

Recovery of Coded-Wire Tags from Chinook Salmon in California's Central Valley Escapement, Inland Harvest, and Ocean Harvest in 2023

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INTRODUCTION

Approximately 35 million fall-run Chinook salmon (*Oncorhynchus tshawytscha*) are produced for each year analyzed in this report at five hatcheries in California's Central Valley (CV): Coleman National Fish Hatchery (CFH), Feather River Hatchery (FRH), Nimbus Fish Hatchery (NIM), Mokelumne River Hatchery (MOK), and Merced River Hatchery (MER). This is a slight increase in average production from the 32 million fall-run analyzed in all prior year reports. Production from these hatcheries contributes to CV escapement and sport harvest while also supporting ocean fisheries in California and Oregon. Since 2007, a constant fractional marking (CFM) program has ensured that at least 25% of all CV hatchery production fish are tagged with a microscopic (≤ 1 mm) coded-wire tag (CWT). Each CWT contains a binary or alpha-numeric code that identifies a specific release group of salmon (e.g., agency, species, run, brood year, hatchery or wild stock, release size, release date(s), release location(s), number tagged and untagged). Each salmon containing a CWT is also externally marked with a clipped adipose fin (ad-clip) to allow for easy visual identification.

This is the 14th annual report on the recovery of CFM CWTs in the CV and ocean fisheries. In 2023, approximately 19,900 CWTs were recovered and successfully read from ad-clipped Chinook salmon sampled in CV fall-, winter-, spring-, and late-fall-run natural area spawning surveys, at CV hatcheries, and in commercial and sport ocean salmon fisheries south of Cape Falcon (i.e., California and most of Oregon). The CV sport fishery and ocean salmon fisheries in California were closed to fishing in 2023 due to poor abundance forecasts.

This report will focus primarily on the results of analyses addressing the following questions:

- What are the proportions of hatchery- and natural-origin salmon in spawner returns to CV hatcheries and natural areas, in inland harvest, and in ocean fisheries? Of the hatchery component, what proportions originated from in-basin versus out-of-basin CWT release strategies?
- What are the relative recovery and stray rates for hatchery-origin salmon released in-basin versus salmon released into the waters of the Sacramento-San Joaquin River Delta, San Francisco-San Pablo bays, or coastal areas? How do recovery and stray rates differ between salmon acclimated in net pens and those released directly into the water?
- What are the relative recovery and contribution rates of hatchery-origin salmon, by run and release type, to ocean and inland harvests?

Please see earlier CFM reports (Kormos et al. 2012, Palmer and Kormos 2013, 2015) for more information and discussion regarding the CFM program, CWT recovery programs, and the methods and analyses used in this report. Additional information on salmon escapement monitoring can be found in the Central Valley Chinook Salmon Escapement Monitoring Plan (Bergman et al. 2012) and other CV salmon population reports (e.g., Killam 2024, McNabb and Mojica 2025, and Rae and O'Brien 2024).

DATA AND METHODS

Inland Escapement and River Sport Harvest Monitoring

During 2023, monitoring of salmon escapement occurred at all five salmon hatcheries¹ and on major rivers and tributaries throughout the CV. Sport fisheries in the CV were closed in 2023 due to historically low forecasts of Chinook salmon abundances so no recovery data was collected from this sector. It should be noted that the late-fall-run escapement in the upper Sacramento River and at CFH in this report is considered the 2024 return year, however the escapement monitoring period began in late 2023.

Sampling and estimation methods (e.g., carcass surveys, snorkel surveys, weir counts) continue to vary among natural spawner surveys throughout the CV (Table 1); however, most 2023 surveys on major rivers and in the hatcheries adequately sampled (sample rate $\geq 20\%$) for ad-clipped fish. The sampling rate was generally lower for smaller creeks where biodata was collected over a few days or in limited areas.

Of the approximately 188,400 Chinook salmon that returned to the CV basins analyzed in this report, roughly 95,300 salmon were sampled, 23,600 ad-clipped salmon were observed, and 19,900 heads were collected by various CV projects (Table 3). Monitoring agencies and projects included the California Department of Fish and Wildlife (CDFW), California Department of Water Resources (DWR), East Bay Municipal Utility District (EBMUD), Pacific States Marine Fisheries Commission (PSMFC), U.S. Bureau of Reclamation (BOR), U.S. Fish and Wildlife Service (FWS), and the Yuba Accord River Management Team (YARMT). Most inland heads were processed by CDFW at the West Sacramento CWT lab, except for 876 heads processed by CDFW staff in the Santa Rosa CWT Lab, 3,200 heads processed by FWS staff at CFH, 3 heads processed by FWS staff in Lodi, and 200 heads processed by CDFW staff in Red Bluff.

All estimates of CV escapement or harvest and the number of salmon sampled in this report were provided by individual monitoring projects or hatcheries.

Ocean Harvest Monitoring

In 2023, California sport and commercial ocean salmon fisheries were closed due to historically low abundance forecasts for fall-run Chinook salmon from the Sacramento and Klamath River basins. There were limited Oregon sport and commercial ocean salmon fisheries in the fall of 2023 (PFMC 2023). Approximately 260 heads collected in Oregon sport and commercial ocean fisheries during 2023 are included in these analyses, since Sacramento River fall-run Chinook salmon is the primary stock harvested in fisheries south of Cape Falcon, Oregon (PFMC 2016).

¹ There is not direct salmon escapement to the Salmon Conservation and Research Facility (SCARF) or Livingston Stone National Fish Hatchery (LSNFH), however they are both represented in this report by the San Joaquin spring-run and Keswick Dam surveys, respectively.

Each year, CDFW validates and uploads all CWT recoveries in California, along with their respective catch-sample data, to the Regional Mark Processing Center (RMPC), which is the central repository for west coast CWT recoveries. All 2023 inland and ocean CWT recoveries are publicly available on the RMPC website at www.rmpec.org.

CWT Data Analysis

A master release database of CWT codes recovered in 2023 was created to determine species, brood year, run, stock origin (hatchery or natural), release site, release date(s), number of salmon tagged with CWTs, total number of salmon released, and any other pertinent release information (e.g., trucked, net pen acclimation, disease issues). Since almost all CV salmon recovered are between the ages of two and five, all CWT release data for Chinook salmon brood years 2018 through 2021 were downloaded from the RMPC. Approximately 140 million CV salmon were released for these brood years, of which 47 million were marked and tagged utilizing 464 unique CWT codes. Although a few thousand natural-origin salmon are often trapped, marked, and tagged annually, salmon produced by hatcheries make up 99% or greater of all CWT releases. In 2023, there were 298 individual CWT codes recovered in the CV, primarily from age-2, age-3, and age-4 salmon. The CWT master file was updated with any additional information obtained for special CV salmon releases and the production factor calculated for each CWT code. The production factor, F_{prod} , is the ratio of the total number of salmon released to the total number of salmon marked containing a CWT. Thus, it is the total number of salmon (i.e., tagged and untagged) represented by each CWT recovery. F_{prod} was calculated for each CWT code and is defined as,

$$F_{\text{prod}} = (\text{Ad.CWT} + \text{Ad.noCWT} + \text{noAd.CWT} + \text{noAd.noCWT}) / \text{Ad.CWT},$$

where Ad.CWT is the number of salmon released with ad-clips and CWTs, Ad.noCWT is the number of salmon released with ad-clips but without CWTs (i.e., shed tags prior to release or CWT not correctly inserted), noAd.CWT is the number of salmon released without ad-clips but with CWTs, and noAd.noCWT is the number of salmon released without ad-clips and without CWTs. F_{prod} allows expansion to total hatchery production from observed recoveries of CV CWTs. In some cases, where numbers of mortalities are unavailable in the release information, the resulting calculation for F_{prod} may bias results.

For this analysis, each CV Chinook salmon CWT release was classified into a “release type” based on the following criteria: hatchery or natural stock, run, release location, and release strategy. All CV CWT codes were assigned by brood year into one of nineteen fall-run, two winter-run, three spring-run, or one late-fall-run release types:

Sacramento River Basin Fall-run Chinook salmon release types

CFHF	Coleman National Fish Hatchery F all-run in-basin releases
CFHFn	Coleman National Fish Hatchery F all-run bay/delta net pen releases
FRHF	Feather River Hatchery F all-run in-basin releases
FRHFn	Feather River Hatchery F all-run bay/delta net pen releases
FRHFgg	Feather River Hatchery F all-run G olden G ate releases (no net pen acclimation)
FRHFt	Feather River Hatchery F all-run bay/delta tr ucked releases (no net pen acclimation)
NIMF	Nimbus Fish Hatchery F all-run in-basin releases
NIMFn	Nimbus Fish Hatchery F all-run bay/delta net pen releases
NIMFgg	Nimbus Fish Hatchery F all-run G olden G ate releases (no net pen acclimation)
NIMFt	Nimbus Fish Hatchery F all-run bay/delta tr ucked releases (no net pen acclimation)

San Joaquin River Basin Fall-run Chinook salmon release types

MOKF	Mokelumne River Hatchery F all-run in-basin releases
MOKFfn	Mokelumne River Hatchery F all-run bay/delta net pen releases
MOKFns	Mokelumne River Hatchery F all-run coastal net pen releases (S anta Cruz/ M onterey)
MOKFnP	Mokelumne River Hatchery F all-run coastal net pen releases (P illar Point)
MOKFgg	Mokelumne River Hatchery F all-run G olden G ate releases (no net pen acclimation)
MOKFt	Mokelumne River Hatchery F all-run bay/delta tr ucked releases (no net pen acclimation)
MOKFtc	Mokelumne River Hatchery F all-run co astal tr ucked releases (no net pen acclimation)
MERF	Merced River Hatchery F all-run in-basin releases
MERFn	Merced River Hatchery F all-run bay/delta net pen releases

Sacramento River Winter-run Chinook salmon release types

SacW	Sacramento River W inter-run supplementation natural production releases (in-basin)
SacWbat	Sacramento River W inter-run B attle Creek reintroduction releases (in-basin)

Central Valley Spring-run Chinook salmon release types

FRHS	Feather River Hatchery S pring-run in-basin releases
FRHSn	Feather River Hatchery S pring-run bay/delta net pen releases
SJOSx	San Joaquin River S pring-run e xperimental reintroduction releases (in-basin)

Central Valley Late-fall-run Chinook salmon release types

CFHL	Coleman National Fish Hatchery L ate-fall-run in-basin releases
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Note that not all release types occur every year and that release sites or net pen use sometimes vary within a given release type (Table 2; Fig. 1). In previous CFM reports, releases that involved trucking to release sites similar to those used for net pen releases were combined. These fish were not acclimated in net pens but were instead released directly into the water. Because they comprise a significant number of fish, it was decided to separate the trucked and net pen releases for the 2023 recoveries. Thus, we urge caution when analyzing or comparing CWT recovery data from certain release types.

To estimate the total escapement or harvest associated with each CWT recovery, each tag recovery was expanded by its respective F_{prod} and sample expansion factor, F_{samp} , which is defined as,

$$F_{\text{samp}} = 1 / (f_e \times f_a \times f_d),$$

where f_e is the fraction of the total salmon escapement or harvest sampled and visually examined for an ad-clip, f_a is the fraction of heads from ad-clipped salmon collected and processed, and f_d is the fraction of observed CWTs that were successfully decoded (Tables 3 and 4).

Salmon sampled in CV carcass surveys are generally classified as ‘fresh’ or ‘non-fresh’ based on criteria such as condition of the eyes (clear vs. opaque) or gills (pink vs. grey). Often the ad-clipped (marked) status of a non-fresh (i.e., decayed) salmon cannot be determined due to the deteriorating condition of the carcass. While condition criteria are somewhat ambiguous and classification may vary among surveys, the ad-clip rate of fresh salmon sampled in 2023 was generally higher or similar to the rate observed in non-fresh fish (Appendix 1). Fresh carcass heads also usually contain CWTs at a higher rate than heads collected from non-fresh fish, although that was not the case for one survey done on the Upper Sacramento River in 2023. Furthermore, the sample sizes between fresh and non-fresh fish are usually very different with the number of fresh salmon sampled generally being much greater than non-fresh salmon in surveys that collected both conditions.

Mohr and Satterthwaite (2013) demonstrated how the sampling differences noted above could negatively bias the estimates of hatchery contribution. However, they cautioned that using only CWT data from fresh fish could eliminate the occurrence of rare CWT codes in analyses due to the small sample sizes common with fresh carcasses in these surveys. As in previous CFM reports, the following equation developed by Mohr and Satterthwaite (2013) was used to calculate F_{samp} for carcass surveys collecting fish condition data, thus reducing the potential to underestimate hatchery contribution while still incorporating CWT codes from both fresh and non-fresh fish:

$$F_{\text{samp}} = (N \times p_{\text{adc|fresh}} \times p_{\text{cwt|fresh,adc}}) / (n_{\text{valid cwt}}),$$

where N = estimated total escapement, $p_{adc|fresh}$ = proportion of fresh salmon sampled that were ad-clipped, $p_{cwt|fresh,adc}$ = proportion of ad-clipped fresh salmon that contained a CWT, and $n_{valid\ cwt}$ = total number of valid CWTs collected from fresh and decayed salmon.

To help differentiate between raw CWT recoveries, CWT recoveries expanded for production, CWTs expanded for sampling, and CWTs expanded for production and sampling, the following nomenclature is used:

CWT = Raw count CWT recoveries

CWT_{prod} = CWT recoveries expanded by their respective production factor, F_{prod}

CWT_{samp} = CWT recoveries expanded by their respective sample expansion factor, F_{samp}

CWT_{total} = CWT recoveries expanded by both F_{prod} and F_{samp}

Determining hatchery- and natural-origin proportions in CV escapement and harvest

To determine the contribution of hatchery- and natural-origin salmon, all CWT_{total} were summed to estimate the total number of hatchery salmon in each survey. The contribution of natural-origin salmon for each survey was then determined by subtracting the total number of hatchery salmon from the total escapement estimate, as follows:

$$\text{Estimate of natural-origin salmon} = \text{Total escapement estimate} - \sum_{i=1}^m CWT_{total,i} ,$$

where m = total number of hatchery-origin CWT release groups identified in an escapement survey or hatchery.

Determining recovery rates of various release types in CV escapement and ocean harvest

To determine the relative CV recovery rate, R_{cwt} , of each unique CWT release group (i.e., code), all recoveries were expanded by their location-specific F_{samp} , summed over all recovery locations, and then divided by the total number of salmon tagged and released with this CWT. Since expanded recoveries for several individual CWT groups were less than 0.001% of the total number released, recovery rates are reported in recoveries per 100,000 CWT salmon released, as follows:

$$R_{cwt} = \sum_{j=1}^l CWT_{samp,j} \text{ recoveries} / (\text{CWT release group size} / 100,000),$$

where j ($=1,2,3,\dots,l$) denotes recovery location.

Data from all CWT release groups belonging to the same brood year and release type (e.g., coastal net pen) were combined and an overall release type-specific CV recovery rate, R_{type} , was calculated as:

$$R_{type} = \sum_{j=1}^l \sum_{k=1}^n CWT_{samp,j,k} / \left(\sum_{k=1}^n \text{release group size of } CWT_k / 100,000 \right),$$

where k ($= 1, 2, 3, \dots, n$) denotes release group.

Determining stray proportions of various release groups in CV escapement

To be consistent with previous reports (Kormos et al. 2012, Letvin et al. 2020, 2021, Palmer-Zwahlen and Kormos 2013, 2015, 2020, Palmer-Zwahlen et al. 2018, 2019a, 2019b), basin-of-origin is defined as the drainage within which a particular hatchery is located. Given the five hatcheries under consideration in this report, the CV is divided into five hatchery basins (hatchery code in parentheses): (1) upper Sacramento River, including Battle Creek (CFH), (2) Feather River, including the Yuba River (FRH), (3) American River (NIM), (4) Mokelumne River (MOK), and (5) Merced River (MER). Hatchery-origin salmon not returning to their basin-of-origin or to streams and rivers not included in any hatchery basin (e.g., Butte Creek, Stanislaus River, Tuolumne River) are considered strays. Appendices 2 and 3 present alternative recovery and stray rates for CFH and FRH CWT releases based on the assumption that recoveries in the upper Sacramento River and Yuba River, respectively, are strays.

To determine the CV stray proportion, S_{cwt} , for each CWT code, the sum of all CWT_{samp} recoveries collected outside the basin of origin was divided by total CV CWT_{samp} recoveries for that release group, as follows:

$$S_{cwt} = \sum_{p=1}^o CWT_{samp,p} \text{ (out-of-basin locations)} / \sum_{p=1}^q CWT_{samp,p} \text{ (all CV locations)},$$

where p denotes recovery location, o denotes the number of out-of-basin recovery locations, and q denotes the total number of recovery locations.

Data from all CWT releases belonging to the same brood year and release type were combined and release type-specific CV stray proportion, S_{type} , was calculated as:

$$S_{type} = \sum_{p=1}^o \sum_{k=1}^n CWT_{samp,p,k} \text{ (out-of-basin)} / \sum_{p=1}^q \sum_{k=1}^n CWT_{samp,p,k} \text{ (all CV locations)}.$$

RESULTS

General overview of 2023 CV inland recoveries and California ocean harvest

All of the nearly 19,640 valid CWTs recovered in the CV during 2023 were from CV Chinook salmon releases. Most CWTs were brood year 2019 through 2021 releases (Table 5). About 96% of all CWT_{total} were fall-run, followed by spring- and late-fall-run (2%, each) salmon releases. Less than 1% of CWT_{total} were winter-run, some of which were collected from spawners returning to CFH as part of the FWS Battle Creek winter-run Jumpstart program. The remaining winter-run CWTs were all collected in the upper Sacramento River, which includes the Keswick Dam Fish Trap (KES) where winter-run are collected for broodstock purposes at Livingston Stone National Fish Hatchery (LSH). The majority of fall-run CWT_{total} recovered in the CV were age-3 (82%) fish.

Of the approximately 250 valid CWT recoveries from the 2023 Oregon ocean harvest (south of Cape Falcon), 7% were CV fall-run salmon releases (Table 6). Recoveries of other CV run types were scarce off Oregon. Non-CV stocks made up 92% of the Oregon ocean harvest CWT_{total} , with most originating from the Columbia River Basin, coastal streams in Oregon, and the Klamath-Trinity Basin. Most of the hatchery-origin fish in the Oregon ocean harvest were age-4 (57%) and age-2 (29%) fish.

1. Proportion of Hatchery- and Natural-origin Salmon in CV Escapement

During 2023, approximately 136,150 fall-run Chinook salmon returned to spawn in the CV natural areas included in these analyses (Table 7, Fig. 2). There were approximately 1,800 fall-run salmon that spawned in natural areas of tributaries that are excluded here because sample rates and resultant CWT recoveries were too low to produce reliable results. Thresholds by which surveys are excluded from analyses because of low sample rates (those significantly lower than the standard 20%) and CWT recoveries are assessed on an annual basis, however these recoveries are still reported on RMPC. The proportion of hatchery-origin salmon in the sampled areas varied throughout the CV. The lowest fall-run hatchery proportion occurred in the Merced River (55%), followed by the Stanislaus River (70%). The highest fall-run hatchery proportion occurred in the Yuba River below the Daguerre Point Dam (DPD; 97%). The total CV fall-run hatchery proportion for all natural areas that were adequately sampled during 2023 was 88%.

One of the upper Sacramento Basin tributaries included in these analyses is Battle Creek. The hatchery proportion for this tributary was estimated using a surrogate since a CWT recovery program has not occurred in this waterway since 2005. The hatchery contribution and CWT release type composition in the Battle Creek fall-run escapement is assumed equivalent to the hatchery fall-run return sampled at CFH (K. Niemela, FWS, pers. comm.).

Of the 43,100 fall-run salmon returning to the four CV hatcheries, there was a combined hatchery-origin proportion of 95%, which ranged from 81% to 97% (Table 7, Fig. 3). The

late-fall-run return to CFH was almost entirely hatchery-origin salmon (99%). The spring-run return to FRH was predominantly hatchery-origin salmon (70%).

To help differentiate the hatchery composition, all CV release types from the same stock, run, and hatchery use the same shade of color in the pie chart figures: Blue = Sacramento River Basin fall-run releases, Green = San Joaquin Basin fall-run releases, Purple = Central Valley spring-run releases, Yellow = Sacramento River winter-run releases, and Orange = Central Valley late-fall-run releases (Fig. 4). Additionally, select patterns are used to designate different release types. All bay/delta net pen releases contain black dots, while coastal net pen releases are designated with a crisscross pattern. Golden Gate releases are shown with horizontal stripes. Trucked releases are shown with vertical stripes. In-basin releases do not have any pattern. To present the data in a less complicated manner, several release types have been merged in the pie chart figures and many of the tables. Please refer to the footnotes on Tables 7-8 and 10 for a description of which release types were merged.

Upper Sacramento River Basin

At CFH in 2023, the fall-run spawning period was considered to be early October through November, and the late-fall-run spawning period was considered to be November through April 2024. However, FWS staff ultimately parsed the final escapement into run types based on CWT recoveries and the dominant run type by date. All ad-clipped salmon were sampled during the entire run, and additionally during the late-fall-run period all unmarked salmon were electronically checked for CWTs. An additional 9 late-fall-run salmon were trapped at CFH after spawning operations ended. Due to the low returns for the late-fall-run salmon trapped at CFH post-spawning operations, the survey was excluded from further analysis. 2023 was also the fifth year of spawner returns to CFH for winter-run salmon that were spawned at LSH, raised at CFH, and released into North Fork Battle Creek as part of the FWS Jumpstart program.

Fall-, late-fall-, and winter-run returns to CFH were predominantly hatchery-origin salmon, as were fall-run spawners in Battle Creek where CFH is located. Natural-origin spawners composed most of the late-fall- and winter-run returns to the upper Sacramento River mainstem (Figs. 5, 6). Winter-run spawners collected at KES were almost evenly distributed between natural- and hatchery-origin fish. Fall-run spawners in the upper Sacramento River mainstem and Clear Creek were primarily hatchery-origin fish. The proportion of hatchery-origin fish (most prevalent release type shown in parentheses) at each of the following locations was:

- Winter-run returns CFH: 96% (SacW)
- Fall-run returns CFH: 81% (CFHF)
- Late-fall-run returns CFH: 99% (CFHL)
- Winter-run spawners for broodstock KES: 54% (SacW)
- Winter-run spawners upper Sacramento River: 21% (SacW)
- Fall-run spawners upper Sacramento River: 90% (MOKFnp)
- Late-fall-run spawners upper Sacramento River: 16% (CFHL)
- Fall-run spawners Clear Creek: 71% (CFHF)
- Fall-run spawners Battle Creek: 81% (CFHF)

Butte Creek and Feather River Basin

In Butte Creek, spring-run spawners were not reported and no assumptions could be made about hatchery contributions to the population. In the Feather River Basin, spring- and fall-run returns to FRH and spawners in the Feather and Yuba Rivers were predominantly hatchery-origin (Figs. 7, 8). The proportion of hatchery-origin fish (most prevalent release type shown in parentheses) at each of the following locations was:

- Spring-run returns FRH: 70% (FRHS)
- Fall-run returns FRH: 97% (FRHFt)
- Fall/spring-run spawners Feather River: 90% (FRHFt)
- Fall/spring-run spawners Yuba River above DPD: 87% (FRHFt)
- Fall/spring-run spawners Yuba River below DPD: 97% (FRHFt)

In 2023, escapement to the Yuba River below the DPD was sufficient to produce separate escapement estimates for each river sector as had been done in previous reports. Escapement estimates for these sectors are based on a combination of ad-clips observed via video weir and CWTs recovered during carcass surveys.

