Recovery of Coded-Wire Tags from Chinook Salmon in California's Central Valley Escapement, Inland Harvest, and Ocean Harvest in 2020

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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 11th annual report on the recovery of CFM CWTs in the CV and ocean fisheries. In 2020, approximately 33,800 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., FWS 2020, Kelly and Phillips 2020, Kowalik and Massa 2020).

DATA AND METHODS

Inland Escapement and River Sport Harvest Monitoring

During 2020, 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 2021 return year, however the escapement monitoring period began in late 2020.

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 2020 surveys on major rivers and in the hatcheries adequately sampled (sample rate ≥ 20%) for ad-clipped fish. The sampling rate was generally lower for smaller creeks where biodata was collected over a few days or in limited areas.

Of the approximately 188,300 Chinook salmon that returned to the CV basins analyzed in this report, roughly 82,900 salmon were sampled, 24,200 ad-clipped salmon were observed, and 22,000 heads were collected by various CV projects (Table 3). Monitoring agencies and projects included the California Department of Fish and Wildlife (CDFW), California Department of Water Resources (DWR), East Bay Municipal Utility District (EBMUD), Pacific States Marine Fisheries Commission (PSMFC), U.S. Bureau of Reclamation, 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 5,200 heads processed by FWS staff at CFH, 16 heads processed by FWS staff in Lodi, and 1,800 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 2020, 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; Letvin et al. 2021). However, due to the COVID-19 pandemic preventing sampling of 2020 ocean salmon fisheries, data and CWTs from the months of May and June for both sport and commercial ocean salmon fisheries have been excluded from analysis. Of the approximately 136,200 salmon harvested in California ocean fisheries during 2020, CDFW field staff sampled approximately 37,500 salmon and collected nearly 7,700 heads that were processed at the Santa Rosa CWT lab (Table 4). Approximately 1,200 heads collected in Oregon sport and commercial ocean fisheries during 2020 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 2016).

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 2020 inland and ocean CWT recoveries are publicly available on the RMPC website at www.rmpc.org.

Due to the COVID-19 pandemic, CDFW field staff were unable to sample ocean salmon fisheries as usual in May and June 2020. As a result, CWTs recovered in those months are excluded from this analysis.

CWT Data Analysis

A master release database of CWT codes recovered in 2020 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 2015 through 2018 were downloaded from the RMPC. Approximately 97 million CV salmon were released for these brood years, of which 36 million were marked and tagged utilizing 328 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 2020, there were 294 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,

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

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. It should be noted that certain release types (e.g., barge study) experienced significant pre-release mortality due to factors related to transport and predation at the release site that went unreported in the RMPC. 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
FRHFn	Feather River Hatchery **F**all-run bay/delta **n**et pen releases
FRHFgg	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
NIMFn	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 **Bat**tle 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**x**perimental 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

Note that not all release types occur every year and that release sites sometimes vary within a given release type (Table 5; 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,

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

where f_e is the fraction of the total salmon escapement or harvest sampled and visually examined for an ad-clip, f_a is the fraction of heads from ad-clipped salmon collected and

processed, and f_d is the fraction of observed CWTs that were successfully decoded (Tables 3 and 4).

Salmon sampled in CV carcass surveys are generally classified as 'fresh' or 'non-fresh' based on criteria such as condition of the eyes (clear vs. opaque) or gills (pink vs. grey). Often the ad-clipped (marked) status of a non-fresh (i.e., decayed) salmon cannot be determined due to the deteriorating condition of the carcass. While condition criteria are somewhat ambiguous and classification may vary among surveys, the ad-clip rate of fresh salmon sampled in 2020 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 2020. 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:

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

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

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

CWT	= Raw count CWT recoveries
CWT_{prod}	= CWT recoveries expanded by their respective production factor, F_{prod}
CWT_{samp}	= CWT recoveries expanded by their respective sample expansion factor, F_{samp}
CWT_{total}	= CWT recoveries expanded by both F_{prod} and F_{samp}

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

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

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

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

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

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

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

where j *(=1,2,3,…,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:

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

where k *(= 1,2,3,…,n)* denotes release group.

Determining stray proportions of various release groups in CV escapement

To be consistent with previous reports (Kormos et al. 2012, Letvin et al. 2020, 2021, Palmer-Zwahlen and Kormos 2013, 2015, 2020, Palmer-Zwahlen et al. 2018, 2019a, 2019b), basin-of-origin is defined as the drainage within which a particular hatchery is located. Given the five hatcheries under consideration in this report, the CV is divided into five hatchery basins (hatchery code in parentheses): (1) upper Sacramento River,

including Battle Creek (CFH), (2) Feather River, including the Yuba River (FRH), (3) American River (NIM), (4) Mokelumne River (MOK), and (5) Merced River (MER). Hatchery-origin salmon not returning to their basin-of-origin or to streams and rivers not included in any hatchery basin (e.g., Butte Creek, Stanislaus River, Tuolumne River) are considered strays. Appendices 2 and 3 present alternative recovery and stray rates for CFH and FRH CWT releases based on the assumption that recoveries in the upper Sacramento River and Yuba River, respectively, are strays.

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

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

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

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

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

RESULTS

General overview of 2020 CV inland recoveries and California ocean harvest

All of the nearly 25,400 valid CWTs recovered in the CV during 2020 were from CV Chinook salmon releases. Most CWTs were brood year 2016 through 2018 releases (Table 6). About 92% of all CWT_{total} were fall-run, followed by spring-run (3%) and late-fall-run (2%) salmon releases. Only 3% of CWT_{total} were winter-run, some of which were collected from the first two cohorts of spawners to return to CFH as part of the FWS Battle Creek winter-run Jumpstart program (age-2 and age-3). 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 (66%) and age-4 (27%) fish.

Most of the approximately 7,300 valid CWT recoveries from the 2020 California ocean harvest were CV salmon releases belonging to brood year 2017 (Table 7). Approximately 96% of all CWT_{total} in the ocean harvest were CV fall-run, followed by CV spring-run (1%), CV late-fall-run (1%), and CV winter-run (0.5%) salmon. The remaining 1% 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 (83%), distantly followed by age-4 (11%) and age-2 (6%) fish.

Over two-thirds of the nearly 1,200 valid CWT recoveries from the 2020 Oregon ocean harvest (south of Cape Falcon) were CV fall-run salmon releases (Table 8), which composed 69% of all CWT_{total}. Recoveries of other CV run types were scarce off Oregon. Non-CV stocks made up 31% 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 (52%) and age-4 (44%) fish.

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

During 2020, approximately 110,700 fall-run Chinook salmon returned to spawn in the CV natural areas included in these analyses (Table 9, Fig. 2). There were an additional 1,000 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 Tuolumne River (40%), followed by the upper Sacramento River mainstem and the Yuba River above Daguerre Point Dam (DPD; both 42%). The highest fall-run hatchery proportion occurred in the American River and Battle Creek (both 87%) and the Yuba River below DPD (81%). The total CV fall-run hatchery proportion for all natural areas that were adequately sampled during 2020 was 71%.

One of the upper Sacramento Basin tributaries included in these analyses is Battle Creek, however the hatchery proportion was estimated using a surrogate since a carcass survey or 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 45,800 fall-run salmon returning to the five CV hatcheries ranged from 86% to 88% (Table 9, Fig. 3). The fall-run hatchery proportion for all CV hatcheries combined was 87%. The spring-run return to FRH and the late-fall-run return to CFH were almost entirely hatchery-origin salmon (95% and 98%, respectively).

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 2020, the fall-run spawning period was considered early October through late November, and the late-fall-run spawning period was considered late December through late February 2021. 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 54 late-fall-run salmon were trapped at CFH after spawning operations ended. Also, 2020 was the second 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 (prevalent release type shown in parentheses) at each of the following locations was:

- Winter-run returns CFH: 99% (SacW)
- Fall-run returns CFH: 87% (CFHF)
- Late-fall-run returns CFH: 98% (CFHL)
- Late-fall-run returns CFH (post-spawning): 96% (CFHL)
- Winter-run spawners for broodstock KES: 66% (SacW)
- Winter-run spawners upper Sacramento River: 43% (SacW)
- Fall-run spawners upper Sacramento River: 42% (CFHF)
- Late-fall-run spawners upper Sacramento River: 13% (CFHL)
- Fall-run spawners Clear Creek: 51% (CFHF)
- Fall-run spawners Battle Creek: 87% (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, spawners in the Feather River, and spawners in the Yuba River below DPD were predominantly of hatchery-origin, while spawners in the Yuba River above DPD were relatively evenly distributed between hatchery- and natural-origin (Figs. 7, 8). The proportion of hatchery-origin fish (prevalent release type shown in parentheses) at each of the following locations was:

- Spring-run spawners Butte Creek: 0%
- Spring-run returns FRH: 95% (FRHS)
- Fall-run returns FRH: 88% (FRHFn)
- Fall/spring-run spawners Feather River: 71% (FRHFn)
- Fall/spring-run spawners Yuba River above DPD: 42% (MOKFn)
- Fall/spring-run spawners Yuba River below DPD: 81% (FRHFn)

Appendix 5 provides the F_{samp} calculation for natural area spawners in the Yuba River above DPD, which was based on a combination of ad-clips observed via video weir and CWTs recovered during carcass surveys.

American River Basin

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

- Fall-run returns NIM: 86% (NIMFn)
- Fall-run spawners American River: 87% (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. This was done because salmon that were encountered upstream of the weir tended to exhibit an earlier run timing (e.g., strays from other hatcheries) since many of them would have migrated above the weir before it was put in place each year. Additionally, separate escapement estimates have been produced for NIM weir “washbacks” and the carcass survey downstream for almost 40 years. However, 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. So, these two escapement sectors are now merged and the same F_{samp} is applied to CWTS recovered at both the weir and in the downstream carcass survey. This was the second year that fishing was permanently closed upstream of the NIM weir, so there were many carcasses encountered above the weir that would have likely been harvested under prior fishing regulations. Appendix 4 provides a comparison of raw CWT recoveries by release type between fish sampled upstream and downstream of the NIM weir in 2020.

Mokelumne, Stanislaus, and Tuolumne Rivers

Fall-run returns to MOK and Mokelumne River natural areas were predominantly hatchery-origin salmon. Spawners in the Stanislaus River were mostly of hatchery-origin by a small margin, while spawners in the Tuolumne River were predominantly of natural-origin (Fig. 10). The proportion of hatchery-origin fish (prevalent release type shown in parentheses) at each of the following locations was:

- Fall-run returns MOK: 86% (MOKFn)
- Fall-run spawners Mokelumne River: 74% (FRHFgg)
- Fall-run spawners Stanislaus River: 63% (MOKFn)
- Fall-run spawners Tuolumne River: 40% (MERFn)

Appendix 6 provides the F_{samp} calculation for Mokelumne River natural area spawners, which was based on a combination of ad-clips observed via video weir, ad-clips returning to MOK, and CWTs recovered during carcass surveys.

Merced and upper San Joaquin rivers

Fall-run returns to MER were mostly hatchery-origin. Natural area spawners in the Merced River were relatively evenly distributed between hatchery- and natural-origin salmon. 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 (prevalent release type shown in parentheses) at each of the following locations was:

- Fall-run returns MER: 86% (MERFn)
- Fall-run spawners Merced River: 49% (MERFn)
- Spring-run spawners upper San Joaquin River: 89% (SJOSx)

2. Contribution of CV Release Types to Total Salmon Escapement

In 2020, 74% of the 170,500 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 (20%) followed by fall-run bay/delta net pen releases from FRH and fall-run Golden Gate release from FRH (19% and 11%, respectively). MOK fall-run bay/delta net pen releases had the highest number of strays, while MER fall-run bay/delta net pen and MOK Golden Gate releases, had the highest rates of straying (95% and 87%, respectively), closely followed by MOK fall-run coastal net pen releases (86%). About 15% of all recoveries occurred outside their basin-of-origin and ranged from <1% to 95%, 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	33,745	20%	2,369	7%
FRHF	Fall	977	1%	8	1%
FRHFn	Fall	31,901	19%	3,320	10%
FRHFgg	Fall	19,020	11%	2,168	11%
NIMF	Fall	2,492	1%	14	1%
NIMFn	Fall	14,558	9%	911	6%
MOKF	Fall	83	<1%	39	47%
MOKFn	Fall	8,397	5%	6,033	72%
MOKFnc	Fall	1,338	1%	1,163	87%
MOKFgg	Fall	423	<1%	365	86%
MERF	Fall	49	<1%	5	10%
MERFn	Fall	2,549	1%	2,412	95%
SacW	Winter	3,839	2%	0	0%
FRHS	Spring	4,495	3%	19	<1%
SJOSx	Spring	30	<1%	17	57%
CFHL	Late-fall	2,085	1%	4	<1%
Non-CV		0	0%	0	
	Total	125,981	74%	18,847	15%

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

In 2020, 73% of the 16,900 salmon harvested in the CV river sport fishery were hatchery-origin fish (Table 9; Figs. 12, 13). The proportion of hatchery-origin fish (prevalent release type[s] shown in parentheses) in each of the following fisheries was:

- Upper Sacramento River fall-run harvest: 75% (CFHF)
- Lower Sacramento River fall-run harvest: 82% (FRHFn)
- Feather River fall-run harvest: 69% (FRHFn)
- American River fall-run harvest: 52% (NIMFn)
- Mokelumne River fall-run harvest: 60% (MOKFn)
- Upper Sacramento River late-fall-run harvest: 64% (CFHL)

Of all hatchery release types, CFH fall-run in-basin releases contributed the most (23%) to the total CV sport harvest, followed by FRH fall-run bay/delta net pen releases (21%) 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	3,811	23%
FRHF	Fall	70	<1%
FRHFn	Fall	3,562	21%
FRHFgg	Fall	1,458	9%
NIMF	Fall	0	0%
NIMFn	Fall	1,664	10%
MOKF	Fall	0	0%
MOKFn	Fall	522	3%
MOKFnc	Fall	272	2%
MOKFgg	Fall	107	1%
MERF	Fall	0	0%
MERFn	Fall	143	1%
SacW	Winter	83	<1%
FRHS	Spring	216	1%
SJOSx	Spring	0	0%
CFHL	Late-fall	385	2%
Non-CV		0	0%
	Total	12,293	73%

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 2015 through 2017 brood year releases were more consistent than release types analyzed in earlier CFM reports (Kormos et. al. 2012, Palmer-Zwahlen and Kormos 2013, 2015) and very few "mixed strategy" releases were identified (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 2020. 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	2018	Fall	18	0	2%
FRHFn	2018	Fall	25	3	13%
NIMF	2018	Fall	18	0	0%
NIMFn	2018	Fall	61	5	8%
MOKF	2018	Fall	7.3	0	0%
MOKFn	2018	Fall	33	18	55%
MOKFnc	2018	Fall	24	20	84%
MERFn	2018	Fall	69	64	94%
FRHS	2018	Spring	7	0	0%
SJOSx	2018	Spring	2	2	100.0%
SacW	2018	Winter	81	0	0%
SacWbat	2018	Winter	0	0	-
CFHL	2019	Late-fall	15	0.2	1%

Age-3 CV Escapement Recovery and Stray Rates

R_{type}	Brood year	Run	# Recoveries per 100K Released	# Strays per 100K Released	% stray
CFHF	2017	Fall	265	21	8%
FRHF	2017	Fall	6	0	0.0%
FRHFn	2017	Fall	434	42	10%
FRHFgg	2017	Fall	708	74	10%
NIMF	2017	Fall	17	1	6.1%
NIMFn	2017	Fall	406	23	6%
MOKF	2017	Fall	2	1	54%
MOKFn	2017	Fall	60	40	67%
MOKFnc	2017	Fall	146	128	87%
MERFn	2017	Fall	168	160	95%
FRHS	2017	Spring	469	3	0.7%
SJOSx	2017	Spring	11	6	56%
SacW	2017	Winter	1,224	0	0%
SacWbat	2017	Winter	468	0	0%
CFHL	2018	Late-fall	117	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	2016	Fall	138	10	7%
FRHF	2016	Fall	89	1	1%
FRHFn	2016	Fall	138	20	14%
FRHFgg	2016	Fall	151	32	21%
NIMF	2016	Fall	75	0	0%
NIMFn	2016	Fall	236	19.8	8%
MOKF	2016	Fall	4	3	76%
MOKFn	2016	Fall	67	58	86%
MOKFnc	2016	Fall	5	5	93%
MOKFgg	2016	Fall	42	38	92%
MERF	2016	Fall	4	0	11%
FRHS	2016	Spring	120	0	0%
SJOSx	2016	Spring	3	0	0%
SacW	2016	Winter	5	0	0%
CFHL	2017	Late-fall	84	0.1	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) due to the smaller size limits in effect during 2020 compared to those for 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	2018	Fall	11	99%
FRHFn	2018	Fall	18	97%
NIMF	2018	Fall	8	82%
NIMFn	2018	Fall	41	82%
MOKF	2018	Fall	0	-
MOKFn	2018	Fall	10	90%
MOKFnc	2018	Fall	50	93%
MERFn	2018	Fall	22	100%
FRHS	2018	Spring	16	98%
SJOSx	2018	Spring	8	87%
CFHL	2019	Late-fall	1	100%

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

R_{type}	Brood year	Run	# Recoveries per 100K Released	% sport
CFHF	2017	Fall	131	26%
FRHF	2017	Fall	9	0%
FRHFn	2017	Fall	325	27%
FRHFgg	2017	Fall	807	21%
NIMF	2017	Fall	10	61%
NIMFn	2017	Fall	588	17%
MOKF	2017	Fall	1	0%
MOKFn	2017	Fall	82	19%
MOKFnc	2017	Fall	582	29%
MERFn	2017	Fall	196	29%
FRHS	2017	Spring	64	14%
SJOSx	2017	Spring	4	0%
SacW	2018	Winter	167	90%
SacWbat	2018	Winter	8	100%
CFHL	2018	Late-fall	50	23%

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

R_{type}	Brood year	Run	# Recoveries per 100K Released	% sport
CFHF	2016	Fall	34	37%
FRHF	2016	Fall	29	36%
FRHFn	2016	Fall	40	38%
FRHFgg	2016	Fall	71	0%
NIMF	2016	Fall	35	38%
NIMFn	2016	Fall	140	26%
MOKF	2016	Fall	1.8	48%
MOKFn	2016	Fall	37	25%
MOKFnc	2016	Fall	28	30%
MOKFgg	2016	Fall	50	26%
MERF	2016	Fall	2	47%
FRHS	2016	Spring	1	0%
SJOSx	2016	Spring	0	-
SacW	2017	Winter	5	39%
CFHL	2017	Late-fall	56	14%

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

Over half of the nearly 155,800 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 Golden Gate releases from FRH and bay/delta net pen releases from NIM.

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

R_{type}	Run	CWT_{total}	% harvest
CFHF	Fall	12,701	8%
FRHF	Fall	303	<1%
FRHFn	Fall	21,919	14%
FRHFgg	Fall	20,629	13%
NIMF	Fall	1,208	1%
NIMFn	Fall	17,982	12%
MOKF	Fall	19	<1%
MOKFn	Fall	7,038	5%
MOKFnc	Fall	5,005	3%
MOKFgg	Fall	813	1%
MERF	Fall	23	<1%
MERFn	Fall	2,615	2%
Other CV	Non-fall	2,122	1%
Non-CV		3,727	2%
	Total	96,103	62%

California ocean sport fishery

California anglers harvested approximately 40,100 Chinook salmon in the ocean sport fishery during 2020. The total contribution of hatchery-origin salmon to the California ocean sport fishery was 60%, ranging from 48% to 61% of the total harvest depending on major port area (Fig. 18). Most of the harvest occurred in the San Francisco port area (88%), Fort Bragg (5%), Eureka/Crescent City (5%), and Monterey (3%) port areas (Table 12).

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 FRH fall-run Golden Gate releases (11% and 10%, respectively). Non-CV releases composed less than 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	4,317	11%
FRHF	Fall	80	<1%
FRHFn	Fall	6,322	16%
FRHFgg	Fall	4,159	10%
NIMF	Fall	461	1%
NIMFn	Fall	3,389	8%
MOKF	Fall	8	<1%
MOKFn	Fall	1,561	4%
MOKFnc	Fall	1,615	4%
MOKFgg	Fall	566	1%
MERF	Fall	0	0%
MERFn	Fall	830	2%
SacW	Winter	355	1%
FRHS	Spring	330	1%
SJOSx	Spring	16	<1%
CFHL	Late-fall	193	<1%
Non-CV		27	<1%
	Total	24,219	60%

California ocean commercial fishery

California trollers harvested approximately 96,000 Chinook salmon in the commercial ocean fishery during 2020. The total contribution of hatchery-origin salmon to the California commercial ocean fishery was 66%, ranging from 66% to 76% of the total harvest depending on major port area (Fig. 19). Most of the harvest occurred in the San Francisco port area (95%), followed by the Monterey (3%), and Fort Bragg (2%) port areas (Table 14).

Of all hatchery release types, FRH fall-run Golden Gate releases contributed the most (17%) to the total California commercial harvest, followed by fall-run bay/delta net pen releases from NIM and FRH (both 15%). Non-CV releases contributed 1% 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	6,874	7%
FRHF	Fall	132	<1%
FRHFn	Fall	14,145	15%
FRHFgg	Fall	15,871	17%
NIMF	Fall	496	1%
NIMFn	Fall	13,927	15%
MOKF	Fall	11	<1%
MOKFn	Fall	4,849	5%
MOKFnc	Fall	3,114	3%
MOKFgg	Fall	173	<1%
MERF	Fall	12	<1%
MERFn	Fall	1,663	2%
SacW	Winter	43	<1%
FRHS	Spring	281	<1%
SJOSx	Spring	10	<1%
CFHL	Late-fall	868	1%
Non-CV		1,193	1%
	Total	63,757	66%

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

In 2020, 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 2016 through 2018 (ages 2-4). Experimental releases include barge studies that utilized approximately 300,000 fall-run salmon from MOK, and non-acclimated Golden Gate releases at Fort Baker which utilized approximately 3.5 million and 500,000 fall-run salmon from FRH and MOK, respectively.

Net pen releases can be categorized into either bay/delta or coastal releases. Bay/delta net pen releases include those that are released in the western Delta (CFH, 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 2019 are differentiated into the following release types:

- 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)
- MOKFbb Mokelumne River Hatchery **F**all-run **b**arge study: trucked and released in SF **B**ay
- MOKFbg Mokelumne River Hatchery **F**all-run **b**arge study: bar**g**ed to SF Bay and released
- MOKFbr Mokelumne River Hatchery **F**all-run **b**arge study: released in-**r**iver (Mok R)
- 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	2018	Fall	25	3	13%
NIMFn	2018	Fall	61	5	8%
MOKFgg	2018	Fall	31	26	83%
MOKFn	2018	Fall	33	18	55%
MOKFnp	2018	Fall	27	22	83%
MOKFns	2018	Fall	6	5	86%
MERFn	2018	Fall	69	64	94%

Age-3 CV Escapement Recovery and Stray Rates

R_{type}	Brood year	Run	# Recoveries per 100K Released	# Strays per 100K Released	% stray
FRHFgg	2017	Fall	708	74	10%
FRHFn	2017	Fall	434	42	10%
NIMFn	2017	Fall	406	23	6%
MOKFn	2017	Fall	60	40	67%
MOKFnp	2017	Fall	146	128	87%
MERFn	2017	Fall	168	160	95%

Age-4 CV Escapement Recovery and Stray Rates

R_{type}	Brood year	Run	# Recoveries per 100K Released	# Strays per 100K Released	% stray
FRHFgg	2016	Fall	151	32	21%
FRHFn	2016	Fall	138	20	14%
NIMFn	2016	Fall	236	20	8%
MOKFbb	2016	Fall	10	10.1	100%
MOKFbg	2016	Fall	40	38	95%
MOKFbr	2016	Fall	29	22	76%
MOKFgg	2016	Fall	42	38	92%
MOKFn	2016	Fall	67	58	86%
MOKFnp	2016	Fall	6	5	93%
MOKFns	2016	Fall	0	0	-

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	2018	Fall	18	97%
NIMFn	2018	Fall	41	82%
MOKFgg	2018	Fall	62	95%
MOKFn	2018	Fall	10	90%
MOKFnp	2018	Fall	56	92%
MOKFns	2018	Fall	16	100%
MERFn	2018	Fall	22	100%

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

R_{type}	Brood year	Run	# Recoveries per 100K Released	% sport
FRHFgg	2017	Fall	807	21%
FRHFn	2017	Fall	325	27%
NIMFn	2017	Fall	588	17%
MOKFn	2017	Fall	82	19%
MOKFnp	2017	Fall	582	29%
MERFn	2017	Fall	196	29%

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

R_{type}	Brood year	Run	# Recoveries per 100K Released	% sport
FRHFgg	2016	Fall	71	29%
FRHFn	2016	Fall	40	38%
NIMFn	2016	Fall	140	26%
MOKFbb	2016	Fall	23	0%
MOKFbg	2016	Fall	20	19%
MOKFbr	2016	Fall	9	55%
MOKFgg	2016	Fall	92	28%
MOKFn	2016	Fall	37	25%
MOKFnp	2016	Fall	31	29%
MOKFns	2016	Fall	10	38%

2020 CFM ANALYSES KEY POINTS

- A majority (74%) of the total 2020 CV salmon escapement (all run-types) was hatchery-origin fish. This was an increase of 17% in hatchery contribution from the 2019 escapement. Between 2010 and 2019, the hatchery contribution to the total CV escapement averaged 74% and ranged between 57% and 88%. The increase observed in 2020 suggests a return to normal conditions observed since the CFM program was fully implemented. CFH fall-run in-basin releases had the highest contribution (20%) to the total 2020 CV escapement hatchery spawners, with FRH fall-run bay/delta and Golden Gate releases being the next highest contributors (19% and 11%, respectively).

