

Recovery of Coded-Wire Tags from Chinook Salmon in California's Central Valley Escapement, Inland Harvest, and Ocean Harvest in 2021

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INTRODUCTION

Each year, approximately 32 million fall-run Chinook salmon (*Oncorhynchus tshawytscha*) are produced 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). 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 12th annual report on the recovery of CFM CWTs in the CV and ocean fisheries. In 2021, approximately 35,700 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, in the CV angler sport harvest, and in commercial and sport ocean salmon fisheries south of Cape Falcon (i.e., California and most of Oregon).

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 their siblings released directly into the water? Are these metrics affected by transporting salmon smolts down their natal waterways by vessel and exposing them to river water prior to release in the bay?
- 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 2022, Grimes and Galinat 2022).

DATA AND METHODS

Inland Escapement and River Sport Harvest Monitoring

During 2021, monitoring of salmon escapement occurred at all five salmon hatcheries and on major rivers and tributaries throughout the CV. In addition, an angler creel survey was conducted on sport fisheries in the Sacramento, Feather, American, and Mokelumne river basins. It should be noted that the late-fall-run escapement in the upper Sacramento River and at CFH in this report is considered the 2022 return year, however the escapement monitoring period began in late 2021.

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 2021 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 166,500 Chinook salmon that returned to the CV basins analyzed in this report, roughly 70,500 salmon were sampled, 20,500 ad-clipped salmon were observed, and 19,200 heads were collected by various CV projects (Table 4). 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 Sacramento CWT lab, except for 6,500 heads processed by FWS staff at CFH, 30 heads processed by FWS staff in Lodi, and 1,500 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 2021, California sport and commercial ocean salmon fisheries had decreased opportunities compared to the previous year due to poorer abundance forecasts for fall-run Chinook salmon from the Sacramento and Klamath basins (Table 2). Of the approximately 258,000 salmon harvested in California ocean fisheries during 2021, CDFW field staff sampled approximately 71,700 salmon and collected nearly 11,900 heads that were processed at the Santa Rosa CWT lab (Table 5). Approximately 1,500 heads collected in Oregon sport and commercial ocean fisheries during 2021 are also included in these analyses, since Sacramento River fall-run Chinook salmon is the primary stock harvested in fisheries south of Cape Falcon, Oregon (PFMC 2024).

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 2021 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 2021 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 2016 through 2019 were downloaded from the RMPC. Approximately 128 million CV salmon were released for these brood years, of which 45 million were marked and tagged utilizing 419 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 2021, there were 319 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 (e.g., barge study) 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 thirteen fall-run, two winter-run, two 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
FRHF	Feather River Hatchery F all-run in-basin releases
FRHF _n	Feather River Hatchery F all-run bay/delta n et pen releases
FRHF _{gg}	Feather River Hatchery F all-run G olden G ate releases (no net pen acclimation)
NIMF	Nimbus Fish Hatchery F all-run in-basin releases
NIMF _n	Nimbus Fish Hatchery F all-run bay/delta n et pen releases

San Joaquin River Basin Fall-run Chinook salmon release types

MOKF	Mokelumne River Hatchery F all-run in-basin releases
MOKFn	Mokelumne River Hatchery F all-run bay/delta n et pen releases
MOKFnc	Mokelumne River Hatchery F all-run c oastal n et pen releases (Pillar Point/Santa Cruz)
MOKFgg	Mokelumne River Hatchery F all-run G olden G ate releases (no net pen acclimation)
MOKFb	Mokelumne River Hatchery F all-run b arge study releases
MERF	Merced River Hatchery F all-run in-basin releases
MERFn	Merced River Hatchery F all-run bay/delta n et 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
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 sometimes vary within a given release type (Table 3; Fig. 1). There were also a few problematic CWT releases where fish were released utilizing more than one strategy (e.g., one out of the fifteen bay/delta net pen MOKFn release groups from the 2017 brood was not actually acclimated in net pens due to traffic delays). 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 4 and 5).

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 2021 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 most surveys in 2021. Furthermore, the sample sizes between fresh and non-fresh fish are usually very different with the number of non-fresh salmon sampled generally much greater than 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:

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

where N = estimated total escapement, $p_{\text{adc}|\text{fresh}}$ = proportion of fresh salmon sampled that were ad-clipped, $p_{\text{cwt}|\text{fresh},\text{adc}}$ = proportion of ad-clipped fresh salmon that contained a CWT, and $n_{\text{valid cwt}}$ = 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_{smp} recoveries collected outside the basin of origin was divided by total CV CWT_{smp} recoveries for that release group, as follows:

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

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:

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

RESULTS

General overview of 2021 CV inland recoveries and California ocean harvest

All of the nearly 22,900 valid CWTs recovered in the CV during 2021 were from CV Chinook salmon releases. Most CWTs were brood year 2017 through 2019 releases (Table 6). About 87% of all CWT_{total} were fall-run, followed by spring-run (8%) and late-fall-run (2%) salmon releases. Only 3% of CWT_{total} were winter-run, some of which were collected from the first three cohorts of spawners to return to CFH as part of the FWS Battle Creek winter-run Jumpstart program (age-2, age-3, and age-4). 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 (61%) fish.

Most of the approximately 11,300 valid CWT recoveries from the 2021 California ocean harvest were CV salmon releases belonging to brood year 2018 (Table 7). Approximately 92% of all CWT_{total} in the ocean harvest were CV fall-run, followed by CV spring-run (2%), CV late-fall-run (1%), and CV winter-run (0.1%) salmon. The remaining 5% of California ocean harvest CWT_{total} originated primarily from the Klamath-Trinity Basin and Smith River in northern California, the Elk River in Oregon, and the Columbia

River Basin. Most of the hatchery-origin fish in the California ocean harvest were age-3 fish (74%), followed by age-4 (14%) and age-2 (11%) fish.

Of the nearly 1,500 valid CWT recoveries from the 2021 Oregon ocean harvest (south of Cape Falcon), 39% were CV fall-run salmon releases (Table 8). Recoveries of other CV run types were scarce off Oregon. Non-CV stocks made up 60% 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-3 (61%) and age-4 (33%) fish.

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

During 2021, approximately 83,500 fall-run Chinook salmon returned to spawn in the CV natural areas included in these analyses (Table 9, Fig. 2). There were an additional 6,000 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. The proportion of hatchery-origin salmon in those areas sampled varied throughout the CV. The lowest fall-run hatchery proportion occurred in the upper Sacramento mainstem (39%), followed by the Yuba River (52%). The highest fall-run hatchery proportion occurred in the Stanislaus River (91%), followed closely by the American River (90%). The total CV fall-run hatchery proportion for all natural areas that were adequately sampled during 2021 was 69%.

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.).

The hatchery proportion of the 44,400 fall-run salmon returning to the five CV hatcheries ranged from 80% to 100% (Table 9, Fig. 3). The fall-run hatchery proportion for all CV hatcheries combined was 86%. The late-fall-run return to CFH was entirely hatchery-origin salmon (100%).

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. 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 footnote b/ in Table 9 for a description of which release types were merged.

Upper Sacramento River Basin

At CFH in 2021, the fall-run spawning period was considered early October through November, and the late-fall-run spawning period was considered November through April 2022. 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 74 late-fall-run salmon were trapped at CFH after spawning operations ended. Also, 2021 was the third 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.

Winter-, fall- and late-fall-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 winter-, fall-, and late-fall-run returns to the upper Sacramento River mainstem, and Clear Creek (Figs. 5, 6). Winter-run spawners collected at KES 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: 24% (SacW)
- Fall-run returns CFH: 89% (CFHF)
- Late-fall-run returns CFH: 100% (CFHL)
- Late-fall-run returns CFH (post-spawning): 100% (CFHL)
- Winter-run spawners upper Sacramento River: 29% (SacW)
- Fall-run spawners upper Sacramento River: 39% (CFHF)
- Late-fall-run spawners upper Sacramento River: 5% (SacW)
- Fall-run spawners Clear Creek: 54% (CFHF)
- Fall-run spawners Battle Creek: 89% (CFHF)

Butte Creek and Feather River Basin

In Butte Creek, spring-run spawners were entirely of natural-origin. In the Feather Basin, spring- and fall-run returns to FRH and spawners in the Feather River were predominantly hatchery-origin, while spawners in the Yuba River were relatively evenly distributed between hatchery- and natural-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: 94% (FRHS)
- Fall-run returns FRH: 80% (FRHFn)
- Fall/spring-run spawners Feather River: 85% (FRHS)
- Fall/spring-run spawners Yuba River: 52% (FRHS)

In previous reports, separate escapement estimates were produced for the Yuba River above and below the Daguerre Point Dam (DPD) based on a combination of ad-clips observed via video weir and CWTs recovered during carcass surveys. However, in 2021, spawner returns and recoveries of CWTs below the DPD were low. Thus, for this report, the Yuba River is reported as a single natural area escapement estimate.

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: 86% (NIMFn)
- Fall-run spawners American River: 90% (NIMFn)

In prior versions of this report, CWTs that were collected from fish sampled on the NIM weir (i.e., “washbacks”) were analyzed separately from those that were collected during carcass surveys downstream of the weir. Separate escapement estimates were produced for NIM weir “washbacks” and the carcass survey downstream for almost 40 years, but, beginning in 2018, a single natural area escapement estimate has been reported annually utilizing mark recapture methods and treating the entire American Basin (i.e., both upstream and downstream of the weir) as one system. In previous reports, a comparison of raw CWT recoveries by release type upstream and downstream of the NIM weir were included. Prior to the 2021 escapement year, the NIM weir was decommissioned due to the completion of the new fish ladder, so this comparison is no longer needed.

Mokelumne, Stanislaus, and Tuolumne Rivers

Fall-run returns to MOK were predominantly hatchery-origin salmon, while returns to the Mokelumne River natural areas were low, with only 826 spawners returning, and no CWTs were recovered. Spawners in the Stanislaus River and Tuolumne 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 MOK: 89% (MOKFn)
- Fall-run spawners Stanislaus River: 91% (MOKFn)
- Fall-run spawners Tuolumne River: 84% (SJOSx)

Merced and upper San Joaquin rivers

Fall-run returns to MER were entirely of hatchery-origin. Natural area spawners in the Merced River were mostly of hatchery-origin. Very few spring-run spawners returned to the upper San Joaquin River, but spawners that did return were predominantly hatchery-origin salmon (Fig. 11). The proportion of hatchery-origin fish (most prevalent release type shown in parentheses) at each of the following locations was:

- Fall-run returns MER: 100% (MOKFn)
- Fall-run spawners Merced River: 68% (MOKFn)
- Spring-run spawners upper San Joaquin River: 75% (SJOSx)

2. Contribution of CV Release Types to Total Salmon Escapement

In 2021, 69% of the 149,100 salmon that returned to the CV hatcheries and natural areas included in these analyses were hatchery-origin fish (Tables 9, 10). The hatchery release types that contributed the most to total CV escapement were CFH fall-run in-basin releases (27%) followed by fall-run bay/delta net pen releases from FRH (11%). MOK fall-run bay/delta net pen releases had the highest number of strays, while MER fall-run bay/delta net pen and SJO spring-run experimental reintroduction releases had the highest rates of straying (96% and 90%, respectively), closely followed by MOK fall-run coastal net pen releases (86%). About 28% of all recoveries occurred outside their basin-of-origin and ranged from 0% to 96%, depending on release type:

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

R_{type}	Run	CWT _{total}	% total	# Stray	% stray
CFHF	Fall	40,224	27%	6,425	16%
FRHF	Fall	83	<1%	0	0%
FRHF _n	Fall	15,900	11%	6,124	39%
FRHF _{egg}	Fall	2,083	1%	1,089	52%
NIMF	Fall	4,637	3%	186	4%
NIMF _n	Fall	9,866	7%	1,996	20%
MOKF	Fall	80	<1%	26	33%
MOKF _n	Fall	9,845	7%	7,699	78%
MOKF _{nc}	Fall	732	<1%	633	86%
MOKF _{egg}	Fall	3,656	2%	3,092	85%
MERF	Fall	34	<1%	0	0%
MERF _n	Fall	1,701	1%	1,629	96%
SacW	Winter	3,362	2%	0	0%
FRHS	Spring	8,372	6%	4	<1%
SJOS _x	Spring	251	<1%	227	90%
CFHL	Late-fall	2,447	2%	1	<1%
Non-CV		0	0%	0	
	Total	103,273	69%	29,131	28%

3. Hatchery Proportion and Contribution of CV Release Types to CV Sport Fishery

In 2021, 64% of the 14,500 salmon harvested in the CV river sport fishery were hatchery-origin fish (Table 9; Figs. 12, 13). The proportion of hatchery-origin fish (most prevalent release type shown in parentheses) in each of the following fisheries was:

- Upper Sacramento River fall-run harvest: 58% (CFHF)
- Lower Sacramento River fall-run harvest: 81% (MOKFgg)
- Feather River fall-run harvest: 51% (FRHFn)
- American River fall-run harvest: 80% (NIMFn)
- Mokelumne River fall-run harvest: 0% (only three fish total were sampled due to low returns, none of which were ad-clipped)
- Upper Sacramento River late-fall-run harvest: 70% (CFHL)

Of all hatchery release types, CFH fall-run in-basin releases contributed the most (28%) to the total CV sport harvest, followed by FRH fall-run bay/delta net pen releases (11%). In-basin releases were primarily harvested in their basin-of-origin or the lower Sacramento River (which all CV stocks must traverse before reaching their basin-of-origin). Conversely, net pen and Golden Gate releases were harvested out-of-basin at much higher rates (Tables 9, 10).

Hatchery-origin contribution by R_{type} to total CV river harvest

R _{type}	Run	CWT _{total}	% harvest
CFHF	Fall	4,108	28%
FRHF	Fall	14	<1%
FRHFn	Fall	1,650	11%
FRHFgg	Fall	286	2%
NIMF	Fall	263	2%
NIMFn	Fall	1,250	9%
MOKF	Fall	15	<1%
MOKFn	Fall	361	2%
MOKFnc	Fall	124	1%
MOKFgg	Fall	583	4%
MERF	Fall	0	0%
MERFn	Fall	228	2%
SacW	Winter	0	0%
FRHS	Spring	38	<1%
SJOSx	Spring	42	<1%
CFHL	Late-fall	363	2%
Non-CV		0	0%
	Total	9,325	64%

4. 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 or differing policies among agencies with respect to best release practices. The 2017 through 2019 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 3).

Table 11 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 ocean fisheries during 2021. The CWTs collected in the CV river sport fishery are not included since it is not possible to ascertain the location where these fish would have eventually spawned. 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 14 and 15 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	2019	Fall	26	0	0%
FRHF	2019	Fall	6	0	0%
FRHFn	2019	Fall	35	16	45%
NIMF	2019	Fall	69	1	2%
NIMFn	2019	Fall	217	49	23%
MOKF	2019	Fall	0	0	-
MOKFn	2019	Fall	81	59	74%
MOKFnc	2019	Fall	24	19	78%
MOKFgg	2019	Fall	170	144	85%
MERFn	2019	Fall	93	84	90%
FRHS	2019	Spring	2	0	0%
SJOSx	2019	Spring	0	0	-
SacW	2019	Winter	15	0	0%
SacWbat	2019	Winter	7	2	24%
CFHL	2020	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	2018	Fall	262	48	18%
FRHF	2018	Fall	7	0	0.1%
FRHFn	2018	Fall	114	43	38%
NIMF	2018	Fall	98	7	6.7%
NIMFn	2018	Fall	200	23	12%
MOKF	2018	Fall	19	6	33%
MOKFn	2018	Fall	116	93	80%
MOKFnc	2018	Fall	40	37	92%
MOKFgg	2018	Fall	40	32	81%
MERFn	2018	Fall	122	117	96%
FRHS	2018	Spring	411	0	0.1%
SJOSx	2018	Spring	110	99	90%
SacW	2018	Winter	1,397	0	0%
SacWbat	2018	Winter	53	32	60%
CFHL	2019	Late-fall	162	0	0.1%

Age-4 CV Escapement Recovery and Stray Rates

R _{type}	Brood year	Run	# Recoveries per 100K Released	# Strays per 100K Released	% stray
CFHF	2017	Fall	76	8	11%
FRHF	2017	Fall	1	0	0%
FRHFn	2017	Fall	97	36	37%
FRHFgg	2017	Fall	85	45	52%
NIMF	2017	Fall	5	4	88%
NIMFn	2017	Fall	90	26	29%
MOKF	2017	Fall	1	0	0%
MOKFn	2017	Fall	10	8	84%
MOKFnc	2017	Fall	5	5	89%
MERFn	2017	Fall	8	8	100%
FRHS	2017	Spring	145	0	0%
SJOSx	2017	Spring	5	5	100%
SacW	2017	Winter	36	0	0%
SacWbat	2017	Winter	5	0	0%
CFHL	2018	Late-fall	64	0	0%

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

The total recovery rate of CV hatchery releases in California and Oregon (south of Cape Falcon) sport and commercial ocean salmon fisheries varied by age and release type (Table 11). A higher percentage of age-2 CV hatchery salmon were recovered in the ocean sport fishery (Fig. 16) than the commercial fishery due to the smaller size limits in 2021 for the sport fishery compared to the commercial fishery (Table 2).

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

R _{type}	Brood year	Run	# Recoveries per 100K Released	% sport
CFHF	2019	Fall	8	91%
FRHF	2019	Fall	2	100%
FRHFn	2019	Fall	41	97%
NIMF	2019	Fall	23	97%
NIMFn	2019	Fall	126	93%
MOKF	2019	Fall	0	-
MOKFn	2019	Fall	49	91%
MOKFnc	2019	Fall	149	95%
MOKFgg	2019	Fall	245	92%
MERFn	2019	Fall	71	92%
FRHS	2019	Spring	4	95%
SJOSx	2019	Spring	0	-
CFHL	2020	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	2018	Fall	224	23%
FRHF	2018	Fall	211	8%
FRHFn	2018	Fall	384	21%
NIMF	2018	Fall	152	14%
NIMFn	2018	Fall	786	14%
MOKF	2018	Fall	31	13%
MOKFn	2018	Fall	192	18%
MOKFnc	2018	Fall	486	18%
MOKFgg	2018	Fall	541	15%
MERFn	2018	Fall	212	23%
FRHS	2018	Spring	112	16%
SJOSx	2018	Spring	51	30%
SacW	2019	Winter	13	91%
SacWbat	2019	Winter	16	100%
CFHL	2019	Late-fall	90	16%

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

R _{type}	Brood year	Run	# Recoveries per 100K Released	% sport
CFHF	2017	Fall	26	28%
FRHF	2017	Fall	2	100%
FRHFn	2017	Fall	74	28%
FRHFgg	2017	Fall	256	0%
NIMF	2017	Fall	1	0%
NIMFn	2017	Fall	182	16%
MOKF	2017	Fall	0	-
MOKFn	2017	Fall	16	13%
MOKFnc	2017	Fall	66	26%
MERFn	2017	Fall	13	18%
FRHS	2017	Spring	2	0%
SJOSx	2017	Spring	0	-
SacW	2018	Winter	25	23%
SacWbat	2018	Winter	6	43%
CFHL	2018	Late-fall	56	8%

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

Over half of the nearly 281,800 Chinook salmon harvested in California and Oregon (south of Cape Falcon) ocean salmon fisheries were hatchery-origin fish (Fig. 17). The most prevalent CV release types recovered off both states were FRH fall-run bay/delta net pen releases followed by fall-run in-basin releases from CFH.

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

R _{type}	Run	CWT _{total}	% harvest
CFHF	Fall	30,093	11%
FRHF	Fall	101	<1%
FRHFn	Fall	34,281	12%
FRHFgg	Fall	6,323	2%
NIMF	Fall	4,793	2%
NIMFn	Fall	21,032	7%
MOKF	Fall	124	<1%
MOKFn	Fall	12,404	4%
MOKFnc	Fall	6,494	2%
MOKFgg	Fall	9,649	3%
MERF	Fall	0	0%
MERFn	Fall	1,910	1%
Other CV	Non-fall	3,867	1%
Non-CV		14,243	5%
Total		145,315	52%

California ocean sport fishery

California anglers harvested approximately 55,500 Chinook salmon in the ocean sport fishery during 2021. The total contribution of hatchery-origin salmon to the California ocean sport fishery was 64%, ranging from 52% to 68% of the total harvest depending on major port area (Fig. 18). Most of the harvest occurred in the San Francisco port area (62%), followed by the Monterey (31%), Fort Bragg (7%), and Eureka/Crescent City (1%) port areas (Table 12). The relatively low harvest in the Eureka/Crescent City port area should be contextualized with the area experiencing a shorter season of 34 days compared to other management areas (Table 2).

Of all hatchery release types, FRH fall-run bay/delta net pen releases contributed the most (16%) to the total California ocean sport harvest, followed by CFH fall-run in-basin and MOK Golden Gate releases (13% and 9%, respectively). Non-CV releases composed 1% of the total sport harvest (Table 13).

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

R _{type}	Run	CWT _{total}	% harvest
CFHF	Fall	7,248	13%
FRHF	Fall	41	<1%
FRHFn	Fall	8,807	16%
FRHFgg	Fall	1,182	2%
NIMF	Fall	1,104	2%
NIMFn	Fall	4,695	8%
MOKF	Fall	16	<1%
MOKFn	Fall	3,475	6%
MOKFnc	Fall	2,394	4%
MOKFgg	Fall	4,911	9%
MERF	Fall	0	0%
MERFn	Fall	558	1%
SacW	Winter	75	<1%
FRHS	Spring	379	1%
SJOSx	Spring	33	<1%
CFHL	Late-fall	192	<1%
Non-CV		437	1%
Total		35,534	64%

California ocean commercial fishery

California trollers harvested approximately 202,500 Chinook salmon in the commercial ocean fishery during 2021. The total contribution of hatchery-origin salmon to the California commercial ocean fishery was 48%, ranging from 44% to 53% of the total harvest depending on major port area (Fig. 19). Most of the harvest occurred in the San Francisco port area (52%), followed by the Monterey (26%), and Fort Bragg (22%) port areas (Table 14). The Eureka/Crescent City port area was closed to commercial fishing during 2021.

Of all hatchery release types, FRH fall-run bay/delta net pen releases contributed the most (12%) to the total California commercial harvest, followed by CFH fall-run in-basin releases and NIM bay/delta net pen releases (11% and 8%, respectively). Non-CV releases contributed 3% to the total commercial harvest (Table 15).

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

R _{type}	Run	CWT _{total}	% harvest
CFHF	Fall	21,830	11%
FRHF	Fall	58	<1%
FRHFn	Fall	24,281	12%
FRHFgg	Fall	4,611	2%
NIMF	Fall	3,585	2%
NIMFn	Fall	15,649	8%
MOKF	Fall	103	<1%
MOKFn	Fall	8,345	4%
MOKFnc	Fall	3,834	2%
MOKFgg	Fall	4,370	2%
MERF	Fall	0	0%
MERFn	Fall	1,138	1%
SacW	Winter	54	<1%
FRHS	Spring	1,675	1%
SJOSx	Spring	78	<1%
CFHL	Late-fall	1,266	1%
Non-CV		6,120	3%
Total		96,999	48%

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

In 2021, CWTs from many fall-run experimental and net pen release types were recovered in the CV escapement and ocean harvest, and this section will focus on those from brood years 2017 through 2019 (ages 2-4). Experimental releases include non-acclimated Golden Gate releases at Fort Baker which utilized approximately 2.8 million and 2.4 million fall-run salmon from MOK and FRH, respectively, as well as 30,000 FRH in-basin releases.

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 (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.

The experimental and net pen releases recovered in 2021 are differentiated into the following release types:

- **FRHFe** Feather River Hatchery **F**all-run in-basin **e**xperimental releases
- **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
- **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 16, Fig. 20).

Age-2 CV Escapement Recovery and Stray Rates

R _{type}	Brood year	Run	# Recoveries per 100K Released	# Strays per 100K Released	% stray
FRHFn	2019	Fall	35	16	45%
NIMFn	2019	Fall	217	49	23%
MOKFn	2019	Fall	81	59	74%
MOKFnp	2019	Fall	38	31	82%
MOKFns	2019	Fall	15	11	73%
MOKFgg	2019	Fall	170	144	85%
MERFn	2019	Fall	93	84	90%

Age-3 CV Escapement Recovery and Stray Rates

R _{type}	Brood year	Run	# Recoveries per 100K Released	# Strays per 100K Released	% stray
FRHFe	2018	Fall	7	0	0%
FRHFn	2018	Fall	114	43	38%
NIMFn	2018	Fall	200	23	12%
MOKFn	2018	Fall	116	93	80%
MOKFnp	2018	Fall	46	43	92%
MOKFns	2018	Fall	1	0	0%
MOKFgg	2018	Fall	40	32	81%
MERFn	2018	Fall	122	117	96%

Age-4 CV Escapement Recovery and Stray Rates

R _{type}	Brood year	Run	# Recoveries per 100K Released	# Strays per 100K Released	% stray
FRHFn	2017	Fall	97	36	37%
FRHFgg	2017	Fall	85	45	52%
NIMFn	2017	Fall	90	26	29%
MOKFn	2017	Fall	10	8	84%
MOKFnp	2017	Fall	5	5	89%
MERFn	2017	Fall	8	8	100%

Ocean Fishery Harvest

The recovery rate for all fall-run experimental and net pen releases in California and Oregon ocean salmon fisheries, and the percent that occurred in the sport fishery, are shown below to allow direct comparison among these release types (Table 16, Fig. 21).

