APPENDIX B. DETAILED ANALYSIS OF 2015 STEELHEAD MONITORING IN THE SAN LORENZO, SOQUEL, APTOS AND CORRALITOS WATERSHEDS.

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SCOPE OF WORK

In fall 2015, 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─2014. Aptos Creek was previously sampled in 1981, 2006─2014. 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.

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

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

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

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

During summer in the mainstem San Lorenzo River, downstream of the Boulder Creek confluence, steelhead use primarily fastwater habitat where insect drift is 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 use primarily heads of pools in all but the highest flow years, with some YOY using shallower runs and riffles. In summer in the Soquel mainstem upstream of Moores Gulch 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 small YOY in the upper mainstem more so than in the branches, where they are shallower.

In summer in San Lorenzo tributaries, the upper San Lorenzo mainstem above the Boulder Creek confluence, the Aptos watershed and in the Corralitos sub-watershed, the primary habitat for soon-to-smolt steelhead and smaller YOY is pools and step-runs because riffles and runs are very shallow. Riffle and run habitat offers 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. In winters with significant stormflows (i.e. 1982, 1995, 1998 and 2006), overwintering habitat may be 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 2015 fall fish sampling and habitat evaluation included comparison of 2015 juvenile steelhead densities at sampling sites and rearing habitat conditions with those in 1997–2001 and 2003–2014 for the San Lorenzo River mainstem and 8 tributaries and with those in 1997−2014 for the Soquel Creek mainstem and branches. 2015 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 2015 in the Corralitos Creek sub-watershed were compared to those in 1981, 1994 and 2006−2014. Fall 2015 steelhead densities and habitat conditions in the Aptos Creek watershed were compared to those in 1981 and 2006−2014. Aptos Lagoon/estuary was not inventoried because CDFW staff intended to sample it in 2015, although they did not in the end. Findings in Pajaro Lagoon were compared with earlier sampling results.

In 2015, instream wood was inventoried in Bean Creek Reach 14a, Zayante Creek Reach 13i and Aptos Creek Reach 3 to guide the County in choosing potential habitat enhancement projects.

DETAILED METHODS

M-1. Choice of Reaches and Vicinity of Sample Sites− 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 of juveniles. 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. In 2015, a segment of Zayante Reach 13i above Mt. Charlie confluence was habitat typed and sampled. 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 2015, the previous year's sampling site was replicated. Steelhead inhabit other tributaries. In the past, 9 major tributaries were sampled, including Carbonera and Kings creeks. 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 Valencia Creek sites were not in 2015.

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 upon 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 <u>California Salmonid Stream Habitat Restoration Manual</u> (**Flosi et al. 1998**). Habitat characteristics that were measured 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 better quantify it in a biologically relevant manner.

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.

<u>Fine Sediment.</u> 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. Escape cover is important because the more there is, the higher the production of steelhead, particularly for steelhead =>

75 mm SL. Escape cover was identified 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 completely blocking the view from above. 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 and concrete debris 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 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. Measurements were quantified by habitat type because in the mainstem San Lorenzo below the Boulder Creek confluence, fastwater habitat was the primary habitat of importance for juvenile steelhead. But in the upper San Lorenzo and San Lorenzo tributaries, as well as in all reaches in the other watersheds, pools were the habitats of primary importance for juvenile salmonids 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. Steelhead habitat is illustrated in the following drawings.

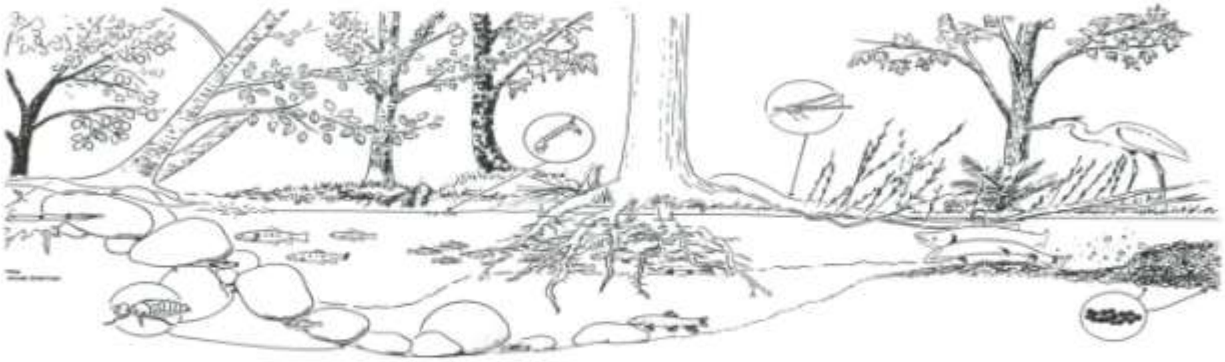

Illustration of pool habitat (stream flowing from left to right) showing escape cover under boulders and undercut bank with tree roots. Juvenile steelhead are feeding at the head of the pool. (Female steelhead is covering her redd of eggs after spawning at the tail of the pool.)

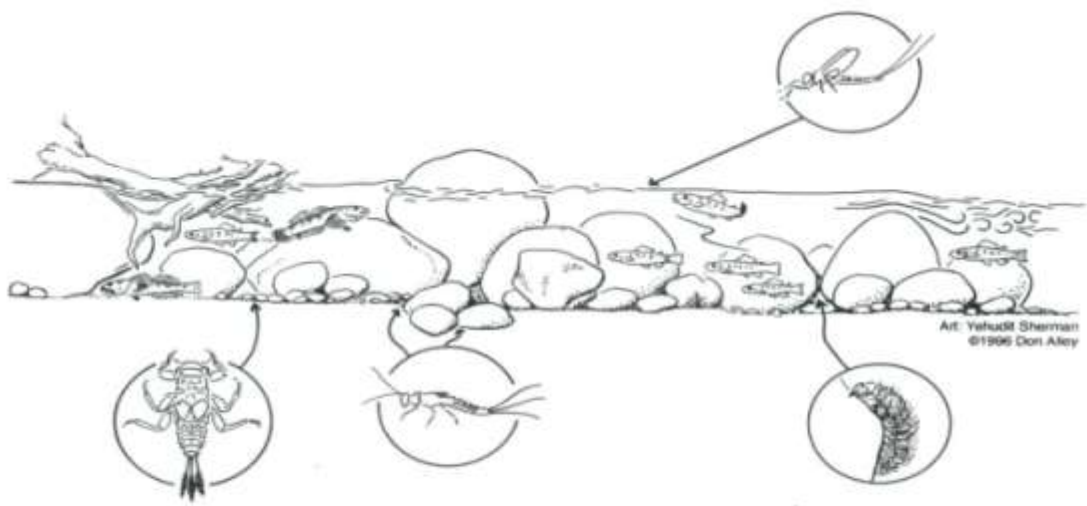

Illustration of riffle habitat (stream flowing from left to right) showing escape cover under rootwad and boulders. (Juvenile steelhead are holding feeding positions, facing upstream.)

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 2007−2015, 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 soon-to-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 habitats at all electrofishing sites to prevent 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 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 2006−2015, deeper pools were snorkel-censused at Sites 1, 2, 4, 6, 8 and 9 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. 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 are associated with high erosion and sedimentation, pool depth and escape cover may diminish as embeddedness increases afterwards, despite higher baseflow. Sometimes during a mild winter, sedimentation is reduced and escape cover and pool depth may increase because sediment is removed from the streambed. Embeddedness and percent fines may be reduced in this scenario.

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

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

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

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

Creek-Reach #	Reach Boundaries (Downstream to Upstream)	Reach Length (ft)
Zayante 13a	San Lorenzo River Confluence to Bean Creek Confluence CM0.0-CM0.61	3,221
13b	Bean Creek Confluence to Trib. Draining from S.Cruz Aggregate Quarry CM0.61-CM2.44	9,662
13c*	Santa Cruz Aggregate Tributary to Lompico Creek Confluence CM2.44-CM3.09	3,432
13d*	Lompico Creek Confluence to Mt. Charlie Gulch Confluence CM3.09-CM5.72	13,886
Lompico 13e	Lompico Creekmouth to 1st Culvert Crossing CM0.0-CM0.5	4,265
Lompico 13f	1st Culvert Crossing to Carol Road Bridge CM0.5-CM1.77	5,077
Lompico 13g	Carol Road Bridge to Mill Creek Confluence CM1.77-CM2.35	3,046
Lompico 13h	Mill Creek Confluence to End of Perennial Channel CM2.35-CM3.73	7,311
Zayante 13i*	Mt. Charlie Gulch Confluence to Confluence Immediately Above Camp Wasibo Access Bridge CM5.72-CM6.64	4,874
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

Creek-Reach #	Reach Boundaries (Downstream to Upstream)	Reach Length (ft)
17b	Foreman Creek Confluence to Narrowing of Gorge Adjacent Forest Springs CM0.85-CM2.0	6,072
17c	Narrow Gorge to Bedrock Chute At Kings Highway Junction with Big Basin Way CM2.0-CM3.46	7,709
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	182,680 (34.6 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. (2015 Sites Indicated by Asterisk.)

Reach #	Sampling Site # -Channel Mile	<u>MAINSTEM SITES</u> 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.
13i	*13i-CM6.3	Zayante Creek upstream of first bridge crossing upstream of Mt. Charlie Gulch confluence.
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 2015.)

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	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 2015.)

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. 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 by snorkeling 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 2003-2015, 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 2015, the second lowest baseflow year since sampling began, only the lower mainstem Sites 0, 1 and 2 of the San Lorenzo River had a 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. No YOY reached 75 mm SL in the middle mainstem San Lorenzo Sites 6 and 8, with only a few at Site 9. Middle Bean, Lompico, upper Fall, Newell, Bear and middle Branciforte creeks had YOY reaching the larger size class, but YOY juvenile densities were very low at these sites in 2015. In the sunny middle Reach 13c of Zayante Creek, 30% of YOY reached Size Class II despite high densities and low baseflow, as did more than 30% in the wetter years of 2010 and 2011. Growth had been slower in 2014. The lower mainstem of Soquel Creek showed slow growth in 2015, with the majority of YOY being less than 75 mm SL at Sites 1 and 4. The upper mainstem Sites 10 and 12 had no YOY reaching Size Class II. In this monitoring report, sampling site densities were compared for 18 years in the San Lorenzo system by size and age (1997−2001 and 2003 onward) and for 19 years in Soquel Creek (1997 onward). At each sampling site, habitat types were sampled separately, with density estimates calculated for each habitat by size class and age class. 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 and 2015 abundance to contrast production in a year with a near median statistic of baseflow in late spring through fall (2010) with production in critically dry years (2014 and 2015). 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 Pajaro Estuary− Methods

On 28 September 2015, the main lagoon along the beach and Watsonville Slough near its mouth were sampled for steelhead with the 106-foot bag seine (8 seine hauls). On 29 September 2015, the upper lagoon was sampled for steelhead with the 106-foot seine (3 seine hauls) at the model airport and Thurwachter Bridge (3 seine hauls). On 29 September 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). On 1 October 2015, the main lagoon along the beach (5 seine hauls) and the upper lagoon (3 seine hauls), were sampled for tidewater goby with the 30-foot, fine-meshed seine oriented perpendicular to the beach. On 1 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 6 stations.

DETAILED RESULTS

R-1. Capture and Mortality Statistics

For the overall sampling activities in 2015, a total of 2,542 juvenile steelhead and 11 juvenile coho salmon (Soquel Creek) were captured by electrofishing at 41 electrofishing sites and 1 lagoon site, with 25 steelhead mortalities (0.98% mortality rate). Aptos Lagoon/Estuary was not sampled in 2015 because CDFW took over monitoring and was to do it instead. However, CDFW did not sample it either in 2015. No steelhead were captured in Pajaro Lagoon. A total of 18 juvenile steelhead were visually censused in pools at 6 San Lorenzo mainstem sites. Ten mainstem sites and 16 tributary sites were sampled in the San Lorenzo watershed in 2015, with a total of only 1,689 juvenile steelhead captured and 16 mortalities (0.95%). A total of 546 juvenile steelhead and 11 juvenile coho were captured at 7 sites in the Soquel watershed in 2015 with 6 steelhead mortalities (1.08%). Only 16 juveniles steelhead were captured by electrofishing in the Aptos Watershed at 2 Aptos sites with no mortality. A total of 307 juveniles were captured in the Corralitos watershed at 6 sites with 3 mortalities (0.98%). A high proportion of YOY steelhead were small in 2015, and they were more vulnerable to electrofishing mortality than larger fish.

R-2. Habitat Change in the San Lorenzo River Mainstem and Tributaries, 2014 to 201, and Long Term Trends at Two Sites

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.

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.

Baseflow in 2015 was higher than in 2014 early on in the dry season but diminished below 2014 levels later in the dry season. So, we judged baseflow conditions more favorable for growth in 2015 than 2014 in all but Newell Creek, which had a regulated release the same in both years with drier conditions late in the dry season of 2015 that lead to intermittency of surface flow. Unlike in the wet 2011 year, all reaches in 2015 were much below the median daily statistic for baseflow from May through the summer, the second lowest in 19 years of calculations behind 2014 (**Figure 45**), and they were less than in the previous dry years of 2012 and 2013 (**Figures 33a-b, 34a−b; Appendix C**). During the 2014-2015 winter, there were 4 storms in rapid succession in early to mid-December 2014 (one of which was likely above bankfull and prior to the main steelhead spawning season) and then only 1 modest stormflow (below bankfull) between 1,000 and 2,000 cfs at Big Trees gage in February 2015. From previous calculations, bankfull at the Big Trees gage was between 2,800 and 4,300 cfs, corresponding to the 1.3 and 1.5 year recurrence intervals, respectively (**Alley 1999**). Small stormflows of less than 200 cfs occurred in April 2015 (**Figures 36a−b**). Very low baseflow in 2015 provided less food (lower insect drift velocity and reduced fastwater habitat) and reduced growth rate at most sites similar to conditions in 2014 but slightly better early on, except with more YOY present in 2015 to increase competition for food as indicated by higher total juvenile densities (**Figures 21 and 23**). The average mean monthly streamflow for May−September in 2015 at the Big Trees gage was the second lowest in 19 years behind 2014 (10.4 cfs in 2015 with an 19-year average of 34.7 cfs) (**Figure 45**). Slower YOY growth was exemplified by the low percent of YOY reaching Size Class II in 2015 compared to those in another relatively dry year of 2014 and wetter 2011, except where YOY and total densities were very low in 2015 (Sites 13e, 15b and 16) (**Figures 17a and 17b**).

In 2015, habitat typing occurred in segments of Reaches 2, 4 and 12a in the mainstem and Reaches 13c, 13d, 13i, 14a and 14b in the tributaries. Therefore, other reaches were evaluated according to habitat changes at sampling sites. Rearing habitat quality improved slightly in mainstem reaches/sites in 2015 with slightly higher average baseflow from May through September and more escape cover at 5 of 8 sites (except Site 2 compared to 2008) (summary **Table 13b based on Tables 5a-c; 6a-b; 7a-b; 8a-b; 9a-b; 10, 11, 12a-b; 13a**). Rearing habitat quality also improved slightly in most tributary reaches/sites due to slightly higher average baseflow from May through September and similar or better escape cover at most sites (**Figure 13b**). Exceptions were Lompico 13e, Newell 16, Boulder17b and Branciforte 21b−c, where escape cover had lessened and baseflow was noticeably reduced to a trickle during fall sampling (intermittent in Newell Creek). Baseflow was still very low in 2015 at all sites to reduce food availability and reduce habitat depth at the end of the dry season. Several of the tributary sites improved with greater pool depth and more pool escape cover despite slightly lower baseflow at the end of the dry season. Percent fines and embeddedness were mostly similar or improved in the mainstem. Percent fines were mostly similar or improved in tributary pools except for upper Fall 15b, upper Boulder 17b and middle and upper Branciforte 21b−c. Embeddedness in tributaries remained mostly similar or improved. It worsened in pools of Zayante 13c and Newell 16, as well as fastwater habitat of Newell 16 and Bear 18a. Erosion and sedimentation were likely minimized in another drought winter.

In the lower mainstem (downstream of the Zayante Creek confluence) habitat conditions in Reach 2 (in the Rincon area below the gorge and the Felton water diversion) were analyzed in detail in 1999─2000 and 2007−2015, with no habitat typing in the years between. Habitat in riffles was focused on in the lower mainstem because warm water temperatures there will increase energy requirements of juvenile steelhead, forcing them to select fastwater habitat where water velocity and insect drift are maximized. Riffle habitat conditions have worsened in Reach 2 between 1999 and 2015 primarily due to shallower conditions with much less escape cover. Riffle depth was fairly constant in 2007−2010 but much shallower than in 2000 (**Figure 45**), which had a higher baseflow than in 2007−-2009 to at least partially explain greater depth then (**Figure 54**). But baseflow in 2000 and 2010 were very similar, indicating greater sedimentation and habitat decline in 2010. Then in 2011 the habitat typed segment was changed to include the northern meander section at the lower end, which had become the main channel. The increased depth from 2010 to 2011 may have been partially due to this change, along with the higher baseflow in 2011 (**Figure 45**). However, riffle depth would be expected to be fairly consistent through the reach. Riffle depth was maintained in 2012, despite a reduction in baseflow. This may have indicated continued, less sedimented conditions in 2012. Then riffle depth steadily declined annually to 2015 during drought to a level less than in 2007−2010. Escape cover in riffles has also declined substantially since 1999 and 2000 (**Figure 55**), which may be partially explained by higher baseflows in the earlier years (**Figure 45**). The escape cover index has fluctuated between 0.101 and 0.133 (between 10.1 and 13.3 feet of cover per 100 ft of stream) since the much better conditions in 2008 with twice as much cover (0.287). 2014 showed an improvement that continued in 2015 over the low in 2013. However, with nearly 4 times the escape cover measured in 1999 compared to 2015, conditions were certainly better in 1999.

The trend in pool depth in upper Zayante Reach 13d (**Figure 56**) mirrored fluctuation in baseflow (**Figure 45**). Depths were greatest during wetter years of 1998, 1999, 2005, 2006, 2010 and 2011. Depths improved more so in 2010 than expected merely from increased baseflow, indicating pool scour of more sediment that year. After 2011, pool depth steadily declined with drought to a low in 2014. Maximum pool depth increased slightly in 2015 despite lower baseflow. These trends indicate the importance of streamflow in affecting habitat quality. During the wet years of 1998 and 1999, the average mean pool depth was similar to the average maximum pool depth in 2014 and 2015. However, as flows decline, some habitats classified as run in a wet year became shallow pools in a dry year, to drive the mean and maximum pool depths downward further. Escape cover indices have fluctuated since 1998 (**Figure 57**), with somewhat higher ones in some wetter years (1998−2000, 2003, 2005 and 2011) (**Figure 45**). However, there was an abrupt decline in 2006, despite high baseflow, and there was an abrupt improvement in 2009 despite low baseflow. The low point was in 2014 during the recent drought, but a sizeable improvement occurred in 2015. This resulted from more instream wood and rootmasses in the segment in 2015.

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	2015
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	7.81
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	3.25
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	1.11
9- SLR/ Below Bould.	4.6		7.2	3.5		3.0	3.7	2.1	5.8						0.80	0.88
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	0.21
12a-b SLR/ L Waterman G			1.0	0.7										0.33	0.10	0.22
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	2.9
13b/ Zayante above Bean			3.9	2.9	2.8	1.9	2.1	1.7	3.2	2.8						
14b/Bean bel Lockhart G	1.5		1.1	1.1	1.0	1.1	1.1	0.77	1.0	1.1						0.62
14c/Bean abv MacKenzie											0.03	0.11	Dry	Dry	Dry	Dry
15b/ Fall	2.0 Above Div.		3.4 Above Div.	2.2 Above Div.	1.7 Above Div.	1.7 Above Div.									1.0 below div. Bal.	0.32 Below div. Bal.
16/ Newell	1.6				0.51						1.2	0.92	0.78	0.78	0.08	0.04
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	0.66 (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	0.02
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		0.13

***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 2006−2015 and from Stream Gages; Measurements by D.W. ALLEY & Associates; 2010 (September), 2011−2015 (October) at fall baseflow conditions, County Staff (Date specified).

Location	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
SLR at Santa Cruz Gage	14 (30 Oct)	0.6 (4 Sep)	0.3 (3 Sep)	0.6 (3 Sep)	5.5 (2 Oct)	12 (23 Sep)	5.2 (19 Oct)	5.6 (23 Oct) 9.1 (27 Oct) 3.2 (7 Jan 14	0.6−7.1 (17 Oct) 1.2 (19 Oct)	2.4−8.5 (month of October) 2.4−4.4 (16 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)	7.8 Paradise P. (DWA)
SLR at Big Trees Gage	21 (30 Oct)	11 (4 Sep)	11 (3 Sep)	12 (3 Sep) 11 (11 Oct)	15 (2 Oct)	22 (23 Sep)	15 (9 Oct); 16 (19 Oct)	11.0 (27 Oct)	7.8 (17 Oct)	6.2 (14 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)	0.88 (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)	0.09 (8/20)
SLR @ Teihl Rd					0.97 (DWA)	1.1 (DWA)	0.40 (DWA)	0.38 (DWA)	0.13 (DWA)	0.21 (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)	2.9 Below Bean (DWA)
Zayante Cr below Lompico Cr	1.2	0.96	0.41	0.43	1.51 (8/24)			0.47 (8/15)		
Zayante Cr above Lompico Cr									0.23 (Balance Hydrologics) (10/2)	0.16 (Balance Hydrologics) (8/27)
Lompico Cr @ Carrol Ave						0.3 (8/10)	0.39 (6/13) 0.26 (8/2)	0.18 (6/13)	0.06 (8/20)	0.04 (8/12)
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)	2.00 (7/22)
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)	0.62 (DWA)
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)	0.04 (DWA) 0.11 (8/12)
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)	0.66 (10/15) (Balance Hydrologics) 0.74 (8/20)
Bear Cr above Hopkins Gulch					0.68 (DWA)	1.3 (DWA)	0.23 (DWA)	0.16 (DWA)	0.03 (DWA)	0.02 (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)	0.10 (8/20
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.)	0.18 (DWA) (Walnut St.)
Soquel Cr @ USGS Gage	6.6**	1.4**	0.65**	1.2**	3.4**	5.8**	1.8**	0.36**	0.35**	0.36** 0.10 (9/9)
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)	0.35 (9/9)

Location	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Soquel Cr above Moores Gulch					2.16 (DWA)	4.3 (DWA)	2.0 (DWA)	1.26 (DWA)	0.72 (7/16) 0.80 (DWA)	0.54 (7/28) 0.56 (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)	0.58 (9/14) 0.59 @ Mouth (DWA)
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)	Dry (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)	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)	0.44 (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.	0.37 (9/9)
Corralitos Cr above Los Cosinos Road Br					2.0 (DWA)	2.6 (DWA)	2.0 (DWA)	1.54 (DWA)	1.29 (DWA)	1.21 (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)	1.01 (9/9)
Corralitos above Eureka Gulch					0.63 (DWA)	0.71 (DWA)	0.23 (DWA)	0.16 (DWA)	0.07 (DWA)	0.04 (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)	0.13 (DWA)

* After 2 early October storms that increased baseflow.

** Estimated from USGS Hydrographs for September 1.

Table 6a. Averaged Mean and Maximum WATER DEPTH in SAN LORENZO Reaches Since 2009.

Reach	Pool 2009	Pool 2010	Pool 2011	Pool 2012	Pool 2013	Pool 2014	Pool 2015	Riffle 2009	Riffle 2010	Riffle 2011	Riffle 2012	Riffle 2013	Riffle 2014	Riffle 2015	Run/ Step Run 2009	Run/ Step Run 2010	Run/ Step Run 2011	Run/ Step Run 2012	Run/Step Run 2013	Run/Step Run 2014	Run/Step Run 2015
1- L. Main						1.9/ 3.1							0.6/ 0.9							**0/9 1.4**	
2- L. Main	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	2.2/ 3.8	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	0.7/ 1.2	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**	**1.1/ 1.9**
3- L. Main																					
4- L. Main	**2.0/ 3.6 (2008)**						1.9/ 3.5	0.5/ 1.0 (2008)						0.45/ 0.8	0.9/ 1.5 (2008)						**0.9/ 1.45**
5- L. Main																					
6- M. Main																					
7- M. Main																					
8- M. Main	2.8/ 5.1					2.4/ 4.0		0.65/ 1.0					0.4/ 0.7		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	1.05/ 1.8			1.1/ 2.0				0.25/ 0.4			0.3/ 0.5				0.4/ 0.75			**0.5/ 0.7**			
12- U. Main							1.05/ 1.7							0.3/ 0.6							**0.4/ 0.7**
12b- U. Main				1.1/ 1.9							0.3/ 0.7							**0.5/ 0.8**			
Zayante 13a																					
Zayante 13c		1.3/ 2.2	1.5/ 2.4				1.3/ 2.2		0.4/ 0.7	0.5/ 0.8				0.2/ 0.4		0.6/ 1.0	0.7/ 1.1				**0.35/ 0.6**
Zayante 13d	0.9/ 1.5	1.2/ 2.0	1.3/ 2.0	1.1/ 1.8	1.0/ 1.6	0.8/ 1.4	0.8/ 1.5	0.25/ 0.5	0.4/ 0.6	0.45/ 0.8	0.3/ 0.6	0.3/ 0.5	0.2/ 0.35	0.15/ 0.3	0.55/ 0.9	0.7/ 1.1	0.8/ 1.2	**0.6/ 1.0**	**0.5/ 0.9**	**0.3/ 0.5**	**0.4/ 0.8**
Lompico 13e																					
Zayante 13i							1.15/ 1.9							0.2/ 0.4							**0.3/ 0.5**

Reach	Pool 2009	Pool 2010	Pool 2011	Pool 2012	Pool 2013	Pool 2014	Pool 2015	Rif-fle 2009	Rif-fle 2010	Rif-fle 2011	Riffle 2012	Riffle 2013	Riffle 2014	Riffle 2015	Run/ Step Run 2009	Run/ Step Run 2010	Run/ Step Run 2011	Run/ Step Run 2012	Run/Step Run 2013	Run/Step Run 2014	Run/step Run 2015
Bean 14a							1.2/ 2.0							0.4/ 0.6							**0.5/ 0.8**
Bean 14b	1.2/ 1.9	1.15/ 2.0	1.2/ 2.0	1.2/ 2.1	1.0/ 1.9	0.9/ 1.5	1.0/ 1.8	0.2/ 0.4	0.2/ 0.4	0.3/ 0.6	0.3/ 0.5	0.3/ 0.5	0.3/ 0.5	0.25/ 0.5	0.4/ 0.6	0.4/ 0.6	0.5/ 0.8	**0.4/ 0.9**	**0.4/ 0.7**	**0.4/ 0.6**	**0.35 0.6**
Bean 14c		0.9/ 1.6	1.0/ 1.8						0.1/ 0.2	0.2/ 0.4						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		1.3/ 1.9			0.8/ 1.2		0.35/ 0.75		0.6/ 1.05			0.3/ 0.6		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	1.8/ 2.9				1.4/ 2.4			0.35/ 0.7				0.4/ 0.7			0.65/ 1.05				**0.6/ 1.0**		
Boul-der 17b					1.4/ 2.4							0.4/ 0.8							**0.55/ 1.0**		
Boul-der 17c																					
Bear 18a				1.4/ 2.2							0.2/ 0/4							**0.4/ 0.7**			
Bear 18b																					
Branci-forte 21a-1																					
Branci-forte 21a-2	1.0/ 1.8	1.0/ 1.9				0.95/ 1.6		0.2/ 0.35	0.2/ 0.4				0.25/ 0.5		0.45/ 0.65	0.5/ 0.8				**0.5/ 0.7**	
Branci-forte 21b				1.1/ 1.9	1.22 .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 2009−2015.

Site	Pool 2009	Pool 2010	Pool 2011	Pool 2012	Pool 2013	Pool 2014	Pool 2015	Riffle 2009	Riffle 2010	Riffle 2011	Riffle 2012	Riffle 2013	Riffle 2014	Riffle 2015	Run/Step Run 2009	Run/Step Run 2010	Run/Step Run 2011	Run/Step Run 2012	Run/Step Run 2013	Run/Step Run 2014	Run/Step Run 2015
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	0.9/1.4	0.15/0.2	0.75/0.9	1.1/1.8	0.6/0.9			0.7/1.5	0.4/0.8	0.95/1.8	1.0/1.8	−	**1.8/3.0**	0.6/1.2	1.0/1.5
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	0.7/1.0	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	0.85/1.1			1.7/2.95	**1.9/2.6**	**1.9/2.5**	1.5/2.2	1.4/2.2
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	0.6/1.0	0.8/1.35	1.1/2.2	1.55/2.0	**1.2/1.65**	**1.3/1.6**	1.05/1.45	1.0/1.4
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	0.35/0.8	0.6/1.1	0.6/1.2	0.7/1.2	**0.7/1.1**	**0.75/1.05**	0.5/0.9	0.6/1.6
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	0.55/1.0	0.85/1.0	0.95/1.2	1.0/1.3	**0.8/1.2**	**0.8/1.0**	0.65/1.0	0.65/1.0
9								0.9/1.4 (2005				0.4/0.7	0.4/0.85	0.45/0.75	1.0/1.3 (2005)				**0.6/1.0**	0.5/0.7	0.6/0.9
10						1.3/2.5	1.0/2.4						0.1/0.15	0.1/0.2						0.3/0.5	0.4/0.8
11	1.0/1.8	1.0/1.6	0.9/1.5	1.2/1.75	1.05/1.7	1.1/1.85	1.05/1.55	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	0.15/0.4	0.4/0.8	0.6/0.8	0.6/1.1	**0.4/0.5**	**0.3/0.5**	0.2/0.5	0.25/0.4
12a							1.1/1.8							0.4/0.55							0.4/0.6
12b				1.05/2.0	0.95/1.4	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	1.3/2.4	0.15/0.4	0.2/0.5	0.5/0.8	0.4/0.7	0.6/1.0	0.35/0.6	0.3/0.5	0.65/1.0	0.75/1.3	0.9/1.5	**0.7/1.05**	**0.8/1.2**	0.75/1.1	0.7/1.4
Zayante 13c			1.1/1.85	1.1/1.75	1.05/1.85	0.95/1.75	1.0/1.85			0.6/0.9	0.3/0.7	0.3/0.5	0.2/0.5	0.15/0.4			0.7/0.95	0.5/0.75	0.55/0.85	0.4/0.5	0.4/0.5
Zayante 13d				1.1/1.95	0.8/1.2 Δ Site	0.7/1.45 Δ Site	065/1.0							0.2/0.4				0.75/1.0	0.3/0.5	0.3/0.5	0.45/0.7

Site	Pool 2009	Pool 2010	Pool 2011	Pool 2012	Pool 2013	Pool 2014	Pool 2015	Riffle 2009	Riffle 2010	Riffle 2011	Riffle 2012	Riffle 2013	Riffle 2014	Riffle 2015	Run/ Step Run 2009	Run/ Step Run 2010	Run/ Step Run 2011	Run/ Step Run 2012	Run/ Step Run 2013	Run/ Step Run 2014	Run/ Step Run 2015
Zayante 13i							1.4/2.2							0.1/0.2							0.3/0.65
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	0.9/1.7	0.1/0.15	0.1/0.3	0.2/0.4	0.2/0.5	0.05/0.3	0.05/0.2	0.05/0.15	0.3/0.5	0.45/0.75	0.5/0.8	0.35/0.9	0.4/0.9	0.4/0.7	0.3/0.6
Bean 14a							**0.8/1.7**							**0.5/0.7**							0.5/0.8
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	1.1/2.0 Δ Site	0.2/0.4	0.25/0.4	0.25/0.8	0.35/0.6	0.1/0.2	0.15/0.2	0.15/0.3	0.2/0.4	0.5/0.6	0.5/0.7	0.5/0.8	0.5/0.7	0.4/0.5	0.3/0.7
Bean 14c			0.8/1.65	0.8/1.45 dry	Dry	Dry				0.2/0.3	0.1/0.2 dry	Dry	Dry				0.3/0.5	0.25/0.35 dry	Dry	Dry	
Fall 15a						0.7/0.95	0.7/1.2						0.25/0.5	0.25/0.5						0.45/0.8	0.65/0.9
Fall 15b			1.1/1.85	1.15/1.65	0.8/1.3	0.9/1.2 Δ Site	0.75/1.05			0.7/1.4	0.45/0.8	0.3/0.6	0.35/0.55	0.3/0.6			0.9/1.4	0.6/1.1	0.45/0.8	0.4/0.5	0.4/0.6
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	0.9/1.45	0.2. 0.5	.25/.55	0.4/0.5	0.35/0.45	0.4/0.7	0.03/0.1	0.15/0.4	0.3/0.5	0.5/0.9	0.4/0.6	0.3/0.5	0.4/0.55	0.2/0.5	0.2/0.45
Boulder 17a	1.1/1.8	1.2/1.75	1.4/1.95	1.2/1.8	1.05/1.8	1.0/1.75	1.1/1.85	0.4/0.8	0.7/1.1	–	0.5/1.0	0.5/0.7	0.35/0.6	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	0.7/1.0
Boulder 17b	1.4/2.4	1.5/2.2	1.2/1.85	1.3/1.9	1.05/1.85 Δ Site	1.15/1.75	1.05/1.9	0.5/1.0	0.6/1.1	0.7/1.2	0.65/1.1	0.5/0.6	0.3/0.6	0.4/0.7	0.5/0.9	0.7/0.9	0.8/1.4	0.6/1.2	0.4/0.85	0.4/0.7	0.45/0.7
Bear 18a		1.4/2.6	1.4/2.2	1.1/1.85	1.3/2.3	1.2/1.95	1.2/2.4		0.3/0.6	0.3/0.6	0.3/0.6	0.3/0.5	0.2/0.4	0.2/0.4		0.7/0.9	0.65/1.0	0.45/0.9	0.4/0.6	0.35/0.6	0.3/0.6
Branciforte 21a-2	1.2/1.9	1.3/2.1	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	0.9/1.65				0.3/0.6	0.4/0.6	0.2/0.4	0.25/0.5				0.5/0.85	0.5/0.7	0.5/0.8	0.4/0.7
Branciforte 21c					1.2/2.35	1.4/2.5	1.45/2.4					0.1/0.15	0.05/0.1	0.1/0.2					0.3/0.4	0.2/0.4	0.15/0.3

Table 7a. Average PERCENT FINE SEDIMENT* IN SAN LORENZO REACHES Since 2009.

Reach	Pool 2009	Pool 2010	Pool 2011	Pool 2012	Pool 2013	Pool 2014	Pool 2015	Riffle 2009	Riffle 2010	Riffle 2011	Riffle 2012	Riffle 2013	Riffle 2014	Riffle 2015	Run Step Run 2009	Run Step Run 2010	Run Step Run 2011	Run Step Run 2012	Run Step Run 2013	Run Step Run 2014	Run Step Run 2015
1						60							5							**31**	
2	48	48	47	44	50	38	37	13	10	8	9	6	6	5	26	40	13	**17**	**9**	**8**	**12**
4	65 (2008)						62	10 (2008)						7	37 (2008)						**19**
6																					
7																					
8	44					37		12					6		25					**8**	
9					46							9							**23**		
10						44							4							**6**	
11	40			25				12			8				14			**17**			
12a							15							2							**6**
12b				27							4							**9**			
Zayante 13a																					
Zayante 13b																					
Zayante 13c		41	43				53		10	14			3.5			19	19				**14**
Zayante 13d	46	42	40	26	31	19	28	12	19	14	14	6	6	9	28	27	28	**19**	**16**	**13**	**15**
Zayante 13i							26							8							**48**
Lompico 13e																					
Bean 14a							59							18							**28**
Bean 14b	67	55	61	49	64	60	65	13	13	32	10	13	13	15	34	28	72	**25**	**34**	**56**	**66**
Bean 14c		54	51						14	9						26	19				
Fall 15a						28							19							**23**	
Fall 15b	69		57			40		34		19			13		50		37			**47**	
Newell 16	46	22	22					11	6	3					19	12	4				
Boulder 17a	28				59			11				13			11				**19**		
Boulder 17b					22							3							**7**		
Boulder 17c																					
Bear 18a		41		38					13		9					19		**19**			
Branci. 21a-2	38	43				40		8	9				6		13	22				**14**	
Branci. 21b				**56**	45						**24**	18						**43**	**41**		
Branci. 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	Pool 2015	Riffle 2011	Riffle 2012	Riffle 2013	Riffle 2014	Riffle 2015	Run/ Step Run 2011	Run/ Step Run 2012	Run/ Step Run 2013	Run/ Step Run 2014	Run/ Step Run 2015
0a	50	50	NA	25	60	30	5	NA	10	30	25	**15**	**NA**	**10**	**30**
1	NA	NA	NA	NA	NA	10	15	5	5	10	15	**20**	**40**	**25**	**20**
2	NA	NA	NA	NA	NA	10	15	5	15	10	20	**25**	**5**	**20**	**25**
4	NA	NA	NA	NA	NA	15	10	5	5	5	38	**30**	**35**	**30**	**25**
6	NA	NA	NA	NA	NA	15	15	5	10	15	15	**15**	**10**	**15**	**15**
8	NA	NA	NA	NA	NA	15	15	15	5	20	20	**30**	**15**	**5**	**25**
9	NA (2005)		NA	NA	NA	10 (2005)		13	8	13	35 (2005)		**45**	**23**	**23**
10	60 (2001)			30	15	25 (2001)			1	10	40 (2001)			**20**	**30**
11	35	20	33	33	38	5	NA	5	1	10	5	**NA**	**15**	**10**	**15**
12a					5					1					**5**
12b	45 (2001)	35	30	28		23 (2001)	5	5	2		20 (2001)	**5**	**5**	**10**	
Zayante 13a	80	50	75	60	30	1	5	10	10	15	15	**30**	**50**	**50**	**40**
Zayante 13c	15	10	5	15	20	15	10	2	NA	2	10	**13**	**10**	**NA**	**10**
Zayante 13d	33	22	30	17	20	NA	NA	NA	NA	10	23	**25**	**20**	**15**	**20**
Zayante 13i					18					10					**15**
Lompico 13e	45	40	45	50	48	NA	20	10	2	10	25	**20**	**30**	**30**	**40**
Bean 14a					70					20					**20**
Bean 14b	70	60	80	95	23 Δ Site	10	10	10	20	2	35	**25**	**25**	**25**	**10**
Bean 14c	38	10	Dry	Dry	Dry	5	2	Dry	Dry	Dry	15	**10**	**Dry**	**Dry**	**Dry**
Fall 15a				32	25				15	7				**13**	**15**
Fall 15b	50	68	40	28	50	20	20	15	23	30	25	**35**	**60**	**25**	**60**
Newell 16	18	28	8	20	NA	5	2	2	1	NA	5	**2**	**10**	**5**	**10**
Boulder 17a	20	30	60	38	28	5	15	10	10	25	15	**10**	**15**	**15**	**20**
Boulder 17b	25	25	18	18	30	0	2	2	1	1	10	**10**	**5**	**2**	**5**
Bear 18a	28	33	43	45	35	5	15	5	5	10	20	**20**	**10**	**15**	**20**
Branciforte 21a-2	75	48	65	43		2	NA	15	5		25	**20**	**20**	**10**	
Branciforte 21b	73 (2001)	**53**	28	50	35	15 (2001)	**10**	10	5	15	45 (2001)	**20**	**20**	**15**	**20**
Branciforte 21c			80	55	75			15	5	10			**15**	**10**	**15**

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

Table 8a. Average EMBEDDEDNESS IN SAN LORENZO Reaches Since 2009.

Reach	Pool 2009	Pool 2010	Pool 2011	Pool 2012	Pool 2013	Pool 2014	Pool 2015	Riffle 2009	Riffle 2010	Riffle 2011	Riffle 2012	Riffle 2013	Riffle 2014	Riffle 2015	Run Step Run 2009	Run Step Run 2010	Run Step Run 2011	Run Step Run 2012	Run Step Run 2013	Run Step Run 2014	Run Step Run 2015
1						52							23							44	
2	36	37	49	39	33	50	33	16	25	20	19	20	21	15	32	27	28	38	31	30	23
4	45 (2008)						52	33 (2008)						32	42 (2008)						39
5																					
6																					
7																					
8	33					56		19					36		32					38	
9					48							26							63		
10						57							28							35	
11	48			46				22			14				33			30			
12a							47							23							41
12b				35							32							53			
Zayante 13a																					
Zayante 13b																					
Zayante 13c		49	48				54		29	31				29		36	56				54
Zayante 13d	49	57	53	53	56	63	60	43	39	45	49	41	43	39	41	51	40	43	51	54	53
Zayante 13i							50							29							48
Lompico 13e																					
Bean 14a							53							25							33
Bean 14b	44	53	51	59	38	50	49	16	25	32	48	25	26	24	35	30	55	53	36	41	44
Bean 14c		60	53						42	31						43	46				
Fall 15a						48							30							37	
Fall 15b	52		46			53		28		18			26		41		42			46	
Newell 16	42	39	53					20	24	31					31	34	43				
Boulder 17a	38				58			18				27			27				39		
Boulder 17b					33							26							34		
Boulder 17c																					
Bear 18a		49		60					25		44					34		50			
Branc-21a-2	49	53				53		28	30				30		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	Pool 2015	Riffle 2011	Riffle 2012	Riffle 2013	Riffle 2014	Riffle 2015	Run/ Step Run 2011	Run/ Step Run 2012	Run/ Step Run 2013	Run/ Step Run 2014	Run/ Step Run 2015
0a	60	40		45	50	30	20		25	20	35	35		25	30
1				65		25	30	20	25	20	50	40	40	40	30
2	55	35	33	58		15	20	25	35	25	30	30	25	30	35
4						15	20	20	25	5	50	50	50	38	33
6						20	30	40	50	30	30	30	40	50	30
8				65		30	25	45	35	30	35	45	45	25	35
9			55		30	15 (2005)		25	38	38	25 (2005)		65	60	35
10				45	30				15	20				20	30
11	40	50	53	68	50	5	NA	15	15	15	5	NA	30	40	25
12a					40					20					25
12b	43 (2001)	55	55	58		35 (2001)	30	35	35		35 (2001)	45	45	40	
Zayante 13a	60	65	45	50	50	20	30	30	30	30	35	40	40	50	35
Zayante 13c	30	45	50	28	55	45	45	30	35	10	35	35	40	60	20
Zayante 13d	43	53	55	73	53	20				35	45	45	65	75	70
Zayante 13i					38					30					35
Lompico 13e	50	40	38	58	50	NA	30	25	60	35	45	30	35	50	30
Bean 14a					65					30					30
Bean 14b	45	60	35	60	45	20	45	15	45	10	35	70	35	35	25
Bean 14c	53	10	Dry	Dry	Dry	10	25	Dry	Dry	Dry	40	30	Dry	Dry	Dry
Fall 15a				43	45				30	30				43	35
Fall 15b	38	60	45	58	38	25	50	20	48	28	30	45	30	50	30
Newell 16	65	33	60	20	48	15	15	35	25	15	35	15	40	15	35
Boulder 17a	40	38	58	50	38	25	40	20	30	30	35	25	20	45	40
Boulder 17b	30	35	35	40	33	10	10	35	35	25	30	25	30	30	25
Bear 18a	38	65	50	50	58	25	60	65	60	70	35	60	60	45	50
Branciforte 21a-2	53	48	53	63		20		25			60	40	30	40	
Branciforte 21b	42 (2001)	48	50	53	35	40 (2001)	20	20	25	25	40 (2001)	30	35	30	20
Branciforte 21c			20	35	38			35	10	10			15	30	25

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	2015
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	.132
3	0.250	0.216	0.257	-	-										
4	0.125	0.078	0.109	-	-	0.183	0.354	0.141							.112
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			
12a															0
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 in reach segment.**

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	2015
Santa Cruz Levees 0a	0.211	0.298	0.205	0.403	2.000 Floating veg.	0.182	0.247
Paradise Park 1	0.155	0.183	0.128	0.106	0.045	0.073	0.150
Rincon 2			0.129	0.117	0.100	0.141	0.200
Henry Cowell 4	0.537	0.479	0.374	0.308	0.307	0.320	0.379
Below Fall Creek 6	0.113	0.230	0.109	0.088	0.183	0.141	0.223
Below Clear Creek 8	0.082	0.194	0.154	0.163	0.148	0.054	0.104
Below Boulder Creek 9	0.133 (2005)				0.035	0.060	0.122
Below Kings Creek 10						0	0.053
Above Kings Creek Near Teihl Rd 11	0.0	0.024	0.036	–	0.041	0	0.020
Waterman Gap 12b				0.000	0.031	0.038	0.008 (Site 12a)

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

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	2015
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	0.108
3	0.186	0.113	0.144	-	-										
4	0.234	0.159	0.091	-	-	0.125	0.204	0.221							0.166
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			
12a															.011
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 in reach segment.**

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	2015
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	0.084
3	-	-										
4	-	-	0.203	0.275	0.290							0.268
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			0.115 (12a)

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

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	2015
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				**0.145**
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**	**0.120**
Zayante 13i															**0.111**
Lompico 13e						0.089	0.082	0.095							
Bean 14a	0.248	0.143	0.186	0.124	0.155										**0.189**
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**	**0.203**
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 length as pool habitat in reach segment**.

Table 12b. POOL ESCAPE COVER Indices (Habitat Typing Method*) at Replicated San Lorenzo Tributary Sites Since 2009, Including the Mainstem Below Kings Creek, 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	Pool Escape Cover 2015
Mainstem below Kings Cr. 10						**0.026**	**0.102**
Mainstem @ Teihl 11	0.058*	0.094	**0.033**	**0.039**	**0.081**	**0.085**	**0.120**
Mainstem @ Waterman Gap 12b				**0.091**	**0.124**	**0.155**	**0.220 (Site 12a)**
Zayante 13a	0.140	0.103	**0.167**	**0.222**	**0.122**	**0.060**	**0.379**
Zayante 13c			**0.120**	**0.178**	**0.164**	**0.186**	**0.212**
Zayante 13d	0.285	0.113	**0.168**	**0.135 Site Δ**	**0.135 Site Δ**	**0.073 Site Δ**	**0.096**
Zayante 13i							**0.223**
Lompico 13e	0.154	0.092	**0.061**	**0.072**	**0.098**	**0.057**	**0.065**
Bean 14a							**0.192**
Bean 14b	0.145	0.120	**0.165**	**0.175**	**0.137**	**0.181**	**0.424 Site Δ**
Bean 14c			**0.098**	**0.094**	**Dry**	**Dry**	**Dry**
Fall 15a						**0.170**	**0.220**
Fall 15b	0.302	0.571	**0.429**	**0.500**	**0.357**	**0.174 Site Δ**	**0.491**
Newell 16	0.150	0.118	**0.101**	**0.154**	**0.142**	**0.033**	**0.037**
Boulder 17a	0.066	0.094	**0.110**	**0.092**	**0.060**	**0.041**	**0.096**
Boulder 17b	0.356	0.266	**0.258**	**0.461**	**0.088 Site Δ**	**0.138**	**0.109**
Bear 18a		0.138	**0.101**	**0.050 Site Δ**	**0.068**	**0.034**	**0.056**
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**	**0.225**
Branciforte 21c					**0.252**	**0.286**	**0.280**

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

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	2015
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				**0.017**
Zayante 13d	0.050	0.098	0.143	0.223	0.297	0.071	0.101	0.130	0.136	0.103	0.134	0.072	0.030	**0.042**	**0.036**
Zayante 13i															**0.023**
Lompico 13e						0.001	0.042	0.020							
Bean 14a	0.060	0.058	0.092	0.051	0.086										**0.025**
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**	**0.051**
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 2014 to 2015, Based on Reach Data Where Available and Site Data, Otherwise.

Reach Comparison or (Site Only)	Baseflow Avg. May-September (Most Important Parameter)	Pool Depth / Fastwater Habitat Depth in Mainstem below Boulder Cr.	Fine Sediment Pool/ Fastwater	Embed-dedness Pool/ Fastwater	Pool Escape Cover/ Fastwater Habitat Cover in Mainstem below Boulder Creek	Overall Habitat Change
(Mainstem 0a)	+	− / +	NA	Similar	+/+	+
(Mainstem 1)	+ Similar	/ −	/ Similar	/ + Runs	/ +	+
Mainstem 2	+ Similar	− / −	Similar	+ / Similar	+ pools / + riffles; − runs	+
Mainstem 4	− (since 2008)	− / − Similar (since 2008)	+ (since 2008)	Similar (since 2008)	− / − (since 2008)	−
(Mainstem 6)	+ Similar	/ +	Similar	/ +	/ +	+
(Mainstem 8)	+ Similar	/ + Similar	/ −	/ − runs	/ +	+
(Mainstem 9)	+ Similar	/ − riffles + runs	/ Similar	/ + runs	/ +	+
(Mainstem 10)	+ Similar	− / + run	Similar/ - run	+/ − runs	+	+
(Mainstem Near Teihl Rd 11)	+ Similar	− / Similar	Similar	+ (pool and run)	+	+
(Zayante 13a)	+	−/−	+ (pool)/ Similar	+ (run)	+	+ (Cover)
(Zayante 13c)	+ Similar	+ / Similar	Similar/ Similar	− (pool) + (fastwater)	+	+ (Cover)
Zayante 13d	+ Similar	+ / +	− (pool)/ Similar	Similar	+	+ (Cover)
(Lompico 13e)	+ then − Late	− / +	Similar/ −	Similar/ +	Similar	−
Bean 14b	+ Similar	+/ Similar	+ /+	+ / +	Similar	+
Bean 14c						Dry
(Fall 15a)	Similar	+ / +	Similar/ Similar	+ / +	Similar	+
(Fall 15b)	+ Similar	−/+	− / −	+ / +	Similar	+
(Newell 16)	− Similar	−/+	NA	− /− run + riffle	similar	−
(Boulder 17a)	+ Similar	+ / Similar	+ / −	+/ Similar	+	+
(Boulder 17b)	+ then very − late	−/ +	−/ Similar	Similar	−	−
(Bear 18a)	+ Similar	+/Similar	+/Similar	Similar/ − riffle	+	+
(Branciforte 21b)	+ then very − late	− / −	+ / −	+ / + run	−	−
(Branciforte 21c)	+ then very − late	− / −	−/ Similar	Similar/ Similar	Similar	−

***NA = Not available.**

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

Refer to **Appendix A** for maps of reach locations. Summary tables of habitat change for all sites are provided in **Tables 15g and 40**. Weighing the relative importance of streamflow as an aspect of fall habitat quality with other habitat parameters is not clear cut. Baseflow was higher early on in 2015 than in 2014. However, in September 2015, baseflow was much lower than in September 2014 at most sites except in the upper mainstem. Most steelhead growth occurs in spring and early summer before baseflow decreases, allowing for slightly better growth in 2015 than 2014. All reaches had lower baseflow in fall 2015 than in fall 2014 (**Table 5b; Figures 36a-b; 37a-b; and 38**). There were four December 2014 storms in the Soquel watershed, one of which likely approached bankfull at approximately 1,400 cfs **(Figure 39a)**. In February 2015, stormflow reaching approximately 1,800 cfs and likely above bankfull during a 5-7 day period of elevated streamflow (**Figures 39a-b**). The only stormflow afterwards was a small storm in April 2015 of about 80 cfs, which was enough for late adults to move upstream to spawn. The average mean monthly streamflow for May−September in 2015 at the Soquel Village gage was the second lowest in 19 years after 2014 (1.6 cfs in 2015, with a 19-year average of 8.5 cfs), with very low summer baseflow (**Figures 39c and 45**).

Overall habitat quality declined in all Soquel reaches/sites in 2015 from 2014 except the upper mainstem (Reaches 7 and 8) where pool depth and escape cover were similar or improved in 2015. (**Table 15g**). However, Reach 8 also declined in quality when compared to 2013, when fall baseflow was more than double that in 2015 (**Table 5b**). With habitat typed Reaches 3, 7, 8 and 13 there was pool shallowing (except Reach 7 since 2014 had the same pool depth) and reduced fastwater habitat depth since previous habitat typing (**Tables 14a and 15g**). Average maximum pool depth in the West Branch Reach 13 declined from 2.8 to 1.8 feet since 2012, and in mainstem reaches it declined 0.1 ft in Reach 3 and 0.2 feet in Reach 8 since 2013. Pools at replicated Sites 1 (Reach 1), 13a (Reach 9a), and 21 (Reach 14b) also shallowed between 0.2 and 0.5 feet averaged maximum depth since 2014 (**Tables 14b**). Average pool depth declined between 0.05 and 0.3 feet at replicated sites. Soquel Lagoon lost depth in 2015 due to sand pushed in from the beach (**Alley 2016**). Escape cover decreased in mainstem Reach 3 but improved in Reaches 8 and 13 and at all replicated Sites 1, 10, 13a and 21 (**Tables 15e-g**), it being increased by more overhanging vegetation and reduced embeddedness.

Percent fines were mostly similar or lessened in 2015, except in pools at mainstem Reach 7 and in the West Branch Reach 13 and Site 21 (**Tables 15a-b; 15g**). Percent fines in pools were in the 30-85% range. In riffles it was in the 1-15% range. In runs/step-runs it was in the 10-25% range. Embeddedness was mostly similar except for improvement in pools at Sites 1 and 21 and worsening in Reach 7 (**Tables 15c-b; 15g**). Embeddedness in pools generally was in the 35-60% range. It was in the 20-40% range in riffles and in the 10-65% range in runs/step-runs.

Low baseflow in 2015, as in 2014, provided low food and slow YOY growth in all reaches compared to 2011 (wet year), as exemplified by lower percent of YOY reaching Size Class II in 2015 compared to 2011 (**Figure 18a**). Yearling densities were often below average, despite a mild winter in 2015 (**Figure 7**). The other contributing factor was below average YOY densities in the Branches in 2014.

Table 14a. Averaged Mean and Maximum WATER DEPTH (ft) of Habitat in SQOUEL CREEK Reaches* Since 2009.

Reach	Pool 2009	Pool 2011	Pool 2012	Pool 2013	Pool 2014	Pool 2015	Riffle 2009	Riffle 2011	Riffle 2012	Riffle 2013	Riffle 2014	Riffle 2015	Run/ Step Run 2009	Run/ Step Run 2011	Run/ Step Run 2012	Run/ Step Run 2013	Run/ Step Run 2014	Run/ Step Run 2015
1	1.15/ 2.7		1.35/ 3.6		1.0/ 2.7		0.25/ 0.45		0.35/ 0.6		0.1/ 0.2		0.35/ 0.5		0.5/ 0.8		**0.3/ 0.5**	
2																		
3	1.4/ 2.35	1.6/ 3.0		1.2/ 2.4		1.1/ 2.2	0.25/ 0.4	0.45/ 0.75		0.3/ 0.6		0.2/ 0.35	0.45/ 0.7	0.7/ 1.1		0.5/ 0.7		**0.4/ 0.6**
4																		
5																		
6																		
7	1.35/ 2.4		1.2/ 2.5		1.1/ 2.1	1.1/ 2.1	0.35/ 0.55		0.4/ 0.7		0.3/ 0.5	0.3/ 0.45	0.5/ 0.8		0.6/ 1.0		**0.4/ 0.7**	**0.4/ 0.7**
8	1.6/2 .8	1.9/ 3.5		1.1/ 2.1		1.0/ 2.2	0.3/ 0.45	0.6/ 0.9		0.3/ 0.6		0.2/ 0.4	0.5/ 0.75	0.9/ 1.3		0.5/ 0.85		**0.3/ 0.65**
9	1.45/ 2.3	1.6/ 2.7		1.0/ 1.8	0.8/ 1.5		0.2/ 0.45	0.5/ 0.7		0.2/ 0.3	0.15/ 0.3		0.5/ 0.75	0.6/ 0.85		0.3/ 0.6	**0.2/ 0.45**	
10																		
11																		
12a	1.0/ 1.5	1.0/ 1.7	0.9/ 1.5	0.6/ 1.0	Dry		0.25/ 0.45	0.4/ 0.7	0.3/ 0.6	0.15/ 0.3	Dry		0.45/ 0.8	0.6/ 1.05	0.5/ 0.9	0.3/ 0.6	**Dry**	**Dry**
12b																		
13	1.25/ 2.3		1.3/ 2.5			0.9/ 1.8	0.3/ 0.5		0.3/ 0.5			0.3/ 0.45	0.5/ 0.8		0.55/ 0.9			**0.4/ 0.7**
14a																		
14b	1.35/ 2.5				1.3/ 2.35		0.25/ 0.5				0.2/ 0.4		0.5/ 0.8				**0.4/ 0.7**	
14c																		

*Partial, ½-mile segments habitat typed in 2006–2009 and 2011−2015. 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 2010.

Site (Reach)	Pool 2010	Pool 2011	Pool 2012	Pool 2013	Pool 2014	Pool 2015	Riffle 2010	Riffle 2011	Riffle 2012	Riffle 2013	Riffle 2014	Riffle 2015	Run/ Step Run 2010	Run/ Step Run 2011	Run/ Step Run 2012	Run/ Step Run 2013	Run/ Step Run 2014	Run/ Step Run 2015
1 (1)	1.0/ 2.8	0.9/ 3.2	1.65/ 3.5 Site Δ	1.65/ 3.6	1.3/ 3.1 Site Δ	1.2/ 2.6	0.5/ 0.75	0.5/ 0.8	0.4/ 0.6 Site Δ	0.05/ 0.3	0.2/ 0.4 Site Δ	0.05/ 0.1	0.35/ 0.8	0.8/ 1.1	0.6/ 0.9 Site Δ	0.25/ 0.4	0.3/ 0.4 Site Δ	0/1/ 0.2
4 (3)	2.0/ 4.3	1.2/ 2.5	1.7/ 2.6	1.4/ 2.2	1.35/ 2.0	1.3/ 1.7	0.55/ 0.8	0.6/ 0.9	0.3/ 0.5	0.3/ 0.7	0.3/ 0.5	0/3/ 0.6	0.7/ 1.0	0.7/ 1.0	0.5/ 0.9	0.6/ 1.0	**0.3/ 0.5**	**0.5/ 0.7**
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	1.1/ 2.0	0.6/ 1.2	0.65/ 0.9	0.5/ 0.9 Site Δ	0.35/ 0.9	0.3/ 0.45 Site Δ	0.2/ 0.35	0.6/ 1.2	0.9/ 1.2	0.8/ 0.9	0.5/ 0.85	0.3/ 0.9 Site Δ	0.3/ 0.8
12 (8)		2.2/ 2.8	1.8/ 2.6	0.9/ 2.0 Site Δ	0.7/ 2.3	1.2/ 3.3 Site Δ		0.9/ 1.2	0.45/ 0.95	0.3/ 0.5	0.3/ 0.5	0/2/ 0.6		1.0/ 1.5	0.8/ 1.1	0.6/ 0.8	**0.45/ 0.7**	**0.4/ 0.6**
13a (9a)		1.65/ 2.4	1.2/ 1.9	0.95/ 1.95 Site Δ	0.7/ 1.8 Site Δ	0.75/ 1.6		0.5/ 0.7	0.3/ 0.6	0.1/ 0.3	0.3/ 0.4 Site Δ	0.25/ 0.5		0.7/ 0.9	0.75/ 1.1	0.35/ 0.5	**0.1/ 0.15** Site Δ	**0.1/ 0.25**
16 (12a)		1.2/ 1.85	1.25/ 2.05 Site Δ	0.5/ 0.85 Site Δ	Dry	Dry			0.2/ 0.4 Site Δ	0.1/ 0.15	Dry	Dry		0.55/ 0.95	0.4/ 0.9 Site Δ	0.3/ 0.8	**Dry**	**Dry**
19 (13)	1.1/ 2.1	0.9/ 2.9	1.0/ 1.9	0.9/ 2.5	0.8/ 2.2	1.5/ 2.4 Site Δ	0.5/ 0.9	0.45/ 0.6	0.4/ 0.8	0.35/ 0.6	0.3/ 0.5	0.25/ 0.4 Site Δ	0.6/ 1.1	0.7/ 1.1	0.5/ 1.1	0.5/ 1.0	**0.4/ 0.95**	**0.5/ 0.6** Site Δ
21 (14b)	1.8/ 3.85	1.9/ 3.75			1.55/ 2.5 Site Δ	1.25/ 2.2	0.4/ 0.55	0.3/ 0.7			0.4/ 0.6 Site Δ	0.2/ 0.4	0.6/ 1.3	0.4/ 1.3			**0.35/ 0.6** Site Δ	**0.3/ 0.5**

Table 15a. Average PERCENT FINE SEDIMENT in Habitat-typed Reaches* in SOQUEL CREEK Since 2009.

Reach	Pool 2009	Pool 2011	Pool 2012	Pool 2013	Pool 2014	Pool 2015	Riffle 2009	Riffle 2011	Riffle 2012	Riffle 2013	Riffle 2014	Riffle 2015	Run/ Step Run 2009	Run/ Step Run 2011	Run/ Step Run 2012	Run/ Step Run 2013	Run/ Step Run 2014	Run/ Step Run 2015
1	59		62		64		14		8		7		16		24		**16**	
2																		
3	58	59		60		56	8	11		19		14	19	14		38		**17**
4																		
5																		
6																		
7	70		51		31	42	16		11		4	13	20		21		**14**	**10**
8	58	63		68		64	5	11		5		3	28	23		15		**9**
9a	42	58		50	49		6	6		3	10		19	24		14	**19**	
10																		
11																		
12a	35	42	34	24	Dry		12	8	8	5	Dry		19 (S.run)	15	14	20	**Dry**	**Dry**
12b																		
13	58		57			70	11		9			7	20*		18			**22**
14a																		
14b	52				27		8				3		20 (run)				**11**	
14c																		

*Partial, ½-mile segments habitat typed in 2006–2009 and 2011−2015 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	Pool 2015	Riffle 2011	Riffle 2012	Riffle 2013	Riffle 2014	Riffle 2015	Run/ Step Run 2011	Run/ Step Run 2012	Run/ Step Run 2013	Run/ Step Run 2014	Run/ Step Run 2015
1 (1)	85	85	75	75	75	5	10	10	3	1	10	20	5	**30**	**25**
4 (3a)	45	70	70	70	80	10	5	20	20	15	10	15	25	**5**	**25**
10 (7)	70	38	28	30	30	15	NA	5	5	8	20	25	10	**2**	**15**
12 (8)	25	30	80 Site Δ	95	70	10	NA	5	2 Site Δ	5	15	15	15	**5** Site Δ	**10**
13a (9)	50	40	40 Site Δ	95 Site Δ	53	15	20	2	15 Site Δ	10	25	15	15	**25** Site Δ	**15**
16 (12a)	50	50	20 Site Δ	Dry	Dry	NA	15	5	Dry	Dry	NA	15	25	**Dry**	**Dry**
19 (13)	60	70	70	90	85 Site Δ	15	10	15	10	10 Site Δ	40	25	30	**30**	**15** Site Δ
21 (14b)	70			20 Site Δ	45	2			5 Site Δ	2	10			**15** Site Δ	**10**

Table 15c. Average EMBEDDEDNESS in Pool and Fastwater (Riffle and Run) Habitat of SOQUEL CREEK REACHES Since 2008.

