California Coastal Salmonid Population Monitoring in the Russian River Watershed: 2024/2025

FRGP Grant # P2281002; Annual Report
Reporting Period: July 1, 2024 – June 30, 2025

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Executive Summary

On July 1, 2022, Sonoma Water (SW) and California Sea Grant (CSG) began implementation of a new contract that continues work begun in 2013 to monitor anadromous CCC Coho Salmon, CCC steelhead, and, to a lesser extent, CC Chinook Salmon in the Russian River watershed. Work was implemented in accordance with California Department of Fish and Wildlife (CDFW) Fish Bulletin 180, the California Coastal Salmonid Population Monitoring Plan (CMP, Adams et al. 2011). The CMP uses the Viable Salmonid Population (VSP; McElhany et. al. 2000) concept to assess salmonid viability in terms of four key population characteristics: abundance, productivity, spatial structure, and diversity. To accomplish CMP goals, we performed basin-wide spawner surveys, basin-wide snorkel surveys, and operated life cycle monitoring stations (LCSs) in four life cycle monitoring subwatersheds (LCMs) to measure status and trends in anadromous Coho Salmon and steelhead populations in the Russian River basin. With data generated from these field efforts, we estimated basin-wide adult Coho and steelhead redd abundance, basin-wide spatial structure of juvenile Coho, freshwater survival of successive

cohorts of Coho and steelhead in LCMs, and marine survival of successive cohorts of Coho and steelhead in LCMs within the Russian River watershed.

This annual report provides a summary of salmonid abundance at multiple life stages and at multiple spatial scales. We estimated Coho and steelhead smolt, adult and redd abundance in four subwatersheds (one LCS per subwatershed) and basin-wide redd abundance using spawner survey data collected from a GRTS-ordered random sample of reaches in the watershed containing habitat for both Coho and steelhead (Coho-steelhead stratum). Sonoma Water also operated a LCS at the Mirabel dam site on the mainstem Russian River at rkm 39.67 aimed at assessing status and trends of Chinook Salmon smolt and adult abundance in the mainstem Russian and tributaries upstream of the dam. The spatial structure of juvenile Coho populations in the Coho-steelhead sample stratum was estimated using snorkel counts from a GRTS-ordered random sample of reaches. We also attempted to estimate juvenile steelhead abundance using a modified basin-wide visual estimation technique (BVET) in the four LCMs. The goal of this annual report is to keep CDFW and other interested parties informed of the tasks accomplished in accordance with the primary activities and deliverables outlined in FRGP Grant # P2281002. Related monitoring conducted by CSG but funded by non-CDFW sources is reported in CSG (2004-2025).

Report Status

a) The funding agreement for this project was executed on June 21, 2022, and Amendment 1 was executed on July 21, 2023. The term of the grant is July 1, 2022 – June 30, 2025. The agreement between Sonoma Water and Regents of the University of California was executed on August 10, 2022.
b) This report covers: continuous PIT antenna monitoring, downstream migrant trapping conducted in spring 2024, snorkel surveys conducted in 2024, electrofishing surveys conducted in 2024, and spawner surveys conducted during the 2024/25 spawner season.
c) Issues or concerns affecting schedule and/or budget: None
d) Activities for the next reporting period:
    a. Monitoring coordination and planning
    b. Adult monitoring
    c. Juvenile and smolt monitoring
e) Financial Reporting/Invoices:

An invoice for work through June 30, 2025 will be submitted in the amount of $230,598.56.

Task Updates

Task 1. Monitoring Coordination and Planning

This task includes:

- overall project coordination and oversight of field activities;
- QA/QC of data;
- spatial and tabular database management and data accessibility;
- refinement of the Russian River sample frame as necessary;
- responding to data requests, map preparation and reporting;
- coordination with existing monitoring efforts in the watershed;
- coordination of technical advisory meetings.

General monitoring coordination and planning tasks were performed throughout the reporting period and included contacting landowners, scheduling field crews, training field personnel, preparation of reports, and coordination of field activities associated with spawner surveys, snorkel surveys and electrofishing surveys. Prior to each season of field work, training was provided to crews of technicians to inform new staff and reacquaint existing field staff with data collection protocols. Fish identification, survey techniques, field safety, landowner communication, and a short course in tablet computing were components of each training. After the completion of each season of field work, monitoring data were error checked, uploaded to tabular and spatial databases, and final estimates of redd, adult, and smolt abundance were calculated for LCM subwatersheds (Coho Salmon and steelhead) and smolt and adult abundance at the Russian River LCS (Chinook Salmon). Estimates of redd abundance were also calculated for the Russian River basin (Coho Salmon and steelhead), as well as estimates of juvenile spatial structure (Coho Salmon only). Data were shared with local CDFW and Army Corps staff for purposes of fish rescue, Coho Salmon broodstock collection and drought stressor monitoring. Data were also shared with habitat restoration practitioners including local Resource Conservation Districts and Trout Unlimited.

We recognize that stakeholder communication and funding agency buy-in are essential to the continued success of this project. To that end, we convened a meeting of the Russian River CMP Technical Advisory Committee (RRCMPTAC) on September 5, 2024. The general goals of this meeting were to update stakeholders on monitoring progress and obtain feedback from members of the statewide CMP team and other CMP practitioners concerning proper implementation of the CMP in the Russian River Basin. The meeting was well attended by over 20 individuals representing CDFW, CSG, Trout Unlimited (TU), NOAA, and SW. Topics for discussion included monitoring updates and summaries, past and future directions of Russian River CMP implementation, and the cost efficiency of different field study alternatives for accomplishing the goals of CMP.

Because the Russian River watershed is over 90% privately owned, obtaining landowner access permission and tracking landowner communications is also an important component of project coordination. In total, over 490 contacts were made during the current reporting period by phone, email, and personal communication to gain access from 130 new and existing landowners and property representatives. These contacts were made for securing temporary access for Sonoma Water field crews during the 2024 snorkel season, 2024 BVET survey season, and the 2024/25 spawner season. Contacts were also made to secure temporary access for partners including CDFW, local Resource Conservation Districts, and Trout Unlimited. All landowner contact records, contact information, response information and details about landowner preferences were stored in a relational database designed for that purpose. During spawner, snorkel and electrofishing seasons, parking spots, entry points, details of landowner access and other miscellaneous information were recorded and updated by field crews using Survey 123 (Esri) forms and stored in a relational database for ready access when planning and implementing field surveys.

Sampling Conditions

During the reporting period, we generally experienced sampling conditions that were conducive to salmonid smolt migration (late winter/spring 2024), over-summer survival of juveniles (summer/fall 2024), and upstream migration of adults (winter 2024/25, Figure 1, Figure 2). However, there were challenges for some of our monitoring efforts. Most notable were the late spring rains which made it difficult to install downstream migrant traps during the period encompassing the entire smolt migration period.

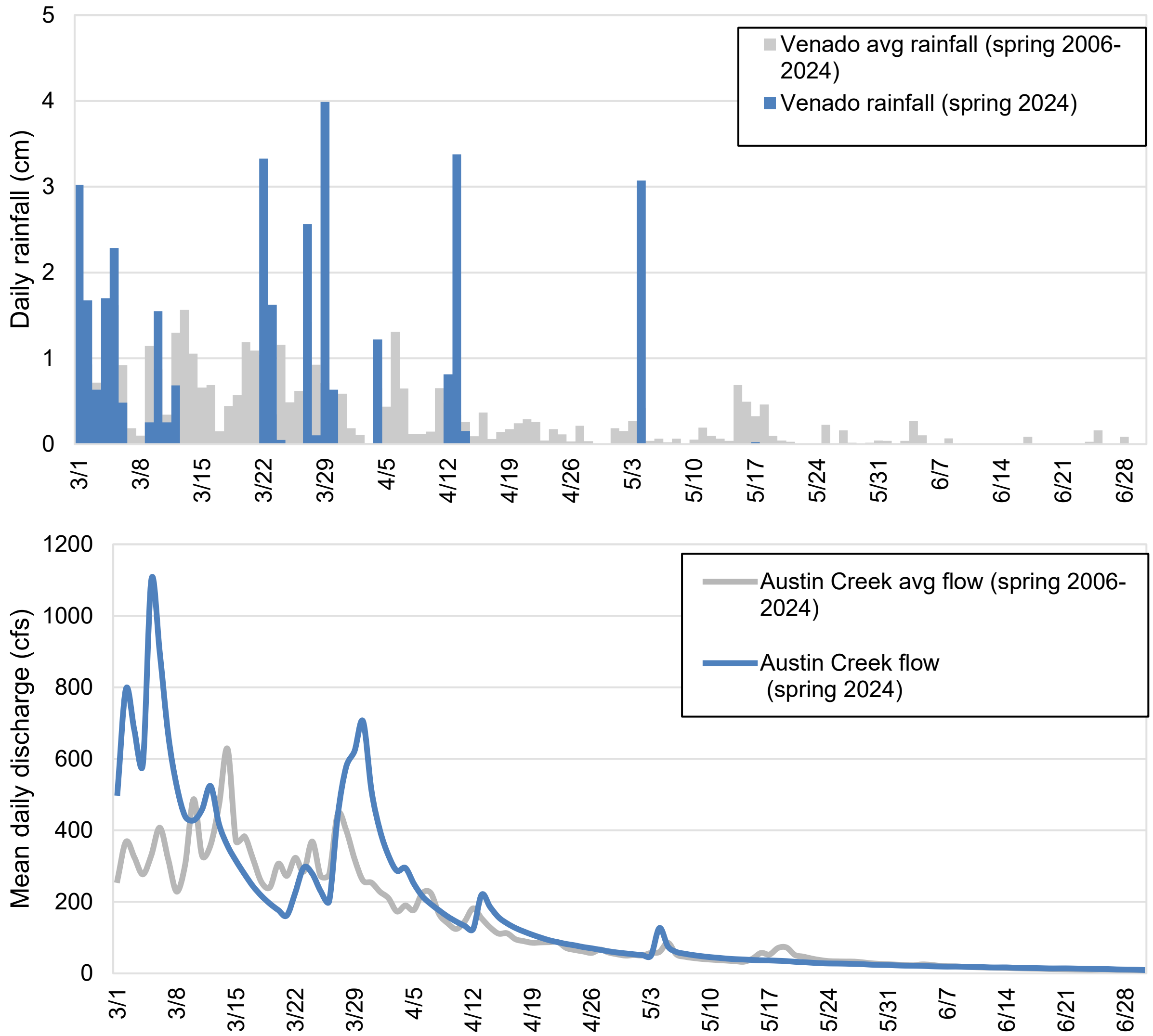


Figure 1. Historical and 2024 rainfall at Venado (upper panel) and stream discharge in Austin Creek USGS gage 11467200 (lower panel) during the spring smolt migration season.

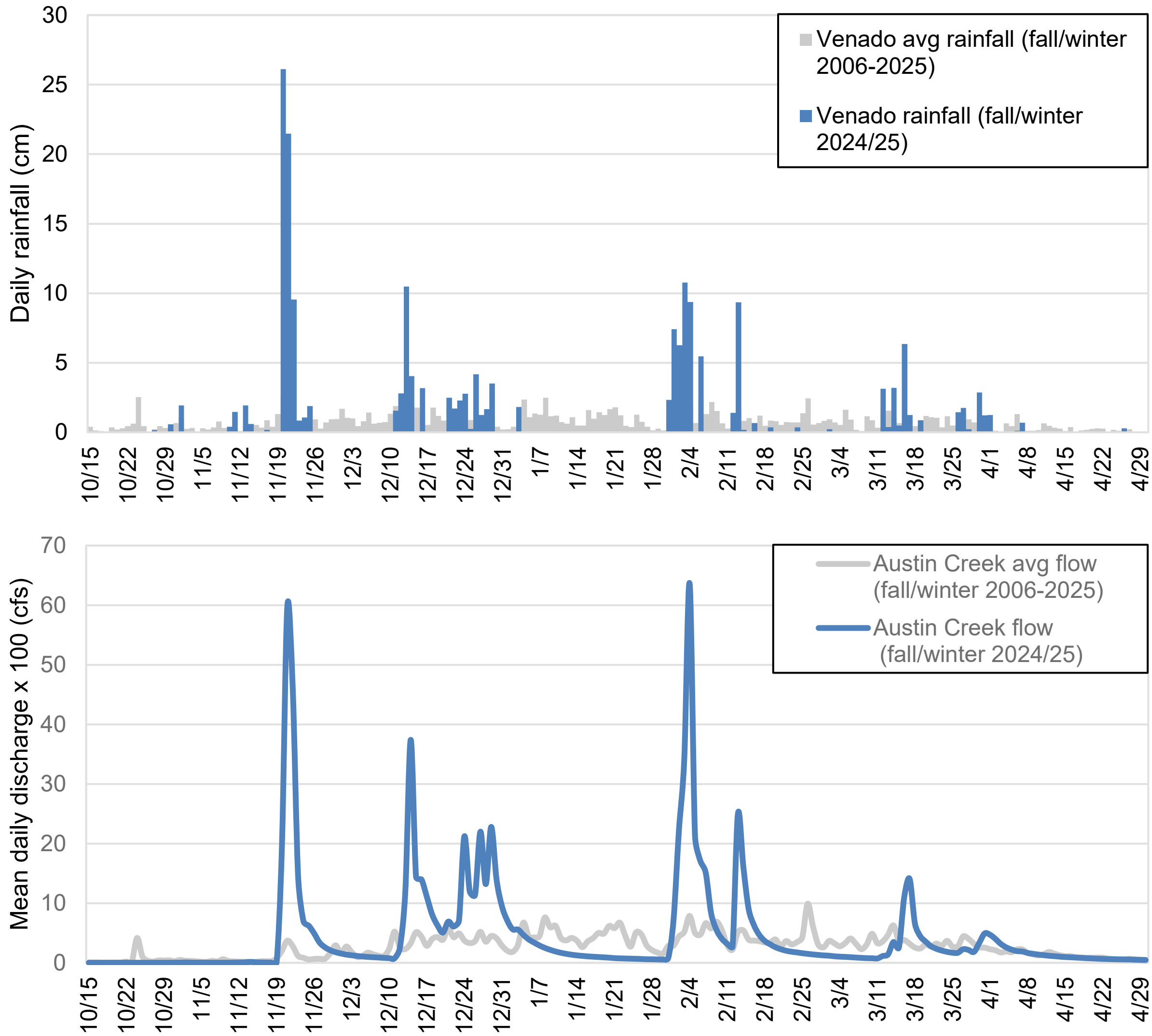


Figure 2. Historical and 2024/25 rainfall at Venado (upper panel) and stream discharge in Austin Creek USGS gage 11467200 (lower panel) during the fall/winter adult migration season.

Task 2. Life Cycle Monitoring

Introduction

This task and the associated data reported here includes:

- spawner surveys conducted during the 2024/25 spawner season in the four Coho-steelhead LCM subwatersheds (paid for by non-project funding sources through February 28);
- PIT antenna monitoring for adults and juveniles in the four Coho-steelhead LCM subwatersheds (paid for by non-project funding sources);

- downstream migrant trapping conducted in spring 2024 at five life cycle stations (LCSs) (paid for by non-project funding sources);
- basin-wide visual estimation technique monitoring during late summer 2024 in the four Coho-steelhead LCM subwatersheds (paid for by project funding source).

The objective of CMP life cycle monitoring is to detect trends in abundance of smolts and adults (Adams et al. 2011). The subwatersheds we selected for life cycle monitoring for Coho Salmon and steelhead are: Mill, Green Valley, Dutch Bill and Willow (Figure 3). These subwatersheds were chosen partly because of the substantial monitoring infrastructure already in place and the long-term datasets for juvenile and adult Coho abundance collected by CSG as part of Russian River Coho Salmon Captive Broodstock Program monitoring. Life cycle monitoring for Chinook was conducted on the mainstem Russian River at Sonoma Water's Mirabel dam (Figure 3). This site also has long-term datasets for smolt and adult Chinook abundance from monitoring infrastructure already in place.

We estimated Coho and Chinook smolt abundance using downstream migrant trapping methods like those described in FB 180. We operated downstream migrant traps (DSMT) on Mill Creek (rkm 2.01), Green Valley Creek (6.13 rkm), Dutch Bill Creek (rkm 0.68), and Willow Creek (rkm 3.70) for Coho smolts and at Sonoma Water's Mirabel dam site (rkm 28.11) on Russian River mainstem for Chinook smolts (Figure 3). Based on experience, in most years it is possible to generate robust estimates of Coho and Chinook smolt abundance from DSMTs alone because Coho and Chinook smolt migration typically occurs from March through June which coincides with a period when DSMTs can be successfully installed and operated.

A significant issue with relying on downstream migrant trapping for estimation of steelhead smolt abundance, however, is the fact that steelhead smolt migration occurs well before DSMTs can be safely installed and operated. If we were to rely on DSMTs alone, steelhead smolt abundance would be severely underestimated. To avoid this underestimation, we combined data from DSMTs with outputs from a pre-smolt steelhead abundance and survival model (SW and CSG 2015). This approach relies on steelhead smolt abundance estimates generated from late summer/early fall abundance estimates coupled with efficiency-adjusted detections of PIT-tagged steelhead at stationary PIT antenna arrays near the mouths of LCM streams throughout the ensuing winter. We began implementing this pre-smolt model in Mill in summer/fall 2018, and Green Valley, Dutch Bill and Willow in summer/fall 2019. Although we have been successful at detecting years with poor steelhead survival, producing quantitative estimates of steelhead smolt abundance has not always been possible.

We conducted census spawner surveys in Green Valley, Dutch Bill, and Willow and near-census spawner surveys in Mill to estimate Coho and steelhead redd abundance (some reaches in Mill were excluded because landowners adjacent to the creek would not allow access). We operated PIT antenna arrays at the mouths of all four Coho and steelhead LCM streams to estimate adult Coho abundance.

Figure 3. Coho Salmon and steelhead LCMs (shaded polygons) and downstream migrant traps coupled with stationary PIT antennas for each LCS. Blue line segments represent reaches containing habitat for one or more species.

Methods

Smolt abundance

Coho Salmon smolts Downstream migrant traps (funnel and/or pipe) were operated on Mill, Green Valley, Dutch Bill, and Willow creeks and a rotary screw trap was operated on mainstem Russian River during the spring when most of the Coho and Chinook Salmon smolt outmigration occurs and when the flows are conducive to safe trap operation. In Willow Creek, the trap site was relocated to river km 0.98 (Figure 3) from the original site (river km 3.70) because hatchery coho were released at river km 2.57, downstream of the original trap location. Traps were tended daily with additional checks during peak outmigration and when flow and/or debris load was high. PIT tags were applied to individuals and data were collected to assess smolt abundance at LCSs, population diversity, and to facilitate future estimation of marine survival and adult abundance. Specific protocols for fish handling, work-up, and PIT-tagging for Mill, Green Valley, Dutch Bill, and Willow creeks can be found in CSG (2004-2025).

A two-trap mark-recapture design and analytical methodology was used to estimate the total number of Coho Salmon smolts emigrating from each subwatershed during the trapping season (Bjorkstedt 2010) while the traps were operating. An antenna array located immediately upstream of each smolt trap acted as an upstream “trap” where fish were “marked” (marked fish=all PIT tag detections on antenna array), and the smolt trap served as a downstream trap where fish were recaptured. PIT-tagged fish detected at both the antenna array and captured in the trap were considered recaptures, and non-PIT-tagged fish and PIT-tagged fish only detected in the trap (but not the antenna) were considered unmarked fish.

Steelhead Smolts For steelhead smolt estimation each year in the four LCMs, we attempt to employ a smolt abundance model that is founded on abundance estimates of juvenile steelhead in each LCM in late summer/fall prior to a given steelhead smolt emigration season. Juvenile abundance estimates are from two-stage sampling following a modified basin-wide visual estimation technique (BVET) of Hankin and Reeves (1988). The first stage is visual sampling (snorkeling) in every other pool (i.e., every 2nd pool) of a given reach just prior to electrofishing (second stage sampling) in every nth pool in that same reach. On a given day when second stage sampling (backpack electrofishing) is set to occur, a pool is randomly selected as a “calibration” pool which is first snorkeled (single pass) to obtain a minimum count followed immediately by removal sampling (using backpack electrofishing) to obtain an abundance estimate in that same pool. The ratio of these two values is then used as a “calibration ratio” to expand snorkel counts conducted during the first stage sampling. For each stream, the expanded snorkel counts from each pool are summed and then doubled to account for the fact that only every other pool was snorkeled. This final number is then used as the estimated abundance of late summer/fall juveniles in each LCM. The final steps to arrive at smolt abundance come from a combination of efficiency-expanded detection counts at stationary PIT antennas located at the mouth of each LCM and operated year-round, which are, in turn, used to estimate survival from the juvenile to smolt stage (survival index). The survival index for each

LCM stream is then applied to the respective juvenile abundance estimate, yielding an estimate of smolts emigrating from each LCM stream. Detailed steps are described in SW and CSG (2020).

Chinook Salmon smolts At the mainstem Russian River trap site, regardless of whether the dam was inflated, we historically operated one to two rotary screw traps downstream of the dam that were attached to a cable anchored to each bank of the river. When the new vertical slot fish ladder was constructed on the west side of the river and the old Denil fish ladder on the east side was decommissioned, changes to the river channel downstream of the dam made it very difficult to fish traps in that same location. Before the dam is inflated in the spring and except for brief periods immediately prior to dam inflation, flows at this site are too high to allow personnel to safely access the trap, while after the dam is inflated water depths are too shallow to effectively operate the trap. After the dam is inflated, however, we can operate the trap immediately downstream (1-2 meters) of the fish ladder. Because the date of dam inflation varies considerably (early-April in drier years and late-May or June in wetter years), this substantially impacts the period of trap operation and can therefore impact our Chinook smolt abundance estimates.

In 2024 we operated a single rotary screw trap (1.5 m diameter cone) downstream of the dam for a brief period before the dam was inflated then immediately downstream of the downstream opening of the fish ladder on the west side of the river after the dam was inflated. Consequently, we only operated the trap for 8 days. All fish captured in the trap were identified to species and enumerated. The few Coho Salmon and steelhead captured that were ≥55 mm were scanned for a PIT tag and Coho were scanned for CWTs. A subsample of each species was anesthetized and measured for fork length (±1 mm) and mass (±0.1 g). Because the capture of Chinook smolts was so low, we did not attempt a mark-recapture estimate of abundance. All species were released downstream of the first riffle downstream of the trap. All anesthetized fish were allowed to recover fully in aerated buckets prior to release.

Adult Abundance

Coho Salmon adults PIT tagging of hatchery origin Coho smolts has occurred at the Don Claussen Fish Hatchery at Warm Springs Dam in some capacity since 2007. PIT-tagged fish are released into several Russian River tributaries, including the four LCM subwatersheds. In addition, we applied PIT tags to approximately 50% of all natural-origin Coho Salmon smolts captured in downstream migrant traps on LCMs. PIT-tagged fish are subject to detection when they return as adults at stationary PIT tag detection systems at a network of PIT antenna arrays including near the mouths of the four LCMs (Figure 3). Because these systems contain pairs (Mill, Green Valley, Dutch Bill) or triplet (Willow) antennas within an array that are oriented longitudinally along the stream channel, we can use detections on antennas within an array to estimate antenna efficiency. Antenna efficiency estimates are then used to expand the number of PIT antenna detections. Because we know the tagged to untagged ratio of juvenile/smolt Coho in the source population (i.e., at the hatchery or at downstream migrant traps), we can then use that ratio for a final expansion to arrive at an estimate for all adults returning to each LCM.

Estimates of the number of adult Coho Salmon returning to LCM subwatersheds were calculated by 1) counting the number of unique adult PIT tag detections on the lower antennas of each antenna array (minimum count), 2) dividing the minimum count for each stream by the proportion of PIT-tagged fish either released from the hatchery into each respective stream or tagged at the smolt trap (expanded count per stream), and 3) dividing the expanded count by the estimated efficiency of the lower antennas of each stream array (estimated count per stream). The efficiency of the lower antennas of each paired antenna array was estimated by dividing the number of detections on both upstream and downstream antennas by all detections on the upper antennas. Individual data recorded at the time of tagging was used to estimate the number of returns by release group (age and season of release).

Steelhead adults We use a similar approach to estimate adult steelhead abundance in LCMs, but this requires a significant juvenile steelhead PIT tagging effort in the fall (because of the lack of a large pool of PIT-tagged hatchery fish as is the case with Coho). A significant tagging effort was accomplished in Mill in 2017 and 2018, but this effort was not begun until 2019 in other LCM subwatersheds. Given the greater variability in life history strategies (e.g., age at smolting, length of estuary and marine residence, etc.) as compared to Coho, the age at which steelhead smolt return as adults is inconsistent leading to greater uncertainty in classifying detections as steelhead adults as compared to classifying detections as Coho adults.

First, we attempt to classify individuals as potential smolts when they are detected traveling downstream during the smolt migration season (December-May). This comes mainly from antenna detections of PIT-tagged fish at locations downstream of their tagging site but could come from captures at downstream migrant traps. Individuals are classified as potential adult spawner migrants when they are detected traveling upstream during the spawning season (October-May) after having been absent from the PIT detection record (days at large) for 9 months or longer.

Chinook Salmon adults The adult counting station for Chinook is located on the mainstem Russian River at Sonoma Water’s inflatable dam in Forestville (river km 28.11). Instead of PIT tags and PIT antennas, we use a continuous underwater video monitoring system in a fish ladder to count Chinook adults returning to the Russian River basin as they pass upstream of the Mirabel dam through the fish ladder. This site is downstream of habitat that most Chinook spawners use (Chase et al. 2007) and, in most years, the system is operated late enough into the season to encompass the majority of fish migrating past the dam. The monitoring system consists of an underwater video camera at the upstream end of a fish ladder located on the west side of the inflatable dam. The video system operated continuously throughout most of the adult Chinook migration period except for brief periods (seconds to minutes) when the camera was inoperable (e.g., due to power outages). All data were reviewed by technicians and counts of fish moving upstream through the ladder were recorded in a database. Installation of the video system occurred in early September prior to the onset of adult migration and removal occurred when Sonoma Water's inflatable dam was lowered for the season.

Redd Abundance (Coho Salmon and Steelhead)

We used protocols outlined in Adams et al. (2011) and Gallagher et al. (2007) to survey all LCMs and recorded salmonid redds, live adult fish, and carcasses (excluding some reaches and portions of reaches in Mill subwatershed where we were unable to secure landowner access). We attempted to sample reaches every 10-14 days, though storms and heavy rains (and subsequent turbidity) prevented crews from surveying at times. Our survey start dates coincided with the first rains of winter sufficient to connect tributary streams to the mainstem. The minimum visibility threshold for surveys was 0.5 m though some surveys were completed below this threshold depending on the size of the stream and if crews thought they could effectively identify redds and fish. Reaches were surveyed by two observers walking the reach from a downstream to upstream direction. When a redd was encountered it was measured (±0.1 m), marked with flagging, and a GPS location was recorded. Each redd was assigned a unique identification number. When live fish were encountered, species, length and condition were recorded. When carcasses were encountered, they were measured (±0.1 mm) and identified to species if possible. To avoid double-counting, carcasses were tagged with a metal hog tag on a piece of wire punched through the skin and around the spine just posterior of the dorsal fin. If possible, scale samples were collected and heads were removed for otolith collection. All carcasses, regardless of species, were scanned for PIT tags, coded wire tags (CWT), and examined for any fin clips or other markings that might indicate hatchery origin. GPS locations were collected for all live fish and carcass observations.