American River Basin

Fall-run returns to NIM and spawners in the American River were predominantly of hatchery-origin (Fig. 9). The proportion of hatchery-origin fish (most prevalent release type shown in parentheses) at each of the following locations was:

- Fall-run returns NIM: 96% (NIMFn)
- Fall-run spawners American River: 90% (NIMFn)

Mokelumne, Stanislaus, and Tuolumne Rivers

Fall-run returns to MOK and Mokelumne River were predominantly hatchery-origin salmon. Spawners in the Stanislaus and Tuolumne Rivers were predominantly of hatchery-origin (Fig. 10). The proportion of hatchery-origin fish (most prevalent release type shown in parentheses) at each of the following locations was:

- Fall-run returns MOK: 96% (MOKFn)
- Fall-run spawners Mokelumne River: 83% (NIMFn)
- Fall-run spawners Stanislaus River: 70% (MOKFn)
- Fall-run spawners Tuolumne River: 71% (MOKFn)

Merced and upper San Joaquin Rivers

Fall-run returns to MER were predominately hatchery-origin salmon, while returns to the Merced River were almost evenly split between hatchery- and natural-origin salmon. Spring-run spawner returns to the upper San Joaquin River continued to be low in 2023 with only 3 recoveries. Due to this, reliable results could not be produced, and the survey was excluded from further expansion in this report. The proportion of hatchery-origin fish (most prevalent release type shown in parentheses) at each of the following locations was:

- Fall-run returns MER: 91% (MOKFn)
- Fall-run spawners Merced River: 55% (MOKFn)

2. Contribution of CV Release Types to Total Salmon Escapement

In 2023, 88% of the 187,600 salmon that returned to the CV hatcheries and natural areas included in these analyses were hatchery-origin fish (Tables 7, 8). The hatchery release types that contributed the most to total CV escapement were FRH fall-run bay/delta trucked releases (19%), followed by NIM fall-run bay/delta net pen releases (15%). CFH fall-run bay/delta net pen releases had the highest number of strays, while SJO spring-run experimental reintroduction releases had the highest rate of straying (100%) of the surveys examined, followed by CFH fall-run bay/delta net pen releases (97%). About 22% of all recoveries occurred outside their basin-of-origin and ranged from 0% to 100%, depending on release type:

Hatchery-origin contribution by R_{type} to total CV salmon escapement

R _{type}	Run	CWT _{total}	% total escapement	# Stray	% stray
CFHF	Fall	5,599	3%	123	2%
CFHFn	Fall	4,947	3%	4,793	97%
FRHF	Fall	179	<1%	0	0%
FRHFn	Fall	24,325	13%	1,366	6%
FRHFgg	Fall	13,718	7%	471	3%
FRHFt	Fall	35,338	19%	1,199	3%
NIMF	Fall	956	1%	12	1%
NIMFn	Fall	28,522	15%	8,327	29%
NIMFgg	Fall	4,389	2%	1,492	34%
NIMFt	Fall	12,707	7%	3,801	30%
MOKFn	Fall	10,903	6%	4,660	43%
MOKFnp	Fall	6,241	3%	4,064	65%
MOKFgg	Fall	7,895	4%	3,773	48%
MOKFt	Fall	119	<1%	7	6%
MOKFtc	Fall	1,719	1%	1,232	72%
MERFn	Fall	800	<1%	623	78%
SacW	Winter	727	<1%	0	0%
FRHS	Spring	2,893	2%	0	0%
FRHSn	Spring	322	<1%	23	7%
SJOSx	Spring	12	<1%	12	100%
CFHL	Late-fall	3,005	2%	15	<1%
Non-CV		0	0%	0	
	Total	165,316	88%	35,993	22%

3. Relative Recovery and Stray Rates of CV Release Types in Total Escapement

Release strategies vary among hatcheries from year to year. This variability has often been in response to annual fluctuations in the abundance of certain stocks, water conditions, or differing policies among agencies with respect to best release practices. The 2019 through 2021 brood year releases were more consistent than release types analyzed in earlier CFM reports (Kormos et. al. 2012, Palmer-Zwahlen and Kormos 2013, 2015; Table 2).

Table 9 summarizes total CWT_{samp} recoveries and the escapement recovery rate, R_{type} , (in-basin and stray) for all release types collected in the CV escapement and Oregon ocean fisheries during 2023. Recovery rates are standardized utilizing total CWT_{samp} recoveries per 100,000 tagged salmon released. Release types with less than 15,000 total fish released with CWTs are not reported below since just a few recoveries could result in relatively large recovery and stray rate estimates.

Figures 12 and 13 provide a graphical representation of R_{type} for Sacramento River fall-run Chinook salmon and other CV stocks, respectively, and include the total number of salmon released with CWTs for each release type. Fall-run salmon that were released offsite, both those acclimated in net pens and those released directly into the water, had higher CV recovery rates than their respective in-basin releases, but offsite releases also had higher stray rates than their in-basin counterparts.

Age-2 CV Escapement Recovery and Stray Rates

R_{type}	Brood year	Run	# Recoveries per 100K Released	# Strays per 100K Released	% stray
CFHF	2021	Fall	2	0	0%
FRHFn	2021	Fall	61	7	12%
FRHFgg	2021	Fall	36	5	13%
FRHFt	2021	Fall	62	7	12%
NIMFn	2021	Fall	135	20	15%
NIMFt	2021	Fall	56	9	17%
MOKFn	2021	Fall	82	27	33%
MOKFnp	2021	Fall	77	33	42%
MOKFgg	2021	Fall	81	30	37%
MOKFtc	2021	Fall	30	14	46%
MERFn	2021	Fall	236	181	77%
FRHS	2021	Spring	1	0	0%
FRHSn	2021	Spring	34	2	7%
SJOSx	2021	Spring	0	0	-
SacW	2021	Winter	6	0	0%
SacWbat	2021	Winter	0	0	-
CFHL	2022	Late-fall	12	0	0%

Age-3 CV Escapement Recovery and Stray Rates

R _{type}	Brood year	Run	# Recoveries per 100K Released	# Strays per 100K Released	% stray
CFHF	2020	Fall	44	4	10%
CFHF _n	2020	Fall	554	539	97%
FRHF _n	2020	Fall	671	35	5%
FRHF _{gg}	2020	Fall	1,320	36	3%
FRHF _t	2020	Fall	1,171	32	3%
NIMF _n	2020	Fall	1,112	365	33%
NIMF _{gg}	2020	Fall	647	220	34%
NIMF _t	2020	Fall	834	264	32%
MOKF _n	2020	Fall	194	96	50%
MOKF _{np}	2020	Fall	646	448	69%
MOKF _{gg}	2020	Fall	252	137	54%
MOKF _t	2020	Fall	24	1	6%
MOKF _{tc}	2020	Fall	481	353	73%
MERF _n	2020	Fall	210	167	79%
FRHS	2020	Spring	270	0	0%
SJOS _x	2020	Spring	5	5	100%
SacW	2020	Winter	208	0	0%
SacW _{bat}	2020	Winter	26	3	10%
CFHL	2021	Late-fall	224	1	0%

Age-4 CV Escapement Recovery and Stray Rates

R _{type}	Brood year	Run	# Recoveries per 100K Released	# Strays per 100K Released	% stray
CFHF	2019	Fall	10	<1	1%
FRHF	2019	Fall	18	0	0%
FRHF _n	2019	Fall	108	4	4%
NIMF	2019	Fall	31	<1	1%
NIMF _n	2019	Fall	161	18	11%
MOKF _n	2019	Fall	28	8	28%
MOKF _{np}	2019	Fall	84	36	43%
MOKF _{gg}	2019	Fall	59	21	35%
MOKF _{tc}	2019	Fall	15	10	63%
MERF _n	2019	Fall	6	3	55%
FRHS	2019	Spring	8	0	0%
SJOS _x	2019	Spring	1	<1	67%
SacW	2019	Winter	3	0	0%
SacW _{bat}	2019	Winter	1	0	0%
CFHL	2020	Late-fall	67	1	1%

5. Relative Recovery Rate of CV Release Types in the Ocean Harvest

Recovery rates of CV fish in Oregon ocean fisheries were negligible with only 6 CWTs from 4 release types captured (Tables 6, 9, and 10). Of the 4 release types recovered, only 3 release types were recovered at a rate sufficient enough to determine a recovery rate. A majority of the CV fish recovered in Oregon ocean fisheries were age-2 and recovered in the sport fishery (Fig. 14).

Age-2 Ocean Harvest Recovery Rate; Percent taken in Sport Harvest

R _{type}	Brood year	Run	# Recoveries per 100K Released	% sport
CFHF	2021	Fall	0	-
FRHFn	2021	Fall	0	-
FRHFgg	2021	Fall	0	-
FRHFt	2021	Fall	<1	100%
NIMFn	2021	Fall	1	100%
NIMFt	2021	Fall	0	-
MOKFn	2021	Fall	<1	100%
MOKFnp	2021	Fall	0	-
MOKFgg	2021	Fall	0	-
MOKFtc	2021	Fall	0	-
MERFn	2021	Fall	0	-
FRHS	2021	Spring	0	-
FRHSn	2021	Spring	1	100%
SJOSx	2021	Spring	0	-
CFHL	2022	Late-fall	0	-

Age-3 Ocean Harvest Recovery Rate; Percent taken in Sport Harvest

R _{type}	Brood year	Run	# Recoveries per 100K Released	% sport
CFHF	2020	Fall	0	-
CFHF _n	2020	Fall	0	-
FRHF _n	2020	Fall	0	-
FRHF _{gg}	2020	Fall	0	-
FRHF _t	2020	Fall	<1	0%
NIMF _n	2020	Fall	1	100%
NIMF _{gg}	2020	Fall	0	-
NIMF _t	2020	Fall	0	-
MOKF _n	2020	Fall	0	-
MOKF _{np}	2020	Fall	0	-
MOKF _{gg}	2020	Fall	0	-
MOKF _t	2020	Fall	0	-
MOKF _{tc}	2020	Fall	0	-
MERF _n	2020	Fall	0	-
FRHS	2020	Spring	0	-
SJOS _x	2020	Spring	0	-
SacW	2021	Winter	0	-
SacW _{bat}	2021	Winter	0	-
CFHL	2021	Late-fall	0	-

Age-4 Ocean Harvest Recovery Rate; Percent taken in Sport Harvest

R _{type}	Brood year	Run	# Recoveries per 100K Released	% sport
CFHF	2019	Fall	0	-
FRHF	2019	Fall	0	-
FRHF _n	2019	Fall	0	-
NIMF	2019	Fall	0	-
NIMF _n	2019	Fall	0	-
MOKF _n	2019	Fall	0	-
MOKF _{np}	2019	Fall	0	-
MOKF _{gg}	2019	Fall	0	-
MOKF _{tc}	2019	Fall	0	-
MERF _n	2019	Fall	0	-
FRHS	2019	Spring	0	-
SJOS _x	2019	Spring	0	-
SacW	2020	Winter	0	-
SacW _{bat}	2020	Winter	0	-
CFHL	2020	Late-fall	0	-

6. Hatchery Proportion and Contribution of CV Release Types to Ocean Salmon Fisheries

In 2023, 40% of the nearly 3,200 Chinook salmon harvested in Oregon (south of Cape Falcon) ocean salmon fisheries were hatchery-origin fish (Fig. 15). The majority of which were from non-CV hatcheries. The most prevalent CV release types recovered in Oregon fisheries were NIM fall-run bay/delta net pen releases followed by FRH fall-run bay/delta trucked releases.

Hatchery-origin contribution by R_{type} to OR ocean harvest

R _{type}	Run	CWT _{total}	% harvest
CFHF	Fall	0	0%
CFHF _n	Fall	0	0%
FRHF	Fall	0	0%
FRHF _n	Fall	0	0%
FRHF _{gg}	Fall	0	0%
FRHF _t	Fall	31	1%
NIMF	Fall	0	0%
NIMF _n	Fall	49	2%
NIMF _{gg}	Fall	0	0%
NIMF _t	Fall	0	0%
MOKF _n	Fall	12	<1%
MOKF _{np}	Fall	0	0%
MOKF _{gg}	Fall	0	0%
MOKF _t	Fall	0	0%
MOKF _{tc}	Fall	0	0%
MERF _n	Fall	0	0%
Other CV	Non-fall	5	<1%
Non-CV		1,176	37%
	Total	1,273	40%

7. Relative Recovery and Stray Rates of Fall-run Experimental and Net Pen Release Types

In 2023, CWTs from many fall-run experimental and net pen release types were recovered in the CV escapement and a few were recovered in Oregon's ocean harvest, and this section will focus on those from brood years 2019 through 2021 (ages 2-4). Experimental releases include non-acclimated Golden Gate releases at Fort Baker, which utilized approximately 6.1 million, 3 million, and 680,000 fall-run salmon from MOK, FRH, and NIM, respectively.

Net pen releases can be categorized into either bay/delta or coastal releases. Bay/delta net pen releases include those that are released in the western Delta (MOK and MER), and those that are released where the Carquinez Strait meets San Pablo Bay (CFH, FRH, and NIM). Coastal net pen releases include those coordinated by the Coastside Fishing Club in Pillar Point and those coordinated by the Monterey Bay Trout and Salmon Project in Santa Cruz and Monterey.

The experimental and net pen releases recovered in 2023 are differentiated into the following release types:

- CFHFn Coleman National Fish Hatchery **F**all-run bay/delta **n**et pens
- FRHFn Feather River Hatchery **F**all-run bay/delta **n**et pens
- FRHFgg Feather River Hatchery **F**all-run **G**olden **G**ate releases (no net pen acclimation)
- NIMFn Nimbus Fish Hatchery **F**all-run bay/delta **n**et pens
- NIMFgg Nimbus Fish Hatchery **F**all-run **G**olden **G**ate releases (no net pen acclimation)
- MOKFn Mokelumne River Hatchery **F**all-run bay/delta **n**et pens
- MOKFnp Mokelumne River Hatchery **F**all-run coastal **n**et pens – **P**illar Point
- MOKFns Mokelumne River Hatchery **F**all-run coastal **n**et pens – **S**anta Cruz
- MOKFgg Mokelumne River Hatchery **F**all-run **G**olden **G**ate releases (no net pen acclimation)
- MERFn Merced River Hatchery **F**all-run bay/delta **n**et pens

Central Valley Escapement

The CV escapement recovery rate and percent stray for all fall-run experimental and net pen releases are included below to allow direct comparison among these release types (Table 11, Fig. 16).

Age-2 CV Escapement Recovery and Stray Rates

R _{type}	Brood year	Run	# Recoveries per 100K Released	# Strays per 100K Released	% stray
FRHFn	2021	Fall	61	7	12%
FRHFgg	2021	Fall	36	5	13%
NIMFn	2021	Fall	135	20	15%
MOKFn	2021	Fall	82	27	33%
MOKFnp	2021	Fall	77	33	42%
MOKFgg	2021	Fall	81	30	37%
MERFn	2021	Fall	236	181	77%

Age-3 CV Escapement Recovery and Stray Rates

R _{type}	Brood year	Run	# Recoveries per 100K Released	# Strays per 100K Released	% stray
CFHFn	2020	Fall	554	539	97%
FRHFn	2020	Fall	671	35	5%
NIMFn	2020	Fall	1,112	365	33%
NIMFgg	2020	Fall	647	220	34%
MOKFn	2020	Fall	194	96	50%
MOKFnp	2020	Fall	646	448	69%
MOKFgg	2020	Fall	252	137	54%
MERFn	2020	Fall	210	167	79%

Age-4 CV Escapement Recovery and Stray Rates

R _{type}	Brood year	Run	# Recoveries per 100K Released	# Strays per 100K Released	% stray
FRHFn	2019	Fall	108	4	4%
NIMFn	2019	Fall	161	18	11%
MOKFn	2019	Fall	28	8	28%
MOKFnp	2019	Fall	84	36	43%
MOKFgg	2019	Fall	59	21	35%
MERFn	2019	Fall	6	3	55%

Ocean Fishery Harvest

The recovery rate for all fall-run experimental and net pen releases in Oregon ocean salmon fisheries, and the percentage that occurred in the sport fishery, are shown below to allow direct comparison among these release types (Table 11, Fig. 17).

Age-2 Ocean Harvest Recovery Rate; Percent taken in Sport Harvest

R _{type}	Brood year	Run	# Recoveries per 100K	
			Released	% sport
FRHFn	2021	Fall	0	-
FRHFgg	2021	Fall	0	-
NIMFn	2021	Fall	1	100%
MOKFn	2021	Fall	<1	100%
MOKFnp	2021	Fall	0	-
MOKFgg	2021	Fall	0	-
MERFn	2021	Fall	0	-

Age-3 Ocean Harvest Recovery Rate; Percent taken in Sport Harvest

R _{type}	Brood year	Run	# Recoveries per 100K	
			Released	% sport
CFHFn	2020	Fall	0	-
FRHFn	2020	Fall	0	-
NIMFn	2020	Fall	1	100%
NIMFgg	2020	Fall	0	-
MOKFn	2020	Fall	0	-
MOKFnp	2020	Fall	0	-
MOKFgg	2020	Fall	0	-
MERFn	2020	Fall	0	-

Age-4 Ocean Harvest Recovery Rate; Percent taken in Sport Harvest

R _{type}	Brood year	Run	# Recoveries per 100K	
			Released	% sport
FRHFn	2019	Fall	0	-
NIMFn	2019	Fall	0	-
MOKFn	2019	Fall	0	-
MOKFnp	2019	Fall	0	-
MOKFgg	2019	Fall	0	-
MERFn	2019	Fall	0	-

2023 CFM ANALYSES KEY POINTS

- Beginning in 2020 and continuing through 2022, California experienced a severe drought, with water year 2021 being one of the driest years in almost a century (DWR 2022). This significantly impacted release strategies, especially for brood years 2020 and 2021, which saw the highest percentage of fall-run released out-of-basin compared to in-basin of any other brood year examined in this report (61% and 57% fish released out-of-basin, respectively). Brood year 2020 was the first year where CFH fish were released in bay/delta net pens since brood year 2014, in part due to unfavorable river conditions in the upper Sacramento River.
- The majority (88%) of the 2023 CV salmon escapement (all run-types) were hatchery-origin fish. This was an increase of 17% in hatchery contribution from the 2022 escapement, and the highest proportion since 2017 (Letvin et al. 2020). Between 2010 and 2022, the hatchery contribution to the total CV escapement averaged 74% and ranged between 57% and 88%. This increase in hatchery proportion is likely impacted by the drought conditions discussed above that in-river spawners experienced. FRH fall-run bay/delta trucked releases had the highest contribution (19%) to the total 2023 CV escapement hatchery spawners, with NIM fall-run bay/delta net pen releases (15%) being the next highest contributor, again supporting the idea that fish that did not experience in-river drought conditions had higher survival.
- The highest stray rates for fall-run recoveries in the surveys analyzed occurred with CFH fall-run bay/delta net pen releases (97%). Additionally, offsite releases from MOK, except bay/delta trucked releases, strayed at very high rates, with the highest being coastal trucked (72%), followed by Pillar Point coastal net pen (65%) and Golden Gate (48%) releases. Offsite releases from other hatcheries strayed at lower rates, with the lowest being FRH fall-run bay/delta trucked and Golden Gate releases (3%), followed by FRH fall-run bay/delta net pen releases (6%).
- Salmon escapement into all CV hatcheries were predominately hatchery-origin fish. At each CV hatchery, except MER, the majority of the return was composed of their respective releases. MER had the highest proportion of out-of-basin hatchery returns (82%), with most of those strays originating from MOK.
- Hatchery contribution to natural area escapements was the highest since the CFM program was fully implemented. For fall-run specifically, the hatchery contribution across all CV natural areas was 88% compared to the 2010-2022 average of 69% (range: 51% - 81%). Most natural area spawners were predominantly hatchery-origin fish. The exceptions were winter- and late-fall-run spawners in the upper Sacramento River mainstem.
- The hatchery-origin component of the natural area escapement to the Feather and American Rivers consisted primarily of release types from the hatcheries located on each of the respective rivers. Strays from out-of-basin hatcheries made noticeable contributions to the natural area escapements in the Sacramento and Mokelumne

Rivers (72% and 56% of the hatchery-origin components, respectively). Strays from out-of-basin hatcheries comprised almost the entirety of the hatchery-origin component in the Merced River (92% of the hatchery-origin component). MOK fall-run Pillar Point coastal net pen releases were the highest contributor to the Sacramento River (26% of the hatchery-origin component). NIM fall-run bay/delta net pen releases were the highest contributor to the Mokelumne River (29% of the hatchery-origin component). MOK fall-run bay/delta net pen releases made the highest contribution to the Merced River (42% of the hatchery-origin component).

- Fall-run escapement in the upper Sacramento River mainstem was 90% hatchery-origin salmon. The hatchery contribution was the highest for the area since the CFM program was fully implemented. The total escapement to the upper Sacramento River was below the long-term average. MOK fall-run Pillar Point coastal net pen and CFH fall-run in-basin releases made the highest contributions to the Sacramento River mainstem fall-run escapement (26% and 25% of the hatchery-origin component, respectively).
- Fall- and spring-run escapement to the natural spawning areas of the Feather River was predominantly hatchery-origin salmon. FRH fall-run bay/delta trucked releases had the highest contribution of any release type, followed by FRH fall-run bay/delta net pen releases (42% and 31% of the hatchery-origin component, respectively). In-basin fall-run releases from FRH composed <0.5% of the escapement.
- Returns to the Yuba River below DPD increased in 2023, with 487 salmon returning to the area. In 2021 and 2022, escapement to the Yuba River below DPD was less than 100 salmon. The escapement to the Yuba River above and below DPD were predominantly hatchery-origin salmon (87% and 97% hatchery, respectively). The hatchery-origin component was largely composed of FRH fall-run bay/delta trucked releases for the above and below DPD river sectors (31% and 46% of the hatchery-origin component, respectively).
- Fall-run escapement to the natural spawning areas of the American River was dominated by hatchery-origin salmon (10% natural vs. 90% hatchery). NIM fall-run bay/delta net pen releases were the highest contributing release type (49% of the hatchery-origin component), followed by NIM fall-run bay/delta trucked releases (21% of the hatchery-origin component).
- In 2023, the Mokelumne River had one of the highest escapements recorded since reporting began in the 1980s (PFMC 2026). Fall-run escapement to the natural spawning areas of the Mokelumne River was predominantly hatchery-origin salmon (17% natural vs. 83% hatchery). NIM fall-run bay/delta net pen releases were the highest contributing release type (29% of the hatchery-origin component), followed by MOK fall-run bay/delta net pen releases (19% of the hatchery-origin component).
- Fall-run escapement to the Stanislaus and Tuolumne Rivers was predominantly hatchery-origin salmon (70% and 71% hatchery, respectively), with stray MOK

bay/delta net pen releases being the greatest contributors (47% and 49% of the hatchery-origin component, respectively).

- Fall-run escapement to the Merced River was composed of slightly more hatchery-origin salmon (45% natural vs. 55% hatchery), which was the highest ratio of natural- to hatchery-origin salmon of any of the other fall-run natural spawning areas. Stray MOK bay/delta net pen releases were the greatest contributors to the Merced River (42% of the hatchery-origin component).
- For age-2 fall-run salmon, MER bay/delta net pen releases had the highest CV escapement recovery rate for their cohort (236 recoveries per 100,000 released), followed by NIM bay/delta net pen releases (137 recoveries per 100,000 released).
- For age-3 fall-run salmon, FRH Golden Gate releases had the highest CV escapement recovery rates for their cohort (1,323 recoveries per 100,000 released), followed by FRH bay/delta trucked releases (1,171 recoveries per 100,000 released).
- For age-4 fall-run salmon, NIM bay/delta net pen releases had the highest CV escapement recovery rate for their cohort (164 recoveries per 100,000 released), followed by FRH bay/delta net pen releases (109 recoveries per 100,000 released).
- Age-3 CFH bay/delta net pen releases had the highest stray rate of any other offsite release of fall-run salmon examined in this report (97%). Of the remaining offsite releases of fall-run salmon, MOK and MER continued to stray at high rates for ages-2, -3, and -4, ranging from 28-79%, except age-3 MOK bay/delta trucked releases where only 6% of salmon strayed. Recoveries from FRH and NIM strayed at comparatively lower rates.
- CV stocks comprised a very small proportion of the overall Oregon ocean sport and commercial harvests (5% and <0.5%, respectively). NIM fall-run bay/delta net pen releases were the highest contributors of the CV stocks captured in the Oregon ocean sport fishery (9% of the hatchery-origin component). FRH fall-run bay/delta trucked releases were the only CV stock captured in the Oregon ocean commercial fishery.
- This is the seventh report in the series that has recovery data for non-experimental FRH fall-run in-basin releases, providing another year of recovery and stray rate comparisons between in-basin and out-of-basin FRH fall-run releases from the same brood year. In 2023, FRH fall-run in-basin and out-of-basin releases only co-occurred in age-4 salmon. Out-of-basin releases included only bay/delta net pen releases. Recovery rates of in-basin releases continued to be low, however, compared to the out-of-basin releases, there are significantly fewer releases using this strategy. FRH in-basin releases experienced no straying, while out-of-basin releases had stray rates of 5%.
- The age-3 upper Sacramento River winter-run CV recovery rate of 208 CWTs per 100,000 released was higher than in 2022, and the fifth lowest recovery rate since reporting began. Between 2012 and 2022, the age-3 winter-run CV recovery rate

averaged 582 CWTs per 100,000 released and ranged between 72 and 1,896. Additionally, the 2023 winter-run escapement to the upper Sacramento River decreased significantly from the previous year and was the lowest escapement since 2017 (Letvin et al. 2020).

