D.W. ALLEY & Associates aquatic biology

RIPARIAN CORRIDOR WOOD SURVEY IN THE SAN LORENZO AND SOQUEL WATERSHEDS, 2014

Large Catcher Log with Accumulated Branches and Escape Cover; Fall Creek Reach 15b, September 2013

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Scope of Work

Three half-mile stream segments previously habitat typed and sampled for steelhead were surveyed for wood in 2014. Half-mile segments were surveyed in Fall Creek Reach 15a, Aptos Creek Reach 4 and Corralitos Creek Reach 7 (**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 2011−2013 (**Alley 2012−2014**) 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 especially coho salmon (**Alley et al. 2004; Alley 2014a**). These wood surveys provide baseline information about the density of instream wood and natural recruitment potential in reaches that could greatly benefit steelhead and coho salmon from wood enhancement projects. In 2014, a wood survey was performed in Fall Creek, where coho salmon were detected in 1981 and water is cool enough to provide future habitat for coho salmon. However, pool habitat is very limited, and vertical banks are common in Reach 15a, making residency time for instream wood potentially short. Upper Aptos Creek was surveyed above the metal bridge where water is cool enough for coho salmon in a reach containing substantial pool habitat protected within Nisene Marks State Park. Wood projects could be developed within the Park without residential impediments. Upper Corralitos Creek was surveyed upstream of Eureka Gulch, where productive steelhead habitat is present due to unembedded, large boulders without instream wood. If instream wood was allowed to accumulate in Reach 7, habitat would improve further.

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 2014, 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 rulers.

The bankfull 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. The most common streambed particle size was visually estimated. 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 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. Coho salmon are more exclusively pool-dwelling than steelhead and require more escape cover, which is usually provided by instream wood. Though not necessarily ideal in-channel wood densities exist 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. Fall Reach 15a had similar total in-channel wood densities as Scott Creek overall, but about half that in Gazos and Waddell creeks, (**Table 1; Figures 3 and 4**). Fall

15a had a greater conifer component than did Scott Creek. Instream wood was limited in Fall 15a due to mostly steep banks and a confined stream channel that likely prevented stable large wood accumulation. There are also residential properties that line the creek, which restricts riparian forest development. The total in-channel wood density in Aptos Reach 4 was similar to Scott Creek, with more conifer contribution. Soquel Reach 3a had lower total in-channel wood density than the 3 reference streams, all of it being contributed by hardwoods. In decreasing order of in-channel wood densities, the 2013 segments were Zayante 13a (44 pieces/ 1,000 ft), Zayante 13d (15 pieces/ 1,000 ft) and Soquel 3a (10 pieces). Gazos and Waddell creeks had 30+ pieces/ 1,000 ft, and Scott had 16.5 pieces/ 1,000 ft.

In comparing densities of the longer-lasting, in-channel conifer pieces, Zayante 13a had similar densities per 1,000 ft (19) compared to Gazos (21.5 pieces) or Waddell (18.4 pieces) (**Table 1; Figure 3**). Zayante 13d (11) was less than in Gazos or Waddell but more than in Scott (5.9). Soquel 3a had no in-channel conifer pieces.

The maximum density of in-channel conifers in 200-ft sites in Zayante 13a (70 pieces primarily due to clustering on the railroad trestle) (**Table 1; Figure 3**) was comparable to 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**). The maximum density of in-channel conifers in 200-ft sites in Zayante 13d (35 pieces/1,000 ft) was less than in Gazos and Waddell but more than in Scott Creek (10−15 pieces/1,000 ft). Although in-channel wood was dominated by conifers in Gazos, Waddell and Zayante 13d, Zayante 13a had an equally high density of hardwood pieces. All in-channel pieces in Soquel 3a were hardwood.

Regarding in-channel densities per 1,000 ft of the shorter-lasting hardwood pieces, Zayante 13a had a much higher density (25 pieces) than the three reference streams, Gazos (9.4 pieces), Scott (10.6 pieces) and Waddell (13.9 pieces) creeks (**Table 1; Figure 3**). Soquel 3a had a similar density (10 pieces), and Zayante 13d had less (4 pieces).

In-channel Structural Wood Density. An even more important management goal than enhancing overall in-channel wood density should be to increase densities of in-channel conifer pieces which actually provide habitat structure 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.

Table 1. 2010−2014. Densities of IN-CHANNEL 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
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- 2010	4	9	13
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
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 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	8.6	7.6	16.2

Creek densities of structural conifer vs. 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 Zayante 13a (19 vs. 24 (nearly all overwintering functionality) and Zayante 13d (7 vs. 2) compared favorably with overall Gazos, Waddell and Scott creek, while Soquel 3a (0 vs. 10) had no structural conifers but higher densities of structural hardwoods.

According to NOAA Fisheries restoration guidelines (**Jonathan Ambrose, personal communication**), 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, Zayante 13a (43 pieces) and Soquel 3a (10 pieces) are rated in the "Good" range for larger channels. Zayante 13d (9 pieces) has much less than "good" densities for smaller channels.

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). None of the Santa Cruz Mountain segments surveyed in 2010‒2013 went above 28% (Soquel 9a) for wood scour pools, and most ranged 10‒15% (**Table 2**). Zayante 13a, Zayante 13d and Soquel 3a averaged only 8%, 3% and 7% of the pools, respectively.

Perched Riparian Wood Density. Density of perched riparian trees/logs was above average (average = 36) for Zayante 13a (41) and below the average for Zayante 13d (27) and Soquel 3a (28) (**Table 3 and Figure 5**). All 3 reaches compared favorably to Gazos (24), Waddell (20) and Scott creeks (37) (**Leicester 2005**). However, all 3 reaches had higher perched hardwood densities and lower perched conifer densities than these 3 reference streams. The Zayante 13i reach had the highest density of perched conifer and hardwood trees/logs by far (89) of any reach or overall stream surveyed thus far, and, therefore, had the highest potential recruitment of perched trees/logs to the active channel in the event of a large stormflow capable of undermining those trees.

The relatively higher densities of perched trees in surveyed upper reaches of some watersheds in 2010‒2013 are to be expected when compared to perched densities in Gazos, Waddell and Scott creeks because lower reaches of watersheds that are included in those 3 creeks' overall densities tend to have lower perched tree densities, especially conifers. Nine of 15 reaches surveyed in 2010-2013 had higher perched tree densities than those 3 creeks.

