D.W. ALLEY & Associates aquatic biology

RIPARIAN CORRIDOR WOOD SURVEY IN THE SAN LORENZO WATERSHED, 2016

Fall Creek with Douglas Fir Across the Channel at the Beginning of Reach Segment 15b February 2016

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Scope of Work

Three half-mile stream segments previously habitat typed and sampled for steelhead were surveyed for wood in 2016. Half-mile segments were surveyed in the lower San Lorenzo mainstem Reach 2, upper Fall Creek Reach 15b and lower Boulder Creek Reach 17a (**Appendix A**). Live and dead wood, one foot and greater in diameter, was tallied according to size, location (low-flow channel, bankfull channel, perched riparian, additional riparian and upslope) and habitat function for salmonids (structure-forming for rearing and overwintering or extra). Results were compared to data collected from 6 segments in 2010 (**Alley 2011a**) and 3 segments each in 2011−2015 (**Alley 2012−2016**) and other Central Coast steelhead/coho streams in San Mateo County in 2002, using the same methodology developed by Smith and Leicester (**2005**).

Project Relevance

Instream wood has been identified as critically important in providing overwintering and rearing habitat for juvenile steelhead and coho salmon (**Alley et al. 2004; Alley 2016**). These wood surveys provide baseline information about the density of instream wood within monitored stream segments and document changes through time. This monitoring will allow us to track the natural recruitment of instream wood and detect any positive results of the County's Stream Wood Program and associated outreach and education to increase retention of instream wood. Wood densities can also be used to identify areas that would benefit from stream wood enhancement and will serve as a monitoring baseline for these projects. In 2016, a wood survey was performed in the mainstem of the San Lorenzo in Reach 2 where a split channel exists with considerable wood accumulation within the bankfull channel that could be secured to provide reliable overwinter cover for juvenile steelhead. Potential downstream liability issues must be considered when securing or anchoring wood in channels, in the event that this wood breaks free during large stormflows. Upper Fall Creek in Reach 15b was surveyed because it is within the state park where wood projects could be accomplished without concern for threat to adjacent private property. In this reach, instream wood provides the primary scour to create pool habitat where coho salmon were once detected (1981) and where instream wood is heavily relied upon for rearing habitat by yearling steelhead. Lower Boulder Creek in Reach 17a was surveyed to document the limited instream wood present in such a confined channel where pools are primarily bedrock-scoured. Instream wood must be firmly anchored in Reach 17a to remain as a structural component of steelhead habitat.

Methods

Each 1/2 –mile surveyed segment was divided into two 1,000-foot sub-segments and one 600-foot sub-segment. For all segments in 2016, two, 200-foot sites in each 1000-foot sub-segment and one 200-foot site in the furthest upstream 600 feet were selected in a stratified random manner and inventoried for live trees and dead wood, totaling 5 sites. Distance was measured with a hip chain. The beginning and ending points of each segment were located with a Garmin GPS unit. A Large Woody Debris (LWD) inventory form developed by Master's graduate student Michelle Leicester and Dr. Jerry Smith, fishery professor at San Jose State University was used (**Figure 1**). It was similar to the Flosi form in the 1998 California Salmonid Stream Habitat Restoration Manual. However, this data form provided more functional habitat information. Large wood pieces and standing trees (alive and dead) were inventoried according to 1-foot diameter size increments for pieces =>1 foot, length (6-20 feet and >20 feet), species and location (within stream bankfull channel and 75 feet beyond bankfull channel on left and right bank). Trees were measured with graduated staffs.

The bankfull channel (also called in-channel) was divided into the low flow channel (wood as structure forming/ enhancing or extra) and the remaining bankfull channel beyond the low-flow channel (wood as backwater forming/ enhancing or extra) (**Figure 2**). Wood that was part of jams was denoted. Old wood was denoted when bark was absent. The right and left banks were divided into perched riparian (standing within the channel or on the edge of the bankfull (active) channel and likely to be recruited at high flows), other riparian and upslope zones within 75 feet beyond the bankfull width. Distances were measured with a rangefinder. Wood was categorized as dead-down, dead-standing and live within the 75-foot riparian/upslope widths beyond the bankfull channel on either side of the creek. The boundary between riparian and upslope zones was based on distribution of typical riparian broadleaf species.

In addition, the amount of entrenchment was measured (ratio of the flood-prone width divided by the bankfull width). Widths were measured with a tape measure. The Width/Depth ratio was measured (ratio of the bankfull width divided by the average bankfull depth) with the stream gradient estimated from map contours. Depths were measured with a graduated stadia rod. Using these stream characteristics, each inventoried segment was classified into Rosgen channel types (**Rosgen 1996**). Upslope angles were measured with clinometers. All significant logjams found in each ½-mile segment was inventoried and located by GPS coordinates, when possible. Field tallies (piece/tree counts) were organized by 200-foot surveyed sites, and total piece counts were compiled and multiplied by a factor of 2.5 to represent 1,000 ft segments and added together to represent the entire reach. Densities of logs and trees/1,000 feet were grouped as conifer and hardwood and graphed for the entire reach for comparisons with other reaches and streams previously surveyed. Densities of logs and trees were also graphed by 1,000 foot sub-segment by component within the bankfull channel, perched and upslope zones.

Relative proportions of in-channel wood providing structure-forming habitat function versus that providing nonfunctional, extra wood were graphed for the reach to compare with other previously surveyed reaches and streams, using Microsoft EXCEL software. In-channel wood (functional and extra) was graphed per 1000-foot sub-segment.

Results and Discussion

In-channel (bankfull) Wood Density. Gazos, Waddell and Scott creeks were the last creeks south of the San Francisco Bay to have coho salmon populations and presently retain steelhead populations. Therefore, it is appropriate to compare instream wood density in our local watersheds to densities in those streams, assuming that instream wood contributed to adequate cover for a salmonid species that requires considerable cover. A management goal may be to increase wood density to the level found in coho streams in order to recover the species in our local watersheds. Coho salmon are more exclusively pool-dwelling than steelhead and require more escape cover than steelhead, which is usually provided by instream wood. Though not necessarily ideal structural in-channel wood densities existed in these 3 streams, a management goal should be to establish structure-forming in-channel wood densities in our Santa Cruz Mountain surveyed segments comparable with the best conditions in these 3 streams. Boulder 17a had much lower total in-channel wood density compared to Gazos, Waddell and Scott creeks; less than 1/2 that in Scott and only about 1/4 that in Waddell and Gazos (**Table 1; Figure 3**). Functional in-channel wood was similar density to Gazos and Scott and less than in Waddell. But Boulder 17a had mostly hardwood and less conifer structural instream wood (**Figure 4**). The total in-channel wood density in Fall 15b was about 7/8 that in Gazos and Waddell and 1.7 times as much as in Scott. Fall 15b had 2.4 times the structural in-channel wood as Gazos and 3.5 times as much as Waddell and Scott. With regard to total in-channel wood density in Reach 2 of the San Lorenzo mainstem, it had more than 3 times that in Gazos, Waddell and Scott. Reach 2 had 7.5 times the density of structural instream wood as Gazos and more than 11 times the density compared to Waddell and Scott. This was largely due to the high deposition of large wood in the bankfull channel of the split channel having a wide flooded area at bankfull. In decreasing order of total in-channel wood densities, the 2016 segments were San Lorenzo 2 (115 pieces/ 1,000 ft), Fall 15b (28 pieces/ 1,000 ft) and Boulder 17a (7 pieces/ 1000 ft). Gazos and Waddell creeks had 30+ pieces/ 1,000 ft, and Scott had 16.5 pieces/ 1,000 ft. In decreasing order of structural (functional) in-channel wood, the segments were San Lorenzo 2 (89 pieces/ 1,000 ft), Fall 15b (28 pieces/ 1,000 ft) and Boulder 17a (7 pieces/ 1000 ft). Gazos and Waddell creeks had 11.8 and 8 pieces/ 1,000 ft, respectively, and Scott had 6.7 pieces/ 1,000 ft for structural instream wood. Therefore, the San Lorenzo 2 and Fall 15b had much more structural instream wood than the 3 reference coho streams, Gazos, Waddell and Scott, while Boulder 17a had somewhat less.

The maximum density of in-channel conifers in 200-ft sites in San Lorenzo 2, Fall 15b and Boulder 17a was 225, 40 and 5 pieces/ 1000 ft, respectively. The San Lorenzo 2 density was 4 times the maximum densities in individual reaches of Gazos Creek (Reaches 3 and 6 with as many as 50−60 instream conifer pieces/1,000 ft) and Waddell Creek (Reach W1 in Waddell Creek had 50+ pieces/1,000 ft) (**Leicester 2005**). Fall 15b was 2/3 to 4/5 the density of Gazos and Waddell. There is considerable room for improvement in Boulder 17a to reach in-channel densities on Gazos and Waddell creeks. We suspect that the wood deposits in San Lorenzo 2 are quite variable from year to year when bankfull events occur along with large stormflows as occurred in 2017.

Regarding in-channel densities per 1,000 ft of the shorter-lasting hardwood pieces, San Lorenzo 2 had much higher total in-channel (bankfull) hardwood densities as Scott, Waddell and Gazos creeks (**Table 1; Figure 3**). Fall 15b had slightly less in-channel hardwood density than Waddell and 1.2 to 1.3 times the density as Gazos and Scott creeks. Regarding in-channel hardwood density for Boulder 17a, it had 2/5 to 3/5 the density of Waddell, Gazos and Scott creeks.

In-channel (bankfull) Structural Wood Density. An important component of in-channel wood density is the density of in-channel conifer pieces that actually provide habitat structure for salmonids, comparable to the best densities found in reaches of Gazos, Waddell and Scott creeks. Densities per reach were not provided in Leicester (**2005**), but may be available from the author. Overall creek densities were provided. Creek densities of structural conifer vs. structural hardwood pieces per 1,000 feet were provided for Gazos (8.3 vs. 3.5), Waddell (5 vs. 3) and Scott (2.8 vs. 3.9) creeks (**Table 2; Figure 4**). Overall, densities of structure-forming conifer and hardwood pieces in Fall 15b (15 vs. 13) (13 vs. 9 had rearing functionality) and San Lorenzo 2 (53 vs. 36) (only 3 vs. 3 had rearing functionality) compared favorably with overall Gazos, Waddell and Scott creeks, while Boulder 17a (1 vs. 6) (0 vs. 6 had rearing functionality) had limited structural conifers but slightly higher densities of structural hardwoods.