- 2023 was the fifth year that winter-run salmon released into North Fork Battle Creek as part of the FWS Jumpstart program began to return as spawners and contribute to ocean harvest. The CV recovery rates for this release type were lower than for winter-run released into the upper Sacramento River. Among the winter-run that returned to the CV in 2023, those that were released into the upper Sacramento River and age-4 winter-run releases into Battle Creek returned entirely to their basins of origin, while age-3 winter-run releases into Battle Creek strayed at a rate of 10%. For the second year, there were no CV recoveries of age-2 winter-run releases into Battle Creek.
- This is the fifth report in the series that includes data for the upper San Joaquin River mainstem spring-run escapement. In most years such passage does not exist, and spawners must be trapped further downstream and translocated to the upper San Joaquin River. In 2023, only 3 spring-run salmon were captured in the upper San Joaquin River. With these low numbers expansions were not conducted and it cannot be determined what the composition of the expanded population looked like for 2023 based on CWT recoveries from natural escapement carcasses. However, because it is early in the reintroduction process and all fish that were captured were of hatchery-origin, it can be assumed that the escapement to this sector is overwhelmingly hatchery-origin salmon. More information regarding the reintroduction process and more robust life cycle monitoring, which is outside of the scope of this report, can be found through the San Joaquin River Restoration Project reporting.
- 2023 was the first year encountering recoveries from FRH fall-run fish trucked to Point Richmond, which was an enhancement program sponsored by agencies, stakeholders, and the city of Richmond in an effort to create a more localized fishery. Unlike with other fall-run and trucked releases, 100% of the almost 200,000 fish released were tagged with CWTs. Due to the relatively small size of the release and the closed fishing season in California in 2023, recoveries were not separated from the FRH fall-run bay/delta trucked releases from the same brood year for analysis in this report. However, 44 of the approximately 19,600 raw CWTs recovered in CV hatchery and natural spawning areas were from this release at Point Richmond. No CWTs from this release were recovered in Oregon ocean fisheries.
- 419 CWTs were recovered in 2023 with a CWT code that was identified as a replicate code. The first instance where the CWT code was used was for a NIM fall-run bay/delta net pen release for brood year 2018, the second instance was for a NIM fall-run Golden Gate release for brood year 2020. In order to assign the correct replicate code to each recovery, staff reviewed age-at-length data and prevalence of age-3 and age-5 recoveries. After review, all recoveries were assigned to the brood year 2020 release. No recoveries of the CWT code were encountered in Oregon fisheries in 2023.

CONCLUSION

A primary goal of this report is to provide information that will be useful in California salmon management, including CV hatchery assessment. As with each of the previous 13 CFM reports, the estimates of hatchery contribution and recovery rate by release type presented in this report should be viewed as a “single year snapshot” of salmon escapement and harvest in the CV and California ocean fisheries during 2023. Although no discussion section is included, as in earlier CFM reports covering the 2010, 2011, and 2012 escapement and harvest years, the authors plan to further analyze these data as these and additional tagged broods become complete. This report contains the data and analyses needed to determine the contribution of hatchery- and natural-origin salmon to hatchery and natural areas throughout the CV, evaluate hatchery release strategies and programs, improve California ocean and river salmon fisheries management, evaluate the effectiveness of habitat restoration, and determine if other goals of the CFM program are being met on an annual basis. This information, combined with other tools such as cohort reconstruction and harvest models, will allow resource managers to determine the total contribution of various release strategies to CV escapement and to ocean and inland fisheries by time and area.

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LIST OF ACRONYMS AND ABBREVIATIONS

- Ad-clipped Clipped Adipose Fin
- BOR U.S. Bureau of Reclamation
- BY Brood Year
- CDFW California Department of Fish and Wildlife
- CFH Coleman National Fish Hatchery
- CFM Constant Fractional Marking
- CV California Central Valley
- CWT Coded-Wire Tag
- DPD Daguerre Point Dam (Yuba River)
- DWR California Department of Water Resources
- EBMUD East Bay Municipal Utilities District
- FRH Feather River Hatchery
- FWS U.S. Fish and Wildlife Service
- KES Keswick Dam Fish Trap
- LSNFH Livingston Stone National Fish Hatchery
- MER Merced River Hatchery
- MOK Mokelumne River Hatchery
- NMFS National Marine Fisheries Service
- NIM Nimbus Fish Hatchery
- OSP Ocean Salmon Project
- PFMC Pacific Fishery Management Council
- PSMFC Pacific States Marine Fisheries Commission
- RMPC Regional Mark Processing Center
- SCARF Salmon Conservation and Research Facility
- SFRA Sport Fish Restoration Act
- SJ San Joaquin
- TL Total Length
- WD Woodbridge Dam (Mokelumne River)
- YARMT Yuba Accord River Management Team

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Table 1a. Estimation and sampling methods used for the 2023 CV Chinook hatchery escapement.

Sampling Location	Estimation and Sampling Methods	Agency
Hatchery Spawners		
Coleman National Fish Hatchery (CFH) Fall and Late-Fall (2024)	Direct count. All fish examined and bio-sampled ^{a/} for fin-clips, tags, marks. All ad-clipped fish sampled and heads collected for CWT recovery. The fall-run period is considered early Oct through Nov and the late-fall-run period is considered Nov through April. However, the final escapement is ultimately parsed into run types based on CWT code recoveries and dominant run type by date. During the late-fall-run period, all unmarked fish are electronically checked for CWTs. Some untagged phenotypic late-fall-run fish are released into Battle Creek above CFH. Grilse cutoff: 670 mm females, 750 mm males fall; 520 mm females, 590 mm males late-fall.	FWS
CFH Winter and Late-Fall (2024) Fish Trap	Direct count of winter-run which are identified by left pelvic fin-clips and CWTs, or late-fall-run that are trapped after CFH spawning operations cease. All fish examined and bio-sampled for fin-clips, tags, marks. All ad-clipped fish sampled and heads collected for CWT recovery, and all unmarked fish are electronically checked for CWTs. Any untagged phenotypic late-fall-run fish are released into Battle Creek above CFH. Any additional fish observed on video after trap removal are examined for fin-clips and added to escapement estimates. Grilse cutoff: 520 mm females, 590 mm males late-fall; 550 mm females, 640 mm males winter ^{b/} .	FWS
Keswick Fish Trap Winter and Late-Fall (2024)	Direct count. All fish examined and bio-sampled for fin-clips, tags, marks. During Feb-Jul, all retained unmarked fish electronically sampled for presence of CWT and genetically tested to ensure winter-run broodstock. To promote genetic integrity of CFH broodstock, Keswick fish trap was also utilized to collect late-fall-run during Jan-Feb. Grilse cutoff: 550 mm females, 640 mm males winter; 520 mm females, 590 mm males late-fall ^{b/c/} .	FWS
Feather River Hatchery (FRH) Spring and Fall	Direct count. All fish examined for fin-clips, tags, marks. Fish arriving at the hatchery May 4 - July 13 (n~ 2,168) were considered "spring-run" and marked with uniquely-numbered dart tags prior to release back into the Feather River. Only fish marked with dart tags returning to FRH in fall were spawned as spring-run. All remaining fish were considered fall-run. FRH fish ladder opened Sep 15 and spring spawning began Sep 20. All spring-run fish bio-sampled. Fall spawning occurred on Oct 3 for the cold water program and began normally on Oct 12. Fall spawning ceased on Nov 16. Systematic random bio-sample ~20% of all fish for fall-run. All ad-clipped fish were sampled and heads collected for CWT recovery. Grilse cutoff: 650 mm spring and fall.	CDFW
Nimbus Fish Hatchery (NIM) Fall	Direct count. NIM ladder was open Nov. 3 - Feb. 27. All fish examined for fin-clips, tags, marks. Systematic random bio-sample of 20% of total fish. All ad-clipped fish sampled and heads collected for CWT recovery. Grilse cutoff: 685 mm.	CDFW
Mokelumne River Hatchery (MOK) Fall	Direct count. MOK open Oct 2 - Feb 13. All fish examined for fin-clips, tags, marks. Systematic random bio-sample 20% of total fish. All ad-clipped fish sampled and heads collected for CWT recovery. Grilse cutoff: 640 mm females, 680 mm males.	CDFW
Merced River Hatchery (MER) Fall	Direct count. MER open Oct 1 - Dec 18. All fish examined for fin-clips, tags, marks. All ad-clipped fish were sampled and heads processed for CWT recovery. Grilse cutoff: 650 mm females, 720 mm males.	CDFW

^{a/} Biological sampling ("bio-samples" or "bio-data") of live fish or carcasses may include observed tags or marks, sex, fork length, scales, carcass condition, spawning condition, and heads collected from ad-clipped fish for CWT recovery.

^{b/} A combination of Keswick and winter-run carcass data are used to determine grilse cutoffs, but they are generally not calculated, especially for females, due to low sample sizes.

^{c/} Late-fall grilse cutoffs are determined based on CNFH returns.

Table 1b. Estimation and sampling methods used for the 2023 CV Chinook natural escapement. (Page 1 of 2)

Sampling Location	Estimation and Sampling Methods	Agency
Natural Spawners		
Upper Sacramento River Mainstem Winter, Fall, and Late-Fall (2024)	Population estimate for each run produced utilizing five-step process: 1) Superpopulation modification of the Cormack-Jolly-Seber mark-recapture estimate using all females within carcass survey area (Balls Ferry Bridge to Keswick Dam). 2) Total female escapement estimate in upper Sacramento River is derived using expansions for females spawning outside of the survey area (Princeton to Balls Ferry) through aerial redd surveys. 3) Adult male escapement estimated using adult sex ratio of live fish counts at CFH or Keswick Trap. 4) Grilse escapement estimated using survey ratio of fresh adult males to fresh grilse. 5) Addition of any fish removed for hatchery brood stock purposes. All fish in carcass survey examined for fin-clips, tags, marks, and condition (e.g., fresh, non-fresh, skeleton). Bio-data ^{af} collected from all fresh fish. Systematic random bio-sample may occur if carcass counts expected to be high. All ad-clipped fish (fresh and non-fresh), including "unknown" ad-clipped status, were sexed, measured and heads collected for CWT recovery. Grilse cutoff: 580 mm females, 610 mm males winter; 610 mm females, 725 mm males fall; 610 mm females, 650 mm males late-fall.	CDFW, FWS
Clear Creek Fall	Video Station count used to estimate population. Supplemental bio-sampling survey used to estimate biological characteristics of the population (age, sex, hatchery-origin, spawn success). All fish in carcass survey examined for fin-clips, tags, marks, and condition (e.g., fresh, non-fresh, skeleton). Bio-data collected from all fresh fish. All ad-clipped fish (fresh and non-fresh), including "unknown" ad-clipped status, were sampled and heads collected for CWT recovery. Bio-sampling data from CFH used as a surrogate.	CDFW, FWS
Cow Creek Fall	Video weir count in lower creek used to determine total escapement. Kayak surveys conducted to collect bio-data from fresh fish. Opportunistic collection of CWTs, however only 2 carcasses observed. Bio-sampling data from CFH used as a surrogate.	CDFW
Battle Creek Fall	Video weir count (Aug 16 - Nov 30) in lower creek used to determine total fall-run escapement. Natural fall-run escapement into Battle Creek calculated by subtracting CFH fall-run return from total run. Surrogate CWTs based on hatchery proportion and CWT composition of CFH fall-run return. Bio-sampling data from CFH used as a surrogate.	CDFW
Cottonwood Creek Fall	Video weir count (Oct 5 - Dec 15) in lower creek used to determine total escapement. Kayak surveys conducted to collect bio-data from fresh fish, however no carcasses were observed. Bio-sampling data from CFH used as a surrogate.	CDFW
Mill Creek Fall	Video counts at Ward Dam in lower Mill Creek plus expanded redd count between Ward Dam and the Sacramento River confluence used to determine total escapement. Bio-sampling surveys conducted to collect bio-data from fresh fish. All ad-clipped fish (fresh and non-fresh), including "unknown" ad-clipped status, were sampled and heads collected for CWT recovery, however no ad-clipped fish were encountered. Bio-sampling data from CFH used as a surrogate.	CDFW

Table 1b. Estimation and sampling methods used for the 2023 CV Chinook natural escapement. (Page 2 of 2)

Sampling Location	Estimation and Sampling Methods	Agency
Natural Spawners cont.		
Feather River Fall	Superpopulation modification of the Cormack-Jolly-Seber mark-recapture estimate. All fish examined for fin-clips, tags, marks. Systematic random bio-sample of fresh fish. All ad-clipped fresh fish sampled and heads collected for CWT recovery. Escapement estimate includes spring-run. Grilse cutoff: 650 mm.	DWR
Yuba River Fall	Above Daguerre Point Dam (DPD): Vaki Riverwatcher direct count of escapement and ad-clipped fish. Supplemental carcass survey to collect bio-data and heads from ad-clipped fish (fresh fish only). Below DPD: Superpopulation modification of the Cormack-Jolly-Seber mark-recapture estimate. All fish examined for fin-clips, tags, marks, and condition. All ad-clipped fresh fish sampled and heads collected for CWT recovery. Escapement estimate includes spring-run. Grilse cutoff: 650 mm.	CDFW, YARMT
American River Fall	Superpopulation modification of the Cormack-Jolly-Seber mark-recapture estimate. All fish examined for fin-clips, tags, marks, and condition. Systematic random bio-sample of all fish. All ad-clipped fish sampled and heads collected for CWT recovery. Grilse cutoff: 680 mm females, 750 mm males.	CDFW
Mokelumne River Fall	Video count at Woodbridge Irrigation District Dam (WIDD) used to determine total escapement and ad-clipped fish above WIDD. Natural spawner escapement estimate and ad-clip rate calculated by subtracting total count and number of ad-clipped fish returning to MOK. Supplemental carcass survey to collect bio-data from fresh fish and heads from all ad-clipped fish. Grilse cutoff: 700 mm.	EBMUD
Stanislaus River Fall	Superpopulation modification of the Cormack-Jolly-Seber mark-recapture estimate. All fresh fish examined for fin-clips, tags, marks. All fresh ad-clipped fish sampled and heads collected for CWT recovery. Grilse cutoff: 650 mm females, 720 mm males.	CDFW
Tuolumne River Fall	Superpopulation modification of the Cormack-Jolly-Seber mark-recapture estimate. All fish examined for fin-clips, tags, marks, and condition. All ad-clipped fish sampled and heads collected for CWT recovery. Grilse cutoff: 650 mm females, 720 mm males.	CDFW
Merced River Fall	Superpopulation modification of the Cormack-Jolly-Seber mark-recapture estimate. All fresh fish examined for fin-clips, tags, marks. All fresh ad-clipped fish sampled and heads collected for CWT recovery. Grilse cutoff: 650 mm females, 720 mm males.	CDFW
Upper San Joaquin River Mainstem Spring	Direct count of carcasses encountered in the upper San Joaquin Restoration Area. All fish examined for fin-clips, tags, marks, condition, and other bio-data. Heads collected for CWT recovery from all fish regardless of ad-clip status. Using various tags and later confirmed with CWTs, all fish classified as either: 1) volitional returns via the Eastside Bypass, 2) translocated from downstream traps, or 3) captive broodstock adult releases. Fish determined to be captive broodstock are removed from the escapement estimate. Fish found dead in downstream traps are bio-sampled in the same manner as other carcasses and are added to the escapement estimate.	FWS, CDFW

^{a/} Biological sampling ("bio-samples" or "bio-data") of live fish or carcasses may include observed tags or marks, sex, fork length, scales, carcass condition, spawning condition, and heads collected from ad-clipped fish for CWT recovery.

Table 2. Central Valley coded-wire tag (CWT) Chinook releases recovered in 2023 by age, run, stock, and release type. (Page 1 of 2)

Age-2 CWT releases											
Release type*	Brood year	Hatchery / wild	Stock origin	Run type	CWT codes	# CWT tagged	Total fish released	% CWT	Release strategy	Release locations / notes	
SacW	2021	LSH	Sac R	Wint	11	515,191	518,221	99%	In-basin	Sacramento River (Lake Redding Park)	
SacWbat	2021	LSH	Sac R	Wint	5	130,056	132,929	98%	Reintroduction	North Fork Battle Creek	
FRHS	2021	FRH	Fea R	Spr	2	719,565	1,457,181	49%	In-basin	Feather River (Boyds Pump Ramp and Gridley)	
FRHSn	2021	FRH	Fea R	Spr	2	708,572	955,628	74%	Bay/Delta pens	San Pablo Bay (Mare Island) net pen releases	
SJOSx	2021	SJO	San Joa R	Spr	8	224,446	225,736	99%	Reintroduction	San Joaquin River (Fremont Ford Bridge and Friant)	
CFHF	2021	CFH	Sac R	Fall	32	3,261,039	12,142,328	27%	In-basin	CFH and Sacramento River (Butte City)	
FRHFn	2021	FRH	Fea R	Fall	3	415,681	1,667,612	25%	Bay/Delta pens	San Pablo Bay (Mare Island) net pen releases	
FRHFgg	2021	FRH	Fea R	Fall	6	505,955	2,036,695	25%	Trucked	Golden Gate releases; trucked to Fort Baker	
FRHFt	2021	FRH	Fea R	Fall	11	1,400,256	5,014,935	28%	Trucked	Direct release; trucked to San Pablo Bay (Wickland Oil, Pt San Quentin, and Point Richmond)	
NIMFn	2021	NIM	Ame R	Fall	4	506,558	2,033,960	25%	Bay/Delta pens	San Pablo Bay (Mare Island) net pen releases	
NIMFt	2021	NIM	Ame R	Fall	5	655,144	2,632,425	25%	Trucked	Direct release; trucked to San Pablo Bay (Wickland Oil)	
MOKFn	2021	MOK	Mok R	Fall	8	873,793	3,499,315	25%	Bay/Delta pens	Western Delta (Sherman Island) net pen releases	
MOKFnp	2021	MOK	Mok R	Fall	1	187,417	750,065	25%	Coastal pens	Coastal (Pillar Point) net pen releases	
MOKFgg	2021	MOK	Mok R	Fall	6	541,032	2,165,391	25%	Trucked	Golden Gate releases; trucked to Fort Baker	
MOKFtc	2021	MOK	Mok R	Fall	2	320,981	321,786	100%	Trucked	Direct release; trucked to Santa Cruz and Monterey	
MERFn	2021	MER	Mer R	Fall	2	88,084	90,916	97%	Bay/delta pens	Western Delta (Sherman Island) net pen releases	
CFHL	2022	CFH	Sac R	Late	14	837,377	875,562	96%	In-basin	CFH (includes spring surrogate releases)	
Total age-2 releases:					122	11,891,147	36,520,685	33%			
Age-3 CWT releases											
Release type*	Brood year	Hatchery / wild	Stock origin	Run type	CWT codes	# CWT tagged	Total fish released	% CWT	Release strategy	Release locations / notes	
SacW	2020	LSH	Sac R	Wint	6	302,805	303,422	100%	In-basin	Sacramento River (Lake Redding Park)	
SacWbat	2020	LSH	Sac R	Wint	4	212,751	213,378	100%	Reintroduction	North Fork Battle Creek	
FRHS	2020	FRH	Fea R	Spr	4	993,132	1,012,735	98%	In-basin	Feather River (Boyds Pump Ramp)	
SJOSx	2020	SJO	San Joa R	Spr	6	206,180	207,042	100%	Reintroduction	San Joaquin River (Fremont Ford Bridge and Friant)	
CFHF	2020	CFH	Sac R	Fall	30	3,278,256	12,042,296	27%	In-basin	CFH and Sacramento River (Butte City)	
CFHFn	2020	CFH	Sac R	Fall	2	219,750	888,882	25%	Bay/Delta pens	San Pablo Bay (Pt San Quentin) net pen releases	
FRHFn	2020	FRH	Fea R	Fall	9	642,114	2,588,649	25%	Bay/Delta pens	San Pablo Bay (Mare Island) net pen releases	
FRHFgg	2020	FRH	Fea R	Fall	1	241,688	981,529	25%	Trucked	Golden Gate releases; trucked to Fort Baker	
FRHFt	2020	FRH	Fea R	Fall	4	677,565	2,755,403	25%	Trucked	Direct release; trucked to San Pablo Bay (Wickland Oil and Pt San Quentin)	
NIMFn	2020	NIM	Ame R	Fall	4	507,267	2,039,296	25%	Bay/Delta pens	San Pablo Bay (Mare Island) net pen releases	
NIMFgg	2020	NIM	Ame R	Fall	1	169,117	678,942	25%	Trucked	Golden Gate release; trucked to Fort Baker	
NIMFt	2020	NIM	Ame R	Fall	4	335,371	1,350,156	25%	Trucked	Direct releases; trucked to San Pablo Bay (Wickland Oil and Pt San Quentin)	
MOKFn	2020	MOK	Mok R	Fall	8	889,472	3,577,566	25%	Bay/Delta pens	Western Delta (Sherman Island) net pen releases	
MOKFnp	2020	MOK	Mok R	Fall	1	185,794	747,386	25%	Coastal pens	Coastal (Pillar Point) net pen releases	
MOKFgg	2020	MOK	Mok R	Fall	5	494,114	1,980,909	25%	Trucked	Golden Gate release; trucked to Fort Baker	
MOKFt	2020	MOK	Mok R	Fall	2	124,689	499,041	25%	Trucked	Direct release; trucked to San Pablo Bay (Pt San Quentin)	
MOKFtc	2020	MOK	Mok R	Fall	2	322,878	323,280	100%	Trucked	Direct release; trucked to Santa Cruz and Monterey	
MERFn	2020	MER	Mer R	Fall	1	74,909	266,294	28%	Bay/Delta pens	Western Delta (Sherman Island) net pen releases	
CFHL	2021	CFH	Sac R	Late	14	1,009,914	1,038,384	97%	In-basin	CFH (includes spring surrogate releases)	
Total age-3 releases:					108	10,887,766	33,494,590	33%			

Table 2. Central Valley coded-wire tag (CWT) Chinook releases recovered in 2023 by age, run, stock, and release type. (Page 2 of 2)

Age-4 CWT releases

Release type*	Brood year	Hatchery	Stock origin	Run type	CWT codes	# CWT tagged	Total fish released	% CWT	Release strategy	Release locations / notes
SacW	2019	LSH	Sac R	Wint	4	247,216	249,119	99%	In-basin	Sacramento River (Lake Redding Park)
SacWbat	2019	LSH	Sac R	Wint	3	165,858	168,144	99%	Reintroduction	North Fork Battle Creek
FRHS	2019	FRH	Fea R	Spr	6	1,771,532	1,784,999	99%	In-basin	Feather River (Boyd's Pump Ramp and Gridley)
SJOSx	2019	SJO	San Joa R	Spr	13	232,903	238,855	98%	Reintroduction	San Joaquin River (Fremont Ford Bridge and Friant)
CFHF	2019	CFH	Sac R	Fall	33	3,352,800	12,392,944	27%	In-basin	CFH only
FRHF	2019	FRH	Fea R	Fall	1	248,810	1,000,800	25%	In-basin	Feather River (Boyd's Pump Ramp)
FRHFn	2019	FRH	Fea R	Fall	12	1,335,074	5,398,892	25%	Bay/Delta pens	San Pablo Bay (Mare Island) net pen releases
NIMF	2019	NIM	Ame R	Fall	4	796,467	2,594,954	31%	In-basin	American River (Sunrise Recreation Area)
NIMFn	2019	NIM	Ame R	Fall	5	453,171	1,823,412	25%	Bay/Delta pens	San Pablo Bay (Mare Island) net pen releases
MOKFn	2019	MOK	Mok R	Fall	10	1,068,378	4,276,402	25%	Bay/Delta pens	Western Delta (Sherman Island) net pen releases
MOKFnp	2019	MOK	Mok R	Fall	1	192,201	769,419	25%	Coastal pens	Coastal (Pillar Point) net pen releases
MOKFgg	2019	MOK	Mok R	Fall	4	486,615	1,947,732	25%	Trucked	Golden Gate releases; trucked to Fort Baker
MOKFtc	2019	MOK	Mok R	Fall	2	316,528	336,125	94%	Trucked	Direct release; trucked to Santa Cruz and Monterey
MERFn	2019	MER	Mer R	Fall	2	109,375	1,220,123	9%	Bay/Delta pens	Western Delta (Sherman Island) net pen releases
CFHL	2020	CFH	Sac R	Late	14	<u>872,269</u>	<u>878,771</u>	<u>99%</u>	In-basin	CFH (includes spring surrogate releases)
Total age-4 releases:					114	11,649,197	35,080,691	33%		

Age-5 CWT releases (with recoveries in 2021)

