Codornices Creek Restoration Project

2014 Monitoring Report

Phase 3 Vegetation Monitoring
Phase 3 Geomorphic Monitoring
Phase 1-3 Benthic Macro Invertebrate Sampling
Phase 1-3 Stream Temperature Monitoring
Phase 1-3 Stream Habitat Condition Survey

RWQCB Permit number: 02-01-C0763
USACOE Permit number: 28288-1S
DFG Notification Number: 1600-2006-0169-3

City of Albany / City of Berkeley

Appendices:
Appendix A: *2014 Habitat Assessment*
Appendix B: *Phase 3 Cross Section Locations*
Appendix C: *Photopoint Locations*
Appendix D: *2014 Site Images*
Appendix E*: New Zealand Mudsnail Occurrence*

Prepared By:
Restoration Design Group
2612 Suite B, Eighth Street
Berkeley, California 94710

Codornices Creek Monitoring 2014

1. Overview

This report presents the 2014 monitoring results for Phase 3 of the Codornices Creek Restoration Project and follows the December 2013 Supplemental Monitoring Report that summarized the previous year's monitoring of Lower Codornices Creek.

To date, three phases of Codornices Creek restoration have been completed. Phase 1 was completed in 2005, Phase 2 in 2006 and Phase 3 in 2010. The following is a calendar of scheduled monitoring activities for the three phases of the Codornices Creek Restoration Project for 2014. Geomorphic and vegetation surveys were completed for Phase 3 and benthic macroinvertebrate sampling and a stream condition survey, assessing the suitability of the three phases of restoration for Steelhead, were completed for all three phases.

Table 1: Monitoring Calendar

Calendar Year 2014				
Phase	*Geomorphic Survey*	*Vegetation Survey*	*BMI Survey*	*Fish Survey*
I	None (Yr. 10)	None (Yr. 10)	Spring 2014	Spring 2014
II	None (Yr. 7)	None (Yr. 8)	Spring 2014	Spring 2014
III	Summer 2014 (Yr. 4)	Spring 2014 (Yr. 4)	Spring 2014	Spring 2014

In addition to the scheduled work, the City had four temperature data loggers installed in the creek to monitor stream temperatures within Phase 3 to address ongoing concerns about elevated stream temperatures and lack of vegetated cover along this reach.

2. Vegetation Monitoring Results (Phase 3 Only)

Year 4 / April 2014

2.1. METHODS:

The project monitoring was performed in accordance with the elements of the Monitoring and Mitigation Plan (MMP) prepared by FarWest Restoration Engineering (FRE) dated April 16, 2006. The MMP describes the project goals, monitoring questions, performance criteria and monitoring protocols required to evaluate the success of the restoration project towards achieving project objectives. The vegetation monitoring was broken down into four separate tasks. Monitoring for each task was conducted separately using distinct methods:

MMP Task 2.1: Task 2.1 monitors the soil bioengineering components of the project. For year 4, all poles with sprouts over 6-ft tall are counted.

Table 2: Soil Bioengineering Success Criteria

Year	Criteria
Year 1: 2011	Sprouts
Year 2: 2012	2-feet tall
Year 3: 2013	4-feet tall
Year 4: 2014	6-feet tall
Year 5: 2015	Evaluate entire canopy for percent cover
Year 10: 2020	Evaluate entire canopy for percent cover

MMP Task 2.2: This task evaluates the success of the live staking outside the active channel bank. For year 4, all stakes with sprouts over 2-ft tall are counted.

Table 3: Dogwood Stake Success Criteria

Year	Criteria
Year 1: 2011	Survival
Year 2: 2012	Survival
Year 3: 2013	1-foot tall
Year 4: 2014	2-feet tall
Year 5: 2015	Evaluate entire canopy for percent cover
Year 10: 2020	Evaluate entire canopy for percent cover

MMP Task 2.3: Container plants are monitored under this task. The entire site was surveyed and all living plants from the original list of species planted, including additional plants installed by volunteers since the project completion were tallied and compiled on a per species basis. Native species planted or growing as volunteers but not on the original plant list were not tallied. Dead plants were noted but not compiled.

MMP Task 2.4: The final task measures percent cover of native and non-native plants in 10 randomly sampled 3 foot by 3 foot plots using the Daubenmire method as detailed in the USFS Technical Reference: Sampling Vegetation Attributes, 1996.

2.2. RESULTS

2.2.1. MMP Tasks 2.1 and 2.2: Soil Bioengineering and Live Stakes

Soil Bioengineering and live stakes are performing well. Due to additional willow stake planting efforts in December 2012, it was difficult to quantify which stakes were planted with the original project planting vs. additional plantings. Therefore, all living willow stakes were counted; A total of 423 live willow stakes were noted within the project limits with >50% over 6-ft tall; 18 were noted to be volunteer seedlings outside the original willow planted areas. There were 24 dead willow cuttings. Dogwood staking also performed well between 2013 and 2014. 67 individuals (100%) survived through 2014.

2.2.2. MMP Task 2.3: Container Planting

Table 4: Phase 3 Container Planting Results

		2011 as-built		2012		2013		2014	
Species	**Specified**	#	*% survival from previous period*	#	*% survival from previous period*	#	*% survival from previous period*	#	*% survival from previous period*
Acer macrophyllum	6	6	*100%*	7	*117%*	8	*114%*	7	*88%*
Acer negundo	3	3	*100%*	3	*100%*	3	*100%*	3	*100%*
Aesculus californica	18	17	*94%*	16	*94%*	17	*106%*	17	*100%*
Alnus rhombifolia	40	37	*93%*	37	*100%*	36	*97%*	33	*92%*
Heteromeles arbutifolia	18	15	*83%*	17	*113%*	20	*118%*	19	*95%*
Mimulus aurantiacus	15	1	*7%*	3	*300%*	5	*167%*	3	*60%*
Populus fremontii	20	18	*90%*	19	*106%*	21	*111%*	18	*86%*
Quercus agrifolia	23	28	*122%*	29	*104%*	29	*100%*	34	*117%*
Rhamnus californica	14	13	*93%*	22	*169%*	19	*86%*	21	*111%*
Ribes sanguineum	8	8	*100%*	8	*100%*	9	*113%*	3	*33%*
Rosa californica	11	8	*73%*	15	*188%*	16	*107%*	14	*88%*
Sambucus mexicana	11	13	*NA*	14	*108%*	14	*100%*	12	*86%*
TOTAL # OF INDIV.	**187**	**167**	*89%*	**190**	*114%*	**197**	*104%*	**184**	*93%*

2.2.3. MMP Task 2.4: Percent Cover

The 2014 survey of percent cover indicates a decrease in bare soil. Native plant establishment on the Phase 3 floodplain is better than the previous two phases. *Leymus triticoides, Bromus carinatus, Hordeum brachyantherum, Baccharis douglasii,* and *Equisetum* have successfully established and account for the majority of the native cover on the floodplain. Even with the limited initial container plant palette, ongoing maintenance by the City of Albany and maintenance / follow up planting by volunteer groups has been successful at adding further native cover and limiting the colonization of many of the invasive species typical of urban restoration areas.

Table 5: Percent Cover Results

2014		Species		Species		Species		Species	
		Native		Exotic Forbs		Exotic Grasses		Bare Soil	
Cover Class	Mid-point	Number	Product	Number	Product	Number	Product	Number	Product
1-5%	2.5	0	0	0	0	1	2.5	2	5
5-25%	15	1	15	1	15	2	30	4	60
25-50%	37.5	2	75	5	187.5	4	150	1	37.5
50-75%	62.5	4	250	3	187.5	1	62.5	0	0
75-95%	85	3	255	1	85	0	0	0	0
95-100%	97.5	0	0	0	0	0	0	0	0
Total Canopy			595		475		245		102.5
Number of Samples			10		10		10		10
% Canopy Cover			60%		48%		25%		10%
Species Composition			**45%**		**36%**		**18%**		**8%**
Frequency			100%		100%		80%		70%

2.3. DISCUSSION

2.3.1. MMP Task 2.1 and 2.2: Soil Bioengineering and Live Stakes

The willow used for soil bioengineering is healthy and growing, with >10 willows exceeding 10-ft tall. The large areas of the channel receiving direct sunlight noted in 2013 have been reduced by the expanding willow canopy with watercress and cattails noted in smaller numbers than last year. Due to the addition of the most recent willow pole planting in December of 2012, the overall number of individual willows has increased significantly; however these young willows have yet to provide much additional shade to the creek. There was one meander at the upstream end of the project where the willow was noted in the 2013 report as lacking vigor. The willows in this area are surviving but continue to grow slowly. Dogwood stakes are establishing well within their planted areas.

2.3.2. MMP Task 2.3: Container Planting

Fewer container plants (93%) were observed in 2014 than in 2013. The 93% does not take into account species that were planted by volunteers or natural colonization. There were specimens of Oregon ash, Twinberry, Fuchsia-Flowering Gooseberry, California Sagebrush, Mugwort, Bee plant, Blue-eyed grass, Douglas Iris, Ocean-spray, Coyote Brush, Ceanothus and Ninebark noted during the survey. Of the species planted after the initial project completion, Ninebark and Ceanothus species are doing extremely well. Additionally some species are beginning to self-colonize. Two volunteer seedlings of Fremont poplar were observed on the floodplain in 2013 and continue to thrive in 2014. Overall, the dense cover of vegetation made locating all of the container plants challenging.

