Mill Creek Salmonid Lifecycle Monitoring Station Juvenile Coho Salmon Outmigrant Trapping Project 2014-2017, Smith River, California

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FINAL REPORT TO THE CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE
FISHERIES RESTORATION GRANTS PROGRAM
GRANTEE AGREEMENT: P1410546

ON BEHALF OF

THE SMITH RIVER ALLIANCE

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Abstract

We used spring outmigrant trapping data to estimate the abundance of salmonid smolts emigrating from Mill Creek, Smith River (California), over four years from 2014 to 2017. Mill Creek has one of California's longest running salmonid outmigrant trapping programs dating back to 1994 and we summarize abundance estimates across the 24 years. We also estimated the apparent overwinter survival probability of Coho Salmon (*Oncorhynchus kisutch*) marked during the fall of 2013-2016 in Mill Creek and its two primary subbasins, East Fork Mill Creek and West Branch Mill Creek, using data collected by California Department of Fish and Wildlife. We operated a rotary screw trap (RST) in lower Mill Creek from mid-March through late June each year. The RST was operational for 96 of 98 days in 2014, 88 of 91 days in 2015, 92 of 94 days in 2016 and 105 of 106 days in 2017. Young-of-the-year Chinook Salmon (*Oncorhynchus tshawytscha*) were the most numerous fish captured during all four seasons (5319, 47399, 114797 and 56969 individuals during 2014-2017) followed by unidentified trout (3148, 3377, 3341 and 2341 individuals during 2014-2017). We captured a total of 2188, 3529, 2207 and 1542 Coho Salmon smolts and 266, 383, 1158 and 699 young-of-the-year Coho Salmon in the rotary trap during 2014-2017. We captured a total of 1464, 2579, 1752 and 1857 steelhead (*Oncorhynchus mykiss*) and 751, 1464, 760 and 1102 Coastal Cutthroat Trout (*Oncorhynchus clarki clarki*) during 2014-2017. Mark-recapture of fin clipped 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 7416 (95% CI: 6580-8251), 8195 (95% CI: 7342-9047), 7567 (95% CI: 6706-8427) and 9383 (95% CI: 6349-12418) spring migrant Coho Salmon smolts emigrated past the Mill Creek outmigrant trapping site in 2014, 2015, 2016 and 2017 respectively. We estimated a total of 1075 (95% CI: 695-1456), 2554 (95% CI: 1931-3176), 2078 (95% CI: 1159-2997) and 3882 (95% CI: 1944-5820) steelhead smolts emigrated in 2014, 2015, 2016, and 2017, respectively. We estimated a total of 340 (95% CI: 191-488), 4175 (95% CI: 3144-5205), 2427 (95% CI: 1315-3539) and 5423 (95% CI: 3536-7310) Coastal Cutthroat Trout smolts emigrated in 2014, 2015, 2016, and 2017 respectively.

We used Cormack-Jolly-Seber (CJS) mark-recapture models to estimate the 'apparent' overwinter survival and early emigration (individuals emigrating prior to the installation of the RST) of Coho Salmon tagged in the previous fall by using the recaptures at the RST and three stationary PIT tag antenna arrays in Mill Creek and two arrays located in the Smith River estuary. Apparent overwinter survival, ranged from 6.0%-12.8% throughout the Mill Creek basin, 4.2%-12.9% for West Branch Mill Creek, 7.2%-14% for East Fork Mill Creek and 3.5%-6.3% for mainstem Mill Creek. Minimum annual early emigrants comprised on average 20.6% (15.2%-26.2%) of fall tagged fish recaptures in Mill Creek, showing significant numbers of Coho Salmon juveniles emigrated early. Estuary antenna detections during 2015 thorough 2017 showed 46.2% (34.9%-57.5%) of early Mill Creek emigrants used these habitats. Our results highlight a diversity of life history patterns in the Smith River across species, age classes, space, and years that are not quantified using spring outmigrant trapping alone. Complete lifecycle monitoring stations are needed to capture the whole suite of life history characteristics being expressed in salmonid populations while accounting for abundance and survival of individuals not accounted for during a single period or centralized location.

Cover Photo: ***Lower Mill Creek near outmigrant trap location. Photo: Justin Garwood.***

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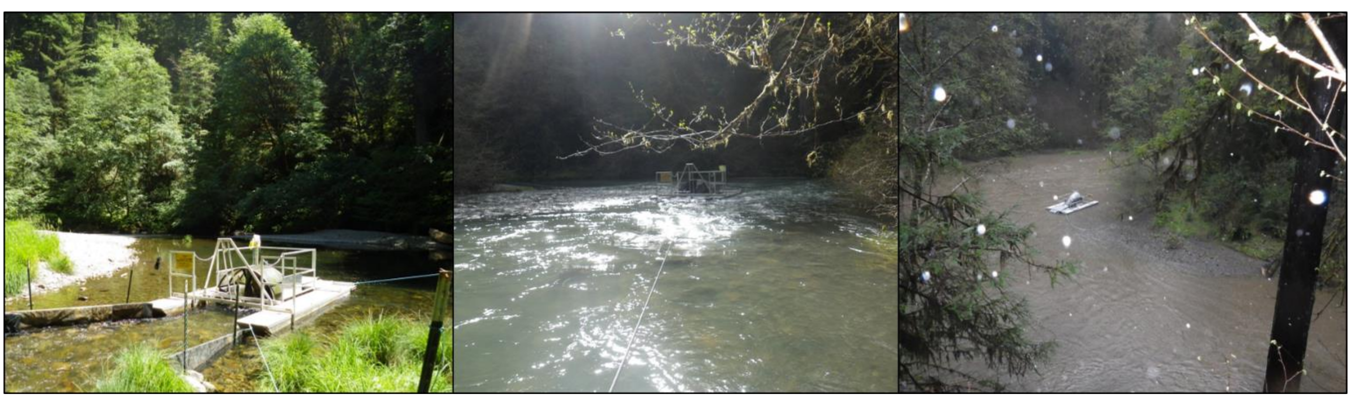
Acknowledgments

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 outmigrant trapping portion of the Mill Creek Life Cycle Monitoring program through contributions from Sportfish Restoration Act funds. The rotary screw trap is included among the many contributions to the Mill Creek Life Cycle Monitoring Station by the California Department of Fish and Wildlife. We also wish to acknowledge the critical support provided by the Save The Redwoods League. A grant to Justin Garwood supported fall coho salmon 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 throughout these four years of sampling: Jeff Abrams, Sunny Bourdon, Tara Dettmar, Vimal Golding, Ken Lindke, Rachael McCain, Jesse Nolan, Zach Wenderott and Angela Zondervan. We thank Mary Kuehner and Marisa Parish for administrative assistance throughout the study. We thank Patty McCleary and Grant Werschkull 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 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.



Photos of the Mill Creek rotary screw trap in different flow conditions. Left: operating during low flow conditions with weir panels. Middle: operating during high flow conditions. Right: trap pulled to the side and not operating during a flood. Photos*: J. Garwood and J. Walkley*

Introduction

The California Coastal Salmonid Monitoring Program (CMP) was developed for California to meet the monitoring needs required by both the Federal and State endangered species act's recovery plans. These data are used to focus species recovery efforts and to track salmonid population responses to management and restoration (Adams et al. 2011). Similar data collected across many populations is often aggregated to assess recovery at the evolutionary significant unit (ESU). The monitoring strategy is guided by four key population characteristics including abundance, productivity, spatial structure, and diversity. These four characteristics are collectively defined as the Viable Salmonid Population conceptual framework (VSP) (McElhany et al. 2000). Salmonid monitoring is costly, which limits the scale and intensity of monitoring across an ESU. For example, VSP metrics such as smolt production (abundance), marine survival (productivity), and migratory behavior (diversity of life histories) currently require local intensive mark-recapture programs to obtain reliable data. In order to obtain this information, Lifecycle Monitoring Stations (LCMs) need to be established in multiple small watersheds throughout an ESU. This report primarily summarizes the Mill Creek LCM station (Smith River basin, California) smolt outmigrant trapping program results from 2014-2017. Additionally, given this is one of the longest running smolt trapping programs in California (1994-2017), we provide an overall summary of annual Coho Salmon smolt estimates throughout the program's history.

Lifecycle Monitoring Station Goals and Design

Lifecycle Monitoring stations are established to estimate ocean and freshwater survival to better assess salmonid recovery at the population-level. Additionally, LCM stations can provide precise estimates of local adult salmon abundance that can be used to inform regional adult sampling efforts. Last, LCM stations provide the infrastructure for exploring detailed research questions. For example, population vital rates such as individual growth, emigration patterns, and habitat-based productivity can be measured at LCM stations as secondary goals. Each LCM station consists of three primary components: 1) an adult counting station (e.g. weir), 2) spawning surveys above the counting station, and 3) smolt outmigrant trapping. For component 1, an adult counting station does not currently exist in the Mill Creek basin. The installation of an adult weir is currently not feasible due to the large, flashy nature of the drainage and its management under the State and National Parks. However, a recent transgenerational genetic mark-recapture study (Whitmore and Kinziger 2016, Hankin and Mohr 2016, Whitmore 2016) was performed using Mill Creek Coho Salmon carcass and smolt offspring DNA collected during the 2011-2012 and 2012-2013 spawning years coupled with the 2013 and 2014 smolt outmigration years. This novel alternative to estimating adult Coho Salmon abundance used genotypes of individual fish in a mark-recapture framework to determine how many adults were explained by their smolt progeny (Rawding et al. 2014). Although this approach resulted in reasonable adult population estimates, it has not been accepted by CDFW as a viable alternative to weir estimates despite the inherent difficulties in estimating population size using calibrated redd surveys from weir estimates (*see* Garwood et al. 2014 and Walkley and Garwood 2017). Component 2, the adult spawning survey census, has been implemented for six years since the 2011/2012 spawning migration season (Garwood and Larson 2014, Walkley and Garwood 2017). Component 3, outmigrant trapping, is used to estimate the abundance of spring outmigrating Coho Salmon smolts (*this study*) and marine survival when coupled with components 1 and 2. Additionally, Passive Integrated Transponder (PIT) antenna arrays situated at the mouths of East Fork and West Branch Mill Creek, and the lower mainstem Mill Creek have been in operation from 2014 to present (Garwood and Deibner-Hanson 2017). These antennas intercept fall tagged juvenile Coho Salmon and are used in conjunction with the outmigrant trap to estimate early emigration rates and overwinter survival of juvenile Coho Salmon prior to trap installation. Although we cannot produce reasonable adult population estimates from antennas independent of spawning surveys, we can use antennas to estimate smolt-to-adult survival and to describe spatial and temporal movement patterns of PIT tagged adult Coho Salmon.

Mill Creek Juvenile Salmonid Monitoring Program Chronology (1994-2017)

The Mill Creek salmonid outmigrant trapping program was initiated in 1994 by Rellim Redwood Company in response to Coho Salmon entering endangered species candidacy for the Southern Oregon/ Northern California Evolutionary Significant Unit (Rellim Redwood Company 1994, Howard and McLeod 2005, McLeod and Howard 2010, Larson 2013). The trapping program has been in operation now for 24 consecutive years and has adapted most recently to meet the goals of the California Coastal Salmonid Monitoring Program (CMP). During the early years, pipe traps were installed each spring near the mouths the East Branch Mill Creek and West Fork Mill Creek to estimate smolt production for Coho Salmon, steelhead, and Coastal Cutthroat Trout. Additionally, annual counts of young-of-the-year (YOY) Chinook Salmon, YOY Coho Salmon, and other fishes were also reported. The data collected from the traps informed agencies and nonprofits about the conservation value of the upper Mill Creek watershed and its importance as a conservation area for salmonids. Rellim Redwood Company ran both traps annually through 2001 when the property was purchased from Stimson Lumber Company and transferred to California State Parks.

From 2002 to 2012 both pipe trap operations continued through various funding sources with most support coming from the California Department of Fish and Wildlife Fisheries Restoration Grants Program (FRGP) and nonprofits such as Save The Redwoods League. From 2013 to 2015 the California Department of Fish and Wildlife managed the outmigrant trapping operations and made significant changes to adapt the program into a functioning lifecycle monitoring station (LCM) as defined by the CMP (Adams et al. 2011). The most significant change was relocating the trapping operation 7 kilometers downstream to trap a much larger portion of the Mill Creek watershed and switching the trap design from stream anchored pipe traps to a single floating rotary screw trap. Three PIT tag antenna arrays were installed in Mill Creek in 2013; one array in the lower basin and one each in the East Fork and West Branch. Batches of juvenile Coho Salmon were tagged throughout the basin each fall from 2013 through 2016. The antennas and outmigrant trap are used together to estimate overwinter survival, emigration timing, abundance, and individual growth rates of Coho Salmon as measurements of freshwater productivity. Furthermore, the antenna stations operated from the first fall rains through the Coho Salmon spawning period to detect tagged adults during the spawning migration as a measure of apparent marine survival. During 2016 and 2017 (years 23-24), the outmigrant trap was supported by this FRGP grant.

In this report, we present final estimates of the 2014-2017 spring out-migrating Coho Salmon smolt abundance using outmigrant trapping (OMT) collected by the Smith River Alliance and the California Department of Fish and Wildlife (CDFW) in the Mill Creek Lifecycle Monitoring Station, Smith River basin, California. We also report on the final estimates of apparent Coho Salmon overwinter survival from 2013-2016 using data from the OMT and PIT tag antenna arrays. We describe an ecologically important alternate late fall/winter migrant Coho Salmon life history strategy that was previously undefined in the Smith River. We also highlight the prevalence of a previously reported downstream redistribution of an early Coho Salmon young-of-the-year. We include abundance estimates for steelhead and Coastal Cutthroat Trout smolts and young-of-the-year Chinook Salmon counts. Last, we summarize long-term population monitoring results across the 24 years of salmonid monitoring in the Mill Creek watershed. Through this study we have identified various opportunities for restoring and enhancing salmonid habitats in the Mill Creek watershed. The management focus of this entire watershed includes restoration, conservation, cultural, and recreational uses (State Parks 2011). Large-scale restoration activities have been occurring in Mill Creek over the past 15 years and our recommendations provide managers with some of the most current opportunities to maintain and enhance salmonid habitats throughout the basin.

Materials and Methods

Outmigrant Trap Site Description

The Mill Creek outmigrant 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, 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 when flows are minimal. Nearby old growth redwoods and alders provide ample shade for trapping and fish handling activities during warm days.

Outmigrant Rotary Screw Trap Operation 2014-2017

The outmigrant trapping conducted from 2014 through 2017 closely followed the methodology described in (Walkley et al. 2015) and followed a strategy and methods outlined in the California Coastal Salmonid Monitoring Plan (Adams et al. 2011). 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 ft diameter 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 (#11532500). In anticipation of steeply rising water levels or increased debris loads, the trap cone was elevated out of the water and 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 remained fishing during smaller flow increases; however, it was closely monitored for debris accumulations. We installed weir panels in front of the trap pontoons to focus water flow into the trap cone as water flow decreased toward the latter half of each season. Weir panels were angled and completely covered in plastic pond liner with all seams and holes covered to avoid fish impingement. These efforts were an attempt to balance daily trap capture efficiency with minimizing migration obstacles for not-target organisms such as Pacific lamprey and adult steelhead. We made frequent adjustments to the RST's position as flows changed across each trapping season. We checked and cleaned the RST once a day in the morning, while multiple cleanings occurred 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), 1+ parr, smolt, or resident/adult. Because of the difficulty in distinguishing between juvenile Coastal Cutthroat Trout and steelhead trout, even by trained and experienced samplers, all trout <100mm fork length were identified as trout spp. and were classified as YOY or as 1+ parr. Trout >100mm were identified as Coastal Cutthroat Trout or steelhead and assigned a life stage. YOY were generally small in size (and had distinct parr marks). Larger individuals (generally greater than 60mm) possessing distinct parr marks were grouped as 1+ Parr. Coastal Cutthroat Trout and steelhead whose body was silver and had obscured parr marks, darkening fin edges and deciduous scales were classified as smolts. Steelhead and Coastal Cutthroat Trout >150mm FL and not displaying parr marks or showing signs of smolting were classified as adults. Trout, including both Coastal Rainbow Trout and Coastal Cutthroat Trout that lacked parr marks but did not display signs of smolting were classified as residents. Following Mcleod and Howard

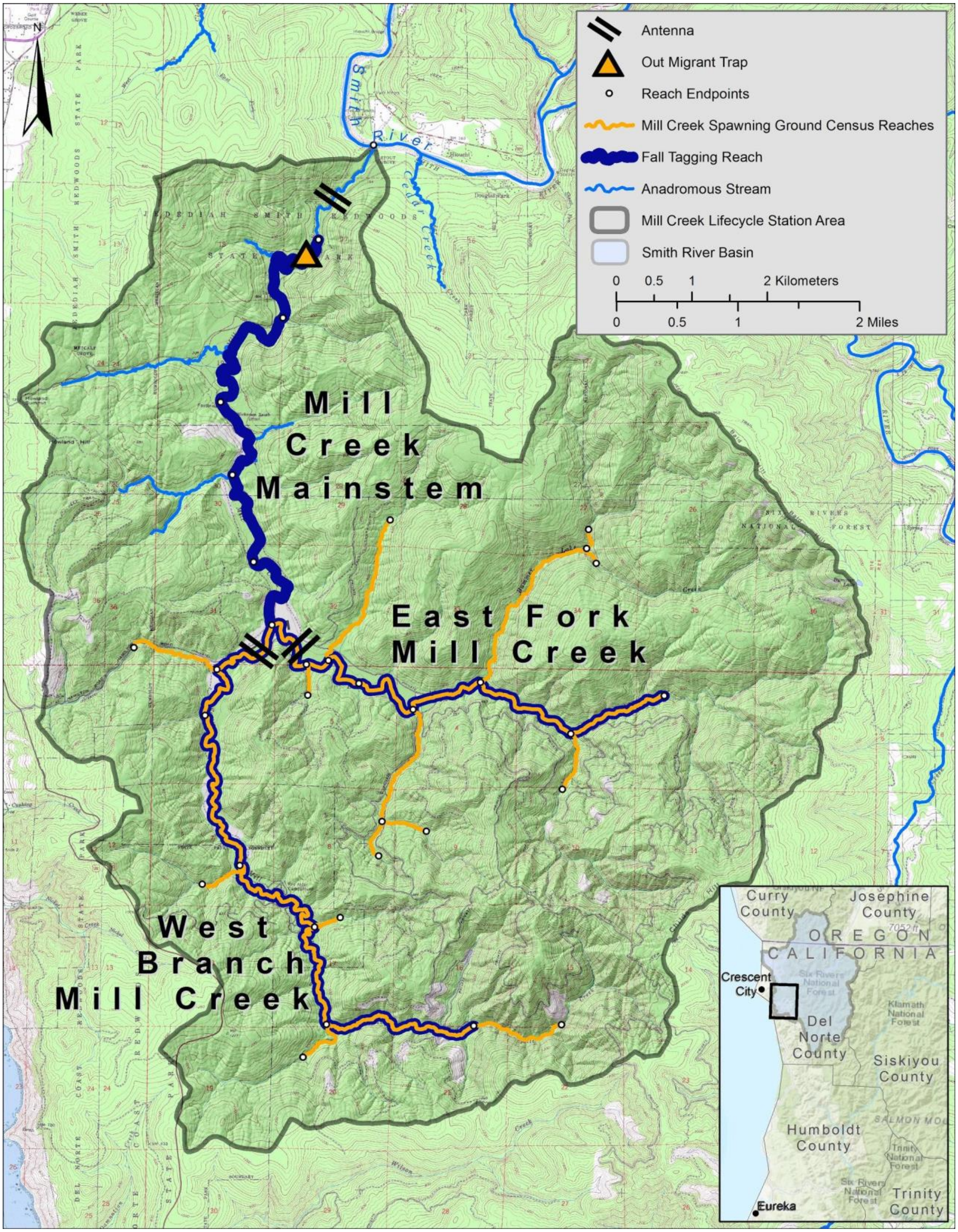


Figure 1. Mill Creek Lifecycle Monitoring Station outmigrant trapping and Passive Integrated Transponder tag antenna (antenna) array locations, Smith River Basin, Del Norte County, CA.

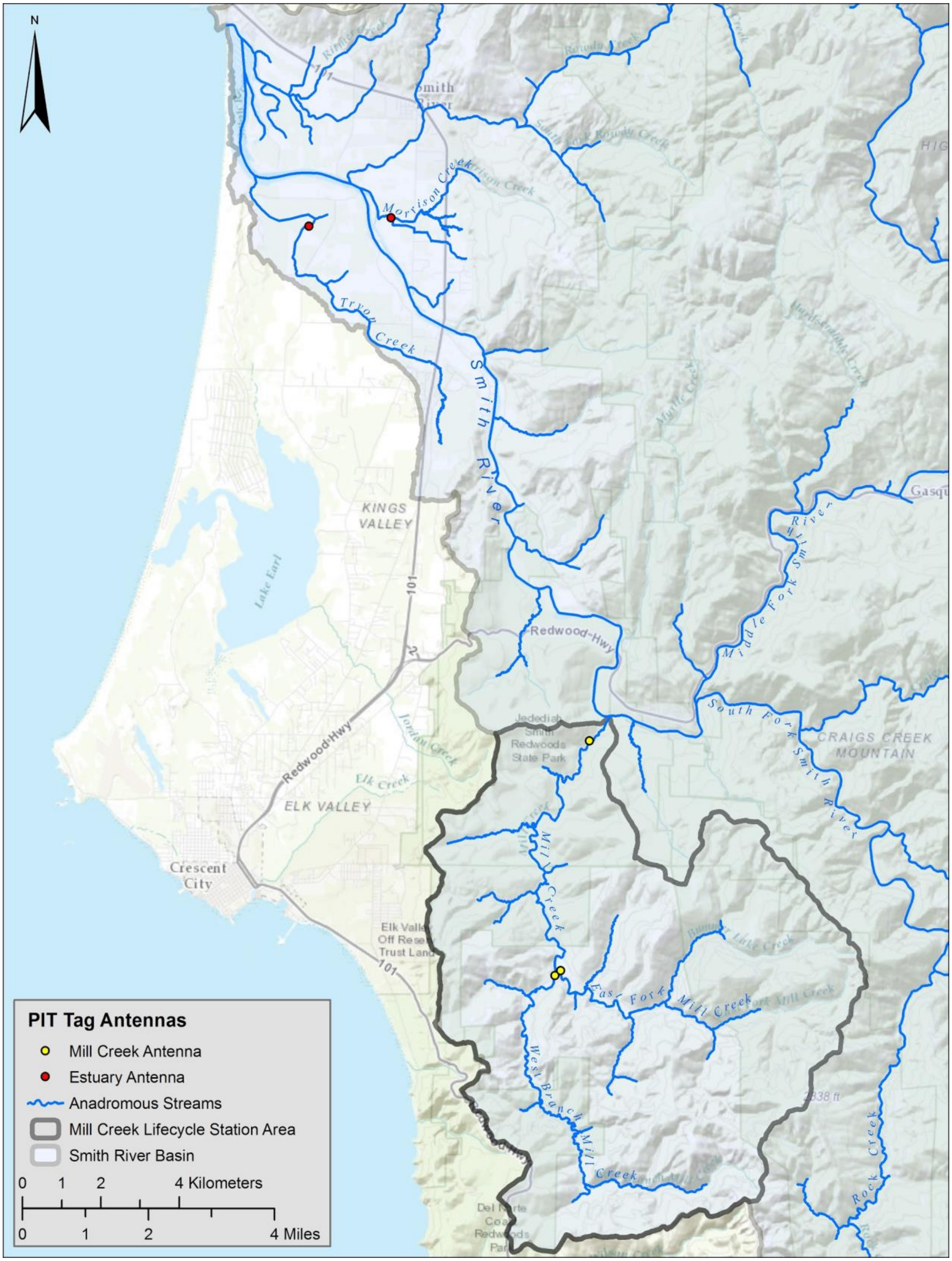


Figure 2. Passive Integrated Transponder antenna locations throughout Mill Creek and estuary tributaries, Smith River Basin, Del Norte County, CA.

(2010), all Coho Salmon 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 and 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 CDFW during the previous fall were measured and weighed to the nearest 0.1g. Genetic samples were taken from healthy fall-tagged individuals. Recaptured fall-tagged fish were included in the upstream weekly batch clip release groups (see *Outmigrant Smolt Abundance Estimates* below) to determine trapping efficiency and smolt abundance estimation when smolt catches were low.

Lamprey were identified to species and classified to life stage, measured and released downstream of the trap. During 2015 and 2016 trapping crews scanned adult Pacific Lamprey for PIT tags and applied PIT tags to untagged individuals. Non-anadromous fish and amphibians were identified to species. A representative subsample was measured to the nearest mm and all fish were released at multiple locations downstream of the trap to avoid predator habituation.

