APPENDIX B. DETAILED ANALYSIS OF 2016 STEELHEAD MONITORING IN THE SAN LORENZO, SOQUEL, APTOS AND CORRALITOS WATERSHEDS.

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SCOPE OF WORK

In fall 2016, 4 Santa Cruz County watersheds were sampled for juvenile steelhead to primarily compare juvenile abundance with past years to assess trends and compare habitat conditions at sampling sites and in limited habitat typed segments with those in 2015 and past years in selected reaches of the San Lorenzo. Results from steelhead and habitat monitoring are used to guide watershed management and planning (including implementation of public works projects) and enhancement projects for species recovery. Refer to maps below that delineate reaches and sampling sites in **Appendix A**. Hydrographs of all previous sampling years are included in **Appendix C**.

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.

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─2015. Aptos Creek was previously sampled in 1981, 2006─2015. Fall streamflow was typically measured at 18 locations in the 4 sampled watersheds under this contract. However, in 2016 an early storm in October occurred before baseflow measurements could be made, and streamflow measurements were cancelled. Half-mile segments were surveyed for riparian and instream wood in mainstem San Lorenzo Reach 2, upper Fall Creek Reach 15b and lower Boulder Creek Reach 17a. Wood survey results may be found in a separate report.

Study Area

San Lorenzo River. The mainstem San Lorenzo River and 8 tributaries were sampled at 27 sites (10 mainstem and 17 tributary sites). Sampled tributaries included Branciforte, Carbonera, Zayante, Lompico, Bean, Fall, Newell, Boulder and Bear creeks. A new segment with sampling site was added to Bean Creek (14c-2) because the traditional site was dry again in 2016. An original reach in lower Carbonera Creek (20a) with sampling site were resumed in 2016, the first time since 2001. Nine half-mile segments were habitat typed in the San Lorenzo system to assess habitat conditions and select habitats of average quality to sample for fish density. For the remaining 18 sites, the 2015 sites were replicated for fish sampling, and depth and cover were measured at all sampling sites.

Soquel Creek. Soquel Creek and its branches were sampled at 8 sites (4 mainstem and 4 Branch sites). Four half-mile segments were habitat typed to assess habitat conditions and select habitats of average quality to sample for fish density. For the remaining 4 sites, the 2015 sites were replicated for fish sampling, and depth and cover were measured at all sampling sites.

Aptos Creek. Aptos watershed was sampled at two Aptos and two Valencia creek sites in 2016. The upper Valencia 3 reach was habitat typed with a new site chosen. The other three 2015 sites were replicated for fish sampling. Depth and cover were measured at all sampling sites.

Corralitos Creek. In the Corralitos sub-watershed of the Pajaro River drainage, fish sampling included 4 sites in Corralitos Creek and 2 sites in Browns Creek. Two associated half-mile reach segments habitat typed, one each in Corralitos and Browns creeks, upstream of diversion dams. Depth and cover were measured at all sampling sites. A half-mile reach in Casserly Creek, up and downstream of the Mt. Madonna Road Bridge, was habitat typed and a representative site was sampled.

Pajaro River Lagoon. The Pajaro River Lagoon was sampled in late September and early October for steelhead and tidewater goby, and water quality conditions were measured during sampling.

I-1. Steelhead and Coho Salmon Ecology

Migration. Adult steelhead in small coastal streams typically 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 48^{o}F 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 lower and middle mainstem San Lorenzo River, downstream of the Boulder Creek confluence, steelhead use primarily fastwater habitat where insect drift is greatest. This includes deeper riffles, heads of pools and runs. YOY and small yearling steelhead that have moved down from tributaries can grow very fast in this mainstem habitat if streamflows are high and sustained through the summer. In the upper mainstem, Shallow riffle habitat is used 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 the Soquel mainstem, upstream of Moores Gulch, and in the two branches (East and West), juvenile steelhead use primarily pool habitat and deeper step-runs where cover is available. 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, in 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 2016 fall fish sampling and habitat evaluation included comparison of 2016 juvenile steelhead densities at sampling sites and rearing habitat conditions with those in 1997–2001 and 2003–2015 for the San Lorenzo River mainstem and 8 tributaries and with those in 1997−2015 for the Soquel Creek mainstem and branches. 2016 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 2016 in the Corralitos Creek sub-watershed were compared to those in 1981, 1994 and 2006−2015. Fall 2016 steelhead densities and habitat conditions in the Aptos Creek watershed were compared to those in 1981 and 2006−2015. Beyond our control, Aptos Lagoon/estuary was not inventoried in 2015 or 2016. Findings in Pajaro Lagoon were compared with earlier sampling results from 2011 onward.

In 2016, instream wood was inventoried in mainstem San Lorenzo Reach 2, upper Fall Creek Reach 15b and lower Boulder Creek Reach 17a to evaluate the County's educational program and to guide water agencies 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 existed 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, indices of 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. These juvenile reach indices were also calculated for 2010, 2014 and 2015.

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.

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 (tributary to Zayante Creek), 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 with relatively low steelhead densities include Glen Canyon and Granite creeks (tributary to Branciforte Creek); 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 some steelhead migrational barriers, such as in 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 California Salmonid Stream Habitat Restoration Manual (**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.

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

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

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

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

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

Escape Cover– Fish Sampling Sites. The escape cover index for each habitat type within sampled sites was quantitatively determined in the same manner in 1994-2001 and in 2003 onward. 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.

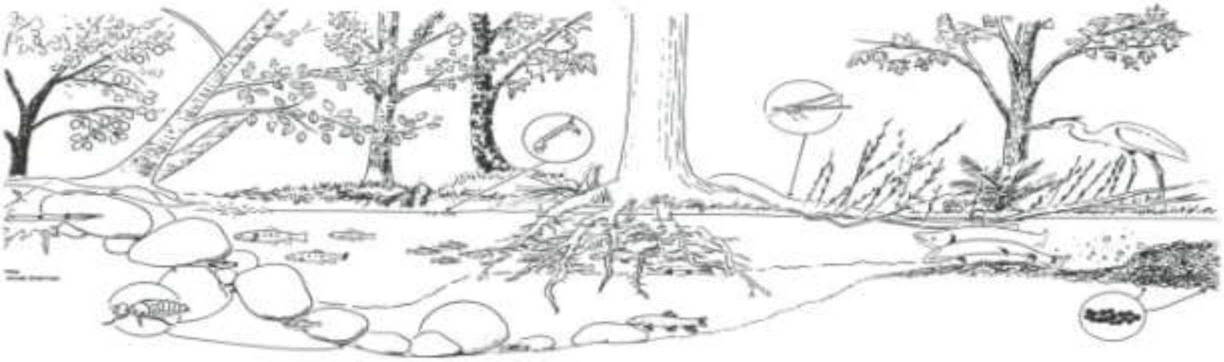

Illustration of pool habitat (stream flowing from left to right) showing escape cover under boulders and undercut bank with tree roots. Juvenile steelhead are feeding at the head of the pool. (Female steelhead is covering her redd of eggs after spawning at the tail of the pool.)

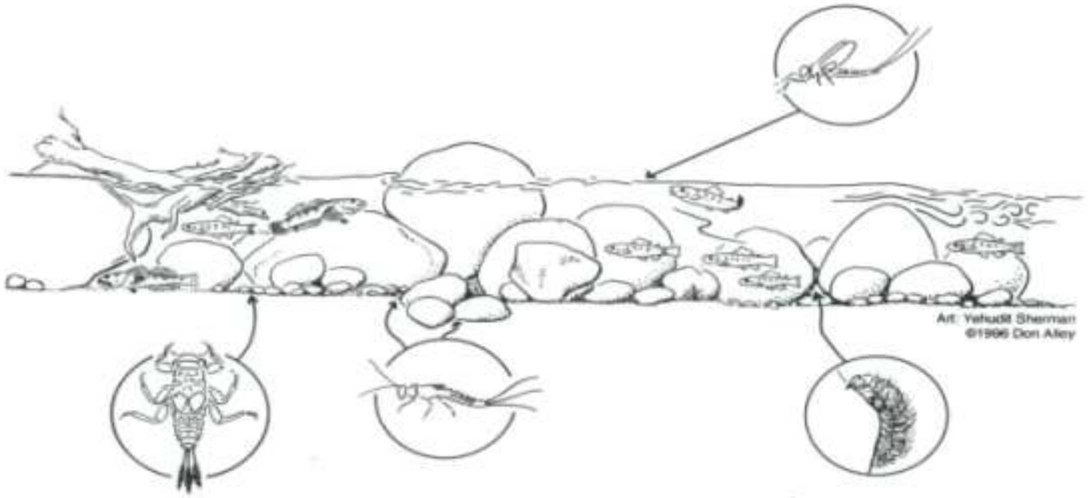

Illustration of riffle habitat (stream flowing from left to right) showing escape cover under rootwad and boulders. (Juvenile steelhead are holding feeding positions, facing upstream.)

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.
(2016 Sites Indicated by Asterisk.)

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

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

Reach #	Sampling Site # −Channel Mile Location of Sampling Sites	TRIBUTARY SITES
13a	*13a-CM0.3	Zayante Creek Upstream of Conference Drive Bridge
13b	13b-CM1.6	Zayante Creek Above First Zayante Rd crossing
13c	*13c-CM2.8	Zayante Creek downstream of Zayante School Road Intersection with E. Zayante Road
13d	*13d-CM4.1	Zayante Creek upstream of Third Bridge Crossing of East Zayante Road After Lompico Creek Confluence
13e	*13e-CM0.4	Lompico Creek upstream of the fish ladder and downstream of first bridge crossing.
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-2 CM4.7	Bean Creek Adjacent to Redwood Camp.
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 2016.)

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 habitat typing by reach and/or sampling in 2016.)

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		
0	Filtration Plant outfall to Browns Creek Confl. CM8.45 – CM9.46	3,250
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	34,242 (6.5 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)
Casserly Creek		
3	Casserly Rd Bridge Crossing to Mt. Madonna Rd Bridge Crossing CM1.62 – CM2.54	4,874 (0.92 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 2016.)

Corralitos Creek

Reach #	Site # -Channel Mile	Location of Sampling Sites
0	*0 –CM8.5	Upstream of Filtration Plant Outfall
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 2003-2016, 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) and a below median baseflow year afterwards (2016). 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 29 September 2016, the main estuary along the beach and Watsonville Slough near its mouth were sampled for steelhead with the 106-foot bag seine (8 seine hauls). On 30 September 2016, the upper estuary was sampled for steelhead with the 106-foot seine at the model airport (3 seine hauls) and Thurwachter Bridge (3 seine hauls). On 30 September during steelhead sampling at Thurwachter

Bridge in the upper estuary, water quality was measured through the water column, mid-channel from a boat (2 sites). On 3 October 2016, 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 3 October during tidewater goby sampling in the lower (mid-channel) and upper estuary (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 in 2016

For the overall sampling activities in 2016, a total of 1,979 juvenile steelhead were captured by electrofishing at 47 electrofishing sites and 1 lagoon site, with 15 steelhead mortalities (0.76% mortality rate). Beyond our control, Aptos Lagoon/Estuary was not sampled in 2015 or 2016, as it had been accomplished previously. No steelhead were captured in Pajaro Lagoon. A total of 20 juvenile steelhead were visually censused by snorkeling in pools at 6 San Lorenzo mainstem sites. Ten mainstem sites and 17 tributary sites were electrofished in the San Lorenzo watershed, with a total of 1,547 juvenile steelhead captured and 12 mortalities (0.78%). A total of 179 juvenile steelhead were electrofished at 8 sites in the Soquel watershed with 1 steelhead mortality (0.56%). A total of 99 juvenile steelhead were electrofished at two Aptos and two Valencia creek sites in the Aptos Watershed with 1 mortality (1%). A total of 99 juvenile steelhead were electrofished at 7 sites in the Corralitos/Browns sub-watershed with 1 mortality (1%). A total of 55 juvenile steelhead were electrofished at one Casserly Creek site with no mortalities.

R-2. Habitat Change in the San Lorenzo River Mainstem and Tributaries, 2015 to 2016, 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 37**. Weighing the relative importance of streamflow as an aspect of habitat quality with other habitat parameters in the fall is not clear cut, especially when exact fall streamflow measurements 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 2016 was higher than in 2013−2015. However, baseflow after March was below the median daily statistic throughout the summer and fall of 2016 because of previous years of drought. Even so, we judged baseflow conditions more favorable for growth in 2016 than in 2014 or 2015, though 2016 baseflows were less than in the previous dry year of 2012 (**Figures 33a-b, 34a−b; 53; Appendix C**). During the 2015-2016 winter, there were 4 main stormflows, occurring in January (≈ 3,500 cfs and ≈ 1,200 cfs at Big Trees gage in close succession), and early March (≈12,000 cfs and ≈ 4,000 cfs at Big Trees gage), with little precipitation after 15 March. 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**). Less than median baseflow in 2016 likely provided only modest food supply (lower insect drift velocity and reduced fastwater habitat) and only modest growth rate at most sites, except where YOY densities were very low (mainstem sites below Boulder Creek confluence, Zayante 13a and 13c, Bean 14a-b, Newell 16 and Bear 18a) (**Figure 21b**). The average mean monthly streamflow for May−September in 2016 at the Big Trees gage was 22.5 cfs (higher than dry years of 2004, 2007−2009 and 2013−2015, but considerably below the 20-year average since 1997 of 34.1 cfs (**Figure 53**).

In 2016, habitat typing occurred in segments of Reaches 2 and 11 in the mainstem and Reaches 13a, 13d, 14a, 14b, 17a, 18a, 20a and 21b in the tributaries. 2016 reach averages were compared to the most recent years of reach data. Other reaches without 2016 reach data were evaluated according to habitat changes at sampling sites from 2015 to 2016. Rearing habitat quality improved in mainstem reaches/sites in 2016 mostly due to higher average baseflow from May through September and more escape cover at 3 of 10 sites (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 in most tributary reaches/sites due to higher average baseflow from May through September (except Bear 18a compared to 2012) and despite similar or better escape cover in pools at only 6 of 16 reaches/sites (**Figure 13b**). All mainstem and tributary reaches/ sites had deeper habitat conditions except pools in Mainstem 11 (compared to a wetter year of 2012), Mainstem 12a (landslide had occurred), runs in Fall 15a and pools in Branciforte 21b (compared to 2013). Percent fines and embeddedness were mostly similar or improved in the mainstem. Percent fines in the mainstem were mostly similar in fastwater habitat except increased in Mainstem 2 runs and Mainstem 11 runs. Percent fines in pools of upper mainstem and tributary reaches/ sites were mostly similar compared to 2015 except for pools in Mainstem 10, Mainstem 12a and fastwater habitat (usually runs) in 6 of 14 tributary reaches/ sites. A typical improvement came in pools of Boulder 17a and Branciforte 21b compared to 2013 reach conditions. Embeddedness mostly worsened in mainstem fastwater habitat except for similar levels to 2015 in Mainstem 0a, 2 and 11.Embeddedness also increased in fastwater habitat of tributary reaches/ sites in 8 of 14 instances. Embeddedness in tributary pools was similar to 2015 except worsening in Bean 14a. So, in the first year with a sizeable stormflow (> 10,000 cfs) after 3 years of drought, the percent fines remained mostly similar to 2016 conditions. Embeddedness increased in fastwater habitat in a majority of the reaches/ sites but not in most pools. Pools in Lower Carbonera 20a widened since 1995 (avg. width = 16.8 ft (2016); avg. width = 10.9 ft (1995)). Average mean pool depth was 1.0 ft in 2016 and 1995, while average maximum pool depth was 2.0 ft in 2016 and 1.7 ft in 1995. Two especially wet water years occurred in 1998 and 2006, which may have resulted in considerable streambank erosion. The reach looked much more open in 2016 than it did in the mid-1990's. Stormflows become more flashy and extreme as impermeable surfaces increase in the city of Scotts Valley.

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 2007−2016, 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 2016 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 53**), which had a higher baseflow than in 2007–2009 to at least partially explain greater depth then (**Figure 60**). 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 more westerly channel at the lower end, which had become the main channel where the streamflow splits in two. The increased depth from 2010 to 2011 may have been partially due to this change, along with the higher baseflow in 2011 (**Figure 53**). 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. In 2016, riffle depth increased with the increased baseflow. Escape cover in riffles has also declined substantially since 1999 and 2000 (**Figure 61**), which may be partially explained by higher baseflows in the earlier years (**Figure 53**). The escape cover index in riffle habitat has fluctuated between 0.101 and 0.133 (between 10.1 and 13.3 feet of linear cover distance 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. The escape cover index declined from 0.132 in 2015 to 0.119 in 2016, which was consistent with increased embeddedness. There was more than 4 times the escape cover in 1999 compared to that measured in 2016.

Streamflow affects habitat quality. The trend in pool depth in upper Zayante Reach 13d (**Figure 62**) mirrored fluctuation in baseflow until 2016, when depth did not increase with increased baseflow (**Figure 53**). 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. Average maximum pool depth decreased slightly in 2016 to 1.4 ft, despite higher baseflow, and average mean pool depth remained at 0.8 ft. During the wet years of 1998 and 1999, the average mean pool depth was similar to the average maximum pool depth in 2014–2016. 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 for pool habitat have fluctuated since 1998 in Zayante Reach 13d (**Figure 63**), with somewhat higher ones in some wetter years (1998–2000, 2003, 2005 and 2011) (**Figure 53**). However, there was an abrupt decline in 2006 (0.109), despite high baseflow, and there was an abrupt improvement in 2009 (0.181) despite low baseflow. The low point was in 2014 (0.073) during the recent drought. But a sizeable improvement occurred in 2015 (0.120) only to be lost in 2016 (0.076) down to nearly 2014 conditions. There was less than 1/3 the amount of escape cover in 2016 compared to the high reached in 2005 (0.269).

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	2016
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	6.99
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	2.35
9- SLR/ Below Bould.	4.6		7.2	3.5		3.0	3.7	2.1	5.8						0.80	0.88	1.82
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	Dry
15a–b/ 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.	1.39 Below div. Alley
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	1.39 (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	2016
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)	13 (13 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)	1.29 (8/10)
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)	5.0 (8/2)
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)	0.38 (8/4)
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)	0.08 (8/4)
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)	2.48 (10/24)
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)	0.76 (8/4) Glen Arbor
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)	1.41(8/4)
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	0.47 (8/10)
Location	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**
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)	1.16 (10/4)
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)	0.67 (7/21)
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)		0.46 (9/22)
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)	0.73 (9/22) 0.33 (7/22) Below Browns Cr.
Corralitos Cr above Los Cosinos Road					2.0 (DWA)	2.6 (DWA)	2.0 (DWA)	1.54 (DWA)	1.29 (DWA)	1.21 (DWA)	

Bridge											
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)	1.14 (9/21)
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 2010.

Reach	**Pool 2010**	**Pool 2011**	**Pool 2012**	**Pool 2013**	**Pool 2014**	**Pool 2015**	**Pool 2016**	**Riffle 2010**	**Riffle 2011**	**Riffle 2012**	**Riffle 2013**	**Riffle 2014**	**Riffle 2015**	**Riffle 2016**	**Run/ Step Run 2010**	**Run/ Step Run 2011**	**Run/ Step Run 2012**	**Run/ Step Run 2013**	**Run/Step Run 2014**	**Run/ Step Run 2015**	**Run/ Step Run 2016**
1- L. Main					1.9/3.1							0.6/0.9							**0/9 1.4**		
2- L. Main	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	2.4/4.6	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	0.9/1.4	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**	**1.6/2.0**
3- L. Main																					
4- L. Main						1.9/3.5							0.45/0.8							**0.9/1.45**	
5- L. Main																					
6- M. Main																					
7- M. Main																					
8- M. Main					2.4/4.0							0.4/0.7							**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			1.1/2.0				1.1/1.9			0.3/0.5				0.3/0.5			**0.5/0.7**				**0.45/0.7**
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	1.5/2.5 (2008						1.3/2.3	0.4/0.8 (2008)						0.4/0.7	**0.6/0.9 (2008**						**0.6/0.9**
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	1.2/2.0	1.3/2.0	1.1/1.8	1.0/1.6	0.8/1.4	0.8/1.5	1.0/1.75	0.4/0.6	0.45/0.8	0.3/0.6	0.3/0.5	0.2/0.35	0.15/0.3	0.2/0.7	0.7/1.1	0.8/1.2	**0.6/1.0**	**0.5/0.9**	**0.3/0.5**	**0.4/0.8**	**0.4/0.9**
Lompico 13e																					
Zayante 13i						1.15/1.9							0.2/0.4							**0.3/0.5**	
Bean 14a						1.2/2.0							0.4/0.6							**0.5/0.8**	
Bean 14b	1.15/2.0	1.2/2.0	1.2/2.1	1.0/1.9	0.9/1.5	1.0/1.8	1.0/1.85	0.2/0.4	0.3/0.6	0.3/0.5	0.3/0.5	0.3/0.5	0.25/0.5	0.2/0.4	0.4/0.6	0.5/0.8	**0.4/0.9**	**0.4/0.7**	**0.4/0.6**	**0.35 0.6**	**0.4/0.8**
Bean 14c	0.9/1.6	1.0/1.8					1.2/2.1 Seg.Δ	0.1/0.2	0.2/0.4					None	0.2/0.4	0.3/0.5					**0.2/0.4**

Reach	Pool 2010	Pool 2011	Pool 2012	Pool 2013	Pool 2014	Pool 2015	Pool 2016	Riffle 2010	Riffle 2011	Riffle 2012	Riffle 2013	Riffle 2014	Riffle 2015	Riffle 2016	Run/ Step Run 2010	Run/ Step Run 2011	Run/ Step Run 2012	Run/ Step Run 2013	Run/Step Run 2014	Run/ step Run 2015	Run/ step Run 2016
Fall 15a					0.7/ 1.1							0.3/ 0.6							**0.4/ 0.8**		
Fall 15b		1.3/ 1.9			0.8/ 1.2				0.6/ 1.05			0.3/ 0.6				0.8/ 1.25			**0.5/ 0.7**		
Newell 16	1.5/ 2.5	1.4/ 2.3						0.3/ 0.5	0.3/ 0.5						0.4/ 0.8	0.5/ 0.8					
Boulder 17a				1.4/ 2.4			1.6/ 2.55				0.4/ 0.7			0.5/ 0.8				**0.6/ 1.0**			**0.7/ 1.1**
Boulder 17b				1.4/ 2.4							0.4/ 0.8							**0.55/ 1.0**			
Boulder 17c																					
Bear 18a			1.4/ 2.2							0.2/ 0/4							**0.4/ 0.7**				
Bear 18b																					
Branciforte 21a-1																					
Branciforte 21a-2	1.0/ 1.9				0.95 / 1.6			0.2/ 0.4				0.25 / 0.5			0.5/ 0.8				**0.5/ 0.7**		
Branciforte 21b			1.1/ 1.9	1.2/ 2.0			1.1/ 1.8			0.2/ 0.45	0.3/ 0.5			0.3/ 0.5			**0.4/ 0.8**	**0.4/ 0.7**			**0.5/ 0.7**

Table 6b. Averaged Mean and Maximum WATER DEPTH (ft) at REPLICATED San Lorenzo Sampling Sites Since 2010.

Site	Pool 2010	Pool 2011	Pool 2012	Pool 2013	Pool 2014	Pool 2015	Pool 2016	Riffle 2010	Riffle 2011	Riffle 2012	Riffle 2013	Riffle 2014	Riffle 2015	Riffle 2016	Run/Step Run 2010	Run/Step Run 2011	Run/Step Run 2012	Run/Step Run 2013	Run/Step Run 2014	Run/Step Run 2015	Run/Step Run 2016
0a	1.2/2.2	1.6/2.0	1.3/2.5	2.2/3.5	1.2/1.9	0.9/1.4	1.4/2.4	0.75/0.9	1.1/1.8	0.6/0.9			0.7/1.5	0.7/1.5	0.95/1.8	1.0/1.8	–	**1.8/3.0**	0.6/1.2	1.0/1.5	1.0/1.7
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	0.8/1.0	1.3/1.9	1.6/2.1	**1.1/1.7**	**1.3/1.9**	1.0/1.5	1.0/1.5	1.1/1.8
2									1.3/1.5	1.1/1.5	1.0/1.8	0.9/1.4	0.85/1.1	1.0/1.5		1.7/2.95	**1.9/2.6**	**1.9/2.5**	1.5/2.2	1.4/2.2	1.6/2.0
4								0.55/0.9	0.85/1.1	0.6/1.0	0.6/0.9	0.5/0.7	0.6/1.0	0.5/1.5 (Site Δ)	1.1/2.2	1.55/2.0	**1.2/1.65**	**1.3/1.6**	1.05/1.45	1.0/1.4	1.9/2.8 (Site Δ)
6								0.65/0.8	0.65/1.0	0.6/1.05	0.5/0.9	0.4/0.6	0.35/0.8	0.6/0.9	0.6/1.2	0.7/1.2	**0.7/1.1**	**0.75/1.05**	0.5/0.9	0.6/1.6	0.5/1.5
8								0.8/1.0	0.9/1.2	0.7/1.1	0.6/1.1	0.6/0.8	0.55/1.0	0.75/1.05	0.95/1.2	1.0/1.3	**0.8/1.2**	**0.8/1.0**	0.65/1.0	0.65/1.0	0.75/1.0
9											0.4/0.7	0.4/0.85	0.45/0.75	0.6/1.0				**0.6/1.0**	0.5/0.7	0.6/0.9	0.8/1.0
10					1.3/2.5	1.0/2.4	1.2/2.6					0.1/0.15	0.1/0.2	0.25/0.4					0.3/0.5	0.4/0.8	0.5/0.9
11	1.0/1.6	0.9/1.5	1.2/1.75	1.05/1.7	1.1/1.85	1.05/1.55	1.4/2.6 Δ Site	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	0.4/0.6 Δ Site	0.6/0.8	0.6/1.1	**0.4/0.5**	**0.3/0.5**	0.2/0.5	0.25/0.4	0.6/1.0 Δ Site
12a						1.1/1.8	0.8/1.3						0.4/0.55	0.3/0.6						0.4/0.6	0.6/0.9
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	2.1/3.4	1.8/3.8	1.9/3.7	1.7/3.0	1.4/2.9	1.3/2.4	1.4/3.1 Δ Site	0.2/0.5	0.5/0.8	0.4/0.7	0.6/1.0	0.35/0.6	0.3/0.5	0.3/0.5 Δ Site	0.75/1.3	0.9/1.5	**0.7/1.05**	**0.8/1.2**	0.75/1.1	0.7/1.4	0.6/0.9 Δ Site
Zayante 13c		1.1/1.85	1.1/1.75	1.05/1.85	0.95/1.75	1.0/1.85	1.1/2.05		0.6/0.9	0.3/0.7	0.3/0.5	0.2/0.5	0.15/0.4	0.25/0.8		0.7/0.95	0.5/0.75	0.55/0.85	0.4/0.5	0.4/0.5	0.5/0.9
Zayante 13d			1.1/1.95	0.8/1.2 Δ Site	0.7/1.45 Δ Site	065/1.0	0.8/2.0 Δ Site						0.2/0.4				0.75/1.0	0.3/0.5	0.3/0.5	0.45/0.7	0.5/0.9 Δ Site

Site	Pool 2010	Pool 2011	Pool 2012	Pool 2013	Pool 2014	Pool 2015	Pool 2016	Riffle 2010	Riffle 2011	Riffle 2012	Riffle 2013	Riffle 2014	Riffle 2015	Riffle 2016	Run/ Step Run 2010	Run/ Step Run 2011	Run/ Step Run 2012	Run/ Step Run 2013	Run/ Step Run 2014	Run/ Step Run 2015	Run/ Step Run 2016
Zayante 13i						1.4/ 2.2	1.2/ 2.2						0.1/ 0.2	0.2/ 0.4						0.3/ 0.65	0.3/ 0.5
Lompico 13e	1.2/ 1.6	1.25/ 1.75	1.2/ 1.65	1.2/ 2.0	1.0/ 1.75	0.9/ 1.7	1.05/ 1.65	0.1/ 0.3	0.2/ 0.4	0.2/ 0.5	0.05/ 0.3	0.05/ 0.2	0.05/0.15	0.2/ 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	0.25/ 0.5
Bean 14a						**0.8/ 1.7**	**0.8/ 1.8**						**0.5/ 0.7**	**0.4/ 0.75**						0.5/ 0.8	0.7/ 1.0
Bean 14b	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	1.0/ 2.5	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/ 0.5	0.5/ 0.6	0.5/ 0.7	0.5/ 0.8	0.5/ 0.7	0.4/ 0.5	0.3/ 0.7	0.4/ 0.9
Bean 14c		0.8/ 1.65	0.8/ 1.45 dry	Dry	Dry	Dry	1.3/ 2.4 Δ Seg		0.2/ 0.3	0.1/ 0.2 dry	Dry	Dry	Dry	None Δ Seg		0.3/ 0.5	0.25/ 0.35 dry	Dry	Dry	Dry	0.1/ 0.2 Δ Site
Fall 15a					0.7/ 0.95	0.7/ 1.2	0.8/ 1.35					0.25/ 0.5	0.25/ 0.5	0.4/ 0.8					0.45/ 0.8	0.65/ 0.9	0.5/ 0.8
Fall 15b		1.1/ 1.85	1.15/ 1.65	0.8/ 1.3	0.9/ 1.2 Δ Site	0.75/ 1.05	0.95/ 1.35		0.7/ 1.4	0.45/ 0.8	0.3/ 0.6	0.35/ 0.55	0.3/ 0.6	0.4/ 0.9		0.9/ 1.4	0.6/ 1.1	0.45/ 0.8	0.4/ 0.5	0.4/ 0.6	0.45/ 0.8
Newell 16	1.25/ 1.9	1.15/ 1.85	1.05/ 1.8	1.2/ 2.1	0.95/ 1.75	0.9/ 1.45	1.05/ 1.55	.25/ .55	0.4/ 0.5	0.35/ 0.45	0.4/ 0.7	0.03/ 0.1	0.15/0.4	0.2/ 0.4	0.5/ 0.9	0.4/ 0.6	0.3/ 0.5	0.4/ 0.55	0.2/ 0.5	0.2/ 0.45	0.35/ 0.6
Boulder 17a	1.2/ 1.75	1.4/ 1.95	1.2/ 1.8	1.05/ 1.8	1.0/ 1.75	1.1/ 1.85	2.05/ 3.4 Δ Site	0.7/ 1.1	–	0.5/ 1.0	0.5/ 0.7	0.35/ 0.6	0.35/ 0.6	0.5/ 0.7 Δ Site	0.9/ 1.2	1.1/ 1.4	0.8/ 1.2	0.85/ 1.0	0.7/ 1.0	0.7/ 1.0	0.8/ 1.0 Δ Site
Boulder 17b	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	1.15/ 1.9	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/ 0.8		0.8/ 1.4	0.6/ 1.2	0.4/ 0.85	0.4/ 0.7	0.45/ 0.7	0.4/ 1.0
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	1.2/ 2.45	0.3/ 0.6	0.3/ 0.6	0.3/ 0.6	0.3/ 0.5	0.2/ 0.4	0.2/ 0.4	0.4/ 0.5	0.7/ 0.9	0.65/ 1.0	0.45/ 0.9	0.4/ 0.6	0.35/ 0.6	0.3/ 0.6	0.4/ 0.9
Carbonera 20a							0.75/ 1.4							0.15/ 0.2							0.2/ 0.6
Branciforte 21a-2	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	0.25/ 0.5	0.1/ 0.3	0.1/ 0.3	0.35/ 0.5			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	1.1/ 1.6			0.3/ 0.6	0.4/ 0.6	0.2/ 0.4	0.25/ 0.5	0.4/ 0.6			0.5/ 0.85	0.5/ 0.7	0.5/ 0.8	0.4/ 0.7	0.6/ 0.85
Branciforte 21c				1.2/ 2.35	1.4/ 2.5	1.45/ 2.4	1.4/ 2.55				0.1/ 0.15	0.05/ 0.1	0.1/ 0.2	0.1/ 0.2				0.3/ 0.4	0.2/ 0.4	0.15/ 0.3	0.25/ 0.45

Table 7a. Average PERCENT FINE SEDIMENT* IN SAN LORENZO REACHES Since 2010.

Reach	**Pool 2016**	**Pool 2010**	**Pool 2011**	**Pool 2012**	**Pool 2013**	**Pool 2014**	**Pool 2015**	**Riffle 2016**	**Riffle 2010**	**Riffle 2011**	**Riffle 2012**	**Riffle 2013**	**Riffle 2014**	**Riffle 2015**	**Run Step Run 2016**	**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	50	48	47	44	50	38	37	10	10	8	9	6	6	5	23	40	13	**17**	**9**	**8**	**12**
4							62							7							**19**
6																					
7																					
8						37							6							**8**	
9					46							9							**23**		
10						44							4							**6**	
11	18			25				4			8				6			**17**			
12a							15							2							**6**
12b				27							4							**9**			
Zayante 13a	54							10							19						
Zayante 13b																					
Zayante 13c		41	43				53		10	14			3.5			19	19				**14**
Zayante 13d	34	42	40	26	31	19	28	2	19	14	14	6	6	9	20	27	28	**19**	**16**	**13**	**15**
Zayante 13i							26							8							**48**
Lompico 13e																					
Bean 14a							59							18							**28**
Bean 14b	73	55	61	49	64	60	65	12	13	32	10	13	13	15	41	28	72	**25**	**34**	**56**	**66**
Bean 14c	58 Seg. Δ	54	51					none Seg.Δ	14	9					12 Seg.Δ	26	19				
Fall 15a						28							19							**23**	
Fall 15b			57			40				19			13				37			**47**	
Newell 16		22	22						6	3						12	4				
Boulder 17a	27				59			16				13			13				**19**		
Boulder 17b					22							3							**7**		
Boulder 17c																					
Bear 18a		41		38					13		9					19		**19**			
Branci. 21a-2		43				40			9				6			22				**14**	
Branci. 21b	35			**56**	45			8			**24**	18			17			**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**	**Pool 2016**	**Riffle 2011**	**Riffle 2012**	**Riffle 2013**	**Riffle 2014**	**Riffle 2015**	**Riffle 2016**	**Run/ Step Run 2011**	**Run/ Step Run 2012**	**Run/ Step Run 2013**	**Run/ Step Run 2014**	**Run/ Step Run 2015**	**Run/ Step Run 2016**
0a	50	50	NA	25	60	30	30	5	NA	10	30	25	25	**15**	**NA**	**10**	**30**	**25**
1	NA	NA	NA	NA	NA	NA	10	15	5	5	10	10	15	**20**	**40**	**25**	**20**	**25**
2	NA	NA	NA	NA	NA	NA	10	15	5	15	10	15	20	**25**	**5**	**20**	**25**	**25**
4	NA	NA	NA	NA	NA	NA	15	10	5	5	5	10 ΔSite	38	**30**	**35**	**30**	**25**	**15** ΔSite
6	NA	NA	NA	NA	NA	NA	15	15	5	10	15	20	15	**15**	**10**	**15**	**15**	**20**
8	NA	NA	NA	NA	NA	NA	15	15	15	5	20	20	20	**30**	**15**	**5**	**25**	**25**
9	NA (2005		NA	NA	NA	NA	10 (2005)		13	8	13	20	35 (2005)		**45**	**23**	**23**	**30**
10	60 (2001			30	15	25	25 (2001)			1	10	5	40 (2001)			**20**	**30**	**10**
11	35	20	33	33	38	30 Δ Site	5	NA	5	1	10	3 Δ Site	5	**NA**	**15**	**10**	**15**	**5** Δ Site
12a					5	33					1	5					**5**	**5**
12b	45 (2001	35	30	28			23 (2001)	5	5	2			20 (2001)	**5**	**5**	**10**		
Zay 13a	80	50	75	60	30	65 Δ Site	1	5	10	10	15	15 Δ Site	15	**30**	**50**	**50**	**40**	**60** Δ Site
Zay 13c	15	10	5	15	20	13	15	10	2	NA	2	2	10	**13**	**10**	**NA**	**10**	**5**
Zay 13d	33	22	30	17	20	48 Δ Site	NA	NA	NA	NA	10	NA ΔSite	23	**25**	**20**	**15**	**20**	**10** Δ Site
Zay 13i					18	53					10	5					**15**	**30**
Lompico 13e	45	40	45	50	48	50	NA	20	10	2	10	20	25	**20**	**30**	**30**	**40**	**20**
Bean 14a					70	70					20	15					**20**	**20**
Bean 14b	70	60	80	95	23 Δ Site	90 Δ Site	10	10	10	20	2	5 Δ Site	35	**25**	**25**	**25**	**10**	**25** Δ Site
Bean 14c	38	10	Dry	Dry	Dry	60 Δ Seg	5	2	Dry	Dry	Dry	none	15	**10**	**Dry**	**Dry**	**Dry**	**5** Δ Seg
Fall 15a				32	25	37				15	7	15				**13**	**15**	**20**
Fall 15b	50	68	40	28	50	45	20	20	15	23	30	43	25	**35**	**60**	**25**	**60**	**35**
Newell 16	18	28	8	20	NA	10	5	2	2	1	NA	1	5	**2**	**10**	**5**	**10**	**2**
Bould 17a	20	30	60	38	28	20 Δ Site	5	15	10	10	25	2	15	**10**	**15**	**15**	**20**	**10**
Bould 17b	25	25	18	18	30	23	0	2	2	1	1	15	10	**10**	**5**	**2**	**5**	**2**
Bear 18a	28	33	43	45	35	40	5	15	5	5	10	15	20	**20**	**10**	**15**	**20**	**10**
Bran21a-2	75	48	65	43			2	NA	15	5			25	**20**	**20**	**10**		
Carb 20a						60						15						**15**
Branc 21b	73 (2001	**53**	28	50	35	30	15 (2001)	**10**	10	5	15	5	45 (2001)	**20**	**20**	**15**	**20**	**28**
Branc 21c			80	55	75	70			15	5	10	15			**15**	**10**	**15**	**60**

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

Table 8a. Average EMBEDDEDNESS IN SAN LORENZO Reaches Since 2010.

Reach	**Pool 2016**	**Pool 2010**	**Pool 2011**	**Pool 2012**	**Pool 2013**	**Pool 2014**	**Pool 2015**	**Riffle 2016**	**Riffle 2010**	**Riffle 2011**	**Riffle 2012**	**Riffle 2013**	**Riffle 2014**	**Riffle 2015**	**Run Step Run 2016**	**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	38	37	49	39	33	50	33	19	25	20	19	20	21	15	30	27	**28**	**38**	**31**	**30**	**23**
4							52							32							**39**
5																					
6																					
7																					
8						56							36							**38**	
9					48							26							**63**		
10						57							28							**35**	
11	45			46				23			14				27			**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	57	57	53	53	56	63	60	18	39	45	49	41	43	39	56	51	**40**	**43**	**51**	**54**	**53**
Zayante 13i							50							29							**48**
Lompico 13e																					
Bean 14a							53							25							**33**
Bean 14b	58	53	51	59	38	50	49	15	25	32	48	25	26	24	57	30	**55**	**53**	**36**	**41**	**44**
Bean 14c	56	60	53		Dry	Dry	Dry	None	42	31					42	43	**46**				
Fall 15a						48							30							**37**	
Fall 15b			46			53				18			26				**42**			**46**	
Newell 16		39	53						24	31						34	**43**				
Boulder 17a	51				58			29				27			45				**39**		
Boulder 17b					33							26							**34**		
Boulder 17c																					
Bear 18a		49		60					25		44					34		**50**			
Branc-21a-2		53				53			30				30			41				**34**	
Branc-21b	51			48	**48**			22			18	**25**			34			**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	Pool 2016	Riffle 2011	Riffle 2012	Riffle 2013	Riffle 2014	Riffle 2015	Riffle 2016	Run/ Step Run 2011	Run/ Step Run 2012	Run/ Step Run 2013	Run/ Step Run 2014	Run/ Step Run 2015	Run/ Step Run 2016
0a	60	40		45	50	50	30	20		25	20	30	35	35		25	30	30
1				65			25	30	20	25	20	30	50	40	40	40	30	35
2	55	35	33	58			15	20	25	35	25	20	30	30	25	30	35	35
4							15	20	20	25	5	30	50	50	50	38	33	35
6							20	30	40	50	30	40	30	30	40	50	30	45
8				65			30	25	45	35	30	40	35	45	45	25	35	45
9			55		30		15 (2005		25	38	38	35	25 (2005		65	60	35	50
10				45	30	35				15	20	30				20	30	35
11	40	50	53	68	50	45	5	NA	15	15	15	20	5	NA	30	40	25	15
12a					40	48					20	Na					25	60
12b	43 (2001	55	55	58			35 (2001	30	35	35			35 (2001	45	45	40		
Zayante 13a	60	65	45	50	50	55	20	30	30	30	30	20	35	40	40	50	35	35
Zayante 13c	30	45	50	28	55	53	45	45	30	35	10	40	35	35	40	60	20	10
Zayante 13d	43	53	55	73	53	48	20				35		45	45	65	75	70	45
Zayante 13i					38	43					30	25					35	35
Lompico 13e	50	40	38	58	50	58	NA	30	25	60	35	50	45	30	35	50	30	50
Bean 14a					65	65					30	25					30	40
Bean 14b	45	60	35	60	45	50	20	45	15	45	10	25	35	70	35	35	25	35
Bean 14c	53	10	Dry	Dry	Dry	60	10	25	Dry	Dry	Dry	none	40	30	Dry	Dry	Dry	20
Fall 15a				43	45	50				30	30	37				43	35	40
Fall 15b	38	60	45	58	38	38	25	50	20	48	28	43	30	45	30	50	30	40
Newell 16	65	33	60	20	48	40	15	15	35	25	15	20	35	15	40	15	35	35
Boulder 17a	40	38	58	50	38	48	25	40	20	30	30	20	35	25	20	45	40	40
Boulder 17b	30	35	35	40	33	40	10	10	35	35	25	30	30	25	30	30	25	30
Bear 18a	38	65	50	50	58	50	25	60	65	60	70	50	35	60	60	45	50	65
Carbonera 20a						63						15						45
Branciforte 21a-2	53	48	53	63			20		25				60	40	30	40		
Branciforte 21b	42 (2001	48	50	53	35	40	40 (2001	20	20	25	25	25	40 (2001)	30	35	30	20	35
Branciforte 21c			20	35	38	45			35	10	10	30			15	30	25	40

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	2016
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	0.119
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				0.033
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	2016
Santa Cruz Levees 0a	0.211	0.298	0.205	0.403	2.000 Floating veg.	0.182	0.247	0.178
Paradise Park 1	0.155	0.183	0.128	0.106	0.045	0.073	0.150	0.152
Rincon 2			0.129	0.117	0.100	0.141	0.200	0.115
Henry Cowell 4	0.537	0.479	0.374	0.308	0.307	0.320	0.379	0.230 Site Δ
Below Fall Creek 6	0.113	0.230	0.109	0.088	0.183	0.141	0.223	0.059
Below Clear Creek 8	0.082	0.194	0.154	0.163	0.148	0.054	0.104	0.122
Below Boulder Creek 9	0.133 (2005)				0.035	0.060	0.122	0.106
Below Kings Creek 10						0	0.053	0.020
Above Kings Creek Near Teihl Rd 11	0.0	0.024	0.036	–	0.041	0	0.020	0.080 Site Δ
Waterman Gap 12b				0.000	0.031	0.038	0.008 (Site 12a)	0.031 (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	2016
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	0.064
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				0.038
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	2016
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	0.050
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				0.082
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	2016
Zayante 13a	0.320	0.069	0.056	0.169	0.081	0.074	0.071	0.086								**0.069**
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**	**0.076**
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**	**0.130**
Bean 14c	0.259	0.093	0.100	0.142	0.141	0.131	0.142	0.131		0.135	0.115					**0.121** Seg Δ
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**			**0.040**
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**				**0.046**
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**			**0.222**
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	Pool Escape Cover 2016
Mainstem below Kings Cr. 10						**0.026**	**0.102**	**0.119**
Mainstem @ Teihl 11	0.058*	0.094	**0.033**	**0.039**	**0.081**	**0.085**	**0.120**	**0.051 Site Δ**
Mainstem @ Waterman Gap 12b				**0.091**	**0.124**	**0.155**	**0.220 (Site 12a)**	**0.220 (Site 12a)**
Zayante 13a	0.140	0.103	**0.167**	**0.222**	**0.122**	**0.060**	**0.379**	**0.116 Site Δ**
Zayante 13c			**0.120**	**0.178**	**0.164**	**0.186**	**0.212**	**0.265**
Zayante 13d	0.285	0.113	**0.168**	**0.135 Site Δ**	**0.135 Site Δ**	**0.073 Site Δ**	**0.096**	**0.113 Site Δ**
Zayante 13i							**0.223**	**0.126**
Lompico 13e	0.154	0.092	**0.061**	**0.072**	**0.098**	**0.057**	**0.065**	**0.071**
Bean 14a							**0.192**	**0.219**
Bean 14b	0.145	0.120	**0.165**	**0.175**	**0.137**	**0.181**	**0.424 Site Δ**	**0.129 Site Δ**
Bean 14c			**0.098**	**0.094**	**Dry**	**Dry**	**Dry**	**0.177 Seg Δ**
Fall 15a						**0.170**	**0.220**	**0.115**
Fall 15b	0.302	0.571	**0.429**	**0.500**	**0.357**	**0.174 Site Δ**	**0.491**	**0.417**
Newell 16	0.150	0.118	**0.101**	**0.154**	**0.142**	**0.033**	**0.037**	**0.073**
Boulder 17a	0.066	0.094	**0.110**	**0.092**	**0.060**	**0.041**	**0.096**	**0.071 Site Δ**
Boulder 17b	0.356	0.266	**0.258**	**0.461**	**0.088 Site Δ**	**0.138**	**0.109**	**0.087**
Bear 18a		0.138	**0.101**	**0.050 Site Δ**	**0.068**	**0.034**	**0.056**	**0.012**
Carbonera 20a								**0.092**
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**	**0.209**
Branciforte 21c					**0.252**	**0.286**	**0.280**	**0.235**

***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	2016
Zayante 13a	0.127	0.059	0.059	0.065	0.031	0.038	0.027	0.009								**0.006**
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**	**0.039**
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**	**0.036**
Bean 14c	-	0.018	0.023	0.015	0.012	0.009	0.0	0.0		0.0	0.018					**0 Seg** Δ
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			**0.060**
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				**0.015**
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			**0.168**
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 2015 to 2016, 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)	+	+ / +	+/ Similar	Similar	+/ –	+
(Mainstem 1)	+	/ +	/ Similar	/ – riffle	/ Similar	+
Mainstem 2	+ (since 2015)	+ / +	–/ – run	Similar/ Similar	–/ –	+ (flow)
(Mainstem 4)	+	/ +	/ + run	/ – riffle	/ –	+ (flow)
(Mainstem 6)	+	/ +	/ Similar	/ –	/ –	+ (flow)
(Mainstem 8)	+	/ +	/ Same	/ –	/ +	+
(Mainstem 9)	+	+/ +	/ Similar	/ – runs	/ –	+ (flow)
(Mainstem 10)	+	+/ +	–/ + run	Similar/ – riffle	+/ –	+
Mainstem 11	– (since 2012)	– / Similar	Similar/ – run	Similar/ Similar	+/ +	+
(Mainstem 12a)	+	–/ +	–/ Similar	Similar/ –	Same/ +	+
Zayante 13a	+ (since 2008)	+/ Similar	Similar/ + run	–/ – run	–/ Similar	+ (flow)
(Zayante 13c)	+	+ / +	Similar	Similar/ – riffle; + run	+/ –	+
Zayante 13d	+ (since 2015)	+ / +	Similar	Similar/ + riffle	–/ Similar	+ (flow)
(Lompico 13e)	+ Similar	Similar	Similar/ – riffle; + run	Similar/ –	+/ Similar	+
(Bean 14a)	+	+/ + run	Same/ – run	Same/ – run	+/ Similar	+
Bean 14b	+ (since 2015)	Similar/ +	Similar/ – run	Similar / –	–/ –	+ (flow)
Bean 14c-1	Dry	Dry	Dry	Dry	Dry	Old segment Dry both years
(Fall 15a)	+	+ / + riffle; – run	–/ Similar	Similar	–/ Similar	+ (flow)
(Fall 15b)	+	+/ +	Similar / – riffle; + run	Similar/ –	–/ +	+
(Newell 16)	+	+/ +	NA	Similar	+/ +	+
Boulder 17a	+ (since 2013)	+ / +	+ / Similar	Similar	+/ +	+
(Boulder 17b)	+	+/ +	Similar/ – riffle	Similar/ – riffle; + run	–/ Similar	+ (flow)
Bear 18a	– (since 2012)	Similar/ +	Similar/ + run	Similar/ + run	–/ –	–
Branciforte 21b	+ (since 2013)	–/ Similar	+ / +	Similar	Similar/ +	+
(Branciforte 21c)	+	+/ +	Similar/ – run	Similar/ –	–/ Similar	+ (flow)

*NA = Not available.

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

Refer to **Appendix A** for maps of reach locations. Summary tables of habitat change for all sites and reaches (when comparisons were possible) are provided in **Tables 14a−15g and 37**. 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 in 2016 than in 2013− 2015. However, baseflow after March was below the median daily statistic throughout the summer and fall of 2016 because of previous years of drought. Most steelhead growth occurs in spring and early summer before baseflow decreases, allowing for better growth in 2016 than 2015. Based on gage readings in Soquel Village, all reaches had higher baseflow in fall 2016 than in fall 2015 (**Table 5b; Figures 36a-b; 37a-b; and 38**). The 5-month average baseflow for May−September was 4.4 cfs in 2016 compared to only 1.6 cfs in 2015, with a 20-year average of 8.3 cfs (**Figure 53**). Reach 12 in the SDSF maintained surface flow for the first dry season since 2013. During the 2015-2016 winter, there were 4 likely above bankfull stormflows occurring in January (≈2,300 cfs and ≈2,200 cfs at the Soquel Village gage in close succession), and early March (≈8,000 cfs and ≈ 2,400 cfs at the Soquel Village gage in rapid succession), with little precipitation after 15 March. By comparison, during the 2014-2015 winter there was a stormflow in February 2015 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. So, spawning access was much improved in 2016.

Overall habitat quality increased in all Soquel reaches/sites in 2016 from 2015 primarily due to increased baseflow (**Table 15g**). Reach 12a in the SDSF had surface flow and steelhead for the first time since 2013. However, pools shallowed considerably in 2016 at lower mainstem Sites 1 and 4 with increased fines sediment in runs and pools (Site 4 only for pools) and increased embeddedness at Site 4. These are indications of sedimentation in the lower mainstem in 2016. Reach 8 in the upper mainstem and Reach 13a in lower East Branch, as well as Site 19 in the lower West Branch, had increased embeddedness in fastwater habitat and reduced pool escape cover. Pool depth decreased at the replicated Reach 8 site (Site 12) and both sampling sites in the West Branch (19 and 21) despite increased baseflow, indicating sedimentation. Reach 8 had the largest geomorphic changes seen in years. Three historical pools combined to make one long pool below and above the Soquel Creek Road bridge (398 feet long in 2016). What was historically a pool upstream of there was converted mostly into a 204-foot long shallow run because the pool had filled with sediment except for a shallow 38-foot pool at its head. The sampled pool at Site 12 in Reach 8 had a maximum depth of 3.3 feet in 2015 and only 2.4 feet in 2016 (**Table 14b**). The pool escape cover index decreased from 0.143 in 2015 to 0.034 in 2016 in that pool (**Table 15f**).

Table 14a. Averaged Mean and Maximum WATER DEPTH (ft) of Habitat in SQOUEL CREEK Reaches* Since 2011.

