

# Recovery Monitoring of Endangered Coho Salmon in the Russian River

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*Final Report for the California Department of Fish and Wildlife, Contract P1330005*



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**Cover photograph:** A male coho salmon observed in Mill Creek.

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## INTRODUCTION

The Russian River Coho Salmon Captive Broodstock Program (RRCSCBP), initiated by the California Department of Fish and Wildlife (CDFW), National Marine Fisheries Service, and U.S. Army Corps of Engineers in the late 1990's, is working to recover endangered coho salmon populations by stocking offspring of wild, captive-reared coho raised at Don Clausen Warm Springs Hatchery into historic coho tributaries within the Russian River watershed.

Since 2004, University of California Cooperative Extension and California Sea Grant (UC) personnel have worked with agency partners to implement a monitoring program to evaluate the effectiveness of the RRCSCBP by documenting whether released coho are surviving in the streams in which they are stocked and returning as adults to spawn.

The work conducted under this contract (P1330005) was a continuation of this monitoring program from December 15, 2013 through December 31, 2014. A summary of annual juvenile coho releases and corresponding hatchery-origin adult returns to the Russian River basin from 2000 through 2014 is provided in **Figure 1**.

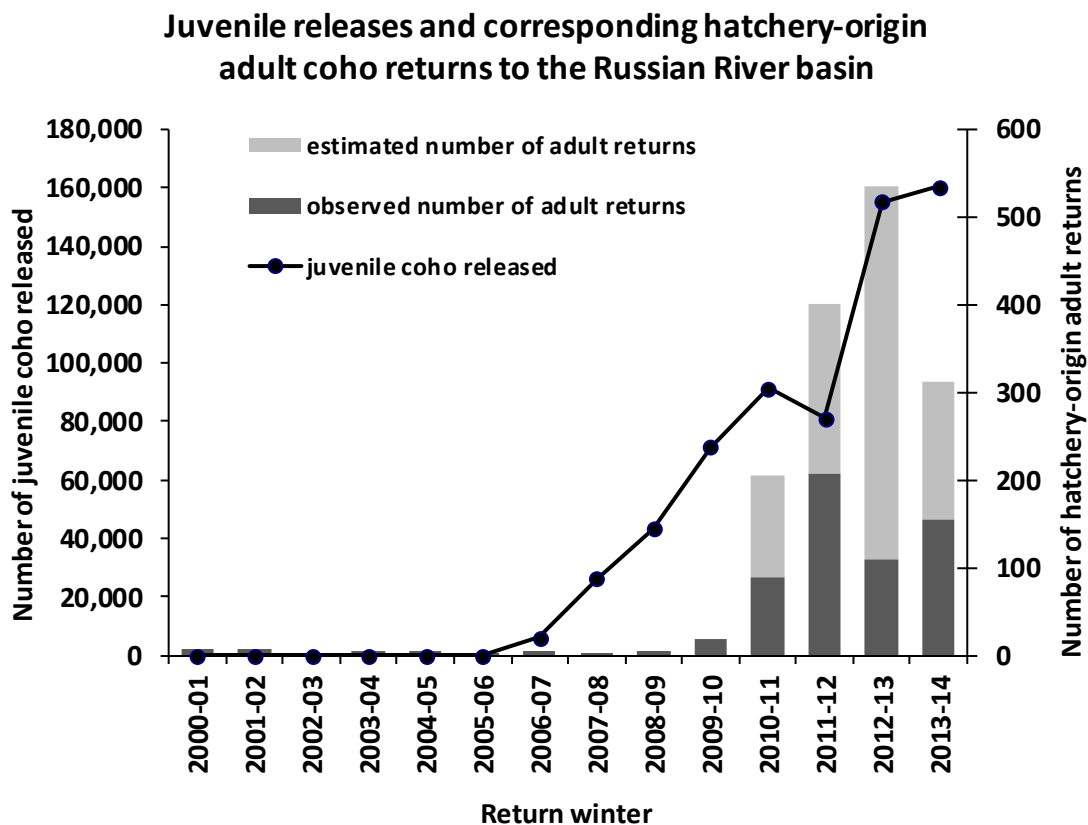


Figure 1. Juvenile releases and corresponding hatchery-origin adult coho returns to the Russian River basin.

## **WORK PERFORMED AND RESULTS**

### ***DOWNSTREAM MIGRANT TRAPPING***

UC personnel operated seasonal downstream migrant traps on Mill and Willow Creeks to document the number and size of coho smolts emigrating during the spring of 2014 (**Figure 2**). Following trap installation, two UC biologists checked each trap at least one time daily, and more frequently during rain and wind events. Captured coho, Chinook and steelhead were counted, weighed, measured, scanned for coded-wire (CWT) and/or PIT tags, and then released into the stream below the trap site following recovery in a cool aerated bucket of water. Genetics samples were taken from up to five juvenile coho salmon at each site daily by clipping a 1 mm square tip of the lower lobe of the caudal fin, and samples will be transferred to the NOAA Southwest Fisheries Science Center in early March, 2015. All other fish, amphibians, crustaceans and other species captured were counted, recorded, and released. Field computers with built in error checks were used for data collection. Upon returning from the field, biologists downloaded the field computers, performed additional error checks in Microsoft Excel and imported the data into a Microsoft Access database.

Data collected at the downstream migrant traps was used to provide summaries of trap counts for salmonids (**Table 1**) and non-salmonids (**Table 2**), smolt run-timing (**Figure 3**, **Figure 4**), average smolt length (**Figure 5**, **Figure 6**), and average size and growth rates by hatchery release group (**Table 3**). In combination with antenna data (see Operation of PIT tag antenna array section below), trapping data was used to estimate smolt abundance using two-trap DARR (Bjorkstedt 2005, 2010) (**Figure 7**).

In 2014, the Mill Creek trap was installed on 3/12/14 and operated through 5/23/14. Due to storm events, it was not operated between 3/29 and 4/4 (**Figure 3**). A total of 1,451 coho smolts were captured in the trap with an abundance estimate of 6,570 (**Figure 7**). Genetics samples were collected from 222 CWT-tagged coho smolts, and 184 from nonCWT-tagged smolts. The average fork length of all coho smolts passing through the trap (CWT, nonCWT, all release groups) was 109 mm  $\pm$  9mm (**Figure 5**), and the average size for the 2013 fall release group was slightly higher than fish that were stocked into Mill and Palmer Creeks during the spring of 2013 (**Table 3**).

The Willow Creek trap was installed on 3/12/14 and operated until 5/30/14. Due to storm events, this trap was not operated on the following dates: 3/29-4/4, 4/20, and 5/24 (**Figure 4**). A total of 929 coho smolts were captured in the trap with an abundance estimate of 1,522. Genetics samples were collected from 216 CWT-tagged coho smolts, and 299 from nonCWT-tagged smolts. The average fork length of all coho smolts passing through the trap (CWT and nonCWT) was 109 mm  $\pm$  10 mm (**Figure 6**), and the average fork length of all hatchery fall release coho was 111mm  $\pm$  8mm (**Table 3**). Growth rates of fall release fish were higher in Willow Creek than in Mill Creek (**Table 3**).

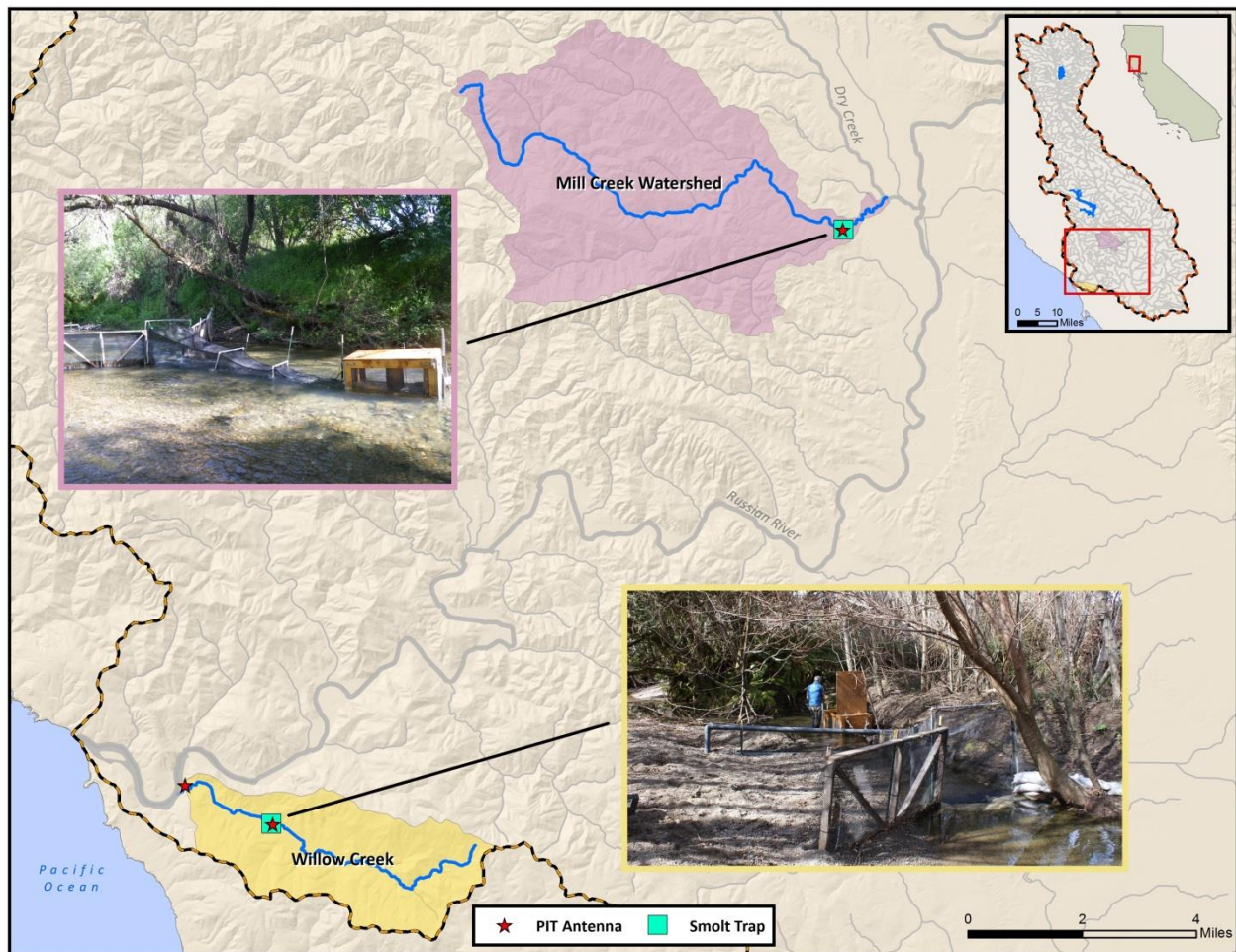


Figure 2. 2014 Mill and Willow Creek downstream migrant trapping locations.

Table 1. The total number of salmonid species by life stage captured at each downstream migrant trapping tributary site in 2014. Coded wire tagged or adipose fin clipped hatchery release individuals (tagged) are separated from non-tagged individuals and individuals without a known tagging history.

Tributary	Species	Life Stage (size class)	Tagged	Not-Tagged	Unknown	Total
Mill Creek	Coho salmon	smolt ( $\geq 130$ mm)	1273	170	8	1451
	Chinook salmon	smolt	0	17	1	18
		juvenile ( $< 130$ mm)	0	108	0	108
	Steelhead	smolt ( $\geq 130$ mm)	0	8	0	8
		adult	1	0	0	1
Unknown salmonids	yoy	0	2	3	5	
Willow Creek	Coho salmon	smolt	583	344	2	929
	Chinook salmon	smolt	0	0	0	0
	Steelhead	juvenile ( $< 130$ mm)	0	866	0	866
		smolt ( $\geq 130$ mm)	0	11	0	11
	Unknown salmonids	yoy	0	4	0	4



Table 2. The total number of non-salmonids captured at each downstream migrant trapping tributary site in 2014. Some individuals were not identified to the species level.

Tributary	Species	Count of Individuals
Mill Creek	Bluegill	29
	Bullfrog	41
	California Roach	20
	Cyprinid species	1
	Foothill Yellow-Legged Frog	3
	Frog species	1
	Green Sunfish	5
	Mouse species	1
	Salamander species	3
	Sculpin species	60
	Sunfish species	2
	Threespine Stickleback	1
	Western Toad	3
	Willow Creek	Amphibian species
California Giant Salamander		7
California Roach		1
Crayfish species		5
Rough Skinned Newt		1
Sacramento Sucker		1
Sculpin species		680
Threespine Stickleback		296

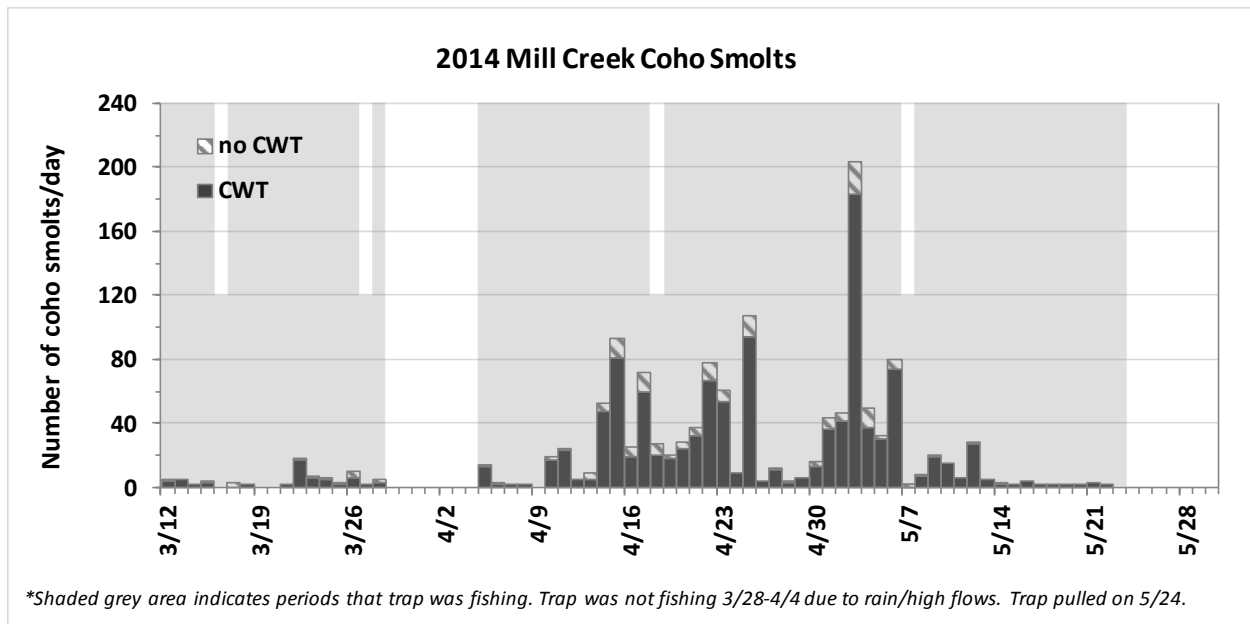


Figure 3. 2014 Mill Creek daily smolt counts.

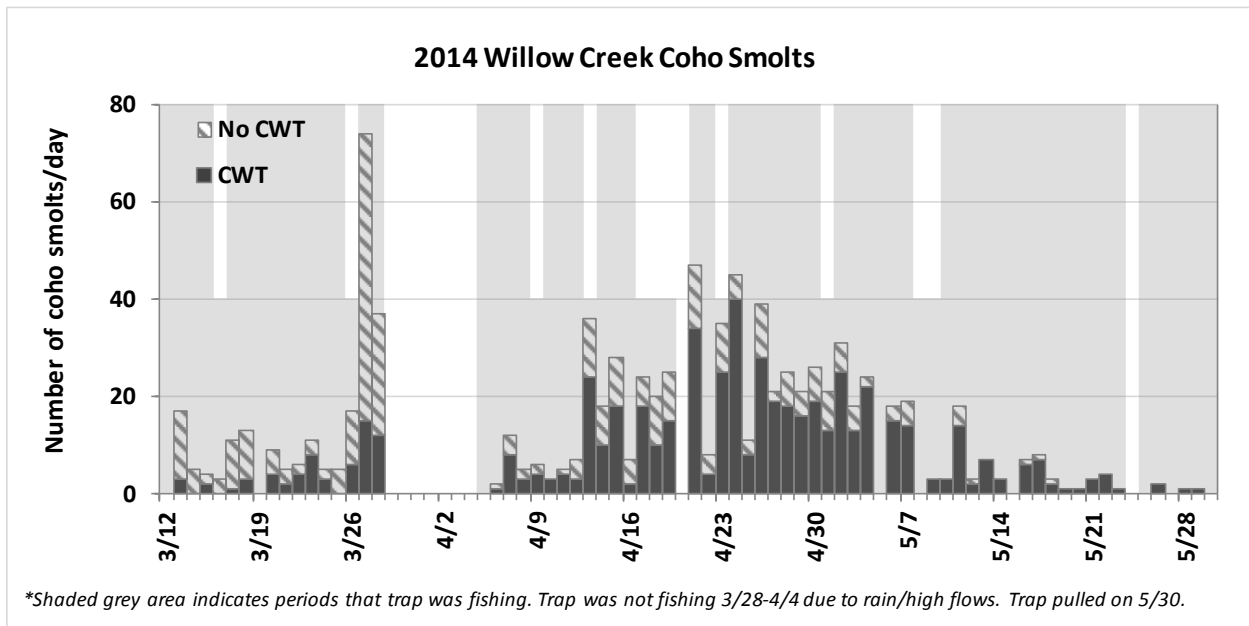


Figure 4. 2014 Willow Creek daily smolt counts.

