March 2013

Ms. Leslie Koenig, Alameda County RCD
Ms. Katie Bergmann, USDA NRCS
By electronic delivery

Re: Results of Stonybrook Creek pool/spawning habitat survey and fish sampling

Prepared by Gordon Becker, Center for Ecosystem Management and Restoration

Introduction

Alameda County's Stonybrook Creek has been of interest to members of the Alameda Creek Fisheries Restoration Workgroup (Workgroup) for a number of years for its potential to support steelhead/rainbow trout (*Oncorhynchus mykiss*)[1]. Previous work in the drainage includes pool surveys, radio tracking of tagged steelhead, streamflow monitoring, and passage barrier survey and removal study, among other efforts. An ongoing volunteer program also seeks to stay ahead of a steady pattern of illegal dumping into the creek.

From its confluence with Alameda Creek upstream for about two miles, Stonybrook Creek is a high-gradient stream with boulder and cobble dominating the substrate composition. At the top of Stonybrook Canyon, slope drops and finer sediments form the bed. The lower pool frequency upstream from the canyon, combined with substantially greater land use intensity, suggests that the creek's potential salmonid habitat occurs predominantly in these lower two miles.

Two total barriers to fish passage occur where Palomares Road crosses the stream about one mile up the creek for which removal conceptual designs have been developed (Winzler & Kelly *et al.* 2005). These projects would be complex, expensive and inconvenient for travelers on Palomares Road during the period of construction. Additional passage barriers also occur upstream from the two road crossings. The situation leads to the question: "What is the value of implementing the migration barrier removal project?"

The current study was conducted to characterize available habitat in the creek so that resource agency staff and other interested parties have sufficient information to make decisions about management "next steps." In particular, we sought to compare pool volume and distribution downstream and upstream from the major migration barriers to shed light on the relative value of the reaches for rearing juvenile *O. mykiss*. We also documented spawning habitat suitability below and above the culverts to confirm that potential rearing habitat could be "seeded."

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[1] For purposes of this report, the term *O. mykiss* is used to reflect uncertainty about the ancestry of SH/RT observed in Stonybrook Creek and their proclivity to express a stream maturing (*i.e.,* "resident") versus anadromous (*i.e.*, "steelhead") life history pattern. The terms "steelhead" or "rainbow trout" are used where residency or anadromy is known.

Approach

The survey entailed securing access permits from local landowners. Staff at the Alameda County Resource Conservation District (RCD) contacted landowners who mostly granted access. Fieldwork was conducted by CEMAR staff with assistance from RCD and Natural Resources Conservation Service (NRCS) staff.

The goal of the study, comparing cumulative pool volume in the lower reach (downstream from the downstream total barrier) and the upper reach (upstream from the downstream total barrier), did not require calculating *absolute* volumes. Rather, we used a simple measurement approach that would allow us to move quickly through the study area while providing a consistent *standard* volume calculation method that would produce a reasonable estimate of *relative* cumulative volume. At each pool unit greater than five feet in length or width, we determined maximum length (L_{max}), maximum width (W_{max}), and maximum depth (D_{max}), at a resolution of 0.1 feet. Standard volume (V_{std}), was later calculated as $V_{std} = L_{max} \times W_{max} \times D_{max}$.

The survey was conducted in October, after water had disappeared from most pools or lowered from their "filled" level. The study design therefore involved determining the elevation of the hydraulic control of the pool (*e.g.*, riffle crest thalweg), leveling our tape (with a post leveling tool modified for the purpose), and measuring the distance to the upstream extreme of the pool boundary. Width was taken perpendicular to the length line at the pool's widest point, and depth was measured between the lowest point in the pool and the leveled tape. In the field, however, we rarely needed to evaluate the hydraulic control, as virtually every pool had a "bathtub ring," or mineralogical discoloration, that we assume indicates the water surface elevation when pools are "full" during winter baseflow.

Where pools contained water at the time of the survey, we measured depth in two parts: lowest point in pool to water surface elevation (WSE) and WSE to leveled tape (or "bathtub ring"). This technique allowed us to compare both cumulative *available* pool volume and *potential* pool volume between the two reaches.

At pool tails and runs with suitable spawning gravels (0.08-2.5 inch diameter), we performed an embeddedness test as described in the California Salmonid Stream Habitat Restoration Manual. Potential spawning patches were evaluated if they were 0.6 feet or greater below the "full" pool elevation. We selected five cobbles with diameter between 2.5 and 5.0 inches and recorded the percentage of the cobble that was "shiny" over the percentage that was "dull." Values of 1 to 5 were assigned according to the protocol and the suitability of the spawning patch was evaluated.