Reach	Pool 2011	Pool 2012	Pool 2013	Pool 2014	Pool 2015	Pool 2016	Riffle 2011	Riffle 2012	Riffle 2013	Riffle 2014	Riffle 2015	Riffle 2016	Run/ Step Run 2011	Run/ Step Run 2012	Run/ Step Run 2013	Run/ Step Run 2014	Run/ Step Run 2015	Run/ Step Run 2016
1		1.35/ 3.6		1.0/ 2.7		1.1/ 2.8		0.35/ 0.6		0.1/ 0.2		0.4/ 0.6		0.5/ 0.8		**0.3/ 0.5**		**0.5/ 0/8**
2																		
3	1.6/ 3.0		1.2/ 2.4		1.1/ 2.2		0.45/ 0.75		0.3/ 0.6		0.2/ 0.35		0.7/ 1.1		0.5/ 0.7		**0.4/ 0.6**	
4																		
5																		
6																		
7		1.2/ 2.5		1.1/ 2.1	1.1/ 2.1			0.4/ 0.7		0.3/ 0.5	0.3/ 0.45			0.6/ 1.0		**0.4/ 0.7**	**0.4/ 0.7**	
8	1.9/ 3.5		1.1/ 2.1		1.0/ 2.2	1.2/ 2.4	0.6/ 0.9		0.3/ 0.6		0.2/ 0.4	0.3/ 0.65	0.9/ 1.3		0.5/ 0.85		**0.3/ 0.65**	**0.5/ 0/9**
9	1.6/ 2.7		1.0/ 1.8	0.8/ 1.5		1.05/ 2.0	0.5/ 0.7		0.2/ 0.3	0.15/ 0.3		0.3/ 0.5	0.6/ 0.85		0.3/ 0.6	**0.2/ 0.45**		**0.4/ 0.7**
10																		
11																		
12a	1.0/ 1.7	0.9/ 1.5	0.6/ 1.0	Dry	Dry	**0.9/ 1.35**	0.4/ 0.7	0.3/ 0.6	0.15/ 0.3	Dry	Dry	0.3/ 0.6	0.6/ 1.05	0.5/ 0.9	0.3/ 0.6	**Dry**	**Dry**	**0.4/ 0.8**
12b																		
13		1.3/ 2.5			0.9/ 1.8			0.3/ 0.5			0.3/ 0.45			0.55/ 0.9			**0.4/ 0.7**	
14a																		
14b				1.3/ 2.35						0.2/ 0.4						**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 2011**	**Pool 2012**	**Pool 2013**	**Pool 2014**	**Pool 2015**	**Pool 2016**	**Riffle 2011**	**Riffle 2012**	**Riffle 2013**	**Riffle 2014**	**Riffle 2015**	**Riffle 2016**	**Run/ Step Run 2011**	**Run/ Step Run 2012**	**Run/ Step Run 2013**	**Run/ Step Run 2014**	**Run/ Step Run 2015**	**Run/ Step Run 2016**
1 (1)	0.9/ 3.2	1.65/ 3.5 Site Δ	1.65/ 3.6	1.3/ 3.1 Site Δ	1.2/ 2.6	1.1/ 1.8	0.5/ 0.8	0.4/ 0.6 Site Δ	0.05/ 0.3	0.2/ 0.4 Site Δ	0.05/ 0.1	0.4/ 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	0.5/ 0.7
4 (3)	1.2/ 2.5	1.7/ 2.6	1.4/ 2.2	1.35/ 2.0	1.3/ 1.7	1.0/ 1.4	0.6/ 0.9	0.3/ 0.5	0.3/ 0.7	0.3/ 0.5	0.3/ 0.6	0.35/ 0.7	0.7/ 1.0	0.5/ 0.9	0.6/ 1.0	**0.3/ 0.5**	**0.5/ 0.7**	**0.6/ 1.0**
10 (7)	1.4/ 3.0	1.1/ 2.05 Site Δ	1.55/ 2.35	0.9/ 1.6 Site Δ	1.1/ 2.0	1.3/ 2.0	0.65/ 0.9	0.5/ 0.9 Site Δ	0.35/ 0.9	0.3/ 0.45 Site Δ	0.2/ 0.35	0.4/ 0.8	0.9/ 1.2	0.8/ 0.9	0.5/ 0.85	0.3/ 0.9 Site Δ	0.3/ 0.8	0.5/ 1.1
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	1.4/ 2.4	0.9/ 1.2	0.45/ 0.95	0.3/ 0.5	0.3/ 0.5	0/2/ 0.6	0.3/ 0.9	1.0/ 1.5	0.8/ 1.1	0.6/ 0.8	**0.45/ 0.7**	**0.4/ 0.6**	**0.5/ 1.1**
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	0.9/ 1.6	0.5/ 0.7	0.3/ 0.6	0.1/ 0.3	0.3/ 0.4 Site Δ	0.25/ 0.5	0.4/ 0/6	0.7/ 0.9	0.75/ 1.1	0.35/ 0.5	**0.1/ 0.15** Site Δ	**0.1/ 0.25**	**0.5/ 0.9**
16 (12a)	1.2/ 1.85	1.25/ 2.05 Site Δ	0.5/ 0.85 Site Δ	Dry	Dry	0.75/ 1.3		0.2/ 0.4 Site Δ	0.1/ 0.15	Dry	Dry	0.25/ 0.5	0.55/ 0.95	0.4/ 0.9 Site Δ	0.3/ 0.8	**Dry**	**Dry**	**0.5/ 0.9**
19 (13)	0.9/ 2.9	1.0/ 1.9	0.9/ 2.5	0.8/ 2.2	1.5/ 2.4 Site Δ	1.3/ 2.4	0.45/ 0.6	0.4/ 0.8	0.35/ 0.6	0.3/ 0.5	0.25/ 0.4 Site Δ	0.25/ 0.4	0.7/ 1.1	0.5/ 1.1	0.5/ 1.0	**0.4/ 0.95**	**0.5/ 0.6** Site Δ	**0.7/ 1.0**
21 (14b)	1.9/ 3.75			1.55/ 2.5 Site Δ	1.25/ 2.2	1.15/ 1.9	0.3/ 0.7			0.4/ 0.6 Site Δ	0.2/ 0.4	0.25/ 0.6	0.4/ 1.3			**0.35/ 0.6** Site Δ	**0.3/ 0.5**	**0.3/ 0.5**

Table 15a. Average PERCENT FINE SEDIMENT in Habitat-typed Reaches* in SOQUEL CREEK Since 2010.

Reach	Pool 2016	Pool 2011	Pool 2012	Pool 2013	Pool 2014	Pool 2015	Riffle 2016	Riffle 2011	Riffle 2012	Riffle 2013	Riffle 2014	Riffle 2015	Run/ Step Run 2016	Run/ Step Run 2011	Run/ Step Run 2012	Run/ Step Run 2013	Run/ Step Run 2014	Run/ Step Run 2015
1	72		62		64		7		8		7		33		24		**16**	
2																		
3		59		60		56		11		19		14		14		38		**17**
4																		
5																		
6																		
7			51		31	42			11		4	13			21		**14**	**10**
8	58	63		68		64	7	11		5		3	18	23		15		**9**
9a	40	58		50	49		9	6		3	10		18	24		14	**19**	
10																		
11																		
12a	22	42	34	24	Dry	Dry	2	8	8	5	Dry	Dry	10	15	14	20	**Dry**	**Dry**
12b																		
13			57			70			9			7			18			**22**
14a																		
14b					27						3						**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**	**Pool 2016**	**Riffle 2011**	**Riffle 2012**	**Riffle 2013**	**Riffle 2014**	**Riffle 2015**	**Riffle 2016**	**Run/ Step Run 2011**	**Run/ Step Run 2012**	**Run/ Step Run 2013**	**Run/ Step Run 2014**	**Run/ Step Run 2015**	**Run/ Step Run 2016**
1 **(1)**	85	85	75	75	75	85	5	10	10	3	1	10	10	20	5	**30**	**25**	**65**
4 **(3a)**	45	70	70	70	80	90	10	5	20	20	15	5	10	15	25	**5**	**25**	**95**
10 **(7)**	70	38	28	30	30	65	15	NA	5	5	8	10	20	25	10	**2**	**15**	**50**
12 **(8)**	25	30	80 Site Δ	95	70	70	10	NA	5	2 Site Δ	5	5	15	15	15	**5** Site Δ	**10**	**10**
13a **(9)**	50	40	40 Site Δ	95 Site Δ	53	60 Site Δ	15	20	2	15 Site Δ	10	2 Site Δ	25	15	15	**25** Site Δ	**15**	**15** Site Δ
16 **(12a)**	50	50	20 Site Δ	Dry	Dry	15	NA	15	5	Dry	Dry	NA	NA	15	25	**Dry**	**Dry**	**10**
19 **(13)**	60	70	70	90	85 Site Δ	68	15	10	15	10	10 Site Δ	15	40	25	30	**30**	**15** Site Δ	**40**
21 **(14b)**	70			20 Site Δ	45	28	2			5 Site Δ	2	15	10			**15** Site Δ	**10**	**10**

Table 15c. Average EMBEDDEDNESS in Pool and Fastwater (Riffle and Run) Habitat of SOQUEL CREEK REACHES Since 2009.

Reach	Pool 2016	Pool 2009	Pool 2011	Pool 2012	Pool 2013	Pool 2014	Pool 2015	Riffle 2016	Riffle 2009	Riffle 2011	Riffle 2012	Riffle 2013	Riffle 2014	Riffle 2015	Run/ Step Run 2016	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	51	37		54		58		21	19		30		32		36	23		39		**40**	
2																					
3		37*	40*		50*		54*		19*	13*		31*		24*		23*	24*		38*		**40***
4																					
5																					
6																					
7		41*		52*		49*	59*		23*		32*		24*	31*		38*		43*		**40***	**43***
8	56*	45*	60*		52*		50*	23*	17*	28*		24*		31*	47*	33*	50*		43*		**52***
9a	53	50	59		45	59		23	26	28		30	47		41	42	50		45	**54**	
10																					
11																					
12a	62	59	57	61	65	dry	dry	34	34	28	42	38	Dry	Dry	50	46 (S.run)	38 (S.run)	43 (S.run)	51 (S.run)	**Dry**	**Dry**
12b																					
13		53*		50*			58*		22*		27*			23*		37*		33*			**33***
14a																					
14b		44				60			16				29			38 (run)				**46**	
14c																					

***Partial, ½-mile segments habitat typed in 2006–2009 and 2011‒2016 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	Pool 2016	Riffle 2011	Riffle 2012	Riffle 2013	Riffle 2014	Riffle 2015	Riffle 2016	Run/ Step Run 2011	Run/ Step Run 2012	Run/ Step Run 2013	Run/ Step Run 2014	Run/ Step Run 2015	Run/ Step Run 2016
1 (1)	55	60	70	60 Site Δ	50	65	35	30	25	25 Site Δ	25	25	25	35	**40**	**40** Site Δ	**40**	**40**
4 (3a)	40	40	50	45	60	NA	25	25	35	30	35	30	30	50	**30**	**30**	**45**	**NA**
10 (7)	50	50	40	50 Site Δ	60	40	25	NA	25	30	40	15	35	35	**35**	**30**	**30**	**60**
12 (8)	30	55	65 Site Δ	65	50 Site Δ	50	35	35	15 Site Δ	30	40	25	35	50	**35** Site Δ	**35**	**65**	**40**
13a (9)	60	40	50	60 Site Δ	60	60	35	35	15	18 Site Δ	20	15	35	40	**55**	**60** Site Δ	**65**	**35**
16 (12a)	63	58	65	Dry	Dry	60	NA	45	45	Dry	Dry	25	NA	40	**75**	**Dry**	**Dry**	**40**
19 (13)	60	60	30	NA	65 Site Δ	NA	15	25	40	35	20 Site Δ	25	40	30	**45**	**30**	**10** Site Δ	**25**
21 (14b)	60	-	-	65 Site Δ	35	50	40	-	-	20	20	35	45	-	-	**35**	**50**	**40**

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	Pool 2016
1	0.091	0.103	0.107		0.147	0.134	0.116		0.099		**0.108**		**0.111**
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** **	**0.042**
9a	0.146		0.101	0.086	0.117	0.147	0.100	0.128		0.114	**0.069**		**0.057**
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**	**0.096**
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	Pool Escape Cover 2016
1 (1)	0.101*	0.132	0.104	0.117 Site Δ	0.178	**0.140** Site Δ	**0.167**	**0.110**
4 (3)	0.102	0.067	0.085	0.191	0.086	**0.094**	**0.111**	**0.162**
10 (7)		0.124	0.254	0.096 Site Δ	0.152	**0.097** Site Δ	**0.102**	**0.130**
12 (8)			0.092	0.231 (Wood cluster)	0.059 Site Δ	**0.089** (more wood)	**0.143** Site Δ	**0.034**
13a (9a)			0.101	0.164 (Wood cluster)	0.127 Site Δ	**0.111**	**0.128**	**0.059** **Site Δ**
16 (12a)			0.079	0.064 Site Δ	0.093 Site Δ	**Dry**	**Dry**	**0.107**
19 (13)	0.041	0.080	0.131	0.060	0.143	**0.146**	**0.108** Site Δ	**0.077**
21 (14b)	0.029	0.017	0.021	–	–	**0.048** Site Δ	**0.084**	**0.107**

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

Table 15g. Habitat Change in SOQUEL CREEK WATERSHED Reaches (2014 to 2016 or 2015-2016) or Replicated Sites (2015 to 2016).

Reach Comparison or (Site Only)	Baseflow Avg. May-September	Pool Depth	Fine Sediment	Embeddedness	Pool Escape Cover	Overall Habitat Change
Site 1 Reach 1	+ Compared to 2014	+ (Reach) – (Site)	– run	+ riffle	Similar	+
(Site 4) Reach 3a	+	–	– pool – run + riffle	–	+	+
(Site 10) Reach 7	+	+ Similar	– run	+ Pool and riffle – run	+	+
Site 12 Reach 8	+ Compared to 2015	+ (Reach) – (Site)	Similar	– riffle	–	+ (flow)
Site 13a Reach 9a	+ Compared To 2014	+	Similar	– run	–	+ (flow)
Site 16 Reach 12a	+ Compared to 2013	+	+ run	Similar	+	+
(Site 19) W. Br. Reach 13	+	– Similar	+ pool – run	– run	–	+ (flow)
(Site 21) W. Br. Reach 14b	+	–	+ pool – riffle	– pool and riffle + 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 16a−c and 37**. The January 1982 storm caused severe streambank erosion and landsliding throughout the Santa Cruz Mountains, and streams have been recovering since. The 1997-98 winter also brought significant stormflow and sedimentation into some watersheds by 1999, such as the San Lorenzo River (**Alley 2000**). Weighing the relative importance of streamflow as an aspect of habitat quality with other habitat parameters is not clear cut, especially when no stream gage exists on Aptos Creek and streamflow measurements are very limited. In 2010, we began measuring fall baseflow in this watershed. Most juvenile steelhead growth occurs in the spring-early summer when baseflow 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 higher baseflow in 2016 compared to 2013−2015, but below the median streamflow statistic in spring and summer. There was undoubtedly increased food supply in Aptos Creek in 2016. However, juvenile densities were so low in 2016 at the lower Aptos site that it was of little benefit there.

In 2016, habitat quality improved at lower Aptos Site 3 due to likely increased baseflow and pool escape cover (**Table 16c**). However, pool depth decreased. Upper Aptos Site 4 worsened in habitat quality because, despite likely higher baseflow than 2015, pool depth declined, as did pool escape cover substantially (**Table 16b**). Thus, habitat deterioration due to sedimentation occurred at both Aptos sampling sites after bankfull stormflows that occurred overwinter. Habitat typed segment 3 in Valencia Creek above Valencia Road crossing declined in habitat quality compared to 2009 conditions. Despite likely similar baseflow between 2009 and 2016, pool depth and escape cover declined, and fine sediment increased in 2016 (**Table 16a**). Pools were absent at Site 2, downstream of Valencia Road crossing in 2014 and 2016 due to sedimentation, though they were sparingly present in 2009. Thus, substantial sedimentation had occurred in Valencia Creek since 2009, after likely bankfull stormflows in 2010, 2011 and 2016.

Table 16a. AVERAGE POOL HABITAT CONDITIONS IN REACHES and REPLICATED SITES (in yellow) of APTOS, VALENCIA, CORRALITOS, SHINGLE MILL and BROWNS Creeks in 2012-2016.

Reach #/ Sampling Site #	Mean Depth/ Maximum Depth					Escape Cover*					Embeddedness					Percent Fines				
	2016	2012	2013	2014	2015	2016	2012	2013	2014	2015	2016	2012	2013	2014	2015	2016	2012	2013	2014	2015
Aptos #2/#3- in County Park		1.1/ 2.2	1.0/ 1.8				0.105	0.141			65	55	52	55	55	63	59	59	85	80
Aptos #3/#4- Above Steel Bridge Xing (Nis. Marks)				0.9/ 1.7					0.091		55			59	73	85			60	83
Valencia #2/#2- Below Valencia Road Xing	No pool	0.6/ 1.2 (2009)		No pool		No pool	0.143 (2009)		No pool		No pool	51 (2009)		No pool		No pool	79 (2009)		No pool	
Valencia #3/#3- Above Valencia Road Xing	0.5/ 1.0	0.8/ 1.5 (2009)				0.132	0.217 (2009)				60	53 (2009)				90	76 (2009)			
Corralitos #1/#1- Below Dam			1.1/ 1.9		1.3/ 2.3			0.080		0.103	65		43		53	28		43		53
Corralitos #3/#3- Above Colinas Drive		1.1/ 2.0		1.0/ 2.0			0.161		0.172		63	63		52	53	20			44	70
Corralitos #5-6/#8- Below Eureka Gulch		1.0/ 1.8			0.8/ 1.6		0.072			0.058	70	58			64	10				28
Corralitos #7/#9- Above Eureka Gulch	0.9/ 1.5	0.9/ 1.35		0.7/ 1.2		0.108	0.146		0.093		58	63		63	60	12			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			43		56	30	38	20		29	20	25
Browns Valley #2/#2- Above Dam	1.2/ 1.9		1.3/ 1.9			0.346		0.250			44		38	48	45	17		22	30	48
Casserly #3/#3- Below Mt. Madonna Bridge	0.6/ 1.0					0.099					48					29				

* 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/ Max Pool Depth - 2010**	**Avg Mean/ Max Pool Depth - 2011**	**Avg Mean/ Max Pool Depth - 2012**	**Avg Mean/ Max Pool Depth - 2013**	**Avg Mean/ Max Pool Depth - 2014**	**Avg Mean/ Max Pool Depth - 2015**	**Avg Mean/ Max Pool Depth - 2016**	**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**	**Pool Escape Cover Index-2016**
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	0.85/ 1.7	0.183	0.055	0.080 (Site Δ)	0.179 (Site Δ)	**0.186**	**0.185**	**0.241**
Aptos #3/#4- Above Steel Bridge	–	1.35/ 3.25	1.1/ 2.05	0.85/ 2.4	0.85/ 1.45 (Site Δ)	1.35/ 2.7	0.85/ 1.85	–	0.156	0.177	0.170	**0.064** (Site Δ)	0.128	0.043
Valencia #2/#2- Below Valencia Road	0.45/ 1.05	–	–	–	No pool habitat	–	No pool habitat	0.156	–	–	–	**0.015 mostly run**	**–**	**–**
Valencia #3/#3- Above Valencia Rd	0.9/ 1.45	–	–	–	0.35/ 0.8	–	0.5/ 1.4	0.250	–	–	–	**0.049 less wood**	**–**	**0.079**
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	0.75/ 1.2	0.087	0.120	0.156	0.083	**0.111**	**0.109**	**0.124**
Corralitos #3/#3- Above Colinas	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	1.4/ 2.4	0.173	0.231	0.121 (Site Δ)	0.128	**0.206** (Site Δ)	**0.150**	**0.160**
Corralitos #5-6//#8- Below EurekaG	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)	0.85/ 1.75	0.048	0.033	0.061	0.053	**0.067**	**0.054**	**0.173**
Corralitos #7/#9- Above EurekaG	–	1.0/ 1.8	1.0/ 1.6	0.9/ 1.3	0.6/ 1.3 (Site Δ)	0.7/ 1.3	0.9/ 1.5		0.112	0.148	0.133	**0.092** (Site Δ)	**0.102**	**0.133**
Shingle Mill #1/#1- Below 2nd 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 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	1.35/ 2.3	0.125	0.187	0.201	0.283 (Site Δ)	**0.219**	**0.255**	**0.267**
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	0.95/ 1.9 (Site Δ)	0.243	0.203	0.272	0.210 (Site Δ)	**0.213**	**0.209**	**0.284** (Site Δ)

* 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 2016) AND CORRALITOS WATERSHED Reaches (2011− 2013 to 2016) and Replicated Sites in Both Watersheds (2015 to 2016).

Reach Comparison or (Site Only Comparison)	Baseflow	Pool Depth	Fine Sediment	Embeddedness	Pool Escape Cover	Overall Habitat Change
(Aptos Site 3) Aptos 3	+	–	+	–	+	+
(Aptos Site 4) Aptos 4	+	–	Similar	+	–	– Compared to 2015 Site
Valencia Site 3 Valencia 3	+ Slightly, Compared to 2009	–	–	Similar	–	– Compared to 2009 Reach
(Corralitos Site 1) Corralitos R-1	+	–	+	–	+	+
(Corralitos Site 3) Corralitos R-3	+	+	+	–	+	+
(Corralitos Site 8) Corralitos R- 5/6	+	−	+	Similar	+	+
Corralitos Site 9 Corralitos R-7	+ Compared to 2014	+	Similar	Similar	+	+
Shingle Mill Site 1						NA
Shingle Mill Site 3 above fault line						NA
(Browns Site 1) Brown R-1	+	+ max. depth	Similar	Similar	Similar	+
Browns Site 2 Brown R-2	+ Compared to 2013	+ avg. depth	Similar	Similar	+	+

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

Refer to **Appendix A** for maps of reach locations. Tables of habitat change for all reaches are provided in **Tables 16a-c and 37**. Weighing the relative importance of streamflow with other habitat parameters is not clear cut, especially when exact streamflow measurements are limited. Baseflow was higher in 2016 than 2013−2015 and above the median flow after the early March storm until the end of May, based on stream gage data from other watersheds and Corralitos Creek at Freedom (**Figure 50**). The 4 main stormflows of the 2015-2016 were in January (≈1,750 cfs and 750 cfs) and March (≈3,300 cfs and ≈2,000 cfs). Three of the 4 likely exceeded bankfull discharge. Most juvenile steelhead growth occurs in the spring-early summer when baseflow is higher and most important. With higher streamflow in 2016, there was undoubtedly more food and faster growth rate in all reaches in 2016 than in 2013–2015, especially when juvenile densities were low. Adult steelhead spawning access to Corralitos and Browns creeks also greatly improved in 2016.

Overall habitat quality improved in the Corralitos-Browns-Shingle Mill sub-watershed in 2016 primarily due to increased baseflow and increased pool escape cover (**Table 16a-c**). However, indication of sedimentation was detected with shallower pools at Sites 1 and 8 and increased embeddedness at Sites 1 and 3 in Corralitos Creek. Pools in the other 4 Sites/Reaches deepened.

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 2016, 30 of 47 sites (64%) were rated "below average" or worse, based on densities of Size Class II and III juveniles and their average sizes (**Tables 37 and 38**); the breakdown was "below average" (16), "poor" (7) and "very poor" (7), and one site was dry. The remainder of sites were rated "fair" (13) and "good" (4). These ratings were an improvement over 2014 and 2015, which had the lowest ratings since the comparison began in 2006. Ratings were much better in 2012 when most sites (20 of 38; 53%) were rated "good" and "very good."

R-6. 2016 Juvenile Steelhead Densities in the San Lorenzo Drainage Compared to 2015 and Trends in Density Since 1997

In 2016, 22 of 26 wetted sites had below average total densities, with 2 of the above average sites likely having resident rainbow trout (**Figure 1**). Branciforte Site 21c likely had resident rainbow trout with possibly steelhead and SLR Site 12a likely had both. The lowest total densities measured since 1997 occurred at SLR-8, upper Bean 14a (limited recent sampling), Bean 14b, Zayante 13c and Carbonera 20a (limited recent sampling) (**Tables 17a-b; 22a-b**). Sites with above average total densities were mainstem SLR 12a, Zayante 13d, Fall 15a (limited sampling) and Branciforte 21c (limited sampling). Regarding the trend in total densities, the average mainstem site total density declined from 2015 (**Figure 17**) to 8.9 juveniles/100 ft, and was one of the 4 lowest averages since 1997. The 2016 average total density at tributary sites remained similar to 2015 (**Figure 19**) at 47.6 juveniles/ 100 ft.

In 2016, twenty-three of 26 wetted sites had below average YOY densities, with the only 3 sites having above average YOY densities being Mainstem 12a, Zayante 13d and Branciforte 21c (**Figure 2a**). In comparing 2016 to 2015, mainstem sites were similar at 4 locations and less in 2016 at 6 sites. In tributaries, those on the western side of the drainage had similar or higher YOY densities in 2016, while those on the eastern side had similar or lower densities except for notable increases at Zayante 13d and Branciforte 21b (**Figure 2b**). Decline at Zayante 13c was substantial. Twenty-three of 26 wetted sites had below average yearling densities after low recruitment from few YOY in 2015 and a high stormflow in early March that may have encouraged out-migration (**Figure 3**). Sites with above average yearling density were Mainstem SLR 0a (still low), Fall 15a and Boulder 17a.

In 2016, twenty-two of 26 wetted sites had below average densities of Size Class II and III steelhead (**Figure 4**). Zayante 13i had average density, while above average densities were found at Zayante 13i (slightly above), Fall 15a and Boulder 17a. All mainstem sites had below average densities of larger size classes, consistent with below average total, YOY and yearling densities. Regarding the trend in soon-to-smolt-densities, the 2016, the 6-site mainstem average increased slightly from 2.7 in 2015 to 2.8 juveniles/ 100 ft in 2016 (**Figure 21**). But the 8-site tributary average declining from 9.3 in 2015 to 8.2 juveniles/ 100 ft in 2016 (Zayante 13a included in the average). A positive correlation was evident between average site densities of these larger juveniles and the 5-month baseflow average. When baseflow average was higher, average site density tended to be higher in many years and vice versa. When baseflow was relatively high in the April to June growth period in tributaries, more YOY could reach Size Class II than with reduced baseflow. This was evident in middle and lower Zayante Creek and middle Bean Creek in wetter years. In drier years, reduced streamflow with associated reduced food supply hindered YOY from growing into the soon-to-smolt Size Class II.

A similar positive correlation between average baseflow and average densities of larger juveniles was evident at 2 middle mainstem sites (**Figure 22**). However, densities did not increase in the wet years of 2006 and 2011 despite high baseflow averages. Relatively fewer adult spawners and reduced spawning success in those years in those reaches may have been factors resulting in low densities. Both 2006 and 2011 had large stormflows in late March and April that may have scoured redds and encouraged yearlings to out-migrate.

One obvious exception for the positive correlation between average baseflow and mainstem densities of larger fish was in 1997, when the average juvenile density at mainstem sites was high despite relatively low average baseflow. That was a year of moderate stormflows and baseflows when YOY densities were extremely high in the mainstem, presumably after high spawning success from a relatively large adult return in a year with adequate early stormflows but none later in the rainy season to scour redds. Yet the baseflow was sufficient to grow many YOY into Size Class II in the lower mainstem. The overall trend in densities of larger size classes in the mainstem and tributaries has been downward since 2010, associated with low average baseflow since 2012. The decline has been greatest since 1997 in the mainstem.

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 and 2016 after 4 years of very low density. 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 very low in 2015 and 2016 as in past years except at Teihl 11 and Waterman Gap 12a, which likely had included older residents (**Table 19b; Figure 3**).

Table 17a. TOTAL Density of Juvenile Steelhead at MAINSTEM SAN LORENZO RIVER Monitoring Sites (Excluding Lagoon) 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	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. TOTAL Density of Juvenile Steelhead at MAINSTEM SAN LORENZO RIVER Monitoring Sites (Excluding Lagoon) in 2006-2016.
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	2016 L-D	1997-2016 Avg.
0a				2.4	20.4	2.1	26.9	4.6	6.2	12.4	5.6	9.6
0b												4.8
1	1.2	1.9	7.0	3.4	16.4	2.7	7.6	4.2	1.8	6.5	6.2	7.6
2a		14.8	20.6	9.2	28.4	11.2	6.7	8.1	2.9	7.8	8.9	15.8
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	9.4	28.2
5												52.0
6	4.5	24.0	21.4	13.2	17.4	9.1	16.7	20.6	4.6	15.7	4.5	15.4
7												35.7
8	13.7	5.5	33.0	18.0	36.7	9.2	14.2	30.7	5.7	10.1	4.4	33.4
9								20.9	2.1	11.8	12.8	30.5
10									0.7	15.1	10.1	25.5
11	3.0	21.3	47.6	6.8	29.1	9.1	4.5	5.7	6.5	23.2	20.3	24.4
12a										18.5	48.0	37.8
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 2006-2016. 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	2016 L-D	1997-2016 Avg.
0a				1.2	19.0	2.1	23.4	4.6	5.1	12.5	3.5	8.2
0b												2.8
1	1.2	1.6	7.0	2.7	16.0	1.9	6.6	4.1	1.4	6.1	5.9	6.8
2a		13.7	19.0	8.1	27.6	8.6	6.4	8.1	2.7	7.6	8.6	14.2
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	9.2	26.7
5												
6	4.2	23.4	20.6	11.1	16.7	8.1	15.8	20.5	4.5	15.7	4.5	14.6
7												30.4
8	11.6	5.5	31.2	16.3	35.4	5.8	13.7	30.1	4.9	10.1	4.7	31.7
9								20.8	1.9	11.8	12.4	28.6
10									0.7	13.7	9.3	21.0
11	1.5	20.8	46.1	4.4	26.8	8.4	3.7	3.4	4.9	17.4	17.4	21.3
12a										11.8	45.6	30.5
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 2006-2016.
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	2016 L-D	1997-2016 Avg.
0a				1.2	1.7	0	3.9	0	1.1	0	2.1	1.4
0b												2.0
1	0	0.3	0	0.7	0.4	0.5	1.0	0.1	0.4	0.4	0.8	0.8
2a		0.9	0.4	1.0	0.5	2.2	0.4	0	0.2	0.5	0.9	1.3
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	0.2	1.4
5												2.5
6	0.3	0.7	0.03	0	0.5	1.2	0.3	0.9	0	0	0	0.7
7												3.4
8	1.6	0	2.0	1.5	1.0	0.2	0.3	0.5	0.6	0	0.2	1.5
9								0.2	0.2	0.3	0.4	1.9
10									0	1.4	0.7	3.9
11	1.5	0.6	1.1	2.5	2.4	0.6	0.8	2.3	1.6	5.8	2.9	3.9
12a										7.0	2.4	7.5
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 2006-2016.
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	2016 L-D	1997-2016 Avg.
0a				0	0.6	0	0	0	0	7.6	0	0.9
0b												0
1	0	0.3	2.1	0	1.1	0.1	0	0.8	0	2.1	0.6	0.7
2a		3.7	8.4	1.2	6.0	0	0.1	1.9	0.5	4.3	0.6	2.6
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	3.1	15.3
5												8.1
6	2.2	22.8	19.2	10.7	11.3	3.4	13.5	18.6	3.2	15.2	4.0	11.5
7												26.9
8	7.9	4.8	29.4	14.5	28.5	5.8	12.2	28.8	4.3	10.1	3.1	28.1
9								18.6	1.5	10.5	9.2	24.2
10									0.7	13.7	6.6	20.5
11	0	20.8	44.9	3.7	24.4	1.3	1.6	3.4	4.9	17.4	15.7	19.5
12a										11.8	45.6	30.7
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 2006-2016.
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	2016 L-D	1997-2016 Avg.
0a				2.4	19.8	2.1	26.9	4.1	6.2	4.8	5.6	8.6
0b												4.8
1	1.2	1.6	4.9	3.4	15.3	2.6	7.6	3.4	1.8	4.4	5.6	6.9
2a		11.1	12.2	8.0	22.4	11.2	6.6	6.2	2.4	3.5	8.3	13.2
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	6.3	12.8
5												43.9
6	2.3	1.2	2.2	0.5	6.1	5.3	3.3	2.0	1.4	0.5	0.5	3.8
7												8.8
8	5.8	0.7	3.6	3.5	8.2	3.4	2.0	1.9	1.4	0	1.3	5.3
9								2.3	0.6	1.3	3.6	6.4
10									0	1.4	3.5	5.0
11	3.0	0.6	2.8	3.1	4.7	7.9	2.9	2.3	1.6	5.8	4.6	5.9
12a										6.8	2.4	7.2
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 San Lorenzo sites, 2016 soon-to-smolt ratings were the same as in 2015 at 5 of 10 sites (**Table 42**). Two of 3 of the middle mainstem sites (6 and 8) and upper mainstem Site 10 were still rated “very poor.” Sites 4 and 9 had improved to the “poor” rating and Sites 0a, 2 and 11 had improved to the “fair” rating in 2016. Site 0a dropped to a “poor” rating. Sites 1 and 11 increased to “below 6average” ratings, the highest rating in the mainstem. YOY densities were similar or slightly lower than in 2015, but more grew into the soon-to-smolt size range in 2016.

In tributaries of the San Lorenzo River in 2016, soon-to-smolt ratings increased at 8 of 15 sites and decreased at 3 sites compared to 2015 (“good” ratings at Zayante 13c and Boulder 17a; “fair” rating at

Zayante 13d, Bean 14c-2, Fall 15a-b and Branciforte 21c) (**Table 37**). Ten of 15 tributary sites were rated “below average” or worse.

In tributaries, total and YOY juvenile steelhead densities increased at 8 of 15 wetted, re-sampled tributary sites (Zayante 13d, Fall 15a-b, Newell (slightly), Boulder 17a-b and Branciforte 21b-c) (**Table 22b and 23b**). But they decreased substantially at Zayante 13a and 13c and Bean 14a-b. Adult steelhead access to Bear 18a appeared restricted because YOY densities were very low. The flashboard dam abutment below Lanktree Bridge is a chronic collector of wood, likely making it difficult to pass at times. However, it was observed a few times over the 2015-2016 winter without wood jammed on it (**K. Kittleson, pers. comm.**). Bean 14c-1 went dry before fall sampling, as it had in 2013−2015. Bean Site 14c-2 was added upstream, which had surface water in September but was going intermittent. The slight increase in juvenile density in Newell Creek indicated slight improvement but much below average density.

In tributaries in 2016, yearling and older densities were relatively low, similar to those in 2013−2015 and below average at 13 of 16 sites, except above average at Fall 15a (only 3 years of data) and Boulder 17a and average at Zayante 13i (limited data) (**Table 24; Figure 3**).

In tributaries in 2016, Size Class II and III densities (soon-to-smolt sized fish) were more than in 2015 at 9 of 15 steelhead sites and below average at 10 of 15 sites (**Table 25b; Figure 4**). The poor showing in smolt densities in tributaries occurred because the juvenile steelhead population in 2016 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 2013−2015. The overall trend in average Size Class II and III densities had declined in tributaries since 1999, with a slight down turn in 2016 from 2015, as indicated by the site average values graphed since 1997 (**Figure 20**). Bean 14c-1 was again dry, and Bear 18a had low density after being inaccessible to adult spawners until 2015 after 3 years of blockage. The notable exceptions to low densities of larger juveniles were Zayante Sites 13c and 13d and Boulder 17a. Growth likely occurred in spring and early summer before baseflow became reduced. Baseflow was below the median from April onward (**Figure 34**).

Table 22a. TOTAL DENSITY of Juvenile Steelhead 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		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-1		78.2	22.7	87.5	36.8	41.3	99.6	87.4
Bean 14c-2								
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 2006-2016.

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	2016 L-D	1997-2016 Avg.
Zay 13a	17.0	66.9	84.8	29.9	61.4	5.2	26.3	91.7	22.8	37.5	6.4	51.7
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	29.8	74.3
Zay 13d	69.8	80.5	131.7	105.5	91.9	29.1	70.6	169.7	116.0	82.2	173.0	107.6
Lomp 13e	26.2	108.3	27.8	123.3	23.1	16.6	54.8	56.3	44.2	8.5	7.1	45.1
Zay 13i										57.6	50.7	54.2
Bean 14a										77.1	7.1	40.7
Bean 14b	13.1	8.9	67.6	11.2	32.8	18.2	10.5	27.7	20.4	47.8	4.5	51.9
Bean 14c-1	66.0	18.2	0 dry	0 dry	58.8	29.1	0 dry	0 dry	0 dry	0 dry	0 dry	34.8
Bean 14c-2											31.3	31.4
Fall 15a									32.9	25.8	30.9	29.9
Fall 15b			84.0	48.7	46.1	78.5	101.5	92.6	50.4	8.1	40.9	65.6
New 16	26.0			18.6	32.5	13.4	37.7	36.8	3.8	2.6	5.6	32.7
Boul 17a	30.7	62.7	69.9	13.6	19.2	19.0	19.6	73.2	8.1	17.9	35.9	50.2
Boul 17b	57.6	45.1	97.8	44.0	43.4	48.7	108.7	90.3	26.8	26.0	47.3	62.0
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	11.2	50.1
Bear 18b												79.2
King 19a												6.8
King 19b												39.9
Carb 20a											2.0	14.1
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	35.6	45.0
Bran 21c								15.7	13.3	8.6	18.8	14.1

*** 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-1		71.8	6.9	76.6	18.1	23.0	87.4	81.5
Bean 14c-2								
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 2006-2016.

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	2016 L-D	1997-2016 Avg.
Zay 13a	14.6	62.1	82.3	26.1	58.3	2.6	21.9	72.2	20.4	35.4	4.0	46.7
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	27.1	67.6
Zay 13d	68.0	63.1	107.0	88.6	83.3	25.6	62.2	151.2	92.4	81.3	159.9	93.7
Lomp 13e	24.2	96.9	21.4	118.4	14.4	14.2	52.5	47.7	39.5	7.2	3.3	40.0
Zay 13i										50.1	43.3	46.7
Bean 14a										75.7	7.1	38.1
Bean 14b	10.9	0	63.0	4.9	31.7	14.3	8.3	26.9	17.6	38.3	2.7	44.0
Bean 14c-1	61.1	12.8	0 dry	0 dry	55.7	27.2	0 dry	0 dry	0 dry	0 dry	0 dry	29.0
Bean 14c-2											24.9	24.9
Fall 15a									28.5	20.8	22.4	23.9
Fall 15b			68.2	30.6	33.5	71.7	86.2	84.3	42.2	6.7	36.1	55.2
Newell 16	20.1			15.0	31.2	13.1	37.1	33.7	2.3	2.1	5.0	27.0
Boul 17a	25.3	55.9	64.9	9.3	16.3	17.0	13.5	70.0	4.3	16.9	21.8	43.1
Boul 17b	56.1	35.1	94.1	33.3	39.6	46.4	98.1	79.6	13.9	20.3	41.0	53.7
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	10.2	41.9
Bear 18b												65.6
Kings 19a												5.6
Kings 19b												32.2
Carb 20a											0.8	10.4
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	28.7	33.7
Bran 21c								5.7	0	2.5	12.8	5.3

*** 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-1		6.4	15.8	10.9	18.7	18.3	12.2	5.9
Bean 14c-2								
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 2006-2016.

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	2016 L-D	1997-2016 Avg.
Zay 13a	3.2	4.9	2.1	2.6	2.9	1.4	4.0	0.3	2.1	2.1	2.5	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	4.1	6.4
Zay 13d	1.7	17.4	24.0	16.9	8.6	1.5	8.3	18.5	23.5	8.3	13.4	14.3
Lomp 13e	1.9	11.3	6.4	4.9	8.7	3.3	2.3	8.7	9.5	1.1	3.8	5.9
Zay 13i										7.4	7.4	7.4
Bean 14a										1.4	0.9	2.9
Bean 14b	2.0	8.9	3.7	5.6	0.8	3.9	2.9	1.1	2.8	7.1	1.6	7.7
Bean 14c-1	4.1	5.4	0 dry	0 dry	3.1	1.8	0 dry	0 dry	0 dry	0 dry	0 dry	5.7
Bean 14c-2											6.8	6.8
Fall 15a									2.9	4.9	8.4	5.4
Fall 15b			15.8	18.0	12.3	6.5	14.5	8.3	7.7	2.2	4.8	10.3
Newell 16	5.4			3.9	1.5	0.6	1.2	2.8	1.5	0.7	0.7	5.8
Boul 17a	5.9	6.8	5.8	4.1	2.8	2.9	6.3	3.2	3.8	1.0	14.3	7.2
Boul 17b	1.1	9.8	3.8	10.7	3.6	1.8	10.6	10.7	13.0	5.7	6.1	8.3
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	1.7	7.1
Bear 18b												13.6
Kings 19a												1.2
Kings 19b												7.7
Carb 20a											1.3	3.7
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	6.9	11.0
Bran 21c								10.0	13.3	6.2	6.1	8.9

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

E=early large stormflows before March 1, L=late large stormflows after March 1,
M=near median baseflow, D="dry"-below median baseflow, W="wet"-above median baseflow

Table 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-1		6.4	15.8	10.9	18.4	18.3	12.2	12.4
Bean 14c-2								
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 20a		11.5	5.7	4.1	3.1			
Carb 20b		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 2006-2016.

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	2016 L-D	1997-2016 Avg.
Zay 13a	11.7	4.9	6.3	12.1	18.8	4.8	14.2	2.7	2.4	2.1	4.6	9.1
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	15.9	15.3
Zay 13d	17.3	17.4	22.5	16.9	9.1	11.7	8.6	18.5	22.1	8.3	14.0	16.2
Lomp 13e	5.7	11.3	6.4	4.9	8.7	7.8	2.3	8.7	6.7	6.8	3.8	6.6
Zay 13i										7.4	7.4	7.4
Bean 14a										1.4	6.2	4.4
Bean 14b	11.9	8.9	4.7	10.9	8.4	7.4	10.1	12.5	2.8	11.5	4.5	11.6
Bean 14c-1	17.1	5.4	0 dry	0 dry	6.7	8.8	0 dry	0 dry	0 dry	0 dry	0 dry	
Bean 14c-2											7.1	7.1
Fall 15a									2.7	6.0	8.4	5.7
Fall 15b			15.8	18.7	14.3	14.7	13.0	12.1	7.3	6.7	4.8	12.1
New 16	16.2			4.4	24.7	13.1	7.3	23.7	3.1	2.0	4.3	12.4
Boul 17a	18.2	6.8	7.2	5.5	11.8	10.6	7.2	3.2	3.8	1.0	17.1	10.5
Boul 17b	13.7	9.8	3.8	10.7	12.7	13.6	10.6	10.7	13.0	5.7	7.2	10.4
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	2.2	9.0
Bear 18b												13.9
King 19a												2.5
King 19b												7.9
Carb 20a											1.6	5.2
Carb 20b												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	7.4	12.6
Bran 21c								10.0	13.3	6.2	6.1	8.9

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

E=early large stormflows before March 1, L=late large stormflows after March 1,
M=near median baseflow, D=”dry”-below median baseflow, W=”wet”-above median baseflow

R-7. 2016 Juvenile Steelhead Densities in Soquel Creek Compared to 2015 and Trends Since 1997

2016 total and YOY juvenile steelhead densities increased from 2015 at only 1 of 7 repeated sampling sites, and East Branch Site 16 had surface flow and steelhead in 2016 after being dry the 2 previous years (**Tables 26b and 27b**). 2016 total and YOY site densities were below average at all 8 sampled sites (**Figures 5 and 6**). The trend in total densities (consisting of mostly YOY) for the watershed showed a decrease in 2016 to the lowest 6-site average since 1997 (19 years) (8.1 fish/ 100 ft) (**Figure 23**). Total densities have steadily declined through the years at the SDSF Site 16 to zero in 2014 and 2015, when the reach went dry, and were much below average in 2016. In 2016, the juvenile steelhead population in Soquel Creek consisted primarily of YOY in Size Class II where densities were low in mainstem sites and lower East Branch 13a, and Size Class I in upper East Branch 16 and the 2 West Branch sites (19 and 21) (**Tables 27b and 29b**). The trend in Size Class II/III densities increased slightly in 2016 (5.6 juveniles/ 100 feet, on average) (**Figure 24**) largely due to the higher density of larger YOY and above average yearling density at mainstem Site 12, East Branch 13a and West Branch 19 (**Table 28b; Figure 7**). Size Class II steelhead densities were below average at 7 of 8 sites except upper mainstem Site 12, but close to average at East Branch Site 16 (**Table 30b; Figure 8**).

When averaged soon-to-smolt site densities were plotted annually with the 5-month average baseflow (May through September), a positive correlation was indicated in many years (**Figure 25**). Average density increased or remained relatively high during some average to wetter years (1998, 2005, 2010 and 2012). Average density decreased in some drier years (2000, 2004, 2008 and 2013−2015). But it remained relatively high in 2007, 2009 and 2012 despite relatively low baseflows. It was relatively low in 2003 and did not increase in 2011 when baseflow increased. The trend in site densities of Size Class II/III fish 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, only 2 sites reached the “fair” rating in 2016 (mainstem Site 12 and East Branch Site 16 (**Table 37**). Two sites were rated “below average” (East Branch Site 13a and West Branch Site 21). Mainstem Site 10 was rated “poor,” while 3 sites were rated the lowest at “very poor” (lower mainstem Sites 1 and 4 and lower West Branch Site 19). There was improvement at 4 of 7 sites and lower ratings at 2 sites (East Branch 13a and West Branch 19) in 2016 compared to 2015.

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 Cherryvale	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 2006–2016.
(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	2016 L-M	Avg
1- Near Grange		15.8	8.7	7.7	9.5	2.7	4.2	10.7	2.4	6.6	0.3	5.6
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	1.0	17.4
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	6.3	33.1
11- Below Purling Br												30.0
12- Near Soq Ck Br		50.7	61.8	37.4	12.3	6.0	33.8	134	44.3	73.3	15.7	41.9
13a- Below Mill Pond	3.2	35.0	57.9	22.8	37.1	11.2	41.1	61.2	22.8	33.6	7.1	43.7
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	18.3	91.5
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	9.1	33.9
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	36.8	59.5
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 2006–2016. (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	2016 L-M	Avg
1- Near Grange		14.6	8.0	6.1	8.1	1.8	3.0	9.6	1.7	5.3	0.3	4.6
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	1.0	15.6
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	5.3	31.4
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	11.7	39.4
13a- Belo Mill Pond	2.5	34.6	55.0	21.4	35.2	8.3	37.8	56.6	18.5	29.5	3.7	38.1
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	14.1	84.9
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	8.7	31.5
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	35.4	54.9
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 2006–2016. (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	2016 L-M	Avg.
1- Near Grange		1.0	0.7	1.6	1.9	0.9	1.2	0.4	0.7	1.0	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	0	1.3
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	1.0	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	4.0	1.6
13a- Below Mill Pond	0.7	0.7	2.9	1.6	1.9	2.7	2.6	4.0	4.3	3.3	3.4	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	5.3	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	3.3	1.8
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	2.8	4.6
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 2006–2016.

(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	2016 L-M	Avg.
1- Near Grange		9.2	4.9	2.6	1.6	0	0.2	8.9	1.7	4.2	0	2.1
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	0	9.4
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	2.6	25.1
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	3.2	33.9
13a-Belo Mill Pd	0	31.8	53.9	11.6	4.3	0.7	22.5	54.4	18.5	24.5	0.4	33.2
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	9.2	82.3
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	5.8	28.1
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	31.7	50.3
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 2006–2016.

(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	2016 L-M	Avg
1-Near Grange		6.6	3.8	5.1	7.9	2.7	4.0	1.8	0.7	2.4	0.3	3.5
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	1.0	8.0
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	3.7	8.0
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	12.5	7.8
13a-below MillPond	3.2	3.1	4.0	11.2	32.8	10.1	18.6	6.8	4.3	9.1	6.8	10.4
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	9.0	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	3.3	5.9
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	5.1	9.2
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 2016 to 2015 and Average Steelhead Densities and Trends in Aptos Creek

Results from the two Aptos Creek sampling sites indicated that all size classes and age classes of juvenile steelhead increased at upper Aptos Site 4 and declined at lower Aptos Site 3 in 2016, with only 1 juvenile steelhead captured at the lower site (**Tables 31−35**). Densities of all size and age classes were below average at the Aptos and Valencia creek sites (**Figures 9-12**). The trend in average total density at the 4 sites (10.4 juveniles/ 100 ft) remained near the 2014 low (**Figure 26a**). The trend in average YOY density was similarly low as in 2009 and 2014 at 7.0 YOY/ 100 ft (**Figure 26b**). The trend in average Size Class II/III density was the lowest 4-site average of 4.7 fish/ 100 ft, with no YOY captured at Aptos Site 3 (**Figure 27**).

The low soon-to-smolt density detected in Aptos and Valencia creeks in 2016 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 with likely below median baseflow, and poor overwinter recruitment or retention of yearlings (less than average densities of YOY in 2015 to become yearlings and a large stormflow in early March to encourage out-migration). The soon-to-smolt density ratings for Aptos #3 and Aptos #4 were “poor” and “below average,” respectively (**Table 37**). Both sites in Valencia Creek were rated “below average.” Yearling and older densities were higher in Valencia than Aptos Creek, despite poor habitat conditions and lower baseflow, because older resident rainbow trout likely contributed to the salmonid population in Valencia Creek. The ratings would have been lower in Aptos 3 and Valencia 3 except that the average size of the few larger fish present was greater than 102 mm SL at each site.

Table 31. TOTAL DENSITY of Juvenile Steelhead at Monitoring Sites in APTOS, VALENCIA, CORRALITOS, SHINGLE MILL, BROWNS and CASSERLY Creeks, 1981, 1994 and 2006–2016.

Empty boxes indicate no data.

Sample Site	1981	1994	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	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	0.7	24.3
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	22.7	31.8
Valencia #2- Below Valencia Road	33.1		28.3	43.0	38.5	22.7	25.1				3.0		11.6	25.7
Valencia #3- Above Valencia Road	29.8		33.4	23.0	55.5	26.3	39.4				5.4		6.6	27.4
Corralitos #0 Below Dam													6.0	6.0
Corralitos #1-Below Dam	33.9			36.2	69.9	34.2	10.4	16.2	65.4	41.1	10.1	40.1	3.7	32.7
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	8.2	26.8
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	21.2	36.3
Corralitos #9- Above Eureka Glch	86.1	29.9	87.1	38.5	61.7	73.2	33.6	38.7	49.2	43.4	8.8	27.4	25.1	46.4
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	11.7	36.1
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	6.7	48.0
Casserly #1													24.7	24.7

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

Table 32. YOUNG-OF-THE-YEAR Steelhead Density at Monitoring Sites in APTOS, VALENCIA, CORRALITOS, SHINGLE MILL, BROWNS and CASSERLY Creeks, 1981, 1994, 2006–2016.
Empty boxes indicate no data.

Sample Site	1981	1994	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	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	0	20.1
Aptos #4- 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	20.5	26.7
Valencia #2- below Valencia Road	16.6		24.5	26.6	27.5	8.9	16.4				2.7		4.1	15.9
Valencia #3- Above Valencia Road	16.6		20.5	4.7	41.5	7.8	25.6				2.5		3.3	15.3
Corralitos #0-Below Dam													0.8	0.8
Corralitos #1-Below Dam	30.8			27.0	61.2	26.5	9.1	14.8	57.5	30.4	3.9	35.4	0.0	26.6
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	0.9	19.3
Corralitos #8- Below Eureka G	59.7	14.3	45.0	44.0	46.6	39.3	19.0	29.4	18.2	28.9	2.4	9.4	16.4	28.7
Corralitos #9- Above Eureka G	55.8	16.7	78.4	31.3	44.6	54.0	30.7	33.5	36.9	32.9	3.2	22.4	18.0	35.3
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	2.3	24.0
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	1.9	38.2
Casserly #1													22.1	22.1

*** 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, BROWNS And CASSERLY Creeks, 1981, 1994 and 2006–2016. Empty boxes indicate no data.

