Recovery of Coded-Wire Tags from Chinook Salmon in California's Central Valley Escapement, Inland Harvest, and Ocean Harvest in 2017

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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 eighth annual report on the recovery of CFM CWTs in the CV and ocean fisheries. In 2017, approximately 32,400 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 ocean salmon commercial and sport fisheries south of Cape Falcon (i.e., California and 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 annual CFM reports (Kormos et al. 2012, Palmer and Kormos 2013, 2015) for more in-depth information and discussion regarding the CFM program, CWT marking and recovery programs in California, and the methods and analyses used in this report. Additional information on salmon escapement monitoring can be found in the Central Valley Chinook Salmon Escapement Monitoring Plan (Bergman et al. 2012) and other CV salmon population reports (e.g., Killam and Mache 2018, PSMFC 2018).

DATA AND METHODS

Inland Escapement and River Sport Harvest Monitoring

During 2017, 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 2018 return year, however the escapement monitoring period began in late 2017.

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 2017 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 147,600 Chinook salmon that returned to the CV basins analyzed in this report, 81,800 salmon were sampled, 27,300 ad-clipped salmon were observed, and 25,200 heads were collected by various CV projects. 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, U.S. Bureau of Reclamation, U.S. Fish and Wildlife Service (FWS), and the Yuba Accord River Management Team (YARMT). Most heads were processed by CDFW at their Santa Rosa and Sacramento CWT labs, except for 5,500 heads collected at CFH, which were processed by FWS staff, and several hundred heads collected and processed by CDFW projects in Red Bluff and La Grange.

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 2017, California sport and commercial ocean salmon fisheries (Table 2) were highly constrained compared to most years primarily due to a sharp decrease in the abundance of Klamath River fall-run Chinook salmon. The poor status of this stock resulted in complete fishery closures off northern California and southern Oregon, and extremely limited seasons southward through the San Francisco Bay Area. Salmon fisheries in Monterey Bay and south were also highly constrained mostly due to protections that were enacted for Sacramento River winter-run Chinook salmon. Of the approximately 104,500 salmon harvested in California ocean fisheries during 2017, CDFW field staff sampled over 27,700 salmon and collected over 7,200 heads that were processed by the Santa Rosa CWT lab. Almost 700 heads collected in Oregon ocean sport and commercial fisheries during 2017 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 2017 inland and ocean CWT recoveries are publicly available on the RMPC website at www.rmpc.org.

CWT Data Analysis

A master release database of CWT codes recovered in 2017 was created to determine species, brood year, run, stock origin (hatchery or natural), release site, release date(s), number of salmon CWT tagged, 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 2012 through 2015 were downloaded from the RMPC. Approximately 132 million CV salmon were released for these brood years, of which 47 million were marked and tagged utilizing 370 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 2017, there were 257 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,

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

where Ad.CWT is the number of salmon released with ad-clips and CWTs, Ad.noCWT is the number of salmon released with ad-clips but without CWTs (i.e., shed tags prior to release or CWT not correctly inserted), noAd.CWT is the number of salmon released without ad-clips but with CWTs, and noAd.noCWT is the number of salmon released without ad-clips and without CWTs. F_{prod} allows expansion to total hatchery production from observed recoveries of CV CWTs. 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 holding strategy. All CV CWT codes were assigned by brood year into one of seventeen fall-run release types, two spring-run release types, one winter-run release type, or two late-fall-run release types:

Sacramento River Basin Fall-run Chinook salmon release types:

CFHFh Coleman National Fish Hatchery **F**all-run **h**atchery releases (in-basin)
CFHFn Coleman National Fish Hatchery **F**all-run bay/delta **n**et pen releases

FRHF Feather River Hatchery **F**all-run in-basin releases
FRHFn Feather River Hatchery **F**all-run bay/delta **n**et pen releases
FRHFnc Feather River Hatchery **F**all-run **c**oastal **n**et pen releases (Pillar Point)
FRHFtib Feather River Hatchery **F**all-run **Tib**uron net pen releases
FRHFb Feather River Hatchery **F**all-run **b**arge study releases
FRHFk Feather River Hatchery **F**all-run **K**naggs Ranch experimental releases
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 (various sites)
MOKFb Mokelumne River Hatchery **F**all-run **b**arge study releases
MOKFx Mokelumne River Hatchery **F**all-run e**x**perimental releases (raised Merced Hatchery)
MERFn Merced River Hatchery **F**all-run bay/delta **n**et pen releases
MERFt Merced River Hatchery **F**all-run **t**rucked releases (no net pen acclimation)

Sacramento River Winter-run Chinook salmon release type:
SacW Sacramento River **W**inter-run supplementation natural production releases (in-basin)

Central Valley Spring-run Chinook salmon release types:
FRHS Feather River Hatchery **S**pring-run in-basin releases
FRHSn Feather River Hatchery **S**pring-run bay/delta **n**et pen releases

Central Valley Late-fall-run Chinook salmon release types:
CFHLh Coleman National Fish Hatchery **L**ate-fall-run **h**atchery releases (in-basin)
CFHLe Coleman National Fish Hatchery **L**ate-fall-run **e**mergency releases (Balls Ferry)

Note that not all release types occur every year and that release sites sometimes vary within a given release type (Table 3; Fig. 1). There were also a few problem CWT releases where fish were released utilizing more than one strategy (e.g., only half of brood year 2014 coastal MOKFnc was released into Moss Landing net pens while the other half was released into bay/delta net pens). 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 sampled and visually examined for an ad-clip, f_a is the fraction of heads from ad-clipped salmon collected and

processed, and f_d is the fraction of observed CWTs that were successfully decoded (Tables 4 and 5).

Salmon sampled in CV carcass surveys are generally classified as 'fresh' or 'non-fresh' based on criteria such as condition of the eyes (clear vs. opaque) or gills (pink vs. grey). Often the ad-clipped (marked) status of a non-fresh (i.e., decayed) salmon cannot be determined due to the deteriorating condition of the carcass. While condition criteria are somewhat ambiguous and classification may vary among surveys, the ad-clip rate of fresh salmon sampled in 2017 was generally higher or similar to the rate observed in non-fresh fish (Appendix 1). Fresh carcass heads also contained CWTs at a slightly higher rate than heads collected from non-fresh fish. 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:

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

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:

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

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, 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 2017 CV inland recoveries and California ocean harvest

All of the 24,700 valid CWTs recovered in the CV during 2017 were from CV Chinook salmon releases. Most CWTs were brood year 2013 through 2015 releases (Table 6). A small number of CWT recoveries (n=9) were removed from CFM analyses because they were age-1 and/or part of experimental releases by the San Joaquin River Restoration Program (SJRRP). About 94% of all CWT_{total} were fall-run, followed by late-fall-run (4%) and spring-run (1%) salmon releases. Less than 1% of CWT_{total} were winter-run, all of which were collected in the upper Sacramento River winter- and late-fall-run carcass surveys, and the Keswick Dam Fish Trap (KES), where natural winter-run fish are collected for broodstock purposes at Livingston Stone National Fish Hatchery. The majority of fall-run CWT_{total} recovered in the CV were age-3 (53%), age-2 (43%), and age-4 (4%) fish.

Most of the 7,000 valid CWT recoveries (tagged natural-origin and experimental SJRRP fish removed; n=8) in the 2017 California ocean harvest were CV salmon releases belonging to brood years 2013 through 2015 (Table 7). Approximately 97% of all CWT_{total} in the ocean harvest were CV fall-run, followed by CV late-fall-run (1%), CV spring-run (0.4%), and CV winter-run (0.4%) salmon. The remaining 1% of California ocean CWT recoveries originated primarily from the Klamath-Trinity Basin and Smith River in northern California, the Rogue and Elk rivers in Oregon, and the Columbia River Basin. Most of the hatchery-origin fish in the California ocean harvest were age-3 (56%) and age-2 (41%) fish.

Over one-third of the 600 valid CWT recoveries (age-6 removed; n=6) in the 2017 Oregon ocean harvest were CV salmon releases (Table 8). Approximately 38% of all CWT_{total} in the ocean harvest were CV fall-run salmon; no other CV run types were recovered. Non-CV stocks made up 62% of the CWT_{total} harvest with most originating from the Columbia River Basin, coastal streams in Oregon, and the Klamath-Trinity Basin. Most of the hatchery fish in the Oregon ocean harvest were age-3 (76%) and age-4 (18%) fish.

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

During 2017, approximately 37,500 fall-run Chinook salmon returned to spawn in the CV natural areas included in these analyses (Table 9, Fig. 2). There were an additional 3,900 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 hatchery proportion occurred in Butte Creek (0%), while the highest proportion (98%) occurred in the Stanislaus River. The second highest hatchery proportion occurred in the Feather River (92%). The total CV fall-run hatchery proportion for all natural areas that were adequately sampled during 2017 was 81%.

The only upper Sacramento Basin tributary that is included in these analyses is Battle Creek fall-run, 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 58,200 fall-run salmon returning to the five CV hatcheries and KES ranged from 49% to 97% (Table 9, Fig. 3). The fall-run hatchery proportion for all CV hatcheries combined was 94%. The spring-run return to FRH was almost entirely hatchery-origin fish (98%), while the late-fall-run return to CFH was 100% hatchery-origin salmon.

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 (FRH) spring-run releases, Yellow = Sacramento River winter-run releases, and Orange = Central Valley (CFH) 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. Experimental barge study and Knaggs Ranch rice field study releases are designated with straight and wavy horizontal stripes, respectively. In-basin releases do not have any pattern.

Upper Sacramento River Basin

At CFH, sampling of the fall-run return began in early October and continued through late November 2017. All ad-clipped salmon were sampled during the entire run. CFH began late-fall-run sampling five weeks after fall-run sampling ceased and continued through mid-March 2018. For the interim five weeks, and even the last month of fall-run spawning, there was overlap between runs and FWS staff parsed them out based on CWT recoveries. As a result, the final escapement was 6,396 fall-run and 3,906 late-fall-run salmon. Due to low counts of fall-run salmon at CFH during early October and to promote genetic integrity, an additional 111 fall-run salmon (93 unmarked) were collected at KES in the mainstem Sacramento River and transported to CFH as supplemental broodstock. In addition, 18 late-fall-run salmon (16 unmarked) were collected at KES and transported to CFH for spawning to promote genetic integrity. Only one additional late-fall-run salmon was trapped at CFH after spawning operations ended in mid-March 2018, and none were observed via the video weir. Thus, the CFH late-fall-run fish trap data, which is usually reported separately, has been merged with the CFH late-fall-run hatchery return data for this report.

Fall-run returns to CFH and fall spawners in Battle Creek were predominantly hatchery-origin salmon, and late-fall-run returns to CFH were entirely hatchery-origin. Natural-origin spawners comprised most of the fall and late-fall returns to KES and the upper Sacramento River mainstem. Winter-run spawners in the upper Sacramento River were primarily hatchery-origin fish (Figs. 5, 6). The proportion of hatchery-origin fish (prevalent release type[s] shown in parentheses) at each of the following locations was:

- Fall-run returns CFH: 87% (CFHFh)
- Late-fall-run returns CFH: 100% (CFHLh)
- Fall-run supplemental spawners KES: 49% (CFHFh)
- Late-fall-run supplemental spawners KES: 11% (CFHLh)
- Winter-run spawners upper Sacramento River: 82% (SacW)
- Fall-run spawners upper Sacramento River: 21% (CFHFn, CFHFh)
- Late-fall-run spawners upper Sacramento River: 12% (CFHLh)
- Fall-run spawners Battle Creek: 86% (CFHFh)

Butte Creek and Feather River Basin

Spring- and fall-run returns to FRH and spawners in the Feather and Yuba rivers were predominantly hatchery-origin, while both spring- and fall-run spawners in Butte Creek were entirely natural-origin (Figs. 7, 8). Unlike most prior reports, the Yuba River escapement below and above Daguerre Point Dam (DPD) was combined in 2017 because the estimate below DPD was only 20 fish (PSMFC 2018). The proportion of hatchery-origin fish (prevalent release type[s] shown in parentheses) at each of the following locations was:

- Spring-run spawners Butte Creek: 0%
- Fall-run spawners Butte Creek: 0%

- Spring-run returns FRH: 98% (FRHS)
- Fall-run returns FRH: 97% (FRHFn)
- Fall/spring-run spawners Feather River: 92% (FRHFn)
- Fall/spring-run spawners Yuba River: 87% (CFHFn)

Appendix 4 provides the F_{samp} calculations for the Yuba River, which was based on ad-clips observed via video above DPD and visual counts below DPD, combined with 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), while "washbacks" collected on the NIM weir were mostly natural-origin salmon. In 2017, NIM opened three weeks early to collect stray CFH fall-run spawners, which were expected to stray into the American River in high numbers due to the age-3 year class being entirely released into bay/delta net pens. The proportion of hatchery-origin fish (prevalent release type[s] shown in parentheses) at each of the following locations was:

- Fall-run returns NIM: 90% (NIMFn, CFHFn)
- Fall-run spawners American River: 77% (CFHFn, NIMFn)
- Fall-run returns NIM weir: 40% (CFHFn)

Mokelumne River Basin

The 2017 fall-run return to the Mokelumne River Basin was the largest on record (Del Real and Hunter 2018, PFMC 2020). Returns to MOK and spawners in the Mokelumne River were predominantly hatchery-origin salmon (Fig. 10). The proportion of hatchery-origin fish (prevalent release type[s] shown in parentheses) at each of the following locations was:

- Fall-run returns MOK: 94% (MOKFn)
- Fall-run spawners Mokelumne River: 86% (MOKFn, NIMFn)

Appendix 5 provides the F_{samp} calculations 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. There were weekly high pulse flow events throughout much of the spawning period in 2017 (Del Real and Hunter 2018), which likely hampered carcass recovery efforts.

Merced River and other San Joaquin Basin tributaries

Fall-run returns to MER and spawners in the Merced, Stanislaus, and Tuolumne rivers were predominantly hatchery-origin salmon (Fig. 11). The proportion of hatchery-origin fish (prevalent release type[s] shown in parentheses) at each of the following locations was:

- Fall-run returns MER: 96% (MOKFn)
- Fall-run spawners Merced River: 87% (MOKFn, CFHFn)
- Fall-run spawners Stanislaus River: 98% (MOKFn)
- Fall-run spawners Tuolumne River: 87% (MOKFn)

2. Contribution of CV Release Types to Total Salmon Escapement

In 2017, 88% of the 102,800 salmon that returned to the CV hatcheries and natural areas included in these analyses were hatchery-origin fish (Tables 9, 10). Of all hatchery release types, fall-run bay/delta net pen releases contributed the most to total CV escapement: FRHFn (31%), MOKFn (16%), NIMFn (11%), and CFHFn (10%). Bay/delta CFHFn, MOKFn, and NIMFn had the highest numbers of strays, while bay/delta CFHFn and MERFn had the highest rates of straying. About a third of all recoveries occurred outside their basin-of-origin and ranged from 0% to 98%, depending on release type:

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

R_{type}	Run	CWT_{total}	% total	# Stray	% stray
CFHFh	Fall	5,923	6%	4	<1%
CFHFn	Fall	9,884	10%	9,726	98%
FRHF	Fall	44	<1%	0	0%
FRHFn	Fall	31,908	31%	2,717	9%
FRHFnc	Fall	2,884	3%	399	14%
FRHFb	Fall	65	<1%	3	5%
FRHFk	Fall	21	<1%	0	0%
NIMF	Fall	373	<1%	4	1%
NIMFn	Fall	10,874	11%	4,669	43%
MOKF	Fall	246	<1%	73	30%
MOKFn	Fall	16,262	16%	6,938	43%
MOKFnc	Fall	2,843	3%	915	32%
MOKFb	Fall	1,299	1%	398	31%
MERFn	Fall	1,654	2%	1,206	73%
FRHS	Spring	1,046	1%	1	<1%
FRHSn	Spring	175	<1%	0	0%
SacW	Winter	834	1%	0	0%
CFHLh	Late-fall	4,031	4%	20	<1%
	Total	90,366	88%	27,073	30%

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

In 2017, 81% of the 41,600 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: 76% (CFHFh)
- Lower Sacramento River fall-run harvest: 66% (FRHFn, NIMFn, CFHFn, MOKFn)
- Feather River fall-run harvest: 88% (FRHFn)
- American River fall-run harvest: 86% (CFHFn, NIMFn, FRHFn, MOKFn)
- Mokelumne River fall-run harvest: 82% (MOKFn, NIMFn)
- Upper Sacramento River late-fall-run harvest: 72% (CFHLh)

Of all hatchery release types, FRHFn contributed the most (33%) to the total CV sport harvest, followed by CFHFn (14%) and NIMFn (11%). In-basin releases were primarily harvested in their basin-of-origin or the lower Sacramento River (which all CV stocks must traverse before reaching their basin-of-origin), with the only exceptions being a small number of MOKF and CFHLh harvested out-of-basin. Conversely, net pen releases were harvested out-of-basin at considerably higher rates, and it is worth noting that very few of them were harvested in the upper Sacramento River including zero CFHFn which originated from there (Tables 9, 10).

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

R_{type}	Run	CWT_{total}	% harvest
CFHFh	Fall	2,333	6%
CFHFn	Fall	6,012	14%
FRHF	Fall	93	<1%
FRHFn	Fall	13,534	33%
FRHFnc	Fall	845	2%
FRHFb	Fall	12	<1%
FRHFk	Fall	0	0%
NIMF	Fall	520	1%
NIMFn	Fall	4,419	11%
MOKF	Fall	131	<1%
MOKFn	Fall	3,174	8%
MOKFnc	Fall	763	2%
MOKFb	Fall	243	1%
MERFn	Fall	464	1%
FRHS	Spring	70	<1%
FRHSn	Spring	0	0%
SacW	Winter	0	0%
CFHLh	Late-fall	885	2%
	Total	33,498	81%

4a. 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 2013 through 2015 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 only a 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 2017. 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 acclimated in bay/delta and coastal net pens generally had higher CV recovery rates than their respective in-basin releases, but net pen releases also had higher stray rates than their in-basin counterparts in most cases.

Age-2 CV Escapement Recovery and Stray Rates

R_{type}	Brood year	Run	# Recoveries per 100K Released	# Strays per 100K Released	% stray
CFHFh	2015	Fall	45	<0.1	0.1%
FRHF	2015	Fall	5	0	0%
FRHFn	2015	Fall	169	13	8%
FRHFk	2015	Fall	21	0	0%
NIMF	2015	Fall	13	0.1	1%
NIMFn	2015	Fall	107	40	37%
MOKF	2015	Fall	19	1	6%
MOKFn	2015	Fall	201	73	36%
MOKFnc	2015	Fall	502	151	30%
MOKFb	2015	Fall	428	132	31%
MERFn	2015	Fall	272	199	73%
MERFt	2015	Fall	245	163	66%
FRHS	2015	Spring	32	0.1	0.2%
SacW	2015	Winter	75	0	0%
CFHLh	2016	Late-fall	526	3	1%
CFHLe	2016	Late-fall	0	0	-

Age-3 CV Escapement Recovery and Stray Rates

R_{type}	Brood year	Run	# Recoveries per 100K Released	# Strays per 100K Released	% stray
CFHFn	2014	Fall	76	74	98%
FRHFn	2014	Fall	409	37	9%
FRHFnc	2014	Fall	791	108	14%
FRHFk	2014	Fall	2	0	0%
NIMFn	2014	Fall	228	103	45%
MOKFn	2014	Fall	108	59	55%
MOKFnc	2014	Fall	167	76	46%
MOKFx	2014	Fall	29	7	24%
MERFn	2014	Fall	68	63	92%
MERFt	2014	Fall	35	33	96%
FRHS	2014	Spring	14	0	0%
SacW	2014	Winter	81	0	0%
CFHLh	2015	Late-fall	151	0	0%
CFHLe	2015	Late-fall	0.2	0	0%

Age-4 CV Escapement Recovery and Stray Rates

R_{type}	Brood year	Run	# Recoveries per 100K Released	# Strays per 100K Released	% stray
CFHFh	2013	Fall	9	0	0%
CFHFn	2013	Fall	13	13	100%
FRHFn	2013	Fall	14	1	8%
FRHFnc	2013	Fall	72	11	16%
FRHFb	2013	Fall	21	1	5%
FRHFk	2013	Fall	0	0	-
NIMFn	2013	Fall	12	2	17%
MOKFn	2013	Fall	3	2	86%
MOKFnc	2013	Fall	0.4	0	0%
MOKFb	2013	Fall	1	0	0%
MERFt	2013	Fall	0.3	0.3	100%
FRHS	2013	Spring	9	0	0%
FRHSn	2013	Spring	17	0	0%
SacW	2013	Winter	12	0	0%
CFHLh	2014	Late-fall	10	0.1	1%

4b. Relative Recovery Rate of CV Release Types in the Ocean Harvest

The total recovery rate of CV hatchery releases in all California and Oregon ocean salmon sport and commercial 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 2017 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
CFHFh	2015	Fall	18	94%
FRHF	2015	Fall	8	82%
FRHFn	2015	Fall	134	95%
FRHFk	2015	Fall	7	49%
NIMF	2015	Fall	25	96%
NIMFn	2015	Fall	131	89%
MOKF	2015	Fall	5	100%
MOKFn	2015	Fall	172	93%
MOKFnc	2015	Fall	839	93%
MOKFb	2015	Fall	343	97%
MERFn	2015	Fall	159	94%
MERFt	2015	Fall	146	96%
FRHS	2015	Spring	12	93%
CFHLh	2016	Late-fall	11	95%
CFHLe	2016	Late-fall	14	100%

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

R_{type}	Brood year	Run	# Recoveries per 100K Released	% sport
CFHFn	2014	Fall	104	38%
FRHFn	2014	Fall	309	36%
FRHFnc	2014	Fall	980	41%
FRHFk	2014	Fall	9	0%
NIMFn	2014	Fall	193	39%
MOKFn	2014	Fall	151	33%
MOKFnc	2014	Fall	351	31%
MOKFx	2014	Fall	34	21%
MERFn	2014	Fall	18	0%
MERFt	2014	Fall	12	48%
FRHS	2014	Spring	2	100%
SacW	2015	Winter	66	83%
CFHLh	2015	Late-fall	46	58%
CFHLe	2015	Late-fall	4	25%

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

R_{type}	Brood year	Run	# Recoveries per 100K Released	% sport
CFHFh	2013	Fall	2	16%
CFHFn	2013	Fall	12	14%
FRHFn	2013	Fall	7	21%
FRHFnc	2013	Fall	76	24%
FRHFb	2013	Fall	9	30%
FRHFk	2013	Fall	0	-
NIMFn	2013	Fall	12	43%
MOKFn	2013	Fall	2	0%
MOKFnc	2013	Fall	19	9%
MOKFb	2013	Fall	7	31%
MERFt	2013	Fall	0	-
FRHS	2013	Spring	1	100%
FRHSn	2013	Spring	0	-
SacW	2014	Winter	0	-
CFHLh	2014	Late-fall	4	53%

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

More than two-thirds of the 126,400 Chinook salmon harvested in all California and Oregon ocean salmon fisheries were hatchery-origin fish (Fig. 17). The most prevalent CV release types recovered in both states were fall-run net pen releases.

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

R_{type}	Run	CWT_{total}	% harvest
CFHFh	Fall	2,341	2%
CFHFn	Fall	13,259	10%
FRHF	Fall	75	<1%
FRHFn	Fall	24,400	19%
FRHFnc	Fall	3,529	3%
FRHFb	Fall	27	<1%
FRHFk	Fall	10	<1%
NIMF	Fall	687	1%
NIMFn	Fall	9,844	8%
MOKF	Fall	220	<1%
MOKFn	Fall	16,870	13%
MOKFnc	Fall	4,968	4%
MOKFb	Fall	1,058	1%
MERFn	Fall	897	1%
Other CV	Non-fall	994	1%
NonCV		7,620	6%
	Total	86,799	69%

California ocean sport fishery

California anglers harvested approximately 62,200 Chinook salmon in the ocean sport fishery during 2017. The total contribution of hatchery-origin salmon to the California ocean sport fishery was 75%, ranging from 62% to 81% of the total harvest among major port area (Fig. 18). Most of the harvest occurred in San Francisco (86%), followed by Monterey (11%) and Fort Bragg (3%) port areas (Table 12). The Eureka-Crescent City port area was closed to salmon fishing in 2017.

Of all hatchery release types, FRHFn contributed the most (24%) to the total California ocean sport harvest, followed by MOKFn (18%). Non-CV releases contributed less than 1% to the total harvest (Table 13).

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

R_{type}	Run	CWT_{total}	% harvest
CFHFh	Fall	2,127	3%
CFHFn	Fall	4,766	8%
FRHF	Fall	62	0%
FRHFn	Fall	15,134	24%
FRHFnc	Fall	1,408	2%
FRHFb	Fall	8	<1%
FRHFk	Fall	3	<1%
NIMF	Fall	660	1%
NIMFn	Fall	4,657	7%
MOKF	Fall	59	<1%
MOKFn	Fall	11,047	18%
MOKFnc	Fall	4,045	7%
MOKFb	Fall	1,008	2%
MERFn	Fall	802	1%
FRHS	Spring	278	<1%
SacW	Winter	231	<1%
CFHLh	Late-fall	287	<1%
NonCV		329	1%
	Total	46,913	75%

California ocean commercial fishery

California trollers harvested over 42,300 Chinook salmon in the ocean commercial fishery during 2017. The total contribution of hatchery-origin salmon to the California ocean commercial fishery was 69%, ranging from 55% to 73% of the total harvest depending on major port area (Fig. 19). Most of the harvest occurred in San Francisco (66%), followed by Monterey (29%) and Fort Bragg (5%) port areas (Table 14). The Eureka-Crescent City port area was closed to salmon fishing in 2017.

Of all hatchery release types, FRHFn contributed the most (20%) to the total California commercial harvest, followed by CFHFn (18%), MOKFn (11%), and NIMFn (11%). Non-CV releases contributed about 2% to the total harvest (Table 15).

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

R_{type}	Run	CWT_{total}	% harvest
CFHFh	Fall	192	<1%
CFHFn	Fall	7,587	18%
FRHF	Fall	13	<1%
FRHFn	Fall	8,309	20%
FRHFnc	Fall	1,948	5%
FRHFb	Fall	9	<1%
FRHFk	Fall	7	<1%
NIMF	Fall	27	<1%
NIMFn	Fall	4,525	11%
MOKF	Fall	119	<1%
MOKFn	Fall	4,706	11%
MOKFnc	Fall	845	2%
MOKFb	Fall	41	<1%
MERFn	Fall	87	<1%
FRHS	Spring	17	<1%
SacW	Winter	48	<1%
CFHLh	Late-fall	132	<1%
NonCV		676	2%
	Total	29,288	69%

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

In 2017, CWTs from many fall-run experimental and net pen release types were recovered in the CV escapement, river sport fishery, and ocean harvest, and this section will focus on those from brood years 2013 through 2015 (ages 2-4). Experimental releases include barge studies that utilized approximately 900,000 fall-run salmon from two different hatcheries (FRH and MOK), and rice field studies at Knaggs Ranch that utilized almost 200,000 fall-run from FRH. Additionally, low spawner returns to MER during fall 2014 required the use of supplemental fall-run eggs from MOK to ensure minimum hatchery production numbers were met. Almost 600,000 smolts were produced from these transported eggs and designated experimental MOKFx. Recoveries of these age-3 CWTs in either the Mokelumne or Merced basins were considered in-basin recoveries for this report.