The location of individual pools was noted in relation to mile markers (MM) present on Palomares Road. At several points, Global Positioning System (GPS) coordinates were taken to facilitate mapping. At selected pools with standing water, we measured water temperature. In some instances, additional notes were taken to help planning of future creek cleanup and other restoration activities.

During the first day of the survey, the team observed *O. mykiss* in several pools (Photo 1). The locations of these pools were noted, and the scope of work was later expanded to include fish sampling at these locations. This effort was led by East Bay Regional Park District (EBRPD) staff with assistance from CEMAR.

We used a 0.5-millimeter mesh size seine, dip nets, and a Smith-Root Model 12-B POW electrofisher to capture fish in four pools. For each individual, we recorded species, fork length (FL), total length (TL), and weight in grams (g). Tissue samples were taken from the top lobe of the caudal fin. We attempted to collect a minimum of 24 *O. mykiss* tissue samples for a robust genetic analysis. Scale samples were taken from the same individuals sampled for tissue. Scales were removed from the left side between the posterior insertion of the dorsal fin and the anterior insertion of the anal fin. Both tissue and scale samples were placed in coin envelops and labeled in preparation for later analysis.[2]

Results and Discussion

Pool and Spawning Habitat

Lower Canyon (River Mile 0.00 to 0.98)

On October 18th, we completed the pool survey for the lower reach, downstream from a total passage barrier (Stobk#2) at River Mile (RM) 0.98. (Deeper, wetted pools and important passage barriers in the lower canyon are shown on Figure 2. Field data and calculations are presented in Appendix A.) The reach length was about 0.9 miles and contained 49 pool features, almost all of which were bedrock controlled (Photo 2). Pools had a mean V_{std} value of about 450 cubic feet at an average depth of 1.6 feet. The cumulative V_{std} estimate for the lower canyon is 22,130 cubic feet (ft^3).

Eighteen of the pools (39 percent) contained water at the time of the survey, at an average depth of 1.2 feet. The calculated standard wetted (*i.e.,* available) pool volume was about 8,113 ft^3. Only eight pools in the lower reach are greater than 2.0 feet deep when "full," and only three pools in the lower reach had more than 2.0 feet of water at the time of the survey. (Pools greater than 2.0 feet deep are assumed to be important for juvenile rearing either to sexual maturity (for resident fish) or growth to large smolt size (for anadromous fish)). Water temperatures ranged between 14.4 and 16.7 degrees Centigrade (C).

Wetted pools on average were about 1.8 feet deep, less than 13 percent deeper than the average for all pools in the reach. We suspect that pools that hold water throughout the dry season do so because of their position in relation to the water table. The creek bed appears

[2] Tissue samples will be analyzed at the National Marine Fisheries Service's Fish Ecology Laboratory in Santa Cruz, California by arrangement with the San Francisco Public Utilities Commission. Results will be discussed at a regular meeting of the Workgroup. Scale sample analysis results are discussed generally in this report, with additional detail available by request.

to intersect bedrock at intervals throughout the canyon, interspersed with portions where it passes through alluvium and colluvium. Perennial pools likely occur where groundwater is "perched" on bedrock in little or no alluvial/colluvial cover.

Within the reach we observed four areas of suitable spawning substrate. Mean cobble embeddedness was estimated at 3, 3.3, 1.4 and 1.4 at these patches (with a value of 5 indicating unsuitable substrate). Spawning habitat is extremely limited but production, based on the presence of juvenile *O. mykiss* in proximate pools, appears sufficient to saturate available pool rearing habitat.

Upper Canyon (RM 0.98 to RM 2.05)

The survey upstream of "Stobk#2" barrier was completed on October 31 and consisted of about 1.1 miles. (Deeper, wetted pools and passage barriers in the upper canyon are shown on Figure 3.) We observed 62 pools with a mean V_{std} value of about 485 ft^3 at an average depth of 1.7 feet. Thirty-two of these pools (52 percent) were wetted and had average water depth of 1.0 feet, with a distance of 0.6 feet between the WSE and "full" pool depth. The estimated cumulative standard pool volume for the upper canyon reach was 30,220 ft^3, with about 7,640 ft^3 containing water (*i.e.,* available) at the time of the survey. Mimicking the results from the lower reach, eight pools in the upper reach are greater than 2.0 feet deep when "full," and three pools had more than 2.0 feet of water at the time of the survey. Water temperatures were measured in the range of 13.4-13.7° C.