Table 2. 2010−2014 Densities (pieces/ 1000 ft) of In-channel Wood Providing 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	–
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- 2010 (S)	2.5	6	8.5	16
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
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 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	6.2	5.7	11.8	14.2

*** 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**).**

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
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 (2010)	Perched Riparian	21.5	67.5	89
Bean 14b (2010)	Perched Riparian	0	24	24
Bean 14c (2011)	Perched Riparian	7	30	37
Fall 15a (2014)	Perched Riparian	4	15	19
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 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	5.8	27.7	33.4

*** From Leicester (2005).**

Riparian Wood Density Beyond the Perched Zone. Of the 2013 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 Figure 5**). All 2010−2013 surveyed segments except Zayante 13i and Bear 18a (with their narrow riparian widths) had higher hardwood riparian densities than those 3 creeks, especially Zayante 13a, Soquel 3a, Soquel 7, Soquel 9a, Soquel 12a and Bean 14b, all with 2–3 times as much. 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, Branciforte 21a-2, Soquel 12a, Corralitos 3 and Corralitos 5/6, one of which was surveyed in 2013.The much above average riparian density in Zayante 13d was due to much above average conifer density and near average hardwood density. The much above average riparian density in Soquel 3a was due to much above average hardwood density. The below average riparian density in lower Zayante 13a was due to very low conifer density.

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
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 (2010)	Riparian Beyond Perched	7	13.5	20.5
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
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	144
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 4 (2014)	Riparian Beyond Perched	51	48	99
Corralitos 3 (2010)	Riparian Beyond Perched	73	62	79
Corralitos 5/6 (2012)	Riparian Beyond Perched	70	43	113
Corralitos 7 (2014)	Riparian Beyond Perched	123	50	173
Average	Riparian Beyond Perched	36.8	65.1	100.2

*** From Leicester (2005).**

<u>Upslope Wood Density.</u> Upslope wood density 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. All 3 segments surveyed for upslope densities in 2013 had relatively low upslope densities because the riparian width was wide in Zayante 13d and Soquel 3a, and it extended out as far as encroaching development in Zayante 13a. Streamside residences were in close proximity to the creek in Zayante 13d but most residents left much of the trees standing. Zayante 13d had the highest upslope density beyond the riparian (25 trees/logs per 1,000 feet; 22 as conifer). Zayante 13a was second (18 trees/logs per 1,000 feet; 3 as conifer) and Soquel 3a with its wide riparian corridor had the lowest density of any reach surveyed thus far (5 pieces per 1,000 feet; 1 as conifer). The upslope densities of trees/logs all three 2013 reaches were well below the range of densities for Gazos, Waddell and Scott creeks (**Table 5 and Figure 5**).

If riparian or upslope conifers were to be cut to supply instream structures or catcher logs, ample conifers (primarily redwoods) would be available in all 2010−2013 surveyed segments except Zayante 13a, Zayante 13c, Bean 14b, Soquel 3a and Soquel 7. However, buy-in from streamside residents would be required to use their trees.

Table 5. Wood Density (Live and Dead) in the UPSLOPE BEYOND THE RIPARIAN ZONE and Within 75 Feet of the Bankfull Channel of 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
Zayante 13a (2013)	Upslope	3	13	18
Zayante 13c (2010)	Upslope	6	64	70
Zayante 13d (2013)	Upslope	22	3	25
Zayante 13i (2010)	Upslope	115.5	28.5	144
Bean 14b (2010)	Upslope	1.3	4.4	5.7
Bean 14c (2011)	Upslope	82	17	99
Fall 15a (2014)	Upslope	97	52	149
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 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	56.2	25.8	82.1

*** 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. If it is decided that naturally occurring wood clusters must be modified for safety reasons, cut and remove a minimum of instream wood. Mitigate by installing instream wood clusters elsewhere in the reach.

3. If funds are available, initiate a program to artificially introduce secured redwood logs (preferably with attached rootwads) to the stream channel, with a goal of increasing wood-scoured pools containing structure-forming wood to at least 50%. An additional goal should be to increase the frequency of structural in-channel wood to within the "good" range (NOAA Fisheries restoration guidelines (**J. Ambrose, personal communication**) of 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. This should be done for every 1,000 feet of stream.

4. Establish an educational outreach program for streamside residents in the vicinity of intended enhancement to facilitate local cooperation.

5. The intent of habitat enhancement with wood should be to place the most wood into the channel as cheaply as possible. Onsite sources of logs are preferable to offsite. Engineered, cabled wood clusters should be avoided due to their relatively high cost/ benefit ratio. Placement of secured catcher logs which will gradually accumulate instream wood during ensuing winter stormflows is the preferred technique.

6. Felling of large, tall redwood trees in close proximity to the stream channel is recommended to make vehicular access less important for wood placement. It may be possible to wench cut logs into place without the need for heavy equipment. Felling of a relatively small number of redwoods in each reach will not significantly reduce stream shading or increase streambank erosion.

7. Position catcher logs that extend into the low-flow channel where they may be wedged between existing trees to help secure them in place most cheaply by cabling. These locations would preferably be at the heads of existing pools or where new pools may be scoured, allowing high flows to spread out to provide backwaters for overwintering fish. If trees may be felled into place, so much the better. Bedrock streambed should be avoided because added wood would have the lowest potential to create complexity.

8. Prior to introducing wood to the stream and floodplain, collect fall baseline salmonid density and habitat data in the stream segments to be enhanced.
9. Annually monitor salmonid density and habitat in enhanced segments to assess benefits of wood placement.

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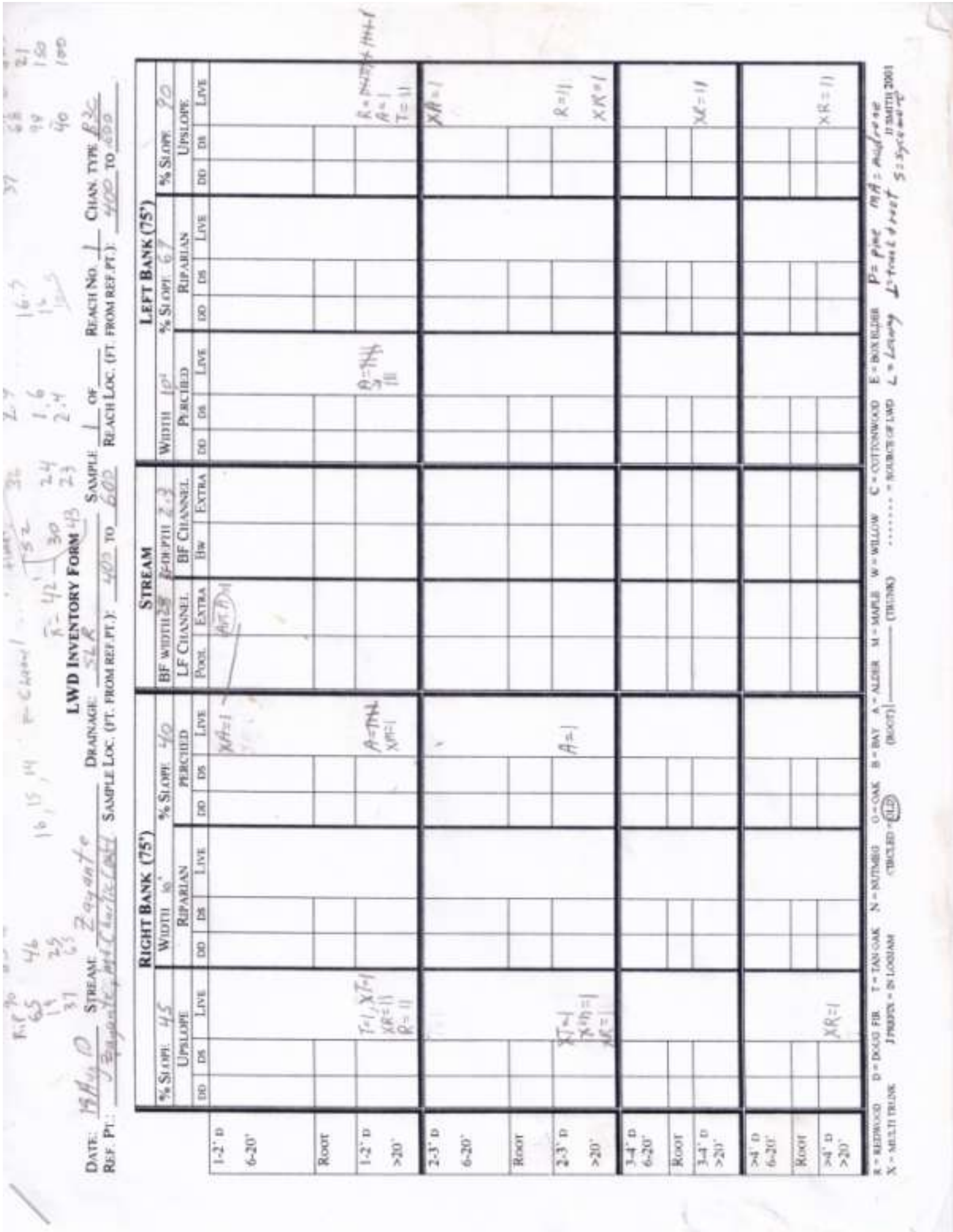


