D.W. ALLEY & Associates aquatic biology

2011 SUMMARY REPORT− Juvenile Steelhead Densities in the San Lorenzo, Soquel, Aptos and Corralitos Watersheds, Santa Cruz County, CA

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Prepared For the

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Funding From the

San Lorenzo Valley Water District, Soquel Creek Water District, Lompico County Water District, Cities of Santa Cruz, Scotts Valley and Watsonville and the County of Santa Cruz

June 2012 **Project # 200-09a**

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A. EXECUTIVE SUMMARY

In fall 2011, 4 Santa Cruz County watersheds were sampled for juvenile steelhead to compare juvenile abundance and habitat conditions with past years. Watersheds included the San Lorenzo River, Soquel Creek, Aptos Creek and Corralitos Creek.

i. Steelhead Abundance in All Watersheds

WY2011 streamflows in spring and summer were even higher than in WY2010 (which had ample flows), with high stormflows occurring in late March with much above median flows during the April-May growth period as in 2010. The wet spring was followed by much above median baseflows through the dry season. This was the second above average streamflow year following an extended 3-year dry period. Rearing habitat quality improved at most sites due to increased streamflow (more food), deeper habitat and sometimes more escape cover. The high proportion of young-of-the-year (YOY) reaching Size Class II and average soon-to-smolt lengths of 102 mm Standard Length (SL) or greater in 2011 were responsible for maintaining "Fair" soon-to-smolt abundance ratings in many sites throughout the 4 watersheds, despite the low densities of YOY and yearlings. Total juvenile steelhead densities at San Lorenzo and Soquel sites were the lowest in 15 years of monitoring. Total densities remained low in Aptos Creek and increased in the Corralitos sub-watershed (still below average in Corralitos Creek), which was recovering from the summit fire. After a winter with multiple stormflows in WY2011, yearling densities were generally below average and less than in 2010, though similarly low between years in the San Lorenzo mainstem, throughout the Soquel watershed and Aptos Creek and slightly higher in the Corralitos watershed in 2011.

2011 abundance of YOY was generally below average in all 4 watersheds except Corralitos and less than 2010 at the majority of sites in the San Lorenzo and Soquel watersheds. Below average YOY abundance was likely caused by high redd (nest) destruction and reduced YOY survival during spring stormflows, followed by insufficient adult spawners to saturate habitat with YOY after March stormflows passed. The highest YOY densities at upper sites indicated that most spawning effort and/or spawning success was furthest upstream, except in Zayante Creek where they were highest in a middle site. However, there were likely insufficient YOY produced at upstream locations to filter downstream to seed lower reaches.

ii. Steelhead Abundance in the San Lorenzo River Watershed

In the lower and middle mainstem, overall habitat quality improved at most replicated sampling sites primarily due to increased baseflow and deeper fastwater habitat, though there was reduced escape cover in fastwater habitat compared to 2010. All tributary reaches likely had similar high quality habitat in spring 2011 compared to 2010 due to high baseflows for good fish growth, as indicated by the high percent of YOY reaching Size Class II in the first growing season.

In San Lorenzo tributaries, of the 5 reaches with segments habitat typed, habitat quality declined only in Newell 16 in 2011. In San Lorenzo tributaries where only sampling sites were evaluated**,** only Boulder Site 17b had reduced habitat quality. Spring growth conditions were good as indicated by the high percentage of YOY reaching Size Class II in 2011 compared to 2009, a drier year.

Densities of larger Size Class II and III steelhead are most important because they will soon smolt and contribute to the adult return. Densities of Size Class II and III steelhead at mainstem sites were below average at 5 of 7 sites in 2011 and less than in 2010. Size Class II and III abundance in tributaries was close to average or above at all sites except at least 4 fish/ 100 feet below average at Zayante 13a, Zayante 13d and Bean 14b. These 3 sites well below average had few YOY or yearlings present.

Six of 12 tributary sites had lower Size Class II and III abundance than in 2010, but densities were similar at Zayante 13c, Zayante 13d, Lompico 13e, Fall 15, Boulder 17a and 17b, Bear 18a and Branciforte 21a-2. Newell 16 density was half the 2010 level. Sunny Zayante 13c had the highest Size Class II and III density (29.2/ 100 ft), followed by Fall 15 (14.7/ 100 ft). Zayante 13c had the highest densities of YOY and yearlings, with a high percent of YOY reaching Size Class II.

Yearling densities at mainstem sites were similarly low in 2011 as they have been since 2000 and were near or slightly below average, consistent with high spring baseflow that allowed good growth rate, along with large, late winter storms that either caused higher overwinter mortality or encouraged young yearlings to emigrate early in spring. Yearling densities at tributary sites were generally less than in 2010 and much below average at most sites except Zayante 13c. This may be partially explained by reduced overwinter survival and early emigration associated with rapid spring growth.

YOY abundance at all mainstem sites was less than in 2010 and below average. This was consistent with large, late winter storms that destroyed redds and small YOY, followed by insufficient adult spawners to saturate the watershed with eggs and new YOY. Low YOY densities led to continued low total juvenile abundance at mainstem sites occurring since 2000 and very similar to 2006 after another wet winter. YOY abundance at tributary sites was generally less than 2010 and still much below average at most sites except Fall 15. This led to the lowest average total juvenile abundance at tributary sites in 15 years. The continued below average YOY densities were consistent with large, late winter storms that destroyed redds and small YOY, followed by insufficient adult spawners to saturate the watershed with eggs and new YOY.

iii. Steelhead Abundance in the Soquel Creek Watershed

All reaches had higher summer baseflow in 2011 than 2010, with similar spring baseflow due to late storms in both years. This provided high food levels in spring in both years and better growth rates in summer in 2011. Of the 4 reaches and 4 sampling sites compared, all had overall positive habitat change based on more baseflow, greater water depth and generally more pool escape cover (6 of 8 reaches/sites).

Despite fast YOY growth rate associated with high streamflow (more food) and low YOY densities (less competition), all 4 mainstem sites had below average Size Class II and III abundance. Two of the branch sites were near average and two others were above average. Five of 8 sites had lowe abundance than in 2010, but only 2 sites had reduced soon-to-smolt ratings (mainstem Soquel 1 ("Below Average") and East Branch 16 ("Fair").

Yearling and older abundance remained similarly low as in 2010 and most years. It was near average at sites with typically low densities and below average at the two Branch sites that typically have higher densities (West Branch 21 and East Branch 16). High spring baseflows allowed some young yearlings to grow quicker and emigrate early if they survived the large stormflows. These factors contributed to low yearling densities, along with low recruitment of YOY into the yearling age class from 2010.

Young-of-the-year (YOY) abundance was generally much lower in 2011 than 2010, below average at all sites, and led to the lowest average total juvenile abundance in the last 15 years. Low YOY densities were consistent with large, late winter storms that destroyed redds and small YOY, followed by insufficient adult spawners to saturate the watershed with eggs and new YOY.

The 2011 juvenile steelhead population in Soquel Lagoon was an estimated 678, which was much less than the 18-year average of 1,667 and about 60% of the 2010 estimate (**Alley 2011a**). The 2011 population size fit the typical pattern for wetter years when less spawning occurs near the lagoon and lagoon numbers are down. The 2011 population size was similar to 1998 (671) after a wet winter. However, in 2011, YOY densities were much lower than in 1998 throughout the watershed and less at upper watershed sites than in 2006, after another wet winter.

iv. Steelhead Abundance in the Aptos Creek Watershed

Habitat quality declined in lower Aptos Creek and was similar to 2010 in upper Aptos Creek. Although Lower Aptos 3 had higher baseflow, its pool depth shallowed with less escape cover. Reach 3 with Aptos 4 in Nisene Marks had higher baseflow, similar pool depth and embeddedness and slightly less escape cover and more fines (though not 10% or more).

Abundance of larger juveniles (Size Classes II and III => 75 mm SL) was below average at lower Aptos 3 and above average at upper Aptos 4. Compared to 2010, abundance went down in Aptos 3 and up in Aptos 4. Abundance of larger juveniles depended primarily on density of fast-growing YOY in 2011 (higher in Aptos 4) and good escape cover from instream wood at Aptos 4. Smolt ratings were "Below Average" in Aptos 3 and "Very Good" in Aptos 4.

Below average yearling and older densities in the Aptos watershed followed the same pattern in the other 3 watersheds in 2011. Reduced abundance was likely caused by greater overwinter mortality with large spring stormflows and early spring emigration because high spring baseflows allowed faster yearling growth.

YOY abundance was below average in Aptos Creek as in other watersheds. It was much less at Aptos 3 and similar at Aptos 4 compared to 2010. The low YOY density at Aptos 3 was consistent with large, late winter storms that destroyed redds and small YOY, followed by insufficient adult spawners to saturate the watershed with eggs and new YOY. Despite higher YOY densities in 2011, a high percent of YOY reached Size Class II. Elevated streamflows provided more food and stimulated growth.

Total juvenile abundance went down at the lower Aptos 3 site and remained similar at the upper Aptos 4 site compared to 2010, consistent with the YOY abundance pattern. Total juvenile densities were below average at both sites. Aptos Lagoon/Estuary was productive steelhead habitat and had a small tidewater goby population. The lagoon's juvenile steelhead population size was estimated to be 420 large fish. Two tidewater gobies were captured.

v. Steelhead Abundance in the Corralitos Creek Sub-Watershed

Habitat conditions at all Corralitos/Shingle Mill/Browns reaches/sites improved in 2011 (increased baseflow throughout, similar or increased pool depth except at Corralitos Site 1, less fine sediment, similar embeddedness in compared reaches and generally similar or improved escape cover). Three reaches in Corralitos Creek had segments habitat typed after sedimentation was detected in 2010, the first wet winter after the summit fire of 2008, which brought pool shallowing and loss of escape cover. Results indicated that pool depth had recovered in reaches upstream of the Corralitos diversion dam to 2009 levels and had less fine sediment, with increased depths in the middle Corralitos 5/6 segment.

Size Class II and III abundance was below the long term average at 6 of 8 sites but higher than in 2010 at all sites except Corralitos 1. This resulted from below average yearling and YOY densities, though a high percentage of YOY grew into Size Class II.

Yearling abundance was below average at 7 of 8 sites but higher than in 2010 at 7 of 8 sites. The decline was likely caused by poor overwinter survival in the face of high spring stormflow, generally low YOY recruitment from 2010 and early spring emigration of fast growing yearlings.

As in other watersheds YOY abundance was below average at 6 of 8 sites but greater than in 2010 at 7 of 8 sites. Low YOY densities were consistent with large, late winter storms that destroyed redds and small YOY, followed by insufficient adult spawners to saturate habitat with eggs and new YOY. Abundance was greater than in 2010 likely because eggs survived better after large spring storms with less sedimentation in 2011. With below average YOY and yearling abundance, total juvenile abundance was below average at Corralitos sites and close to average at the other sites (except at upper Shingle Mill 3), and higher than 2010 at 7 of 8 sites (excepting Shingle Mill Site and 3).

With regard to adult steelhead passage above the Corralitos Creek diversion dam between Corralitos Sites 1 and 3, passage conditions should have been good in 2011 as in 2010 with higher winter stormflows than 2009. Though YOY densities were below average at 3 of 4 sites above the dam in 2011, they did increase in Corralitos Creek at the upper 2 sites. This indicated that some adult steelhead successfully spawned upstream of the dam.

B. INTRODUCTION

i. Scope of Work

In fall 2011, 4 Santa Cruz County watersheds were sampled for juvenile steelhead to primarily compare juvenile abundance with past years and habitat conditions at sampling sites and in limited habitat typed segments with those in 2010. 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 in **Appendix A** that delineate reaches and sampling sites. Tables and figures referenced in this summary report and not included may be found in **Appendix B**, the detailed analysis report. Hydrographs of all previous sampling years are included in **Appendix E**.

ii. Study Area

San Lorenzo River. The mainstem San Lorenzo River and 8 tributaries were sampled at 19 sites (7 mainstem and 12 tributary sites). Sampled tributaries included Branciforte, Zayante, Lompico, Bean, Fall, Newell, Boulder and Bear creeks. Six 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 13 sites, the 2010 sites were replicated for fish sampling, and depth and cover measurements were made 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 2010 sites were replicated for fish sampling, and depth and cover measurements were made at all sampling sites.

Aptos Creek. Aptos Creek was sampled at two stream sites and in the estuary/lagoon. The upper Aptos reach was habitat typed in a half-mile segment to assess habitat conditions and select habitats of average quality to sample for fish density. For the lower Aptos reach, the 2010 site was replicated for fish sampling, and depth and cover measurements were made at all sampling sites.

Corralitos Creek. In the Corralitos sub-watershed of the Pajaro River drainage, fish sampling included 4 sites in Corralitos Creek, 2 sites in Shingle Mill Gulch and 2 sites in Browns Creek, along with 3 associated half-mile reach segments habitat typed in Corralitos Creek upstream of the diversion dam. Depth and cover measurements were made at all sampling sites.

iii. Steelhead Life History

Most juvenile steelhead spend 1-2 years in freshwater before smolting and migrating to the ocean to reach sexual maturity. In the ocean they spend 1-2 years of rapid growth before returning as adults to their natal streams to spawn. When juveniles reach 75 mm Standard Length (SL) (Size Class II) by fall sampling time (~ 3 ½ inches total length) they are considered large enough to smolt the following late winter and spring. Unpublished, independent research has shown that many returning adult steelhead in some local streams reached smolt size their first growing season (**Alley 2010; J. Smith, pers. comm.; E.**

Freund, pers. comm.). Smith also found evidence of one-year smolts in fall 1978 in Uvas Creek after the drought of 1976-77 that had prevented adult access until winter of 1977-78 (**Smith and Li 1983**). more recent sampling in Uvas Creek (2005-2011) found that juvenile steelhead in highly productive downstream reaches consistently reached smolt size by the end of their first summer (**Casagrande 2010; 2012**). Therefore, habitat conditions are very important in portions of watersheds that have the highest capacity to grow a percentage of young-of-the-year (YOY) to Size Class II in their first growing season. In this study, these include the San Lorenzo River Lagoon, Aptos Lagoon, Soquel Lagoon, lower mainstem (all years) and middle mainstem (wet years only) of the San Lorenzo River and lower mainstem Soquel Creek (downstream of Moores Gulch). High baseflow in May−September increases the percentage of YOY reaching Size Class II. Increased production of Size Class II and III juveniles will increase adult returns because ocean survival increases exponentially with smolt size. Studies have shown that smolts size at ocean entry can greatly influence ocean survival and therefore the abundance of adult returns (**Bond 2006**). Increased production of Size Class II and III juveniles should improve adult returns in these systems.

YOY emerge from the spawning gravels and spread (primarily downstream) throughout the watershed in spring and early summer. Since more adult steelhead spawning tends to occur in the upstream and tributary reaches of the watershed (barring passage difficulties), the highest initial YOY densities tend to be there. Therefore, it is likely that juveniles distribute mostly in a downstream direction where competition is reduced. High streamflows probably increase downstream dispersal, and it may be reduced in drier years. In general, once habitats have been selected, juveniles remain in the same habitats or in close proximity throughout the summer and fall. However, extensive steelhead rescues conducted in Uvas Creek have shown that when downstream reaches previously containing rescued steelhead become dewatered and subsequently become re-wetted briefly later in summer, steelhead re-disperse downstream and re-colonize these habitats, indicating there is some downstream dispersal through the dry season (**J. Casagrande, pers. comm.**). Juveniles distribute according to the quality of feeding habitat (fastwater with adequate depth) and/ or maintenance habitat (water depth and degree of escape cover as overhanging vegetation, undercut banks, surface turbulence, cracks under boulders and submerged wood). Habitat quality improves when less sand enters the stream (called sedimentation) from soil and streambank erosion because less sand input increases aquatic insect habitat. With less sand, the embeddedness of larger cobbles and boulders is reduced to provide more cracks and crevices for insects to use. Less sand and embeddedness provide better fish habitat with more escape cover for fish to hide under from predators and increased water depth around scour objects (more escape cover).

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 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 fast-water feeding positions for capture of drifting insects in "growth habitat" (provided mostly in spring and early summer except in larger mainstem sites where summer growth is possible) determine the size of these smolts. Study of steelhead growth in Soquel Creek determined that growth is higher in winter-spring compared to summer-fall (**Sogard et al. 2009**).

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.

C. METHODS

i. Habitat Assessment

Refer to the Detailed Analysis Appendix B for more information. Section M-6 in Appendix B describes methods of assessing change in rearing habitat quality. Monitored watersheds included the San Lorenzo, Soquel, Aptos and Corralitos, a sub-watershed of the Pajaro River. Maps of sampling sites, habitat typed segments and reaches contained in **Appendix A** are provided below.

In the San Lorenzo and Soquel watersheds since 1998 and in the Aptos and Corralitos watersheds since 2006, half-mile reach segments were habitat-typed using a modified CDFG Level IV habitat inventory method in mainstem and tributary reaches; with fish sampling sites chosen within each segment based on average habitat conditions. See sampling methods in **Appendix B** for more details. Habitat types were classified according to the categories outlined in the California Salmonid Stream Habitat Restoration Manual (**Flosi et al. 1998**). Some habitat characteristics were estimated according to the manual's guidelines, including length, width, mean depth, maximum depth, shelter rating, substrate composition and tree canopy. Additional data were collected for escape cover, however, to better quantify it.

ii. Fisheries Sampling

Prior to 2006 juvenile steelhead abundance was estimated by reach. An index of juvenile steelhead population size was estimated by reach and by watershed in the San Lorenzo and Soquel drainages. Indices of adult steelhead population size were also calculated from indices of juvenile population size. Prior to 2006, estimated 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 habitat proportions within reaches factored in. Since 2006, indices of juvenile population size per watershed were no longer possible because number of sampling sites had been reduced. Santa Cruz County staff decided in 2006 that indices of juvenile reach production were no longer useful.

Since 2006, fish abundance at sampling sites of average habitat quality in previously determined reach segments of 4 Santa Cruz County watersheds (San Lorenzo, Soquel, Aptos and Corralitos) have been compared to past years' abundances. Comparisons go back to 1997 in the San Lorenzo and Soquel watersheds, 2006 in the Aptos watershed and 1981 in the Corralitos sub-watershed, although consecutive years began in 2006. The proportion of habitat types sampled at each site within a reach was kept similar between years so that site fish densities could be compared between years in each reach. However, site fish density did not necessarily reflect fish densities for entire reaches because the habitat proportions sampled were not exactly similar to the habitat proportions of the reach. In most cases, habitat proportions at sites were roughly similar to habitat proportions in reaches because sampling sites were more or less continuous and lengths of each habitat type were roughly similar to others within reaches. However, in reaches where pools are less common, such as Reach 12a on the East Branch of Soquel Creek and Reach 2 in lower Valencia Creek, a higher proportion of pool habitat was sampled than exists in these respective reaches. More pool habitat was sampled because larger yearlings, almost exclusively utilize pool habitat in small streams, and changes in yearling densities in pools are the most important to monitor. In these two cases, site densities of yearlings were higher than reach densities.

Electrofishing was used to measure steelhead abundance at sampling sites. Captured juvenile steelhead were grouped into two juvenile age classes and three size classes. Block nets were used at all sites to separate habitats during electrofishing. A three-pass depletion process was used to estimate fish densities. If there was poor depletion in 3 passes, a fourth pass was performed, and the fish captured in 4 passes were assumed to be a total count in the habitat. Electrofishing mortality rate has been approximately 1% or less over the years. Snorkel-censusing was used in deeper pools that could not be electrofished at sites in the mainstem reaches of the San Lorenzo River, downstream of the Boulder Creek confluence. For catch data in the lower and middle mainstem reaches included in **Appendix C**, underwater censusing of deeper pools was incorporated into density estimates with electrofishing data from more shallow habitats.

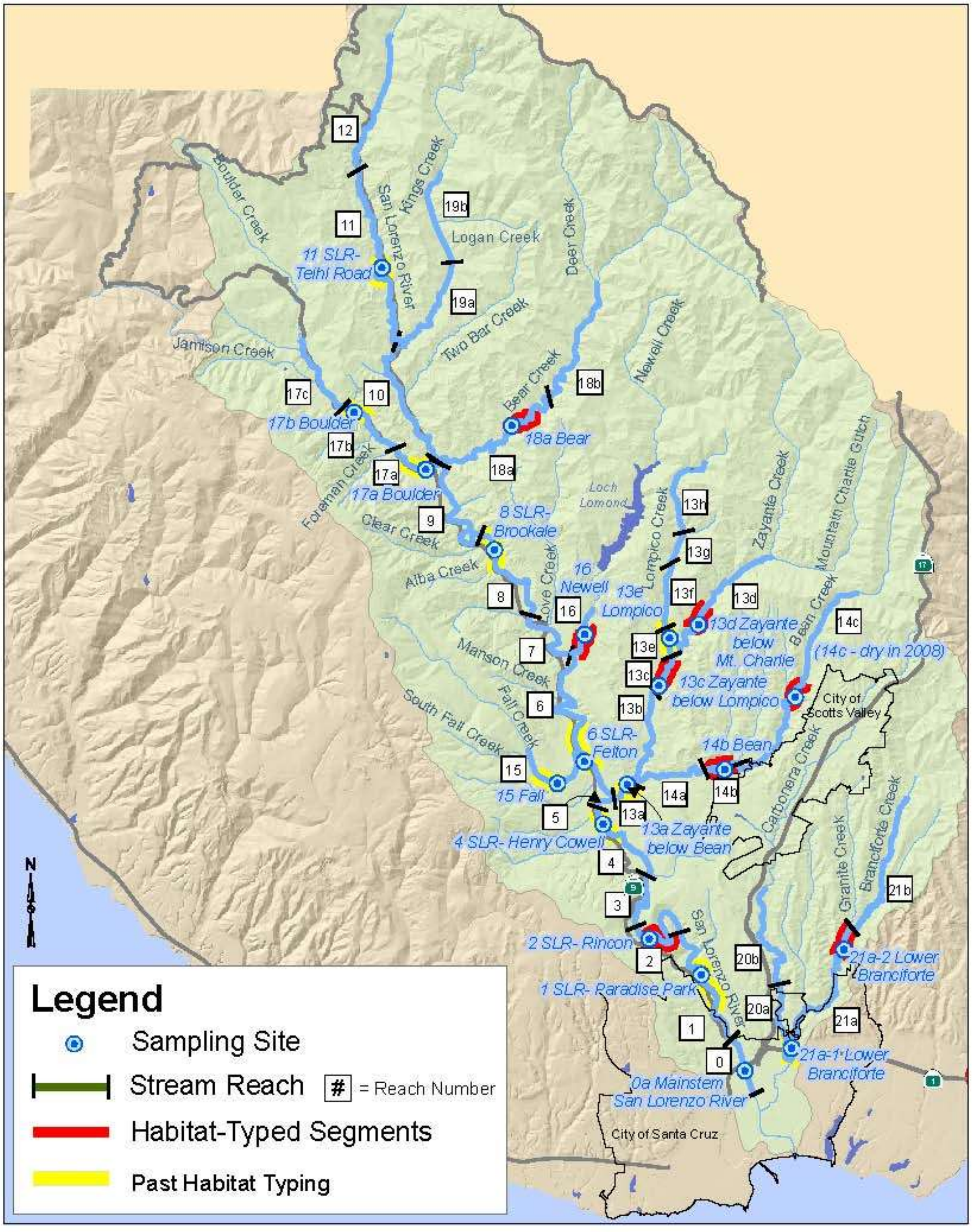


Figure A-2. San Lorenzo River Watershed.

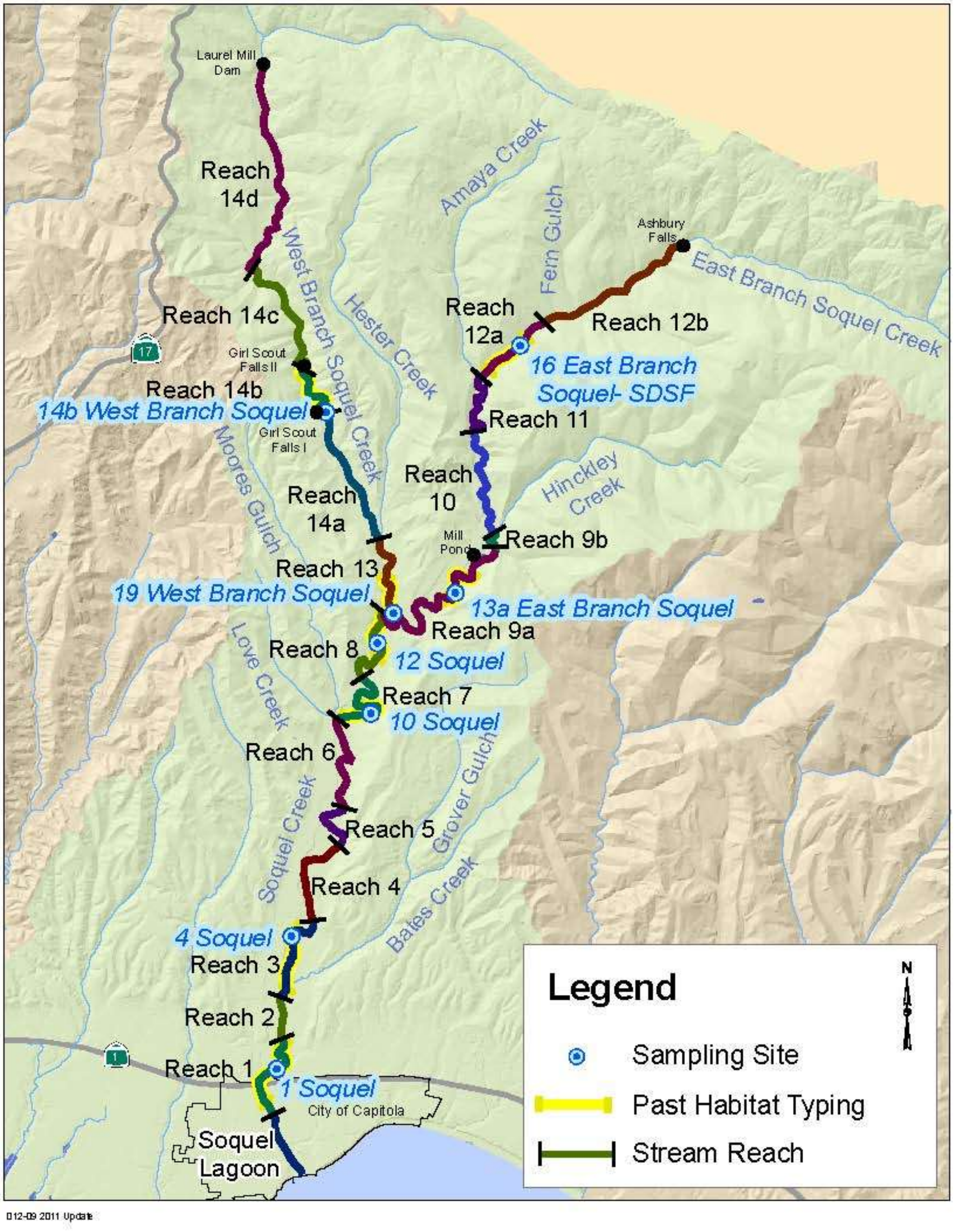


Figure A-3. Soquel Creek Watershed.