Spawning gravel patches were even more limited in the upper reach than in the lower. We observed only one patch with suitable gravel diameter and at sufficient depth to appear suitable as spawning substrate. We measured mean cobble embeddedness at this location as 1.4. This patch (between pools US25 and US31 on Figure 3), while suitable for spawning, is located upstream from only six pools deeper than 0.7 feet, one of which contained more than 2.0 feet of water at the time of the survey. Assuming *O. mykiss* fry occupy habitat downstream from the gravels from which they emerge, spawning at the identified patch could "seed" about 30 percent of mapped upper canyon pool volume.

It should be noted that habitat information provided as part of a road crossing inventory (Love 2001) includes reference to spawning gravel observed upstream and downstream from "Stobk#5". These gravels may have been eroded (and not replaced) in the roughly 11-year period since the last survey, or buried. Alternately, the patches observed in 2001 may have been deemed in the current study to be under insufficient water depth (minimum 0.6 feet) at winter baseflow (indicated by "full" pool level) to be suitable for spawning.

In summary, the upper canyon contains greater cumulative *potential* pool habitat than the lower canyon, and the downstream and upstream reaches offer approximately equal estimated *available* (*i.e*., wetted) over-summering habitat. Favorable surface geology appears to account for the similar volume of available pool habitat in the upper reach, despite the reach having a smaller contributing watershed area. Spawning habitat in the upper canyon is notably scarce and may not be located favorably to "seed" much of the available over-summering habitat.

Fish Sampling

On October 31, staff from EBRPD and CEMAR sampled pools previously observed to contain *O. mykiss*. Four pools produced a total of 50 individuals which were processed with the following results: FL min, 43 mm; FL max, 274 mm; mean FL, 86 mm; TL min, 46 mm; TL max, 287 mm; mean TL, 92 mm; weight min, 0.8 g; weight max, 135 g; mean weight, 17 g. Sizes are depicted in Figure 1.

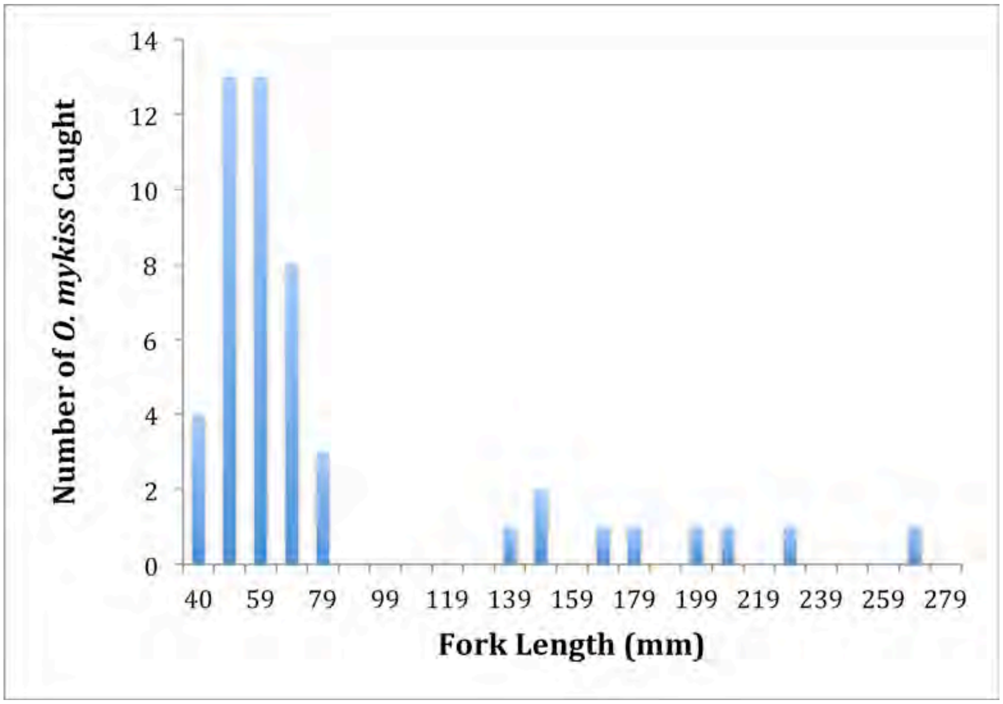

Figure 1. Length-frequency distribution for 50 Stonybrook Creek *O. mykiss.*

Scale pattern analysis indicates that the Stonybrook Creek population consists of only two year classes: age 0+ (young of the year) and age 1+ (including some sexually mature individuals). The age 1+ fish had a broad size distribution and, in some cases, were able to achieve very large fork lengths, indicating that very fast growth is possible for some fish (mean FL, 213.4 mm; standard deviation (SD), 38.0 mm; FL min, 165 mm: FL max, 287 mm; number (n), 8). A scale length/fork length linear regression model (R^2=0.97) was generated from 26 scale samples, which allowed for back-calculation of size at age 1 for the 1+ fish. Mean FL at age 1 for these eight fish was 96.7 mm (SD, 9.3 mm; min, 86.8 mm; max, 115.7 mm). Assuming fry emergence on April 1, average growth rate is estimated at 0.55 mm/day during months 13-19. This value is higher than we expected for *O. mykiss* in a system like Stonybrook Creek with very low summer streamflow.