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

R _{type}	Brood year	Run	# Recoveries per 100K	
			Released	% sport
FRHFn	2019	Fall	41	97%
NIMFn	2019	Fall	126	93%
MOKFn	2019	Fall	49	91%
MOKFnp	2019	Fall	155	93%
MOKFns	2019	Fall	145	96%
MOKFgg	2019	Fall	245	92%
MERFn	2019	Fall	71	92%

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

R _{type}	Brood year	Run	# Recoveries per 100K	
			Released	% sport
FRHFe	2018	Fall	211	8%
FRHFn	2018	Fall	384	21%
NIMFn	2018	Fall	786	14%
MOKFn	2018	Fall	192	18%
MOKFnp	2018	Fall	532	19%
MOKFns	2018	Fall	197	9%
MOKFgg	2018	Fall	541	15%
MERFn	2018	Fall	212	23%

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

R _{type}	Brood year	Run	# Recoveries per 100K	
			Released	% sport
FRHFn	2017	Fall	74	28%
FRHFgg	2017	Fall	256	20%
NIMFn	2017	Fall	182	16%
MOKFn	2017	Fall	16	12%
MOKFnp	2017	Fall	65	26%
MERFn	2017	Fall	13	18%

2021 CFM ANALYSES KEY POINTS

- A majority (69%) of the 2021 CV salmon escapement (all run-types) were hatchery-origin fish. This was a decrease of 5% in hatchery contribution from the 2020 escapement. Between 2010 and 2020, the hatchery contribution to the total CV escapement averaged 74% and ranged between 57% and 88%. CFH fall-run in-basin releases had the highest contribution (27%) to the total 2021 CV escapement hatchery spawners, with FRH fall-run bay/delta net pen releases (11%) being the next highest contributor.
- The highest stray rates occurred with MER fall-run bay/delta net pen releases (96%) followed by San Joaquin River spring-run experimental reintroduction releases (90%). Additionally, offsite releases from MOK strayed at very high rates, with the highest being fall-run coastal net pen (86%), followed by Golden Gate (85%; includes those that were barged to the Golden Gate) and bay/delta (78%) releases. Offsite releases from other hatcheries strayed at lower rates, with the lowest being NIM fall-run bay/delta releases (20%), followed by FRH fall-run Golden Gate and bay/delta releases (52% and 39%, respectively).
- Salmon escapement into all CV hatcheries was predominately hatchery-origin fish. At all CV hatcheries, except MER, the majority of their return was composed of their respective releases. The out-of-basin hatchery returns at MER and NIM were quite high (82% and 31%, respectively), with most of those strays originating from MOK.
- Hatchery contributions to natural area escapements fell in-line with the average hatchery contribution since the CFM program was fully implemented. For fall-run specifically, the hatchery contribution across all CV natural areas was 69% compared to the 2010-2018 average of 69% (range: 53% - 81%). Most natural area spawners were primarily hatchery-origin fish. The exceptions were late fall-, winter-, and fall-run spawners in the upper Sacramento River mainstem.
- In the Sacramento, Feather, and American Rivers most of the hatchery-origin components consisted of release types from their respective hatcheries. However, strays from out-of-basin hatcheries made noticeable contributions to the natural area escapements in the American and Merced Rivers (35% and 56% of the hatchery-origin components, respectively), with MOK fall-run bay/delta releases making the most notable contribution to the American and Merced Rivers (21% and 39% of the hatchery-origin component, respectively).
- Fall-run escapement in the upper Sacramento River mainstem was predominately natural-origin salmon (61% natural vs. 39% hatchery). The hatchery contribution was the lowest of all the natural area fall-run escapements. The total escapement to the upper Sacramento River was below the long-term average and may be impacting the relative hatchery contributions of the different survey areas. The 39% hatchery contribution however is equal to the average contribution between 2010 and 2018 (Letvin et al. 2021). CFH in-basin releases composed more than half of the hatchery-origin portion of the Sacramento River mainstem fall-run escapement.

- Fall- and spring-run escapement to the natural spawning areas of the Feather River was mostly hatchery-origin salmon. FRH spring-run releases had the highest contribution of any release type, followed by FRH fall-run bay/delta net pen releases (55% and 35% of the hatchery-origin component, respectively). In-basin fall-run releases from FRH composed <1% of the escapement.
- Returns to the Yuba River below DPD were extremely low in 2021. As such, it was decided to combine the river sectors above and below the DPD for the purposes of this report. The escapement to the Yuba River was composed of marginally more hatchery-origin salmon (48% natural vs. 52% hatchery). The hatchery-origin component was largely comprised of FRH spring-run and NIM fall-run bay/delta net pen releases (both 28% of the hatchery-origin component), followed closely by MOK fall-run Golden Gate releases (21% of the hatchery-origin component).
- Fall-run escapement to the natural spawning areas of the American River was dominated by hatchery-origin salmon (10% natural vs. 90% hatchery). NIM bay/delta releases were the highest-contributing release types (38% of the hatchery-origin component), followed by NIM in-basin and MOK bay/delta releases (both 23% of the hatchery-origin component).
- Fall-run escapement to the natural spawning areas of the Mokelumne River were low in 2021, with just over 800 salmon returning. Due to low returns and no recoveries of CWTs from ad-clipped salmon no assumptions can be made about hatchery- and natural-origin contributions to this system.
- Fall-run escapement to the Stanislaus and Tuolumne Rivers were mostly hatchery-origin salmon (91% and 84% hatchery-origin, respectively). Stray MOK bay/delta net pen releases comprised the majority of the hatchery-origin component for the Stanislaus River (64% of the hatchery-origin component), while San Joaquin River spring-run experimental reintroduction releases comprised the majority of the hatchery-origin component for the Tuolumne River (53% of the hatchery-origin component).
- Fall-run escapement to the natural spawning areas of the Merced River was predominantly composed of hatchery-origin salmon (32% natural vs. 68% hatchery). Stray MOK bay/delta releases comprised the majority of the hatchery-origin component (57% of the hatchery-origin component).
- For age-2 fall-run salmon, NIM bay/delta releases had the highest CV escapement recovery rate for their cohort (217 recoveries per 100,000 released), followed by MOK Golden Gate releases (170 recoveries per 100,000 released).
- For age-3 fall-run salmon, CFH in-basin releases had the highest CV escapement recovery rates for their cohort (262 recoveries per 100,000 released), followed by NIM bay/delta releases (200 recoveries per 100,000 released).

- For age-4 fall-run salmon, FRH bay/delta releases had the highest CV escapement recovery rate for their cohort (97 recoveries per 100,000 released), followed by NIM bay/delta releases (90 recoveries per 100,000 released).
- Offsite releases from MER and MOK strayed at the highest rates for ages-2, -3, and -4, ranging from 74-100%, of fall-run salmon. Recoveries from other hatcheries and MOK in-basin strayed at much lower rates, except for age-4 NIM in-basin and FRH Golden Gate releases (88% and 52%, respectively).
- Most of the total CV river sport harvest was comprised of hatchery-origin salmon (64%). Between 2010 and 2020, the hatchery contribution to the CV river sport harvest averaged 75% and ranged between 60% and 84%. The highest-contributing hatchery release types were CFH fall-run in-basin, FRH fall-run bay/delta, and NIM bay/delta releases. While in-basin releases were largely recovered in their basin-of-origin, the hatchery-origin fish recovered in the lower Sacramento River were comprised of MOK, FRH, and NIM releases. This is expected as all CV salmon must pass through the lower Sacramento River when returning to their basin-of-origin.
- Over half of the California ocean sport harvest was composed of hatchery-origin fish, while California ocean commercial harvest was evenly split between hatchery- and natural-origin fish (48% and 52%, respectively). FRH fall-run bay/delta and CFH fall-run in-basin releases had the highest contributions to sport and commercial fisheries. There were also moderate contributions from NIM bay/delta and MOK Golden Gate releases for the sport fishery, and NIM bay/delta and MOK bay/delta releases for the commercial fishery. Non-CV hatchery production contributed little to the ocean harvest (1% for sport and 3% for commercial fisheries).
- Ocean recovery rates for NIM fall-run releases were higher than 2020. The bay/delta releases from brood year 2018 had the highest age-3 ocean recovery rate of any release type analyzed in this report (786 recoveries per 100,000 released).
- Ocean recovery rates for Golden Gate releases were very high in 2021. The Golden Gate releases from MOK and FRH had the highest recoveries rates of age-2 and age-4 salmon, respectively (245 and 256 recoveries per 100,000 released, respectively). For the ages at which they were present, their ocean recovery rates exceeded those of the bay/delta and coastal net pen releases from the same hatchery and brood, except for NIM bay/delta releases from brood year 2018. The sole Golden Gate release from FRH strayed at a lower rate than those produced at MOK.
- Coastal fall-run releases, all of which were from MOK, also had high ocean recovery rates at all ages. CV escapement recovery rates were significantly lower than ocean recovery rates at all ages. Releases from Pillar Point and Santa Cruz only co-occurred in age-2 and -3 fish. While the age-2 and age-3 CV recovery rates were low for both release locations, the Santa Cruz CV recovery rate was noticeably lower, particularly for age-3 salmon. Additionally, the Santa Cruz releases had lower CV recovery rates than other offsite releases.

- This is the fifth 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. Results from 2021 suggest lower survival rates overall for both release strategies when compared to previous years, but in-basin survival was much lower than out-of-basin releases, particularly for brood years 2019 and 2017 (ages-2 and -4, respectively).
- Recovery rates for the 2019 brood of FRH in-basin releases were 6 and 2 CWTs per 100,000 released for the CV and ocean, respectively. Comparatively, recovery rates for FRH bay/delta releases in the CV and ocean were 35 and 41 CWTs per 100,000 released, respectively. Age-4 in-basin CV and ocean recovery rates were 1 and 2 CWTs per 100,000 released, respectively, while both the FRH bay/delta and Golden Gate releases had higher CV and ocean recovery rates. Between the two out-of-basin releases, FRH bay/delta releases had a higher CV recovery rate than FRH Golden Gate releases (97 and 85, respectively), but the Golden Gate releases had a significantly higher ocean recovery rate than the bay/delta releases (256 and 74, respectively). The in-basin recovery rates for brood year 2018, which was limited to a single experimental release, were lower than out-of-basin, especially for CV recoveries with a rate of 7 CWTs per 100,000 released for in-basin. However, the ocean recovery rate for in-basin releases was significantly higher than the CV with a rate of 211 CWTs per 100,000 released.
- FRH in-basin releases experienced almost no straying, while out-of-basin releases had higher stray rates for all brood years, ranging from 37-52% for brood years 2017-2019, which was much higher than in previous years of reporting.
- The age-3 upper Sacramento River winter-run CV recovery rate of 1,397 CWTs per 100,000 released was the second highest recovery rate that has been observed in these reports. Between 2012 and 2020, the age-3 winter-run CV recovery rate averaged 544 CWTs per 100,000 released and ranged between 72 and 1,896. While water year 2018/19 was relatively wet, brood year 2018 releases occurred at the same downstream site, Bonnyview Boat Ramp, as the previous year (DWR 2020). Additionally, the 2021 winter-run escapement to the upper Sacramento River was the highest escapement observed since 2006 (PFMC 2024).
- 2021 was the third 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 (ages-2 through -4). The CV and ocean recovery rates for this release type were both lower than for winter-run released into the upper Sacramento River, except for ocean recoveries of brood year 2019, which was slightly higher. Among the winter-run that returned to the CV in 2021, 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-2 and age-3 winter-run releases into Battle Creek strayed at rates of 24% and 60%, respectively.

- Winter- and spring-run were recovered at low rates in both inland and ocean fisheries not exceeding 1% of the hatchery component when encountered. In ocean sport and commercial fisheries, after expansion, 129 winter-run and 2,161 FRH spring-run were recovered. No winter-run were recovered in inland fisheries.
- This is the third 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. 2021 saw low flows during the spring, however returns were slightly higher than in 2020. The spring-run escapement to this sector was overwhelmingly hatchery-origin salmon, although that is expected this early in the reintroduction effort.

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 11 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 2021. 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.

The CFM program should be continued with the current design to provide comparable, consistent data needed for hatchery and harvest management. Securing permanent and comprehensive inland and ocean funding for this marking, tagging, monitoring, and evaluation program is critical. Such funding is essential to providing complete analyses of recovery and stray rates across release strategies and will allow critical data to be available by February of each year to manage CV salmon stocks, hatchery production, and California ocean and river fisheries using the most recent information, similar to the Klamath Basin fall-run Chinook salmon management process.

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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
- 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
- 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 2021 CV Chinook hatchery escapement.

Sampling Location	Estimation and Sampling Methods	Agency
Hatchery Spawners		
Coleman National Fish Hatchery (CFH) Fall and Late-Fall (2022)	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, 730 mm males fall; 560 mm females, 600 mm males late-fall.	FWS
CFH Winter and Late-Fall (2022) 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: 560 mm females, 600 mm males late-fall; 520 mm females, 600 mm males winter ^{b/} .	FWS
Keswick Fish Trap Winter and Late-Fall (2022)	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 Dec-Feb. Grilse cutoff: 520 mm females, 600 mm males winter; 560 mm females, 600 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 April 30 - July 6 (n~ 4,797) 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 16 and spring spawning began Sep 21. All spring-run fish bio-sampled. Fall spawning occurred on Oct 4 for the cold water program and began normally on Oct 8. Fall spawning ceased on Nov 10. 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 open Oct 29 - Feb 24. 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 1 - Mar 31. 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 14. All fish examined for fin-clips, tags, marks. All ad-clipped fish were sampled and heads processed for CWT recovery. Grilse cutoff: 610 mm females, 670 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 2021 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 (2022)	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: 525 mm females, 625 mm males winter; 610 mm females, 670 mm males fall; 660 mm 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 4 carcasses observed. Bio-sampling data from CFH used as a surrogate.	CDFW
Battle Creek Fall	Video weir count (Aug 19 - Dec 9) 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 (Sep 30 - 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
Butte Creek Spring	Superpopulation modification of the Cormack-Jolly-Seber mark-recapture estimate for spring-run. All fish examined for fin-clips, tags, marks. Systematic random bio-sample of all fish. No ad-clipped fish were observed. Grilse cutoff: 600 mm.	CDFW

Table 1b. Estimation and sampling methods used for the 2021 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: 640 mm females, 730 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: 610 mm females, 670 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: 610 mm females, 670 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: 610 mm females, 670 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 1c. Survey design and open dates for the 2021 CV Chinook river sport harvest.

Sampling Location	Survey Design and Open Dates	Agency
<u>Sport Harvest</u>		
	Survey Design	
Central Valley Angler Survey (CVAS)	Stratified-random sampling design (four weekday and four weekend samples per month per section during the open season in each management zone) that included roving counts, roving interviews, access interviews, and sub-sampling of kept salmon. Almost all ad-clipped salmon sampled and heads collected for CWT recovery. Estimates of fishing effort, catch, and harvest of Chinook salmon made monthly for each survey section and then summed for the season total. Grilse cutoff for Sacramento Basin fall-run fishery sectors: 715 mm females, 729 mm males.	CDFW
	Open Dates	
Upper Sacramento River Fall and Late-Fall	Open Aug 1 - Dec 31 from the Deschutes Road Bridge to Red Bluff Diversion Dam and Jul 16 - Dec 16 from Red Bluff Diversion Dam to the Highway 113 bridge near Knights Landing. Nov 1 is used to delineate the cutoff between the fall-run fishery and the late-fall-run fishery.	
Feather River Fall	Open Jul 16 - Oct 31 from the unimproved boat ramp above the Thermalito Afterbay Outfall to 200 yards above the Live Oak boat ramp and Jul 16 - Dec 16 from 200 yards below the Live Oak boat ramp to the Sacramento River confluence.	
American River Fall	Open Jul 16 - Oct 31 from the USGS cable crossing to the Ancil Hoffman powerlines and Jul 16 - Dec 31 from the Ancil Hoffman powerlines to the confluence with the Sacramento River.	
Lower Sacramento River Fall	Open Jul 16 - Dec 16 from the Highway 113 bridge near Knights Landing to the Carquinez Bridge.	
Mokelumne River Fall	Open Jul 16 - Dec 16 from the Camanche Dam to the Highway 12 overcrossing.	
	Bag and Size Limit	
All Areas	2 Chinook salmon per day with a 4 salmon possession limit per angler; no minimum size limit.	

Table 2. California ocean salmon sport and commercial fishery seasons by major port area, 2021.

Major Port Area	Sport Fishery			Commercial Fishery		
	Season	Size Limit ^{a/}	Days Open	Season	Size Limit ^{a/}	Days Open
Eureka/Crescent City (Klamath Mgmt Zone) ^{b/c/}	June 29 - August 1	20" TL	34	Closed		
Fort Bragg ^{b/}	June 29 - October 31	20" TL	125	August 1 - 17	27" TL	17
				September 1 -30	27" TL	<u>30</u>
						47
San Francisco	June 26 - October 31	20" TL	128	June 16 - 30	27" TL	15
				July 17 - 22	27" TL	6
				August 1 - 17	27" TL	17
				September 1 -30	26" TL	30
				October 1, 4 - 8, 11 - 15 ^{d/}	26" TL	<u>11</u>
						79
Monterey ^{e/}	April 3 - May 15	24" TL	43	May 1 - 12, 20 - 27	27" TL	20
	May 16 - September 30	20" TL	<u>138</u>	June 16 - 30	27" TL	15
			181	July 17 - 22	27" TL	6
				August 1 - 17	27" TL	<u>17</u>
						58
California Total			468			184

a/ Size limit in inches total length (TL).

b/ Boundary between the Klamath Management Zone and Fort Bragg Management Area was changed from Horse Mountain to the 40°10' Line near Cape Mendocino in 2021.

c/ Special Salmon Closures included Smith River mouth closed year round, Klamath River mouth closed year round and the closure expanded to the Klamath Control Zone in August, and Eel River mouth closed in August and September.

d/ Open Monday through Friday between Pt. Reyes and Pt. San Pedro.

e/ Regulations apply from the Monterey area to the U.S./Mexico border.

Table 3. Central Valley coded-wire tag (CWT) Chinook releases recovered in 2021 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	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 (Boyds Pump Ramp and Gridley)
SJOSx	2019	SJO	San Joa R	Spr	13	232,903	238,855	98%	Reintroduction	San Joaquin River (Fremont Ford Bridge, Friant, and Owl Hollow)
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	Sacramento River (Boyds 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
MOKFnc	2019	MOK	Mok R	Fall	3	508,729	1,105,544	46%	Coastal pens	70% released in Pillar Point; 15% released in Santa Cruz; 15% released in Monterey
MOKFgg	2019	MOK	Mok R	Fall	4	486,615	1,947,732	25%	Trucked	Golden Gate releases; trucked to Fort Baker
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	872,269	878,771	99%	In-basin	CFH (includes spring surrogate releases)
Total age-2 releases:					114	11,649,197	35,080,691	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	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 (Boyds 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, Friant, and Owl Hollow)
CFHF	2018	CFH	Sac R	Fall	32	3,448,504	12,835,143	27%	In-basin	CFH only
FRHF	2018	FRH	Fea R	Fall	1	30,000	30,000	100%	In-basin	Feather 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	2	873,909	878,603	99%	Coastal pens	86% released in Pillar Point; 14% released in Santa Cruz
MOKFgg	2018	MOK	Mok R	Fall	2	225,158	901,151	25%	Trucked	Golden Gate release; 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)
Total age-3 releases:					120	13,041,064	35,232,986	37%		

Table 3. Central Valley coded-wire tag (CWT) Chinook releases recovered in 2021 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	2017	LSH	Sac R	Wint	5	216,237	216,746	100%	In-basin	Sacramento River (Bonnyview Boat Ramp)
SacWbat	2017	LSH	Sac R	Wint	7	212,136	213,546	99%	Reintroduction	North Fork Battle Creek
FRHS	2017	FRH	Fea R	Spr	2	488,223	493,903	99%	In-basin	Feather River (Boyds Pump Ramp)
SJOSx	2017	SJO	San Joa R	Spr	8	209,308	213,526	98%	Reintroduction	San Joaquin River (Fremont Ford Bridge and Friant)
CFHF	2017	CFH	Sac R	Fall	16	1,369,512	5,498,252	25%	In-basin	CFH only
FRHF	2017	FRH	Fea R	Fall	3	250,489	1,007,846	25%	In-basin	Feather River (Elkhorn Boat Ramp)
FRHFn	2017	FRH	Fea R	Fall	2	1,496,598	6,005,638	25%	Bay/Delta pens	San Pablo Bay (Mare Island) net pen releases
FRHFgg	2017	FRH	Fea R	Fall	8	609,272	2,460,352	25%	Trucked	Golden Gate releases; trucked to Fort Baker
NIMF	2017	NIM	Ame R	Fall	2	334,047	1,336,727	25%	In-basin	American River (Jibboom Street Bridge and Sunrise Recreation Area)
NIMFn	2017	NIM	Ame R	Fall	4	664,585	2,667,426	25%	Bay/Delta pens	San Pablo Bay (Mare Island and Wickland Oil) net pen releases
MOKF	2017	MOK	Mok R	Fall	2	398,785	400,790	99%	In-basin	Mokelumne River (Hatchery and Woodbridge Dam)
MOKFn	2017	MOK	Mok R	Fall	15	1,649,629	5,383,993	31%	Bay/Delta pens	Western Delta (Sherman Island) net pen releases
MOKFnc	2017	MOK	Mok R	Fall	1	727,344	742,256	98%	Coastal pens	Pillar Point coastal net pen releases
MERFn	2017	MER	Mer R	Fall	3	255,259	1,224,315	21%	Bay/Delta pens	Western Delta (Sherman Island) net pen releases
CFHL	2018	CFH	Sac R	Late	14	881,364	901,122	98%	In-basin	CFH (includes spring surrogate releases)
Total age-4 releases:					92	9,762,788	28,766,438	34%		
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	2016	LSH	Sac R	Wint	5	138,803	141,332	98%	In-basin	Sacramento River (Lake Redding Park)
FRHS	2016	FRH	Fea R	Spr	5	1,682,317	1,699,791	99%	In-basin	Feather River (Boyds Pump Ramp & Gridley)
SJOSx	2016	SJO	San Joa R	Spr	6	90,741	90,741	100%	Reintroduction	San Joaquin River (Hills Ferry, Friant, and Eastside Bypass)
CFHF	2016	CFH	Sac R	Fall	28	3,020,565	12,184,997	25%	In-basin	CFH only
FRHFn	2016	FRH	Fea R	Fall	6	733,880	2,900,225	25%	Bay/Delta pens	San Pablo Bay (Mare Island) net pen releases
NIMF	2016	NIM	Ame R	Fall	4	591,200	2,367,561	25%	In-basin	American River (Jibboom Street Bridge and Sunrise Recreation Area)
NIMFn	2016	NIM	Ame R	Fall	2	277,532	1,113,203	25%	Bay/Delta pens	San Pablo Bay (Mare Island) net pen releases
MOKF	2016	MOK	Mok R	Fall	2	398,284	398,784	100%	In-basin	Mokelumne River (Hatchery and Woodbridge Dam)
MOKFn	2016	MOK	Mok R	Fall	12	1,155,829	4,640,819	25%	Bay/Delta pens	Western Delta (Sherman Island) net pen releases
MOKFnc	2016	MOK	Mok R	Fall	2	841,802	852,419	99%	Coastal pens	86% released in Pillar Point; 14% released in Santa Cruz
MOKFgg	2016	MOK	Mok R	Fall	1	225,243	225,870	100%	Trucked	Golden Gate releases; trucked to Fort Baker
MOKFb	2016	MOK	Mok R	Fall	3	295,120	301,692	98%	Barge study	3 release sites: Mok R (Miller's Ferry), barged (SF Bay), trucked (Sausalito)
MERF	2016	MER	Mer R	Fall	3	245,340	1,334,843	18%	In-basin	MER only
CFHL	2017	CFH	Sac R	Late	14	1,047,211	1,063,413	98%	In-basin	CFH (includes spring surrogate and trap efficiency releases)

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

CFHF	Coleman National Fish Hatchery fall in-basin 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)
NIMF	Nimbus Fish Hatchery fall in-basin releases
NIMFn	Nimbus Fish Hatchery fall bay/delta net pen releases

Other CV Chinook release types (OCV)

MOKF	Mokelumne River Hatchery fall in-basin releases
MOKFn	Mokelumne River Hatchery fall bay/delta net pen releases
MOKFnc	Mokelumne River Hatchery fall coastal net pen releases
MOKFgg	Mokelumne River Hatchery fall Golden Gate releases (no net pens)
MOKFb	Mokelumne River Hatchery fall barge study releases
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
SJOSx	San Joaquin Salmon Conservation and Research Facility spring reintroduction releases
CFHL	Coleman National Fish Hatchery late-fall in-basin releases

Table 4. Central Valley hatchery and natural area escapement estimates, sport harvest, and sample data, 2021.