Sample Site	1981	1994	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	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	0.7	4.2
Aptos #4- above 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	2.0	4.8
Valencia #2- below Valencia Road Xing	16.5		3.8	16.4	11.0	13.8	8.9				0.3		7.5	9.8
Valencia #3- Above Valencia Road Xing	13.2		12.9	11.5	14.0	18.5	14.2				3.0		3.3	11.3
Corralitos #0- Below Dam													5.2	5.2
Corralitos #1- Below Dam	3.1			9.1	8.7	6.9	1.3	1.3	7.3	10.7	6.1	4.6	3.7	6.0
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	7.3	7.5
Corralitos #8- Below Eureka G	22.2	14.3	4.0	9.0	9.4	13.2	1.1	3.9	9.4	1.8	3.7	2.2	4.8	7.6
Corralitos #9- Above Eureka G	30.3	13.2	9.5	7.2	17.1	19.2	2.8	5.1	12.2	10.5	5.6	5.0	6.8	11.1
Shingle Mill #1- Below 2nd Road Xing	10.2	24.3	9.0	13.3	5.6	6.7	5.6	6.3	4.2	6.9	4.2			8.8
Shingle Mill #3- Above 2nd Road Xing	14.0		3.4	6.7	0.7	7.2	6.1	8.0	5.7	6.9	5.8			6.5
Browns #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	9.4	11.8
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	4.6	9.8
Casserly #1													2.6	2.6

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

Table 34. SIZE CLASS I (<75 mm SL) Steelhead Density at Monitoring Sites in APTOS, VALENCIA, CORRALITOS, SHINGLE MILL, BROWNS and CASSERLY Creeks, 1981, 1994, 2006–2016.
Empty boxes indicate no data.

Sample Site	1981	1994	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	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	0	15.8
Aptos #4- above Bridge Nisene Marks	37.1		28.5	9.0	83.8	0	12.0	4.9	51.9	17.4	13.7	0	14.3	22.7
Valencia #2- below Valencia Road Xing	16.6		24.5	26.6	27.5	8.9	16.4				2.7		5.2	16.1
Valencia #3- Above Valencia Road Xing	16.6		20.5	5.7	41.5	7.8	24.6				2.5		3.3	15.3
Corralitos #0- Below Dam													0.8	0.8
Corralitos #1- Below Dam	30.8			27.0	61.2	20.5	1.7	8.6	56.8	29.0	1.8	35.1	0.0	24.2
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	0.9	16.6
Corralitos #8- Below Eureka G	59.7	14.3	35.8	43.0	46.6	36.6	14.1	21.7	18.2	28.9	0	9.4	16.4	26.5
Corralitos #9- Above Eureka G	55.8	16.7	45.5	31.3	44.6	53.5	22.4	24.2	36.5	32.9	0.5	22.4	16.6	31.0
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	2.3	21.8
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	0.8	36.2
Casserly #1													22.1	22.1

*** 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, BROWNS and CASSERLY Creeks, 1981, 1994 and 2006–2016.

Empty boxes indicate no data.

Sample Site	1981	1994	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	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	0.7	8.5
Aptos #4- above Bridge Nisene Marks	5.9		10.1	17.8	5.5	8.0	9.7	16.7	9.6	6.1	4.7	1.9	8.4	8.7
Valencia #2- below Valencia Road	16.5		3.8	16.4	11.0	13.8	8.7				0.3		6.4	9.6
Valencia #3- Above Valencia Road	13.2		12.9	10.5	14.0	18.5	14.8				3.0		3.3	11.3
Corralitos #0- Below Dam													5.2	5.2
Corralitos #1- Below Dam	3.1			9.1	8.7	13.7	8.7	7.6	8.7	12.1	8.3	5.0	3.7	8.6
Corralitos #3- Above Colinas Dr	5.2	8.4	19.3	11.5	8.3	9.3	5.5	6.6	24.2	10.7	12.1	4.0	7.3	10.2
Corralitos #8- Below Eureka G	22.2	14.3	13.2	9.9	9.4	15.3	6.0	12.3	9.4	1.8	6.1	2.2	4.8	9.8
Corralitos #9- Above Eureka G	30.3	13.2	41.6	7.2	17.1	19.7	11.2	14.5	12.7	10.5	8.3	5.0	8.5	15.3
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	9.4	14.0
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	5.9	11.8
Casserly #1													2.6	2.6

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

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

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

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

Below Average - 4 to 8 " " "

Fair - 8 to 16 " " "

Good - 16 to 32 " " "

Very Good - 32 to 64 " " "

Excellent - 64 or more " " "

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

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

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

Table 37. 2016 Sampling Sites Rated by Potential Smolt-Sized Juvenile Steelhead Density (=>75 mm SL) and Average Size in Standard Length Compared to 2015, with Physical Habitat Change Since 2015 Conditions.

Site	2016 Potential Smolt Density (per 100 ft)/ Avg Pot. Smolt Size SL	2016 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	5.6/ 120 mm	Fair	4.8/ 83 mm	Poor	Site Positive
Low. San Lorenzo #1	5.6/ 100 mm	Below Average	4.4/ 95 mm	Below Average	Site Positive
Low. San Lorenzo #2	8.3/ 100 mm	Fair	3.5/ 90 mm	Poor	Reach Positive
Low. San Lorenzo #4	6.3/ 88 mm	Poor	2.6/ 80 mm	Very Poor	Site Positive
Mid. San Lorenzo #6	0.5/ 81 mm	Very Poor	0.5/ 75 mm	Very Poor	Site Positive
Mid. San Lorenzo #8	1.3/ 81 mm	Very Poor	0/ 0 mm	Very Poor	Site Positive
Mid. San Lorenzo #9	3.6/ 89 mm	Poor	1.3/ 83 mm	Very Poor	Site Positive
Up. San Lorenzo #10	3.5/ 86 mm	Very Poor	1.4/ 82 mm	Very Poor	Site Positive
Up. San Lorenzo #11	4.6/ 117 mm	Fair	5.8/ 98 mm	Below Average	Site Positive
Up.San Loren #12a (res. rt)	2.4/ 122 mm	Below Average	6.8/ 97 mm	Below Average	Site Positive
Zayante #13a	4.6/ 95 mm	Below Average	2.1/ 86 mm	Very Poor	Site Positive
Zayante #13c	15.9/ 91 mm	*Good*	44.7/ 87 mm	*Good*	Site Positive
Zayante #13d	14.0/ 100 mm	Fair	8.3/ 97 mm	Fair	Site Positive
Lompico #13e	3.5/ 112 mm	Below Average	6.8/ 93 mm	Below Average	Site Negative
Zayante #13i	7.4/ 96 mm	Below Average	7.4/ 112 mm	Fair	Site Positive
Bean #14a	6.2/ 89 mm	Below Average	1.4/ 90 mm	Very Poor	Site Positive
Bean #14b	4.5/ 99 mm	Below Average	11.5/ 104 mm	*Good*	Reach Positive
Bean #14c-1	Dry	Dry	Dry	Dry	Dry
Bean #14c-2	7.1/ 103 mm	Fair	Not Sampled	Not Sampled	NA
Fall #15a	8.4/ 102 mm	Fair	6.0/ 99 mm	Below Average	Site Positive
Fall #15b	4.8/ 116 mm	Fair	6.7/ 95 mm	Below Average	Site Positive
Newell #16	4.3/ 87 mm	Poor	2.0/ 86 mm	Very Poor	Site Positive
Boulder #17a	17.1/ 99 mm	*Good*	1.0/ 106 mm	Poor	Reach Positive
Boulder #17b	7.2/ 88 mm	Below Average	5.7/ 88 mm	Poor	Site Positive
Bear #18a	2.2/ 102 mm	Poor	1.0/ 76 mm	Very Poor	Reach Negative
Carbonera #20a	1.6/ 102 mm	Very Poor	Not Sampled	Not Sampled	NA
Branciforte #21b	7.4/ 102 mm	Below Average	6.8/ 103 mm	Fair	Site Positive
Branciforte #21c (res. Rt)	6.1/ 106 mm	Fair	6.2/ 115 mm	Fair	Site Positive
Soquel #1	0.3/ 88 mm	Very Poor	2.4/ 101 mm	Poor	Reach Positive
Soquel #4	1.0/ 89 mm	Very Poor	0.9/ 79 mm	Very Poor	Site Positive
Soquel #10	3.7/ 98 mm	Poor	0.5/ 76 mm	Very Poor	Site Positive
Soquel #12	12.5/ 96 mm	Fair	2.9/ 82 mm	Very Poor	Reach Positive
East Branch Soquel #13a	6.8/ 98 mm	Below Average	9.1/ 91 mm	Fair	Reach Positive
East Branch Soquel #16	9.0/ 89 mm	Fair	Dry	Dry	Reach Positive
West Branch Soquel #19	3.3/ 83 mm	Very Poor	4.4/ 101 mm	Below Average	Reach Negative
West Branch Soquel #21	5.1/ 98 mm	Below Average	1.6/ 92 mm	Very Poor	Site Positive
Aptos #3	0.7/ 148 mm	Poor	3.5/ 112 mm	Below Average	Site Positive
Aptos #4	8.4/ 88 mm	Below Average	1.9/ 109 mm	Poor	Site Positive
Valencia #2	6.4/ 96 mm	Below Average	Not Sampled	Not Sampled	Site Negative
Valencia #3	3.3/ 107 mm	Below Average	Not Sampled	Not Sampled	Reach Negative
Corralitos #0	5.2/ 128 mm	Fair	Not Sampled	Not Sampled	NA
Corralitos #1	3.7/ 125 mm	Poor	5.0/ 85 mm	Poor	Site Positive
Corralitos #3	7.3/ 129 mm	Below Average	4.0/ 126 mm	Fair	Site Positive
Corralitos #8	4.8/ 120 mm	Fair	2.2/ 105 mm	Below Average	Site Positive
Corralitos #9	8.5/ 110 mm	*Good*	5.0/ 108 mm	Fair	Reach Positive
Browns #1	9.4/ 106 mm	*Good*	4.8/ 126 mm	Fair	Site Positive

Browns #2	**5.9/ 111 mm**	**Fair**	**5.4/ 106 mm**	**Fair**	**Reach Positive**
Casserly #3	**2.6/ 115 mm**	**Below Average**	**Not Sampled**	**Not Sampled**	**NA**

Table 38. Summary of Sampling Site Ratings in 2006–**2016, 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
2016 (n=47)	7 (+1 dry)	7	16	13	4	0

R-10. Comparison of 2016 to 2015 and Average Steelhead Densities and Trends in the Corralitos Sub-Watershed and Pajaro Lagoon

Fall baseflow in Corralitos Creek was likely greater in 2016 than 2015, based on gage readings in the San Lorenzo River and Soquel Creek (**Figures 36-37 and 42-43**). The gage at Freedom indicated flow until late August in 2016 (**Figure 51**) compared to flow only until late April in 2015 (**Figure 52**). 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 apparently missed the sedimentation caused by the fire.

In 2016, total and YOY juvenile densities were lower than in 2015 except at Corralitos Site 8 and below average at all 6 repeated sites (**Tables 31 and 32; Figures 13 and 14**). This occurred despite better adult spawning access in 2016. Total densities at sites ranged between 3.7 and 25.1 juveniles/ 100 ft in 2016. YOY densities at sites ranged between 0 and 18 YOY/ 100 ft in 2016. The trend in total densities for the 6 Corralitos and Browns creek sites decreased in 2016 from 2015 to the second lowest 6-site average (12.8 juveniles/ 100 ft) in the last 9 years of monitoring (**Figure 28**). YOY steelhead density in Casserly Creek was the highest of Corralitos sub-watershed sites in 2016 (22 YOY/ 100 ft) (**Table 32; Figure 14**).

In 2016, yearling densities were slightly higher than in 2015 at 4 of 6 repeated Corralitos/Browns sites (**Table 33**) but below average at all sites (nearly average at Corralitos Site 3) (**Figure 15**).

In 2016, Size Class II densities were higher than in 2015 at 5 of 6 sites (slightly higher at Browns 2 and less than in 2015 at Corralitos 1) (**Table 35**). 2016 Size Class II densities were below average at all 6 sites (**Table 35; Figure 16**), with a range of 3.7 at Corralitos 1 to 9.4 fish/ 100 ft at Browns 1. The trend in soon-to-smolt densities increased slightly in 2016, with the 6-site average of 6.6 fish/ 100 ft, after declining from 2012 to 2015 (**Figure 29**). The same pattern was evident for the 4 sites only, in Corralitos Creek (**Figure 30**), with an average of 6.1 fish/ 100 ft in 2016. Increased densities of larger fish in 2016 were consistent with rearing habitat improvement at all Corralitos/Browns sites due to likely increased baseflow throughout in 2016, along with other improved habitat conditions (**Table 16c**). Pool depth increased in the 2 habitat typed reaches and 2 other sampling sites. Fine sediment lessened at 3 sites and was similar to 2015 at 1 other site and in the 2 habitat typed reaches. Pool escape cover increased at 3 sites and in 2 other habitat typed reaches, with it similar at another site. Size Class II (yearling) density was relatively low in Casserly Creek (2.6 fish/ 100 ft) (Table 35; **Figure 16**) and likely included resident rainbow trout. Habitat typed Casserly Creek Reach 3 was dominated by shallow pools (46% of stream length; average mean depth = 0.6 ft; average maximum depth = 1.0 ft; average length = 26 ft.) with moderate escape cover (10 ft/ 100 ft of stream).

In comparing sampling site ratings based on soon-to-smolt densities, 3 sites improved, 1 site declined and two remained the same (**Table 37**). Of all of the sites sampled in the Corralitos sub-watershed, Corralitos 9 and Browns 1 were rated “good.” Corralitos 0, Corralitos 3, Corralitos 8 and Browns 2 were rated fair. Casserly 3 was rated “below average.” Corralitos 1 was rated “poor.” Sites that obtained the “fair” and “good” ratings did so because their ratings were increased one increment due to the average sizes of these larger fish at the sites being greater than 102 mm SL and not because of high densities.

R-11. Comparison of Abundance Indices for Size Class II and III Juveniles in 2010 and 2014‒2016 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, then abundance indices were calculated for each sampled reach in each watershed. An overall watershed index of abundance for the sampled reaches combined was then calculated. Indices were compared for 2010 (a wet baseflow year) and drier years, 2014‒2016. Refer to the methods section for more details.

For the San Lorenzo watershed, the total reach index for 18 reaches (not including the lagoon) was 21,000 (2010), 7,800 (2014), 7,500 (2015) and 9,900 (2016) for Size Class II and III juveniles (**Figure 31**). 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 2016, Zayante 13d and Boulder 17a reaches provided higher indices than in the wet year of 2010. Bean 14c produced juveniles in 2016 because a portion of it was watered. Reach indices for Bean 14b, Newell 16 and Bear 18a increased little in 2016, despite likely higher baseflow.

For the Soquel watershed, the total reach index for 8 reaches (not including the lagoon) was 3,800

(2010), 880 (2014), 580 (2015) and 2,500 (2016) for Size Class II and III juveniles (**Figure 32**). The 2016 total index increased substantially from the 2 previous drought years because East Branch Soquel 13a remained completely watered in 2016, and East Branch Soquel 12a also had surface flow after being dry in 2014 and 2015. However, the remainder of the mainstem and lower West Branch were still low in production, perhaps indicating patchy spawning and/or spawning success by a dwindling adult steelhead population. Also, upper mainstem Soquel 8 had a higher index in 2016 than in 2010 due to fast growth of high density YOY's present in fastwater habitat. In 2010, the lagoon population estimate was about 1,200 soon-to-smolt sized 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. In 2016, the Soquel lagoon population estimate was only 237 soon-to-smolt sized fish (**Alley 2017**).

For the Corralitos sub-watershed, the total reach index for 6 reaches (excluding Shinglemill Gulch) for Size Class II and III juveniles was 3,000 (2010), 2,000 (2014), 1,000 (2015) and 1,400 (2016) (**Figure 33**). The reach index total in 2016 was an improvement over the 2015 total but was less than the 2014 total.

R-12. Sampling Results for the Pajaro River Lagoon in 2016

The Santa Cruz County Flood Control and Water Conservation District Zone 7 is required to conduct annual fish sampling in the Pajaro Lagoon as a permit condition for lagoon breaching. The fish sampling documents the presence/absence, distribution and abundance of steelhead *(Oncorhynchus mykiss*), tidewater goby (*Eucyclogobius newberryi*), and other fish and wildlife. 2016 was the fifth year of annual sampling, which began in 2012. An estuary was present with periodic opening and closing of the sandbar in summer 2016 (Michael Sapunor, Santa Cruz County staff, pers. comm.). There was daily tidal influence during the sampling period. No steelhead were captured in Pajaro River Estuary in fall 2016, as was the case in fall 2012− 2015. Tidewater gobies were captured in reduced numbers in 2016, especially at the upper site where they were abundant in the past. However, its future is uncertain due to potential conflicts between maintaining fish habitat and flood control.

Methods

The purpose of sampling was to determine presence/absence and distribution of tidewater goby and steelhead. On 29 September 2016, the main estuary 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). On 30 September 2016, the upper estuary was sampled for steelhead with the 106-foot seine. Three seine hauls were made at the model airport, with 3 more at the Thurwachter Bridge . On 3 October 2016, tidewater goby were sampled using a 30-foot seine with 1/8-inch mesh. Five seine hauls were made in the main estuary along the beach, and 3 seine hauls were made in the upper estuary (model airport, Thurwachter Bridge and boat ramp). On 3 October 2016, during tidewater goby sampling in the lower and upper estuary, the water temperature, salinity and oxygen were measured through the water column at 0.25 meter intervals at 6 stations. The 3 lower estuary measurements were made mid-channel by wading, and the 3 upper lagoon measurements were made along the estuary margin. On 30 September 2016 during steelhead sampling at Thurwachter Bridge, water quality was measured through the water column, mid-channel from a boat.

Results – Fish Capture

Sampling of the lower estuary along the beachfront with the larger bag seine yielded only 3 native fish species compared to 1 in 2015, 3 in 2014 and 10 in 2013 (**Table 39**). Smelt were again the most abundant species with a few staghorn sculpins (*Leptocottus armatus*) and anchovy (*Engraulis mordax)*. No steelhead were captured. Despite the periodic opening and closing of the sandbar in 2016, many Bay species that were present in the 2013 estuary in sufficient numbers to be captured were absent in 2016. Two harbor seals were present in the lower estuary during sampling. They may have hampered our sampling success on some seine hauls. Results of sampling the upper estuary near the model airport and Thurwachter Bridge with the large seine yielded similar results; more smelt, 1 threespine stickleback (*Gasterosteus aculeatus*) and no steelhead (**Table 40**).

Our tidewater goby sampling with the finer meshed seine yielded no tidewater gobies in the lower estuary along the beachfront where arrow goby, smelt and staghorn sculpin (mostly small YOY) were captured. Submerged aquatic vegetation was very scarce, as had been the case in 2015. The main estuary was very shallow and mostly wadeable except for a narrow thalweg and near the Watsonville Slough confluence. In the upper estuary, few tidewater goby were captured at the model airport, Thurwachter Bridge and the boat ramp (**Table 41**). Other species captured in the upper estuary were arrow goby (*Clevelandia ios*) (more common than tidewater goby), abundant smelt, staghorn sculpin (mostly small YOY), mosquitofish (*Gambusia spp.*) and threespine stickleback.

Table 39. Fish capture* results from sampling lower Pajaro Estuary *with the 106-foot bag seine (3/8-inch mesh)*, 29 September 2016.

Date	**Location**	**Seine Haul**	**Tide-water Goby**	**Arrow goby**	**Anchovy**	**Smelt (jack and top)**	**Stag-horn Sculpin**	**Stri-ped Bass**	**Three-spine stickle-back**	**Prickly sculpin**	**Gambusia**
29 Sep 2016	East of Watsonville Slough confluence	1				34	5				
	East of #1	2									
	East of #2	3				42					
	East of #3	4				33					
	East of #4	5									
	East of #5	6					6				
	East of #6	7			3	4					
	Adj. mouth of Watsonville Slough	8			3	400					
Total			**0**	**0**	**6**	**513**	**11**	**0**	**0**	**0**	**0**

*6 nudibranchs and 122 crabs were captured. Crabs included Dungeness, green, kelp and an unidentified species.

Table 40. Fish capture results from sampling Upper Pajaro Estuary *with the 106-foot bag seine (3/8 inch (3/8-inch mesh)*, 30 September 2016.

Date	**Location**	**Seine Hauls**	**Tide-water Goby**	**Arrow Goby**	**Yellow fin goby**	**Hitch**	**Prickly sculpin**	**Sac. sucker**	**Smelt (jack and top)**	**Staghorn Sculpin**	**Three-spine Stickle-back**	**Striped Mullet**
30 Sep 2016	Model Airport	1–3							1078+			
	Thurwachter Bridge	4–6							412		1	
Total			**0**	**0**	**0**	**0**	**0**	**0**	**1490+**	**0**	**1**	**0**

Table 41. Fish capture* results from sampling the periphery of lower Pajaro Estuary, Watsonville Slough and upper Pajaro Lagoon *with the 30-foot seine (1/8-inch mesh)*, 3 October 2016.

Date	Location	Seine Haul	Tide-water Goby	Arrow goby	Gam-busia	Hitch	Bay pipe-fish	Prickly sculpin	Smelt (jack and top)	Staghorn Sculpin	Three-spine stickle-back
3 Oct 2016	Approx. 200 m east of Pajaro Dunes Complex	1		5						7	
	East of #1	2								9	
	East of #2	3							35	5	
	East of #3	4		2						6	
	East of #4	5		2						18	
	Airport- 0.3 miles down from Thurwachter Br	6	8	13	56				189		
	Thurwachter Br.	7	20	99					100+		
	Boat Ramp- 0.8 miles upstream of Thurwachter Bridge and 2.9 miles upstream of Watsonville Slough confl.	8	1	1	27			1	200+		5
Total			**29**	**117**	**83**	**0**	**0**	**1**	**524+**	**45**	**5**

* 38 green crabs, 41 nudibranchs and 168 snails were captured.

Water Quality

On 3 October during tidewater goby sampling in the lower and upper estuary, it was found that the water temperature, salinity and oxygen were unstratified except for increasing salinity with depth at the boat ramp (**Table 42**). Oxygen levels were high (near full saturation or higher) throughout in the morning and afternoon. Water temperature was well below 20 C (14.7 C at 0947 hr in the lower estuary to 17.7 C at the boat ramp at 1527 hr). The weather was overcast with sprinkles in the afternoon. Salinity was highest near the beach and less as one progressed further up the estuary, ranging from a maximum of 30.8 ppt in the lower estuary to a minimum of 9.5 ppt near the surface at the boat ramp (15.3 ppt at the bottom).

On 30 September during steelhead sampling at the Thurwachter Bridge in the upper lagoon, water temperature and salinity were unstratified. But oxygen declined slightly with depth to 4.86 mg/ L at the bottom (**Table 43**). Oxygen levels were lower at the bridge on 30 September (morning fog and then clearing around noon and overcast the previous day) than on 3 October (overcast and misty in the afternoon).

Table 42. Water quality measurements in the lower Pajaro Estuary (Stations 1, 3 and 5 in mid-channel) and upper estuary sites (along margin) during tidewater goby sampling, 3 October 2016.

			3-October 2016					
	Station 1 (lower estuary) air temp. 16.2 C		0947 hr		**Station 3 (lower estuary)**			1041 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	14.8	27.0	9.01	33781	15.0	30.6	11.90	38046
0.25	14.7	27.5	7.46	34353	15.0	30.6	9.95	38020
0.50	14.7	28.9	8.78	35857	15.0	30.6	10.97 (131%)	38009
0.70b	14.7	29.1	8.43 (99.5%)	36108	15.0	30.6	10.03 (120%)	38008
0.87b					15.0	30.6	9.67	38011
	Station 5 (lower estuary)			1134 hr	**Model Airport –** **(below Thurwachter Br.)** air temp. 16.9 C			1331 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	15.0	30.8	11.68	38304	16.9	24.4	10.17	32369
0.25	15.0	30.6	9.63	38095	16.9	24.3	8.59	32268
0.50	15.0	30.6	9.60	38039	16.9	24.3	8.58	32288
0.75	15.0	30.6	9.62	38023	16.9	24.3	8.58 (103%)	32300
0.80b					16.9	24.3	8.53	32299
0.92b	15.0	30.6	9.56 (114%)	38009				

Table 42 (continued). Water quality measurements in the lower Pajaro Estuary (Stations 1, 3 and 5) and the upper estuary sites during tidewater goby sampling, 3 October 2016.

			3 October 2016					
	Thurwachter Bridge Air Temp 16.0 C			1438 hr	**Boat Launch Ramp** **(above Thurwachter Br.)** Air Temp. 17.9 C			1527 hr
Depth	**Temp 2**	**Salin 2**	**O2 2 (%sat.)**	**Cond 2**	**Temp 2**	**Salin 2**	**O2 2 (%sat.)**	**Cond 2**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**umhos**	**(C)**	**(ppt)**	**(mg/l)**	**umhos**
0.00	17.6	21.2	13.71	28971	17.1	9.5	9.50	13663
0.25	17.7	21.2	14.04	28973	17.1	9.9	9.01	14288
0.50	27.7	21.2	13.34	28975	17.4	13.1	9.22	18687
0.65b					17.6	15.3	9.96	21440
0.75	17.7	21.4	13.67 (163%)	29250				
0.95b	17.7	21.5	13.75	29428				

Table 43. Water quality measurements in the upper Pajaro Estuary during steelhead sampling, 30 September 2016.

			30 September 2016					
	Model Airport (mid-channel)				**Thurwachter Bridge** (mid-channel)			1217 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					18.1	22.5	6.02	30927
0.25					18.1	22.8	5.05	31310
0.50					18.1	22.9	4.82	31466
0.75					18.1	23.0	4.91 (60%)	31490
1.00					18.1	23.1	4.91	31710
1.05b					18.1	23.1	4.86	31712
1.25								
1.50								

CONCLUSIONS- Pajaro Lagoon/ Estuary

No steelhead were detected in Pajaro Estuary despite the absence of temperature and oxygen stratification and good oxygen concentrations in the lower estuary along the beach. The sandbar was open during sampling and water quality measurements. The Pajaro Estuary, with its daily tidal influence was less favorable to juvenile steelhead for rearing and tidewater goby for spawning than a deeper freshwater lagoon without depth fluctuation and stratification would be. The estuary had high saline content throughout the water column and evidence of temporal oxygen fluctuations. Oxygen was adequate for steelhead during the sampling period, although it fluctuated considerably and may have been temporarily low at dawn on 30 September. Water temperature was cool during sampling due to the lack of saltwater stratification at most sites and the strong tidal influence. The low oxygen concentrations at midday on 30 September indicated that the biological oxygen demand was high and capable of depressing oxygen levels. While water quality data were not collected throughout the summer and during periods of sandbar closure, habitat conditions for steelhead can become difficult when the sandbar closes to form a lagoon with little stream inflow, and trapped saltwater creates a stratified water column with higher water temperatures throughout and lower oxygen levels at greater depth. Much of the Pajaro Estuary was less than 1 meter deep at water quality stations, with a narrow thalweg present nearby in the lower estuary that was somewhat deeper.

A small population of tidewater goby still existed in Pajaro Estuary, but again appeared absent in the lower estuary along the beach, as was the case in 2015. Algae and submerged vegetation appeared absent in the lower estuary in both years. The highest tidewater goby densities were in the upper estuary at Thurwachter Bridge. But they were much reduced from past years, particularly at the boat ramp. Water quality was adequate for tidewater goby survival during the dry season, though oxygen may have been low at times in some locations. They spawn along freshwater margins, which were absent at sampling sites in 2016. Freshwater habitat may have existed at the very top of the estuary where the River entered the estuary earlier in the dry season.

Recommendations- Pajaro Lagoon/ Estuary

After 15 years of water quality monitoring and fish sampling of Santa Rosa Creek Lagoon near Cambria, California and 26 years of the same at Soquel Creek Lagoon in Capitola, the following were recommendations to insure steelhead habitation. These recommendations would be difficult to attain at Pajaro Lagoon/Estuary 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 for steelhead.*
- *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.*

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 if freshwater exists. 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 summer lagoon/estuary to the east of Watsonville Slough. This is significant summer habitat in some years for tidewater goby and arrow goby along the beachfront.

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. Elevation of Beach Street, the only 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.

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.

Two factors may explain the much below average YOY densities at most sites in all 4 watersheds sampled. As in 2015, the main factor in 2016 may have been low adult returns to all 4 watersheds. Seven of the last 10 years have been on the dry side, including 2012−2016, 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 of juveniles to adulthood and low adult returns. Trapping data from Scott Creek indicated a slight increase in adult returns in winter 2015-2016, where adult steelhead escapement estimates in water years 2006─2016 were 219, 259, 293, 126, 109, 214, 140, 167, 50, 86 and 123, respectively (**Joseph Kiernan, NOAA Fisheries personal communication**). The adult coho escapement for water year 2016 was 13, based on redd counts. In 2015 it was163, resulting from 31,000 coho salmon hatchery smolts released in 2013. On the Carmel River, San Clemente Dam was demolished and no adult estimates were available except that no adult steelhead were observed at the Los Padres Dam fish ladder through April, despite adequate passage flows. This would indicate either a low adult return or restricted passage from impediments downstream (possibly in the new channel adjacent to the footprint of the former San Clemente Reservoir) or both. Adult estimates at San Clemente Dam in 2006−2015 were 368, 222, 412, 95, 157, 452, 470, 249, 0 and 7, respectively (**Chaney, 2015**). San Clemente Dam has now been dismantled. 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.

Another indication of low adult returns was based on juvenile sampling in 2016. YOY densities across the sites were patchy, with highest densities at upper watershed sites and lower densities at lower watershed sites. Examples of higher YOY densities were at mainstem SLR 12a, Zayante 13d, Zayante 13i, Fall 15b and Boulder 17b in the San Lorenzo watershed; West Branch 21 in the Soquel watershed; Aptos 4 in the Aptos watershed; Corralitos 9 in the Corralitos sub-watershed. This pattern also indicated better access to upper watershed sites than recent drier winters.

A second factor contributing to low YOY densities may have been poor egg survival in redds laid prior to the large March 2016 stormflows. On 5 March and 13 March 2016, peak stormflows measured at the Big Trees gage on the San Lorenzo were 11,600 cfs and 3,970 cfs, respectively. The first was nearly 3 times bankfull as previously estimated in 1999, and the second was above bankfull. On 5 March and 13 March 2016, peak stormflows measured at the Soquel Village gage on Soquel Creek were 7,240 cfs and 2,390 cfs, respectively, with both likely above bankfull. On 6 March and 13 March 2016, peak stormflows measured at the Freedom gage on Corralitos Creek were 3,360 cfs and 1,990 cfs, respectively, with both likely above bankfull. It is under bankfull flow conditions that streambed becomes mobilized and redd scour and redd smothering with sand are possible.

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

San Lorenzo Watershed

The below average densities of larger juveniles at all sites in mainstem downstream (**Figure 4**) resulted partially from retention of few yearlings being recruited from a small YOY age class in 2015 (**Figure 3**), as had been the case the previous 2014 and 2015 drought years. Also, there may have been poor overwinter survival with the large 5 March stormflow. Densities of less than 1 yearling/ 100 ft were detected at mainstem sites downstream of the Boulder Creek confluence, with none detected at SLR-6. With limited turbidity in the spring due to lack of stormflow after mid-March, 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 resulting in few YOY to reach Size Class II (**Figure 2**). For the middle and upper mainstem to Waterman Gap, there were below average Size Class II fish because of below average densities of juvenile steelhead present, a small proportion of 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 and 2015, resulted from patchy shortage of yearlings at most sites, resulting from poor recruitment from the small YOY age class of 2015, possibly poor overwinter survival and possibly early out-migration due to good spring growth without turbid feeding conditions after mid-March. The near-average or higher than average Size Class II densities at some steelhead sites (Zayante 13d, Bean 14a, Fall 15a and Boulder 17a) resulted from moderate YOY densities in 2015 to recruit yearlings, retention of some yearlings and, the filtering downstream of yearlings from upstream habitat. The near average Size Class II density at Zayante 13c despite the much below average YOY density (**Figure 2a**) resulted primarily from good escape cover and good growth of a high proportion of YOY into Size Class II at this sunny site.

Soquel Watershed

The below average densities of Size Class II and III juveniles at 6 of 8 sites in the Soquel drainage again in 2016 as in 2013–2015 (**Table 30b; Figure 8**) were due to 1) typical poor survival/retention of yearlings either because they were flushed out or killed during the high 5 March stormflow or grew sufficiently in low turbidity water in spring to smolt early, and 2) very low densities of YOY to grow into Size Class II at all but the upper mainstem site 12 in mainstem and lower East Branch sites where a portion of YOY grew into the larger size classes in 2016. East Branch Site 16 had average densities of larger juveniles despite it being dry the 2 previous years. This occurred because YOY densities were very low, allowing some

YOY to reach Size Class II, which is unusual at the site, and because yearlings moved into the site probably filtered in from upstream.

Aptos Watershed

Below average densities of larger juveniles in Aptos sites in 2016 resulted from very low total juvenile steelhead densities, YOY densities and yearlings and older densities at 3 of 4 sites (**Figures 9−12**). Only 1 juvenile steelhead was captured at lower Aptos 3, which was a yearling. Good habitat was available but fish were absent. Valencia 2 had higher yearling and older densities than the other 3 sites because older resident rainbow trout likely contributed to this age class. Size Class II and III densities were less than yearling and older densities because some yearlings were smaller than Size Class II. Aptos 4 had higher Size Class II and III densities than other sites because a high proportion of the YOY reached the larger size class.

Corralitos Sub-Watershed

The below average densities of larger juveniles at all 6 repeated sites (**Figure 16**) resulted from 1) very low densities of YOY at 6 of 8 sites and below average YOY densities at all sites (**Figure 14**), 2) almost no YOY reaching Size Class II, and 3) low densities of yearlings and older steelhead at 5 of 8 sites after low recruitment from below average YOY densities in 2015 (**Table 32**).

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

The annual trend in average YOY density increased in Scott and Waddell creeks and decreased in Gazos Creeks in 2016 compared to 2015 (**Figure 54; Smith 2016**). Average YOY densities decreased in San Lorenzo mainstem or tributaries, Soquel Creek and Corralitos/Browns creeks. The average YOY density increased for the 2 sites in Aptos Creek. YOY densities were below average at 5 of 8 Gazos sites, above average at one sites and near average at 1 site (**Figure 56; Smith 2016**). As mentioned before, the average YOY density for all sites combined in Waddell Creek increased in 2016 but we do not have the multi-year averages for each site. YOY site densities in Scott Creek were below average at 9 of 10 sites (**Figure 58**), consistent with YOY site densities in San Lorenzo, Soquel, Aptos and Corralitos/Browns creeks.

The annual trend in average yearling (Size Class II/III) site density decreased in Scott and Waddell creeks in 2016 while it increased slightly in Gazos Creek (**Figure 55; Smith 2016**). Average Size Class II/III site density increased slightly for mainstem San Lorenzo sites, Soquel sites, Aptos sites and Corralitos/Browns sites but was unchanged for San Lorenzo tributary sites. In 2016, yearling juvenile densities were below average at 5 of 7 sites in Gazos Creek and all 10 sites in Scott Creek (**Figures 57 and 59; Smith 2016**). This was consistent with the San Lorenzo (22 of 26 sites below average), Soquel (5 of 7 sites below average), Aptos (all 4 sites below average) and Corralitos/Browns (all 6 sites below average).

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FIGURES

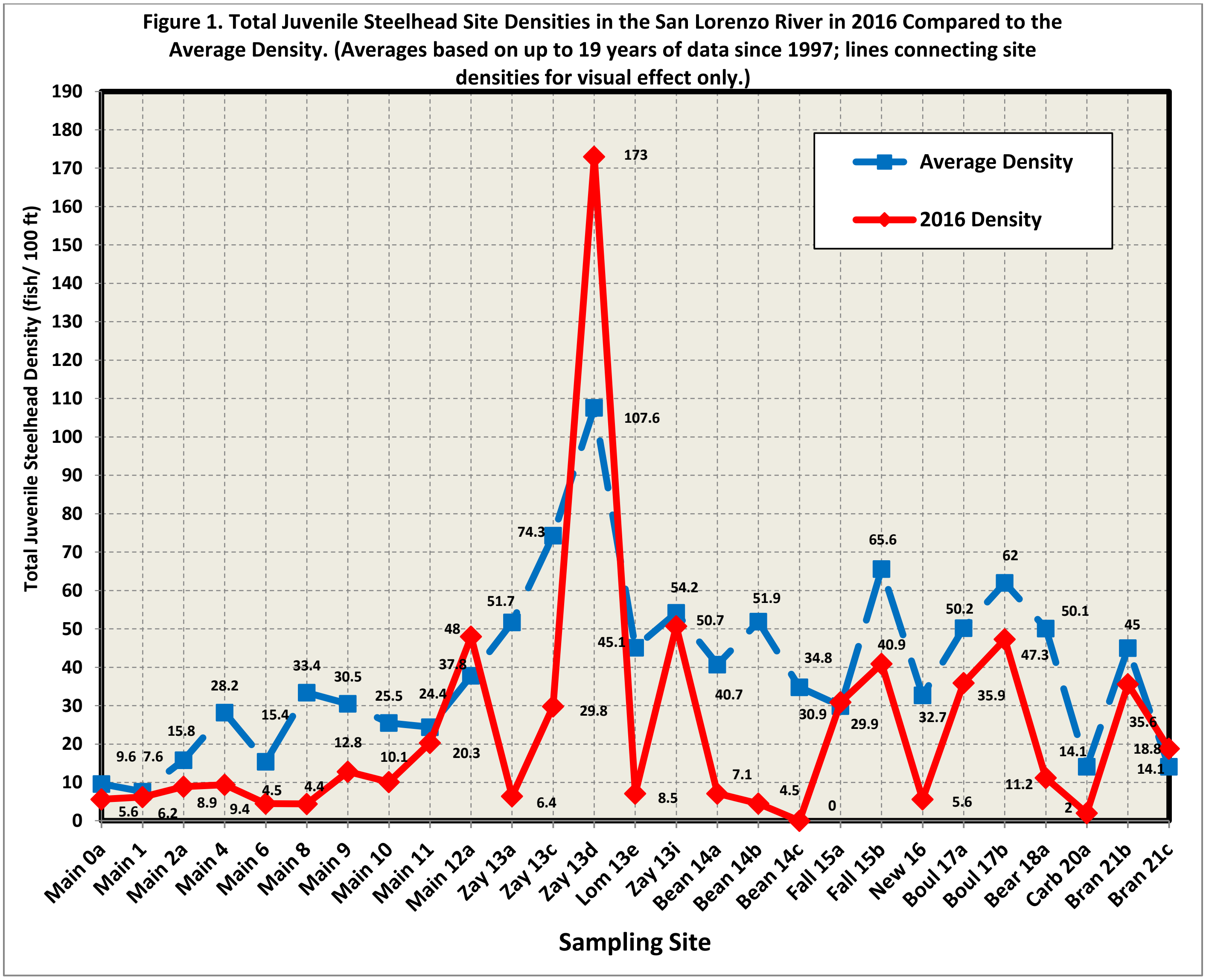


Figure 1. Total Juvenile Steelhead Site Densities in the San Lorenzo River in 2016 Compared to the Average Density. (Averages based on up to 19 years of data since 1997; lines connecting site densities for visual effect only.)

Figure 1. Total Juvenile Steelhead Site Densities in the San Lorenzo River in 2016 Compared to the Average Density. (Averages based on up to 19 years of data since 1997).

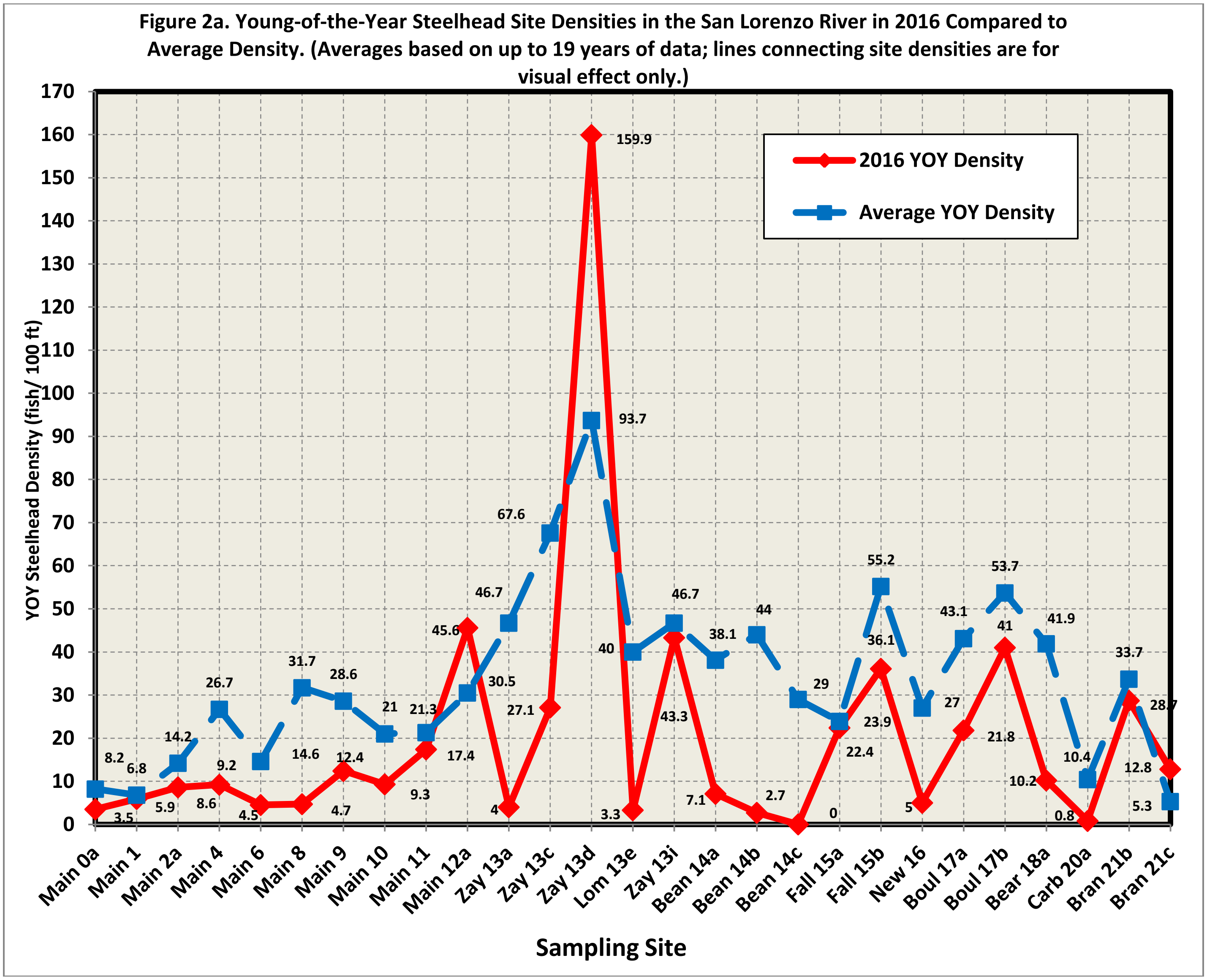


Figure 2a. Young-of-the-Year Steelhead Site Densities in the San Lorenzo River in 2016 Compared to Average Density. (Averages based on up to 19 years of data.)

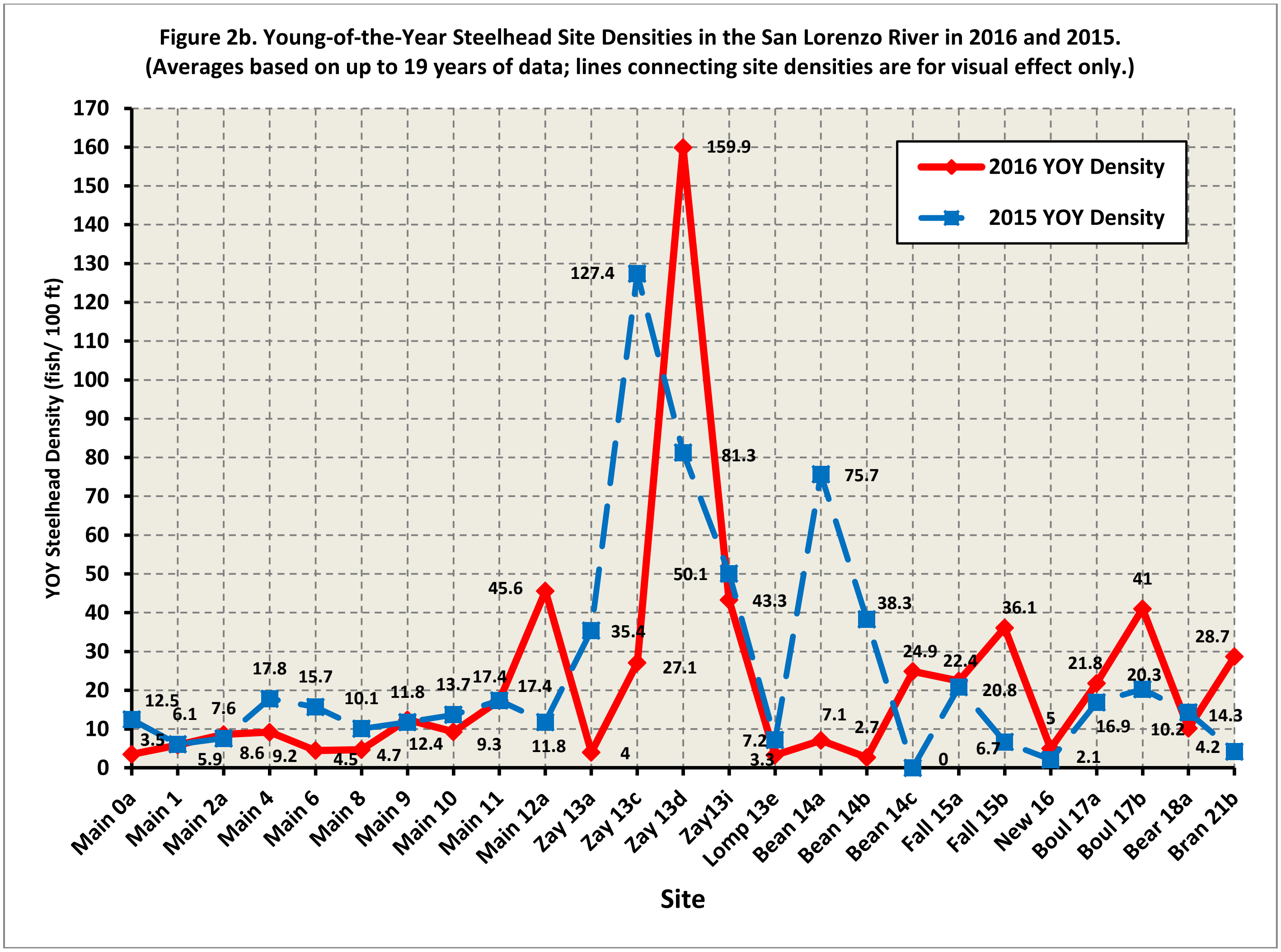


Figure 2b. Young-of-the-Year Steelhead Site Densities in the San Lorenzo River in 2016 Compared 2015. (Averages based on up to 19 years of data.)

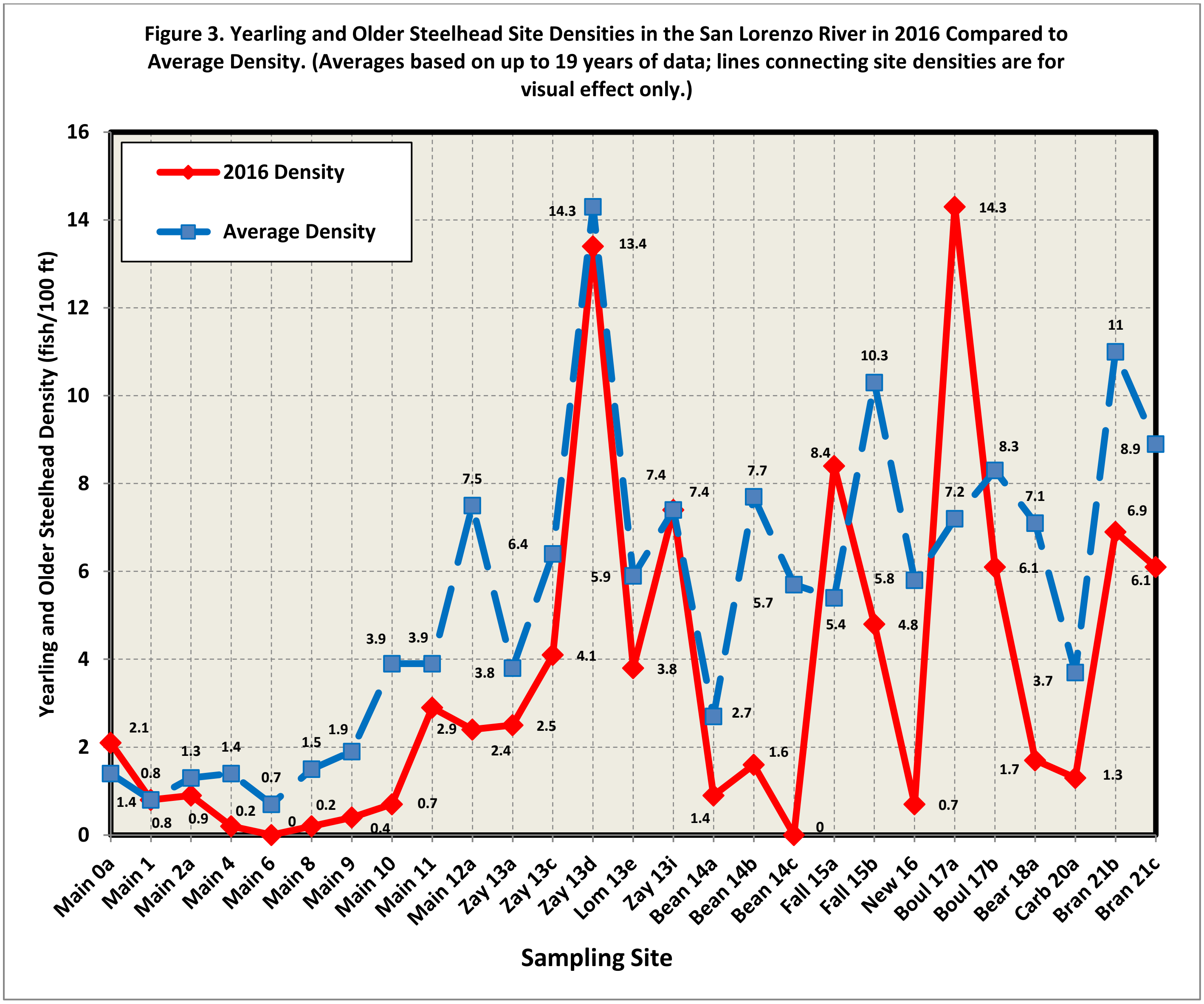


Figure 3. Yearling and Older Steelhead Site Densities in the San Lorenzo River in 2016 Compared to Average Density. (Averages based on up to 19 years of data.)