- The highest stray rates all occurred with offsite MOK and MER releases. MER fall-run bay/delta net pen releases strayed the most (95%) followed by MOK fall-run coastal net pen (87%), Golden Gate (86%; includes those that were barged to the Golden Gate), and MOK fall-run bay/delta (72%) releases. Offsite releases from other hatcheries strayed at much lower rates, with the lowest being NIM fall-run bay/delta releases (6%), followed by FRH fall-run bay/delta and Golden Gate releases (10% and 11%, respectively).

- Salmon escapement into all CV hatcheries was predominately hatchery-origin fish. At all CV hatcheries, the majority of their return was composed of their respective releases. The out-of-basin hatchery return at MER and NIM were quite high (42% and 23%, respectively), with most of those strays originating from MOK.

- Hatchery contributions to natural area escapements fell close to the average hatchery contribution since the CFM program was fully implemented. For fall-run specifically, the hatchery contribution across all CV natural areas was 71% compared to the 2010-2018 average of 69% (range: 53% - 81%). Most natural area spawners were primarily hatchery-origin fish. The exceptions were spring-run spawners in Butte Creek, fall-run spawners in the upper Sacramento River mainstem, the Yuba River above DPD, and the Tuolumne and Merced Rivers, and late-fall-run spawners in the upper Sacramento River mainstem.

- In all rivers that contain hatcheries excluding the Merced River, 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, Mokelumne, and Merced Rivers (37%, 40%, and 52% of the hatchery-origin components, respectively), with MOK fall-run bay/delta releases making the most notable contribution to the American and Merced Rivers (20% and 31% of the hatchery-origin component, respectively) and FRH Golden Gate releases making the most notable contribution to the Mokelumne River (40% of the hatchery-origin component).

- Fall-run escapement in the upper Sacramento River mainstem was predominately natural-origin salmon (58% natural vs. 42% hatchery). CFH in-basin releases

composed more than half of the hatchery-origin portion of the Sacramento River mainstem fall-run escapement.

- Fall/spring-run escapement to the natural spawning areas of the Feather River was mostly hatchery-origin salmon compared to last year where escapement was predominately natural-origin. FRH fall-run bay/delta and Golden Gate releases had the highest contributions of any release type. Spring-run releases from FRH only formed 4% of the escapement but were the next highest contributor. In-basin fall-run releases from FRH composed 1% of the escapement.

- Of the total fall/spring-run escapement in the Yuba River, 92% occurred above DPD and 8% occurred below. The escapement above DPD was predominately natural-origin by a small margin, while the escapement below DPD was predominantly hatchery-origin salmon. FRH fall-run bay/delta releases composed the bulk of the hatchery-origin component below DPD while MOK, FRH fall-run, and NIM bay/delta releases made up the majority of the hatchery-origin component above DPD.

- Fall-run escapement to the natural spawning areas of the American River was dominated by hatchery-origin salmon. NIM bay/delta and stray MOK bay/delta releases were the highest-contributing release types, followed by in-basin releases.

- Fall-run escapement to the natural spawning areas of the Mokelumne River was primarily hatchery-origin salmon, with FRH fall-run Golden Gate and MOK bay/delta releases composing over half of the total escapement.

- Fall-run escapement to the Stanislaus River was mostly hatchery-origin salmon, with stray MOK bay/delta releases composing the bulk of the hatchery-origin component. Conversely, the fall-run escapement to the Tuolumne River was predominantly natural-origin salmon, with stray MER and MOK bay/delta releases being the highest contributors.

- Fall-run escapement to the natural spawning areas of the Merced River was evenly distributed between hatchery- and natural-origin salmon. MER, MOK, and NIM bay/delta releases composed the majority of the hatchery-origin component.

- For age-2 fall-run salmon, MER bay/delta releases had the highest CV escapement recovery rate for their cohort, followed by NIM bay/delta, MOK bay/delta, FRH bay/delta, and MOK coastal net pen releases. Offsite releases from MOK and MER had the highest stray rates among this cohort, with MOK coastal and MER bay/delta releases straying at particularly high rates. Releases from other hatcheries and MOK in-basin releases all had substantially lower stray rates.

- For age-3 fall-run salmon, FRH Golden Gate releases had the highest CV escapement recovery rates for their cohort, followed by FRH bay/delta, NIM bay/delta, CFH in-basin, and MER bay/delta releases. Offsite releases from MER and MOK had the highest stray rates among this cohort, with MER bay/delta and MOK coastal releases

straying at particularly high rates. Releases from other hatcheries and MOK in-basin releases all had substantially lower stray rates.

- For age-4 fall-run salmon, NIM bay/delta releases had the highest CV escapement recovery rate for their cohort, followed by FRH Golden Gate, FRH bay/delta and CFH in-basin releases. Offsite and in-basin releases from MOK had the highest stray rates among this cohort, with all MOK releases straying at particularly high rates. Releases from other hatcheries had substantially lower stray rates.

- Most of the total CV river sport harvest was comprised of hatchery-origin salmon (73%). Between 2010 and 2019, 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. The American River was the only fishery sector where in-basin hatchery fish did not compose a majority of the harvest, as NIM releases only accounted for 24% of the catch. Strays from MOK and FRH represented 24% and 5% of the American River sport harvest, respectively.

- The COVID-19 pandemic prevented sampling of California ocean sport and commercial harvest prior to July 2020. As a result, ocean harvest and CWT prior to July 2020 was excluded from analysis. Encounters with winter-run and spring-run are more frequent in ocean fisheries earlier in the season, and thus, the recoveries for these runs are likely underreported here.

- Over half of the California ocean sport and commercial harvest was composed of hatchery-origin fish. FRH fall-run Golden Gate releases had the highest contribution to the total harvest in the commercial fishery, while FRH bay/delta releases had the highest contribution to total harvest in the sport fishery. There were also moderate contributions from NIM bay/delta releases, as well as CFH in-basin releases. Non-CV hatchery production contributed less than 1% to ocean harvest.

- Ocean recovery rates for NIM fall-run releases were much lower than 2019, particularly for the 2016 brood. However, the bay/delta releases from that brood had the highest age-4 ocean recovery rate of any release type analyzed in this report. The ocean recovery rates for both age-3 and age-4 NIM bay/delta were similar to those of FRH bay/delta releases.

- Golden Gate fall-run releases from FRH (ages 3 and 4 also had very high ocean recovery rates), in addition to the high CV escapement recovery rates previously mentioned. For the ages at which they were present, both their CV and ocean recovery rates exceeded those of the bay/delta and coastal net pen releases from the same hatchery and brood. The sole Golden Gate release from MOK strayed at a lower rate than those produced at FRH.

- Coastal fall-run releases, all of which were from MOK, also had high ocean recovery rates at all ages. The age-3 CV escapement recovery rate was also high for coastal fall-run releases, but the age-2 CV recovery rate was quite low. Among the coastal

release locations, which in 2020 only co-occurred in age-2 and age-4 fish, the Pillar Point release had higher CV and ocean recovery rates than the Santa Cruz release. While the age-2 and age-4 CV recovery rates were low for both release locations, the Santa Cruz CV recovery rate was noticeably lower, particularly for age-2 salmon. The Santa Cruz release had much lower CV and ocean recovery rates than any other offsite release from that brood.

- This is the fourth 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 2020 suggest lower survival but less straying for in-basin releases. The differences in survival were stark for the 2017 brood (i.e., age 3). Recovery rates for the 2017 brood released in-basin were 6 and 9 CWTs per 100,000 released for the CV and ocean, respectively, while FRH bay/delta releases had age-3 CV and ocean recovery rates of 434 and 325 CWTs per 100,000 released, respectively. Age-3 CV and ocean recovery rates were even higher for FRH Golden Gate releases at 708 and 807 CWTs per 100,000 released, respectively. While offsite FRH releases from the 2017 brood did have higher stray rates than in-basin releases, they were not particularly high at 10% for both Golden Gate and bay/delta releases. Age-4 recovery rates were much closer between in-basin and bay/delta releases than they were for age-3 salmon, but the same general pattern was observed. Specifically, age-4 CV and ocean recovery rates for FRH in-basin releases were 89 and 29 CWTs per 100,000 released, respectively, compared to 138 and 40, respectively, for bay/delta releases and 151 and 71, respectively for Golden Gate releases. Stray rates for this brood of FRH fall-run were higher than they were for the other broods, at 1% for in-basin releases, 14% for bay/delta releases, and 21% for Golden Gate releases. FRH in-basin releases were limited to an experimental release in 2018 and were excluded from this analysis due to no CWTs being recovered.

- The age-3 upper Sacramento River winter-run CV recovery rate of 1,218 CWTs per 100,000 released was the second highest recovery rate that has been observed in these reports. Between 2012 and 2019, the age-3 winter-run CV recovery rate averaged 459 CWTs per 100,000 released and ranged between 72 and 1,896. While water year 2017/18 was relatively dry, the 2017 brood was released further downstream of the previous release site of Lake Redding Park. It is possible that this change in release location allowed for greater survival for out-migrating juveniles. Additionally, the 2020 winter-run escapement to the upper Sacramento River was the second highest escapement observed since 2006 (PFMC 2023).

- 2020 was the second 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 and-3 only). The CV and ocean recovery rates for this release type were both lower than for winter-run released into the upper Sacramento River. Among the winter-run that returned to the CV in 2020, those that were released into the upper Sacramento River returned entirely to the upper Sacramento River, while age-2 and age-3 winter-run releases into Battle Creek

strayed at rates of 100% and 1%, respectively. However, it is important to note that age-2 returns were limited to only 2 fish.

- This is the second 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. While 2019 saw high flows during the spring, 2020 once again saw low flows during the spring making volitional return to the upper San Joaquin River nonexistent. The spring-run escapement to this sector was overwhelmingly hatchery-origin salmon, although that is expected this early in the reintroduction effort.

- CV and ocean recoveries of winter-run releases were predominantly age-3 salmon, while recoveries of spring- and late-fall-run releases were more evenly distributed between ages 3 and 4.

- Among the age-4 recoveries of barge study releases, salmon that were barged from the Mokelumne River to the Golden Gate had the highest CV recovery rate but also the second highest stray rate. Salmon that were trucked to Tiburon and then barged to the Golden Gate had the highest ocean recovery rate, although it was similar to those that were barged the entire route. The control group of in-river releases had lower recoveries rates in both the ocean and CV as well as a lower stray rate as compared to both experimental releases.

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 nine 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 2020. 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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REFERENCES

Bergman, J., R. Nielson, and A. Low. 2012. Central Valley Chinook Salmon In-River Escapement Monitoring Plan. California Department of Fish and Game (CDFG) Fisheries Branch Administrative Report 2012-01. Sacramento, CA.

Kelly, B. and J. Phillips. 2020. Lower American River Fall-run Chinook Salmon Escapement Survey, October 2019 – January 2020. California Department of Fish and Wildlife (CDFW) Report. Rancho Cordova, CA.

Kormos, B., M. Palmer-Zwahlen, and A. Low. 2012. Recovery of Coded-Wire Tags from Chinook Salmon in California's Central Valley Escapement and Ocean Harvest in 2010. CDFG Fisheries Branch Administrative Report 2012-02. Santa Rosa, CA.

Kowalik, D. and D. Massa. 2020. Lower Yuba River Accord Monitoring and Evaluation Plan: Chinook Salmon Escapement Technical Memorandum, Fall 2019. Pacific States Marine Fisheries Commission (PSMFC) Report. Marysville, CA.

Letvin, A., M. Palmer-Zwahlen, and B. Kormos. 2020. Recovery of Coded-Wire Tags from Chinook Salmon in California's Central Valley Escapement, Inland Harvest, and Ocean Harvest in 2017. Joint CDFW-PSMFC Report. Santa Rosa, CA.

Letvin, A., M. Palmer-Zwahlen, and B. Kormos. 2021. Recovery of Coded-Wire Tags from Chinook Salmon in California's Central Valley Escapement, Inland Harvest, and Ocean Harvest in 2018. Joint CDFW-PSMFC Report. Santa Rosa, CA.

Letvin, A., M. Palmer-Zwahlen, B. Kormos, and P. McHugh. 2021. Recovery of Coded-Wire Tags from Chinook Salmon in California's Central Valley Escapement, Inland Harvest, and Ocean Harvest in 2019. Joint CDFW-PSMFC Report. Santa Rosa, CA.

Mohr, M. and W. Satterthwaite. 2013. Coded-Wire Tag Expansion Factors for Chinook Salmon Carcass Surveys in California: Estimating the Numbers and Proportions of Hatchery-Origin Fish. San Francisco Estuary and Watershed Science 11(4).

Pacific Fishery Management Council (PFMC). 2016. Pacific Coast Salmon Fishery Management Plan for Commercial and Recreational Salmon Fisheries off the Coasts of Washington, Oregon, and California as Amended through Amendment 19. PFMC, 7700 NE Ambassador Place, Suite 101, Portland, OR 97220.

PFMC. 2023. Review of 2022 Ocean Salmon Fisheries: Stock Assessment and Fishery Evaluation Document for the Pacific Coast Salmon Fishery Management Plan. PFMC, 7700 NE Ambassador Place, Suite 101, Portland, OR 97220.

Palmer-Zwahlen, M., V. Gusman, and B. Kormos. 2018. Recovery of Coded-Wire Tags from Chinook Salmon in California's Central Valley Escapement, Inland Harvest, and Ocean Harvest in 2013. Joint PSMFC-CDFW Report. Santa Rosa, CA.

Palmer-Zwahlen, M., V. Gusman, and B. Kormos. 2019a. Recovery of Coded-Wire Tags from Chinook Salmon in California's Central Valley Escapement, Inland Harvest, and Ocean Harvest in 2014. Joint PSMFC-CDFW Report. Santa Rosa, CA.

Palmer-Zwahlen, M., V. Gusman, and B. Kormos. 2019b. Recovery of Coded-Wire Tags from Chinook Salmon in California's Central Valley Escapement, Inland Harvest, and Ocean Harvest in 2015. Joint PSMFC-CDFW Report. Santa Rosa, CA.

Palmer-Zwahlen, M. and B. Kormos. 2013. Recovery of Coded-Wire Tags from Chinook Salmon in California's Central Valley Escapement and Ocean Harvest in 2011. California Department of Fish and Wildlife. Fisheries Branch Administrative Report 2013-02. Santa Rosa, CA.

Palmer-Zwahlen, M. and B. Kormos. 2015. Recovery of Coded-Wire Tags from Chinook Salmon in California's Central Valley Escapement, Inland Harvest, and Ocean Harvest in 2012. California Department of Fish and Wildlife. Fisheries Branch Administrative Report 2015-04. Santa Rosa, CA.

Palmer-Zwahlen, M. and B. Kormos. 2020. Recovery of Coded-Wire Tags from Chinook Salmon in California's Central Valley Escapement, Inland Harvest, and Ocean Harvest in 2016. Joint PSMFC-CDFW Report. Santa Rosa, CA.

United States Fish and Wildlife Service (FWS). 2020. Upper Sacramento River Winter Chinook Salmon Carcass Survey, 2019 Annual Report. FWS Report. Red Bluff, CA.

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
- 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 2020 CV Chinook hatchery escapement.

Sampling Location	Estimation and Sampling Methods	Agency
Hatchery Spawners		
Coleman National Fish Hatchery (CFH) Fall and Late-Fall (2021)	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. Access upstream of the hatchery closed beginning Aug 1. The fall-run period is considered early Oct through late Nov and the late-fall-run period is considered late Dec through late Feb. 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, 710 mm males fall; 570 mm females, 600 mm males late-fall.	FWS
CFH Winter and Late-Fall (2021) 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: 510 mm females, 540 mm males late-fall; 660 mm males winter, no age-2 winter females observed.	FWS
Keswick Fish Trap Winter and Late-Fall (2021)	Direct count. All fish examined and bio-sampled for fin-clips, tags, marks. During Jan-Jun, all 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: 610 mm females, 670 mm males winter; 510 mm females, 540 mm males late-fall.	FWS
Feather River Hatchery (FRH) Spring and Fall	Direct count. All fish examined for fin-clips, tags, marks. Fish arriving at the hatchery May 6 - Jun 29 (n~ 2,746) 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 19 and spring spawning began Sep 21. All spring-run fish bio-sampled. Fall spawning occured on Oct 5 for the cold water program and began normally on Oct 14. Fall spawning ceased on Dec 4. Eggs collected after Nov 16 were transferred to MOK. 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 Nov 2 - Jan 5. 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 20 - Dec 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 Sep 26 - Nov 30. 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, 710 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.

Table 1b. Estimation and sampling methods used for the 2020 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 (2021)	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[a/] 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: 590 mm females, 665 mm males winter; 630 mm females, 670 mm males fall; 610 mm females, 620 mm males late-fall.	CDFW, FWS
Clear Creek Fall	Video Station count used to estimate population. Supplemental bio-sampling survey used to estimate biological characteristics of the population (age, sex, hatchery-origin, spawn sucess). 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 5 carcasses were observed. Bio-sampling data from CFH used as a surrogate.	CDFW
Battle Creek Fall	Video weir count (Aug 19 - Dec 5) in lower creek used to determine total fall-run escapement. Natural fall-run escapement into Battle Creek calculated by substracting CFH fall-run return from total run. Surrogate CWTs based on hatchery proportion and CWT composition of CFH fall-run return. Bio-sampling data from CFH used as a surrogate.	CDFW
Cottonwood Creek Fall	Video weir count (Oct 5 - Dec 15) in lower creek used to determine total escapement. Kayak surveys conducted to collect bio-data from fresh fish, however only one carcass was 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 2020 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, including all fish trapped between Nimbus Dam and the Nimbus Fish Hatchery weir, and all dead fish ("washbacks") that were sampled on the weir. 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: 650 mm females, 710 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: 650 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, 710 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, 710 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, 710 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 2020 CV Chinook river sport harvest.

Sampling Location	Survey Design and Open Dates	Agency
Sport Harvest		
	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. Expansion of known-age fall-run Chinook from CWTs used to estimate grilse contribution at 8.25% due to significant overlap in size distibrutions.	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 above 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 SMUD power line crossing, Jul 16 - Dec 31 from the SMUD power line crossing to the Sacramento River confluence.	
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 Camanche Dam to the Highway 12 overcrossing.	
	Bag and Size Limit	
All Areas	3 Chinook salmon per day for the Feather River, 2 Chinook salmon per day in all other sectors; no minimum size limit.	

Table 2. California ocean salmon sport and commercial fishery seasons by major port area, 2020.

	Sport Fishery			Commercial Fishery		
Major Port Area	Season	Size Limit[a/]	Days Open	Season	Size Limit[a/]	Days Open
Eureka/Crescent City (Klamath Mgmt Zone)	June 6 - August 9	20" TL	65	Closed		
Fort Bragg	May 1 - November 8	20" TL	192	August 1 - 10	27" TL	10
				September 1 - 30	27" TL	30
						40
San Francisco	May 1 - November 8	20" TL	192	May 6 - 12, 18 - 31	27" TL	21
				June 1 - 6, 14 - 30	27" TL	23
				July 13 - 31	27" TL	19
				August 1 - 28	27" TL	28
				September 1 - 30	26" TL	30
				Oct. 1 - 2, 5 - 9, 12 - 15[d/]	26" TL	11
						132
Monterey[c/]	May 1 - October 4	24" TL	157	May 1 - 12, 18 - 31	27" TL	26
				June 1 - 6, 14 - 30	27" TL	23
				July 13 - 31	27" TL	19
				August 1 - 28	27" TL	28
						96
California Total			606			228

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

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

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

Table 3. Central Valley hatchery and natural area escapement estimates, sport harvest, and sample data, 2020.

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_{samp}
Hatchery Escapement										
Coleman National Fish Hatchery	Winter	1,008	1,008	1,002	101	100	1.000	0.101	1.000	9.92 [b/]
Keswick Dam Fish Trap	Winter	191	191	126	125	123	1.000	0.992	0.984	1.02
Feather River Hatchery	Spring	1,554	1,554	1,472	1,472	1,444	1.000	1.000	0.997	1.00
Coleman National Fish Hatchery	Fall	13,737	13,737	3,093	3,093	3,012	1.000	1.000	0.999	1.00
Feather River Hatchery	Fall	22,193	22,193	6,195	6,195	6,068	1.000	1.000	1.000	1.00
Nimbus Fish Hatchery	Fall	6,264	6,264	1,474	1,474	1,434	1.000	1.000	0.999	1.00
Mokelumne River Hatchery	Fall	3,443	3,443	911	911	887	1.000	1.000	0.999	1.00
Merced River Hatchery	Fall	185	185	40	40	40	1.000	1.000	1.000	1.00
Coleman National Fish Hatchery	Late-fall[c/]	1,846	1,846	1,811	1,811	1,761	1.000	1.000	0.994	1.01
Coleman Hatchery Fish Trap	Late-fall[c/]	54	54	54	48	45	1.000	0.889	0.978	1.15
Keswick Dam Fish Trap	Late-fall[c/]	0	0	0	0	0	0.000	0.000	0.000	0.00
Total Hatchery Escapement		**50,475**	**50,475**	**16,178**	**15,270**	**14,914**				
Natural Area Escapement										
Upper Sacramento River (above Princeton)	Winter	6,195	3,480	1,478	1,465	1,403	0.562	0.991	0.999	1.91 [d/]
Butte Creek	Spring	1,281	680	0	0	0	0.531	-	-	-
Upper San Joaquin River (above Merced R.)	Spring	19	19	16	16	14	1.000	1.000	1.000	1.00 [d/]
Upper Sacramento River (above Princeton)	Fall	13,527	3,393	187	184	173	0.251	0.984	0.994	8.28 [d/]
Clear Creek	Fall	6,631	577	123	123	112	0.087	1.000	0.966	7.73 [d/]
Battle Creek	Fall	19,055	0	Video - no biodata collected		4,178 [e/]	-	-	-	1.00
Cow Creek[f/]	Fall	452	5	Video - opportunistic CWTs		0	0.011	-	-	-
Cottonwood Creek[f/]	Fall	86	1	Video - opportunistic CWTs		0	0.012	-	-	-
Mill Creek[f/]	Fall	382	25	Video - opportunistic CWTs		0	0.065	-	-	-
Butte Creek	Fall	0	0	0	0	0	0.000	-	-	-
Feather River	Fall	42,969	4,893	1,126	1,125	1,071	0.114	0.999	0.999	8.80 [d/]
Yuba River above Daguerre Point Dam (DPD)	Fall	3,846	3,789	1,108	45	42	0.985	0.041	1.000	12.61 [g/]
Yuba River below DPD	Fall	348	63	17	17	16	0.181	1.000	1.000	5.52 [d/]
American River[h/]	Fall	22,456	12,774	3,325	3,323	3,085	0.569	0.999	0.999	1.76
Mokelumne River	Fall	601	601	219	5	4	1.000	0.023	1.000	43.80 [g/]
Stanislaus River	Fall	541	162	33	33	32	0.299	1.000	1.000	3.34 [d/]
Tuolumne River	Fall	271	227	19	19	14	0.838	1.000	1.000	1.75 [d/]
Merced River	Fall	426	80	10	10	9	0.188	1.000	1.000	5.33 [d/]
Upper Sacramento River (above Princeton)	Late-fall[c/]	1,847	438	38	38	36	0.237	1.000	0.973	6.41 [d/]
Total Natural Area Escapement		**120,933**	**31,207**	**7,699**	**6,403**	**10,189**				
CV Sport Harvest										
Upper Sacramento River (above Feather R.)	Fall	5,645	495	97	96	93	0.088	0.990	1.000	11.52
Lower Sacramento River (below Feather R.)	Fall	5,186	198	48	47	47	0.038	0.979	1.000	26.75
Feather River	Fall	3,368	324	75	73	73	0.096	0.973	1.000	10.68
American River	Fall	2,038	85	17	17	17	0.042	1.000	1.000	23.98
Mokelumne River[f/]	Fall	183	15	3	3	3	0.082	-	-	-
Upper Sacramento River (above Feather R.)	Late-fall	438	70	44	44	44	0.160	1.000	1.000	6.26
Total Sport Harvest		**16,858**	**1,187**	**284**	**280**	**277**				
Total Sampled			**82,869**	**24,161**	**21,953**	**25,380**				

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_{samp} 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 2019 through early 2020 (return year 2020).