Reach	Pool 2008	Pool 2009	Pool 2011	Pool 2012	Pool 2013	Pool 2014	Pool 2015	Riffle 2008	Riffle 2009	Riffle 2011	Riffle 2012	Riffle 2013	Riffle 2014	Riffle 2015	Run/ Step Run 2008	Run/ Step Run 2009	Run/ Step Run 2011	Run / Step Run 2012	Run/ Step Run 2013	Run/ Step Run 2014	Run / Step Run 2015
1	35	37		54		58		18	19		30		32		29	23		39		**40**	
2																					
3	39*	37*	40*		50*		54*	22*	19*	13*		31*		24*	33*	23*	24*		38*		**40***
4																					
5																					
6																					
7	44*	41*		52*		49*	59*	23*	23*		32*		24*	31*	39*	38*		43*		**40***	**43***
8	43*	45*	60*		52*		50*	17*	17*	28*		24*		31*	48*	33*	50*		43*		**52***
9a	44	50	59		45	59		22	26	28		30	47		47	42	50		45	**54**	
10																					
11																					
12a	54	59	57	61	65	Dry		45	34	28	42	38	Dry	Dry	39 (S.run)	46 (S.run)	38 (S.run)	43 (S.run)	51 (S.run)	**Dry**	**Dry**
12b																					
13	42*	53*		50*			58*	23*	22*		27*			23*	29*	37*		33*			**33***
14a																					
14b	44	44				60		19	16				29		27 (run)	38 (run)				**46**	
14c																					

***Partial, ½-mile segments habitat typed in 2006–2009 and 2011–2015 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	Pool 2015	Riffle 2011	Riffle 2012	Riffle 2013	Riffle 2014	Riffle 2015	Run/ Step Run 2011	Run/ Step Run 2012	Run/ Step Run 2013	Run/ Step Run 2014	Run/ Step Run 2015
1 (1)	55	60	70	60 Site Δ	50	35	30	25	25 Site Δ	25	25	35	**40**	**40** Site Δ	**40**
4 (3a)	40	40	50	45	60	25	25	35	30	35	30	50	**30**	**30**	**45**
10 (7)	50	50	40	50 Site Δ	60	25	NA	25	30	40	35	35	**35**	**30**	**30**
12 (8)	30	55	65 Site Δ	65	50 Site Δ	35	35	15 Site Δ	30	40	35	50	**35** Site Δ	**35**	**65**
13a (9)	60	40	50	60 Site Δ	60	35	35	15	18 Site Δ	20	35	40	**55**	**60** Site Δ	**65**
16 (12a)	63	58	65	Dry	Dry	NA	45	45	Dry	Dry	NA	40	**75**	**Dry**	**Dry**
19 (13)	60	60	30	NA	65 Site Δ	15	25	40	35	20 Site Δ	40	30	**45**	**30**	**10** Site Δ
21 (14b)	60	-	-	65 Site Δ	35	40	-	-	20	20	45	-	-	**35**	**50**

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	Pool 2015
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 **		**0.109** **
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** **	**0.138**
8	0.047	0.036	0.060		0.070 **	0.071 **	0.037 **	0.052 **		0.032 **		**0.056** **
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**	**Dry**
12b	0.129		0.158									
13	0.077				0.081 **	0.069 **	0.060 **		0.064 **			**0.075** **
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 2011−2015 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	Pool Escape Cover 2015
1 (1)	0.101*	0.132	0.104	0.117 Site Δ	0.178	**0.140** Site Δ	**0.167**
4 (3)	0.102	0.067	0.085	0.191	0.086	**0.094**	**0.111**
10 (7)		0.124	0.254	0.096 Site Δ	0.152	**0.097** Site Δ	**0.102**
12 (8)			0.092	0.231 (Wood cluster)	0.059 Site Δ	**0.089** (more wood)	**0.143** Site Δ
13a (9a)			0.101	0.164 (Wood cluster)	0.127 Site Δ	**0.111**	**0.128**
16 (12a)			0.079	0.064 Site Δ	0.093 Site Δ	**Dry**	**Dry**
19 (13)	0.041	0.080	0.131	0.060	0.143	**0.146**	**0.108** Site Δ
21 (14b)	0.029	0.017	0.021	–	–	**0.048** Site Δ	**0.084**

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

Table 15g. Habitat Change in SOQUEL CREEK WATERSHED Reaches (2012 to 2015 or 2013-2015) or Replicated Sites (2014 to 2015).

Reach Comparison or (Site Only)	Baseflow Avg. May-September	Pool Depth	Fine Sediment	Embeddedness	Pool Escape Cover	Overall Habitat Change
(Site 1) Reach 1	+ then very − later	−	Similar	+ pools	+	−
Site 4 Reach 3a	−Compared to 2013	− Since 2013	+ run Since 2013	Similar Since 2013	−	−
Site 10 Reach 7	+ Similar	Same	− pool	− Pool and riffle	+	+ (cover)
Site 12 Reach 8	−Compared to 2013	− avg. + max.	+ pool Since 2013	Similar Since 2013	+ Since 2013	−
(Site 13a) Reach 9a	+ then very − later	−	+ pool and run	Similar	+	−
Site 16 Reach 12a	Dry	Dry	Dry	Dry	Dry	Dry 2014 and 2015
Site 19 W. Br. Reach 13	− Compared to 2012	− Since 2012	− (pool) Since 2012	Similar Since 2012	+ Since 2012	−
(Site 21) W. Br. Reach 14b	+ then very − later	−	− (pool)	+ pool −run	+	−

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 42**. 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 2015 compared to 2011−2014, and considerably below the median streamflow statistic in spring and summer. There was undoubtedly reduced food supply in all reaches in 2015 as was the case in previous dry years. However, juvenile densities were so low in 2015 that short food supply did not reduce YOY growth because there was little competition. Measured streamflow in fall in lower Aptos Creek confirmed lower baseflow in 2015 than 2012−2014 (dry years) and much lower than in 2011 (**Table 5b**). Baseflow early on in the dry season of 2015 was likely higher than in 2014, however, based on hydrographic data from the San Lorenzo and Soquel stream gages.

Habitat quality was improved at lower Aptos Site 3 above Valencia Creek confluence due to increased pool depth and likely higher baseflow early in the dry season compared to conditions in 2014. Habitat quality worsened in the upper Aptos Site 4 (Nisene Marks State Park) compared to 2011 conditions (wetter year) due to reduced baseflow, pool depth and escape cover in Reach 3 (**Tables 16a-c**). Substrate conditions regarding percent fines and embeddedness were similar to previous measured conditions at both sites. The percent of YOY reaching soon-to-smolt-size, as an indicator of YOY growth rate, showed higher percent and YOY reaching size class II in 2015 than previous years, despite low baseflow (**Figures 19a-b**). This was due to the extremely low YOY juvenile densities at sites in 2015 and reduced competition for food (**Table 32**).

Table 16a. AVERAGE POOL HABITAT CONDITIONS IN REACHES and REPLICATED SITES (in yellow) of APTOS, VALENCIA, CORRALITOS, SHINGLE MILL and BROWNS Creeks in 2011-2015.

Reach #/ Sampling Site #	Mean Depth/ Maximum Depth					Escape Cover*					Embeddedness					Percent Fines				
	2011	2012	2013	2014	2015	2011	2012	2013	2014	2015	2011	2012	2013	2014	2015	2011	2012	2013	2014	2015
Aptos #2/#3- in County Park		1.1/ 2.2	1.0/ 1.8				0.105	0.141				55	52	55	55		59	59	85	80
Aptos #3/#4- Above Steel Bridge Xing (Nis. Marks)	1.2/ 2.3			0.9/ 1.7		0.107			0.091		54			59		66			60	
Valencia #2/#2- Below Valencia Road Xing																				
Valencia #3/#3- Above Valencia Road Xing																				
Corralitos #1/#1- Below Dam			1.1/ 1.9		1.3/ 2.3			0.080		0.103			43		53			43		53
Corralitos #3/#3- Above Colinas Drive	1.3/ 2.0	1.1/ 2.0		1.0/ 2.0		0.175	0.161		0.172		50	63		52	53	32	42		44	70
Corralitos #5-6/#8- Below Eureka Gulch	1.2/ 2.0	1.0/ 1.8			0.8/ 1.6	0.052	0.072			0.058	58	58			64	29	29			28
Corralitos #7/#9- Above Eureka Gulch	1.0/ 1.5	0.9/ 1.35		0.7/ 1.2		0.119	0.146		0.093		54	63		63	60	20	28		12	20
Shingle Mill #1/#1- Below 2nd Road Xing																				
Shingle Mill #3/#3- Above 3rd Road Xing																				
Browns Valley #1/#2- Below Dam			1.35/ 2.0					0.208					56	30	38			29	20	25
Browns Valley #2/#2- Above Dam			1.3/ 1.9					0.250					38	48	45			22	30	48

* 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 2010.

Reach #/ Sampling Site #	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	Avg Mean/ Maximum Pool Depth-2015	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	Pool Escape Cover Index-2015
Aptos #2/#3- in County Park	1.25/ 2.6	1.0/ 2.4	1.0/ 2.5 (Site Δ)	0.85/ 1.75 (Site Δ)	0.8/ 1.55	1.0/ 2.2	0.183	0.055	0.080 (Site Δ)	0.179 (Site Δ)	**0.186**	**0.185**
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)	1.35/ 2.7	–	0.156	0.177	0.170	**0.064** (Site Δ)	0.128
Valencia #2/#2- Below Valencia Road Xing	0.45/ 1.05	–	–	–	No pool habitat	–	0.156	–	–	–	**0.015 mostly run**	
Valencia #3/#3- Above Valencia Road Xing	0.9/ 1.45	–	–	–	0.35/ 0.8	–	0.250	–	–	–	**0.049 less wood**	
Corralitos #1/#1- Below Dam	0.85/ 1.5	0.9/ 1.25	1.05/ 1.4	0.85/ 1.7 (Site Δ)	0.9/ 1.65	0.9/ 1.55	0.087	0.120	0.156	0.083	**0.111**	**0.109**
Corralitos #3/#3- Above Colinas Drive	0.7/ 1.6	0.95/ 1.95	1.35/ 2.2 (Site Δ)	1.4/ 2.25	0.85/ 2.1 (Site Δ)	1.1/ 2.1	0.173	0.231	0.121 (Site Δ)	0.128	**0.206** (Site Δ)	**0.150**
Corralitos #5-6/#8- Below Eureka Gulch	0.55/ 0.9	1.0/ 1.85	0.7/ 1.05	0.45/ 0.95	0.5/ 0.9	1.05/ 2.05 (Site Δ)	0.048	0.033	0.061	0.053	**0.067**	**0.054**
Corralitos #7/#9- Above Eureka Gulch	–	1.0/ 1.8	1.0/ 1.6	0.9/ 1.3	0.6/ 1.3 (Site Δ)	0.7/ 1.3		0.112	0.148	0.133	**0.092** (Site Δ)	**0.102**
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	0.6/ 0.9	1.0/ 1.5	0.9/ 1.4	1.0/ 1.7	0.9/ 1.4	–	0.139	0.173	0.145	0.168	**0.233**	**–**
Browns Valley #1/#2- Below Dam	1.25/ 2.0	1.3/ 2.05	1.1/ 1.6	1.5/ 2.3 (Site Δ)	1.35/ 2.05	1.35/ 2.15	0.125	0.187	0.201	0.283 (Site Δ)	**0.219**	**0.255**
Browns Valley #2/#2- Above Dam	1.15/ 1.85	1.35/ 1.85	1.25/ 1.8	1.3/ 1.75 (Site Δ)	0.9/ 1.9	0.8/ 1.45	0.243	0.203	0.272	0.210 (Site Δ)	**0.213**	**0.209**

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

Table 16c. Habitat Change in APTOS Reaches (2011 to 2015) AND CORRALITOS WATERSHED Reaches (2011− 2013 to 2015) and Replicated Sites in Both Watersheds (2014 to 2015).

Reach Comparison or (Site Only Comparison)	Baseflow	Pool Depth	Fine Sediment	Embeddedness	Pool Escape Cover	Overall Habitat Change
(Aptos Site 3) Aptos 3	+ early − late	+	Similar	Similar	Similar	+
(Aptos Site 4) Aptos 4	−	+	Similar	Similar	+	+
Corralitos Site 1 Corralitos R-1	− Compared to 2013	+ Since 2013	− Since 2013	Similar Since 2013	−	−
(Corralitos Site 3) Corralitos R-3	+ early Similar late	+ avg. depth	−	Similar	−	+
Corralitos Site 8 Corralitos R- 5/6	− Compared to 2012	− Since 2012	Similar Since 2012	Similar Since 2012	− Since 2012	−
(Corralitos Site 9) Corralitos R-7	+ early − late	+ avg. depth	Similar	Similar	+	+
Shingle Mill Site 1						NA
Shingle Mill Site 3 above fault line						NA
(Browns Site 1) Brown R-1	+ early − late	+ max. depth	Similar	Similar	+	+
(Browns Site 2) Brown R-2	+ early − late	+	Similar	Similar	Similar	+

R-5. Habitat Change in Corralitos and Browns Valley Creeks

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. Based on stream gage data from other watersheds and Corralitos Creek, baseflow was higher early on in the dry season of 2015 than in 2014, with streamflow disappearing at the town of Corralitos later in 2015 than 2014 (**Figures 42c and 44**). Most juvenile steelhead growth occurs in the spring-early summer when baseflow is higher and most important. Baseflow measurements in October indicated very similar streamflows in Corralitos Creek in both years and higher baseflow in Browns Valley Creek in 2014 (**Table 5b**). There was undoubtedly less food and slower growth rate in all reaches in 2014 and 2015 in spring-early summer compared to the previous 3 years. Segments in Reaches 1 and 5/6 in Corralitos Creek of the 8 reaches were habitat typed in 2015 to compare with reach habitat quality in 2013 and 2012, respectively. Habitat quality in 2015 was compared to replicated sites in 2014 for the remainder of reaches.

Overall habitat quality improved slightly at replicated sites of the Corralitos-Browns-Shingle Mill sub-watershed in 2015 compared to 2014, primarily due to higher baseflow in spring and early summer (**Table 16a-c**). Habitat quality decreased in habitat typed Reaches 1 and 5/6 in 2015 compared to previous years due to lower baseflow and less escape cover. Pool depth increased at all replicated sites (Corralitos 3, Corralitos 9, Browns 1 and Browns 2) in 2015, despite slightly lower baseflow. Escape cover was similar or increased at replicated sites except Corralitos 3. Embeddedness and fine sediment levels were similar at replicated sites between 2014 and 2015 except fine sediment increased at Corralitos 3. Corralitos Reach 1 had increased pool depth but less escape cover in 2015 than in 2013. Corralitos Reach 5/6 had shallower pool depth and less escape cover in 2015 compared to 2012, indicating lingering negative effects from the Summit Fire of 2008.

With somewhat improved habitat conditions in 2015, the Corralitos sub-watershed had improved YOY densities at all 8 sites compared to 2014 but still below the average YOY density except at Corralitos 1 (**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. Spawning access was likely improved in 2015, but spring baseflows were not better in 2015 for spawning and egg incubation compared to 2014 (**Figures 42c and 44**). The small April storms in 2015 helped maintain baseflow, however. 2015 yearling densities were similar to 2014 densities, despite low YOY densities in 2014 but were below the long-term averages. There was higher yearling survival over the mild winter than normal 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 2015, 29 of 40 sites were rated "below average" or worse, based on densities of Size Class II and III juveniles and their average sizes (**Tables 40 and 41**); the breakdown was "below average" (9), "poor" (7) and "very poor" (13), and two sites were dry. The remainder of sites were rated "fair" (9) and "good" (2). These were the lowest ratings since the comparison began in 2006. 16 of the 40 sampled sites with surface water declined in ratings since 2014, which already had relatively poor ratings due to the drought. Ratings were much better in 2012 when most sites (20 of 38) were rated "good" and "very good."

R-6. 2015 Juvenile Steelhead Densities in the San Lorenzo Drainage Compared to 2014 and Averages Since 1997

In 2015, all but 3 of 24 wetted sites had below average total densities, with 2 sites likely having resident rainbow trout (**Figure 1**). Branciforte Site 21c likely had resident rainbow trout without steelhead and SLR Site 12a likely had both. Five sites had near average total densities, 4 of which were in the mainstem. The lowest total densities measured since 1997 occurred at upper Fall 15b, Newell 16 and Boulder 17b and since 2006 at Lompico 13e (**Tables 22a-b**). Mainstem 0a, Zayante 13c and Bean 14a had above average total densities. Looking at the trend in total densities, 2015 had higher densities than 2014 but the fifth lowest 5-mainstem site average since 1997 (14.6 juveniles/ 100 ft) since 1997 (**Figure 21**). 2015 also had the fifth lowest 4 to 7-tributary site average (46.2 juveniles/ 100 ft) since 1997 (**Figure 23**).

Twenty of 24 wetted sites had below average YOY densities, with only 4 sites having above average YOY densities (2 of which were near-average); Mainstem 0a, Mainstem 6, Zayante 13c and bean 14a (**Figure 2a**). YOY density increased at most sites compared to 2014 (**Figure 2b**). The lowest YOY densities measured since 1997 were at upper Fall 15b and Newell 16 and since 2006 at Lompico 13e (**Tables 23a-b**). Twenty-two of 24 wetted sites had below average yearlings densities (5 of which had no yearlings due to low YOY densities in 2014) (**Figure 3**).

Twenty-two of 24 wetted sites had below average densities of Size Class II and III steelhead (**Figure 4**). Regarding the trend in soon-to-smolt-densities, 2015 had slightly higher mainstem densities than 2014, but had the third lowest 5-mainstem site average (2.7 fish/ 100 ft) since 1997 (**Table 21b; Figure 22**). 2015 also had slightly decreased or similar soon-to-smolt densities at most tributaries sites (except for an abundance at Zayante 13c that inflated the average) compared to 2014, with a below average 4 to 7-tributary site average (10.3 fish/ 100 ft) since 1997 (**Table 25b**; **Figure 24a**). A small percentage of the YOY population reached soon-to-smolt size in 2015 with such low baseflows, little insect drift and slow growth rate (**Figures 17a and 17b**). When annual average site densities of soon-to-smolt sized steelhead were plotted with 5-month baseflow averages (May through September), they increased in some wetter years because more YOY reached Size Class II (**Figures 24b and 24c**).

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**). Few YOY grew into the larger size class with the low habitat quality attributed to much reduced baseflow, shallower conditions and food shortage in 2015. The increases in total and YOY density from 2014 to 2015 at mainstem sites were statistically significant (**Table 45**). The decreased yearling densities and increased Size Class II/III juvenile densities from 2014 to 2015 were not statistically significant (**Table 44**). The Waterman Gap Site 12a (not sampled in 2014) and Branciforte Site 21c (resident rainbows) were 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 density improved at Site 11 in 2015 after 4 years of very low density. YOY densities increased at 9 of 9 mainstem sites up to Teihl Road in 2015 compared to 2014 but were below average at 7 of 9 mainstem sites (**Table 18b; Figure 2a−b**). The low YOY densities resulted in below average densities at 8 of 9 mainstem sites (close to average at 3 sites) (**Table 17b; Figure 1**). No lagoon PIT-tagged juveniles were detected at Sites 0a, 1 or 2 in 2015. 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 2015 as in past years except at Teihl 11 and Waterman Gap 12a, which likely had included older residents (**Table 19b; Figure 3**).

Densities of larger Size Class II and III juveniles were higher in 2015 than 2014 at 5 of 9 mainstem sites (**Table 21b**) and below average at all sites (**Figure 4**). Relatively low densities of these important soon-to-smolt fish in high growth potential reaches (1−9) was due to low densities of YOY and the low percent that grew into Size Class II 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 from 2010 to 2014, with only a slight increase in 2015 to the third lowest value since 1997 (2.7 fish/ 100 ft) (**Figure 22**). Spring and early summer baseflows in 2015 were substantially below the median statistic (**Figure 38b**), as they had been in 2014 (**Figure 36a**), and the 5-month mean monthly streamflow (May−September) was the second lowest in the last 19 years (**Figure 45**). Baseflow in 2015 began higher than in 2014 in spring and early summer but was less than in 2014 by the end of summer. Reduced streamflow with associated reduced food supply hindered YOY from growing into the soon-to-smolt Size Class II.

Table 17a. Density of Juvenile Steelhead for ALL SIZES at MAINSTEM SAN LORENZO RIVER Monitoring Sites (Excluding Lagoon) in 1997-2001 and 2003-2015. Empty boxes indicate no data. (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
0a				5.4				
0b				4.3	5.2			
1	34.2*	26.9	17.6	3.4	7.6			
2a	74.9	21.4	4.6	3.9	13.5			
2b				24.8	15.4			
3	83.9	73.5	29.0	33.0	36.0			
4	86.9	37.8	39.6	12.0	33.1			
5		133.8	46.2	4.5	23.6			
6	45.4	46.0	14.1	4.0	10.9	4.7	8.7	6.7
7	149.3	21.7	11.8	7.6	15.5	29.4	38.9	11.0
8	158.6	140.1	48.2	11.2	21.4	32.3	21.6	20.3
9	126.8	77.3	27.6	12.0	29.6	17.4	10.9	17.1
10	69.1	17.9	10.9	18.4	19.7	51.9	44.6	21.9
11	73.0	10.9	33.4	28.7	5.1	57.2	45.7	32.3
12a	56.8	30.8	21.1	39.9	49.8			
12b		32.2	25.9	43.5	30.4	51.9	48.4	98.2

*** 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 17b. Density of Juvenile Steelhead for ALL SIZES at MAINSTEM SAN LORENZO RIVER Monitoring Sites (Excluding Lagoon) in 2006-2015.
Empty boxes indicate no data. (Resident rainbow trout likely present at Site 12b).

Sample Site	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	2015 E-D	1997-2015 Avg.
0a				2.4	20.4	2.1	26.9	4.6	6.2	12.4	10.1
0b											4.8
1	1.2	1.9	7.0	3.4	16.4	2.7	7.6	4.2	1.8	6.5	7.7
2a		14.8	20.6	9.2	28.4	11.2	6.7	8.1	2.9	7.8	16.3
2b											20.1
3											51.1
4	16.6	21.3	71.2	28.4	23.1	4.1	17.5	21.3	12.0	17.6	29.5
5											52.0
6	4.5	24.0	21.4	13.2	17.4	9.1	16.7	20.6	4.6	15.7	16.0
7											35.7
8	13.7	5.5	33.0	18.0	36.7	9.2	14.2	30.7	5.7	10.1	35.0
9								20.9	2.1	11.8	32.1
10									0.7	15.1	27.0
11	3.0	21.3	47.6	6.8	29.1	9.1	4.5	5.7	6.5	23.2	24.6
12a										18.5	36.2
12b							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 18a. 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 2003-2005. Empty boxes indicate no data. (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
0a				2.2				
0b				3.3	2.3			
1	32.3*	25.6	12.6	1.8	6.8			
2a	66.3	19.2	3.2	2.7	11.0			
2b				21.2	12.1			
3	84.3	68.2	24.7	29.4	29.6			
4	86.2	32.9	34.2	10.5	30.5			
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
7	143.5	19.8	5.7	3.6	12.0	9.7	38.0	11.2
8	152.0	135.3	44.2	10.9	21.0	30.5	20.9	18.7
9	119.9	69.7	23.4	11.0	28.9	17.6	10.0	15.4
10	65.8	11.7	6.5	13.4	5.9	45.1	40.5	18.4
11	64.2	6.8	27.6	16.4	21.8	49.8	34.5	29.6
12a	50.9	27.9	5.4	34.4	37.3			
12b		24.2	14.3	37.9	15.8	44.4	39.3	89.1

***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 18b. Density of Juvenile Steelhead for the YOUNG-OF-THE-YEAR Age Class at MAINSTEM SAN LORENZO RIVER Monitoring Sites (Stream Habitat) in 2006-2015. Empty boxes indicate no data. (Resident rainbow trout likely present at Site 12b).

Sample Site	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	2015 E-D	1997-2015 Avg.
0a				1.2	19.0	2.1	23.4	4.6	5.1	12.5	8.8
0b											2.8
1	1.2	1.6	7.0	2.7	16.0	1.9	6.6	4.1	1.4	6.1	6.8
2a		13.7	19.0	8.1	27.6	8.6	6.4	8.1	2.7	7.6	14.6
2b											16.7
3											
4	13.9	20.7	69.8	26.5	22.5	3.5	17.2	19.9	11.4	17.8	27.8
5											
6	4.2	23.4	20.6	11.1	16.7	8.1	15.8	20.5	4.5	15.7	15.2
7											30.4
8	11.6	5.5	31.2	16.3	35.4	5.8	13.7	30.1	4.9	10.1	33.2
9								20.8	1.9	11.8	30.0
10									0.7	13.7	22.2
11	1.5	20.8	46.1	4.4	26.8	8.4	3.7	3.4	4.9	17.4	21.6
12a										11.8	28.0
12b							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 19a. Density of Juvenile Steelhead for YEARLINGS AND OLDER at MAINSTEM SAN LORENZO RIVER Monitoring Sites in 1997-2001 and 2003-2005. Empty boxes indicate no data. (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
0a				2.2				
0b				1.0	2.9			
1	1.6*	1.4	2.9	1.9	0.5			
2a	7.9	1.5	0.9	1.2	1.5			
2b				2.4	2.0			
3	5.2	5.3	3.9	4.4	6.6			
4	7.6	4.7	2.2	1.2	0.5			
5		2.9	5.4	1.0	0.8			
6	4.6	2.2	0.8	0.7	0.5	0.3	0.2	0.8
7	6.0	2.5	6.3	4.8	3.6	0.4	0.3	3.0
8	5.4	4.2	4.1	0.3	0.4	2.0	2.6	2.4
9	4.3	8.1	2.5	1.0	0.6	0.8	1.9	2.5
10	3.3	6.4	4.6	5.5	4.1	6.8	2.7	4.7
11	8.8	3.9	6.5	11.2	4.7	7.4	3.0	7.1
12a	5.9	3.2	15.7	5.5	12.9			
12b		6.8	12.6	5.5	14.3	7.5	9.1	9.3

***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 19b. Density of Juvenile Steelhead for YEARLINGS AND OLDER at MAINSTEM SAN LORENZO RIVER Monitoring Sites in 2006-2015.
Empty boxes indicate no data. (Resident rainbow trout likely present at Site 12b).

Sample Site	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	2015 E-D	1997-2015 Avg.
0a				1.2	1.7	0	3.9	0	1.1	0	1.3
0b											2.0
1	0	0.3	0	0.7	0.4	0.5	1.0	0.1	0.4	0.4	0.8
2a		0.9	0.4	1.0	0.5	2.2	0.4	0	0.2	0.5	1.4
2b											2.2
3											5.1
4	2.4	0.2	0.3	0.4	0.6	0.6	0.2	0.2	0.7	0	1.5
5											2.5
6	0.3	0.7	0.03	0	0.5	1.2	0.3	0.9	0	0	0.8
7											3.4
8	1.6	0	2.0	1.5	1.0	0.2	0.3	0.5	0.6	0	1.6
9								0.2	0.2	0.3	2.0
10									0	1.4	4.0
11	1.5	0.6	1.1	2.5	2.4	0.6	0.8	2.3	1.6	5.8	4.0
12a										7.0	8.4
12b							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 20a. Density of Juvenile Steelhead for SIZE CLASS I (<75 mm SL) at MAINSTEM SAN LORENZO RIVER Monitoring Sites (Stream Habitat) in 1997-2001 and 2003-2005. Empty boxes indicate no data. (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
0a				0				
0b				0	0			
1	3.3*	0.2	2.2	0	0.7			
2a	7.9	1.3	0.4	0.2	2.5			
2b				1.2	6.7			
3	47.7	9.4	3.7	5.9	18.1			
4	63.0	8.6	6.8	3.1	17.6			
5		19.1	5.2	0	8.1			
6	35.1	20.5	11.2	1.8	8.4	4.1	8.3	4.7
7	126.7	11.7	2.9	1.5	8.6	23.6	35.0	4.9
8	138.6	118.7	37.4	8.0	20.5	27.9	19.9	13.2
9	102.2	57.5	18.5	6.2	28.4	15.4	9.6	12.2
10	65.8	9.6	4.4	10.1	12.2	45.1	39.8	17.6
11	64.2	4.1	26.9	15.6	18.7	49.8	34.5	19.3
12a	50.9	26.2	5.4	34.4	40.3			
12b		19.5	4.1	37.0	17.4	44.4	39.3	87.6

*** 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 20b. Density of Juvenile Steelhead for SIZE CLASS I (<75 mm SL) at MAINSTEM SAN LORENZO RIVER Monitoring Sites (Stream Habitat) in 2006-2015.
Empty boxes indicate no data. (Resident rainbow trout likely present at Site 12b).

Sample Site	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	2015 E-D	1997-2015 Avg.
0a				0	0.6	0	0	0	0	7.6	1.0
0b											0
1	0	0.3	2.1	0	1.1	0.1	0	0.8	0	2.1	0.7
2a		3.7	8.4	1.2	6.0	0	0.1	1.9	0.5	4.3	2.7
2b											4.0
3											17.0
4	0.5	15.4	58.1	14.5	10.5	0.4	8.6	14.6	4.4	15.0	16.1
5											8.1
6	2.2	22.8	19.2	10.7	11.3	3.4	13.5	18.6	3.2	15.2	11.9
7											26.9
8	7.9	4.8	29.4	14.5	28.5	5.8	12.2	28.8	4.3	10.1	29.5
9								18.6	1.5	10.5	25.5
10									0.7	13.7	21.9
11	0	20.8	44.9	3.7	24.4	1.3	1.6	3.4	4.9	17.4	19.8
12a										11.8	28.2
12b							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 21a. 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 2003-2005. Empty boxes indicate no data. (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
0a				5.4				
0b				4.3	5.2			
1	30.9*	26.7	15.4	3.4	6.9			
2a	67.0	20.1	4.2	3.7	11.0			
2b				23.6	8.7			
3	36.2	64.1	25.3	27.1	17.9			
4	23.8	29.2	32.8	8.9	15.5			
5		114.7	41.0	4.5	15.5			
6	10.3	25.5	2.9	2.2	2.5	0.6	0.4	2.0
7	22.6	10.0	8.9	6.1	6.9	5.8	3.9	6.1
8	20.0	21.4	10.8	3.2	0.9	4.4	1.7	7.1
9	24.6	19.8	9.1	5.8	1.2	2.0	1.3	4.9
10	3.3	8.3	6.5	8.3	7.5	6.8	4.8	4.3
11	8.8	6.8	6.5	13.1	6.4	7.4	11.2	13.0
12a	5.9	4.6	15.7	5.5	9.5			
12b		12.7	21.8	6.5	13.0	7.5	9.1	10.6

*** 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 21b. Density of Juvenile Steelhead for SIZE CLASS II/ III (=>75 mm SL) at MAINSTEM SAN LORENZO RIVER Monitoring Sites (Stream Habitat) in 2006-2015.
Empty boxes indicate no data. (Resident rainbow trout likely present at Site 12b).

Sample Site	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	2015 E-D	1997-2015 Avg.
0a				2.4	19.8	2.1	26.9	4.1	6.2	4.8	9.0
0b											4.8
1	1.2	1.6	4.9	3.4	15.3	2.6	7.6	3.4	1.8	4.4	7.0
2a		11.1	12.2	8.0	22.4	11.2	6.6	6.2	2.4	3.5	13.5
2b											16.1
3											34.1
4	16.2	6.0	13.2	13.9	12.6	3.7	8.9	6.7	4.4	2.6	13.2
5											43.9
6	2.3	1.2	2.2	0.5	6.1	5.3	3.3	2.0	1.4	0.5	4.0
7											8.8
8	5.8	0.7	3.6	3.5	8.2	3.4	2.0	1.9	1.4	0	5.6
9								2.3	0.6	1.3	6.6
10									0	1.4	5.1
11	3.0	0.6	2.8	3.1	4.7	7.9	2.9	2.3	1.6	5.8	6.0
12a										6.8	8.0
12b							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, 2015 soon-to-smolt ratings were the same as in 2014 at 5 of 10 sites (**Table 42**). All 3 of the middle mainstem sites, Site 2 in the lower mainstem and Site 10 in the upper mainstem remained at the "very poor" or "poor" rating in 2015. Site 0a dropped to a "poor" rating. Sites 1 and 11 increased to "below average" ratings, the highest rating in the mainstem. YOY densities were higher than in 2014, but few grew into the soon-to-smolt size range in 2015.

In tributaries of the San Lorenzo River in 2015, soon-to-smolt ratings increased at only 3 of 15 sites compared to 2014 ("good" ratings at Zayante 13c and Bean 14b; "fair" rating at Branciforte 21b) (**Table 42**). Nine of 15 sites were rated "below average" or worse. Total juvenile steelhead densities increased at 6 of 12 wetted, re-sampled sites (Zayante 13a, Zayante 13c, Bean 14b, Boulder 17a, Boulder 17b and Bear 18a) (**Table 22b**). YOY densities increased at 5 of the same 12 sites except not at Boulder 17b (**Table 23b**). Despite the slight uptick in 2015, there has been a general downward trend in total juvenile densities in tributaries since 2003, 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 2012-2014. Bear 18a had more YOY in 2015, indicating it was more passable. Densities for YOY and all juveniles combined were below average at 12 of 14 tributary sites having steelhead (**Figures 1 and 2a**). Zayante 13c had Bean 14a had above average YOY and total densities. The lowest YOY densities in 2015 were at Newell 16, Branciforte 21b and Fall 15b, in increasing order. Newell Creek streamflow was less than 0.1 cfs in the fall and intermittent in places during fish sampling (as in 2014) 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 somewhat successful with the remaining logs at a dam remnant below the Lanktree Road Bridge flushed out over the winter. Bean 14c went dry before fall sampling, as it had in 2013 and 2014 and after sampling in 2012, to eliminate typically high densities of steelhead inhabiting the area.

All tributary sites were dominated by very small YOY in 2015 except at sites where YOY and total densities were very low, allowing the few YOY to grow larger than usual (Lompico 13e, Fall 15b, Newell 16 and Branciforte 21b). Very few YOY reached soon-to-smolt-size in 2015 at tributary sites with more than few YOY due to low baseflow and very limited insect drift. The exception was the sunny Zayante Site 13c (**Figure 17a−b**). At tributary sites in 2015, yearling and older densities were relatively low, similar to those in 2013 and 2014 and below average at 12 of 14 sites, except at Fall 15a (only 2 years of data (**Table 24; Figure 3**). The highest yearling and older steelhead densities were at Zayante 13d, Zayante 13i, Bean 14b and Boulder 17b, in decreasing order.

In tributaries, Size Class II and III densities (soon-to-smolt sized fish) were more than in 2014 at 5 of 12 steelhead sites and below average at 12 of 14 sites (**Table 25b; Figures 4 and 24**). The poor showing in smolt densities in tributaries occurred because the juvenile steelhead population in 2015 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 and 2014. 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 being inaccessible to adult spawners until 2015 after 3 years of blockage. The big exception to low densities of larger juveniles was Zayante Site 13c, with high YOY density and 31% of those reaching Size Class II. Growth likely occurred in spring and early summer before baseflow became much reduced.

Table 22a. TOTAL DENSITY of Juvenile Steelhead at SAN LORENZO TRIBUTARY Monitoring Sites in 1997-2001 and 2003-2015.

Empty boxes indicate no data.

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
Zay 13a		83.0	104.0	46.6	54.8	68.3	69.9	53.6
Zay 13b	74.9*	50.7	74.9	24.9	38.0	70.0	65.1	53.3
Zay 13c		69.0	61.9	25.8	40.0	123.6	63.4	78.2
Zay 13d		82.2	105.0	57.5	84.1	243.8	145.3	99.7
Lomp 13e								
Zay 13i								
Bean 14a		44.2	45.9	17.0	38.0	50.9	31.9	54.0
Bean 14b	73.0	115.6	92.1	48.3	65.5	146.4	78.5	103.5
Bean 14c		78.2	22.7	87.5	36.8	41.3	99.6	87.4
Fall 15a								
Fall 15b	84.5	82.7	85.0	55.0	59.8			
New 16	94.9	76.3	40.5	28.8	40.3			
Boul 17a	134.2	149.2	68.5	32.0	61.1	60.0	38.6	40.1
Boul 17b	100.7	74.9	49.5	43.0	51.8	98.6	54.2	70.2
Boul 17c		42.8	33.9	36.0	39.4	75.8	81.5	67.4
Bear 18a	118.5	81.2	76.0	33.6	58.8	86.8	87.7	87.9
Bear 18b		69.5	116.1	67.6	63.5			
King 19a		10.8	0.5	8.4	7.6			
King 19b	52.7	22.9	44.9	37.5	41.6			
Carb 20a	13.4	21.0	18.9	9.7	19.6			
Carb 20b		53.4	51.7	45.2	45.2			
Bran21a-1								
Bran21a-2	70.0	60.2	47.1	65.2	45.2			
Bran 21b		67.8	57.6	59.6	57.5			20.4
Bran 21c								

*** 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 22b. TOTAL DENSITY of Juvenile Steelhead at SAN LORENZO TRIBUTARY Monitoring Sites in 2006-2015.

Empty boxes indicate no data.

Sample Site	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	2015 E-D	1997-2015 Avg.
Zay 13a	17.0	66.9	84.8	29.9	61.4	5.2	26.3	91.7	22.8	37.5	54.3
Zay 13b											56.5
Zay 13c	18.0	94.4	112.2	74.1	66.6	54.0	62.4	189.4	40.1	134.9	76.9
Zay 13d	69.8	80.5	131.7	105.5	91.9	29.1	70.6	169.7	116.0	82.2	103.8
Lomp 13e	26.2	108.3	27.8	123.3	23.1	16.6	54.8	56.3	44.2	8.5	48.9
Zay 13i										57.6	57.6
Bean 14a										77.1	44.9
Bean 14b	13.1	8.9	67.6	11.2	32.8	18.2	10.5	27.7	20.4	47.8	54.5
Bean 14c	66.0	18.2	0 dry	0 dry	58.8	29.1	0 dry	0 dry	0 dry	0 dry	36.8
Fall 15a									32.9	25.8	29.4
Fall 15b			84.0	48.7	46.1	78.5	101.5	92.6	50.4	8.1	67.5
New 16	26.0			18.6	32.5	13.4	37.7	36.8	3.8	2.6	34.8
Boul 17a	30.7	62.7	69.9	13.6	19.2	19.0	19.6	73.2	8.1	17.9	51.0
Boul 17b	57.6	45.1	97.8	44.0	43.4	48.7	108.7	90.3	26.8	26.0	62.9
Boul 17c											53.8
Bear 18a	52.9	47.3	69.6	20.7	47.6	30.0	22.2	3.3	1.6	14.3	52.2
Bear 18b											79.2
King 19a											6.8
King 19b											39.9
Carb 20a											16.5
Carb 20b											48.9
Bran21a-1		6.6	3.3								5.0
Bran21a-2	29.5	49.1	33.0	20.0	15.7	25.0	31.4	10.9	44.6		39.1
Bran 21b							50.7	69.9	22.6	7.9	46.0
Bran 21c								15.7	13.3	8.6	12.5

*** 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 23a. 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 2003-2005. Empty boxes indicate no data.

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
Zay 13a		80.0	96.4	29.0	52.9	64.4	68.3	50.1
Zay 13b	64.9*	43.5	60.6	7.7	31.2	60.4	58.7	48.1
Zay 13c		66.9	50.2	9.4	30.9	112.9	53.2	74.2
Zay 13d		77.4	77.7	41.9	67.0	220.6	130.0	88.5
Lomp 13e								
Zay 13i								
Bean 14a		43.4	42.0	11.1	36.0	46.4	30.0	50.9
Bean 14b	60.7	104.3	59.0	41.3	60.2	137.3	70.3	84.7
Bean 14c		71.8	6.9	76.6	18.1	23.0	87.4	81.5
Fall 15a								
Fall 15b	79.6	74.8	68.1	45.1	45.4			
Newell 16	77.1	67.6	17.7	19.9	35.6			
Boul 17a	119.2	141.5	50.7	22.9	55.9	45.6	31.3	36.5
Boul 17b	91.8	68.0	36.2	33.9	38.9	84.1	48.0	62.0
Boul 17c		37.6	15.3	27.5	30.7	64.0	69.7	61.3
Bear 18a	100.2	72.4	57.9	12.6	50.8	75.0	76.6	75.2
Bear 18b		66.6	89.2	58.3	48.1			
Kings 19a		9.8	0	6.6	6.0			
Kings 19b	48.2	20.8	32.1	31.5	28.5			
Carb 20a	9.1	17.2	13.2	5.6	16.5			
Carb 20b		50.9	40.3	29.7	33.4			
Bran 21a-1								
Bran 21a-2	64.6	54.1	35.5	47.2	34.2			
Bran 21b		60.1	44.2	45.8	49.4			9.1
Bran 21c								

*** 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 23b. 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 2006-2015.

Empty boxes indicate no data.

Sample Site	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	2015 E-D	1997-2015 Avg.
Zay 13a	14.6	62.1	82.3	26.1	58.3	2.6	21.9	72.2	20.4	35.4	49.2
Zay 13b											46.9
Zay 13c	17.1	85.1	109.4	65.0	59.4	43.4	58.1	187.6	38.9	127.4	69.9
Zay 13d	68.0	63.1	107.0	88.6	83.3	25.6	62.2	151.2	92.4	81.3	89.8
Lomp 13e	24.2	96.9	21.4	118.4	14.4	14.2	52.5	47.7	39.5	7.2	43.6
Zay 13i										50.1	50.1
Bean 14a										75.7	41.9
Bean 14b	10.9	0	63.0	4.9	31.7	14.3	8.3	26.9	17.6	38.3	46.3
Bean 14c	61.1	12.8	0 dry	0 dry	55.7	27.2	0 dry	0 dry	0 dry	0 dry	30.7
Fall 15a									28.5	20.8	24.7
Fall 15b			68.2	30.6	33.5	71.7	86.2	84.3	42.2	6.7	56.6
Newell 16	20.1			15.0	31.2	13.1	37.1	33.7	2.3	2.1	28.7
Boul 17a	25.3	55.9	64.9	9.3	16.3	17.0	13.5	70.0	4.3	16.9	44.3
Boul 17b	56.1	35.1	94.1	33.3	39.6	46.4	98.1	79.6	13.9	20.3	54.4
Boul 17c											43.7
Bear 18a	51.0	41.7	64.5	19.1	24.2	29.0	19.1	1.3	1.0	14.3	43.7
Bear 18b											65.6
Kings 19a											5.6
Kings 19b											32.2
Carb 20a											12.3
Carb 20b											38.6
Bran 21a-1		2.8	2.7								2.8
Bran 21a-2	30.6	47.6	27.3	12.5	11.2	21.5	22.2	10.0	40.0		56.4
Bran 21b							23.4	56.7	15.3	4.2	34.2
Bran 21c								5.7	0	2.5	2.7

*** 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 24a. Density of Juvenile Steelhead for YEARLING and OLDER Fish at SAN LORENZO TRIBUTARY Monitoring Sites in 1997-2001 and 2003-2005.

Empty boxes indicate no data.

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
Zay 13a		3.0*	7.6	17.7	1.9	3.9	1.6	3.5
Zay 13b	10.0	7.2	14.3	17.2	6.8	9.6	6.4	5.2
Zay 13c		2.1	11.7	16.4	9.1	10.7	10.2	4.0
Zay 13d		4.7	27.3	15.6	17.1	23.2	15.3	11.2
Lomp 13e								
Zay 13i								
Bean 14a		0.8	3.9	5.9	2.0	4.5	1.9	3.1
Bean 14b	12.3	11.3	33.1	7.0	5.3	9.1	8.2	18.8
Bean 14c		6.4	15.8	10.9	18.7	18.3	12.2	5.9
Fall 15a								
Fall 15b	4.9	7.9	16.9	9.9	14.4			
Newell 16	17.8	8.7	22.8	8.9	4.7			
Boul 17a	15.0	7.7	17.8	9.1	5.2	14.4	7.3	3.6
Boul 17b	8.9	6.9	13.3	9.1	12.9	14.5	6.2	8.2
Boul 17c		5.2	18.6	8.5	8.7	11.8	11.8	6.1
Bear 18a	18.3	7.8	18.1	21.0	8.0	11.8	11.1	12.7
Bear 18b		2.9	26.9	9.3	15.4			
Kings 19a		1.0	0.5	1.8	1.6			
Kings 19b	4.5	2.1	12.8	6.0	13.1			
Carb 20a	4.3	3.8	5.7	4.1	3.1			
Carb 20b		2.5	11.4	15.5	11.8			
Bran21a-1								
Bran 21a-2	5.4	6.1	11.6	18.0	11.0			
Bran 21b		7.6	13.4	11.1	8.1			11.3
Bran 21c								

*** 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 24b. Density of Juvenile Steelhead for YEARLING and OLDER Fish at SAN LORENZO TRIBUTARY Monitoring Sites in 2006-2015.

Empty boxes indicate no data.

Sample Site	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	2015 E-D	1997-2015 Avg.
Zay 13a	3.2	4.9	2.1	2.6	2.9	1.4	4.0	0.3	2.1	2.1	3.8
Zay 13b											9.6
Zay 13c	1.0	8.8	2.9	9.1	7.6	10.1	2.1	2.9	1.0	6.7	6.8
Zay 13d	1.7	17.4	24.0	16.9	8.6	1.5	8.3	18.5	23.5	8.3	14.3
Lomp 13e	1.9	11.3	6.4	4.9	8.7	3.3	2.3	8.7	9.5	1.1	6.5
Zay 13i										7.4	7.4
Bean 14a										1.4	2.9
Bean 14b	2.0	8.9	3.7	5.6	0.8	3.9	2.9	1.1	2.8	7.1	8.0
Bean 14c	4.1	5.4	0 dry	0 dry	3.1	1.8	0 dry	0 dry	0 dry	0 dry	6.0
Fall 15a									2.9	4.9	3.9
Fall 15b			15.8	18.0	12.3	6.5	14.5	8.3	7.7	2.2	10.7
Newell 16	5.4			3.9	1.5	0.6	1.2	2.8	1.5	0.7	6.2
Boul 17a	5.9	6.8	5.8	4.1	2.8	2.9	6.3	3.2	3.8	1.0	6.8
Boul 17b	1.1	9.8	3.8	10.7	3.6	1.8	10.6	10.7	13.0	5.7	8.4
Boul 17c											10.1
Bear 18a	1.6	5.7	5.1	2.0	3.5	0.7	3.2	2.0	0.7	0	7.4
Bear 18b											13.6
Kings 19a											1.2
Kings 19b											7.7
Carb 20a											4.2
Carb 20b											10.3
Bran21a-1		3.9	0.5								2.2
Bran 21a-2	0	1.5	5.7	7.5	4.4	3.4	9.2	1.5	4.6		6.4
Bran 21b							27.3	13.3	7.3	3.7	11.5
Bran 21c								10.0	13.3	6.2	9.8

*** 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 25a. Density of Juvenile Steelhead for SIZE CLASS II/III (=>75 mm SL) Fish at SAN LORENZO TRIBUTARY Monitoring Sites in 1998-2001 and 2003-2005.
Empty boxes indicate no data.

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
Zay 13a		12.3*	13.5	17.7	1.9	3.9	1.6	31.4
Zay 13b	11.7	14.9	19.9	17.2	7.1	9.6	6.4	17.3
Zay 13c		14.7	16.8	16.4	9.5	10.7	10.2	15.0
Zay 13d		10.7	27.3	15.6	17.1	23.2	15.3	15.7
Lomp 13e								
Zay 13i								
Bean 14a		2.1	3.9	5.9	2.0	4.5	1.9	12.0
Bean 14b	13.7	11.3	33.1	7.1	5.3	9.1	8.2	39.4
Bean 14c		6.4	15.8	10.9	18.4	18.3	12.2	12.4
Fall 15a								
Fall 15b	8.2	13.3	16.9	9.9	13.0			
New 16	23.6	14.9	22.8	8.9	4.7			
Boul 17a	22.8	21.9	17.8	9.1	5.2	14.4	7.3	9.0
Boul 17b	9.7	11.5	13.3	9.1	12.9	14.5	6.2	8.2
Boul 17c		5.2	18.6	8.5	8.7	11.8	11.8	8.4
Bear 18a	18.3	13.0	18.1	21.0	8.0	11.8	11.1	13.7
Bear 18b		6.2	26.9	9.3	13.2			
King 19a		6.2	0.5	1.8	1.6			
King 19b	4.5	6.2	12.8	6.0	10.0			
Carb 0a		11.5	5.7	4.1	3.1			
Carb 0b		11.4	11.4	15.5	11.8			
Bran21a-1								
Bran21a-2	4.3	8.5	11.6	18.0	10.8			
Bran 21b		14.8	13.4	11.1	8.1			16.0
Bran 21c								

*** 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 25b. Density of Juvenile Steelhead for SIZE CLASS II/III (=>75 mm SL) Fish at SAN LORENZO TRIBUTARY Monitoring Sites in 2006-2015.
Empty boxes indicate no data.

Sample Site	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	2015 E-D	1997-2015 Avg.
Zay 13a	11.7	4.9	6.3	12.1	18.8	4.8	14.2	2.7	2.4	2.1	9.4
Zay 13b											13.0
Zay 13c	12.6	8.8	4.4	10.4	24.5	29.2	20.0	8.4	3.7	44.7	15.2
Zay 13d	17.3	17.4	22.5	16.9	9.1	11.7	8.6	18.5	22.1	8.3	16.3
Lomp 13e	5.7	11.3	6.4	4.9	8.7	7.8	2.3	8.7	6.7	6.8	6.9
Zay 13i										7.4	7.4
Bean 14a										1.4	4.2
Bean 14b	11.9	8.9	4.7	10.9	8.4	7.4	10.1	12.5	2.8	11.5	12.0
Bean 14c	17.1	5.4	0 dry	0 dry	6.7	8.8	0 dry	0 dry	0 dry	0 dry	7.8
Fall 15a									2.7	6.0	4.4
Fall 15b			15.8	18.7	14.3	14.7	13.0	12.1	7.3	6.7	12.6
New 16	16.2			4.4	24.7	13.1	7.3	23.7	3.1	2.0	13.0
Boul 17a	18.2	6.8	7.2	5.5	11.8	10.6	7.2	3.2	3.8	1.0	10.2
Boul 17b	13.7	9.8	3.8	10.7	12.7	13.6	10.6	10.7	13.0	5.7	10.5
Boul 17c											10.4
Bear 18a	13.6	5.7	5.1	2.5	9.5	9.4	4.1	2.6	0.7	1.0	9.4
Bear 18b											13.9
King 19a											2.5
King 19b											7.9
Carb 0a											6.1
Carb 0b											12.5
Bran21a-1		3.9	0.5								2.2
Bran21a-2	10.8	1.5	5.7	7.5	12.6	13.6	12.3	6.0	4.6		9.1
Bran 21b							27.3	13.3	7.3	6.8	13.1
Bran 21c								10.0	13.3	6.2	9.8

*** 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. 2015 Juvenile Steelhead Densities in Soquel Creek Compared to 2014 and Averages Since 1997

2015 total and YOY juvenile steelhead densities increased from 2014 at 6 of 7 wetted sampling sites, except for mainstem Site 4 (**Tables 26b and 27b**). The increased YOY densities were statistically significant (**Table 46**). Site 16 (Reach 12a) in the SDSF went dry again in 2015. 2015 total and YOY site densities were below average at 5 of 8 sampled sites (**Figures 5 and 6**). The two upper mainstem sites were above average. The trend in total densities (consisting of mostly YOY) for the watershed showed an increase in 2015, with the fifth lowest 6-site average since 1997 (18 years) (29.9 fish/ 100 ft) (**Figure 25**). Total densities have steadily declined through the years at the SDSF Site 16 to zero in 2014 and 2015, when the reach went dry. In 2015, the juvenile steelhead population in Soquel Creek consisted primarily of little Size Class 1 steelhead, whose densities were below average except at Sites 1, 10 and 12 in the mainstem (**Table 29**).

2015 yearling densities decreased at 4 of 7 wetted sites from 2014 and were above average at 3 of 7 sampled sites (Mainstem 12, East Branch 13a and West Branch 19) (**Table 28; Figure 7**). Mainstem Sites 4 and 10 had no yearling steelhead. Overwinter retention/survival of yearlings may have been good in 2015 after a very mild winter, though yearling density was very low at all sites (maximum of 4.4 yearlings/ 100 ft at Site 19).

2015 densities of Size Class II and III juveniles increased at 4 of 7 sites from 2014, but were below average at 7 of 7 sites (**Table 30; Figure 8**). Below average densities were partly because few YOY grew into the soon-to-smolt size class in the mainstem compared to past years and few yearlings (**Figure 7**) remained in the watershed despite only mild winter stormflows (**Figures 39a‒b**). Also, baseflows were substantially below the median statistic (less food) (**Figures 41a and 45**) 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 averaged mean monthly streamflow for May through September was the second lowest since 1997. 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 showed a decline since 2012 to the second lowest 6-site average (2.6 fish/ 100 ft) since 1997 (**Figure 26a**). When averaged soon-to-smolt site densities were plotted annually with the 5-month average baseflow (May through September), densities increased during some wet years and decreased in some dry years (**Figure 26b**).This fluctuation in site densities was affected by the proportion of YOY reaching Size Class II, it being higher in wet years and lower in dry years. Based on soon-to-smolt size densities, 4 of 7 sampled sites decreased in ratings compared to 2014, and Site 16 was dry again (**Table 42**). Three of the mainstem sites dropped to "very poor" and the lowermost site improved from "very poor" to "poor." There were no yearlings at some of these sites and few YOY reached Size Class II length (**Figures 7 and 18a**). The highest 2015 rating was "fair" at Site 13a below Mill Pond on the East Branch Soquel.

Table 26a. TOTAL Juvenile Steelhead SITE DENSITIES (fish/ 100 ft) at Monitoring Sites in SOQUEL CREEK in 1997–2005.
(Resident rainbow trout likely present at Sites 18 and 22). Empty boxes indicate no data.

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
1- Near Grange	2.9	5.6	3.0	2.4	3.5	7.4	2.5	1.7	9.5
2- Adj. USGS Gage	4.5	9.4	1.2	5.9	7.7	-	4.1	3.5	4.2
3- Above Bates Ck	13.2	50.6	7.6	2.2	8.4	14.8			7.9
4- Adj. Flower Fld	49.6	20.7	6.8	5.5	23.0	33.3	7.7	20.1	9.2
5-Adj. Beach Shk	56.3	20.6	8.1	9.2	28.0				
6- End of Cherryval e	24.7	9.4	2.6	5.3	5.7	47.6	15.9	13.1	16.1
7- Adj. Orchard	96.6	14.0	5.6	2.0	27.5				
8- Below Rivervale	21.0	10.7	4.1	4.9	12.4	59.2			
9- Adj. Mt. School	61.6	18.4	5.1	7.9	20.7	94.8	26.2	45.8	26.8
10- Above Allred	54.2	11.9	9.1	9.2	15.5	70.7	19.9	37.2	26.2
11- Below Purling Br	81.9	13.1	10.5	13.1	31.6				
12- Near SoqCk Br	83.5	19.5	17.4	12.0	34.4	65.5	20.1	48.5	21.3
13a- Below Mill Pond	79.4	57.6	21.5	22.8	26.2	142.0	33.3	110.5	46.9
13b- Below Hinckley			17.0	24.4	47.3	110.6			
14- Above Hinckley	49.6	47.7	23.6	18.5	37.7	107.6	86.0	78.0	39.5
15- Below Amaya Ck	137.9	79.9	55.4	39.0	38.3	91.6			
16- Above Amaya Ck*	153.2	179.7	283.5	122.6	85.7	121.9	134.6	98.7	127.3
17- Above Fern Glch*	138.3	104.2	170.9	93.8	96.3	129.5	102.4	117.2	157.3
18- Above Ashbury G*	44.1	24.5	53.0						
19- Below Hester Ck	62.3	21.7	32.1	27.6	37.8				
20- Above Hester Ck		28.2	36.9	37.7	28.3	52.1	49.1	87.2	50.2
21- Above GS Falls I						119.0	112.9	99.4	102.0
22- Above GS Falls II						65.5	27.5	58.1	5.5

*** 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 26b. TOTAL Juvenile Steelhead SITE DENSITIES (fish/ 100 ft) at Monitoring Sites in SOQUEL CREEK in 2006–2015.
(Resident rainbow trout likely present at Sites 18 and 22). Empty boxes indicate no data.

Sample Site	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	2015 E-D	Avg
1- Near Grange		15.8	8.7	7.7	9.5	2.7	4.2	10.7	2.4	6.6	5.9
2- Adj. USGS Gage											5.1
3- Above Bates Ck											15.0
4- Adj. Flower Fld	3.2	23.5	63.0	18.6	5.3	5.3	13.5	20.4	12.1	5.5	18.2
5-Adj. Beach Shk											24.4
6- End of Cherryvale											15.6
7- Adj. Orchard											29.1
8- Below Rivervale											18.7
9- Adj. Mt. School											34.1
10- Above Allred	12.1	54.3	105.8	18.0	15.0	5.8	37.1	54.9	38.0	60.0	34.5
11- Below Purling Br											30.0
12- Near SoqCk Br		50.7	61.8	37.4	12.3	6.0	33.8	134	44.3	73.3	43.3
13a- Below Mill Pond	3.2	35.0	57.9	22.8	37.1	11.2	41.1	61.2	22.8	33.6	45.6
13b- Below Hinckley											49.8
14- Above Hinckley											54.2
15- Below Amaya Ck											73.7
16- Above Amaya Ck*	69.4	57.0	76.0	107	71.4	37.8	43.0	42.2	0	0	95.3
17- Above Fern Glch*											123
18- Above Ashbury G*											40.5
19- Below Hester Ck	8.3	26.5	70.7	43.1	13.0	24.3	48.7	58.2	25.1	34.3	35.6
20- Above Hester Ck	22.9										43.6
21- Above GS Falls I	44.2 **	68.3 **		49.9	26.2	13.7			16.6	25.2	61.6
22- Above GS Falls II	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 27a. SITE DENSITIES (fish/ 100 ft) of Juvenile Steelhead by YOUNG-OF-THE-YEAR AGE CLASS at Monitoring Sites in SOQUEL CREEK in 1997–2005.
(Resident rainbow trout likely present at Sites 18 and 22). Empty boxes indicate no data.

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
1- Near Grange	1.7	4.3	1.0	0.9	2.8	6.7	1.7	1.2	8.6
2- Adj. USGS Gage	4.1	8.3	0.4	5.3	6.3		4.9	3.5	2.6
3- Above Bates Ck	11.7	48.0	5.6	2.0	8.2	14.1			6.7
4- Adj. Flower Fd	45.7	18.2	6.2	3.5	19.9	28.8	7.1	19.4	8.7
5-Adj. Shack	54.0	19.2	5.8	7.6	27.2				
6- End of Cherryval	21.1	8.3	2.4	4.4	5.1	46.4	15.8	12.8	12.9
7- Adj. Orchard	94.0	13.6	5.2	1.6	26.4				
8- Below Rivervale	18.9	9.9	3.9	1.7	11.4	57.2			
9- Adj. Mt. Schl	53.4	16.0	4.5	4.9	18.8	92.5	22.7	43.6	22.2
10- Above Allred	52.2	10.8	7.8	7.9	12.9	68.8	17.2	36.3	22.3
11- Below Purlin Br	78.3	12.4	9.5	10.2	31.7				
12- Near SoqCkRd B	79.8	18.7	14.4	11.2	33.1	65.1	19.7	48.6	9.3
13a- Belo Mill Pond	75.3	57.4	20.9	24.5	24.0	73.4	30.9	109.9	41.7
13b- Belo Hinckley			16.2	22.0	45.9	109.5			
14- Above Hinckley	46.9	46.6	24.7	14.6	37.2	104.6	83.7	76.8	36.7
15- Below Amaya Ck	139.0	76.9	49.6	35.8	35.4	87.1			
16- Above Amaya Ck*	148.6	171.9	271.6	123.8	77.6	113.9	131.1	96.4	122.4
17- Above Fern Gch*	131.9	101.3	159.4	84.7	78.1	112.4	94.4	10.1	147.9
18- Above Ashbury G*	29.4	24.8	33.3						
19- Below Hester Ck	60.6	5.7	30.8	27.0	36.6				
20- Above Hester Ck		30.6	36.3	34.3	26.2	49.2	45.3	84.9	49.4
21- Above GS Falls I						107.2	104.0	93.7	98.7
22- Above GS Falls II						56.2	24.7	53.2	1.0

*** 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 27b. SITE DENSITIES (fish/ 100 ft) of Juvenile Steelhead by YOUNG-OF-THE-YEAR AGE CLASS at Monitoring Sites in SOQUEL CREEK in 2006–2015. (Resident rainbow trout likely present at Sites 18 and 22). Empty boxes indicate no data.

Sample Site	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	2015 E-D	Avg
1- Near Grange		14.6	8.0	6.1	8.1	1.8	3.0	9.6	1.7	5.3	4.8
2- Adj. USGS Gage											4.4
3- Above Bates Ck											13.8
4- Adj. Flower Fd	2.4	22.2	61.4	14.4	4.2	3.9	12.6	19.1	8.5	5.5	16.4
5-Adj. Shack											22.8
6- End of Cherryval											14.4
7- Adj. Orchard											28.2
8- Below Rivervale											17.4
9- Adj. Mt. Schl											31.0
10- Above Allred	11.8	51.9	105.3	17.1	12.3	5.2	34.3	54.0	35.2	60.0	32.8
11- Below Purlin Br											28.4
12- Near SoqCkRd B	–	49.2	61.5	33.5	12.3	4.3	31.4	133.1	41.6	70.4	41.0
13a- Belo Mill Pond	2.5	34.6	55.0	21.4	35.2	8.3	37.8	56.6	18.5	29.5	39.9
13b- Belo Hinckley											48.4
14- Above Hinckley											52.4
15- Below Amaya Ck											70.6
16- Above Amaya Ck*	65.8	37.1	67.3	93.5	63.9	32.8	29.2	36.0	0 dry	0 Dry	88.6
17- Above Fern Gch*											102.2
18- Above Ashbury G*											29.2
19- Below Hester Ck	8.3	24.9	70.4	38.3	12.5	22.6	48.7	55.5	22.7	30.0	33.0
20- Above Hester Ck	21.5										42.0
21- Above GS Falls I	42.7 **	63.2 **		44.9	20.8	11.9			11.9	24.7	56.7
22- Above GS Falls II	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 28a. SITE DENSITIES (fish/ 100 ft) of Juvenile Steelhead by YEARLING AND OLDER AGE CLASS at Monitoring Sites in SOQUEL CREEK in 1997–2005. (Resident rainbow trout likely present at Sites 18 and 22). Empty boxes indicate no data.

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
1- Near Grange	1.2	1.5	1.0	1.9	0.7	0.6	0.9	0.5	1.0
2- Adj. USGS Gage	0.6	1.2	0.4	0.5	1.4		0	0	1.3
3- Above Bates Ck	2.5	2.6	2.0	0.5	0.2	0.5			1.3
4- Adj. Flower Field	2.2	1.5	0.9	2.0	0.7	2.6	0.6	0.7	0.6
5-Adj. Beach Shck	2.8	1.4	2.0	1.6	0.5				
6- End of Cherryvale	3.2	1.7	0.7	1.0	0.5	1.3	0	0.3	3.1
7- Adj. Orchard	2.2	0.5	0.4	0.4	1.1				
8- Below Rivervale	1.0	0.9	0.7	3.1	1.4	1.6			
9- Adj. Mt. School	3.4	1.7	1.3	4.7	1.7	2.6	3.6	2.3	4.5
10- Above Allred	1.3	1.1	1.3	1.1	0.9	1.8	3.0	0.2	2.9
11- Below Purling Br	2.7	0.6	2.2	4.1	0.3				
12- Near SoqCkRd B	3.6	0.5	2.0	1.1	0.9	0.3	0.5	0	1.9
13a- Below Mill Pond	7.1	0	1.1	2.9	2.1	2.6	2.1	0.6	5.3
13b- Below Hinckley			1.1	4.7	1.4	2.0			
14- Above Hinckley	2.6	1.0	1.6	4.8	1.9	2.9	1.4	0.6	2.8
15- Below Amaya Ck	0	2.5	6.7	4.0	2.9	4.3			
16- Above Amaya Ck*	3.6	5.4	11.6	2.8	8.1	8.0	3.5	2.3	4.4
17- Above Fern Gch*	5.7	3.1	11.5	6.9	18.2	17.0	7.8	7.1	9.6
18- Above Ashbury G*	13.8	9.6	19.8						
19- Below Hester Ck	1.2	0.4	1.6	1.2	1.2				
20- Above Hester Ck		0.3	0.3	3.0	2.1	2.9	3.8	2.3	1.0
21- Above GS Falls I						11.9	8.8	5.3	2.1
22- Above GS Falls II						9.3	2.8	4.9	4.5

*** 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 28b. SITE DENSITIES (fish/ 100 ft) of Juvenile Steelhead by YEARLING AND OLDER AGE CLASS at Monitoring Sites in SOQUEL CREEK in 2006–2015. (Resident rainbow trout likely present at Sites 18 and 22). Empty boxes indicate no data.