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 (MBTSP) in Santa Cruz and Moss Landing. It should be noted that in 2015, MBTSP moved their net pen operations to Moss Landing due to operational issues with the Santa Cruz Port District. After receiving and releasing their first group of brood year 2014 fall-run salmon from MOK (120,000 salmon), it was determined that MBTSP did not have the proper permits to release salmon in the Moss Landing area so the remaining 120,000 fish with the same CWT code were instead released into bay/delta net pens.

The experimental and net pen releases recovered in 2017 are differentiated into the following release types:

- CFHFn Coleman National Fish Hatchery **F**all-run bay/delta **n**et pens

- FRHFbb Feather River Hatchery **F**all-run **b**arge study: trucked and released in SF **B**ay
- FRHFbg Feather River Hatchery **F**all-run **b**arge study: bar**g**ed to SF Bay and released
- FRHFbr Feather River Hatchery **F**all-run **b**arge study: released in-**r**iver (Sac R)

- FRHFkc Feather River Hatchery **F**all-run rice field study: Elkhorn Boat Ramp (**K**naggs **c**ontrol)
- FRHFkr Feather River Hatchery **F**all-run rice field study: **K**naggs **R**anch (Yolo Bypass)

- FRHFn Feather River Hatchery **F**all-run bay/delta **n**et pens

- FRHFnp Feather River Hatchery **F**all-run coastal **n**et pens – **P**illar Point

- NIMFn Nimbus Fish Hatchery **F**all-run bay/delta **n**et pens

- 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)

- 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/Moss Landing

- MOKFx Mokelumne River Hatchery **F**all-run e**x**perimental: raised at Merced Hatchery

- 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
FRHFkc	2015	Fall	36	0	0%
FRHFkr	2015	Fall	6	0	0%
FRHFn	2015	Fall	169	13	8%
NIMFn	2015	Fall	107	40	37%
MOKFbb	2015	Fall	499	198	40%
MOKFbg	2015	Fall	722	197	27%
MOKFbr	2015	Fall	64	0	0%
MOKFn	2015	Fall	201	73	36%
MOKFnp	2015	Fall	502	151	30%
MERFn	2015	Fall	272	199	73%

Age-3 CV Escapement Recovery and Stray Rates

R_{type}	Brood year	Run	# Recoveries per 100K Released	# Strays per 100K Released	% stray
CFHFn	2014	Fall	76	74	98%
FRHFkr	2014	Fall	2	0	0%
FRHFn	2014	Fall	409	37	9%
FRHFnp	2014	Fall	791	108	14%
NIMFn	2014	Fall	228	103	45%
MOKFx	2014	Fall	29	7	24%
MOKFn	2014	Fall	108	59	55%
MOKFns	2014	Fall	167	76	46%
MERFn	2014	Fall	68	63	92%

Age-4 CV Escapement Recovery and Stray Rates

R_{type}	Brood year	Run	# Recoveries per 100K Released	# Strays per 100K Released	% stray
CFHFn	2013	Fall	13	13	100%
FRHFbb	2013	Fall	27	3	11%
FRHFbg	2013	Fall	10	0	0%
FRHFbr	2013	Fall	25	0	0%
FRHFkr	2013	Fall	0	0	-
FRHFn	2013	Fall	14	1	8%
FRHFnp	2013	Fall	72	11	16%
NIMFn	2013	Fall	12	2	17%
MOKFbb	2013	Fall	2	0	0%
MOKFbg	2013	Fall	2	0	0%
MOKFbr	2013	Fall	0	0	-
MOKFn	2013	Fall	3	2	86%
MOKFns	2013	Fall	0.4	0	0%

Ocean Fishery Harvest

The total recovery rate of fall-run experimental and net pen releases in all California and Oregon ocean salmon sport and commercial fisheries varied by age and release type (Table 16, Fig. 21). A higher percentage of age-2 releases were recovered in the ocean sport fishery, again due to smaller size limits in effect during 2017 compared to the commercial fishery (Table 2).

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

R_{type}	Brood year	Run	# Recoveries per 100K Released	% sport
FRHFkc	2015	Fall	13	49%
FRHFkr	2015	Fall	0	-
FRHFn	2015	Fall	134	95%
NIMFn	2015	Fall	131	89%
MOKFbb	2015	Fall	503	97%
MOKFbg	2015	Fall	498	96%
MOKFbr	2015	Fall	28	100%
MOKFn	2015	Fall	172	93%
MOKFnp	2015	Fall	839	93%
MERFn	2015	Fall	159	94%

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

R_{type}	Brood year	Run	# Recoveries per 100K Released	% sport
CFHFn	2014	Fall	104	38%
FRHFkr	2014	Fall	9	0%
FRHFn	2014	Fall	309	36%
FRHFnp	2014	Fall	980	41%
NIMFn	2014	Fall	193	39%
MOKFx	2014	Fall	34	21%
MOKFn	2014	Fall	151	33%
MOKFns	2014	Fall	351	31%
MERFn	2014	Fall	18	0%

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

R_{type}	Brood year	Run	# Recoveries per 100K Released	% sport
CFHFn	2013	Fall	12	14%
FRHFbb	2013	Fall	2	0%
FRHFbg	2013	Fall	8	100%
FRHFbr	2013	Fall	17	0%
FRHFkr	2013	Fall	0	-
FRHFn	2013	Fall	7	21%
FRHFnp	2013	Fall	76	24%
NIMFn	2013	Fall	12	43%
MOKFbb	2013	Fall	0	-
MOKFbg	2013	Fall	20	31%
MOKFbr	2013	Fall	0	-
MOKFn	2013	Fall	2	0%
MOKFns	2013	Fall	19	9%

2017 CFM ANALYSES KEY POINTS

- During 2012 through 2016, California experienced a severe drought, with the 2012 through 2014 period being the driest in the state's history. All brood years covered in this report were affected as juvenile outmigrants during this drought as they were subjected to high temperatures and low flows during their freshwater residency. Dewatering of eggs and/or pre-emergent fry loss was reported by numerous CV projects during this period, especially when minimum flow requirements were reduced in late fall. Pre-spawn mortality rates were also above normal in many rivers and streams. Due to these factors, natural-origin juvenile production was low for the broods that contributed most to escapement and fisheries in 2017 (PFMC 2019).

- To increase the survival of hatchery smolts to the ocean during the peak of the drought, state hatchery managers in the CV transported and released all of their fall-run salmon production for brood years 2013 and 2014 into bay/delta net pens. Federal hatchery managers at CFH, who historically released all of their fall-run production directly into Battle Creek in the upper Sacramento Basin where CFH is located, also transported and released two-thirds of brood year 2013 and all of their brood year 2014 fall-run production into bay/delta net pens. In 2017 there was some concern over the potential for high stray rates for hatchery-origin fall-run salmon, since these broods that were almost entirely planted offsite were returning to the CV at ages 3 and 4. Based on previously high stray rates (>90%) for offsite CFH releases, coupled with poor freshwater rearing and emigration conditions for these broods during the drought, there was special concern over the potential for low fall-run spawner returns in the upper Sacramento Basin. That potential was realized when a record-low number of fall-run returned to the upper Sacramento Basin, at only 10% of the long-term average (Killam and Mache 2018, PFMC 2020). This had a substantial effect on the river sport fishery as it redistributed a large amount of angling effort to the American and Feather rivers, resulting in a record-high river exploitation rate on Sacramento River Basin fall-run Chinook salmon in 2017 (PFMC 2019).

- The cumulative effects of the drought, straying outside of the basin, and possibly abnormal ocean conditions resulted in a 2017 escapement for Sacramento River Basin fall-run Chinook salmon that was about one-third of the federal conservation objective and the second-lowest on record. It was the third consecutive year of poor spawner returns for this stock, and due to its continued decline and the severity of the escapement shortfall it met the federal criteria for overfished status after the 2017 escapement (PFMC 2019). At the time of this report's publication in 2020, this stock was still overfished.

- A large majority (88%) of the total 2017 CV salmon escapement (all run-types) were hatchery-origin fish. This was the highest hatchery contribution since the CFM program was fully implemented, suggesting low natural-origin production for at least a portion of the broods that contributed to the 2017 escapement. Between 2010 and 2016, the hatchery contribution to the total CV escapement averaged 75% and ranged between 66% and 83%. FRH fall-run bay/delta releases composed almost one-third of the total 2017 CV escapement, and bay/delta fall-run releases from MOK, NIM, and CFH were the next highest contributors.

- Almost all (98%) expanded recoveries of CFH fall-run bay/delta releases occurred out-of-basin. MER fall-run offsite releases also strayed at a very high rate (73%), followed by NIM and MOK fall-run bay/delta releases which both strayed at 43%.

- This was the highest stray rate for NIM fall-run bay/delta releases since the CFM program was fully implemented, and the third consecutive year of higher than average stray rates. Between 2011 and 2014, stray rates for this release type ranged between 2% and 5%, but then increased sharply in 2015 to 25%, followed by 31% in 2016 and 43% in 2017. During those three years of increased straying, a large majority of those

strays returned to the Mokelumne River. It is possible that inter-annual variations in CV water operations, such as pulse flow events and management of the Delta Cross Channel, are influencing the degree to which NIM bay/delta releases stray outside of the American River. Fall pulse flows in the Mokelumne River were higher than average during 2016 and 2017 (Del Real and Hunter 2018, Del Real and Rible 2017).

- Salmon escapement into CV hatcheries was predominately hatchery-origin fish. At all CV hatcheries except MER, the majority of their return was composed of their respective releases. But a large proportion of the return to MER (82%) were fish from other hatcheries, particularly MOK fall-run bay/delta releases. The out-of-basin hatchery return at NIM was also quite high (47%), and almost half of those strays were CFH fall-run bay/delta releases. CDFW staff were prepared for this high influx of CFH-origin spawners due to the release strategies employed for the 2013 and 2014 broods, and NIM opened three weeks early to collect these strays due to the differential run timing between the CFH and NIM fall-run stocks.

- Most natural spawning areas had very high proportions of hatchery-origin fish, with the only exceptions being Butte Creek, washbacks on the NIM weir, and the upper Sacramento River fall- and late-fall-run escapements. Most of the hatchery-origin component in the Feather and Mokelumne rivers and Battle Creek consisted of release types from their respective hatcheries, whereas hatchery-origin spawners in natural areas of the American and Merced rivers were predominantly stray CFH and MOK fall-run bay/delta releases.

- Fall-run escapement in the upper Sacramento River mainstem was predominantly natural-origin salmon but was also the lowest escapement on record. The hatchery contribution in 2017 (21%) was the lowest since the CFM program was fully implemented. Between 2010 and 2016, the hatchery contribution in the upper Sacramento River mainstem averaged 48% and ranged between 27% and 68%. The low hatchery contribution during 2017 was likely due to extensive straying of CFH bay/delta releases into other basins further downstream. CFH bay/delta and in-basin releases each composed one-third of the hatchery-origin portion of the mainstem escapement. Due to the record-low number of spawners in the upper Sacramento Basin in 2017, relatively few fish were sampled in upper basin tributaries and only one CWT was recovered, so those tributaries were excluded from these analyses.

- Fall-run escapement to the natural spawning areas of the Feather River was predominantly hatchery-origin salmon. FRH bay/delta releases composed a large majority of the run, distantly followed by FRH coastal (Pillar Point) releases.

- Fall-run escapement in the Yuba River was predominantly hatchery-origin salmon with stray CFH bay/delta releases composing a majority of the run.

- Fall-run escapement to the natural spawning areas of the American River was predominantly hatchery-origin salmon, a third of which were stray CFH bay/delta releases, followed by NIM bay/delta releases. Conversely, washbacks on the NIM weir were predominantly natural-origin salmon, however fresh and non-fresh washbacks

were not differentiated which may underestimate the hatchery contribution (Mohr and Satterthwaite 2013).

- Fall-run escapement to the natural spawning areas of the Mokelumne River was predominately hatchery-origin salmon, primarily MOK bay/delta releases and stray NIM bay/delta releases.

- The natural area fall-run escapements in all sampled tributaries of the San Joaquin Basin south of the Mokelumne River (Stanislaus, Tuolumne, and Merced rivers) were predominantly hatchery-origin salmon with the majority being stray MOK bay/delta releases. The second-highest contributor was stray CFH bay/delta releases, particularly in the Merced River where it composed over a quarter of the run.

- For age-2 fall-run salmon, MOK coastal (Pillar Point), MOK barge study (excluding the in-river control group), MER bay/delta, and MER non-acclimated trucked releases had the highest CV escapement recovery rates for their cohort, however they also had high stray rates. Fall-run releases from MER, both those that were acclimated in net pens and those that were not, had the highest stray rates with approximately three-fourths and two-thirds of the age-2 return, respectively, spawning in non-natal basins, distantly followed by NIM bay/delta, MOK bay/delta, MOK barge study (excluding the in-river control group), and MOK coastal (Pillar Point) releases.

- For age-3 fall-run salmon, FRH coastal (Pillar Point), FRH bay/delta, and NIM bay/delta releases had the highest CV escapement recovery rates for their cohort. CFH bay/delta, MER non-acclimated trucked, and MER bay/delta releases from this cohort had extremely high stray rates approaching 100%.

- For age-4 fall-run salmon, FRH coastal (Pillar Point) had the highest CV escapement recovery rate for its cohort, distantly followed by FRH barge study, FRH bay/delta, CFH bay/delta, and NIM bay/delta releases. CFH bay/delta releases from this cohort returned entirely to non-natal basins (i.e., stray rate of 100%), as did the only age-4 MER non-acclimated trucked recovery. MOK bay/delta releases from this brood also strayed at a very high rate.

- Most (81%) of the total CV river sport harvest was of hatchery origin and predominantly composed of bay/delta fall-run releases from FRH, CFH, NIM, and MOK. A large majority (81%) of the river harvest recoveries of CFH fall-run bay/delta releases occurred in the American River sport fishery, which was the only fishery sector where in-basin hatchery fish did not compose a majority of the harvest.

- Approximately three-fourths and two-thirds of the California ocean sport and commercial harvest, respectively, was composed of hatchery-origin fish. Bay/delta fall-run releases from FRH, MOK, and CFH contributed heavily to the total harvest in both fisheries. Non-CV hatchery production contributed very little to California ocean harvest, however in 2017 ocean salmon fisheries off northern California were either closed or extremely limited, and that is the section of California coast where non-CV stocks typically have higher contributions to harvest.

- CV hatchery production contributed less to Oregon ocean harvest than is usually observed, although in 2017 salmon fishing was prohibited in federal waters off southern Oregon, and that is the section of Oregon coast where contacts with CV stocks are expected to be highest.

- Coastal fall-run releases from FRH and MOK had the highest ocean recovery rates among all release types and broods. Generally speaking, their ocean recovery rates were several times greater than the rates for bay/delta fall-run releases of the same cohort.

- Among the coastal net pen release locations, Pillar Point releases (MOK and FRH) had both the highest CV and ocean recovery rates. While recovery rates of Santa Cruz/Moss Landing releases (MOK) were not necessarily low, they were much lower than Pillar Point releases for cohorts that had both release types (i.e., 2013 and 2014 broods). However, as mentioned above, half of the brood year 2014 (age-3) Moss Landing net pen release group from MOK was actually released into bay/delta net pens after encountering permitting issues with Moss Landing fish releases. Most CV recoveries of coastal releases occurred in-basin.

- CV recoveries of late-fall- and spring-run releases were dominated by age-2 salmon. Since all late-fall-run hatchery production is released in-basin and all spring-run hatchery production has been released in-basin since brood year 2014 (age-3), the high preponderance of age-2 salmon in the CV spawner return suggests low outmigrant survival for these run types prior to brood year 2015, likely due to in-river drought conditions.

- Among age-2 barge study releases, salmon transported from MOK to San Francisco Bay for release both via barge and truck had much higher CV and ocean recovery rates than the in-river control group, but also had higher stray rates.

- Due to low river flows caused by drought conditions, there was no barge study conducted for brood year 2014 (age-3).

- Among age-4 barge study releases, salmon released as part of the Feather River barge study had much higher CV recovery rates than those released as part of the Mokelumne River barge study, and both exhibited minimal straying. Salmon transported via barge from MOK and the in-river control group from FRH had the highest ocean recovery rates among both of the barge studies conducted for this brood. There were no ocean recoveries of salmon transported via truck from MOK. Additionally, there were no recoveries whatsoever (CV or ocean) of this cohort's in-river control group from MOK for the second consecutive year, suggesting low outmigrant survival for this release type and brood.

- This is the first report in the series that has recovery data for non-experimental FRH fall-run in-basin releases (age-2), allowing for recovery and stray rate comparisons between in-basin and out-of-basin FRH fall-run releases from the same brood. Initial results for the 2015 brood suggest substantially lower survival for in-basin releases as

their CV and ocean recovery rates were only 5 and 8 CWTs per 100,000 released, respectively, compared to recovery rates of 169 and 134 CWTs per 100,000 released, respectively, for bay/delta releases. While there were very few inland CWT recoveries of these in-basin releases (n=13), they were all recovered in the Feather River whereas bay/delta releases from the same brood strayed at 8%.

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 seven 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 2017. It is highly probable that all the release types and broods in this report were affected by one of the most significant droughts in California history. 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. A need still exists to secure permanent and comprehensive inland and ocean funding for this marking, tagging, monitoring, and evaluation program. 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 in real-time, similar to the Klamath Basin fall-run Chinook salmon management process.

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LIST OF ACRONYMS AND ABBREVIATIONS

- Ad-clipped clipped adipose fin
- BOR U.S. Bureau of Reclamation
- BY Brood year
- CDFW California Department of Fish and Wildlife
- CFH Coleman National Fish Hatchery
- CFM Constant Fractional Marking
- CV California Central Valley
- CWT coded-wire tag
- DPD Daguerre Point Dam (Yuba River)
- DWR California Department of Water Resources
- EBMUD East Bay Municipal Utilities District
- FRH Feather River Hatchery
- FWS U.S. Fish and Wildlife Service
- MBTSP Monterey Bay Trout and Salmon Project
- 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
- SJRRP San Joaquin River Restoration Program
- 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 2017 CV Chinook hatchery escapement.

Sampling Location	Estimation and Sampling Methods	Agency
Hatchery Spawners		
Coleman National Fish Hatchery (CFH) Fall and Late-Fall (2018)	Direct count. All fish examined and bio-sampled[a/] for fin-clips, tags, marks. Access upstream of the hatchery closed Aug 1 - Sep 30. Fall-run period: Oct 3 - Nov 21, Late-fall-run period: Dec 27 - Mar 14. All ad-clipped fish sampled. Fish returning to CFH from late Oct through late Dec parsed into run-type based on CWT code recoveries and total run-type proportions by date. All unmarked phenotypic late-fall-run fish released into Battle Creek above CFH beginning Nov 21. After spawning operations ceased, one additional ad-clipped late-fall-run fish was trapped and sampled; none were observed via video weir. Grilse cutoff: 700 mm fall, 600 mm late-fall.	FWS
Keswick Fish Trap (KES) Winter, Fall, and Late-Fall (2018)	Direct count. All fish examined and bio-sampled for fin-clips, tags, marks. During Mar-Jul, all unmarked fish electronically sampled for presence of CWT and genetically tested to ensure winter-run broodstock. To supplement CFH broodstock due to low hatchery returns, KES was also utilized to collect fall-run during Oct-Nov and late-fall-run during Dec-Jan. Grilse cutoff: 620 mm females, 710 mm males winter; 700 mm fall; 600 mm 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 Jun 5 - Jul 14 (n~ 762) 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 18 and spring spawning began Sep 22. All spring-run fish bio-sampled. From Sep 23 - 29, fall-run CWT fish were spawned, and eggs for all fish found to be spring-run were kept and used for spring-run sampling. All fish were bio-sampled. Fall spawning occured on Sep 19 for the cold water program and began normally on Oct 9. Systematic random bio-sample ~20% of all fish for fall-run until Oct 31, when the rate was reduced to 10%. All ad-clipped fish were sampled and heads collected for CWT recovery. Grilse cutoff: 650 mm spring and fall.	CDFW
Nimbus Fish Hatchery (NIM) Fall	Direct count. NIM ladder open Oct 9 - Jan 2. 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 17 - Jan 18. All fish examined for fin-clips, tags, marks. Systematic random bio-sample 25% of total fish returning until Oct 24 when the rate was reduced to 10%. All ad-clipped fish sampled and heads collected for CWT recovery. Grilse cutoff: 640 mm females, 680 mm males.	CDFW
Merced River Hatchery (MER) Fall	Direct count. MER open Oct 19 - Dec 11. All fish examined for fin-clips, tags, marks. All ad-clipped fish were sampled and heads processed for CWT recovery. Grilse cutoff: 630 mm females, 740 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 2017 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 (2018)	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: 645 mm females, 720 mm males winter; 675 mm females, 765 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. Grilse cutoff: 665 mm female, 745 mm male.	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 one unmarked carcass observed. Due to low sample size, bio-sampling data from Clear Creek used as a surrogate.	CDFW
Battle Creek Fall	Video weir count (Aug 23 - Dec 7) 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. Grilse cutoff: 700 mm.	CDFW
Cottonwood Creek Fall	Video weir count (Sep 20 - Dec 15) in lower creek used to determine total escapement. Kayak surveys conducted to collect bio-data from fresh fish, however no carcasses were observed. Due to low sample size, bio-sampling data from Clear Creek 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, however only three unmarked carcasses observed. Due to low sample size, bio-sampling data from Clear Creek used as a surrogate.	CDFW
Deer Creek Fall	Video counts at Stanford Vina Ranch Irrigation Company (SVRIC) Dam plus expanded redd count between SVRIC Dam and the Sacramento River confluence used to determine total escapement. Kayak surveys conducted to collect bio-data from fresh fish, however no carcasses were observed. Due to low sample size, bio-sampling data from Clear Creek used as a surrogate.	CDFW

Table 1b. Estimation and sampling methods used for the 2017 CV Chinook natural escapement. (page 2 of 2)

Sampling Location	Estimation and Sampling Methods	Agency
Natural Spawners cont.		
Butte Creek Spring and Fall	Superpopulation modification of the Cormack-Jolly-Seber mark-recapture estimate for spring-run, however too few fall-run carcasses handled (n=9) to utilize this methodology, so fall-run estimate derived from Vaki Riverwatcher count and number of carcasses handled downstream. All fish examined for fin-clips, tags, marks. Systematic random bio-sample of all fish. No ad-clipped fish were observed in either survey. Grilse cutoff: 600 mm spring, 650 mm fall.	CDFW
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: Mark-recapture estimate not used in 2017 due to low numbers of fresh carcasses (n=8) and recaptures (n=1), so estimate derived from number of carcasses observed. All fish examined for fin-clips, tags, marks, and condition. All ad-clipped fresh fish sampled and heads collected for CWT recovery. Escapement estimate includes spring-run. Grilse cutoff: 650 mm.	CDFW, YARMT
American River Fall	Superpopulation modification of the Cormack-Jolly-Seber mark-recapture estimate. All fish examined for fin-clips, tags, marks, and condition. Systematic random bio-sample of all fish. All ad-clipped fish sampled and heads collected for CWT recovery. Grilse cutoff: 650 mm females, 730 mm males.	CDFW
Nimbus Weir Fall	Direct count. Installed Sept 21 to force returning salmon into Nimbus Hatchery; salmon that migrated above prior to installation trapped between Nimbus Dam (located 1/4 mile upstream) and weir. All dead fish that washed back down river ("washbacks") onto weir examined for fin-clips, tags, marks. All ad-clipped fish sampled and heads collected for CWT recovery. Grilse cutoff: 685 mm.	CDFW
Mokelumne River Fall	Video count at Woodbridge Irrigation District Dam (WIDD) used to determine total escapement and ad-clipped fish above WIDD. Natural spawner escapement estimate and ad-clip rate calculated by subtracting total count and number of ad-clipped fish returning to MOK. Supplemental carcass survey to collect bio-data from fresh fish and heads from all ad-clipped fish. Grilse cutoff: 700 mm.	EBMUD
Stanislaus River Fall	Superpopulation modification of the Cormack-Jolly-Seber mark-recapture estimate. All fresh fish examined for fin-clips, tags, marks. All fresh ad-clipped fish sampled and heads collected for CWT recovery. Opportunistic sampling of ad-clipped fish on Stanislaus Weir (i.e., "washbacks"). Grilse cutoff: 630 mm females, 740 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: 630 mm females, 740 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: 630 mm females, 740 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 1c. Survey design and open dates for the 2017 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 (one weekday and one weekend sample per week per section during the open season in each management zone) that included both roving counts and access interview components 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.	CDFW
	Open Dates	
Upper Sacramento River Fall and Late-Fall	Open Jul 16 - Dec 16 From the Lower Red Bluff Boat Ramp to Highway 113 bridge and Aug 1 - Dec 16 from the Deschutes Road Bridge to the Red Bluff Diversion Dam. Nov 1 is used to delineate the cutoff between the fall-run fishery and the late-fall-run fishery. Grilse cutoff: 650 mm fall, 600 mm late-fall.	
Feather River Fall	Open Jul 16 - Oct 15 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. Grilse cutoff: 600 mm.	
American River Fall	Open Jul 16 - Dec 31 from Nimbus Dam to the Hazel Avenue Bridge, Jul 16 - Aug 15 from the Hazel Avenue Bridge to the USGS cable crossing, 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 Jibboom Street Bridge, and Jul 16 - Dec 16 from the Jibboom Street Bridge to the Sacramento River confluence. Grilse cutoff: 650 mm.	
Lower Sacramento River Fall	Open Jul 16 - Dec 16 from the Highway 113 bridge to the Carquinez Bridge. Grilse cutoff: 650 mm.	
Mokelumne River Fall	Open Jul 16 - Oct 15 from Camanche Dam to the Highway 99 Bridge, Jul 16 - Dec 31 from the Highway 99 Bridge to Woodbridge Dam, including Lodi Lake, and Jul 16 - Dec 16 from the Lower Sacramento Road bridge to the San Joaquin River confluence. Grilse cutoff: 675 mm.	
	Bag and Size Limit	
All Areas	2 Chinook salmon per day; no minimum size limit.	

Table 2. California ocean salmon sport and commercial fishery seasons by major port area, 2017.