Figure 1. Wood Survey Data Sheet (from Leicester's Thesis (2005)).

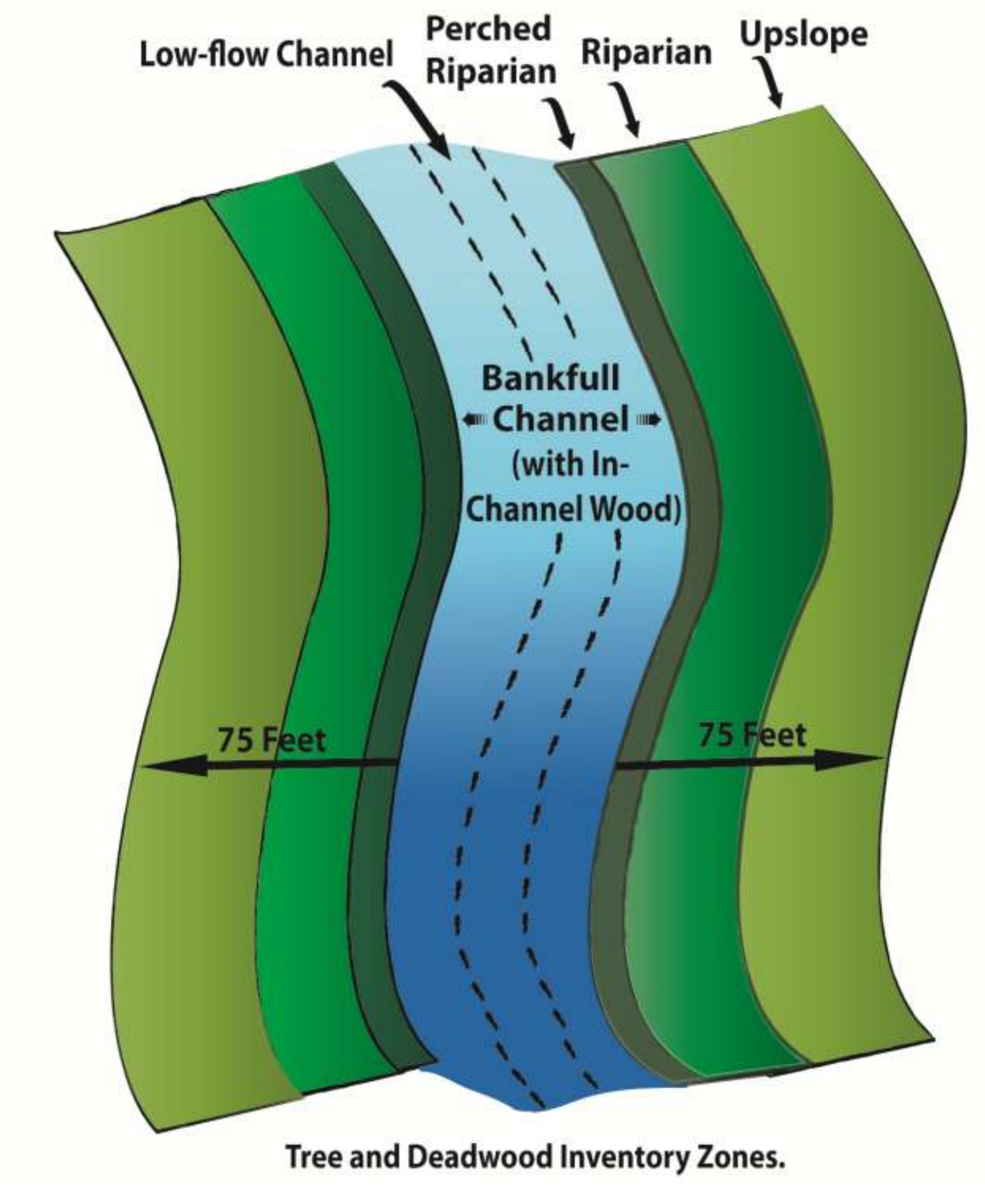


Figure 2. Tree and Deadwood Inventory Zones.

