2014 Annual Report for the Green Valley Creek Winter Refugia Enhancement Project

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Introduction

Green Valley Creek

The University of California Cooperative Extension and California Sea Grant (UC) coho monitoring program has monitored wild and hatchery coho salmon populations in the Russian River watershed for the last ten years as part of the Russian River Coho Salmon Captive Broodstock Program (RRCSCBP). Part of these hatchery stocking and monitoring efforts occur in Green Valley Creek, one of the last tributaries in the watershed known to have wild coho salmon. The RRCSCBP currently releases juvenile coho salmon into Green Valley Creek as young-of-year in the spring and fall season, as well as one-year old smolts in early spring. In 2013, approximately 13,500 juvenile coho were released in Green Valley watershed, primarily upstream of the Green Valley Creek winter refugia enhancement project (enhancement corridor). As part of its monitoring efforts, UC manages PIT antenna sites across the watershed. Since a known percentage of hatchery release coho are PIT tagged (about fifteen percent), it is possible to estimate the total number of hatchery coho migrating through the enhancement corridor using PIT tag detection data. This monitoring infrastructure across the watershed and in Green Valley Creek provides a unique foundation for evaluating the effects of the enhancement corridor on the coho populations in Green Valley Creek.

Project Objectives

The objective of the winter refugia enhancement project is to create off channel habitat that will provide much needed velocity refugia habitat for juvenile coho salmon. The project site floods readily in the winter, so much so that flows may currently be too swift for the area to provide adequate refuge. Creating off channel habitat could provide this needed slow flow refugia to juvenile salmonids during winter high flow events. Juvenile coho salmon survival could likely be improved by providing this improved winter rearing habitat in this habitat corridor.

Year One Project Accomplishments

Pre-project flow and fish passage data were collected from fall 2013 through June 15, 2014. Data was collected through the use of PIT antenna arrays, a pressure transducer flow gauge, and in-stream flow measurements in the Green Valley Creek main channel site adjacent to the planned off channel restoration.

Two PIT antenna arrays were installed in the main channel of Green Valley Creek to track coho salmon migration timing, rate of passage through the enhancement corridor, and estimated number of coho salmon moving through the corridor (Figure 1 and 2a-2b). These two arrays were installed during the fall 2013 season, prior to winter flow conditions. They are located upstream (Array 1) and downstream (Array 4) of the planned off channel project inlet and outlet. Two additional arrays will be installed at the inlet (Array 2) and outlet (Array 3) once the off channel enhancement is completed in fall 2014. Array 2 and Array 3 will track PIT tagged coho salmon movement through the newly provided winter habitat, which will allow for a comparison of migration patterns between main channel and off channel habitat as well as pre and post project implementation differences.