Sample Site	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	2015 E-D	Avg.
1- Near Grange		1.0	0.7	1.6	1.9	0.9	1.2	0.4	0.7	1.0	1.0
2- Adj. USGS Gage											0.7
3- Above Bates Ck											1.4
4- Adj. Flower Field	0.7	2.2	1.6	1.9	0.7	1.4	1.0	1.2	3.5	0	1.4
5-Adj. Beach Shck											1.7
6- End of Cherryvale											1.3
7- Adj. Orchard											0.9
8- Below Rivervale											1.2
9- Adj. Mt. School											2.9
10- Above Allred	0.4	4.3	0.4	0.7	0.7	0.6	2.5	0.7	2.8	0	1.4
11- Below Purling Br											2.0
12- Near SoqCkRd B		1.5	0.3	3.2	0	1.7	2.3	1.1	2.8	2.9	1.5
13a- Below Mill Pond	0.7	0.7	2.9	1.6	1.9	2.7	2.6	4.0	4.3	3.3	2.6
13b- Below Hinckley											2.3
14- Above Hinckley											2.2
15- Below Amaya Ck											3.4
16- Above Amaya Ck*	3.5	20.0	11.0	13.1	7.5	5.1	13.8	6.2	0 dry	0 dry	6.8
17- Above Fern Gch*											9.7
18- Above Ashbury G*											14.4
19- Below Hester Ck	0.3	1.6	0.4	4.6	0.4	2.4	1.0	2.7	2.4	4.4	1.7
20- Above Hester Ck	0.6										1.8
21- Above GS Falls I	1.2**	5.1**		4.9	5.7	2.1			4.7	0.8	4.8
22- Above GS Falls II	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 29a. SITE DENSITIES (fish/ 100 ft) of Juvenile Steelhead by SIZE CLASS I at Monitoring Sites in SOQUEL CREEK in 1997–2005.
(Resident rainbow trout likely present at Sites 18 and 22). Empty boxes indicate no data.

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
1- Near Grange	1.7	0.2	0	0	0.5	3.5	0.3	0.5	0
2- Adj. USGS Gge	0.9	0.2	0	0	2.2	3.5	1.7	1.9	0
3- Above Bates Ck	1.8	0	0	0.9	4.0	10.4			0
4- Adj. Flower F	20.1	1.5	0	0.5	7.6	20.0	4.4	13.8	0
5-Adj Beach Shk	38.2	0	0.3	1.1	21.6				
6-End of Cherryval	14.3	0	0	0	2.8	42.9	13.7	12.5	0.4
7- Adj. Orchard	71.6	1.0	1.6	0.4	21.5				
8- Below Rivervale	11.7	0.2	1.0	0.2	6.3	49.6			
9- Adj. Mt.Schl	36.7	1.1	0.4	0.5	6.6	79.7	12.7	27.1	2.1
10- Abov Allred	43.2	0	3.3	0	9.4	60.8	13.8	34.7	3.5
11- Belo Purlin Br	60.5	0.9	4.1	2.8	29.1				
12- Near SoqCkRdBr	68.1	3.8	9.2	5.9	28.9	60.1	16.3	44.0	4.5
13a-Belo Mill Pd	60.2	30.4	13.0	16.4	23.1	138.3	29.8	109.9	20.8
13b-Belo Hinckley			3.2	15.8	43.9	105.1			
14-Above Hinckley	27.4	26.9	11.8	3.5	24.3	101.7	78.9	76.1	17.8
15-Below Amaya Ck	130.4	64.1	38.2	30.5	35.4	84.9			
16-Above Amaya *	143.3	165	267.8	114.7	77.6	113.9	131	96.4	118.2
17-Abov Fern Gh*	130.3	90.1	151.7	82.4	78.1	112.4	94.4	110.1	130.9
18-Above Ashbury G*	29.2	20.6	33.2						
19-Belo Hester C	60.1	20.4	23.4	24.5	36.6				
20- Abov Hester C		20.6	33.2	32.4	26.2	49.2	45.3	84.9	47.3
21-Above GS Fall I						107.2	103	91.8	90.0
22-Above GS Fall II						56.2	24.7	50.9	0.3

*** 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 29b. SITE DENSITIES (fish/ 100 ft) of Juvenile Steelhead by SIZE CLASS I at Monitoring Sites in SOQUEL CREEK in 2006–2015.
(Resident rainbow trout likely present at Sites 18 and 22). Empty boxes indicate no data.

Sample Site	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	2015 E-D	Avg.
1- Near Grange		9.2	4.9	2.6	1.6	0	0.2	8.9	1.7	4.2	2.2
2- Adj. USGS Gge											1.2
3- Above Bates Ck											2.4
4- Adj. Flower F	0.4	17.2	58.1	10.5	0.4	0	2.4	18.3	7.8	4.7	9.9
5-Adj Beach Shk											12.2
6-End of Cherryval											9.6
7- Adj. Orchard											19.2
8- Below Rivervale											11.5
9- Adj. Mt.Schl											18.5
10- Abov Allred	5.8	43.0	102.7	11.8	1.0	0	21.2	49.6	35.2	59.5	26.2
11- Belo Purlin Br											19.5
12- Near SoqCkRdBr		45.9	60.4	25.5	4.3	0.4	20.7	131	41.6	70.4	35.6
13a-Belo Mill Pd	0	31.8	53.9	11.6	4.3	0.7	22.5	54.4	18.5	24.5	35.0
13b-Belo Hinckley											42.0
14-Above Hinckley											40.9
15-Below Amaya Ck											63.9
16-Above Amaya *	60.3	37.1	66.0	94.1	63.4	22.5	29.2	36.0	0 dry	0 dry	86.1
17-Abov Fern Gh*											109
18-Above Ashbury G*											27.7
19-Belo Hester C	3.6	21.7	65.0	29.0	1.4	7.4	43.8	54.8	22.7	30.0	29.6
20- Abov Hester C	17.1										39.6
21-Above GS Fall I	30.1 **	61.3 **		43.1	8.7	1.2			11.9	23.6	52.0
22-Above GS Fall II	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 30a. SITE DENSITIES (fish/ 100 ft) of Juvenile Steelhead by SIZE CLASS II/III at Monitoring Sites in SOQUEL CREEK in 1997–2005.

(Resident rainbow trout likely present at Sites 18 and 22). Empty boxes indicate no data.

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
1-Near Grange	1.2	5.4	3.0	2.4	3.0	3.9	2.3	1.2	9.5
2-Adj. USGS G	3.6	9.4	0.8	5.9	5.5		2.4	1.6	4.2
3-Above Bates C	11.4	50.6	7.6	1.3	4.4	4.4			7.9
4-Adj. Flowerily	29.5	19.2	6.8	5.0	15.4	13.3	3.3	6.3	9.2
5-Adj. Beach Shk	18.1	20.6	7.8	8.1	6.4				
6-End of Cherryval	10.4	9.4	2.6	5.3	2.9	4.7	2.2	0.6	15.7
7- Adj. Orchard	25.0	13.0	4.0	1.6	6.0				
8-Below Riverval	9.3	10.5	3.1	4.7	6.1	9.6			
9- Adj. Mt. Schl	24.9	17.3	4.7	7.4	14.1	15.1	13.5	18.7	24.7
10-Above Allred	11.0	11.9	5.8	9.2	6.1	9.9	6.1	2.5	22.7
11-Below Purlin Br	21.4	12.2	6.4	10.3	2.5				
12- Near SoqCkRdBr	15.4	15.7	8.2	6.1	5.5	5.4	3.8	4.5	16.8
13a-below MillPond	19.2	27.2	8.5	6.4	3.1	3.7	3.5	0.6	26.1
13b-below Hinckley			13.8	8.6	3.4	5.5			
14-Above Hinckley	22.2	20.8	11.8	15.0	13.4	5.9	7.1	1.9	21.7
15-Below Amaya Ck	7.5	15.8	17.2	8.5	2.9	6.7			
16-Above Amaya C*	9.9	14.9	15.7	7.9	8.1	8.0	3.5	2.3	9.1
17-Above Fern G*	8.0	14.1	19.2	11.4	18.2	17.1	8.0	7.1	26.4
18-Above AshburyG*	14.9	3.9	19.8						
19- Below Hester C	2.2	1.3	8.7	3.1	1.2				
20- Above Hester C		7.6	3.7	5.3	2.1	2.9	3.8	2.3	2.9
21-Above GS Falls I						11.8	9.8	7.6	12.0
22-Above GS Falls II						9.3	2.8	7.2	5.2

*** 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 30b. SITE DENSITIES (fish/ 100 ft) of Juvenile Steelhead by SIZE CLASS II/III at Monitoring Sites in SOQUEL CREEK in 2006–2015.

(Resident rainbow trout likely present at Sites 18 and 22). Empty boxes indicate no data.

Sample Site	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	2015 E-D	Avg
1-Near Grange		6.6	3.8	5.1	7.9	2.7	4.0	1.8	0.7	2.4	3.7
2-Adj. USGS G											4.1
3-Above Bates C											12.5
4-Adj. FlowerFld	2.8	6.3	4.9	8.1	4.9	5.3	11.1	2.1	4.2	0.9	8.3
5-Adj. Beach Shk											12.2
6-End of Cherryval											6.0
7- Adj. Orchard											9.9
8-Below Riverval											7.2
9- Adj. Mt. Schl											15.6
10-Above Allred	6.3	11.3	3.1	6.2	14.0	5.8	16.0	5.2	2.8	0.5	8.2
11-Below Purlin Br											10.6
12- Near SoqCkRdBr		4.8	1.5	11.9	8.0	5.6	13.1	3.1	2.8	2.9	7.5
13a-below MillPond	3.2	3.1	4.0	11.2	32.8	10.1	18.6	6.8	4.3	9.1	10.6
13b-below Hinckley											7.8
14-Above Hinckley											13.3
15-Below Amaya Ck											9.8
16-Above Amaya C*	9.1	20.0	10.0	13.1	8.0	15.4	13.8	6.2	0 dry	0 dry	9.2
17-Above Fern G*											14.4
18-Above AshburyG*											12.9
19- Below Hester C	4.7	4.8	5.7	14.1	11.6	16.9	6.1	3.4	2.4	4.4	6.0
20- Above Hester C	5.8										4.0
21-Above GS Falls I	14.1 **	7.5 **		6.8	17.5	12.4			4.7	1.6	9.6
22-Above GS Falls II	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 2015 to 2014 and Average Steelhead Densities in Aptos Creek

Results from the two Aptos Creek sampling sites indicated that all size classes and age classes of juvenile steelhead declined in 2015 to the lowest levels in the recent 10 years (**Tables 31−35; Figures 9−12**). The trend in total densities declined to a 11-year low (2.9 juveniles/ 100 ft), without Valencia Creek densities available (**Figure 27**). This was 1/10th the multi-year average. No yearlings were captured at the upper Aptos #4 site. The trend in Size Class II and III juveniles declined to an 11-year low (2.5 juveniles/ 100 ft), without Valencia Creek data (**Figure 28**).The low soon-to-smolt density detected in Aptos Creek in 2015 was due to few YOY present that could grow into soon-to-smolt size (likely few adult spawners), poor growth of YOY fish into Size Class II in a year with low baseflow, and overwinter retention of few yearlings (fewer than average densities of YOY in 2014 to become yearlings). The soon-to-smolt ratings for Aptos #3 and Aptos #4 were “below average” and “poor,” respectively (**Table 42**). The ratings would have been lower except the average size of the few larger fish was greater than 102mm SL at each site.

Table 31. TOTAL DENSITY of Juvenile Steelhead at Monitoring Sites in APTOS, VALENCIA, CORRALITOS, SHINGLE MILL and BROWNS VALLEY Creeks, 1981, 1994 and 2006–2015. Empty boxes indicate no data.

Sample Site	1981	1994	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	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	3.9	26.4
Aptos #4- above steel Bridge Xing Nisene Marks	43.0		38.6	26.8	89.3	8.0	21.7	21.6	65.5	23.5	18.5	1.9	32.6
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	33.9			36.2	69.9	34.2	10.4	16.2	65.4	41.1	10.1	40.1	36.0
Corralitos #3- Above Colinas Dr	39.1	18.6	35.5	42.1	35.9	14.9	6.2	16.2	60.2	44.1	13.3	14.0	28.3
Corralitos #8- Below Eureka Glch	81.9	28.6	49.0	52.9	55.9	51.9	20.1	34.0	27.6	30.7	6.1	11.6	37.5
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	27.4	48.1
Shingle Mill #1- Below 2nd Road Xing	24.5	30.0	33.9	16.2	18.8	6.7	11.9	22.0	25.2	8.9	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	16.1	38.1
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	36.3	51.4

*** 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, 2006–2015. Empty boxes indicate no data.

Sample Site	1981	1994	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	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	1.6	22.0
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	1.9	27.2
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	30.8			27.0	61.2	26.5	9.1	14.8	57.5	30.4	3.9	35.4	29.5
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	10.0	20.8
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	9.4	29.7
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	22.4	36.7
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	11.3	25.8
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	30.9	41.2

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

Table 33. YEARLING AND OLDER Juvenile Steelhead Density at Sites in APTOS, VALENCIA, CORRALITOS, SHINGLE MILL and BROWNS VALLEY Creeks, 1981, 1994 and 2006–2015. Empty boxes indicate no data.

Sample Site	1981	1994	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	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	2.3	4.5
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	0	5.1
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	3.1			9.1	8.7	6.9	1.3	1.3	7.3	10.7	6.1	4.6	6.2
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	4.0	7.5
Corralitos #8- Below Eureka Glch	22.2	14.3	4.0	9.0	9.4	13.2	1.1	3.9	9.4	1.8	3.7	2.2	7.9
Corralitos #9- Above Eureka Glch	30.3	13.2	9.5	7.2	17.1	19.2	2.8	5.1	12.2	10.5	5.6	5.0	11.5
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 #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	4.8	12.0
Browns #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	5.4	10.2

*** 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, 2006–2015. Empty boxes indicate no data.

Sample Site	1981	1994	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	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	0.4	17.3
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	0	23.5
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	30.8			27.0	61.2	20.5	1.7	8.6	56.8	29.0	1.8	35.1	26.9
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	10.0	17.9
Corralitos #8- Below Eureka Glch	59.7	14.3	35.8	43.0	46.6	36.6	14.1	21.7	18.2	28.9	0	9.4	27.4
Corralitos #9- Above Eureka Glch	55.8	16.7	45.5	31.3	44.6	53.5	22.4	24.2	36.5	32.9	0.5	22.4	32.2
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 #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	11.3	23.4
Browns #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	30.9	39.1

*** 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 2006–2015.
Empty boxes indicate no data.

Sample Site	1981	1994	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	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	3.5	9.2
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	1.9	8.7
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	3.1			9.1	8.7	13.7	8.7	7.6	8.7	12.1	8.3	5.0	9.1
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	4.0	10.4
Corralitos #8- Below Eureka Glch	22.2	14.3	13.2	9.9	9.4	15.3	6.0	12.3	9.4	1.8	6.1	2.2	10.2
Corralitos #9- Above Eureka Glch	30.3	13.2	41.6	7.2	17.1	19.7	11.2	14.5	12.7	10.5	8.3	5.0	15.9
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 #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	4.8	14.4
Browns #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	5.4	12.3

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

R-10. Comparison of 2015 to 2014 and Average Steelhead Densities in the Corralitos Sub-Watershed and Pajaro Lagoon

Fall baseflow in Corralitos Creek was slightly less in 2015 than 2014 but not reduced as much as in the San Lorenzo and Soquel watersheds compared to 2014 (**Table 5b**). Measured baseflow in Browns Creek was much lower in October 2015 (0.13 cfs) than measured in October 2014 (0.3 cfs). However, spring and early summer baseflows in 2015 were likely higher than 2014, based on the observations in other Santa Cruz Mountain watersheds, but dropped slightly below 2014 levels by fall (**Figure 42c**). The gage at Freedom indicated flow until late April 2015, with two late stormflows in April, albeit small. In 2014, flow at the Freedom gage stopped in mid-April (**Figure 44**). 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 sediment.

In 2015, YOY densities were not as low as in 2014 but still below average at 5 of 6 sites (except the site downstream of the Corralitos diversion dam) (**Table 32; Figure 14**). This indicated either better adult spawning access or more spawners in 2015 than 2014. The upper Browns Creek site had the highest YOY density (30.9 YOY/ 100 ft) in 2015, as was the case in 2014. Increased YOY juvenile densities at sites from 2014 to 2015 were statistically significant (**Table 47**).

In 2015, total juvenile densities followed the same pattern as YOY densities compared to 2014 and long term average densities (**Table 31; Figure 13**). Total densities were below average at 5 of 6 sites but higher than in 2014 at all of them. The trend in total densities for the 6 Corralitos and Browns creek sites increased from 2014 but was still the third lowest in 12 years of monitoring (**Figure 29**). Increased total juvenile densities from 2014 to 2015 were statistically significant (**Table 47**).

In 2015, yearling densities varied between 2.2 and 5.4 fish/ 100 feet (**Table 33; Figure 15**). Yearling densities were less than in 2014 at 4 of 6 sites with so few YOY present in 2014 (decrease not statistically significant (**Table 47**)). 2015 yearling densities were below average at all 6 sites.

In 2015, Size Class II densities were less than those in 2014 at all 6 sites (decrease statistically significant (**Tables 35 and 47**)). Densities were much below average at all 6 sites (**Table 35; Figure 16**). The trend in soon-to-smolt densities had declined since 2012. The 4-site average in Corralitos Creek by itself was the lowest since 2007 (4.1 fish/ 100 ft) (**Figure 31**). The 6-site average in 2015 for both Corralitos and Browns creeks (4.4 fish/ 100 ft) was the lowest compared to past years of 8-site averages in 12 years of monitoring (**Figure 32**). The highest density of soon-to-smolt fish in 2015 was at Browns 2 above the dam (5.4 fish/ 100 ft). 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 previous years. Only 1% of YOY reached soon-to-smolt size at Site 1 and none reached it at the other 5 sites, compared to much higher percentages in a wetter year like 2011 (**Figure 20a**). Sampling site ratings based on soon-to-smolt densities declined at 1 site in

2015 compared to 2014 (Corralitos Site 1 went from “fair” to “poor”) and improved at one site (Browns Site 2 went from “below average” to “fair”)(**Table 42**). The Corralitos sub-watershed had relatively higher ratings than the other 3 sampled watersheds, with 4 of 6 sites rated as “fair.”

The much below average densities of Size Class II consisting of few yearlings and a preponderance of YOY (at below average densities) that could not reach Size Class II were consistent with lower baseflow, limited spawning success and reduced habitat quality overall. There were mixed indications of habitat improvement in 2015 regarding sedimentation problems caused by the previous fire. In Reach 5/6 below Eureka Gulch on Corralitos Creek, pool depth was reduced from 2012, pool escape cover was less and percent fines in pools had increased (**Table 16a**). However, in Reach 1 below the dam, pool depth and pool escape cover had increased compared to 2013, though embeddedness and percent fines had increased. Pool depths at replicated sites were similar between 2014 and 2015 (**Table 16b**). Pool escape cover was also similar at 4 of 6 sites, except Corralitos 3 pools had less cover and Browns 1 pools had more.

R-11. Comparison of Abundance Indices for Size Class II and III Juveniles in 2015, 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, the total reach indices for 18 reaches (not including the lagoon) were 21,000 (2010), 7,800 (2014) and 7,500 (2015) for Size Class II and III juveniles (**Figures 33a-b**). The 2015 index was 36% 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 from stream habitat in 2014 and 2015 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, especially in the mainstem, upper Zayante, Newell and Bear creeks. In wetter years, the mainstem River contributes much more to the index than in drier years, when YOY densities and growth rate are curtailed. In comparing reach indices between 2015 and 2014, reaches which contributed decidedly more in 2015 included SLR-11, Zayante 13c and Bean 14b (**Figure 33b**). Reaches that contributed decidedly less to the index in 2015 were Zayante 13d (39% of the total 2014 index) and Boulder 17b. All sampled mainstem reaches in 2010 had higher densities of YOY than in 2015 (**Table 18b**), and still a sizeable, higher percentage of YOY reached Size Class II in 2010 (**Figures 17b−c**). In 2015, larger juveniles as fast growing YOY and yearlings were scarce in lower and middle mainstem reaches, and their reach indices were much reduced by 2−6 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 and 2015. 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 16 was likely because of poor spawning success below the dam for 2 winters 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 summers of 2014 and 2015. Newell Creek averages 29 YOY/ 100 ft (**Table 23b**), and a sizeable portion reach Size Class II with the 1 cfs minimum release. In 2015 the YOY density was only 2.1 YOY/ 100 ft (**Figure 2**). Yearlings that contribute to the soon-to-smolt index average 6.2 yearlings/ 100 ft in Newell 16 (**Table 24b**). But yearling density was only 0.7 yearlings/ 100 ft in 2015 (**Figure 3**).

For the Soquel watershed, the total reach index total for 8 reaches (not including the lagoon) was 3,800 (2010), 880 (2014) and 580 (2015) for Size Class II and III juveniles (**Figure 34a-b**). The 2015 index was only 15% 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 2015 from stream habitat was less than 1/5th 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 2015, as in 2014, all 8 reaches contributed less than 201 each. In 2014and 2015, Reach 12a was dry, only ½ mile of the 1.9 mile Reach 9a had surface flow in 2014 and 2015, and Reach 1 experienced intermittency in 2015 and possibly in 2014 due to water diversion. Five of 8 reaches had reduced indices in 2015 compared to 2014 by at least ½ in most cases, with the only improvement being in Soquel 9a below Mill Pond (**Figure 34b**). The negative difference in 2014 and 2015 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 and 2015, only 10 and 15 were captured during 2 sampling days, respectively, and no recaptures were made in either year (**Alley 2015; 2016**). The lagoon population was likely less than 100 in 2014 and 2015.

For the Corralitos sub-watershed in the abundance indices for Size Class II and III juveniles for 6 reaches (excluding Shinglemill Gulch) were 3,000 in 2010, 2,000 in 2014 and 1,000 in 2015 (**Figures 35a and 35b**). The reach index total in 2015 was only one third 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 2015 from stream habitat was only about 1/3 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 2015, these 4 reaches contributed only 250 or less fish. The decline was due to virtually no YOY reaching Size Class II in 2015, and reach indices consisted of yearlings at below average densities (**Figures 15 and 20a**). The total index in 2014 was double that in 2015 partially because yearling densities were generally higher in 2014 (**Table 33**) and some YOY reached Size Class II in 2014 due to their low densities and lack of competition (**Table 32**).

R-12. Sampling Results for the Pajaro River Lagoon in 2015

An expansive lagoon had formed behind the complete barrier beach in summer 2015, another severe drought year. The lagoon extended more than three miles from the beach. No steelhead were captured in Pajaro River Lagoon in fall 2015, as was the case in fall 2012− 2014. A small population of tidewater goby still existed in 2015. However, its future is uncertain due to potential conflicts between maintaining fish habitat and flood control. Tidewater gobies were captured in reduced numbers in 2015.

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 28 September 2015, 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) (8 seine hauls) (**Table 36**). On 29 September 2015, the upper lagoon was sampled for steelhead with the 106-foot seine (3 seine hauls) at the model airport and Thurwachter Bridge (3 seine hauls) (**Table 37**). On 1 October 2015, the main lagoon along the beach (5 seine hauls) and the upper lagoon (3 seine hauls) were sampled for tidewater goby with a 30-foot seine with 1/8-inch mesh (**Table 38**). On 1 October 2015, 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 (**Table 39**). On 29 September 2015 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) (**Table 40**).

Results – Fish Capture

Results of sampling the lower lagoon on 28 September with the large bag seine (106 ft long) yielded only 1 native fish species (smelt) compared to 3 in 2014 and 10 in 2013 (**Table 36**). The presumably early closure of the sandbar in 2015 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 29 September with the large seine yielded more species diversity; 4 tidewater goby, despite the 3/8-inch mesh size, an arrow goby, a staghorn sculpin, more smelt, threespine stickleback and a new species, striped mullet (**Table 37**). Our tidewater goby sampling on 1 October yielded no tidewater gobies in the main, lower lagoon along the beach and low densities 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 mosquitofish and threespine stickleback.

Water Quality

On 1 October during tidewater goby sampling in the lower (mid-channel) and upper lagoon (along margin), the water temperature, salinity and oxygen were not stratified in the lower lagoon regarding water temperature, salinity or oxygen (**Table 39**). Oxygen levels were high in the lower lagoon.

However, although only slight increases in salinity and water temperature occurred at the bottom in the upper lagoon, oxygen concentration was very stratified and rapidly diminishing with depth to complete depletion at the bottom even in late morning and early afternoon. Salinity concentration was low at all sites.

On 29 September during steelhead sampling at the model airport and Thurwachter Bridge in the upper lagoon, neither water temperature nor salinity stratification were at mid-channel from a boat with low salinity conditions (**Table 40**). However, oxygen concentration diminished with depth and was low throughout the water column (< 3.23 mg/l) at 0944 hr adjacent to the model airport.

Table 36. Fish capture* results from sampling lower Pajaro Lagoon *with the 106-foot bag seine (3/8-inch mesh)*, 28 September 2015.

Date	Location	Seine Haul	Tide-water Goby	Arrow goby	Yellow fin goby	Pacific herring	Bay pipe-fish	Shiner Surf-perch	Smelt (jack and top)	Stag-horn Sculpin	Stri-ped Bass	Three-spine stickle-back	Prick ly sculp in	Gam busia
28 Sep 2015	East of Watsonville Slough confluence	1							5					1
	East of #1	2							96					
	East of #2	3							197					
	East of #3	4							604					
	East of #4	5							330					
	East of #5	6							96					
	East of #6	7							28					
	Adj. mouth of Watsonville Slough	8							44					
Total			**0**	**0**	**0**	**0**	**0**	**0**	**1,400**	**0**	**0**	**0**	**0**	**1**

*2 Crabs captured from 2 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)*, 29 September 2015.

Date	Location	Seine Hauls	Tide-water Goby	Arrow Goby	Yellow fin goby	Hitc h	Prickly sculpin	Sac. sucke r	Smelt (jack and top)	Staghorn Sculpin	Three-spine Stickle-back	Striped Mullet
29 Sep 2015	Model Airport	1–3	2	1					181		9	4
	Thurwachter Bridge	4–6	2						23	1	13	21
Total			**4**	**1**	**0**	**0**	**0**	**0**	**204**	**1**	**22**	**25**

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)*, 1 October 2015.

Date	Location	Seine Haul	Tide-water Goby	Arrow goby	Yellow fin goby	Gam-busia	Hitc h	Bay pipe-fish	Shiner Surf-perch	Smelt (jack and top)	Staghorn Sculpin	Three-spine stickle-back
1 Oct 2015	Approx. 200 m east of Pajaro Dunes Complex	1				2						
	East of #1	2										
	East of #2	3										
	East of #3	4										
	East of #4	5				2						
	Airport- 0.3 miles down from Thurwachter Br	6	3									15
	Thurwachter Br.	7	19									21
	Boat Ramp- 0.8 miles upstream of Thurwachter Bridge and 2.9 miles upstream of Watsonville Slough confl.	8	16			93						40
Total			**38**	**0**	**0**	**97**	**0**	**0**	**0**	**0**	**0**	**76**

Table 39. Water quality measurements in the lower Pajaro lagoon (Stations 2 and 4 in mid-channel) and the upper lagoon sites (along margin) during tidewater goby sampling, 1 October 2015.

			1-October 2015					
	Station 2 (lower lagoon)		1033 hr		Station 5 (lower lagoon)			0950 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	19.8	4.8	14.78	7657	18.4	5.1	12.02	7927
0.25	19.6	4.8	14.52	7631	18.4	5.1	11.49	7956
0.50	19.5	4.7	14.34	7586	18.4	5.1	11.60	7953
0.75	19.6	4.7	14.42 (162%)	7586	18.4	5.1	11.45 (126%)	7962
1.00b	19.6	4.7	14.15	7590	18.4	5.1	11.12	7967
	Model Airport – air temp. 19.1 C			1139 hr	Thurwachter Bridge – air temp. 18.0 C			1258 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	22.4	3.1	12.22	5457	21.6	2.6	18.33	4516
0.25	20.4	3.2	5.53	5331	21.3	2.6	11.82	4511
0.50	20.3	3.2	4.06 (44%)	5339	20.0	2.6	1.62 (18%)	4569
0.75	20.4	3.2	1.62	5385	20.8	3.1	0.12	5156
1.00b	21.0	4.2	0.00	7106	21.4	4.3	0.08	7313
1.25								
1.50								

Table 39 (continued). Water quality measurements in the lower lagoon (Stations 2 and 4) and the upper lagoon during tidewater goby sampling, 1 October 2015.

			1-October 2015					
	Boat Launch Ramp (above Thurwachter Br.)		1356 hr	Air Temp 21.8 C				
Depth	Temp 2	Salin 2	O2 2 (%sat.)	Cond 2				
(m)	(C)	(ppt)	(mg/l)	umhos				
0.00	19.8	1.0	4.41	1723				
0.25	18.7	1.0	3.85	1727				
0.50	19.1	1.1	1.04 (12%)	1876				
0.75	20.6	2.3	0.10	3912				
1.00	20.9	2.7	0.00	4573				
1.10b	20.6	2.8	0.00	4764				

Table 40. Water quality measurements in the upper Pajaro lagoon during steelhead sampling, 29 September 2015.

			29 September 2015					
	Model Airport (mid-channel)			0944 hr	**Thurwachter Bridge** (mid-channel)			1258 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	21.3	3.5	3.23	5951	21.4	3.0	9.52	5186
0.25	21.3	3.5	3.01	5937	21.4	3.0	9.64	5148
0.50	21.3	3.5	2.73	5947	21.4	3.1	1.92 (21%)	5244
0.75	21.3	3.5	2.59 (29%)	5976	21.5	3.4	0.05 (0.6%)	5789
0.85b				6017	21.6	3.6	0.04	6135
1.00	21.3	3.5	1.35 (15%)					
1.25b	21.6	3.7	0.04	6376				
1.50								

CONCLUSIONS- Pajaro Lagoon

The upper lagoon showed evidence of low oxygen concentrations in the morning and near the bottom that would likely restrict steelhead distribution there. The low oxygen levels even at the surface on a sunny afternoon near the boat ramp indicated that oxygen levels had been very low at dawn. These low oxygen concentrations indicated that the biological oxygen demand was high and capable of depressing oxygen levels even during the period of high photosynthetic production of oxygen during sunny days. No steelhead were detected in lower Pajaro Lagoon or elsewhere in the lagoon in 2015. This was despite the absence of temperature and oxygen stratification, low salinity and good oxygen concentrations in the lower lagoon along the beach which made the lower lagoon habitable for steelhead, though water temperature was warm. A small population of tidewater goby still existed in Pajaro Lagoon in fall 2015 but appeared absent in the lower lagoon along the beach where algae and submerged vegetation appeared absent. The highest tidewater densities were in the upper lagoon, but they were much reduced from past years. Water quality was adequate for tidewater goby survival during the dry season, though oxygen was very low at times in some locations. However, the presence of striped mullet, a more southern species, indicated their distributional shift northward as the El Nino developed.

After 15 years of water quality monitoring and fish sampling of Santa Rosa Creek Lagoon near Cambria and 25 years at Soquel Creek Lagoon in Capitola, the following were recommendations to insure steelhead habitation. These recommendations would be difficult to attain at Pajaro Lagoon because of the absence of or extremely limited stream inflow.

- *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 5 milligrams/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 following recommendations are suggested under the current hydrologic realities. The sandbar should be allowed to continue to close naturally as flows decline in the summer, as it has in the past. Artificial breaching should continue to be prohibited in summer, as it has been in the past. Spatial heterogeneity should be protected in the Pajaro Lagoon/estuary so that slackwater areas with overhanging riparian vegetation continue to be allowed. Slackwater pockets among overhanging vegetation provide rearing and perhaps breeding habitat for tidewater goby during the dry season. Tule beds are valuable rearing habitat and provide winter refuge. Natural training of the 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 beachfront 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 on an incoming tide as high tide approaches will encourage this. It may be infeasible to cut the notch in the sandbar with heavy equipment on the beach near high tide. The notch may be cut ahead of time, as is done at Soquel Lagoon prior to emergency breaching. A berm may be left at the upstream end of the notch at the lagoon margin, which may be breached with hand shovels at the appropriate time if access with a loader is infeasible. The elevating of Beach Street, road access 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 to alleviate flooding of essential infrastructure. If levees bordering the lagoon are reconstructed, tidewater gobies should be relocated from lagoon margins along affected reaches prior to disturbance, and any wetted work area should be isolated from fish.

Status of the Tidewater Gobies in Pajaro Lagoon

A small population of tidewater goby still existed in Pajaro Lagoon in 2015, with lower densities than in previous years.

R-13. Rating of Rearing Habitat in 2015, 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 2015.

For 2014 and 2015, soon-t-smolt-sized juvenile ratings for sampling sites were tabulated and summarized (**Tables 42 and 43**). Ratings for 5 sites in the San Lorenzo drainage improved; San Lorenzo 1(poor to below average- more YOY), San Lorenzo 11 (poor to below average- yearling retention) and Zayante 13c (very poor to good- many fast growing YOY at a sunny site), Bean 14b (poor to good- retention of large yearlings) and Branciforte 21b (below average to fair- a few, large YOY and a few yearlings). Five San Lorenzo watershed sites (20%) had decreased ratings in 2015, despite already depressed ratings in 2014. In the San Lorenzo drainage, 19 of 25 sampled sites (76%) were rated between very poor (9), poor (4) and below average (6). And Bean 14c was dry. Only 4 sites were rated fair; Zayante 13d, Zayante 13i, Branciforte 21b and Branciforte 21c (resident rainbow) Only two steelhead sites, Zayante 13c and Bean 14b were rated good due to high YOY density and some growth into Size Class II at the former and increased retention of yearlings after a mild winter at both sites.

In the Soquel drainage in 2015, only 1 site was rated fair or better (Site 13a on the East Branch rated fair) (**Table 42**). The ratings less than fair went from very poor (4) to poor (1) to below average (1). And Site 16 in the SDSF went dry. In the Aptos drainage in 2015, lower Aptos #3 had the highest rating of below average due to the near absence of yearlings and slow growing YOY. Aptos #4 was rated poor, with its absence of yearlings and few YOY that were able to grow into Size Class II due to the lack of competition.

The Corralitos sub-watershed had the best overall ratings of the 4 watersheds sampled (**Table 42**). Four of the 6 sampled sites were rated fair due to retention of a few, large yearlings and older steelhead; Corralitos #3 and #9 and Browns #1 and #2. These same sites were rated fair in 2014 except Brown #2 improved. Corralitos #1 worsened in 2015 to a rating of poor due to the lack of retention of large yearlings. Corralitos #8 was again rated below average with very few yearlings present.

Table 41. Rating of Steelhead Rearing Habitat For Small, Central Coastal Streams.*
(From Smith 1982.)

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

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

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

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

Table 42. 2015 Sampling Sites Rated by Potential Smolt-Sized Juvenile Steelhead Density (=>75 mm SL) and Average Size in Standard Length Compared to 2014, with Physical Habitat Change Since 2014 Conditions.

Site	2014 Potential Smolt Density (per 100 ft)/ Avg Pot. Smolt Size SL	2014 Smolt Rating (With Size Factored In)	2015 Potential Smolt Density (per 100 ft)/ Avg Pot. Smolt Size SL	2015 Smolt Rating (With Size Factored In)	Physical Habitat Change by Reach/Site Since 2014
Low. San Lorenzo #0a	6.2/ 108 mm	Fair	4.8/ 83 mm	Poor	+
Low. San Lorenzo #1	1.8/ 125 mm	Poor	4.4/ 95 mm	Below Average	+
Low. San Lorenzo #2	2.4/ 98 mm	Poor	3.5/ 90 mm	Poor	+
Low. San Lorenzo #4	4.4/ 89 mm	Below Average	2.6/ 80 mm	Very Poor	–
Mid. San Lorenzo #6	1.4/ 80 mm	Very Poor	0.5/ 75 mm	Very Poor	+
Mid. San Lorenzo #8	1.4/ 92 mm	Very Poor	0/ 0 mm	Very Poor	+
Mid. San Lorenzo #9	0.6/ 92 mm	Very Poor	1.3/ 83 mm	Very Poor	+
Up. San Lorenzo #10	None	Very Poor	1.4/ 82 mm	Very Poor	+
Up. San Lorenzo #11	1.6/ 112 mm	Poor	5.8/ 98 mm	Below Average	+
Up.San Loren #12a (res. rt)		Not Sampled	6.8/ 97 mm	Below Average	NA
Zayante #13a	2.4/ 89 mm	Poor	2.1/ 86 mm	Very Poor	+ (Cover)
Zayante #13c	3.7/ 81 mm	Very Poor	44.7/ 87 mm	*Good*	+ (Cover)
Zayante #13d	22.1/ 93 mm	*Good*	8.3/ 97 mm	Fair	+ (Cover)
Lompico #13e	6.7/ 94 mm	Below Average	6.8/ 93 mm	Below Average	NA
Zayante #13i	Not Sampled	Not Sampled	7.4/ 112 mm	Fair	NA
Bean #14a	Not Sampled	Not Sampled	1.4/ 90 mm	Very Poor	NA
Bean #14b	2.8/ 101 mm	Poor	11.5/ 104 mm	*Good*	+
Bean #14c	Dry	Dry	Dry	Dry	Dry
Fall #15a	2.7/ 103 mm	Below Average	6.0/ 99 mm	Below Average	+
Fall #15b	7.3/ 103 mm	Fair	6.7/ 95 mm	Below Average	+
Newell #16	3.1/ 109 mm	Below Average	2.0/ 86 mm	Very Poor	–
Boulder #17a	3.8/ 91 mm	Poor	1.0/ 106 mm	Poor	+
Boulder #17b	13.0/ 90 mm	Fair	5.7/ 88 mm	Poor	–
Bear #18a	0.7/ 116 mm	Poor	1.0/ 76 mm	Very Poor	+
Branciforte #21b	7.3/ 98 mm	Below Average	6.8/ 103 mm	Fair	–
Branciforte #21c (res. Rt)	13.3/103 mm	*Good*	6.2/ 115 mm	Fair	–
Soquel #1	0.7/ 102 mm	Very Poor	2.4/ 101 mm	Poor	–
Soquel #4	4.2/ 98 mm	Below Average	0.9/ 79 mm	Very Poor	–
Soquel #10	2.8/ 89 mm	Poor	0.5/ 76 mm	Very Poor	+
Soquel #12	2.8/ 95 mm	Poor	2.9/ 82 mm	Very Poor	–
East Branch Soquel #13a	4.3/ 100 mm	Below Average	9.1/ 91 mm	Fair	–
East Branch Soquel #16	Dry	Dry	Dry	Dry	Dry
West Branch Soquel #19	2.4/ 92 mm	Poor	4.4/ 101 mm	Below Average	–
West Branch Soquel #21	4.7/ 87 mm	Poor	1.6/ 92 mm	Very Poor	–
Aptos #3	4.7/ 117 mm	Fair	3.5/ 112 mm	Below Average	+
Aptos #4	4.7/ 95 mm	Below Average	1.9/ 109 mm	Poor	–
Corralitos #1	8.3/ 97 mm	Fair	5.0/ 85 mm	Poor	–
Corralitos #3	12.1/ 95 mm	Fair	4.0/ 126 mm	Fair	+
Corralitos #8	6.1/ 97 mm	Below Average	2.2/ 105 mm	Below Average	–
Corralitos #9	8.3/ 94 mm	Fair	5.0/ 108 mm	Fair	+
Shingle Mill #1	4.2/ 97 mm	Below Average	Not Sampled	Not Sampled	NA
Shingle Mill #3	5.2/ 84 mm	Below Average	Not Sampled	Not Sampled	NA
Browns #1	6.6/ 106 mm	Fair	4.8/ 126 mm	Fair	+
Browns #2	7.2/ 92 mm	Below Average	5.4/ 106 mm	Fair	+

Table 43. Summary of Sampling Site Ratings in 2006–2015, 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
2015 (n=40)	13 (+ 2 dry)	7	9	9	2	0

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

The trend in fish densities between 2014 and 2015 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 2014 and 2015 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 2015 were compared to 2014, such that a positive difference indicated that the densities in 2015 were larger than in 2014 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 2014 and 2015 densities. The 95% confidence limits are standard and a p-value of < 0.05 was considered significant.

With 20 comparable sites in the San Lorenzo mainstem and tributaries, the mean difference in densities of none of the size classes or age classes were significant (**Table 44**). However, when comparing the 9 mainstem sites separately, the positive mean differences (increased site densities) for YOY and all juveniles combined were statistically significant (**Table 45**). In the mainstem San Lorenzo, Site 12a was excluded from the analysis because it was judged to be at least partially inhabited by resident rainbow trout. In the tributaries, Branciforte Site 21c was excluded as having resident rainbow trout. Branciforte 21a-2 was not sampled in 2015, and Zayante 13i and Bean 14a were newly added and incomparable. With 6 comparable sites in the Soquel watershed, the increase in YOY site densities was statistically significant (**Table 46**). With only 2 comparable sites in Aptos watershed, no statistical tests were made. With 5 comparable sites in the Corralitos sub-watershed, statistical significance was found in the decrease in Size Class II and III densities, and increases in YOY and total densities (**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 (2015 to 2014; n=20).

Statistic	s.c. 2	a.c. 1-YOY	a.c. 2	All Sizes
Mean difference	1.14	5.66	-1.65	3.71
Df	19	19	19	19
Std Error	2.27	5.41	1.04	6.17
t Stat	-3.61	1.05	-1.59	0.60
P-value (2-tail)	0.621	0.309	0.129	0.556
95% CL (lower)	-3.61	-5.67	-3.83	-9.22
95% CL (upper)	5.89	16.98	0.53	16.63

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 (2015 to 2014; n=9).

Statistic	s.c. 2	a.c. 1-YOY	a.c. 2	All Sizes
Mean difference	0.50	8.36	0.40	8.63
Df	8	8	8	8
Std Error	0.69	1.11	0.53	1.53
t Stat	0.73	7.51	0.75	5.65
P-value (2-tail)	0.486	0.0001	0.473	0.0005
95% CL (lower)	-1.08	5.79	-0.83	5.11
95% CL (upper)	2.08	10.92	1.63	12.16

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 (2015 to 2014; n=6).

Statistic	s.c. 2	a.c. 1-YOY	a.c. 2	All Sizes
Mean difference	-0.35	13.00	-1.80	11.33
Df	5	5	5	5
Std Error	1.30	4.96	0.75	5.18
t Stat	-0.27	2.62	-2.39	2.19
P-value (2-tail)	0.799	0.047	0.062	0.081
95% CL (lower)	-3.70	0.26	-3.73	-1.99
95% CL (upper)	3.00	25.74	0.13	24.66

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 (2015 to 2014; n=5).

Statistic	s.c. 2	a.c. 1-YOY	a.c. 2	All Sizes
Mean difference	-3.66	15.00	-0.72	15.02
Df	4	4	4	4
Std Error	1.16	5.40	0.534	4.91
t Stat	-3.16	2.89	-1.35	3.06
P-value (2-tail)	0.034	0.045	0.249	0.038
95% CL (lower)	-6.88	0.60	-2.20	1.37
95% CL (upper)	-0.44	30.60	0.76	28.67

R-14. Adult Trapping Results at the Felton Dam's Fish Ladder and 2015 Planting Records

2015 PLANTING LOG

San Lorenzo River Steelhead

Date	Site Origin	BY	Inven-tory	Weight (lbs)	Size fish/ lb	Length (In.)	Length (mm)	Mark	Release Location
3/10/2015	Big Creek Hatchery	2014	3,540	625.4	5.66	7.89	200.35	AD-100	San Lorenzo River Highland Park
3/12/2015	Big Creek Hatchery	2014	3,540	625.4	5.66	7.89	200.35	AD-100	San Lorenzo River Lomond St Bridge
3/16/2015	Big Creek Hatchery	2014	3,730	659.0	5.66	7.89	200.35	AD-100	San Lorenzo River Highland Park
3/18/2015	Big Creek Hatchery	2014	5,197	785.0	6.62	7.49	190.16	AD-100	San Lorenzo River Henry Cowell Park
3/23/2015	Big Creek Hatchery	2014	1,125	169.9	6.62	7.49	190.16	AD-100	San Lorenzo River Paradise Park
3/25/2015	Powder Mill Tank	2014	4,401	607.0	7.25	7.26	184.48	AD-100	San Lorenzo River Powder Mill Cr/ SLR confluence
Totals/Avg.			21,533	3,471.9	6.20				

Table 48. 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
2014-15	No trapping.		

(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 Densities of YOY 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 or insufficient passage flows to provide spawning access.

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. Seven of the last 9 years have been on the dry side, including 2012−2015, 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 a slight increase in adult returns in winter 2014-2015, where adult steelhead escapement estimates in water years 2006─2015 were 219, 259, 293, 126, 109, 214, 140, 167, 50 and 86 , respectively (**Joseph Kiernan, NOAA Fisheries personal communication**). The adult coho escapement for water year 2015 was 163, resulting from 31,000 coho salmon hatchery smolts released in 2013. The total 2014-15 adult steelhead count on the Carmel River at San Clemente Dam was 7, including two in December, zero in January, three in February, two in March, and zero in April. Excluding the 2013-2014 winter, when the river did not reach the ocean, this was the lowest adult count since 1991. Adult estimates at San Clemente Dam in 2006−15 were 368, 222, 412, 95, 157, 452, 470, 249, 0 and 7, respectively (**Chaney, 2015**). San Clemente Dam has now been dismantled. So, adult steelhead estimates will no longer be available from the old fish counter on the dam's fish ladder. A DIDSON camera was installed in the Carmel River in the lower valley on January 12, 2016 to count the latest winter steelhead run. Data are currently being reviewed and preliminary results will be reported once available. No adult fish have been observed at the Los Padres Dam fish ladder through February 2016 despite adequate passage stormflows, indicating that the engineered channel through the former San Clemente Dam and reservoir footprint may be impassable to adult steelhead.

A second factor contributing to low YOY densities in the San Lorenzo, upper Soquel and Corralitos watersheds was likely that adult steelhead spawning access was restricted to narrow windows of time in 2015. This was indicated by sporadic distribution of YOY in the San Lorenzo system in Fall 2015 (**Figure 2**). During the 2014-2015 wet season, most storms occurred in December prior to the main steelhead spawning season. Early stormflows benefitted coho adult migration, which begins earlier than steelhead migration. Only 2 short migration windows occurred after December, which were provided by a modest 5-10 day storm period in early February and a small storm in early April (**Figure 36a**). There were near average to above average YOY densities at sites in the larger tributaries, Zayante and Bean creeks (except upper Bean 14c went dry with high YOY density present beforehand (**K. Kittleson, pers. comm.**)), and YOY densities increased in 2015 over 2014 at mainstem sites. However, few adult steelhead apparently reached upper mainstem Site 12a, upper Fall Site 15b, Newell 16 and middle Branciforte 21b, judging by the very low YOY densities there. This may have been a result of poor access and/or few adults returning.

In the Soquel drainage, adult access was apparently adequate to the mainstem and lower Branch sites, and YOY densities were near or above average at most mainstem and lower Branch sites (**Figure 6**). However, upper West Branch Site 21 (above Girl Scout Falls I) had low YOY densities, and upper East Branch Site 16 went dry.

In the Aptos system, the continued below average YOY density in 2015 at the 2 Aptos Creek sites (**Figure 10**) is attributable to low spawning effort by a potentially small adult steelhead population. YOY densities were very low both Aptos sites in 2015. Aptos lagoon was not sampled in 2015 because CDFW staff planned to sample it. However, this did not occur.

Sporadic spawning of an apparently small adult population with limited access was also observed in the Corralitos sub-watershed again in 2015 as in 2014, where below average YOY densities were found at 5 of 6 sites (**Figure 14**). Adults successfully accessed the Corralitos Creek fish ladder because YOY were present above, albeit at below average densities. The highest YOY density occurred below the fish ladder.

Several partial passage impediments likely became factors in either preventing or slowing adult steelhead passage in the San Lorenzo drainage. 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 when logs collect at it.

The salmonid population at the lower Waterman Gap Site 12a appeared to consist of some 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 2014-2015 with such limited stormflows after December (**Figure 36a and 38b**). The very low YOY density of 2.7 YOY/ 100 ft at Branciforte 21b during fall sampling indicated that very few steelhead successfully accessed Branciforte Creek and spawned above the flood control channel and the remnant Santa Cruz city diversion dam in 2015. However, the Branciforte 21a-2 site between the flood control channel and the remnant dam abutment was not sampled to tease out access problems between the two impediments. Fish captured at the upper Site 21c were likely resident rainbow trout, based on the low YOY fish density and a population dominated by larger fish in 2013–2015. 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 on Branciforte Creek included 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 increased YOY density at the Bear Creek site in 2015 indicated that the flashboard dam abutment on lower Bear Creek near Lanktree Bridge was passable. Adult spawning redds were also observed in upper Bear Creek during the 2014-2015 winter (**J. Jankovitz, CDFW fish biologist, pers. comm.**).

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 again in 2015 as in 2014, as indicated by low YOY densities measured below Girl Scout Falls II. We suspect that Girl Scout Falls II has been a complete barrier to adult passage in most years, though no sampling has occurred above that falls since 2006.

Adult steelhead passage from the Bay to the monitored reaches of Corralitos and Browns creeks may have been restricted to December (3 storms between 70 and 350 cfs at Freedom) and a 5-10 day period in early February when stormflow reached as much as 500 cfs at Freedom. (**Figures 42a-b**). YOY densities were higher in 2015 than 2014 (statistically significant), indicating better access in 2015 but not good access. YOY densities were below average at 5 of 6 sites in 2015(**Figure 14**). However, YOY densities increased at the uppermost sites in each tributary, indicating that adults were able to negotiate both dams, the baffled box culvert at the beginning of Reach 5 on Corralitos and bedrock cascade in Reach 7 on Corralitos.

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 20–30 cfs range at Big Trees gage on the San Lorenzo and in the 6−15 cfs range at the Soquel Village gage on Soquel Creek for much of the March−April incubation period (**Figures 36b; 39b**). 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 2015, 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 second lowest in the past 19 years since 1997 (**Figure 45**). The preponderance of small YOY (except where their density was very low) (**Tables 18b, 23b and 27b**) and small, Size Class II yearlings throughout these two watersheds (**Table 42**) indicated slow growth rate in 2015. 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. Habitat in Reaches 5 and 6 had worsened in 2015 since 2012 with regard to shallower pools and less pool cover (**Table 16a**), with still highly sedimented conditions and poor rearing habitat. This contributed to poor YOY survival, along with very low baseflows upstream of Rider Creek confluence.

Higher than pre-drought water temperatures increased food requirements for steelhead in 2015. Metabolic rate was elevated when less food was available in drift at slower velocities than if baseflow was higher. In 2015, baseflow started out in spring higher than in 2014 but fell to near or below 2014 levels by the end of the dry period. Air temperature during the dry period of 2015 showed spiked periods of higher temperature than in 2014. 2015 water 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 and warmer at most mainstem sites in August 2015 compared to August 2014. With relatively low baseflows, habitat typing data in fall 2015 indicated a reduced proportion of riffle habitat per stream length and reduced surface area in riffles for insect production due to narrow 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

<u>San Lorenzo Watershed</u>

The below average densities of larger juveniles at all sites in the lower and middle mainstem downstream of Kings Creek (**Figure 4**) resulted partially from retention of few yearlings being recruited from a small YOY age class in 2014, as had been the case the previous 2014 drought year, and despite a mild winter that would have improved overwinter survival. No yearlings were captured at Mainstem Sites 0a, 4, 5 or 8, and densities at Sites 1, 2 and 9 were less than 1 fish per 100 ft. 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 lower mainstem sites (below Zayante Creek) in fall were primarily due to below average YOY densities and few YOY reaching Size Class II (**Figure 17a**). Slow growth of YOY resulted from relatively low baseflows, the second lowest average for May−September in 19 years of monitoring (**Figure 45**). For the middle and upper mainstem below Kings Creek, there were below average Size Class II fish because there were below average densities of juvenile steelhead present, no YOY reaching Size Class II and very low densities of yearlings.

Low densities of Size Class II steelhead at many tributary sites (**Figure 4**), as was the case in 2014, resulted from poor rearing habitat created by low-flow drought conditions, low retention of yearlings at some sites 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 (Mainstem Site 11, Bean 14b, and Fall 15a) resulted from moderate YOY densities in 2014 to recruit yearlings, retention of some yearlings and, in the cased of Bean 14b, a portion of YOY reaching Size Class II (13%) in the early summer when baseflows were higher (**Table 42; Figure 17a**). The yearlings present at Fall 15a may have filtered down from upstream of the fish ladder where YOY densities were relatively high the previous year in 2014. The very much above average Size Class II density at Zayante 13c resulted primarily from good escape cover, high YOY densities and good growth of a high proportion of them into Size Class II at this sunny site. The 2015 Size Class II density in Lompico Creek likely resulted from very low steelhead densities, allowing the few YOY to just reach Size Class II.

Soquel Watershed

The below average densities of Size Class II and III juveniles at all sites in the Soquel drainage again in 2015 as in 2013 and 2014 (**Table 30b; 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, and 2) no YOY grew into Size Class II at upper mainstem sites 10 and 12 or lower East Branch Site 19 due to reduced food from low baseflow and relatively high YOY density and competition (**Figure 18a**), unlike wetter years like 2010 and 2012 (**Figure 18a-b**). The averaged mean monthly streamflow for May−September in Soquel Creek was the second lowest in the past 19 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 2015 resulted from very low juvenile steelhead densities, YOY and yearlings (**Figures 10 and 11**). Yearlings were undetected at Aptos #4. Habitat was available but fish were absent.

Corralitos Sub-Watershed

The below average densities of larger juveniles at 6 of 6 sites (**Figure 16**) resulted from low densities of YOY (**Figure 14**), almost no YOY reaching Size Class II (**Figure 20a**), and low densities of yearlings and older steelhead after very low YOY densities in 2014 (**Figure 15**).

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

As in the watersheds we sampled in 2015, YOY densities were well below average at all sampling sites in Scott Creek (**Figure 49; from Smith 2015**), and the average YOY density for all sites combined was the lowest since monitoring began in 1988 (**Figure 52; from Smith 2015**). YOY densities were below average at 7 of 8 Gazos sites, but all were near average (**Figure 48; from Smith 2015**). The average YOY density for all sites combined in Gazos Creek in 2015 increased to 2012 levels but was still considerably less than during the 1998–2004 period (**Figure 52; from Smith 2015**). The average YOY density for all sites combined in Waddell Creek increased slightly in 2015 from its lowest point in 2014 (**Figure 52; from Smith 2015**). 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**).

In 2015, yearling juvenile densities were near average or above average at 6 of 8 sites in Gazos Creek and 7 of 11 sites in Scott Creek (**Figures 50 and 51;** data from **Smith 2015**). Near or above average survival of yearlings after a mild winter was in contrast to poor survival/retention of yearlings in the 4 watersheds we sampled, except for 3 of the 7 sites in the Soquel drainage (**Figures 3, 7, 11 and 15**). However, yearling densities in Soquel Creek were generally less than in Gazos or Scott creeks. 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. Until a slight upswing in yearling densities in 2015 tributary sites, there had been an overall downward trend in San Lorenzo mainstem sites and tributary sites, averaged separately during the 2011-2014 period (**Figures 22, 24**). In contrast, an upswing occurred in Scott in 2011-2014 and in Waddell in 2011- 2015 (**Figure 53**). Soon-to-smolt densities have fluctuated at the Soquel stream sites, with them at a low point in 2015 (**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 and 2015, reach indices for soon-to-smolt juvenile densities were calculated in the San Lorenzo, Soquel and Corralitos watersheds in 2015, 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 dry years (2014 and 2015). 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 continue 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. Return to previously inventoried reaches for comparison after large stormflows would be informative as to the rate of wood recruitment.

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

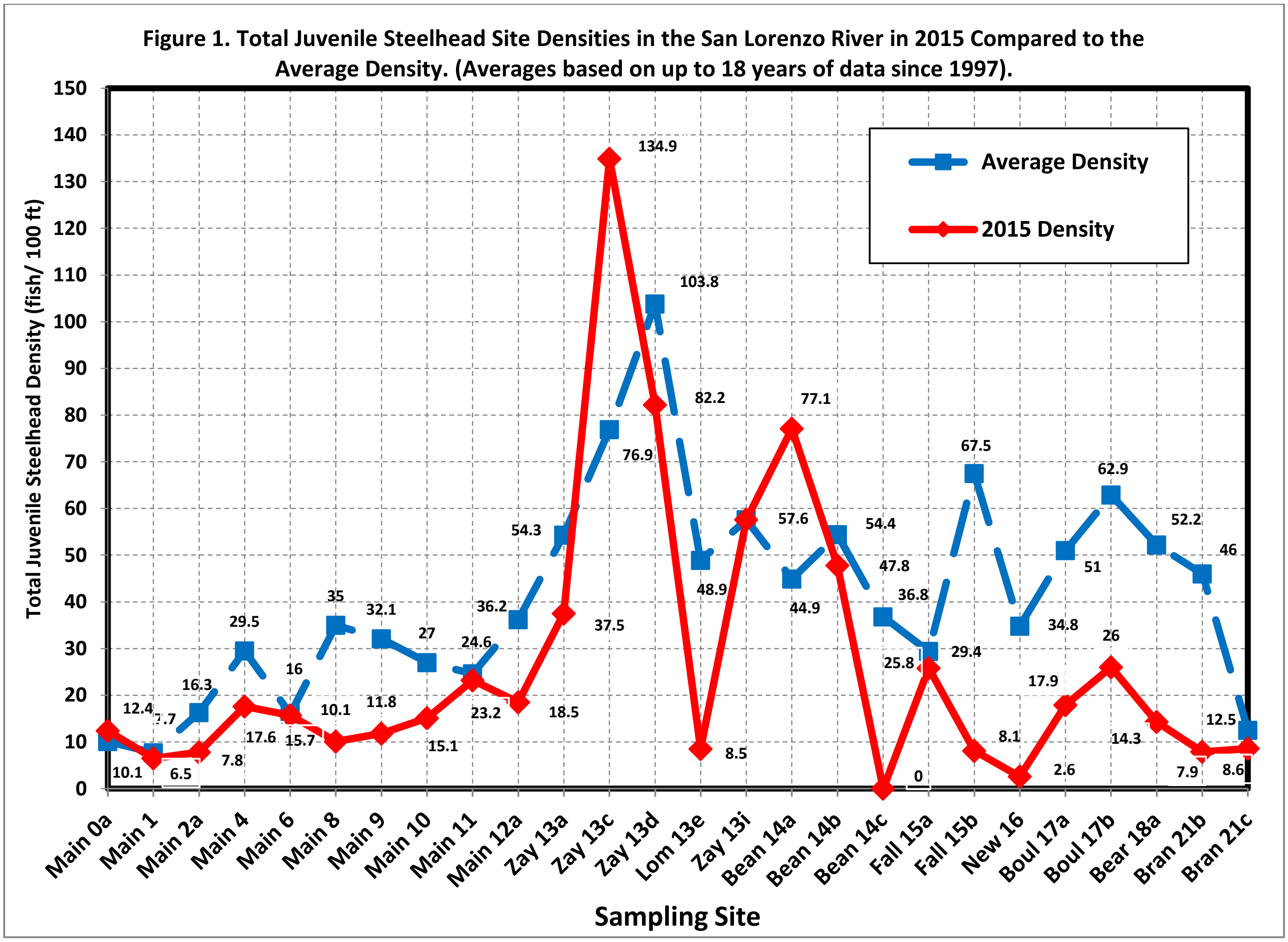


Figure 1. Total Juvenile Steelhead Site Densities in the San Lorenzo River in 2015 Compared to the Average Density. (Averages based on up to 18 years of data since 1997).

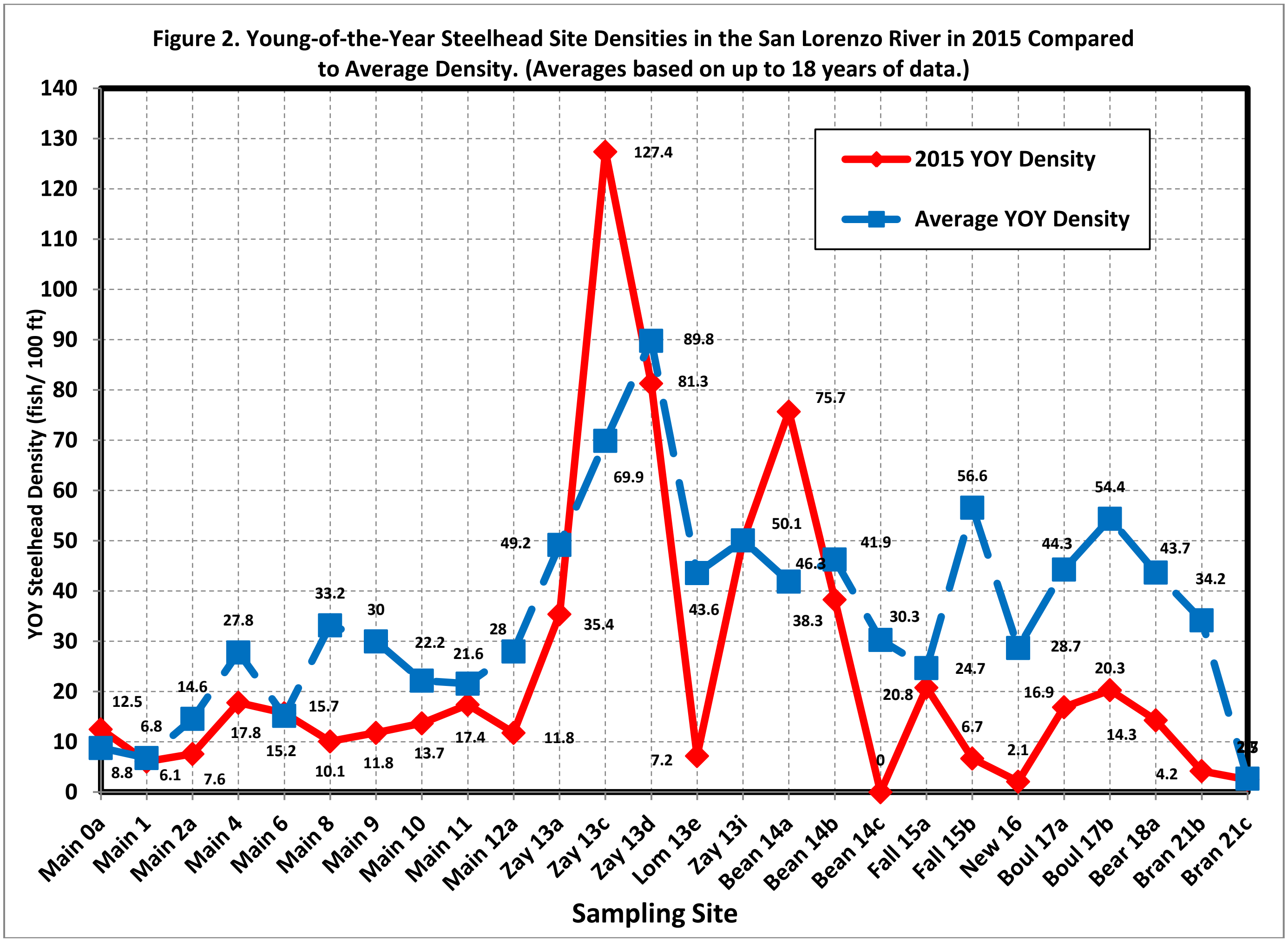


Figure 2a. Young-of-the-Year Steelhead Site Densities in the San Lorenzo River in 2015 Compared to Average Density. (Averages based on up to 18 years of data.)