According to NOAA Fisheries restoration guidelines (**Fox and Bolton 2007**), the frequency of structural in-channel wood is within the "good" range when it reaches 18−34 pieces/ 1,000 ft (6-11 pieces/ 100 meters) for streams with bankfull widths of 1-10 meters and 4−12 pieces/ 1,000 ft (1.3−4 pieces/ 100 meters) for streams with bankfull widths of >10 meters. By this standard, San Lorenzo 2 (89 pieces) and Fall 15b (28 pieces) were in the "Good" range and Boulder 17a (7 pieces) was not (**Table 2**). These criteria do not distinguish between bankfull functionality and low flow channel functionality.

In our habitat typing of Gazos Creek in 2001 (**Alley 2003b**), it was determined that 56% of the inventoried pools (184 of 327) were scoured and formed by instream wood (mostly previously cut redwood stumps and redwood logs resulting from past logging and past stream channel clearing activities). Upper Fall 15b had a slightly higher percentage of 58%. None of the other Santa Cruz Mountain segments surveyed in 2010−2016 went above 28% (Soquel 9a) for wood scour or dammed pools, and most ranged 10−15% (**Table 2**). San Lorenzo 2 and Boulder 17a had much lower percentages than Fall 15b at 10 and 0 %, respectively.

Table 1. 2010−2016. Densities of IN-CHANNEL (BANKFULL) WOOD in Santa Cruz Mountain Stream Reaches (0.5-mile segments) Compared to Gazos, Waddell, Scott and Lower Soquel Creeks in 2001-2002.

	Conifer In-channel (pieces/ 1000 ft)	Hardwood In-channel (pieces/ 1000 ft)	Total In-channel (pieces/ 1000 ft)
Gazos (4.5 mi.)	21.5	9.4	30.9
Waddell (6.4 mi.)	18.4	13.9	32.3
Scott (7.8 mi.)	5.9	10.6	16.5
Lower Soquel (10.2 mi.)	0.9	1.2	2.1
San Lorenzo 2- 2016	65	50	115
Zayante 13a- 2013	19	25	44 (large wood cluster at RR trestle)
Zayante 13c- 2010	1	4	5
Zayante 13d- 2013	11	4	15
Zayante 13i>Mt. Charlie)- 2015	11	9	20
Bean 14a-2015	20	5	25
Bean 14b- 2010	1.9	6.3	8.2
Bean 14c- 2011	12	11	23 (large wood cluster at 1 corner pool)
Fall 15a- 2014	9	7	16
Fall 15b- 2016	15	13	28
Boulder 17a	1	6	7
Bear 18a- 2011	4	7	11
Branciforte 21a-2 – 2012	4	3	7
Soquel 3a- 2013	0	10	10
Soquel 7- 2012	5	3	8
Soquel 8- 2011	15	16	31 (large wood cluster on 1 mid-channel bar)
Soquel 9a- 2010	6	11	17
Soquel 12a- 2010	5	5	10
Aptos 3- 2015	2	11	13
Aptos 4- 2014	19	7	26
Corralitos 3- 2010	11	4	15
Corralitos 5/6- 2012	9	0	9
Corralitos 7- 2014	7	0	7
Average	**11**	**9.4**	**20.4**

Creek densities of structural conifer vs. structural hardwood pieces per 1,000 feet were provided for Gazos (8.3 vs. 3.5), Waddell (5 vs. 3) and Scott (2.8 vs. 3.9) creeks (**Table 2; Figure 4**). Overall, densities of structure-forming conifer and hardwood pieces in Fall 15b (15 vs. 13) (13 vs. 9 had rearing functionality) and San Lorenzo 2 (53 vs. 36) (only 3 vs. 3 had rearing functionality) compared favorably with overall Gazos, Waddell and Scott creeks, and while Boulder 17a (1 vs. 6) (0 vs. 6 had rearing functionality) had limited structural conifers but slightly higher densities of structural hardwoods.

According to NOAA Fisheries restoration guidelines (**Fox and Bolton 2007**), the frequency of structural in-channel wood is within the "good" range when it reaches 18−34 pieces/ 1,000 ft (6-11 pieces/ 100 meters) for streams with bankfull widths of 1-10 meters and 4−12 pieces/ 1,000 ft (1.3−4 pieces/ 100 meters) for streams with bankfull widths of >10 meters. By this standard, San Lorenzo 2 (89 pieces) and Fall 15b (28 pieces) were in the "Good" range and Boulder 17a (7 pieces) was not (**Table 2**). These criteria do not distinguish between bankfull functionality and low flow channel functionality.

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Table 2. 2010−2016 Densities (pieces/ 1000 ft) of In-channel Wood Providing SALMONID HABITAT STRUCTURE in Santa Cruz Mountain Stream Reaches (0.5-mile segments) Compared to Gazos, Waddell, Scott and Lower Soquel Creeks in 2001-2002.

Stream or Reach Large (L) >10m BF width; Small (S) <= 10m BF width	Conifer Structure (pieces/ 1000 ft)	Hardwood Structure (pieces/ 1000 ft)	Total Structural (pieces/ 1000 ft)	% Pools With Instream Wood Creating Scour
Gazos (4.5 mi.*) (L)	8.3	3.5	11.8**	56 (**Alley (2003b)**)
Waddell (6.4 mi.*) (L)	5	3	8**	−
Scott (7.8 mi.*) (L)	2.8	3.9	6.7**	−
Lower Soquel (10.2 mi.*) L	0.3	0.3	0.6	−
San Lorenzo 2- 2016 (L)	53	36	89**	10
Zayante 13a- 2013 (L)	19	24	43** Jam at RR trestle	8
Zayante 13c- 2010 (L)	1	3	3	5
Zayante 13d- 2013 (mostly S)	7	2	9	3
Zayante 13i> Mt. Charlie- 2015 (S)	10	4	14	20
Bean 14a-2015 (L- mostly)	19	4	23**	29
Bean 14b- 2010 (S- barely)	1.3	5.6	6.9	11
Bean 14c- 2011 (S)	11	9	20**	10
Fall 15a- 2014 (S)	8	7	15	22
Fall 15b- 2016 (S)	15	13	28**	58
Boulder 17a-2016 (mostly S)	1	6	7	0
Bear 18a- 2011 (S- barely)	4	5	9	0
Branciforte 21a-2- 2012 (S- barely)	4	2	6	10
Soquel 3a- 2013 (L)	0	10	10**	7
Soquel 7- 2012 (L)	3	3	6**	12
Soquel 8- 2011(S)	14	14	28**	11
Soquel 9a- 2010 (L)	4	10	14**	28
Soquel 12a- 2010 (L)	5	4	9**	21
Aptos 3- 2015 (S)	2	10	12	14
Aptos 4- 2014 (S)	16	6	22**	12
Corralitos 3- 2010 (L)	8	4	12**	13
Corralitos 5/6- 2012 (L- barely)	5	0	5**	10
Corralitos 7- 2014 (S)	7	0	7	0
Average	**8.6**	**7.2**	**20.4**	**15.4**

*** From Leicester (2005).**

****Good Rating by NOAA Fisheries Standards** (no conifer vs. hardwood discrimination− 18−34 pieces/ 1,000 ft (6-11 pieces/ 100 meters) for streams with bankfull widths of 1-10 meters and 4−12 pieces/ 1,000 ft (1.3−4 pieces/ 100 meters) for streams with bankfull widths of >10 meters**).**

Perched Riparian Wood Density. Density of perched riparian trees/logs was more than twice the average in the San Lorenzo 2 segment (72 tree/logs per 1000 ft; average = 32.8) but below average in Fall15b (8) and Boulder 17a (30) (**Table 3 and Figures 5, 6a-c**). San Lorenzo 2 and Boulder 17a compared favorably to Gazos (23.9), Waddell (19.6) and Scott creeks (36.5) (**Leicester 2005**). Of the stream segments surveyed thus far, the mainstem San Lorenzo 2 segment had the highest density of perched conifer and hardwood trees/logs followed by mainstem Soquel 7 (53) and with 3 other reach segments at 50, including Zayante 13i, East Branch Soquel 12a, and Corralitos 3. As was the case in most surveyed segments, much more hardwoods were perched than conifers in San Lorenzo 2 and Boulder 17a, those typically being mostly alders. Streams with the highest density of perched trees have the highest potential recruitment of trees/logs into the active channel during a large stormflow capable of undermining those trees.

The relatively higher densities of perched trees in surveyed upper reaches of some watersheds in 2010−2016 are to be expected when compared to perched densities in Gazos, Waddell and Scott creeks. This is because lower reaches of watersheds that were included in those 3 creeks' overall densities tended to have lower perched tree densities, especially conifers. Eleven of 23 reach segments surveyed in 2010-2016 had higher perched tree densities than those 3 creeks.

Riparian Wood Density Beyond the Perched Zone. Of the 2016 surveyed segments, all 3 had much higher riparian densities beyond the perched zone of conifers and hardwoods compared to Gazos, Waddell and Scott creeks (**Table 4 and Figures 5, 6a-c**). All 2010−2016 surveyed segments except Fall 15a, Zayante 13d, Bean 14a and Bear 18a (with their narrow riparian widths or heavily shaded conifer forest) had higher hardwood riparian densities than those 3 creeks. The riparian along San Lorenzo 2 and Boulder 17a was dominated by hardwoods, while conifers dominated the riparian zone along Fall 15b. The 5 reach segments with 2−4 times the densities of conifer riparian trees beyond the perched zone compared to those 3 creeks were Zayante 13d, Zayante 13i, Bean 14a, Branciforte 21a-2, Soquel 12a, Corralitos 3, Corralitos 5/6 and Corralitos 7. Zayante 13i had the second highest total riparian density beyond the perched riparian behind only Soquel 12a (SDSF), owing at times to a wider riparian zone caused by artificial sunny openings caused by roads adjacent to the streams. Aptos 3 had a wide, flat floodplain containing a cottonwood grove. Bean 14b, Soquel 3a, Soquel 7 and Soquel 9a had flat terrain with wider hardwood riparian forests.