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	247	247	58	56	56	1.000	0.966	1.000	1.04
Keswick Dam Fish Trap	Winter	298	298	242	242	240	1.000	1.000	0.992	1.01
Feather River Hatchery	Spring	1,722	1,722	1,624	1,624	1,594	1.000	1.000	0.997	1.00
Coleman National Fish Hatchery	Fall	16,438	16,438	4,041	3,918	3,853	1.000	0.970	0.998	1.03
Feather River Hatchery	Fall	12,385	12,385	3,812	3,812	3,725	1.000	1.000	0.998	1.00
Nimbus Fish Hatchery	Fall	11,077	11,077	2,656	2,656	2,578	1.000	1.000	0.999	1.00
Mokelumne River Hatchery	Fall	4,217	4,217	1,105	1,105	1,054	1.000	1.000	0.997	1.00
Merced River Hatchery	Fall	267	267	71	71	71	1.000	1.000	1.000	0.98
Coleman National Fish Hatchery	Late-fall ^{c/}	2,310	2,310	2,268	2,259	2,220	1.000	0.996	0.998	1.01 ^{b/}
Coleman Hatchery Fish Trap	Late-fall ^{c/}	74	74	74	25	23	1.000	0.338	0.958	3.09
Total Hatchery Escapement		49,035	49,035	15,951	15,768	15,414				
Natural Area Escapement										
Upper Sacramento River (above Princeton)	Winter	9,971	4,545	1,203	1,189	1,136	0.456	0.988	0.999	2.57 ^{d/}
Butte Creek	Spring	1,807	374	0	0	0	0.207	-	-	-
Upper San Joaquin River (above Merced R.)	Spring	32	32	32	32	23	1.000	1.000	1.000	1.03 ^{d/}
Upper Sacramento River (above Princeton)	Fall	15,629	1,577	70	70	61	0.101	1.000	0.968	29.42 ^{d/}
Clear Creek	Fall	19,867	1,178	225	225	203	0.059	1.000	0.990	14.16 ^{d/}
Battle Creek	Fall	17,453	0	Video - no biodata collected		4,215 ^{e/}	-	-	-	1.00
Cow Creek ^{f/}	Fall	1,463	4	Video - no CWTs observed		0	0.003	-	-	1.00
Mill Creek ^{f/}	Fall	589	27	Video - opportunistic CWTs		3	0.046	-	-	1.00
Feather River	Fall	9,688	1,260	721	721	704	0.130	1.000	0.997	7.71 ^{d/}
Yuba River ^{f/}	Fall	4,669	4,473	1,091	28	28	0.958	0.026	1.000	41.69 ^{g/}
American River ^{h/}	Fall	11,232	4,871	753	753	702	0.434	1.000	0.994	3.80
Mokelumne River ^{f/}	Fall	826	826	0	0	0	1.000	0.000	0.000	1.00 ^{g/}
Stanislaus River	Fall	4,314	840	208	208	205	0.195	1.000	1.000	5.14 ^{d/}
Tuolumne River	Fall	188	101	23	23	22	0.537	1.000	1.000	4.59 ^{d/}
Merced River	Fall	470	113	12	12	12	0.240	1.000	1.000	6.53 ^{b/d/}
Upper Sacramento River (above Princeton)	Late-fall ^{c/}	4,734	210	4	4	4	0.044	1.000	1.000	59.18 ^{d/}
Total Natural Area Escapement		102,932	20,431	4,342	3,265	7,318				
CV Sport Harvest										
Upper Sacramento River (above Feather R.)	Fall	8,951	672	115	106	105	0.075	0.922	1.000	14.45
Lower Sacramento River (below Feather R.)	Fall	2,586	152	35	35	35	0.059	1.000	1.000	17.01
Feather River	Fall	801	64	12	12	11	0.080	1.000	1.000	12.52
American River	Fall	1,593	72	15	15	15	0.045	1.000	1.000	22.12
Mokelumne River ^{f/}	Fall	36	3	0	0	0	0.083	-	-	-
Upper Sacramento River (above Feather R.)	Late-fall	593	65	38	36	36	0.110	0.947	1.000	9.63
Total Sport Harvest		14,560	1,028	215	204	202				
Total Sampled		70,494	20,508	19,237	22,934					

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 2021 through early 2022 (return year 2022).

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.

i/ Yuba River escapement for above and below the DPD merged for 2021 due to low returns.

Table 5. Total harvest and sample data for 2021 ocean salmon sport and commercial fisheries by major port area.

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_{sample}
California Sport									
Eureka/Crescent	647	244	51	49	35	0.377	0.961	1.000	2.76
Fort Bragg	3,775	910	188	185	173	0.241	0.984	0.994	4.24
San Francisco	34,171	9,626	1,898	1,874	1,827	0.282	0.987	0.997	3.60
Monterey	<u>16,954</u>	<u>3,917</u>	<u>748</u>	<u>654</u>	<u>625</u>	<u>0.231</u>	<u>0.874</u>	<u>0.998</u>	<u>4.96</u>
	55,547	14,697	2,885	2,762	2,660	0.265	0.957	0.997	3.96
California Commercial									
Eureka/Crescent ^{b/}	-	-	-	-	-	-	-	-	-
Fort Bragg	44,725	11,451	1,795	1,795	1,611	0.256	1.000	0.998	3.91
San Francisco	104,893	28,514	4,550	4,549	4,270	0.272	1.000	0.999	3.68
Monterey	<u>52,837</u>	<u>16,995</u>	<u>2,822</u>	<u>2,813</u>	<u>2,729</u>	<u>0.322</u>	<u>0.997</u>	<u>0.996</u>	<u>3.13</u>
	202,455	56,960	9,167	9,157	8,610	0.281	0.999	0.998	3.57
California Total	258,002	71,657	12,052	11,919	11,270				
Oregon Sport	6,440	1,938	264	263	236	0.301	0.996	0.992	3.36
Oregon Commercial	17,360	8,032	1,283	1,278	1,227	0.463	0.996	0.995	2.18
Oregon Total	23,800	9,970	1,547	1,541	1,463				

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

b/ The Eureka/Crescent City port area was closed to salmon fishing in 2021 for commercial fisheries.

Table 6. Raw and expanded Chinook CWT recoveries in the Central Valley by run type and brood year during 2021^{a/}.

<u>Fall-run</u>		2019	2018	2017	2016	Total CV CWTs	Total CV %
Age		2	3	4	5		
Raw CWT Recoveries		3,231 (21%)	9,963 (65%)	2,058 (13%)	68 (<1%)	15,320	67%
Expanded CWT _{total}		21,202 (22%)	59,582 (61%)	16,222 (17%)	732 (<1%)	97,737	87%
<u>Spring-run</u>		2019	2018	2017	2016	Total CV CWTs	Total CV %
Age		2	3	4	5		
Raw CWT Recoveries		19 (<1%)	3,640 (93%)	227 (6%)	11 (<1%)	3,897	17%
Expanded CWT _{total}		33 (<1%)	7,893 (91%)	740 (9%)	38 (<1%)	8,704	8%
<u>Late-fall-run</u>		2020	2019	2018	2017	Total CV CWTs	Total CV %
Age		2	3	4	5		
Raw CWT Recoveries		106 (5%)	1,679 (74%)	491 (22%)	6 (<1%)	2,282	10%
Expanded CWT _{total}		108 (4%)	2,071 (74%)	625 (22%)	6 (<1%)	2,810	2%
<u>Winter-run</u>		2019	2018	2017	2016	Total CV CWTs	Total CV %
Age		2	3	4	5		
Raw CWT Recoveries		30 (2%)	1,359 (95%)	42 (3%)		1,431	6%
Expanded CWT _{total}		48 (1%)	3,225 (96%)	90 (3%)		3,362	3%
<u>All Runs</u>		2019	2018	2017	2016	Total CV CWTs	Total CV %
Age		2	3	4	5		
Raw CWT Recoveries		3,386 (15%)	16,641 (73%)	2,818 (12%)	85 (<1%)	22,930	100%
Expanded CWT _{total}		21,391 (19%)	72,770 (65%)	17,677 (16%)	777 (<1%)	112,614	100%

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

Table 7. Raw and expanded Chinook CWT recoveries in 2021 California ocean fisheries by run type and brood year^{a/}.

<u>Fall-run</u>		2019	2018	2017	2016	Total Ocean CWTs	Total Ocean %
Age		2	3	4	5		
Raw CWT Recoveries		1,102 (11%)	7,496 (76%)	1,200 (12%)	7 (<1%)	9,805	87%
Expanded CWT _{total}		14,821 (12%)	90,894 (74%)	16,465 (13%)	55 (<1%)	122,236	92%
<u>Spring-run</u>		2019	2018	2017	2016	Total Ocean CWTs	Total Ocean %
Age		2	3	4	5		
Raw CWT Recoveries		19 (3%)	552 (96%)	3 (<1%)		574	5%
Expanded CWT _{total}		73 (3%)	2,083 (96%)	11 (<1%)		2,167	2%
<u>Late-fall-run</u>		2020	2019	2018	2017	Total Ocean CWTs	Total Ocean %
Age		2	3	4	5		
Raw CWT Recoveries			252 (64%)	140 (36%)		392	3%
Expanded CWT _{total}			959 (66%)	499 (34%)		1,458	1%
<u>Winter-run</u>		2020	2019	2018	2017	Total Ocean CWTs	Total Ocean %
Age		2	3	4	5		
Raw CWT Recoveries			14 (42%)	19 (58%)		33	0.3%
Expanded CWT _{total}			60 (47%)	69 (53%)		129	0.1%
<u>Non-CV stocks</u>		2019	2018	2017	2016	Total Ocean CWTs	Total Ocean %
Age		2	3	4	5		
Raw CWT Recoveries		2 (<1%)	309 (67%)	141 (31%)	9 (2%)	461	4%
Expanded CWT _{total}		132 (2%)	4,480 (68%)	1,912 (29%)	33 (<1%)	6,557	5%
<u>All Runs</u>						Total Ocean CWTs	Total Ocean %
Age		2	3	4	5		
Raw CWT Recoveries		1,123 (10%)	8,623 (77%)	1,503 (13%)	16 (<1%)	11,265	100%
Expanded CWT _{total}		15,026 (11%)	98,476 (74%)	18,956 (14%)	88 (<1%)	132,547	100%
CV Expanded CWT _{total} (Proportion CV stocks)		14,894 (99%)	93,996 (95%)	17,044 (90%)	55 (63%)	125,990	95%

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

Table 8. Raw and expanded Chinook CWT recoveries in 2021 Oregon ocean fisheries by run type and brood year^{a/}.

<u>Fall-run</u>		2019	2018	2017	2016	Total Ocean CWTs	Total Ocean %
Age		2	3	4	5		
Raw CWT Recoveries		10 (2%)	337 (51%)	298 (45%)	13 (2%)	658	45%
Expanded CWT _{total}		102 (2%)	2,607 (52%)	2,190 (44%)	70 (1%)	4,968	39%
<u>Late-fall-run</u>		2020	2019	2018	2017	Total Ocean CWTs	Total Ocean %
Age		2	3	4	5		
Raw CWT Recoveries				4 (100%)		4	0%
Expanded CWT _{total}				7 (100%)		7	0%
<u>Spring-run</u>		2019	2018	2017	2016	Total Ocean CWTs	Total Ocean %
Age		2	3	4	5		
Raw CWT Recoveries		1 (2%)	39 (95%)		1 (2%)	41	3%
Expanded CWT _{total}		4 (4%)	100 (94%)		2 (2%)	106	0.8%
<u>Non-CV stocks</u>		2019	2018	2017	2016	Total Ocean CWTs	Total Ocean %
Age		2	3	4	5		
Raw CWT Recoveries		2 (<1%)	272 (36%)	261 (35%)	219 (29%)	754	52%
Expanded CWT _{total}		123 (2%)	5,083 (66%)	1,976 (26%)	503 (7%)	7,686	60%
<u>All Runs</u>		2019	2018	2017	2016	Total Ocean CWTs	Total Ocean %
Age		2	3	4	5		
Raw CWT Recoveries		13 (<1%)	648 (44%)	563 (39%)	233 (16%)	1,457	100%
Expanded CWT _{total}		230 (2%)	7,790 (61%)	4,173 (33%)	575 (5%)	12,768	100%
CV Expanded CWT _{total} (Proportion CV stocks)		107 (46%)	2,707 (35%)	2,197 (53%)	71 (12%)	5,082	40%

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

Table 9. Percentage^{a/} of inland CWT_{total} recoveries by location, run, and release type^{b/} in hatchery returns, natural escapement and sport harvest during 2021.

			CFH		FRH				NIM		MOK				MER		SJO	Non-CV	Total %		Total Run
Location	Run	SacW	CFHL	CFHF	FRHS	FRHF	FRHF _n	FRHF _{egg}	NIMF	NIMF _n	MOKF	MOKF _n	MOKF _{nc}	MOKF _{egg}	MERF	MERF _n	SJOSx		Hatchery	Natural	
Hatchery Spawners																					
Coleman National Fish Hatchery	Winter	24%																	24%	76%	247
Keswick Dam Fish Trap	Winter	82%																	82%	18%	298
Feather River Hatchery	Spring				92%		1%	0%									1%		94%	6%	1,722
Coleman National Fish Hatchery	Fall		0%	88%			1%	0%		0%			0%	0%		0%			89%	11%	16,438
Feather River Hatchery	Fall			0%	13%	1%	54%	6%	0%	2%	0%	1%	0%	1%	1%	0%			80%	20%	12,385
Nimbus Fish Hatchery	Fall			0%			1%	0%	19%	37%	0%	16%	2%	9%	2%	0%			86%	14%	11,077
Mokelumne River Hatchery	Fall			0%			4%	0%	0%	10%	1%	51%	2%	13%	6%	0%			89%	11%	4,217
Merced River Hatchery	Fall		0%				3%			7%		61%		10%	17%	1%			100%	0%	267
Coleman National Fish Hatchery	Late-fall ^{c/}		100%																100%	0%	2,310
Coleman Hatchery Fish Trap	Late-fall ^{c/}		100%																100%	0%	74
Total Hatchery Fall-run			0%	33%	4%	0%	16%	2%	5%	11%	0%	10%	1%	4%		1%	0%		86%	14%	44,384
Natural Spawners																					
Upper Sacramento River	Winter	29%																	29%	71%	9,971
Butte Creek	Spring																		0%	100%	1,807
Upper San Joaquin River	Spring																75%		75%	25%	32
Upper Sacramento River	Fall			26%			12%	2%									0%		39%	61%	15,629
Clear Creek	Fall			32%			16%	3%	0%	1%			0%	0%	1%				54%	46%	19,867
Battle Creek ^{d/}	Fall		0%	88%			1%	0%		0%			0%	0%	0%				89%	11%	17,453
Feather River	Fall				46%	0%	30%	2%	0%	1%		2%	0%	2%	0%	1%			85%	15%	9,688
Yuba River ^{e/}	Fall				14%		4%		1%	14%		7%	1%	11%					52%	48%	4,669
American River	Fall				0%		2%	0%	21%	34%	0%	21%	2%	5%	6%	0%			90%	10%	11,232
Stanislaus River	Fall						3%	2%		6%		58%	1%	15%	6%	0%			91%	9%	4,314
Tuolumne River	Fall											29%			10%	45%			84%	16%	188
Merced River	Fall								11%			39%		6%	7%	6%			68%	32%	470
Upper Sacramento River	Late-fall ^{c/}	3%	1%										1%						5%	95%	4,734
Total Natural Area Fall-run			0%	31%	6%	0%	10%	2%	3%	6%	0%	7%	0%	2%	0%	1%	0%		69%	31%	83,510
In-basin CWT _{total}	All	3%	2%	28%	7%	0%	8%	1%	4%	7%	0%	2%	0%	0%	0%	0%	0%		62%	38%	119,958
Stray CWT _{total}	All		0%	22%	0%		21%	4%	1%	7%	0%	26%	2%	11%	6%	1%			100%		29,131
Total CV Spawners		2%	2%	27%	6%	0%	11%	1%	3%	7%	0%	7%	0%	2%	0%	1%	0%		69%	31%	149,089
CV Sport Harvest																					
Upper Sacramento River	Fall			46%		0%	10%	1%			0%						0%		58%	42%	8,951
Lower Sacramento River	Fall		1%				16%	5%	3%	16%		9%	4%	21%	5%				81%	19%	2,586
Feather River	Fall				5%		38%					6%				2%			51%	49%	801
American River	Fall							6%	11%	50%		6%	1%		6%				80%	20%	1,593
Upper Sacramento River	Late-fall		55%	2%						7%				7%					70%	30%	593
Total Sport Harvest			2%	28%	0%	0%	11%	2%	2%	9%	0%	2%	1%	4%		2%	0%		64%	36%	14,524

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, barged and trucked releases for MOKFb merged with MOKFegg, coastal trucked releases for MOKFt merged with MOKFnc, bay/delta trucked releases for MOKFt merged with MOKFnc.

c/ Late-fall-run hatchery returns and natural area escapement occurred during late-fall of 2021 through early 2022 (return year 2022).

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

e/ Yuba River escapement for above and below the DPD merged for 2021 due to low returns.

Table 10. Total inland CWT_{total} recoveries by location, run, and release type^{a/} in hatchery returns, natural escapement and sport harvest during 2021.

			CFH		FRH				NIM		MOK				MER		SJO	Non-	Total CWT _{total}		Total
Location	Run	SacW	CFHL	CFHF	FRHS	FRHF	FRHF _n	FRHF _{gg}	NIMF	NIMF _n	MOKF	MOKF _n	MOKF _{nc}	MOKF _{gg}	MERF	MERF _n	SJOS _x	CV	Hatchery	Natural	Run
<u>Hatchery Spawners</u>																					
Coleman National Fish Hatchery	Winter	59																	59	188	247
Keswick Dam Fish Trap	Winter	243																	243	55	298
Feather River Hatchery	Spring				1,590		12	4									11		1,617	105	1,722
Coleman National Fish Hatchery	Fall		1	14,449			183	4		4			1	8		4			14,654	1,784	16,438
Feather River Hatchery	Fall			10	1,635	75	6,708	772	48	217	2	133	41	120		130	29		9,920	2,465	12,385
Nimbus Fish Hatchery	Fall			4			138	24	2,091	4,080	16	1,824	241	976		172	1		9,567	1,510	11,077
Mokelumne River Hatchery	Fall			4			178	20	8	430	54	2,146	99	564		247	1		3,751	466	4,217
Merced River Hatchery	Fall		1				8			20		162		27		46	2		266	1	267
Coleman National Fish Hatchery	Late-fall ^{b/}		2,309																2,309	1	2,310
Coleman Hatchery Fish Trap	Late-fall ^{b/}		74																74		74
Total Hatchery Fall-run			2	14,467	1,635	75	7,215	820	2,147	4,751	72	4,265	382	1,695		599	33		38,158	6,226	44,384
<u>Natural Spawners</u>																					
Upper Sacramento River	Winter	2,940																	2,940	7,031	9,971
Butte Creek	Spring																			1,807	1,807
Upper San Joaquin River	Spring																24		24	8	32
Upper Sacramento River	Fall			3,996			1,898	237									30		6,161	9,468	15,629
Clear Creek	Fall			6,407			3,193	686	57	227			14	57		133			10,774	9,093	19,867
Battle Creek ^{c/}	Fall		1	15,354			195	4		4			1	9		4			15,572	1,881	17,453
Feather River	Fall				4,469	8	2,888	218	31	124		162	23	185		30	55		8,193	1,495	9,688
Yuba River ^{d/}	Fall				674		168		42	670		336	42	500					2,432	2,237	4,669
American River	Fall				4		185	31	2,360	3,790	8	2,358	173	547		625	4		10,085	1,147	11,232
Stanislaus River	Fall						146	83		248		2,486	37	637		265	10		3,912	402	4,314
Tuolumne River	Fall											55				19	84		158	30	188
Merced River	Fall									52		183		26	34	26			321	149	470
Upper Sacramento River	Late-fall ^{b/}	120	61										60						241	4,493	4,734
Total Natural Area Fall-run			1	25,757	5,147	8	8,673	1,259	2,490	5,115	8	5,580	290	1,961	34	1,102	183		57,608	25,902	83,510
In-basin CWT _{total}	All	3,362	2,446	33,799	8,368	83	9,776	994	4,451	7,870	54	2,146	99	564	34	72	24		74,142	45,816	119,958
Stray CWT _{total}	All		1	6,425	4		6,124	1,089	186	1,996	26	7,699	633	3,092		1,629	227		29,131		29,131
Total CV Spawners		3,362	2,447	40,224	8,372	83	15,900	2,083	4,637	9,866	80	9,845	732	3,656	34	1,701	251		103,273	45,816	149,089
% stray			0.0%	16%	0.0%		39%	52%	4.0%	20%	33%	78%	86%	85%		96%	90%		28%		20%
<u>CV Sport Harvest</u>																					
Upper Sacramento River	Fall			4,098		14	933	59			15						29		5,148	3,803	8,951
Lower Sacramento River	Fall		35				412	137	85	410		221	102	544		138			2,084	502	2,586
Feather River	Fall				38		305					51					13		407	394	801
American River	Fall							90	178	801		89	22			90			1,270	323	1,593
Upper Sacramento River	Late-fall		328	10						39				39					416	177	593
Total Sport Harvest			363	4,108	38	14	1,650	286	263	1,250	15	361	124	583		228	42		9,325	5,199	14,524

a/ Release types defined in Table 3; SacWbat recoveries merged with SacW, barged and trucked releases for MOKFb merged with MOKFgg, coastal trucked releases for MOKFt merged with MOKFnc, bay/delta trucked releases for MOKFt merged with MOKFn.

b/ Late-fall-run hatchery returns and natural area escapement occurred during late-fall of 2021 through early 2022 (return year 2022).

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

d/ Yuba River escapement for above and below the DPD merged for 2021 due to low returns.