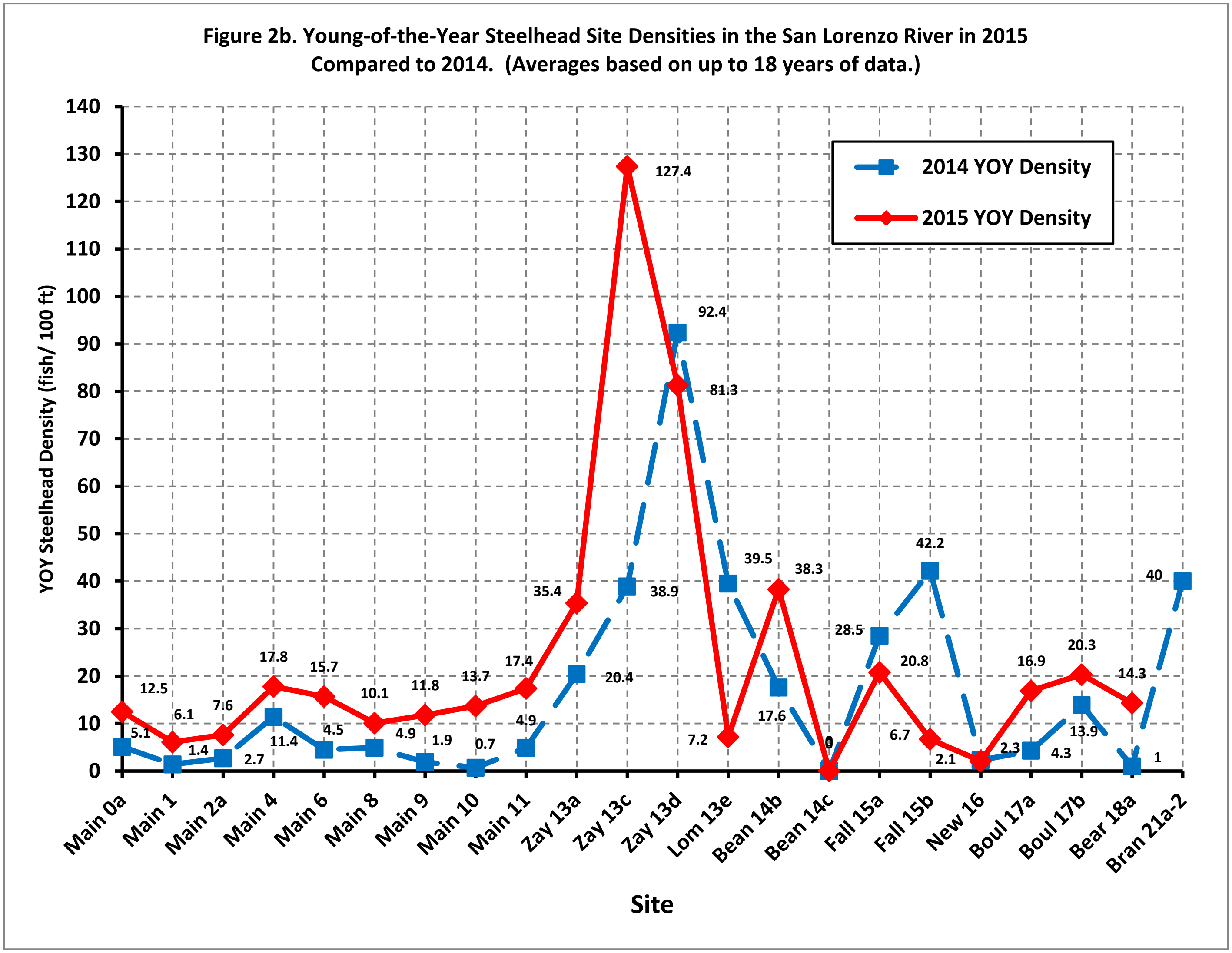


Figure 2b. Young-of-the-Year Steelhead Site Densities in the San Lorenzo River in 2015 Compared 2014. (Averages based on up to 18 years of data.)

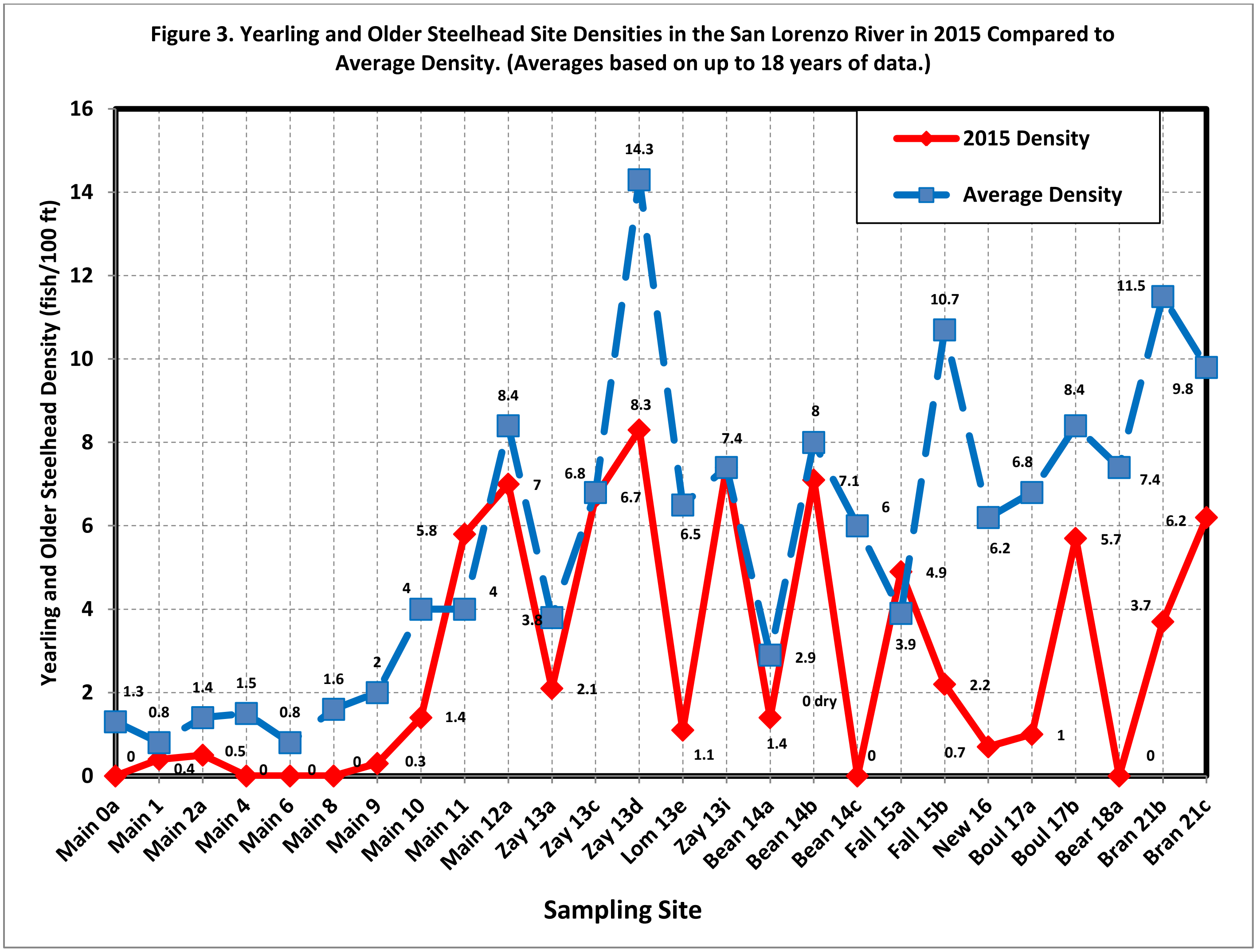


Figure 3. Yearling and Older Steelhead Site Densities in the San Lorenzo River in 2015 Compared to Average Density. (Averages based on up to 18 years of data.)

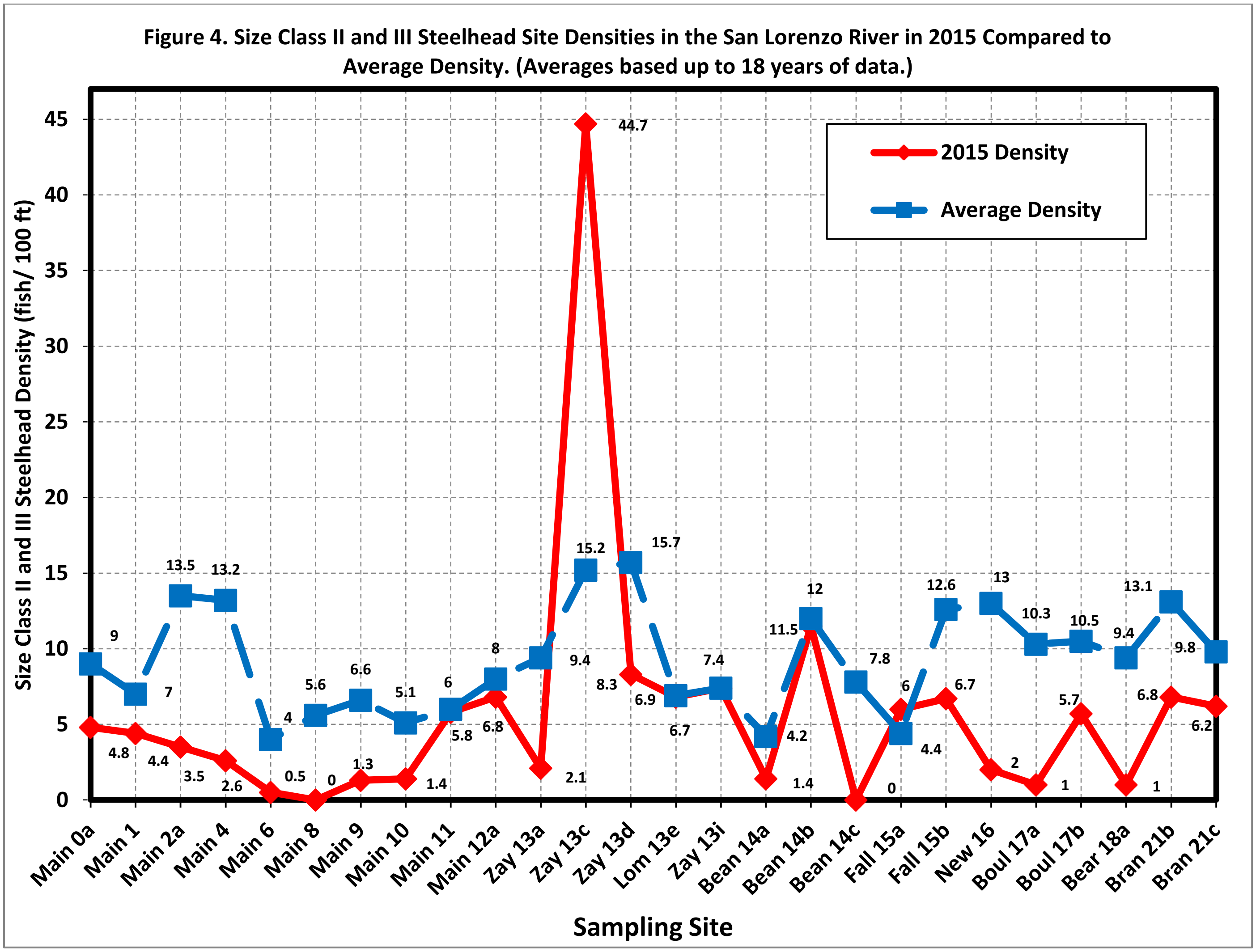


Figure 4. Size Class II and III Steelhead Site Densities in the San Lorenzo River in 2015 Compared to Average Density. (Averages based on up to 18 years of data.)

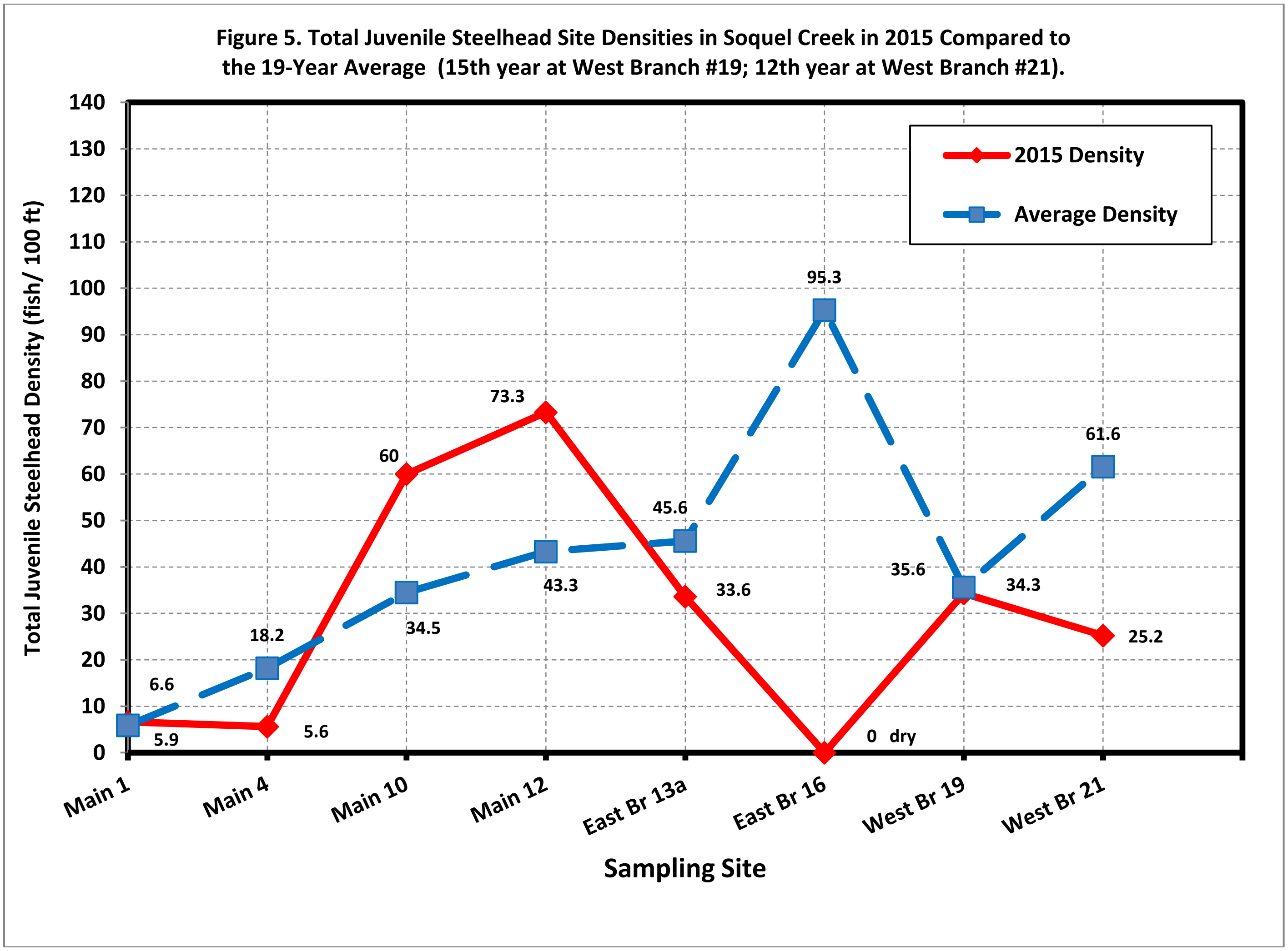


Figure 5. Total Juvenile Steelhead Site Densities in Soquel Creek in 2015 Compared to the 19-Year Average (15th year at West Branch #19).

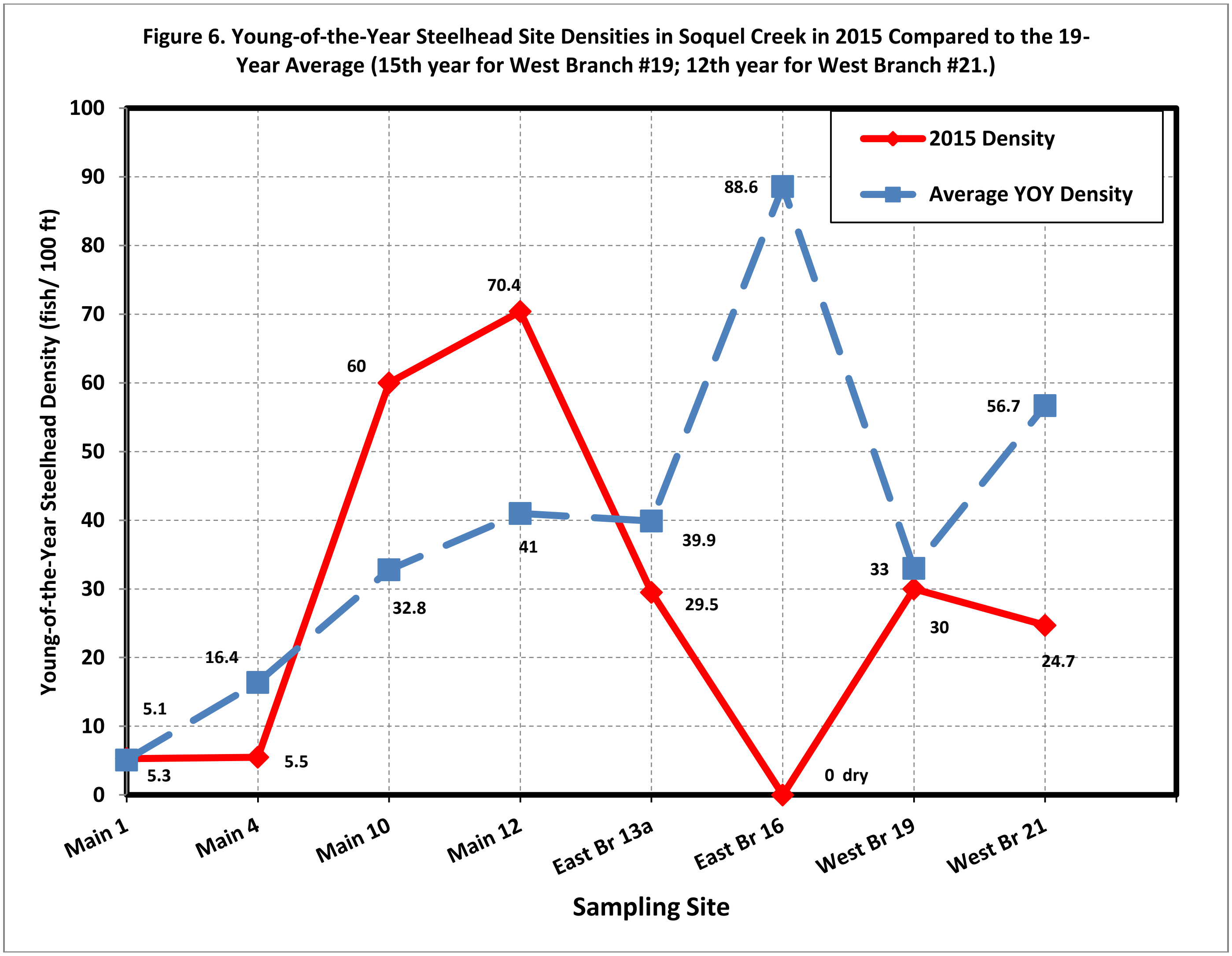


Figure 6. Young-of-the-Year Steelhead Site Densities in Soquel Creek in 2015 Compared to the 18-Year Average (15th year for West Branch #19.)

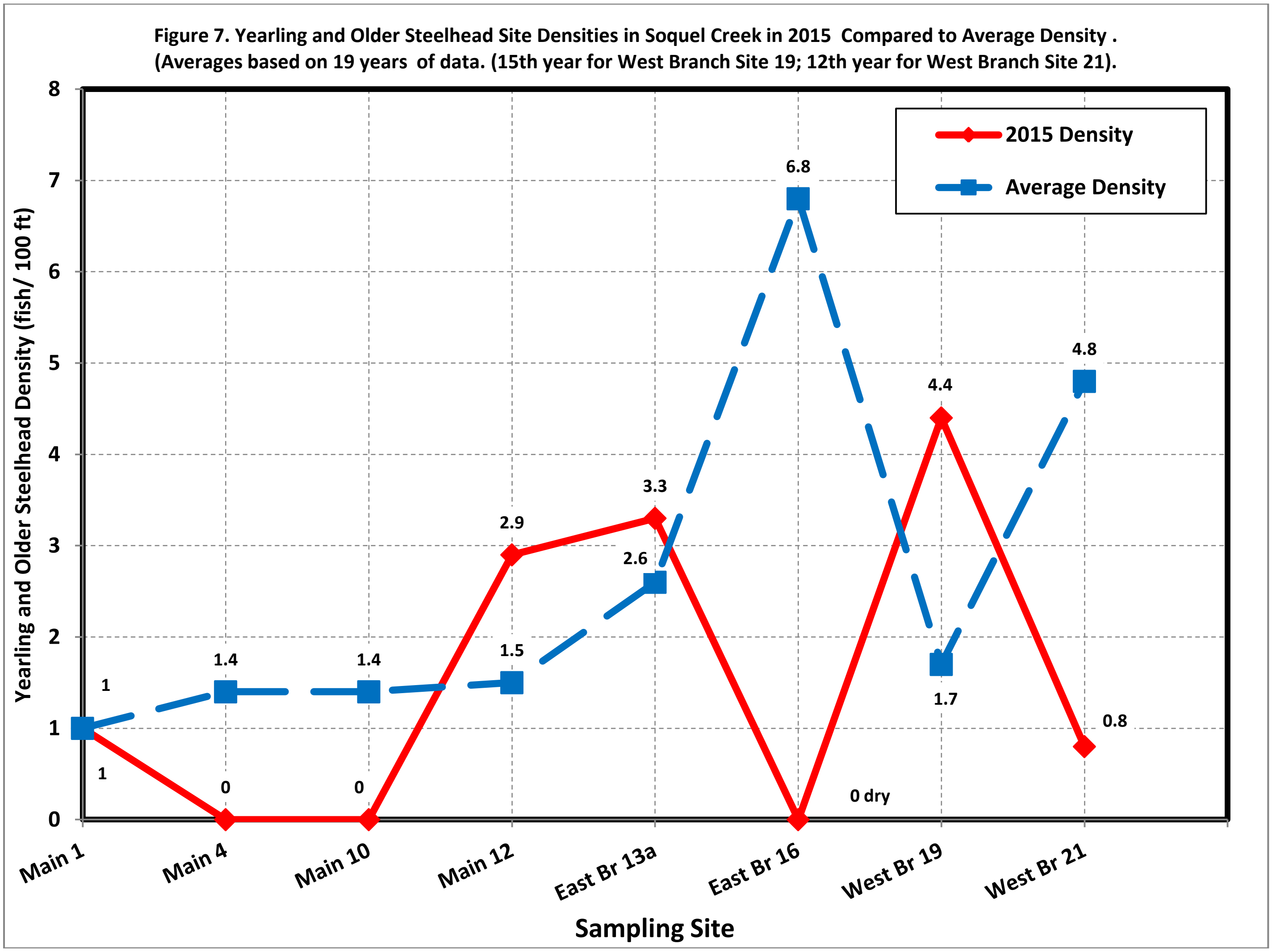


Figure 7. Yearling and Older Steelhead Site Densities in Soquel Creek in 2015 Compared to Average Density. (Averages based on 19 years of data. (15th year for West Branch Site 19).

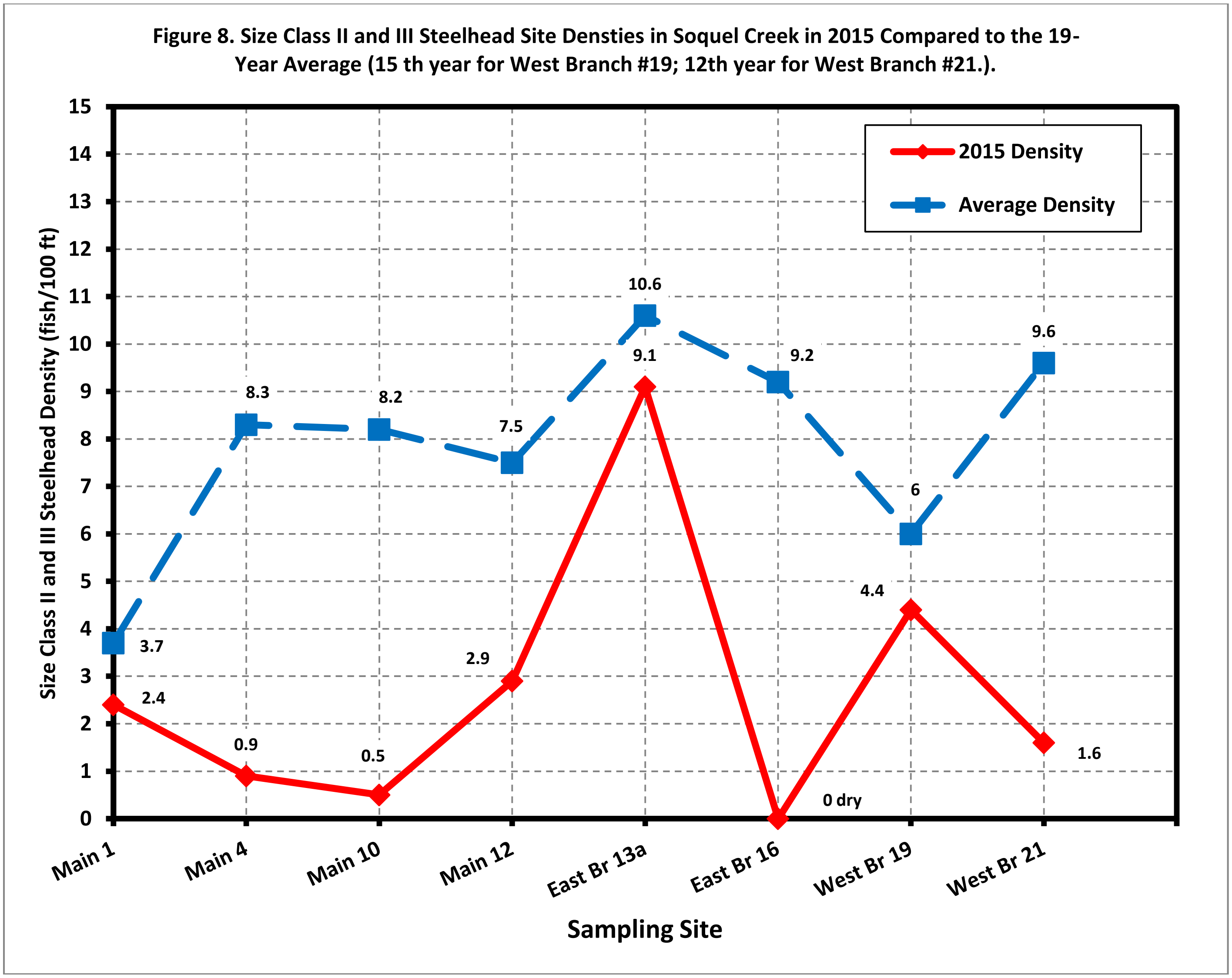


Figure 8. Size Class II and III Steelhead Site Densities in Soquel Creek in 2015 Compared to the 19-Year Average (15th year for West Branch #19.)

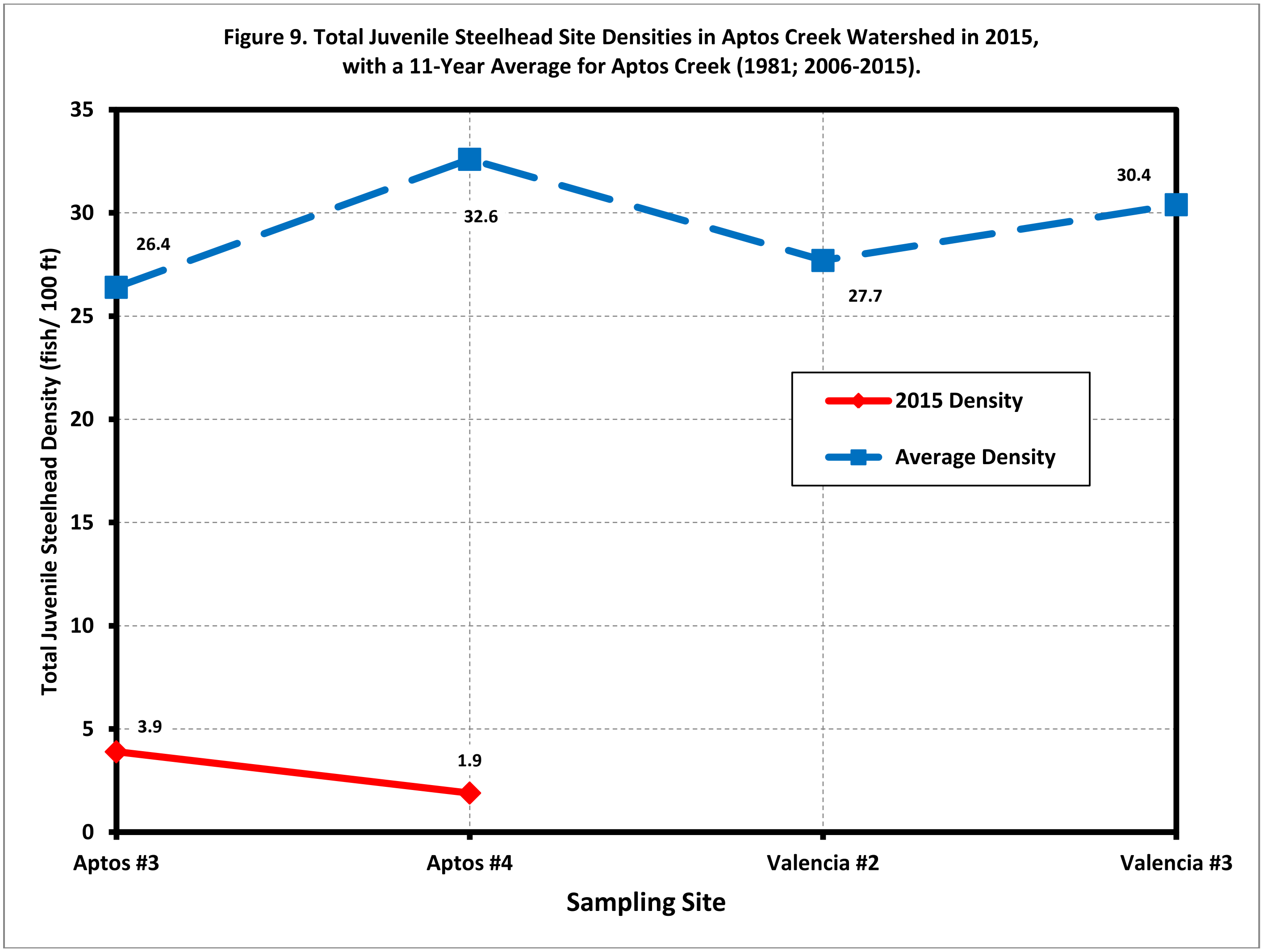


Figure 9. Total Juvenile Steelhead Site Densities in Aptos Creek in 2015, with an 11-Year Average (1981; 2006-2015).

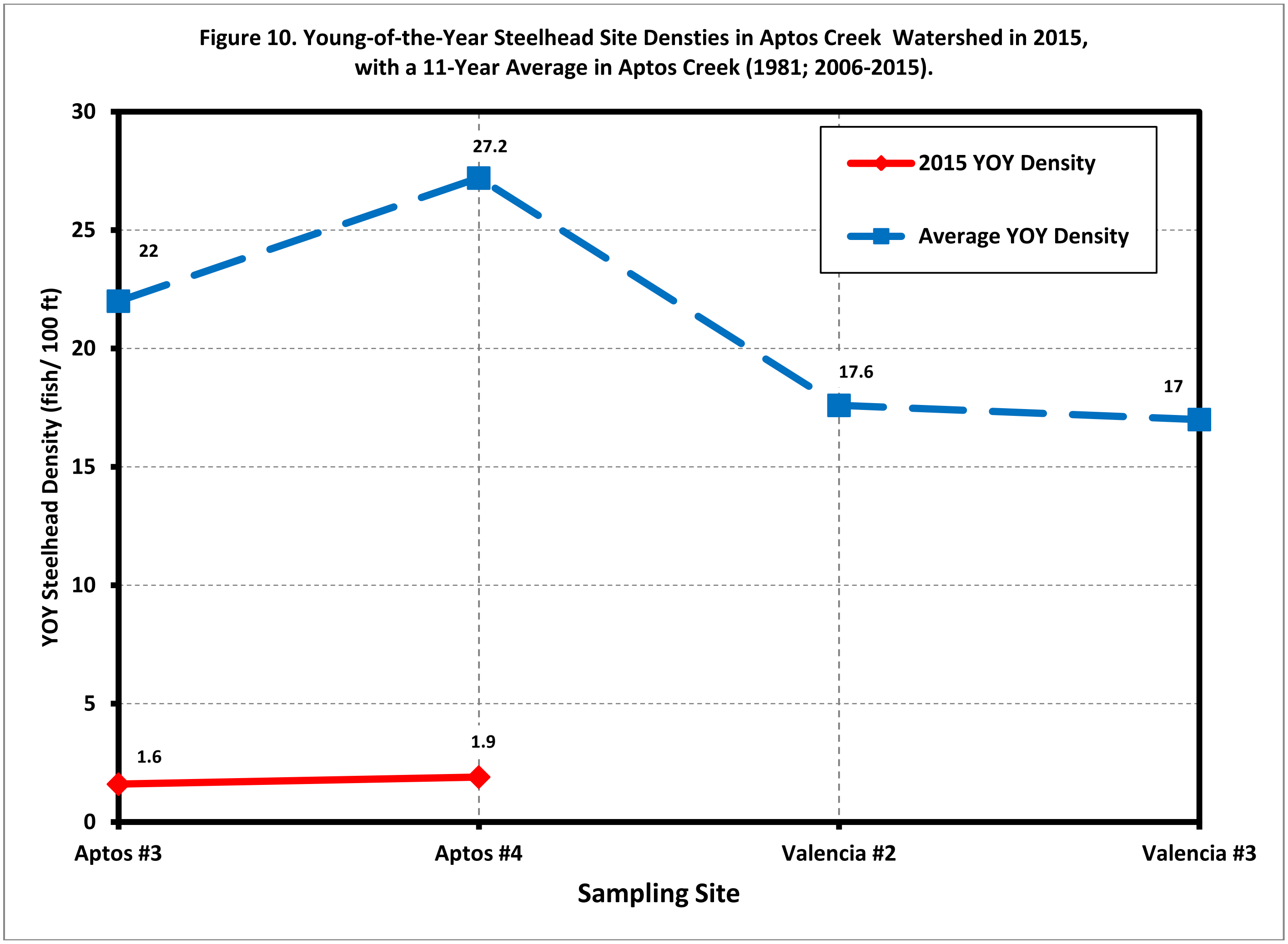


Figure 10. Young-of-the-Year Steelhead Site Densities in Aptos Creek in 2015, with a 11-Year Average (1981; 2006-2015).

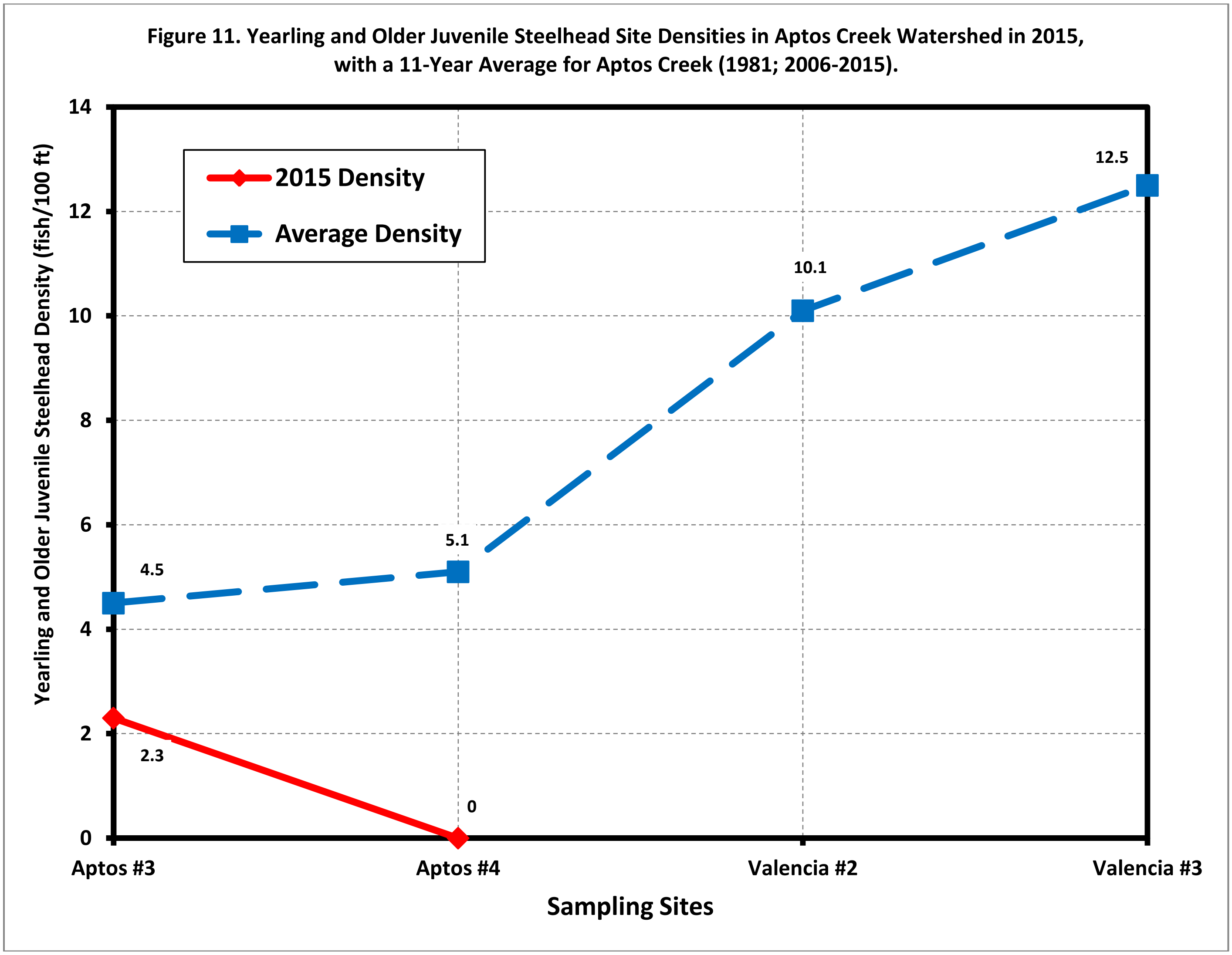


Figure 11. Yearling and Older Juvenile Steelhead Site Densities in Aptos Creek in 2015, with a 11-Year Average (1981; 2006-2015).

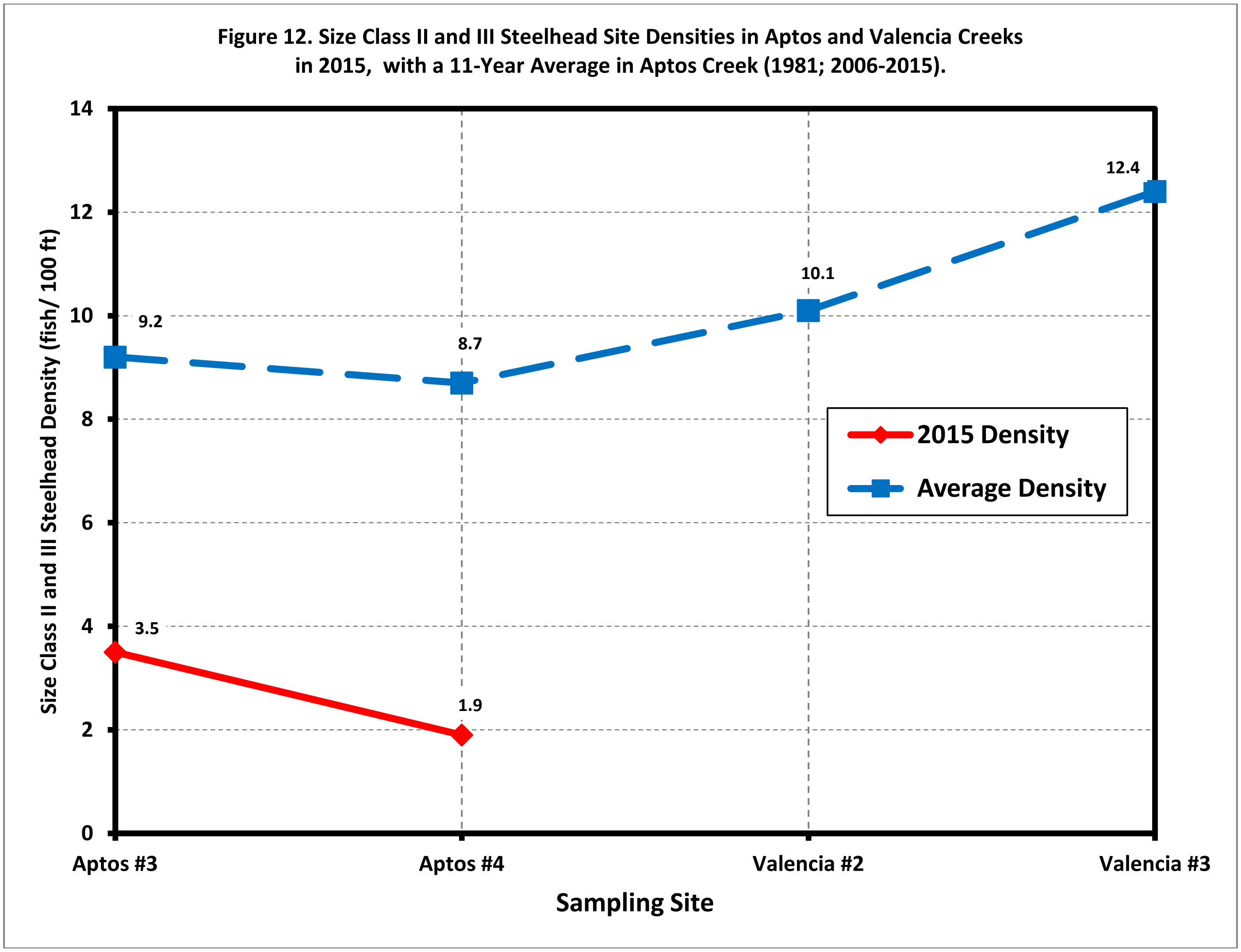


Figure 12. Size Class II and III Steelhead Site Densities in Aptos Creek in 2015, with a 11-Year Average (1981; 2006-2015).

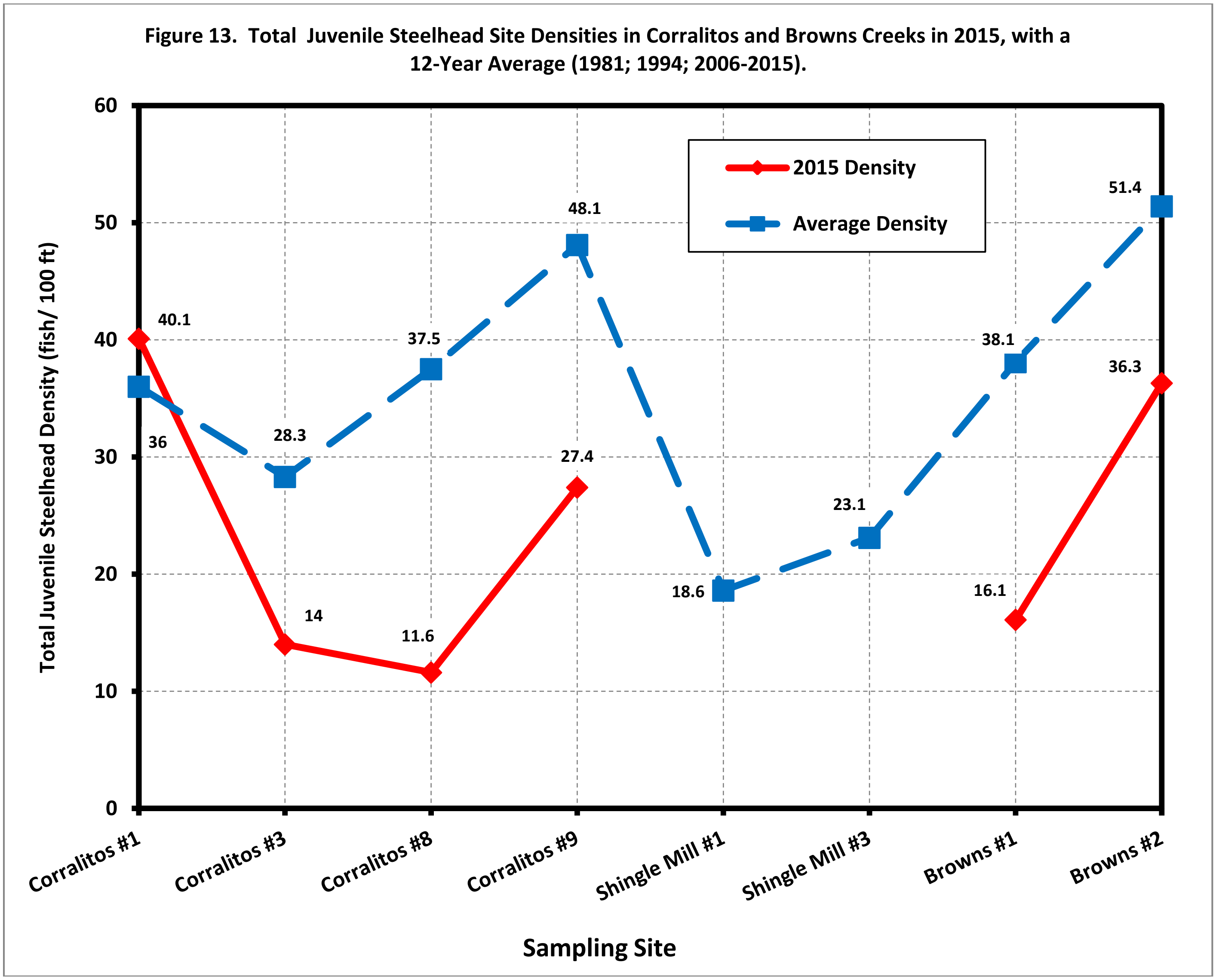


Figure 13. Total Juvenile Steelhead Site Densities in Corralitos, Shingle Mill and Browns Creeks in 2015, with a 12-Year Average (1981; 1994; 2006-2015).

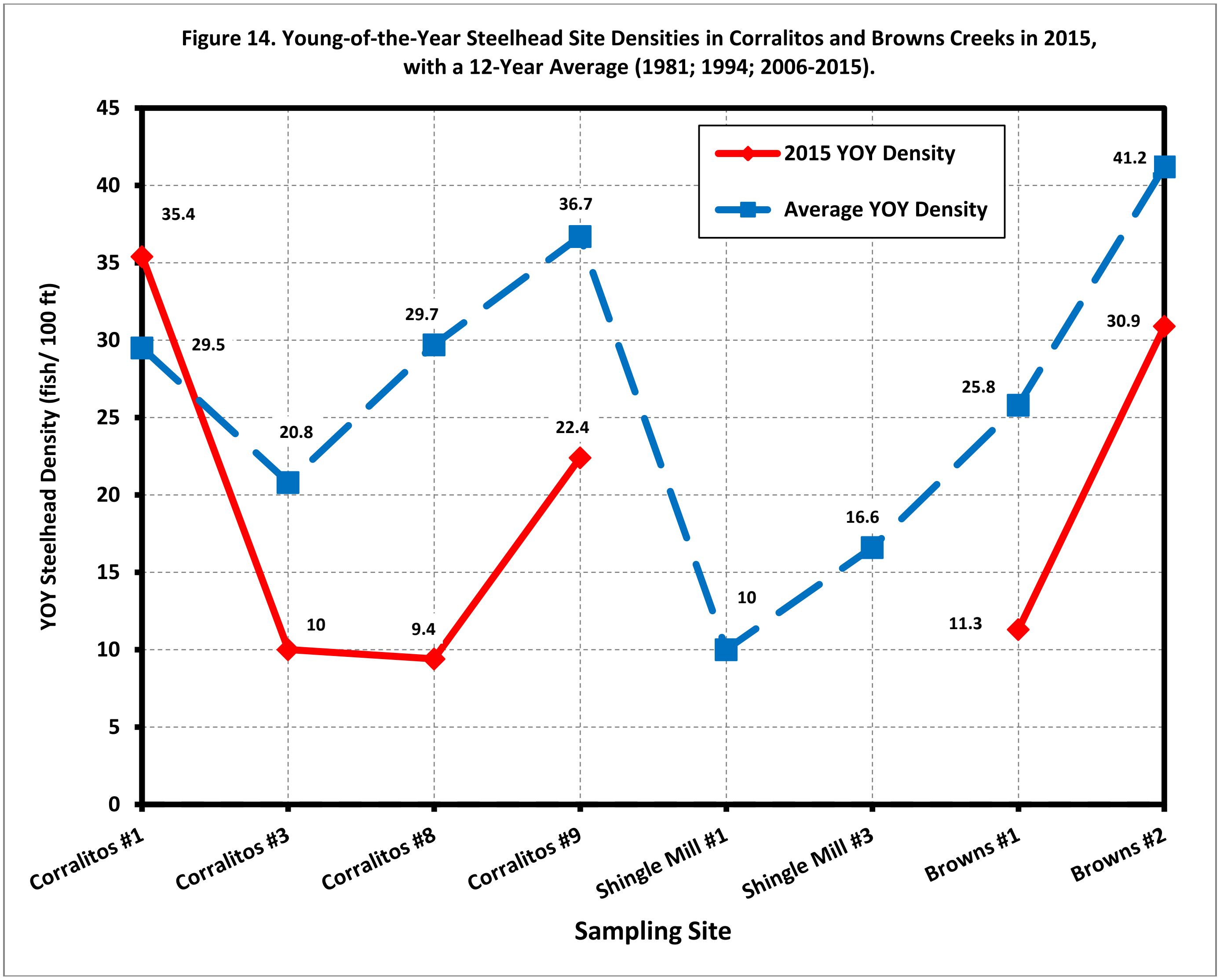


Figure 14. Young-of-the-Year Steelhead Site Densities in Corralitos and Browns Creeks in 2015, with a 12-Year Average (1981; 1994; 2006-2015).

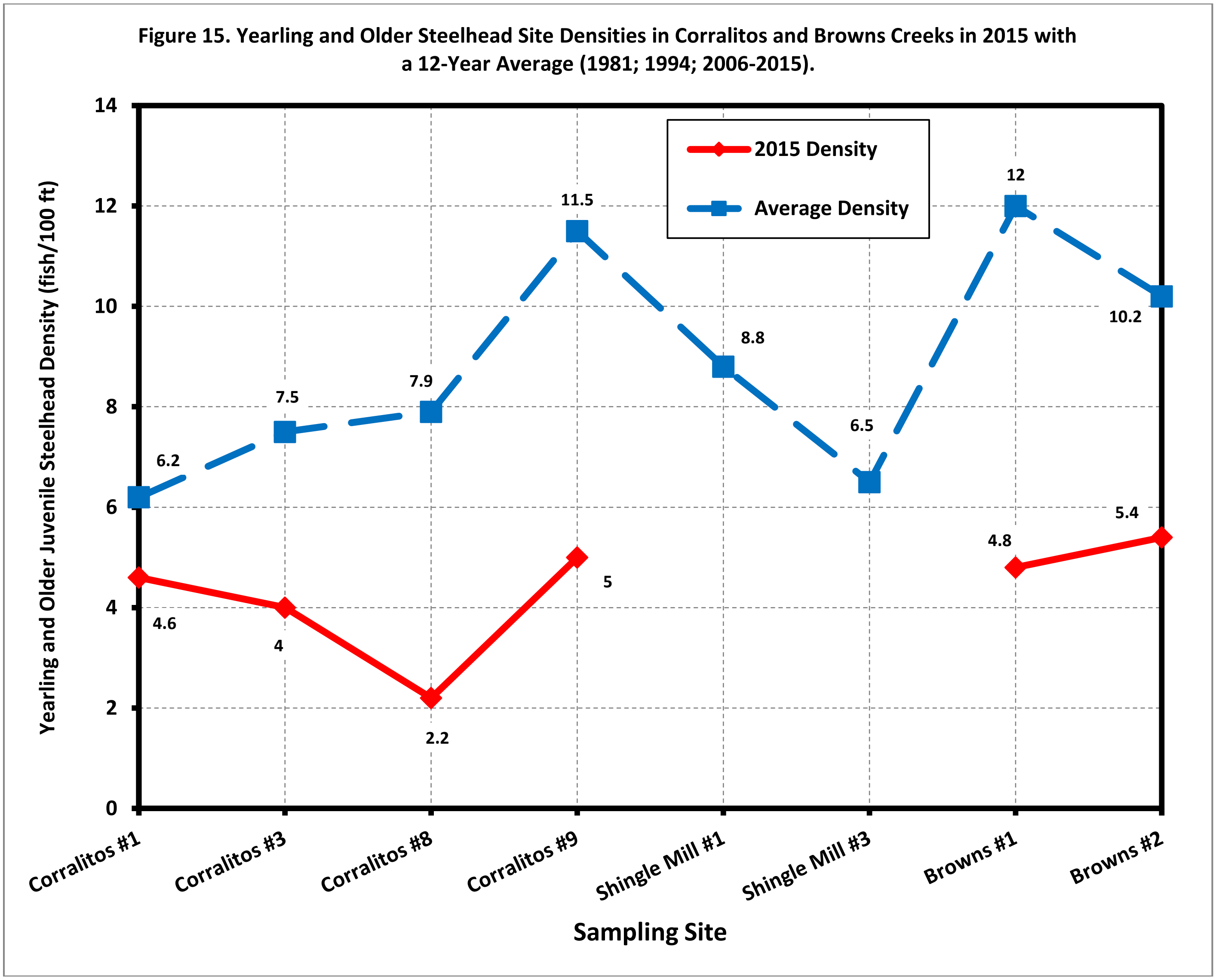


Figure 15. Yearling and Older Steelhead Site Densities in Corralitos and Browns Creeks in 2015 with a 12-Year Average (1981; 1994; 2006-2015).

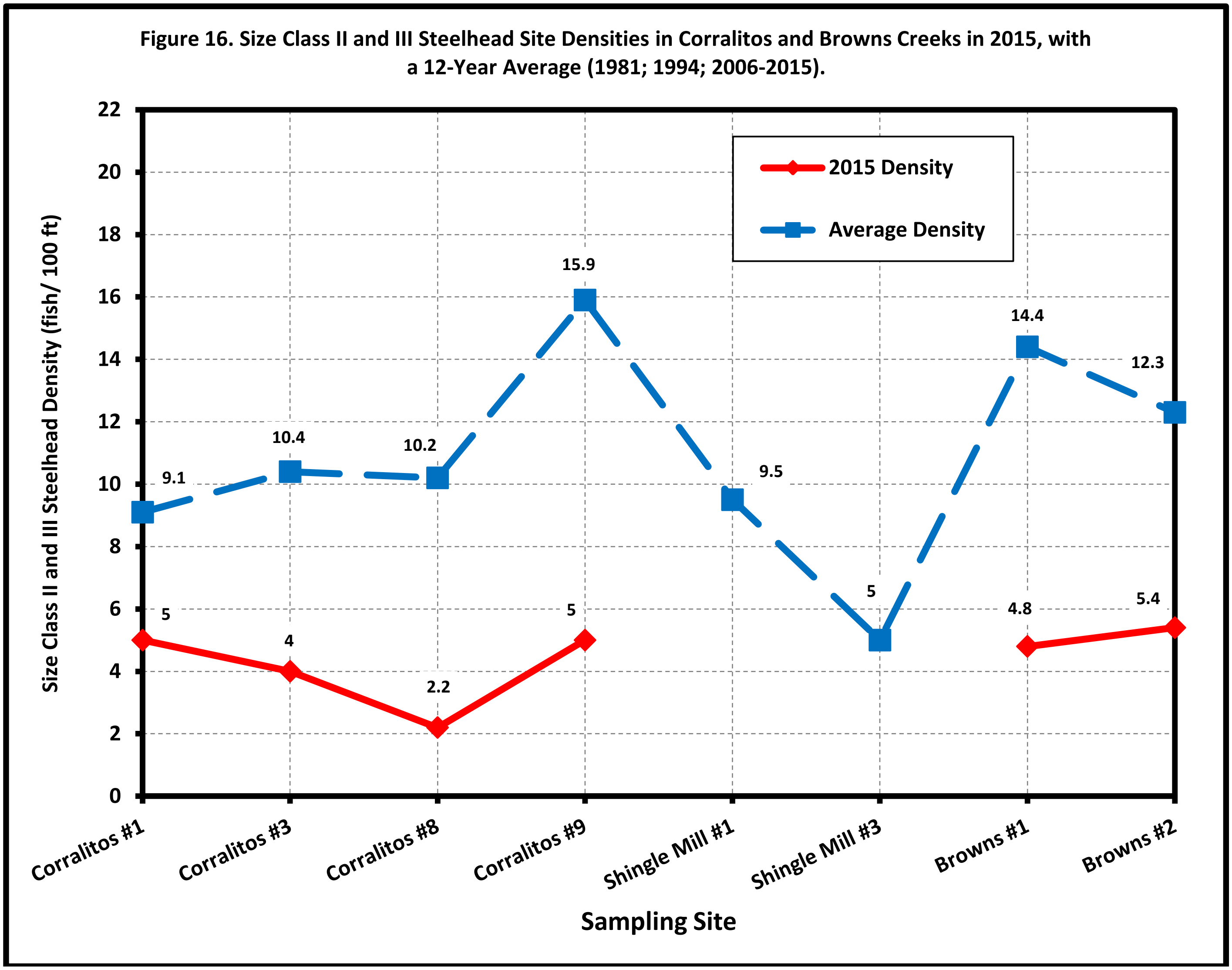


Figure 16. Size Class II and III Steelhead Site Densities in Corralitos and Browns Creeks in 2015, with a 12-Year Average (1981; 1994; 2006-2015).

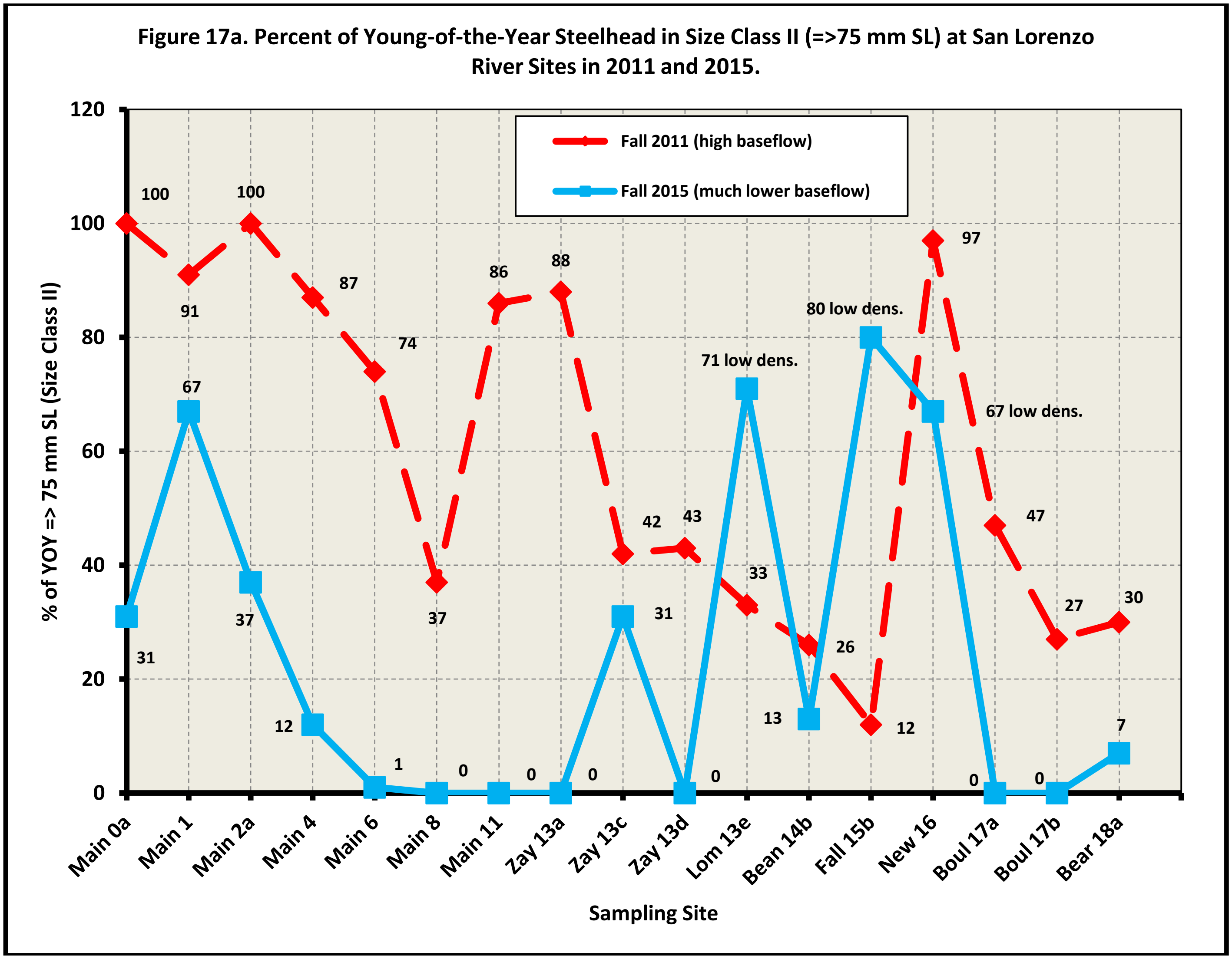


Figure 17a. Percent of Young-of-the-Year Steelhead in Size Class II (=>75 mm SL) at San Lorenzo River Sites in 2011 and 2015.