The alders are struggling in some locations (some dead-wood noted in many of the specimens) and three were noted as dead but the remaining ones are bigger than last year and showing signs of improvement. There were two volunteer alder growing on the active channel bank. Overall the container plants are exceeding the 60% survival threshold.

2.3.3. MMP Task 2.4: Percent Cover

The goal for the fourth year of monitoring is to have less than 30% exotic species cover. There is currently 54% cover non-native species detected in the random selected sample plots. Multiple aggressive exotic species were detected within the reach. Acacia seedlings, bristly ox-tongue, fennel, pampas grass, curly dock, bindweed, white clover, rye grass and wild oat are found scattered throughout the site and should continue to be addressed through on-going maintenance. Additional effort should continue with removing these and other invasives.

2.4. General Notes

Overall the vegetation in Phase 3 is performing well. Site soil preparation and compaction mitigation was improved over techniques employed during the prior two phases, and the maintenance and irrigation programs have also been more consistent. Colonization of the site by invasive plant species continues to be an ongoing challenge. City maintenance and the additional planting and maintenance efforts by volunteers has played a significant role in getting native species to colonize this urban site, which in turn decreases invasive plant infestations.

Although the vegetation monitoring indicates that plantings are meeting the permit requirements, there are a few locations that could benefit from additional planting. The first location is a section of willows on an outside bend that are growing poorly. Additional willow planting have occurred, but the area continues to show slow growth of willow. These willows may be stunted do to the hardpan clay soils in this location. The second area is directly across the creek on the floodplain. This area has few trees or shrubs and would benefit from additional plantings as well. It is appropriate to plant species such as Box elder *Acer negundo* and Coffeeberry *Frangula californica* in both of these areas.

2.5. Maintenance Recommendations

2.5.1. Weed: Locate and remove acacia seedlings, bristly ox-tongue, fennel, pampas grass, curly dock, Himalayan blackberry, bindweed, ivy, ripgut brome, wild oat grass and nasturtium
2.5.2. Mulch: Keep area around container plants/trees clear of weeds; mulch as often as possible around the base of the plants for weed suppression and water retention
2.5.3. Consider adding trees on bank adjacent to upstream channel meander where willows remain feeble.
2.5.4. Consider adding additional vegetation to inside meander bend across from feeble willows.
2.5.5. Remove Tree Stakes: Check tree stakes and remove if not needed
2.5.6. Remove and dispose of post and rope restoration fencing along multi-use trail.
2.5.7. Weed 6th Street Rain Gardens: Remove Fennel and bristly ox-tongue and other invasive species.
2.5.8. Remove sediment from Rain Garden entry points. It appears adjacent construction has washed fines and material into rain garden entry forebay. This material should be removed from forebay and disposed.
2.5.9. Pickup trash and cigarette butts in Rain Garden
2.5.10. Prune roses in Rain Garden
2.5.11. Test irrigation system regularly and fix any issues promptly. Turn off the irrigation for all areas except for the rain gardens and monitor the health of the trees and shrubs. Turn on irrigation if vegetation appears significantly stressed.
2.5.12. Empty trash cans on-site more frequently
2.5.13. Clean or paint over graffiti on USPS wall along multi-use trail

3. Geomorphic Survey

Phase 3 – Year 3

3.1. Methods

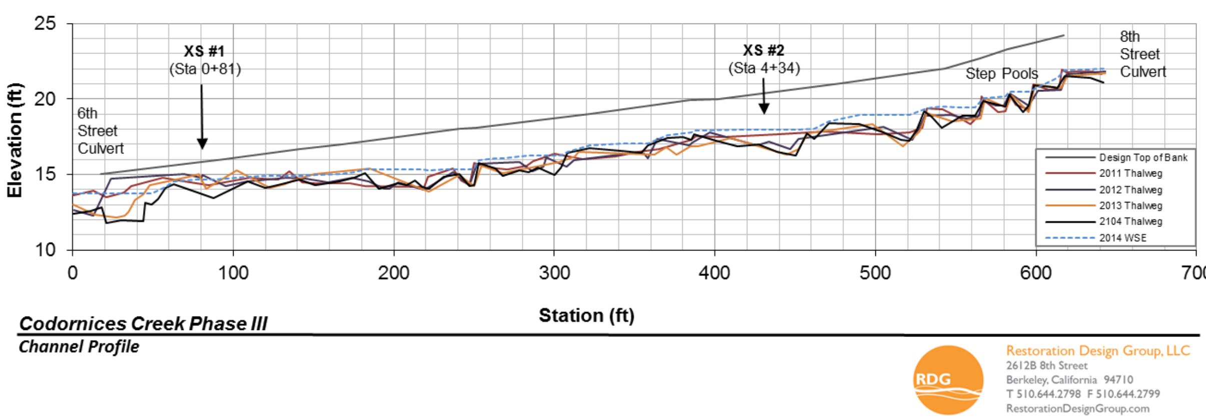
Profile and cross section surveys were completed in 2014 for Phases 3. Cross sections are from established and monumented locations.

3.2. Results

3.2.1. Channel Profile Phase 3

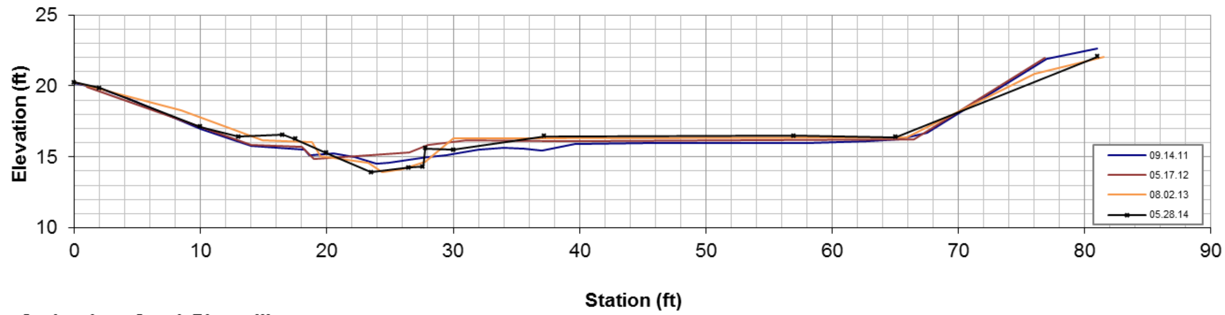
The mild 2013/2014 winter resulted in little change within Phase 3. Much of the bed has maintained a consistent elevation. Some pools have continued to scour and a few riffles aggraded by accumulating fine sediment among the emergent vegetation that persisted through most of the winter. The channel adjustments that occurred during the first winter upstream of the 6th street culvert have slowed and the channel has recreated a single threaded channel in this area. The upstream step pools have remained stable.

Riffle and pool morphology continue to develop within the channel with the exception of areas scoured to hardpan. The hardpan is hampering sediment deposition in these areas and limiting development of depositional feature such as point bars. Emergent vegetation was thick during the summer and led to minor sedimentation within the active channel except in the location of the hardpan, which remained exposed throughout the summer.



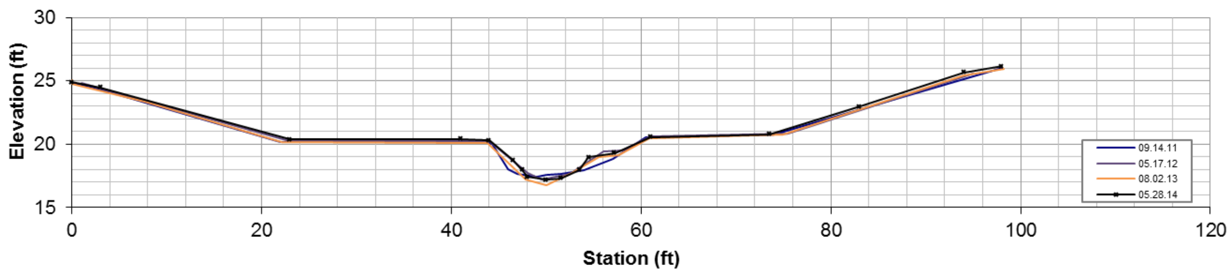
3.2.2. Cross Sections Phase 3

The two riffle cross sections were resurveyed in 2014. Cross section #1 is in the lower portion of the creek and is influenced by the culvert backwater. Cross section #2 is upstream in the location adjacent to the hardpan bed. Cross section 1 shows continued adjustment of the channel above the 6th street culvert, with active aggradation of the floodplain and narrowing of the channel. Cross section 2 continues to build its inner depositional bench formed in 2012, while maintaining a consistent thalweg elevation.



