Recovery of Coded-Wire Tags from Chinook Salmon in California's Central Valley Escapement, Inland Harvest, and Ocean Harvest in 2015

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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 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 sixth annual report on the recovery of CFM CWTs in the CV and ocean fisheries. In 2015, approximately 41,500 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 our 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 previous annual CFM reports (Kormos et al. 2012, Palmer and Kormos 2013, 2015, Palmer et al. 2018, 2019) 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 (Killam et al. 2014).

DATA AND METHODS

Inland Escapement and River Sport Harvest Monitoring

During 2015, 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 2016 return year, however the escapement monitoring period began in late 2015.

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 surveys on major rivers and tributaries in 2015 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 and/or limited areas.

There were almost 93,500 salmon sampled, 28,600 ad-clipped salmon observed, and approximately 27,400 heads 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 with the exception of heads collected at CFH, which were processed by FWS staff. A few hundred additional heads were 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 2015, California sport and commercial ocean salmon fisheries (Table 2) continued to be less constrained than during the late 2000s primarily due to an increase in the abundance of both Sacramento River and Klamath River fall-run Chinook salmon. CDFW field staff sampled 48,600 salmon and collected 11,400 heads that were processed by the Santa Rosa CWT lab. An additional 4,600 heads collected in Oregon ocean sport and commercial fisheries during 2015 are also included in the analyses since Sacramento River fall Chinook is the primary stock harvested in fisheries south of Cape Falcon (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 2015 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 2015 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 (BY) 2010 through 2013 was downloaded from the RMPC. Approximately 142 million CV salmon were released for these brood years, of which 49 million were marked and tagged utilizing 449 unique CWT codes. Although a few thousand natural-origin salmon are trapped, marked, and tagged each year, primarily in the Feather and Mokelumne rivers, salmon produced by hatcheries make up more than 99% of all CWT releases. In 2015, there were 294 individual CWT codes recovered in the CV, primarily from age-2, age-3, and age-4 salmon. The CWT master file was updated with any additional information obtained for special CV salmon releases (e.g., barge study) and the production factor calculated for each CWT code. The production factor, $F_{prod,}$ is the ratio of the total number of salmon released to the total number of salmon marked containing a CWT. Thus it is the total number of salmon (i.e., tagged and untagged) represented by each CWT recovery. F_{prod} was calculated for each CWT code and is defined as,

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

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.

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 sixteen fall-run release types, two spring-run release types, one winter-run release type, and one late-fall-run release type:

<u>Sacramento River Basin Fall-run Chinook salmon release types</u>

CFHFh	Coleman National Fish Hatchery **F**all-run **h**atchery releases (in-basin)
CFHFn	Coleman National Fish Hatchery **F**all-run bay **n**et pen releases (San Pablo Bay)
FRHFb	Feather River Hatchery **F**all-run **b**arge study releases
FRHFk	Feather River Hatchery **F**all-run **K**naggs Ranch **e**xperimental releases
FRHFn	Feather River Hatchery **F**all-run bay **n**et pen releases (San Pablo Bay)
FRHFnc	Feather River Hatchery **F**all-run **c**oastal **n**et pen releases (Santa Cruz and Pillar Point)
FRHFtib	Feather River Hatchery **F**all-run **Tib**uron net pen releases (held several months)
NIMF	Nimbus Fish Hatchery **F**all-run in-basin releases
NIMFn	Nimbus Fish Hatchery **F**all-run bay **n**et pen releases (San Pablo Bay)

<u>San Joaquin River Basin Fall-run Chinook salmon release types</u>

MOKF	Mokelumne River Hatchery **F**all-run in-basin releases
MOKFb	Mokelumne River Hatchery **F**all-run **b**arge study releases

MOKFn Mokelumne River Hatchery **F**all-run bay **n**et pen releases (Sherman Island)
MOKFnc Mokelumne River Hatchery **F**all-run **c**oastal **n**et pen releases (Santa Cruz)
MOKFt Mokelumne River Hatchery **F**all-run **t**rucked releases (no net pen acclimation)
MERF Merced River Hatchery **F**all-run in-basin releases
MERFt Merced River Hatchery **F**all-run **t**rucked releases (no net pen acclimation)

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 **n**et pen releases (San Pablo Bay)

Sacramento River winter-run Chinook salmon release types
SacW Sacramento River **W**inter-run supplementation natural production in-basin releases

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

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 multiple strategies (e.g., 15% of BY 2011 FRHFn were released directly into the bay). 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 2015 was generally higher than 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:

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

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

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

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

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

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

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

where j *(=1,2,3,,,l)* denotes recovery location.

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

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

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

Determining stray proportions of various release groups in CV escapement

To be consistent with previous reports (Kormos et al. 2012, Palmer-Zwahlen and Kormos 2013, 2015, Palmer-Zwahlen et al. 2018, 2019), basin-of-origin is defined as the drainage of any major river as it pertains to the geographic region of the CV where a hatchery is located. The CV is divided into five hatchery basins: upper Sacramento River (including Battle Creek), Feather River (including the Yuba River), American River, Mokelumne River, and Merced River. Hatchery-origin salmon not returning to their basin-of-origin or to streams and rivers not included in any hatchery basin (e.g., Mill Creek, Butte Creek, Stanislaus 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:

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

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 2015 CV inland recoveries and California ocean harvest

All except four of the 26,546 valid CWTs recovered in the CV during 2015 were from CV Chinook salmon releases. Most CWTs were brood year 2011 through 2013 releases (Table 6). About 89% of all CWT_{total} recoveries were fall-run, followed by spring-run (8%), and late-fall-run (2%) salmon releases. Less than one percent of all CWT_{total} recovered were winter-run, all of which were collected in the upper Sacramento River winter-run carcass survey and the Keswick Dam Fish Trap, where natural winter-run fish are collected for broodstock purposes at Livingston Stone National Hatchery. The four non-CV salmon were fall-run Chinook salmon released from hatcheries in the Klamath-Trinity River Basin and Smith River. The majority of fall-run CWT_{total} recovered in the CV were age-3 (59%), age-4 (21%), and age-2 (19%) fish (Table 6).

Most of the 10,501 valid CWT recoveries in the 2015 California ocean harvest were CV salmon releases belonging to brood years 2011 through 2013 (Table 7). Approximately 91% of all CWT_{total} in the ocean harvest were CV fall-run, followed by CV spring-run (3%), CV late-fall-run (1%), and CV winter-run (0.01%) salmon. The remaining 6% of California ocean CWT recoveries originated primarily from the Klamath-Trinity Basin and Smith River in northern California, and Oregon coastal streams. The majority of the hatchery-origin fish in the California harvest were age-3 (70%) and age-4 (18%) fish.

Approximately half of the 4,443 valid CWT recoveries in the 2015 Oregon ocean harvest were CV salmon releases (Table 8). Approximately 48% of all CWT_{total} in the ocean harvest were CV fall-run salmon and 1% were CV spring-run. Non-CV stocks made up 51% of the harvest with most originating from the Columbia River Basin, coastal streams in Oregon, and the Klamath-Trinity Basin. The majority of the hatchery fish in the Oregon harvest were age-3 (58%) and age-4 (37%) fish.

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

Approximately 100,000 fall-run Chinook salmon returned to spawn in natural areas during 2015 (Table 4) and the proportion of hatchery-origin salmon in those areas sampled varied throughout the CV. The lowest hatchery proportion occurred in Cottonwood Creek (15%) while the highest proportion (100%) occurred in Deer Creek (Table 9, Fig. 2). It should be noted that the Battle Creek hatchery proportion is estimated using a surrogate since there has not been a carcass survey or CWT recovery program conducted in this waterway since 2005. The hatchery contribution and CWT release type composition in the Battle Creek escapement is assumed equivalent to the hatchery fall-run return sampled at CFH (K. Niemela, FWS, pers. comm.). The second highest hatchery proportion occurred in the Mokelumne River (94%). The total fall-run hatchery proportion for all natural areas surveyed in the CV was 71%.

The hatchery proportion of the 55,900 fall-run salmon returning to the five CV hatcheries ranged from 74% to 96% (Table 9, Fig. 3). The fall-run hatchery proportion for all CV hatcheries combined was 85%. The spring-run return to FRH was almost entirely hatchery-origin fish (98%) while the late-fall-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 color scheme 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 net pen releases contain black dots while net pen coastal releases are designated with a criss-cross pattern. Experimental barge study and trucked releases are designated with black stripes.

Upper Sacramento River Basin

At CFH, sampling of the fall-run return began in early October and continued through early December 2015 (Table 10). All ad-clipped salmon were sampled during the entire run. CFH began late-fall sampling immediately following fall-run sampling and continued through early-March 2015. Based solely on the run-timing above, 15,806 salmon returned to CFH during the

"fall" run sampling period, and 2,266 salmon returned during the "late-fall" run period. However, based on the composition of CWT recoveries, FWS staff determined there was some overlap between runs, especially in late November through December. As a result, the final escapement was adjusted to 15,724 fall-run and 2,348 late-fall-run salmon. To promote genetic integrity, 65 natural (i.e., unmarked) late-fall salmon were collected at the Keswick Dam Fish Trap in the mainstem Sacramento River and transported to CFH as supplemental broodstock. An additional 104 late-fall salmon were trapped or counted via video at CFH after spawning operations ended in early-March.

Fall- and late-fall-run returns to CFH and fall spawners in most natural areas in the upper Sacramento River basin were predominantly hatchery-origin salmon with the exception of Cottonwood and Mill creeks (Figs. 5, 6). The proportion of hatchery-origin fish (prevalent release type shown in parentheses) at each of the following locations was:

- Fall-run returns CFH: 74% (CFHFh)
- Late-fall-run returns CFH: 100% (CFHLh)
- Fall-run spawners Upper Sacramento River: 68% (FRHFn)
- Fall-run spawners Clear Creek: 74% (FRHFn)
- Fall-run spawners Battle Creek: 74% (CFHFh)
- Fall-run spawners Cottonwood Creek: 15% (CFHFn)
- Fall-run spawners Deer Creek: 100% (FRHFn)
- Fall-run spawners Mill Creek: 44% (FRHFn)
- Winter-run spawners Upper Sacramento River: 18% (SacW)
- Spring-run spawners Butte Creek: zero hatchery fish observed
- Late-fall-run spawners Upper Sacramento River: 8% (CFHLh)

Feather River Basin

Spring- and fall-run returns to FRH and spawners in both the Feather River and Yuba River above Daguerre Point Dam (DPD) were predominantly hatchery-origin while escapement to the Yuba River below DPD contained more natural-origin salmon (Figs. 7, 8). The proportion of hatchery-origin fish (prevalent release type shown in parentheses) at each of the following locations was:

- Spring-run returns FRH: 98% (FRHS)
- Fall-run returns FRH: 90% (FRHFn)
- Fall/spring-run spawners Feather River: 83% (FRHFn)
- Fall/spring-run spawners Yuba River above DPD: 60% (CFHFn)
- Fall/spring-run spawners Yuba River below DPD: 45% (FRHFn)

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 primarily natural-origin salmon. The proportion of hatchery-origin fish (prevalent release type shown in parentheses) at each of the following locations was:

- Fall-run returns NIM: 83% (NIMFn, NIMF, MOKFn)
- Fall-run spawners American River: 65% (NIMF, NIMFn)
- Fall-run returns NIM weir: 43% (NIMFn)

Mokelumne River Basin
Hatchery-origin salmon (Fig. 10) dominated fall-run returns to MOK and spawners in the Mokelumne River. The proportion of hatchery-origin fish (prevalent release type shown in parentheses) at each of the following locations was:

- Fall-run returns MOK: 96% (MOKFn)
- Fall-run spawners Mokelumne River: 94% (MOKFn)

Merced River and other San Joaquin Basin Tributaries
Hatchery-origin salmon dominated fall-run returns to MER and spawners in the Merced, Stanislaus, and Tuolumne rivers (Fig. 11). The proportion of hatchery-origin fish (prevalent release type shown in parentheses) at each of the following locations was:

- Fall-run returns MER: 88% (MOKFn)
- Fall-run spawners Merced River: 81% (MOKFn)
- Fall-run spawners Stanislaus River: 78% (MOKFn)
- Fall-run spawners Tuolumne River: 65% (MOKFn)

2. Contribution of CV Release Types to Total Salmon Escapement
Approximately 75% of the 167,700 total salmon escapement to CV hatcheries and natural areas during 2015-2016 were hatchery-origin fish (Table 11). The proportion of these fish that strayed from their basin-of-origin ranged from zero to 88 percent, depending on release type:

R_{type}	Run	CWT_{total}	#Strays	(%)
CFHFh	Fall	14,846	773	(5%)
CFHFn	Fall	4,938	3,891	(79%)
FRHFk	Fall	18	0	(0%)
FRHFb	Fall	2,435	966	(40%)
FRHFn	Fall	48,090	23,337	(49%)
FRHFnc	Fall	2,757	1,301	(47%)
NIMF	Fall	6,177	631	(10%)
NIMFn	Fall	7,639	1,872	(25%)
MOKF	Fall	173	16	(9%)
MOKFn	Fall	20,202	11,343	(56%)
MOKFe	Fall	1,304	808	(62%)
MERF	Fall	4	0	(0%)
MERFt	Fall	2,143	1,894	(88%)
FRHS	Spr	5,706	4	(0%)
FRHSn	Spr	5,391	506	(9%)
SacW	Wint	558	0	(0%)
CFHLh	Late	2,646	4	(0.2%)
	Total	125,054	47,373	(38%)

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

In 2015, approximately 78% of the 24,400 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 shown in parentheses) in each of the following fisheries was:

- Upper Sacramento River fall-run harvest: 73% (CFHFh, FRHFn)
- Lower Sacramento River fall-run harvest: 77% (FRHFn, NIMFn)
- Feather River fall-run harvest: 100% (FRHFn)
- American River fall-run harvest: 75% (NIMFn, MOKFn)
- Mokelumne River fall-run harvest: 98% (MOKFn)
- Upper Sacramento River late-fall-run harvest: 51% (CFHLh)

It should be noted that the sample expansion factor, F_{samp}, for the Feather River fall-run harvest had to be reduced from 23.24 to 21.81 to prevent the calculated hatchery component from exceeding the total harvest (106%). Of all hatchery release types, FRHFn contributed the most (24%) to the total CV sport harvest, followed by CFHFh (13%), NIMFn (13%), and MOKFn (12%). All of the CFHFh recoveries occurred in the Upper Sacramento River fall fishery whereas FRHFn were recovered in all inland fisheries (Table 11).

Contribution of CV Release Types to CV Sport Harvest

R_{type}	Run	CWT_{total}	(% harvest)
CFHFh	Fall	3,256	(13%)
CFHFn	Fall	850	(3%)
FRHFk	Fall	0	(0%)
FRHFb	Fall	407	(2%)
FRHFn	Fall	5,896	(24%)
FRHFnc	Fall	258	(1%)
NIMF	Fall	796	(3%)
NIMFn	Fall	3,132	(13%)
MOKF	Fall	0	(0%)
MOKFn	Fall	2,971	(12%)
MOKFe	Fall	95	(0%)
MERF	Fall	0	(0%)
MERFt	Fall	382	(2%)
FRHS	Spr	152	(1%)
FRHSn	Spr	434	(2%)
SacW	Wint	0	(0%)
CFHLh	Late	276	(1%)
	Total	18,903	(78%)

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 2011 through 2013 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 12 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 2015. The CWTs collected in the river sport fishery are not included since it is not possible to ascertain 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 fish released with CWTs are not reported below since just a few recoveries may 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 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 and coastal net pens generally had higher CV recovery rates than their respective in-basin or trucked-only releases, but net pen and trucked release types also had higher stray proportions than their in-basin sibling releases in most cases.

Age-2 CV Escapement recovery rate; percent stray

R_{type}	Brdyr	Run	# recoveries per 100K released	% stray
CFHFh	2013	Fall	18	0%
CFHFn	2013	Fall	67	79%
FRHFk	2013	Fall	5	0%
FRHFb	2013	Fall	35	18%
FRHFn	2013	Fall	83	29%
FRHFnc	2013	Fall	254	32%
NIMFn	2013	Fall	122	32%
MOKFb	2013	Fall	110	53%
MOKFn	2013	Fall	79	61%
MOKFnc	2013	Fall	31	79%
MERFt	2013	Fall	11	92%
FRHS	2013	Spr	2	7%
FRHSn	2013	Spr	4	10%
SacW	2013	Wint	8	0%
CFHLh	2014	Late	76	0%

Age-3 CV Escapement recovery rate; percent stray

R_{type}	Brdyr	Run	# recoveries per 100K released	% stray
CFHFh	2012	Fall	56	6%
FRHFk	2012	Fall	12	0%
FRHFb	2012	Fall	666	42%
FRHFn	2012	Fall	577	49%
FRHFnc	2012	Fall	200	54%
NIMF	2012	Fall	142	8%
NIMFn	2012	Fall	217	16%
MOKF	2012	Fall	93	10%
MOKFn	2012	Fall	290	54%
MERFt	2012	Fall	139	88%
FRHS	2012	Spr	316	0%
FRHSn	2012	Spr	439	9%
SacW	2012	Wint	371	0%
CFHLh	2013	Late	49	1%

Age-4 CV Escapement recovery rate; percent stray

R_{type}	Brdyr	Run	# recoveries per 100K released	% stray
CFHFh	2011	Fall	57	6%
FRHFb	2011	Fall	99	30%
FRHFn	2011	Fall	101	57%
FRHFnc	2011	Fall	119	57%
NIMF	2011	Fall	40	19%
NIMFn	2011	Fall	126	13%
MOKF	2011	Fall	74	8%
MOKFn	2011	Fall	27	63%
MOKFt	2011	Fall	216	65%
MERF	2011	Fall	1	0%
FRHS	2011	Spr	188	0%
FRHSn	2011	Spr	71	12%
SacW	2011	Wint	2	0%
CFHLh	2012	Late	119	0%

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

The relative recovery rate of CV hatchery releases in 2015 ocean salmon sport and commercial fisheries varied by age and release type (Table 12). Almost all CWTs from age-2 CV salmon were recovered in the ocean sport fishery, most likely due to smaller size limits in effect

compared to those for the commercial fishery (Table 2). Fall-run net pen releases (coastal and bay) generally had the highest ocean recovery rates for all ages (Fig. 16).

Age-2 Ocean Harvest recovery rate; percent taken in sport harvest

R_{type}	Brdyr	Run	# recoveries per 100K released	% sport
CFHFh	2013	Fall	5	100%
CFHFn	2013	Fall	41	91%
FRHFk	2013	Fall	9	100%
FRHFb	2013	Fall	11	88%
FRHFn	2013	Fall	29	97%
FRHFnc	2013	Fall	256	98%
NIMFn	2013	Fall	45	97%
MOKFb	2013	Fall	70	93%
MOKFn	2013	Fall	26	97%
MOKFnc	2013	Fall	206	94%
MERFt	2013	Fall	1	100%
FRHS	2013	Spr	6	100%
FRHSn	2013	Spr	11	100%
CFHLh	2014	Late	1	100%

Age-3 Ocean Harvest recovery rate; percent taken in sport harvest

R_{type}	Brdyr	Run	# recoveries per 100K released	% sport
CFHFh	2012	Fall	48	19%
FRHFk	2012	Fall	17	10%
FRHFb	2012	Fall	924	23%
FRHFn	2012	Fall	616	18%
FRHFnc	2012	Fall	1,143	20%
NIMF	2012	Fall	98	16%
NIMFn	2012	Fall	234	26%
MOKF	2012	Fall	9	71%
MOKFn	2012	Fall	234	18%
MERFt	2012	Fall	137	16%
FRHS	2012	Spr	77	34%
FRHSn	2012	Spr	189	29%
SacW	2013	Wint	1	100%
CFHLh	2013	Late	6	64%

Age-4 Ocean Harvest recovery rate; percent taken in sport harvest

R_{type}	Brdyr	Run	# recoveries per 100K released	% sport
CFHFh	2011	Fall	38	12%
FRHFb	2011	Fall	119	12%
FRHFn	2011	Fall	94	11%
FRHFnc	2011	Fall	337	16%
NIMF	2011	Fall	23	7%
NIMFn	2011	Fall	181	10%
MOKF	2011	Fall	12	14%
MOKFn	2011	Fall	30	12%
MOKFt	2011	Fall	111	13%
MERF	2011	Fall	2	100%
FRHS	2011	Spr	23	22%
FRHSn	2011	Spr	12	21%
SacW	2012	Wint	2	0%
CFHLh	2012	Late	43	6%

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

More than half of the 148,000 and 100,100 Chinook salmon harvested in California and Oregon fisheries, respectively, were hatchery-origin fish (Fig. 17). Most of the hatchery-origin salmon in California ocean fisheries originated from the CV. Approximately half of the hatchery-origin salmon in Oregon ocean fisheries were CV stocks.