Outmigrant 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 et al. 1990, Prentice et al. 1994) and received a fin clip. The goal was to deploy PIT tags across the spring Coho Salmon outmigration season. These individually tagged fish were used to track movement and distribution and to estimate marine survival and adult abundance when recaptured as adults on the PIT tag antenna arrays and on spawning surveys by partner projects. The fin clip from each individual tagged with a PIT tag was preserved and deposited into the CDFW'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 seven days before switching to another one, allowing a gap of 3 weeks between each tag group. Dates of weekly clip groups for each season are provided in Appendices B-E. During periods of high smolt abundance, additional Coho Salmon smolts were marked only with fin clips. Rotating fin clips allowed for weekly estimates of trap efficiency and salmonid abundance. Following tagging and/or marking, fish were held in flow-through live cars to allow provide recovery time and to check for handling/marking mortality before being released upstream of the trap. Releases occurred at rotating sites between one and three pool/riffle complexes upstream of the trap to minimize predator habituation. The same marking methodology was followed for steelhead and Coastal Cutthroat Trout pre-smolts and smolts; however, none were tagged with PIT tags during 2014, 2015 and 2016. Mark-recapture of fin clips was broken into time intervals and bounded estimates of abundance were calculated for Coho Salmon, steelhead and Coastal Cutthroat Trout using DARR 2.0.2 (Bjorkstedt 2005, Bjorkstedt 2010) in program R (R development Core Team 2013). We used the single trap experiment with no *a priori* pooling of strata to generate abundance estimates.

Estimation of Apparent Overwinter Survival

We used Program MARK (White and Burnham 1999) 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 permanent emigration of marked individuals. The first occasion used in the CJS model was the initial PIT tagging (1). The second and third occasions occurred throughout the following spring and are represented in the analysis as captures at the rotary screw trap (2) and the mainstem Mill Creek PIT tag antenna (3), respectively.

To satisfy the Occasion 1 in the CJS model, field crews performed fish PIT tagging during the fall (Sept-Oct) in 2013, 2014, 2015 and 2016 when rearing fish were still associated with their summer rearing habitat. Crews sampled a stratified selection of pool habitats each year using beach seines throughout the East Fork, West Branch and in mainstem Mill Creek (2013 and 2014 only). All sampled habitats were above the outmigrant trapping site. Sampled portions of the West Branch and the East Fork extended from their mouths upstream and included much of main channel habitat utilized by rearing Coho Salmon. They measured and weighed Coho Salmon seined from pools and implanted them with PIT tags in each reach. Juvenile Coho Salmon were marked by surgical incision following the tagging methodology of Prentice et al. (1990). To minimize tag effects on juvenile Coho Salmon survival, size-at-tagging restrictions used for PIT tags of 12.0mm long × 2.12mm diameter weighing 0.1g in 2013 (≥63mm) were changed in 2014 as recommended by Peterson et al. (1994) to ≥ 65mm, and again in 2015 to ≥ 70mm as recommended by National Marine Fisheries Service.

We collected data for Occasion 2 in the CJS model by recapturing fall-tagged fish during daily operation of the rotary screw trap. We fulfilled the final occasion in the model, Occasion 3, through continuous operation of a PIT-tag monitoring antenna array located downstream of the outmigrant trapping station (Figure 1). This particular array features two channel-spanning pass-over (i.e. 'flat plate' style) antennas stapled to the substrate. Pass-through (i.e. vertical) antennas are at risk of damage from flood events in streams that routinely experience high annual precipitation totals like Smith River tributaries. As a tradeoff, our pass-over design sacrifices capture efficiency but allows for continuous operation during the wettest months, which is essential for detecting early redistribution and emigration.

In addition to the mainstem PIT tag antenna site, we operated channel-spanning PIT tag antennas at two more locations in Mill Creek and in two estuary tributaries. We used two pairs of antennas operated at the mouths of East Fork and West Branch Mill Creek (Figure 1) to assess year-round movement patterns of juvenile Coho Salmon (2013-2017). Likewise, CDFG installed and operated two antennas in tributaries to the lower Smith River (*hereafter* estuary antennas) (Figure 2) during 2015 and 2016 from which we obtained capture records of Coho Salmon tagged in Mill Creek. These additional antennas greatly helped strengthen our understanding of Coho Salmon winter redistribution and early emigration (i.e. fall or winter out-migration that precedes screw trap installment). Antennas were activated annually in the fall before the first rain events and operated through the following July. During high flow events, we operated the antennas to the maximum extent possible. All antennas experienced periods of malfunction during at least one season. We repaired and restored antenna function as soon as flows safely allowed. After each season, we assessed all antenna detection histories for fall-marked juvenile Coho Salmon to assess early and spring emigration life histories.

Database and Data Storage

We collected outmigrant trapping data using field computers (PDA's) with Pendragon Software forms populating CDFW Coastal Monitoring Program Aquatic Survey Program database (current version: 0.9.7.) (Burch et al., 2014). We fixed data fields in all PDA forms within specific ranges to minimize data entry error. We also ran standard QAQC queries in the database each day after PDA's were downloaded to correct any errors directly after surveys were completed. We backed up databases once a week and uploaded final annual data sets to the regional CDFW database server for long-term storage and retrieval.

Results

2014-2017 Mill Creek LCM Outmigrant Trapping Seasonal Summary

We installed and operated the RST in Mill Creek for four consecutive years from 2014 to 2017. CDFW led operations in 2014 and 2015 and the Smith River Alliance operated the RST in 2016 and 2017. We deployed the trap mid-March each year and operated through mid to late June with a season average of 97 trapping days (Table 1, Figure 3). On average, the trap was operational for 98% of the annual trapping period with an average of two in-operable days per season due to high flow events (Table 1). Storm events typically occurred early in the trapping season in March and April (Figure 3). Differences in annual spring storm events also influenced yearly spring discharge patterns. For example, 2017 experienced over twice as many spring storms than the other three years resulting in the highest flow variation. In contrast, 2015 and 2016 had few storms for the majority of both trapping seasons (Figure 3). However, the general trend each year was flows steadily declined throughout the trapping season. Water temperatures generally increased through the trapping season and ranged from 8.3 – 22.8°C (Table 1, Figure 4). Drought conditions were present during 2014 - 2016 and water temperatures increased more rapidly during these years than during 2017 (Figure 4).

Table 1. Summary data on trap effort with a rotary screw trap from 2014 – 2017 in Mill Creek, Smith River, Del Norte County, CA. Data includes installation, removal, operable and inoperable days, average and range of water temperature, and daily average and range discharge in cubic feet per second (cfs).

	Trapping Season			
OMT Parameter	**2014**	**2015**	**2016**	**2017**
Initiation Date	20-Mar	16-Mar	16-Mar	16-Mar
Completion Date	26-Jun	15-Jun	18-Jun	30-Jun
Season days	98	91	94	106
Operable Days	96	88	92	105
Operable %	98%	97%	98%	99%
Inoperable Days	2	3	2	1
Inoperable %	2%	3%	2%	1%
Mean Temp (°C)	12.5	12.5	13.2	12.0
Temp Range (°C)	8.4 - 18.0	8.3 - 19.4	9.0 - 19.0	8.0 - 18.9
Mean Discharge (cfs)*	2836	1736	2681	5066
Discharge Range (cfs)*	580 - 28664	451 - 15257	616 - 16428	783 - 19180
# Storm Events	7	5	6	16
Weir Panel Installation	1-May	1-May	3-April	5-May

**Discharge at Jed Smith USGS Smith River Gauging Station*

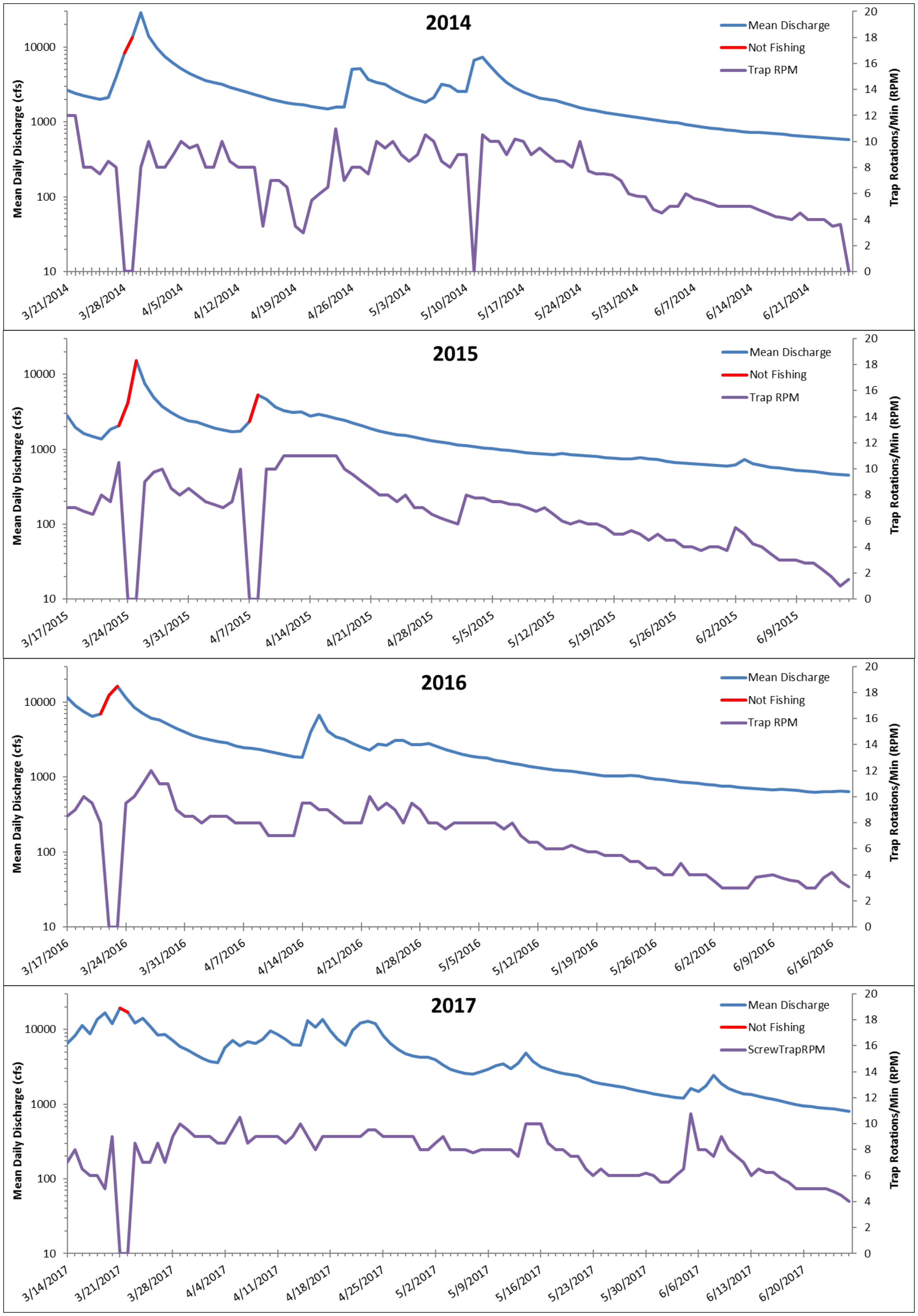


Figure 3. Daily Mill Creek rotary screw trap effort measured by trap cone rotations per minute (RPM) each morning and average daily discharge at the Jed Smith USGS gage station 2014-2017. Gaps in RPM indicate missing data while red lines in discharge indicate periods over which the trap was not fishing.

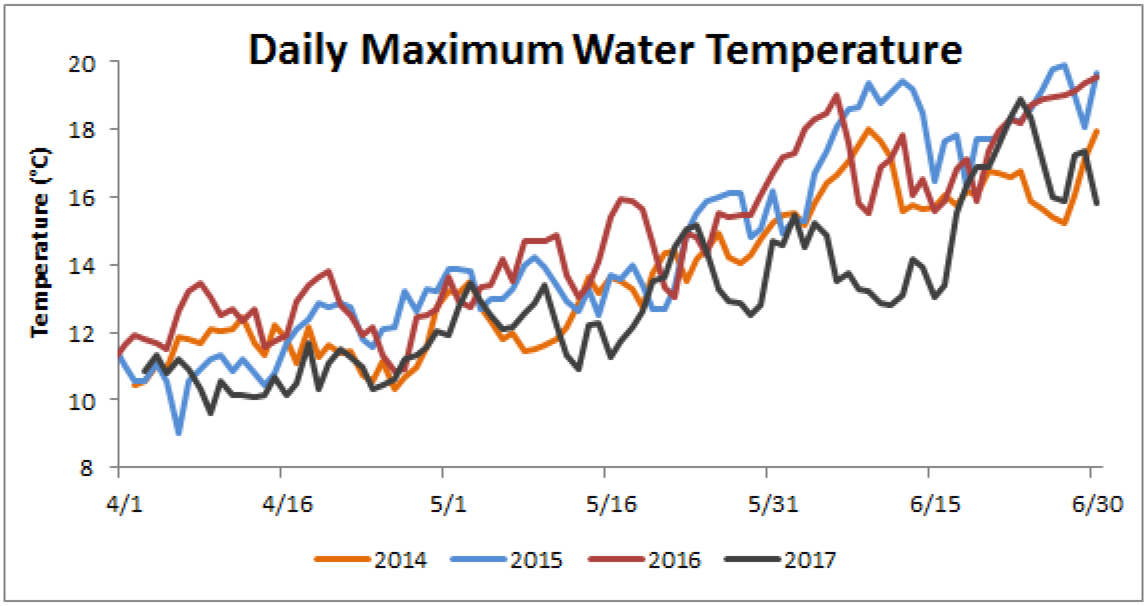


Figure 4. Daily maximum water temperatures at the Mill Creek rotary screw trap (RST) from 2014 - 2017.

Capture Summary

Overall, we captured a total of 265187 fish in the RST over the four seasonal trapping deployments. We captured four species of salmonids including Chinook Salmon, Coho Salmon, steelhead/coastal rainbow trout and Coastal Cutthroat Trout. Captures included 260437 individual salmonids, which comprised 98.5%, 97.1%, 98.5% and 98.5% of the total RST catch during 2014, 2015, 2016 and 2017 seasons, respectively (Table 2). Annual salmonid captures are summarized in Table 2. Non-salmonid captures, which comprised 1.8% of the cumulative catch, are summarized in Appendix A. Total catches were lowest during the 2014 season (13370 individuals) and highest during the 2016 season (125889 individuals) (Table 2).

We captured 224488 Chinook Salmon over the four trapping seasons. Chinook Salmon were the most numerous species captured during all four seasons and comprised 40-93% of the annual salmonid catch (Table 2). However, we only captured 5319 Chinook Salmon during the 2014 trapping effort, compared to 114801 in the 2016 effort. All but 19 (0.00008%) captured Chinook Salmon were young-of-the-year. We captured a total of 12207 unidentified trout over the four trapping seasons. Unidentified trout were the second most abundant salmonid captured after Chinook Salmon during the 2014 and 2017 seasons, comprising 24% and 3.6% of the annual salmonid catch respectively. Coho Salmon comprised 18% and 3.5% of the annual salmonid catch during these same two years. Conversely, during 2015 and 2016, Coho Salmon were the second most abundant salmonid in the RST catch, followed by unidentified trout. We captured 11999 Coho Salmon over the four trapping seasons, including 9466 Coho Salmon smolts, 2506 Coho Salmon YOY and 27 one plus parr. Coho Salmon smolts comprised 1.8-16.6% while Coho Salmon YOY comprised 0.7-2.0% of the annual salmonid catch. Steelhead comprised 1.4-11.0% of the annual RST salmonid catch. Of the 7652 total steelhead captured between 2014 and 2017, we captured the fewest in 2014 (1464 individuals) and the most in 2015 (2579 individuals). We only identified one coastal rainbow trout (resident adult). This 392mm individual lacked parr marks, was heavily spotted and lacked the silvery hue of an anadromous

Table 2. Total numbers of salmonids captured (Cap), marked with fin clips (M) and recaptured (RC) in the Mill Creek outmigrant rotary screw trap from March through June, 2014-2017.

	Stage	2014			2015			2016			2017		
Common Name		Cap [a]	M	RC	Cap	M	RC	Cap	M	RC	Cap	M	RC
Coho Salmon	YOY	266	0	0	383	0	0	1158	0	0	699	0	0
	1+ Parr	15	0	0	1	1	1	8	0	0	3	0	0
	Smolt	2188	1664	574	3529	1982	897	2207	1639	521	1542	1066	273
Steelhead	1+ Parr	1144	0	0	2017	1	0	1337	0	0	1576	0	0
	Smolt	320	74	22	561	436	96	415	404	109	281	267	18
	Adult	0	0	0	1	0	0	0	0	0	0	0	0
Coastal Rainbow Trout	Resident	0	0	0	1	0	0	0	0	0	0	0	0
Coastal Cutthroat Trout	1+ Parr	614	1	0	584	35	8	455	0	0	505	15	0
	Smolt	113	40	13	853	502	122	282	246	33	576	543	62
	Adult	13	1	0	2	0	0	4	0	0	3	0	0
	Resident	11	1	0	25	8	1	19	0	0	18	8	0
Unidentified Trout	YOY	1745	0	0	1139	0	0	2366	0	0	1025	0	0
	1+ Parr	1403	0	0	2238	0	0	975	0	0	1316	0	0
Chinook Salmon	YOY	5309	0	0	47397	0	0	114796	0	0	56967	0	0
	1+	10	1	1	2	1	1	5	0	0	2	0	0
Unidentified Salmonid	YOY	13	0	0	0	0	0	0	0	0	0	0	0

[a] *Captures include mortalities and individuals marked with fin clips but exclude recaptured fin clipped fish.*

steelhead. Coastal Cutthroat Trout comprised 0.6% to 5.7% of the annual salmonid catch during 2014-2017. We captured fewer Coastal Cutthroat Trout in 2014 (751 individuals) and 2016 (760 individuals) than during 2015 (1464 individuals) and 2017 (1102 individuals) (Table 2). We strived to avoid incidental captures of adult anadromous fishes and non-target species by maintaining small migration routes around the RST. Over the four years of this study, we captured one adult steelhead on May 08, 2015 and 66 adult Pacific Lamprey, with the highest lamprey catch (28 individuals) occurring in 2017 (Appendix A). Although few Klamath Smallscale Suckers were captured during 2014, suckers were the most abundant non-salmonid fish in the RST from 2015 to 2017 (Appendix A). Other non-salmonid fishes, including Coast Range Sculpin, Prickly Sculpin and three-spined stickleback, were minor components of seasonal trap catches (Appendix A).

2014-2017 Coho Salmon

Coho Salmon Spring Outmigrant YOY

We captured a total of 2506 Coho Salmon YOY in the RST over the four trapping seasons. We did not perform a mark-recapture experiment with Coho Salmon YOY and thus only report counts of captured individuals. Captures of Coho Salmon YOY were lowest during the 2014 trapping season (204 individuals) and highest during the 2016 spring trapping season (607 individuals) (Table 2). We encountered Coho Salmon YOY during all months of trap operation, except March of 2014 (Figure 5, Appendix F). The mean capture date for Coho Salmon YOY was April 22 across the four years. The mean capture date for Coho Salmon YOY in 2014 was May 8 while in 2015, 2016, and 2017 it was much earlier: April 23 (2015), April 16 (2016) and April 22 (2017), respectively (Figure 5). Multiple Coho Salmon YOY migration peaks occurred in 2015, 2016 and 2017 while only one peak occurred in 2014 (Figure 5). Daily counts of Coho Salmon YOY appeared to increase around or shortly after individual spring storm events but also likely reflect protracted emergence from redds during March and April (Figure 5). Mean fork length for Coho Salmon YOY across the four trapping years was 37mm (Appendix F). Coho Salmon YOY captured during March and April of each year were between 27mm and 59mm while those captured in May and June were between 52mm and 70mm. Many Coho Salmon YOY encountered during March and April still had visible yolk sacs. Mean fork length of Coho Salmon increased across each season (Appendix F), but newly emerged Coho Salmon fry were also captured during May in all years and even during June in 2017.

Coho Salmon Spring Outmigrant Smolts

We captured Coho Salmon smolts throughout each trapping season over the four years with an overall peak capture date (average) of May 11 (Figure 5, Appendix G). Mean annual capture dates were similar between years including May 12, May 10, May 9, and May 16 in 2014, 2015, 2016 and 2017, respectively (Figure 5). Distinct migration pulses occurred between April and early June of each season. We detected three distinct pulses in 2014, 2015, and 2016, but only one protracted peak during 2017 (Figure 5). Overall mean length and weight of Coho Salmon smolts was 104.3mm and 12.7g over the four trapping seasons. Both mean seasonal length and weight of Coho Salmon smolts were lowest during the 2015 season (Appendix G). Mean seasonal length was 106.4mm in 2014, 101.8mm in 2015, 104.5mm in 2016 and 104.4mm in 2017. Mean seasonal weight was 13.4g in 2014, 11.8g in 2014, 13.1g in 2016 and 12.6g in 2017.

In 2014, we captured 2188 Coho Salmon smolts in the RST and 1659 were marked with fin clips and released upstream of the RST. Fifteen distinct fin clip strata were released upstream of the RST (Appendix B). Five Coho Salmon smolts were fin clipped and passed downstream of the RST and were treated as unmarked fish when estimating spring smolt abundance. We recaptured 574 of the available 1659 clipped fish (Table 2). In addition to the fin clipping fish, we tagged 1612 Coho smolts with PIT tags. These individuals were tagged to track their movement and distribution and to estimate marine survival of returning adults. Using DARR, we estimated 7416 (SE= 426) Coho Salmon smolts emigrated from Mill Creek between March 21 and June 26, with lower and upper 95% confidence intervals ranging from 6580 - 8251 smolts (Figure 6).

Estimated capture efficiency for marked Coho Salmon smolts averaged 29% across the season (min= 11%, max= 58%) (Figure 6).

In 2015, we captured 3529 Coho Salmon smolts in the RST and 1908 were marked with fin clips and released upstream of the RST. Thirteen distinct fin clip strata were released upstream of the RST (Appendix C). Seventy-four captured Coho Salmon smolts were fin clipped in order to obtain genetic samples before being passed downstream of the RST and were treated as unmarked fish when estimating spring smolt abundance. We recaptured 987 of the available 1908 clipped Coho Salmon smolts (Table 2). In addition to the fin clipping fish, we tagged 1499 Coho Salmon smolts with PIT tags. The DARR mark-recapture estimated 8195 (SE= 435) Coho Salmon smolts emigrated from Mill Creek between March 16 and June 15, with lower and upper 95% confidence intervals ranging from 7342 - 9047 smolts (Figure 6). Estimated capture efficiency for marked Coho Salmon smolts averaged 35% across the season (min= 12%, max= 86%) (Figure 6).

In 2016, we captured 2207 Coho Salmon smolts, in the RST and 1636 were marked with fin clips and released upstream of the RST. Fourteen distinct fin clip strata were released upstream of the RST (Appendix D). We excluded five Coho Salmon smolts for which clip status could not be determined from the DARR mark-recapture experiment. Three Coho Salmon smolts were fin clipped and passed downstream of the RST and were treated as unmarked fish when estimating spring smolt abundance. We recaptured 521 of the available 1636 clipped Coho Salmon smolts (Table 2). In addition to fin clipping fish, we tagged 1178 Coho Salmon smolts with PIT tags. The DARR mark-recapture estimated 7567 (SE= 439,) Coho Salmon smolts emigrated from Mill Creek between March 16 and June 18, with lower and upper 95% confidence intervals ranging from 6706 - 8427 smolts (Figure 6). Estimated capture efficiency for marked Coho Salmon smolts averaged 30% across the season (min= 12%, max= 82%) (Figure 6).

In 2017, we captured 1542 Coho Salmon smolts in the RST and 1065 were marked with fin clips and released upstream of the RST. Fifteen distinct caudal fin clip strata were released upstream of the RST (Appendix E). One Coho Salmon smolt was fin clipped in order to collect a genetic sample and was passed downstream of the RST and was treated as an unmarked individual when estimating spring smolt abundance. We recaptured 273 of the available 1542 clipped Coho Salmon smolts (Table 2). In addition to fin clipping fish, we tagged 510 Coho Salmon smolts with PIT tags. The DARR mark-recapture estimated 9383 (SE= 1548) Coho Salmon smolts from Mill Creek between March 16 and June 30 with lower and upper 95% confidence intervals from 6349 - 12418 smolts (Figure 6). Estimated capture efficiency for marked Coho Salmon smolts averaged 20% across the season (min= 5%, max= 42%) (Figure 6).

