

# **2015 Mill Creek LCM Station – Juvenile Coho Salmon Out-migrant Trapping Project, Smith River, California**



NOVEMBER, 2015

**ANNUAL PROGRESS REPORT TO THE CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE  
FISHERIES RESTORATION GRANTS PROGRAM  
GRANTEE AGREEMENT: P1410547**

**ON BEHALF OF**

**THE SMITH RIVER ALLIANCE**

**AND**

**THE CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE  
ANADROMOUS FISHERIES RESOURCE AND MONITORING PROGRAM**

# 2015 Mill Creek LCM Station – Juvenile Coho Salmon Outmigrant Trapping Project, Smith River, California

## Annual Progress Report to the California Department of Fish and Wildlife Fisheries Restoration Grants Program Grantee agreement: P1410547

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## Abstract

We used out-migrant trapping data collected by Mill Creek Lifecycle Monitoring Station partners to estimate the abundance of salmonid smolts emigrating from Mill Creek, Smith River (California) during the spring of 2015. We also estimated the apparent overwinter survival probability of Coho Salmon (*Oncorhynchus kisutch*) marked in the Fall of 2014 in Mill Creek and its three primary sub basins. A rotary screw trap was operated in lower Mill Creek from the afternoon of March 16 through the morning of June 15, 2015. The trap was operational for all but three days over this 91 day period. Young-of-the-year Chinook Salmon (*Oncorhynchus tshawytscha*) were the most numerous fish captured (47,400 individuals) followed by Coho Salmon smolts (3,535 individuals). A total of 2,576 steelhead (*Oncorhynchus mykiss*) and 1,470 coastal cutthroat (*Oncorhynchus clarki clarki*) were captured. Mark-recapture of fin clipped smolts and pre-smolts was used to estimate the abundance of Coho Salmon, steelhead, and coastal cutthroat trout emigrants passing the trap site. We estimated a total of 8,231 (SE=308) Coho Salmon smolts, 2,577 steelhead (SE=317) and 4,385 coastal cutthroat trout (SE=540) emigrants passed the Mill Creek out-migrant trapping site during the trapping season. Apparent overwinter survival of Coho Salmon tagged in the Fall of 2014 was estimated using recaptures at the rotary screw trap in conjunction with recaptures from PIT tag antenna arrays. Apparent overwinter survival (not accounting for that portion of the Coho Salmon population that might emigrate before being susceptible to the spring out-migrant trapping effort) was estimated to be 18.1%(SE = 0.026) across all of the Mill Creek basin. In the three major Mill Creek major sub basins (mainstem Mill Creek, the West Branch Mill Creek and the East Fork Mill Creek) apparent overwinter survival was estimated to be 6.4%, 18.3% and 21.3% respectively.

Cover Photo: Mill Creek Lifecycle Monitoring Station rotary screw trap in operation.  
Photo taken by Justin Garwood,

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## Acknowledgments

We would like to thank the California Department of Fish and Wildlife for its continued commitment to and support of all aspects of the Coastal Salmonid Monitoring Program in the Smith River basin including the Mill Creek Life Cycle Monitoring Station. The California Department of Fish and Wildlife was instrumental in the development and implementation of the out-migrant trapping portion of the Mill Creek Life Cycle Monitoring program through contributions from Sportfish Restoration Act funds. Among the many contributions to the Mill Creek Life Cycle Monitoring Station by the California Department of Fish and Wildlife include the rotary screw trap. We also wish to acknowledge the critical support provided by the Save the Redwoods League for their generous contributions toward Fall tagging efforts necessary to better understand Coho Salmon survival and distribution in the Mill Creek Lifecycle Monitoring Station. A hearty shout out goes to all of the exceptional field biologists who collected rigorous field data: Sunny Bourdon, Tara Dettmar, Vimal Golding, Rachael McCain, Jesse Nolan and Marisa Parish. We thank Mary Kuehner and Marisa Parish for administrative assistance throughout the study. We thank Patty McCleary and Grant Werschull of the Smith River Alliance for their continued enthusiastic support for this project. Many thanks to Jeff Bomke of California State Parks for the opportunity of leasing park office and housing space at the “River House”. Last, we would like to thank Redwood National and State Parks for providing critical access to all portions of Mill Creek and helping to make the Mill Creek Lifecycle Monitoring Station possible. Understanding salmonid distribution and abundance throughout this important basin remains essential to defining the status and trends of Smith River salmonid populations.

## Introduction

In this brief progress report, we present an estimate of 2015 out-migrating Coho Salmon smolt abundance and estimates of apparent 2014/2015 Coho Salmon overwinter survival using out-migrant trapping and PIT tag antenna array data collected by the California Department of Fish and Wildlife in the Mill Creek Lifecycle Monitoring Station, Smith River basin, California. We also include abundance estimates for steelhead and coastal cutthroat trout smolts and pre-smolts. Based on current project funding, the Smith River Alliance will continue to operate the Mill Creek out-migrant trap in 2016 and 2017.