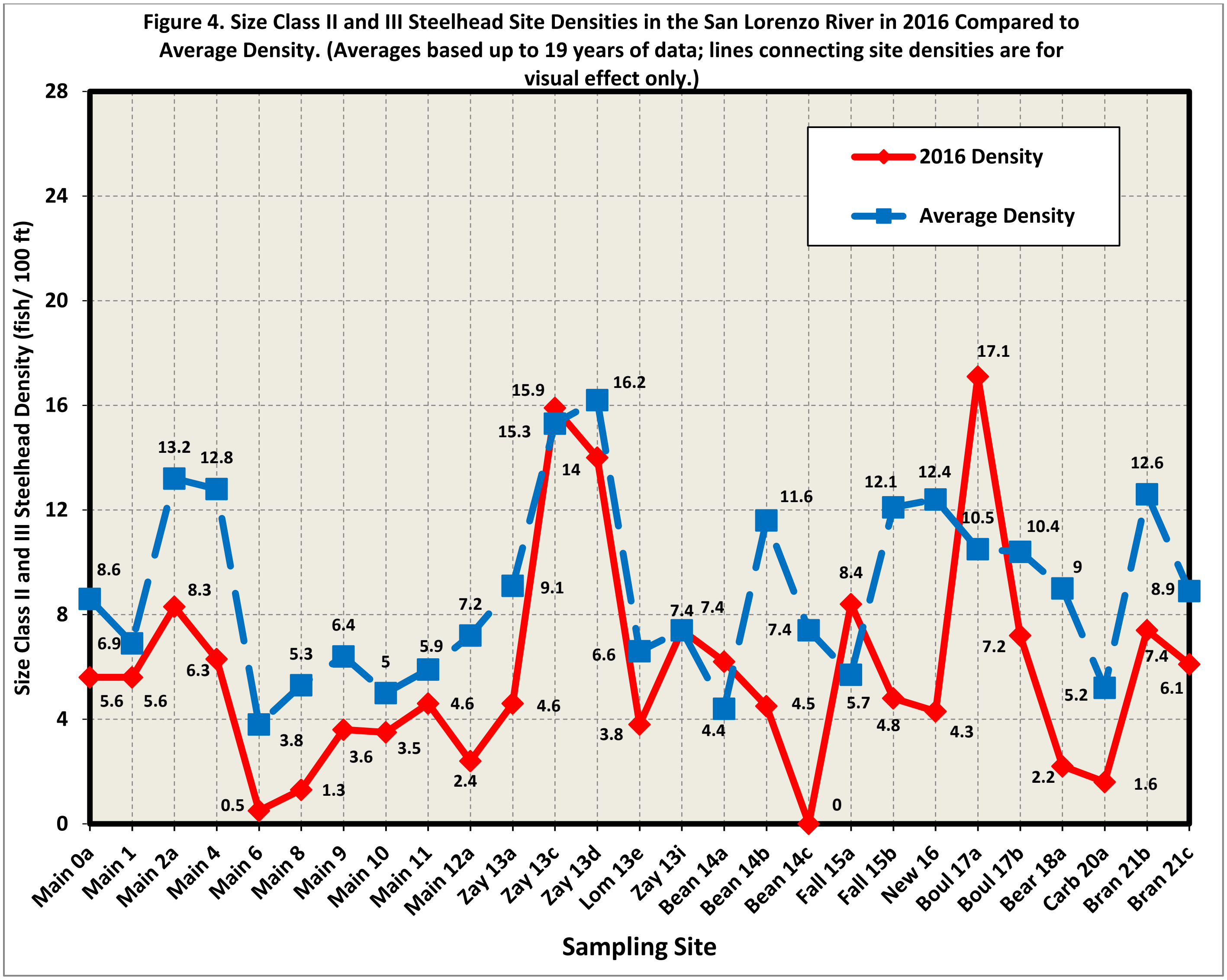


Figure 4. Size Class II and III Steelhead Site Densities in the San Lorenzo River in 2016 Compared to Average Density. (Averages based on up to 19 years of data.)

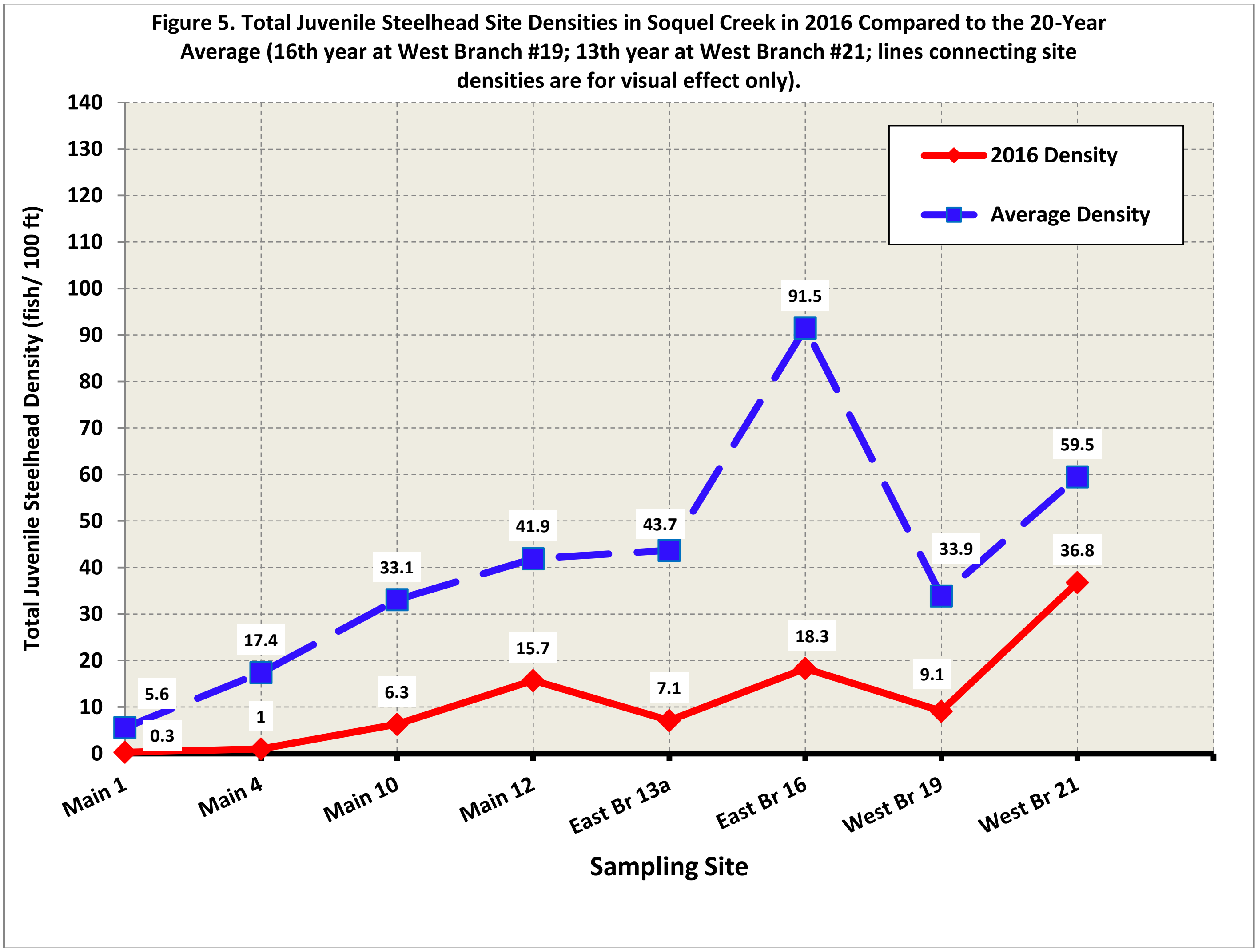


Figure 5. Total Juvenile Steelhead Site Densities in Soquel Creek in 2016 Compared to the 20-Year Average (16th year at West Branch #19).

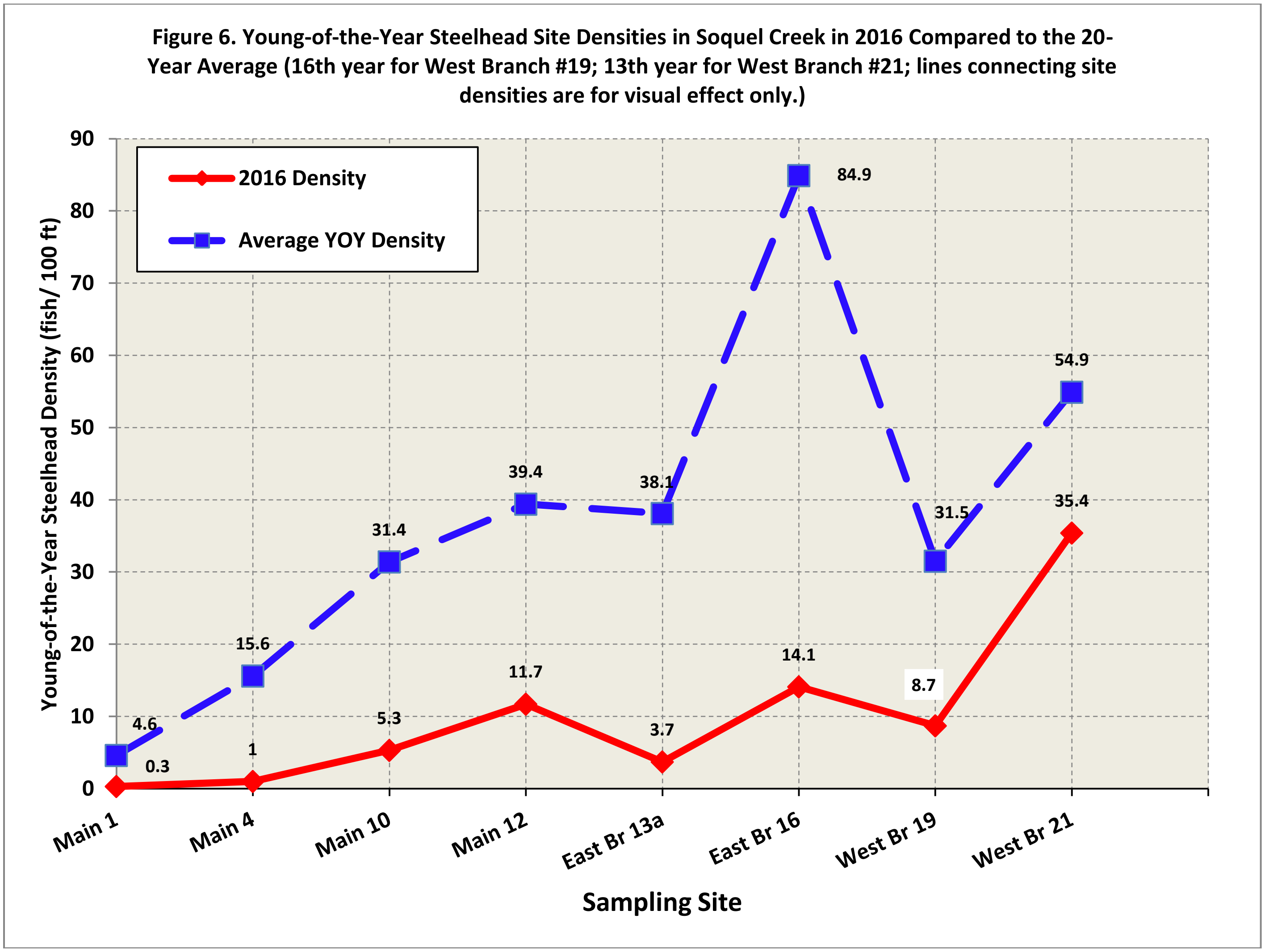


Figure 6. Young-of-the-Year Steelhead Site Densities in Soquel Creek in 2016 Compared to the 20-Year Average (16th year for West Branch #19.)

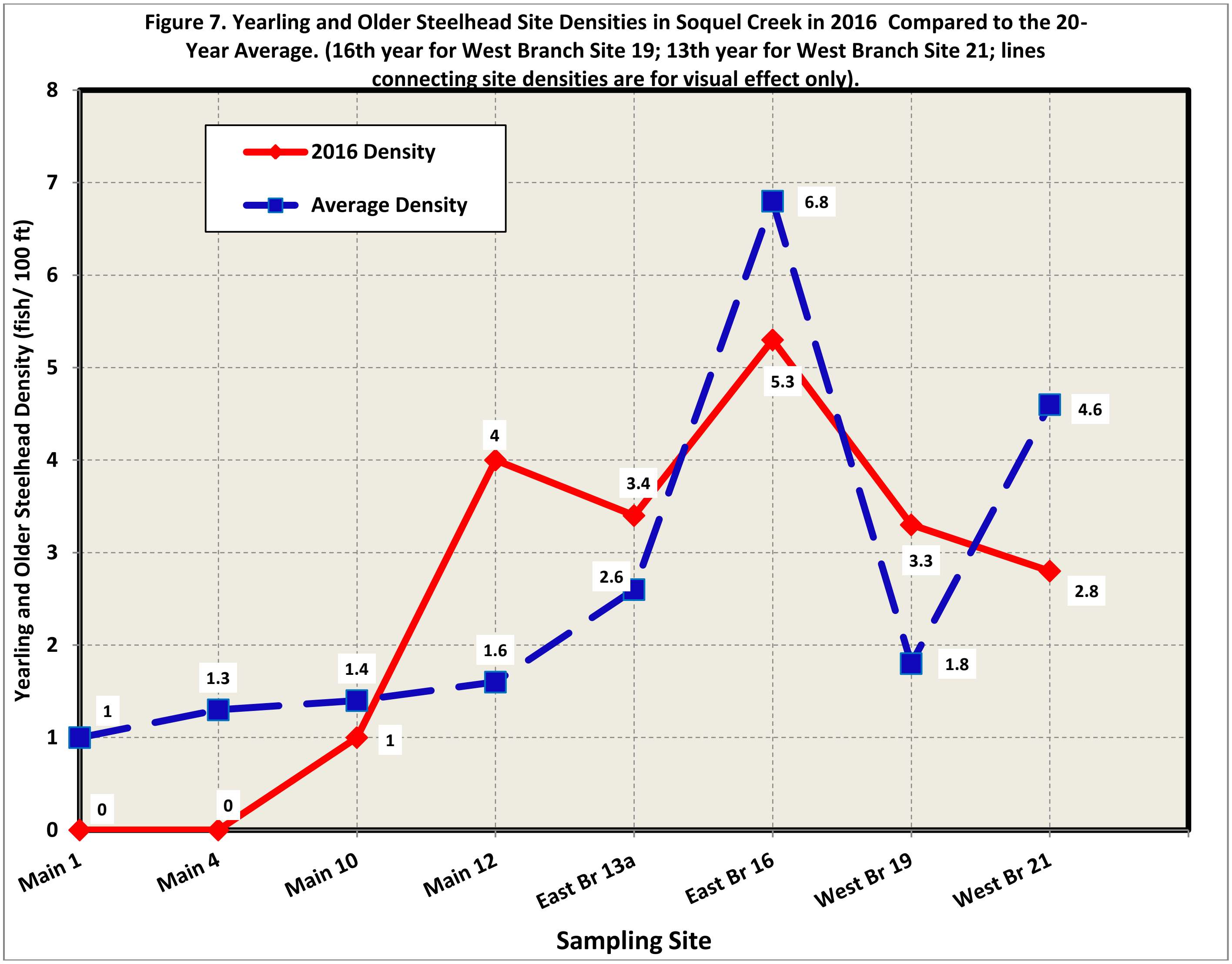


Figure 7. Yearling and Older Steelhead Site Densities in Soquel Creek in 2016 Compared to the 20-Year Average. ((16th year for West Branch # 19).

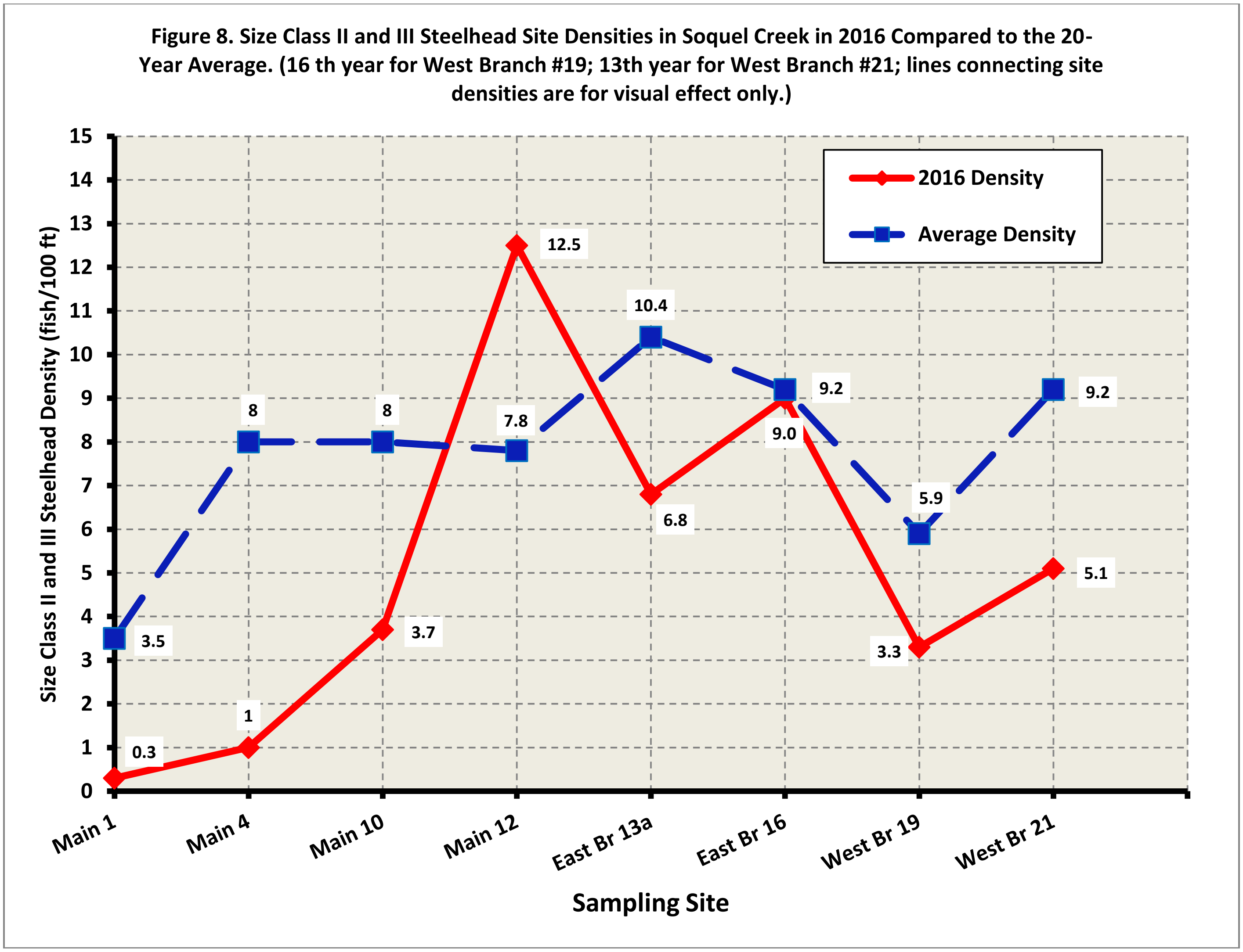


Figure 8. Size Class II and III Steelhead Site Densities in Soquel Creek in 2016 Compared to the 20-Year Average (16th year for West Branch #19.)

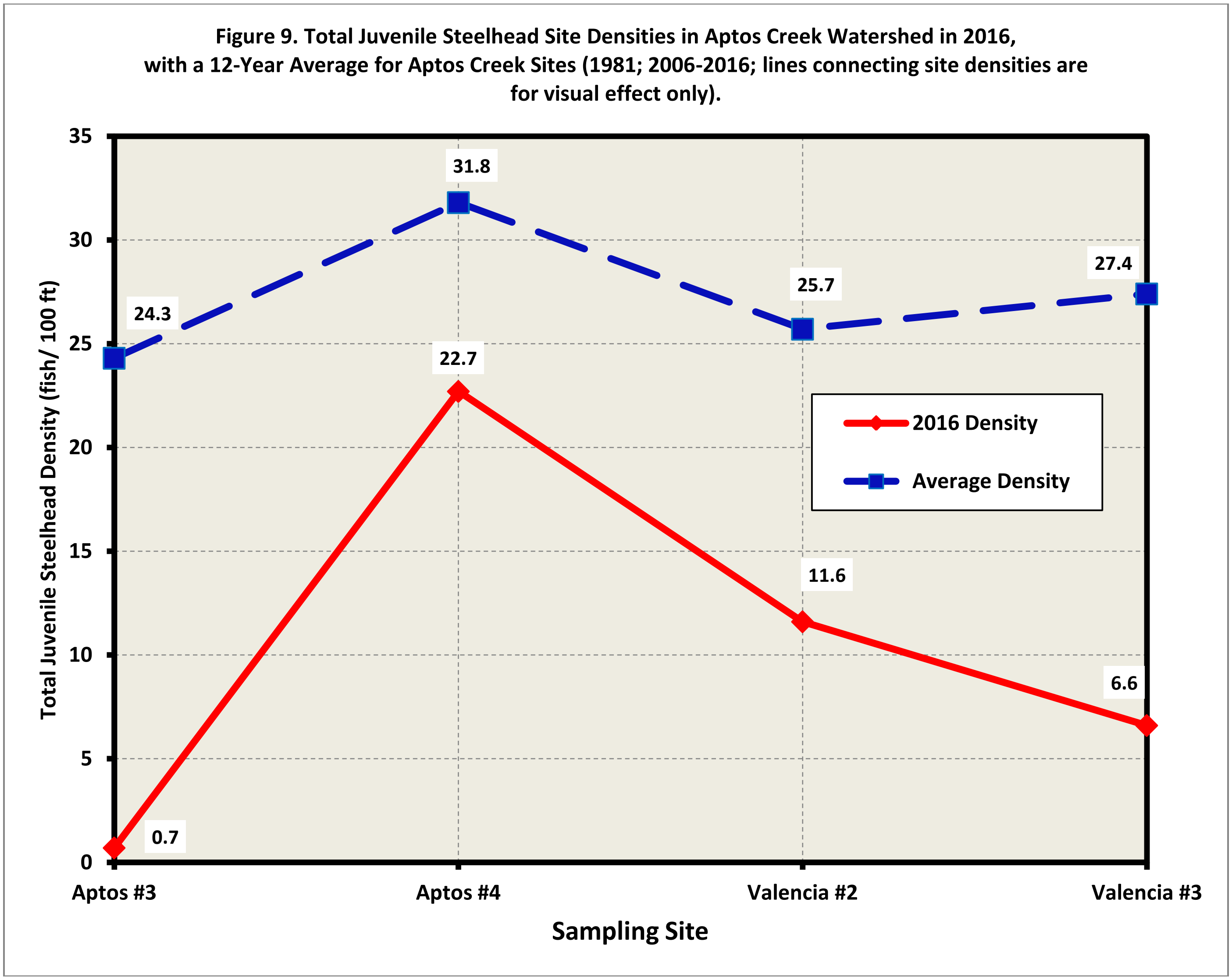


Figure 9. Total Juvenile Steelhead Site Densities in Aptos Creek in 2016, with a 12-Year Average (1981; 2006-2016).

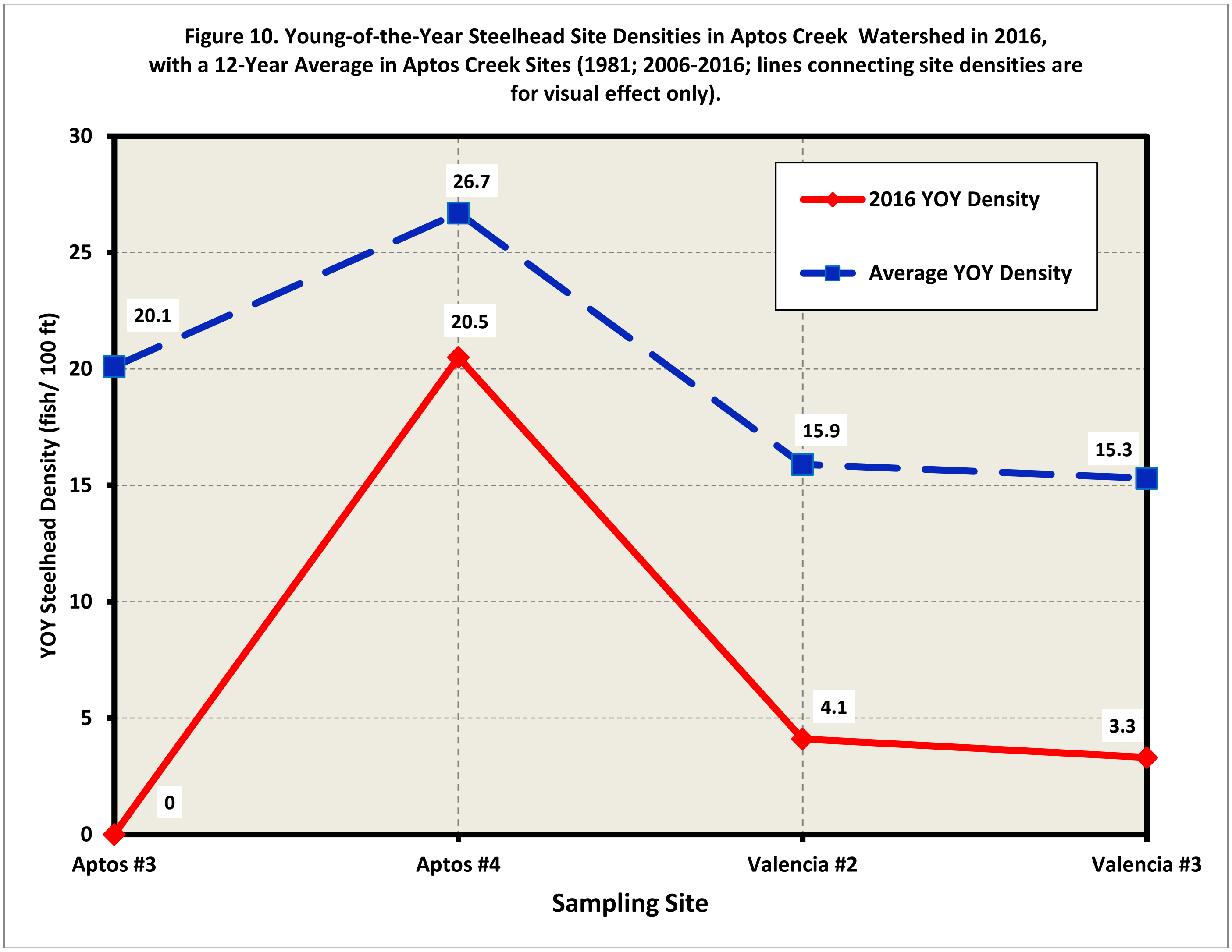


Figure 10. Young-of-the-Year Steelhead Site Densities in Aptos Creek in 2016, with a 12-Year Average (1981; 2006-2016).

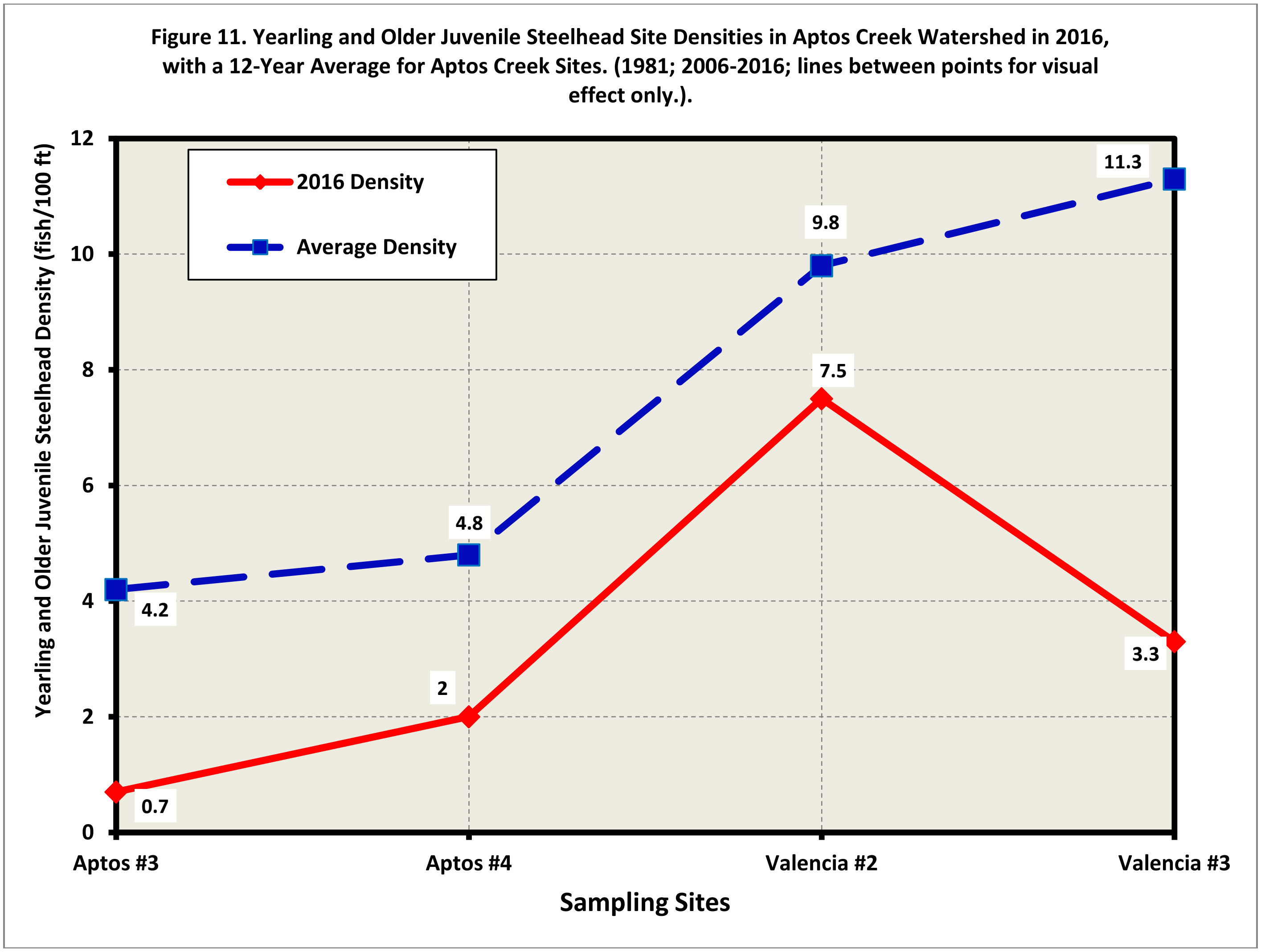


Figure 11. Yearling and Older Juvenile Steelhead Site Densities in Aptos Creek in 2016, with a 12-Year Average (1981; 2006-2016).

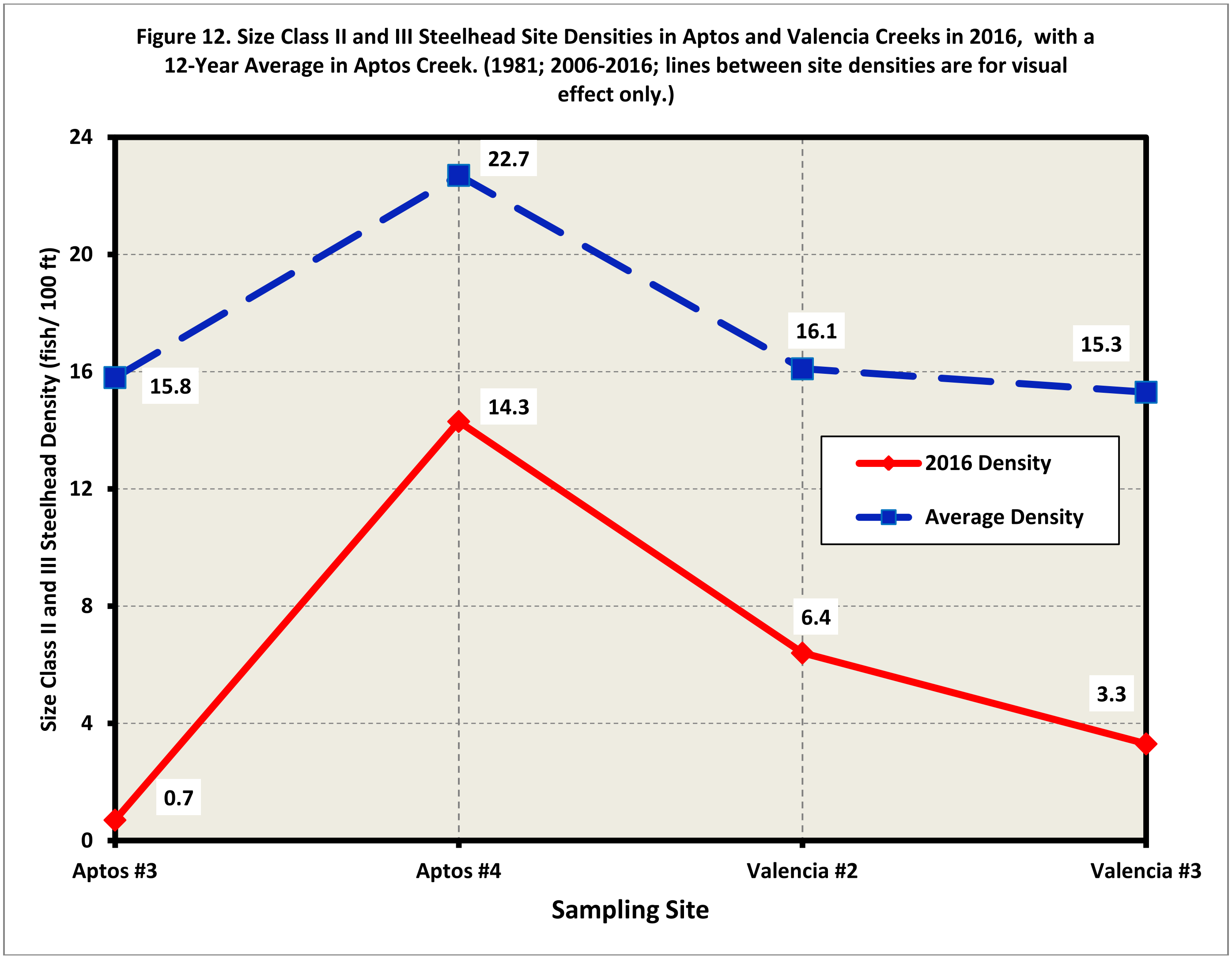


Figure 12. Size Class II and III Steelhead Site Densities in Aptos Creek in 2016, with a 12-Year Average (1981; 2006-2016).

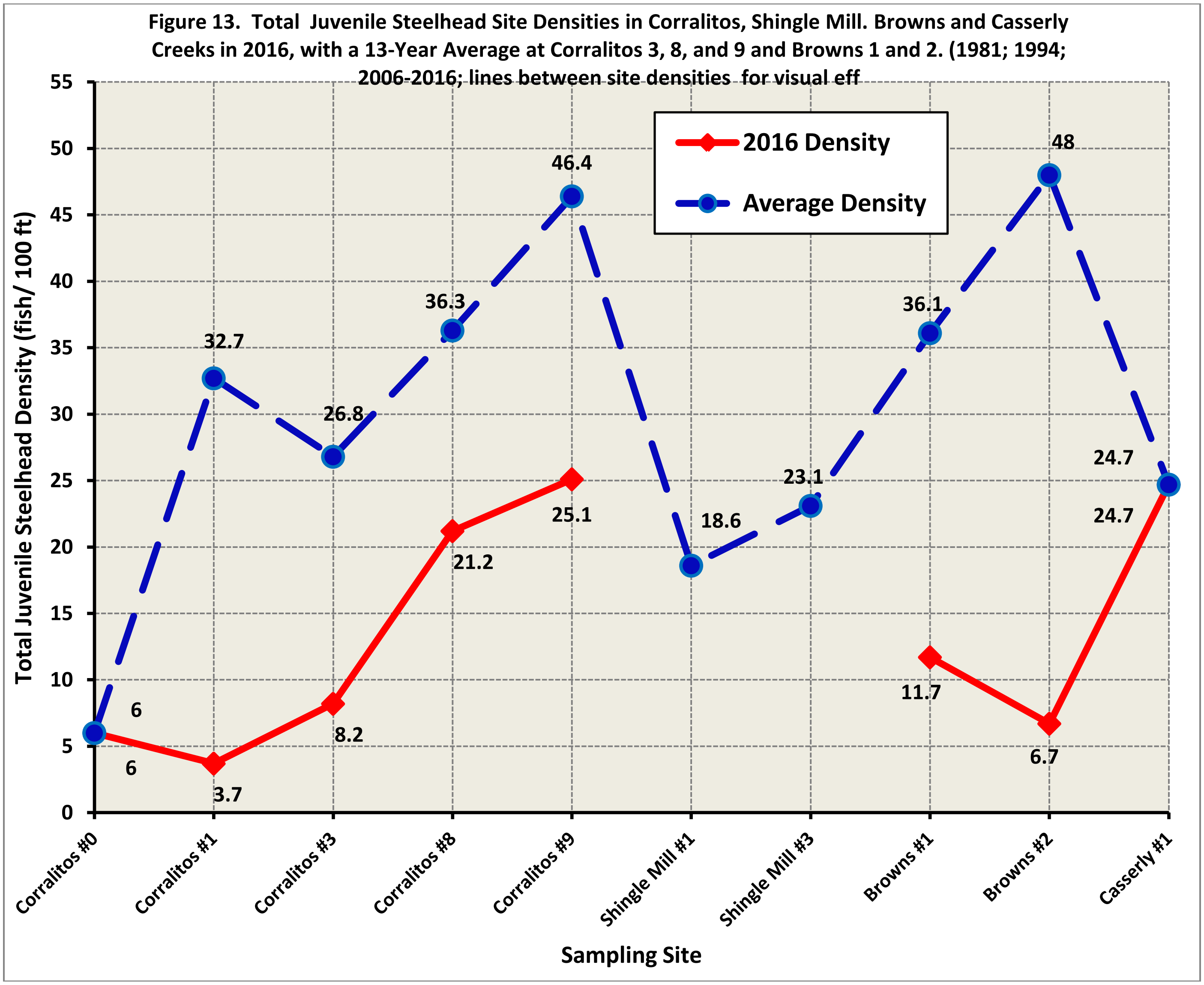


Figure 13. Total Juvenile Steelhead Site Densities in Corralitos, Shingle Mill and Browns Creeks in 2016, with a 13-Year Average (1981; 1994; 2006-2016).

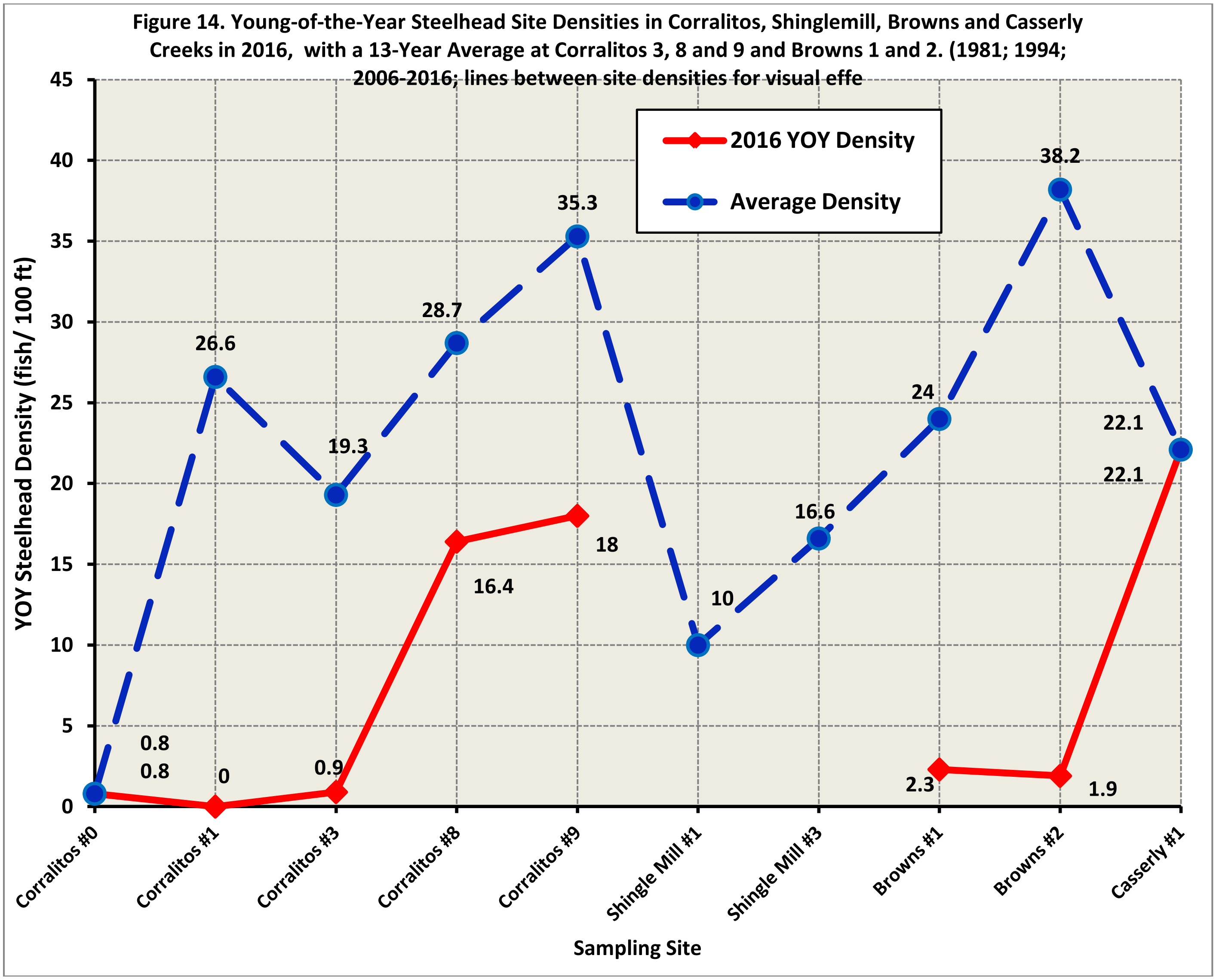


Figure 14. Young-of-the-Year Steelhead Site Densities in Corralitos and Browns Creeks in 2016, with a 13-Year Average (1981; 1994; 2006-2016).

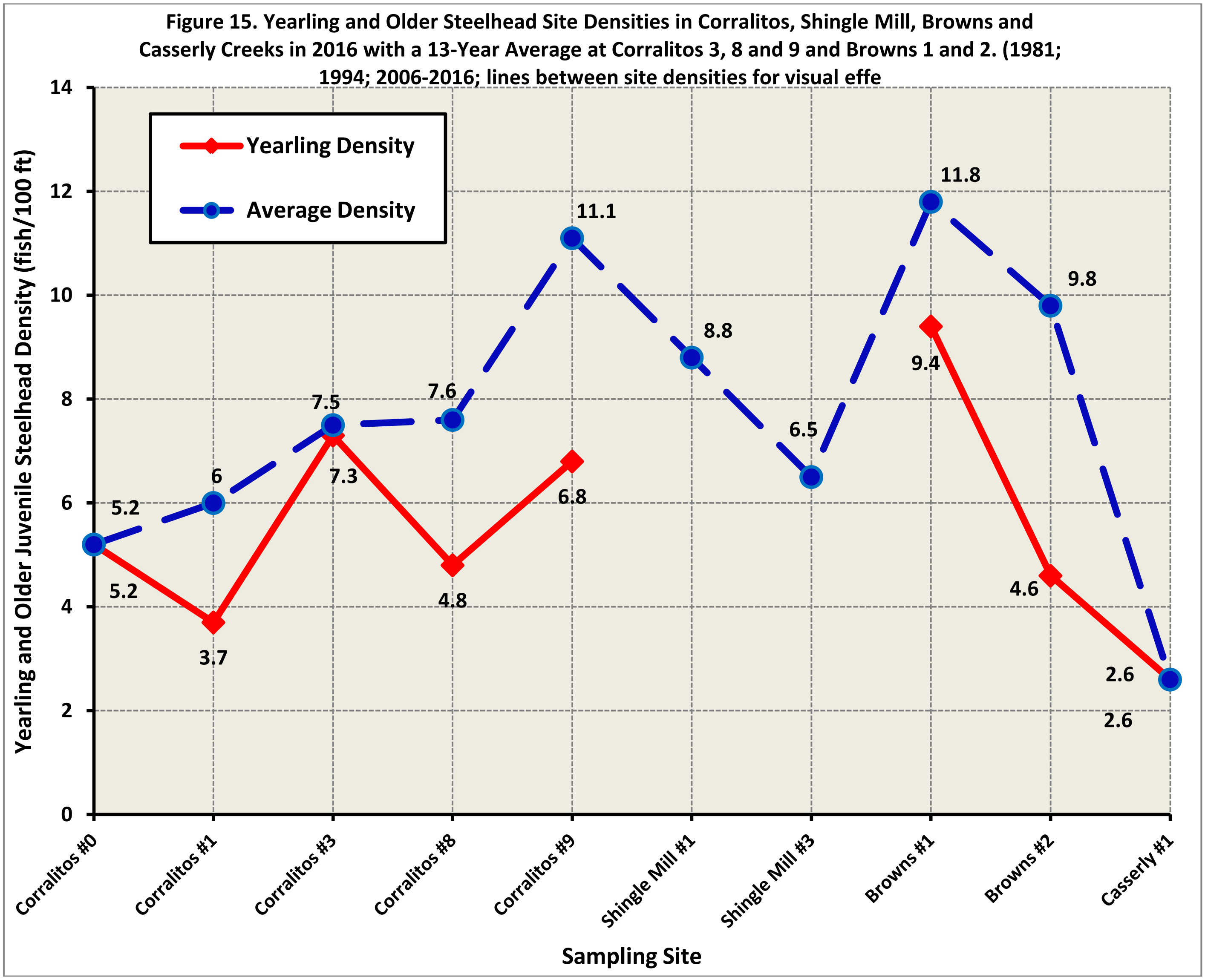


Figure 15. Yearling and Older Steelhead Site Densities in Corralitos and Browns Creeks in 2016 with a 13-Year Average (1981; 1994; 2006-2016).

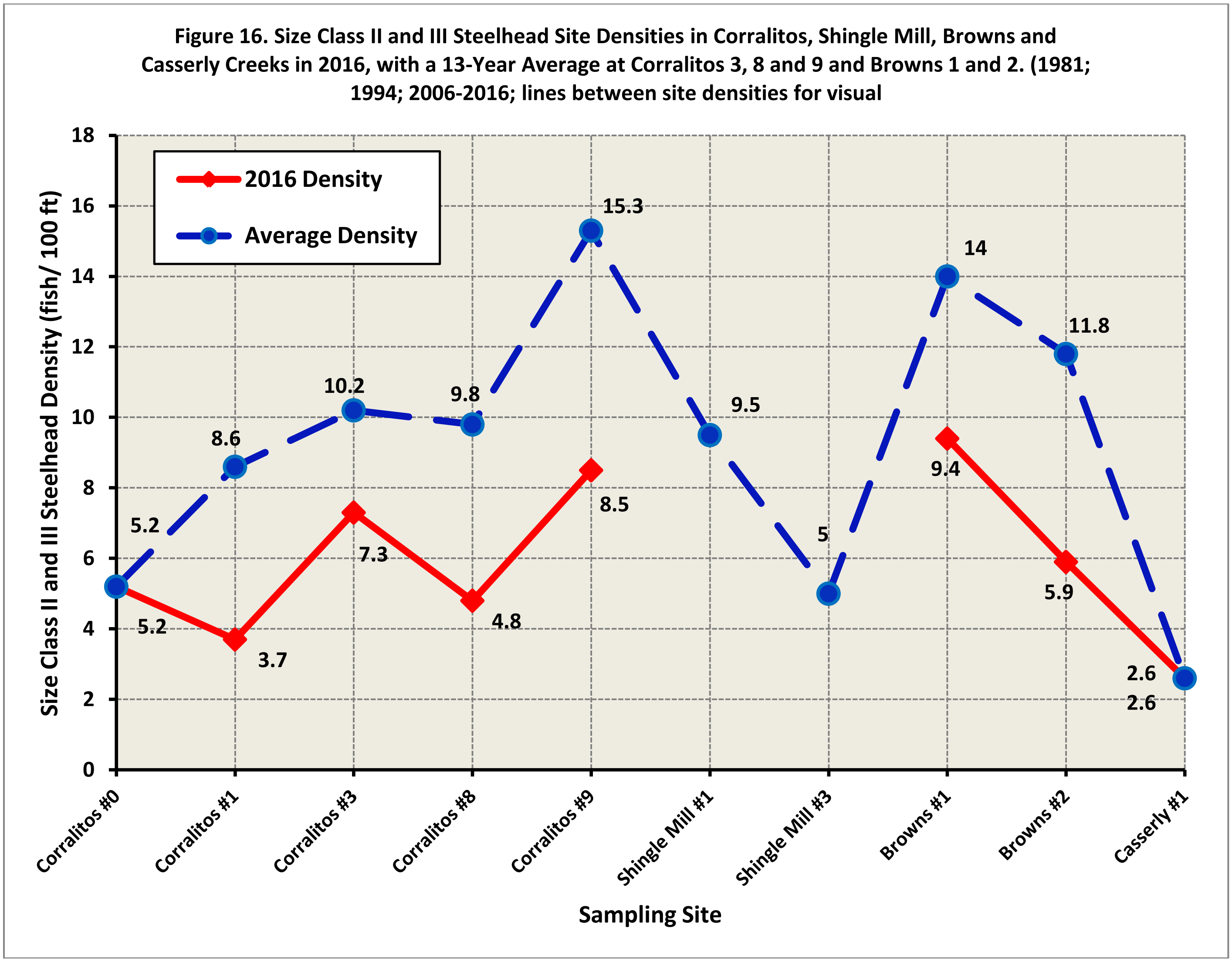


Figure 16. Size Class II and III Steelhead Site Densities in Corralitos and Browns Creeks in 2016, with a 13-Year Average (1981; 1994; 2006-2016).

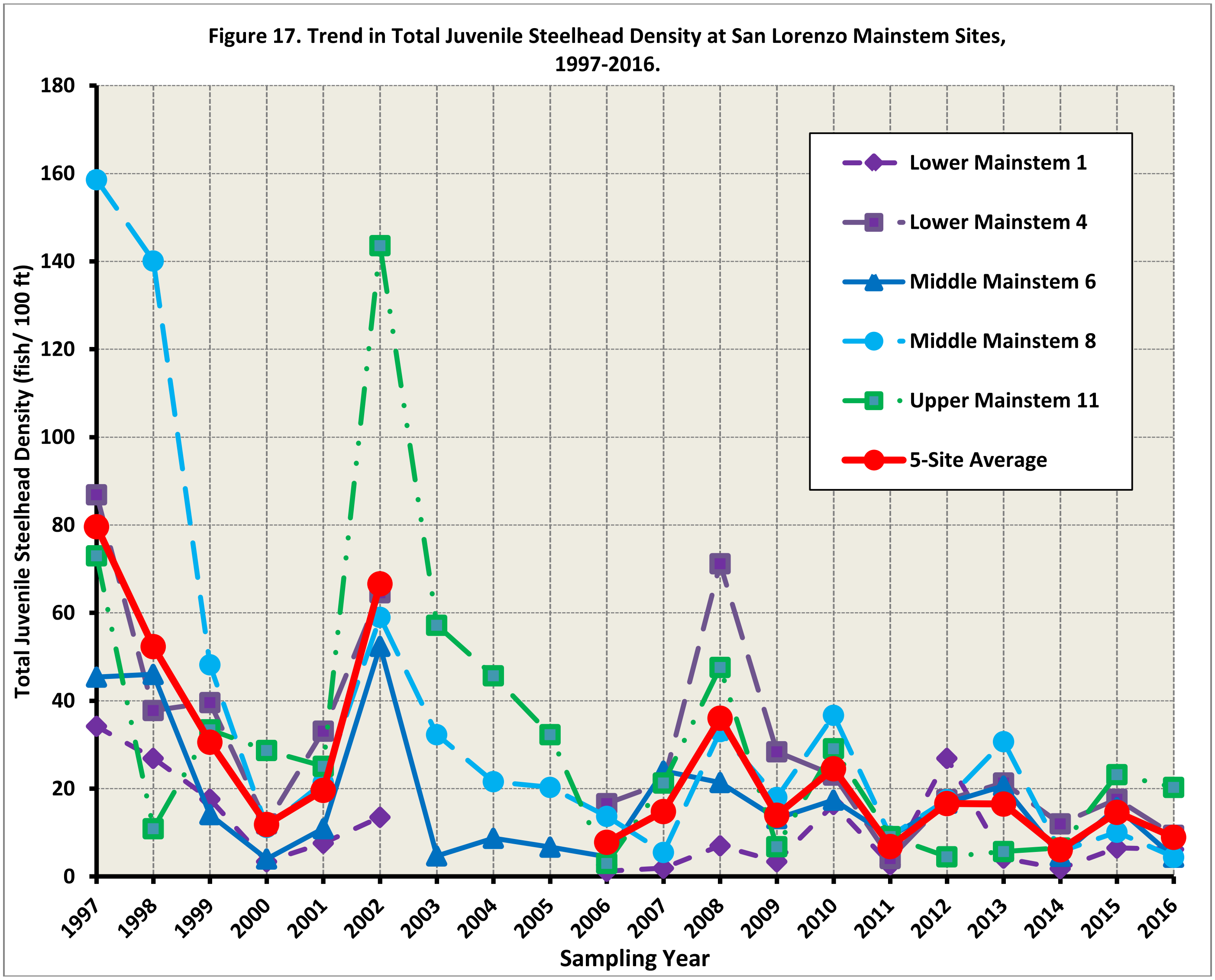


Figure 17. Trend in Total Juvenile Steelhead Density at San Lorenzo Mainstem Sites, 1997-2016.