The mean FL of 0+ fish captured on October 31 was 62.3 mm (SD, 10.6 mm; min, 43 mm; max, 88 mm). In order for these fish to achieve the same size as the age 1+ fish by April 1, they will need to grow at a rate of 0.23 mm/day, on average, during months 8-12. With available information, it is impossible to determine whether or not the 96.7 mm value at age 1 represents a consistent threshold value for survival across multiple years. Future study could investigate this question further and determine the degree to which inter-annual variation in flow regime or other factors affects the value.

While our survey did not involve mark-recapture or other types of population estimation, a number of factors related to the Stonybrook Creek pool survey support a screening level population assessment of about 60-80 individuals for the entire canyon. Relevant background for the estimate includes: 1) the survey covered the vast majority of the canyon; 2) the only available habitat at the time of the surveys was in pools with limited cover; 3) the vast majority of the fish (45 of 50) were collected during one seine haul believed to have very high efficiency; 4) no fish were observed in the upstream reach; and 5) several pools contained *O. mykiss* that were counted (but could not be caught). We also propose that the population presently does not contain age 2+ or older individuals, as they would have been unlikely to escape detection. It is unknown if a fraction of Stonybrook Creek *O. mykiss* outmigrate and smoltify.

The Stonybrook Creek *O. mykiss* population appears to be self-sustaining by production from stream-maturing individuals. Fish that survive to sexual maturity appear to be concentrated in the few deeper pools that are found in the canyon. The fish may be the progeny of steelhead that entered the creek in 2008 after being moved upstream from the BART weir (on lower Alameda Creek), or residualized descendants of either steelhead that entered the creek prior to construction of the Alameda Creek Flood Control Channel or hatchery fish. Tissue analysis is likely to inform the question of ancestry.

Recommendations

Based on the information generated by this study, we can provide context for decision-makers regarding the potential modifications or removals of the total passage barriers at MM 8.75 ("Stobk#2") and 8.60 ("Stobk#3). We estimate that the removals would increase the available over-summering habitat in the canyon by about 45 percent. In combination with passage barrier projects at "Stobk#4" and "Stobk#5", the increase is estimated to be almost 95 percent. It should be noted, however, that the paucity of spawning habitat and its unfavorable distribution (toward the lower end of the upper canyon) might limit the potential contribution of these passage projects to the Stonybrook Creek fishery.

We also recommend that near-term work in Stonybrook Creek focus on mitigating a partial passage barrier in the lower canyon ("Private Drive" on Figure 2 and Photo 3). While this barrier has not been evaluated in detail, it appears to preclude movement at lower creek flows and may prevent outmigration or relocation to downstream pools during decreasing streamflow conditions in spring and summer. The barrier is located at RM 0.48, upstream from 7 of the 15 mapped pools in the lower canyon. The cost of removing this barrier is likely to be substantial, but the project would not involve the significant traffic management issues (and costs) associated with the Palomares Road creek crossings.

If access can be obtained, we recommend that this barrier be surveyed as soon as possible and plans developed to modify or remove it to improve migration conditions for juvenile and adult fish at the widest feasible range of flows. Optimally, a bridge supported outside of the active channel would be built, eliminating impacts on migration associated with the current structure. A possible change of ownership of the property where the culvert is located may allow for minimizing inconvenience associated with the barrier removal.

Implementing passage projects in a downstream to upstream direction represents a logical approach consistent with other restoration planning efforts. Near the mouth of Stonybrook Creek, the culvert under Niles Canyon Road ("Stobk#1" on Figure 2 and Photo 4) also forms a partial barrier to passage. Caltrans and other Alameda Creek watershed stakeholders are working to modify this barrier so passage is improved when the watershed is "opened" to steelhead in the next few years (by fish passage projects in the Flood Control Channel). The "Private Drive" project on Stonybrook Creek is both the "next step" in improving fish passage in the canyon and an opportunity to optimize habitat use and potential production by the existing *O. mykiss* population.