Table 11. CWT recovery rate (recoveries per 100,000 CWTs released) by release type, brood year and recovery location in 2021. (Page 1 of 2)

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	Up SJ	In-basin	Stray	CV total			In-basin	Stray	CV total	Ocean
SacW ^{b/}	2019	Wint	247,216		37									37	0	37	0%	33	15	0	15	13
SacWbat ^{b/}	2019	Wint	165,858	8	3									8	3	11	24%	26	5	2	7	16
FRHS	2019	Spr	1,771,532				32							32	0	32	0%	76	2	0	2	4
SJOSx	2019	Spr	232,903											0	0	0	-	0	0	0	0	0
CFHF	2019	Fall	3,352,800	886										886	0	886	0%	258	26	0	26	8
FRHF	2019	Fall	248,810				15							15	0	15	0%	4	6	0	6	2
FRHFn	2019	Fall	1,335,074	17	118	43	258		13	18	5			258	214	472	45%	549	19	16	35	41
NIMF	2019	Fall	796,467				9		539	2				539	11	550	2%	186	68	1	69	23
NIMFn	2019	Fall	453,171	2			44	83	760	57	31	4		760	222	982	23%	570	168	49	217	126
MOKF	2019	Fall	2,063,722											0	0	0	-	0	0	0	0	0
MOKFn	2019	Fall	1,068,378				16		202	228	350	66		228	633	861	74%	523	21	59	81	49
MOKFnc	2019	Fall	508,729				8		76	26	10			26	94	120	78%	758	5	19	24	149
MOKFgg	2019	Fall	486,615	2		14	67	125	326	124	154	13		124	701	825	85%	1,191	26	144	170	245
MERFn	2019	Fall	109,375				21		22	34	15	10		10	92	102	90%	78	9	84	93	71
CFHL	2020	Late	872,269	107										107	0	107	0%	0	12	0	12	0
Total			13,712,919	1,022	157	58	470	208	1,937	489	565	93		3,030	1,969	4,999	39%	4,253				

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 Stray	Ocean CWT _{samp}	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/}	2018	Wint	221,923		3,099									3,099	0	3,099	0%	57	1,397	0	1,397	25
SacWbat ^{b/}	2018	Wint	180,252	38	58									38	58	96	60%	12	21	32	53	6
FRHS	2018	Spr	1,831,043				6,942	584	4					7,526	4	7,530	0.1%	2,057	411	0	411	112
SJOSx	2018	Spr	216,845		29		93		5	1	84	2	24	24	214	238	90%	110	11	99	110	51
CFHF	2018	Fall	3,448,504	6,368	1,030	1,644	2		1	1				7,397	1,648	9,045	18%	7,717	215	48	262	224
FRHF	2018	Fall	30,000				2							2	0	2	0.1%	63	7	0	7	211
FRHFn	2018	Fall	1,772,613	66	177	411	1,207	42	61	22	31	2		1,249	769	2,018	38%	6,814	71	43	114	384
NIMF	2018	Fall	797,850				11	42	729					729	52	782	6.7%	1,211	91	7	98	152
NIMFn	2018	Fall	439,333				42	22	774	28	10			774	102	876	12%	3,454	176	23	200	786
MOKF	2018	Fall	398,991				2		24	52				52	26	78	33%	124	13	6	19	31
MOKFn	2018	Fall	1,403,247				55	83	881	322	261	20		322	1,300	1,622	80%	2,693	23	93	116	192
MOKFnc	2018	Fall	873,909		59	14	26	42	160	28	21			28	322	350	92%	4,248	3	37	40	486
MOKFgg	2018	Fall	225,158	2			10		55	17	5			17	72	89	81%	1,219	8	32	40	541
MERFn	2018	Fall	169,854	2		14	14		84	29	56	8		8	199	208	96%	360	5	117	122	212
CFHL	2019	Late	1,031,542	1,698								1		1,698	1	1,699	0.1%	928	165	0	165	90
Total			13,041,064	8,174	4,451	2,125	8,386	792	2,777	500	468	34	24	22,965	4,766	27,731	17%	31,068				

Table 11. CWT recovery rate (recoveries per 100,000 CWTs released) by release type, brood year and recovery location in 2021. (Page 2 of 2)

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 Stray	Ocean CWT _{samp}	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/}	2017	Wint	216,237		78									78	0	78	0%	0	36	0	36	0
SacWbat ^{b/}	2017	Wint	212,136	11										11	0	11	0%	0	5	0	5	0
FRHS	2017	Spr	488,223				624	83						707	0	707	0%	11	145	0	145	2
SJOSx	2017	Spr	209,308				1					9		0	10	10	100%	0	0	5	5	0
CFHF	2017	Fall	1,369,512	775	147	113	1							922	114	1,037	11%	350	67	8	76	26
FRHF	2017	Fall	250,489				2							2	0	2	0%	4	1	0	1	2
FRHFn	2017	Fall	1,496,598	11	177	340	913		6	4				913	537	1,450	37%	1,109	61	36	97	74
FRHFgg	2017	Fall	609,272	2	59	171	246		14	5	21			246	271	517	52%	1,560	40	45	85	256
NIMF	2017	Fall	334,047			14			2					2	14	16	88%	4	1	4	5	1
NIMFn	2017	Fall	664,585			14	19	83	423	22	21	14		423	173	596	29%	1,212	64	26.0	90	182
MOKF	2017	Fall	398,785							2				2	0	2	0%	0	1	0	1	0
MOKFn	2017	Fall	1,649,629				5		63	26	66	1		26	135	161	84%	263	2	8	10	16
MOKFnc	2017	Fall	727,344	2			14		13	4	5			4	34	38	89%	479	1	5	5	66
MERFn	2017	Fall	255,259			14	5		2					0	21	21	100%	34	0	8	8	13
CFHL	2018	Late	881,364	504	59									564	0	564	0%	495	64	0	64	56
Total				9,762,788	1,306	520	667	1,829	167	522	63	122	15	3,900	1,309	5,210	25%	5,522				

Age-5 CV recoveries (only release types with recoveries in 2021 are displayed)

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	Up SJ	In-basin	Stray	CV total			In-basin	Stray	CV total	Ocean
FRHS	2016	Spr	1,682,317				38							38	0	38	0	2	2	0	2	0
CFHF	2016	Fall	3,020,565	47	59	28	1							106	29	135	22%	12	4	1	5	0
FRHF	2016	Fall	1,029,808				13							13	0	13	0%	5	1	0	1	0
FRHFn	2016	Fall	733,880				3							3	0	3	0%	2	0	0	0	0
FRHFgg	2016	Fall	263,611											0	0	0	-	4	0	0	0	1
NIMF	2016	Fall	591,200						5					5	0	5	0%	4	1	0	1	1
MOKFn	2016	Fall	1,155,829				8		5	1				1	13	14	93%	3	0	1	1	0
MOKFnc	2016	Fall	841,802											0	0	0	-	7	0	0	0	1
MOKFgg	2016	Fall	225,243											0	0	0	-	11	0	0	0	5
MERF	2016	Fall	245,340									7		7	0	7	0	0	3	0	3	0
CFHL	2017	Late	1,047,211	6										6	0	6	0	0	1	0	1	0
Total				10,836,806	53	59	28	62	10	1		7		177	42	219	19%	50				

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 2017 = age-3 in the ocean).

Sacramento River fall Chinook release types (SFC)

CFHF	Coleman National Fish Hatchery fall in-basin 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)
NIMF	Nimbus Fish Hatchery fall in-basin releases
NIMFn	Nimbus Fish Hatchery fall bay/delta net pen releases

Other CV Chinook release types (OCV)

MOKF	Mokelumne River Hatchery fall in-basin releases
MOKFn	Mokelumne River Hatchery fall bay/delta net pen releases
MOKFnc	Mokelumne River Hatchery fall coastal net pen releases
MOKFgg	Mokelumne River Hatchery fall Golden Gate releases (no net pens)
MERF	Merced River Hatchery fall in-basin releases
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
SJOSx	San Joaquin Salmon Conservation and Research Facility spring reintroduction releases
CFHL	Coleman National Fish Hatchery late-fall in-basin releases

Table 12. Total CWT_{total} recoveries by port area, month, and release type^{a/} in the 2021 California ocean salmon sport fishery.

		<u>CFH</u>		<u>FRH</u>				<u>NIM</u>		<u>MOK</u>				<u>MER</u>		<u>SJO</u>	Non-	Total	Total CWT _{total}		Total
	SacW	CFHL	CFHF	FRHS	FRHF	FRHFn	FRHFgg	NIMF	NIMFn	MOKF	MOKFn	MOKFnc	MOKFgg	MERF	MERFn	SJOSx	CV	CV	Hatchery	Natural	Harvest
California Sport Harvest																					
Eureka/Crescent City																					
May																					
Jun																	16		16	12	28
Jul				3		23		21	20		41	8	10			3	193	129	322	297	619
Aug																					
Sep																					
Total				3		23		21	20		41	8	10			3	209	129	338	309	647
Fort Bragg																					
Apr																					
May																					
Jun			15					12			12		12			3		55	55	98	153
Jul		13	378	9		400	51	56	112		107	60	34		17		17	1,236	1,254	654	1,908
Aug		9	18	18		128	74	18	73		109	50	72					570	570	289	859
Sep								22	22		22	6	89				23	162	170		170
Oct		8	99	8		143		4	111		16	19	77			4		489	489		685
Total		31	511	35		671	125	112	318		266	135	284		17	7	40	2,512	2,538	1,041	3,775
San Francisco																					
Apr																					
May																					
Jun	3	20	279	13		382	39	72	421		212	192	678		64		34	2,376	2,410	1,454	3,864
Jul	14	61	1,970	41	17	2,384	153	373	1,455		1,200	886	2,232		170		108	10,956	11,064	5,365	16,429
Aug	8	12	1,311	23	16	1,583	356	143	649	4	527	427	492		62	4	16	5,616	5,632	3,496	9,128
Sep	4	4	61	7	3	360	57	114	639	7	623	295	734		68			2,976	2,976	876	3,852
Oct		24	17			34			223		102	112	183		17		18	712	730	168	898
Total	29	122	3,638	36	36	4,744	605	701	3,386	11	2,665	1,913	4,319		379	4	175	22,637	22,812	11,359	34,171
Monterey																					
Apr	5	19	1,654	191		1,556	170	107	364		210	87	78		39	20	7	4,499	4,506	3,120	7,626
May	15	15	789	34	5	909	177	78	273	5	161	138	97		39		5	2,736	2,742	1,442	4,184
Jun	5	5	531	26		691	84	41	226		48	43	102		61			1,864	1,864	1,336	3,200
Jul	10		100			212	20	20	60		85	65	20					591	591	1,119	1,710
Aug	12		24	6				24	48						23			137	137	40	177
Sep												6						6	6	51	57
Total	46	40	3,098	257	5	3,368	452	269	970	5	504	338	297		162	20	13	9,833	9,845	7,109	16,954
California Total Sport Harvest																					
	75	192	7,248	379	41	8,807	1,182	1,104	4,695	16	3,475	2,394	4,911		558	33	437	35,111	35,534	19,818	55,547
Oregon Total Sport Harvest (South of Cape Falcon)																					
		3	319	32		392	109	32	177		182	91	181		84		1,524	1,601	3,125	3,315	6,440

^{a/} Release types defined in Table 3; SacWbat recoveries merged with SacW, barged and trucked releases for MOKFb merged with MOKFgg, coastal trucked releases for MOKFt merged with MOKFnc, bay/delta trucked releases for MOKFt merged with MOKFn.

Table 13. Percentage^{a/} of CWT_{total} recoveries by port area, month, and release type^{b/} in the 2021 California ocean salmon sport fishery.

		CFH		FRH				NIM		MOK				MER		SJO	Non-	Total	Total %		Total	
SacW		CFHL	CFHF	FRHS	FRHF	FRHFfn	FRHFgg	NIMF	NIMFn	MOKF	MOKFn	MOKFnc	MOKFgg	MERF	MERFn	SJOSx	CV	CV	Hatchery	Natural	Harvest	
California Sport Harvest																						
Eureka/Crescent City																						
May																	59%		59%	41%	28	
Jun																	31%	21%	52%	48%	619	
Jul				0%	4%			3%	3%	7%		1%	2%			0%						
Aug																						
Sep																						
Total				0%	4%			3%	3%	6%		1%	2%			0%	32%	20%	52%	48%	647	
Fort Bragg																						
Apr																						
May																						
Jun		10%						8%		8%			8%			2%		36%	36%	64%	153	
Jul		1%	20%	0%	21%		3%	3%	6%	6%		3%	2%	1%			1%	65%	66%	34%	1,908	
Aug		1%	2%	2%	15%		9%	2%	8%	13%		6%	8%					66%	66%	34%	859	
Sep								13%	13%	13%		3%	52%				13%	95%	108%	-8%	170	
Oct		1%	15%	1%	21%			1%	16%	2%		3%	11%			1%		71%	71%	29%	685	
Total		1%	14%	1%	18%		3%	3%	8%	7%		4%	8%	0%		0%	1%	67%	68%	32%	3,775	
San Francisco																						
Apr																						
May																						
Jun		0%	1%	7%	0%	10%		1%	2%	11%	5%		5%	18%	2%		1%	62%	62%	38%	3,864	
Jul		0%	0%	12%	0%	0%	15%	1%	2%	9%	7%		5%	14%	1%		1%	67%	67%	33%	16,429	
Aug		0%	0%	14%	0%	0%	17%	4%	2%	7%	0%	6%	5%	5%	1%		0%	62%	62%	38%	9,128	
Sep		0%	0%	2%	0%	0%	9%	1%	3%	17%	0%	16%	8%	19%	2%			77%	77%	23%	3,852	
Oct																						
Total		0%	0%	11%	0%	0%	14%	2%	2%	10%	0%	8%	6%	13%	1%		0%	1%	66%	67%	33%	34,171
Monterey																						
Apr		0%	0%	22%	3%	20%		2%	1%	5%	3%		1%	1%	1%		0%	0%	59%	59%	41%	7,626
May		0%	0%	19%	1%	0%	22%	4%	2%	7%	0%	4%	3%	2%	1%			0%	65%	66%	34%	4,184
Jun		0%	0%	17%	1%	22%		3%	1%	7%	1%		1%	3%	2%				58%	58%	42%	3,200
Jul		1%	6%		12%				1%	3%	5%		4%	1%					35%	35%	65%	1,710
Aug		7%	14%		3%					14%	27%				13%				77%	77%	23%	177
Sep																			10%	10%	90%	57
Total		0%	0%	18%	2%	0%	20%	3%	2%	6%	0%	3%	2%	2%	1%		0%	0%	58%	58%	42%	16,954
California Total Sport Harvest																						
0%		0%	13%	1%	0%	16%	2%	2%	8%	0%	6%	4%	9%	1%		0%	1%	63%	64%	36%	55,547	
Oregon Total Sport Harvest (South of Cape Falcon)																						
		0%	5%	0%	6%		2%	0%	3%	3%		1%	3%	1%			24%	25%	49%	51%	6,440	

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, barged and trucked releases for MOKFb merged with MOKF_{Egg}, coastal trucked releases for MOKFt merged with MOKF_{Fn}, bay/delta trucked releases for MOKFt merged with MOKF_{Fn}.

Table 14. Total CWT_{total} recoveries by port area, month, and release type^{a/} in the 2021 California ocean salmon commercial fishery.

		<u>CFH</u>		<u>FRH</u>				<u>NIM</u>		<u>MOK</u>				<u>MER</u>		<u>SJO</u>	<u>Non-CV</u>	<u>Total CV</u>	<u>Total CWT_{total}</u>		<u>Total Harvest</u>
	<u>SacW</u>	<u>CFHL</u>	<u>CFHF</u>	<u>FRHS</u>	<u>FRHF</u>	<u>FRHF_n</u>	<u>FRHF_{gg}</u>	<u>NIMF</u>	<u>NIMF_n</u>	<u>MOKF</u>	<u>MOKF_n</u>	<u>MOKF_{nc}</u>	<u>MOKF_{gg}</u>	<u>MERF</u>	<u>MERF_n</u>	<u>SJOS_x</u>			<u>Hatchery</u>	<u>Natural</u>	
California Commercial Harvest																					
Eureka/Crescent City																					
Jun																					
Jul																					
Aug																					
Total																					
Fort Bragg																					
Jun																					
Jul																					
Aug		403	2,799	301	8	4,358	960	630	3,030	31	1,582	686	846		300	12	2,409	15,944	18,352	24,465	42,817
Total		429	2,951	319	8	4,492	975	675	3,356	34	1,785	749	891		300	12	2,499	16,975	19,473	25,252	44,725
San Francisco																					
May																					
Jun		343	6,891	687	11	8,090	1,378	1,302	5,346	38	3,125	1,324	1,515		383	30	2,305	30,462	32,767	40,065	72,832
Jul	3	71	938	91	9	1,179	177	148	1,118	3	483	209	225		52	3	369	4,710	5,079	5,909	10,988
Aug		149	1,192	111		1,649	386	348	1,331	8	836	304	259		75	8	505	6,656	7,161	7,223	14,384
Sep		38	165	22		404	178	295	1,182	3	661	373	627		26		6	3,975	3,980	1,669	5,649
Oct		17				13		65	298	3	107	84	94		13			694	694	346	1,040
Total	3	618	9,185	911	21	11,335	2,119	2,158	9,275	55	5,212	2,294	2,720		549	41	3,185	46,497	49,681	55,212	104,893
Monterey																					
May	39	173	8,800	418	27	7,563	1,375	631	2,581	12	1,189	640	655		211	26	321	24,339	24,660	22,221	46,881
Jun	9	22	666	15	3	555	112	64	269		101	83	37		62		107	1,998	2,105	1,786	3,891
Jul	2	24	201	8		323	17	44	126	2	55	47	67		17		8	933	942	702	1,644
Aug			28	3		14	14	14	41		3	21						138	138	283	421
Total	51	219	9,694	445	30	8,454	1,518	753	3,018	14	1,348	791	759		289	26	436	27,408	27,844	24,993	52,837
California Total Commercial Harvest																					
	54	1,266	21,830	1,675	58	24,281	4,611	3,585	15,649	103	8,345	3,834	4,370		1,138	78	6,120	90,879	96,999	105,456	202,455
Oregon Total Commercial Harvest (South of Cape Falcon)																					
		5	696	74	1	802	421	72	511	5	401	175	188		130		6,163	3,480	9,643	7,717	17,360

^{a/} Release types defined in Table 3; SacWbat recoveries merged with SacW, barged and trucked releases for MOKFb merged with MOKFgg, coastal trucked releases for MOKFt merged with MOKFnc, bay/delta trucked releases for MOKFt merged with MOKFn.

Table 15. Percentage^{a/} of CWT_{total} recoveries by port area, month, and release type^{b/} in the 2021 California ocean salmon commercial fishery.

		CFH		FRH				NIM		MOK				MER		SJO	Non-	Total	Total %		Total
	SacW	CFHL	CFHF	FRHS	FRHF	FRHFnc	FRHFgg	NIMF	NIMFn	MOKF	MOKFn	MOKFnc	MOKFgg	MERF	MERFn	SJOSx	CV	CV	Hatchery	Natural	Harvest
California Commercial Harvest																					
Eureka/Crescent City																					
Jun																					
Jul																					
Aug																					
Total																					
Fort Bragg																					
Jun																					
Jul																					
Aug		1%	7%	1%	0%	10%	2%	1%	7%	0%	4%	2%	2%		1%	0%	6%	37%	43%	57%	42,817
Total		1%	7%	1%	0%	10%	2%	2%	8%	0%	4%	2%	2%		1%	0%	6%	38%	44%	56%	44,725
San Francisco																					
May																					
Jun		0%	9%	1%	0%	11%	2%	2%	7%	0%	4%	2%	2%		1%	0%	3%	42%	45%	55%	72,832
Jul		0%	1%	9%	1%	0%	11%	2%	1%	10%	0%	4%	2%	2%	0%	0%	3%	43%	46%	54%	10,988
Aug			1%	8%	1%		11%	3%	2%	9%	0%	6%	2%	2%	1%	0%	4%	46%	50%	50%	14,384
Sep			1%	3%	0%		7%	3%	5%	21%	0%	12%	7%	11%	0%		0%	70%	70%	30%	5,649
Oct			2%				1%		6%	29%	0%	10%	8%	9%	1%			67%	67%	33%	1,040
Total		0%	1%	9%	1%	0%	11%	2%	2%	9%	0%	5%	2%	3%	1%	0%	3%	44%	47%	53%	104,893
Monterey																					
May		0%	0%	19%	1%	0%	16%	3%	1%	6%	0%	3%	1%	1%	0%	0%	1%	52%	53%	47%	46,881
Jun		0%	1%	17%	0%	0%	14%	3%	2%	7%		3%	2%	1%	2%		3%	51%	54%	46%	3,891
Jul		0%	1%	12%	1%		20%	1%	3%	8%	0%	3%	3%	4%	1%		1%	57%	57%	43%	1,644
Aug				7%	1%		3%	3%	3%	10%		1%	5%					33%	33%	67%	421
Total		0%	0%	18%	1%	0%	16%	3%	1%	6%	0%	3%	1%	1%	1%	0%	1%	52%	53%	47%	52,837
California Total Commercial Harvest																					
0%		1%	11%	1%	0%	12%	2%	2%	8%	0%	4%	2%	2%		1%	0%	3%	45%	48%	52%	202,455
Oregon Total Commercial Harvest (South of Cape Falcon)																					
		0%	4%	0%	0%	5%	2%	0%	3%	0%	2%	1%	1%		1%		36%	20%	56%	44%	17,360

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

b/ Release types defined in Table 3; SacW_{bat} recoveries merged with SacW, barged and trucked releases for MOKF_b merged with MOKF_{egg}, coastal trucked releases for MOKF_t merged with MOKF_{nc}, bay/delta trucked releases for MOKF_t merged with MOKF_n.

Table 16. CWT recovery rate (recoveries per 100,000 CWTs released) for experimental & net pen release types in 2021.

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	2019	Fall	1,335,074	17	118	43	258		13	18			258	214	472	45%	549	19	16	35	41
NIMFn	2019	Fall	453,171	2			44	83	760	57	31	4	760	222	982	23%	570	168	49	217	126
MOKFn	2019	Fall	1,068,378				16		202	228	350	66	228	633	861	74%	523	21	59	81	49
MOKFnp	2019	Fall	192,201				5		54	13			13	59	72	82%	298	7	31	38	155
MOKFns	2019	Fall	316,528				3		22	13	10		13	35	48	73%	459	4	11	15	145
MOKFgg	2019	Fall	486,615	2		14	67	125	326	124	154	13	124	701	825	85%	1,191	26	144	170	245
MERFn	2019	Fall	109,375				21		22	34	15	10	10	92	102	90%	78	9	84	93	71

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 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
FRHFe	2018	Fall	30,000				2						2	0	2	0%	63	7	0	7	211
FRHFn	2018	Fall	1,772,613	66	177	411	1,207	42	61	22	31	2	1,249	769	2,018	38%	6,814	71	43	114	384
NIMFn	2018	Fall	439,333			42	22		774	28	10		774	102	876	12%	3,454	176	23	200	786
MOKFn	2018	Fall	1,403,247				55	83	881	322	261	20	322	1,300	1,622	80%	2,693	23	93	116	192
MOKFnp	2018	Fall	754,295		59	14	26	42	160	27	21		27	322	349	92%	4,013	4	43	46	532
MOKFns	2018	Fall	119,614							1			1	0	1	0%	236	1	0	1	197
MOKFgg	2018	Fall	225,158	2			10		55	17	5		17	72	89	81%	1,219	8	32	40	541
MERFn	2018	Fall	169,854	2		14	14		84	29	56	8	8	199	208	96%	360	5	117	122	212

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 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	2017	Fall	1,496,598	11	177	340	913		6	4			913	537	1,450	37%	1,109	61	36	97	74
FRHFgg	2017	Fall	609,272	2	59	171	246		14	5	21		246	271	517	52%	1,560	40	45	85	256
NIMFn	2017	Fall	664,585			14	19	83	423	22	21	14	423	173	596	29%	1,212	64	26	90	182
MOKFn	2017	Fall	1,649,629				5		63	26	66	1	26	135	161	84%	267	2	8	10	16
MOKFnp	2017	Fall	727,344	2			14		13	4	5		4	34	38	89%	475	1	5	5	65
MERFn	2017	Fall	255,259			14	5		2				0	21	21	100%	34	0	8	8	13

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:

FRHFe Feather River Hatchery fall in-basin experimental 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
 MOKFn Mokelumne River Hatchery fall bay/delta net pen releases
 MOKFnp Mokelumne River Hatchery fall coastal net pen releases (Pillar Point)

MOKFns Mokelumne River Hatchery fall coastal net pen releases (Santa Cruz)
 MOKFgg Mokelumne River Hatchery fall Golden Gate releases (no net pen acclimation)
 MERFn Merced River Hatchery fall bay/delta net pen releases

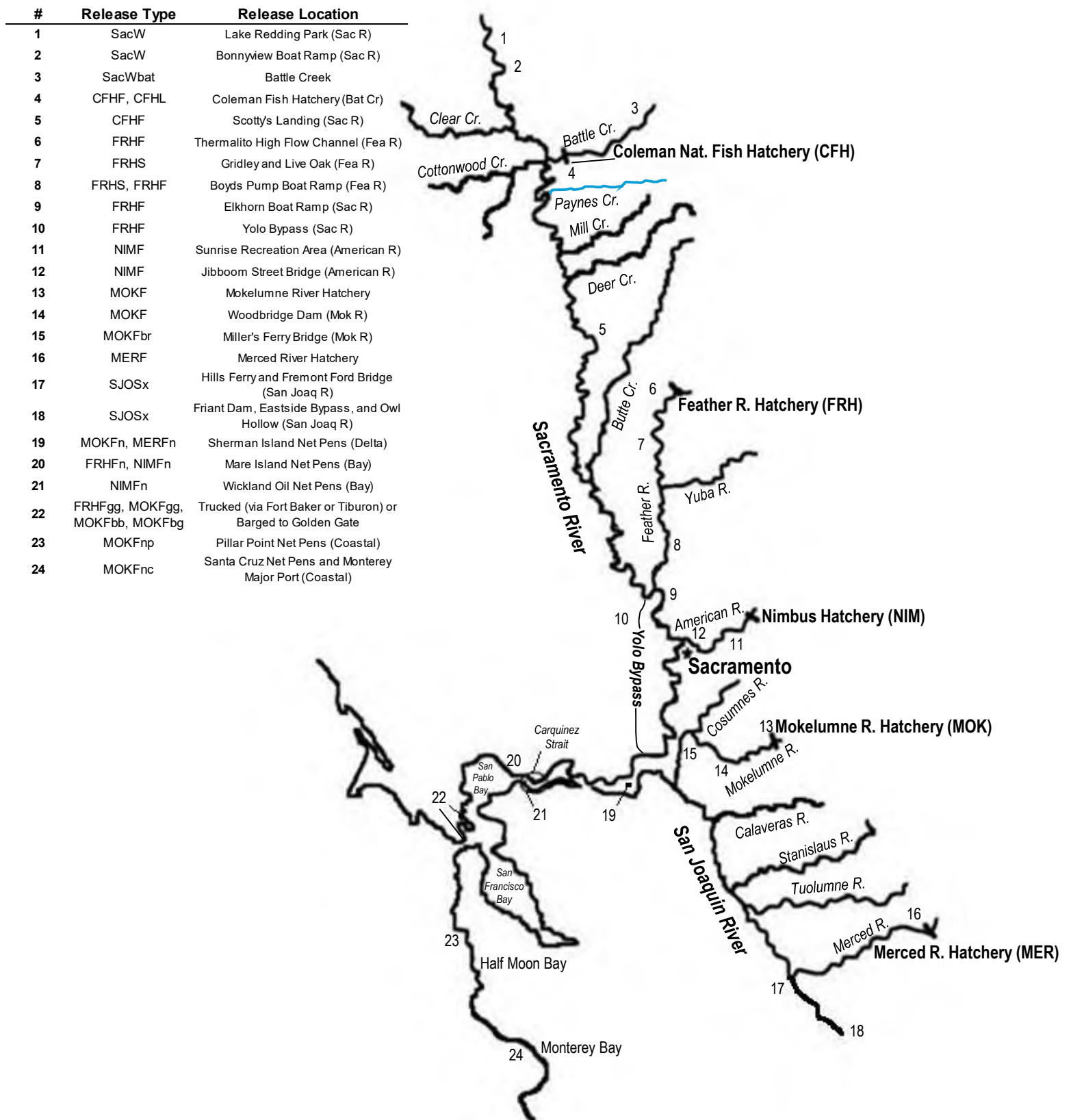


Figure 1. Map of release sites for CV hatchery release types, brood years 2016-2019.

