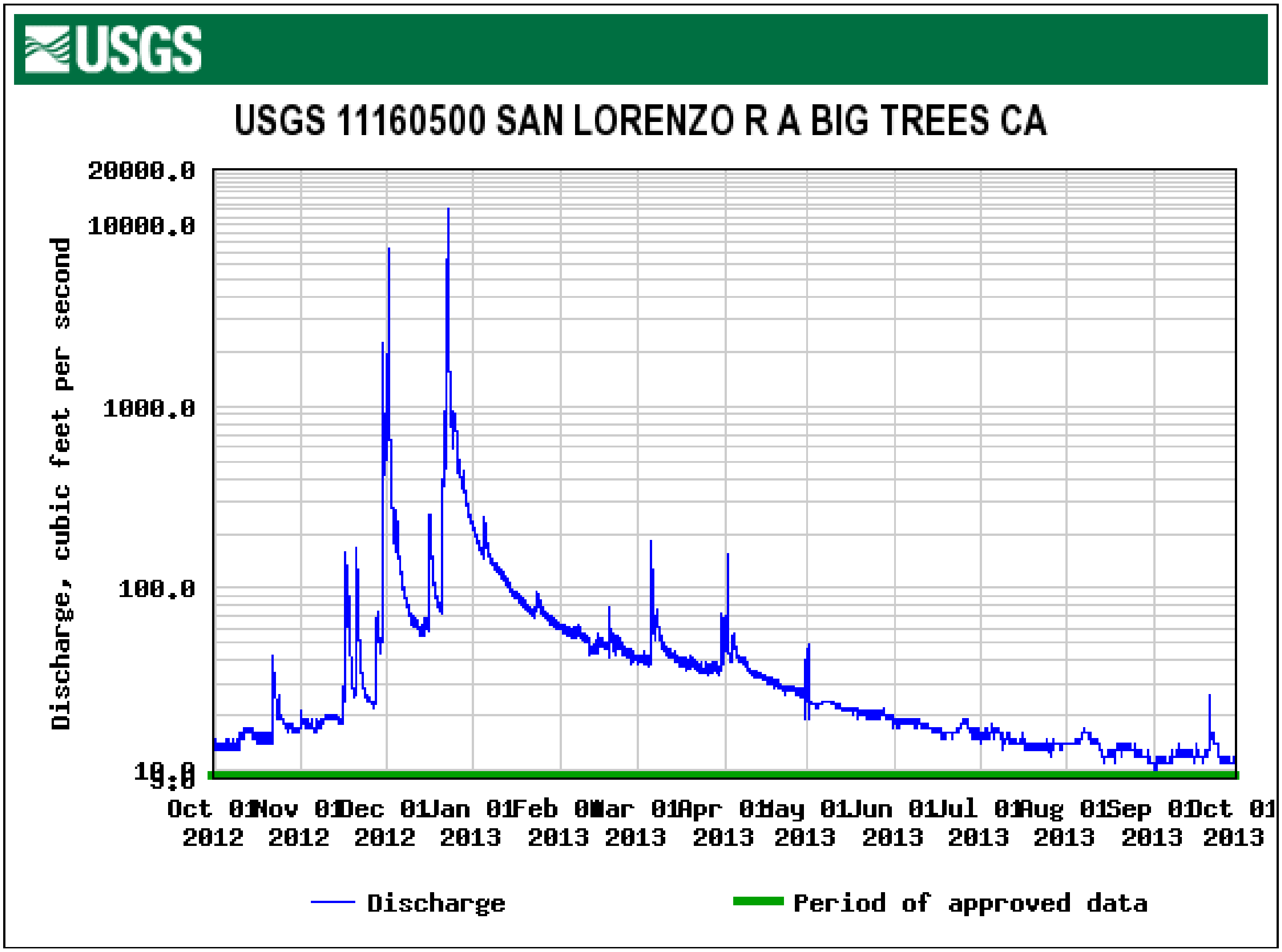


Figure 36b. The 2013 Mean Daily Discharge Flow of Record with Median Statistic for the USGS Gage On the San Lorenzo River at Big Trees.

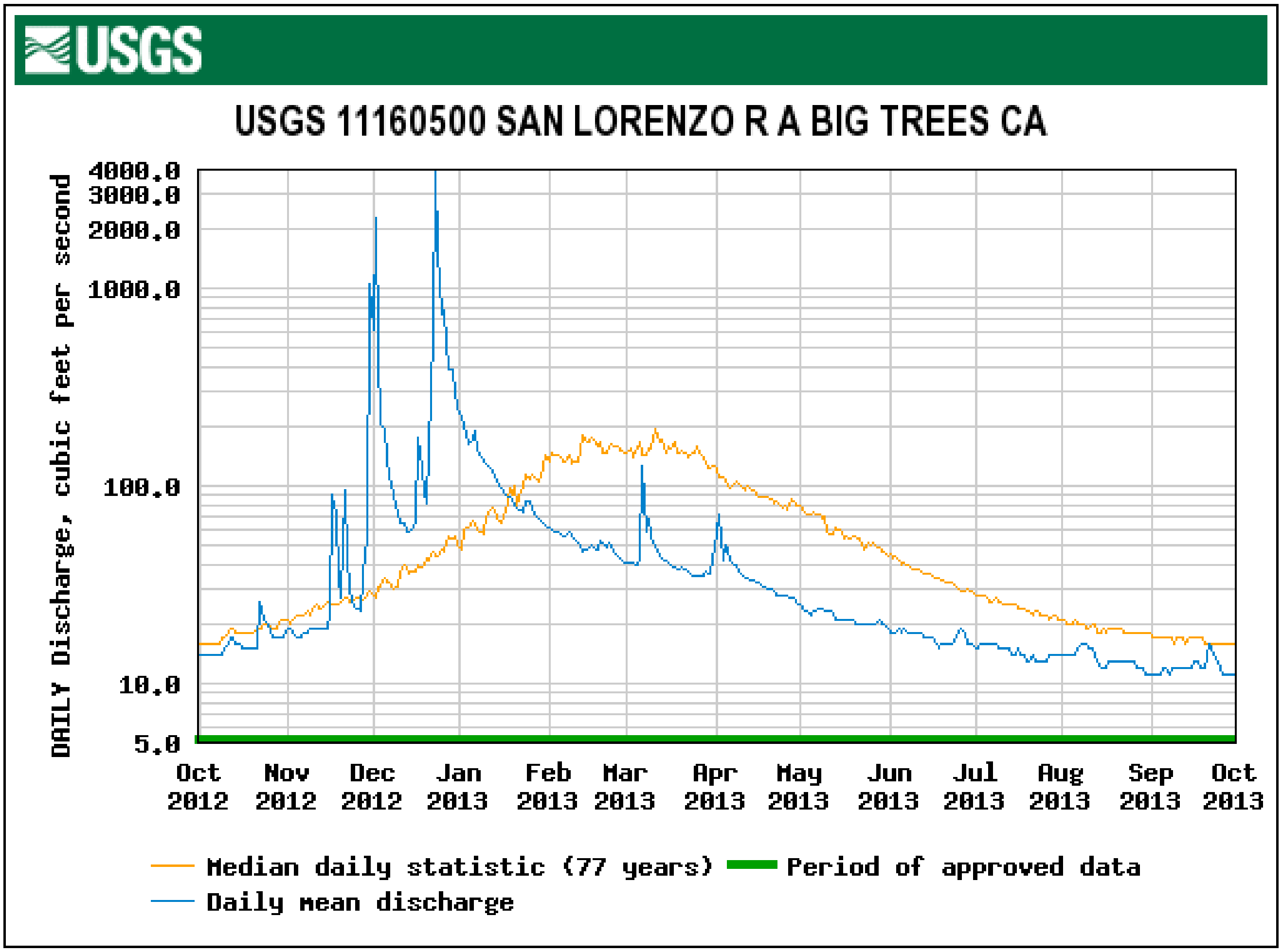


Figure 37a. The 2014 Discharge for the USGS Gage On the San Lorenzo River at Big Trees.

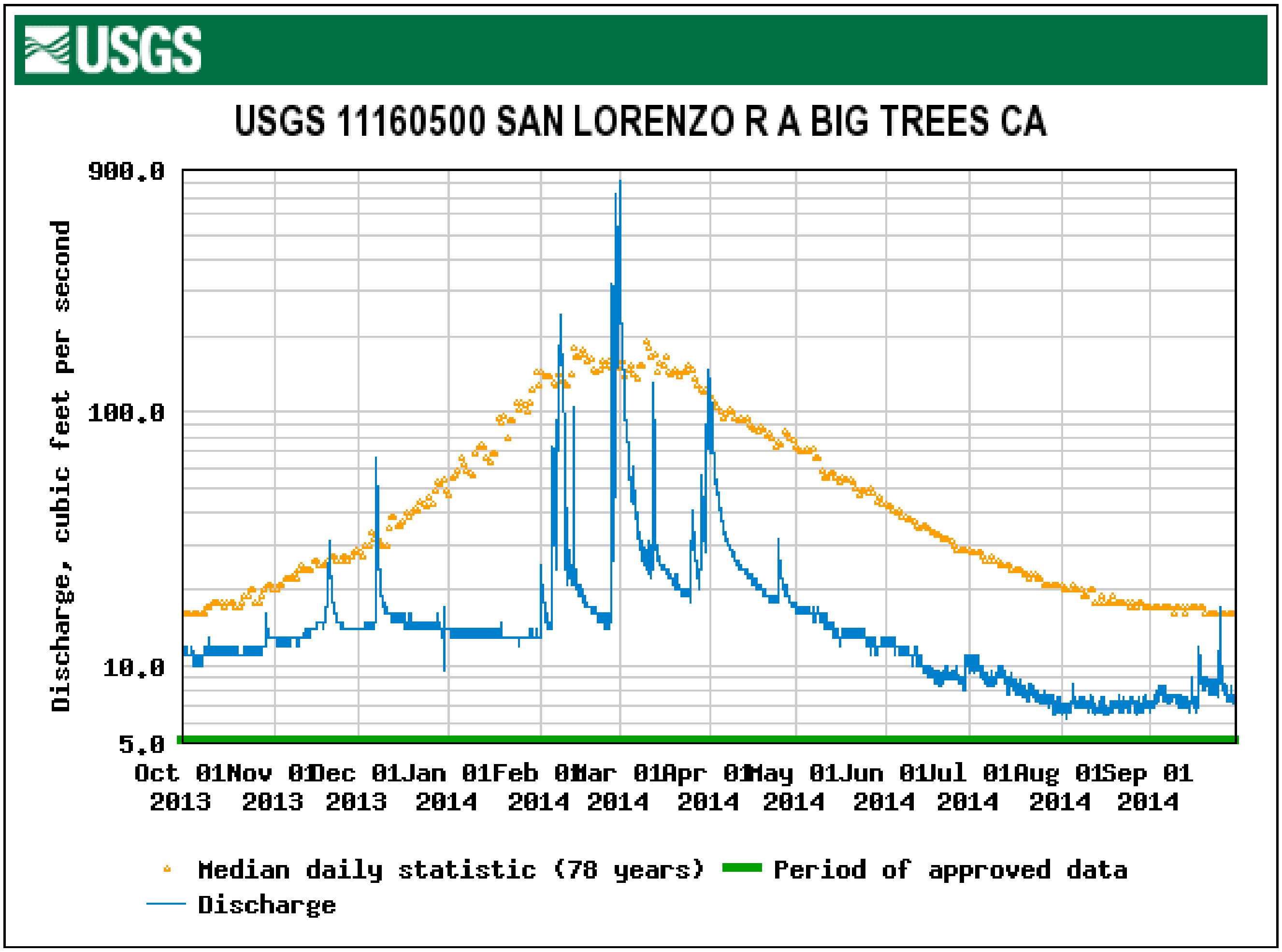


Figure 37b. The 2014 Mean Daily Flow of Record and Median Statistic for the USGS Gage On the San Lorenzo River at Big Trees.

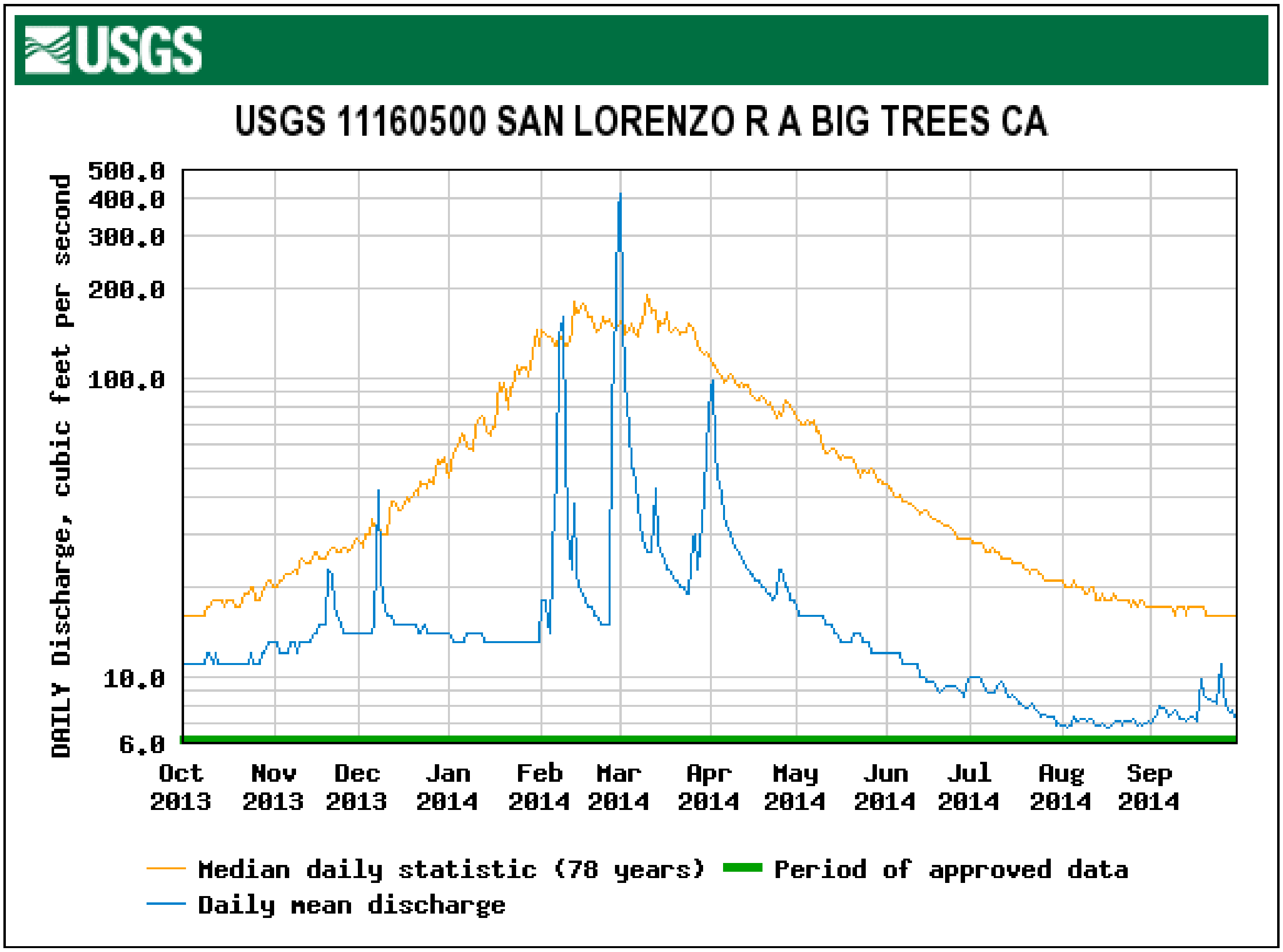


Figure 38. The March−May 2014 Discharge of Record for the USGS Gage On the San Lorenzo River at Big Trees.