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

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

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

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

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

Table 4. Total harvest and sample data for 2020 ocean salmon sport and commercial fisheries by major port area.[a/]

Fishery - Port Area	Ocean Harvest	Chinook Sampled[b/]	Observed Ad-Clips	Heads Processed	Valid CWTs	Sample rate (fe)	Ad-clips processed (fa)	Valid CWTs (fd)	CWT F_{samp}
California Sport									
Eureka/Crescent	1,831	430	80	44	42	0.235	0.550	1.000	7.74
Fort Bragg	1,877	387	61	48	46	0.206	0.787	1.000	6.17
San Francisco	35,140	9,019	1,882	1,730	1,676	0.257	0.919	0.994	4.26
Monterey	1,293	219	40	23	23	0.169	0.575	1.000	10.29
	40,141	**10,055**	**2,063**	**1,845**	**1,787**	**0.250**	**0.894**	**0.994**	**4.49**
California Commercial									
Eureka/Crescent[c/]	-	-	-	-	-	-	-	-	-
Fort Bragg	1,849	832	172	172	167	0.450	1.000	1.000	2.22
San Francisco	91,471	25,834	5,457	5,445	5,168	0.282	0.998	0.995	3.57
Monterey	2,707	818	191	189	183	0.302	0.990	1.000	3.34
	96,027	**27,484**	**5,820**	**5,806**	**5,518**	**0.286**	**0.998**	**0.995**	**3.52**
California Total	**136,168**	**37,539**	**7,883**	**7,651**	**7,305**				
Oregon Sport	**7,035**	**2,226**	**343**	**343**	**315**	**0.316**	**1.000**	**0.981**	**3.23**
Oregon Commercial	**12,622**	**6,208**	**881**	**879**	**843**	**0.492**	**0.998**	**0.985**	**2.07**
Oregon Total	**19,657**	**8,434**	**1,224**	**1,222**	**1,158**				

a/ California harvest and sample data excludes the months of May and June.

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

c/ The Eureka/Crescent City port area was closed to commercial salmon fishing in 2020.

Table 5. Central Valley coded-wire tag (CWT) Chinook releases recovered in 2020 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	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	216,835	219,550	99%	Reintroduction	San Joaquin River (Fremont Ford Bridge and Friant)
CFHF	2018	CFH	Sac R	Fall	32	3,448,504	12,835,143	27%	In-basin	CFH and Sacramento River (Scotty's Landing)
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	Pillar Point and Santa Cruz Harbor coastal net pen releases
MOKFgg	2018	MOK	Mok R	Fall	2	225,158	901,151	25%	Trucked	Golden Gate releases; trucked to Fort Baker
MERFn	2018	MER	Mer R	Fall	3	169,854	666,149	25%	Bay/delta pens	Western Delta (Sherman Island) net pen releases
CFHL	2019	CFH	Sac R	Late	14	1,031,542	1,065,159	97%	In-basin	CFH (includes spring surrogate releases)
			Total age-2 releases:		119	13,011,054	35,202,976	37%		

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	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	Sacramento River (Elkhorn 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-3 releases:		92	9,762,788	28,766,438	34%		

Table 5. Central Valley coded-wire tag (CWT) Chinook releases recovered in 2020 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	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 and Gridley)
SJOSx	2016	SJO	San Joa R	Spr	6	90,741	90,741	100%	Reintroduction	San Joaquin River (Friant and Eastside Bypass)
CFHF	2016	CFH	Sac R	Fall	28	3,020,565	12,184,997	25%	In-basin	CFH only
FRHF	2016	FRH	Fea R	Fall	5	1,029,808	1,037,894	99%	In-basin	Feather River (Boyds Pump Ramp and Thermalito High Flow Channel)
FRHFn	2016	FRH	Fea R	Fall	6	733,880	2,900,225	25%	Bay/Delta pens	San Pablo Bay (Mare Islandl) net pen releases
FRHFgg	2016	FRH	Fea R	Fall	2	263,611	1,059,692	25%	Trucked	Golden Gate releases; trucked to Fort Baker
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, Woodbridge Dam, and Miller's Ferry Bridge)
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	Pillar Point and Santa Cruz Harbor coastal net pen releases
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)
MOKFgg	2016	MOK	Mok R	Fall	1	225,243	225,870	100%	Trucked	Golden Gate releases; trucked to Fort Baker
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 releases)
			Total age-4 releases:		100	12,037,286	31,413,276	38%		

Age-5 CWT releases (with recoveries in 2020)

Release type*	Brood year	Hatchery	Stock origin	Run type	CWT codes	# CWT tagged	Total fish released	% CWT	Release strategy	Release locations / notes
MOKFb	2015	MOK	Mok R	Fall	3	302,730	303,235	100%	Barge study	3 release sites: Mok R (Miller's Ferry), barged (SF Bay), trucked (Tiburon)
CFHL	2016	CFH	Sac R	Late	14	1,044,705	1,101,484	95%	Hatchery	CFH (includes spring surrogate releases)

***CWT release types:**

Sacramento River fall Chinook release types (SFC)

CFHF	Coleman National Fish Hatchery fall in-basin releases
CFHFn	Coleman National Fish Hatchery fall bay/delta net pen releases
FRHF	Feather River Hatchery fall in-basin releases
FRHFn	Feather River Hatchery fall bay/delta net pen releases
FRHFgg	Feather River Hatchery fall Golden Gate releases (no net pens)
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 6. Raw and expanded Chinook CWT recoveries in the Central Valley by run type and brood year during 2020[a/].

Fall-run	2018	2017	2016	2015	Total CV	
Age	2	3	4	5	CWTs	Total CV %
Raw CWT Recoveries	1,796 (9%)	11,296 (60%)	5,817 (31%)	1 (<1%)	18,910	75%
Expanded CWT$_{total}$	**9,337** (7%)	**83,705** (66%)	**34,095** (27%)	**1** (<1%)	127,138	92%

Spring-run	2018	2017	2016	2015	Total CV	
Age	2	3	4	5	CWTs	Total CV %
Raw CWT Recoveries	125 (4%)	1,592 (55%)	1,184 (41%)		2,901	11%
Expanded CWT$_{total}$	**152** (3%)	**2,424** (51%)	**2,165** (46%)		4,741	3%

Late-fall-run	2019	2018	2017	2016	Total CV	
Age	2	3	4	5	CWTs	Total CV %
Raw CWT Recoveries	139 (7%)	998 (52%)	789 (41%)	4 (<1%)	1,930	8%
Expanded CWT$_{total}$	**186** (8%)	**1,280** (52%)	**988** (40%)	**15** (<1%)	2,469	2%

Winter-run	2018	2017	2016	2015	Total CV	
Age	2	3	4	5	CWTs	Total CV %
Raw CWT Recoveries	93 (6%)	1,542 (94%)	4 (<1%)		1,639	6%
Expanded CWT$_{total}$	**240** (6%)	**3,674** (94%)	**7** (<1%)		3,921	3%

All Runs					Total CV	
Age	2	3	4	5	CWTs	Total CV %
Raw CWT Recoveries	2,153 (8%)	15,428 (61%)	7,794 (31%)	5 (<1%)	25,380	100%
Expanded CWT$_{total}$	**9,915** (7%)	**91,083** (66%)	**37,255** (27%)	**16** (<1%)	138,270	100%

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

Table 7. Raw and expanded Chinook CWT recoveries in 2020 California ocean fisheries by run type and brood year[a/].

Fall-run	2018	2017	2016	2015	Total Ocean	Total Ocean
Age	2	3	4	5	CWTs	%
Raw CWT Recoveries	409 (6%)	5,561 (83%)	699 (10%)		6,669	91%
Expanded CWT$_{total}$	**5,261** (6%)	**71,090** (84%)	**8,319** (10%)		84,670	96%
Spring-run	2018	2017	2016	2015	Total Ocean	Total Ocean
Age	2	3	4	5	CWTs	%
Raw CWT Recoveries	73 (45%)	87 (54%)	1 (<1%)		161	2%
Expanded CWT$_{total}$	**315** (49%)	**319** (50%)	**4** (<1%)		637	1%
Late-fall-run	2019	2018	2017	2016	Total Ocean	Total Ocean
Age	2	3	4	5	CWTs	%
Raw CWT Recoveries	2 (<1%)	127 (43%)	163 (55%)	2 (<1%)	294	4%
Expanded CWT$_{total}$	**8** (<1%)	**454** (43%)	**593** (56%)	**6** (<1%)	1,061	1%
Winter-run	2019	2018	2017	2016	Total Ocean	Total Ocean
Age	2	3	4	5	CWTs	%
Raw CWT Recoveries		87 (96%)	4 (4%)		91	1.2%
Expanded CWT$_{total}$		**385** (97%)	**14** (3%)		398	0.5%
Non-CV stocks	2018	2017	2016	2015	Total Ocean	Total Ocean
Age	2	3	4	5	CWTs	%
Raw CWT Recoveries		44 (49%)	46 (51%)		90	1%
Expanded CWT$_{total}$		**726** (59%)	**494** (41%)		1,220	1%
All Runs					Total Ocean	Total Ocean
Age	2	3	4	5	CWTs	%
Raw CWT Recoveries	484 (7%)	5,906 (81%)	913 (12%)	2 (<1%)	7,305	100%
Expanded CWT$_{total}$	**5,583** (6%)	**72,973** (83%)	**9,424** (11%)	**6** (<1%)	87,987	100%
CV Expanded CWT$_{total}$ (Proportion CV stocks)	5,583 (100%)	72,248 (99%)	8,930 (95%)	6 (100%)	86,767	99%

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

Table 8. Raw and expanded Chinook CWT recoveries in 2020 Oregon ocean fisheries by run type and brood year[a/].

Fall-run	2018	2017	2016	2015	Total Ocean	Total Ocean
Age	2	3	4	5	CWTs	%
Raw CWT Recoveries	1 (<1%)	396 (51%)	387 (49%)		784	68%
Expanded CWT$_{total}$	**24** (<1%)	**3,041** (54%)	**2,612** (46%)		5,677	69%

Late-fall-run	2019	2018	2017	2016	Total Ocean	Total Ocean
Age	2	3	4	5	CWTs	%
Raw CWT Recoveries			3 (75%)	1 (25%)	4	0%
Expanded CWT$_{total}$			**6** (83%)	**1** (17%)	8	0%

Spring-run	2018	2017	2016	2015	Total Ocean	Total Ocean
Age	2	3	4	5	CWTs	%
Raw CWT Recoveries		3 (43%)	4 (57%)		7	1%
Expanded CWT$_{total}$		**7** (49%)	**7** (51%)		14	0.2%

Non-CV stocks	2018	2017	2016	2015	Total Ocean	Total Ocean
Age	2	3	4	5	CWTs	%
Raw CWT Recoveries	3 (<1%)	81 (23%)	234 (65%)	42 (12%)	360	31%
Expanded CWT$_{total}$	**153** (6%)	**1,238** (49%)	**993** (40%)	**123** (5%)	2,507	31%

All Runs					Total Ocean	Total Ocean
Age	2	3	4	5	CWTs	%
Raw CWT Recoveries	4 (<1%)	481 (42%)	628 (54%)	43 (4%)	1,156	100%
Expanded CWT$_{total}$	**177** (2%)	**4,289** (52%)	**3,619** (44%)	**124** (2%)	8,209	100%
CV Expanded CWT$_{total}$ (Proportion CV stocks)	24 (13%)	3,051 (71%)	2,626 (73%)	1 (1%)	5,702	69%

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 2020.

			CFH		FRH				NIM		MOK				MER		SJO	Non-	Total %		Total
Location	**Run**	**SacW**	**CFHL**	**CFHF**	**FRHS**	**FRHF**	**FRHFn**	**FRHFgg**	**NIMF**	**NIMFn**	**MOKF**	**MOKFn**	**MOKFnc**	**MOKFgg**	**MERF**	**MERFn**	**SJOSx**	**CV**	**Hatchery**	**Natural**	**Run**
Hatchery Spawners																					
Coleman National Fish Hatchery	Winter	99%																	99%	1%	1,008
Keswick Dam Fish Trap	Winter	66%																	66%	34%	191
Feather River Hatchery	Spring				94%		1%	1%									0%		95%	5%	1,554
Coleman National Fish Hatchery	Fall		0%	86%			1%	1%	0%	0%		0%	0%	0%					87%	13%	13,737
Feather River Hatchery	Fall				6%	2%	49%	30%	0%	1%		0%	0%	0%		1%	0%		88%	12%	22,193
Nimbus Fish Hatchery	Fall		0%	0%			1%	1%	9%	54%	0%	15%	1%	1%		3%			86%	14%	6,264
Mokelumne River Hatchery	Fall		0%	0%			1%	1%		6%	1%	64%	2%	2%	0%	8%			86%	14%	3,443
Merced River Hatchery	Fall		1%				2%	6%		6%		22%	2%	2%	10%	34%			86%	14%	185
Coleman National Fish Hatchery	Late-fall[c/]		97%	0%						1%				0%					98%	2%	1,846
Coleman Hatchery Fish Trap	Late-fall[c/]		96%																96%	4%	54
Total Hatchery Fall-run			***0%***	***26%***	***3%***	***1%***	***24%***	***15%***	***1%***	***8%***	***0%***	***7%***	***1%***	***0%***	***0%***	***2%***	***0%***		***87%***	***13%***	***45,822***
Natural Spawners																					
Upper Sacramento River	Winter	43%																	43%	57%	6,195
Butte Creek	Spring																		0%	100%	1,281
Upper San Joaquin River	Spring									21%							68%		89%	11%	19
Upper Sacramento River	Fall			24%	0%		11%	6%				0%	0%			0%			42%	58%	13,527
Clear Creek	Fall			36%		0%	10%	5%					0%						51%	49%	6,631
Battle Creek[d/]	Fall		0%	86%			1%	1%	0%	0%		0%	0%	0%					87%	13%	19,055
Feather River	Fall				4%	1%	40%	23%		0%		0%	0%			1%	0%		71%	29%	42,969
Yuba River above DPD	Fall				0%	1%	9%	4%		8%	0%	11%	3%	1%		5%			42%	58%	3,846
Yuba River below DPD	Fall						45%	13%		6%		2%	5%	2%		8%			81%	19%	348
American River	Fall				0%		4%	2%	8%	46%	0%	18%	3%	1%		5%	0%		87%	13%	22,456
Mokelumne River	Fall							30%				29%	15%						74%	26%	601
Stanislaus River	Fall						5%			2%		48%	2%			6%			63%	37%	541
Tuolumne River	Fall						3%			5%		13%				20%			40%	60%	271
Merced River	Fall									10%		15%			6%	17%			49%	51%	426
Upper Sacramento River	Late-fall[c/]	2%	10%							1%									13%	87%	1,847
Total Natural Area Fall-run			***0%***	***20%***	***2%***	***1%***	***19%***	***11%***	***2%***	***10%***	***0%***	***5%***	***1%***	***0%***	***0%***	***2%***	***0%***		***71%***	***29%***	***110,671***
In-basin CWT_{total}	All	3%	1%	21%	3%	1%	19%	11%	2%	9%	0%	2%	0%	0%	0%	0%	0%		71%	29%	151,641
Stray CWT_{total}	All		0%	13%	0%	0%	18%	12%	0%	5%	0%	32%	6%	2%	0%	13%	0%		100%		18,847
Total CV Spawners		**2%**	**1%**	**20%**	**3%**	**1%**	**19%**	**11%**	**1%**	**9%**	**0%**	**5%**	**1%**	**0%**	**0%**	**1%**	**0%**		**74%**	**26%**	**170,488**
CV Sport Harvest																					
Upper Sacramento River	Fall	0%	0%	66%			8%	1%											75%	25%	5,645
Lower Sacramento River	Fall	1%	3%	2%		1%	35%	10%		23%		3%	1%	2%		3%			82%	18%	5,186
Feather River	Fall				6%	1%	38%	23%					0%						69%	31%	3,368
American River	Fall							5%		24%		14%	10%						52%	48%	2,038
Mokelumne River	Fall											54%	7%						60%	40%	183
Upper Sacramento River	Late-fall	10%	54%																64%	36%	438
Total Sport Harvest		**0%**	**2%**	**23%**	**1%**	**0%**	**21%**	**9%**		**10%**		**3%**	**2%**	**1%**		**1%**			**73%**	**27%**	**16,858**

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, in-river control releases for MOKFb merged with MOKF, barged and trucked releases for MOKFb merged with MOKFgg.

c/ Late-fall-run hatchery returns and natural area escapement occurred during late-fall of 2019 through early 2020 (return year 2020).

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

Table 10. Total inland CWT_{total} recoveries by location, run, and release type[a/] in hatchery returns, natural escapement and sport harvest during 2020.

			CFH		FRH				NIM		MOK				MER		SJO	Non-	Total CWT_{total}		Total
Location	**Run**	**SacW**	**CFHL**	**CFHF**	**FRHS**	**FRHF**	**FRHFn**	**FRHFgg**	**NIMF**	**NIMFn**	**MOKF**	**MOKFn**	**MOKFnc**	**MOKFgg**	**MERF**	**MERFn**	**SJOSx**	**CV**	**Hatchery**	**Natural**	**Run**
Hatchery Spawners																					
Coleman National Fish Hatchery	Winter	1,002																	1,002	6	1,008
Keswick Dam Fish Trap	Winter	126																	126	65	191
Feather River Hatchery	Spring				1,455		20	8									1		1,484	70	1,554
Coleman National Fish Hatchery	Fall		23	11,772			73	69	4	8		4	1	4					11,958	1,779	13,737
Feather River Hatchery	Fall				1,236	335	10,840	6,626	4	157		97	68	2		208	5		19,578	2,615	22,193
Nimbus Fish Hatchery	Fall		1	4			80	77	576	3,361	1	927	80	84		218			5,409	855	6,264
Mokelumne River Hatchery	Fall		2	4			36	32		217	44	2,188	86	58	5	287			2,959	484	3,443
Merced River Hatchery	Fall		1				4	12		12		41	4	4	18	63			159	26	185
Coleman National Fish Hatchery	Late-fall[b/]		1,793	8						12				4					1,817	29	1,846
Coleman Hatchery Fish Trap	Late-fall[b/]		52																52	2	54
Total Hatchery Fall-run			***27***	***11,780***	***1,236***	***335***	***11,033***	***6,816***	***584***	***3,755***	***45***	***3,257***	***239***	***152***	***23***	***776***	***5***		***40,063***	***5,759***	***45,822***
Natural Spawners																					
Upper Sacramento River	Winter	2,681																	2,681	3,514	6,195
Butte Creek	Spring																			1,281	1,281
Upper San Joaquin River	Spring									4							13		17	2	19
Upper Sacramento River	Fall			3,266	17		1,465	835				33	17			34			5,667	7,860	13,527
Clear Creek	Fall			2,361		8	683	314					24						3,390	3,241	6,631
Battle Creek[c/]	Fall		31	16,330			101	96	6	11		6	1	6					16,588	2,467	19,055
Feather River	Fall				1,772	583	17,212	10,021		71		212	197			342	9		30,419	12,550	42,969
Yuba River above DPD	Fall				13	51	352	152		303	13	405	103	50		176			1,618	2,228	3,846
Yuba River below DPD	Fall						157	45		22		6	17	6		29			282	66	348
American River	Fall				2		844	554	1,902	10,286	25	3,945	638	205		1,034	2		19,437	3,019	22,456
Mokelumne River	Fall							179				176	89						444	157	601
Stanislaus River	Fall						27			13		258	13			31			342	199	541
Tuolumne River	Fall						7			14		35				53			109	162	271
Merced River	Fall									43		64			26	74			207	219	426
Upper Sacramento River	Late-fall[b/]	30	182							24									236	1,611	1,847
Total Natural Area Fall-run			***31***	***21,957***	***1,804***	***642***	***20,848***	***12,196***	***1,908***	***10,763***	***38***	***5,140***	***1,099***	***267***	***26***	***1,773***	***11***		***78,503***	***32,168***	***110,671***
In-basin CWT_{total}	All	3,839	2,081	31,376	4,476	969	28,581	16,852	2,478	13,647	44	2,364	175	58	44	137	13		107,134	44,507	151,641
Stray CWT_{total}	All		4	2,369	19	8	3,320	2,168	14	911	39	6,033	1,163	365	5	2,412	17		18,847		18,847
Total CV Spawners		**3,839**	**2,085**	**33,745**	**4,495**	**977**	**31,901**	**19,020**	**2,492**	**14,558**	**83**	**8,397**	**1,338**	**423**	**49**	**2,549**	**30**		**125,981**	**44,507**	**170,488**
	% stray		0.2%	7%	0.4%	0.8%	10%	11%	0.6%	6%	47%	72%	87%	86%	10%	95%	57%		15%		11%
CV Sport Harvest																					
Upper Sacramento River	Fall	12	12	3,703			457	46											4,230	1,415	5,645
Lower Sacramento River	Fall	27	136	108		27	1,816	536		1,182		135	54	107		143			4,271	915	5,186
Feather River	Fall				216	43	1,289	779					11						2,338	1,030	3,368
American River	Fall							97		482		289	195						1,063	975	2,038
Mokelumne River	Fall											98	12						110	73	183
Upper Sacramento River	Late-fall	44	237																281	157	438
Total Sport Harvest		**83**	**385**	**3,811**	**216**	**70**	**3,562**	**1,458**		**1,664**		**522**	**272**	**107**		**143**			**12,293**	**4,565**	**16,858**

a/ Release types defined in Table 3; SacWbat recoveries merged with SacW, in-river control releases for MOKFb merged with MOKF, barged and trucked releases for MOKFb merged with MOKFgg.

b/ Late-fall-run hatchery returns and natural area escapement occurred during late-fall of 2019 through early 2020 (return year 2020).

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

Table 11. CWT recovery rate (recoveries per 100,000 CWTs released) by release type, brood year and recovery location in 2020. (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	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		CWT_{samp}	In-basin	Stray	**CV total**	**Ocean**
SacW[b/]	2018	Wint	221,923		180									180	0	180	**0%**	370	81	0	**81**	**167**
SacWbat[b/]	2018	Wint	180,252											0	0	0	**-**	14	0	0	**0**	**8**
FRHS	2018	Spr	1,831,043				136							136	0	136	**0%**	294	7	0	**7**	**16**
SJOSx	2018	Spr	216,835				4							0	4	4	**100%**	18	0	2	**2**	**8**
CFHF	2018	Fall	3,448,504	592	17	15								609	15	624	**2%**	364	18	0	**18**	**11**
FRHFn	2018	Fall	1,772,613			23	392		33	3				392	59	451	**13%**	314	22	3	**25**	**18**
NIMF	2018	Fall	797,850						142					142	0	142	**0%**	66	18	0	**18**	**8**
NIMFn	2018	Fall	439,333	2			4	6	247	8	2			247	21	269	**8%**	178	56	5	**61**	**41**
MOKF	2018	Fall	398,991							29				29	0	29	**0%**	0	7.3	0	**7**	**0**
MOKFn	2018	Fall	1,403,247	2	8		2	25	186	207	18	8		207	251	458	**55%**	141	15	18	**33**	**10**
MOKFnc	2018	Fall	873,909		8		20		132	34	10	3		34	173	207	**84%**	441	4	20	**24**	**50**
MERFn	2018	Fall	169,854		8			13	57	31		7		7	109	117	**94%**	38	4	64	**69**	**22**
CFHL	2019	Late	1,031,542	130	18					1		1		148	2	150	**1%**	8	14	0.2	**15**	**1**
		Total	12,785,896	727	239	39	557	43	798	313	30	20		2,131	635	2,766	**23%**	2,246				

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	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		CWT_{samp}	In-basin	Stray	**CV total**	**Ocean**
SacW[b/]	2017	Wint	216,237		2,646									2,646	0	2,646	**0%**	10	1,224	0	**1,224**	**5**
SacWbat[b/]	2017	Wint	212,136	992										992	0	992	**0%**	4	468	0	**468**	**2**
FRHS	2017	Spr	488,223		17		2,262	13						2,275	17	2,291	**0.7%**	313	466	3	**469**	**64**
SJOSx	2017	Spr	209,308				11		2				10	10	13	23	**56%**	8	5	6	**11**	**4**
CFHF	2017	Fall	1,369,512	3,070	282	278			1	1				3,351	280	3,632	**8%**	1,795	245	21	**265**	**131**
FRHF	2017	Fall	250,489				14							14	0	14	**0.0%**	23	6	0	**6**	**9**
FRHFn	2017	Fall	1,496,598	38	331	139	5,787	84	99	6	8	1		5,871	623	6,494	**10%**	4,861	392	42	**434**	**325**
FRHFgg	2017	Fall	609,272	41	174	77	3,810	49	105	52		3		3,859	451	4,311	**10%**	4,919	633	74	**708**	**807**
NIMF	2017	Fall	334,047	2			1		52					52	3	55	**6.1%**	34	16	1	**17**	**10**
NIMFn	2017	Fall	664,585	6	6		47	38	2,550	36	5	13	1	2,550	151	2,701	**6%**	3,910	384	23	**406**	**588**
MOKF	2017	Fall	398,785						4	3				3	4	7	**54%**	4	1	1	**2**	**1**
MOKFn	2017	Fall	1,649,629				40	18	531	328	50	18		328	657	985	**67%**	1,350	20	40	**60**	**82**
MOKFnc	2017	Fall	727,344	2	8	23	232	117	546	136				136	930	1,065	**87%**	4,234	19	128	**146**	**582**
MERFn	2017	Fall	255,259				113	31	212	34	17	22		22	408	429	**95%**	500	9	160	**168**	**196**
CFHL	2018	Late	881,364	974	53				1					1,028	1	1,029	**0.1%**	444	117	0	**117**	**50**
		Total	9,762,788	5,125	3,517	518	12,318	349	4,103	595	81	56	11	23,136	3,537	26,673	**13%**	22,409				