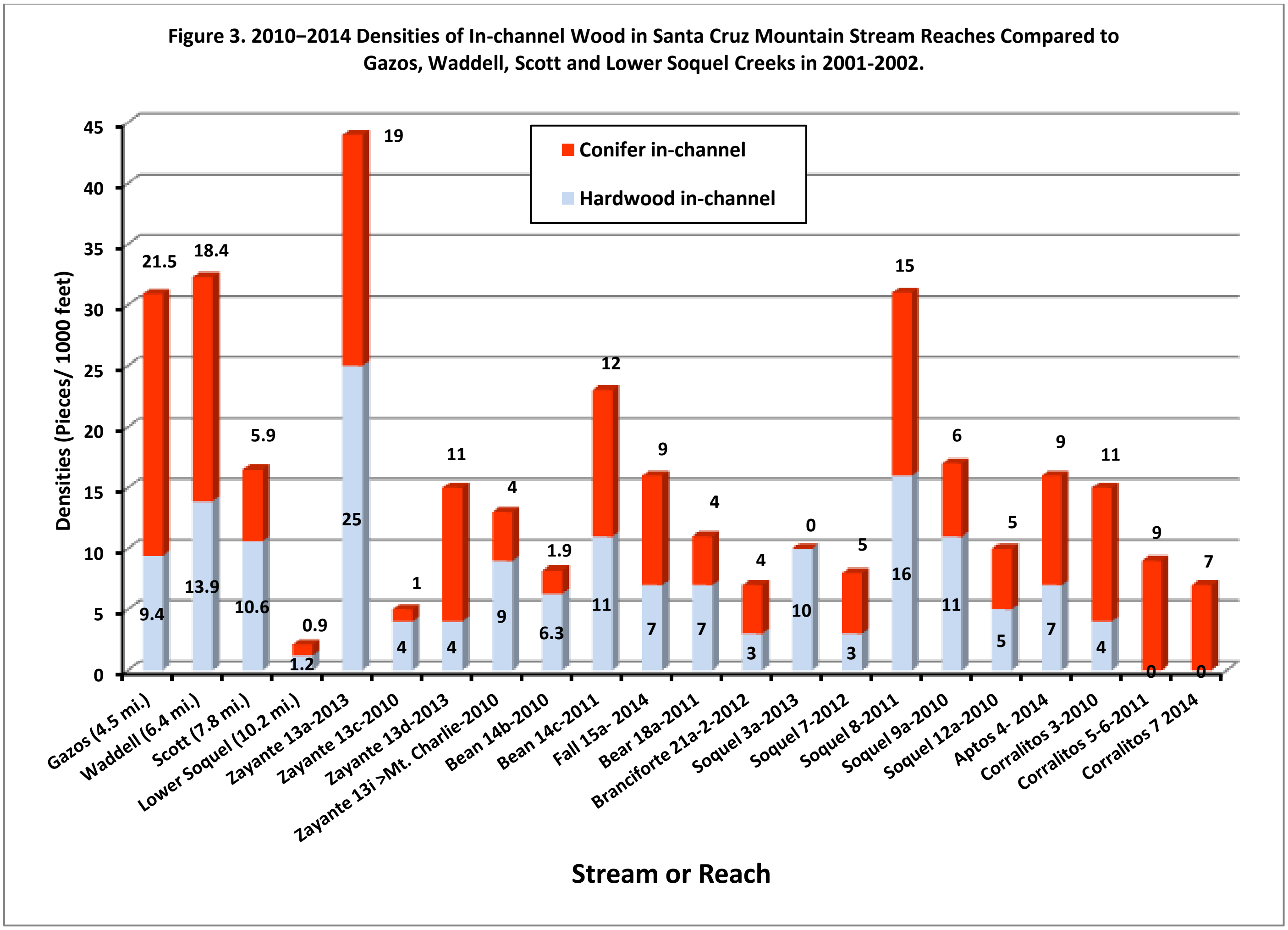


Figure 3. 2010–2014 Densities of In-channel Wood in Santa Cruz Mountain Stream Reaches Compared to Gazos, Waddell, Scott and Lower Soquel Creeks in 2001-2002.
Conifer in-channel
Hardwood in-channel