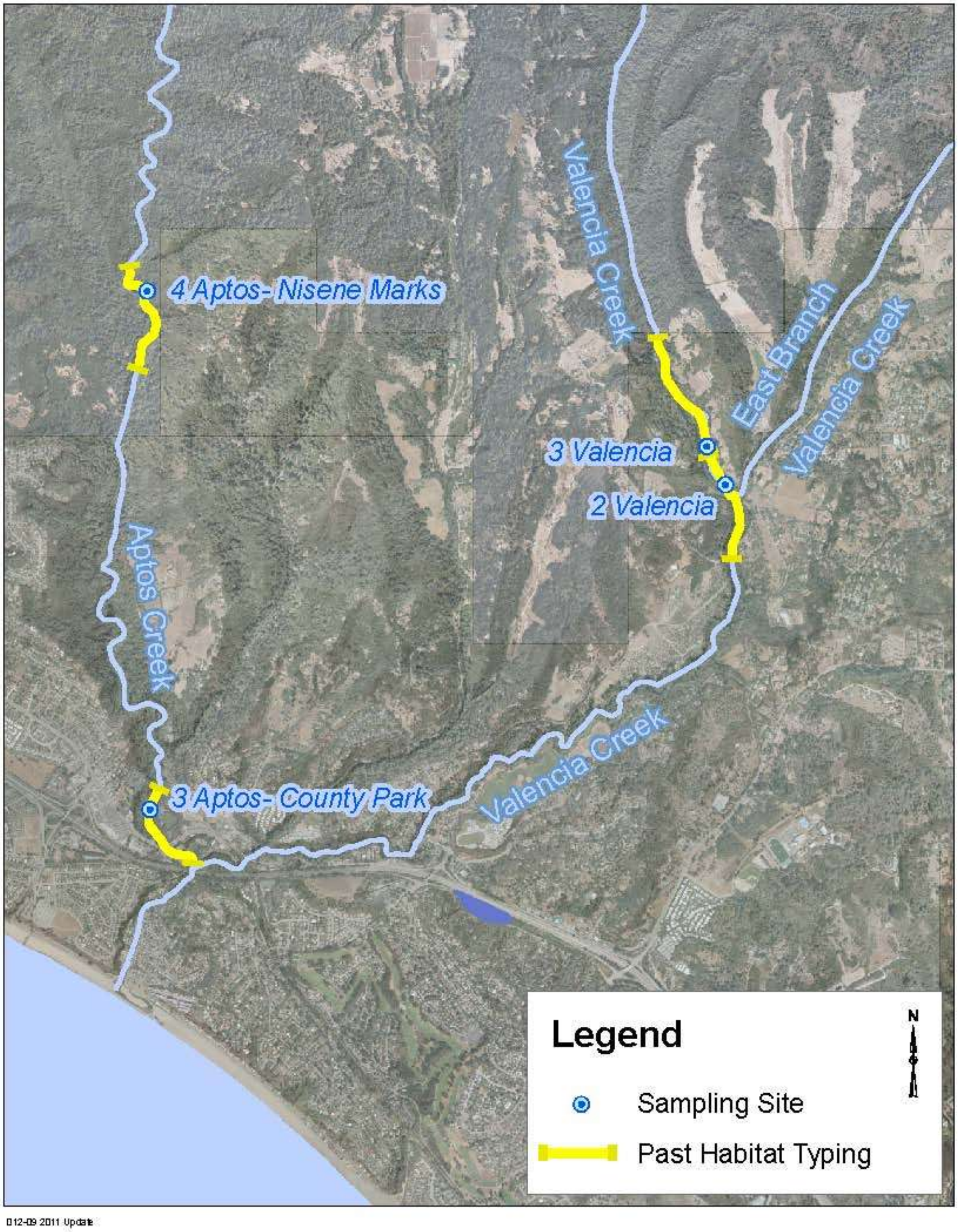


Figure A-6. Aptos Creek Watershed.

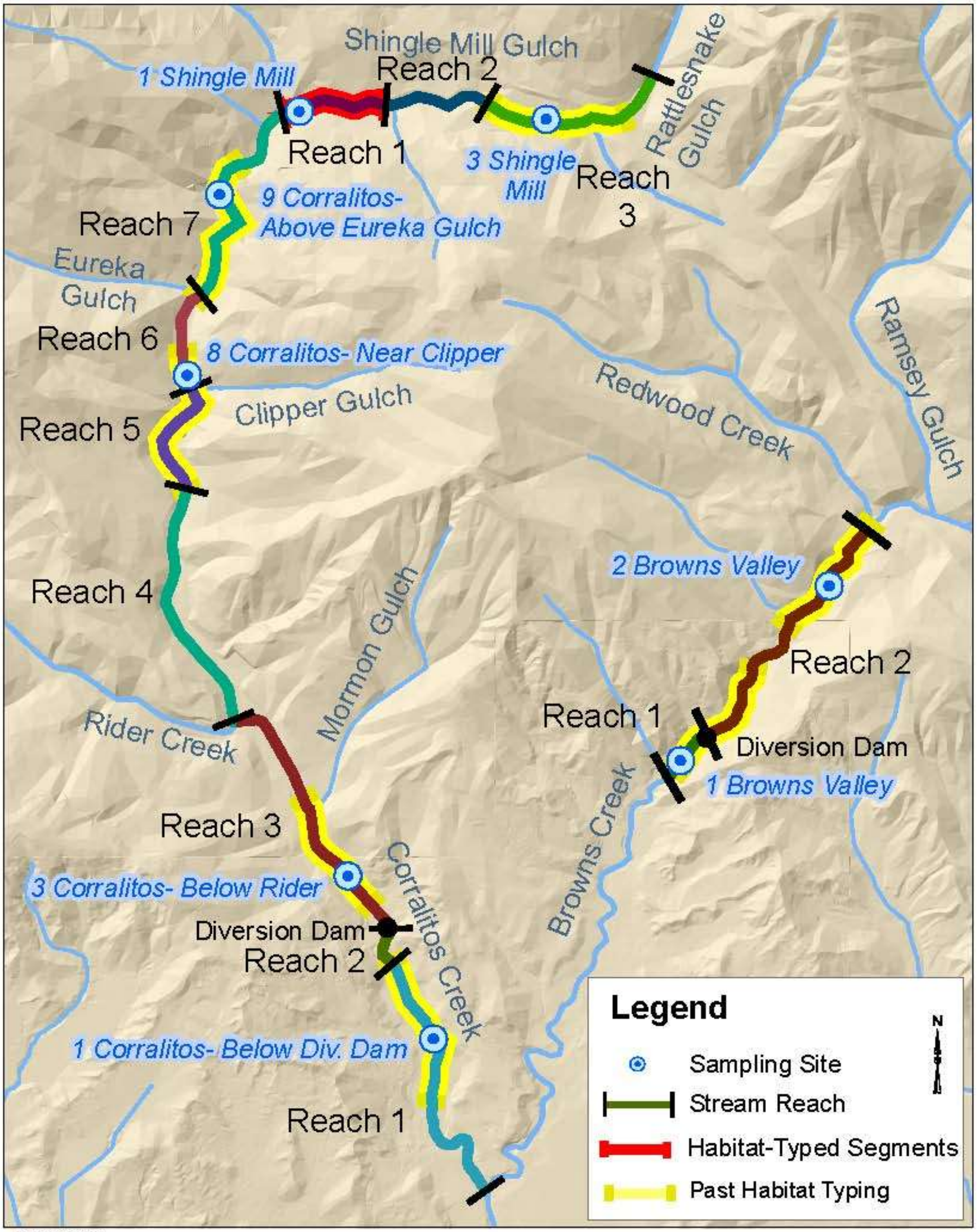


Figure A-7. Corralitos Creek Sub-Watershed.

D. RESULTS

Figures and tables contained in this summary report were extracted from the detailed analysis found in Appendix B.

i. Steelhead Abundance and Habitat Conditions in All Watersheds

1. WY2011 streamflows in spring and summer were even higher than in WY2010 (which had ample flows). High stormflows occurred in late March, with much above median flows during the April-May growth period as in 2010. This was followed by much above median baseflows through the dry season. This was the second above median streamflow year following an extended 3-year dry period. Streamflow comparisons between years were made for 5-month averages (May through September) expressed in Figure B-41 *in Appendix B.*

2. Rearing habitat quality improved at most sites due to increased streamflow (more food), deeper habitat and sometimes more escape cover.

3. Total juvenile steelhead densities at San Lorenzo and Soquel sites were the lowest in 15 years of monitoring. Total densities remained low in Aptos Creek and increased in the Corralitos sub-watershed (still below average in Corralitos Creek), which was recovering from fire.

4. In comparing soon-to-smolt-sized juvenile densities (Size Classes II and III) in fall and the average size of these large juveniles between the 4 watersheds, sites that made a "5" (Good) or "6" (Very Good) abundance rating were usually in the upper reaches (**Tables S-1 and S-2 below**).

5. Despite the low densities of YOY and yearlings, the high proportion of YOY reaching Size Class II and average soon-to-smolt average lengths of 102 mm SL or greater in 2011 were responsible for maintaining "Fair" (4 rating) soon-to-smolt abundance ratings in many sites throughout the 4 watersheds. Sites with this pattern included Zayante 13a, Bean 14b, mainstem Soquel 4, 10, and 12, Corralitos 1 and Corralitos 3.

6. Following the winter of WY2011, which had multiple stormflows, yearling densities were generally below average and less than in 2010, though similarly low between years in the San Lorenzo mainstem, throughout Soquel and Aptos creeks and slightly higher in the Corralitos sub-watershed in 2011.

7. 2011 abundance of young-of-the-year (YOY) was generally below average in all 4 watersheds except Corralitos and less than 2010 at the majority of sites in the San Lorenzo (statistically significant) and Soquel watersheds.

8. Below average YOY abundance was likely caused by high redd (nest) destruction and reduced YOY survival during spring stormflows, followed by insufficient adult spawners to saturate habitat with YOY after March stormflows passed.

9. The highest YOY densities at upper sites indicated that most spawning effort and/or spawning success was furthest upstream, except in Zayante Creek where they were highest in a middle site. However, there were likely insufficient YOY produced at upstream locations to filter downstream to seed lower reaches.

Figure B-41. Averaged Mean Monthly Streamflow for May – September in the San Lorenzo and Soquel Watersheds, 1997-2011.

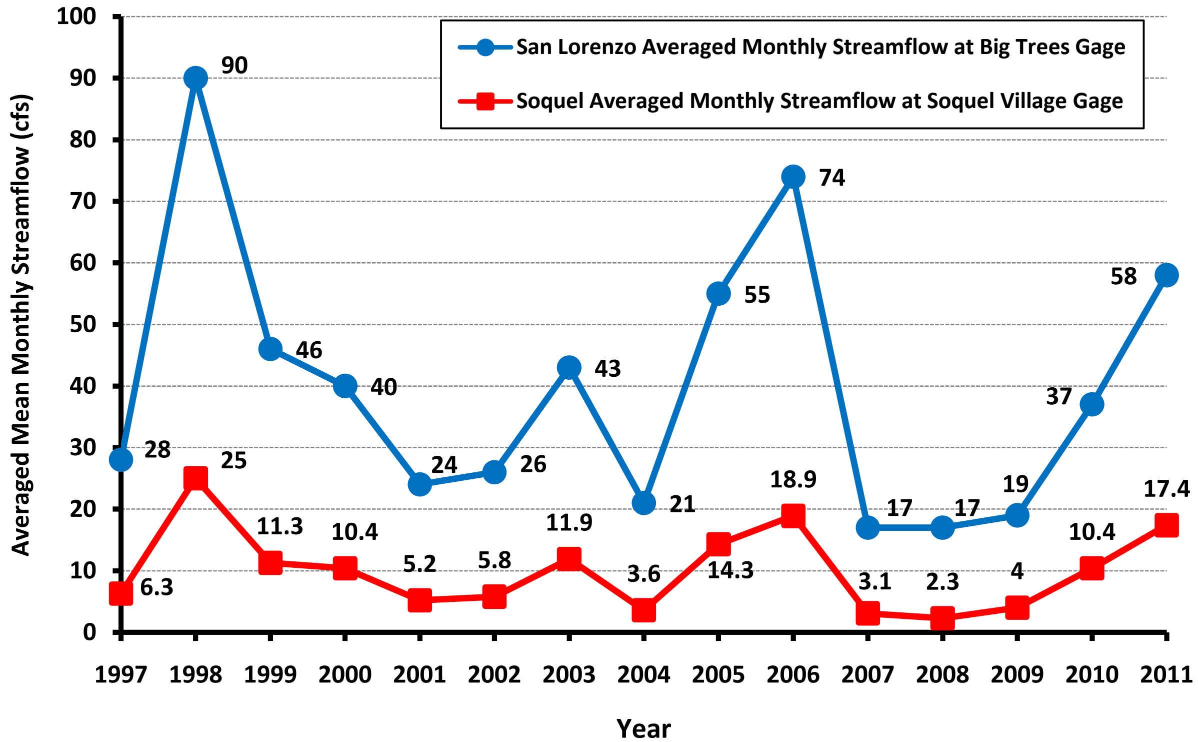


Table S-1. Rating of Steelhead Rearing Habitat For Small, Central Coastal Streams.*
(From Smith 1982.)

1. Very Poor - less than 2 potential smolt-sized** fish per 100 ft 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	"	"	"	

* 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.

** Potential 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 potential 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.

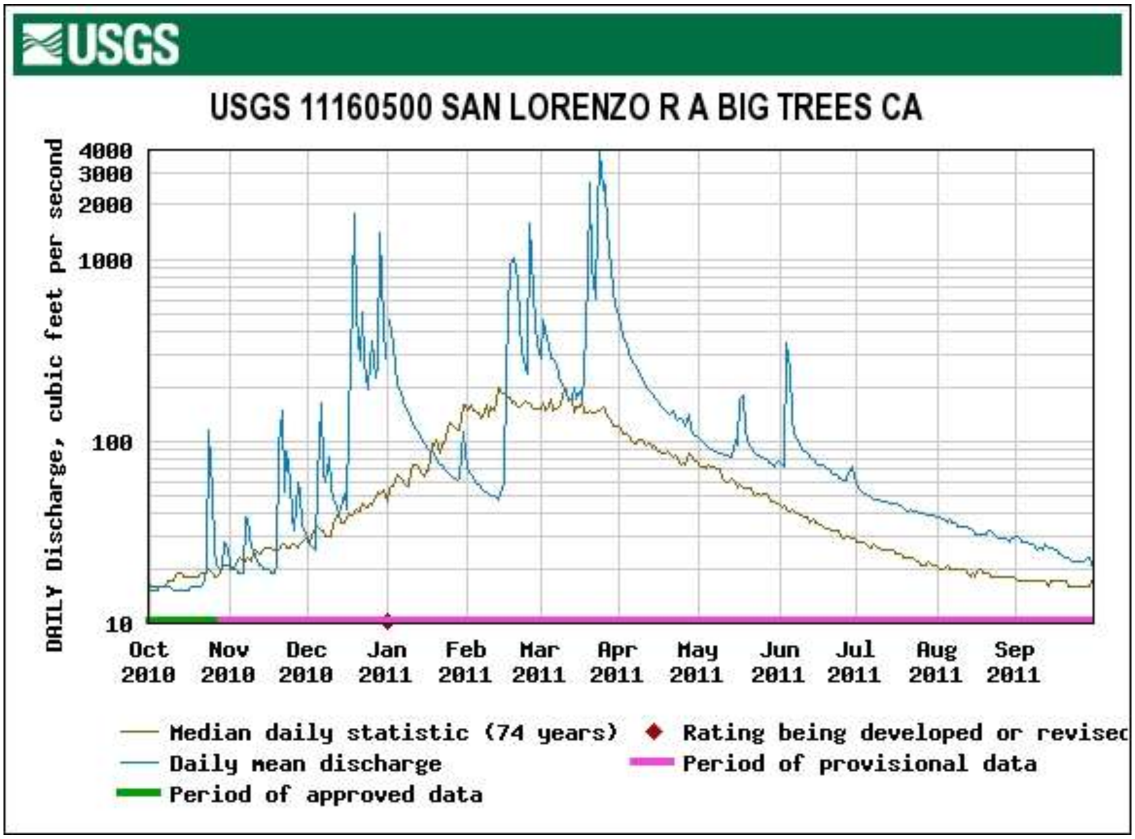
Table S-2. 2011 Sampling Sites Rated by Potential Smolt-Sized Juvenile Density (=>75 mm SL) and Average Smolt Size, with Physical Habitat Change since 2010. (Red denotes ratings of 1 and 2 or negative habitat change; italicized purple denotes ratings of 5 and 6. Methods for habitat change in M-6 of Appendix B).

Site	Multi-Year Avg. Potential Smolt Density Per 100 ft (Years of data)	2011 Potential Smolt Density (per 100 ft)/ Avg Smolt Size (mm)	2011 Smolt Numeric Rating	Symbolic Rating (1 to 7)	Physical Habitat Change by Reach or Site Since 2009/2010
Low. San Lorenzo #0a	7.4 (n=3)	2.1/ 124 mm	3	***	Site Positive
Low. San Lorenzo #1	10.2 (n=11)	2.6/ 148 mm	3	***	Site Positive
Low. San Lorenzo #2	***17.1 (n=10)***	11.2/ 142 mm	*5*	*****	Reach Positive
Low. San Lorenzo #4	16.0 (n=11)	3.7/ 103 mm	3	***	Site Positive
Mid. San Lorenzo #6	**4.6 (n=14)**	**5.3/ 85 mm**	**2**	**	Site Positive
Mid. San Lorenzo #8	**6.8 (n=14)**	**3.4/ 82 mm**	**1**	*	Site Positive
Up. San Lorenzo #11	**6.8 (n=14)**	**7.9/ 84 mm**	**2**	**	**Site Negative**
Zayante #13a	10.8 (n=13)	4.8/ 116 mm	4	****	Site Positive
Zayante #13c	***14.1 (n=13)***	***29.2/ 95 mm***	*5*	*****	Reach Positive
Zayante #13d	**16.1 (n=13)**	11.7/ 97 mm	4	****	Reach Positive
Lompico #13e	7.5 (n=6)	7.8/ 95 mm	3	***	Site Positive
Bean #14b	12.8 (n=14)	7.4/ 127 mm	4	****	Reach Positive
Bean #14c	***11.0 (n=11)***	***8.8/ 104 mm***	*5*	*****	Reach Positive
Fall #15	***14.7 (n=9)***	***14.7/ 115 mm***	*5*	*****	Reach Positive
Newell #16	14.8 (n=8)	13.1/ 99 mm	4	****	**Reach Negative**
Boulder #17a	12.2 (n=14)	10.6/ 101 mm	4	****	Site Positive
Boulder #17b	***10.7 (n=14)***	***13.6/ 106 mm***	*5*	*****	**Site Negative**
Bear #18a	11.5 (n=14)	9.4/ 98 mm	4	****	Site Positive
Branciforte #21a-2	9.5 (n=11)	13.6/ 100 mm	4	****	**Reach Negative**
Soquel #1	4.1 (n=14)	2.7/ 135 mm	3	***	Site Positive
Soquel #4	9.4 (n=15)	5.3/ 118 mm	4	****	Reach Positive
Soquel #10	8.8 (n=15)	5.8/ 107 mm	4	****	Site Positive
Soquel #12	8.1 (n=14)	5.6/ 109 mm	4	****	Reach Positive
E. Branch Soquel #13a	***10.8 (n=15)***	***10.1/ 112 mm***	*5*	*****	Reach Positive
E. Branch Soquel #16	10.3 (n=15)	15.4/ 100 mm	4	****	Reach Positive
W. Branch Soquel #19	6.8 (n=11)	16.9/ 95 mm	4	****	Site Positive
W. Branch Soquel #21	11.1 (n=10)	12.4/ 97 mm	4	****	Site Positive
Aptos #3	10.9 (n=7)	7.1/ 101 mm	3	***	**Site Negative**
Aptos #4	***10.5 (n=7)***	***16.7/ 104 mm***	*4*	******	Reach Positive
Valencia #2	11.7 (n=6)	–	–	–	–
Valencia #3	14.1 (n=6)	–	–	–	–
Corralitos #1	9.6 (n=5)	7.6/ 100 mm	4	****	Site Positive
Corralitos #3	9.3 (n=8)	6.6/ 123 mm	4	****	Reach Positive
Corralitos #8	***12.8 (n=8)***	***12.3/ 109 mm***	*5*	*****	Reach Positive
Corralitos #9	***19.4 (n=8)***	***14.5/ 104 mm***	*5*	*****	Reach Positive
Shingle Mill #1	11.2 (n=8)	7.0/ 100 mm	3	***	Site Positive
Shingle Mill #3	5.2 (n=8)	8.0/ 98 mm	4	****	Site Positive
Browns Valley #1	15.8 (n=8)	14.2/ 100 mm	4	****	Site Positive
Browns Valley #2	13.2 (n=8)	13.3/ 101 mm	4	****	Site Positive

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

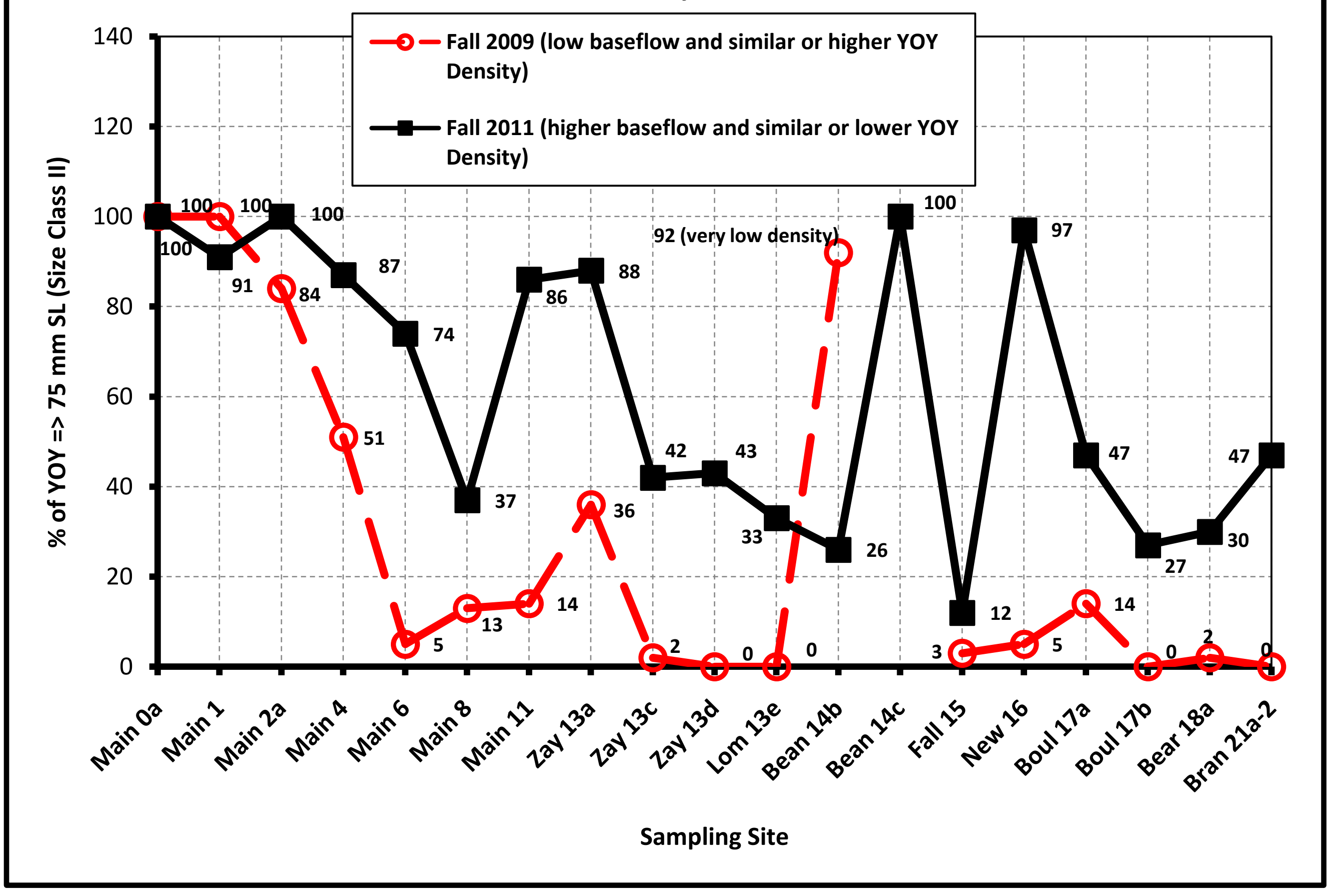
1. ***In the lower and middle mainstem***, habitat quality improved at most replicated sampling sites primarily due to increased baseflow and deeper fastwater habitat, though there was reduced escape cover in fastwater habitat compared to 2010 (**Tables S-2 above and B-13b below**).