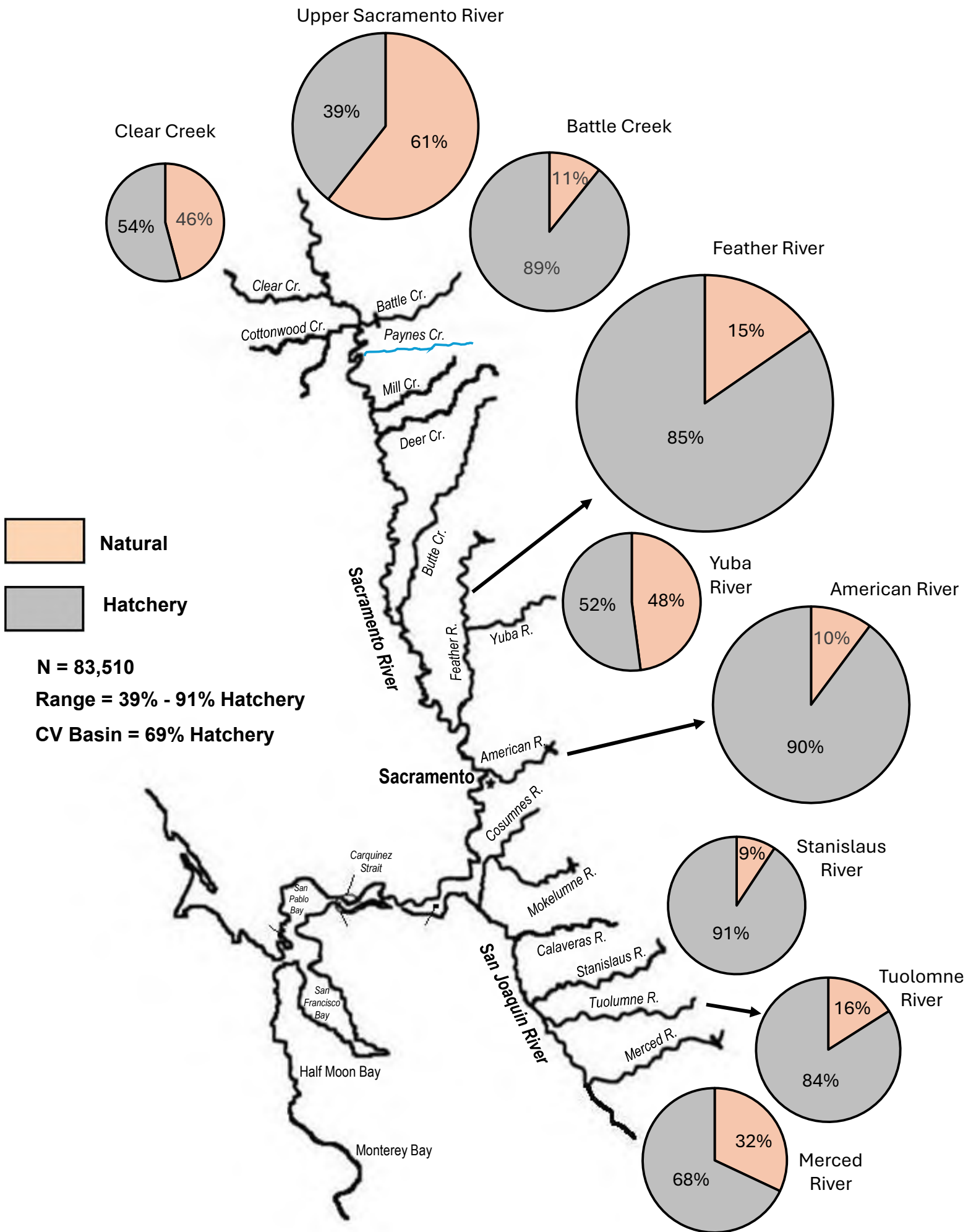


Figure 2. Fall-run CV natural area escapement, hatchery and natural proportions, 2021.

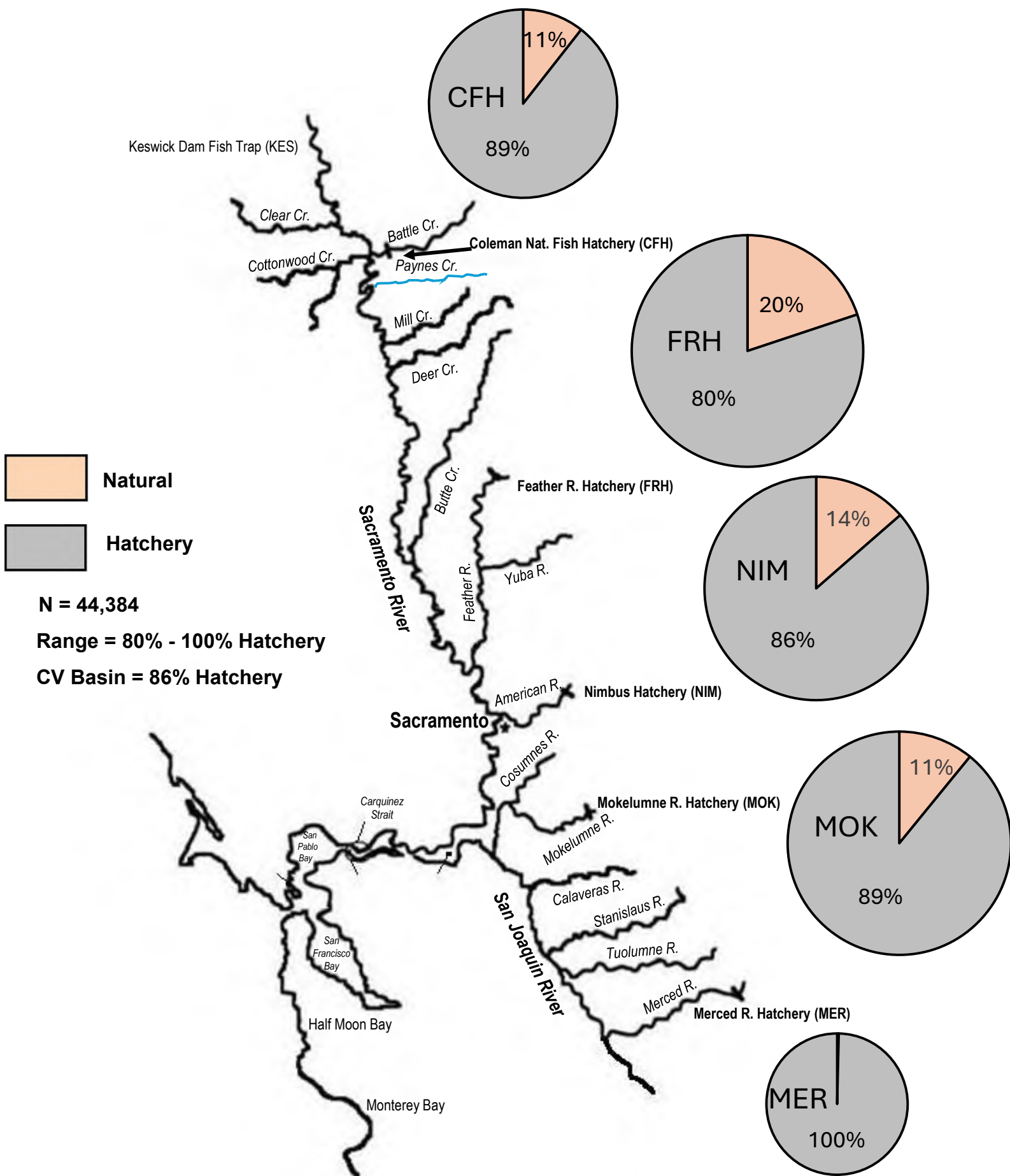


Figure 3. Fall-run CV hatchery escapement, hatchery and natural proportions, 2021.

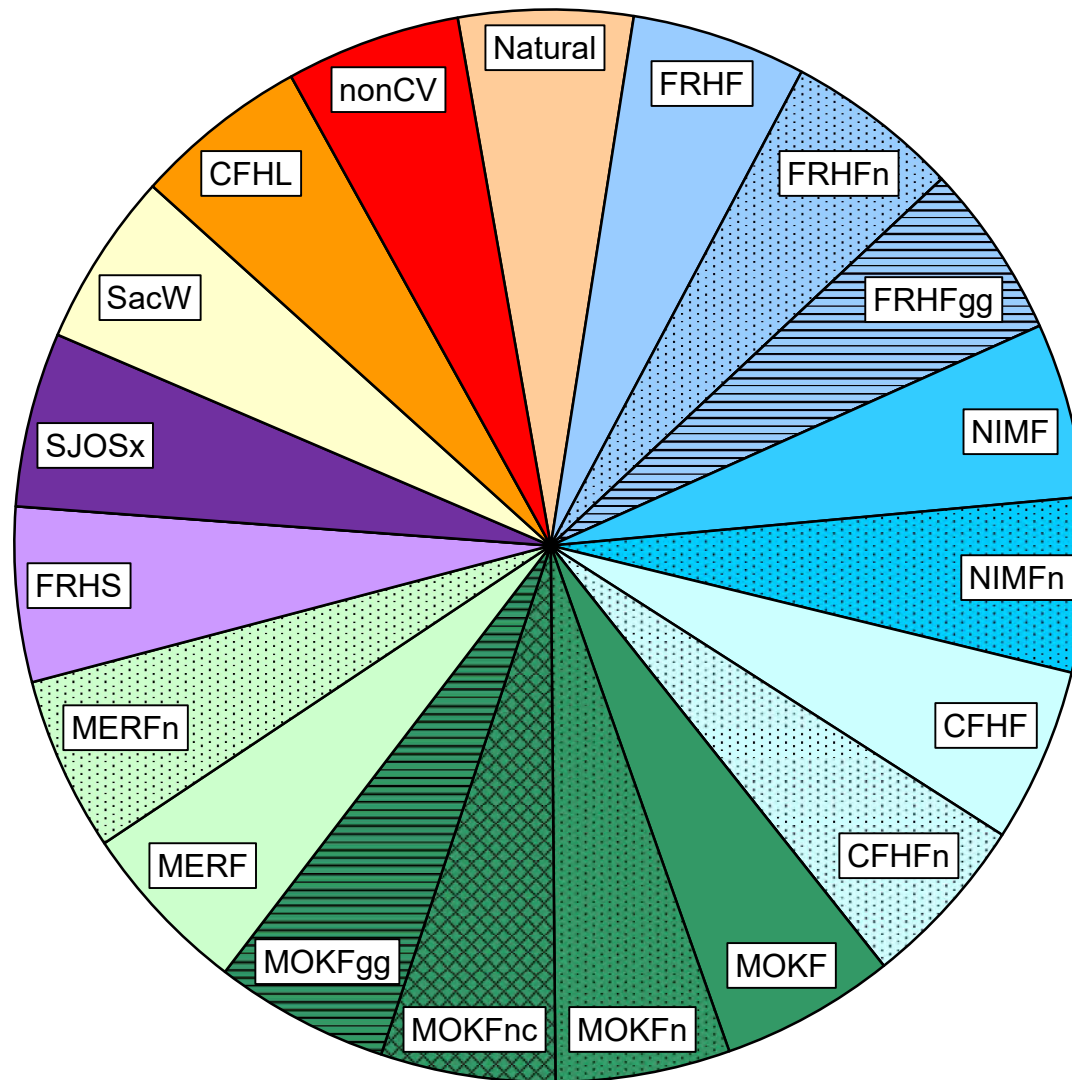
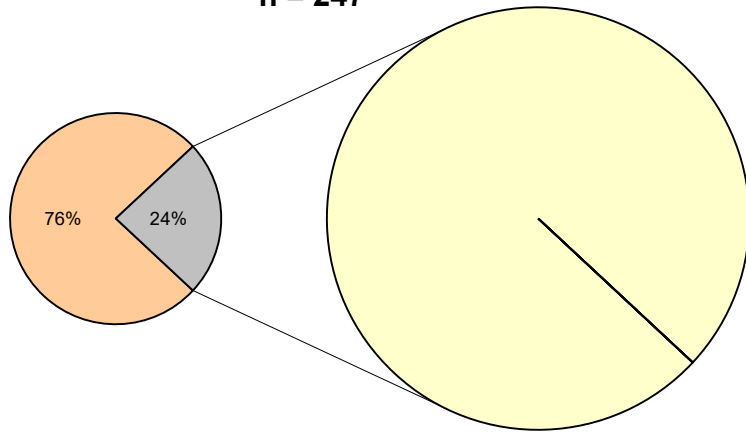
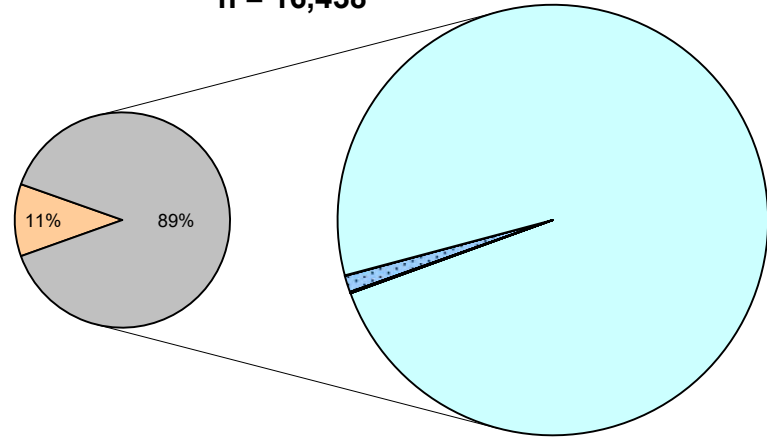


Figure 4. Color and pattern scheme used in all pie chart figures for Central Valley hatchery release types, brood years 2016-2019.

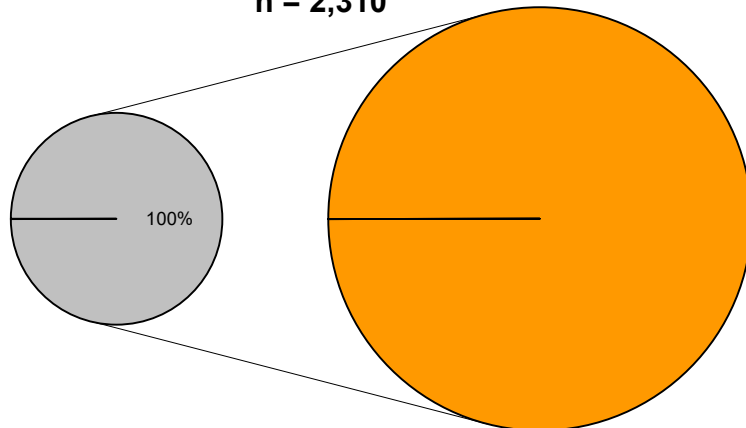
Coleman National Fish Hatchery winter 2021
n = 247



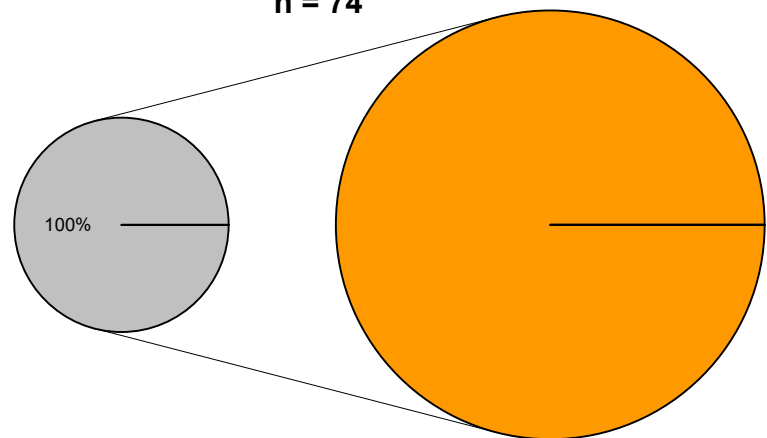
Coleman National Fish Hatchery fall 2021
n = 16,438



Coleman National Fish Hatchery late-fall 2022
n = 2,310



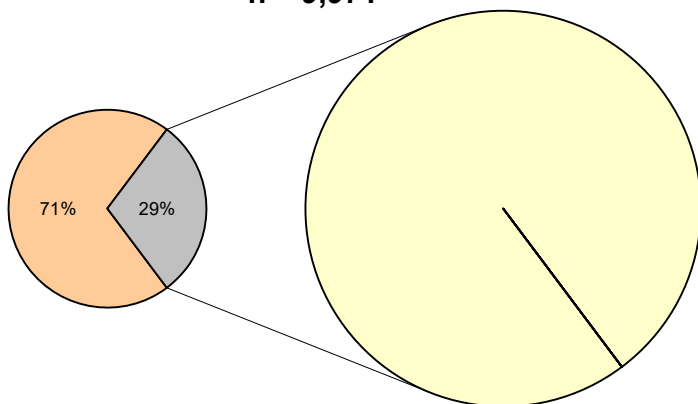
Coleman Fish Trap late-fall 2022 (post-spawning)
n = 74



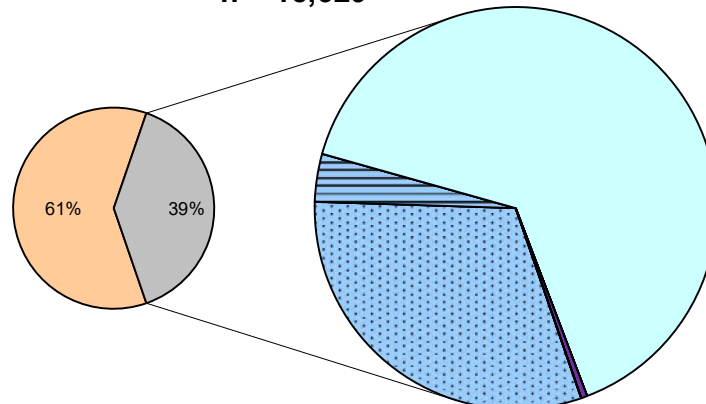
■ Natural
 ■ FRHF
 ■ FRHFfn
 ■ FRHFfgg
 ■ NIMF
 ■ NIMFn
 ■ CFHF
 ■ CFHFfn
 ■ MOKF
 ■ MOKFn
 ■ MOKFnc
 ■ MOKFgg
 ■ MERF
 ■ MERFn
 ■ FRHS
 ■ SJOSx
 ■ SacW
 ■ CFHL
 ■ nonCV

Figure 5. Proportion of hatchery- and natural-origin fish at Coleman National Fish Hatchery, 2021-22.

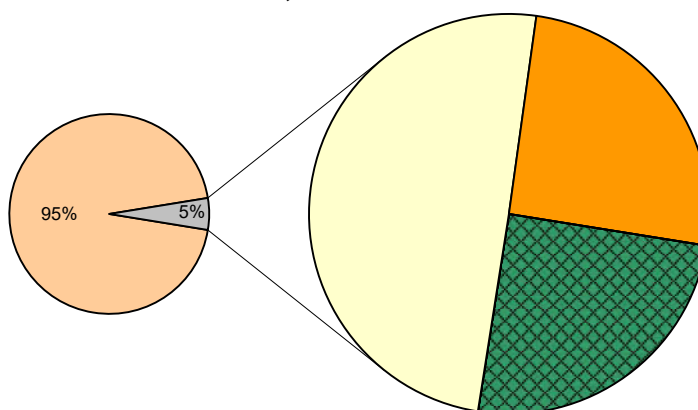
Upper Sacramento River winter carcass 2021
n = 9,971



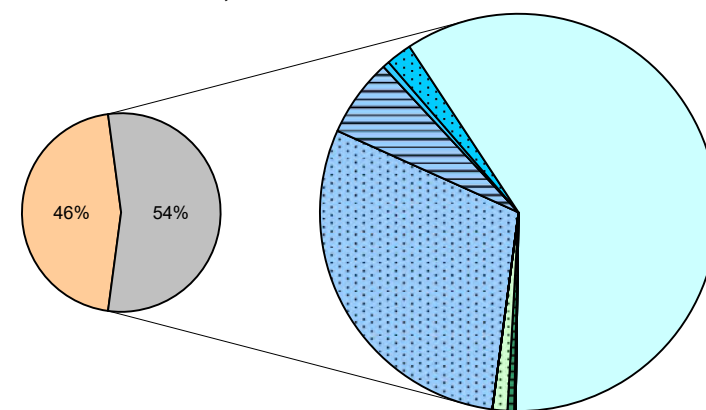
Upper Sacramento River fall carcass 2021
n = 15,629



Upper Sacramento late-fall carcass 2022
n = 4,734



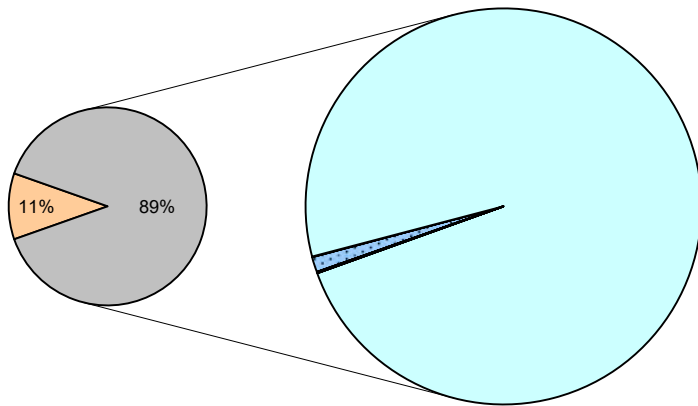
Clear Creek fall carcass 2021
n = 19,867



Natural FRHF FRHFn FRHFgg NIMF NIMFn CFHF CFHFn MOKF MOKFn
 MOKFnc MOKFgg MERF MERFn FRHS SJOSx SacW CFHL nonCV

Figure 6. Proportion of hatchery- and natural-origin fish in Upper Sacramento River & tributaries, 2021-22. (Page 1 of 2)

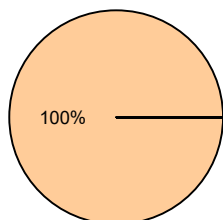
Battle Creek fall spawners
n = 17,453



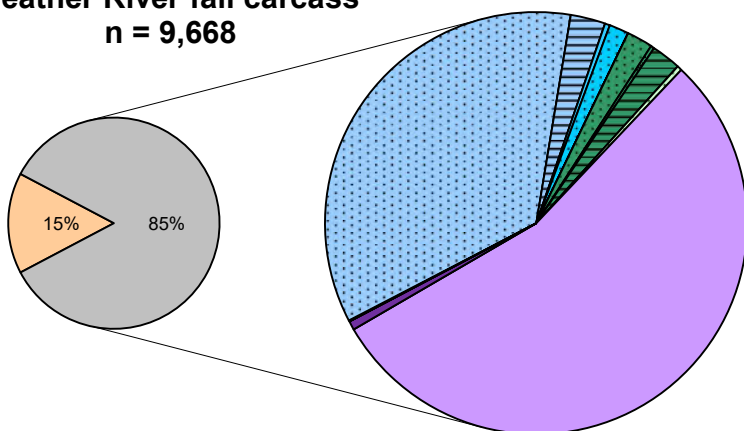
■ Natural
 ■ FRHF
 ■ FRHFn
 ■ FRHFegg
 ■ NIMF
 ■ NIMFn
 ■ CFHF
 ■ CFHFn
 ■ MOKF
 ■ MOKFn
■ MOKFnc
■ MOKFegg
■ MERF
■ MERFn
■ FRHS
■ SJOSx
■ SacW
■ CFHL
■ nonCV