The species responsible for constructing a redd (redd species) as well as the observer's confidence in that species assignment (redd species certainty) was assigned to each redd observed in the field based on the presence of live fish associated with the redd or observed characteristics of the redd that were indicative of a certain species. We defined association between a fish and a redd strictly based on whether the individual was exhibiting digging and/or guarding behavior adjacent to a redd. Redd species certainty was assigned as follows:

Certainty 1. Certain:
- one or more live adult(s) associated with the redd that the crew could identify to species with the highest level of certainty.

Certainty 2. Somewhat certain:
- one or more live adult(s) associated with the redd but the crew could not positively identify to species;
- no live adults associated with the redd but based on redd characteristics redd species could be inferred.

Certainty 3. Uncertain:
- no live adults associated with the redd and/or redd characteristics to indicate species were unclear.

Similarly, we assigned species certainty (1=certain; 2=somewhat certain; 3=uncertain) to observed live adult salmonids and carcasses:

Certainty 1. Certain:

- two or more physical/behavioral characteristics unique to the species were observed by the crew.

Certainty 2. Somewhat certain:

- only one physical/behavioral characteristics unique to the species was observed by the crew;
- timing of the encounter was short enough that characteristics could not be confirmed.

Certainty 3. Uncertain:

- no physical/behavioral characteristics were observed to indicate species.

Upon classification of redd species in the field, we sought to make a final redd species assignment at the end of the season. We evaluated the method of redd species classification recommended by Adams et al. (2011) and described in Gallagher and Gallagher (2005) and Gough (2010). This method uses logistic regression models to classify unknown redds based on redd area and date of first observation. It was generally useful in distinguishing Coho redds from steelhead redds, but it incorrectly classified 100% of known Chinook redds as Coho redds. Consequently, this led to an inflated Coho redd abundance estimate. Because this and other redd species classification methods appeared biased for the Russian River, we decided to use a hybrid approach:

1. Observer redd species was assigned as the final redd species:
    a. for all observer certainty 1 redd species (i.e., species identification was possible and fish species certainty=1 for one or more fish associated with the redd);
    b. for any redd identified by the field crew as Chinook regardless of certainty level.
2. Estimated species from the Gallagher/Gough logistic regression equations was assigned as the final redd species for remaining redds where redd species certainty was 2 or unspecified and redd measurements were made

If field crews never observed a certainty 1 fish species associated with a redd and if measurements were never taken, (which would make estimation with Gallagher/Gough logistic equations impossible), we used a method whereby fisheries biologists familiar with life histories of salmonids in the watershed assigned redd species based on the closest certainty 1 fish in space and time. Since this situation only occurred when the crew could not get measurements on a redd (because fish were present), but also could not positively identify fish on a redd, this method was rarely used (the number of redds classified in this way never exceeded 2% in a season).

Once all redds were classified to species using the method described above, we estimated within-reach redd abundance following the methods of Ricker et al. (2014). These methods are based on the Jolly-Seber capture-mark-capture model to allow for the estimation of redd abundance by making assumptions about the recruitment process and mark-recapture survival estimates of redds between sampling occasions. Estimated redd survival is then used to account for redds that are constructed and obscured between survey occasions (meaning they were never actually observed). The estimation of total redds constructed within a survey reach can be described as a flag-based open population mark-recapture experiment in which redds are (1) individually identified and marked with unique redd IDs upon first observation; (2) recaptured (resighted) on subsequent survey occasions. The population of redds is considered open because new redds are recruited into the population when they are constructed, then removed from the population when they become obscured and therefore no longer visible. We estimated total abundance of redds in the four LCM subwatersheds using the simple random estimator described in Adams et al. (2011). Additional details can be found in Ricker at al. (2014).

We attempted to survey all reaches in the four LCM subwatersheds containing habitat for Coho and steelhead. However, in the Mill subwatershed there were three full reaches and sections of two other reaches that we could not survey due to lack of landowner access. Despite this they were included in the estimation of total redd abundance in Mill Creek as follows. For the two unsurveyed stream sections, redd density (redds·km^{-1}) was calculated in the surveyed sections and the product of redd density and each section length (km) was used to estimate the number of redds in the unsurveyed sections. The estimated redd abundance for each unsurveyed stream section was then added to the estimate for the surveyed section in the reach to arrive at an adjusted redd abundance for each reach. Estimates of total redds in these unsurveyed sections were calculated prior to calculation of total redd abundance. Within-reach variance could not be calculated for these unsurveyed reaches so they were not included in the calculation of total standard error of the total redd estimate for the Mill Creek subwatershed.

Results

Smolt abundance

Detailed information on trap operation and fish work-up can be found in CSG data reports (CSG and SW 2004-2025) and SW Biological Opinion data reports (Martini-Lamb and Manning et al. 2009-2022).

Because of late rains in spring 2024 (Figure 1), downstream migrant traps in the four Coho-steelhead LCSs could not be installed until mid-April and all four were operated until mid-June. We ceased operating traps when stream flow in the vicinity of traps became disconnected and/or daily catches of Coho and steelhead dropped to near zero for several consecutive days (Figure 4, Figure 5, Figure 6). PIT antennas were operated throughout the period in the Coho-steelhead LCM subwatersheds thus facilitating smolt abundance estimation.

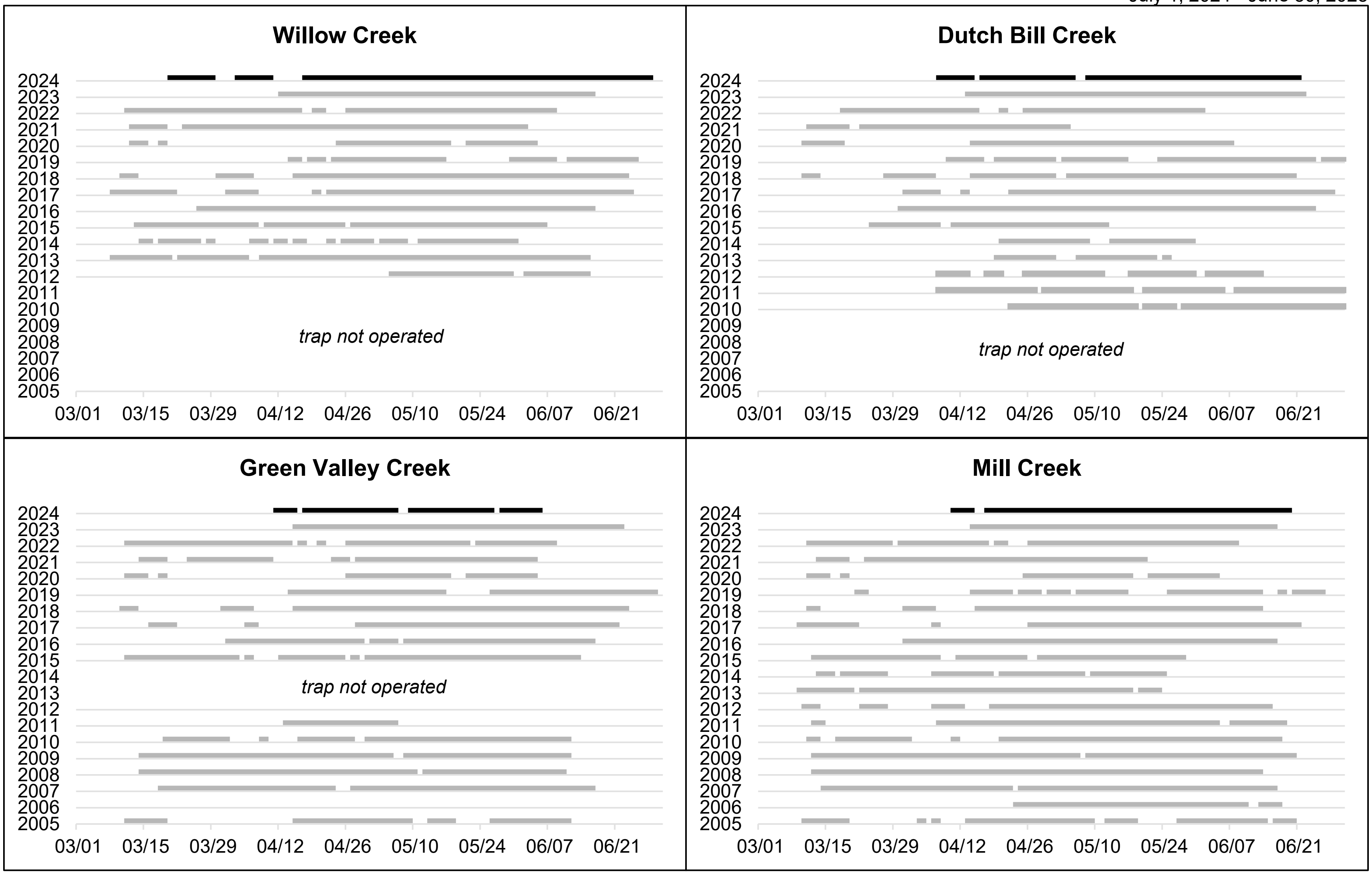


Figure 4. Period of operation of downstream migrant traps in Coho-steelhead LCM subwatersheds by year, 2005-2024.

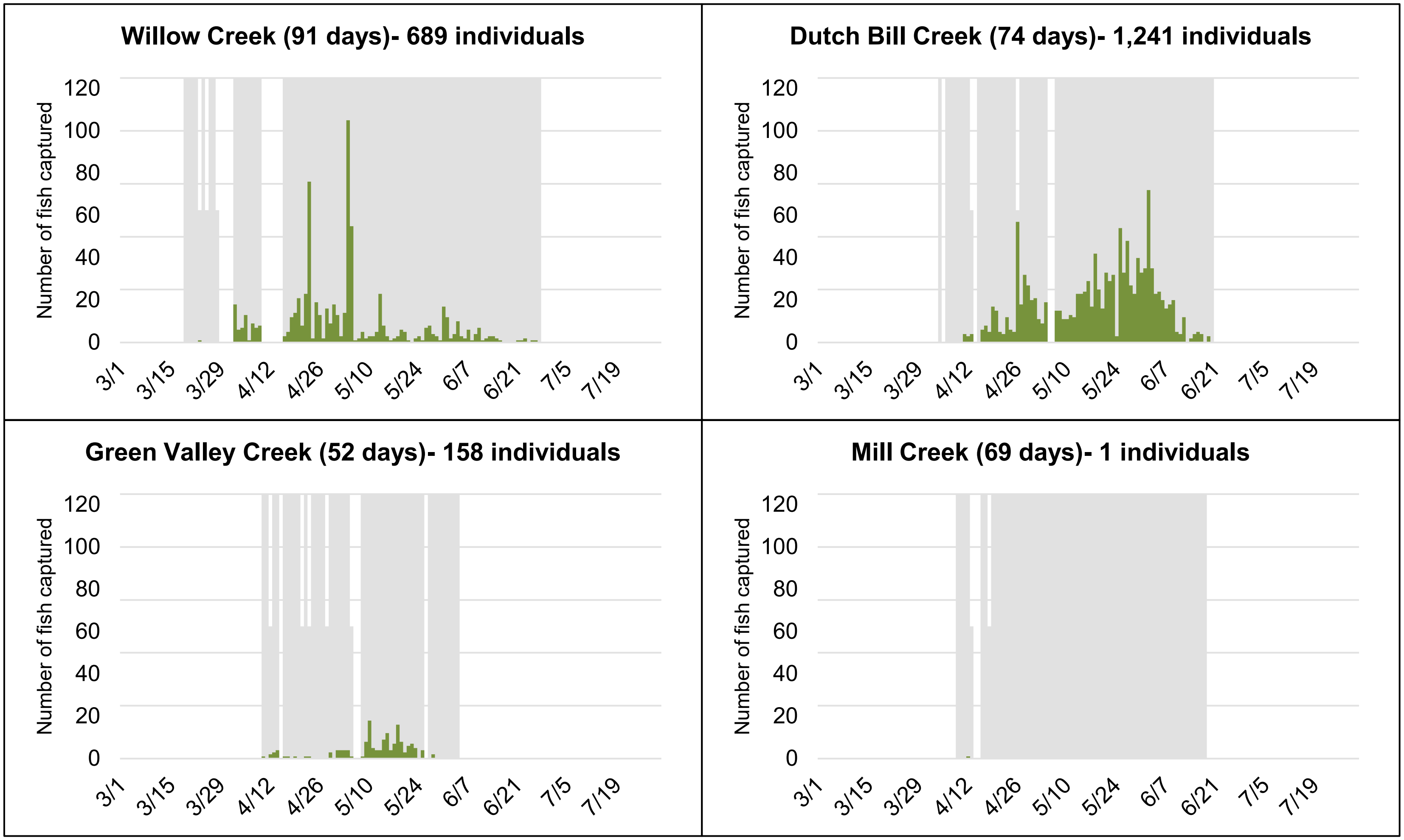


Figure 5. Coho Salmon smolt capture by date and dates downstream migrant traps were operating (grey shading) in Coho-steelhead LCM subwatersheds, 2024.

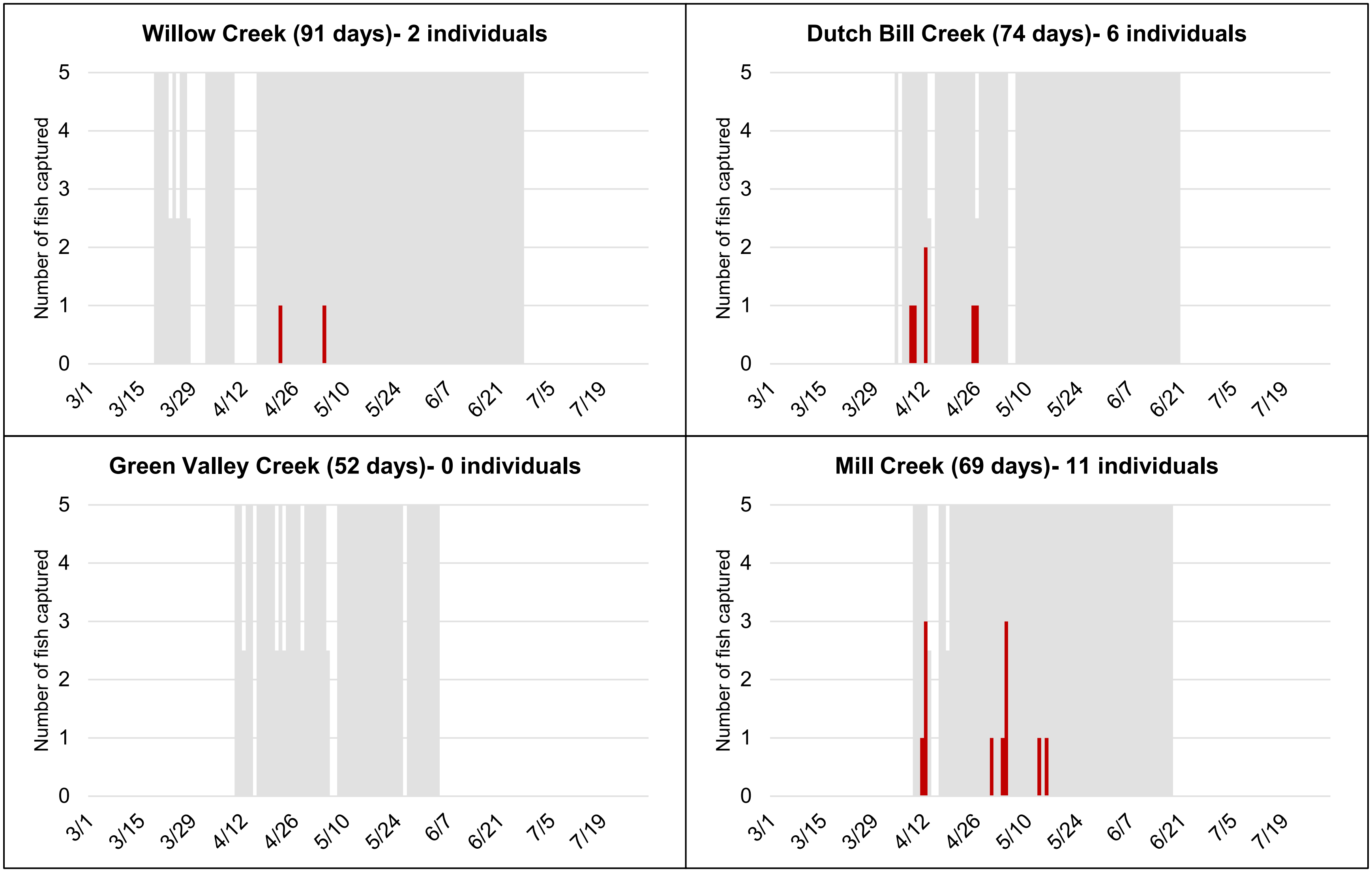


Figure 6. Steelhead smolt capture by date and dates downstream migrant traps were operating (grey shading) in Coho-steelhead LCM subwatersheds, 2024.

Coho Salmon smolts Among the four LCMs, the 2023 abundance estimate was by far the highest in Willow Creek (Figure 7). However, because the Willow trap was operated at a new location in 2024 that was downstream of high numbers of presmolts/smolts hatchery releases into Willow Creek a short distance upstream of the trap, the trap catch and abundance estimate is largely reflective of those releases. The abundance estimate in Dutch Bill was similar to recent years; population estimates in Green Valley and Mill were not possible because of low trap catches (Figure 8).

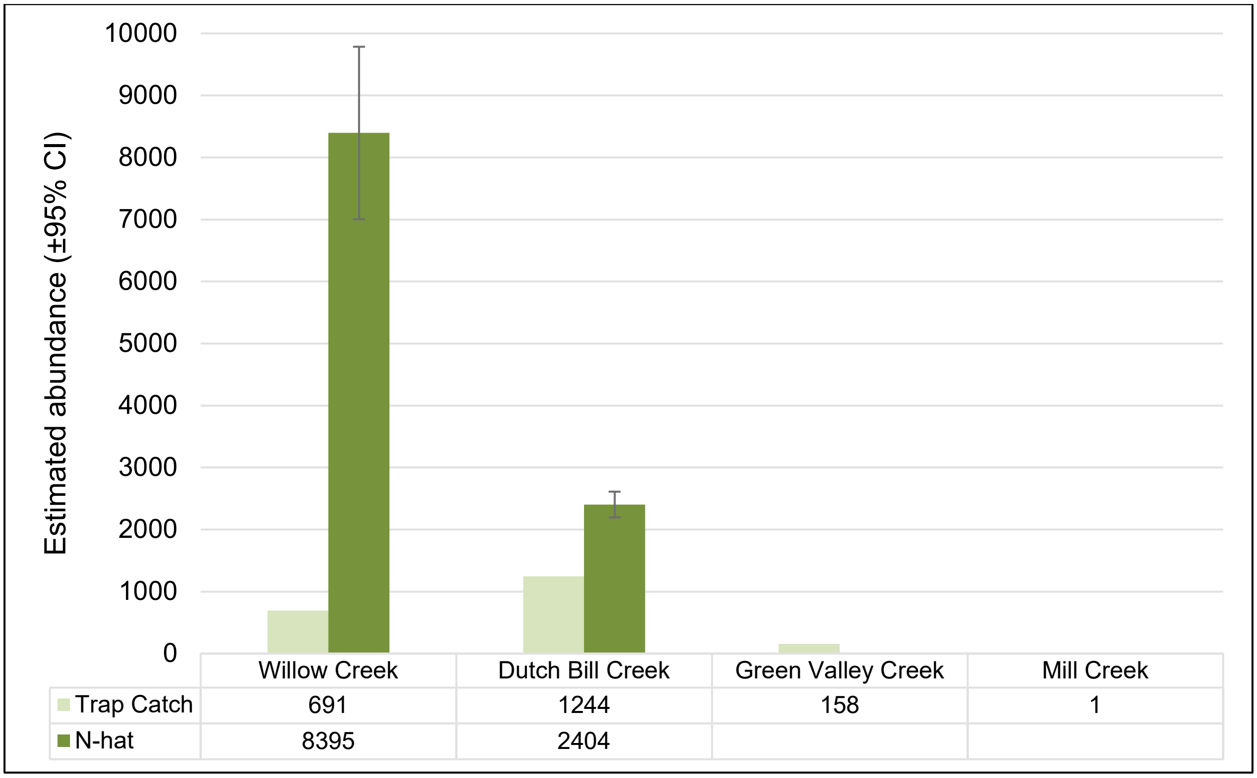


Figure 7. Coho Salmon smolt abundance estimates for the Coho-steelhead LCM subwatersheds, 2024. Because of the low trap catch in 2024 in Green Valley and Mill creeks, we were unable to estimate abundance.

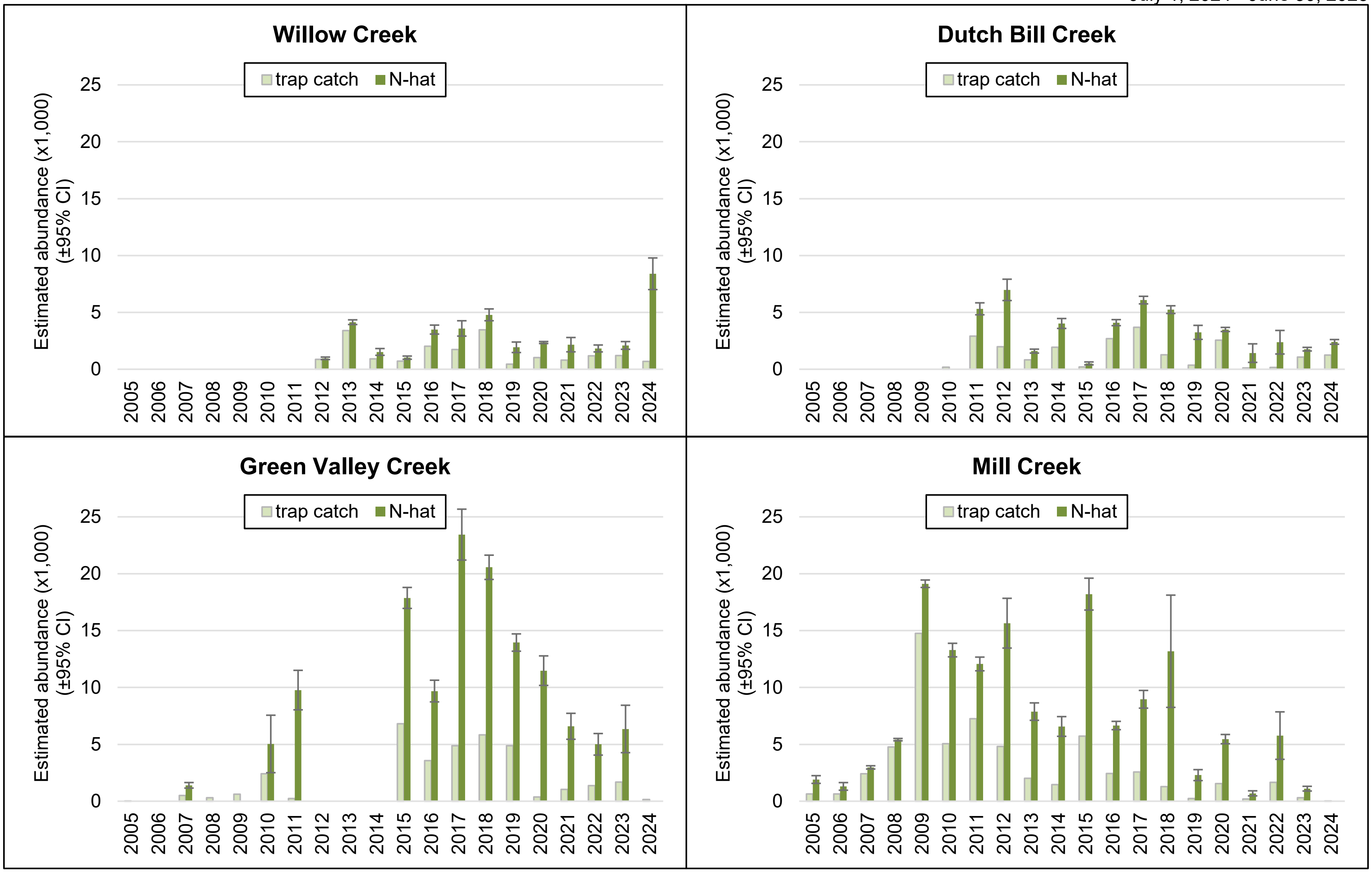


Figure 8. Estimated annual abundance of Coho Salmon smolts in the Coho-steelhead LCM subwatersheds for the years abundance estimates were possible, 2005-2024.

Steelhead smolts The estimate for steelhead smolts (2023-2024) is based on antenna detections of steelhead juveniles that were pit-tagged during the late summer of 2023 (Figure 9, Figure 10). The 2023 season had good stream conditions, similar to 2019 in terms of water levels, however in some streams there were high temperatures and low dissolved oxygen. Electrofishing surveys occurred from mid-August to mid-September in selected streams (Mill, Palmer, Felta, and Purrington). Due to the low number of juvenile steelhead encountered during snorkel surveys (first stage sampling), we did not select Dutch Bill and Willow creeks for electrofishing surveys (second stage sampling). Green Valley Creek was not electrofished due to low dissolved oxygen levels. In streams where electrofishing was conducted, surveys were used to calibrate snorkel counts using paired snorkel/electrofishing sampling in the same pools and to PIT tag juveniles for future detection as they emigrate from their natal streams. These detections were used to calculate a survival index to the smolt stage and generate a smolt estimate when possible. During the sampling period between August 15 and September 18, 2023, we PIT-tagged 507 steelhead and 6 Coho in all LCMs combined.

A calibration ratio (correction factor) for the number of steelhead juveniles observed snorkeling was calculated using the ratio of steelhead estimated from depletion electrofishing surveys to steelhead observed in visual surveys (electrofishing estimate/snorkel count). Observer confidence was recorded for all snorkeled pools using a 1, 2, or 3 ranking where ranking 1 indicates the snorkeler had high confidence in their count, or ability to see fish, and ranking 3 indicated that the observer had low confidence in their counts, or ability to see fish. ANOVA was used to evaluate the relationship between observer confidence, tributary, and number of steelhead in the pool with calibration ratios. Observer confidence was the only factor where the group means varied (Kruskal-Wallis chi-squared = 8.0393, df = 2, p-value = 0.01796). Tukey's HSD multiple comparisons tests showed that the groups means varied only between the uncertain ranking (3) and the very certain (1) and somewhat certain (2) rankings. A new grouping of count certainty was then defined, where rankings 1 and 2 were combined (group = certain) and a new R-hat was calculated. ANOVA was rerun with the new calculation and groupings: Kruskal-Wallis chi-squared = 7.7449, df = 1, p-value = 0.005386 (Table 1).