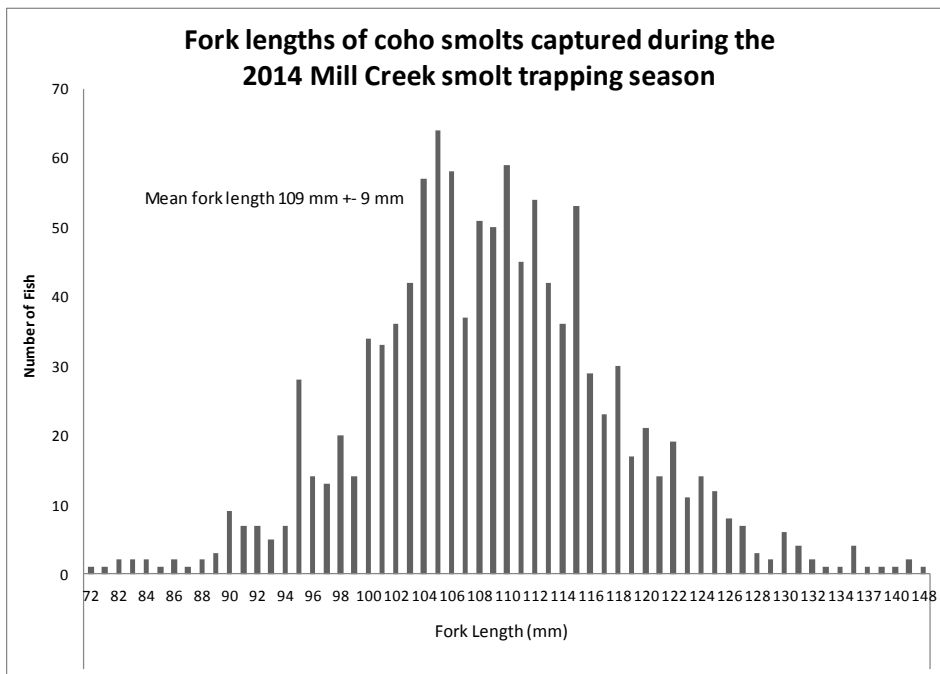


Figure 5. Length-frequency distribution of coho smolts captured during the 2014 Mill Creek smolt trapping season.

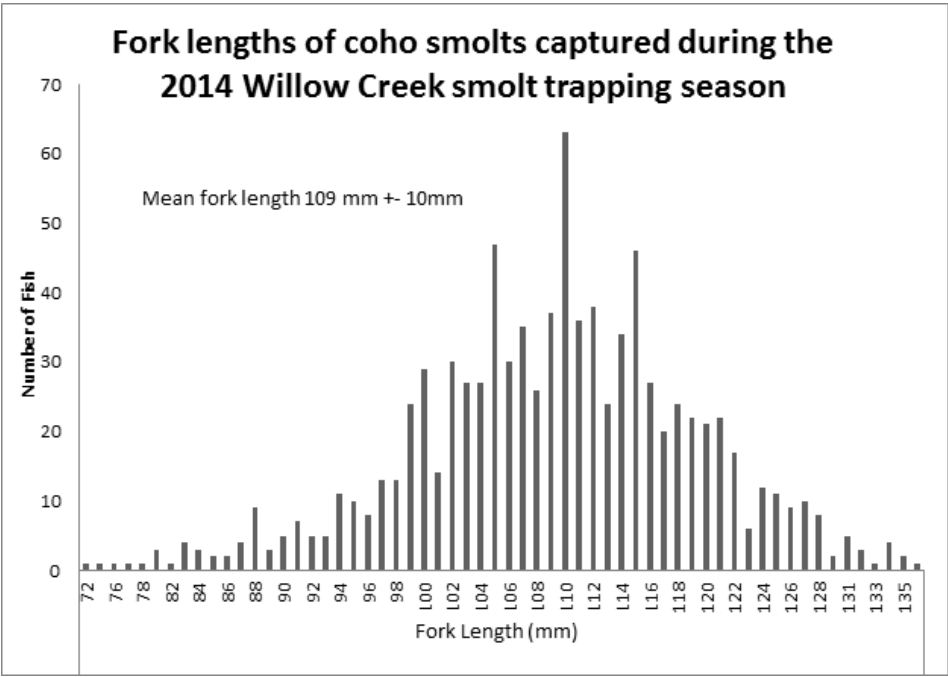


Figure 6. Length-frequency distribution of coho smolts captured during the 2014 Willow Creek smolt trapping season.

Table 3. Fork length (FL), Weight (WT), and growth rates of hatchery coho released in the spring or fall of 2013 into Mill or Willow Creeks and recaptured in smolt traps during the spring of 2014.

Trap Site	Release Tributary	Release Season	N	Avg FL(mm) +/- 1 SD at release	Avg WT (g) +/- 1 SD at release	Avg FL(mm) +/- 1 SD at trap	Avg WT (g) +/- 1 SD at trap	Avg growth interval (days)	Avg growth rate FL (mm)/day +/- 1 SD	Avg growth rate lnWT (g)/day +/- 1 SD
Willow Creek	Willow Creek	fall	157	89 +/- 8	8.1 +/- 2.2	111 +/- 8	14.4 +/- 3.0	208	0.11 +/- 0.03	0.0028 +/- 0.0012
Mill Creek	Mill Creek	fall	164	94 +/- 9	9.9 +/- 3.0	110 +/- 8	13.5 +/- 3.2	190	0.08 +/- 0.04	0.0017 +/- 0.0014
		spring	20	64 +/- 6	3.2 +/- 0.9	106 +/- 8	12.8 +/- 2.9	367	0.12 +/- 0.03	0.0039 +/- 0.0010
	Palmer Creek	spring	10	70 +/- 4	4.1 +/- 0.7	104 +/- 6	12.6 +/- 2.3	368	0.10 +/- 0.02	0.0031 +/- 0.0007

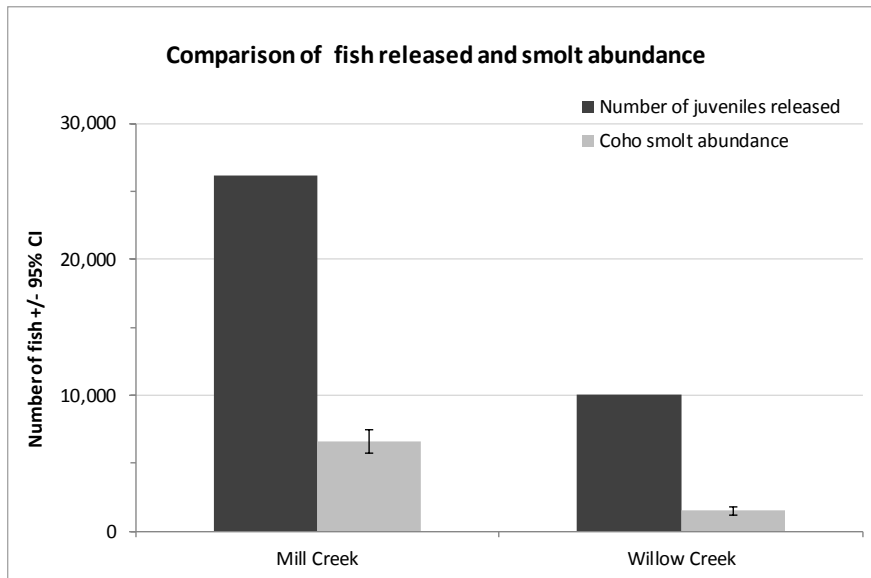


Figure 7. The total number of juvenile hatchery coho salmon released and the estimated abundance of coho salmon smolts emigrating from Mill and Willow Creeks during the spring of 2014.

## ***OPERATION OF PIT TAG ANTENNA ARRAYS***

Paired flatplate or upright PIT tag antennas were operated near the mouths of Willow, Dutch Bill, Green Valley, Mill, Palmer, and Grape Creeks throughout contract period (**Figure 8**). A 24-antenna array was also operated in cooperation with the Sonoma County Water Agency on the mainstem of the Russian River near Duncans Mills (**Figure 9**). Antenna transceivers were downloaded and batteries were changed bi-weekly at sites that did not have solar or AC power sources. Additional checks and downloads were performed during storm events. Data was converted from text files into Excel where they were error checked and imported into an Access database.

Antenna data collected on the tributaries was used to document stock-to-smolt survival (**Figure 10**, **Table 4**) and year-round movement patterns of different release groups (**Figure 11-Figure 15**). Data collected at Duncans Mills, in combination with tributary data was used to estimate the total number of hatchery coho adults returning to the Russian River basin (**Table 5**).

Not surprisingly, survival was lowest for the spring release group which spent over a year in the stream environment, and highest for the smolt release group which was released in April-May of the 2014 smolt season (**Figure 10**, **Table 4**). For the spring release group, survival was highest in Mill Creek, and for the fall and smolt release groups, it was highest in Green Valley Creek (**Figure 10**, **Table 4**).

Pulses of juvenile emigration following the first significant rain event of the winter (2/7/14) were observed in Mill, Palmer, and Dutch Bill Creeks, but not in Green Valley or Willow Creeks (**Figure 11-Figure 16**). In general, smolt emigration peaked in the last week of April/first week of May. Due to the low flow conditions during the spring of 2014, smolt releases only occurred in Green Valley and Dutch Bill Creeks. Hatchery fish were acclimated in tanks and then released on two occasions in both streams (Green Valley: 4/15 and 5/7; Dutch Bill: 4/24 and 5/8). Nearly all of the smolt release fish emigrated within the first week of being released into the streams (**Figure 12**, **Figure 13**). No spring-released coho in Grape Creek were detected emigrating as smolts, despite continuous operation of a PIT tag antenna array (**Figure 16**). As part of a separate summer survival and flow study, UC estimated that survival in the reach where the Grape Creek spring release group was stocked was 0.03 (0.02-0.03), with nearly all of the fish perishing in the extreme low flow conditions during the summer of 2013.

A total of 37 unique adult hatchery coho were detected on PIT tag antenna arrays located throughout the watershed, and several individuals were detected on more than one antenna array. All 37 fish were 2 year-olds and no older age fish were detected. Operation of paired antenna arrays at both Duncans Mills and at the mouth of Willow Creek were the basis for an adult return estimate for the Russian River watershed. Detections of adult coho salmon upstream of Duncans Mills were used to estimate an overall detection efficiency at Duncans Mills of 0.46. Efficiency of the paired Willow Creek array was 1. Antenna efficiency estimates and the ratio of PIT-tagged to nonPIT-tagged hatchery fish at the time of release were used to expand a count of 23 at Duncans Mills and Willow combined to an estimated total of 285 hatchery coho entering the Russian River during the winter of 2013-2014 (**Table 5**). To estimate the total number of adult coho (wild and hatchery) entering the Russian River, the ratio of wild to hatchery coho observed at the Wohler-Mirabel video counting station (0.10) was applied to the estimated number of hatchery fish entering the Russian River for a total of 313 fish (**Table 5**).

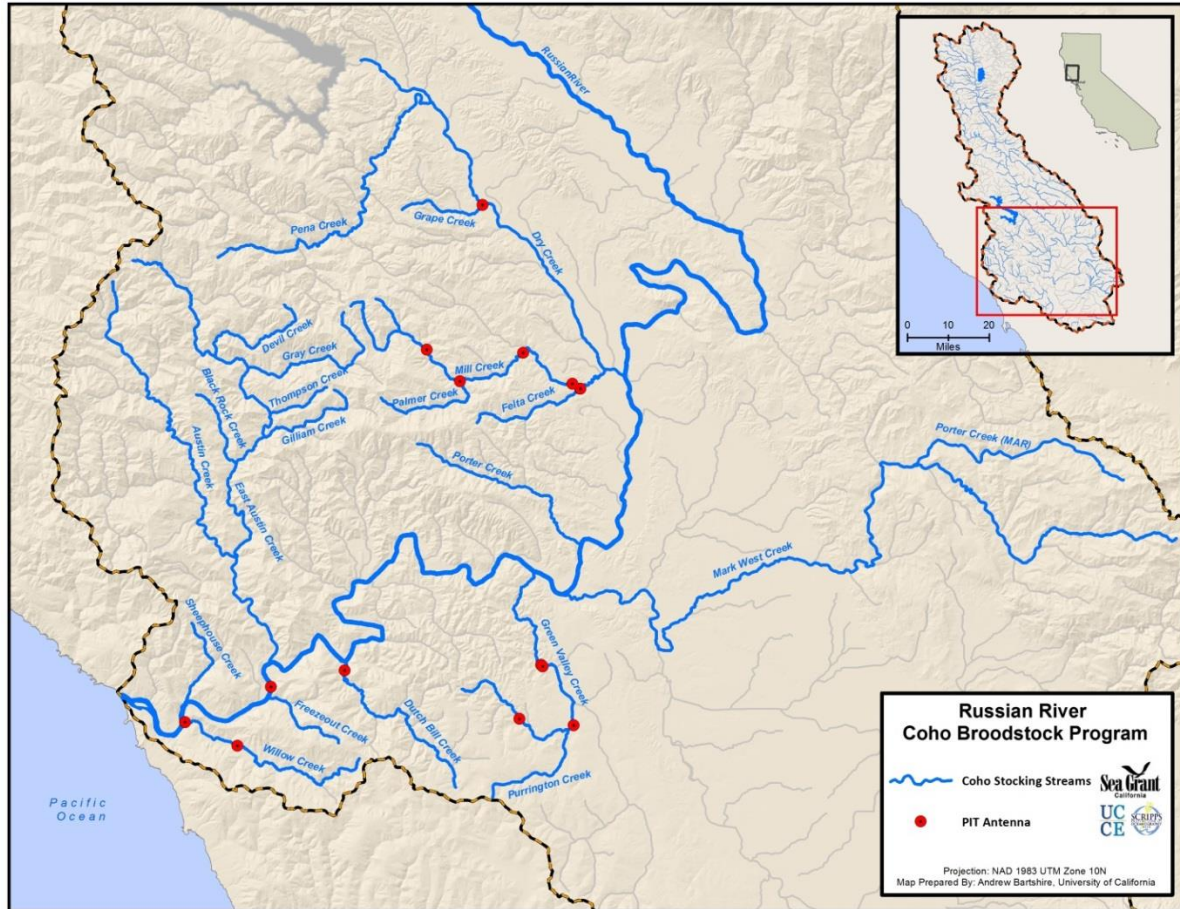


Figure 8. 2014 PIT antenna monitoring sites on the Russian River and its tributaries.



Figure 9. A section of the Duncans Mills PIT tag antenna array.

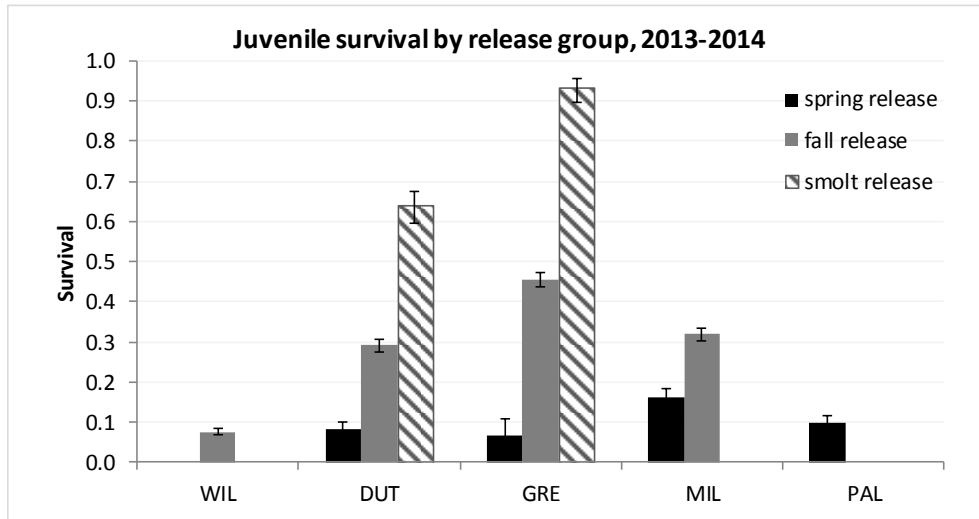


Figure 10. Estimated survival of juvenile coho based on PIT tagged coho released in 2013 as young-of-year in spring or fall, or as 1+ smolts in 2014. Note that spring releases were typically < 1,000 fish and were stocked into one or two 250 m reaches/stream, therefore survival and emigration estimates for the spring release group are not representative of the entire stream.