2. ***All tributary reaches*** had high spring baseflows, creating high quality habitat in spring 2011 and good fish growth (**Hydrograph** below), as indicated by the high percent of YOY reaching Size Class II in the first growing season (**Figure B-17** below**;** *size histograms in **Appendix D***).



3. ***In San Lorenzo River tributaries***, of the 5 reaches with segments habitat typed, habitat quality declined only in Newell 16 in 2011 (shallower pools, similar sediment, more embeddedness and less escape cover) (**Table B-13b** below; ***Tables 6a, 7, 8, 12a, 13a and 13b** in Appendix B***;** **Figure B-17** above). Zayante 13c improved (higher summer baseflow, deeper pools, less fine sediment, less embeddedness in runs and similar pool escape cover). Zayante 13d improved (higher summer baseflow, deeper pools, similar sediment, less embeddedness in runs and more escape cover in pools and step-runs. Bean 14b improved (higher summer baseflow, deeper habitat and more pool escape cover, though there was more fine sediment and higher embeddedness). Bean 14c improved (much higher summer baseflow, deeper habitat, similar fine sediment and less embeddedness in riffles, though pool escape cover declined).

Figure B-17. Percent of Young-of-the-Year Steelhead in Size Class II (=>75 mm SL) at San Lorenzo River Sites in Dry 2009 and Wet 2011.



4. ***In San Lorenzo tributaries where only sampling sites were evaluated,*** only Boulder Site 17b had reduced habitat quality (higher summer baseflow but shallower pools and similar pool escape cover (***Tables 6b, 12b and 13b*** *in Appendix B*). Zayante Site 13a improved (higher summer baseflow, deeper pools, less fine sediment and more pool escape cover). Fall Site 15 improved (higher baseflow, deeper pools, less fine sediment, less embeddedness in riffles and more pool escape cover). Lompico Site 13e improved (more baseflow, deeper habitat, though less escape cover). Boulder Site 17a improved (more baseflow, deeper habitat and similar pool escape cover). Spring growth conditions were good as indicated by the high percentage of YOY reaching Size Class II in 2011 compared to a drier year (**Figure B-17** above).

5. ***Densities of important larger Size Class II and III steelhead*** (=>75 mm SL; soon-to-smolt) ***at mainstem sites*** were below average at 5 of 7 sites in 2011 and less than in 2010 (statistically significant) (***Tables 21, 39 and Figure 22*** *in Appendix B*; **Figure B-4** below). (Lines drawn between data points do not imply changes in density between sites.)

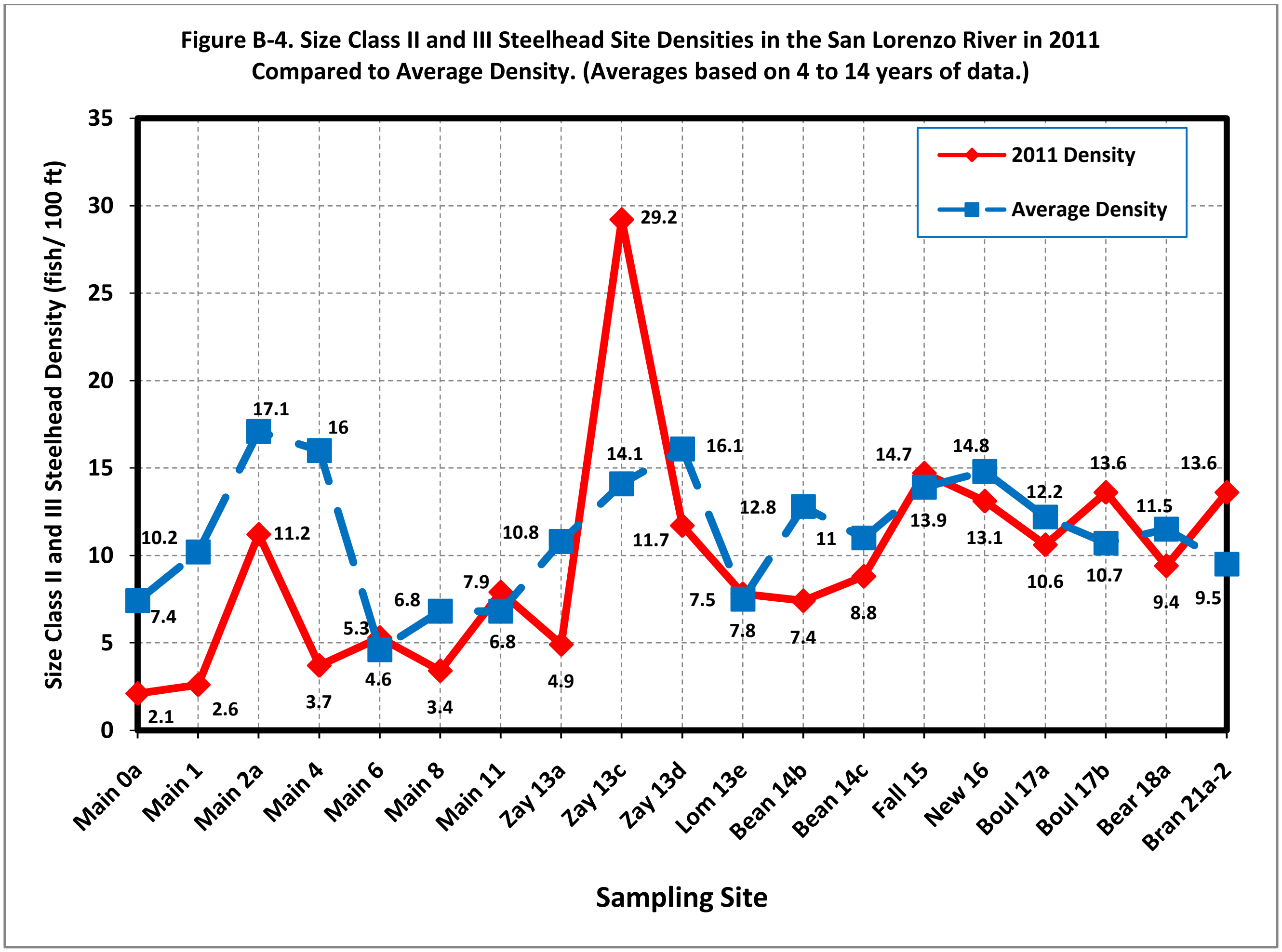
6. ***Size Class II and III abundance in tributaries*** were close to average or above at all sites except below average at Zayante 13a, Zayante 13d and Bean 14b (only 4 fish/ 100 feet) (**Figure B-4** below). This was in a year with low YOY recruitment to yearlings from below

average 2010 tributary YOY abundance, low YOY density (reduced competition) and high streamflow (more food) that allowed a high percentage of YOY to reach Size Class II. These 3 sites well below average had few YOY and yearlings present. (Lines drawn between data points do not imply changes in density between sites.)

Table B-13b. Habitat Change in the SAN LORENZO MAINSTEM AND TRIBUTARIES.

Reach Comparison or (Site Only)	Baseflow	Pool Depth/ Fastwater Habitat Depth in Mainstem below Boulder Creek	Fine Sediment	Embeddedness	Pool Escape Cover/ Fastwater Habitat Cover in Mainstem below Boulder Creek	Overall Habitat Change
(Mainstem 0a)	+	+ / +	NA*	NA	/−	+
(Mainstem 1)	+	/ +	NA	NA	/−	+
Mainstem 2	+	+ / +	+ (Run)	− (Pool)	+ / + Riffle; − Run (Segment Δ)	+
(Mainstem 4)	+	/ +	NA	NA	/−	+
(Mainstem 6)	+	/ +	NA	NA	/−	+
(Mainstem 8)	+	/ +	NA	NA	/−	+
(Mainstem Near Teihl 11)	Slightly +	Slightly −	NA	NA	−	−
(Zayante 13a)	+	+	+	NA	+	+
Zayante 13c	+	+	Similar	− (run)	Similar	+
Zayante 13d	+	+	Similar	+ (run)	+ (and step-run)	+
(Lompico 13e)	+	+	NA	NA	−	+
Bean 14b	+	+	−	− (run)	+	+
Bean 14c	+	+	Similar	+ (riffle)	−	+
Fall 15 (2009 to 2011)	+	+	+	+ (riffle)	+	+
Newell 16	Similar	−	Similar	−	−	−
(Boulder 17a)	+	+	NA	NA	Similar	+
(Boulder 17b)	+	−	NA	NA	Similar	−
(Bear 18a)	+	Similar	+ (riffle)	Similar	−	+
(Branciforte 21a-2)	+	−	−	− (run)	−	−

***NA = Not available.**



7. Six of 12 tributary sites had lower Size Class II and III abundance than in 2010, but there were similar densities at 8 of the sites, including Zayante 13c, Zayante 13d, Lompico 13e, Fall 15, Boulder 17a and 17b, Bear 18a and Branciforte 21a-2 (**Figure B-24** below and ***Table 25** in Appendix B*). Newell 16 density was about half the 2010 level. (Lines drawn between data points do not imply changes in density between sites.)

8. Zayante 13c (29.2/ 100 ft) had by far the highest Size Class II and III density, followed by Fall 15 (14.7/ 100 ft). Zayante 13c had the highest density of yearlings and a high density of YOY, with a high percent of YOY reaching Size Class II (**Figure B-17** above). Zayante 13c was a sunny site which likely had higher food production due to greater photosynthesis and algae production, leading to higher fish growth.

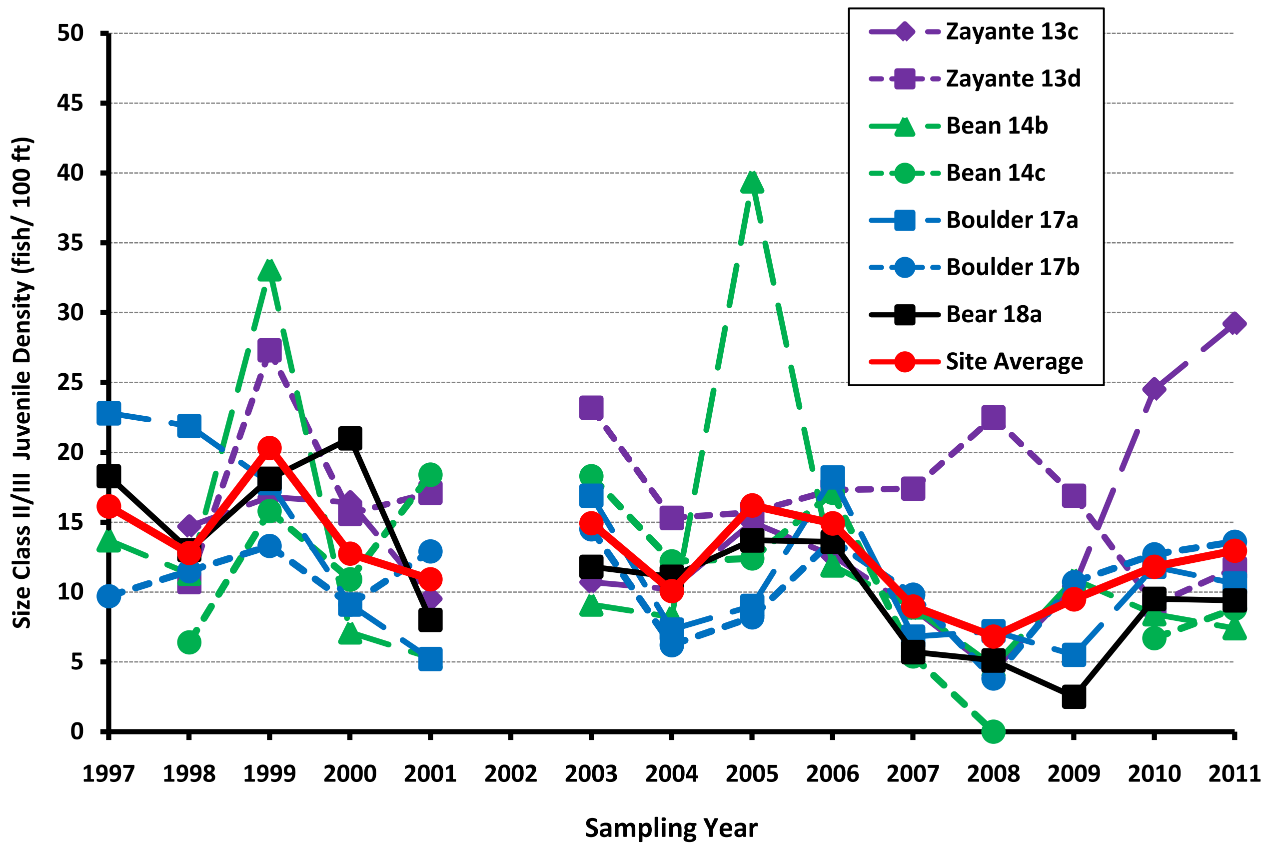
9. Average size of Size Class II and III fish at all sites was generally similar to 2010 when densities were similar and larger when densities were less, presumably due to less competition (**Table S-3** below).

Table S-3. 2011 Sampling Sites Rated by Potential Smolt-Sized Juvenile Density (=>75 mm SL) and Their Average Size in Standard Length Compared to 2010, with Physical Habitat Change from 2010 Conditions.

(Red denotes ratings of 1−3 (as in Table S-1) and negative habitat change and italicized purple denotes ratings of 5−7. Methods for habitat change in M-6 of Appendix B.)

Site	2010 Potential Smolt Density (per 100 ft)/ Avg Smolt Size SL (mm)	2010 Smolt Rating (With Size Factored In)	2011 Potential Smolt Density (per 100 ft)/ Avg Smolt Size SL (mm)	2011 Smolt Rating (With Size Factored In)	Physical Habitat Change by Reach/Site Since 2010
Low. San Lorenzo #0a	19.8/ 106 mm	*Very Good*	2.1/ 124 mm	Below Average	+
Low. San Lorenzo #1	15.3/ 98 mm	Fair	2.6/ 148 mm	Below Average	+
Low. San Lorenzo #2	22.4/ 91 mm	*Good*	11.2/ 142 mm	*Good*	+
Low. San Lorenzo #4	12.6/ 87 mm	Below Average	3.7/ 103 mm	Below Average	+
Mid. San Lorenzo #6	6.1/ 80 mm	Poor	5.3/ 85 mm	Poor	+
Mid. San Lorenzo #8	8.2/ 88 mm	Below Average	3.4/ 82 mm	Very Poor	+
Up. San Lorenzo #11	4.7/ 93 mm	Below Average	7.9/ 84 mm	Poor	−
Zayante #13a	18.8/ 89 mm	Fair	4.8/ 116 mm	Fair	+
Zayante #13c	24.5/ 90 mm	*Good*	29.2/ 95 mm	*Good*	+
Zayante #13d	9.1/ 101 mm	Fair	11.7/ 97 mm	Fair	+
Lompico #13e	8.7/ 96 mm	Fair	7.8/ 95 mm	Below Average	+
Bean #14b	8.4/ 87 mm	Below Average	7.4/ 127 mm	Fair	+
Bean #14c	6.7/ 99 mm	Below Average	8.8/ 104 mm	*Good*	+
Fall #15	14.3/ 118 mm	*Good*	14.7/ 115 mm	*Good*	+
Newell #16	24.7/ 86 mm	Fair	13.1/ 99 mm	Fair	−
Boulder #17a	11.8/ 89 mm	Fair	10.6/ 101 mm	Fair	+
Boulder #17b	12.7/ 90 mm	Fair	13.6/ 106 mm	*Good*	−
Bear #18a	9.5/ 99 mm	Fair	9.4/ 98 mm	Fair	+
Branciforte #21a-2	12.6/ 105 mm	*Good*	13.6/ 100 mm	Fair	−
Soquel #1	7.9/ 108 mm	Fair	2.7/ 135 mm	Below Average	+
Soquel #4	4.9/ 98 mm	Below Average	5.3/ 118 mm	Fair	+
Soquel #10	14.0/ 96 mm	Fair	5.8/ 107 mm	Fair	+
Soquel #12	8.0/ 88 mm	Below Average	5.6/ 109 mm	Fair	+
East Branch Soquel #13a	32.8/ 88 mm	*Good*	10.1/ 112 mm	*Good*	+
East Branch Soquel #16	8.0/ 106 mm	*Good*	15.4/ 100 mm	Fair	+
West Branch Soquel #19	11.6/ 93 mm	Fair	16.9/ 95 mm	Fair	+
West Branch Soquel #21	17.5/ 99 mm	*Good*	12.4/ 97 mm	Fair	+
Aptos #3	17.2/ 90 mm	*Good*	7.1/ 101 mm	Below Average	−
Aptos #4	9.7/ 96 mm	Fair	16.7/ 104 mm	*Very Good*	Similar
Valencia #2	8.7/ 100 mm	Fair	–	–	NA
Valencia #3	14.8/ 105 mm	*Good*	–	–	NA
Corralitos #1	8.7/ 99 mm	Fair	7.6/ 100 mm	Fair	+
Corralitos #3	5.5/ 116 mm	Fair	6.6/ 123 mm	Fair	+
Corralitos #8	6.0/ 90 mm	Below Average	12.3/ 109 mm	*Good*	+
Corralitos #9	11.2/ 104 mm	*Good*	14.5/ 104 mm	*Good*	+
Shingle Mill #1	6.3/ 104 mm	Fair	7.0/ 100 mm	Below Average	+
Shingle Mill #3	6.1/ 99 mm	Below Average	8.0/ 98 mm	Fair	+
Browns #1	10.1/ 103 mm	*Good*	14.2/ 100 mm	Fair	+
Browns #2	9.4/ 104 mm	*Good*	13.3/ 101 mm	Fair	+

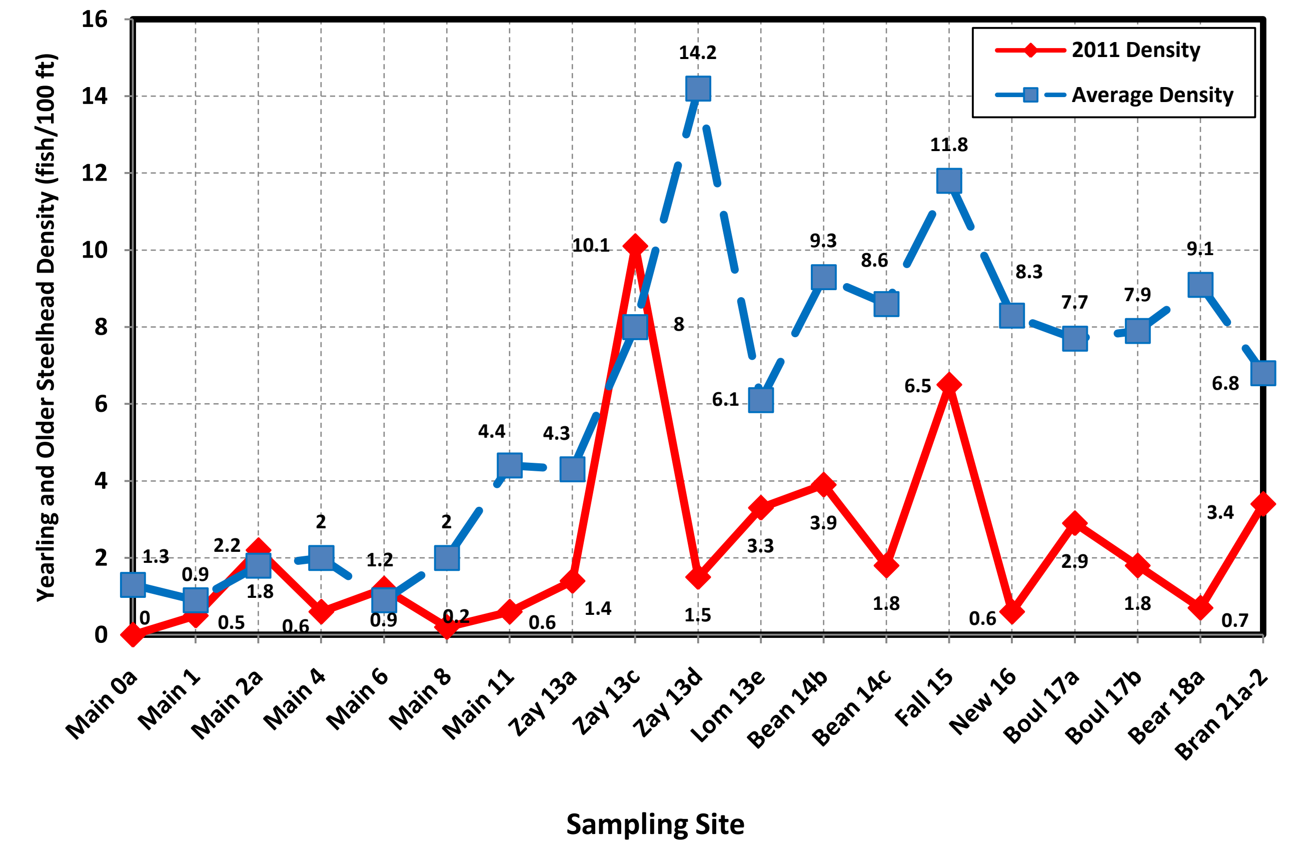
Figure B-24. Trend in Size Class II/III (=>75 mm SL) Juvenile Steelhead Density at San Lorenzo Tributary Sites, 1997-2011.



10. ***Yearling densities at mainstem sites*** were similarly low in 2011 as they have been since 2000. Yearling densities were near or slightly below average (**Figure B-3** below), consistent with high spring baseflow that allowed good growth rate in young yearlings that chose to emigrate early in spring. (Lines drawn between data points do not imply changes in density between sites.) Also, the late winter storms may have caused higher overwinter mortality of yearlings.

11. ***Yearling densities at tributary sites*** were generally less than in 2010 and much below average at most sites except Zayante 13c (**Figure B-3** below). (Lines drawn between data points do not imply changes in density between sites.) This may be partially explained by reduced overwinter survival and early emigration associated with rapid spring growth.

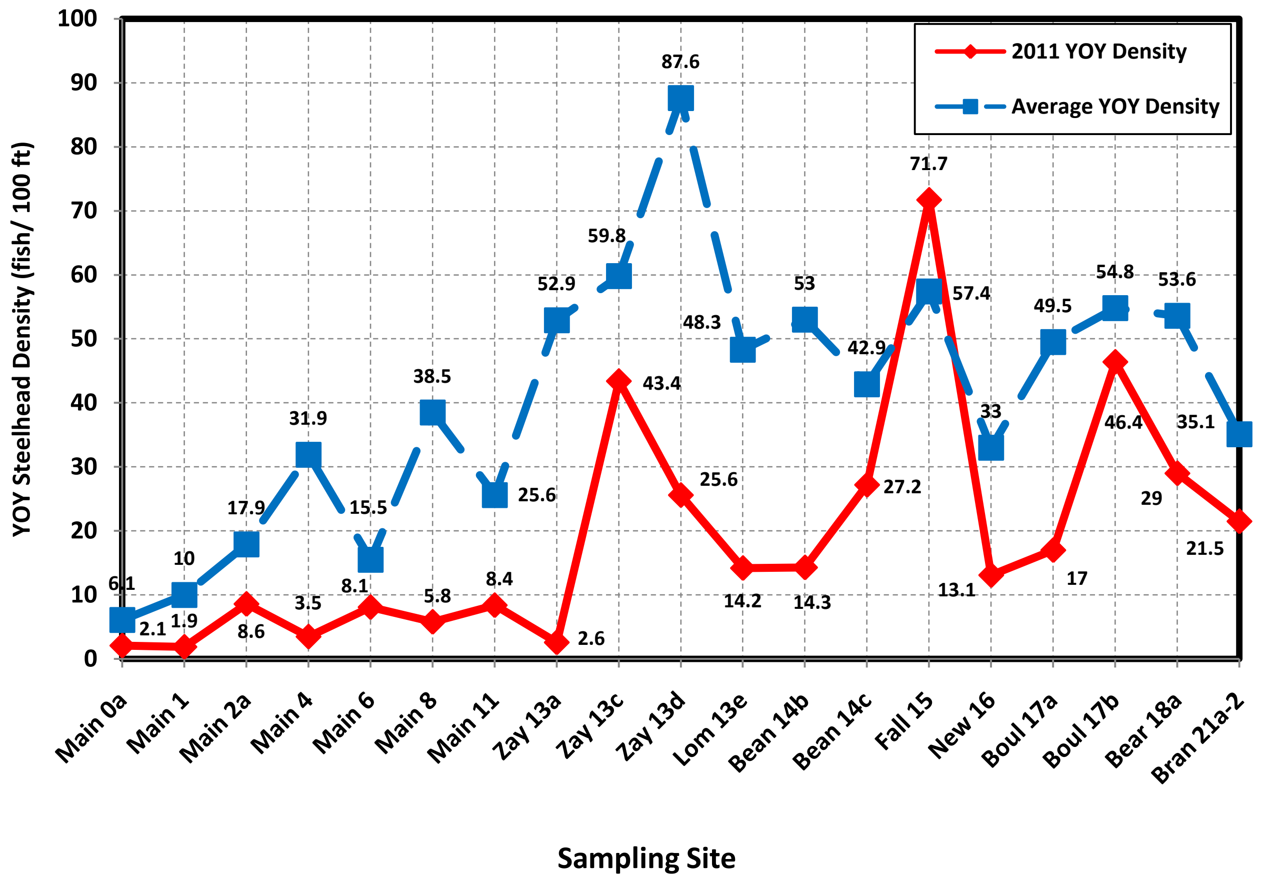
Figure B-3. Yearling and Older Steelhead Site Densities in the San Lorenzo River in 2011 Compared to Average Density. (Averages based on 4 to 14 years of data.)