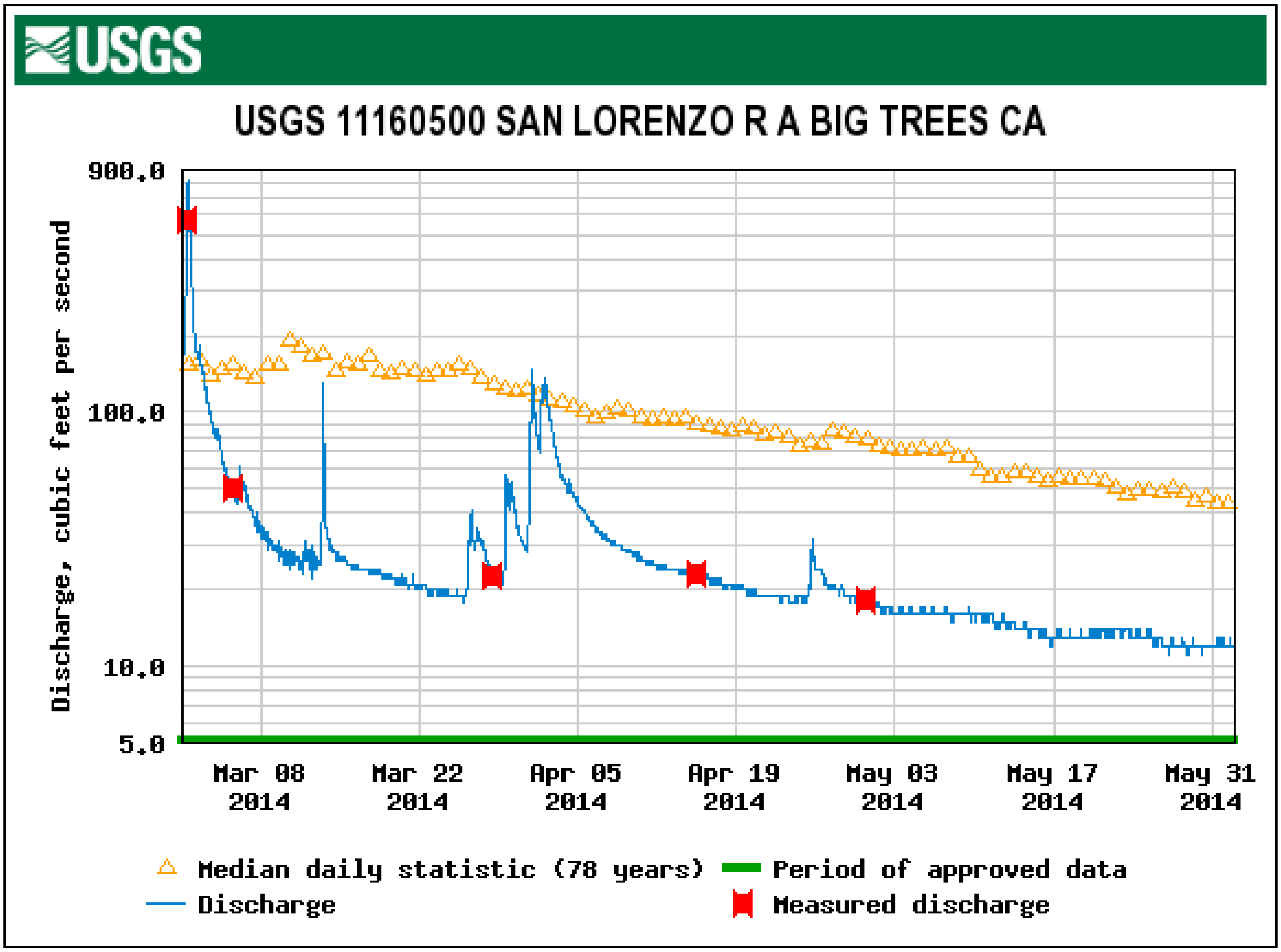


Figure 39a. The 2013 Discharge at the USGS Gage on Soquel Creek at Soquel Village.

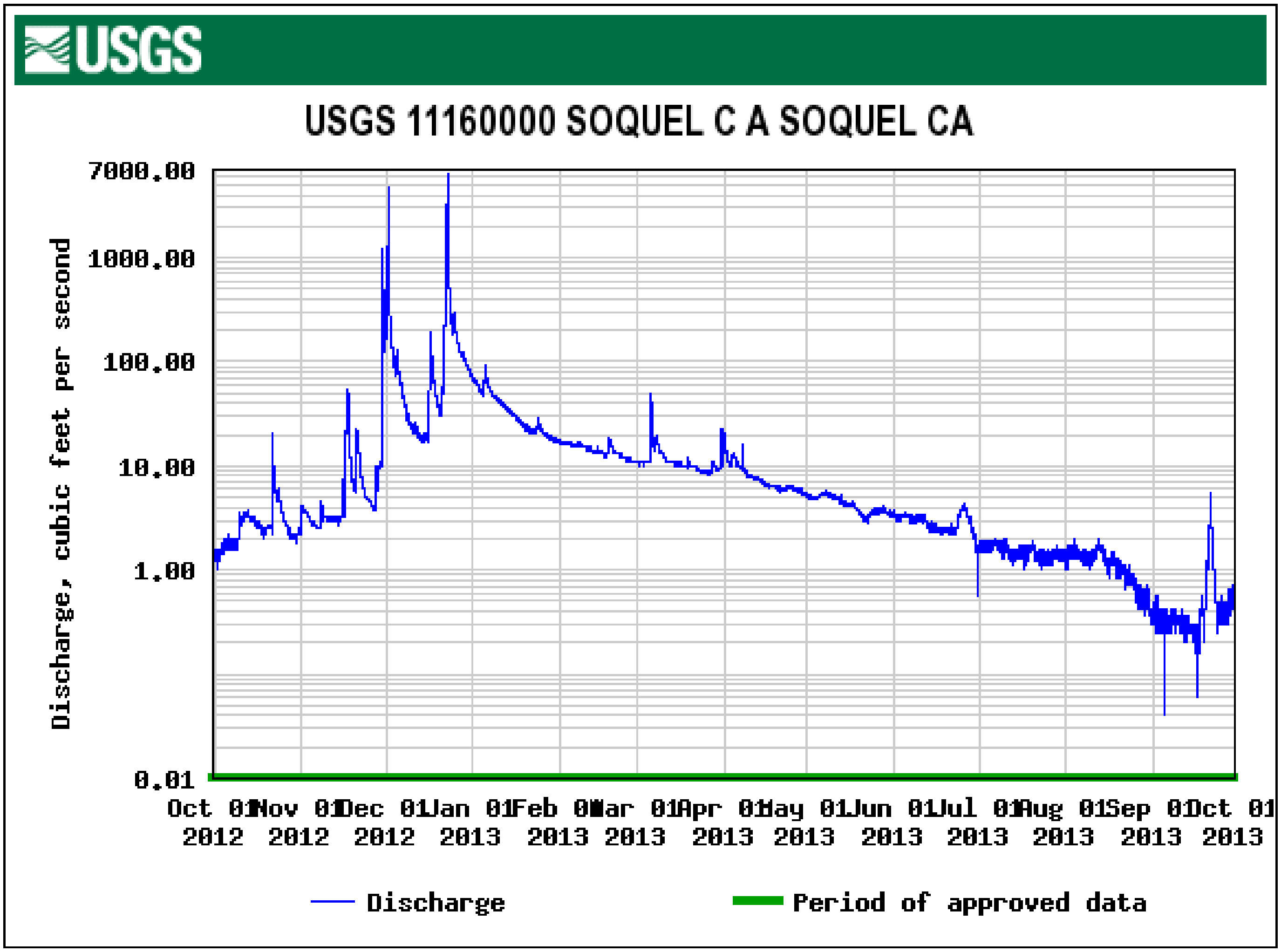


Figure 39b. The 2013 Daily Mean and Median Flow at the USGS Gage on Soquel Creek at Soquel Village.

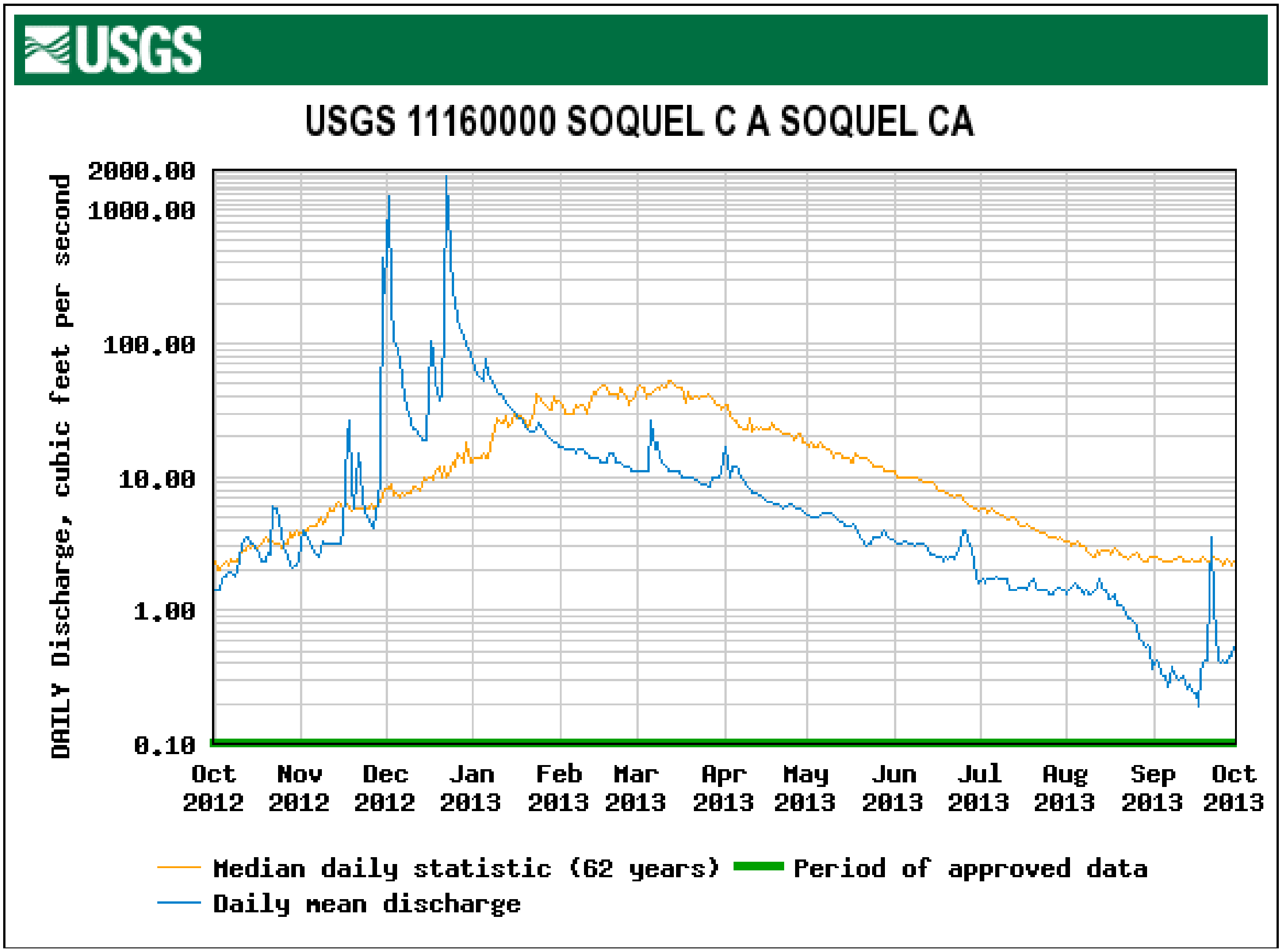


Figure 40a. The 2014 Discharge at the USGS Gage on Soquel Creek at Soquel Village.

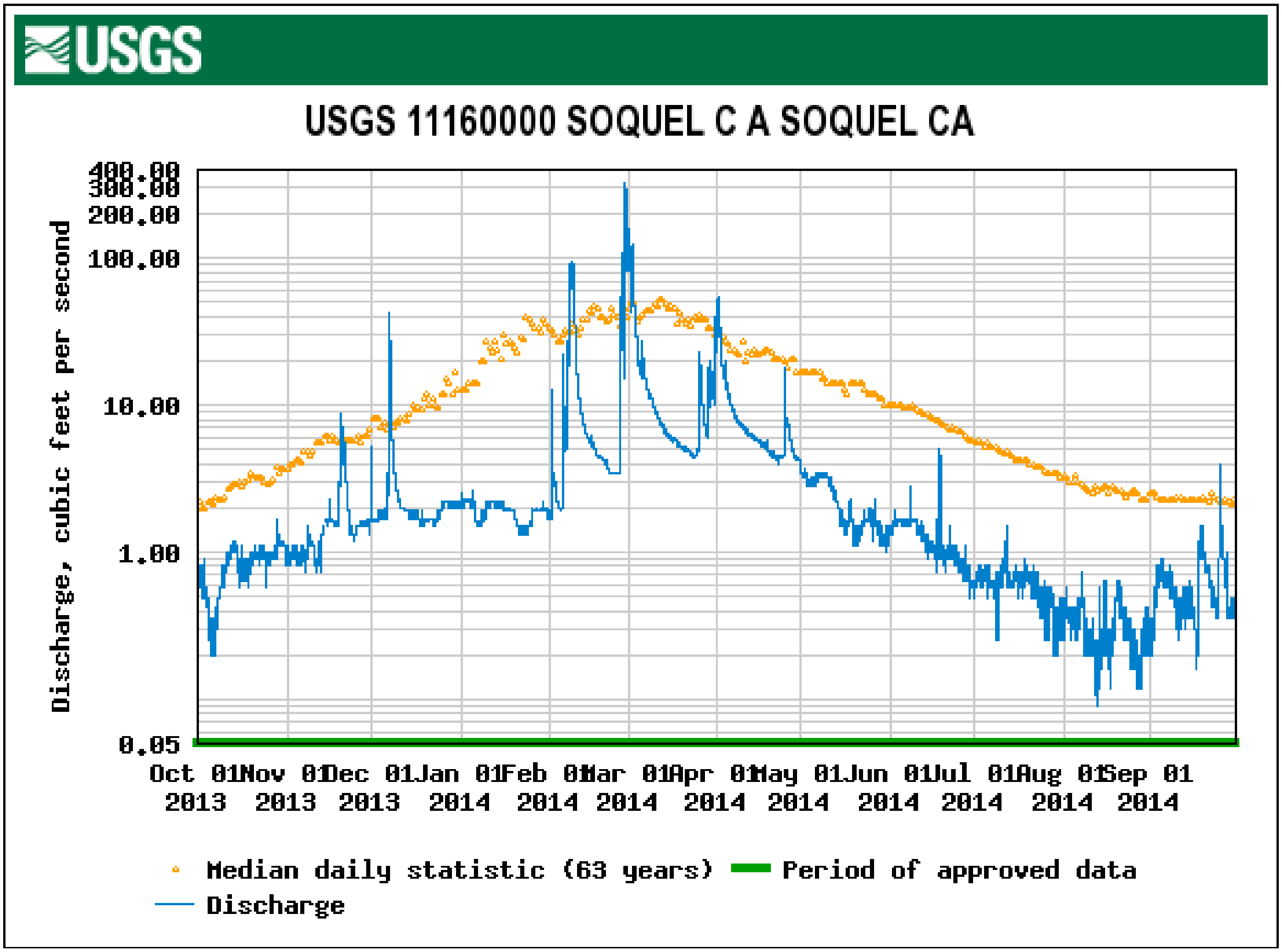


Figure 40b. The 2014 Daily Mean and Median Flow at the USGS Gage on Soquel Creek at Soquel Village.