Table 4. Estimates of survival and emigration for coho juveniles based on PIT tagged coho released in 2013 as young-of-year in spring or fall, or as 1+ smolts in 2014. Note that spring releases were typically < 1,000 fish and were stocked into one or two 250 m reaches/stream, therefore survival and emigration estimates for the spring release group are not representative of the entire stream.

Hatch year	Trap year	Tributary	Spring release			Fall release			Smolt release	
			Survival interval	Survival (95%CI)	Emigration before 3/1 (95% CI)	Survival interval	Survival +/- 95%CI	Emigration before 3/1 (95% CI)	Survival interval	Survival +/- 95%CI
2013	2014	Willow Creek	NA	NA	NA	11/25/13-6/30/14	0.08 (0.07-0.09)	0.00 (0.00-0.01)	NA	NA
		Dutch Bill Creek	6/13/13-6/30/14	0.08 (0.07-0.10)	0.06 (0.04-0.07)	12/11/13-6/30/14	0.29 (0.27-0.31)	0.08 (0.07-0.09)	4/15/14-6/30/14	0.64 (0.60-0.67)
		Green Valley Creek	6/13/13-6/30/14	0.07 (0.04-0.11)	0.00 (0.00-0.00)	12/12/13-6/30/14	0.46 (0.44-0.47)	0.00 (0.00-0.01)	4/24/14-6/30/14	0.93 (0.91-0.95)
		Mill Creek	6/12/13-6/30/14	0.16 (0.14-0.18)	0.03 (0.02-0.04)	11/18/13-6/30/14	0.32 (0.32-0.34)	0.02 (0.01-0.02)	NA <sup>1</sup>	NA <sup>1</sup>
		Palmer Creek	6/20/13-6/30/14	0.10 (0.08-0.12)	0.01 (0.00-0.01)	NA	NA	NA	NA	NA
		Grape Creek	6/12/13-6/30/14	0.00 (0.00-0.00)	NA	NA	NA	NA	NA	NA

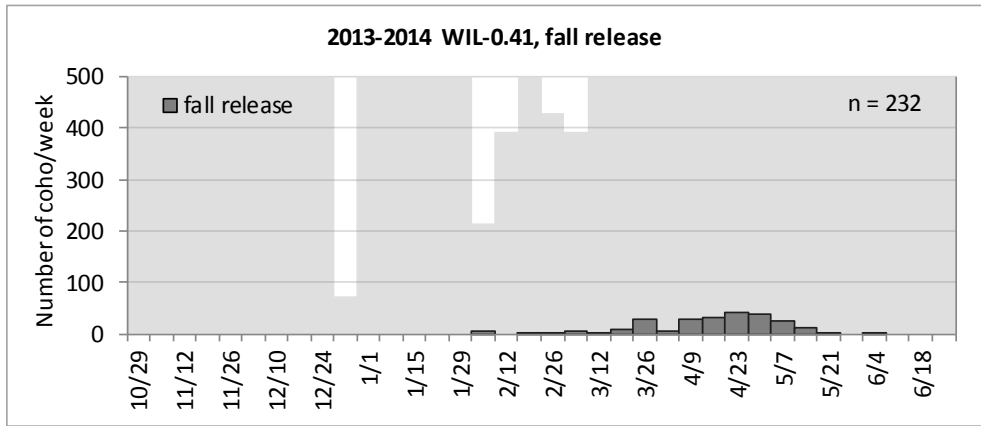


Figure 11. Movement timing for 2014 hatch year PIT tagged hatchery coho salmon from a paired antenna site in Willow Creek (0.41 rkm). Only a fall hatchery group was released for the 2014 hatch year. Shaded background indicates when the antennas were in operation.

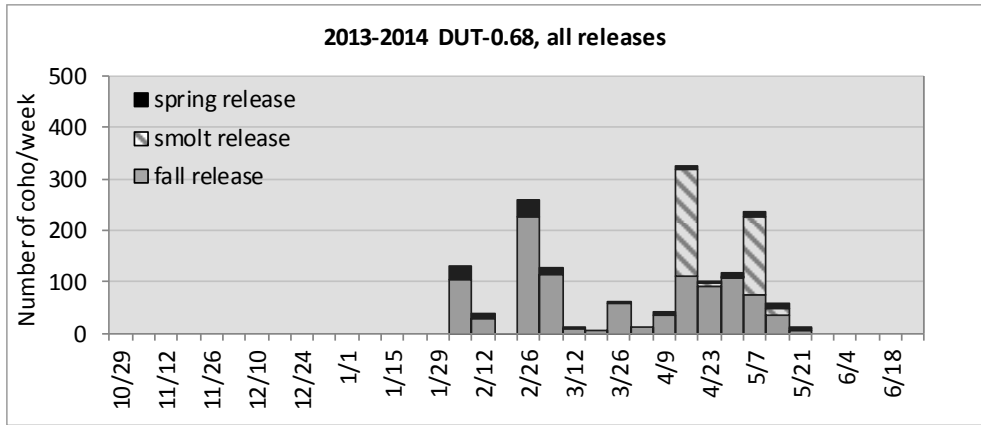


Figure 12. Movement timing for 2014 hatch year PIT tagged hatchery coho salmon from a paired antenna site in Dutch Bill Creek (0.68 rkm). Shaded background indicates when the antennas were in operation.

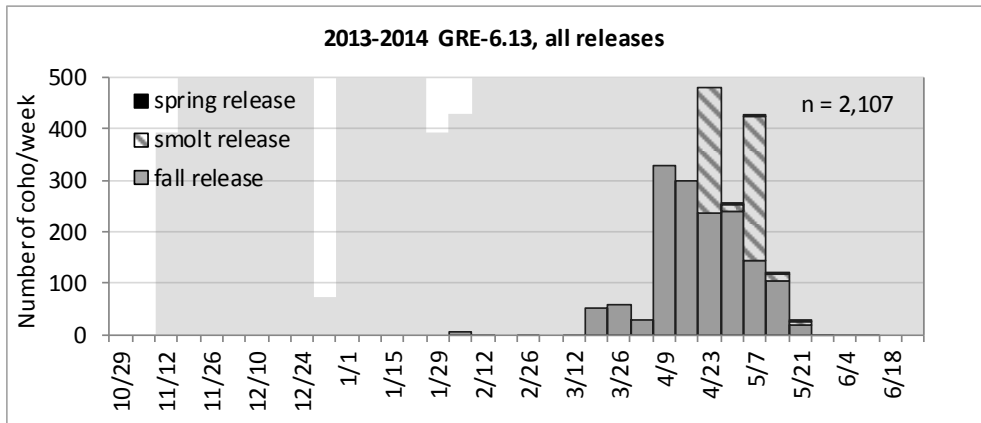


Figure 13. Movement timing for 2014 hatch year PIT tagged hatchery coho salmon from a paired antenna site in Green Valley Creek (6.13 rkm). Shaded background indicates when the antennas were in operation.



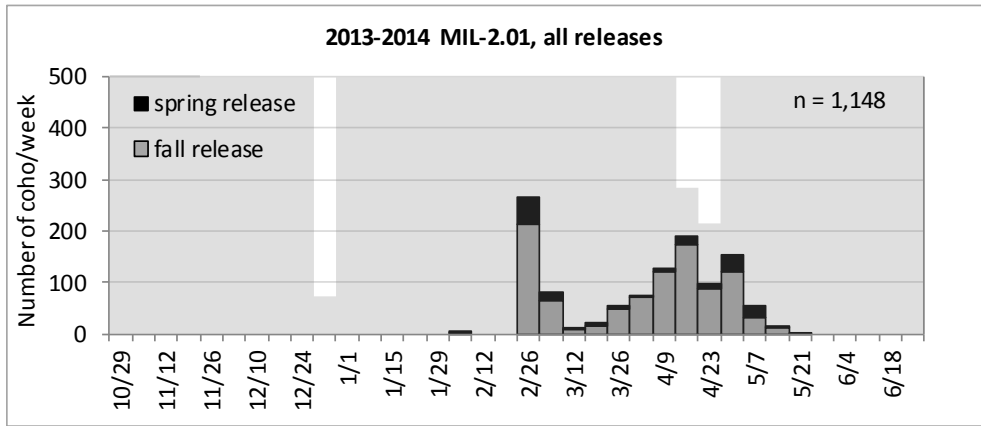


Figure 14. Movement timing for 2014 hatch year PIT tagged hatchery coho salmon from a paired antenna site in Mill Creek (2.01 rkm). Shaded background indicates when the antennas were in operation.

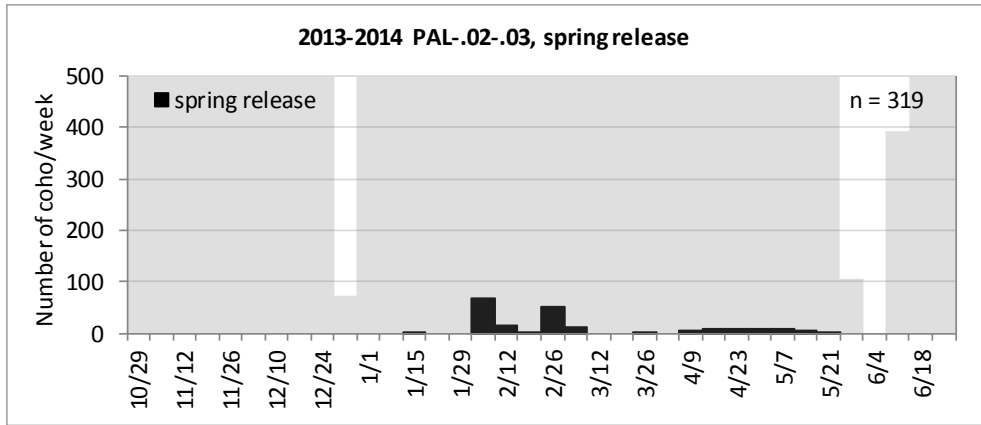


Figure 15. Movement timing for 2014 hatch year PIT tagged hatchery coho salmon from a paired antenna site in Palmer Creek (0.02 and 0.03 rkm). Only a spring hatchery group was released for the 2014 hatch year. Shaded background indicates when the antennas were in operation.

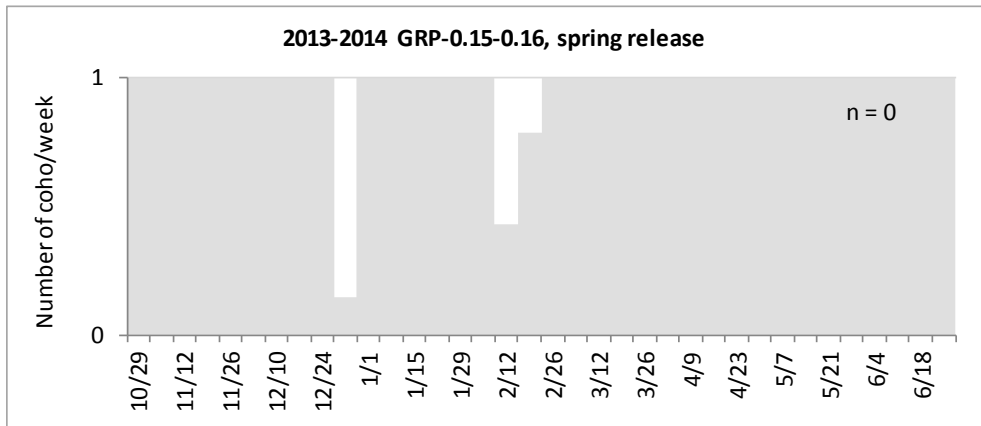


Figure 16. No 2014 hatch year PIT tagged hatchery coho salmon were detected at a paired antenna site in Grape Creek (0.15 and 0.16 rkm). Only a spring hatchery group was released for the 2014 hatch year. Shaded background indicates when the antennas were in operation.

Table 5. Minimum adult coho returns to the Russian River during winter 2013-2014.

Note that if there was a potential for fish to be detected using more than one method, redundancy was assumed and the most conservative number was used. If  $\geq 10$  wild juvenile coho were observed during snorkeling surveys in 2014 and/or  $\geq 10$  wild smolts were observed during 2015 downstream migrant trapping, we assumed a minimum of two adults returned to that stream during the winter of 2013-2014. Blank fields indicate that no survey was conducted.

Stream	Wohler Video/PIT	Spawner surveys: minimum (estimated)	Unique PIT tag detections <sup>1</sup>	Hatchery returns	Observations of $\geq 10$ wild juvenile coho during spring/summer surveys 2014	Observations of $\geq 10$ wild coho smolts during spring downstream migrant trapping 2015	Total minimum (minus potential within-stream redundancy)
Willow Creek		10 (22)	6		yes		10
Sheephouse Creek					no		0
Freezeout Creek					no		0
Russian River mainstem at Duncans Mills			19				19
Austin Creek					no		0
Kidd Creek					no		0
East Austin Creek					no <sup>2</sup>		0
Black Rock Creek					no		0
Gilliam Creek					no		0
Thompson Creek					no		0
Gray Creek					no		0
Devil Creek					no		0
Dutch Bill Creek		17 (41)	3		yes		17
Unnamed trib of Dutch Bill Creek					no		0
Grub Creek					no		0
Duvoul Creek					no		0
Green Valley Creek		12 (36)	3		yes		12
Purrington Creek		0			no		0
Mark West Creek					no		0
Porter Creek (MW)					no		0
Santa Rosa Creek					no		0
Russian River mainstem at Wohler-Mirabel	156		17				156
Porter Creek					no		0
Press Creek					no		0
Dry Creek				23			23
Mill Creek		9 (0 redds)	1		no		9
Felta Creek		2 (0 redds)			no		0
Wallace Creek		0			no		0
Palmer Creek		0			no		0
Angel Creek		0			no		0
Crane Creek					no		0
Grape Creek		0			no		0
Wine Creek		0			no		0
Pena Creek		5			yes		2
Pechaco Creek		0			no		0
Woods Creek		0			no		0
Maacama Creek					no		0
Redwood Creek					no		0
Kellogg Creek					no		0

Russian River total minimum (accounting for potential redundancy): 156

Expanded Russian River count<sup>3</sup>: 313

<sup>1</sup> A total of 37 unique individuals were detected in the watershed. Certain individuals were detected in multiple streams. Those individuals were included in the minimum count for each stream, but only counted one time in the minimum count for the Russian River watershed.

<sup>2</sup> 296 juvenile coho of unknown origin were observed in East Austin during the summer of 2014, however, we think they originated from the 21,000 hatchery coho released into East Austin tributaries during June 2014.

<sup>3</sup> Antenna efficiency estimates and the ratio of PIT to non-PIT tagged hatchery releases were used to expand the count of unique PIT tag detections of hatchery returns passed the Duncans Mills and Willow Creek antenna arrays from 23 to 285. The ratio of wild to hatchery coho adults observed at Wohler-Mirabel video monitoring station was then used to estimate that a total of 28 wild coho passed Duncans Mills, for a total estimated return of 313 returning to the Russian River.

## ***JUVENILE SNORKEL SURVEYS***

UC personnel conducted snorkeling surveys in Russian River coho salmon release streams to document the presence or absence of juvenile coho. In 2014 this study was coordinated with efforts by the Sonoma County Water Agency to implement the California Coastal Monitoring Plan (CMP). This collaborative effort allowed for broodstock and CMP stream reaches to be surveyed in a single season and for survey methods to be standardized between the two projects.

During surveys, snorkeler(s) moved from the downstream end of the unit (pool tail crest) to the upstream end, surveying as much of the unit as water depth allowed (**Figure 17**). Snorkelers avoided sudden/loud movements to reduce spooking fish and avoid creating a sediment disturbance. A zigzag snorkeling pattern was used by individual snorkelers, moving across the unit to check the main channel as well as undercut sections along the edges. Snorkelers only counted salmonids once the fish were downstream to reduce double counting. In units requiring two snorkelers, two lanes were agreed upon and then snorkeled at the same pace. Final counts for the unit were the sum of all lane counts. Dive lights were used to inspect shaded and covered areas. All observed salmonids were identified to species and age class (**Figure 18**). Non salmonid species presence was noted on the reach scale. The next day, a repeat dive pass was conducted in 20% of first pass snorkeled pools and flatwaters to calibrate minimum counts.