Table 3. Wood Density (Live and Dead) in the PERCHED Riparian Zone of Surveyed Streams and Reach Segments.

Stream or Reach Segment (Year)	Zone	Conifer Density (trees/logs per 1000 ft)	Hardwood Density (trees/logs per 1000 ft)	Total Density (trees/logs per 1000 ft)
Gazos (2002*)	Perched Riparian	4.8	19.1	23.9
Waddell (2002*)	Perched Riparian	4.4	15.2	19.6
Scott (2002*)	Perched Riparian	6.4	30.1	36.5
Lower Soquel (2002*)	Perched Riparian	0.5	2.1	2.6
San Lorenzo 2- 2016	Perched Riparian	5	67	72
Zayante 13a (2013)	Perched Riparian	1	40	41
Zayante 13c (2010)	Perched Riparian	2	43	45
Zayante 13d (2013)	Perched Riparian	4	23	27
Zayante 13i (2015)	Perched Riparian	4	46	50
Bean 14a (2015)	Perched Riparian	21	15	36
Bean 14b (2010)	Perched Riparian	0	24	24
Bean 14c (2011)	Perched Riparian	7	30	37
Fall 15a (2014)	Perched Riparian	4	15	19
Fall 15b- 2016	Perched Riparian	3	5	8
Boulder 17a	Perched Riparian	3	27	30
Bear 18a (2011)	Perched Riparian	1	28	29
Branciforte 21a-2 (2012)	Perched Riparian	13	16	29
Soquel 3a (2013)	Perched Riparian	1	27	28
Soquel 7 (2012)	Perched Riparian	0	53	53
Soquel 8 (2011)	Perched Riparian	10	28	38
Soquel 9a (2010)	Perched Riparian	6	31	37
Soquel 12a (2010)	Perched Riparian	5	45	50
Aptos 3 (2015)	Perched Riparian	12	31	43
Aptos 4 (2014)	Perched Riparian	12	9	21
Corralitos 3 (2010)	Perched Riparian	11	39	50
Corralitos 5/6 (2012)	Perched Riparian	6	8	14
Corralitos 7 (2014)	Perched Riparian	6	16	22
Average	Perched Riparian	**5.7**	**27.1**	**32.8**

*** From Leicester (2005).**

Table 4. Wood Density (Live and Dead) in the RIPARIAN ZONE BEYOND THE PERCHED ZONE of Surveyed Streams and Reach Segments.

Stream or Reach Segment (Year)	Zone	Conifer Density (trees/logs per 1000 ft)	Hardwood Density (trees/logs per 1000 ft)	Total Density (trees/logs per 1000 ft)
Gazos (2002*)	Riparian Beyond Perched	19.9	25.9	45.8
Waddell (2002*)	Riparian Beyond Perched	25.6	35.6	61.2
Scott (2002*)	Riparian Beyond Perched	18.7	49.1	67.8
Lower Soquel (2002*)	Riparian Beyond Perched	1.1	9	10.1
San Lorenzo 2- 2016	Riparian Beyond Perched	21	91	112
Zayante 13a (2013)	Riparian Beyond Perched	3	80	83
Zayante 13c (2010)	Riparian Beyond Perched	7	94	101
Zayante 13d (2013)	Riparian Beyond Perched	83	56	139
Zayante 13i (2015)	Riparian Beyond Perched	114	91	205
Bean 14a (2015)	Riparian Beyond Perched	80	20	100
Bean 14b (2010)	Riparian Beyond Perched	11.3	116.3	127.6
Bean 14c (2011)	Riparian Beyond Perched	42	56	98
Fall 15a (2014)	Riparian Beyond Perched	9	23	32
Fall 15b- 2016	Riparian Beyond Perched	97	67	164
Boulder 17a	Riparian Beyond Perched	35	64	99
Bear 18a (2011)	Riparian Beyond Perched	6	33	39
Branciforte 21a-2 (2012)	Riparian Beyond Perched	54	72	126
Soquel 3a (2013)	Riparian Beyond Perched	22	102	124
Soquel 7 (2012)	Riparian Beyond Perched	38	124	162
Soquel 8 (2011)	Riparian Beyond Perched	25	67	92
Soquel 9a (2010)	Riparian Beyond Perched	27	114	141
Soquel 12a (2010)	Riparian Beyond Perched	92	158	250
Aptos 3 (2015)	Riparian Beyond Perched	37	142	179
Aptos 4 (2014)	Riparian Beyond Perched	51	48	99
Corralitos 3 (2010)	Riparian Beyond Perched	73	62	135
Corralitos 5/6 (2012)	Riparian Beyond Perched	70	43	113
Corralitos 7 (2014)	Riparian Beyond Perched	123	50	173
Average	Riparian Beyond Perched	**43.9**	**70.1**	**114**

*** From Leicester (2005).**

Upslope Wood Density. Upslope wood density (as far as 75 feet out from bankfull) is largely dependent on the width of the riparian corridor and the level of streamside development which has resulted in tree clearing. If the riparian corridor is wide and/or development is high, the upslope density of trees is less and vice versa. Of the 3 segments surveyed for upslope densities in 2016, Boulder 17a had above average densities (154 trees/logs per 1000 ft; average = 84.9). The riparian was typically less than 30 feet wide on a side and the upslope was heavily forested. San Lorenzo 2 (40) and Fall 15b (72) had below average upslope densities because the riparian width was at times relatively wide in these segments. The upslope density of trees/logs along Boulder 17aZayante 13i and Bean 14a was above the range of densities for Gazos, Waddell and Scott creeks (**Table 5 and Figures 5, 6a-c**). Fall 15b was within the range, and San Lorenzo 2 was below the range.

Table 5. Wood Density (Live and Dead) in the UPSLOPE BEYOND THE RIPARIAN ZONE and Within 75 Feet of the Bankfull Channel in Reach Segments.

Stream or Reach Segment (Year)	Zone	Conifer Density (trees/logs per 1000 ft)	Hardwood Density (trees/logs per 1000 ft)	Total Density (trees/logs per 1000 ft)
Gazos (2002*)	Upslope	49.5	8.6	58.1
Waddell (2002*)	Upslope	93.8	19.8	113.6
Scott (2002*)	Upslope	55.4	3.3	58.7
Lower Soquel (2002*)	Upslope	4.9	1.9	6.8
San Lorenzo 2- 2016	Upslope	28	12	40
Zayante 13a (2013)	Upslope	3	13	18
Zayante 13c (2010)	Upslope	6	64	70
Zayante 13d (2013)	Upslope	22	3	25
Zayante 13i (2015)	Upslope	146	53	199
Bean 14a (2015)	Upslope	118	16	134
Bean 14b (2010)	Upslope	1.3	4.4	5.7
Bean 14c (2011)	Upslope	82	17	99
Fall 15a (2014)	Upslope	97	52	149
Fall 15b- 2016	Upslope	48	24	72
Boulder 17a	Upslope	113	41	154
Bear 18a (2011)	Upslope	101	88	189
Branciforte 21a-2 (2012)	Upslope	52	55	107
Soquel 3a (2013)	Upslope	1	4	5
Soquel 7 (2012)	Upslope	22	1	23
Soquel 8 (2011)	Upslope	76	64	140
Soquel 9a (2010)	Upslope	75	15	90
Soquel 12a (2010)	Upslope	81	25	106
Aptos 3 (2015)	Upslope	17	15	32
Aptos 4 (2014)	Upslope	116	46	162
Corralitos 3 (2010)	Upslope	42	30	72
Corralitos 5/6 (2012)	Upslope	75	3	78
Corralitos 7 (2014)	Upslope	64	22	86
Average	Upslope	**58.9**	**26**	**84.9**

*** From Leicester (2005).**

Recommendations

1. Protect natural recruitment of wood pieces to the stream channel. If concern develops for manmade structures possibly jeopardized by instream wood, seek county and fishery biologist guidance on any proposed wood removal. Wood recruitment is likely to occur primarily during large flood events and must be judiciously managed so that adequate wood remains in the stream channel between large, episodic recruitment events.

2. Establish an educational outreach program for streamside residents in the vicinity of monitored segments and monitor the amount and frequency of riparian and instream wood cutting in those segments to measure effectiveness of educational outreach in recruitment and retention of instream wood.