	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)	*Closed in 2017*	-	0	*Closed in 2017*	-	0
Fort Bragg	April 1 - May 31	20" TL	61	September 1-5, 8-12, 15-19,	27" TL	22
	August 15 - November 12	20" TL	90	22-26, 29-30 (3,000 fish quota[b/])		
San Francisco	April 1 - 30	24" TL	30	August 1 - 29	27" TL	29
	May 15 - October 31	20" TL	170	September 1 - 30	26" TL	30
				October 2 - 6, 9 - 13[c/]	26" TL	10
Monterey - North (Pigeon Pt. - Pt. Sur)	April 1 - July 15	24" TL	106	May 1 - June 30	27" TL	61
Monterey - South (Pt. Sur - Mexican border)	April 1 - May 31	24" TL	61	May 1 - June 30	27" TL	61
California Total[d/]			457			152

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

b/ Fort Bragg commercial quota fishery; landing and possession limit of 60 salmon per open period.

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

d/ California Total does not include days open in Monterey - South (subset of Monterey port area).

Table 3. Central Valley coded-wire tag (CWT) Chinook releases recovered in 2017 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	2015	LSH	Sac R	Wint	9	415,865	419,690	99%	In-basin	Sacramento River (Lake Redding Park)
FRHS	2015	FRH	Fea R	Spr	5	2,109,278	2,124,688	99%	In-basin	Feather River (Boyds Pump Ramp & Gridley)
CFHFh	2015	CFH	Sac R	Fall	29	3,033,741	12,160,858	25%	Hatchery	CFH only
FRHF	2015	FRH	Fea R	Fall	1	246,501	992,283	25%	In-basin	Feather River (Boyds Pump Ramp)
FRHFn	2015	FRH	Fea R	Fall	14	2,019,877	8,130,003	25%	Bay pens	San Pablo Bay (Mare Island, Wickland Oil) net pen releases
FRHFk	2015	FRH	Fea R	Fall	2	94,971	94,971	100%	Experimental	Yolo Bypass experimental (Knaggs Ranch rice field study)
NIMF	2015	NIM	Ame R	Fall	4	692,262	2,770,112	25%	In-basin	American River (Jibboom Street bridge & Sunrise Recreation Area)
NIMFn	2015	NIM	Ame R	Fall	2	349,016	1,397,391	25%	Bay pens	San Pablo Bay (Mare Island) net pen releases
MOKF	2015	MOK	Mok R	Fall	2	401,194	402,706	100%	In-basin	Mokelumne River (Hatchery and Woodbridge Dam)
MOKFn	2015	MOK	Mok R	Fall	13	1,339,629	5,367,009	25%	Bay pens	San Pablo Bay (Sherman Island) net pen releases
MOKFnc	2015	MOK	Mok R	Fall	1	484,920	486,138	100%	Coastal pens	Pillar Point net pens; acclimated 1-2 weeks
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)
MERFn	2015	MER	Mer R	Fall	3	148,804	273,470	54%	Bay pens	San Pablo Bay (Sherman Island) net pen releases
MERFt	2015	MER	Mer R	Fall	2	97,228	280,784	35%	Trucked	San Joaquin River at Jersey Point
CFHLh	2016	CFH	Sac R	Late	8	594,043	630,175	94%	Hatchery	CFH (includes spring surrogate & small experimental releases)
CFHLe	2016	CFH	Sac R	Late	6	450,662	471,309	96%	Emergency	Trucked to Balls Ferry
			Total age 2 releases:		104	12,780,721	36,304,822	35%		

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	2014	LSH	Sac R	Wint	7	590,623	609,311	97%	In-basin	Sacramento River (Lake Redding Park)
FRHS	2014	FRH	Fea R	Spr	7	1,690,972	1,708,640	99%	In-basin	Feather River (Boyds Pump Ramp & Gridley)
CFHFn	2014	CFH	Sac R	Fall	28	2,951,944	11,846,951	25%	Bay pens	San Pablo Bay (Rio Vista) net pen releases
FRHFn	2014	FRH	Fea R	Fall	4	1,047,852	4,191,625	25%	Bay pens	San Pablo Bay (Mare Island, Crockett) net pen releases
FRHFnc	2014	FRH	Fea R	Fall	1	321,527	331,177	97%	Coastal pens	Pillar Point net pens; acclimated 1-2 weeks
FRHFtib	2014	FRH	Fea R	Fall	1	10,336	10,356	100%	Bay pens	Tiburon net pens; acclimated 1 week
FRHFk	2014	FRH	Fea R	Fall	1	45,200	45,200	100%	Experimental	Yolo Bypass experimental (Knaggs Ranch rice field study)
NIMFn	2014	NIM	Ame R	Fall	6	979,827	3,932,549	25%	Bay pens	San Pablo Bay (Mare Island, Wickland Oil) net pen releases
MOKFn	2014	MOK	Mok R	Fall	13	1,244,314	4,998,641	25%	Bay pens	San Pablo Bay (Sherman Island) net pen releases
MOKFnc	2014	MOK	Mok R	Fall	1	241,335	243,164	99%	Mixed pens	50% released in Moss Landing; 50% released in SF Bay
MOKFx	2014	MOK	Mok R	Fall	2	166,978	573,204	29%	Experimental	MOKF eggs shipped/raised at Merced Hatchery; Jersey Point
MERFn	2014	MER	Mer R	Fall	1	37,064	144,392	26%	Bay pens	San Pablo Bay (Sherman Island) net pen releases
MERFt	2014	MER	Mer R	Fall	2	71,430	282,510	25%	Trucked	San Joaquin River at Jersey Point
CFHLh	2015	CFH	Sac R	Late	7	463,924	474,938	98%	Hatchery	CFH (includes spring surrogate & small experimental releases)
CFHLe	2015	CFH	Sac R	Late	6	420,514	433,404	97%	Emergency	Trucked to Balls Ferry
			Total age 3 releases:		87	10,283,840	29,826,062	34%		

Table 3. Central Valley coded-wire tag (CWT) Chinook releases recovered in 2017 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	2013	LSH	Sac R	Wint	4	190,905	193,155	99%	In-basin	Sacramento River (Lake Redding Park)
FRHS	2013	FRH	Fea R	Spr	4	1,217,640	1,227,476	99%	In-basin	Feather River (Boyds Pump Ramp & Gridley)
FRHSn	2013	FRH	Fea R	Spr	1	997,962	1,009,198	99%	Bay pens	San Pablo Bay (Mare Island) net pen releases
CFHFh	2013	CFH	Sac R	Fall	4	1,125,706	4,506,160	25%	Hatchery	CFH only
CFHFn	2013	CFH	Sac R	Fall	11	1,810,972	7,273,847	25%	Bay pens	San Pablo Bay (Rio Vista) net pen releases
FRHFn	2013	FRH	Fea R	Fall	5	1,459,468	5,906,741	25%	Bay pens	San Pablo Bay (Wickland Oil) net pen releases
FRHFnc	2013	FRH	Fea R	Fall	1	366,033	368,458	99%	Coastal pens	Pillar Point net pens; acclimated 1-2 weeks
FRHFtib	2013	FRH	Fea R	Fall	1	11,791	11,791	100%	Bay pens	Tiburon net pens; acclimated 1 week
FRHFb	2013	FRH	Fea R	Fall	3	300,145	301,417	100%	Barge study	3 release sites: Sac R (Rio Vista), barged (SF Bay), trucked (Tiburon)
FRHFk	2013	FRH	Fea R	Fall	1	44,127	44,127	100%	Experimental	Yolo Bypass experimental (Knaggs Ranch rice field study)
NIMFn	2013	NIM	Ame R	Fall	4	896,419	3,587,565	25%	Bay pens	San Pablo Bay (Mare Island) net pen releases
MOKFn	2013	MOK	Mok R	Fall	11	1,148,423	4,604,315	25%	Bay pens	San Pablo Bay (Sherman Island) net pen releases
MOKFnc	2013	MOK	Mok R	Fall	1	239,294	240,497	99%	Coastal pens	Santa Cruz net pens; 60K released per week, acclimated a few hours
MOKFb	2013	MOK	Mok R	Fall	3	302,658	303,669	100%	Barge study	3 release sites: Mok R (Miller's Ferry), barged (SF Bay), trucked (Tiburon)
MERFt	2013	MER	Mer R	Fall	3	393,182	1,501,007	26%	Trucked	San Joaquin River at Jersey Point
CFHLh	2014	CFH	Sac R	Late	14	1,056,322	1,094,719	96%	Hatchery	CFH (includes spring surrogate & small experimental releases)
			Total age 4 releases:		71	11,561,047	32,174,142	36%		

Age 5 CWT releases (with recoveries in 2017)

Release type*	Brood year	Hatchery	Stock origin	Run type	CWT codes	# CWT tagged	Total fish released	% CWT	Release strategy	Release locations / notes
FRHS	2012	FRH	Fea R	Spr	2	1,106,679	1,125,897	98%	In-basin	Feather River (Boyds Pump Ramp & Gridley; 50% net pens at Gridley)
FRHSn	2012	FRH	Fea R	Spr	1	1,015,285	1,033,174	98%	Bay pens	San Pablo Bay (Wickland Oil) net pen releases
CFHFh	2012	CFH	Sac R	Fall	14	2,956,348	11,873,864	25%	Hatchery	CFH only
FRHFn	2012	FRH	Fea R	Fall	4	1,453,105	5,848,045	25%	Bay pens	San Pablo Bay net pen releases (various sites)
FRHFb	2012	FRH	Fea R	Fall	3	293,784	299,404	98%	Barge study	3 release sites: Sac R (Broderick), barged (SF Bay), trucked (Ft. Baker)
NIMF	2012	NIM	Ame R	Fall	3	1,026,596	3,277,594	31%	In-basin	American River (Jibboom Street bridge & Howe Ave launch ramp)
NIMFn	2012	NIM	Ame R	Fall	1	182,413	734,906	25%	Bay pens	San Pablo Bay (Mare Island) net pen releases; 19% mortality tranport
MOKFn	2012	MOK	Mok R	Fall	13	1,275,158	5,123,986	25%	Bay pens	San Pablo Bay (Sherman Island) net pen releases
MERFt	2012	MER	Mer R	Fall	4	325,953	1,384,973	24%	Trucked	San Joaquin River at Jersey Point and Mossdale
CFHLh	2013	CFH	Sac R	Late	14	960,075	984,977	97%	Hatchery	CFH (includes spring surrogate & small experimental releases)

***CWT release types:**

Sacramento River fall Chinook release types (SFC)

CFHFh	Coleman National Fish Hatchery fall hatchery releases
CFHFn	Coleman National Fish Hatchery fall net pen releases
FRHF	Feather River Hatchery fall in-basin releases
FRHFn	Feather River Hatchery fall bay net pen releases
FRHFnc	Feather River Hatchery fall coastal net pen releases
FRHFtib	Feather River Hatchery fall Tiburon net pen releases
FRHFb	Feather River Hatchery fall barge study releases
FRHFk	Feather River Hatchery fall experimental Knaggs Ranch releases
NIMF	Nimbus Fish Hatchery fall in-basin releases
NIMFn	Nimbus Fish Hatchery fall bay net pens

Other CV Chinook release types (OCV)

MOKF	Mokelumne River Hatchery fall in-basin releases
MOKFn	Mokelumne River Hatchery fall bay net pen releases
MOKFnc	Mokelumne River Hatchery fall coastal net pen releases
MOKFb	Mokelumne River Hatchery fall barge study releases
MOKFx	Mokelumne River Hatchery fall experimental releases (raised in Merced Hatchery)
MERFn	Merced River Hatchery fall bay net pen releases
MERFt	Merced River Hatchery fall trucked releases (no net pens)
SacW	Livingston Stone National Fish Hatchery winter in-basin releases
FRHS	Feather River Hatchery spring in-basin releases
FRHSn	Feather River Hatchery spring net pen releases
CFHLh	Coleman National Fish Hatchery late-fall hatchery releases
CFHLe	Coleman National Fish Hatchery late-fall emergency trucked releases (no net pens)

Table 4. Central Valley hatchery and natural escapement estimates, sport harvest, and sample data, 2017.

Central Valley Survey	Run	Total Escapement	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										
Keswick Dam Fish Trap	Winter	180	180	169	169	163	1.000	1.000	1.000	1.00
Feather River Hatchery	Spring	580	580	509	509	507	1.000	1.000	1.000	1.00
Keswick Dam Fish Trap	Fall	111	111	18	18	18	1.000	1.000	1.000	1.00
Coleman National Fish Hatchery	Fall	6,396	6,396	1,411	1,407	1,379	1.000	0.997	0.994	1.01
Feather River Hatchery	Fall	25,046	25,046	7,857	7,857	7,749	1.000	1.000	0.999	1.00
Nimbus Fish Hatchery	Fall	10,579	10,579 [b/]	2,859	2,859	2,799	1.000	1.000	0.997	1.00
Mokelumne River Hatchery	Fall	14,319	14,319	5,348	5,348	5,291	1.000	1.000	0.998	1.00
Merced River Hatchery	Fall	1,701	1,701	547	547	543	1.000	1.000	0.998	1.00
Coleman National Fish Hatchery[c/]	Late-fall[d/]	3,906	3,906	3,887	3,881	3,812	1.000	0.998	0.996	1.01
Keswick Dam Fish Trap	Late-fall[d/]	18	18	2	2	2	1.000	1.000	1.000	1.00
Total Hatchery Escapement		**62,836**	**62,836**	**22,607**	**22,597**	**22,263**				
Natural Area Escapement										
Upper Sacramento River (above Princeton)	Winter	795	133	109	108	106	0.167	0.991	1.000	6.00 [e/]
Butte Creek	Spring	515	182	0	0	0	0.353	-	-	-
Upper Sacramento River (above Princeton)	Fall	1,752	265	20	20	16	0.151	1.000	0.889	7.96 [e/]
Clear Creek	Fall	2,353	99	Video - opportunistic CWTs		1	0.042	-	-	1.00 [f/]
Battle Creek	Fall	353	353	Video count only		77 [g/]	1.000	-	-	1.00
Cow Creek	Fall	288	1	Video - no CWTs observed		0	0.003	-	-	-
Cottonwood Creek	Fall	124	0	Video - no CWTs observed		0	0.000	-	-	-
Mill Creek	Fall	342	3	Video - no CWTs observed		0	0.009	-	-	-
Deer Creek	Fall	106	0	Video - no CWTs observed		0	0.000	-	-	-
Butte Creek	Fall	105	9	Video - no CWTs observed		0	0.086	-	-	-
Feather River	Fall	10,534	956	310	310	303	0.091	1.000	0.997	11.06 [e/]
Yuba River	Fall	1,648	1,619	422	22	22	0.982	0.052	1.000	19.53 [h/]
American River	Fall	7,234	2,843	629	567	482	0.393	0.901	0.996	3.29 [e/]
Nimbus Fish Hatchery Weir	Fall	2,429	2,429	348	348	325	1.000	1.000	0.994	1.01
Mokelumne River	Fall	5,644	5,644	1,717	114	108	1.000	0.066	1.000	15.06 [h/]
Stanislaus River	Fall	3,499	394	137	137	134	0.113	1.000	1.000	7.58 [i/]
Tuolumne River	Fall	1,118	624	131	131	125	0.558	1.000	1.000	2.29 [e/]
Merced River	Fall	3,181	432	115	115	112	0.136	1.000	1.000	7.36 [e/]
Upper Sacramento River (above Princeton)	Late-fall[d/]	1,175	445	42	42	34	0.379	1.000	0.971	3.55 [e/]
Total Natural Area Escapement		**43,195**	**16,431**	**3,980**	**1,914**	**1,845**				
CV Sport Harvest										
Sacramento River (above Feather River)	Fall	2,833	270	55	55	53	0.095	1.000	0.981	10.69
Sacramento River (below Feather River)	Fall	9,852	291	66	66	65	0.030	1.000	0.985	34.38
Feather River	Fall	12,031	1,190	324	284	273	0.099	0.877	0.996	11.58
American River	Fall	14,521	612	156	156	155	0.042	1.000	0.994	23.88
Mokelumne River	Fall	1,625	112	28	28	28	0.069	1.000	1.000	14.51
Sacramento River (above Feather River)	Late-fall	709	84	55	55	55	0.118	1.000	1.000	8.44
Total Sport Harvest		**41,571**	**2,559**	**684**	**644**	**629**				
	Total Sampled	**81,826**	**27,271**	**25,155**	**24,737**					

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/ Nimbus Fish Hatchery opened three weeks early to collect anticipated stray fall-run from Coleman National Fish Hatchery (CFH). During those three weeks there were 2,886 fish collected.

c/ Prior versions of this report have evaluated the CFH late-fall-run trap separately, which consisted of late-fall-run that were trapped at CFH or observed via video weir after spawning operations had ceased. In 2017, only one fish was trapped after spawning had ended and none were observed on video, so the CFH late-fall-run trap and hatchery sectors were merged for this report.

d/ Late-fall-run hatchery returns and natural area escapement occurred during late fall of 2017 through early 2018 (return year 2018).

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

f/ Escapement estimate based on video counts; CWTs collected opportunistically in separate survey (e.g., kayak survey, snorkel survey).

g/ Battle Creek natural escapement estimated using Battle Creek video count minus fall return to CFH. Surrogate CWTs based on CFH hatchery proportion and CWT recoveries.

h/ Yuba and Mokelumne natural escapement CWTs collected on spawning grounds and expanded based on total ad-clip count observed via video weir (see appendices 4 and 5, respectively). For the Yuba River, 20 fish including 3 ad-clips observed below Daguerre Point Dam were added to the video count.

i/ Stanislaus natural escapement and sample expansion factor based on fresh fish only and expanded to all valid CWTs (29 CWTs recovered from washbacks on Stanislaus Weir; see Appendix 1).

Table 5. Total harvest and sample data for 2017 ocean salmon sport and commercial fisheries by major port area.

Fishery - Port Area	Ocean Harvest	Chinook Sampled[a/]	Observed Ad-Clips	Heads Processed	Valid CWTs	Sample rate (fe)	Ad-clips processed (fa)	Valid CWTs (fd)	CWT F_{samp}
California Sport									
Eureka/Crescent[b/]	-	-	-	-	-	-	-	-	-
Fort Bragg	1,887	420	87	87	84	0.223	1.000	0.988	4.54
San Francisco	53,756	14,255	4,105	4,090	4,000	0.265	0.996	0.997	3.80
Monterey	6,554	981	256	255	246	0.150	0.996	1.000	6.69
	62,197	**15,656**	**4,448**	**4,432**	**4,330**	**0.252**	**0.996**	**0.997**	**4.00**
California Commercial									
Eureka/Crescent[b/]	-	-	-	-	-	-	-	-	-
Fort Bragg	1,935	987	207	206	173	0.510	0.995	0.994	1.98
San Francisco	27,912	7,935	1,908	1,908	1,838	0.284	1.000	0.995	3.54
Monterey	12,479	3,156	703	700	681	0.253	0.996	0.994	3.99
	42,326	**12,078**	**2,818**	**2,814**	**2,692**	**0.285**	**0.999**	**0.994**	**3.53**
California Total	**104,523**	**27,734**	**7,266**	**7,246**	**7,022**				
Oregon Sport	**2,686**	**1,000**	**98**	**98**	**89**	**0.372**	**1.000**	**0.989**	**2.72**
Oregon Commercial	**19,218**	**3,790**	**559**	**559**	**546**	**0.197**	**1.000**	**0.995**	**5.10**
Oregon Total	**21,904**	**4,790**	**657**	**657**	**635**				

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

b/ The Eureka/Crescent City port area was closed to salmon fishing in 2017 for both sport and commercial fisheries.

Table 6. Raw and expanded Chinook CWT recoveries in the Central Valley by run type and brood year during 2017[a\].

Fall-run	2015	2014	2013	2012	Total CV	
Age	2	3	4	5	CWTs	Total CV %
Raw CWT Recoveries	10,315 (53%)	8,380 (43%)	688 (4%)	15 (<1%)	19,398	78%
Expanded CWT$_{total}$	**50,548** (43%)	**61,995** (53%)	**4,175** (4%)	**114** (<1%)	116,832	94%

Late-Fall-run	2016	2015	2014	2013	Total CV	
Age	2	3	4	5	CWTs	Total CV %
Raw CWT Recoveries	3,144 (80%)	675 (17%)	102 (3%)	2 (<1%)	3,923	16%
Expanded CWT$_{total}$	**3,864** (79%)	**941** (19%)	**108** (2%)	**2** (<1%)	4,916	4%

Spring-run	2015	2014	2013	2012	Total CV	
Age	2	3	4	5	CWTs	Total CV %
Raw CWT Recoveries	666 (59%)	219 (19%)	234 (21%)	15 (1%)	1,134	5%
Expanded CWT$_{total}$	**745** (58%)	**252** (20%)	**277** (21%)	**15** (1%)	1,289	1%

Winter-run	2015	2014	2013	2012	Total CV	
Age	2	3	4	5	CWTs	Total CV %
Raw CWT Recoveries	85 (31%)	181 (66%)	7 (3%)		273	1%
Expanded CWT$_{total}$	**314** (38%)	**498** (60%)	**22** (3%)		834	1%

All Runs					Total CV	
Age	2	3	4	5	CWTs	Total CV %
Raw CWT Recoveries	14,210 (57%)	9,455 (38%)	1,031 (4%)	32 (<1%)	24,728	100%
CV Expanded CWT$_{total}$	**55,471** (45%)	**63,686** (51%)	**4,583** (4%)	**131** (<1%)	123,871	100%

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

Table 7. Raw and expanded Chinook CWT recoveries in 2017 California ocean fisheries by run type and brood year[a\].

Fall-run	2015	2014	2013	2012	Total Ocean	Total
Age	2	3	4	5	CWTs	Ocean%
Raw CWT Recoveries	3,042 (45%)	3,507 (52%)	153 (2%)	1 (<1%)	6,703	96%
Expanded CWT$_{total}$	**30,851** (42%)	**41,768** (56%)	**1,567** (2%)	**16** (<1%)	74,202	97%
Late-Fall-run	2016	2015	2014	2013	Total Ocean	Total
Age	2	3	4	5	CWTs	Ocean%
Raw CWT Recoveries	35 (31%)	66 (59%)	11 (10%)		112	2%
Expanded CWT$_{total}$	**134** (32%)	**237** (57%)	**48** (11%)		419	1%
Spring-run	2015	2014	2013	2012	Total Ocean	Total
Age	2	3	4	5	CWTs	Ocean%
Raw CWT Recoveries	64 (90%)	5 (7%)	2 (3%)		71	1%
Expanded CWT$_{total}$	**257** (87%)	**28** (10%)	**10** (3%)		295	0.4%
Winter-run	2016	2015	2014	2013	Total Ocean	Total
Age	2	3	4	5	CWTs	Ocean%
Raw CWT Recoveries		66 (100%)			66	1%
Expanded CWT$_{total}$		**279** (100%)			279	0.4%
Non-CV stocks	2015	2014	2013	2012	Total Ocean	Total
Age	2	3	4	5	CWTs	Ocean%
Raw CWT Recoveries	1 (2%)	49 (79%)	12 (19%)		62	1%
Expanded CWT$_{total}$	**21** (2%)	**663** (66%)	**322** (32%)		1,006	1%
All Runs					Total Ocean	Total
Age	2	3	4	5	CWTs	Ocean%
Raw CWT Recoveries	3,142 (45%)	3,693 (53%)	178 (3%)	1 (<1%)	7,014	100%
Expanded CWT$_{total}$	**31,263** (41%)	**42,975** (56%)	**1,948** (3%)	**16** (<1%)	76,201	100%
CV Expanded CWT$_{total}$ (Proportion CV stocks)	31,242 (100%)	42,312 (98%)	1,626 (83%)	16 (100%)	75,195	99%

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

Table 8. Raw and expanded Chinook CWT recoveries in 2017 Oregon ocean fisheries by run type and brood year[a\].

Fall-run	2015	2014	2013	2012	Total Ocean	Total
Age	2	3	4	5	CWTs	Ocean%
Raw CWT Recoveries	9	174	59		242	38%
	(4%)	(72%)	(24%)			
Expanded CWT$_{total}$	**52**	**3,174**	**758**		3,983	38%
	(1%)	(80%)	(19%)			

Non-CV stocks	2015	2014	2013	2012	Total Ocean	Total
Age	2	3	4	5	CWTs	Ocean%
Raw CWT Recoveries		120	174	93	387	62%
		(31%)	(45%)	(24%)		
Expanded CWT$_{total}$		**4,872**	**1,189**	**554**	6,614	62%
		(74%)	(18%)	(8%)		

All Runs					Total Ocean	Total
Age	2	3	4	5	CWTs	Ocean%
Raw CWT Recoveries	9	294	233	93	629	100%
	(1%)	(47%)	(37%)	(15%)		
Expanded CWT$_{total}$	**52**	**8,045**	**1,947**	**554**	10,598	100%
	(<1%)	(76%)	(18%)	(5%)		
CV Expanded CWT$_{total}$	52	3,174	758		3,983	38%
(Proportion CV stocks)	(100%)	(39%)	(39%)			

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 2017.