California ocean sport fishery

California anglers harvested almost 37,500 Chinook salmon in the ocean sport fishery during 2015. The total contribution of hatchery-origin salmon to the California ocean sport fishery was 69%, ranging from 59% to 81% of the total harvest, depending on major port area (Fig. 18). Most of the harvest occurred in San Francisco (67%) and Fort Bragg (15%), followed by Eureka-Crescent City (10%) and Monterey (8%) port areas (Table 13).

Of all hatchery release types, FRHFn contributed the most (24%) to the total California ocean sport harvest, followed by MOKFn (9%), CFHFn (7%) and NIMFn (6%). Non-CV releases (e.g., Klamath-Trinity River Basin, Smith River, Oregon and Washington hatchery stocks) contributed 1% to the total harvest (Table 14).

Contribution of CV Release Types to Ocean Salmon Sport Fishery

R_{type}	Run	CWT_{total}	(% harvest)
CFHFh	Fall	1,911	(5%)
CFHFn	Fall	2,673	(7%)

FRHFk	Fall	6	(<1%)
FRHFb	Fall	682	(2%)
FRHFn	Fall	8,928	(24%)
FRHFnc	Fall	2,640	(7%)
FRHFtib	Fall	34	(<1%)
NIMF	Fall	507	(1%)
NIMFn	Fall	2,209	(6%)
MOKF	Fall	8	(<1%)
MOKFb	Fall	193	(1%)
MOKFn	Fall	3,545	(9%)
MOKFnc	Fall	464	(1%)
MOKFt	Fall	67	(<1%)
MERF	Fall	464	(1%)
MERFt	Fall	306	(1%)
FRHS	Spr	417	(1%)
FRHSn	Spr	694	(2%)
SacW	Wint	3	(<1%)
CFHLh	Late	72	(<1%)
NonCV		469	(1%)
	Total	25,828	(69%)

California ocean commercial fishery

California trollers harvested over 110,500 Chinook salmon in the ocean commercial fishery during 2015. The total contribution of hatchery-origin salmon to the California ocean commercial fishery was 55%, ranging from 41% to 81% of the total harvest, depending on major port area (Fig. 19). Most of the harvest occurred in Fort Bragg (54%) and San Francisco (32%), followed by Monterey (13%) and Eureka-Crescent City (<1%) port areas (Table 15).

Of all hatchery release types, FRHFn contributed the most (24%) to the total California commercial harvest, followed by MOKFn (8%) and CFHFh (5%). Non-CV releases (e.g., Klamath-Trinity River Basin, Smith River, Oregon and Washington hatchery stocks) contributed 4% to the total harvest (Table 16).

Contribution of CV Release Types to Ocean Salmon Commercial Fishery

R_{type}	Run	CWT_{total}	(% harvest)
CFHFh	Fall	5,996	(5%)
CFHFn	Fall	316	(<1%)
FRHFk	Fall	20	(<1%)
FRHFb	Fall	2,009	(2%)
FRHFn	Fall	26,200	(24%)
FRHFnc	Fall	5,504	(5%)

FRHFtib	Fall	69	(<1%)
NIMF	Fall	2,408	(2%)
NIMFn	Fall	2,129	(2%)
MOKF	Fall	6	(<1%)
MOKFb	Fall	16	(<1%)
MOKFn	Fall	8,366	(8%)
MOKFnc	Fall	29	(<1%)
MOKFt	Fall	238	(<1%)
MERF	Fall	29	(<1%)
MERFt	Fall	1,361	(1%)
FRHS	Spr	554	(1%)
FRHSn	Spr	1,109	(1%)
SacW	Wint	3	(<1%)
CFHLh	Late	374	(<1%)
NonCV		4,331	(4%)
	Total	61,037	(55%)

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

In 2015, CWTs from several experimental and net pen release types were recovered in both the CV escapement and ocean harvest. These included a new experimental barge study and a coastal net pen program utilizing fish from Mokelumne Hatchery. The barge study involved approximately 300,000 BY 2013 MOK fall-run salmon that were either: 1) released into the Mokelumne River directly at Miller's Ferry Bridge, 2) barged from Miller's Ferry Bridge to the San Francisco Bay and released at the Golden Gate Bridge, or 3) trucked to San Francisco Bay and loaded into the barge at Tiburon and released at the Golden Gate Bridge. An additional 240,000 BY 2013 MOK fall-run salmon were trucked to and released from net pens operated by the Monterey Bay Trout and Salmon Project (MBTSP) in Santa Cruz. Approximately 60,000 salmon were trucked to and released into Monterey Bay each week during May 2014. This is the first time since the MBTSP began coastal pen releases in the 1990s that fall-run salmon from Feather River Hatchery are not being used for this program. This was also the second year that CWTs from the Knaggs Ranch rice field study were recovered.

These experimental and net pen releases are differentiated into the following release types:

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 (numerous sites on Sac R)

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

FRHFnp Feather River Hatchery **F**all-run net pen coastal releases – **P**illar Point
FRHFns Feather River Hatchery **F**all-run net pen coastal releases – **S**anta Cruz

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 (Miller's Ferry, Mok R)

MOKFns Mokelumne River Hatchery **F**all-run net pen coastal releases – **S**anta Cruz

Central Valley Escapement

The CV escapement recovery rate and percent stray for other fall-run experimental and net pen releases are included below to allow direct comparison among these release types (Table 17, Fig. 20).

Age-2 CV Escapement recovery rate; percent stray

R_{type}	Brdyr	Run	# recoveries per 100K released	% stray
CFHFn	2013	Fall	67	79%
FRHFbb	2013	Fall	23	16%
FRHFbg	2013	Fall	46	5%
FRHFbr	2013	Fall	38	34%
FRHFkr	2013	Fall	5	0%
FRHFn	2013	Fall	83	29%
FRHFnp	2013	Fall	254	32%
NIMFn	2013	Fall	122	32%
MOKFbb	2013	Fall	72	78%
MOKFbg	2013	Fall	248	48%
MOKFbr	2013	Fall	8	0%
MOKFn	2013	Fall	79	61%
MOKFns	2013	Fall	31	79%

Age-3 CV Escapement recovery rate; percent stray

R_{type}	Brdyr	Run	# recoveries per 100K released	% stray
FRHFbb	2012	Fall	922	49%
FRHFbg	2012	Fall	1062	36%
FRHFbr	2012	Fall	2	0%
FRHFkc	2012	Fall	32	0%
FRHFkr	2012	Fall	1	0%
FRHFn	2012	Fall	577	49%
FRHFnp	2012	Fall	262	58%
FRHFns	2012	Fall	92	35%
NIMFn	2012	Fall	216	16%
MOKFn	2012	Fall	290	54%

Age-4 CV Escapement recovery rate; percent stray

R_{type}	Brdyr	Run	# recoveries per 100K released	% stray
FRHFbb	2011	Fall	54	24%
FRHFbg	2011	Fall	88	50%
FRHFbr	2011	Fall	155	22%
FRHFn	2011	Fall	101	57%
FRHFnp	2011	Fall	239	55%
FRHFns	2011	Fall	26	68%
NIMFn	2011	Fall	126	13%
MOKFn	2011	Fall	27	63%

Ocean Harvest

The ocean harvest recovery rate and proportion taken in the sport fishery for other fall-run experimental and net pen releases are included below to allow direct comparison among these release types (Table 17, Fig. 21).

Age-2 Ocean Harvest recovery rate; percent taken in sport harvest

R_{type}	Brdyr	Run	# recoveries per 100K released	% sport
CFHFn	2013	Fall	41	91%
FRHFbb	2013	Fall	14	71%
FRHFbg	2013	Fall	0	
FRHFbr	2013	Fall	19	100%
FRHFkr	2013	Fall	9	100%
FRHFn	2013	Fall	29	97%
FRHFnp	2013	Fall	256	98%
NIMFn	2013	Fall	45	97%
MOKFbb	2013	Fall	87	100%
MOKFbg	2013	Fall	117	91%
MOKFbr	2013	Fall	5	0%
MOKFn	2013	Fall	26	97%
MOKFns	2013	Fall	206	94%

Age-3 Ocean Harvest recovery rate; percent taken in sport harvest

R_{type}	Brdyr	Run	# recoveries per 100K released	% sport
FRHFbb	2012	Fall	1,433	20%
FRHFbg	2012	Fall	1,300	25%
FRHFbr	2012	Fall	25	38%
FRHFkc	2012	Fall	40	13%
FRHFkr	2012	Fall	5	0%
FRHFn	2012	Fall	616	18%
FRHFnp	2012	Fall	1,076	23%
FRHFns	2012	Fall	1,259	17%
NIMFn	2012	Fall	234	26%
MOKFn	2012	Fall	234	18%

Age-4 Ocean Harvest recovery rate; percent taken in sport harvest

R_{type}	Brdyr	Run	# recoveries per 100K released	% sport
FRHFbb	2011	Fall	125	7%
FRHFbg	2011	Fall	122	21%
FRHFbr	2011	Fall	110	8%
FRHFn	2011	Fall	94	11%
FRHFnp	2011	Fall	393	18%
FRHFns	2011	Fall	293	14%
NIMFn	2011	Fall	181	10%
MOKFn	2011	Fall	30	12%

2015 CFM ANALYSES KEY POINTS

- Salmon escapement into CV hatcheries was predominately hatchery-origin fish. The majority of hatchery-origin fish returning to each hatchery was comprised primarily of its respective releases with the exception of Merced River Hatchery. Almost two-thirds of all hatchery-origin fish at MER were net pen MOKFn releases.
- Rivers and creeks with hatchery installations generally had the highest proportions of hatchery-origin spawners in natural areas. Most of the hatchery proportion consisted of release types from their respective hatcheries with the exception of hatchery-origin spawners in the Merced River, which were primarily net pen MOKFn releases.
- Fall-run escapement into the Upper Sacramento River and its sampled tributaries was predominantly hatchery-origin salmon with the exception of Cottonwood and Mill creeks. Net pen FRHFn was the hatchery release type most often observed in these rivers and creeks.

- Fall-run escapement into the Yuba River below DPD was predominantly natural-origin salmon while the Yuba River above the dam was primarily hatchery-origin. Net pen CNFHn, FRHFn and MOKFn were the predominate release types recovered in both sectors.
- Fall-run escapement into the Feather River was predominantly hatchery-origin salmon, primarily net pen FRHFn, along with spring-run FRHS and FRHSn releases.
- Fall-run escapement into the American River was predominantly hatchery-origin salmon, primarily in-basin NIMF, along with net pen NIMFn and MOKFn releases.
- Fall-run escapement into all sampled tributaries of the San Joaquin Basin (Mokelumne, Stanislaus, Tuolumne and Merced rivers) was predominantly hatchery-origin salmon, the vast majority of which were net pen MOKFn releases. Trucked MERFt, along with net pen NIMFn, also contributed to hatchery-origin returns.
- Approximately three-fourths of the total 2015-2016 CV salmon escapement (all run-types) were hatchery-origin fish. Net pen FRHFn and MOKFn, along with hatchery CFHFh releases, contributed most to the total CV escapement. Trucked MERFt and MOKFt, along with net pen CFHFn, MOKFn and FRHFn releases, had the highest total stray proportions.
- For age-2 fall-run salmon, coastal net pen FRHFnc, net pen NIMFn and experimental barge study MOKFb releases had the highest CV recovery rates for their cohort. Trucked MERFt, coastal net pen MOKFnc, and net pen CFHFn had the highest stray proportions observed for age-2 releases.
- For age-3 fall-run salmon, coastal net pen FRHFnc, along with net pen FRHFn and MOKFn releases, had the highest CV recovery rates for their cohort. Trucked MERFt, net pen MOKFn and coastal net pen FRHFnc had the highest stray proportions observed for age-3 release types.
- For age-4 fall-run salmon, trucked MOKFt, net pen NIMFn and FRHFn, and coastal net pen FRHFnc had the highest CV recovery rates for their cohort. These same releases, with the exception of net pen NIMFn, also had the highest stray proportions observed for age-4 release types.
- Approximately three-fourths of the CV inland sport harvest was hatchery-origin fish. Net pen FRHFn, NIMFn, and MOKFn, along with hatchery CFHFh releases, contributed the most to the total harvest.
- More than half of the California ocean sport and commercial harvest was comprised of hatchery-origin fish. Net pen FRHFn, MOKFn and NIMFn, along with coastal net pen FRHFnc and hatchery CFHFh releases, contributed the most to the total harvest.
- Coastal net pen FRHFnc releases had the highest ocean recovery rates for all release types and ages. Their recovery rate was several times greater than that for other net pen releases of the same cohort and nearly an order of magnitude greater than that of most in-basin releases for the same age. The age-2 ocean recovery rate for coastal net pen Pillar Point FRHFnp and Santa Cruz MOKFns releases were very similar.
- Pillar Point coastal net pen FRHFnp releases had the highest CV recovery rates among all age-2 releases whereas relatively few Santa Cruz coastal net pen releases MOKFns returned

to the CV. The majority of Pillar Point FRHFnp recoveries occurred in the Feather River Basin whereas most of the Santa Cruz MOKFns recovered strayed outside the Mokelumne River.

- Among the barge study releases, salmon barged down the Mokelumne River (MOKFbg) had the highest age-2 CV recovery rate with moderate straying. This release also had the highest age-2 ocean recovery rate in this study group. Salmon trucked to and released into San Francisco Bay (MOKFbb) had the highest stray rate among all barge study releases. Salmon released as part of the Feather River barge study (FRHFbb, FRHFbg, and FRHFbr) had relatively low CV and ocean age-2 recovery rates, especially compared to previous reports.
- Salmon transported via barge (FRHFbg) or trucked and released (FRHFbb) into San Francisco Bay had the highest age-3 CV and ocean recovery rates among all experimental and net pen releases. Recoveries of age-3 salmon released in river (FRHFbr) as part of this study were minimal.
- Pillar Point coastal net pen FRHFnp releases had the highest CV and ocean recovery rates among all age-4 releases. Approximately half of the FRHFnp recoveries in the CV strayed outside of the Feather River Basin. Although the age-4 ocean recovery rate of Santa Cruz coastal net pen FRHFns was slightly lower than the Pillar Point releases, this release also had the lowest CV recovery and highest stray rate among all age-4 experimental and net pen releases.

CONCLUSION

A primary goal of this report is to provide information that will be useful in California salmon management, including CV hatchery assessment. 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. Although no discussion section is included, as in earlier CFM reports, the authors plan to further analyze these data and draw general conclusions as these and additional tagged broods become complete. This 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.

We believe the CFM program should be continued with the current design to provide comparable, consistent data needed for hatchery and harvest management. Efforts are still ongoing to secure permanent funding for this program, which 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 River fall-run 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
CFM	Constant Fractional Marking
CFH	Coleman National Fish Hatchery
CV	California Central Valley
CWT	coded-wire tag
CDFW	California Department of Fish and Wildlife
DPD	Daguerre Point Dam (Yuba River)
DWR	California Department of Water Resources
EBMUD	East Bay Municipal Utilities District
FRH	Feather River Hatchery
FWS	U.S. Fish and Wildlife Service
MER	Merced River Hatchery
MOK	Mokelumne River Hatchery
NMFS	National Marine Fisheries Service
NIM	Nimbus Fish Hatchery
OSP	Ocean Salmon Project
PFMC	Pacific Fishery Management Council
PSMFC	Pacific States Marine Fisheries Commission
RMPC	Regional Mark Processing Center
SJ	San Joaquin
TL	Total length
WD	Woodbridge Dam (Mokelumne River)
YARMT	Yuba Accord River Management Team

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Table 1a. Estimation and sampling methods used for the 2015 CV Chinook hatchery escapement.

Sampling Location	Estimation and Sampling Methods	Agency
Hatchery Spawners		
Coleman National Fish Hatchery (CFH) Fall and Late-Fall (2016)	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 6-Dec 3, Late-fall-run period: Dec 30 - Mar 9. All ad-clipped fish sampled. Fish returning to CFH from mid-Nov through early Dec parsed into run-type based on CWT code recoveries and total run-type proportions by date. Grilse cutoff: 700 mm fall, 580 mm late-fall.	FWS
CFH Late-Fall Fish Trap	Direct count. All fish examined and bio-sampled for fin-clips, tags, marks. All unmarked untagged-phenotypic late-fall fish released into Battle Creek above CFH Dec 9 - Mar 31. All ad-clipped fish sampled and heads collected for CWT recovery Mar 10 - 31 (after CFH spawning operations cease). Late-fall data from video weir counts during Apr-May added. Grilse cutoff: 580mm.	FWS
Keswick Fish Trap (KES) Winter	Direct count. All fish examined and bio-sampled for fin-clips, tags, marks. All unmarked fish electronically sampled for presence of CWT and genetically tested to ensure winter-run broodstock. Grilse cutoff: 580mm.	FWS
Feather River Hatchery (FRH) Spring and Fall	Direct count. All fish examined for fin-clips, tags, marks. Fish arriving at the hatchery May 21-Jul 2 (n~ 5,355) 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 14 and spring spawning began Sep 17. All spring-run fish bio-sampled until Sep 28 when the rate was reduced to 50%. Fall spawning occured on Oct 1 for the cold water program and began normally on Oct 7. Systematic random bio-sample ~20% of all fish for fall-run. All ad-clipped fish were sampled and heads collected for CWT recovery. Grilse cutoff: 650 mm spring and fall.	CDFW
FRH Trap Spring	Direct count of salmon that died during early processing of "spring-run" salmon returning to FRH during May-June. All fish examined for fin-clips, tags, marks. All ad-clipped fish were sampled and heads collected for CWT recovery. These fish are not included in FRH spring escapement. Grilse cutoff: 650 mm.	DWR
Nimbus Fish Hatchery (NIM) Fall	Direct count. NIM ladder open Nov 2 - Dec 22. All fish examined for fin-clips, tags, marks. Systematic random bio-sample of 33.3% of total fish returning until November 19th when the rate was reduced to 20%. All ad-clipped fish sampled and heads collected for CWT recovery. Grilse cutoff: 650 mm.	CDFW
Mokelumne River Hatchery (MOK) Fall	Direct count. MOK open Oct 1 - Feb. 28. All fish examined for fin-clips, tags, marks. Systematic random bio-sample ~33% of total fish returning. All ad-clipped fish sampled and heads collected for CWT recovery. Grilse cutoff: 650 mm.	CDFW
Mokelumne Weir Fall	Direct count. All fish examined for fin-clips, tags, marks. All ad-clipped fish were bio-sampled and heads processed for CWT recovery. Grilse cutoff: 650 mm females, 710 mm males.	CDFW
Merced River Hatchery (MER) Fall	Direct count. MER open Nov 5-Dec 24. All fish examined for fin-clips, tags, marks. All ad-clipped fish were sampled and heads processed for CWT recovery. Grilse cutoff: 620 mm females, 700 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 2015 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 (2015)	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: 575 mm females, 610 mm males winter; 610 mm females, 670 mm males fall; 610 mm females, 610 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: 610 mm.	CDFW, FWS
Cow Creek Fall	Video weir count in lower creek used to determine total escapement. Two kayak surveys conducted to collect bio-data from fresh fish. Less than 1% of total escapement sampled; opportunistic collection of CWTs. Grilse cutoff: 610 mm females, 670 mm males.	CDFW
Battle Creek Fall	Video weir count (Aug 17 - Nov 24) in lower creek used to determine total fall escapement. Natural fall escapement into Battle Creek calculated by substracting CFH fall return from total run. Surrogate CWTs based on hatchery proportion and CWT composition of CFH fall return. Grilse cutoff: 700 mm.	CDFW
Cottonwood Creek Fall	Video weir count (Sep 24 - Dec 11) in lower creek used to determine total escapement. Kayak surveys conducted to collect bio-data from fresh fish. All ad-clipped fish (fresh and non-fresh), including "unknown" ad-clipped status, were sampled and heads collected for CWT recovery. Grilse cutoff: 610 mm females, 670 mm males.	CDFW
Mill Creek Fall	Video counts at Ward Dam in lower Mill Creek plus expanded redd count between Ward Dam and the Sacramento River confluence used to determine total escapement. Bio-sampling surveys conducted to collect bio-data from fresh fish. All ad-clipped fish (fresh and non-fresh), including "unknown" ad-clipped status, were sampled and heads collected for CWT recovery. Grilse cutoff: 610 mm females, 670 mm males.	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. Approximately 1% of total escapement sampled; opportunistic collection of CWTs. Grilse cutoff: 610 mm females, 670 mm males.	CDFW

Table 1b. Estimation and sampling methods used for the 2015 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 and fall. All fish examined for fin-clips, tags, marks. Systematic random bio-sample of all fish. All ad-clipped fish sampled and heads collected for CWT recovery. 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: 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 Daguerre Point Dam: Superpopulation modification of the Cormack-Jolly-Seber mark-recapture estimate. All fish examined for fin-clips, tags, marks, and condition. All ad-clipped fresh fish sampled and heads collected for CWT recovery. Escapement estimate includes spring-run. Grilse cutoff: 650 mm.	CDFW, YARMT
American River Fall	Superpopulation modification of the Cormack-Jolly-Seber mark-recapture estimate. All fish examined for fin-clips, tags, marks, and condition. Systematic random bio-sample of all fish. All ad-clipped fish sampled and heads collected for CWT recovery. Grilse cutoff: 620 mm females, 690 mm males.	CDFW
Nimbus Weir Fall	Direct count. Installed Sept 4 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: 650 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: 620 mm females, 700 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: 620 mm females, 700 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: 620 mm females, 700 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 2015 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.	
Feather River Fall	Open Jul 16 - Oct 15 from the unimproved boat ramp above the Thermolito 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: 700 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, 2015.

