D.W. ALLEY & Associates aquatic biology

2022 SUMMARY REPORT– Juvenile Steelhead Densities and Indices of Juvenile Production in the San Lorenzo, Soquel and Aptos Watersheds, Santa Cruz County, CA

Sediment Bar Deposited after the CZU Fire, Mainstem San Lorenzo River below Boulder Creek Confluence (View Looking Downstream into Pool Habitat)

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Prepared for the **City of Santa Cruz Water Department**
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(Sampling for Tidewater Goby under USFWS Endangered Species Recovery Permit TE-793645-4)

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A. ABSTRACT

Water Year 2022 baseflow in the San Lorenzo was low and well below the median flow statistic after a third dry year in a row. One greater than bankfull stormflow and other near bankfull stormflows in December provided good adult steelhead spawning access early on. But no rain occurred in January or February in the middle of steelhead spawning season, and stormflows in March and April were small. **In the San Lorenzo watershed (SLR)**, **rearing habitat** improved across most sites in 2022 compared to 2021 due to **increased baseflow** (more food) and generally increased depth, although most sites were rated very poor to below average based on densities of soon-to-smolt sized juvenile steelhead (**Tables 2 and 3; Figures 6b and 7b**). Baseflow in 2022 downstream of the Boulder Creek confluence at Sites 0a to 9 was much improved from 2021. This may have been an affect of the CZU fire and loss of vegetation and/or reduced surface flow diversion in summer and fall. Based on NOAA Fisheries' best estimate of only modest adult steelhead returns to Scott Creek over the 2021/2022 winter and spring (**Joseph Kiernan, NOAA Fisheries pers. comm.**), we suspect that numbers of returning adults may have also been similarly low in the SLR, Soquel and Aptos watersheds as in other recent years, excepting over the 2018/2019 winter and spring. **SLR total and YOY juvenile densities** were below average at 9 of 10 mainstem sites (especially low in the middle and upper mainstem) with the exception of lower mainstem Site 4 being above average, averaging 11 total juveniles /100 ft compared to the long term average of 22, (**Figures 8 and 9**). At tributary sites, total and YOY juvenile densities were below average at 13 of 16 and 12 of 16 sites, respectively (averaging 31 total juveniles/100 ft with the long term average of 50). Spawning success was evident at all tributary sites in 2022. YOY densities increased at 13 of 26 SLR sites by more than 1 fish/ 100 ft compared to 2021 (**Figure 10**), as they did at 13 sites for total density (neither statistically different from 2021; **Table 8**). **Yearlings and Size Class II/III densities** were below average at 23 of 26 sites and their differences from 2021 were not statistically significant. Few YOY grew into Size Class II with the low May-September baseflow. The 2022 **mainstem average Size Class II density** was 3.0/100 ft compared to the long term annual average of 7.6. The 2022 **tributary average** density was 6.2/100 compared to the long term annual average of 9.8. The **production index** for Size Class II/III juveniles continued to track well with the 5-month baseflow average and was predictively low in 2022 and the third lowest since 2010. (**Figures 20a-b**). Juvenile coho salmon were not detected at our sampling sites in 2022. No juvenile steelhead PIT-tagged in the SLR lagoon/estuary were detected upstream in 2022. Nonnative bullfrog tadpoles were again present at both Boulder Creek sites, and 2 adults were again heard through the summer in a mainstem Site 8 pool in Brookdale, indicating presence downstream. A large, gravid female bullfrog was captured at middle Bean Creek Site 14b. Tables of fish densities and habitat measurements are presented in the detailed analysis report available upon request.

Water Year 2022 in Soquel Creek provided 4 bankfull flows in rapid succession in December. Then there was no rain in January and February, with 4 small stormflows in March and April (**Figure 22**). The early winter stormflow provided good spawning access in this low gradient watershed up to Hidden Falls on the West Branch (laddering of which would provide 4.5 miles of additional steelhead access) and to the East Branch in the Soquel Demonstration State Forest (SDSF). The smaller stormflows in March and April provided additional adult access to lower reaches and also encouraged out-migration of smolts. Baseflow steadily declined from early May on at well below median baseflow, with an unexpected upturn in August followed by a downturn in September down to 0.19 cfs on 13 September at the Soquel Village stream gage with wide daily fluctuations. We suspect that well pumpage and/or surface water diversion increased at this time. An early stormflow came on 18 September 2022 which peaked at 36.4 cfs at Soquel Village. Fish sampling in Soquel and Aptos creeks occurred after this small stormflow but likely did not affect juvenile densities, based on sampling experience by Alley and Smith (**pers. comm.**). **Overall 2022 rearing habitat conditions in Soquel Creek** improved in six site/reaches and declined in three (**Table 5**). Baseflow was higher in 2022 than in 2021 (**Table 4**). Sites 1, 10, 16 (SDSF on East Branch) and 21 (upper West Branch) improved with increased baseflow (more food) and generally increased pool depth and pool escape cover. Site 13a (East Branch below Mill Pond) worsened due to reduced habitat depth, increased

percent fines in runs and increased pool embeddedness. The large instream wood that was present in 2021 had moved downstream in 2022. Sedimentation from upstream was detected in Reach 8 below the branch confluences and in mainstem Reach 3a. Conditions in Reaches 3a and 8 declined from 2020 due to less baseflow, reduced habitat depth and reduced escape cover. Reach 4 improved due to increased pool depth and escape cover, despite reduced baseflow, indicating that sediment had moved through Reach 4 into Reach 3a. **Total and YOY juvenile steelhead densities in Soquel Creek** in 2022 were near average at Site 1 but much below average at the other 8 sampling sites (9 sites averaging 11.4 total juveniles/100 ft compared to the long term average of 34.4 and 10.2 YOY/100 ft compared to the long term average of 31.6) (**Figures 23 and 24**). The decrease in total and YOY juvenile densities from 2021 to 2022 were statistically significant (**Table 9; Figure 25**). Although **yearling densities** were below average at 8 of 9 sites in 2022, the differences between 2022 and 2021 densities were not statistically significant (**Table 9; Figure 26**). Though the **Size Class II densities** were well below average in 2022, the differences between 2022 and 2021 densities were not statistically significant (**Table 9; Figures 27 and 28**). The **production index** for Size Class II/III juveniles continued to track well with the 5-month baseflow average and predictively declined in 2022 to the second lowest since 2010 (**Figure 31b**).

Aptos Creek likely had a WY2022 hydrograph similar to the Soquel drainage, with stormflows at the same frequency and intensity, with several bankfull stormflows occurring in December. These stormflows likely provided better spawning access in this lower gradient watershed compared to the SLR early on. But the small stormflows in March and April 2022 may not have. An extensive instream wood cluster was detected by Chad Steiner between the two sampling sites in Aptos Creek, causing a significant adult steelhead passage impediment. There may be a suboptimal fish ladder in lower Valencia Creek, likely causing passage impedance there. Baseflow likely declined steadily from April onward. **Habitat conditions in Aptos Reach 3** in 2022 were similar to conditions in 2020, with slightly less baseflow but increased pool escape cover (**Table 6**). **Habitat conditions in Aptos Reach 4** declined slightly due to slightly reduced baseflow and reduced pool depth. **Habitat conditions declined at Site 2.** Bankfull events in December caused substantial sedimentation of Valencia Reach 2 (Site 2) below Valencia Road crossing likely caused by streambank erosion. Pool depth shallowed considerably with less escape cover, and percent fine sediment increased. Pool embeddedness remained poor. **Habitat conditions at Valencia Site 3** above Valencia Road improved with increased baseflow, deeper pool habitat and increased pool escape cover with scour objects present. Percent fine sediment and embeddedness remained similar to 2021 conditions in pools at Site 3. **Total and YOY steelhead densities in Aptos Creek** in 2022 were again below average at all 4 sites, as was the case in the two previous years (averaging 7.8 total juveniles/100 ft with the long term annual average of 23.8) (**Figures 32 and 33**. The increase in total densities was not statistically significant from 2021 levels (**Table 10**). YOY were detected in 2022 at upper Aptos Site 4 above the substantial instream wood cluster, though absent in 2021. YOY densities in 2022 were higher than in 2021 at 3 of 4 sites (**Figure 34**) with statistical significance (**Table 10**). **Yearling and older steelhead densities** were below average at all 4 sites, averaging 2.6 yearlings/100 ft (2.3 in 2021; annual average 6.1) (**Figure 35**). Annual differences were statistically insignificant. Low numbers of YOY in 2021 offered low recruitment to the yearling age class in 2022. **Size Class II/III densities** were below average at the all 4 sites, averaging 2.6 Size Class II/III juveniles/100 ft (2.3 in 2021; annual average 8.5) **(Figure 36**). They increased slightly at 3 of 4 sites in 2022 from 2021 (**Figure 37**) without statistical significance (**Table 10**). As in other watersheds, in the Aptos watershed the index of production of larger juveniles tracked positively with 5-month average baseflow (**Figure 39b**), registering the second lowest since 2010.

The **Aptos Lagoon** juvenile steelhead population was estimated at 40 (**Figure 40**) with only 8 steelhead captured the first week and 5 the second. There was one recapture. Tidewater gobies were common in the lagoon with favorable, low salinity conditions and adequate oxygen present in the shallow margins.

B. INTRODUCTION

i. Scope of Work

In fall 2022, 3 Santa Cruz County watersheds were sampled for juvenile steelhead to primarily compare juvenile abundance at multiple stratified sites in each watershed to assess trends and compare habitat conditions in habitat typed segments and at sampling sites with those in 2021 and past years in selected reaches of the San Lorenzo, Soquel and Aptos watersheds (**Figures 1−3**). Photos of selected sampling sites may be found in **Appendix A**. Results from salmonid sampling and habitat monitoring guide watershed management and planning (including implementation of public works projects) and enhancement for species recovery. Refer to the Santa Cruz County Environmental Health website http://scceh.com/steelhead.aspx for the database and more sampling site photos. Hydrographs of all previous sampling years are also available at the website. Methods of data collection and tables of habitat conditions and steelhead density by size and age class since 1997 are available upon request, and past reports that include the methods are available at the county website. Sampling sites represented average habitat conditions regarding escape cover and water depth within reaches, based on systematic and consistent habitat typing of ½-mile segments within.

ii. Study Area

San Lorenzo River. The mainstem San Lorenzo River and 8 tributaries were sampled at 26 sites (10 mainstem and 16 tributary sites) (**Figure 1**). Sampled tributaries included Branciforte, Zayante, Bean, Fall, Newell, Boulder and Bear creeks. Eight 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 2021 sites were replicated for fish sampling. Depth, cover, percent fines, embeddedness, percent tree canopy and water temperature were measured at sampling sites.

Soquel Creek. Soquel Creek and its branches were sampled at 9 sites (5 mainstem and 4 branch sites), Site 6 in Reach 4 added in 2020 after a 15-year break. Four half-mile segments were habitat typed to assess habitat conditions and select habitats of average quality to sample for fish density (**Figure 2**). For the remaining 5 sites, the 2021 sites were replicated for fish sampling. Depth, cover, percent fines, embeddedness, percent tree canopy and water temperature were measured at sampling sites.

Aptos Creek and Lagoon/Estuary. Aptos watershed was sampled for steelhead at two Aptos and two Valencia creek sites, as well as the lagoon (**Figure 3**). After habitat typing of the 2 Aptos Creek segments, sites were chosen for sampling with some 2021 site overlap at both sites, and the Valencia sites were replicated. Depth, cover, percent fines, embeddedness, percent tree canopy and water temperature were measured at all sampling sites. Water quality conditions were measured during lagoon sampling. A lagoon steelhead population estimate was made with a mark and recapture effort on 2 days in late September and early October, using a beach seine with a central bag.

Pajaro River Lagoon/ Estuary. The Pajaro River Lagoon was sampled in late September/ early October for steelhead and tidewater goby. Water quality conditions were measured during sampling. Results are presented in a separate report to the county flood control district and available if requested.

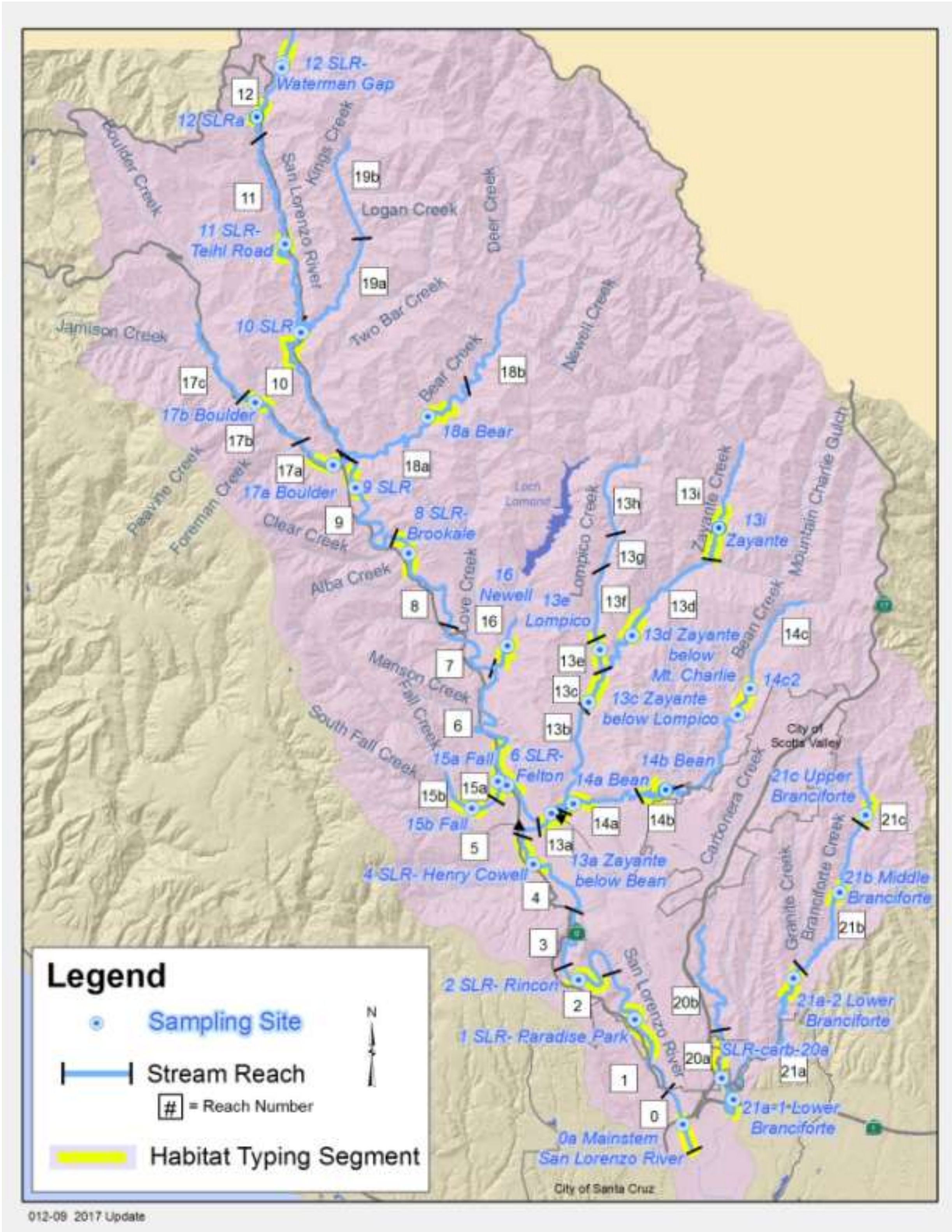

Figure 1. San Lorenzo River Watershed− Sampling Sites and Reaches.

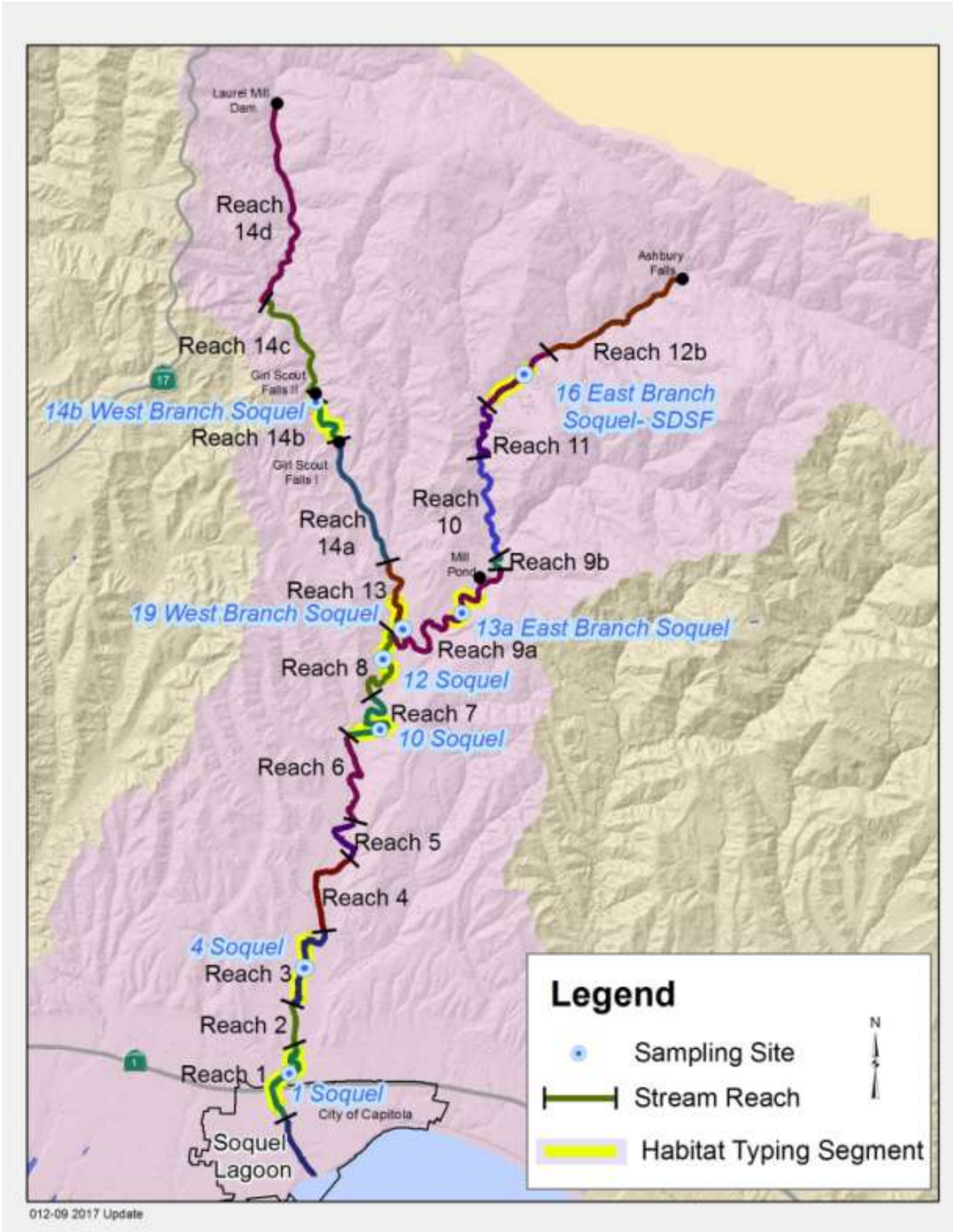

Figure 2. Soquel Creek Watershed.

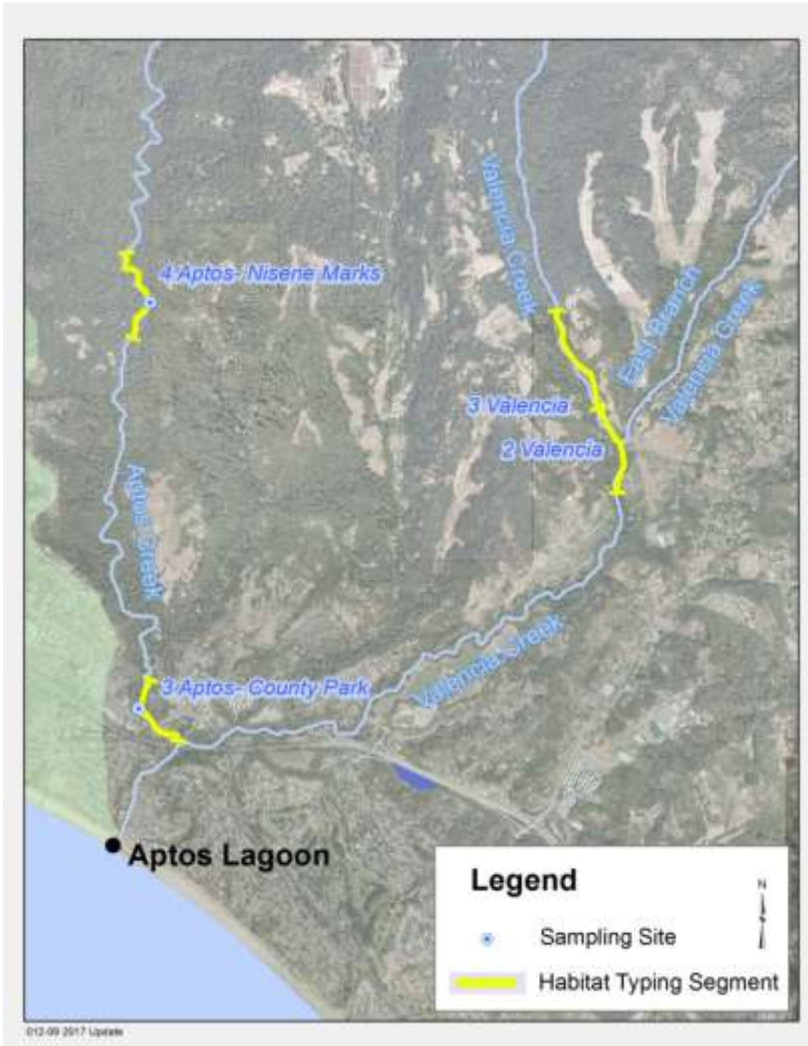

Figure 3. Aptos Creek Watershed.

C. RESULTS

i. Steelhead Abundance and Habitat Conditions in the San Lorenzo River Watershed

1. WY2022 baseflow was low and well below the median flow statistic after a third dry year in a row. This made 11 of the last 16 water years below median flow (**Table 1; Figures 4 and 5**). Based on NOAA Fisheries' best estimate of only modest adult steelhead returns to Scott Creek over the 2021/2022 winter and spring (**Joseph Kiernan, NOAA Fisheries pers. comm.; Figure 11**), we suspect that numbers of returning adults may have been similarly modest in the SLR watershed, as it may have been during the two previous winters and springs. Locally, during the 2021/2022 winter and spring in the SLR, significant stormflows occurred in November and December, with one in December at near 6,000 cfs and 2 more close to 2,500 cfs (bankfull > 3,000 cfs) at the Big Trees gage. There was no stormflow in January and February, with 4 minor stormflows less than 150 cfs each in March and April. Baseflow declined steadily from May onward at much below median baseflow levels until a low of 10.1 cfs registered at the Big Trees Gage on 12 September. Baseflow in 2022 was measured by us a month after the first early stormflow that occurred on 18 September, registering a peak of 77.6 cfs at Big Trees Gage. Fish sampling was completed in the SLR watershed prior to this small stormflow. Streamflow at the Big Trees Gage was 13.4 cfs on 14 October when other streamflow measurements were made (**Table 1**).

2. In the SLR watershed, rearing habitat improved across most sites in 2022 compared to 2021 due to **increased baseflow** (more food) and generally **increased depth**, although most sites were rated very poor to below average based on densities of soon-to-smolt sized juvenile steelhead (**Tables 2 and 3; Figures 6b and 7b**). Baseflow was much improved from 2021 downstream of the Boulder Creek confluence at Sites 0a to 9. This may have been an affect of the CZU fire and loss of vegetation and/or reduced surface flow diversion. In the mainstem, fine sediment percent and embeddedness were similar to 2021 in Reach 2, with the average and averaged maximum depth in pools and fastwater habitats in the ½-mile habitat typed segment increasing 0.1 to 0.2 feet, likely due to increased baseflow. Fine sediment and embeddedness increased in fastwater habitats at most other mainstem sampling sites. Escape cover declined considerably at Sites 1, 4 and 6 and in Reach 2 (**Figure 6a**) and was mostly similar at other mainstem sites. Only Site 4 in the mainstem had overall habitat decline from 2021 due to increased sediment, increased embeddedness and less escape cover in fastwater habitat, despite increased baseflow. Site 10 below the Kings Creek confluence showed sedimentation with reduced pool and riffle depth and increased sediment percent and embeddedness in pool and fastwater habitat. Pool depth declined and percent sediment increased in pools at the Waterman Gap Site 12b. Tables of habitat measurements are presented in the detailed analysis report available upon request.

3. In SLR tributaries, habitat quality increased at all sites and reaches due to increased baseflow and mostly increased habitat depth and mostly similar or increased escape cover. Only habitat in Reach 14b in middle Bean Creek below the Lockhart Gulch confluence declined overall with reduced maximum pool depth and reduced escape cover. In Reach 13d below Mt. Charlie Gulch, pool escape cover decreased while pool depth increased slightly (**Figures 7a and 7b**). Both Fall Creek reaches showed improved habitat overall with much increased baseflow, increased habitat depth and increased escape cover compared to 2021. Both Boulder Creek reaches showed habitat improvement overall with much higher baseflow and habitat depth, despite higher percent sediment in both reaches (sedimentation) and reduced pool escape cover and increased run embeddedness in lower Reach 17a. Newell Creek Site 16a showed much improved habitat compared to 2021 with increased baseflow, deeper habitat, reduced pool percent fines and greater pool escape cover. Upper Bear Creek Site 18b showed evidence of sedimentation with increased fine sediment and embeddedness, though baseflow was higher and habitat was deeper in 2022 compared to 2021. Branciforte Creek sites showed sedimentation with shallower pool depth at both sites and increased percent sediment at the uppermost Site 21b.

4. **SLR total and YOY juvenile densities** were below average at 9 of 10 mainstem sites (especially low in the middle and upper mainstem), averaging 11 total juveniles /100 ft (8 in 2021; 12 in 2020; 35 in 2019), with the exception of lower mainstem Site 4 being above average (**Figures 8 and 9**). Year classes and size classes are defined in the glossary. Some YOY may reach Size Class II where food is more abundant. Therefore, at some sites the Size Class II/III group includes YOY and yearlings. At tributary sites, total and YOY juvenile densities were below average at 13 of 16 and 12 of 16 sites, respectively (averaging 31 total juveniles/100 ft (32 in 2021; 35 in 2020; 68 in 2019). YOY densities were above average at middle Zayante 13c below Lompico Creek and both Boulder Creek Sites 17a and 17b. YOY juveniles were present at intermittent upper Bean Site14c-2 but in low densities. Spawning success was evident at all tributary sites in 2022. Upper Bear Site 18b had near average YOY densities while lower Bear Site 18a had much below YOY densities, as did both

Branciforte sites. 2022 YOY densities increased at 13 of 26 SLR sites by more than 1 fish/ 100 ft compared to 2021 (**Figure 10**), as they did at 13 sites for total density (neither statistically different from 2020; **Table 8**). Upper tributary sites had much higher YOY densities than 2021 presumably because of better spawning access in 2022, except for upper Branciforte 21b. In 2022, middle Zayante 13c doubled its 2021 YOY density to an above average level. Tables of fish densities are in the detailed analysis report available upon request.

5. The 5-mainstem site, long term ***trend in total density*** (consisting of mostly YOY) increased slightly in 2022 (**Figure 15**). The 10-site mainstem average YOY density increased from 7 juveniles/100 ft in 2021 to 10 in 2022 (10 in 2020; 33 in 2019- a wetter year). The 8-tributary site, long term ***trend in total density*** (consisting of mostly YOY) increased slightly in 2022 (**Figure 16**). The 2022 16-site tributary average YOY density remained at 28 juveniles/100 ft in 2022 as it was in 2021 (25 in 2020; 63 in 2019- a wetter year).

6. Four factors may explain the **below average YOY densities** at most sites in 2022. The **main factor** may have been low adult returns. Supportively, adult returns to Scott Creek indicated a relatively low adult steelhead run (**Figure 11**). Indications of low adult returns may have resulted from less favorable ocean rearing conditions as other recent years. A **second factor** may have been limited spawning access to the upper watershed. Larger stormflows came in December, which was early in the spawning season, and no rain came in January or February, with only a small stormflow in April. A **third factor** may have been poor egg survival during a relatively dry winter that provided poor spawning conditions except early on. A **fourth factor** may have been much below median baseflow that provided less food and rearing habitat to reduce YOY survival where YOY densities were moderate in spring/early summer but food competition intensified through the dry season.YOY size was small at most sites, indicating slow growth and high competition for food, except at middle Bean 14b where YOY densities were very low and baseflow was moderate (**Figure 21**). Average steelhead length at sites was greater in most years with higher baseflow, excepting 2019 when storms were late and steelhead spawning may have been delayed. Relevant here is that Smith (**pers. comm.**) found from scale analysis of returning adult steelhead that YOY that did not reach at least 60 mm SL their first year did not survive to return as adults to the San Lorenzo River.

7. Inconsistent with low YOY densities found in the San Lorenzo in 2022, Smith (**2022**) found YOY steelhead to be relatively abundant and at above average densities in Gazos Creek (47 YOY/ 100 ft) and Scott Creek (54 YOY/ 100 ft), similar to higher baseflow years of 2017 and 2019 and despite relatively high coho juvenile densities in Scott Creek. However, Waddell Creek had a low average YOY density (6.3 YOY/ 100 ft), consistent with the low San Lorenzo YOY densities. All three of the Smith-sampled watersheds were impacted by the 2020 CZU fire, and baseflows were elevated due to the vegetation transpiration loss.

8. **Yearling densities** were below average at most SLR sites in 2022 (23 of 26 sites, averaging 2.7 fish/100 ft; ranging from 0.3 to 8/100 ft) (**Figure 12**), as they had been below average in dry 2020 and 2021. The slightly reduced density from 2021 to 2022 was not statistically significant (**Table 8**). Densities were only slightly above average at lower Bean 14a and lower Fall 15a, which had increased streamflow compared to 2021, Yearling densities were lowest at all mainstem sites, as well as middle and upper Bean (14b and 14c-2) and lower Bear (18a). Near average densities were found at mainstem SLR-1 and SLR-10, lower Zayante 13a and lower Bean 14a. Smith (**2022**) found yearling density in Gazos Creek (5.1/100 ft) “similar to past years,” though much higher at sites upstream of 2020 fire damage than below. He found yearling densities in Scott Creek “lower than usual” (3.1/100 ft) and in Waddell Creek very low (0.9/100 ft).