12. ***YOY abundance at all mainstem sites*** was less than in 2010 (statistically significant) and below average (***Tables 18 and 40*** *in Appendix B*; **Figure B-2** below). (Lines drawn between data points do not imply changes in density between sites.) This was consistent with large, late winter storms that destroyed redds and small YOY, followed by insufficient adult spawners to saturate the watershed with eggs and new YOY. Low YOY densities led to continued low ***total juvenile abundance at mainstem sites*** occurring since 2000 and very similar to 2006 after another wet winter (**Figure B-21** below).

13. ***YOY abundance at tributary sites*** was generally less than 2010 (statistically significant for mainstem and tributary sites combined) (***Tables 23 and 39*** *in Appendix B*) and still much below average at most sites except Fall 15 (**Figure B-2** below). This led to the lowest average ***total juvenile abundance at tributary*** sites in 15 years (**Figure B-23** below). (Lines drawn between data points do not imply changes in density between sites.)The highest YOY density was at Fall Site 15 (71.7/ 100 ft). The continued below average YOY densities were consistent with large, late winter storms that destroyed redds and small YOY, followed by insufficient adult spawners to saturate the watershed with eggs and new YOY.

Figure B-2. Young-of-the-Year Steelhead Site Densities in the San Lorenzo River in 2011 Compared to Average Density. (Averages based on 4 to 14 years of data.)



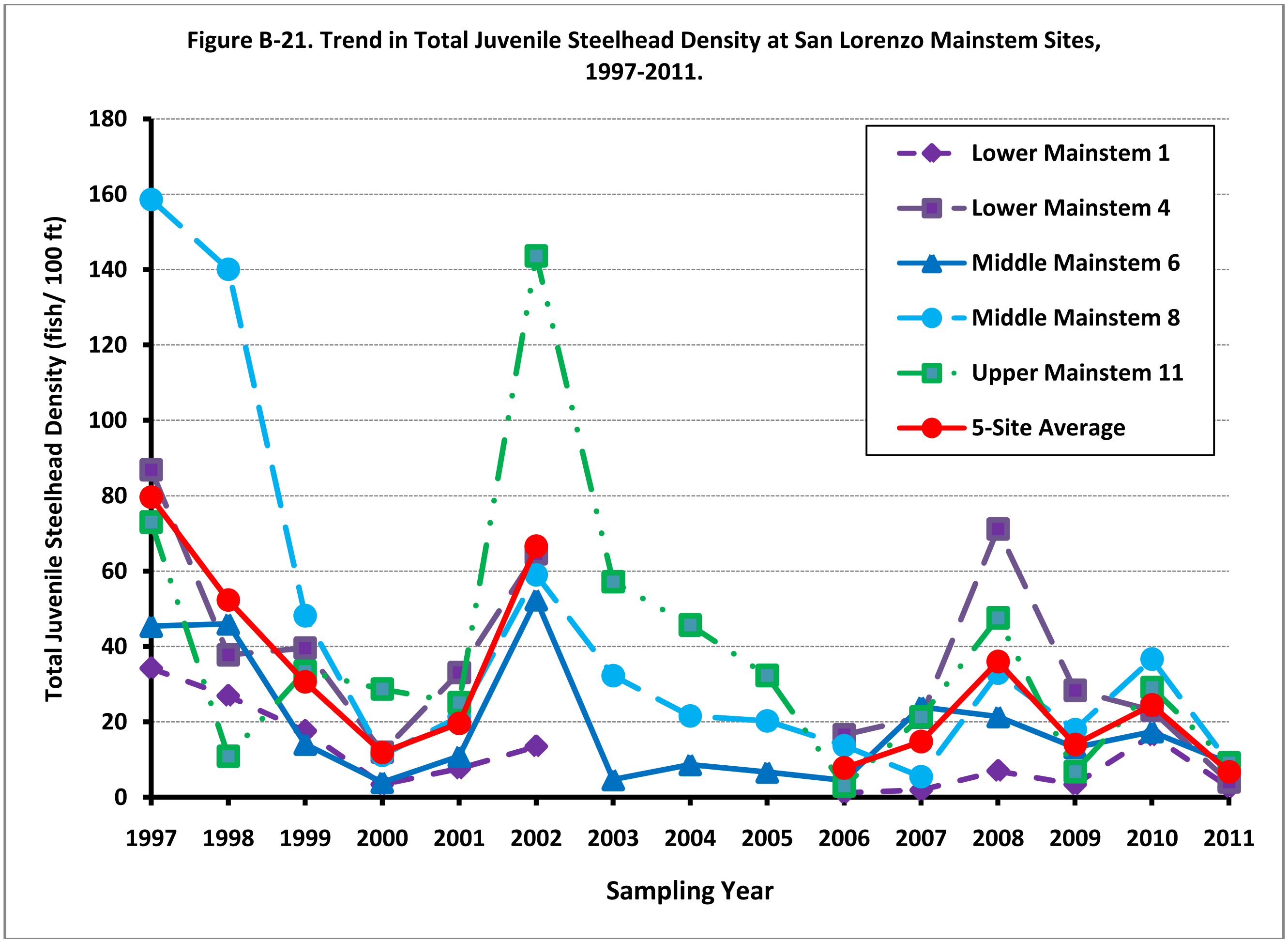
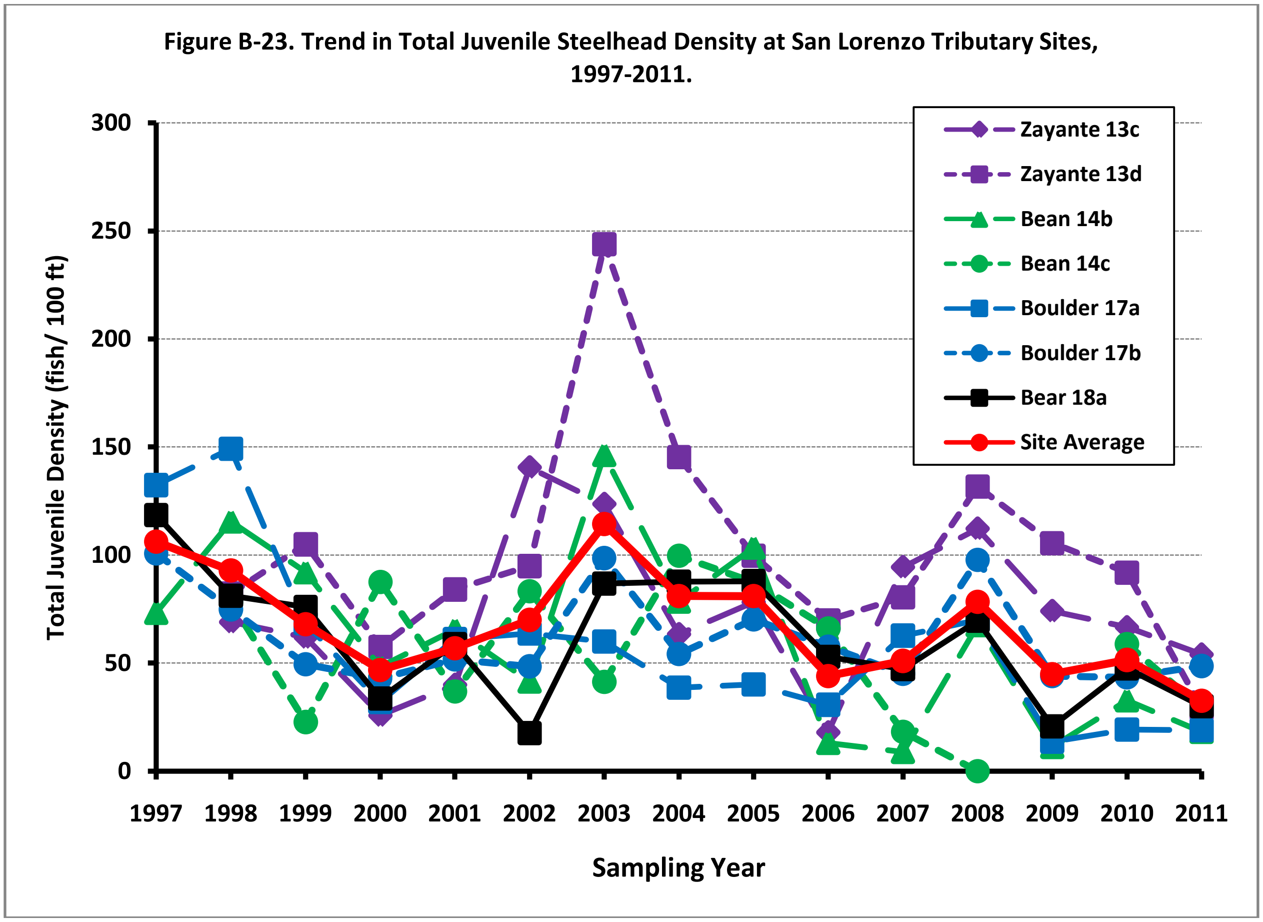


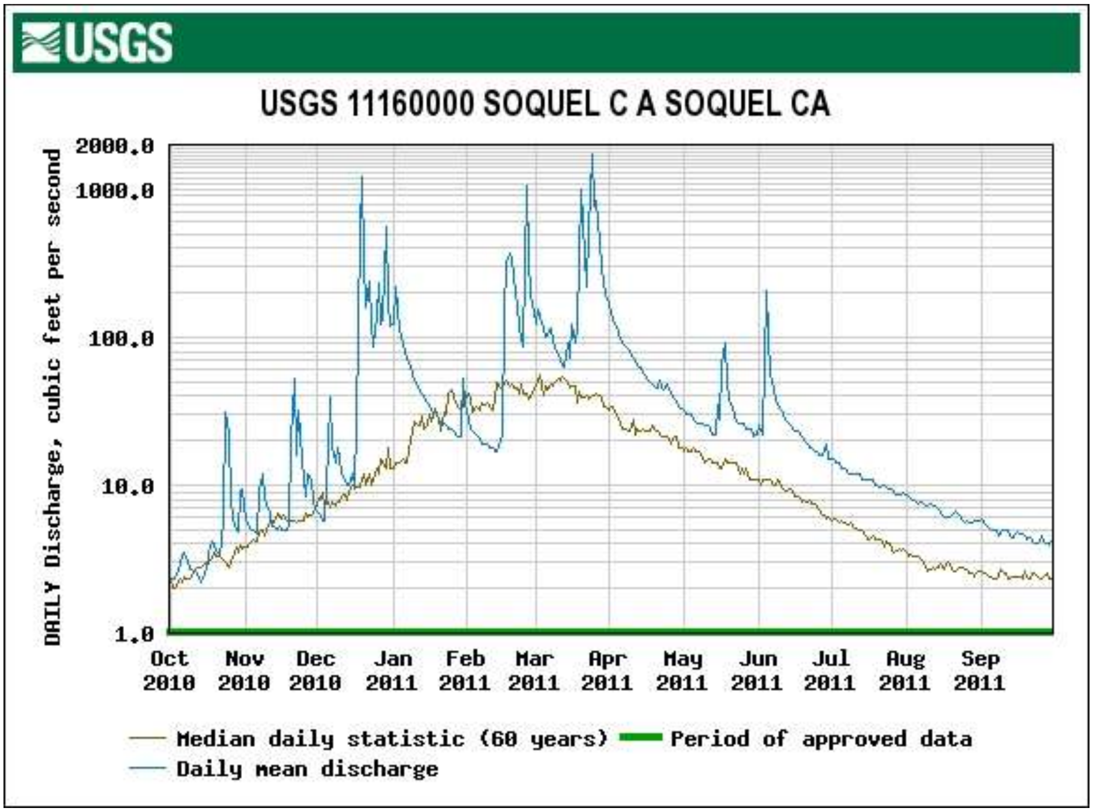
Figure B-21. Trend in Total Juvenile Steelhead Density at San Lorenzo Mainstem Sites, 1997-2011.
180
160
140
120
100
80
60
40
20
0
Total Juvenile Steelhead Density (fish/ 100 ft)
Lower Mainstem 1
Lower Mainstem 4
Middle Mainstem 6
Middle Mainstem 8
Upper Mainstem 11
5-Site Average
1997
1998
1999
2000
2001
2002
2003
2004
2005
2006
2007
2008
2009
2010
2011
Sampling Year



iii. Steelhead Abundance in the Soquel Creek Watershed

1. All reaches had higher summer baseflow in 2011 than 2010, with similar spring baseflow due to storms in both years (**Soquel Creek Hydrograph** below). This provided high food levels in spring in both years and better growth rates in the summer in 2011. Of the 4 reaches and 4 sampling sites compared, all had overall positive habitat change based on more baseflow, greater water depth and generally more pool escape cover (6 of 8 reaches/sites) (***Table 15e** in Appendix B*).

2. Despite fast YOY growth rate associated with high streamflow (more food) and low YOY densities (less competition), all 4 mainstem sites had below average ***Size Class II and III abundance*** (**Figures B-8, B-18 and B-26** below). (Lines drawn between data points do not imply changes in density between sites.)Two of the Branch sites were near average and two others were above average. Five of 8 sites had less abundance than in 2010, but only 2 sites had reduced soon-to-smolt ratings (mainstem Soquel 1 ("Below Average") and East Branch 16 ("Fair"). Two sites had improved soon-to-smolt ratings due to large average smolt size (mainstem Soquel 4 ("Fair") and 12 ("Fair")) (***Table 30** in Appendix B* and **Table S-3** above). West Branch 19 had the one "Good" rating at a site having a large wood cluster providing cover. The remaining 3 sites had "Fair" ratings.



3. ***Yearling and older abundance*** remained similarly low as in 2010 and most years. It was near average at sites with typically low densities and below average at the two Branch sites that typically have higher densities (West Branch 21 and East Branch 16) (***Table 28*** *in Appendix B* and **Figure B-7** below). High spring baseflows allowed some young yearlings to grow quicker and emigrate early in spring, if they survived the large stormflows. These factors contributed to the low yearling densities, along with low recruitment of YOY from 2010.

4. ***Young-of-the-year (YOY) abundance*** was generally much lower in 2011 than 2010, below average at all sites, and lead to the lowest average ***total juvenile abundance*** in the last 15 years (***Tables 26−27*** *in Appendix B* and **Figures B-6 and B-25** below). Low YOY densities were consistent with large, late winter storms that destroyed redds, emerging fry and small YOY, followed by insufficient adult spawners to saturate the watershed with eggs and new YOY.

5. The 2011 juvenile steelhead population in Soquel Lagoon in fall was an estimated 678, which was much less than the 18-year average of 1,667, about 60% of the 2010 estimate. The 2011 lagoon estimate was similar to the estimate in 1998 (671) after a wet winter (**Alley 2011a**). The 2011 population size fit the typical pattern for wetter years when less spawning occurs near the lagoon and lagoon numbers are down. However, in 2011, YOY densities were lower throughout the watershed compared to 1998 and lower than in the upper watershed in 2006, after a wet winter.

Figure B-18. Percent of Young-of-the-Year Steelhead in Size Class II (=>75 mm SL) at Soquel Creek Sites in Dry 2009 and Wet 2011.

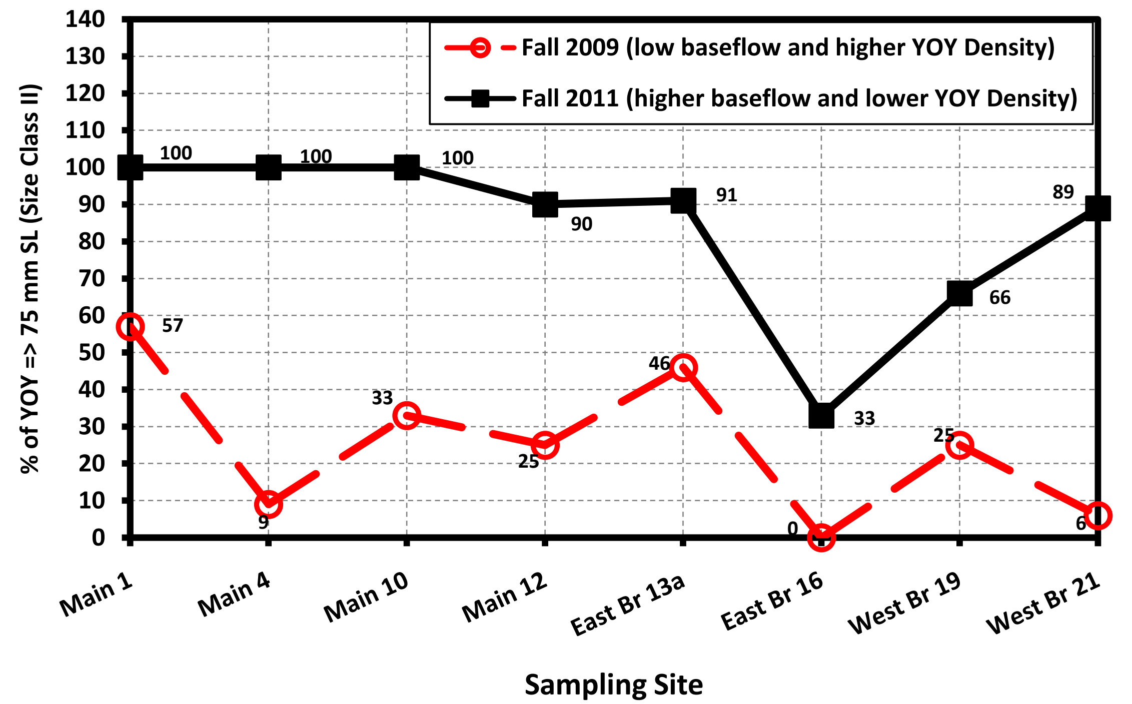


Figure B-8. Size Class II and III Steelhead Site Densties in Soquel Creek in 2011 Compared to the 15-Year Average (11 th year for West Branch #19.)

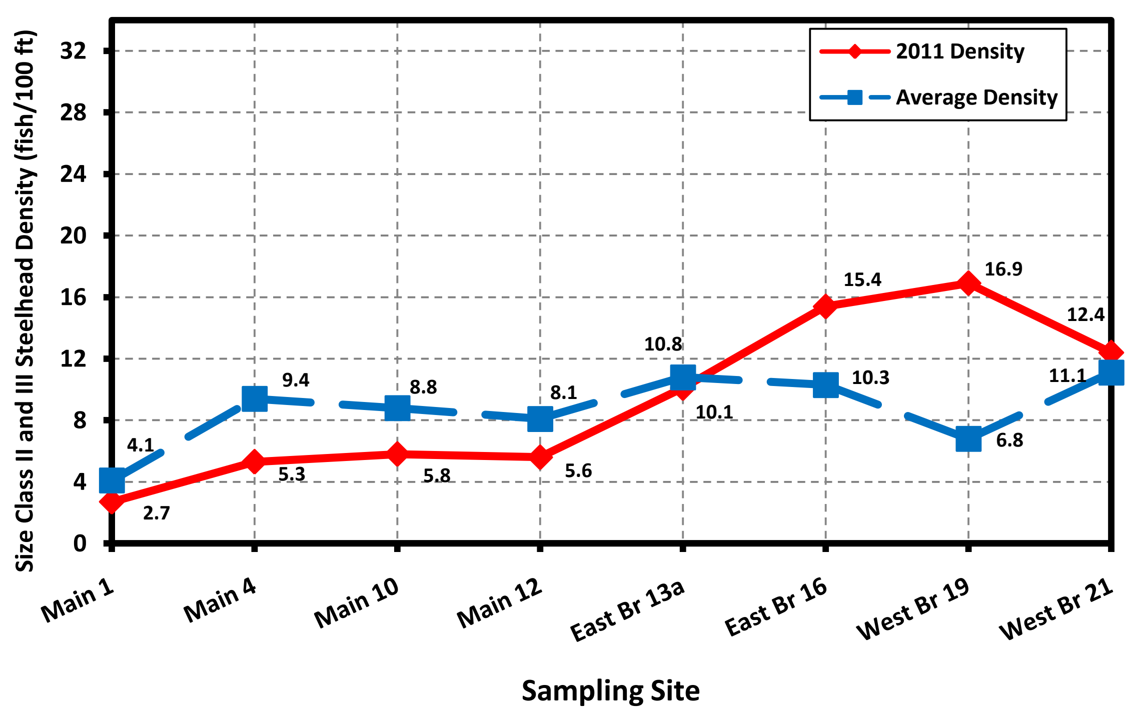
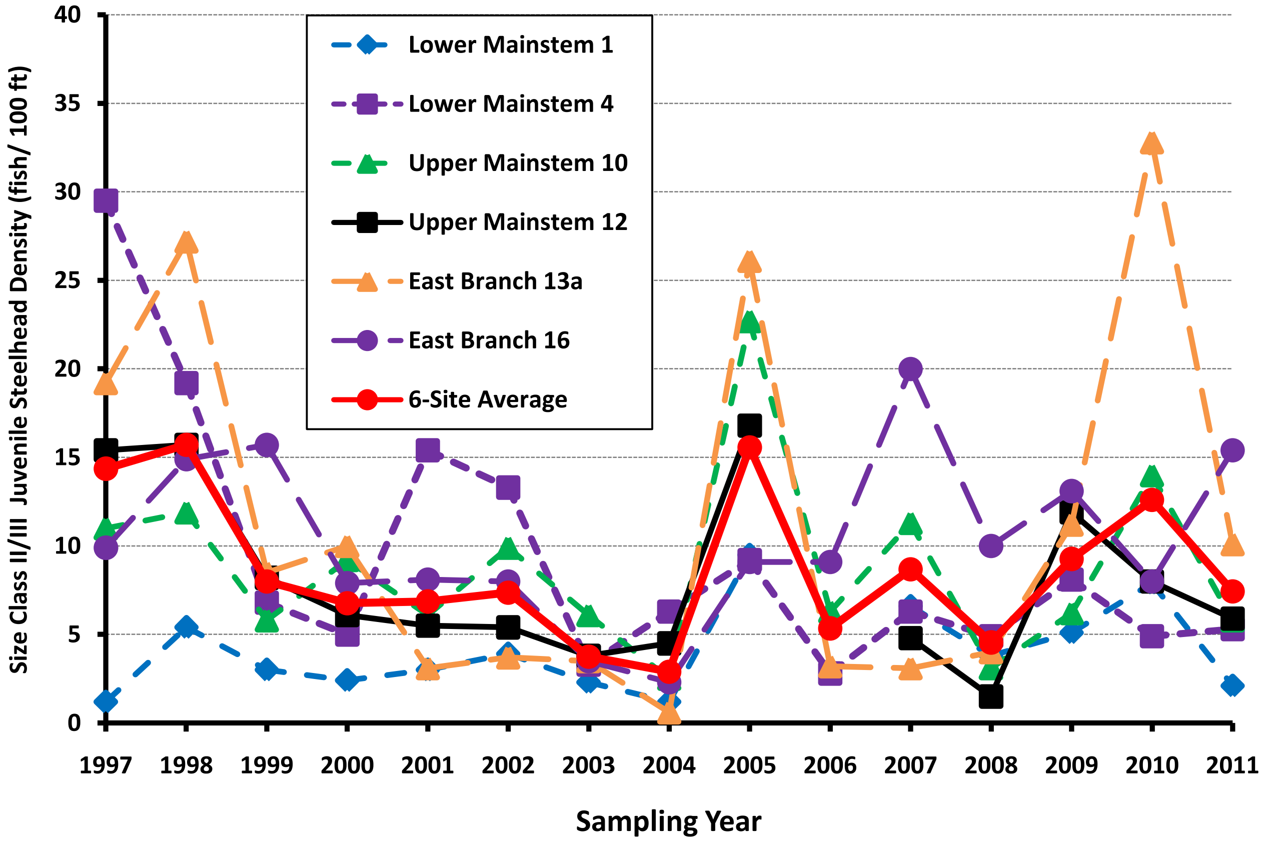


Figure B-26. Trend in Size Class II/III (=>75 mm SL) Juvenile Steelhead Density at Soquel Creek Sites, 1997-2011.