	Sport Fishery			Commercial Fishery			
Major Port Area	Season	Size Limit[a/]	Days Open	Season	Size Limit[a/]	Days Open	Quota
Eureka/Crescent City (Klamath Mgmt Zone)	May 1 - Sep 7	20" TL	130	Sep 11 - 30	28" TL	18	3,000[b/]
Fort Bragg	Apr 4 - Nov 8	20" TL	219	May 1 - 31	27" TL	31	
				Jun 15 - 30	27" TL	16	
				Jul 12 - Aug 26	27" TL	46	
				Sep 1 - 30	27" TL	30	
						123	
San Francisco	Apr 4 - Apr 30	24" TL	27	May 1 - 31	27" TL	31	
	May 1 - Nov 8	20" TL	184	Jun 7 - 30	27" TL	24	
			211	Jul 8 - Aug 29	27" TL	53	
				Sep 1 - 30	26" TL	30	
				Oct 1 - 15[c/]	26" TL	11	
						149	
Monterey - North (Pigeon Pt - Pt Sur)	Apr 4 - May 31	24" TL	58	May 1 - 31	27" TL	31	
	May 1 - Sep 7	20" TL	99	Jun 7 - 30	27" TL	24	
			157	Jul 8 - Aug 15	27" TL	39	
						94	
Monterey - South (Pt Sur - US / Mexico)	Apr 4 - May 31	24" TL	58	May 1 - 31	27" TL	31	
	May 1 - July 19	20" TL	49	Jun 7 - 30	27" TL	24	
			107	Jul 8 - 31	27" TL	24	
						79	
California Total [d/]			717			384	

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

b/ Klamath Management Zone quota fishery; daily bag and possession limit of 20 salmon per day.

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 2015 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
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	Wickland Oil 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 net pen releases
FRHFk	2013	FRH	Fea R	Fall	1	44,127	44,127	100%	Experimental	Yolo Bypass experimental (Knaggs Ranch rice field study)
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)
FRHFn	2013	FRH	Fea R	Fall	5	1,459,468	5,906,741	25%	Bay pens	San Pablo Bay 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
NIMFn	2013	NIM	Ame R	Fall	4	896,419	3,587,565	25%	Bay pens	Mare Island net pens
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 (Tiburo
MOKFn	2013	MOK	Mok R	Fall	11	1,148,423	4,604,315	25%	Bay pens	Sherman Island net pens
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
MERFt	2013	MER	Mer R	Fall	3	393,182	1,501,007	26%	Trucked	San Joaquin River at Jersey Point and Mossdale
SJOx	2013	MER/FRH	MER/FRH	Fall/Spr	7	139,393	184,393	76%	Experimental	San Joaquin River Conservation Hatchery experimental releases
SacW	2013	LSH	Sac R	Wint	4	190,905	193,155	92%	In-basin	Sacramento River (Lake Redding Park)
CFHLh	2014	CFH	Sac R	Late	14	1,056,322	1,094,719	96%	Hatchery	CFH (includes spring surrogate & small experimental releases)
			Total age 2 releases:		78	11,700,440	32,358,535	36%		

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
FRHS	2012	FRH	Fea R	Spr	2	1,106,679	1,125,897	98%	In-basin	Feather River (Boyds Pump Ramp & Gridley net pens)
FRHSn	2012	FRH	Fea R	Spr	1	1,015,285	1,033,174	98%	Bay pens	Wickland Oil net pen releases
CFHFh	2012	CFH	Sac R	Fall	14	2,956,348	11,873,864	25%	Hatchery	CFH only
FRHFk	2012	FRH	Fea R	Fall	12	138,888	138,888	100%	Experimental	Yolo Bypass experimental (Knaggs Ranch rice field study)
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)
FRHFn	2012	FRH	Fea R	Fall	4	1,453,105	5,848,045	25%	Bay pens	San Pablo Bay net pen releases
FRHFnc	2012	FRH	Fea R	Fall	2	649,160	656,564	99%	Coastal pens	Santa Cruz and Pillar Point net pens; acclimated 1-14 days
FRHFtib	2012	FRH	Fea R	Fall	1	9,918	10,028	99%	Bay pens	Tiburon net pens
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	Mare Island net pens (19% transportation mortality prior to release)
MOKF	2012	MOK	Mok R	Fall	1	99,548	100,306	99%	In-basin	Mokelumne Hatchery (yearlings)
MOKFn	2012	MOK	Mok R	Fall	13	1,275,158	5,123,986	25%	Bay pens	Sherman Island net pens
MERFt	2012	MER	Mer R	Fall	4	325,953	1,384,973	24%	Trucked	San Joaquin River at Jersey Point and Mossdale
SacW	2012	LSH	Sac R	Wint	16	169,967	181,857	92%	In-basin	Sacramento River (Lake Redding Park)
CFHLh	2013	CFH	Sac R	Late	14	960,075	984,977	97%	Hatchery	CFH (includes spring surrogate & small experimental releases)
			Total age 3 releases:		91	11,662,877	32,774,463	36%		

Table 3. Central Valley coded-wire tag (CWT) Chinook releases recovered in 2015 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
FRHS	2011	FRH	Fea R	Spr	2	1,088,286	1,110,709	98%	In-basin	Feather River (Boyds Pump Ramp & Thermolito Bypass)
FRHSn	2011	FRH	Fea R	Spr	1	1,125,189	1,134,280	99%	Bay pens	San Pablo Bay net pen releases
CFHFh	2011	CFH	Sac R	Fall	28	3,117,042	12,508,161	25%	Hatchery	CFH only
FRHFk	2011	FRH	Fea R	Fall	1	10,218	10,218	100%	Experimental	Yolo Bypass experimental (Knaggs Ranch rice field study)
FRHFb	2011	FRH	Fea R	Fall	3	297,089	297,969	100%	Barge study	3 release sites: Sac R (Elkhorn), barged (SF Bay) & trucked (Ft Baker)
FRHFn	2011	FRH	Fea R	Fall	6	2,293,211	9,265,375	25%	Bay pens	San Pablo Bay net pen releases (approx 15% released directly into bay)
FRHFnc	2011	FRH	Fea R	Fall	3	426,190	427,337	100%	Coastal pens	Santa Cruz and Pillar Point net pens; acclimated 1-14 days
FRHFtib	2011	FRH	Fea R	Fall	1	9,933	9,967	100%	Bay pens	Tiburon net pens
FeaFw	2011	wild	Fea R	Fall	23	156,526	159,811	98%	In-basin	Thermalito Bypass & Feather River Outlet launch ramp
NIMF	2011	NIM	Ame R	Fall	3	1,078,191	3,492,113	31%	In-basin	American River (Howe Ave launch ramp)
NIMFn	2011	NIM	Ame R	Fall	2	328,073	1,312,930	25%	Bay pens	Mare Island net pens
MOKF	2011	MOK	Mok R	Fall	1	92,020	109,043	84%	In-basin	Mokelumne Hatchery (yearlings)
MOKFn	2011	MOK	Mok R	Fall	21	1,487,132	5,973,754	25%	Bay pens	Sherman Island net pens
MOKFt	2011	MOK	Mok R	Fall	2	110,737	448,659	25%	Trucked	Sherman Island, opposite Jersey Point
MERF	2011	MER	Mer R	Fall	9	262,108	262,108	100%	In-basin	Merced River Hatchery and Hatfield State Area
SacW	2011	LSH	Sac R	Wint	18	185,313	194,264	92%	In-basin	Sacramento River (Lake Redding Park)
CFHLh	2012	CFH	Sac R	Late	14	1,031,419	1,094,288	94%	Hatchery	CFH (includes spring surrogate & small experimental releases)
			Total age 4 releases:		138	13,098,677	37,810,986	35%		

Age 5 CWT releases

Release type*	Brood year	Hatchery	Stock origin	Run type	CWT codes	# CWT tagged	Total fish released	% CWT	Release strategy	Release locations / notes
FRHS	2010	FRH	Fea R	Spr	2	1,170,340	1,181,710	99%	In-basin	Feather River (Boyds Pump Ramp)
CFHFh	2010	CFH	Sac R	Fall	25	2,835,420	11,369,732	25%	Hatchery	CFH
CFHFn	2010	CFH	Sac R	Fall	3	334,756	1,339,659	25%	Bay pens	Mare Island net pens
FRHFn	2010	FRH	Fea R	Fall	9	2,554,115	10,308,722	25%	Bay pens	San Pablo Bay net pens; Wickland Oil net pens
NIMF	2010	NIM	Ame R	Fall	3	1,014,340	3,259,868	31%	In-basin	American River (at Sunrise launch ramp & Discovery Park)
NIMFn	2010	NIM	Ame R	Fall	0	368,363	1,595,731	23%	Bay pens	Wickland Oil net pens
CFHLh	2011	CFH	Sac R	Late	14	1,037,859	1,053,282	99%	Hatchery	CFH (includes spring surrogate 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
FRHFk	Feather River Hatchery fall experimental Knaggs Ranch releases
FRHFb	Feather River Hatchery fall barge study 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
FeaFw	Feather River fall wild
NIMF	Nimbus Fish Hatchery fall in-basin releases
NIMFn	Nimbus Fish Hatchery fall net pens

Other CV Chinook release types (OCV)

MOKF	Mokelumne Hatchery fall in-basin releases
MOKFb	Mokelumne Hatchery fall barge study releases
MOKFn	Mokelumne Hatchery fall net pen releases
MOKFnc	Mokelumne Hatchery fall coastal net pen releases (Santa Cruz)
MOKFt	Mokelumne Hatchery fall trucked releases (no net pens)
MERF	Merced River Hatchery fall in-basin releases
MERFt	Merced River Hatchery fall trucked releases (no net pens)
FRHS	Feather River Hatchery spring in-basin releases
FRHSn	Feather River Hatchery spring net pen releases
SacW	Livingston Stone Hatchery winter in-basin releases
CFHLh	Coleman National Fish Hatchery late fall hatchery releases

Table 4. Central Valley hatchery and natural escapement estimates, sport harvest, and sample data, 2015.

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	257	257	133	132	127	1.000	0.992	1.000	1.01
Feather River Hatchery	Spring	3,386	3,386	3,270	3,270	3,227	1.000	1.000	0.999	1.00
Coleman National Fish Hatchery	Fall	15,724	15,724	3,123	3,119	3,032	1.000	0.998	0.995	1.01 [b/]
Feather River Hatchery	Fall	20,816	20,816	9,070	9,070	8,901	1.000	1.000	0.998	1.00
Nimbus Fish Hatchery	Fall	9,822	9,822	2,273	2,273	2,131	1.000	1.000	0.964	1.04
Mokelumne River Hatchery	Fall	8,298	8,298	2,227	2,227	2,181	1.000	1.000	0.998	1.00
Merced River Hatchery	Fall	1,198	1,198	287	286	261	1.000	0.997	0.942	1.07
Coleman National Fish Hatchery	Late-fall[c/]	2,348	2,348	2,297	2,297	2,274	1.000	1.000	0.997	1.00 [b/]
Coleman National Fish Hatchery Trap	Late-fall[c/]	104	104	103	46	45	1.000	0.447	1.000	2.24
Keswick Dam Fish Trap	Late-fall[c/]	65	65	4	4	4	1.000	1.000	1.000	1.00
Total Hatchery Escapement		**62,018**	**62,018**	**22,787**	**22,724**	**22,183**				
Natural Area Escapement										
Upper Sacramento River (above RBDD)	Winter	3,182	1,076	195	194	161	0.338	0.995	1.000	3.23 [d/]
Butte Creek	Spring	413	185	0	0	0	0.448	-	-	-
Upper Sacramento River (above RBDD)	Fall	28,668	3,175	405	404	381	0.111	0.998	0.974	16.05 [d/]
Clear Creek	Fall	8,809	1,778	271	270	246	0.202	0.996	0.946	8.30 [f/]
Cow Creek	Fall	591	12	Video - no biodata collected		0	0.020	-	-	-
Battle Creek	Fall	3,631	3,631	Video - no biodata collected		112 [e/]	-	-	-	-
Cottonwood Creek	Fall	604	33	2	2	2	0.055	1.000	1.000	18.30 [f/]
Mill Creek	Fall	1,033	62	9	9	8	0.060	1.000	1.000	15.65 [f/]
Deer Creek	Fall	612	51	15	15	15	0.083	1.000	1.000	10.68 [f/]
Butte Creek	Fall	82	4	Video - no biodata collected		0	0.049	-	-	-
Feather River	Fall	20,566	3,578	1,323	1,323	1,238	0.174	1.000	0.968	5.94
Yuba River above Daguerre Point Dam (DPD)	Fall	4,981	148	28	28	28	0.030	1.000	1.000	33.66 [g/]
Yuba River below DPD	Fall	2,569	237	36	36	32	0.092	1.000	1.000	10.50 [d/]
American River	Fall	13,793	7,516	1,374	1,242	1,100	0.545	0.904	0.967	2.23 [d/]
Nimbus Fish Hatchery Weir	Fall	1,946	1,946	290	290	247	1.000	1.000	0.961	1.04
Mokelumne River	Fall	4,581	4,581	1,229	194	178	1.000	0.158	0.994	6.37 [g/]
Stanislaus River	Fall	6,136	794	200	200	190	0.129	1.000	0.960	6.55 [h/]
Tuolumne River	Fall	113	45	8	8	8	0.398	1.000	1.000	2.51
Merced River	Fall	1,247	443	75	75	69	0.355	1.000	0.945	3.78 [d/]
Upper Sacramento River (above RBDD)	Late-fall[c/]	3,085	637	16	16	13	0.206	1.000	0.867	14.73 [d/]
Total Natural Area Escapement		**106,642**	**29,932**	**5,476**	**4,306**	**4,028**				
CV Sport Harvest										
Sacramento River (above Feather River)	Fall	8,088	733	155	138	134	0.091	0.890	0.993	12.49
Sacramento River (below Feather River)	Fall	6,205	232	60	60	57	0.037	1.000	0.983	27.21
Feather River	Fall	1,906	82	32	32	32	0.043	1.000	1.000	21.81
American River	Fall	6,630	322	76	75	75	0.049	0.987	1.000	20.86
Mokelumne River	Fall	1,281	101	26	26	26	0.079	1.000	1.000	12.68
Sacramento River (above Feather River)	Late-fall[c/]	252	28	11	11	11	0.111	1.000	1.000	9.00
Total Sport Harvest		**24,362**	**1,498**	**360**	**342**	**335**				
	Total Sampled	**93,448**	**28,623**	**27,372**	**26,546**					

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/ Average sample expansion factor. Coleman National Fish Hatchery sample expansion factors calculated based on run-timing and sampling protocol; fall and late-fall counts parsed based on CWT codes.

c/ Late-fall hatchery returns, natural escapement, and sport harvest occurred during late fall of 2015 through early 2016 (return year 2016).

d/ Carcass survey sample expansion factor based on fresh fish only and expanded to all valid CWTs (Mohr and Satterthwaite, 2013; Appendix 1)

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

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

g/ Natural escapement CWTs collected on spawning grounds and expanded based on total ad-clip count observed via video weir (e.g., Mokelumne River, Yuba River above DPD).

h/ Stanislaus natural escapement and sample expansion factor based on fresh fish only and expanded to all valid CWTs (e.g., 37 CWTs recovered from washbacks on Stanislaus Weir).

Table 5. Total harvest and sample data for 2015 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	3,690	1,180	261	259	239	0.320	0.992	0.992	3.18
Fort Bragg	5,493	1,311	303	303	277	0.239	1.000	0.965	4.34
San Francisco	25,227	8,474	2,491	2,469	2,326	0.336	0.991	0.970	3.10
Monterey	3,070	637	274	271	258	0.207	0.989	0.977	5.00
	37,480	**11,602**	**3,329**	**3,302**	**3,100**	**0.310**	**0.992**	**0.939**	
California Commercial									
Eureka/Crescent	46	5	1	1	1	0.109	1.000	1.000	9.17
Fort Bragg	60,052	20,341	3,390	3,384	2,965	0.339	0.998	0.976	3.03
San Francisco	35,696	11,032	2,750	2,748	2,603	0.309	0.999	0.973	3.33
Monterey	14,713	5,612	1,925	1,924	1,832	0.381	0.999	0.974	2.70
	110,507	**36,990**	**8,066**	**8,057**	**7,401**	**0.335**	**0.999**	**0.919**	
California Total	**147,987**	**48,592**	**11,395**	**11,359**	**10,501**	**0.328**	**0.997**	**0.924**	
Oregon Sport	**6,685**	**2,071**	**194**	**194**	**181**	**0.310**	**1.000**	**0.995**	3.24
Oregon Commercial	**93,377**	**28,203**	**4,442**	**4,440**	**4,262**	**0.302**	**1.000**	**0.990**	3.34
Oregon Total	**100,062**	**30,274**	**4,636**	**4,634**	**4,443**	**0.303**	**1.000**	**0.959**	

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

Table 6. Raw and expanded Chinook CWT recoveries in the Central Valley by run type and brood year during 2015.

Fall-run	2014	2013	2012	2011	2010	Total CV	
Age	1	2[a/]	3	4[a/]	5	CWTs	Total CV %
Raw CWT Recoveries	4 (<1%)	3,712 (23%)	9,425 (59%)	2,835 (18%)	88 (<1%)	16,064	61%
Expanded CWT$_{total}$	**13** (<1%)	**24,835** (19%)	**76,266** (59%)	**26,960** (21%)	**730** (<1%)	128,805	89%

Spring-run	2013	2012	2011	2010	Total CV	
Age	2	3	4	5	CWTs	Total CV %
Raw CWT Recoveries	45 (<1%)	5,800 (74%)	1,976 (25%)	18 (<1%)	7,839	30%
Expanded CWT$_{total}$	**111** (<1%)	**8,477** (73%)	**3,052** (26%)	**43** (<1%)	11,683	8%

Late-Fall-run	2014	2013	2012	2011	Total CV	
Age	2	3	4	5	CWTs	Total CV %
Raw CWT Recoveries	796 (34%)	469 (20%)	1,041 (44%)	49 (2%)	2,355	9%
Expanded CWT$_{total}$	**932** (32%)	**582** (20%)	**1,347** (46%)	**60** (2%)	2,922	2%

Winter-run	2014	2013	2012	2011	2010	Total CV	
Age	1	2	3	4	5	CWTs	Total CV %
Raw CWT Recoveries	6 (2%)	4 (1%)	277 (96%)	1 (<1%)		288	1.1%
Expanded CWT$_{total}$	**9** (1%)	**6** (<1%)	**676** (97%)	**3** (<1%)		694	0.5%

All Runs						Total CV	
Age	1	2[a/]	3	4[a/]	5	CWTs	Total CV %
Raw CWT Recoveries	10 (<1%)	4,557 (17%)	15,971 (60%)	5,853 (22%)	155 (<1%)	26,546	100%
CV Expanded CWT$_{total}$	**22** (<1%)	**25,884** (18%)	**86,001** (60%)	**31,363** (22%)	**833** (<1%)	144,103	100%

a/ Includes one age-2 and three age-4 fall-run Chinook released from northern California hatcheries.

Table 7. Raw and expanded Chinook CWT recoveries in 2015 California ocean fisheries by run type and brood year.