A late summer (pre-smolt) population estimate for steelhead was calculated based on snorkel counts using the correction factor calculated during the 2023 season (Table 1). Detections of PIT-tagged individuals from late summer sampling in 2023 at downstream antennas during the steelhead emigration period (Nov 1, 2023-June 30, 2024) were used to estimate survival of juveniles to the smolt stage and calculate a smolt estimate for the 2023-2024 emigration season. The survival indexes for the Mill and Green Valley watersheds were greater compared to all other years (Table 2). PIT antenna-based steelhead estimates were several orders of magnitude higher than raw trap catches (Figure 9, Figure 10) meaning that if we had relied on trap catch alone our "estimates" would have been severely biased low. This is consistent with our findings in past years when smolt abundance estimates could be calculated.

Table 1. Calibration ratio (R-hat) applied to snorkel counts based on number of steelhead observed in pool habitat only, calculated in 2023 and applied to snorkel counts.

Group	R-hat	SE	95% LCI	95% UCI	n
Certain (1,2)	1.86	0.16	1.53	2.18	36
Uncertain (3)	2.94	0.33	2.19	3.70	9

Table 2. Steelhead pre-smolt abundance estimates, number of pools sampled, survival indexes and smolt estimates in the four LCMs, 2017-2024.

Season	LCM	pre-Smolt N-hat	Number of pools snorkeled[1]	Survival index[2]	Smolt N-hat (±95% CI)
2017-2018	Mill	8300	175	0.26	2158 (229)
2018-2019	Mill	4645	191	0.24	1115 (220)
2019-2020	Willow	4220	91	0.08	338 (72)
2019-2020	Dutch Bill	7864	126	0.17	1337 (349)
2019-2020	Green Valley	9431	168	0.11	1037 (249)
2019-2020	Mill	11596	193	0.20	2319 (582)
2020-2021	Willow	781	44	NA	NA
2020-2021	Dutch Bill	1509	64	0.17	251 (39)
2020-2021	Green Valley	3876	109	0.06	251 (45)
2020-2021	Mill	NA	NA	0.10	NA
2021-2022	Willow	60	39	NA	NA
2021-2022	Dutch Bill	1351	59	NA	NA
2021-2022	Green Valley	1080	120	NA	NA
2021-2022	Mill	1755	138	NA	NA
2022-2023	Willow	45	99	0.07	3 (0.4)
2022-2023	Dutch Bill	1468	92	0.06	90 (13)
2022-2023	Green Valley	2018	132	0.05	95 (15)
2022-2023	Mill	2012	162	0.16	326 (48)
2023-2024	Willow	184	94	NA	NA
2023-2024	Dutch Bill	192	108	NA	NA
2023-2024	Green Valley	3508	156	0.23	822 (162)
2023-2024	Mill	8014	222	0.39	3151 (656)

[1] Approximately 50% of all pools in each LCM were snorkeled each summer and provide the basis for the pre-smolt estimate, except for Mill in 2020 due to impacts from the Walbridge Fire

[2] Survival index and smolt estimate could not be calculated when electrofishing and pit-tagging did not occur due to poor water quality.

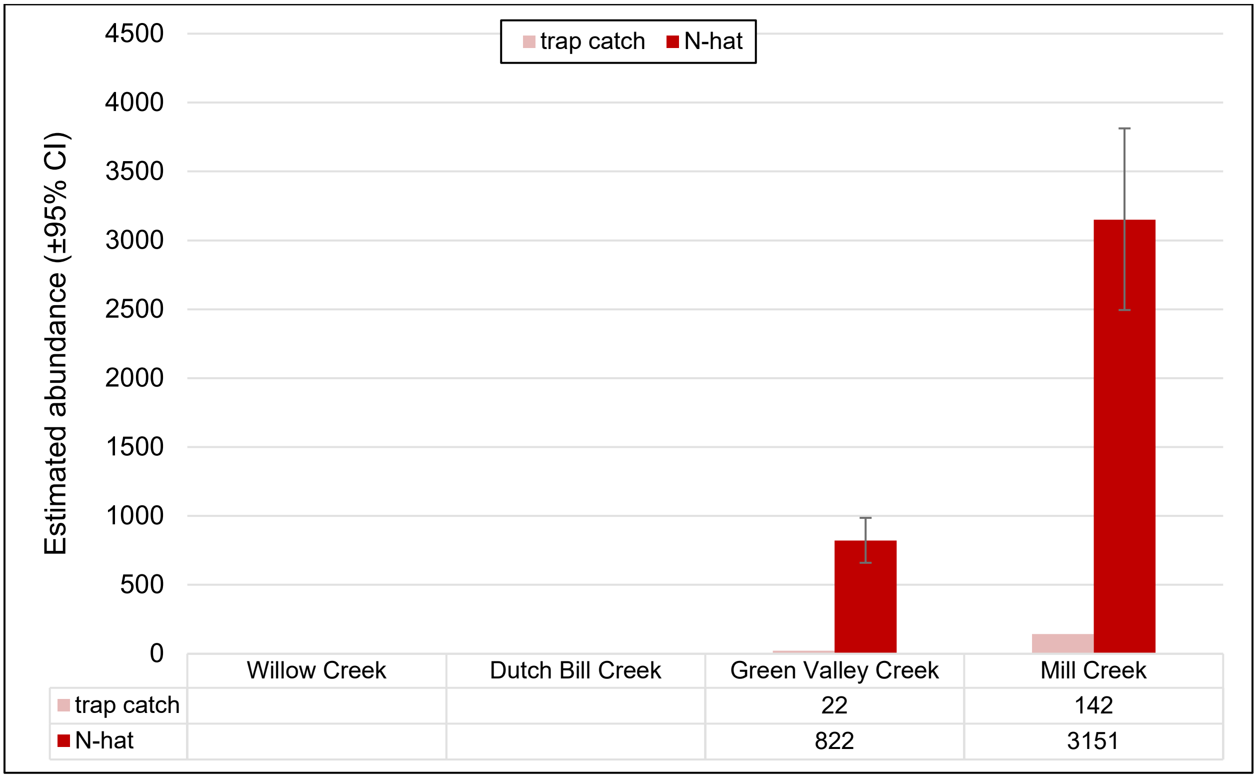


Figure 9. Estimated abundance of steelhead smolts in the Coho-steelhead LCM subwatersheds for the subwatersheds where abundance estimates were possible, 2024.

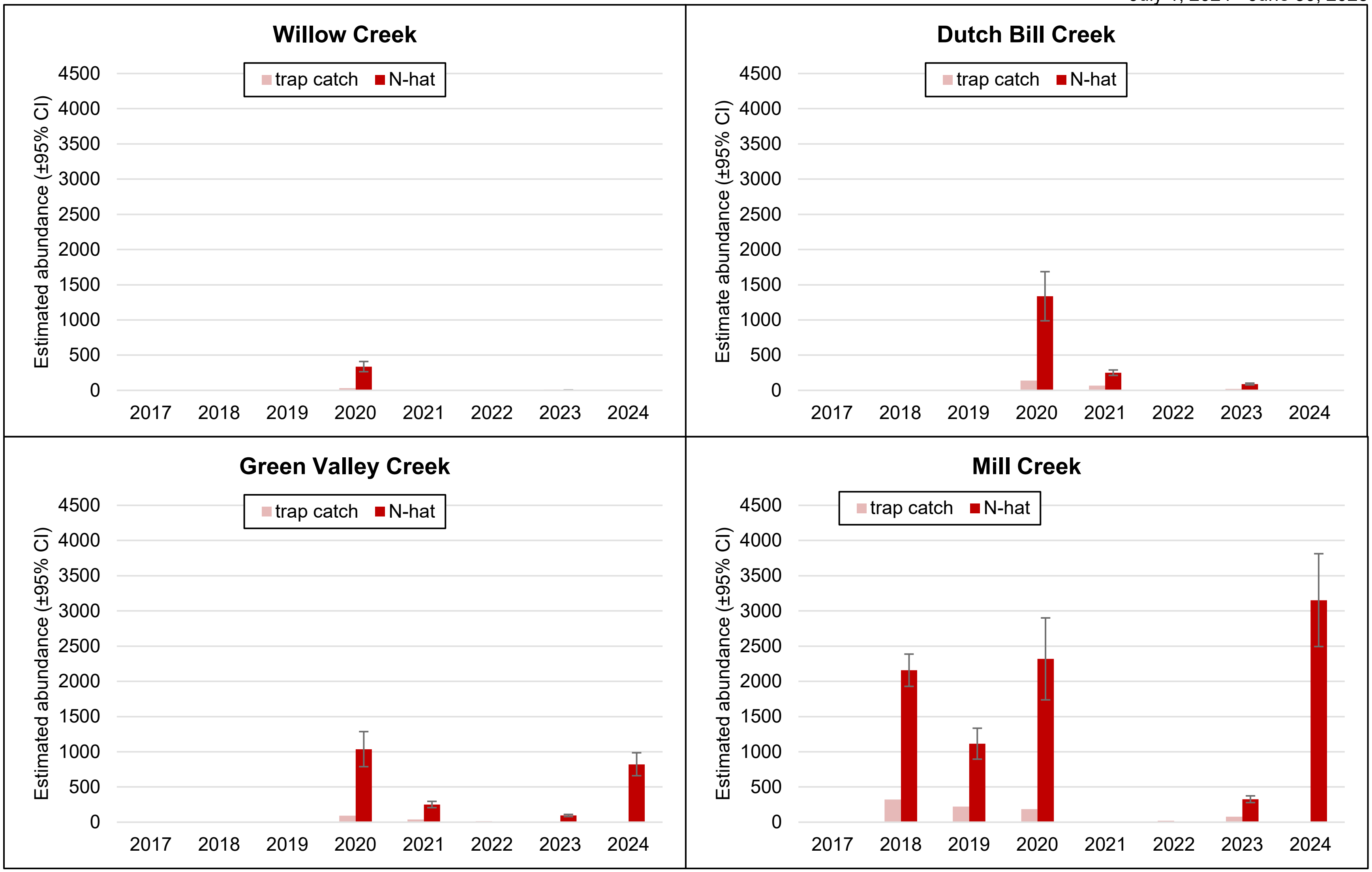


Figure 10. Estimated annual abundance of steelhead smolts in the Coho-steelhead LCM subwatersheds for the years abundance estimates were possible, 2017-2024.

<u>Chinook Salmon smolts</u> As with the Coho-steelhead LCMs, late spring rain delayed inflation of the Mirabel dam and therefore impacted our ability to effectively sample for Chinook smolts at the Chinook LCS on the mainstem Russian River. We were only able to install the trap several days after dam inflation on June 11 and had to cease operation on June 18 when daily water temperatures at the site regularly exceeded 21°C. Due to the late installation of the Mirabel downstream migrant trap (only operated 8 days, Figure 11) and low trap catch (4 individuals, Figure 12), we were unable to estimate Chinook Salmon smolt abundance for 2024 (Figure 13).

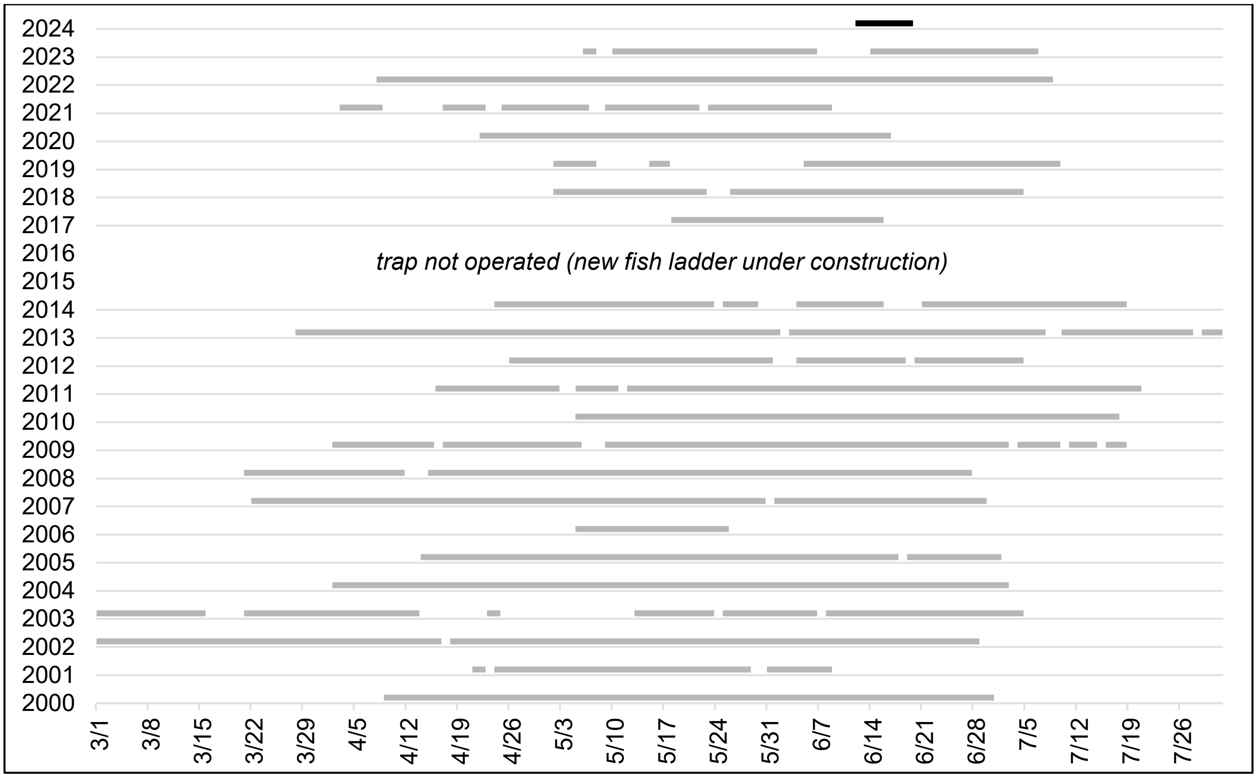


Figure 11. Period of operation by year of the downstream migrant trap at the mainstem Russian River Chinook Salmon LCS, 2000-2024.

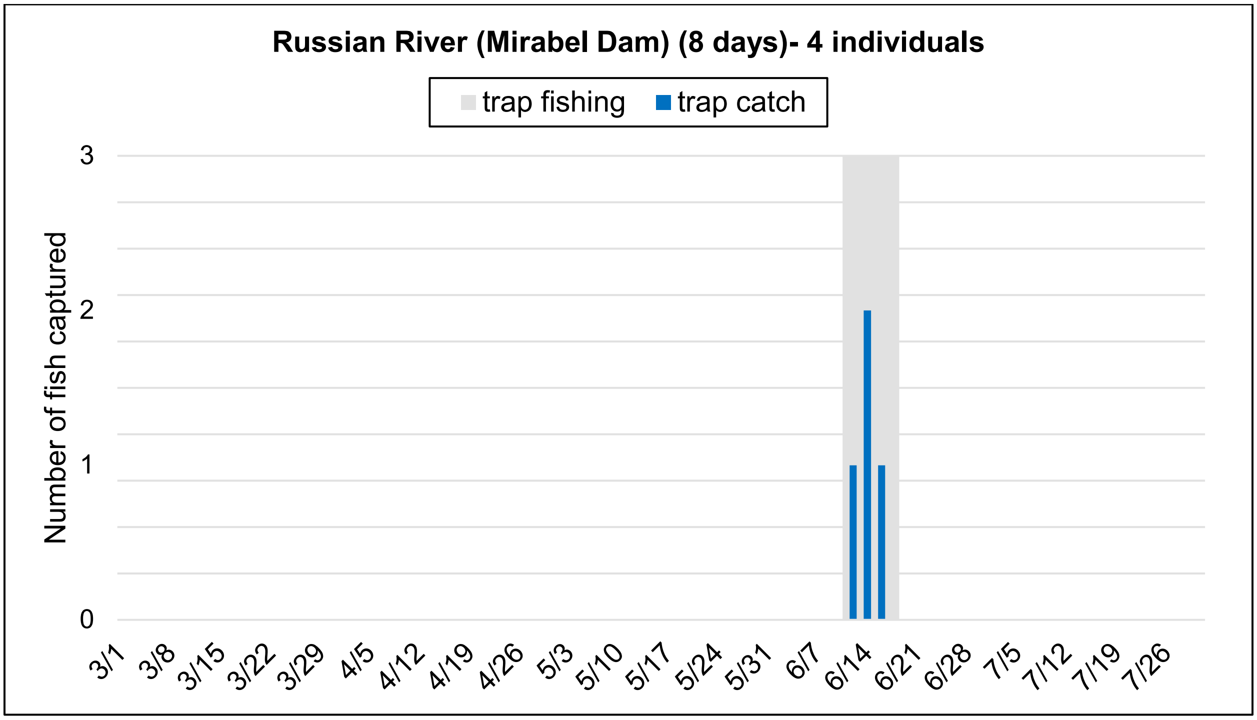


Figure 12. Chinook Salmon smolt capture by date and dates downstream migrant trap was operating (grey shading) at the mainstem Russian River Chinook Salmon LCS, 2024.

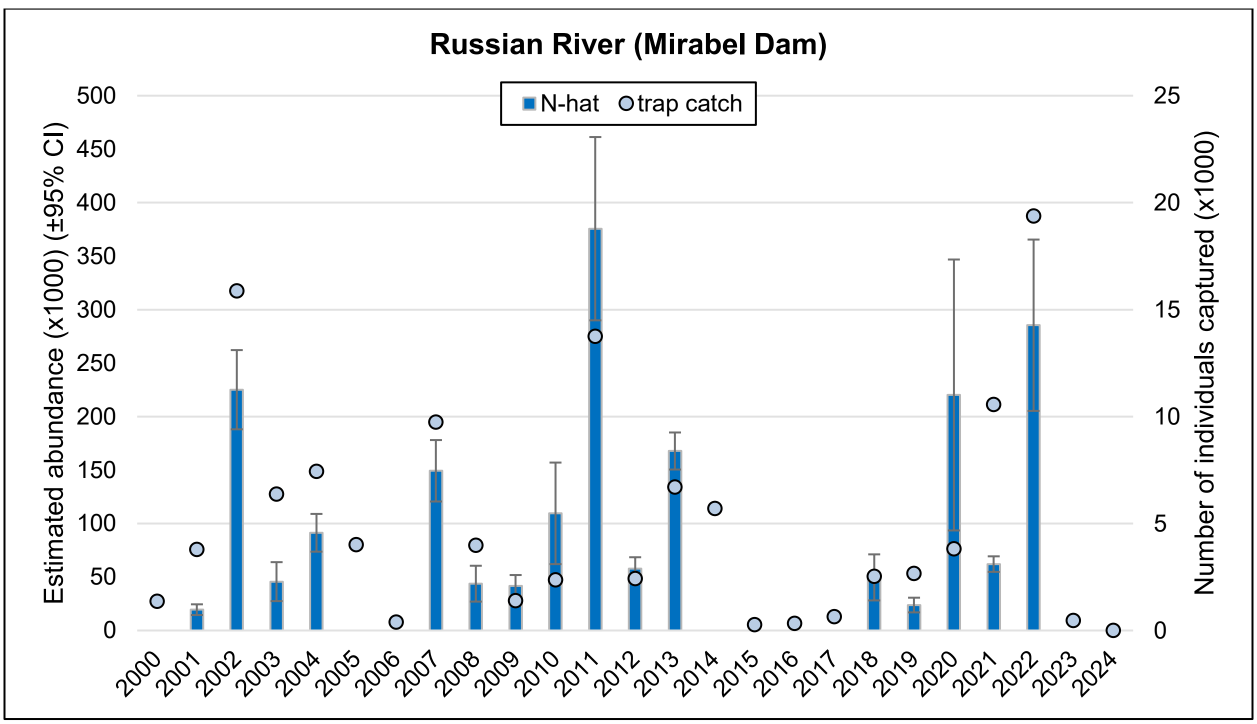


Figure 13. Estimated annual abundance of Chinook Salmon smolts at the mainstem Russian River Chinook Salmon LCS for the years abundance estimates were possible, 2000-2024.

Adult abundance

Coho Salmon adults Adult Coho estimates from PIT tag detections in the LCMs (626) were more than two times higher than the previous high of 328 in 2023/24. Dutch Bill had the highest adult Coho estimate (180) followed closely by Willow (174, Figure 14, Figure 15). More detailed results and analysis can be found in CSG and SW (2025).

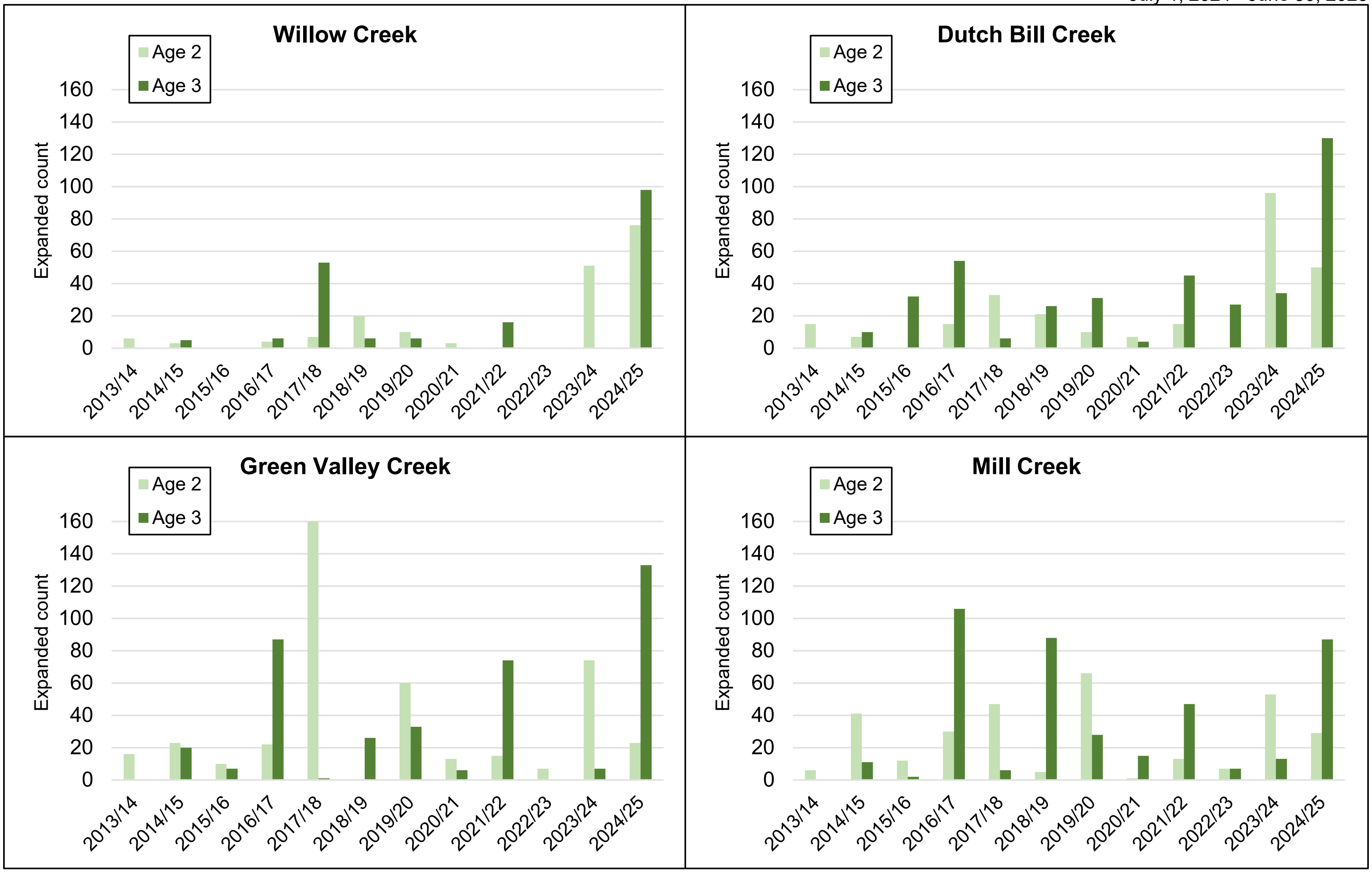


Figure 14. Estimates of adult Coho Salmon abundance in LCM subwatersheds, return winters 2013/14 through 2024/25. Total adult estimates are broken out by age class and include both natural- and hatchery-origin fish.

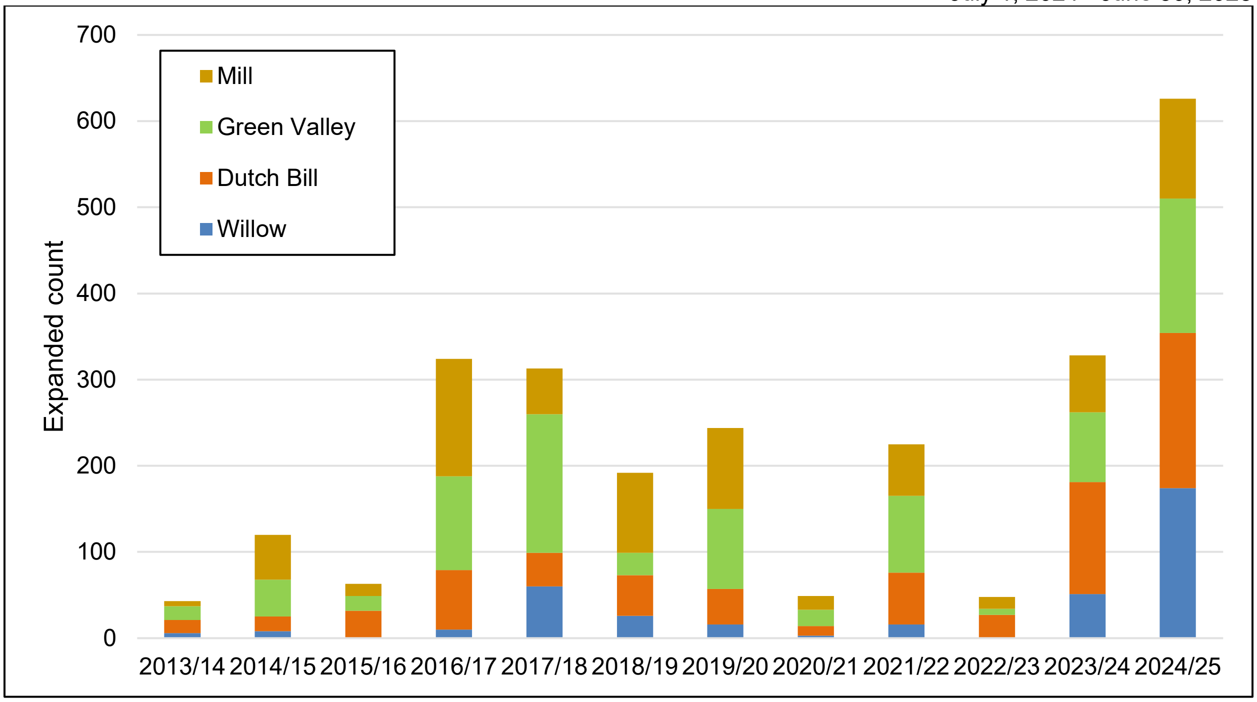


Figure 15. Trends in estimated adult Coho Salmon abundance in LCM subwatersheds, return winters 2013/14 through 2024/25. Estimates include both 2-year-olds and 3-year-olds and both natural- and hatchery-origin fish.