Release type*	Brood year	Hatchery	Stock origin	Run type	CWT codes	# CWT tagged	Total fish released	% CWT	Release strategy	Release locations / notes
SacW	2018	LSH	Sac R	Wint	5	221,923	224,101	99%	In-basin	Sacramento River (Bonnyview Boat Ramp)
SacWbat	2018	LSH	Sac R	Wint	3	180,252	182,758	99%	Reintroduction	North Fork Battle Creek
FRHS	2018	FRH	Fea R	Spr	9	1,831,043	1,848,318	99%	In-basin	Feather River (Boyd's Pump Ramp, Gridley, and Live Oak)
SJOSx	2018	SJO	San Joa R	Spr	8	216,845	219,560	99%	Reintroduction	San Joaquin River (Fremont Ford Bridge and Friant)
CFHF	2018	CFH	Sac R	Fall	32	3,448,504	12,835,143	27%	In-basin	CFH and Sacramento River (Scotty's Landing)
FRHF	2018	FRH	Fea R	Fall	1	30,000	30,000	100%	In-basin	Sacramento River (Yolo Bypass)
FRHFn	2018	FRH	Fea R	Fall	16	1,772,613	7,196,006	25%	Bay/Delta pens	San Pablo Bay (Mare Island) net pen releases
NIMF	2018	NIM	Ame R	Fall	4	797,850	2,602,318	31%	In-basin	American River (Sunrise Recreation Area)
NIMFn	2018	NIM	Ame R	Fall	5	439,333	1,763,232	25%	Bay/Delta pens	San Pablo Bay (Mare Island) net pen releases
MOKF	2018	MOK	Mok R	Fall	2	398,991	400,493	100%	In-basin	Mokelumne River (Hatchery and Woodbridge Dam)
MOKFn	2018	MOK	Mok R	Fall	14	1,403,247	4,419,995	32%	Bay/Delta pens	Western Delta (Sherman Island) net pen releases
MOKFnc	2018	MOK	Mok R	Fall	1	119,614	120,518	99%	Coastal pens	Coastal (Santa Cruz) net pen releases
MOKFnp	2018	MOK	Mok R	Fall	1	754,295	758,085	100%	Coastal pens	Coastal (Pillar Point) net pen releases
MOKFgg	2018	MOK	Mok R	Fall	2	225,158	901,151	25%	Trucked	Golden Gate releases; trucked to Fort Baker
MERFn	2018	MER	Mer R	Fall	3	169,854	666,149	25%	Bay/Delta pens	Western Delta (Sherman Island) net pen releases
CFHL	2019	CFH	Sac R	Late	14	1,031,542	1,065,159	97%	In-basin	CFH (includes spring surrogate releases)

CWT release types:*Sacramento River fall Chinook release types (SFC)**

CFHF	Coleman National Fish Hatchery fall in-basin releases
CFHFn	Coleman National Fish Hatchery fall bay/delta net pen releases
FRHF	Feather River Hatchery fall in-basin releases
FRHFn	Feather River Hatchery fall bay/delta net pen releases
FRHFgg	Feather River Hatchery fall Golden Gate releases (no net pens)
FRHFc	Feather River Hatchery fall bay/delta trucked releases (no net pens)
NIMF	Nimbus Fish Hatchery fall in-basin releases
NIMFn	Nimbus Fish Hatchery fall bay/delta net pen releases
NIMFgg	Nimbus Fish Hatchery fall Golden Gate releases (no net pens)
NIMFc	Nimbus Fish Hatchery fall bay/delta trucked releases (no net pens)

Other CV Chinook release types (OCV)

MOKF	Mokelumne River Hatchery fall in-basin releases
MOKFn	Mokelumne River Hatchery fall bay/delta net pen releases
MOKFns	Mokelumne River Hatchery fall coastal net pen releases (Santa Cruz/Monterey)
MOKFnp	Mokelumne River Hatchery fall coastal net pen releases (Pillar Point)
MOKFgg	Mokelumne River Hatchery fall Golden Gate releases (no net pens)
MOKFc	Mokelumne River Hatchery fall bay/delta trucked releases (no net pens)
MOKFtc	Mokelumne River Hatchery fall coastal trucked releases (no net pens)
MERFn	Merced River Hatchery fall bay/delta net pen releases
SacW	Livingston Stone National Fish Hatchery winter in-basin releases
SacWbat	Livingston Stone National Fish Hatchery winter Battle Creek reintroduction releases
FRHS	Feather River Hatchery spring in-basin releases
FRHSn	Feather River Hatchery spring bay/delta net pen releases
SJOSx	San Joaquin Salmon Conservation and Research Facility spring reintroduction releases
CFHL	Coleman National Fish Hatchery late-fall in-basin releases

Table 3. Central Valley hatchery and natural area escapement estimates and sample data, 2023.

Central Valley Survey	Run	Total Escapement or Harvest	Chinook Sampled ^{a/}	Observed Ad-Clips	Heads Processed	Valid CWTs	Sample rate (fe)	Ad-clips processed (fa)	Valid CWTs (fd)	CWT F_{sample}
Hatchery Escapement										
Coleman National Fish Hatchery	Winter	55	55	55	44	42	1.000	0.800	1.000	1.25
Keswick Dam Fish Trap	Winter	507	507	274	272	268	1.000	0.993	0.989	1.02
Feather River Hatchery	Spring	1,529	1,529	1,030	1,030	1,002	1.000	1.000	0.993	1.01 ^{b/}
Coleman National Fish Hatchery	Fall	4,687	4,687	1,122	1,120	1,090	1.000	0.998	0.989	1.01
Feather River Hatchery	Fall	18,342	18,342	4,931	4,931	4,804	1.000	1.000	0.998	1.00
Nimbus Fish Hatchery	Fall	9,272	9,272	2,457	2,457	2,383	1.000	1.000	0.998	1.00
Mokelumne River Hatchery	Fall	9,866	9,866	2,589	2,589	2,533	1.000	1.000	0.999	1.00
Merced River Hatchery	Fall	894	894	261	261	249	1.000	1.000	0.996	1.00
Coleman National Fish Hatchery	Late-fall ^{c/}	2,870	2,870	2,860	2,854	2,805	1.000	0.998	0.993	0.99 ^{b/}
Coleman Hatchery Fish Trap ^{f/}	Late-fall ^{c/}	9	9	9	9	9	1.000	1.000	1.000	1.00
Keswick Dam Fish Trap ^{f/}	Late-fall ^{c/}	32	32	0	0	0	1.000	-	-	0.00
Total Hatchery Escapement		48,063	48,063	15,588	15,567	15,185				
Natural Area Escapement										
Upper Sacramento River (above Princeton)	Winter	1,920	480	110	109	94	0.250	0.991	0.989	4.25 ^{d/}
Upper San Joaquin River (above Merced R.) ^{f/}	Spring	3	3	3	3	3	1.000	1.000	1.000	0.50 ^{d/}
Upper Sacramento River (above Princeton)	Fall	3,560	203	49	49	47	0.057	1.000	1.000	23.12 ^{a/}
Clear Creek	Fall	1,110	118	34	34	32	0.106	1.000	0.970	9.05 ^{d/}
Battle Creek	Fall	1,255	0	Video - no biodata collected		294 ^{e/}	1.000	-	-	1.00
Cow Creek ^{f/}	Fall	195	2	Video - no CWTs observed		0	0.010	-	-	1.00
Cottonwood Creek ^{f/}	Fall	214	4	Video - opportunistic CWTs		0	0.019	-	-	1.00
Mill Creek ^{f/}	Fall	360	18	Video - opportunistic CWTs		3	0.050	1.000	0.750	26.67
Feather River	Fall	63,889	3,566	922	910	866	0.056	0.987	0.997	18.32 ^{d/}
Yuba River above DPD	Fall	4,359	4,347	960	27	27	0.997	0.028	1.000	35.65 ^{g/}
Yuba River below DPD	Fall	487	130	39	18	17	0.267	0.462	1.000	7.58 ^{d/}
American River ^{f/}	Fall	37,321	17,589	1,082	1,072	1,023	0.471	0.991	0.999	8.37
Mokelumne River	Fall	18,831	18,831	4,271	1,603	1,550	1.000	0.375	0.996	2.67 ^{g/}
Stanislaus River	Fall	1,623	444	123	123	117	0.274	1.000	1.000	2.62 ^{d/}
Tuolumne River	Fall	1,341	505	165	164	158	0.377	0.994	1.000	1.70 ^{d/}
Merced River	Fall	2,371	714	208	206	193	0.301	0.990	0.995	2.05 ^{d/}
Upper Sacramento River (above Princeton)	Late-fall ^{c/}	1,506	285	37	36	29	0.189	0.973	0.967	5.87 ^{a/}
Total Natural Area Escapement		140,345	47,239	8,003	4,354	4,453				
Total Sampled			95,302	23,591	19,921	19,638				

a/ Number of Chinook salmon sampled and visually checked for a clipped adipose fin or electronically scanned to check for the presence of a CWT.

b/ As calculated, the value for F_{sample} resulted in a hatchery contribution greater than 100%, so it was adjusted downward until the hatchery contribution equaled 100%.

c/ Late-fall-run hatchery returns and natural area escapement occurred during late-fall of 2022 through early 2023 (return year 2023).

d/ Carcass survey sample expansion factor based on fresh fish only and expanded to all valid CWT recoveries if collected (see Appendix 1).

e/ Battle Creek fall natural escapement estimated using video count minus fall return to Coleman National Fish Hatchery (CFH). Surrogate CWTs based on CFH hatchery proportion and CWT recoveries.

f/ Due to the low sample rate and paucity of CWTs collected, this sector has been excluded from further analyses in this report.

g/ Natural area escapement CWTs collected on spawning grounds and expanded based on total ad-clip count observed via video weir (see Appendices 5 and 6).

h/ Prior versions of this report have evaluated "washbacks" on the Nimbus Fish Hatchery weir separately from the American River carcass survey downstream of the weir. Beginning in 2018, these two sectors were merged and one natural area escapement estimate is now calculated for the entire American Basin.

Table 4. Total harvest and sample data for 2023 ocean salmon sport and commercial fisheries by major port area.^{b/}

Fishery - Port Area	Ocean Harvest	Chinook Sampled ^{a/}	Observed Ad-Clips	Heads Processed	Valid CWTs	Sample rate (fe)	Ad-clips processed (fa)	Valid CWTs (fd)	CWT F_{samp}
Oregon Sport	1,728	487	32	32	31	0.282	1.000	1.000	3.55
Oregon Commercial	1,461	396	231	231	225	0.271	1.000	0.983	3.75
Oregon Total	3,189	883	263	263	256				

a/ Number of salmon visually checked for a clipped adipose fin or electronically scanned to check for the presence of a CWT.

Table 5. Raw and expanded Chinook CWT recoveries in the Central Valley by run type and brood year during 2023^{a/}.

<u>Fall-run</u>		2021	2020	2019	2018	Total CV CWTs	Total CV %
Age		2	3	4	5		
Raw CWT Recoveries		2,230 (15%)	11,369 (77%)	1,224 (8%)	5 (<1%)	14,828	76%
Expanded CWT _{total}		14,690 (9%)	129,142 (82%)	14,090 (9%)	17 (<1%)	157,939	96%
<u>Spring-run</u>		2021	2020	2019	2018	Total CV CWTs	Total CV %
Age		2	3	4	5		
Raw CWT Recoveries		180 (12%)	1,320 (85%)	55 (4%)	3 (<1%)	1,558	8%
Expanded CWT _{total}		340 (11%)	2,742 (85%)	143 (4%)	3 (<1%)	3,227	2%
<u>Late-fall-run</u>		2022	2021	2020	2019	Total CV CWTs	Total CV %
Age		2	3	4	5		
Raw CWT Recoveries		92 (3%)	2,231 (78%)	525 (18%)	1 (<1%)	2,849	15%
Expanded CWT _{total}		100 (3%)	2,327 (77%)	587 (19%)	1 (<1%)	3,015	2%
<u>Winter-run</u>		2021	2020	2019	2018	Total CV CWTs	Total CV %
Age		2	3	4	5		
Raw CWT Recoveries		28 (7%)	371 (92%)	5 (1%)		404	2%
Expanded CWT _{total}		32 (4%)	685 (94%)	9 (1%)		726	0.4%
<u>All Runs</u>		2021	2020	2019	2018	Total CV CWTs	Total CV %
Age		2	3	4	5		
Raw CWT Recoveries		2,530 (13%)	15,291 (78%)	1,809 (9%)	9 (<1%)	19,639	100%
Expanded CWT _{total}		15,162 (9%)	134,897 (82%)	14,828 (9%)	20 (<1%)	164,907	100%

a/ Recoveries of age-1, age-6+, and tagged natural-origin fish removed.

Table 6. Raw and expanded Chinook CWT recoveries in 2023 Oregon ocean fisheries by run type and brood year^{a/}.

<u>Fall-run</u>		2021	2020	2019	2018	Total Ocean CWTs	Total Ocean %
Age		2	3	4	5		
Raw CWT Recoveries		3 (60%)	2 (40%)			5	2%
Expanded CWT _{total}		61 (66%)	31 (34%)			92	7%
<u>Spring-run</u>		2021	2020	2019	2018	Total Ocean CWTs	Total Ocean %
Age		2	3	4	5		
Raw CWT Recoveries		1 (100%)				1	0%
Expanded CWT _{total}		5 (100%)				5	0%
<u>Non-CV stocks</u>		2021	2020	2019	2018	Total Ocean CWTs	Total Ocean %
Age		2	3	4	5		
Raw CWT Recoveries		1 (<1%)	30 (12%)	206 (83%)	11 (4%)	248	98%
Expanded CWT _{total}		300 (25%)	120 (10%)	731 (62%)	26 (2%)	1,176	92%
<u>All Runs</u>		2021	2020	2019	2018	Total Ocean CWTs	Total Ocean %
Age		2	3	4	5		
Raw CWT Recoveries		5 (2%)	32 (13%)	206 (81%)	11 (4%)	254	100%
Expanded CWT _{total}		366 (29%)	151 (12%)	731 (57%)	26 (2%)	1,273	100%
CV Expanded CWT _{total} (Proportion CV stocks)		66 (18%)	31 (21%)			97	8%

a/ Recoveries of age-1, age-6+, and tagged natural-origin fish removed.

Table 7. Percentage^{a/} of inland CWT_{total} recoveries by location, run, and release type^{b/} in hatchery returns and natural escapement during 2023.

			CFH			FRH						NIM				MOK					MER	SJO	Non-CV	Total %		Total	
Location	Run	SacW	CFHL	CFHF	CFHF _n	FRHS	FRHS _n	FRHF	FRHF _n	FRHF _{egg}	FRHF _t	NIMF	NIMF _n	NIMF _{egg}	NIMF _t	MOKF _n	MOKF _{np}	MOKF _{egg}	MOKF _t	MOKF _{tc}	MERF _n	SJOS _x		Hatchery	Natural	Run	
Hatchery Spawners																											
Coleman National Fish Hatchery	Winter	96%																							96%	4%	55
Keswick Dam Fish Trap	Winter	54%																							54%	46%	507
Feather River Hatchery	Spring					64%	5%			2%	1%														70%	30%	1,529
Coleman National Fish Hatchery	Fall		0%	79%	1%					0%	0%		0%	0%		0%	0%	0%		0%					81%	19%	4,687
Feather River Hatchery	Fall			0%	0%	2%	1%	0%	25%	19%	47%		0%	0%	0%	0%	1%	1%		0%	0%				97%	3%	18,342
Nimbus Fish Hatchery	Fall				2%				1%	1%	2%	2%	41%	7%	22%	4%	6%	6%		2%	1%				96%	4%	9,272
Mokelumne River Hatchery	Fall		0%		1%				0%	0%	0%	0%	17%	3%	9%	33%	9%	18%	0%	2%	1%				96%	4%	9,866
Merced River Hatchery	Fall		0%		1%				0%		1%		1%		0%	40%	20%	15%		3%	9%	0%			91%	9%	894
Coleman National Fish Hatchery	Late-fall ^{d/}	99%														0%									99%	1%	2,870
Total Hatchery Fall-run			0%	9%	1%	1%	0%	0%	11%	8%	21%	0%	13%	2%	7%	9%	4%	6%	0%	1%	1%	0%		95%	5%	43,061	
Natural Spawners																											
Upper Sacramento River	Winter	21%																							21%	79%	1,920
Upper Sacramento River	Fall			22%	3%					13%	3%		18%			3%	23%	3%		2%					90%	10%	3,560
Clear Creek	Fall			10%	3%					7%	7%	3%	7%	3%	3%	7%	7%	13%		5%					71%	29%	1,110
Battle Creek ^{d/}	Fall			79%	1%						0%	0%	0%	0%	0%	0%	0%	0%		0%					81%	19%	1,255
Feather River	Fall				1%	2%	0%	0%	28%	15%	38%		1%	0%	0%	1%	1%	1%		1%	0%				90%	10%	63,889
Yuba River above DPD	Fall				3%					17%	3%	27%		13%		13%	3%	7%		1%					87%	13%	4,359
Yuba River below DPD	Fall					2%				13%		44%		6%	6%	13%	6%	6%		2%					97%	3%	487
American River	Fall				8%		0%		2%	1%	2%	2%	44%	6%	18%	2%	2%	3%		1%	1%				90%	10%	37,321
Mokelumne River	Fall		0%		2%				0%	0%	0%		24%	5%	13%	16%	7%	12%	0%	1%	1%				83%	17%	18,831
Stanislaus River	Fall				3%								7%	1%	4%	33%	10%	10%		1%	1%				70%	30%	1,623
Tuolumne River	Fall		0%	1%	2%					1%			5%	2%	3%	35%	2%	14%	1%	1%	4%	1%			71%	29%	1,341
Merced River	Fall				0%				1%	0%	1%	0%	1%		1%	23%	12%	8%		3%	4%	0%			55%	45%	2,371
Upper Sacramento River	Late-fall ^{d/}		10%		2%								2%	2%			2%			0%					16%	84%	1,506
Total Natural Area Fall-run			0%	1%	3%	1%	0%	0%	14%	7%	19%	1%	17%	2%	7%	5%	3%	4%	0%	1%	0%	0%		88%	12%	136,147	
In-basin CWT _{total}	All	0%	2%	4%	0%	2%	0%	0%	15%	9%	23%	1%	13%	2%	6%	4%	1%	3%	0%	0%	0%				85%	15%	151,602
Stray CWT _{total}	All		0%	0%	13%		0%		4%	1%	3%	0%	23%	4%	11%	13%	11%	10%	0%	3%	2%	0%			100%		35,993
Total CV Spawners		0%	2%	3%	3%	2%	0%	0%	13%	7%	19%	1%	15%	2%	7%	6%	3%	4%	0%	1%	0%	0%		88%	12%	187,595	

a/ Any non-zero values less than 0.5% of CWT_{total} are displayed as 0%.

b/ Release types defined in Table 3; SacWbat recoveries merged with SacW.

c/ Late-fall-run hatchery returns and natural area escapement occurred during late-fall of 2023 through early 2024 (return year 2024).

d/ Battle Creek natural area escapement CWT_{total} based on hatchery proportions at CFH (FWS staff, per. comm).

Table 8. Total inland CWT_{total} recoveries by location, run, and release type^{a/} in hatchery returns and natural escapement during 2023.

			CFH			FRH						NIM				MOK					MER	SJO	Non-	Total CWT _{total}		Total	
Location	Run	SacW	CFHL	CFHF	CFHF _n	FRHS	FRHS _n	FRHF	FRHF _n	FRHF _{egg}	FRHF _t	NIMF	NIMF _n	NIMF _{egg}	NIMF _t	MOKF _n	MOKF _{np}	MOKF _{egg}	MOKF _t	MOKF _{tc}	MERF _n	SJOS _x	CV	Hatchery	Natural	Run	
Hatchery Spawners																											
Coleman National Fish Hatchery	Winter	53																							53	2	55
Keswick Dam Fish Trap	Winter	274																							274	233	507
Feather River Hatchery	Spring					973	71			25	8														1,077	452	1,529
Coleman National Fish Hatchery	Fall		1	3,696	29					4	8		8	4		16	12	16		3					3,797	890	4,687
Feather River Hatchery	Fall			6	81	363	154	32	4,596	3,486	8,619		52	4	20	60	221	112		54	5				17,865	477	18,342
Nimbus Fish Hatchery	Fall				215				105	89	189	163	3,834	682	2,005	361	510	524		149	90				8,916	356	9,272
Mokelumne River Hatchery	Fall		6		113				28	24	21	4	1,669	329	928	3,231	923	1,802	48	206	98				9,430	436	9,866
Merced River Hatchery	Fall		1		8				4		8		12		8	357	177	136		27	77	1			816	78	894
Coleman National Fish Hatchery	Late-fall ^{b/}		2,845													4									2,849	21	2,870
Total Hatchery Fall-run			8	3,702	446	363	154	32	4,733	3,603	8,845	167	5,575	1,019	2,961	4,025	1,843	2,590	48	439	270	1			40,824	2,237	43,061
Natural Spawners																											
Upper Sacramento River	Winter	400																							400	1,520	1,920
Upper Sacramento River	Fall			792	93				467	94			653			93	836	93		69					3,190	370	3,560
Clear Creek	Fall			110	37				73		73		73	36	36	73	73	145		54					783	327	1,110
Battle Creek ^{c/}	Fall			988	8					1	2		2	1		4	3	4		1					1,014	241	1,255
Feather River	Fall				816	1,549	74	147	17,582	9,591	24,130	443	73	147		662	957	807		513	38				57,529	6,360	63,889
Yuba River above DPD	Fall				145				720	145	1,166		574			575	143	285		36					3,789	570	4,359
Yuba River below DPD	Fall					8			61		216			30	30	61	30	30		8					474	13	487
American River	Fall				2,877			23	607	204	819	781	16,361	2,215	6,901	840	605	1,073		203	208				33,717	3,604	37,321
Mokelumne River	Fall		5		422				65	33	54		4,608	953	2,510	3,012	1,254	2,320	64	281	101				15,682	3,149	18,831
Stanislaus River	Fall				43								116	11	63	537	158	168		24	24				1,144	479	1,623
Tuolumne River	Fall		3	7	28					14			68	27	34	465	27	191	7	17	59	9			956	385	1,341
Merced River	Fall				8				17	8	25	8	25		25	552	288	189		68	100	2			1,315	1,056	2,371
Upper Sacramento River	Late-fall ^{b/}		144		24								24	24			24			6					246	1,260	1,506
Total Natural Area Fall-run			8	1,897	4,477	1,557	97	147	19,592	10,090	26,485	789	22,923	3,346	9,746	6,874	4,374	5,305	71	1,274	530	11			119,593	16,554	136,147
In-basin CWT _{total}	All	727	2,990	5,476	154	2,893	299	179	22,959	13,247	34,139	944	20,195	2,897	8,906	6,243	2,177	4,122	112	487	177				129,323	22,279	151,602
Stray CWT _{total}	All		15	123	4,793		23		1,366	471	1,199	12	8,327	1,492	3,801	4,660	4,064	3,773	7	1,232	623	12			35,993		35,993
Total CV Spawners		727	3,005	5,599	4,947	2,893	322	179	24,325	13,718	35,338	956	28,522	4,389	12,707	10,903	6,241	7,895	119	1,719	800	12			165,316	22,279	187,595
% stray			0.5%	2%	97%		7.1%		6%	3%	3%	1.3%	29%	34%	30%	43%	65%	48%	6%	72%	78%	100%			22%		19%

a/ Release types defined in Table 3; SacWbat recoveries merged with SacW.

b/ Late-fall-run hatchery returns and natural area escapement occurred during late-fall of 2023 through early 2024 (return year 2023).

c/ Battle Creek natural area escapement CWT_{total} based on hatchery proportions at CFH (FWS staff, per. comm).