Densities (Pieces/ 1000 feet)
Stream or Reach
Gazos (4.5 mi.)
Waddell (6.4 mi.)
Scott (7.8 mi.)
Lower Soquel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

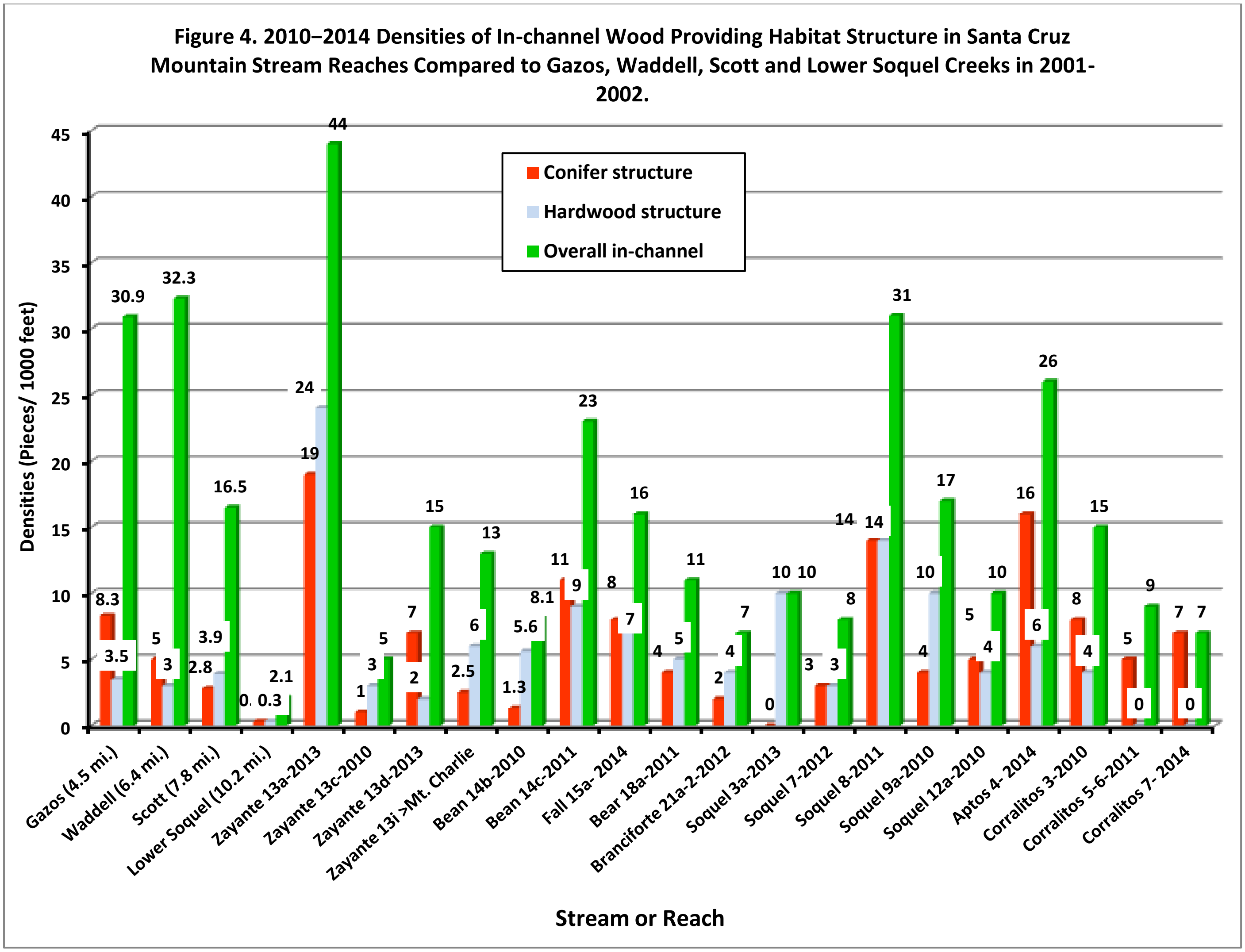
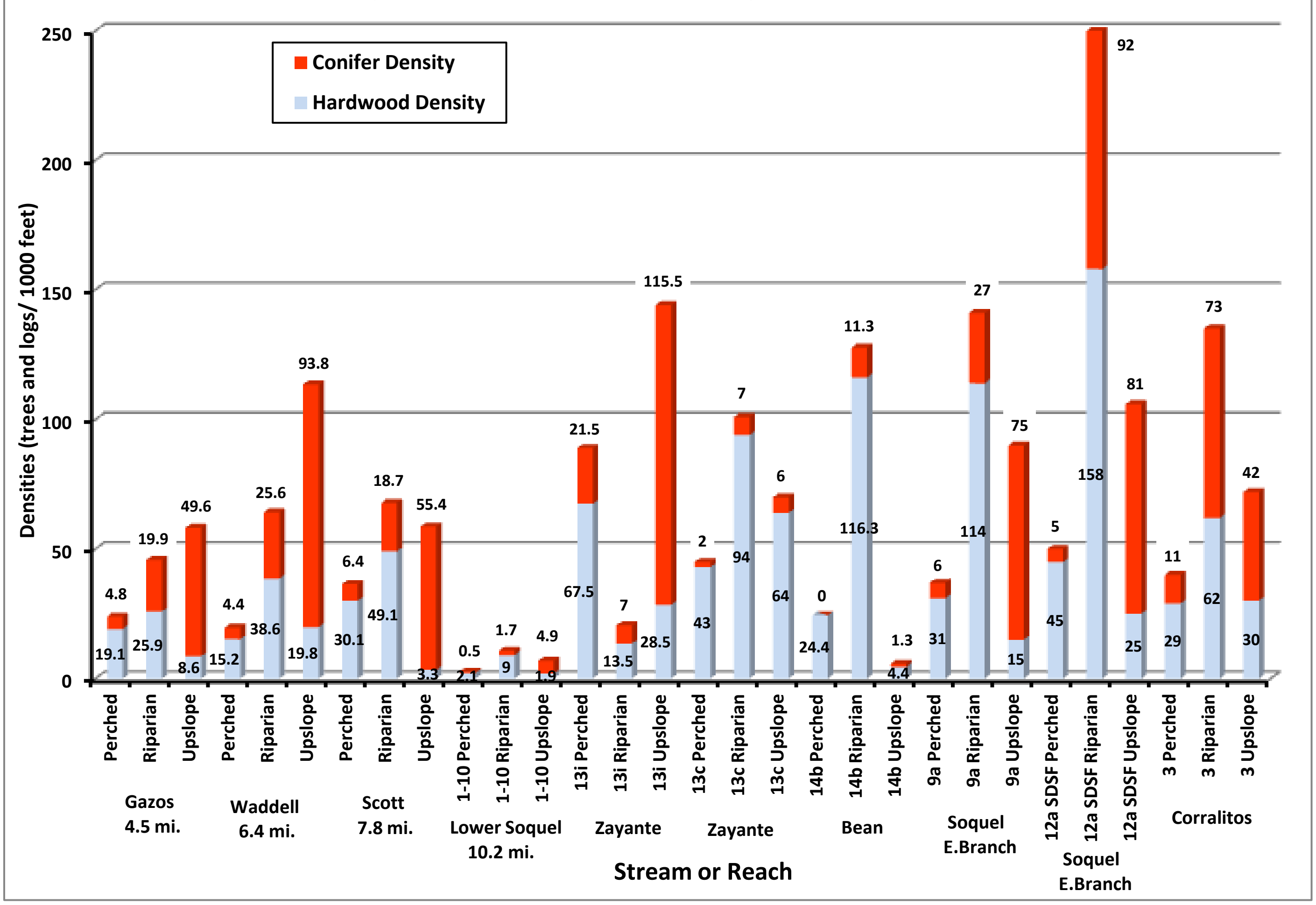