REFERENCES AND COMMUNICATIONS

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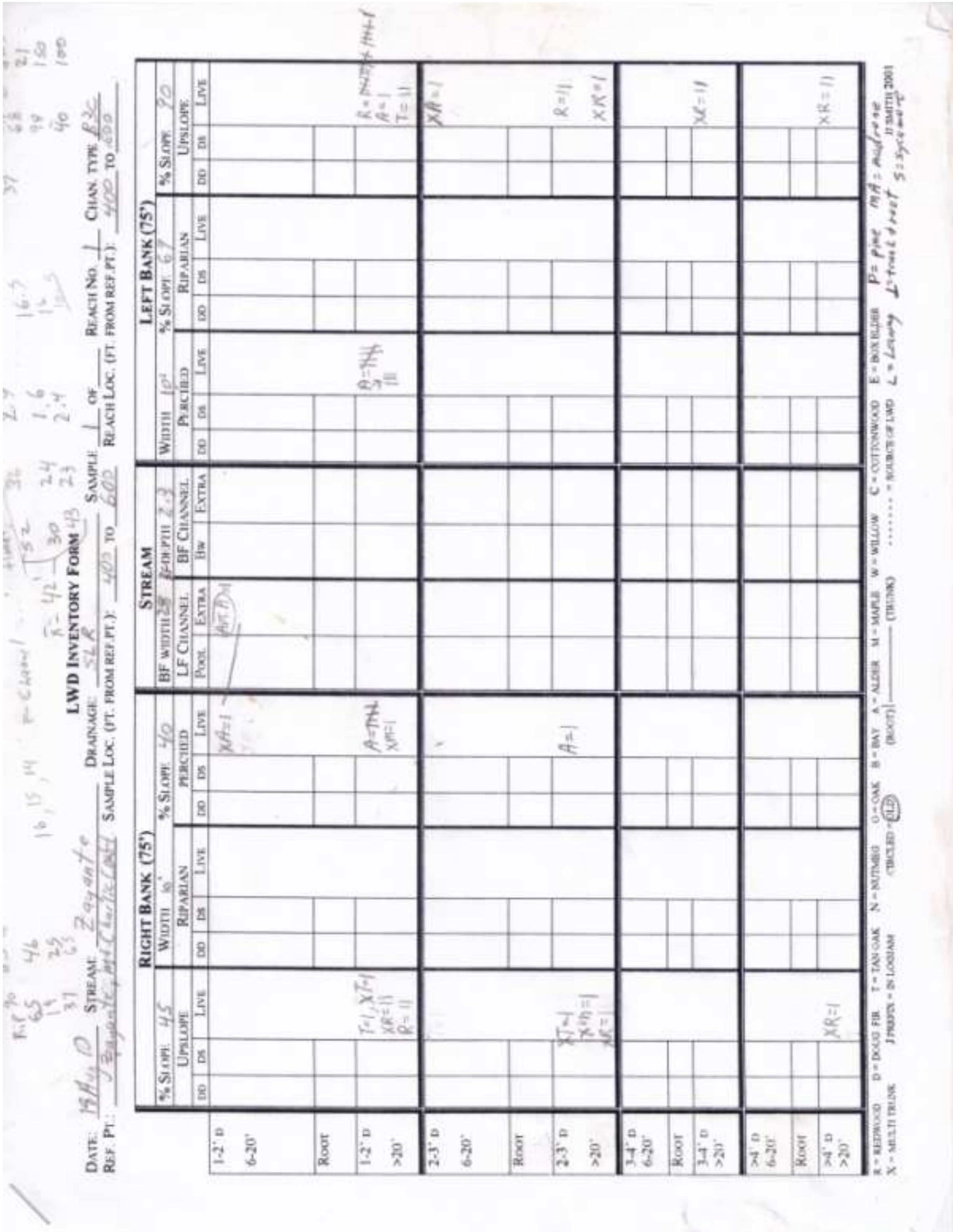
LWD INVENTORY FORM

DATE: 19 Aug 10 STREAM: Zayante SAMPLE 1 OF ___ REACH NO. 1 CHAN. TYPE B3c

DRAINAGE: SLR

SAMPLE LOC. (FT. FROM REF. PT.): 400 TO 600 REACH LOC. (FT. FROM REF. PT.): 400 TO 600

RIGHT BANK (75') — STREAM — LEFT BANK (75')

R = REDWOOD D = DOUG FIR T = TAN OAK N = NUTMEG O = OAK B = BAY A = ALDER M = MAPLE W = WILLOW C = COTTONWOOD E = BOX ELDER

X = MULTI TRUNK J PREFIX = IN LOGJAM

JJ SMITH 2001

Figure 1. Wood Survey Data Sheet (from Leicester's Thesis (2005)).

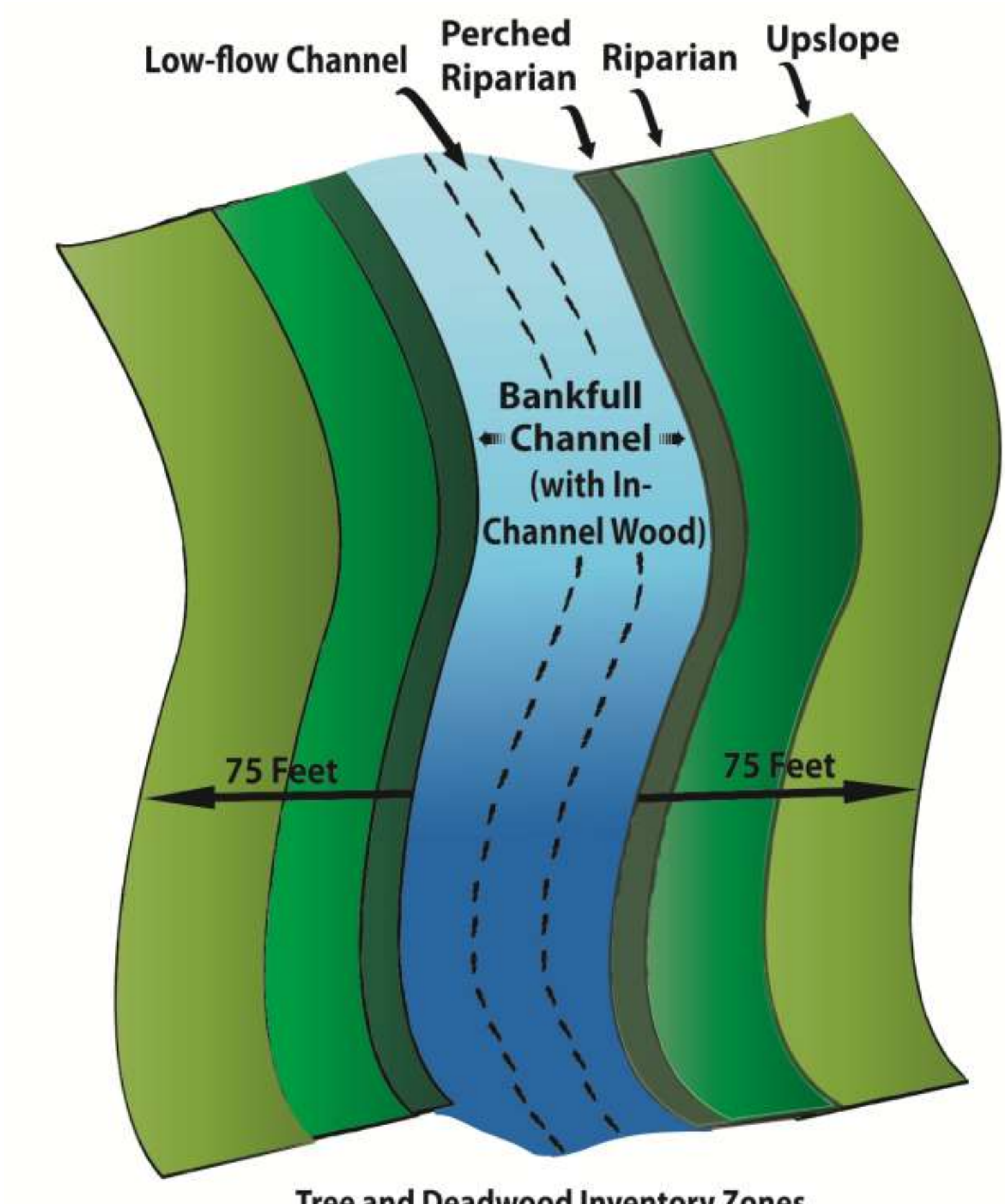

Figure 2. Tree and Deadwood Inventory Zones.

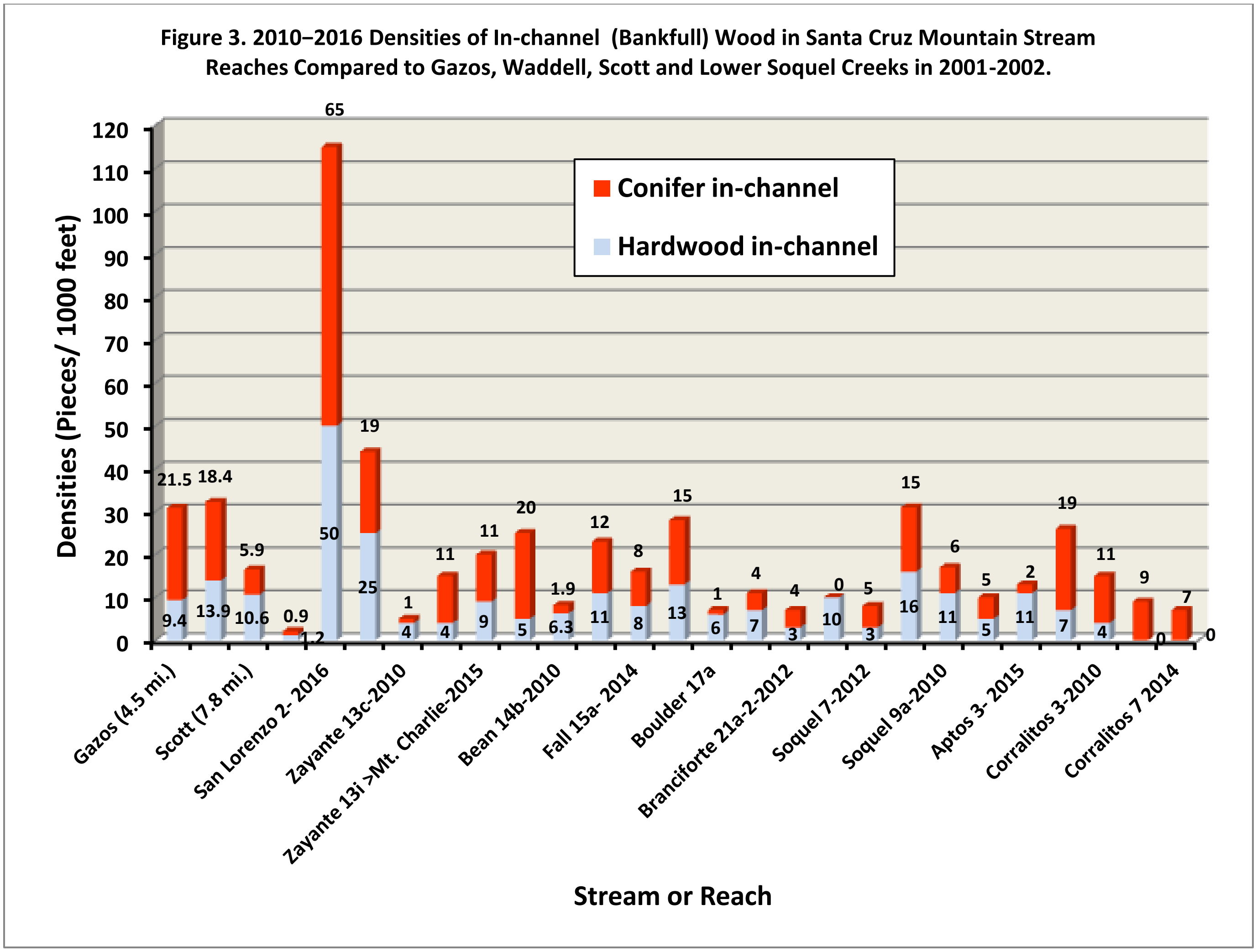
Figure 3. 2010–2016 Densities of In-channel (Bankfull) Wood in Santa Cruz Mountain Stream Reaches Compared to Gazos, Waddell, Scott and Lower Soquel Creeks in 2001-2002.
Conifer in-channel
Hardwood in-channel
Densities (Pieces/ 1000 feet)
Stream or Reach
Gazos (4.5 mi.)
Scott (7.8 mi.)
San Lorenzo 2- 2016
Zayante 13c-2010
Zayante 13i >Mt. Charlie-2015
Bean 14b-2010
Fall 15a- 2014
Boulder 17a
Branciforte 21a-2-2012
Soquel 7-2012
Soquel 9a-2010
Aptos 3- 2015
Corralitos 3-2010
Corralitos 7 2014