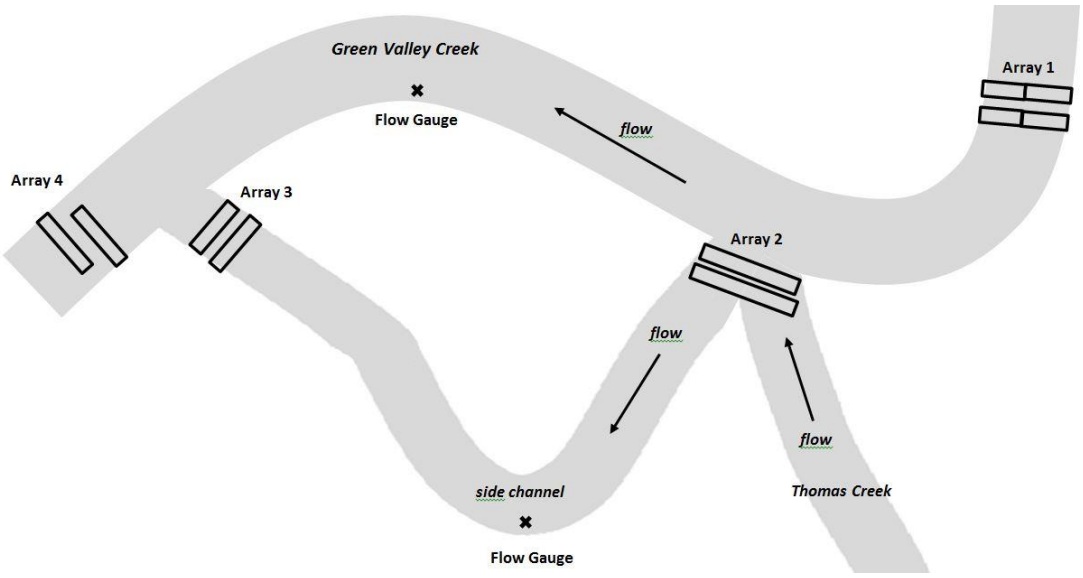

Figure 1. PIT antenna arrays at the Green Valley Creek Off Channel Winter Refugia Habitat Enhancement Project. Arrays 1 and 4 were established during the fall 2013 season and Arrays 2 and 3 will be installed following off channel construction. The main channel flow gauge was installed in Fall 2013 and the off channel one will be installed after project completion in Fall 2014.

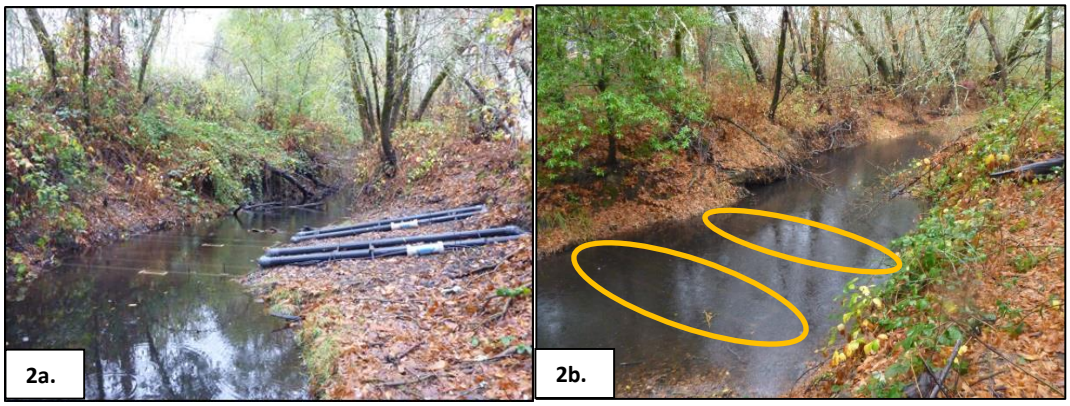

Figure 2a-b. PIT antenna arrays in the main channel of Green Valley Creek. 2a: Array 1, four antenna array. 2b: Array 4, two antenna array with antennas circled in orange.

A pressure transducer gauge was installed in the mainstem of Green Valley Creek between Array 1 and Array 4 and began collecting data on November 20, 2013, prior to initial winter rain events. This gauge will be used to calculate flow through the main channel of Green Valley Creek (Figure 1). Once the side channel is completed, a second flow gauge will be installed to track flow through the new channel. This will allow for a comparison of flows between main channel and off channel sections and can be related to any migration differences between fish in main channel versus off channel habitat.

Methods

PIT antenna detection

Data was collected continuously from the time of PIT antenna installation in November 2013 through June 15, 2014 at Array One and Array Four. Antenna data consists of the date, time, and tag number of each detected PIT tagged fish as well as the individual antenna within an array where the detection occurred. PIT antenna data logger clocks drift inconsistently, so time comparisons were logged at each

antenna site visit and data download. The data logger time was compared to Pacific Standard Time on an atomic watch at each site, which was then used to calculate an adjusted time for each tag detection in the enhancement corridor. This allowed for more accurate comparisons of unique PIT tag detection timing among antenna arrays. Downloaded antenna data was then uploaded to a Microsoft Access database, where antenna location (upstream or downstream within an array) and antenna site (Array 1 or Array 4) were included along with the PIT tag number, adjusted detection time, and date of detection. This database also includes all PIT tagged fish release information. Since each PIT number is unique to an individual fish, each tag detection at an antenna was linked to the initial tagging and release of that individual fish into the watershed. Data from the Green Valley Creek enhancement corridor was joined by PIT number to the initial tagging and release records, from which total number of hatchery fish each PIT tagged fish represents was calculated. This is possible because the percentage of PIT tagged fish is known per hatchery release group.