Fall-run	2013	2012	2011	2010	Total Ocean	Total
Age	2	3	4	5	CWTs	Ocean%
Raw CWT Recoveries	1,096 (12%)	6,755 (75%)	1,173 (13%)	22 (<1%)	9,046	86%
Expanded CWT$_{total}$	**9,386** (12%)	**58,048** (74%)	**11,184** (14%)	**223** (<1%)	78,841	91%
Spring-run	2013	2012	2011	2010	Total Ocean	Total
Age	2	3	4	5	CWTs	Ocean%
Raw CWT Recoveries	54 (6%)	749 (85%)	78 (9%)	1 (<1%)	882	8%
Expanded CWT$_{total}$	**175** (6%)	**2,367** (85%)	**229** (8%)	**3** (<1%)	2,773	3%
Late-Fall-run	2014	2013	2012	2011	Total Ocean	Total
Age	2	3	4	5	CWTs	Ocean%
Raw CWT Recoveries	2 (1%)	17 (12%)	122 (86%)	1 (<1%)	142	1%
Expanded CWT$_{total}$	**8** (2%)	**59** (13%)	**376** (84%)	**3**	446	1%
Winter-run	2014	2013	2012	2011	Total Ocean	Total
Age	2	3	4	5	CWTs	Ocean%
Raw CWT Recoveries		1 (50%)	1 (50%)		2	0.02%
Expanded CWT$_{total}$		**3** (49%)	**3** (51%)		5	0.01%
Non-CV stocks	2013	2012	2011	2010	Total Ocean	Total
Age	2	3	4	5	CWTs	Ocean%
Raw CWT Recoveries	1 (<1%)	46 (11%)	382 (89%)		429	4%
Expanded CWT$_{total}$	**11** (<1%)	**585** (12%)	**4,204** (88%)		4,800	6%
All Runs					Total Ocean	Total
Age	2	3	4	5	CWTs	Ocean%
Raw CWT Recoveries	1,153 (11%)	7,568 (72%)	1,756 (17%)	24 (<1%)	10,501	100%
Expanded CWT$_{total}$	**9,580** (11%)	**61,061** (70%)	**15,996** (18%)	**228** (<1%)	86,866	100%
CV Expanded CWT$_{total}$	9,569	60,476	11,792	228	82,065	94%
proportion CV stocks	(100%)	(99%)	(74%)	(100%)		

Table 8. Raw and expanded Chinook CWT recoveries in 2015 Oregon ocean fisheries by run type and brood year.

Fall-run	2013	2012	2011	2010	Total Ocean	Total
Age	2	3	4	5	CWTs	Ocean%
Raw CWT Recoveries	14 (<1%)	1,406 (60%)	892 (38%)	21 (<1%)	2,333	53%
Expanded CWT_{total}	**93** (<1%)	**12,891** (57%)	**9,560** (42%)	**236** (1%)	22,780	48%

Spring-run	2013	2012	2011	2010	Total Ocean	Total
Age	2	3	4	5	CWTs	Ocean%
Raw CWT Recoveries		128 (75%)	42 (25%)		170	4%
Expanded CWT_{total}		**451** (73%)	**164** (27%)		614	1%

Late-Fall-run	2014	2013	2012	2011	Total Ocean	Total
Age	2	3	4	5	CWTs	Ocean%
Raw CWT Recoveries			27 (93%)	2 (7%)	29	1%
Expanded CWT_{total}		(<1%)	**89** (92%)	**8**	97	0.2%

Non-CV stocks	2013	2012	2011	2010	Total Ocean	Total
Age	2	3	4	5	CWTs	Ocean%
Raw CWT Recoveries		568 (30%)	990 (52%)	353 (18%)	1,911	43%
Expanded CWT_{total}		**14,186** (59%)	**7,802** (32%)	**2,231** (9%)	24,219	51%

All Runs					Total Ocean	Total
Age	2	3	4	5	CWTs	Ocean%
Raw CWT Recoveries	14 (<1%)	2,102 (47%)	1,951 (44%)	376 (8%)	4,443	100%
Expanded CWT_{total}	**93** (<1%)	**27,527** (58%)	**17,614** (37%)	**2,475** (5%)	47,709	100%
CV Expanded CWT_{total} (proportion CV stocks)	93 (100%)	13,341 (48%)	9,812 (56%)	244 (10%)	23,491	49%

Table 9. Percentage of inland CWT_{total} recoveries by location, run, and release type[a/] in hatchery returns, natural escapement and sport harvest during 2015.

			CFH			FRH						NIM		MOK			MER		Total %		Total
Location	**Run**	**SacW**	**CFHLh**	**CFHFh**	**CFHFn**	**FRHS**	**FRHSn**	**FRHFk**	**FRHFb**	**FRHFn**	**FRHFnc**	**NIMF**	**NIMFn**	**MOKF**	**MOKFn**	**MOKFe**	**MERF**	**MERFt**	**Hatchery**	**Natural**	**Run**
Hatchery Spawners																					
Keswick Dam Fish Trap	Winter	53%																	53%	47%	257
Feather River Hatchery	Spring					60%	37%		0%	1%									98%	2%	3,386
Coleman National Fish Hatchery	Fall			60%	3%		-		1%	9%	1%	0%	-		0%	-		0%	74%	26%	15,724
Feather River Hatchery	Fall			0%	2%	10%	10%	0%	4%	58%	4%	0%	1%	-	1%	0%		1%	90%	10%	20,816
Nimbus Fish Hatchery	Fall		-		2%				-	3%	0%	24%	24%	0%	24%	2%		3%	83%	17%	9,822
Mokelumne River Hatchery	Fall		-		3%		-		0%	3%	0%		10%	1%	69%	3%		5%	96%	4%	8,298
Merced River Hatchery	Fall				4%					6%	1%		3%		62%	2%		12%	88%	12%	1,198
Coleman National Fish Hatchery	Late-fall[b/]		100%																100%		2,348
Coleman Hatchery Fish Trap	Late-fall[b/]		100%																100%		104
Keswick Dam Fish Trap	Late-fall[b/]		6%																6%	94%	65
Total Hatchery Fall Run			***-***	***17%***	***3%***	***4%***	***4%***	***-***	***2%***	***25%***	***2%***	***4%***	***6%***	***0%***	***16%***	***1%***		***2%***	***85%***	***15%***	***55,858***
Natural Spawners																					
Upper Sacramento River	Winter	18%																	18%	82%	3,182
Upper Sacramento River	Fall			8%	2%		1%		2%	52%	3%								68%	32%	28,668
Clear Creek	Fall			8%	4%		1%		3%	55%	3%								74%	26%	8,809
Battle Creek	Fall[c/]			60%	3%				1%	9%	1%	0%	-		0%			0%	74%	26%	3,631
Cottonwood Creek	Fall				12%						3%								15%	85%	604
Deer Creek	Fall				14%					77%	2%				7%				100%		612
Mill Creek	Fall			6%	6%					30%	2%								44%	56%	1,033
Feather River	Fall			0%	2%	8%	8%		3%	57%	3%	1%	0%		1%	-		1%	83%	17%	20,566
Yuba River above DPD	Fall				19%		1%		1%	11%	2%	9%	3%		12%	3%			60%	40%	4,981
Yuba River below DPD	Fall				11%				0%	15%	1%		3%		10%	1%		4%	46%	54%	2,569
American River	Fall		-		2%				-	1%	0%	23%	21%	-	15%	1%		1%	65%	35%	13,793
Nimbus Fish Hatchery Weir	Fall				5%	0%	1%		0%	3%	0%	1%	23%	0%	8%	1%		1%	43%	57%	1,946
Mokelumne River	Fall				2%					2%	0%		10%	1%	68%	6%		5%	94%	6%	4,581
Stanislaus River	Fall				3%					2%	0%		1%		66%	3%		3%	78%	22%	6,136
Tuolumne River	Fall												9%		47%			10%	65%	35%	113
Merced River	Fall				1%					4%	0%		1%		62%	4%	0%	9%	81%	19%	1,247
Upper Sacramento River	Late-fall[b/]		6%															2%	8%	92%	3,085
Total Natural Area Fall-run[d/]			***-***	***5%***	***3%***	***2%***	***2%***		***1%***	***34%***	***2%***	***4%***	***4%***	***0%***	***11%***	***1%***	***-***	***1%***	***71%***	***29%***	***99,289***
In-basin CWT_{total}	All	0%	2%	12%	1%	5%	4%	-	1%	21%	1%	5%	5%	0%	7%	0%	-	0%	65%	35%	120,292
Stray CWT_{total}	All		-	2%	8%	-	1%		2%	49%	3%	1%	4%	-	24%	2%		4%	100%		47,373
Total CV Spawners		**0%**	**2%**	**9%**	**3%**	**3%**	**3%**	**-**	**1%**	**29%**	**2%**	**4%**	**5%**	**0%**	**12%**	**1%**	**-**	**1%**	**75%**	**25%**	**167,665**
CV Sport Harvest																					
Upper Sacramento River	Fall			40%	1%		1%		2%	28%	1%								73%	27%	8,088
Lower Sacramento River	Fall		3%		9%				1%	28%	3%		21%		9%	1%		2%	77%	23%	6,205
Feather River	Fall				5%	4%	6%		6%	74%	1%							5%	100%		1,906
American River	Fall				3%	1%	4%		1%	5%	0%	12%	25%		23%			1%	75%	25%	6,630
Mokelumne River	Fall		1%							8%			12%		72%	1%		4%	98%	2%	1,281
Upper Sacramento River	Late-fall[b/]		37%							14%									51%	49%	252
Total Sport Harvest			**1%**	**13%**	**3%**	**1%**	**2%**		**2%**	**24%**	**1%**	**3%**	**13%**		**12%**	**0%**		**2%**	**78%**	**22%**	**24,362**

a/ Any values less than 0.05% of CWT_{total} are displayed as "-"; values equal or greater than 0.05% but less than 0.5% of CWT_{total} are displayed as 0%.

b/ Late-fall hatchery returns, natural escapement, and sport harvest occurred in late fall 2015 (return year 2016).

c/ No CWT recovery survey or ad-clip count available for Battle Creek natural escapement. CWT release groups and hatchery proportions assumed to be equivalent to fall return at CFH (FWS staff, per. comm).

d/ Total Natural Area Fall-run does not include unsampled escapement into Cow Creek (n=591) and Butte Creek (n=82).

Note: Recoveries of Mokelumne Hatchery MOKFb (age-2 barge study releases) and MOKFt (age-4 trucked releases) merged into MOKFe.

Table 10. Fall- and late-fall-run Chinook salmon escapement at Coleman National Fish Hatchery in 2015 based on run-timing and CWT stock composition.

Calculation of CFH sample expansion factors based on run-timing only

2015 CFH fall-run escapement (Oct 6, 2015 - Dec 3, 2015)

Run timing (CWT sample rate)	Escapement N	Chinook sampled (n)	Observed ad-clips	Heads processed	CWTs recovered	Valid CWTs	Sample rate (fe)	Ad-clips processed (fa)	Valid CWTs (fd)	F_{samp}	Avg F_{prod}	$\sum_{i=1}^{m} CWT_{total,i}$	Hatchery proportion
Oct 6 - Dec 3 (100%)	**15,806**	**15,806**	**3,204**	**3,200**	**3,128**	**3,113**	**100%**	**99.9%**	**99.5%**	**1.01**	**3.742**	**11,763**	**74.4%**

2016 CFH late-fall-run escapement (Dec 23, 2015 - Mar 9, 2016)

Run timing (CWT sample rate)	Escapement N	Chinook sampled	Observed ad-clips	Heads processed	CWTs recovered	Valid CWTs	Sample rate (fe)	Ad-clips processed (fa)	Valid CWTs (fd)	F_{samp}	Avg F_{prod}	$\sum_{i=1}^{m} CWT_{total,i}$	Hatchery proportion
Dec 23 - Mar 9 (100%)	**2,266**	**2,266**	**2,216**	**2,216**	**2,199**	**2,193**	**100%**	**100.0%**	**99.7%**	**1.00**	**1.046**	**2,294**	**>100%**
Total CFH count	**18,072**	**18,072**	**5,420**	**5,416**	**5,327**	**5,306**							

Final CFH escapment based on CWT stock segregation

2015 CFH fall-run escapement

Run timing	Escapement N	Chinook sampled	Observed ad-clips	Heads processed	CWTs recovered	Fall CWTs	Sample rate (fe)	Ad-clips processed (fa)	Valid CWTs (fd)	F_{samp}	Avg F_{prod}	$\sum_{i=1}^{m} CWT_{total,i}$	Hatchery proportion
Oct 6 - Jan 27	**15,724**	**15,724**	**3,123**	**3,119**	**3,047**	**3,032**	**100%**	**99.8719%**	**99.5%**	**1.01**	**3.824**	**11,712**	**74.5%**

2016 CFH late-fall-run escapement

Run timing	Escapement N	Chinook sampled	Observed ad-clips	Heads processed	CWTs recovered	Late fall CWTs	Sample rate (fe)	Ad-clips processed (fa)	Valid CWTs (fd)	F_{samp}	Avg F_{prod}	$\sum_{i=1}^{m} CWT_{total,i}$	Hatchery proportion
Nov 11 - Mar 9	**2,348**	**2,348**	**2,297**	**2,297**	**2,280**	**2,274**	**100%**	**100.0%**	**99.7%**	**1.00**	**1.030**	**2,348**	**100%**
Total CFH count	**18,072**	**18,072**	**5,420**	**5,416**	**5,327**	**5,306**							

Table 11. Total inland CWT_{total} recoveries by location, run, and release type[a/] in hatchery returns, natural escapement and sport harvest during 2015.

			CFH			FRH						NIM		MOK			MER			Total CWT_{total}		Total
Location	**Run**	**SacW**	**CFHLh**	**CFHFh**	**CFHFn**	**FRHS**	**FRHSn**	**FRHFk**	**FRHFb**	**FRHFn**	**FRHFnc**	**NIMF**	**NIMFn**	**MOKF**	**MOKFn**	**MOKFe**	**MERF**	**MERFt**	**nonCV**	**Hatchery**	**Natural**	**Run**
Hatchery Spawners																						
Keswick Dam Fish Trap	Winter	136																		136	121	257
Feather River Hatchery	Spring					2,023	1,256		4	24										3,307	79	3,386
Coleman National Fish Hatchery	Fall			9,500	483		2		88	1,489	105	8	4		12	1		19		11,711	4,013	15,724
Feather River Hatchery	Fall			20	462	2,080	1,992	18	863	12,043	794	51	172	1	139	11		153		18,799	2,017	20,816
Nimbus Fish Hatchery	Fall		1		217				4	251	25	2,324	2,392	9	2,378	183		339	5	8,129	1,693	9,822
Mokelumne River Hatchery	Fall		1		265		2		5	282	31		833	107	5,757	212		456		7,951	347	8,298
Merced River Hatchery	Fall				43					69	6		34		741	24		142		1,058	140	1,198
Coleman National Fish Hatchery	Late-fall[b/]		2,348																	2,348		2,348
Coleman Hatchery Fish Trap	Late-fall[b/]		104																	104		104
Keswick Dam Fish Trap	Late-fall[b/]		4																	4	61	65
Total Hatchery Fall Run			***2***	***9,520***	***1,470***	***2,080***	***1,996***	***18***	***960***	***14,134***	***961***	***2,383***	***3,435***	***117***	***9,027***	***431***		***1,109***	***5***	***47,648***	***8,210***	***55,858***
Natural Spawners																						
Upper Sacramento River	Winter	558																		558	2,624	3,182
Upper Sacramento River	Fall			2,382	453		392		602	14,784	760									19,373	9,295	28,668
Clear Creek	Fall			666	368		85		235	4,875	259									6,488	2,321	8,809
Battle Creek	Fall[c/]			2,191	111				21	343	25	2	1		3			4		2,701	930	3,631
Cottonwood Creek	Fall				73						18									92	512	604
Deer Creek	Fall				86					472	11				43					612		612
Mill Creek	Fall			63	63					314	16									455	578	1,033
Feather River	Fall			24	453	1,599	1,603		523	11,762	527	131	71		119	6		137	24	16,979	3,587	20,566
Yuba River above DPD	Fall				945		34		68	544	103	439	135		575	136				2,978	2,003	4,981
Yuba River below DPD	Fall				295				11	380	32		84		253	21		93		1,168	1,401	2,569
American River	Fall		2		215				4	179	9	3,209	2,926	5	2,049	162		176	3	8,939	4,854	13,793
Nimbus Fish Hatchery Weir	Fall				104	4	25		7	50	6	13	449	1	147	16		14		838	1,108	1,946
Mokelumne River	Fall				103					77	6		460	50	3,102	284		247		4,329	252	4,581
Stanislaus River	Fall				184					106	20		53		4,057	198		180		4,798	1,338	6,136
Tuolumne River	Fall												10		53			11		74	39	113
Merced River	Fall				15					46	4		15		774	50	4	107		1,014	233	1,247
Upper Sacramento River	Late-fall[b/]		186															65		251	2,834	3,085
Total Natural Area Fall-run[d/]			***2***	***5,326***	***3,468***	***1,603***	***2,139***		***1,471***	***33,932***	***1,796***	***3,794***	***4,204***	***56***	***11,175***	***873***	***4***	***969***	***27***	***70,838***	***28,451***	***99,289***
In-basin CWT_{total}	All	558	2,642	14,073	1,047	5,702	4,885	18	1,469	24,753	1,456	5,546	5,767	157	8,859	496	4	249		77,681	42,611	120,292
Stray CWT_{total}	All		4	773	3,891	4	506		966	23,337	1,301	631	1,872	16	11,343	808		1,894	32	47,373		47,373
Total CV Spawners		**558**	**2,646**	**14,846**	**4,938**	**5,706**	**5,391**	**18**	**2,435**	**48,090**	**2,757**	**6,177**	**7,639**	**173**	**20,202**	**1,304**	**4**	**2,143**	**32**	**125,054**	**42,611**	**167,665**
%stray		0%	0.2%	5%	79%	0%	9%	0%	40%	49%	47%	10%	25%	9%	56%	62%	0%	88%		38%		28%
CV Sport Harvest																						
Upper Sacramento River	Fall			3,256	50		89		152	2,263	50									5,860	2,228	8,088
Lower Sacramento River	Fall		169		545				82	1,753	165		1,308		547	82		130		4,781	1,424	6,205
Feather River	Fall				87	67	111		110	1,405	22							104		1,906		1,906
American River	Fall				168	85	234		63	337	21	796	1,672		1,507			92		4,974	1,656	6,630
Mokelumne River	Fall		14							102			152		917	13		56		1,253	28	1,281
Upper Sacramento River	Late-fall[b/]		93							36										129	123	252
Total Sport Harvest			**276**	**3,256**	**850**	**152**	**434**		**407**	**5,896**	**258**	**796**	**3,132**		**2,971**	**95**		**382**		**18,903**	**5,459**	**24,362**

a/ Release types defined in Table 3; recoveries of Mokelumne Hatchery MOKFb (age-2 barge study releases) and MOKFt (age-4 trucked releases) merged into MOKFe.

b/ Late-fall hatchery returns, natural escapement, and sport harvest occurred in late fall 2015 (return year 2016).

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

d/ Total Natural Area Fall-run does not include unsampled escapement into Cow Creek (n=591) and Butte Creek (n=82).