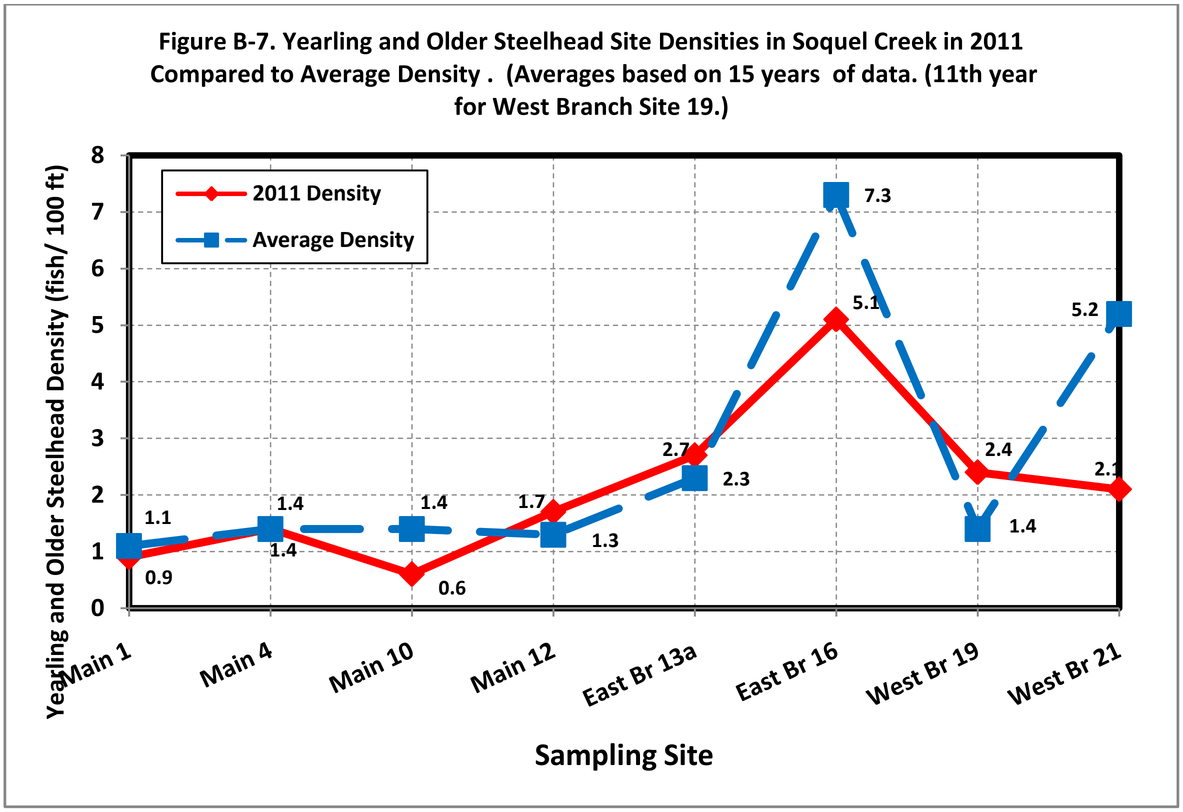


Figure B-7. Yearling and Older Steelhead Site Densities in Soquel Creek in 2011 Compared to Average Density . (Averages based on 15 years of data. (11th year for West Branch Site 19.)
2011 Density
Average Density
Yearling and Older Steelhead Density (fish/ 100 ft)
Main 1
Main 4
Main 10
Main 12
East Br 13a
East Br 16
West Br 19
West Br 21
Sampling Site

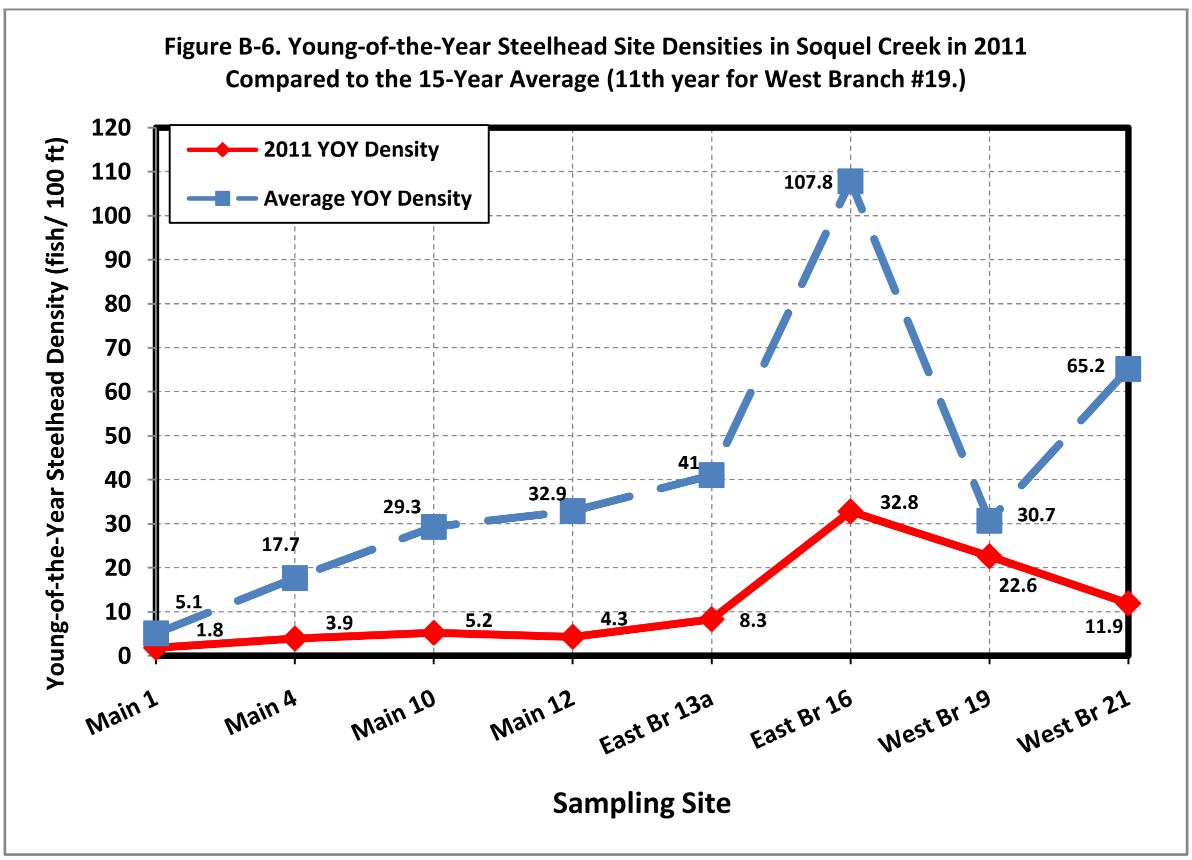
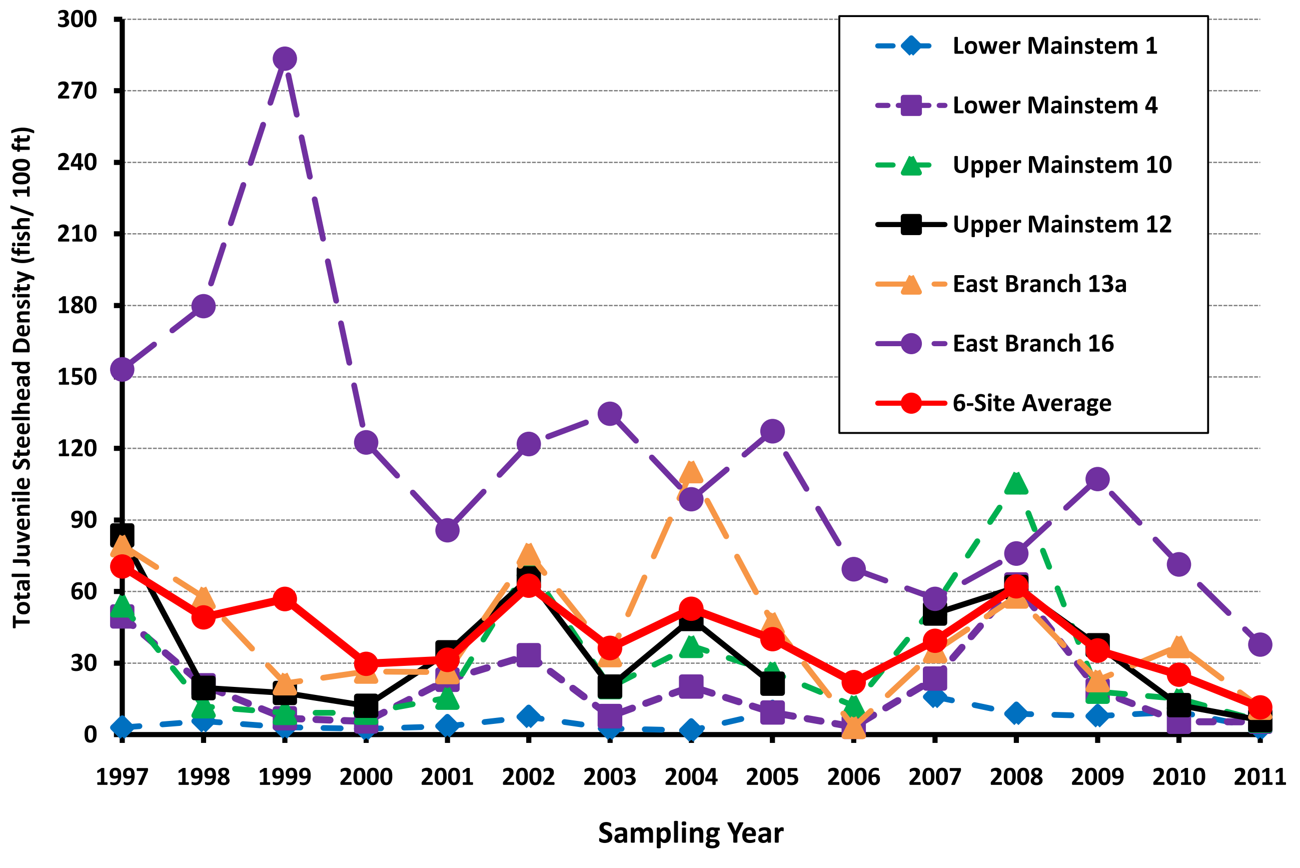


Figure B-6. Young-of-the-Year Steelhead Site Densities in Soquel Creek in 2011 Compared to the 15-Year Average (11th year for West Branch #19.)
2011 YOY Density
Average YOY Density
Young-of-the-Year Steelhead Density (fish/ 100 ft)
Main 1
Main 4
Main 10
Main 12
East Br 13a
East Br 16
West Br 19
West Br 21
Sampling Site

Figure B-25. Trend in Total Juvenile Steelhead Density at Soquel Creek Sites, 1997-2011.

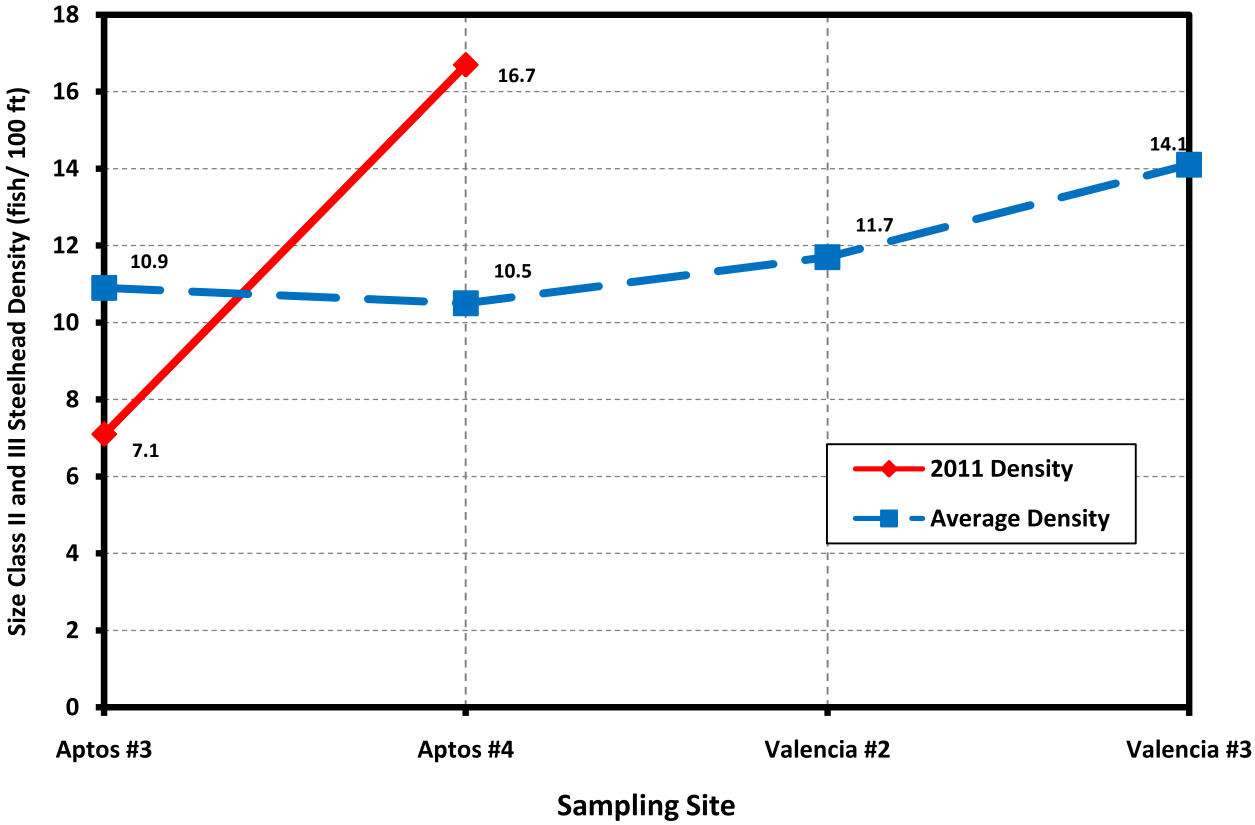


iv. Steelhead Abundance in the Aptos Creek Watershed

1. **Habitat quality** declined in lower Aptos Creek and was similar to 2010 in upper Aptos Creek (**Table B-16c** below). Although Lower Aptos 3 had higher baseflow, its pool depth shallowed with less escape cover (***Tables 16a-b*** *in Appendix B*). Reach 3 with Aptos 4 in Nisene Marks had higher baseflow, similar pool depth and embeddedness and slightly less escape cover and more fine sediment in the substrate (though not 10% or more).

2. ***Abundance of larger juveniles*** (Size Classes II and III => 75 mm SL) was below average at lower Aptos 3 and above average at upper Aptos 4 (**Figure B-12** below). (Lines drawn between data points do not imply changes in density between sites.) Compared to 2010, abundance went down in Aptos 3 and up in Aptos 4 (***Table 35*** *in Appendix B*). Abundance of larger juveniles depended primarily on density of fast-growing YOY in 2011 (higher in Aptos 4; **Figure B-19** below) and good escape cover from instream wood at Aptos 4. Smolt ratings were "Below Average" in Aptos 3 and "Very Good" in Aptos 4 (**Table S-3** above).

Figure B-12. Size Class II and III Steelhead Site Densities in Aptos and Valencia Creeks in 2011, with a 7-Year Average (1981; 2006-2011).



3. ***Below average yearling and older densities*** in the Aptos watershed followed the pattern in the other 3 watersheds in 2011 (**Figure B-11** below). Reduced abundance was likely caused by greater overwinter mortality with more stormflows and early spring emigration because high spring baseflows allowed faster yearling growth.

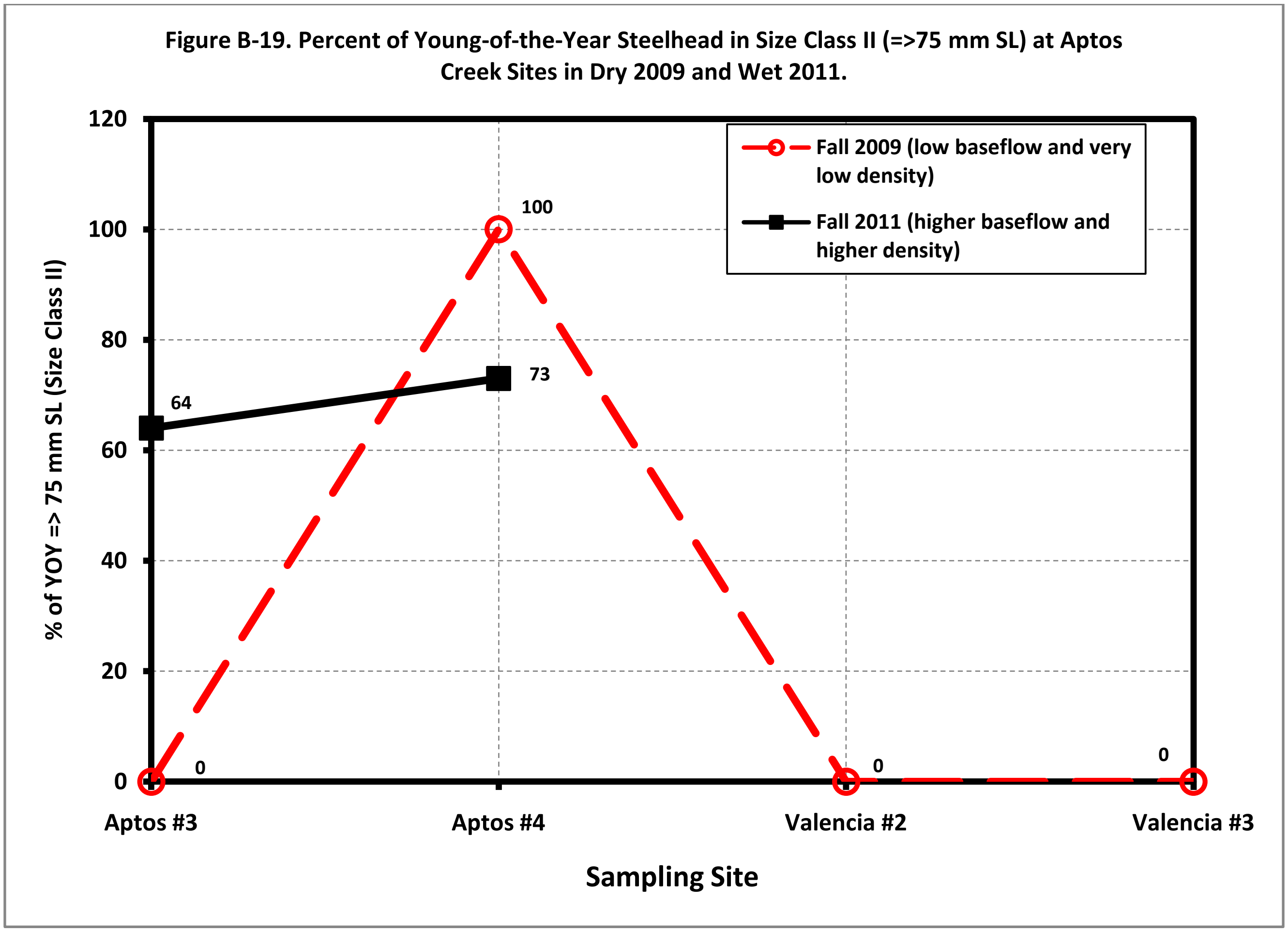
4. ***YOY abundance*** was below average in Aptos Creek as was the pattern in other watersheds (**Figure B-10** below). It was much less at Aptos 3 and similar at Aptos 4 compared to 2010 (***Table 32*** *in Appendix B*). The low YOY density at Aptos 3 was consistent with large, late winter storms that destroyed redds and small YOY, followed by insufficient adult spawners to saturate the watershed with eggs and new YOY.

5. Despite higher YOY densities in 2011, a high percent of YOY reached Size Class II (**Figure B-19** above). Elevated streamflows provided more food and stimulated growth.

Table B-16c. Habitat Change in APTOS AND CORRALITOS WATERSHED Reaches (2009 to 2011) and Replicated Sites (2010 to 2011).

Reach Comparison or (Site Only)	Baseflow	Pool Depth	Fine Sediment	Embeddedness	Pool Escape Cover	Overall Habitat Change
(Aptos 3)	+	−	NA*	NA	−	−
Aptos 4	+	Similar	Similar	Similar	−	**Similar**
(Corralitos 1)	+	−	NA	NA	+	+
Corralitos 3	+	Similar	+	Similar	+	+
Corralitos 5/6	+	+	+	Similar	−	+
Corralitos 7	+	Similar	+	Similar	Similar	+
(Shingle Mill 1)	+	Similar	NA	NA	Similar	+
(Shingle Mill 3)	+	+	NA	NA	+	+
(Browns 1)	+	Similar	NA	NA	+	+
(Browns 2)	+	+	NA	NA	−	+

*** NA = Not Available.**



1. The ***total juvenile abundance*** went down at the lower Aptos 3 site and remained similar at the upper Aptos 4 site compared to 2010, consistent with the YOY abundance pattern. Total juvenile densities were below average at both sites (**Figure B-27** below).

2. Aptos Lagoon/Estuary was productive steelhead habitat (population estimate of 420 large fish) and had a small tidewater goby population (two gobies captured) (**Figure B-43** below).

Figure B-11. Yearling and Older Juvenile Steelhead Site Densities in Aptos Creek in 2011, with a 7-Year Average (1981; 2006-2011).

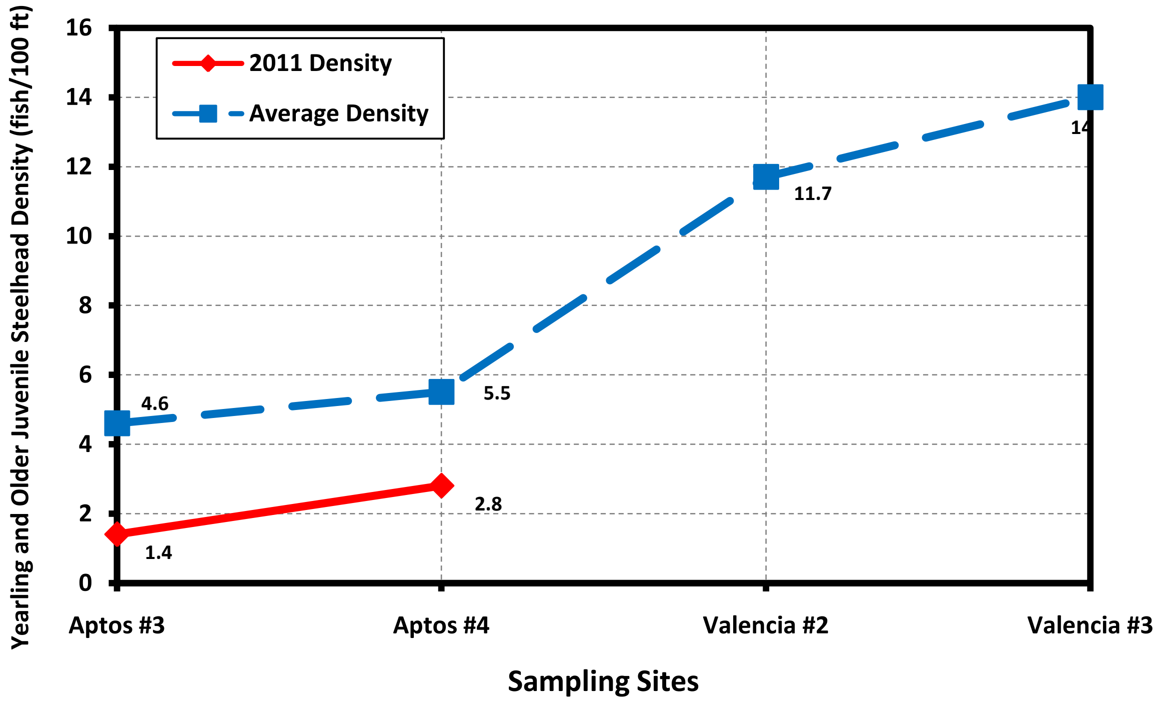


Figure B-10. Young-of-the-Year Steelhead Site Densties in Aptos Creek in 2011, with a 7-Year Average (1981; 2006-2011).

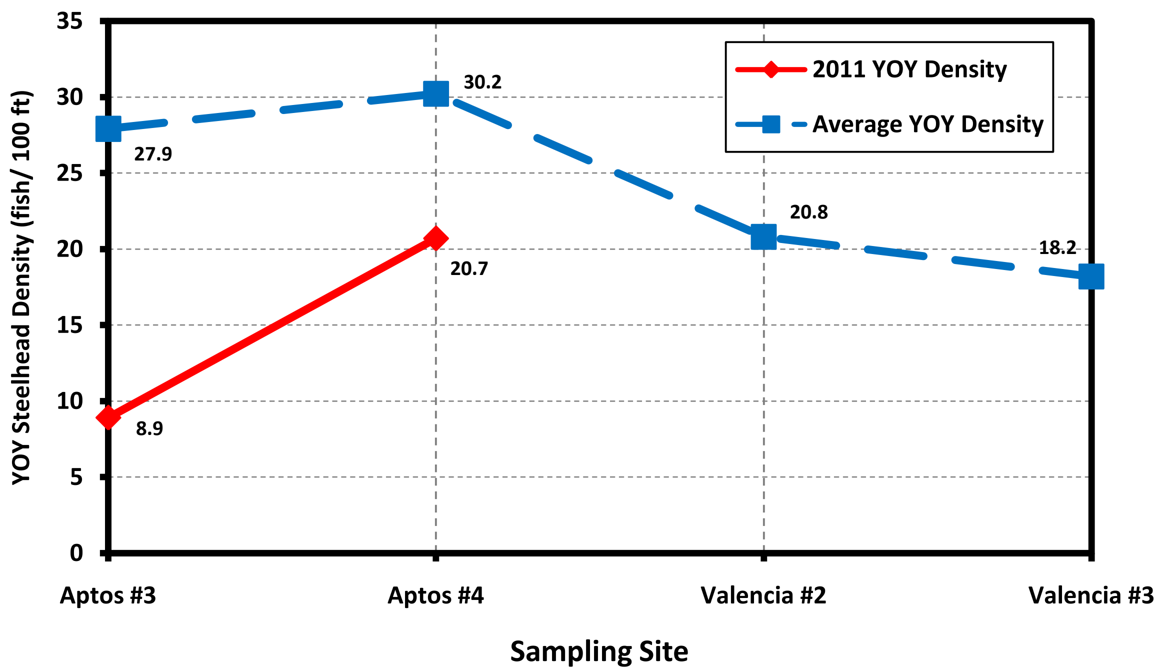


Figure B-27. Trend in Total Juvenile Steelhead Density in Aptos and Valencia Creek Sites, 2006-2011.