Upon returning from the field, biologists performed error checks on the data and transferred it into an Access database. Data was then used to document spawning success in coho release streams and map distribution of naturally-spawned juvenile coho (**Figure 19**). In reaches where every second pool was snorkeled, the expanded count was derived by expanding the number of fish observed by the actual number of pools (multiplying by 2).

240 naturally-spawned juvenile coho were observed in the summer of 2014 with an expanded count of 426 fish (**Table 6**). This is the lowest number of juvenile wild spawn coho observed since the 2009 snorkel surveys (**Figure 20**). Successful coho spawning appears to have occurred in only four streams (Willow, Dutch Bill, Green Valley, and Pena) during the 2013-2014 spawning season.



Figure 17. A UC crew member conducting a snorkel survey.



Figure 18. A juvenile coho salmon and juvenile steelhead trout observed during summer snorkel surveys.

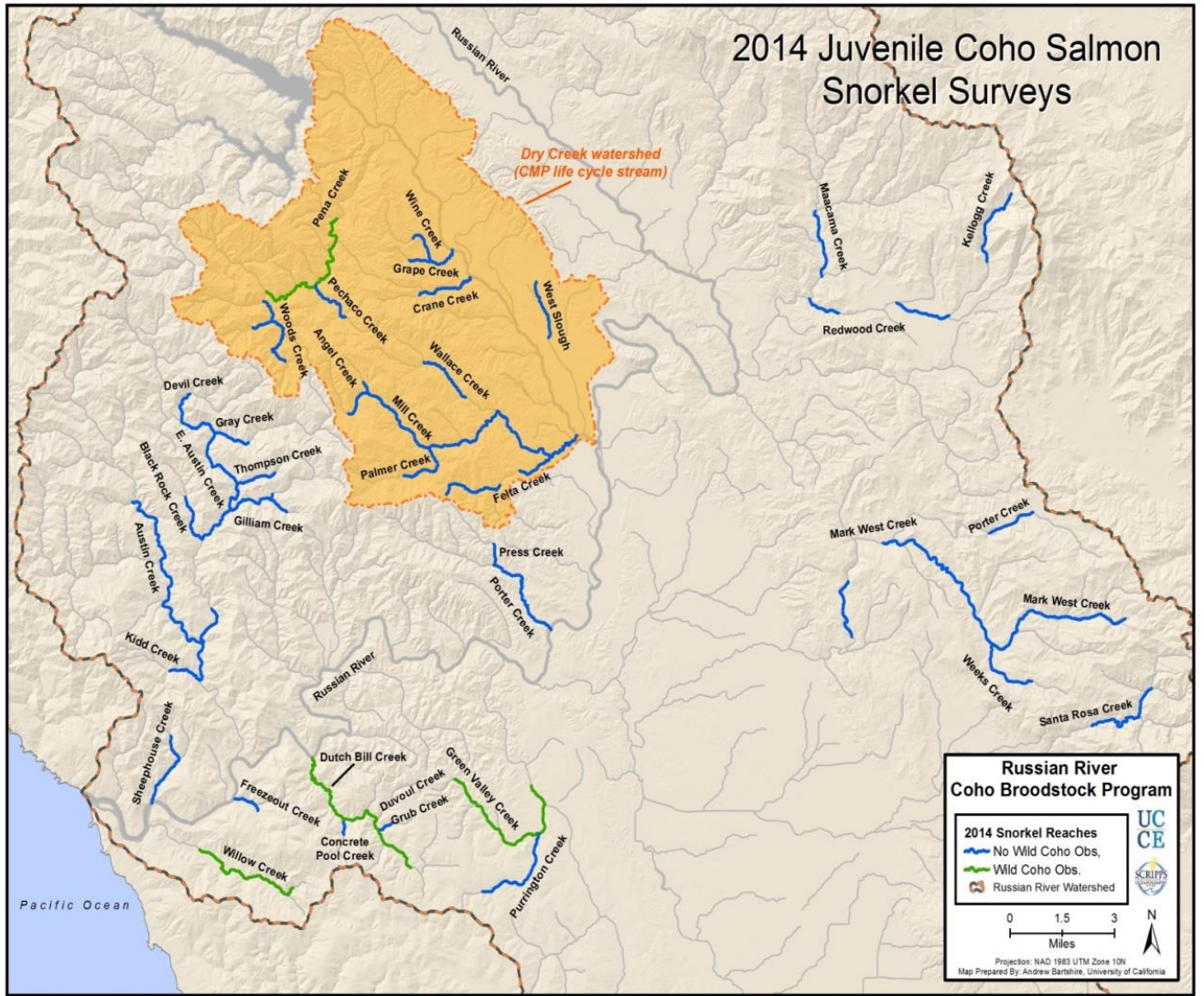


Figure 19. Presence of juvenile wild spawn coho observed during 2014 summer snorkel surveys.

Table 6. Observed and expanded count of juvenile wild coho YOY in Russian River tributaries during 2014 summer snorkel surveys.

<b>Stream</b>	<b>Observed Coho YOY (Wild)</b>	<b>Expanded Count<sup>1</sup> (Wild)</b>
Austin Creek	0	0
Black Rock Creek	0	0
Crane Creek	0	0
Devil Creek	0	0
Dutch Bill Creek	28	28
East Austin Creek	0	0
Felta Creek	0	0
Freezeout Creek	2	4
Gilliam Creek	0	0
Grape Creek	2	4
Gray Creek	0	0
Green Valley Creek	26	26
Kellogg Creek	0	0
Kidd Creek	0	0
Maacama Creek	0	0
Mark West Creek	0	0
Mill Creek	0	0
Palmer Creek	0	0
Pechaco Creek	0	0
Pena Creek	163	326
Porter Creek (Mark West)	0	0
Porter Creek (Russian)	0	0
Purrington Creek	0	0
Redwood Creek	0	0
Santa Rosa Creek	0	0
Sheephouse Creek	1	2
Thompson Creek	0	0
Wallace Creek	0	0
Weeks Creek	0	0
Willow Creek	18	36
Wine Creek	0	0
Woods Creek	0	0
<b>TOTAL MINIMUM OBSERVED COUNT WILD COHO <sup>2</sup></b>	<b>240</b>	
<b>TOTAL EXPANDED COUNT WILD COHO <sup>3</sup></b>		<b>426</b>
STREAMS SURVEYED = 32, REACHES SURVEYED = 62		

<sup>1</sup> In reaches where every second pool was snorkeled, this total was derived by expanding the number of fish observed by the actual number of pools (multiplying by 2). No change from the observed count means every pool in the reach was snorkeled.

<sup>2</sup> Total number of wild coho observed during spring snorkel surveys prior to spring plantings, plus the **minimum** number of wild fish observed during summer surveys in non-planted streams.

<sup>3</sup> Total number of wild coho observed during spring snorkel surveys prior to plantings, plus the **expanded** number of wild fish observed during summer surveys in non-planted streams.

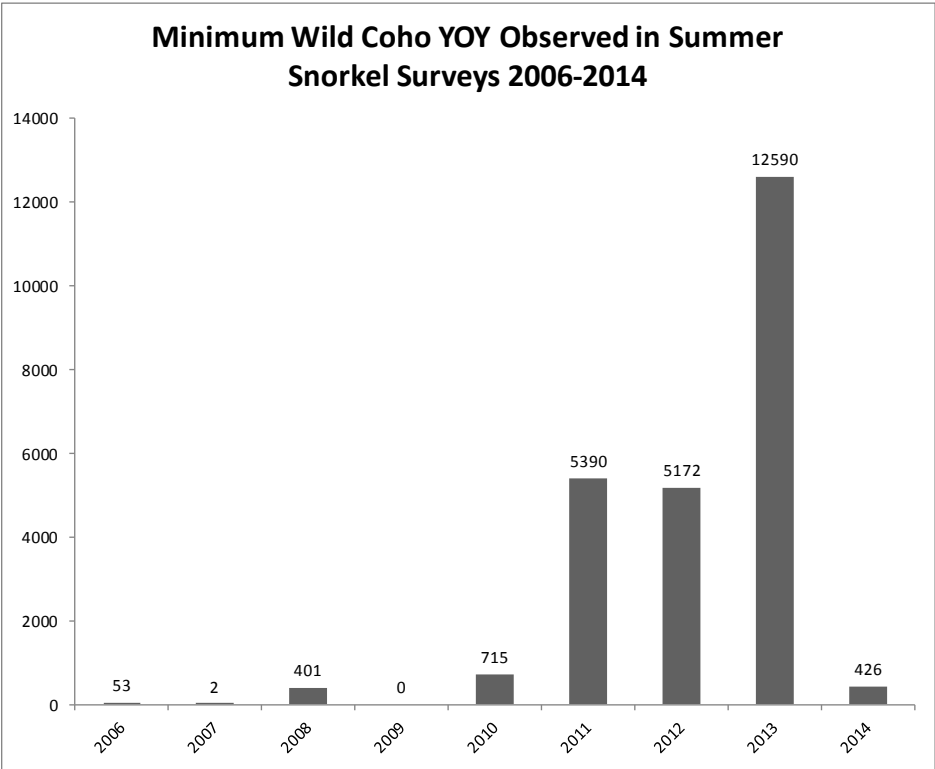


Figure 20. The minimum number of wild spawned coho YOY observed in summer snorkel surveys 2006-2014.

### ***LANDOWNER ACCESS DATABASE***

As per the request of CDFW, UC assumed management responsibilities of the landowner access database for the RRCSCBP. UC staff designed and implemented a new relational database using Microsoft Access database software in conjunction with ESRI ArcGIS software to manage over 1,100 landowner access agreements valid from January 1st 2013 - December 31st 2015. UC staff logged ongoing contact with landowners including: attempts to contact non-responders, filing and uploading entry permits, updating ownership changes and parcels changes.

### ***RRCSCBP MEETINGS***

UC staff participated in the following RRCSCBP technical advisory committee and workgroup meetings:

Coho release workgroup meeting 4/8/2014  
HGMP meeting 5/6/2014  
Broodstock Program TAC meeting 9/10/2014

UC staff continued to work on a model to help set release targets for each program stream using DFW habitat survey data, an Oregon juvenile coho density model, and UC coho monitoring data. Input regarding estimated adult returns in 2013-2014 and current stream conditions was provided to help create a release plan for 2014. Following the HGMP meeting, monitoring summaries were prepared for inclusion in the HGMP (see section below for more detail). Coho salmon monitoring updates were provided at the TAC meeting on 9/10, through email mailings, and on our website <http://ca-sgep.ucsd.edu/russianrivercoho>. In addition, UC staff assisted with DFW fish rescues by providing current information about juvenile coho densities from snorkeling data, current stream flow conditions, landowner access information, and assisting with electrofishing.

### ***LONG TERM DATA ANALYSIS***

Summary figures and tables were prepared for the HGMP that included data collected between 2004 (inception of Russian River Coho Monitoring Program) through 2014 (**Appendix A**). In addition, a detailed accounting of all known adult returns to the Russian River basin from the winter of 2003-2004 through 2013-2014 was prepared (**Appendix B**).



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Bjorkstedt, E.P. 2005. DARR 2.0: updated software for estimating abundance from stratified mark-recapture data. U.S. Depart. Commer., NOAA Technical Memorandum NMFS-SWFSC-368, 13 p.

Bjorkstedt, E.P. 2010. DARR 2.02: DARR for R.

<http://swfsc.noaa.gov/textblock.aspx?Division=FED&id=3346>.

## APPENDICES

### APPENDIX A: HGMP TABLES AND FIGURES

Coho monitoring tables prepared for HGMP:

Table 1. Minimum counts and estimated abundance of adult coho returning to the Russian River watershed. Note that sampling methods and sampling streams were not consistent among years.

Adult return winter	Streams surveyed <sup>1</sup>	Adult return survey methods <sup>2</sup>	Minimum adult return count	Expanded adult return count
2003-2004	GRE, MIL	DSMT-S	4	NA
2004-2005	DUT, FEL, GRE, GRP, MIL, PAL, SHE, WAR	SN, DSMT-Y, DSMT-S	4	NA
2005-2006	DUT, FEL, GRA, GRE, MIL, PAL, SHE, WAR	SN, DSMT-Y, DSMT-S	2	NA
2006-2007	AUS, FEL, GRA, GRE, MIL, PAL, SHE, WAR	SS, VID, SN, DSMT-Y, DSMT-S	4	NA
2007-2008	DUT, FEL, GRA, GRE, MIL, PAL, SHE	SS, AT, SN, DSMT-Y, DSMT-S	2	NA
2008-2009	DUT, FEL, GRA, GRE, MAR, MIL, PAL, SHE, WAR	SS, AT, IO, SN, DSMT-Y, DSMT-S	5	NA
2009-2010	AUS, DRY, DUT, FEL, FRE, GRA, GRE, GIL, MIL, PAL, RUS, SHE	SS, AT, PIT, VID, HAT, SN, DSMT-Y, DSMT-S	19	NA
2010-2011	CRA, DEV, DRY, DUT, FEL, FRE, GIL, GRA, GRE, GRP, MAR, MIL, PAL, PEN, POR, PUR, RUS, SHE, WIL, WIN	SS, AT, PIT, VID, SN, EF, DSMT-Y, DSMT-S	90	206 <sup>3</sup>
2011-2012	CRA, DEV, DRY, DUT, EAU, FEL, FRE, GIL, GRA, GRE, GRP, MAR, MIL, PAL, PEN, POR, PRE, PUR, RED, RUS, SCH, SHE, THO, WEE, WIL, WIN	SS, PIT, VID, HAT, SN, DSMT-Y, DSMT-S	207	401 <sup>4</sup>
2012-2013	WIL, SHE, FRE, RUS, AUS, EAU, BLA, GIL, GRA, DEV, DUT, GRU, DUV, GRE, PUR, MAR, SAN, POR, PRE, DRY, MIL, FEL, WAL, PAL, ANG, CRA, GRP, WIN, PEN, PEC, RED	SS, PIT, VID, HAT, SN, DSMT-Y, DSMT-S	109	536 <sup>5</sup>
2013-2014	WIL, SHE, FRE, RUS, AUS, EAU, BLA, GIL, GRA, DEV, DUT, GRU, DUV, GRE, PUR, MAR, SAN, POR, PRE, DRY, MIL, FEL, WAL, PAL, ANG, CRA, GRP, WIN, PEN, PEC, RED	SS, PIT, VID, HAT, SN	156	313 <sup>6</sup>

Table 1 (*cont*). Minimum counts and estimated abundance of adult coho returning to the Russian River watershed. Note that sampling methods and sampling streams were not consistent among years.

---

<sup>1</sup>Stream Codes: AUS: Austin Creek, CRA: Crane Creek, DEV: Devil Creek, DRY: Dry Creek, DUT: Dutch Bill Creek, EAU: East Austin Creek, FEL: Felta Creek, FRE: Freezeout Creek, GIL: Gilliam Creek, GRA: Gray Creek, GRE: Green Valley Creek, GRP: Grape Creek, MAR: Mark West Creek, MIL: Mill Creek, PAL: Palmer Creek, PEN: Pena Creek, POR: Porter Creek, PRE: Press Creek, PUR: Purrington Creek, RED: Redwood Creek, RUS: Russian River mainstem, SCH: Schoolhouse Creek, SHE: Sheephouse Creek, THO, Thompson Creek, WAR: Ward Creek, WEE: Weeks Creek, WIL: Willow Creek, WIN: Wine Creek

<sup>2</sup> Methods used to document returning adults. Note that not all methods were used on all streams.

SS: spawner survey to document adult returns and redds

AT: adult trap

PIT: PIT tag antenna array

VID: video monitoring during the winter of adult returns

HAT: returns to Warm Springs Hatchery

IO: independent observations

SN: summer snorkeling survey following winter of anticipated adult returns to document presence/absence of naturally produced yoy.

EF: electrofishing survey summer/fall after the winter of adult returns, documentation of naturally produced yoy.

DSMT-Y: operation of smolt trap the spring after the winter of adult returns, documentation of naturally produced yoy captures.

DSMT-S: operation of smolt trap two springs the spring after the winter of adult returns,

<sup>3</sup> Sum of estimated number of coho returning to Mill and the minimum number returning to all other surveyed streams.

<sup>4</sup> Sum of the estimated number passing the Russian River at Wohler-Mirabel, estimated returns to Green Valley and Dutch Bill Creeks, and minimum counts for all other creeks downstream of Wohler-Mirabel.

<sup>5</sup> Sum of estimated returns passing the mainstem at Duncans Mills antenna array and minimum counts to Willow, Sheephouse and Freezeout Creeks.

<sup>6</sup> Sum of estimated returns passed the mainstem at Duncans Mills antenna array, estimated returns to Willow Creek, and minimum counts to Sheephouse and Freezeout Creeks.