Steelhead adults Similar to the 2023/24 season, and because of the very low numbers of adult steelhead PIT detections that meet the criteria for a returning adult, we were unable to calculate an adult steelhead abundance estimate for the 2024/25 season. However, we observed 6 steelhead that we assumed were adults based on having reached a minimum assumed age and potential time at sea (days at large) of at least 9 months (Table 3). Greater confidence is assumed for individuals that also have a downstream detection of emigration during the smolt season and subsequent upstream migration at a stream mouth during the spawning season.

Table 3. Encounter information from steelhead tagged during late summer sampling as juveniles detected as likely adults during the 2024-2025 adult spawning migration season.

Tag stream	Size at tagging (mm)	Year tagged	Smolt date	Brood year	Adult detects	Comments
Dutch Bill	79	2022		2021	2024	No smolt detection
Purrington	70	2022	1/24/2024	2021	2025	
Purrington	100	2023	2/16/2024	2021	2025	Detected leaving stream as adult 7 days post entry
Purrington	99	2023	12/31/2023	2021	2025	Adult detection only in estuary
Willow	103	2023	3/12/2024	2022	2025	Tagged as a parr at Willow smolt trap
Mill	88	2023	12/19/2023	2022	2025	
Felta	60	2023	5/12/2024	2022	2024	days smolt to adult = 197
Felta	71	2023	4/30/2024	2022	2024	days smolt to adult = 205

Chinook Salmon adults With the exception of two years when new fish screens and fish ladder were being installed (2014, 2015) and a year when an early storm led to dam deflation prior to the onset of the adult Chinook migration (2021), an underwater video system has facilitated counts of adult Chinook Salmon swimming past the Mirabel dam since 2000 (Figure 16). In 2024, the video system was operated from 9/2 until 11/19 when the dam was lowered due to an atmospheric river that raised flows above the level where we could safely keep the dam inflated (Figure 17). The pro-rated count of 1,545 was lower than 2023, as well as the long-term median (2,021) and average (2,562) for the data set (Figure 18). However, because of the truncated period of video operation relative to the adult Chinook run, the 2024 total was potentially a significant undercount of the true number returning to the basin to spawn.

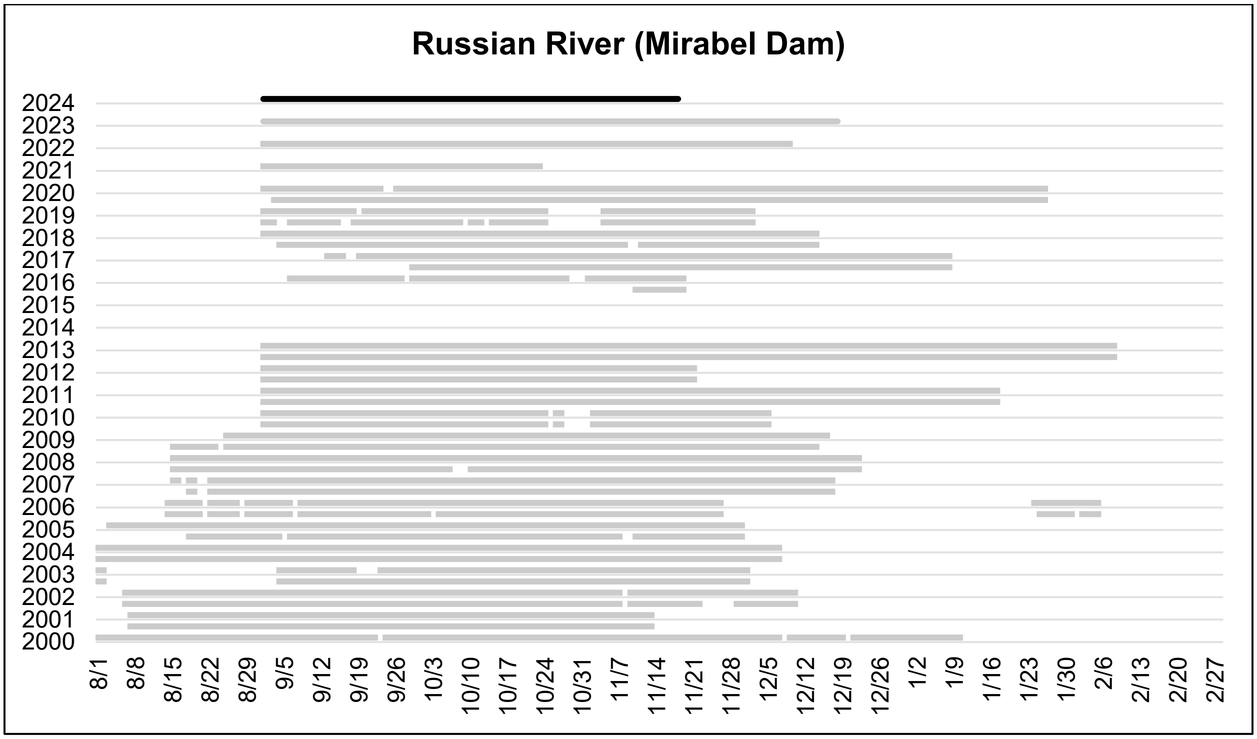


Figure 16. Period of operation by year of underwater video system at the mainstem Russian River Chinook Salmon LCS, 2000-2024.

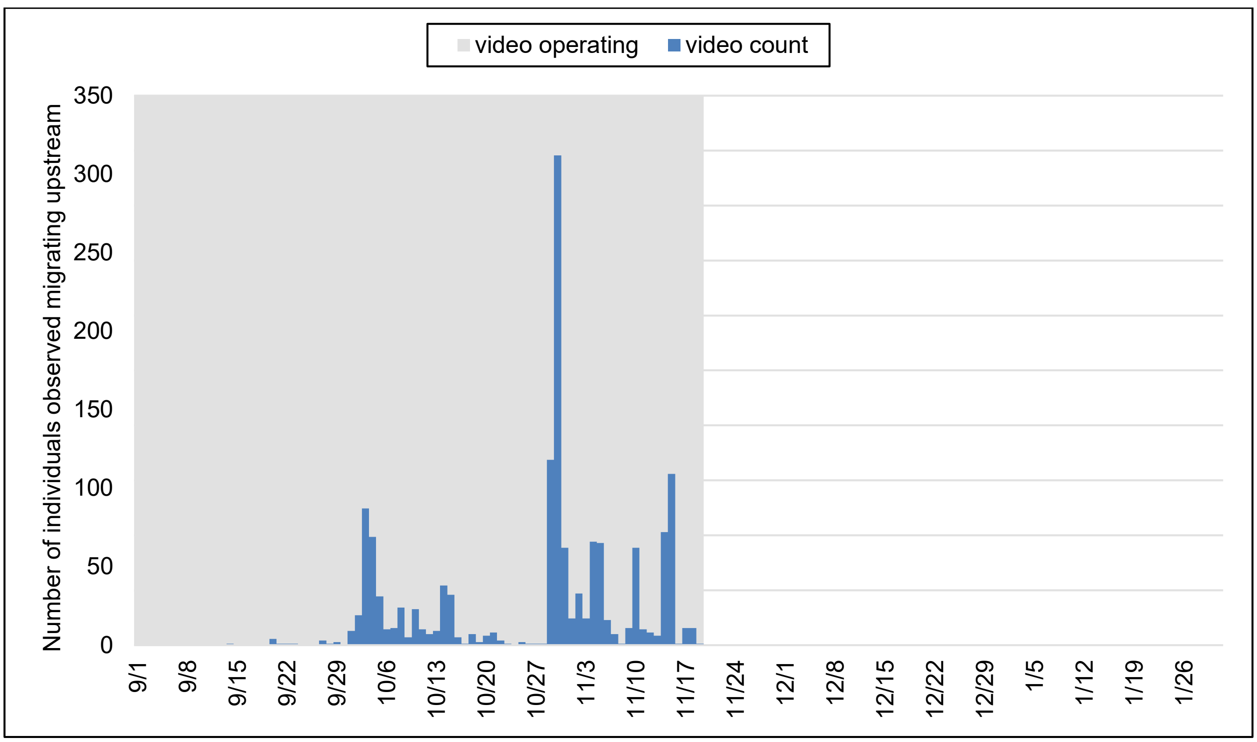


Figure 17. Chinook Salmon adult movement upstream past the mainstem Russian River Chinook Salmon LCS by date and dates video system was operating, 2024.

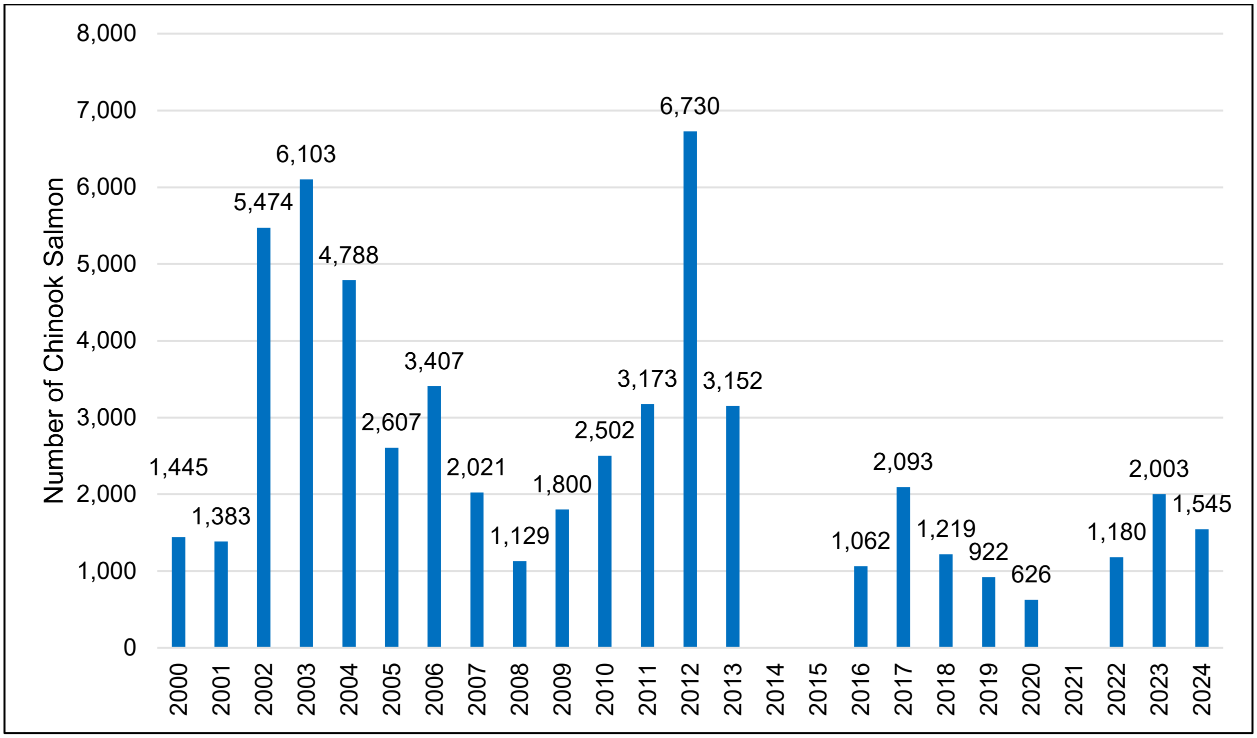


Figure 18. Adult Chinook prorated video counts at the mainstem Russian River Chinook Salmon LCS, 2000-2024.

Redd abundance (Coho Salmon and Steelhead)

Surveys began November 25, 2024, and were completed April 30, 2025. During that period, we attempted to repeat surveys in reaches at a 10 to 14-day interval; however, there were large atmospheric river events that prevented sampling for multiple days (Figure 19). The first atmospheric river event occurred at the end of November. It was characterized as a 1000-year storm event for parts of California (including Sonoma County). The Venado rain gage recorded over 57 cm (22 inches) of rain in a 3-day period between 11/20 and 11/22/2024 (Figure 19). This storm caused flows that connected all tributaries and therefore coincided with our first spawner surveys of the season, but we did not see much spawning activity associated with this event. It was after the second atmospheric river in mid-December that we saw a marked increase in Coho Salmon spawning activity, especially in Willow Creek where there was an order of magnitude increase in spawning activity compared to the year before (Figure 20, Figure 21). These atmospheric river events were followed by one of the driest Januarys on record, resulting in a small percentage of redds becoming partially or completely dewatered. Fortunately, another large atmospheric river event at the end of February brought high flows again and rewetted any redds that had been in danger of dewatering. We completed 155 surveys in LCM parent reaches during the 2024/25 season.

Of the 16 parent reaches surveyed in LCMs, Coho redds or individuals were recorded in 14 reaches (88%). Steelhead redds or individuals were recorded in 14 of the 16 reaches as well. We observed the largest number of Coho redds in Willow by far, but Mill had the largest number of steelhead redds (Figure 20). Likewise, Willow also had the largest number of Coho individuals (live fish and carcasses) observed, and Mill had the largest number of steelhead individuals observed (Figure 21). The Willow Creek Coho redd abundance estimate for 2024/25 was considerably higher than all other LCM subwatersheds combined, and higher than any other estimate from any subwatershed in any season since CMP reporting began. Prior to this season, Willow had the lowest or second lowest Coho Salmon redd abundance estimates of the LCM subwatersheds in 10 of the last 12 seasons. For the previous two seasons, Mill had the highest estimate of Coho redd abundance, but this season Green Valley had a higher estimate than Mill. The Dutch Bill estimate (while higher than most Dutch Bill estimates in the past decade) was the lowest of the LCMs (Figure 22). For the fourth consecutive season, Mill had the highest steelhead redd abundance of the LCM subwatersheds. Though estimates in Willow, Dutch Bill, and Green Valley were higher this season than in the previous three seasons, they were still low compared to Mill with the highest (Willow) having only half the estimate of Mill. The last time any other LCM subwatershed had a higher steelhead redd abundance estimate than Mill was during the 2020/21 spawner season (Dutch Bill, Figure 23).

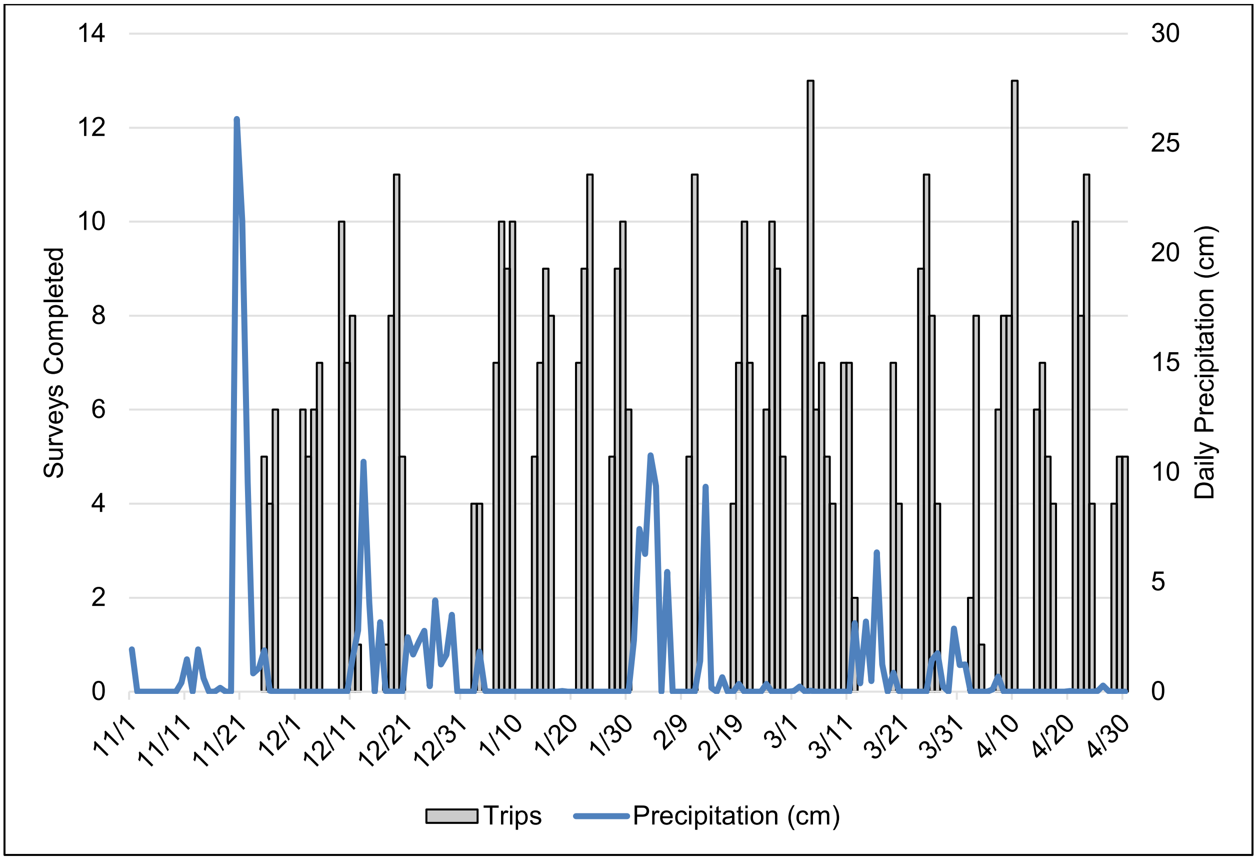
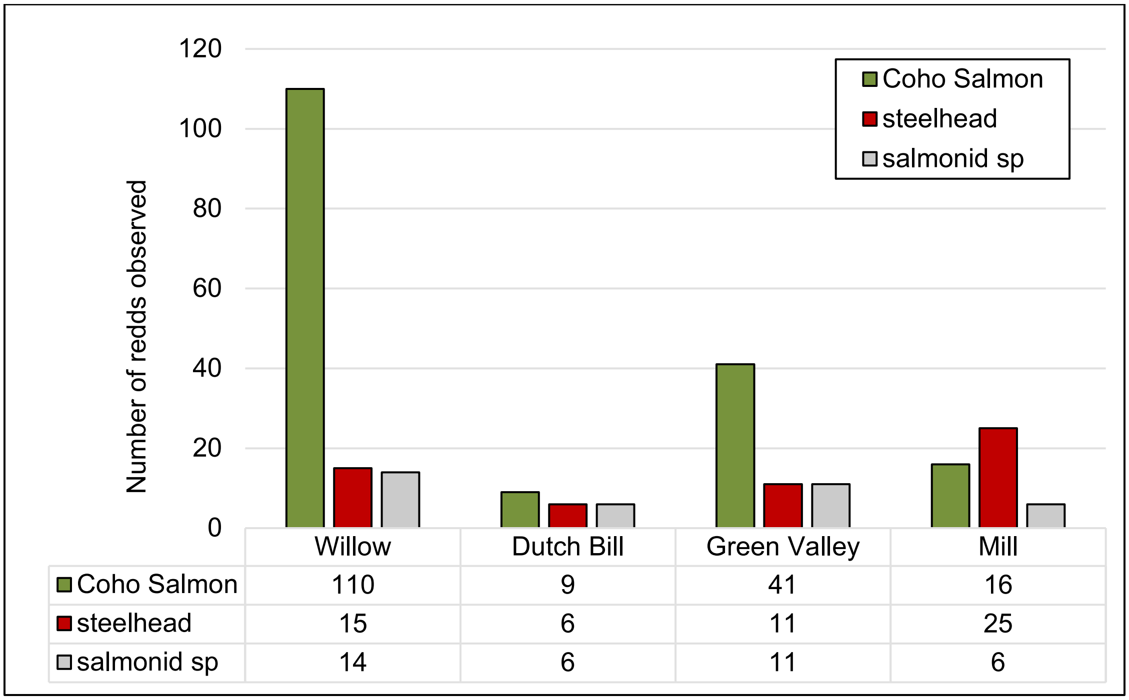
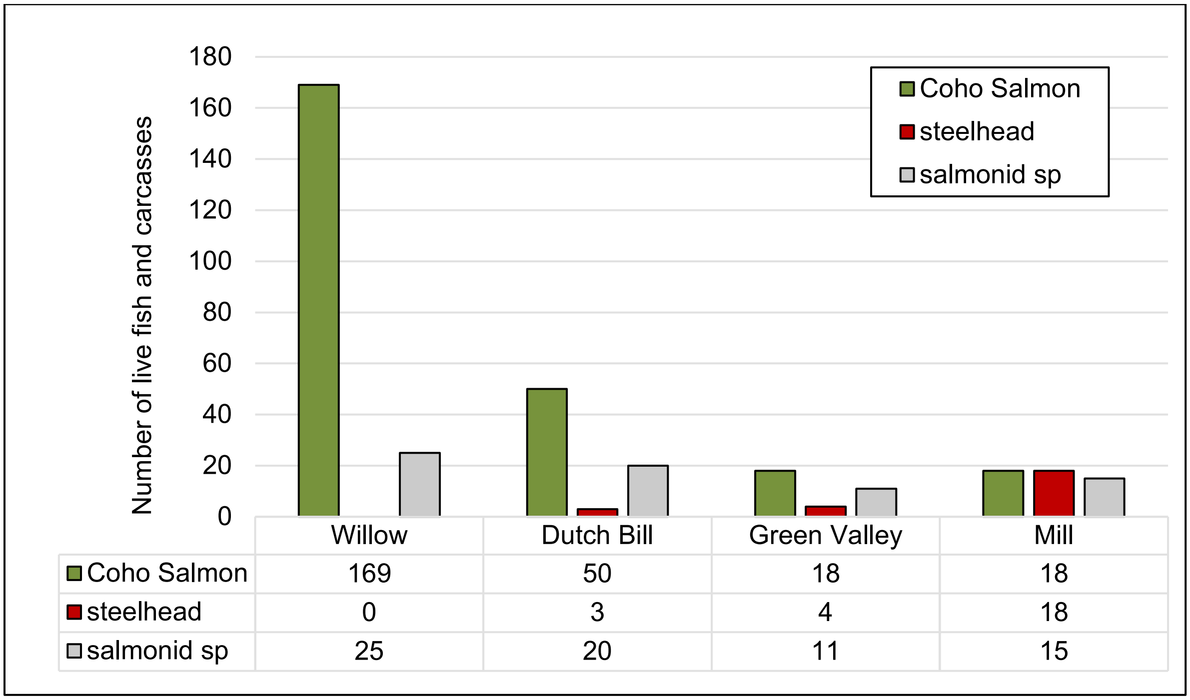


Figure 19. Daily rainfall totals measured at the Venado rain gage during the 2024/25 spawning season (blue line) and number of successful spawner survey trips during the 2024/25 spawning season (gray bars).



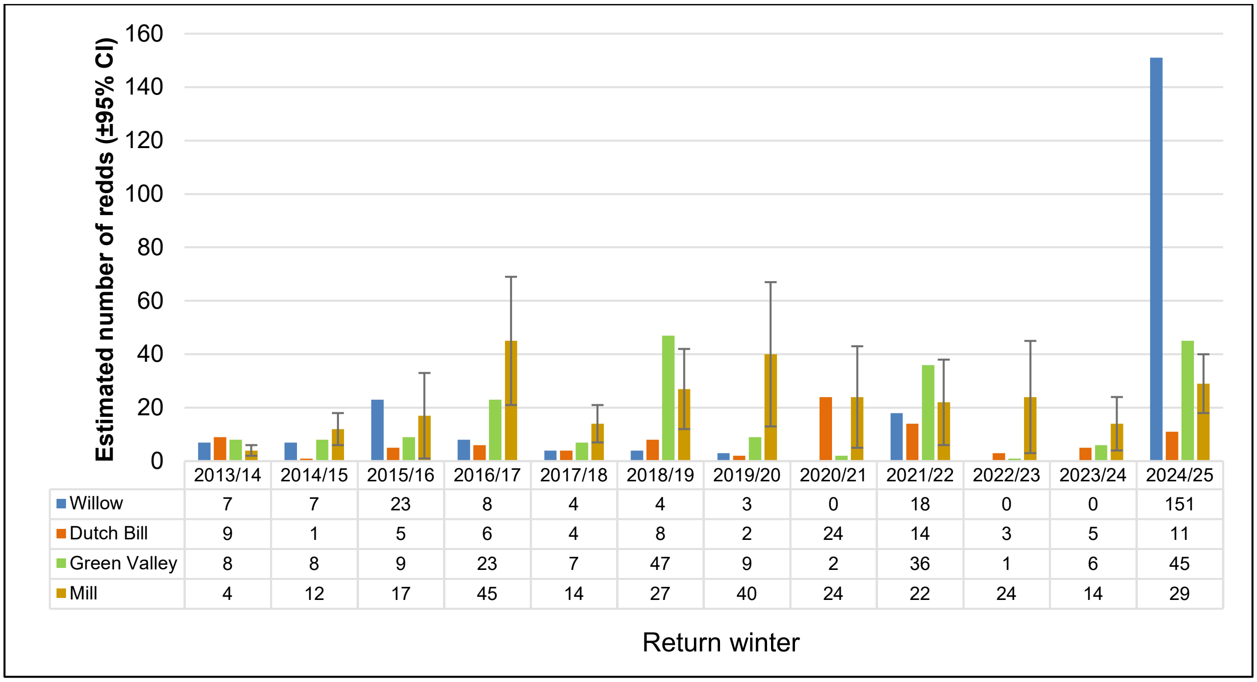
	Willow	Dutch Bill	Green Valley	Mill
Coho Salmon	110	9	41	16
steelhead	15	6	11	25
salmonid sp	14	6	11	6

Figure 20. New redds counted in LCMs for all three levels of redd species certainty during the 2024/25 spawner season. Mill totals include all Mill Creek tributaries (Felta, Wallace, and Palmer creeks) and Green Valley totals include Purrington Creek.