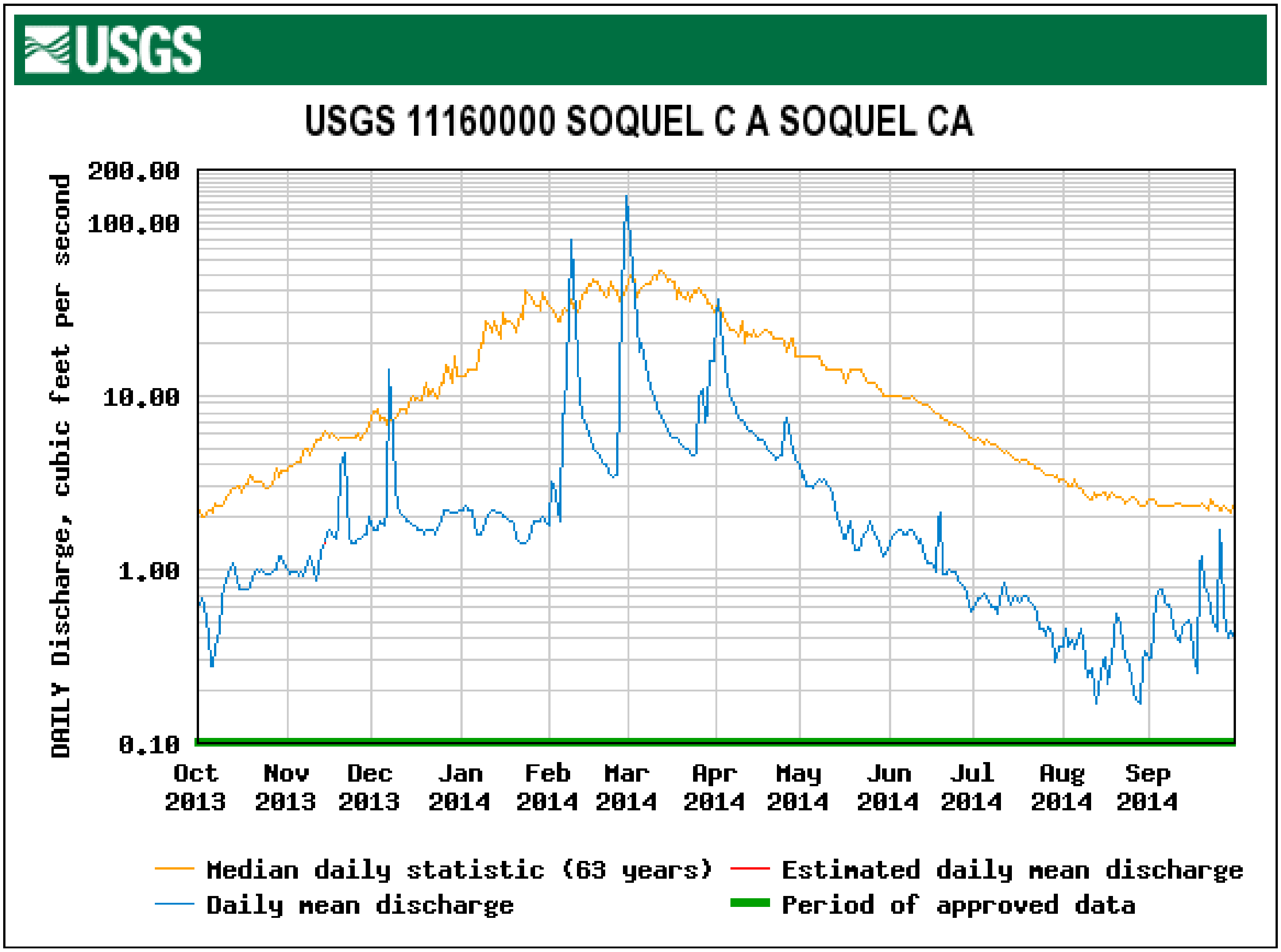


Figure 41. The March–May 2014 Discharge of Record for the USGS Gage on Soquel Creek at Soquel Village.

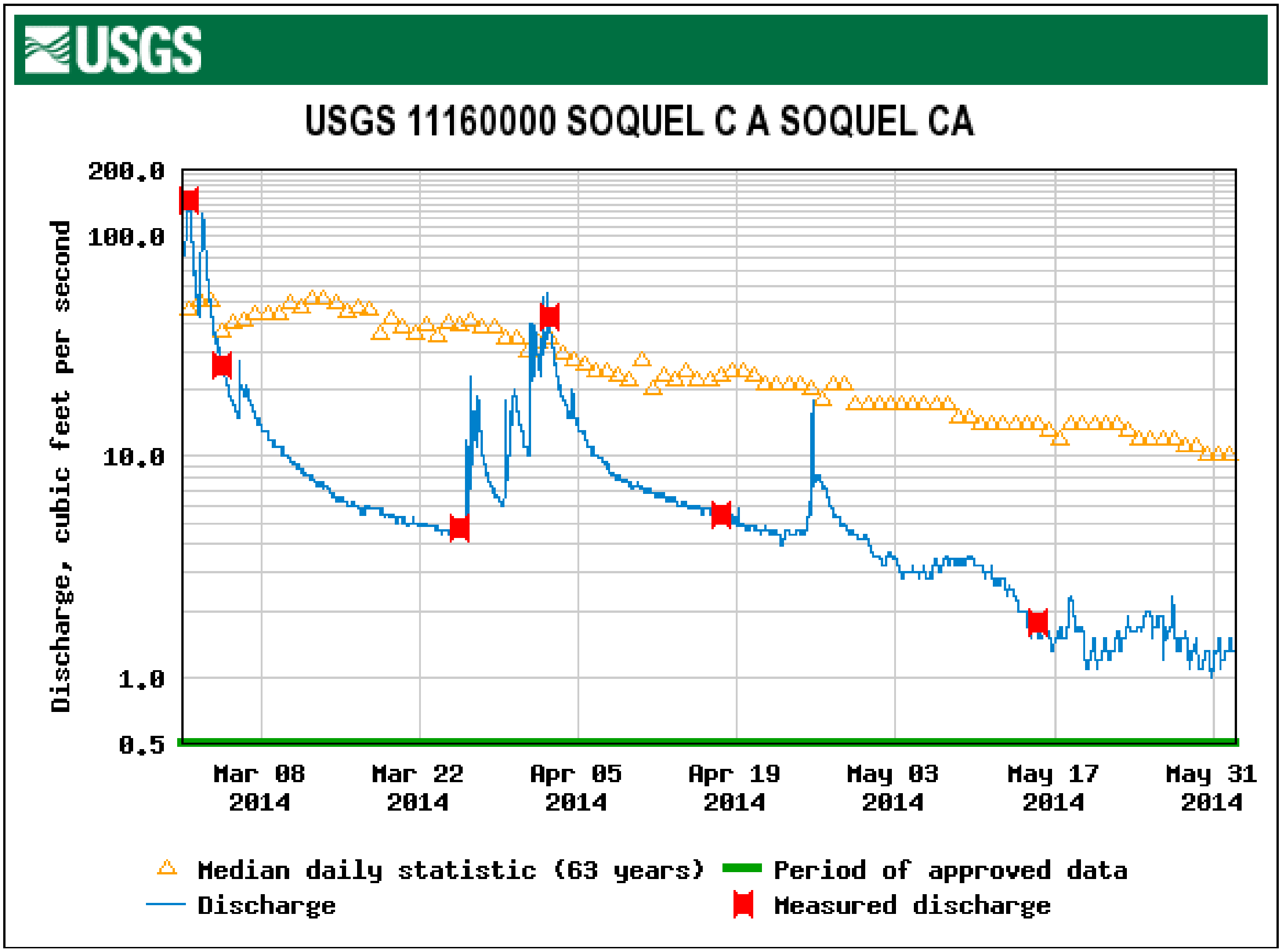


Figure 42a. The 2013 Discharge at the USGS Gage on Corralitos Creek at Freedom.

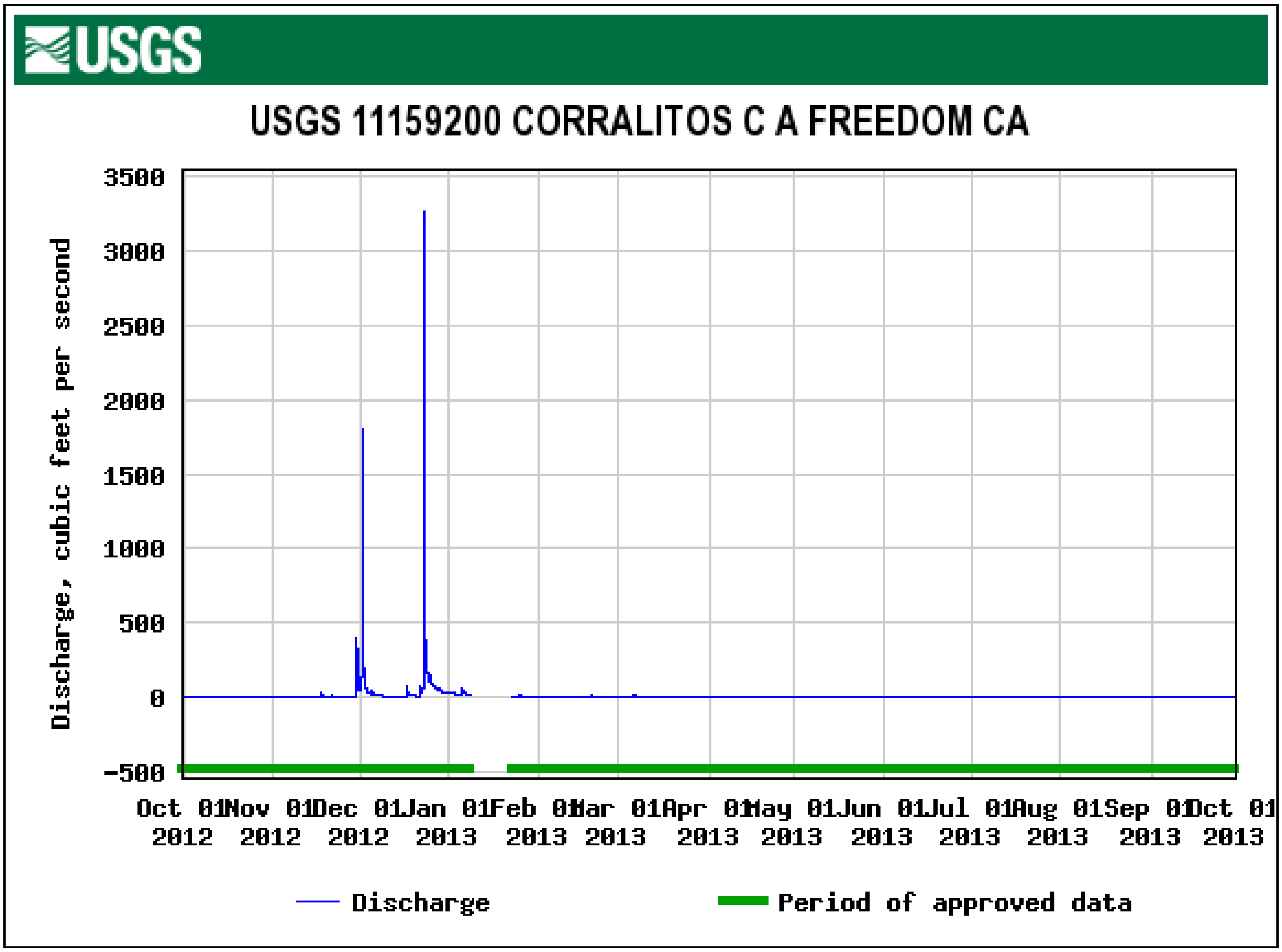


Figure 42b. The 2013 Daily Mean and Median Flow at the USGS Gage on Corralitos Creek at Freedom.

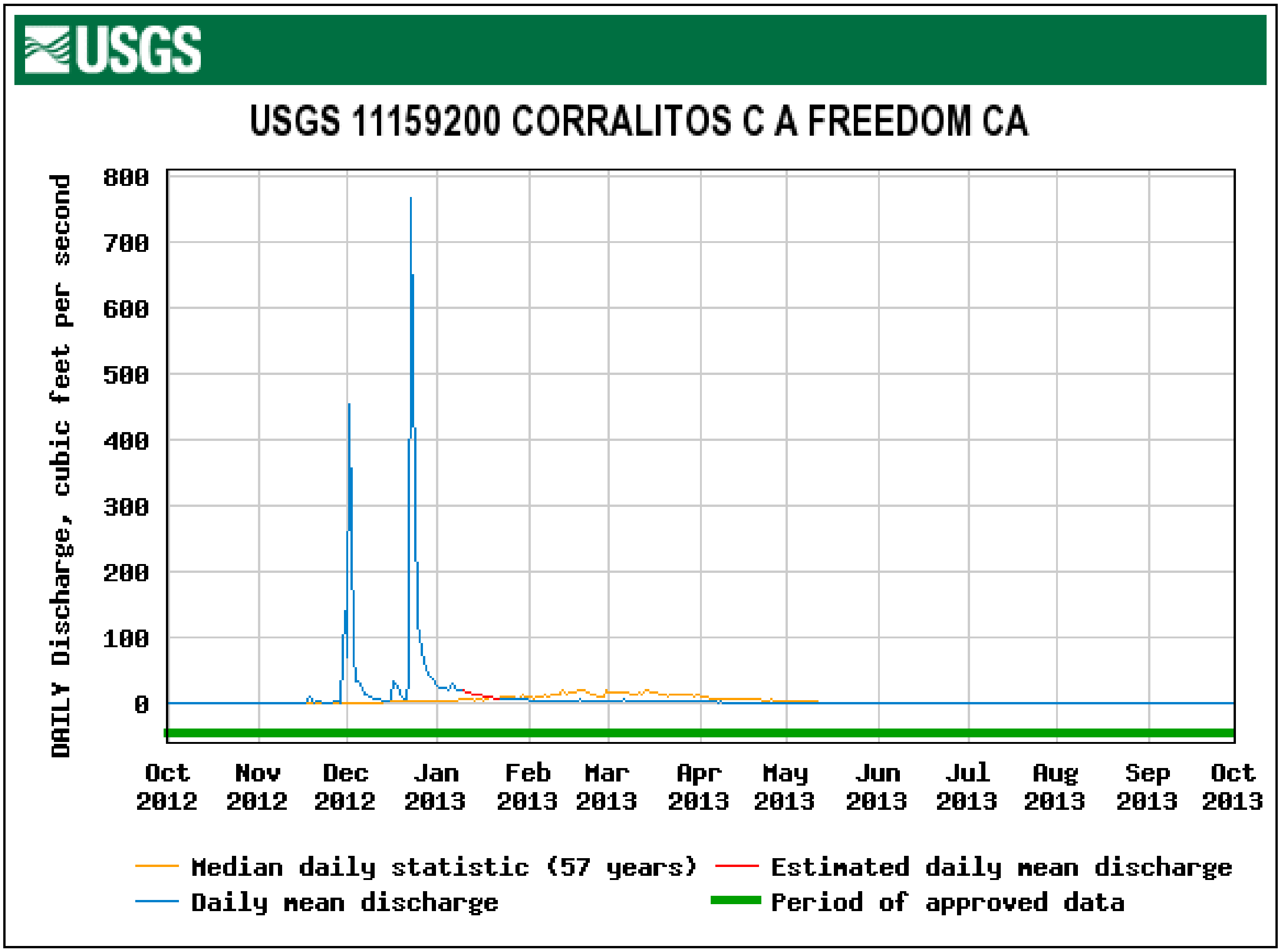


Figure 42c. The March–May 2013 Discharge of Record for the USGS Gage on Corralitos Creek at Freedom.