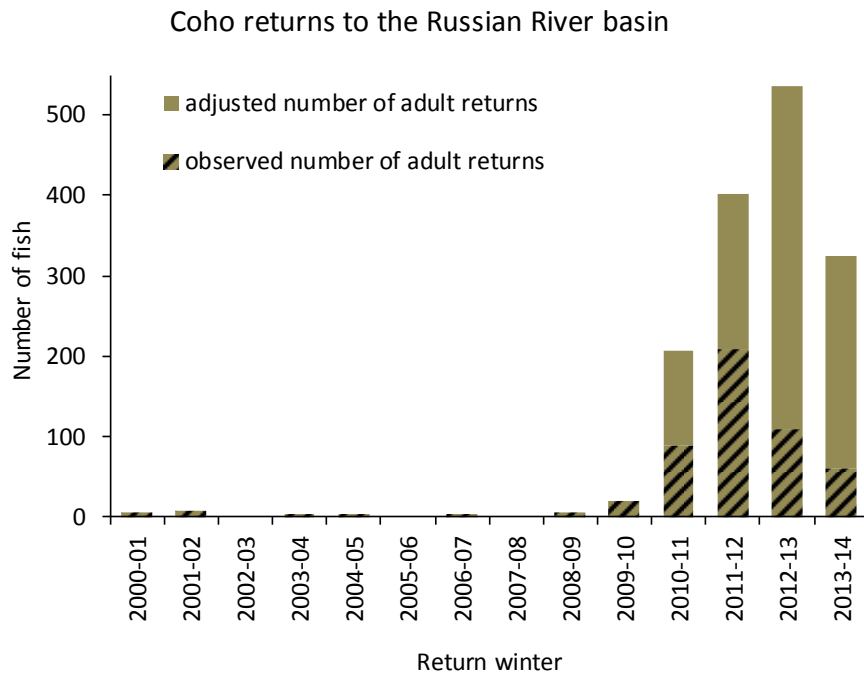


Figure 1. Number of adult coho salmon returning to the Russian River basin. Note that sampling methods and sampling streams were not consistent among years. See Table XX for further detail. 2013-2014 data is preliminary and will be finalized following 2014 summer snorkeling surveys.

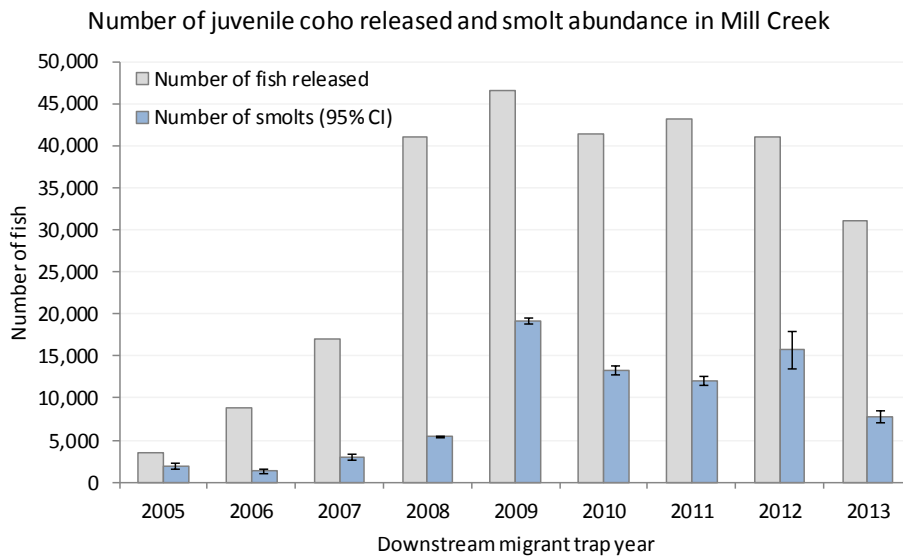


Figure 2. Number of fish released and estimated smolt abundance in Mill Creek from 2005 through 2013.

Table 2. The presence or absence of coho salmon adult returns to Russian River tributaries by brood year. Brood year was considered the first year of the winter of return (i.e. adults returning during the winter of 2004-2005 were considered brood year 2004). Presence of a brood year was confirmed by observations of returning adults (naturally-spawned or hatchery origin), or by subsequent observations of 10 or more naturally-spawned juveniles following the winter of return.

Stream name	Years coho brood year detected	Years coho brood year not detected
Angel Creek		2010 - 2012
Austin Creek	2006, 2009, 2011	
Black Rock Creek		2012
Crane Creek	2010	2011, 2012
Devil Creek	2010, 2012	2011
Dry Creek	2009-2012	
Dutch Bill Creek	2004, 2010-2012	2005-2009
Duvoul Creek		2012
East Austin Creek	2010	2011, 2012
Felta Creek	2004-2007, 2010-2012	2008, 2009
Freezeout Creek	2012	2009, 2010, 2011
Gilliam Creek	2010-2012	2009
Grape Creek	2010-2012	2004, 2009
Gray Creek	2010-2012	2004-2009
Green Valley Creek	2009-2012	2003-2008
Grub Creek		2012
Mark West Creek	2010	2008, 2011, 2012
Mill Creek	2007-2012	2003-2006
Palmer Creek	2009-2012	2004-2008
Pechaco Creek		2012
Pena Creek	2010-2012	
Porter Creek	2010-2012	
Porter Creek (MAR)		2010
Press Creek		2011, 2012
Purrington Creek	2012	2009 - 2011
Redwood Creek	2010	2011
Russian River	2009, 2011, 2012	2010
Santa Rosa Creek		2012
Schoolhouse Creek	2011	
Sheephouse Creek	2010-2012	2003-2009
Thompson Creek		2009-2011
Wallace Creek		2012
Ward Creek		2003-2008
Weeks Creek		2011
Willow Creek	2010-2012	
Wine Creek	2010	2011, 2012

Table 3. Mortality and injury rates of juvenile salmonids captured by electrofishing in Russian River tributaries.

Year	Mortalities: # mortalities/# captured		Injuries: # injured/# captured	
	Coho	Steelhead	Coho	Steelhead
2005	0/1,257	2/1,666	2/1,257	1/1,666
2006	7/978	8/3,390	9/978	8/3,390
2007	1/1,839	6/2,384	6/1,828	10/2,384
2008	0/1,078	5/938	6/1,059	2/937
2009	3/766	1/256	5/765	2/256
2010	1/1,373	0/341	8/1,373	2/341
2011	2/1,571	0/359	7/1,458	3/351
2012	3/1,462	0/395	16/1,462	0/395
2013	19/1,294	0/185	16/1,254	3/181

Table 4. Number of salmonid mortalities related to operation of downstream migrant trapping in Russian River tributaries: Mortalities = # mortalities/# captured.

Year	Coho		Steelhead			Chinook
	yoy	smolt	yoy/parr	smolt	adult	smolt
2005	11/3,373	11/1,370	20/4,402	2/204	3/13	23/997
2006	1/340	27/1,308	6/858	1/102	0/7	1/128
2007	0/58	21/3,995	4/3133	1/407	0/60	6/228
2008	0/43	55/5,798	44/4,086	3/210	4/16	2/71
2009	0	120/15,364	6/584	2/161	0/2	0/1
2010	1/5	29/7,584	4/422	2/219	0/3	1/15
2011	4/329	21/7,258	4/521	3/97	0	0
2012	1/515	11/5,677	10/885	1/49	0/1	0/11
2013	3/530	14/5,412	2/585	0/54	0/6	0

Table 5. Overwinter apparent survival of juvenile coho released in the spring and fall from 2004 through 2007.

Hatch year	Trap year	Streams surveyed <sup>1</sup>	Estimated overwinter apparent survival: average (range)
2004	2005	MIL, SHE, WAR	0.37 (0.11-0.56)
2005	2006	MIL PAL, SHE, WAR	0.12 (0.05-0.18)
2006	2007	GRE, MIL, PAL, SHE	0.23 (0.08-0.33)
2007	2008	MIL, PAL, SHE	0.21 (0.17-0.24)

<sup>1</sup> Stream Codes: GRE: Green Valley Creek, MIL: Mill Creek, PAL: Palmer Creek, SHE: Sheephouse Creek, WAR: Ward Creek

Table 6. Instream survival of juvenile coho released as young-of-year in spring or fall, or as 1+ smolts from 2009 through 2012.

Hatch year	Trap year	Streams surveyed <sup>2</sup>	Estimated survival: average (range)		
			Spring release (June-June)	Fall release (October-June)	Smolt (March-June)
2009	2010	GRE, MIL, PAL	0.16 (0.15-0.17), n=2	0.29 (0.23-0.34), n=3	0.66 (0.62-0.73), n=3
2010	2011	GRE, GRP, MIL, PAL	0.17 (0.05-0.39), n=4	0.26 (0.12-0.46), n=4	0.68 (0.60-0.75), n=2
2011	2012	GRP, MIL, PAL	0.17 (0.03-0.25), n=3	0.31 (0.27-0.35), n=2	0.32, n=1

<sup>1</sup> Stream Codes: GRE: Green Valley Creek, GRP: Grape Creek, MIL: Mill Creek, PAL: Palmer Creek

<sup>2</sup> Streams listed were included in at least one estimate of survival but not necessarily for spring, fall and smolt.

Table 7. Number of returning coho salmon and coho salmon redds observed during spawner surveys in Russian River tributaries.

Adult return winter	Streams surveyed <sup>1</sup>	Minimum coho	Estimated coho	Minimum coho redds	Comments
2006-2007	FEL, MIL, PAL, SHE	1	NA	1	
2007-2008	DUT, FEL, GRA, MIL, PAL, SHE	0	NA	0	
2008-2009	DUT, FEL, GRA, GRE, MIL, PAL, SHE	2	NA	0	
2009-2010	DUT, FEL, GIL, GRA, GRE, MIL, PAL, SHE	9	NA	3	All observations were made in MIL and PAL after the release of hatchery adults into the Mill Creek watershed
2010-2011	DUT, GIL, GRA, GRE, MIL, PAL, SHE	17	NA	11	
2011-2012	DUT, FEL, GRE, MIL, PAL	66	128	29	
2012-2013	DUT, FEL, GRE, MIL, PAL, WIL	29	97	48	

<sup>1</sup>Stream Codes: DEV: Devil Creek, DUT: Dutch Bill Creek, EAU: East Austin Creek, FEL: Felta Creek, GIL: Gilliam Creek, GRA: Gray Creek, GRE: Green Valley Creek, GRP: Grape Creek, MIL: Mill Creek, PAL: Palmer Creek, SHE: Sheephouse Creek, WIL: Willow Creek

Table 8. Proportion of natural and hatchery origin coho salmon returns observed during spawner surveys in Russian River tributaries. Origin was determined based on the presence (natural) or absence (hatchery) of an adipose fin observed on live fish and/or carcasses.

Adult return winter	Streams surveyed <sup>1</sup>	Natural origin	Hatchery origin	Unknown origin	Proportion natural
2006-2007	FEL, MIL, PAL, SHE	0	1	0	0.00
2007-2008	DUT, FEL, GRA, MIL, PAL, SHE	0	0	0	NA
2008-2009	DUT, FEL, GRA, GRE, MIL, PAL, SHE	0	0	2	NA
2009-2010	DUT, FEL, GIL, GRA, GRE, MIL, PAL, SHE	0	8	1	0.00
2010-2011	DUT, GIL, GRA, GRE, MIL, PAL, SHE	0	11	6	0.00
2011-2012	DUT, FEL, GRE, MIL, PAL	4	53	8	0.07
2012-2013	DUT, FEL, GRE, MIL, PAL, WIL	4	17	7	0.19

<sup>1</sup>Stream Codes: DEV: Devil Creek, DUT: Dutch Bill Creek, EAU: East Austin Creek, FEL: Felta Creek, GIL: Gilliam Creek, GRA: Gray Creek, GRE: Green Valley Creek, GRP: Grape Creek, MIL: Mill Creek, PAL: Palmer Creek. SHE: Sheephouse Creek, WIL: Willow Creek

Table 9. Proportion of natural and hatchery origin coho salmon returns observed at Wohler-Mirabel video counting station. Origin was determined based on the presence (natural) or absence (hatchery) of an adipose fin.

Adult return winter	Natural origin	Hatchery origin	Unknown origin	Proportion natural
2011-2012	3	123	3	0.02
2012-2013	11	62	0	0.15
2013-2014	14	142	0	0.09



**APPENDIX B: COHO ADULT RETURN DOCUMENTATION**

**Documentation of Coho Salmon Adult Returns to the Russian River Basin  
CA Sea Grant and UC Cooperative Extension**

CA Sea Grant and UC Cooperative Extension (UC) began monitoring coho salmon populations in the Russian River in 2004 immediately following the first release of juvenile coho salmon by the Russian River Coho Salmon Captive Broodstock Program (RRCSCBP). Since 2004 the number of fish released has grown from approximately 6,000 to nearly 200,000, and the number of streams stocked has gone from three to over 20. Similarly, UC has increased the number of streams it monitors and it has developed and refined the methods used to count and/or estimate the number of returning adults each year. The following documentation describes the methods used to document annual coho salmon adult returns to the Russian River. It is important to note that in each year multiple methods were used, and that methods and streams sampled were not consistent among years. For each year, a table is included listing the different methods used on the streams sampled for that year, and the number of fish detected using each method. We included data collected from adult surveys or counting stations (spawner surveys, adult trapping, video monitoring, PIT tag detections, etc.), as well as indirect evidence of adult returns resulting from surveys of naturally-spawned juveniles detected in subsequent years (juvenile snorkeling surveys and downstream migrant trapping). In a given year, fish are frequently counted using more than one method. To avoid duplication in the overall count for the Russian River watershed each year, we always used the most conservative count (i.e. if there was a possibility for counting a fish using more than one method, we assumed duplication and used the smallest number).

**2003-2004: minimum count: 4**

Streams with expected hatchery returns: none

Sampling methods:

- 2005 downstream migrant trap streams (smolts): Green Valley Creek, Mill Creek

Results:

Table 1. Minimum adult coho returns to the Russian River during winter 2003-2004. If smolts were observed in a stream in 2005, we assumed a minimum of two adults returned to that stream during the winter of 2003-2004.

<b>Stream</b>	<b>Number of wild coho smolts captured during spring downstream migrant trapping 2005</b>	<b>Total minimum</b>
Green Valley Creek	10	2
Mill Creek	2	2

**Minimum Russian River total: 4**

Downstream migrant trapping: During the spring of 2005, 10 wild coho smolts were captured in the Green Valley Creek downstream migrant trap and two wild smolts were captured in the Mill Creek downstream migrant trap. Assuming that these fish emigrated as smolts at age 1, this provides evidence for a minimum of two adults that returned to each watershed during the winter of 2003-2004. Because only two smolts were captured in the Mill Creek downstream migrant trap, it is possible that these fish

strayed from another watershed, however, we concluded that they likely did not result from the same parents as the smolts captured in the Green Valley trap, and that a minimum of four adults returned to the watershed during the winter of 2003-2004.

**2004-2005: minimum count: 4**

Streams with expected hatchery returns: none

Sampling methods:

- 2005 snorkeling survey streams: Sheephouse Creek, Ward Creek, Dutch Bill Creek, Green Valley Creek, Mill Creek, Felta Creek, Palmer Creek, Grape Creek
- 2005 downstream migrant trap streams (yoy): Sheephouse Creek, Ward Creek, Green Valley Creek, Mill Creek
- 2006 downstream migrant trap streams (smolts): Sheephouse Creek, Ward Creek, Mill Creek

Results:

Table 2. Minimum adult coho returns to the Russian River during winter 2004-2005. Note that if there was a potential for fish to be detected using more than one method, redundancy was assumed and the most conservative number was used. If  $\geq 10$  wild juvenile coho were observed during snorkeling surveys in 2005 and/or  $\geq 10$  wild smolts were observed during 2006 downstream migrant trapping, we assumed a minimum of two adults returned to that stream during the winter of 2004-2005. Blank fields indicate that no survey was conducted.

Stream	Observations of $\geq 10$ wild juvenile coho during spring/summer surveys 2005	Observations of $\geq 10$ wild coho smolts during spring downstream migrant trapping 2006	Total minimum
Sheephouse Creek	no	no	0
Ward Creek	no	no	0
Dutch Bill Creek	yes		2
Green Valley Creek	no		0
Mill Creek	no	no	0
Felta Creek	yes		2
Palmer Creek	no		0
Grape Creek	no		0
<b>Minimum Russian River total:</b>			<b>4</b>

Snorkeling surveys: During the spring of 2005, 33 wild coho yoy were observed during snorkeling surveys in Felta Creek (tributary of Mill), indicating that a minimum of two adult coho returned to the Mill Creek watershed during the winter of 2004-2005. Seven wild coho yoy were also observed during snorkeling surveys in Mill Creek, however, they were found near the confluence with Felta Creek, and likely originated from Felta Creek. One hundred and eighteen wild coho yoy were observed during snorkeling surveys in Dutch Bill Creek, indicating that a minimum of two adult coho returned to Dutch Bill Creek during the winter of 2004-2005. Two wild coho yoy were observed in the lowest pools of Ward Creek, but not further upstream. It is possible that these fish strayed from Dutch Bill Creek or another tributary that was not surveyed, but we do not think that this is sufficient evidence for spawning activity in Ward Creek.