Declines in Coho Salmon abundance across California have resulted in their listing under both the California and federal Endangered Species Acts (Federal Register 1997, CDFG 2002). State and federal restoration plans have called for the creation of long-term assessment and monitoring programs to both assist in and gauge the effectiveness of Coho Salmon recovery efforts (CDFG 2004, NMFS 2014). Creating such programs is especially important for Coho Salmon in basins like the Smith River, where until relatively recently, very little comprehensive monitoring designed to quantify specific population recovery metrics has taken place.

The first steps toward a comprehensive long-term monitoring program for Smith River Coho Salmon began in 2011 when California Department of Fish and Wildlife (CDFW) and the Smith River Alliance (SRA) implemented a sampling program driven by goals outlined by Adams et al. (2011) to assess the population abundance and geographical distribution of salmonids throughout their California ranges. In this randomized reach-based sampling program consistent with the region-wide California Coastal Salmonid Monitoring Plan (CMP), spawning ground surveys are utilized to track trends in adult Coho Salmon redd abundance while juvenile snorkel surveys are utilized to assess trends in their spatial structure. These adult spawning and juvenile snorkel surveys conducted across the Smith basin during the past four years by CDFW/SRA, confirm the importance of Mill Creek to the Smith River Coho Salmon core population (Garwood and Larson 2014, Garwood et al. 2014, Walkley and Garwood *in preparation*).

Mill Creek is the subject of the longest continuous fisheries monitoring in the Smith Basin (McLeod and Howard 2010, Larson 2013). Out-migrant pipe traps located on its two major tributaries, the East Fork and West Branch Mill Creek, began operation in 1994 and continued through 2012 when the Mill Creek Monitoring Group dissolved. CDFW temporarily took over the trapping effort from 2013 through 2015 to maintain data collection while alternative management and funding sources were pursued to adapt the program to fit specific goals of a CMP Lifecycle monitoring station (LCM) defined in Adams et al. (2011). The Smith River Alliance applied for and received a FRGP grant to conduct smolt out-migrant trapping in 2016 and 2017.

The goals of this out-migrant trapping project are to ensure that the CMP's goal of a lifecycle monitoring station is fully implemented. Lifecycle Monitoring (LCM) stations – as described the California Coastal Salmonid Monitoring Program (Adams et al. 2011) – are intended to estimate ocean and freshwater survival to better assess salmonid recovery. Each LCM station consists of 3 primary components: 1) an adult counting station, 2) spawning surveys above the counting station, and 3) out-migrant juvenile trapping. Components 1 and 2 of the Mill Creek LCM station are currently in place through other partner projects. An adult counting weir does not exist in the Mill Creek basin and is not feasible due to the large, flashy nature of the drainage and its management under the State and National Parks. Instead of installing a weir, Passive Integrated Transponder (PIT) antenna arrays situated at the mouths of East Fork and West Branch Mill Creek and in the lower main stem Mill Creek intercept returning PIT tagged adult Coho Salmon. Reach-based spawning surveys, which include the use of portable PIT tag scanners for detection of returning tagged adults, occur throughout Mill Creek in all designated Coho Salmon spawning areas. Together these projects will be used to estimate both the number of returning adults and their distribution

throughout the system though the success of these methods have yet to be assessed since the winter of 2014-2015 is the first year that returning adult coho salmon will have having a group marked with PIT tags. Out-migrant trapping provides a means to estimate the abundance of outmigrating Coho Salmon smolts, a capture point essential for apparent overwinter survival estimation, and also is a means of tagging smolts to estimate ocean survival. Additionally, Humboldt State University and CDFW are assessing the utility of genetic mark-recapture techniques in Mill Creek by estimating the number of returning adults from estimated parentage rates of genotyped adult carcasses with genotypes from a sample of their smolt offspring similar to (Rawding et al. (2014).

## **Materials and Methods**

### **Out-migrant Trap Site Description**

The Mill Creek out-migrant trapping site is located 2.4 stream kilometers upstream from its confluence with the Smith River, and approximately 0.65 stream kilometers downstream of the Howland Hill Road bridge (Figure 1 and Figure 2) in Redwood National and State Parks. The rotary screw trap was placed at the head of a 35 meter long pool immediately upstream of a large corner pool. This site offers both bankside refugia during high flows, as well as sufficient depth and focused current to allow the rotary screw trap to operate during the latter part of the trapping season. Nearby old growth redwoods and alders provide ample shade for trapping and fish handling activities.