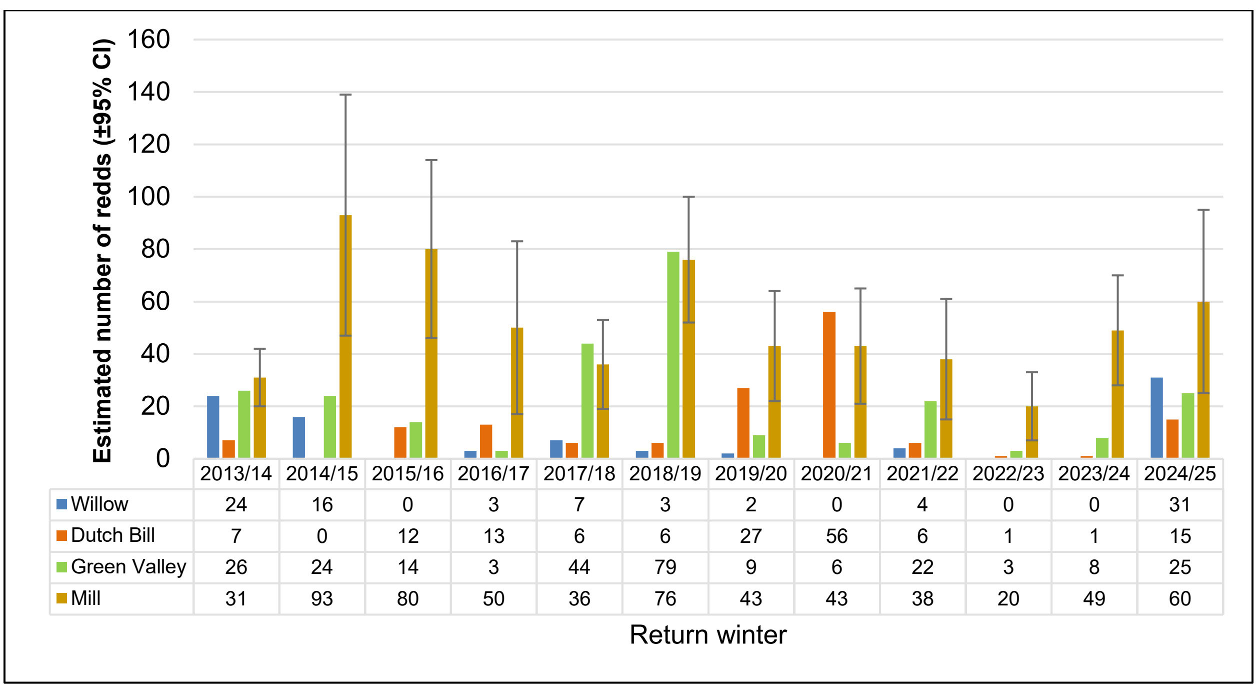
	Willow	Dutch Bill	Green Valley	Mill
Coho Salmon	169	50	18	18
steelhead	0	3	4	18
salmonid sp	25	20	11	15

Figure 21. Live fish and carcasses counted in LCMs for all three levels of species certainty during the 2024/25 spawner season. Mill watershed totals include all tributaries (Felta, Wallace, and Palmer Creeks) and Green Valley watershed totals include Purrington Creek.



	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25
Willow	7	7	23	8	4	4	3	0	18	0	0	151
Dutch Bill	9	1	5	6	4	8	2	24	14	3	5	11
Green Valley	8	8	9	23	7	47	9	2	36	1	6	45
Mill	4	12	17	45	14	27	40	24	22	24	14	29

Figure 22. Estimates of Coho Salmon redd abundance in LCMs, return winters 2013/14 through 2024/25. Because Mill is the only LCM where census spawner surveys could not be performed (due to landowner access), it is the only LCM where an expansion was calculated and is therefore the only one with confidence intervals.



	2013/14	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25
Willow	24	16	0	3	7	3	2	0	4	0	0	31
Dutch Bill	7	0	12	13	6	6	27	56	6	1	1	15
Green Valley	26	24	14	3	44	79	9	6	22	3	8	25
Mill	31	93	80	50	36	76	43	43	38	20	49	60

Figure 23. Estimates of steelhead redd abundance in LCMs, return winters 2013/14 through 2024/25. Because Mill is the only LCM where census spawner surveys could not be performed (due to landowner access), it is the only LCM where an expansion was calculated and is therefore the only one with confidence intervals.

Discussion

Smolt abundance

Because of higher than average rainfall in early March-early April (Figure 1) we installed the downstream migrant traps approximately 1 to 3 weeks later than our target date of the second week in March; however, PIT antenna detections suggest that we did not miss the peak of the smolt migration which occurred April through May (CSG and SW 2024).

Because we operate PIT antennas in close proximity upstream of our downstream migrant traps, we have been able to document trap-related delays to downstream migration of salmonid smolts. Because of this, we recommend exploring other means of counting downstream migrating salmonids during the spring trapping season. One idea we plan to explore is a video/PIT antenna system inside a downstream migrant trap. If we can collect and record clear images, we could operate the video along with an “inside-the-box” PIT antenna every day but only operate the trap on days we want to collect biological information (i.e., we would only capture and handle fish on a subset of days in the downstream migrant trapping season). If we operated a PIT antenna inside the trap in conjunction with the video camera (i.e., fish are subject to PIT detection at the same time their image is captured on the video), we could apportion migrants by tagged vs. untagged thereby facilitating abundance estimation even on days we were not actually capturing fish.

In 2024, our Coho Salmon and smolt trap catches (and abundance estimates where they could be calculated) were quite low for all but Willow Creek. This is largely because in 2023, New Zealand mud snails (NZMS) were found at Warm Springs hatchery which meant that the location of hatchery releases was severely restricted. In keeping with CDFW policy, no fish were allowed for release into waters where NZMS had not been previously documented. This, in turn, led to no releases of any Coho at any life stage in Mill Creek and releases of smolts and presmolts only in lower portions of Green Valley (downstream of our migrant trap) and Willow Creek (upstream of our migrant trap). Therefore, we can interpret the extremely low trap catches to mean very low abundance of natural-origin smolts (9% for all LCMs combined; Figure 24) in 2024.

Steelhead smolt estimates for 2023/24 were greater than in previous years, approaching the same numbers observed in 2019/20, prior to the recent drought conditions (Table 2). However, even in a year without high levels of late summer stream drying, low dissolved oxygen limited our ability to conduct electrofishing surveys (second-stage sampling) in Green Valley Creek. The average dissolved oxygen was below 5 mg/L and only 3 of the 31 pools where measurements were taken had dissolved oxygen above 5 mg/L. The low numbers of steelhead juveniles observed in Willow and Dutch Bill creeks during both basin-wide juvenile surveys (SW and CSG 2023) and first-stage sampling (snorkel surveys) led to our decision not to conduct second-stage sampling in these creeks and thus limited our ability to calculate a smolt estimate. Low juvenile numbers were not surprising given the low number of steelhead redds observed in 2022/23 (SW and CSG 2023). It is worth noting that where second-stage sampling could be conducted, an increase in the survival index contributed to the increase in the smolt estimates.

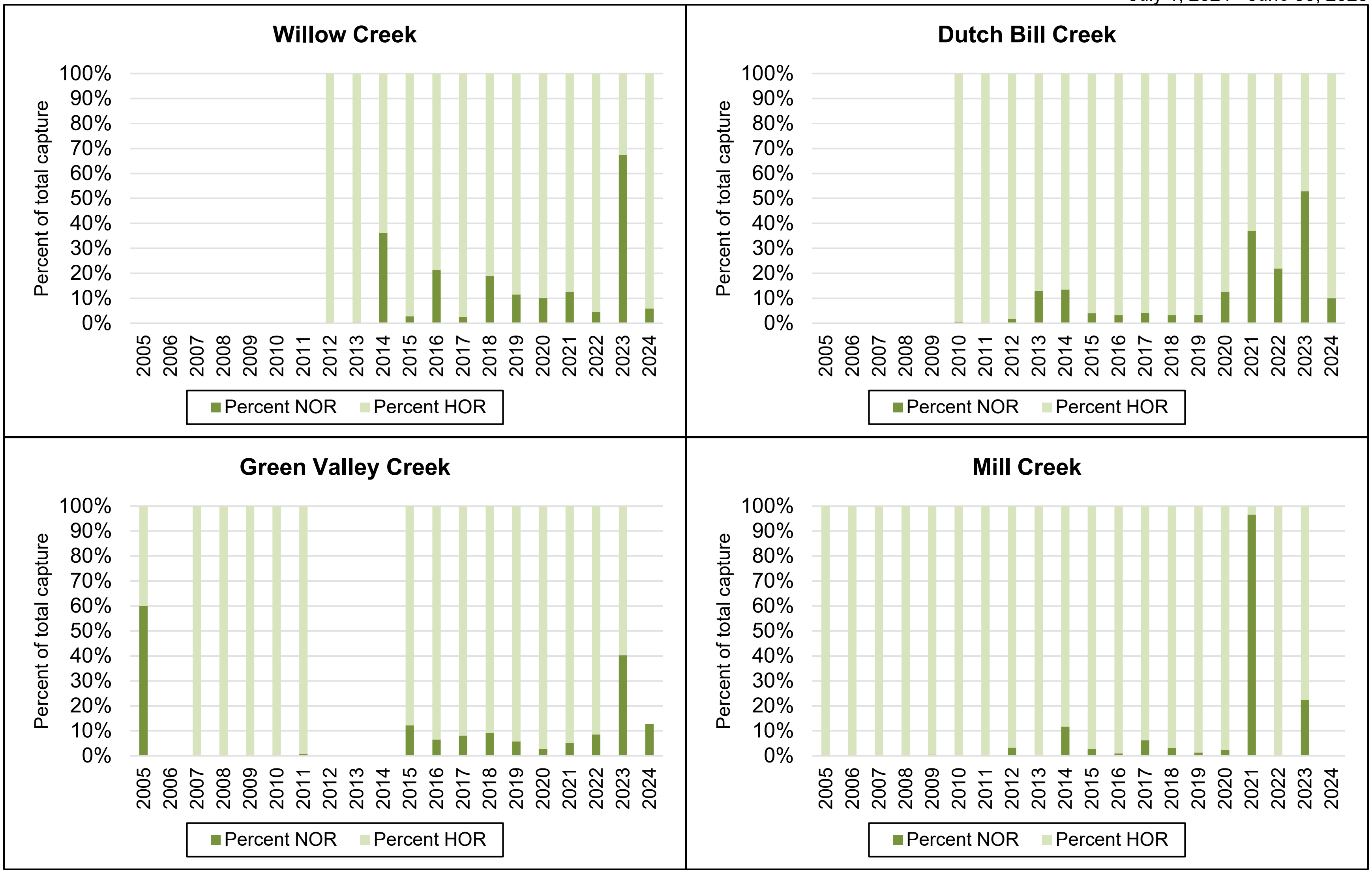


Figure 24. Proportion of natural- and hatchery-origin Coho Salmon smolts captured at the Coho-steelhead LCMs 2005-2024.

Adult and redd abundance

Estimates of Coho Salmon redd abundance in the Coho-steelhead LCM subwatersheds were higher than they have been in past years and that increase was mostly because of large increases in Willow Creek spawning activity (Figure 25). In past years, adult abundance estimates from PIT antenna detections generally track with redd abundance estimates, and they did again this year in Willow (where both adult and redd abundances were high). However, in the other 3 LCM subwatersheds redd abundance and adult abundance did not track quite as closely (see Figure 15 compared to Figure 22). The likely reason for this difference is the timing of spawner surveys relative to winter storms. We were able to conduct a survey in Willow Creek in late December immediately before a large rain event that led to an approximately 2-week period of high flows and turbidity that temporarily prevented us from conducting spawner surveys in Dutch Bill, Green Valley and Mill. Given the large adult Coho estimates from PIT antenna detections in those subwatersheds, it is likely that there was significant spawning activity that we were unable to document with spawner surveys. Given similar discrepancies in other years, we question the adequacy of basing adult estimates on spawner surveys alone. In years with a high frequency of large storms, spawner surveys may not be an adequate indicator of the amount of spawning but may still be suitable as an indicator of the spatial distribution of spawning. Consequently, we recommend continuing to use spawner surveys, along with more direct means of estimating actual adult returns (e.g., PIT antennas) so that we can continue characterizing the extent of spawning and the number of adults returning to LCMs as accurately as possible.

Discrepancies between adult sampling methods notwithstanding, there was a much larger than average return of adult Coho salmon this season. This was likely due to favorable conditions for this cohort as they moved through both freshwater and marine life stages. After extremely severe summertime drought conditions in 2020 and 2021, the winter of 2021/22 saw high, frequent, and late rainfall which created favorable juvenile rearing conditions in the summer and high flow conditions in the spring of 2023. A study of acoustic-tagged Coho smolts in the Russian River mainstem indicated that smolts in the summer of 2023 experienced higher survival than the previous two summers (SW unpublished data). It is also possible that marine conditions were more favorable once fish did reach the ocean (we suspect that curtailing the Chinook Salmon ocean fishing season for the last few years may have decreased Coho salmon bycatch), and when adults did finally reach freshwater to spawn, stream flow conditions were favorable for upstream migration to access high quality spawning habitat.

Steelhead returns to LCM subwatersheds were also higher than the previous two seasons, owing mostly to 3 times the average number of redds in Willow since 2013/14 (Figure 26). Numbers of redds in Mill and Green Valley were about average but still below average in Dutch Bill. We were once again unable to calculate an adult steelhead estimate from PIT tagging juvenile steelhead in LCM subwatersheds and detection on PIT antennas as adult returns. The detections we have seen illustrate some of the inherent difficulties with studying steelhead that have such a varied life history and return as adults at a time when environmental conditions for monitoring are challenging. A consistent and predictable source of PIT-tagged steelhead juveniles, from hatchery stock for example, would help improve our ability to generate estimates of freshwater and marine survival.

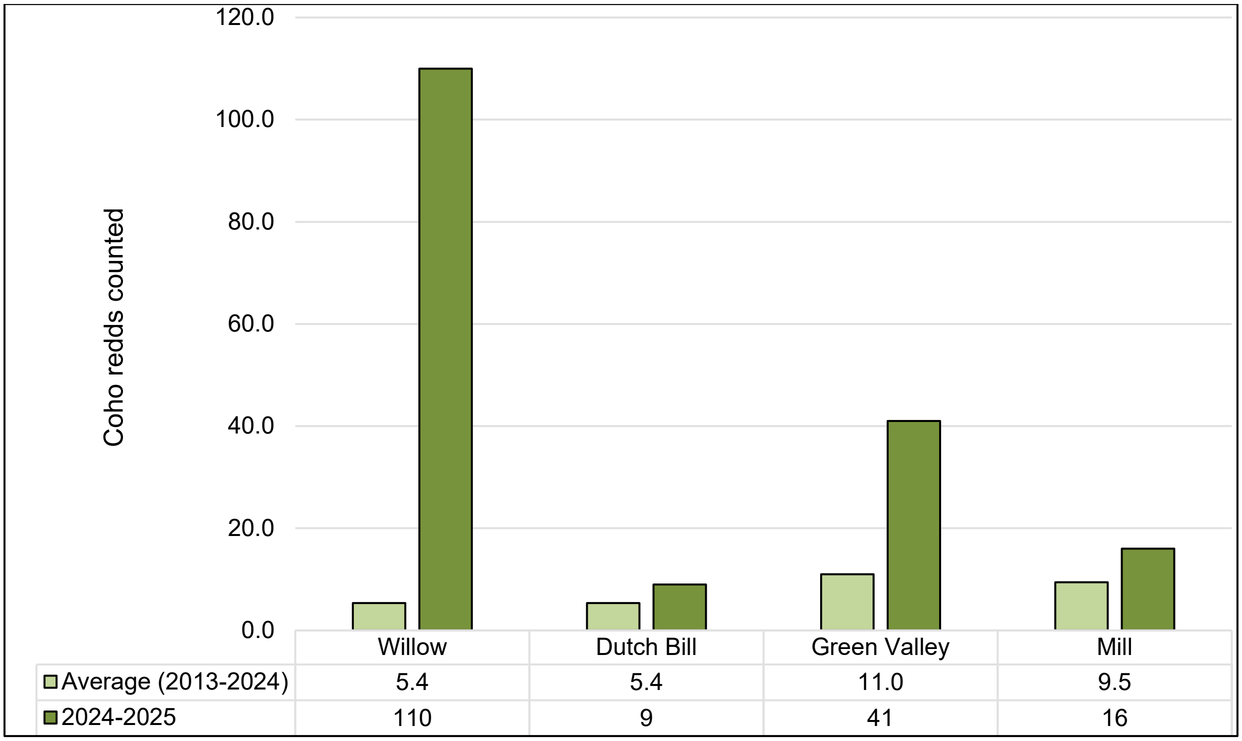
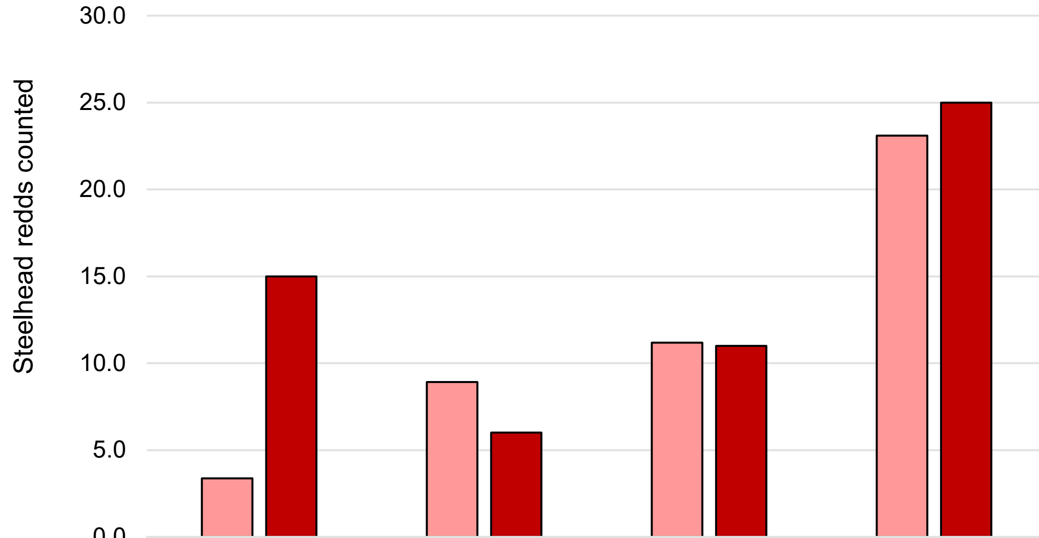


Figure 25. Number of Coho redds counted in LCMs in 2024/25 compared to the long-term average (2013/14-2023/24).



	Willow	Dutch Bill	Green Valley	Mill
Average (2013-2024)	3.4	8.9	11.2	23.1
2024-2025	15	6	11	25

Figure 26. Number of steelhead redds counted in LCMs in 2024/25 compared to the long-term average (2013/14-2023/24).

Task 3. Basin-wide Monitoring

Introduction

This task and the associated data reported here includes:

- annual juvenile snorkel surveys to evaluate the spatial structure of juvenile Coho Salmon in the Coho-steelhead stratum;
- annual adult spawner surveys to generate estimates of Coho Salmon and steelhead redds in the Coho-steelhead stratum.

Basin-wide sampling using a GRTS framework is designed to work in concert with life cycle monitoring to provide information on population status and trends at the watershed scale. These data can be combined with CMP data from other coastal systems to measure progress toward population recovery at the ESU scale (Adams et al. 2011). Here we provide results of juvenile spatial structure sampling (from snorkel surveys) and basin-wide adult redd abundance sampling (from spawner surveys) aimed at accomplishing basin-wide CMP objectives.

Methods

Juvenile Coho Salmon occupancy

Sampling to estimate juvenile Coho occupancy was based on modifications of protocols in Garwood and Ricker (2014). In each survey reach, two independent snorkel passes were completed. On the first pass, juvenile Coho Salmon and steelhead were counted in every other pool within the reach, with the first pool sampled (pool 1 or pool 2) determined randomly. Pools were defined as habitat units with a depth of greater than 0.3 m in an area at least as long as the maximum wetted width and a surface area of greater than 3 m^2. A second pass was completed the following day in which every other pool that was snorkeled during the first pass was snorkeled a second time (i.e., every fourth pool). These data were then used in an occupancy model to estimate occupancy at the reach scale and occupancy at the pool scale for Coho Salmon only. A GPS point was collected at the downstream end of each pool snorkeled during the pass 1 survey.

During each survey, snorkeler(s) moved from the downstream end of each pool (pool tail crest) to the upstream end, surveying as much of the pool as water depth allowed. Dive lights were used to inspect shaded and covered areas. To minimize disturbance of fish and sediment, snorkelers avoided sudden movements. Double counting was minimized by only counting fish as they moved downstream of the observer. In larger pools requiring two snorkelers, two lanes were agreed upon and each snorkeler moved upstream through their designated lane at a similar rate. Final counts of double-diver pools were the sum of both lane counts. All observed salmonids were identified to species based on physical characteristics and assigned life stage based solely on estimated length (young-of-the-year [YOY] if less than 100mm or parr [≥ age-1] if greater than 100mm). The presence of non-salmonid species was recorded at the pool scale, but actual counts were not recorded. Field computers with Survey 123 (Esri) were used for data entry and, upon returning from the field, data files were downloaded, QA/QC’d, and transferred to a SQL database. Spatial data were downloaded, QA/QC’d, and stored in an ArcGIS geodatabase for map production.

A multiscale occupancy model was used to estimate the probability of juvenile Coho occupancy at the reach scale (ψ) and conditional occupancy at the pool scale (θ), given presence in the reach (Nichols et al. 2008; Garwood and Larson 2014). Detection probability (p) at the pool scale was calculated using the data from repeat dives. The proportion of area occupied (PAO) for the sample frame was then estimated as the product of the reach and pool scale occupancy parameter estimates (ψ*θ). All models were run in Program MARK (White and Burnham 1999). Snorkel surveys were carried out prior to the release of hatchery juveniles to ensure that occupancy estimates reflected natural-origin fish only.

Redd abundance

Field methods for basin-wide spawner surveys were almost identical to those described above for spawner surveys in the four LCMs. The difference was that while a near-census of reaches was conducted in all the LCMs, only a subsample of reaches for basin-wide surveys were chosen based on GRTS ordering and placed into rotating panels. During each spawner season, reaches from two panels are surveyed. One panel of reaches is surveyed every season, and one panel is on a three-year cycle. During the 2024/25 spawner season, we employed the methods recommended by Adams et al. (2011) and outlined in Gallagher et al. (2007) to survey for redds, live fish, and carcasses in the Coho-steelhead sample stratum only, whereas in previous years we had been funded to sample in the steelhead-only sample stratum as well.

Reaches where landowner access could not be secured for at least 75% of the reach length were skipped and the next reach in the GRTS draw was substituted.

We estimated basin-wide redd abundance in the Coho-steelhead sample stratum (79 reaches) for the 2024/25 spawner season using survey methods identical to the methods described for deriving total redd estimates from spawner surveys in LCMs (Ricker et al. 2014; Adams et al. 2011). Like LCM surveys, the estimation approach employed both a within-reach and among-reach expansion each season and variance associated with each was combined into an overall variance estimate.

Results

Juvenile Coho Salmon occupancy

Between June 10 and September 19, 2024, we snorkeled 55 reaches in 31 streams encompassing 154 km (96 mi) of stream length (Figure 27). All accessible juvenile Coho Salmon rearing reaches of Willow, Dutch Bill, Green Valley, and Mill subwatersheds were surveyed, and 51 reaches within the Russian River sample frame that were considered to contain juvenile Coho Salmon habitat (49% of juvenile Coho reaches) were included in the basin-wide occupancy estimate. This is less than the portion that has been included in previous seasons because fewer crew were available to complete surveys. Despite this a sampling rate approximating 50% seems adequate for making a robust estimate of PAO.

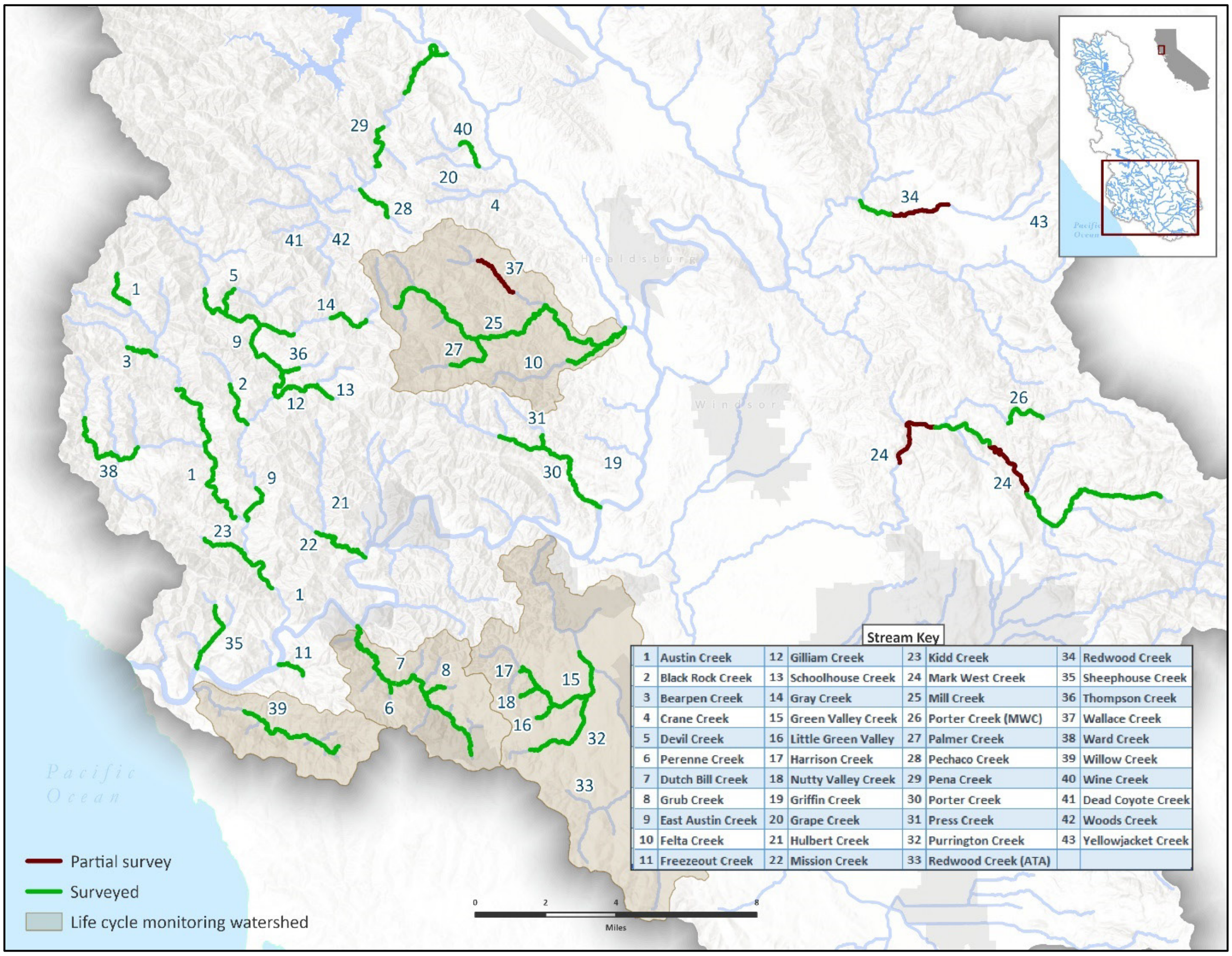


Figure 27. Map of reaches snorkeled during the 2024 snorkel season. Reaches in Wallace, Mark West, and Redwood Creeks had only partial surveys completed because of a loss of the data collection device (Wallace) or turbid, stagnant, overgrown conditions (Mark West, Redwood).