9. **Size Class II/III** (=> 75 mm SL) **densities** were much below average at most SLR sites (23 of 26 sites as was the case in 2021) for these larger juveniles, averaging 5.0/100 ft; ranging from 0.2 to 12.6/100 ft) (**Figure 13**), as they had been below average in dry 2021 and 2020. The differences in Size Class II/III densities from 2021 to 2022 were not statistically significant, with half decreasing in 2022 and half increasing (**Table 8; Figure 14**), as the reductions had been significant from 2019 to 2020 and 2020 to 2021. Densities were slightly above average at only mainstem SLR-10, lower Fall 15a and lower Boulder 17a. The sites most below average were 8 of 10 mainstem sites (especially SLR 12b in Waterman Gap), upper Zayante 13d, middle Bean 14b, upper Bean 14c-2, upper Fall 15b and upper Boulder 17b. At all sites in 2022, low YOY densities and their slow growth due to low baseflow in spring and summer likely caused reduced Size Class II densities (fewer YOY reached 75 mm SL), along with low yearling densities. The 2022 **mainstem average** density was 3.0/100 ft (2.8/100 ft in 2021; 6.6 in 2020; 9.7 in 2019). The 2022 **tributary average** density was 6.2/100 ft (5.6/100 ft in 2021; 7.8. 100 ft in 2020; 7.5/100 ft in 2019). The average **5-site mainstem trend** in soon-to-smolt densities decreased slightly in 2022 (**Figure 17**) (3.0 fish/100 ft; 22-year average of 6.9). The average **7-site tributary trend** also decreased in 2022 (**Figure 18a**) (6.0 fish/ 100 ft; 25-year average of 10.9). Trends in densities of these larger juveniles follow similar fluctuations through the wet and dry years in the SLR and Soquel watersheds (**Figure 18b**), but less so for the Aptos/Valencia watershed where annual baseflow fluctuates less. Densities of Size Class II/III steelhead typically increase in wet years with faster YOY growth rate and decrease in dry years in the SLR and Soquel watersheds.

10. Low yearling and Size Class II/III densities in 2022 at non-headwater sites may have occurred partially because of poor recruitment of YOY from low 2021 densities and limited winter and spring stormflows that resulted in high water clarity and sufficient drifting aquatic insects to allow young yearlings to grow and smolt in late spring without spending a second summer in freshwater. This spring growth was noted from our smolts trapped during drought in 1987 and 1988 (**Jerry Smith pers. comm.**). The small March and April stormflows also facilitated smolt out-migration. Also, with **1)** the generally low YOY densities, **2)** low yearling densities (Zayante 13d, Bean 14b and 14c-2, Boulder 17b, Branciforte21a-2), **3)** low 2022 baseflow in eastern tributaries, and **4)** low YOY densities in mainstem sites that benefited from higher baseflows entering from Boulder, Clear and Fall creeks in 2022, **the result was** fewer yearlings in Size Class II and fewer YOY reaching Size Class II in the normally more food abundant lower mainstem reaches and lower tributary reaches of Zayante and Bear creeks and middle Bean Creek. Consistent with other dry years with slower juvenile steelhead growth rate, The average size of juveniles at sampling sites in the dry 2022 was generally on the small side, except at some sites where total densities were very low and competition for food was low (Bean 14b and Bear 18a) (**Figures 8 and 21**).

11. For soon-to-smolt-sized juveniles, annual average site densities positively tracked with the 5-month baseflow average for 1997-2022 (**Figures 18b, 19a-b**). Production indices of these larger juveniles also track well with the 5-month (May-September) monthly baseflow average at the Big Trees USGS gage on the San Lorenzo River for 2010-2022 and for additional mainstem production indices from the late 1990’s and early 2000’s to the 2010-2022 period (**Figures 20a-b**).

12. The 10 mainstem sites were rated between “very poor” and “below average” in 2022 based on soon-to-smolt densities (**Table 2**). Ratings incorporate fish density and fish size. Eight of 16 tributary sites were rated in the same range, including Zayante 13d at “below average,” which usually has much higher ratings due to normally higher yearling densities (**Figure 12**). Fall 15a and Newell 16 were rated “good.” Those tributary sites rated “fair” were Zayante 13a and 13c, Fall 15b, Boulder 17a, Bear 18b and Branciforte 21b. Sites that had large rating reductions from 2021 to 2022 were Zayante 13d and Bear 18a.

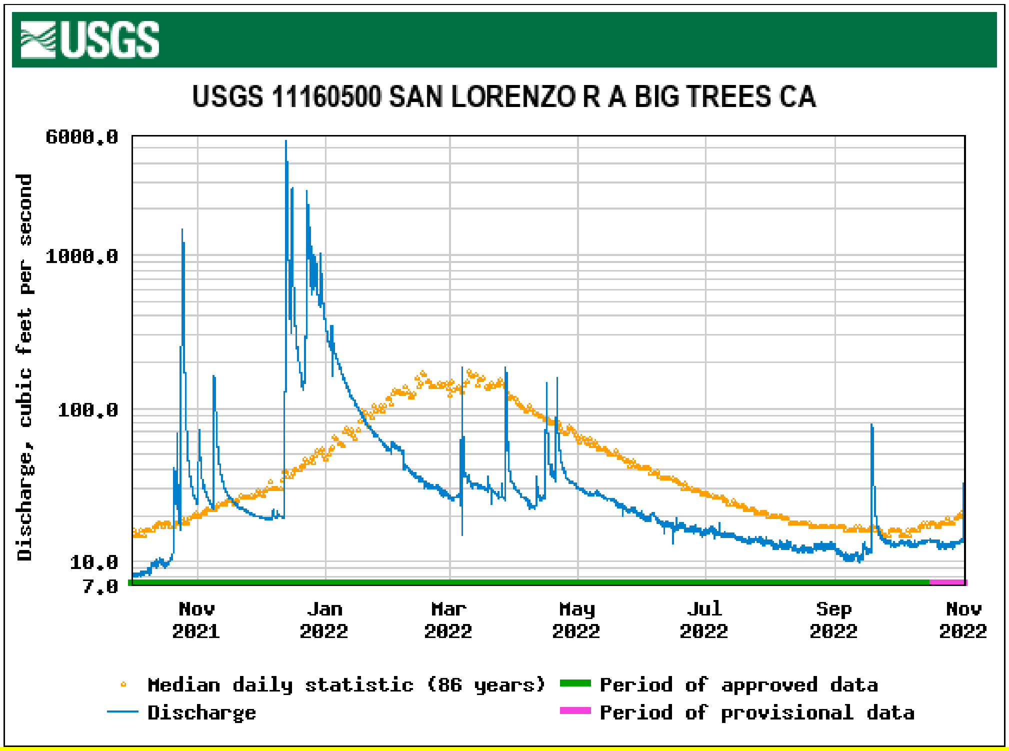

Figure 4. The WY2022 Streamflow for the USGS Big Trees Gage on the San Lorenzo River at Felton.

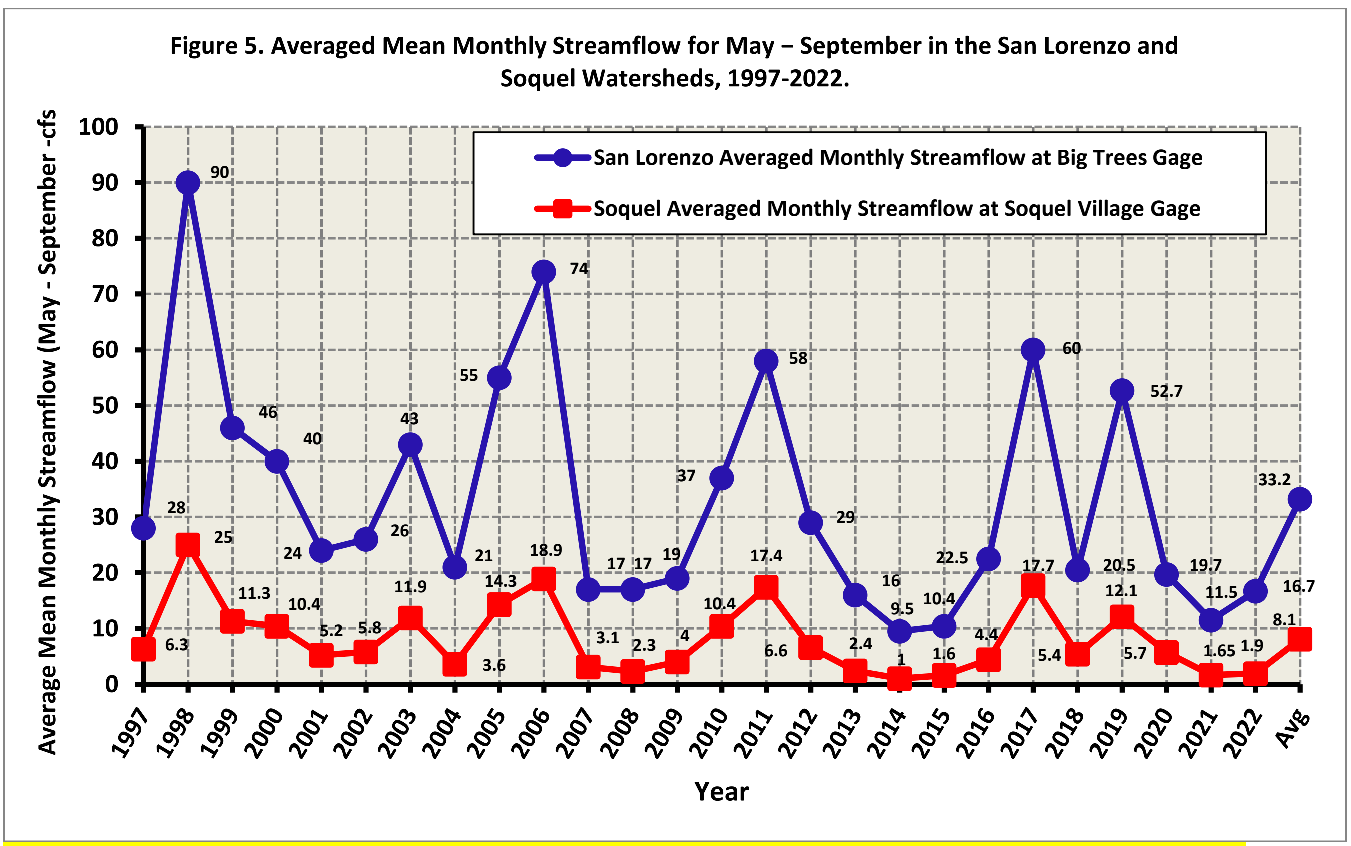

Figure 5. Average Mean Monthly Streamflow, May–September, San Lorenzo and Soquel Watersheds 1997-2022.

Table 1. Fall STREAMFLOW (cubic feet/ sec) measured by D.W. ALLEY & Associates at SAN LORENZO sampling sites before fall storms (or in 2011 and 2022 when baseflow had resumed after an early storm) and at the USGS Gages at Big Trees (Felton) and Santa Cruz..

Site # / Location	1995/ 1996	1998	1999	2000	2001	2005	2006	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022**
0a- Santa Cruz								5.5 2 Oct	12 23 Sep	5.2 19 Oct	5.6 23 Oct	1.2 19 Oct	2.4–4.4 16 Oct	8.8 6 Oct	14 12 Oct	8.7 12 Oct	15.2 12 Oct	8.9 12 Oct	3.8 16 Oct	8.8 16 Oct
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		22.6	13.5	22.8	13.1	9.65	13.7
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 Big Trees Gage	22.0/ 21.0	27.0	21.0	22.0	13.0	21.0	27.0	15.1	24.8	15.9	11.2	6.41	6.19	12.2 6 Oct	21.4	12.1	18.1	11.8	9.8	13.4 14 Oct
6- SLR/ Below Fall	14.6	23.4	12.8	11.6	9.4	18.9	14.3					3.7	3.25	6.99	12.9	6.68				
8- SLR/ Below Clear	4.2	10.3	4.9	4.2	3.1	7.1	6.4	4.0		2.8	1.7	0.95	1.11	2.35	4.71	2.61	4.53	2.41	1.54	3.85
9- SLR/ Below Bould.	4.6	7.2	3.5		3.0	5.8						0.80	0.88	1.82	4.02	1.43	4.36			
10- SLR/ Below Kings			3.0	1.1	1.3	1.4														
11- SLR/ Teihl Rd		1.7	0.8	0.8	0.4	1.5		0.94	1.10	0.40	0.38	0.13	0.21		1.07	0.35	0.87	0.24	0.17	0.28
12a-b SLR/ Lower Waterman		1.0	0.7								0.33	0.10	0.22		0.85	0.39	0.78	0.32	0.17	0.20
13a/ Zayante below Bean		8.5	6.3	5.2	4.7	7.4	7.8*	4.9	7.2	4.4	3.9	3.2	2.9		8.27	4.04	5.96	4.64	3.05	3.95
14b/Bean bel Lockhart G	1.5	1.1	1.1	1.0	1.1	1.0	1.1						0.62							
14c/Bean abv MacKenzie								0.03	0.11	Dry	Dry	Dry	Dry	Dry	0.07	Dry	Wet	Dry	Dry	Dry
14c-2/Bean abv MacKenzie																0.02	0.06	0.02	Part Dry	Part 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 Bel div Bal	1.39 Below div.	2.80 Bel div.	1.00 Bel div.		1.01 Below div	0.61 Below div	1.33 Below Div
16/ Newell	1.6			0.51				1.2	0.92	0.78	0.78	0.08	0.04		1.05	0.87		1.07 SCWD	0.29 (SCWD)	0.96 (SCWD)
17a/ Boulder	2.0	2.2		1.1	1.0	1.6	1.7	1.6	2.2	1.1	1.1	0.76 Bal	0.66 Bal	1.39 Bal	1.76	0.94	1.45	1.24	1.00	1.81
18a/ Bear abv Hopkins G			0.45	0.61	0.34	0.90	1.1	0.68	1.3	0.23	0.16	0.03	0.02		0.90	0.21	0.70	0.10	0.06	0.175
21a-2/ Branciforte		0.80						0.44	0.81	0.32	0.29		0.13			0.37	0.38	0.29	0.18	0.44

***Streamflow in lower Zayante Creek done 3 weeks earlier in 2006 than usual and before other sites.**
****Streamflow was measured in mid-October 2022 after a mid-September stormflow, which partially elevated baseflow.**

Table 2. 2022 Sampling Sites Rated by Potential Smolt-Sized Juvenile Density (=>75 mm SL) and Average Smolt Size, with Physical Habitat Change since Previous Reach or Site Measurements. (Number of @ symbols refers to Smith ratings 1-7 listed after this table. Red denotes ratings of 1−3 below average or negative habitat change; purple denotes ratings of 5−7. Methods for assessing habitat change are in previous years' reports and available upon request. Average size affects rating.)

Site	Multi-Year Avg. Potential Smolt Density Per 100 ft/ Avg Pot. Smolt Length SL (since 2006 for SL)	2022 Potential Smolt Density (per 100 ft)/ Avg Pot. Smolt Size SL	2022 Symbolic Rating (1 to 7)	2021 Potential Smolt Density (per 100 ft)/ Avg Pot. Smolt Size SL	Physical Habitat Change by Reach/Site (Since 2021 unless Specified)
Low. San Lorenzo #0a	7.3/ 119 mm	2.4/ 117 mm	@@@ Below Average	3.1/ 85 mm	*Site* +
Low. San Lorenzo #1	7.7/ 108 mm	3.2/ 96 mm	@@ Poor	4.8/ 89 mm	*Site* +
Low. San Lorenzo #2	12.9/ 100	5.5/ 89 mm	@@@ Below Average	2.3/ 103 mm	*Reach* +
Low. San Lorenzo #4	12.5/ 89 mm	10.5/ 84 mm	@@@ Below Average	8.3/ 85 mm	*Site* +
Mid. San Lorenzo #6	3.4/ 95 mm	0.2/ 165 mm	@@ Poor	1.0/ 103 mm	*Site* +
Mid. San Lorenzo #8	4.5/ 93 mm	0.3/ 143 mm	@@ Poor	0.5/ 92 mm	*Site* +
Mid. San Lorenzo #9	4.8/ 92 mm	0.7/ 88 mm	@ Very Poor	0.5/ 96 mm	*Site* +
Up. San Lorenzo #10	4.9/ 102 mm	5.1/ 84 mm	@@@ Below Average	1.1/ 116 mm	*Site* +
Up. San Lorenzo #11	5.6/ 107 mm	0.85/ 157 mm	@@ Poor	2.5/ 121 mm	*Site* +
Up. San Loren #12b	12.3/ 105 mm	1.7/ 157 mm	@@ Poor	4.2/ 119 mm	*Site* +
Zayante #13a	8.0/ 100 mm	4.8/ 142 mm	@@@@ Fair	3.7/ 95 mm	*Site* +
Zayante #13c	14.9/ 92 mm	12.6/ 90 mm	@@@@ Fair	6.1/ 90 mm	*Site* +
Zayante #13d	15.2/ 101 mm	5.6/ 100 mm	@@@ Below Average	11.3/ 101 mm	*Reach* +
Zayante #13i	8.6/ 104 mm	2.4/ 112 mm	@@@ Below Average	5.2/ 111 mm	*Site* +
Bean #14a	4.1/ 94 mm	2.6/ 106 mm	@@@ Below Average	2.6/ 99 mm	*Site* +
Bean #14b	10.6/ 104 mm	3.4/ 102 mm	@@@ Below Average	5.3/ 113 mm	*Reach* −
Bean #14c-2	7.5/ 110 mm (14c-1 & 14c-2)	0.7/ 178 mm	@@ Poor	2.5/ 121 mm	*Site* +
Fall #15a	7.9/ 102 mm	8.8/ 105 mm	@@@@@ Good	7.0/ 102 mm	*Reach* +
Fall #15b	11.2/ 106 mm	6.3/ 114 mm	@@@@ Fair	6.4/ 108 mm	*Reach* + *(Since 2020)*
Newell #16	11.4/ 98 mm	9.8/ 110 mm	@@@@@ Good	0.9/ 100 mm	*Site* +
Boulder #17a	9.9/ 105 mm	11.3/ 95 mm	@@@@ Fair	2.9/ 100 mm	*Reach* +
Boulder #17b	9.8/ 97 mm	3.2/ 101 mm	@@ Poor	5.9/ 98 mm	*Reach* + *(Since 2020)*
Bear #18a	8.2/ 101 mm	4.4/ 97 mm	@@@ Below Average	11.8/ 88 mm	*Site* +
Bear #18b	9.8/ 102 mm	5.9/ 110 mm	@@@@ Fair	3.8/ 112 mm	*Site* +

Site	Multi-Year Avg. Potential Smolt Density Per 100 ft/ Avg Pot. Smolt Size Since 2006	2022 Potential Smolt Density (per 100 ft)/ Avg Pot. Smolt Size SL	2022 Symbolic Rating (1 to 7)	2021 Potential Smolt Density (per 100 ft)/ Avg Pot. Smolt Size SL	Physical Habitat Change by Reach/Site (Since Previous Measure)
Branciforte #21a-2	8.4/ 101 mm	7.6/ 88 mm	@@ Poor	5.2/ 96 mm	*Reach +* *(Since 2020)*
Branciforte 21b	11.5/ 100 mm	8.5/ 94 mm	@@@@ Fair	9.0/ 101 mm	*Site +*
Soquel #1	3.6/ 104 mm	0.6/ 121 mm	@@ Poor	4.1/ 101 mm	*Site +*
Soquel #4	6.7/ 103 mm	0.4/ 84 mm	@ Very Poor	1.9/ 99 mm	*Reach –* *(Since 2020)*
Soquel #6	5.2/ 100 mm	1.5/ 105 mm	@@ Poor	3.6/ 96 mm	*Reach +* *(Since 2020)*
Soquel #10	9.0/ 90 mm	3.1/ 81 mm	@ Very Poor	2.4/ 78 mm	*Site +*
Soquel #12	7.6/ 93 mm	0.4/ 77 mm	@ Very Poor	1.1/ 82 mm	*Reach –* *(Since 2020)*
East Branch Soquel #13a	8.8/ 99 mm	6.3/ 88 mm	@@ Poor	1.4/ 93 mm	*Site –*
East Branch Soquel #16	9.2/ 99mm	2.0/ 119 mm	@@@ Below Average	3.5/ 91 mm (Site #15)	*Site +* *(Since 2020)*
West Branch Soquel #19	5.4/ 93 mm	1.3/ 82 mm	@ Very Poor	1.8/ 87 mm	*Reach +* *(Since 2015)*
West Branch Soquel #21	9.4/ 97 mm	3.5/ 99 mm	@@ Poor	4.2/ 95 mm	*Site +*
Aptos #3	7.8/ 107 mm	2.5/ 103 mm	@@@ Below Average	1.6/ 98 mm	*Reach Similar* *(Since 2020)*
Aptos #4	8.5/ 106 mm	3.8/ 104 mm	@@@ Below Average	2.1/ 139 mm	*Reach –* *(Since 2020)*
Valencia #2	7.3/ 97 mm	1.5/ 113 mm	@@ Poor	3.8/ 102 mm	*Site –*
Valencia #3	10.2/ 103 mm	2.6/ 109 mm	@@@ Below Average	1.8/ 123 mm	*Site +*

Ratings of Steelhead Rearing Habitat For Small, Central Coast Streams.
(Assumes saturated habitat; From Smith 1982.)

1. Very Poor- less than 2 smolt-sized (<=75 mm SL) fish per 100 feet of stream.

2. Poor- from 2 to 4 " " " "

3. Below Average- 4 to 8 " " " "

4. Fair- 8 to 16 " " " "

5. Good- 16 to 32 " " " "

6. Very Good- 32 to 64 " " " "

7. Excellent- 64 or more " " " "

Average Length less than 89 mm SL- reduces rating;
Average Length greater than 102 mm SL- increases rating

Table 3. Habitat Change in the SAN LORENZO MAINSTEM AND TRIBUTARIES from most recent years' reach averages compared to 2022 reach averages, or site comparisons when reach averages were unavailable. (Green highlight indicates Reach Comparisons. Yellow highlight indicates Site Comparisons.)

Reach or (Site Only) Comparison To Previous Years	2022 Baseflow Comparison (Most Important Factor May-September)	Pool Depth / Fastwater Habitat Depth	Fine Sediment Pool/ Fastwater	Embed-dedness Pool/ Fastwater	Pool Escape Cover/ Fastwater Habitat Cover	Overall Habitat Change & (Any Improvement)
(Mainstem Site 0a) (Since lower baseflow 2021)	Very +	Same / + riffle	Same / +	−+ / Sim	Sim / +	+ (more food, less sediment & more cover in fastwater)
(Mainstem Site 1) (Since lower baseflow 2021)	+	/ − riffle & + run	/ −	/ Sim	/ Very −	+ (more food, deeper runs)
Mainstem Rch 2 (Since lower baseflow 2021)	+	+ / +	Sim / Sim	Sim / Sim	− / Very −	+ (more food, deeper habitat)
(Mainstem Site 4) (Since lower baseflow 2021)	+	/ Same riffle + run	/ + riffle − run	/ Same run − riffle	/ Very −	− (more food less riffle sediment, deeper runs)
(Mainstem Site 6) (Since lower baseflow 2021)	+	/ +	/ − riffle Sim. run	/ − riffle Sim run	/ Very −	+ (more food, deeper fastwater habitat)
(Mainstem Site 8) (Since lower baseflow 2021)	+	/ − riffle max + run	/ + run Same riffle	/ same riffle Sim run	/ Sim	+ (more food, greater run depth and less fun sediment)
(Mainstem Site 9) (Since lower baseflow 2021)	+	/ +	/ −	/ Sim riffle − run	/ +	+ (more food, deeper fastwater habitat with more cover)
(Mainstem Site 10) (Since lower baseflow 2021)	Slightly +	− / − riffle + run	− / −	− / −	Sim / Sim	+ (more food, deeper runs)
(Mainstem Site 11) (Since lower baseflow 2021)	Slightly +	+ / + max	Same/ Sim	Sim / − run	+ / Sim	+ (more food, deeper habitat, more pool cover)
(Mainstem Site 12b) (Since lower baseflow 2021)	Slightly +	− max / + max	− / Sim	Sim / − run + riffle	Same / Sim	+ (more food, deeper fastwater habitat, reduced riffle embed.)

Reach or (Site Only) Comparison To Previous Years	2022 Baseflow Comparison (Most Important Factor May-September)	Pool Depth / Fastwater Habitat Depth	Fine Sediment Pool/ Fastwater	Embed-dedness Pool/ Fastwater	Pool Escape Cover/ Fastwater Habitat Cover in Mainstem below Boulder Creek	Overall Habitat Change & (Any Improvement)
(Zayante Site 13a) (Since lower baseflow 2021)	+	+ / +	Same / − riffle Same run	− / −	Sim /	+ (more food, deeper habitat)
(Zayante Site 13c) (Since lower baseflow 2021)	+	Same / +	+ / Same	Same / Sim riffle + run	− /	+ (more food, deeper fastwater habitat, less pool sediment, less run embeddedness)
Zayante Reach 13d (Since lower baseflow 2021)	+	+ / Same riffle + run	Sim / Sim	Sim / Sim riffle + run	− / Sim	+ (more food deeper habitat, less run embeddedness)
(Zayante Site 13i) (Since lower baseflow 2021)	+	− / +	− / − riffle Same Run	− / Sim riffle − run	+ /	+ (more food, deeper fastwater habitat, more pool cover)
(Bean Site 14a) (Since lower baseflow 2021)	+	+ avg, − max / Same avg, − run max	− / Sim riffle + run	− / − riffle Sim run	Sim /	+ (more food, increased avg pool depth, less run sediment)
Bean Reach 14b (Since lower baseflow 2021)	+	− max / Same riffle + run avg	Sim / Sim	Same / Sim	− / −	− (more food, increased avg run depth)
(Bean Site 14c-2) (Since similar baseflow 2021)	Same (partially dry, poor water quality)	+ / Same	Same / + run	+ / + run	+ /	+ (more pool depth and cover)
Fall Reach 15a (Since lower baseflow 2021)	Very +	+ / +	Sim / Sim	Same / Sim	Sim / +	+ (more food, deeper habitat, more fastwater cover)
(Fall Reach 15b) (Since lower baseflow 2020)	Very +	+ / +	Sim / Sim riffle − run	+ / Sim	+ / +	+ (more food, deeper habitat, less pool embed., more cover)

Reach or (Site Only) Comparison To Previous Years	2022 Baseflow Comparison (Most Important Factor May-September)	Pool Depth / Fastwater Habitat Depth in Mainstem below Boulder Creek	Fine Sediment Pool/ Fastwater	Embed-dedness Pool/ Fastwater	Pool Escape Cover/ Fastwater Habitat Cover in Mainstem below Boulder Creek	Overall Habitat Change & (Any Improvement)
(Newell Site 16) (Since lower baseflow 2021)	**Very +**	**+ / +**	**+ / Sim riffle − run**	**Sim / Sim riff − run**	**+ /**	**+ (more food, deeper habitat, less pool sediment, more pool cover)**
Boulder Reach 17a (Since lower baseflow 2021)	**Very +**	**+ / +**	**− / Sim riffle − run**	**Sim / Sim riffle − run**	**− / Sim**	**+ (more food, deeper habitat)**
(Boulder Reach 17b) (Since lower baseflow 2020)	**Very +**	**+ max / + riffle avg + run max**	**− / −**	**Same / Sim**	**Sim / +**	**+ (more food, deeper habitat, more fastwater cover)**
(Bear Site 18a) (Since lower baseflow 2021)	**Slightly +**	**+ pool max / +**	**Same / + riffle Same rnn**	**− / + riffle − run**	**Sim /**	**+ (more food, deeper pools, less sediment and less embeddedness in riffles)**
(Bear Site 18b) (Since lower baseflow 2021)	**Slightly +**	**+ avg / + run avg**	**− / − riff Same run**	**− / + riffle − run**	**+ /**	**+ (more food, deeper habitat, less riffle embed. more pool cover)**
Branciforte Reach 21a-2 (Since lower baseflow 2020)	**+**	**− / − run max**	**Sim / Sim riffle + run**	**Sim / Sim**	**+ / −**	**+ (more food and more pool cover)**
(Branciforte Site 21b) (Since lower baseflow 2021)	**+**	**− / Same**	**− / −**	**Sim / Sim run − riffle**	**Sim /**	**+ (more food)**

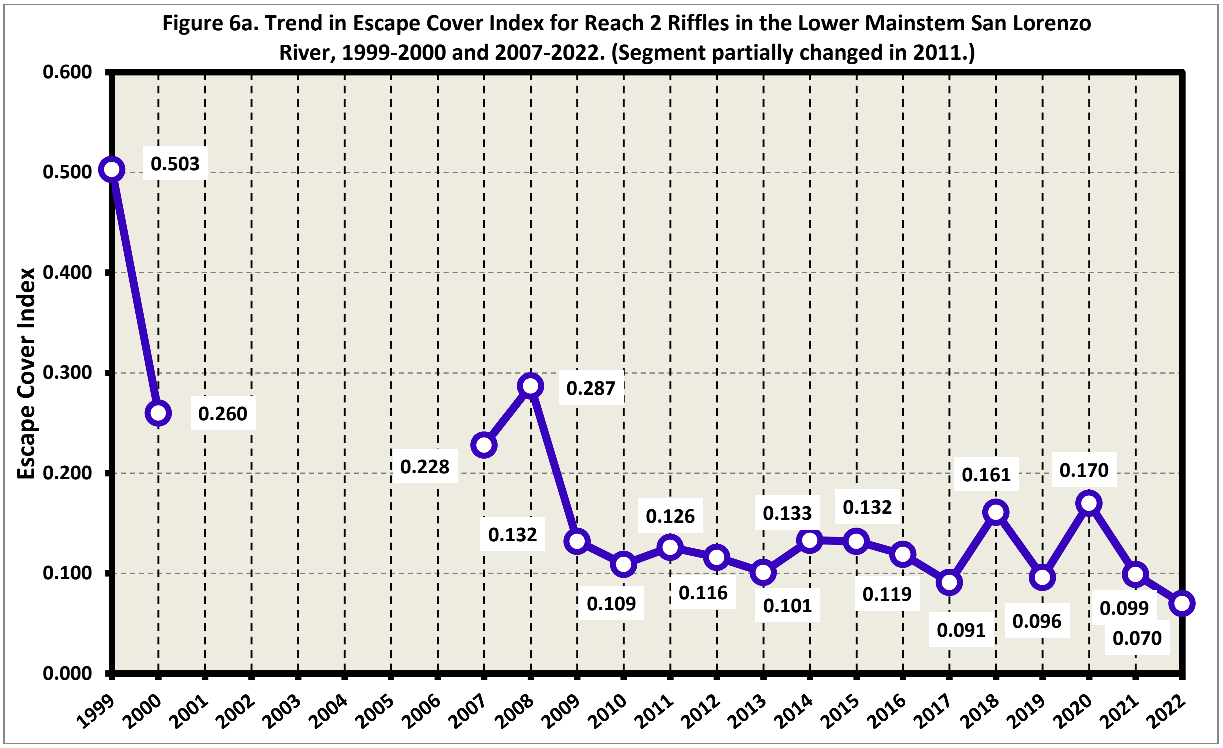

Figure 6a. Trend in the Escape Cover Index for Reach 2 Riffles in the Lower San Lorenzo River.