### **Out-migrant Trap Operation**

The out-migrant trapping conducted by CDFW in 2015 followed a strategy and methods outlined in the California Salmonid Monitoring Plan (Adams et al. 2011) and those followed by CDFW during the 2014 Mill Creek trapping season. This trapping methodology incorporated methods used in previous monitoring efforts to estimate smolt populations in Mill Creek and Freshwater Creek (McLeod and Howard 2010, Ricker and Anderson 2011) and methods used in Freshwater Creek by Ricker and Anderson (2011) to estimate overwinter survival. The rotary screw trap (RST) deployed in Mill Creek was built by EG Solutions and consists of a flow-driven 5 foot cone and 18 foot pontoons. A built-in covered live well with a cone-driven debris removal drum is mounted posterior to the cone. The trap was anchored to large riparian trees with a cable and pulley system so in-stream adjustments could be made to optimize trap revolutions. The RST operated over a range of flows as measured at the USGS Jed Smith stream gage. In anticipation of steeply rising water levels or increased debris loads, the trap cone was removed from the water and/or the entire trap was moved to the margin of the stream. Fishing at the upper end of the flow range only occurred as flows declined. The RST was left fishing during smaller flow increases; however it was closely monitored. Weir panels were installed in front of the trap pontoons to focus water flow into the trap cone as water flow decreased toward the latter half of the season. Weir panels were angled and completely covered in plastic pond liner with all seams and holes covered to avoid fish impingement. However, we attempted to balance daily trap capture efficiency while minimizing migration obstacles for not-target organisms such as pacific lamprey, adult steelhead. The screw trap was checked and cleaned once daily in the morning with multiple cleanings occurring throughout the day during peak migration periods or as debris loads required. Fish were removed with 3/16"(or finer) cloth dip nets and placed in 5-gallon buckets containing fresh creek water or in fine mesh live-cars anchored in the channel margin immediately adjacent to the shaded fish processing station.

All captured salmonids were identified to species and classified by their developmental stage as: young-of-the-year (YOY), parr, pre-smolt, smolt, or adult. Because of the difficulty in distinguishing between juvenile coastal cutthroat trout and steelhead trout, even by trained and experienced samplers, all trout < 100 mm were identified as trout spp. and were classified as YOY or as parr. Trout > 100mm were identified



**Figure 1.** Map of the Smith River Basin, Del Norte County (California) and Curry County (Oregon) and the Mill Creek LCM station. Stream lines indicate potential anadromous salmonid stream habitat based on Garwood and Larson (2014).



**Figure 2.** Mill Creek Lifecycle Monitoring Station out-migrant trapping and PIT tag antenna array locations, Smith River basin, CA.

as cutthroat trout or steelhead and assigned a life stage. YOY were generally small in size and had distinct parr marks. Parr possessed distinct parr marks. Samplers made a distinction between steelhead and cutthroat trout pre-smolt and smolts. Those cutthroat trout and steelhead whose body was silver and had completely obscured parr marks, darkening fin edges and deciduous scales were classified as smolts while individuals displaying some but not all of these characteristics were classified as pre-smolts. Steelhead and cutthroat trout > 150mm FL and not displaying parr marks or showing signs of smolting were classified as adults. Following Mcleod and Howard (2010), all coho showing signs of smolting were classified as smolts.

All Chinook salmon were classified as YOY unless exceptionally large individuals (yearlings) were captured. The first 20 individuals of each species/developmental stage were measured to the nearest mm (FL). All parr, pre-smolts and smolts were scanned for PIT tags and were checked for fin clips. Those with fin clips and those not included in the trapping efficiency and smolt abundance estimation were released 1-3 habitat units downstream of the trap. Coho Salmon PIT tagged by DFW during the fall of 2014 were measured and weighed to the nearest 0.1g and—if not fin-clipped—were marked with the designated weekly batch clip and released upstream of the trap.

Lamprey were identified to species and classified to life stage, measured and released downstream of the trap. Non anadromous fish and amphibians were identified to species. A representative subsample was measured to the nearest mm. All fish were released at multiple locations downstream of the trap.

## **Out-migrant Smolt Abundance Estimates**

A single trap mark-recapture strategy was used to estimate trapping efficiency and Coho Salmon smolt abundance following McLeod and Howard 2010 and Ricker and Anderson (2011). Each day, a representative sample of previously unmarked Coho Salmon smolts were tagged with individually numbered PIT tags (Prentice 1990, Prentice et al. 1994) and received a fin clip. The fin clip from each individual tagged with a PIT tag was preserved and deposited into the DFW's North Coast Scale and Tissue Archive. Four different batch fin clips were used over the course of trapping: upper horizontal caudal clip (UHC), lower horizontal caudal clip (LHC), upper vertical caudal clip (HVC) and lower vertical caudal clip (LVC). A single clip was applied for roughly seven days before switching to another one, allowing a gap of 3 weeks between each tag group. The goal was to deploy 1500 PIT tags across the Coho Salmon outmigration season. These individually tagged fish will be used to estimate marine survival and adult abundance when recaptured as adults on the PIT tag antenna arrays and on spawning surveys. During periods of high smolt abundance, additional coho smolts were marked only with fin clips. Following tagging and/or marking, fish were held in flow-through live cars to check for handling/marking mortality before being released upstream of the trap. Releases occurred at rotating sites between 1 and 3 pool/riffle complexes upstream of the trap to minimize predator habituation. The same marking methodology was followed for steelhead and cutthroat trout pre-smolts and smolts, however, none were tagged with PIT tags. Mark-recapture of fin clips was broken into time intervals and bounded estimates of abundance were calculated for Coho Salmon, steelhead and cutthroat trout using DARR 2.0.2 (Bjorkstedt 2005 and Bjorkstedt 2010) in program R (R development Core Team 2013). For abundance estimates, smolts and pre-smolts were lumped together and the single trap experiment with no *a priori* pooling of strata was used.