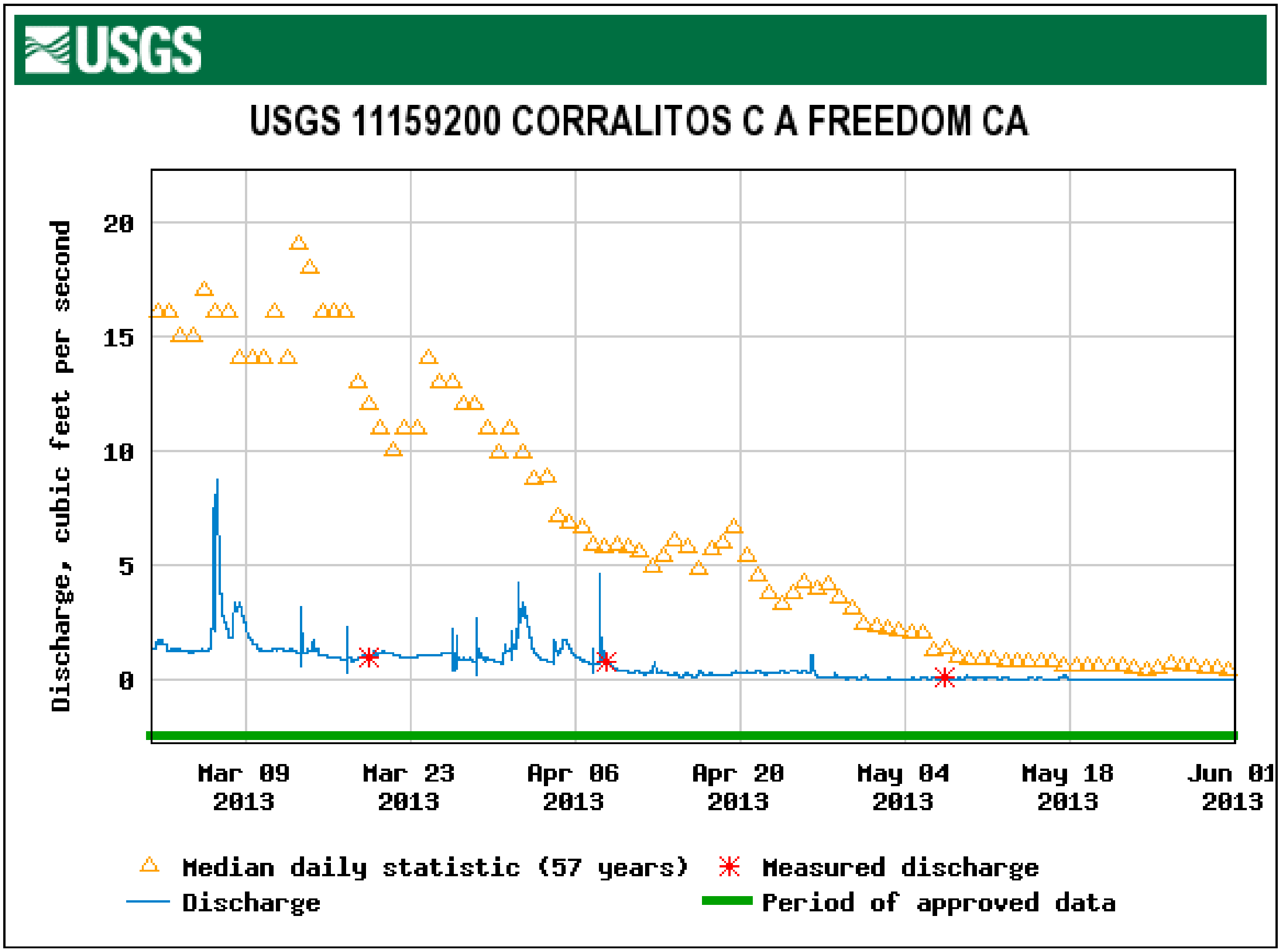


Figure 43a. The 2014 Discharge at the USGS Gage on Corralitos Creek at Freedom.

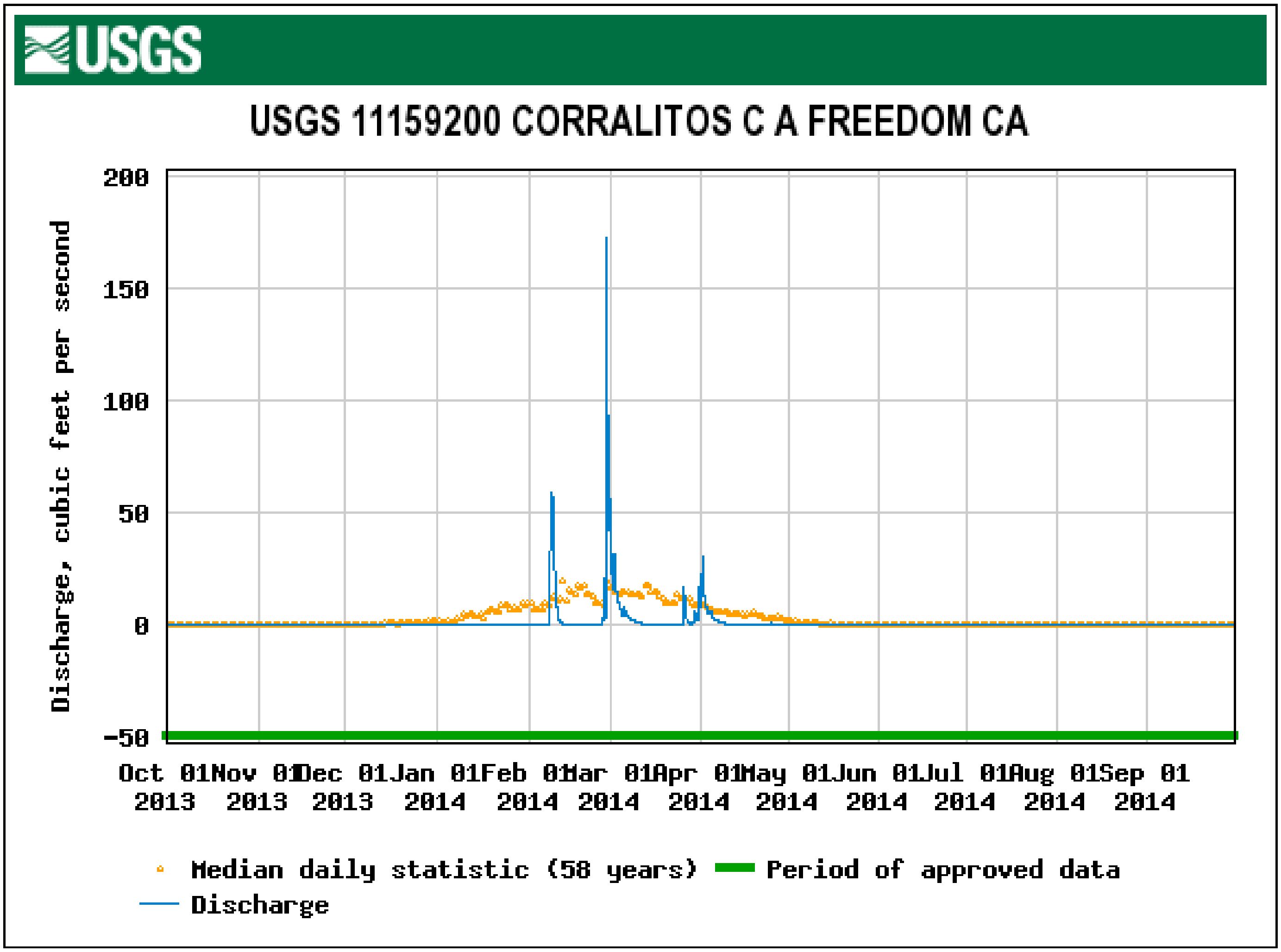


Figure 43b. The 2014 Daily Mean and Median Flow at the USGS Gage on Corralitos Creek at Freedom.

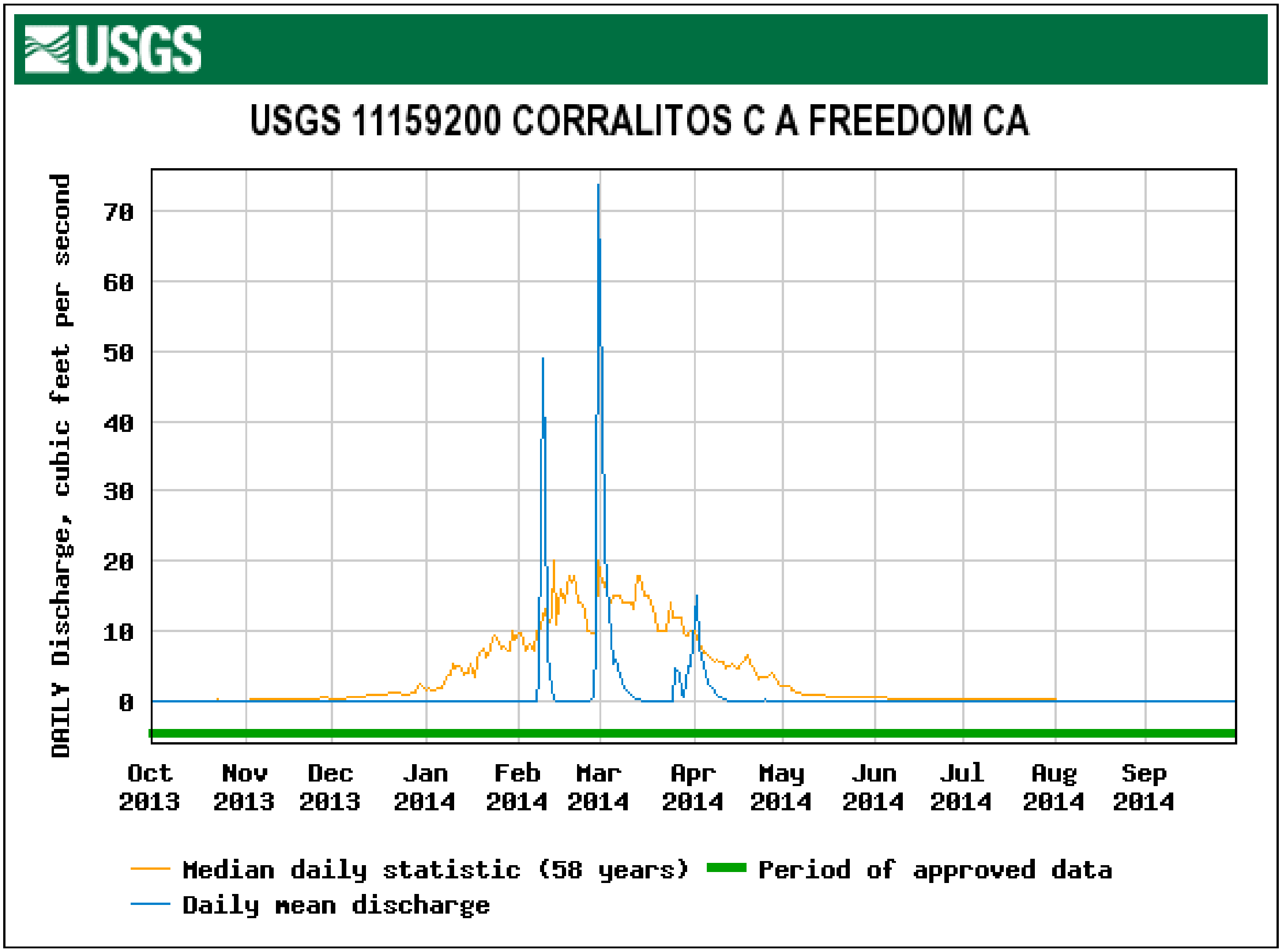
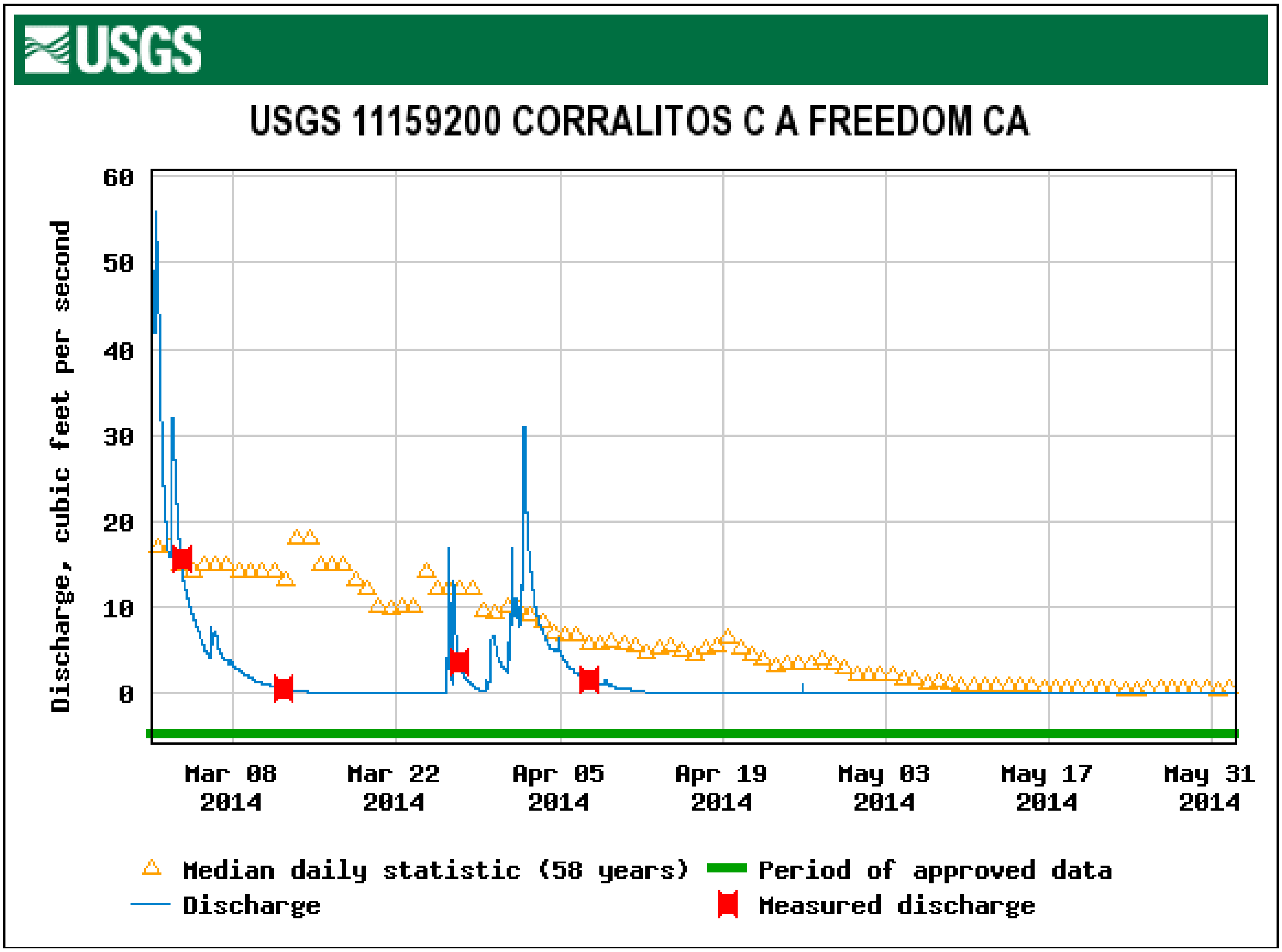


Figure 44. The March−May 2014 Discharge of Record for the USGS Gage on Corralitos Creek at Freedom.