Table 12. CWT recovery rate (recoveries per 100,000 CWTs released) by release type, brood year and recovery location in 2015. (page 1 of 2)

Age 2 CWT recoveries

Release type	Brood year	Run type	# CWT tagged	Central Valley total recoveries (CWT_{samp}) by basin									CV CWT_{samp} totals			% CV Stray	Ocean CWT_{samp}	Recovery rate per 100K released			
				Bat Cr	Up Sac	Nat crks[a/]	Fea	Yub	Ame	Mok	Mer	SJ	In-basin	Stray	CV total			In-basin	Stray	CV total	Ocean
FRHS	2013	Spr	1,217,640				26		2				26	2	28	7%	68	2	0	**2**	**6**
FRHSn	2013	Spr	997,962				36		4				36	4	40	10%	105	4	0	**4**	**11**
CFHFh	2013	Fall	1,125,706	201									201	0	201	0%	61	18	0	**18**	**5**
CFHFn	2013	Fall	1,810,972	147	112	138	228	309	134	91	14	46	259	961	1,220	79%	736	14	53	**67**	**41**
FRHFk	2013	Fall	44,127				2						2	0	2	0%	4	5	0	**5**	**9**
FRHFtib	2013	Fall	11,791	5			9			1			9	6	15		30				
FRHFb	2013	Fall	300,145	6		8	88		2	2			88	19	106	18%	33	29	6	**35**	**11**
FRHFn	2013	Fall	1,459,468	52	144	77	801	67	27	36	6	7	868	349	1,217	29%	422	59	24	**83**	**29**
FRHFnc	2013	Fall	366,033	44	80	84	607	21	34	35	4	20	628	301	930	32%	938	172	82	**254**	**256**
NIMFn	2013	Fall	896,419				31	55	742	248	9	7	742	349	1,091	32%	405	83	39	**122**	**45**
MOKFb	2013	Fall	302,658	1			9	21	87	156	19	39	156	176	332	53%	212	52	58	**110**	**70**
MOKFn	2013	Fall	1,148,423	1			6	44	87	358	138	278	358	554	912	61%	303	31	48	**79**	**26**
MOKFnc	2013	Fall	239,294				2	34	12	15	2	9	15	59	74	79%	493	6	25	**31**	**206**
MERFt	2013	Fall	393,182				1		5	20	3	13	3	39	43	92%	2	1	10	**11**	**1**
SacW[b/]	2013	Wint	190,905		14								14	0	14	0%	3	8	0	**8**	**1**
CFHLh	2014	Late	1,056,322	789	15					1			804	1	805	0%	7	76	0	**76**	**1**
		Total	11,561,047	1,246	366	308	1,845	551	1,136	965	196	418	4,211	2,820	7,031	40%	3,823				

Age 3 CWT recoveries

Release type	Brood year	Run type	# CWT tagged	Central Valley total recoveries (CWT_{samp}) by basin									CV CWT_{samp} totals			% CV Stray	Ocean CWT_{samp}	Recovery rate per 100K released			
				Bat Cr	Up Sac	Nat crks[a/]	Fea	Yub	Ame	Mok	Mer	SJ	In-basin	Stray	CV total			In-basin	Stray	CV total	Ocean
FRHS	2012	Spr	1,106,679				3,495		1				3,495	1	3,496	0%	848	316	0	**316**	**77**
FRHSn	2012	Spr	1,015,285	2	305	66	4,026	34	20	2			4,060	396	4,455	9%	1,916	400	39	**439**	**189**
CFHFh	2012	Fall	2,956,348	1,473	80	90	1						1,553	91	1,645	6%	1,418	53	3	**56**	**48**
FRHFk	2012	Fall	138,888				16						16	0	16	0%	23	12	0	**12**	**17**
FRHFtib	2012	Fall	9,918			17	14						14	17	31		81				
FRHFb	2012	Fall	293,784	92	546	174	1,057	78	8	1			1,135	821	1,956	42%	2,714	386	280	**666**	**924**
FRHFn	2012	Fall	1,453,105	360	2,520	1,080	4,101	162	75	51	18	20	4,262	4,124	8,386	49%	8,957	293	284	**577**	**616**
FRHFnc	2012	Fall	649,160	57	465	168	482	111	6	2	6		594	704	1,298	54%	7,418	91	109	**200**	**1143**
NIMF	2012	Fall	1,026,596	2			42	67	1,343				1,343	112	1,455	8%	1,011	131	11	**142**	**98**
NIMFn	2012	Fall	182,413	1			7		330	49	1	7	330	65	394	16%	428	181	36	**217**	**234**
MOKF	2012	Fall	99,548				1		9	83			83	10	92	10%	9	83	10	**93**	**9**
MOKFn	2012	Fall	1,275,158	2		11	49	143	875	1,693	220	698	1,693	1,998	3,692	54%	2,990	133	157	**290**	**234**
MERFt	2012	Fall	325,953	5	15		65	21	115	143	56	35	56	399	455	88%	447	17	122	**139**	**137**
SacW[b/]	2012	Wint	169,967		631								631	0	631	0%	3	371	0	**371**	**2**
CFHLh	2013	Late	960,075	467					3				467	3	470	0.7%	58	49	0	**49**	**6**
		Total	11,662,877	2,463	4,561	1,606	13,356	616	2,785	2,024	302	759	19,732	8,741	28,473	31%	28,320				

Table 12. CWT recovery rate (recoveries per 100,000 CWTs released) by release type, brood year and recovery location in 2015. (page 2 of 2)

Age 4 CWT recoveries

Release type	Brood year	Run type	# CWT tagged	Central Valley total recoveries (CWT_{samp}) by basin									CV CWT_{samp} totals			% CV Stray	Ocean CWT_{samp}	Recovery rate per 100K released			
				Bat Cr	Up Sac	Nat crks[a/]	Fea	Yub	Ame	Mok	Mer	SJ	In-basin	Stray	CV total			In-basin	Stray	CV total	Ocean
FRHS	2011	Spr	1,088,286				2,051		1				2,051	1	2,052	0%	254	188	0	**188**	**23**
FRHSn	2011	Spr	1,125,189		80	17	698		1				698	98	796	12%	132	62	9	**71**	**12**
CFHFh	2011	Fall	3,117,042	1,208	465	91	10						1,674	101	1,775	6%	1,172	54	3	**57**	**38**
FRHFtib	2011	Fall	9,933	1									0	1	1		3				
FRHFb	2011	Fall	297,089	2	48	33	206		5	1			206	90	296	30%	354	69	30	**99**	**119**
FRHFn	2011	Fall	2,293,211	41	1,011	250	984		16	2			984	1,321	2,304	57%	2,163	43	58	**101**	**94**
FRHFnc	2011	Fall	426,190	27	209	50	220						220	286	506	57%	1,435	52	67	**119**	**337**
NIMF	2011	Fall	1,078,191				14	67	350				350	81	431	19%	247	32	8	**40**	**23**
NIMFn	2011	Fall	328,073				23		361	26	2	3	361	54	415	13%	593	110	16	**126**	**181**
MOKF	2011	Fall	92,020						5	63			63	5	68	8%	11	68	6	**74**	**12**
MOKFn	2011	Fall	1,487,132				9	11	169	150	19	46	150	253	403	63%	444	10	17	**27**	**30**
MOKFt	2011	Fall	110,737				2	34	67	84	13	39	84	155	239	65%	123	76	140	**216**	**111**
MERF	2011	Fall	262,108								4		4	0	4	0%	4	1	0	**1**	**2**
SacW[b/]	2011	Wint	185,313		3								3	0	3	0%	0	2	0	**2**	**0**
CFHLh	2012	Late	1,031,419	1,061	166								1,227	0	1,227	0.00%	440	119	0	**119**	**43**
		Total	12,931,933	2,342	1,983	441	4,216	111	975	326	38	88	8,074	2,446	10,520	23%	7,375				

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 CWT_{samp}	Recovery rate per 100K released			
				Bat Cr	Up Sac	Nat crks[a/]	Fea	Yub	Ame	Mok	Mer	SJ	In-basin	Stray	CV total			In-basin	Stray	CV total	Ocean
FRHS	2010	Spr	1,170,340				20						20	0	20	0%	3	2	0	**2**	**0.2**
CFHFh	2010	Fall	2,835,420	32	48								80	0	80	0%	20	3	0	**3**	**1**
CFHFn	2010	Fall	334,756	1		8							1	8	10	87%	16	0	3	**3**	**5**
FRHFn	2010	Fall	2,554,115	1			32		2		4		32	7	39	18%	59	1	0	**2**	**2**
NIMF	2010	Fall	1,014,340				1		12				12	1	13	8%	10	1	0	**1**	**1**
NIMFn	2010	Fall	368,363						5				5	0	5	0%	3	2	0	**2**	**1**
CFHLh	2011	Late	1,037,859	58									58	0	58	0%	11	6	0	**6**	**1**

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 CV (i.e., brood year 2012 = age-4 ocean).

Sacramento River fall Chinook release types (SFC)

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

Other CV Chinook release types (OCV)

FRHS	Feather River Hatchery spring in-basin releases
FRHSn	Feather River Hatchery spring bay net pen releases
MOKF	Mokelumne River Hatchery fall in-basin releases
MOKFb	Mokelumne River Hatchery fall barge study releases
MOKFn	Mokelumne River Hatchery fall bay net pen releases
MOKFnc	Mokelumne River Hatchery fall coastal net pen releases (Santa Cruz)
MOKFt	Mokelumne River Hatchery fall trucked releases
MERF	Merced River Hatchery fall in-basin releases
MERFt	Merced River Hatchery fall trucked releases
SacW	Livingston Stone Hatchery winter in-basin releases
CFHLh	Coleman National Fish Hatchery late fall hatchery releases

Table 13. Percentage of CWT_{total} recoveries by port area, month and release type[a/] in 2015 California ocean salmon sport fishery.

		CFH			FRH[/b]						NFH		MOK[/b]				MER	Non	Total	Total %		Total
	SacW	CFHLh	CFHFh	CFHFn	FRHS	FRHSn	FRHFk	FRHFb	FRHFn	FRHFnc	NIMF	NIMFn	MOKF	MOKFb	MOKFn	MOKFnc	MERFt	CV	CV	Hatchery	Natural	Harvest
California Sport Harvest																						
Eureka/Crescent City																						
May		0%	7%		1%	2%		1%	20%	4%	4%	6%	2%		12%		2%	15%	61%	76%	24%	900
Jun			14%	7%	1%			2%	19%	5%	4%				3%	2%			57%	57%	43%	279
Jul		0%	1%	6%	1%	0%		2%	14%	2%		4%		2%	8%	1%		6%	40%	47%	53%	1,088
Aug		0%	3%	7%	0%	1%		0%	19%	4%	4%	5%	0%	1%	9%	2%		4%	55%	59%	41%	1,407
Sep																					100%	16
Total		**0%**	**4%**	**5%**	**1%**	**1%**		**1%**	**18%**	**3%**	**3%**	**4%**	**1%**	**1%**	**9%**	**1%**	**0%**	**7%**	**52%**	**59%**	**41%**	**3,690**
																						(10%)
Fort Bragg																						
Apr					3%	5%		2%	15%	3%	4%				9%			4%	40%	44%	56%	394
May		1%	4%		2%	1%			24%	4%		4%			8%				47%	47%	53%	331
Jun			7%						30%	6%								2%	43%	46%	54%	215
Jul			4%	4%	0%			2%	27%	5%	1%	4%	1%		7%	1%		3%	57%	60%	40%	3,071
Aug			6%	11%				2%	26%	6%	1%	6%			12%	1%		3%	69%	73%	27%	1,295
Sep				14%					7%	5%		20%		2%	22%	2%	8%		79%	79%	21%	187
Total		**0%**	**4%**	**6%**	**0%**	**0%**		**2%**	**25%**	**5%**	**1%**	**5%**	**0%**	**0%**	**9%**	**1%**	**0%**	**3%**	**58%**	**61%**	**39%**	**5,493**
																						(15%)
San Francisco																						
Apr		0%	7%		7%	8%		4%	28%	6%	1%	1%	0%		3%		2%	0%	68%	68%	32%	933
May		0%	5%	2%	3%	4%		3%	28%	9%	1%	2%			12%		2%	1%	72%	73%	27%	1,072
Jun		0%	4%	8%	2%	4%	0%	2%	27%	6%	1%	4%		0%	9%	1%	1%		72%	72%	28%	2,396
Jul	0%	-	5%	10%	0%	1%		2%	26%	8%	0%	7%		1%	8%	2%	1%	0%	71%	71%	29%	5,126
Aug		0%	7%	12%	0%	0%	0%	2%	23%	10%	1%	8%		0%	8%	2%		0%	75%	75%	25%	6,113
Sep		0%	3%	9%	0%	0%		0%	22%	8%	1%	5%	0%	1%	13%	1%	1%		66%	66%	34%	8,014
Oct		1%	1%	1%	0%	0%		0%	3%	1%	5%	24%	1%	1%	29%	2%	5%		74%	74%	26%	1,573
Total	**-**	**0%**	**5%**	**9%**	**1%**	**1%**	**-**	**2%**	**23%**	**8%**	**1%**	**7%**	**0%**	**1%**	**11%**	**2%**	**1%**	**0%**	**70%**	**71%**	**29%**	**25,227**
																						(67%)
Monterey																						
Apr			9%		8%	18%		5%	39%	7%					1%				87%	87%	13%	1,697
May			5%		4%	1%		12%	66%	2%	4%				5%			1%	99%	100%	0%	490
Jun			11%					4%	26%	7%	5%	8%							59%	59%	41%	543
Jul			36%					2%	9%	11%									58%	58%	42%	313
Aug										68%									68%	68%	32%	27
Total			**11%**		**5%**	**10%**		**5%**	**38%**	**7%**	**1%**	**1%**			**1%**			**0%**	**81%**	**81%**	**19%**	**3,070**
																						(8%)
California Total Sport Harvest																						
	-	**0%**	**5%**	**7%**	**1%**	**2%**	**-**	**2%**	**24%**	**7%**	**1%**	**6%**	**0%**	**1%**	**9%**	**1%**	**1%**	**1%**	**68%**	**69%**	**31%**	**37,480**
Oregon Total Sport Harvest																						
		-	***1%***	***0%***		***0%***		***0%***	***3%***	***1%***	***0%***	***1%***		***-***	***1%***	***0%***	***0%***	***9%***	***7%***	***16%***	***84%***	***6,685***

a/ Any values less than 0.05% of CWT_{total} are displayed as "-"; values equal or greater than 0.05% but less than 0.5% of CWT_{total} are displayed as 0%.

b/ In 2015, several hatch_grps were grouped together in ocean fisheries: FRHFn includes FRHFtib, MOKF includes MOKFt .

Table 14. Total CWT_{total} recoveries by port area, month and release type in 2015 California ocean salmon sport fishery.

		CFH			FRH[/a]						NFH		MOK[/a]				MER	Non	Total	Total CWT_{total}		Total
	SacW	CFHLh	CFHFh	CFHFn	FRHS	FRHSn	FRHFk	FRHFb	FRHFn	FRHFnc	NIMF	NIMFn	MOKF	MOKFb	MOKFn	MOKFnc	MERFt	CV	CV	Hatchery	Natural	Harvest
California Sport Harvest																						
Eureka/Crescent City																						
May		4	60		6	22		11	181	39	33	50	17		109		18	136	549	685	215	900
Jun			40	19	4			5	53	14	12				9	5			160	160	119	279
Jul		3	11	68	7	3		18	152	23		45		18	84	7		71	439	510	578	1,088
Aug		3	41	105	3	12		3	272	51	51	70	3	16	122	26		51	778	829	578	1,407
Sep																					16	16
Total		**10**	**152**	**192**	**19**	**37**		**38**	**657**	**127**	**96**	**164**	**19**	**34**	**324**	**38**	**18**	**258**	**1,925**	**2,184**	**1,506**	**3,690** (10%)
Fort Bragg																						
Apr					10	20		7	57	13	14				36			14	158	172	222	394
May		3	13		7	3			78	12		13			26				156	156	175	331
Jun			16						65	12								5	93	98	117	215
Jul			137	136	5			59	822	163	29	137	20		215	20		104	1,742	1,846	1,225	3,071
Aug			71	141				22	340	72	9	74			158	9		44	897	941	354	1,295
Sep				26					14	9		37		3	41	3	15		148	148	39	187
Oct																						
Total		**3**	**237**	**303**	**22**	**24**		**89**	**1,376**	**281**	**52**	**261**	**20**	**3**	**477**	**32**	**15**	**167**	**3,194**	**3,362**	**2,131**	**5,493** (15%)
San Francisco																						
Apr		2	67		68	79		40	261	52	11	7	2		31		18	2	635	637	296	933
May		3	57	18	33	45		36	295	94	15	24			131		25	9	777	786	286	1,072
Jun		11	102	185	51	102	2	53	643	148	34	104		8	225	14	30		1,713	1,713	683	2,396
Jul	3	3	280	528	8	35		98	1,313	403	12	377		44	386	100	47	14	3,637	3,651	1,475	5,126
Aug		11	404	718	26	23	4	128	1,417	638	82	478		26	465	136		15	4,556	4,572	1,541	6,113
Sep		16	255	716	23	27		29	1,790	661	85	374	20	61	1,015	118	82		5,271	5,271	2,743	8,014
Oct		13	14	14	3	7		3	55	21	76	379	14	17	449	27	71		1,161	1,161	412	1,573
Nov																						
Total	**3**	**58**	**1,179**	**2,179**	**212**	**318**	**6**	**387**	**5,773**	**2,016**	**315**	**1,743**	**36**	**157**	**2,702**	**394**	**273**	**39**	**17,751**	**17,791**	**7,436**	**25,227** (67%)
Monterey																						
Apr			149		143	309		80	663	117					19				1,481	1,481	216	1,697
May			22		20	6		60	326	11	18				22			5	486	490		490
Jun			59					20	140	35	25	41							321	321	222	543
Jul			112					7	28	35									182	182	131	313
Aug										18									18	18	9	27
Sep																						
Oct																						
Total			**342**		**163**	**315**		**168**	**1,156**	**217**	**43**	**41**			**42**			**5**	**2,488**	**2,493**	**577**	**3,070** (8%)
California Total Sport Harvest																						
	3	**72**	**1,911**	**2,673**	**417**	**694**	**6**	**682**	**8,963**	**2,640**	**507**	**2,209**	**75**	**193**	**3,545**	**464**	**306**	**469**	**25,359**	**25,828**	**11,652**	**37,480**
Oregon Total Sport Harvest																						
		2	***41***	***10***		***3***		***14***	***198***	***39***	***17***	***38***		***3***	***72***	***5***	***8***	***613***	***450***	***1,063***	***5,622***	***6,685***

a/ In 2015, several hatch_grps were grouped together in ocean fisheries: FRHFn includes FRHFtib, MOKF includes MOKFt .

Table 15. Percentage of CWT_{total} recoveries by port area, month and release type[a/] in 2015 California ocean salmon commercial fishery.

		CFH			FRH[/b]						NFH		MOK[/b]				MER	Non	Total	Total %		Total
	SacW	CFHLh	CFHFh	CFHFn	FRHS	FRHSn	FRHFk	FRHFb	FRHFn	FRHFnc	NIMF	NIMFn	MOKF	MOKFb	MOKFn	MOKFnc	MERFt	CV	CV	Hatchery	Natural	Harvest
California Commercial Harvest																						
Eureka/Crescent City																						
Sep																		**80%**		**80%**	**20%**	**46** (1%)
Fort Bragg																						
Jun		0%	6%	0%	0%	1%	-	2%	26%	4%	3%	2%	0%		5%		1%	6%	50%	55%	45%	11,317
Jul		0%	3%		0%	0%		1%	22%	4%	2%	2%			11%		2%	4%	49%	54%	46%	5,333
Aug		0%	4%			0%		1%	26%	7%	2%	2%	0%		11%		2%	2%	55%	58%	42%	3,848
Sep		0%		1%	0%				16%	4%	13%		1%		25%		3%		64%	64%	36%	1,008
Total		**0%**	**4%**	**0%**	**1%**	**1%**	**-**	**1%**	**16%**	**3%**	**2%**	**1%**	**0%**		**5%**		**1%**	**6.5%**	**35%**	**41%**	**59%**	**60,052** (54%)
San Francisco																						
May	-	1%	8%		1%	2%		2%	30%	8%	2%	3%	0%		7%		1%	2%	66%	68%	32%	7,407
Jun		1%	4%		1%	1%	0%	2%	36%	6%	2%	2%			10%		1%	4%	67%	70%	30%	4,762
Jul		0%	9%		0%	0%		3%	28%	6%	3%	2%			9%		2%	1%	63%	65%	35%	4,456
Aug			11%	0%	0%	0%	-	2%	38%	6%	1%	1%			6%	0%	1%	-	67%	67%	33%	7,055
Sep		0%	4%	2%	-			0%	27%	5%	4%	2%		0%	20%	0%	4%		68%	68%	32%	9,399
Oct		0%	2%	1%					2%	0%	10%	15%	2%	0%	37%		8%		76%	76%	24%	2,617
Total	**-**	**0%**	**7%**	**1%**	**0%**	**1%**	**-**	**2%**	**29%**	**6%**	**3%**	**3%**	**0%**	**-**	**13%**	**0%**	**2%**	**1%**	**67%**	**68%**	**32%**	**35,696** (32%)
Monterey																						
May		1%	10%	0%	2%	3%	-	6%	40%	9%	1%	2%	0%		4%		0%	0%	79%	79%	21%	7,608
Jun		0%	9%		0%	0%	0%	5%	45%	10%	4%	2%	0%		6%		1%	0%	81%	81%	19%	3,410
Jul		0%	9%		0%	0%		3%	43%	12%	2%	4%	0%		11%		1%		86%	86%	14%	3,131
Aug		1%	4%					1%	25%	19%	2%	2%	2%		17%				73%	73%	27%	564
Total		**1%**	**10%**	**0%**	**1%**	**2%**	**-**	**5%**	**41%**	**10%**	**2%**	**2%**	**0%**		**7%**		**1%**	**0%**	**81%**	**81%**	**19%**	**14,713** (13%)
California Total Commercial Harvest																						
	-	**0%**	**5%**	**0%**	**1%**	**1%**	**-**	**2%**	**24%**	**5%**	**2%**	**2%**	**0%**	**-**	**8%**	**-**	**1%**	**4%**	**51%**	**55%**	**45%**	**110,507**
Oregon Total Commercial Harvest																						
		0%	***3%***	***-***	***0%***	***0%***	***-***	***0%***	***12%***	***2%***	***1%***	***1%***	***0%***		***3%***		***0%***	***24%***	***25%***	***49%***	***51%***	***93,377***

a/ Any values less than 0.05% of CWT_{total} are displayed as "-"; values equal or greater than 0.05% but less than 0.5% of CWT_{total} are displayed as 0%.

b/ In 2015, several hatch_grps were grouped together in ocean fisheries: FRHFn includes FRHFtib, MOKF includes MOKFt .