Figure 6. Proportion of hatchery- and natural-origin fish in Upper Sacramento River & tributaries, 2021-22. (Page 2 of 2)

Butte Creek spring carcass
n = 1,807



Feather River fall carcass
n = 9,668



Yuba River fall carcass
n = 4,669

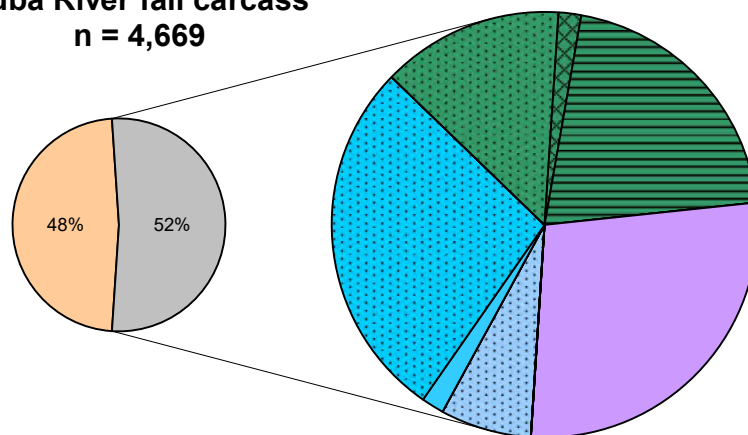
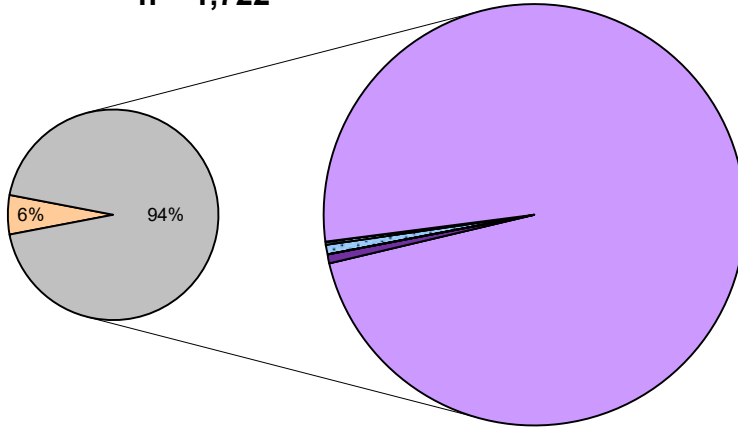
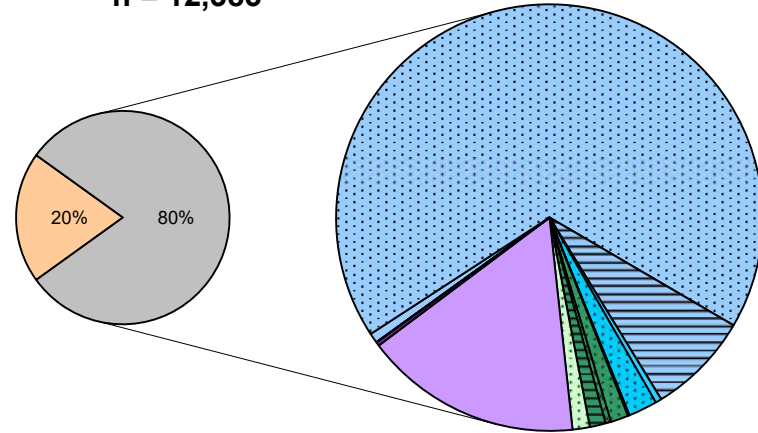


Figure 7. Proportion of hatchery- and natural-origin fish in Feather and Yuba River, 2021.

Feather River Hatchery spring
n = 1,722



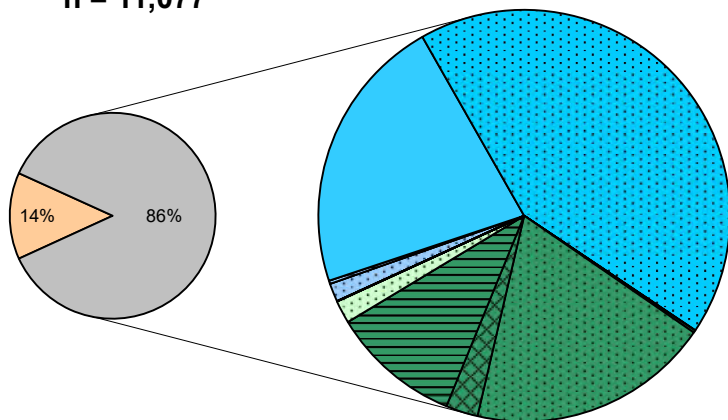
Feather River Hatchery fall
n = 12,385



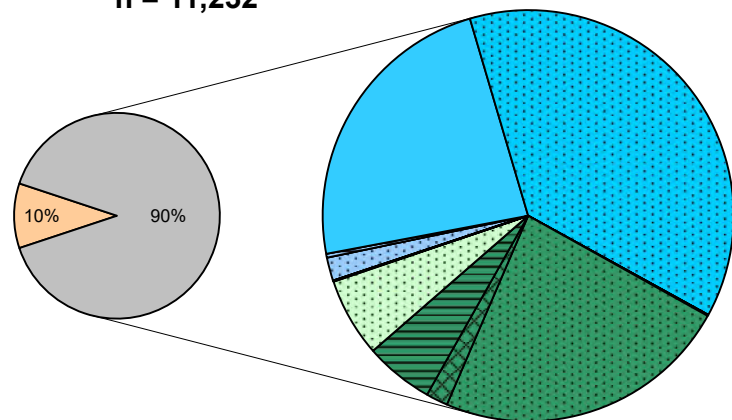
Natural FRHF FRHFfn FRHFegg NIMF NIMFn CFHF CFHFfn MOKF MOKFn
 MOKFnc MOKFegg MERF MERFn FRHS SJOSx SacW CFHL nonCV

Figure 8. Proportion of hatchery- and natural-origin fish in the Feather River, 2021.

Nimbus Hatchery fall
n = 11,077



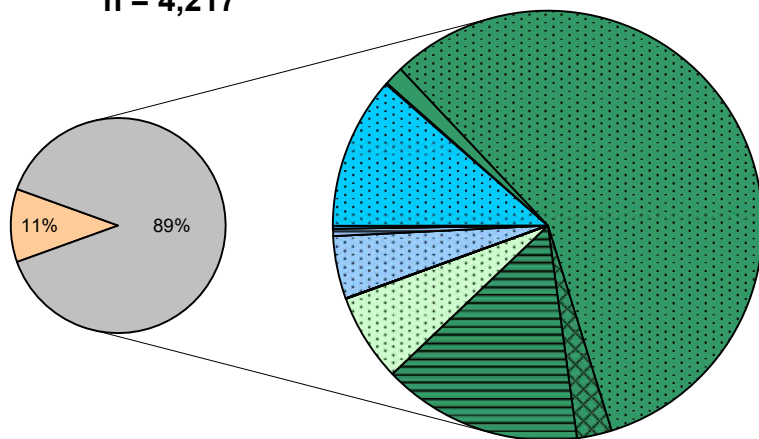
American River fall carcass
n = 11,232



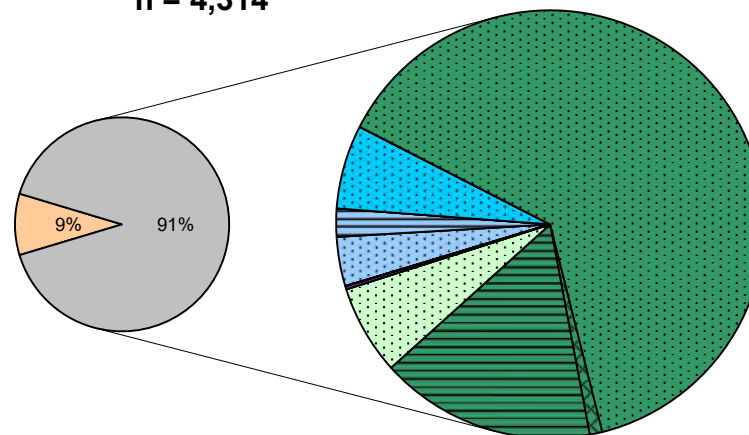
Natural FRHF FRHFn FRHFegg NIMF NIMFn CFHF CFHFn MOKF MOKFn
 MOKFnc MOKFegg MERF MERFn FRHS SJOSx SacW CFHL nonCV

Figure 9. Proportion of hatchery- and natural-origin fish in the American River, 2021.

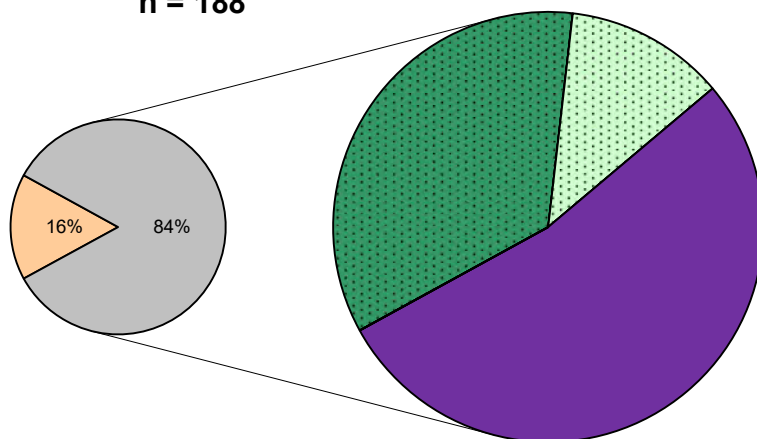
Mokelumne Hatchery fall
n = 4,217



Stanislaus River fall carcass
n = 4,314



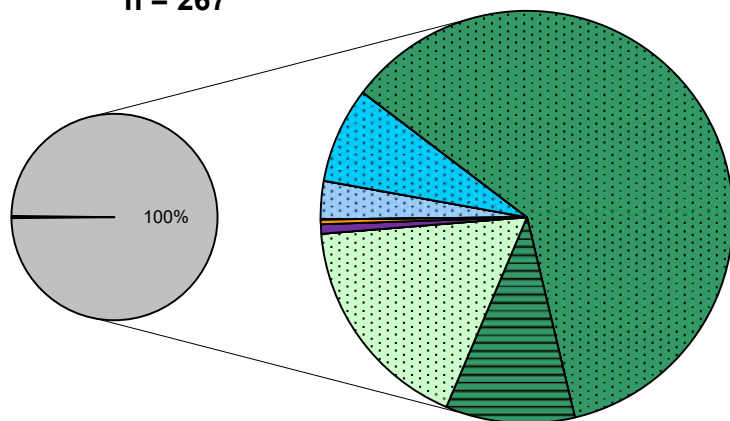
Tuolumne River fall carcass
n = 188



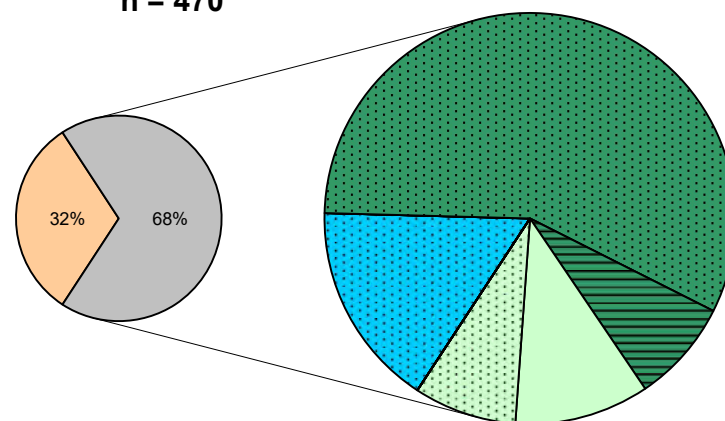
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 ■ FRHFgg
 ■ NIMF
 ■ NIMFn
 ■ CFHF
 ■ CFHFnc
 ■ MOKF
 ■ MOKFn
 ■ MOKFnc
 ■ MOKFgg
 ■ MERF
 ■ MERFn
 ■ FRHS
 ■ SJOSx
 ■ SacW
 ■ CFHL
 ■ nonCV

Figure 10. Proportion of hatchery- and natural-origin fish in the Mokelumne, Stanislaus, & Tuolumne rivers, 2021.

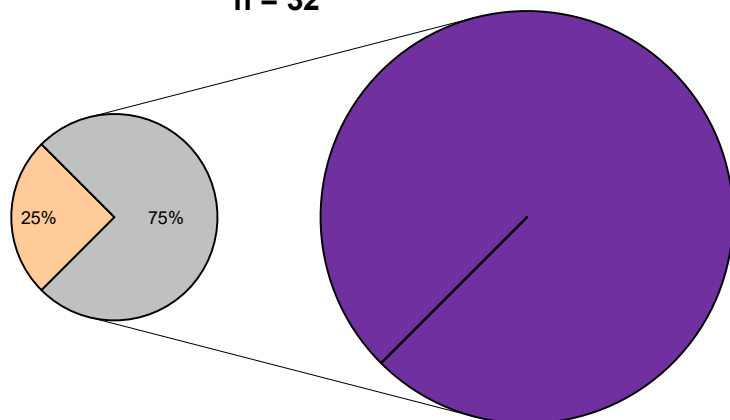
Merced River Hatchery fall
n = 267



Merced River fall carcass
n = 470



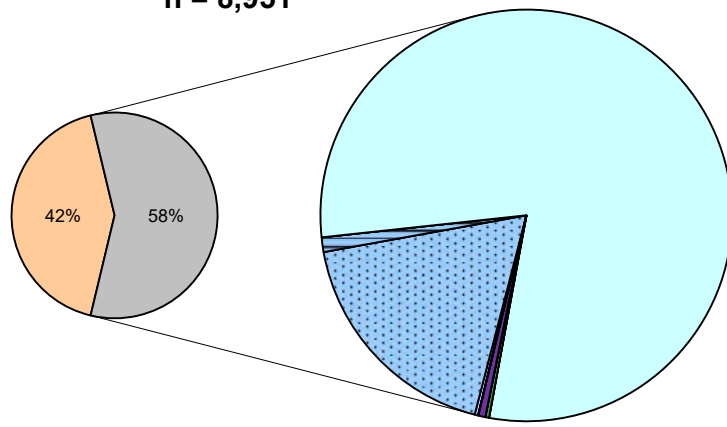
Upper San Joaquin River spring carcass
n = 32



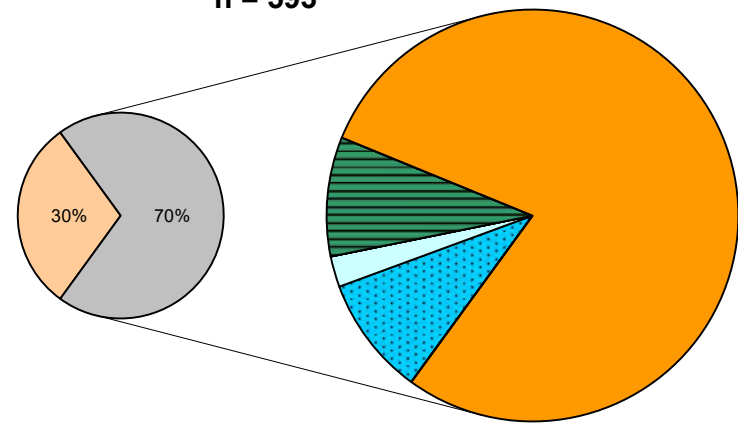
Natural FRHF FRHFfn FRHFgg NIMF NIMFn CFHF CFHFfn MOKF MOKFn
 MOKFnc MOKFgg MERF MERFn FRHS SJOSx SacW CFHL nonCV

Figure 11. Proportion of hatchery- and natural-origin fish in the Merced & Upper San Joaquin rivers, 2021.

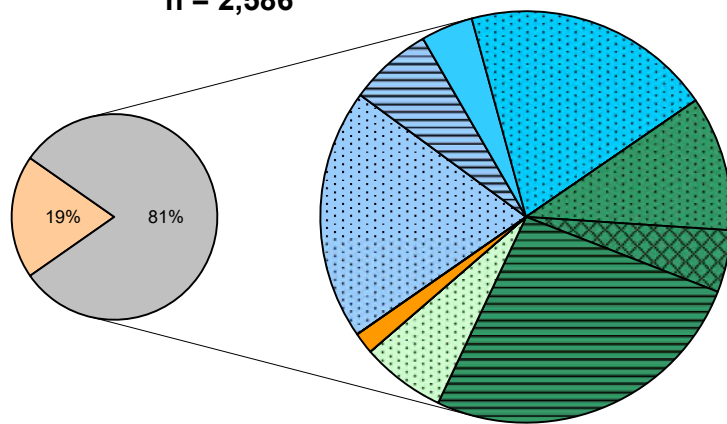
Upper Sacramento River fall creel
n = 8,951



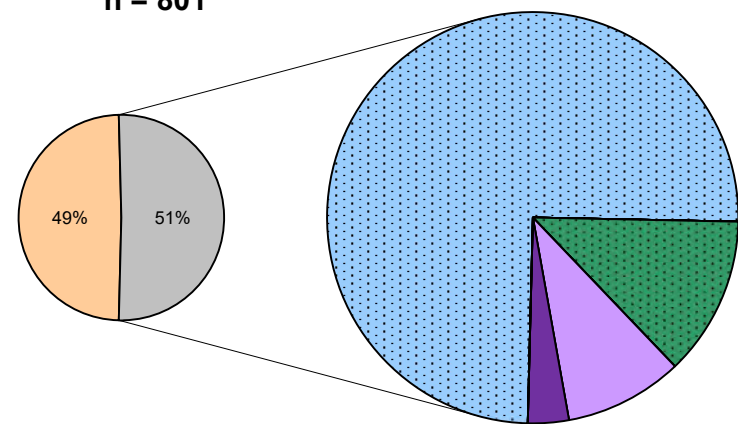
Upper Sacramento River late-fall creel
n = 593



Lower Sacramento River fall creel
n = 2,586



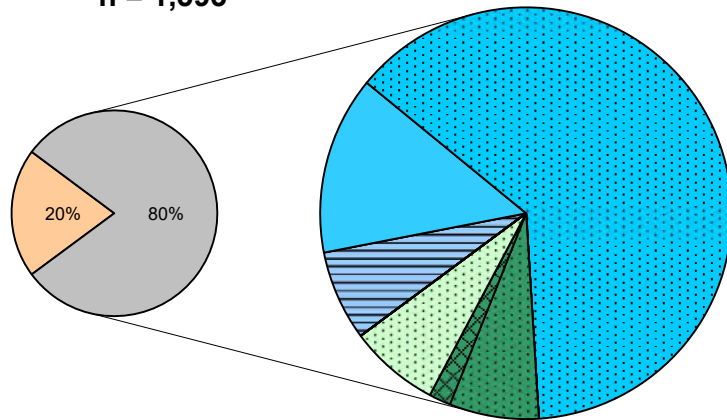
Feather River fall creel
n = 801



Natural FRHF FRHFfn FRHFgg NIMF NIMFn CFHF CFHFfn MOKF MOKFn
 MOKFnc MOKFgg MERF MERFn FRHS SJOSx SacW CFHL nonCV

Figure 12. Proportion of hatchery- and natural-origin fish in sport harvest on the Sacramento & Feather rivers, 2021.

American River fall creel
n = 1,593



Natural FRHF FRHFn FRHFgg NIMF NIMFn CFHF CFHFn MOKF MOKFn
 MOKFnc MOKFgg MERF MERFn FRHS SJOSx SacW CFHL nonCV

Figure 13. Proportion of hatchery- and natural-origin fish in sport harvest on the American River, 2021.

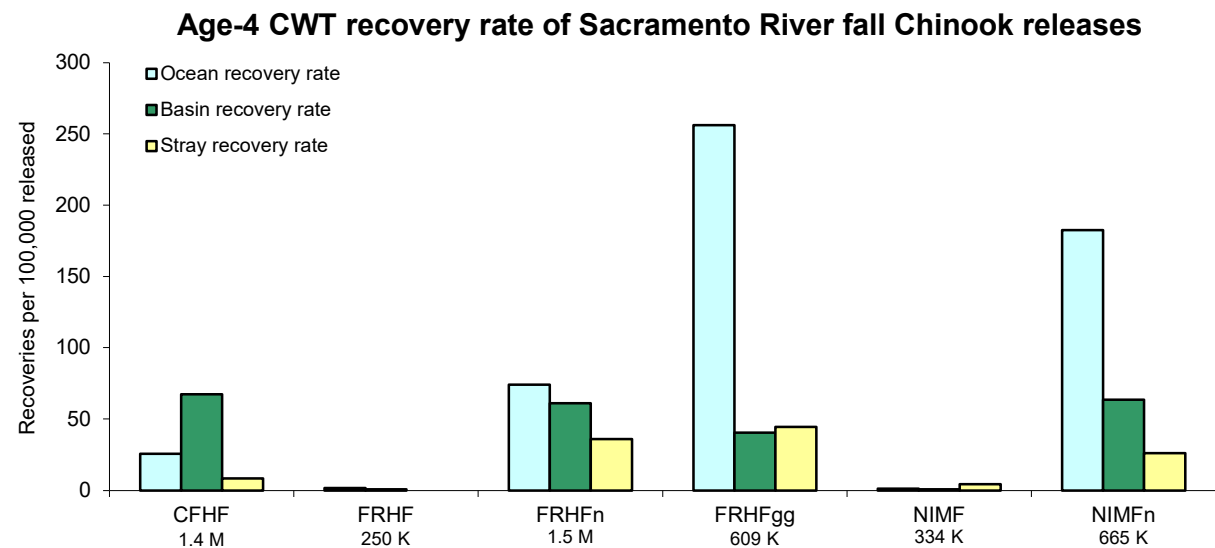
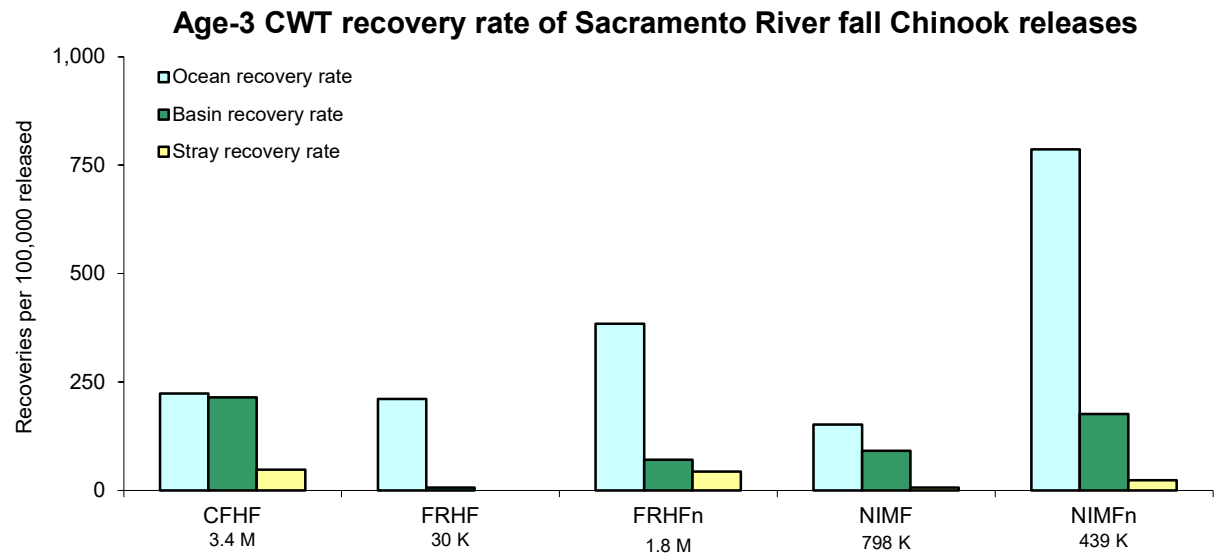
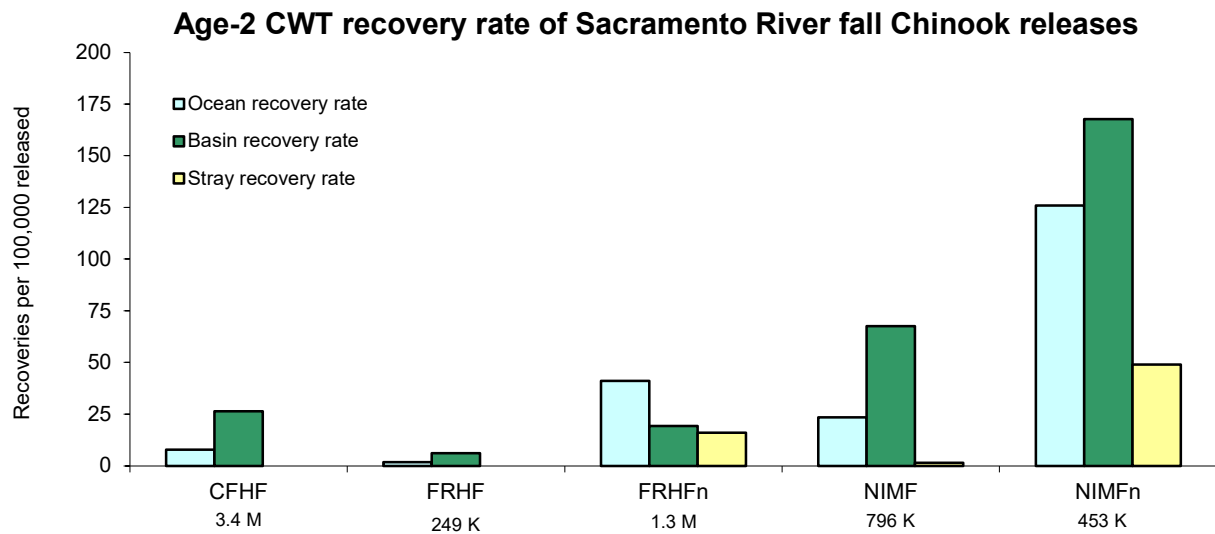


Figure 14. CWT recovery rates of Sacramento River fall Chinook releases by age in 2021.