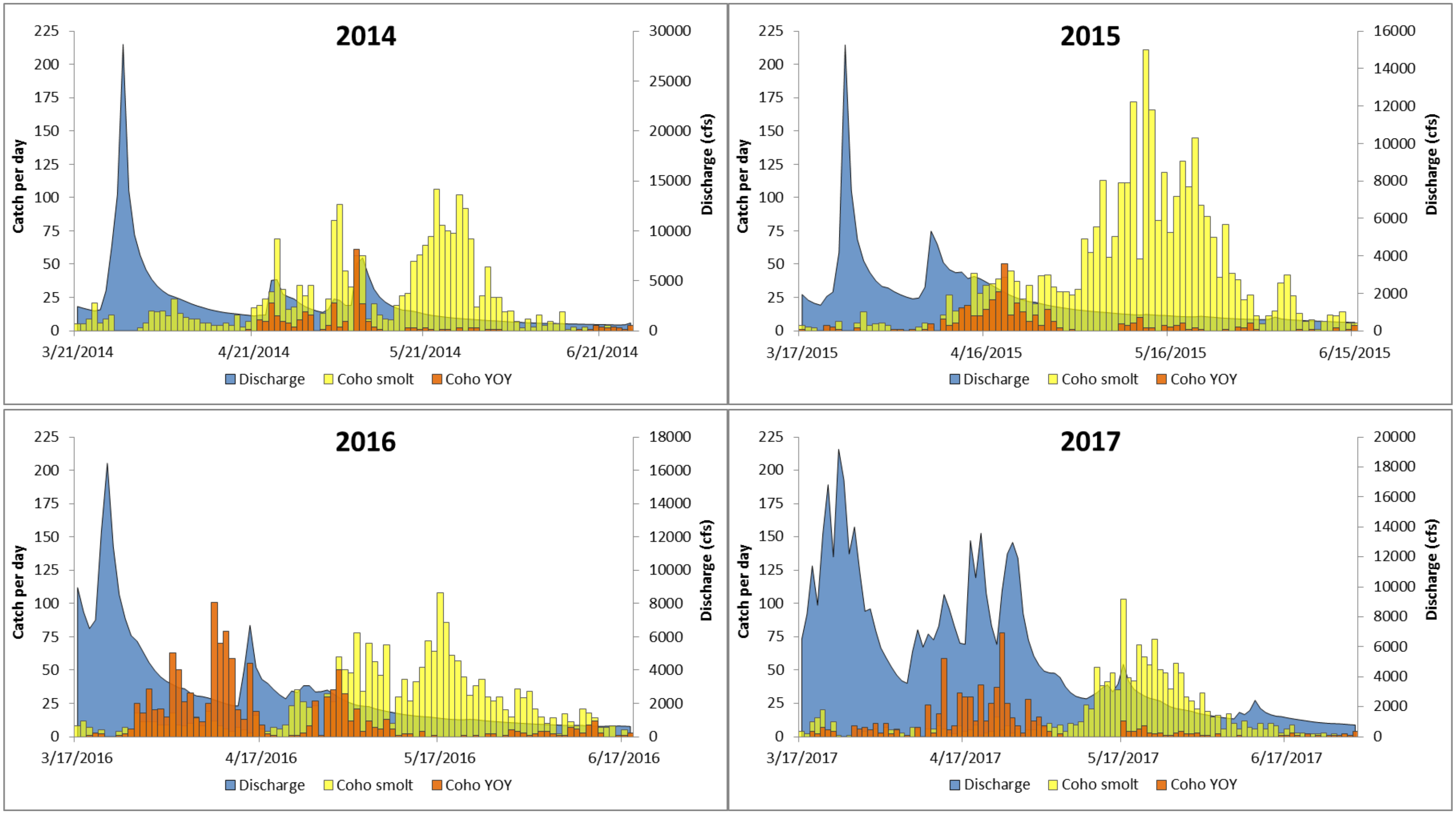


Figure 5. Daily catch of Coho Salmon smolts (yellow) and Young of the Year (YOY) (orange) age classes at the rotary screw trap in Mill Creek, Smith River, CA, during four years of operation from 2014 – 2017. Graph includes daily maximum mean discharge measured in cubic feet per second (cfs) by USGS Jed Smith stream gage (#11532500) (USGS 2017).

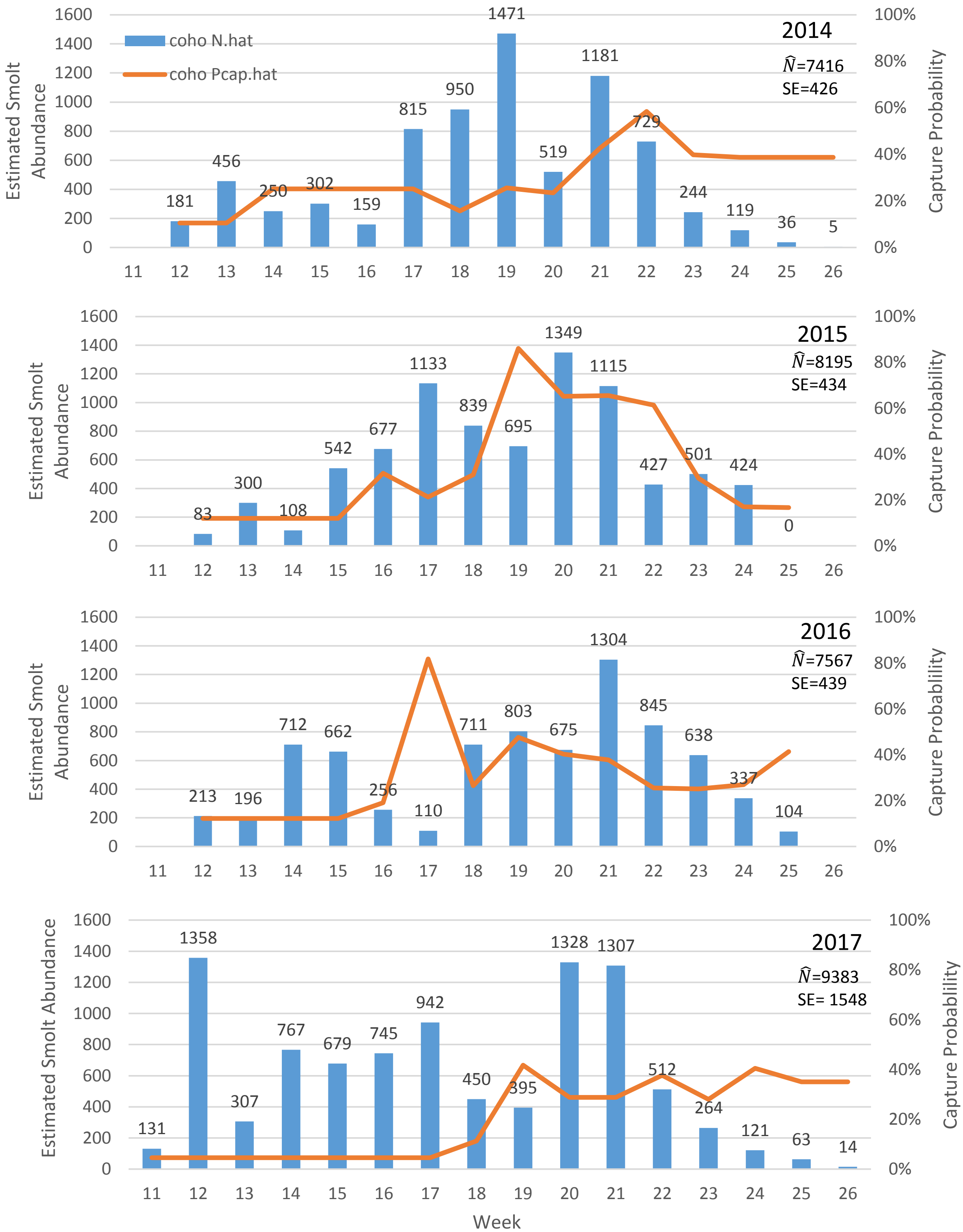


Figure 6. DARR estimates of Coho Salmon smolt abundance for each weekly marking strata at the Mill Creek outmigrant trap between March 16, 2014 and June 30, 2017, Smith River basin, CA.

Coho Salmon 'Apparent' Overwinter Survival

Cormack-Jolly-Seber (CJS) mark-recapture models allow for the estimation of 'apparent' survival of a marked population while accounting for imperfect detection. In this research, survival is referred to as 'apparent' instead of 'true' survival because CJS models cannot separate estimates of mortality from permanent emigration from the study area. Since our marked population in Mill Creek was 'open' (i.e. Coho Salmon can emigrate permanently from the study area) our estimates are 'apparent' overwinter survival.

We marked 4152 total juvenile Coho Salmon with PIT tags (2013-2016) each fall preceding the four years of outmigrant trapping (2014-2017). Individuals were typically marked between September 16 and October 22. However, due to uncommon early and consistent storms in 2016, we tagged an additional 141 individuals on November 10th to increase the tag group size. We marked the largest number of individuals in 2013, the first year of this survey effort (Table 2). We marked the fewest number of individuals in 2016 due to early and consistent rains beginning October 13 (USGS 2017) which prevented continued tagging efforts.

We used Program MARK (White and Burnham 1999) to analyze the mark-recapture data with three-occasion CJS models to estimate the 'apparent' survival probabilities for juvenile Coho Salmon in East Fork, West Branch and mainstem Mill Creek. During the four years of sampling, total 'apparent' overwinter survival throughout the Mill Creek basin ranged from 6.0 – 12.8% (Table 4). Annual separated sub-basin models estimated 'apparent' overwinter survival for West Branch Mill Creek to range from 4.2-12.9% and East Fork Mill Creek from 7.2-14.5%. For the two survey years we tagged Coho Salmon in lower mainstem Mill Creek, 'apparent' overwinter survival ranged from 3.5-6.3%.

There was no consistency across all years among apparent overwinter survival estimates of each sub-basin. However, for three of the four year's, survival was higher in the East Fork when compared the West Branch (Table 4). 'Apparent' overwinter survival estimates from all four years in Mill Creek are lower than those estimated by other studies in nearby basins, such as Prairie Creek and Freshwater Creek (Rebenack et al. 2015, Sparkman et al. 2015, Ricker and Anderson 2011).

Coho Salmon life-history diversity

To assess differences in Coho Salmon life history patterns throughout Mill Creek, we defined various movement patterns observed in the population and quantified the individuals expressing each pattern. We defined all fall-tagged individuals detected emigrating from Mill Creek at the mainstem antennas *before* the installation of the rotary screw trap near mid-March were considered "early emigrants'; individuals detected emigrating from Mill Creek at the mainstem antennas *or* the migrant trap after its installation were considered 'spring emigrants'. Start dates each year for migrant trapping were March 21 in 2014 and March 17 in 2015-2017. Additionally, we detected individuals exhibiting movements within the basin at antennas near the East Fork and West Branch confluence (see Figure 1) before trap installation. Extreme variation in the timing and direction of Coho Salmon redistribution within Mill Creek made it challenging to define specific movement patterns. Hereafter, these individuals are generally referred to as 'early local migrants'.

Over four years of recapturing fall-tagged Coho Salmon, we detected 472 (11.1%) of the 4237 PIT tagged fish in Mill Creek on at least one antenna during the early emigration period. During the first two years before estuary antennas were installed, 5.6% of the tagged Coho Salmon (157 out of 2827) were captured early while 11.1% of tagged fish (157 out of 1410) were detected early after installation (Table 3). While some of these detections include individuals moving between the two tributaries (i.e., East Fork and West Branch) (25.8%) or upstream from the mainstem Mill Creek into a tributary (19.1%), the majority of the detected individuals (55.1%) exhibited downstream movement. (Table 3, Figure 7).

We quantified Mill Creek antenna detections of Coho Salmon tagged in the East Fork and West Branch showing that an annual average of 20.6% of the fish detected early migrated out of the Mill Creek basin, ranging from 15.2% - 26.2% (Figure 8). Due to design limitations at the mainstem Mill Creek antenna, there was limited vertical read range across the channel, especially during high winter flow events. Therefore, these percentages represent a minimum for the percentage of the early emigrants migrating out of Mill Creek. However, the two estuary antennas installed in 2015 had nearly 100% detection rates and greatly increased our ability to detect individuals expressing early emigration from Mill Creek during the last two years of sampling. By adding detections at estuary antennas after they were installed in 2015, an average of 56.9% of the early emigrants migrated out of the Mill Creek basin, ranging from 46.5% - 67.3%. Furthermore, based on detections at estuary antennas, an average of 46.2% of early emigrants migrated into estuary tributaries, ranging from 34.9% - 57.5% (Table 3, Figure 8). The high percentage of individuals detected at the estuary antennas during these two years suggests that early emigrants were more common than reported for 2013-14 and 2014-15 seasons lacking the two estuary antennas (Figure 8).

While a range of 46.4 - 82.3% of the detected early emigrants moved downstream at minimum into mainstem Mill Creek, not all early emigrants migrated in a downstream fashion. Rather, an average of 17.7% - 42.9% of early emigrants last winter detected movement was from the East Fork into the West Branch, or vice versa (Figure 8). These detections show that movements into proximal basins of similar size with similar habitats occur during freshwater winter rearing period.

Table 3. Detection and movement summaries of mark-recapture efforts for four cohorts of juvenile Coho Salmon in Mill Creek (2013-2016). 'Coho detection site' values represent raw counts of individual Coho Salmon tagged in each sub-basin detected at each site. 'Early Coho Salmon movement' values represent raw counts of individuals detected at antennas before spring migration as they redistributed among sub-basins or emigrated early from Mill Creek. While examining count data may be useful, analyzing detection counts from PIT tag antennas should be exercised with caution as totals will not account for missed fish (i.e. antenna detection is imperfect). The counts below may not be proportional to the true movements within the population. Rather, these numbers represent the minimum number of detected individuals at each location.

Year	Mill Creek Sub-basin:	Main Stem Mill Creek	West Branch Mill Creek	East Fork Mill Creek	Mill Creek (Total)
2013 - 14	**Individually tagged Coho Salmon**	477	493	472	1442
	Coho Detection site:				
	Mainstem antennas† (Nov 1-Mar 14)	19	6	4	29
	Mainstem antennas (Mar 15-Jun 15)	6	11	18	35
	Screw trap recaptures (Mar 15-Jun 15)	5	19	19	43
	Total overwinter survivors (Mar 15-Jun 15)	10	22	27	59
	Early Coho Movements From Tagging Reach:				
	To East Fork (Nov 1 - Mar 14)	14	7	-	21
	To West Branch (Nov 1 - Mar 14)	41	-	16	57
	To Mainstem Mill Creek (Nov 1 - Mar 14)	-	36	22	58
	Out of Mill Creek† (Nov 1 - Mar 14)	19	6	4	29
2014 - 15	**Individually tagged Coho Salmon**	368	550	467	1385
	Coho Detection Site:				
	Mainstem antennas† (Nov 1-Mar 14)	7	8	8	23
	Mainstem antennas (Mar 15-Jun 15)	6	12	24	42
	Screw trap recaptures (Mar 15-Jun 15)	7	37	42	86
	Total overwinter survivors (Mar 15-Jun 15)	10	45	50	103
	Early Coho Movements From Tagging Reach:				
	To East Fork (Nov 1 - Mar 14)	0	2	-	2
	To West Branch (Nov 1 - Mar 14)	5	-	18	23
	To Mainstem Mill Creek (Nov 1 - Mar 14)	-	22	25	47
	Out of Mill Creek† (Nov 1 - Mar 14)	7	8	8	23
2015 - 16	**Individually tagged Coho Salmon**	0	406	415	821
	Coho Detection Site:				
	Mainstem antennas† (Nov 1-Mar 14)	-	6	7	13
	Estuary antennas† (Nov 1-Mar 14)	-	24	43	67
	Mainstem antennas (Mar 15-Jun 15)	-	9	14	23
	Screw trap recaptures (Mar 15-Jun 15)	-	24	19	43
	Total overwinter survivors (Mar 15-Jun 15)	-	30	26	56
	Early Coho Movements From Tagging Reach:				
	To East Fork (Nov 1 - Mar 14)	-	5	-	5
	To West Branch (Nov 1 - Mar 14)	-	-	21	21
	To Mainstem Mill Creek (Nov 1 - Mar 14)	-	17	30	47
	Out of Mill Creek† (Nov 1 - Mar 14)	-	6	7	13
	To Estuary† (Nov 1 - Mar 14)	-	24	43	67
2016 - 17	**Individually tagged Coho Salmon**	0	301	288	589
	Coho Detection Site:				
	Mainstem antennas† (Nov 1-Mar 14)	-	2	3	5
	Estuary antennas† (Nov 1-Mar 14)	-	13	6	19
	Mainstem antennas (Mar 15-Jun 15)	-	3	5	8
	Screw trap recaptures (Mar 15-Jun 15)	-	8	14	22
	Total overwinter survivors (Mar 15-Jun 15)	-	9	16	25
	Early Coho Movements From Tagging Reach:				
	To East Fork (Nov 1 - Mar 14)	-	2	-	2
	To West Branch (Nov 1 - Mar 14)	-	-	10	10
	To Mainstem Mill Creek (Nov 1 - Mar 14)	-	10	13	23
	Out of Mill Creek† (Nov 1 - Mar 14)	-	2	3	5
	To Estuary† (Nov 1 - Mar 14)	-	13	6	19

†Early detections here represent early emigrants from Mill Creek

Table 4. 'Apparent' overwinter survival estimates of juvenile Coho Salmon using Program MARK (White and Burnham 1999). Estimates represent the probability an individual did not emigrate early and survived through winter. Survival estimates and confidence intervals from Cormack-Jolly-Seber models for each year of the study.

Mill Creek Sub-basin:	**Main Stem Mill Creek**	**West Branch Mill Creek**	**East Fork Mill Creek**	**Mill Creek (Total)**
Estimated 'apparent' overwinter survival (2013-14)	2.8%	6.3%	7.3%	5.5%
95% Confidence Interval	(1.4 – 5.4%)	(3.9 – 10.1%)	(4.8 – 11.0%)	(4.0 – 7.5%)
Estimated 'apparent' overwinter survival (2014-15)	3.5%	11.7%	14.5%	10.4%
95% Confidence Interval	(1.8 - 6.5%)	(8.1 - 16.5%)	(10.5 - 19.7%)	(8.0 – 13.5%)
Estimated 'apparent' overwinter survival (2015-16)	*n/a*	15.4%	10.8%	13.1%
95% Confidence Interval	*n/a*	(78.5 – 26.4%)	(6.2 - 18.1%)	(7.9 – 20.8%)
Estimated 'apparent' overwinter survival (2016-17)	*n/a*	4.2%	7.8%	6.0%
95% Confidence Interval	*n/a*	(1.9 - 8.9%)	(4.1 - 14.6%)	(3.3 - 10.4%)

Overwinter Growth Rates

Daily overwinter growth rates were summarized using fall tagged Coho Salmon that were captured subsequently as smolts in the rotary screw trap during the subsequent spring. Coho Salmon originally captured and tagged in the West Branch Mill Creek and East Fork Mill Creek grew more on average than those tagged in the lower mainstem Mill Creek, with the West Branch having the highest growth rates over the four years (Table 5, Figure 9). Overall growth rates were similar among years except during the winter of 2015-2016 where fish grew substantially larger on average (Figure 9). Because we only marked fish in the lower mainstem for two years, we cannot test for differences among the three basins across four years. However, the overall pattern indicates West Branch Mill Creek consistently had the highest average growth rates and the two tributaries had higher growth rates than the lower mainstem.

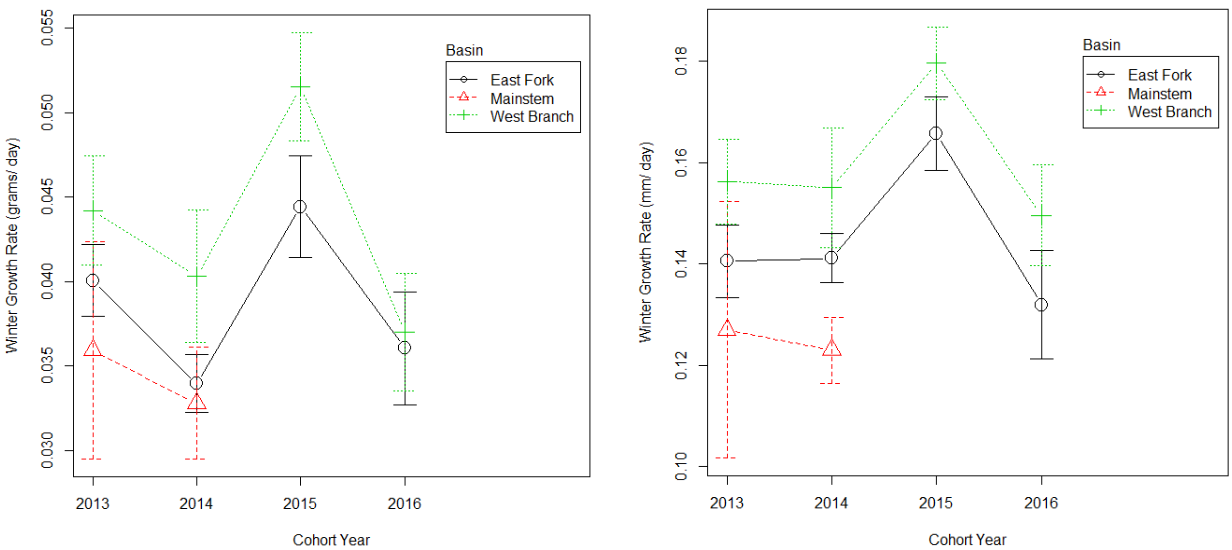


Figure 7. Mean overwinter growth rate of juvenile Coho Salmon marked during the fall and recaptured during the spring among three reaches of Mill Creek, Smith River, Del Norte County, California. We collected four years of data for the West Branch and East Fork (2013-2016) and two years for the lower Mainstem Mill Creek (2013-2014). Panel A represents mean daily growth in weight and Panel B represents mean daily growth rate in length. Error bars represent ± one standard error.

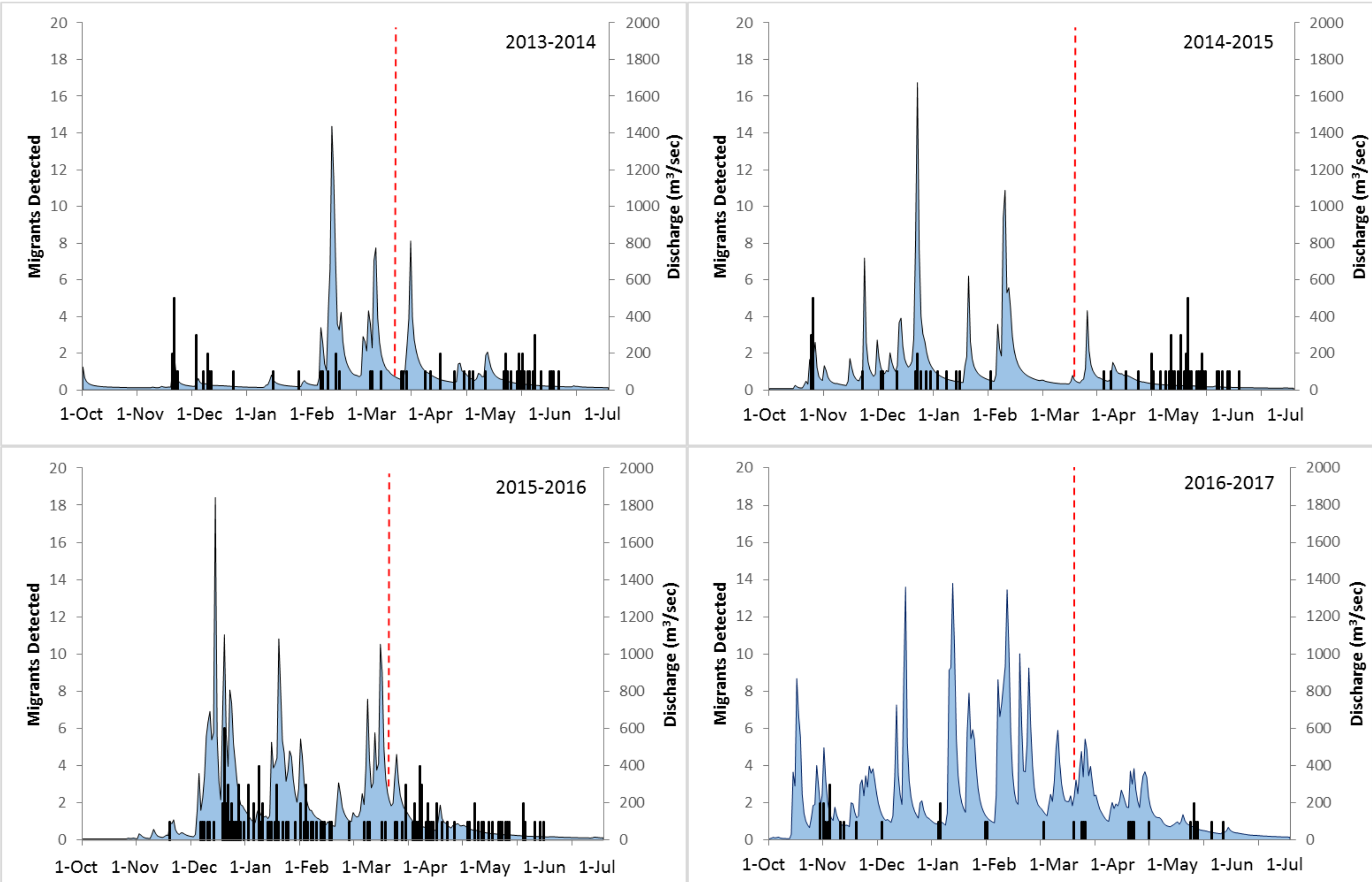


Figure 8. Detections of fall marked Coho Salmon at antennas located throughout the Mill Creek sub-basin and Smith River estuary across four years of operation. Dotted red line in each panel represents the end of our described Coho Salmon early immigration period and near the annual rotary screw trap installation date. Annual Smith River hydrographs are displayed in blue within each panel.