*Downstream migrant trapping:* Twenty-three wild coho yoy were captured in the Mill Creek downstream migrant trap during the spring of 2005, and one wild coho smolt was captured in the Mill Creek downstream migrant trap during the spring of 2006. Because the Mill Creek downstream migrant trap is located immediately downstream of the confluence with Felta Creek, we think that these fish originated from Felta Creek, and do not have evidence for more than two adults returning to the Mill Creek watershed.

**2005-2006: minimum count: 2**

Streams with expected hatchery returns: none

Sampling methods:

- 2006 snorkeling survey streams: Sheephouse Creek, Gray Creek, Ward Creek, Dutch Bill Creek, Green Valley Creek, Mill Creek, Felta Creek, Palmer Creek
- 2006 downstream migrant trap streams (yoy): Sheephouse Creek, Ward Creek, Mill Creek
- 2007 downstream migrant trap streams (smolts): Sheephouse Creek, Ward Creek, Green Valley Creek, Mill Creek

Results:

Table 3. Minimum adult coho returns to the Russian River during winter 2005-2006. Note that if there was a potential for fish to be detected using more than one method, redundancy was assumed and the most conservative number was used. If  $\geq 10$  wild juvenile coho were observed during snorkeling surveys in 2006 and/or  $\geq 10$  wild smolts were observed during 2007 downstream migrant trapping, we assumed a minimum of two adults returned to that stream during the winter of 2005-2006. Blank fields indicate that no survey was conducted.

Stream	Observations of $\geq 10$ wild juvenile coho during spring/summer surveys 2006	Observations of $\geq 10$ wild coho smolts during spring downstream migrant trapping 2007	Total minimum
Sheephouse Creek	no	no	0
Ward Creek	no	no	0
Gray Creek	no		0
Dutch Bill Creek	no		0
Green Valley Creek	no	no	0
Mill Creek	no	no	0
Felta Creek	yes		2
Palmer Creek	no		0
<b>Minimum Russian River total:</b>			<b>2</b>

*Snorkeling surveys:* Approximately 40 to 50 wild coho yoy were observed during 2006 snorkeling surveys in Felta Creek, indicating that a minimum of two adult coho returned to Felta Creek during the winter of 2005-2006. No wild juvenile coho were observed in any other stream surveyed.

*Downstream migrant trapping:* During the spring of 2007, one wild coho smolt was captured in Mill Creek, one in Green Valley Creek, and one in Sheephouse Creek. Because it was only a single smolt in each stream, we did not include this as evidence for additional adult returns during the winter of 2005-2006; PIT tag studies beginning in 2012 demonstrate that juvenile coho can move as far as 40 km

upstream into neighboring watersheds (UC unpublished data), therefore it is possible that smolts from Mill Creek entered Green Valley and Sheephouse Creeks prior to ocean entry.

**2006-2007: minimum count: 4**

Streams with expected hatchery returns: Sheephouse Creek, Ward Creek, Mill Creek

Sampling methods:

- 2006-2007 spawner survey streams: Sheephouse Creek, Mill Creek, Felta Creek, Palmer Creek
- 2007 video monitoring: Austin Creek
- 2007 snorkeling survey streams: Sheephouse Creek, Gray Creek, Mill Creek, Palmer Creek
- 2007 downstream migrant trap streams (yoy): Sheephouse Creek, Ward Creek, Green Valley Creek, Mill Creek
- 2008 downstream migrant trap streams (smolts): Sheephouse Creek, Green Valley Creek, Mill Creek

Results:

Table 4. Minimum adult coho returns to the Russian River during winter 2006-2007. Note that if there was a potential for fish to be detected using more than one method, redundancy was assumed and the most conservative number was used. If  $\geq 10$  wild juvenile coho were observed during snorkeling surveys in 2007 and/or  $\geq 10$  wild smolts were observed during 2008 downstream migrant trapping, we assumed a minimum of two adults returned to that stream during the winter of 2006-2007. Blank fields indicate that no survey was conducted.

Stream	Spawner surveys	Independent observations <sup>1</sup>	Observations of $\geq 10$ wild juvenile coho during spring/summer surveys 2007	Observations of $\geq 10$ wild coho smolts during spring downstream migrant trapping 2008	Total minimum
Sheephouse Creek	0		no	no	0
Austin Creek		1			1
Ward Creek			no		0
Gray Creek			no		0
Dutch Bill Creek					
Green Valley Creek			no	no	0
Mill Creek	1		no <sup>2</sup>	no <sup>2</sup>	3 <sup>2</sup>
Felta Creek	0				0
Palmer Creek	0		no		0

**Minimum Russian River total: 4**

<sup>1</sup>A video camera was run by NMFS for part of the winter on Austin Creek and one adipose clipped adult coho was observed, likely a fish that was released from Warms Springs Hatchery into Ward Creek during the fall of 2004.

<sup>2</sup> Two wild coho yoy were captured in the Mill Creek smolt trap during the spring of 2007, and one wild coho smolt was captured in the Mill Creek downstream migrant trap in 2008, indicating that two additional adult coho likely returned to the Mill Creek watershed during the winter of 2006-2007. Because the number of wild juvenile coho observed was few, it is possible that they strayed from another watershed. However, we decided to include these observations as evidence for two additional adult returns because there was no potential for duplicate counts with another watershed.

Spawner surveys: One adipose clipped adult female coho was observed during a spawner survey in lower Mill Creek on 12/14/06 and was observed again as a prespawncarcass on 12/19/06. No adult coho were observed in any other spawner survey streams.

Video monitoring: A video camera was run by NMFS for part of the winter on Austin Creek and one adipose clipped adult coho was observed, likely a fish that was released from Warms Springs Hatchery into Ward Creek during the fall of 2004.

Snorkeling surveys: No wild juvenile coho were observed in any of the streams snorkeled.

Downstream migrant trapping: Two wild coho yoy were captured in the Mill Creek smolt trap during the spring of 2007, and one wild coho smolt was captured in the Mill Creek downstream migrant trap in 2008, indicating that two additional adult coho likely returned to the Mill Creek watershed during the winter of 2006-2007. Because the number of wild juvenile coho observed was few, it is possible that they strayed from another watershed. However, we decided to include these observations as evidence for two additional adult returns because there was no potential for duplicate counts with another watershed. No wild coho juveniles were observed in any of the other downstream migrant trapping streams.

**2007-2008: minimum count: 2**

Streams with expected hatchery returns: Sheephouse Creek, Gray Creek, Ward Creek, Mark West Creek (adults released), Mill Creek, Palmer Creek

Sampling methods:

- 2007-2008 spawner survey streams: Sheephouse Creek, Gray Creek, Dutch Bill Creek, Mill Creek, Felta Creek, Palmer Creek
- 2007-2008 adult trap streams: Mill Creek
- 2008 snorkeling survey streams: Mill Creek, Felta Creek, Palmer Creek
- 2008 downstream migrant trap streams (yoy): Sheephouse Creek, Green Valley Creek, Mill Creek
- 2009 downstream migrant trap streams (smolts): Green Valley Creek, Mill Creek

Results:

Table 5. Minimum adult coho returns to the Russian River during winter 2007-2008. Note that if there was a potential for fish to be detected using more than one method, redundancy was assumed and the most conservative number was used. If  $\geq 10$  wild juvenile coho were observed during snorkeling surveys in 2008 and/or  $\geq 10$  wild smolts were observed during 2009 downstream migrant trapping, we assumed a minimum of two adults returned to that stream during the winter of 2007-2008. Blank fields indicate that no survey was conducted.

Stream	Spawner surveys	Adult trap	Observations of $\geq 10$ wild juvenile coho during spring/summer surveys 2008	Observations of $\geq 10$ wild coho smolts during spring downstream migrant trapping 2009	Total minimum
Sheephouse Creek	0				0
Gray Creek	0				0
Ward Creek					
Dutch Bill Creek	0				0
Green Valley Creek					
Mill Creek	0	0	yes <sup>1</sup>	yes <sup>1</sup>	0
Felta Creek	0		yes		2
Palmer Creek	0		0		0

**Minimum Russian River total: 2**

<sup>1</sup> Thirty-five wild coho yoy were captured in the Mill Creek downstream migrant trap during the spring of 2008, and 65 wild coho smolts were captured in the Mill Creek downstream migrant trap in 2009, however, because the smolt trap was operated immediately downstream of the confluence with Felta Creek, we believe these fish originated from Felta Creek, and we do not think that adults returned to Mill Creek.

Spawner surveys: No adult coho or coho redds were observed during spawner surveys.

Adult trap: No coho were captured in the Mill Creek adult trap.

Snorkeling surveys: 366 wild coho yoy were observed in drying pools in lower Felta Creek during the spring of 2008, evidence for a minimum of two adult coho returning to spawn in Felta Creek during the winter of 2007-2008. No wild juvenile coho were observed in any other snorkeling survey stream.

Downstream migrant trapping: Thirty-five wild coho yoy were captured in the Mill Creek downstream migrant trap during the spring of 2008, and 65 wild coho smolts were captured in the Mill Creek downstream migrant trap in 2009, however, because the smolt trap is operated immediately downstream of the confluence with Felta Creek, we believe these fish originated from Felta Creek. One wild coho smolt was captured in the Green Valley downstream migrant trap during the spring of 2009, however, because this single smolt was potentially a stray from Mill Creek, we did not think there was sufficient evidence to concluded that adults returned to Green Valley during the winter of 2007-2008.

**2008-2009: minimum count: 5**

Streams with expected hatchery returns: Sheephouse Creek, Gray Creek, Ward Creek, Dutch Bill Creek, Green Valley Creek, Mark West Creek (adults released), Mill Creek, Palmer Creek

Sampling methods:

- 2008-2009 spawner survey streams: Sheephouse Creek, Gray Creek, Dutch Bill Creek, Green Valley Creek, Mill Creek, Felta Creek, Palmer Creek
- 2008-2009 adult trap streams: Green Valley Creek, Mill Creek
- 2009 snorkeling survey streams: Sheephouse Creek, Gray Creek, Ward Creek, Dutch Bill Creek, Green Valley Creek, Mark West Creek, Mill Creek, Palmer Creek
- 2009 downstream migrant trap streams (yoy): Green Valley Creek, Mill Creek
- 2010 downstream migrant trap streams (smolts): Austin Creek, Dutch Bill Creek, Green Valley Creek, Mill Creek

Results:

Table 6. Minimum adult coho returns to the Russian River during winter 2008-2009. Note that if there was a potential for fish to be detected using more than one method, redundancy was assumed and the most conservative number was used. If  $\geq 10$  wild juvenile coho were observed during snorkeling surveys in 2009 and/or  $\geq 10$  wild smolts were observed during 2010 downstream migrant trapping, we assumed a minimum of two adults returned to that stream during the winter of 2008-2009. Blank fields indicate that no survey was conducted.

Stream	Spawner surveys	Adult trap	Independent observations <sup>1</sup>	Observations of $\geq 10$ wild juvenile coho during spring/summer surveys 2009	Observations of $\geq 10$ wild coho smolts during spring downstream migrant trapping 2010	Total minimum
Russian River			1			1
Sheephouse Creek	0			0		0
Austin Creek					0	0
Gray Creek	0			0		0
Ward Creek				0		0
Dutch Bill Creek	0			0	0	0
Green Valley Creek	0	0		0	0	0
Mark West Creek				0		0
Mill Creek	2	2		0	0	4
Felta Creek	0					
Palmer Creek	0			0		
<b>Minimum Russian River total:</b>						<b>5</b>

<sup>1</sup> One female adult hatchery coho was incidentally captured by a steelhead fisherman in the Russian River.

Spawner surveys: Two adult hatchery coho (1 jack and one 3yo male) were observed during spawner surveys on Mill Creek on 12/28/08 (in pool below waterfall). No other coho adults were observed in spawner survey streams.

Adult trap: Two hatchery coho jacks were captured in the Mill Creek adult trap in mid-February. No adults were captured in the Green Valley Creek adult trap.

Independent observations: A female adult hatchery coho was incidentally captured by a steelhead fisherman in the Russian River.

Snorkeling surveys: No wild coho yoy were observed during snorkeling surveys.

Downstream migrant trapping: No wild coho yoy were observed in the smolt traps during the spring of 2009. Nine wild coho smolts were captured in the Mill Creek downstream migrant trap during spring of 2010. This is possible evidence for an adult female (and 5<sup>th</sup> adult) returning to spawn in Mill Creek during the winter of 2008-2009, however, given the fact that no wild coho yoy were observed in Mill Creek during spring/summer trapping or snorkeling surveys, it is more likely that the nine wild smolts captured in 2010 were 2 year-old smolts resulting from spawning in 2007-2008. One wild smolt was captured in the Dutch Bill Creek smolt trap, however, it is more likely that this fish was a stray or a hatchery fish that failed to receive an adipose clip than the result of adults spawning in Dutch Bill Creek during the winter of 2008-2009.

**2009-2010: minimum count: 19**

Streams with expected hatchery returns: Sheephouse Creek, Gilliam Creek, Gray Creek, Dutch Bill Creek, Green Valley Creek, Mill Creek, Palmer Creek

Sampling methods:

- 2009-2010 spawner survey streams: Sheephouse Creek, Gilliam Creek, Gray Creek, Dutch Bill Creek, Green Valley Creek, Mill Creek, Felta Creek, Palmer Creek
- 2009-2010 adult trap streams: Mill Creek
- 2009-2010 PIT tag antenna streams: Mill Creek, Palmer Creek
- 2009 video monitoring: Russian River at Wohler-Mirabel
- 2009-2010: returns to Warm Springs Hatchery
- 2010 snorkeling survey streams: Sheephouse Creek, Freezeout Creek, Gilliam Creek, Gray Creek, Dutch Bill Creek, Green Valley Creek, Mill Creek, Palmer Creek, Grape Creek
- 2010 downstream migrant trap streams (yoy): Austin Creek, Dutch Bill Creek, Green Valley Creek, Mill Creek
- 2011 downstream migrant trap streams (smolts): Austin Creek, Dutch Bill Creek, Green Valley Creek, Mill Creek

Results:

Table 7. Minimum adult coho returns to the Russian River during winter 2009-2010. Note that if there was a potential for fish to be detected using more than one method, redundancy was assumed and the most conservative number was used. If  $\geq 10$  wild juvenile coho were observed during snorkeling surveys in 2010 and/or  $\geq 10$  wild smolts were observed during 2011 downstream migrant trapping, we assumed a minimum of two adults returned to that stream during the winter of 2009-2010. Blank fields indicate that no survey was conducted.

Stream	Wohler Video	Mill adult trap/waterfall	Spawner surveys	Unique PIT tag detections	Hatchery returns	Independent observations	Observations of $\geq 10$ wild juvenile coho during summer surveys 2010	Observations of $\geq 10$ wild coho smolts during spring downstream migrant trapping 2011	Total (minus potential within-stream redundancy)
Sheephouse Creek			0				no		0
Freezeout Creek							no		0
Austin Creek						1			1
Gilliam Creek			0				no		0
Dutch Bill Creek			0				no		0
Gray Creek			0				no		0
Green Valley Creek			0				yes	no	2
Russian River mainstem	4							yes	4
Dry Creek					6			yes	6
Mill Creek		6 <sup>2</sup>	7 <sup>1</sup>	1			yes	yes	6 <sup>1</sup>
Felta Creek			0						0
Palmer Creek			2 <sup>1</sup>	0			yes		0 <sup>1</sup>
Grape Creek							no		0
<b>Russian River total minimum count (minus potential among-stream redundancy):</b>									<b>19</b>

<sup>1</sup> All adult observations were made after the release of 42 hatchery adults at the confluence of Mill and Palmer Creeks on 1/28/10. These fish were not included in the total adult return counts.

<sup>2</sup> One jack was captured in the trap, one jack carcass washed up on the weir, and four uniques individuals were observed upstream of the weir and downstream of the waterfall.



Spawner surveys: During spawner surveys, a minimum of seven individuals were observed in Mill Creek and a minimum of two were observed in Palmer Creek. All of these observations occurred after forty-two adult hatchery coho were released at the confluence of Mill and Palmer Creeks on 1/28/10, therefore observations of these fish were not included in the total minimum count for this year. No adult coho were observed during spawner surveys in other streams surveyed.