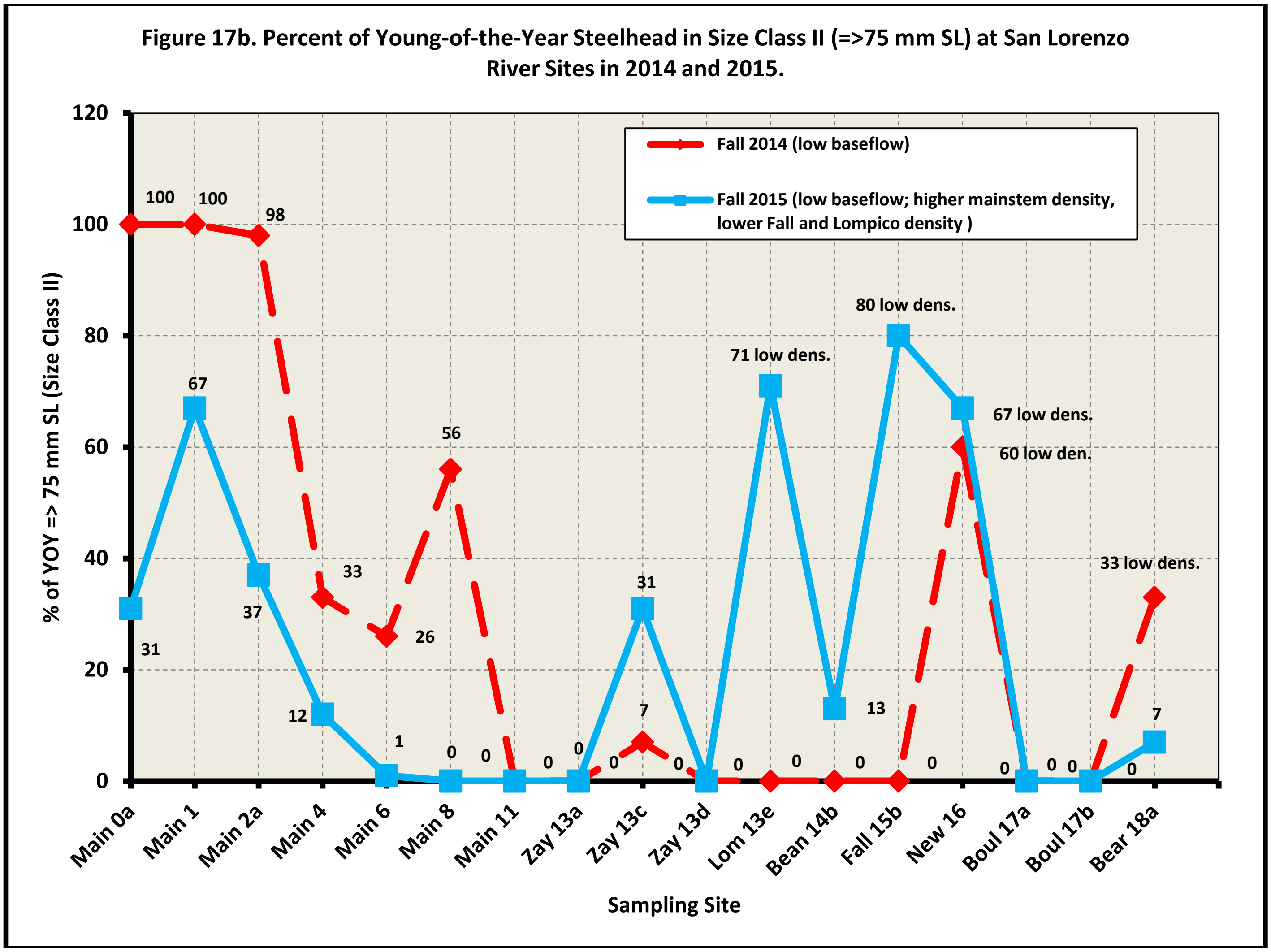


Figure 17b. Percent of Young-of-the-Year Steelhead in Size Class II (=>75 mm SL) at San Lorenzo River Sites in 2014 and 2015.

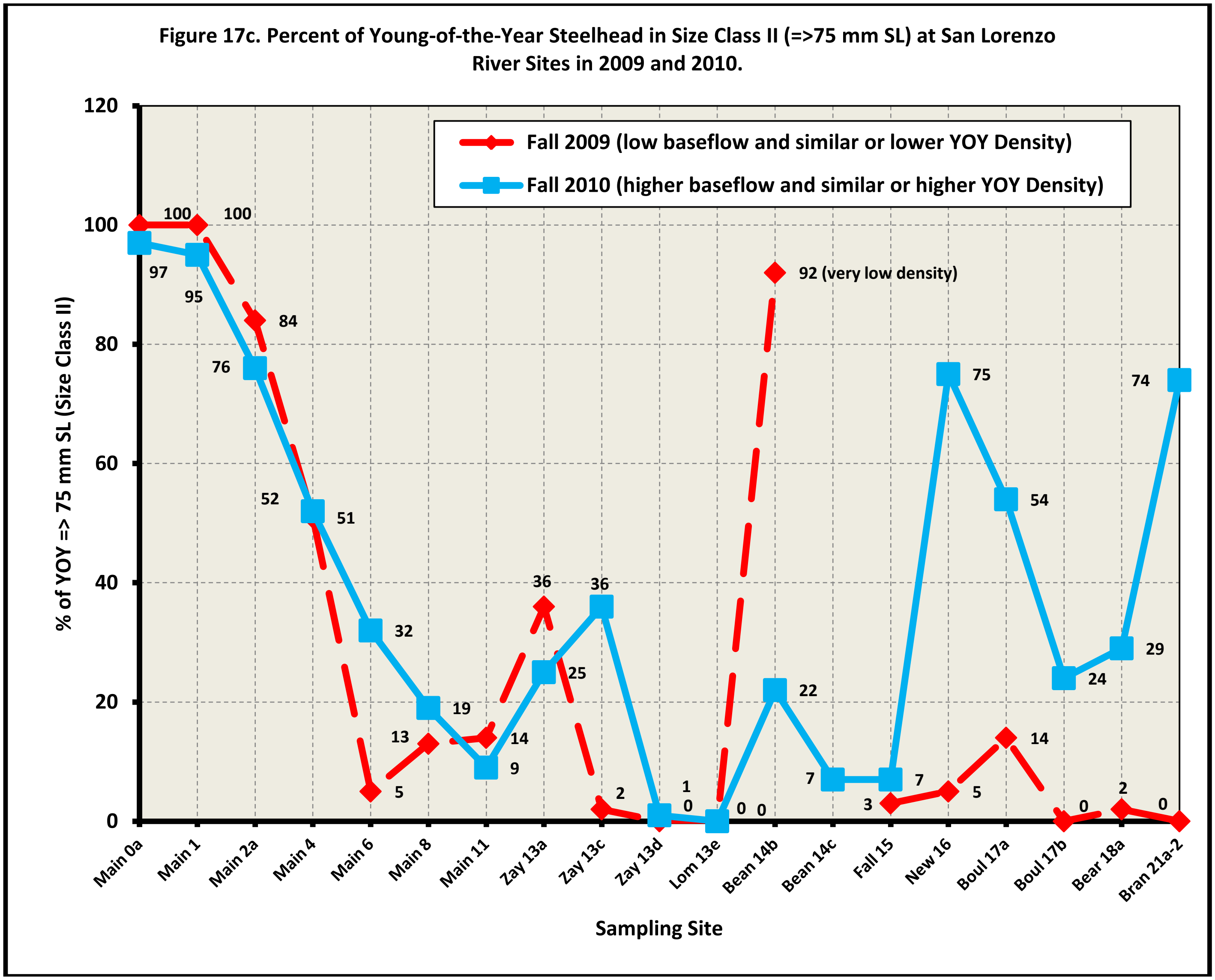


Figure 17c. Percent of Young-of-the-Year Steelhead in Size Class II (=>75 mm SL) at San Lorenzo River Sites in 2009 and 2010.

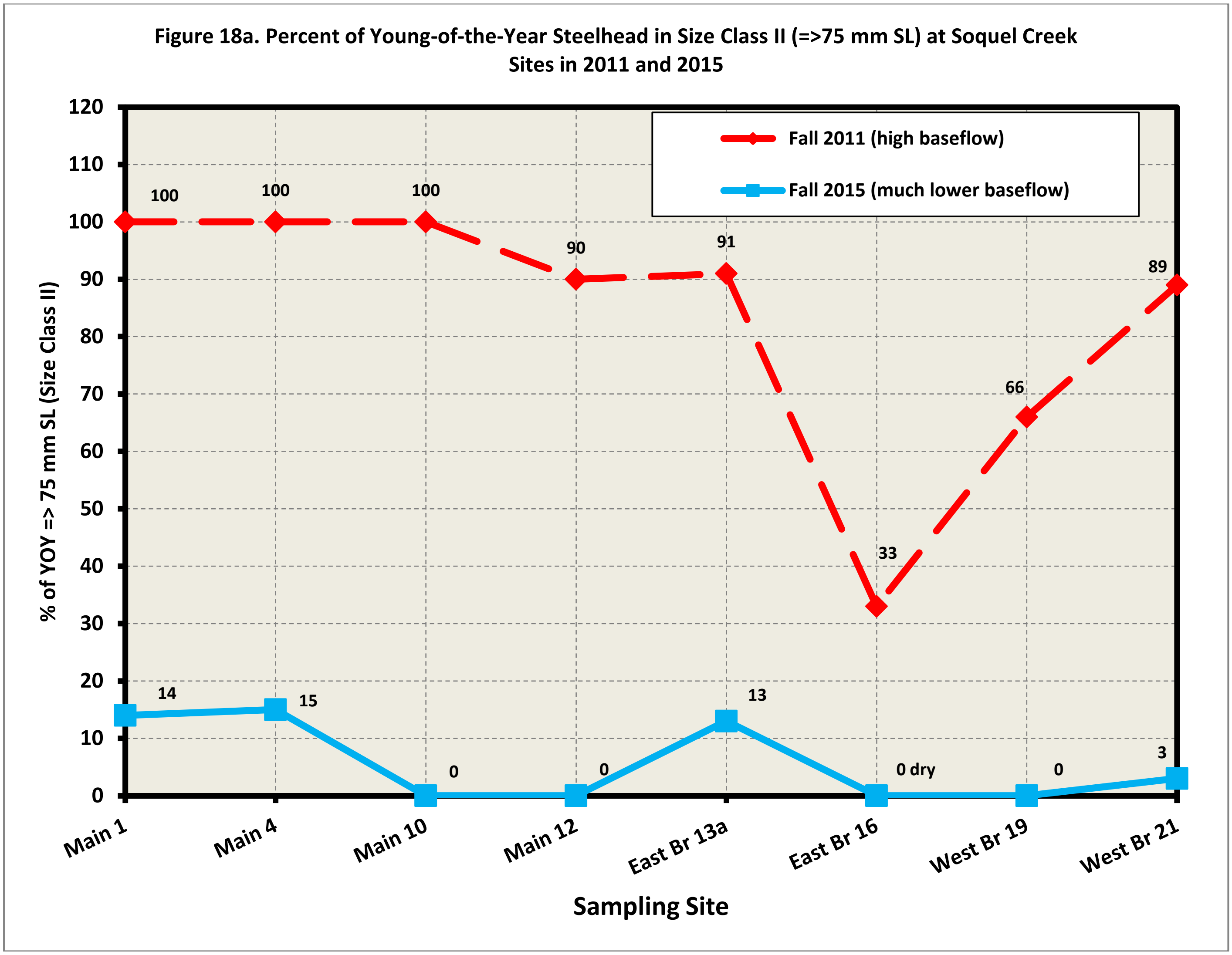


Figure 18a. Percent of Young-of-the-Year Steelhead in Size Class II (=>75 mm SL) at Soquel Creek Sites in 2011 and 2015.

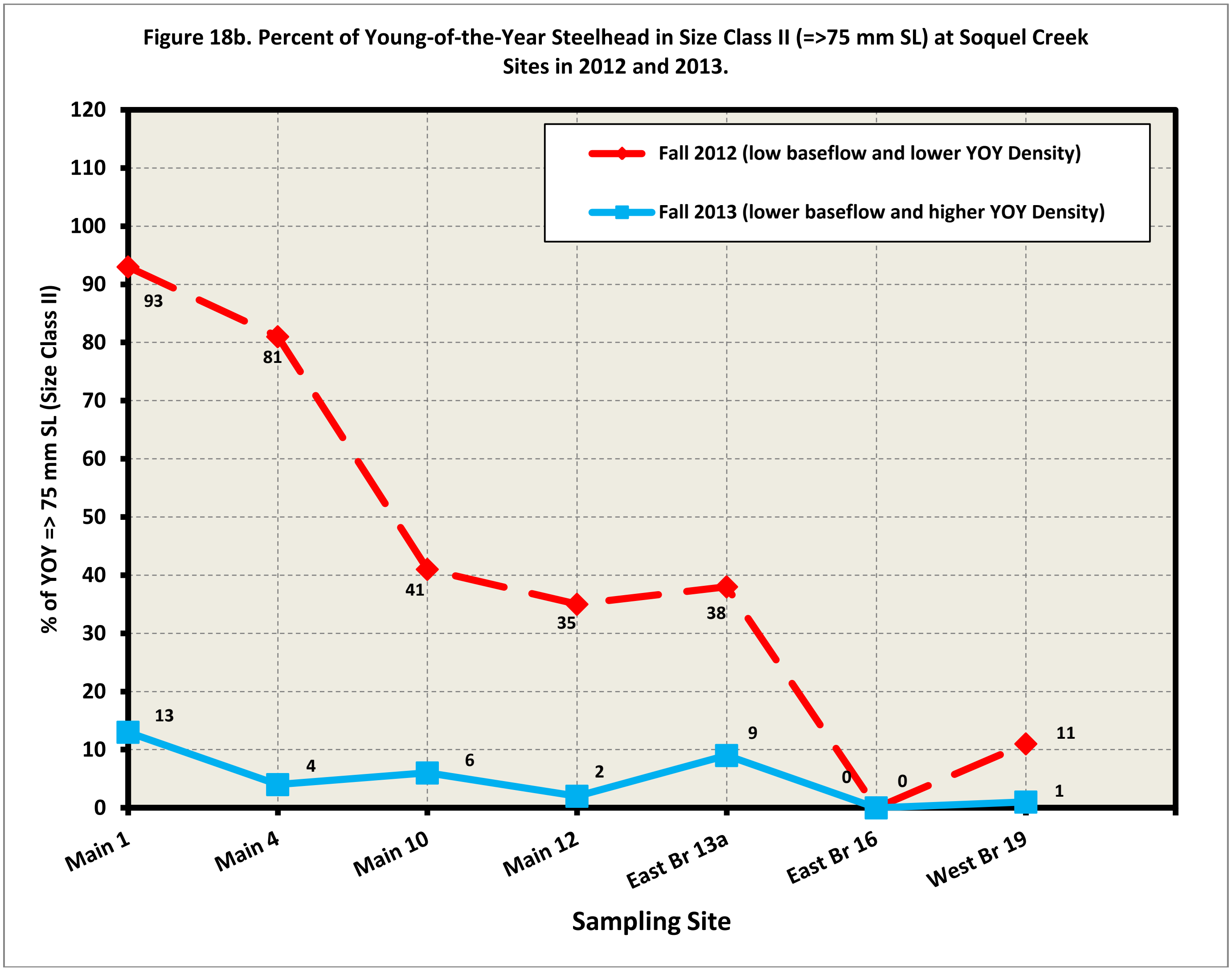


Figure 18b. Percent of Young-of-the-Year Steelhead in Size Class II (=>75 mm SL) at Soquel Creek Sites in 2012 and 2013.

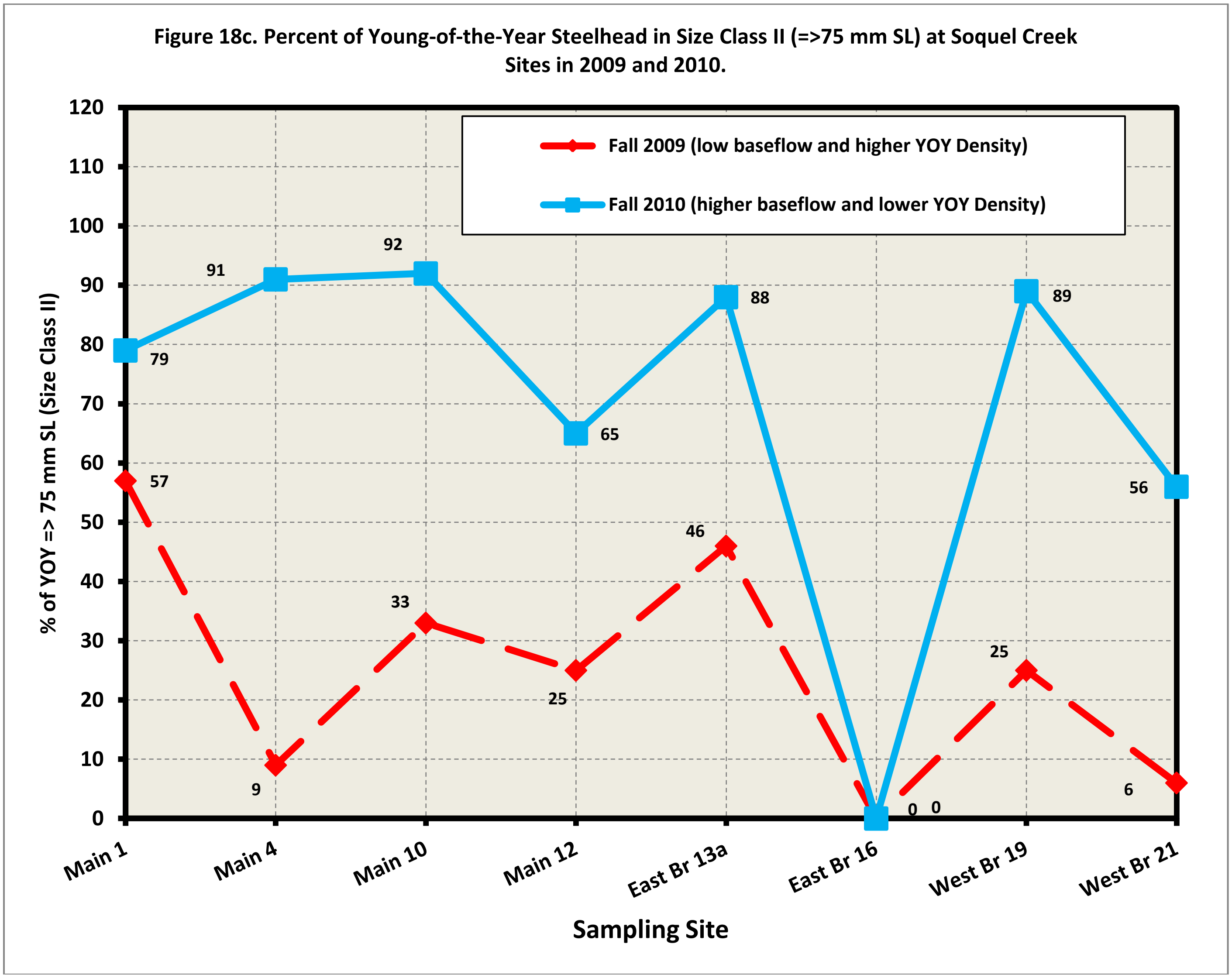


Figure 18c. Percent of Young-of-the-Year Steelhead in Size Class II (=>75 mm SL) at Soquel Creek Sites in 2009 and 2010.

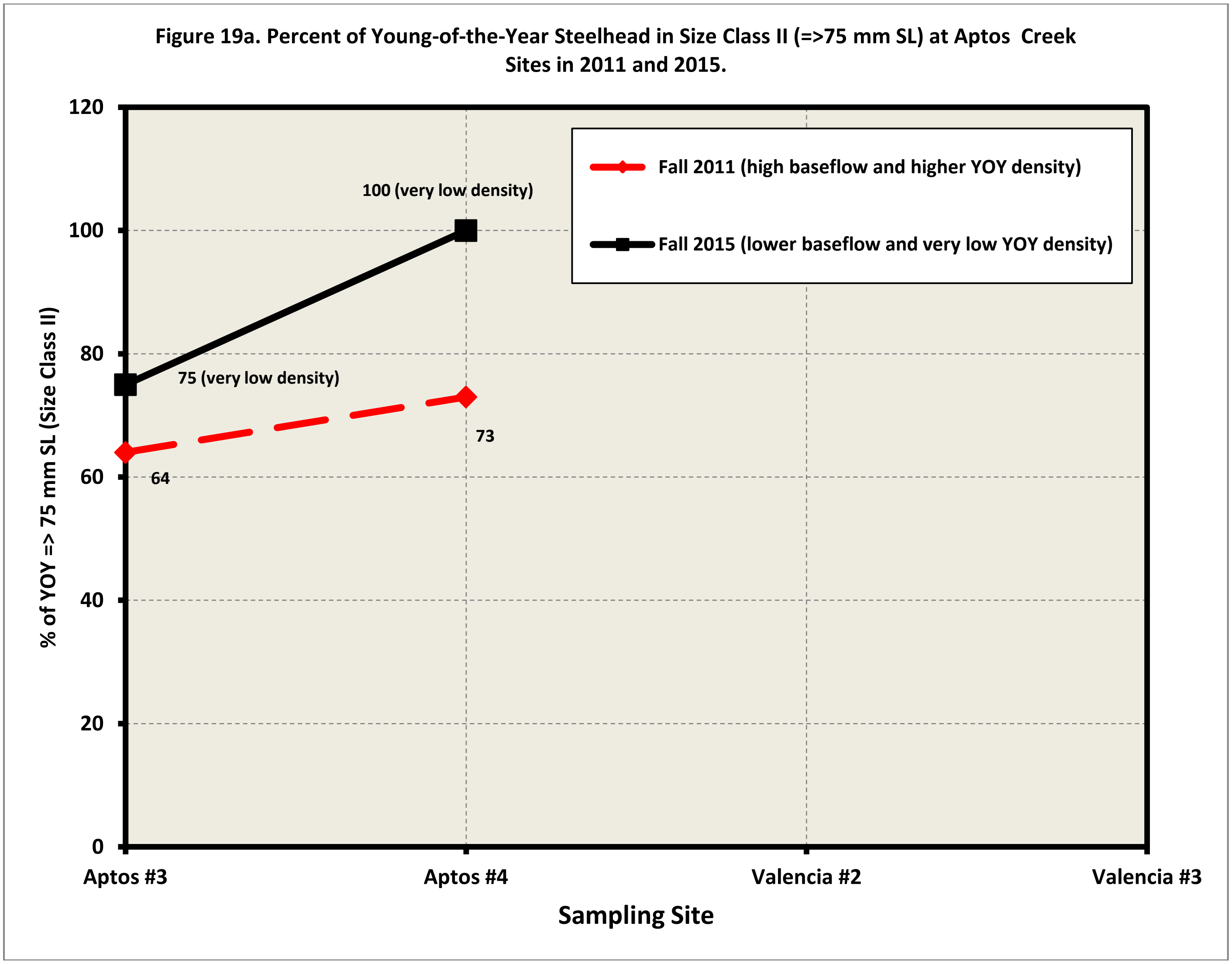


Figure 19a. Percent of Young-of-the-Year Steelhead in Size Class II (=>75 mm SL) at Aptos Creek Sites in 2011 and 2015.

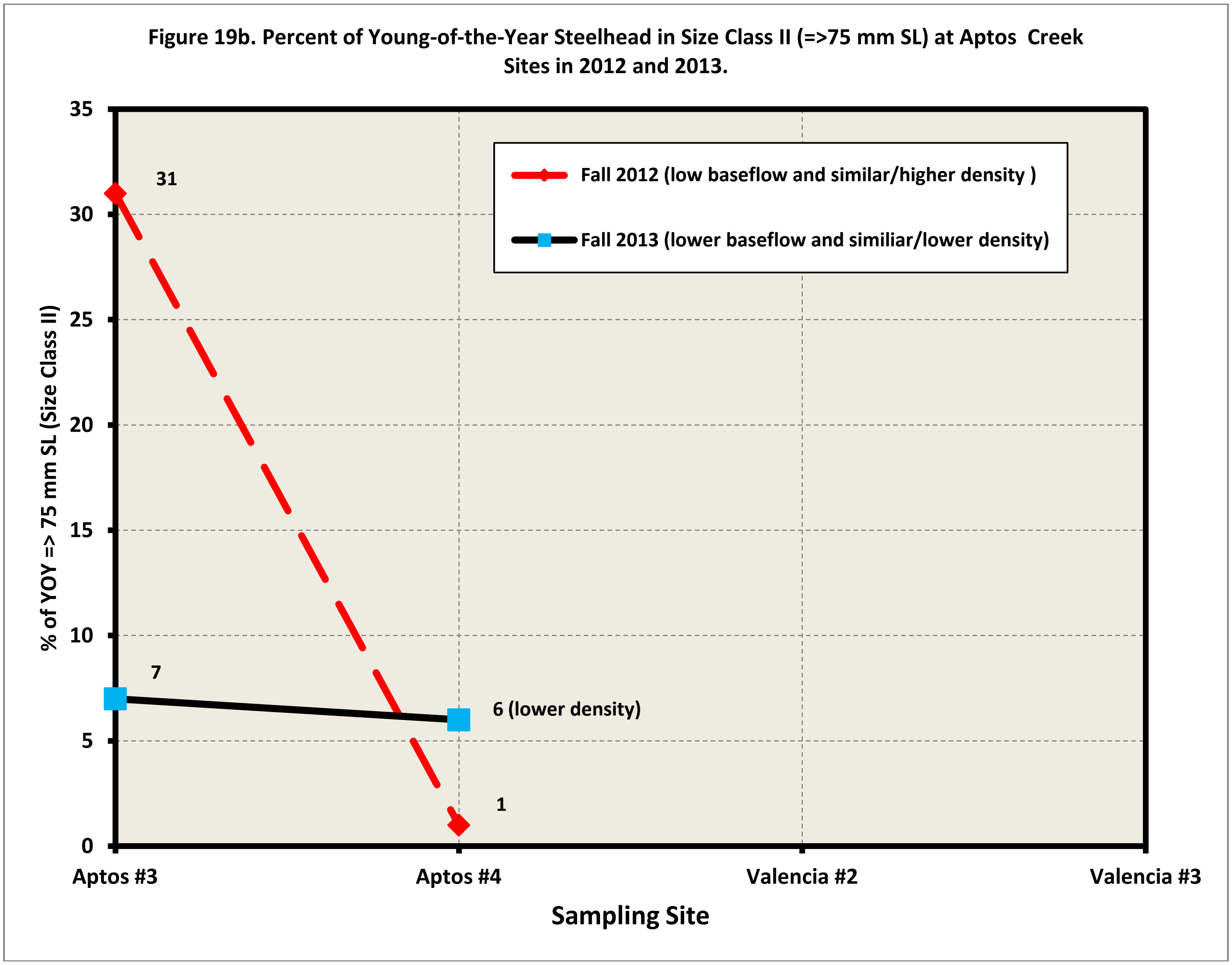


Figure 19b. Percent of Young-of-the-Year Steelhead in Size Class II (=>75 mm SL) at Aptos Creek Sites in 2012 and 2013.

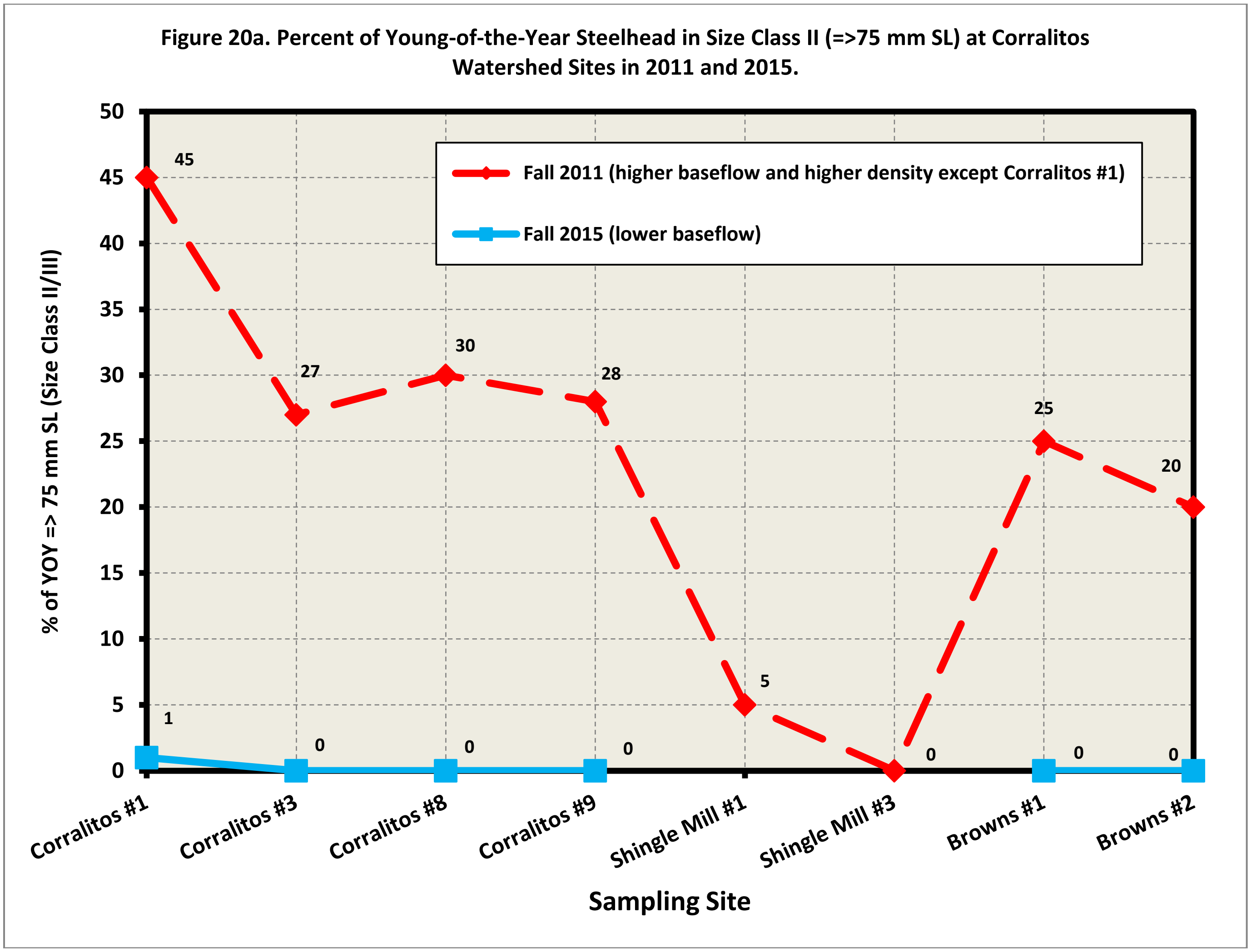


Figure 20a. Percent of Young-of-the-Year Steelhead in Size Class II (=>75 mm SL) at Corralitos Sub-Watershed Sites in 2011 and 2015.

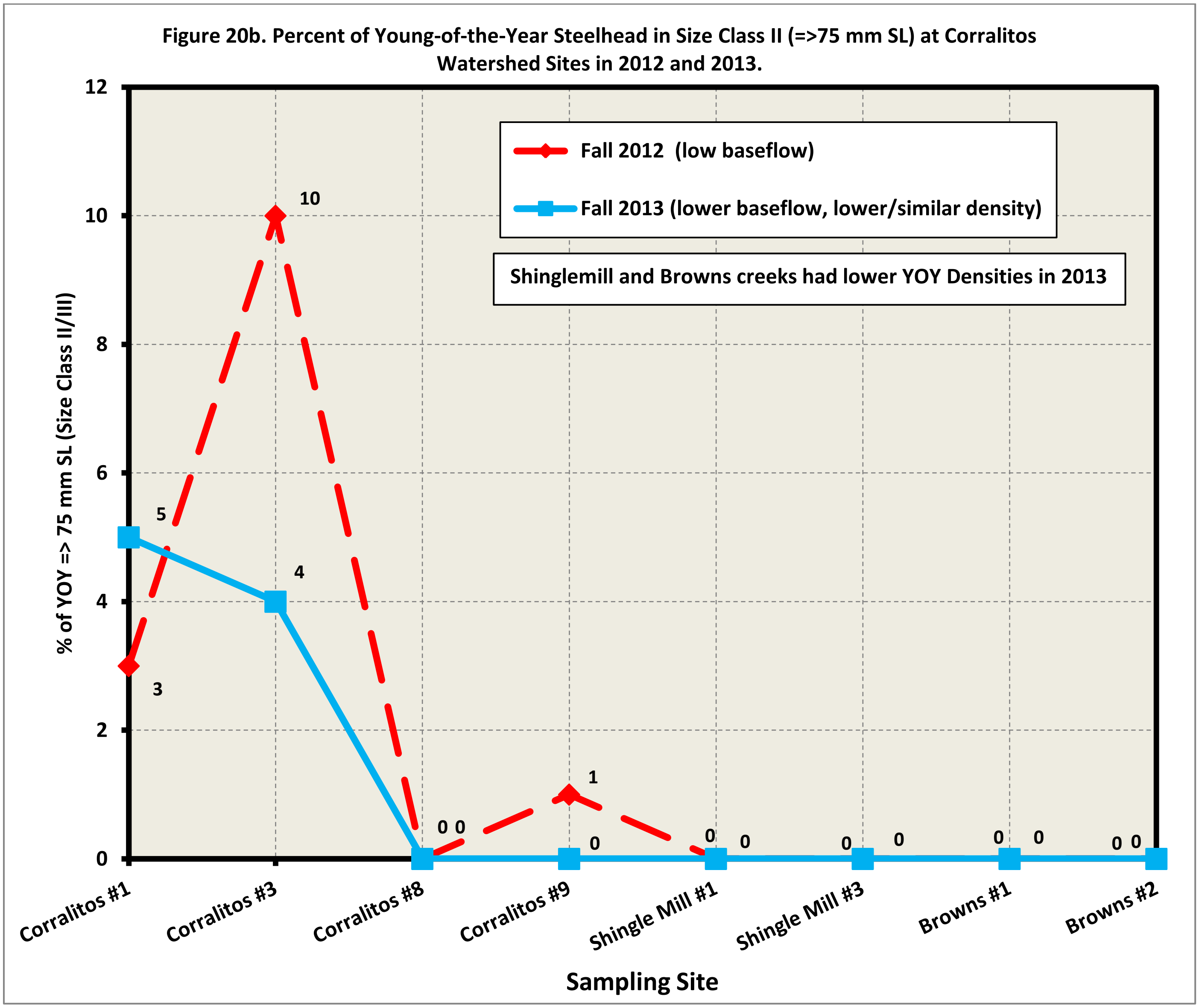


Figure 20b. Percent of Young-of-the-Year Steelhead in Size Class II (=>75 mm SL) at Corralitos Sub-Watershed Sites in 2012 and 2013.

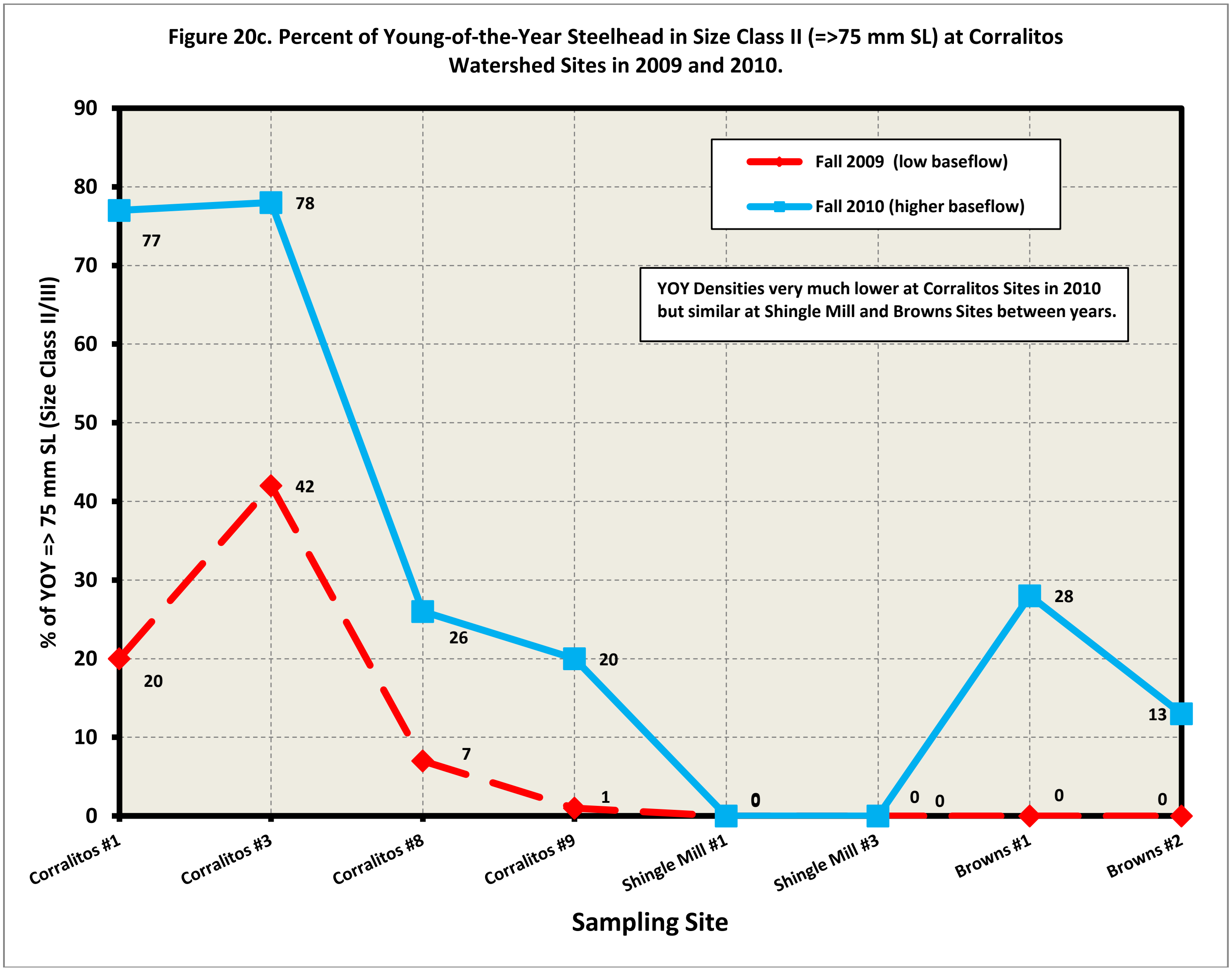


Figure 20c. Percent of Young-of-the-Year Steelhead in Size Class II (=>75 mm SL) at Corralitos Sub-Watershed Sites in 2009 and 2010.

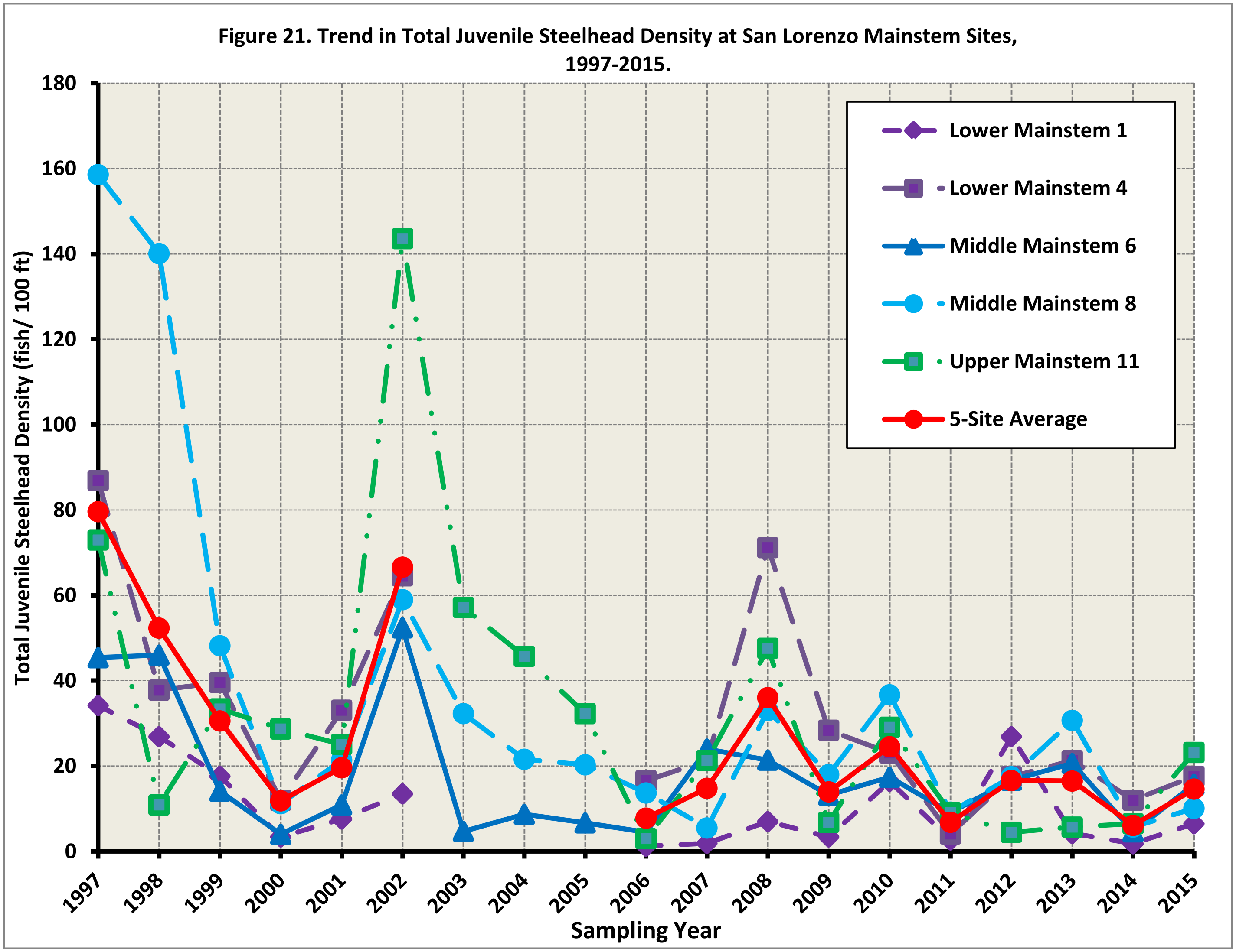


Figure 21. Trend in Total Juvenile Steelhead Density at San Lorenzo Mainstem Sites, 1997-2015.

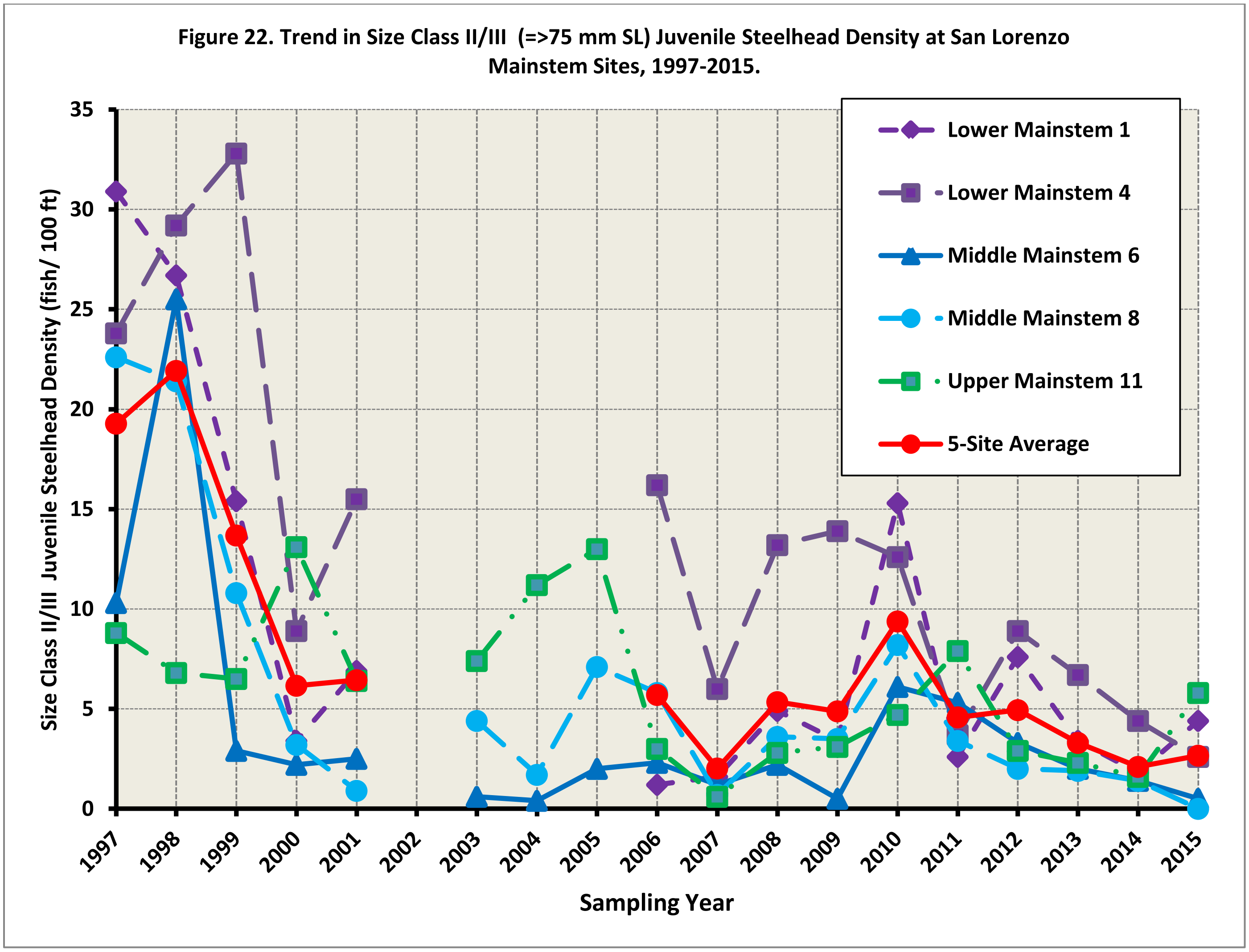


Figure 22. Trend in Size Class II/III (=>75 mm SL) Juvenile Steelhead Density at San Lorenzo Mainstem Sites, 1997-2015.

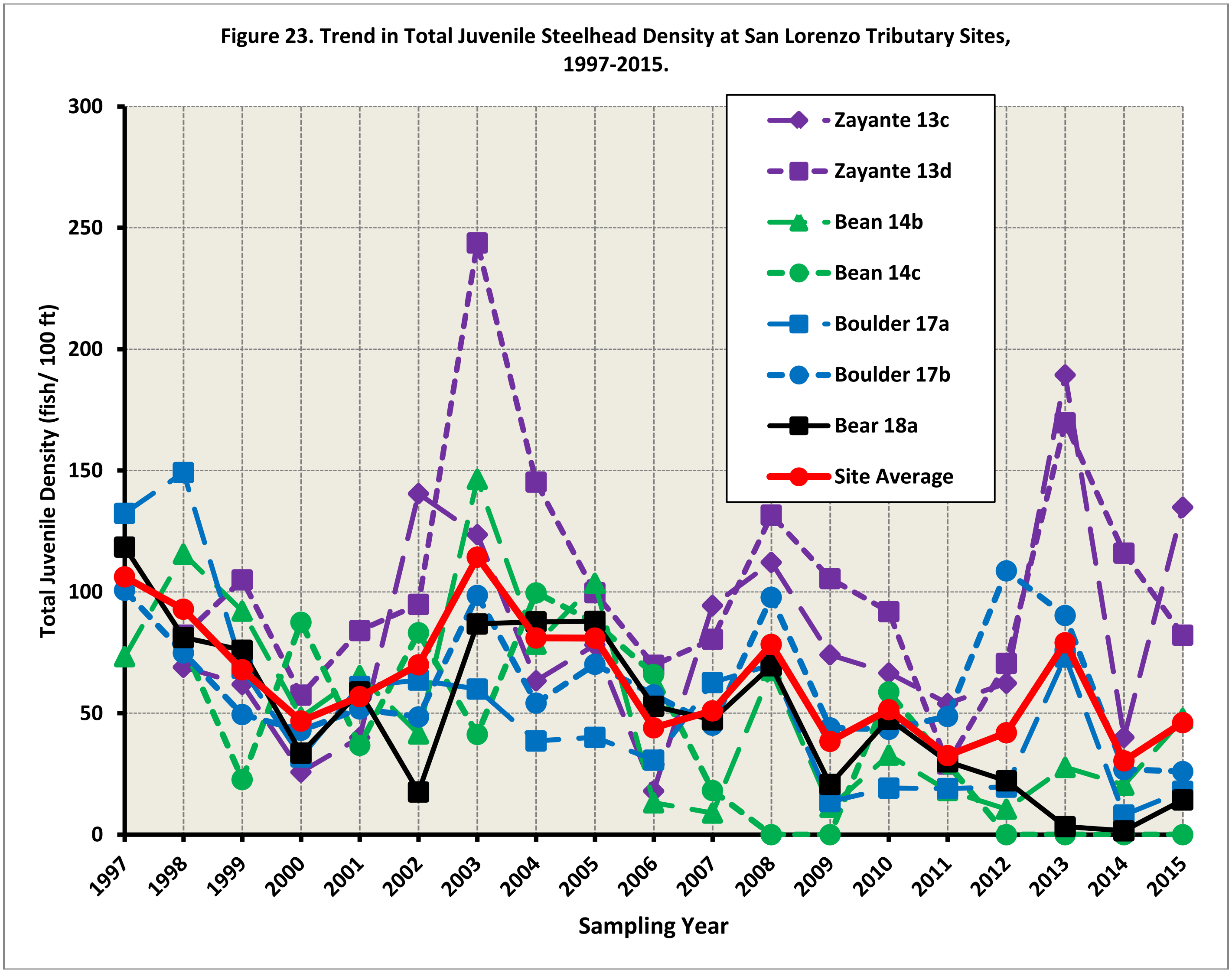


Figure 23. Trend in Total Juvenile Steelhead Density at San Lorenzo Tributary Sites, 1997-2015.

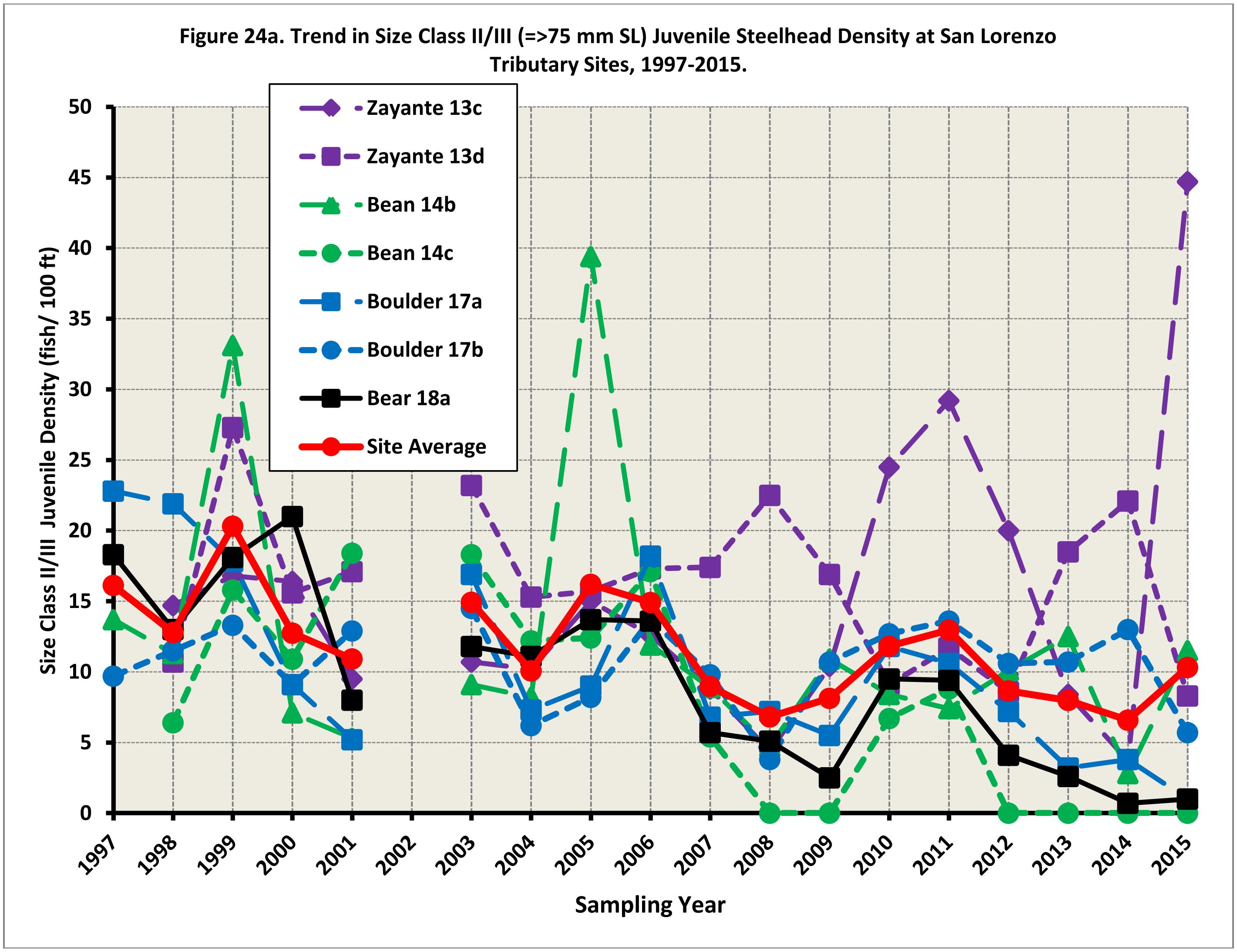


Figure 24a. Trend in Size Class II/III (=>75 mm SL) Juvenile Steelhead Density at San Lorenzo Tributary Sites, 1997-2015.

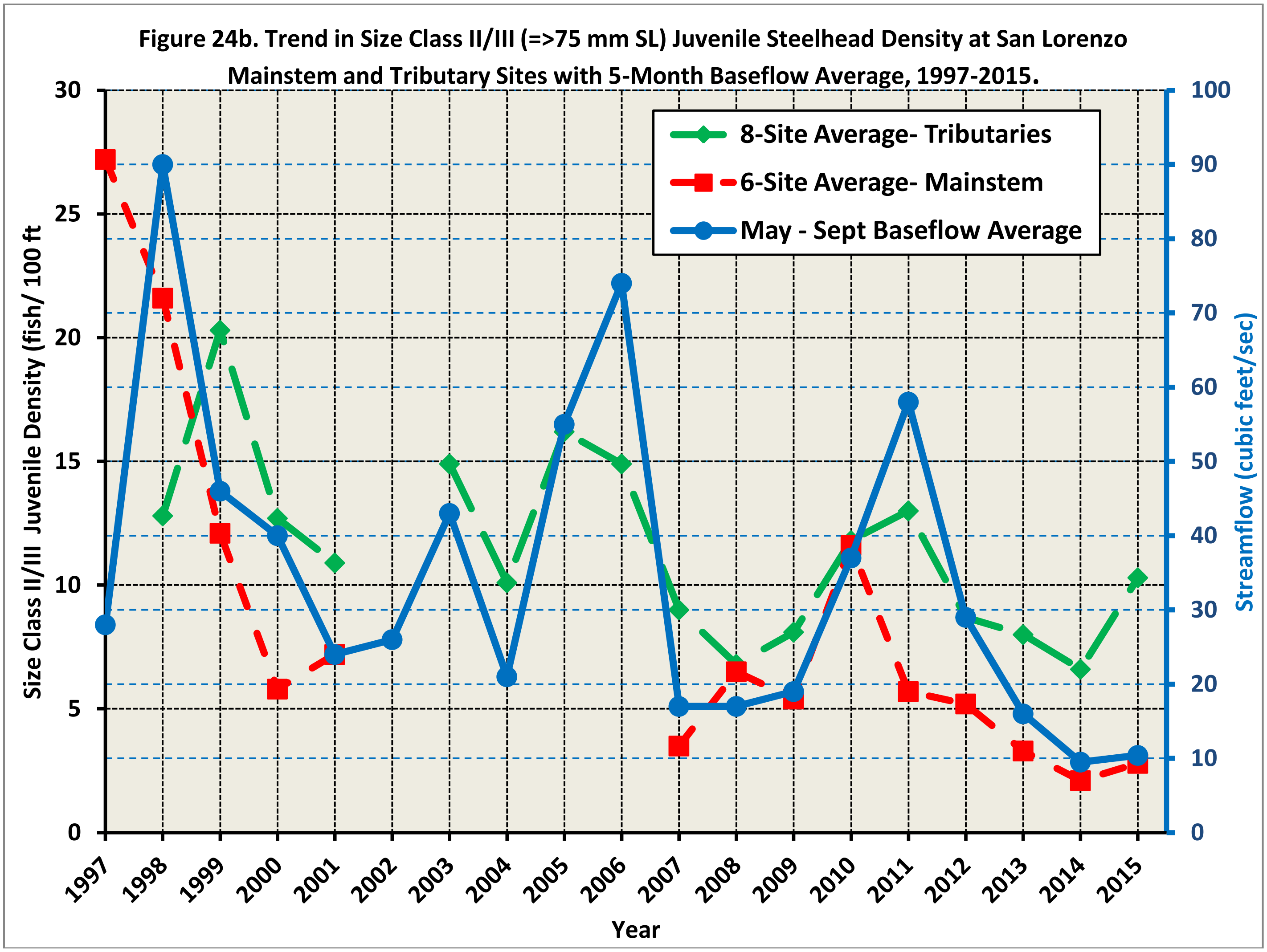


Figure 24b. Trend in Size Class II/III (=>75 mm SL) Juvenile Steelhead Density at San Lorenzo Mainstem and Tributary Sites with 5-Month Baseflow Average, 1997-2015.

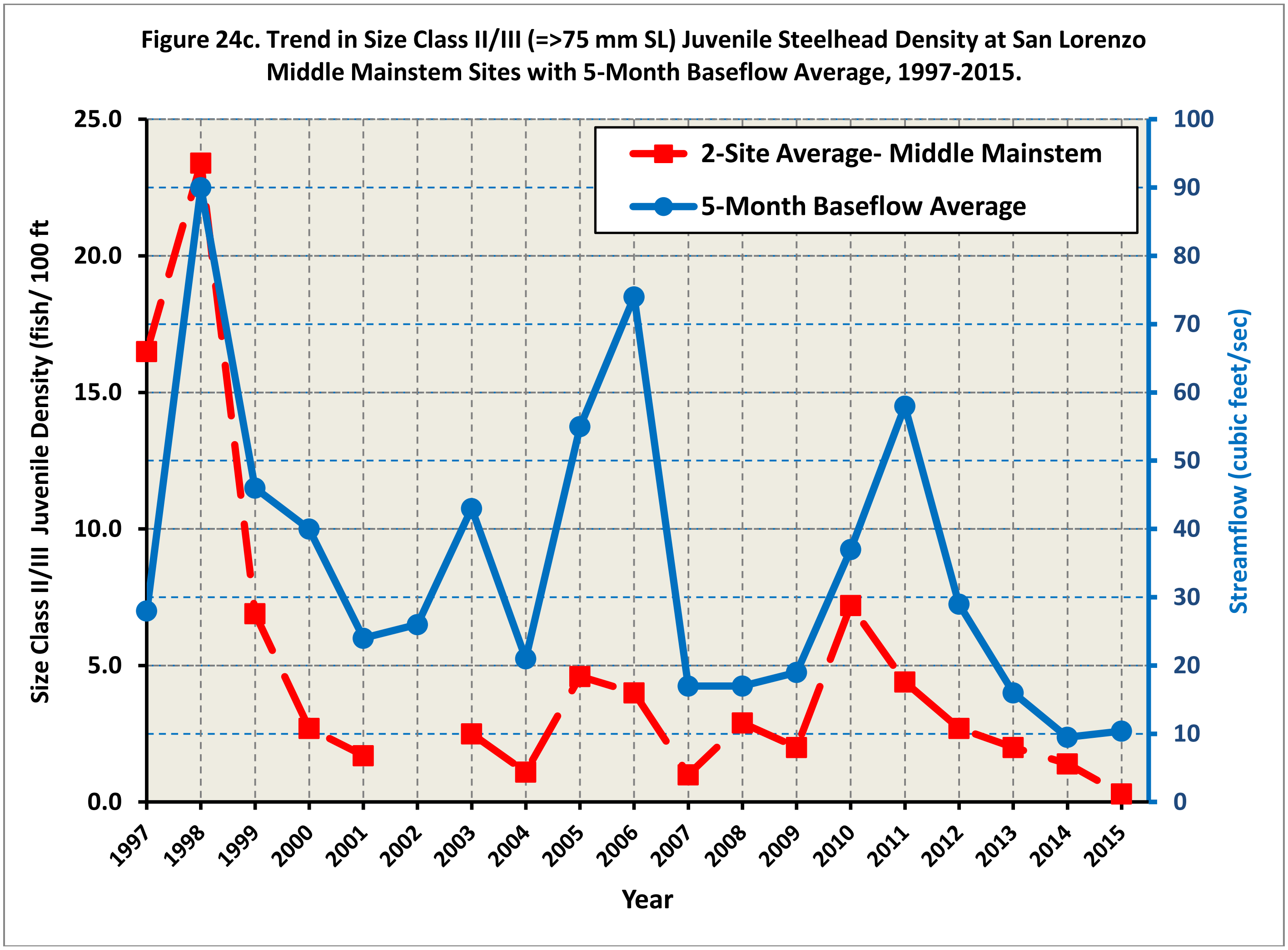


Figure 24c. Trend in Average Size Class II/III (=>75 mm SL) Juvenile Steelhead Density at San Lorenzo Middle Mainstem Sites with 5-Month Baseflow Average, 1997-2015.

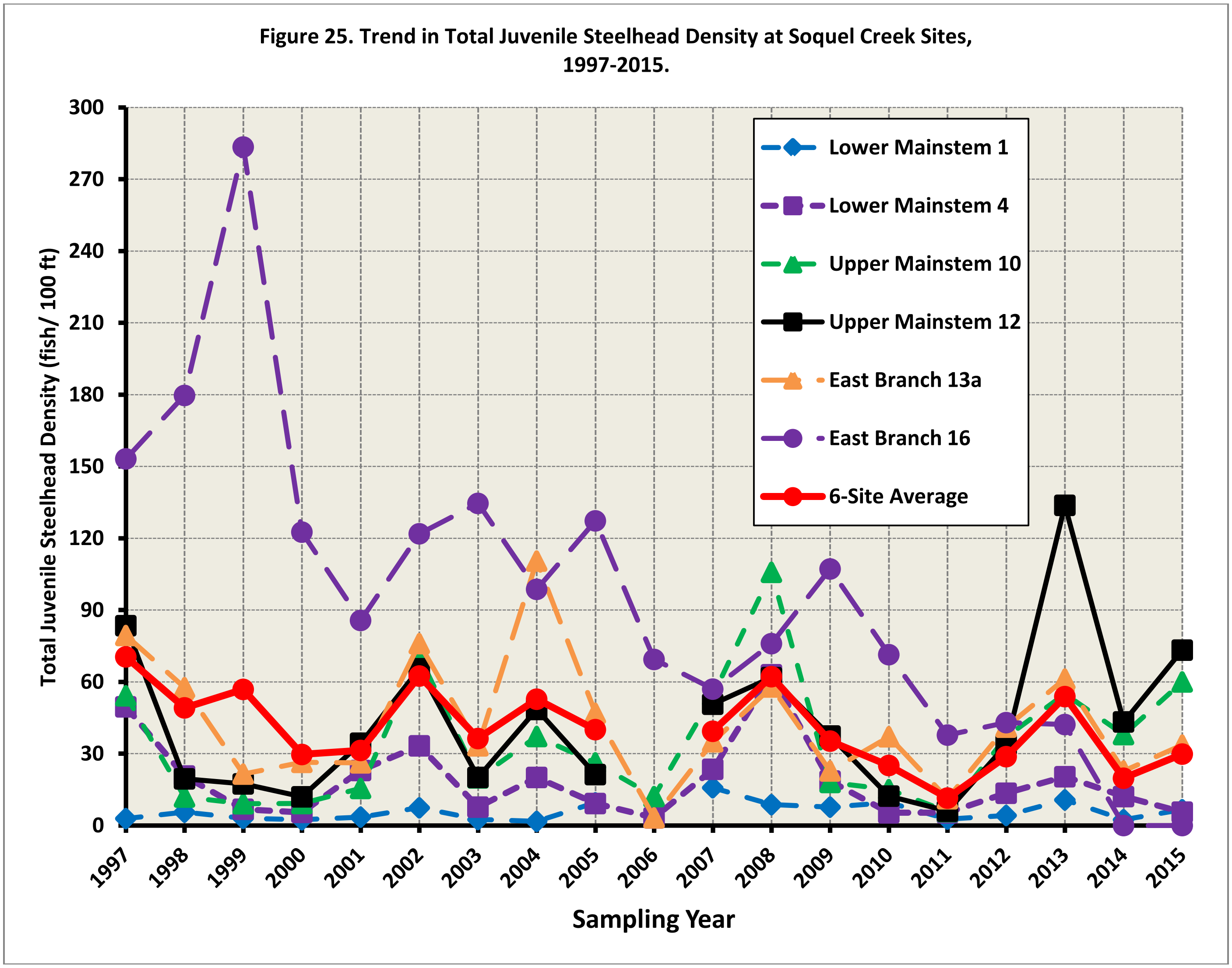


Figure 25. Trend in Total Juvenile Steelhead Density at Soquel Creek Sites, 1997-2015.