Since arrays consist of upstream and downstream antennas, the migration rate, direction (upstream or downstream from an antenna array), and detection efficiency between the arrays was determined. Migration rates through the reach were estimated for coho salmon detected at both antenna arrays and were based on the first detection of each PIT tagged fish at each array. Antenna efficiencies were estimated for each array by calculating the percentage of tagged fish detections at an antenna in comparison to other antennas at the same site. For example, to estimate the efficiency at Array 1, the number tagged smolts detected on both Array 1 and Array 4 was divided by the number detected at Array 4 (since all of the juveniles were released upstream of the enhancement corridor and smolts were migrating downstream, we assumed that fish detected at Array 4 had to pass through Array 1). Antenna efficiencies along with known proportions of tagged to untagged hatchery coho were then used to estimate the total number of hatchery coho smolts migrating past the enhancement corridor.

Flow Monitoring

The pressure transducer gauge collected pressure (PSI), water temperature (°C), and depth (feet) of the logger in fifteen minute intervals. This data was then compared to cross section flow surveys that were conducted adjacent to the gauge site in the main channel at a range of stage and flows (Somers and Buchanan, 1969).

Results

Antenna Efficiency

Antenna efficiency was calculated for antenna arrays one and four in order to estimate the number of fish moving through the Green Valley Creek enhancement corridor (Table 1). Within arrays, antenna efficiency was high for Array 1 (98.6% of PIT tagged fish detected at the upper antennas within Array 1 were also detected at the lower antennas), and lower for Array 4 (77.6% of PIT tagged fish detected at the upper antenna within Array 4 were also detected at the lower antenna). Lower efficiency at Array 4 was likely due to antenna malfunctions throughout the season. This array was run on a different transceiver than Array 1, and antenna malfunctions will be addressed by switching to the Array 4 transceiver in Fall 2014. The high antenna efficiencies between arrays are comparable or higher than antenna sites managed by UC in other parts of the watershed. High efficiencies were also likely due to lower than usual water depths this winter.

Table 1. Efficiency of antenna arrays in the Green Valley Creek winter refugia enhancement corridor.

Array	Antenna(s) within Array	Efficiency within Arrays	Efficiency Between Arrays
Array 1	Lower (2 antennas)	98.6%	99.8%
	Upper (2 antennas)	99.2%	
Array 4	Lower (1 antenna)	77.6%	90.8%
	Upper (1 antenna)	81.1%	

Antenna status (whether an antenna was recording data fully, partially, or not at all) was also tracked for installed antenna arrays. Array 1 was fully working from installation through June except for some partial working days in January and February, 2014 (January 29 – February 7, 2014). Unfortunately, this overlaps with the first winter storm (February 6 to about February 10 with peak flow conditions on February 9). Partial status during this storm was due to low power issues that caused the data logger to turn off. Power outages were caused by low solar input, which was remediated during the early February storm by increasing power storage capabilities at the site. Array 4 was fully running though through this first storm, so the majority of migrating fish (based on 90.8% efficiency of Array 4 in comparison to Array 1) were still captured during this storm event.