We observed 1,287 Coho Salmon YOY and 15,045 steelhead YOY during snorkel surveys in 2024. All YOY were presumed to be of natural origin. Though hatchery origin steelhead are adipose clipped, we recognize that marks indicating hatchery origin are nearly impossible to distinguish while snorkeling; however, because hatchery steelhead are released as smolts that would be much larger in size than natural-origin age-0+ or age-1+ fish, we are confident that we could readily distinguish them and therefore not include them in counts. Coho Salmon YOY were observed in 18 of the 54 juvenile Coho reaches surveyed and in 16 of the 35 juvenile Coho streams snorkeled (33% and 46%, respectively) (Figure 28). Steelhead YOY were observed in 51 of the 54 steelhead reaches and 32 of the 35 steelhead streams surveyed (90% and 85%, respectively). In 6 of the 16 streams where Coho YOY were found, fewer than 10 Coho were observed. Coho YOY counts were highest in Green Valley, Dutch Bill and Willow creeks, though even in those streams counts were low (Figure 29). Counts of steelhead YOY were highest in the Pena and Mill subwatersheds, and relatively high numbers were also observed in Porter Creek. (Figure 30).

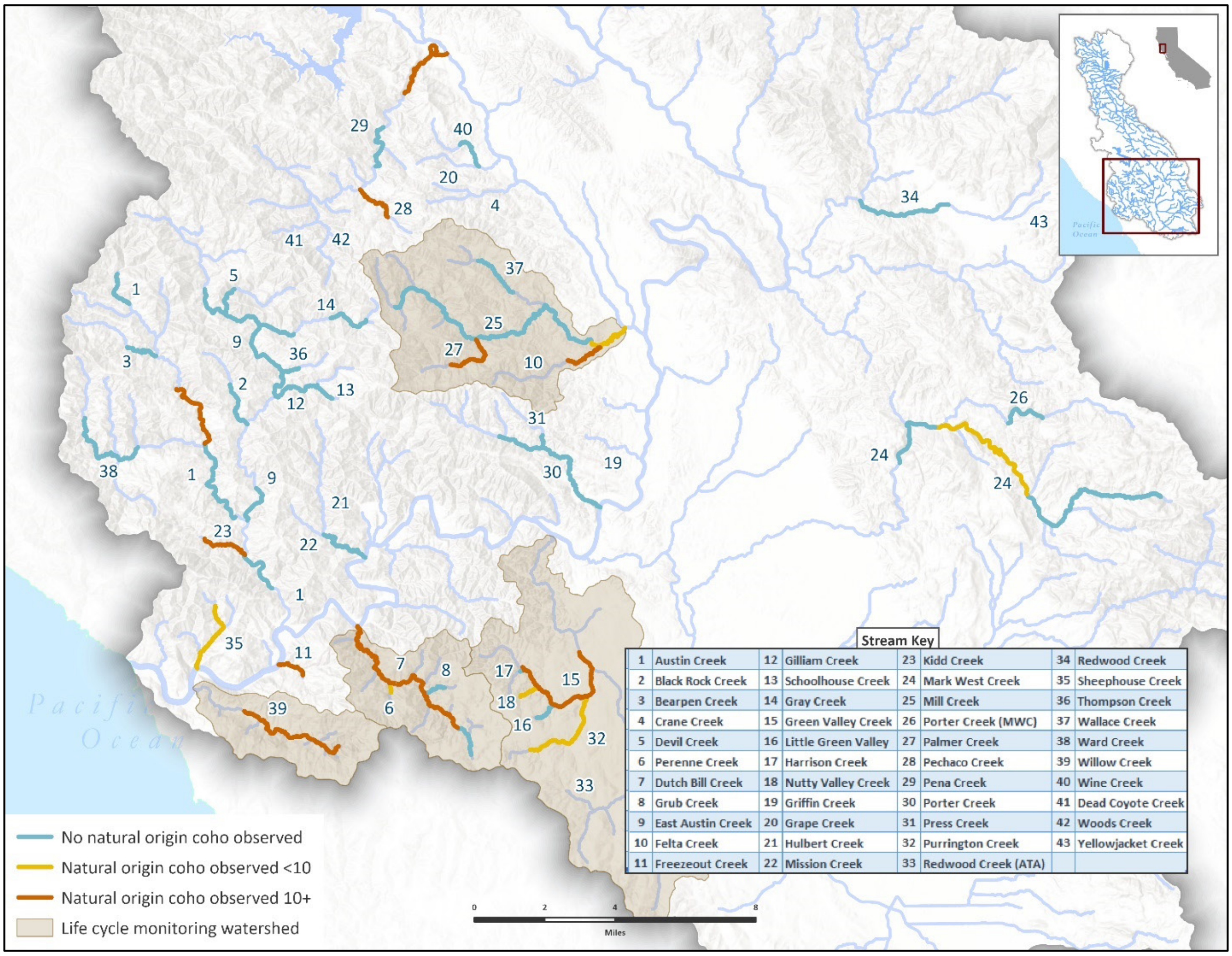


Figure 28. Natural origin Coho Salmon presence by reach in Russian River streams surveyed in summer 2024.

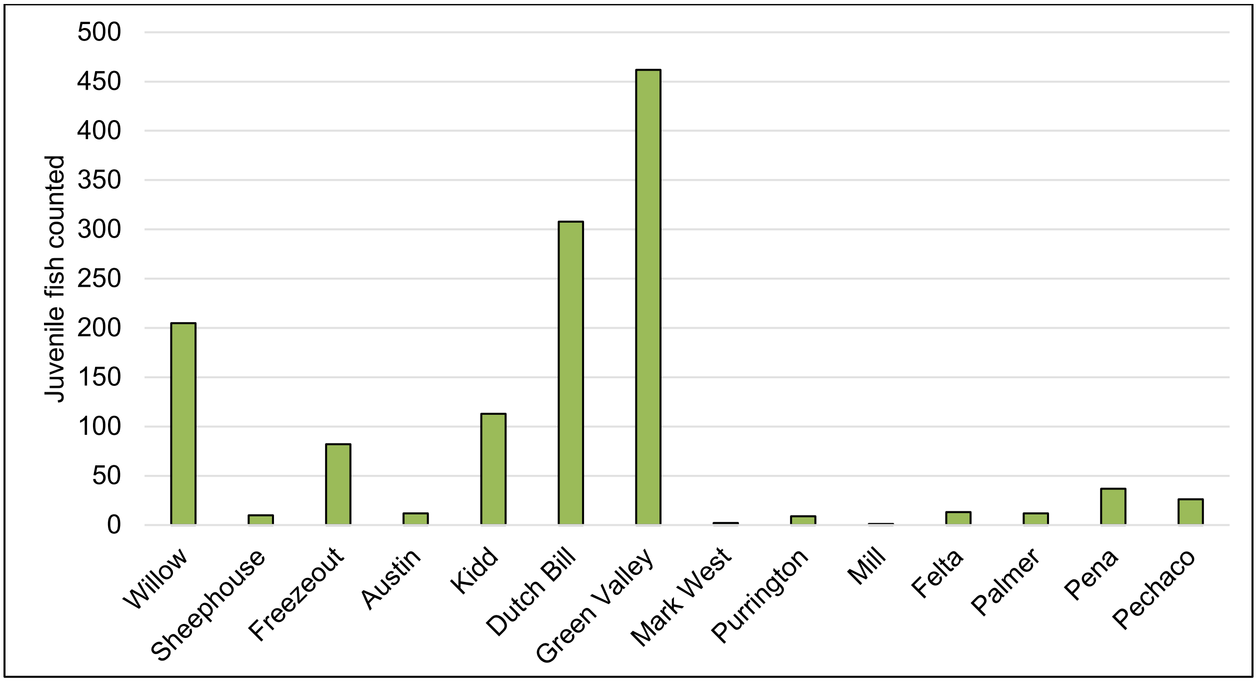


Figure 29. First pass counts of juvenile Coho Salmon (YOY and parr) in streams surveyed during the 2024 snorkel season. Only streams where juvenile Coho were found are included. Note that not all habitat within each creek may have been surveyed in a given year.

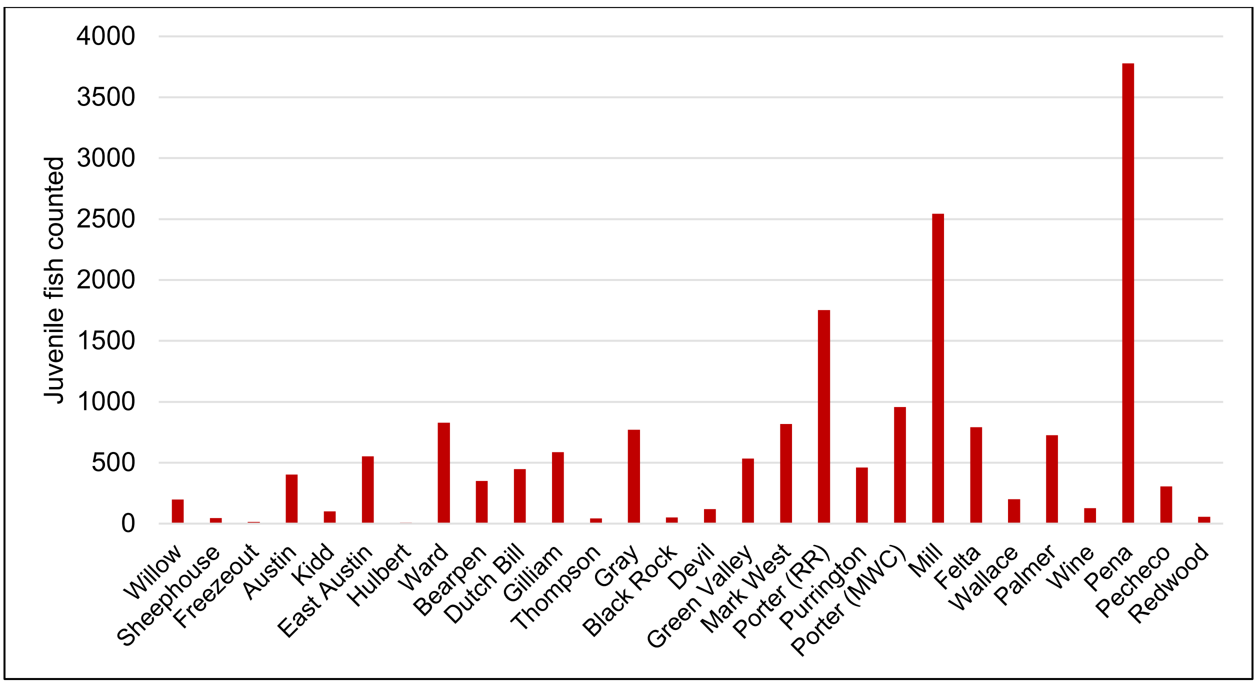


Figure 30. First pass counts of juvenile steelhead (YOY and parr) in streams surveyed during the 2024 snorkel season. Only streams where juvenile steelhead were found are included. Note that not all habitat within each creek may have been surveyed in a given year.

Based on results of the multiscale occupancy model, we estimate that the probability of coho salmon YOY occupying a given reach within the basin-wide Russian River coho salmon stratum (ψ) in 2024 was 0.34 (0.22 - 0.48, 95% CI), and the conditional probability of coho salmon YOY occupying a pool within a reach, given that the reach was occupied (θ), was 0.40 (0.35 - 0.46, 95% CI). The proportion of the coho salmon stratum occupied (PAO) was 0.14, which was the second lowest observed since we began occupancy surveys in 2015 and approximately 55% of the 10-year average of 0.25 (Figure 31).

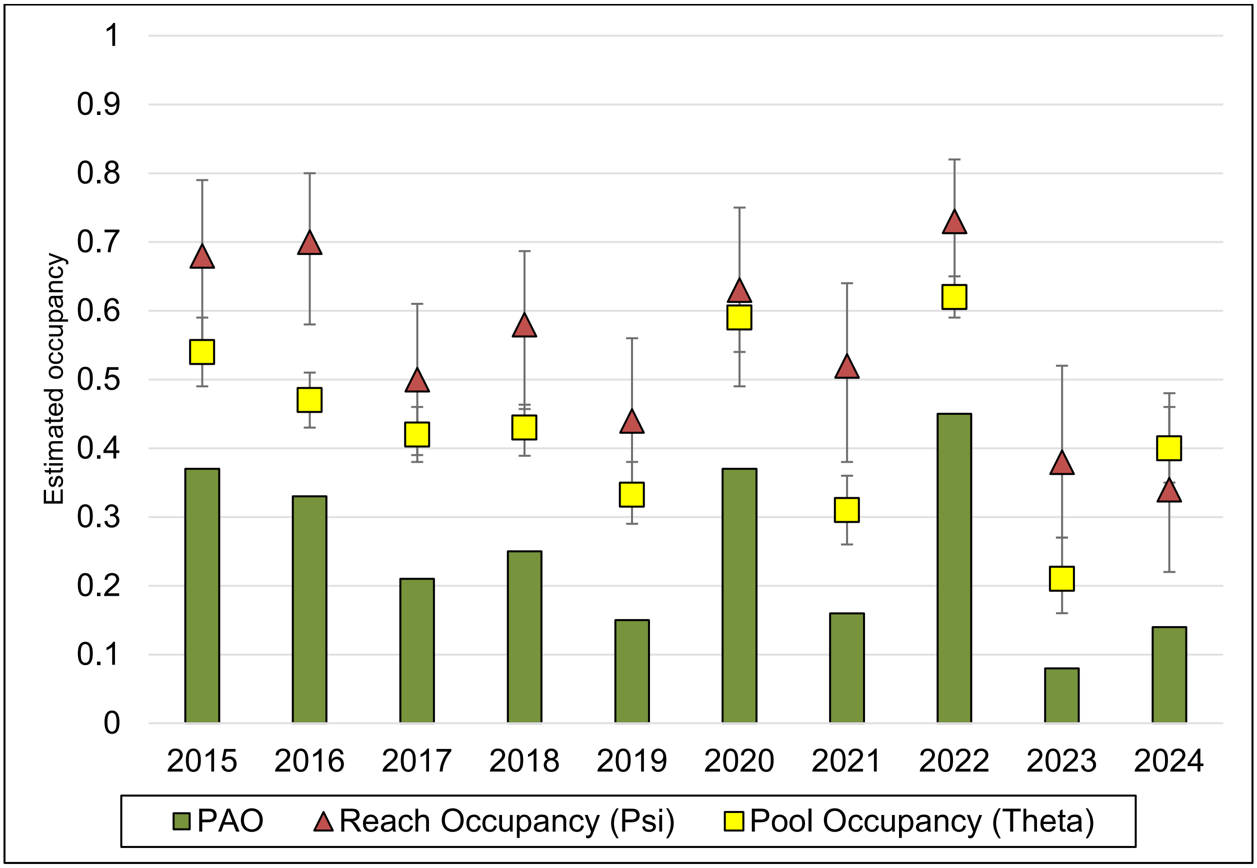


Figure 31. Estimated reach occupancy, conditional pool occupancy, and PAO for juvenile Coho Salmon in the Coho-steelhead sample stratum, summer 2015 through 2024.

Redd abundance

We began surveys on November 25, 2024, following the first rain event of the season, and continued surveying through April 30, 2025. Despite persistently high and turbid flow conditions during the winter of 2024/25 (Figure 19), we were generally able to maintain our goal of conducting surveys within each reach on a 10-14 day cycle, resulting in the number of days surveyed similar to the average for the previous 10 years since 2014/15 (74.8 days, Figure 32). The median time between surveys was 15 days with a maximum time between repeated surveys on any reach of 36 days. In all, we conducted a total of 492 surveys (in parent and sub reaches combined) in the Russian River basin (Figure 32). Forty-three parent reaches in 24 streams within the basin were surveyed (Figure 33). Pena, Woods and Grape Creeks were the only streams where Chinook redds or Chinook individuals were observed (Figure 34, Figure 35). Coho Salmon redds or individuals were observed in 35 of the 43 parent reaches surveyed (81%), and steelhead redds or individuals were observed in 39 of the 43 parent reaches surveyed (91%) (Table 4, Figure 36, Figure 37). A total of 591 salmonid redds were observed: 251 Coho Salmon redds, 197 steelhead redds, 34 Chinook Salmon redds, and 109 redds of unknown salmonid species origin (Table 4).

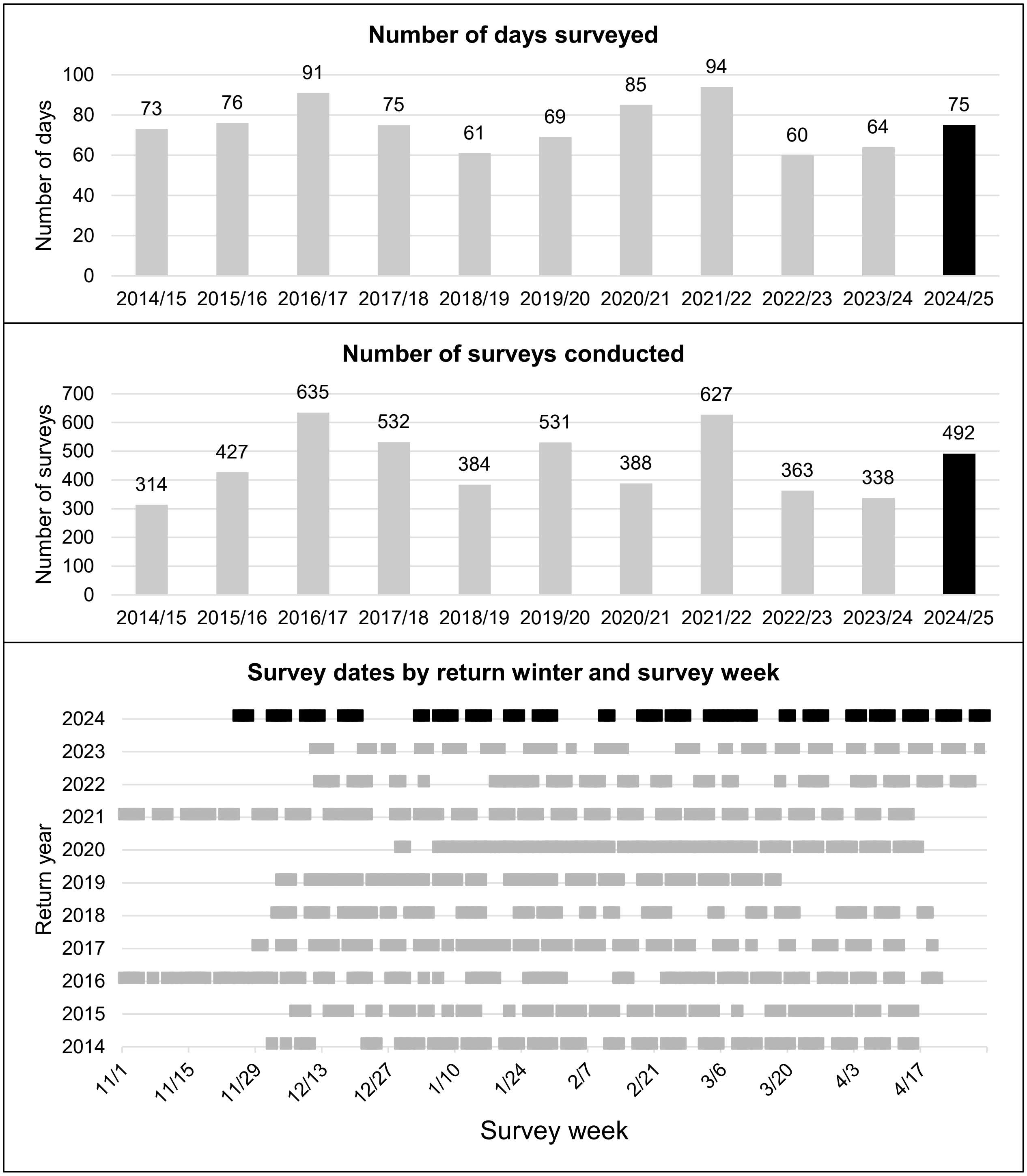


Figure 32. Historical spawner survey effort. Note this does not include surveys that were conducted in steelhead-only reaches.

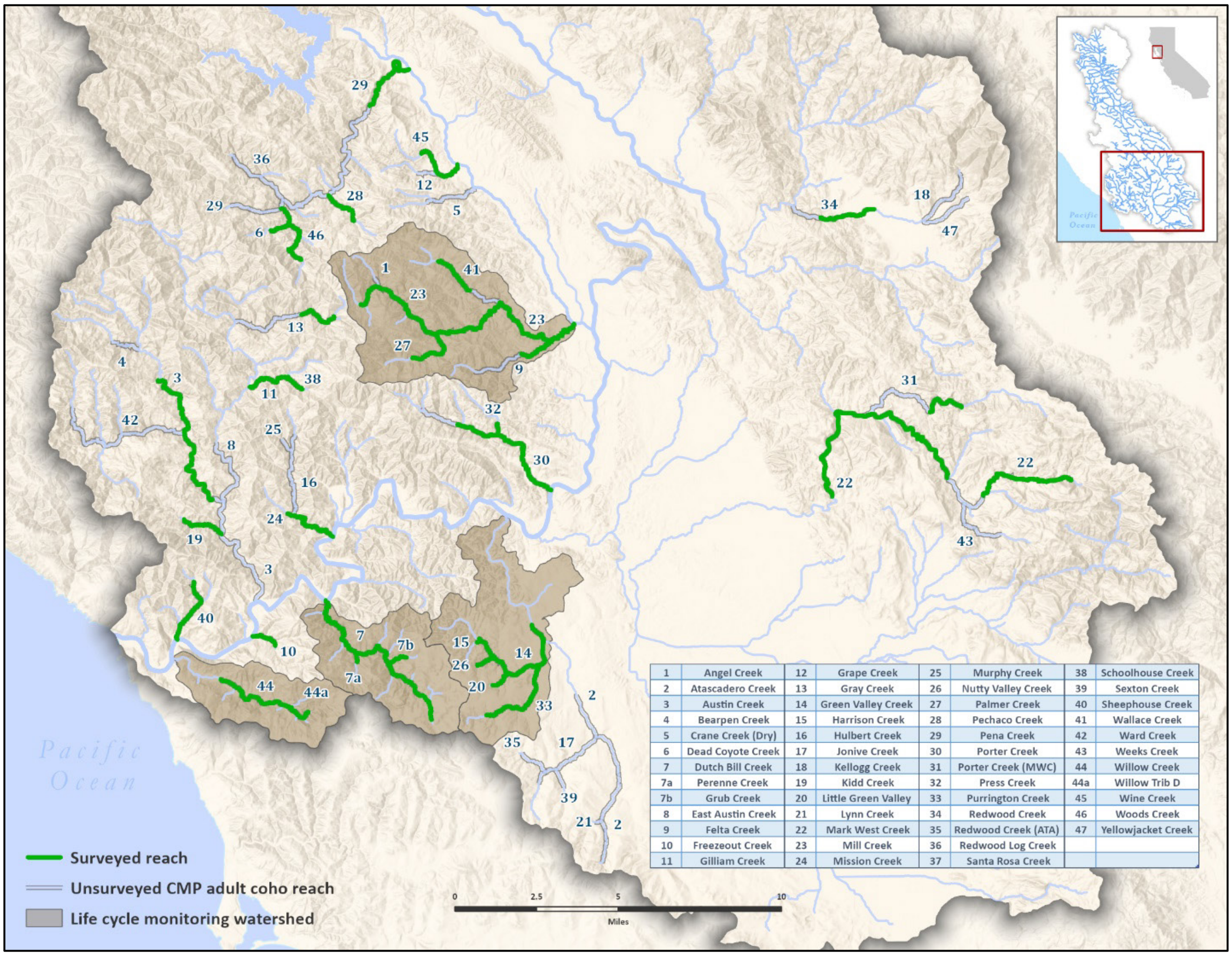


Figure 33. Spawner survey reaches sampled within the Coho-steelhead stratum during the 2024/25 spawning season.

Table 4. Number of salmonid redds (and percentages) observed by species during winter 2024/25 in Russian River streams.