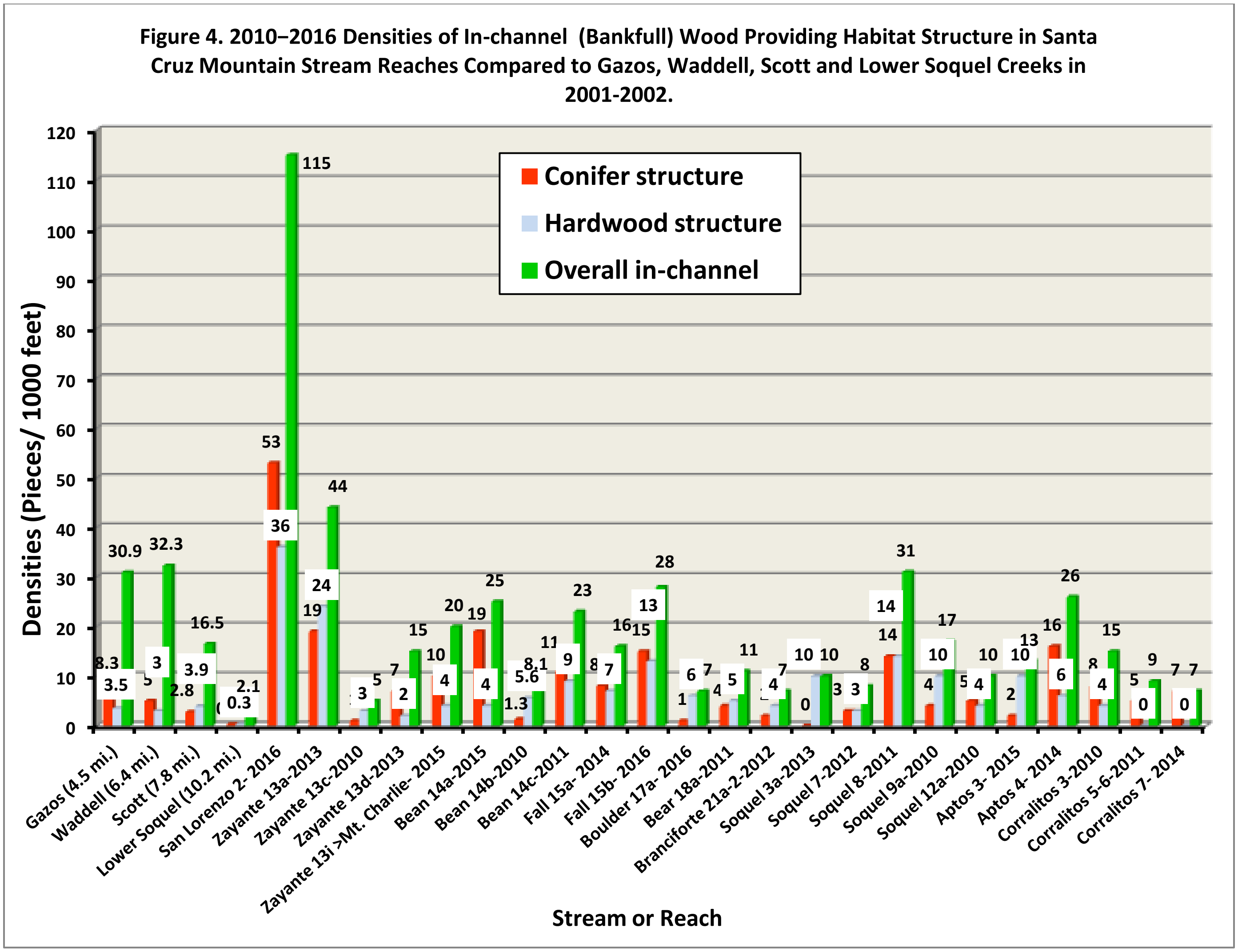
Figure 4. 2010–2016 Densities of In-channel (Bankfull) Wood Providing Habitat Structure in Santa Cruz Mountain Stream Reaches Compared to Gazos, Waddell, Scott and Lower Soquel Creeks in 2001-2002.
Conifer structure
Hardwood structure
Overall in-channel
Densities (Pieces/ 1000 feet)
Stream or Reach
Gazos (4.5 mi.)
Waddell (6.4 mi.)
Scott (7.8 mi.)
Lower Soquel (10.2 mi.)
San Lorenzo 2- 2016
Zayante 13a-2013
Zayante 13c-2010
Zayante 13d-2013
Zayante 13i >Mt. Charlie- 2015
Bean 14a-2015
Bean 14b-2010
Bean 14c-2011
Fall 15a- 2014
Fall 15b- 2016
Boulder 17a- 2016
Bear 18a-2011
Branciforte 21a-2-2012
Soquel 3a-2013
Soquel 7-2012
Soquel 8-2011
Soquel 9a-2010
Soquel 12a-2010
Aptos 3- 2015
Aptos 4- 2014
Corralitos 3-2010
Corralitos 5-6-2011
Corralitos 7- 2014

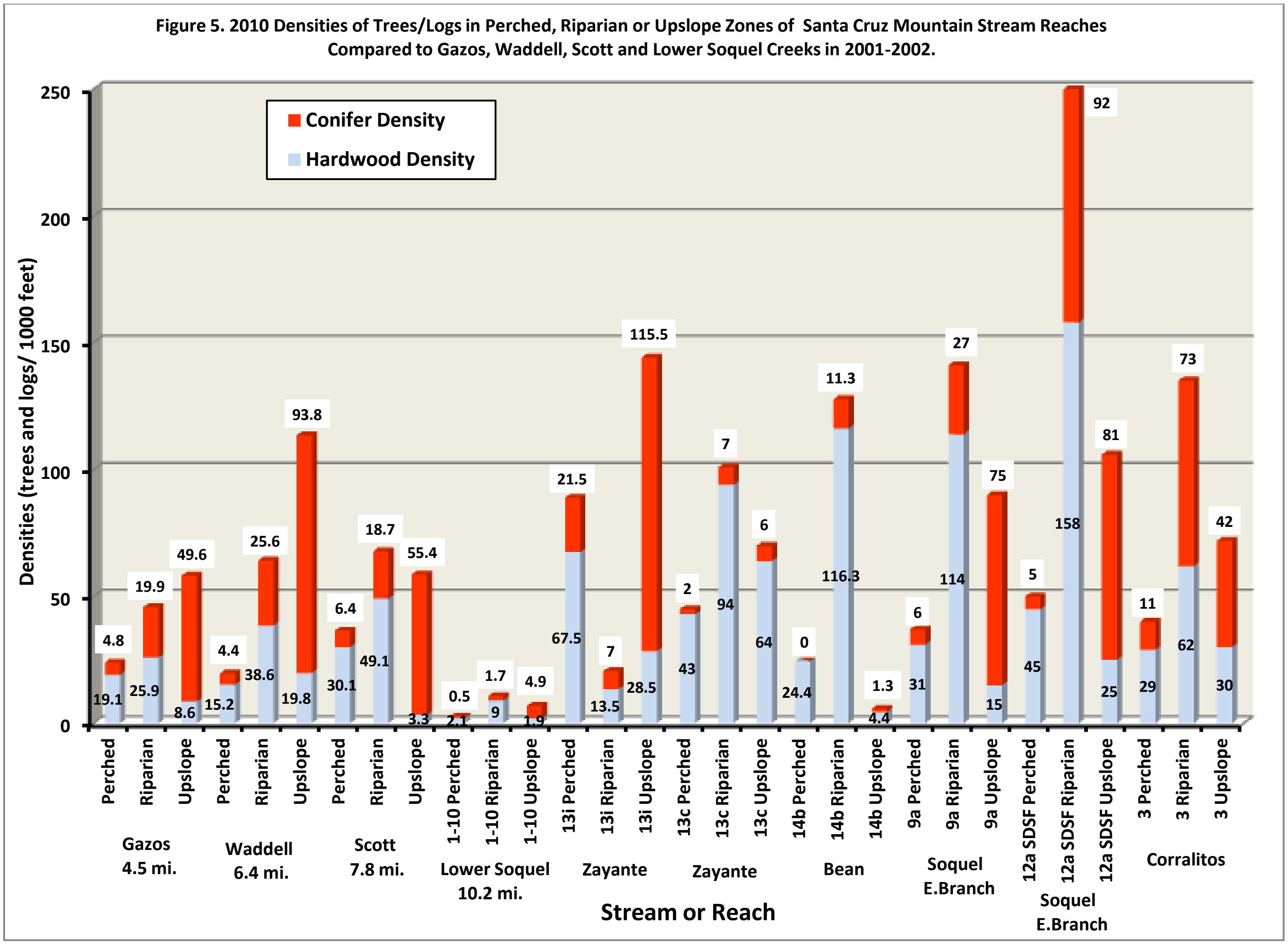
Figure 5. 2010 Densities of Trees/Logs in Perched, Riparian or Upslope Zones of Santa Cruz Mountain Stream Reaches Compared to Gazos, Waddell, Scott and Lower Soquel Creeks in 2001-2002.
Conifer Density
Hardwood Density
Densities (trees and logs/ 1000 feet)
Stream or Reach
Gazos 4.5 mi.
Waddell 6.4 mi.
Scott 7.8 mi.
Lower Soquel 10.2 mi.
Zayante
Zayante
Bean
Soquel E.Branch
Soquel E.Branch
Corralitos