			CFH			FRH							NIM		MOK				MER	Total %		Total
Location	**Run**	**SacW**	**CFHLh**	**CFHFh**	**CFHFn**	**FRHS**	**FRHSn**	**FRHF**	**FRHFn**	**FRHFnc**	**FRHFb**	**FRHFk**	**NIMF**	**NIMFn**	**MOKF**	**MOKFn**	**MOKFnc**	**MOKFb**	**MERFn**	**Hatchery**	**Natural**	**Run**
Hatchery Spawners																						
Keswick Dam Fish Trap	Winter	93%																		93%	7%	180
Feather River Hatchery	Spring					71%	14%		13%		0%									98%	2%	580
Keswick Dam Fish Trap	Fall			25%					11%	5%				4%		4%				49%	51%	111
Coleman National Fish Hatchery	Fall			85%	0%	0%			0%	0%				0%		1%	0%	0%	0%	87%	13%	6,396
Feather River Hatchery	Fall		0%	0%	1%	2%	0%	0%	85%	6%	0%	0%		0%	0%	1%	0%	0%	0%	97%	3%	25,046
Nimbus Fish Hatchery	Fall		0%		23%				9%	2%	0%		1%	42%	0%	9%	3%	1%	1%	90%	10%	10,579
Mokelumne River Hatchery	Fall		0%		4%				5%	1%			0%	15%	1%	50%	11%	6%	2%	94%	6%	14,319
Merced River Hatchery	Fall		0%		8%				6%	0%				7%	0%	54%	5%	2%	14%	96%	4%	1,701
Coleman National Fish Hatchery	Late-fall[c/]		100%																	100%		3,906
Keswick Dam Fish Trap	Late-fall[c/]		11%																	11%	89%	18
Total Hatchery Fall Run			***0%***	***9%***	***6%***	***1%***	***0%***	***0%***	***40%***	***3%***	***0%***	***0%***	***0%***	***12%***	***0%***	***16%***	***3%***	***2%***	***1%***	***94%***	***6%***	***58,152***
Natural Spawners																						
Upper Sacramento River	Winter	82%																		82%	18%	795
Butte Creek	Spring																			0%	100%	515
Upper Sacramento River	Fall			7%	7%				4%	1%							1%		1%	21%	79%	1,752
Battle Creek[d/]	Fall			85%	1%											1%				86%	14%	353
Butte Creek	Fall																			0%	100%	105
Feather River	Fall				5%	0%	0%		73%	10%	0%	0%		1%		1%	1%		1%	92%	8%	10,534
Yuba River	Fall				57%	1%			10%	1%				9%		5%	1%	2%		87%	13%	1,648
American River	Fall				36%				2%	0%			3%	23%	0%	9%	2%	1%	1%	77%	23%	7,234
Nimbus Fish Hatchery Weir	Fall				14%				7%	0%			2%	6%	0%	5%	2%	2%	1%	40%	60%	2,429
Mokelumne River	Fall				10%				2%	1%				24%	1%	37%	7%	2%	2%	86%	14%	5,644
Stanislaus River	Fall		0%		10%				4%					10%		61%	2%	2%	7%	98%	2%	3,499
Tuolumne River	Fall				13%				6%	1%				3%	1%	54%	2%	1%	7%	87%	13%	1,118
Merced River	Fall				27%				6%	1%				9%	1%	33%	2%	1%	7%	87%	13%	3,181
Upper Sacramento River	Late-fall[c/]	1%	9%											1%		1%				12%	88%	1,175
Total Natural Area Fall-run			***0%***	***1%***	***17%***	***0%***	***0%***		***23%***	***3%***	***0%***	***0%***	***1%***	***11%***	***0%***	***18%***	***2%***	***1%***	***2%***	***81%***	***19%***	***37,497***
In-basin CWT_{total}	All	1%	5%	8%	0%	1%	0%	0%	39%	3%	0%	0%	0%	8%	0%	12%	3%	1%	1%	84%	16%	75,745
Stray CWT_{total}	All		0%	0%	36%	0%			10%	1%	0%		0%	17%	0%	26%	3%	1%	4%	100%		27,073
Total CV Spawners		**1%**	**4%**	**6%**	**10%**	**1%**	**0%**	**0%**	**31%**	**3%**	**0%**	**0%**	**0%**	**11%**	**0%**	**16%**	**3%**	**1%**	**2%**	**88%**	**12%**	**102,818**
CV Sport Harvest																						
Upper Sacramento River	Fall		1%	73%					2%	0%										76%	24%	2,833
Lower Sacramento River	Fall		4%	3%	10%				20%	2%			1%	11%	1%	8%	1%	1%	3%	66%	34%	9,852
Feather River	Fall				1%	1%		1%	81%	5%	0%						0%			88%		12,031
American River	Fall				34%				12%	1%			3%	20%	0%	11%	4%	1%	1%	86%	14%	14,521
Mokelumne River	Fall		1%		4%				1%					21%		50%	1%	3%	2%	82%	18%	1,625
Upper Sacramento River	Late-fall[c/]		67%						5%											72%	28%	709
Total Sport Harvest			**2%**	**6%**	**14%**	**0%**		**0%**	**33%**	**2%**	**0%**		**1%**	**11%**	**0%**	**8%**	**2%**	**1%**	**1%**	**81%**	**19%**	**41,571**

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

b/ Release types defined in Table 3; CFHLe recoveries merged with CFHLh, FRHFtib merged with FRHFn, MOKFx merged with MOKF, MERFt merged with MERFn.

c/ Late-fall hatchery returns, natural escapement, and sport harvest occurred in late fall 2017 (return year 2018).

d/ Battle Creek natural 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 2017.

			CFH			FRH						NIM		MOK				MER	Total CWT_{total}		Total
Location	**Run**	**SacW**	**CFHLh**	**CFHFh**	**CFHFn**	**FRHS**	**FRHSn**	**FRHF**	**FRHFn**	**FRHFnc**	**FRHFb**	**FRHFk**	**NIMF**	**NIMFn**	**MOKF**	**MOKFn**	**MOKFnc**	**MOKFb**	**MERFn**	**Hatchery**	**Natural**	**Run**
Hatchery Spawners																					
Keswick Dam Fish Trap	Winter	168																		168	12	180
Feather River Hatchery	Spring					412	80		73		2									567	13	580
Keswick Dam Fish Trap	Fall			28					12	6				4		4				54	57	111
Coleman National Fish Hatchery	Fall			5,464	28	1			8	1				8		40	3	1	2	5,556	840	6,396
Feather River Hatchery	Fall		2	4	341	579	61	44	21,293	1,419	38	10		96	5	241	80	22	106	24,341	705	25,046
Nimbus Fish Hatchery	Fall		2		2,404				967	175	3		132	4,402	16	970	286	75	110	9,542	1,037	10,579
Mokelumne River Hatchery	Fall		7		507				695	89			4	2,172	114	7,209	1,520	796	336	13,449	870	14,319
Merced River Hatchery	Fall		1		129				100	5				116	7	926	82	30	238	1,634	67	1,701
Coleman National Fish Hatchery	Late-fall[b/]		3,906																	3,906		3,906
Keswick Dam Fish Trap	Late-fall[b/]		2																	2	16	18
Total Hatchery Fall Run			***12***	***5,496***	***3,409***	***580***	***61***	***44***	***23,075***	***1,695***	***41***	***10***	***136***	***6,798***	***142***	***9,390***	***1,971***	***924***	***792***	***54,576***	***3,576***	***58,152***
Natural Spawners																					
Upper Sacramento River	Winter	652																		652	143	795
Butte Creek	Spring																				515	515
Upper Sacramento River	Fall			127	128				64	16							24		15	374	1,378	1,752
Battle Creek[c/]	Fall			300	2											2				304	49	353
Butte Creek	Fall																				105	105
Feather River	Fall				533	34	34		7,668	1,046	22	11		88		89	66		107	9,698	836	10,534
Yuba River	Fall				939	20			157	20				156		78	20	39		1,429	219	1,648
American River	Fall				2,603				179	30			197	1,649	3	646	125	76	66	5,574	1,660	7,234
Nimbus Fish Hatchery Weir	Fall				352				171	9			40	154	3	130	56	41	20	976	1,453	2,429
Mokelumne River	Fall				547				121	31				1,328	59	2,115	408	105	117	4,831	813	5,644
Stanislaus River	Fall		8		366				151					364		2,128	84	76	254	3,431	68	3,499
Tuolumne River	Fall				147				64	7				28	16	606	23	9	73	973	145	1,118
Merced River	Fall				858				185	30				295	23	1,064	66	29	210	2,760	421	3,181
Upper Sacramento River	Late-fall[b/]	14	103											14		14				145	1,030	1,175
Total Natural Area Fall-run			***8***	***427***	***6,475***	***54***	***34***		***8,760***	***1,189***	***22***	***11***	***237***	***4,062***	***104***	***6,858***	***872***	***375***	***862***	***30,350***	***7,147***	***37,497***
In-basin CWT_{total}	All	834	4,011	5,919	158	1,045	175	44	29,191	2,485	62	21	369	6,205	173	9,324	1,928	901	448	63,293	12,452	75,745
Stray CWT_{total}	All		20	4	9,726	1			2,717	399	3		4	4,669	73	6,938	915	398	1,206	27,073		27,073
Total CV Spawners		**834**	**4,031**	**5,923**	**9,884**	**1,046**	**175**	**44**	**31,908**	**2,884**	**65**	**21**	**373**	**10,874**	**246**	**16,262**	**2,843**	**1,299**	**1,654**	**90,366**	**12,452**	**102,818**
%stray			0.5%	0.1%	98%	0.1%			9%	14%	5%		1%	43%	30%	43%	32%	31%	73%	30%		26%
CV Sport Harvest																					
Upper Sacramento River	Fall		33	2,058					43	11										2,145	688	2,833
Lower Sacramento River	Fall		363	275	971				1,968	177			138	1,104	107	828	138	103	297	6,469	3,383	9,852
Feather River	Fall				93	70		93	9,749	583	12						12			10,612	1,419	12,031
American River	Fall				4,890				1,725	74			382	2,966	24	1,533	598	96	139	12,427	2,094	14,521
Mokelumne River	Fall		15		58				15					349		813	15	44	28	1,337	288	1,625
Upper Sacramento River	Late-fall[b/]		474						34											508	201	709
Total Sport Harvest			**885**	**2,333**	**6,012**	**70**		**93**	**13,534**	**845**	**12**		**520**	**4,419**	**131**	**3,174**	**763**	**243**	**464**	**33,498**	**8,073**	**41,571**

a/ Release types defined in Table 3; CFHLe recoveries merged with CFHLh, FRHFtib merged with FRHFn, MOKFx merged with MOKF, MERFt merged with MERFn.

b/ Late-fall hatchery returns, natural escapement, and sport harvest occurred in late fall 2017 (return year 2018).

c/ Battle Creek natural 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 2017. (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	Mer	SJ	In-basin	Stray	CV total		CWT_{samp}	In-basin	Stray	**CV total**	**Ocean**
SacW[b/]	2015	Wint	415,865		310								310	0	310	**0%**	276	75	0	**75**	**66**
FRHS	2015	Spr	2,109,278	1			659	20					679	1	680	**0.2%**	254	32	0.1	**32**	**12**
CFHFh	2015	Fall	3,033,741	1,358	20		1						1,378	1	1,379	**0.1%**	561	45	<0.1	**45**	**18**
FRHF	2015	Fall	246,501				11						11	0	11	**0%**	19	5	0	**5**	**8**
FRHFn	2015	Fall	2,019,877	2			3,124	20	104	101	39	22	3,143	269	3,412	**8%**	2704	156	13	**169**	**134**
FRHFk	2015	Fall	94,971				20						20	0	20	**0%**	6	21	0	**21**	**7**
NIMF	2015	Fall	692,262						89	1			89	1	90	**1%**	172	13	0.1	**13**	**25**
NIMFn	2015	Fall	349,016	1			5		236	123	7	2	236	138	375	**37%**	456	68	40	**107**	**131**
MOKF	2015	Fall	401,194				1		3	73			73	4	77	**6%**	19	18	1	**19**	**5**
MOKFn	2015	Fall	1,339,629	9			50		263	1,713	291	363	1,713	975	2,688	**36%**	2301	128	73	**201**	**172**
MOKFnc	2015	Fall	484,920	3			129	20	409	1,706	117	52	1,706	730	2,436	**30%**	4066	352	151	**502**	**839**
MOKFb	2015	Fall	302,730	1			22	39	192	897	59	85	897	399	1,296	**31%**	1037	296	132	**428**	**343**
MERFn	2015	Fall	148,804	1	8		49		53	126	109	59	109	295	405	**73%**	236	73	199	**272**	**159**
MERFt	2015	Fall	97,228				39		13	44	80	62	80	158	239	**66%**	142	82	163	**245**	**146**
CFHLh	2016	Late	594,043	3,075	30		2		1	7	1	8	3,105	19	3,124	**1%**	65	523	3	**526**	**11**
CFHLe	2016	Late	450,662										0	0	0	**-**	63	0	0	**0**	**14**
		Total	12,780,721	4,451	368		4,112	98	1,364	4,791	704	652	13,550	2,991	16,542	**18%**	12,378				

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	Mer	SJ	In-basin	Stray	CV total		CWT_{samp}	In-basin	Stray	**CV total**	**Ocean**
SacW[b/]	2014	Wint	590,623		481								481	0	481	**0%**	0	81	0	**81**	**0**
FRHS	2014	Spr	1,690,972				238						238	0	238	**0%**	28	14	0	**14**	**2**
CFHFn	2014	Fall	2,951,944	7	32		198	195	1,194	242	238	125	39	2,193	2,232	**98%**	3077	1	74	**76**	**104**
FRHFn	2014	Fall	1,047,852		19		3,883	20	207	98	28	32	3,903	384	4,286	**9%**	3,240	373	37	**409**	**309**
FRHFnc	2014	Fall	321,527	1	20		2,177	20	179	115	25	7	2,197	347	2,544	**14%**	3,152	683	108	**791**	**980**
FRHFk	2014	Fall	45,200				1						1	0	1	**0%**	4	2	0	**2**	**9**
NIMFn	2014	Fall	979,827	1	5	1	38	39	1,220	742	88	96	1,220	1,010	2,230	**45%**	1895	125	103	**228**	**193**
MOKFn	2014	Fall	1,244,314	2	5		31	20	165	608	195	311	608	729	1,338	**55%**	1877	49	59	**108**	**151**
MOKFnc	2014	Fall	241,335		24		17		57	219	31	55	219	184	402	**46%**	847	91	76	**167**	**351**
MOKFx[c/]	2014	Fall	166,978				1		6	27	9	5	36	12	48	**24%**	57	22	7	**29**	**34**
MERFn	2014	Fall	37,064						5	18	2		2	23	25	**92%**	7	5	63	**68**	**18**
MERFt	2014	Fall	71,430				2		7	5	1	10	1	24	25	**96%**	9	1	33	**35**	**12**
CFHLh	2015	Late	463,924	635	64								699	0	699	**0%**	215	151	0	**151**	**46**
CFHLe	2015	Late	420,514	1									1	0	1	**0%**	17	0.2	0	**0.2**	**4**
		Total	10,273,504	648	649	1	6,586	293	3,041	2,075	618	640	9,645	4,906	14,550	**34%**	14,423				

Table 11. CWT recovery rate (recoveries per 100,000 CWTs released) by release type, brood year and recovery location in 2017. (page 2 of 2)

Age 4 CWT recoveries

Release type	Brood year	Run type	# CWT tagged	Central Valley total recoveries (CWT_{samp}) by basin									CV CWT_{samp} totals			% CV Stray	Ocean	Recovery rate per 100K released			
				Bat Cr	Up Sac	Nat crks[a/]	Fea	Yub	Ame	Mok	Mer	SJ	In-basin	Stray	CV total		CWT_{samp}	In-basin	Stray	**CV total**	**Ocean**
SacW[b/]	2013	Wint	190,905		22								22	0	22	**0%**	0	12	0	**12**	**0**
FRHS	2013	Spr	1,217,640				109						109	0	109	**0%**	10	9	0	**9**	**1**
FRHSn	2013	Spr	997,962				165						165	0	165	**0%**	0	17	0	**17**	**0**
CFHFh	2013	Fall	1,125,706	80	19								99	0	99	**0%**	23	9	0	**9**	**2**
CFHFn	2013	Fall	1,810,972				20	39	140	19	7	2	0	228	228	**100%**	222	0	13	**13**	**12**
FRHFn	2013	Fall	1,459,468				193		13	2	2		193	17	210	**8%**	109	13	1	**14**	**7**
FRHFnc	2013	Fall	366,033		2		221		29	1	9		221	42	262	**16%**	279	60	11	**72**	**76**
FRHFb	2013	Fall	300,145				59		3				59	3	62	**5%**	27	20	1	**21**	**9**
FRHFk	2013	Fall	44,127										0	0	0	**-**	0	0	0	**0**	**0**
NIMFn	2013	Fall	896,419				3		87	8	7		87	18	106	**17%**	105	10	2	**12**	**12**
MOKFn	2013	Fall	1,148,423				1		8	4	9	8	4	26	30	**86%**	25	0.3	2	**3**	**2**
MOKFnc	2013	Fall	239,294							1			1	0	1	**0%**	46	0.4	0	**0.4**	**19**
MOKFb	2013	Fall	302,658							4			4	0	4	**0%**	20	1	0	**1**	**7**
MERFt	2013	Fall	393,182						1				0	1	1	**100%**	0	0	0.3	**0.3**	**0**
CFHLh	2014	Late	1,056,322	99	7				1				106	1	107	**1%**	47	10	0.1	**10**	**4**
		Total	11,549,256	179	50		771	39	282	39	35	10	1,070	335	1,406	**24%**	913				

Age 5 CV 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	Mer	SJ	In-basin	Stray	CV total		CWT_{samp}	In-basin	Stray	**CV total**	**Ocean**
FRHS	2012	Spr	1,106,679				8						8	0	8	**0%**	0	1	0	**1**	**0**
FRHSn	2012	Spr	1,015,285				7						7	0	7	**0%**	0	1	0	**1**	**0**
CFHFh	2012	Fall	2,956,348	1									1	0	1	**0%**	0	<0.1	0	**<0.1**	**0**
FRHFn	2012	Fall	1,453,105				4						4	0	4	**0%**	0	0.3	0	**0.3**	**0**
FRHFb	2012	Fall	293,784				3						3	0	3	**0%**	0	1	0	**1**	**0**
NIMF	2012	Fall	1,026,596						3				3	0	3	**0%**	0	0.3	0	**0.3**	**0**
NIMFn	2012	Fall	182,413						4				4	0	4	**0%**	0	2	0	**2**	**0**
MOKFn	2012	Fall	1,275,158							1			1	0	1	**0%**	4	0.1	0	**0.1**	**0.3**
MERFt	2012	Fall	325,953						2				0	2	2	**100%**	0	0	1	**1**	**0**
CFHLh	2013	Late	960,075	2									2	0	2	**0%**	0	0.2	0	**0.2**	**0**

a/ Natural creeks can include Clear Creek, Cow Creek, Cottonwood Creek, Paynes Creek, Mill Creek, Deer Creek, and Butte Creek, depending on survey year.
b/ Ocean recoveries of SacW are considered one year older than those of the same brood year recovered in the CV (i.e., brood year 2015 = age-3 in the ocean).
c/ Since MOKFx were raised at Merced Hatchery, recoveries in both the Mokelumne and Merced basins are considered in-basin.

Sacramento River fall Chinook release types (SFC)

CFHFh	Coleman National Fish Hatchery fall hatchery releases
CFHFn	Coleman National Fish Hatchery fall delta/bay net pen releases
FRHF	Feather River Hatchery fall in-basin releases
FRHFn	Feather River Hatchery fall bay net pen releases
FRHFnc	Feather River Hatchery fall coastal net pen releases
FRHFb	Feather River Hatchery fall barge study releases
FRHFk	Feather River Hatchery fall experimental Knaggs Ranch releases
NIMF	Nimbus Fish Hatchery fall in-basin releases
NIMFn	Nimbus Fish Hatchery fall bay net pen releases

Other CV Chinook release types (OCV)

MOKF	Mokelumne River Hatchery fall in-basin releases
MOKFn	Mokelumne River Hatchery fall delta/bay net pen releases
MOKFnc	Mokelumne River Hatchery fall coastal net pen releases
MOKFb	Mokelumne River Hatchery fall barge study releases
MOKFx	Mokelumne River Hatchery fall experimental releases (raised in Merced Hatchery)
MERFn	Merced River Hatchery fall delta/bay net pen releases
MERFt	Merced River Hatchery fall trucked releases (no net pens)
SacW	Livingston Stone National Fish Hatchery winter in-basin releases
FRHS	Feather River Hatchery spring in-basin releases
FRHSn	Feather River Hatchery spring bay net pen releases
CFHLh	Coleman National Fish Hatchery late-fall hatchery releases
CFHLe	Coleman National Fish Hatchery late-fall emergency trucked releases (no net pens)

Table 12. Total CWT_{total} recoveries by port area, month, and release type[a/] in the 2017 California ocean salmon sport fishery.

		CFH			FRH						NIM		MOK				MER	Non	Total	Total CWT_{total}		Total
	SacW	CFHLh	CFHFh	CFHFn	FRHS	FRHF	FRHFn	FRHFnc	FRHFb	FRHFk	NIMF	NIMFn	MOKF	MOKFn	MOKFnc	MOKFb	MERFn	CV	CV	Hatchery	Natural	Harvest
California Sport Harvest																						
Eureka/Crescent City - *Closed in 2017*																						
Fort Bragg																						
Apr/May[b/]				81			63	24				18		16	4			16	206	222	450	672
Aug	5			96	5		171	15				171		96	52	5			615	615	222	837
Sep			22	69			23	17				22		157	11		8		330	330	40	370
Oct																					8	8
Total	5		**22**	**246**	**5**		**257**	**56**				**211**		**268**	**68**	**5**	**8**	**16**	**1,151**	**1,167**	**720**	**1,887** (3%)
San Francisco																						
Apr		3		100	5		43	17				42		33	3			11	246	257	141	398
May	10	3	13	158		13	354	44			13	157		184	30	10	9	13	998	1,011	195	1,206
Jun	34	16	165	475	8		1,353	200	4		15	487		709	148	18	31	4	3,661	3,665	1,576	5,241
Jul	81	57	1,211	865	82	32	5,875	297			326	1,666	48	4,458	1,638	390	301	227	17,325	17,553	6,653	24,206
Aug	27	99	577	771	110	17	4,548	258	4		289	915	11	3,895	1,576	477	368	57	13,943	14,000	3,972	17,972
Sep	4	36	81	318	20		759	263		3	17	345		863	478	92	78		3,358	3,358	532	3,890
Oct		45	9	19	5		41	18				268		119	63	17	7		611	611	232	843
Total	**156**	**258**	**2,057**	**2,705**	**230**	**62**	**12,973**	**1,096**	**8**	**3**	**660**	**3,881**	**59**	**10,260**	**3,935**	**1,003**	**794**	**313**	**40,142**	**40,455**	**13,301**	**53,756** (86%)
Monterey																						
Apr	52	23		1,317	37		1,225	162				268		200	7				3,291	3,291	587	3,878
May	6	7		102			152	13				75		26					381	381	68	449
Jun				60			60					30		30					179	179	13	192
Jul	12		48	336	6		467	80				191		263	36				1,440	1,440	595	2,035
Total	**70**	**29**	**48**	**1,815**	**43**		**1,904**	**256**				**565**		**519**	**43**				**5,291**	**5,291**	**1,263**	**6,554** (11%)
California Total Sport Harvest																						
	231	**287**	**2,127**	**4,766**	**278**	**62**	**15,134**	**1,408**	**8**	**3**	**660**	**4,657**	**59**	**11,047**	**4,045**	**1,008**	**802**	**329**	**46,584**	**46,913**	**15,284**	**62,197**
Oregon Total Sport Harvest																						
			13	***57***			***98***	***7***				***99***		***58***	***23***	***3***	***8***	***464***	***365***	***829***	***1,857***	***2,686***

a/ Release types defined in Table 3; CFHLe recoveries merged with CFHLh, FRHFtib merged with FRHFn, MOKFx merged with MOKF, MERFt merged with MERFn. No ocean recoveries of FRHSn.

b/ April and May were merged for the Fort Bragg sport harvest due to low catch rates and resultant CWT recoveries during April.

Table 13. Percentage[a/] of CWT_{total} recoveries by port area, month, and release type[b/] in the 2017 California ocean salmon sport fishery.

		CFH			FRH						NIM		MOK				MER	Non	Total	Total %		Total
	SacW	CFHLh	CFHFh	CFHFn	FRHS	FRHF	FRHFn	FRHFnc	FRHFb	FRHFk	NIMF	NIMFn	MOKF	MOKFn	MOKFnc	MOKFb	MERFn	CV	CV	Hatchery	Natural	Harvest
California Sport Harvest																						
Eureka/Crescent City - *Closed in 2017*																						
Fort Bragg																						
Apr/May[c/]				12%			9%	4%				3%		2%	1%			2%	31%	33%	67%	672
Aug	1%			11%	1%		20%	2%				20%		11%	6%	1%			73%	73%	27%	837
Sep			6%	19%			6%	5%				6%		42%	3%		2%		89%	89%	11%	370
Oct																					100%	8
Total	**0%**		**1%**	**13%**	**0%**		**14%**	**3%**				**11%**		**14%**	**4%**	**0%**	**0%**	**1%**	**61%**	**62%**	**38%**	**1,887**
San Francisco																						
Apr		1%		25%	1%		11%	4%				11%		8%	1%			3%	62%	65%	35%	398
May	1%	0%	1%	13%		1%	29%	4%			1%	13%		15%	2%	1%	1%	1%	83%	84%	16%	1,206
Jun	1%	0%	3%	9%	0%		26%	4%	0%		0%	9%		14%	3%	0%	1%	0%	70%	70%	30%	5,241
Jul	0%	0%	5%	4%	0%	0%	24%	1%			1%	7%	0%	18%	7%	2%	1%	1%	72%	73%	27%	24,206
Aug	0%	1%	3%	4%	1%	0%	25%	1%	0%		2%	5%	0%	22%	9%	3%	2%	0%	78%	78%	22%	17,972
Sep	0%	1%	2%	8%	1%		20%	7%		0%	0%	9%		22%	12%	2%	2%		86%	86%	14%	3,890
Oct		5%	1%	2%	1%		5%	2%				32%		14%	7%	2%	1%		72%	72%	28%	843
Total	**0%**	**0%**	**4%**	**5%**	**0%**	**0%**	**24%**	**2%**	**0%**	**0%**	**1%**	**7%**	**0%**	**19%**	**7%**	**2%**	**1%**	**1%**	**75%**	**75%**	**25%**	**53,756**
Monterey																						
Apr	1%	1%		34%	1%		32%	4%				7%		5%	0%				85%	85%	15%	3,878
May	1%	1%		23%			34%	3%				17%		6%					85%	85%	15%	449
Jun				31%			31%					15%		15%					93%	93%	7%	192
Jul	1%		2%	17%	0%		23%	4%				9%		13%	2%				71%	71%	29%	2,035
Total	**1%**	**0%**	**1%**	**28%**	**1%**		**29%**	**4%**				**9%**		**8%**	**1%**				**81%**	**81%**	**19%**	**6,554**
California Total Sport Harvest																						
	0%	**0%**	**3%**	**8%**	**0%**	**0%**	**24%**	**2%**	**0%**	**0%**	**1%**	**7%**	**0%**	**18%**	**7%**	**2%**	**1%**	**1%**	**75%**	**75%**	**25%**	**62,197**
Oregon Total Sport Harvest																						
			0%	***2%***			***4%***	***0%***				***4%***		***2%***	***1%***	***0%***	***0%***	***17%***	***14%***	***31%***	***69%***	***2,686***

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

b/ Release types defined in Table 3; CFHLe recoveries merged with CFHLh, FRHFtib merged with FRHFn, MOKFx merged with MOKF, MERFt merged with MERFn. No ocean recoveries of FRHSn.

c/ April and May were merged for the Fort Bragg sport harvest due to low catch rates and resultant CWT recoveries during April.

Table 14. Total CWT_{total} recoveries by port area, month, and release type[a/] in the 2017 California ocean salmon commercial fishery.