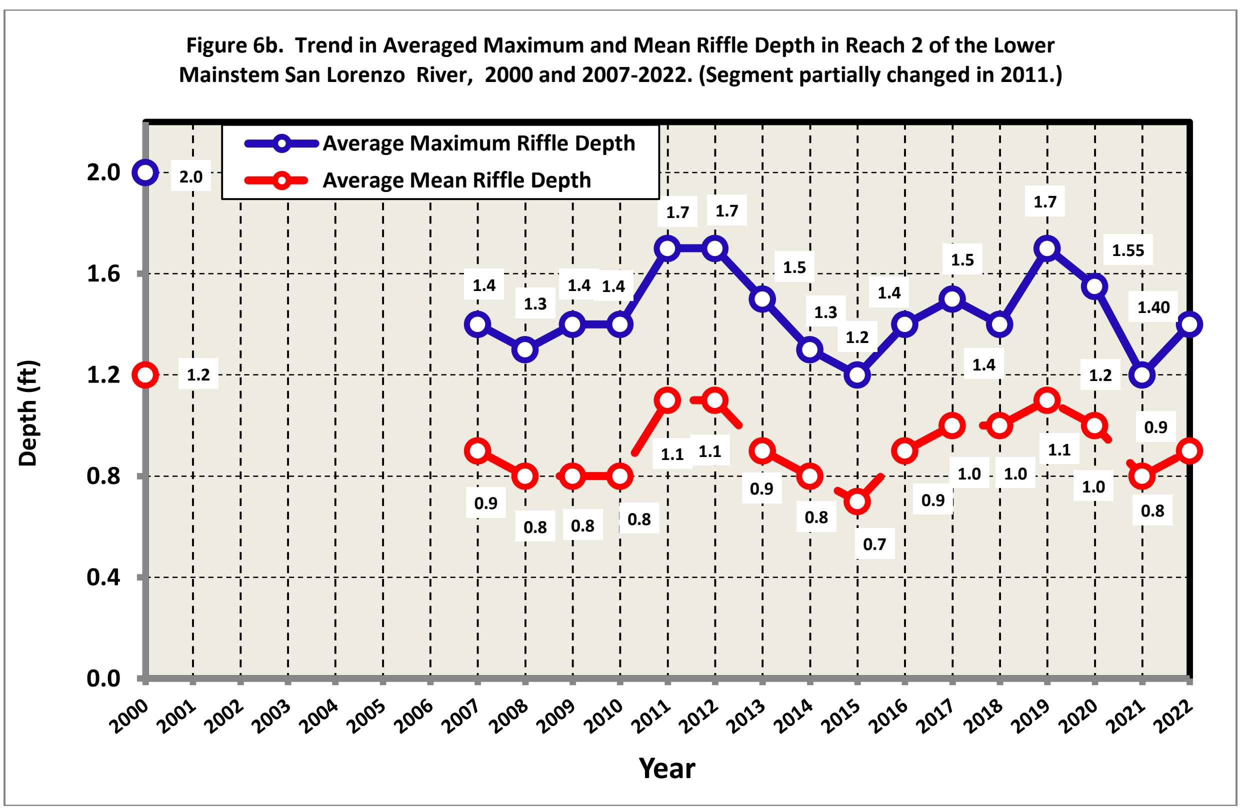

Figure 6b. Trend in Riffle Depth for Reach 2 in the Lower San Lorenzo River.

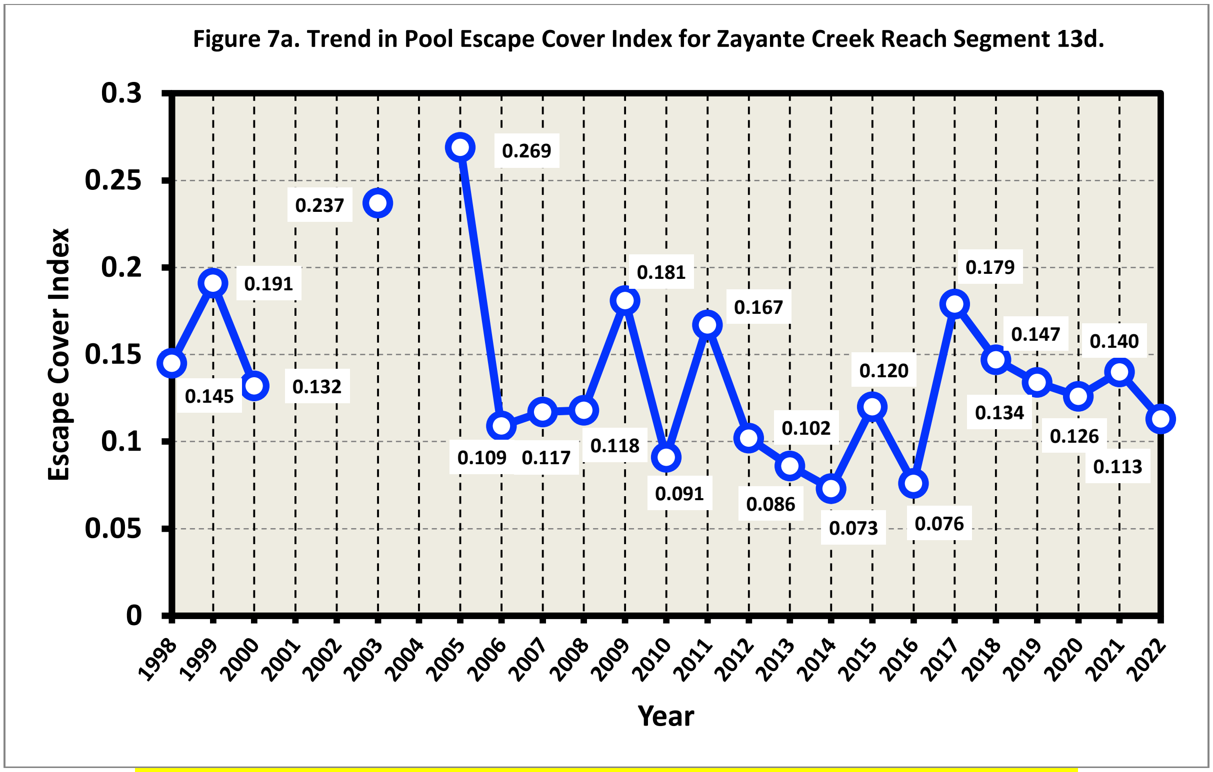

Figure 7a. Trend in Pool Escape Cover Index for Zayante Creek, Reach Segment 13d.

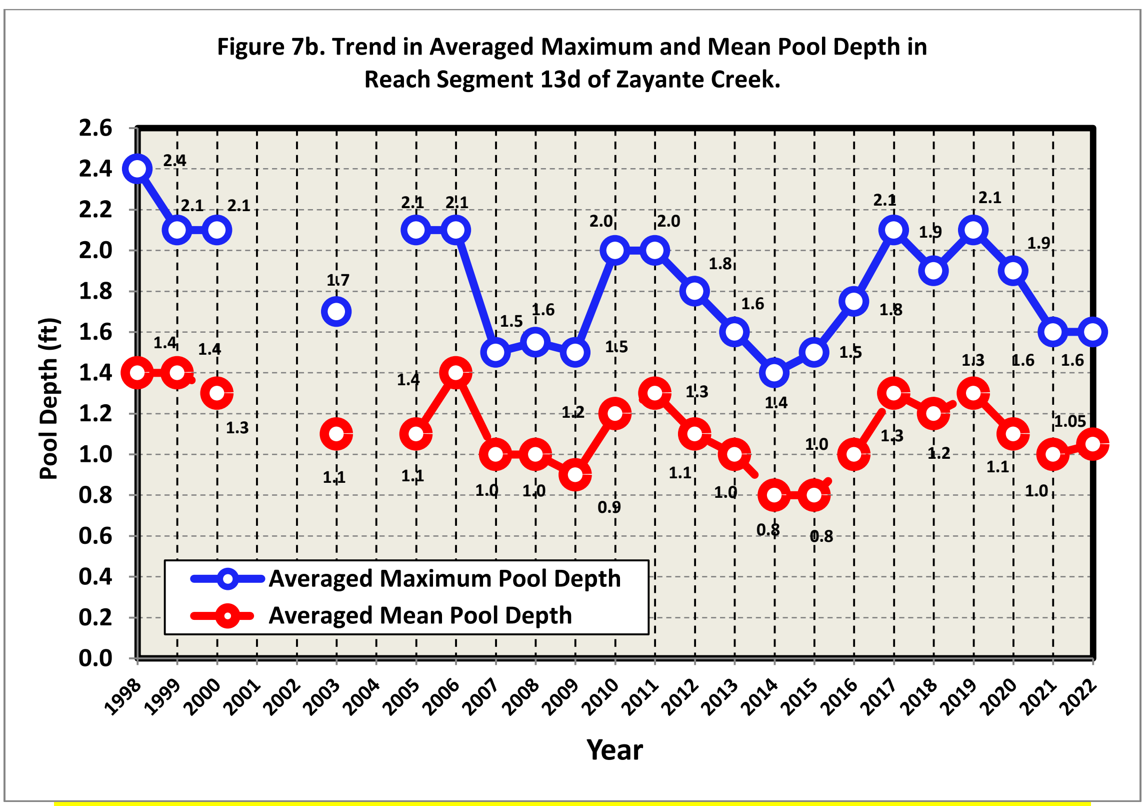

Figure 7b. Trend in Averaged Maximum and Mean Pool Depth in Reach 13d , Zayante Creek.

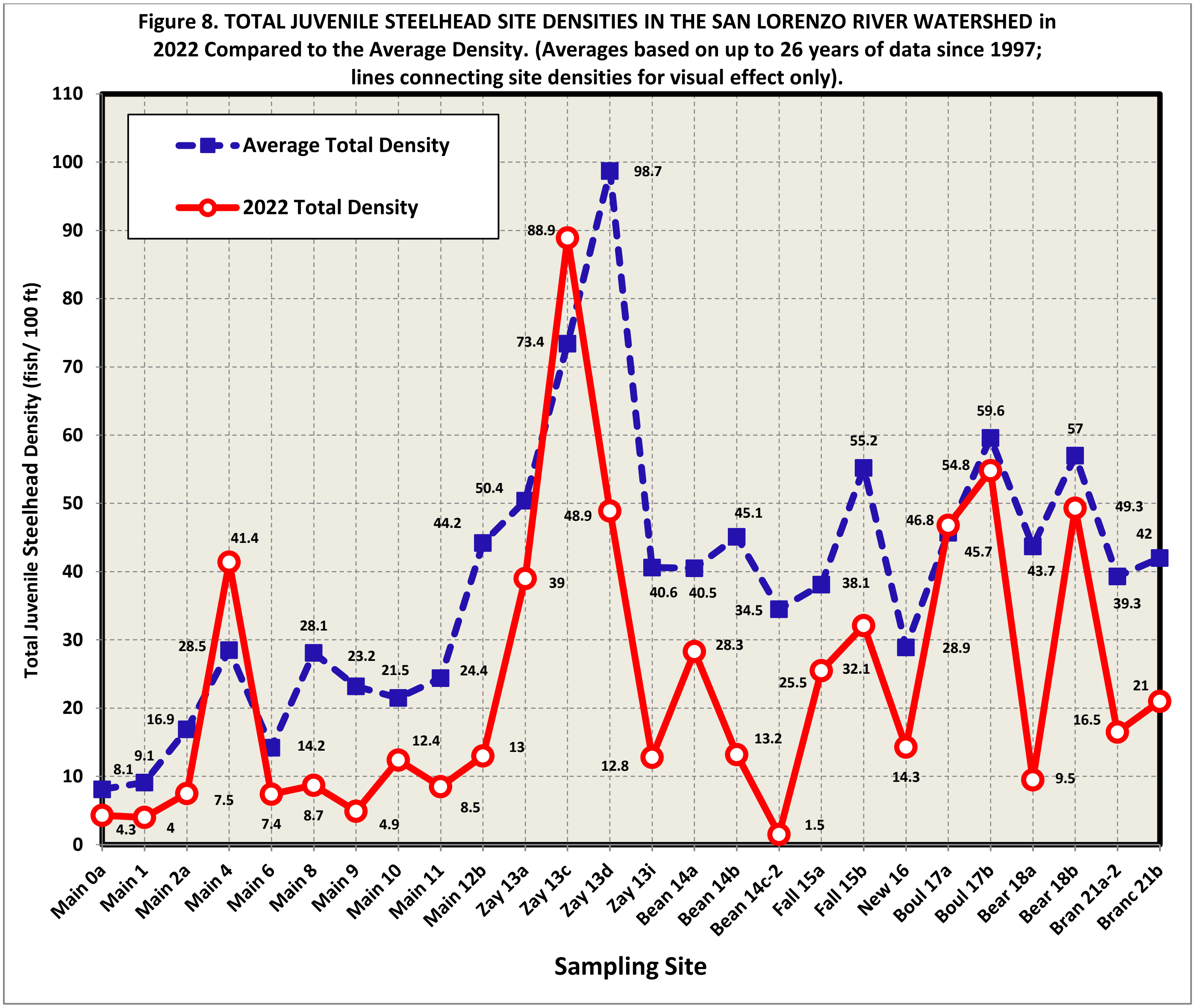

Figure 8. Total Juvenile Steelhead Site Densities in the San Lorenzo River in 2022 Compared to Average Density. (Averages based on up to 26 years of data.)

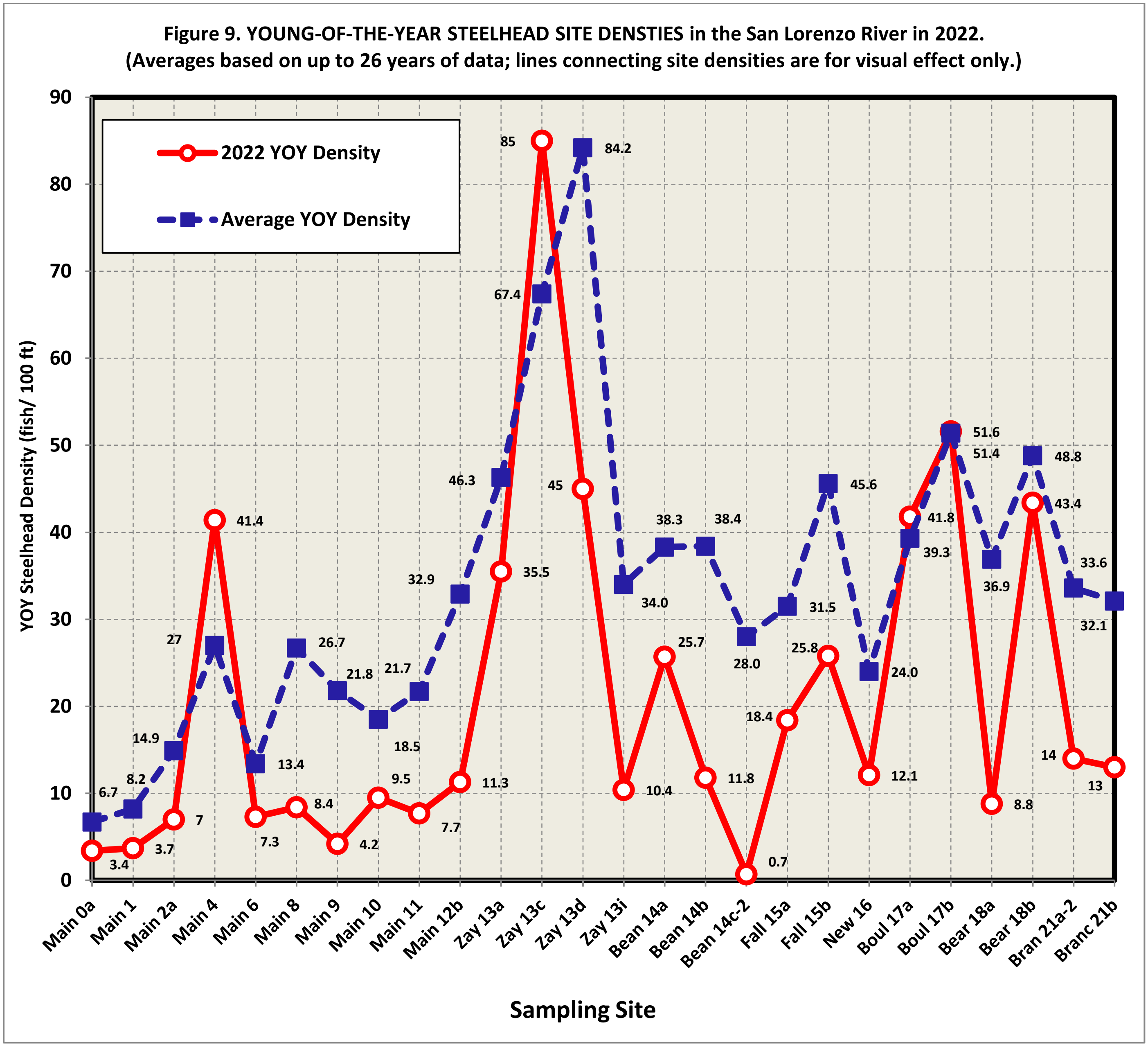

Figure 9. Young-of-the-Year Steelhead Site Densities in the San Lorenzo River in 2022 Compared to Average Density. (Averages based on up to 26 years of data.)

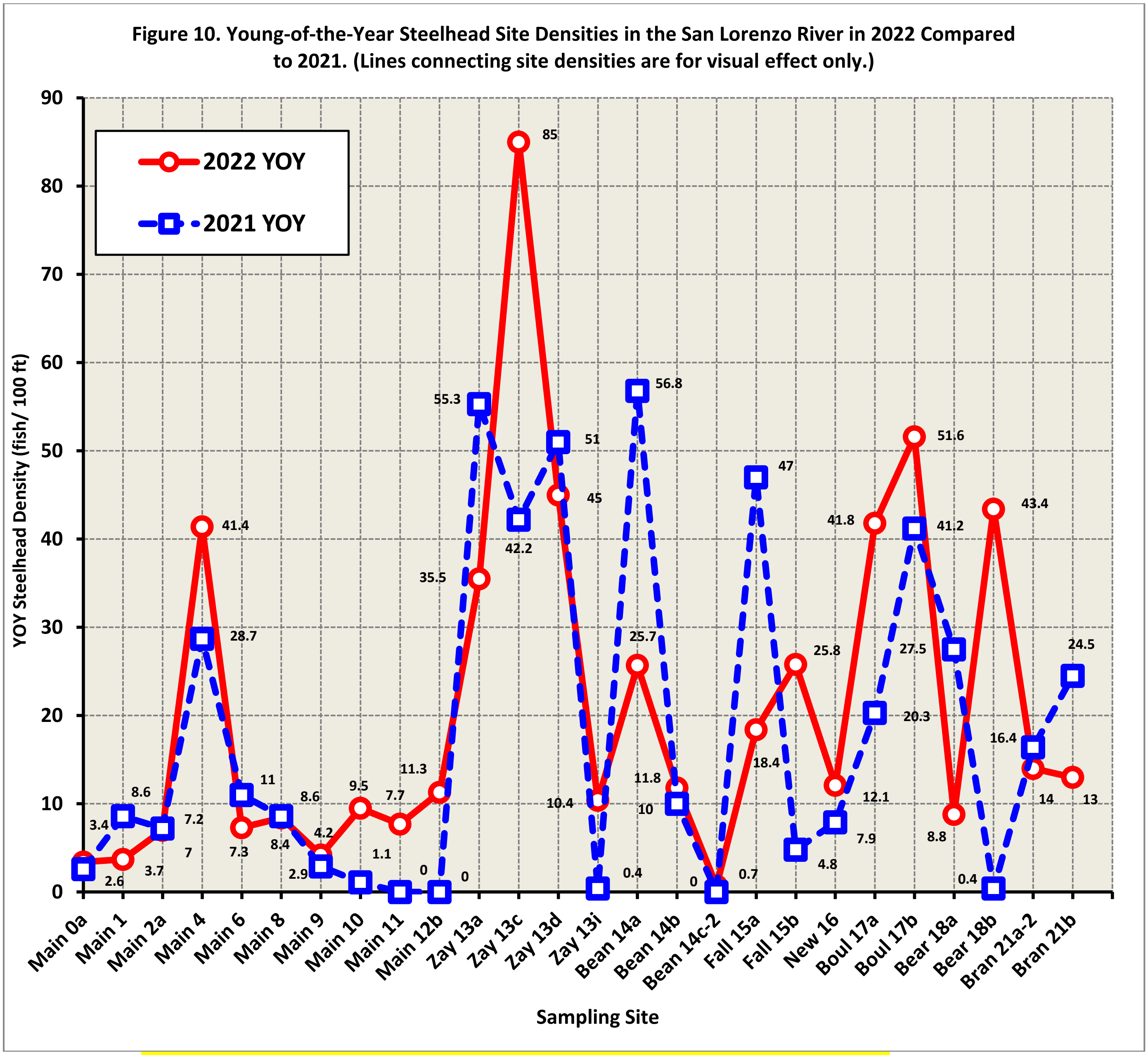

Figure 10. Young-of-the-Year Site Densities in the San Lorenzo Watershed Comparing 2022 to 2021.

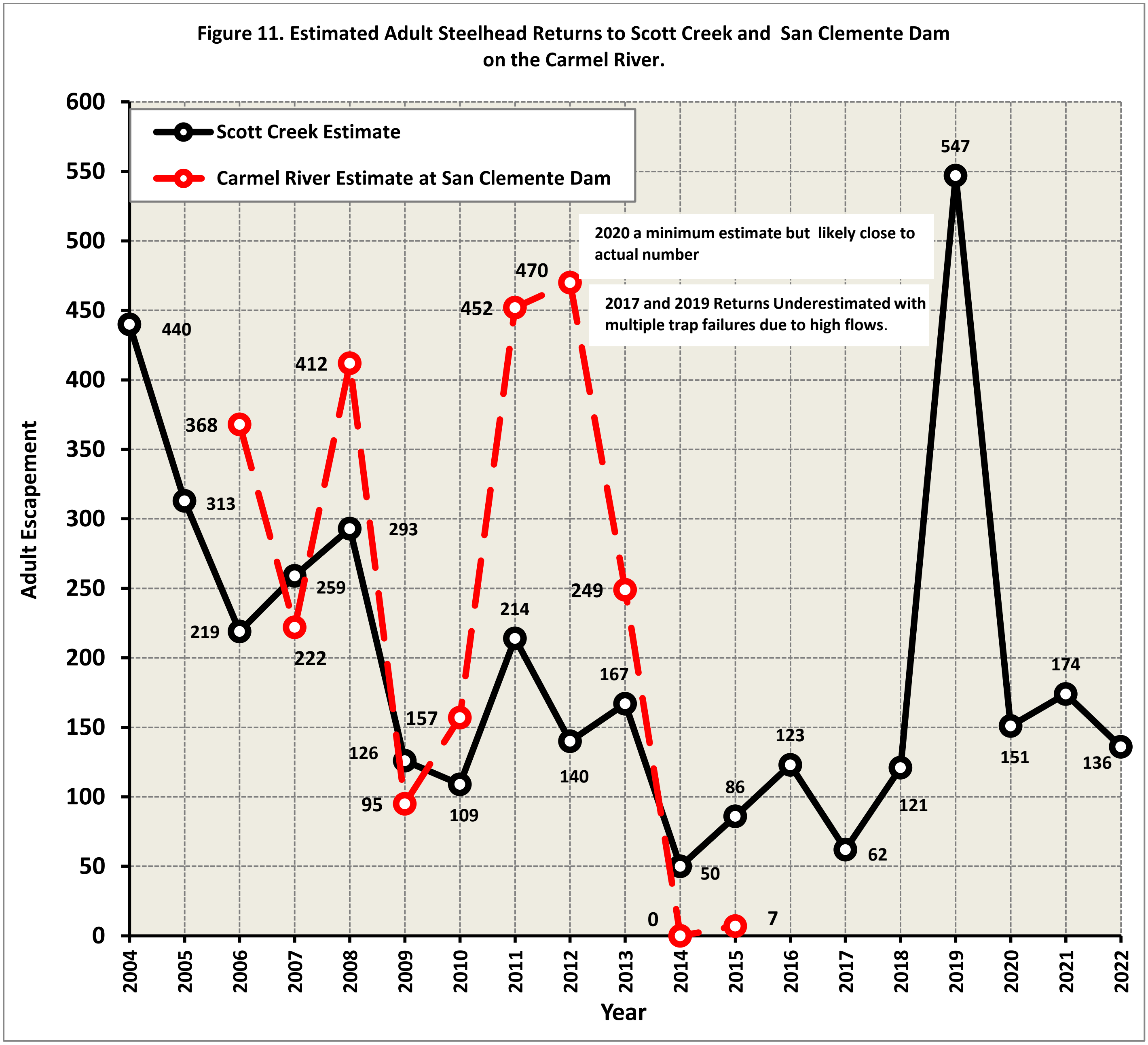

Figure 11. Estimated Adult Steelhead Returns to Scott Creek and San Clemente Dam on the Carmel River.

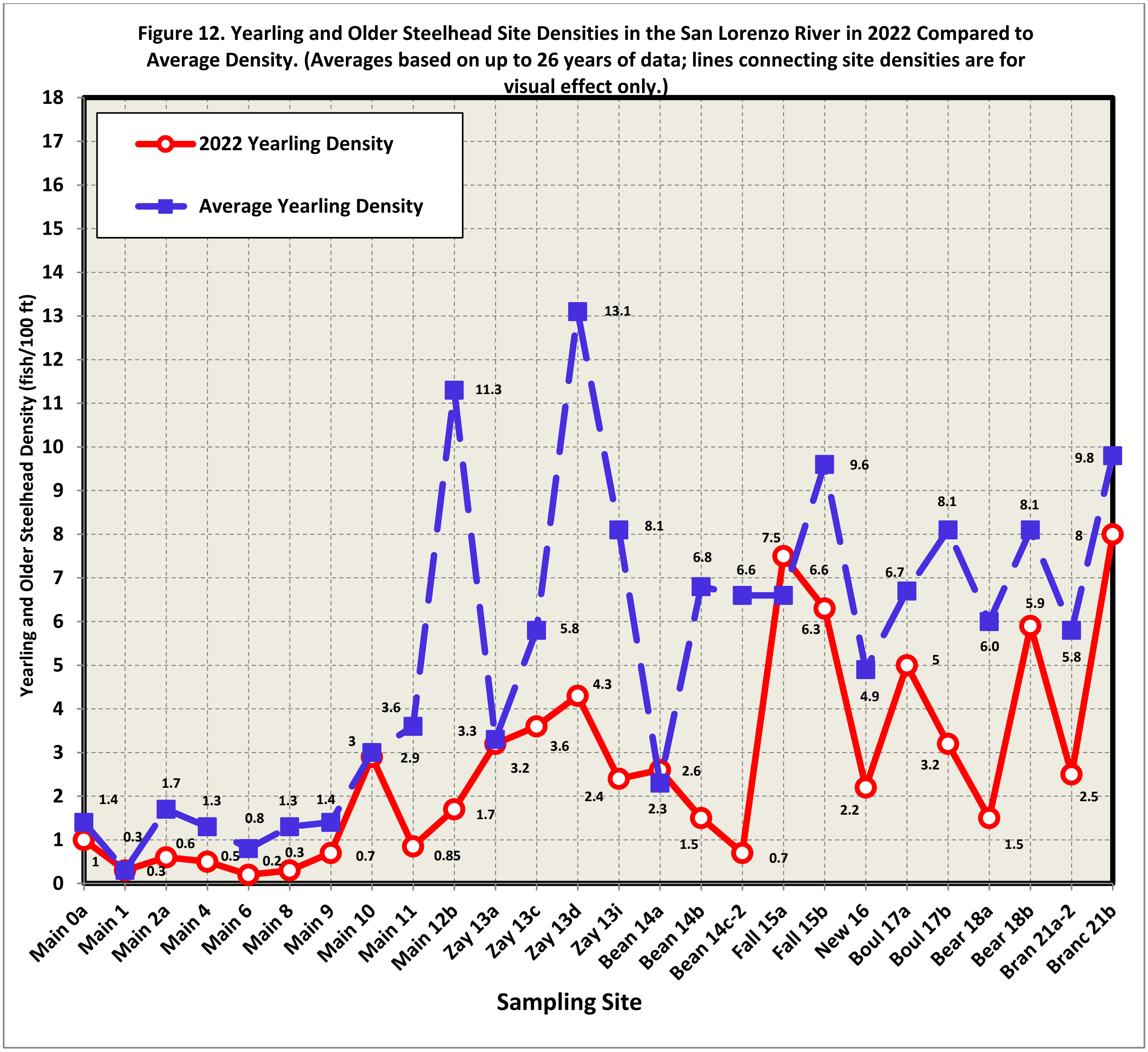

Figure 12. Yearling Steelhead Site Densities in the San Lorenzo River in 2022 Compared to Average Density. (Averages based on up to 26 years of data.)