Table 11. CWT recovery rate (recoveries per 100,000 CWTs released) by release type, brood year and recovery location in 2020. (Page 2 of 2)

Age-4 CWT recoveries

Release	Brood	Run	# CWT	Central Valley total recoveries (CWT_{samp}) by basin										CV CWT_{samp} totals			% CV	Ocean	Recovery rate per 100K released			
type	year	type	tagged	Bat Cr	Up Sac	Nat crks[a/]	Fea	Yub	Ame	Mok	Sta/Tuo	Mer	Up SJ	In-basin	Stray	CV total	Stray	CWT_{samp}	In-basin	Stray	**CV total**	**Ocean**
SacW[b/]	2016	Wint	138,803		7									7	0	7	**0%**	0	5	0	**5**	**0**
FRHS	2016	Spr	1,682,317				2,010		2					2,010	2	2,012	**0%**	11	120	0	**120**	**1**
SJOSx	2016	Spr	90,741										3	3	0	3	**0%**	0	3	0	**3**	**0**
CFHF	2016	Fall	3,020,565	3,363	513	294								3,876	294	4,170	**7%**	1,019	128	10	**138**	**34**
FRHF	2016	Fall	1,029,808			8	860	50						910	8	918	**1%**	301	88	1	**89**	**29**
FRHFn	2016	Fall	733,880	5	33	8	825	43	101					869	146	1,015	**14%**	291	118	20	**138**	**40**
FRHFgg	2016	Fall	263,611		33		314		52					314	85	399	**21%**	187	119	32	**151**	**71**
NIMF	2016	Fall	591,200						443					443	0	443	**0%**	206	75	0	**75**	**35**
NIMFn	2016	Fall	277,532				6	38	600	10		1		600	55	655	**8%**	389	216	19.8	**236**	**140**
MOKF	2016	Fall	398,284					13		4				4	13	17	**76%**	7	1	3	**4**	**1.8**
MOKFn	2016	Fall	1,155,829				35	63	552	105	17	1		105	669	774	**86%**	423	9	58	**67**	**37**
MOKFnc	2016	Fall	841,802				9		26	3	3	1		3	39	42	**93%**	237	0	5	**5**	**28**
MOKFgg	2016	Fall	225,243				2	6	79	8				8	86	94	**92%**	208	4	38	**42**	**92**
MERF	2016	Fall	245,340							1		8		8	1	9	**11%**	4	3	0	**4**	**2**
CFHL	2017	Late	1,047,211	769	107					1				876	1	877	0	588	84	0	84	56
		Total	11,742,166	4,137	693	309	4,062	213	1,853	132	20	11	3	10,037	1,397	11,434	**12%**	3,874				

Age-5 CV recoveries (only release types with recoveries in 2020 are displayed)

Release	Brood	Run	# CWT	Central Valley total recoveries (CWT_{samp}) by basin										CV CWT_{samp} totals			% CV	Ocean	Recovery rate per 100K released			
type	year	type	tagged	Bat Cr	Up Sac	Nat crks[a/]	Fea	Yub	Ame	Mok	Sta/Tuo	Mer	Up SJ	In-basin	Stray	CV total	Stray	CWT_{samp}	In-basin	Stray	**CV total**	**Ocean**
MOKFgg	2015	Fall												0	0	0	-	0	#DIV/0!	#####	**#DIV/0!**	**0**
CFHL	2016	Late	1,044,705	3										3	0	3	**0**	7	0	0	**0**	**1**
		Total	1,044,705	3										3	0	3	0	7				

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
CFHFn	Coleman National Fish Hatchery fall bay/delta net pen releases
FRHF	Feather River Hatchery fall in-basin releases
FRHFn	Feather River Hatchery fall bay/delta net pen releases
FRHFgg	Feather River Hatchery fall Golden Gate releases (no net pens)
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
MERF	Merced River Hatchery fall in-basin releases
MERFn	Merced River Hatchery fall bay/delta net pen releases
MERFt	Merced River Hatchery fall trucked releases (no net pens)
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 2020 California ocean salmon sport fishery.

		CFH			FRH				NIM		MOK				MER		SJO	Non-	Total	Total CWT_{total}		Total
	SacW	CFHL	CFHF	CFHFn	FRHS	FRHF	FRHFn	FRHFgg	NIMF	NIMFn	MOKF	MOKFn	MOKFnc	MOKFgg	MERF	MERFn	SJOSx	CV	CV	Hatchery	Natural	Harvest
California Sport Harvest																						
Eureka/Crescent City																						
Jun[b/]																						
Jul		16	93		7	16	296	135	35	186		58	32						875	875	687	1,562
Aug			32				32	64				32	16						176	176	93	269
Total		**16**	**125**		**7**	**16**	**328**	**199**	**35**	**186**		**90**	**49**						**1,051**	**1,051**	**780**	**1,831** (5%)
Fort Bragg																						
May[b/]																						
Jun[b/]																						
Jul		7	249		7	7	110		28	83			21						511	511	687	1,198
Aug			152		5	5	21	79		40			20						323	323	242	565
Sep							62												62	62	52	114
Oct																						
Nov																						
Total		**7**	**401**		**12**	**12**	**193**	**79**	**28**	**123**			**41**						**896**	**896**	**981**	**1,877** (5%)
San Francisco																						
May[b/]																						
Jun[b/]																						
Jul	257	63	1,952		205	19	3,347	2,170	151	1,649	5	875	801	274		394	5	19	12,166	12,186	7,476	19,662
Aug	55	16	1,353		66	19	1,826	904	46	341		155	357	116		172	8		5,434	5,434	3,706	9,140
Sep	16	8	386		4	3	399	589	172	327		217	224	53		198		8	2,598	2,606	1,339	3,945
Oct/Nov[c/]	10	83	57		25		58	44	29	635	3	182	93	123		17	3		1,363	1,351	1,042	2,393
Total	**338**	**170**	**3,747**		**300**	**42**	**5,630**	**3,708**	**399**	**2,952**	**8**	**1,429**	**1,475**	**566**		**782**	**16**	**27**	**21,561**	**21,577**	**13,563**	**35,140** (88%)
Monterey																						
May[b/]																						
Jun[b/]																						
Jul	11		43		11	11	171	173		128		43	43			49			682	682	560	1,242
Aug	7																		7	7	26	33
Sep													6						6	6	12	18
Oct																						
Total	**17**		**43**		**11**	**11**	**171**	**173**		**128**		**43**	**50**			**49**			**695**	**695**	**598**	**1,293** (3%)
California Total Sport Harvest																						
	355	**193**	**4,317**		**330**	**80**	**6,322**	**4,159**	**461**	**3,389**	**8**	**1,561**	**1,615**	**566**		**830**	**16**	**27**	**24,202**	**24,219**	**15,922**	**40,141**
Oregon Total Sport Harvest (South of Cape Falcon)																						
		5	***459***		***3***	***29***	***693***	***244***	***141***	***325***		***254***	***123***	***31***	***11***	***34***		***842***	***2,350***	***3,192***	***3,843***	***7,035***

a/ Release types defined in Table 3; SacWbat recoveries merged with SacW, in-river control releases for MOKFb merged with MOKF, barged and trucked releases for MOKFb merged with MOKFgg.

b/ CWTs recovered in May and June were excluded due to incomplete sampling as a result of COVID-19.

c/ October and November were merged for the San Francisco sport harvest due to low catch rates and resultant CWT recoveries during November.

Table 13. Percentage[a/] of CWT_{total} recoveries by port area, month, and release type[b/] in the 2020 California ocean salmon sport fishery.

		CFH			FRH				NIM		MOK				MER		SJO	Non-	Total	Total %		Total
	SacW	CFHL	CFHF	CFHFn	FRHS	FRHF	FRHFn	FRHFgg	NIMF	NIMFn	MOKF	MOKFn	MOKFnc	MOKFgg	MERF	MERFn	SJOSx	CV	CV	Hatchery	Natural	Harvest
California Sport Harvest																						
Eureka/Crescent City																						
Jun[c/]																						
Jul		1%	6%		0%	1%	19%	9%	2%	12%		4%	2%						56%	56%	44%	1,562
Aug			12%				12%	24%				12%	6%						65%	65%	35%	269
Total		**1%**	**7%**		**0%**	**1%**	**18%**	**11%**	**2%**	**10%**		**5%**	**3%**						**57%**	**57%**	**43%**	**1,831**
Fort Bragg																						
May[c/]																						
Jun[c/]																						
Jul		1%	21%		1%	1%	9%		2%	7%			2%						43%	43%	57%	1,198
Aug			27%		1%	1%	4%	14%		7%			4%						57%	57%	43%	565
Sep							54%												54%	54%	46%	114
Oct																						
Nov																						
Total		**0%**	**21%**		**1%**	**1%**	**10%**	**4%**	**1%**	**7%**			**2%**						**48%**	**48%**	**52%**	**1,877**
San Francisco																						
May[c/]																						
Jun[c/]																						
Jul	1%	0%	10%		1%	0%	17%	11%	1%	8%	0%	4%	4%	1%		2%	0%	0%	62%	62%	38%	19,662
Aug	1%	0%	15%		1%	0%	20%	10%	1%	4%		2%	4%	1%		2%	0%		59%	59%	41%	9,140
Sep	0%	0%	10%		0%	0%	10%	15%	4%	8%		6%	6%	1%		5%		0%	66%	66%	34%	3,945
Oct/Nov[d/]	0%	3%	2%		1%		2%	2%	1%	27%	0%	8%	4%	5%		1%	0%		57%	57%	43%	2,393
Total	**1%**	**0%**	**11%**		**1%**	**0%**	**16%**	**11%**	**1%**	**8%**	**0%**	**4%**	**4%**	**2%**		**2%**	**0%**	**0%**	**61%**	**61%**	**39%**	**35,140**
Monterey																						
May[c/]																						
Jun[c/]																						
Jul	1%		3%		1%	1%	14%	14%		10%		3%	3%			4%			55%	55%	45%	1,242
Aug	20%																		20%	20%	80%	33
Sep													34%						34%	34%	66%	18
Oct																						
Total	**1%**		**3%**		**1%**	**1%**	**13%**	**13%**		**10%**		**3%**	**4%**			**4%**			**54%**	**54%**	**46%**	**1,293**
California Total Sport Harvest																						
	1%	**0%**	**11%**		**1%**	**0%**	**16%**	**10%**	**1%**	**8%**	**0%**	**4%**	**4%**	**1%**		**2%**	**0%**	**0%**	**60%**	**60%**	**40%**	**40,141**
Oregon Total Sport Harvest (South of Cape Falcon)																						
		0%	***7%***		***0%***	***0%***	***10%***	***3%***	***2%***	***5%***		***4%***	***2%***	***0%***	***0%***	***0%***		***12%***	***33%***	***45%***	***55%***	***7,035***

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, in-river control releases for MOKFb merged with MOKF, barged and trucked releases for MOKFb merged with MOKFgg.

c/ CWTs recovered in May and June were excluded due to incomplete sampling as a result of COVID-19.

d/ October and November were merged for the San Francisco sport harvest due to low catch rates and resultant CWT recoveries during November.

Table 14. Total CWT_{total} recoveries by port area, month, and release type[a/] in the 2020 California ocean salmon commercial fishery.

		CFH			FRH				NIM		MOK				MER		SJO	Non-	Total	Total CWT_{total}		Total
	SacW	CFHL	CFHF	CFHFn	FRHS	FRHF	FRHFn	FRHFgg	NIMF	NIMFn	MOKF	MOKFn	MOKFnc	MOKFgg	MERF	MERFn	SJOSx	CV	CV	Hatchery	Natural	Harvest
California Commercial Harvest																						
Eureka/Crescent City - *Closed in 2020*																						
Fort Bragg																						
Aug		14	256		6	4	255	160	32	200		112	45	4		9			1,096	1,096	521	1,617
Sep							44	45				44							133	133	99	232
Total		**14**	**256**		**6**	**4**	**299**	**205**	**32**	**200**		**156**	**45**	**4**		**9**			**1,229**	**1,229**	**620**	**1,849** (2%)
San Francisco																						
May[b/]																						
Jun[b/]																						
Jul	16	533	4,193		187	69	9,388	10,070	185	8,655	4	2,944	1,975	66		1,042	8	981	39,335	40,362	22,776	63,138
Aug	7	142	1,717		35	45	2,832	3,421	89	2,337	4	783	662	30		316		169	12,420	12,635	5,023	17,658
Sep	10	99	406		39	14	1,027	1,494	106	1,319		576	250	22	12	177	2	34	5,554	5,588	2,652	8,240
Oct	7	37	9		12		18	137	84	1,107		267	83	47		80			1,888	1,888	547	2,435
Total	**39**	**811**	**6,325**		**272**	**128**	**13,266**	**15,121**	**464**	**13,418**	**8**	**4,570**	**2,970**	**166**	**12**	**1,615**	**10**	**1,184**	**59,196**	**60,472**	**30,999**	**91,471** (95%)
Monterey																						
May[b/]																						
Jun[b/]																						
Jul	4	37	294				497	518		265	4	121	90	4		39			1,872	1,872	495	2,367
Aug		5			2		83	27		45		2	10					9	174	183	157	340
Total	**4**	**42**	**294**		**2**		**581**	**545**		**309**	**4**	**123**	**100**	**4**		**39**		**9**	**2,046**	**2,055**	**652**	**2,707** (3%)
California Total Commercial Harvest																						
	43	**868**	**6,874**		**281**	**132**	**14,145**	**15,871**	**496**	**13,927**	**11**	**4,849**	**3,114**	**173**	**12**	**1,663**	**10**	**1,193**	**62,471**	**63,757**	**32,270**	**96,027**
Oregon Total Commercial Harvest (South of Cape Falcon)																						
	3	***3***	***1,051***		***12***	***61***	***759***	***355***	***110***	***341***		***374***	***153***	***43***		***88***		***1,664***	***3,352***	***5,017***	***7,605***	***12,622***

a/ Release types defined in Table 3; SacWbat recoveries merged with SacW, in-river control releases for MOKFb merged with MOKF, barged and trucked releases for MOKFb merged with MOKFgg.

b/ CWTs recovered in May and June were excluded due to incomplete sampling as a result of COVID-19.

Table 15. Percentage[a/] of CWT_{total} recoveries by port area, month, and release type[b/] in the 2020 California ocean salmon commercial fishery.

		CFH			FRH				NIM		MOK				MER		SJO	Non-	Total	Total %		Total
	SacW	CFHL	CFHF	CFHFn	FRHS	FRHF	FRHFn	FRHFgg	NIMF	NIMFn	MOKF	MOKFn	MOKFnc	MOKFgg	MERF	MERFn	SJOSx	CV	CV	Hatchery	Natural	Harvest
California Commercial Harvest																						
Eureka/Crescent City - *Closed in 2020*																						
Fort Bragg																						
Aug		1%	16%		0%	0%	16%	10%	2%	12%		7%	3%	0%		1%			68%	68%	32%	1,617
Sep							19%	19%				19%							57%	57%	43%	232
Total		**1%**	**14%**		**0%**	**0%**	**16%**	**11%**	**2%**	**11%**		**8%**	**2%**	**0%**		**0%**			**66%**	**66%**	**34%**	**1,849**
San Francisco																						
May[c/]																						
Jun[c/]																						
Jul	0%	1%	7%		0%	0%	15%	16%	0%	14%	0%	5%	3%	0%		2%	0%	2%	62%	64%	36%	63,138
Aug	0%	1%	10%		0%	0%	16%	19%	1%	13%	0%	4%	4%	0%		2%		1%	70%	71%	29%	17,658
Sep	0%	1%	5%		0%	0%	12%	18%	1%	16%		7%	3%	0%	0%	2%	0%	0%	67%	68%	32%	8,240
Oct	0%	2%	0%		0%		1%	6%	3%	45%		11%	3%	2%		3%			78%	78%	22%	2,435
Total	**0%**	**1%**	**7%**		**0%**	**0%**	**15%**	**17%**	**1%**	**15%**	**0%**	**5%**	**3%**	**0%**	**0%**	**2%**	**0%**	**1%**	**65%**	**66%**	**34%**	**91,471**
Monterey																						
May[c/]																						
Jun[c/]																						
Jul	0%	2%	12%				21%	22%		11%	0%	5%	4%	0%		2%			79%	79%	21%	2,367
Aug		1%			1%		24%	8%		13%		1%	3%					3%	51%	54%	46%	340
Total	**0%**	**2%**	**11%**		**0%**		**21%**	**20%**		**11%**	**0%**	**5%**	**4%**	**0%**		**1%**		**0%**	**76%**	**76%**	**24%**	**2,707**
California Total Commercial Harvest																						
	0%	**1%**	**7%**		**0%**	**0%**	**15%**	**17%**	**1%**	**15%**	**0%**	**5%**	**3%**	**0%**	**0%**	**2%**	**0%**	**1%**	**65%**	**66%**	**34%**	**96,027**
Oregon Total Commercial Harvest (South of Cape Falcon)																						
	0%	***0%***	***8%***		***0%***	***0%***	***6%***	***3%***	***1%***	***3%***		***3%***	***1%***	***0%***		***1%***		***13%***	***27%***	***40%***	***60%***	***12,622***

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, in-river control releases for MOKFb merged with MOKF, barged and trucked releases for MOKFb merged with MOKFgg.

c/ CWTs recovered in May and June were excluded due to incomplete sampling as a result of COVID-19.

Table 16. CWT recovery rate (recoveries per 100,000 CWTs released) for experimental & net pen release types in 2020.

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	Recovery rate per 100K released			
				Bat Cr	Up Sac	Nat crks[a/]	Fea	Yub	Ame	Mok	Sta/Tuo	Mer	In-basin	Stray	CV total		CWT_{samp}	In-basin	Stray	**CV total**	**Ocean**
FRHFn	2018	Fall	1,772,613			23	392		33	3			392	59	**451**	**13%**	**314**	22	3	**25**	**18**
NIMFn	2018	Fall	439,333	2			4	6	247	8	2		247	21	**269**	**8%**	**178**	56	5	**61**	**41**
MOKFgg	2018	Fall	225,158	3				13	41	12		1	12	58	**70**	**83%**	**140**	5	26	**31**	**62**
MOKFn	2018	Fall	1,403,247	2	8		2	25	186	207	18	8	207	251	**458**	**55%**	**141**	15	18	**33**	**10**
MOKFnp	2018	Fall	754,295		8		19		127	33	10	3	33	167	**200**	**83%**	**422**	4	22	**27**	**56**
MOKFns	2018	Fall	119,614				1		5	1			1	6	**7**	**86%**	**19**	1	5	**6**	**16**
MERFn	2018	Fall	169,854		8			13	57	31		7	7	109	**117**	**94%**	**38**	4	64	**69**	**22**

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	Recovery rate per 100K released			
				Bat Cr	Up Sac	Nat crks[a/]	Fea	Yub	Ame	Mok	Sta/Tuo	Mer	In-basin	Stray	CV total		CWT_{samp}	In-basin	Stray	**CV total**	**Ocean**
FRHFgg	2017	Fall	609,272	41	174	77	3,810	49	105	52		3	3,859	451	**4,311**	**10%**	**4,919**	633	74	**708**	**807**
FRHFn	2017	Fall	1,496,598	38	331	139	5,787	84	99	6	8	1	5,871	623	**6,494**	**10%**	**4,861**	392	42	**434**	**325**
NIMFn	2017	Fall	664,585	6	6		47	38	2,550	36	5	13	2,550	151	**2,701**	**6%**	**3,910**	384	23	**406**	**588**
MOKFn	2017	Fall	1,649,629				40	18	531	328	50	18	328	657	**985**	**67%**	**1,350**	20	40	**60**	**82**
MOKFnp	2017	Fall	727,344	2	8	23	232	117	546	136			136	930	**1,065**	**87%**	**4,234**	19	128	**146**	**582**
MERFn	2017	Fall	255,259				113	31	212	34	17	22	22	408	**429**	**95%**	**500**	9	160	**168**	**196**

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	Recovery rate per 100K released			
				Bat Cr	Up Sac	Nat crks[a/]	Fea	Yub	Ame	Mok	Sta/Tuo	Mer	In-basin	Stray	CV total		CWT_{samp}	In-basin	Stray	**CV total**	**Ocean**
FRHFgg	2016	Fall	263,611		33		314		52				314	85	**399**	**21%**	**187**	119	32	**151**	**71**
FRHFn	2016	Fall	733,880	5	33	8	825	43	101				869	146	**1,015**	**14%**	**291**	118	20	**138**	**40**
NIMFn	2016	Fall	277,532				6	38	600	10		1	600	55	**655**	**8%**	**389**	216	20	**236**	**140**
MOKFbb	2016	Fall	96,885						10				0	10	**10**	**100%**	**22**	0	10.1	**10**	**23**
MOKFbg	2016	Fall	98,203						37	2			2	37	**39**	**95%**	**20**	2	38	**40**	**20**
MOKFbr	2016	Fall	100,032						22	7			7	22	**29**	**76%**	**9**	7	22	**29**	**9**
MOKFgg	2016	Fall	225,243				2	6	79	8			8	86	**94**	**92%**	**208**	4	38	**42**	**92**
MOKFn	2016	Fall	1,155,829				35	63	552	105	17	1	105	669	**774**	**86%**	**423**	9	58	**67**	**37**
MOKFnp	2016	Fall	720,759				9		26	3	3	1	3	39	**42**	**93%**	**224**	0	5	**6**	**31**
MOKFns	2016	Fall	121,043										0	0	**0**	**-**	**13**	0	0	**0**	**10**

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:

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)

MOKFbb Mokelumne River Hatchery fall barge study: trucked & released in SF Bay

MOKFbg Mokelumne River Hatchery fall barge study: barged to SF Bay and released

MOKFbr Mokelumne River Hatchery fall barge study: in-river releases (Miller's Ferry, Mok R.)

MERFn Merced River Hatchery fall bay/delta net pen releases

#	Release Type	Release Location
1	SacW	Lake Redding Park (Sac R)
2	SacW	Bonnyview Boat Ramp (Sac R)
3	SacWbat	Battle Creek
4	CFHF, CFHL	Coleman Fish Hatchery (Bat Cr)
5	CFHF	Scotty's Landing (Sac R)
6	FRHF	Thermalito High Flow Channel (Fea R)
7	FRHS	Gridley and Live Oak (Fea R)
8	FRHS, FRHF	Boyds Pump Boat Ramp (Fea R)
9	FRHF	Elkhorn Boat Ramp (Sac R)
10	NIMF	Sunrise Recreation Area (American R)
11	NIMF	Jibboom Street Bridge (American R)
12	MOKF	Mokelumne River Hatchery
13	MOKF	Woodbridge Dam (Mok R)
14	MOKF	Miller's Ferry Bridge (Mok R)
15	MERF	Merced River Hatchery
16	SJOSx	Fremont Ford Bridge (San Joaq R)
17	SJOSx	Below Friant Dam and Eastside Bypass (San Joaq R)
18	MOKFn, MERFn	Sherman Island Net Pens (Delta)
19	FRHFn, NIMFn	Mare Island Net Pens (Bay)
20	NIMFn	Wickland Oil Net Pens (Bay)
21	FRHFgg, MOKFgg, MOKFbb, MOKFbg	Trucked (via Fort Baker or Tiburon) or Barged to Golden Gate
22	MOKFnc	Pillar Point Net Pens (Coastal)
23	MOKFnc	Santa Cruz Net Pens (Coastal)

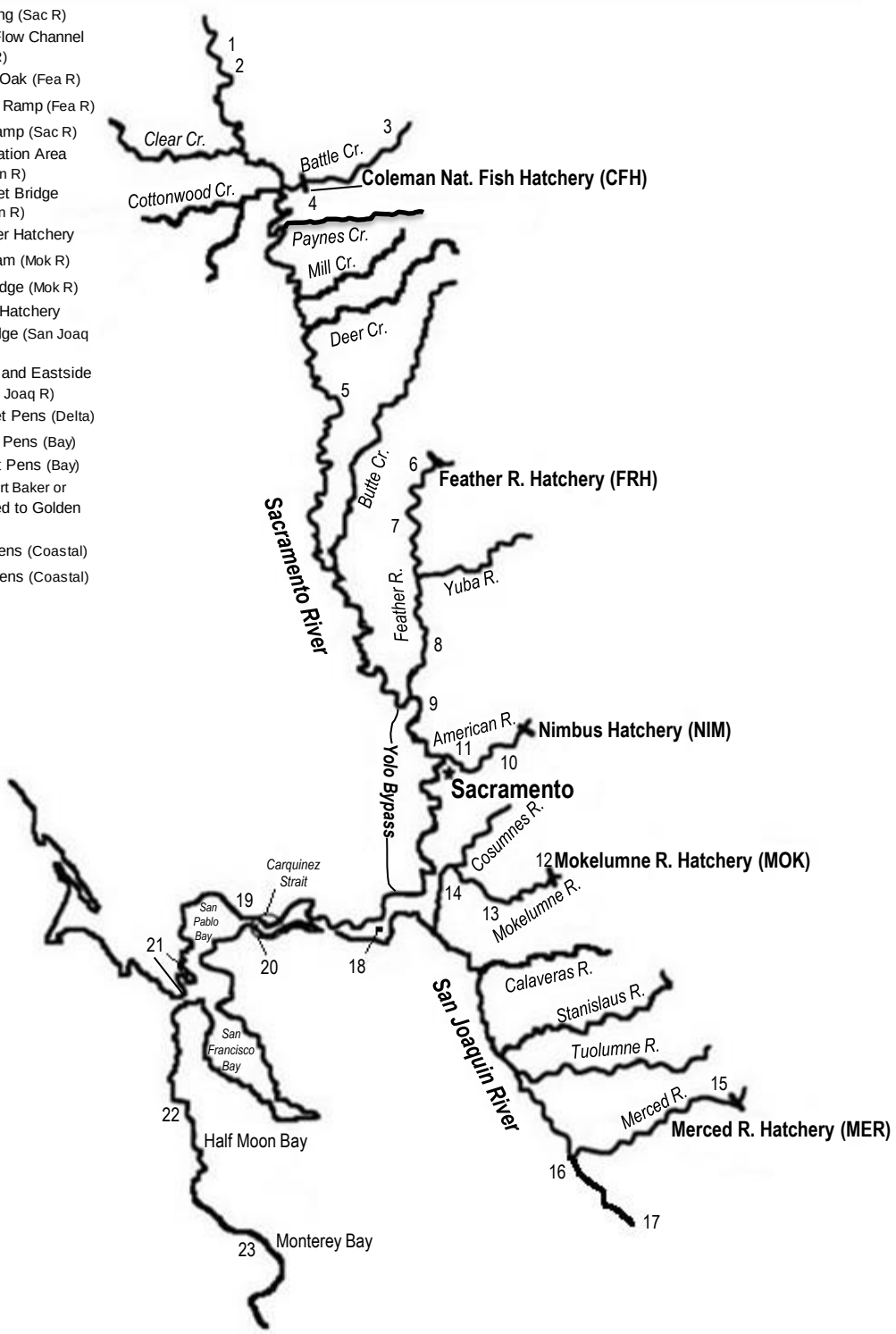


Figure 1. Map of release sites for CV hatchery release types, brood years 2015-2018.