		CFH			FRH						NIM		MOK				MER	Non	Total	Total CWT_{total}		Total
	SacW	CFHLh	CFHFh	CFHFn	FRHS	FRHF	FRHFn	FRHFnc	FRHFb	FRHFk	NIMF	NIMFn	MOKF	MOKFn	MOKFnc	MOKFb	MERFn	CV	CV	Hatchery	Natural	Harvest
California Commercial Harvest																						
Eureka/Crescent City - *Closed in 2017*																						
Fort Bragg																						
Sep		4		184			144	59				254	14	294	32	4		71	989	1,060	875	1,935
																						(5%)
San Francisco																						
Aug	25	59	112	2,954	7		3,869	887			14	1,969	25	1,689	305	15	37	357	11,969	12,326	6,010	18,336
Sep		57		1,003	10	13	1,067	506		3	13	1,151	46	1,495	357	19	24	13	5,763	5,776	2,521	8,297
Oct	5	7		36				7				509	14	304	51	2	26		962	962	317	1,279
Total	**29**	**122**	**112**	**3,993**	**17**	**13**	**4,936**	**1,400**		**3**	**27**	**3,629**	**85**	**3,488**	**714**	**37**	**87**	**371**	**18,693**	**19,064**	**8,848**	**27,912**
																						(66%)
Monterey																						
May	3		34	1,333			1,430	166	3			280	20	436	43			20	3,747	3,767	1,821	5,588
Jun	16	5	46	2,077			1,799	323	5	4		363		488	56			216	5,182	5,397	1,494	6,891
Total	**19**	**5**	**80**	**3,410**			**3,228**	**489**	**9**	**4**		**642**	**20**	**924**	**99**			**235**	**8,929**	**9,164**	**3,315**	**12,479**
																						(29%)
California Total Commercial Harvest																						
	48	**132**	**192**	**7,587**	**17**	**13**	**8,309**	**1,948**	**9**	**7**	**27**	**4,525**	**119**	**4,706**	**845**	**41**	**87**	**676**	**28,612**	**29,288**	**13,038**	**42,326**
Oregon Total Commercial Harvest																						
			9	***849***			***859***	***166***	***10***			***562***	***42***	***1,059***	***55***	***6***		***6,150***	***3,619***	***9,769***	***9,449***	***19,218***

a/ Release types defined in Table 3; CFHLe recoveries merged with CFHLh, FRHFtib merged with FRHFn, MOKFx merged with MOKF, MERFt merged with MERFn. No ocean recoveries of FRHSn.

Table 15. Percentage[a/] of CWT_{total} recoveries by port area, month, and release type[b/] in the 2017 California ocean salmon commercial fishery.

		CFH			FRH						NIM		MOK				MER	Non	Total	Total %		Total
	SacW	CFHLh	CFHFh	CFHFn	FRHS	FRHF	FRHFn	FRHFnc	FRHFb	FRHFk	NIMF	NIMFn	MOKF	MOKFn	MOKFnc	MOKFb	MERFn	CV	CV	Hatchery	Natural	Harvest
California Commercial Harvest																						
Eureka/Crescent City - *Closed in 2017*																						
Fort Bragg																						
Sep		0%		9%			7%	3%				13%	1%	15%	2%	0%		4%	51%	55%	45%	1,935
San Francisco																						
Aug	0%	0%	1%	16%	0%		21%	5%			0%	11%	0%	9%	2%	0%	0%	2%	65%	67%	33%	18,336
Sep		1%		12%	0%	0%	13%	6%		0%	0%	14%	1%	18%	4%	0%	0%	0%	69%	70%	30%	8,297
Oct	0%	1%		3%				1%				40%	1%	24%	4%	0%	2%		75%	75%	25%	1,279
Total	**0%**	**0%**	**0%**	**14%**	**0%**	**0%**	**18%**	**5%**		**0%**	**0%**	**13%**	**0%**	**12%**	**3%**	**0%**	**0%**	**1%**	**67%**	**68%**	**32%**	**27,912**
Monterey																						
May	0%		1%	24%			26%	3%	0%			5%	0%	8%	1%			0%	67%	67%	33%	5,588
Jun	0%	0%	1%	30%			26%	5%	0%	0%		5%		7%	1%			3%	75%	78%	22%	6,891
Total	**0%**	**0%**	**1%**	**27%**			**26%**	**4%**	**0%**	**0%**		**5%**	**0%**	**7%**	**1%**			**2%**	**72%**	**73%**	**27%**	**12,479**
California Total Commercial Harvest																						
	0%	**0%**	**0%**	**18%**	**0%**	**0%**	**20%**	**5%**	**0%**	**0%**	**0%**	**11%**	**0%**	**11%**	**2%**	**0%**	**0%**	**2%**	**68%**	**69%**	**31%**	**42,326**
Oregon Total Commercial Harvest																						
			0%	***4%***			***4%***	***1%***	***0%***			***3%***	***0%***	***6%***	***0%***	***0%***		***32%***	***19%***	***51%***	***49%***	***19,218***

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

b/ Release types defined in Table 3; CFHLe recoveries merged with CFHLh, FRHFtib merged with FRHFn, MOKFx merged with MOKF, MERFt merged with MERFn. No ocean recoveries of FRHSn.

Table 16. CWT recovery rate (recoveries per 100,000 CWTs released) for experimental & net pen release types in 2017. (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	Mer	SJ	In-basin	Stray	CV total		CWT_{samp}	In-basin	Stray	**CV total**	**Ocean**
FRHFkc	2015	Fall	47,661				17						17	0	**17**	**0%**	**6**	36	0	**36**	**13**
FRHFkr	2015	Fall	47,310				3						3	0	**3**	**0%**	**0**	6	0	**6**	**0**
FRHFn	2015	Fall	2,019,877	2			3,124	20	104	101	39	22	3,143	269	**3,412**	**8%**	**2,704**	156	13	**169**	**134**
NIMFn	2015	Fall	349,016	1			5		236	123	7	2	236	138	**375**	**37%**	**456**	68	40	**107**	**131**
MOKFbb	2015	Fall	100,982				10	20	99	304	29	42	304	200	**504**	**40%**	**508**	301	198	**499**	**503**
MOKFbg	2015	Fall	100,613	1			12	20	93	528	31	42	528	198	**727**	**27%**	**501**	525	197	**722**	**498**
MOKFbr	2015	Fall	101,135							65			65	0	**65**	**0%**	**29**	64	0	**64**	**28**
MOKFn	2015	Fall	1,339,629	9			50		263	1,713	291	363	1,713	975	**2,688**	**36%**	**2,301**	128	73	**201**	**172**
MOKFnp	2015	Fall	484,920	3			129	20	409	1,706	117	52	1,706	730	**2,436**	**30%**	**4,066**	352	151	**502**	**839**
MERFn	2015	Fall	148,804	1	8		49		53	126	109	59	109	295	**405**	**73%**	**236**	73	199	**272**	**159**

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	Mer	SJ	In-basin	Stray	CV total		CWT_{samp}	In-basin	Stray	**CV total**	**Ocean**
CFHFn	2014	Fall	2,951,944	7	32		198	195	1,194	242	238	125	39	2,193	**2,232**	**98%**	**3,077**	1	74	**76**	**104**
FRHFkr	2014	Fall	45,200				1						1	0	**1**	**0%**	**4**	2	0	**2**	**9**
FRHFn	2014	Fall	1,047,852		19		3,883	20	207	98	28	32	3,903	384	**4,286**	**9%**	**3,240**	373	37	**409**	**309**
FRHFnp	2014	Fall	321,527	1	20		2,177	20	179	115	25	7	2,197	347	**2,544**	**14%**	**3,152**	683	108	**791**	**980**
NIMFn	2014	Fall	979,827	1	5	1	38	39	1,220	742	88	96	1,220	1,010	**2,230**	**45%**	**1,895**	125	103	**228**	**193**
MOKFx[b/]	2014	Fall	166,978				1		6	27	9	5	36	12	**48**	**24%**	**57**	22	7	**29**	**34**
MOKFn	2014	Fall	1,244,314	2	5		31	20	165	608	195	311	608	729	**1,338**	**55%**	**1,877**	49	59	**108**	**151**
MOKFns	2014	Fall	241,335		24		17		57	219	31	55	219	184	**402**	**46%**	**847**	91	76	**167**	**351**
MERFn	2014	Fall	37,064						5	18	2		2	23	**25**	**92%**	**7**	5	63	**68**	**18**

Table 16. CWT recovery rate (recoveries per 100,000 CWTs released) for experimental & net pen release types in 2017. (page 2 of 2)

Age 4 CWT recoveries

Release type	Brood year	Run type	# CWT tagged	Central Valley total recoveries (CWT_{samp}) by basin									CV CWT_{samp} totals			% CV Stray	Ocean	Recovery rate per 100K released			
				Bat Cr	Up Sac	Nat crks[a/]	Fea	Yub	Ame	Mok	Mer	SJ	In-basin	Stray	CV total		CWT_{samp}	In-basin	Stray	CV total	Ocean
CFHFn	2013	Fall	1,810,972				20	39	140	19	7	2	0	228	**228**	**100%**	**222**	0	13	**13**	**12**
FRHFbb	2013	Fall	100,227				24		3				24	3	**27**	**11%**	**2**	24	3	**27**	**2**
FRHFbg	2013	Fall	100,564				10						10	0	**10**	**0%**	**8**	10	0	**10**	**8**
FRHFbr	2013	Fall	99,354				25						25	0	**25**	**0%**	**17**	25	0	**25**	**17**
FRHFkr	2013	Fall	44,127										0	0	**0**	**-**	**0**	0	0	**0**	**0**
FRHFn	2013	Fall	1,459,468				193		13	2	2		193	17	**210**	**8%**	**109**	13	1	**14**	**7**
FRHFnp	2013	Fall	366,033		2		221		29	1	9		221	42	**262**	**16%**	**279**	60	11	**72**	**76**
NIMFn	2013	Fall	896,419				3		87	8	7		87	18	**106**	**17%**	**105**	10	2	**12**	**12**
MOKFbb	2013	Fall	101,051							2			2	0	**2**	**0%**	**0**	2	0	**2**	**0**
MOKFbg	2013	Fall	101,426							2			2	0	**2**	**0%**	**20**	2	0	**2**	**20**
MOKFbr	2013	Fall	100,181										0	0	**0**	**-**	**0**	0	0	**0**	**0**
MOKFn	2013	Fall	1,148,423				1		8	4	9	8	4	26	**30**	**86%**	**25**	0.3	2	**3**	**2**
MOKFns	2013	Fall	239,294							1			1	0	**1**	**0%**	**46**	0.4	0	**0.4**	**19**

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/ Since MOKFx were raised at Merced Hatchery, recoveries in both the Mokelumne and Merced basins are considered in-basin.

Central Valley Chinook Experimental and Net Pen release types

CFHFn Coleman National Fish Hatchery fall delta/bay net pen releases

FRHFbb Feather River Hatchery fall barge study: trucked & released in SF Bay (Ft. Baker, Tiburon)

FRHFbg Feather River Hatchery fall barge study: barged to SF Bay and released

FRHFbr Feather River Hatchery fall barge study: in-river releases (numerous sites Sac R.)

FRHFkc Feather River Hatchery fall rice field study: Elkhorn boat ramp Sac River (control group)

FRHFkr Feather River Hatchery fall rice field study: Yolo Bypass Knaggs Ranch rice field

FRHFn Feather River Hatchery fall bay net pen releases

FRHFnp Feather River Hatchery fall coastal net pen releases (Pillar Point)

NIMFn Nimbus Fish Hatchery fall bay net pen releases

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

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.)

MOKFx Mokelumne River Hatchery fall experimental releases (raised in Merced Hatchery)

MOKFn Mokelumne River Hatchery fall delta/bay 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, Moss Landing)

MERFn Merced River Hatchery fall delta/bay net pen releases

#	Release Type	Release Location
1	SacW	Lake Redding Park (Sac R)
2	CFHLe	Balls Ferry (Sac R)
3	CFHFh, CFHLh	Coleman Fish Hatchery
4	FRHS	Gridley (Fea R)
5	FRHS, FRHF	Boyds Pump Boat Ramp (Fea R)
6	FRHFkc	Elkhorn Boat Ramp (Sac R)
7	NIMF	American River
8	FRHFbr	Broderick Boat Ramp (Sac R)
9	FRHFkr	Yolo Bypass - Knaggs Ranch
10	MOKF	Mokelumne River Hatchery
11	MOKFbr	Miller's Ferry Bridge (Mok R)
12	CFHFn, FRHFbr	Rio Vista Net Pens (Delta)
13	MERFt	Mossdale (San Joaq R)
14	MERFt, MOKFx	Jersey Point (San Joaq R)
15	MOKFn, MERFn	Sherman Island Net Pens (Delta)
16	FRHSn, FRHFn, NIMFn	Mare Island Net Pens (Bay)
17	FRHSn, FRHFn, NIMFn	Wickland Oil Net Pens (Bay)
18	FRHFtib	Tiburon Net Pens (Bay)
19	FRHFbb, MOKFbb	Trucked to SF Bay (Fort Baker, Tiburon)
19	FRHFbg, MOKFbg	Barged to SF Bay (Golden Gate mouth)
20	FRHFnp, MOKFnp	Pillar Point Net Pens (Coastal)
21	MOKFns	Santa Cruz Net Pens (Coastal)
22	MOKFns	Moss Landing Net Pens (Coastal)

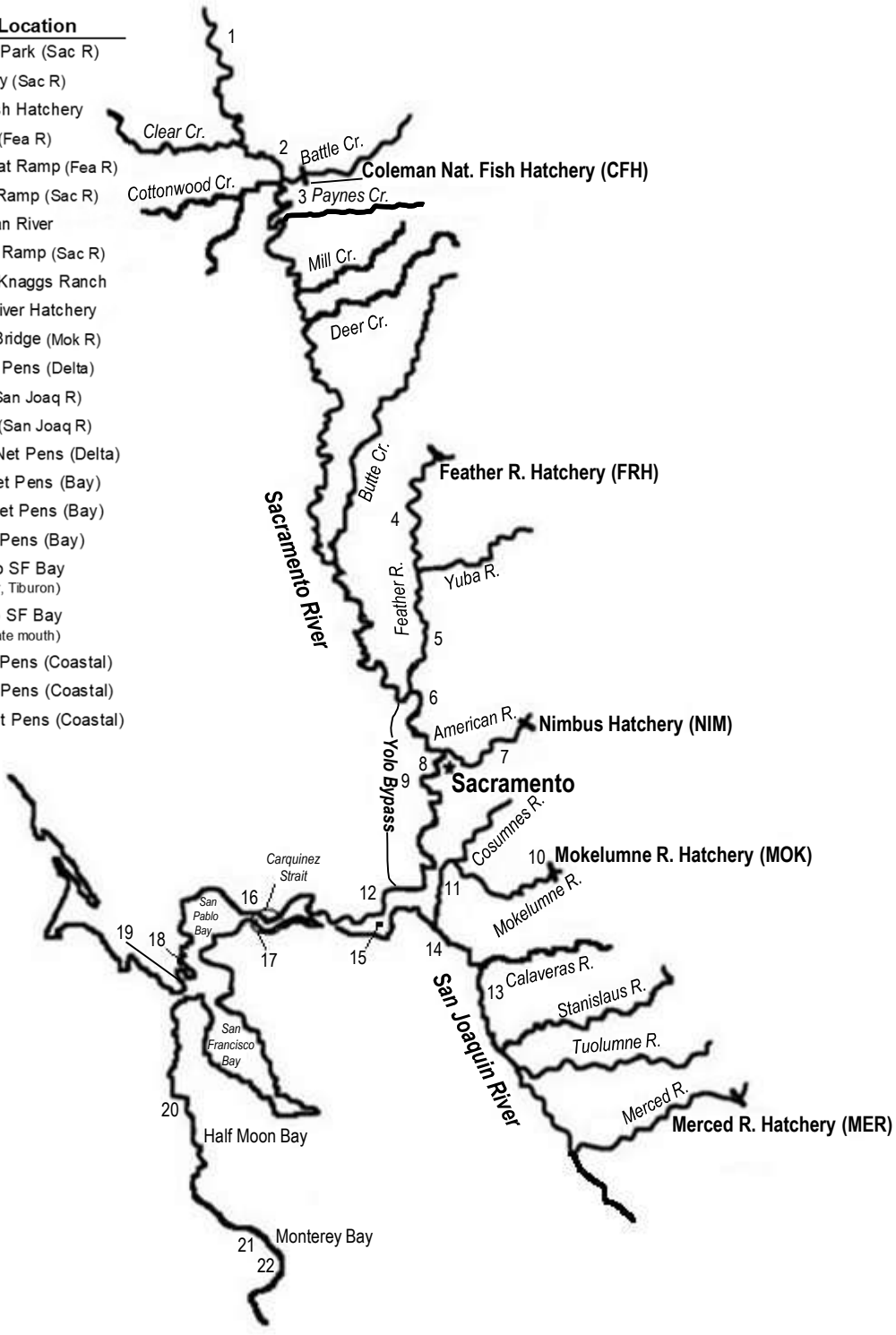


Figure 1. Map of release sites for CV hatchery release types, brood years 2012-2015.

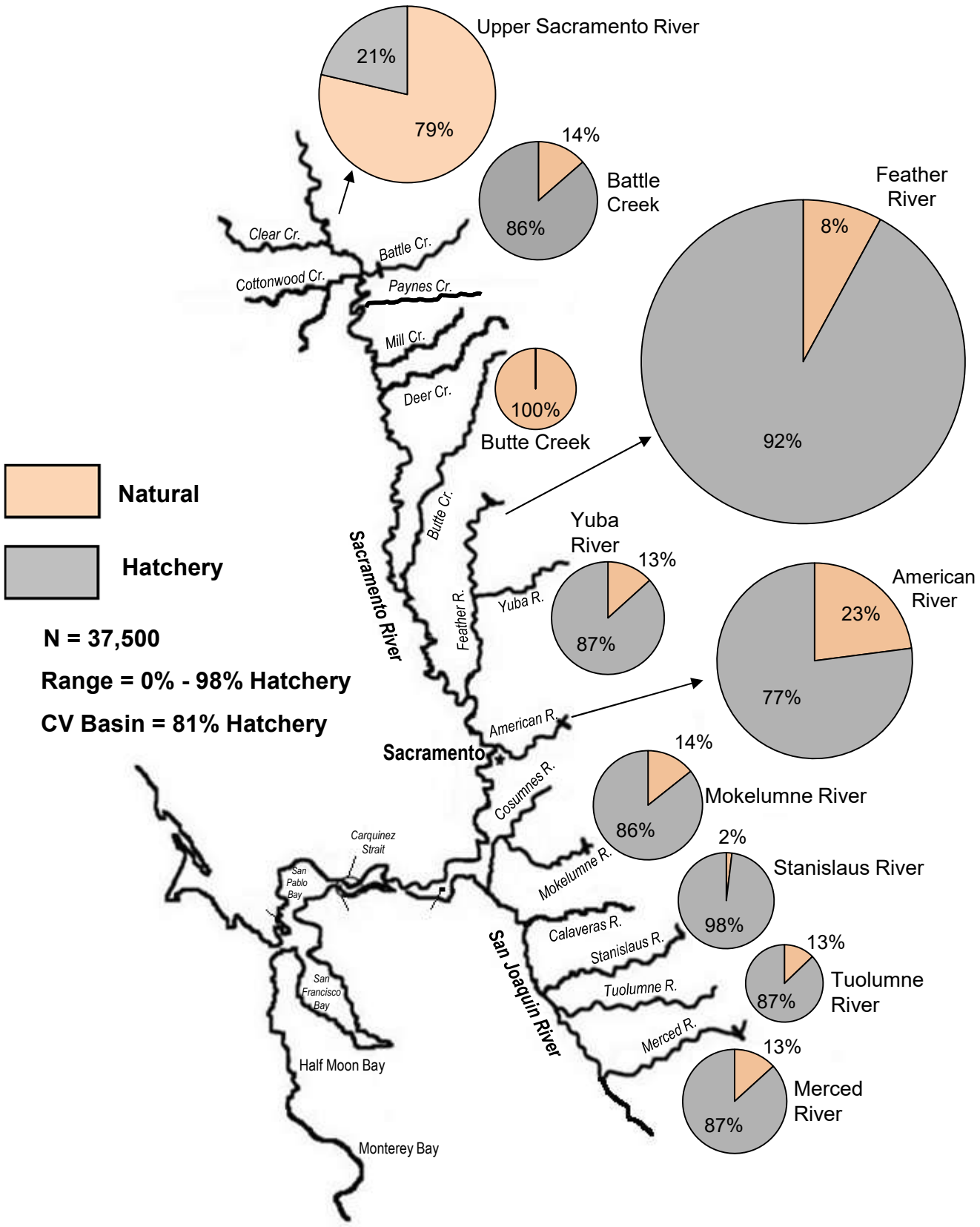


Figure 2. Fall-run CV natural area escapement, hatchery and natural proportions, 2017.

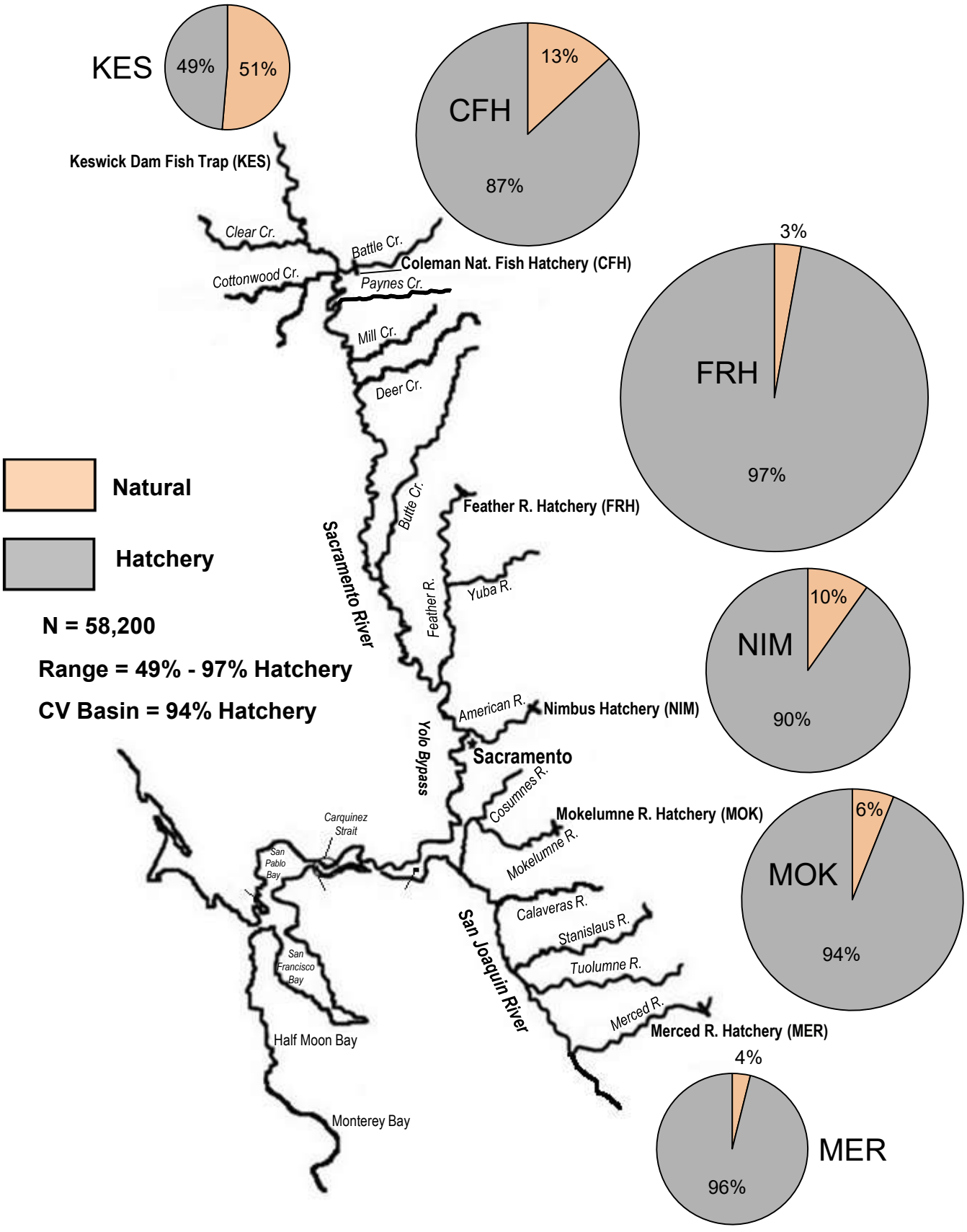


Figure 3. Fall-run CV hatchery escapement, hatchery and natural proportions, 2017.

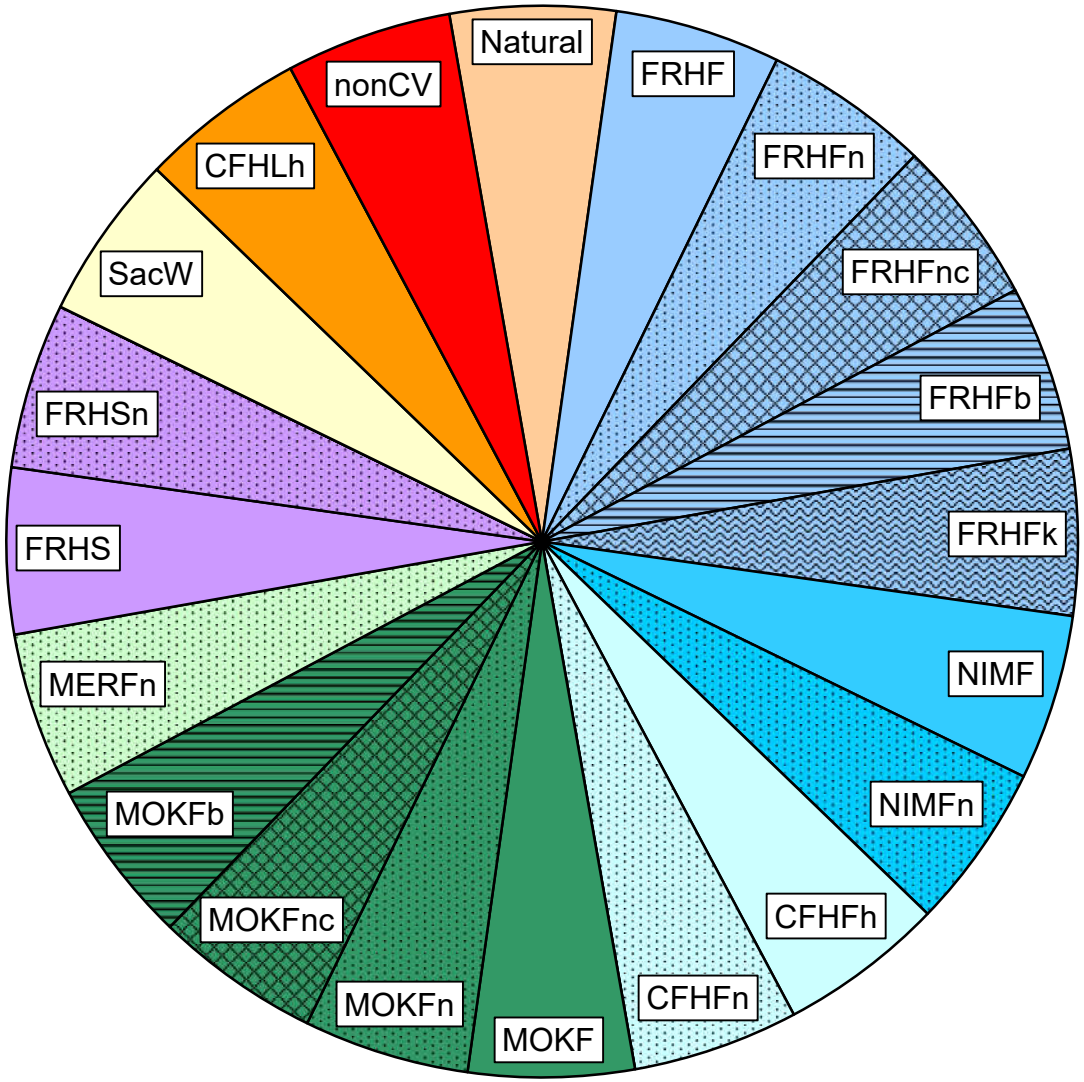


Figure 4. Color and pattern scheme used in all pie chart figures for Central Valley hatchery release types, brood years 2012-2015.