## **Estimation of Apparent Overwinter Survival**

Program MARK (White and Burnham 1999) was used to perform a three-occasion Cormack-Jolly-Seber (CJS) analysis (Cormack 1964, Jolly 1965, Seber 1965) to estimate the 'apparent' survival probabilities for marked juvenile Coho Salmon in the three sub basins of Mill Creek (i.e. East Fork, West Branch, and mainstem Mill Creek). CJS models allow for imperfect detection while using common capture methods (e.g. rotary screw trap, stationary PIT tag antenna, etc.) by accounting for detection probability (Cooch and White 2011). When using CJS models, the survival estimates are called 'apparent' due to the model's

inability to distinguish between mortality and undetected emigration of marked individuals. The first occasion used in the CJS model was the initial PIT tagging (1). The second and third encounters occurred simultaneously throughout the following spring and are represented in the analysis as captures at the rotary screw trap (2) and the main stem Mill Creek PIT tag antennas (3), respectively.

To satisfy the first occasion, fish tagging was performed by DFW field crews in fall 2014, when rearing fish were still associated with their summer rearing habitat. A stratified selection of pool habitats was sampled throughout the East Fork, West Branch and mainstem Mill Creek using beach seines. All sampled habitats were above the out-migrant trapping site; sampled portions of the West Branch and the East Fork extended from their mouths upstream and included much of mainchannel habitat utilized by rearing Coho Salmon. The Coho Salmon seined from pools were measured, weighed and tagged with PIT tags in each reach in October 2014. Juvenile Coho Salmon were marked by surgical incision following the tagging methodology of Prentice et al. (1990) and the size-at-tagging restrictions set in Peterson et al. (1994). To minimize effects of added tag-weight to juvenile Coho Salmon, PIT tags of 12.0 mm long × 2.12 mm diameter weighing 0.1 g were used for fish ≥ 65 cm.

The secondary occasion in the CJS model represented by captures at the rotary screw trap during spring followed trapping procedures outlined above. The final occasion in the model was fulfilled by the set of PIT tag antennas located downstream of the out-migrant trapping station. Additionally, the mainstem PIT antennas and two alternative sets of antennas operated at the mouths of East Fork and West Branch of Mill Creek were used to assess year-round movement patterns of juvenile Coho Salmon, including early outmigration (i.e. fall or winter migration out of the stream before screw trap installment).

## **Database and Data Storage**

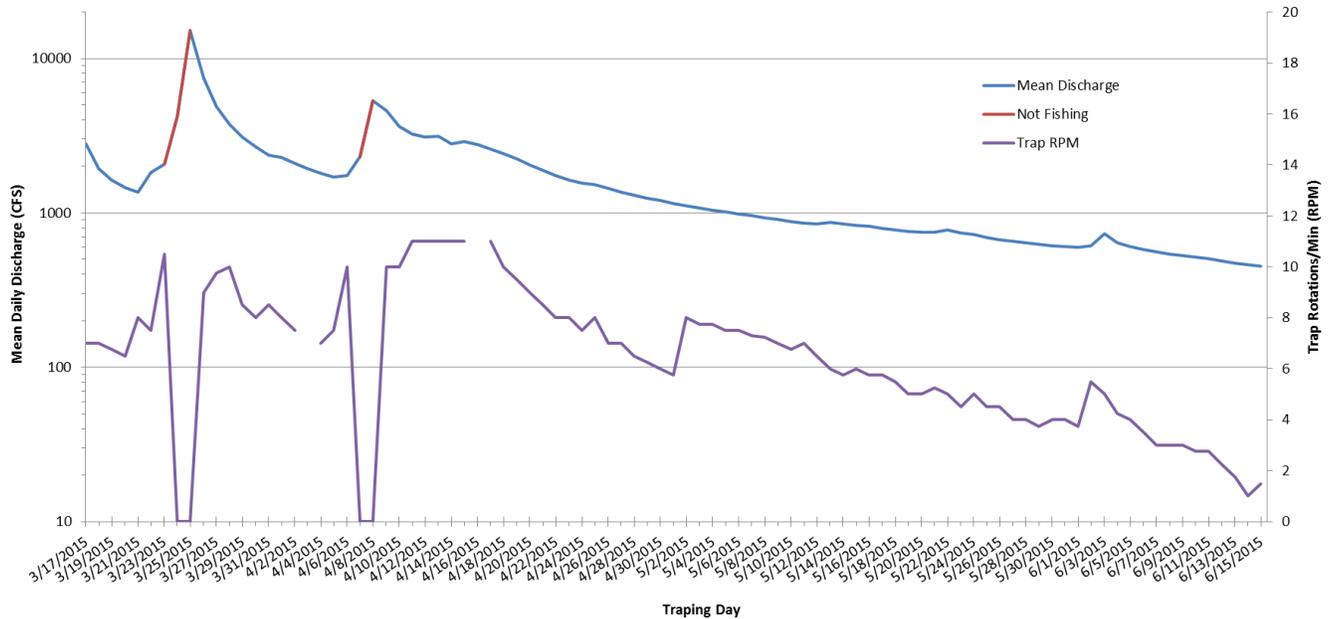
Out-migrant trapping data was collected using field computers (PDA's) operating the DFW Coastal Monitoring Program Aquatic Survey Program database (current version: 0.9.3.) (Burch et al. 2014). Data fields in all PDA forms were fixed within specific ranges to minimize data entry error. Standard QAQC queries were run each day after PDA's were downloaded to correct data errors directly after surveys were completed. Databases were backed up once a week.