Pressure vs. flow data

High flow events were unsafe to measure during cross section flow surveys, which reduces the range of the measured flow rating curve. Since the maximum measured flow during a cross section survey at this site was 26.4 cfs at 1.56 stage depth, calculated flow data at flows greater than this maximum measured point is presented with high uncertainty (Figure 3).However, recorded stage depths from the pressure transducer logger do follow the precipitation pattern for this data collection time span in Green Valley Creek. This data also displays comparable patterns to corrected depth and flow data from the USGS Austin Creek gage, which is a watershed with similar precipitation patterns as the Green Valley Creek watershed. For these reasons, we are confident in comparing general stream condition patterns in flow and depth to coho migration timing through the enhancement corridor.

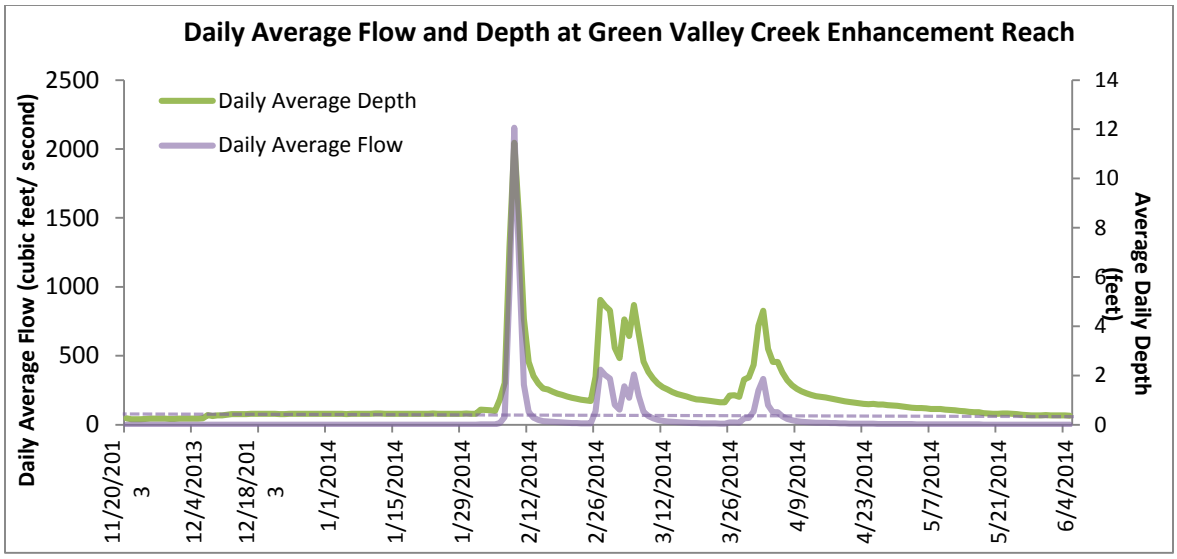

Figure 3. Daily Average flow (cfs) and stage depth (ft) from the Green Valley Creek Enhancement Reach. Dotted line at the maximum cross section flow measurement (26.4 cfs) is included since flow calculated above this value has a high uncertainty.

Migration timing and rate of passage past the site.

Although antennas were installed in November 2013, fish were not detected until February 2014, due to delayed winter rains: the initial winter storm event occurred the first week of February (Figure 3). However, the majority of tag detections did not occur until April and May 2014, when most coho salmon smolts out migrated from Green Valley Creek (Table 2). Of the 2,124 unique PIT detections at the Green Valley antenna arrays through June 15, 2014, three were spawning adults, which were detected from February 6 through February 16, 2014. The remaining detections were coho smolts (2,109 detected individuals), which were first detected on February 8, 2014 and through June 13, 2014 (Figure 4). 2014 smolt release fish (released in Green Valley Creek in Spring 2014) are not included in the migration timing summary since their tendency is to immediately migrate downstream once released and thus may not respond to natural stream conditions like hatchery fish that overwintered in natural habitat. Sample size for evaluation of migration timing patterns was thus reduced to 1,549 individuals.