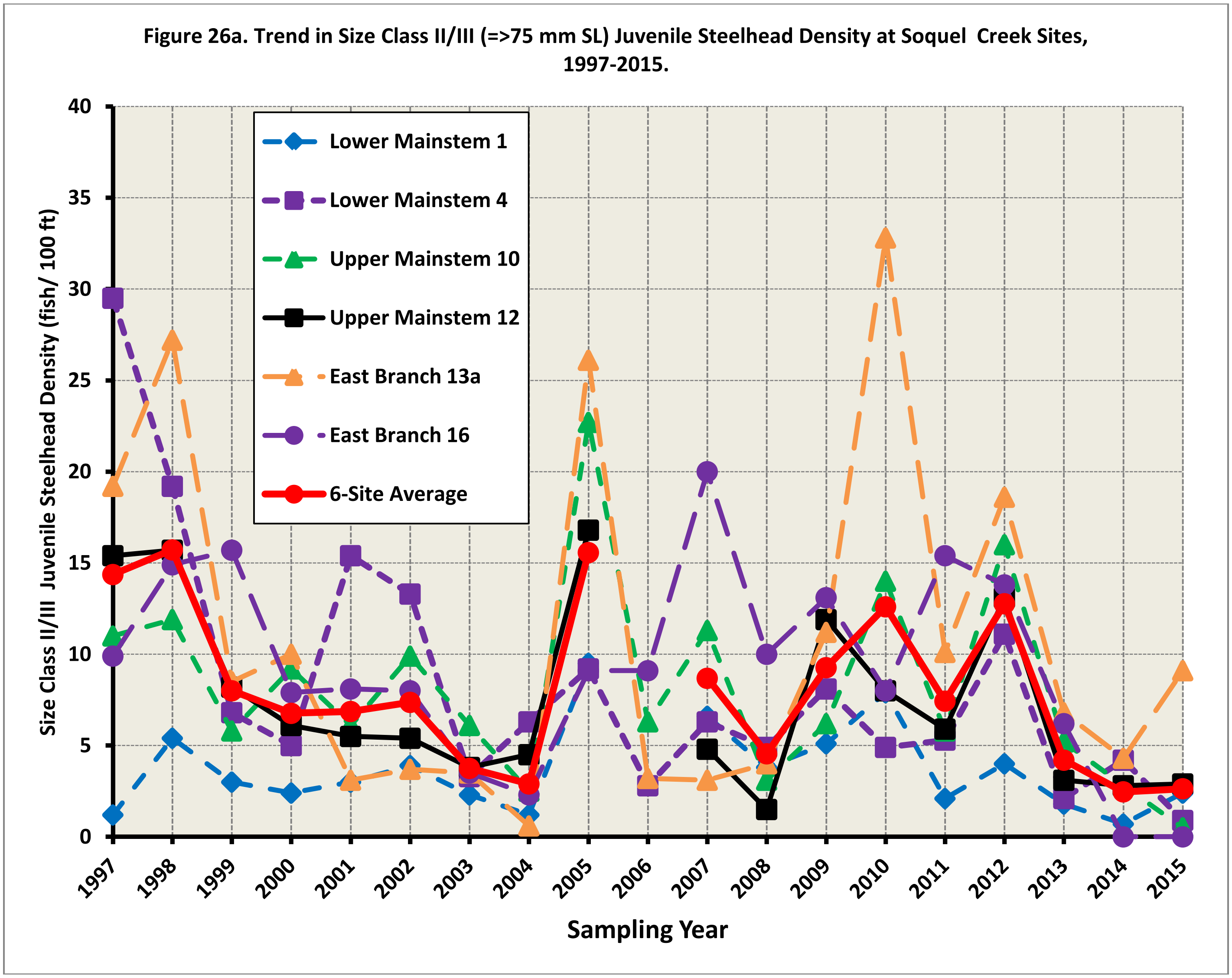


Figure 26a. Trend in Size Class II/III (=>75 mm SL) Juvenile Steelhead Density at Soquel Creek Sites, 1997-2015.

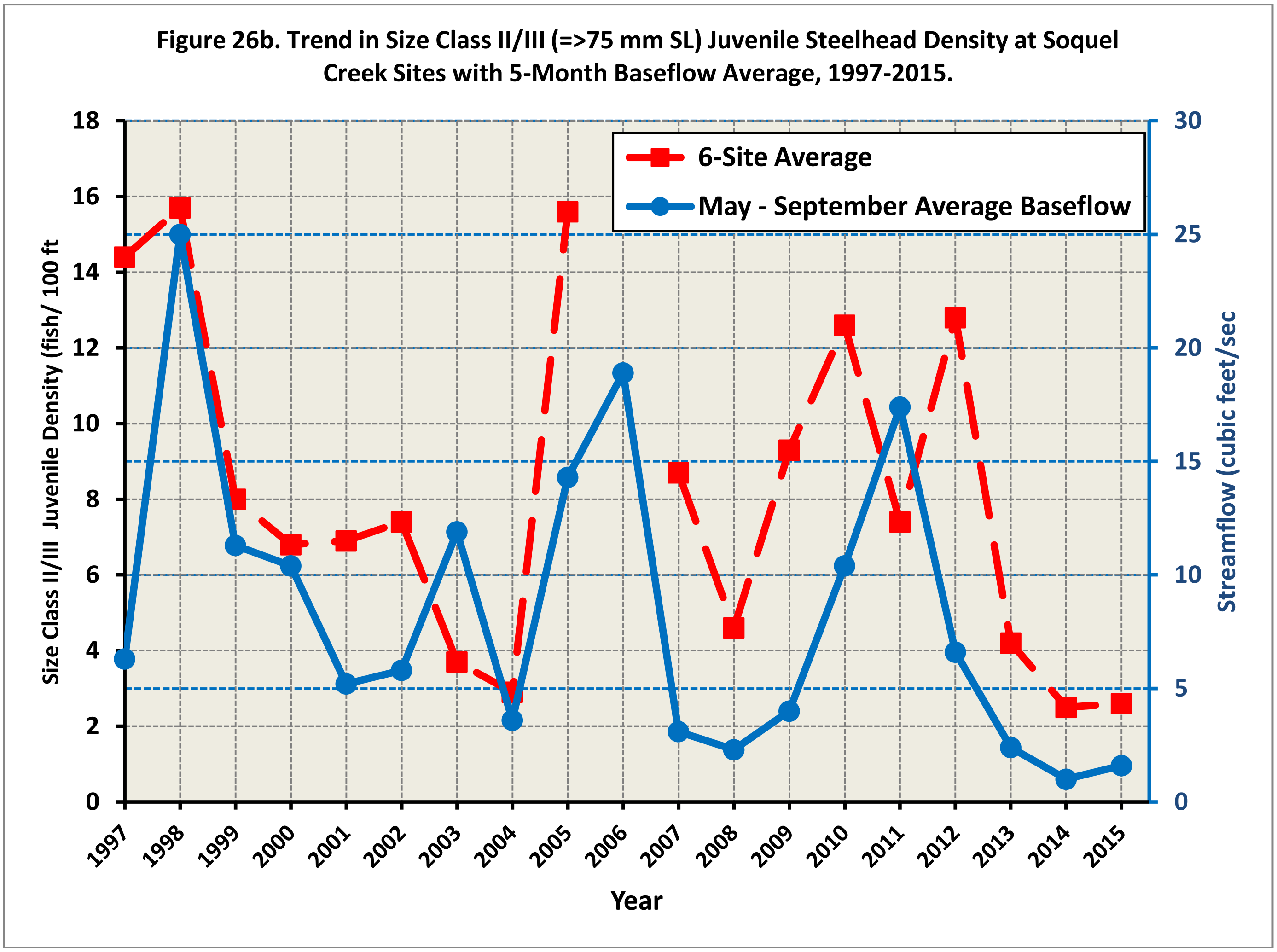


Figure 26b. Trend in Size Class II/III (=>75 mm SL) Juvenile Steelhead Density at Soquel Creek Sites with 5-Month Baseflow Average, 1997-2015.

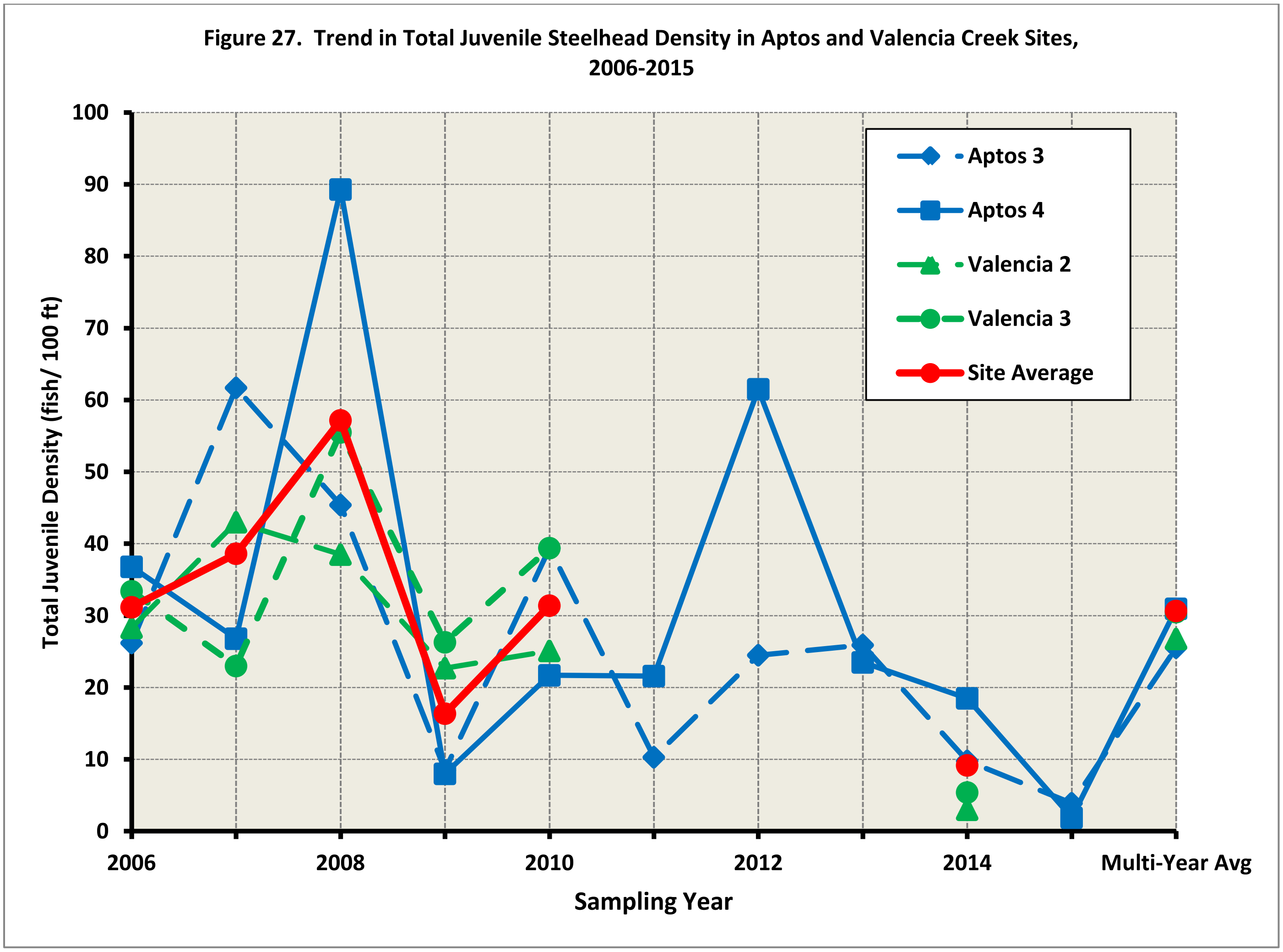


Figure 27. Trend in Total Juvenile Steelhead Density in Aptos and Valencia Creek Sites, 2006-2015.

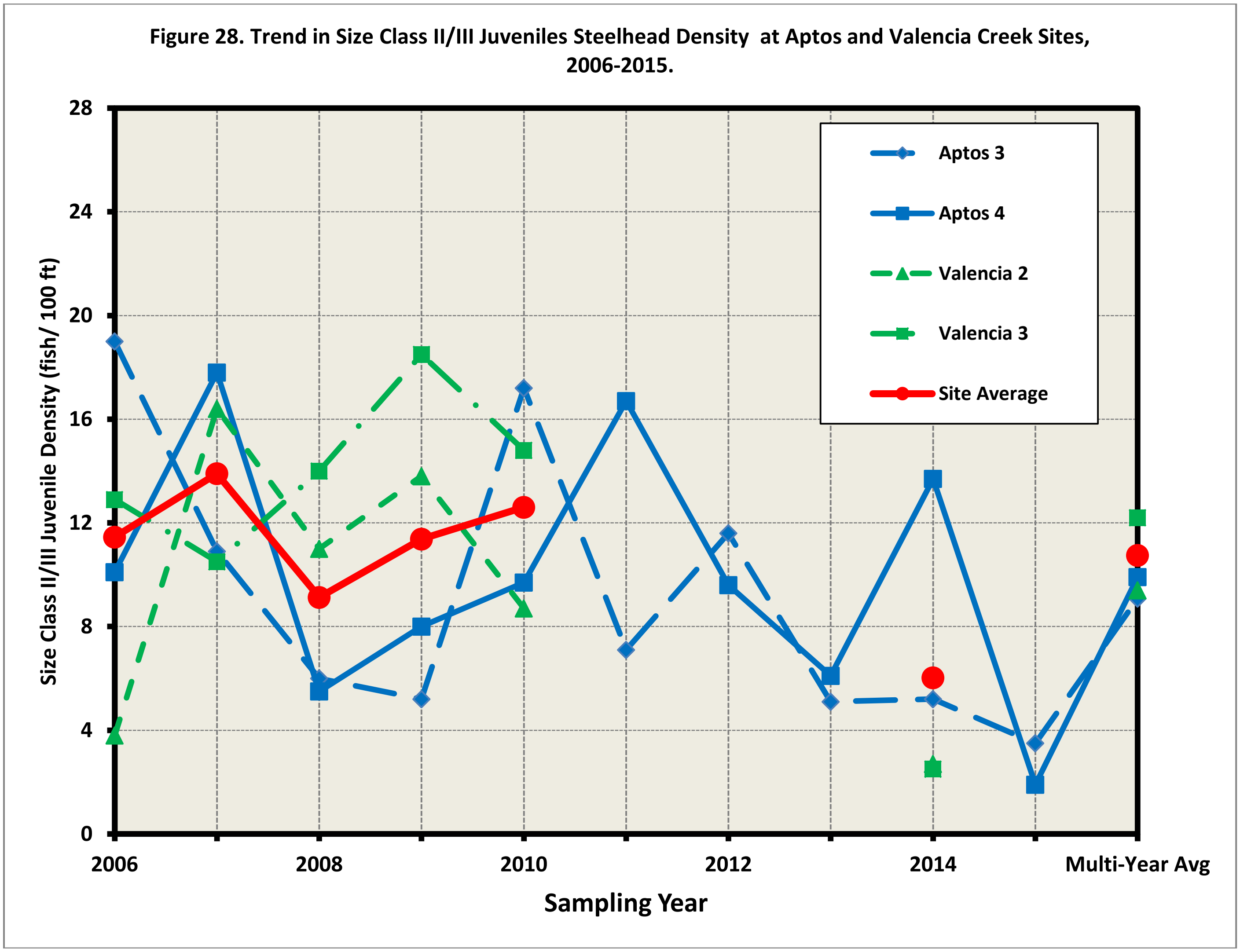


Figure 28. Trend in Size Class II/III Juveniles Steelhead Density at Aptos and Valencia Creek Sites, 2006-2015.

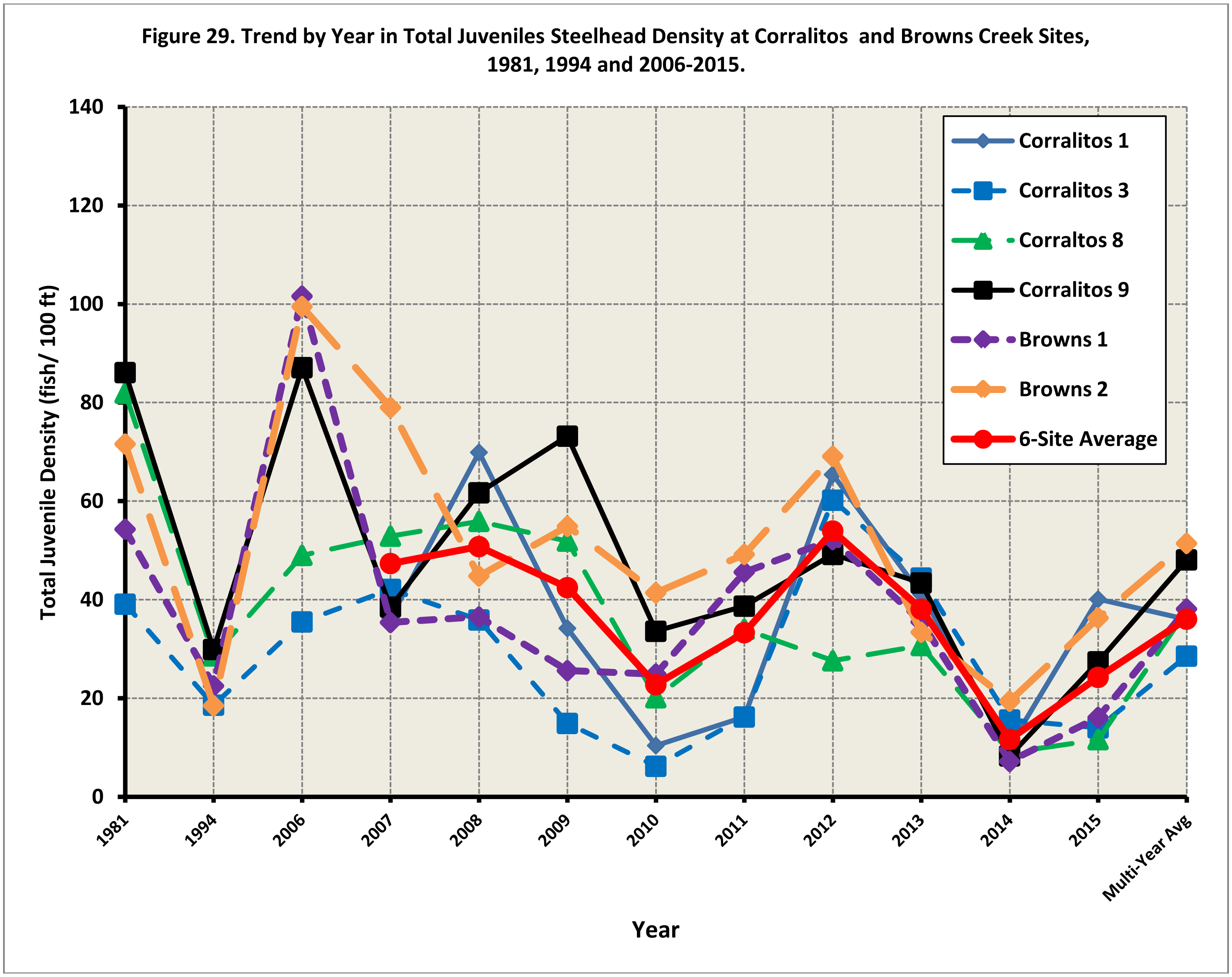


Figure 29. Trend by Year in Total Juveniles Steelhead Density at Corralitos and Browns Creek Sites, 1981, 1994 and 2006-2015.

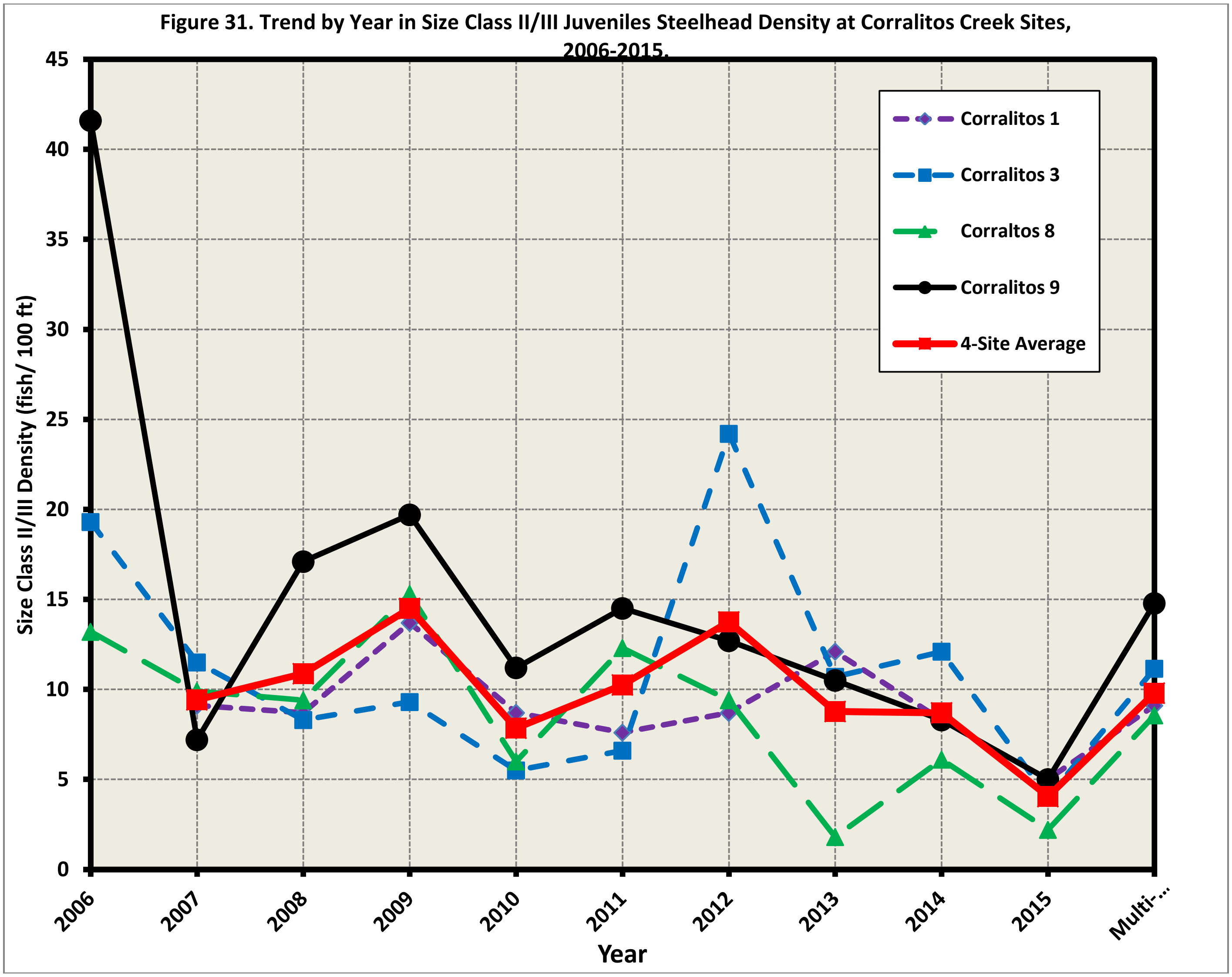


Figure 31. Trend by Year in Size Class II/III Juveniles Steelhead Density at Corralitos Creek Sites, 2006-2015.

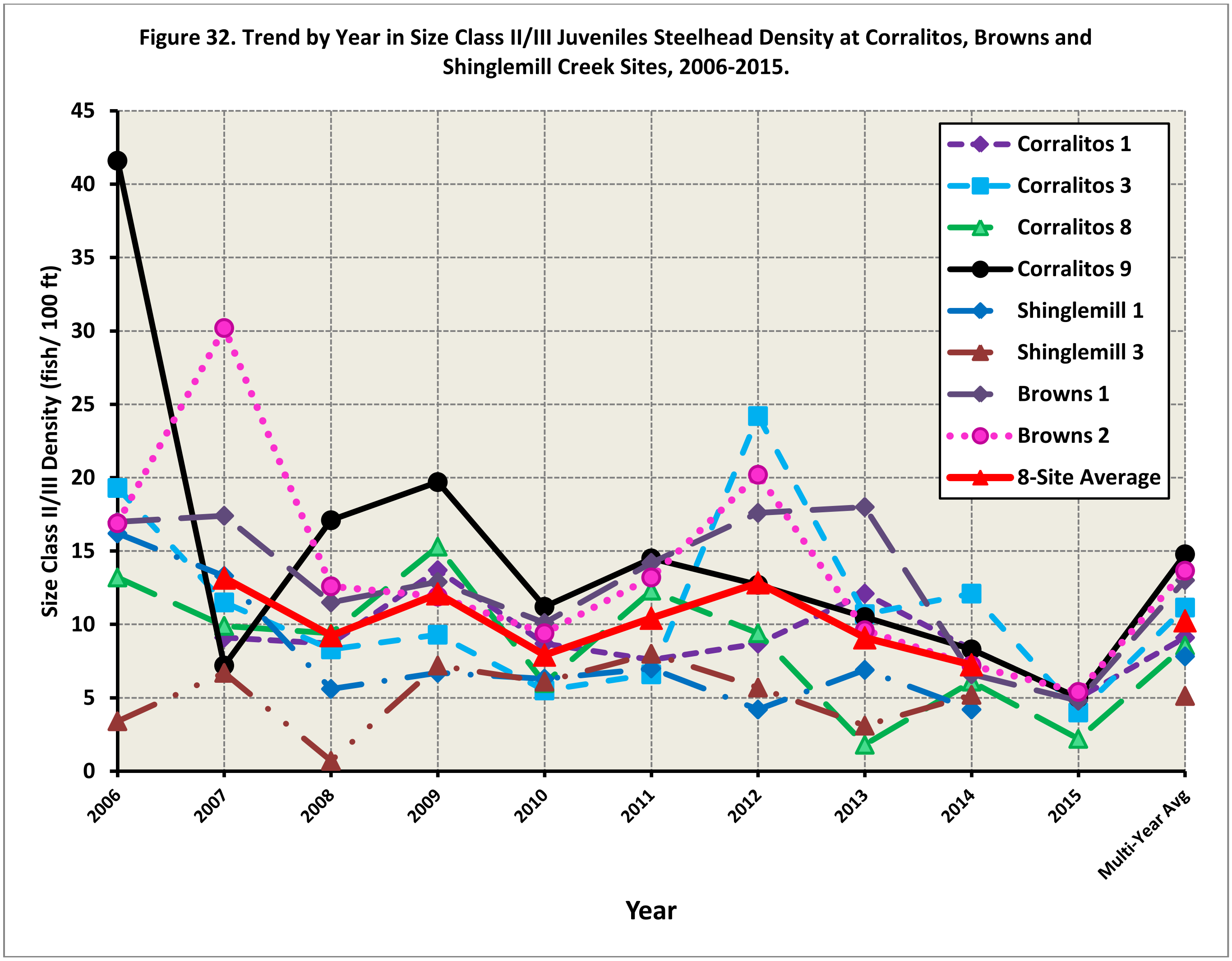


Figure 32. Trend by Year in Size Class II/III Juveniles Steelhead Density at Corralitos, Browns and Shinglemill Creek Sites, 2006-2015.

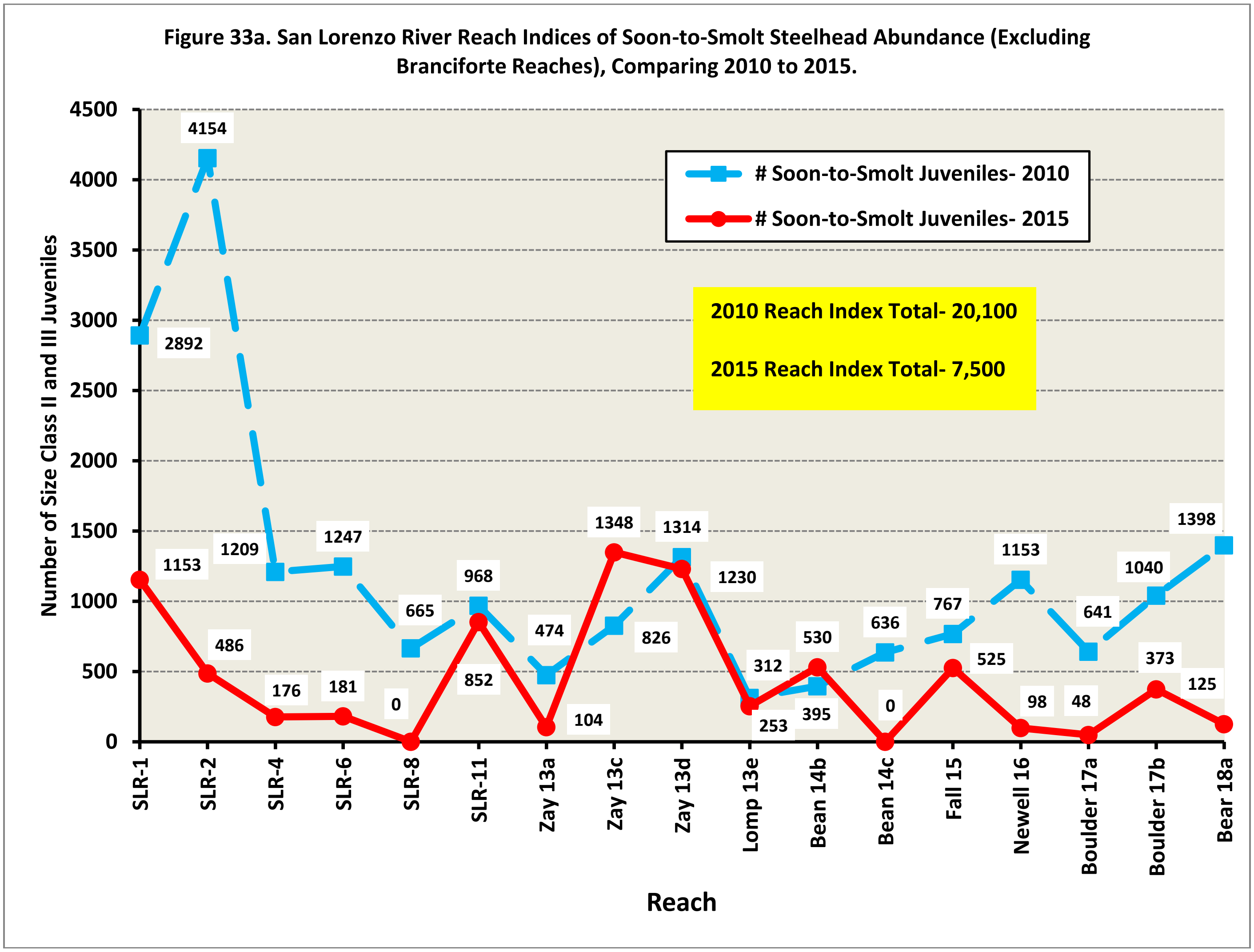


Figure 33a. San Lorenzo River Reach Indices of Soon-to-Smolt Steelhead Abundance, Comparing 2010 to 2015.

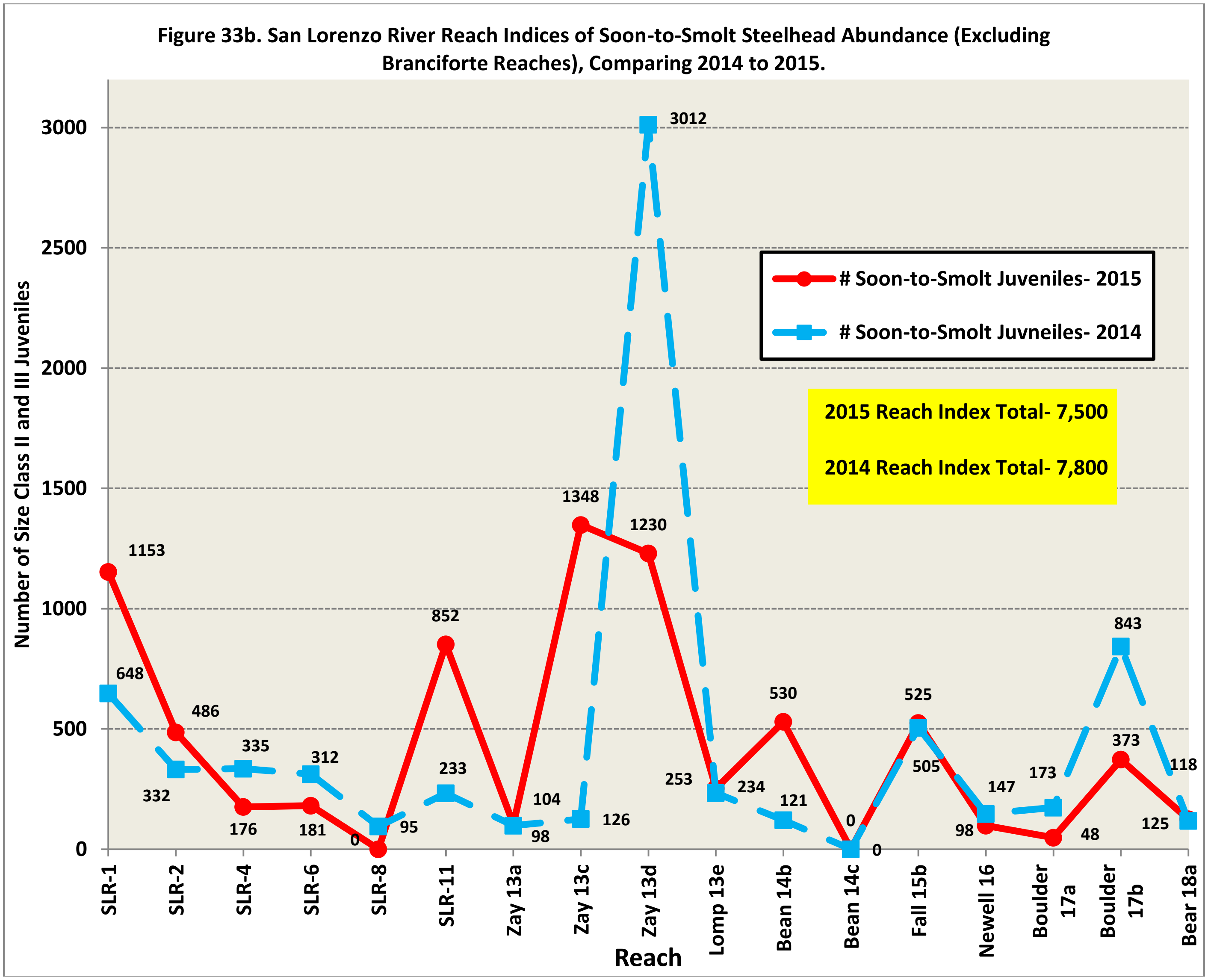


Figure 33b. San Lorenzo River Reach Indices of Soon-to-Smolt Steelhead Abundance, Comparing 2014 to 2015.

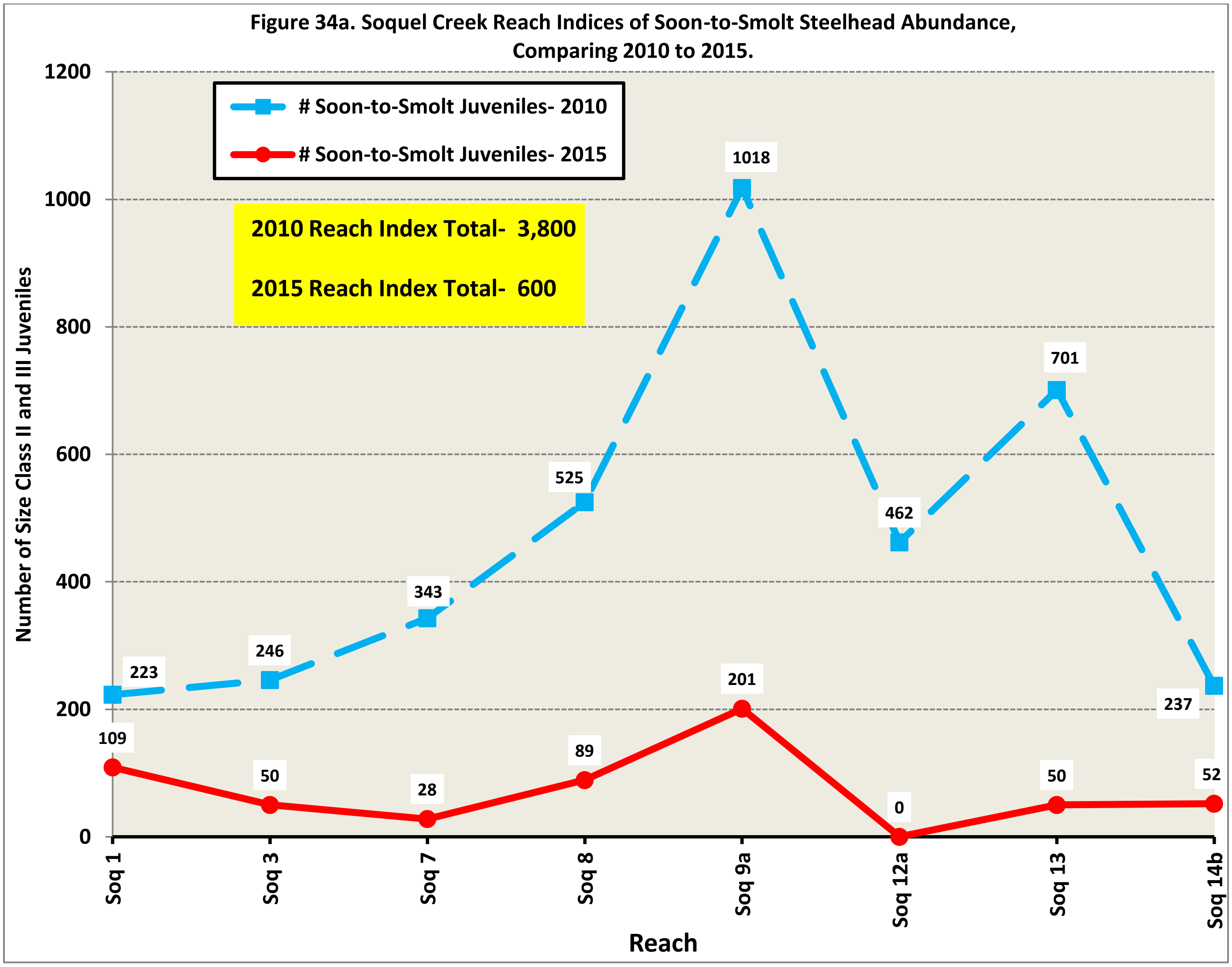


Figure 34a. Soquel Creek Reach Indices of Soon-to-Smolt Steelhead Abundance, Comparing 2010 to 2015.

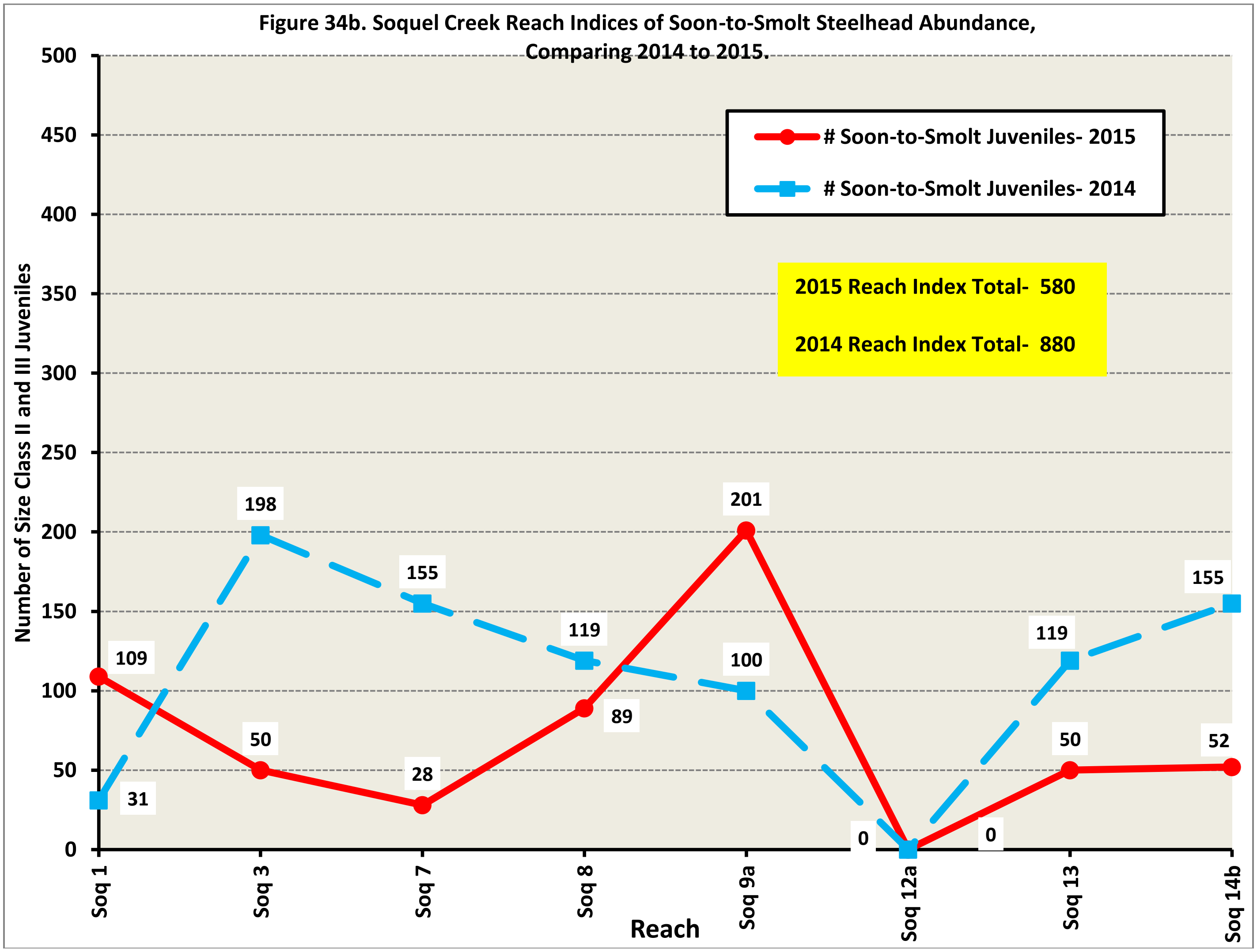


Figure 34b. Soquel Creek Reach Indices of Soon-to-Smolt Steelhead Abundance, Comparing 2014 to 2015.

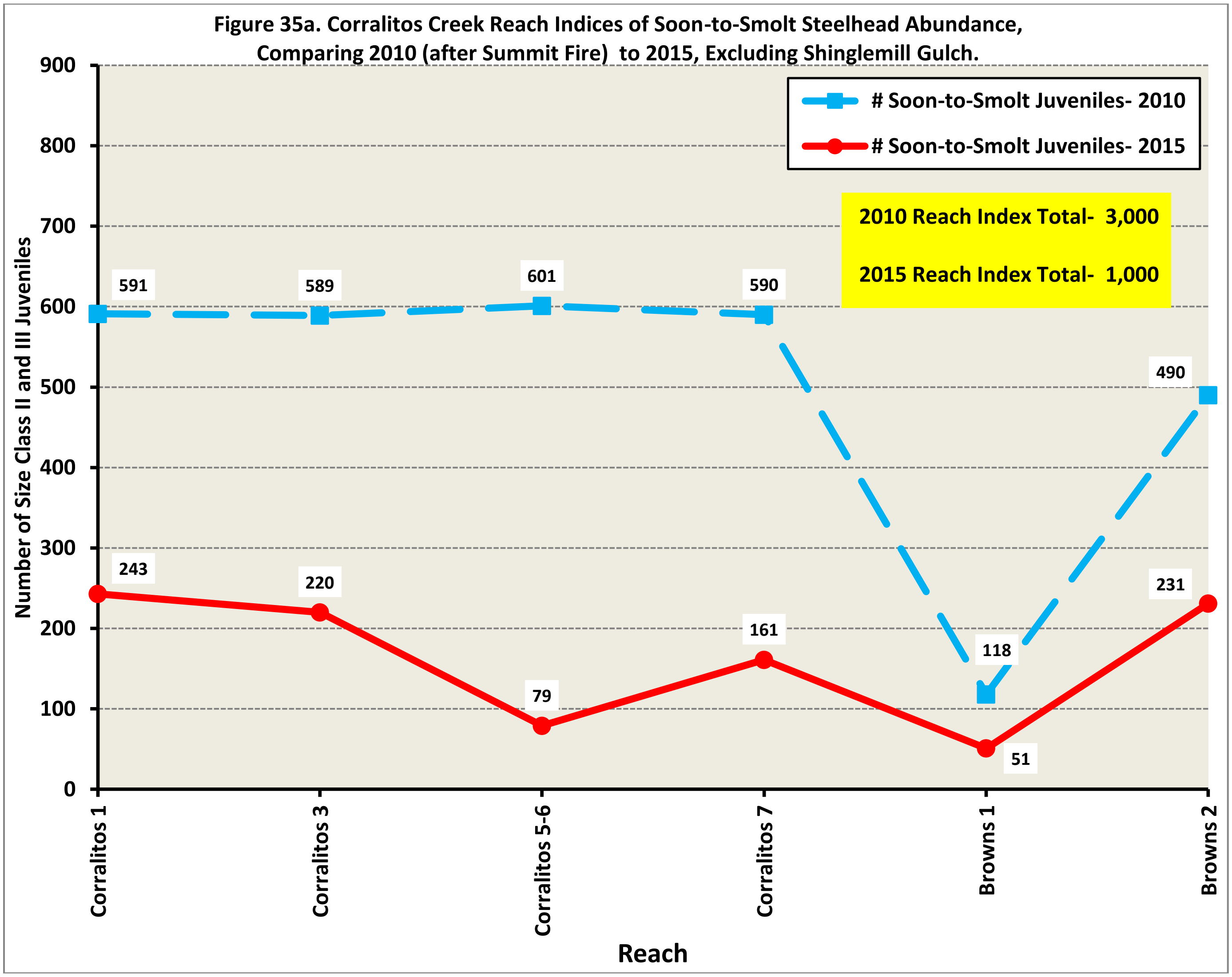


Figure 35a. Corralitos and Browns Creek Reach Indices of Soon-to-Smolt Steelhead Abundance, Comparing 2010 to 2015.

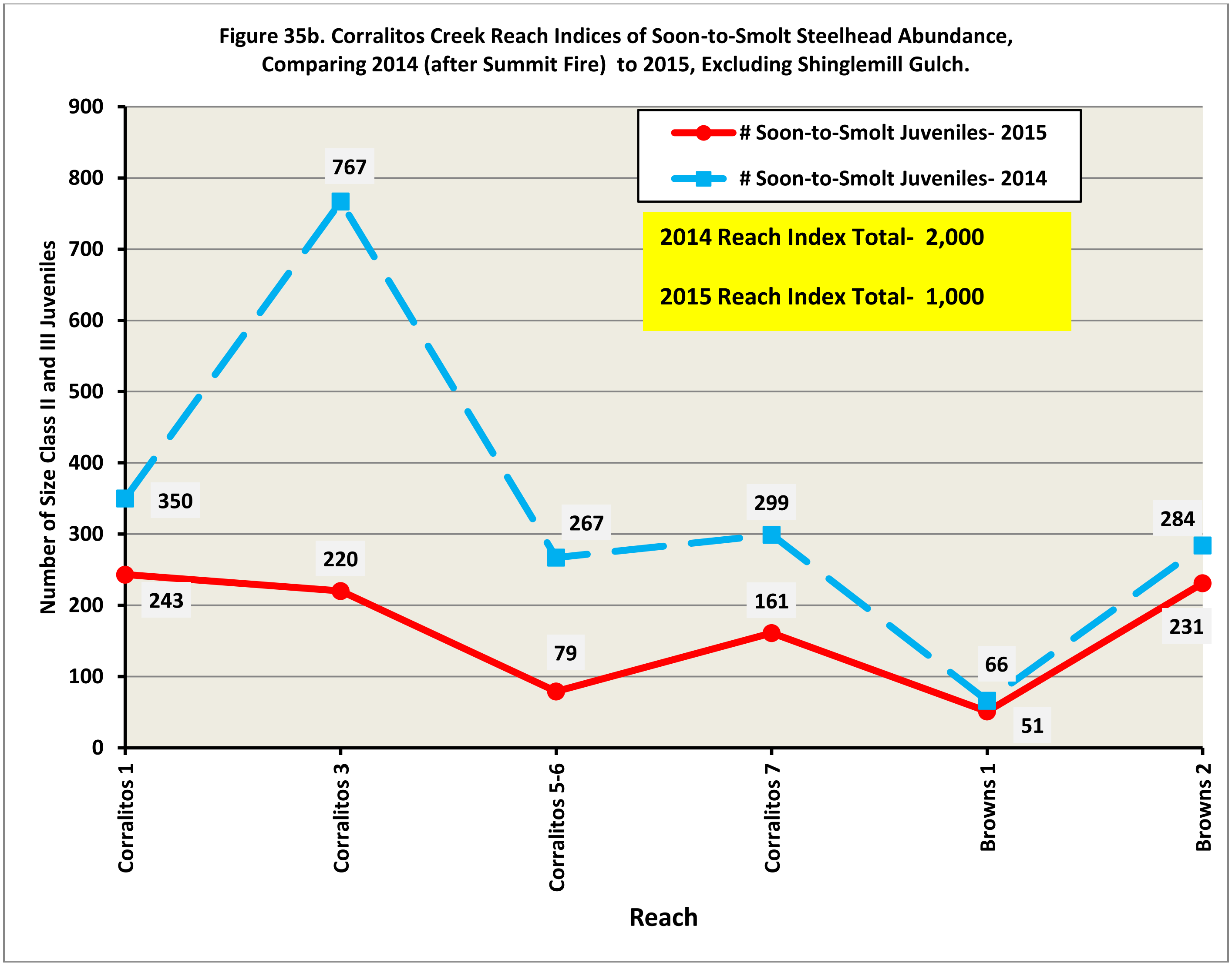


Figure 35b. Corralitos and Browns Creek Reach Indices of Soon-to-Smolt Steelhead Abundance, Comparing 2014 to 2015.

Figure 36a. The 2015 Discharge Flow of Record for the USGS Gage on the San Lorenzo River at Big Trees.

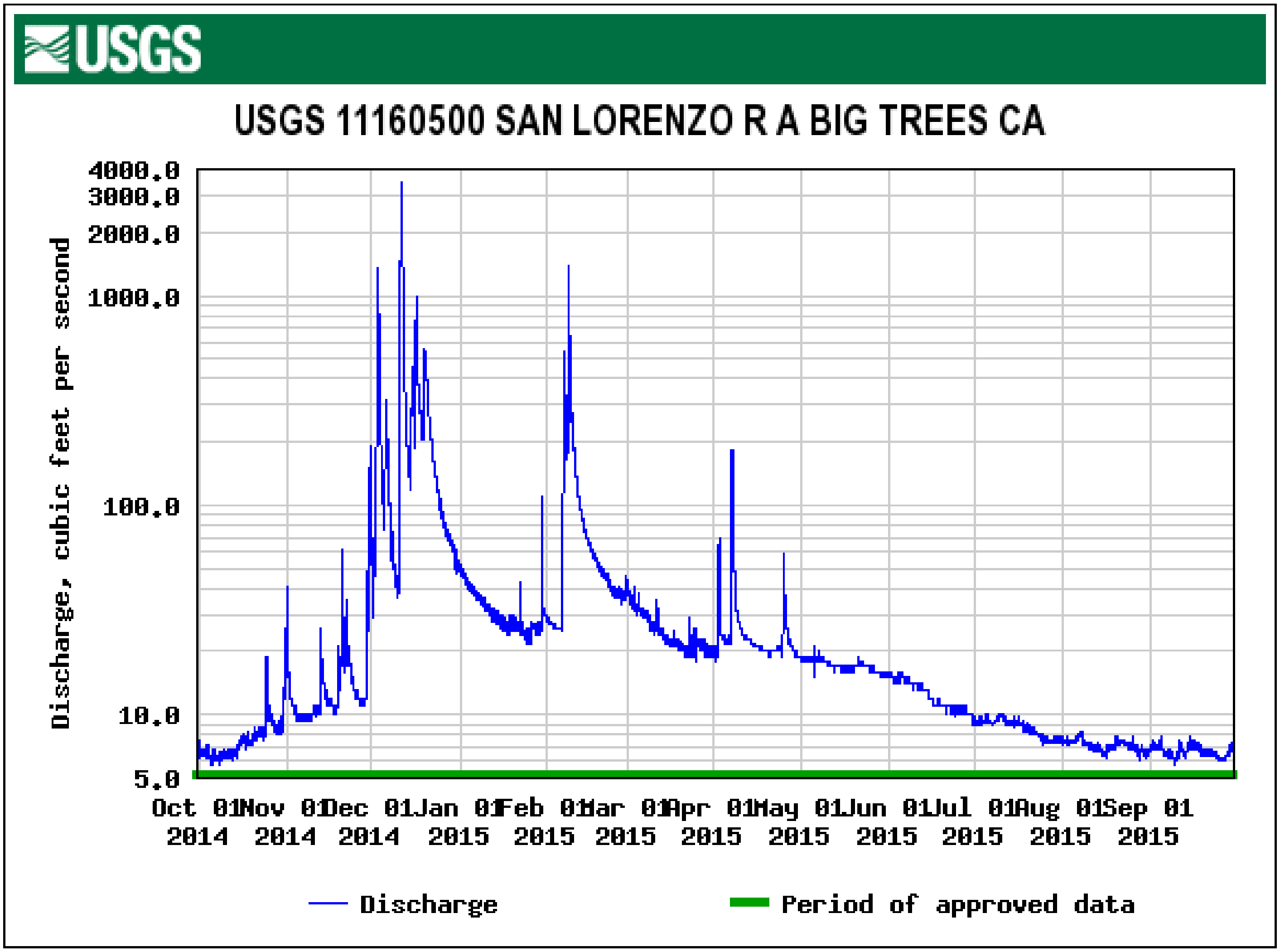


Figure 36b. The 2015 Mean Daily Discharge Flow of Record with Median Statistic for the USGS Gage On the San Lorenzo River at Big Trees.

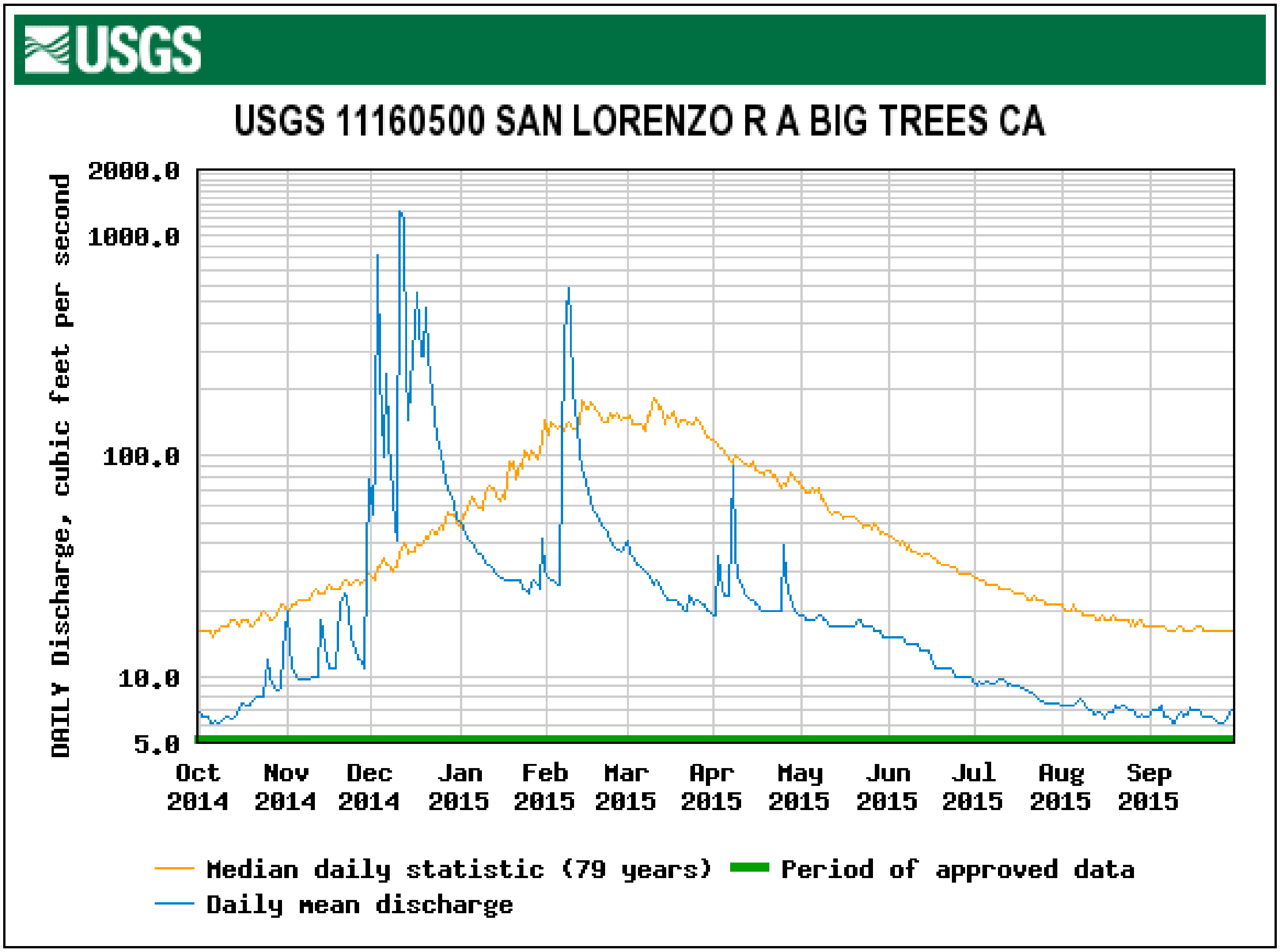


Figure 37a. The 2014 Discharge for the USGS Gage on the San Lorenzo River at Big Trees.

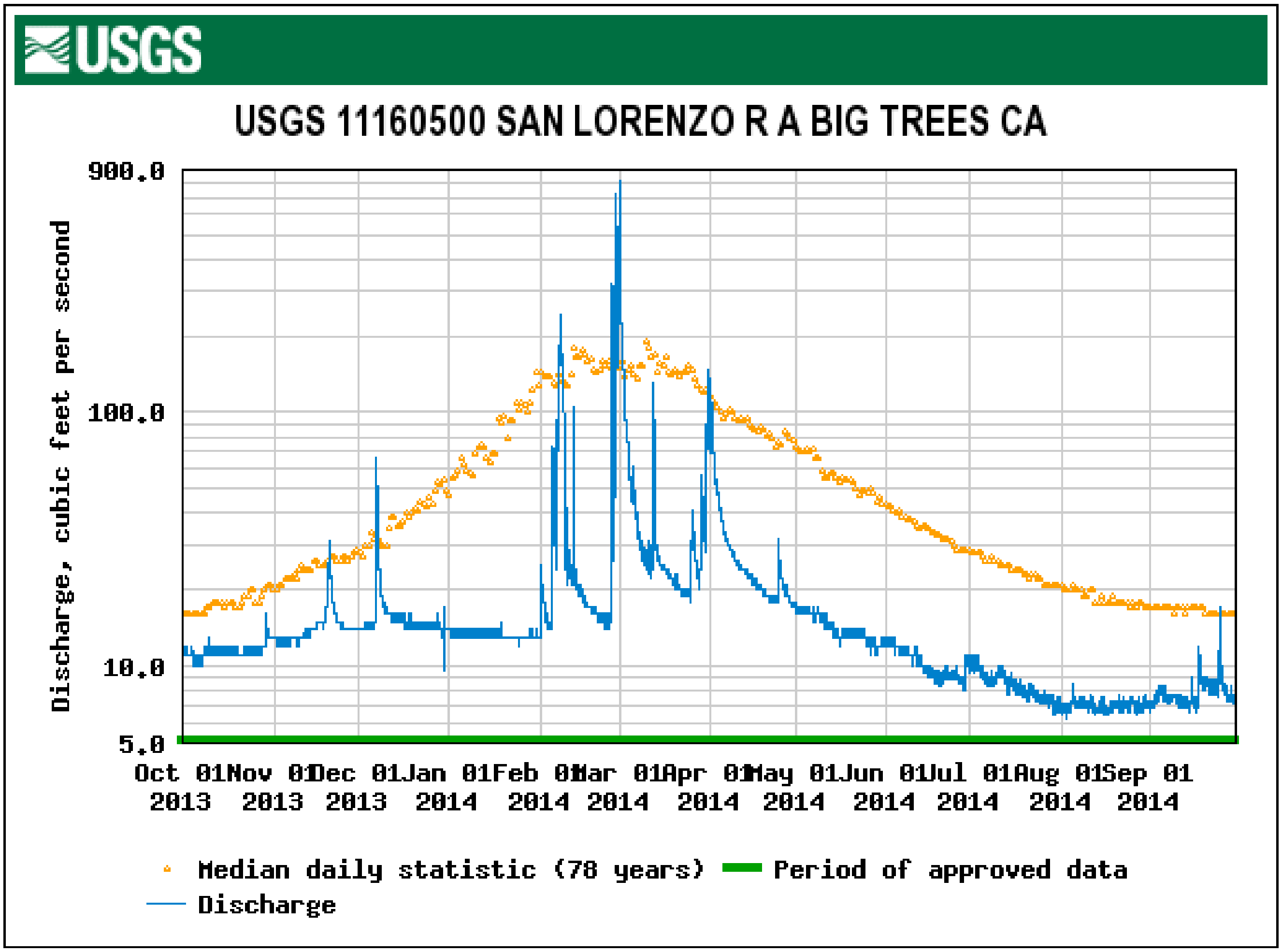


Figure 37b. The 2014 Mean Daily Flow of Record and Median Statistic for the USGS Gage on the San Lorenzo River at Big Trees.