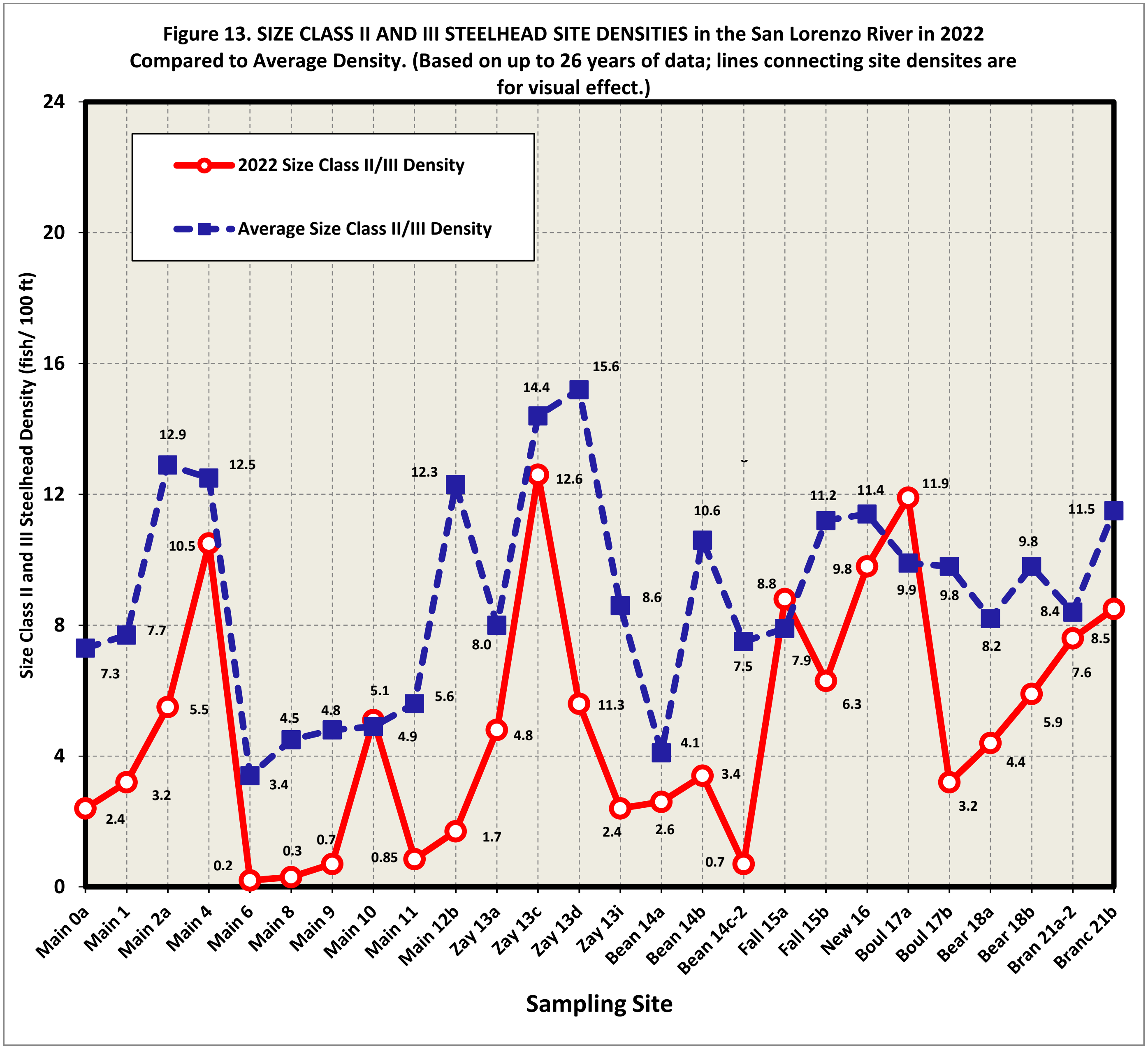

Figure 13. Size Class II/III Steelhead Site Densities in the San Lorenzo River in 2022 Compared to Average Density. (Averages based on up to 26 years of data.)

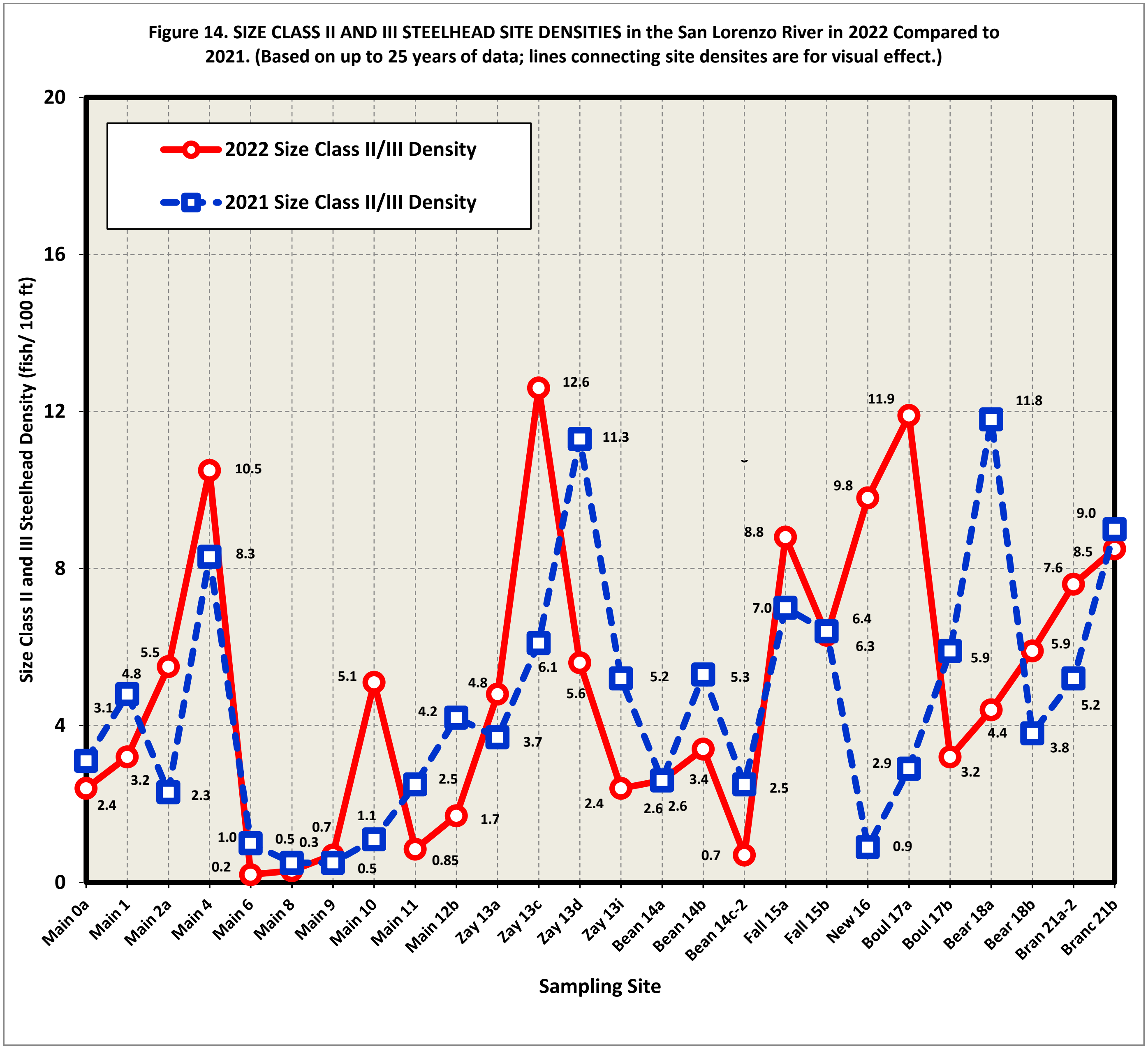

Figure 14. Size Class II/III Steelhead Site Densities in the San Lorenzo Watershed Comparing 2022 to 2021.

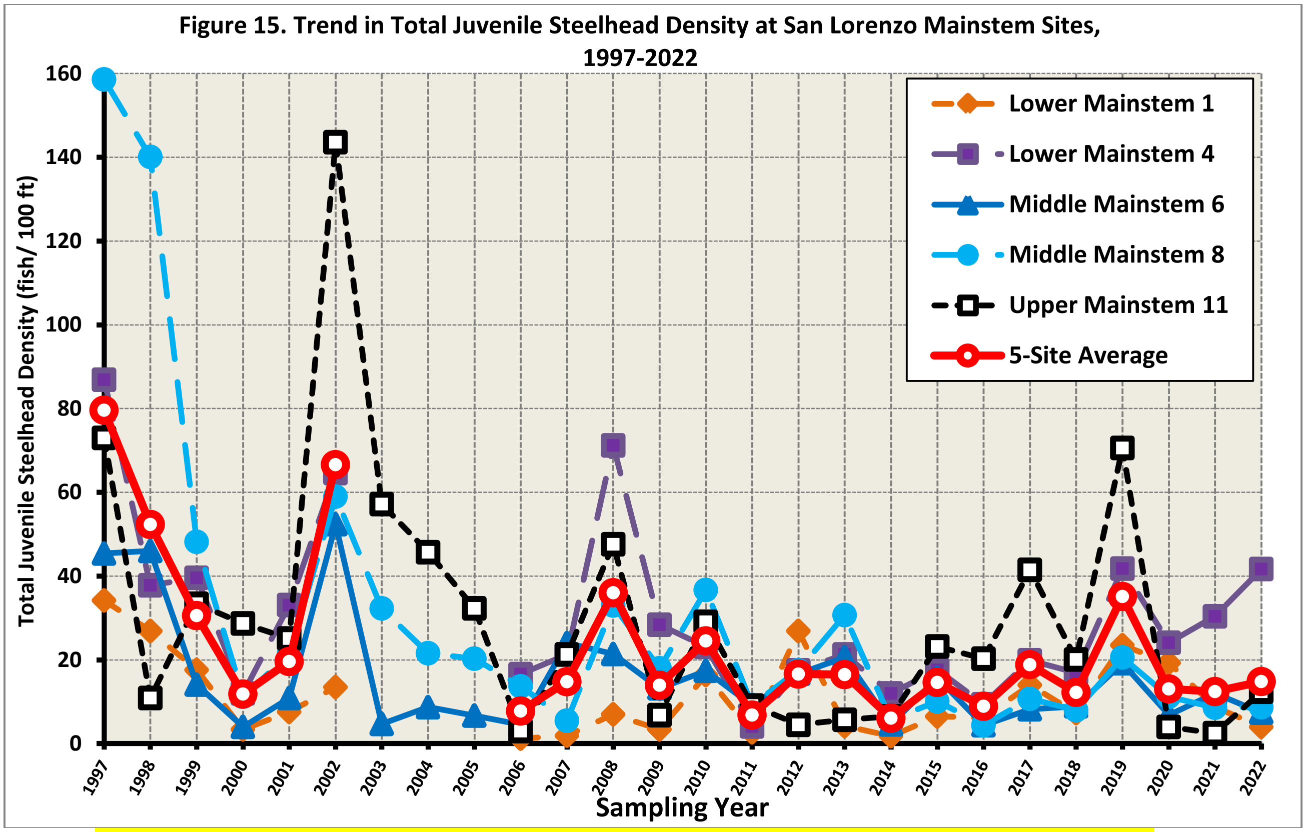

Figure 15. Trend in Total Juvenile Steelhead Density at San Lorenzo Mainstem Sites, 1997-2022.

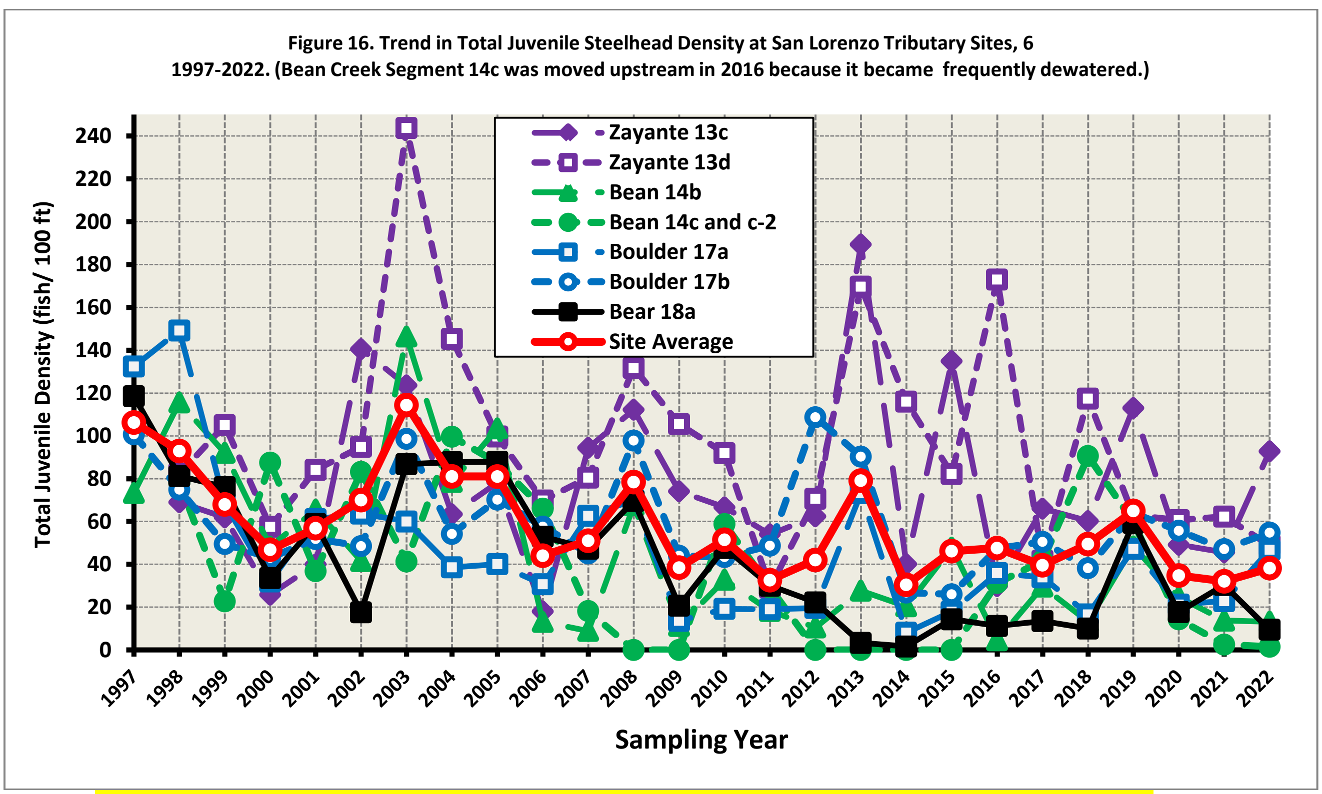

Figure 16. Trend in Total Juvenile Steelhead Density at San Lorenzo Tributary Sites, 1997-2022.

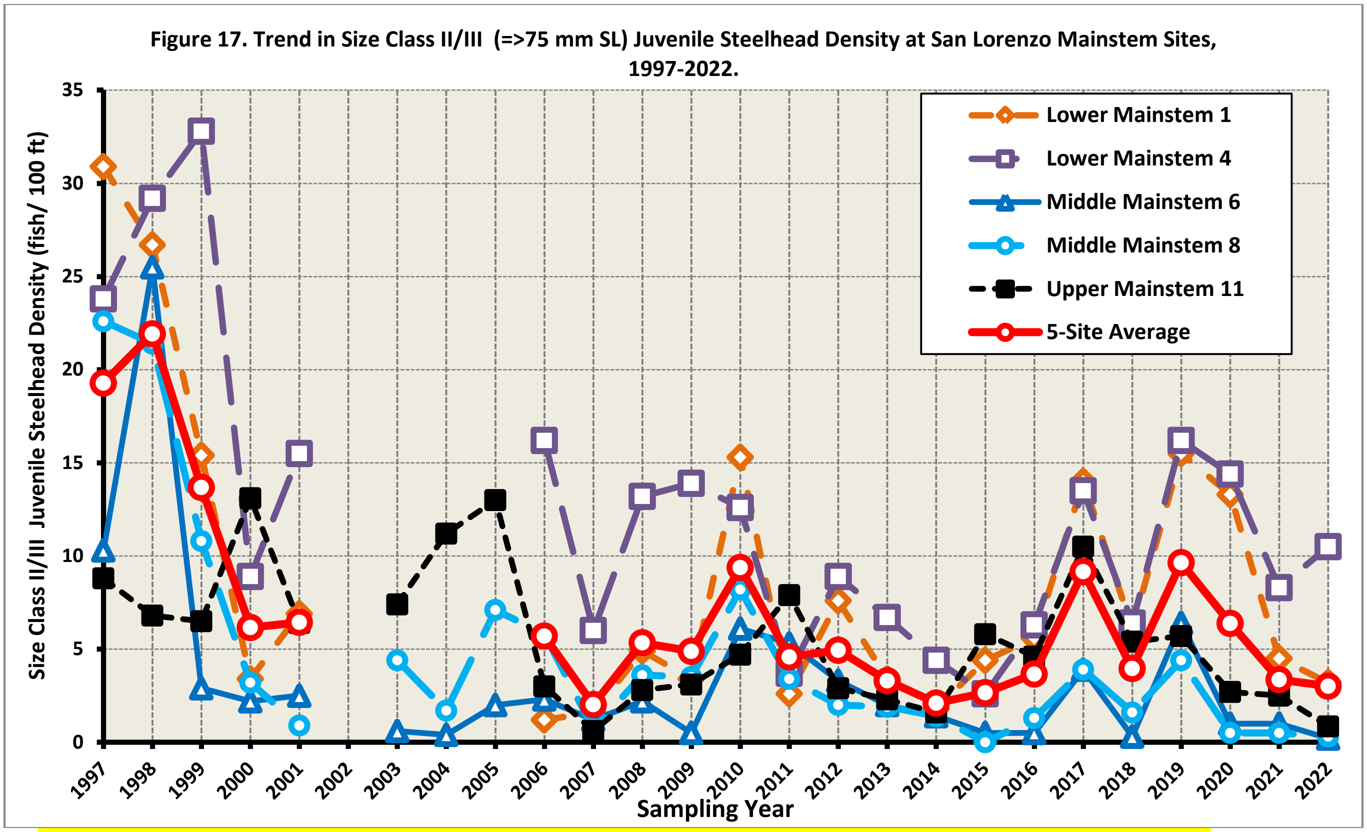

Figure 17. Trend in Size Class II/III Juvenile Steelhead Density at San Lorenzo Mainstem Sites, 1997-2022.

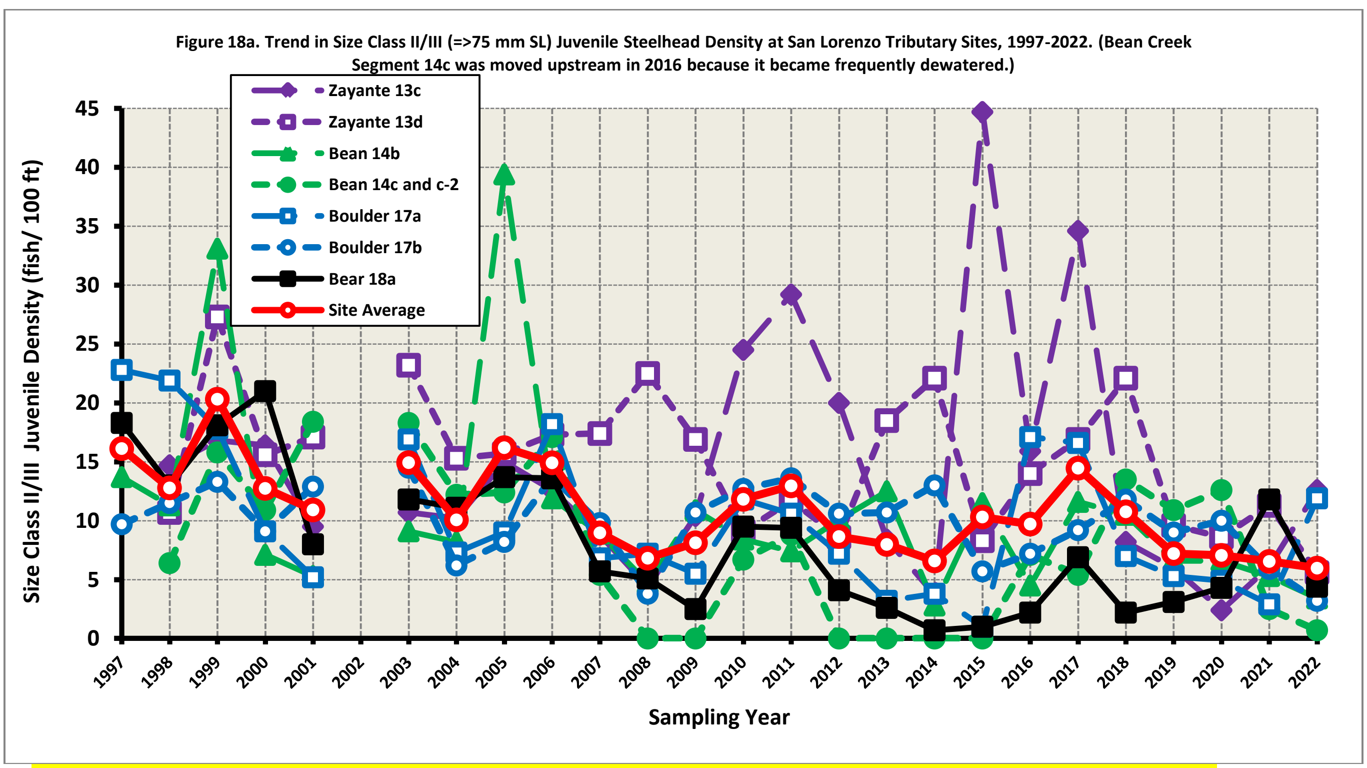

Figure 18a. Trend in Size Class II/III Juvenile Steelhead Density at San Lorenzo Tributary Sites, 1997-2022.

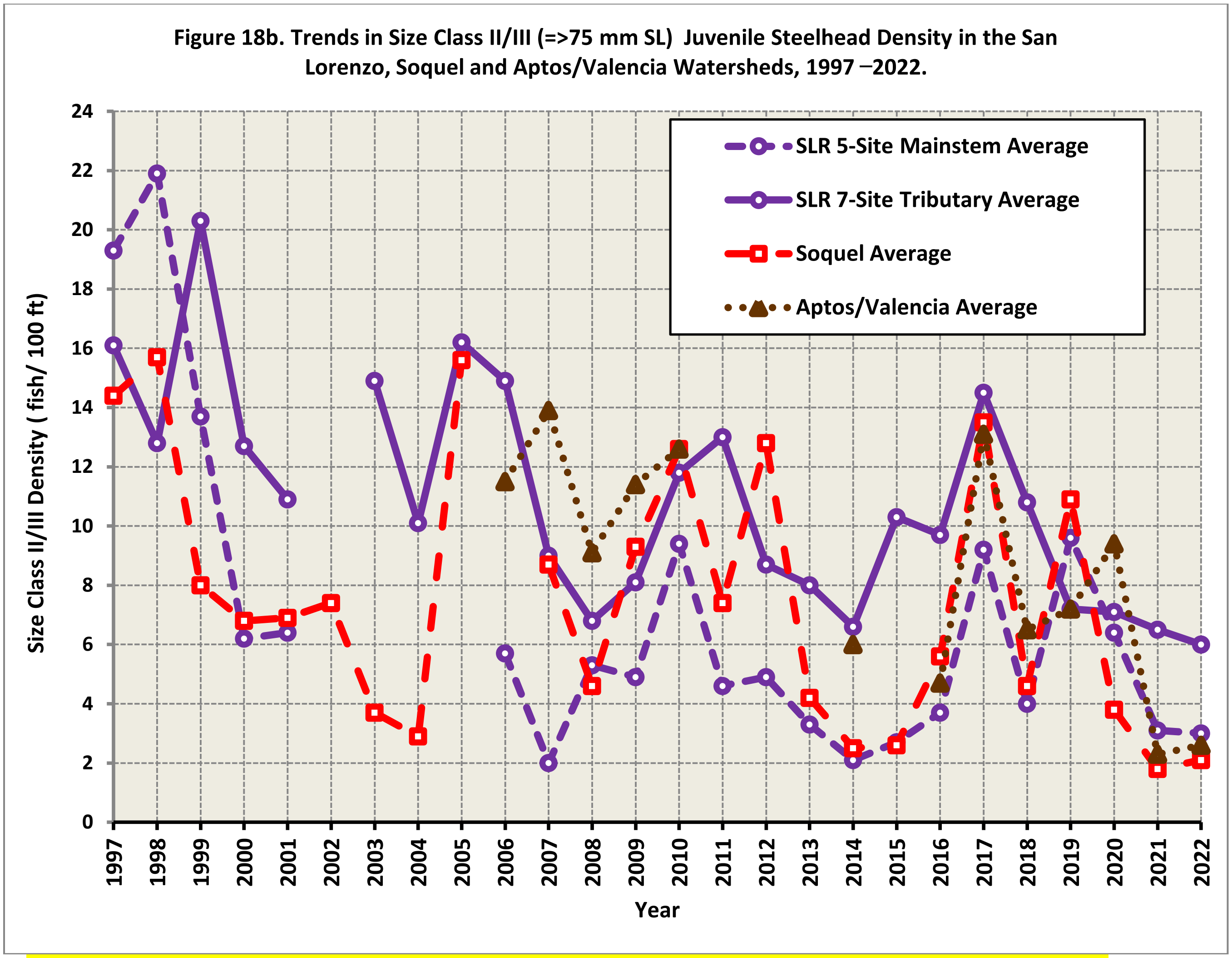

Figure 18b. Trend in Size Class II/III Juvenile Steelhead Density in San Lorenzo, Soquel and Aptos/Valencia Sites, 1997-2022.

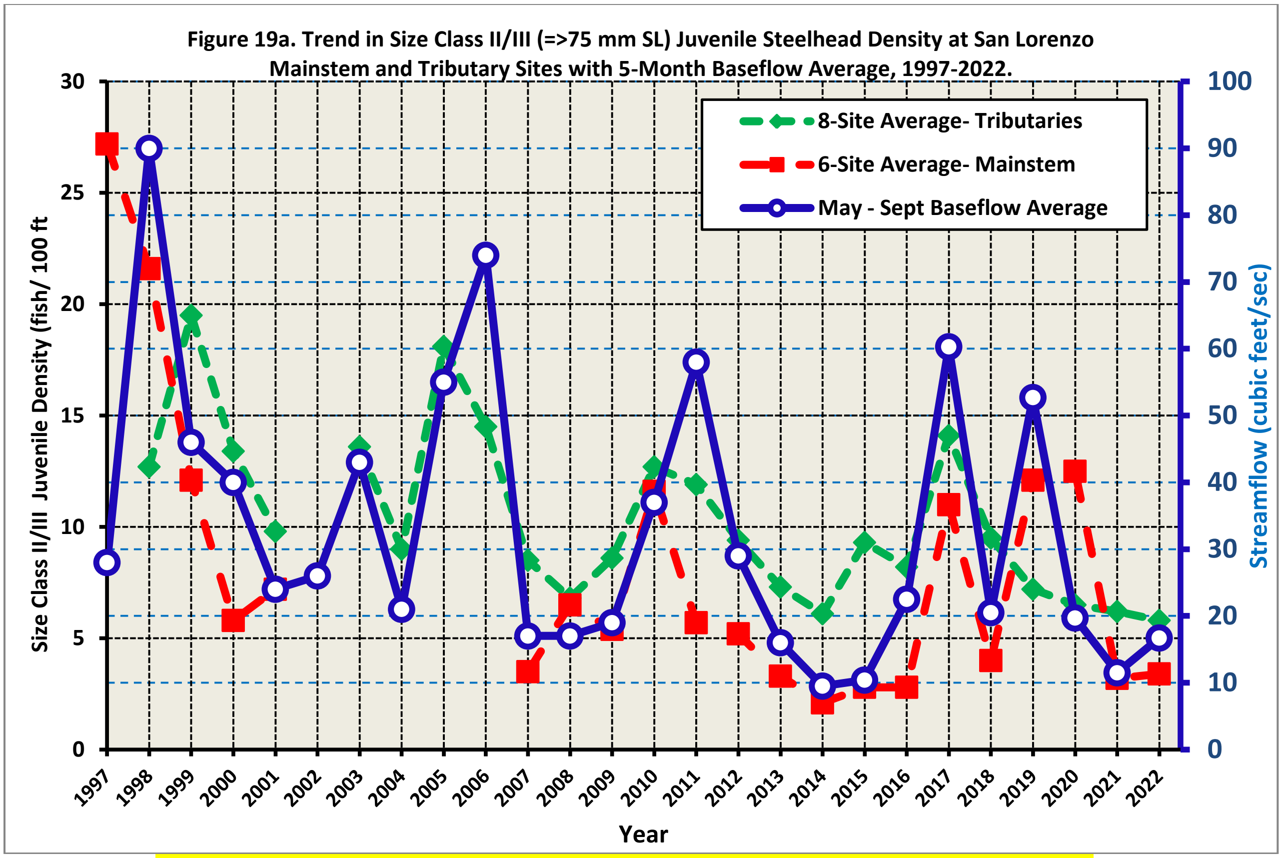

Figure 19a. Trend in Size Class II/III (=>75 mm SL) Juvenile Steelhead Density at San Lorenzo Mainstem and Tributary Sites with 5-Month Baseflow Average, 1997-2022.