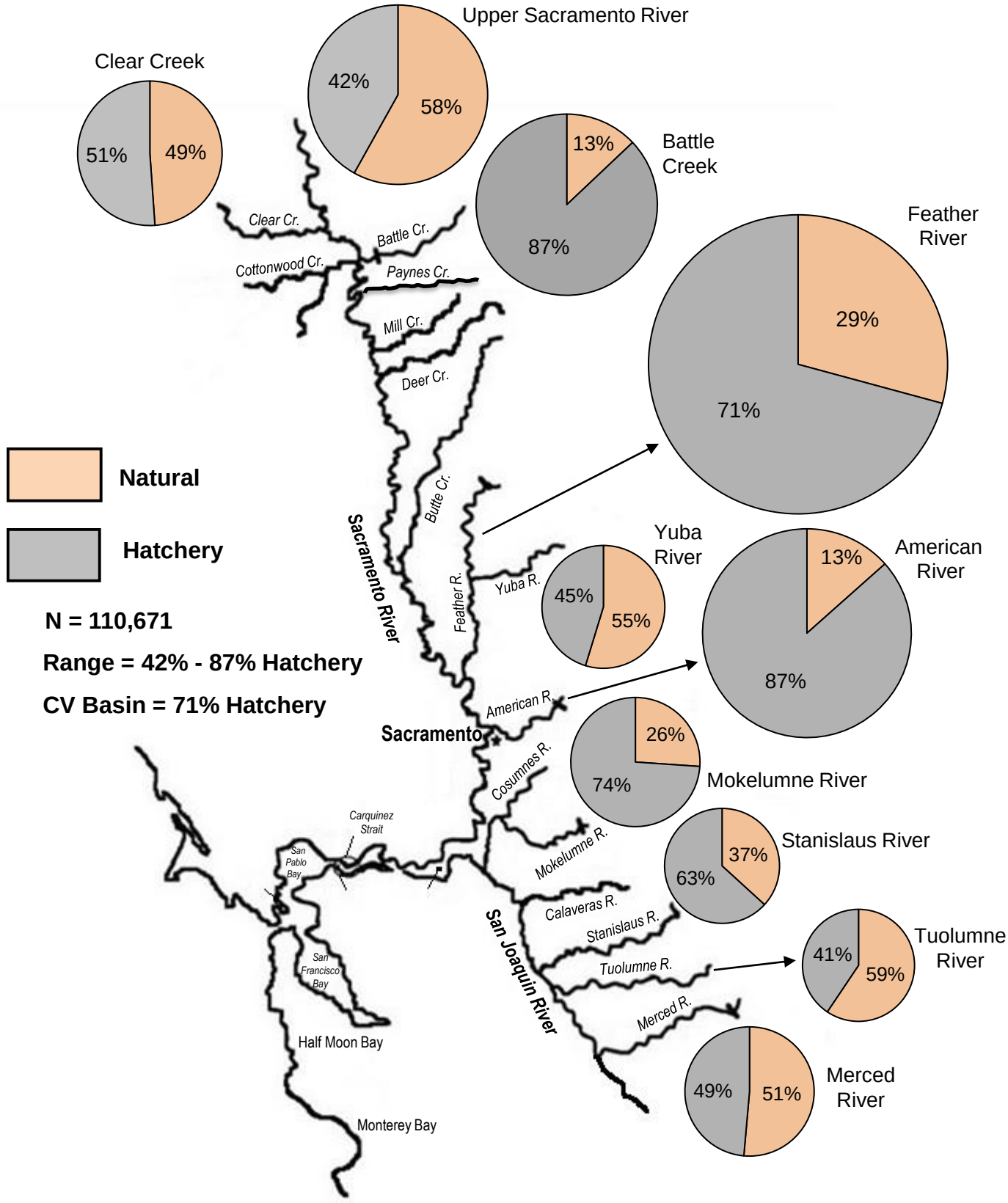


Figure 2. Fall-run CV natural area escapement, hatchery and natural proportions, 2020.

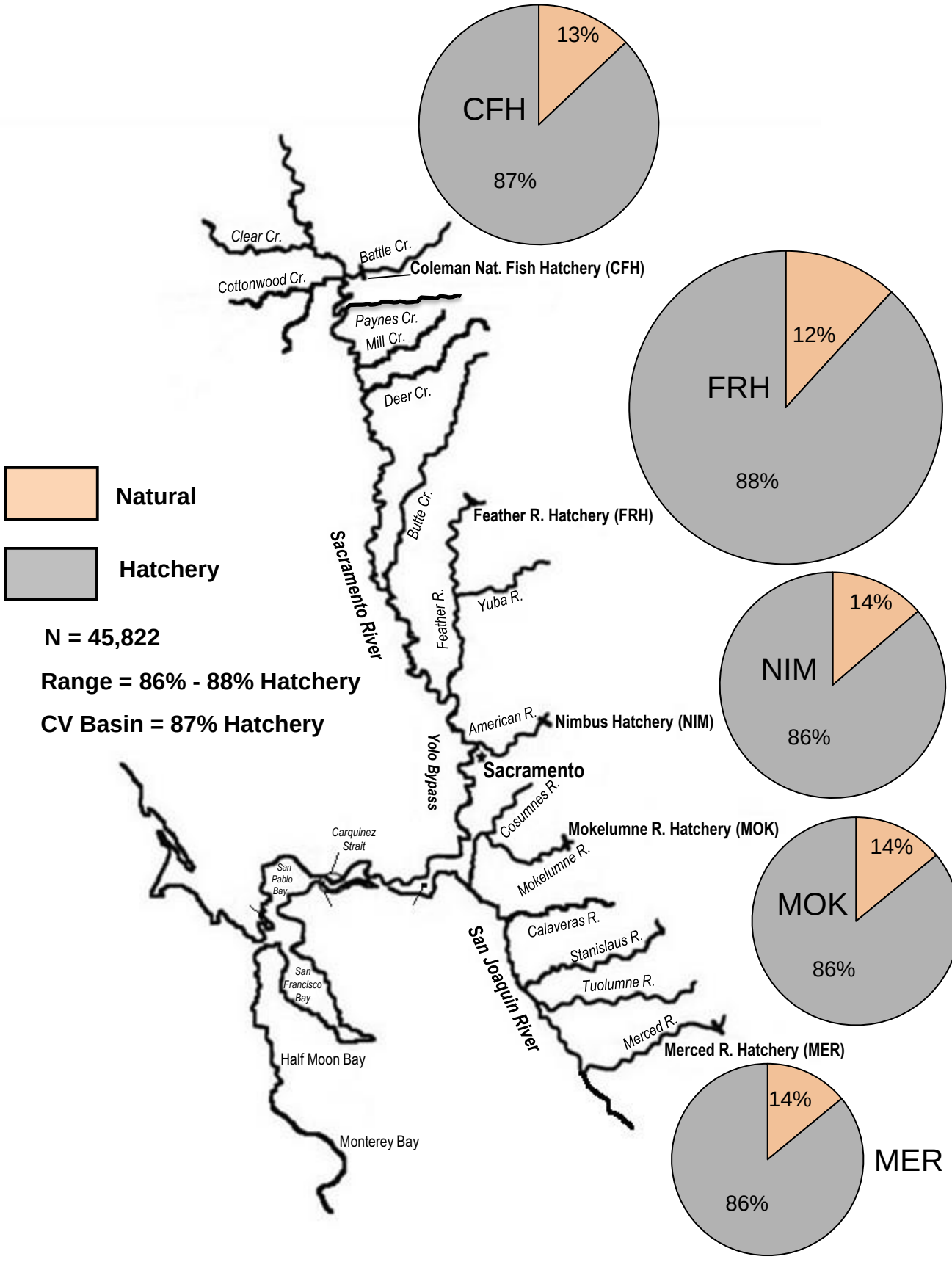


Figure 3. Fall-run CV hatchery escapement, hatchery and natural proportions, 2020.

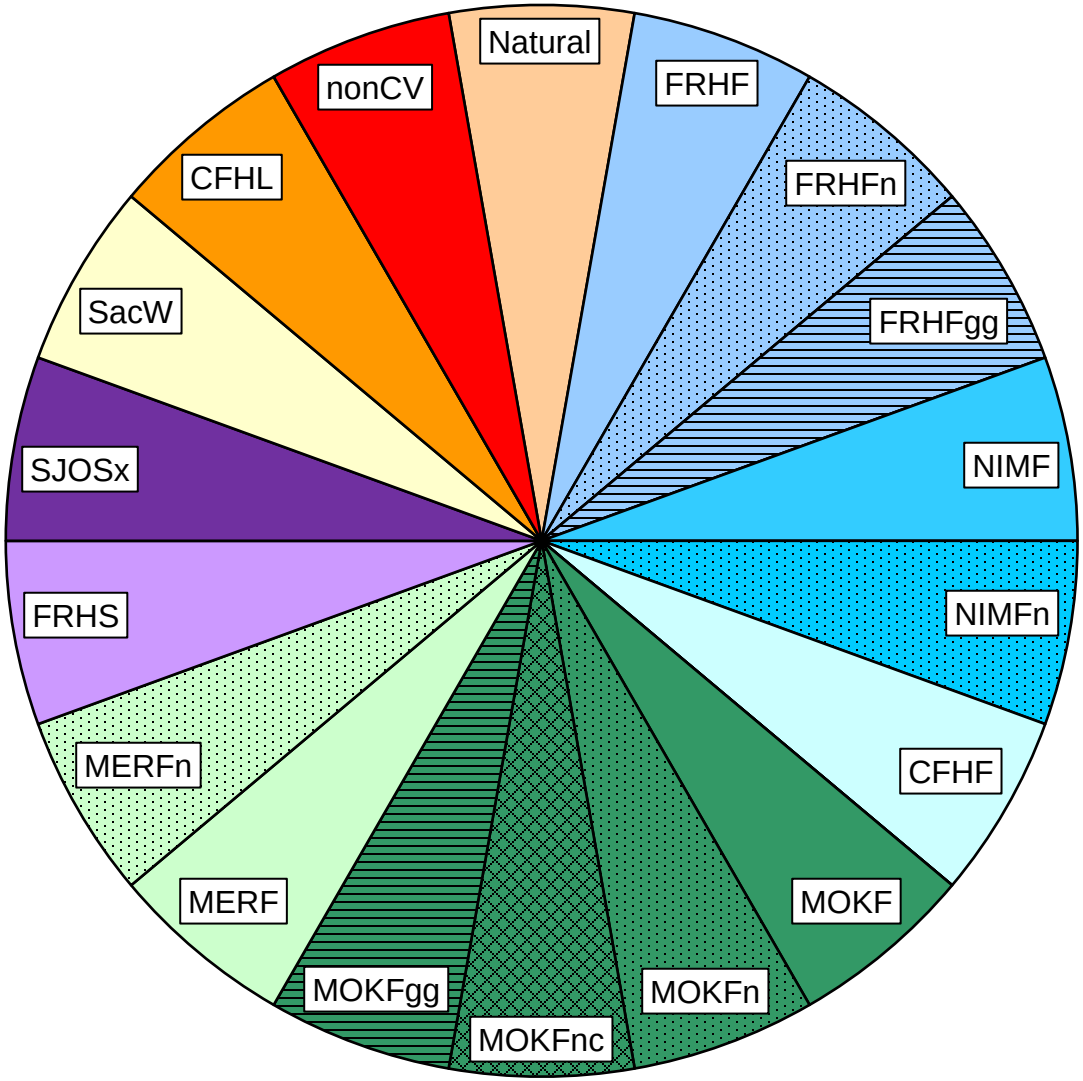


Figure 4. Color and pattern scheme used in all pie chart figures for Central Valley hatchery release types, brood years 2014-2017.

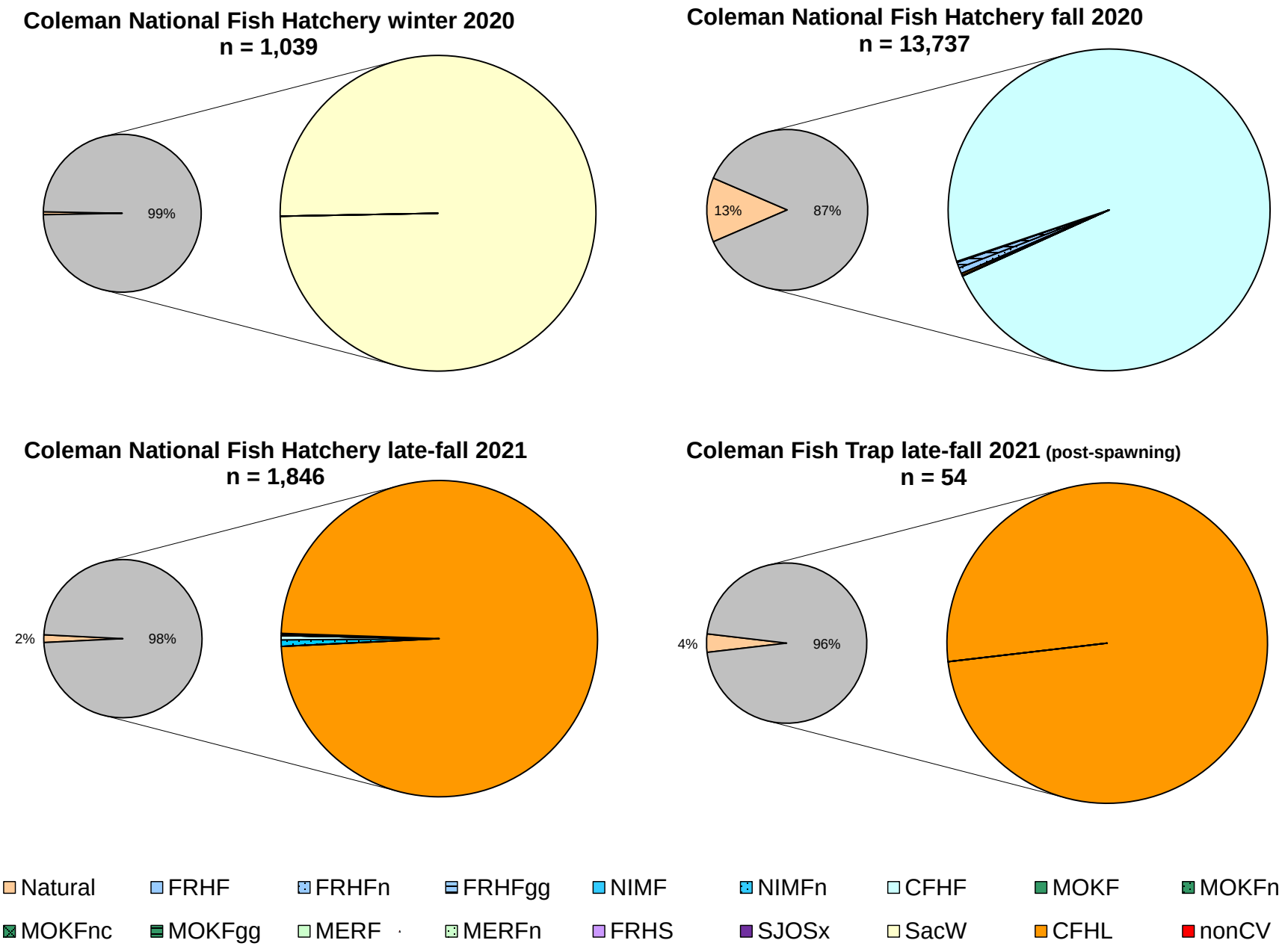


Figure 5. Proportion of hatchery- and natural-origin fish at Coleman National Fish Hatchery, 2020-21.

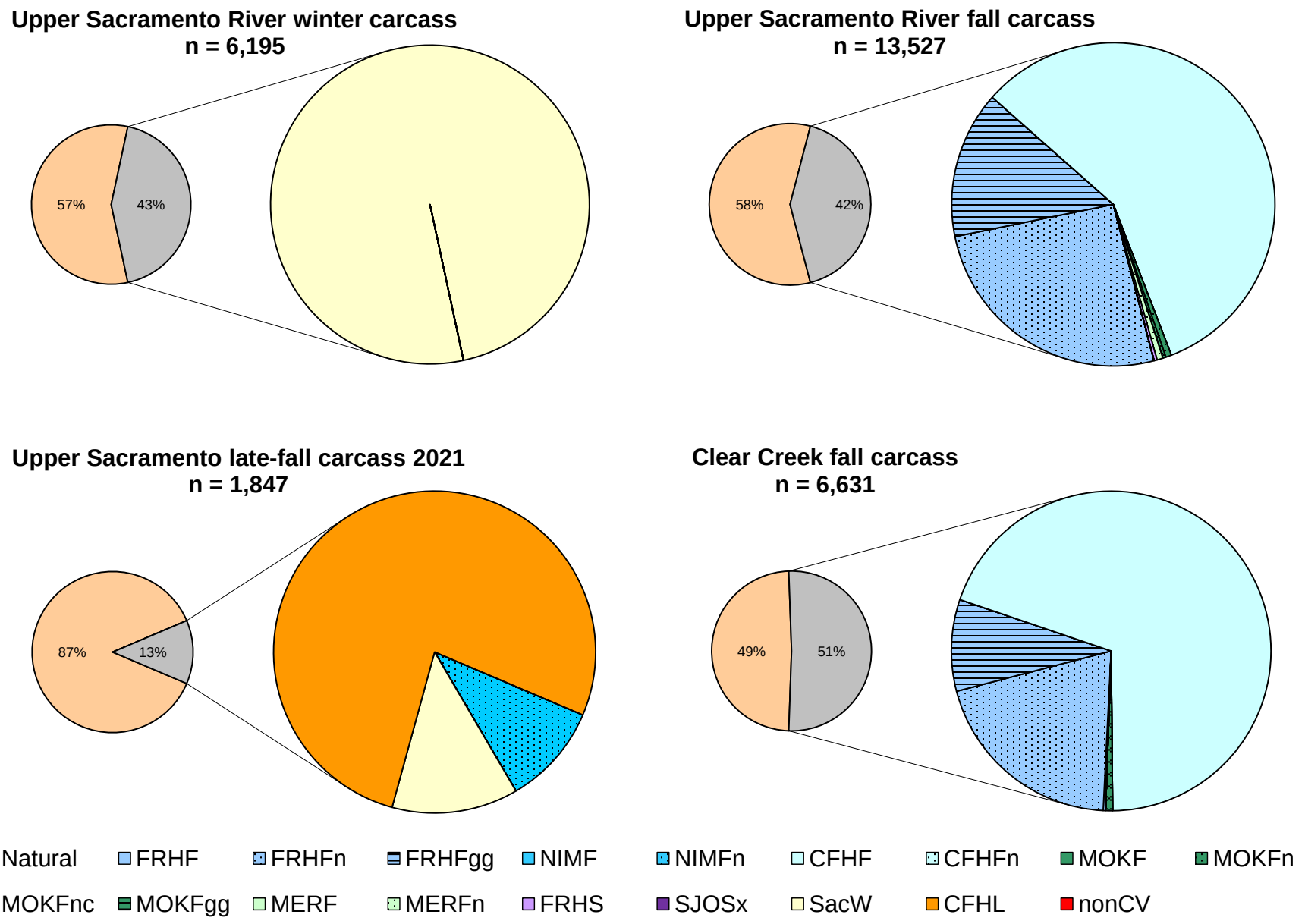


Figure 6. Proportion of hatchery- and natural-origin fish in Upper Sacramento River & tributaries, 2020. (Page 1 of 2)

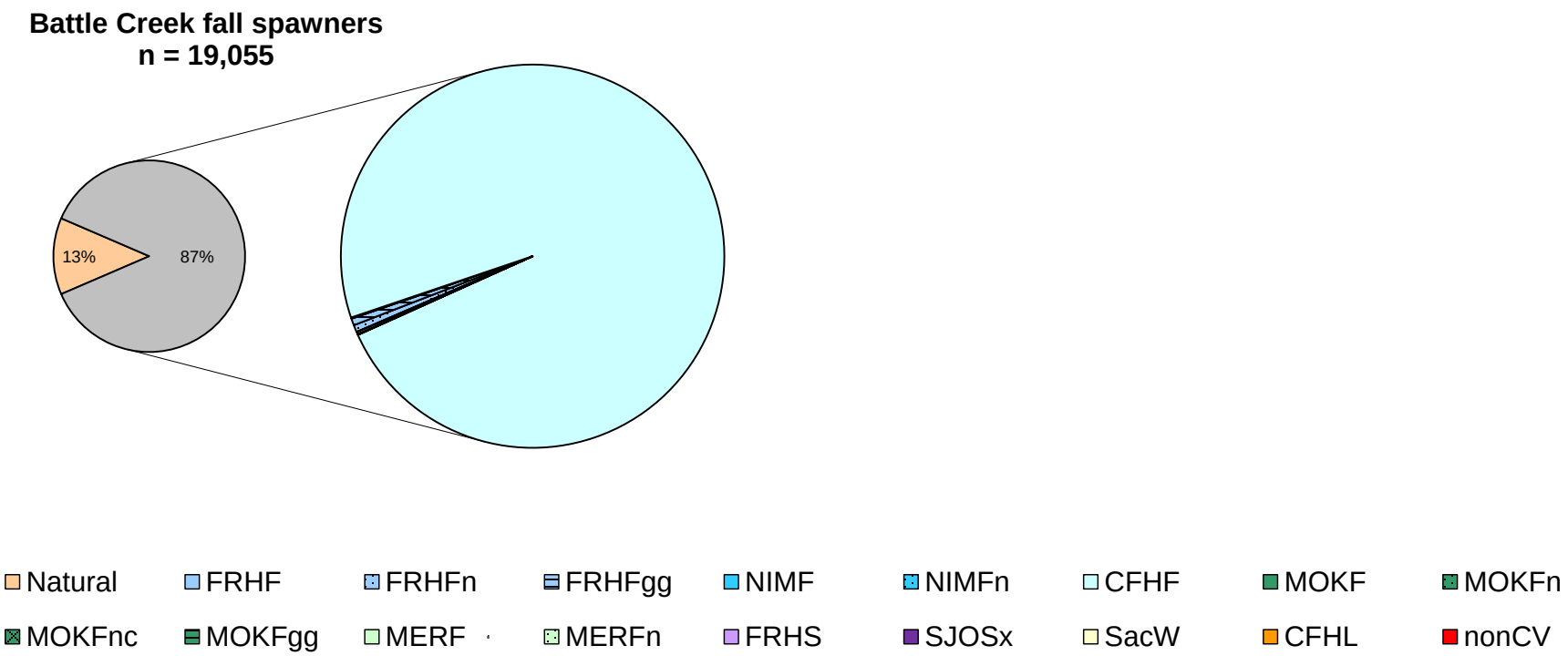


Figure 6. Proportion of hatchery- and natural-origin fish in Upper Sacramento River & tributaries, 2020.