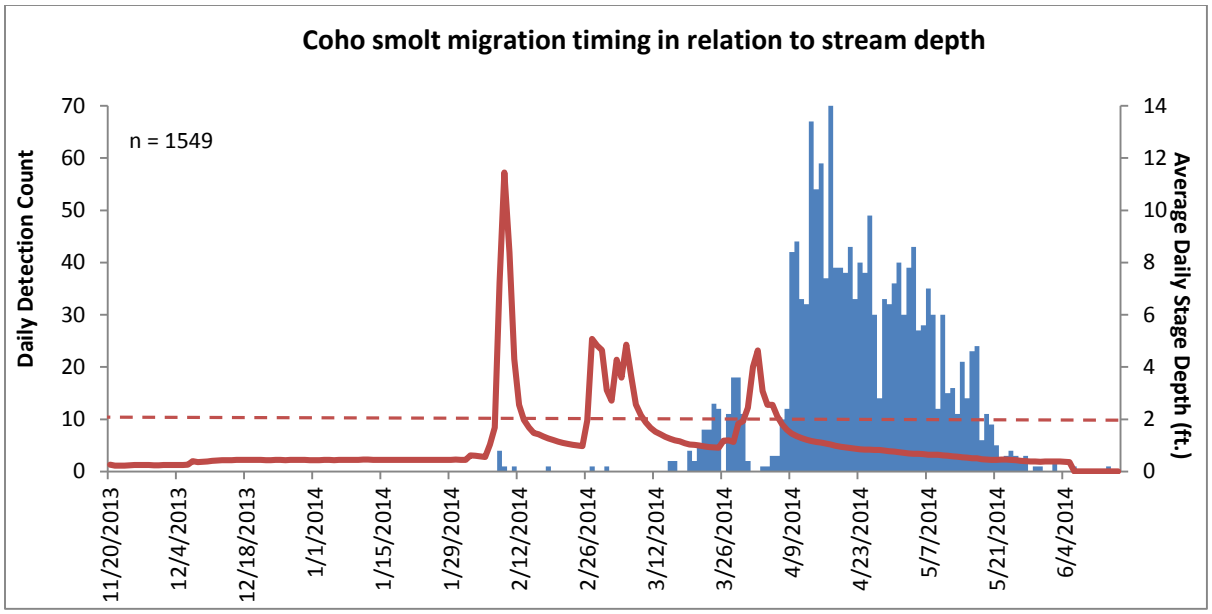

Figure 4. Migration timing of all hatchery coho salmon smolts detected in the enhancement corridor during the pre-project phase (November 2013 - June 2014). Migration timing is based on the first date of detection for each tagged hatchery coho smolt. Stream depth represents flow conditions through the enhancement corridor, but confidence is low above two feet due to no in-stream flow surveys occurring above this depth (red dotted line).

Coho salmon smolt migration through the enhancement corridor mainly occurred after high winter flow conditions ended the first week of April 2014 (Table 2): 1,419 of 1,549 PIT tagged coho smolts, or 92% of coho smolts. When looking at migration by week after the final winter storm ended, the majority of coho salmon smolts migrated through the enhancement corridor the second week (Table 3): 365 of 1,549 fish (23.6%) were initially detected in the corridor from 4/13/2014 through 4/19/2014, when stream flow was gradually decreasing after the winter rains.

Table 2. Coho smolt migration through the enhancement corridor by storm event (n = 1,549): November 14, 2013 – June 15, 2014.

Before Winter Storms	During Winter Storms		Between Winter Storms		After Winter Storms	
0	43	2.8%	87	5.6%	1,419	91.6%

Table 3. Coho smolt migration through the enhancement corridor after winter storms (n = 1,419). Time period is 4/6/2014 - 6/15/2014 with first day of week listed. Percentage of fish is based on total number of detected coho smolts (n = 1,549).

After Winter Storms			
Week 1	April 6	176	11.4%
Week 2	April 13	365	23.6%
Week 3	April 20	271	17.5%
Week 4	April 27	224	14.5%
Week 5	May 4	205	13.2%
Week 6	May 11	124	8.0%
Week 7	May 18	40	2.6%
Week 8	May 25	10	0.6%
Week 9	June 1	3	0.2%
Week 10	June 8	1	0.1%
Total: 1419		**91.6%**	

The average rate of downstream migration through the enhancement corridor for coho salmon smolts was 81 minutes (n = 1,907). However, if you exclude fish that had a migration rate greater than 30 minutes (6.1% of all downstream migrating smolts), the average rate of migration through the corridor was just under twelve minutes (Table 4).