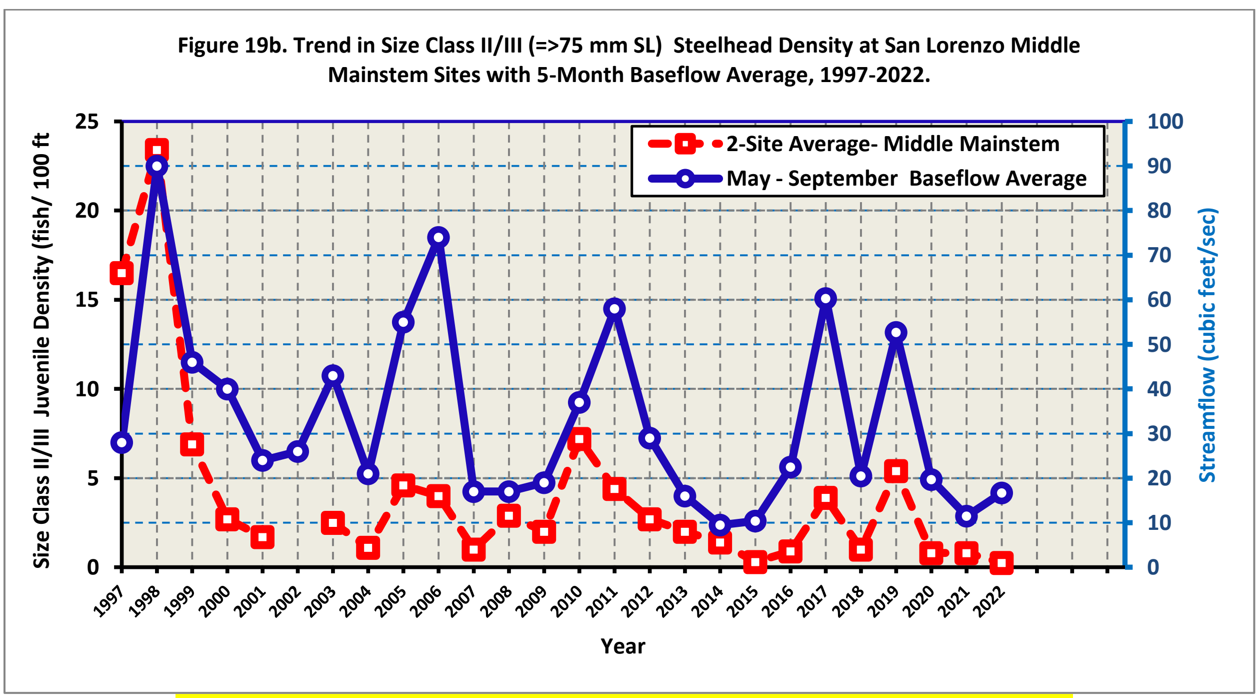

Figure 19b. Trend in Average Size Class II/III (=>75 mm SL) Juvenile Steelhead Density at San Lorenzo Middle Mainstem Sites with 5-Month Baseflow Average, 1997-2022.

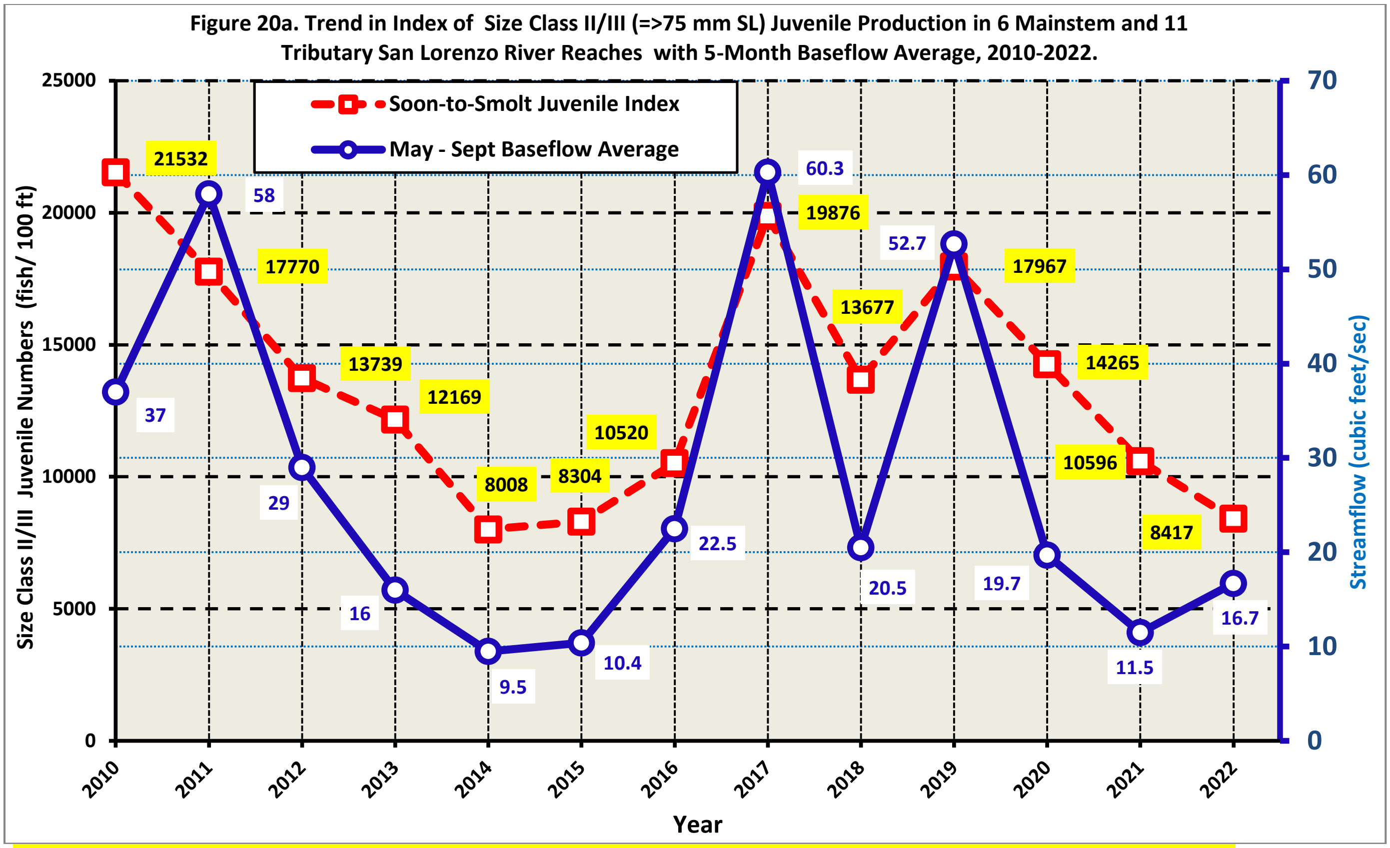

Figure 20a. Trend in Index of Size Class II/III (=>75 mm SL) Juvenile Steelhead Production in 6 Mainstem and 11 Tributary San Lorenzo River Reaches with 5-Month Baseflow Average, 2010-2022.

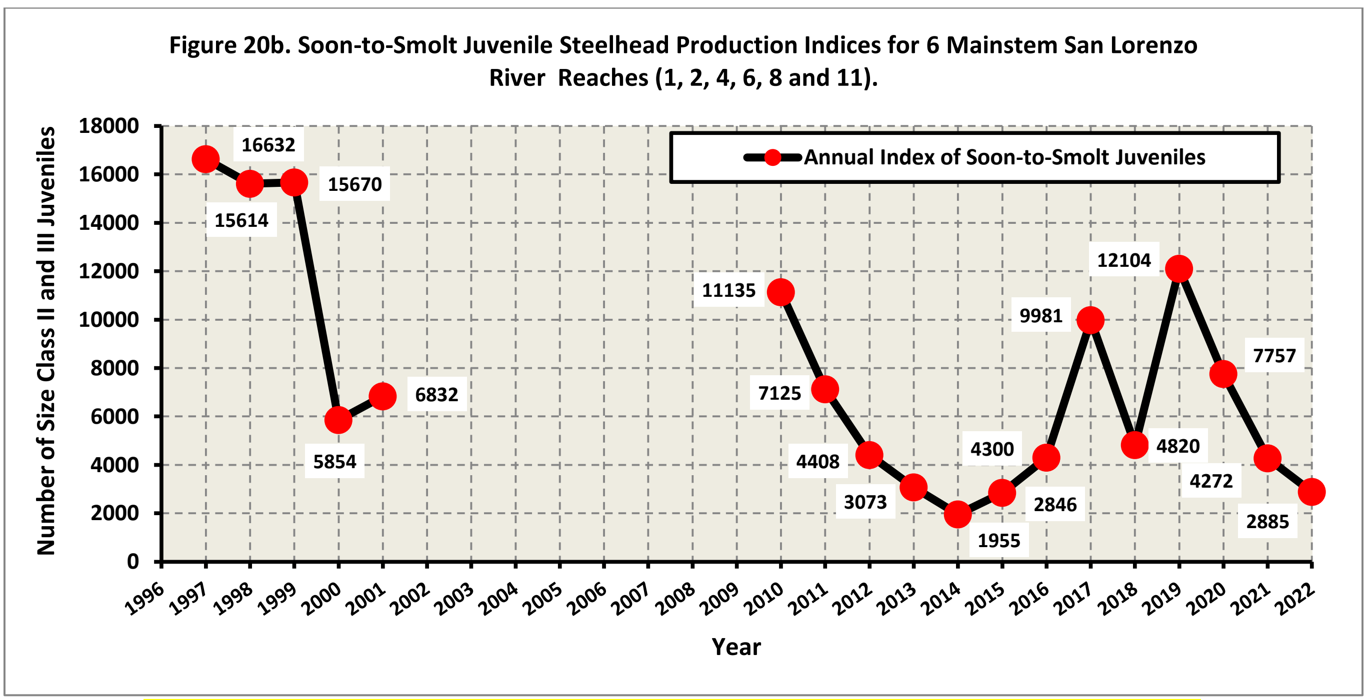

Figure 20b. Trend in Index of Size Class II/III Juvenile Steelhead Production in 6 Mainstem San Lorenzo River Reaches Since 1997.

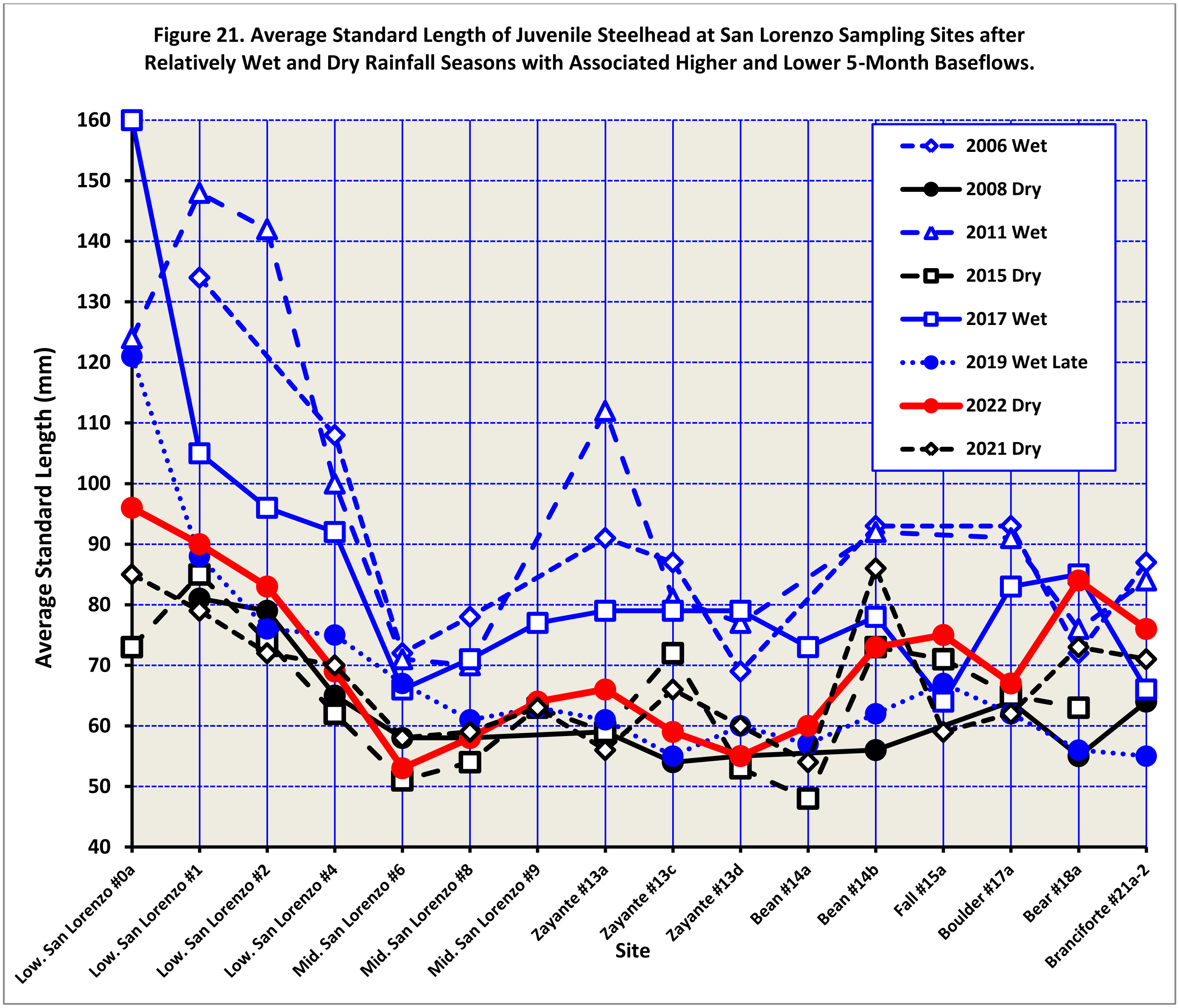

Figure 21. Average Standard Length of Juvenile Steelhead at San Lorenzo Sampling Sites after Relatively Wet and Dry Rainfall Seasons, with Associated High and Low Annual Baseflows.

ii. Steelhead Abundance and Habitat in the Soquel Creek Watershed

1. Streamflow measured at the Soquel Village gage indicated similar dry stormflow patterns as in the SLR for WY2022 with likely 4 bankfull flows in rapid succession in December between 1,500 and 2,000 cfs at Soquel Village. Then there was no rain in January and February, with 4 small stormflows between 10 and 70 cfs in March and April (**Figure 22**). The early winter stormflow provided better spawning access in this lower gradient watershed up to Hidden Falls on the West Branch (laddering of which would provide 4.5 miles of additional steelhead access) and to Spanish Ranch on the East Branch compared to the SLR. The smaller stormflows in March and April provided additional adult access to lower reaches and also encouraged out-migration of smolts. Baseflow steadily declined from early May on at well below median baseflow, with an unexpected upturn in baseflow to about 2 cfs in August followed by a downturn in September down to 0.19 cfs on 13 September at the Soquel Village stream gage with wide daily fluctuations. We suspect that well pumpage and/or surface water diversion increased at this time. An early stormflow came on 18 September which peaked at 36.4 cfs at Soquel Village. Fish sampling in Soquel and Aptos creeks occurred after this small stormflow but likely did not affect juvenile densities, based on sampling experience by Alley and Smith (**pers. comm.**). Baseflows measured a month later are in **Table 4**. Streamflow at the Soquel Village Gage was 1.76 cfs on 18 October when other streamflows were measured in the watershed. Streamflow measurements in 2022 were higher than in 2021. The East Branch above Amaya Creek confluence went dry in 2021 but not in 2022. The 5-month average (May – September) of mean monthly streamflow increased from 1.65 cfs in 2021 to 1.9 cfs in 2022 (**Figure 5**), with a 26-year average of 8.1 cfs.

2. **Overall 2022 habitat conditions** improved in six site/reaches and declined in three, since 2021 and 2020, respectively (**Table 5**). Habitat typed reaches were compared to 2020 conditions, except for Reach 13, which was last habitat typed in 2015. Where only site data were collected in 2022, sites were compared to 2021 conditions, except Site 16 conditions were compared to 2020 conditions because it had been dry in 2021. Baseflow was higher in 2022 than in 2021, which improved habitat, but was slightly less than in 2020 (**Table 4**). Conditions at 5 of 6 site comparisons improved. Sites 1, 10, 16 (SDSF on East Branch) and 21 (upper West Branch) (**Map in Figure 2**) improved with increased baseflow and generally increased pool depth and pool escape cover compared to 2021. Substrate conditions (percent fines and embeddedness) at those sites worsened at Sites 1 (lower mainstem) and 21 (upper West Branch), but overall conditions at those sites improved with much increased escape cover at Site 21. Site 13a (East Branch Reach 9a below Mill Pond) worsened compared to 2021 due to reduced habitat depth, increased run percent fines and increased pool embeddedness. The large instream wood that was present in 2021 had moved downstream in 2022. Habitat conditions in Reaches 3a and 8 on the mainstem declined from 2020 due to sedimentation from upstream. In 2022 these reaches had less baseflow, reduced habitat depth and reduced escape cover compared to 2020. Reach 4 improved from 2020 due to increased pool depth and escape cover, despite reduced baseflow, indicating that sediment had moved through Reach 4 to Reach 3a. Reach 13 (lower West Branch) improved from 2015 extreme drought conditions, with increased baseflow and deeper pool depth and reduced percent fines and embeddedness, despite less pool escape cover. Tables of habitat measurements are in the detailed analysis report available upon request.

3. Habitat conditions based on soon-to-smolt densities were rated "**very poor**" at 4 sites (mainstem Sites 4, 10 and 12 and West Branch Site 19), "**poor**" at 4 sites (Mainstem Sites 1 and 6, East Branch Site 13a and West Branch Site 21) and "**below average**" at East Branch Site 16 in the SDSF (**Table 2**). These ratings incorporate density and fish length.

4. ***Total and YOY juvenile steelhead densities*** in 2022 were near average at Site 1 but much below average at the other 8 sampling sites (9 sites averaging 11.4 total juveniles/100 ft compared to the long term average of 34.4 and 10.2 YOY/100 ft compared to the long term average of 31.6) (**Figures 23 and 24**). The decrease in total and YOY juvenile densities from 2021 to 2022 at 7 of 8 sites were statistically significant (**Table 9; Figure 25**). Year classes and size classes are defined in the glossary. Some YOY

may reach Size Class II where food is more abundant. Therefore, at some sites the Size Class II/III group includes YOY and yearlings. Although ***yearling densities*** were below average at 8 of 9 sites in 2022, the differences between 2022 and 2021 densities were not statistically significant (**Table 9; Figure 26**). Though the ***Size Class II densities*** were well below average in 2022, the differences between 2022 and 2021 densities were not statistically significant (**Table 9; Figures 27 and 28**). The average 6-site trend in total site densities (consisting mostly of YOY) decreased slightly in 2022 and was the second lowest average in 25 years at 10.1 fish/100 ft (15.8 in 2021; 13.4 in 2020; 57.2 in 2019; 25-year average of 34.9) (**Figure 29**). The downward trend in total and YOY juvenile steelhead densities in Soquel Creek over the years, excepting 2019, was likely due to a steady decline in returning adults that made spawning patchy and egg survival low during a preponderance of dry winters. Two of the 4 factors considered to explain low YOY densities in the SLR watershed likely apply to the Soquel watershed except that adult spawning access was likely not a factor in Soquel. Those factors were 1) low adult returns and 2) poor egg survival during a relatively dry winter that provided poor spawning conditions. Similar to our low YOY densities in Soquel Creek and the San Lorenzo drainage, Smith (**2022**) found low densities in Waddell Creek (6.3 YOY/ 100 ft) which was significantly damaged by 2020 CZU fire). However, he found YOY steelhead to be relatively abundant and at above average densities in Gazos Creek (47 YOY/ 100 ft) and Scott Creek (54 YOY/ 100 ft), similar to higher baseflow years of 2017 and 2019 and despite relatively high coho juvenile densities in Scott Creek. Tables of fish densities are provided in the detailed analysis report available upon request.

5. In 2022, the 6-site long-term ***trend in Size Class II/ III densities*** increased slightly from 2021 to 2022 (**Figure 30**). This density trend and the trend in production index of Size Class II/III numbers positively tracked with averaged 5-month baseflow (**Figure 31a-b**). The production index decreased slightly from 2021 (737) to 2022 (646) and was the second lowest since 2010. The 6-site average in 2022 was the second lowest since 1997. The 9-site average Size Class II/III density during the last 3 years of drought decreased from 4.4 fish/100 ft in 2020 to 2.4 fish/100 ft in 2021 to 2.1 fish/100 ft in 2022. Decline in these larger juveniles in low baseflow years was partially caused by fewer YOY growing into Size Class II in their first summer. Trends in these larger juveniles in Soquel Creek follow similar fluctuations through the wet and dry years in the SLR watershed (**Figures 20a-b**), and to a degree in the Aptos/Valencia watershed (**Figure 38b**). The 2022 Soquel lagoon steelhead population estimate was 1,674 (above average and above the median) compared to 2,500 in 2021, 1,283 in 2020 and 3,353 in 2019, and 85% of captured juveniles were in Size Class II/III. This significant lagoon population estimate despite the low YOY densities at stream sites indicated that adult steelhead spawning near the lagoon was relatively successful and seeded the lagoon.

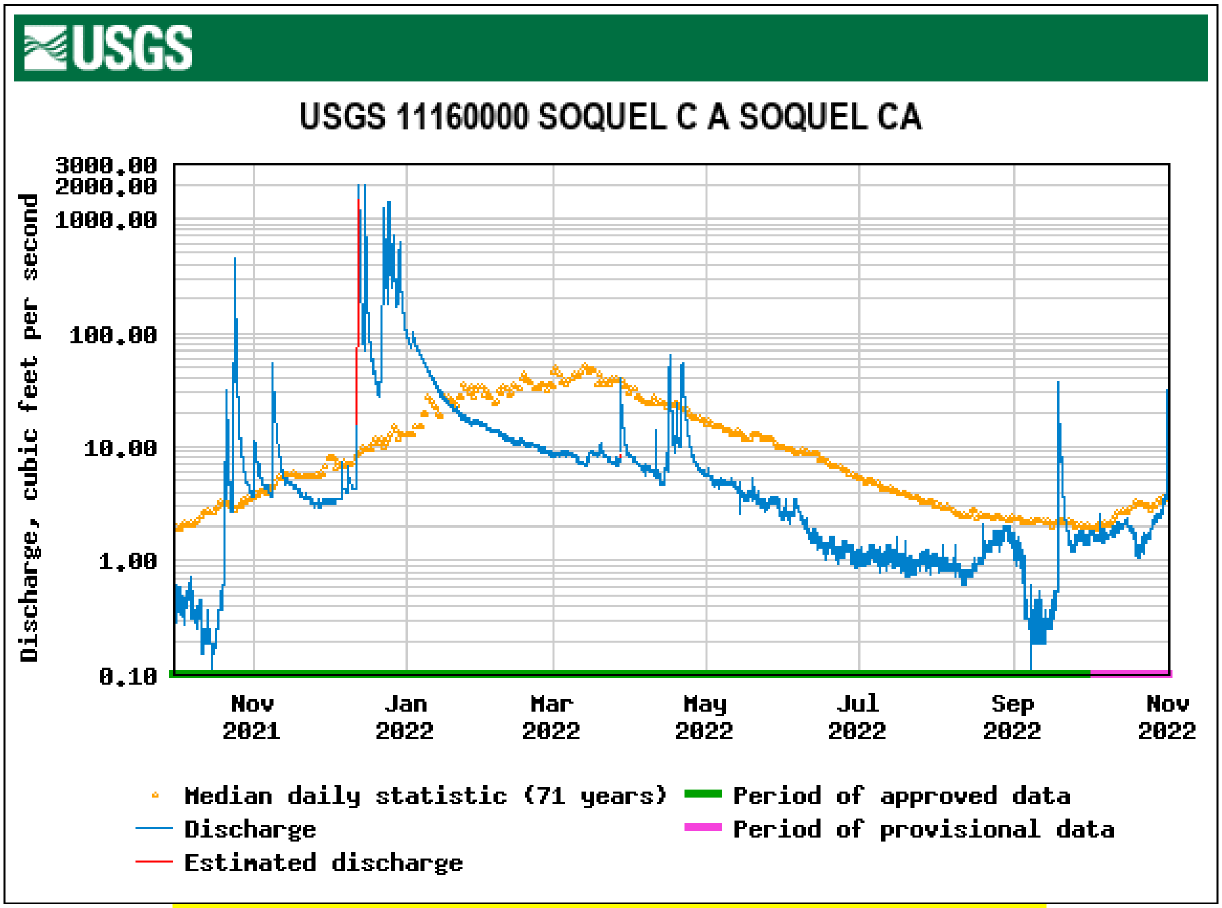

Figure 22. The WY2022 Discharge at the USGS Gage on Soquel Creek at Soquel Village.

Table 4. Fall/Late Summer STREAMFLOW (cubic feet/ sec) Measured by Santa Cruz County Staff in 2006−2017 (Date specified) and from Stream Gages; Measurements by D.W. ALLEY & Associates; 2010 (September), 2011−2015, 2018− 2022 (October) at fall baseflow conditions.

Location	2007	2008	2009	2010	2011	2012	2013	2014	2015	2017	2018	2019	2020	2021	2022*
Branciforte @ Isabel Lane		0.3	0.25	0.42 (8/26)		0.57 (8/22)	0.59 (6/20)	0.31 (8/7)							
Soquel Creek above Lagoon				2.3 (DWA)	4.9 (DWA)	1.8 (DWA)	0.33 (DWA)	0.19 (DWA) (Walnut St.)	0.18 (DWA) (Walnut St.)	3.98 (DWA) (Walnut St)	1.59 (DWA) (Walnut St)	2.84 (DWA) (Walnut St)	1.50 (DWA) (Walnut St)	0.29 (DWA) (Walnut St)	1.40 (DWA) (Walnut St)
Soquel Cr @ USGS Gage	1.4**	0.65**	1.2**	3.4**	5.8**	1.8**	0.36**	0.35**	0.36** 0.10 (9/9)	5.0 (12 Oct)	2.18 (12 Oct)	2.93 (12 Oct)	1.79 (12 Oct)	0.25 (15 Oct)	1.76 (18 Oct)
Soquel Cr @ Bates Cr	-	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)						
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)	4.46 (DWA)	1.51 (DWA)	3.30 (DWA)	1.57 (DWA)	0.72 (DWA)	1.35 (DWA)
W. Branch Soquel Cr below Old S.J. Road Olive Springs Bridge	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)	1.85 @ Mouth (DWA)	1.16 @ Mouth (DWA)	1.59 @ Mouth (DWA)	0.93@ Mouth (DWA)	0.79@ Mouth (DWA)	0.96@ Mouth (DWA)
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)	1.44@ Mouth (DWA)	0.45@ Mouth (DWA)	1.06@ Mouth (DWA	0.44@ Mouth (DWA)	Trickle Immeas urable (DWA)	0.24@ Mouth (DWA)
E. Branch Soquel Cr above Amaya Creek			Trickle (DWA)	0.44 (DWA)			0.03 (DWA)	Dry (DWA)	Dry (DWA)	0.71 (DWA)	0.15 (DWA)	0.46 (DWA)	0.10 (DWA)	Dry (DWA)	0.12 (DWA)
Aptos Cr below Valencia Creek confluence	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)		2.52 (DWA)	1.08 (DWA)	1.65 (DWA)	1.12 (DWA)	0.72 (DWA)	0.96 (DWA)
Aptos Cr above Valencia Creek				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 Creek below Valencia Rd				0.22 (DWA)											

***Streamflow was measured in 2022 a month after mid-September stormflow that partially elevated baseflow.**

Table 5. Habitat change in SOQUEL CREEK WATERSHED Reaches and Sites from the Most Recent, Previous Year Having Data. (Green highlight indicates Reach Comparisons. Yellow highlight indicates Site Comparisons.)

Reach or (Site Only) Comparison To Previous Years	2022 Baseflow Comparison (Most Important Habitat Factor May-September)	Depth - Pool / Fast-water Habitat	Fine Sediment- Pool / Fastwater Habitat	Embeddedness - Pool / Fastwater Habitat	Pool Escape Cover	Overall Habitat Change and (Any Improvement)
(Site 1) Reach 1 (Since higher baseflow 2021)	+	+ / + riffle − avg run	− / Sim riffle Same run	Same / Sim run − riffle	−	+ (more food, deeper habitat)
Site 4 Reach 3a (Since higher baseflow 2020)	Slightly −	− / −	Sim / Same riff Sim run	Sim / Sim	Sim	− (no improvement)
Site 6 Reach 4 (Since higher baseflow 2020)	Slightly −	+ / Sim riffle + avg run	Sim / Sim	Sim / Same riffle + run	+	+ (increased pool depth & cover & run depth, less run embeddedness)
(Site 10) Reach 7 (Since higher baseflow 2021)	+	+ avg; − max / +	+ / Sim riffle + run	+ / Sim riffle + run	+	+ (more food, increased pool and fastwater depth, reduced sediment and embed. in runs)
Site 12 Reach 8 (Since higher baseflow 2020)	Slightly −	− / −	Sim / Sim	Sim / Sim	Slightly −	− (no improvement)
East Branch (Site 13a) Reach 9a (Since higher baseflow 2021)	Slightly +	Very − / − max riffle + run	Same / + riffle − run	− / +	Very −	− (more food, deeper run, reduced riffle sediment, reduced fastwater embeddedness)
East Branch (Site 16) Reach 12a (Since higher baseflow 2020)	Very Slightly +	− / −	Sim / Sim	Sim / − run	Very +	+ (much more pool cover)
West Branch Site 19 Reach 13 (Since higher baseflow 2015)	+	Very + / Sim run same riffle	+ / −	+ / Sim	−	+ (more food, much deeper pools with less sediment & embeddedness)
West Branch (Site 21) Reach 14b (Since similar baseflow 2021)	+	Sim / +	− / Sim	− / Very +	Very +	+ (more food, more pool cover deeper fastwater and less fastwater embeddedness)

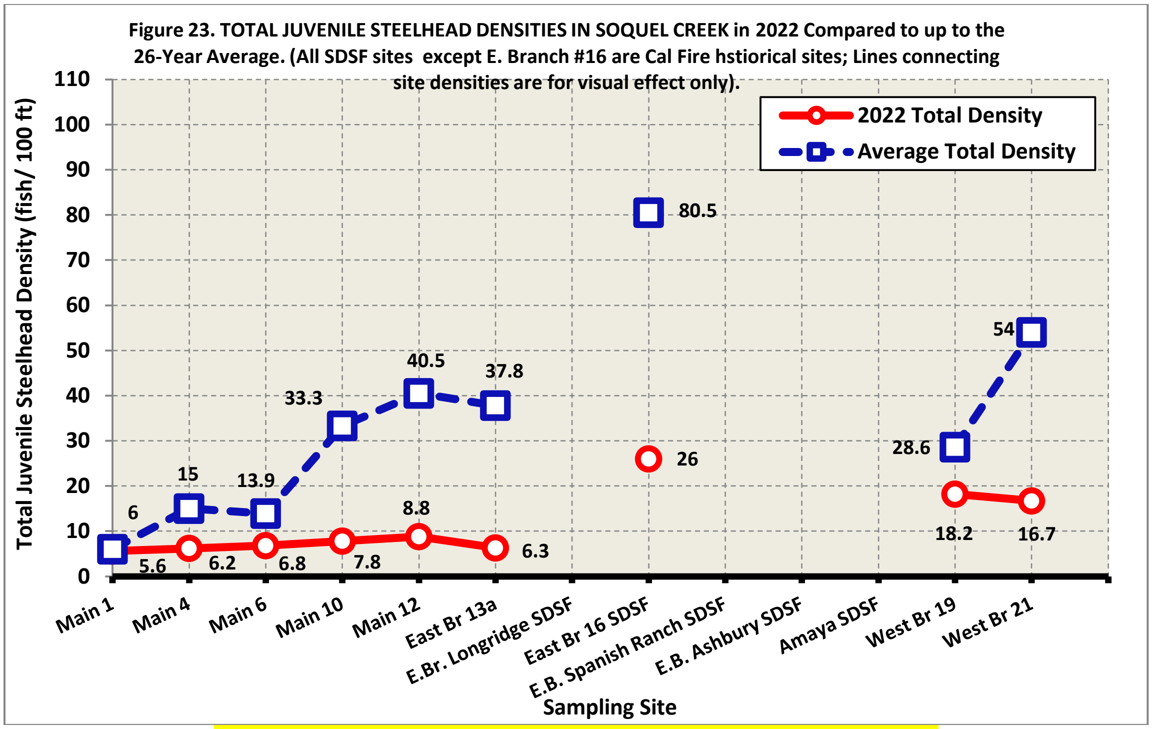

Figure 23. Total Juvenile Steelhead Site Densities in Soquel Creek in 2022 Compared to up to the 26-Year Average (12-year average for Mainstem Site #6.)