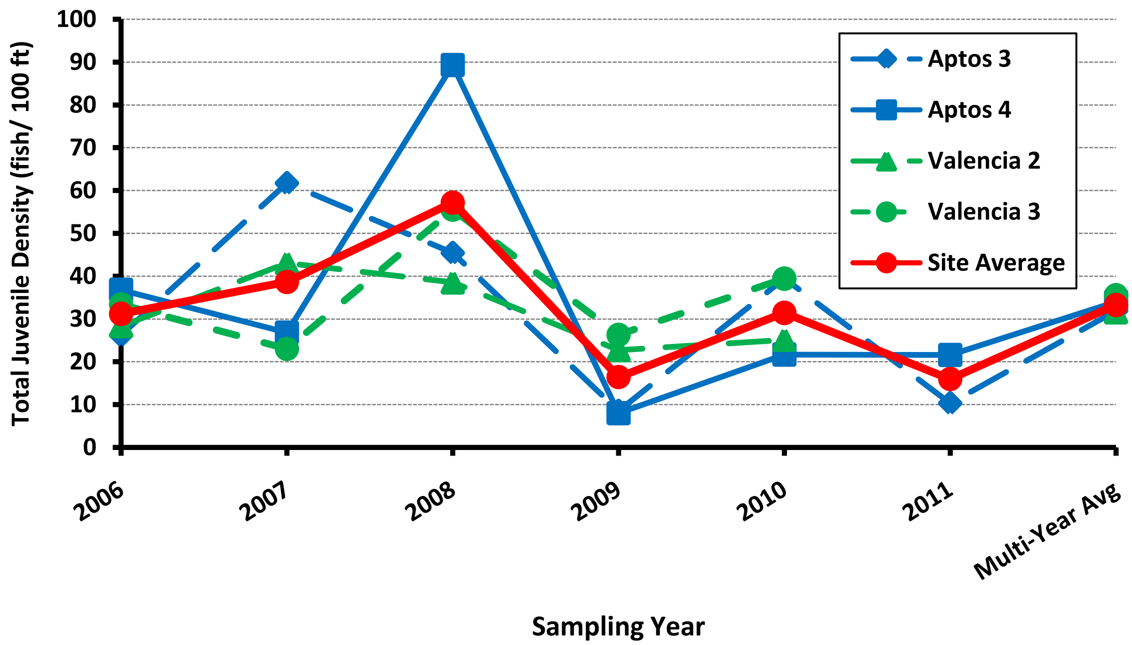
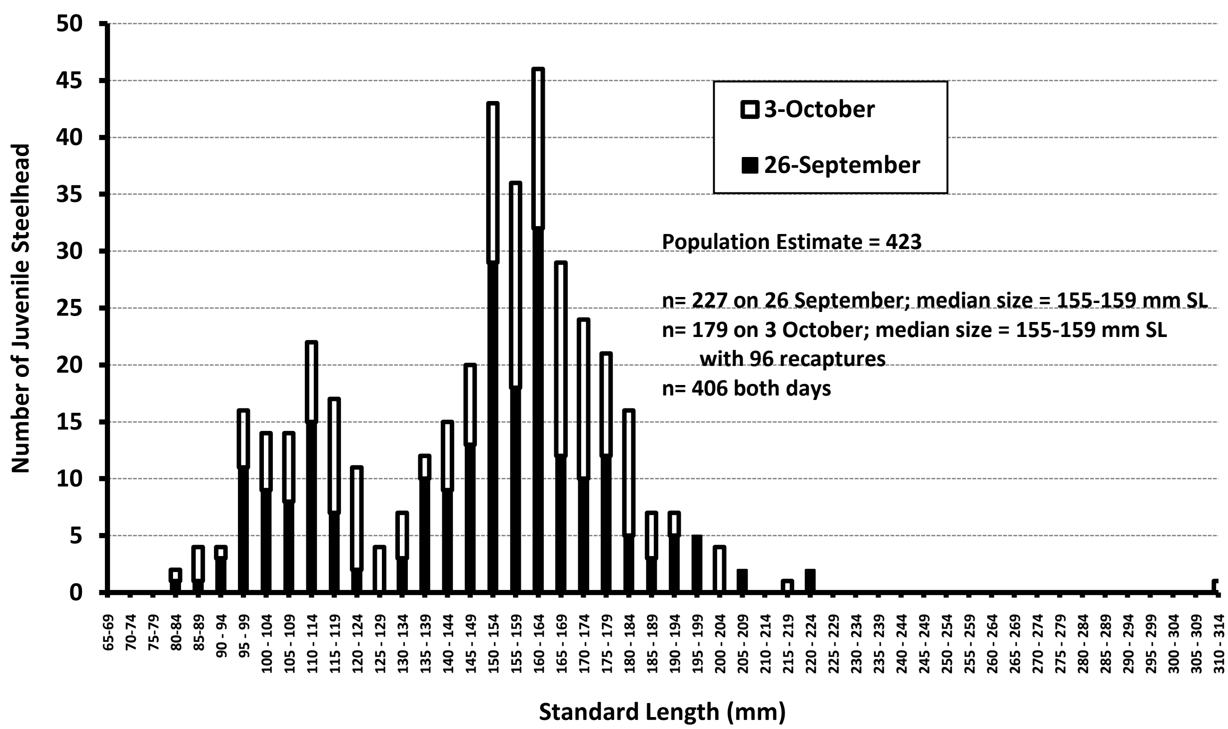
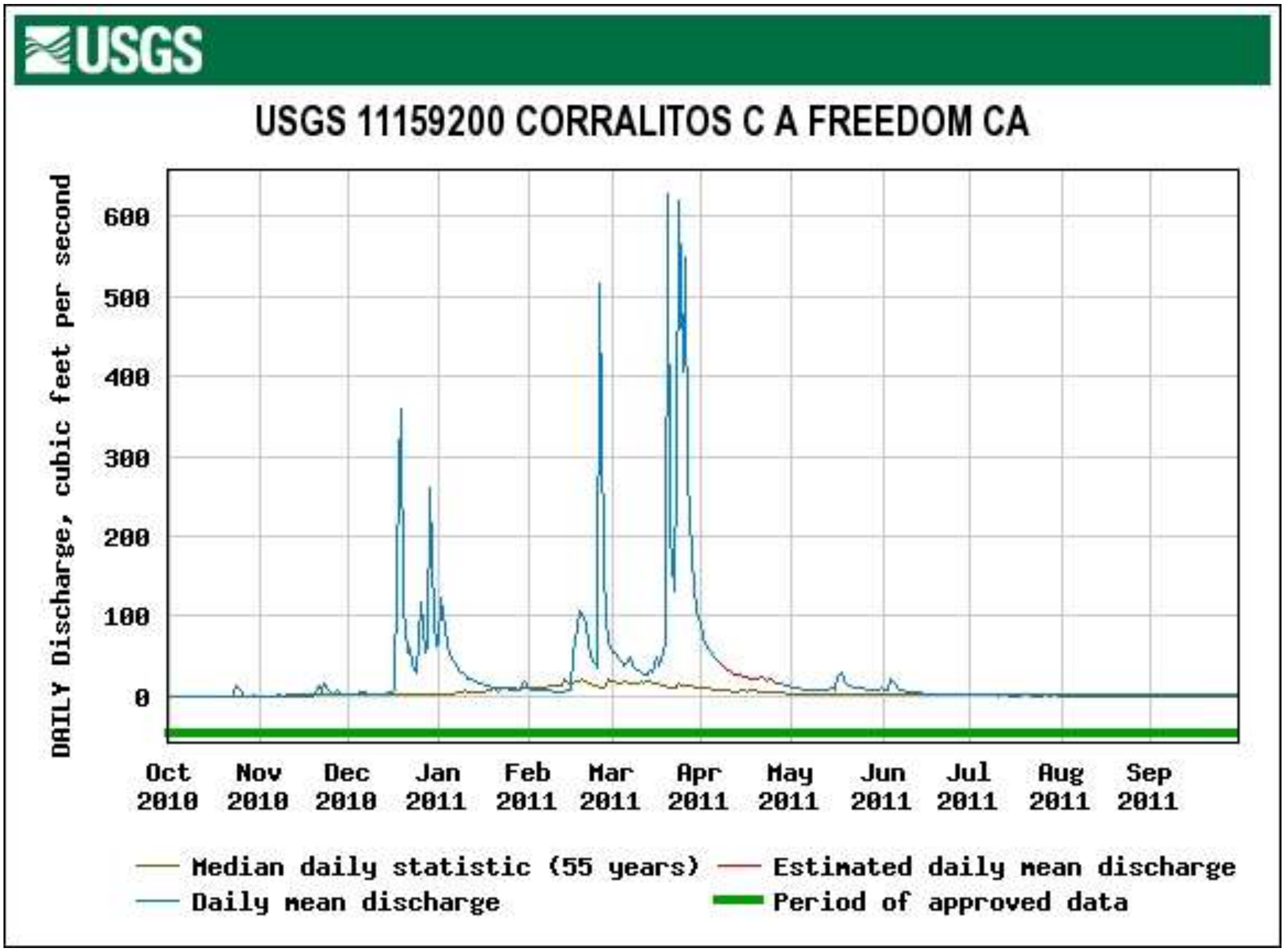


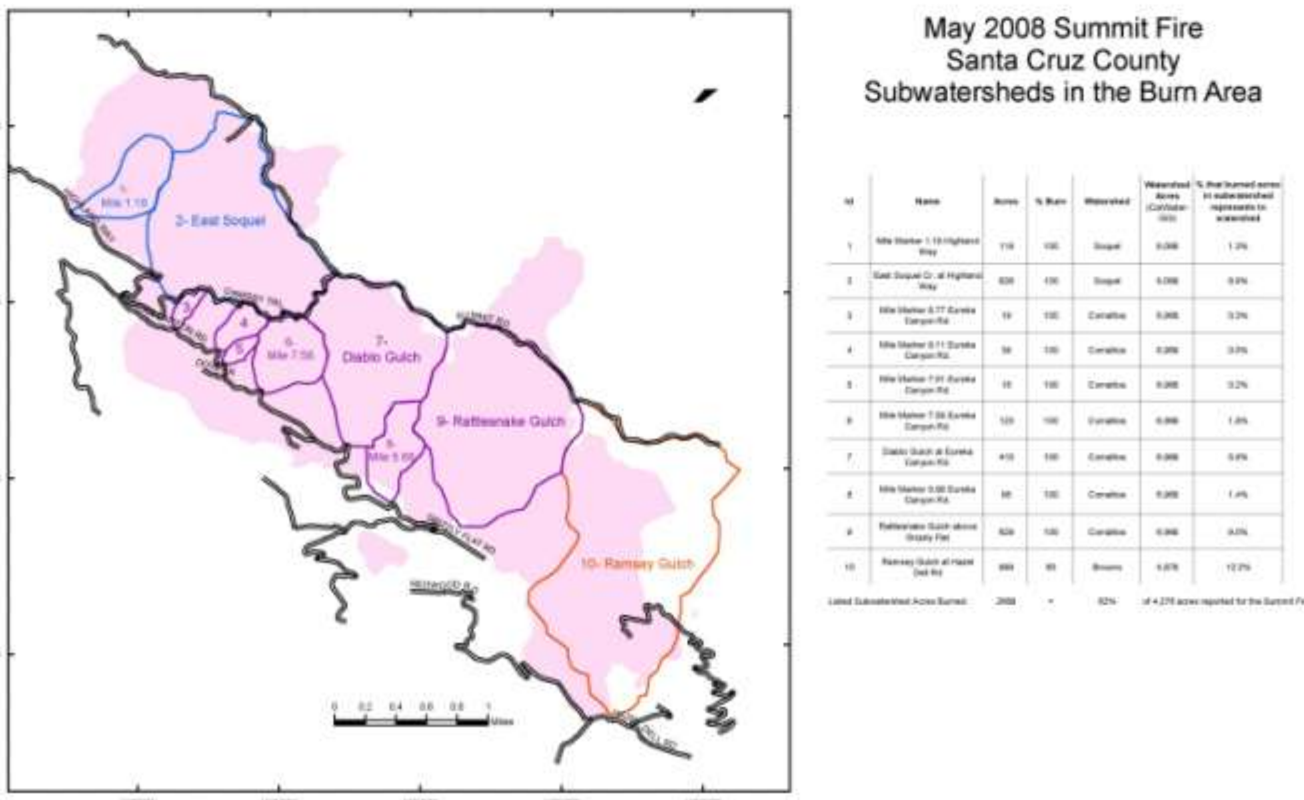
Figure B-43. Size Frequency Histogram of Juvenile Steelhead Captured on 26 September and 3 October 2011 in Aptos Lagoon/Estuary.



__v. Steelhead Abundance in the Corralitos Creek Sub-Watershed__

1. **Habitat conditions** at all Corralitos/Shingle Mill/Browns reaches/sites improved in 2011 (increased baseflow throughout (**Hydrograph** below), similar or increased pool depth except at Corralitos Site 1, less fine sediment and similar embeddedness in compared reaches and generally similar or improved escape cover). Three reaches in Corralitos Creek had segments habitat typed after sedimentation was detected in 2010, the first wet winter after the summit fire of 2008 (**map below**), which brought pool shallowing and loss of escape cover. Results indicated that pool depth had recovered in reaches upstream of the Corralitos diversion dam to 2009 levels and had less fine sediment, with increased depths in the middle Corralitos 5/6 segment (**Table B-16c** above and ***Tables 16a-b*** *in Appendix B*).





2. ***Size Class II and III abundance*** was below the long term average at 6 of 8 sites but higher than in 2010 at all sites except Corralitos 1 (statistically significant) (***Table 35*** *in Appendix B*, **Tables S-2 and S-3** below and **Figures B-16 and B-31** below). This resulted from below average yearling and YOY densities, though a high percentage of YOY grew into Size Class II (**Figure B-20** below). The 2 Corralitos sites below Shingle Mill Gulch had smolt ratings of "Good" and the lower Shingle Mill 1 site's rating was "Below Average." The remaining sites had "Fair" ratings.

3. ***Yearling abundance*** was below average (7 of 8 sites with the upper Shingle Mill 3 site having above average densities) (**Figure B-15** below) but higher than in 2010 at 7 of 8 sites (statistically significant for the sub-watershed and Corralitos sites only) (***Tables 33, 42 and 43*** *in Appendix B*). The decline was likely caused by poor overwinter survival in the face of high spring stormflow, generally low YOY recruitment from 2010 and early spring emigration of fast growing yearlings (**Corralitos Hydrographs** above; ***Table 32*** *in Appendix B*).

4. As in other watersheds ***YOY abundance*** was below average at 6 of 8 sites (except Shingle Mill 1 and Browns 1) but greater than in 2010 at 7 of 8 sites (almost statistically significant) (***Tables 32 and 42*** *in Appendix B* and **Figure B-14** below). Low YOY densities were consistent with large, late winter storms that destroyed redds and small YOY, followed by insufficient adult spawners to saturate habitat with eggs and new YOY. Abundance was greater than in 2010 likely because eggs survived better after large spring storms with less sedimentation in 2011.

5. With below average YOY and yearling abundance, ***total juvenile abundance*** was below average at Corralitos sites and close to average at the other sites (except at upper Shingle Mill 3), and higher than 2010 at 7 of 8 sites (excepting Shingle Mill Site and 3) (statistically significant) (***Tables 31 and 42*** *in Appendix B* and **Figures B-13 and B29** below).

6. With regard to adult steelhead passage above the Corralitos Creek diversion dam between Corralitos Sites 1 and 3, passage conditions should have been good in 2011 as in 2010 with higher winter stormflows than 2009 (**Hydrographs** above). Though YOY densities were below average at 3 of 4 sites above the dam in 2011, they did increase in Corralitos Creek at the upper 2 sites. This indicated that adult steelhead successfully spawned upstream of the dam (***Table 32*** *in Appendix B* and **Figure B-14** above).

Figure B-16. Size Class II and III Steelhead Site Densities in Corralitos, Shingle Mill and Browns Creeks in 2011, with an 8-Year Average (1981; 1994; 2006-2011).

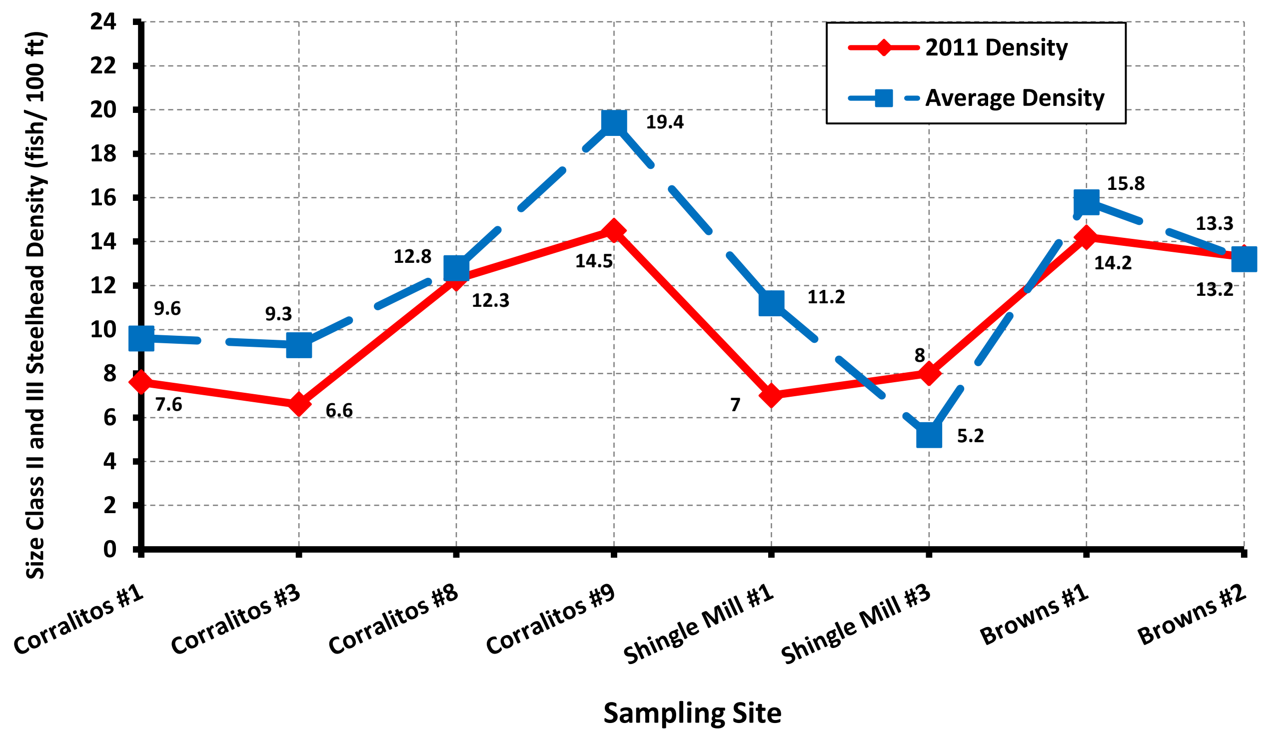


Figure B-31. Trend by Site in Size Class II/III Steelhead Density at Corralitos, Shingle Mill and Browns Creek Sites, 2006-2011.

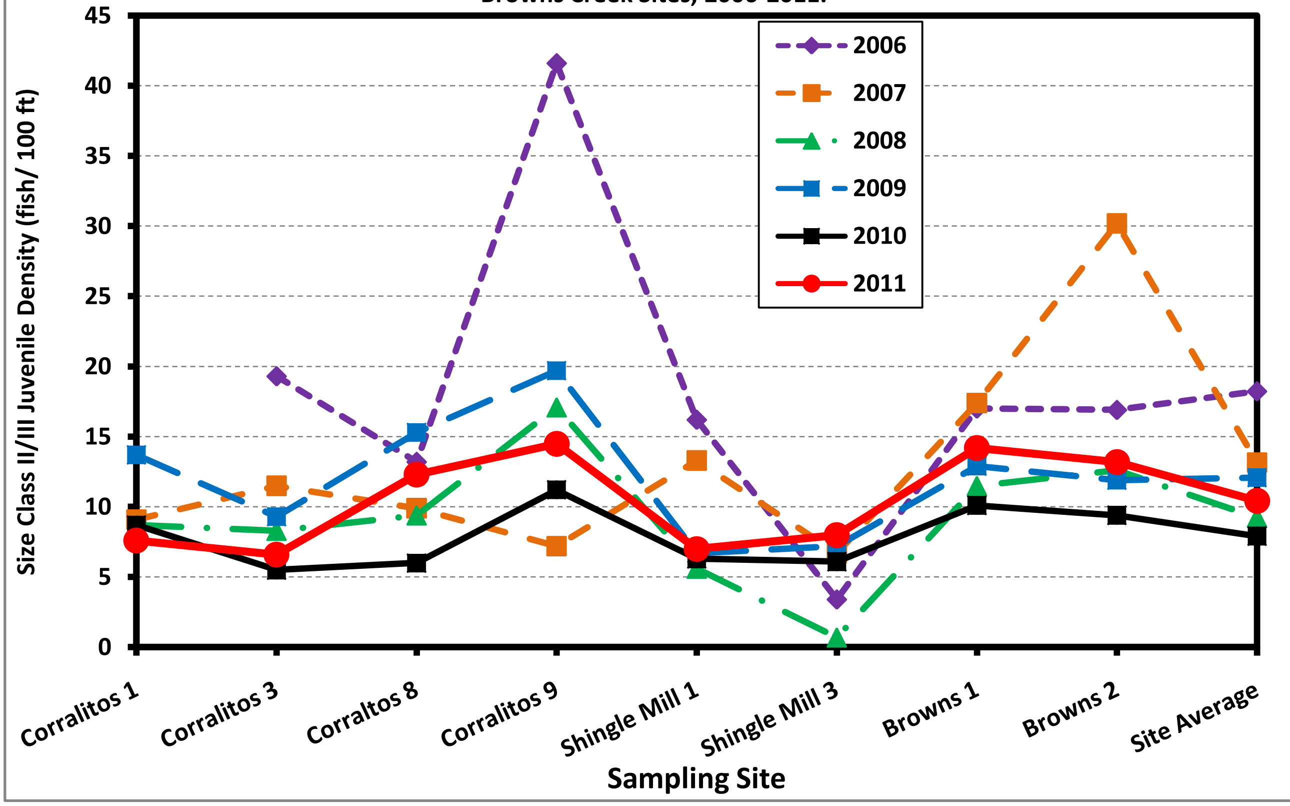


Table S-2. 2011 Sampling Sites Rated by Potential Smolt-Sized Juvenile Density (=>75 mm SL) and Average Smolt Size, with Physical Habitat Change since 2009/2010. (Red denotes ratings of 1 and 2 or negative habitat change; italicized purple denotes ratings of 5 and 6. Methods for habitat change in M-6 of Appendix B.)