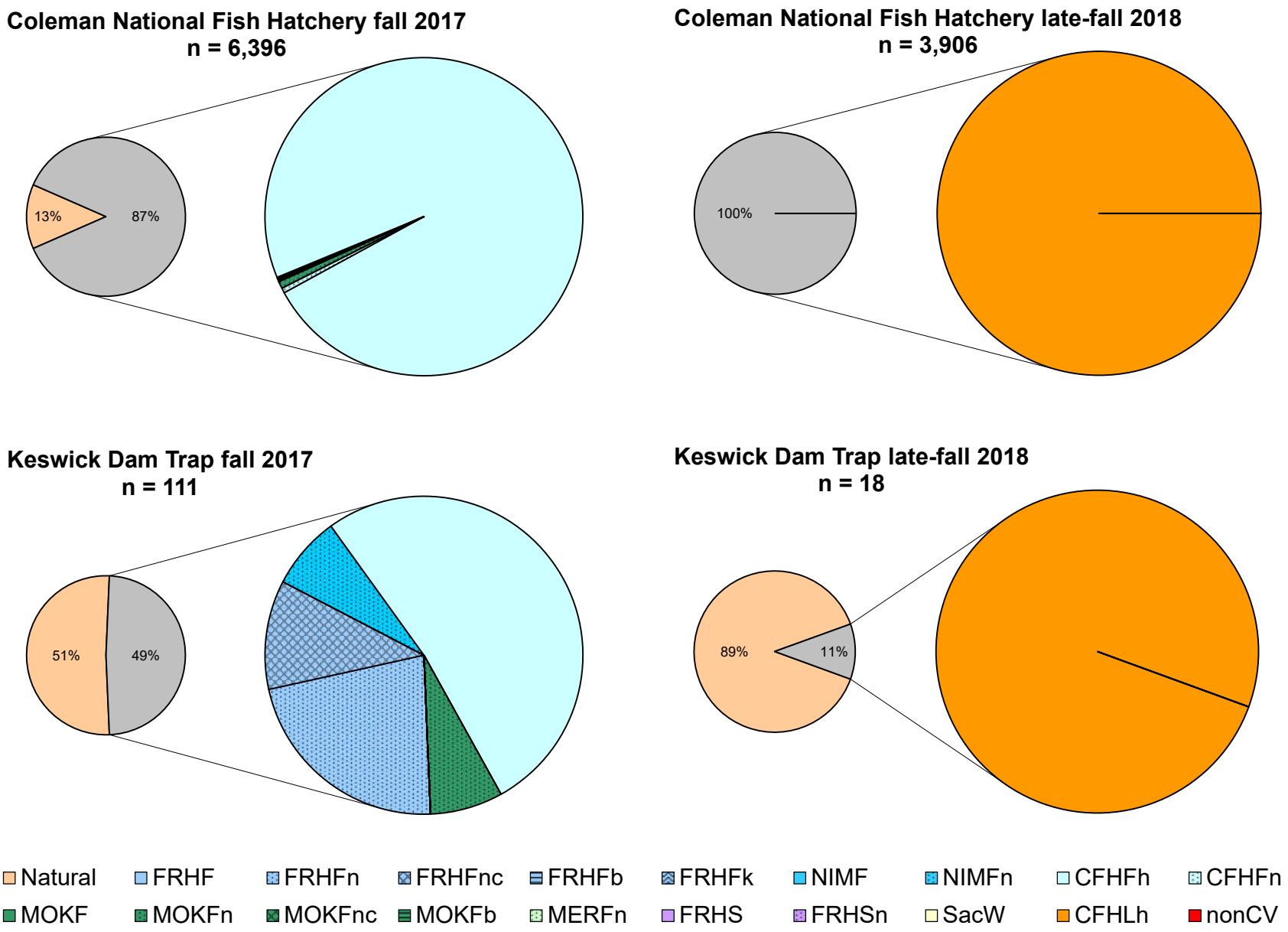


Figure 5. Proportion of hatchery- and natural-origin fish at Coleman National Fish Hatchery, 2017-18.

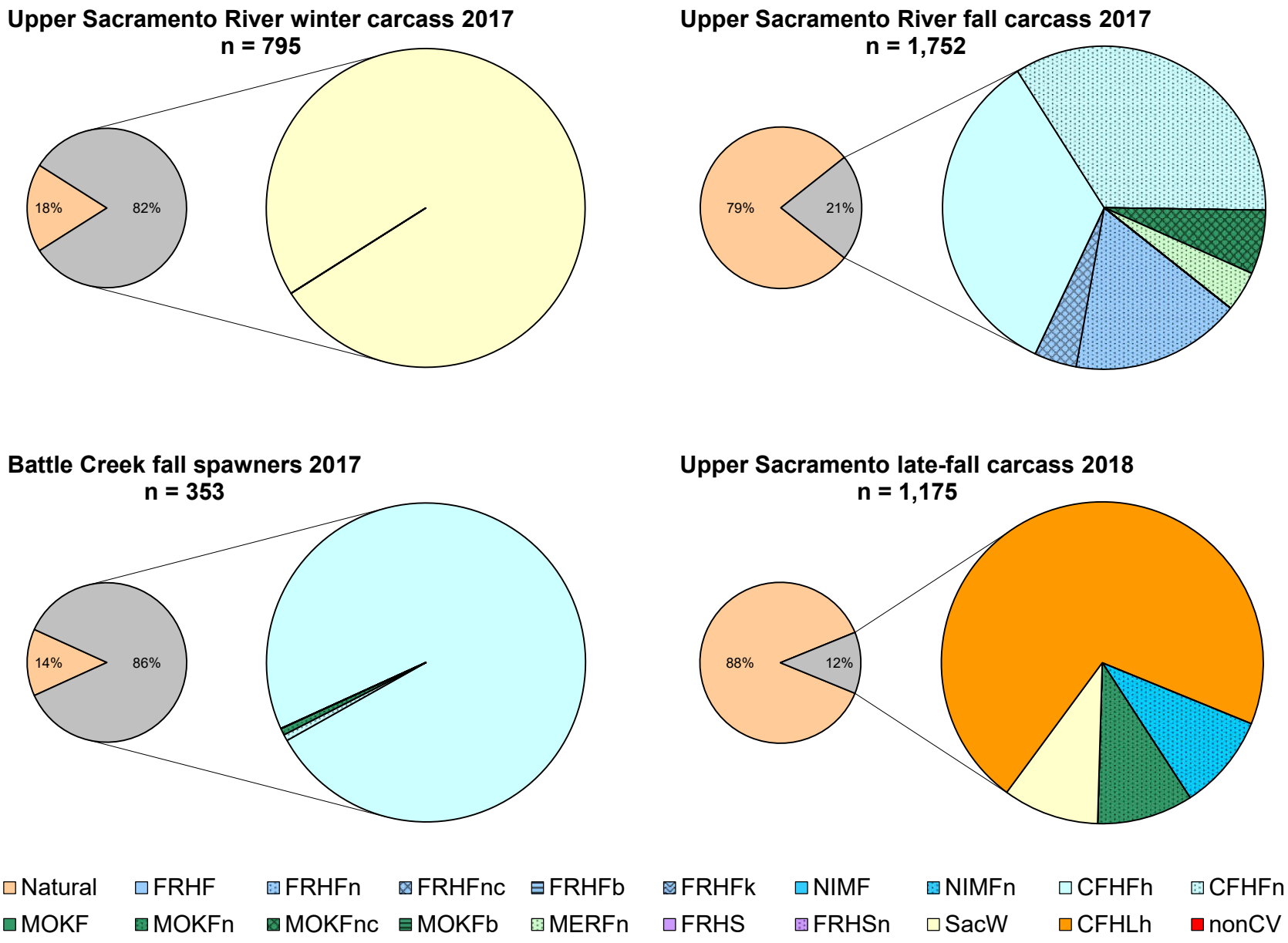


Figure 6. Proportion of hatchery- and natural-origin fish in Upper Sacramento River & Battle Creek, 2017-18.

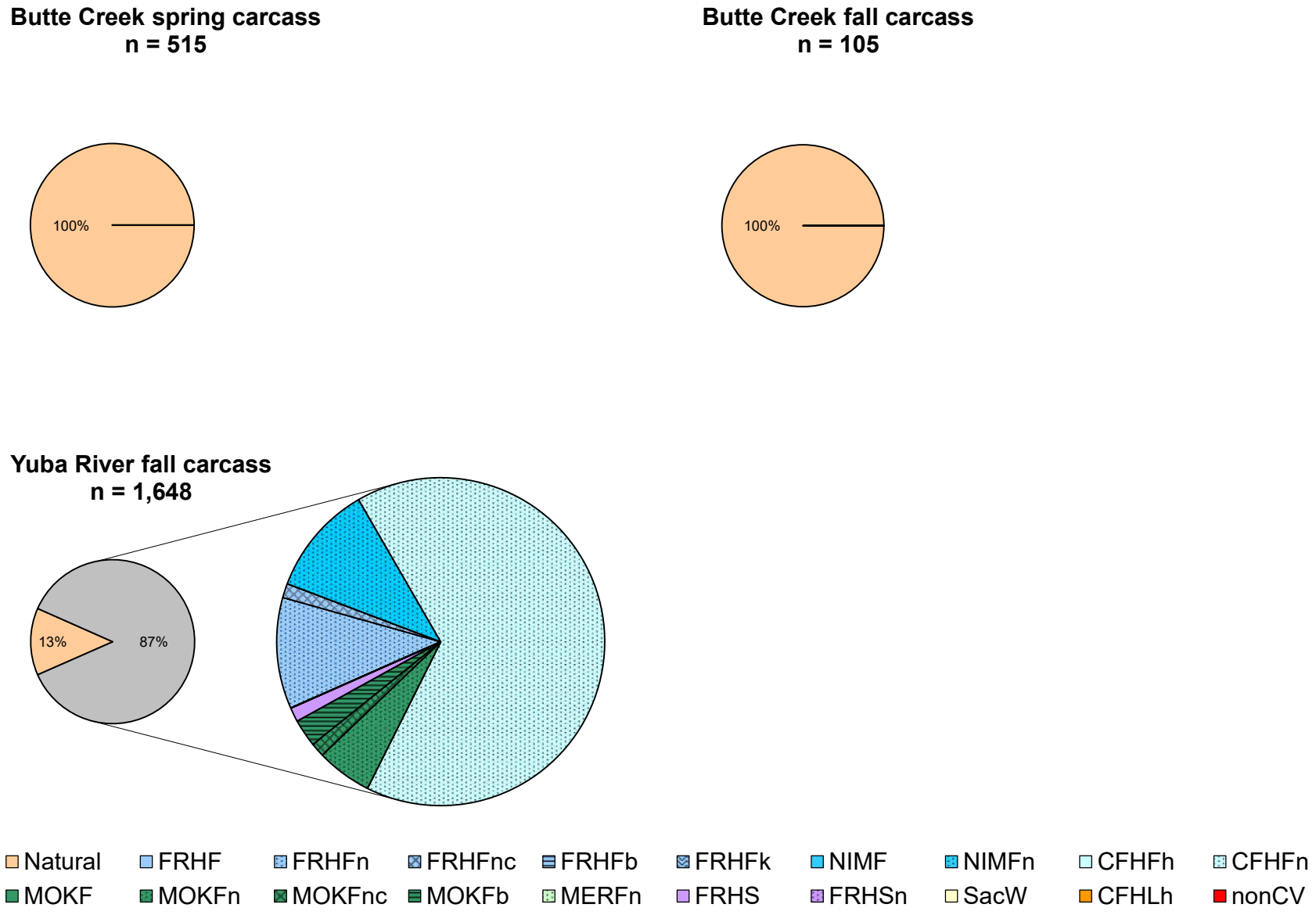


Figure 7. Proportion of hatchery- and natural-origin fish in Butte Creek & Yuba River, 2017.

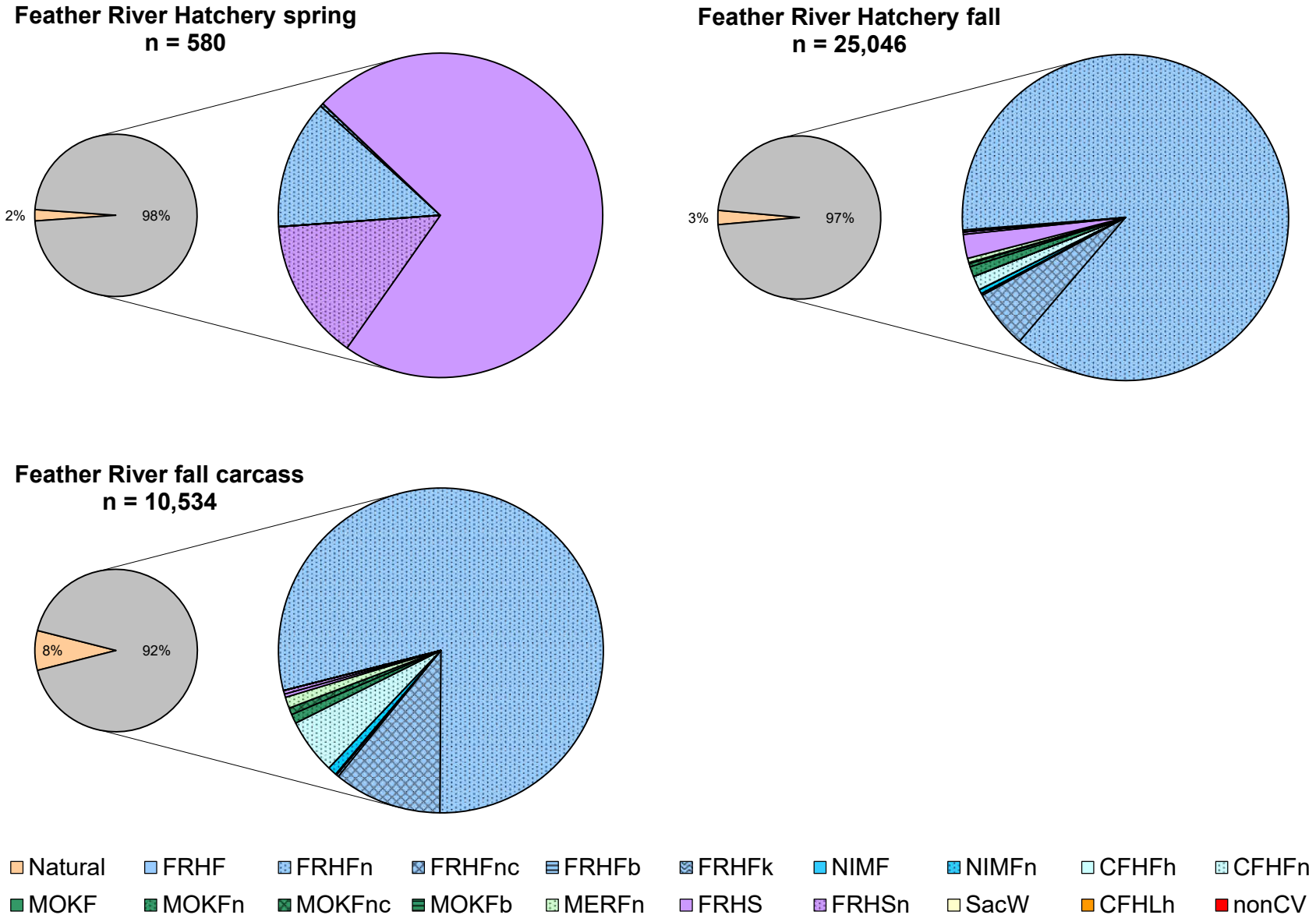


Figure 8. Proportion of hatchery- and natural-origin fish in the Feather River, 2017.

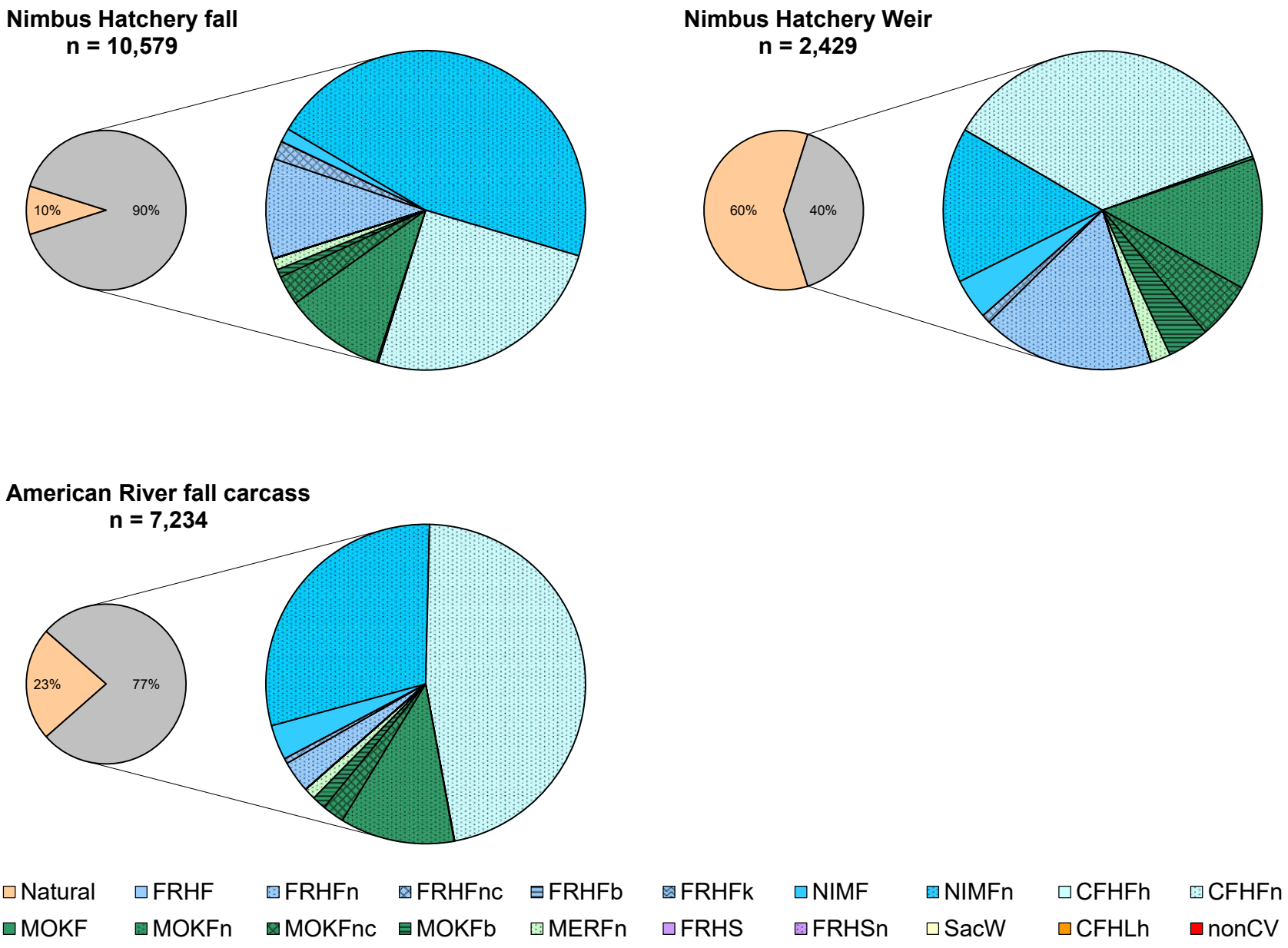


Figure 9. Proportion of hatchery- and natural-origin fish in the American River, 2017.

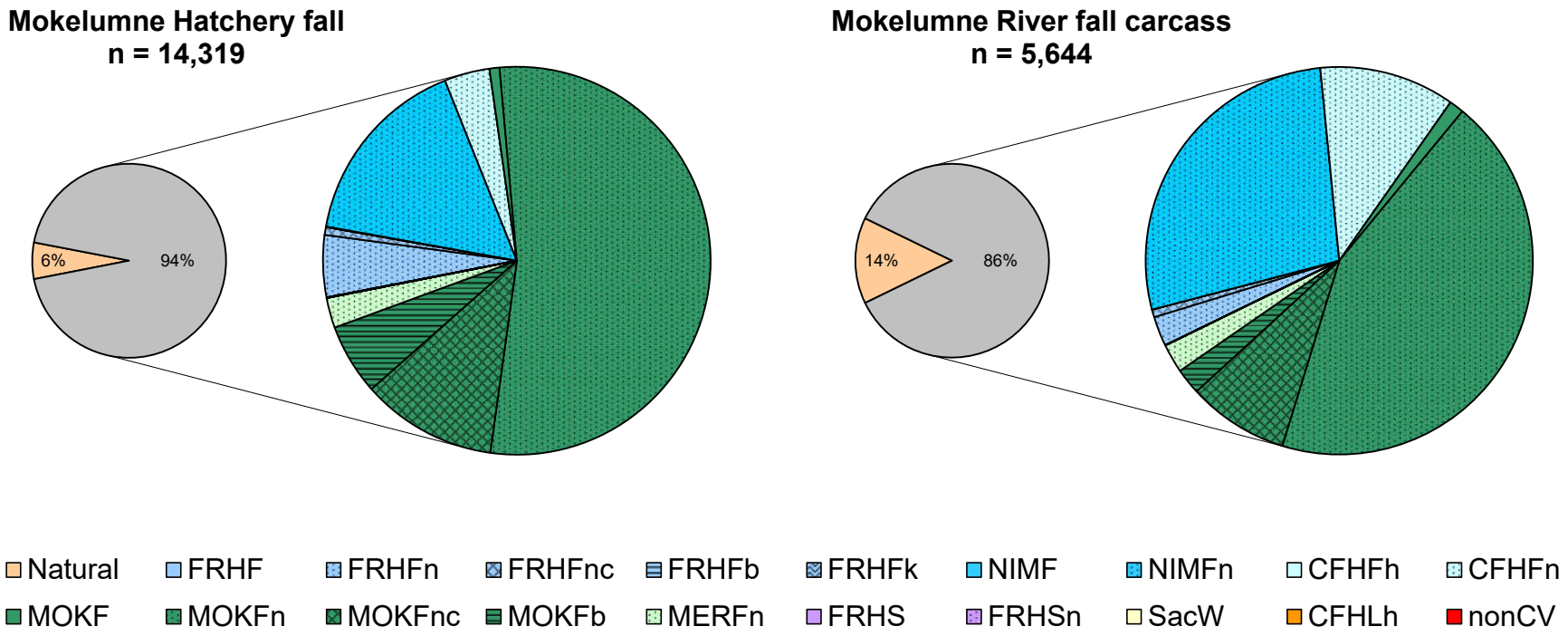


Figure 10. Proportion of hatchery- and natural-origin fish in the Mokelumne River, 2017.

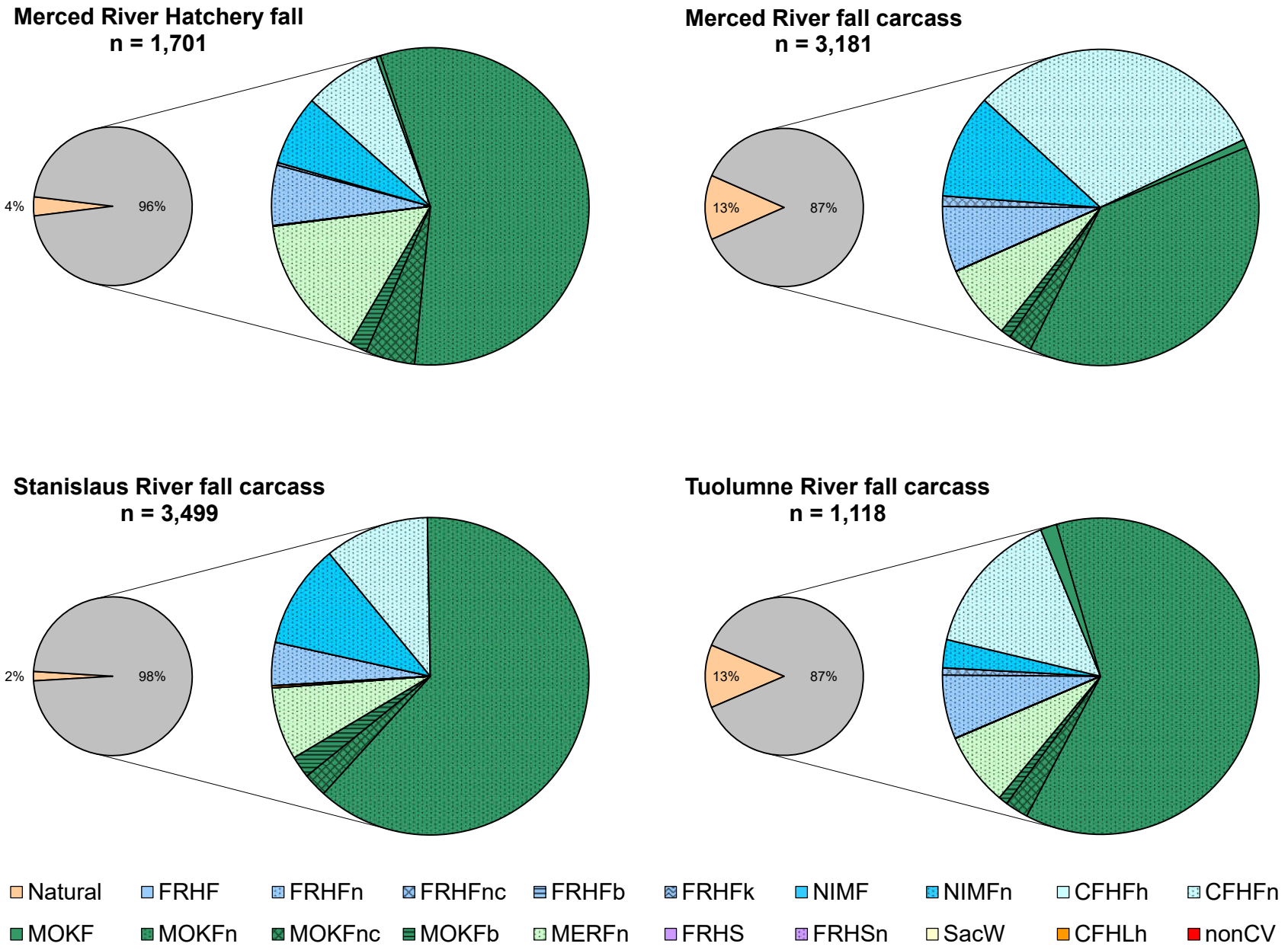


Figure 11. Proportion of hatchery- and natural-origin fish in Merced River & San Joaquin Basin tributaries, 2017.