Codornices Creek Phase III
Cross Section 1
Profile Station 0+81

Restoration Design Group, LLC
2612B 8th Street
Berkeley, California 94710
T 510.644.2798 F 510.644.2799
RestorationDesignGroup.com



Codornices Creek Phase III
Cross Section 2
Profile Station 4+34

Restoration Design Group, LLC
2612B 8th Street
Berkeley, California 94710
T 510.644.2798 F 510.644.2799
RestorationDesignGroup.com

3.3. Discussion

Phase 3 continues to mature well. We have been monitoring two areas closely since the project was constructed. The first area is immediately upstream of the 6th Street culvert, where the channel adjusted immediately after construction. The second area is the upper half of the restoration reach, where the channel has exposed hardpan. The following provides an update for each of these areas.

Above 6th Street Culvert – The hydraulics of the culvert backwater resulted in deposition of sediment in the channel upstream of the culvert and a near immediate evulsion and straightening of the channel leading into the culvert. For the next three years the changes to the channel in this area have slowed as the channel approaches an equilibrium condition.

The resulting changes to the channel have increased the channel capacity in this area. Competency was increased due to the increased channel slope resulting from the evulsion and with continued deposition of the floodplain at the culvert. As a result the channel has reached a more stable configuration. This is supported by the monitoring data showing a slowing of year over year change. As a result of these observations, no adaptive management is required at this time.

Expose Hardpan –The exposed hardpan upstream continues to persist. This hardpan substrate excludes any opportunity for hyporheic flow and does not provide ideal habitat for benthos. This condition is not unique to the restoration areas. A similar condition exists upstream of the project site between 8th and 9th street.

Monitoring of this condition began during the first winter after construction and has not shown any indication of improvement. The channel has incised up to 1-foot below the design grade resulting in increased stream power near bankfull flows. In addition, the floodplain is no longer inundated at the designed frequency.

Although this situation is far from dire, there is currently a missed opportunity to provide high quality habitat in this newly restored reach. Improving the habitat quality can be done with relatively little effort by rebuilding three riffles in the middle to upper section of Phase 3. These riffles would restore the appropriate bankfull channel dimensions. They would be sized with material that could be moved by hand, yet persist during larger storm events. This rock would not require excavation in the channel for placement and would effectively raise the channel at the riffles up to 1.5 to 2-ft to reduce channel entrenchment. Although Codornices Creek is an urbanized watershed it does transport a significant amount of sand and fine gravel as bedload. This bedload can be expected to deposit in the channel between the constructed riffles, effectively burying the hardpan overtime.

3.4. Maintenance Recommendations

3.4.1. Install riffle material in the upper half of Reach III to restore the beneficial channel dimensions and passively bury the hardpan.

4. Benthic Macroinvertebrate Survey

4.1. Methods

RDG collected benthic macroinvertebrates following the California Stream Bioassessment Procedure in July 2014. This protocol is consistent with past sampling conducted by Kier Associates in 2006 and RDG in 2012. Each of the three phases of restoration were sampled separately and were composed of three randomly selected riffle locations for a total of nine (9) collection sites. Each of the three samples was evaluated in the laboratory by Tom King of BioAssessment Services, Folsom, Ca.

4.2. Results

The results continue to show a general impairment of Codornices Creek in each of the three phases of restoration; however, each phase saw a rise in the sensitive EPT index compared to 2006, and 2012 results. Shannon's diversity Index and the California Tolerance Values both remained consistent.

Table 6: BMI Survey Results[1]

Metrics	2014 Phase I	2014 Phase II	2014 Phase III	2012 Phase I	2012 Phase II	2012 Phase III	Phase I 2006	Phase III[2] 2006
Richness:								
Taxonomic	21	18	23	17	17	16	13	14
EPT	2	3	4	2	1	2	2	2
Composition:								
EPT Index (%)	3.4	5.7	8.8	14	1.3	2.0	6	9
Sensitive EPT Index (%)	3.1	3.3	3.1	14	1.3	0.7	0.0	0.0
Shannon Diversity	2.2	2.0	2.1	2.3	2.0	2.2	0.92	0.89
Dominant Taxon (%)	23	39	43	23	24	29	66	77
Non-Insect Taxa (%)	43	44	43	47	59	50		
Tolerance:								
Tolerance Value	5.4	5.6	5.6	5.5	6.2	5.8	5.43	5.58
Intolerant Organisms (%)	3.1	3.3	3.1	14	1.3	0.7		
Intolerant Taxa (%)	4.8	11	13	12	5.9	6.3		
Tolerant Organisms (%)	19	9.6	12	28	24	21		
Tolerant Taxa (%)	19	22	26	29	29	31		
Functional Feeding Groups:								
Collector-Gatherers (%)	64	66	69	46	46	64		
Collector-Filterers (%)	10	1.7	1.0	1.3	2.2	1.4		
Scrapers (%)	12	5.2	10	25	23	11		
Predators (%)	11	24	14	15	27	22		
Shredders (%)	3.3	3.3	3.1	14	1.3	0.7		
Other (%)	0.0	0.0	3.1	0.0	0.0	1.4		
Estimated Abundance:	697	2168	1360					

[1] Metrics based on SAFIT level I standard taxonomic effort except chironomids identified to subfamily/ tribe. Standard taxonomic effort source: Southwest Association of Freshwater Invertebrate Taxonomists (http://www.waterboards.ca.gov/swamp/docs/safit/ste_list.pdf).

[2] 2006 survey occurred in the Phase III reach prior to construction.

The three samples contained a total of 30 discrete taxa, up from 22 in 2012. 26 discrete taxa were observed in during the 2006 survey which included a total of 6 sample sites between Albina Street and Second Street. Taxonomic richness for Phases 1, 2 and 3 is 21, 18, 23 respectively. EPT[3] composed 3.4% of the sample in Phase 1, 5.7% in Phase 2, and 8.8% in Phase 3. The California Tolerance Value was 5.4, for Phase 1 and 5.6 for Phases 2 and 3. Phase 3 has the greatest taxonomic richness of the three phases, and Phase 2 and 3 both had double or triple the estimated abundance of Phase 1.

4.3. Discussion

The higher abundance observed in Phase 2 and 3 may be a result of the higher insolation rate in Phase 3 and the greater abundance of gravel substrate in Phase 2, both of which are known to increase macroinvertebrate abundance and neither of which are present to a high degree in Phase 1. Phase 3 also has the greatest taxonomic richness of the three phases, likely due to the greater variation in habitat due to the variation in shade and channel substrate. As a result, Phase 2 and 3 indicate greater biological integrity than Phase 1. Although there is not enough time-series data to determine trends within the three phases of restoration, the 2012 and 2014 surveys do indicate a modest improvement in stream health for all three phases.

5. Stream Temperature Monitoring

Year 3 / September - October 2013

5.1. Methods

The intent of the stream temperature monitoring is to determine whether summertime stream temperatures within the newly restored reach of Codornices Creek are a concern for steelhead.

Four (4) HOBO U22-001 Temperature Data Loggers set to sample in 15 minute intervals were deployed in Codornices Creek on April 17th 2014 and retrieved on October 15th 2014.

The loggers were positioned along the channel to observe the effects of Phase 3 on stream temperatures. The first logger was installed upstream of the project inside the 8th Street culvert, the next logger was placed within Phase 3 (equivalent to 7th street) and the final two loggers were placed within the 6th street culvert and at 4th street. Phase 3 is bound by 6th and 8th streets. The 8th Street logger provides the baseline and incoming temperatures. The 7th

[3] (Ephemeroptera, Plecoptera, Trichoptera) sensitive taxa that decrease in richness in the presence of pollution

and 6th Street loggers measure temperatures within and just below Phase 3 and the 4th Street logger is situated to capture the attenuation of temperatures downstream.