The "Stobk#2" and "Stobk#3" removals continue to offer valuable flood control and habitat benefits. Particularly as advancements are made toward restoring fish passage in the Alameda Creek Flood Control Channel and improving passage at "Stobk#1" and the "Private Drive", the owner of the Palomares Road crossings should develop plans to address passage at these locations or otherwise consult with the Department of Fish and Wildlife and the National Marine Fisheries Service regarding their disposition. If passage is provided into the upper canyon, spawning habitat also should be enhanced.

Additional recommended work related to Stonybrook Creek relates to water and land management. Ongoing efforts are characterizing streamflow in Stonybrook Canyon, and confirm that flow diminishes or ceases throughout the reaches studied here in the area's long dry season. However, even very low flows (*e.g.*, the 0.75 gallons per minute pool inflow measured on October 31) serve to moderate temperature and dissolved oxygen conditions sufficiently for *O. mykiss* survival. We therefore recommend extending hydrology investigations to provide information on water use upstream from the canyon. Specifically, we believe there may be opportunities to increase dry season streamflow in the canyon by reducing summer diversion rates. Such collaborative study with landowners in the valley area (upstream from Stonybrook Canyon) may offer the chance to examine spawning habitat resources there in greater depth.

Finally, we recommend collaborating with the Alameda Creek Alliance, Alameda County and potential funders to remove garbage from the creek. Five significant dump sites were observed during the surveys and some refuse (such as car batteries, light bulbs and chemicals) may be toxic and affect the biota of Stonybrook Creek. On a long-term basis, additional signage, public education and enforcement will be necessary to curtail this thoughtless behavior. We hope the present study will help increase awareness of the precious resources found in Stonybrook Canyon and foster their protection.