Figure 4. 2010–2014 Densities of In-channel Wood Providing Habitat Structure in Santa Cruz Mountain Stream Reaches Compared to Gazos, Waddell, Scott and Lower Soquel Creeks in 2001-2002.
Conifer structure
Hardwood structure
Overall in-channel
Densities (Pieces/ 1000 feet)
Stream or Reach
Gazos (4.5 mi.)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



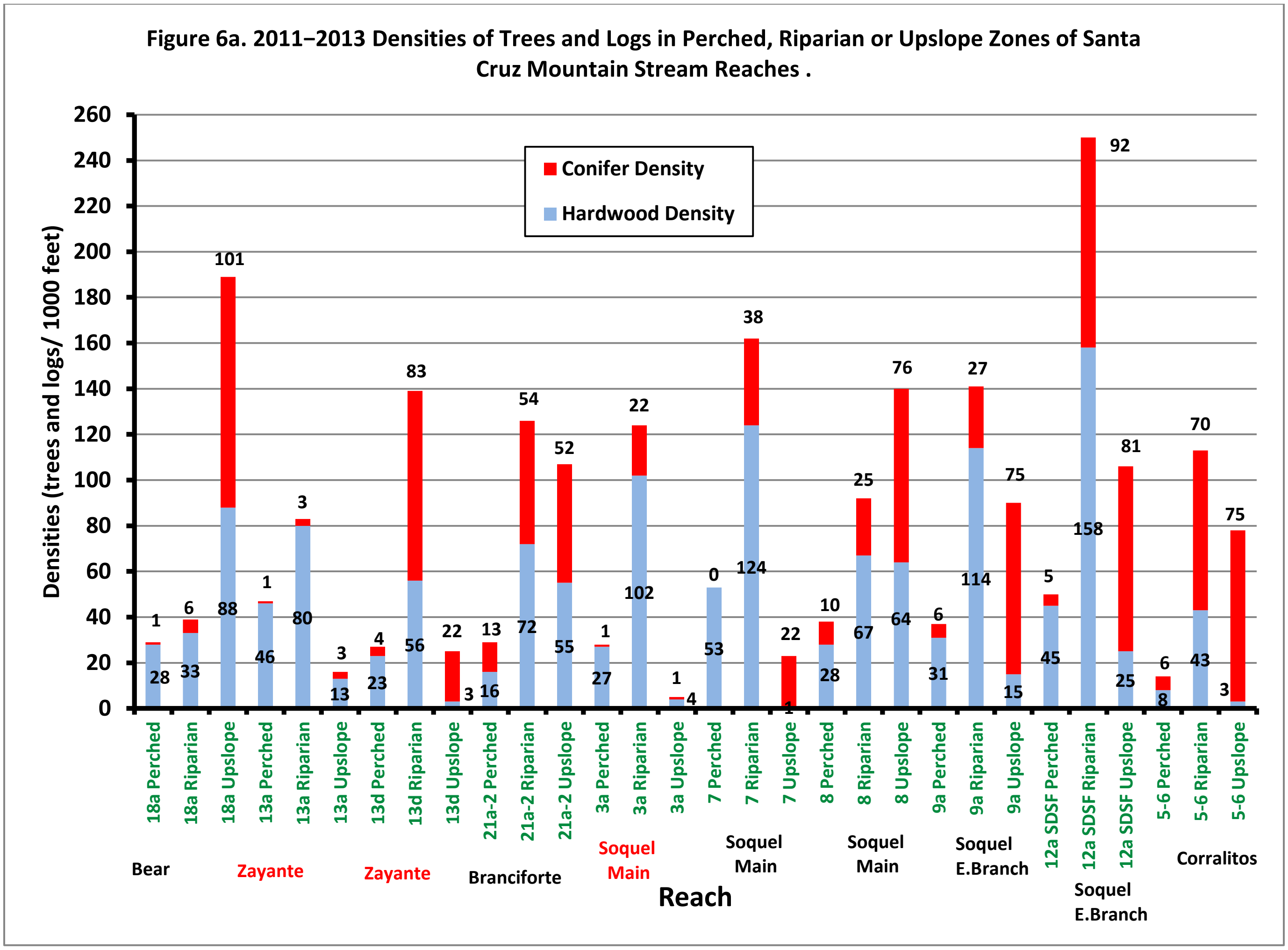
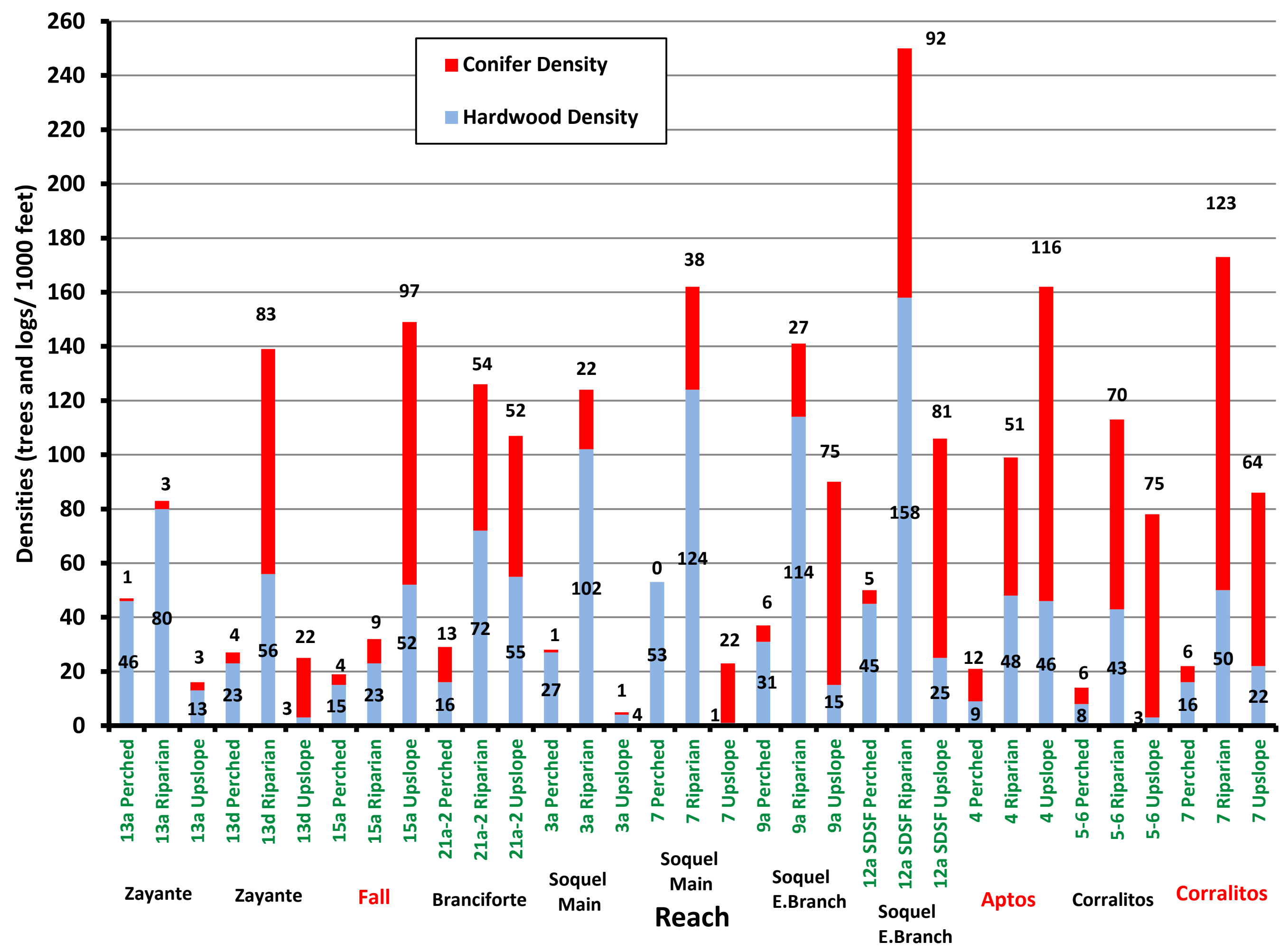


Figure 6a. 2011–2013 Densities of Trees and Logs in Perched, Riparian or Upslope Zones of Santa Cruz Mountain Stream Reaches .
Conifer Density
Hardwood Density
Densities (trees and logs/ 1000 feet)
Reach
18a Perched
18a Riparian
18a Upslope
13a Perched
13a Riparian
13a Upslope
13d Perched
13d Riparian
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 .