Tributary	Length surveyed (km)	Coho salmon	Steelhead	Chinook salmon	Salmonid sp	Total
Angel Creek	0.5	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Austin Creek	8.9	3 (1.2%)	14 (7.1%)	0 (0%)	4 (3.7%)	21 (3.6%)
Dead Coyote Creek	1.1	0 (0%)	2 (1.0%)	0 (0%)	2 (1.8%)	4 (0.7%)
Dutch Bill Creek	11.4	9 (3.6%)	5 (2.5%)	0 (0%)	4 (3.7%)	18 (3.0%)
Duvoul Creek	0.2	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Felta Creek	3.7	5 (2.0%)	8 (4.1%)	0 (0%)	1 (0.9%)	14 (2.4%)
Freezeout Creek	1.5	1 (0.4%)	0 (0%)	0 (0%)	0 (0%)	1 (0.2%)
Gilliam Creek	2.6	9 (3.6%)	1 (0.5%)	0 (0%)	2 (1.8%)	12 (2.0%)
Grape Creek	1.5	8 (3.2%)	8 (4.1%)	2 (5.9%)	5 (4.6%)	23 (3.9%)
Gray Creek	2.2	2 (0.8%)	7 (3.6%)	0 (0%)	1 (0.9%)	10 (1.7%)
Green Valley Creek	7.0	30 (12.0%)	6 (3.0%)	0 (0%)	5 (4.6%)	41 (6.9%)
Grub Creek	1.1	0 (0%)	1 (0.5%)	0 (0%)	1 (0.9%)	2 (0.3%)
Harrison Creek	0.2	0 (0%)	1 (0.5%)	0 (0%)	2 (1.8%)	3 (0.5%)
Hulbert Creek	3.2	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Kidd Creek	2.5	4 (1.6%)	2 (1.0%)	0 (0%)	2 (1.8%)	8 (1.4%)
Little Green Valley Creek	1.2	0 (0%)	2 (1.0%)	0 (0%)	1 (0.9%)	3 (0.5%)
Mark West Creek	19.2	10 (4.0%)	16 (8.1%)	0 (0%)	2 (1.8%)	28 (4.7%)
Mill Creek	16.6	6 (2.4%)	16 (8.1%)	0 (0%)	3 (2.8%)	25 (4.2%)
Mission Creek	0.4	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Nutty Valley Creek	1.2	5 (2.0%)	0 (0%)	0 (0%)	1 (0.9%)	6 (1.0%)
Palmer Creek	2.9	3 (1.2%)	1 (0.5%)	0 (0%)	2 (1.8%)	6 (1.0%)
Pechaco Creek	2.3	7 (2.8%)	8 (4.1%)	0 (0%)	5 (4.6%)	20 (3.4%)
Pena Creek	4.2	6 (2.4%)	39 (19.8%)	17 (50.0%)	15 (13.8%)	77 (13.0%)
Perenne Creek	0.5	0 (0%)	0 (0%)	0 (0%)	1 (0.9%)	1 (0.2%)
Porter Creek	7.4	3 (1.2%)	11 (5.6%)	0 (0%)	1 (0.9%)	15 (2.5%)
Porter Creek (MWC)	2.4	0 (0%)	3 (1.5%)	0 (0%)	0 (0%)	3 (0.5%)
Press Creek	0.6	0 (0%)	0 (0%)	0 (0%)	0 (0%)	0 (0%)
Purrington Creek	4.8	6 (2.4%)	2 (1.0%)	0 (0%)	2 (1.8%)	10 (1.7%)
Redwood Creek	3.0	1 (0.4%)	2 (1.0%)	2 (5.9%)	1 (0.9%)	6 (1.0%)
Schoolhouse Creek	1.1	6 (2.4%)	0 (0%)	0 (0%)	0 (0%)	6 (1.0%)
Sheephouse Creek	3.7	3 (1.2%)	2 (1.0%)	0 (0%)	5 (4.6%)	10 (1.7%)
Wallace Creek	2.5	2 (0.8%)	0 (0%)	0 (0%)	0 (0%)	2 (0.3%)
Willow Creek	6.0	106 (42.2%)	15 (7.6%)	0 (0%)	14 (12.8%)	135 (22.8%)
Willow Creek Trib D	0.1	4 (1.6%)	0 (0%)	0 (0%)	0 (0%)	4 (0.7%)
Wine Creek	1.8	4 (1.6%)	8 (4.1%)	0 (0%)	3 (2.8%)	15 (2.5%)
Woods Creek	4.1	8 (3.2%)	17 (8.6%)	13 (38.2%)	24 (22.0%)	62 (10.5%)
Total	**133.3**	**251 (100%)**	**197 (100%)**	**34 (100%)**	**109 (100%)**	**591 (100%)**

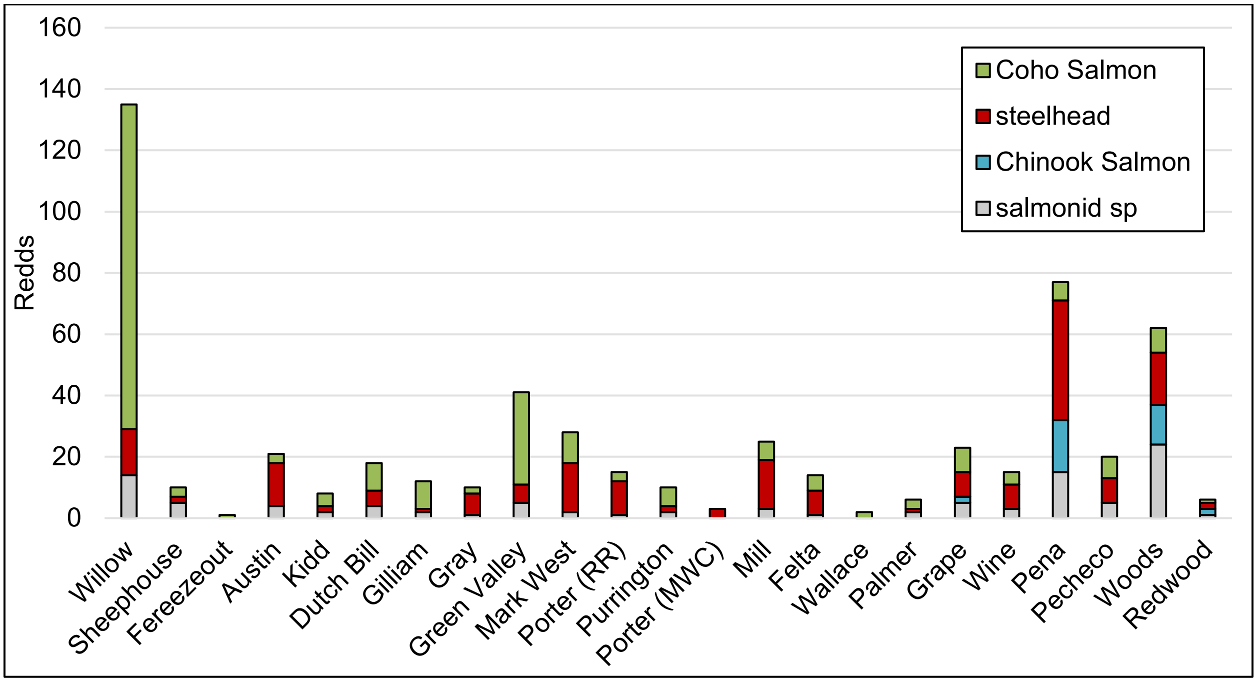


Figure 34. New redds counted during spawner surveys by tributary for all three levels of redd species certainty. Only Streams where redds were found are included. Note that not all habitat within each creek may have been surveyed in a given year (i.e., only reaches included in the rotating panel for a given season were surveyed).

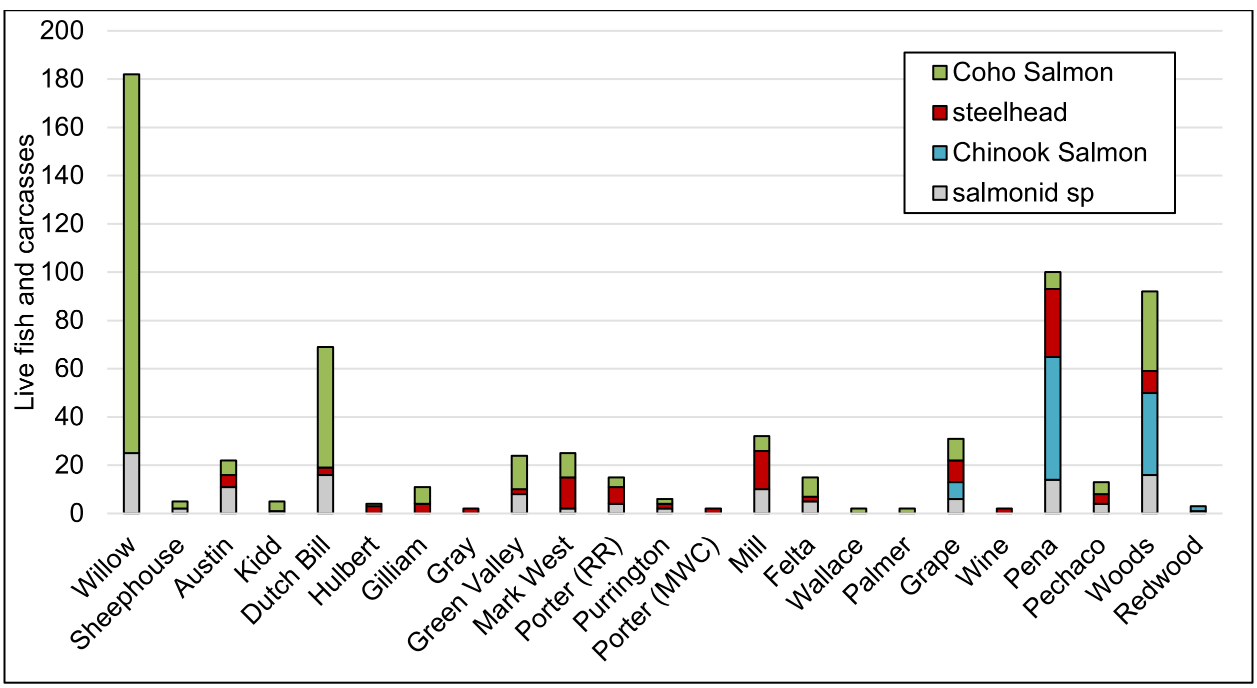


Figure 35. Live adult salmonids and carcasses counted during spawner surveys by tributary for all three levels of redd species certainty. Only streams where redds were found are included. Note that not all habitat within each creek may have been surveyed in a given year (i.e., only reaches included in the rotating panel for a given season were surveyed).

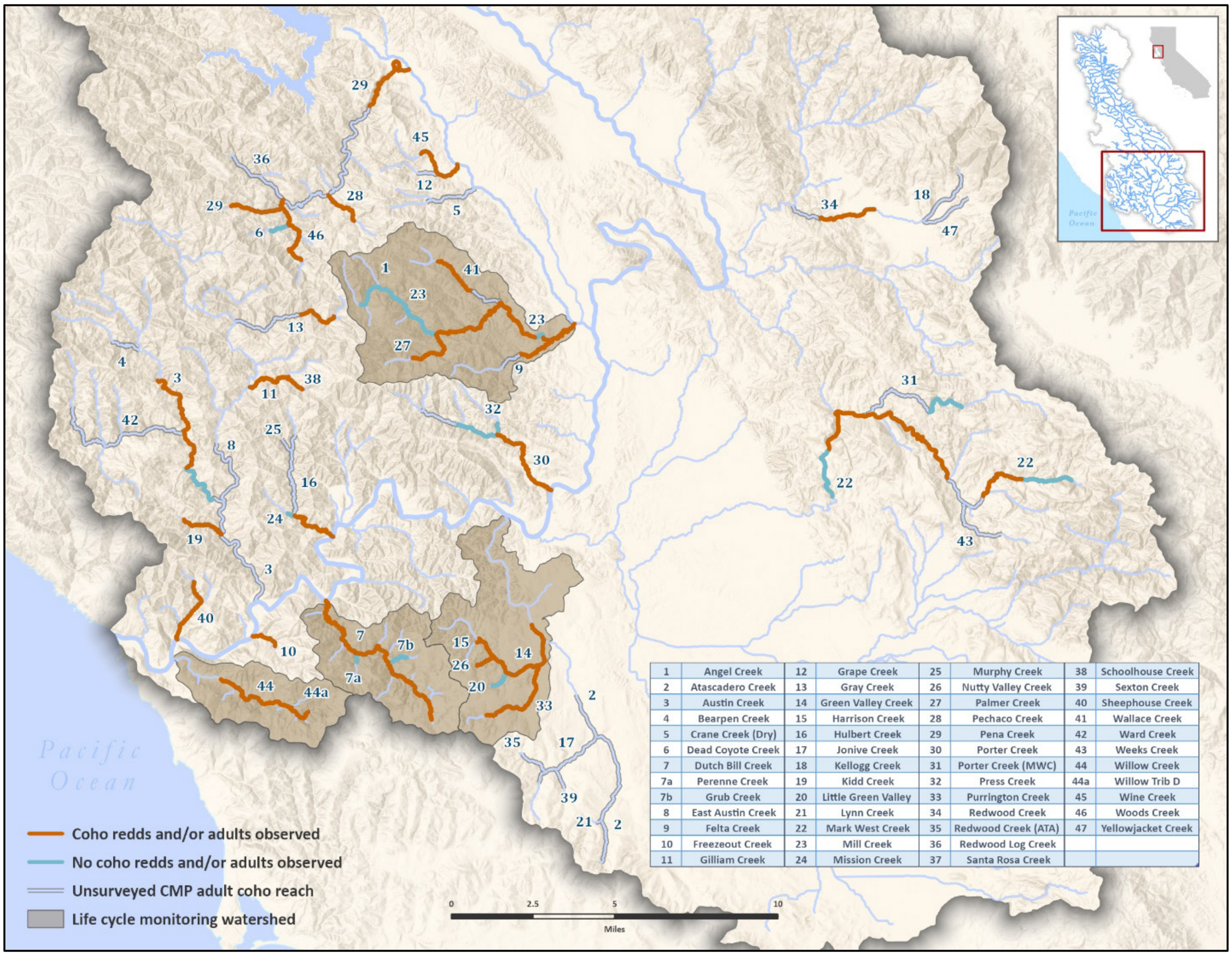


Figure 36. Reaches in the Coho-steelhead stratum where Coho Salmon redds and/or Coho Salmon adults were observed, winter 2024/25. Sampled reaches where the presence of Coho was not documented appear in light blue.

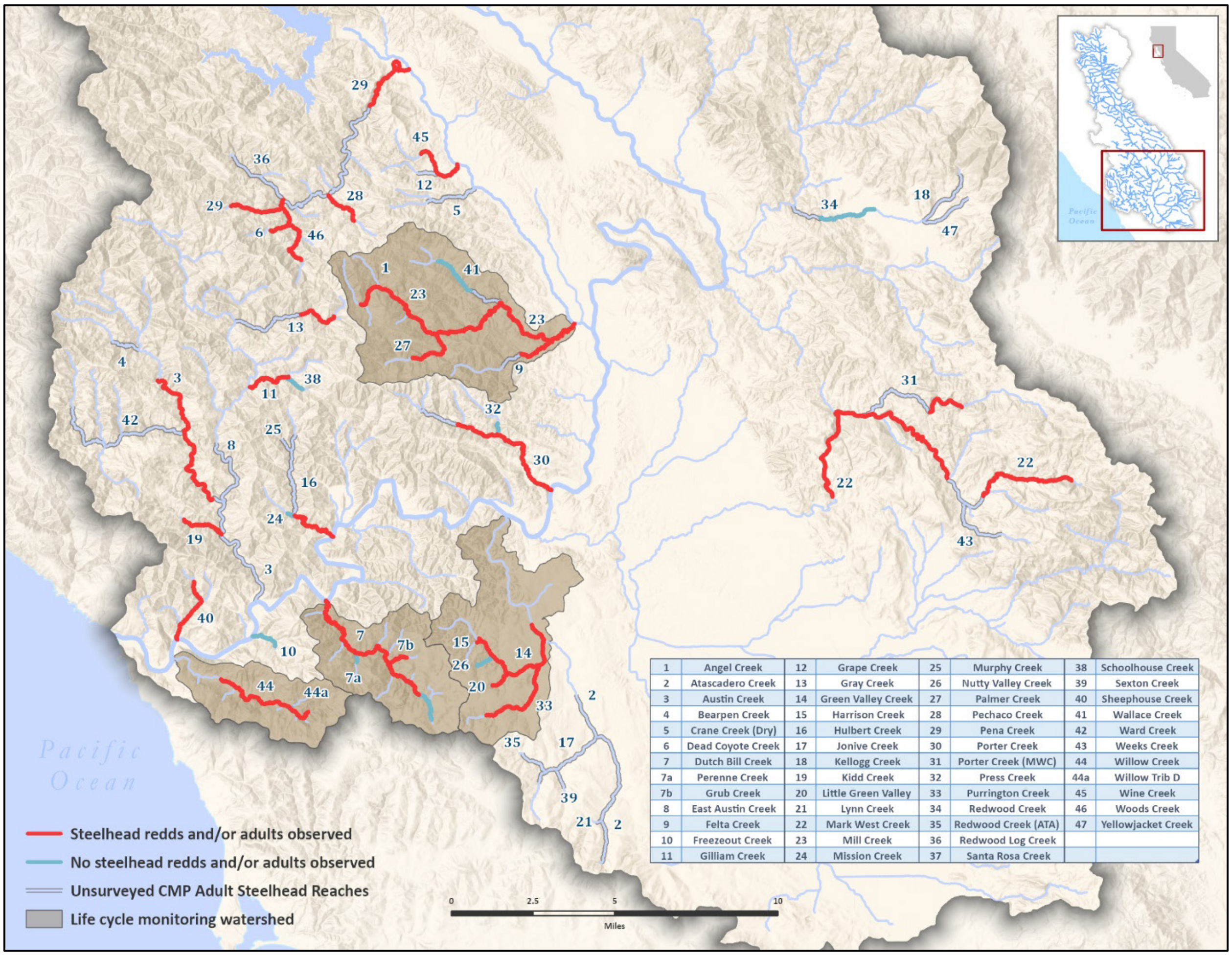


Figure 37. Reaches in the Coho-steelhead stratum where steelhead redds and/or steelhead adults were observed, winter 2024/25. Sampled reaches where the presence of steelhead was not documented appear in light blue.

We first observed Coho Salmon redds in the watershed on December 2, 2024, and we continued to observe new Coho redds until March 10, 2025 (Figure 39). There appeared to be two peaks in Coho spawning activity (one in mid-December and a second in early January), but this was likely due to a series of storms that created high flows and turbidity and prevented us from surveying for about 10 days between December 21, 2024, and January 1, 2025. Steelhead redd observations began in early December and extended into late April, with a somewhat muted peak in early January which was earlier than the average timing of previous years (Figure 40). The average number of observed redds per km for coho salmon was 1.9 and the average number of observed redds per km for steelhead was 1.5. Coho redd density was higher in most streams compared to the previous 10-years average and much higher in Willow Creek (Figure 38). The number of Coho redds counted per survey (0.66 redds per survey) was over 5 times higher than the average of 0.13 redds per survey (Figure 41). The number of steelhead redds counted per survey this season was roughly equivalent to the average (0.4 redds per survey, Figure 42).

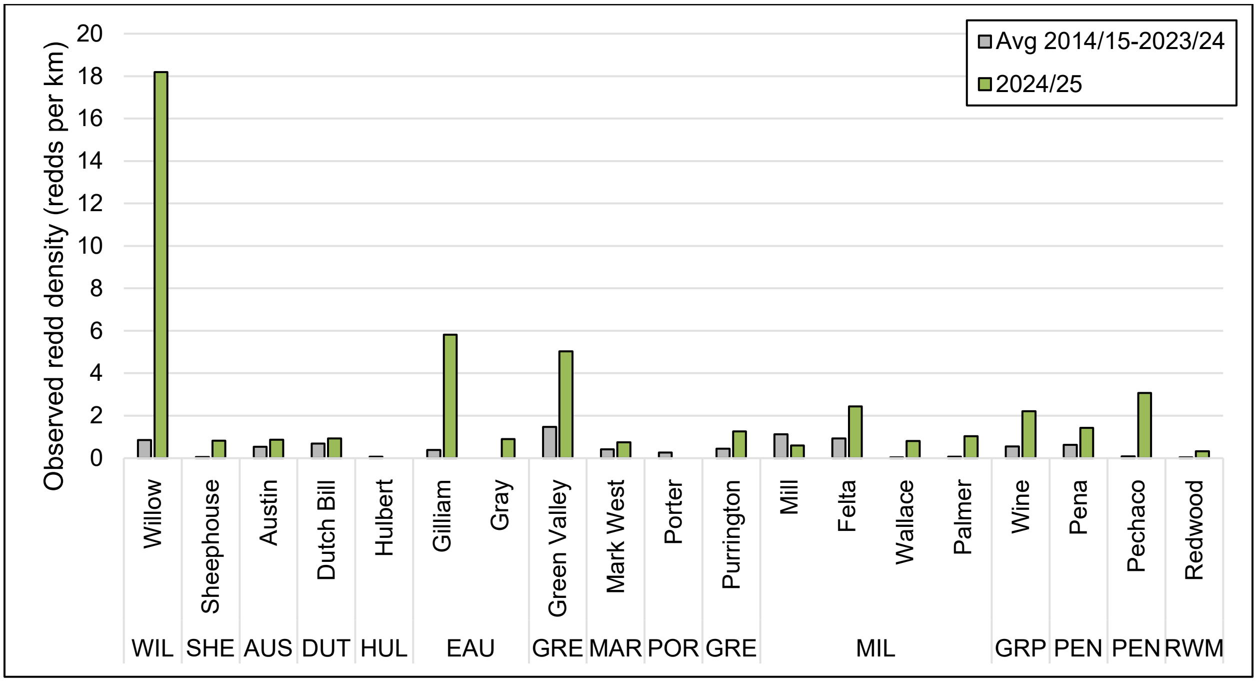


Figure 38. Observed coho salmon redds per km in reaches that are sampled each season since 204/15 (i.e., coho rotating panel 1) summed by tributary, winter 2024/25 in comparison to long term average.

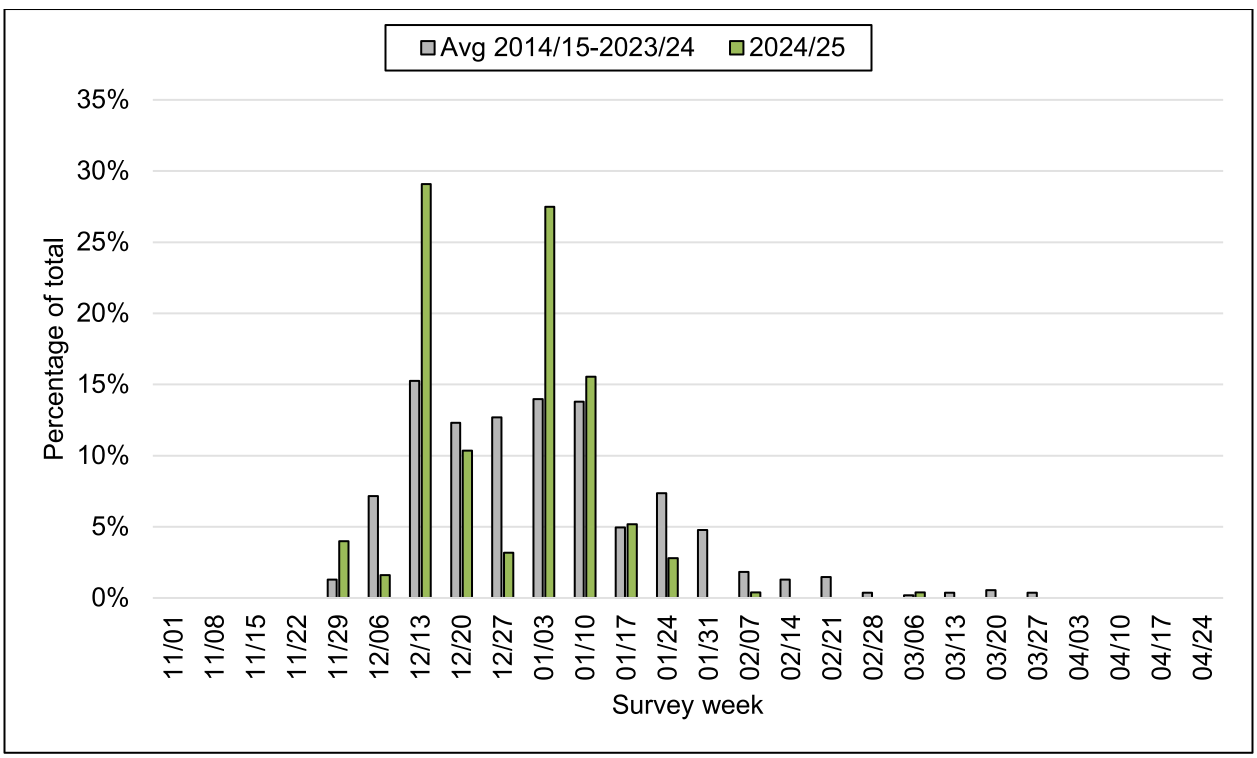


Figure 39. Number of new Coho Salmon redds observed each week in all streams surveyed during the 2024/25 season in comparison to the long-term average.

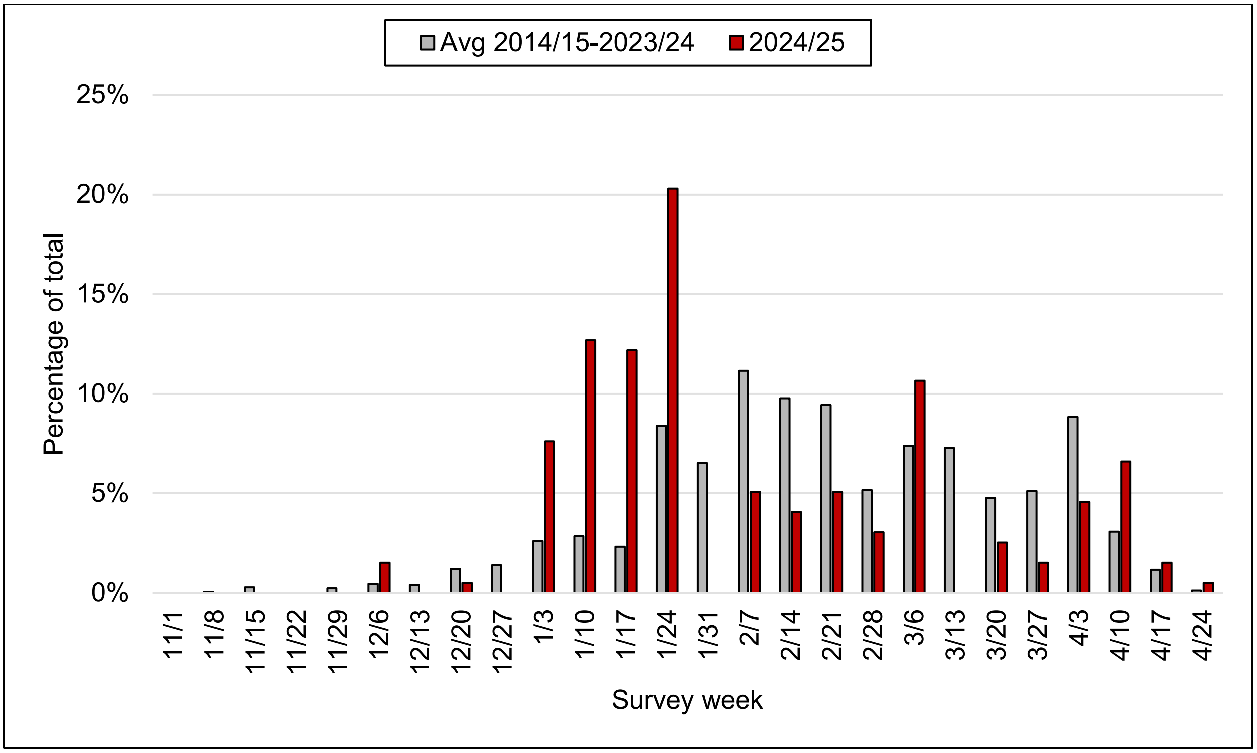


Figure 40. Number of new steelhead redds observed each week in all streams surveyed during the 2023/24 season in comparison to the long-term average.