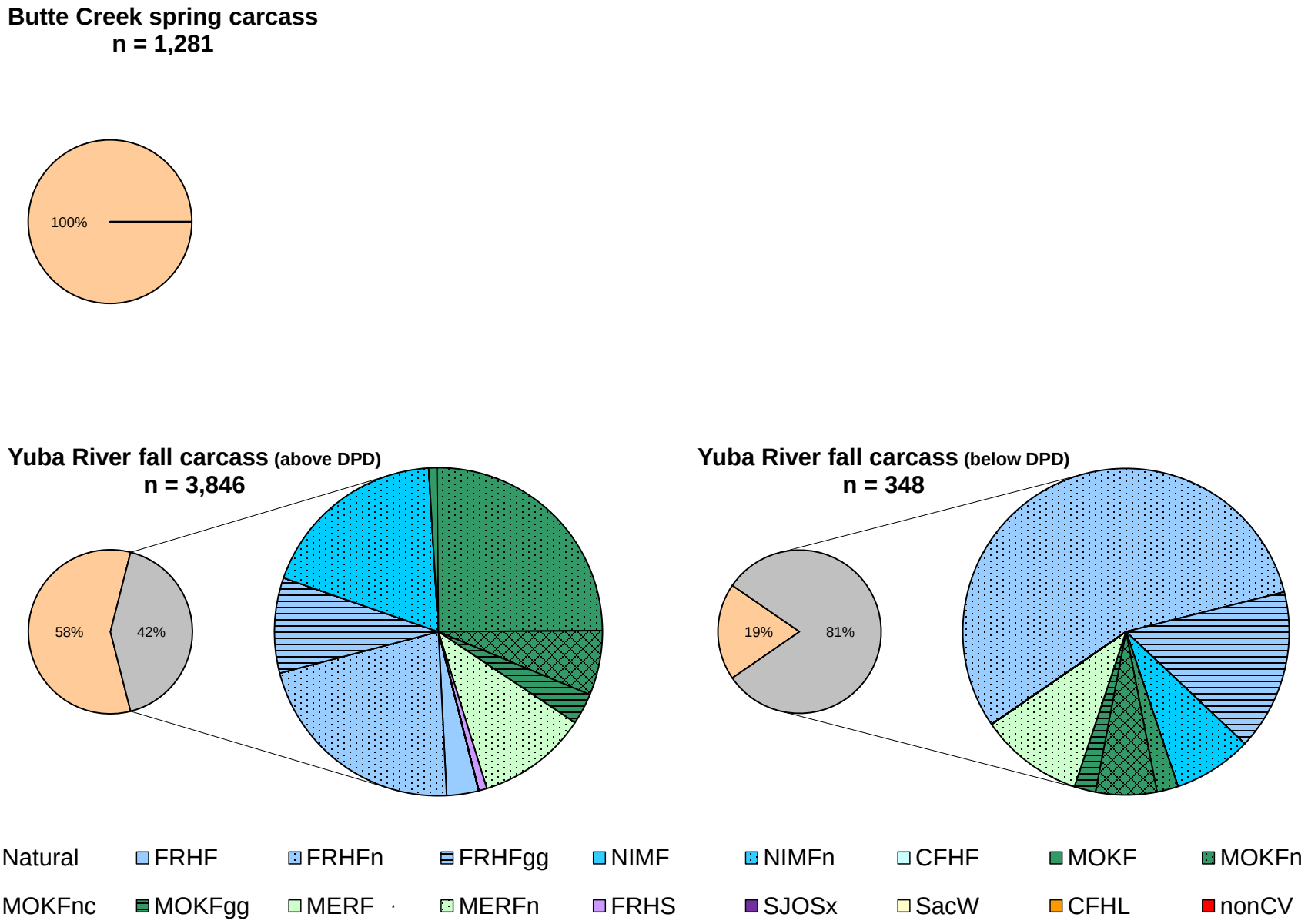


Figure 7. Proportion of hatchery- and natural-origin fish in Butte Creek & Yuba River, 2020.

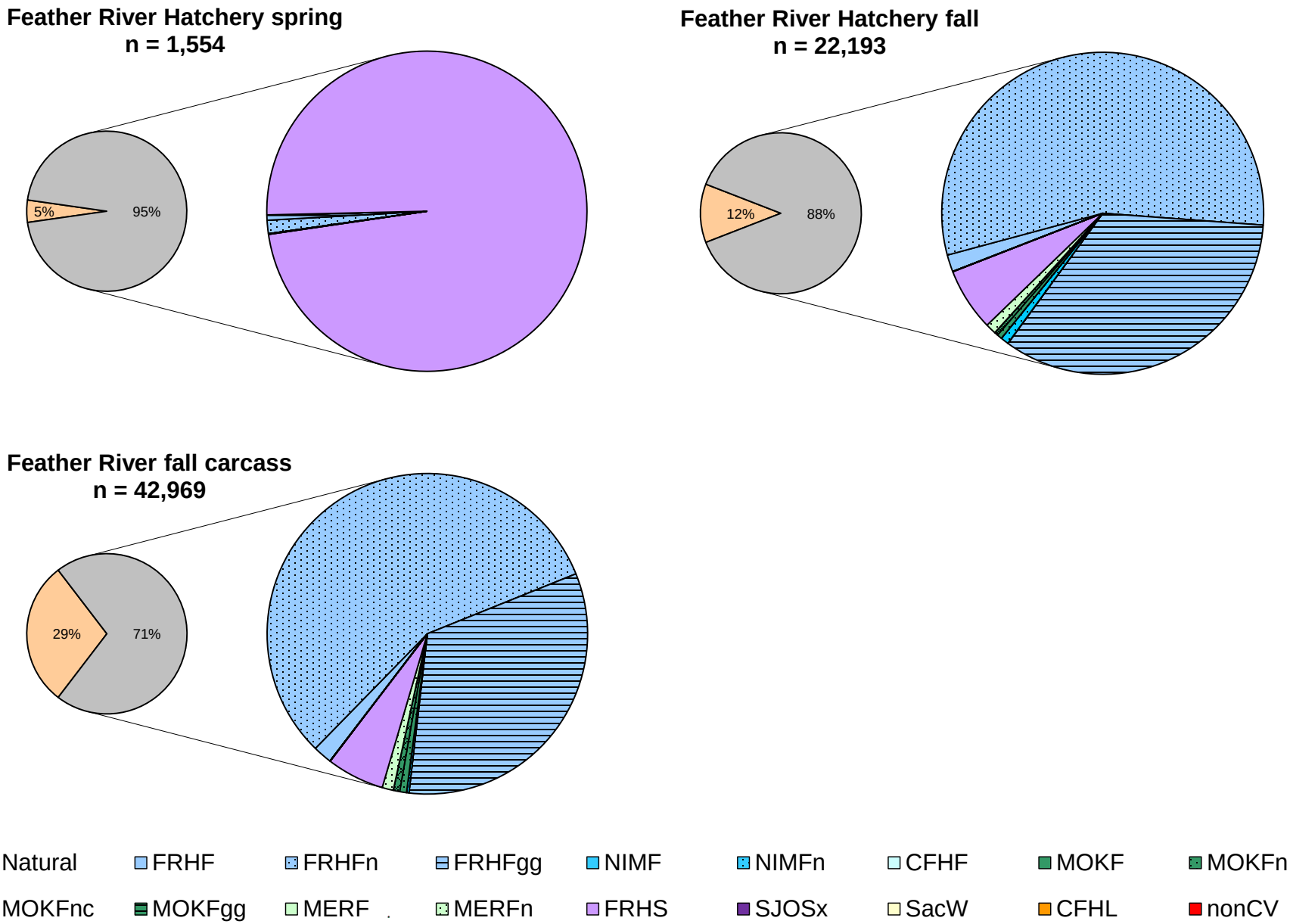


Figure 8. Proportion of hatchery- and natural-origin fish in the Feather River, 2020.

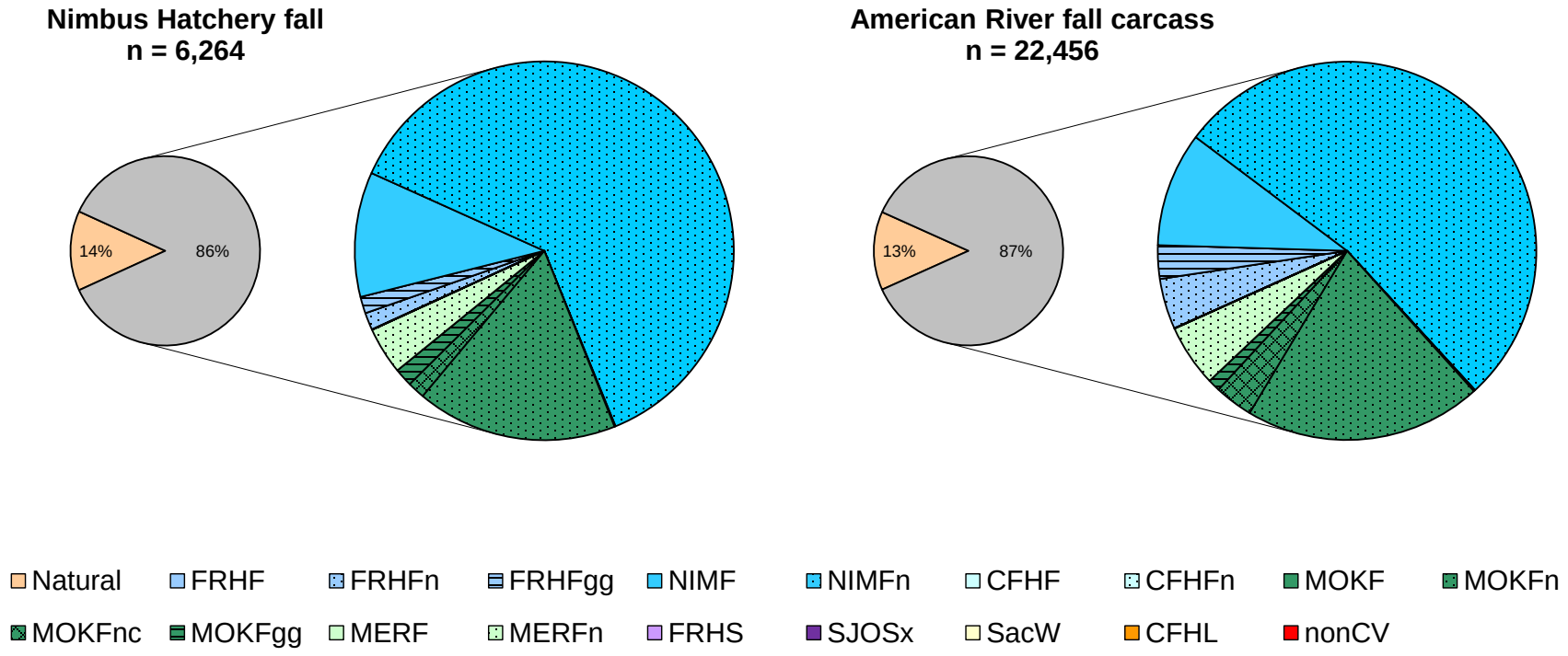


Figure 9. Proportion of hatchery- and natural-origin fish in the American River, 2020.

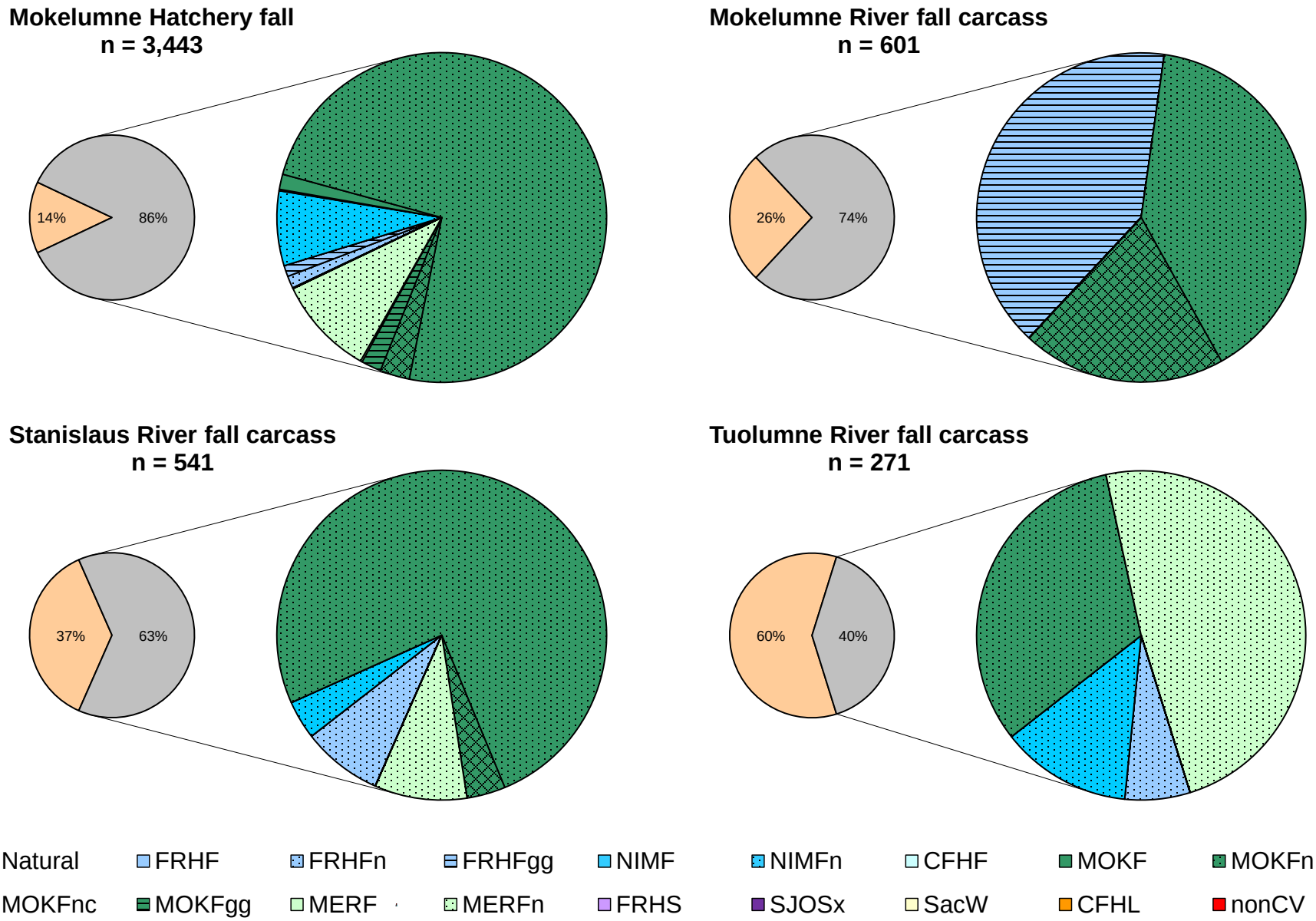


Figure 10. Proportion of hatchery- and natural-origin fish in the Mokelumne, Stanislaus, & Tuolumne rivers, 2020.

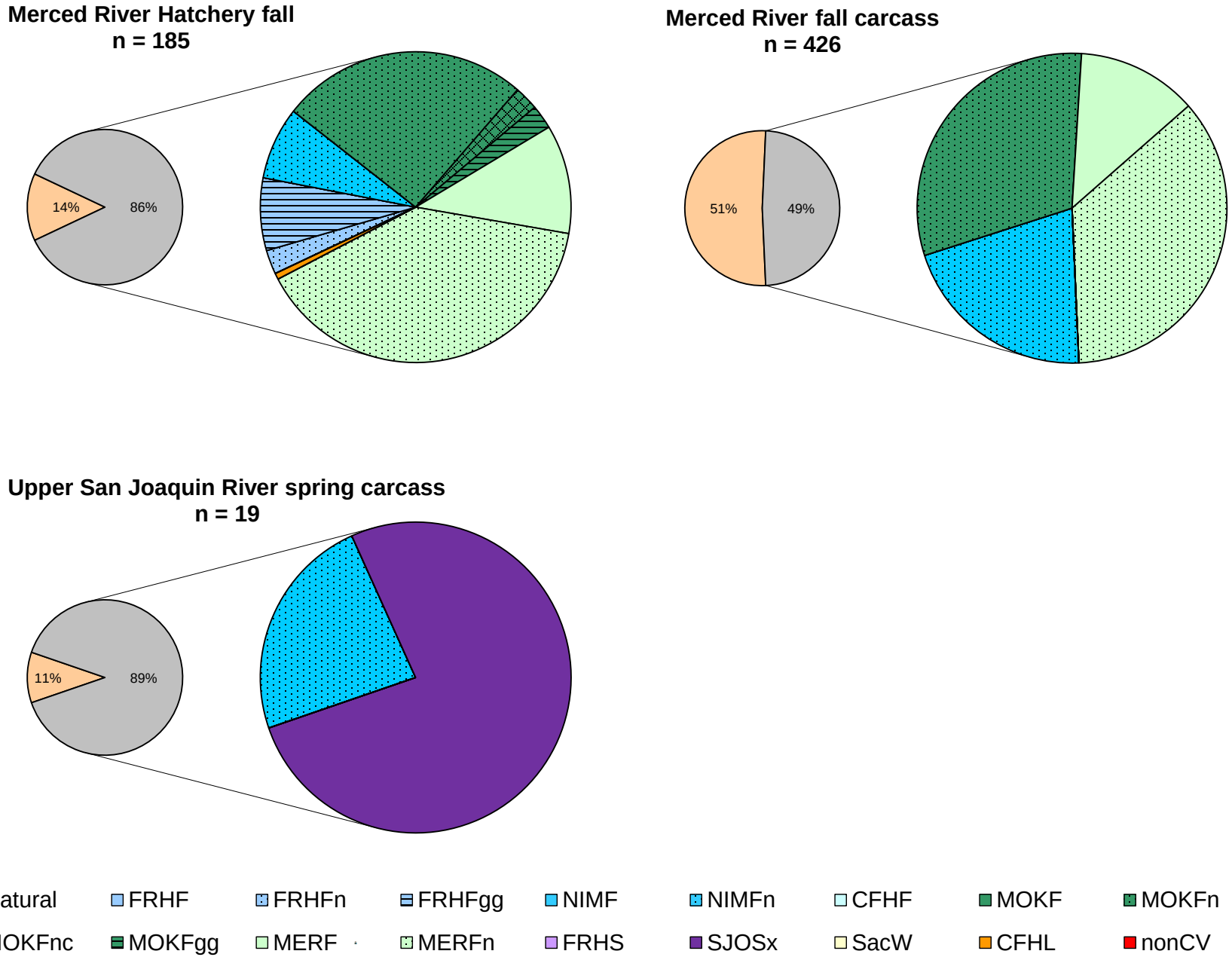


Figure 11. Proportion of hatchery- and natural-origin fish in the Merced & Upper San Joaquin rivers, 2020.

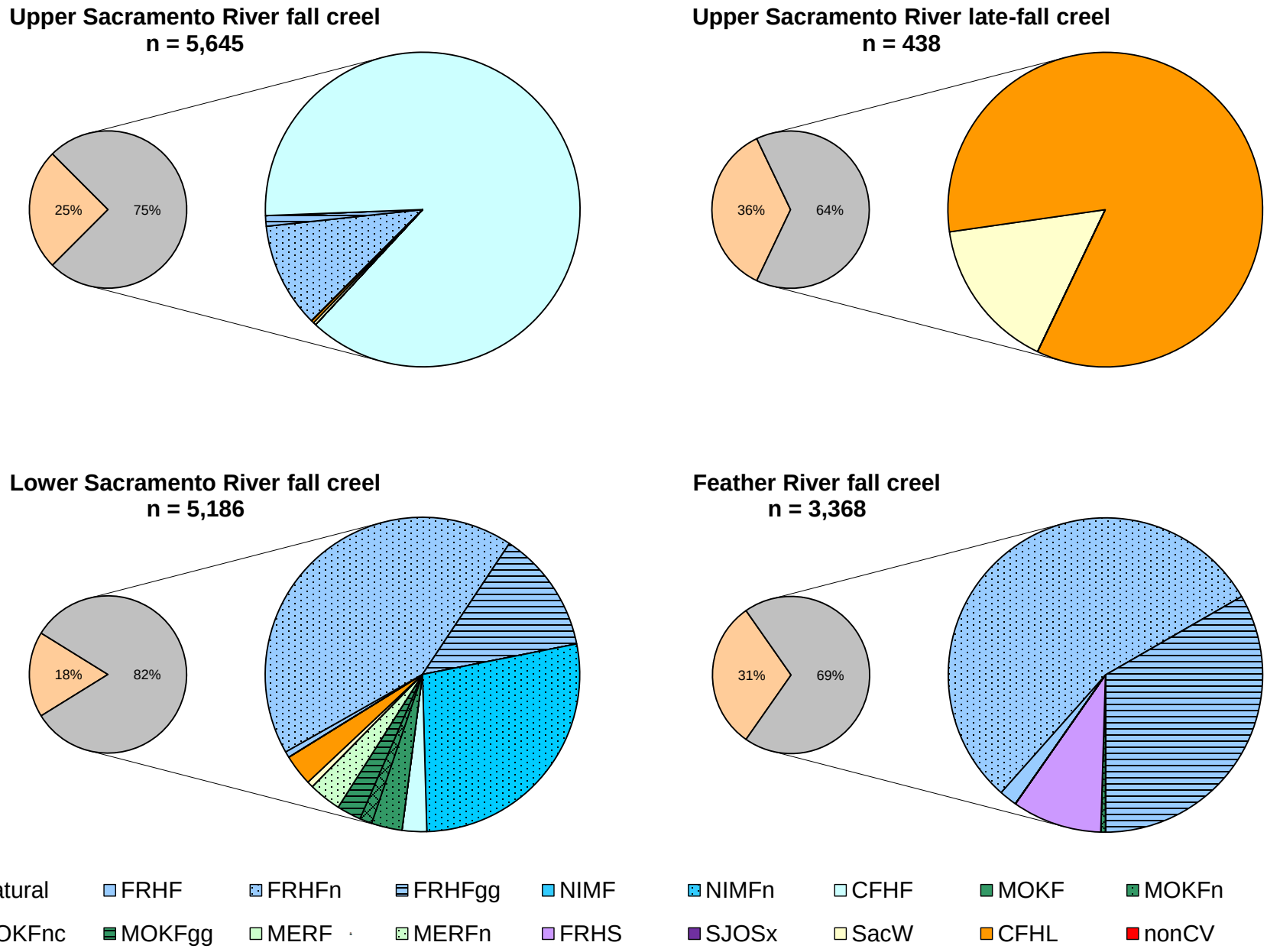


Figure 12. Proportion of hatchery- and natural-origin fish in sport harvest on the Sacramento & Feather Rivers, 2020.