Site	Multi-Year Avg. Potential Smolt Density Per 100 ft (Years of data)	2011 Potential Smolt Density (per 100 ft)/ Avg Smolt Size (mm)	2011 Smolt Numeric Rating	Symbolic Rating (1 to 7)	Physical Habitat Change by Reach or Site Since 2009/2010
Low. San Lorenzo #0a	7.4 (n=3)	2.1/ 124 mm	3	***	Site Positive
Low. San Lorenzo #1	10.2 (n=11)	2.6/ 148 mm	3	***	Site Positive
Low. San Lorenzo #2	***17.1 (n=10)***	11.2/ 142 mm	*5*	*****	Reach Positive
Low. San Lorenzo #4	16.0 (n=11)	3.7/ 103 mm	3	***	Site Positive
Mid. San Lorenzo #6	**4.6 (n=14)**	**5.3/ 85 mm**	**2**	**	Site Positive
Mid. San Lorenzo #8	**6.8 (n=14)**	**3.4/ 82 mm**	**1**	*	Site Positive
Up. San Lorenzo #11	**6.8 (n=14)**	**7.9/ 84 mm**	**2**	**	**Site Negative**
Zayante #13a	10.8 (n=13)	4.8/ 116 mm	4	****	Site Positive
Zayante #13c	***14.1 (n=13)***	***29.2/ 95 mm***	*5*	*****	Reach Positive
Zayante #13d	**16.1 (n=13)**	11.7/ 97 mm	4	****	Reach Positive
Lompico #13e	7.5 (n=6)	7.8/ 95 mm	3	***	Site Positive
Bean #14b	12.8 (n=14)	7.4/ 127 mm	4	****	Reach Positive
Bean #14c	***11.0 (n=11)***	***8.8/ 104 mm***	*5*	*****	Reach Positive
Fall #15	***14.7 (n=9)***	***14.7/ 115 mm***	*5*	*****	Reach Positive
Newell #16	14.8 (n=8)	13.1/ 99 mm	4	****	**Reach Negative**
Boulder #17a	12.2 (n=14)	10.6/ 101 mm	4	****	Site Positive
Boulder #17b	***10.7 (n=14)***	***13.6/ 106 mm***	*5*	*****	**Site Negative**
Bear #18a	11.5 (n=14)	9.4/ 98 mm	4	****	Site Positive
Branciforte #21a-2	9.5 (n=11)	13.6/ 100 mm	4	****	**Reach Negative**
Soquel #1	4.1 (n=14)	2.7/ 135 mm	3	***	Site Positive
Soquel #4	9.4 (n=15)	5.3/ 118 mm	4	****	Reach Positive
Soquel #10	8.8 (n=15)	5.8/ 107 mm	4	****	Site Positive
Soquel #12	8.1 (n=14)	5.6/ 109 mm	4	****	Reach Positive
E. Branch Soquel #13a	***10.8 (n=15)***	***10.1/ 112 mm***	*5*	*****	Reach Positive
E. Branch Soquel #16	10.3 (n=15)	15.4/ 100 mm	4	****	Reach Positive
W. Branch Soquel #19	6.8 (n=11)	16.9/ 95 mm	4	****	Site Positive
W. Branch Soquel #21	11.1 (n=10)	12.4/ 97 mm	4	****	Site Positive
Aptos #3	10.9 (n=7)	7.1/ 101 mm	3	***	**Site Negative**
Aptos #4	***10.5 (n=7)***	***16.7/ 104 mm***	*4*	******	Reach Positive
Valencia #2	11.7 (n=6)	–	–	–	–
Valencia #3	14.1 (n=6)	–	–	–	–
Corralitos #1	9.6 (n=5)	7.6/ 100 mm	4	****	Site Positive
Corralitos #3	9.3 (n=8)	6.6/ 123 mm	4	****	Reach Positive
Corralitos #8	***12.8 (n=8)***	***12.3/ 109 mm***	*5*	*****	Reach Positive
Corralitos #9	***19.4 (n=8)***	***14.5/ 104 mm***	*5*	*****	Reach Positive
Shingle Mill #1	11.2 (n=8)	7.0/ 100 mm	3	***	Site Positive
Shingle Mill #3	5.2 (n=8)	8.0/ 98 mm	4	****	Site Positive
Browns Valley #1	15.8 (n=8)	14.2/ 100 mm	4	****	Site Positive
Browns Valley #2	13.2 (n=8)	13.3/ 101 mm	4	****	Site Positive

Table S-3. 2011 Sampling Sites Rated by Potential Smolt-Sized Juvenile Density (=>75 mm SL) and Their Average Size in Standard Length, with Physical Habitat Change from 2010 Conditions.
(Red denotes ratings of 1−3 and negative habitat change and italicized purple denotes ratings of 5−7. Methods for habitat change in M-6 of Appendix B.)

Site	2010 Potential Smolt Density (per 100 ft)/ Avg Smolt Size SL (mm)	2010 Smolt Rating (With Size Factored In)	2011 Potential Smolt Density (per 100 ft)/ Avg Smolt Size SL (mm)	2011 Smolt Rating (With Size Factored In)	Physical Habitat Change by Reach/Site Since 2010
Low. San Lorenzo #0a	19.8/ 106 mm	*Very Good*	2.1/ 124 mm	**Below Average**	+
Low. San Lorenzo #1	15.3/ 98 mm	Fair	2.6/ 148 mm	**Below Average**	+
Low. San Lorenzo #2	22.4/ 91 mm	*Good*	11.2/ 142 mm	*Good*	+
Low. San Lorenzo #4	12.6/ 87 mm	**Below Average**	3.7/ 103 mm	**Below Average**	+
Mid. San Lorenzo #6	6.1/ 80 mm	**Poor**	5.3/ 85 mm	**Poor**	+
Mid. San Lorenzo #8	8.2/ 88 mm	**Below Average**	3.4/ 82 mm	**Very Poor**	+
Up. San Lorenzo #11	4.7/ 93 mm	**Below Average**	7.9/ 84 mm	**Poor**	−
Zayante #13a	18.8/ 89 mm	Fair	4.8/ 116 mm	Fair	+
Zayante #13c	24.5/ 90 mm	*Good*	29.2/ 95 mm	*Good*	+
Zayante #13d	9.1/ 101 mm	Fair	11.7/ 97 mm	Fair	+
Lompico #13e	8.7/ 96 mm	Fair	7.8/ 95 mm	**Below Average**	+
Bean #14b	8.4/ 87 mm	**Below Average**	7.4/ 127 mm	Fair	+
Bean #14c	6.7/ 99 mm	**Below Average**	8.8/ 104 mm	*Good*	+
Fall #15	14.3/ 118 mm	*Good*	14.7/ 115 mm	*Good*	+
Newell #16	24.7/ 86 mm	Fair	13.1/ 99 mm	Fair	−
Boulder #17a	11.8/ 89 mm	Fair	10.6/ 101 mm	Fair	+
Boulder #17b	12.7/ 90 mm	Fair	13.6/ 106 mm	*Good*	−
Bear #18a	9.5/ 99 mm	Fair	9.4/ 98 mm	Fair	+
Branciforte #21a-2	12.6/ 105 mm	*Good*	13.6/ 100 mm	Fair	−
Soquel #1	7.9/ 108 mm	Fair	2.7/ 135 mm	**Below Average**	+
Soquel #4	4.9/ 98 mm	**Below Average**	5.3/ 118 mm	Fair	+
Soquel #10	14.0/ 96 mm	Fair	5.8/ 107 mm	Fair	+
Soquel #12	8.0/ 88 mm	**Below Average**	5.6/ 109 mm	Fair	+
East Branch Soquel #13a	32.8/ 88 mm	*Good*	10.1/ 112 mm	*Good*	+
East Branch Soquel #16	8.0/ 106 mm	*Good*	15.4/ 100 mm	Fair	+
West Branch Soquel #19	11.6/ 93 mm	Fair	16.9/ 95 mm	Fair	+
West Branch Soquel #21	17.5/ 99 mm	*Good*	12.4/ 97 mm	Fair	+
Aptos #3	17.2/ 90 mm	*Good*	7.1/ 101 mm	**Below Average**	−
Aptos #4	9.7/ 96 mm	Fair	16.7/ 104 mm	*Very Good*	**Similar**
Valencia #2	8.7/ 100 mm	Fair	−	−	**NA**
Valencia #3	14.8/ 105 mm	*Good*	−	−	**NA**
Corralitos #1	8.7/ 99 mm	Fair	7.6/ 100 mm	Fair	+
Corralitos #3	5.5/ 116 mm	Fair	6.6/ 123 mm	Fair	+
Corralitos #8	6.0/ 90 mm	**Below Average**	12.3/ 109 mm	*Good*	+
Corralitos #9	11.2/ 104 mm	*Good*	14.5/ 104 mm	*Good*	+
Shingle Mill #1	6.3/ 104 mm	Fair	7.0/ 100 mm	**Below Average**	+
Shingle Mill #3	6.1/ 99 mm	**Below Average**	8.0/ 98 mm	Fair	+
Browns #1	10.1/ 103 mm	*Good*	14.2/ 100 mm	Fair	+
Browns #2	9.4/ 104 mm	*Good*	13.3/ 101 mm	Fair	+

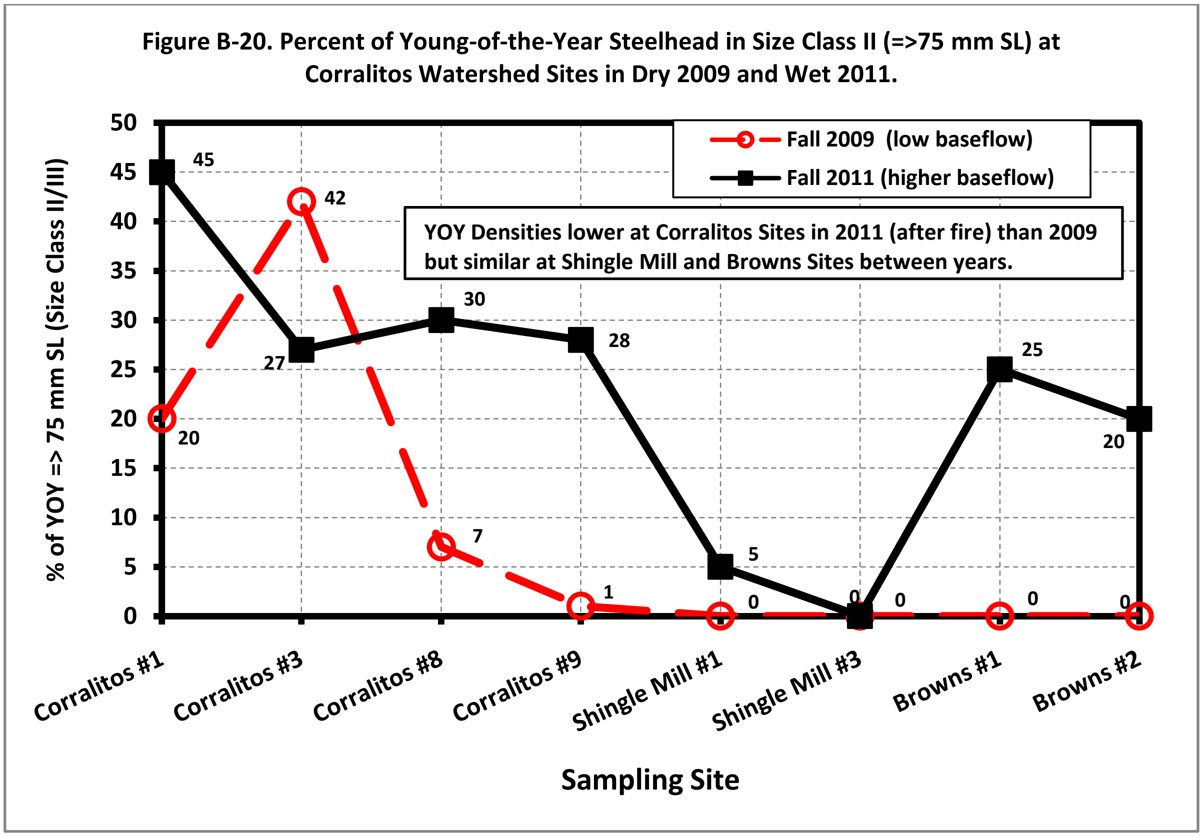


Figure B-20. Percent of Young-of-the-Year Steelhead in Size Class II (=>75 mm SL) at Corralitos Watershed Sites in Dry 2009 and Wet 2011.
Fall 2009 (low baseflow)
Fall 2011 (higher baseflow)
YOY Densities lower at Corralitos Sites in 2011 (after fire) than 2009 but similar at Shingle Mill and Browns Sites between years.
% of YOY => 75 mm SL (Size Class II/III)
50
45
40
35
30
25
20
15
10
5
0
45
42
27
30
28
20
7
1
5
0
0
0
25
0
20
0
Corralitos #1
Corralitos #3
Corralitos #8
Corralitos #9
Shingle Mill #1
Shingle Mill #3
Browns #1
Browns #2
Sampling Site

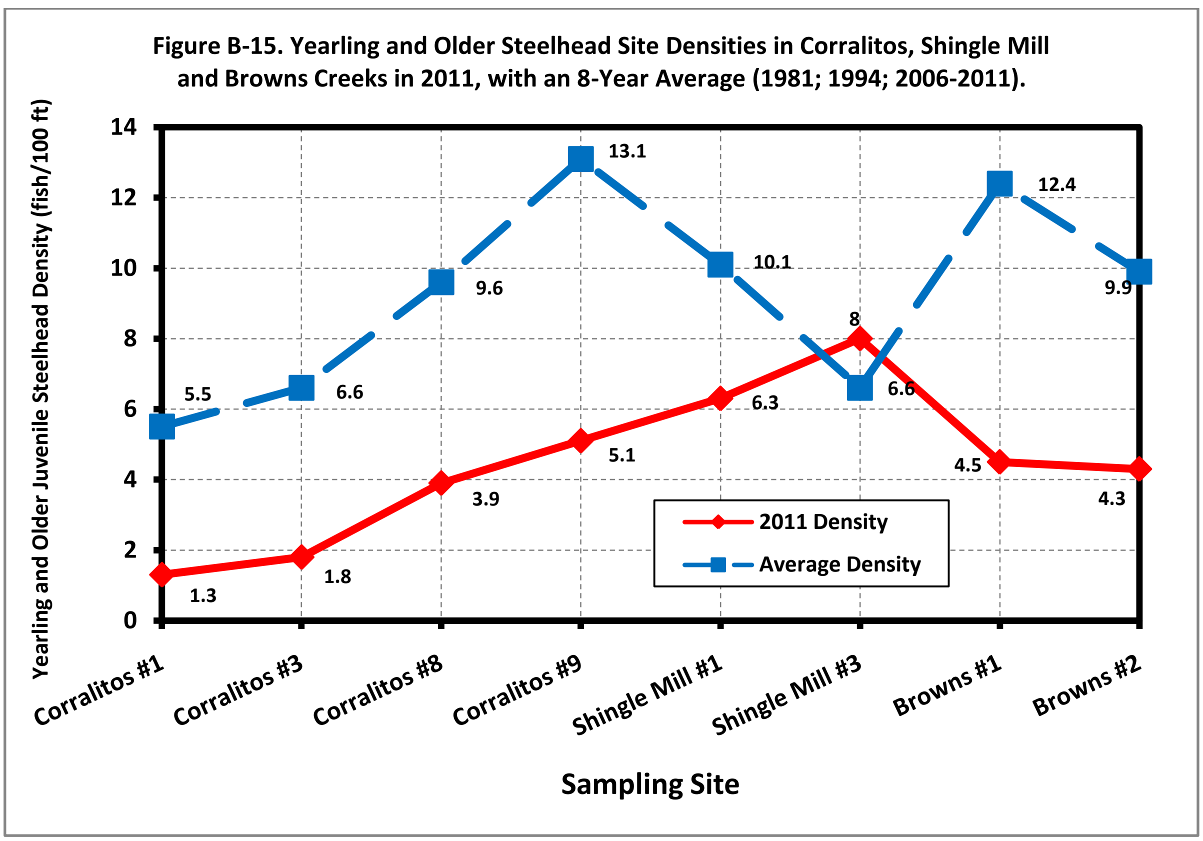


Figure B-15. Yearling and Older Steelhead Site Densities in Corralitos, Shingle Mill and Browns Creeks in 2011, with an 8-Year Average (1981; 1994; 2006-2011).
Yearling and Older Juvenile Steelhead Density (fish/100 ft)
14
12
10
8
6
4
2
0
13.1
12.4
10.1
9.6
9.9
8
5.5
6.6
6.6
6.3
5.1
4.5
4.3
3.9
1.8
1.3
2011 Density
Average Density
Corralitos #1
Corralitos #3
Corralitos #8
Corralitos #9
Shingle Mill #1
Shingle Mill #3
Browns #1
Browns #2
Sampling Site

Figure B-14. Young-of-the-Year Steelhead Site Densities in Corralitos, Shinglemill and Browns Creeks in 2011, with an 8-Year Average (1981; 1994; 2006-2011).

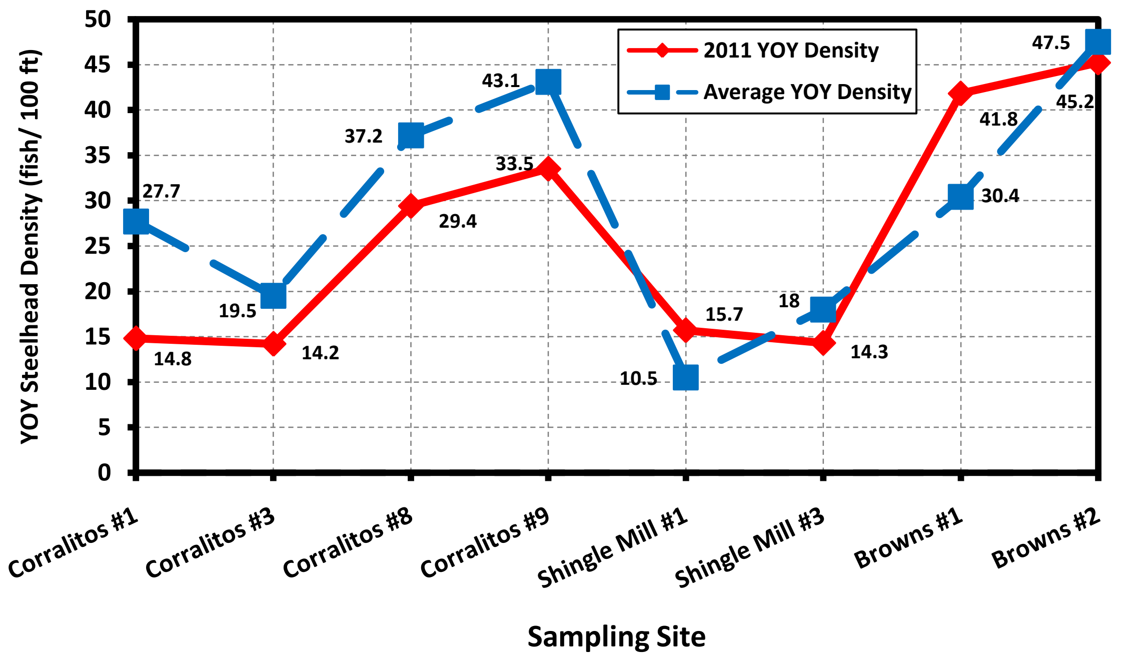
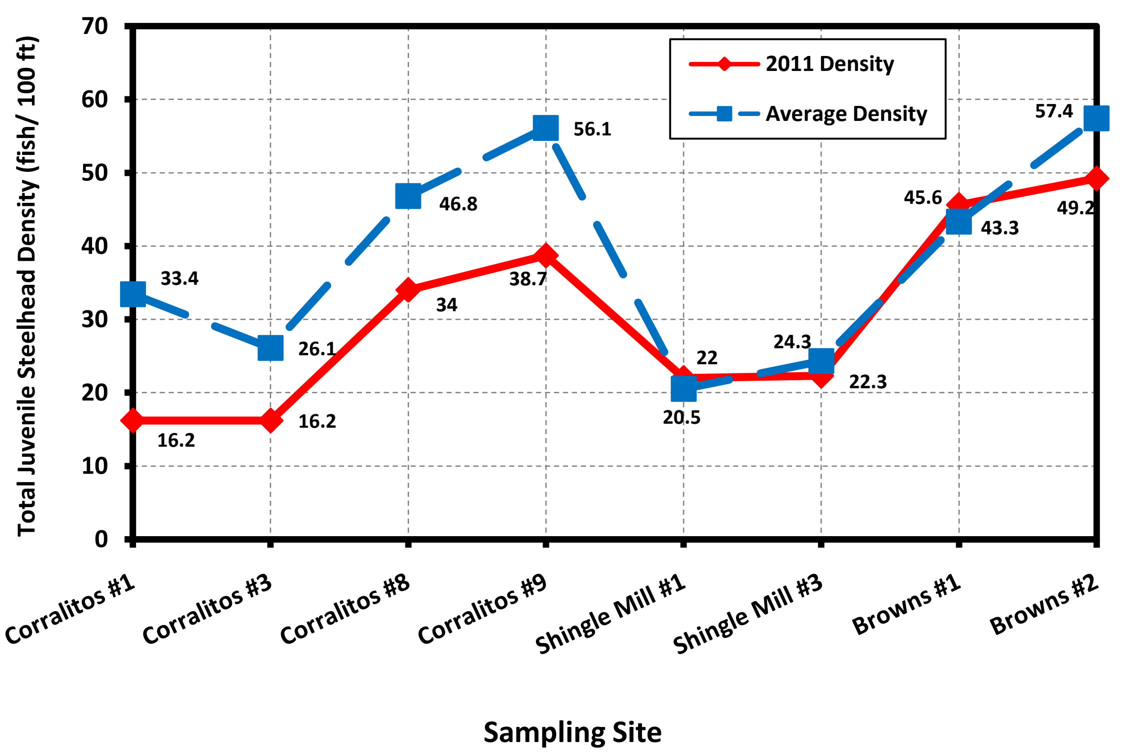
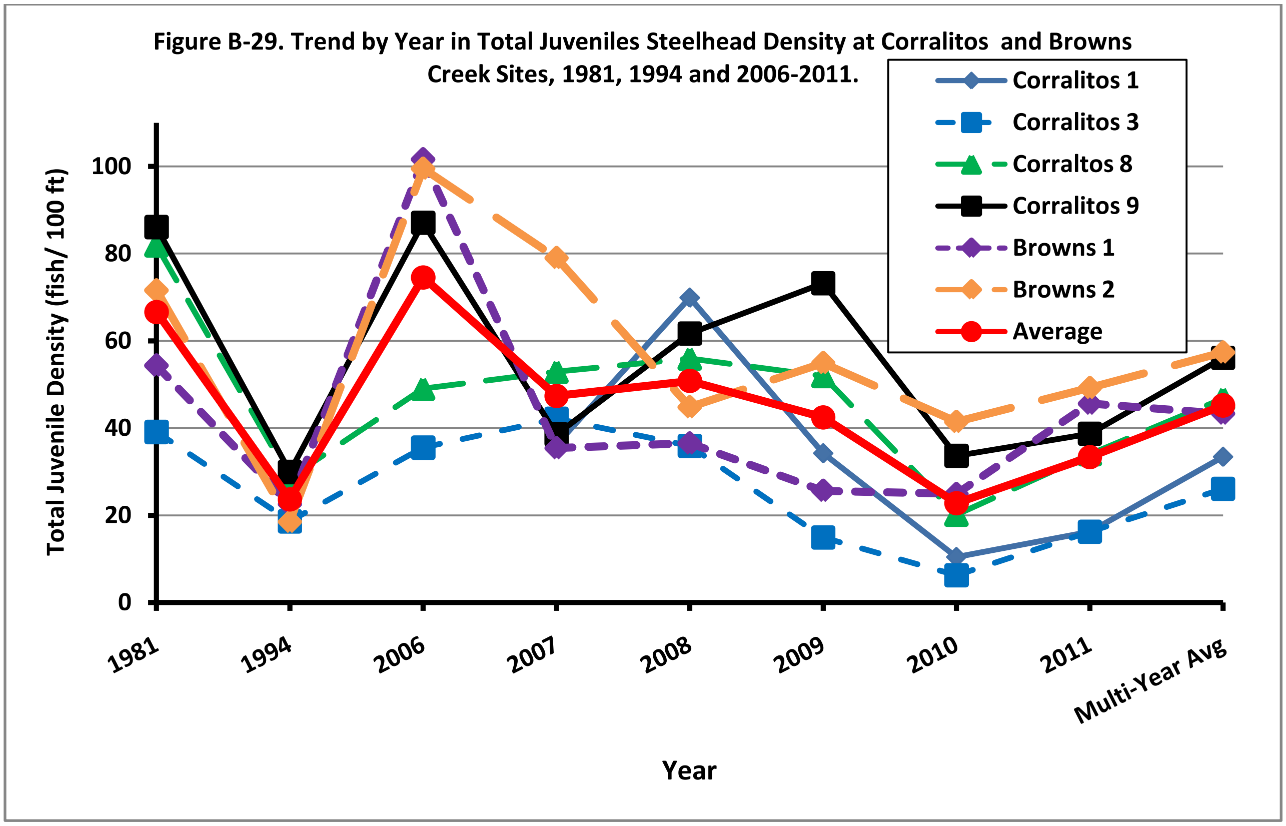


Figure B-13. Total Juvenile Steelhead Site Densities in Corralitos, Shingle Mill and Browns Creeks in 2011, with an 8-Year Average (1981; 1994; 2006-2011).





E. MANAGEMENT RECOMMENDATIONS

1. Retain more large, instream wood throughout all four watersheds under study. More instream wood will promote scour, deepen pools, create patches of coarser spawning gravel and provide escape cover for juvenile steelhead rearing and overwinter yearling survival. The goal is to increase steelhead spawning success and juvenile production to at least the level seen in the late 1990's.

2. Retain more winter storm runoff in Scotts Valley and Felton to reduce stormflow flashiness that causes streambank erosion and sedimentation, leading to poor spawning and rearing conditions in the mainstem. Better storm runoff retention will also increase winter recharge of aquifers to increase spring and summer baseflow, which will increase YOY steelhead growth into Size Classes II and III in the lower mainstem.

3. Support efforts to capture high winter stormflows in the San Lorenzo River for conjunctive use with the Soquel Creek Water District to rest the Soquel Creek groundwater aquifer and to recharge the Santa Margarita aquifer in the San Lorenzo watershed. The goal is to increase spring/summer baseflow steelhead growth rate and densities of soon-to-smolt sized juveniles in both watersheds.

4. After the sandbar forms in the summer at the San Lorenzo rivermouth, artificial breaching should be avoided to prevent saltwater from entering and being trapped in the lagoon. Individuals who artificially breach the sandbar should be prosecuted.

5. Once the sandbar forms at the San Lorenzo rivermouth, provide enough stream inflow to convert the lagoon to freshwater. Reduced inflow can maintain the lagoon afterwards. A freshwater lagoon will potentially produce thousands of soon-to-smolt sized juvenile steelhead.