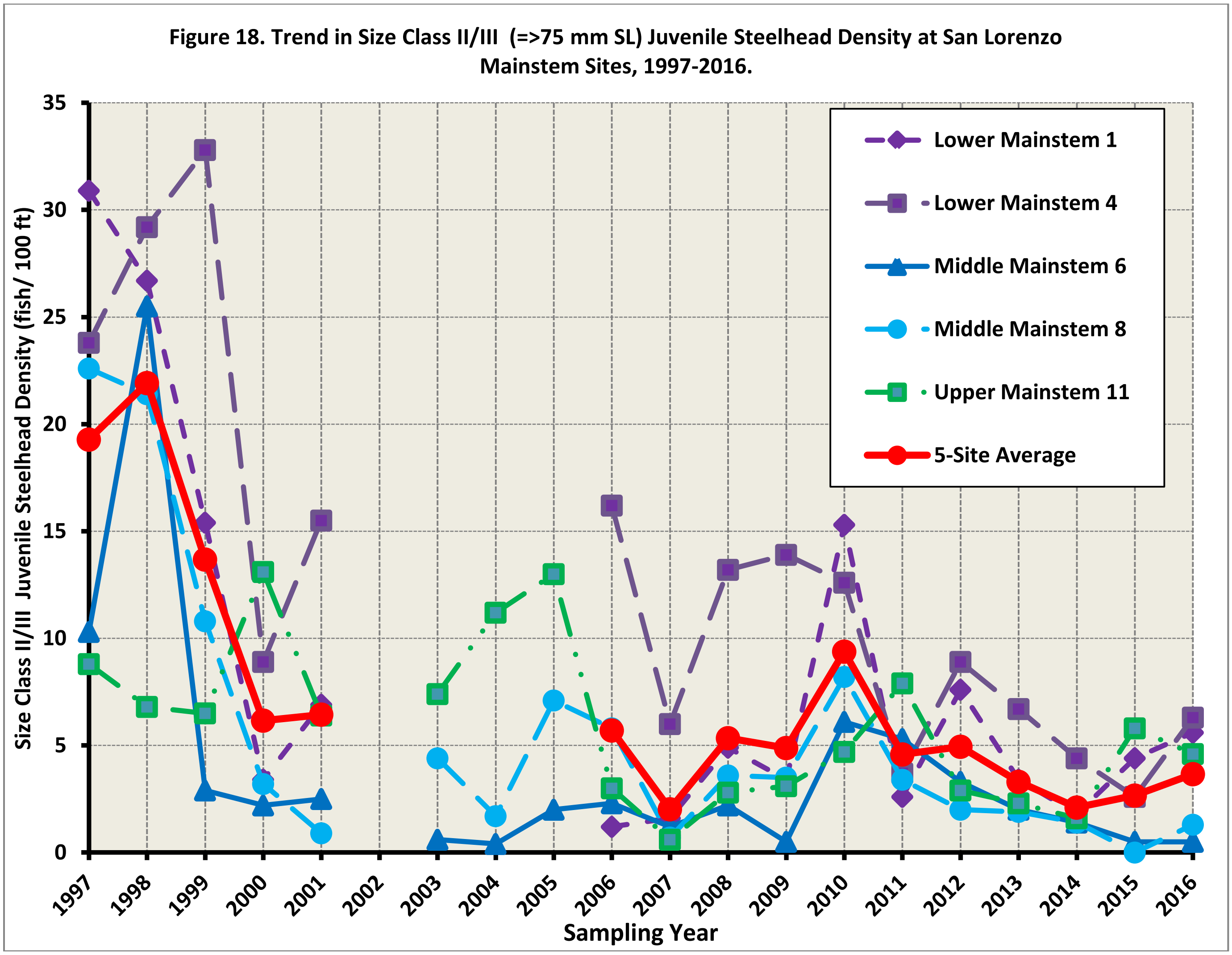


Figure 18. Trend in Size Class II/III (=>75 mm SL) Juvenile Steelhead Density at San Lorenzo Mainstem Sites, 1997-2016.

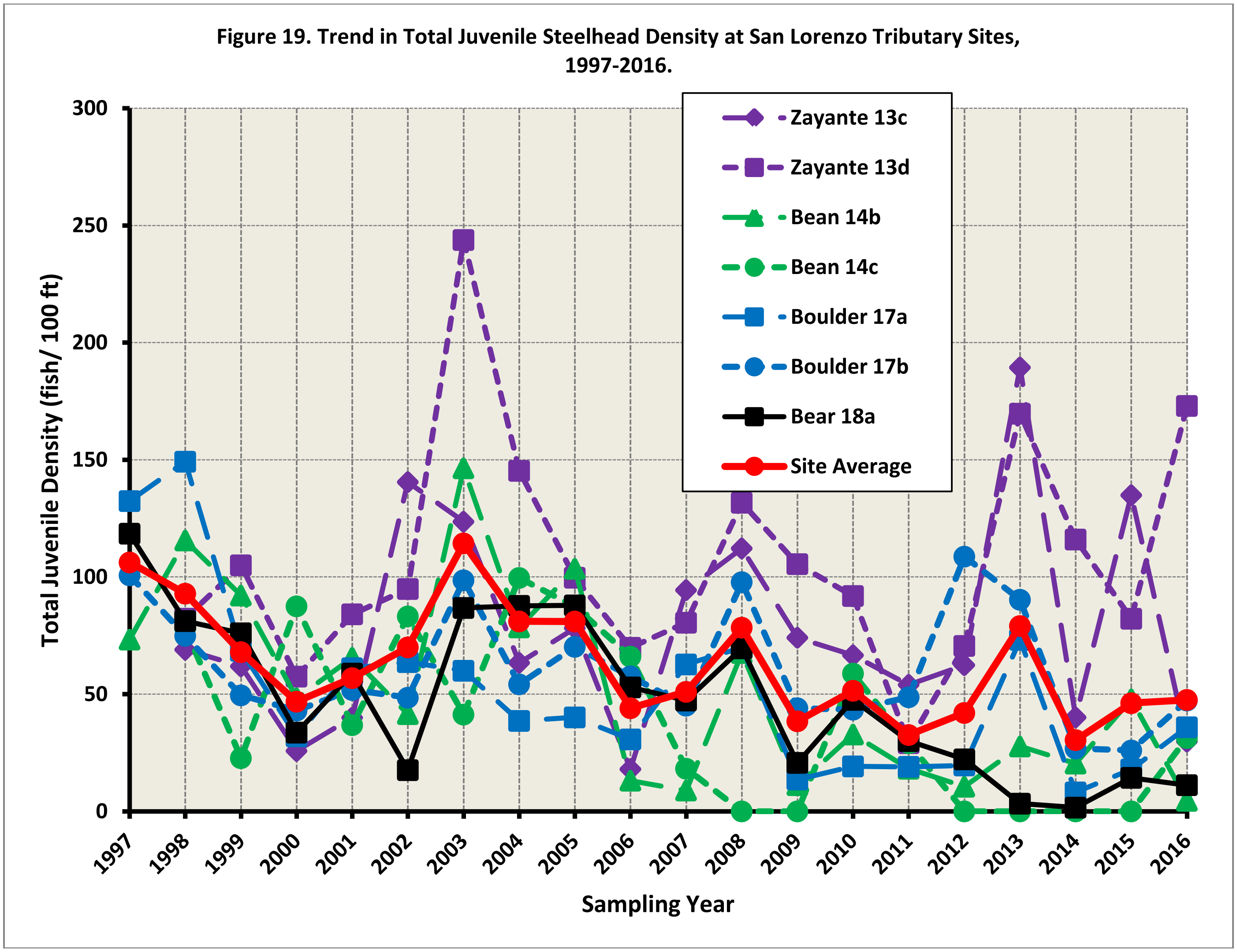


Figure 19. Trend in Total Juvenile Steelhead Density at San Lorenzo Tributary Sites, 1997-2016.

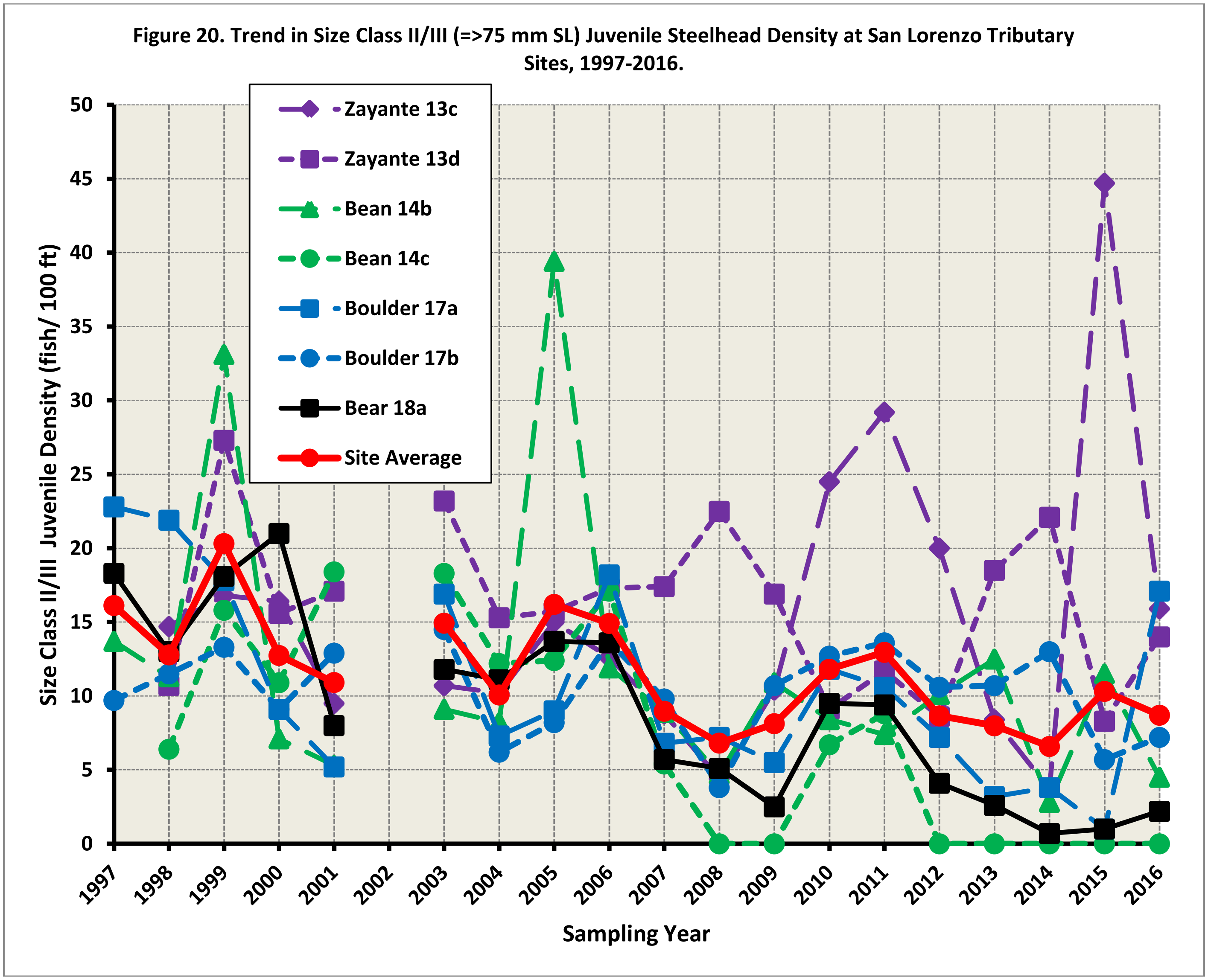


Figure 20. Trend in Size Class II/III (=>75 mm SL) Juvenile Steelhead Density at San Lorenzo Tributary Sites, 1997-2016.

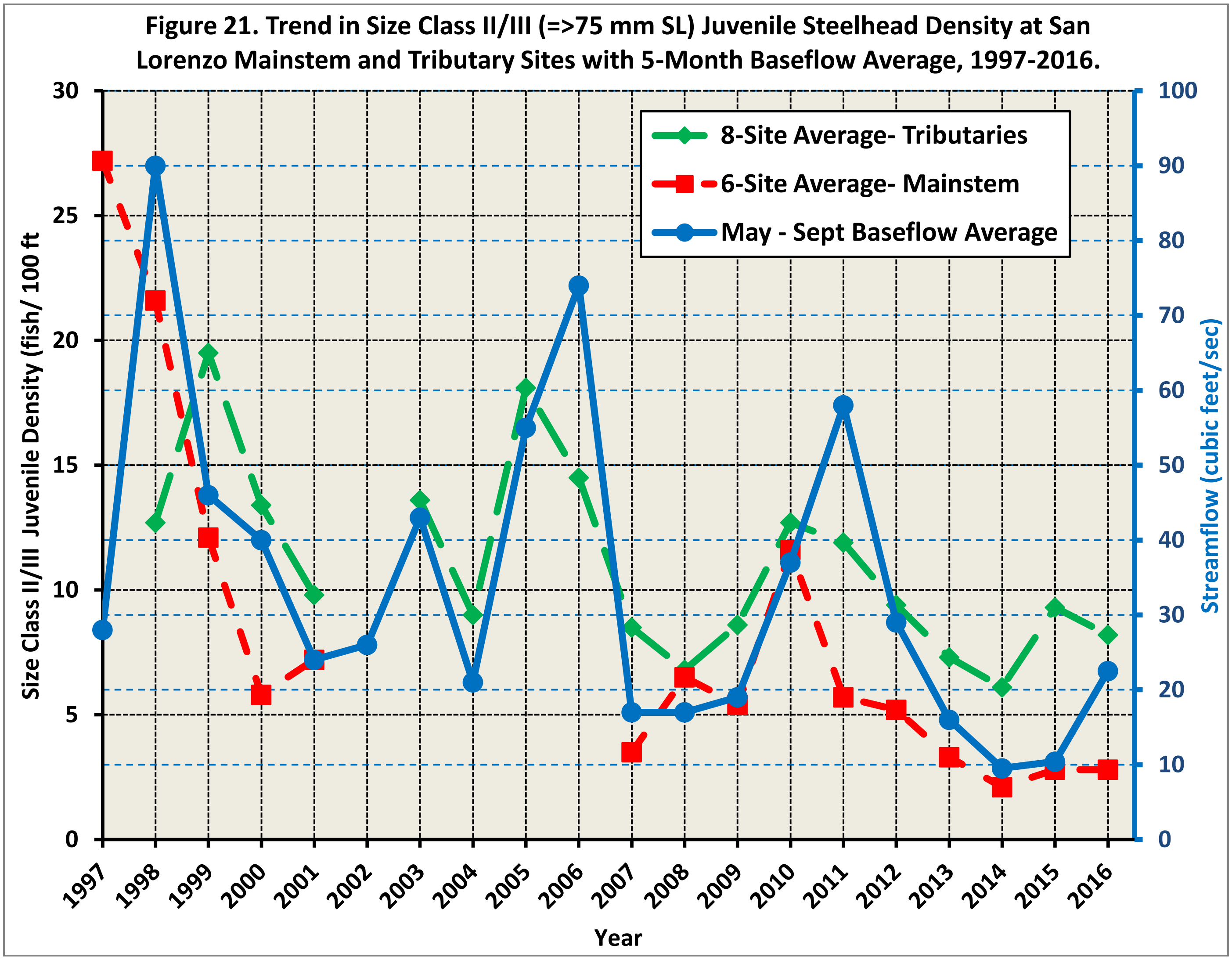


Figure 21. Trend in Size Class II/III (=>75 mm SL) Juvenile Steelhead Density at San Lorenzo Mainstem and Tributary Sites with 5-Month Baseflow Average, 1997-2016.

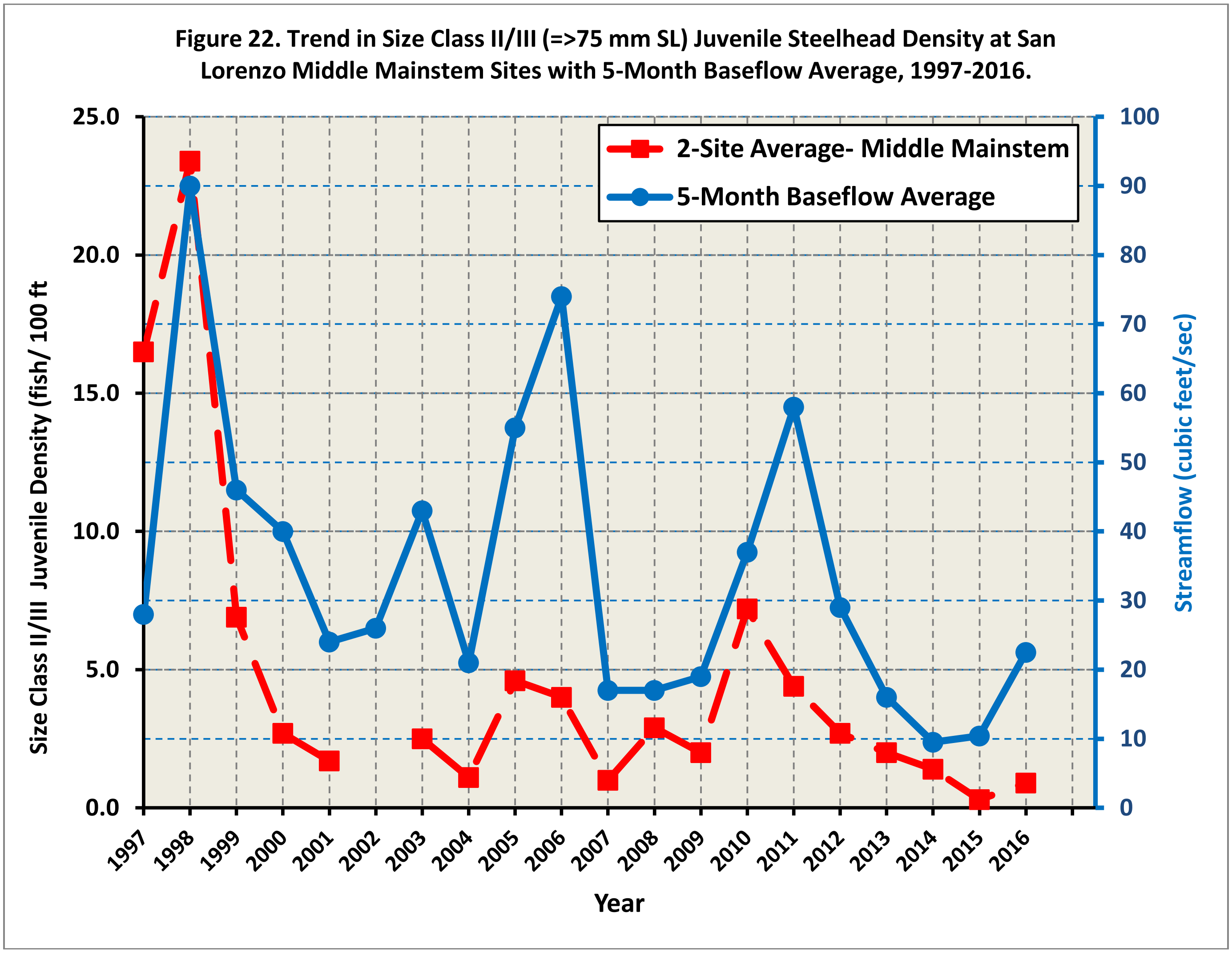


Figure 22. Trend in Average Size Class II/III (=>75 mm SL) Juvenile Steelhead Density at San Lorenzo Middle Mainstem Sites with 5-Month Baseflow Average, 1997-2016.

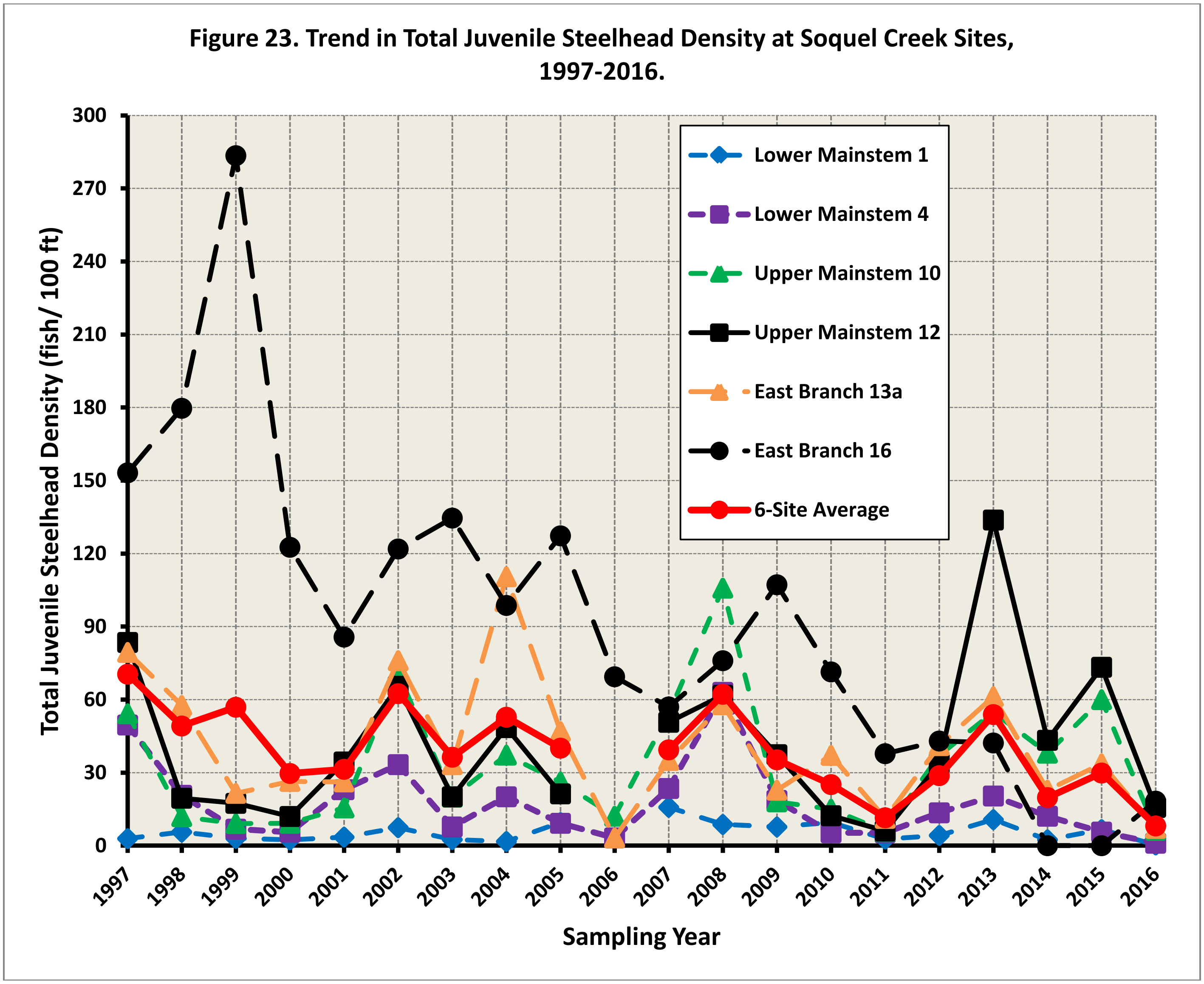


Figure 23. Trend in Total Juvenile Steelhead Density at Soquel Creek Sites, 1997-2016.

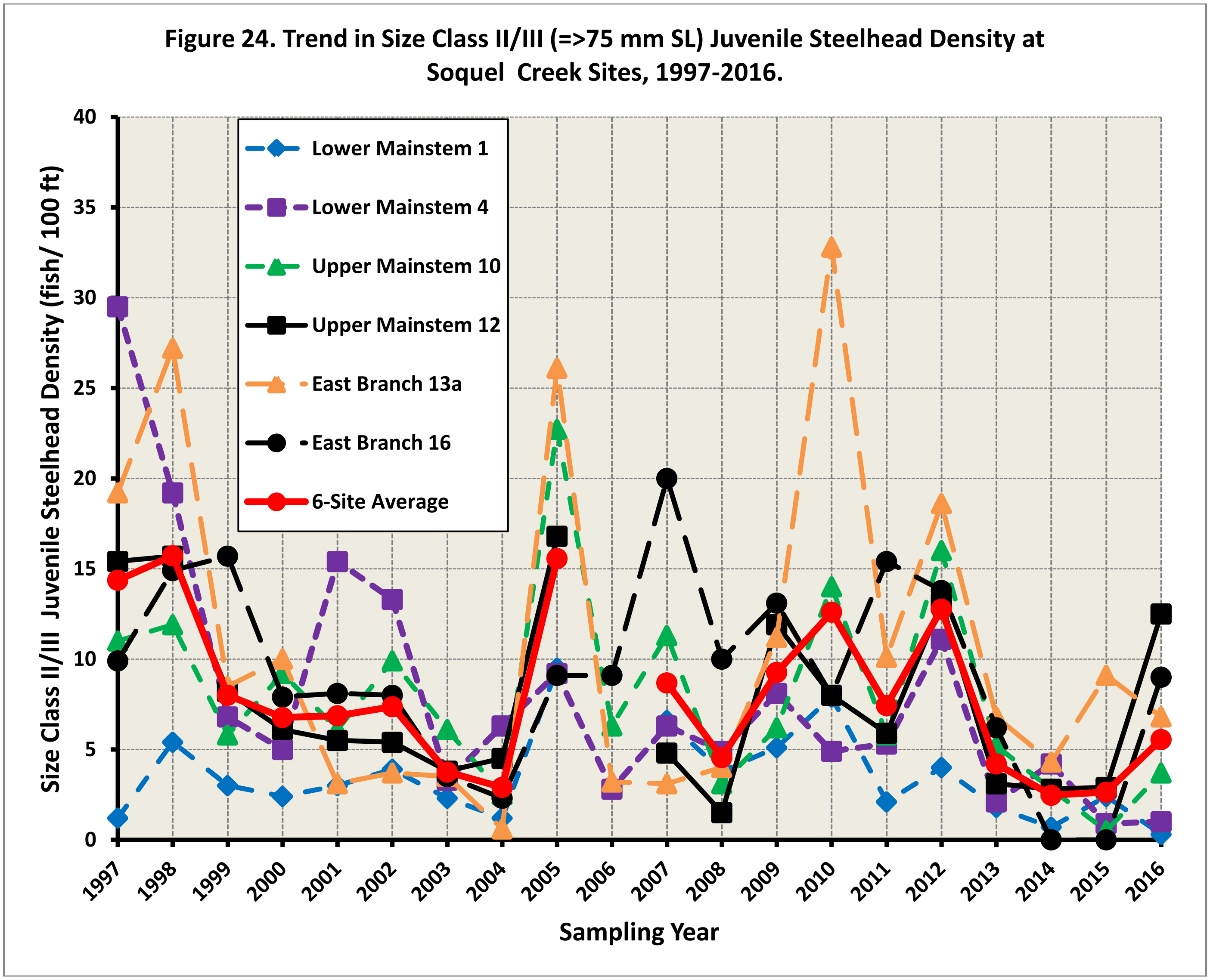


Figure 24. Trend in Size Class II/III (=>75 mm SL) Juvenile Steelhead Density at Soquel Creek Sites, 1997-2016.

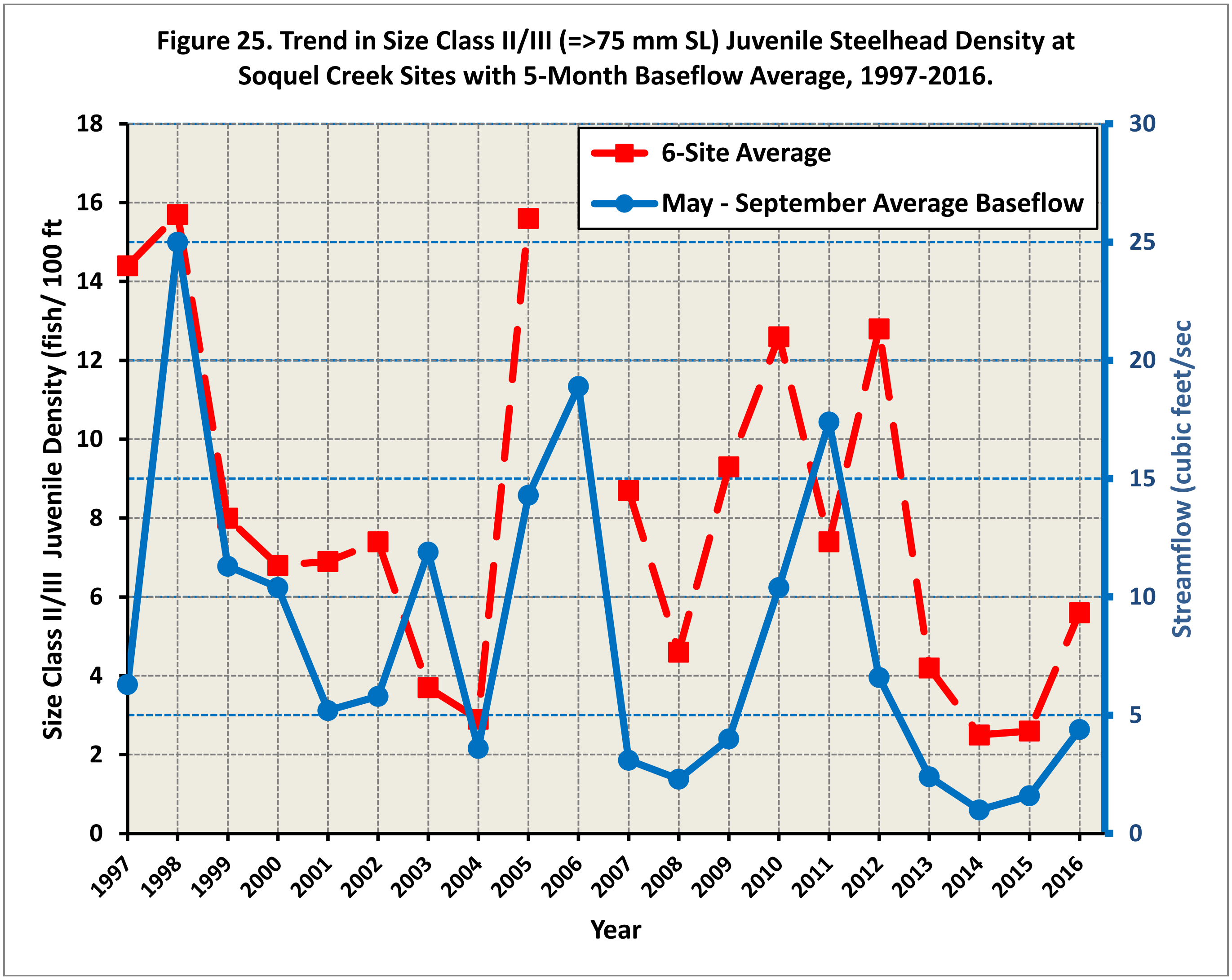


Figure 25. Trend in Size Class II/III (=>75 mm SL) Juvenile Steelhead Density at Soquel Creek Sites with 5-Month Baseflow Average, 1997-2016.

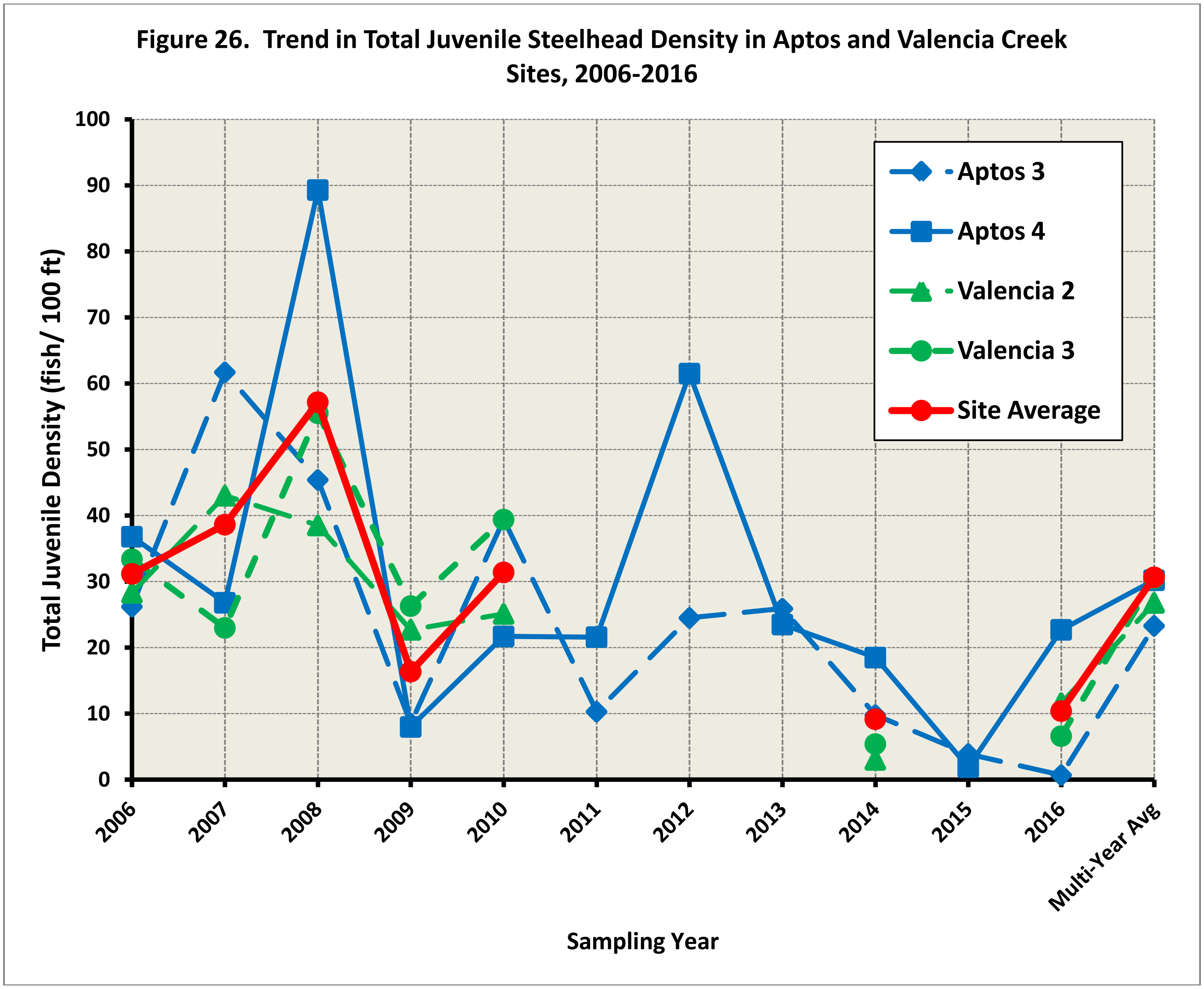


Figure 26a. Trend in Total Juvenile Steelhead Density in Aptos and Valencia Creek Sites, 2006-2016.

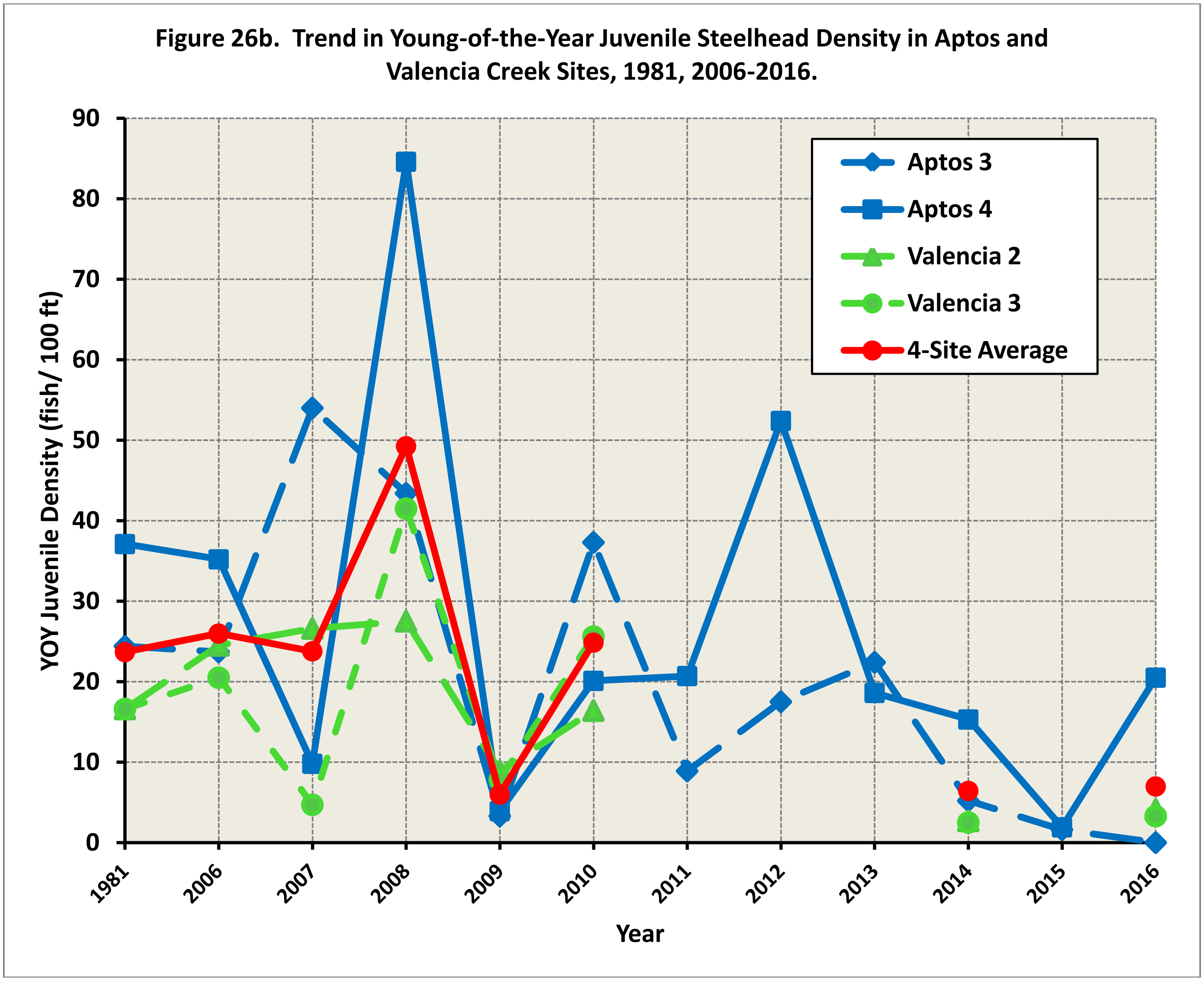


Figure 26b. Trend in YOY Juvenile Steelhead Density in Aptos and Valencia Creek Sites, 1981, 2006-2016.

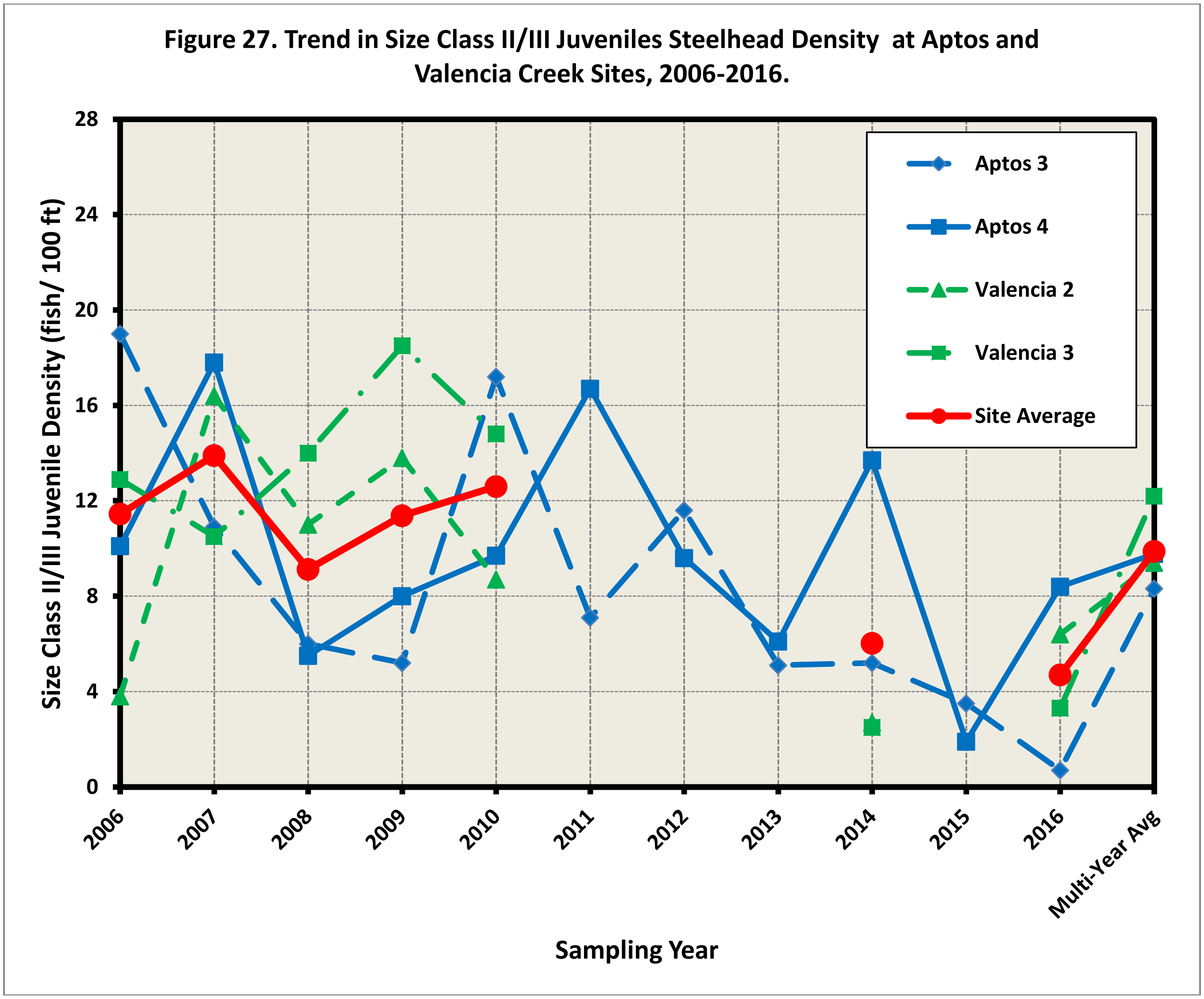


Figure 27. Trend in Size Class II/III Juveniles Steelhead Density at Aptos and Valencia Creek Sites, 2006-2016.

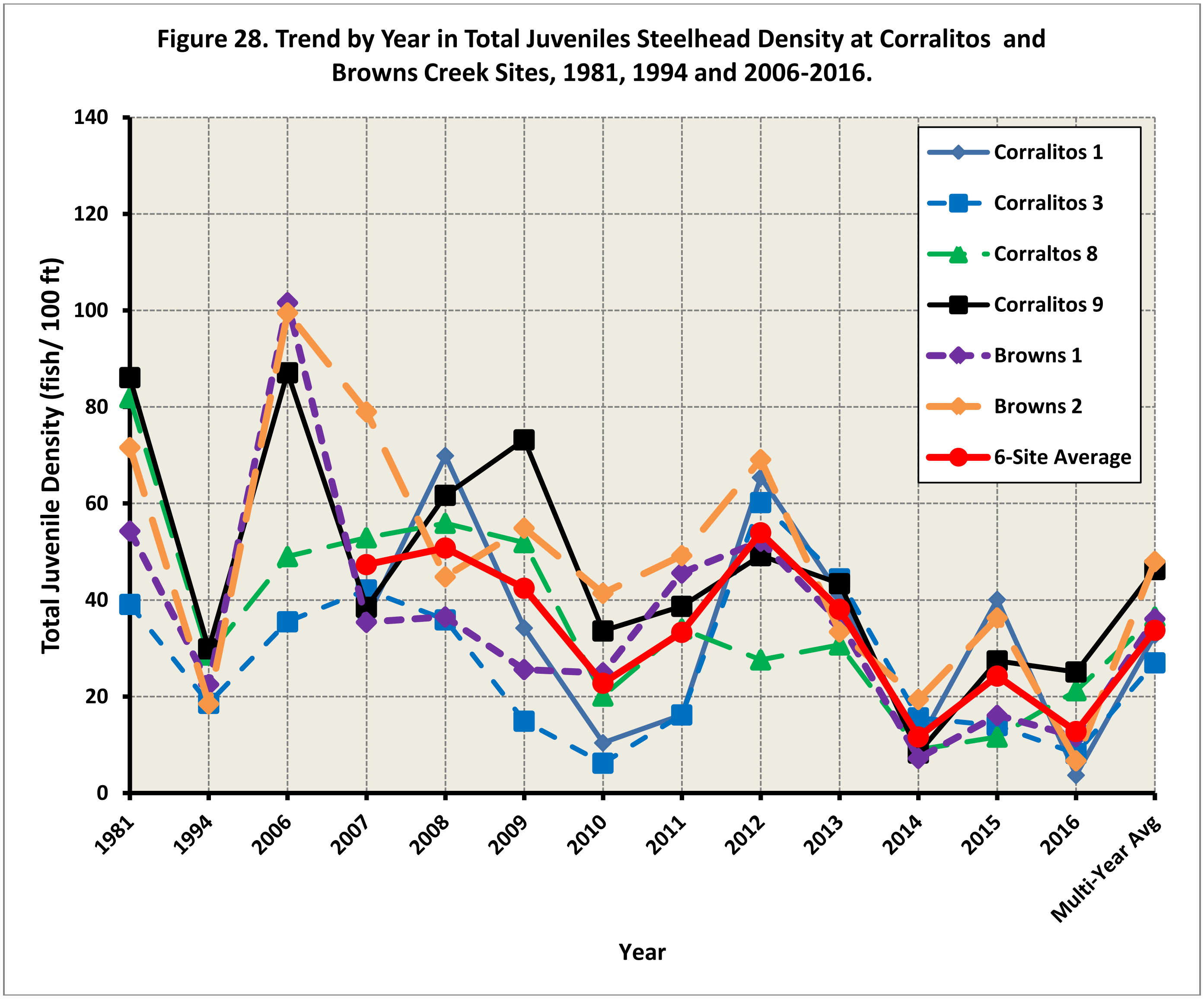


Figure 28. Trend by Year in Total Juveniles Steelhead Density at Corralitos and Browns Creek Sites, 1981, 1994 and 2006-2016.

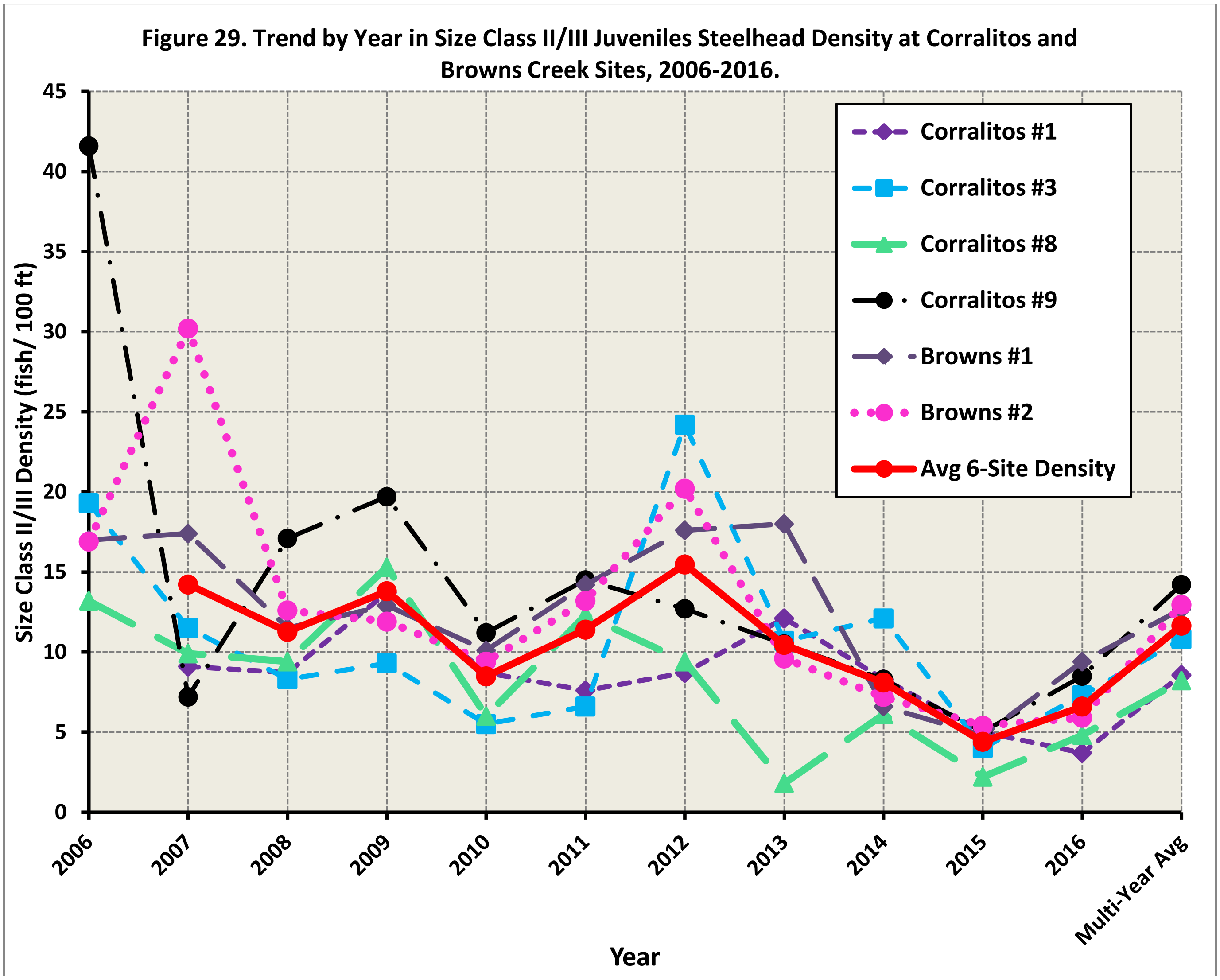


Figure 29. Trend by Year in Size Class II/III Juveniles Steelhead Density at Corralitos, Browns and Shinglemill Creek Sites, 2006-2016.