Adult trap: On 1/13/10, three adult coho were captured in the Mill Creek adult trap including one live jack, one jack mortality that washed up on the weir (2009 Green Valley smolt release based on CWT extraction), and one of unknown age observed upstream of the weir. On the same date, a minimum of three adult coho were also observed attempting to jump over the Mill Creek waterfall at river km 2.45. It is possible that more fish were present, but because of multiple jumping attempts, it was difficult to determine the number of fish. Based on size differences, there were at least three individual coho (one jack and two 3yo adults) jumping at the waterfall, for a total minimum of six.

PIT tag antenna arrays: One PIT-tagged jack was detected on the Mill Creek PIT tag antenna array at river km 2.01 (2009 Mill Creek smolt release). The two jacks captured in the trap did not have PIT tags so we know that these were different fish from the one detected at the antenna array. However, it is possible that one of the jacks was also observed jumping at the waterfall. To be conservative, we did not include one of these fish in the minimum count for the basin.

Wohler-Mirabel video counting station: Four individual coho adults were observed on video data collected at Sonoma County Water Agency's monitoring station at Wohler-Mirabel between 10/28/09 and 12/15/09. Based on the timing of the returns, we counted these fish as unique individuals for the minimum count. In subsequent years, we observed individual adults holding in the mainstem Russian for over two months before entering the tributaries, so it is possible that these fish were counted twice (once at Wohler and a second time either in Mill Creek or at Warm Springs Hatchery).

Hatchery returns: Six adult coho returned to Warm Springs hatchery between 12/14/09 and 1/2/10 and included two jacks released as smolts into Dry Creek in 2009, one jack released as a smolt into Green Valley Creek in 2009, one jack released in the fall of 2008 into Mill Creek, one 3yo female released into Palmer Creek in the spring of 2007, and one 3yo hatchery male of unknown release. Based on the timing of the returns, we counted these fish as unique individuals for the minimum count.

Independent observations: One hatchery adult female coho mortality was found in Austin Creek on 10/18/09. The CWT indicated that the fish was released into Gilliam Creek in 2007.

Snorkeling surveys: Wild coho yoy were observed during 2010 summer snorkeling surveys in Mill, Palmer, Grape, Gilliam, Gray, Freezeout, and Green Valley Creeks. In four streams, fewer than 10 wild juvenile coho were observed: Grape (6), Gilliam (2), Gray (1), and Freezeout (1). Because the numbers were so few in each creek, we suspect that these unclipped fish were either hatchery fish that failed to receive a clip or that they were wild fish that strayed from other creeks. The 394 wild coho yoy observed in Mill Creek and 147 observed in Palmer Creek are thought to have resulted from spawning of the adults released on 1/28/10. 168 wild yoy were documented in Green Valley Creek, evidence that a minimum of two adults returned to spawn in that creek.

Downstream migrant trapping: During the spring of 2010 one wild coho yoy was captured in the Green Valley Creek smolt trap, and four wild coho yoy were captured in the Mill Creek smolt trap. During the

spring of 2011, 22 wild smolts were captured in the Mill Creek smolt trap and 2 wild smolts were captured in the Green Valley Creek smolt trap.

**2010-2011: minimum count: 90, expanded count: 206**

Streams with expected hatchery returns: Sheephouse Creek, Gilliam Creek, Gray Creek, Dutch Bill Creek, Green Valley Creek, Dry Creek, Mill Creek, Palmer Creek

Sampling methods:

- 2010-2011 spawner survey streams: Sheephouse Creek, Gilliam Creek, Gray Creek, Dutch Bill Creek, Green Valley Creek, Mill Creek, Palmer Creek
- 2010-2011 adult trap streams: Mill Creek
- 2010-2011 PIT tag antenna streams: Mill Creek, Palmer Creek, Grape Creek
- 2010-2011 video monitoring: Russian River at Wohler-Mirabel
- 2010-2011: returns to Warm Springs Hatchery
- 2011 snorkeling survey streams: Willow Creek, Sheephouse Creek, Gilliam Creek, Gray Creek, Devil Creek, Dutch Bill Creek, Green Valley Creek, Purrington Creek, Mark West Creek, Porter Creek, Mill Creek, Felta Creek, Palmer Creek, Crane Creek, Grape Creek, Wine Creek, Pena Creek
- 2011 electrofishing surveys (DFW, SCWA): Dry Creek, Redwood Creek
- 2011 downstream migrant trap streams (yoy): Austin Creek, Dutch Bill Creek, Green Valley Creek, Mill Creek
- 2012 downstream migrant trap streams (smolts): Willow Creek, Austin Creek, Dutch Bill Creek, Mark West Creek, Mill Creek

Results:

Table 8. Minimum adult coho returns to the Russian River during winter 2010-2011. Note that if there was a potential for fish to be detected using more than one method, redundancy was assumed and the most conservative number was used. If  $\geq 10$  wild juvenile coho were observed during snorkeling surveys in 2011 and/or  $\geq 10$  wild smolts were observed during 2012 downstream migrant trapping, we assumed a minimum of two adults returned to that stream during the winter of 2010-2011. Blank fields indicate that no survey was conducted.

Stream	Wohler Video	Mill adult trap	Spawner surveys	Unique PIT tag detections	Hatchery returns	Independent observations <sup>2</sup>	Observations of ≥ 10 wild juvenile coho during summer surveys 2011	Observations of ≥ 10 wild coho smolts during spring downstream migrant trapping 2012	Total minimum (minus potential within-stream redundancy)
Willow Creek							yes		2
Sheephouse Creek			0				yes		2
Freezeout Creek							no		0
Austin Creek								yes	2
East Austin Creek						4			4
Gilliam Creek			0				yes		2
Gray Creek			0				yes		2
Devil Creek						5	yes		5
Thompson Creek							no		0
Dutch Bill Creek			4			1	yes	yes	5
Green Valley Creek			6				yes		6
Purrington Creek							no		0
Russian River mainstem	25 <sup>4</sup>							yes	25
Porter Creek							yes		2
Mark West Creek							yes	yes	2
Porter Creek (Mark West)							no		0
Dry Creek					8	6	yes	yes	14
Mill Creek		9	7	27 <sup>1</sup>			yes	yes	36 (152 estimated)
Felta Creek							yes		2
Palmer Creek			0	0			no		0
Crane Creek							yes <sup>3</sup>		0
Grape Creek				10 <sup>1</sup>		1	yes		11
Wine Creek							yes		2
Pena Creek							yes		2
Redwood Creek (Maacama)							yes		2
<b>Russian River total minimum count (accounting for potential among-stream redundancy):</b>									<b>90</b>
<b>Expanded minimum count<sup>5</sup>:</b>									<b>206</b>

<sup>1</sup> Nine individuals were detected in both Mill and Grape Creeks, 18 were detected in Mill only and one was detected in Grape only.

<sup>2</sup> Observations on Devil and Dutch Bill Creeks were video recordings by landowners, Grape and East Austin observations were point observations made by UC staff, and Dry Creek observations were made by hatchery staff immediately downstream of the hatchery and upstream of the fish ladder.

<sup>3</sup> Fifteen wild juvenile coho were observed in Crane Creek, however, they were all found near the confluence with Dry Creek, and likely strayed into Crane, and are not included as evidence for spawning the previous winter in Crane Creek.

<sup>4</sup> Wohler video counts were excluded from the overall minimum counts for the basin because they were potentially the same fish observed in Mill and Dry Creeks.

<sup>5</sup> The expanded minimum count was the sum of the estimated returns to Mill Creek and minimum counts for all other streams surveyed.

**Spawner surveys:** During spawner surveys, a minimum count of six adult coho were observed in Green Valley Creek, seven in Mill Creek, and four in Dutch Bill Creek. No coho were observed in any of the other streams surveyed.

**Adult trap:** Nine hatchery coho adults were captured in the Mill Creek adult trap including four females and five males between 12/6/11 and 12/8/11. None of these fish were PIT-tagged. All were of hatchery origin based on the absence of an adipose fin and two appeared to be jacks based on their shorter length.

**PIT tag antenna arrays:** 28 unique PIT-tagged hatchery adult coho were detected. 18 were detected in Mill Creek only, one was detected in Grape Creek only, and nine were detected in both Mill and Grape Creeks. 18 were 3 year-old fish, and 10 were jacks. All PIT-tagged adults originated from releases into the Mill Creek watershed. PIT tag detections in Mill Creek and known ratios of PIT-tagged to nonPIT-tagged fish were used to estimate a total of 152 adults returning to Mill Creek (80 3 year-old adults, 72 jacks).

Wohler-Mirabel video: The Water Agency operated the Wohler-Mirabel video monitoring station from 9/1/10 through 12/5/10 excluding 10/28/10 – 11/1/10. During this time a minimum of 25 adult coho were observed passing this site. Because these fish may have been potentially observed again in Mill or Dry Creeks, they were excluded from the overall minimum count for the basin.

Hatchery returns: A total of eight coho salmon returned to Warm Springs Hatchery during the winter of 2010-2011. Five were hatchery jacks, two were 3 year-old hatchery females, and one was a wild 3 year-old female. All of the hatchery fish were from the Dry Creek smolt release, with the exception of one jack that was from a Green Valley smolt release. Hatchery staff observed six additional coho adults in the channel immediately downstream of the hatchery and upstream of the fish ladder.

Independent observations: One adult coho was observed by a landowner in Dutch Bill Creek (unique from spawner survey observations), and video observations of five adult coho in Devil Creek were also recorded by a landowner. Point observations of four adult coho in East Austin Creek, and one adult coho carcass in Grape Creek were made by UC staff. The Grape Creek carcass was scanned for a PIT tag, and no tag was found.

Snorkeling surveys: During summer snorkeling surveys in 2011, wild juvenile coho were observed in Sheephouse Creek, Gilliam Creek, Gray Creek, Devil Creek, Dutch Bill Creek, Green Valley Creek, Purrington Creek, Porter Creek, Mark West Creek, Mill Creek, Felta Creek, Crane Creek, Grape Creek, Wine Creek, and Pena Creek. In summer electrofishing surveys related to habitat enhancement monitoring, wild coho juveniles were also found in Willow Creek, Dry Creek, and Redwood Creek. In Purrington Creek only two individuals were observed and likely strayed in from Green Valley Creek. In Crane Creek only 12 individuals were found near the confluence with Dry Creek, and are thought to have strayed in from Dry Creek.

Downstream migrant trapping: During the spring of 2011, 329 wild coho yoy were captured in the Mill Creek smolt trap, 14 in the Austin Creek smolt trap, five in the Dutch Bill Creek smolt trap and one in the Green Valley smolt trap. During the spring of 2012, 154 wild smolts were captured in the Mill Creek smolt trap, 24 in the Austin Creek smolt trap, 35 in the Dutch Bill Creek smolt trap, and 28 in the Mark West Creek smolt trap.

**2011-2012: minimum count 207, expanded count 401**

Streams with expected hatchery returns: Sheephouse Creek, Gilliam Creek, Gray Creek, Dutch Bill Creek, Green Valley Creek, Dry Creek, Mill Creek, Palmer Creek

Sampling methods:

- 2011-2012 spawner survey streams: Dutch Bill Creek, Green Valley Creek, Mill Creek, Felta Creek, Palmer Creek
- 2011-2012 PIT tag antenna streams: Green Valley Creek, Russian River at Wohler-Mirabel, Dry Creek, Mill Creek, Felta Creek, Palmer Creek, Grape Creek
- 2011-2012 video monitoring: Russian River at Wohler-Mirabel
- 2011-2012: returns to Warm Springs Hatchery
- 2012 snorkeling survey streams: Willow Creek, Freezeout Creek, Sheephouse Creek, East Austin Creek, Gilliam Creek, Schoolhouse Creek, Thompson Creek, Gray Creek, Devil Creek, Dutch Bill Creek, Green Valley Creek, Purrington Creek, Mark West Creek, Weeks Creek, Porter Creek, Press Creek, Crane Creek, Mill Creek, Felta Creek, Palmer Creek, Grape Creek, Wine Creek, Pena Creek, Redwood Creek (Maacama)
- 2012 downstream migrant trap streams (yoy): Willow Creek, Austin Creek, Dutch Bill Creek, Mark West Creek, Russian River mainstem at Wohler-Mirabel, Mill Creek
- 2013 downstream migrant trap streams (smolts): Willow Creek, Austin Creek, Dutch Bill Creek, Mark West Creek, Russian River mainstem at Wohler-Mirabel, Dry Creek, Mill Creek

Results:

Table 9. Minimum adult coho returns to the Russian River during winter 2011-2012. Note that if there was a potential for fish to be detected using more than one method, redundancy was assumed and the most conservative number was used. If  $\geq 10$  wild juvenile coho were observed during snorkeling surveys in 2012 and/or  $\geq 10$  wild smolts were observed during 2013 downstream migrant trapping, we assumed a minimum of two adults returned to that stream during the winter of 2011-2012. Blank fields indicate that no survey was conducted.

Stream	Wohler Video/PIT: minimum (estimated)	Spawner surveys: minimum (estimated)	Unique PIT tag detections <sup>1</sup>	Hatchery returns	Independent observations <sup>2</sup>	Observations of ≥ 10 wild juvenile coho during spring/summer surveys 2012	Observations of ≥ 10 wild coho smolts during spring downstream migrant trapping 2013	Total minimum (minus potential within-stream redundancy)
Willow Creek					4	no	yes	4
Freezeout Creek						no		0
Sheephouse Creek						yes		2
Austin Creek					10		yes	10
East Austin Creek						no		0
Gilliam Creek					1	yes		2
Schoolhouse Creek						yes		2
Thompson Creek						no		0
Gray Creek						yes		2
Devil Creek						no		0
Dutch Bill Creek		12 (15)				yes	yes	12
Green Valley Creek		29 (70)	14			yes		29
Purrington Creek						no		0
Mark West Creek						no	yes	2
Weeks Creek						no		0
Russian River mainstem	148 (298)		35		1		yes	148
Porter Creek						yes		2
Press Creek						no		0
Dry Creek			14	19		yes	yes	31
Crane Creek						no		0
Mill Creek		10 (23)	13			yes	no	13
Felta Creek		14 (20)	4			yes		14
Palmer Creek		0				no		0
Angel Creek						no		0
Grape Creek			8			yes		8
Wine Creek						no		0
Pena Creek						yes		2
Redwood Creek						no		0
<b>Russian River Total (accounting for potential redundancy):</b>								<b>207</b>
<b>Expanded Russian River Count<sup>3</sup>:</b>								<b>401</b>

<sup>1</sup> A total of 53 unique individuals were detected in the watershed. Certain individuals were detected in multiple streams. Those individuals were included in the minimum count for each stream, but only counted one time in the minimum count for the Russian River watershed.

<sup>2</sup> On 1/18/12, UC and Water Agency staff observed 10 adult coho in a pool in lower Austin Creek. DFW observed a minimum of one adult coho carcass in Gilliam Creek on 2/23/12. A coho carcass was observed by DFW staff at Johnson's Beach on the mainstem of the Russian River on 2/6/12. On Willow Creek, spawner surveys were conducted by NMFS and PCI and a minimum of four coho

<sup>3</sup> The expanded Russian River count was the sum of the estimated number passing Wohler-Mirabel, estimated returns to Green Valley and Dutch Bill Creeks, and minimum counts for all other creeks downstream of Wohler-Mirabel.

**Spawner surveys:** During the winter of 2011-2012, adult coho were observed in Dutch Bill, Green Valley, Mill, and Felta Creeks, and no adult coho were observed in Palmer Creek (Table 9).

**PIT tag antenna arrays:** Adult coho were detected on all stationary antenna arrays except Palmer Creek (Table 9). A total of 53 unique individuals were detected in the watershed, and several individuals were detected on multiple antenna arrays. Expanded minimum counts of hatchery returns to spawning tributaries based on the proportion of PIT-tagged to nonPIT-tagged hatchery releases are as follows: Green Valley Creek: 49, Mill Creek watershed (including Felta): 68, Grape Creek: 24.

**Wohler-Mirabel video:** The Water Agency operated the Wohler-Mirabel video monitoring station from 9/1/11 through 1/17/12. Because PIT tag antenna arrays were operated at this site, we were able to estimate video detection efficiencies, and use those efficiencies to estimate the total number of hatchery coho passing the site. We were able to further expand the estimate to include wild coho returns by applying the ratio of wild to hatchery coho observed on the video data (presence/absence of adipose fin). The total estimated number of coho passing Wohler-Mirabel was 298.

**Hatchery returns:** A total of 19 adult coho returned to Warm Springs Hatchery during the winter of 2011-2012. All were hatchery releases. The returns included nine male 2 year-olds (jacks), five male 3 year-olds and five female 3 year-olds. Release streams included Gilliam, Gray, Porter, Dry, Mill, Palmer, and Grape Creeks, and release groups included spring, fall, and smolt. PIT tags were detected in two of the returns.