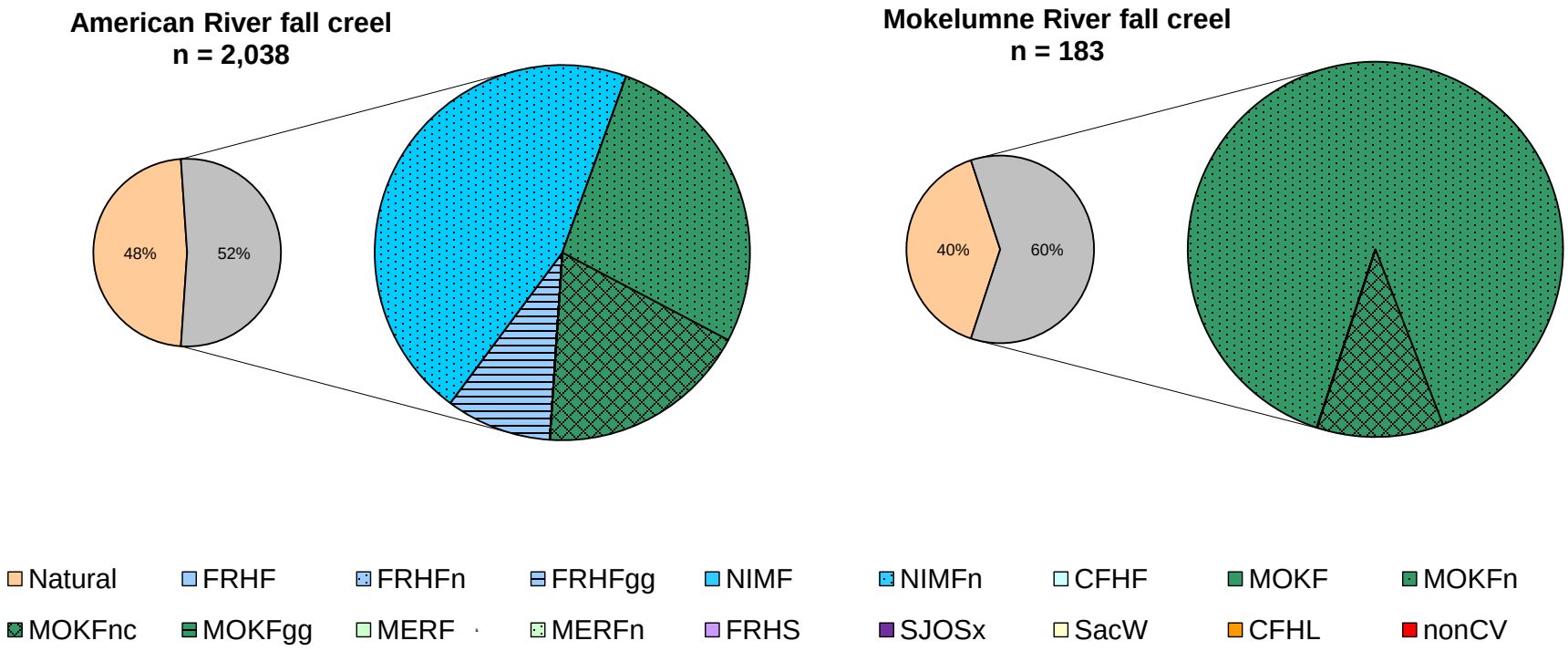
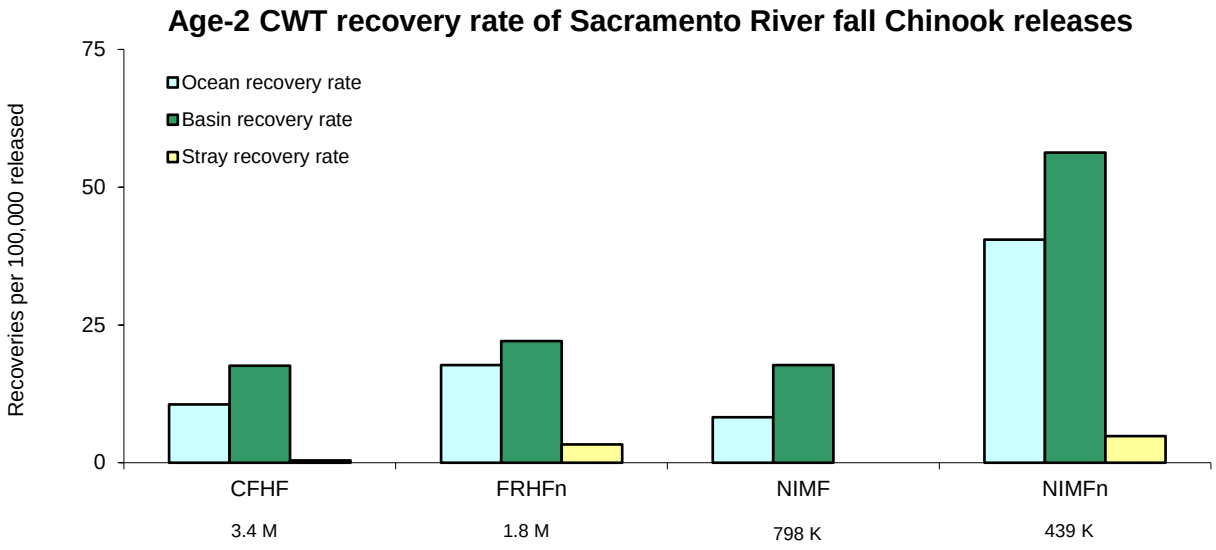
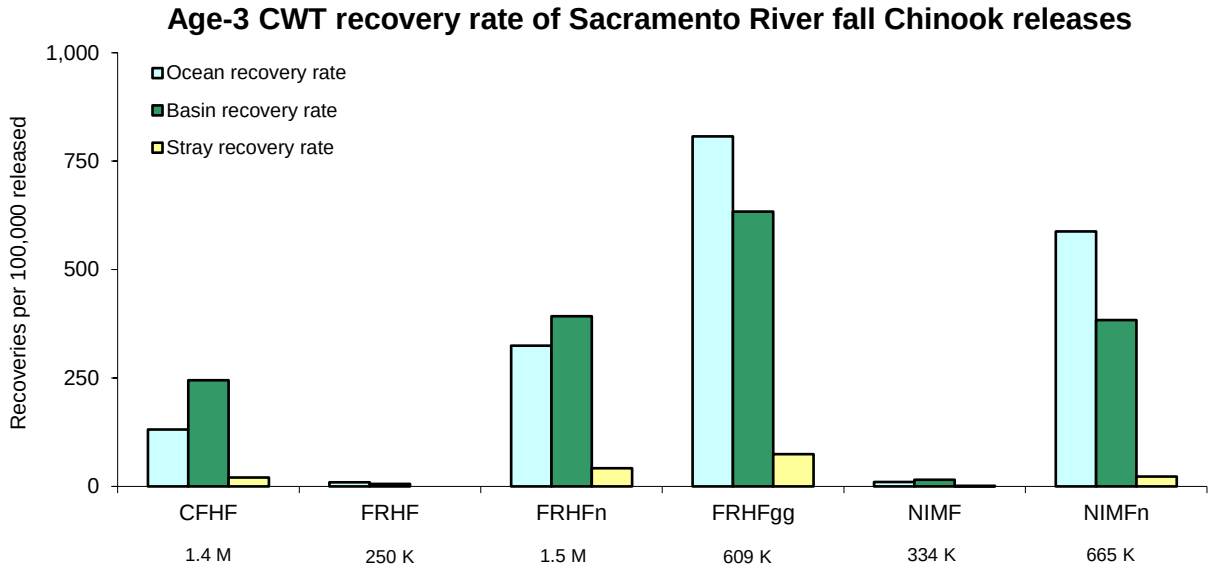


Figure 13. Proportion of hatchery- and natural-origin fish in sport harvest on the American and Mokelumne Rivers, 2020.





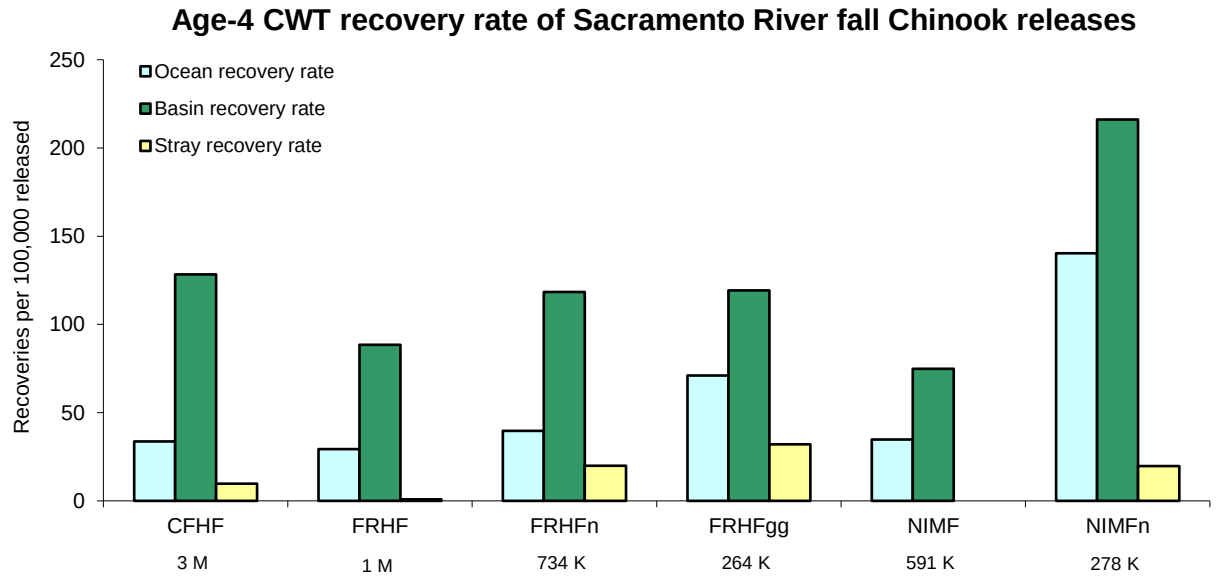


Figure 14. CWT recovery rates of Sacramento River fall Chinook releases by age in 2020.

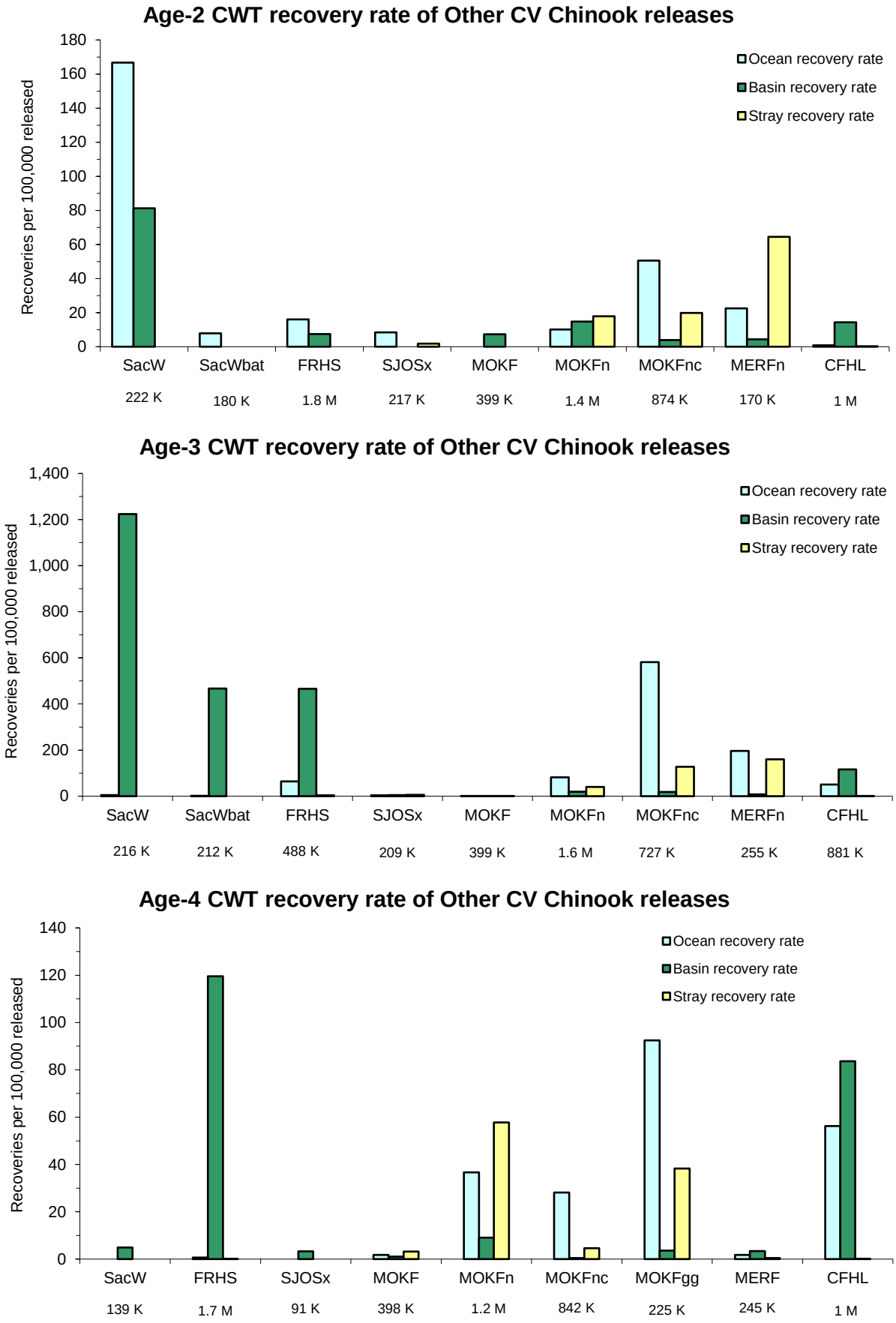


Figure 15. CWT recovery rates of Other CV Chinook releases by age in 2020.

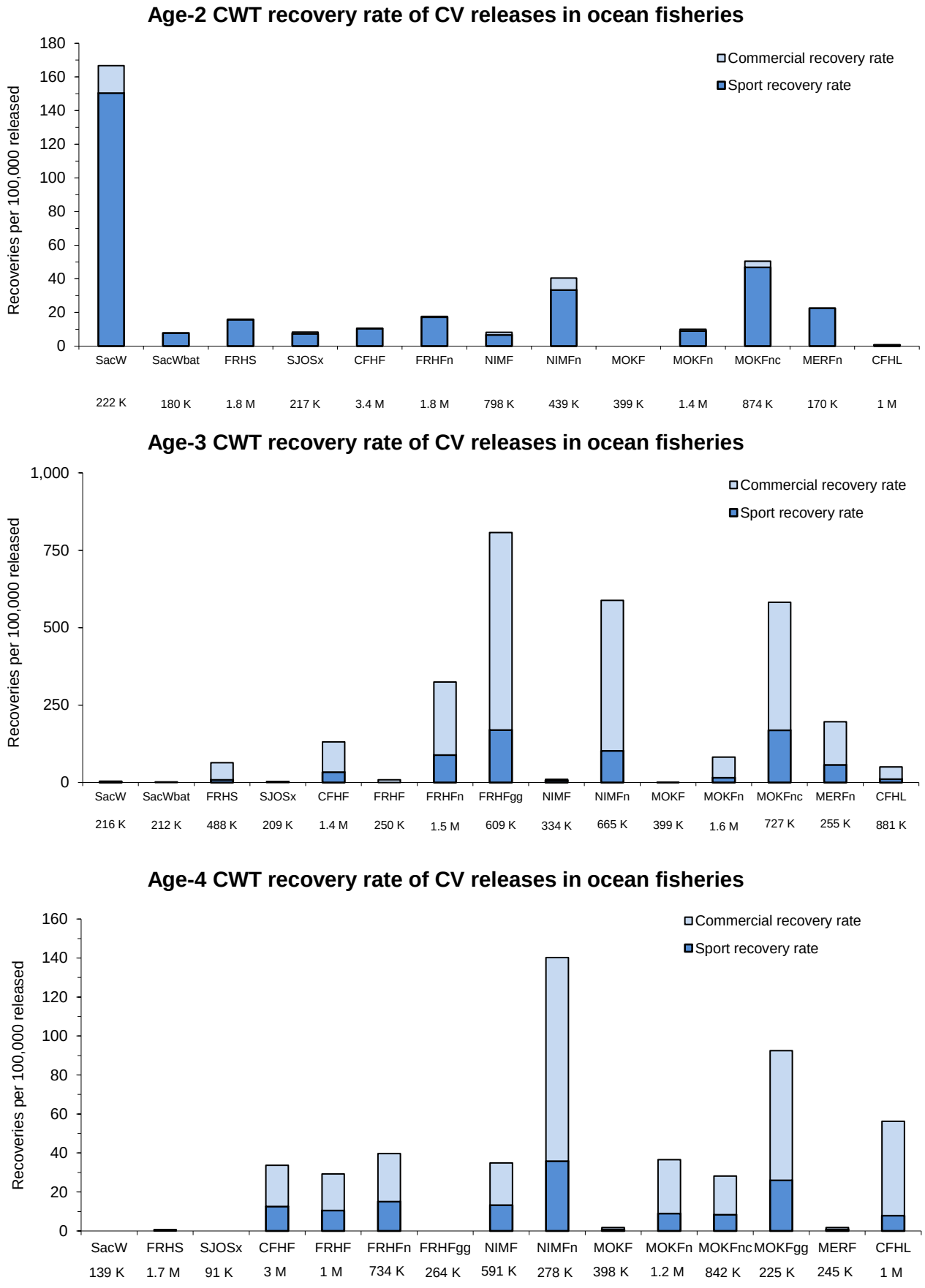


Figure 16. CWT recovery rates by release type in 2020 ocean salmon fisheries.

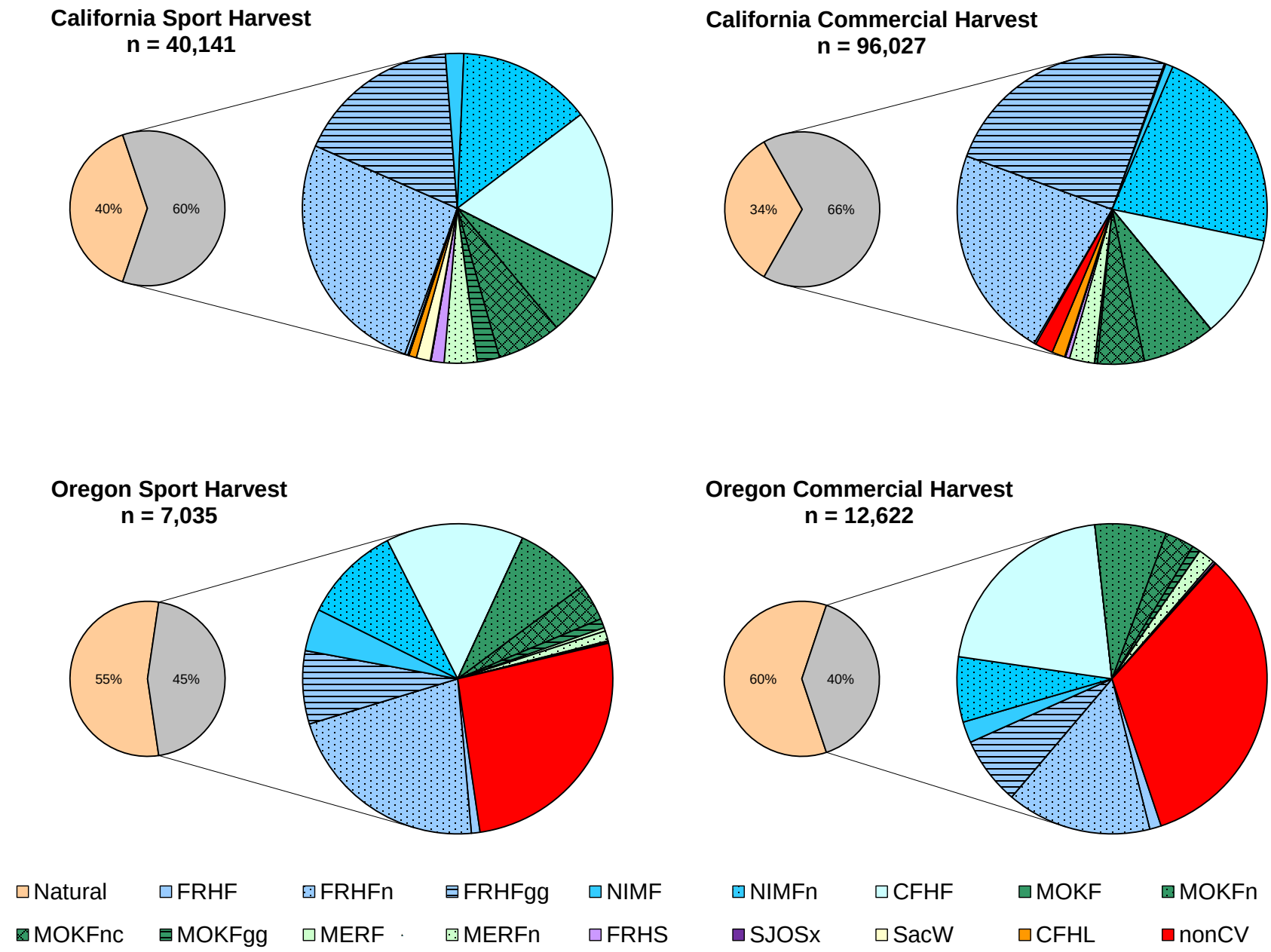


Figure 17. Proportion of hatchery- and natural-origin salmon in 2020 California and Oregon ocean fisheries.

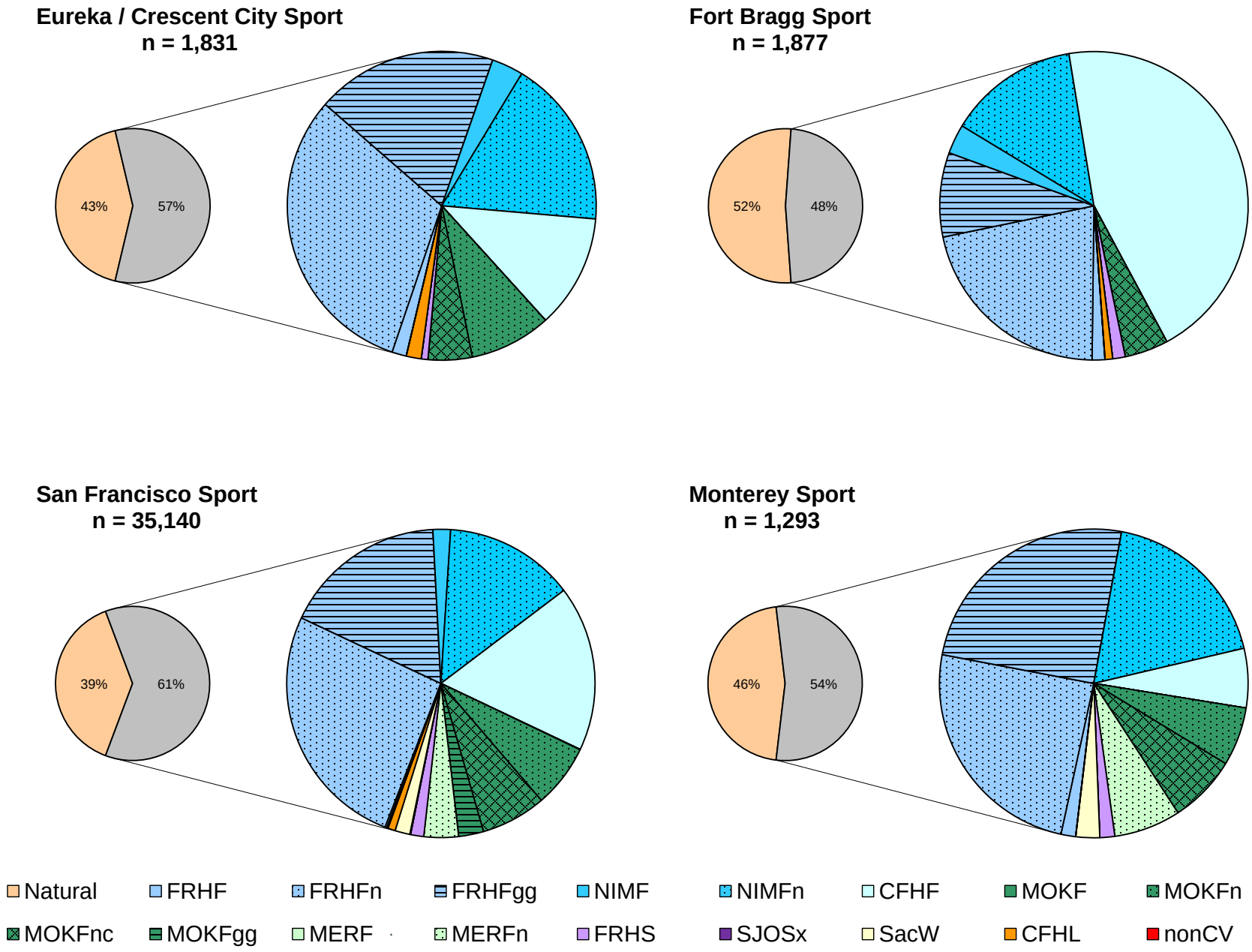


Figure 18. Proportion of hatchery- and natural-origin salmon in the 2020 California ocean sport fishery.

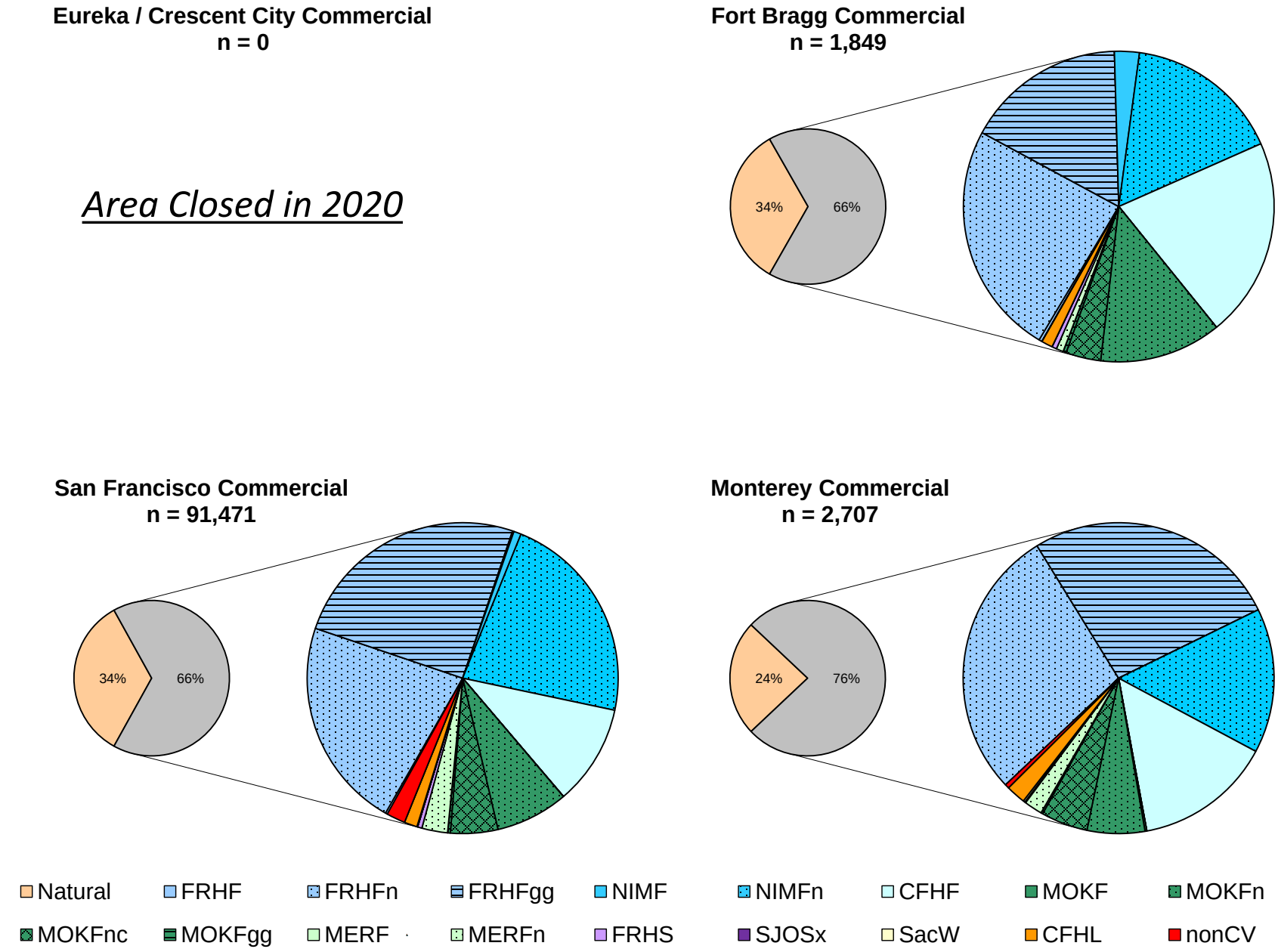


Figure 19. Proportion of hatchery- and natural-origin salmon in the 2020 California ocean commercial fishery.