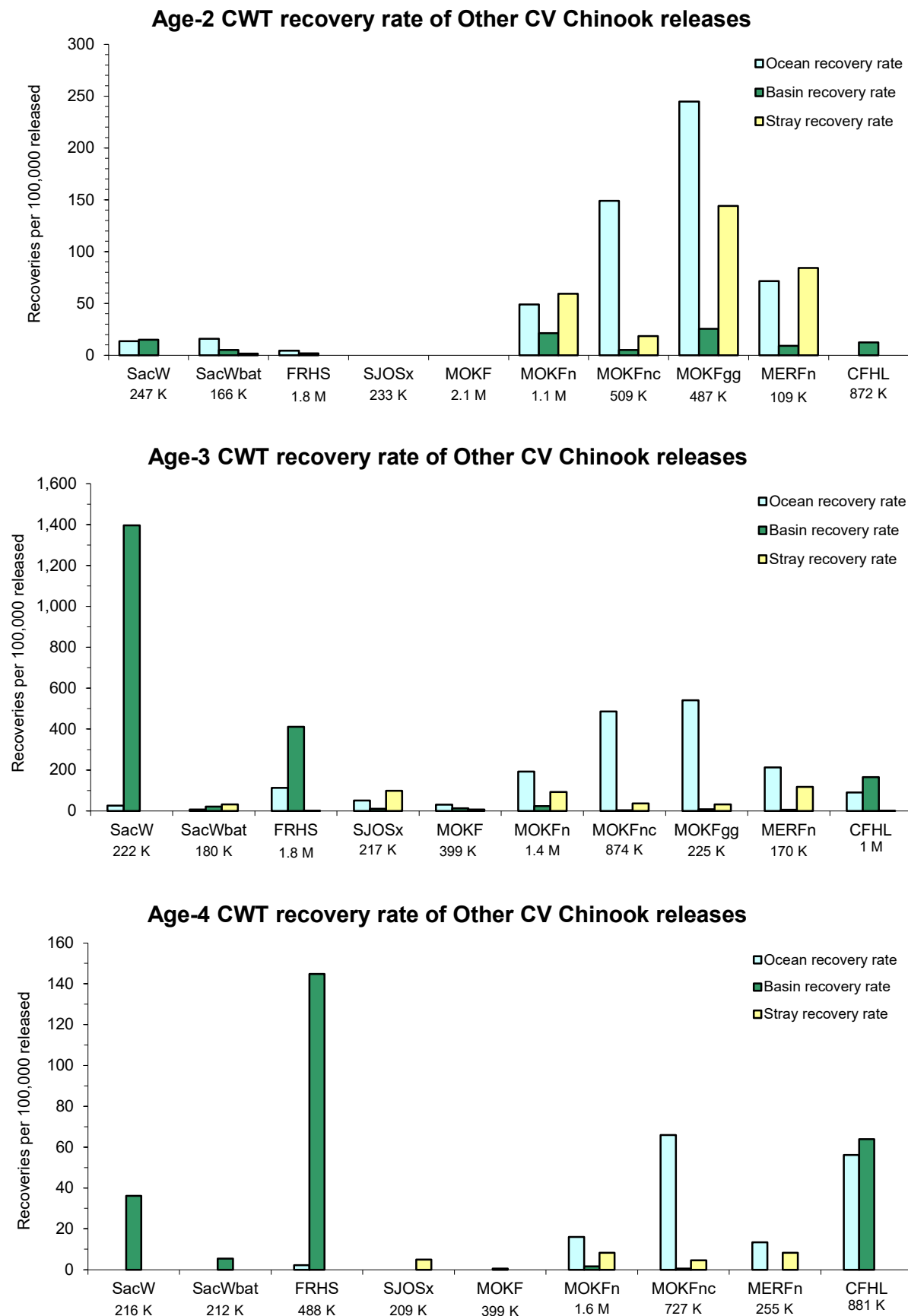


Figure 15. CWT recovery rates of Other CV Chinook releases by age in 2021.

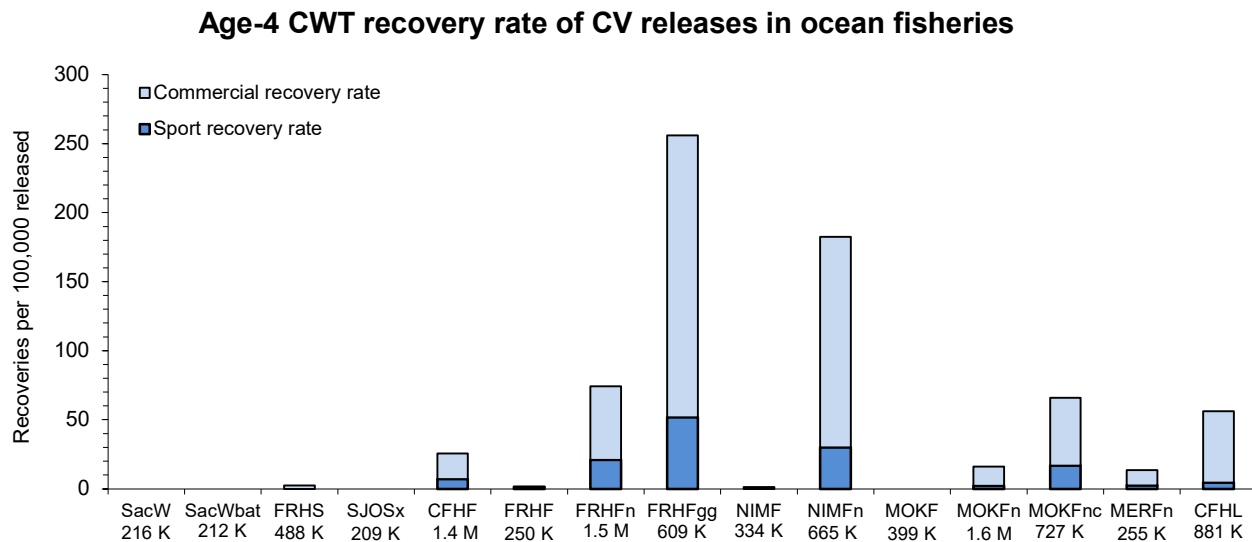
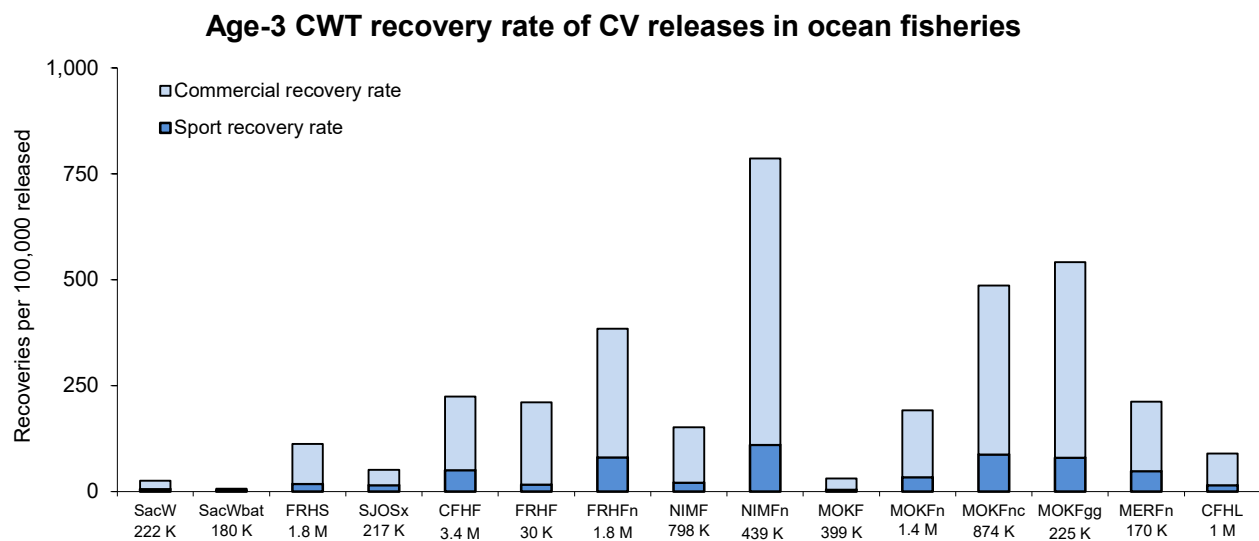
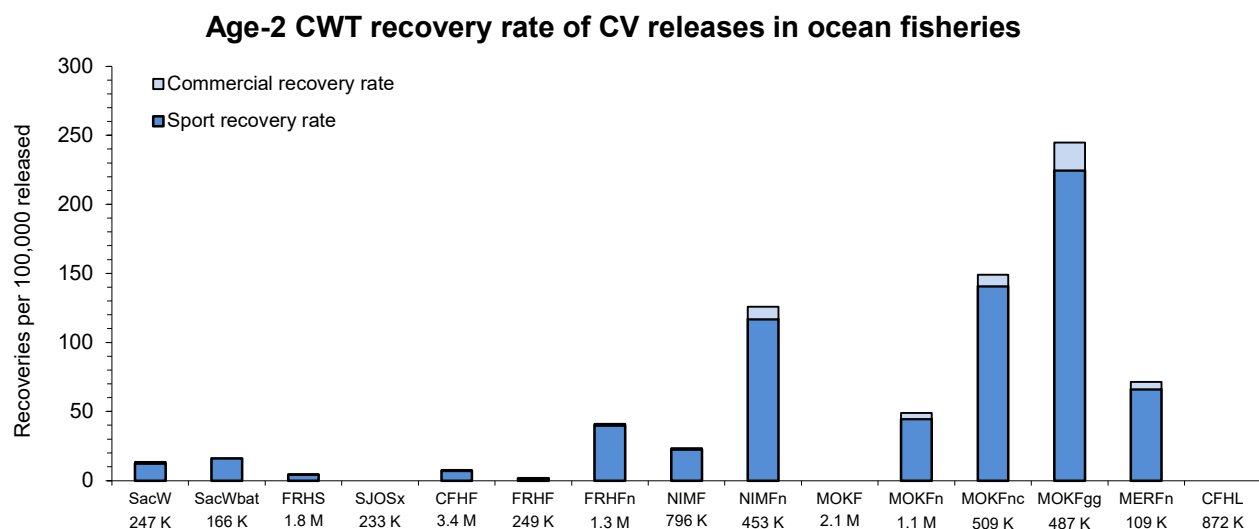
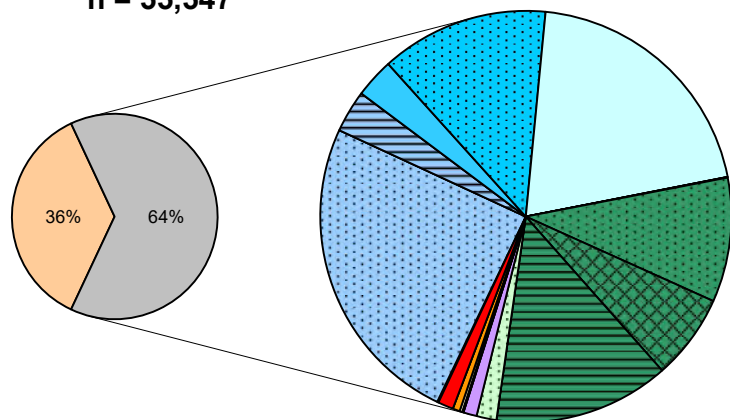
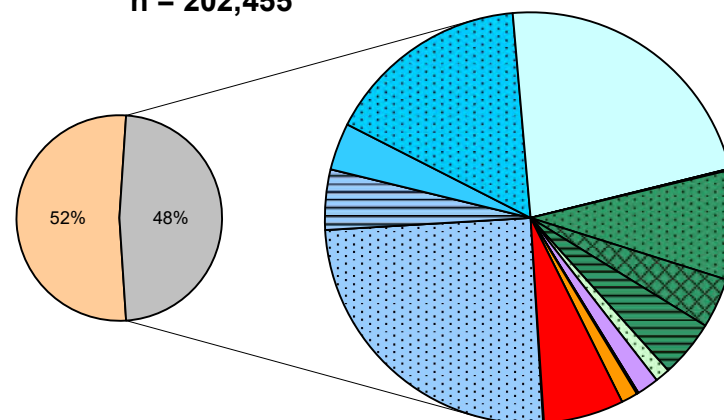


Figure 16. CWT recovery rates by release type in 2021 ocean salmon fisheries.

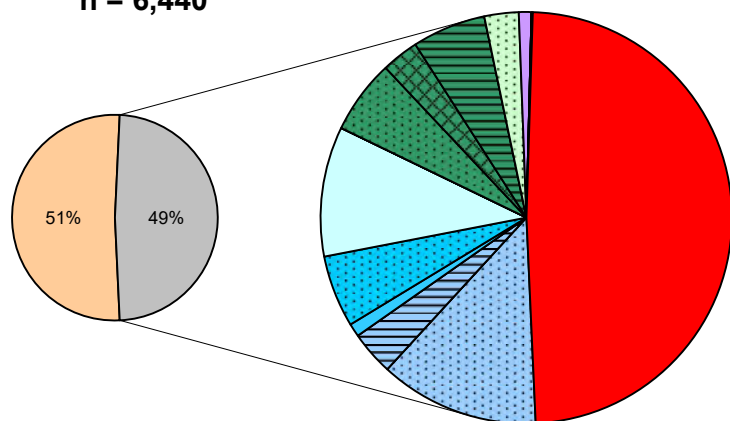
California Sport Harvest
n = 55,547



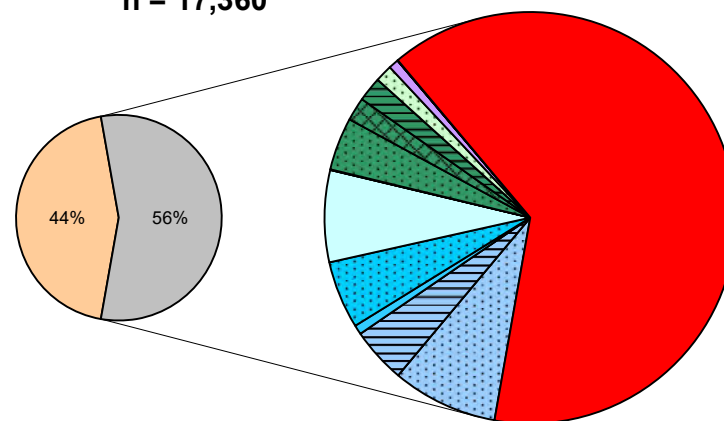
California Commercial Harvest
n = 202,455



Oregon Sport Harvest
n = 6,440



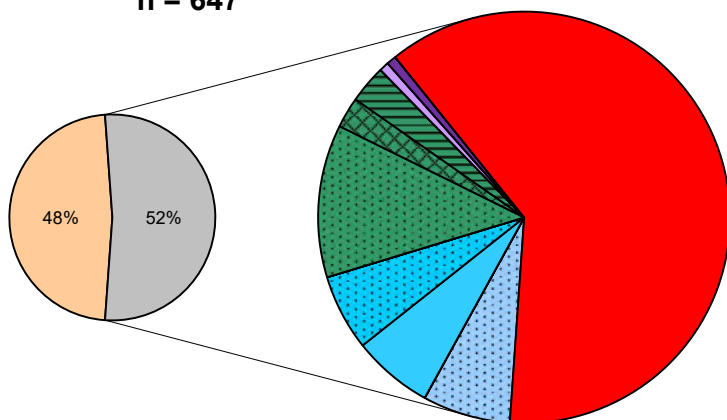
Oregon Commercial Harvest
n = 17,360



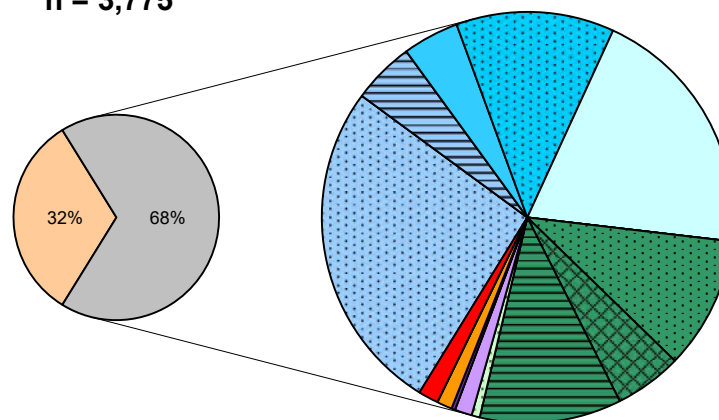
■ Natural
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 ■ NIMF
 ■ NIMFn
 ■ CFHF
 ■ CFHFn
 ■ MOKF
 ■ MOKFn
 ■ MOKFnc
 ■ MOKFegg
 ■ MERF
 ■ MERFn
 ■ FRHS
 ■ SJOSx
 ■ SacW
 ■ CFHL
 ■ nonCV

Figure 17. Proportion of hatchery- and natural-origin salmon in 2021 California and Oregon ocean fisheries.

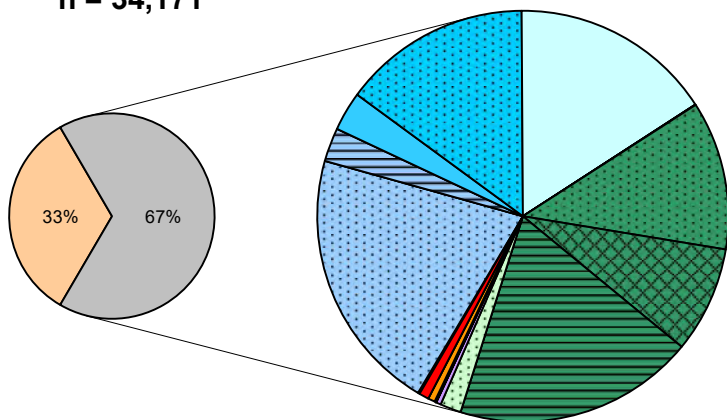
Eureka / Crescent City Sport
n = 647



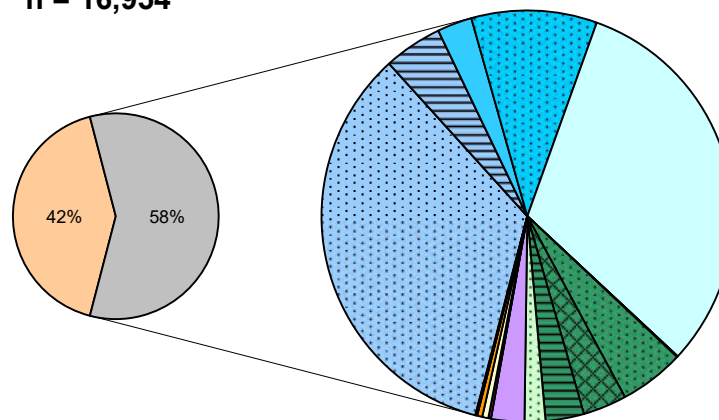
Fort Bragg Sport
n = 3,775



San Francisco Sport
n = 34,171



Monterey Sport
n = 16,954



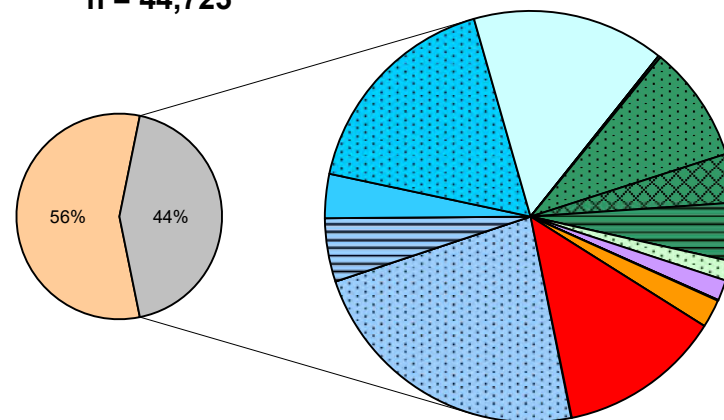
Natural
 FRHF
 FRHFn
 FRHFegg
 NIMF
 NIMFn
 CFHF
 CFHFn
 MOKF
 MOKFn
 MOKFnc
 MOKFegg
 MERF
 MERFn
 FRHS
 SJOSx
 SacW
 CFHL
 nonCV

Figure 18. Proportion of hatchery- and natural-origin salmon in the 2021 California ocean sport fishery.

Eureka / Crescent City Commercial
n = 0

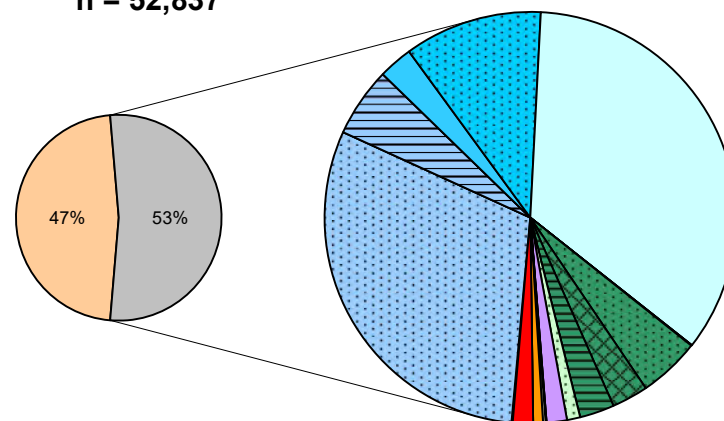
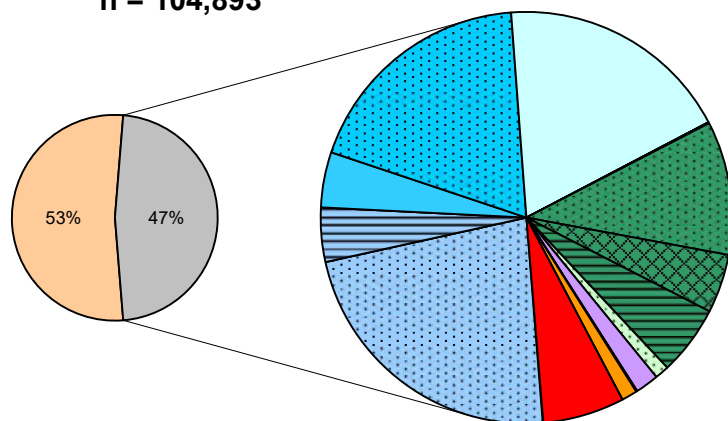
Fort Bragg Commercial
n = 44,725

Area Closed in 2021



San Francisco Commercial
n = 104,893

Monterey Commercial
n = 52,837



Natural FRHF FRHFn FRHFgg NIMF NIMFn CFHF CFHFn MOKF MOKFn
 MOKFnc MOKFgg MERF MERFn FRHS SJOSx SacW CFHL nonCV

Figure 19. Proportion of hatchery- and natural-origin salmon in the 2021 California ocean commercial fishery.