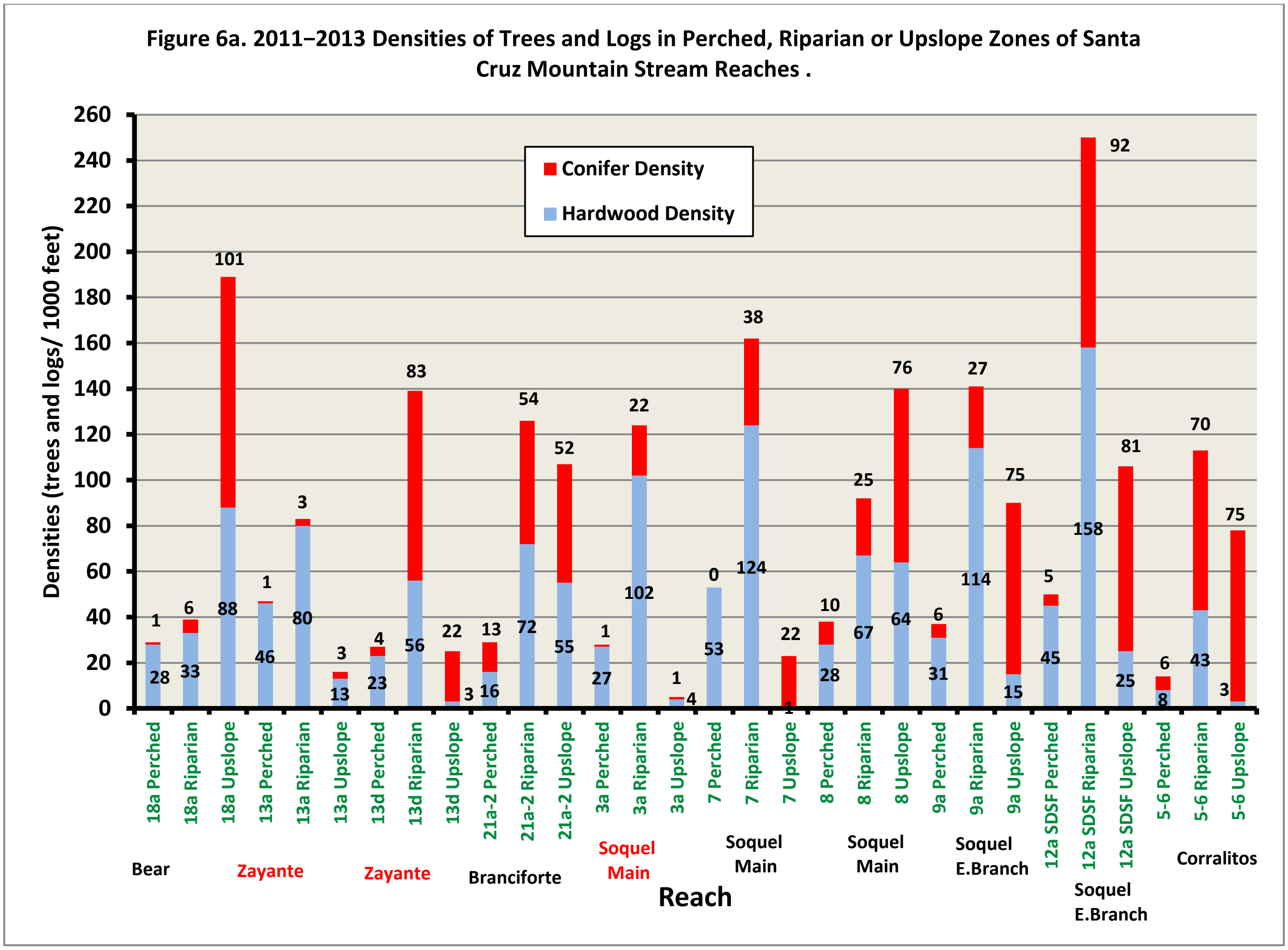
Figure 6a. 2011–2013 Densities of Trees and Logs in Perched, Riparian or Upslope Zones of Santa Cruz Mountain Stream Reaches .
Conifer Density
Hardwood Density
Densities (trees and logs/ 1000 feet)
Reach
18a Perched
18a Riparian
18a Upslope
13a Perched
13a Riparian
13a Upslope
13d Perched
13d Riparian
13d Upslope
21a-2 Perched
21a-2 Riparian
21a-2 Upslope
3a Perched
3a Riparian
3a Upslope
7 Perched
7 Riparian
7 Upslope
8 Perched
8 Riparian
8 Upslope
9a Perched
9a Riparian
9a Upslope
12a SDSF Perched
12a SDSF Riparian
12a SDSF Upslope
5-6 Perched
5-6 Riparian
5-6 Upslope
Bear
Zayante
Zayante
Branciforte
Soquel Main
Soquel Main
Soquel Main
Soquel E.Branch
Soquel E.Branch
Corralitos

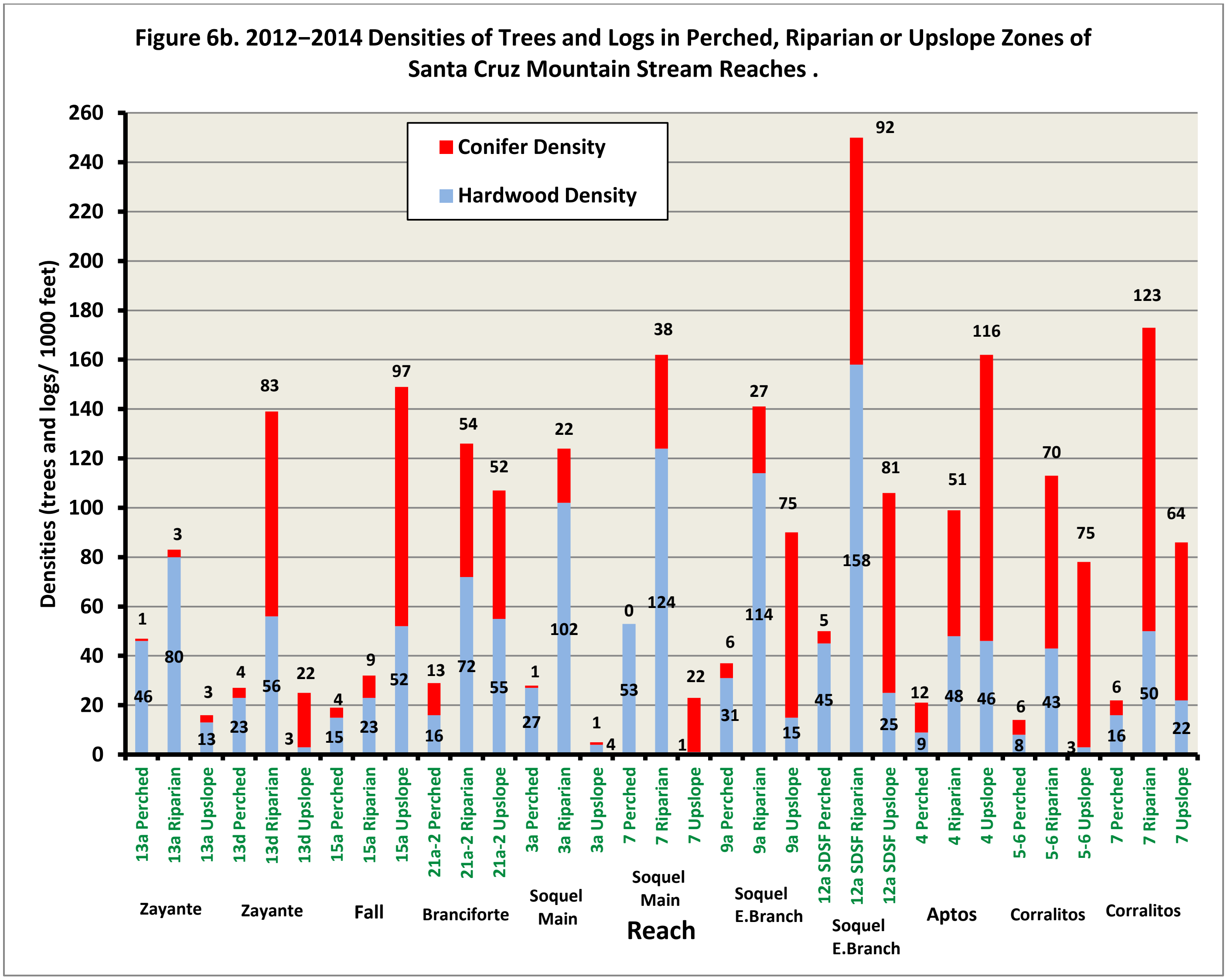
Figure 6b. 2012–2014 Densities of Trees and Logs in Perched, Riparian or Upslope Zones of Santa Cruz Mountain Stream Reaches .
Conifer Density
Hardwood Density
Densities (trees and logs/ 1000 feet)
0
20
40
60
80
100
120
140
160
180
200
220
240
260
13a Perched
13a Riparian
13a Upslope
13d Perched
13d Riparian
13d Upslope
15a Perched
15a Riparian
15a Upslope
21a-2 Perched
21a-2 Riparian
21a-2 Upslope
3a Perched
3a Riparian
3a Upslope
7 Perched
7 Riparian
7 Upslope
9a Perched
9a Riparian
9a Upslope
12a SDSF Perched
12a SDSF Riparian
12a SDSF Upslope
4 Perched
4 Riparian
4 Upslope
5-6 Perched
5-6 Riparian
5-6 Upslope
7 Perched
7 Riparian
7 Upslope
Zayante
Zayante
Fall
Branciforte
Soquel Main
Soquel Main
Reach
Soquel E.Branch
Soquel E.Branch
Aptos
Corralitos
Corralitos