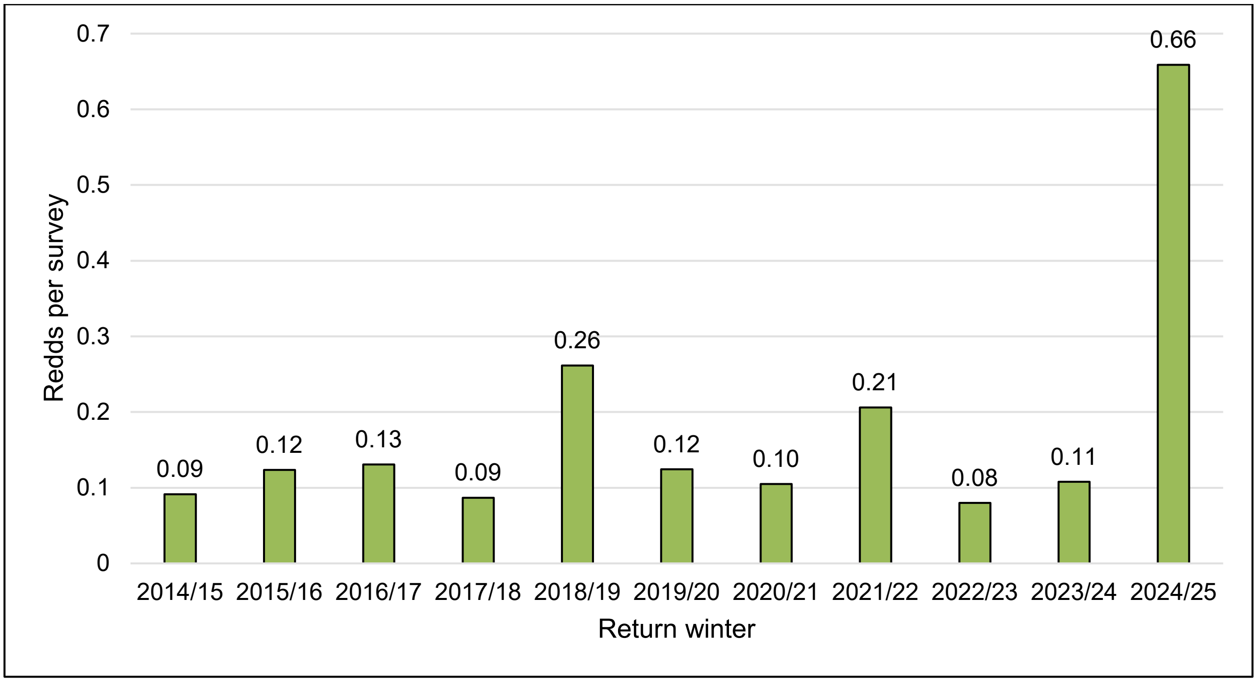


Figure 41. Number of new Coho Salmon redds observed per survey in all streams surveyed during the spawning seasons from 2014 to 2025.

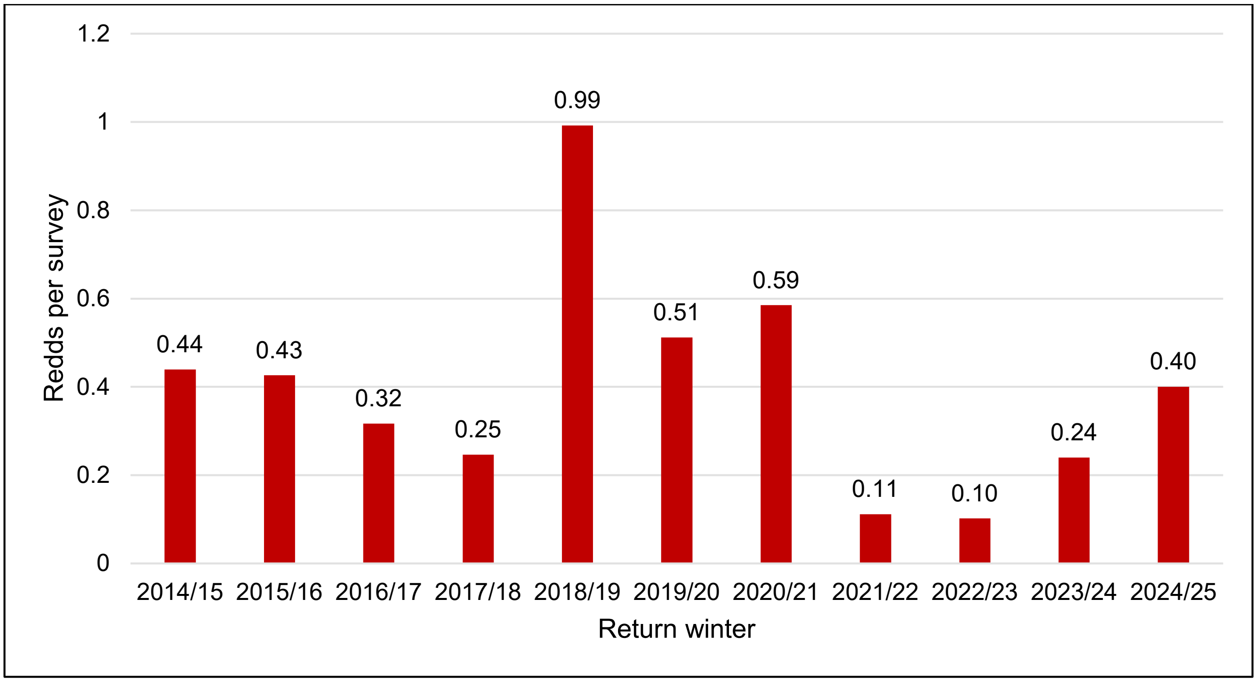


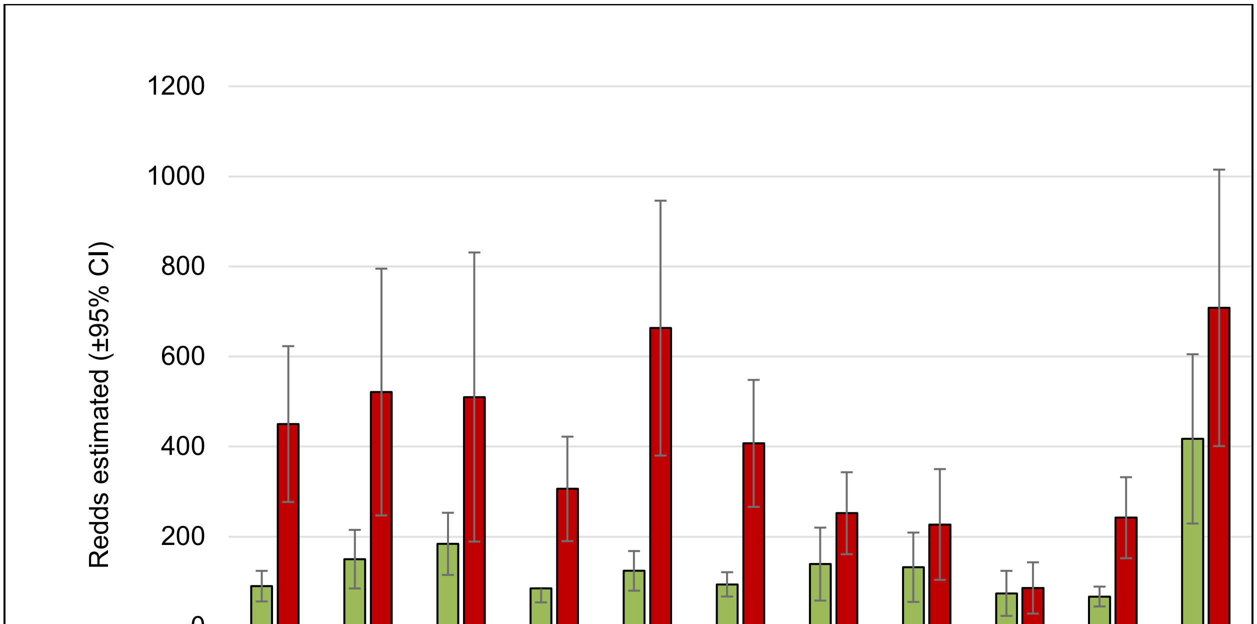
Figure 42. Number of new steelhead redds observed per survey in all streams surveyed during the spawning seasons from 2014 to 2025.

Of the 100 Coho Salmon carcasses found during surveys, we were able to adequately scan 31 for coded wire tags. Forty-five Coho carcasses could be adequately scanned for PIT tags. Based on these two possible indicators of hatchery or natural origin (HOR or NOR), we could assign origin to 32 Coho carcasses. Of those, eight were estimated to be HOR and 24 were estimated to be NOR. Origin could not be determined for live Coho Salmon. All CWT recovered from Coho Salmon carcasses indicated origin from Warm Springs hatchery. Four PIT tags were observed in Coho Salmon carcasses (more than any season since the onset of CMP monitoring). Three of these were tagged at warm springs hatchery and one was tagged at the Willow Creek smolt trap. Three of the four were released at or near Willow Creek, and one was released into a Dry Creek restoration site. The Dry Creek released fish was recovered in Pechaco Creek, and one of the Willow Creek released fish was recovered in Gilliam Creek. The other two Willow Creek released fish were recovered in Willow Creek (Table 5). Steelhead origin could sometimes be determined on live fish if an adequate sighting of an adipose fin clip could be seen from the bank without disturbing the fish. There were 113 steelhead individuals (live fish and carcasses) recorded during the 2024/25 spawning season. Of those, an adequate determination of an adipose clip could be made for only 36. Of those 36, 4 had clipped adipose fins (indicating HOR). We recorded 95 Chinook Salmon individuals this season. Of those, an adequate sighting of an adipose fin clip could be made on 62. Of those 62, 6 had clipped adipose fins (indicating not only HOR, but likely origin from outside the Russian River watershed). We also recorded one Chinook Salmon carcass that appeared to have an upper caudal punch. We did not record any floy-tagged fish this season.

Table 5.Summary of PIT tags recovered from Coho Salmon carcasses during the 2024/25 spawner season.

PIT number	Tag location	Release location	Release date	Recovery location	Recovery date
3DD.003E0A9099	WSH	Willow Creek (mouth)	6/2/2023	Gilliam Creek (R1)	1/8/2025
3DD.003E0A9040	WSH	Willow Creek (mouth)	6/2/2023	Willow Creek (R4)	1/13/2025
3DD.003D955297	Willow Creek (DSMT)	Willow Creek (DSMT)	5/17/2023	Willow Creek (R4)	1/13/2025
3DD.003E3699DD	WSH	Dry creek	11/22/2023	Pechaco Creek (R1)	1/14/2025

We used 33 reaches (roughly 42% of the stratum) to calculate total redd abundance in the Coho-steelhead stratum. The estimate of Coho redd abundance in the Russian River basin was 417 (±95% CI: 188) for the 2024/25 spawner season while the estimate of steelhead redd abundance in the Coho-steelhead stratum was 708 (±95% CI: 307). The Coho redd estimate is the highest estimate we have calculated since the onset of basin-wide CMP monitoring in 2014. It is nearly 4 times the average of 114 redds and 2.3 times higher than the previous highest estimate of 184 in the 2016/17 spawner season. The steelhead estimate is nearly double the average of 366, but only slightly higher than the previous highest estimate of 663 in the 2018/19 spawner season (Figure 43).



	2014/15	2015/16	2016/17	2017/18	2018/19	2019/20	2020/21	2021/22	2022/23	2023/24	2024/25
Coho salmon	90	150	184	85	124	94	139	132	74	67	417
Steelhead	450	521	510	306	663	407	252	227	86	242	708

Figure 43. Basin-wide estimates of Coho Salmon and steelhead redd abundance for the Coho-steelhead sample stratum, return winters 2014/15 through 2024/25. Steelhead estimates do not include the entirety of the range of steelhead in the Russian River, just the portion that overlaps with Coho habitat.

Discussion

Juvenile Coho Salmon occupancy

We recorded the second lowest PAO in 2024 since 2014 when we began using PAO as measure of juvenile spatial structure. The only lower PAO estimate was in 2023 and then the estimate was only slightly lower. The low 2024 estimate of PAO was not unexpected given the basin-wide Coho redd estimate in 2023/24, which was the lowest we have recorded in a decade. What was surprising, however, was that the estimate of adult Coho returns to LCM subwatersheds based on PIT tag detections in 2023/24 was not low. In fact, it was the highest recorded at that time (the 2024/25 estimate the following season was considerably higher). It seems that the low estimate of PAO would be more in line with the low redd estimate than the high adult estimate. The adult estimate was based almost entirely on PIT-tagged hatchery fish, so it could be that high returns of PIT-tagged hatchery fish are not translating to high distribution of Coho YOY across habitats in the basin. One thing that was notable and very unexpected (since it is the first time this has happened since we began surveys), was that the estimate of pool occupancy (given a reach was occupied) was higher than the reach occupancy estimate. Characteristics of the distribution of redds could explain this. For example, low reach occupancy could come about from more concentrated spawning in a small number of reaches. High pool level occupancy could result from large numbers of fish are spreading out into many pools within a reach.

When we overlay Coho redds from 2023/24 with juvenile occupancy from 2024, the spatial data indicates there may be other factors affecting juvenile spatial structure (Figure 44). For example, there are reaches in Austin and East Austin where Coho redds were observed during spawner season, but no Coho YOY were observed during snorkel surveys the following summer. Also, there were reaches in Mark West where Coho redds were observed, but only very low numbers of Coho YOY were counted the following summer. These instances seem to indicate issues with low survival between egg deposition and summer snorkel surveys from poor rearing conditions in certain streams in the basin. We recommend further study of the role of drying reaches and deteriorating summer rearing conditions on juvenile fish, and a focus on restoration and improvement of juvenile habitats with engineered habitat restoration projects and summertime flow enhancement projects.

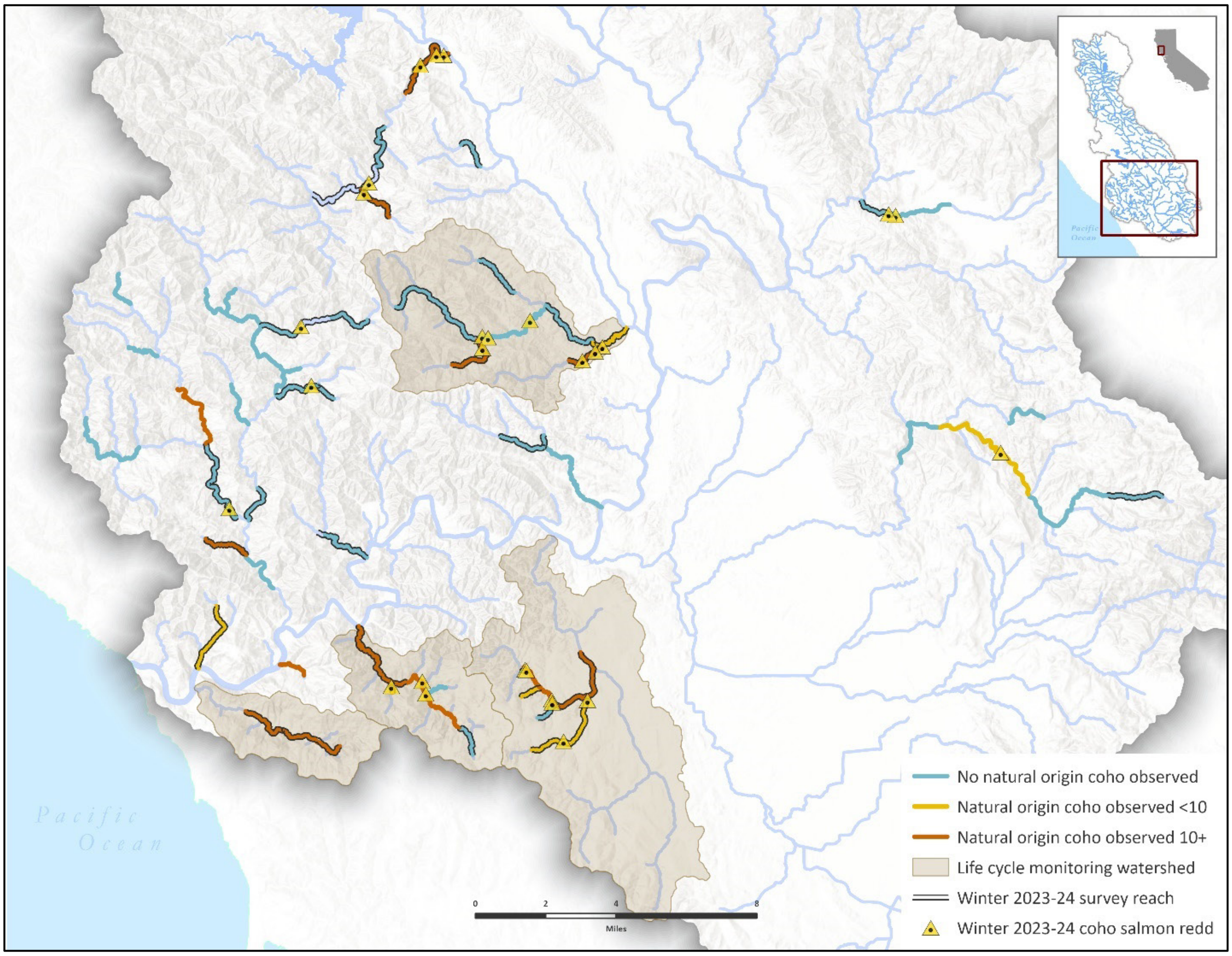


Figure 44. Russian River Coho Salmon redd locations by reach observed during winter 2023/24 in relation to Coho YOY presence/absence in 2024.

Redd abundance

The high basin-wide Coho redd estimate in 2024/25 was indicative of large returns of spawning Coho Salmon as it was corroborated by estimates of adult Coho abundance in LCM streams and hatchery returns to WSH. The large returns were likely facilitated by beneficial conditions at all life stages of the cohort (see Task 2 discussion above). The large Coho redd abundance was mostly driven by Coho redd counts in Willow Creek, which made up over 40% of the total count of Coho redds in the basin (Table 4). While the importance of Willow Creek redds to the overall high redd counts may have been inflated somewhat due to the timing of redd surveys and the possibility of missed redds in other tributaries, there was clearly extensive Coho spawning activity in Willow Creek that was higher than any of the other reaches in the basin. While other reaches saw modest increases in spawning activity compared to previous years, the redd counts in Willow were an order of magnitude higher than all other previous years combined.

There was evidence from recovered PIT tags that many of the adult Coho returning came from cohorts of hatchery fish released from Willow Creek in 2023. These fish may have had a greater chance of survival than other release groups farther upstream because of the proximity of Willow Creek to the mouth of the Russian river. Telemetry studies of Coho migrating through the Russian River mainstem have shown high mortalities for juvenile fish especially in certain parts of the mainstem upstream of the mouth of Willow Creek (i.e., Wohler pool and the mouth of Green Valley Creek; SW unpublished data). This supports statements in the Russian River Biological Opinion about the importance of lower river tributaries to the success of Coho Salmon recovery in the basin (NMFS 2008). We recommend prioritizing lower river tributaries for habitat protection and enhancement and recognition of the lower river as an important release area for hatchery fish to increase the likelihood of smolt migration survival and ultimately increase the number of fish returning to spawn.

Unlike adult Coho Salmon returns in 2024/25 when the highest Coho Salmon redd abundance estimate corresponded with the highest raw counts of Coho redds we have seen since CMP monitoring began, there was no such correspondence for steelhead. The basin-wide steelhead estimate was also the highest it has been in the last decade, but only slightly higher than the next highest estimate in 2018/19, whereas the raw counts of steelhead redds were not the highest we have ever seen, though they were in the top 3 counts in the last decade (Figure 43, Figure 45, Figure 46). This is likely an artifact of two aspects of redd estimate calculation: redd species estimation and calculation of estimates based on the spatially balanced random sample. Prior to calculation of the estimate, redd species is assigned to unknown redds. Multiple methods are utilized as needed for assignment of species, but the most common uses redd area and timing to estimate species (see Task 2 methods above). This method caused many of the redds that were unknown to be assigned as steelhead redds partly because they were observed later in the field season. While this does not necessarily mean the estimator is not functioning as it should, it has in this case caused the estimate to track imperfectly with raw counts of steelhead redds (from field crew estimation based on redd characteristics). The other aspect that may have led to the seeming discrepancy between raw redd counts and the estimate is the spatially balanced random sample. As it happens, the random sample included the reaches that had the highest steelhead redd counts, and fewer of the reaches that had low or 0 counts which could potentially have led to a slightly inflated steelhead redd estimate. Nevertheless, because the random sampler is recognized as a way to reduce bias in redd abundance calculation (Adams 2011), we still recommend applying it to evaluate the viability of Russian River salmonid populations.

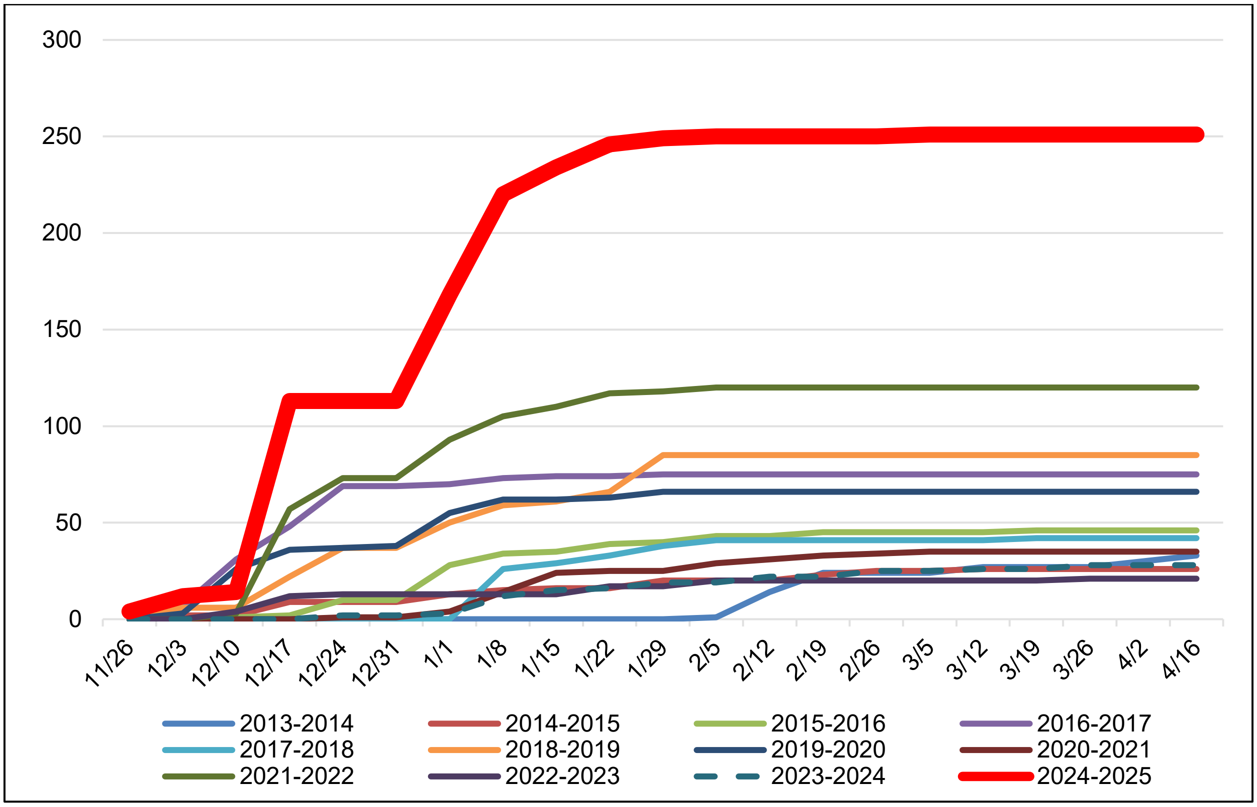


Figure 45. Cumulative Coho Salmon redd counts by survey date from the last decade of CMP spawner surveys. The thickest, red line is the most recent spawning season (2024/25) and the dashed line is the previous spawner season (2023/24).

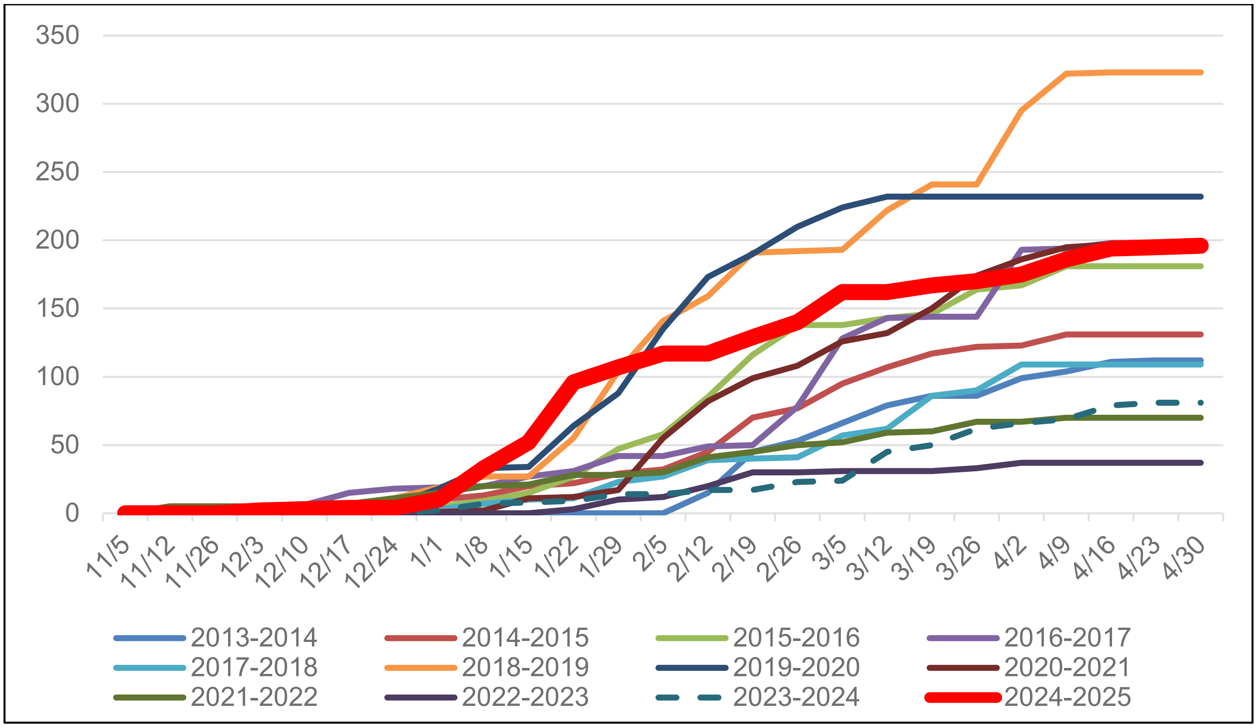


Figure 46. Cumulative steelhead redd counts by survey date from the last decade of CMP spawner surveys. The thickest, red line is the most recent spawning season (2024/25) and the dashed line is the previous spawner season (2023/24).

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