Independent observations:

UC and Water Agency staff snorkeled a pool in lower Austin Creek on 1/18/12 and observed 10 adult coho salmon. DFW observed a minimum of one adult coho carcass in Gilliam Creek on 2/23/12. A coho carcass was observed by DFW staff at Johnson's Beach on the mainstem of the Russian River on 2/6/12. On Willow Creek, spawner surveys were conducted by NMFS and PCI and a minimum of four coho jacks were detected.

Snorkeling surveys:

Ten or more wild juvenile coho were observed in 12 tributaries during the summer of 2012 (Table 9). Five wild juveniles were also observed in East Austin Creek, however, since the numbers are so few, it is likely that those fish originated from tributaries of East Austin Creek, and these observations were not included as evidence of additional adults returning to spawn in East Austin Creek during the winter of 2011-2012.

Downstream migrant trapping:

Ten or more wild coho yoy were captured in the Austin Creek, Russian River mainstem, Dry Creek, and Mill Creek downstream migrant traps during the spring of 2012. Two wild yoy were captured in Dutch Bill Creek, seven in Mark West Creek, and none in Willow Creek. During the spring of 2013, 10 or more wild coho smolts were captured in Willow Creek, Austin Creek, Mark West Creek, Russian River mainstem, and Dry Creek. The data collected on Mark West Creek provided evidence for two additional adult returns to the Russian River watershed.

Russian River expanded count: Because the Wohler-Mirabel video monitoring station on the mainstem of the Russian River remained in operation through the majority of the coho spawning season, and the majority of the adult coho observations were made at that site, video monitoring was the basis for estimating the total number of adult coho returning to the Russian River upstream of Wohler-Mirabel. To account for fish returning downstream of Wohler-Mirabel, we used estimated returns from spawner surveys in Dutch Bill and Green Valley Creeks and minimum counts from all other streams surveyed downstream of Wohler-Mirabel. The final expanded count for the Russian River was the sum of the Wohler-Mirabel estimate, Dutch Bill and Green Valley Creek estimates, and minimum counts from all other streams surveyed downstream of Wohler-Mirabel.

**2012-2013: minimum count: 109, expanded count: 536**

Streams with expected hatchery returns: Sheephouse Creek, Freezeout Creek, East Austin Creek, Gilliam Creek, Thompson Creek, Gray Creek, Devil Creek, Dutch Bill Creek, Green Valley Creek, Purrington Creek, Porter Creek, Dry Creek, Mill Creek, Palmer Creek, Grape Creek

Sampling methods:

- 2012-2013 spawner survey streams: Willow Creek, Dutch Bill Creek, Green Valley Creek, Mill Creek, Felta Creek, Palmer Creek
- 2012-2013 PIT tag antenna streams: Willow Creek, Russian River mainstem at Duncans Mills, Dutch Bill Creek, Green Valley Creek, Russian River mainstem at Wohler-Mirabel, Dry Creek, Mill Creek, Felta Creek, Palmer Creek, Grape Creek
- 2012-2013 video monitoring: Russian River at Wohler-Mirabel
- 2012-2013 returns to Warm Springs Hatchery
- 2013 snorkeling survey streams: Willow Creek, Sheephouse Creek, Freezeout Creek, Austin Creek, East Austin Creek, Black Rock Creek, Gilliam Creek, Gray Creek, Devil Creek, Dutch Bill

Creek, unnamed tributary of Dutch Bill Creek, Grub Creek, Duvoul Creek, Green Valley Creek, Purrington Creek, Mark West Creek, Santa Rosa Creek, Porter Creek, Press Creek, Mill Creek, Felta Creek, Wallace Creek, Palmer Creek, Angel Creek, Crane Creek, Grape Creek, Wine Creek, Pena Creek, Pechaco Creek, Redwood Log Creek

Results:

Table 10. Minimum adult coho returns to the Russian River during winter 2012-2013. Note that if there was a potential for fish to be detected using more than one method, redundancy was assumed and the most conservative number was used. If  $\geq 10$  wild juvenile coho were observed during snorkeling surveys in 2013 and/or  $\geq 10$  wild smolts were observed during 2014 downstream migrant trapping, we assumed a minimum of two adults returned to that stream during the winter of 2012-2013. Blank fields indicate that no survey was conducted.



Stream	Wohler Video/PIT	Spawner surveys: minimum (estimated)	Unique PIT tag detections <sup>1</sup>	Hatchery returns	Observations of ≥ 10 wild juvenile coho during spring/summer surveys 2013	Observations of ≥ 10 wild coho smolts during spring downstream migrant trapping 2014	Total minimum (minus potential within-stream redundancy)
Willow Creek		0	2		yes	yes	2
Sheephouse Creek					yes		2
Freezeout Creek					yes		2
Russian River mainstem at Duncans Mills			49 (530 expanded) <sup>2</sup>				49
Austin Creek					no	yes	0
East Austin Creek					no		0
Black Rock Creek					no		0
Gilliam Creek					yes		2
Gray Creek					yes		2
Devil Creek					yes		2
Dutch Bill Creek		1 (5)	2		yes	yes	2
Unnamed trib of Dutch Bill Creek					no		0
Grub Creek					no		0
Duvoul Creek					no		0
Green Valley Creek		11 (33)	20		yes		20
Purrington Creek					yes		2
Mark West Creek					no	yes	2
Santa Rosa Creek					no		0
Russian River mainstem at Wohler-Mirabel	73		14			yes	73
Porter Creek					yes		2
Press Creek					no		0
Dry Creek			7	4		yes	11
Mill Creek		16 (56)	14		yes	yes	16
Felta Creek		1 (3)			yes		2
Wallace Creek					no		0
Palmer Creek		0			yes		2
Angel Creek					no		0
Crane Creek					no		0
Grape Creek			5		yes		5
Wine Creek					no		0
Pena Creek					yes		2
Pechaco Creek					no		0
Redwood Log Creek					no		0
<b>Russian River total minimum (accounting for potential redundancy):</b>							<b>109</b>
<b>Expanded Russian River count <sup>3</sup>:</b>							<b>536</b>

<sup>1</sup> A total of 57 unique individuals were detected in the watershed. Certain individuals were detected in multiple streams. Those individuals were included in the minimum count for each stream, but only counted one time in the minimum count for the Russian River watershed.

<sup>2</sup> Antenna efficiency estimates and the ratio of PIT to non-PIT tagged hatchery releases were used to expand the count of unique PIT Tag detections of hatchery returns passed the Duncans Mills antenna array from 49 to 450. The ratio of wild to hatchery coho adults observed at Wohler-Mirabel video monitoring station was then used to estimate that a total of 80 wild coho passed Duncans Mills, for a total estimated return of 530 passing Duncans Mills.

<sup>3</sup> The expanded Russian River count was the sum of the estimated number passing Duncans Mills and the minimum counts for Willow, Sheephouse and Freezeout Creeks.

**Spawner surveys:** During the winter of 2012-2013, adult coho were observed in Dutch Bill, Green Valley, Mill, and Felta Creeks, and no adult coho were observed in Willow or Palmer Creeks (Table 10).

**PIT tag antenna arrays:** A total of 57 unique adult hatchery coho were detected on PIT tag antenna arrays located throughout the watershed, and several individuals were detected on more than one antenna array. 43 individuals were 3 year-old returns, five were 2 year-olds and one was a 4 year-old. The winter of 2012-2013 was the first year in which an antenna array was operated on the mainstem of the Russian River at Duncans Mills and data collected at this site was used to estimate the total number of returns to the watershed. Detections of adult coho upstream of Duncans Mills were used to estimate

an overall detection efficiency of 0.81. This efficiency estimate and the ratio of PIT-tagged to nonPIT-tagged hatchery fish at the time of release were used to expand the minimum count to an estimated total of 450 hatchery coho passing the Duncans Mills site during the winter of 2012-2013.

Wohler-Mirabel video: The Water Agency operated the Wohler-Mirabel video monitoring station from 9/1/12 through 11/20/12. During this time, a minimum of 73 adult coho were observed. Based on the presence or absence of the adipose fin, 11 were of natural origin and 62 were of hatchery origin.

Hatchery returns: A total of four adult coho returned to Warm Springs Hatchery during the winter of 2012-2013. Three were hatchery releases and one was a wild fish (no adipose clip or CWT). The returns included one wild male 2 year-old, two 3 year-old hatchery males, and one 3 year-old hatchery female. For two of the fish release information was available. One fish was from the Dutch Bill smolt release group and the other was from the Dry Creek smolt release group. PIT tags were not detected in any of the returns.

Snorkeling surveys: Ten or more wild juvenile coho were observed in 15 tributaries during the summer of 2013 (Table 10). Fewer than 10 fish were observed in Angel (1), Black Rock (3), and Duvoul Creeks (9), however, given their proximity to other streams with higher numbers of wild juveniles, we did not think these were sufficient numbers to represent unique spawning events, and more likely were juvenile strays from adjacent streams.

Downstream migrant trapping: Ten or more wild coho yoy were captured in the Austin Creek, Russian River mainstem, Mark West Creek, and Mill Creek downstream migrant traps during the spring of 2013. Two wild coho yoy were captured in the Dutch Bill Creek trap and six in the Dry Creek trap. During the spring of 2014, ten or more wild smolts were captured in all downstream migrant traps in operation (Table 10).

Russian River expanded count: To estimate the total number of adult coho (wild and hatchery) passing upstream of the mainstem of the Russian River at Duncans Mills, the ratio of wild to hatchery coho observed at the Wohler-Mirabel video counting station (0.18) was applied to the estimated number of hatchery fish passing Duncans Mills for a total of 530 fish. A minimum of six adult coho were observed in tributaries downstream of Duncans Mills and those were added to the Duncans Mills estimate for an overall total of 536.

**2013-2014: minimum count: 156, expanded count: 313**

Streams with expected hatchery returns: Willow Creek, Sheephouse Creek, Freezeout Creek, Black Rock Creek, Gilliam Creek, Thompson Creek, Gray Creek, Devil Creek, Dutch Bill Creek, Green Valley Creek, Purrington Creek, Mark West Creek, Porter Creek (Mark West), Porter Creek, Dry Creek, Mill Creek, Palmer Creek, Angel Creek, Grape Creek, Pena Creek

Sampling methods:

- 2013-2014 spawner survey streams: Willow Creek, Dutch Bill Creek, Green Valley Creek, Purrington Creek, Mill Creek, Felta Creek, Wallace Creek, Palmer Creek, Angel Creek
- 2013-2014 PIT tag antenna streams: Willow Creek, Russian River mainstem at Duncans Mills, Dutch Bill Creek, Green Valley Creek, Russian River mainstem at Wohler-Mirabel, Dry Creek, Mill Creek, Felta Creek, Palmer Creek, Grape Creek
- 2013-2014 video monitoring: Russian River at Wohler-Mirabel
- 2013-2014 returns to Warm Springs Hatchery

- 2014 snorkeling survey streams: Willow Creek, Sheephouse Creek, Freezeout Creek, Austin Creek, Kidd Creek, East Austin Creek, Black Rock Creek, Gilliam Creek, Thompson Creek, Gray Creek, Devil Creek, Dutch Bill Creek, unnamed tributary of Dutch Bill Creek, Grub Creek, Duvoul Creek, Green Valley Creek, Purrington Creek, Mark West Creek, Porter Creek (MW), Santa Rosa Creek, Porter Creek, Press Creek, Mill Creek, Felta Creek, Wallace Creek, Palmer Creek, Angel Creek, Crane Creek, Grape Creek, Wine Creek, Pena Creek, Pechaco Creek, Maacama Creek, Redwood Creek, Kellogg Creek

Results:

Table 11. Minimum adult coho returns to the Russian River during winter 2013-2014. Note that if there was a potential for fish to be detected using more than one method, redundancy was assumed and the most conservative number was used. If  $\geq 10$  wild juvenile coho were observed during snorkeling surveys in 2014 and/or  $\geq 10$  wild smolts were observed during 2015 downstream migrant trapping, we assumed a minimum of two adults returned to that stream during the winter of 2013-2014. Blank fields indicate that no survey was conducted.

Stream	Wohler Video/PIT	Spawner surveys: minimum (estimated)	Unique PIT tag detections <sup>1</sup>	Hatchery returns	Observations of ≥ 10 wild juvenile coho during spring/summer surveys 2014	Observations of ≥ 10 wild coho smolts during spring downstream migrant trapping 2015	Total minimum (minus potential within-stream redundancy)
Willow Creek		10 (22)	6		yes		10
Sheephouse Creek					no		0
Freezeout Creek					no		0
Russian River mainstem at Duncans Mills			19				19
Austin Creek					no		0
Kidd Creek					no		0
East Austin Creek					no <sup>2</sup>		0
Black Rock Creek					no		0
Gilliam Creek					no		0
Thompson Creek					no		0
Gray Creek					no		0
Devil Creek					no		0
Dutch Bill Creek		17 (41)	3		yes		17
Unnamed trib of Dutch Bill Creek					no		0
Grub Creek					no		0
Duvoul Creek					no		0
Green Valley Creek		12 (36)	3		yes		12
Purrington Creek		0			no		0
Mark West Creek					no		0
Porter Creek (MW)					no		0
Santa Rosa Creek					no		0
Russian River mainstem at Wohler-Mirabel	156		17				156
Porter Creek					no		0
Press Creek					no		0
Dry Creek			20	23			23
Mill Creek		9 (0 redds)	1		no		9
Felta Creek		2 (0 redds)			no		0
Wallace Creek		0			no		0
Palmer Creek		0			no		0
Angel Creek		0			no		0
Crane Creek					no		0
Grape Creek		0			no		0
Wine Creek		0			no		0
Pena Creek		5			yes		2
Pechaco Creek		0			no		0
Woods Creek		0			no		0
Maacama Creek					no		0
Redwood Creek					no		0
Kellogg Creek					no		0

Russian River total minimum (accounting for potential redundancy): 156

Expanded Russian River count <sup>3</sup>: 313

<sup>1</sup> A total of 39 unique individuals were detected in the watershed. Certain individuals were detected in multiple streams. Those individuals were included in the minimum count for each stream, but only counted one time in the minimum count for the Russian River watershed.

<sup>2</sup> 296 juvenile coho of unknown origin were observed in East Austin during the summer of 2014, however, we think they originated from the 21,000 hatchery coho released into East Austin tributaries during June 2014.

<sup>3</sup> Antenna efficiency estimates and the ratio of PIT to non-PIT tagged hatchery releases were used to expand the count of unique PIT tag detections of hatchery returns passed the Duncans Mills and Willow Creek antenna arrays from 23 to 285. The ratio of wild to hatchery coho adults observed at Wohler-Mirabel video monitoring station was then used to estimate that a total of 28 wild coho passed Duncans Mills, for a total estimated return of 313 passing Duncans Mills.

Spawner surveys:

During the winter of 2013-2014, adult coho were observed in Willow, Dutch Bill, Green Valley, Mill, and Felta Creeks. All of the fish observed in the Mill Creek watershed were males.

PIT tag antenna arrays:

A total of 37 unique adult hatchery coho were detected on PIT tag antenna arrays located throughout the watershed, and several individuals were detected on more than one antenna array. All 37 fish were 2 year-olds and no older age fish were detected. Operation of paired antenna arrays at both Duncans Mills and at the mouth of Willow Creek were the basis for an adult return estimate for the Russian River watershed. Detections of adult coho upstream of Duncans Mills were used to estimate an overall detection efficiency at Duncans Mills of 0.46. Efficiency of the paired Willow Creek array was 1. Antenna efficiency estimates and the ratio of PIT-tagged to nonPIT-tagged hatchery fish at the time of release were used to expand a count of 23 at Duncans Mills and Willow combined to an estimated total of 285 hatchery coho entering the Russian River during the winter of 2013-2014.

Wohler-Mirabel video:

The Water Agency operated the Wohler-Mirabel video monitoring station from 9/1/2013 through 2/8/2014. During this time, a minimum of 156 adult coho were observed. Based on the presence or absence of the adipose fin, 14 were of natural origin and 142 were of hatchery origin.

Hatchery returns:

Twenty-three adult coho returned to Warm Springs Hatchery during the winter of 2013-2014. Of those, 21 were 2 year-old males, and the two others were 3 year-old females. PIT tags were detected in four of the 2 year-olds. Three of the four were from the Dry Creek smolt release during spring 2013 and one was from a Mill Creek smolt release during spring 2013. CWT data has not been processed yet.

Snorkeling surveys:

Ten or more wild juvenile coho were observed in Willow, Dutch Bill, Green Valley, and Pena Creeks (Table 11). 296 juvenile coho of unknown origin were observed in East Austin Creek, however, we think they originated from the 21,000 hatchery coho released into East Austin tributaries during June 2014 and were not of wild origin.

Downstream migrant trapping:

Will complete after spring 2015.

Russian River expanded count: To estimate the total number of adult coho (wild and hatchery) entering the Russian River, the ratio of wild to hatchery coho observed at the Wohler-Mirabel video counting station (0.10) was applied to the estimated number of hatchery fish entering the Russian River for a total of 313 fish.