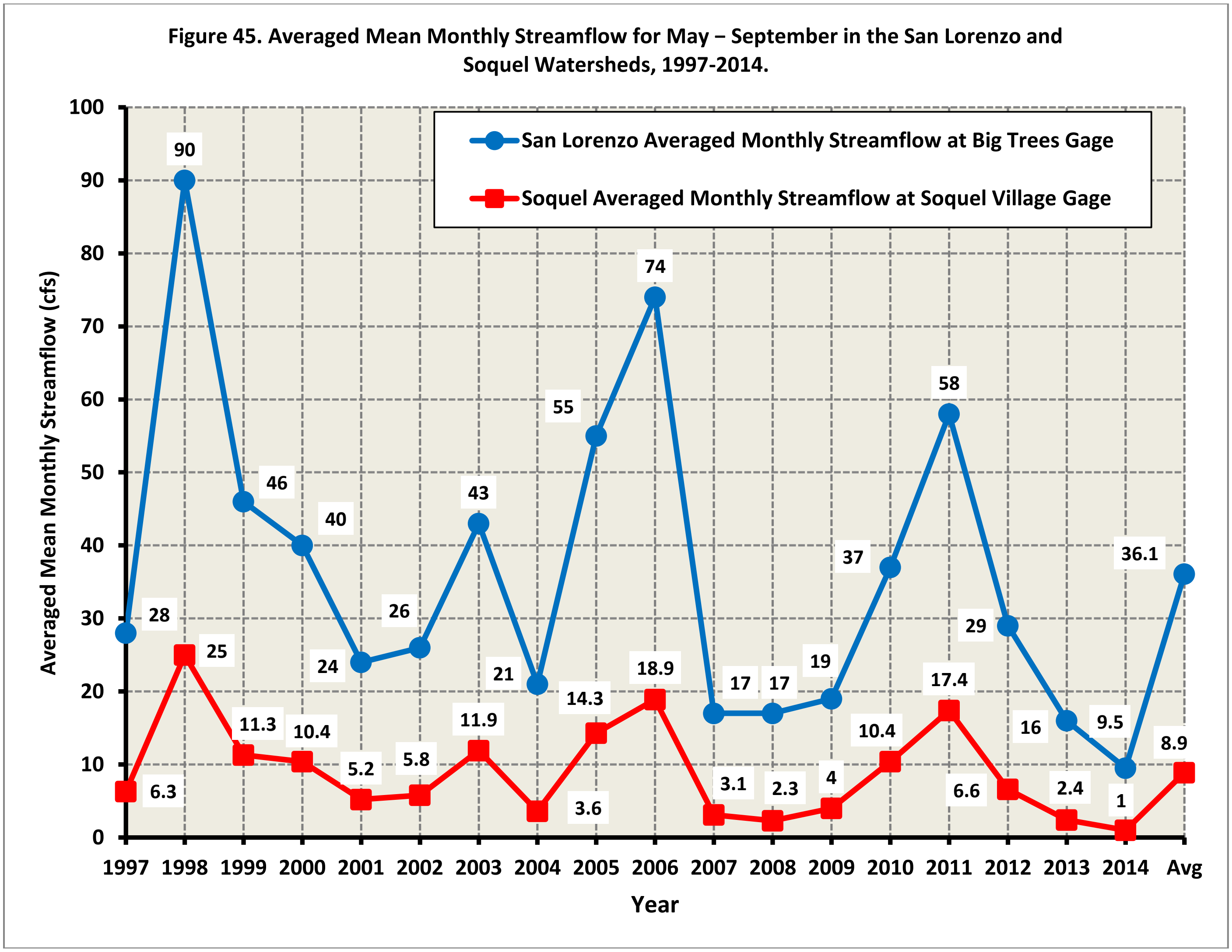


Figure 45. Averaged Mean Monthly Streamflow for May−September in the San Lorenzo and Soquel Watersheds, 1997-2014.

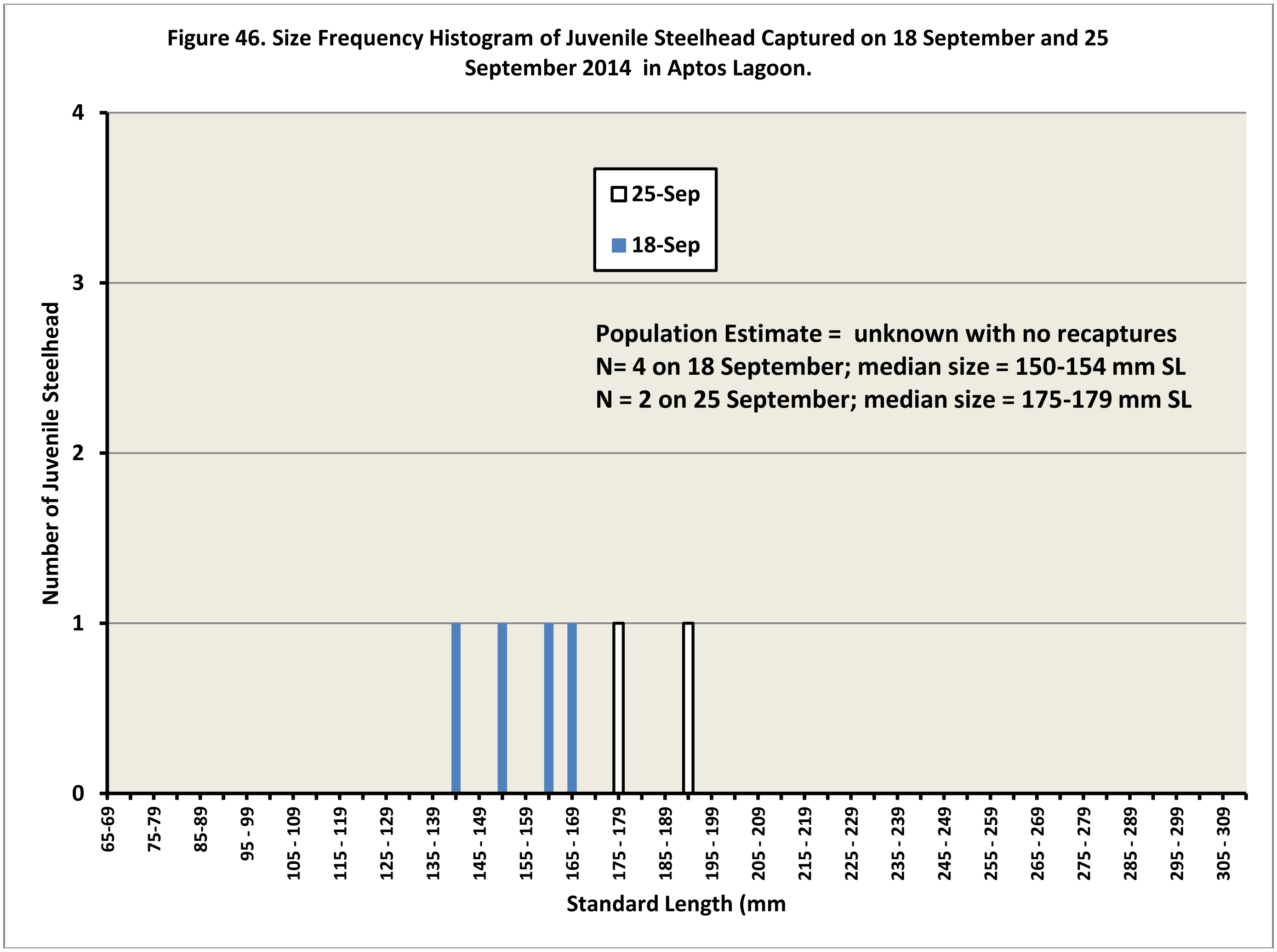


Figure 46. Size Frequency Histogram of Juvenile Steelhead Captured on 18 September and 25 September 2014 in Aptos Lagoon.

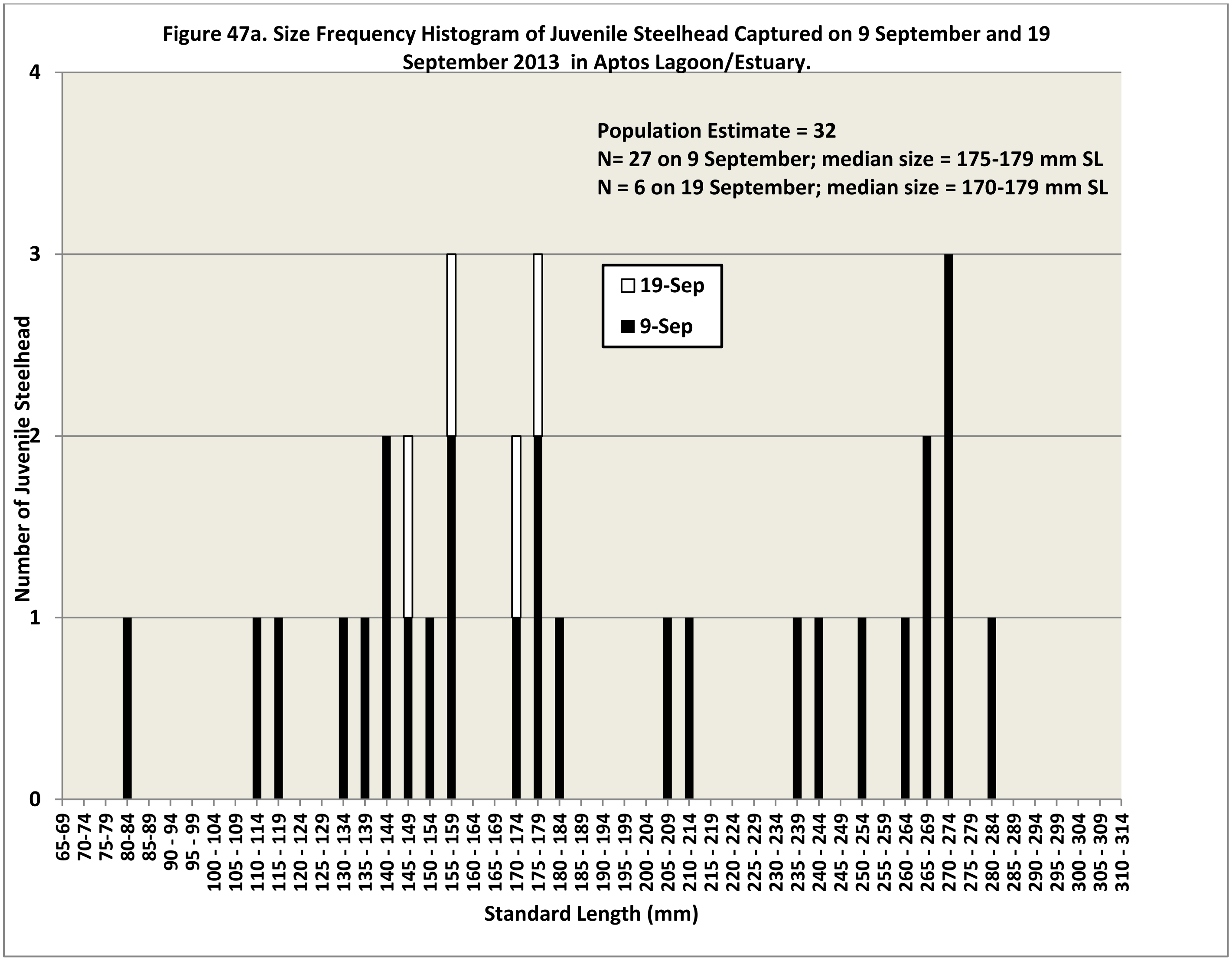


Figure 47a. Size Frequency Histogram of Juvenile Steelhead Captured on 9 September and 19 September 2013 in Aptos Lagoon/Estuary.

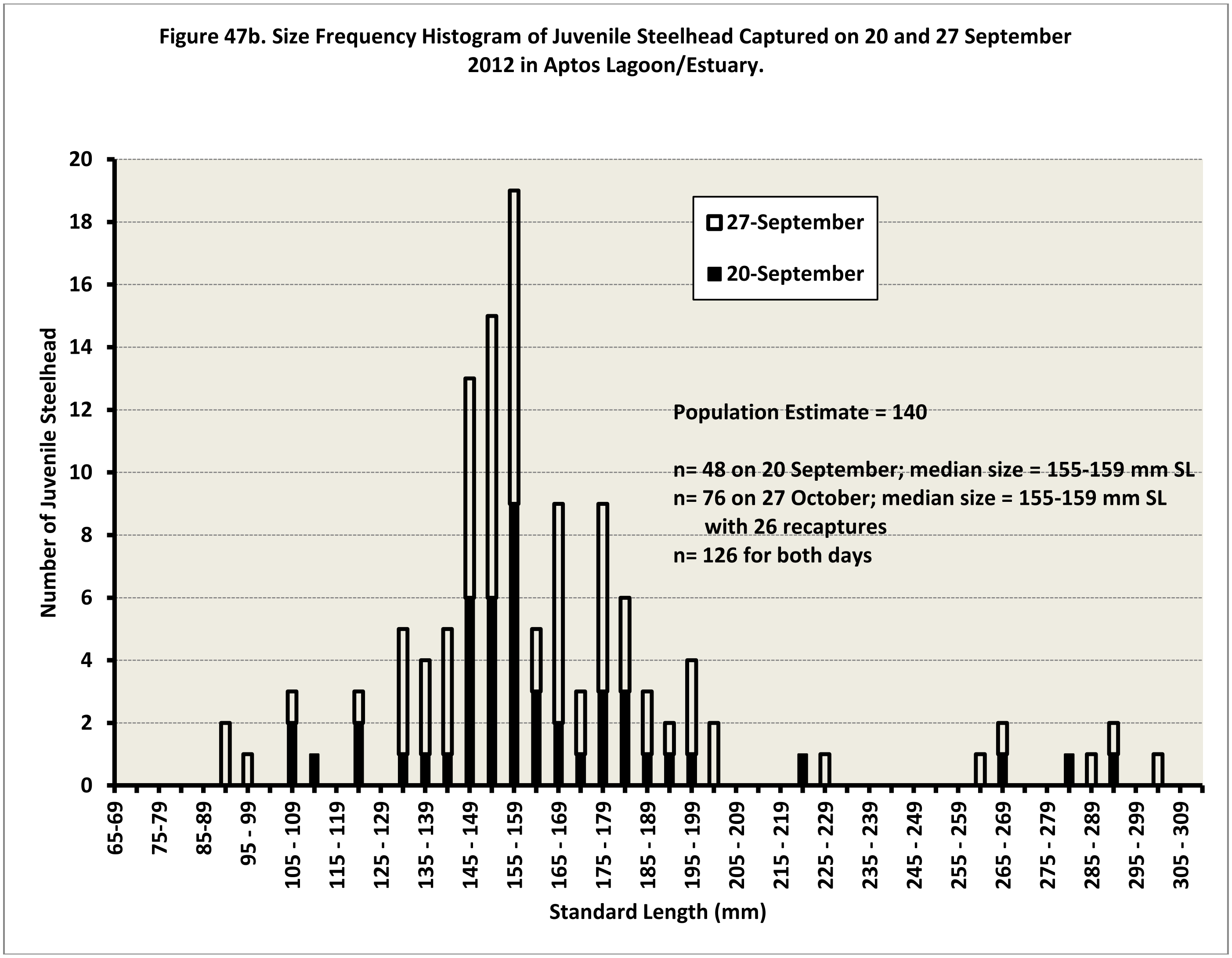


Figure 47b. Size Frequency Histogram of Juvenile Steelhead Captured on 20 and 27 September 2012 in Aptos Lagoon/Estuary.

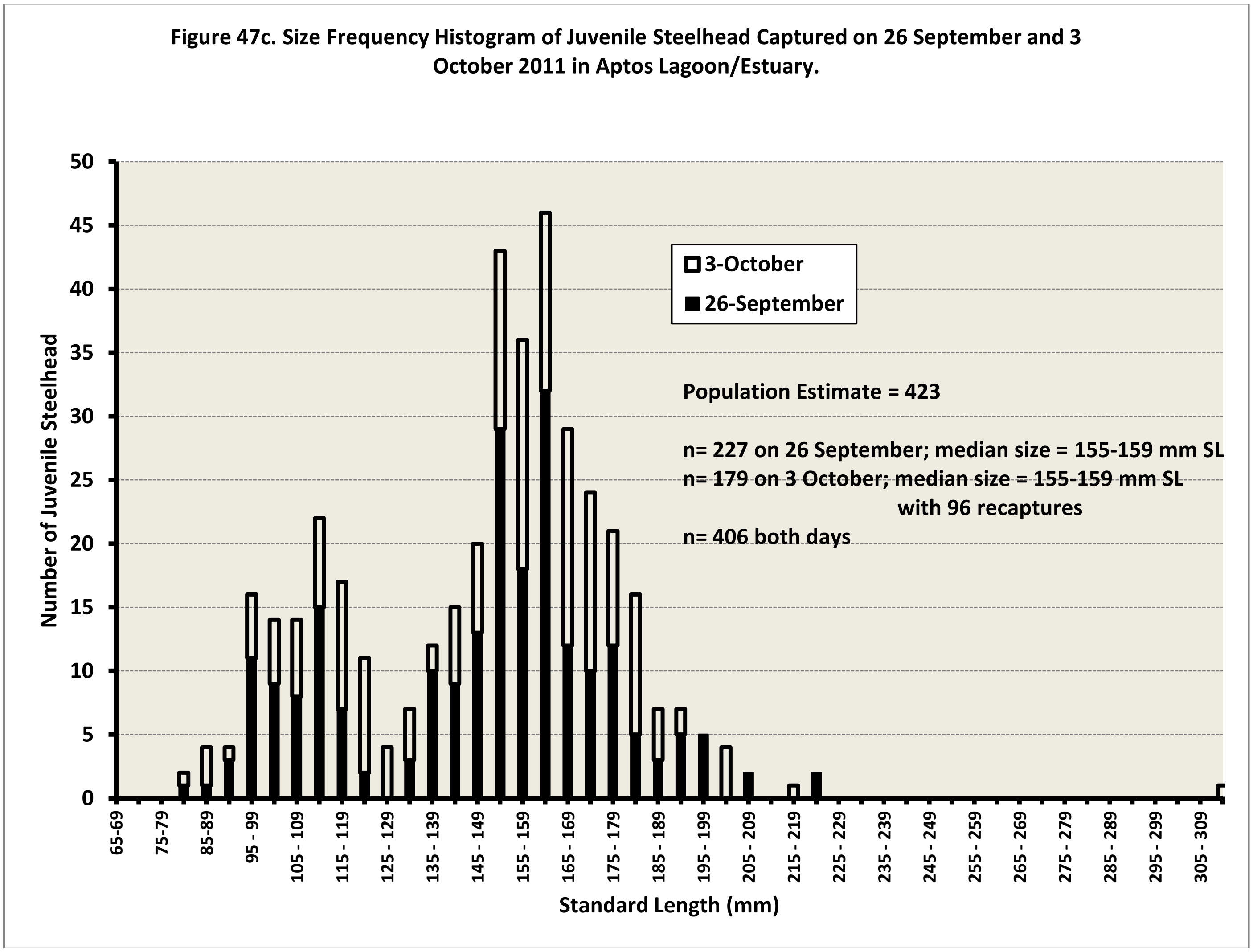


Figure 47c. Size Frequency Histogram of Juvenile Steelhead Captured on 26 September and 3 October 2011 in Aptos Lagoon/Estuary.