Table 9. CWT recovery rate (recoveries per 100,000 CWTs released) by release type, brood year and recovery location in 2023. (Page 1 of 2)

Age-2 CWT recoveries

Release type	Brood year	Run type	# CWT tagged	Central Valley total recoveries (CWT _{sample}) by basin										CV CWT _{sample} totals			% CV Stray	Ocean CWT _{sample}	Recovery rate per 100K released			
				Bat Cr	Up Sac	Nat crks ^{a/}	Fea	Yub	Ame	Mok	Sta/Tuo	Mer	Up SJ	In-basin	Stray	CV total			In-basin	Stray	CV total	Ocean
SacW ^{b/}	2021	Wint	515,191	32										32	0	32	0%	0	6	0	6	0
SacWbat ^{b/}	2021	Wint	130,056											0	0	0	-	0	0	0	0	0
FRHS	2021	Spr	719,565	9										9	0	9	0%	0	1	0	1	0
FRHSn	2021	Spr	708,572	221 17										221	17	238	7%	4	31	2	34	1
SJOSx	2021	Spr	224,446											0	0	0	-	0	0	0	0	0
CFHF	2021	Fall	3,261,039	69										69	0	69	0%	0	2	0	2	0
FRHFn	2021	Fall	415,681	223 28 1										223	29	252	12%	0	54	7	61	0
FRHFgg	2021	Fall	505,955	159 17 4 2 2										159	25	184	13%	0	31	5	36	0
FRHFt	2021	Fall	1,400,256	730 36 95 4 3										766	102	867	12%	6	55	7	62	0
NIMFn	2021	Fall	506,558	18 1 586 81										586	99	686	15%	6	116	20	135	1
NIMFt	2021	Fall	655,144	18 304 37 5 1										304	61	365	17%	0	46	9	56	0
MOKFn	2021	Fall	873,793	5		9	40	8	115	474	42	20		474	239	712	33%	3	54	27	82	0
MOKFnp	2021	Fall	187,417		18				36	83		7		83	61	144	42%	0	44	33	77	0
MOKFgg	2021	Fall	541,032	5			63		77	276	9	7		276	161	437	37%	0	51	30	81	0
MOKFtc	2021	Fall	320,981	1			1		37	52	3	1		52	44	96	46%	0	16	14	30	0
MERFn	2021	Fall	88,084				38		52	54	15	48		48	159	208	77%	0	55	181	236	0
CFHL	2022	Late	837,377	90	6									96	0	96	0%	0	12	0	12	0
Total			11,891,147	170	73	9	1,503	43	1,365	1,065	77	90		3,399	996	4,395	23%	19				

Age-3 CWT recoveries

Release type	Brood year	Run type	# CWT tagged	Central Valley total recoveries (CWT _{sample}) by basin										CV CWT _{sample} totals			% CV Stray	Ocean CWT _{sample}	Recovery rate per 100K released			
				Bat Cr	Up Sac	Nat crks ^{a/}	Fea	Yub	Ame	Mok	Sta/Tuo	Mer	Up SJ	In-basin	Stray	CV total			In-basin	Stray	CV total	Ocean
SacW ^{b/}	2020	Wint	302,805	1	628									628	1	630	0%	0	208	0	208	0
SacWbat ^{b/}	2020	Wint	212,751	50	5									50	5	55	10%	0	24	3	26	0
FRHS	2020	Spr	993,132				2,673	8						2,681	0	2,681	0%	0	270	0	270	0
SJOSx	2020	Spr	206,180								9	1		0	10	10	100%	0	0	5	5	0
CFHF	2020	Fall	3,278,256	1,034	266	135	2							1,301	137	1,437	10%	0	40	4	44	0
CFHFn	2020	Fall	219,750	9	24	9	222	36	764	132	17	4		33	1,184	1,217	97%	0	15	539	554	0
FRHFn	2020	Fall	642,114		53	9	3,932	150	138	18		5		4,082	224	4,306	5%	0	636	35	671	0
FRHFgg	2020	Fall	241,688	1	18		3,069	36	55	10	2			3,105	86	3,191	3%	0	1,285	36	1,320	0
FRHFt	2020	Fall	677,565	3		18	7,417	303	172	16		5		7,720	214	7,933	3%	2	1,139	32	1,171	0
NIMFn	2020	Fall	507,267	3	77	19	120	143	3,785	1,437	46	9		3,785	1,853	5,638	33%	6	746	365	1,112	1
NIMFgg	2020	Fall	169,117	1	6	9	19	8	722	320	9			722	372	1,095	34%	0	427	220	647	0
NIMFt	2020	Fall	335,371			9	23	8	1,911	819	19	7		1,911	885	2,796	32%	0	570	264	834	0
MOKFn	2020	Fall	889,472		18	36	120	150	161	867	181	192		867	857	1,724	50%	0	98	96	194	0
MOKFnp	2020	Fall	185,794	4	148	18	275	43	194	368	43	109		368	833	1,201	69%	0	198	448	646	0
MOKFgg	2020	Fall	494,114		18	36	165	79	251	567	63	65		567	676	1,243	54%	0	115	137	252	0
MOKFt	2020	Fall	124,689							28	2			28	2	30	6%	0	23	1	24	0
MOKFtc	2020	Fall	322,878	3	59	54	565	43	283	416	37	94		416	1,138	1,554	73%	0	129	353	481	0
MERFn	2020	Fall	74,909				1		67	40	17	33		33	125	158	79%	0	43	167	210	0
CFHL	2021	Late	1,009,914	2,192	65					6	2	1		2,257	8	2,265	0%	0	224	1	224	0
Total			10,887,766	3,301	1,385	353	18,603	1,005	8,503	5,044	446	524		30,552	8,611	39,163	22%	8				

Table 9. CWT recovery rate (recoveries per 100,000 CWTs released) by release type, brood year and recovery location in 2023. (Page 2 of 2)

Age-4 CWT recoveries				Central Valley total recoveries (CWT _{samp}) by basin										CV CWT _{samp} totals			% CV	Ocean	Recovery rate per 100K released			
Release type	Brood year	Run type	# CWT tagged	Bat Cr	Up Sac	Nat crks ^{a/}	Fea	Yub	Ame	Mok	Sta/Tuo	Mer	Up SJ	In-basin	Stray	CV total	Stray	CWT _{samp}	In-basin	Stray	CV total	Ocean
SacW ^{b/}	2019	Wint	247,216		7									7	0	7	0%	0	3	0	3	0
SacWbat ^{b/}	2019	Wint	165,858	1										1	0	1	0%	0	1	0	1	0
FRHS	2019	Spr	1,771,532				139							139	0	139	0%	0	8	0	8	0
SJOSx	2019	Spr	232,903									2	1	1	2	3	67%	0	0	1	1	0
CFHF	2019	Fall	3,352,800	251	71		1				2			322	3	325	1%	0	10	0	10	0
FRHF	2019	Fall	248,810				45							45	0	45	0%	0	18	0	18	0
FRHFn	2019	Fall	1,335,074		36	9	1,345	43	10	4				1,388	59	1,447	4%	0	104	4	108	0
NIMF	2019	Fall	796,467						243	1		2		243	3	246	1%	0	31	0	31	0
NIMFn	2019	Fall	453,171		36		2		651	42				651	80	731	11%	0	144	17.6	161	0
MOKFn	2019	Fall	1,068,378	1			20		24	215	26	14		215	86	300	28%	0	20	8	28	0
MOKFnp	2019	Fall	192,201				18		47	91	3			91	69	161	43%	0	48	36	84	0
MOKFgg	2019	Fall	486,615				2		71	186	18	9		186	100	287	35%	0	38	21	59	0
MOKFtc	2019	Fall	316,528				1		29	18				18	30	48	63%	0	6	10	15	0
MERFn	2019	Fall	109,375						2		2	3		3	4	7	55%	0	3	3	6	0
CFHL	2020	Late	872,269	503	70					6	2			573	7	581	1%	0	66	1	67	0
Total				756	220	9	1,573	43	1,078	563	52	31	1	3,884	443	4,326	10%	0				

Age-5 CV recoveries (only release types with recoveries in 2022 are displayed)

Release type	Brood year	Run type	# CWT tagged	Central Valley total recoveries (CWT _{samp}) by basin										CV CWT _{samp} totals			% CV	Ocean	Recovery rate per 100K released			
				Bat Cr	Up Sac	Nat crks ^{a/}	Fea	Yub	Ame	Mok	Sta/Tuo	Mer	Up SJ	In-basin	Stray	CV total	Stray	CWT _{samp}	In-basin	Stray	CV total	Ocean
FRHS	2018	Spr	1,831,043				2							2	0	2	0%	0	0	0	0	0
SJOSx	2018	Spr	216,845										1	1	0	1	0%	0	0	0	0	0
CFHF	2018	Fall	3,448,504	5										5	0	5	0%	0	0	0	0	0
CFHL	2019	Late	1,031,542	1										1	0	1	0%	0	0	0	0	0

a/ Natural creeks can include Clear Creek, Cow Creek, Cottonwood Creek, Paynes Creek, Mill Creek, Deer Creek, and Butte Creek, depending on survey year.

b/ Ocean recoveries of SacW and SacWbat are considered one year older than those of the same brood year recovered in the CV (i.e., brood year 2021 = age-3 in the ocean).

Sacramento River fall Chinook release types (SFC)

CFHF	Coleman National Fish Hatchery fall in-basin releases
CFHFn	Coleman National Fish Hatchery fall bay/delta net pen releases
FRHF	Feather River Hatchery fall in-basin releases
FRHFn	Feather River Hatchery fall bay/delta net pen releases
FRHFgg	Feather River Hatchery fall Golden Gate releases (no net pens)
FRHFt	Feather River Hatchery fall bay/delta trucked releases (no net pens)
NIMF	Nimbus Fish Hatchery fall in-basin releases
NIMFn	Nimbus Fish Hatchery fall bay/delta net pen releases
NIMFgg	Nimbus Fish Hatchery fall Golden Gate releases (no net pens)
NIMFt	Nimbus Fish Hatchery fall bay/delta trucked releases (no net pens)

Other CV Chinook release types (OCV)

MOKFn	Mokelumne River Hatchery fall bay/delta net pen releases
MOKFnp	Mokelumne River Hatchery fall coastal net pen releases (Pillar Point)
MOKFgg	Mokelumne River Hatchery fall Golden Gate releases (no net pens)
MOKFt	Mokelumne River Hatchery fall bay/delta trucked releases (no net pens)
MOKFtc	Mokelumne River Hatchery fall coastal trucked releases (no net pens)
MERFn	Merced River Hatchery fall bay/delta net pen releases
SacW	Livingston Stone National Fish Hatchery winter in-basin releases
SacWbat	Livingston Stone National Fish Hatchery winter Battle Creek reintroduction releases
FRHS	Feather River Hatchery spring in-basin releases
FRHSn	Feather River Hatchery spring bay/delta net pen releases
SJOSx	San Joaquin Salmon Conservation and Research Facility spring reintroduction releases
CFHL	Coleman National Fish Hatchery late-fall in-basin releases

Table 10. Total and Percentage^{a/} of CWT_{total} recoveries by fishery and release type^{b/} in the 2023 Oregon ocean salmon fisheries.

CFH				FRH						NIM				MOK					MER	SJO	Non-CV	Total CV	Total CWT _{total}		Total	
SacW	CFHL	CFHF	CFHFn	FRHS	FRHSn	FRHF	FRHFn	FRHFgg	FRHFt	NIMF	NIMFn	NIMFgg	NIMFt	MOKFn	MOKFnp	MOKFgg	MOKFt	MOKFtc	MERFn	SJOSx			Hatchery	Natural	Harvest	
Oregon Sport Harvest (South of Cape Falcon)																					455	91	545	1,183	1,728	
					5				25		49			12								26%	5%	32%	68%	
					0%				1%		3%			1%												
Oregon Commercial Harvest (South of Cape Falcon)																					722	6	728	733	1,461	
									6													49%	0%	50%	50%	

a/ Any non-zero values less than 0.5% of CWT_{total} are displayed as 0%.
b/ Release types defined in Table 3; SacWbat recoveries merged with SacW.

Table 11. CWT recovery rate (recoveries per 100,000 CWTs released) for experimental & net pen release types in 2023.

Age-2 CWT recoveries

Release type	Brood year	Run type	# CWT tagged	Central Valley total recoveries (CWT _{samp}) by basin									CV CWT _{samp} totals			% CV Stray	Ocean CWT _{samp}	Recovery rate per 100K released			
				Bat Cr	Up Sac	Nat crks ^{a/}	Fea	Yub	Ame	Mok	Sta/Tuo	Mer	In-basin	Stray	CV total			In-basin	Stray	CV total	Ocean
FRHFn	2021	Fall	415,681				223		28	1			223	29	252	12%	0	54	7	61	0
FRHFgg	2021	Fall	505,955				159		17	4	2	2	159	25	184	13%	0	31	5	36	0
NIMFn	2021	Fall	506,558		18		1		586	81			586	99	686	15%	6	116	20	135	1
MOKFn	2021	Fall	873,793	5		9	40	8	115	474	42	20	474	239	712	33%	3	54	27	82	0
MOKFnp	2021	Fall	187,417		18				36	83		7	83	61	144	42%	0	44	33	77	0
MOKFgg	2021	Fall	541,032	5			63		77	276	9	7	276	161	437	37%	0	51	30	81	0
MERFn	2021	Fall	88,084				38		52	54	15	48	48	159	208	77%	0	55	181	236	0

Age-3 CWT recoveries

Release type	Brood year	Run type	# CWT tagged	Central Valley total recoveries (CWT _{samp}) by basin									CV CWT _{samp} totals			% CV	Ocean CWT _{samp}	Recovery rate per 100K released			
				Bat Cr	Up Sac	Nat crks ^{a/}	Fea	Yub	Ame	Mok	Sta/Tuo	Mer	In-basin	Stray	CV total	Stray		In-basin	Stray	CV total	Ocean
CFHFn	2020	Fall	219,750	9	24	9	222	36	764	132	17	4	33	1,184	1,217	97%	0	15	539	554	0
FRHFn	2020	Fall	642,114		53	9	3,932	150	138	18		5	4,082	224	4,306	5%	0	636	35	671	0
NIMFn	2020	Fall	507,267	3	77	19	120	143	3,785	1,437	46	9	3,785	1,853	5,638	33%	6	746	365	1,112	1
NIMFgg	2020	Fall	169,117	1	6	9	19	8	722	320	9		722	372	1,095	34%	0	427	220	647	0
MOKFn	2020	Fall	889,472		18	36	120	150	161	867	181	192	867	857	1,724	50%	0	98	96	194	0
MOKFnp	2020	Fall	185,794	4	148	18	275	43	194	368	43	109	368	833	1,201	69%	0	198	448	646	0
MOKFgg	2020	Fall	494,114		18	36	165	79	251	567	63	65	567	676	1,243	54%	0	115	137	252	0
MERFn	2020	Fall	74,909				1		67	40	17	33	33	125	158	79%	0	43	167	210	0

Age-4 CWT recoveries

Release type	Brood year	Run type	# CWT tagged	Central Valley total recoveries (CWT _{samp}) by basin									CV CWT _{samp} totals			% CV	Ocean CWT _{samp}	Recovery rate per 100K released				
				Bat Cr	Up Sac	Nat crks ^{a/}	Fea	Yub	Ame	Mok	Sta/Tuo	Mer	In-basin	Stray	CV total	Stray		In-basin	Stray	CV total	Ocean	
FRHFn	2019	Fall	1,335,074	1	36	9	1,345	43	10	4			1,388	59	1,447	4%	0	104	4	108	0	
NIMFn	2019	Fall	453,171		36			2		651	42			651	80	731	11%	0	144	18	161	0
MOKFn	2019	Fall	1,068,378					20		24	215	26	14	215	86	300	28%	0	20	8	28	0
MOKFnp	2019	Fall	192,201					18		47	91	3		91	69	161	43%	0	48	36	84	0
MOKFgg	2019	Fall	486,615					2		71	186	18	9	186	100	287	35%	0	38	21	59	0
MERFn	2019	Fall	109,375							2		2	3	3	4	7	55%	0	3	3	6	0

a/ Natural creeks can include Clear Creek, Cow Creek, Cottonwood Creek, Paynes Creek, Mill Creek, Deer Creek, and Butte Creek, depending on survey year.

Central Valley fall Chinook experimental and net pen release types:

CFHFn Coleman National Fish Hatchery fall bay/delta net pen releases
FRHFn Feather River Hatchery fall bay/delta net pen releases
FRHFgg Feather River Hatchery fall Golden Gate releases (no net pen acclimation)
NIMFn Nimbus Fish Hatchery fall bay/delta net pen releases
NIMFgg Nimbus Fish Hatchery fall Golden Gate releases (no net pen acclimation)

MOKFn Mokelumne River Hatchery fall bay/delta net pen releases
MOKFnp Mokelumne River Hatchery fall coastal net pen releases (Pillar Point)
MOKFgg Mokelumne River Hatchery fall Golden Gate releases (no net pen acclimation)
MERFn Merced River Hatchery fall bay/delta net pen releases

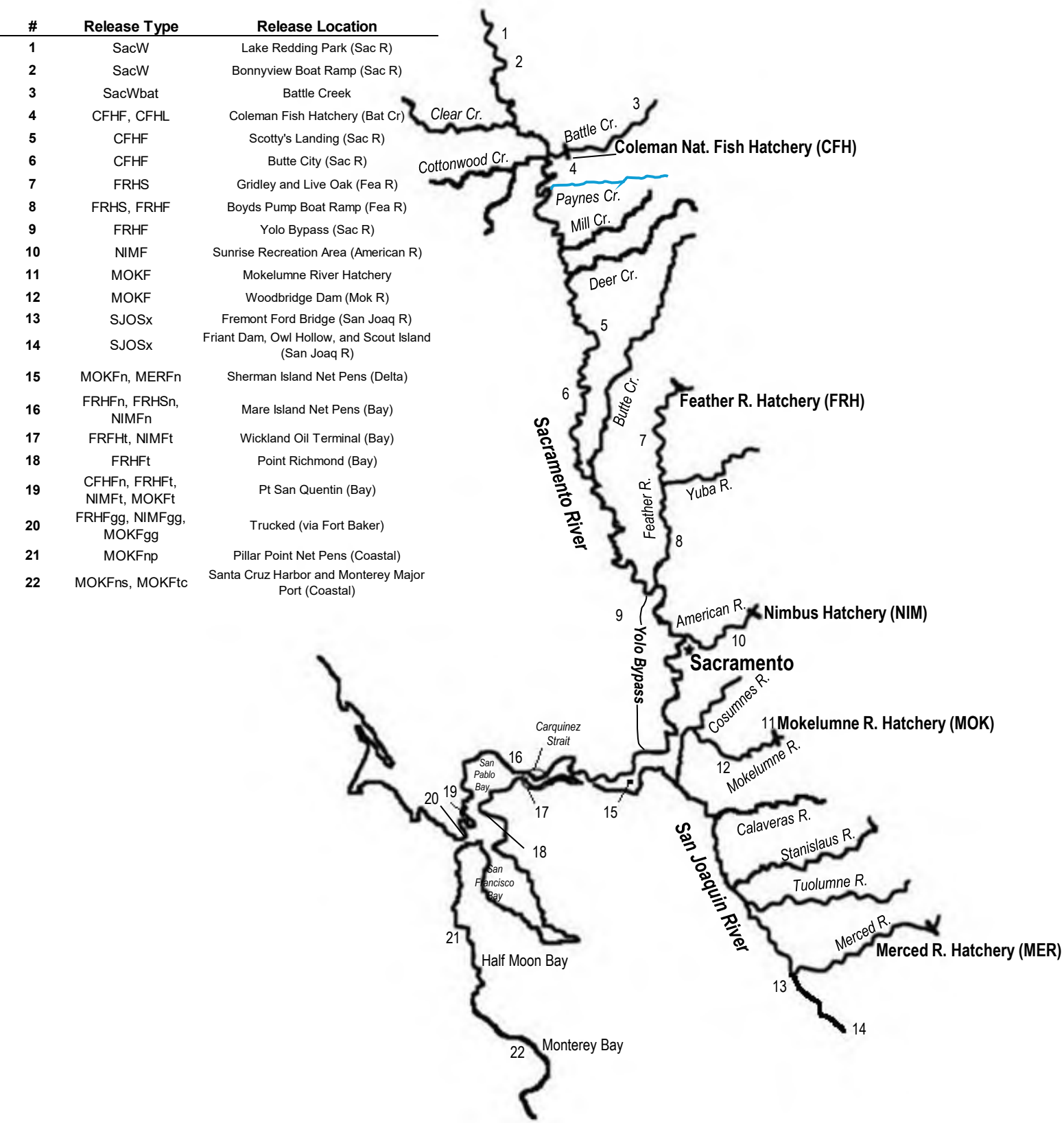


Figure 1. Map of release sites for CV hatchery release types, brood years 2018-2021.

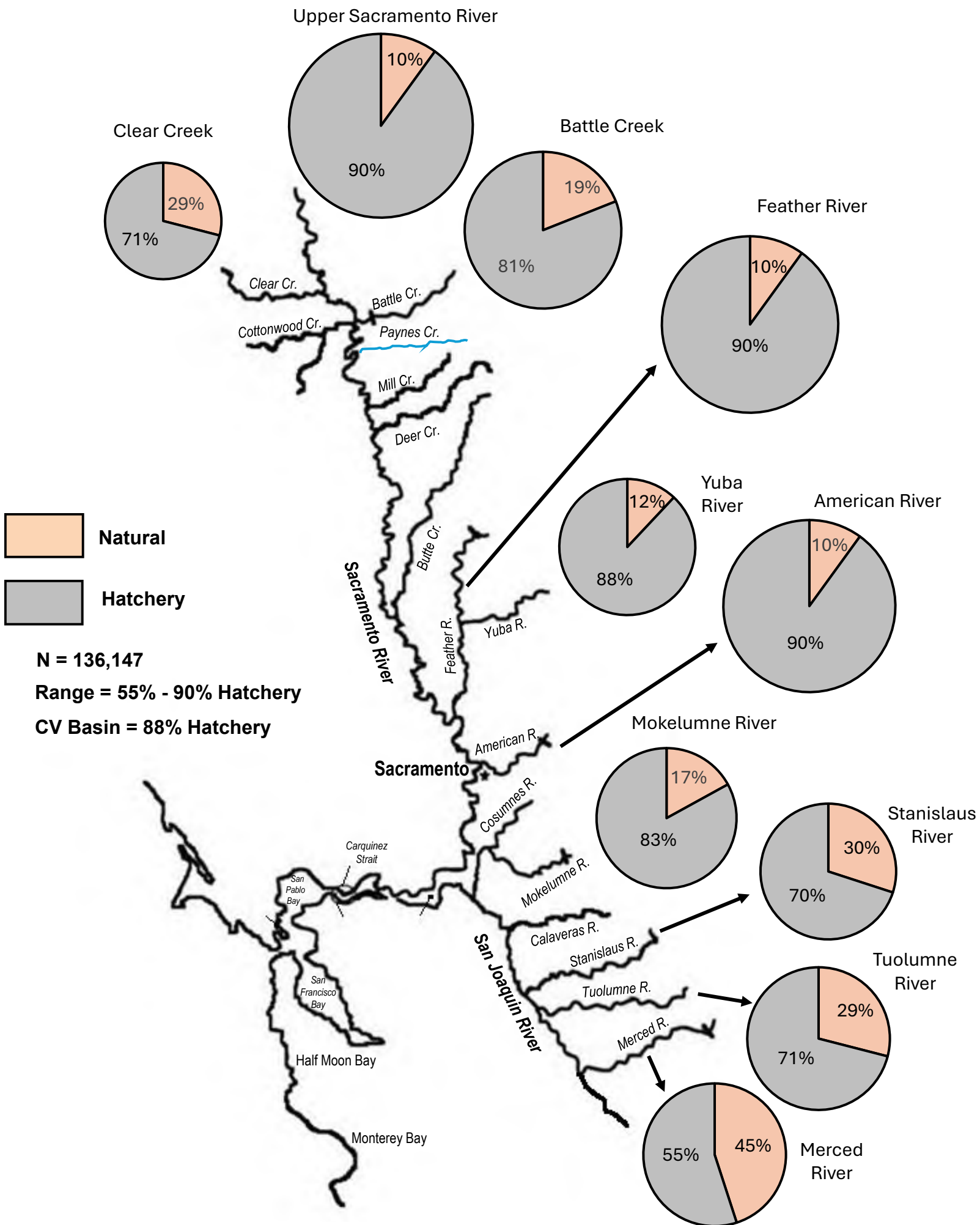


Figure 2. Fall-run CV natural area escapement, hatchery and natural proportions, 2023.