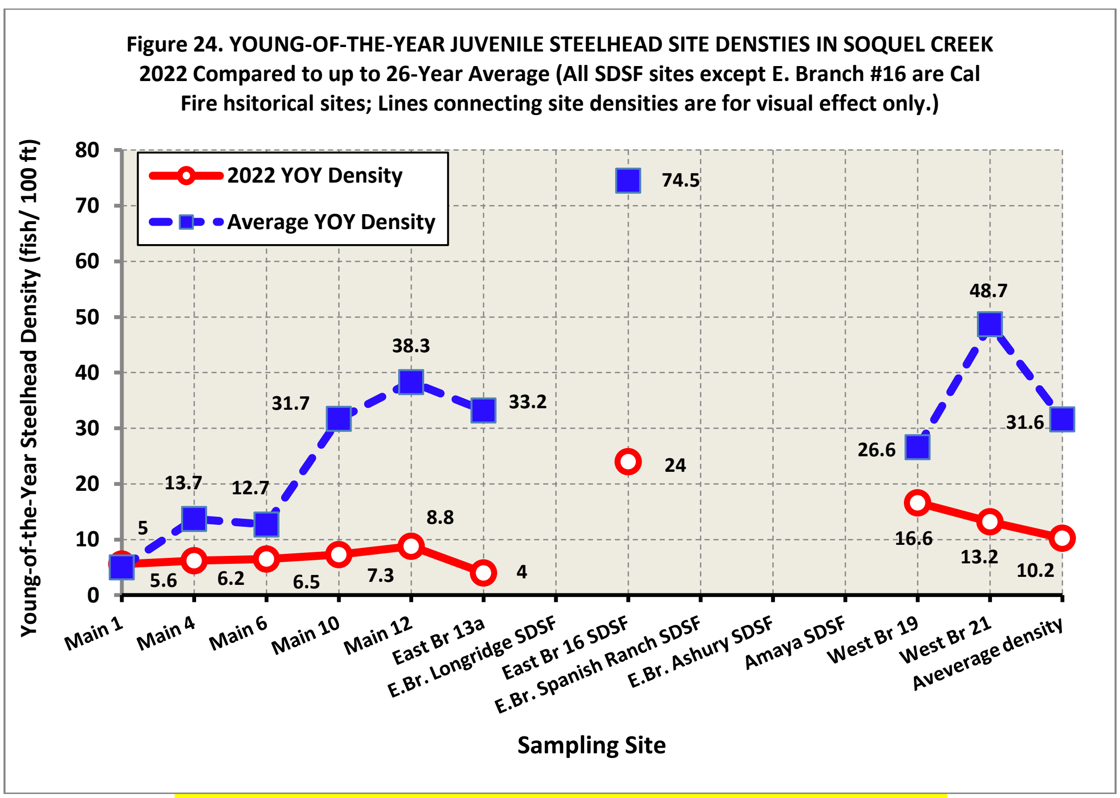

Figure 24. Young-of-the-Year Steelhead Site Densities in Soquel Creek in 2022 Compared to up to the 26-Year Average (12-year average for Mainstem Site #6.)

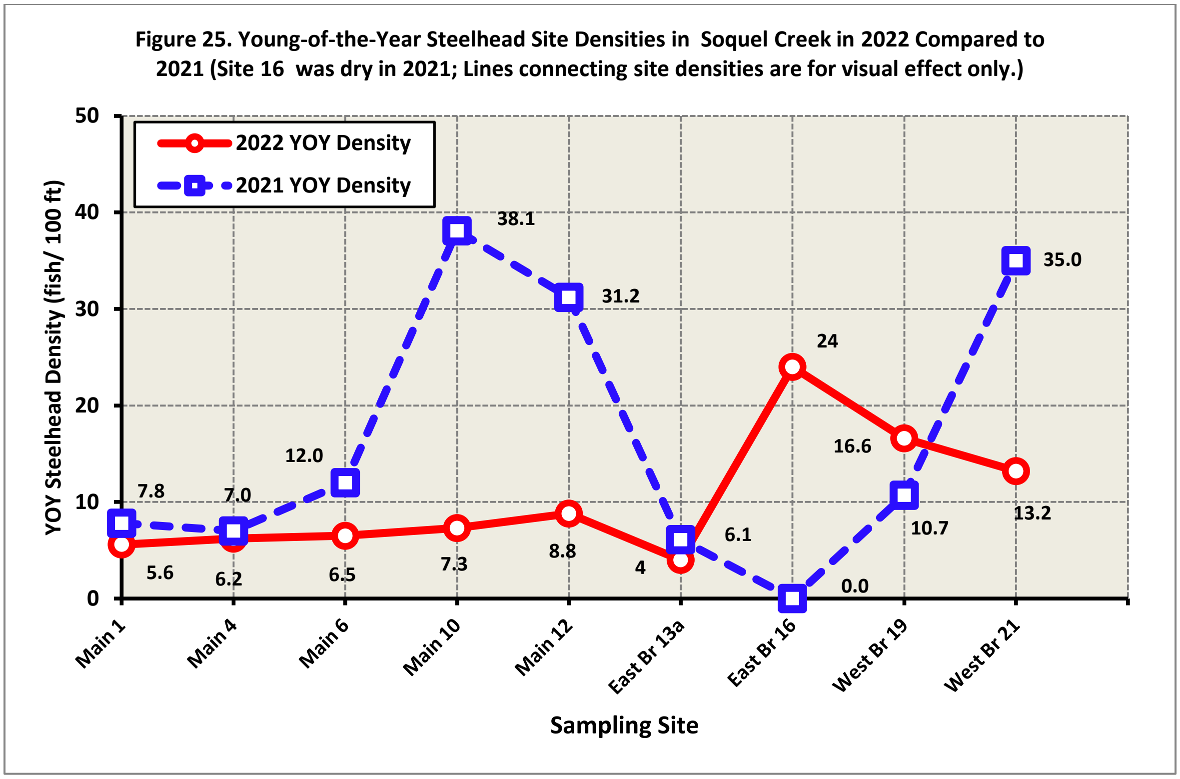

Figure 25. Young-of-the-Year Site Densities in Soquel Creek, Comparing 2022 to 2021.

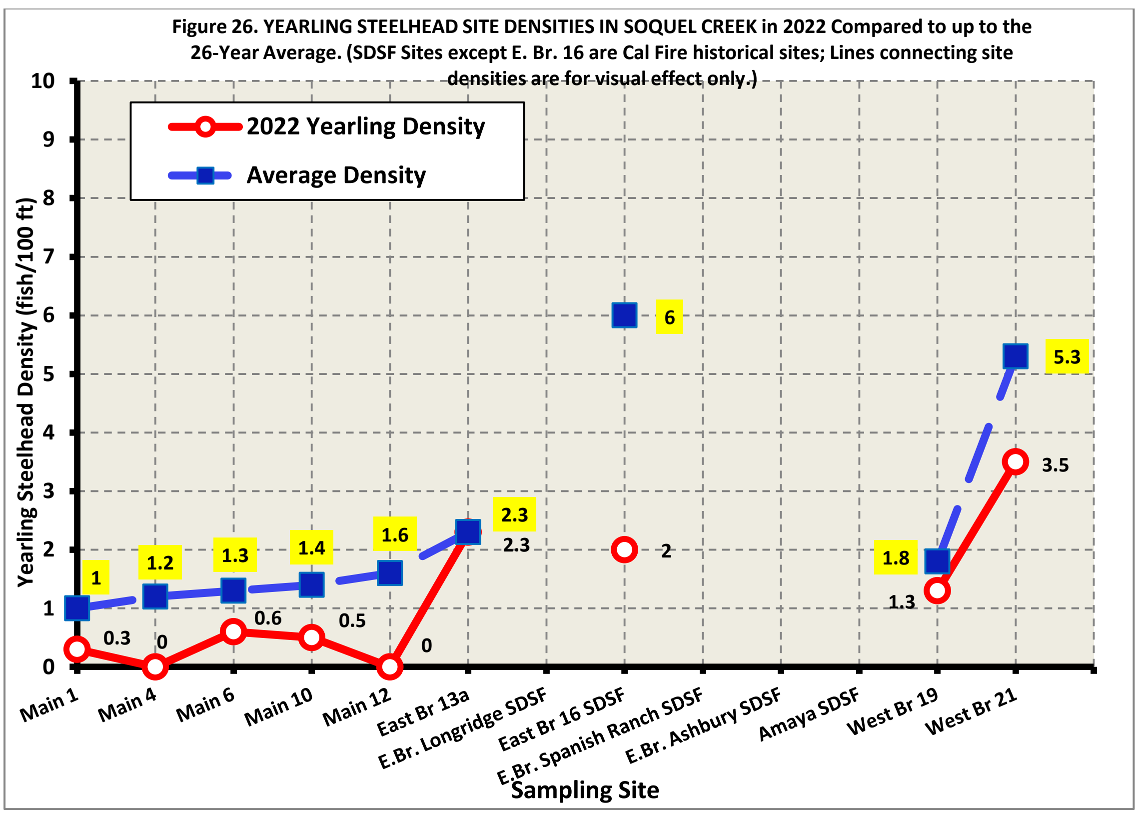

Figure 26. Yearling Steelhead Site Densities in Soquel Creek in 2022 Compared with up to the 26-year Average .

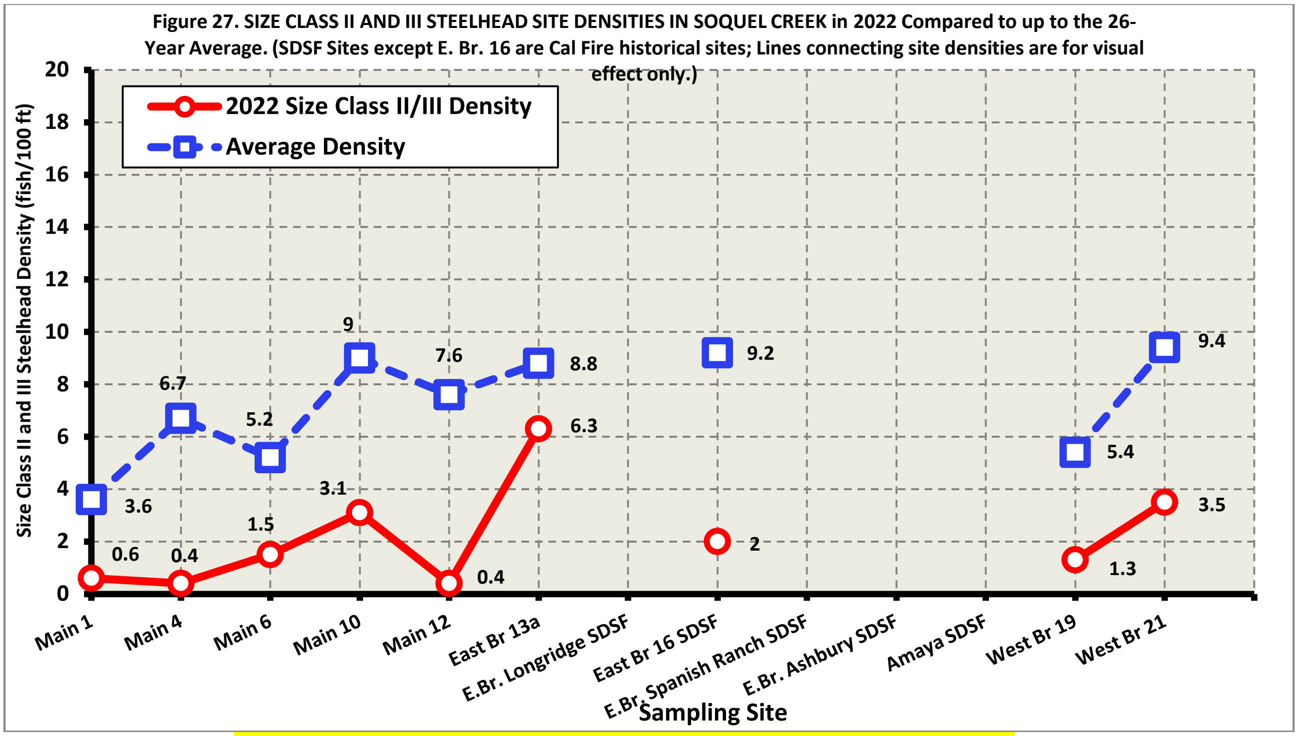

Figure 27. Size Class II and III Steelhead Site Densities in Soquel Creek in 2022 Compared with up to the 26-Year Average.

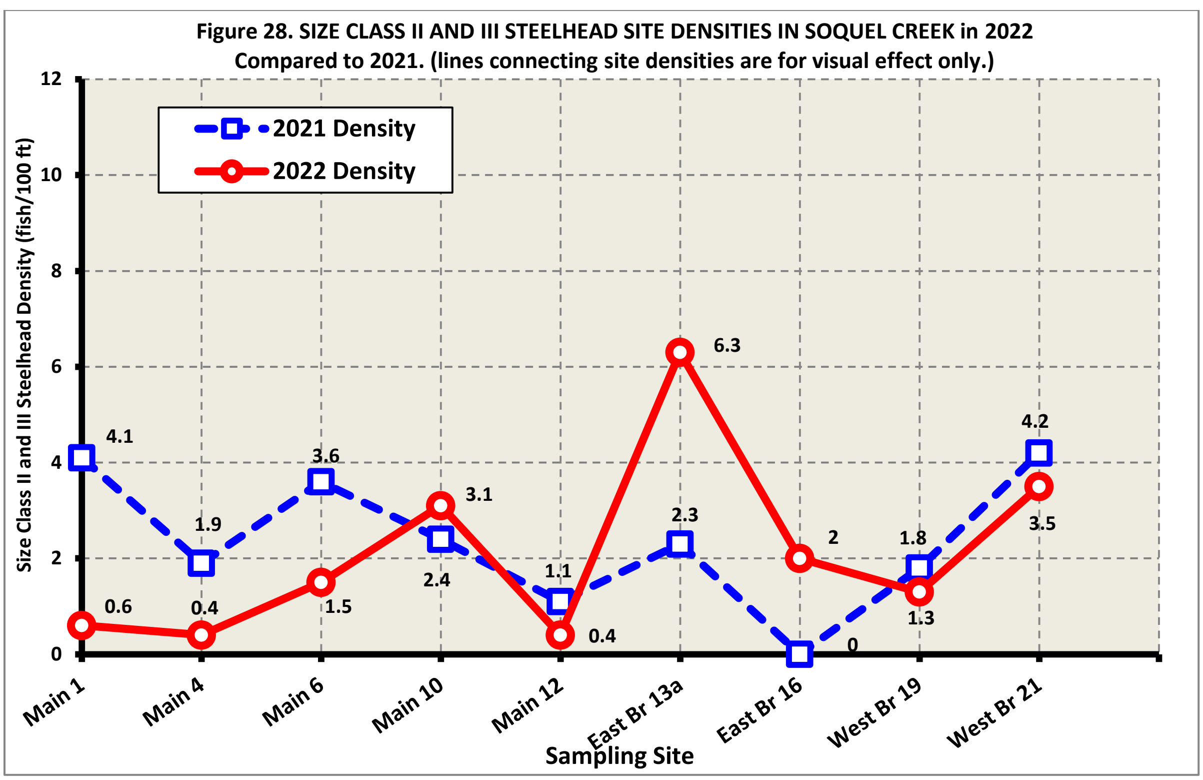

Figure 28. Size Class II/III Steelhead Site Densities in Soquel Creek Comparing 2022 to 2021.

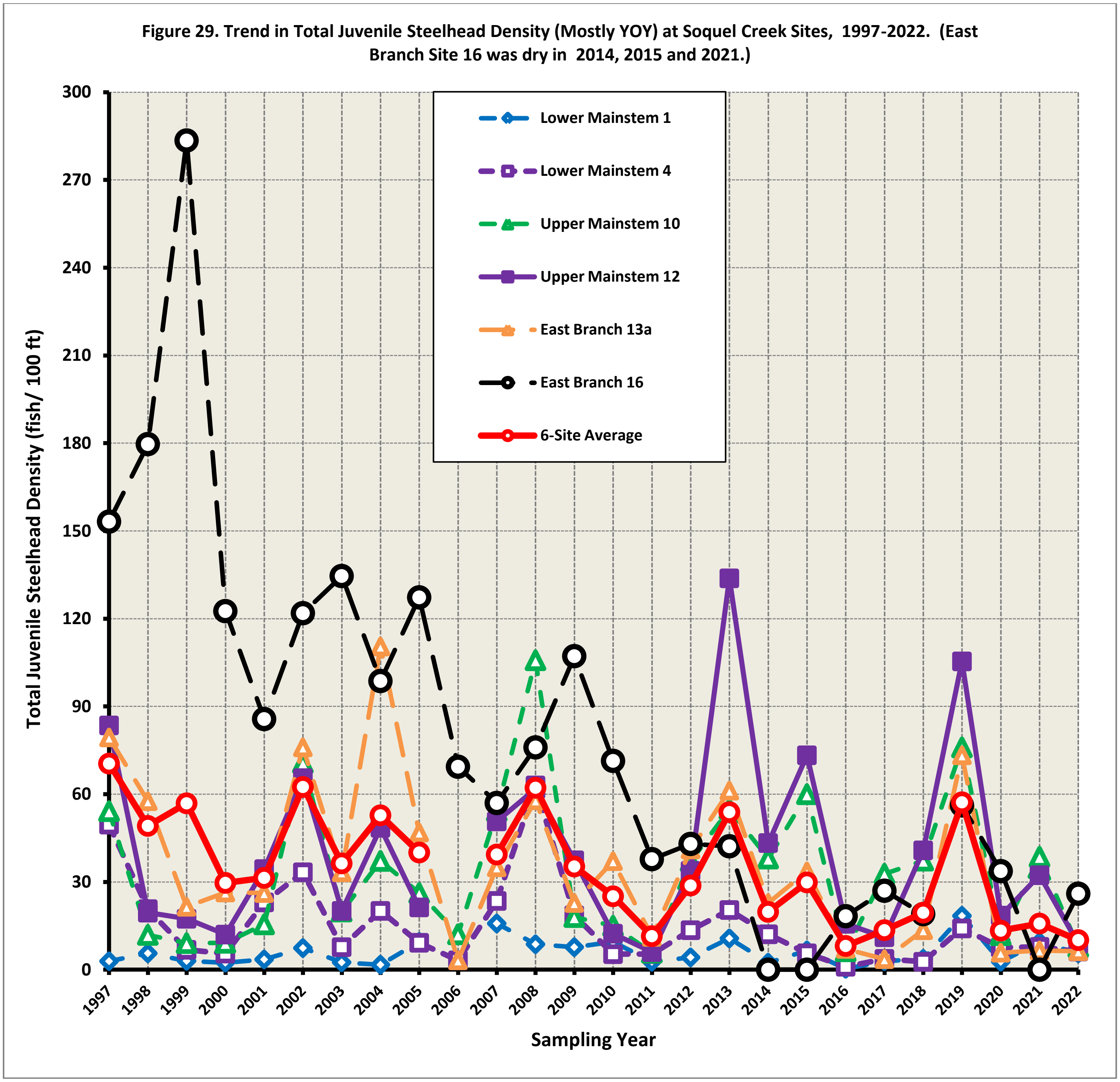

Figure 29. Trend in Total Juvenile Steelhead Density (Mostly YOY) at Soquel Creek Sites, 1997-2022.

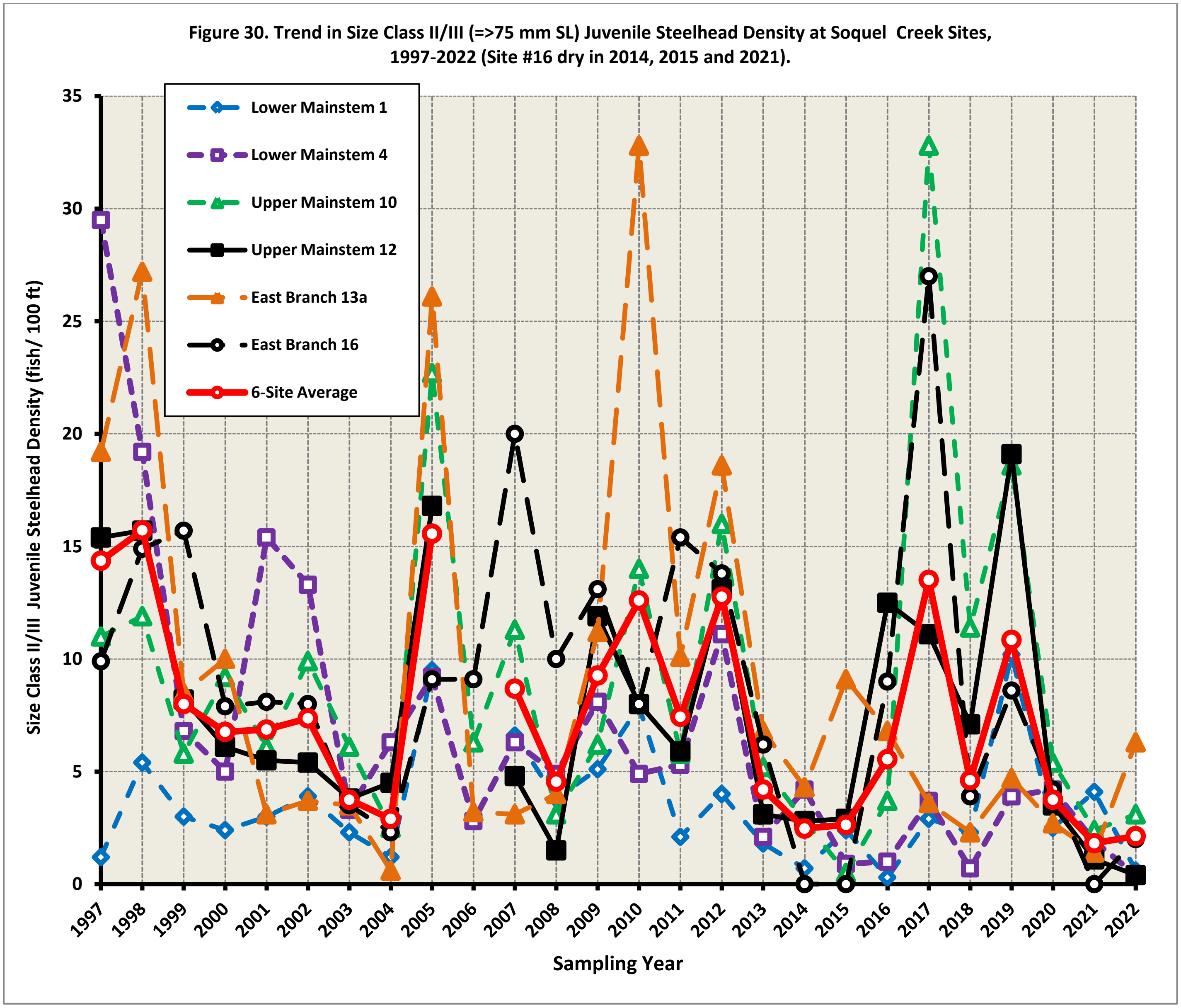

Figure 30. Trend in Size Class II/III Juvenile Steelhead Density at Soquel Creek Sites, 1997-2022.

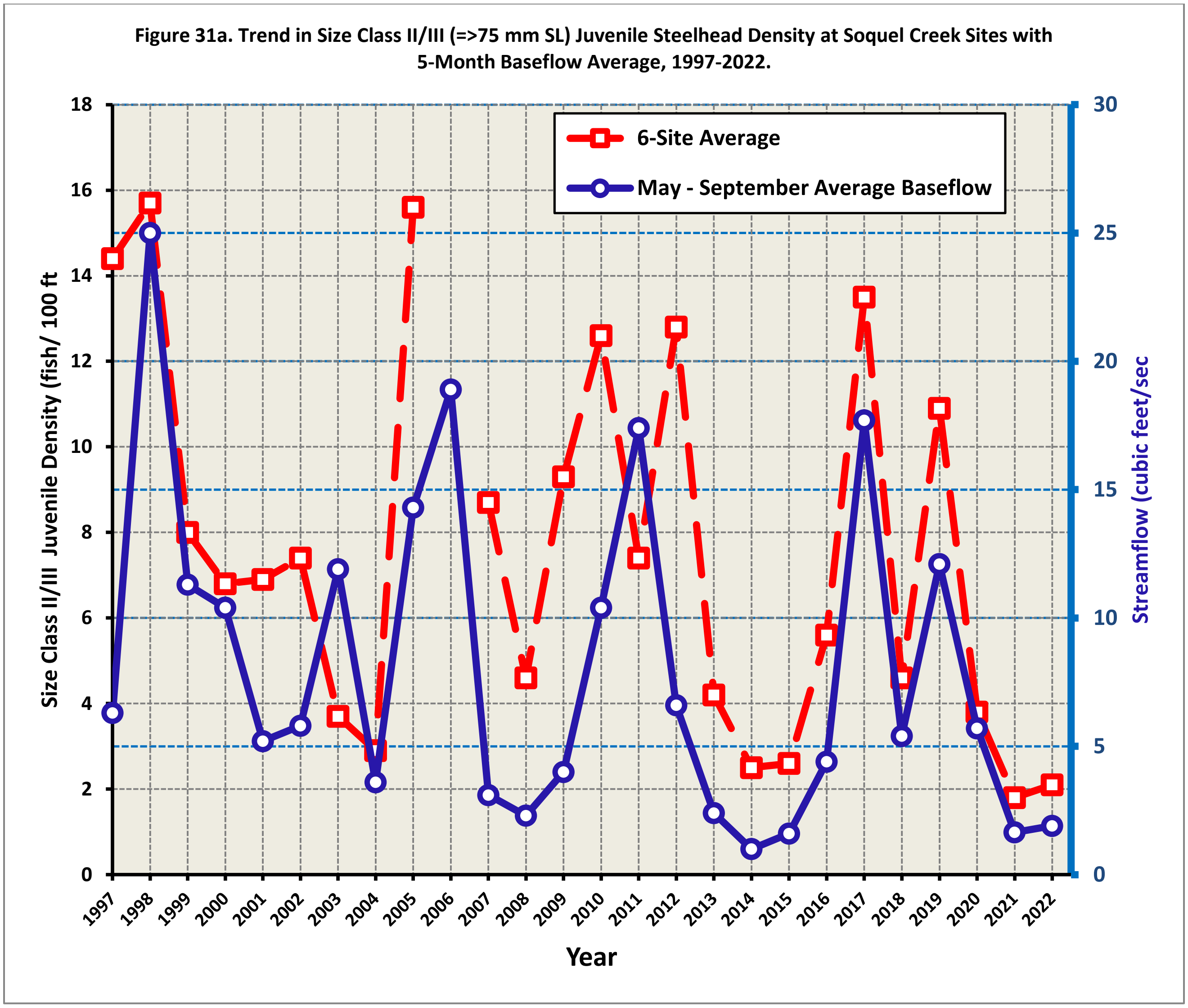

Figure 31a. Trend in Size Class II/III (=>75 mm SL) Juvenile Steelhead Density at Soquel Creek Sites with 5-Month Baseflow Average, 1997-2022.