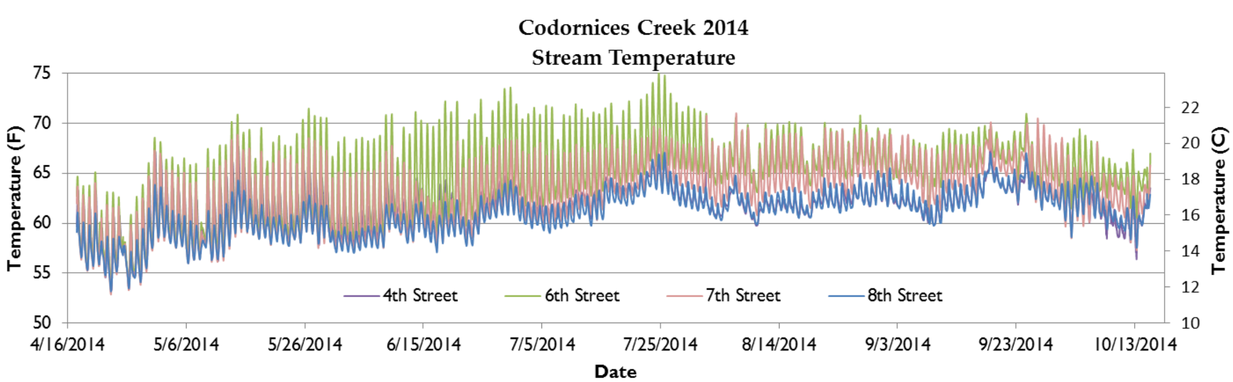
5.2. Results

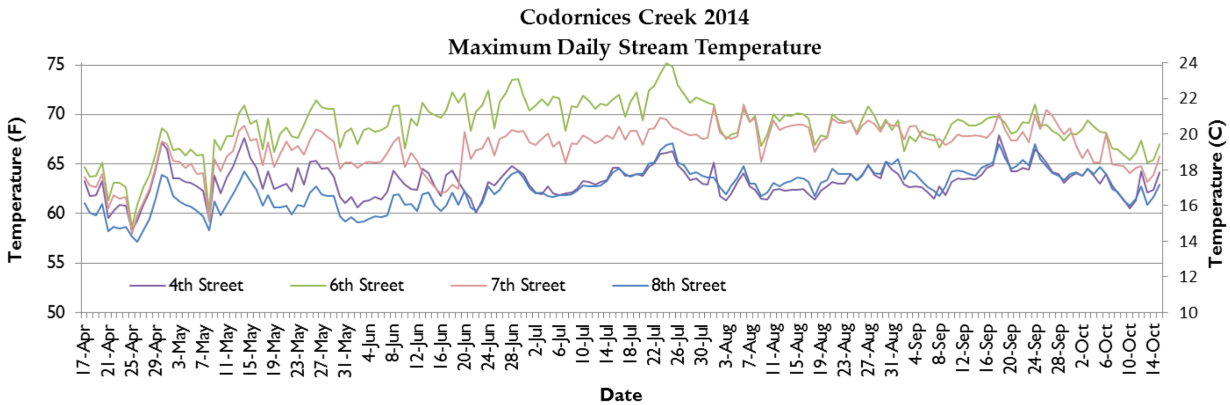
Average and maximum stream temperatures are higher within and immediately downstream of the Phase 3 restoration project. Temperatures downstream of the project, at 4th Street, are largely similar to 8th street indicating that much of the warming that occurred within Phase 3 is sufficiently dampened before reaching the 4th Street data logger.

Table 7: Summary of Temperature Monitoring Result (August – October)

	8th Street	7th Street	6th Street	4th Street
Average Temperature	62.3 F (16.8 C)	64.8 F (18.2 C)	66.1 F (18.9 C)	62.3 F (16.8 C)
Max Temperature	67.0 F (19.4 C)	71.0 F (21.7 C)	71.0 F (21.7 C)	67.9 F (19.9 C)
Min Temperature	57.5 F (14.2 C)	57.3 F (14.1 C)	60.6 F (15.9 C)	56.4 F (13.6 C)
Max Weekly Average Temperature	64.4 F (18.0 C)	66.5 F (19.2 C)	67.6 F (19.8 C)	64.4 F (18.0 C)
Max Weekly Maximum Temperature	65.6 F (18.7 C)	69.2 F (20.7 C)	69.8 F (21.0 C)	65.4 F (18.6 C)

Intermediate temperature readings were completed August 1st, 2014 to acquire data from the first half of the season. After reviewing the data for the entire 2014 monitoring period it became clear that the 6th street temperature data varied significantly before and after this intermediate temperature reading. Prior to August 1st, the daily temperature range varied significantly more than the other loggers, indicating that the logger was partially measuring air temperature at this time. This is further supported by the fact that this particular logger was located in shallow water and the position of the logger was interrupted on August 1st to offload the data. The change in logged temperature is apparent in both Figures below, where readings of the 6th and 7th street loggers become more closely aligned after August 1st.





To further analyze the results we looked at the number of hours and percent time that the water temperatures were above certain temperature thresholds. In addition to referenced temperature thresholds noted in the Codornices Creek Biological Opinion and the Mitigated Negative Declaration, we compared the data to recent published data on steelhead thermal preferences. Sloat and Osterback (2013) showed that steelhead had a marked reduction in feeding and agonistic behavior between 75.2 – 77.0 F (24-25 C). Additionally this same study summarizes a series of other studies that attempt to derive the critical thermal maxima (CTM) for steelhead, which can be approximated as 86.0 F (30 C). Both of these thresholds are substantially higher than the 71.0 F (21.7 C) maximum temperature observed during the study period[4].

Draft temperature guidelines developed for the North Coast RWCQB (Carter, 2008) suggest that MWMT values between 14.5 – 21 C will ensure no more than 10% reduction of Maximum growth (Ferguson, 2011). The MWMT values for Codornices Creek range between 18.6 – 21.0 C. The same guidelines suggest MWAT temperatures of 17 – 19 C ensure no more than 20% reduction from maximum growth. The MWAT values for Codornices Creek range between 18.0 – 19.8 C.

Using 70 and 64 F as more moderate thresholds for steelhead preferences one can begin to see a difference between the reaches of Codornices Creek.[5]

---

[4] The highest recorded temperature of 75.2 F at 6th street does not accurately reflect in-stream conditions due to the partially submerged nature of the logger during this deployment period.

[5] Codornices Creek Biological Opinion States 64 F as an upper limit for rearing habitat. The Codornices Creek MND notes 70 F as a threshold for steelhead presence/absence.

Table 8: Temperature Thresholds (August – October)

	8th Street	7th Street	6th Street	4th Street
Hours Above 70 F (21.1 C)	0	6.25	15.75	0
Percent Time Above 70 F (21.1 C)	0.00%	0.14%	0.36%	0.00%
Hours Above 64 F (17.8 C)	224.25	1095.75	1578.75	190
Percent Time Above 64 F (17.8 C)	12.52%	61.16%	88.12%	10.61%

5.3. Discussion

Temperature monitoring indicates that stream temperature is generally below stressful levels for steelhead (*Oncorhynchus mykiss)* and already well within the suitable range for rearing. Overtime stream temperatures are expected to continue to decline as vegetation along Phase 3 matures and further shades the channel.

The greatest impact to stream temperatures in Phase 3 is the relatively high level of insolation compared to the lower two restoration reaches, and the expansive hard pan clay that limits subsurface flow, which is known to reduce the effects of direct sunlight on stream temperatures.

Although no goals regarding stream temperature were explicitly noted for the restoration, improving steelhead habitat is a goal. Hagar Environmental Services surveyed all three restoration areas for habitat condition for Steelhead in 2014. He concluded that all three reaches are suitable for trout and rearing juvenile steelhead and that the factors limiting the extent and quality of steelhead habitat in Phase 3 include the expanse of hard pan clay and the lack of deep pools and undercut banks, not elevated stream temperatures. His entire technical memorandum is included as Appendix A.

5.4. Maintenance Recommendations

As noted above, there is a large portion of channel that has hard pan clay substrate and does not provide suitable habitat and likely contributes to the elevated stream temperatures seen within Phase 3. Addressing this condition should be considered if there is interest from the regulatory agencies.

6. References

Carter, K. (2008). *Effects of Temperature, Dissolved Oxygen/Total Dissolved Gas, Ammonia, and pH on Salmonids* (p. 53).

Ferguson, L. (2011). *Memorandum to Ann Riley and Brian Wines: Comments on field trip to Codornices Creek Phase 3 Restoration site, July 11, 2011*

Kier Associates (2007) *Final Monitoring Report for the Codornices Creek Watershed Restoration Action Plan, Phase 2* Blue Lake, California

Sloat, M. R., & Osterback, A. K. (2013). *Maximum stream temperature and the occurrence, abundance, and behavior of steelhead trout* Oncorhynchus, *73* (October 2012), 64–73.

Technical Memorandum

Prepared for: **Restoration Design Group**

Prepared by: **Hagar Environmental Science**

2014 Codornices Creek Post-Project Habitat Reconnaissance, UPRR to 8th Street

---

The reaches of Codornices Creek between the Union Pacific Railroad (UPRR) right-of-way and 8th Street were surveyed on September 4, 2014 to assess the general stream habitat condition following a series of stream restoration projects. The restoration project between the UPRR and 5th Street was initiated with grading in 2004 and completed with re-vegetation in 2005. The project between 5th Street and 6th Street was completed in 2006. The reach between 6th Street and 8th Street was completed in 2010. A habitat assessment was also conducted for the entire reach in 2012 (HES 2012), and for the reaches between the UPRR and 6th Street in 2009 (HES 2009). The UPRR to 8th Street habitat reconnaissance was conducted with the following objectives:

- estimate the frequency and relative extent of pool and riffle habitat types in the study reach and measure pool depths;
- evaluate the extent of cover in the study reach and characterize the habitat in terms of ability to support steelhead in comparison to other Central Coast streams;
- note the presence of any fish migration passage obstacles;
- provide a qualitative assessment of macro-invertebrate populations that are visible at the time of the survey; and
- record any observations of trout or steelhead (*Oncorhynchus mykiss*), California red-legged frog (CRLF), or other aquatic life visible during the time of the survey

The three reaches evaluated continued to show significant differences in habitat conditions as a result of the restored channel structure and planform, riparian plantings, and the time elapsed since restoration project completion (Figure 1). The stream channel of Codornices Creek in the reach between the UPRR and 5th Street has high sinuosity and is lined with dense riparian vegetation including dense willows to a height of 12 to 18 feet and a few alder and sycamore saplings. The trees provide a canopy of 90% to 95% coverage in most of the stream reach. This canopy provides extensive shade throughout the day and is expected to result in cooler stream temperature than would occur in its absence. Immediately following the channel work in this reach growths of cattail became established, but these largely disappeared by the time of the 2012 survey.