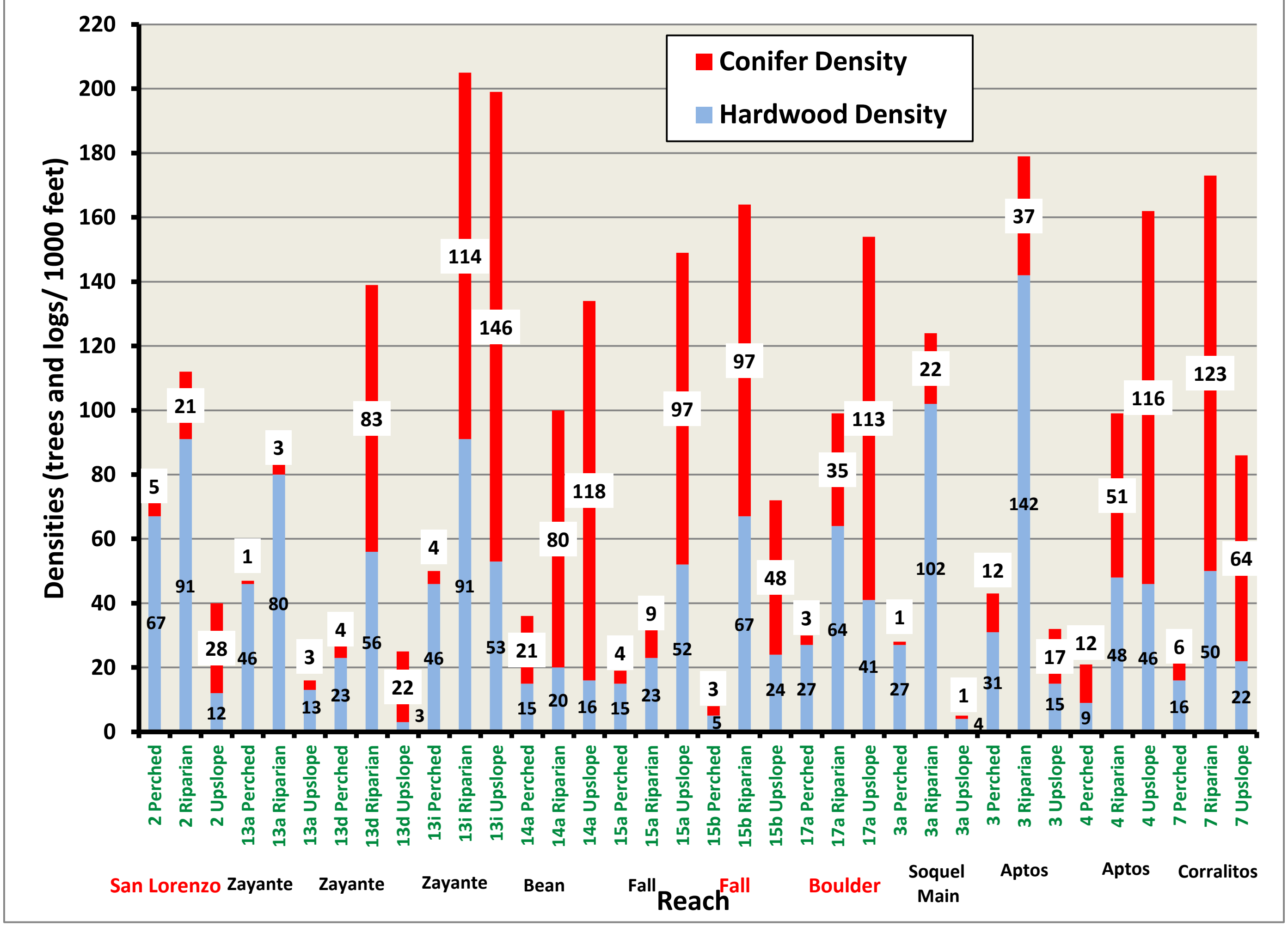

Figure 6c. 2013–2016 Densities of Trees and Logs in Perched, Riparian or Upslope Zones of Santa Cruz Mountain Stream Reaches .

APPENDIX A. WATERSHED MAPS

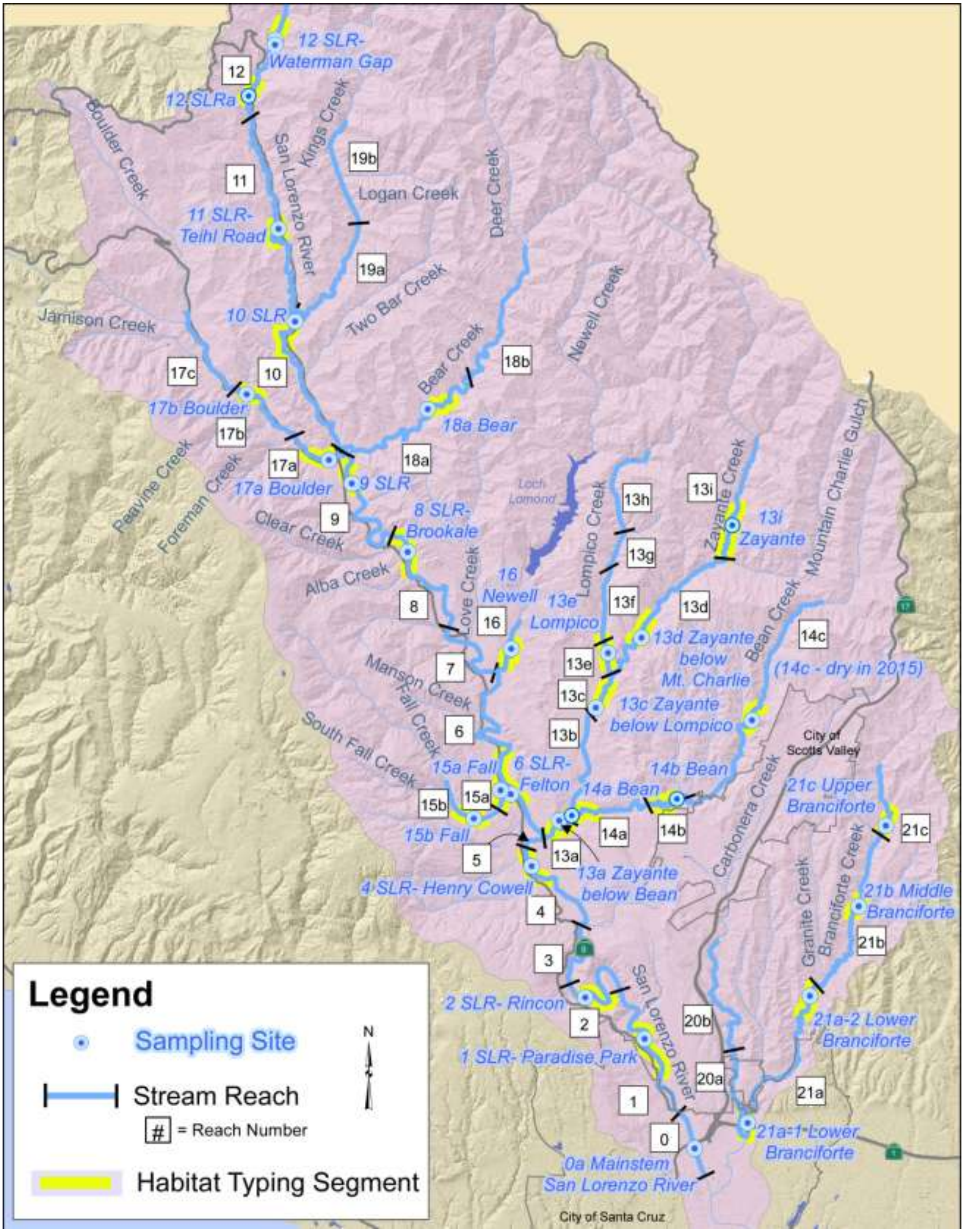

Figure 1. San Lorenzo River Watershed.