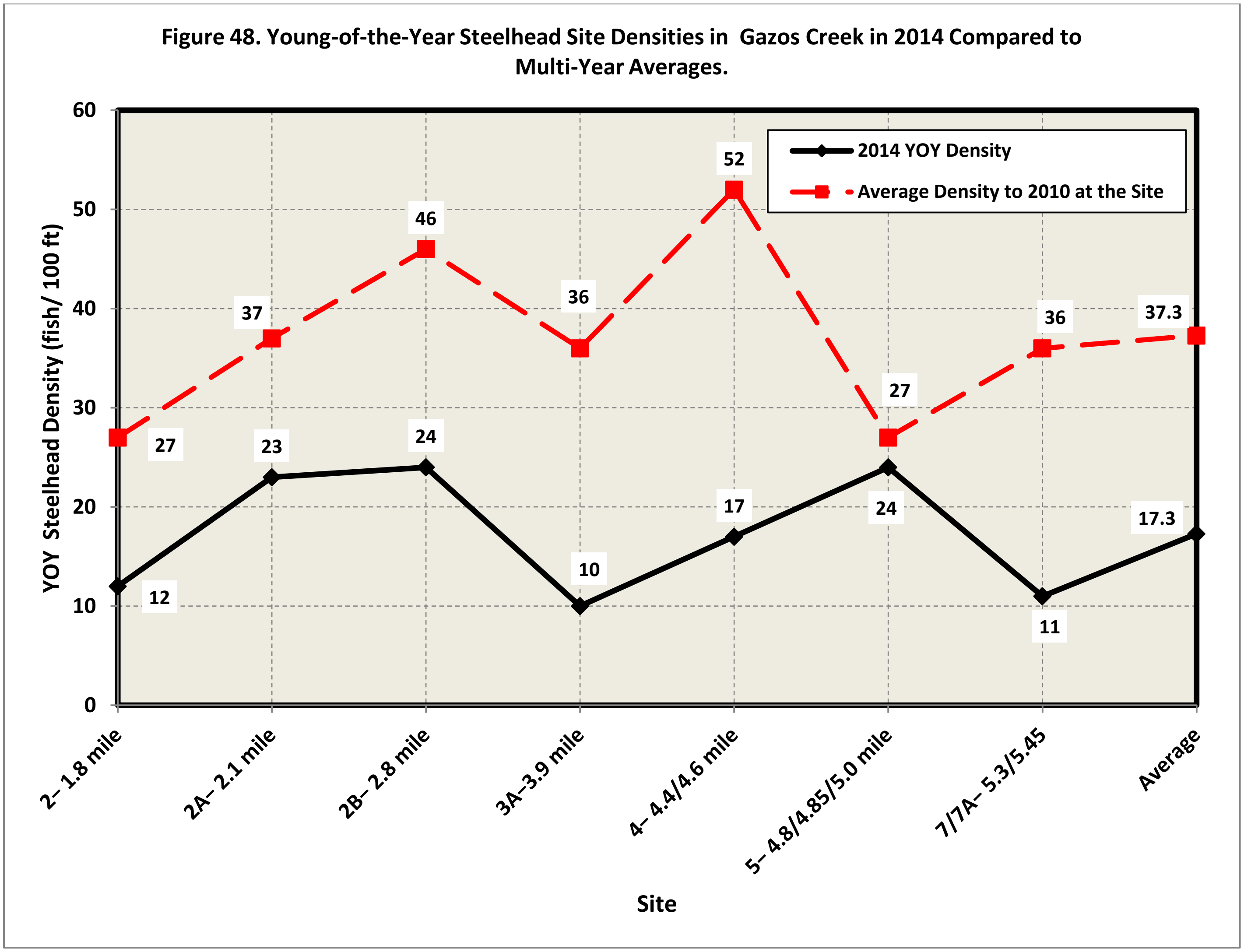


Figure 48. Young-of-Year Steelhead Site Densities in Gazos Creek in 2014 Compared to Multi-Year Averages.

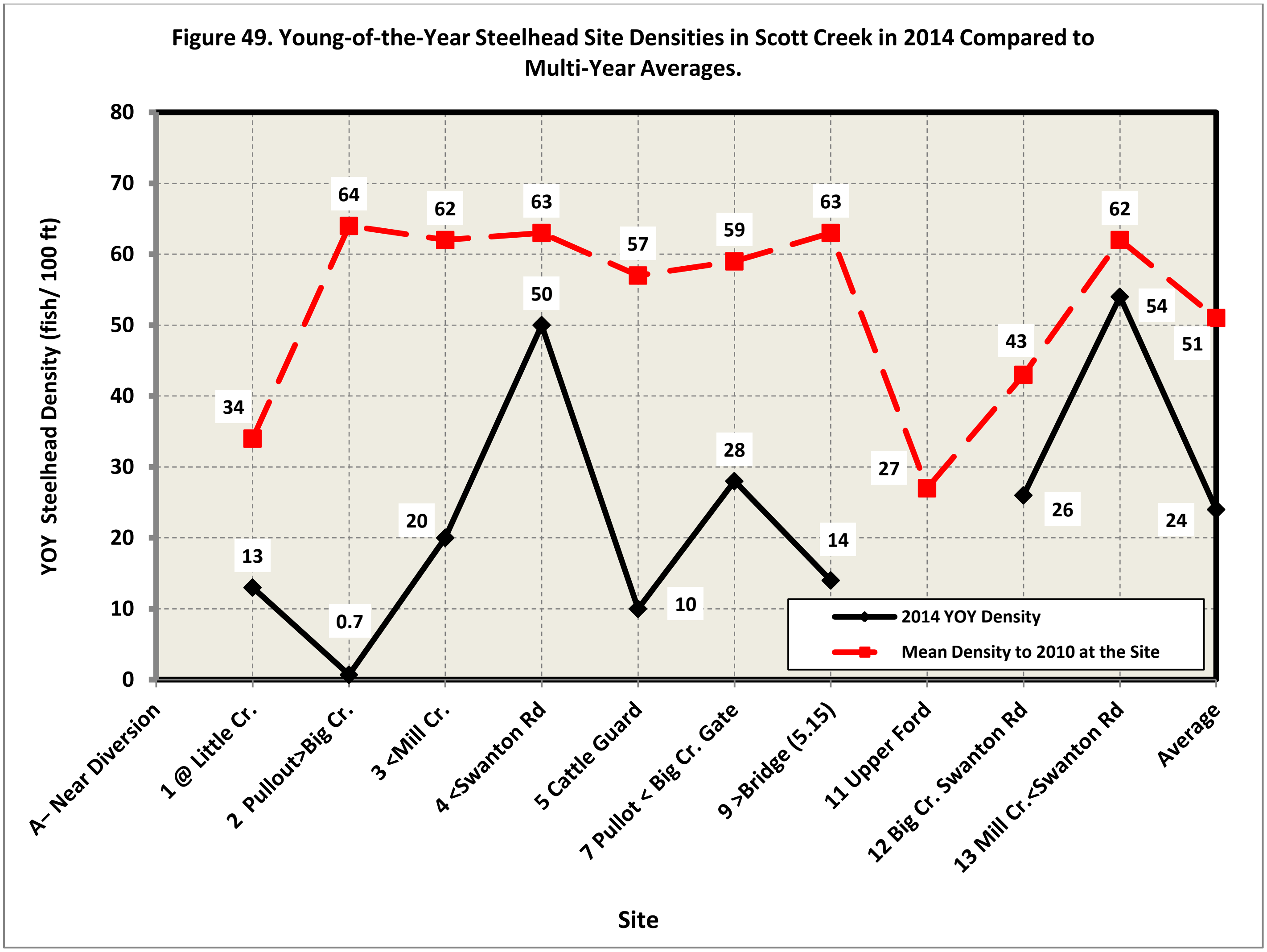


Figure 49. Young-of-the-Year Steelhead Site Densities in Scott Creek in 2014 Compared to Multi-Year Averages.

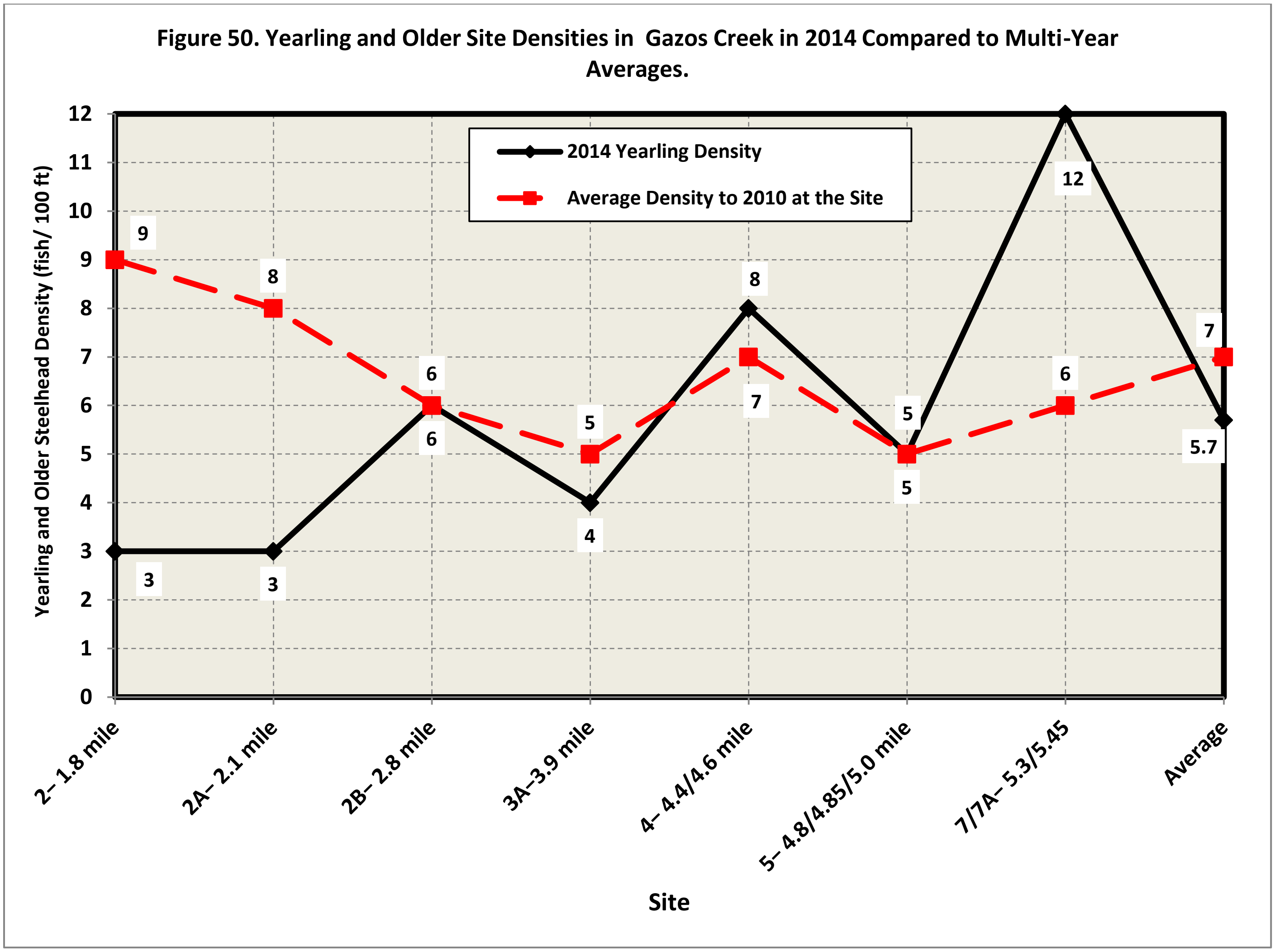


Figure 50. Yearling and Older Site Densities in Gazos Creek in 2014 Compared to Multi-Year Averages.

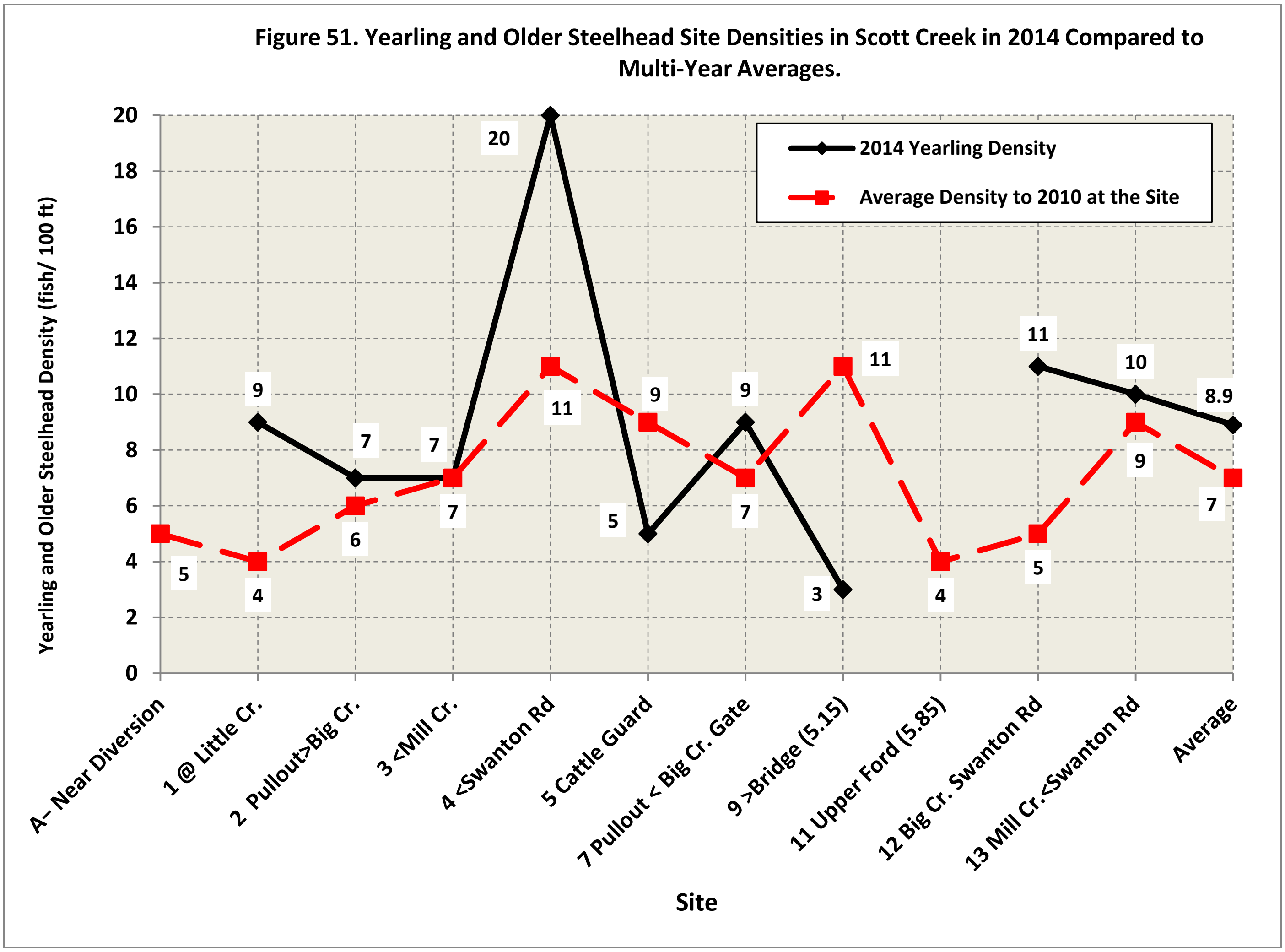


Figure 51. Yearling and Older Steelhead Site Densities in Scott Creek in 2014 Compared to Multi-Year Averages.