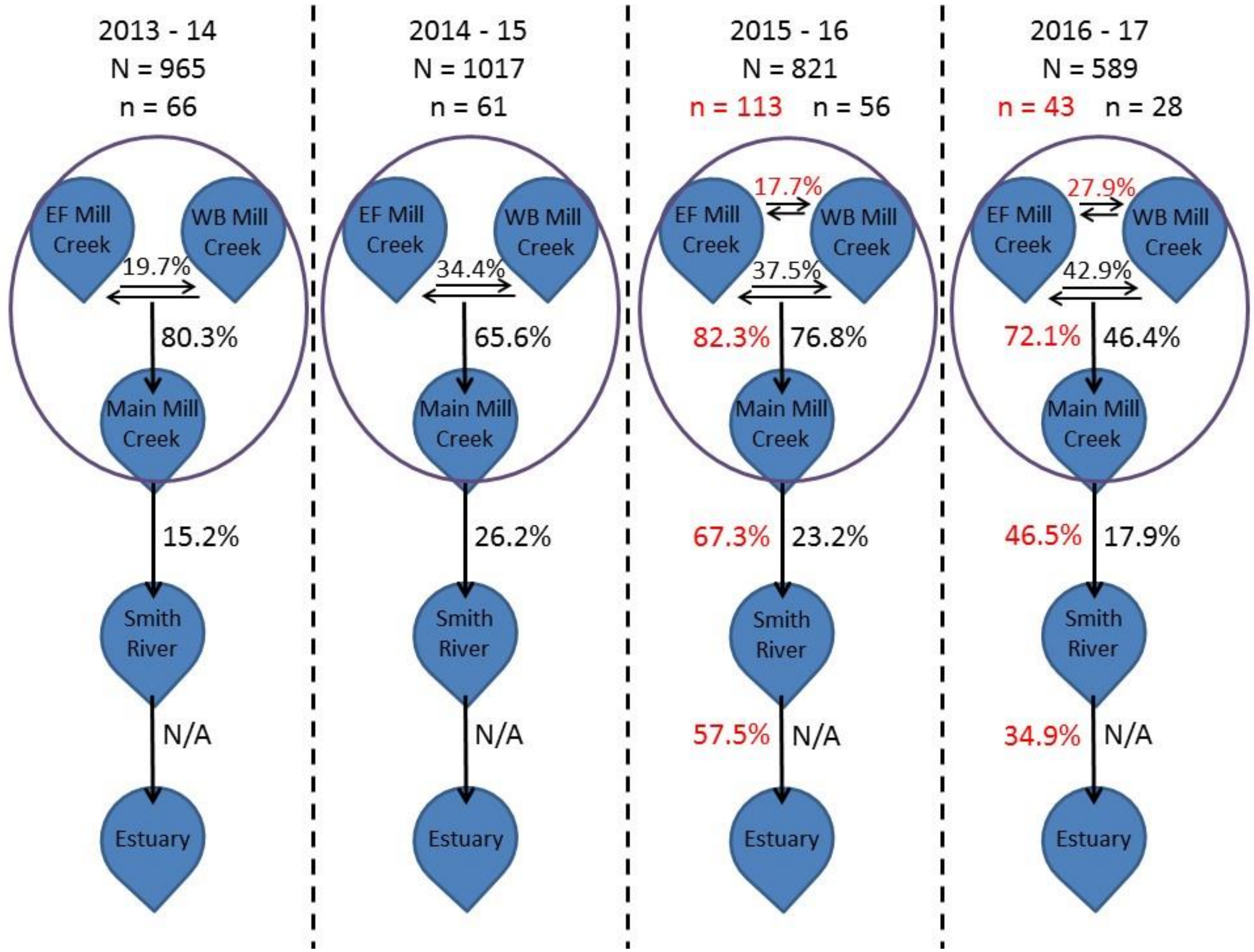


Figure 9. Diagram presenting early emigration patterns of PIT tagged Coho Salmon marked in East Fork Mill and West Branch Mill each fall in 2013-2017. *N* is the total number of individuals tagged each year and *n* is the number of unique individuals detected on antennas throughout Mill Creek as "early migrants" (i.e. detected *anywhere* before March 14). Each blue raindrop represents a sub-basin which fish can enter by passing through PIT tag antennas. The arrows designate a movement from one sub-basin to another. Percentages are the proportion of the early migrants (*n*) detected entering each sub-basin by March 14. Black percentages are based on detections of fish at antennas in the Mill Creek basin only. Red percentages include additional detections of fish at antennas installed in the estuary for the final two years. The difference in red and black values in years 3 and 4 highlights the value in monitoring Coho Salmon in the estuary. The additional estuary sites facilitated better detection of early emigrants and showed that monitoring populations outside their natal streams can significantly enhance our evaluation of fish movement and survival.

Table 5. Mean overwinter growth rate of juvenile Coho Salmon marked during the fall and recaptured during the spring among three reaches of Mill Creek, Smith River, Del Norte County, California. We collected four years of data for the West Branch and East Fork (2013-2016) and two years for the lower Mainstem Mill Creek (2013-2014).

Reach	Individuals	Mean Growth/Day (mm/day)	Standard Deviation Growth/Day	Mean Specific Growth (%/day)
2013-14				
East Fork Mill	18	0.146	0.027	0.166
West Branch Mill	19	0.154	0.030	0.171
Mainstem Mill	5	0.127	0.057	0.133
2013 Total	42	0.148	0.033	0.164
2014-15				
East Fork Mill	42	0.146	0.025	0.170
West Branch Mill	37	0.153	0.037	0.182
Mainstem Mill	7	0.123	0.017	0.134
2014 Total	86	0.147	0.031	0.172
2015-16				
East Fork Mill	17	0.166	0.030	0.183
West Branch Mill	23	0.180	0.035	0.193
Mainstem Mill	NA	NA	NA	NA
2015 Total	40	0.174	0.033	0.189
2016-17				
East Fork Mill	10	0.132	0.032	0.143
West Branch Mill	8	0.150	0.026	0.164
Mainstem Mill	NA	NA	NA	NA
2016 Total	18	0.140	0.031	0.152

2014-2017 Steelhead Trout

Steelhead Trout Spring Outmigrant Abundance and Migration Characteristics

We captured 6071 1+ parr, 1577smolts and one anadromous adult steelhead trout in the RST across the four seasons (Table 2, Figure 10, Appendices H-I). We captured the most steelhead 1+ parr during the 2017 trapping effort and the fewest during the 2014 trapping effort (Table 2, Appendix H). Because we did not carry out a mark-recapture experiment on steelhead 1+ parr, we present only unexpanded trapping counts. Catches of steelhead 1+ parr were higher during the latter half of each trapping season and peaked after steelhead smolts (Figure 10).Overall mean capture date for steelhead 1+ parr across seasons was May 13, with seasonal mean capture dates ranging from between May 6 and May 22 (Appendix H). Monthly mean length of steelhead 1+ parr was similar across seasons and years (Appendix H). Mean capture date for steelhead smolts was between April 6 and April 11 during all four years (Appendix I). Mean monthly length was highest in March during 2015-2017. During 2014, monthly mean length of steelhead smolts was high during March, however, catches in June included some of the largest individuals.

A total of 320 steelhead smolts were captured in the RST during the 2014 trapping season (Table 2, Figure 10). Of these steelhead captures, 74 were marked with caudal fin clips and were released upstream of the RST. Nine distinct clip strata were released over the trapping season (Appendix B). RST steelhead smolt catch tapered off sharply after May 5th. Twenty-two (30%) of these fin clipped steelhead smolts were recaptured over the season. The DARR mark-recapture experiment estimated 1075 (SE= 194) steelhead smolts emigrated out of Mill Creek during the 2014 trapping season (Figure 11). Lower and Upper 95% confidence intervals were 695 - 1456 steelhead smolts. Estimated trapping efficiency for steelhead salmon smolts during this time period averaged 33% (min= 25%, max= 35%).

In 2015, a total of 561 steelhead smolts were captured in the RST (Table 2, Figure 10). Of these steelhead captures, 436 were marked with caudal fin clips and were released upstream of the RST. Eleven distinct clip strata were released over the trapping season (Appendix C). Ninety five (22%) of these fin clipped steelhead smolts were recaptured. From the RST catch, DARR estimated 2554 (SE= 318) steelhead smolts migrated downstream past the RST in 2015 (Figure 11). Lower and upper 95% confidence intervals were 1931 and 3176 steelhead smolts. Estimated trapping efficiency for steelhead smolts averaged 29% (min= 15%, max= 40%).

The 2016 season total catch of steelhead smolts for the RST was 415 smolts. A total of 404 steelhead were marked with caudal fin clips and released upstream of the RST. Twelve distinct clip strata were released, however, as was the case during the 2014 and 2015 seasons, most clipped fish were released in the first nine weeks of the season. (Appendix D). Steelhead smolt catch was drastically reduced after week 20 (Figure 10, Appendix D). A total of 109 (27% of marked) steelhead smolts were recaptured. An estimated 2078 (SE= 469) steelhead smolts emigrated from Mill Creek during the RST trapping period (Figure 10). Lower and upper 95% confidence intervals were 1159 and 2997 smolts. Estimated trapping efficiency for out-migrating steelhead averaged 26% (min= 17%, max= 55%) across the entire trapping season.

During 2017 the RST effort captured 281 steelhead smolts and 267 were marked with caudal fin clips and released upstream of the trap. Twelve distinct clip strata were released, but most steelhead smolts were captured and marked prior to week 20 (Figure 10, Appendix E). Only 18 steelhead smolts (7% of marked) were recaptured. An estimated 3882 (SE= 989) steelhead smolts emigrated from Mill Creek while the RST was operating (Figure 11). Lower and upper 95% confidence intervals were 1944 and 5820 smolts. Estimated trapping efficiency for outmigrating steelhead averaged 6% (min= 5%, max= 9%) across the entire trapping season.

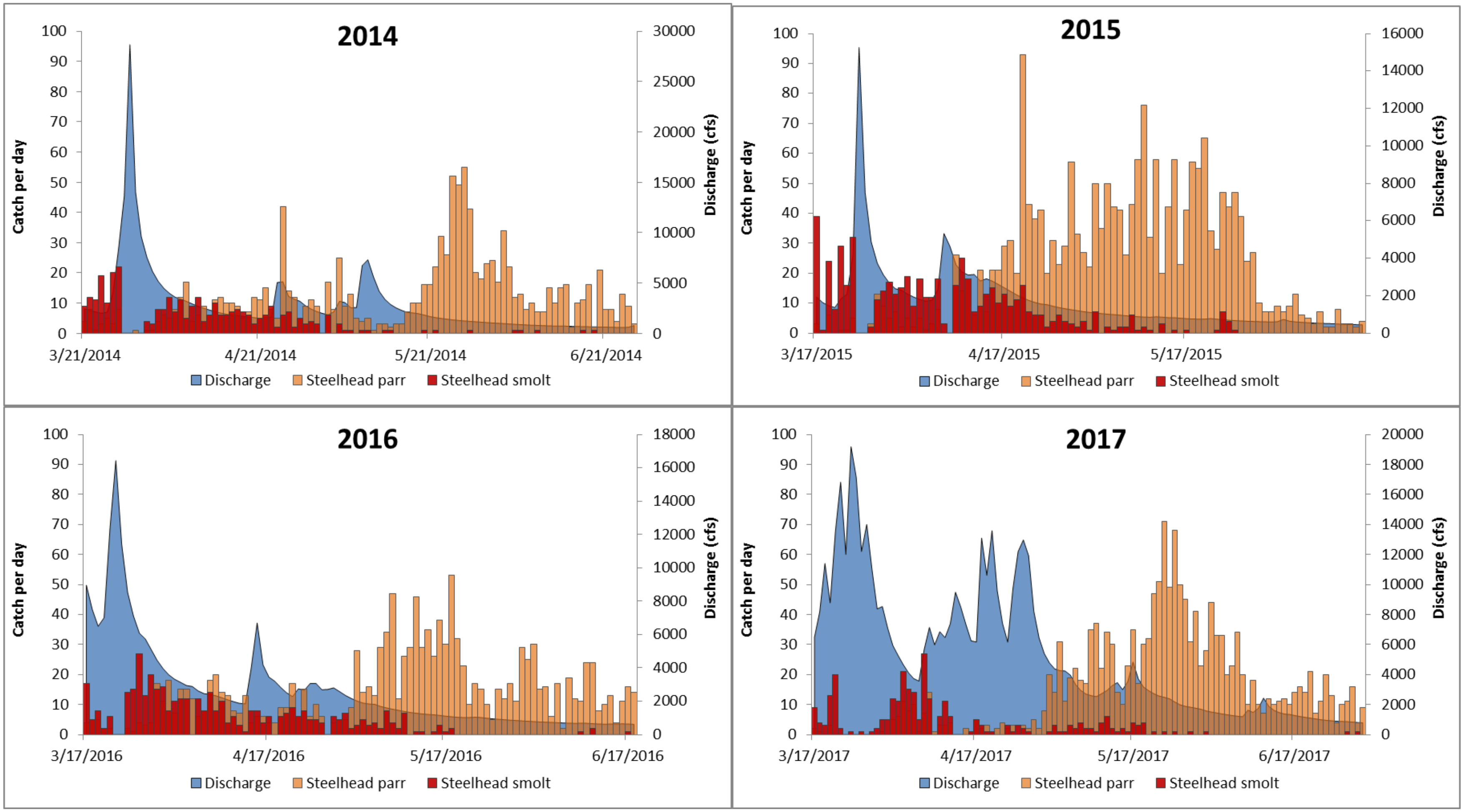


Figure 10. Daily catch of steelhead trout smolts (red) and parr (orange) age classes at the rotary screw trap in Mill Creek, Smith River, CA, during four years of operation from 2014 – 2017. Graph includes daily maximum mean discharge measured in cubic feet per second (cfs) by USGS Jed Smith stream gage (#11532500) (USGS 2017).

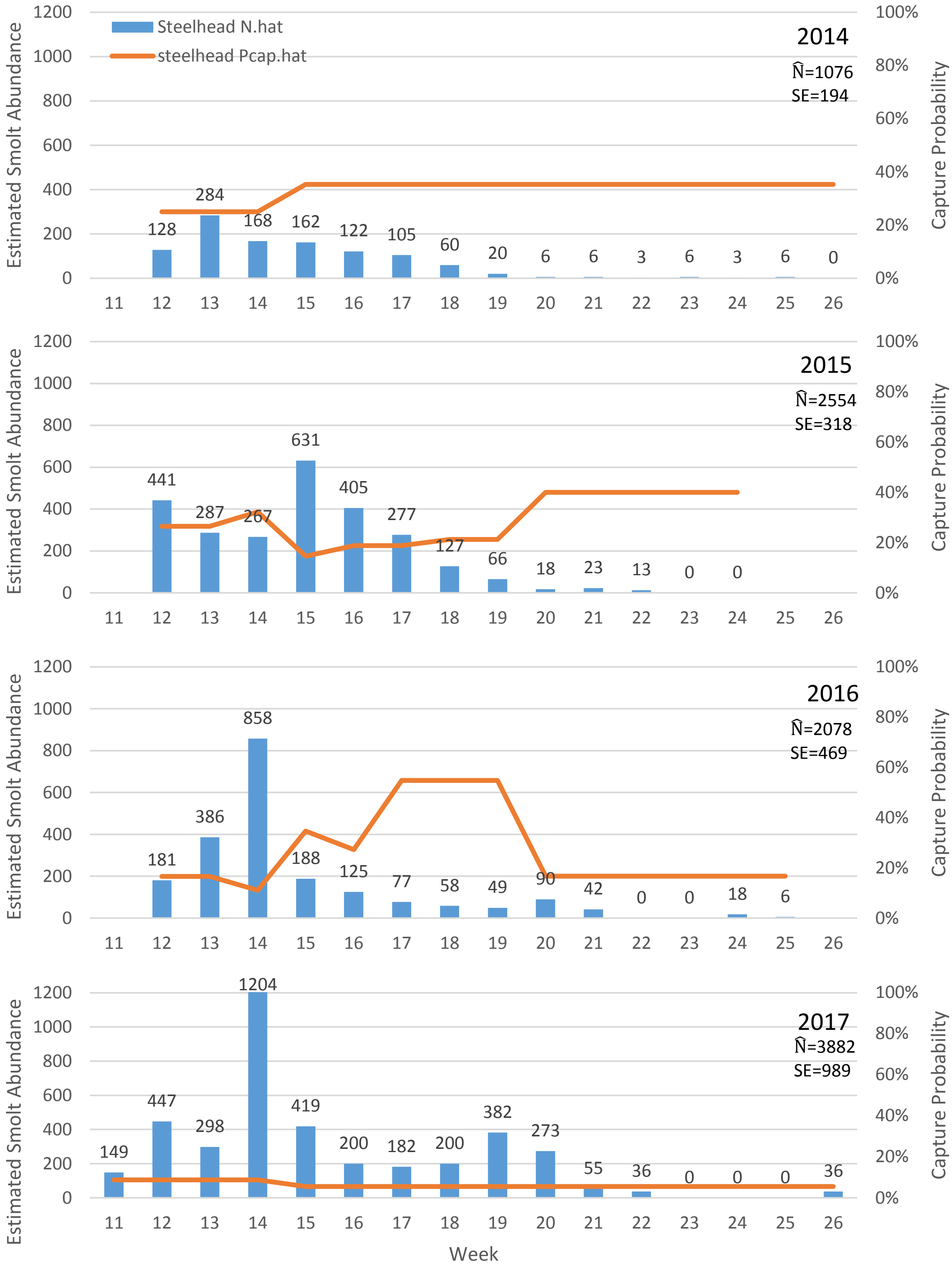


Figure 11. DARR estimates of steelhead trout smolt abundance for each weekly marking strata at the Mill Creek outmigrant trap between March 16, 2014 and June 30, 2017, Smith River basin, CA.

2014-2017 Coastal Cutthroat Trout

Coastal Cutthroat Trout Outmigrant Abundance and Migration Characteristics

Coastal Cutthroat Trout captures included 2159 1+ parr, 1824 smolts, 22 anadromous adults and 73 resident adults (Table 2, Appendices J-M). We captured the most Coastal Cutthroat Trout 1+ parr during 2014 (614 individuals) and the fewest during 2016 (455 individuals). Coastal Cutthroat trout 1+ parr had a cumulative mean capture date of May 8 across the four years (Figure 12, Appendix J). Overall mean FL was 132mm (Range: 50mm - 191mm). Within each season, fork length of Coastal Cutthroat Trout parr ranged from less than 100mm to almost 200mm (Appendix J). The smolt outmigration period for Coastal Cutthroat Trout appeared to be protracted across the season, occurring later than steelhead smolt migrations. Overall mean capture date across the four trapping seasons was May 5 and Coastal Cutthroat trout smolts were captured at the beginning and end of each trapping season (Figure 12, Appendix K). Overall average fork length of Coastal Cutthroat smolts was 158mm (Range: 110mm - 238mm).

Of the 113 Coastal Cutthroat Trout smolts we captured in 2014, a total of 40 were fin clipped and released upstream of the RST. Only 13 fin clipped fish were recaptured (Table 2, Appendix B). An estimated 340 (SE= 76) Coastal Cutthroat Trout smolts emigrated from Mill Creek while the trap was fishing (Figure 12). Estimated trapping efficiency for out-migrating cutthroat smolts was 25% during the first few weeks of trapping and increased to 35% for the remainder of the season.

In 2015, a total of 853 Coastal Cutthroat Trout smolts were captured across the season, 502 received fin clips and were released upstream of the RST and 502 were recaptured. An estimated 4174 (SE= 526) Coastal Cutthroat Trout emigrated from Mill Creek during operation of the RST in 2015. Estimated trapping efficiency for Coastal Cutthroat Trout smolts averaged 23% across the season and remained below 26% for much of the trapping effort. Estimated efficiency peaked at 73% in week 19.

In 2016, a total of 282 Coastal Cutthroat Trout smolts were captured, 246 were marked with fin clips and released upstream of the RST and 33 were recaptured. An estimated 2427 (SE= 568) Coastal Cutthroat Trout emigrated from Mill Creek during operation of the RST in 2016. Estimated trapping efficiency averaged 13% (min= 9%, max= 16%) across the trapping season.

In 2017, a total of 575 Coastal Cutthroat Trout smolts were captured, 543 were marked with fin clips and released upstream of the RST, and 62 were recaptured. An estimated 5423 (SE= 963) Coastal Cutthroat Trout smolts emigrated from Mill Creek during operation of the RST in 2017. Estimated capture efficiency for Coastal Cutthroat Trout smolts was low during much of the season but, like in 2016, peaked during mid-season (average= 14%, min= 6%, max= 44%).

Coastal Cutthroat Trout not displaying signs of smolting and lacking parr marks were identified as either resident or anadromous adults. Classification of these stages by field crews was largely based on overall fish appearance and, given the capacity of Coastal Cutthroat Trout to undertake multiple life history strategies, it is likely that the distinction between these stages is blurred. Also, we suspect that trapping efficiency for larger Coastal Cutthroat Trout was substantially less during the early period of each trapping season when flows were high. Catches of both stages occurred intermittently across each trapping season (Figure 12, Appendices L-M). Mean capture date for resident adult Coastal Cutthroat Trout was May 2 while for anadromous adult Coastal Cutthroat Trout it was May 12 (Appendices L-M). Mean fork length for resident Coastal Cutthroat Trout was 231.9mm (min= 96mm - max= 390mm) and for anadromous adults it was 290.7mm (min= 204mm, max-= 384mm).

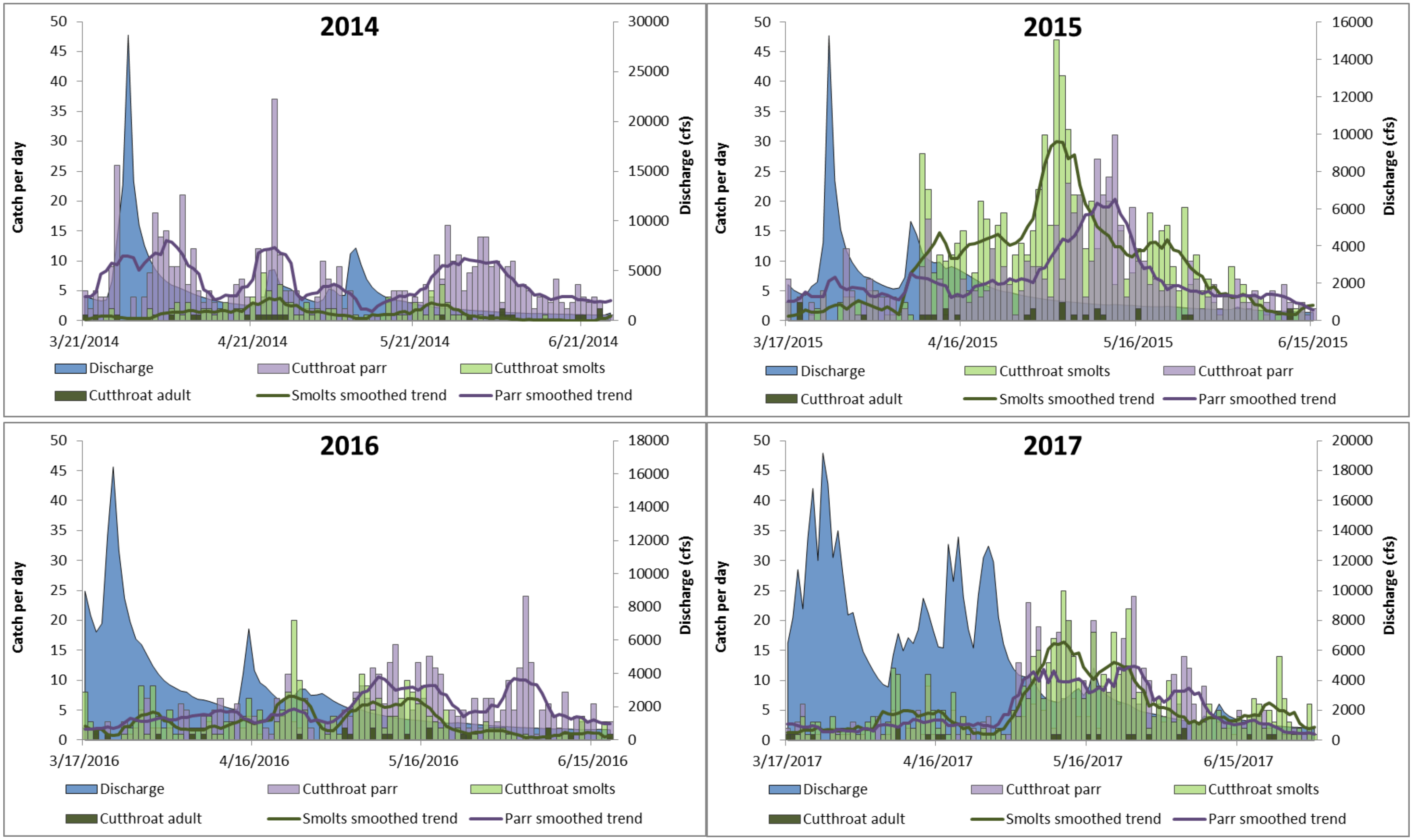


Figure 12. Daily catch of Coastal Cutthroat Trout parr (purple), smolts (light green) and adults (dark green) age classes at the rotary screw trap in Mill Creek, Smith River, CA, during four years of operation from 2014 – 2017. Graph includes daily maximum mean discharge measured in cubic feet per second (cfs) by USGS Jed Smith stream gage (#11532500) (USGS 2017). Smoothed trend lines represent 7-day average of daily capture.