The reach of Codornices Creek between 5th Street and 6th Street has much lower sinuosity than downstream of 5th Street but is also lined with dense riparian vegetation. This reach is relatively shallow and has significantly less pool habitat than downstream of 5th Street. Gravel has accumulated in this reach and provides some potential spawning habitat for resident or anadromous *O. mykiss*.

The reach from 6th Street to 8th Street has lower sinuosity than the reach downstream 5th Street but more than the reach between 5th Street and 6th Street. There is very little tree cover in the reach and the lack of shade has resulted in extensive growths of rooted aquatic macrophytes, primarily watercress (Figure 1). This reach has continued to evolve since the 2012 survey. The channel has deepened in many areas and habitat previously characterized as “marsh” has developed a more stream-like quality.

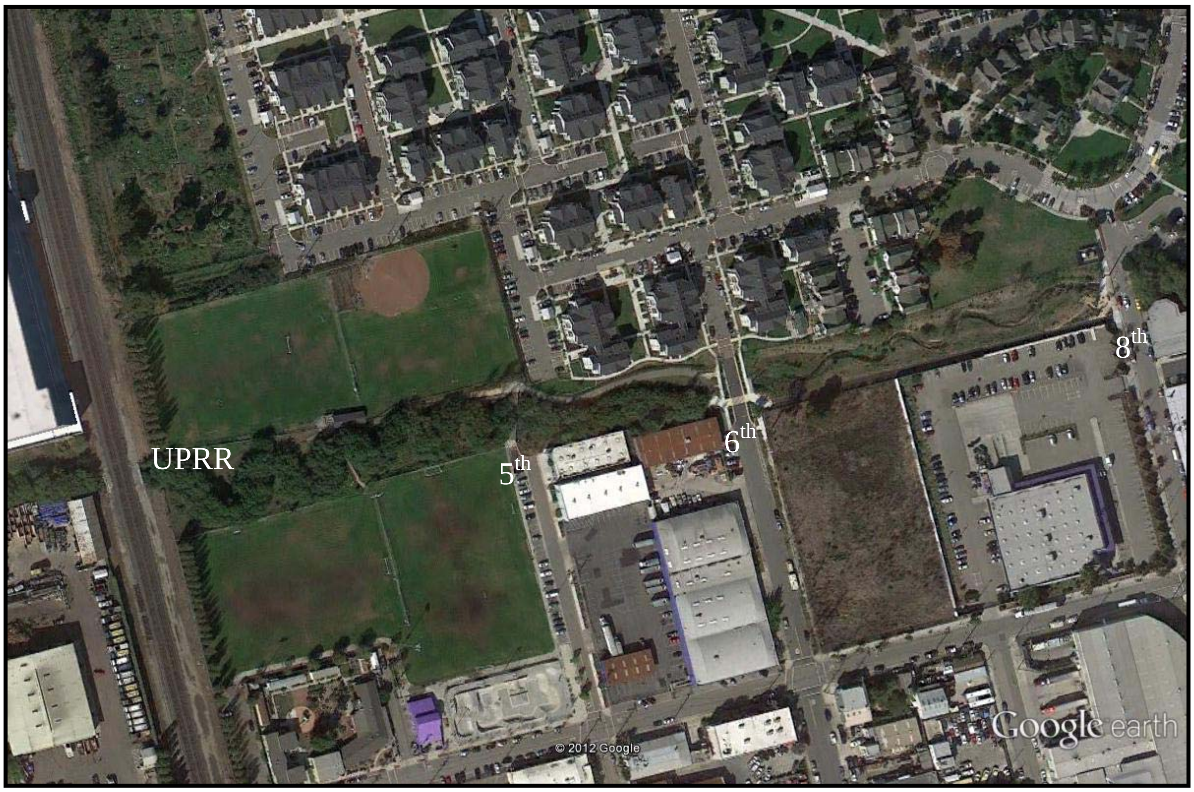


Figure 1. Project location showing three project reaches.

UPRR to 5th Street

The reach was relatively unchanged from previous surveys in 2009 and 2012 in terms of channel position and channel cross-section. Stream wetted width ranged from 5 to 9 feet. Macro-habitat features continue to adjust with pool habitat increasing to 70% of the reach length compared to 49% of the surveyed length in 2012 and 56% in 2009. Riffles were only 16% of the surveyed length compared to 22% in 2012 and 23% in 2009. Run and glide habitat were 10% and 3% of the reach, respectively. It is possible that there continues to be some deepening and concentration of the thalweg since the initial survey. Although pool maximum depth has been consistent across all surveys (1.0 to 2.3 feet in 2014, 1.3 to 2.2 feet in 2012, and 1.1 to 2.3 feet in 2009), the proportion of pool habitat was greater in 2014 compared to shallower flatwater (runs and glides) and riffle habitat. Maximum pool depths averaged 1.61 feet in 2014 compared to

1.69 feet in 2012 and 1.56 feet in 2009. Cover complexity was moderate to high consisting of root mass, overhanging terrestrial vegetation (most commonly willows), undercut banks, small pieces of wood, and small amounts of rooted aquatic vegetation. Root mass was a component of cover in 85% of surveyed units, undercut bank was a component in 62%, terrestrial vegetation was a component in 38%, and small wood was a component in 31% of units, and large wood was a component in 8% of units..

Riffles were relatively short, ranging from 2 to 23 feet and averaging 12 feet. Sixty-nine percent of riffles were 14 feet or less in length. As noted in the previous surveys, many of the riffles were over the entwined fine roots of the riparian willows and these root mats formed much of the substrate in the riffles. Substrate in this reach was predominantly sand and small gravel with some areas of hard clay pan. Substrate suitable for steelhead or rainbow trout spawning was relatively scarce, totaling only about 15 square feet or about 2 square feet per 100 feet of stream. This is a reduction from the 7 square feet per 100 feet found in 2012, and even the initial 4 square feet per 100 feet found in 2009 in this reach. Spawning substrate was of moderate quality with relatively small gravel, not much silt, but fairly sandy.

There were no significant migration obstacles in the survey reach, although due to the stream's small size, passage through riffles would be limited under baseflow conditions. Flow was very low in 2014 and the pool tail/riffle head areas were generally less than 0.1 feet deep. These conditions are to be expected in a stream the size of Codornices Creek, particularly in a drought year, with adult steelhead migration passage limited to periods of storm runoff. The relatively narrow width and steep banks of the low-flow channel should result in a relatively large increase in flow depth with increases in streamflow at these riffles.

No benthic macro-invertebrates were observed in the study reach although crayfish were present and water striders (Family Gerridae) were present on the water surface. The low abundance of benthic invertebrates is likely a result of the small substrate size, high substrate mobility, or water quality issues. The small gravel/sand substrate does not have large pore spaces to support benthic macro-invertebrates and is easily mobilized under high flows. The extensive willow root mats likely provide good habitat for certain types of benthic invertebrates but none were observed on the surface of the mats.

No fish were observed in the UPRR-5th Street reach. It is difficult to observe fish in this section due to the dense shade and ample cover. The habitat appears adequate to support all life stages of resident rainbow trout and rearing juvenile steelhead. There is a potential for steelhead to spawn in Codornices Creek during the winter (December through March). Although steelhead can hold over during the summer in the streams where they spawn, there is little habitat to support over-summering in Codornices Creek. Codornices Creek supported rainbow trout in this reach before the restoration project (HES 2005, HES 2006). Most of the fish were in the relatively deep scour pool and culvert at 5th Street and in an overgrown concrete box culvert in the lower part of the reach between 5th Street and the UPRR.

5^{th} Street to 6^{th} Street

Compared to the downstream reach, this reach had larger substrate with more gravel-sized elements, less channel sinuosity, and fewer pools. There were only two pools in the 300 foot reach.

Stream macro-habitat features consisted of only 20% pools (by survey length), while riffles and glides made up most of the habitat (46% and 34% respectively). Runs made up 19% of this reach in 2012 but were not classified in 2014, possibly due to the lower depth of flow during the drought conditions of 2014.

There was very little cover in the extensive glide and riffle habitat in this reach but both pools had high shelter complexity with coverage of about 50% of the unit. Undercut bank, large woody debris, terrestrial vegetation, and root mass provided the majority of cover with an average contribution of 25%, 22.5%, 17.5% and 10% coverage respectively.

This reach had a total of 105 square feet of potential spawning habitat with relatively clean and non-compacted gravel substrate (Figure 2). That equates to 35 square feet per 100 feet of stream length. Willow root mats were less prevalent in this reach compared to the reach below 5^{th} Street. The extensive shallow riffle habitat in this reach hinders migration during summer low flow conditions.