6. Along Bean Creek, perform educational outreach and better water conservation and winter storage (reduce summer well pumping). The goal is to maintain surface streamflow in the heavily used steelhead reach above MacKenzie Creek confluence, which was lost in 2007–2009. This reach was also used by coho salmon in 2005.

7. In Fall Creek, notch the fallen old-growth Douglas fir across the channel to improve adult passage.

8. In Fall Creek, seal the leakage under the concrete weirs at the San Lorenzo Valley Water District diversion structure. Reduce the jump heights through the first and last of 4 weirs and remove debris as needed to prevent blockage.

9. In Lompico Creek, improve adult steelhead passage at the fish ladder, in the bedrock section above the ladder and at the abandoned flashboard dam spillway between the ladder and the sampling site. YOY production widely fluctuates, indicating problems with adult passage and spawning success.

10. In Soquel Creek, develop better water management and conservation, with the goal of reducing spring and early summer water diversion/pumpage and maximize baseflow. With increased baseflows, growth rate and densities of soon-to-smolt sized juvenile steelhead will likely increase. Educational outreach to capture and store more winter rains should be directed to streamside landowners, agriculturalists and nurseries.

11. We recommended that Aptos Lagoon be closely monitored for unauthorized sandbar breaching, juvenile abundance and water quality. Individuals who illegally breach the sandbar in summer should be prosecuted.

12. Develop an Aptos Lagoon management plan which protects residential and commercial property, as well as the important fishery value of the lagoon with minimal sandbar manipulation.

13. In the Corralitos Creek watershed (especially in the Eureka Gulch sub-watershed), identify the sources of sedimentation stemming from the Summit Fire and institute erosion control and revegetation measures to reduce future sedimentation.

14. Carry out a study to examine the passability of the Pajaro drainage to out-migrant smolts and in-migrant adult steelhead to and from the Corralitos sub-watershed. If passability proves to be difficult in drier years, develop a program of well pumping, water diversion and aquifer recharge that is compatible with successful steelhead migration.

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APPENDIX A. WATERSHED MAPS.

Figure 1. Santa Cruz County Watersheds.

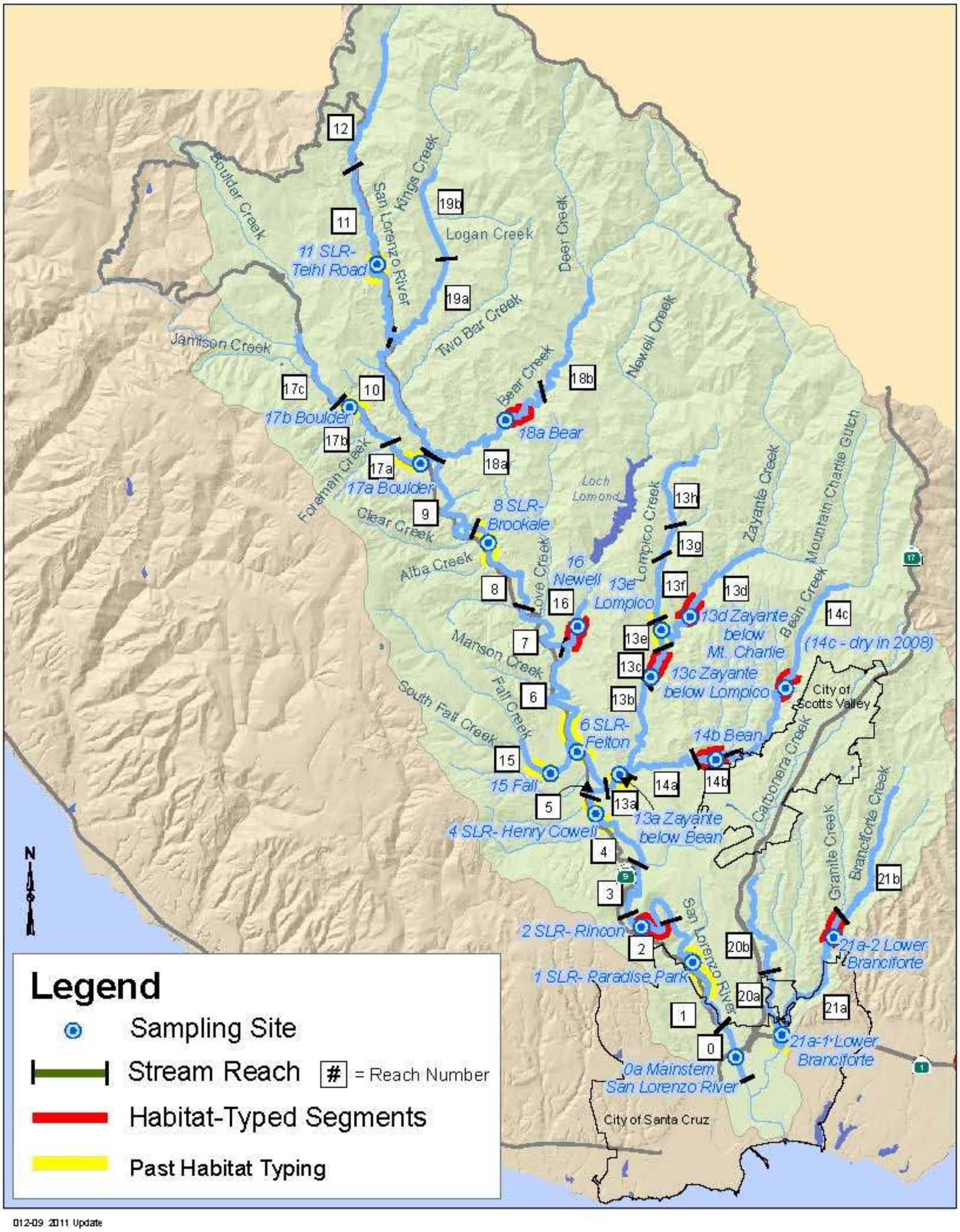

Figure 2. San Lorenzo River Watershed– Sampling Sites and Reaches.

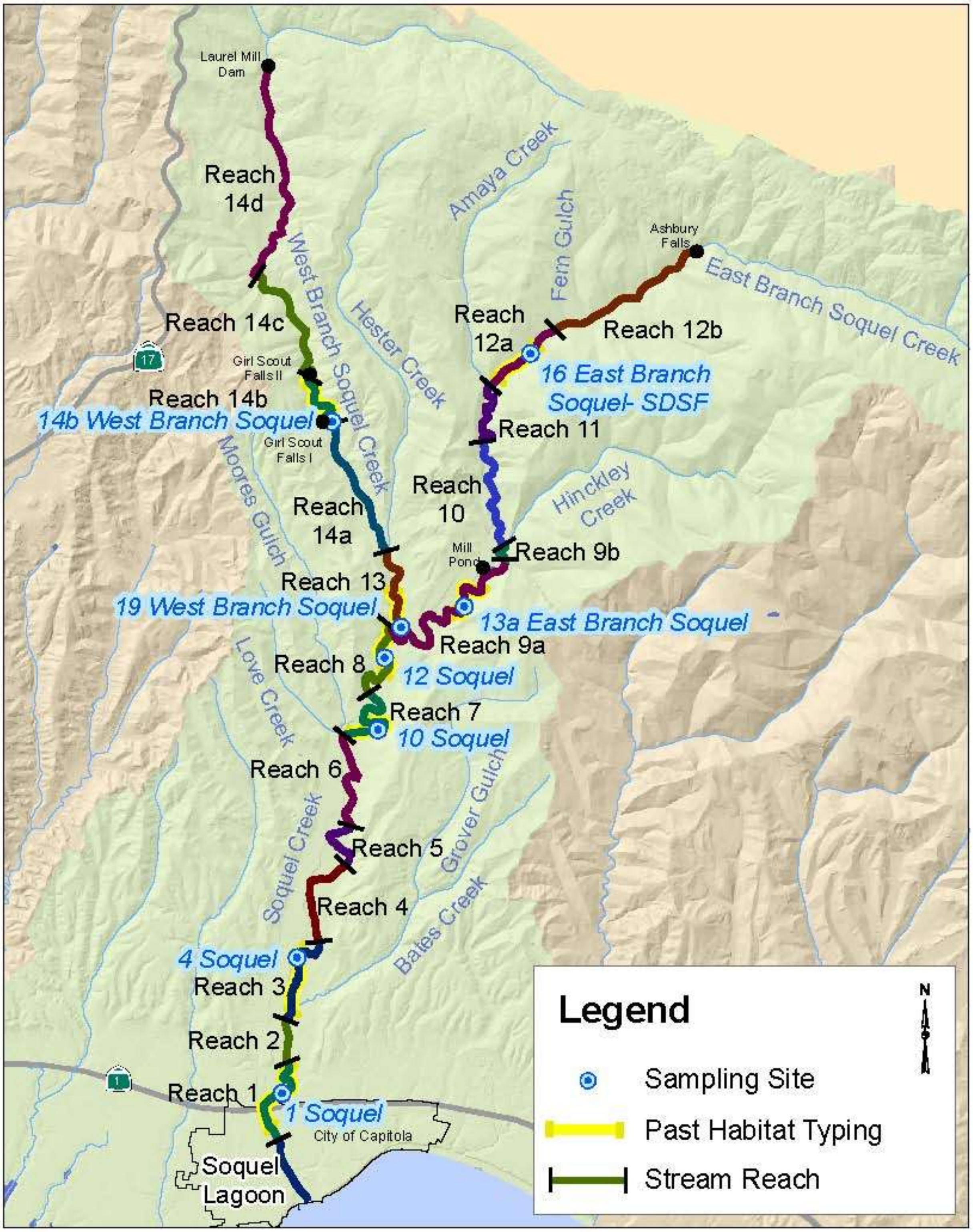

Figure 3. Soquel Creek Watershed.

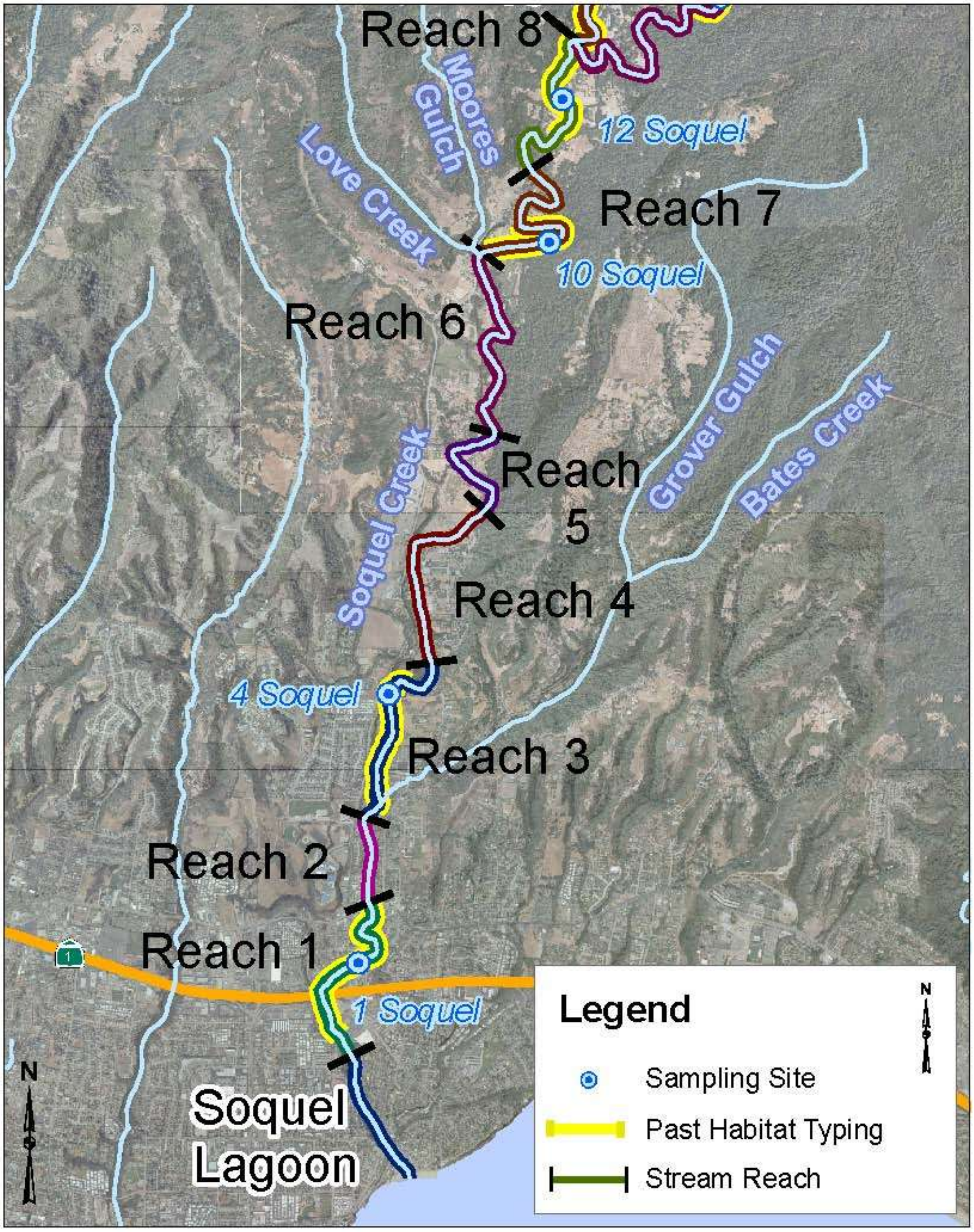

Figure 4. Lower Soquel Creek (Reaches 1–8 on Mainstem).

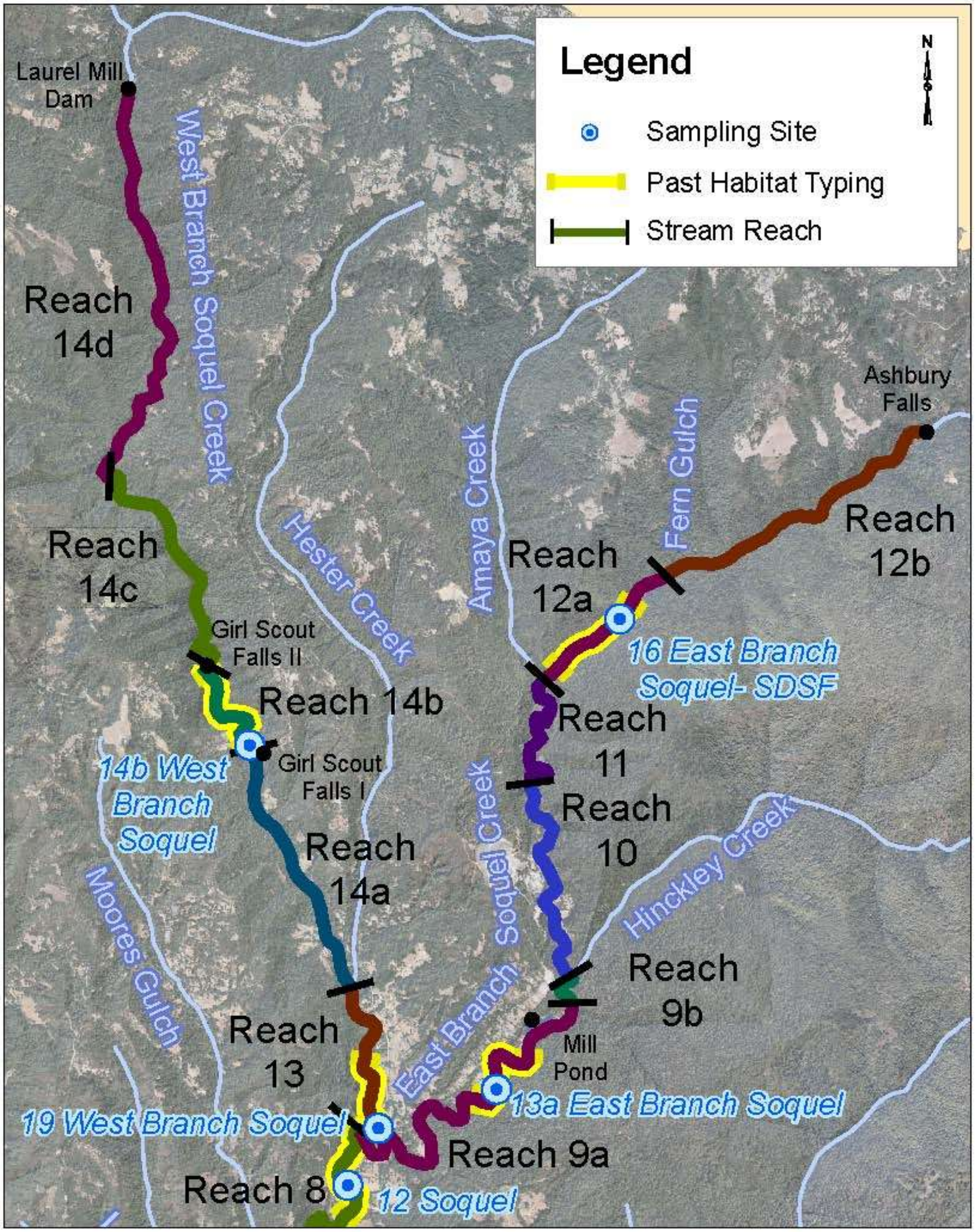

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Figure 5. Upper Soquel Creek Watershed (East and West Branches).

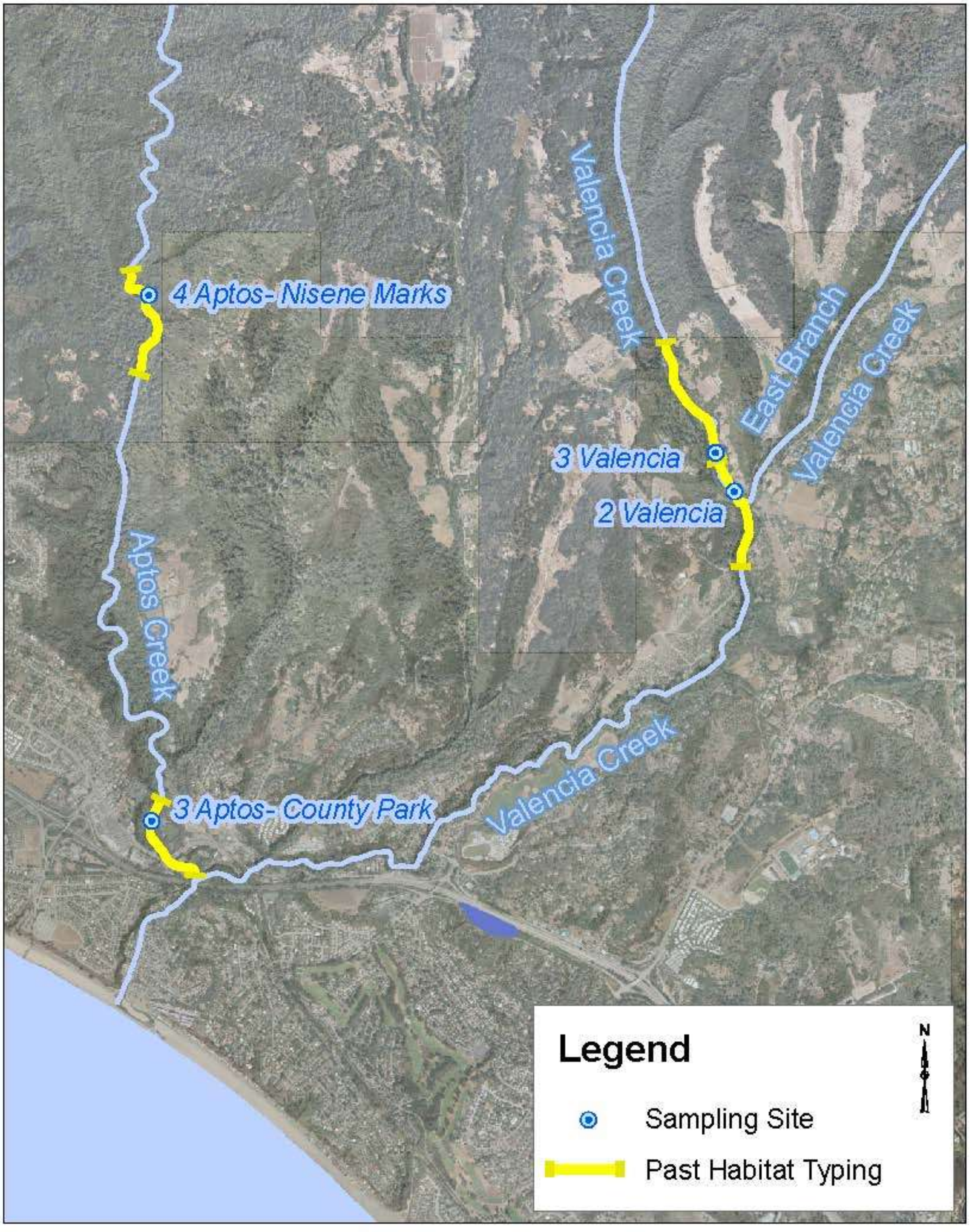

Figure 6. Aptos Creek Watershed.

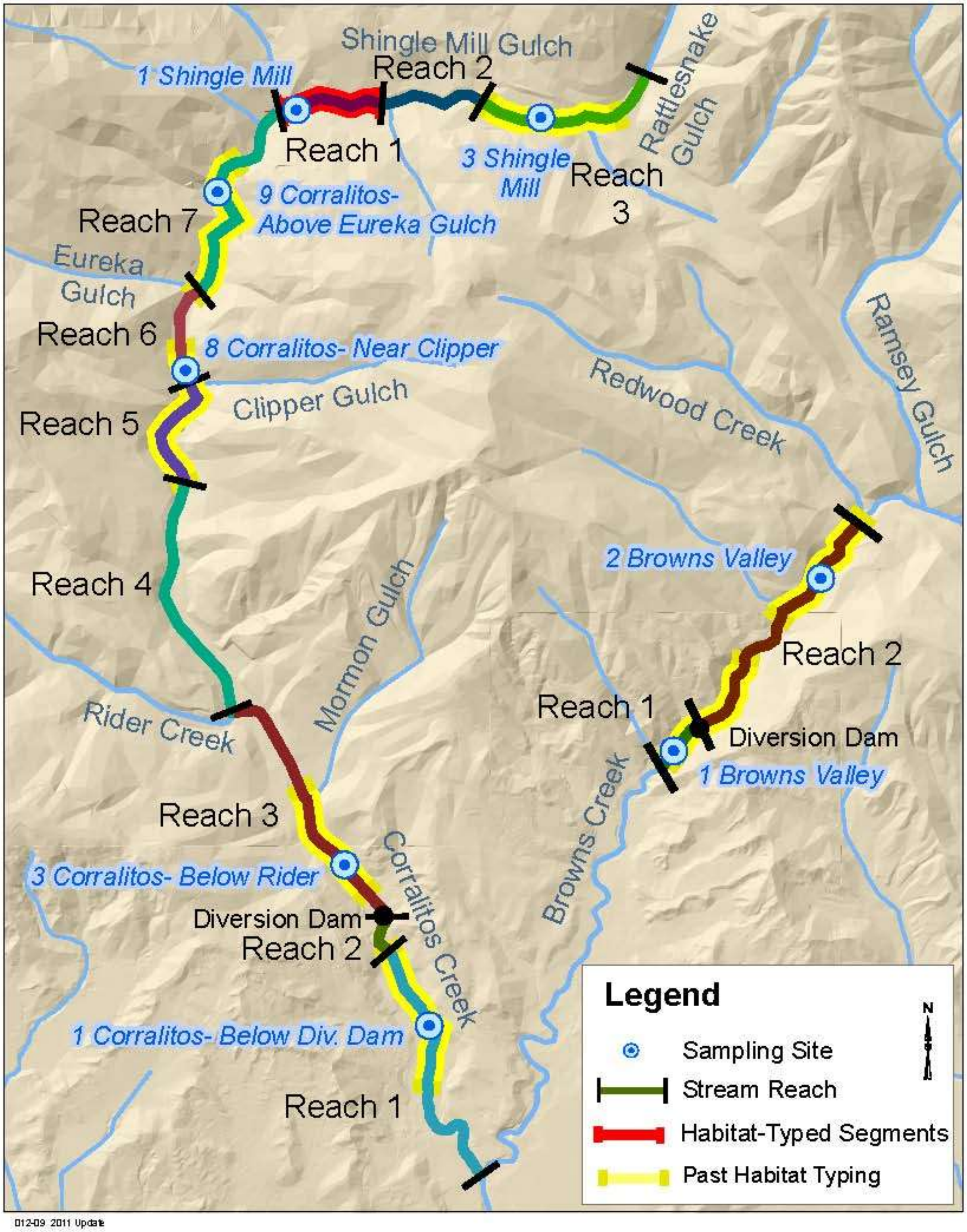

Figure 7. Upper Corralitos Creek Sub-Watershed of the Pajaro River Watershed.

APPENDIX B. DETAILED ANALYSIS OF 2011 STEELHEAD MONITORING IN THE SAN LORENZO, SOQUEL, APTOS AND CORRALITOS WATERSHEDS

(Provided electronically in a separate PDF file.)

APPENDIX C. SUMMARY OF 2011 CATCH DATA AT SAMPLING SITES.

(Provided electronically in the PDF file with the Detailed Analysis, Appendix B.)

APPENDIX D. HABITAT AND FISH SAMPLING DATA WITH SIZE HISTOGRAMS.

(Provided electronically in a separate PDF file.)

APPENDIX E. HYDROGRAPHS OF SAN LORENZO, SOQUEL AND CORRALITOS WATERSHEDS.

(Provided electronically in a separate PDF file.)