## **2015 Mill Creek LCM Out-migrant Trapping Results and Discussion**

### **Out-migrant Trapping Effort and Overall Catch**

The RST was installed in lower Mill Creek on March 16, 2015 and remained in operation until it was removed on June 15, 2015 (Figure 3). Trapping continued almost continually during this 91 day period with the exception of two high flow events that prompted a loss of 3 trapping days. The RST was moved to the stream margin on the afternoon of March 23 and re-deployed the afternoon of March 25. During this period flows at the USGS Jed Smith gaging station peaked around 23,000 CFS (U.S. Geological Survey 2012). The RST was pulled again for a single day on the afternoon of April 7 and redeployed on April 8. Trap cone rotations per minute (RPM) were higher during the first half of the trapping season, but decreased as seasonal flow decreased (Figure 3). Weir panels were installed on the afternoon of May 1 to increase cone RPM and to direct flow into the trap cone.

Total counts of unique individuals (excluding recaptured marked fish) of each species and stage captured in the RST can be found in Table 1. Four species of salmonids were captured. Chinook Salmon YOY were by far the most abundant fish captured in the RST followed by Coho Salmon smolts. Notably, although they occurred in lower numbers than chinook or trout, Coho Salmon YOY were captured in the RST. While it is possible that these YOY emerged from redds in the mainstem of Mill Creek, no Coho Salmon have been



**Figure 3.** Daily Mill Creek rotary screw trap effort measured by trap cone rotations per minute (RPM) each morning from March 17, 2015 through June 15, 2015 and average daily discharge at the Jed Smith USGS gage station. Gaps in RPM indicate missing data while red lines in discharge indicate periods over which the trap was not fishing.

observed building redds in the mainstem of Mill Creek over the four years of CMP spawning surveys (Garwood and Larson 2014, Garwood et al. 2014, Walkley and Garwood *in preparation*). Thus, these fish are likely evidence of an early emigration life history strategy undertaken by YOY coho salmon originating from West Branch and East Fork Mill Creek. More steelhead parr were captured than coastal cutthroat trout parr, however, this trend is reversed for pre-smolt and smolts (Table 1). In addition to juvenile salmonids, adult salmonids, including one steelhead, and 13 Pacific lamprey were captured in the trap, albeit in low numbers. We strived to avoid the incidental capture of these species by maintaining small migration routes around the trap. Klamath smallscale suckers comprised the bulk of the non-salmonid catch with Prickly sculpin and Coast Range Sculpin also captured. Of the few amphibians captured, coastal giant salamander larvae were most numerous in the RST catch.

### Out-migrant Smolt Abundance Estimates

Mark-recapture of fin clipped smolts and pre-smolts was used to estimate the abundance of out-migrating Coho Salmon, steelhead and coastal cutthroat trout over the course of the trapping season. A total of 1,496 Coho Salmon smolts were tagged with PIT tags. Thirteen distinct caudal fin clip strata were released over the course of trapping (Table 2). 1,981 Coho Salmon smolts were clipped and released upstream of the RST and 899 individuals were recaptured. Using DARR, the estimated spring population of Mill Creek emigrating Coho Salmon smolts was 8,231 (SE=307.97) smolts (Figure 4). Peak outmigration of Coho Salmon in lower Mill Creek occurred during late April through early May during 2015.

Estimated probability of capture (trapping efficiency) for out-migrating Coho Salmon averaged 44% (min=14%, max=96%) across the entire trapping season. Trapping efficiency increased as water volume

**Table 1.** Total numbers of unique individuals captured in the Mill Creek out-migrant trap from March 16 through June 15, 2015. Totals exclude recaptured fin-clipped fish used to estimate smolt abundance.