A single trout, 2-3 inches in length, was observed in this reach. Again, visibility of trout was poor due to shade, good cover conditions, and the apparent high sensitivity of these fish and their tendency to hide quickly. Only a small portion of the habitat is deep enough and with good enough cover to support trout in the summer. The culvert under 6^{th} Street at the upper end of the reach was backwatered and appeared to have reasonable depth throughout its length. The culvert could not be surveyed due to insufficient height but may provide good habitat for *O. mykiss*.

Figure 2. Gravel substrate in Codornices Creek between 5th Street and 6th Street.

6^{6th} Street to 8th Street

Restoration work was completed in this reach during the summer and fall of 2010. During the survey in August 2012, the project was still in the early stages of recovery. Riparian plantings were still small and there was very little shade along the stream. Watercress and other emergent aquatic plants were established in the stream channel to the extent that open water was not visible in much of the project. Most of the project was characterized as “marsh” (496 out of 596 total feet or 83% of the project length). The remaining habitat consisted of small pockets of glide (13%) and run (3%) type habitat.

By 2014, there had been some growth of the willows and other riparian vegetation providing additional shading. Although still present in some areas, the extensive growth of emergent aquatic vegetation had been reduced and a defined channel was present through most of the reach (Figure 3). The channel had cut down through the wedge of sediment upstream of the 6th Street culvert, noted in the 2012 survey, improving passage through this section.

Macrohabitat in the reach consisted of pool and glide (each at 37% of the total by length) with smaller amounts of run (15% by length) and riffle (11% by length). Pools were relatively shallow with maximum depths of 1.2 to 1.9 feet (averaging about 1.4 feet). Glides and runs were deep enough to provide rearing habitat for younger *O. mykiss* with maximum depths averaging 0.6 and 1.3 feet, respectively. Observation of the substrate was hindered by the abundant aquatic vegetation but appeared to be dominated by silt and clay. A hard pan of clay was exposed in many areas in this reach.

Cover was moderate to high and was composed of floating and rooted aquatic vegetation and overhanging terrestrial vegetation with smaller amounts of root mass and undercut banks. Boulders included in the constructed rock weirs at the upper end of the reach provided some additional cover. The abundant aquatic vegetation provided ample cover for smaller fish (threespine stickleback), but may have been so dense as to prevent movement of larger fish such as trout. No *O. mykiss* were seen in this reach though conditions for observing fish were poor due to the extensive growth of aquatic vegetation,

As in downstream reaches, aquatic macro-invertebrates were scarce. The abundant aquatic emergent plants and submerged algae provided potential substrate but only water striders (Gerridae) were seen in any abundance.

Figure 3. Codornices Creek upstream of 6^{th} Street.

Conclusions

The two reaches downstream of 6th Street have recovered well following the restoration projects. Riparian vegetation is well established. Plantings downstream of 5th Street are relatively dense and may somewhat limit aquatic productivity due to lack of sunlight. Habitat conditions are suitable for trout and rearing juvenile steelhead. The 5th Street to 6th Street reach has limited rearing potential due to lack of pool development but has potential spawning habitat. The reach downstream of 5th Street has good pool development and cover providing good potential rearing habitat.

The reach between 6th Street and 8th Street continues to evolve. Growth of riparian trees and shrubs is providing more shading while there is still plenty of insolation for high instream productivity. The pan of clay substrate in many areas of the reach may be the biggest limiting factor for *O. mykiss*, although this reach supported a relatively abundant population before the project and certainly has that potential now. The riparian canopy was also quite open before the project; the key difference being the presence of a few large, mature trees before project that provided shaded habitat in conjunction with associated deep water pools formed in association with the well-developed root systems. Key processes for habitat improvement in this reach will be development of pools and undercut banks as a result of interaction of higher winter flows with developing root masses of riparian vegetation and existing rock weirs.

Water temperature is a potential issue, particularly in the more open, less shaded reach upstream of 6th Street. RDG monitored temperature at four locations during 2014 (personal communication, Erik Stromberg, RDG, October 2014). These data indicate that water temperature is generally below stressful levels for *O. mykiss* (70°F or 21°C) and well within the suitable range for rearing. As noted during fish removals before the project, the section of Codornices Creek between 6th and 8th Streets had significant areas lacking tree cover and thus allowing lots of sunlight to reach the stream, before the project, making it very productive (HES 2010). A total of 136 *O. mykiss* were removed from the project area (about 28 fish per 100 feet) with fish in excellent condition, plump, and up to 12 inches in length. Multiple size classes were present indicating a healthy population (HES 2010). As noted in the 2010 report, this portion of Codornices Creek is relatively cool due to its proximity to San Francisco Bay and lack of full tree cover does not necessarily imply intolerably high stream temperature. Sunlight stimulates growth of aquatic plants and invertebrates and *O. mykiss* grow best at temperatures near their upper tolerance levels as long as abundant food is available (Hokanson et al. 1977, Smith and Li 1983). .

References

Hagar Environmental Science (HES). 2005**.** Codornices Creek Restoration Activities Between 2nd Street and 5th Street, Fish Removal Activities. Technical Report prepared for City of Albany. March 11, 2005. 11 pp.

Hagar Environmental Science (HES). 2006**.** Codornices Creek 5th Street Culvert Removal and Channel Modification, Fish Salvage Activities, August 2006. Technical Report prepared for City of Albany. September 26, 2006. 11 pp.

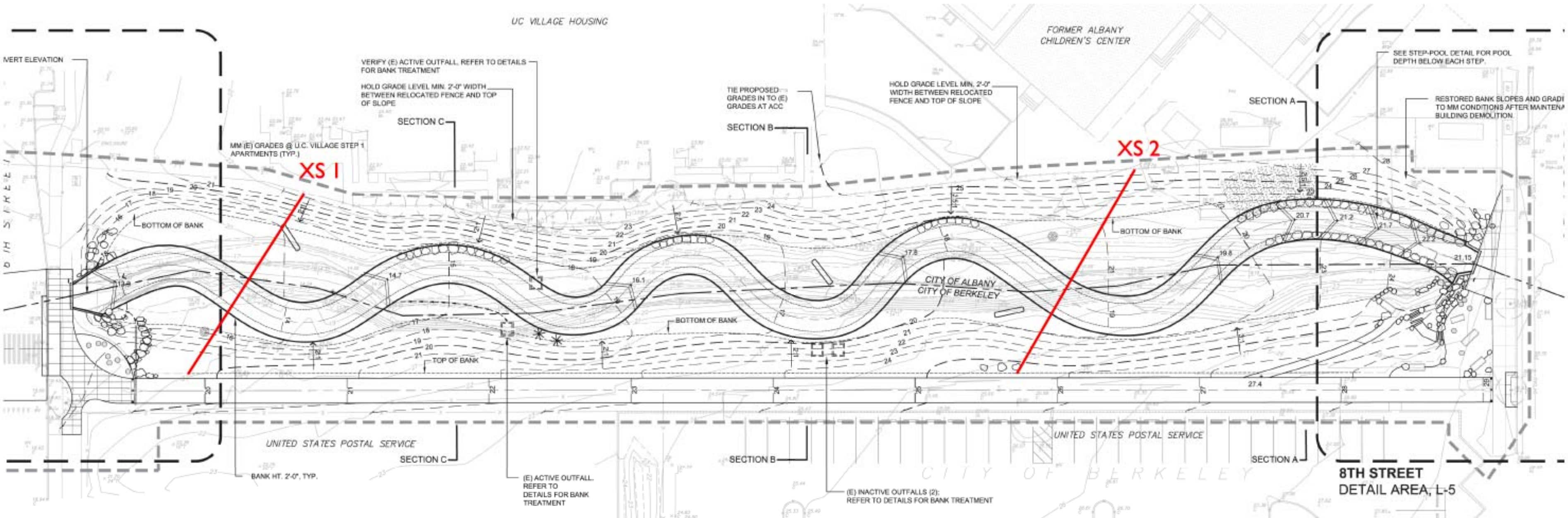
Hagar Environmental Science (HES). 2009**.** Codornices Creek Post-Project Habitat Reconnaissance. Technical Report prepared for FarWest Restoration Engineering. November 17, 2009. 4 pp.

Hagar Environmental Science (HES). 2010**.** Codornices Creek Restoration Phase III: 6th to 8th Street Creek Modifications Fish Relocation Activities, July 2010 Technical Report prepared for City of Albany. September 21, 2010. 7 pp.

Hagar Environmental Science (HES). 2012**.** Hagar Environmental Science (HES). 2009**.** Codornices Creek Post-Project Habitat Reconnaissance. Technical Report prepared for Restoration Design Group. October 2, 2012. 8 pp.

Hokanson, K.E.F., C.F. Kleiner, and T.W. Thorslund. 1977. Effects of Constant Temperatures and Diel Temperature Fluctuations on Specific Growth and Mortality Rates and Yield of Juvenile Rainbow Trout, Salmo gairdneri. Journal of the Fisheries Research Board of Canada 34: 639-648.

Smith, J.J. and H.W. Li. 1983. Energetic factors influencing foraging tactics of juvenile steelhead trout, Salmo gairdneri. In: Predators and Prey in Fishes. Dr. W. Junk Publishers. The Hague. pp. 173-180.