Table 16. Total CWT_{total} recoveries by port area, month and release type in 2015 California ocean salmon commercial fishery.

		CFH			FRH[/a]						NFH		MOK[/a]				MER	Non	Total	Total CWT_{total}		Total
	SacW	CFHLh	CFHFh	CFHFn	FRHS	FRHSn	FRHFk	FRHFb	FRHFn	FRHFnc	NIMF	NIMFn	MOKF	MOKFb	MOKFn	MOKFnc	MERFt	CV	CV	Hatchery	Natural	Harvest
California Commercial Harvest																						
Eureka/Crescent City																						
Sep																		**37**		**37**	**9**	**46 (<1%)**
Fort Bragg																						
Jun		31	649	12	24	80	3	176	2,932	477	327	232	15		569		92	651	5,617	6,268	5,049	11,317
Jul		9	181		17	17		71	1,196	224	115	99			576		126	224	2,629	2,853	2,480	5,333
Aug		7	168			6		35	987	251	96	70	3		440		71	90	2,133	2,224	1,625	3,848
Sep		4		13	4				157	40	132		13		253		29		644	644	364	1,008
Total		**147**	**2,205**	**46**	**303**	**626**	**3**	**681**	**9,830**	**1,945**	**1,008**	**702**	**125**		**2,728**		**488**	**3,887**	**20,837**	**24,725**	**35,327**	**60,052 (54%)**
San Francisco																						
May	3	63	604		73	141		180	2,219	558	168	248	32		530		73	146	4,893	5,039	2,368	7,407
Jun		33	205		36	56	8	112	1,720	278	83	95			490		53	174	3,169	3,343	1,419	4,762
Jul		16	388		6	17		151	1,252	282	143	97			405		68	55	2,825	2,880	1,576	4,456
Aug			802	16	4	4	3	152	2,684	428	86	59			455	4	58	3	4,753	4,757	2,298	7,055
Sep		21	352	221	4			24	2,514	484	335	227		5	1,834	25	334		6,380	6,380	3,019	9,399
Oct		6	43	21					43	11	266	383	43	11	958		212		1,995	1,995	622	2,617
Total	**3**	**140**	**2,393**	**258**	**123**	**219**	**11**	**618**	**10,431**	**2,042**	**1,080**	**1,108**	**75**	**16**	**4,671**	**29**	**798**	**379**	**24,015**	**24,394**	**11,302**	**35,696 (32%)**
Monterey																						
May		60	776	13	115	256	3	464	3,012	690	106	140	13		318		24	25	5,990	6,015	1,593	7,608
Jun		9	321		11	5	3	157	1,520	330	124	52	10		207		23	3	2,772	2,775	635	3,410
Jul		15	277		2	2		83	1,333	391	77	115	9		346		28		2,680	2,680	451	3,131
Aug		3	24					6	142	107	12	12	12		95				412	412	152	564
Total		**87**	**1,398**	**13**	**127**	**263**	**6**	**710**	**6,007**	**1,518**	**319**	**319**	**44**		**967**		**76**	**28**	**11,853**	**11,881**	**2,832**	**14,713 (13%)**
California Total Commercial Harvest																						
	3	**374**	**5,996**	**316**	**554**	**1,109**	**20**	**2,009**	**26,269**	**5,504**	**2,408**	**2,129**	**244**	**16**	**8,366**	**29**	**1,361**	**4,331**	**56,706**	**61,037**	**49,470**	**110,507**
Oregon Total Commercial Harvest																						
		95	***2,765***	***18***	***224***	***387***	***1***	***438***	***11,379***	***1,735***	***1,137***	***1,352***	***200***		***3,044***		***266***	***22,577***	***23,041***	***45,618***	***47,759***	***93,377***

a/ In 2015, several hatch_grps were grouped together in ocean fisheries: FRHFn includes FRHFtib, MOKF includes MOKFt .

Table 17. CWT recovery rate (recoveries per 100,000 CWTs released) for Experimental & Net Pen release types in 2015. (page 1 of 2)

Age 2 CWT recoveries

Release type	Brood year	Run type	# CWT tagged	Central Valley total recoveries (CWT_{samp}) by basin									CV CWT_{samp} totals			% CV Stray	Ocean CWT_{samp}	Recovery rate per 100K released			
				Bat Cr	Up Sac	Nat crks[a/]	Fea	Yub	Ame	Mok	Mer	SJ	In-basin	Stray	CV total			In-basin	Stray	**CV total**	**Ocean**
CFHFn	2013	Fall	1,810,972	147	112	138	228	309	134	91	14	46	259	961	**1,220**	**79%**	**736**	14	53	**67**	**41**
FRHFbb	2013	Fall	100,227	4			19						19	4	**23**	**16%**	**14**	19	4	**23**	**14**
FRHFbg	2013	Fall	100,564	1			44			1			44	2	**46**	**5%**	**0**	44	2	**46**	**0**
FRHFbr	2013	Fall	99,354	1		8	25		2	1			25	13	**38**	**34%**	**19**	25	13	**38**	**19**
FRHFtib	2013	Fall	11,791	5			9			1			9	6	**15**	**40%**	**30**	76	51	**127**	**255**
FRHFkr	2013	Fall	44,127				2						2	0	**2**	**0%**	**4**	5	0	**5**	**9**
FRHFn	2013	Fall	1,459,468	52	144	77	801	67	27	36	6	7	868	349	**1,217**	**29%**	**422**	59	24	**83**	**29**
FRHFnp	2013	Fall	366,033	44	80	84	607	21	34	35	4	20	628	301	**930**	**32%**	**938**	172	82	**254**	**256**
NIMFn	2013	Fall	896,419				31	55	742	248	9	7	742	349	**1,091**	**32%**	**405**	83	39	**122**	**45**
MOKFbb	2013	Fall	101,051				1	11	23	16	9	13	16	56	**72**	**78%**	**88**	16	56	**72**	**87**
MOKFbg	2013	Fall	101,426	1			8	11	64	132	10	26	132	120	**252**	**48%**	**119**	130	118	**248**	**117**
MOKFbr	2013	Fall	100,181							8			8	0	**8**	**0%**	**5**	8	0	**8**	**5**
MOKFn	2013	Fall	1,148,423	1			6	44	87	358	138	278	358	554	**912**	**61%**	**303**	31	48	**79**	**26**
MOKFns	2013	Fall	239,294				2	34	12	15	2	9	15	59	**74**	**79%**	**493**	6	25	**31**	**206**

Age 3 CWT recoveries

Release type	Brood year	Run type	# CWT tagged	Central Valley total recoveries (CWT_{samp}) by basin									CV CWT_{samp} totals			% CV Stray	Ocean CWT_{samp}	Recovery rate per 100K released			
				Bat Cr	Up Sac	Nat crks[a/]	Fea	Yub	Ame	Mok	Mer	SJ	In-basin	Stray	CV total			In-basin	Stray	**CV total**	**Ocean**
FRHFbb	2012	Fall	97,760	52	321	66	458		2	1			458	443	**901**	**49%**	**1,401**	469	453	**922**	**1433**
FRHFbg	2012	Fall	99,192	40	225	108	597	78	6				675	379	**1,053**	**36%**	**1,289**	680	382	**1062**	**1300**
FRHFbr	2012	Fall	96,832				2						2	0	**2**	**0%**	**24**	2	0	**2**	**25**
FRHFtib	2012	Fall	9,918			17	14						14	17	**31**	**54%**	**81**	141	167	**308**	**817**
FRHFkc	2012	Fall	46,492				15						15	0	**15**	**0%**	**19**	32	0	**32**	**40**
FRHFkr	2012	Fall	92,396				1						1	0	**1**	**0%**	**5**	1	0	**1**	**5**
FRHFn	2012	Fall	1,453,105	360	2,520	1,080	4,101	162	75	51	18	20	4,262	4,124	**8,386**	**49%**	**8,957**	293	284	**577**	**616**
FRHFnp	2012	Fall	412,360	47	417	151	409	44	4	2	6		453	628	**1,081**	**58%**	**4,436**	110	152	**262**	**1076**
FRHFns	2012	Fall	236,800	10	48	17	74	67	2				141	77	**218**	**35%**	**2,982**	60	32	**92**	**1259**
NIMFn	2012	Fall	182,413	1			7		330	49	1	7	330	65	**394**	**16%**	**428**	181	35	**216**	**234**
MOKFn	2012	Fall	1,275,158	2		11	49	143	875	1,693	220	698	1,693	1,998	**3,692**	**54%**	**2,990**	133	157	**290**	**234**

Table 17. CWT recovery rate (recoveries per 100,000 CWTs released) for Experimental & Net Pen release types in 2015. (page 2 of 2)

Age 4 CWT recoveries

Release type	Brood year	Run type	# CWT tagged	Central Valley total recoveries (CWT_{samp}) by basin									CV CWT_{samp} totals			% CV Stray	Ocean CWT_{samp}	Recovery rate per 100K released			
				Bat Cr	Up Sac	Nat crks[a/]	Fea	Yub	Ame	Mok	Mer	SJ	In-basin	Stray	CV total			In-basin	Stray	**CV total**	**Ocean**
FRHFbb	2011	Fall	98,241	1		8	41		3				41	13	**54**	**24%**	**122**	41	13	**54**	**125**
FRHFbg	2011	Fall	98,947	1	16	25	44			1			44	43	**87**	**50%**	**121**	44	44	**88**	**122**
FRHFbr	2011	Fall	99,901		32		121		2				121	34	**156**	**22%**	**110**	121	34	**155**	**110**
FRHFn	2011	Fall	2,293,211	41	1,011	250	984		16	2			984	1,321	**2,304**	**57%**	**2,163**	43	58	**101**	**94**
FRHFnp	2011	Fall	185,303	25	177	42	200						200	243	**443**	**55%**	**729**	108	131	**239**	**393**
FRHFns	2011	Fall	240,887	2	32	8	20						20	43	**63**	**68%**	**706**	8	18	**26**	**293**
NIMFn	2011	Fall	328,073				23		361	26	2	3	361	54	**415**	**13%**	**593**	110	16	**126**	**181**
MOKFn	2011	Fall	1,487,132				9	11	169	150	19	46	150	253	**403**	**63%**	**444**	10	17	**27**	**30**

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

Central Valley Chinook Experimental and Net Pen release types

CFHFn Coleman National Fish Hatchery fall 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.)

FRHFtib Feather River Hatchery fall Tiburon net pen releases

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

FRHFkr Feather 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

FRHFns Feather River Hatchery fall coastal net pen releases - Santa Cruz

NIMFn Nimbus Hatchery fall bay net pens 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.)

MOKFn Mokelumne River Hatchery fall bay net pen releases

MOKFns Mokelumne River Hatchery fall coastal net pen releases - Santa Cruz

#	Release Type	Release Location
1	SacW	Lake Redding Park (Sac R)
2	CFHFh,CFHLh	Coleman Fish Hatchery
3	FRHS	Thermalito High Flow, Gridley (Feather R)
4	FRHS	Boyds Pump Boat Ramp (Fea R)
5	FRHFbr, FRHFkc	Elkhorn Boat Ramp (Sac R)
6	NIMF	American River
7	FRHFbr	Broderick Boat Ramp (Sac R)
8	FRHFkr	Yolo Bypass - Knaggs Ranch
9	MOKF	Mokelumne River Hatchery
10	MOKFbr	Miller's Ferry Bridge (Mok R)
11	FRHFbr	Rio Vista (Sac R)
12	MERF	Merced River Hatchery
13	MERF	Hatfield State Area (Mer R)
14	MERFt	Mossdale (San Joaquin R)
15	SJOx	San Joaquin R & Merced R
16	MOKFn, MOKFt	Sherman Island
17	FRHSn, NIMFn	Mare Island Net Pens
18	FRHFn, NIMFn	Wickland Oil Net Pens
17	CFHFn, FRHSn	San Pablo Bay Net Pens
18	FRHFn	(both Wickland & Mare Island)
19	FRHFtib	Tiburon Net Pens
20	FRHFbb, MOKFbb	Trucked to SF Bay (Fort Baker, Tiburon)
20	FRHFbg, MOKFbg	Transported by Barge to SF Bay (Golden Gate mouth)
21	FRHFnp	Pillar Point Net Pens
22	FRHFns, MOKFns	Santa Cruz Net Pens

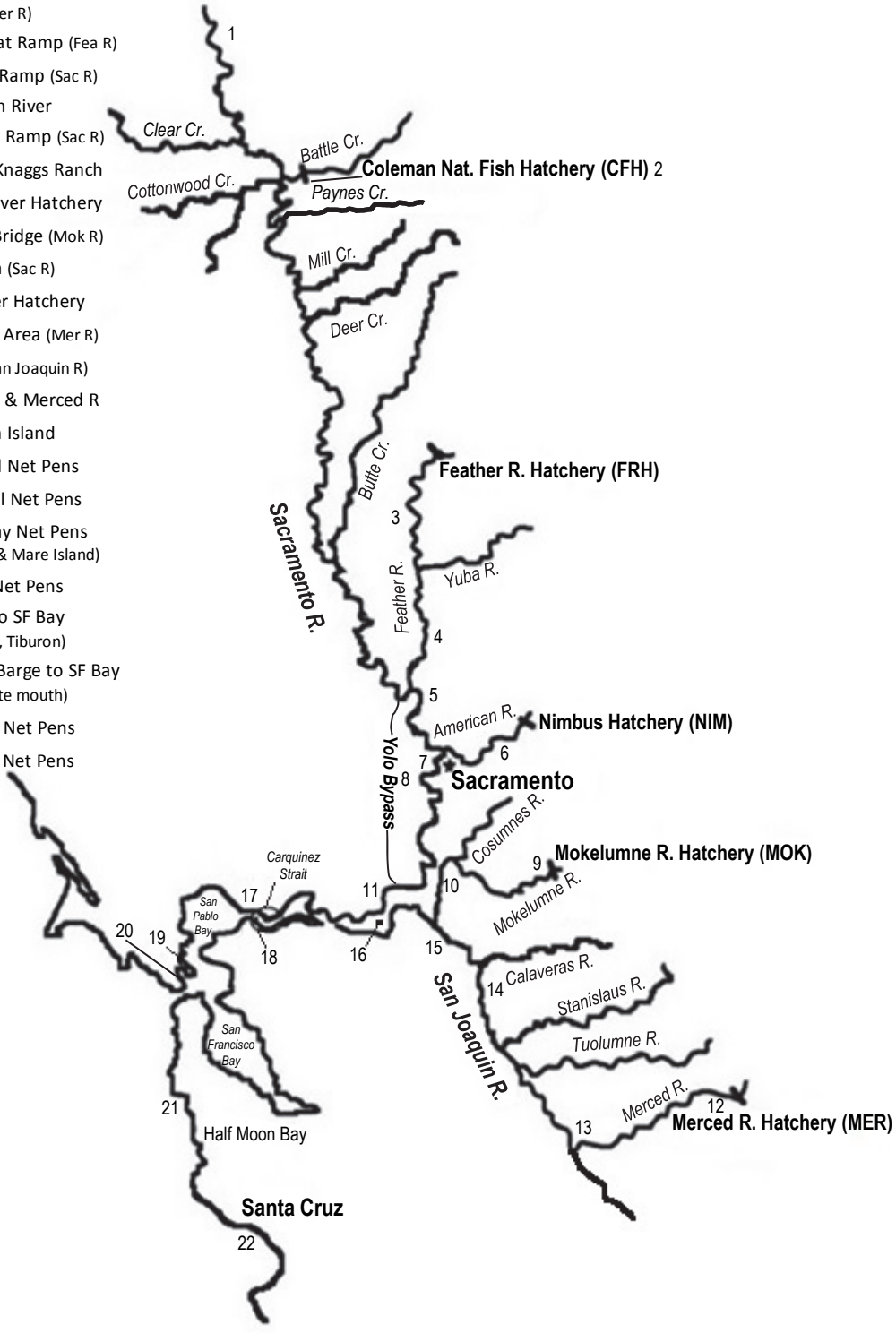


Figure 1. Map of release locations for CV hatchery release types, brood years 2010-2013.

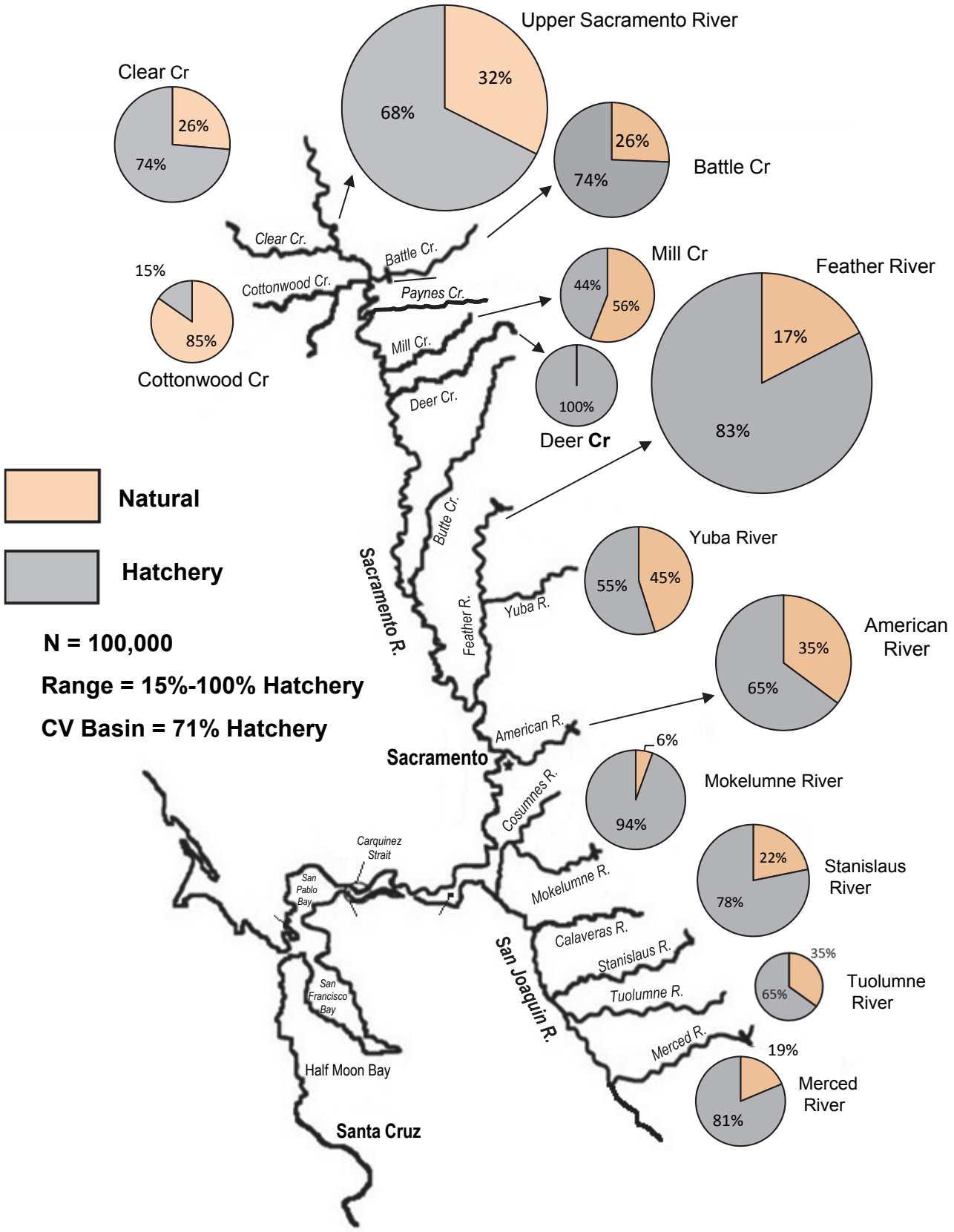


Figure 2. Fall-run CV Natural Area Escapement, Hatchery and Natural Proportions, 2015.