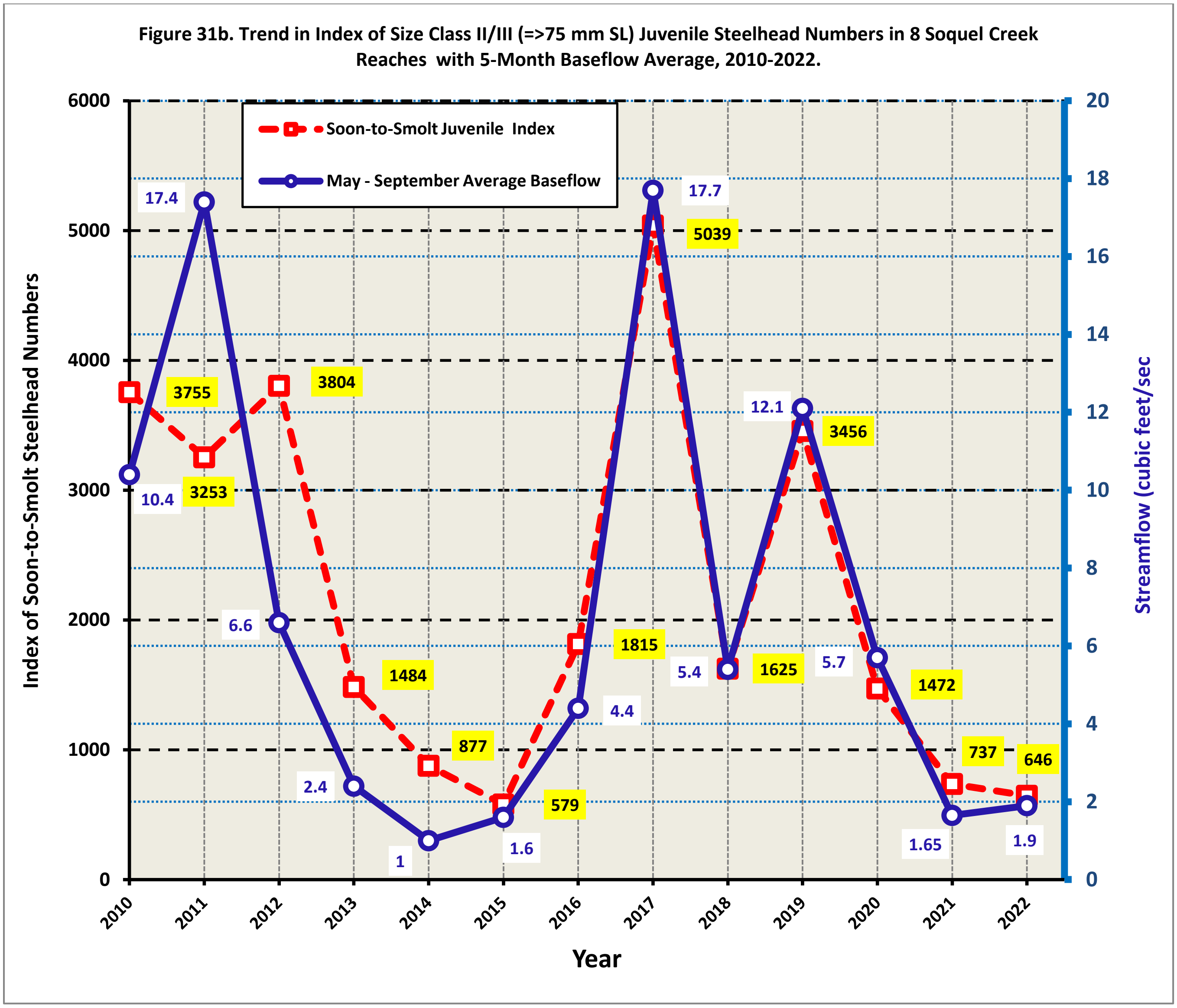

Figure 31b. Trend in Index of Size Class II/III (=>75 mm SL) Juvenile Steelhead Numbers in 8 Soquel Creek Reaches with 5-Month Baseflow Average, 2010 − 2022.

iii. Steelhead Abundance and Habitat in the Aptos Creek Watershed

1. Aptos Creek likely had a WY2022 hydrograph similar to those in the San Lorenzo and Soquel drainages, with stormflows at the same frequency and intensity. This resulted in similar dry stormflow patterns for WY2022, with several bankfull stormflows occurring in December, as they did in the Soquel watershed (**Figure 22**). These stormflows likely provided better spawning access in this lower gradient watershed compared to the SLR early on. But the small stormflows in March and April 2022 may not have. An extensive clustering of instream wood was examined by Chad Steiner between the two sampling sites in Aptos Creek (**Map in Figure 3**), causing an adult steelhead passage impediment. The fish ladder in lower Valencia Creek is suboptimal, likely causing passage impedance there. there. Baseflow likely declined steadily from April to below median baseflow down to 0.96 cfs in mid-October at a location just downstream of the Valencia Creek confluence (**Table 4**). An early stormflow came on 18 September 2022 which peaked at 36.4 cfs in Soquel Creek at Soquel Village. Stormflow was likely less in Aptos Creek. Fish sampling in Soquel and Aptos creeks occurred after this small stormflow but likely did not affect juvenile densities, based on sampling experience by Alley and Smith (**pers. comm.**).

2. ***Habitat conditions*** in 2022 in the Aptos Creek branch of the watershed were compared to 2020 conditions with higher baseflow, based on habitat typing of stream segments. Habitat conditions in 2022 in the Valencia Creek branch were compared to 2021 conditions, based on sampling site habitat conditions. Habitat conditions in Aptos Reach 3 near the County Park were similar to conditions in 2020, with slightly less baseflow but increased pool escape cover (**Table 6**). Habitat conditions in Aptos Reach 4 above the metal bridge declined slightly due to slightly reduced baseflow and reduced pool depth. In Valencia Creek, the bankfull events in December caused substantial sedimentation of Reach 2 (Site 2) below Valencia Road crossing resulting from apparent streambank erosion during bankfull stormflows in December. Habitat conditions declined at lower Site 2, though baseflow was greater in 2022 than 2021. Pool depth shallowed considerably with less escape cover, and percent fine sediment increased. Pool embeddedness remained poor. Habitat conditions at upper Site 3 above Valencia Road improved with increased baseflow from 2021, deeper pool habitat and increased pool escape cover as sediment was scoured by stormflow around scour objects. At Site 3, percent fine sediment and embeddedness remained similar in pools. Tables of habitat measurements are in the detailed analysis report available upon request.

3. ***Total and YOY steelhead densities were again below average at all 4 sites***, as was the case in the two previous years (averaging 7.8 total juveniles/100 ft (4.4 in 2021) and 5.2 YOY/100 ft (2.0 in 2021)) (**Figures 32 and 33**). The increase in total density was not statistically significant from 2021 levels (**Table 10**). YOY were detected in 2022 at upper Site 4 in Aptos Creek above the substantial instream wood cluster, though absent in 2021. Year classes and size classes are defined in the glossary. Some YOY may reach Size Class II where food is more abundant. Therefore, at some sites the Size Class II/III group includes YOY and yearlings. The bankfull events in December apparently afforded adult fish passage above the wood cluster. 2022 YOY densities were greater than in 2021 at 3 of 4 sites (**Figure 34**) and increases were statistically significant (**Table 10**). The 4-site long-term trend in total density increased modestly from 2021 to 2022 (**Figure 38**), consistent with the trend in the SLR watershed. But the average total density was the second lowest measured since 2006. Tables of fish densities are presented in the detailed analysis report available upon request.

4. ***Yearling and older steelhead densities were below average at all 4 sites***, as was the case in 2021, averaging 2.6 yearlings/100 ft (2.3 in 2021) (**Figure 35**). Low numbers of YOY in 2021 offered low recruitment to the yearling age class in 2022.

5. ***Size Class II/III densities were below average at the all 4 sites***, averaging 2.6 Size Class II/III juveniles/100 ft (2.3 in 2021) **(Figure 36**). They increased slightly at 3 of 4 sites in 2022 compared to 2021 (**Figure 37**), and the increase was not statistically significant (**Table 10**). The trend in average site density of Size Class II/III juveniles increased slightly in 2022 but densities were still the second lowest for measurements beginning in 2006 (**Figure 39a**). Trends in the SLR and Soquel watersheds of densities and index numbers of larger juveniles track positively with 5-month average baseflow through the wet and dry years in the San Lorenzo and Soquel watersheds, and to a degree in the Aptos/Valencia watershed (**Figures 19a-b, 20a-b, 30, 31a-b and 39a-b**). The production index in 2019 was an exception. The positive tracking may not occur in every year in the Aptos watershed because the Aptos adult steelhead population has declined to the point where the juvenile offspring are in such low densities that density dependent competition that would reduce juvenile densities in dry years with low baseflows does not intensify. This would occur because the few juveniles produced from a small number of adults do not come close to saturating the rearing habitat in the Aptos Creek branch of the watershed or the upper Reach 3 in Valencia Creek. In the SLR and Soquel watersheds, an increase in these larger juveniles occurs in higher baseflow years partially because more YOY grow into Size Class II their first summer. But in Aptos Creek, total juvenile density may be low enough to allow faster YOY growth even in low baseflow years. However, the higher baseflow 2019 year was an exception, with high YOY densities of small YOY probably produced from late adult spawners during late stormflows with high competition. With few YOY reaching Size Class II and few yearlings present from the previous year, numbers of these larger juveniles did not increase in 2019 in the Aptos watershed as they did in the San Lorenzo and Soquel watersheds.

6. ***The Aptos Lagoon steelhead population estimate was small in 2022,*** with few juveniles captured to be marked and only one recapture to yield an estimate of 40 juveniles (**Figure 40**). This was consistent with the low juvenile densities upstream. The size histogram of the 13 captured steelhead indicated a possible bimodal size distribution of age classes, with juveniles longer than 150 mm SL likely being yearlings (**Figure 41**). The good-sized Aptos estuary steelhead population of Size Class II and III juveniles in 2020 (365 juveniles) and their near average density at the 4 stream sites had offered potential for overall population sustainability. But 2021 and 2022 results dashed this optimism. By comparison, the population estimate in Soquel Lagoon decreased from 2,500 in 2021 to 1,674 (above average and above the median) in 2022.

7. Approximately 20 tidewater gobies (*Eucyclogobius newberryi*) were captured with the large seine (3/8-inch mesh) each day on 30 September and 7 October. Conditions along the shallow margins were nearly freshwater (1.2 ppt) and conducive to goby nesting and reproduction. Tidewater goby sampling was unbudgeted and not done with the finer, 1/8-inch meshed goby seine. Besides steelhead and tidewater goby, other species captured on both days combined were 395 smelt (*Atherinopsis spp.),* 76 starry flounder (*Platichthys stellatus*), 69 staghorn sculpin (*Leptocottus armatus*) and numerous threespine stickleback (*Gasterosteus aculeatus*).

8. Aptos Lagoon in the vicinity of the walk bridge was shallow and had stratified water temperature and salinity on both sampling days (**Table 7**). The sandbar was closed. Oxygen was more than adequate on both sampling days in the morning. On 30 September in the upper 0.50 m of the water column, water temperature went from cool to warm but tolerable for steelhead (15.7 to 21.5 C) and mildly saline (1.2 to 6.3 ppt). However, water temperature had increased to stressful levels for steelhead (23.6 to 23.9 C) near to and at the bottom of 0.8 meters. On 7 October with cooler air temperature, the salinity had lessened (1.0 to 1.7 ppt at 0.5 m), and water temperature was slightly cooler (15.6 to 22.4 C at the bottom) than the previous week. Oxygen levels were still good and higher at the bottom than previously. Some freshwater conversion had begun.

Table 6. Habitat Change in Reaches and Sites in the APTOS WATERSHED from most recent previous years. (Green highlight indicates reach comparisons. Yellow indicates site comparisons.)

Reach or (Site Only) Comparison To Previous Years	2022 Baseflow Comparison (Most Important Factor May-September)	Pool Depth	Pool Fine Sediment	Pool Embeddedness	Pool Escape Cover	Overall Habitat Change (Any Improvement)
Aptos Reach 3 Aptos Reach 3 (Since higher baseflow 2020)	Slightly −	Similar	Similar	Similar	+	Similar (more pool cover)
Aptos Reach 4 Aptos Reach 4 (Since higher baseflow 2020)	Slightly −	−	Similar	Same	Same	− (no improvement)
(Valencia Site 2) (Since lower baseflow 2021)	+	Very −	−	Similar	−	− (slightly more food)
(Valencia Site 3) (Since lower baseflow 2021)	+	+	Similar	Similar	Very +	+ (slightly more flow, deeper pools with more cover)

Table 7. Water quality measurements in Aptos Lagoon (sandbar closed) during steelhead sampling, 30 September and 7 October 2022.

			30 September 2022					7-Oct-2022
	Walk-bridge Air temp. 15.9°C Gage Height = 2.98 ft			0840 hr	**Walk-bridge** (thalweg) Air temp. 14.1°C; Gage Height = 2.82 ft			0855 hr
Depth	**Temp**	**Salin**	**Oxygen**	**Cond**	**Temp**	**Salin**	**Oxygen**	**Cond**
(m)	**(C)**	**(ppt)**	**(mg/l)**	**micro-mhos**	**(C)**	**(ppt)**	**(mg/l)**	**micro-mhos**
0 (surface)	15.7	1.2	9.62	1981	15.6	1.0	9.09	1634
0.25	19.7	3.1	13.24	4927	16.6	1.0	8.95	1643
0.5	21.5	6.3	12.18	10371	19.2	1.7	7.58	2961
0.75b	23.9	13.4	8.87	21836	22.4	6.9	8.44	11480
0.80b	23.6	18.8	2.78	25151				
1.00								
1.25								
1.50								
1.75b								

*** "b" indicates the lagoon/estuary bottom where measurements were taken through the water column.**

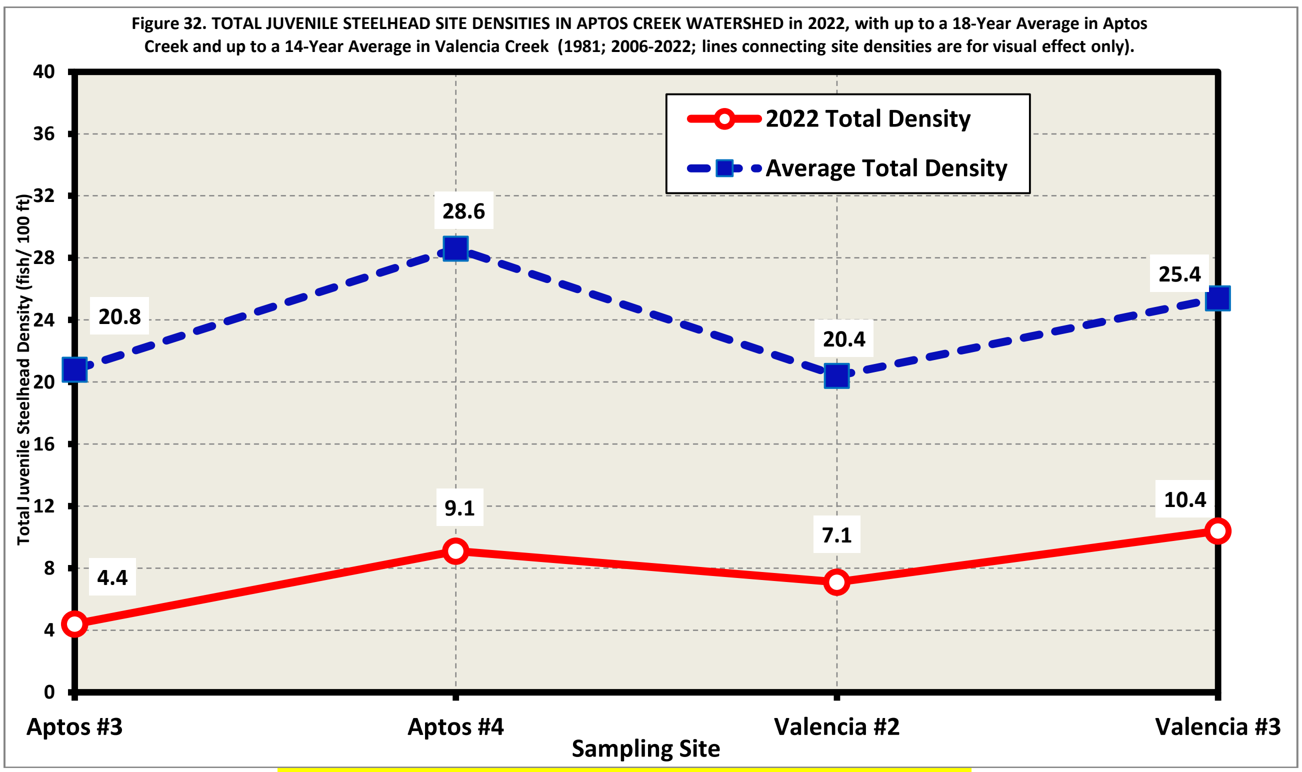

Figure 32. Total Juvenile Steelhead Site Densities in Aptos Watershed in 2022, Compared to up to an 18-Year Average (1981; 2006-2022).

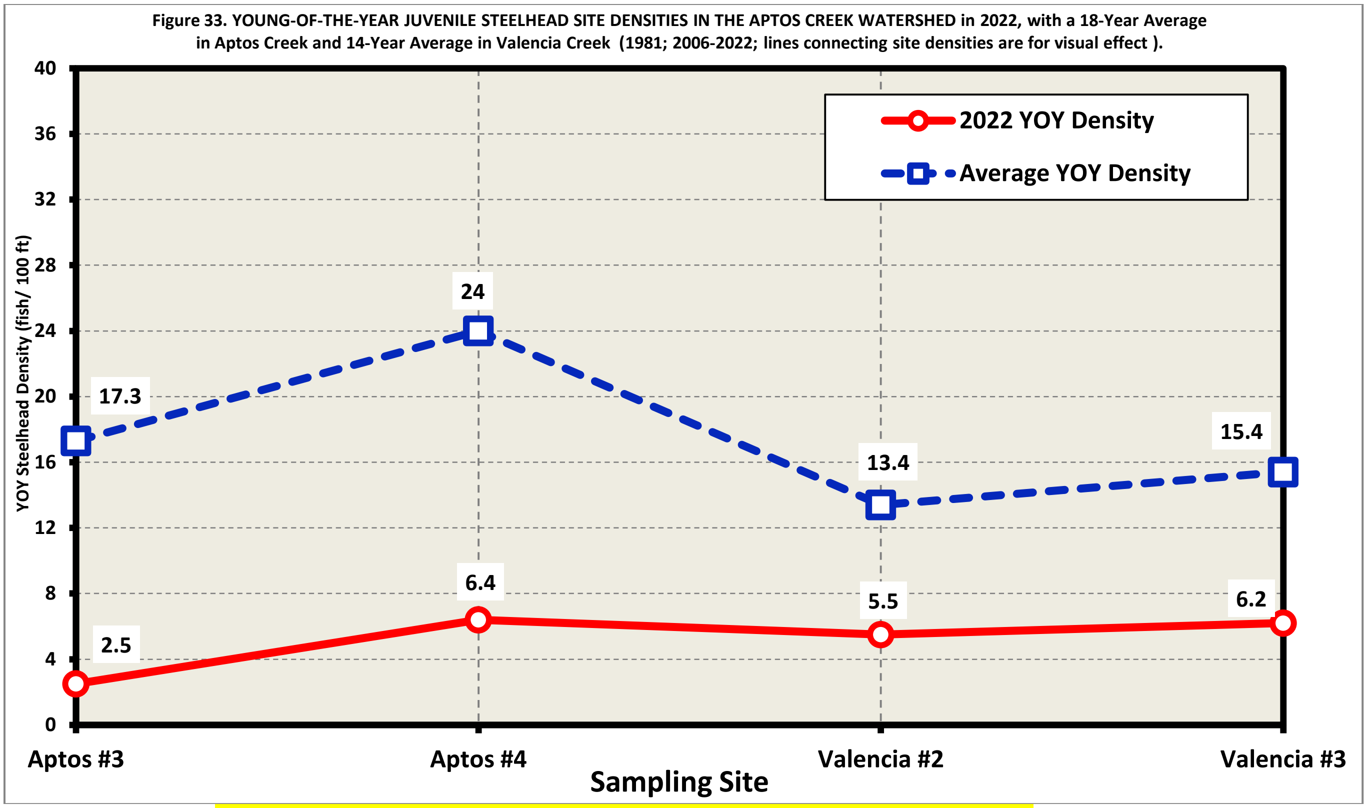

Figure 33. Young-of-the-Year Steelhead Site Densities in Aptos Watershed in 2022, Compared with up to a 18-Year Average (1981; 2006-2022).

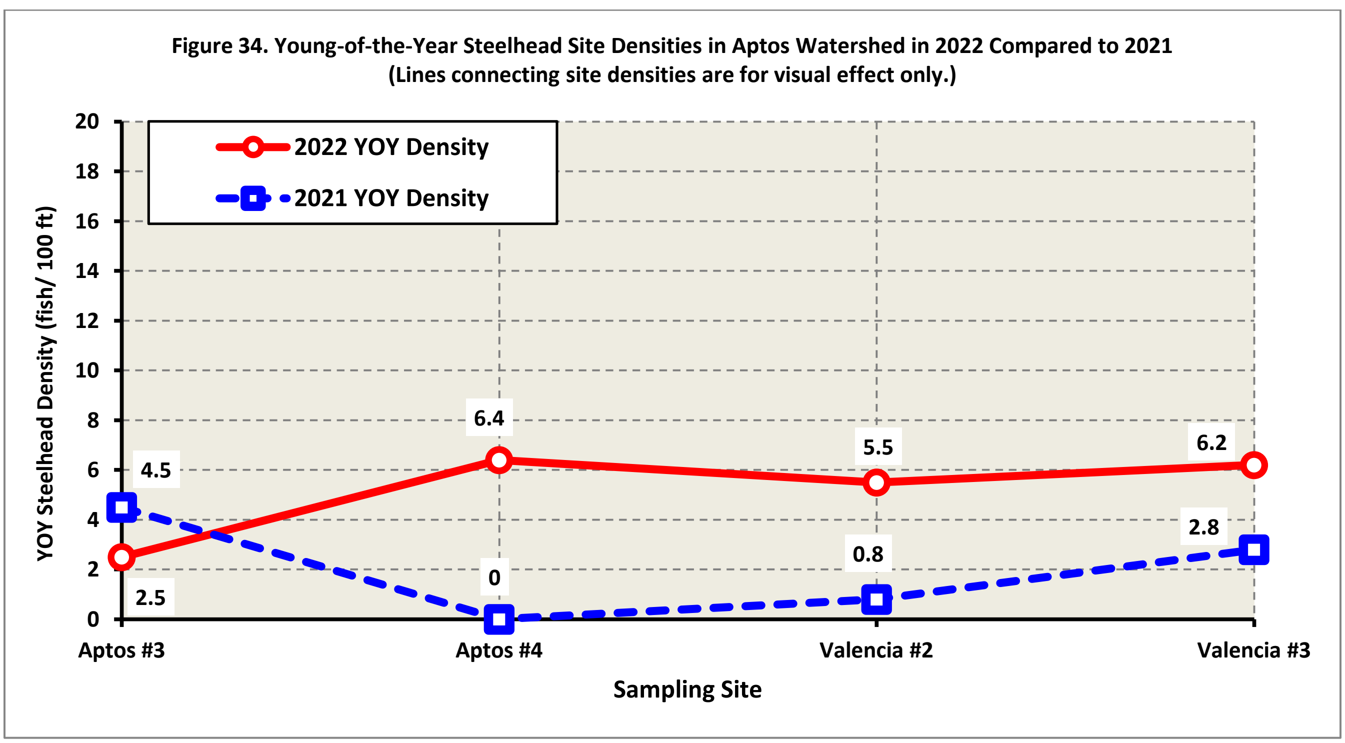

Figure 34. Young-of-the-Year Site Densities in Aptos Creek, Comparing 2022 to 2021.

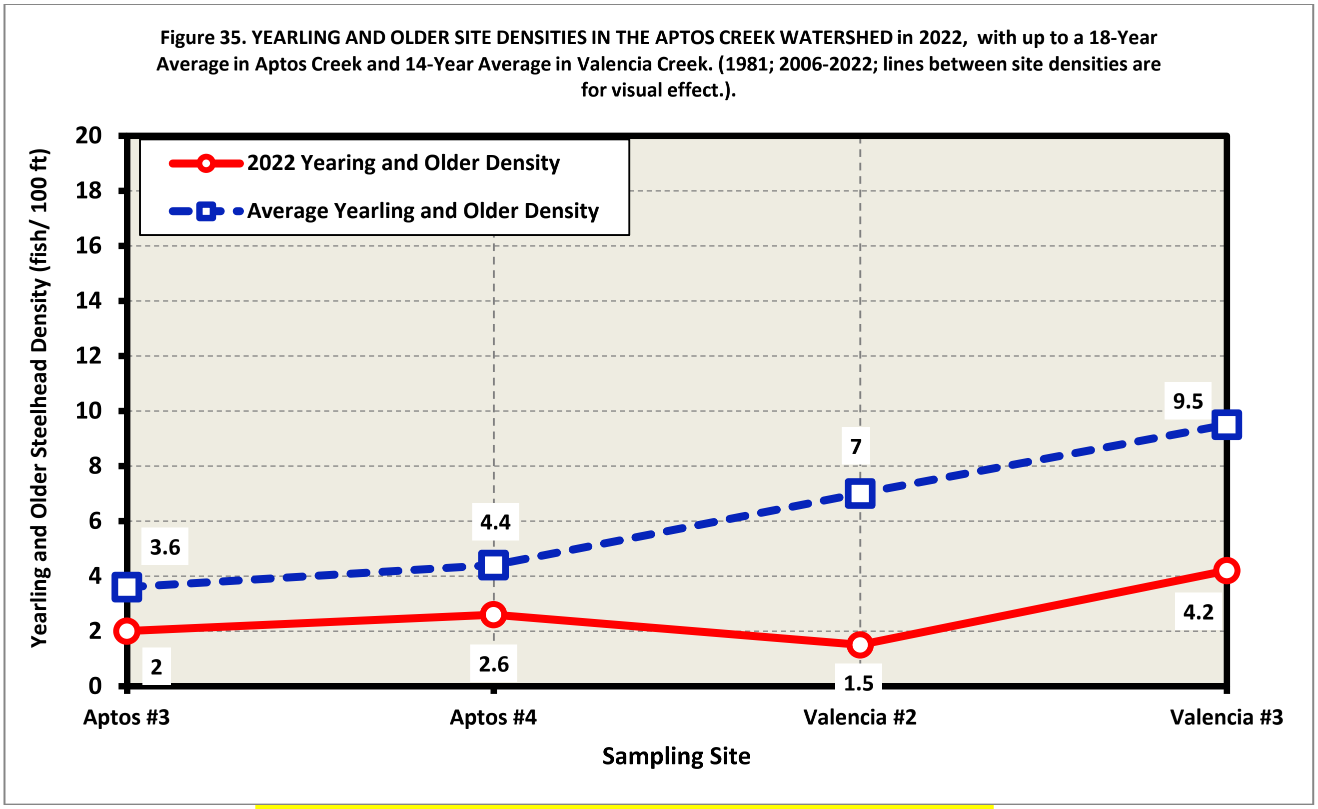

Figure 35. Yearling and Older Steelhead Site Densities in Aptos Watershed in 2022, Compared with up to a 18-Year Average (1981; 2006-2022).

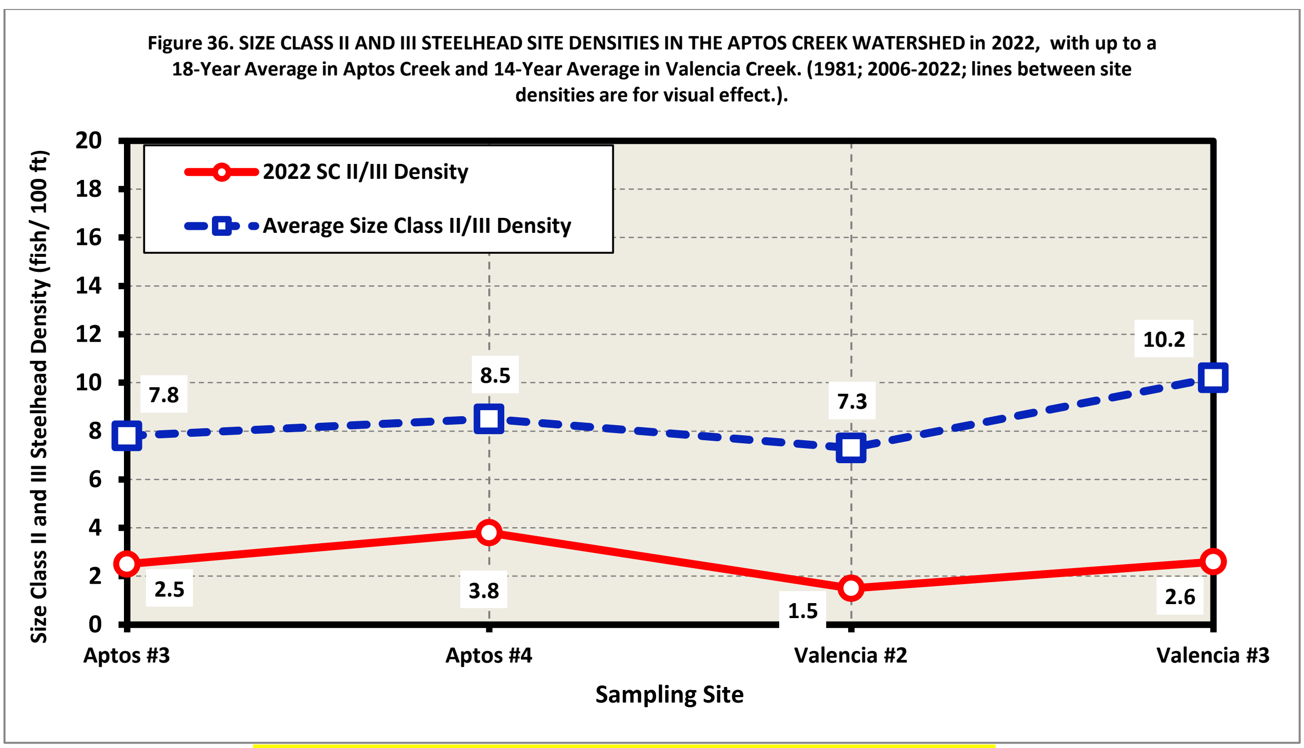

Figure 36. Size Class II and III Steelhead Site Densities in Aptos Watershed in 2022, Compared with up to a 18-Year Average (1981; 2006-2022).