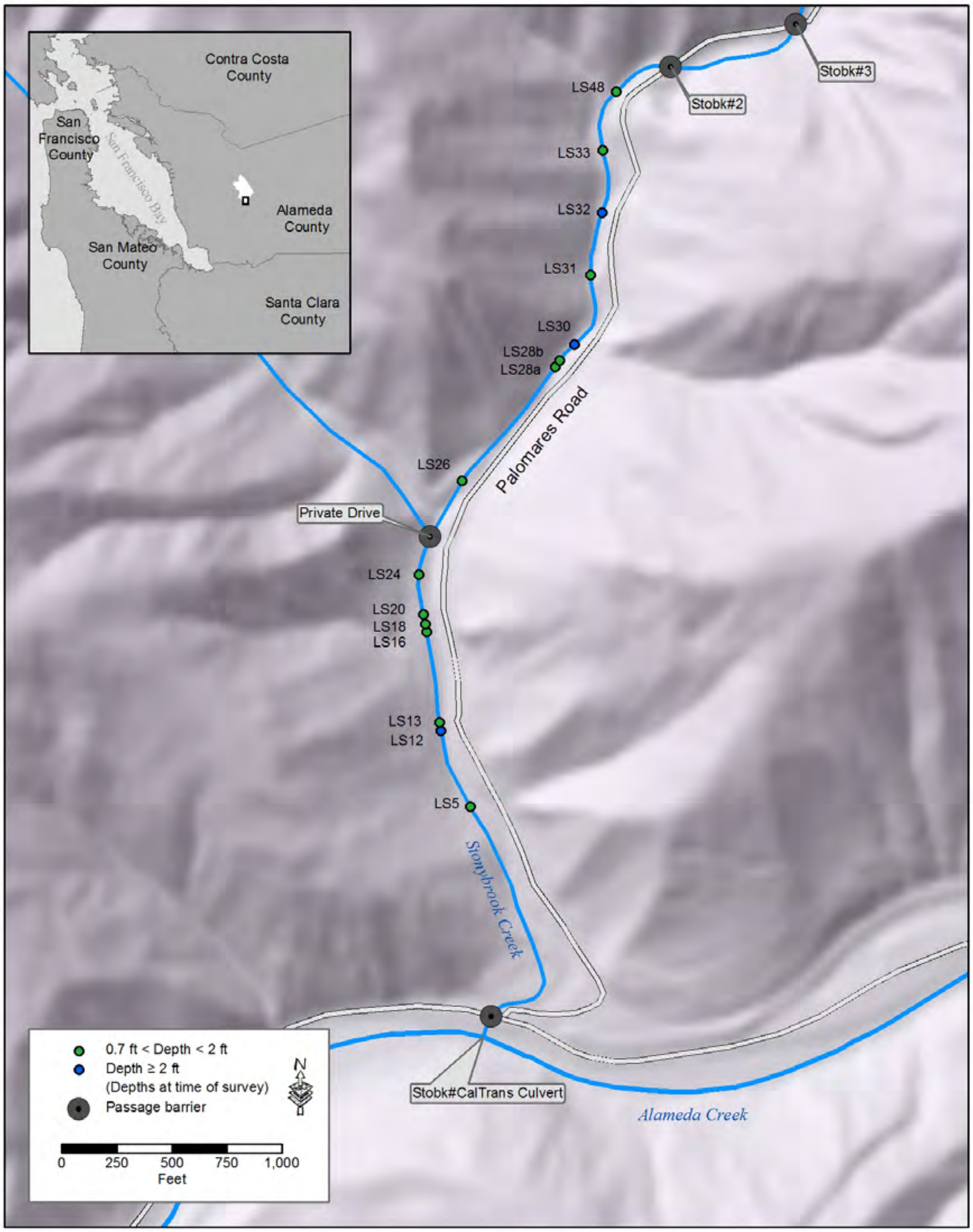

Figure 2. Stonybrook Creek wetted pools greater than 0.7 feet max depth, lower Stonybrook Canyon

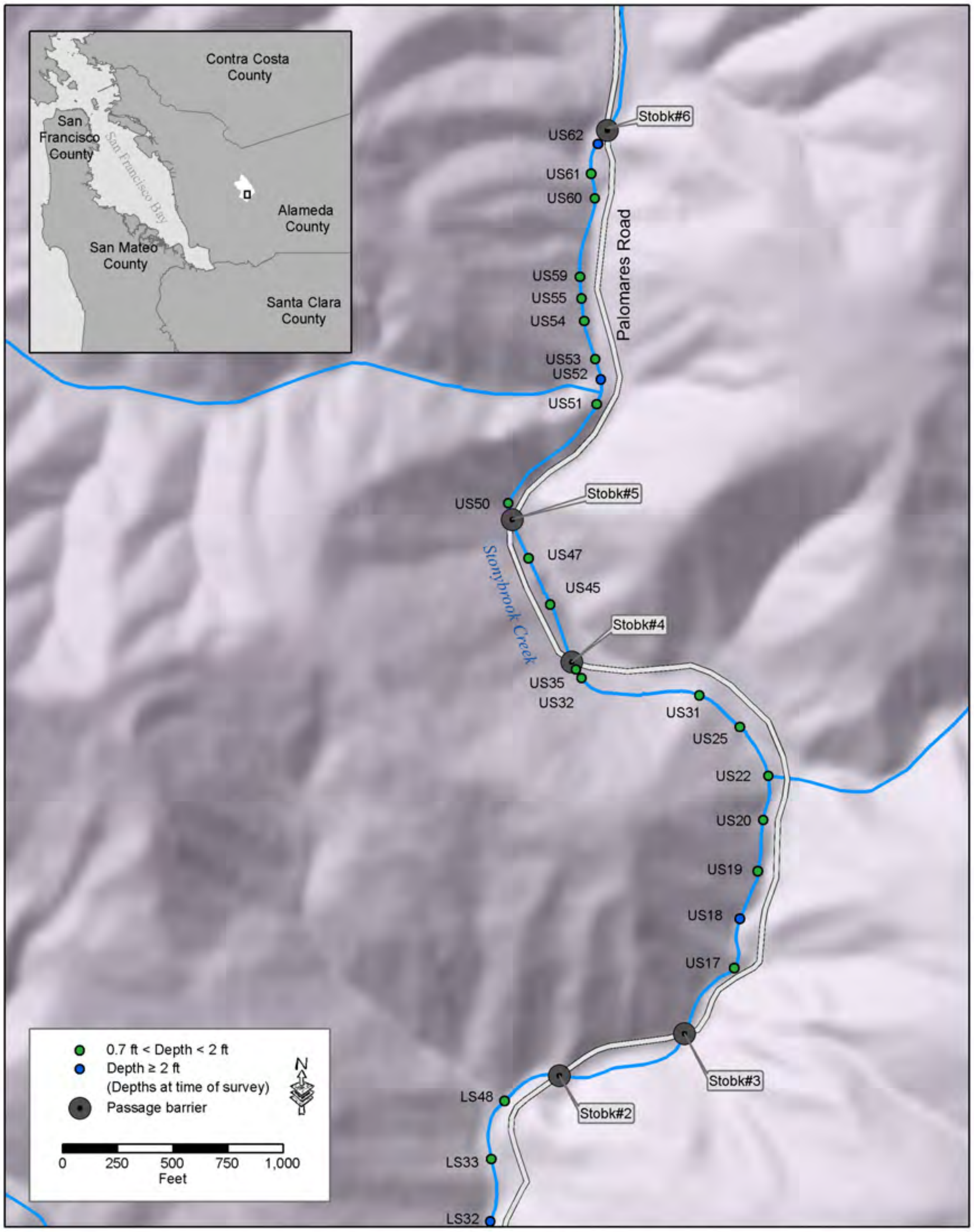

Figure 3. Stonybrook Creek wetted pools greater than 0.7 feet max depth, upper Stonybrook Canyon