<b>Common Name (Scientific Name)</b>	<b>Stage</b>	<b>Total Unique Captures<sup>a</sup></b>
Chinook Salmon ( <i>Oncorhynchus tshawytscha</i> )	YOY	47400
Coho Salmon ( <i>Oncorhynchus kisutch</i> )	YOY	383
	smolt	3535
Steelhead ( <i>Oncorhynchus mykiss</i> )	parr	2014
	pre-smolt	537
	smolt	24
	adult	1
Coastal Cutthroat Trout ( <i>Oncorhynchus clarki clarki</i> )	parr	591
	pre-smolt	765
	smolt	86
	adult	28
Unidentified Trout ( <i>Oncorhynchus sp.</i> )	YOY	1139
	parr	2239
Coast Range Sculpin ( <i>Cottus aleuticus</i> )	resident	142
Prickly sculpin ( <i>Cottus asper</i> )	resident	127
Unidentified Sculpin ( <i>Cottus sp.</i> )	resident	90
Three-spined Stickleback ( <i>Gasterosteus aculeatus</i> )	resident	35
Klamath Smallscale Sucker ( <i>Catostomus rimiculus</i> )	resident	1299
Pacific Lamprey ( <i>Lampetra tridentata</i> )	adult	13
Lamprey genus ( <i>Lampetra sp.</i> )	ammocete	11
Coastal Giant Salamander ( <i>Dicamptodon tenebrosus</i> )	larvae	8
Foothill Yellow-legged Frog ( <i>Rana boylei</i> )	larvae	1

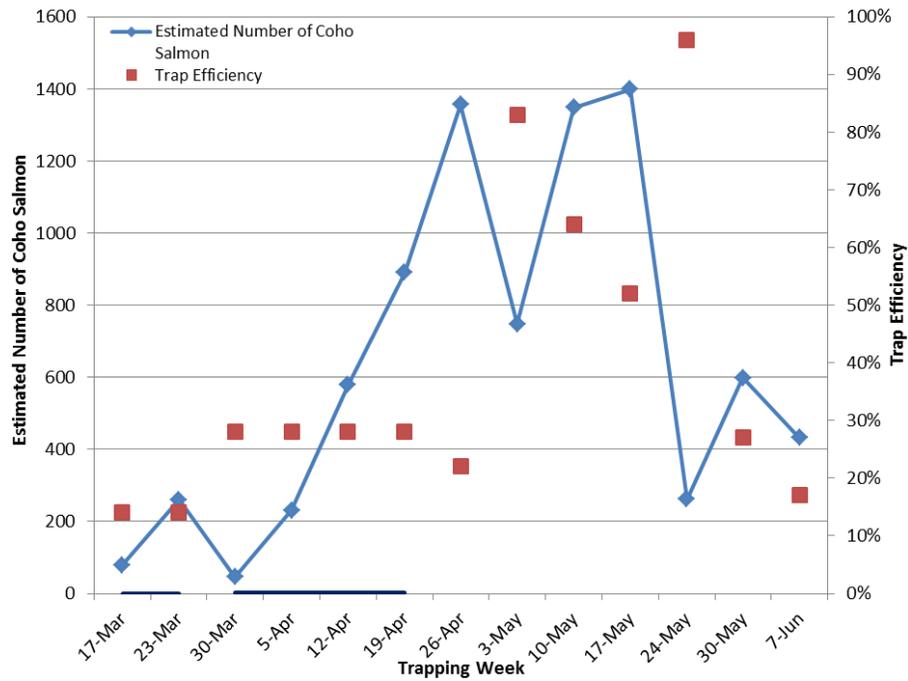
<sup>a</sup> Unique individuals captured exclude recaptured individuals marked with fin clips and include mortalities.

**Table 2.** Mill Creek out-migrant trap marking strata, number of unmarked individuals captured (C) and number of marked (M) Coho Salmon, steelhead and cutthroat trout released upstream of the Mill Creek out-migrant trap from March 16 through June 15, 2015.

Marking Stratum	Start Date	End Date	Clip	Coho Salmon		Steelhead		Cutthroat	
				C <sup>1</sup>	M <sup>2</sup>	C	M	C	M
1	3/17/2015	3/22/2015	UHC	11	11	117	55	8	7
2	3/23/2015	3/29/2015	LHC	36	36	76	63	19	17
3	3/30/2015	4/4/2015	UVC	13	11	86	80	12	10
4	4/5/2015	4/11/2015	LVC	65	57	92	80	62	40
5	4/12/2015	4/18/2015	UHC	163	146	76	64	74	44
6	4/19/2015	4/25/2015	LHC	251	232	53	47	101	76
7	4/26/2015	5/2/2015	UVC	304	252	26	24	161	83
8	5/3/2015	5/9/2015	LVC	622	291	14	13	193	89
9	5/10/2015	5/16/2015	UHC	857	290	7	7	112	51
10	5/17/2015	5/23/2015	LHC	731	270	9	2	85	43
11	5/24/2015	5/29/2015	UVC	251	178	5	1	55	25
12	5/30/2015	6/6/2015	LVC	159	153	0	0	38	14
13	6/7/2015	6/15/2015	UHC	72	54	0	0	10	2

<sup>1</sup>Total number of captured unmarked individuals includes mortalities and first captures of Fall-tagged Coho Salmon.