Figure 13. DARR estimates of Coastal Cutthroat Trout smolt abundance for each weekly marking strata at the Mill Creek outmigrant trap between March 16, 2014 and June 30, 2017, Smith River basin, CA.

Other Species

Unidentified Trout Captures and Migration Characteristics

We captured a total of 6275 young-of the-year trout in the RST across the four seasons (Table 2, Appendix N). Captures of young-of-the-year trout were highest in 2016 (2366 individuals) and lowest in 2017 (1025 individuals). Overall mean catch date was June 9 (min= June 2 during 2015 and max= June 20 during 2014). Few young-of-the-year trout captured during March and April. Fork lengths of young-of-the-year trout, and the presence of individuals with visible yolk sacs during most trapping months, show that trout emergence from redds is protracted and occurs into summer (Appendix N).

Trout smaller than 100mm not showing definitive Coastal Cutthroat Trout or steelhead trout characteristics were classified as 1+ trout parr by field crews. We captured a total of 5932 unidentified trout parr over the four trapping seasons (Table 2, Appendix O), with the highest annual catch occurring during 2015 (2238 captured) and the lowest catch occurring during 2016 (975 captured). Seasonally, catches were greatest during April and May and decreased during June. Overall mean capture date was May 5. Overall mean length of Trout parr was 87.1mm and, within each year, monthly mean length increased across the trapping season (Appendix O).

Chinook Salmon Captures and Migration Characteristics

We captured a total of 224469 Chinook Salmon young-of-the year and 19 Chinook 1+ over the four trapping seasons. We captured 5309, 47397, 114796 and 56967 young-of-the-year Chinook salmon during 2014, 2015, 2016, and 2017 respectively (Table 2). We did not utilize mark-recapture to estimate abundance of Chinook Salmon and thus we report only unexpanded counts. Young-of the-year Chinook Salmon were overall the most numerous salmonid captured in the RST with the exception of 2014 having very few captures (Figure 14 and Appendix P). This likely resulted from low number of spawning adults and drought conditions during the fall/winter of 2013/2014 and was not necessarily due to poor trapping efficiency. Not only were captures lower during 2014, but the mean capture date during 2014 was almost a full month later than mean capture dates for 2015-2017. Mean capture date of Chinook Salmon was May 24 in 2014 but was April 18 during 2015, April 22 during 2016 and April 29 during 2017(Appendix P). Additionally, no young-of-the-year Chinook Salmon were captured during March in 2014. We observed multiple sub-pulses of Chinook young-of-the-year during the 2015 through 2017 seasons (Figure 14). A primary pulse of young-of-the-year occurred during March and early April, with multiple smaller pulses of young-of-the-year during May and June during each of these three years. Monthly mean fork lengths of young-of-the-year Chinook Salmon increased across each trapping season (Appendix P).

Non-salmonid Captures and Migration Characteristics

Pacific Lamprey and other non-salmonid fishes were not the focus of this monitoring project and were thus captured incidentally. We captured more adult than larval Pacific Lamprey in the RST, however, catches for both stages was low (Appendix A). It should also be noted that Adult Pacific lamprey were observed escaping from the live box of the RST during fish processing. Adult Pacific Lamprey catches were similar from 2014-2016 with annual captures ranging from11-14 individuals. In 2017 we captured twenty-eight Pacific Lamprey. Anadromous adult lamprey were mostly captured in April and May with a mean observation date of May 10 (Appendix Q). This timing corresponds with crew members observing groups of Pacific Lamprey building redds in riffle crests near the trap site in Mill Creek. During May 5, 2017 seven separate active Pacific lamprey redds were observed between the Howland Hill Road bridge and the RST site (Jolyon Walkley, personal observation).

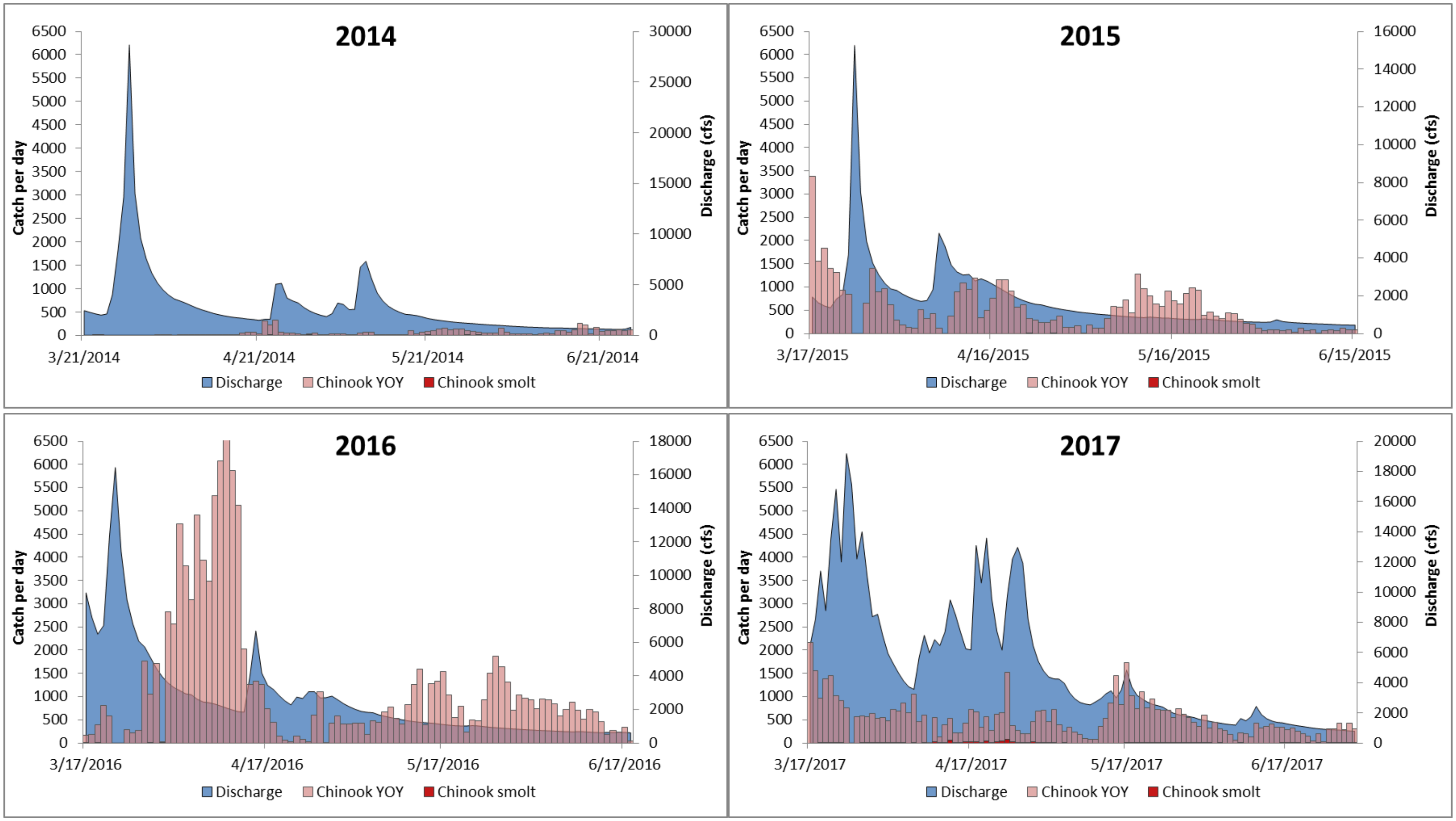


Figure 14. Daily catch of Chinook Young of the Year (YOY) (pink) and smolts (red) age classes at the rotary screw trap in Mill Creek, Smith River, CA, during four years of operation from 2014 – 2017. Graph includes daily maximum mean discharge measured in cubic feet per second (cfs) by USGS Jed Smith stream gage (#11532500) (USGS 2017).

Observed Mortality

Annual observed percent mortality of fish captured in the RST from 2014 - 2017 are summarized in Table 6. Mortality was generally highest for young-of-the-year (YOY) individuals than older/larger individuals. All YOY mortalities appeared to result from predation or debris related trauma and were identified while transferring the fish from the trap live-well or were regurgitated by larger fish during measuring and tagging. Chinook Salmon YOY were the most numerous mortality observed in RST with annual trap-associated mortality ranging from 0.21% -1.88% of the Chinook Salmon handled. Most Chinook Salmon mortalities were a result of predation by steelhead and Coastal Cutthroat Trout. Observed annual Coho Salmon YOY mortality ranged from 0.09% to 2.26% of those handled at the RST. Percent mortality of Coho Salmon YOY mortality was highest during 2014 when six mortalities were observed out of a total of 266 handled. Four of the Coho Salmon mortalities were predator related and two appeared to have been caused by debris related trauma in the live well. Mortality of trout YOY was highest during 2014 but lower during subsequent seasons (Table 6). We recovered an additional 13 unidentified salmonid YOY mortalities from the trap live-well in2014 but trapping crews were unable to determine their species.

Mortality of larger size classes and non-salmonids was generally highest during 2014 and lower during subsequent years. Coho Salmon smolt mortality ranged from 0.11% to 0.44 % of the total handled in the RST, including recaptures. Incidences of mortality for 1+ trout parr, smolts and resident fishes largely correlated with heavy debris loads during and after significant storm events.

Table 6. Observed mortality associated of handled fishes at the Mill Creek rotary screw trap project in Mill Creek from 2014 – 2017. Numbers of handled fish include both first captures and recaptures.

		2014			2015			2016			2017		
Common Name	**Stage**	**Handled**	**Dead**	**%M**	**Handled**	**Dead**	**%M**	**Handled**	**Dead**	**%M**	**Handled**	**Dead**	**%M**
Coho Salmon	YOY	266	6	2.26	383	5	1.31	1158	1	0.09	699	3	0.43
	1+ Parr	15	0	0.00	2	0	0.00	8	0	0.00	3	0	0.00
	Smolt	2762	10	0.36	4427	5	0.11	2728	12	0.44	1815	5	0.28
Steelhead	1+ Parr	1144	17	1.49	2017	0	0.00	1337	0	0.00	1576	0	0.00
	Smolt	342	1	0.29	656	0	0.00	524	0	0.00	299	2	0.67
	anad-adult	0	0	0.00	1	0	0.00	0	0	0.00	0	0	0.00
Coastal Rainbow Trout	resident	0	0	0.00	1	0	0.00	0	0	0.00	0	0	0.00
Coastal Cutthroat Trout	1+ Parr	614	1	0.16	592	0	0.00	455	0	0.00	505	0	0.00
	Smolt	126	1	0.79	975	0	0.00	315	0	0.00	638	1	0.16
	Adult	13	0	0.00	2	0	0.00	4	0	0.00	3	0	0.00
	resident	11	0	0.00	26	0	0.00	19	0	0.00	18	0	0.00
Unidentified Trout	YOY	1745	52	2.98	1139	12	1.05	2366	5	0.21	1025	9	0.88
	1+ Parr	1403	12	0.86	2238	3	0.13	975	3	0.31	1316	2	0.15
Chinook salmon	YOY	5309	100	1.88	47397	274	0.58	114796	246	0.21	56967	219	0.38
	1+	11	0	0.00	3	0	0.00	5	0	0.00	2	0	0.00
Unidentified Salmonid	YOY	13	13	100.00	0	0	0.00	0	0	0.00	0	0	0.00
Klamath smallscale sucker	resident	13	0	0.00	1299	2	0.15	1432	0	0.00	522	1	0.19
Pacific lamprey	larvae	3	0	0.00	0	0	0.00	8	1	12.50	13	0	0.00
	anad-adult	11	0	0.00	13	0	0.00	14	0	0.00	28	0	0.00
western brook lamprey	resident	1	0	0.00	0	0	0.00	0	0	0.00	1	0	0.00
lamprey genus	larvae	5	1	20.00	11	0	0.00	5	0	0.00	0	0	0.00
Coast Range Sculpin	resident	54	1	1.85	142	1	0.70	92	0	0.00	125	0	0.00
prickly sculpin	resident	102	1	0.98	127	2	1.57	198	2	1.01	184	0	0.00
Unidentified sculpin	resident	5	0	0.00	90	1	1.11	77	3	3.90	27	0	0.00
Three-spined Stickleback	resident	2	0	0.00	35	3	8.57	30	2	6.67	16	2	12.50

Discussion

This report summarizes the first four years of the Mill Creek outmigrant trapping program after significant structural changes were made to the study design that had been used from 1994 to 2013. A transition away from two outmigrant pipe traps that operated in the East Fork and West Branch of Mill Creek from 1994 to 2013 toward a floating trap in the lower mainstem of Mill Creek provided multiple benefits. One of the most important reasons for installing a trap lower in the watershed is to intercept outmigrating smolts that rear in the mainstem of Mill Creek and thus are not available for capture at the East Fork and West Branch locations. The lower trapping site adds 7.8 stream kilometers to the overall sampling area in a much larger and unique portion of the watershed. Furthermore, the rotary screw trap resulted in reduced disturbance to natural ecological processes occurring within the stream channel and the organisms that reside within the river substrates. We especially minimized impacts to migrating adult anadromous fishes including post-spawned steelhead and adult Pacific Lamprey. We captured only one adult steelhead over the four years the RST was deployed. In contrast, pipe traps deployed in the West Branch between 1994 and 2009 captured an average of 44 adult steelhead per year (McLeod and Howard 2010). CDFW staff operating the pipe traps during 2013 observed over 100 steelhead kelts stranded upstream of the pipe trap weirs (J. Garwood *pers. Observation*). These stranded fish are likely much more vulnerable to bear and river otter predation than those allowed to freely migrate downstream.

From a functional standpoint, the RST was effective at capturing fish across the season, was less labor intensive and much faster to redeploy after storm events than previously utilized pipe traps. On average, the RST was operational for 98% of each trapping season with 1-3 days out of operation due to elevated flows (Table 1). We operated the trap over contrasting seasonal flow regimes, which included persistent storms that maintained high flows for much of the season (i.e. the 2017 trapping season), and years having few storms interspersed by long dry periods where streamflow steadily decreased (i.e. the 2015 trapping season). By comparison, pipe traps deployed in the West Branch of Mill Creek experienced seasonal sampling outages of up to 18 days due to blowout and subsequent rebuilding (McLeod and Howard 2010). Undoubtedly, capture efficiency (*see* individual species subsections below) of the RST was lower during high flows because it was not fishing the entire thalweg. However, it still provided a means to sample migrating fishes during flows that would have incapacitated fixed traps. We examined the possibility of installing weir panels after stream flows peaked and were declining, but decided that increased funneling of both suspended and floating debris, as well as magnified focused stream flow, would cause unnecessary injury and mortality of fishes in the trap cone and live box.

Coho Salmon

Coho Salmon Young-of-the-year

Notably, Coho Salmon YOY were captured in the RST, although they occurred in lower numbers than Chinook Salmon YOY and trout YOY. While it is possible these YOY emerged from redds in mainstem Mill Creek, no Coho Salmon have been observed building redds in Mill Creek below the confluence of the East Fork and West Branch from over five years of CMP spawning surveys (Garwood and Larson 2014, Garwood et al. 2014, Walkley and Garwood, 2015, Walkley and Garwood 2017). These individuals likely originate from West Branch and East Fork Mill Creek and are exhibiting an early emigration life history strategy. Pipe trap catches near the bottom of the West Branch and East Fork historically captured YOY Coho Salmon as well (Mcleod and Howard 2010). The authors link the emigration of these YOY to saturation of available habitat in the West Branch and East Fork of Mill Creek. It is also possible Coho Salmon YOY become displaced downstream of the West Branch and East Fork during high stream flows during the vulnerable redd emergence period. Since most Coho Salmon YOY captures occurred during the first half of each trapping season, it appears migrations are strongly related to redd emergence rather than incremental increases in discharge. Whether Coho Salmon YOY redistribution within the watershed is active, passive, or both, it appears to occur annually as a distinct behavior being expressed in the population. Further research into survival of these migrant individuals is warranted given Coho Salmon YOY are regularly documented rearing throughout the lower Smith River each year during the summer months (Parish and Garwood 2015, Walkley and Garwood 2017).

Coho Salmon YOY catches peaked in late March through mid-April, with the exception of 2014 when catches peaked in early May (Figure 5). This delay likely resulted from drought conditions during the Fall/winter of 2013/2014 affecting adult Coho Salmon spawning timing. Mill Creek CMP spawning surveys did not detect Coho Salmon actively spawning until mid-January during the Fall/Winter of 2013/2014. Spawning Coho Salmon were typically first detected during early to mid-December in other years (Walkley and Garwood 2017). In general, the Coho Salmon YOY migration period peaked much earlier than yearling smolts each year indicating a small overlap in these two life histories.

Coho Salmon Smolts

Coho Salmon smolt catches were low during the beginning of each trapping season, peaked during early to mid-May and decreased in June (Figure 5). This pattern was also expressed during the persistent spring drought of 2015 (Figure 5). Based on the distribution of counts across the season, we believe our spring outmigrant population estimate includes the majority of spring Coho Salmon smolt outmigrants.

Our Coho Salmon outmigrating smolt abundance estimates ranged from 7416 (2014) to 9383 (2017) during the four years the RST was deployed. The confidence intervals around the Coho Salmon smolt population estimates overlapped across all four years indicating the population size was similar over the period. Low trapping efficiency was likely responsible for the large error around the 2017 population estimate. Estimated annual RST trapping efficiency for Coho Salmon smolts was 20% during the 2017 season, but ranged from 29% to 35% during the other three seasons. Frequent storms maintained elevated discharge in Mill Creek, which may have resulted in reduced captures of both clipped and unclipped Coho Salmon smolts, especially early in the season. Figure 15 shows the spring Coho Salmon smolt abundance estimates derived for the past 24 years. We were unable to operate both pipe traps and the RST simultaneously to compare estimates derived for the same year. However, it appears the 95% confidence intervals around spring Coho Salmon smolt estimates are within similar ranges for both methodologies, despite pipe traps having higher overall capture efficiencies. Mean estimated annual combined abundance of spring outmigrating Coho Salmon for the East Fork and West Branch over the 20 years of pipe trapping was 4912 smolts. Our mean estimated annual abundance of Coho Salmon smolts was 8140 smolts across the four years of this study (Figure 15). This amounts to a 40% increase in average Coho Salmon smolt abundance. Annual estimates derived for 2014-2017 for Mill Creek were surpassed only twice in the 20 years of combined estimates at the West Branch and East Fork estimates. Our PIT tag recapture data shows we intercepted many Coho Salmon smolts rearing in the main stem of Mill Creek that would have been missed by pipe trapping at the forks (Table 3).

An important goal of this project was to continue to estimate the abundance of Coho Salmon smolts leaving Mill Creek to assist in determining population trends in the Smith River and compare these trends to other subpopulations. The Mill Creek basin drains approximately 98 km^2 within the Redwood National and State Parks (RNSP) and is the focus of one of the largest long-term habitat restoration projects in California. Prior to incorporation into RNSP, both the East Fork and West Branch were under private ownership and decades of timber extraction, milling and road construction severely impacted the basin. Two other nearby basins contain LCMs. Prairie Creek, a tributary to Redwood Creek, drains approximately 102.89km^2 and is considered a nearly pristine reference watershed because much of its old growth forest remains intact (Wilzbach et al. 2016). Freshwater Creek, tributary to Humboldt Bay, drains approximately 82.83km^2 and has been impacted through logging. Mill Creek annual spring coho salmon smolt abundance ranged from 39-

58% of those in Prairie Creek during 2014 – 2016 (no trapping occurred in Prairie Creek during the spring of 2017), but followed a similar trend. Estimated abundance of 1+ Coho Salmon in Prairie Creek during 2014 - 2016 was 19047, 21536 and 12938 (Wilzbach et al. 2017). Estimated abundance of Coho Salmon smolts in Mill Creek were 47-89% of those in Freshwater Creek during 2016-2017. Freshwater Creek estimates during 2014-2017 were 15724, 10470, 8467 and 14919 (Anderson and Ward 2017). Average number of Coho Salmon smolts produced during 2014-2016 were 81 smolts/km^2 in Mill Creek, 173 smolts/km^2 in Prairie Creek, and 140 smolts/km^2 in Freshwater Creek.

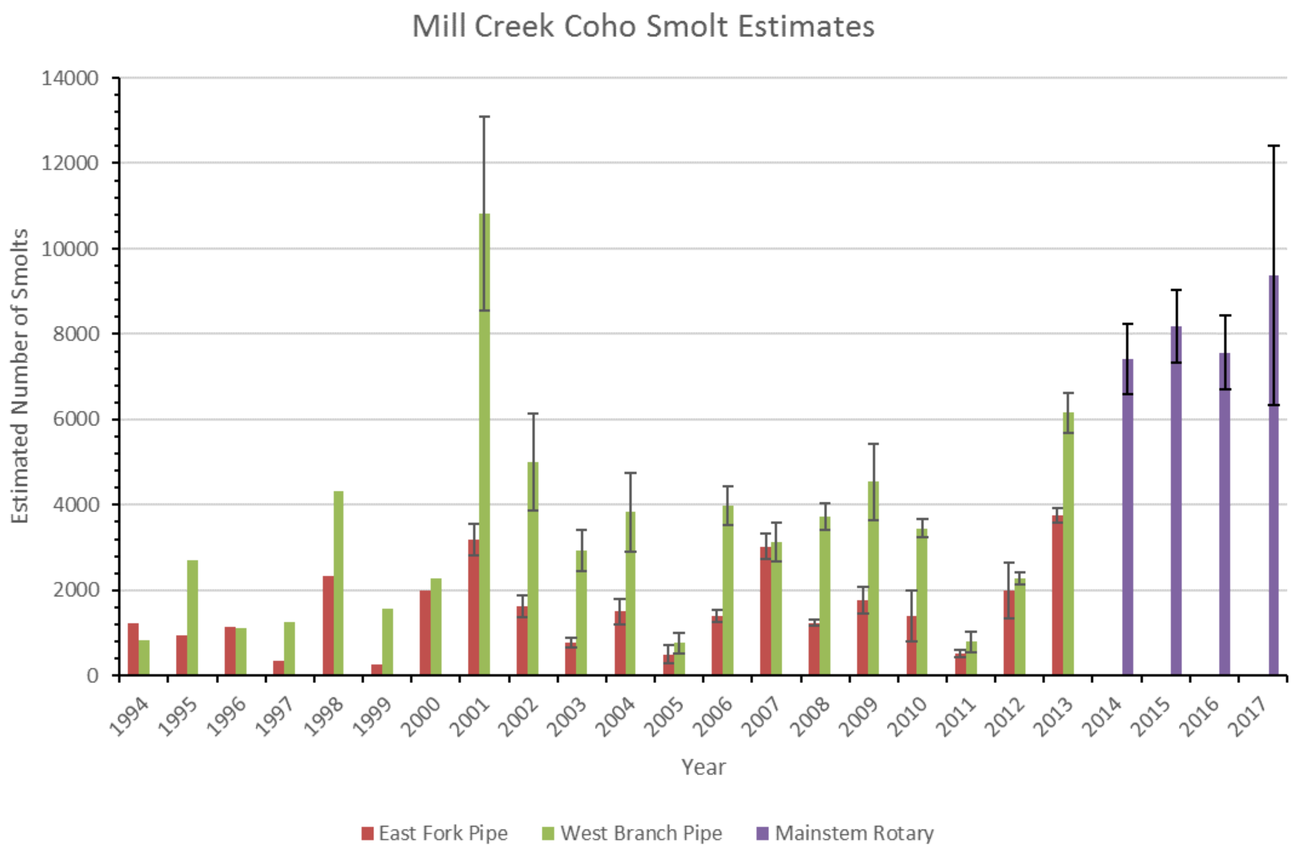


Figure 15. Mill Creek Coho Salmon smolt estimates obtained from outmigrant trapping studies from 1994-2017.