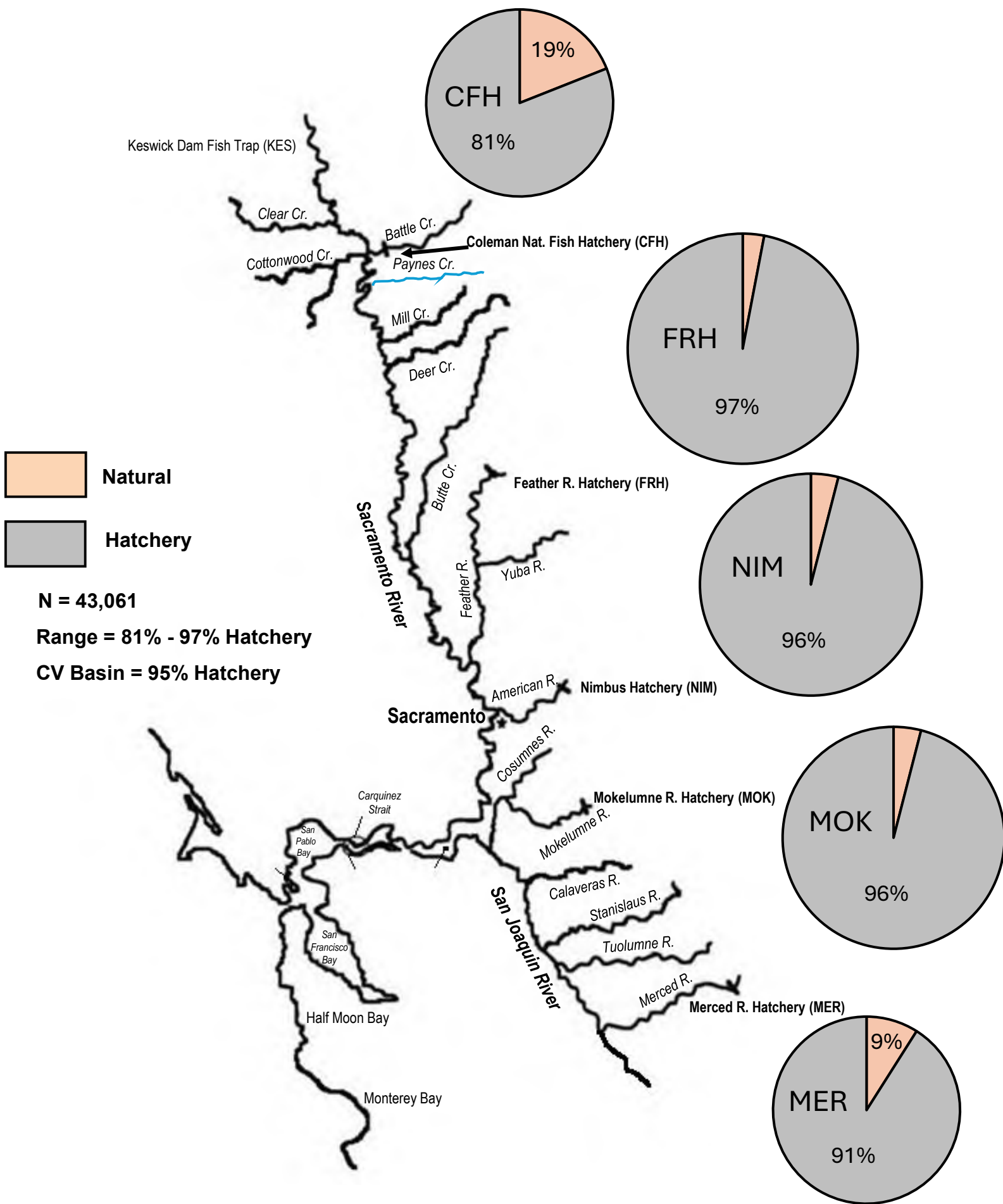


Figure 3. Fall-run CV hatchery escapement, hatchery and natural proportions, 2023.

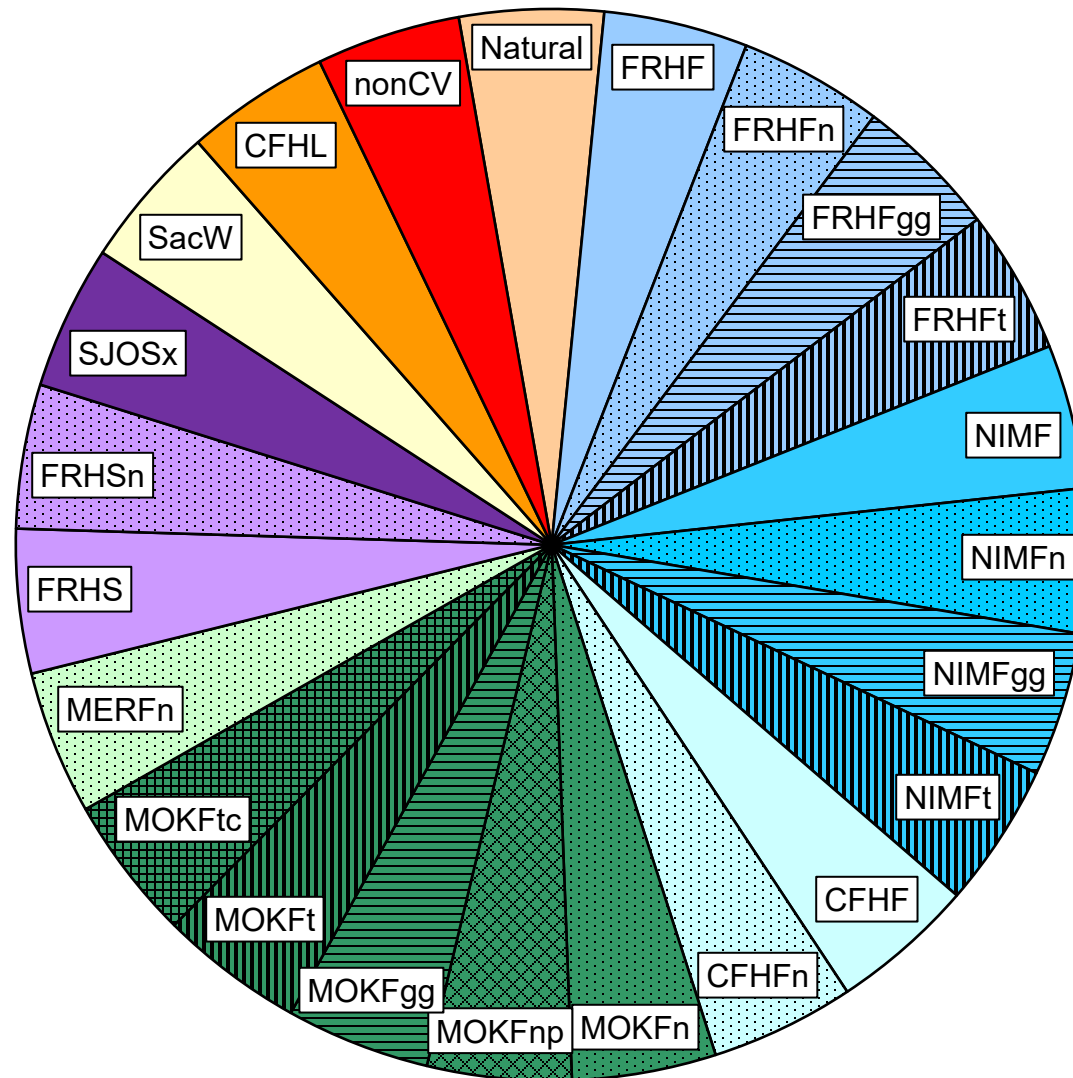
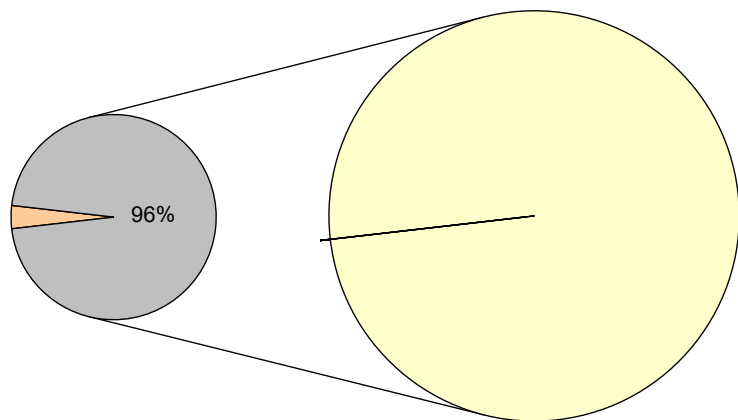
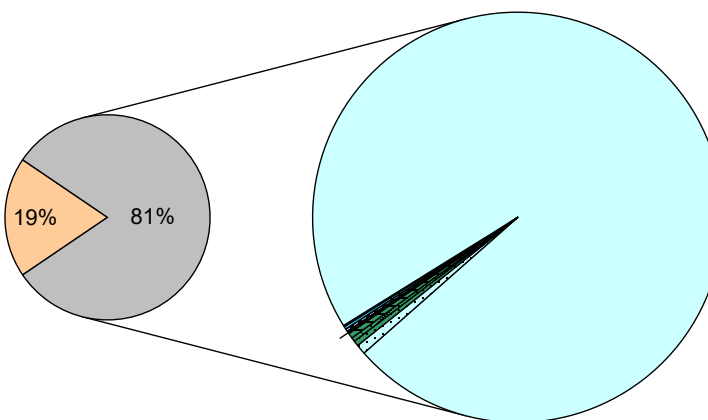


Figure 4. Color and pattern scheme used in all pie chart figures for Central Valley hatchery release types, brood years 2018-2022.

Coleman National Fish Hatchery winter 2023
n=55



Coleman National Fish Hatchery fall 2023
n=4,687



Coleman National Fish Hatchery late-fall 2024
n = 2,870

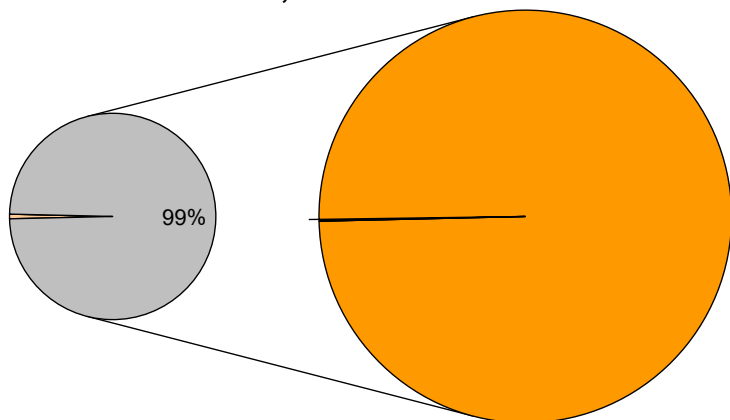
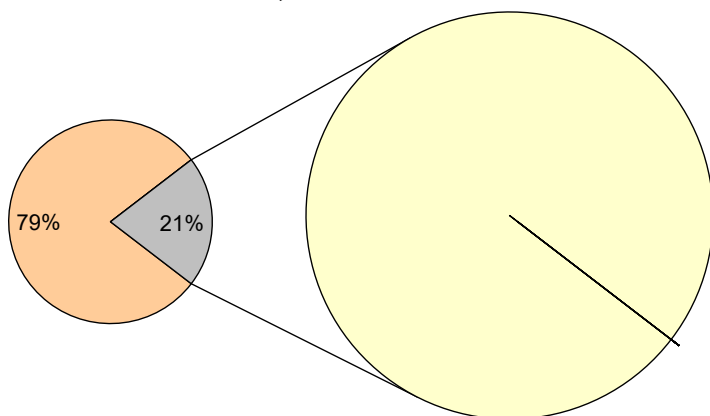
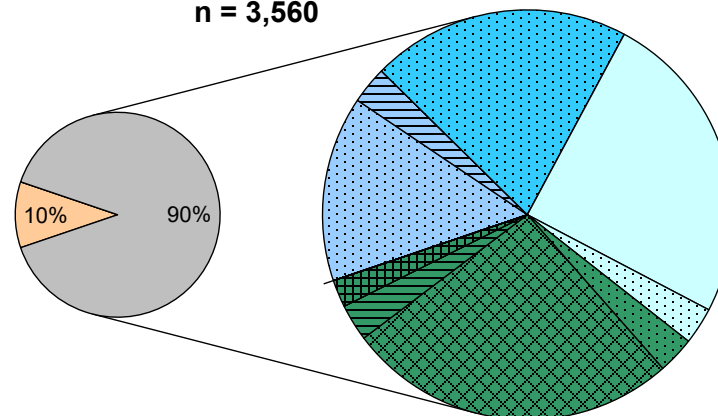


Figure 5. Proportion of hatchery- and natural-origin fish at Coleman National Fish Hatchery, 2023-24.

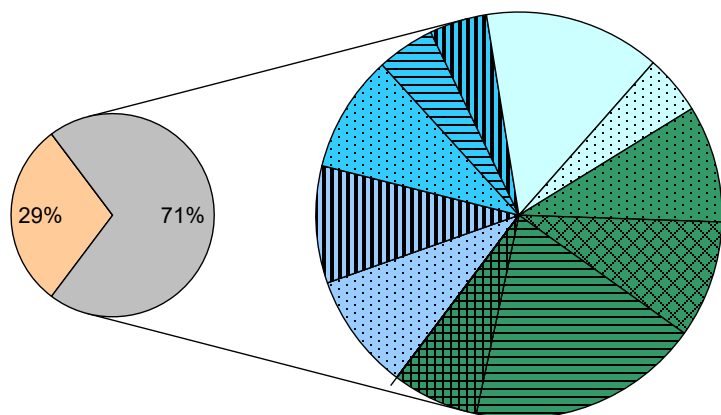
Upper Sacramento River winter carcass 2023
n = 1,920



Upper Sacramento River fall carcass 2023
n = 3,560



Clear Creek fall carcass 2023
n = 1,110



Battle Creek fall spawners 2023
n = 1,255

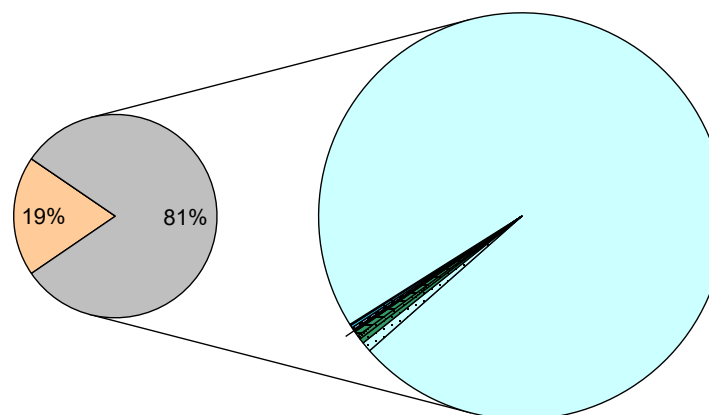


Figure 6. Proportion of hatchery- and natural-origin fish in Upper Sacramento River & tributaries, 2023-24. (Page 1 of 2)

Upper Sacramento River late-fall carcass
2024
n = 1,506

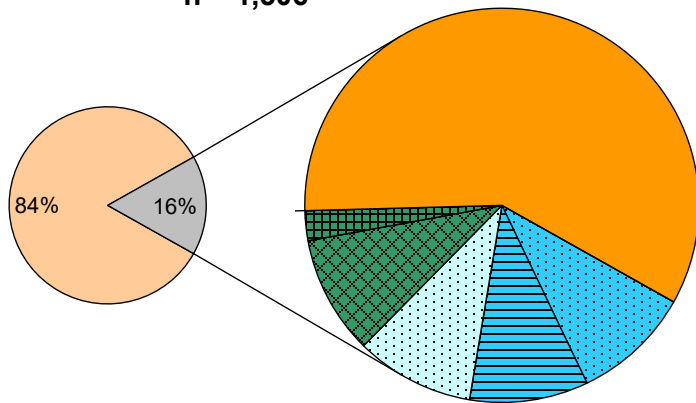
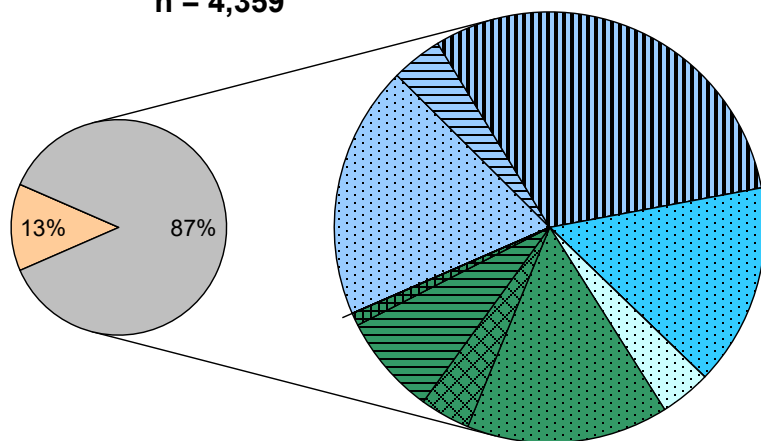


Figure 6. Proportion of hatchery- and natural-origin fish in Upper Sacramento River & tributaries, 2023-24. (Page 2 of 2)

Yuba River fall carcass (above DPD)
n = 4,359



Yuba River fall carcass (below DPD)
n = 487

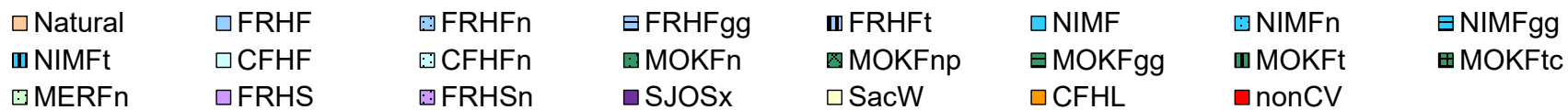
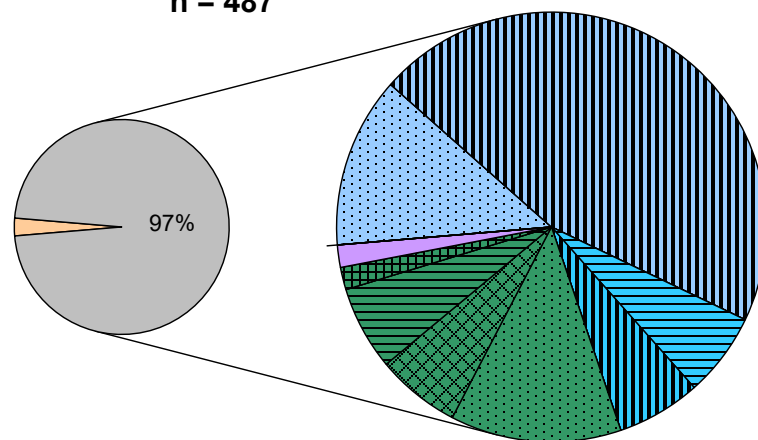
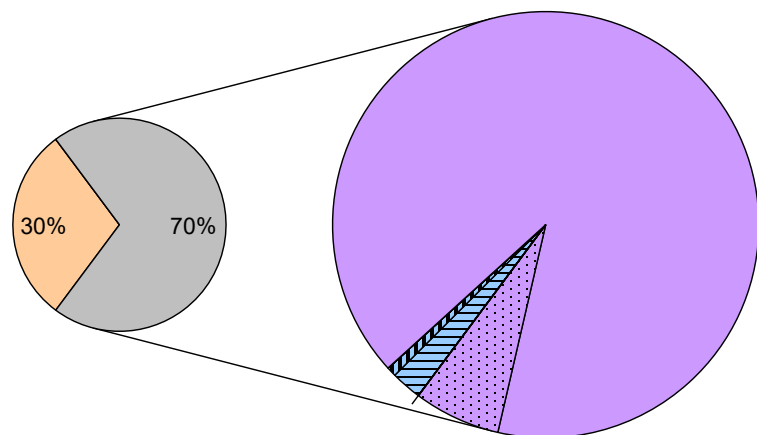
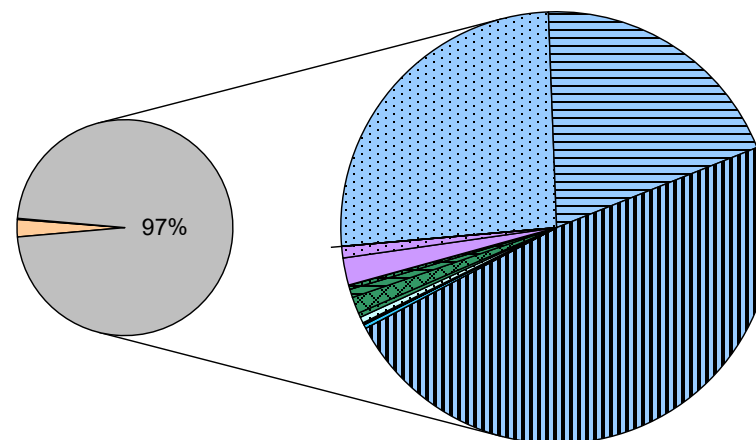


Figure 7. Proportion of hatchery- and natural-origin fish in Yuba River, 2023.

Feather River Hatchery spring
n = 1,529



Feather River Hatchery fall
n = 18,342



Feather River fall carcass
n = 63,889

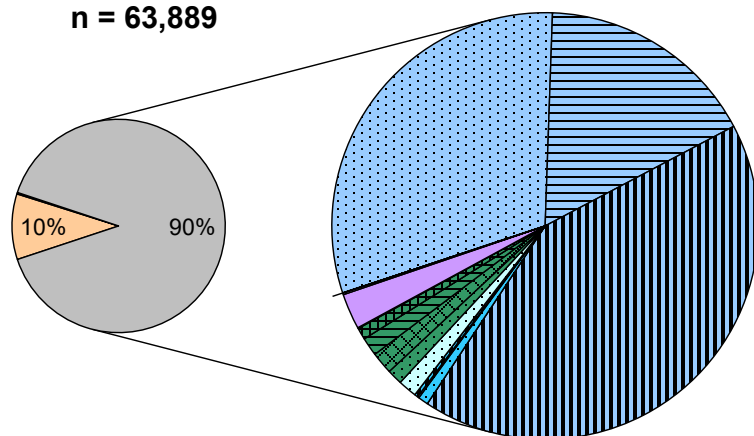
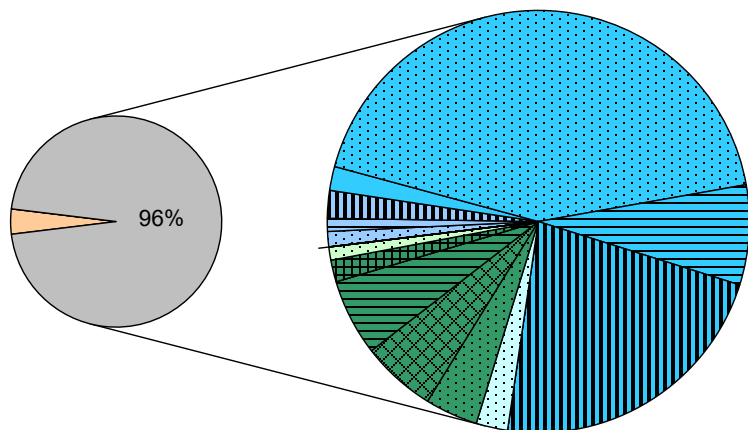


Figure 8. Proportion of hatchery- and natural-origin fish in the Feather River, 2023.

Nimbus Hatchery fall
n = 9,272



American River fall carcass
n = 37,321

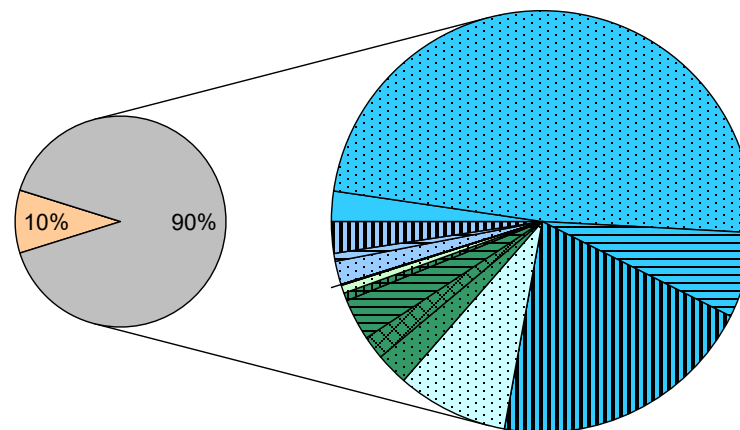
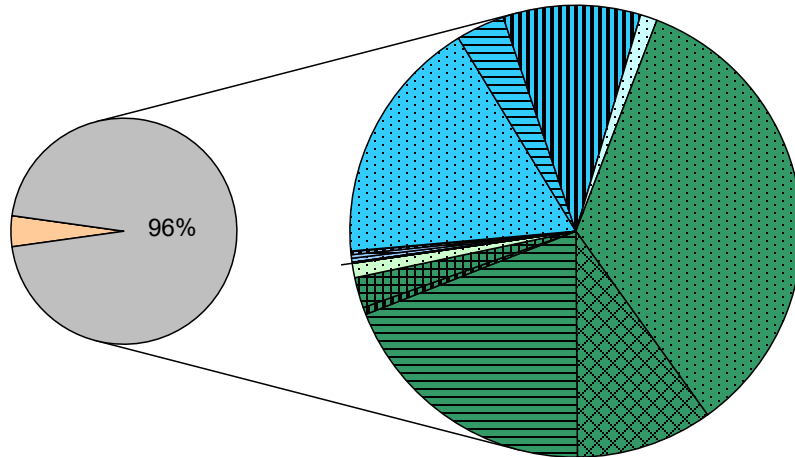
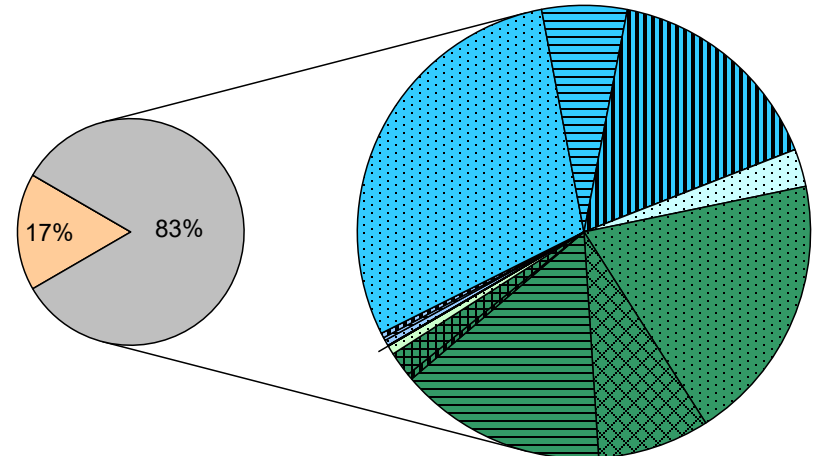


Figure 9. Proportion of hatchery- and natural-origin fish in the American River, 2023.