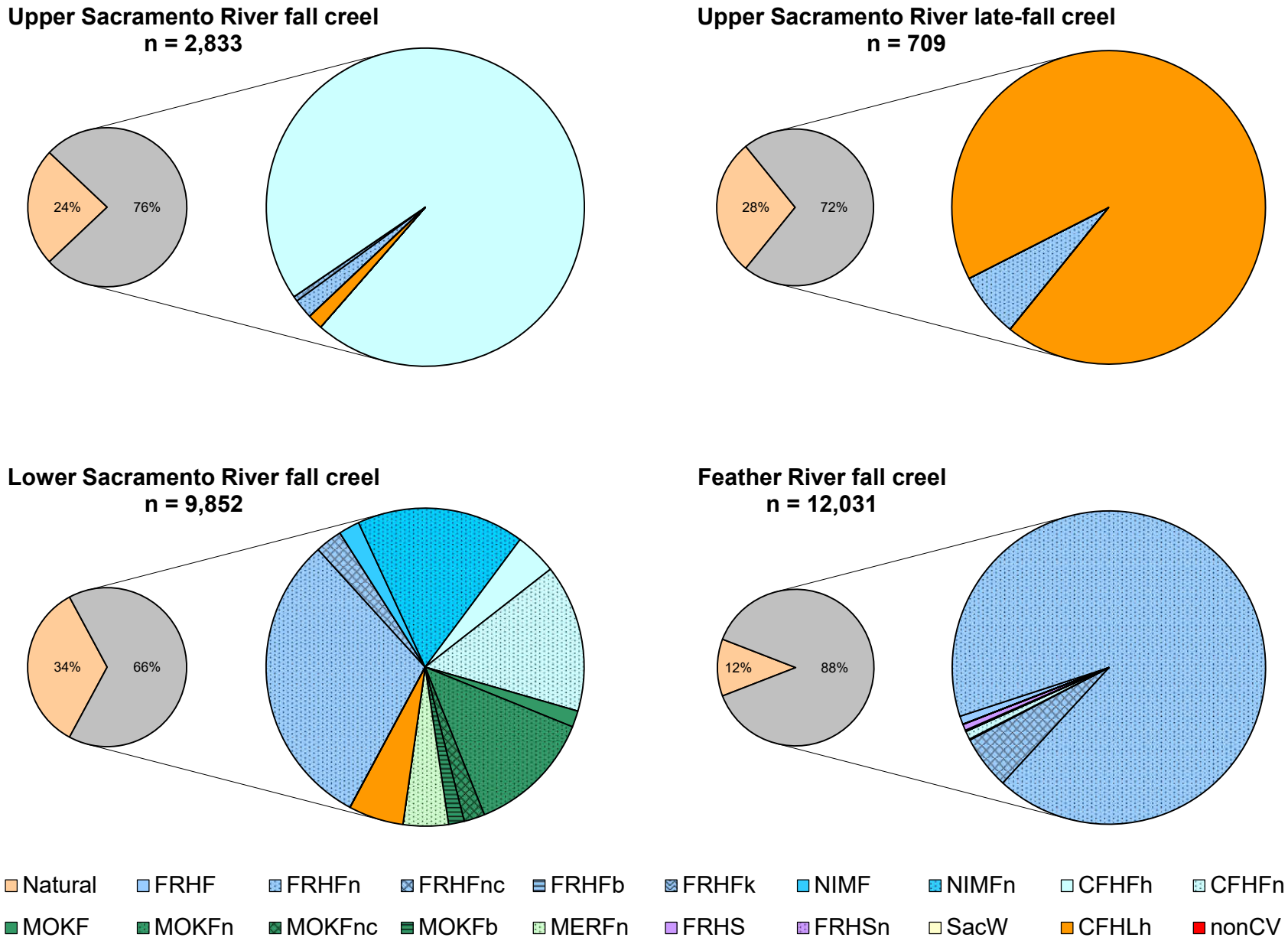


Figure 12. Proportion of hatchery- and natural-origin fish in sport harvest on Sacramento & Feather rivers, 2017.

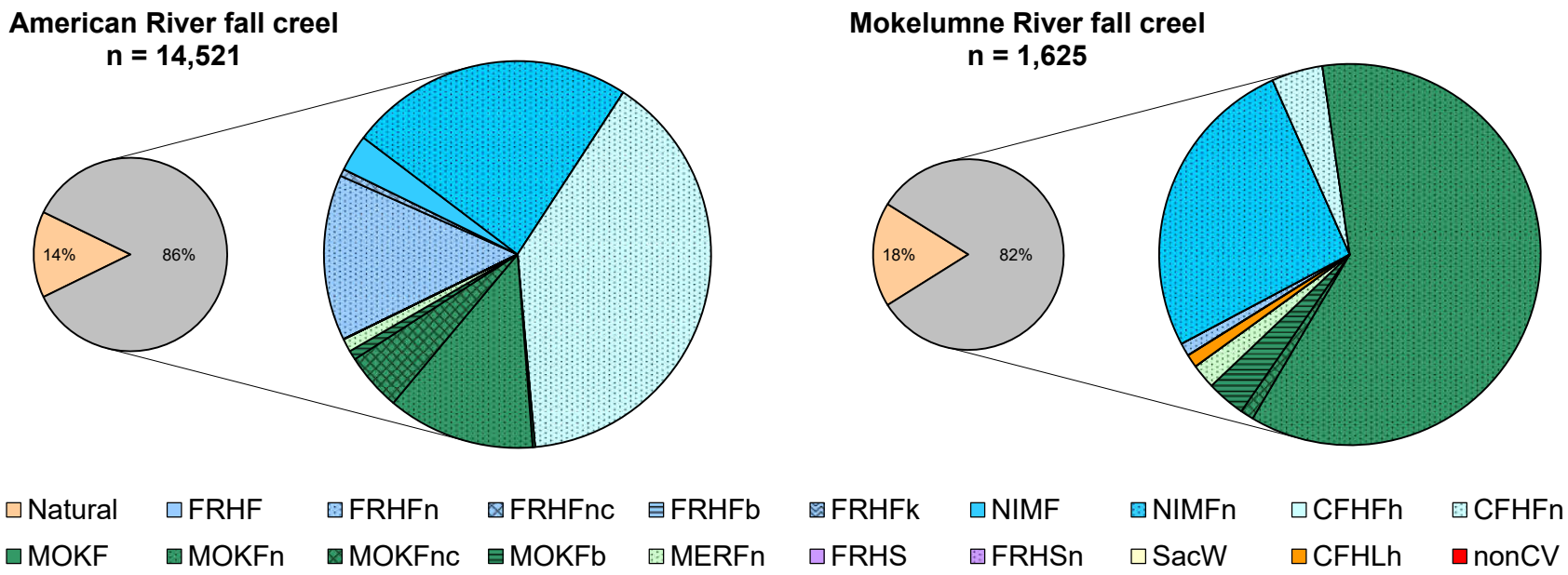


Figure 13. Proportion of hatchery- and natural-origin fish in sport harvest on American & Mokelumne rivers, 2017.

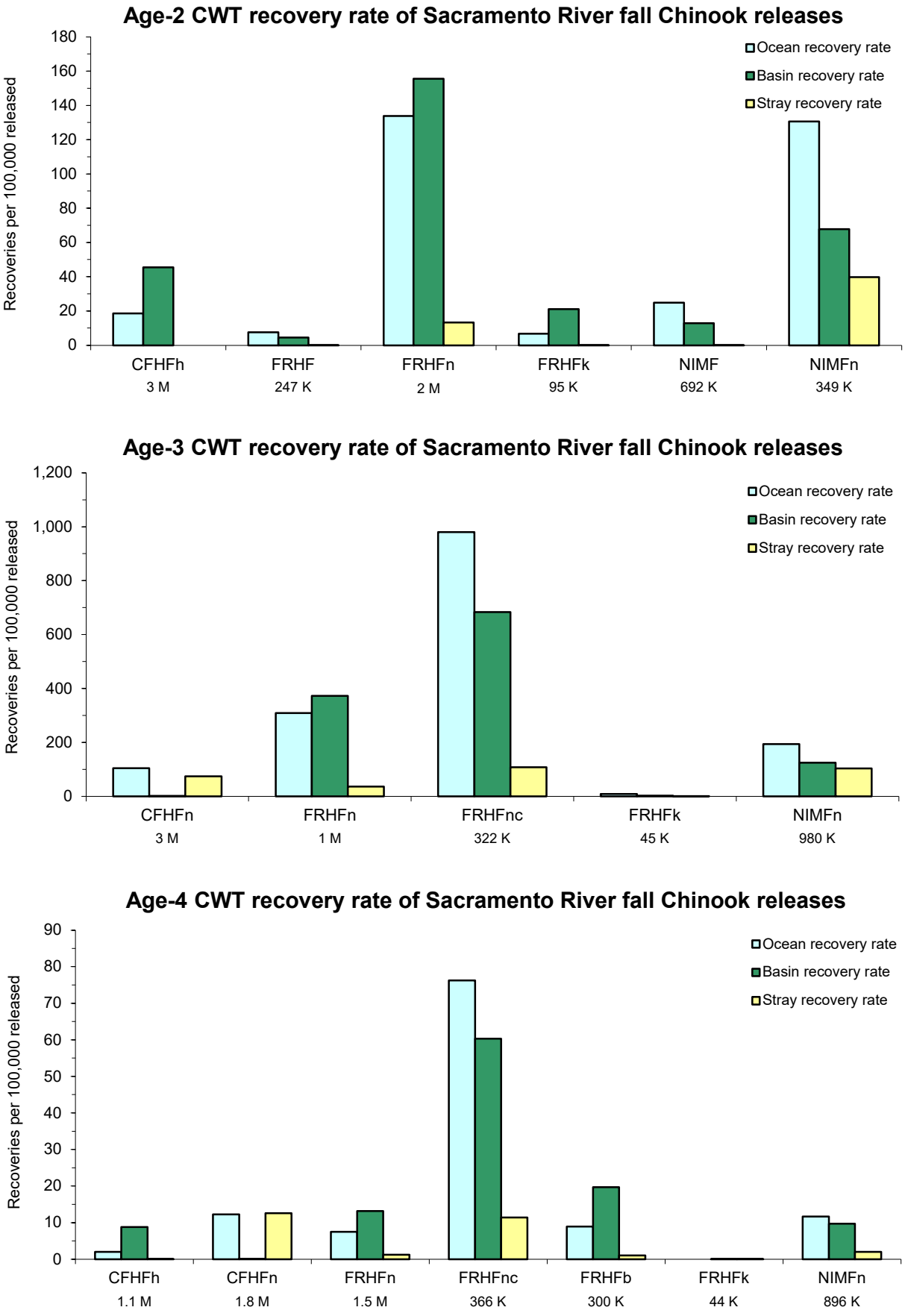


Figure 14. CWT recovery rates of Sacramento River fall Chinook releases by age in 2017.

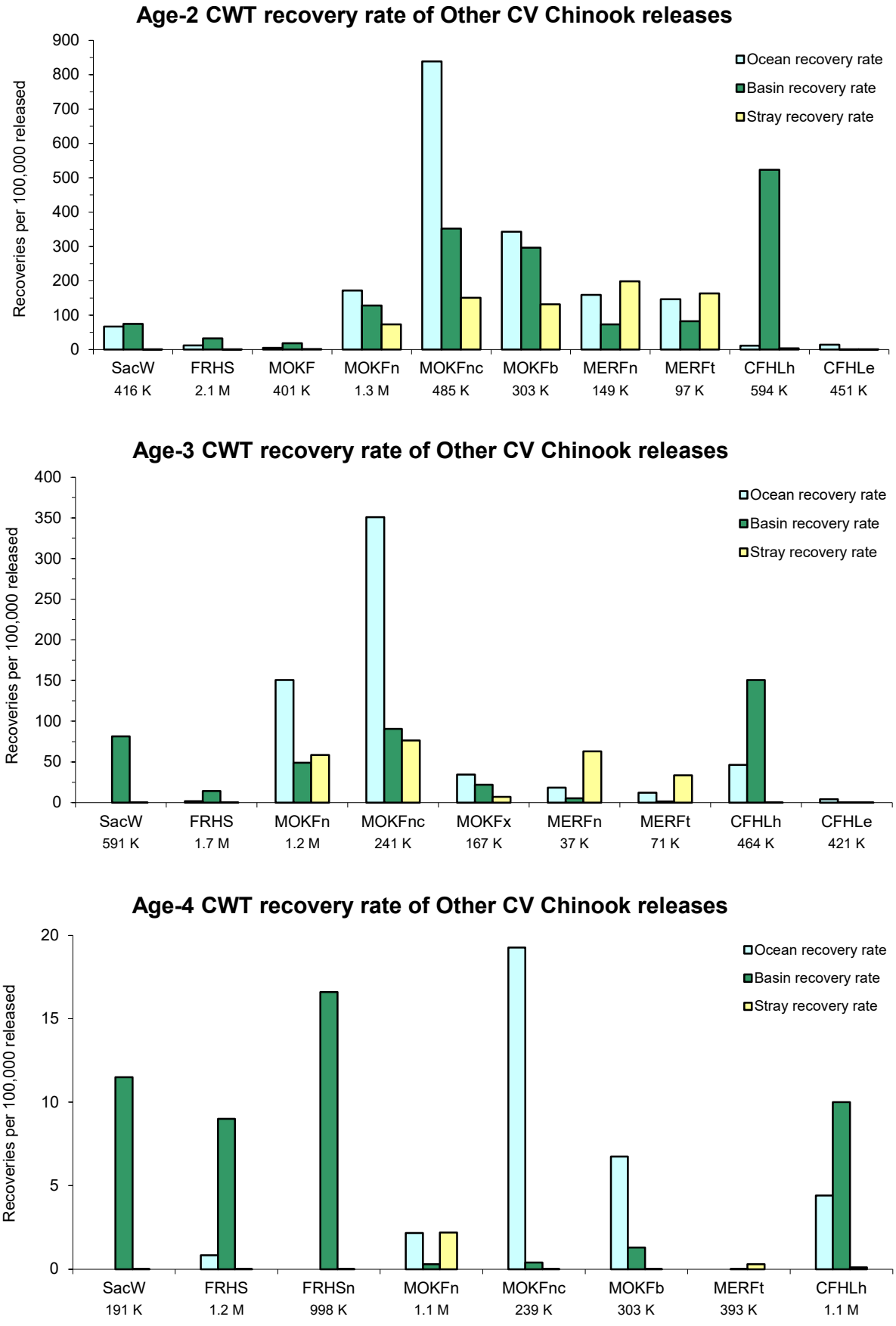


Figure 15. CWT recovery rates of Other CV Chinook releases by age in 2017.

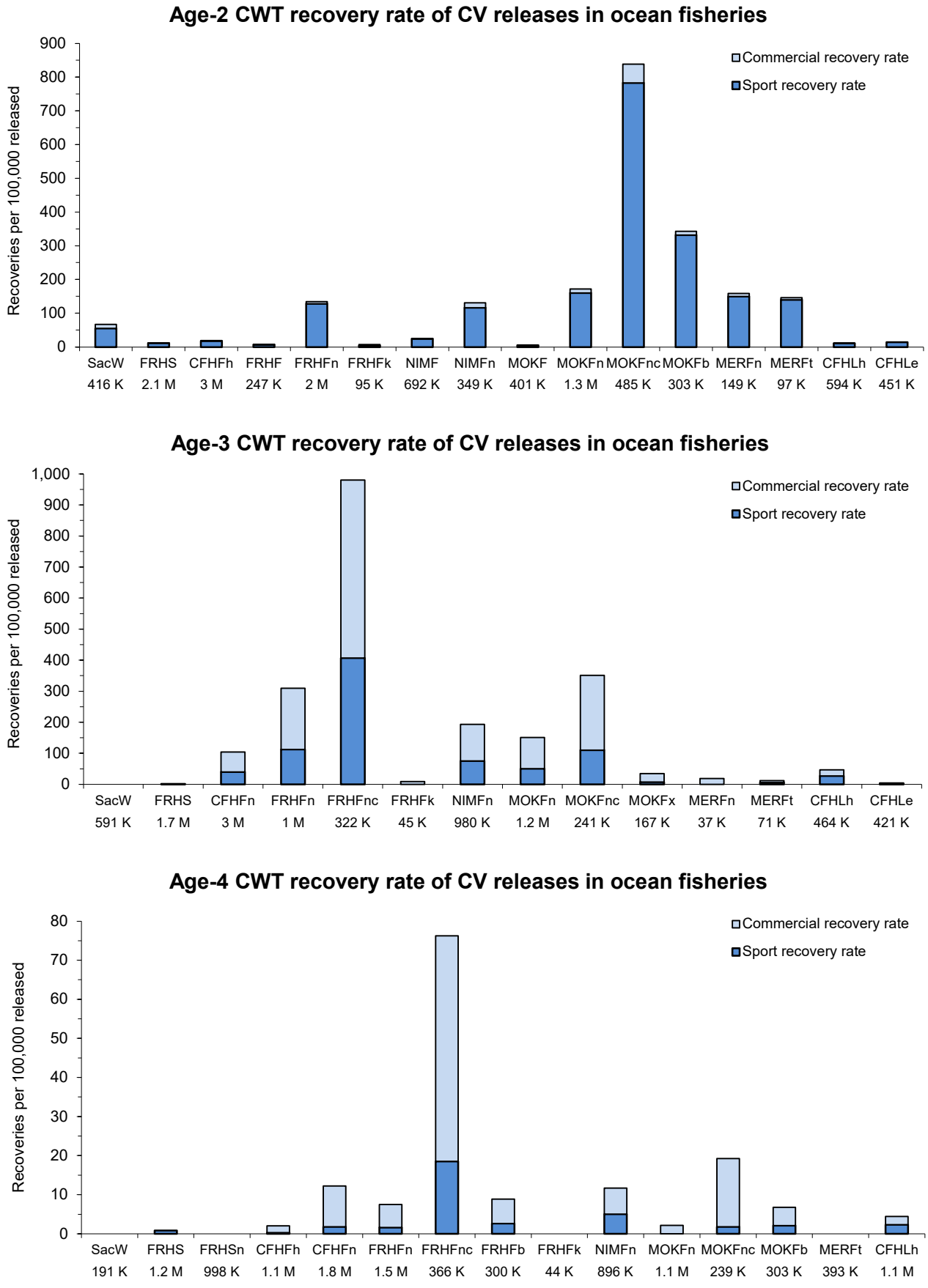


Figure 16. CWT recovery rates by release type in 2017 ocean salmon fisheries.

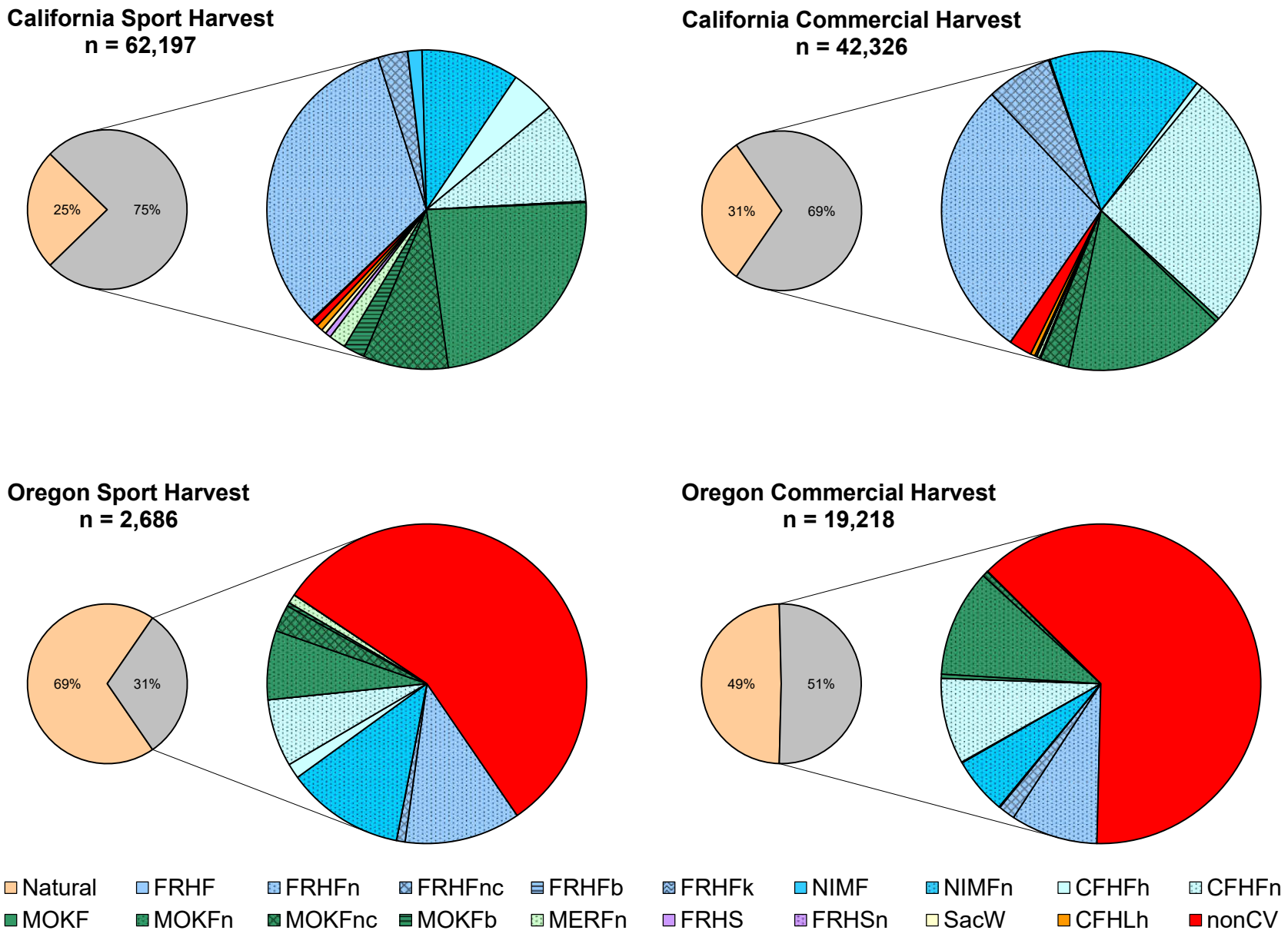


Figure 17. Proportion of hatchery- and natural-origin salmon in 2017 California and Oregon ocean fisheries.

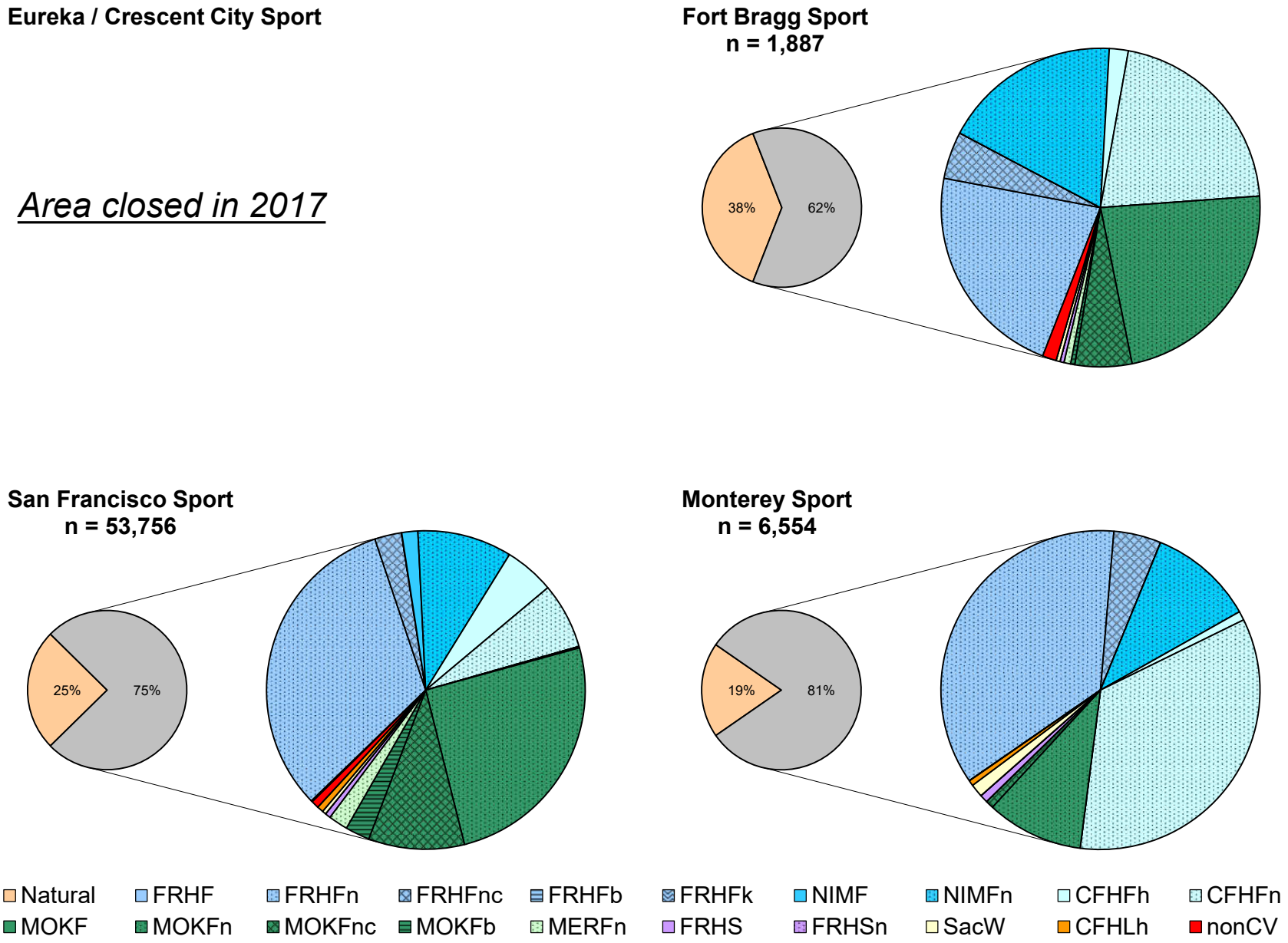


Figure 18. Proportion of hatchery- and natural-origin salmon in the 2017 California ocean sport fishery.