Coho Salmon Overwinter Survival and Life History Diversity

Understanding and protecting diverse life-history patterns expressed among salmonid populations can greatly improve population resilience (Hilborn et al. 2003, Bottom et al. 2009, Healy 2009). To fully understand current and potential life-history diversity influences on juvenile salmonid survival, intensive studies are needed. Information from these studies can be directly used for meeting local population recovery actions with the goal of maximizing life-history diversity through various habitat restoration and conservation strategies.

Life histories of Coho Salmon in coastal Northern California are generally understood to include freshwater occupancy for one or two years before migrating seaward the following spring. Recent studies in Freshwater Creek of Humboldt Bay and the Smith River (Wallace et al. 2015, Rebenack et al. 2015, and Parish and Garwood 2016) describe alternative life history patterns expressed by some juvenile Coho Salmon who emigrate from their natal streams during fall and winter. This life history is commonly referred to as 'early' emigrants in research across the Pacific Northwest (Roni et al. 2012, Jones et al. 2014, Rebenack 2015). We consistently observed early emigration by juvenile Coho Salmon throughout this four-year study in Mill Creek based on antenna detections of fall-marked individuals (Table 3, Figure 7).

Although we discuss the fall and spring migrations extensively for juvenile Coho Salmon in Mill Creek, we observed several other movement patterns during the study. Each year, we captured yearling Coho Salmon in the downstream migrant trap with catches peaking in June (Figure 5). Although once considered "moribund fry" contributing little to population production (Chapman 1962), recent studies suggest many of these yearling emigrants survive to become smolts and contribute to population stability (Koski 2009, Wallace et al. 2015). We also observed juveniles tagged in Mill Creek tributaries during the fall later overwintering in mainstem Mill Creek. Conversely, some fish tagged in mainstem Mill in the fall were detected migrating upstream into tributaries in winter and spring. These patterns are less common but still may contribute to the population growth and resiliency as recent research shows early emigrants rearing in estuarine and slough habitats have high survival (Rebenack et al. 2015) and growth rates (Parish and Garwood 2016, Wallace et al. 2015).

Failing to account for alternative life history strategies in coastal Coho Salmon populations could cause biased estimates of vital rates and misguide local management and recovery strategies. For example, earlier studies failed to account for early emigrant Coho Salmon when estimating overwinter survival using only downstream migrant traps (Peterson et al. 1994, Solazzi et al. 2000). Although we attempted to account for early emigration in 2013-14 and 2014-15 using the mainstem Mill Creek antennas (see Figure 2) poor detection rates at the site reduced our ability to estimate early emigration. If a significant proportion of juveniles emigrating early pass the antennas undetected and successfully migrate to sea, smolt production and overwinter survival estimates will be biased low. Not coincidentally, our apparent overwinter survival estimates for Mill Creek in 2013-14 (5.5%) and 2014-15 (10.4%) (Table 4) were very low, relative to similarly sized local streams, Freshwater and Prairie Creek, which both averaged over 30% over the same years (Anderson and Ward, 2017, Wilzbach et al. 2016).

Future technologies that increase detection rates of large stream-spanning antennas will greatly reduce the uncertainties around Coho Salmon migration timing and survival we documented in our study. Continued marking of juvenile Coho Salmon in the fall coupled with continuous operation of PIT tag antennas in Mill Creek *and* the Smith River estuary allowed us to explain our inherent bias in apparent overwinter survival by increasing our detection of early emigrants in 2015-16 and 2016-17. Given the current antenna technology limited fish detection in large streams such as Mill Creek, additional antennas positioned in estuary greatly improved our early emigration estimates while providing a rich understanding of Coho Salmon behavior and habitat use in the estuary. We detected emigrants leaving Mill Creek as early as October 24, with movements typically coinciding with the first elevated flow event of the season (Figure 8). Emigration occurred throughout the winter and spring months rather than increasing sharply during the spring. This pattern contrasts with other Northern Coastal California streams where early emigration patterns are more truncated with the majority occurring in the spring (Rebenack et al. 2015, Deibner-Hanson *in prep*).

Steelhead Trout

Steelhead Parr

Each year, steelhead trout parr showed well-defined downstream migration patterns. On average, parr migration occurred much later than smolt migrations and likely reflects a portion of the population that is actively moving downstream, possibly in response to loss of habitat or competition for food. Individuals are likely moving downstream to rear in mainstem Mill Creek and other Smith River habitats. Steelhead parr did not display any outward signs of smolting in preparation for entry into saltwater. Summer dive surveys found young-of-the-year and trout parr (including both steelhead and Coastal Cutthroat Trout) rearing in lower Mill Creek, but at lower densities than in upper portions of the basin (Walkley and Garwood 2017). Given a portion of parr are exhibiting early emigration below the trap, smolt population estimates from older cohorts are truncated to individuals displaying natal site fidelity and do not represent the true smolt output for Mill Creek. Further research should estimate the contribution of this migrant group to the overall smolt production and and determine their ultimate contribution toward adult abundance.

Steelhead Smolts

Annual population estimates of emigrating steelhead smolts is biased low for the 2014-2017 seasons. It is evident from the mark recapture data that steelhead smolt outmigration occurred primarily during the first half of each trapping season (Figure 10, Figure 11, Appendices B-E). We captured more smolts during the first few marking stratums, suggesting only a portion of the spring outmigrating population was sampled. Figure 16 shows annual steelhead smolt abundance estimates and their associated 95% confidence intervals derived from pipe trap and RST data for Mill Creek since 1994. Confidence intervals around steelhead smolt abundance estimates derived from pipe trap data and the RST were similarly high. We suspect this high error resulted from the ability of both marked and unmarked steelhead smolts to avoid capture by the RST rather than marked individuals remaining upstream of the RST. Steelhead classified as smolts displayed distinct characteristics indicating they were migrating downstream and it is unlikely that clipped fish would choose to remain upstream of the trap instead of continuing their downward migration.

Our results show we have been able to continue to estimate steelhead smolt abundance after transitioning to the RST. The 19-year mean steelhead smolt abundance for the combined estimates of the Mill Creek Forks was 2433 steelhead smolts. The four-year mean smolt estimate derived from the RST from lower Mill Creek was 2397. Mean RST based estimates for 2014-2017 exceeded combined annual estimates for the West Branch and East Fork between 2003 and 2012.

Abundance estimates for steelhead smolts in the Mill Creek LCM were 12-31% of combined estimates of aged 1+ and 2+ steelhead in the Prairie Creek LCM during 2014 - 2016. While abundance of smolts was estimated in Mill Creek, regardless of age, Wilzbach et al. (2017) report estimates for aged 1+ and 2+ steelhead from Prairie Creek separately and note that the majority of both age groups were composed of smolts. Combined abundance estimates of aged 1+ and 2+ Prairie Creek steelhead during 2014-2016 were 9256, 12306 and 6638 steelhead respectively. Steelhead smolt estimates were 171-772% higher in Mill Creek than in Freshwater Creek LCM during 2014-2017. Freshwater Creek LCM abundance estimates for steelhead smolts were 456, 331, 1218 and 2111 during 2014-2017 respectively (Anderson and Ward 2017). Average number of steelhead smolts produced during 2014-2016 were 20 smolts/ km^2 in Mill Creek, 91 aged 1+ and 2+ steelhead/ km^2 in Prairie Creek and 8 smolts/ km^2 in Freshwater Creek.

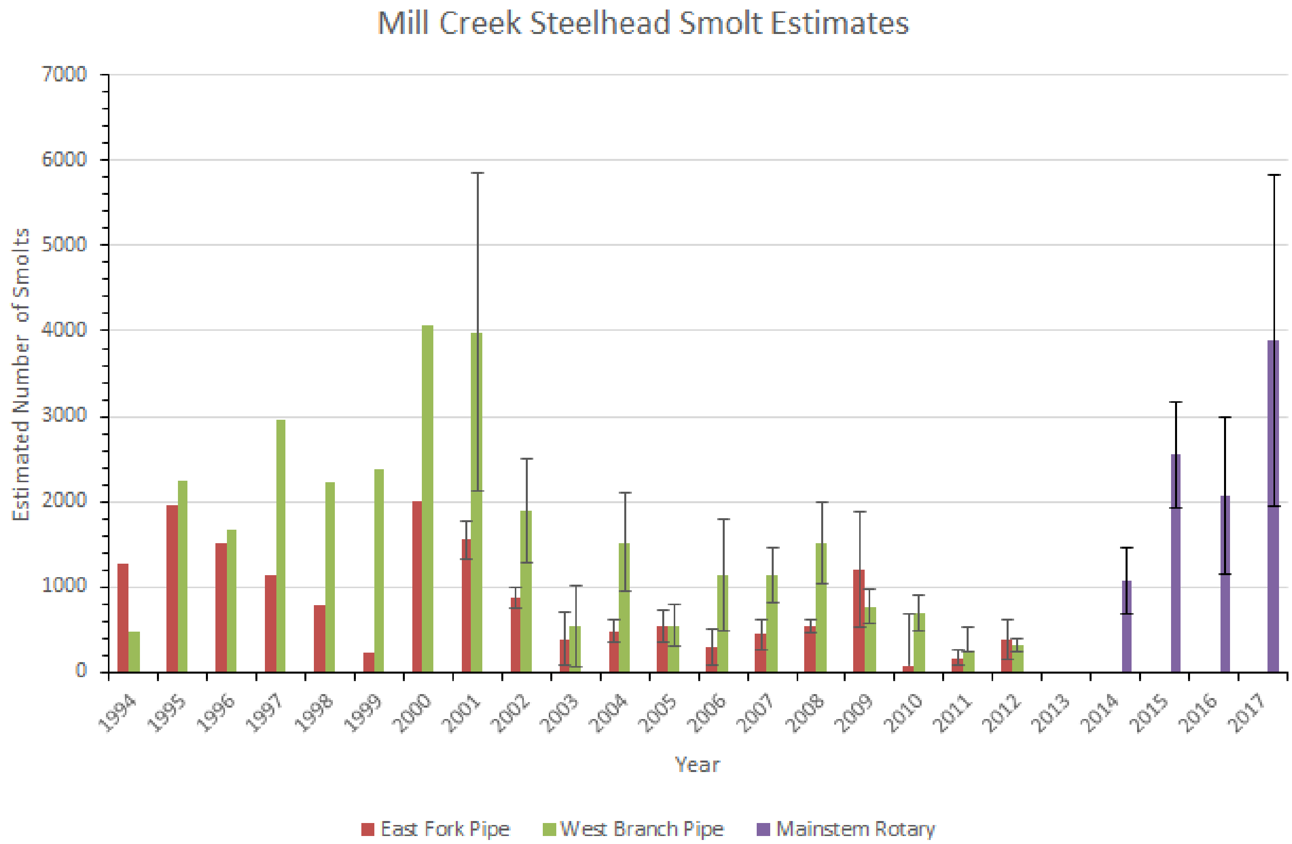


Figure 16. Mill Creek steelhead smolt estimates obtained from outmigrant trapping studies from 1994-2017.

Coastal Cutthroat Trout

Coastal Cutthroat Trout were potentially the most diverse fish species in terms of morphology and life history captured in the RST. Trapping crews only identified individuals as Coastal Cutthroat Trout if they possessed a maxillary extending past the eye, characteristic slash marks along the lower jaw and/or if they possessed distinct cutthroat trout spotting patterns. Aging techniques were not utilized to assign ages and, as such, 1+ Parr included age two and older individuals. Coastal Cutthroat 1+ parr migration peaked during early May.

Coastal Cutthroat Trout Smolts

Unlike Steelhead, the outmigration of Coastal Cutthroat Trout smolts occurred across the trapping season. The abundance estimate for Coastal Cutthroat Trout smolts during 2014 was significantly lower than those for 2015 through 2017. We captured the fewest number of smolts during 2014 and only released 40 clipped fish. As was the case for Coho Salmon, the elevated stream flows during the 2017 season likely resulted in poorer performance of the mark-recapture based estimate.

The 19-year mean Coastal Cutthroat smolt abundance for the combined estimates of the Mill Creek Forks was 2368 Coastal Cutthroat smolts (Figure 17). Our mean annual estimate for this study was 3091 Coastal Cutthroat smolts. Mean RST based estimates for 2014-2017 exceeded combined annual estimates for the West Branch and East Fork between 2003 and 2012.

Estimated abundance of Coastal Cutthroat Trout smolts in the Mill Creek LCM was 7-113% of the estimated abundance of juvenile Coastal Cutthroat Trout estimated for the Prairie Creek LCM from 2014-2016. Abundances of juvenile Coastal Cutthroat Trout were estimated to be 4581, 8572 and 2154 during 2014-2016 in the Prairie Creek LCM (Wilzbach et al. 2017). Wilzbach et al. (2017) note that no Coastal Cutthroat Trout parr were identified and 47%, 49% and 58% of the catch over the three years were smolts, while pre-smolts comprised the remaining portion. In contrast, 56% of our total 2014-2016 Mill Creek Coastal Cutthroat Trout catch were parr and only 44% were defined as smolts. Only 1% of the 2014-2017 Freshwater Creek LCM Coastal Cutthroat Trout catch were defined as smolts (Anderson and Ward 2017). It is possible that migratory Coastal Cutthroat Trout parr continue to develop smolt characteristics once they reach the mainstem Smith River. Mill Creek is farther away from the ocean than Prairie Creek. The Smith River is also a much larger basin than Redwood Creek and likely provides greater opportunity for Coastal Cutthroat Trout to adopt non-ocean migratory strategies. Coastal Cutthroat Trout are widely distributed throughout a wide array of habitats in the Smith River basin (Walkley and Garwood 2017). Some parr likely leave Mill Creek and rear in the Smith River estuary, its mainstem or other tributaries.

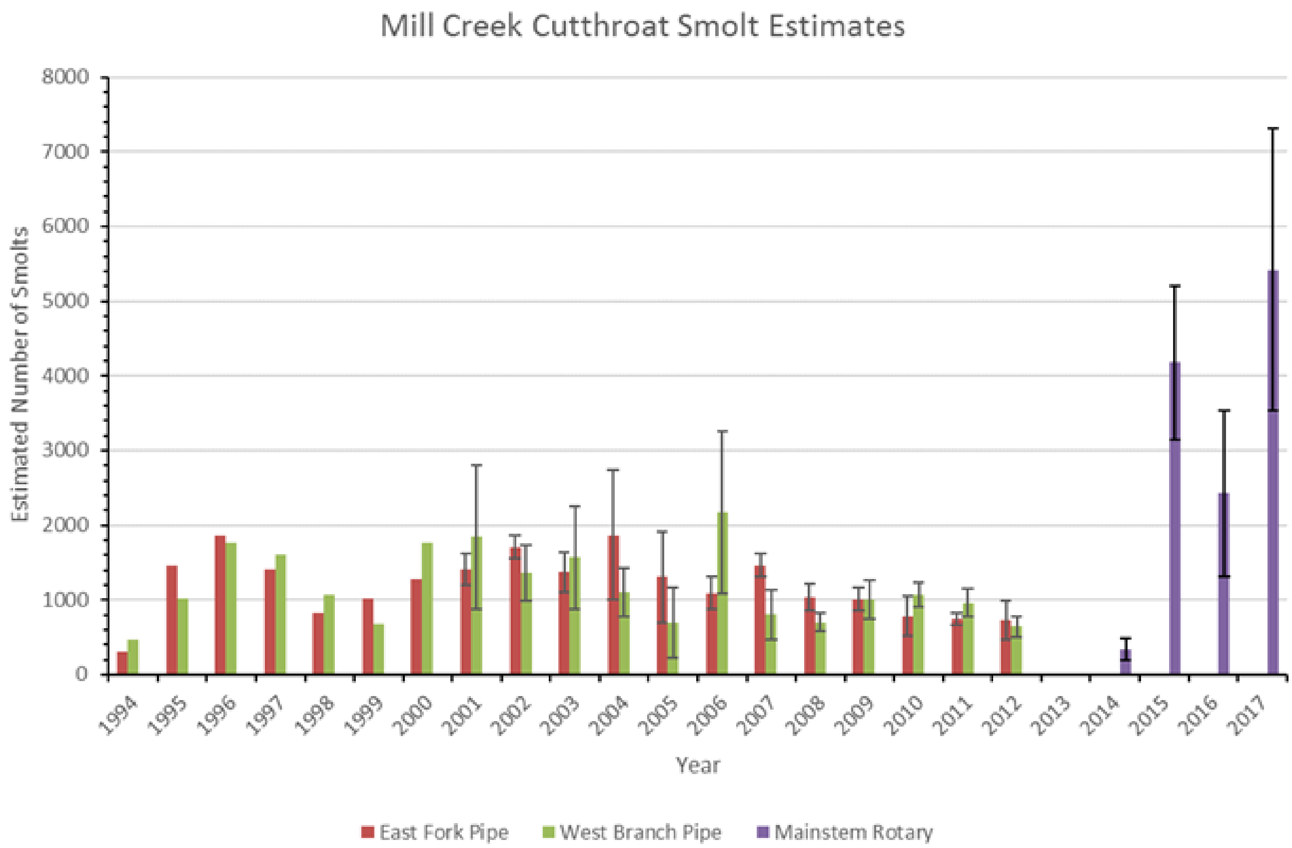


Figure 17. Mill Creek Coastal Cutthroat Trout smolt estimates obtained from outmigrant trapping studies from 1994-2017.

Juvenile Trout

Our captures of juvenile (unidentified) trout included both steelhead and Coastal Cutthroat Trout young-of-the-year and parr. Given the diverse life histories of trout in general, our monitoring represents an unknown proportion of these stages that undertook active or passive downstream distribution. It is likely that both active and passive mechanisms are influencing the downstream distribution of these species. Water levels in both tributaries and the mainstem of Mill Creek decreased across the season. Presumably, this loss of habitat and increased competition for space and food may influence a portion of young-of-the-year and 1+ parr to migrate downstream annually. Sparkman (2016) documented young-of-the-year trout traveling up to 29 miles in Redwood Creek. We captured yolk-sac-larvae in the RST during and immediately after high flow events suggesting flow events are dispersing individuals downstream. Our RST catches of juvenile trout are similar to those in Prairie Creek. Wilzbach et al. (2017) report 1752 0+ trout captured during 2016.

Chinook Salmon

While we did not produce and estimate of Chinook Salmon abundance, our data are useful in evaluating relative abundance and migration characteristics between years. Results from this study compliment juvenile dive and spawning surveys that have occurred concurrently with this project. For example, we had very low catches of young-of-the-year Chinook salmon during the 2014 season compared to the subsequent three years (Figure 14). Migration timing for juvenile Chinook Salmon during this season was also later on average than in previous seasons. Severe drought conditions during late 2013 likely prevented Chinook salmon from spawning in most upper tributaries in the Smith River (Garwood et al. 2014). Juvenile dives completed during the summer of 2014 also show reduced occupancy and relative abundance for Chinook salmon in the Mill Creek basin and the Smith River Basin as a whole compared to summer of 2015 and 2016 (Walkley and Garwood 2017).

Our data continues to show that Mill Creek is an important Chinook Salmon producer compared to Freshwater and Prairie Creeks. During the winter spawner surveys of 2011-2012, Garwood and Larson (2014) estimated Chinook Salmon constructed 1789 redds in Mill Creek above the forks. In contrast, very few Chinook salmon appear to return to in Freshwater Creek. Anderson and Ward (2017) report 0, 463, 62 and 461 Chinook Salmon YOY captures at the Freshwater LCM from 2014-2017. Furthermore, the Mill Creek LCM captures were 76%, 435% and 491% of Prairie Creek captures during 2014-2016. A total of 6943, 10900 and 23375 Chinook Salmon were captured in Prairie Creek from 2014-2016 (Sparkman et al. 2015, Wilzbach et al. 2016, Wilzbach et al. 2017).

Mortality

Mortality of young-of-the-year individuals was low overall, but higher than that of older/larger individuals. We incorporated mesh refugia habitats to reduce predator contact with young-of-the-year salmonids and removed debris multiple times a day during storm events. We believe these contributed to our lower mortality percentages during the last 3 years of this project. We chose to hold captured young-of-the-year individuals in the livewell versus providing an escape for them for two reasons. First, completely excluding young-of the-year individuals and still effectively capturing and holding migrating smolts is unlikely given the willingness of Coho Salmon and steelhead to exploit any small opening to make their escape. Debris would likely clog young-of-the year-sized escape ports or mesh. Secondly, we were also interested in counting young-of-the-year to compare annual relative abundance.

Restoration and Monitoring Recommendations

The Mill Creek Watershed has a recent watershed management plan (State Parks 2011) that details various restoration priorities. Below we provide some individual restoration priorities we identified over the past 6 years of fisheries data collection. We also identify planning opportunities that would benefit from our recent fisheries data collection as a way to complement the management plan and assist planning for various restoration prioritizations.

- Continue planned road decommissioning and maintain/improve existing roads and culverts to minimize impacts on salmonids associated with major slope and culvert failures. Use fisheries data collected during this project and in Walkley and Garwood (2017) as a factor in future road management and decommissioning projects. Most culvert barriers in salmonid streams have been removed or replaced. However, one culvert with a rusted out bottom on a tributary of East Fork Mill Creek is a complete barrier to juvenile salmonids and a partial barrier to adult salmonids (J. Garwood, personal observation) (California Fish Passage Database [PAD] #705649). Based on stream gradient data derived from a digital elevation model, this stream has a minimum gradient less than 8% up to 1.3 kilometers above the mouth. Many small tributaries in Mill Creek shorter than the stream described above are regularly used by salmonids for spawning and rearing. Although the culvert at this crossing will eventually be replaced, this stream should be assessed for salmonid habitat to determine if it's a priority restoration project.

- Continue restoration of riparian and upland forests in drainages having the greatest salmonid diversity and stage-based use. Use current fisheries data as a factor in ranking future high-priority restoration areas, especially spatial and density information provided in Walkley and Garwood (2017).

- Conduct a modern inventory of large woody debris densities throughout the anadromous portions of Mill Creek. It will take many decades for riparian forests in upper Mill Creek to deliver large conifer woody debris to stream channels at a rate defined by natural processes. A complete inventory would inform future wood loading mitigation projects in portions of Mill Creek lacking these important features. Over 80 complex jams were placed throughout the East Fork Mill Creek basin since 2009 in order to create spawning and rearing habitat, while the West Branch was largely untreated. These complex jams likely were effective in benefiting Coho Salmon. McLeod and Howard (2010) report that the abundance of Coho Salmon smolts increased in the East Fork after the installation of these complex jams. Our data show that overwinter survival of Coho Salmon was greater in the East Fork than the West Branch for three out of 4 years.

- Address sediment accumulation in portions of the West Branch Mill Creek valley that result in a seasonal loss of surface water connectivity spanning approximately one kilometer of stream channel.

- Enable natural channel meandering and re-establish channel-floodplain connectivity throughout the lower portions of the East Fork and West Branch within the former Mill Site where channels have been extensively straightened and hardened with rip-rap to protect former mill infrastructure. Identify historic channel configurations that existed prior to Mill construction for planning purposes. Remove unnecessary paved areas and buildings around the old mill site, totaling roughly 12 hectares, to reduce rapid impervious surface runoff and promote infiltration and groundwater storage.

- Relocate the Westbranch Road and bridge that crosses the East Fork Mill Creek near the confluence of Kelley Creek. This bridge and road prism were built across a wide alluvial valley greatly reducing the migration potential and flood plain connectivity of the stream. These broad floodplain features are rare and provide dynamic off-channel salmonid rearing habitats and food during winter when juvenile salmonid survival is lowest.

- Continue PIT tagging juvenile Coho Salmon in the fall and operate PIT tag antennas in Mill Creek and Smith River plain/estuary. We have documented a significant number of Coho Salmon sub-yearlings and yearlings moving within and out of the Mill Creek Basin. Our results show spring smolt outmigrant trapping alone likely will not estimate total smolt production because a significant portion of the population may leave before trapping begins. Additionally, a more powerful PIT tag antenna should be installed in lower Mill Creek to better detect juvenile and adult salmonid movements.

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FEDERAL REGISTER NOTICES:

“Endangered and Threatened Species: Threatened Status for Southern Oregon/Northern California Coast Evolutionarily Significant Unit (ESU) of Coho Salmon”, 62 FR 24588, May 6, 1997.

Appendix A

Total counts of non-salmonids captured at the Rotary Screw Trap in Mill Creek, Smith River, CA during four years of operation from 2014 through 2017.