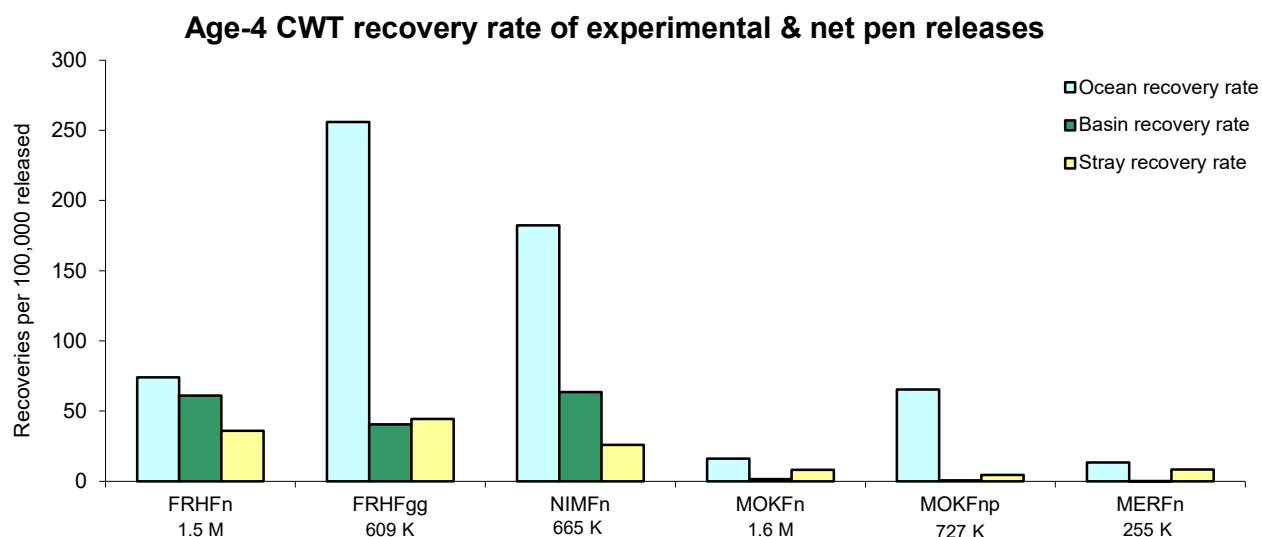
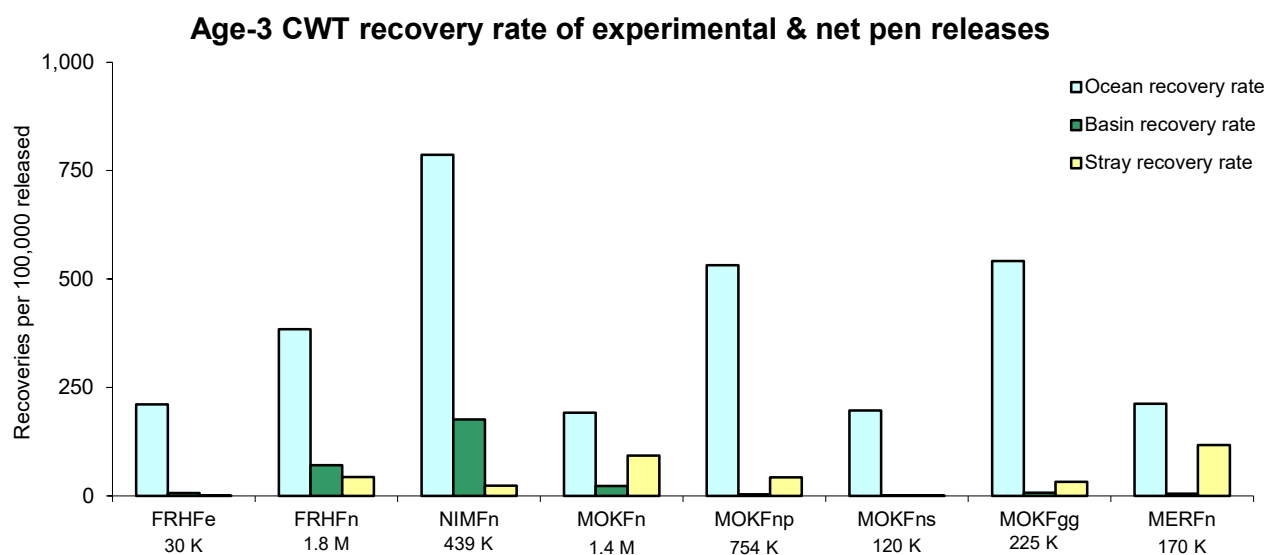
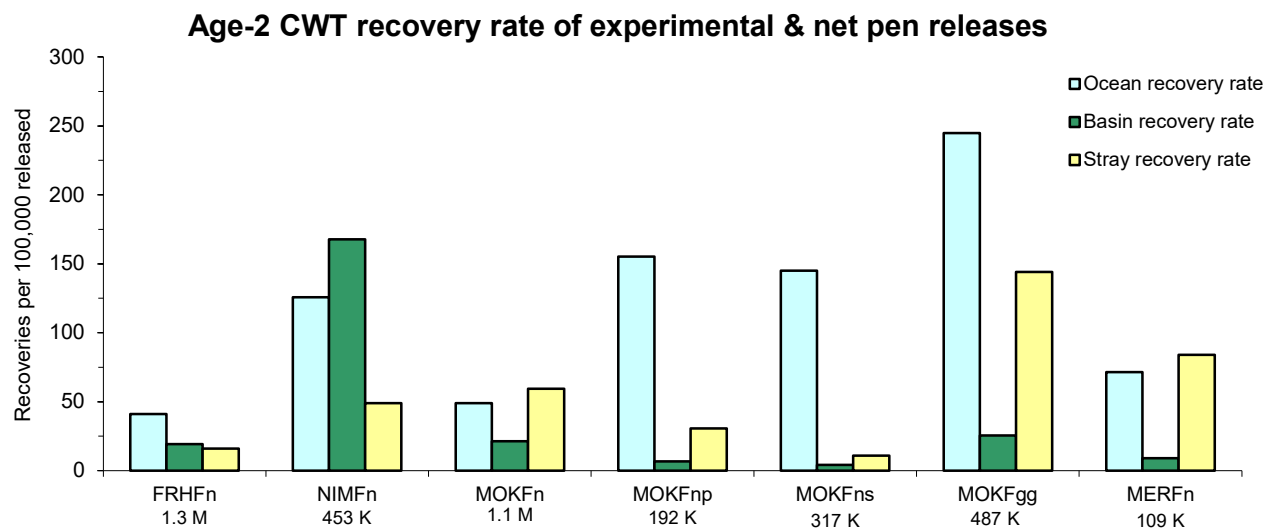


Figure 20. CWT recovery rates of experimental and net pen releases by age in 2021.

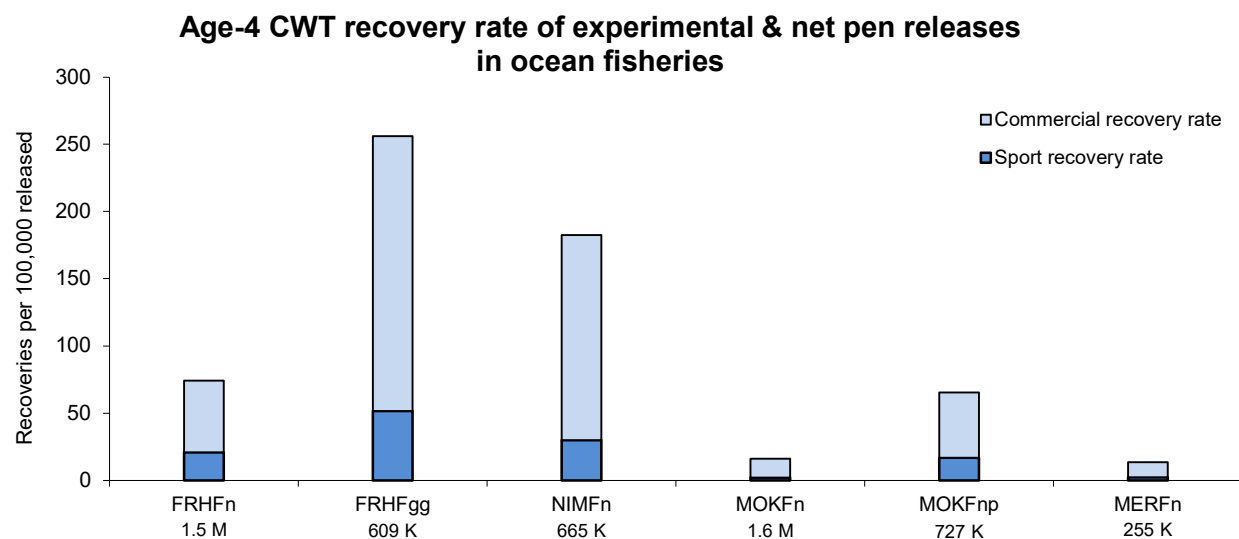
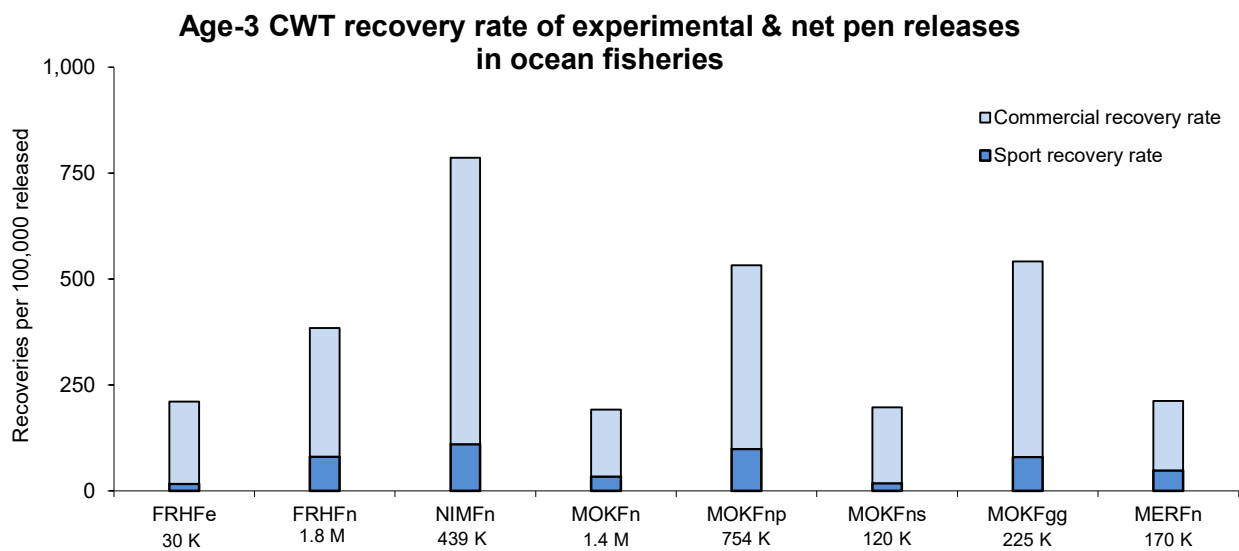
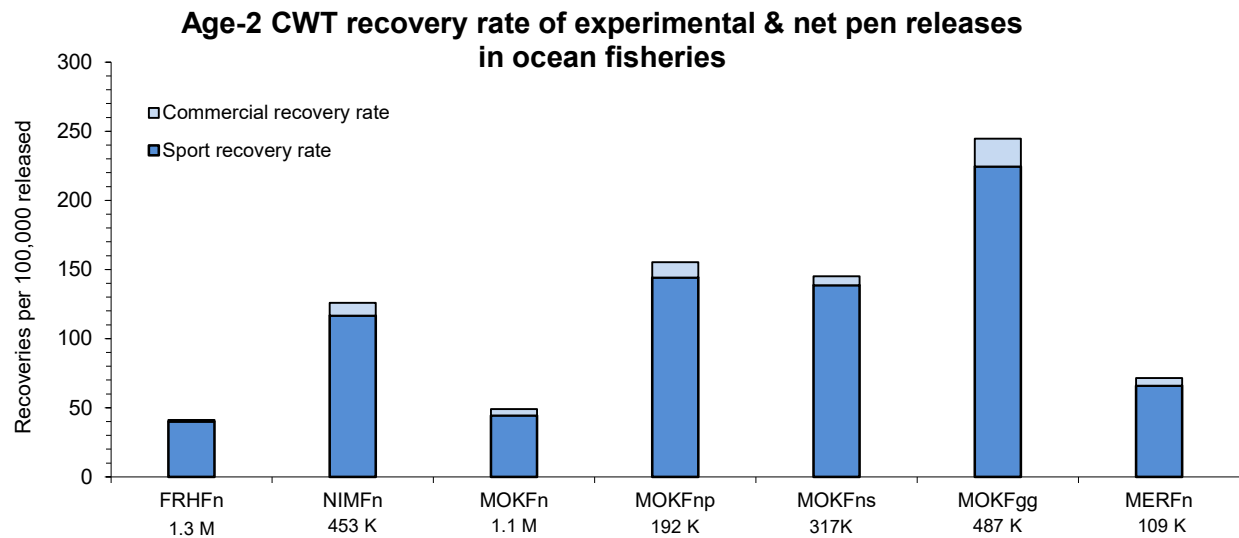


Figure 21. CWT recovery rates of experimental and net pen releases in 2021 ocean sport and commercial fisheries.

Appendix 1. Sample expansion factors for Central Valley salmon carcass surveys collecting fish condition in 2021. (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}	$\sum_{i=1}^m CWT_{total,i}$	% hatchery
fresh 23%		357	2.3%	45	45	41	39	0.13	0.91	46.02	3.43	6,161	39%
non-fresh 77%		1,220	7.8%	25	25	22	22	0.02	0.88				
total	15,629	1,577	10.1%	70	70	63	61			29.43	3.43	6,161	39%

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}	$\sum_{i=1}^m CWT_{total,i}$	% hatchery
fresh 91%		1,071	5.4%	165	165	155	153	0.15	0.94	18.79	3.75	10,774	54%
non-fresh 9%		107	0.5%	60	60	48	50	0.56	0.80				
total	19,867	1,178	5.9%	225	225	203	203			14.16	3.75	10,774	54%

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}	$\sum_{i=1}^m CWT_{total,i}$	% hatchery
fresh 100%		1,260	13.0%	721	721	706	704	0.57	0.98	7.71	1.51	8,192	85%
non-fresh													
total	9,688	1,260	13.0%	721	721	706	704			7.71	1.51	8,192	85%

Yuba 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}	$\sum_{i=1}^m CWT_{total,i}$	% hatchery
fresh 1%		24	0.5%	6	6	6	6	0.25	1.00	194.54	2.08	2,431	52%
non-fresh 99%		4,449		1,085									
total	4,669	4,473	95.8%	1,091	28	28	28			41.69	2.08	2,431	52%

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}	$\sum_{i=1}^m CWT_{total,i}$	% hatchery
fresh 100%		840	19.5%	208	208	205	205	0.25	0.99	5.14	3.71	3,913	91%
non-fresh													
total	4,314	840	19.5%	208	208	205	205			5.14	3.71	3,913	91%

Appendix 1. Sample expansion factors for Central Valley salmon carcass surveys collecting fish condition in 2021. (Page 2 of 2)
Tuolumne 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}	$\sum_{i=1}^m CWT_{total,i}$	% hatchery
fresh 41%		41	21.8%	22	22	22	22	0.54	1.00	4.59	1.56	158	84%
non-fresh 59%		60	31.9%	1	1			0.02					
total	188	101	53.7%	23	23	22	22			4.59	1.56	158	84%

Merced 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}	$\sum_{i=1}^m CWT_{total,i}$	% hatchery
fresh 64%		72	15.3%	12	12	12	12	0.17	1.00	6.53	4.11	322	69%
non-fresh													
total	470	113	24.0%	12	12	12	12			6.53	4.11	322	69%

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}	$\sum_{i=1}^m CWT_{total,i}$	% hatchery
fresh 49%		2,242	22.5%	683	677	650	650	0.30	0.96	4.49	1.01	2,943	30%
non-fresh 51%		2,303	23.1%	520	512	487	486	0.23	0.95				
total	9,971	4,545	45.6%	1203	1189	1137	1136			2.57	1.01	2,943	30%

Upper San Joaquin River spring-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}	$\sum_{i=1}^m CWT_{total,i}$	% hatchery
fresh 72%		23	71.9%	23	23	17	17	1.00	0.74	1.39	1.01	24	75%
non-fresh 28%		9	28.1%	9	9	6	6	1.00	0.67				
total	32	32	100.0%	32	32	23	23			1.03	1.01	24	75%

Upper Sacramento River late-fall-run Chinook salmon carcass survey 2022

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}	$\sum_{i=1}^m CWT_{total,i}$	% hatchery
fresh 38%		80	1.7%	4	4	4	4	0.05	1.00	59.18	1.02	241	5%
non-fresh 62%		130	2.7%										
total	4,734	210	4.4%	4	4	4	4			59.18	1.02	241	5%

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

Appendix 2. Alternative 2021 CWT recovery and stray rates (recoveries per 100,000 CWTs released) of CFH and FRH releases.^{a/}

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 ^{b/}	Fea	Yub	Ame	Mok	Sta/Tuo	Mer	Up SJ	In-basin	Stray	CV total			In-basin	Stray	CV total	Ocean
CFHF	2019	Fall	3,352,800	886										886	0	886	0%	258	26	0	26	8
CFHL	2020	Late	872,269	107										107	0	107	0%	0	12	0	12	0
FRHF	2019	Fall	248,810				15							15	0	15	0%	4	6	0	6	2
FRHFn	2019	Fall	1,335,074	17	118	43	258		13	18	5			258	214	472	45%	549	19	16	35	41
FRHS	2019	Spr	1,771,532				32							32	0	32	0%	76	2	0	2	4

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 Stray	Ocean CWT _{samp}	Recovery rate per 100K released			
				Bat Cr	Up Sac	Nat crks ^{b/}	Fea	Yub	Ame	Mok	Sta/Tuo	Mer	Up SJ	In-basin	Stray	CV total			In-basin	Stray	CV total	Ocean
CFHF	2018	Fall	3,448,504	6,368	1,030	1,644	2		1	1				6,368	2,677	9,045	30%	7,717	185	78	262	224
CFHL	2019	Late	1,031,542	1,698								1		1,698	1	1,699	0%	928	165	0	165	90
FRHF	2018	Fall	30,000				2							2	0	2	0%	63	7	0	7	211
FRHFn	2018	Fall	1,772,613	66	177	411	1,207	42	61	22	31	2		1,207	810	2,018	40%	6,814	68	46	114	384
FRHS	2018	Spr	1,831,043				6,942	584	4					6,942	587	7,530	8%	2,057	379	32	411	112

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 Stray	Ocean CWT _{samp}	Recovery rate per 100K released			
				Bat Cr	Up Sac	Nat crks ^{b/}	Fea	Yub	Ame	Mok	Sta/Tuo	Mer	Up SJ	In-basin	Stray	CV total			In-basin	Stray	CV total	Ocean
CFHF	2017	Fall	1,369,512	775	147	113	1							775	261	1,037	25%	350	57	19.1	76	26
CFHL	2018	Late	881,364	504	59									504	59	564	11%	495	57	7	64	56
FRHF	2017	Fall	250,489				2							2	0	2	0%	4	1	0	1	2
FRHFn	2017	Fall	1,496,598	11	177	340	913		6	4				913	537	1,450	37%	1,109	61	36	97	74
FRHFgg	2017	Fall	609,272	2	59	171	246		14	5	21			246	271	517	52%	1,560	40	44	85	256
FRHS	2017	Spr	488,223				624	83						624	83	707	12%	11	128	17	145	2

a/ CFH and FRH releases recovered in the Upper Sacramento River and Yuba River, respectively, are considered stray recoveries in this table.

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

Sacramento River fall Chinook release types (SFC)

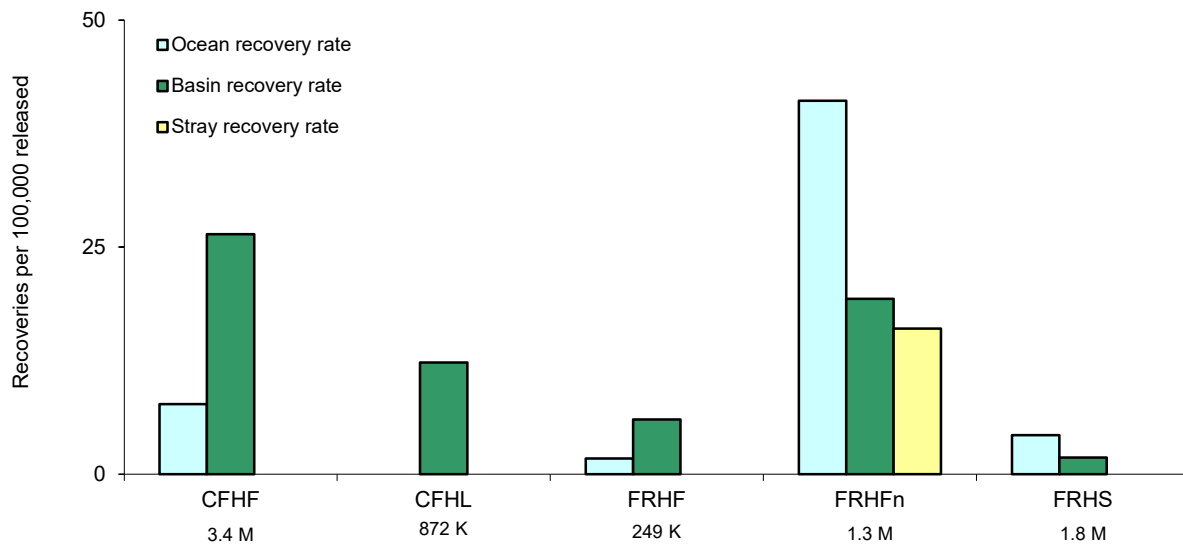
CFHF Coleman National Fish Hatchery fall in-basin releases
FRHF Feather River Hatchery fall in-basin releases
FRHFn Feather River Hatchery fall bay/delta net pen releases
FRHFgg Feather River Hatchery fall Golden Gate releases (no net pens)

Other CV Chinook release types (OCV)

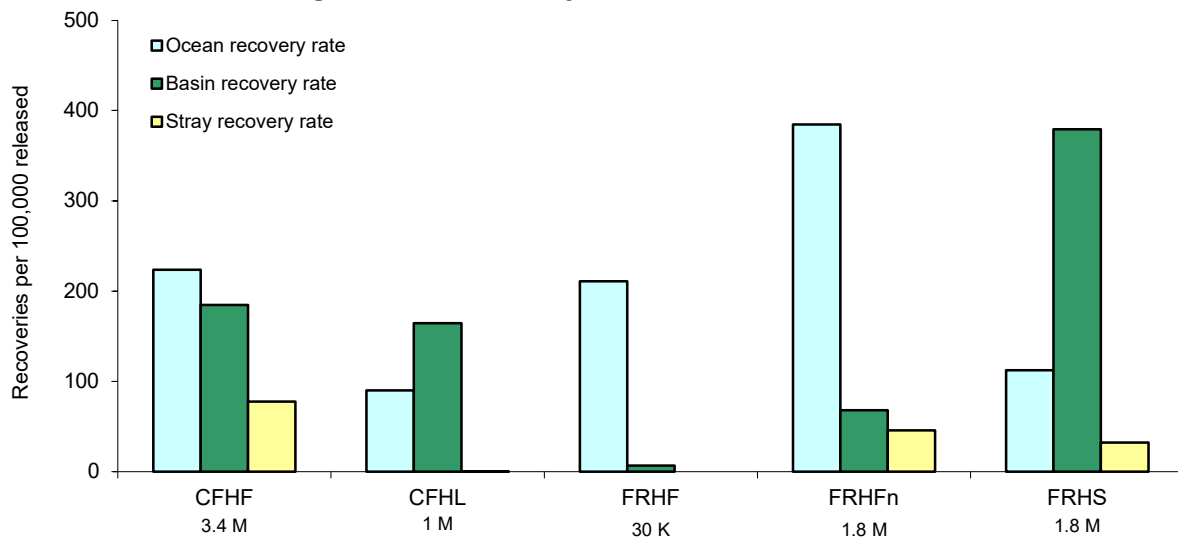
CFHL Coleman National Fish Hatchery late-fall in-basin releases
FRHS Feather River Hatchery spring in-basin releases

Appendix 3. Alternative CWT recovery rates for CFH and FRH releases by age in 2021.

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