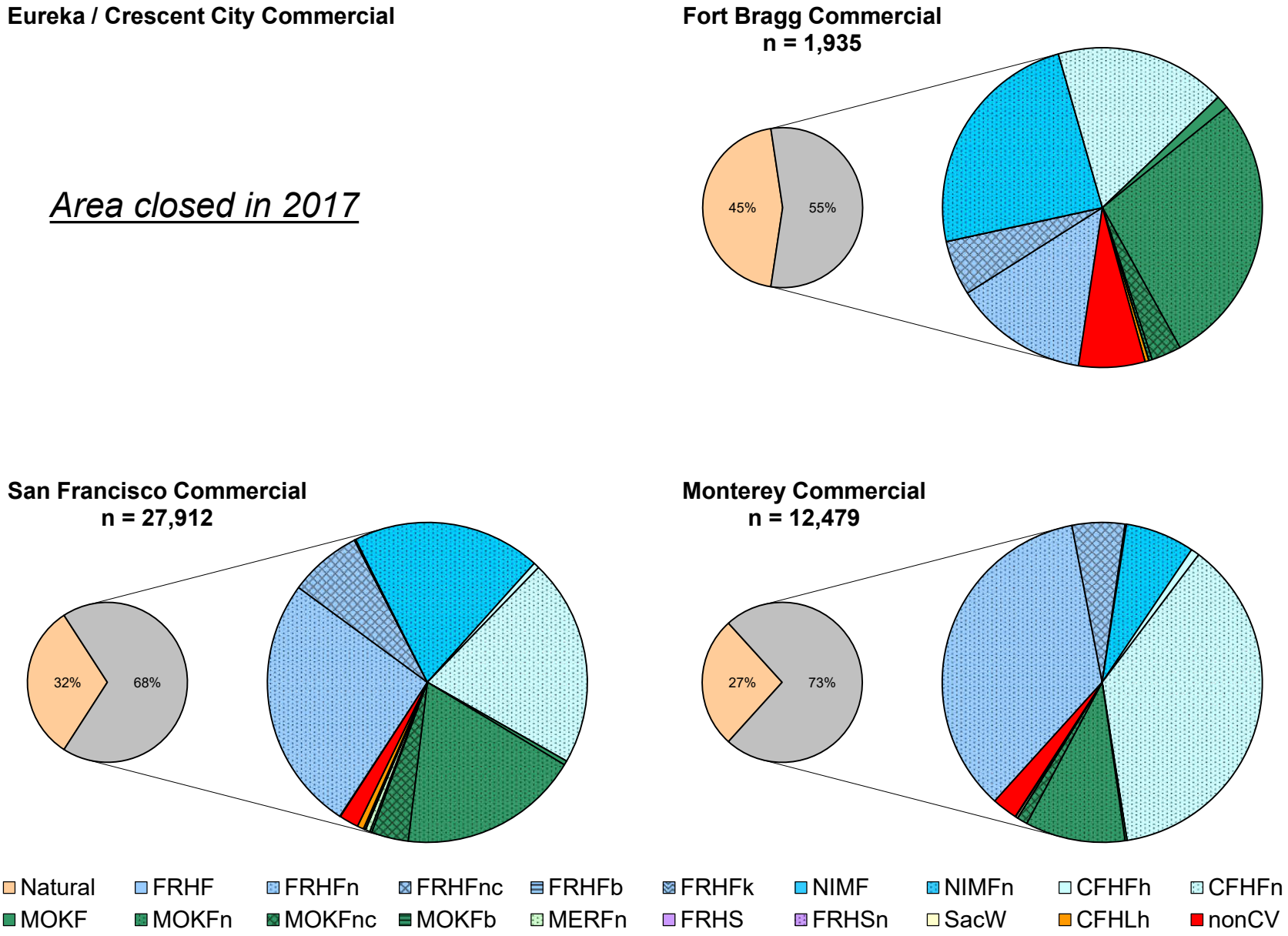


Figure 19. Proportion of hatchery- and natural-origin salmon in the 2017 California ocean commercial fishery.

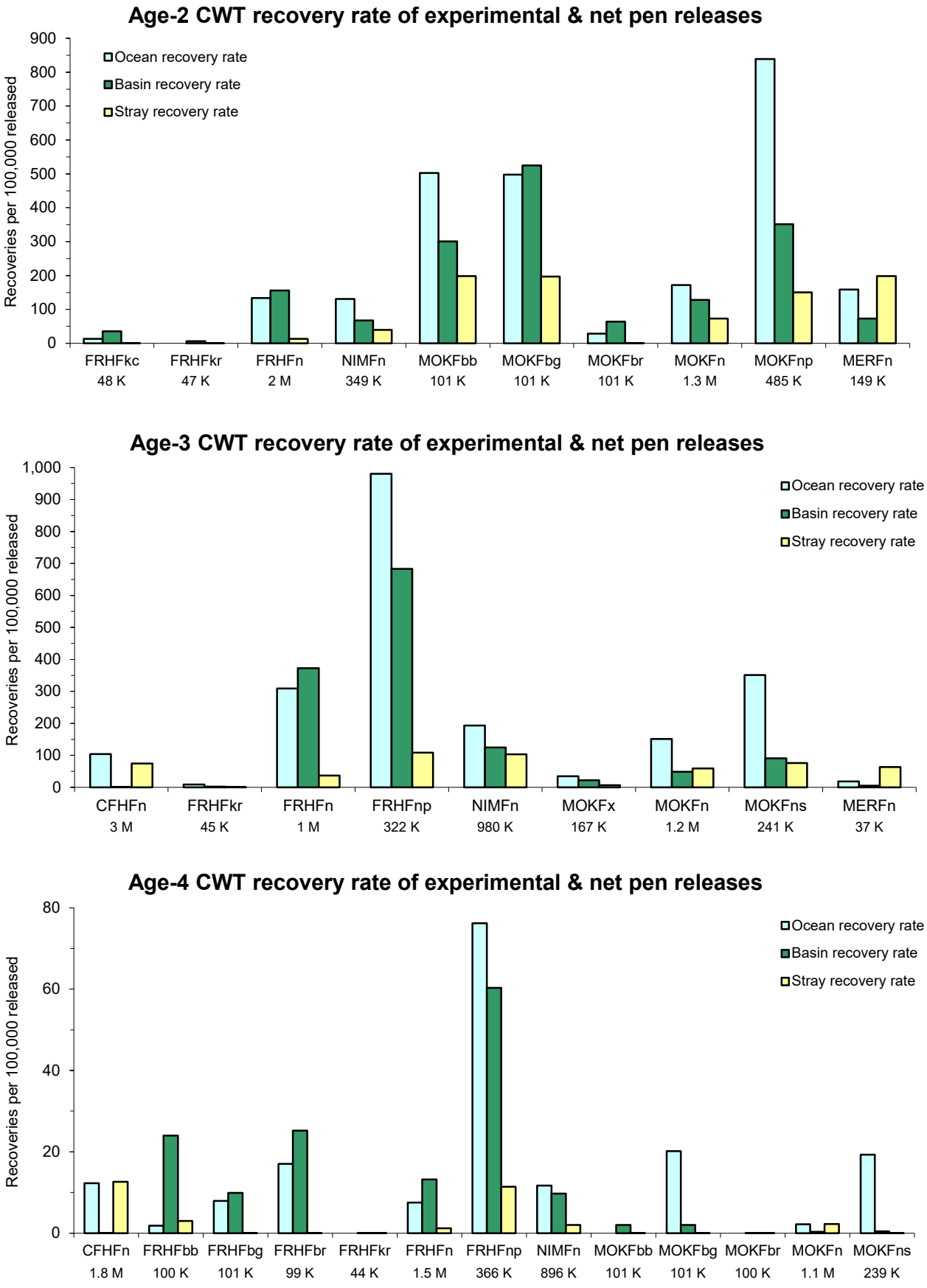


Figure 20. CWT recovery rates of experimental and net pen releases by age in 2017.

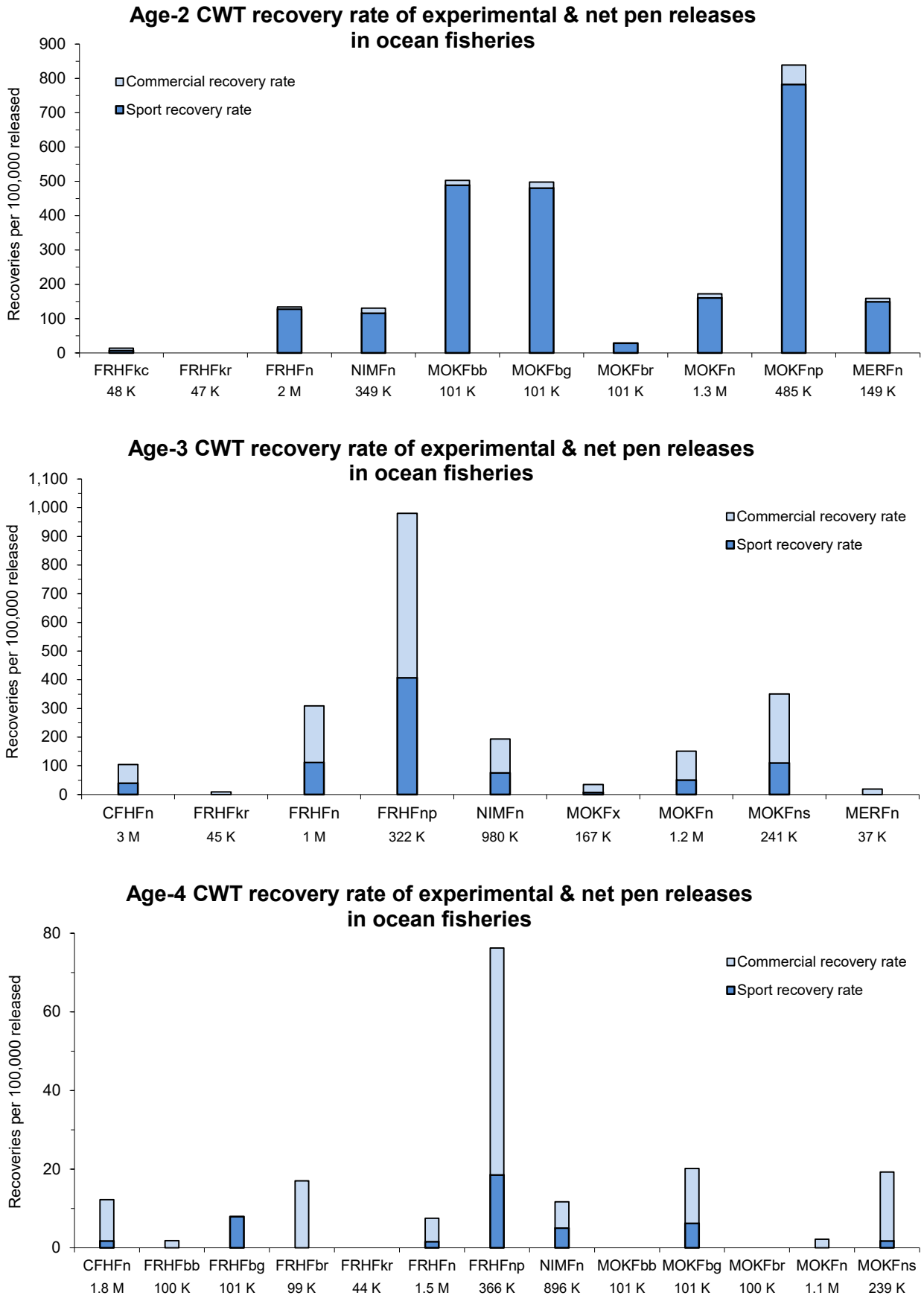


Figure 21. CWT recovery rates of experimental and net pen releases in 2017 ocean sport and commercial fisheries.

Appendix 1. Sample expansion factors for Central Valley salmon carcass surveys collecting fish condition in 2017.

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 42%		110	6.3%	8	8	8	8	**0.07**	**1.00**	15.93	2.95	375	21.4%
non-fresh 58%		155	8.8%	12	12	10	8	0.08	0.83				
total	**1,752**	265	15.1%	20	20	18	**16**			**7.96**	**2.95**	375	**21.4%**

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

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%		956	9.1%	310	310	304	303	**0.32**	**0.98**	11.06	2.89	9,698	92.1%
non-fresh 0%		0	0.0%	0	0	0	0						
total	**10,534**	956	9.1%	310	310	304	**303**			**11.06**	**2.89**	**9,698**	**92.1%**

Lower American 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 15%		415	5.7%	100	100	91	91	**0.24**	**0.91**	17.43	3.51	5,574	77.1%
non-fresh 85%		2,428	33.6%	529	467	393	391	0.22	0.84				
total	**7,234**	2,843	39.3%	629	567	484	**482**			**3.29**	**3.51**	**5,574**	**77.1%**

Stanislaus 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 93%		365	10.4%	108	108	106	106	**0.30**	**0.98**	9.59	3.38	3,432	98.1%
weir CWTs 7%		29	0.8%	29	29	28	28	1.00	0.97				
total	**3,499**	394	11.3%	137	137	134	**134**			**7.58**	**3.38**	**3,432**	**98.1%**

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 58%		363	32.5%	97	97	93	93	**0.27**	**0.96**	3.08	3.40	974	87.1%
non-fresh 42%		261	23.3%	34	34	32	32	0.13	0.94				
total	**1,118**	624	55.8%	131	131	125	**125**			**2.29**	**3.40**	**974**	**87.1%**

Merced River fall-run Chinook salmon carcass survey (fresh only)

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%		432	13.6%	115	115	112	112	**0.27**	**0.97**	7.36	3.35	2,760	86.8%
non-fresh 0%		0	0.0%	0	0	0	0						
total	**3,181**	432	13.6%	115	115	112	**112**			**7.36**	**3.35**	**2,760**	**86.8%**

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 56%		75	9.4%	61	61	60	60	**0.81**	**0.98**	10.60	1.03	652	82.0%
non-fresh 44%		58	7.3%	48	47	46	46	0.83	0.98				
total	**795**	133	16.7%	109	108	106	**106**			**6.00**	**1.03**	**652**	**82.0%**

Upper Sacramento River late-fall-run Chinook salmon carcass survey 2018

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 33%		146	12.4%	16	16	15	15	**0.11**	**0.94**	8.05	1.21	146	12.4%
non-fresh 67%		299	25.4%	26	26	20	19	0.09	0.77				
total	**1,175**	445	37.9%	42	42	35	**34**			**3.55**	**1.21**	**146**	**12.4%**

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

Appendix 2. Alternative 2017 CWT recovery and stray rates (recoveries per 100,000 CWTs released) of CFH and FRH releases.[a/]

Age 2 CWT recoveries

Release type	Brood year	Run type	# CWT tagged	Central Valley total recoveries (CWT_{samp}) by basin								CV CWT_{samp} totals			% CV Stray	Ocean CWT_{samp}	Recovery rate per 100K released			
				Bat Cr	Up Sac	Nat crks[b/]	Fea	Yub	Ame	Mok	Mer	SJ	In-basin	Stray	CV total			In-basin	Stray	**CV total**	**Ocean**
CFHFh	2015	Fall	3,033,741	1,358	20		1						1,358	21	1,379	2%	561	45	1	45	18
CFHLh	2016	Late	594,043	3,075	30		2		1	7	1	8	3,075	49	3,124	2%	65	518	8	526	11
CFHLe	2016	Late	450,662										0	0	0	-	63	0	0	0	14
FRHF	2015	Fall	246,501				11						11	0	11	0%	19	4	0	4	8
FRHFn	2015	Fall	2,019,877	2			3,124	20	104	101	39	22	3,124	288	3,412	8%	2,704	155	14	169	134
FRHFk	2015	Fall	94,971				20						20	0	20	0%	6	21	0	21	7
FRHS	2015	Spr	2,109,278	1			659	20					659	21	680	3%	254	31	1	32	12

Age 3 CWT recoveries

Release type	Brood year	Run type	# CWT tagged	Central Valley total recoveries (CWT_{samp}) by basin								CV CWT_{samp} totals			% CV Stray	Ocean CWT_{samp}	Recovery rate per 100K released			
				Bat Cr	Up Sac	Nat crks[b/]	Fea	Yub	Ame	Mok	Mer	SJ	In-basin	Stray	CV total			In-basin	Stray	**CV total**	**Ocean**
CFHFn	2014	Fall	2,951,944	7	32		198	195	1,194	242	238	125	7	2,225	2,232	100%	3,077	0.3	75	76	104
CFHLh	2015	Late	463,924	635	64								635	64	699	9%	215	137	14	151	46
CFHLe	2015	Late	420,514	1									1	0	1	0%	17	0.2	0	0.2	4
FRHFn	2014	Fall	1,047,852		19		3,883	20	207	98	28	32	3,883	403	4,286	9%	3,240	371	38	409	309
FRHFnc	2014	Fall	321,527	1	20		2,177	20	179	115	25	7	2,177	367	2,544	14%	3,152	677	114	791	980
FRHFk	2014	Fall	45,200				1						1	0	1	0%	4	2	0	2	9
FRHS	2014	Spr	1,690,972				238						238	0	238	0%	28	14	0	14	2

Age 4 CWT recoveries

Release type	Brood year	Run type	# CWT tagged	Central Valley total recoveries (CWT_{samp}) by basin								CV CWT_{samp} totals			% CV Stray	Ocean CWT_{samp}	Recovery rate per 100K released			
				Bat Cr	Up Sac	Nat crks[b/]	Fea	Yub	Ame	Mok	Mer	SJ	In-basin	Stray	CV total			In-basin	Stray	**CV total**	**Ocean**
CFHFh	2013	Fall	1,125,706	80	19								80	19	99	19%	23	7	2	9	2
CFHFn	2013	Fall	1,810,972				20	39	140	19	7	2	0	228	228	100%	222	0	13	13	12
CFHLh	2014	Late	1,056,322	99	7				1				99	8	107	8%	47	9	1	10	4
FRHFn	2013	Fall	1,459,468				193		13	2	2		193	17	210	8%	109	13	1	14	7
FRHFnc	2013	Fall	366,033		2		221		29	1	9		221	42	262	16%	279	60	11	72	76
FRHFb	2013	Fall	300,145				59		3				59	3	62	5%	27	20	1	21	9
FRHFk	2013	Fall	44,127										0	0	0	-	0	0	0	0	0
FRHS	2013	Spr	1,217,640				109						109	0	109	0%	10	9	0	9	1
FRHSn	2013	Spr	997,962				165						165	0	165	0%	0	17	0	17	0

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

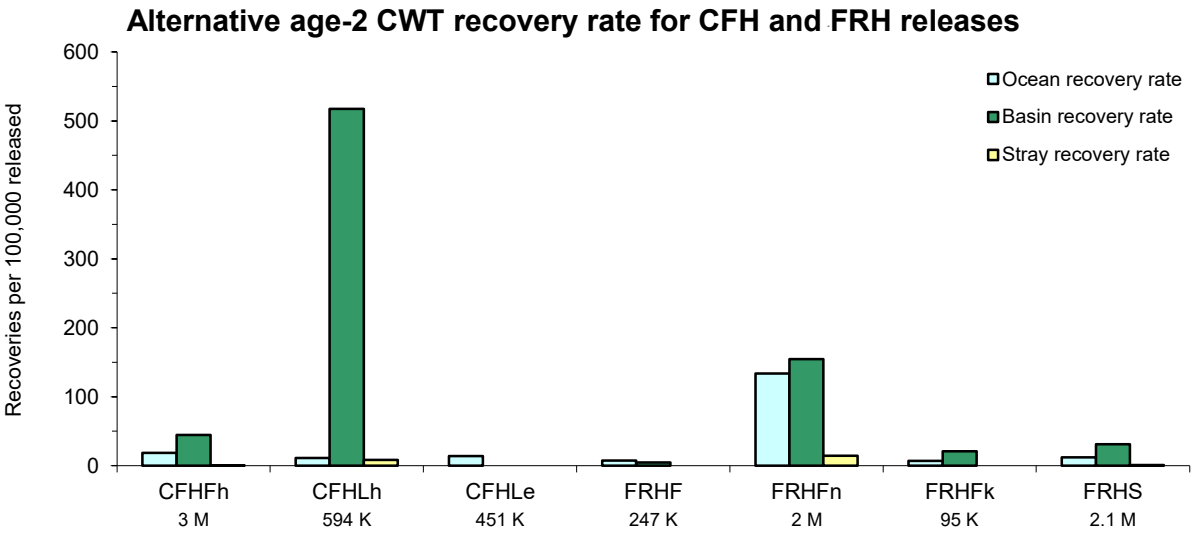
b/ Natural creeks can include Clear Creek, Cow Creek, Cottonwood Creek, Paynes Creek, Mill Creek, Deer Creek, and Butte Creek, depending on survey year.

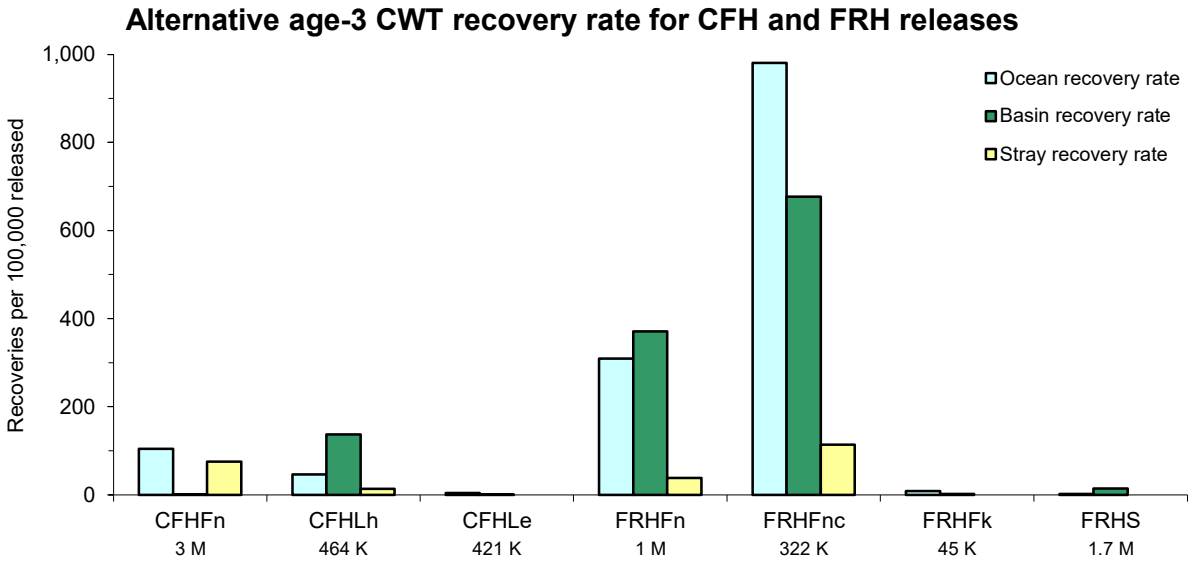
Sacramento River fall Chinook release types (SFC)

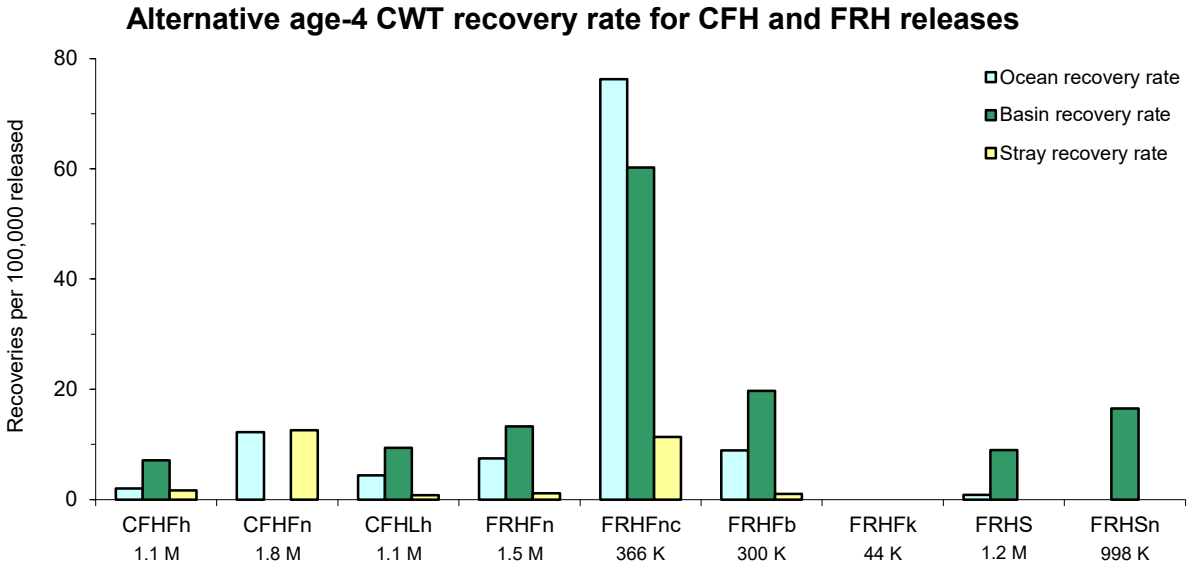
CFHFh Coleman National Fish Hatchery fall hatchery releases
CFHFn Coleman National Fish Hatchery fall net pen releases
FRHF Feather River Hatchery fall in-basin releases
FRHFn Feather River Hatchery fall bay net pen releases
FRHFnc Feather River Hatchery fall coastal net pen releases
FRHFb Feather River Hatchery fall barge study releases
FRHFk Feather River Hatchery fall experimental Knaggs Ranch releases

Other CV Chinook release types (OCV)

CFHLh Coleman National Fish Hatchery late-fall hatchery releases
CFHLe Coleman National Fish Hatchery late-fall emergency trucked releases (no net pens)
FRHS Feather River Hatchery spring in-basin releases
FRHSn Feather River Hatchery spring net pen releases







Appendix 3. Alternative CWT recovery rates for CFH and FRH releases by age in 2017.

Appendix 4. Sample expansion for CWTs recovered in the Yuba River above and below Daguerre Point Dam (DPD) in 2017.

Yuba River natural area escapement: Video count above DPD and visual count below DPD 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
1,648	**1,619**	**98%**	**422**	**22**	**22**	**22**	**0.261**	**1.000**	**19.53**	**3.33**	**1,429**	**86.7%**
Count			Count		Carcass survey							

DPD video count	**Total**	**% ad-clip**
No clip	1,180	
Ad-clip	419	26.2%
Unknown clip	29	
Below DPD count		
No clip	17	
Ad-clip	3	15.0%
Total	1,648	

Appendix 5. Sample expansion for CWTs recovered in the Mokelumne River above Woodbridge Dam (WD) in 2017.

	Total count	**Total ad-clips**	**% ad-clip**
Woodbridge Dam video	19,963	7,065	35.4%
Mokelumne River Hatchery return	14,319	5,348	37.3%
Natural Escapement Mokelume River	**5,644**	**1,717**	30.4%

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
5,644	5,644	100%	**1,717**	**114**	**108**	**108**	**0.304**	**0.947**	**15.06**	**2.97**	**4,832**	**85.6%**
Video count			Video count		Carcass survey							