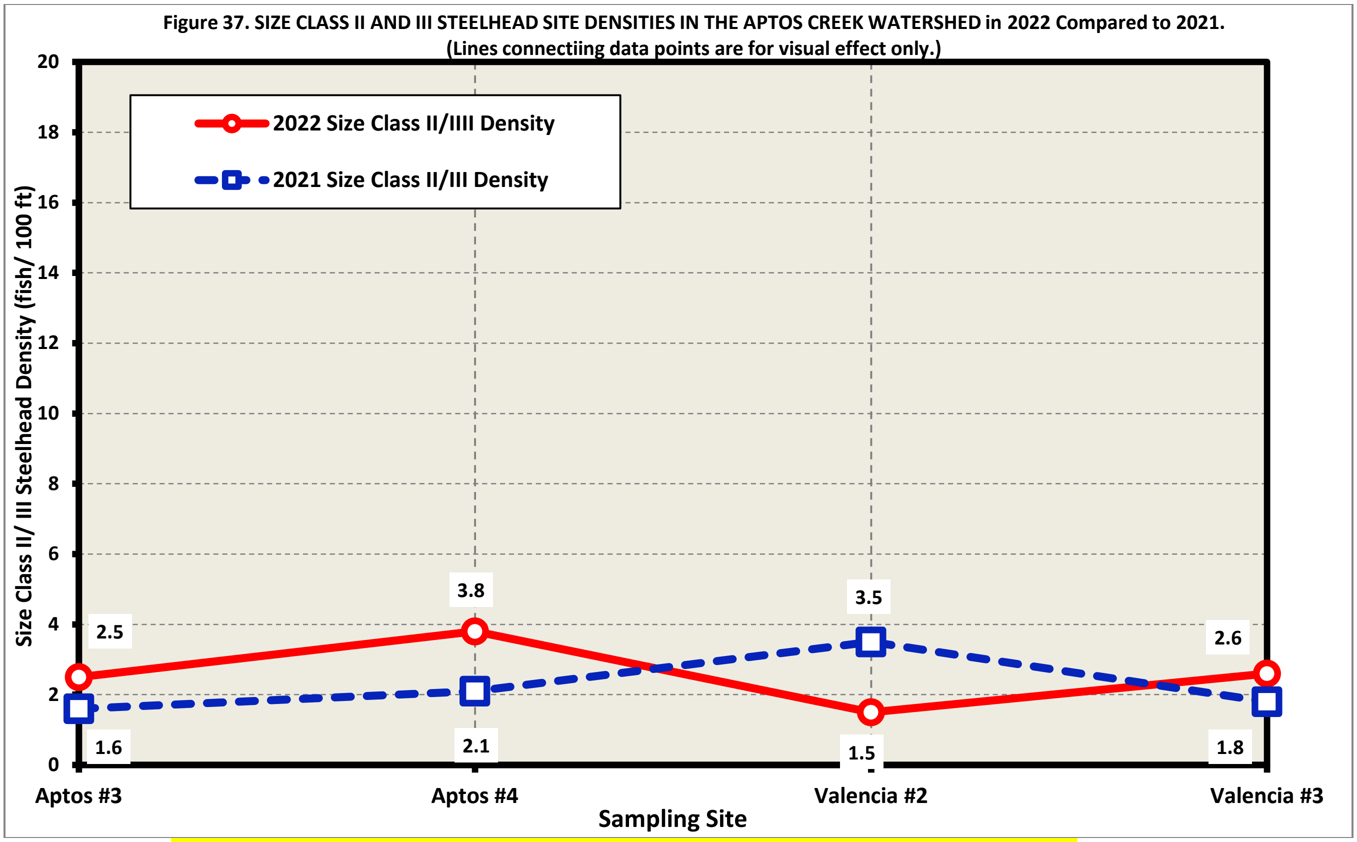

Figure 37. Size Class II/III Steelhead Site Densities in Aptos Creek Comparing 2022 to 2021.

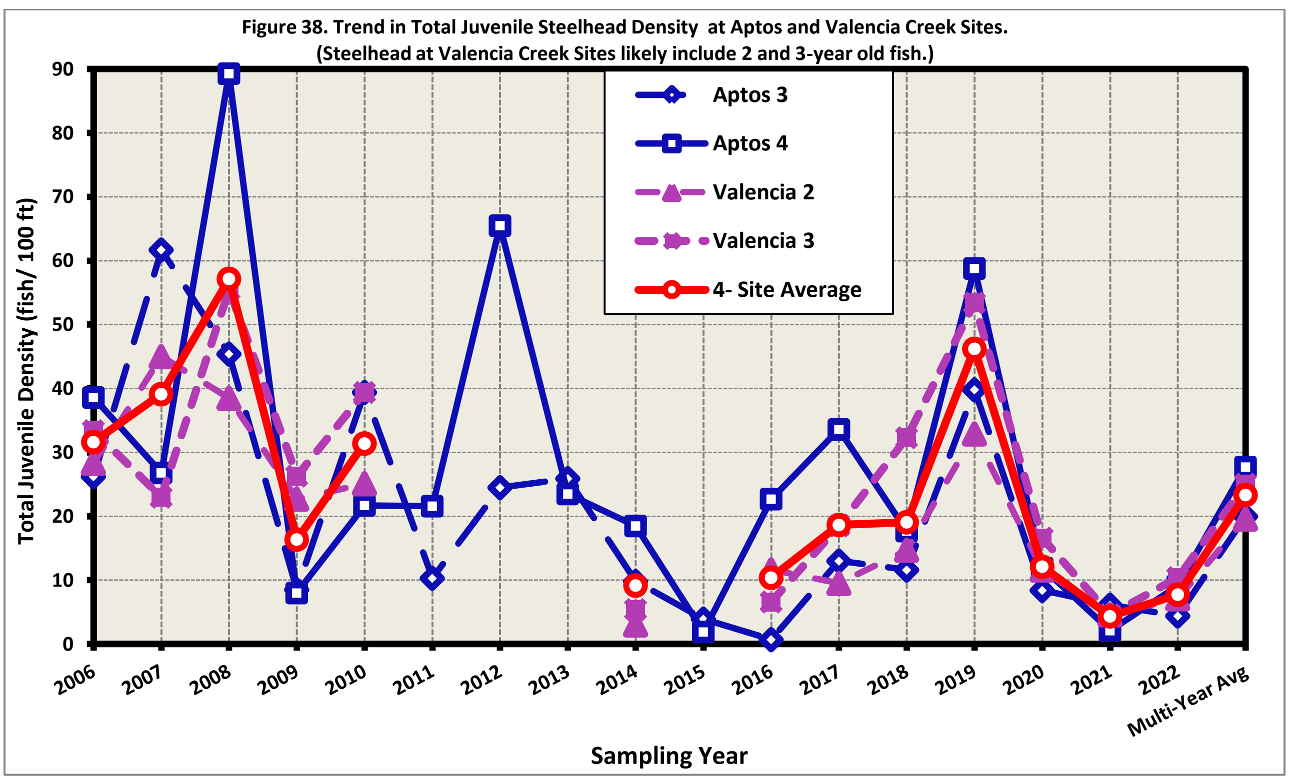

Figure 38. Trend in Total Juvenile Steelhead Site Densities in Aptos Watershed for 2006–2022.

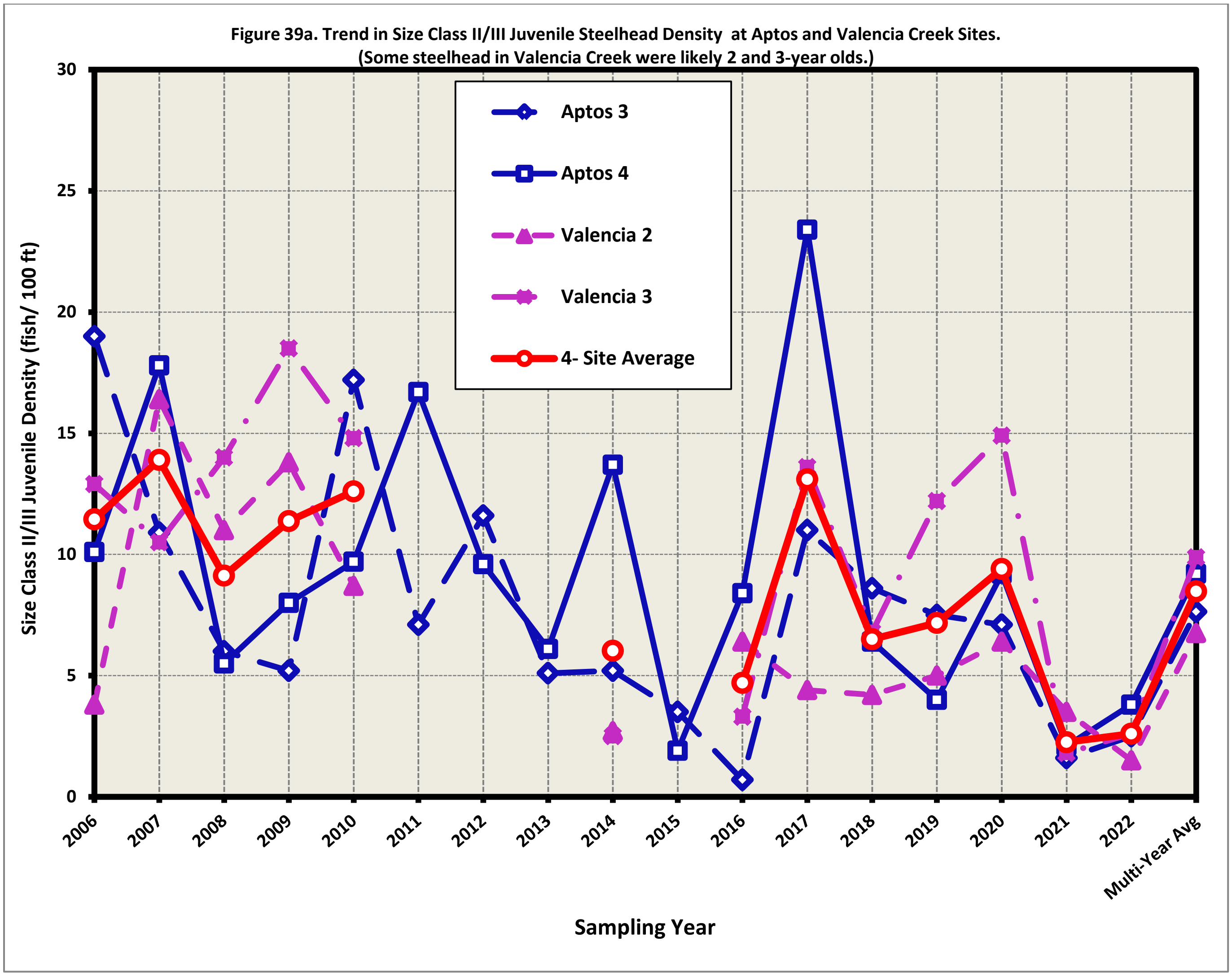

Figure 39a. Trend in Size Class II/III Steelhead Site Densities in Aptos Watershed for 2006 – 2022.

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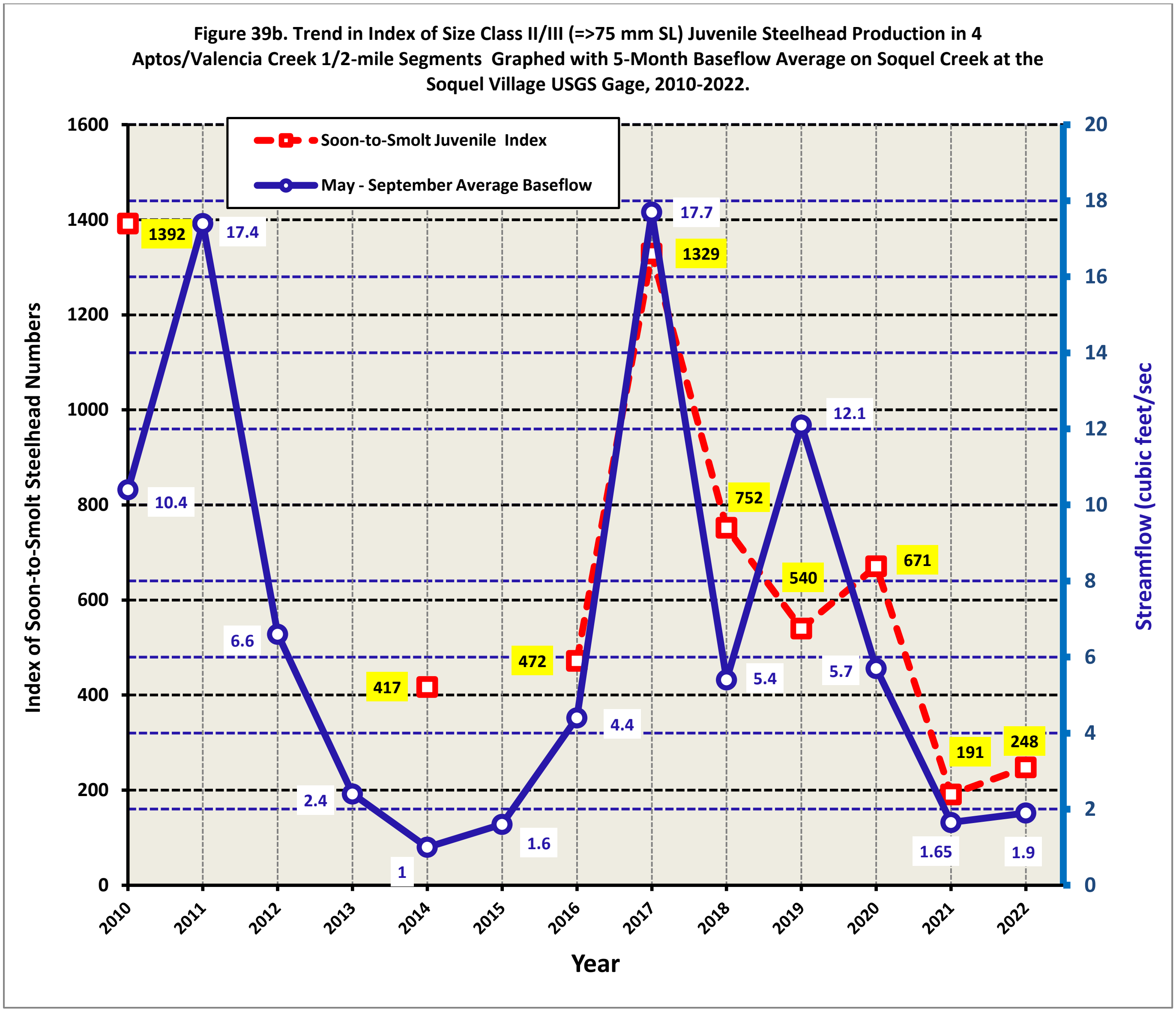

Figure 39b. Trend in Index of Size Class II/III (=>75 mm SL) Juvenile Steelhead Numbers in 4 Aptos/Valencia Creek Segments Graphed with 5-Month Baseflow Average in Soquel Creek, 2010 – 2022.

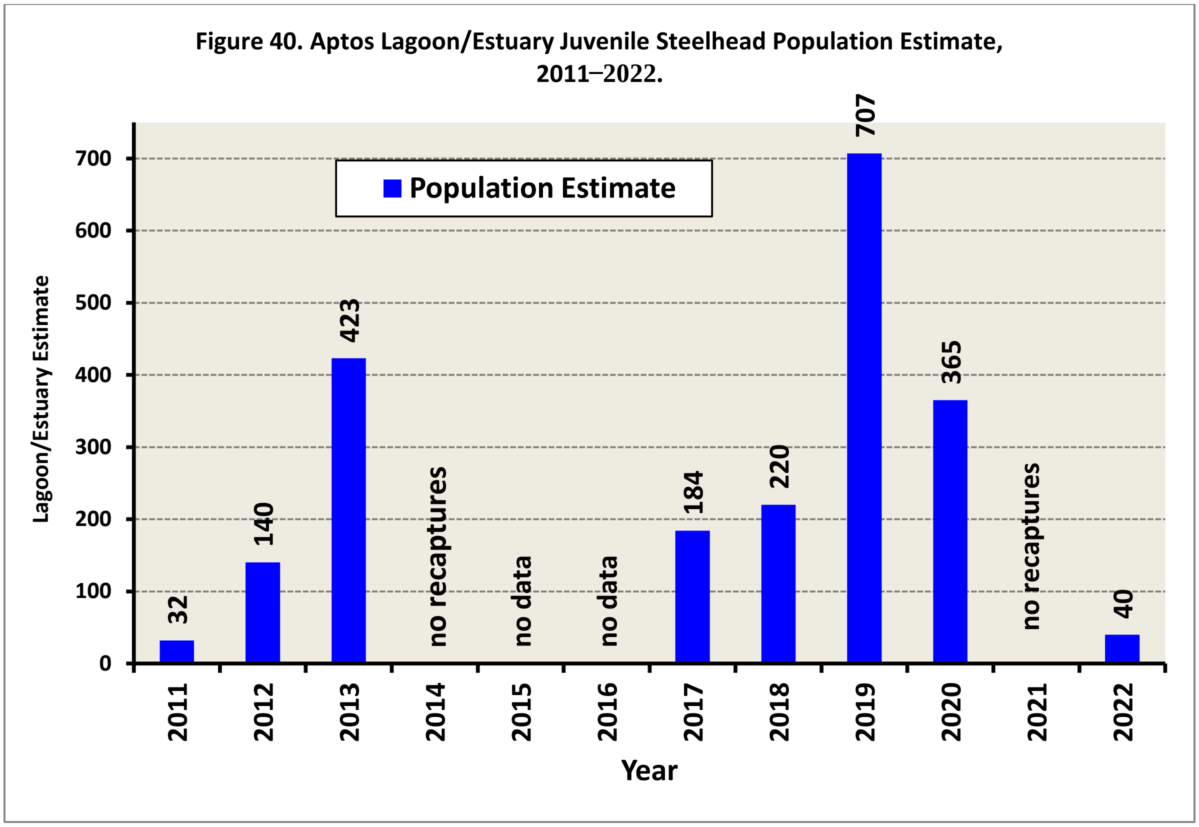

Figure 40. Aptos Lagoon/Estuary Juvenile Steelhead Population Estimate, 2011–2022.

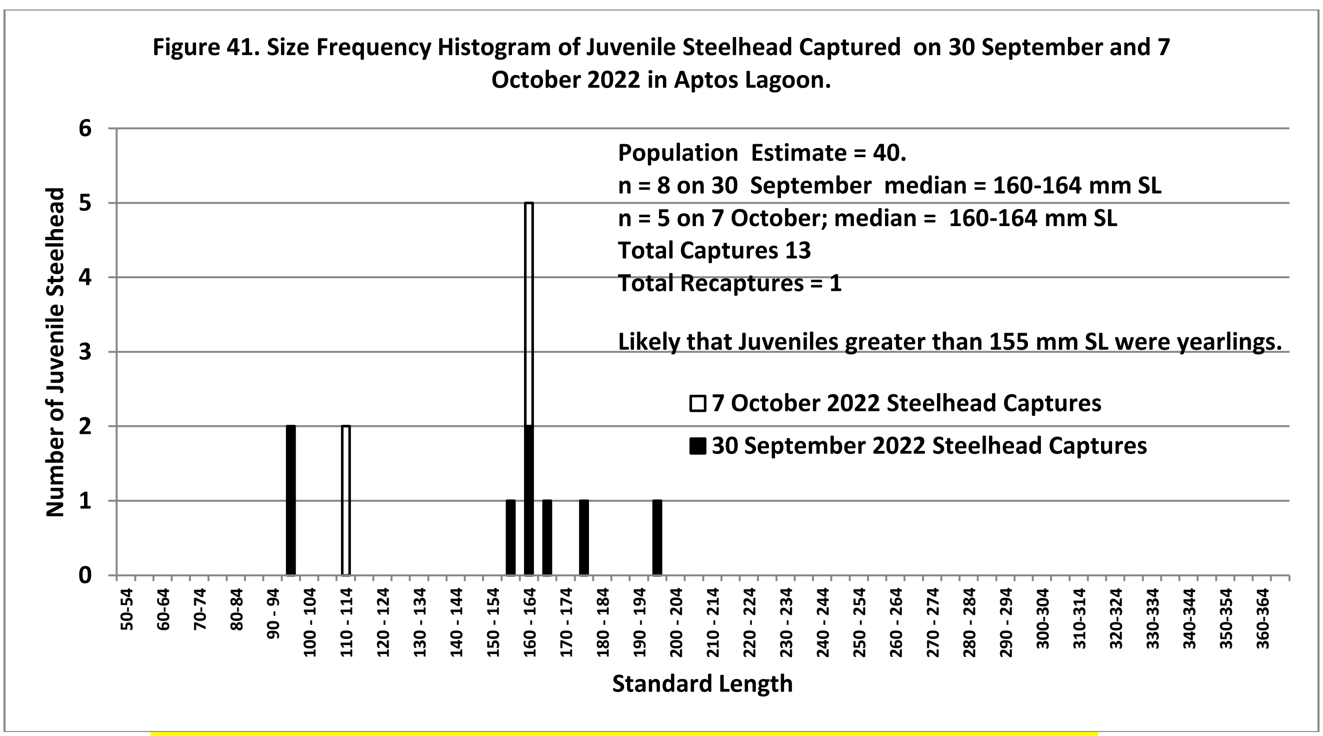

Figure 41. Size Frequency Histogram of Steelhead Captured in Aptos Lagoon, October 2022.

iv. Statistical Analysis of Annual Difference in Juvenile Steelhead Densities

Table 8. Paired T-test for the Trend in Steelhead Site Densities by Size Class and Age Class at All Replicated Sampling Sites in the SAN LORENZO Watershed (2022 to 2021; n=20).

Statistic	s.c. 2	a.c. 1-YOY	a.c. 2	All Sizes
Mean difference	0.28	3.16	-0.21	2.86
Df	19	19	19	19
Std Error	0.80	3.98	0.35	4.00
t Stat	0.35	0.79	-0.60	0.72
P-value (2-tail)	0.7323	0.4366	0.5573	0.4832
95% CL (lower)	-1.34	-5.16	-0.93	-5.51
95% CL (upper)	1.95	11.48	0.52	-11.23

Table 9. Paired T-test for the Trend in Steelhead Site Densities by Size Class and Age Class at All Replicated Sampling Sites in the SOQUEL Watershed (2022 to 2021; n=7).

Statistic	s.c. 2	a.c. 1-YOY	a.c. 2	All Sizes
Mean difference	-0.41	-12.23	-0.26	-12.73
Df	6	6	6	6
Std Error	1.01	4.68	0.39	4.71
t Stat	-0.41	-2.61	-0.66	-2.70
P-value (2-tail)	0.6971	0.0399	0.5357	0.0356
95% CL (lower)	-2.90	-23.68	-1.22	-24.27
95% CL (upper)	2.07	-0.78	0.70	-1.91

Table 10. Paired T-test for the Trend in Steelhead Site Densities by Size Class and Age Class at All Repeated Sampling Sites in the APTOS Watershed (2022 to 2021; n=3).

Statistic	s.c. 2	a.c. 1-YOY	a.c. 2	All Sizes
Mean difference	0.67	4.83	0.20	5.10
Df	2	2	2	2
Std Error	1.21	0.87	1.37	1.35
t Stat	0.06	5.56	0.15	3.79
P-value (2-tail)	0.9611	0.0308	0.8969	0.0631
95% CL (lower)	-5.15	1.10	-5.67	-0.69
95% CL (upper)	5.28	8.57	6.07	10.89

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D. GLOSSARY

Bankfull stage/ discharge: Corresponds to the discharge (streamflow) at which channel maintenance is most effective. It is the discharge at which moving sediment, forming or removing bars, forming or changing bends and meanders, and generally doing work that results in the average morphologic characteristics of stream channels. The bankfull discharge or greater discharges are channel-forming streamflows. The bankfull discharge has a recurrence interval of approximately 1.5 years.

Baseflow: Streamflow that is derived from natural storage i.e., groundwater outflow outside the net rainfall that creates surface runoff. It is the discharge (streamflow) sustained in the stream channel, not as a result of direct runoff and without the effects of regulation, diversion or other human activities. Also called groundwater flow.

Escape cover: Where a fish hides from predators, including beneath surface turbulence and overhanging riparian vegetation and under unembedded boulders, within undercut banks and under instream wood.

Fish Density: Number of fish per 100 feet of stream channel in this report.

Fish Habitat: Where a fish lives that provides food and shelter necessary to survive. There are the aquatic environment and the immediate terrestrial environment that combine to provide biological and physical support systems required by fish species during various life stages.

Fork Length (FL): Fish length from snout to mid point in the tail's edge.

Hydraulic control point: The top of an obstruction in the stream channel in which streamflow must rise before passing over, or a point in the stream where the flow is constricted. The hydraulic control point determines the water surface elevation upstream to the next riffle or run. It is typically at the tail of a pool. Riffles and runs have no hydraulic controls except for very short distances at most.

Hydrograph: A graph showing the discharge (streamflow) or stage (water surface elevation) at a specific location with respect for time.

Instream Wood cluster: Logjam that extends into the summer low flow channel.

Large woody debris: A large piece of relatively stable instream wood having a diameter greater than 1 foot and length greater than 6 feet that extends into the stream channel, either at baseflow or during winter stormflows. We prefer to call it **large instream wood**.

Low flow: The lowest streamflow recorded over a specified period of time. Also called **minimum flow**.

Mainstem: The principal or dominating stream channel in a drainage (watershed) system. Tributary streams flow into the mainstem.

Overwintering cover: Where fish find refuge and resting places from fast water during stormflows. It may be along undercut banks or behind large boulders and/or large instream wood.

Percent Embeddedness: The percent buried in fine sediment or sand of large streambed particles (cobbles and boulders large enough for Size Class II salmonids to hide under for escape cover).

Percent fines: The percent of the streambed area covered with silt and sand in a habitat type.

Pool: A deeper stream habitat with little surface turbulence except at the head and that has places where downstream water velocity is near zero or where water is backwatered with upstream eddies. Pools are formed by scour objects, such as large instream wood, large boulders, streambank tree roots or bedrock faces. Pools are the primary habitat for coho salmon and larger juvenile steelhead in Santa Cruz Mountain tributaries and mainstem headwater sites.

Reach segment: A specified length of stream within a stream reach. In this study, stream segments are ½ mile in length and are considered representative of habitat in the reach. Habitat characteristics and fish are sampled within historically designated reach segments to assess annual trends in habitat conditions and fish densities within reaches.

Representative reach fish sampling: For all stream reaches except the mainstem San Lorenzo River up to the Boulder Creek confluence, fish sampling sites are chosen within representative stream segments of stream reaches based on the pools within the sampling site having near-average pool depth and escape cover for the segment. Representative pools and adjacent fastwater habitats are sampled by electrofishing at the site. For the mainstem San Lorenzo River, representative fastwater riffles and runs regarding near-average stream depth are electrofished, and nearby historical pools are snorkel censused.

Riffle: Relatively shallow, fastwater habitat with surface turbulence and often exposed cobbles and boulders. It is where most of the aquatic insect larvae are produced and where insect drift rate is the highest.

Riparian vegetation: Vegetation growing on or near streambanks or other water bodies on soils that exhibit near or completely water saturated conditions during some portion of the growing season. Common native riparian tree species in the Santa Cruz Mountains include redwood, Douglas fir, California bay, tanoak, willow, alder, bigleaf maple, cottonwood, dogwood, sycamore and box elder. Acacia, a non-native riparian tree species, is becoming more common.

Run: Deeper than riffle, fastwater habitat without surface turbulence, but is moving.
Scour: The localized removal of material from the streambed by flowing water. It causes the stream channel to deepen and is the opposite of fill.

Shade: The percent canopy closure over the stream as estimated by a spherical densiometer.

Size Class I steelhead/ coho salmon: Juvenile steelhead or coho salmon captured in the fall that are less than 75 mm Standard Length.

Size Class II steelhead/ coho salmon: Juvenile steelhead or coho salmon captured in the fall that are 75 and 150 mm Standard Length. Steelhead in this size class include fast-growing young-of-the-year and yearling juveniles.

Size Class III steelhead: Juvenile steelhead captured in the fall that are at least 150 mm Standard Length.

Soon-to-smolt-steelhead: Juvenile steelhead captured in the fall that are 75 mm Standard Length or larger and will likely smolt the following spring.

Spawning Gravel: Streambed particle size between one quarter and 3 and a half inches in diameter. Usually found within **spawning glides** at the tails of pools or runs just upstream of steep, focused riffles.

Standard Fish Length (SL): Fish length from snout to end of spinal column in caudal peduncle before the tail.

Steelhead/ coho salmon adult migration: Adult steelhead are sexually mature and 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 later in the season. Adult fish may be blocked by barriers such as bedrock falls, wide and shallow riffles and occasionally logjams. Man-made objects, such as culverts, bridge abutments, dams and remnant dam abutments 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. However, in drought years and years when storms are delayed, some obstructions can be serious barriers to steelhead and especially coho salmon spawning migration. Sexually mature adult coho salmon often have more severe migrational challenges because much of their migration period, November through early February, may be prior to stormflows needed to pass bridge abutments, 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.

Steelhead/ coho salmon smolt migration: Fish undergo physiological changes to their gills and kidneys to adapt to saltwater to prevent dehydration. Juveniles passively migrate with the current at night, downstream to the ocean, mostly in February through May. They may spend time in the estuary and become silvery with black-tipped fins before exiting the stream.

Step-run: A habitat that is turbulent like a riffle but has many hydraulic controls formed by larger cobbles and boulders to create slower, deeper pocket water as the stream's water surface stair-steps over the multiple hydraulic controls. Step-runs often have considerable escape cover in the form of surface turbulence and spaces under unembedded boulders.

Streambank: The portion of the stream channel cross section that restricts lateral movement of water at below bankfull flows. The streambank often has a gradient steeper than 45 degrees and exhibits a distinct break in slope from the stream bottom.

Stream Gradient: The slope or rate of change in vertical elevation of the water surface of a flowing stream per unit of horizontal distance.

Stream Reach: A relatively homogeneous section of a stream having a repetitious sequence of physical characteristics and habitat types, and it differs from adjacent reaches. Reach boundaries may be determined by changes in stream gradient that determine dominant particle size and habitat length, changes in streamflow and water temperature with the confluence of tributaries, changes in substrate composition associated with stream gradient and tributary sediment input, and changes in tree canopy (shade). As stream gradient lessens, pool length increases and pool to riffle ratios increase.

Thalweg: The line connecting the deepest points along a streambed (where the water depth is greatest). Most of the water volume with the fastest water velocity flows through the thalweg. Salmonids spawn in the thalweg of spawning glides.

Tributary: A smaller stream feeding, joining, confluencing with or flowing into a larger stream.

Turbidity: It is related to water clarity. It is a measure of the extent to which light passing through water is reduced due to suspended materials- can be suspended sediment or phytoplankton. Juvenile salmonids are visual feeders and require conditions of low turbidity to see their drifting prey.

Undercut streambank: A streambank with its base cut away by water scour action along man-made and natural overhangs in streams, such as those formed by rootmasses of riparian trees.

Water Depth: The vertical distance from the water surface to the streambed.

Yearling steelhead: Juvenile steelhead captured in the fall and hatched 2 springs previously.

Young-of-the-year steelhead and coho salmon (YOY): Juvenile steelhead and coho captured in the fall and hatched earlier in the spring. Most are <75 mm Standard Length but many may be => 75 mm Standard Length and in the Size Class II if food is more abundant where they rear, such as in the lower San Lorenzo River downstream of the Zayante Creek confluence and in lagoons in most years.