Table 4. Migration rates for downstream migrating coho salmon smolts through the enhancement corridor (n = 1,907). Migration rate is time difference between the first detection at antenna array 1 to first detection at antenna array 4.

Migration Rate	Count	Percentage	Average Migration Rate (minutes)
less than 30 minutes	1,791	93.9%	11.6
30 to 60 minutes	57	3.0%	38.9
1 hour to 24 hours	53	2.8%	471.3
more than 24 hours	6	0.3%	17,876.6

Estimated number of coho

From the antenna installation in November 2013 through June 15, 2014, 2,109 unique PIT tagged outmigrating hatchery coho smolts were detected at the two project antenna arrays. Detections were extrapolated out to an estimated total number of smolts migrating through the reach based on the known percentage of PIT tagged individuals per hatchery release group. The estimated number of hatchery smolts migrating past the project reach was 8,109 for the study period (Table 5).

Table 3. Number of unique PIT tagged hatchery coho salmon smolts detected in the Green Valley Creek enhancement reach. Estimated totals are based on the known percentage of PIT tagged fish per hatchery release group, which is listed under "Percent Tagged/Release".

Release Watershed	Release Stream	Release Group	Detected Tags	Percent Tagged/ Release Group	Estimated Total	Number and Percent of Estimated Smolts / Release Watershed
Green Valley Creek	Green Valley Creek	Spring 2013	14	100%	14	8,096 (99.8%)
		Fall 2013	1,370	42%	3,262	
		Smolt 2014	560	15%	3,733	
	Purrington Creek	Fall 2013	163	15%	1,087	
Dry Creek	Mill Creek	Fall 2013	1	16%	6	6 (0.1%)
	Pena Creek	Fall 2013	1	15%	7	7 (0.1%)
			Total: 2,109		**Total: 8,109**	

Watershed context

The majority of detected coho smolts were initially released in the Green Valley Creek watershed as juveniles: 1,904 detected smolts were originally released into Green Valley Creek and 163 were originally released into Purrington Creek. The remaining detected fish were from Pena and Mill Creek (0.1% each), both Dry Creek watershed streams. Although a very small percentage of total outmigrating smolts, this does represent some cross-stream connectivity and potential use of Green Valley Creek as overwinter habitat from nomadic coho salmon (fish that either hatched or were released in a different stream than where they outmigrated as smolts from).

Conclusions

Preliminary Conclusions

Because of the drought conditions during the winter of 2013-2014, fall and winter hatchery releases into Green Valley were reduced. For fish that were released, the extreme low flow conditions during the winter likely prevented juvenile movement until the first week of February when the first tag detections were recorded through the enhancement corridor. Although there was little movement of juveniles prior to the smolt season, the data that was collected does show an inter-stream migration component: coho smolts from Mill Creek (estimated n = 6) and Pena Creek (estimated n = 7) were detected through the corridor. Smolt migration was relatively fast through the corridor as well (92% of smolts passed between the two antenna arrays in less than 30 minutes), a possible indication of low availability of winter high flow refuge habitat for juvenile coho salmon.

Next Steps

Upon completion of the off channel habitat, antenna arrays two and three will be installed as well as the off channel flow gauge. These additional monitoring devices will allow for comparison between off channel and main channel habitat usage and migration patterns once the off-channel component of the enhancement corridor is completed.

Reference

Buchanan, T.J., and Somers, W.P., 1969, Discharge measurements at gaging stations: U.S. Geological Survey Techniques of Water-Resources Investigations, Book 3, Chapter A8, 65 p. (Also available at http://pubs.usgs.gov/twri/twri3a8/.)