APPENDIX A. WATERSHED MAPS

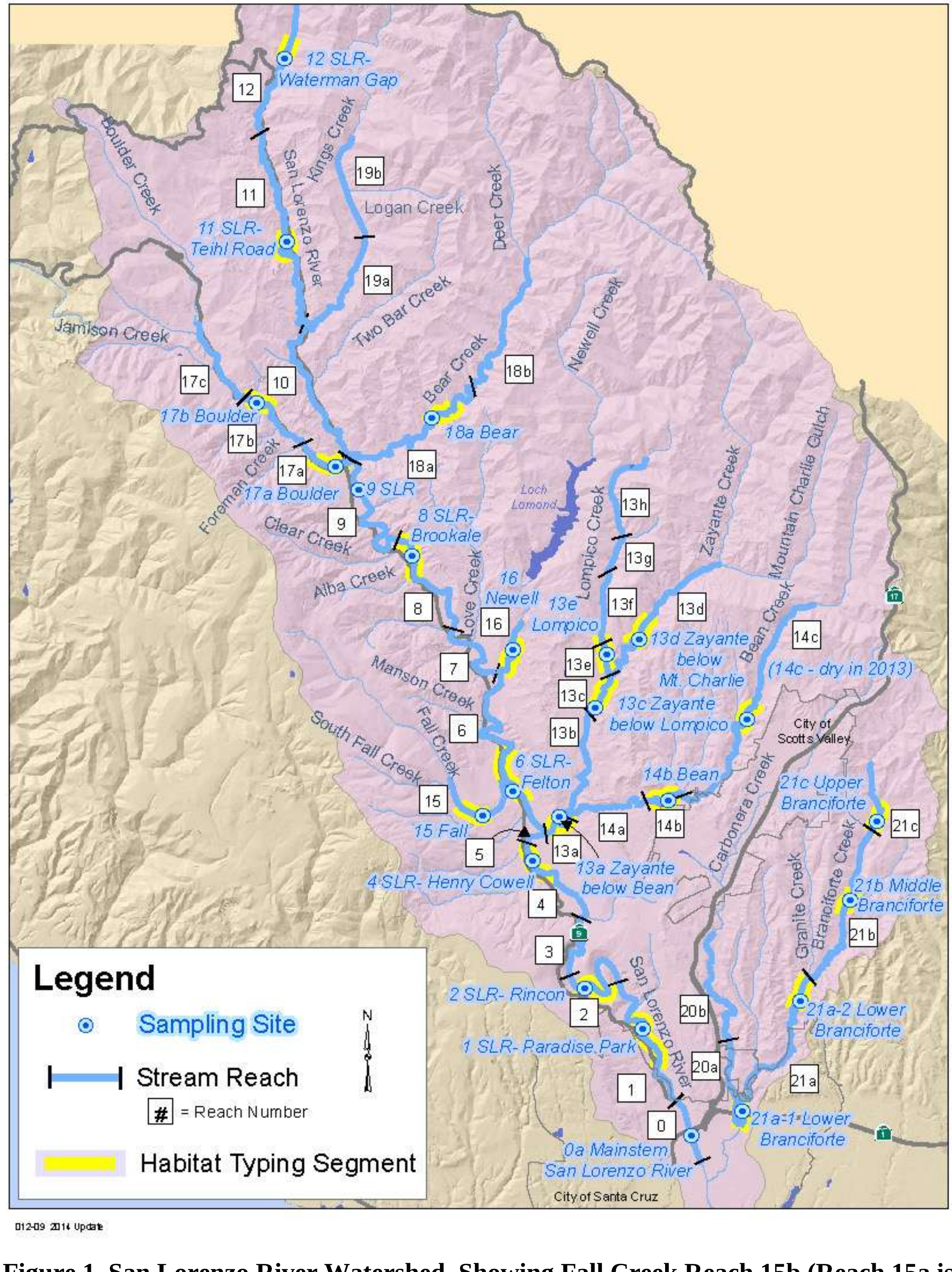


Figure 1. San Lorenzo River Watershed, Showing Fall Creek Reach 15b (Reach 15a is downstream of Reach 15b).

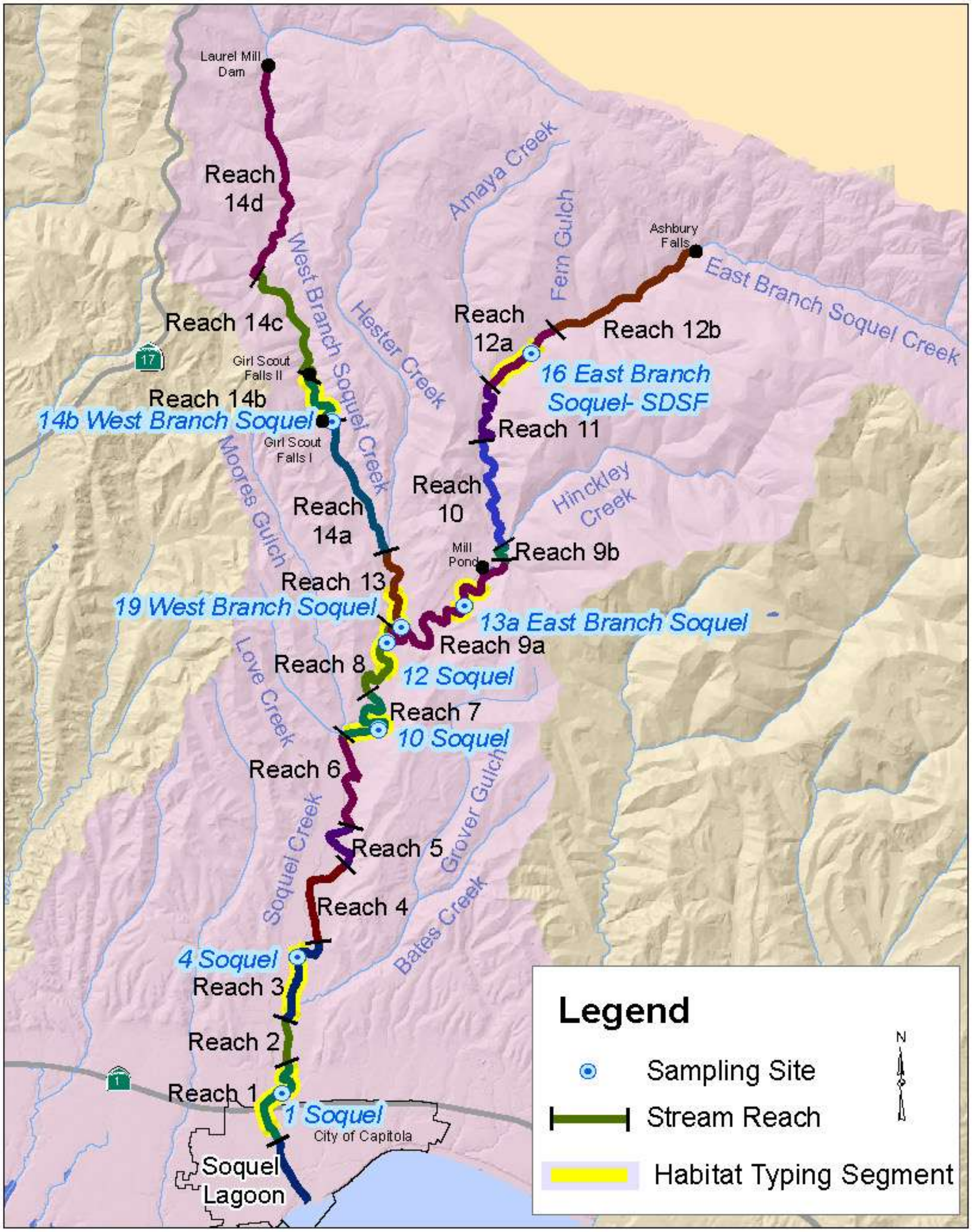


Figure 2. Soquel Creek Watershed, Showing Reach 3a (yellow).