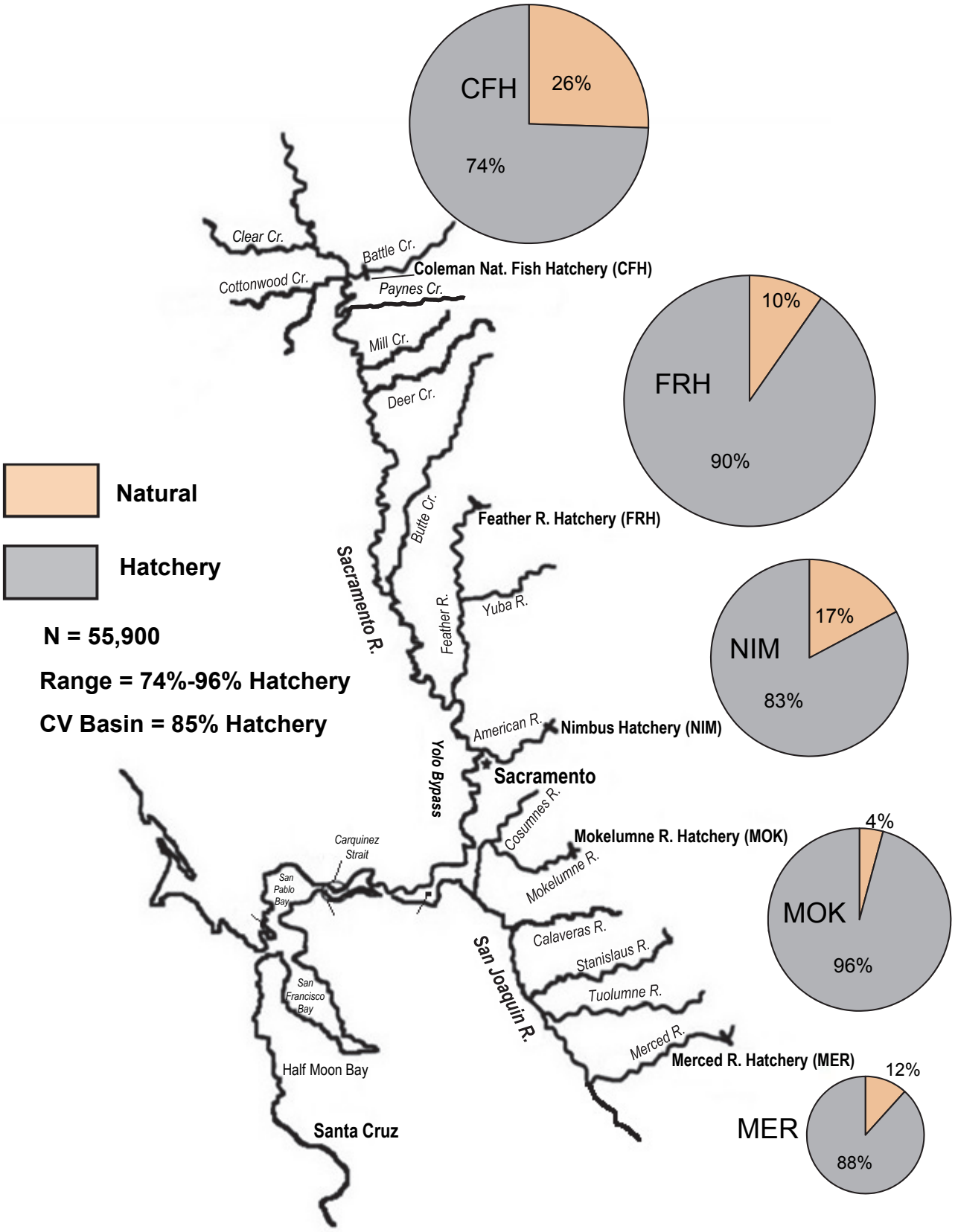


Figure 3. Fall-run CV Hatchery Escapement, Hatchery and Natural Proportions, 2015.

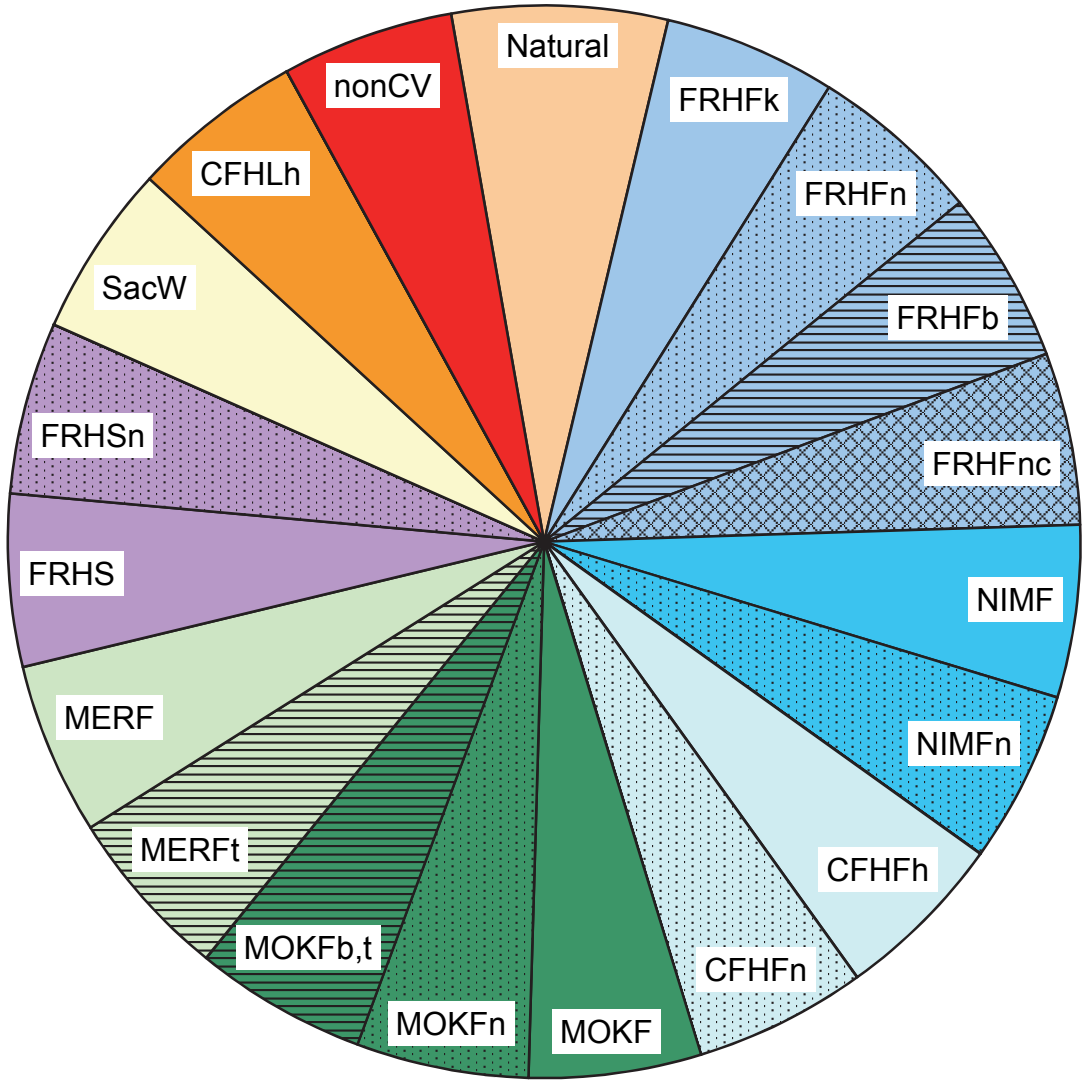


Figure 4. Color and pattern scheme used in all pie chart figures for Central Valley hatchery release types, brood years 2010-2013.

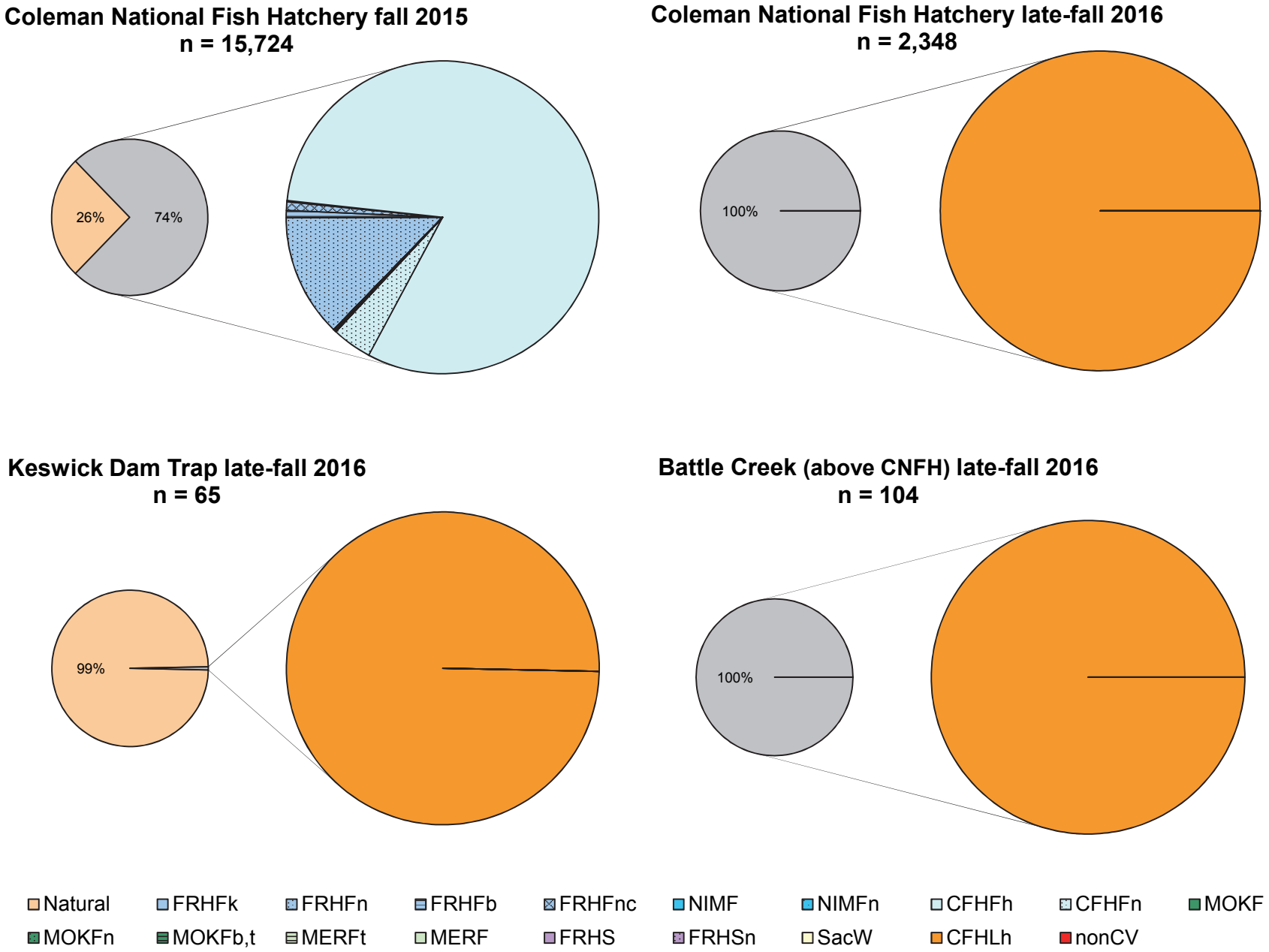


Figure 5. Proportion of hatchery- and natural-origin fish at Coleman National Fish Hatchery, 2015-16.

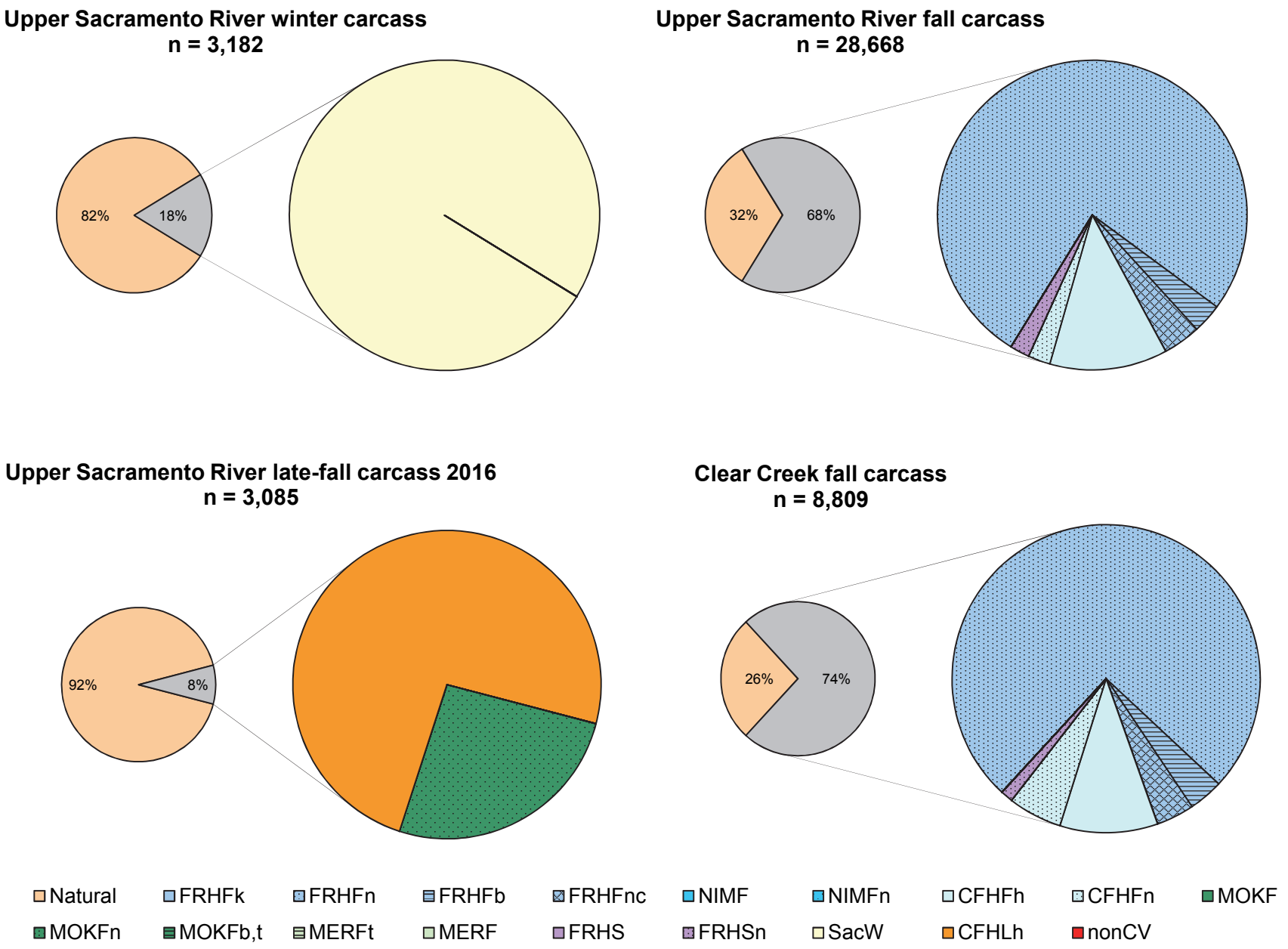


Figure 6. Proportion of hatchery- and natural-origin fish in Upper Sacramento River & tributaries, 2015. (page 1 of 2)

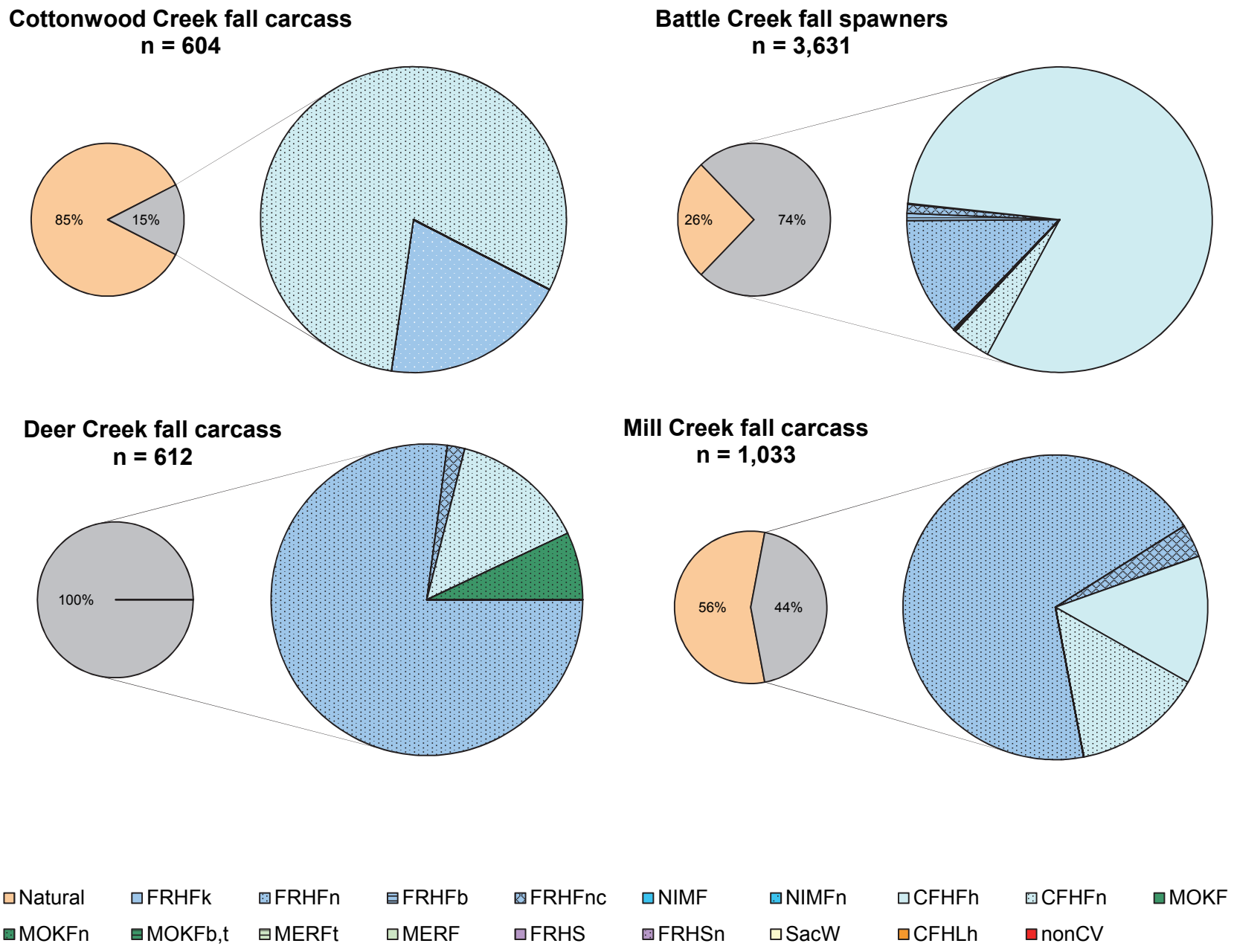


Figure 6. Proportion of hatchery- and natural-origin fish in Upper Sacramento River & tributaries, 2015. (page 2 of 2)

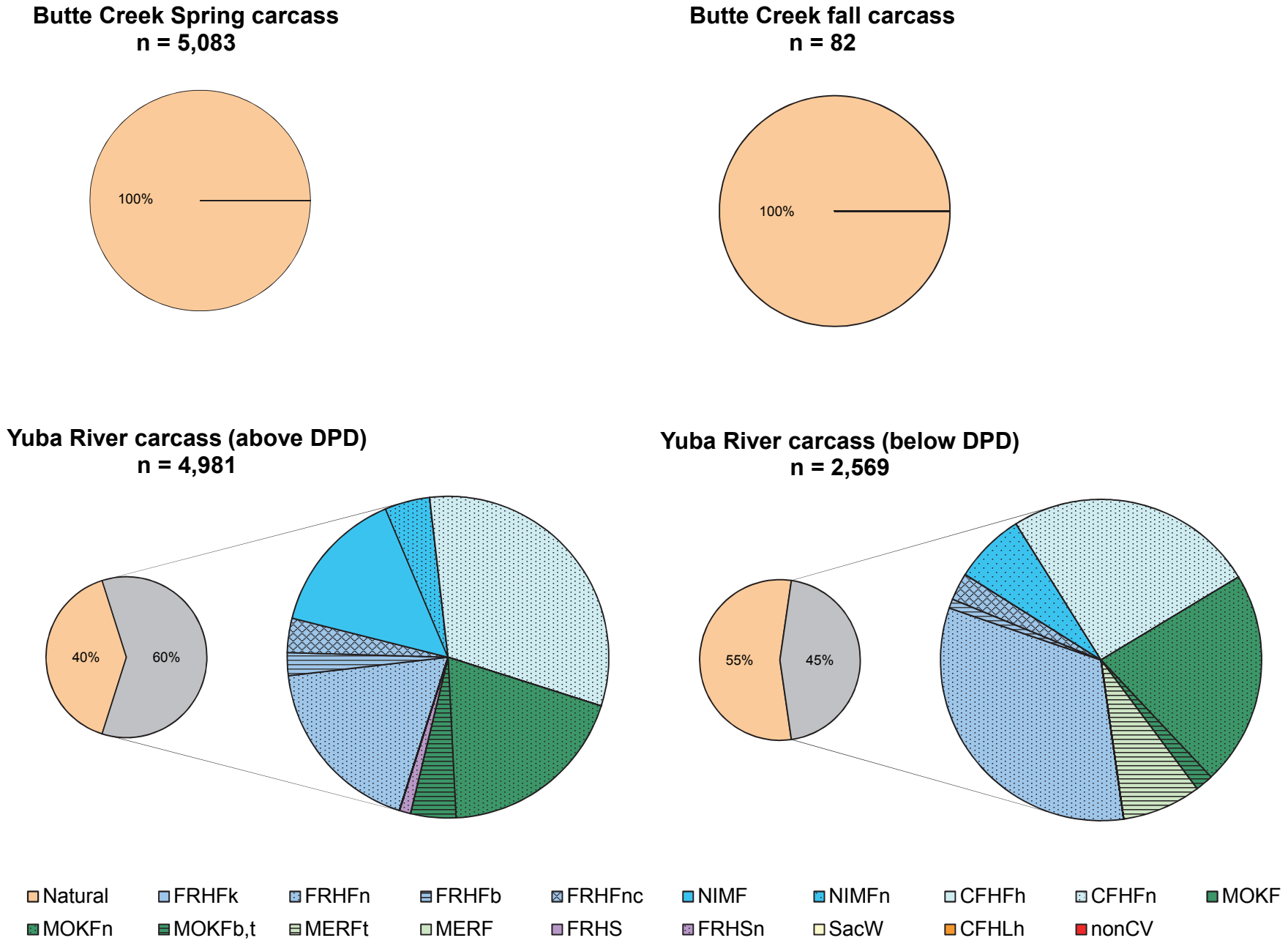


Figure 7. Proportion of hatchery- and natural-origin fish in Butte Creek & Yuba River, 2015.