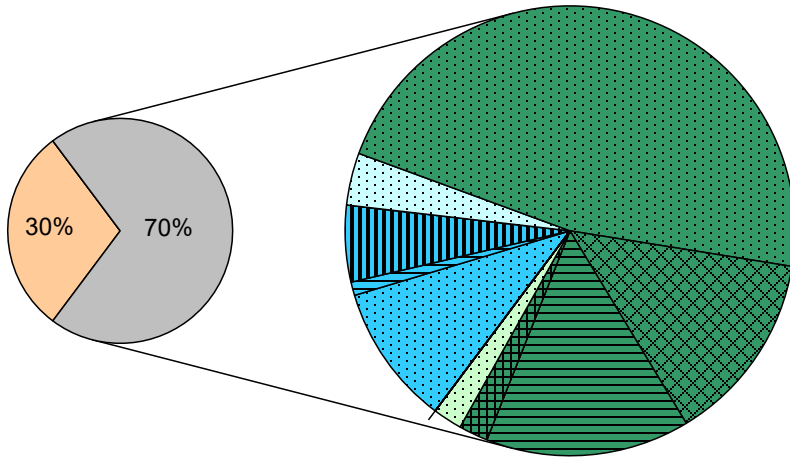
Mokelumne Hatchery fall
n = 9,866



Mokelumne River fall carcass
n = 18,831



Stanislaus River fall carcass
n = 1,623



Tuolumne River fall carcass
n = 1,341

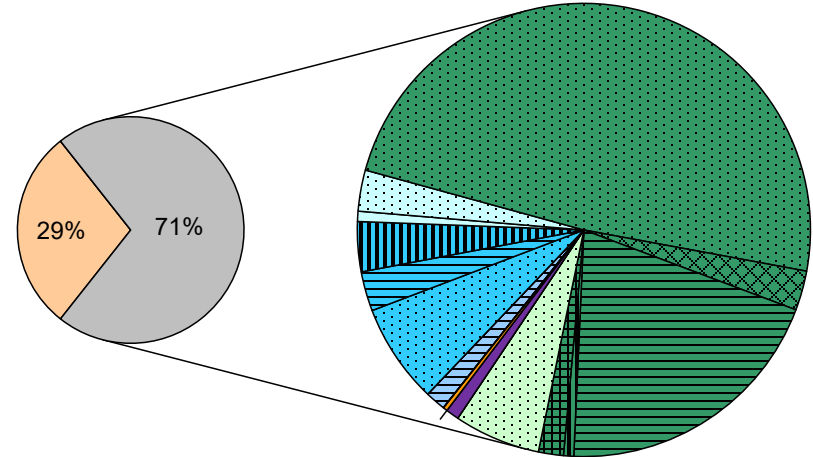
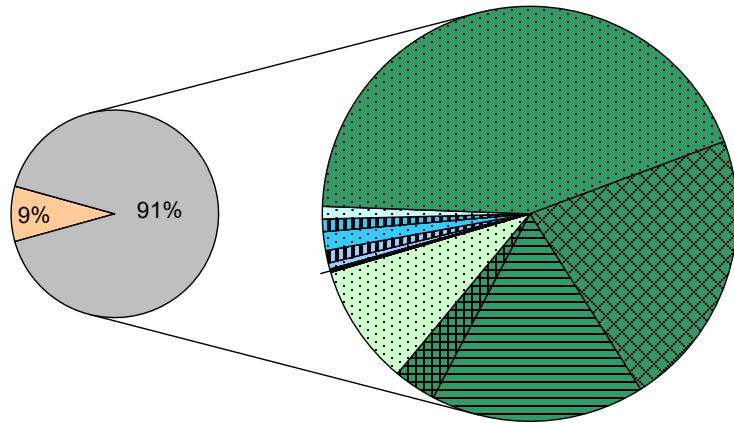


Figure 10. Proportion of hatchery- and natural-origin fish in the Mokelumne, Stanislaus, & Tuolumne rivers, 2023.

Merced River Hatchery fall
n = 894



Merced River fall carcass
n = 2,371

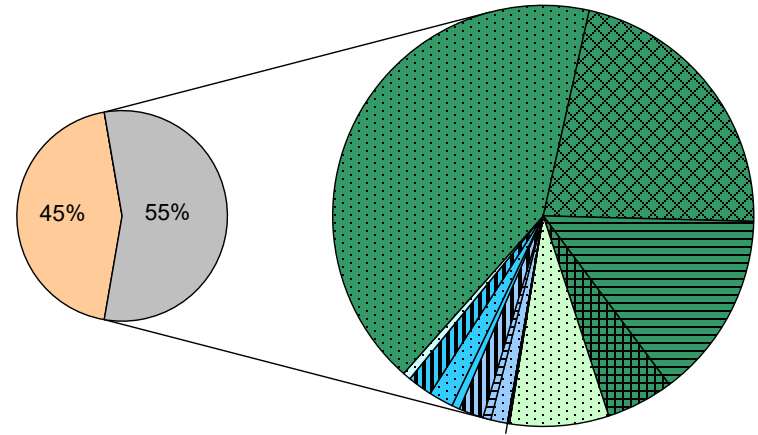


Figure 11. Proportion of hatchery- and natural-origin fish in the Merced River, 2023.

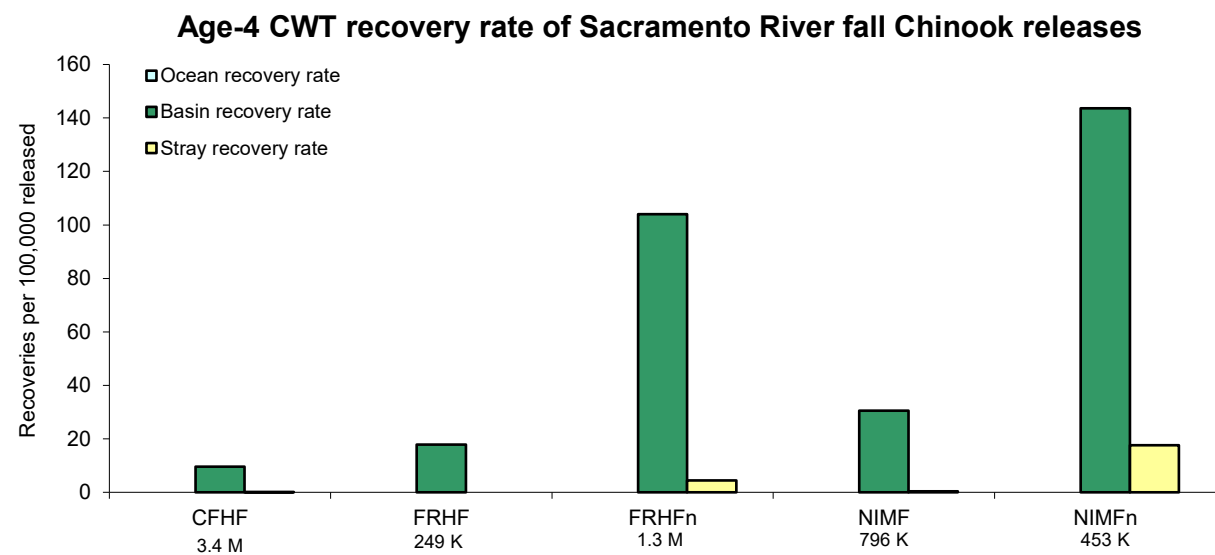
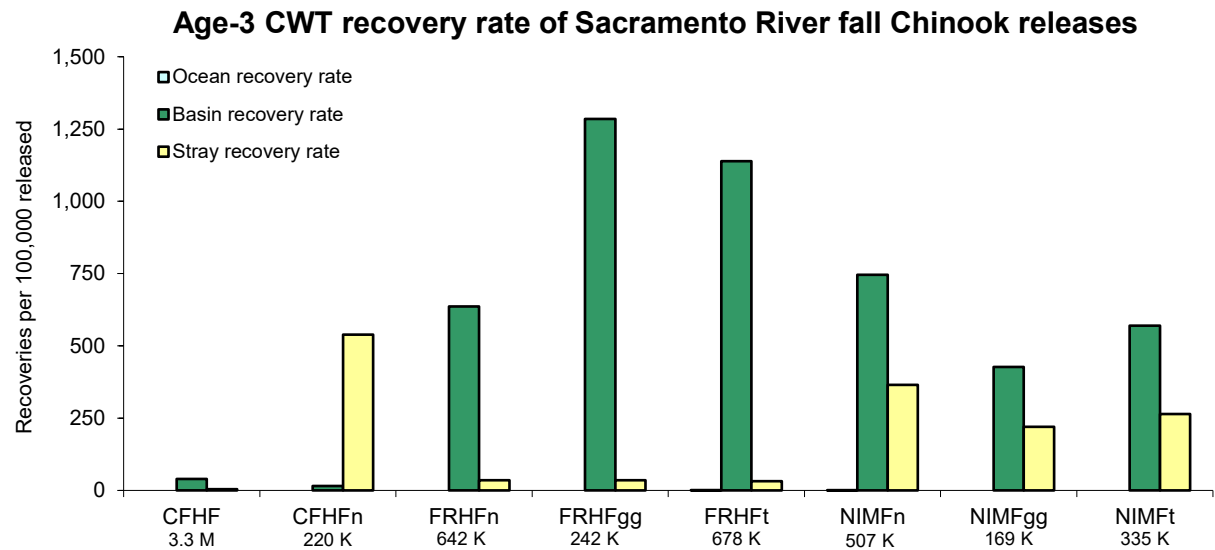
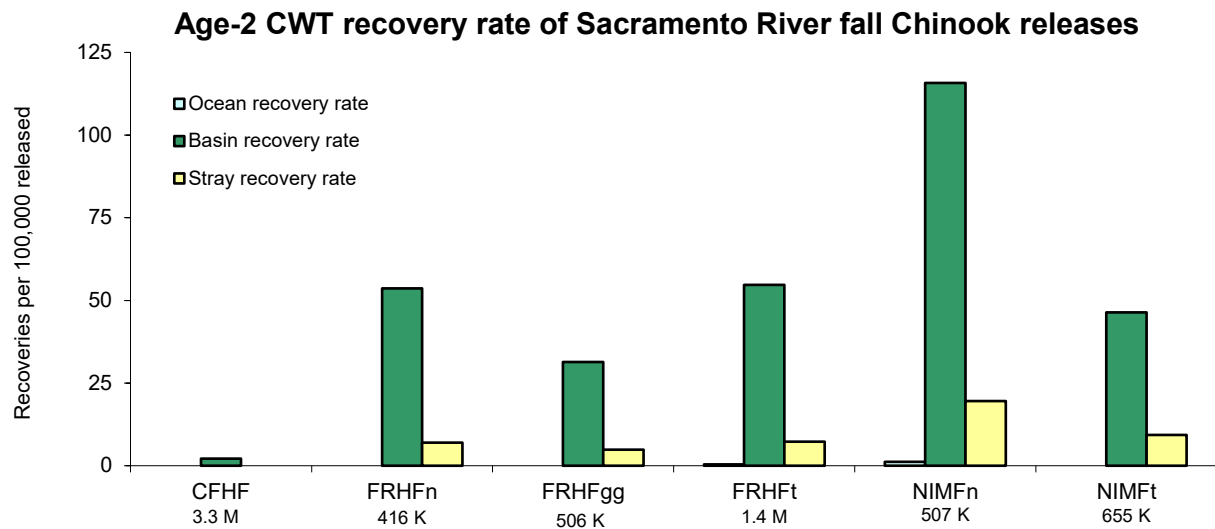


Figure 12. CWT recovery rates of Sacramento River fall Chinook releases by age in 2023.

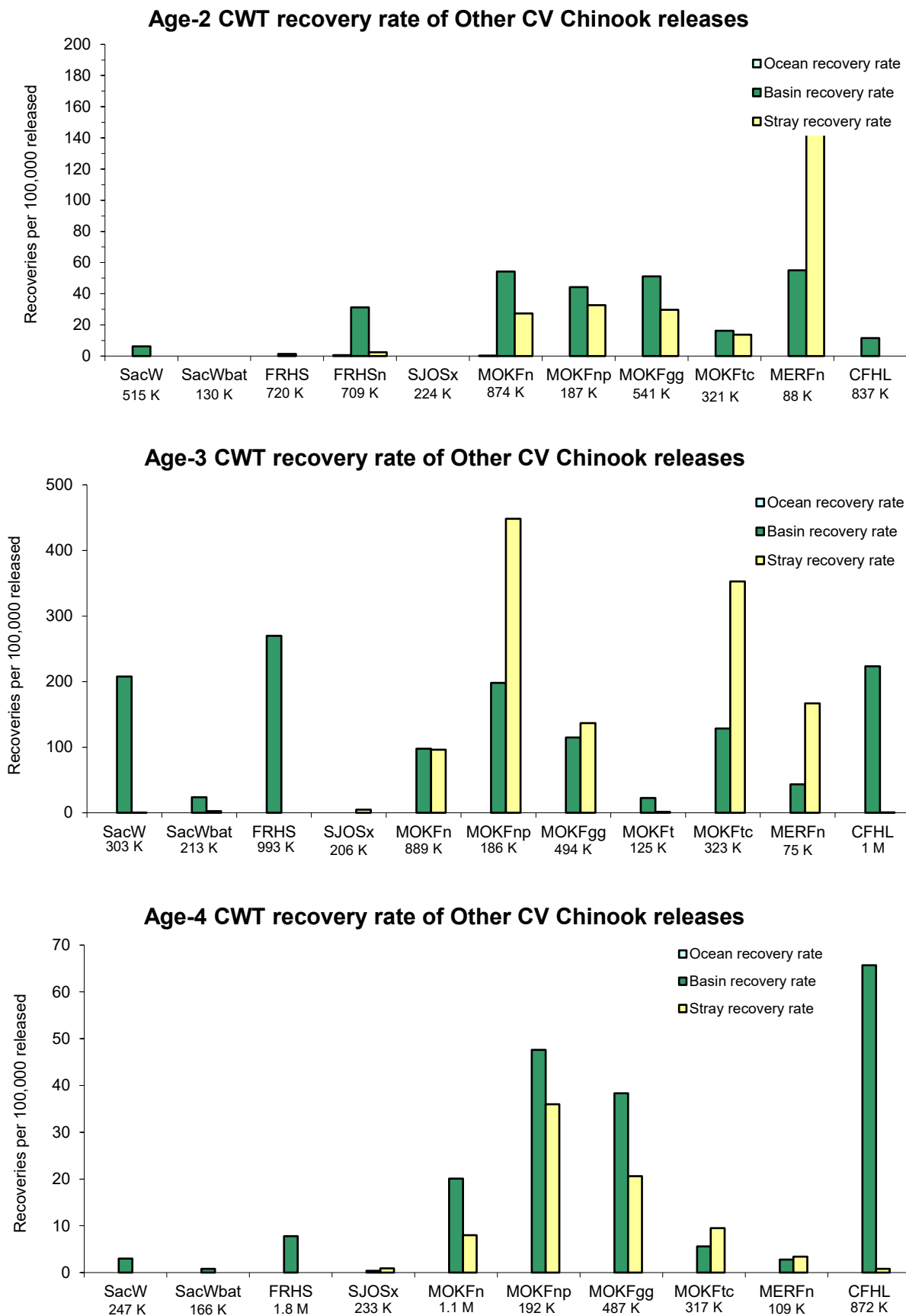


Figure 13. CWT recovery rates of Other CV Chinook releases by age in 2023.

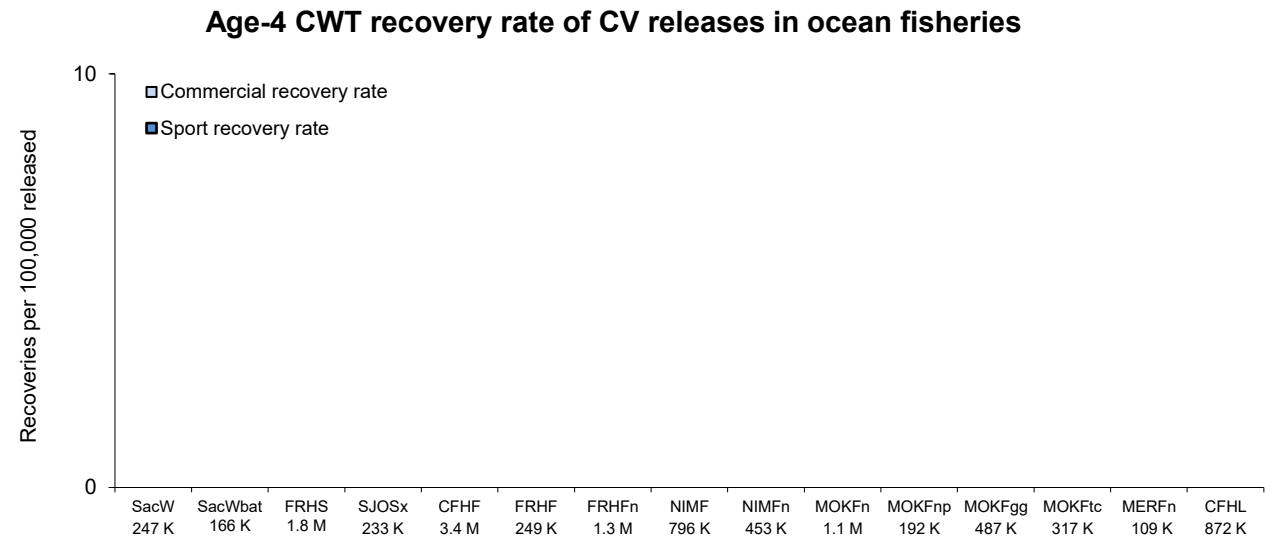
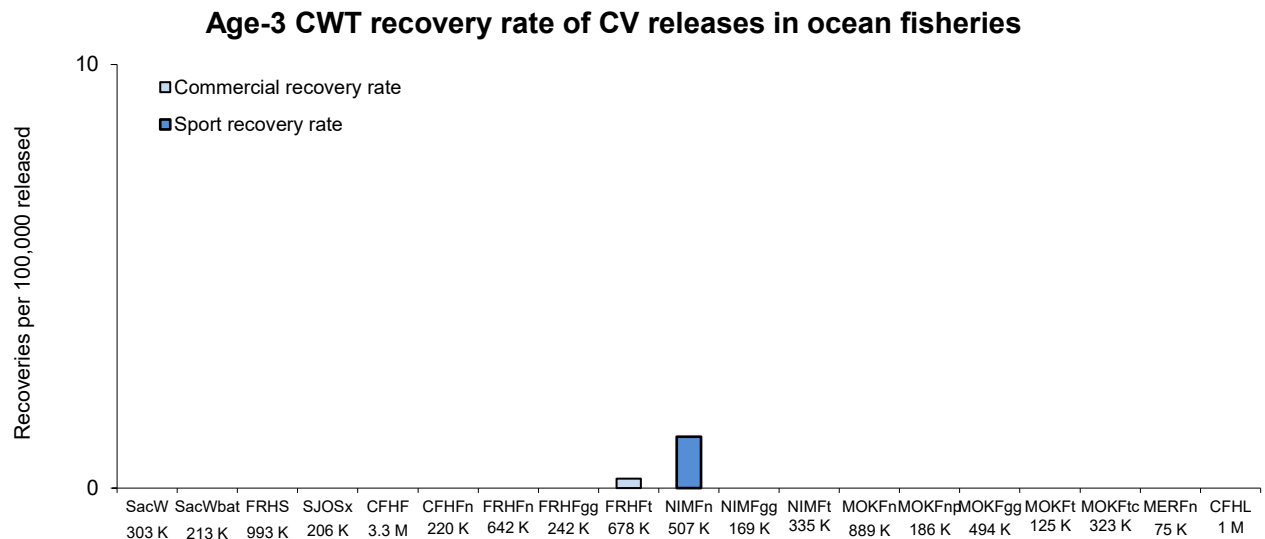
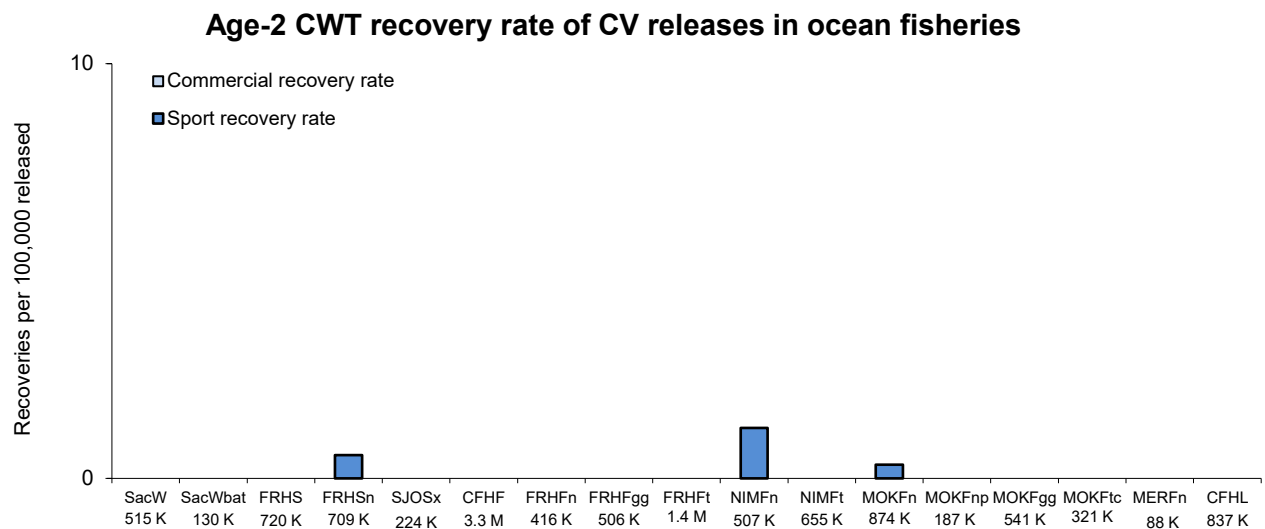


Figure 14. CWT recovery rates by release type in 2023 ocean salmon fisheries.

California Sport Harvest
n = 0

California Commercial Harvest
n = 0

Fishery Closed in 2023

Fishery Closed in 2023

Oregon Sport Harvest
n = 1,728

Oregon Commercial Harvest
n = 1,461

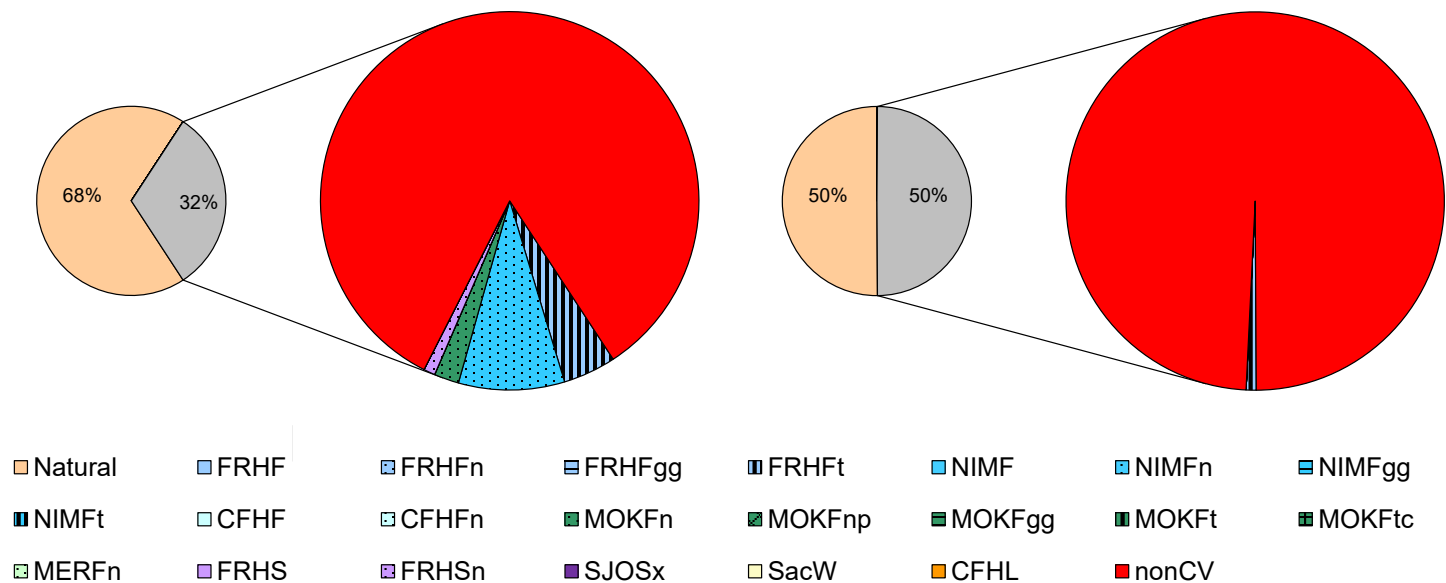


Figure 15. Proportion of hatchery- and natural-origin salmon in 2023 California and Oregon ocean fisheries.