Codornices Creek Phase III

Cross Section Locations

Restoration Design Group, LLC
2612B 8th Street
Berkeley, California 94710
T 510.644.2798 F 510.644.2799
RestorationDesignGroup.com

Codornices Creek Phase III

Photo Point Locations

Restoration Design Group, LLC
2612B 8th Street
Berkeley, California 94710
T 510.644.2798 F 510.644.2799
RestorationDesignGroup.com

4/20/2006

8/4/2009

12/14/2012

11/19/2014

Codornices Creek Phase 1

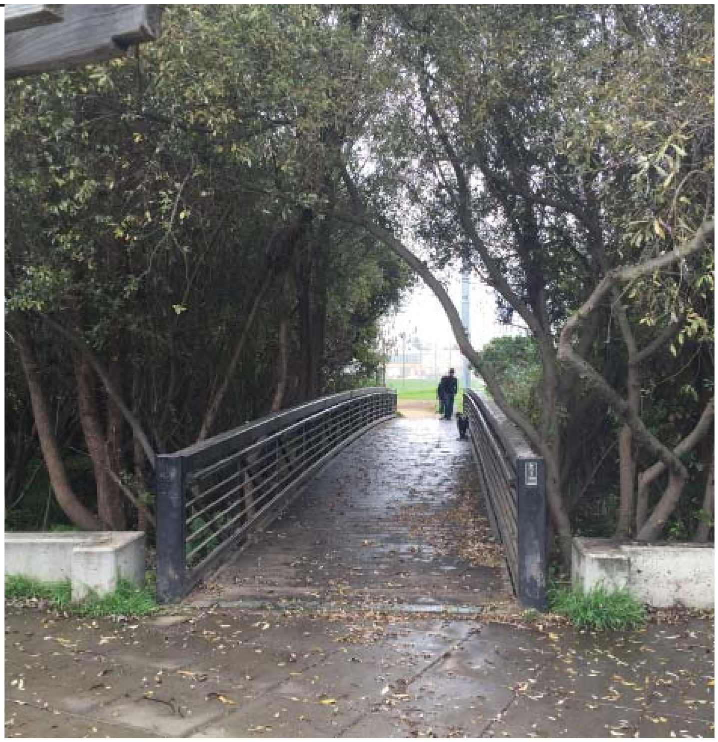
Photo Point #1

Restoration Design Group, LLC
2612B 8th Street
Berkeley, California 94710
T 510.644.2798 F 510.644.2799
RestorationDesignGroup.com

7/12/2007

8/4/2009

12/14/2012



11/19/2014

Codornices Creek Phase 1

Photo Point #2

Restoration Design Group, LLC
2612B 8th Street
Berkeley, California 94710
T 510.644.2798 F 510.644.2799
RestorationDesignGroup.com

10/9/2008

8/4/2009

12/14/2012

11/19/2014

Codornices Creek Phase 2

Photo Point #3

Restoration Design Group, LLC
2612B 8th Street
Berkeley, California 94710
T 510.644.2798 F 510.644.2799
RestorationDesignGroup.com

9/27/2007

7/31/2009

9/25/2013

11/19/2014

Codornices Creek Phase 2

Photo Point #4

Restoration Design Group, LLC
2612B 8th Street
Berkeley, California 94710
T 510.644.2798 F 510.644.2799
RestorationDesignGroup.com

7/02/2007

7/31/2009

12/14/2012

11/19/2014

Codornices Creek Phase 2

Photo Point #5

Restoration Design Group, LLC
2612B 8th Street
Berkeley, California 94710
T 510.644.2798 F 510.644.2799
RestorationDesignGroup.com

10/9/2008

12/14/2012

4/18/2014

11/19/2014

Codornices Creek Phase 2

Photo Point #6

Restoration Design Group, LLC
2612B 8th Street
Berkeley, California 94710
T 510.644.2798 F 510.644.2799
RestorationDesignGroup.com

2/17/2011

2/21/2011

10/22/2012

11/19/2014

Codornices Creek Phase 3

Photo Point #7

Restoration Design Group, LLC
2612B 8th Street
Berkeley, California 94710
T 510.644.2798 F 510.644.2799
RestorationDesignGroup.com

2/17/2011

3/7/2012

12/14/2012

4/18/2014

Codornices Creek Phase 3

Photo Point #8

Restoration Design Group, LLC
2612B 8th Street
Berkeley, California 94710
T 510.644.2798 F 510.644.2799
RestorationDesignGroup.com

1/23/2012

3/7/2012

12/14/2012

4/18/2014

Codornices Creek Phase 3

Photo Point #9

Restoration Design Group, LLC
2612B 8th Street
Berkeley, California 94710
T 510.644.2798 F 510.644.2799
RestorationDesignGroup.com

2/17/2011

3/7/2012

12/14/2012

4/18/2014

Codornices Creek Phase 3

Photo Point #10

Restoration Design Group, LLC
2612B 8th Street
Berkeley, California 94710
T 510.644.2798 F 510.644.2799
RestorationDesignGroup.com

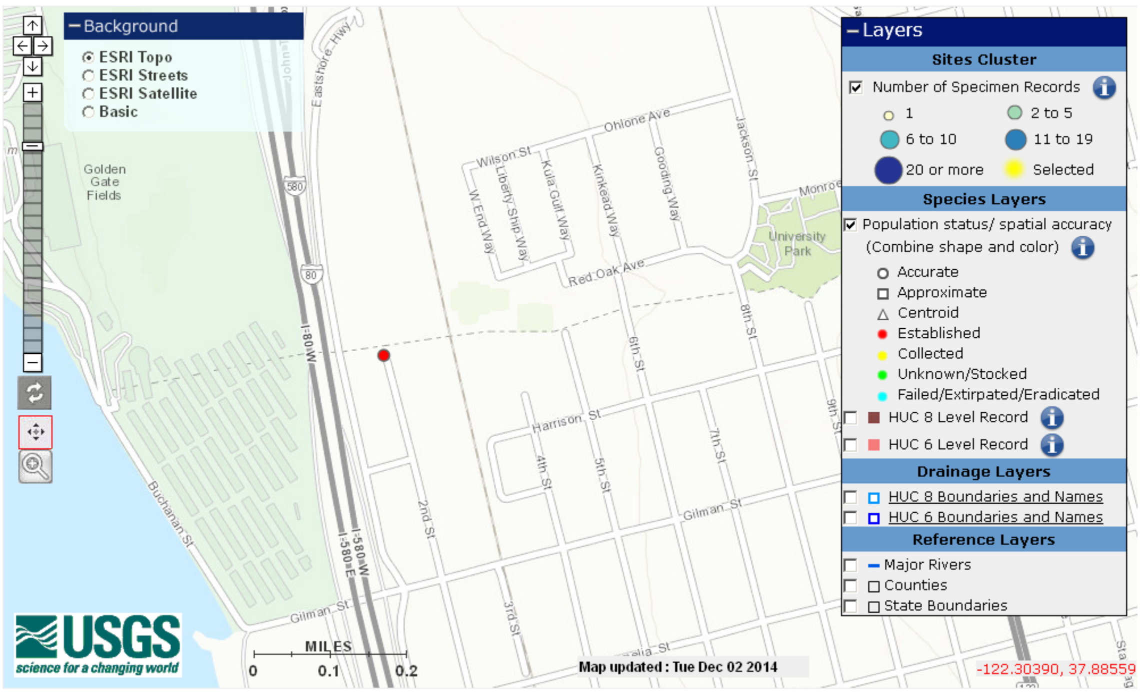
New Zealand Mudsnails in Codornices Creek

December 3, 2014

1. Introduction

In July of 2014, the Alameda County Clean Water Program documented the first know occurrence of New Zealand mudsnails (*Potamopyrgus antipodarum*) in Codornices Creek. Four mudsnails were found below the UPRR in the reach adjacent to the Target store.

Disclaimer: Number of records does not imply species abundance. Recommended browsers are Firefox, Chrome and IE9 or above.



The red dot on the map above indicates the location of New Zealand mudsnails

While small in number (4), the positive identification confirms that the mudsnails are spreading in urban creeks in the East Bay and put Codornices Creek at greater ecological risk. A 2004/2005 survey at multiple sites found no New Zealand mudsnails in the watershed. Little is known about the rate of or factors influencing population increase in Bay Area streams. As such, it is difficult to state the impact of a small number of documented mudsnails in the watershed other than to signify that they have arrived.

This brief memo described the potential impacts of New Zealand mud snails and protocols to prevent further contamination in Codornices Creek or to nearby uncontaminated creeks.

2. New Zealand Mudsnails

The New Zealand mudsnail is a small (4 to 6mm) snail that does well in silty, disturbed watersheds with high nutrient levels. As the name suggests, the New Zealand mudsnail is endemic to New Zealand but has now spread to North America, Asia, Australia, and

Europe. In their native habitat, trematode parasites sterilize New Zealand mudsnails, keeping the population sizes in check. Outside of New Zealand, the mudsnails encounter no natural predators or parasites. The highest recorded density of mudsnails was in Lake Zurich, Switzerland where population densities went from zero to 800,000 per square meter in seven years.