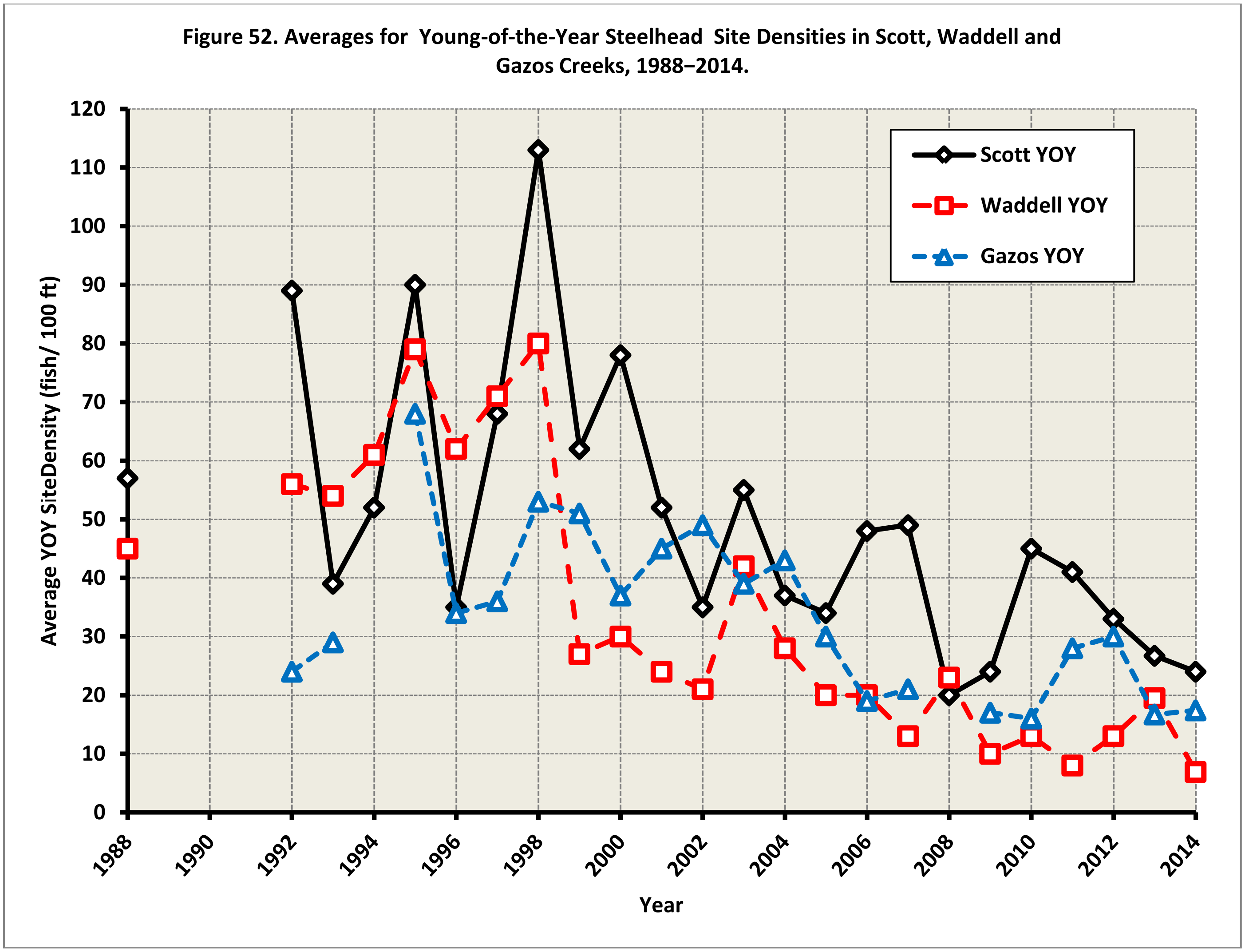


Figure 52. Averages for Young-of-the-Year Steelhead Site Densities in Scott, Waddell and Gazos Creeks, 1988–2014.

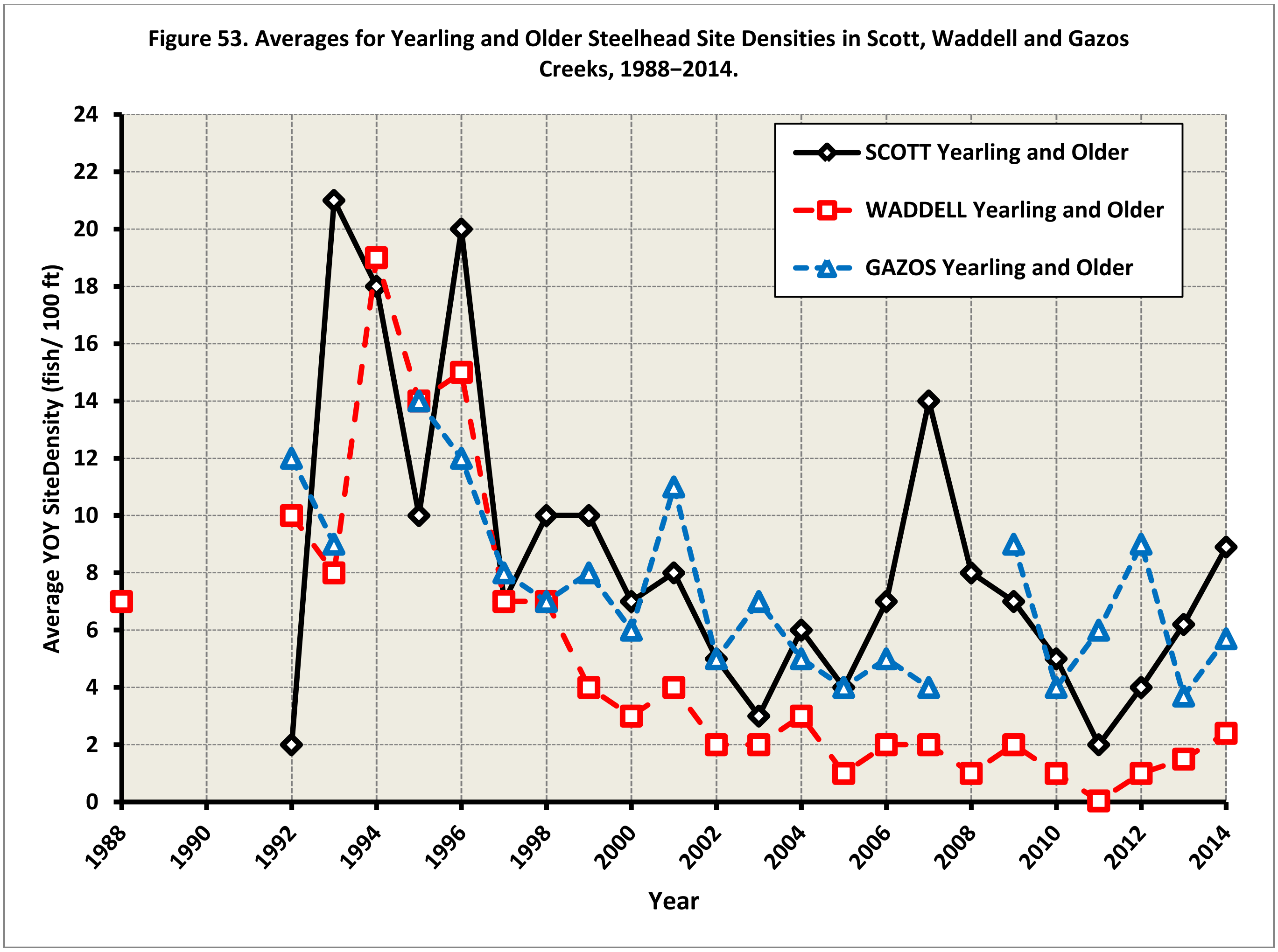


Figure 53. Averages for Yearling and Older Steelhead Site Densities in Scott, Waddell and Gazos Creeks, 1988‒2014.

APPENDIX A. Watershed Maps.

Figure 1. Santa Cruz County Watersheds.

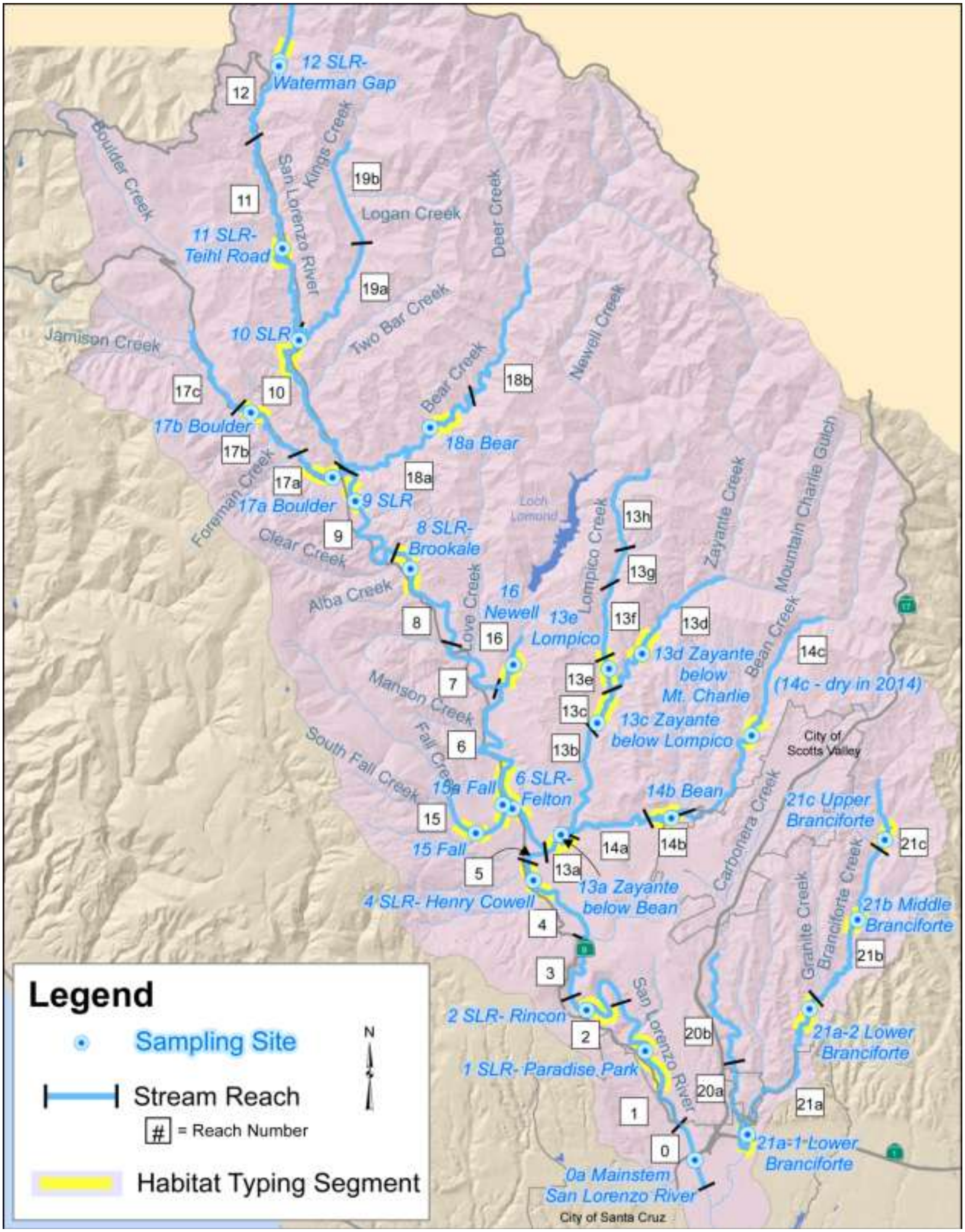


Figure 2. San Lorenzo River Watershed– Sampling Sites and Reaches.

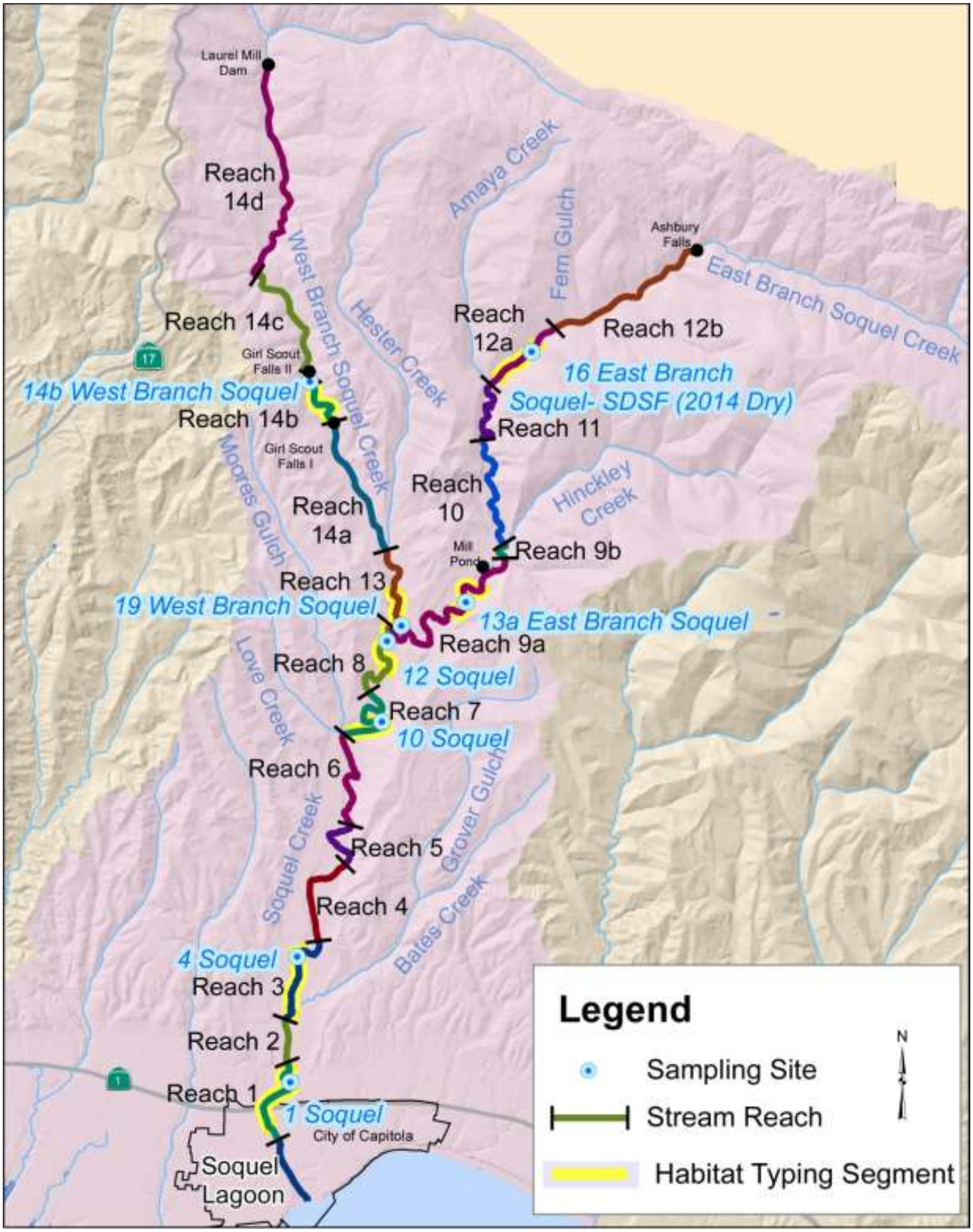


Figure 3. Soquel Creek Watershed.