		2014	2015	2016	2017
Common Name	**Stage**	**Captured**	**Captured**	**Captured**	**Captured**
Klamath Smallscale Sucker	resident	12	1299	1432	522
Pacific Lamprey	larvae	3	0	8	13
	adult	11	13	14	28
Western Brook Lamprey	resident	1	0	0	1
Unidentified lamprey	larvae	5	11	5	0
Coast Range Sculpin	resident	54	142	92	125
Prickly sculpin	resident	102	127	198	184
Unidentified sculpin	resident	5	90	77	27
Three-spined Stickleback	resident	2	35	30	16
Unidentified crayfish	resident	0	0	0	7
Coastal Giant Salamander	larvae	4	1	2	9
	sub-adult	6	7	3	23
Ensatina	adult	0	0	0	1
Foothill Yellow-legged Frog	YOY	0	1	0	0
	adult	1	0	1	0

Appendix B

2014 Mill Creek outmigrant trap marking strata dates, number of unmarked individuals captured (C) and number of marked (M) Coho Salmon, steelhead and Coastal Cutthroat Trout released upstream of the Mill Creek outmigrant trap from March through June and DARR data matrices.

2014 Marking Stratum	Start Date	End Date	Clip	Coho Salmon		Steelhead		Cutthroat	
				C[1]	M[2]	C	M	C	M
12	3/17/2014	3/23/2014	UHC	19	18	32	24	1	1
13	3/24/2014	3/30/2014	UVC	48	39	71	9	4	4
14	3/31/2014	4/6/2014	LHC	63	62	42	7	5	3
15	4/7/2014	4/13/2014	LVC	76	74	57	10	12	6
16	4/14/2014	4/20/2014	UHC	40	38	43	13	10	6
17	4/21/2014	4/27/2014	UVC	205	158	37	7	26	15
18	4/28/2014	5/4/2014	LHC	149	147	21	2	11	2
19	5/5/2014	5/11/2014	LVC	377	291	7	1	6	0
20	5/12/2014	5/18/2014	UHC	122	115	2	1	7	2
21	5/19/2014	5/25/2014	UVC	504	402	2	0	13	0
22	5/26/2014	6/1/2014	LHC	426	190	1	0	13	1
23	6/2/2014	6/8/2014	LVC	97	76	2	0	4	0
24	6/9/2014	6/15/2014	UHC	46	43	1	0	1	0
25	6/16/2014	6/22/2014	UVC	14	6	2	0	0	0
26	6/23/2014	6/29/2014	LHC	2	0	0	0	0	0

[1]Total number of captured unmarked individuals includes mortalities and first captures of Fall-tagged Coho Salmon.

[2]Total marked individuals released upstream of RST during each marking stratum.

2014 Coho Salmon DARR input matrix			12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
release strata	unmarked captured	marked released															
12	19	18	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0
13	48	39	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
14	63	62	0	0	0	2	4	2	0	0	0	0	0	0	0	0	0
15	76	74	0	0	0	16	3	6	2	0	0	0	0	0	0	0	0
16	40	38	0	0	0	0	2	3	1	1	0	0	0	0	0	0	0
17	205	158	0	0	0	0	0	23	8	4	0	0	0	0	0	0	0
18	149	147	0	0	0	0	0	0	8	24	0	1	0	0	0	0	0
19	377	291	0	0	0	0	0	0	0	57	13	2	5	0	0	0	0
20	122	115	0	0	0	0	0	0	0	0	13	24	2	0	0	0	0
21	504	402	0	0	0	0	0	0	0	0	0	114	73	4	0	0	0
22	426	190	0	0	0	0	0	0	0	0	0	0	83	14	4	1	0
23	97	76	0	0	0	0	0	0	0	0	0	0	0	20	6	3	1
24	46	43	0	0	0	0	0	0	0	0	0	0	0	0	7	9	0
25	14	6	0	0	0	0	0	0	0	0	0	0	0	0	0	3	0
26	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

2014 Steelhead DARR input matrix			12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
release strata	unmarked captured	marked released															
12	32	24	3	4	0	0	0	0	0	0	0	0	0	0	0	0	0
13	71	9	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0
14	42	7	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
15	57	10	0	0	0	4	2	1	0	0	0	0	0	0	0	0	0
16	43	13	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0
17	37	7	0	0	0	0	0	2	0	0	0	0	0	0	0	0	0
18	21	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
19	7	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	2	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

2014 Cutthroat DARR input matrix			12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
release strata	unmarked captured	marked released															
12	1	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
13	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	5	3	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0
15	12	6	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
16	10	6	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0
17	26	15	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
18	11	2	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0
19	6	0	0	0	0	0	0	0	0	3	0	0	0	0	0	0	0
20	7	2	0	0	0	0	0	0	0	0	0	3	0	0	0	0	0
21	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	13	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix C

2015 Mill Creek outmigrant trap marking strata dates, number of unmarked individuals captured (C) and number of marked (M) Coho Salmon, steelhead and Coastal Cutthroat Trout released upstream of the Mill Creek outmigrant trap from March through June and DARR data matrices.

2015 Marking Stratum	Start Date	End Date	Clip	Coho Salmon		Steelhead		Cutthroat	
				C[1]	M[2]	C	M	C	M
12	3/17/2015	3/22/2015	UHC	10	10	117	55	8	7
13	3/23/2015	3/29/2015	LHC	36	36	76	63	19	17
14	3/30/2015	4/4/2015	UVC	13	11	86	80	12	10
15	4/5/2015	4/11/2015	LVC	65	57	92	80	63	41
16	4/12/2015	4/18/2015	UHC	214	194	76	64	73	43
17	4/19/2015	4/25/2015	LHC	241	218	52	46	101	75
18	4/26/2015	5/2/2015	UVC	260	203	27	25	155	83
19	5/3/2015	5/9/2015	LVC	598	283	14	13	159	88
20	5/10/2015	5/16/2015	UHC	879	263	7	7	87	54
21	5/17/2015	5/23/2015	LHC	731	257	9	2	85	43
22	5/24/2015	5/29/2015	UVC	262	185	5	1	52	25
23	5/30/2015	6/6/2015	LVC	148	138	0	0	31	14
24	6/7/2015	6/15/2015	UHC	72	53	0	0	8	2

[1]Total number of captured unmarked individuals includes mortalities and first captures of Fall-tagged Coho Salmon.

[2]Total marked individuals released upstream of RST during each marking stratum.

2015 Coho Salmon DARR input matrix			12	13	14	15	16	17	18	19	20	21	22	23	24
release strata	unmarked captured	marked released													
12	10	10	0	1	0	0	0	0	0	0	0	0	0	0	0
13	36	36	0	4	0	0	1	0	0	0	0	0	0	0	0
14	13	11	0	0	1	1	2	1	0	0	0	0	0	0	0
15	65	57	0	0	0	1	6	3	0	0	0	0	0	0	0
16	214	194	0	0	0	0	20	25	3	3	0	0	0	0	0
17	241	218	0	0	0	0	0	31	17	7	6	0	0	0	0
18	260	203	0	0	0	0	0	0	42	33	15	4	0	0	0
19	598	283	0	0	0	0	0	0	0	113	70	28	1	0	0
20	879	263	0	0	0	0	0	0	0	0	94	67	6	2	0
21	731	257	0	0	0	0	0	0	0	0	0	100	48	6	1
22	262	185	0	0	0	0	0	0	0	0	0	0	60	24	1
23	148	138	0	0	0	0	0	0	0	0	0	0	0	39	1
24	72	53	0	0	0	0	0	0	0	0	0	0	0	0	9

2015 Steelhead DARR input matrix			12	13	14	15	16	17	18	19	20	21	22	23	24
release strata	unmarked captured	marked released													
12	117	55	5	8	1	1	0	0	0	0	0	0	0	0	0
13	76	63	0	2	7	2	3	0	0	0	0	0	0	0	0
14	86	80	0	0	13	5	1	0	0	0	0	0	0	0	0
15	92	80	0	0	0	7	6	0	0	0	0	0	0	0	0
16	76	64	0	0	0	0	5	3	0	0	0	0	0	0	0
17	52	46	0	0	0	0	0	10	2	1	0	0	0	0	0
18	27	25	0	0	0	0	0	0	3	3	0	0	0	0	0
19	14	13	0	0	0	0	0	0	0	1	1	0	1	0	0
20	7	7	0	0	0	0	0	0	0	0	1	2	0	0	0
21	9	2	0	0	0	0	0	0	0	0	0	1	0	0	0
22	5	1	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

2015 Cutthroat DARR input matrix			12	13	14	15	16	17	18	19	20	21	22	23	24
release strata	unmarked captured	marked released													
12	8	7	2	0	0	0	0	0	0	0	0	0	0	0	0
13	19	17	0	0	1	0	0	0	0	0	0	0	0	0	0
14	12	10	0	0	1	0	0	0	0	0	0	0	0	0	0
15	63	41	0	0	0	3	1	0	1	0	0	0	0	0	0
16	73	43	0	0	0	0	3	2	2	0	0	0	0	0	0
17	101	75	0	0	0	0	0	5	5	5	1	0	0	0	0
18	155	83	0	0	0	0	0	0	12	2	0	4	0	0	0
19	159	88	0	0	0	0	0	0	0	18	11	3	3	0	0
20	87	54	0	0	0	0	0	0	0	0	7	9	4	1	0
21	85	43	0	0	0	0	0	0	0	0	0	2	3	1	1
22	52	25	0	0	0	0	0	0	0	0	0	0	4	2	0
23	31	14	0	0	0	0	0	0	0	0	0	0	0	3	0
24	8	2	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix D

2016 Mill Creek outmigrant trap marking strata dates, number of unmarked individuals captured (C) and number of marked (M) Coho Salmon, steelhead and Coastal Cutthroat Trout released upstream of the Mill Creek outmigrant trap from March through June and DARR data matrices.

2016 Marking Stratum	Start Date	End Date	Clip	Coho Salmon		Steelhead		Cutthroat	
				C[1]	M[2]	C	M	C	M
12	3/17/2016	3/19/2016	UHC	26	24	30	29	13	13
13	3/20/2016	3/26/2016	LHC	24	24	64	64	6	6
14	3/27/2016	4/2/2016	UVC	87	87	95	94	31	28
15	4/3/2016	4/9/2016	LVC	81	79	65	63	12	12
16	4/10/2016	4/16/2016	UHC	49	49	34	33	21	18
17	4/17/2016	4/23/2016	LHC	90	89	42	40	41	35
18	4/24/2016	4/30/2016	UVC	189	164	32	32	23	19
19	5/1/2016	5/7/2016	LVC	382	233	27	25	35	27
20	5/8/2016	5/14/2016	UHC	272	180	15	14	42	38
21	5/15/2016	5/21/2016	LHC	492	297	7	7	29	28
22	5/22/2016	5/28/2016	UVC	216	177	0	0	9	9
23	5/29/2016	6/4/2016	LVC	160	123	0	0	7	7
24	6/5/2016	6/11/2016	UHC	91	81	3	2	5	2
25	6/12/2016	6/18/2016	LHC	43	29	1	1	8	4

[1]Total number of captured unmarked individuals includes mortalities and first captures of Fall-tagged Coho Salmon.

[2]Total marked individuals released upstream of RST during each marking stratum.

2016 Coho Salmon DARR input matrix			12	13	14	15	16	17	18	19	20	21	22	23	24	25
release strata	unmarked captured	marked released														
12	26	24	2	0	0	1	0	0	0	0	0	0	0	0	0	0
13	24	24	0	1	1	1	1	0	0	0	0	0	0	0	0	0
14	87	87	0	0	6	5	1	2	0	0	0	0	0	0	0	0
15	81	79	0	0	0	4	3	5	2	0	0	0	0	0	0	0
16	49	49	0	0	0	0	6	1	1	6	0	0	0	0	0	0
17	90	89	0	0	0	0	0	15	17	2	1	0	0	0	0	0
18	189	164	0	0	0	0	0	0	22	35	2	1	0	0	0	0
19	382	233	0	0	0	0	0	0	0	51	31	14	3	0	0	0
20	272	180	0	0	0	0	0	0	0	0	32	35	2	0	0	0
21	492	297	0	0	0	0	0	0	0	0	0	62	31	1	2	0
22	216	177	0	0	0	0	0	0	0	0	0	0	32	13	0	0
23	160	123	0	0	0	0	0	0	0	0	0	0	0	29	2	0
24	91	81	0	0	0	0	0	0	0	0	0	0	0	0	16	9
25	43	29	0	0	0	0	0	0	0	0	0	0	0	0	0	12

2016 Steelhead DARR input matrix			12	13	14	15	16	17	18	19	20	21	22	23	24	25
release strata	unmarked captured	marked released														
12	30	29	1	2	0	1	0	0	0	0	0	0	0	0	0	0
13	64	64	0	2	6	2	0	0	0	0	0	0	0	0	0	0
14	95	94	0	0	8	5	2	0	0	0	0	0	0	0	0	0
15	65	63	0	0	0	18	3	0	0	0	0	0	0	0	0	0
16	34	33	0	0	0	0	7	1	1	2	0	0	0	0	0	0
17	42	40	0	0	0	0	0	17	8	1	1	0	0	0	0	0
18	32	32	0	0	0	0	0	0	3	5	0	0	0	0	0	0
19	27	25	0	0	0	0	0	0	0	6	3	0	0	0	0	0
20	15	14	0	0	0	0	0	0	0	0	3	0	0	0	0	0
21	7	7	0	0	0	0	0	0	0	0	0	1	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	3	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0

2016 Cutthroat DARR input matrix			12	13	14	15	16	17	18	19	20	21	22	23	24	25
release strata	unmarked captured	marked released														
12	13	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	6	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	31	28	0	0	1	1	0	0	0	0	0	0	0	0	0	0
15	12	12	0	0	0	2	0	1	0	0	0	0	0	0	0	0
16	21	18	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	41	35	0	0	0	0	0	2	3	1	1	0	0	0	0	0
18	23	19	0	0	0	0	0	0	2	2	2	1	0	0	0	0
19	35	27	0	0	0	0	0	0	0	1	3	0	0	0	0	0
20	42	38	0	0	0	0	0	0	0	0	4	1	0	1	0	0
21	29	28	0	0	0	0	0	0	0	0	0	3	1	0	0	0
22	9	9	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	7	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	5	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	8	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix E

2017 Mill Creek outmigrant trap marking strata dates, number of unmarked individuals captured (C) and number of marked (M) Coho Salmon, steelhead and Coastal Cutthroat Trout released upstream of the Mill Creek outmigrant trap from March through June and DARR data matrices.

2017 Marking Stratum	Start Date	End Date	Clip	Coho Salmon		Steelhead		Cutthroat	
				C[1]	M[2]	C	M	C	M
11	3/12/2017	3/18/2017	UHC	6	6	13	13	0	0
12	3/19/2017	3/25/2017	LHC	62	59	39	37	12	12
13	3/26/2017	4/1/2017	UVC	14	12	26	25	14	14
14	4/2/2017	4/8/2017	LVC	35	34	105	101	34	33
15	4/9/2017	4/15/2017	UHC	31	31	23	20	28	27
16	4/16/2017	4/22/2017	LHC	34	34	11	11	21	21
17	4/23/2017	4/29/2017	UVC	43	43	10	10	7	7
18	4/30/2017	5/6/2017	LVC	51	50	11	11	54	52
19	5/7/2017	5/13/2017	UHC	165	114	21	20	112	110
20	5/14/2017	5/20/2017	LHC	382	226	15	14	71	69
21	5/21/2017	5/27/2017	UVC	376	176	3	3	86	85
22	5/28/2017	6/3/2017	LVC	193	142	2	2	38	31
23	6/4/2017	6/10/2017	UHC	74	72	0	0	19	19
24	6/11/2017	6/17/2017	LHC	49	46	0	0	22	22
25	6/18/2017	6/24/2017	UVC	22	20	0	0	44	41
26	6/25/2017	7/1/2017	LVC	5	0	2	0	13	0

[1]Total number of captured unmarked individuals includes mortalities and first captures of Fall-tagged Coho Salmon.

[2]Total marked individuals released upstream of RST during each marking stratum.

2017 Coho Salmon DARR input matrix			11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
release strata	unmarked captured	marked released																
11	6	6	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	62	59	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	14	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	35	34	0	0	0	3	2	0	0	0	0	0	0	0	0	0	0	0
15	31	31	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	34	34	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
17	43	43	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0
18	51	50	0	0	0	0	0	0	0	5	1	1	0	0	0	0	0	0
19	165	114	0	0	0	0	0	0	0	0	20	19	0	0	0	0	0	0
20	382	226	0	0	0	0	0	0	0	0	0	43	22	0	0	0	0	0
21	376	176	0	0	0	0	0	0	0	0	0	0	40	13	0	1	0	0
22	193	142	0	0	0	0	0	0	0	0	0	0	0	43	7	0	0	1
23	74	72	0	0	0	0	0	0	0	0	0	0	0	0	16	6	0	0
24	49	46	0	0	0	0	0	0	0	0	0	0	0	0	0	14	4	0
25	22	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	2
26	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

2017 Steelhead DARR input matrix			11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
release strata	unmarked captured	marked released																
11	13	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	39	37	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	26	25	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0
14	105	101	0	0	0	7	4	0	0	0	0	0	0	0	0	0	0	0
15	23	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	11	11	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0
17	10	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	11	11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	21	20	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0
20	15	14	0	0	0	0	0	0	0	0	0	2	1	0	0	0	0	0
21	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
24	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
25	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
26	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

2017 Cutthroat DARR input matrix			11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26
release strata	unmarked captured	marked released																
11	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	12	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	14	14	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	34	33	0	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0
15	28	27	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	21	21	0	0	0	0	0	1	0	0	3	0	0	0	0	0	0	0
17	7	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	54	52	0	0	0	0	0	0	0	6	2	1	1	0	0	0	0	0
19	112	110	0	0	0	0	0	0	0	0	3	4	2	0	0	0	0	0
20	71	69	0	0	0	0	0	0	0	0	0	5	8	0	1	0	0	0
21	86	85	0	0	0	0	0	0	0	0	0	0	2	4	0	0	0	0
22	38	31	0	0	0	0	0	0	0	0	0	0	0	0	2	0	1	0
23	19	19	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0
24	22	22	0	0	0	0	0	0	0	0	0	0	0	0	0	2	3	0
25	44	41	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	1
26	13	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Appendix F

Descriptive statistics for Coho Salmon young-of-the-year captured in the Mill Creek rotary screw trap from March through June in 2014-2017.

Year		Fork Length (mm)					Date			
		n	Mean	Min	Max	SD	N	Min	Max	Mean
2014	Mar	0	-	-	-	-	0	-	-	-
	Apr	79	35.4	31	39	2	86	20-Apr	30-Apr	25-Apr
	May	105	35.5	31	44	2.7	156	1-May	30-May	9-May
	Jun	20	50.9	42	60	4.8	24	1-Jun	26-Jun	19-Jun
	Total	204	37	31	60	5.4	266	20-Apr	26-Jun	8-May
2015	Mar	11	35.6	27	39	3.2	11	17-Mar	26-Mar	22-Mar
	Apr	252	36.3	27	59	2.8	300	1-Apr	30-Apr	17-Apr
	May	62	38	30	67	6	63	8-May	30-May	16-May
	Jun	2	54	52	56	2.8	9	6-Jun	15-Jun	12-Jun
	Total	327	36.7	27	67	3.9	383	17-Mar	15-Jun	23-Apr
2016	Mar	107	35.3	31	41	1.9	135	19-Mar	31-Mar	28-Mar
	Apr	356	35.5	30	47	2.2	821	1-Apr	30-Apr	12-Apr
	May	108	38.5	31	55	5.6	142	1-May	31-May	7-May
	Jun	36	54.6	42	69	6.4	60	1-Jun	18-Jun	9-Jun
	Total	607	37.1	30	69	5.7	1158	19-Mar	18-Jun	16-Apr
2017	Mar	57	36.4	28	40	2.4	58	19-Mar	31-Mar	26-Mar
	Apr	354	35.3	31	41	1.7	530	1-Apr	30-Apr	19-Apr
	May	86	39.4	31	61	6.3	87	1-May	31-May	15-May
	Jun	24	49.9	30	70	8.5	24	1-Jun	30-Jun	19-Jun
	Total	521	36.8	28	70	4.8	699	19-Mar	30-Jun	22-Apr
Grand Total		1659	36.9	27	70	5	2506	17-Mar	30-Jun	22-Apr

Appendix G

Descriptive statistics for Coho Salmon smolts captured in the Mill Creek rotary screw trap from March through June in 2014-2017.

Year		Fork Length (mm)					Weight (g)					Date			
		n	Mean	Min	Max	SD	n	Mean	Min	Max	SD	N	Min	Max	Mean
2014	Mar	67	94.7	72	135	11.1	59	10.1	4.5	22.9	3.4	67	21-Mar	27-Mar	24-Mar
	Apr	418	101.7	71	136	9.6	412	11.9	4.1	25.6	3.2	462	1-Apr	30-Apr	19-Apr
	May	1084	108.6	81	134	7.7	1031	14.1	6.2	26.1	2.9	1452	1-May	31-May	18-May
	Jun	167	108.7	91	124	6.3	159	14.2	8.6	22.3	2.4	207	1-Jun	26-Jun	6-Jun
	Total	1736	106.4	71	136	9.1	1661	13.4	4.1	26.1	3.2	2188	21-Mar	26-Jun	12-May
2015	Mar	56	95.0	71	114	9.6	55	10.0	3.8	18.8	3.2	56	17-Mar	31-Mar	25-Mar
	Apr	647	100.4	71	138	10.0	634	11.6	4.7	29.1	3.4	683	1-Apr	30-Apr	19-Apr
	May	845	103.3	82	141	8.0	820	12.1	6.2	31.5	2.8	2575	1-May	31-May	14-May
	Jun	91	102.3	90	117	4.8	55	12.0	8.3	17.6	1.8	215	1-Jun	15-Jun	6-Jun
	Total	1639	101.8	71	141	9.0	1564	11.8	3.8	31.5	3.1	3529	17-Mar	15-Jun	10-May
2016	Mar	108	95.9	72	134	11.7	108	10.6	4.1	25.4	4.1	111	17-Mar	31-Mar	25-Mar
	Apr	411	103.3	71	133	11.8	411	13.1	4.2	29.9	4.3	436	1-Apr	30-Apr	19-Apr
	May	788	106.1	83	132	8.1	766	13.4	6.4	26.2	3.0	1446	1-May	31-May	15-May
	Jun	33	108.0	91	126	8.0	25	13.5	9.3	22	2.8	214	1-Jun	18-Jun	7-Jun
	Total	1340	104.5	71	134	10.1	1310	13.1	4.1	29.9	3.6	2207	17-Mar	18-Jun	9-May
2017	Mar	80	91.9	66	128	12.0	77	9.4	3.5	25.7	4.1	80	17-Mar	31-Mar	22-Mar
	Apr	148	102.4	74	139	10.6	147	12.3	3.8	29.2	4.0	150	1-Apr	30-Apr	16-Apr
	May	664	106.5	80	143	8.7	664	13.3	5.5	29.4	3.3	1095	1-May	31-May	19-May
	Jun	195	103.7	79	127	7.2	190	11.8	5.8	18.7	2.4	217	1-Jun	28-Jun	9-Jun
	Total	1087	104.4	66	143	9.8	1078	12.6	3.5	29.4	3.5	1542	17-Mar	28-Jun	16-May
Grand Total		5802	104.3	66	143	9.6	5613	12.7	3.5	31.5	3.4	9466	17-Mar	28-Jun	11-May

Appendix H

Descriptive statistics for Steelhead Trout 1+ parr captured in the Mill Creek rotary screw trap from March through June in 2014-2017.

		Fork Length (mm)					Weight (g)					Date			
Year		n	Mean	Min	Max	SD	n	Mean	Min	Max	SD	N	Min	Max	Mean
2014	Mar	33	108.4	89	169	15.0	2	18.8	16.2	21.4	3.7	33	21-Mar	30-Mar	24-Mar
	Apr	262	109.6	81	153	11.4	0	-	-	-	-	287	1-Apr	30-Apr	18-Apr
	May	382	112.3	94	168	12.7	0	-	-	-	-	507	1-May	31-May	21-May
	Jun	300	114.2	95	161	12.8	0	-	-	-	-	317	1-Jun	26-Jun	11-Jun
	Total	977	112.0	81	169	12.6	2	18.8	16.2	21.4	3.7	1144	21-Mar	26-Jun	16-May
2015	Mar	54	114.0	100	177	15.6	0	-	-	-	-	54	17-Mar	31-Mar	26-Mar
	Apr	409	112.9	95	172	12.0	0	-	-	-	-	672	1-Apr	30-Apr	20-Apr
	May	555	114.4	99	158	11.8	0	-	-	-	-	1206	1-May	31-May	14-May
	Jun	58	113.4	86	143	10.4	0	-	-	-	-	82	1-Jun	15-Jun	6-Jun
	Total	1076	113.8	86	177	12.0	0	-	-	-	-	2014	17-Mar	15-Jun	6-May
2016	Mar	78	114.2	93	153	14.9	0	-	-	-	-	78	17-Mar	31-Mar	26-Mar
	Apr	259	115.3	79	162	13.9	0	-	-	-	-	272	1-Apr	30-Apr	13-Apr
	May	481	116.7	82	182	13.7	0	-	-	-	-	735	1-May	31-May	15-May
	Jun	192	115.8	94	154	11.9	0	-	-	-	-	252	1-Jun	18-Jun	8-Jun
	Total	1010	116.0	79	182	13.5	0	-	-	-	-	1337	17-Mar	18-Jun	10-May
2017	Mar	7	108.7	82	131	16.9	0	-	-	-	-	8	17-Mar	30-Mar	21-Mar
	Apr	114	113.8	95	142	11.8	1	12.6	12.6	12.6	-	116	1-Apr	30-Apr	12-Apr
	May	638	115.7	96	175	13.7	0	-	-	-	-	975	1-May	31-May	18-May
	Jun	394	113.1	94	160	12.1	0	-	-	-	-	477	1-Jun	30-Jun	12-Jun
	Total	1153	114.6	82	175	13.0	1	12.6	12.6	12.6	-	1576	17-Mar	30-Jun	22-May
Grand Total		4216	114.1	79	182	12.9	3	16.7	12.6	21.4	4.4	6071	17-Mar	30-Jun	13-May

Appendix I

Descriptive statistics for Steelhead Trout smolts captured in the Mill Creek rotary screw trap from March through June in 2014-2017.