<sup>2</sup>Total marked individuals released upstream of RST during each marking stratum.



**Figure 4.** DARR estimates of Coho Salmon smolt abundance for each marking strata at the Mill Creek out-migrant trap between March 16 and June 15, 2015, Smith River basin, CA. Dates represent the start of each trapping week and black bars between dates indicate pooled marking strata.

decreased at the site and also with the installation of the weirs panels on May 1<sup>st</sup>. Weirs will be installed earlier in future trapping seasons when appropriate to boost trapping efficiency.

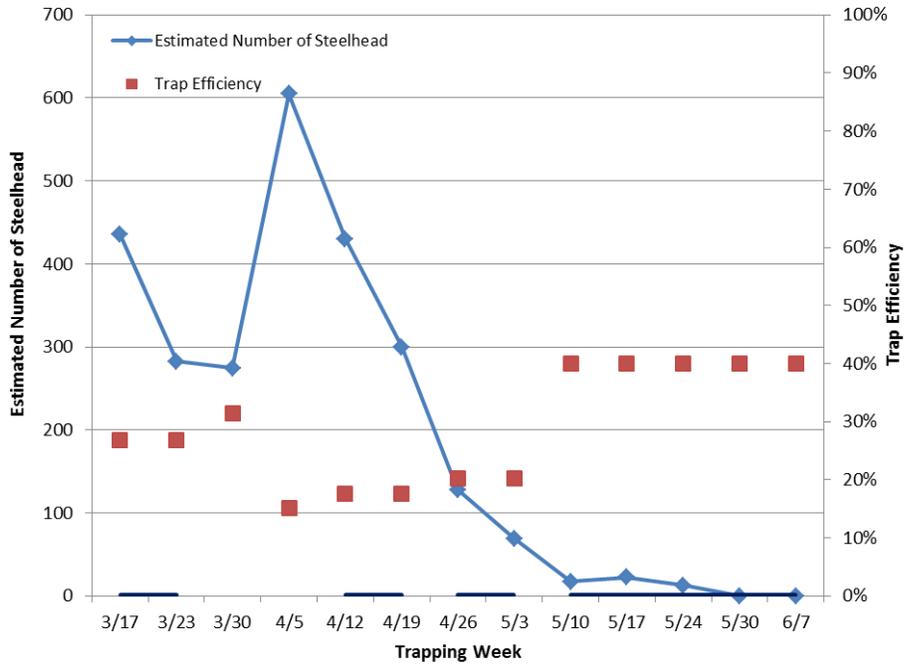
A total of 436 steelhead were clipped and released upstream of the RST and 93 were recaptured. An estimated 2,577 (SE= 317.39) steelhead smolts and pre-smolts emigrated from Mill Creek (Figure 5). Estimated trapping efficiency for out-migrating steelhead averaged 29% (min=15%, max=40%) across the entire trapping season. The estimate of emigrating steelhead smolts and pre-smolts is likely biased low. It is evident from the mark recapture data that steelhead outmigration occurred primarily during the first half of the trapping season (Table 2). High numbers of smolts and pre-smolts were captured during the first trapping stratum, suggesting only a portion of the out-migrating population was sampled.

A total of 501 cutthroat trout were clipped and released upstream of the trap and 121 were recaptured. An estimate of 4,385 (SE= 540.27) cutthroat smolts and pre-smolts emigrated from Mill Creek (Figure 6). Estimated trapping efficiency for out-migrating cutthroat trout averaged 26% (min=12%, max=63%) across the entire trapping season.