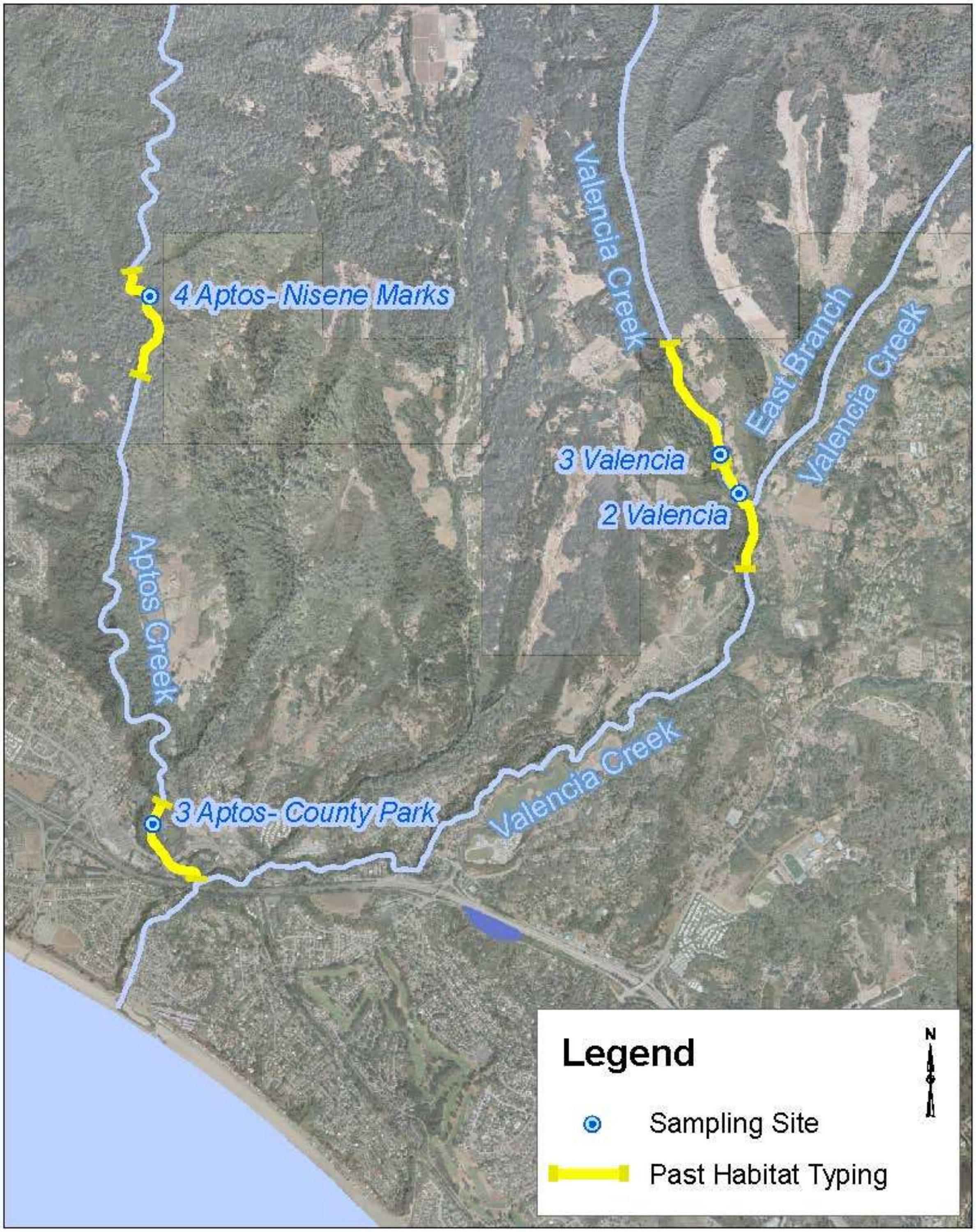


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Figure 3. Aptos Creek Watershed.

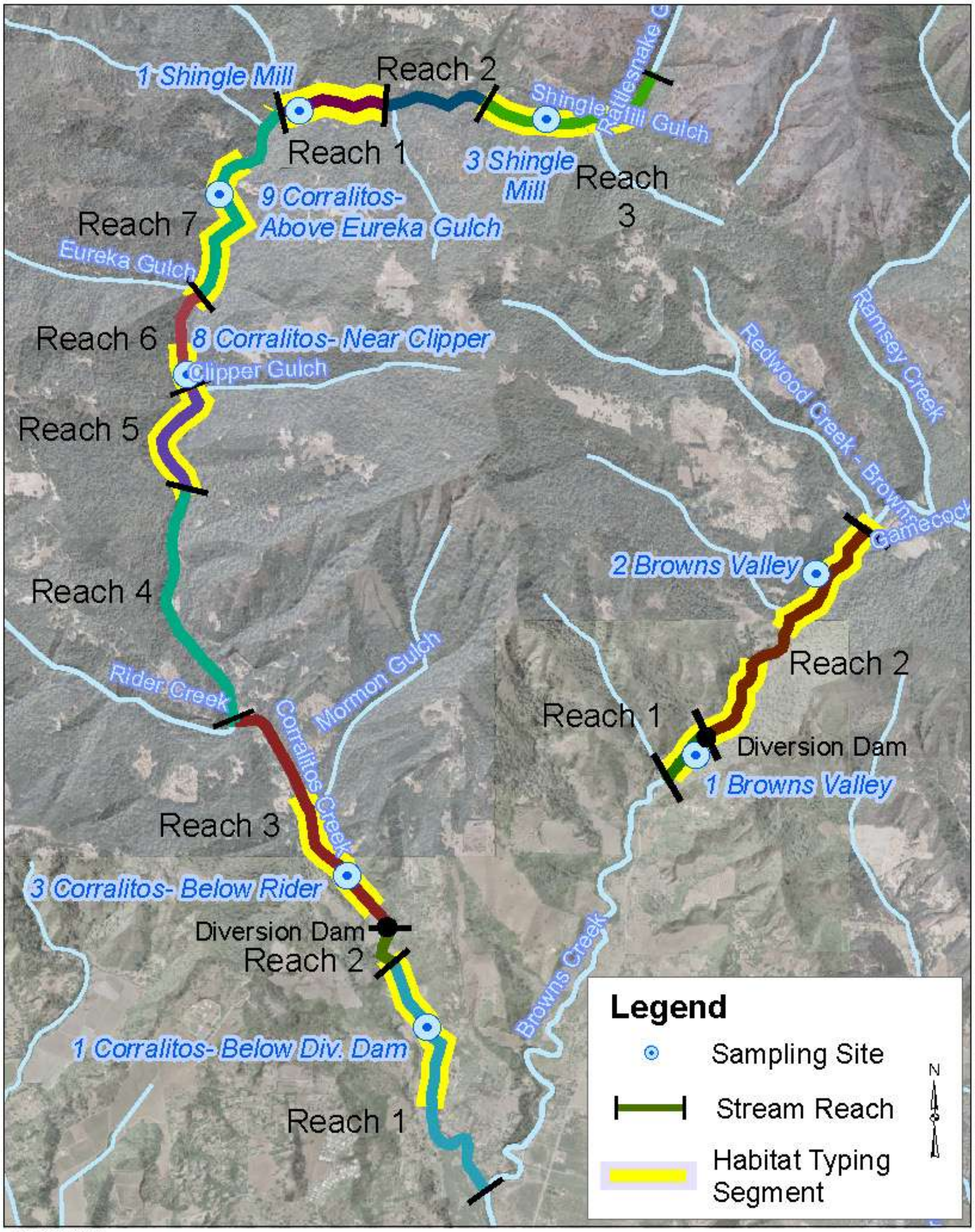

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Figure 4. Upper Corralitos Creek Sub-Watershed.