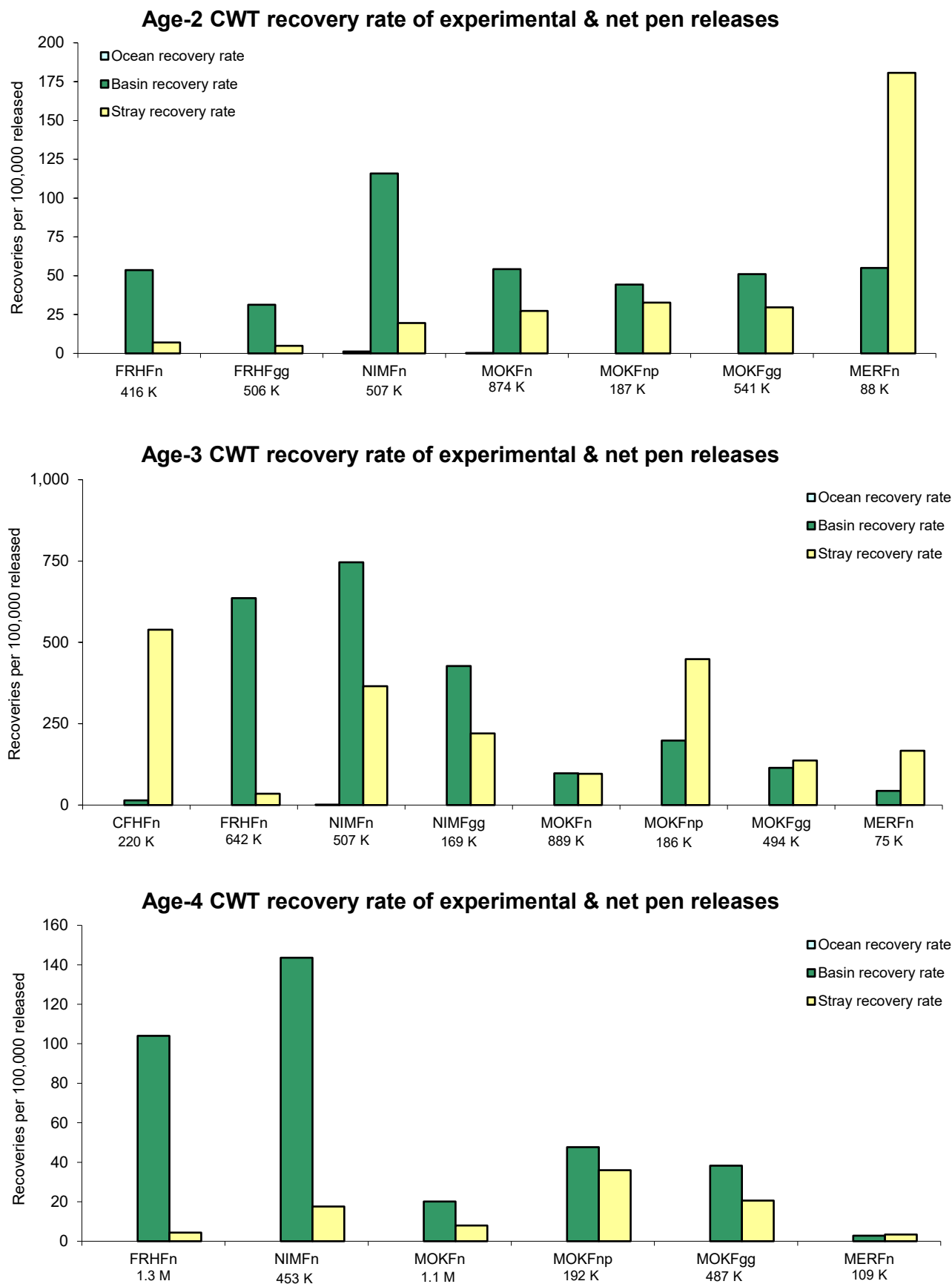


Figure 16. CWT recovery rates of experimental and net pen releases by age in 2023.

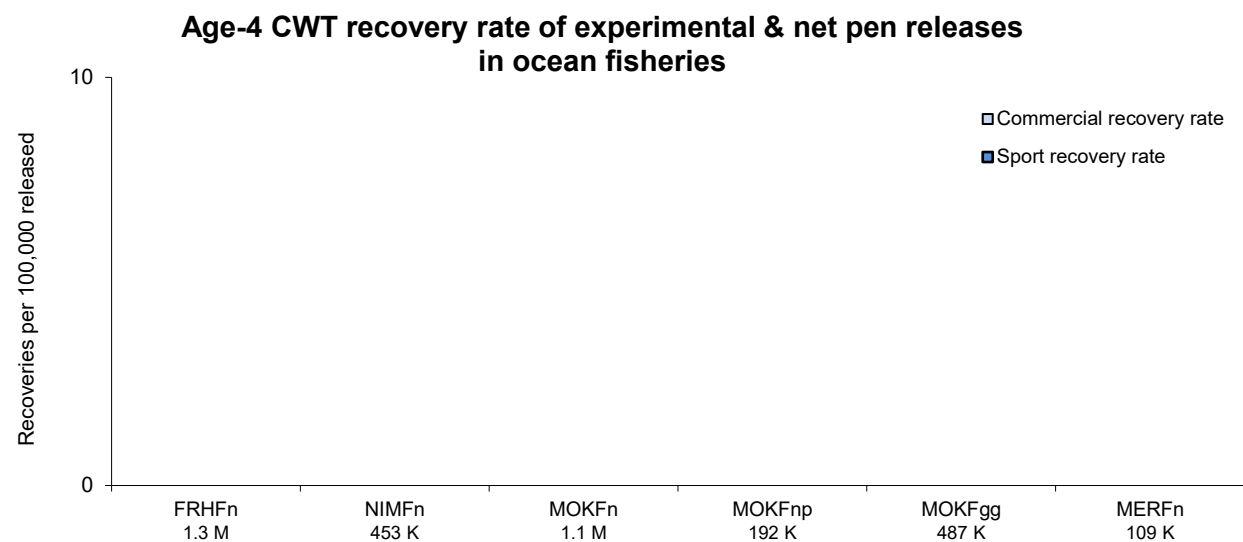
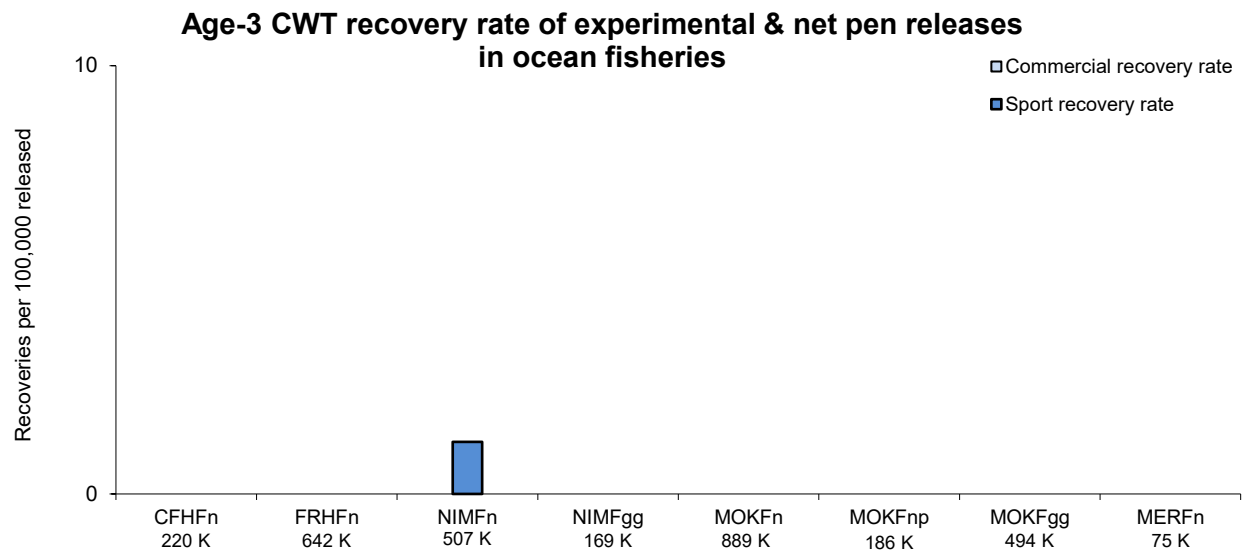
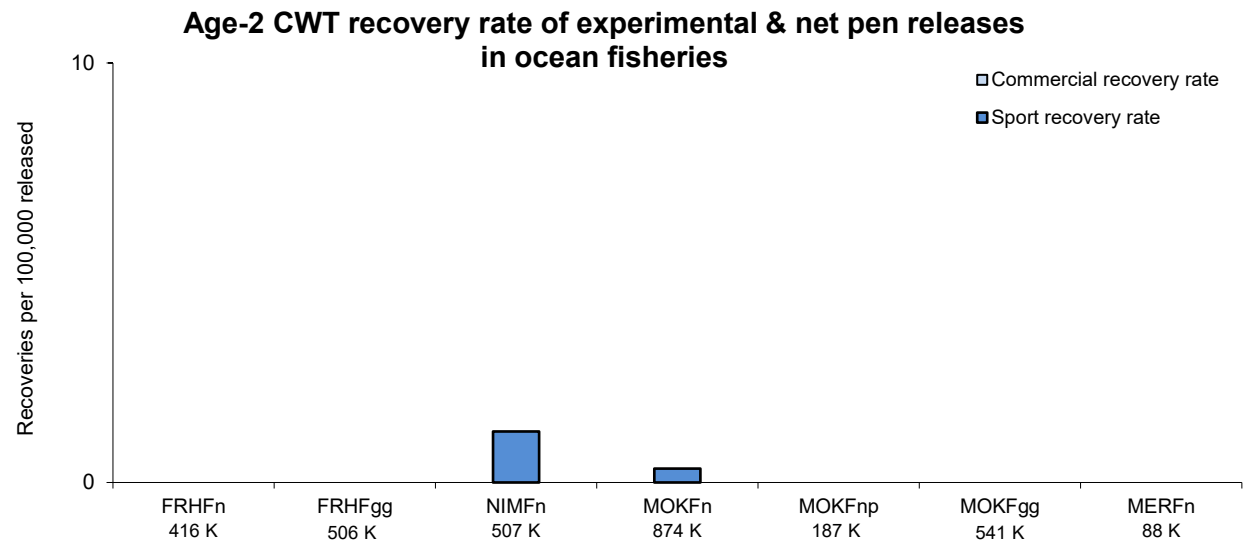


Figure 17. CWT recovery rates of experimental and net pen releases in 2023 ocean sport and commercial fisheries.

Appendix 1. Sample expansion factors for Central Valley salmon carcass surveys collecting fish condition in 2023. (Page 1 of 2)

Upper Sacramento River fall-run Chinook salmon carcass survey

Condition	Escapement N	Chinook sampled (n)	Sample rate	Observed ad-clips	Ad-clips processed	CWTs recovered	Valid CWTs	p_{adc}	$p_{cwt adc}$	F_{samp}	Avg F_{prod}	$\sum_{i=1}^m CWT_{\text{total},i}$	% hatchery
fresh 47%		95	2.7%	30	30	29	29	0.32	0.97	37.47	2.94	3,189	90%
non-fresh 53%		108	3.0%	19	19	18	18	0.18	0.95				
total	3,560	203	5.7%	49	49	47	47			23.12	2.94	3,189	90%

Clear Creek fall-run Chinook salmon carcass survey

Condition	Escapement N	Chinook sampled (n)	Sample rate	Observed ad-clips	Ad-clips processed	CWTs recovered	Valid CWTs	p_{adc}	$p_{cwt adc}$	F_{samp}	Avg F_{prod}	$\sum_{i=1}^m CWT_{\text{total},i}$	% hatchery
fresh 97%		115	10.4%	31	31	30	29	0.27	0.97	9.99	2.70	782	70%
non-fresh 3%		3	0.3%	3	3	3	3	1.00	1.00				
total	1,110	118	10.6%	34	34	33	32			9.05	2.70	782	70%

Feather River fall-run Chinook salmon carcass survey (only fresh fish sampled)

Condition	Escapement N	Chinook sampled (n)	Sample rate	Observed ad-clips	Ad-clips processed	CWTs recovered	Valid CWTs	p_{adc}	$p_{cwt adc}$	F_{samp}	Avg F_{prod}	$\sum_{i=1}^m CWT_{\text{total},i}$	% hatchery
fresh 99%		3,545	5.5%	922	910	869	866	0.26	0.95	18.32	3.63	57,529	90%
non-fresh													
total	63,889	3,566	5.6%	922	910	869	866			18.32	3.63	57,529	90%

Stanislaus River fall-run Chinook salmon carcass survey (only fresh fish sampled)

Condition	Escapement N	Chinook sampled (n)	Sample rate	Observed ad-clips	Ad-clips processed	CWTs recovered	Valid CWTs	p_{adc}	$p_{cwt adc}$	F_{samp}	Avg F_{prod}	$\sum_{i=1}^m CWT_{\text{total},i}$	% hatchery
fresh 100%		444	27.4%	87	87	84	84	0.20	0.97	3.66	3.73	1,143	70%
non-fresh													
total	1,623	444	27.4%	87	87	84	84			3.66	3.73	1,143	70%

Appendix 1. Sample expansion factors for Central Valley salmon carcass surveys collecting fish condition in 2023. (Page 2 of 2)

Tuolumne River fall-run Chinook salmon carcass survey (only fresh fish sampled)

Condition	Escapement N	Chinook sampled (n)	Sample rate	Observed ad-clips	Ad-clips processed	CWTs recovered	Valid CWTs	p_{adc}	$p_{cwt adc}$	F_{samp}	Avg F_{prod}	$\sum_{i=1}^m CWT_{\text{total},i}$	% hatchery
fresh 100%		505	37.7%	105	105	101	101	0.21	0.96	2.66	3.56	956	71%
non-fresh													
total	1,341	505	37.7%	165	164	158	158			1.70	3.56	956	71%

Upper Sacramento River winter-run Chinook salmon carcass survey

Condition	Escapement N	Chinook sampled (n)	Sample rate	Observed ad-clips	Ad-clips processed	CWTs recovered	Valid CWTs	p_{adc}	$p_{cwt adc}$	F_{samp}	Avg F_{prod}	$\sum_{i=1}^m CWT_{\text{total},i}$	% hatchery
fresh 60%		288	15.0%	68	67	59	58	0.24	0.88	6.88	1.00	400	21%
non-fresh 40%		192	10.0%	42	42	36	36	0.22	0.86				
total	1,920	480	25.0%	110	109	95	94			4.25	1.00	400	21%

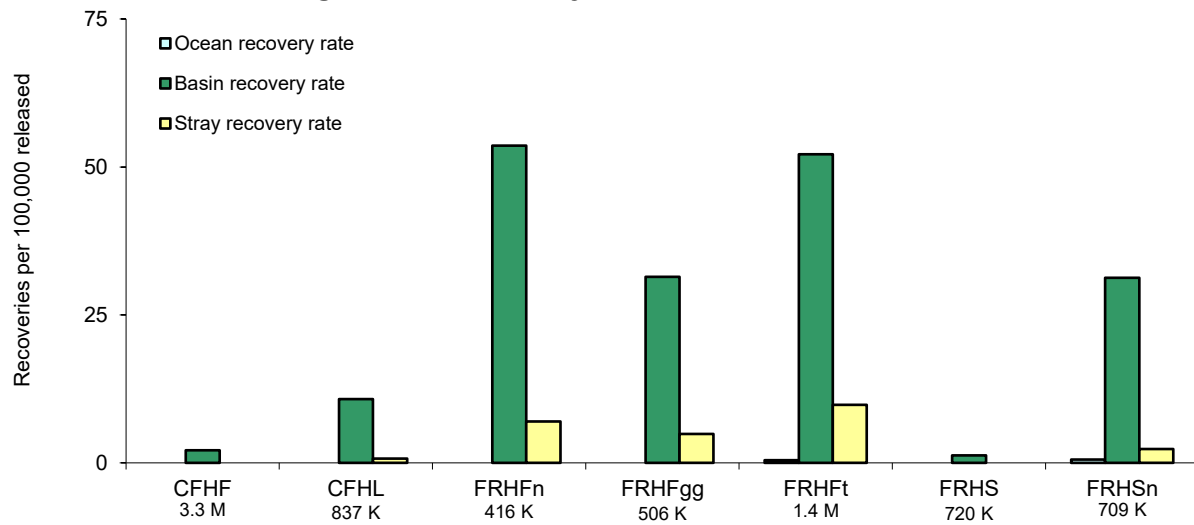
Upper Sacramento River late-fall-run Chinook salmon carcass survey 2024

Condition	Escapement N	Chinook sampled (n)	Sample rate	Observed ad-clips	Ad-clips processed	CWTs recovered	Valid CWTs	p_{adc}	$p_{cwt adc}$	F_{samp}	Avg F_{prod}	$\sum_{i=1}^m CWT_{\text{total},i}$	% hatchery
fresh 52%		149	9.9%	20	19	16	15	0.13	0.84	11.35	1.43	244	16%
non-fresh 48%		136	9.0%	17	17	14	14	0.13					
total	1,506	285	18.9%	37	36	30	29			5.87	1.43	244	16%

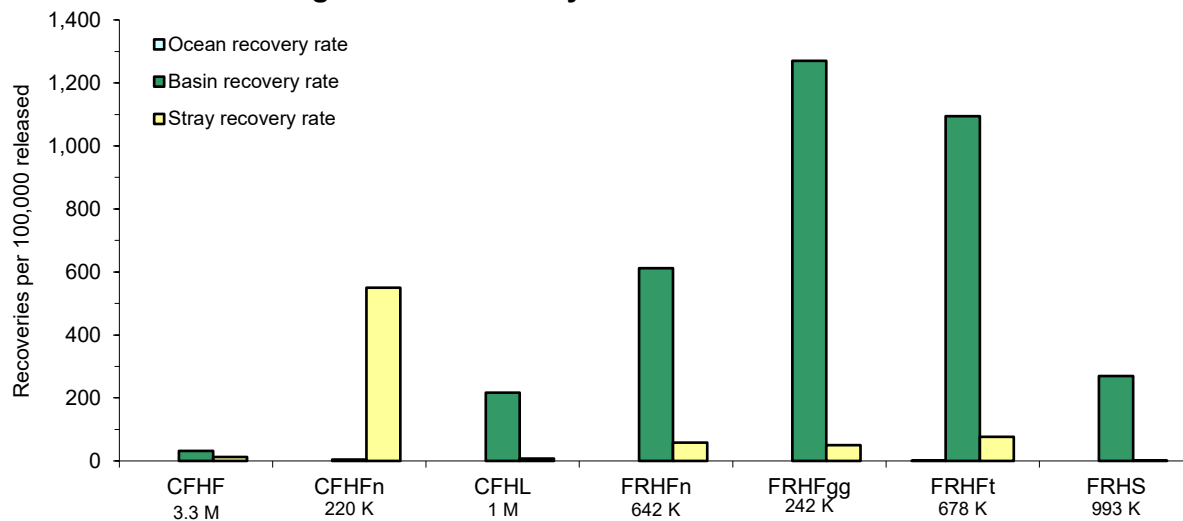
p_{adc} = proportion of sampled fish that were ad-clipped; $p_{cwt|adc}$ = proportion of ad-clipped fish containing CWTs

Appendix 3. Alternative CWT recovery rates for CFH and FRH releases by age in 2023.

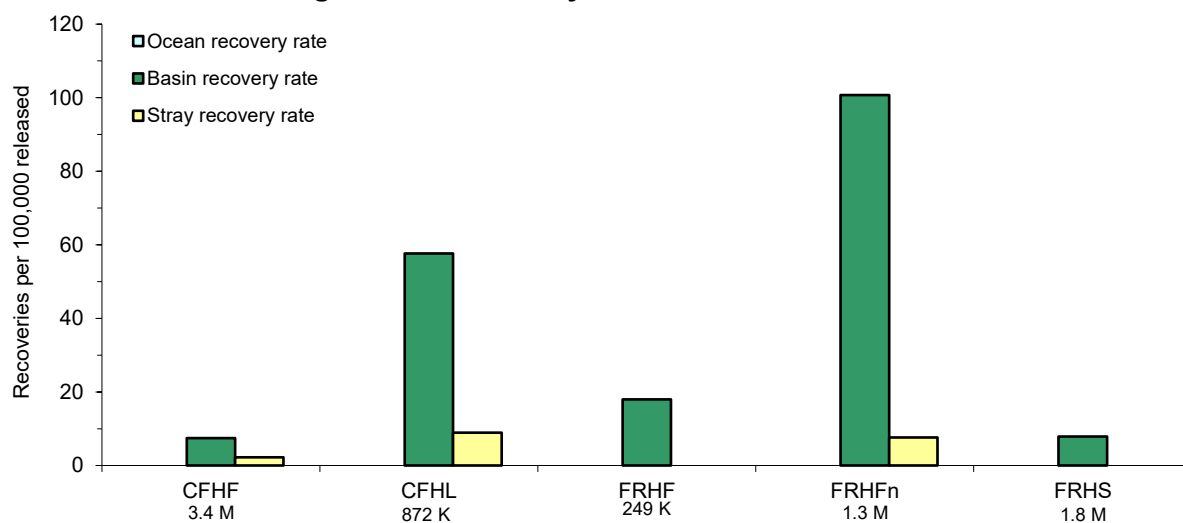
Alternative age-2 CWT recovery rate for CFH and FRH releases



Alternative age-3 CWT recovery rate for CFH and FRH releases



Alternative age-4 CWT recovery rate for CFH and FRH releases



Appendix 4. Sample expansion for CWTs recovered in the Yuba River above Daguerre Point Dam (DPD) in 2023.

Yuba River natural area escapement above DPD: Total video count with supplemental carcass survey CWT data

Escapement N	Chinook sampled (n)	Sample rate	Observed ad-clips	Ad-clips processed	CWTs recovered	Valid CWTs	p_{adc}	$p_{cwt adc}$	F_{samp}	Avg F_{prod}	$\sum_{i=1}^m CWT_{\text{total},i}$	% hatchery
4,359	4,347	100%	960	27	27	27	0.221	1.000	35.65	3.94	3,793	87%
Video count			Video count		Carcass survey							

DPD video count	Total	% ad-clip
No clip	3,387	
Ad-clip	960	22.1%
Unknown clip	12	

Appendix 5. Sample expansion for CWTs recovered in the Mokelumne River above Woodbridge Dam (WD) in 2023.

	Total count	Total ad-clips	% ad-clip
Woodbridge Dam video	28,697	6,860	23.9%
Mokelumne River Hatchery return	9,866	2,589	26.2%
Mokelumne River natural escapement	18,831	4,271	22.7%

Mokelumne River natural area escapement above WD: Total video count minus hatchery return with supplemental carcass survey CWT data

Escapement N	Chinook sampled (n)	Sample rate	Observed ad-clips	Ad-clips processed	CWTs recovered	Valid CWTs	p_{adc}	$p_{cwt adc}$	F_{samp}	Avg F_{prod}	$\sum_{i=1}^m CWT_{\text{total},i}$	% hatchery
18,831	18,831	100%	4,271	1603	1556	1550	0.227	0.971	2.67	3.79	15,712	83%
Video count			Video count		Carcass survey							