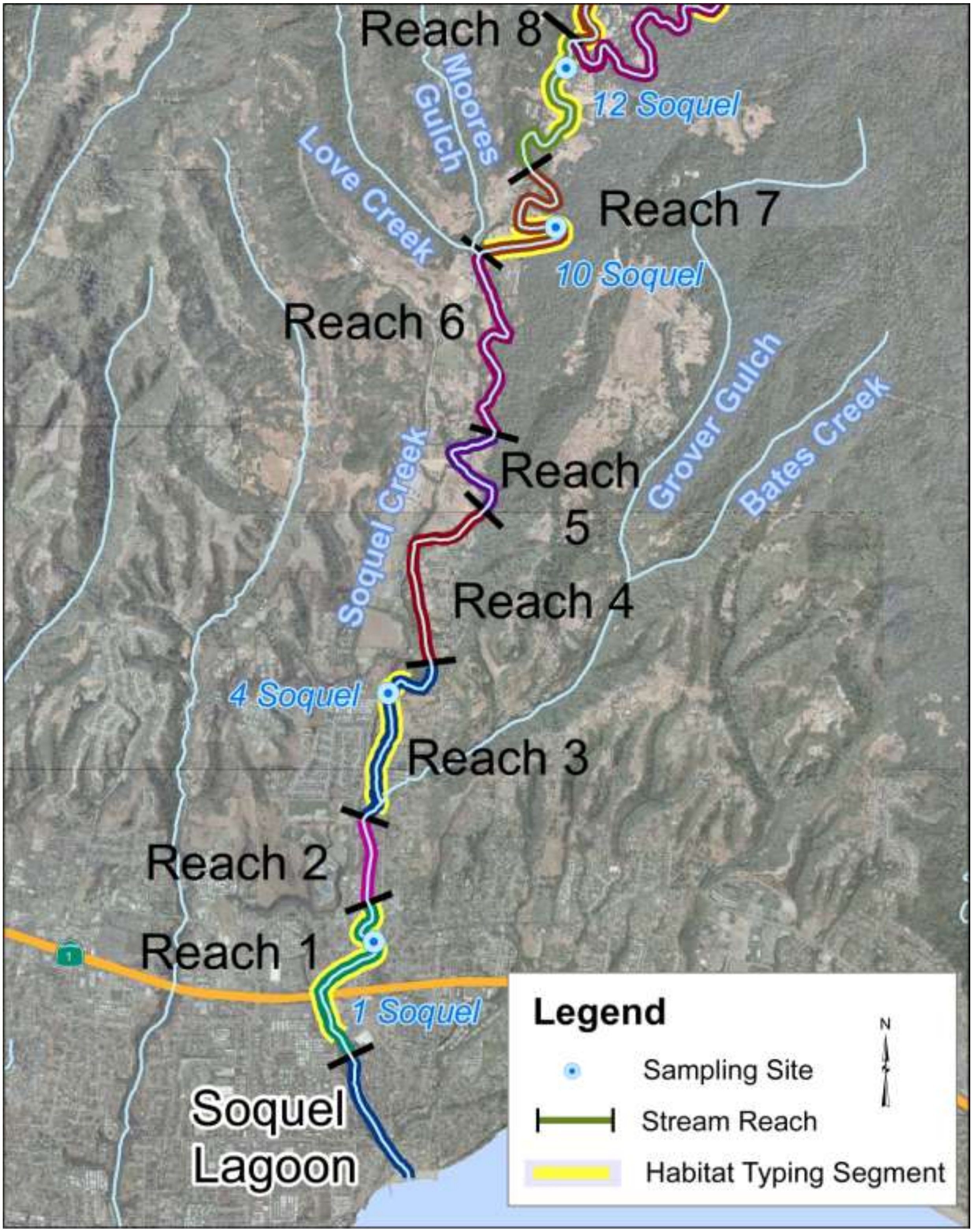


Figure 4. Lower Soquel Creek (Reaches 1–8 on Mainstem).

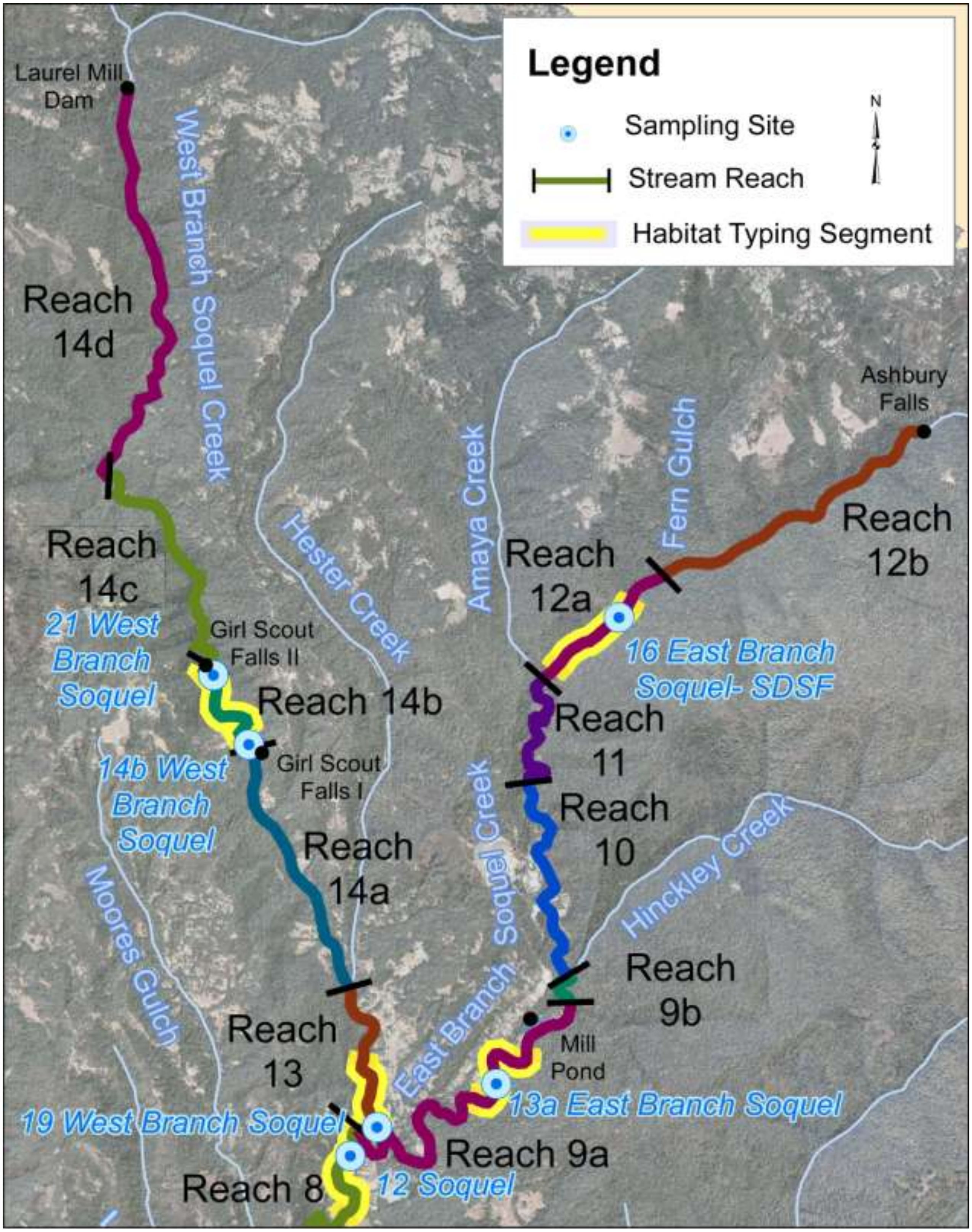


Figure 5. Upper Soquel Creek Watershed (East and West Branches; Reach 9a below habitat-typed segment and Reach 12a were dry in 2014).

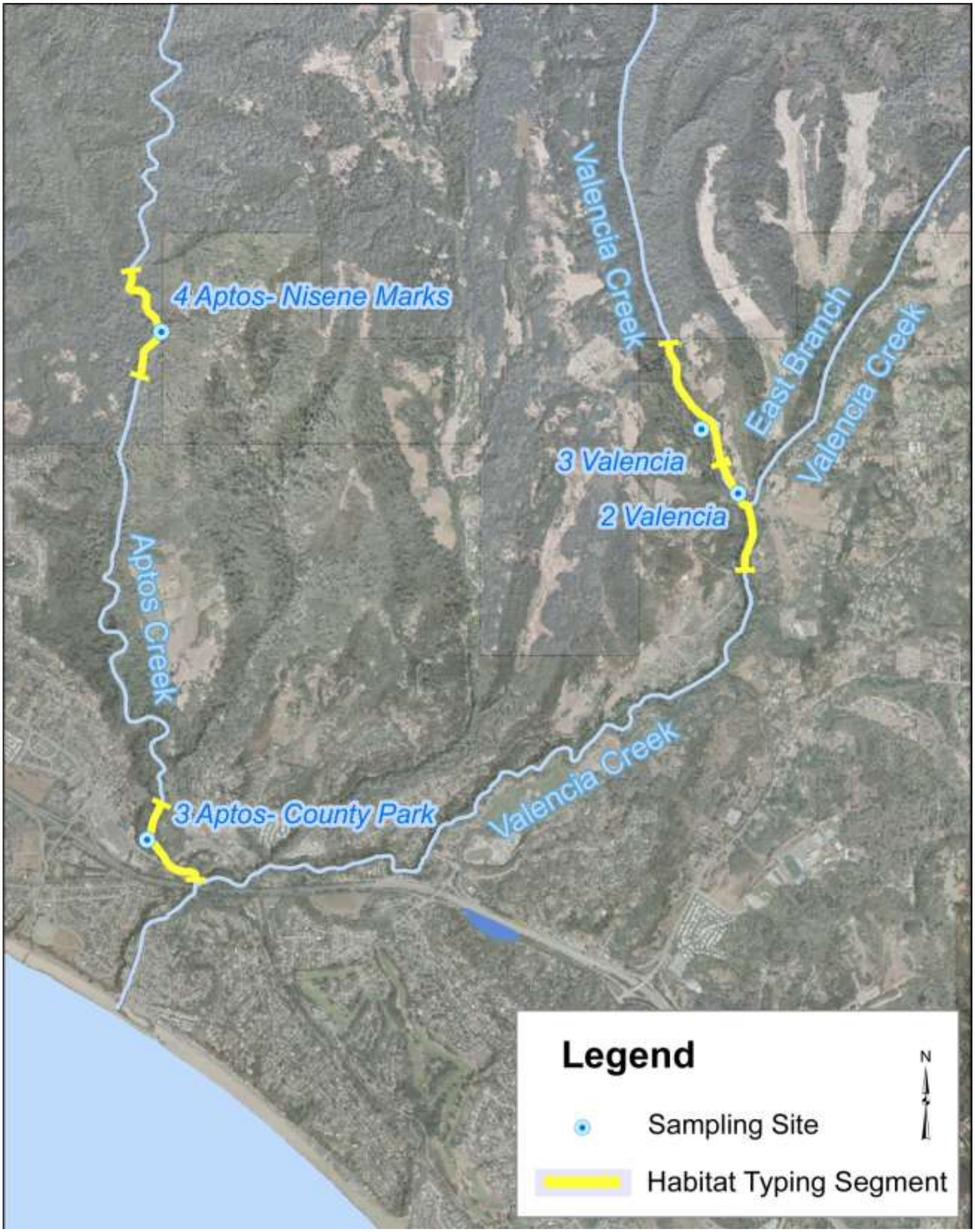


Figure 6. Aptos Creek Watershed (Aptos Lagoon also sampled).

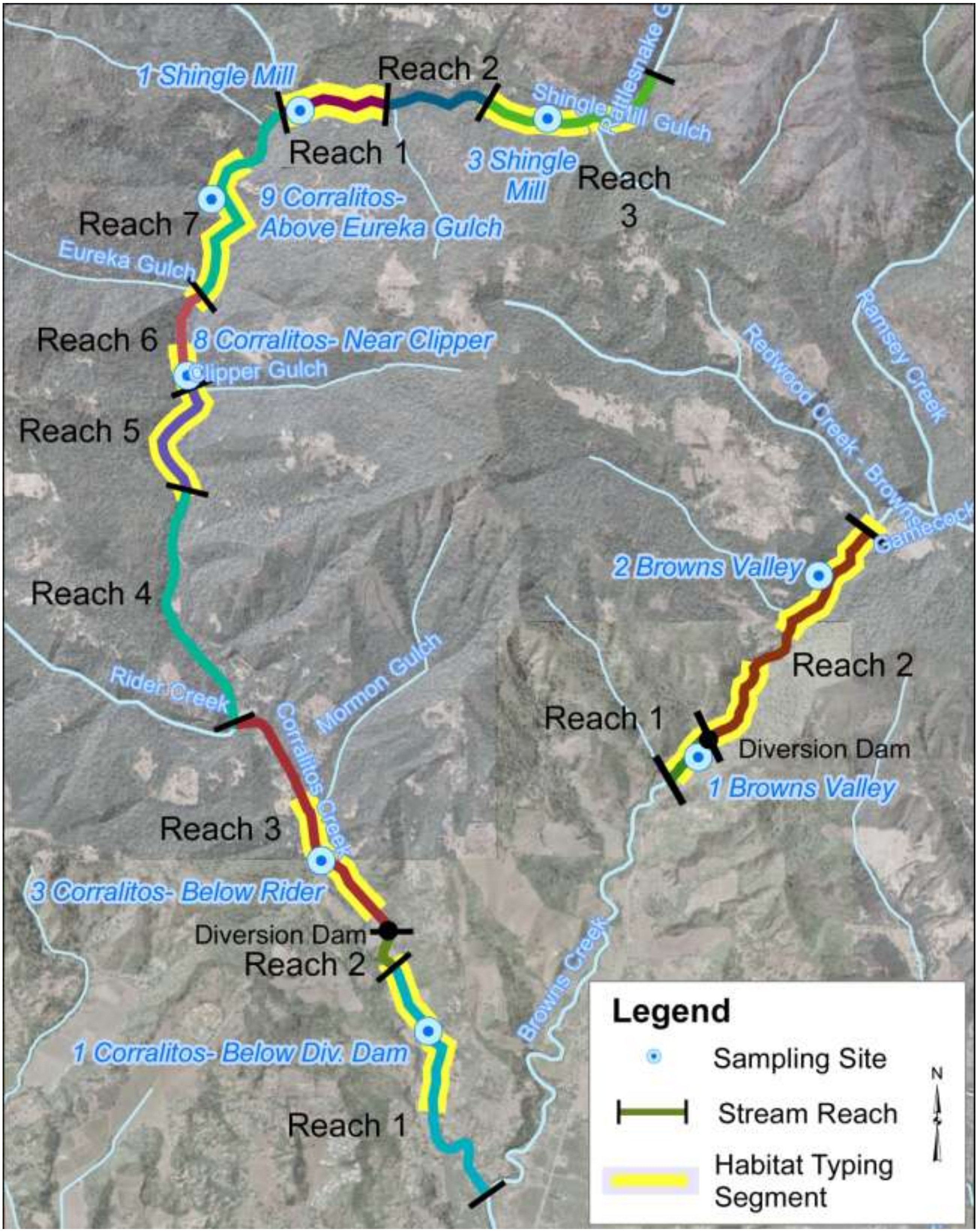


Figure 7. Upper Corralitos Creek Sub-Watershed of the Pajaro River Watershed

APPENDIX C. Summary of 2014 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 2014. 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.)