			Fork Length (mm)					Weight (g)					Date			
Year		**N**	**n**	**Mean**	**Min**	**Max**	**SD**	**n**	**Mean**	**Min**	**Max**	**SD**	**N**	**Min**	**Max**	**Mean**
2014	Mar	103	103	165.0	140	206	13.0	0	-	-	-	-	103	21-Mar	27-Mar	24-Mar
	Apr	191	190	157.6	128	194	11.3	11	48.44	31.1	62	9.90	191	1-Apr	30-Apr	14-Apr
	May	21	21	156.5	138	195	14.2	1	44.70	44.7	44.7	-	21	1-May	28-May	7-May
	Jun	5	5	164.2	136	178	18.1	0	-	-	-	-	5	5-Jun	19-Jun	11-Jun
	Total	320	319	160.0	128	206	12.6	12	48.13	31.1	62	9.50	320	21-Mar	19-Jun	9-Apr
2015	Mar	221	182	172.7	79	208	17.9	0	-	-	-	-	221	17-Mar	31-Mar	23-Mar
	Apr	297	280	165.3	117	238	16.2	0	-	-	-	-	297	1-Apr	30-Apr	12-Apr
	May	43	39	151.1	126	171	11.0	0	-	-	-	-	43	1-May	25-May	12-May
	Jun	0	-	-	-	-	-	0	-	-	-	-	0	-	-	-
	Total	561	501	166.9	79	238	17.4	0	-	-	-	-	561	17-Mar	25-May	6-Apr
2016	Mar	166	166	167.6	60	263	21.9	42	54.77	30	96.3	15.59	166	17-Mar	31-Mar	25-Mar
	Apr	196	195	165.4	104	310	19.7	0	-	-	-	-	196	1-Apr	30-Apr	13-Apr
	May	49	48	157.2	130	186	9.7	0	-	-	-	-	49	1-May	18-May	7-May
	Jun	4	4	140.3	127	150	9.7	0	-	-	-	-	4	9-Jun	17-Jun	12-Jun
	Total	415	413	165.1	60	310	20.0	42	54.77	30	96.3	15.59	415	17-Mar	17-Jun	9-Apr
2017	Mar	66	66	167.1	141	197	13.7	54	53.08	33.3	87.6	12.41	66	17-Mar	31-Mar	21-Mar
	Apr	161	159	165.9	134	225	15.8	157	51.24	26.3	151.3	17.60	161	1-Apr	27-Apr	7-Apr
	May	52	49	158.1	134	191	10.8	48	41.57	27.8	72.1	9.53	52	1-May	31-May	12-May
	Jun	2	2	148.0	143	153	7.1	0	-	-	-	-	2	27-Jun	29-Jun	28-Jun
	Total	281	276	164.7	134	225	14.9	259	49.83	26.3	151.3	15.86	281	17-Mar	29-Jun	10-Apr
Grand Total		1577	1509	164.5	60	310	17.0	313	50.43	26.3	151.3	15.69	1577	17-Mar	29-Jun	8-Apr

Appendix J

Descriptive statistics for Coastal Cutthroat Trout 1+ parr captured in the Mill Creek rotary screw trap from March through June in 2014-2017.

Year		Fork Length (mm)					Weight (g)					Date			
		n	Mean	Min	Max	SD	n	Mean	Min	Max	SD	N	Min	Max	Mean
2014	Mar	55	130.2	80	191	23.9	1	9.40	9.4	9.4	-	59	21-Mar	30-Mar	25-Mar
	Apr	236	125.8	68	187	20.5	0	-	-	-	-	254	1-Apr	30-Apr	14-Apr
	May	153	136.0	100	185	16.8	0	-	-	-	-	156	1-May	31-May	18-May
	Jun	144	141.2	107	189	17.8	0	-	-	-	-	145	1-Jun	26-Jun	9-Jun
	Total	588	132.6	68	191	20.3	1	9.40	9.4	9.4	-	614	21-Mar	26-Jun	4-May
2015	Mar	47	131.3	81	175	22.1	0	-	-	-	-	47	17-Mar	31-Mar	24-Mar
	Apr	159	127.8	88	179	15.9	0	-	-	-	-	160	1-Apr	30-Apr	17-Apr
	May	258	133.3	50	189	15.3	0	-	-	-	-	332	1-May	31-May	12-May
	Jun	37	132.9	111	153	11.5	0	-	-	-	-	45	1-Jun	15-Jun	6-Jun
	Total	501	131.3	50	189	16.1	0	-	-	-	-	584	17-Mar	15-Jun	3-May
2016	Mar	30	121.9	90	160	16.0	0	-	-	-	-	30	17-Mar	30-Mar	25-Mar
	Apr	100	134.1	102	178	17.7	0	-	-	-	-	104	1-Apr	30-Apr	15-Apr
	May	190	136.2	51	190	17.5	0	-	-	-	-	220	1-May	31-May	15-May
	Jun	62	138.7	102	183	20.7	0	-	-	-	-	101	1-Jun	18-Jun	6-Jun
	Total	382	134.9	51	190	18.3	0	-	-	-	-	455	17-Mar	18-Jun	10-May
2017	Mar	25	122.4	90	154	16.5	9	28.92	20.6	39.6	6.14	25	17-Mar	31-Mar	23-Mar
	Apr	60	127.4	87	170	13.6	6	37.95	28.3	59.1	13.11	62	1-Apr	30-Apr	15-Apr
	May	294	128.2	85	172	14.5	0	-	-	-	-	305	1-May	31-May	15-May
	Jun	108	136.6	105	164	10.8	0	-	-	-	-	113	1-Jun	29-Jun	9-Jun
	Total	487	129.6	85	172	14.3	15	32.53	20.6	59.1	10.19	505	17-Mar	29-Jun	14-May
Grand Total		1958	132.0	50	191	17.6	16	31.09	9.4	59.1	11.42	2158	17-Mar	29-Jun	8-May

Appendix K

Descriptive statistics for Coastal Cutthroat Trout smolts captured in the Mill Creek rotary screw trap from March through June in 2014-2017.

Year		Fork Length (mm)					Weight (g)					Date			
Year		n	Mean	Min	Max	SD	n	Mean	Min	Max	SD	N	Min	Max	Mean
2014	Mar	5	160.6	141	187	19.9	1	32.80	32.8	32.8	-	5	23-Mar	27-Mar	25-Mar
	Apr	58	157.9	113	201	17.6	18	45.58	20.4	75.5	15.58	58	2-Apr	30-Apr	18-Apr
	May	45	159.2	119	199	16.5	1	45.00	45	45	-	45	1-May	31-May	17-May
	Jun	5	166.0	149	183	12.6	0	-	-	-	-	5	2-Jun	14-Jun	6-Jun
	Total	113	158.9	113	201	17.0	20	44.91	20.4	75.5	15.01	113	23-Mar	14-Jun	1-May
2015	Mar	32	165.2	130	214	18.9	0	-	-	-	-	32	17-Mar	31-Mar	25-Mar
	Apr	307	160.4	122	232	17.0	0	-	-	-	-	336	1-Apr	30-Apr	19-Apr
	May	404	155.5	118	206	15.8	0	-	-	-	-	450	1-May	31-May	11-May
	Jun	30	155.2	131	202	18.8	0	-	-	-	-	35	1-Jun	13-Jun	4-Jun
	Total	773	157.8	118	232	16.7	0	-	-	-	-	853	17-Mar	13-Jun	1-May
2016	Mar	44	166.4	126	238	23.5	5	72.10	48.4	125	31.33	44	17-Mar	31-Mar	24-Mar
	Apr	103	162.3	125	216	17.0	0	-	-	-	-	103	1-Apr	30-Apr	18-Apr
	May	120	164.7	110	212	16.8	0	-	-	-	-	120	1-May	31-May	12-May
	Jun	14	163.9	150	203	13.8	0	-	-	-	-	15	1-Jun	17-Jun	11-Jun
	Total	281	164.0	110	238	17.9	5	72.10	48.4	125	31.33	282	17-Mar	17-Jun	27-Apr
2017	Mar	24	154.2	123	198	20.9	24	42.16	19.6	81.3	16.44	24	19-Mar	31-Mar	24-Mar
	Apr	92	155.2	121	211	17.9	92	41.00	12.9	119.1	15.44	92	1-Apr	29-Apr	12-Apr
	May	315	156.2	110	230	15.4	306	41.88	21.5	117.5	13.18	340	1-May	31-May	15-May
	Jun	114	155.6	136	209	12.5	96	39.62	21.2	87	10.47	120	1-Jun	30-Jun	15-Jun
	Total	545	155.8	110	230	15.5	518	41.32	12.9	119.1	13.32	576	19-Mar	30-Jun	14-May
Grand Total		1712	158.3	110	238	16.8	543	41.74	12.9	125	13.90	1824	17-Mar	30-Jun	5-May

Appendix L

Descriptive statistics for Coastal Cutthroat Trout residents captured in the Mill Creek rotary screw trap from March through June in 2014-2017.

Year		Fork Length (mm)					Weight (g)					Date			
		n	Mean	Min	Max	SD	n	Mean	Min	Max	SD	N	Min	Max	Mean
2014	Mar	0	-	-	-	-	0	-	-	-	-	0	-	-	-
	Apr	5	239.0	145	340	88.0	1	26.00	26	26	-	5	6-Apr	23-Apr	14-Apr
	May	0	-	-	-	-	0	-	-	-	-	0	-	-	-
	Jun	6	206.7	163	345	68.4	0	-	-	-	-	6	6-Jun	21-Jun	11-Jun
	Total	11	221.4	145	345	75.6	1	26.00	26	26	-	11	6-Apr	21-Jun	15-May
2015	Mar	4	279.5	240	335	42.9	0	-	-	-	-	4	19-Mar	30-Mar	21-Mar
	Apr	9	291.8	214	390	60.1	0	-	-	-	-	9	9-Apr	28-Apr	17-Apr
	May	12	190.5	125	260	37.9	0	-	-	-	-	12	3-May	25-May	10-May
	Jun	0	-	-	-	-	0	-	-	-	-	0	-	-	-
	Total	25	241.2	125	390	67.7	0	-	-	-	-	25	19-Mar	25-May	24-Apr
2016	Mar	3	298.3	248	360	56.9	0	-	-	-	-	3	19-Mar	21-Mar	19-Mar
	Apr	2	260.5	225	296	50.2	0	-	-	-	-	2	5-Apr	7-Apr	6-Apr
	May	12	194.2	145	265	28.1	0	-	-	-	-	12	2-May	24-May	11-May
	Jun	2	198.0	163	233	49.5	0	-	-	-	-	2	11-Jun	18-Jun	14-Jun
	Total	19	218.0	145	360	53.1	0	-	-	-	-	19	19-Mar	18-Jun	2-May
2017	Mar	3	171.7	96	233	69.6	0	-	-	-	-	3	17-Mar	22-Mar	19-Mar
	Apr	4	263.8	204	289	40.1	3	181.93	86.3	242	83.72	4	8-Apr	17-Apr	11-Apr
	May	7	239.4	164	330	51.8	4	105.70	38.5	151.8	54.37	7	9-May	28-May	18-May
	Jun	4	269.5	219	343	53.2	0	-	-	-	-	4	3-Jun	22-Jun	8-Jun
	Total	18	240.2	96	343	58.8	7	138.37	38.5	242	73.99	18	17-Mar	22-Jun	4-May
Grand Total		73	231.9	96	390	62.9	8	124.33	26	242	79.19	73	17-Mar	22-Jun	2-May

Appendix M

Descriptive statistics for Coastal Cutthroat Trout anadromous adults captured in the Mill Creek rotary screw trap from March through June in 2014-2017.

		Fork Length (mm)					Weight (g)					Date			
Year		**n**	**Mean**	**Min**	**Max**	**SD**		**Mean**	**Min**	**Max**	**SD**		**Min**	**Max**	**Mean**
2014	Mar	3	286.3	254	350	55.1		-	-	-	-		21-Mar	27-Mar	23-Mar
	Apr	5	272.2	204	384	68.0		-	-	-	-		22-Apr	27-Apr	24-Apr
	May	2	309.5	256	363	75.7		-	-	-	-		26-May	31-May	28-May
	Jun	3	301.0	272	351	43.5		-	-	-	-		4-Jun	24-Jun	17-Jun
	Total	13	287.8	204	384	55.4	0	-	-	-	-	3	21-Mar	24-Jun	4-May
2015	Mar	0	-	-	-	-		-	-	-	-		-	-	-
	Apr	0	-	-	-	-		-	-	-	-		-	-	-
	May	0	-	-	-	-		-	-	-	-		-	-	-
	Jun	2	325.5	313	338	17.7		-	-	-	-		11-Jun	11-Jun	11-Jun
	Total	2	325.5	313	338	17.7	0	-	-	-	-		11-Jun	11-Jun	11-Jun
2016	Mar	1	238.0	238	238	-		-	-	-	-		30-Mar	30-Mar	30-Mar
	Apr	1	288.0	288	288	-		-	-	-	-		24-Apr	24-Apr	24-Apr
	May	0	-	-	-	-		-	-	-	-		-	-	-
	Jun	2	317.5	305	330	17.7		-	-	-	-		7-Jun	7-Jun	7-Jun
	Total	4	290.3	238	330	38.9	0	-	-	-	-		30-Mar	7-Jun	9-May
2017	Mar	0	-	-	-	-		-	-	-	-		-	-	-
	Apr	1	230.0	230	230	-		-	-	-	-		16-Apr	16-Apr	16-Apr
	May	0	-	-	-	-		-	-	-	-		-	-	-
	Jun	1	320.0	320	320	-		-	-	-	-		17-Jun	21-Jun	19-Jun
	Total	2	275.0	230	320	63.6	0	-	-	-	-		16-Apr	21-Jun	28-May
Grand Total		21	290.7	204	384	49.3	0	-	-	-	-	2	21-Mar	24-Jun	12-May

Appendix N

Descriptive statistics for unidentified trout young-of-the-year captured in the Mill Creek rotary screw trap from March through June in 2014-2017.

Year		Fork Length (mm)					Weight (g)					Date			
		n	Mean	Min	Max	SD	n	Mean	Min	Max	SD	N	Min	Max	Mean
2014	Mar	0	-	-	-	-	0	-	-	-	-	0	-	-	-
	Apr	9	32.4	31	34	1.1	0	-	-	-	-	11	23-Apr	26-Apr	24-Apr
	May	54	32.9	25	52	7.3	0	-	-	-	-	57	4-May	31-May	13-May
	Jun	268	50.9	29	66	7.6	0	-	-	-	-	1677	1-Jun	26-Jun	22-Jun
	Total	331	47.4	25	66	10.3	0	-	-	-	-	1745	23-Apr	26-Jun	20-Jun
2015	Mar	1	31.0	31	31	-	0	-	-	-	-	1	31-Mar	31-Mar	31-Mar
	Apr	6	27.8	27	29	0.8	0	-	-	-	-	10	6-Apr	24-Apr	11-Apr
	May	319	43.7	23	77	9.9	0	-	-	-	-	425	1-May	31-May	19-May
	Jun	85	54.1	34	71	7.4	0	-	-	-	-	703	1-Jun	15-Jun	12-Jun
	Total	411	45.6	23	77	10.5	0	-	-	-	-	1139	31-Mar	15-Jun	2-Jun
2016	Mar	1	18.0	18	18	-	0	-	-	-	-	1	18-Mar	18-Mar	18-Mar
	Apr	61	28.4	25	38	2.3	0	-	-	-	-	70	3-Apr	30-Apr	10-Apr
	May	218	43.4	24	70	12.2	0	-	-	-	-	501	1-May	31-May	25-May
	Jun	276	54.4	26	79	9.5	0	-	-	-	-	1794	1-Jun	18-Jun	8-Jun
	Total	556	47.2	18	79	13.2	0	-	-	-	-	2366	18-Mar	18-Jun	3-Jun
2017	Mar	0	-	-	-	-	0	-	-	-	-	0	-	-	-
	Apr	11	32.4	26	37	2.9	0	-	-	-	-	11	2-Apr	23-Apr	14-Apr
	May	232	31.5	26	61	5.7	0	-	-	-	-	330	4-May	31-May	25-May
	Jun	429	46.1	26	77	11.7	0	-	-	-	-	684	1-Jun	30-Jun	18-Jun
	Total	672	40.8	26	77	12.1	0	-	-	-	-	1025	2-Apr	30-Jun	10-Jun
Grand Total		1970	44.7	18	79	12.2	0	-	-	-	-	6275	19-Mar	30-Jun	9-Jun

Appendix O

Descriptive statistics for unidentified trout 1+ parr captured in the Mill Creek rotary screw trap from March through June in 2014-2017.

Year		Fork Length (mm)					Weight (g)					Date			
		n	Mean	Min	Max	SD	n	Mean	Min	Max	SD	N	Min	Max	Mean
2014	Mar	92	83.0	64	134	10.8	0	-	-	-	-	92	21-Mar	30-Mar	24-Mar
	Apr	474	83.5	51	104	8.6	0	-	-	-	-	550	3-Apr	30-Apr	18-Apr
	May	437	85.4	43	103	7.7	0	-	-	-	-	568	1-May	31-May	19-May
	Jun	181	88.1	55	152	11.8	0	-	-	-	-	193	1-Jun	26-Jun	9-Jun
	Total	1184	84.9	43	152	9.2	0	-	-	-	-	1403	21-Mar	26-Jun	6-May
2015	Mar	173	84.4	62	145	9.5	0	-	-	-	-	193	17-Mar	31-Mar	25-Mar
	Apr	453	87.5	65	103	7.7	0	-	-	-	-	836	1-Apr	30-Apr	18-Apr
	May	521	89.4	41	197	10.1	0	-	-	-	-	1158	1-May	31-May	14-May
	Jun	26	92.5	82	99	4.6	0	-	-	-	-	51	1-Jun	13-Jun	5-Jun
	Total	1173	88.0	41	197	9.2	0	-	-	-	-	2238	17-Mar	13-Jun	30-Apr
2016	Mar	118	82.3	62	99	9.2	0	-	-	-	-	120	17-Mar	31-Mar	26-Mar
	Apr	291	86.3	52	130	9.1	0	-	-	-	-	388	1-Apr	30-Apr	9-Apr
	May	270	90.4	52	130	7.2	0	-	-	-	-	380	1-May	31-May	14-May
	Jun	59	91.9	76	127	7.3	0	-	-	-	-	87	1-Jun	18-Jun	7-Jun
	Total	738	87.6	52	130	8.9	0	-	-	-	-	975	17-Mar	18-Jun	26-Apr
2017	Mar	38	76.6	52	96	12.6	0	-	-	-	-	40	17-Mar	31-Mar	22-Mar
	Apr	134	84.6	58	100	9.1	0	-	-	-	-	134	1-Apr	30-Apr	11-Apr
	May	601	88.6	50	102	7.5	0	-	-	-	-	851	1-May	31-May	17-May
	Jun	243	90.8	60	116	7.0	0	-	-	-	-	291	1-Jun	30-Jun	10-Jun
	Total	1016	88.2	50	116	8.3	0	-	-	-	-	1316	17-Mar	30-Jun	17-May
Grand Total		4111	87.1	41	197	9.0	0	-	-	-	-	5932	17-Mar	30-Jun	5-May

Appendix P

Descriptive statistics for Chinook Salmon Young-of-the-year captured in the Mill Creek rotary screw trap from March through June in 2014-2017.

Year		Fork Length (mm)					Date			
		n	Mean	Min	Max	SD	N	Min	Max	Mean
2014	Mar	0	-	-	-	-	0	-	-	-
	Apr	347	41.3	33	54	2.9	1377	3-Apr	30-Apr	22-Apr
	May	601	52.3	32	71	8.1	1728	1-May	31-May	20-May
	Jun	502	64.4	44	85	6.4	2204	1-Jun	26-Jun	15-Jun
	Total	1450	53.9	32	85	11	5309	3-Apr	26-Jun	24-May
2015	Mar	271	41.3	36	63	3.8	16106	17-Mar	31-Mar	21-Mar
	Apr	577	48	32	91	8.4	14481	1-Apr	30-Apr	15-Apr
	May	608	57.4	40	91	8.5	15731	1-May	31-May	15-May
	Jun	164	62.1	48	90	8.5	1079	1-Jun	15-Jun	8-Jun
	Total	1620	51.8	32	91	10.4	47397	17-Mar	15-Jun	18-Apr
2016	Mar	262	40	35	51	2.1	10265	17-Mar	31-Mar	26-Mar
	Apr	565	41.9	35	67	5.2	67264	1-Apr	30-Apr	9-Apr
	May	585	52	36	80	7.6	26529	1-May	31-May	18-May
	Jun	266	60.1	42	89	8.8	10738	1-Jun	18-Jun	7-Jun
	Total	1678	48	35	89	9.7	114796	17-Mar	18-Jun	22-Apr
2017	Mar	269	40.8	36	46	1.8	13654	17-Mar	31-Mar	22-Mar
	Apr	586	42.1	35	96	5.4	15553	1-Apr	30-Apr	14-Apr
	May	628	51.7	36	81	8.6	19256	1-May	31-May	17-May
	Jun	610	58.8	40	87	9.3	8504	1-Jun	30-Jun	14-Jun
	Total	2093	49.7	35	96	10.4	56967	17-Mar	30-Jun	29-Apr
Grand Total		6841	50.7	32	96	10.6	224469	17-Mar	30-Jun	24-Apr

Appendix Q

Descriptive statistics for adult Pacific Lamprey captured in the Mill Creek rotary screw trap from March through June in 2014-2017. Length (TL) was measured from most anterior tip of head to tip of tail.

Year		Length (mm)					Weight (g)					Date			
		n	Mean	Min	Max	SD	n	Mean	Min	Max	SD	N	Min	Max	Mean
2014	Mar	0	-	-	-	-	0	-	-	-	-	0	-	-	-
	Apr	2	435.0	410	460	35.4	0	-	-	-	-	2	7-Apr	12-Apr	9-Apr
	May	6	441.2	362	510	58.5	0	-	-	-	-	6	5-May	19-May	12-May
	Jun	2	528.0	460	596	96.2	0	-	-	-	-	3	1-Jun	22-Jun	10-Jun
	Total	10	457.3	362	596	66.8	0	-	-	-	-	11	7-Apr	22-Jun	14-May
2015	Mar	1	462.0	462	462	-	0	-	-	-	-	1	20-Mar	20-Mar	20-Mar
	Apr	4	442.0	342	512	72.0	0	-	-	-	-	4	12-Apr	29-Apr	17-Apr
	May	6	429.8	337	552	69.3	0	-	-	-	-	7	3-May	25-May	12-May
	Jun	1	440.0	440	440	-	0	-	-	-	-	1	2-Jun	2-Jun	2-Jun
	Total	12	437.4	337	552	60.7	0	-	-	-	-	13	20-Mar	2-Jun	2-May
2016	Mar	2	356.0	335	377	29.7	0	-	-	-	-	2	17-Mar	27-Mar	22-Mar
	Apr	8	433.6	390	475	29.1	0	-	-	-	-	9	1-Apr	29-Apr	14-Apr
	May	2	450.0	430	470	28.3	0	-	-	-	-	3	2-May	26-May	17-May
	Jun	0	-	-	-	-	0	-	-	-	-	0	-	-	-
	Total	12	423.4	335	475	41.5	0	-	-	-	-	14	17-Mar	26-May	18-Apr
2017	Mar	0	-	-	-	-	0	-	-	-	-	0	-	-	-
	Apr	0	-	-	-	-	0	-	-	-	-	0	-	-	-
	May	17	467.9	415	560	42.5	0	-	-	-	-	19	8-May	28-May	17-May
	Jun	4	480.5	435	545	48.0	0	-	-	-	-	9	1-Jun	19-Jun	6-Jun
	Total	21	470.3	415	560	42.6	0	-	-	-	-	28	8-May	19-Jun	24-May
Grand Total		55	450.5	335	596	53.7	0	-	-	-	-	66	18-Mar	22-Jun	10-May