Invasive New Zealand mudsnails impact the ecology of creeks by out-competing native snails and aquatic insects. The lack of native snails and aquatic insects in turn impacts fish population dependent on them as a food source.

3. Decontamination Protocols

The best way to prevent the further spread of New Zealand mudsnails is to avoid unnecessary contact with contaminated creeks. However, given our professions and passions, it is occasionally necessary to enter Codornices Creek. The protocols summarized below can help prevent further spread.

New Zealand mudsnails can survive for 50 days on a damp surface such as boots, nets, clothes and other equipment often used in monitoring, fishing, play, and other creek-related activities. Given their resilience and extremely small size, it is imperative that anyone working in contaminated creeks inspects and treats any equipment or clothing that comes in contact with the creek. Full decontamination protocols are included in the Bay Area Stormwater Management Agencies Association attachment, but can be summarized as: Clean, Inspect, and Treat.

- **Clean** equipment before leaving the creek, if possible with a scrub brush and high pressure water
- **Inspect** gear before transporting off-site for snails, mud, gravel, or plant material
- **Treat** by either physical or chemical means
    - Physical
        - Freeze gear for 4 hours or more at less than 26 degrees Fahrenheit
        - Soak gear in 120 degree Fahrenheit water or hotter
        - Dry gear until completely dry (48 hours or longer)
    - Chemical
        - Soak gear for five minutes in a disinfecting cleaner containing quaternary ammonium compounds (see attachment for list) and rinse fully

4. References

BASMAA. 2011. Standard Operating Procedures for Field Equipment Decontamination Procedures. Bay Area Stormwater Management Agencies Association Regional Monitoring Coalition.

Feng, A. December 3, 2014. Personal communication.

New Zealand Mud Snail. (n.d.). In Wikipedia. Retrieved December 02, 2014, from http://en.wikipedia.org/wiki/New_Zealand_mud_snail

New Zealand Mudsnail Sightings Distribution. (n.d.). In USGS NAS - Nonindigenous Aquatic Species. Retrieved December 02, 2014, from http://nas.er.usgs.gov/taxgroup/mollusks/newzealandmudsnaildistribution.aspx

Schwartz, S. December 01, 2014. Personal communication.

STANDARD OPERATING PROCEDURES
for
Field Equipment Decontamination Procedures
(SOP FS-8)

Introduction

The Municipal Regional Stormwater NPDES Permit (MRP) was adopted by the San Francisco Bay Regional Water Quality Control Board on October 14, 2009. The Regional Monitoring Coalition (RMC) provides coordination and oversight of monitoring activities conducted in compliance with Provision C.8 (Water Quality Monitoring) of the MRP. The RMC is comprised of those Bay Area Stormwater Management Agencies Association (BASMAA) participants subject to monitoring requirements in the MRP. This SOP is part of the RMC's regional coordination effort.

MRP Requirements from Table 8.1

This SOP applies to the following activities from MRP Table 8.1:

Biological Assessment
General Water Quality
Chlorine
Temperature
Toxicity – Water Column
Toxicity – Bedded Sediment, Fine-Grained
Pollutants – Bedded Sediment, Fine-grained
Pathogen Indicators
Stream Survey

SOP Background and Application

Invasive species, such as the New Zealand Mudsnail (see Attachment 1), can be transported unintentionally from site to site on field equipment and clothing, especially footwear. This SOP is designed to help avoid unintentional spreading of invasives by inspecting, removing, and treating apparel and equipment before moving to a new site or water body.

References to Existing SOPs

This SOP is based on information provided in the following documents:

(1) "**How to Prevent the Spread of New Zealand Mudsnails through Field Gear**", second edition, Feb., 2010, produced by the Oregon Department of Fish and Wildlife. Copies of this brochure, call 541-737-4849 or e-mail Oregon Sea Grant at: sea.grant.communications@oregonstate.edu

A pdf of the brochure is available for download at:
http://seagrant.oregonstate.edu/sgpubs/onlinepubs.html
and is also available on the Oregon DFW web site:
http://www.dfw.state.or.us/conservationstrategy/invasive_species/docs/NZ_Mudsnails_10-page.pdf

(2) California Department of Fish and Game (CDFG) Aquatic Invasive Species Decontamination Protocol, dated September 17, 2010.

Relevant QA/QC protocols are also referenced in the associated RMC QAPPs for bioassessment and water quality monitoring: [PROVIDE LINKS/REFERENCES WHEN AVAILABLE]

Special Cautions and Considerations; Health and Safety

!

CAUTIONS

When using chemical cleaners, always read the product label and adhere to all printed cautions and safety measures. Wear rubber gloves and eye protection when using chemical cleaners.

Treating field gear with chemical methods may result in unintended contamination of the environment. In particular, extreme caution must be taken to avoid contamination of waterways and wetlands. DO NOT rinse your treated gear in a water body.

Treating rubber gear or boots with Formula 409® and other disinfectants with quaternary ammonium compounds (QACs) may result in surface cracking of the rubber and loss of water repellency.

Chemical methods are not always effective in killing mudsnails. Always scrub your gear and consider using physical methods before resorting to chemical methods.

Methods/Procedures

To prevent the survival of mudsnails or other invasives on field clothing and equipment, it is necessary to first clean all field gear and then to treat it, using either the physical or chemical methods listed below. The following steps are recommended:

- If possible, keep different sets of field gear for use in different bodies of water.
- **Clean** all gear before leaving a site, scrubbing with a stiff-bristled scrub brush and rinsing with water, preferably high-pressure. This is often the simplest and most effective measure for prevention.
- **Inspect** gear before it is packed for transport. Visible traces of sand, mud, gravel, and plant fragments are signs that gear has not been properly cleaned and mudsnails may have been retained.

- **Select** a treatment method in addition to scrubbing and rinsing if mudsnails are present or suspected to be present. Two general categories of treatment are available - physical methods and chemical methods:
  - **Freezing, hot water, or drying treatments** are recommended over chemical treatments because they are usually less expensive, more environmentally sound, and possibly less destructive to gear. However, most physical methods require longer treatment times and often cannot be performed in the field.
  - **Chemical treatments** require a 10-minute soak in a special solution (see "CHEMICAL," page 5). After chemical treatment, gear must be rinsed thoroughly with tap water away from all bodies of water, and all soak solutions and rinse water must be properly disposed of.

The CDFG's Invasive Species Program recommends drying of field equipment as the best method for treatment.

PHYSICAL TREATMENT

These methods for cleaning gear are effective as well as environmentally sound. Use *one* of the following methods:

- **Freeze** your gear for a minimum of 4 hours to kill all mudsnails. Freezer temperatures should be at 26°F (-3°C) or below.
- **Soak** gear in a bath of hot water (at least 120°F, 46°C) for 10 minutes. NOTE: This method is not advised for Gortex.
- **Dry** your gear before reuse. A drying time of at least 48 hours under low humidity is recommended to remove all pockets of dampness.
  Gear must be completely dry for a minimum of 24 hours. Check to ensure that boots are totally dry.

CHEMICAL TREATMENT

Common disinfecting cleaners containing quaternary ammonium compounds (QACs, e.g., alkyl dimethyl benzylammonium chloride [ADBAC]; diecyl dimethyl ammonium chloride [DDAC]) are effective for decontaminating gear.

Disinfectants listed below will kill other aquatic invasive species but may not result in 100% mortality.

Gear should be soaked in *one* of the following solutions for 5 minutes and then rinsed thoroughly with tap water, away from the water body:

- Commercial disinfectant solutions containing quaternary ammonium compounds (e.g., Formula 409® Cleaner Degreaser Disinfectant, alkyl dimethyl benzylammonium chloride [ADBAC]; diecyl dimethyl ammonium chloride [DDAC]). Formula 409®. Cleaner Degreaser Disinfectant has been proven effective for killing mudsnails at 50% dilution.

- The compounds Quat 128® and Sparquat 256® are commercial disinfectants with an active ingredient (QAC) similar to that of Formula 409® Cleaner Degreaser Disinfectant, which has proven effective for killing mudsnails and other aquatic invasive species (see the table on the foldout page of the brochure for dilution rates).
- Many household bath and kitchen disinfectants contain quaternary ammonium compounds (check the label for active ingredients containing alkyl dimethyl benzylammonium chloride [ADBAC]; diecyl dimethyl ammonium chloride [DDAC]).

These and other chemical treatments are constantly being evaluated and are updated online at: seagrant.oregonstate.edu/themes/invasives/

Store and dispose of solution and used rinse water properly.

Quality Assurance/Quality Control

If chemical treatments are used, ensure that rinsing is performed thoroughly, to prevent contamination of water courses.

References

For more information on the testing of chemical treatment methodology, see:
R. C. Hosea, and B. Finlayson, 2005, *Controlling the Spread of New Zealand Mud Snails on Wading Gear,* Administrative Report 2005-02, Rancho Cordova, California: Resources Agency, California Department of Fish and Game.

For more information on identification and prevention of spread of aquatic invasive species within California creeks, see: *California Department of Fish and Game Aquatic Invasive Species Decontamination Protocol*, dated September 17, 2010.