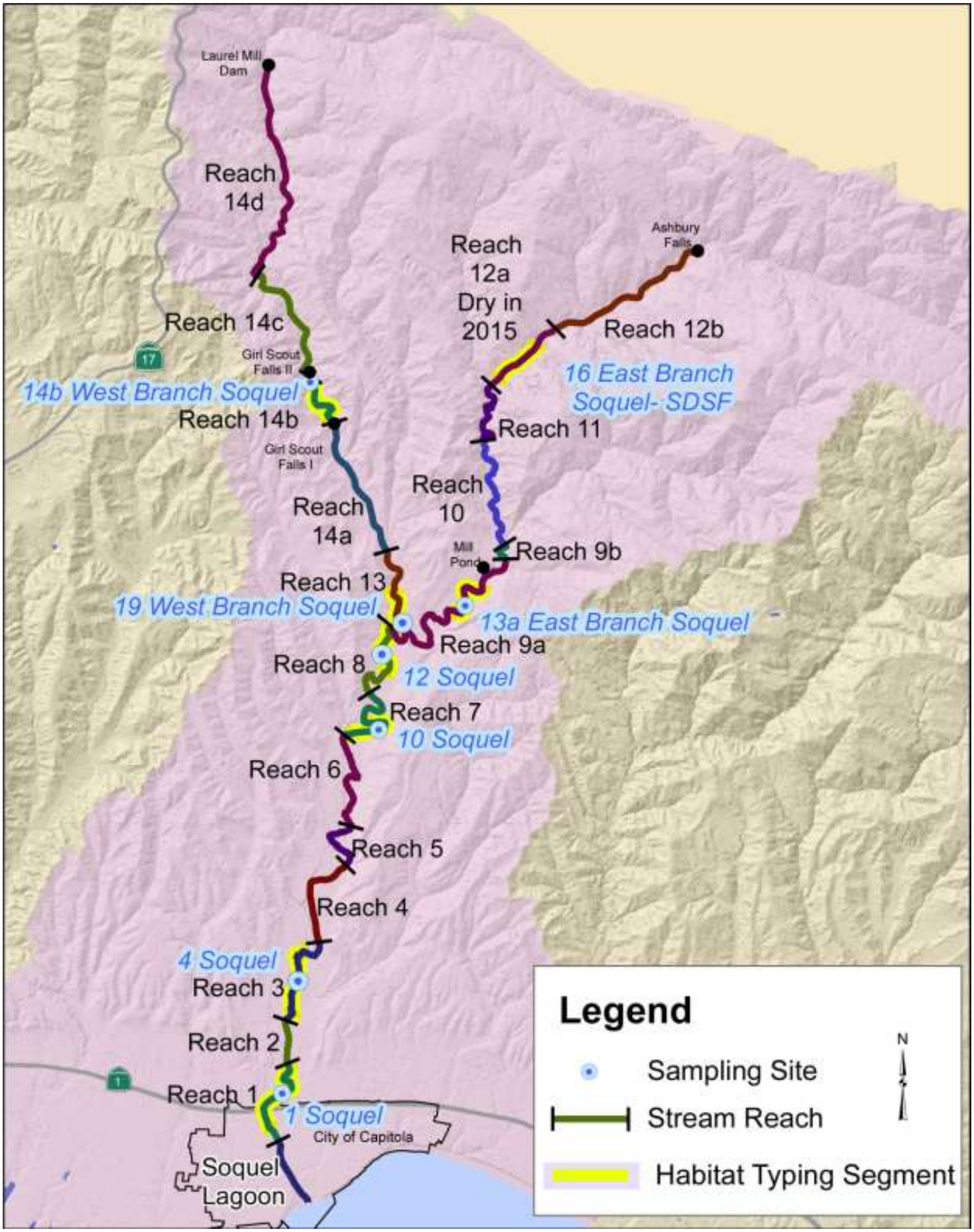

Figure 2. Soquel Creek Watershed.

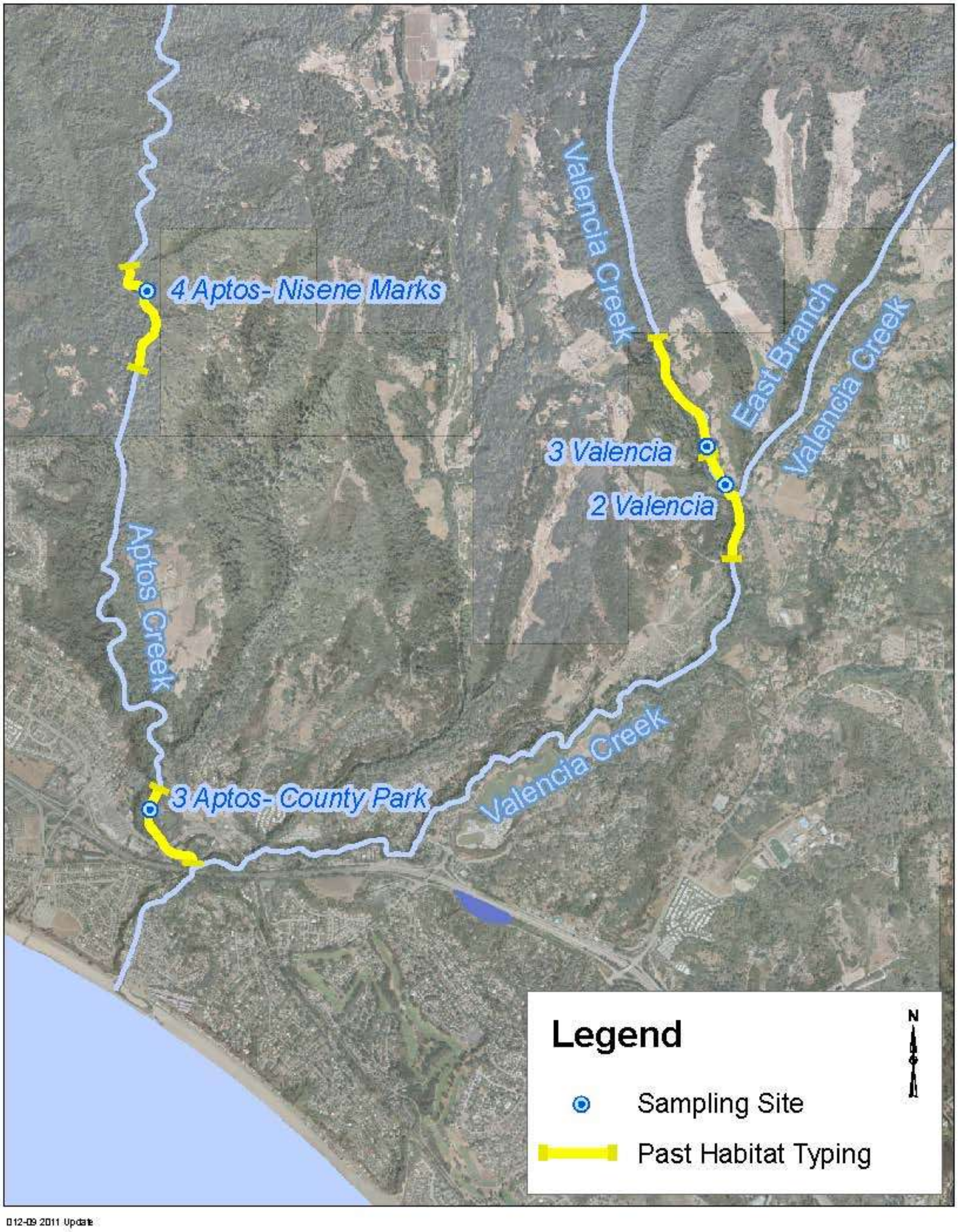

Figure 3. Aptos Creek Watershed.

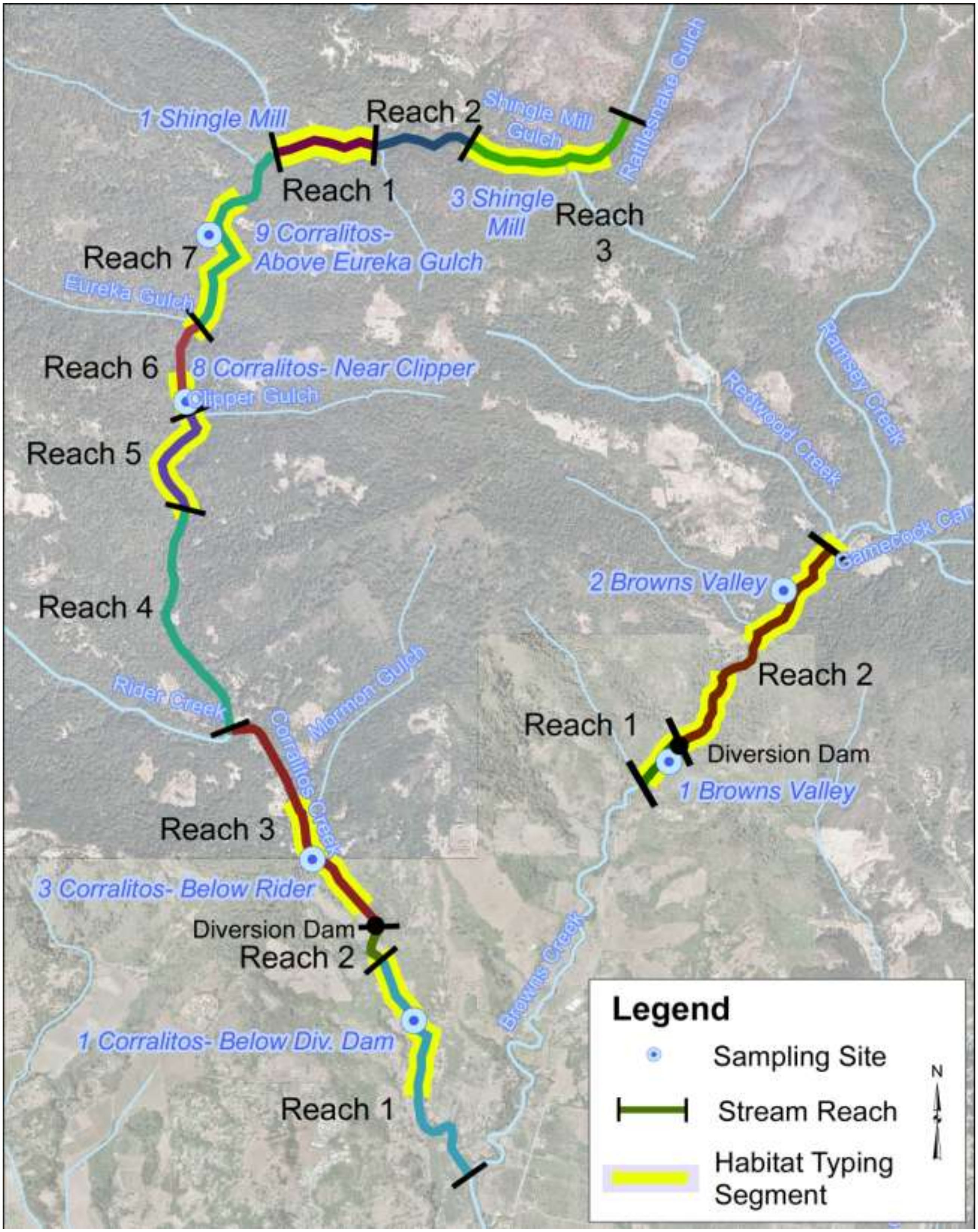

Figure 4. Upper Corralitos Creek Sub-Watershed.