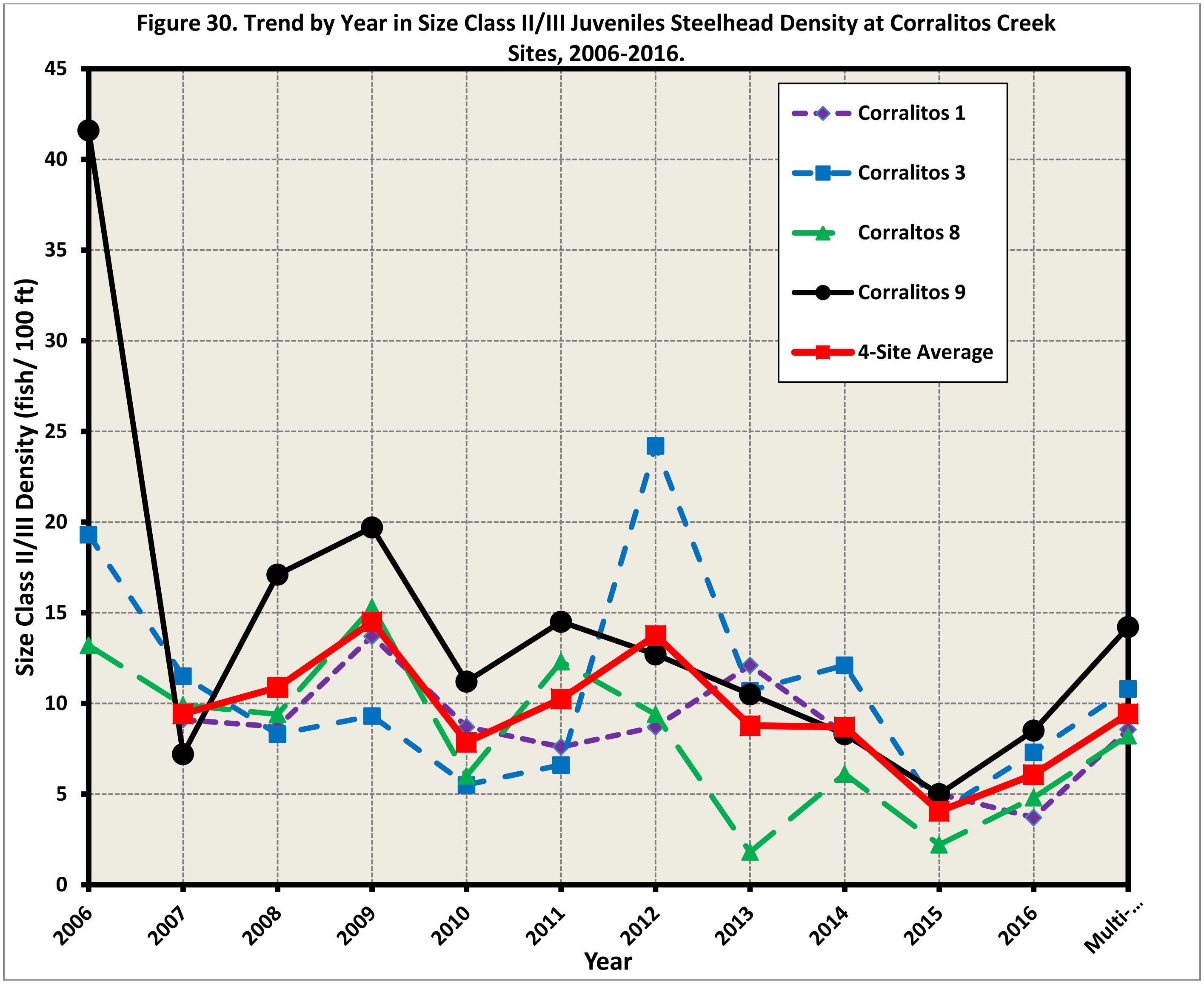


Figure 30. Trend by Year in Size Class II/III Juveniles Steelhead Density at Corralitos Creek Sites, 2006-2016.

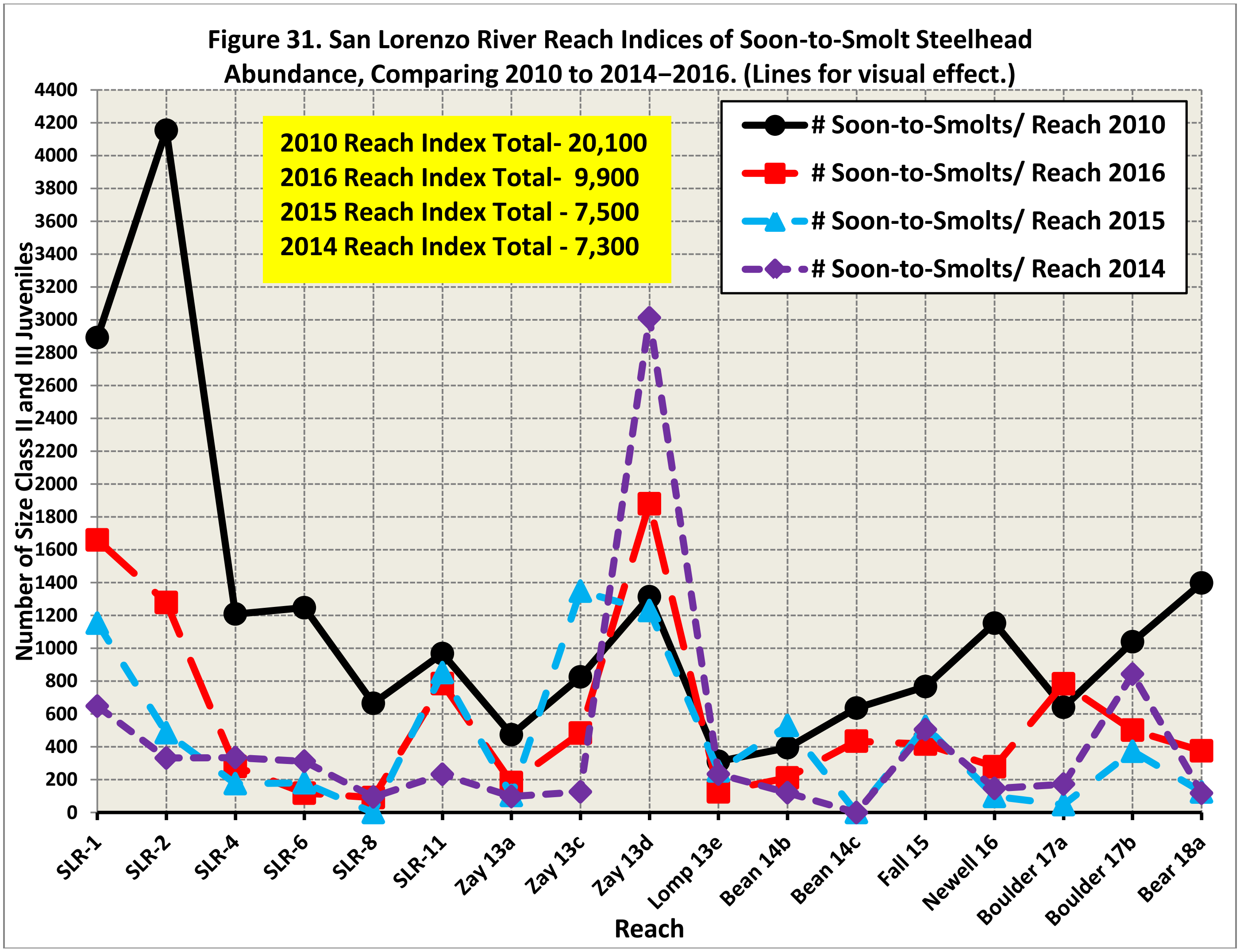


Figure 31. San Lorenzo River Reach Indices of Soon-to-Smolt Steelhead Abundance (excluding Branciforte Reaches), Comparing 2010 to 2014–2016.

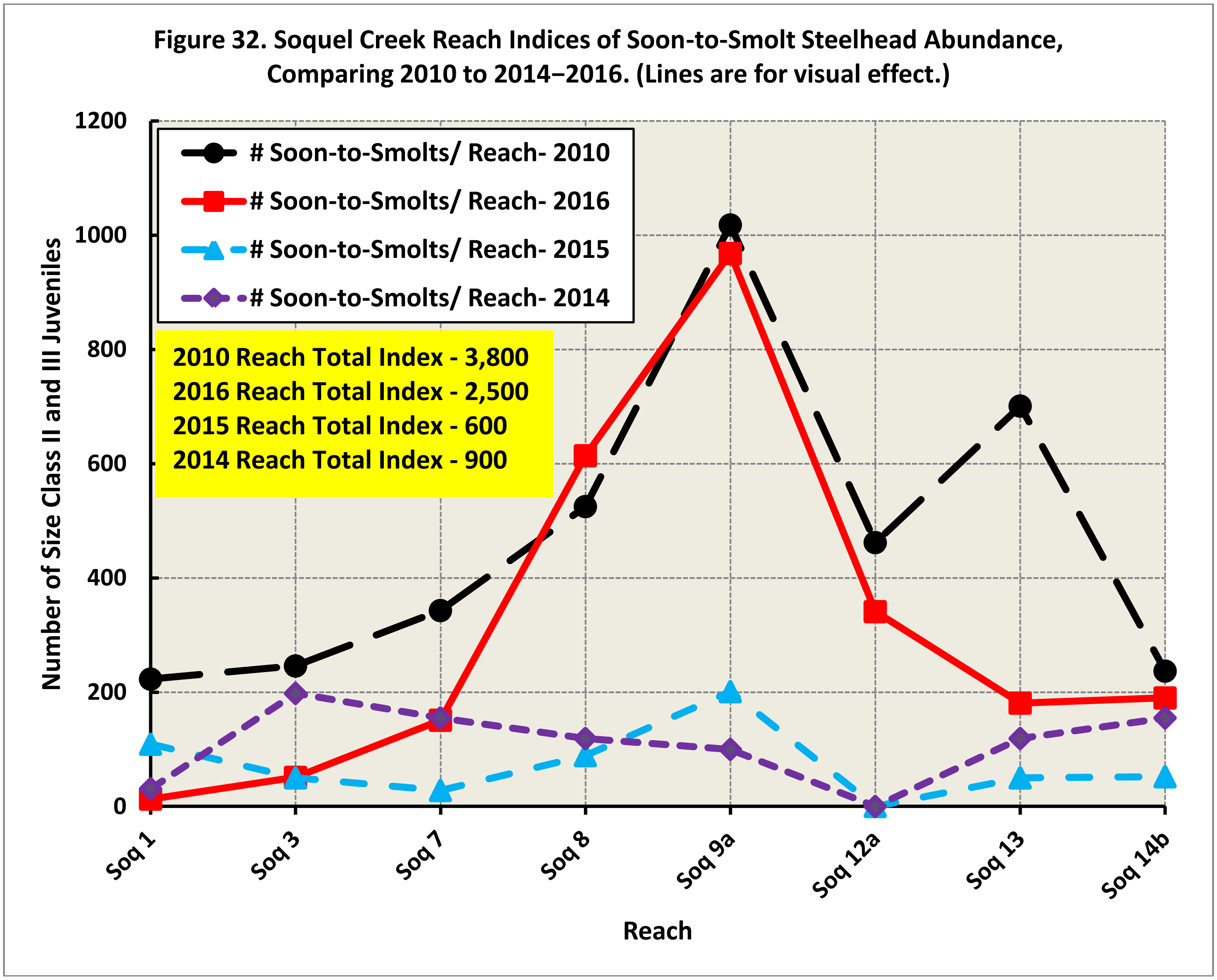


Figure 32. Soquel Creek Reach Indices of Soon-to-Smolt Steelhead Abundance, Comparing 2010 to 2014−2016.

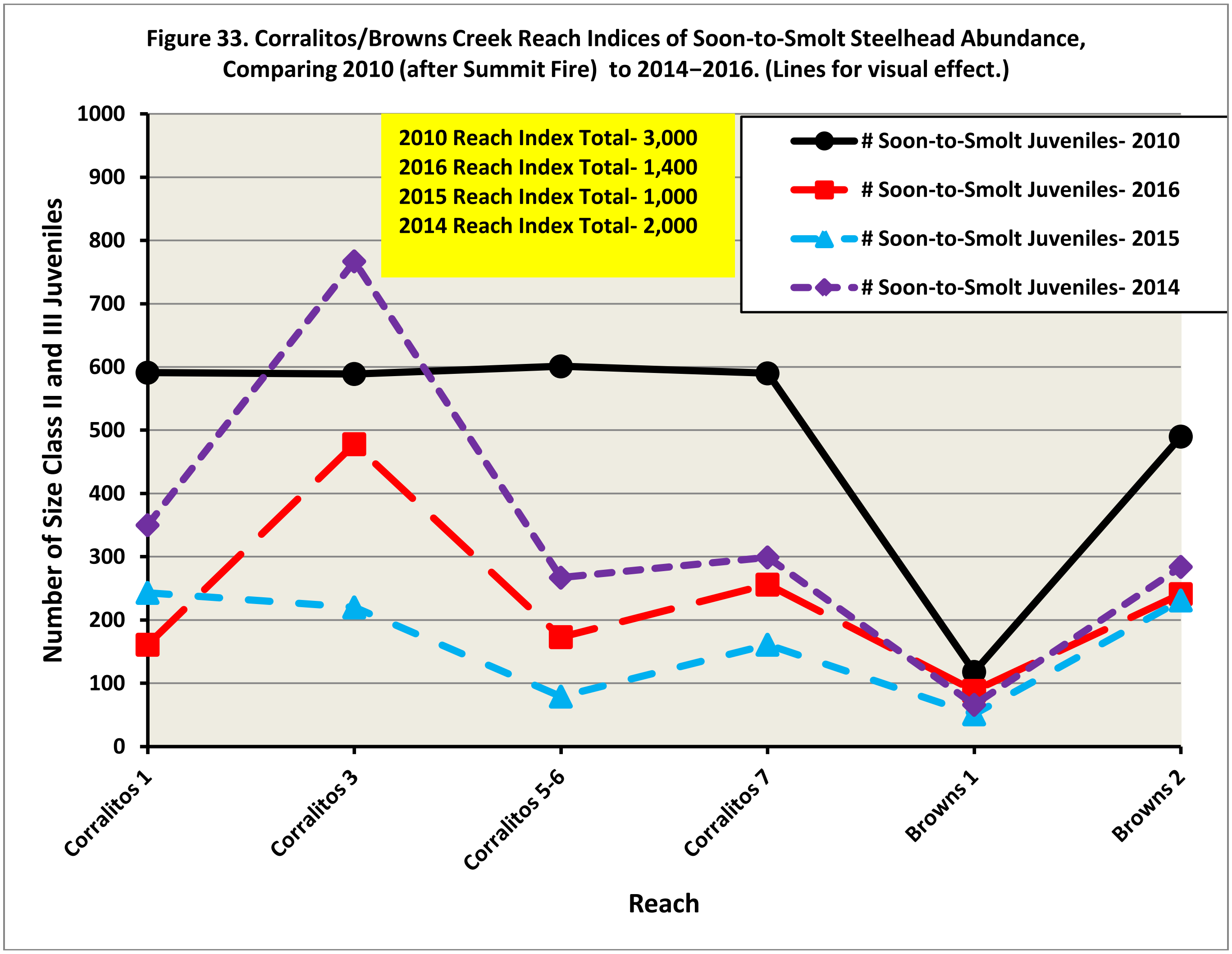


Figure 33. Corralitos/Browns Creek Reach Indices of Soon-to-Smolt Steelhead Abundance, Comparing 2010 to 2014−2016.

Figure 34. The 2016 Discharge Flow of Record for the USGS Gage on the San Lorenzo River at Big Trees.

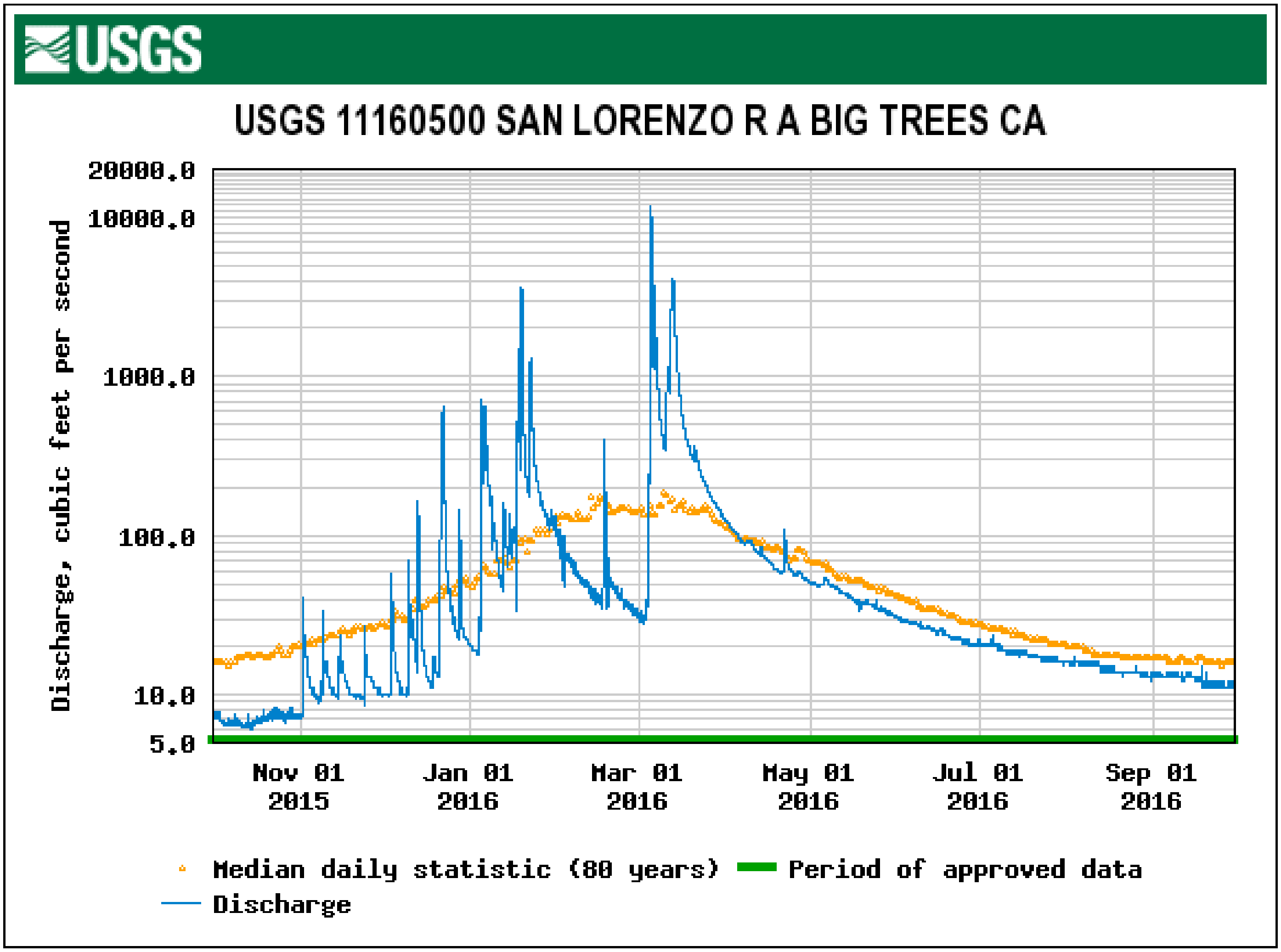


Figure 35. The 2015 Discharge Flow of Record for the USGS Gage on the San Lorenzo River at Big Trees.

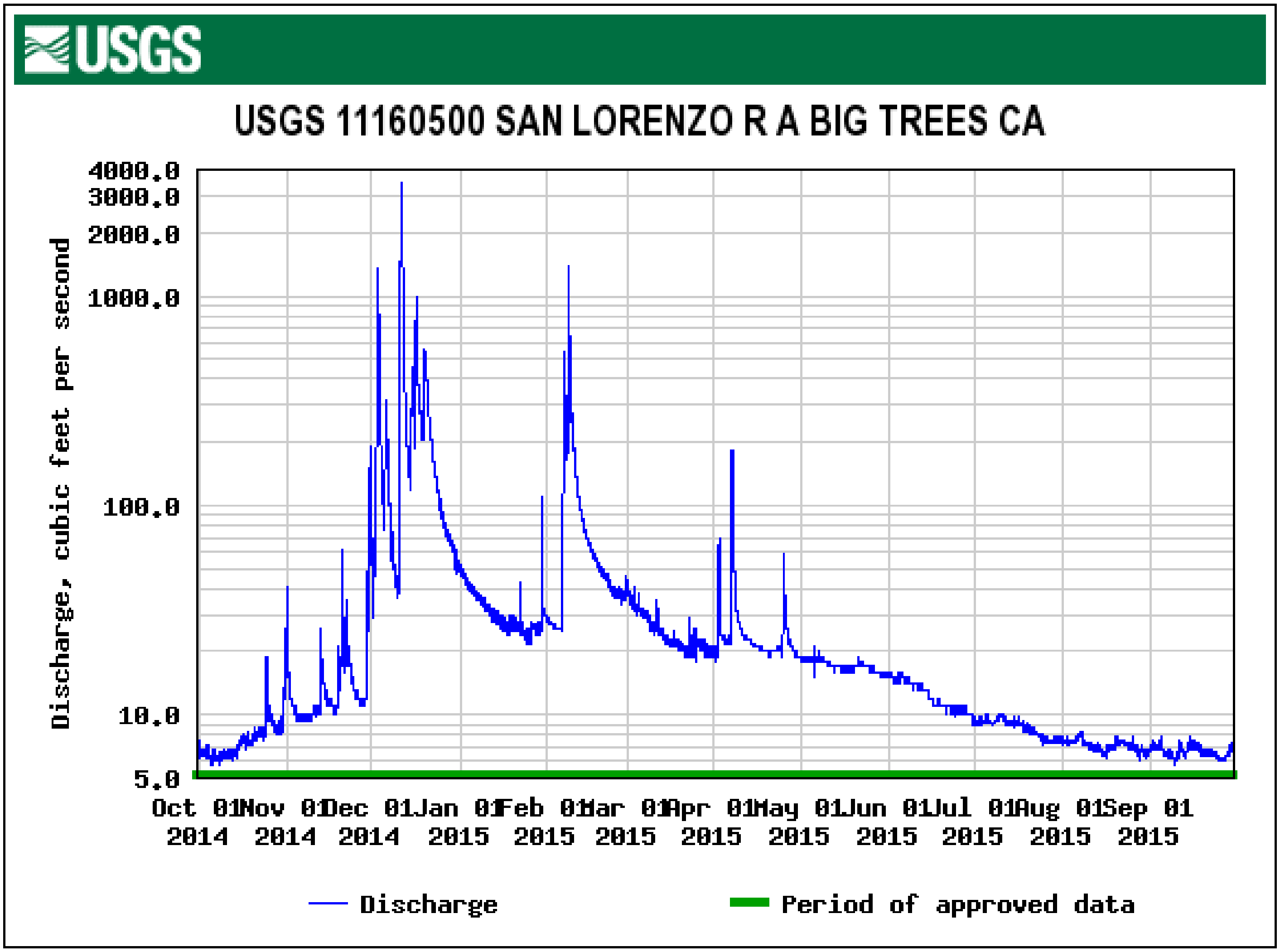


Figure 36. The 2016 Mean Daily Discharge Flow of Record with Median Statistic for the USGS Gage On the San Lorenzo River at Big Trees.

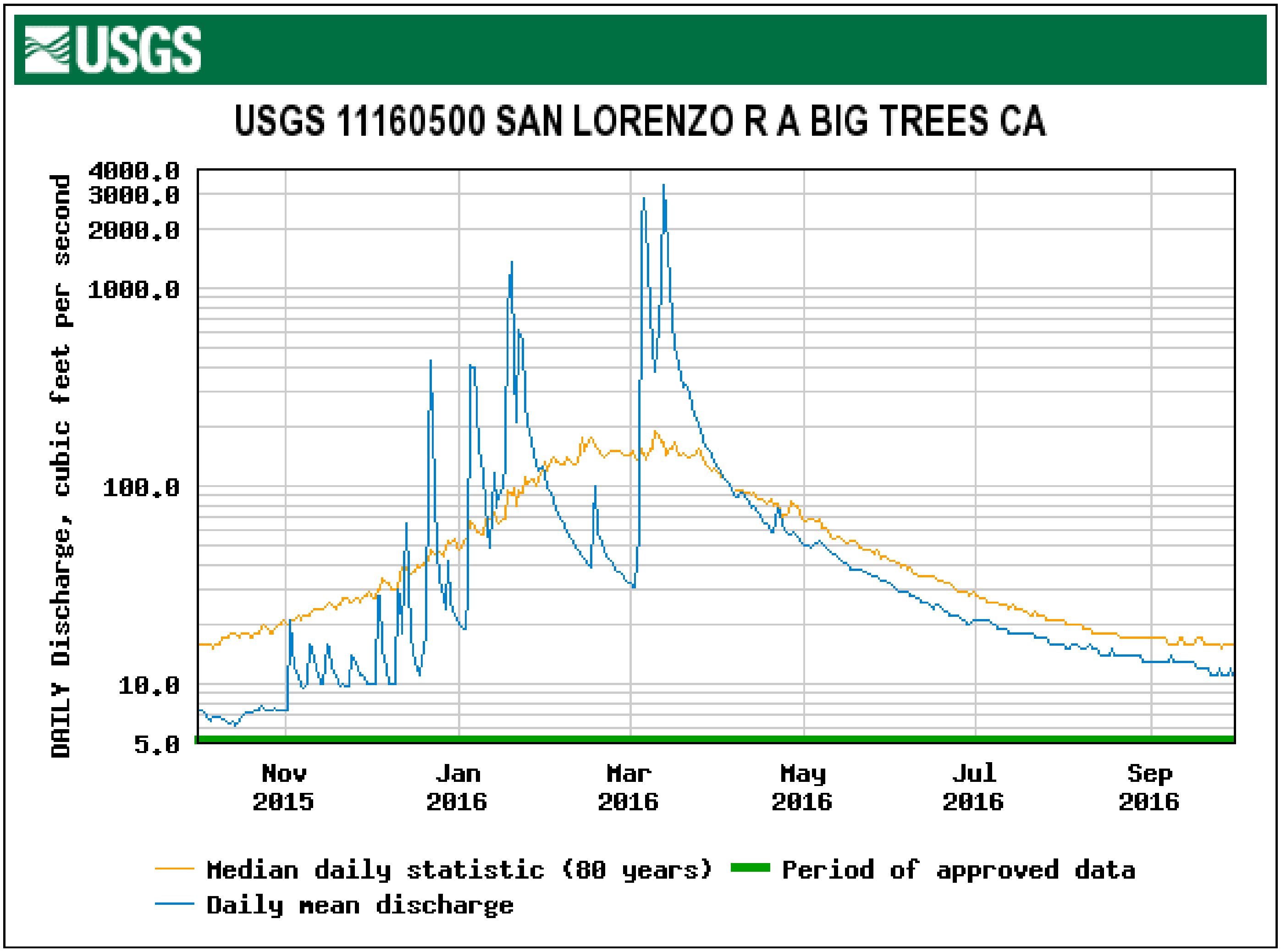


Figure 37. The 2015 Mean Daily Discharge Flow of Record with Median Statistic for the USGS Gage On the San Lorenzo River at Big Trees.

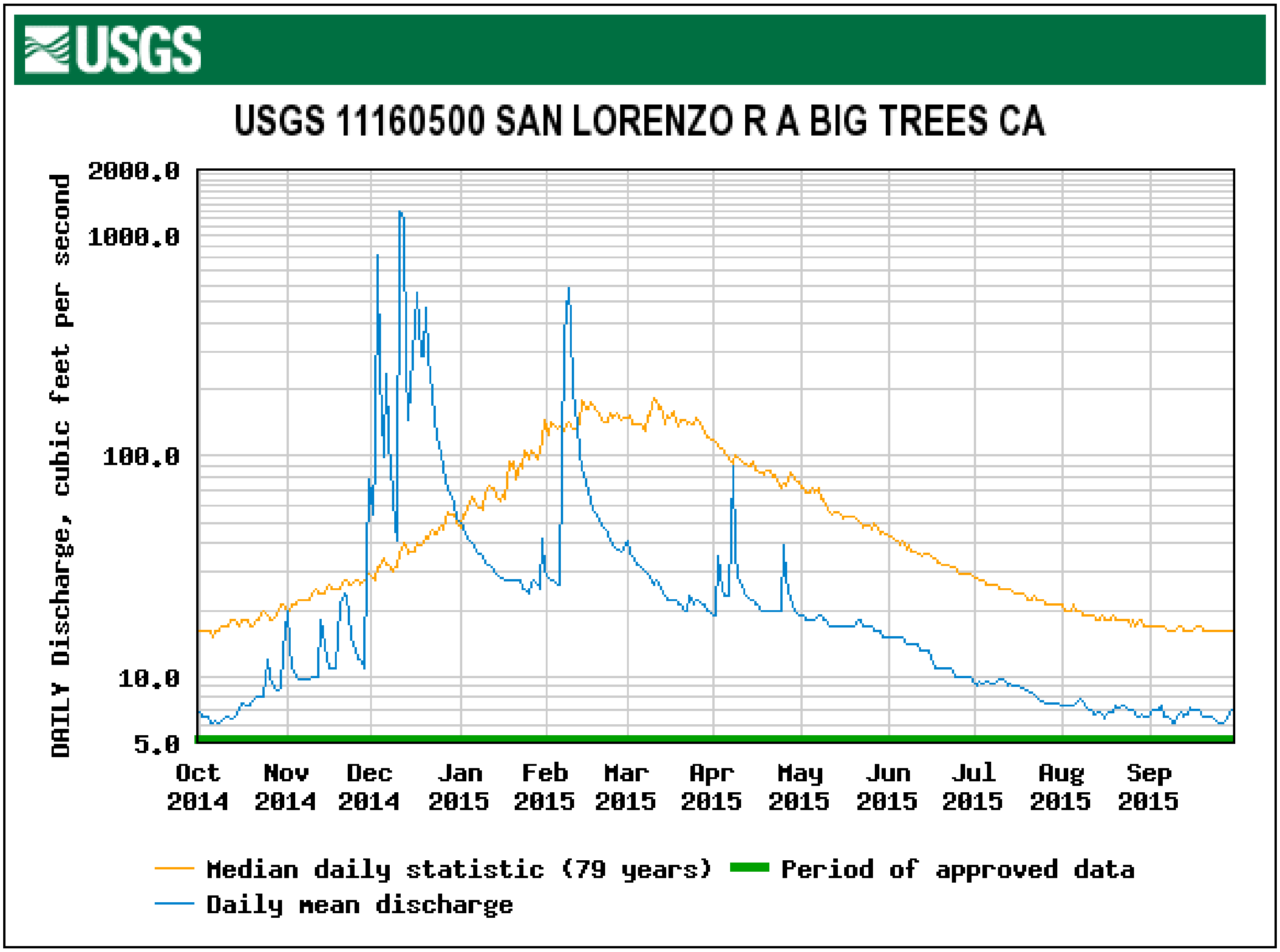


Figure 38. The March–May 2016 Discharge of Record for the USGS Gage On the San Lorenzo River at Big Trees.

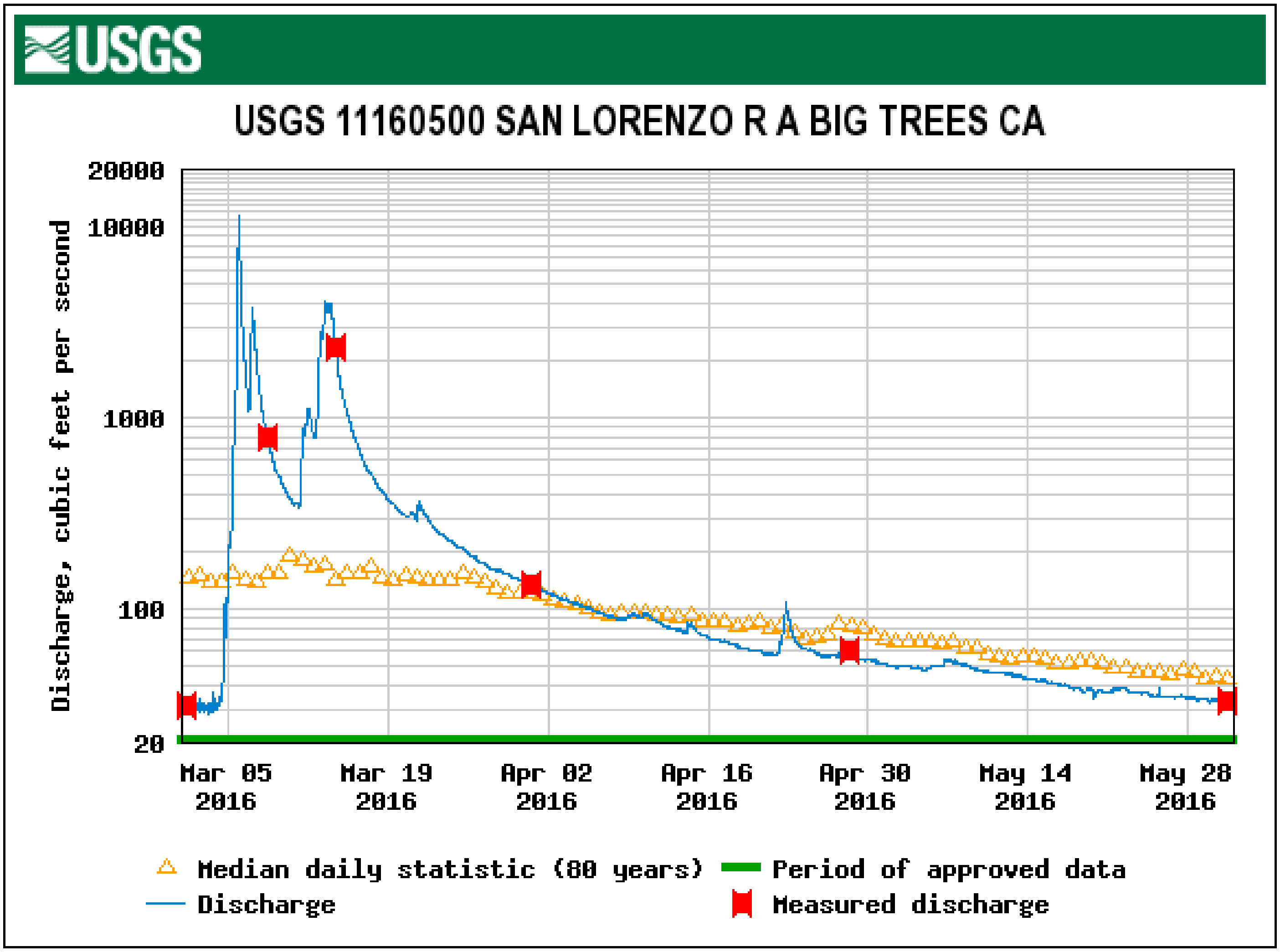


Figure 39. The March−May 2015 Discharge of Record for the USGS Gage On the San Lorenzo River at Big Trees.

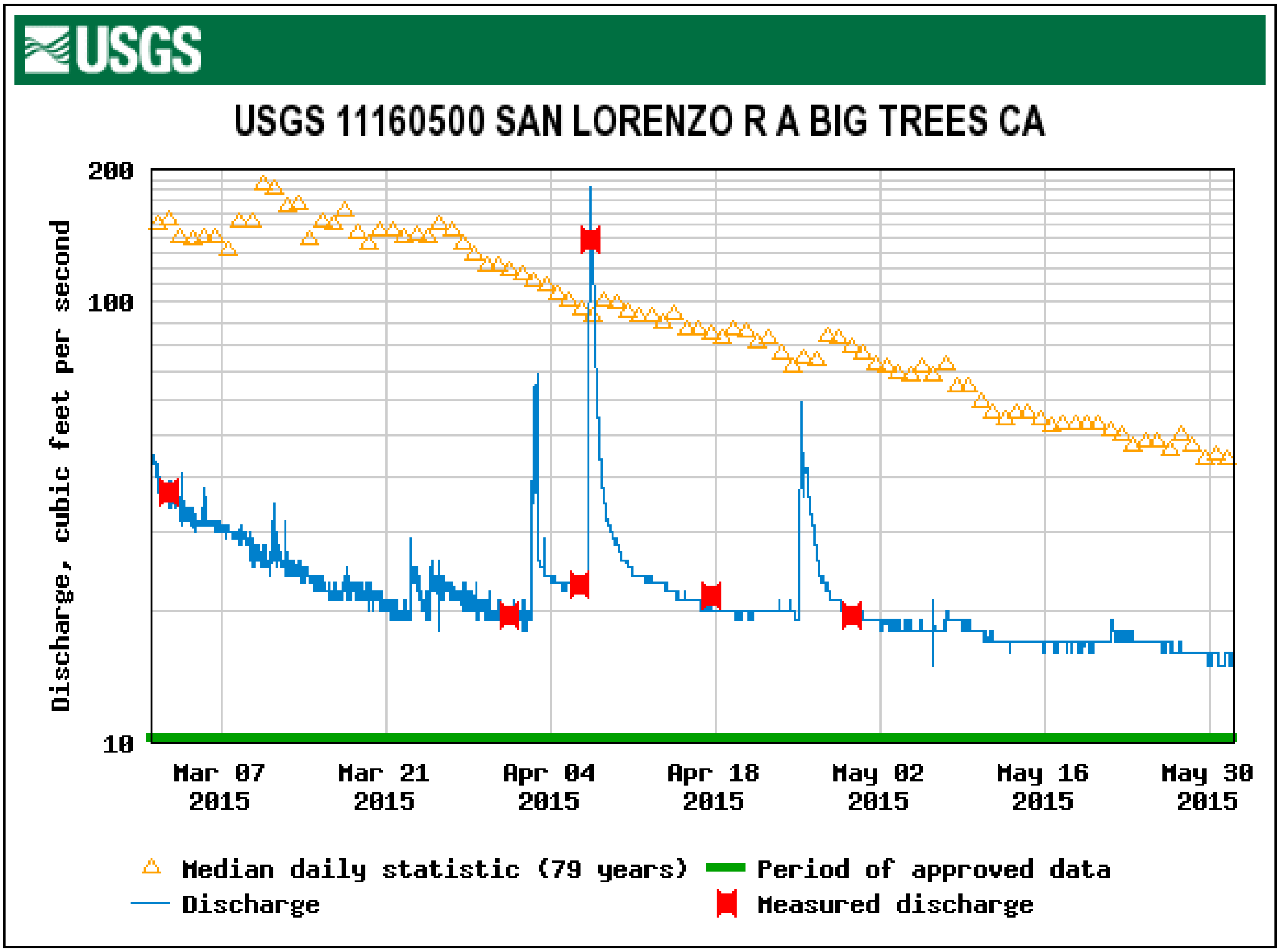


Figure 40. The 2016 Discharge at the USGS Gage on Soquel Creek at Soquel Village.

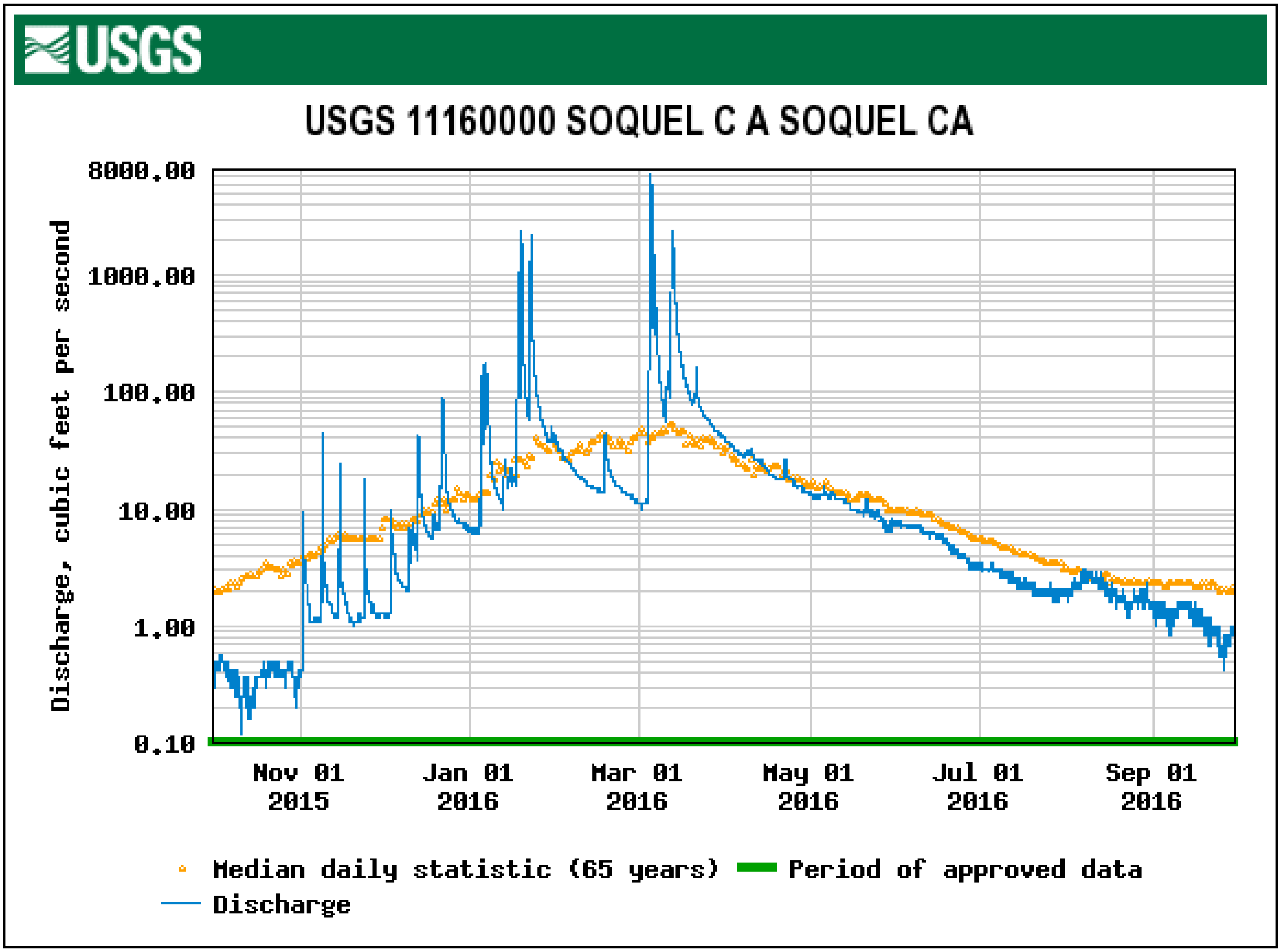


Figure 41. The 2015 Discharge to 31 May at the USGS Gage on Soquel Creek at Soquel Village.

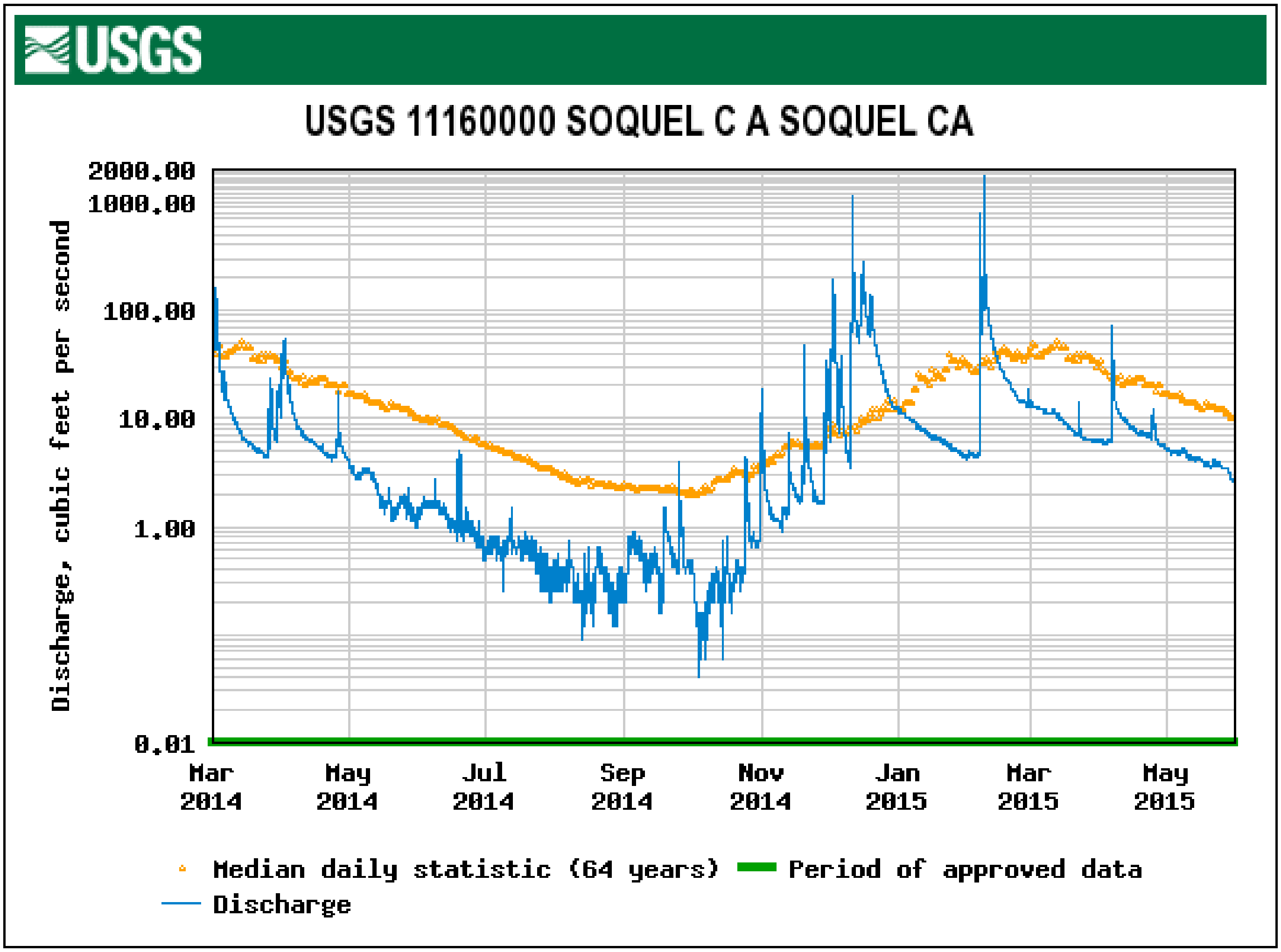


Figure 42. The 2016 Daily Mean and Median Flow at the USGS Gage on Soquel Creek at Soquel Village.

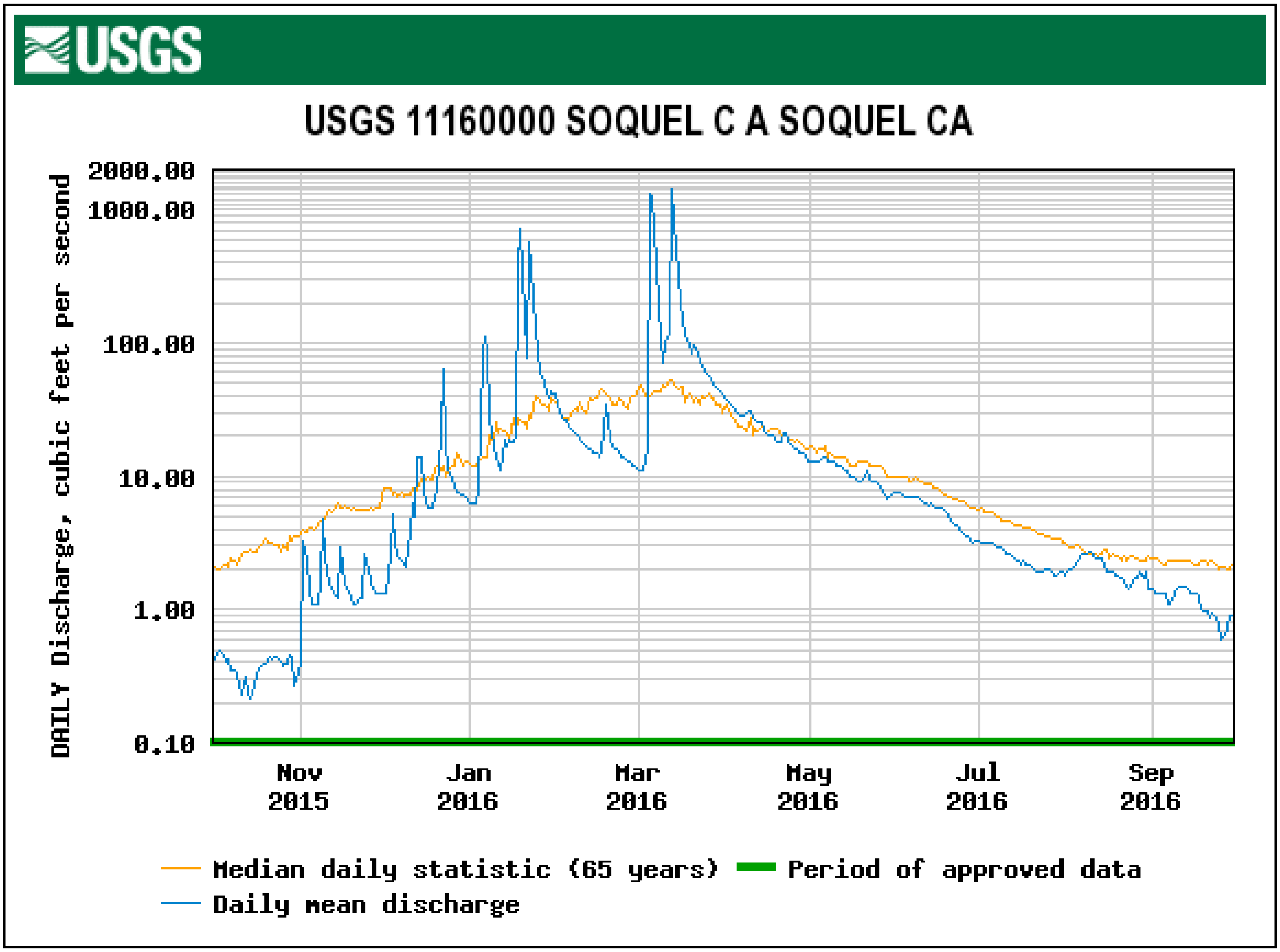


Figure 43. The 2015 Daily Mean and Median Flow at the USGS Gage on Soquel Creek at Soquel Village.

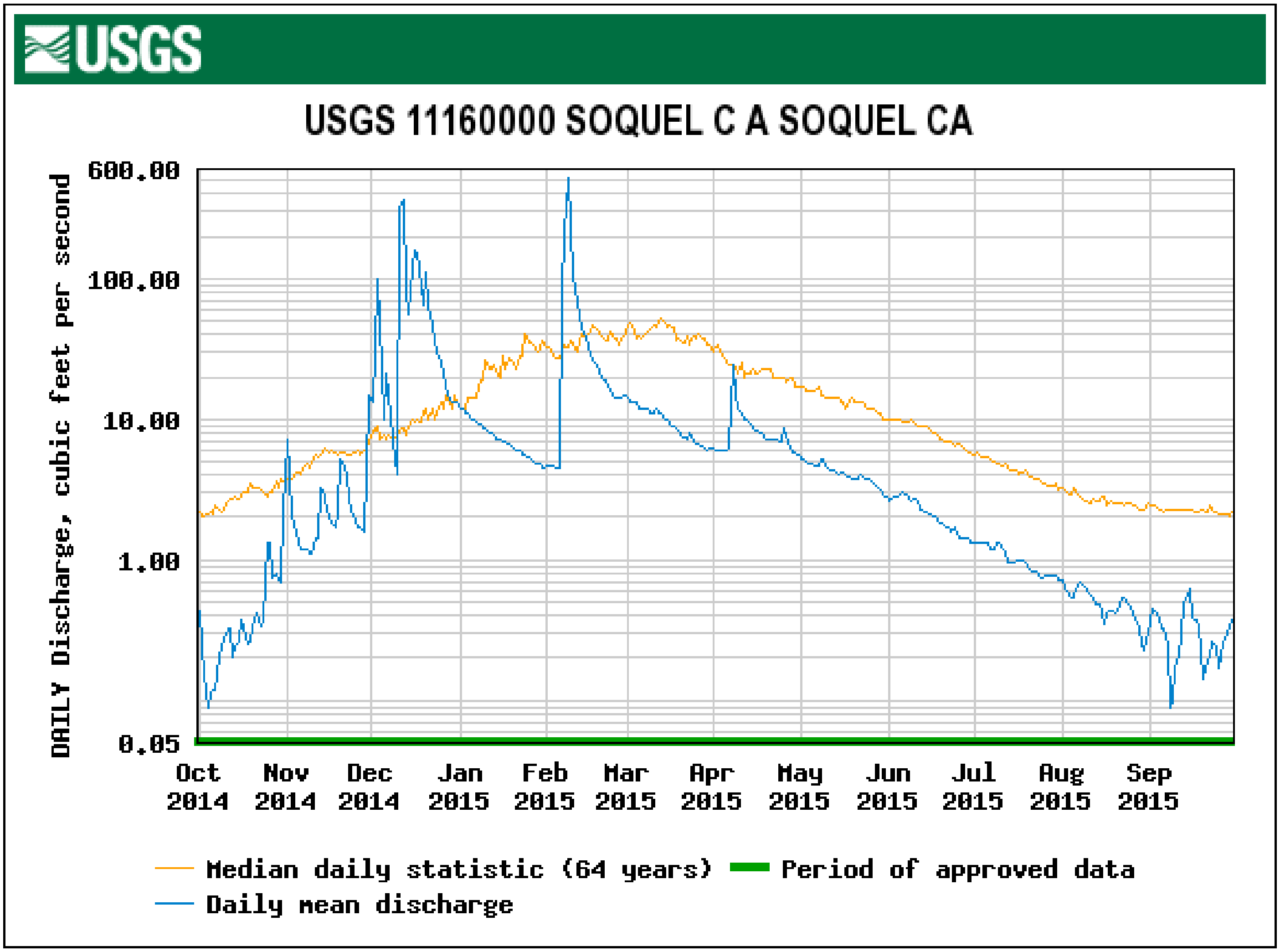


Figure 44. The March–May 2016 Discharge of Record for the USGS Gage on Soquel Creek at Soquel Village.