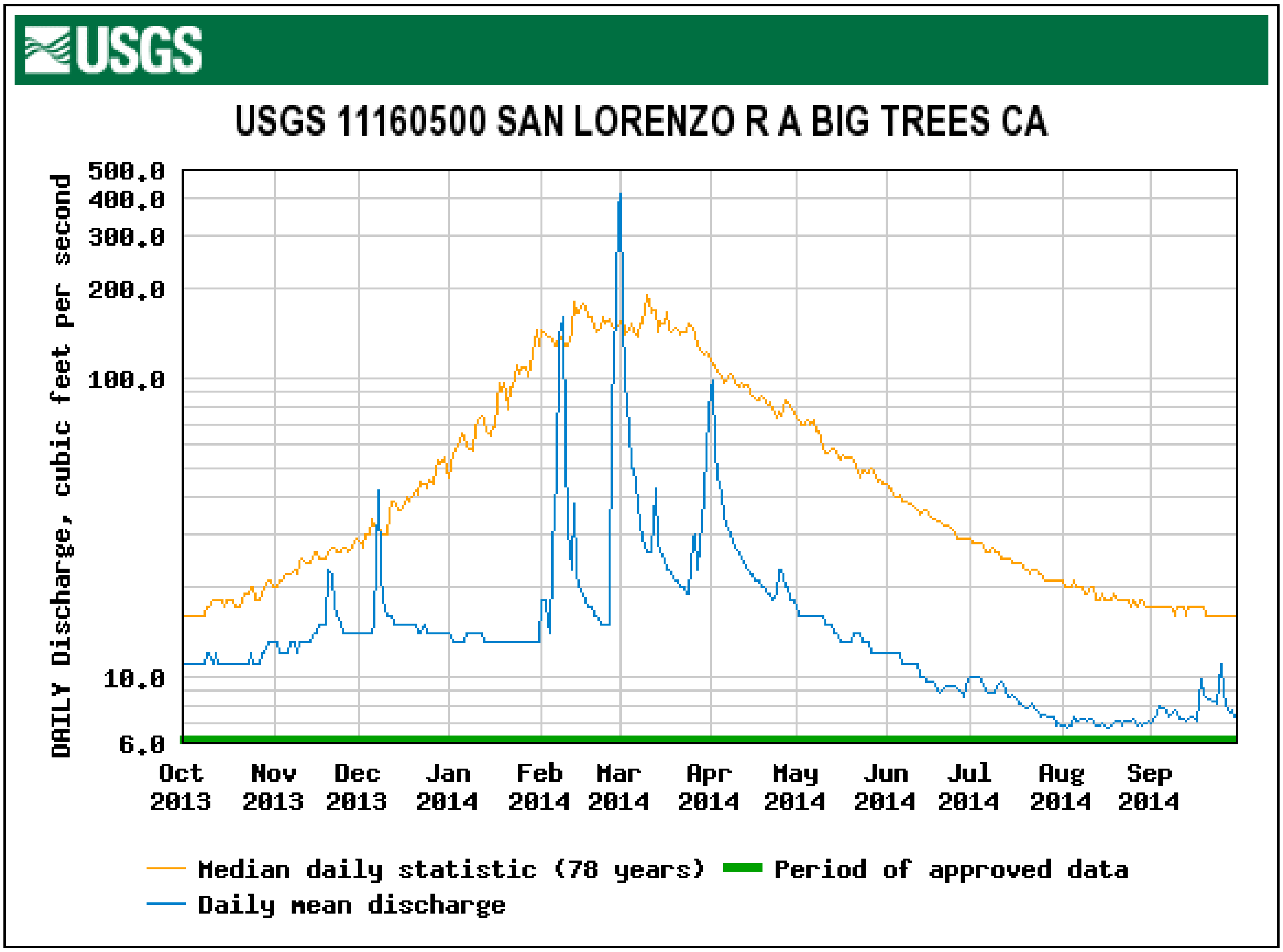


Figure 38a. The March−May 2014 Discharge of Record for the USGS Gage On the San Lorenzo River at Big Trees.

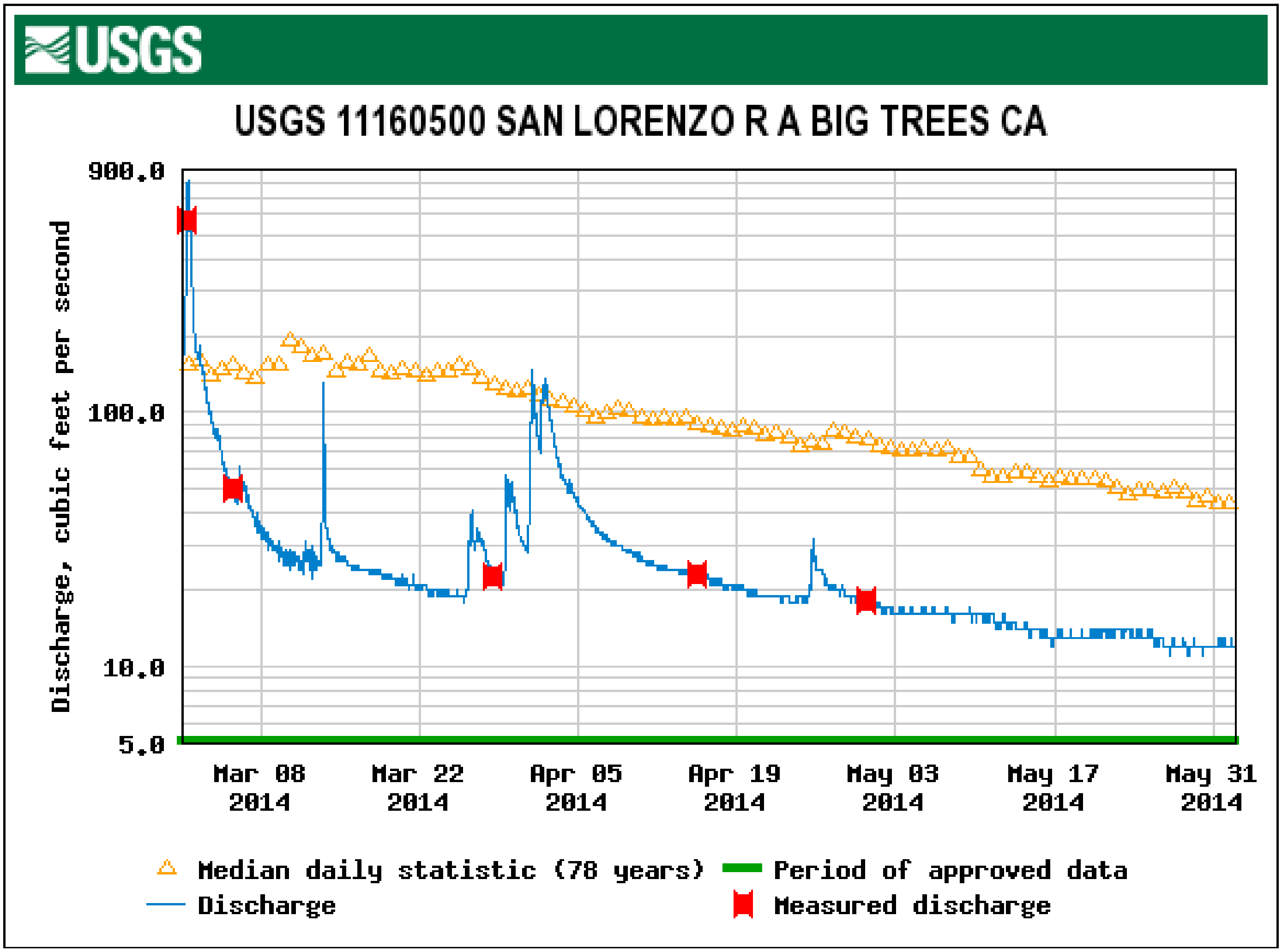


Figure 38b. The March−May 2015 Discharge of Record for the USGS Gage On the San Lorenzo River at Big Trees.

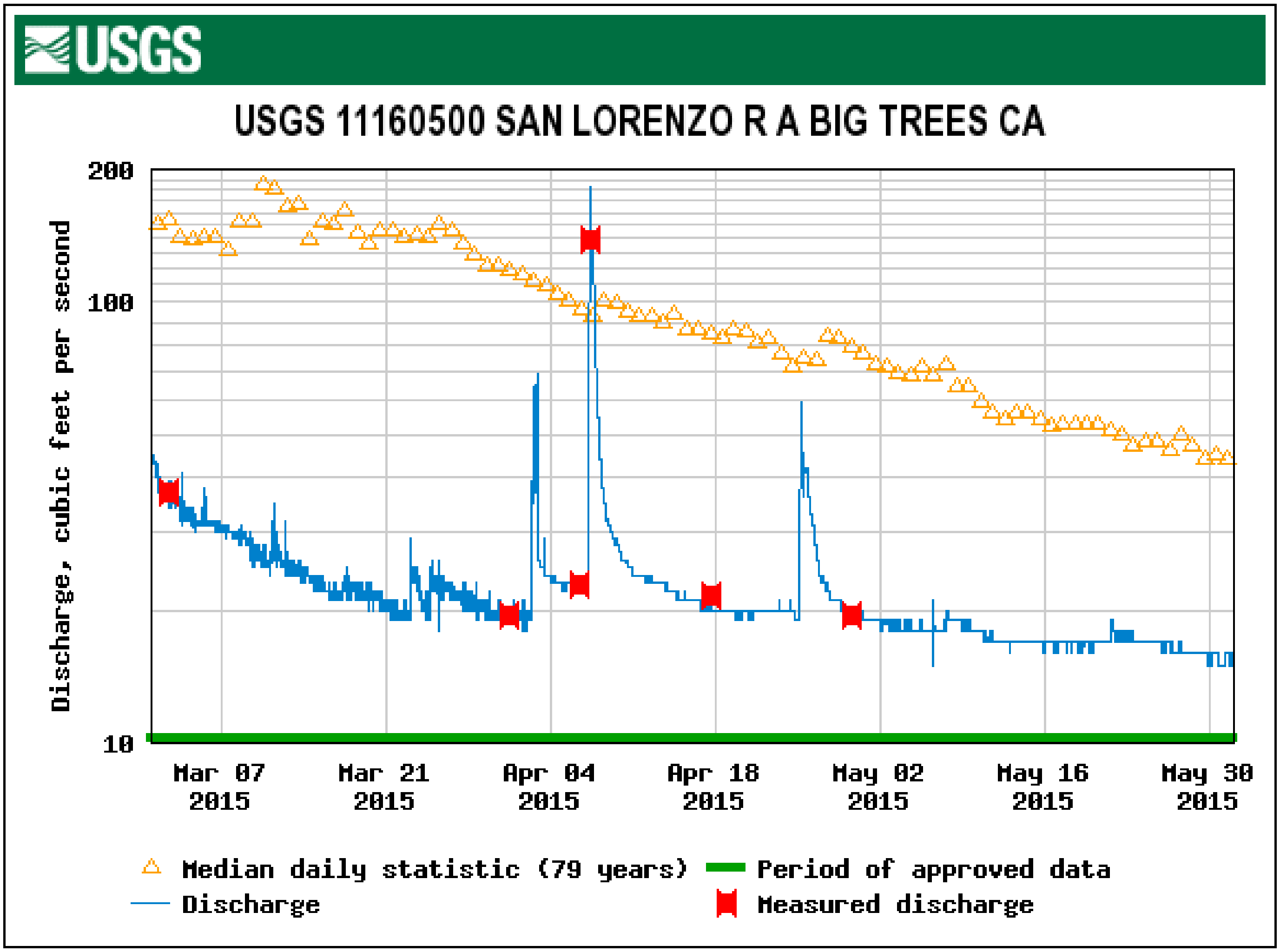


Figure 39a. The 2015 Discharge at the USGS Gage on Soquel Creek at Soquel Village.

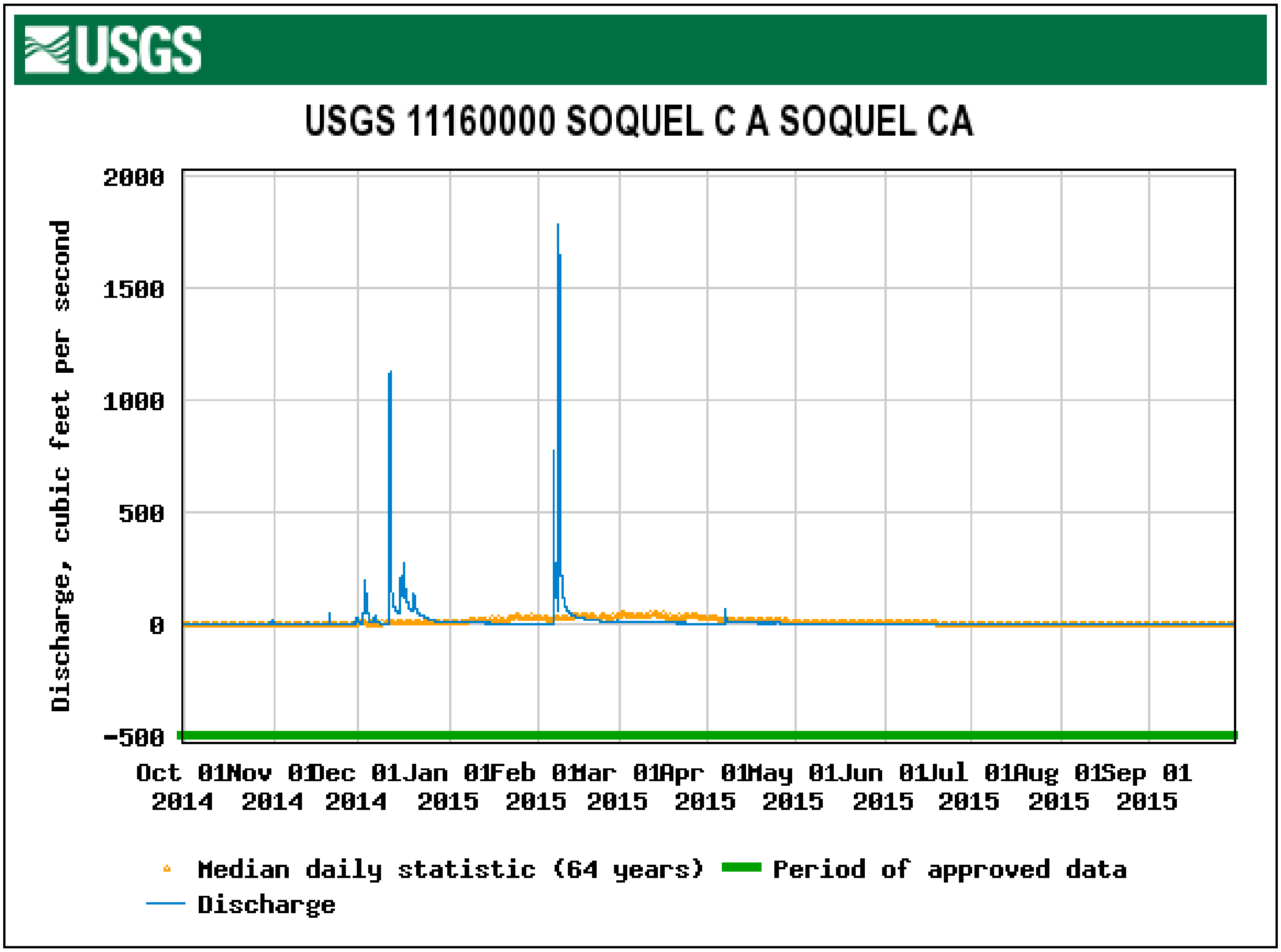


Figure 39b. The 2015 Discharge to 31 May at the USGS Gage on Soquel Creek at Soquel Village.

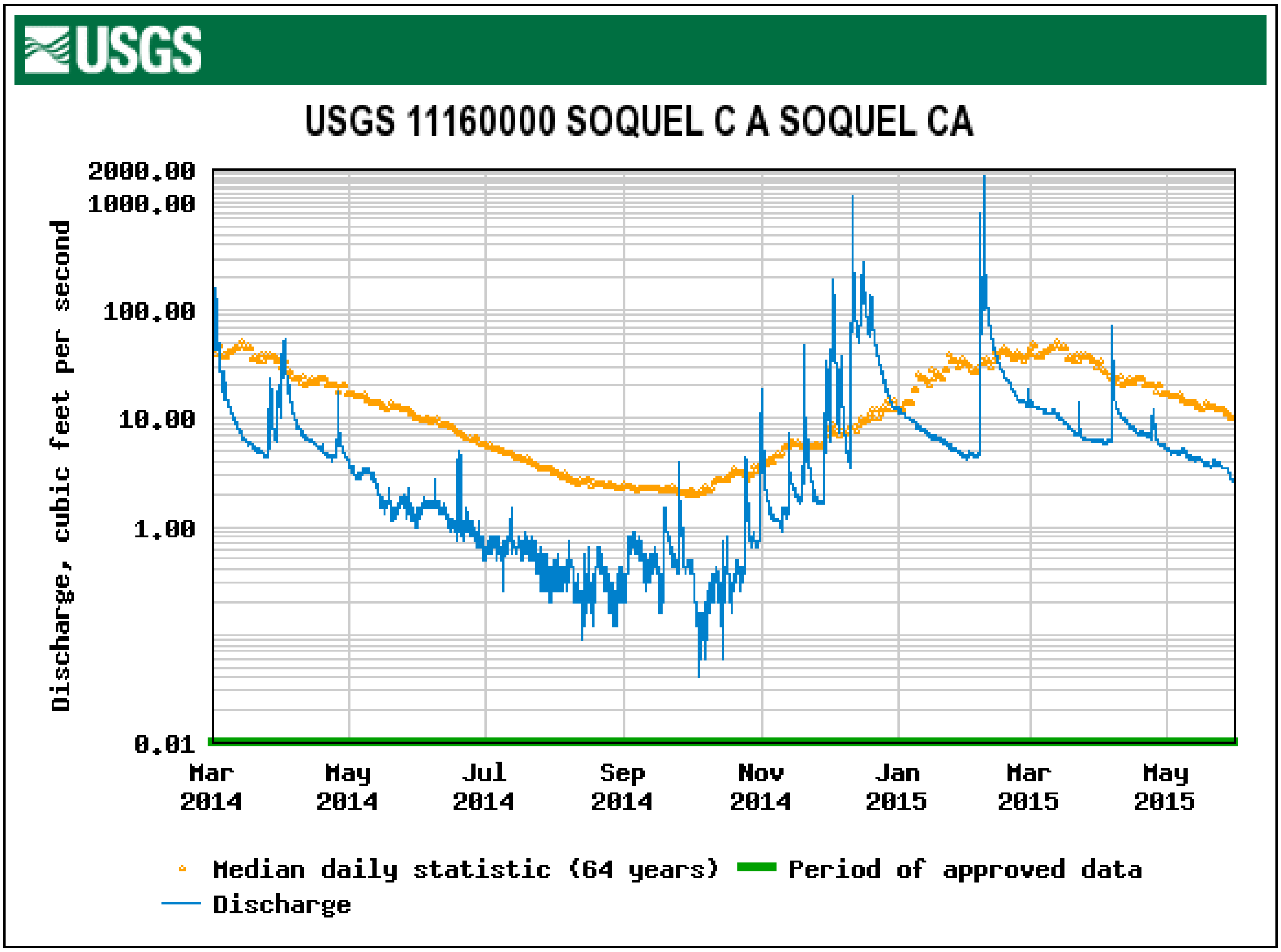


Figure 39c. The 2015 Daily Mean and Median Flow at the USGS Gage on Soquel Creek at Soquel Village.

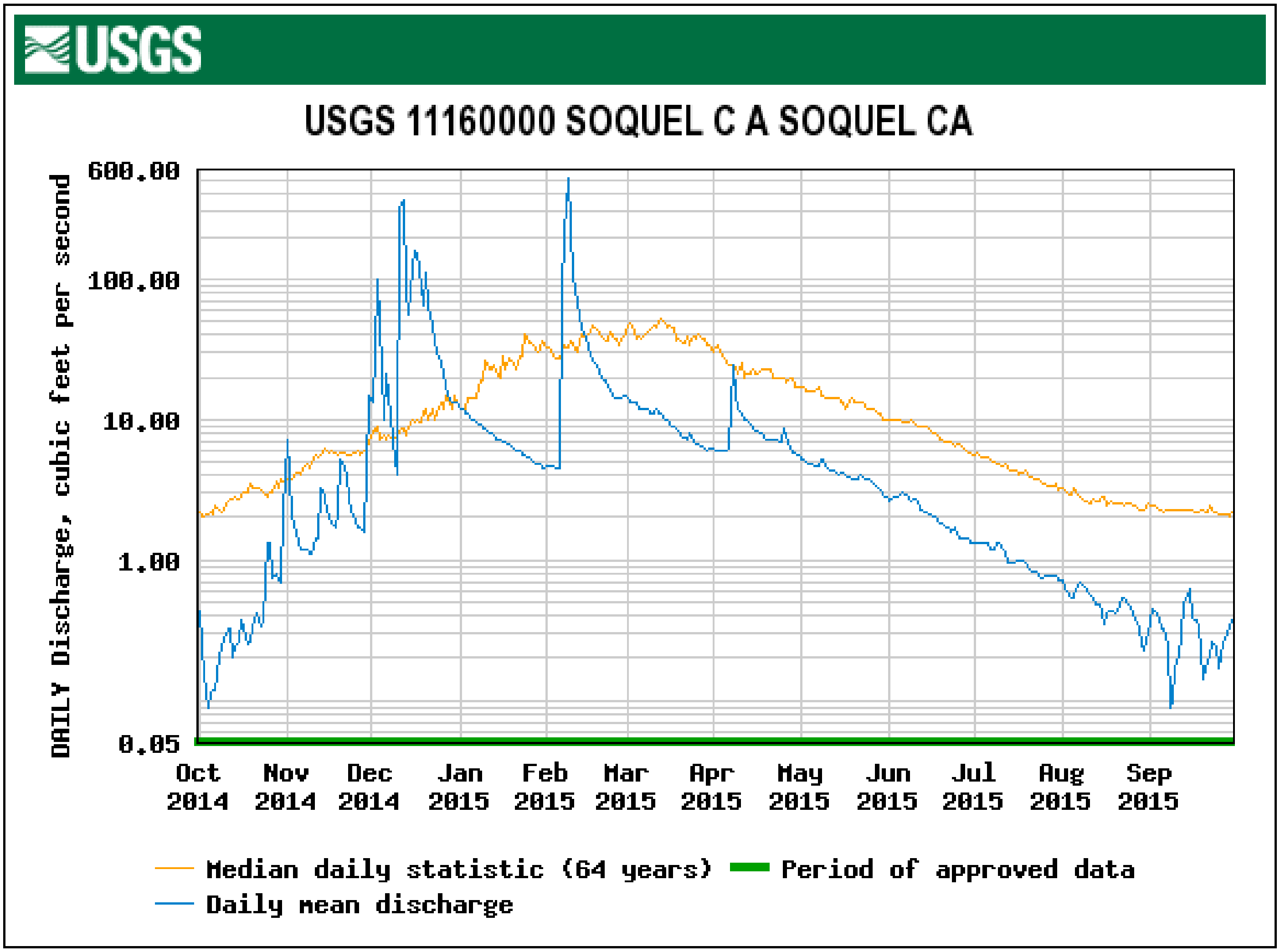


Figure 40a. The 2014 Discharge at the USGS Gage on Soquel Creek at Soquel Village.

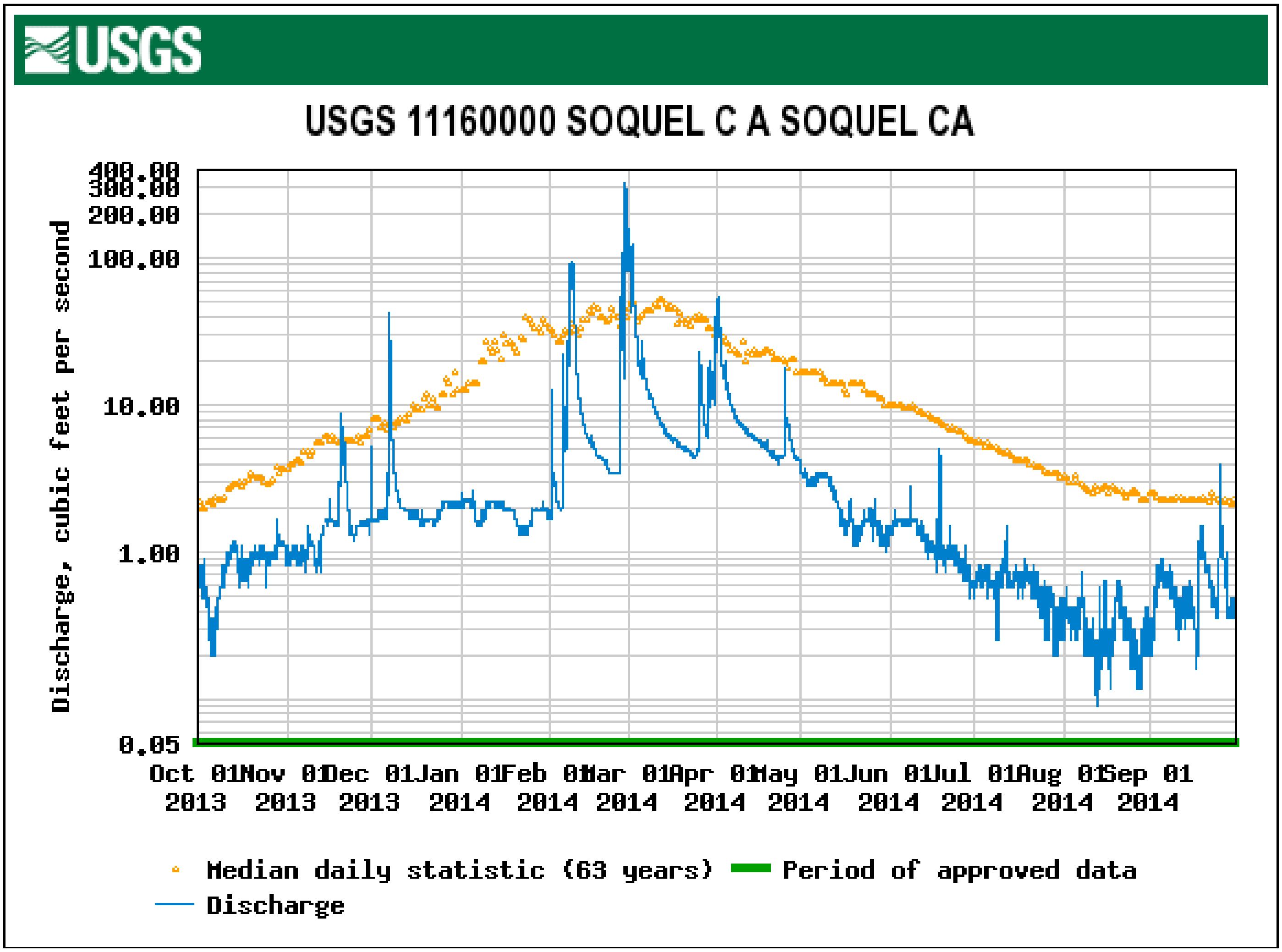


Figure 40b. The 2014 Daily Mean and Median Flow at the USGS Gage on Soquel Creek at Soquel Village.

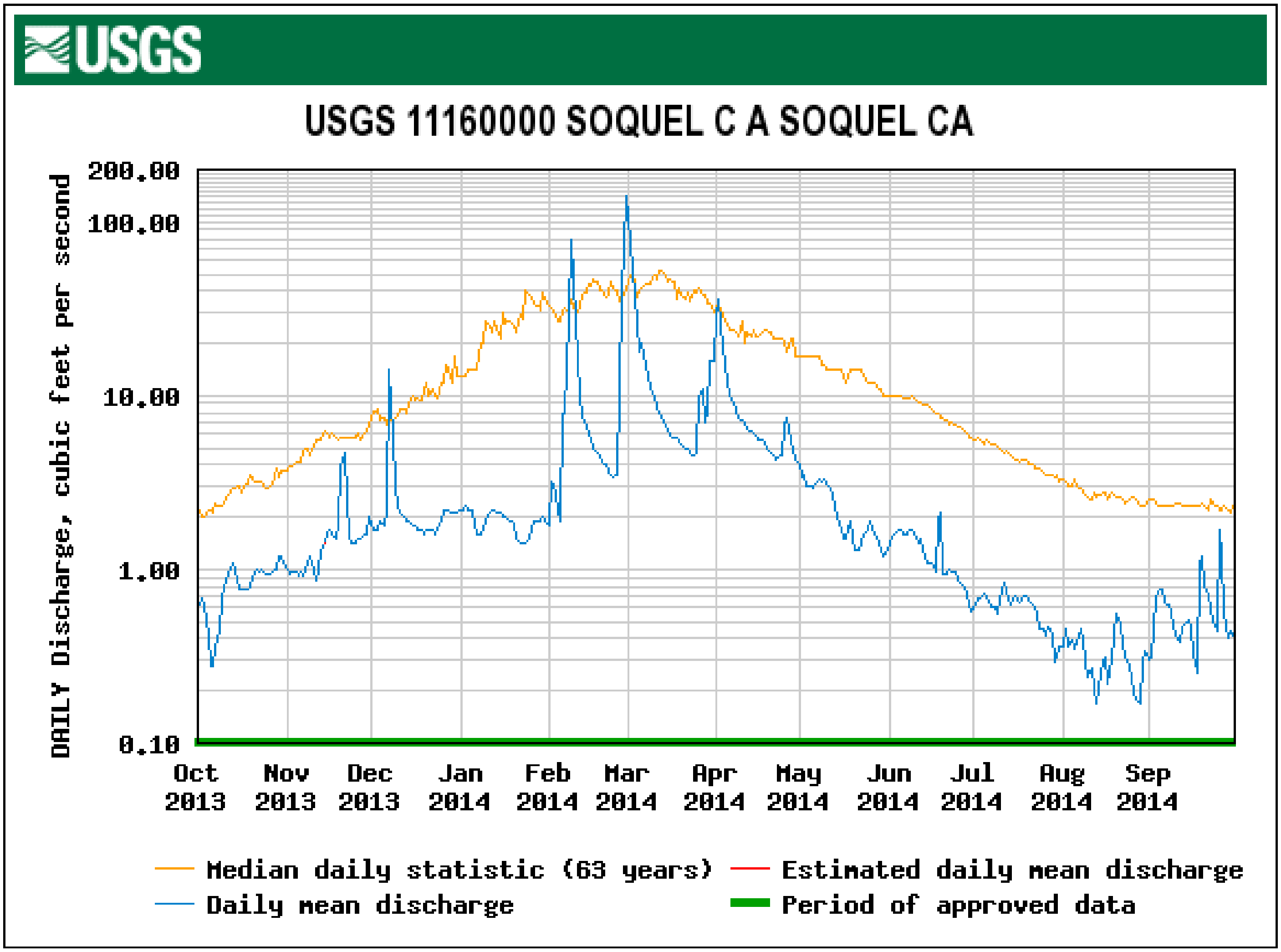


Figure 41a. The March−May 2015 Discharge of Record for the USGS Gage on Soquel Creek at Soquel Village.

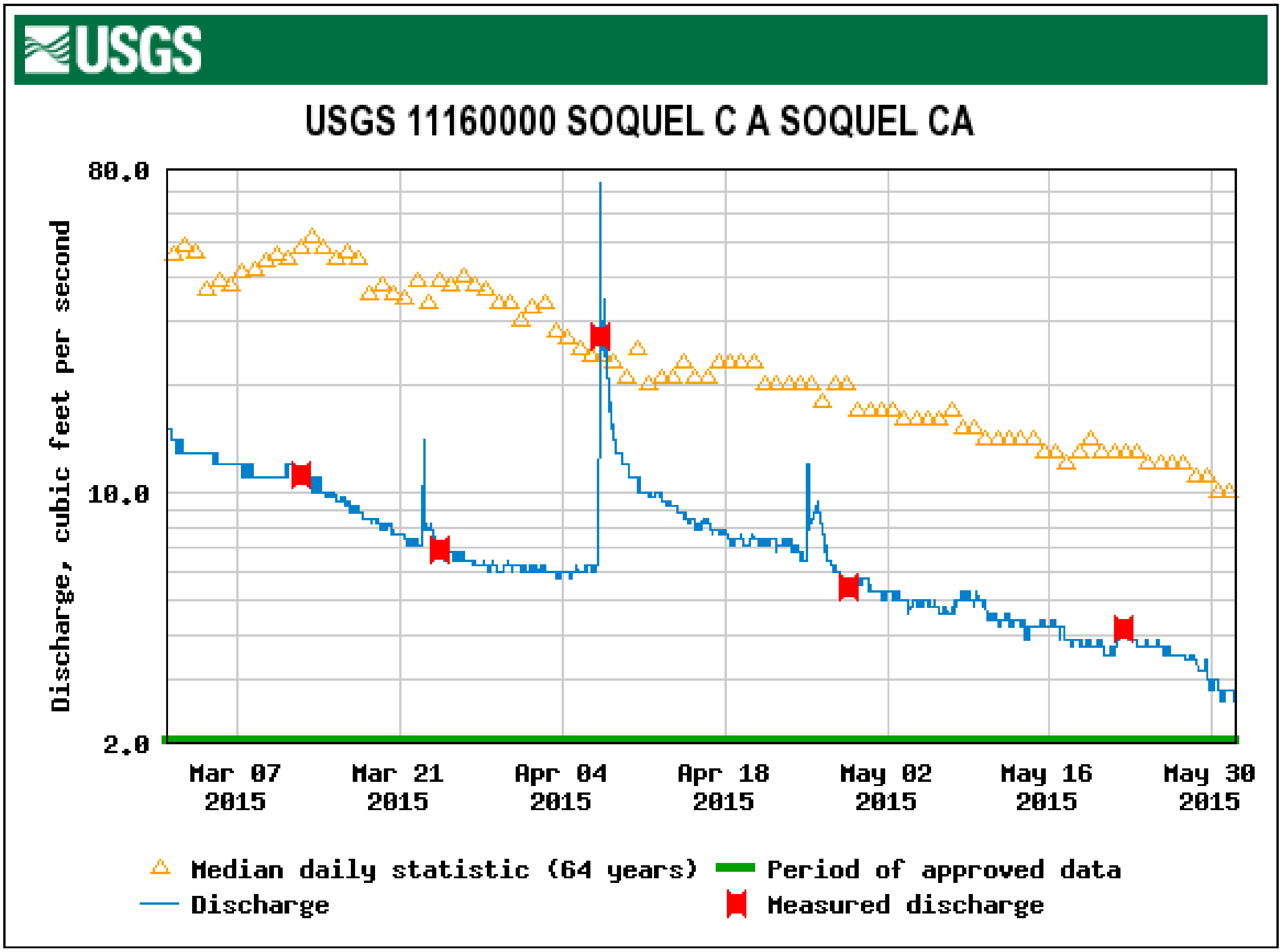


Figure 41b. The March–May 2014 Discharge of Record for the USGS Gage on Soquel Creek at Soquel Village.

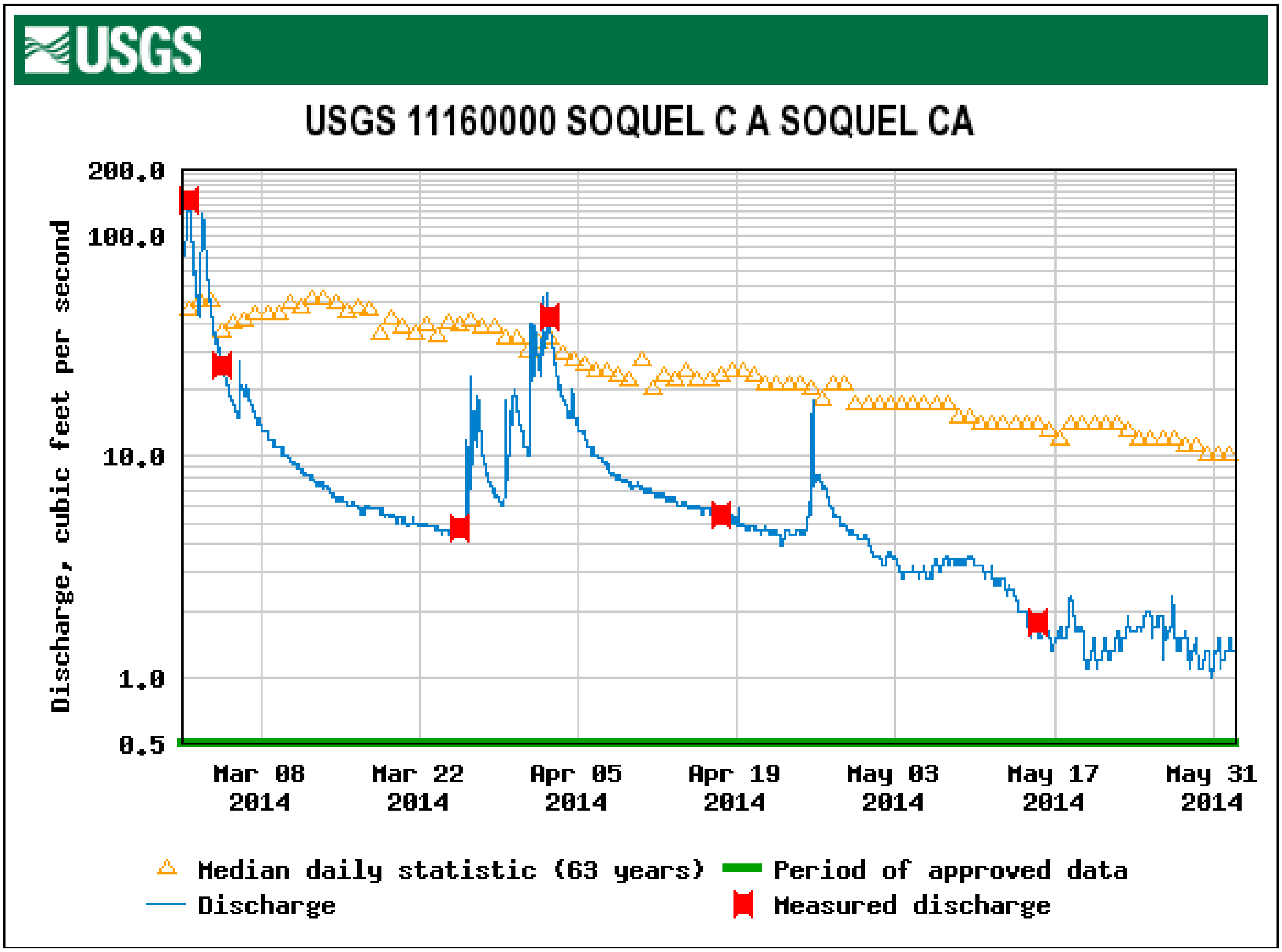


Figure 42a. The 2015 Discharge at the USGS Gage on Corralitos Creek at Freedom.

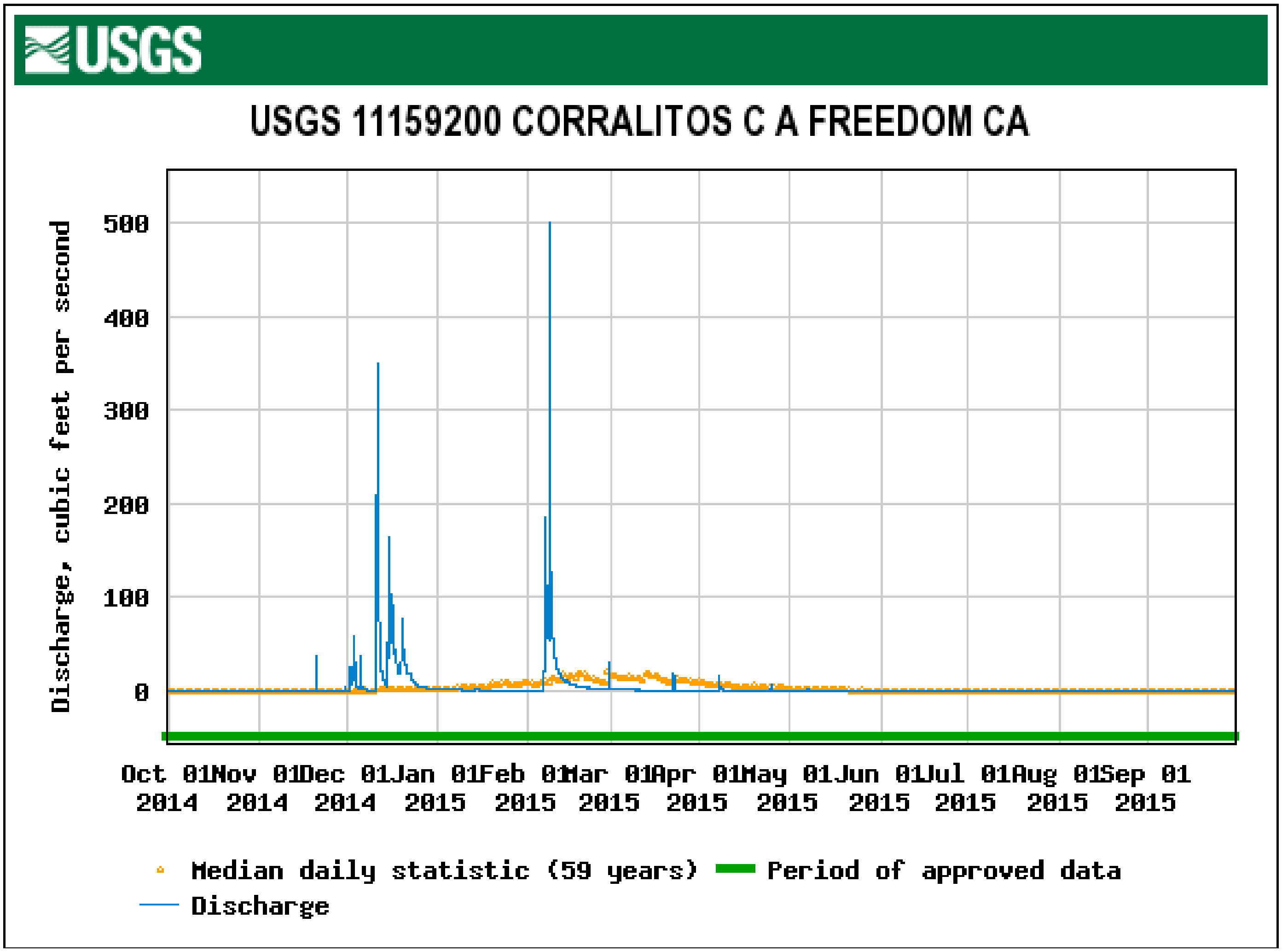


Figure 42b. The 2015 Daily Mean and Median Flow at the USGS Gage on Corralitos Creek at Freedom.

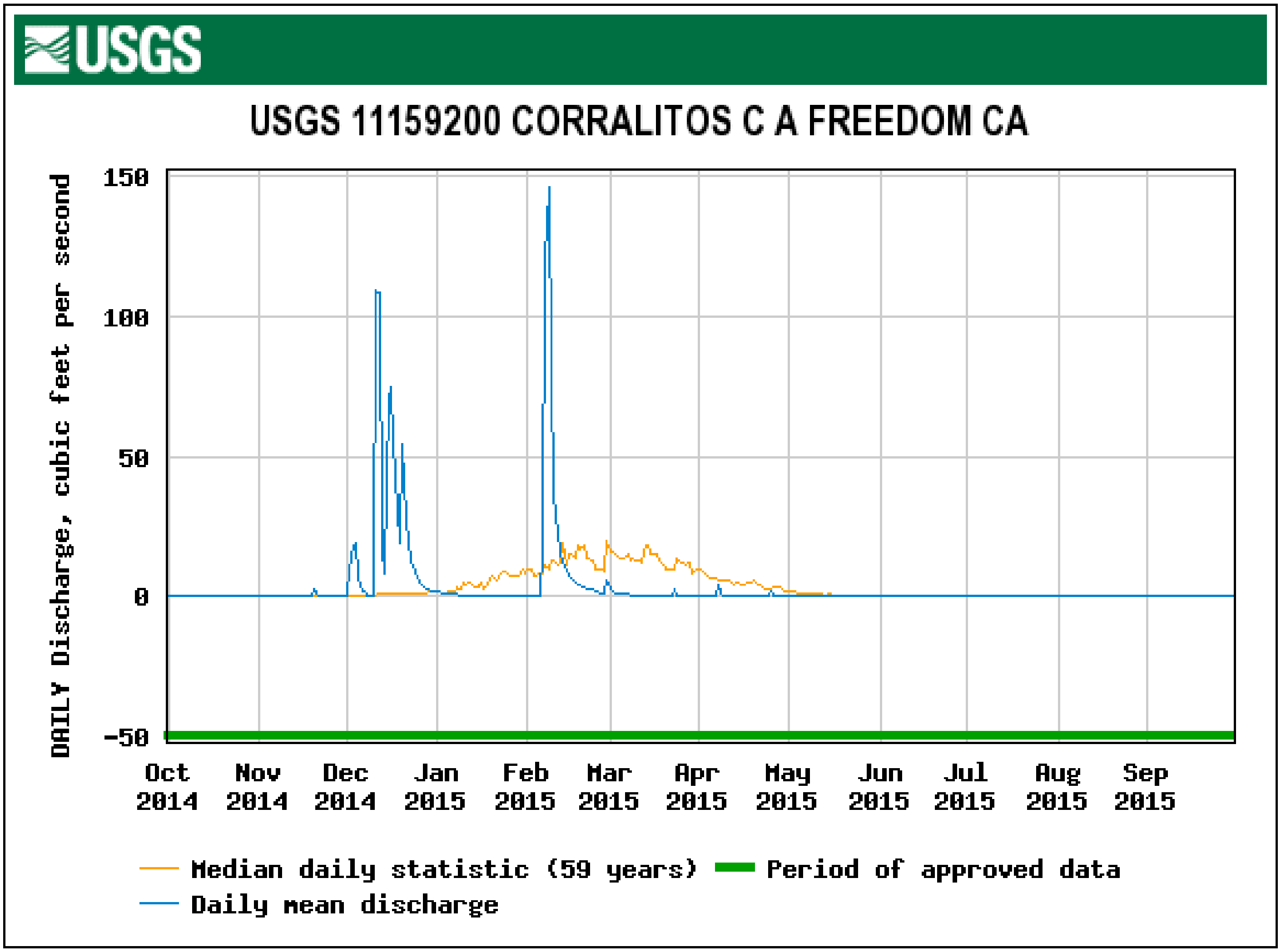


Figure 42c. The March–May 2015 Discharge at the USGS Gage on Corralitos Creek at Freedom.

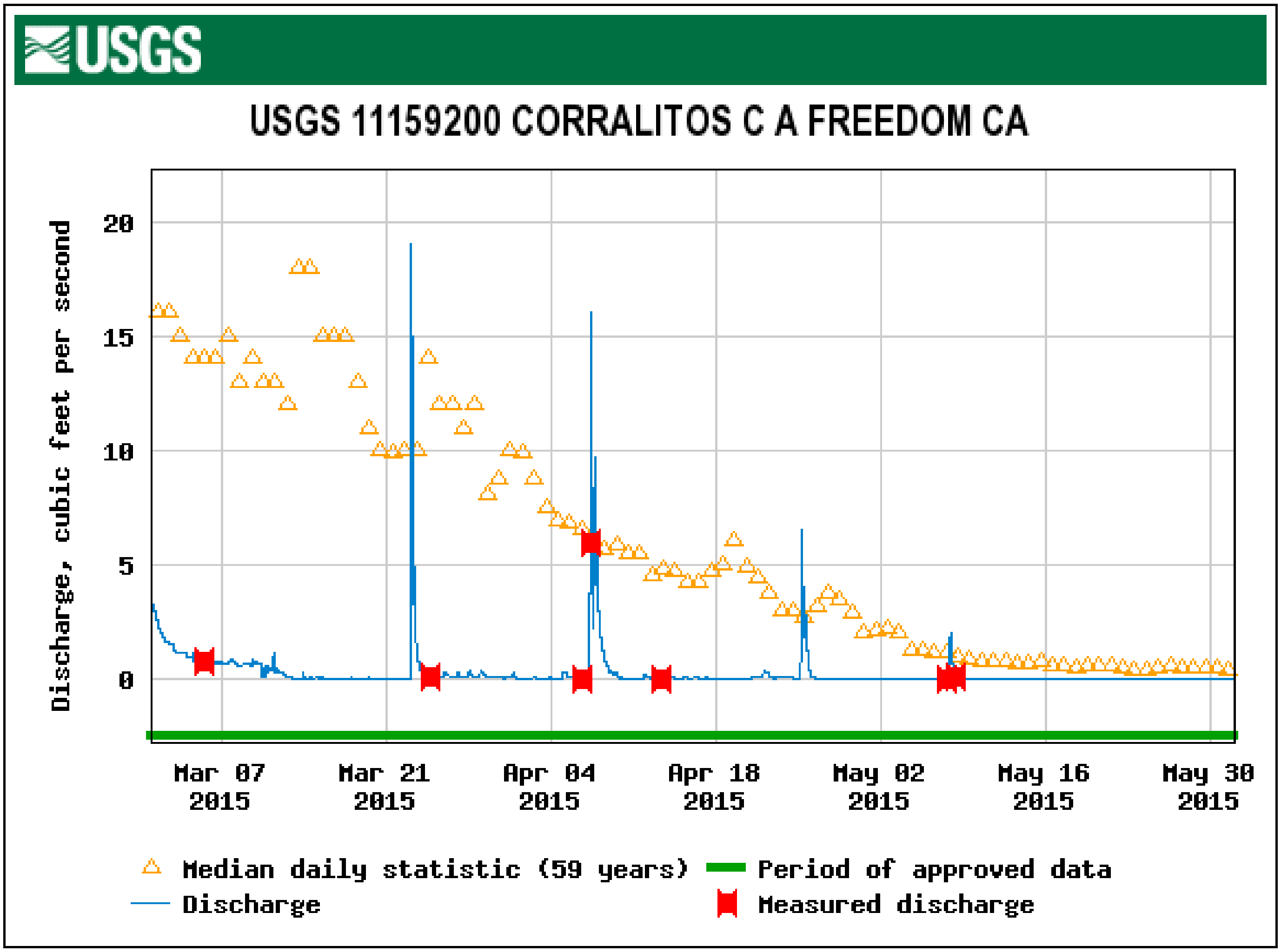


Figure 43a. The 2014 Discharge at the USGS Gage on Corralitos Creek at Freedom.

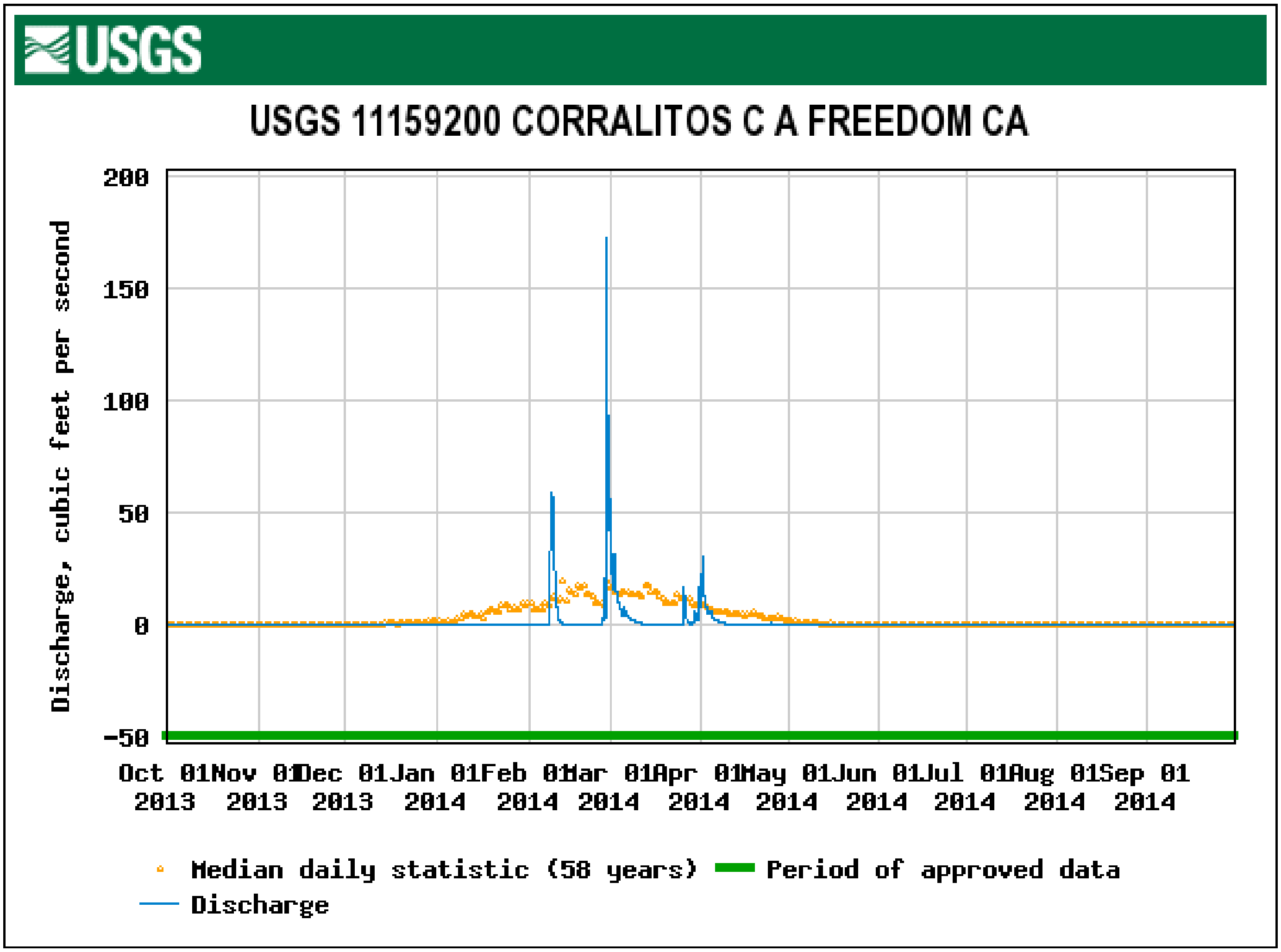


Figure 43b. The 2014 Daily Mean and Median Flow at the USGS Gage on Corralitos Creek at Freedom.

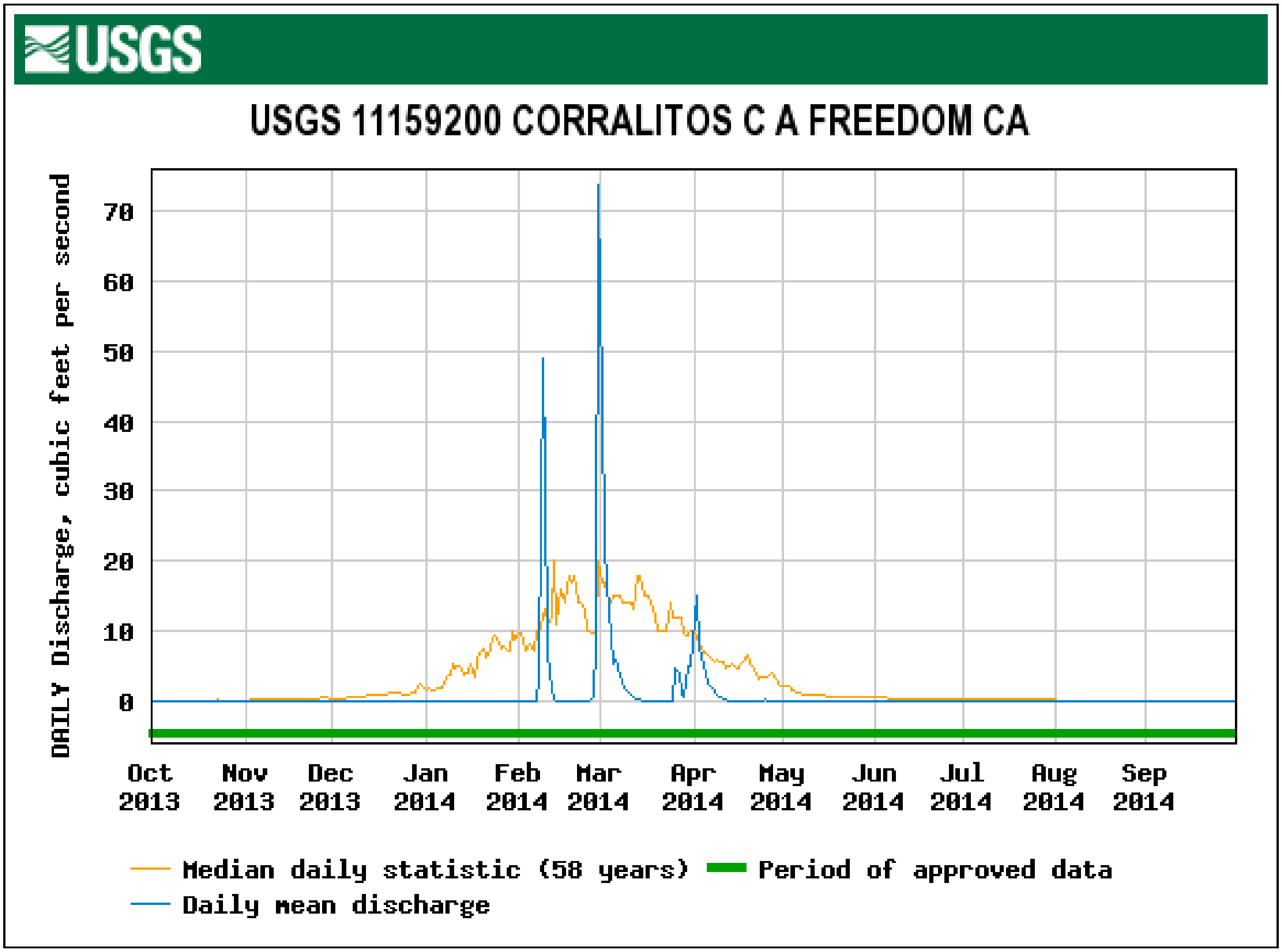
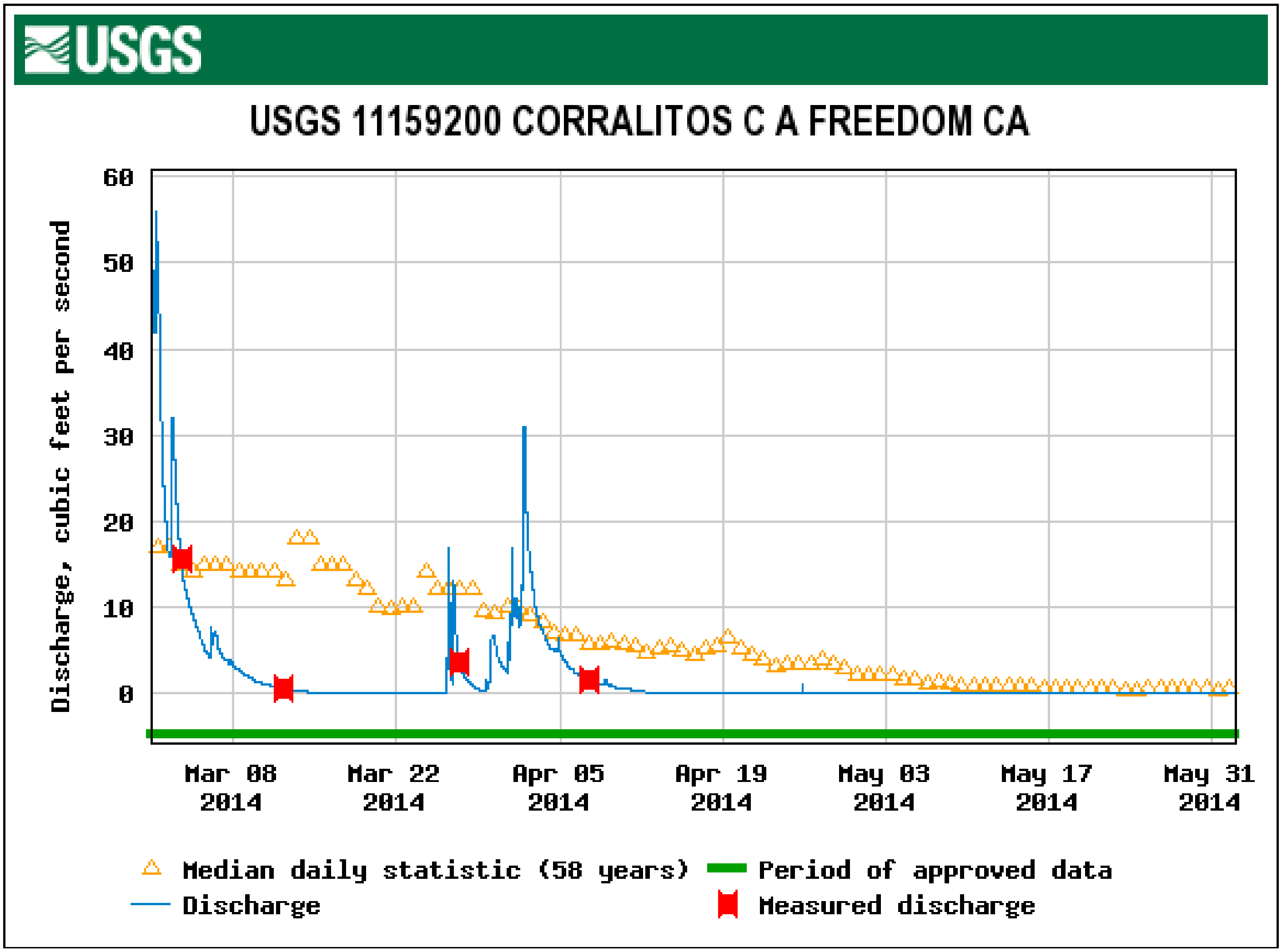


Figure 44. The March–May 2014 Discharge of Record for the USGS Gage on Corralitos Creek at Freedom.