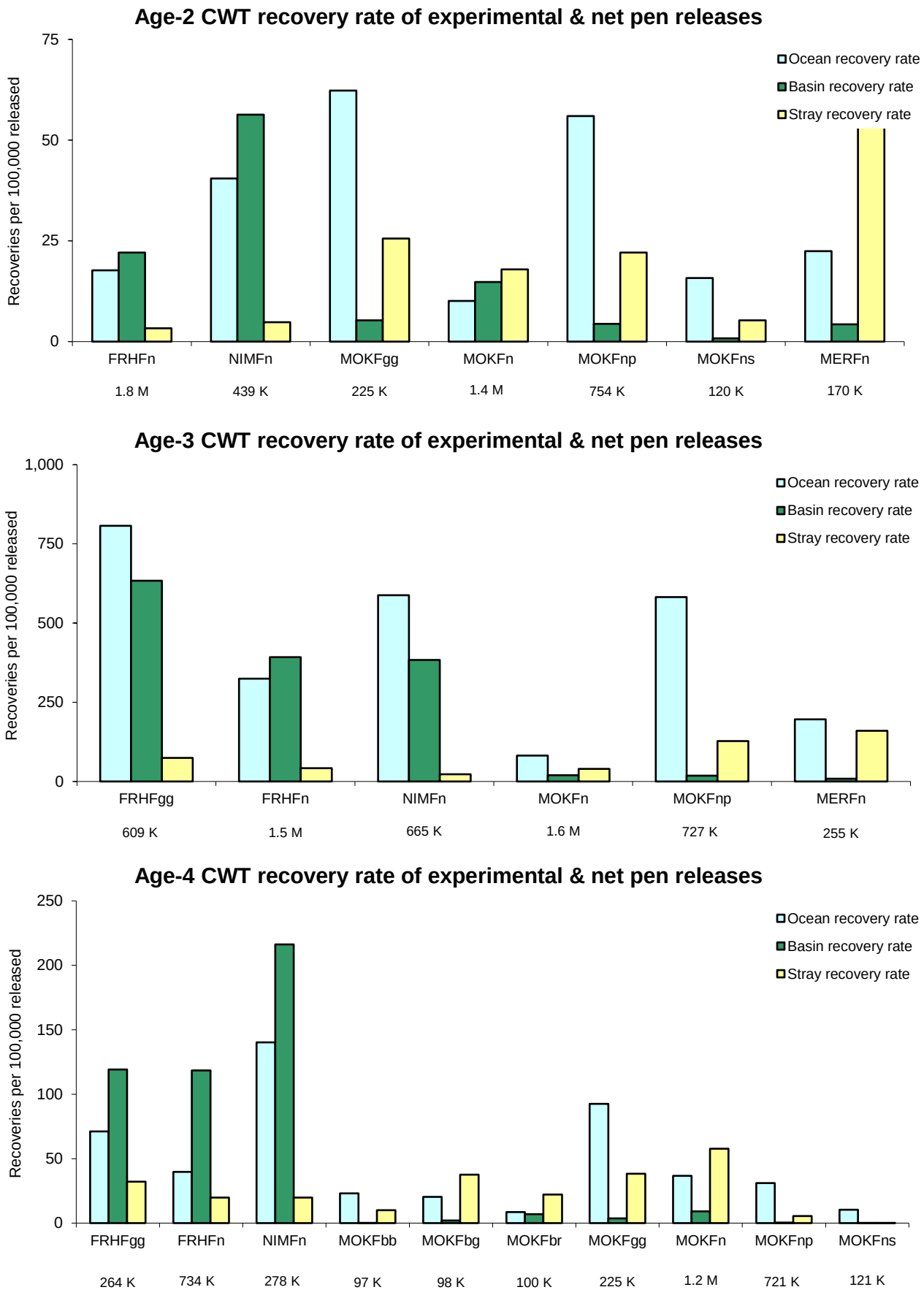


Figure 20. CWT recovery rates of experimental and net pen releases by age in 2020.

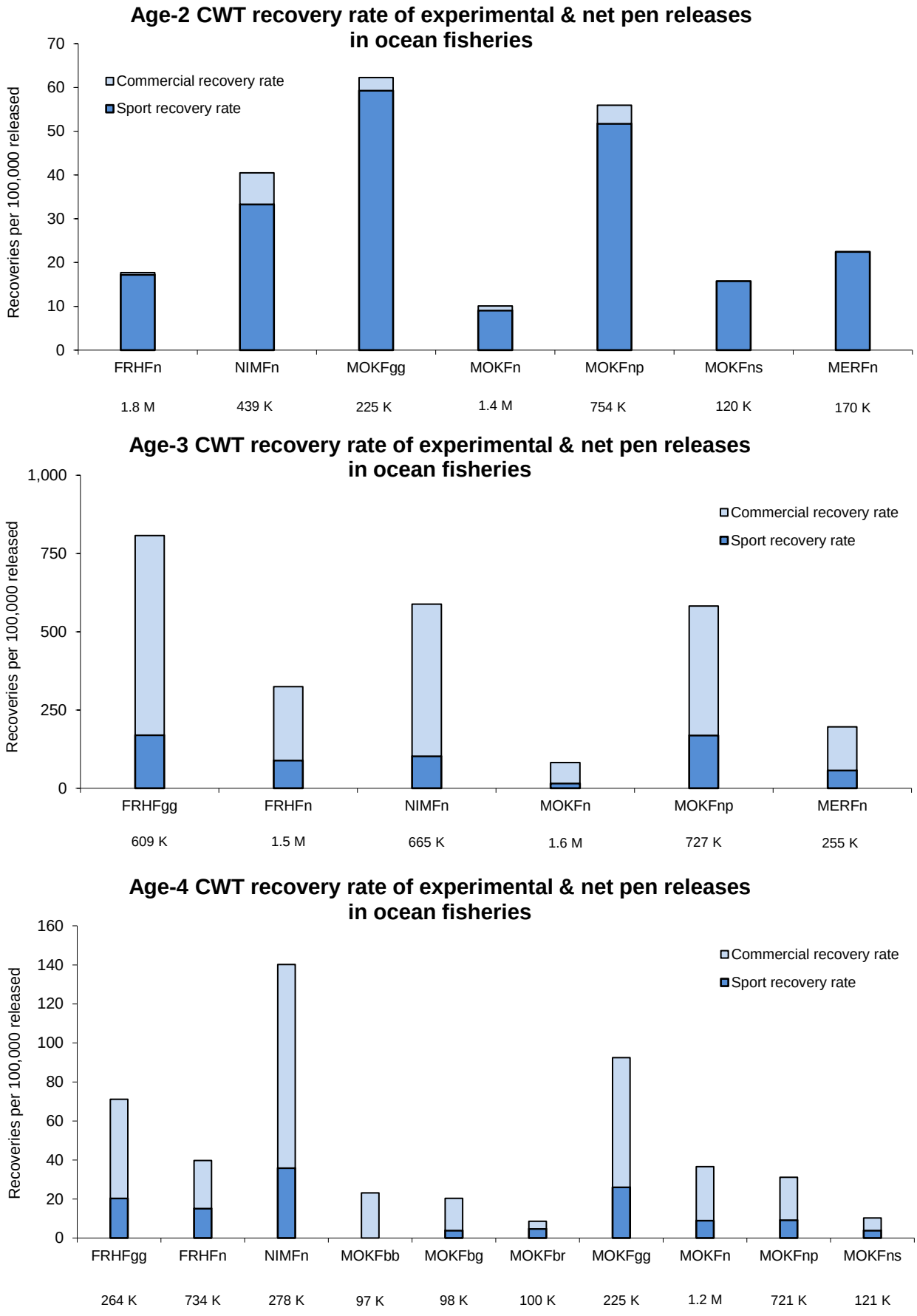


Figure 21. CWT recovery rates of experimental and net pen releases in 2020 ocean sport and commercial fisheries.

Appendix 1. Sample expansion factors for Central Valley salmon carcass surveys collecting fish condition in 2019. (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 27%		925	6.8%	105	104	97	96	**0.11**	**0.93**	14.92	3.96	5,666	42%
non-fresh 73%		2,468	18.2%	82	80	77	77	0.03	0.96				
total	**13,527**	3,393	25.1%	187	184	174	**173**			**8.28**	**3.96**	**5,666**	**42%**

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 89%		513	7.7%	69	69	67	65	**0.13**	**0.97**	13.32	3.92	3,390	51%
non-fresh 11%		64	1.0%	54	54	49	47	0.84	0.91				
total	**6,631**	577	8.7%	123	123	116	112			**7.73**	**3.92**	**3,390**	**51%**

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%		4,893	11.4%	1,126	1,125	1,072	1071	**0.23**	**0.95**	8.80	3.23	30,417	71%
non-fresh													
total	**42,969**	4,893	11.4%	1,126	1,125	1,072	**1,071**			**8.80**	**3.23**	**30,417**	**71%**

Yuba River below Daguerre Point Dam fall-run Chinook salmon carcass survey (only fresh fish processed)

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%		63	18.1%	17	17	16	16	**0.27**	**0.94**	5.52	3.18	281	81%
non-fresh													
total	**348**	63	18.1%	17	17	16	**16**			**5.52**	**3.18**	**281**	**81%**

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%		162	29.9%	33	33	32	32	**0.20**	**0.97**	3.34	3.20	342	63%
non-fresh													
total	**541**	162	29.9%	33	33	32	**32**			**3.34**	**3.20**	**342**	**63%**

Appendix 1. Sample expansion factors for Central Valley salmon carcass surveys collecting fish condition in 2020. (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 68%		155	57.2%	18	18	14	14	**0.12**	**0.78**	1.75	4.47	110	41%
non-fresh 32%		72	26.6%	1	1			0.01					
total	**271**	227	83.8%	19	19	14	**14**			**1.75**	**4.47**	**110**	**41%**

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 100%		80	18.8%	10	10	9	9	**0.13**	**0.90**	5.33	4.32	207	49%
non-fresh													
total	**426**	80	18.8%	10	10	9	**9**			**5.33**	**4.32**	**207**	**49%**

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 57%		1,978	31.9%	887	881	852	851	**0.45**	**0.97**	3.16	1.00	2,683	43%
non-fresh 43%		1,502	24.2%	591	584	553	552	0.39	0.95				
total	**6,195**	3,480	56.2%	1478	1465	1405	**1403**			**1.91**	**1.00**	**2,683**	**43%**

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 84%		16	84.2%	15	15	14	14	**0.94**	**0.93**	1.19	1.23	17	89%
non-fresh 16%		3	15.8%	1	1			0.33					
total	**19**	19	100.0%	16	16	14	**14**			**1.19**	**1.23**	**17**	**89%**

Upper Sacramento River late-fall-run Chinook salmon carcass survey 2021

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 40%		176	10.3%	23	23	22	22	**0.13**	**0.96**	9.71	1.10	236	14%
non-fresh 60%		262	15.3%	15	15	15	14	0.06	1.00				
total	**1,709**	438	25.6%	38	38	37	**36**			**5.93**	**1.10**	**236**	**14%**

p_adc = proportion of sampled fish that were ad-clipped; *p_cwt|adc* = proportion of ad-clipped fish containing CWTs

Appendix 2. Alternative 2020 CWT recovery and stray rates (recoveries per 100,000 CWTs released) of CFH and FRH releases.[a/]

Age-2 CWT recoveries

Release	Brood	Run	# CWT	Central Valley total recoveries (CWT_{samp}) by basin										CV CWT_{samp} totals			% CV	Ocean	Recovery rate per 100K released			
type	year	type	tagged	Bat Cr	Up Sac	Nat crks[b/]	Fea	Yub	Ame	Mok	Sta/Tuo	Mer	Up SJ	In-basin	Stray	CV total	Stray	CWT_{samp}	In-basin	Stray	**CV total**	**Ocean**
CFHF	2018	Fall	3,448,504	592	17	15								592	32	624	5%	364	17	1	18	11
CFHL	2019	Late	1,031,542	130	18					1		1		130	20	150	13%	8	13	1.9	15	1
FRHF	2018	Fall												0	0	0	-	0	0	0	0	0
FRHFn	2018	Fall	1,772,613			23	392		33	3				392	59	451	13%	314	22	3	25	18
FRHS	2018	Spr	1,831,043				136							136	0	136	0%	294	7	0	7	16

Age-3 CWT recoveries

Release	Brood	Run	# CWT	Central Valley total recoveries (CWT_{samp}) by basin										CV CWT_{samp} totals			% CV	Ocean	Recovery rate per 100K released			
type	year	type	tagged	Bat Cr	Up Sac	Nat crks[b/]	Fea	Yub	Ame	Mok	Sta/Tuo	Mer	Up SJ	In-basin	Stray	CV total	Stray	CWT_{samp}	In-basin	Stray	**CV total**	**Ocean**
CFHF	2017	Fall	1,369,512	3,070	282	278			1	1				3,070	562	3,632	15%	1,795	224	41	265	131
CFHL	2018	Late	881,364	974	53				1					974	54	1,029	5%	444	111	6	117	50
FRHF	2017	Fall	250,489				14							14	0	14	0%	23	6	0	6	9
FRHFn	2017	Fall	1,496,598	38	331	139	5,787	84	99	6	8	1		5,787	707	6,494	11%	4,861	387	47	434	325
FRHFgg	2017	Fall	609,272	41	174	77	3,810	49	105	52		3		3,810	500	4,311	12%	4,919	625	82	708	807
FRHS	2017	Spr	488,223		17		2,262	13						2,262	29	2,291	1%	313	463	6	469	64

Age-4 CWT recoveries

Release	Brood	Run	# CWT	Central Valley total recoveries (CWT_{samp}) by basin										CV CWT_{samp} totals			% CV	Ocean	Recovery rate per 100K released			
type	year	type	tagged	Bat Cr	Up Sac	Nat crks[b/]	Fea	Yub	Ame	Mok	Sta/Tuo	Mer	Up SJ	In-basin	Stray	CV total	Stray	CWT_{samp}	In-basin	Stray	**CV total**	**Ocean**
CFHF	2016	Fall	3,020,565	3,363	513	294								3,363	807	4,170	19%	1,019	111	26.7	138	34
CFHL	2017	Late	1,047,211	769	107					1				769	108	877	12%	588	73	10	84	56
FRHF	2016	Fall	1,029,808			8	860	50						860	58	918	6%	301	83	6	89	29
FRHFn	2016	Fall	733,880	5	33	8	825	43	101					825	189	1,015	19%	291	112	26	138	40
FRHFgg	2016	Fall	263,611		33		314		52					314	85	399	21%	187	119	32	151	71
FRHS	2016	Spr	1,682,317				2,010		2					2,010	2	2,012	0%	11	120	0	120	1

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

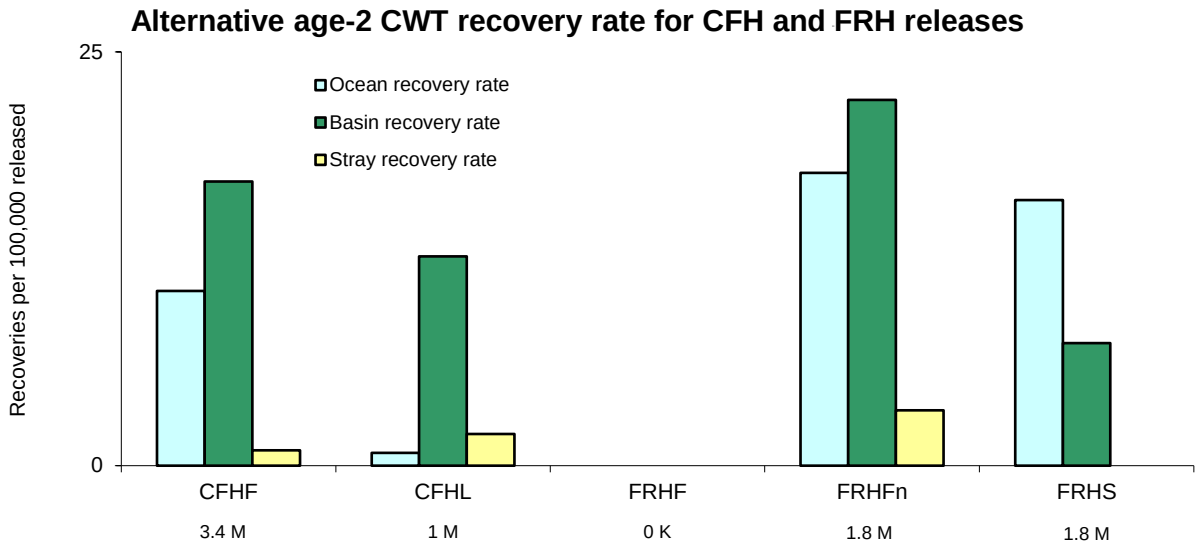
b/ Natural creeks can include Clear Creek, Cow Creek, Cottonwood Creek, Paynes Creek, Mill Creek, Deer Creek, and Butte Creek, depending on survey year.

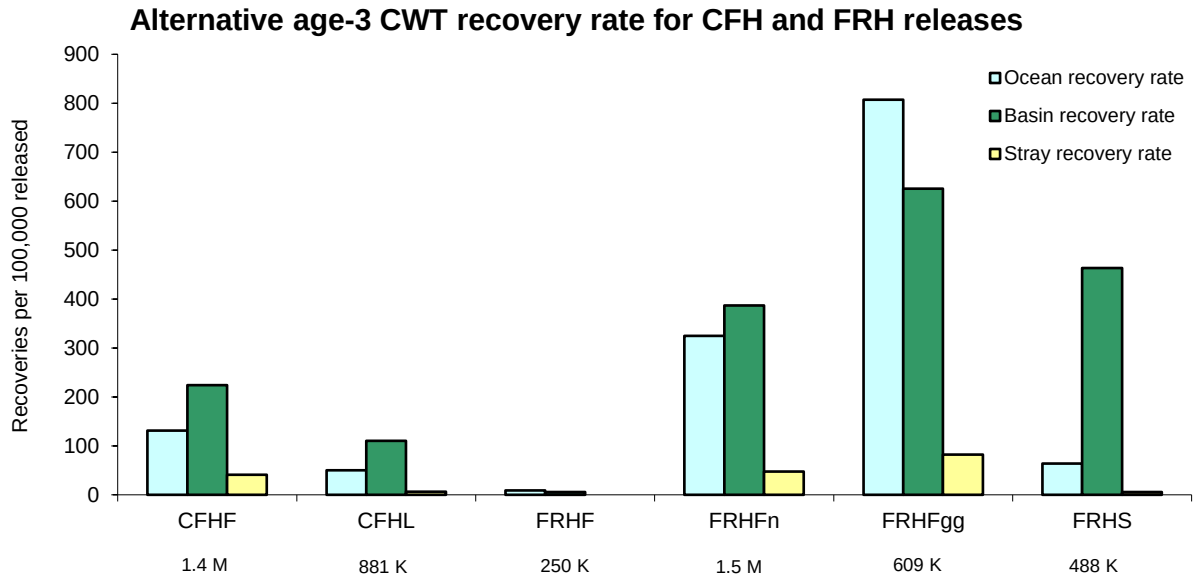
Sacramento River fall Chinook release types (SFC)

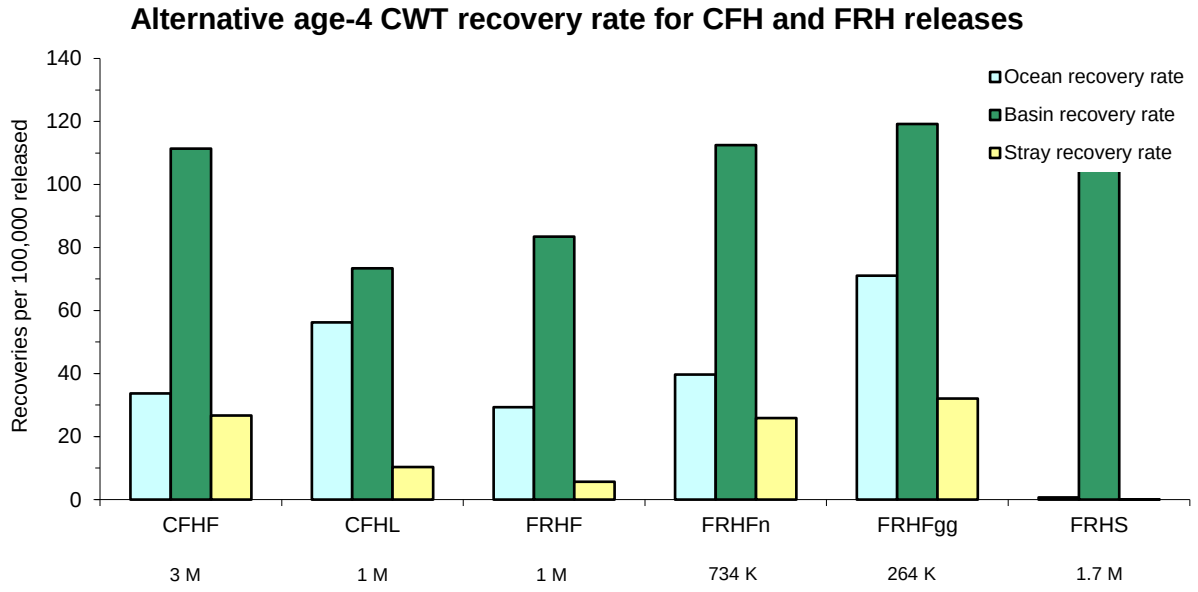
CFHF Coleman National Fish Hatchery fall in-basin releases
FRHF Feather River Hatchery fall in-basin releases
FRHFn Feather River Hatchery fall bay/delta net pen releases
FRHFgg Feather River Hatchery fall Golden Gate releases (no net pens)

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 2020.

Appendix 4. Comparison of raw CWT recoveries by release type between fish sampled in natural areas above and below the NIM weir in 2020.

Release type	Run type	# CWT recoveries above NIM weir	% of total above NIM weir	# CWT recoveries below NIM weir	% of total below NIM weir
FRHS	Spring	0	-	1	<1%
SJOSx	Spring	1	<1%	0	-
CFHF	Fall	0	-	0	-
CFHFe	Fall	0	-	0	-
FRHF	Fall	0	-	0	-
FRHFn	Fall	65	7%	56	3%
FRHFgg	Fall	39	4%	39	2%
FRHFk	Fall	0	-	0	-
NIMF	Fall	106	11%	171	8%
NIMFn	Fall	291	31%	1,164	54%
MOKF	Fall	8	1%	6	<1%
MOKFn	Fall	193	21%	390	18%
MOKFnc	Fall	143	15%	212	10%
MOKFgg	Fall	30	3%	44	2%
MERF	Fall	0	-	0	-
MERFn	Fall	51	6%	75	3%
	Total	927		2,158	

Appendix 5. Sample expansion for CWTs recovered in the Yuba River above Daguerre Point Dam (DPD) in 2020.

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

Escapement N	Chinook sampled (n)	Sample rate	Observed ad-clips	Ad-clips processed	CWTs recovered	Valid CWTs	*p_adc*	*p_cwt|adc*	F_{samp}	Avg F_{prod}	$\sum_{i=1}^{m} CWT_{total,i}$	% hatchery
3,846	**3,789**	**99%**	**601**	**45**	**42**	**42**	**0.159**	**0.933**	**13.56**	**3.06**	**1,338**	**35%**
Video count			Video count		Carcass survey							

DPD video count	Total	% ad-clip
No clip	3,188	
Ad-clip	601	15.9%
Unknown clip	57	
Total	3,846	

Appendix 6. Sample expansion for CWTs recovered in the Mokelumne River above Woodbridge Dam (WD) in 2020.

	Total count	Total ad-clips	% ad-clip
Woodbridge Dam video	4,044	1,073	26.5%
Mokelumne River Hatchery return	3,443	911	26.5%
Mokelume River natural escapement	**601**	**162**	27.0%

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

Escapement N	Chinook sampled (n)	Sample rate	Observed ad-clips	Ad-clips processed	CWTs recovered	Valid CWTs	*p_adc*	*p_cwt|adc*	F_{samp}	Avg F_{prod}	$\sum_{i=1}^{m} CWT_{total,i}$	% hatchery
601	601	100%	**162**	**5**	**4**	**4**	**0.270**	**0.800**	**32.40**	**2.54**	**3,187**	**530%**
Video count			Video count		Carcass survey							