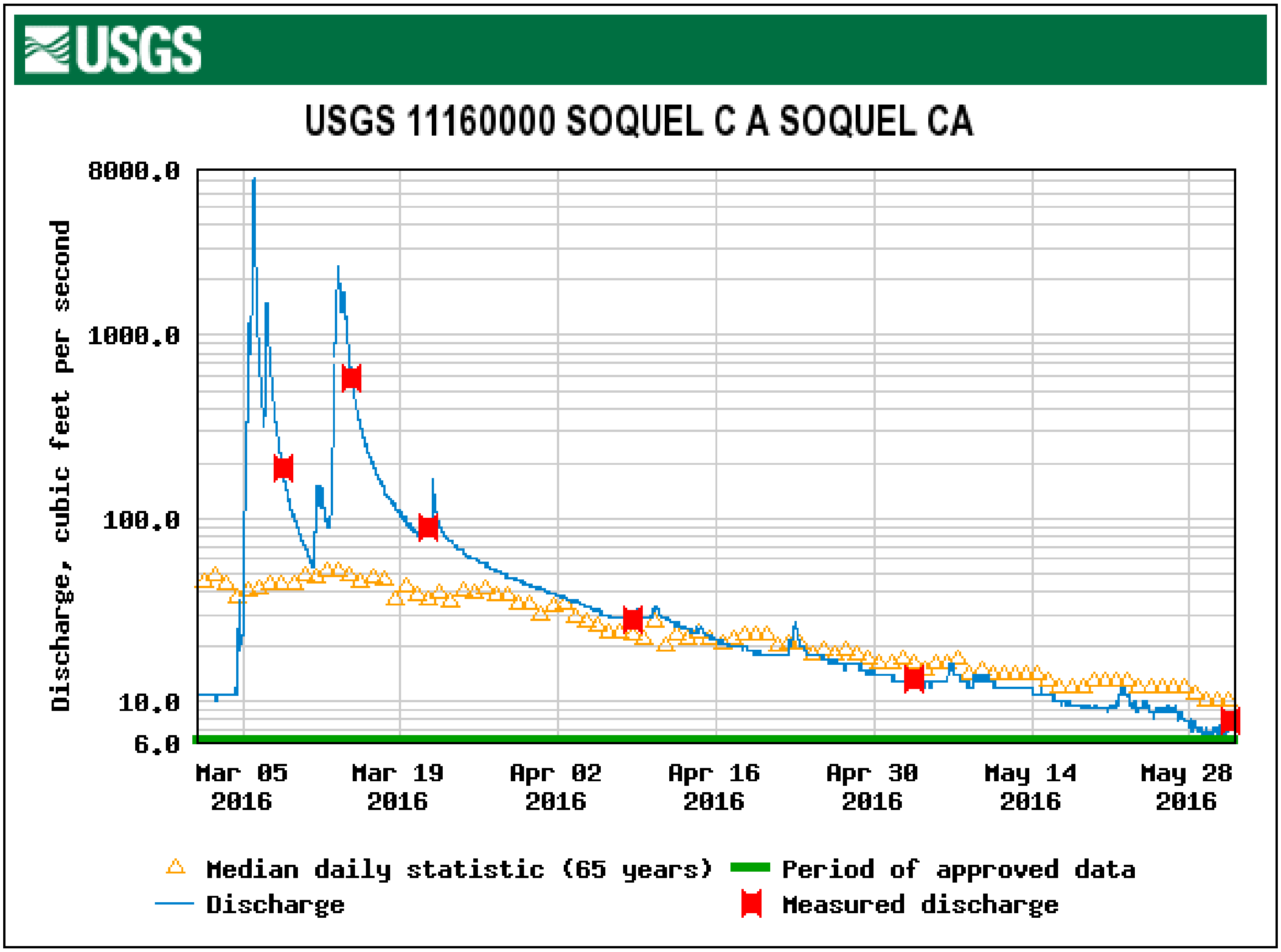


Figure 45. The March–May 2015 Discharge of Record for the USGS Gage on Soquel Creek at Soquel Village.

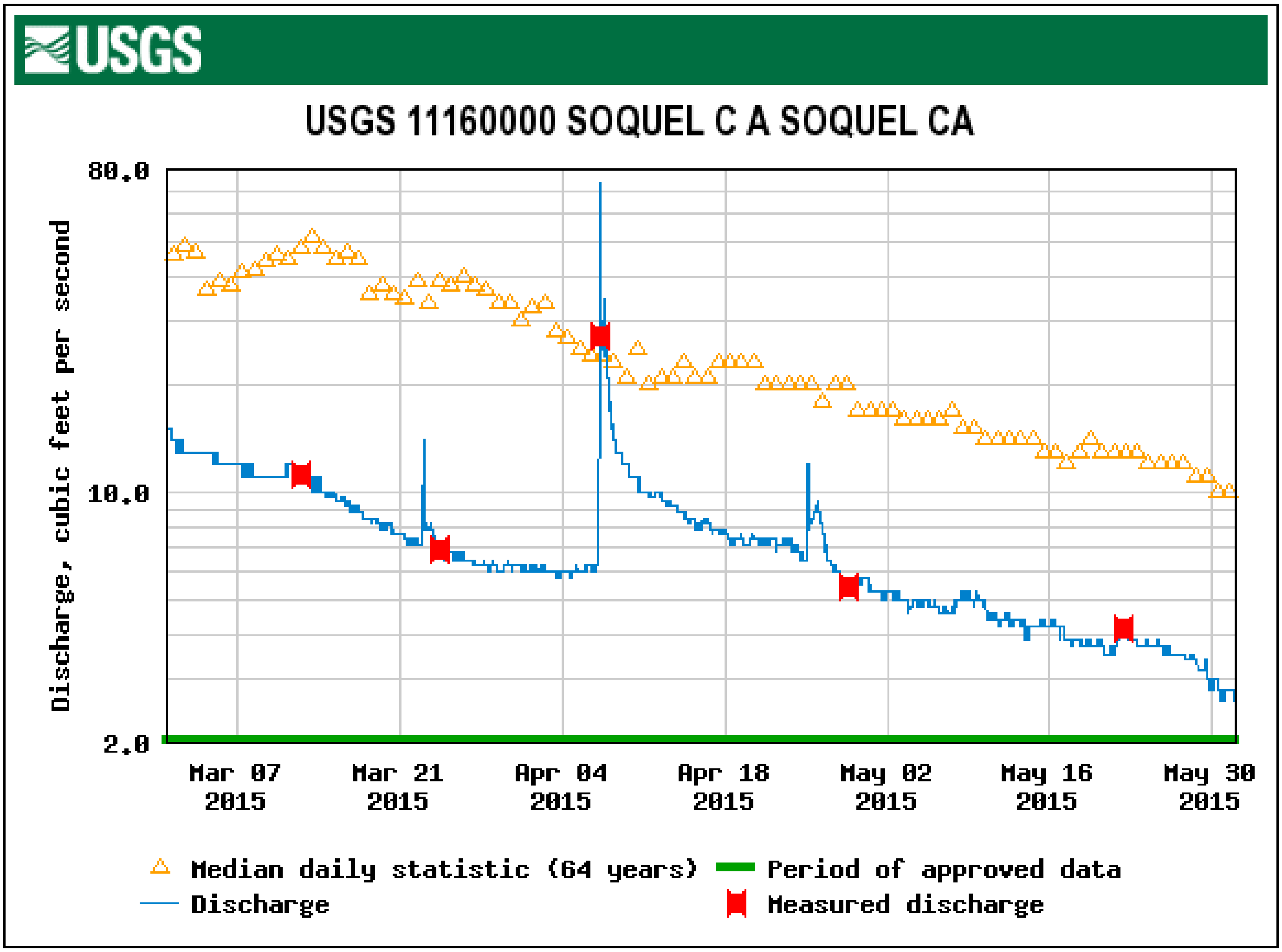


Figure 46. The 2016 Discharge at the USGS Gage on Corralitos Creek at Freedom.

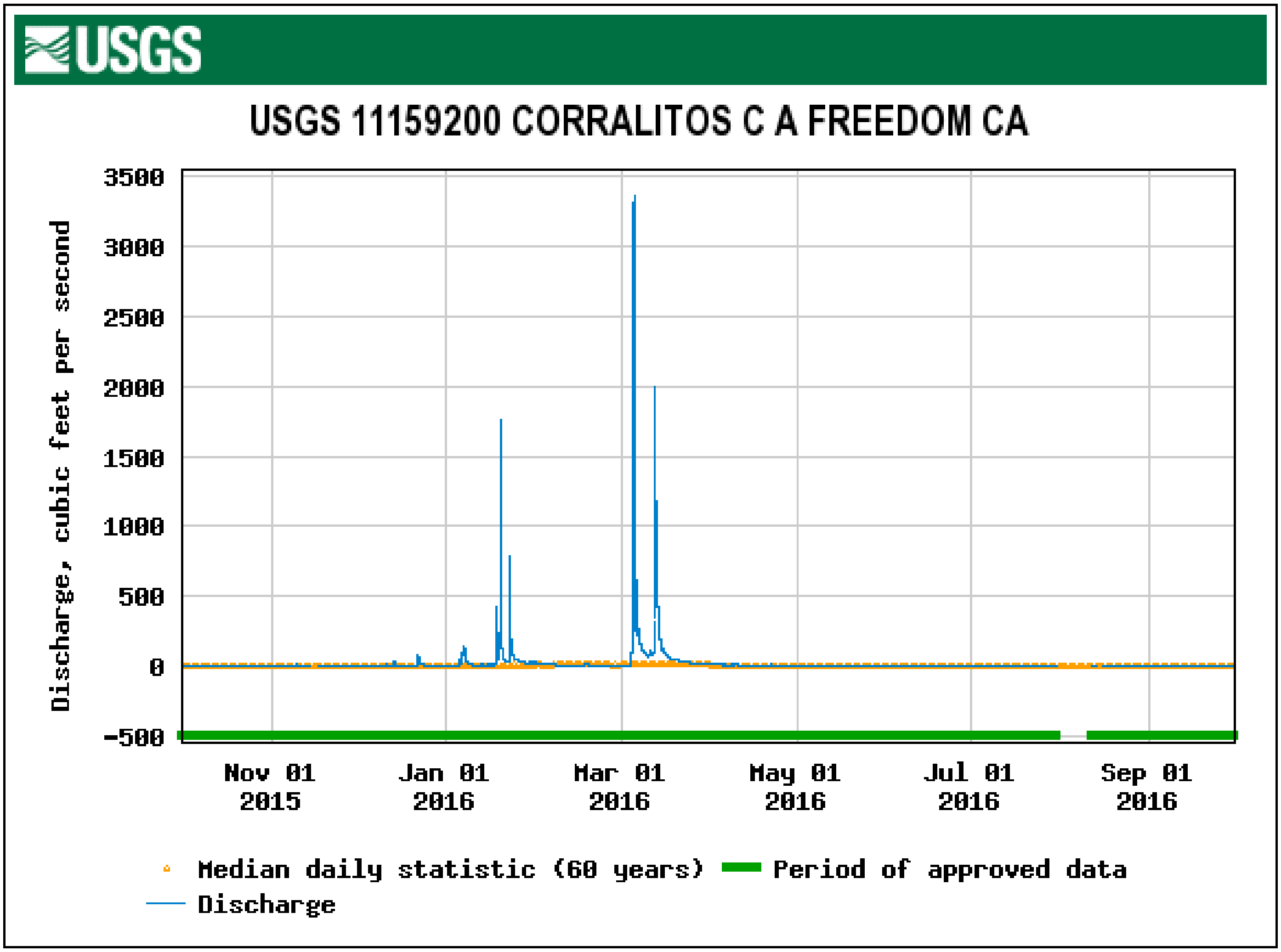


Figure 47. The 2015 Discharge at the USGS Gage on Corralitos Creek at Freedom.

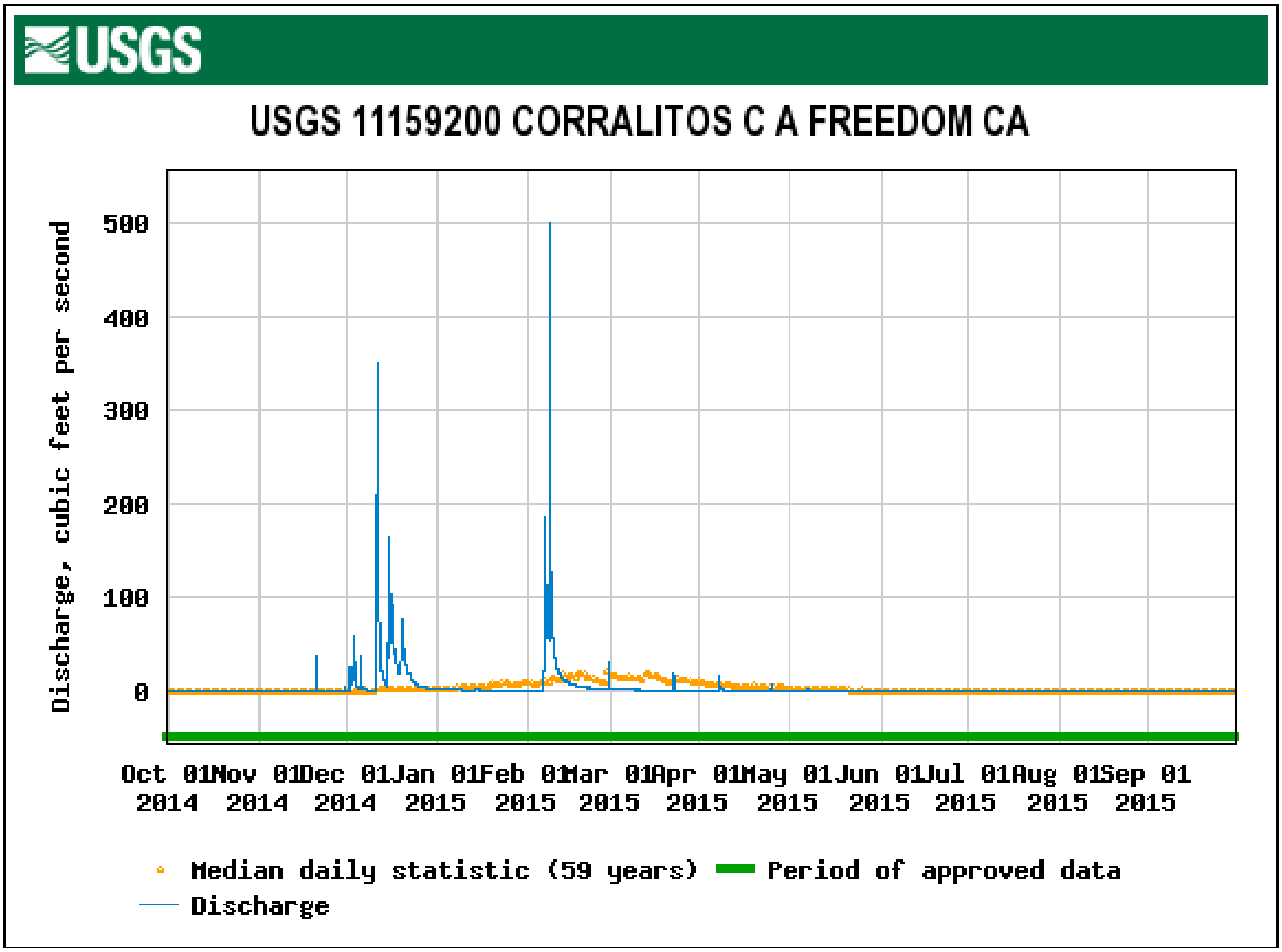


Figure 48. The 2016 Daily Mean and Median Flow at the USGS Gage on Corralitos Creek at Freedom.

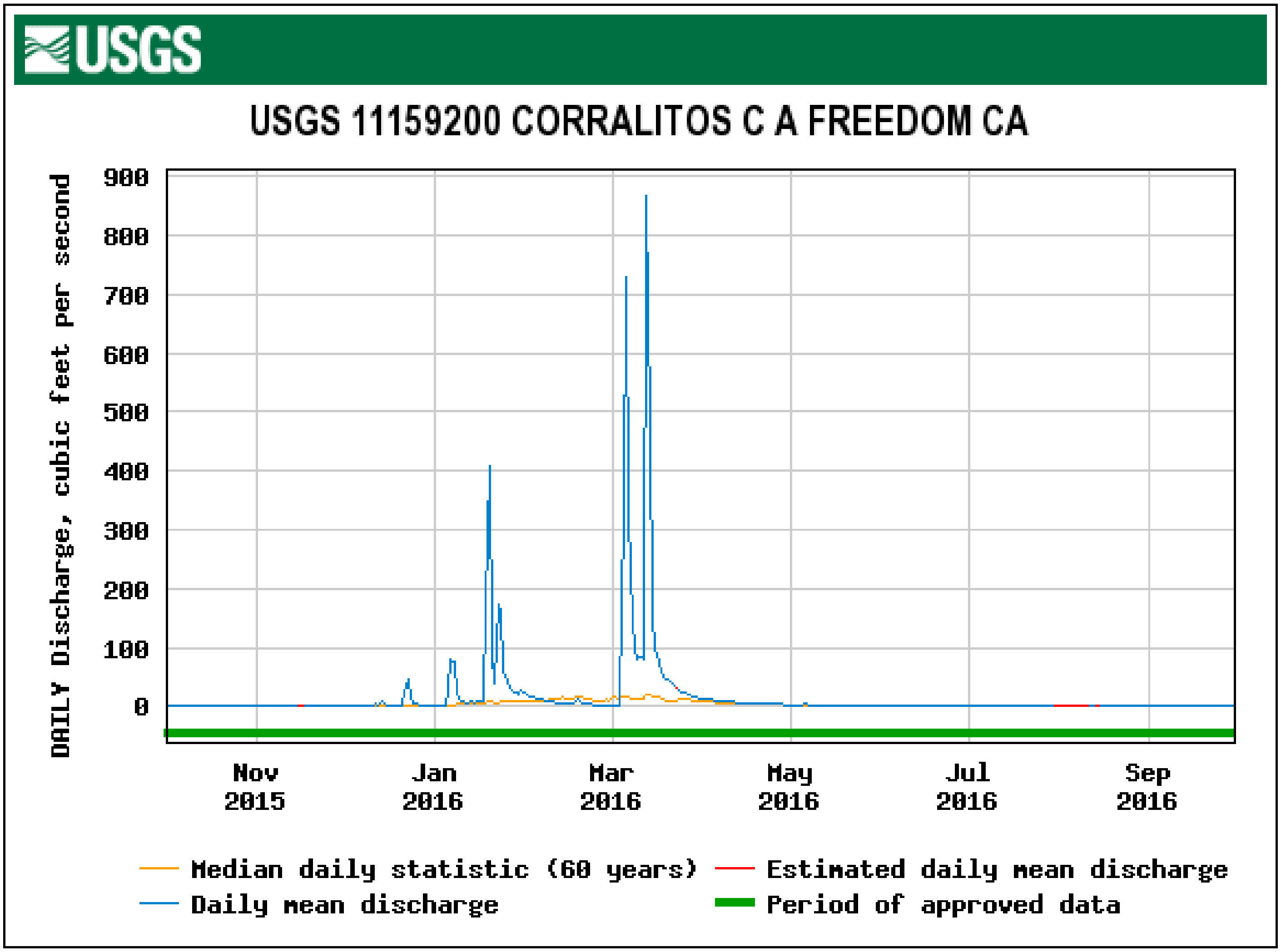


Figure 49. The 2015 Daily Mean and Median Flow at the USGS Gage on Corralitos Creek at Freedom.

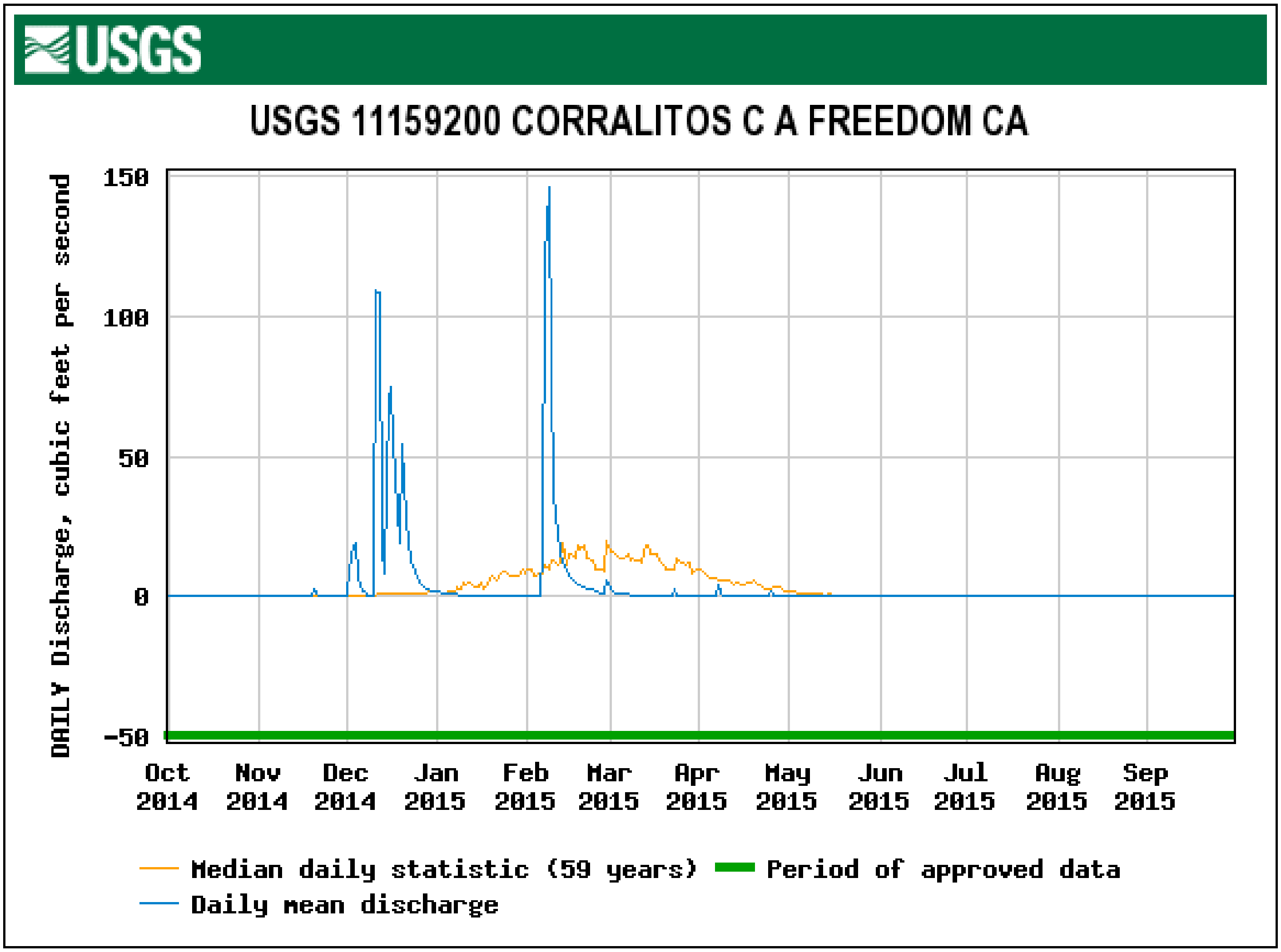


Figure 50. The March–June 2016 Discharge at the USGS Gage on Corralitos Creek at Freedom.

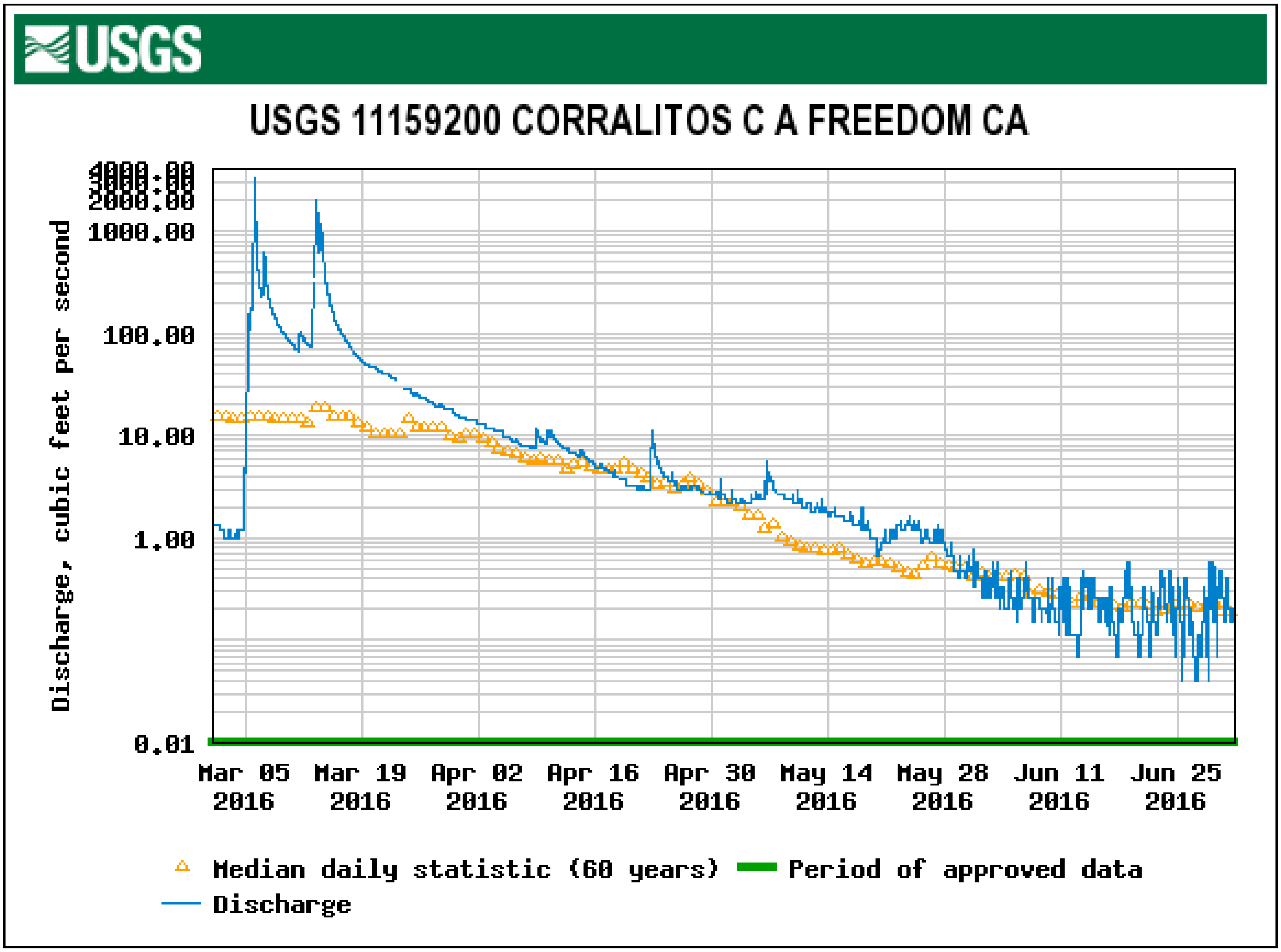


Figure 51. The June–September 2016 Discharge at the USGS Gage on Corralitos Creek at Freedom.

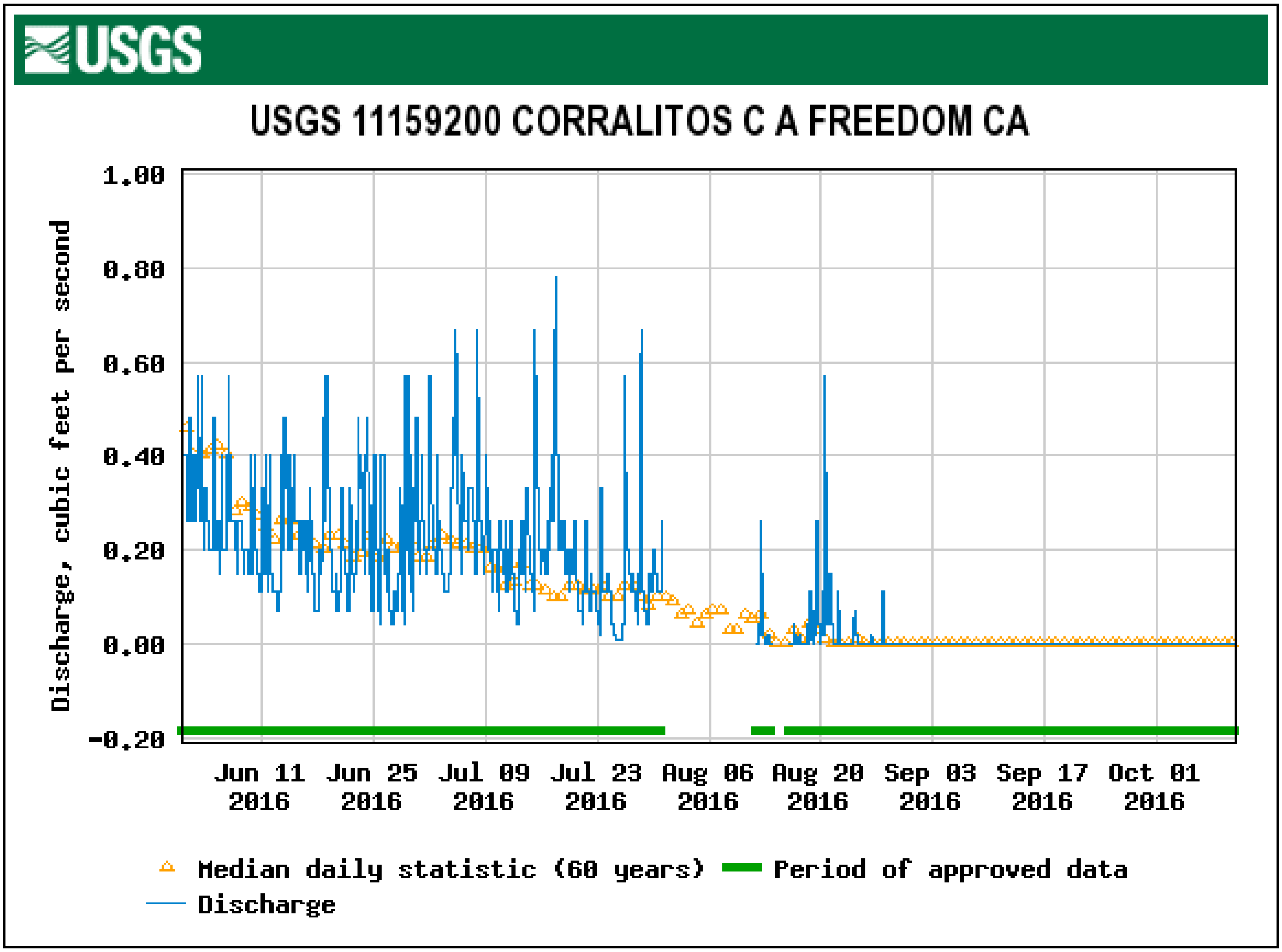
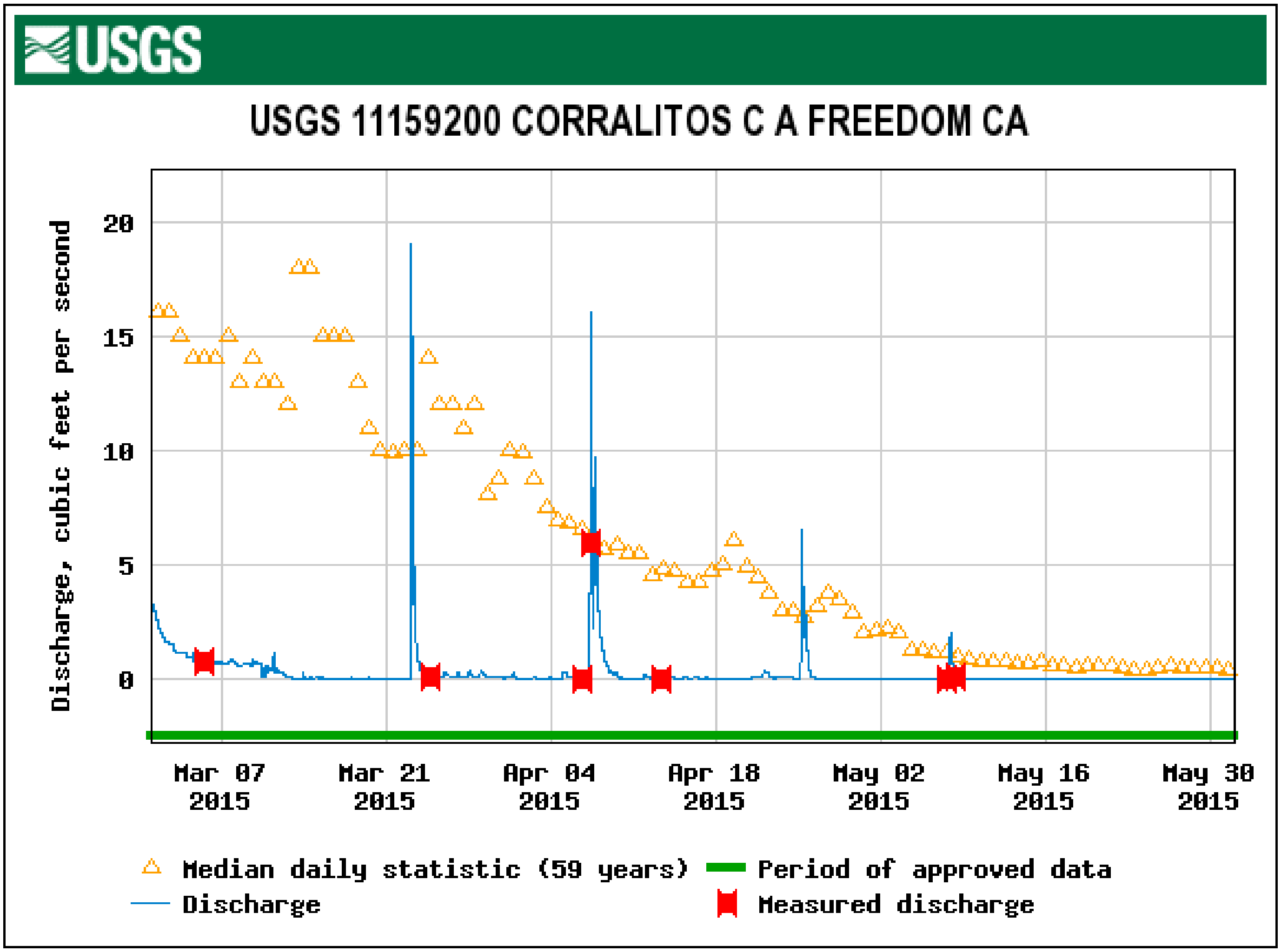


Figure 52. The March−May 2015 Discharge at the USGS Gage on Corralitos Creek at Freedom.



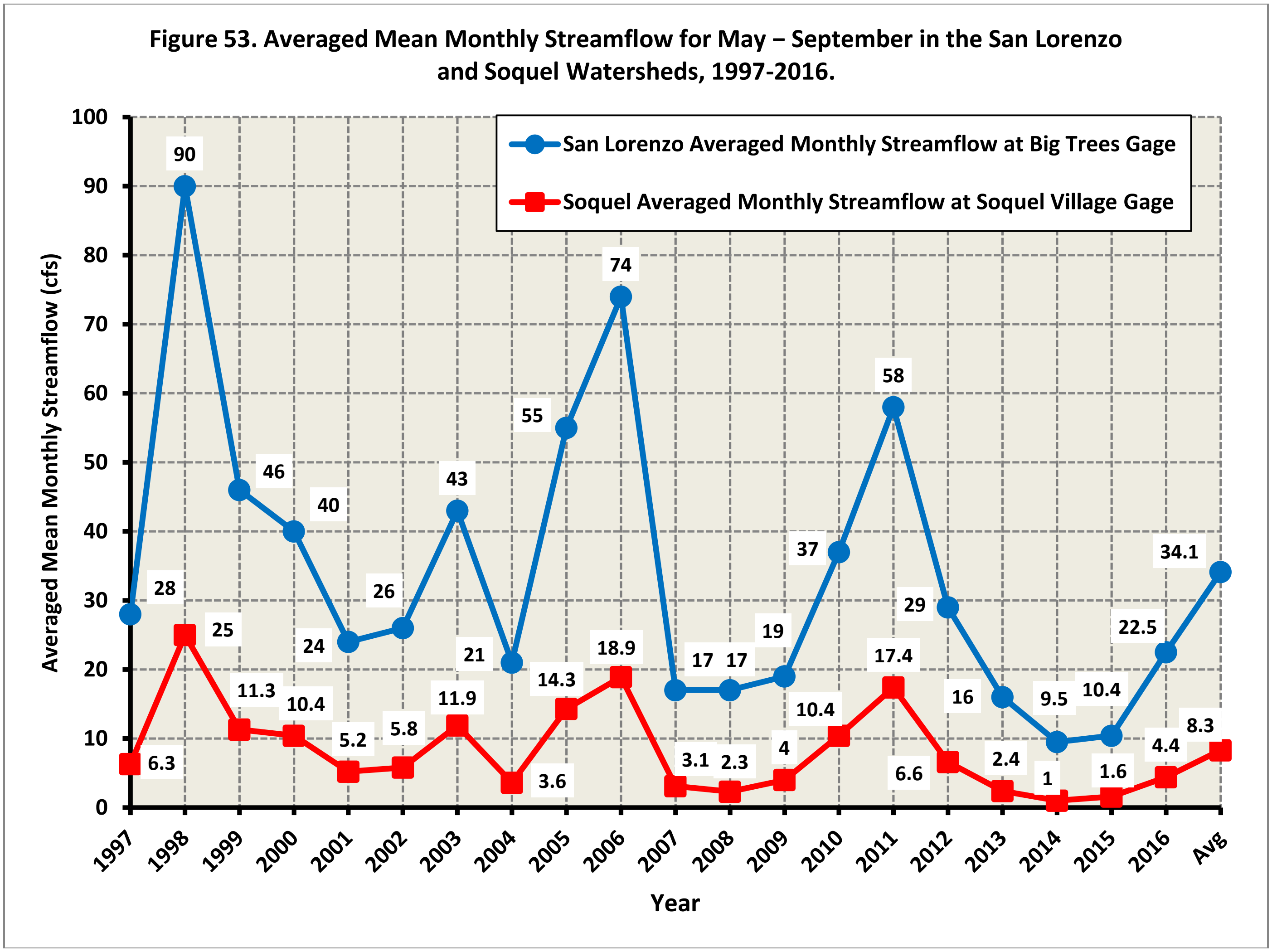


Figure 53. Averaged Mean Monthly Streamflow for May−September in the San Lorenzo and Soquel Watersheds, 1997-2016.

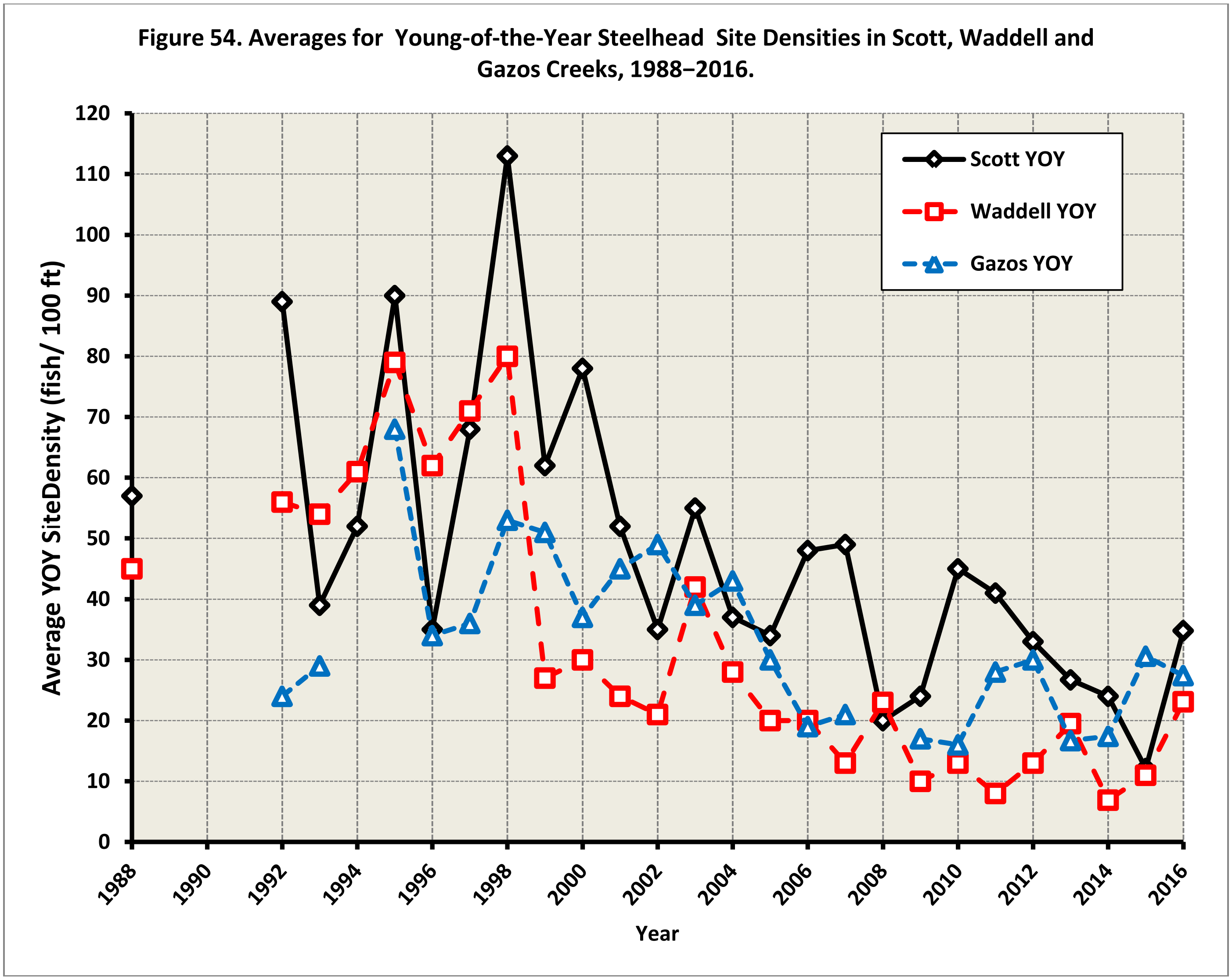


Figure 54. Averages for Young-of-the-Year Steelhead Site Densities in Scott, Waddell and Gazos Creeks, 1988–2016.

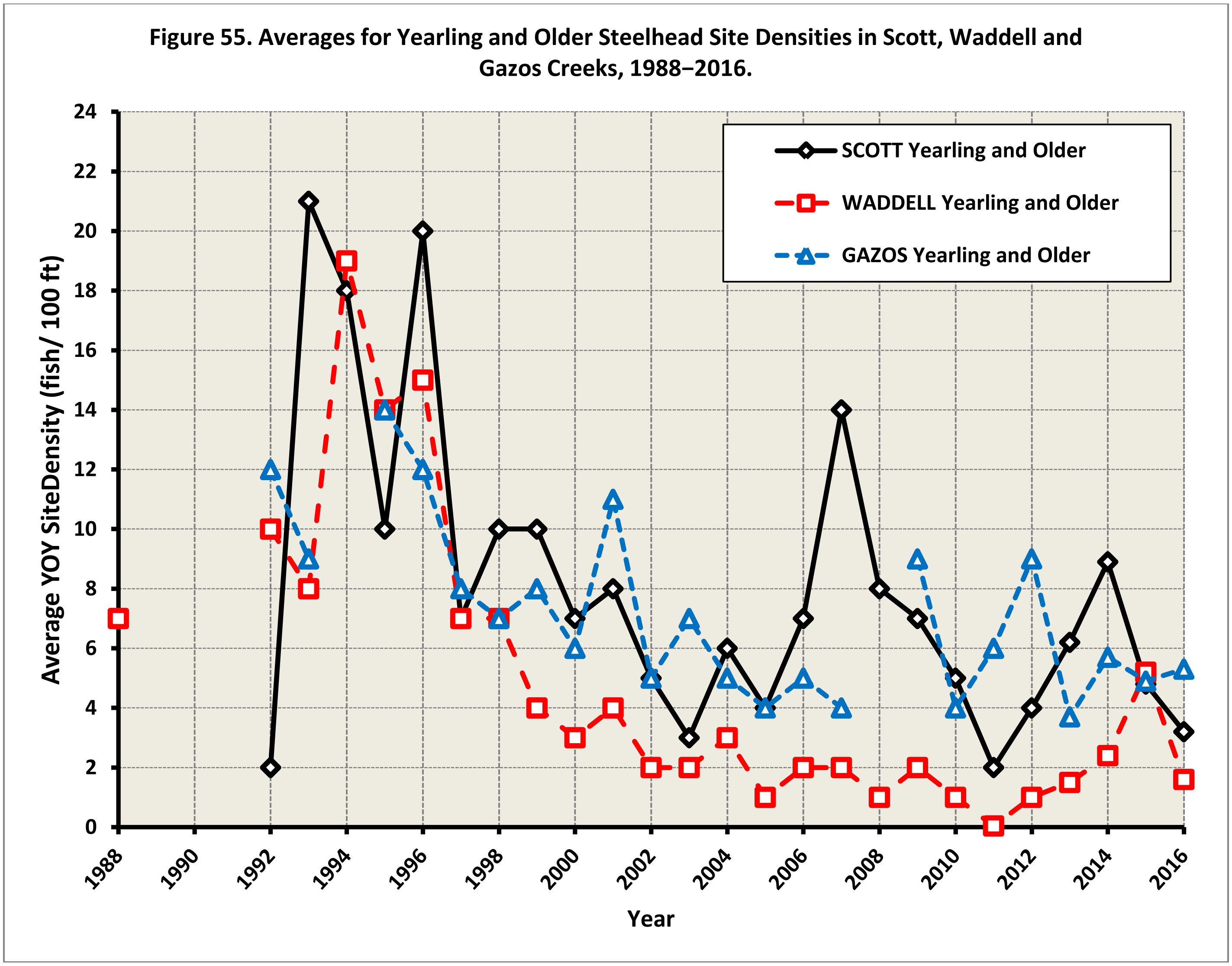


Figure 55. Averages for Yearling and Older Steelhead Site Densities in Scott, Waddell and Gazos Creeks, 1988–2016.

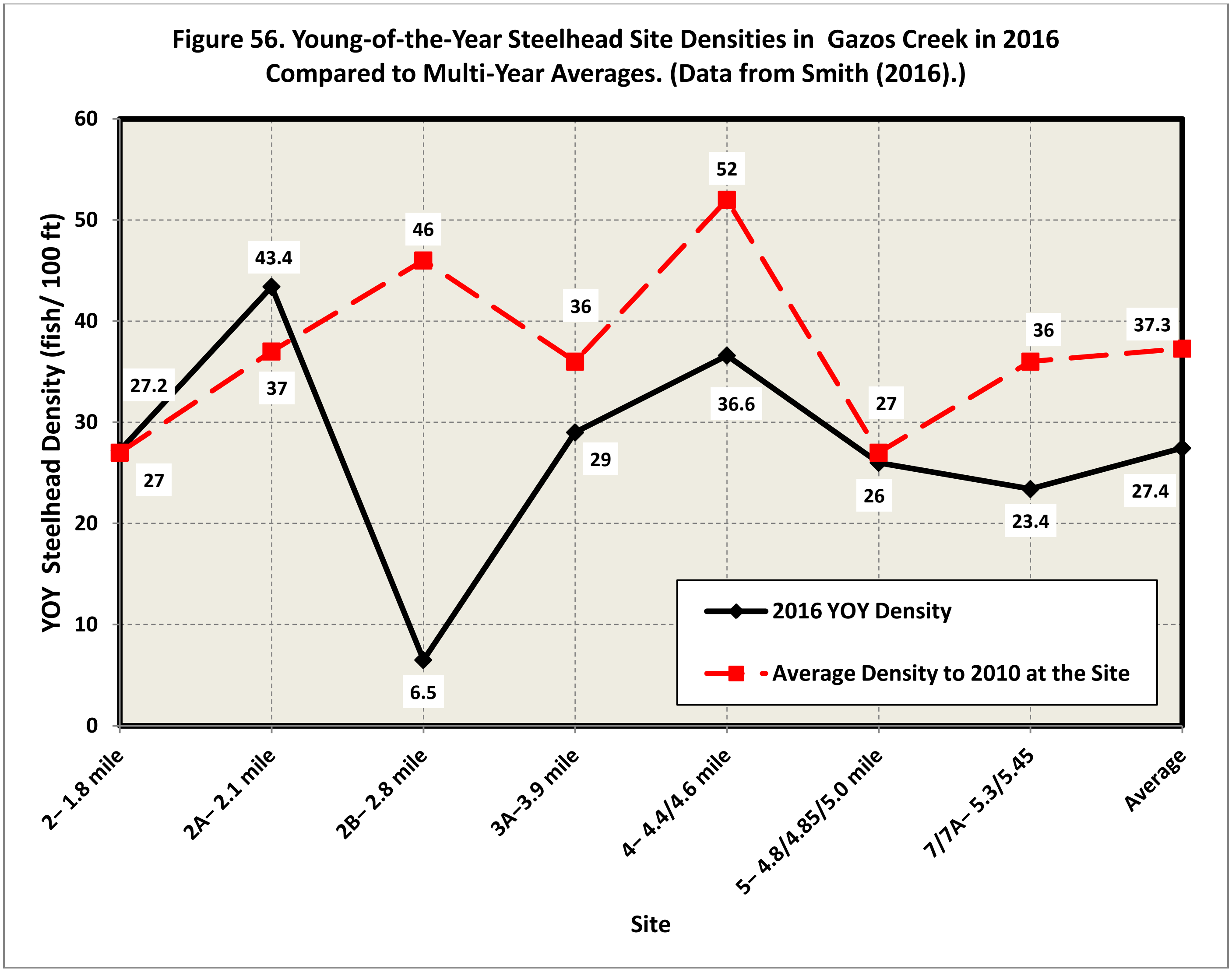


Figure 56. Young-of-the-Year Steelhead Site Densities in Gazos Creek in 2016 Compared to Multi-Year Averages.