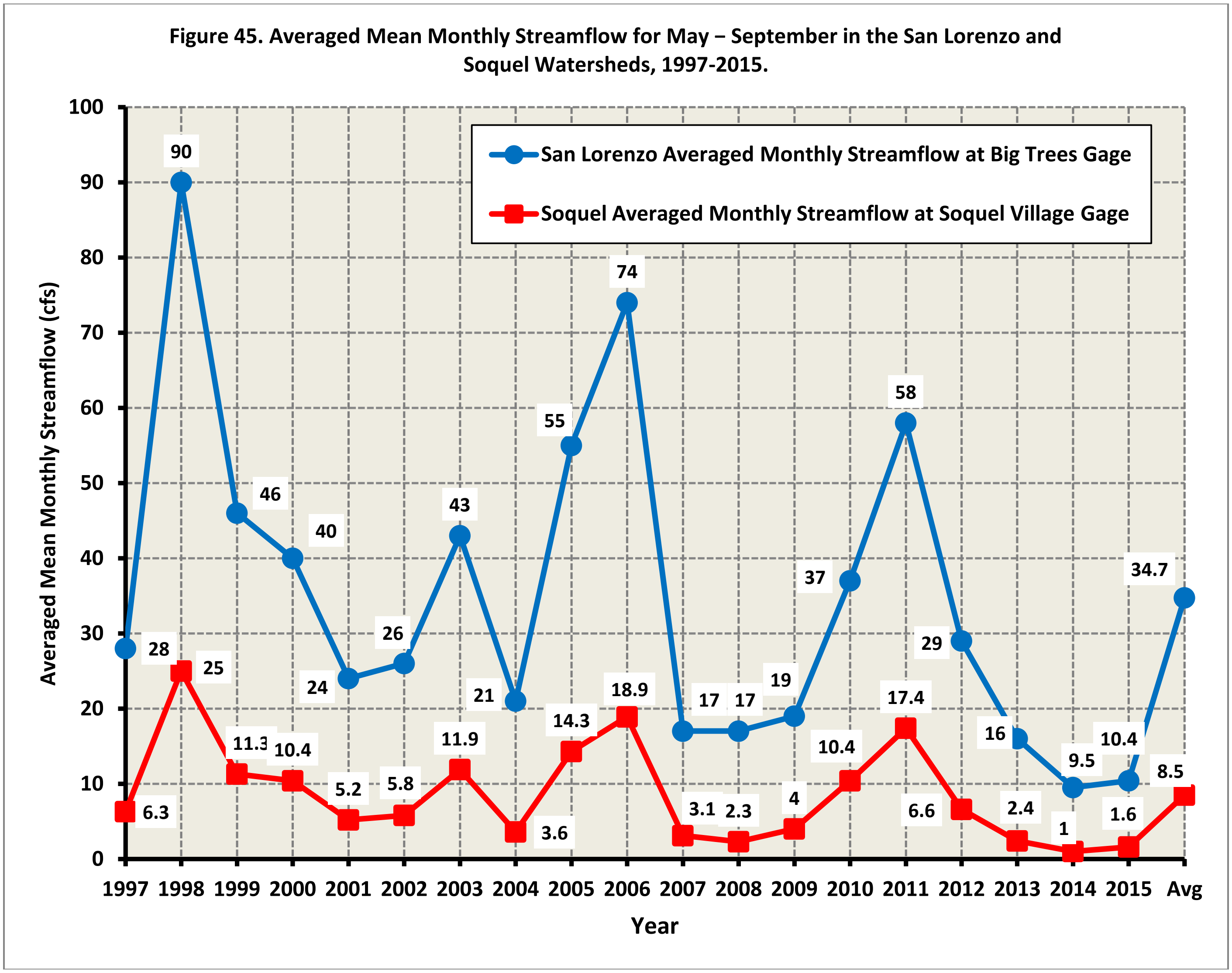


Figure 45. Averaged Mean Monthly Streamflow for May−September in the San Lorenzo and Soquel Watersheds, 1997-2015.

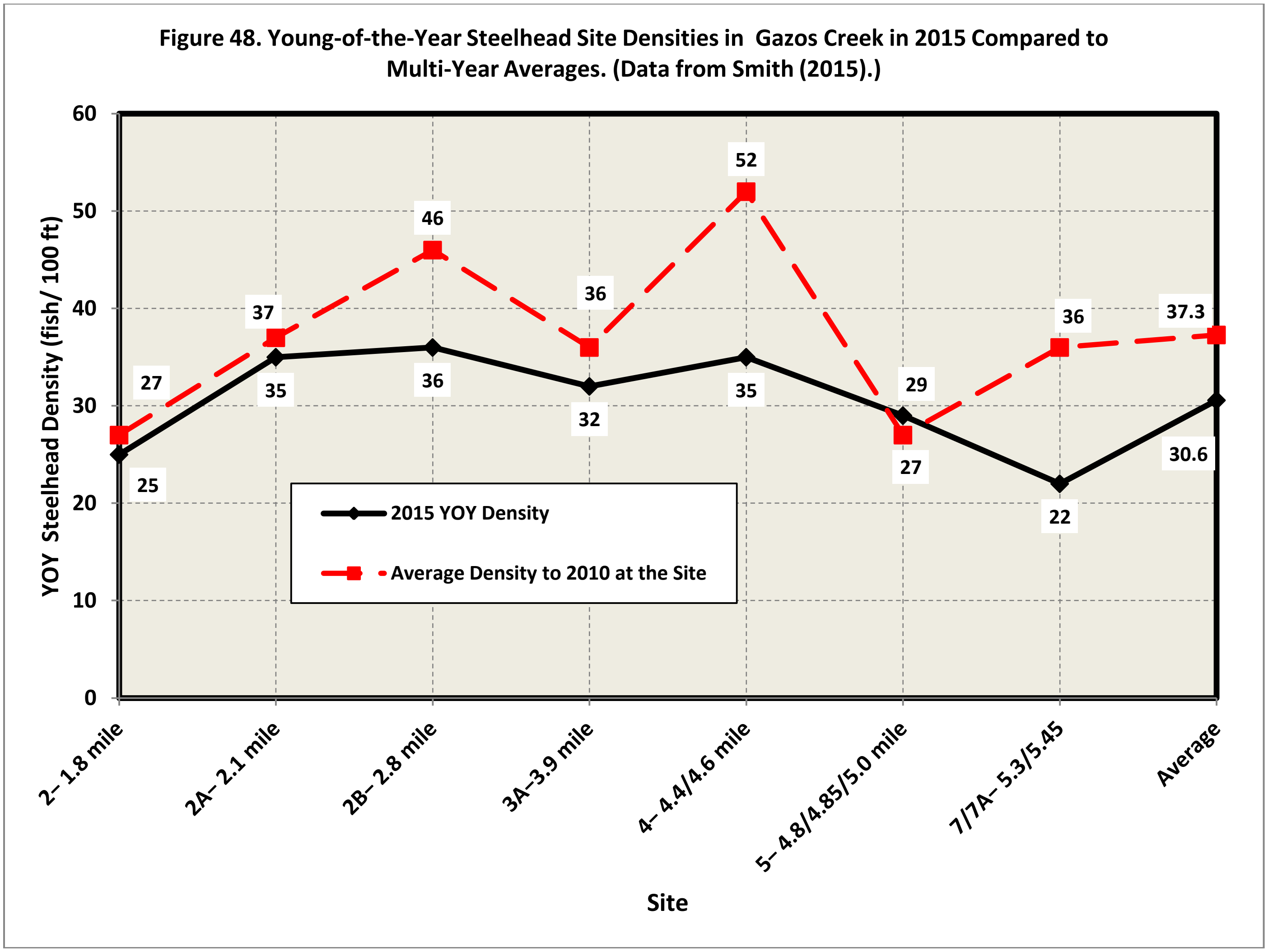


Figure 48. Young-of-Year Steelhead Site Densities in Gazos Creek in 2015 Compared to Multi-Year Averages to 2010.

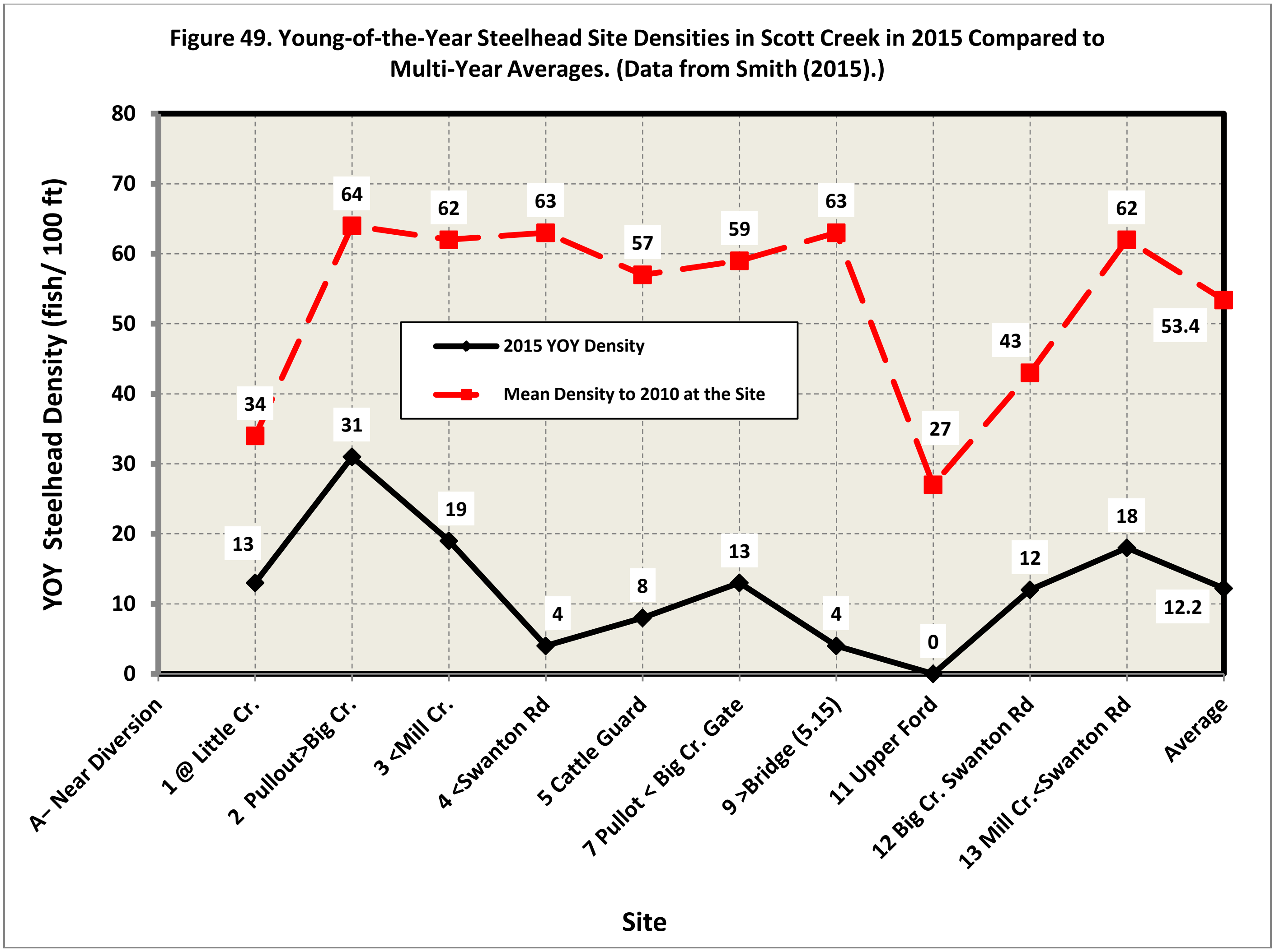


Figure 49. Young-of-the-Year Steelhead Site Densities in Scott Creek in 2015 Compared to Multi-Year Averages to 2010.

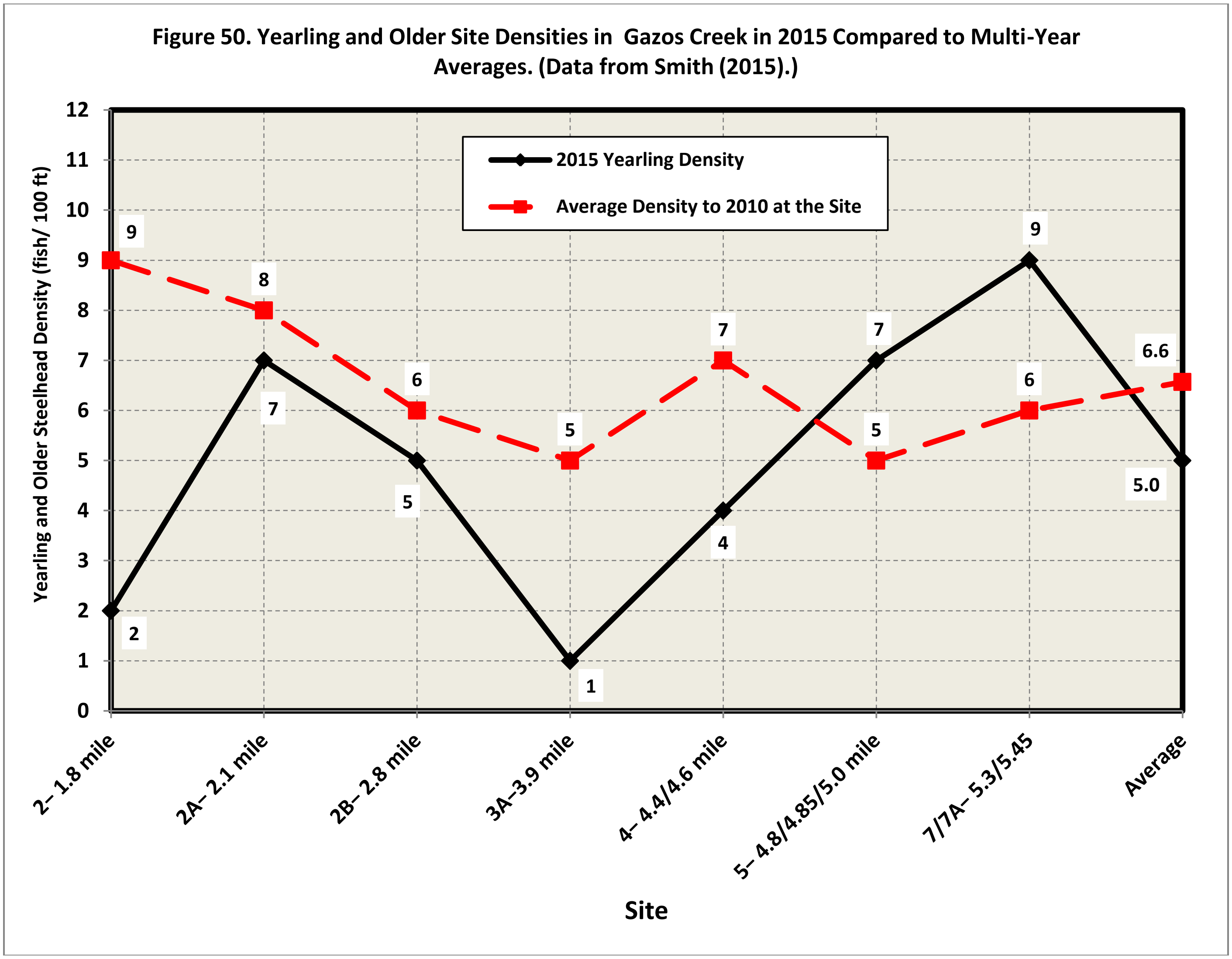


Figure 50. Yearling and Older Site Densities in Gazos Creek in 2015 Compared to Multi-Year Averages to 2010.

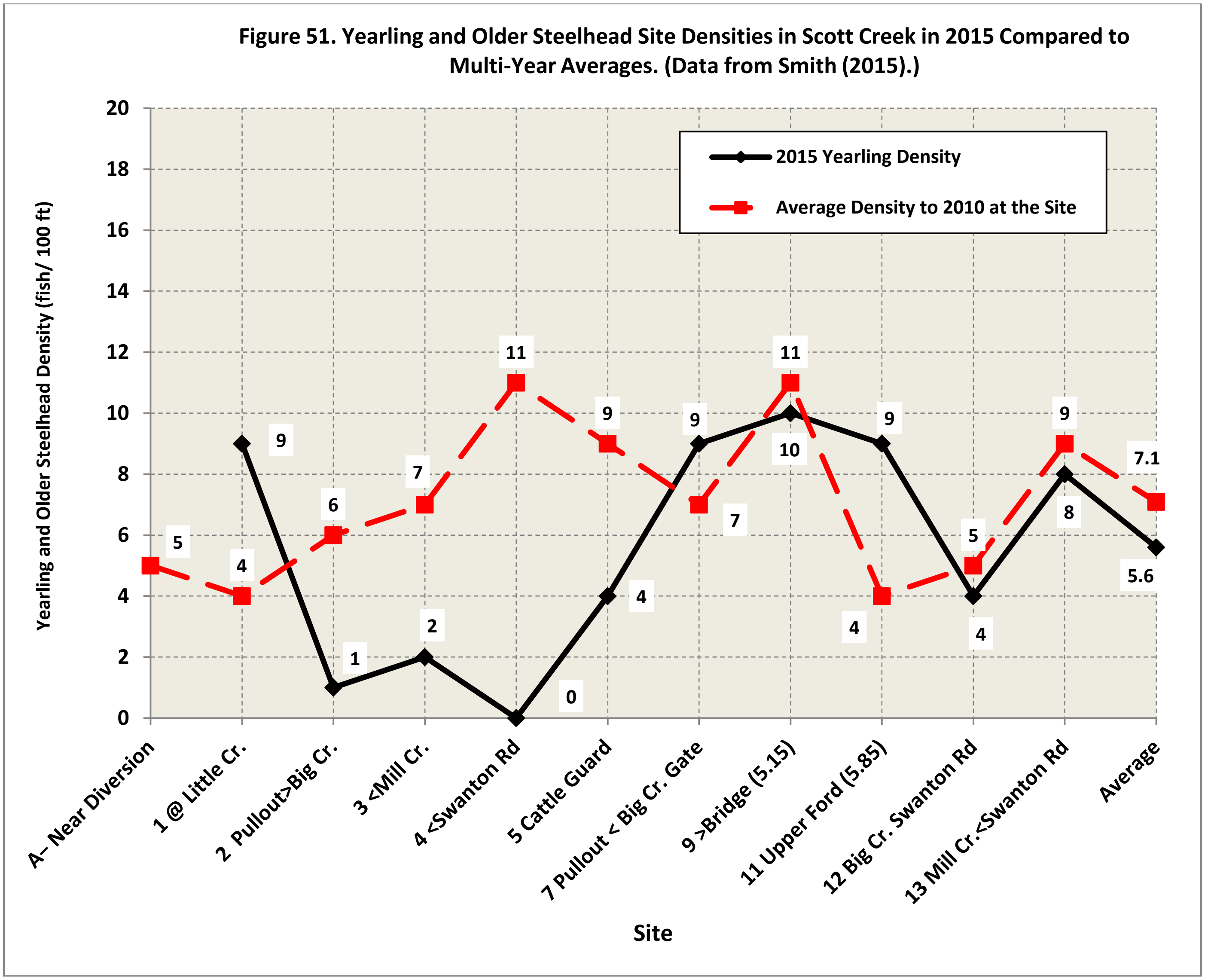


Figure 51. Yearling and Older Steelhead Site Densities in Scott Creek in 2015 Compared to Multi-Year Averages to 2010.

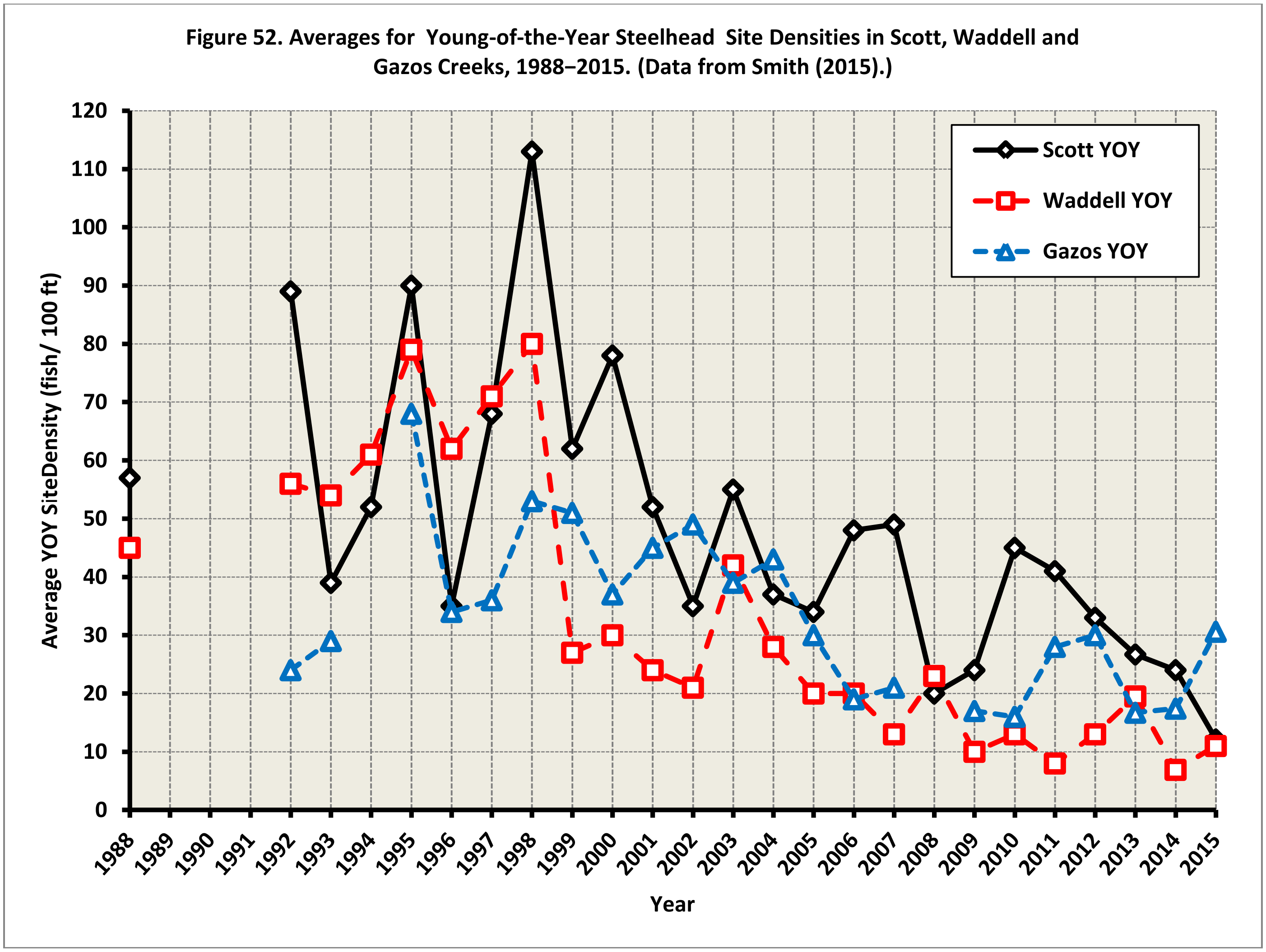


Figure 52. Averages for Young-of-the-Year Steelhead Site Densities in Scott, Waddell and Gazos Creeks, 1988–2015.

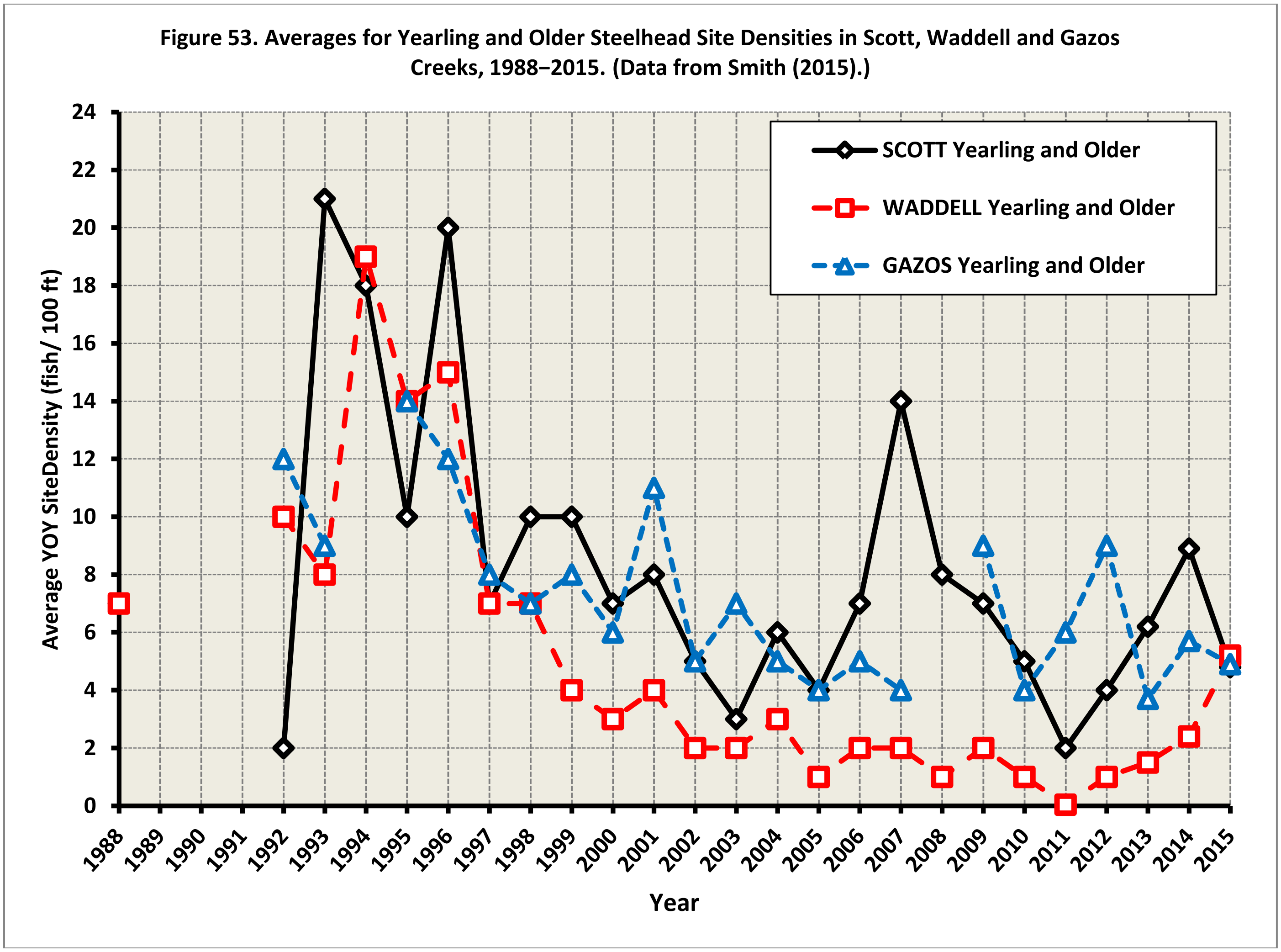


Figure 53. Averages for Yearling and Older Steelhead Site Densities in Scott, Waddell and Gazos Creeks, 1988–2015.

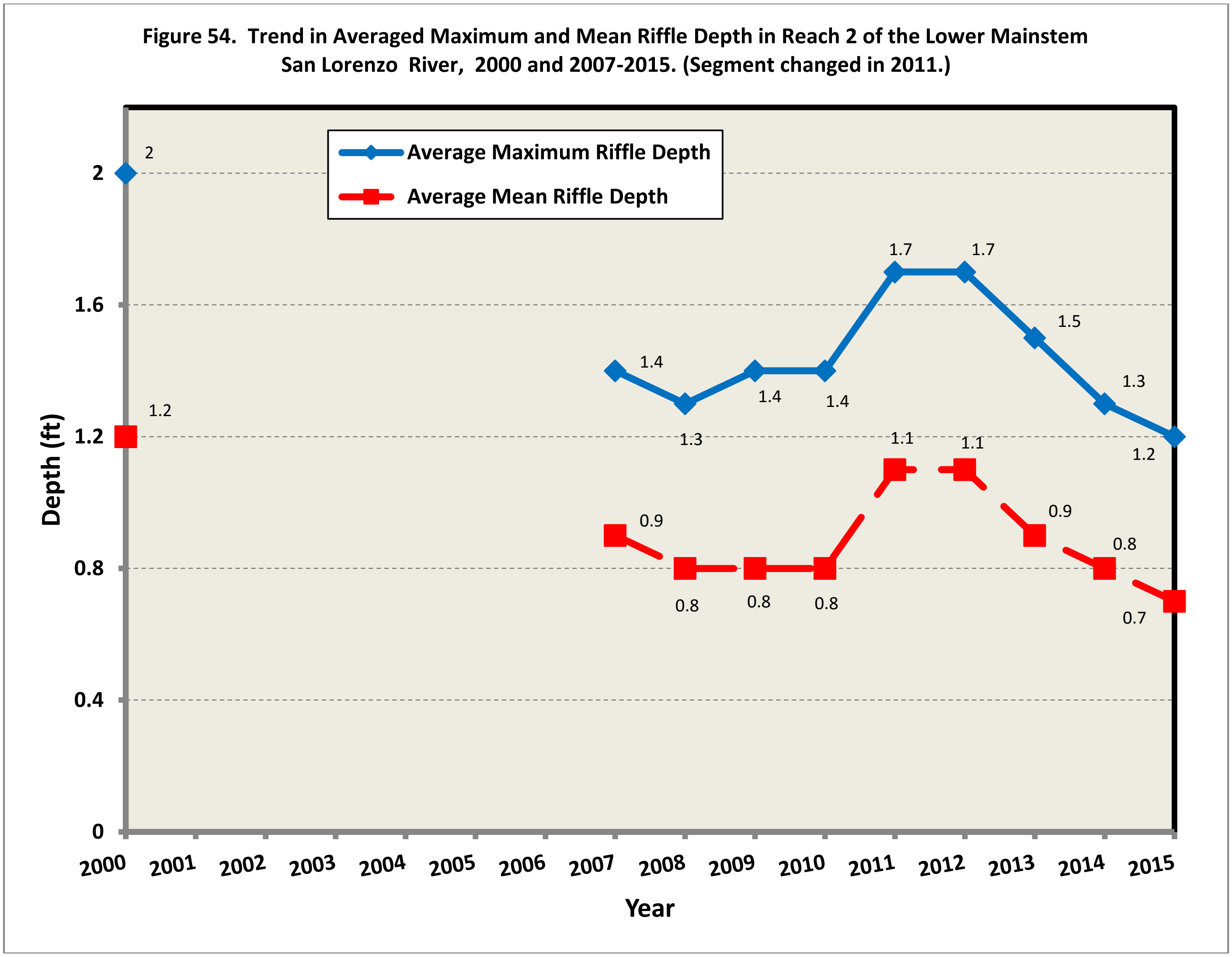


Figure 54. Trend in Averaged Maximum and Mean Riffle Depth in Reach 2 of the Lower Mainstem San Lorenzo River, 2000 and 2007-2015.

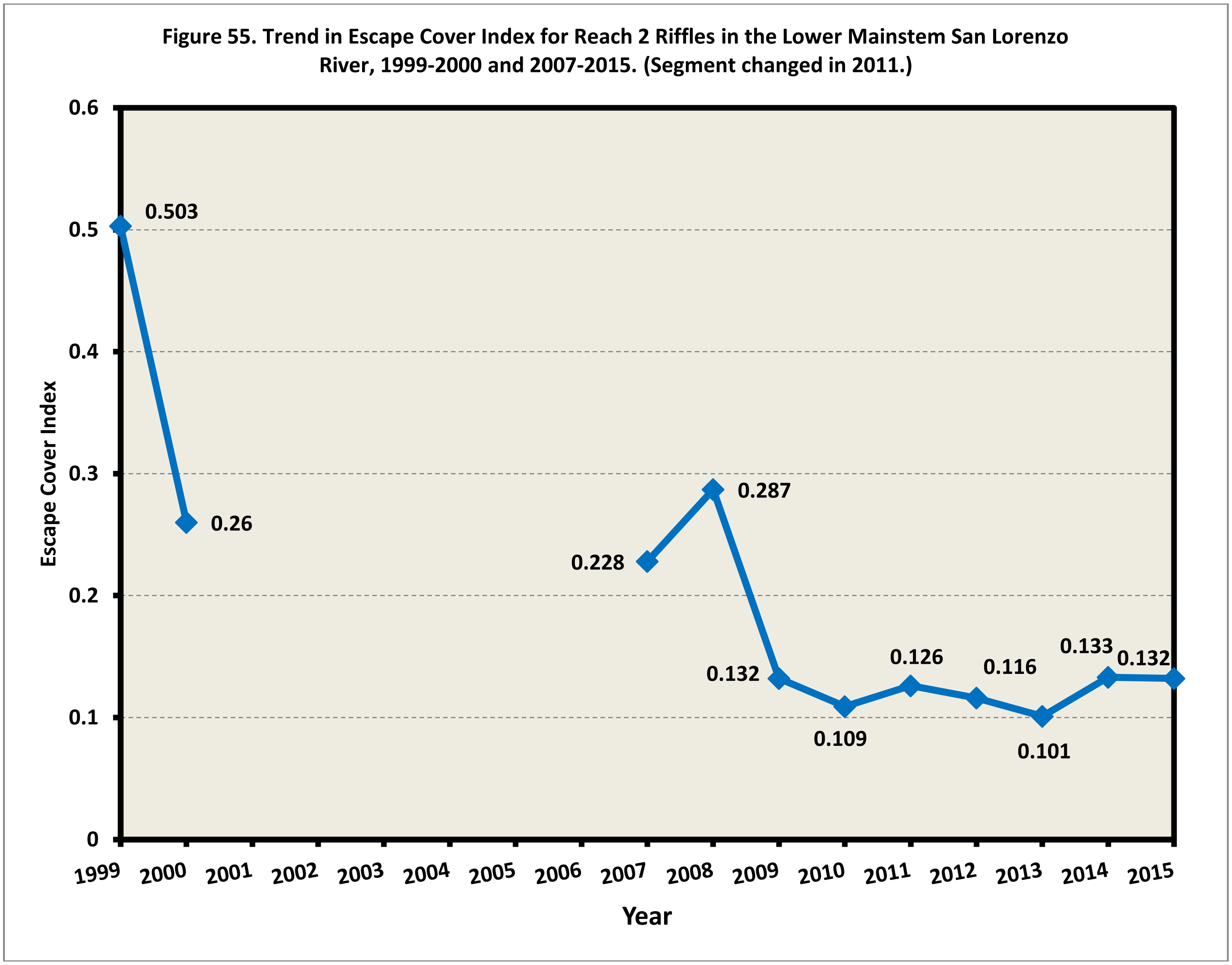


Figure 55. Trend in Escape Cover Index for Reach 2 Riffles in the Lower Mainstem San Lorenzo River, 1999-2000 and 2007-2015.

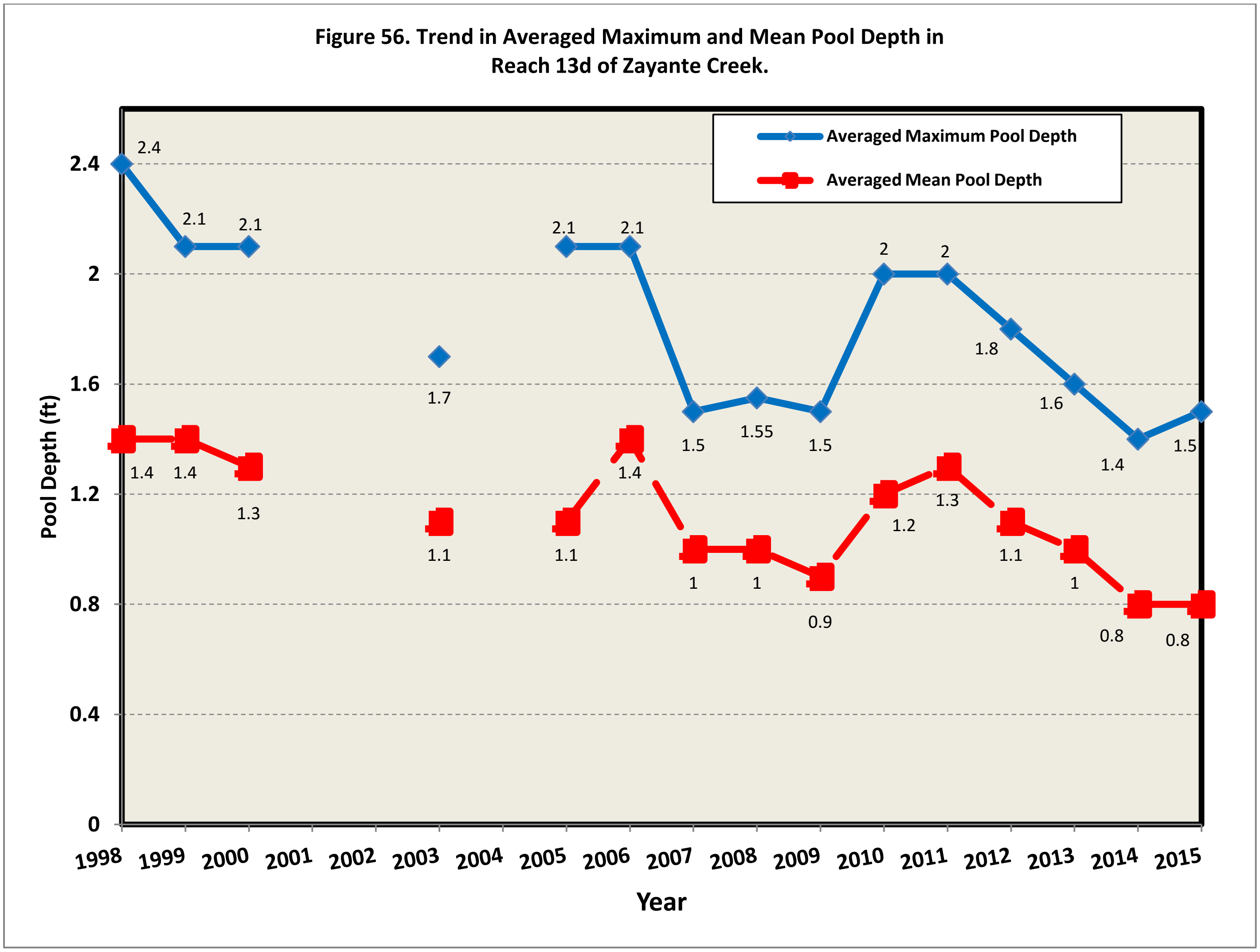


Figure 56. Trend in Averaged Maximum and Mean Pool Depth in Reach 13d of Zayante Creek.

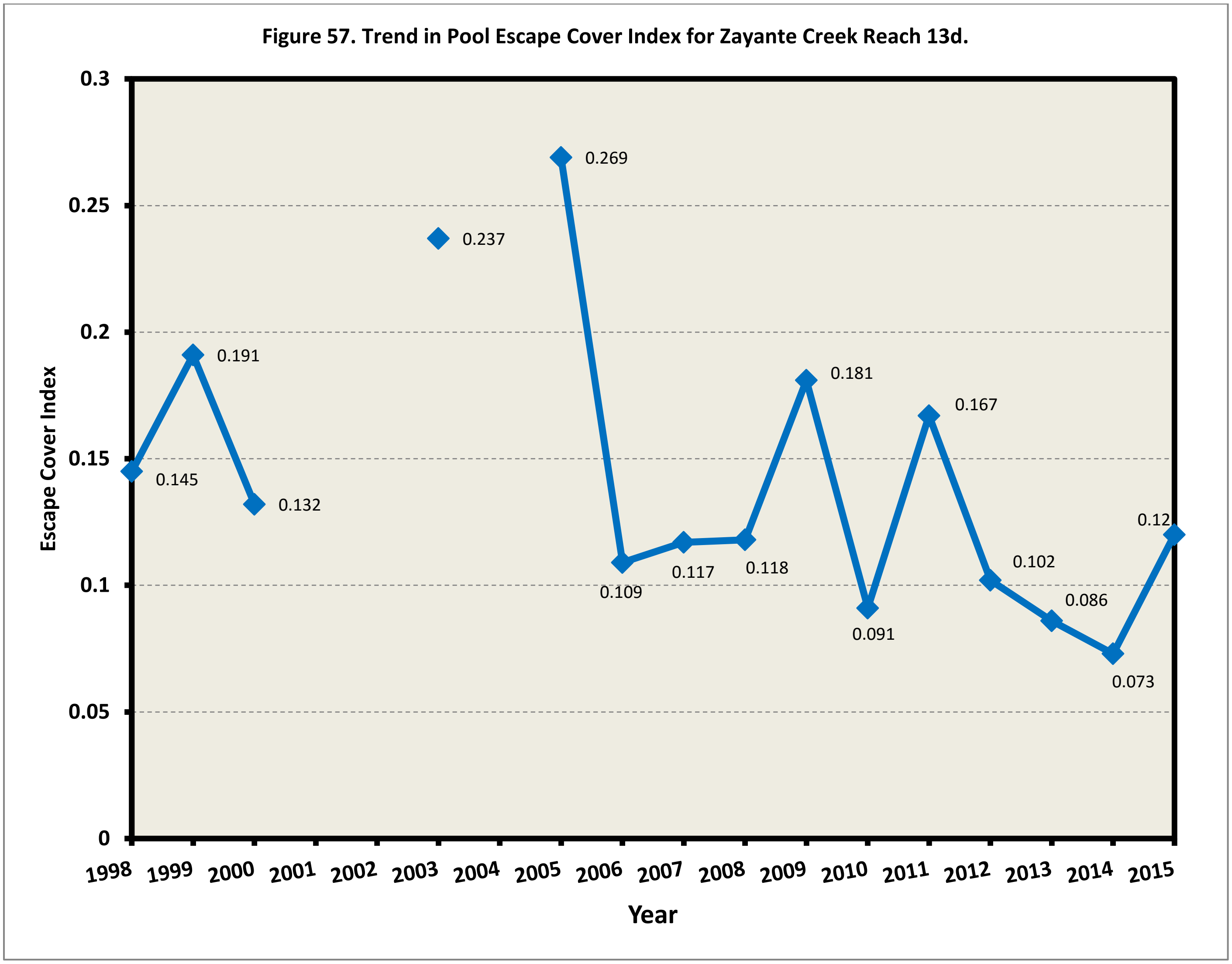


Figure 57. Trend in Pool Escape Cover Index for Zayante Creek Reach 13d.

APPENDIX A. Watershed Maps.

Figure 1. Santa Cruz County Watersheds.

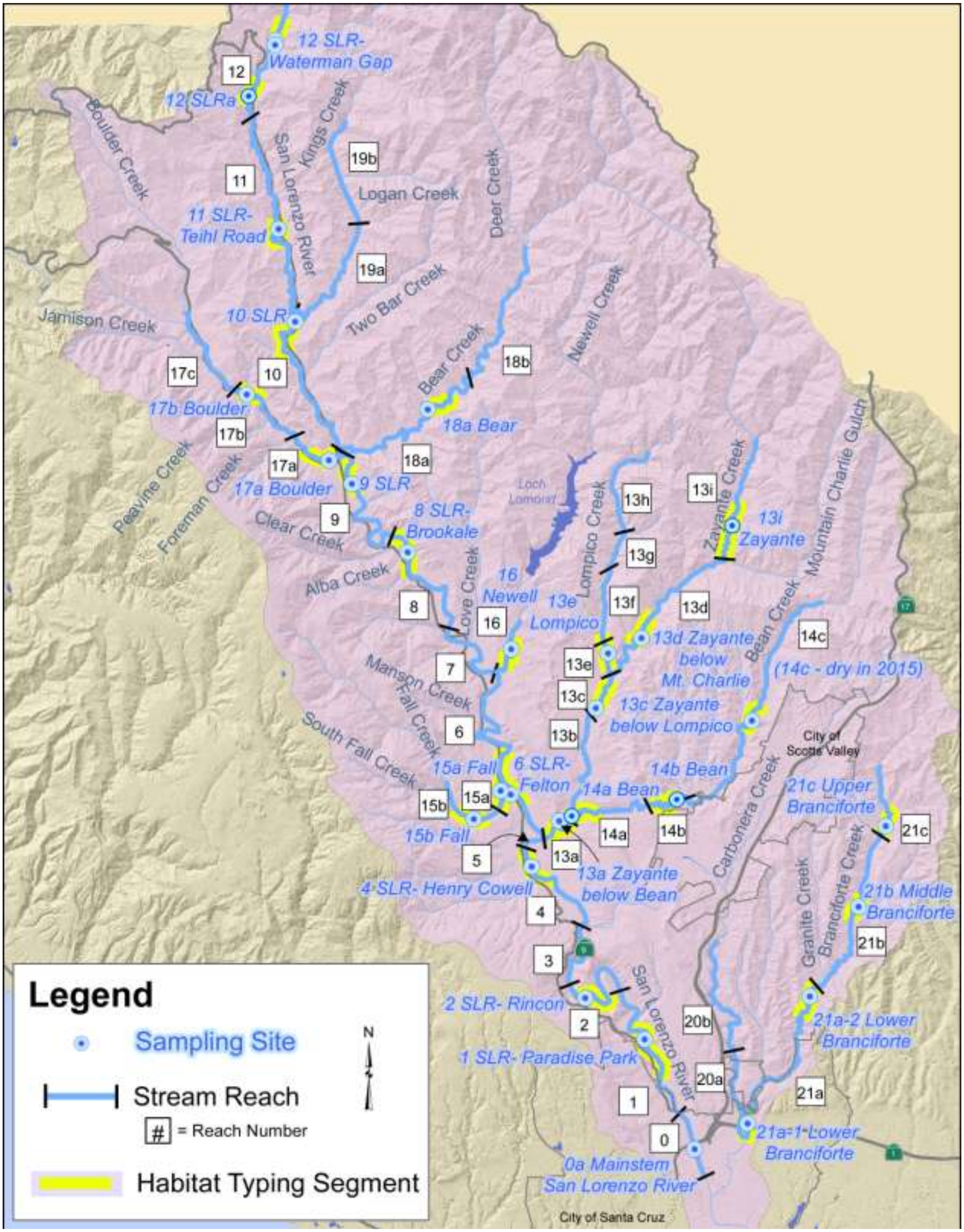


Figure 2. San Lorenzo River Watershed– Sampling Sites and Reaches.

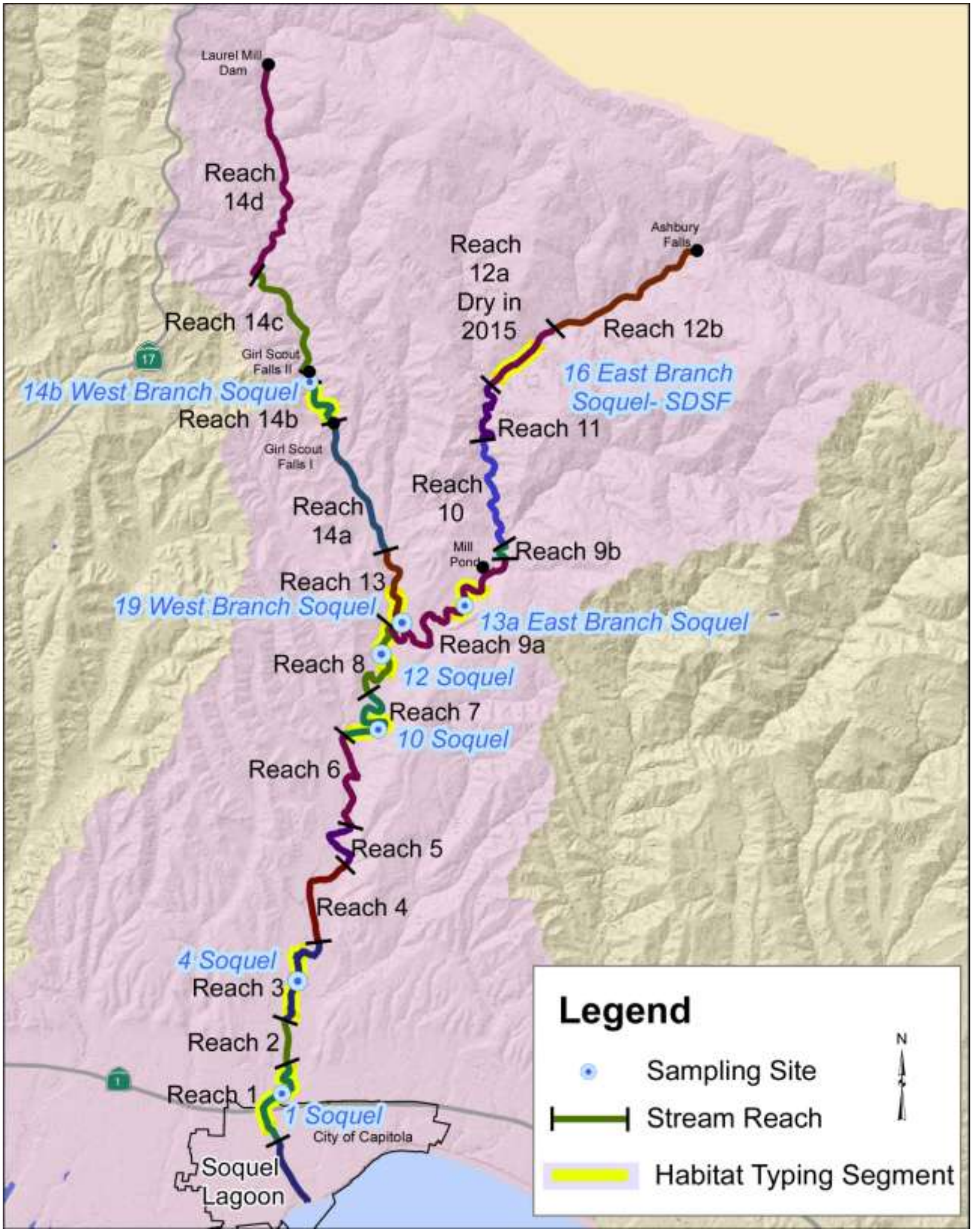


Figure 3. Soquel Creek Watershed.

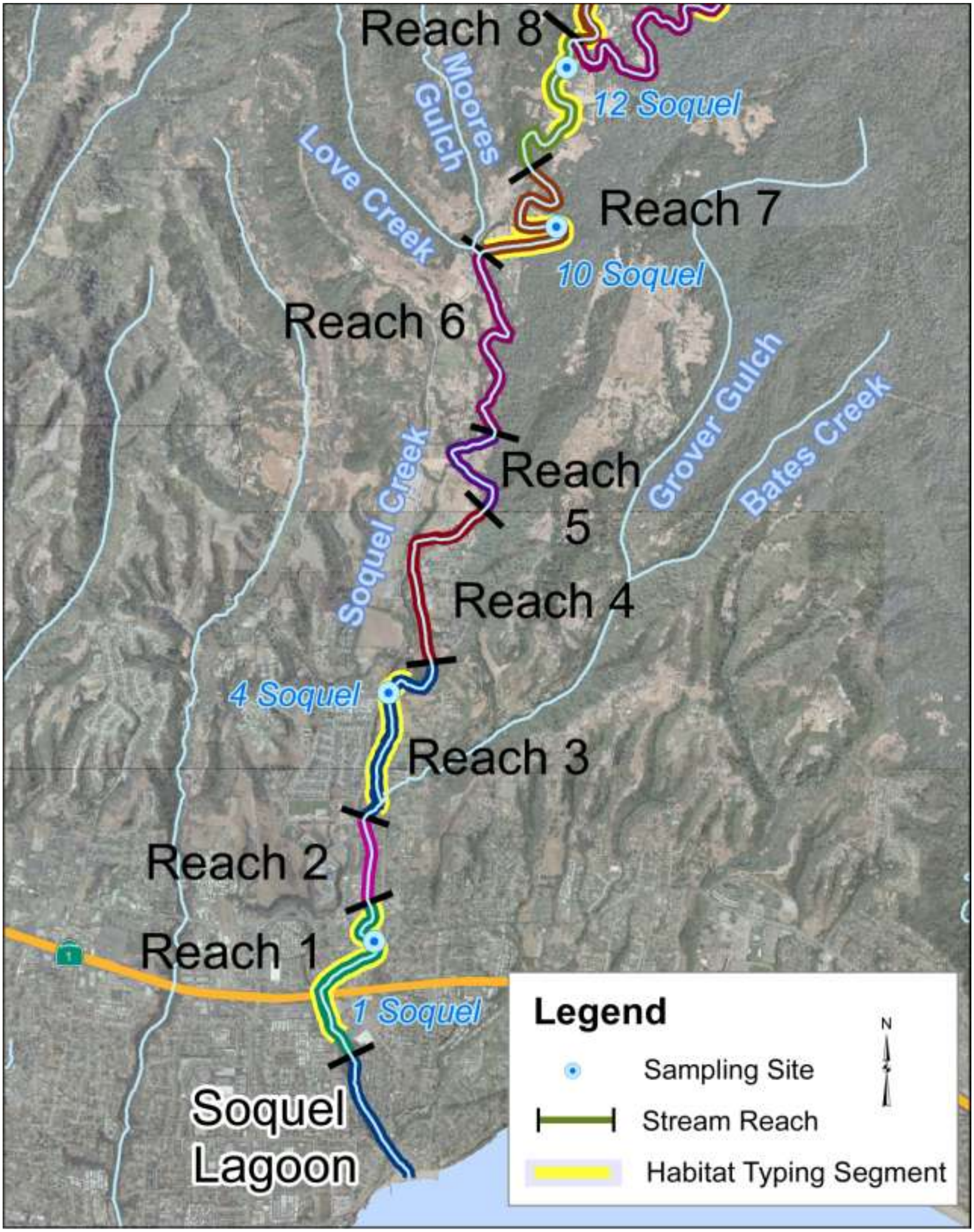


Figure 4. Lower Soquel Creek (Reaches 1–8 on Mainstem).

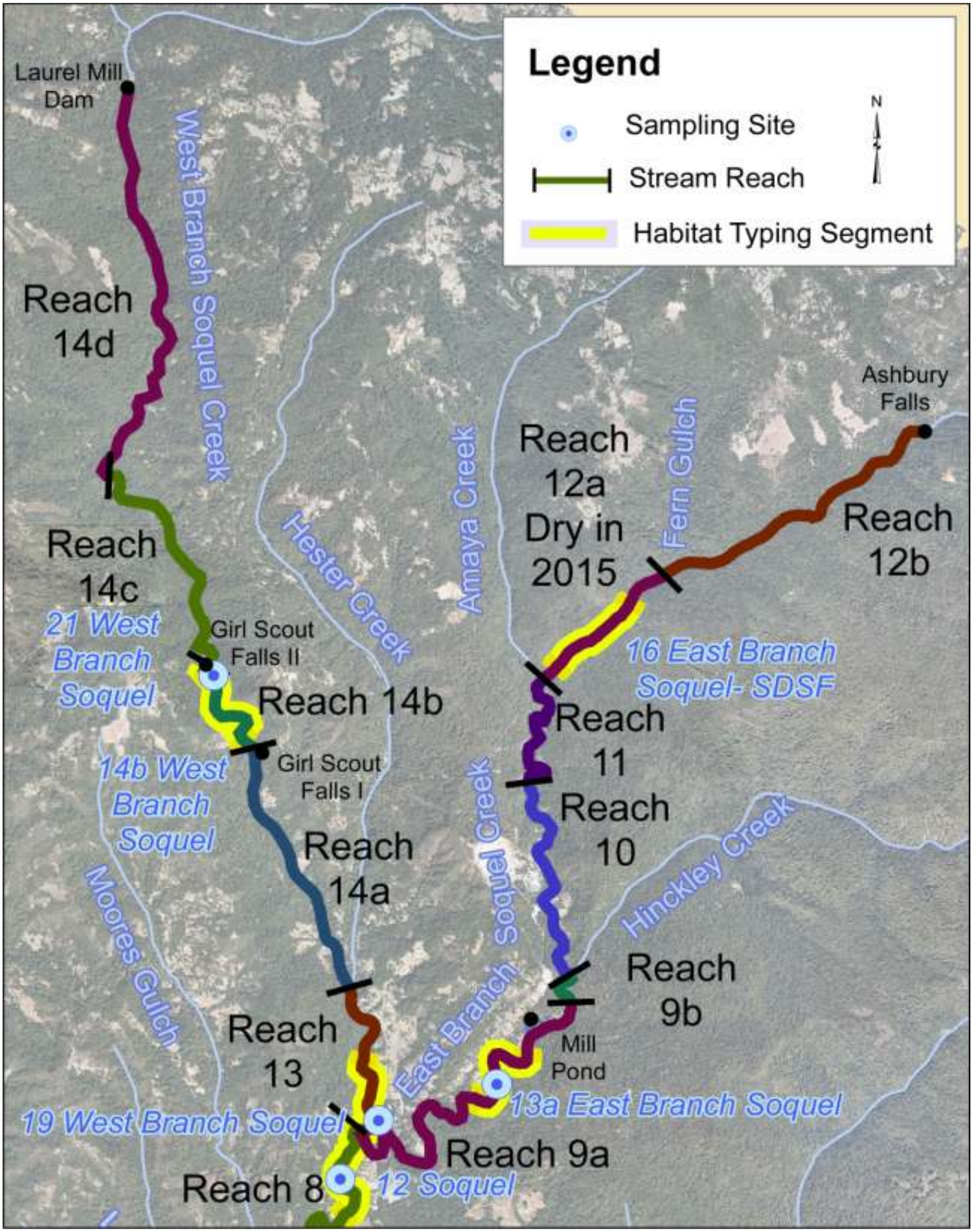


Figure 5. Upper Soquel Creek Watershed (East and West Branches; Reach 9a below habitat-typed segment and Reach 12a were dry in 2014 and 2015).

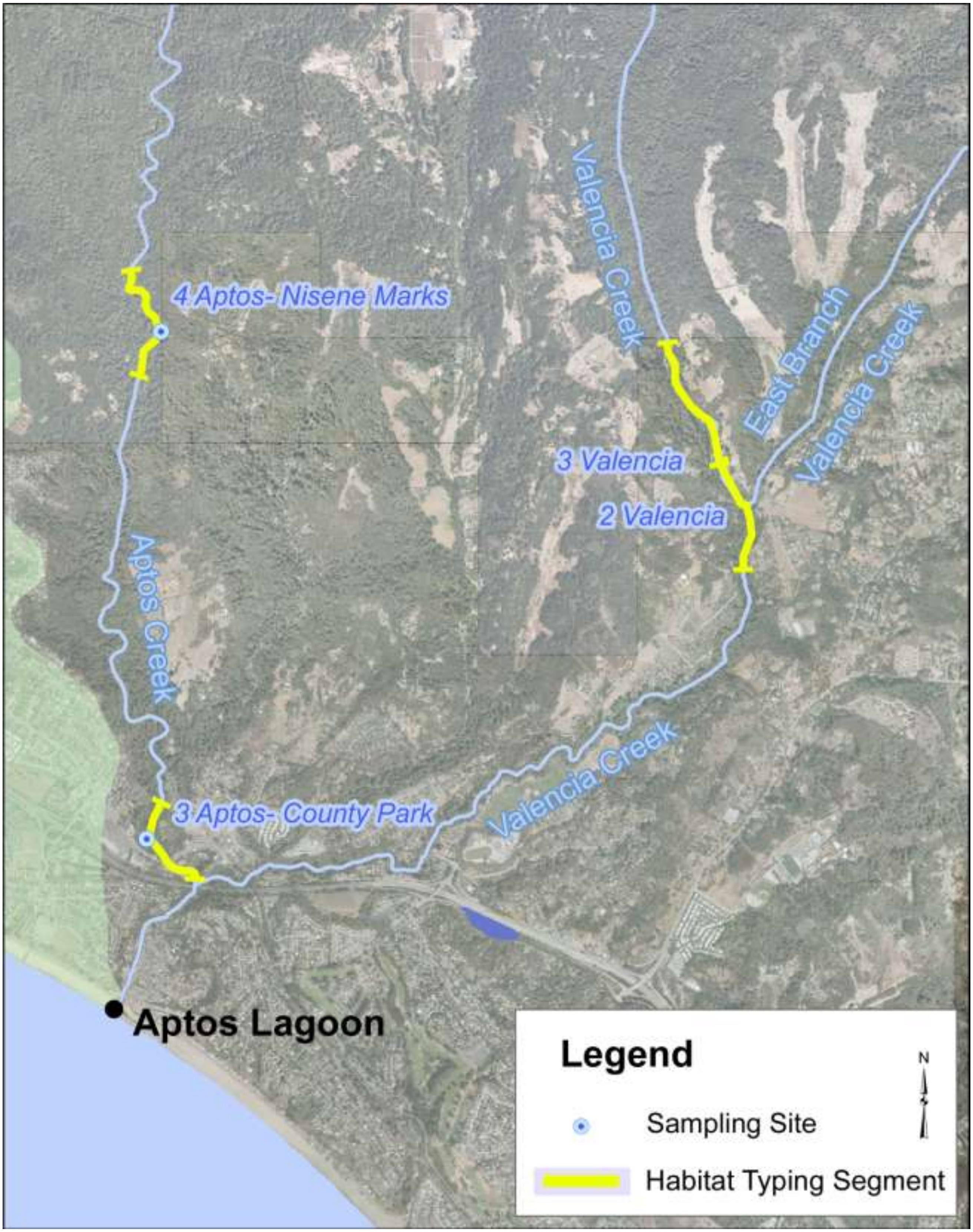


Figure 6. Aptos Creek Watershed (Aptos Lagoon and Valencia not sampled in 2015).

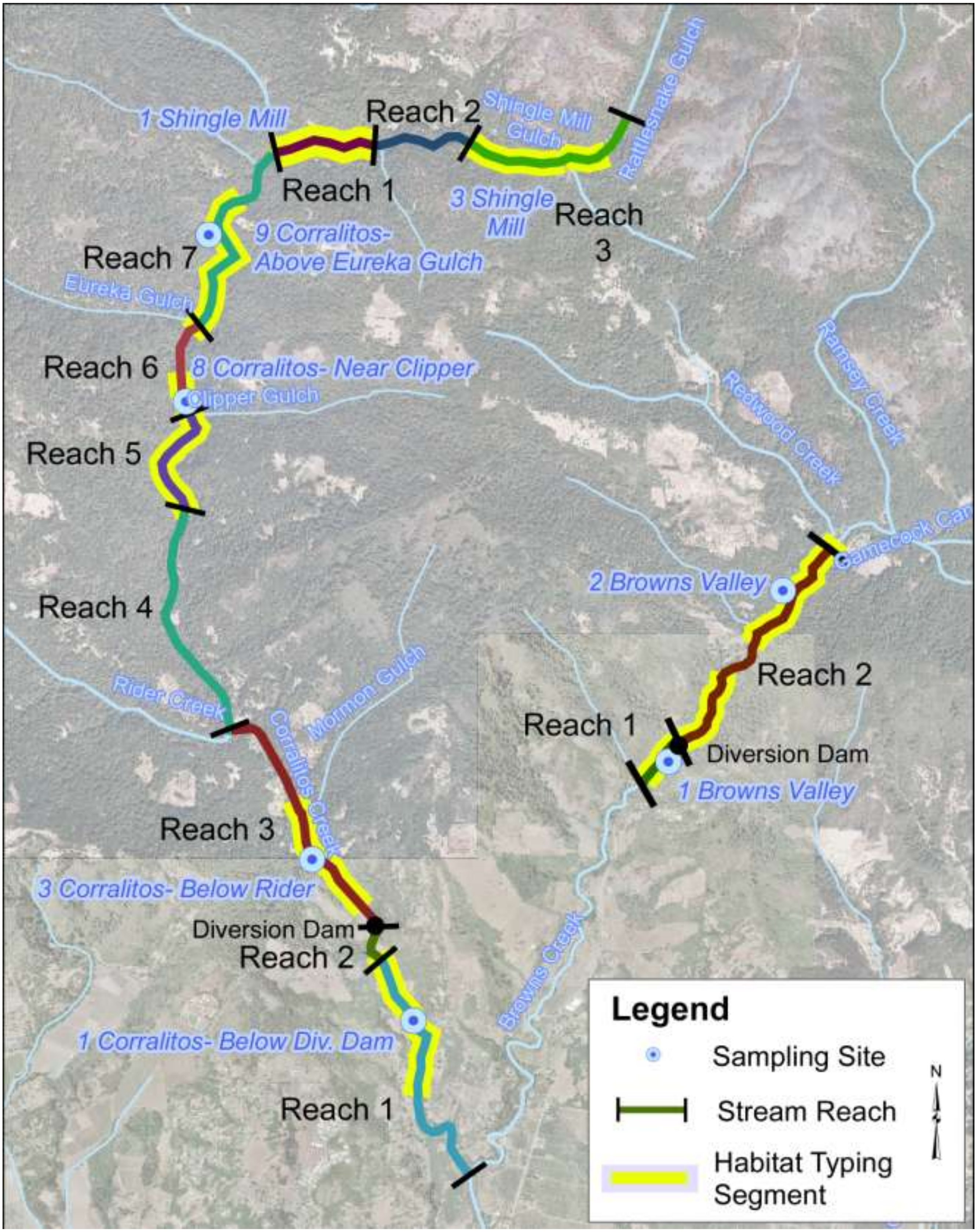


Figure 7. Upper Corralitos Creek Sub-Watershed of the Pajaro River Watershed

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

(Included electronically in a separate PDF file.)