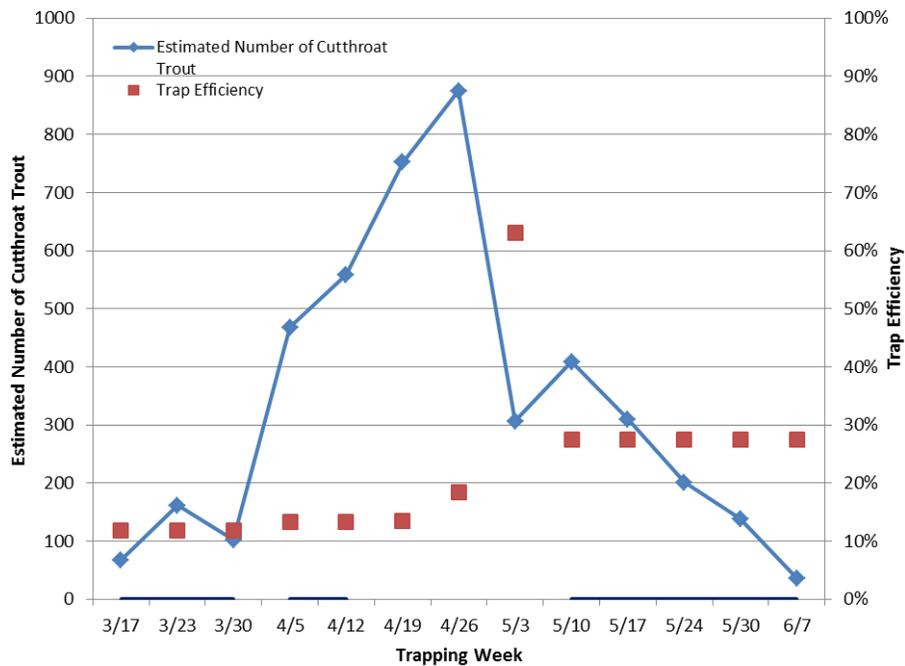
### **Estimation of Apparent Survival**

The estimated overwinter survival of Coho Salmon in all of Mill Creek was 18.1% (SE = 0.026) with a 95% confidence interval of 13.6% to 23.7% (Table 3). A separate sub basin model estimated overwinter survival for the main stem, West Branch and East Fork Mill Creek sub basins equaling 6.4%, 18.3% and 21.3% survival, respectively. 95% Confidence intervals are displayed in Table 3. Goodness of fit for the sub basin model was assessed using the Median  $\hat{c}$  test for overdispersion in the data. A  $\hat{c}$  value above 3.0 suggests the model may not accurately reflect the data (Lebreton et al. 1992). Our  $\hat{c}$  value of 2.48 indicated that corrections for overdispersion in our model were not necessary.

Life histories of Coho Salmon in coastal Northern California are currently understood to include freshwater occupancy for one or two years before migrating seaward the following spring. Recent studies in the Freshwater Creek basin (Rebenack et al. 2015; Ricker and Anderson 2011) indicate that an alternative life history strategy is expressed by some juvenile Coho Salmon that could be described as a fall re-distribution or a fall outmigration. This alternative life-history strategy is apparently exhibited by Coho Salmon in Mill Creek. Parish and Garwood (2015) found what appear to be non-natal Coho Salmon over summering and over wintering in the lower Smith River and its estuary. During January and February of 2015, they recaptured four Coho Salmon juveniles in the lower main stem Smith River and one of its tributaries, Morrison Creek, which had been PIT tagged as part of the 2014 Mill Creek Fall tagging effort. Based on year round antenna operation in Mill Creek near the spring rotary screw trapping site, an unknown proportion of juvenile Coho Salmon are migrating out of Mill Creek during fall and winter months. During fall and winter months in 2014-15, 23 individuals were detected leaving Mill Creek before screw trap installation, indicating that our apparent overwinter survival estimates are likely biased low. Current research is being designed to decouple these alternative life history strategies by estimating fall and winter outmigration probabilities.



**Figure 5.** DARR estimates of combined steelhead smolt and pre-smolt abundance for each marking strata at the Mill Creek out-migrant trap between March 16 and June 15, 2015, Smith River basin, CA. Dates represent the start of each trapping week and black bars between dates indicate pooled marking strata.



**Figure 6.** DARR estimates of combined coastal cutthroat smolt and pre-smolt abundance for each marking strata at the Mill Creek out-migrant trap between March 16 and June 15, 2015, Smith River basin, CA. Dates represent the start of each trapping week and black bars between dates indicate pooled marking strata.

**Table 3.** Summary of CDFW mark-recapture efforts for Coho Salmon in Mill Creek from tagging in Fall 2014 through June 2015. Coho detection values represent basin-specific counts of individual Coho Salmon detected throughout monitoring seasons. Coho Salmon movement values represent counts of individuals which redistributed among sub basins before spring migration. 'Apparent' overwinter survival estimates derived using Program MARK (White and Burnham1999).

<b>Mill Creek Sub basin:</b>	<b>MSM<sup>a</sup></b>	<b>WBM<sup>b</sup></b>	<b>EFM<sup>c</sup></b>	<b>Total<sup>d</sup></b>
<b>Individually tagged Coho Salmon:</b>	367	547	466	1380
<b>Coho Detections:</b>				
Main stem antennas, Mar 15-Jun 15	6	12	24	42
Screw Trap Captures, Mar 15-Jun 15	7	37	42	86
Detected Early Emigrants, Nov 1-Mar 15	7	8	8	23
Detected Overwinter Survivors, Nov 1-Mar 15	10	45	50	105
<b>Coho Movements:</b>				
To East Fork early	0	2	0	2
To West Branch early	5	0	18	23
To Main stem early	0	21	6	27
<b>Estimated 'apparent' overwinter survival</b>	<b>6.4%</b>	<b>18.3%</b>	<b>21.3%</b>	<b>18.1%</b>
<i>Upper 95% Confidence Interval</i>	<i>10.8%</i>	<i>26.2%</i>	<i>29.5%</i>	<i>23.7%</i>
<i>Lower 95% Confidence Interval</i>	<i>3.7%</i>	<i>12.4%</i>	<i>15.0%</i>	<i>13.6%</i>

<sup>a</sup> Main stem Mill Creek sub basin

<sup>b</sup> West Branch Mill Creek sub basin

<sup>c</sup> East Fork Mill Creek sub basin

<sup>d</sup> Mill Creek overall

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