Photo 1. Rainbow trout (*O. mykiss*) in Stonybrook Creek pool, October 31, 2012.

Photo 2. Representative lower Stonybook Creek perennial pool.


Photo 3. Culvert at Palomares Road MM 9.15


Photo 4. Stonybrook Creek culvert at Niles Canyon Road facing upstream.

Dates: October 18 and 31, 2012 Conditions: Sunny on 18th; Overcast on 31st.

Project Name: Stonybrook Creek Pool and Spawning Patch Survey

Purpose: Collect pool dimensions for analysis of O. mykiss habitat

Survey Party: Gordon Becker, Eric Huber CEMAR; Leslie Koenig, Alameda Co RCD; Katie Bergmann, USDA NRCS
CEMAR sponsored by the Alameda County Resource Conservation District

Notes: Pools surved on all accessible parcels in Stonybrook Canyon.
Pool locations mapped in survey report.
Pool depths measured to mineral "bathtub ring" present throughout canyon.

Pool #	L max (ft)	W max (ft)	D max (ft)	D H2O (max)	D to full	Notes	V std	V H2O
1	25.0	13.0	1.5				500.5	
2	10.0	7.0	1.6				109.2	
3	15.8	24.4	1.5				578.3	
4	16.5	15.2	0.8				210.7	
5	34.7	11.9	2.3	1.6	0.7		949.7	668.9
6	16.2	18.5	1.0			Spawning patch test	311.7	
7	17.4	9.2	1.5				241.7	
8	46.0	10.6	1.0				502.2	
9	30.1	8.7	0.8	0.5	0.3		220.0	133.6
10	18.6	11.6	1.4				302.1	
11	22.7	15.5	1.5				541.8	
12	26.2	20.1	2.7	2.3	0.5	MM 9.3. Dumping.	1,437.7	1,195.4
13	29.1	16.3	1.8	1.2	0.7		872.8	550.2
14	17.7	9.1	0.8	0.3	0.5		125.6	45.1
15	26.7	10.7	1.7				491.4	
16	20.3	15.7	1.3	0.8	0.5	MM 9.27. GPS.	407.9	248.6
17	10.9	10.0	1.1				119.9	
18	17.0	10.2	1.7	0.9	0.8		287.8	156.1
19	16.7	13.9	1.5				352.8	
20	42.0	13.9	1.7	1.2	0.5		986.6	688.9
21	18.4	11.0	0.7				149.8	
22	23.3	7.7	1.5				272.7	
23	17.4	11.1	1.5			MM 9.15. Culvert.	291.6	
24	27.5	15.0	2.3	1.2	1.1	Spawning patch test	948.8	486.8
25	33.5	12.2	1.4			U/S culvert. Patch test. GPS.	572.2	
26	34.2	14.5	1.4	1.0	0.4		694.3	486.0
27	15.7	7.7	0.7				84.6	
28a	14.0	5.9	0.8	0.8			62.0	62.0
28b	14.0	5.9	0.8	0.8		O. mykiss. GPS.	62.0	62.0
29	17.3	17.0	1.4				411.7	
30	29.5	14.6	2.8	2.4	0.4		1,184.4	1,033.7
31	13.0	6.7	2.0	1.4	0.6	Spawning patch test. GPS.	172.5	117.6
32	20.6	26.2	3.7	3.0	0.7	O. mykiss	2,013.2	1,619.2
33	16.8	9.8	1.7	1.2	0.5		281.5	202.5
34	23.2	10.6	1.6				393.5	
35	15.2	9.6	2.3				335.6	
36	13.5	7.6	1.3				137.5	
37	16.0	12.0	1.9				355.2	
38	19.0	10.0	2.4				456.0	
39	13.0	10.0	2.0				260.0	
40	15.0	11.5	1.7				284.6	
41	16.5	11.9	1.7	0.5	1.2		333.8	98.2
42	26.4	11.5	1.6				470.6	
43	10.9	5.6	1.7				102.5	
44	16.0	8.5	2.0				272.0	
45	20.0	6.7	1.3				174.2	
46	16.8	12.5	1.4				294	
47	31.5	14.6	2.0				919.8	
48	16.3	13	2.8	1.2	1.6	Gauge.	589.1	258.5
End survey Day 1 at downstream total barrier.						CUMULATIVE VOLS	22,130.1	8,113.0

Start survey Day 2 u/s downstream total barrier.