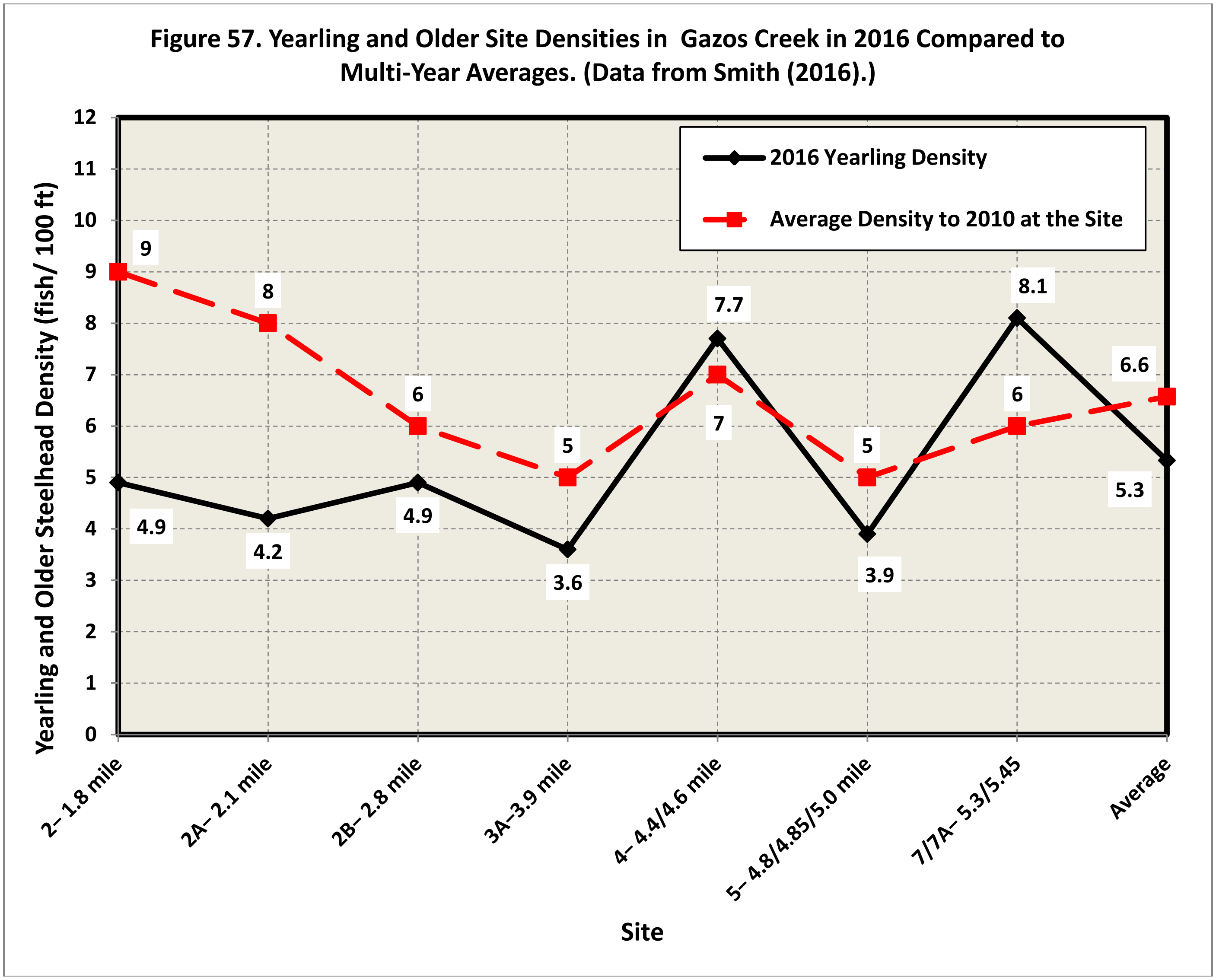


Figure 57. Yearling Steelhead Site Densities in Gazos Creek in 2016 Compared to Multi-Year Averages.

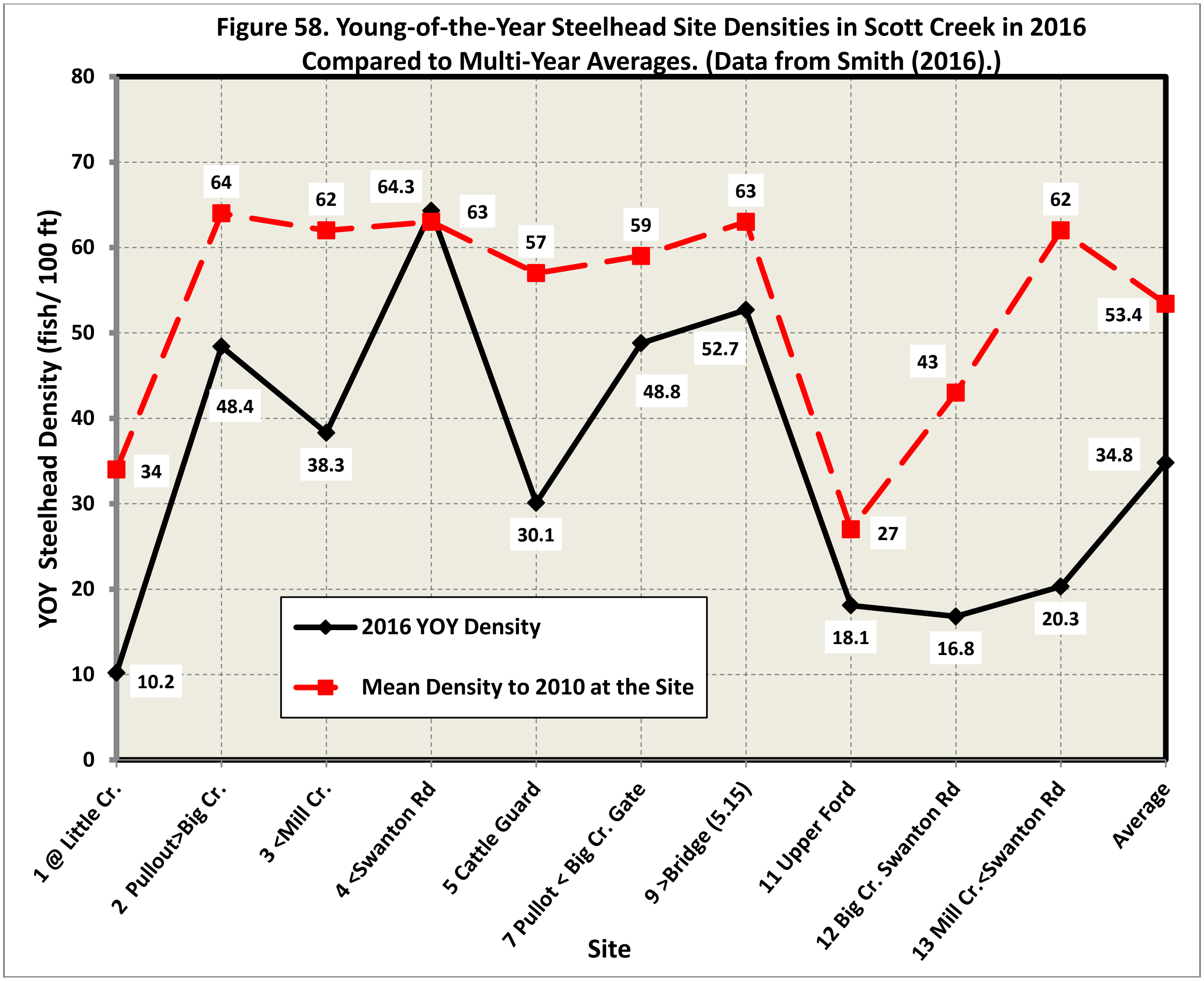


Figure 58. Young-of-the-Year Steelhead Site Densities in Gazos Creek in 2016 Compared to Multi-Year Averages.

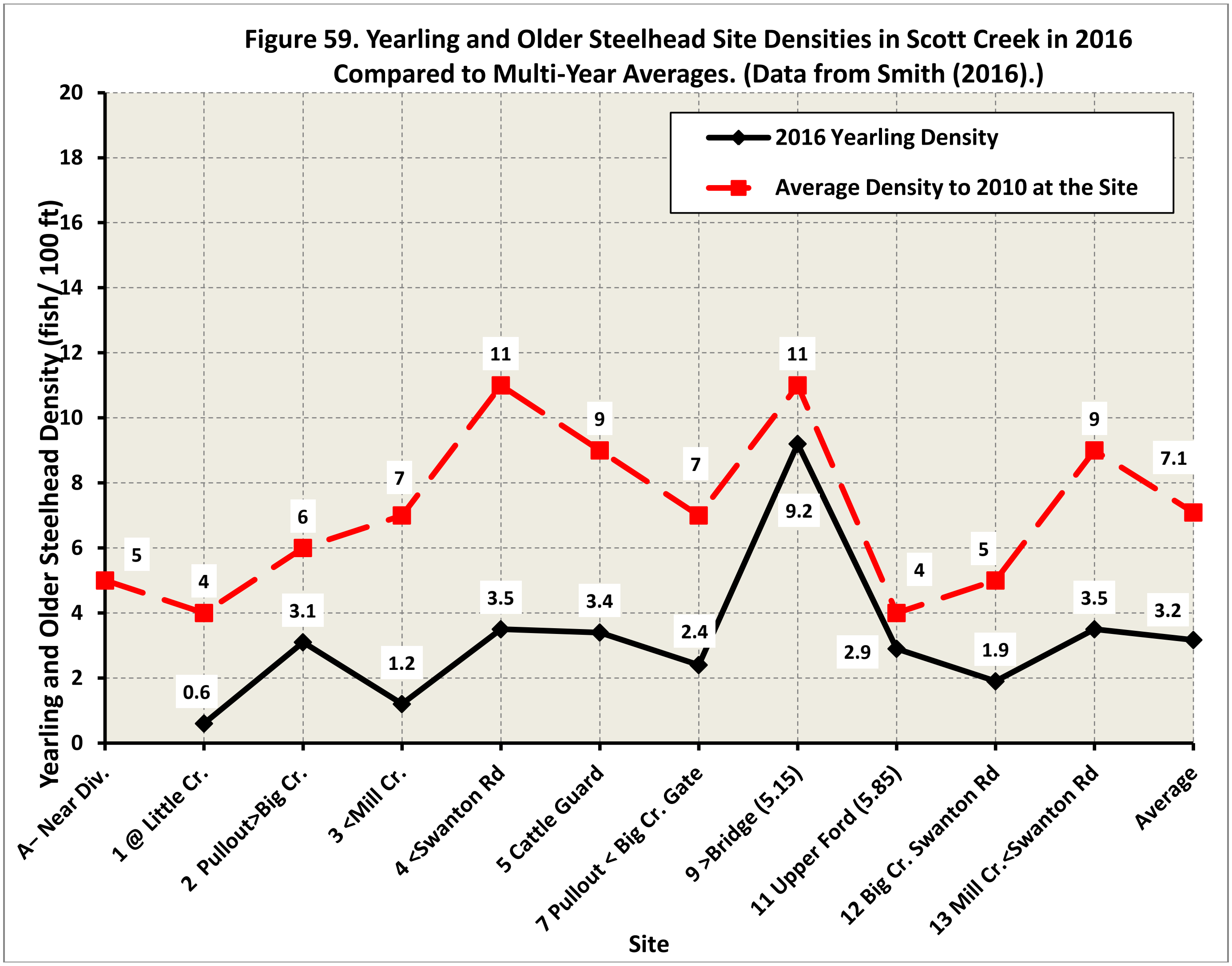


Figure 59. Yearling Steelhead Site Densities in Gazos Creek in 2016 Compared to Multi-Year Averages.

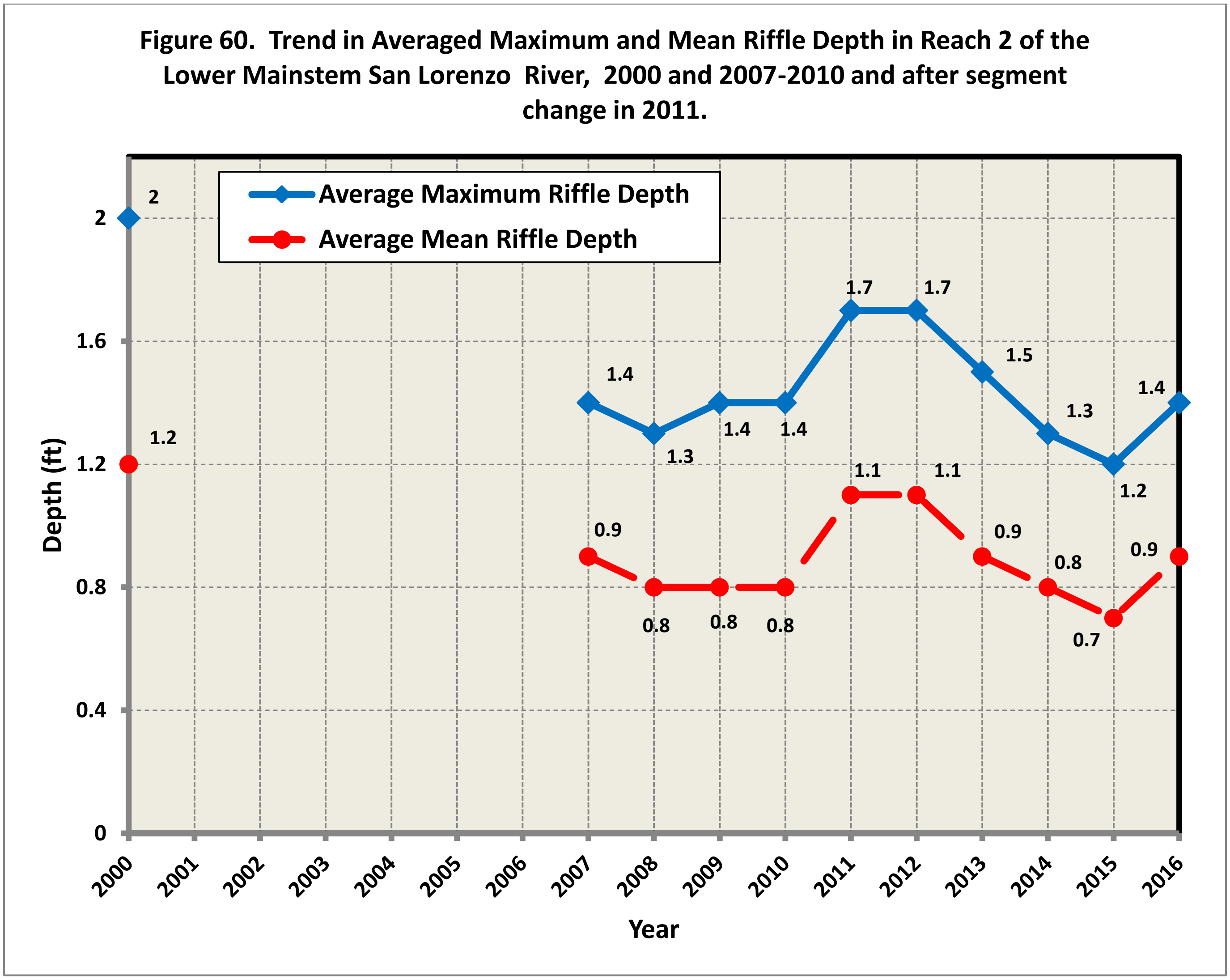


Figure 60. Trend in Averaged Maximum and Mean Riffle Depth in Reach 2 of the Lower Mainstem San Lorenzo River, 2000 and 2007-2016.

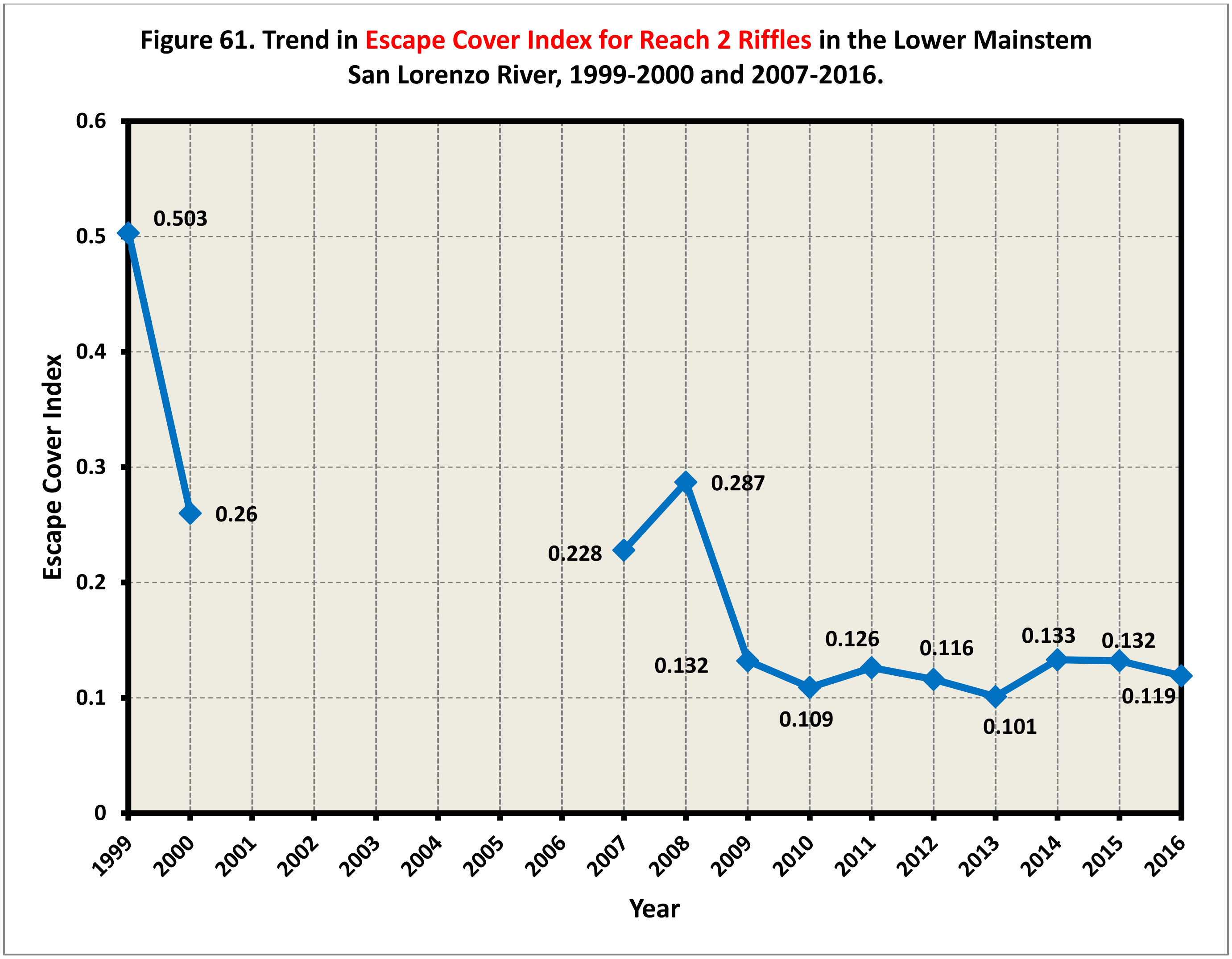


Figure 61. Trend in Escape Cover Index for Reach 2 Riffles in the Lower Mainstem San Lorenzo River, 1999-2000 and 2007-2016.

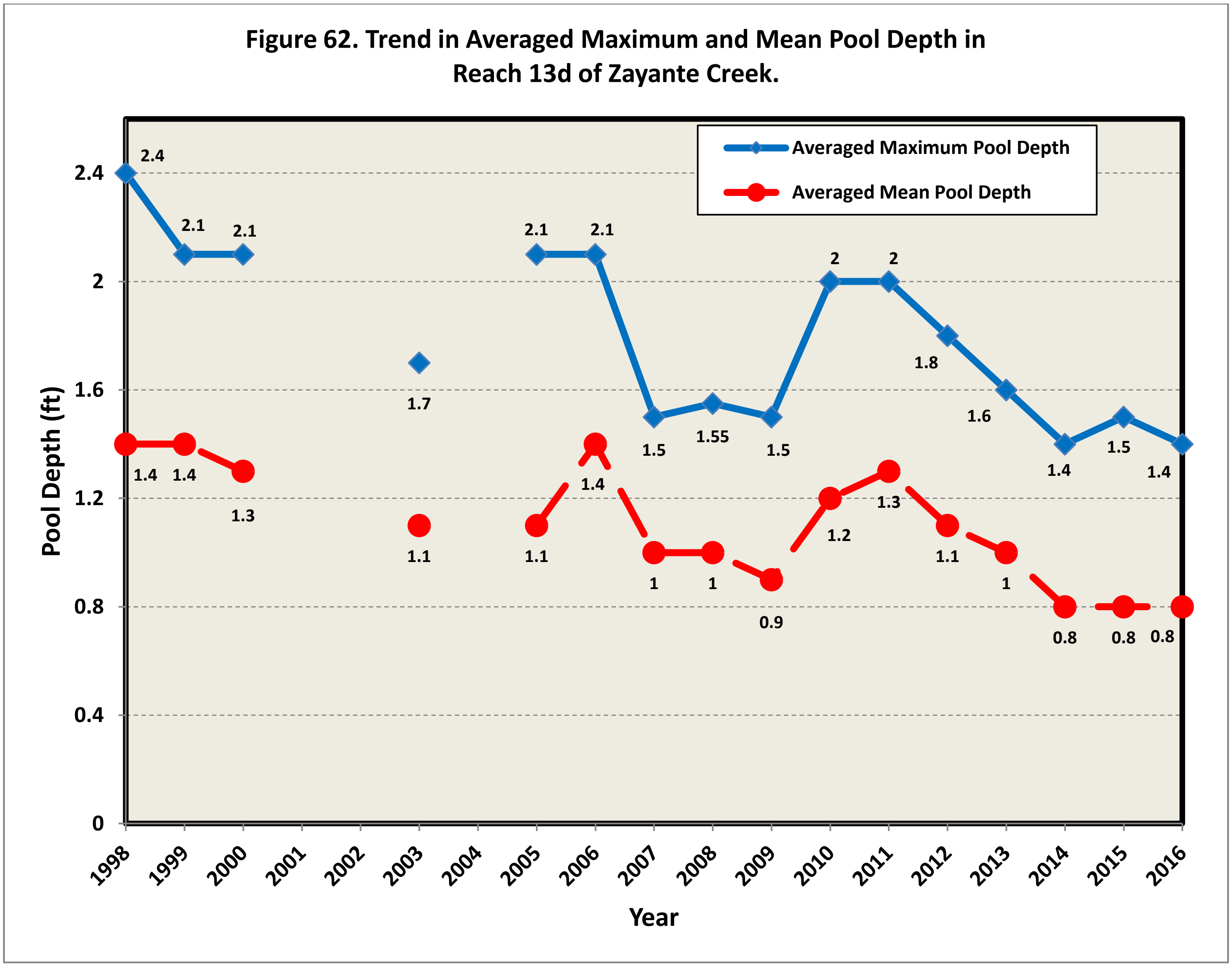


Figure 62. Trend in Averaged Maximum and Mean Pool Depth in Reach 13d of Zayante Creek.

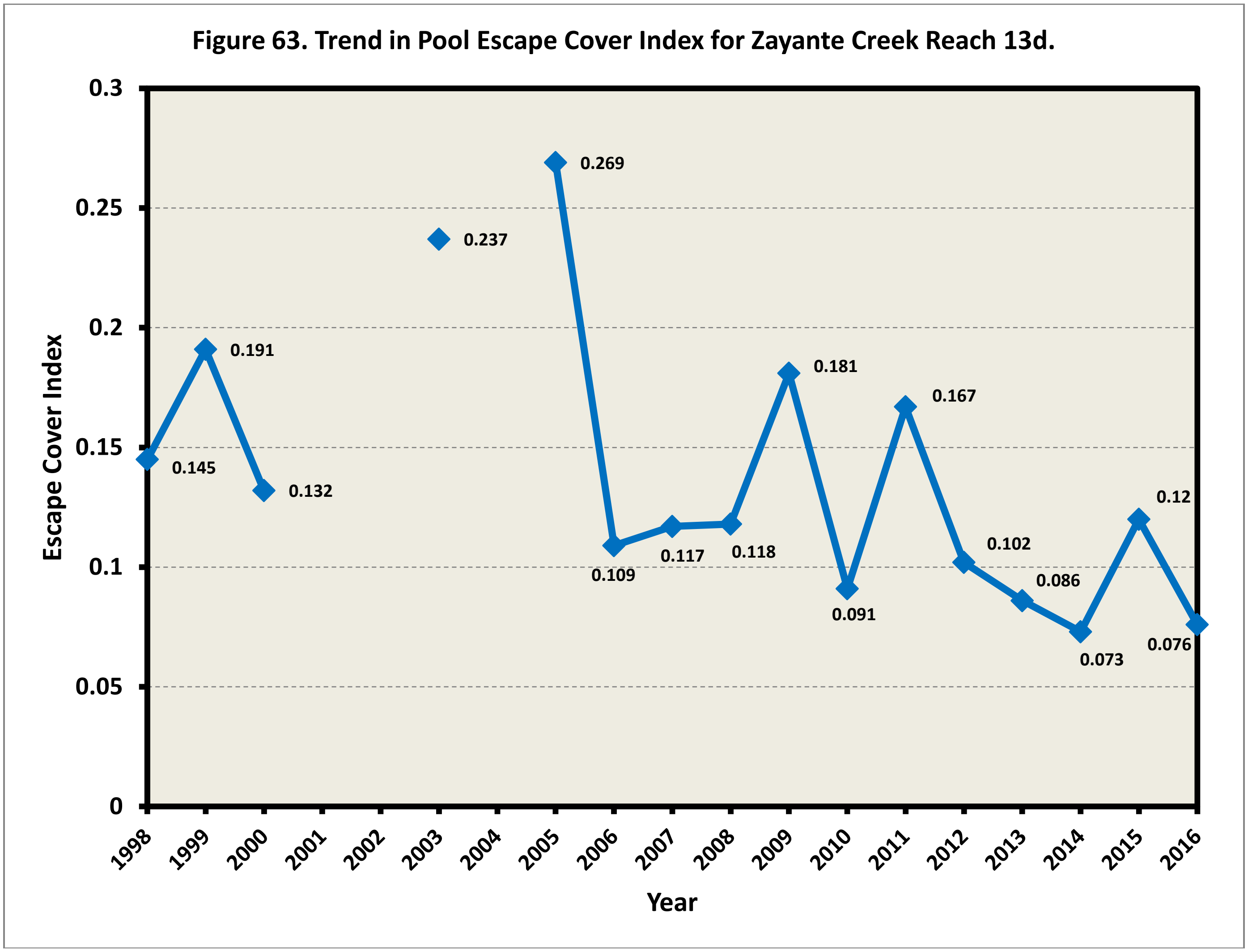


Figure 63. Trend in Pool Escape Cover Index for Zayante Creek Reach 13d.

APPENDIX A. Watershed Maps.

Figure 1. Santa Cruz County Watersheds.

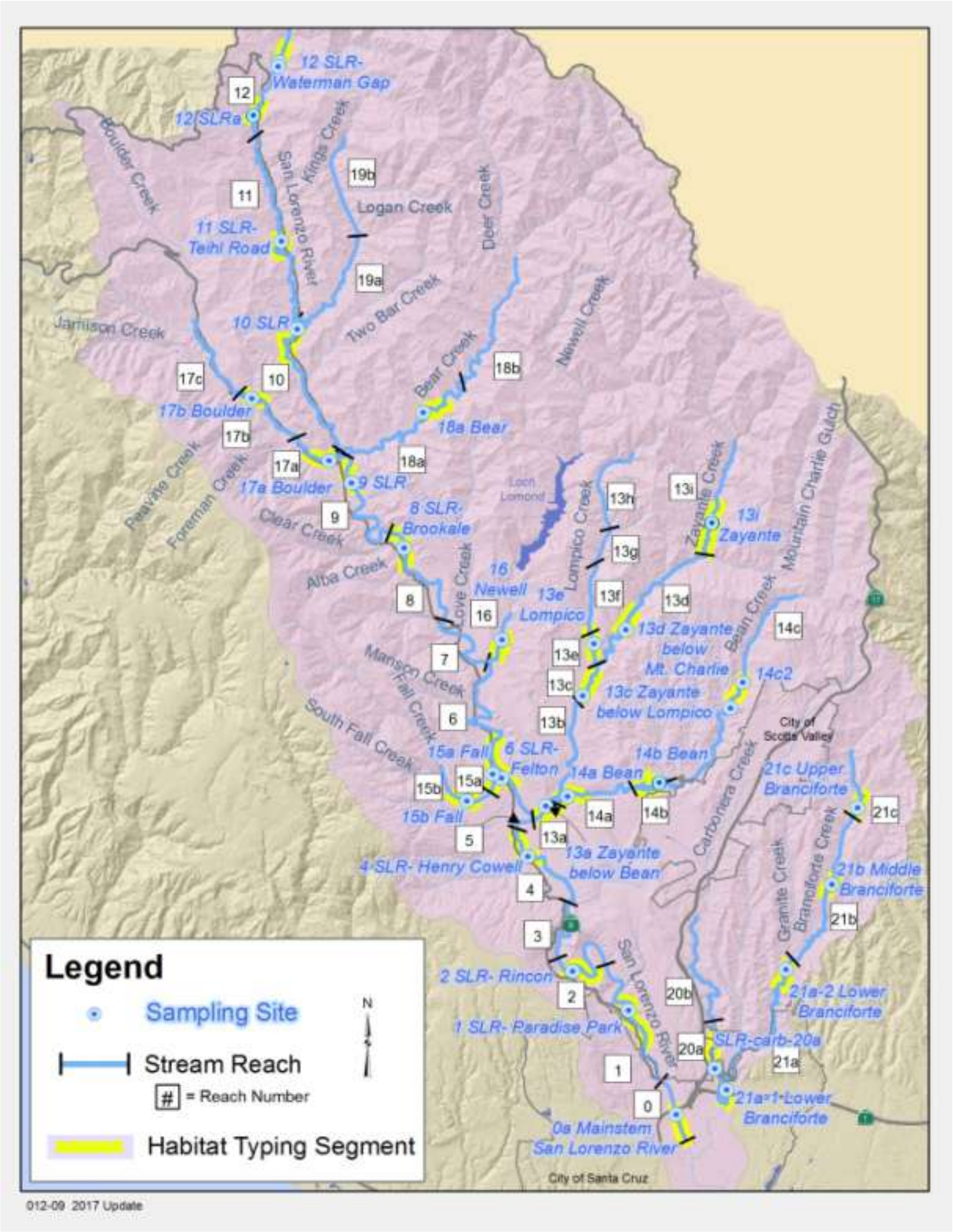


Figure 2. San Lorenzo River Watershed− Sampling Sites and Reaches.

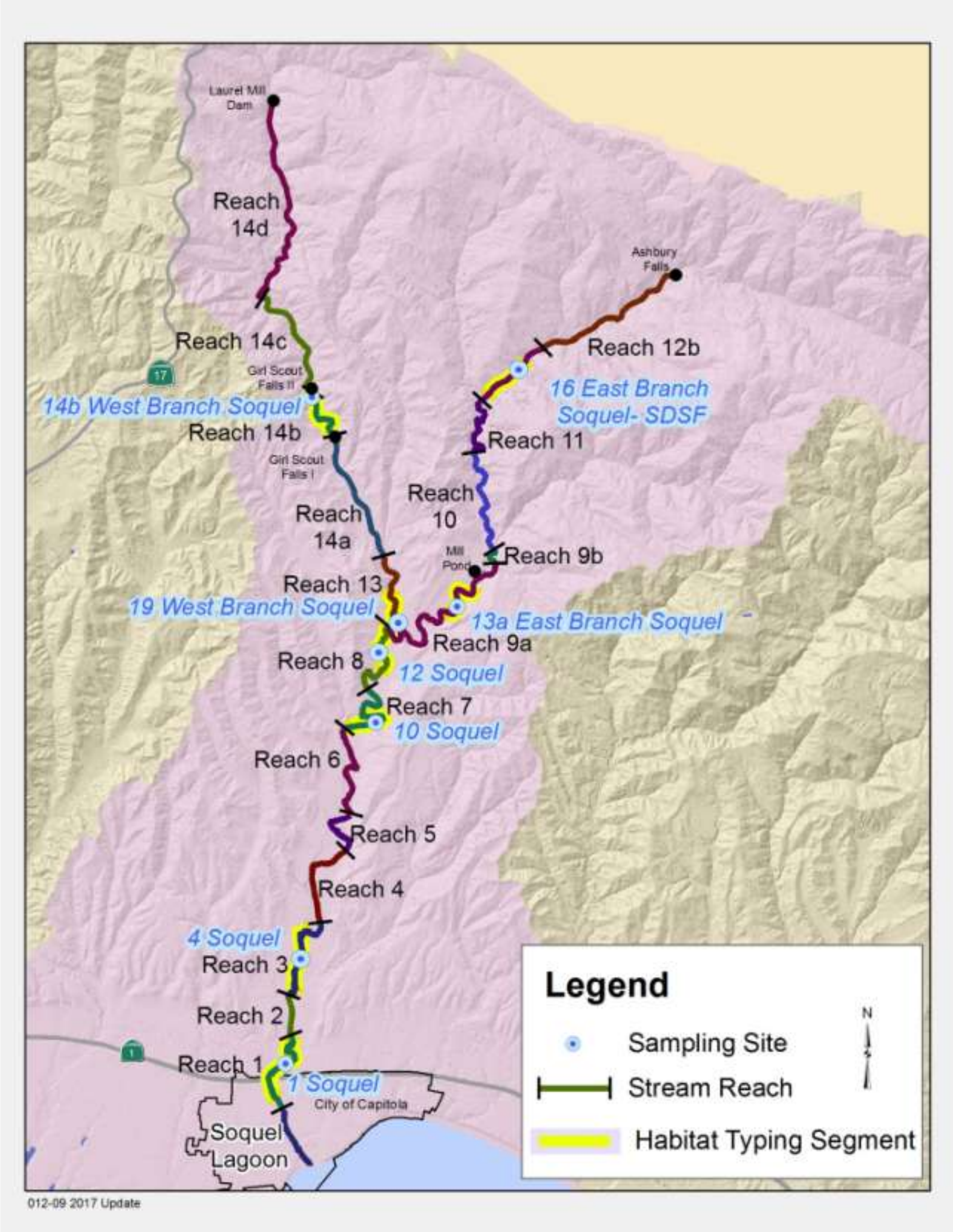


Figure 3. Soquel Creek Watershed.

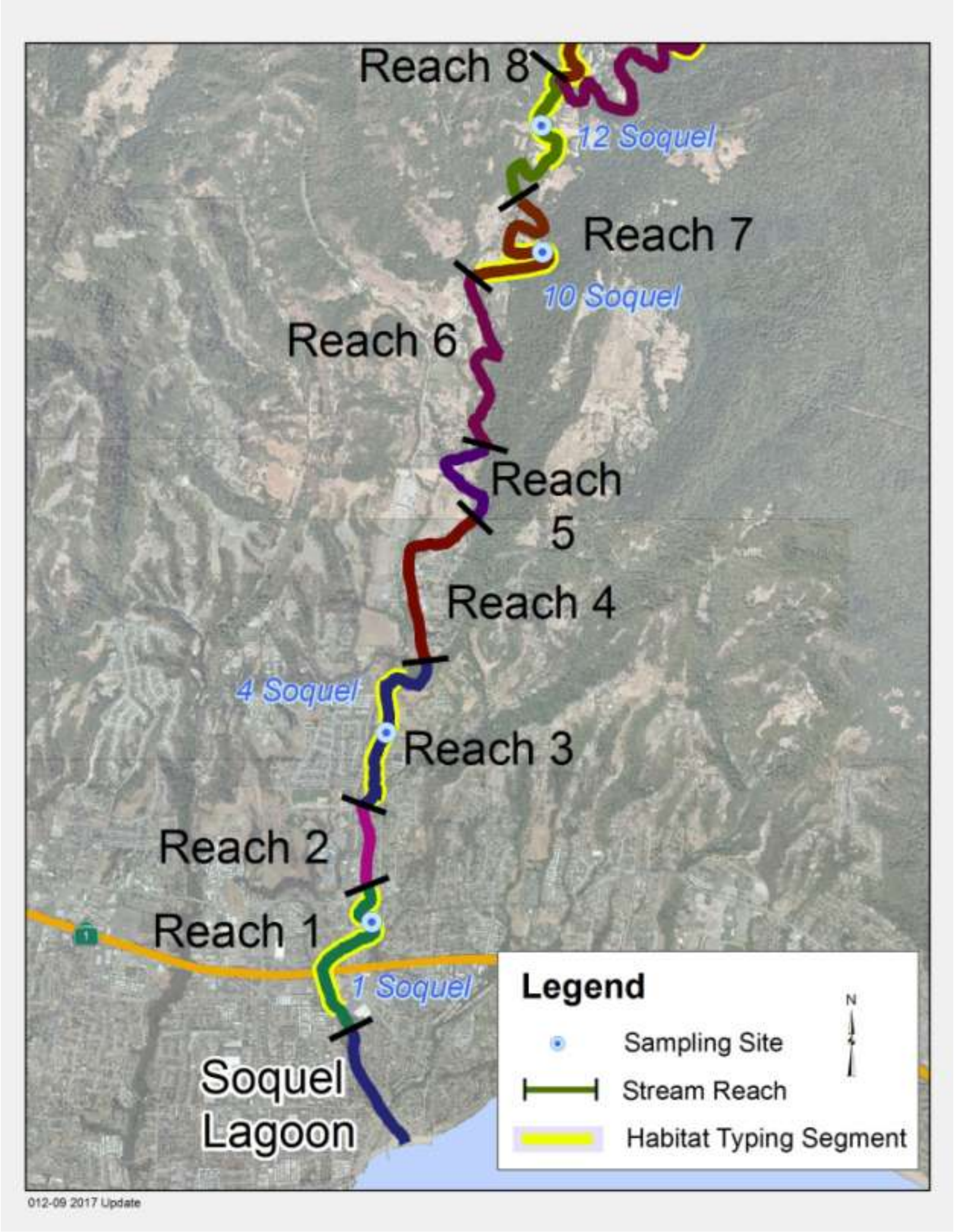


Figure 4. Lower Soquel Creek (Reaches 1–8 on Mainstem).

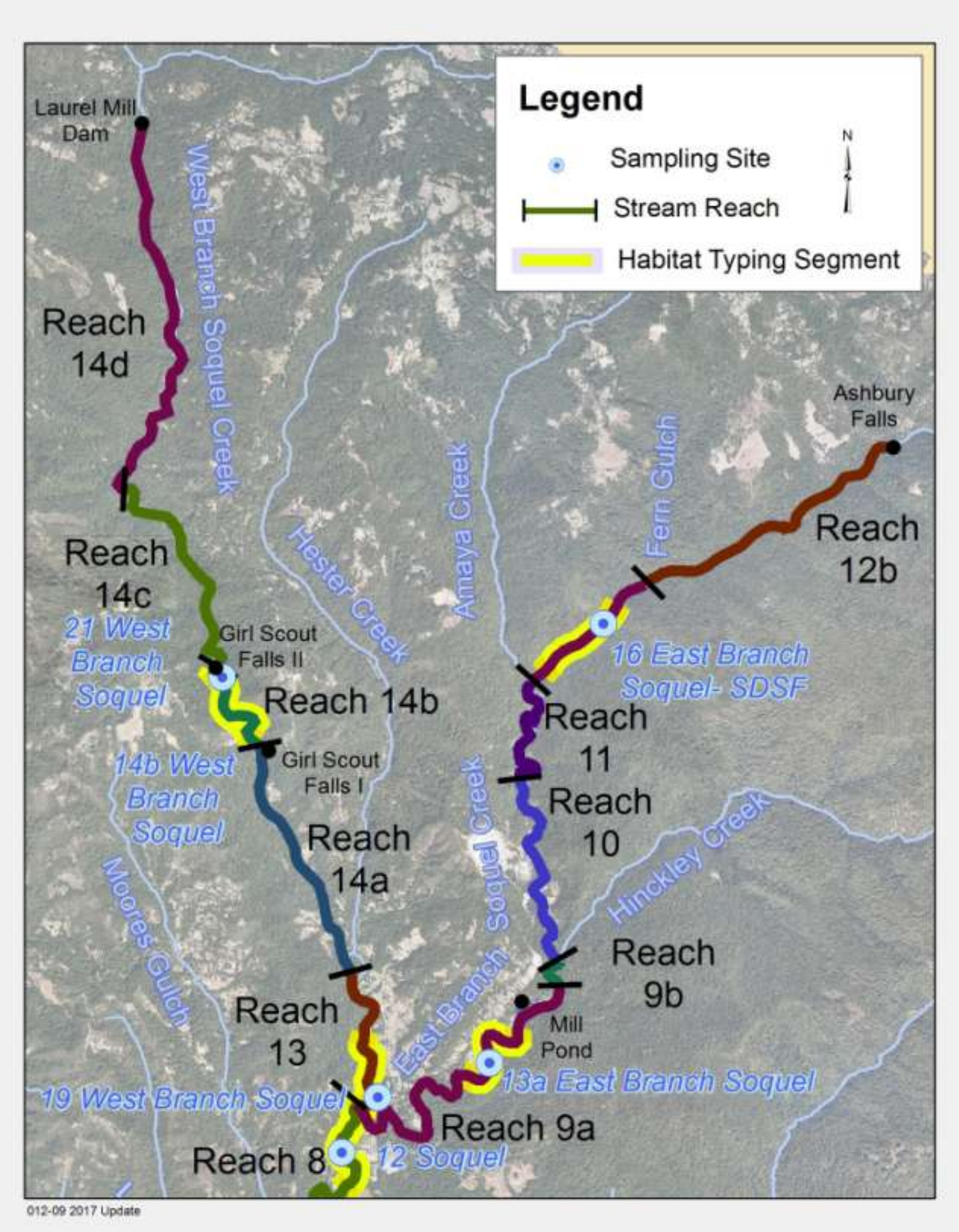


Figure 5. Upper Soquel Creek Watershed (East and West Branches; Reach 9a below habitat-typed segment and Reach 12a were dry in 2014 and 2015).

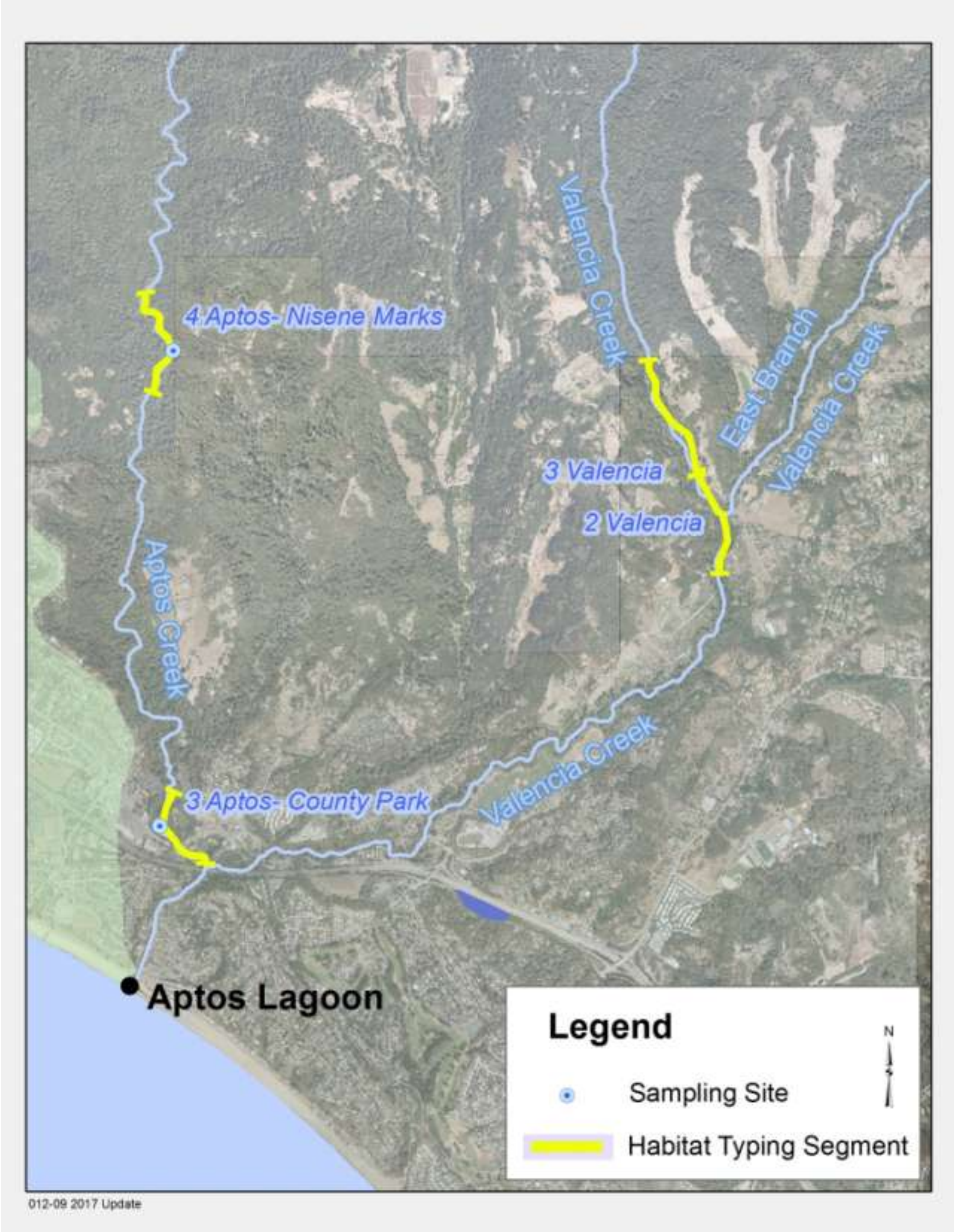


Figure 6. Aptos Creek Watershed (Aptos Lagoon not sampled in 2015 or 2016).

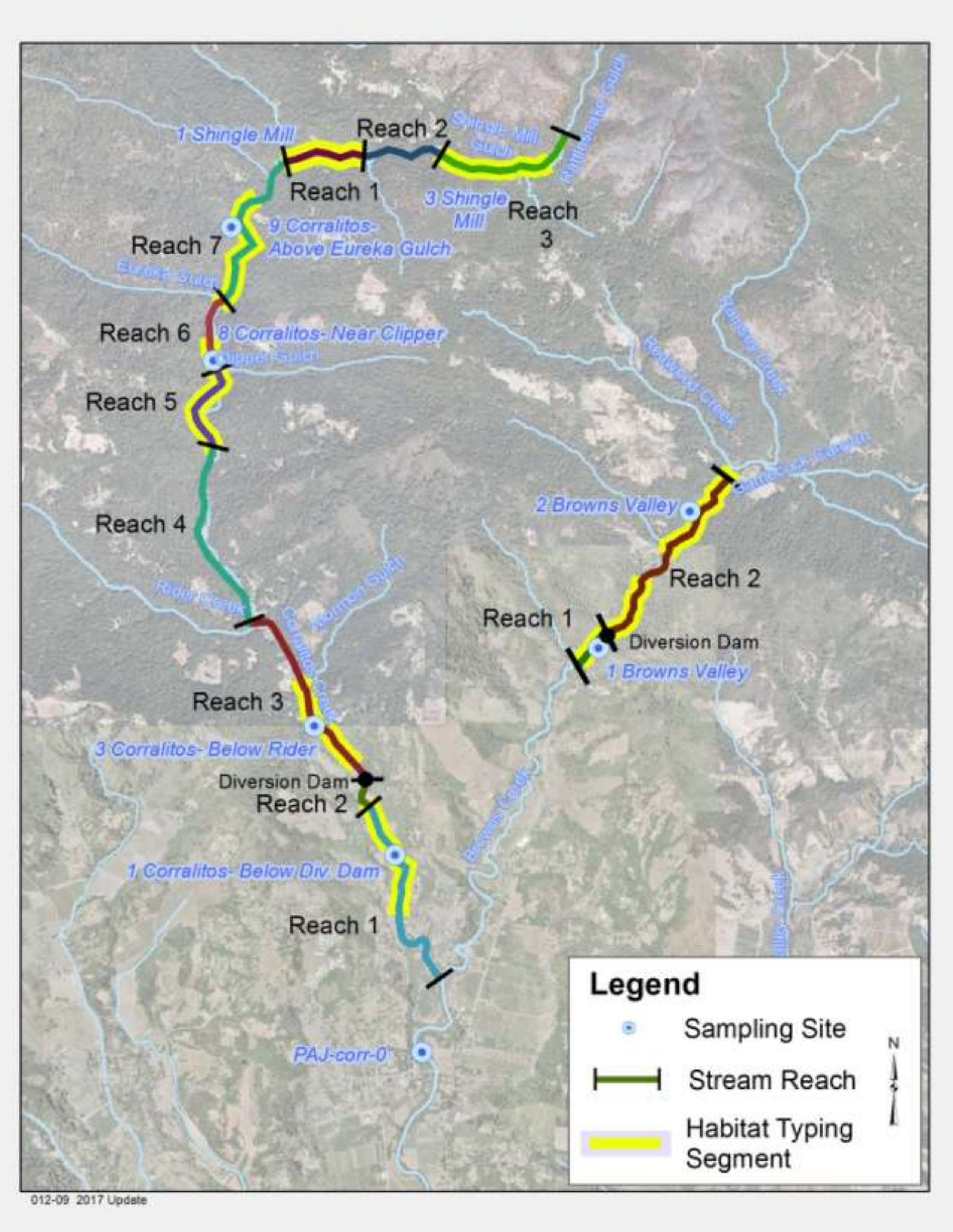


Figure 7. Upper Corralitos Creek Sub-Watershed of the Pajaro River Watershed.

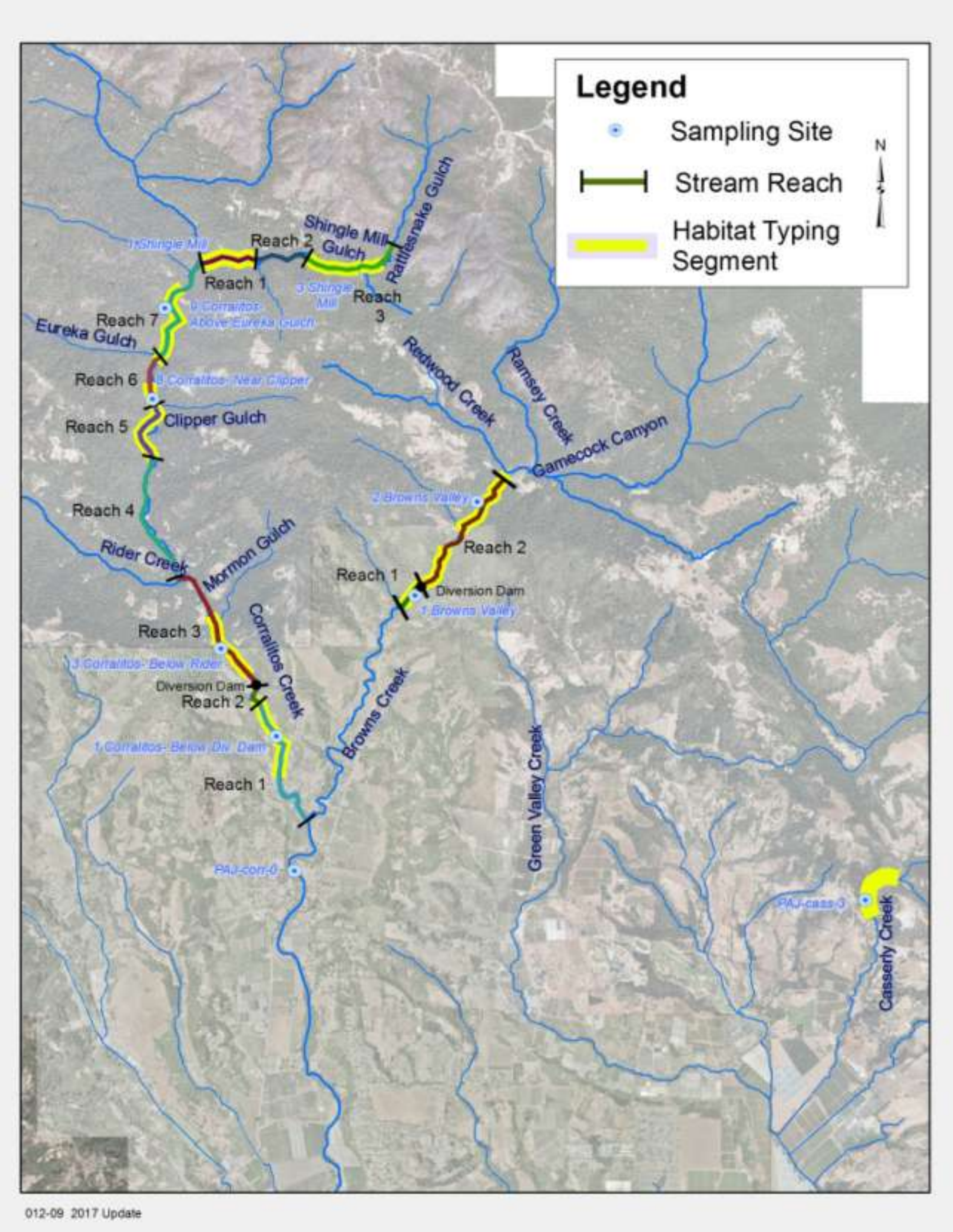


Figure 8. Upper Corralitos Creek and Casserly Sub-Watersheds of the Pajaro River Watershed.

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

(Included electronically in a separate PDF file.)