1	16.2	18.2	2.0				589.7	
2	10.5	5.5	0.8				46.2	
3	11.3	8.6	1.3				126.3	
4	15.4	5.7	0.8				70.2	
5	18.0	14.1	1.4				355.3	
6	16.9	12.4	1.8				377.2	
7	14.6	9.3	1.8				244.4	
8	17.9	13.6	1.8				438.2	
9	12.5	9.0	2.0				225.0	
10	28.3	26.5	5.1				3,824.7	
11	21.2	14.9	4.5			U/S total barrier.	1,421.5	
12	19.3	13.0	1.8				451.6	
13	13.6	8.8	1.6				191.5	
14	14.4	8.0	1.0			Dumping.	115.2	
15	12.1	9.5	1.3				149.4	
16	26.4	10.0	1.3	0.6	0.7		343.2	158.4
17	33.0	10.0	1.6	1.2	0.4		528.0	396.0
18	33	16.7	2.8	2.2	0.6		1,543.1	1,212.4
19	14.9	7.5	2.0	1.7	0.3		223.5	190.0
20	17.9	7.5	1.1	0.8	0.3		147.7	107.4
21	9.2	7.2	1.0	0.6	0.4		66.2	39.7
22	12.7	9.2	1.2	0.8	0.4		140.2	93.5
23	15.2	9.3	1.0	0.5	0.5	Dumping.	141.4	70.7
24	17.2	12.9	1.8	0.5	1.3		399.4	110.9
25	20.0	9.3	1.6	1.1	0.5	MM 8.32.	297.6	204.6
26	11.8	9.5	1.1	0.5	0.6		123.3	56.1
27	16.1	13.4	2.1				453.1	
28	9.0	6.0	1.5			Spawning patch test.	81.0	
29	11.6	11.3	0.9				118.0	
30	13.2	8.0	0.7				73.9	
31	29.8	14.7	2.0	1.1	0.9		876.1	481.9
32	20.6	8.8	2.9	1.8	1.1	100' d/s MM 8.16. Pump.	525.7	326.3
33	9.1	8.4	1.6	0.5	1.1		122.3	38.2
34	12.3	11.0	1.8				243.5	
35	16.3	11.4	1.3	0.9	0.4		241.6	167.2
36	9.4	11.3	1.3	0.5	0.8		138.1	53.1
37	54.6	22.5	3.4				4,176.9	
38	20.8	9.7	1.6				322.8	
39	16.6	9.4	1.0				156.0	
40	15.7	9	1.3				183.7	
41	13.0	13.3	1.6				276.6	
42	11.7	7.6	1.6				142.3	
43	28.0	22.0	3.2				1,971.2	
44	16.1	16.9	2.4				653.0	
45	34.4	9.5	1.9	1.2	0.7		620.9	392.2
46	19.0	8.1	1.3	0.7	0.6		200.1	107.7
47	19.7	10.9	1.3	0.9	0.4		279.1	193.3
48	19.6	8.7	1.3				221.7	
49	15.1	7.9	1.2	0.3	0.9		143.1	35.8
50	17.2	9.0	1.4	0.9	0.5		216.7	139.3
51	11.9	9.2	1.4	0.8	0.6	MM 7.86	153.3	87.6
52	10.7	8.3	2.1	2.1	0.0		186.5	186.5
53	16.4	10.3	1.4	1.1	0.3		236.5	185.8
54	16.0	6.8	1.5	1.0	0.5	30' u/s MM 7.81.	163.2	108.8
55	26.4	12.0	1.7	1.1	0.6		538.6	348.5
56	14.5	13.6	1.4	0.4	1.0		276.1	78.9
57	17.3	8.2	1.3	0.5	0.8		184.4	70.9
58	16.8	11.2	1.6				301.1	
59	19.3	14.8	1.9	1.2	0.7		542.7	342.8
60	30.2	13.0	1.9	1.0	0.9	250' d/s MM 7.64.	745.9	392.6
61	39.6	10.2	2.0	0.9	1.1		807.8	363.5
62	23.0	14.5	3.2	2.7	0.5	Gauge pool. MM 7.64.	1,067.2	900.5
						CUMULATIVE VOLS	30,220.9	7,641.0