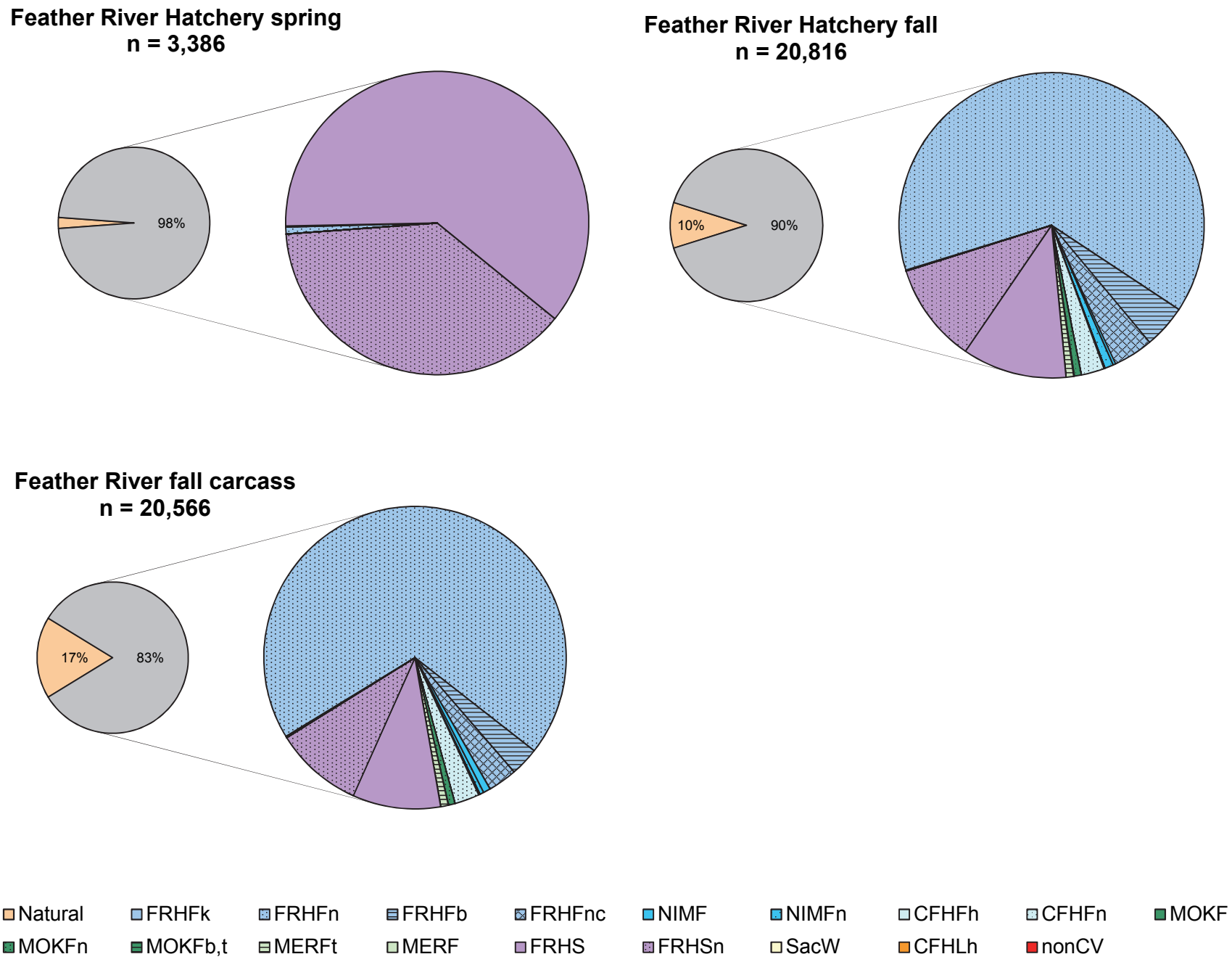


Figure 8. Proportion of hatchery- and natural-origin fish in the Feather River Basin, 2015.

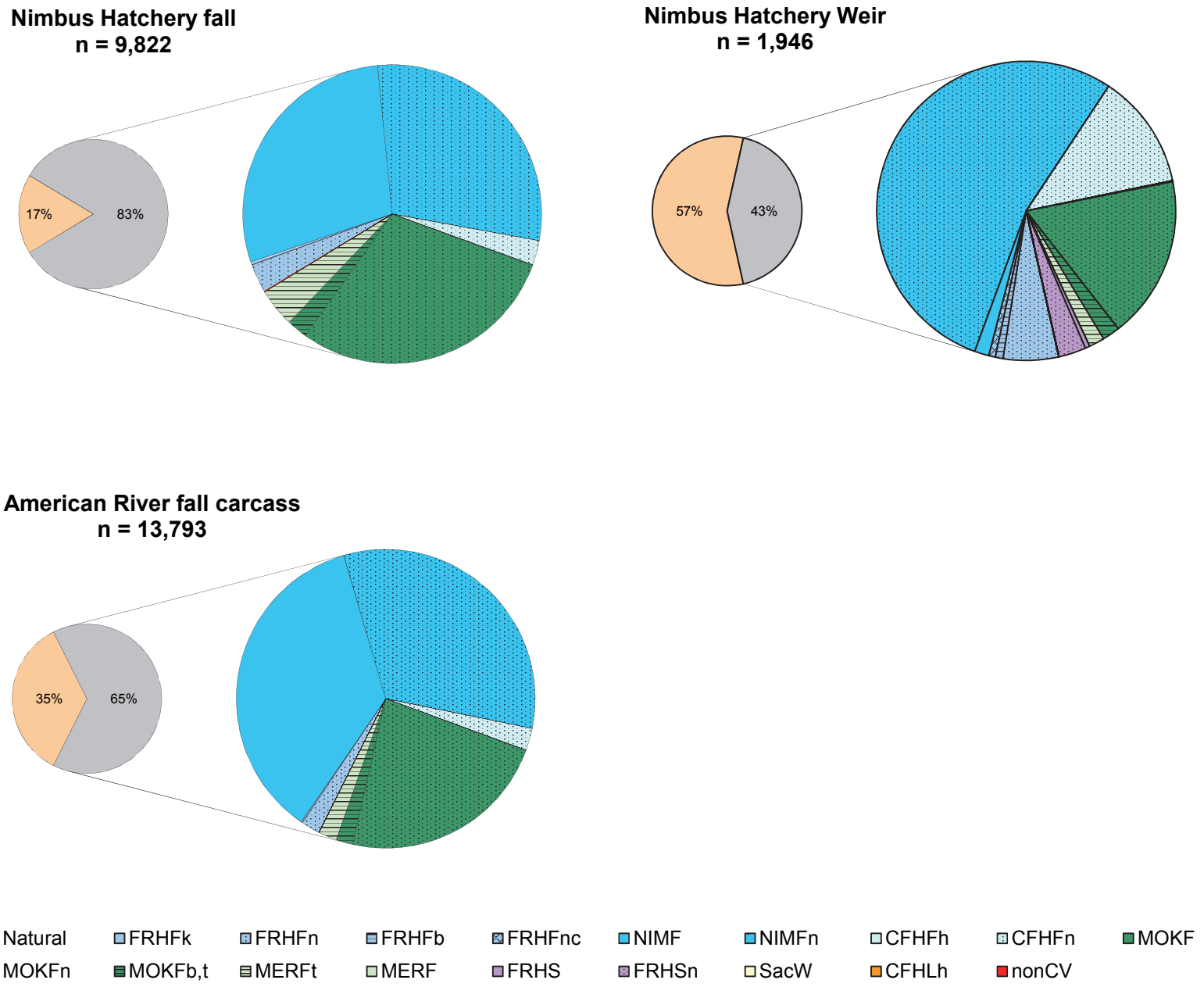


Figure 9. Proportion of hatchery- and natural-origin fish in the American River Basin, 2015.

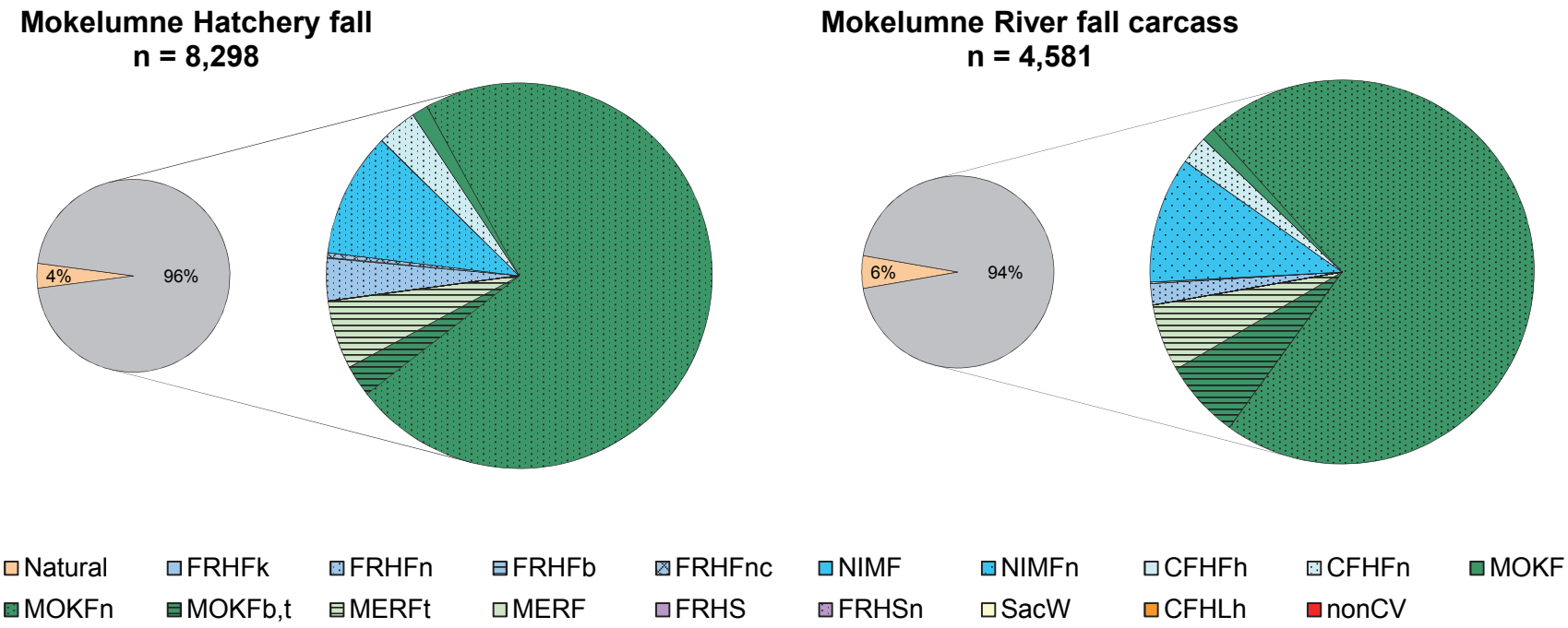


Figure 10. Proportion of hatchery- and natural-origin fish in the Mokelumne River Basin, 2015.

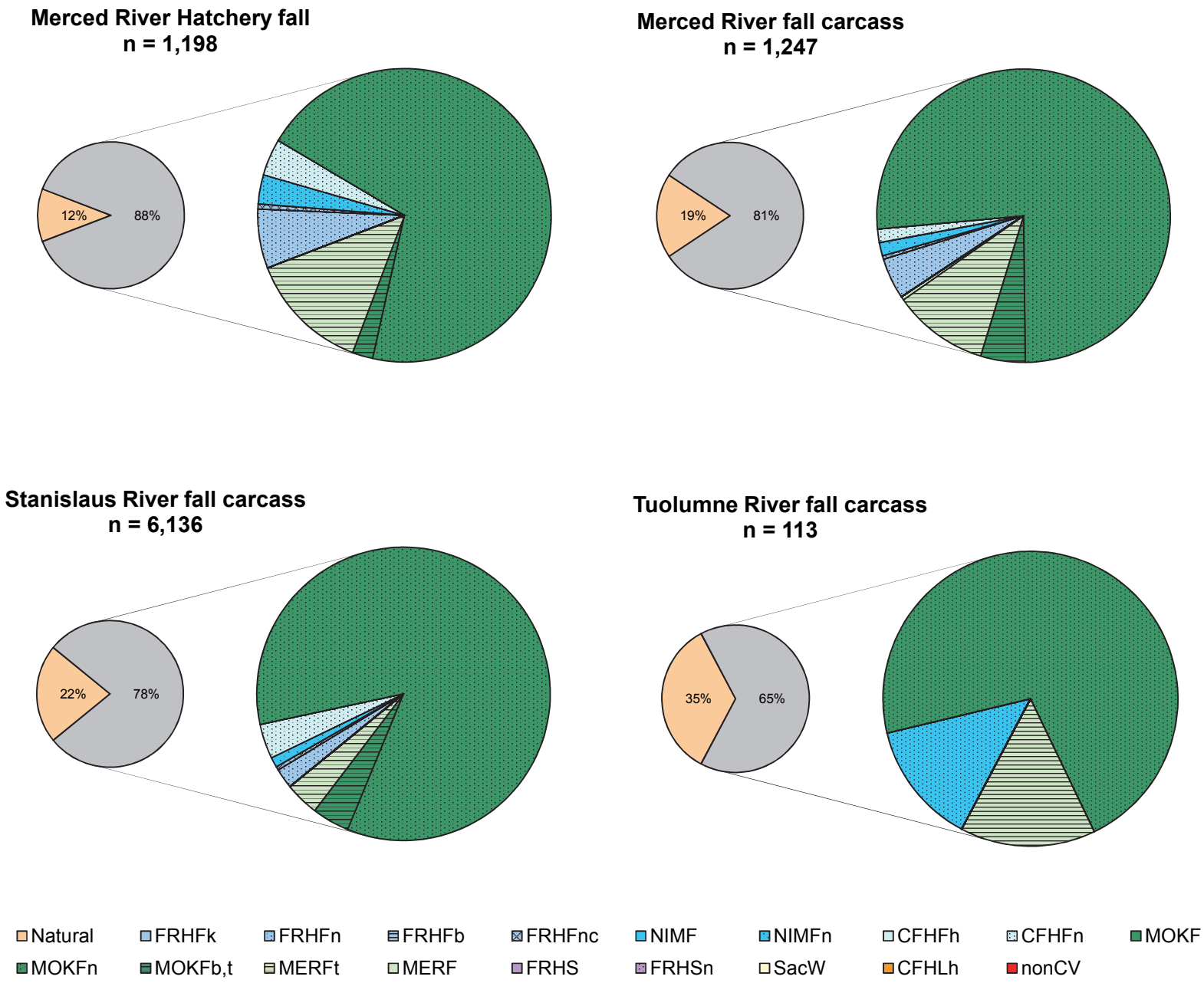


Figure 11. Proportion of hatchery- and natural-origin fish in Merced River & San Joaquin Basin tributaries, 2015.

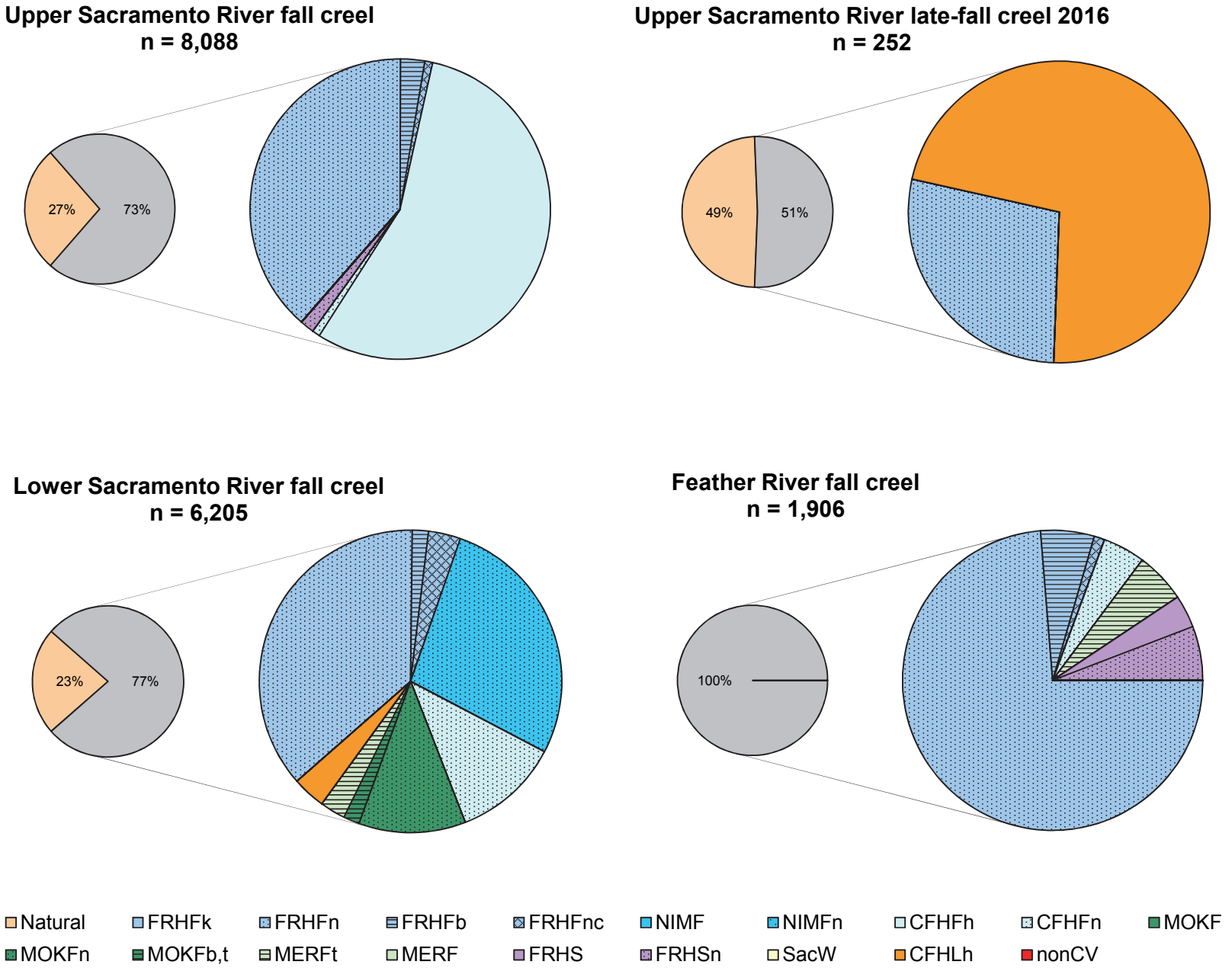


Figure 12. Proportion of hatchery- and natural-origin fish in sport harvest on Sacramento & Feather rivers, 2015.

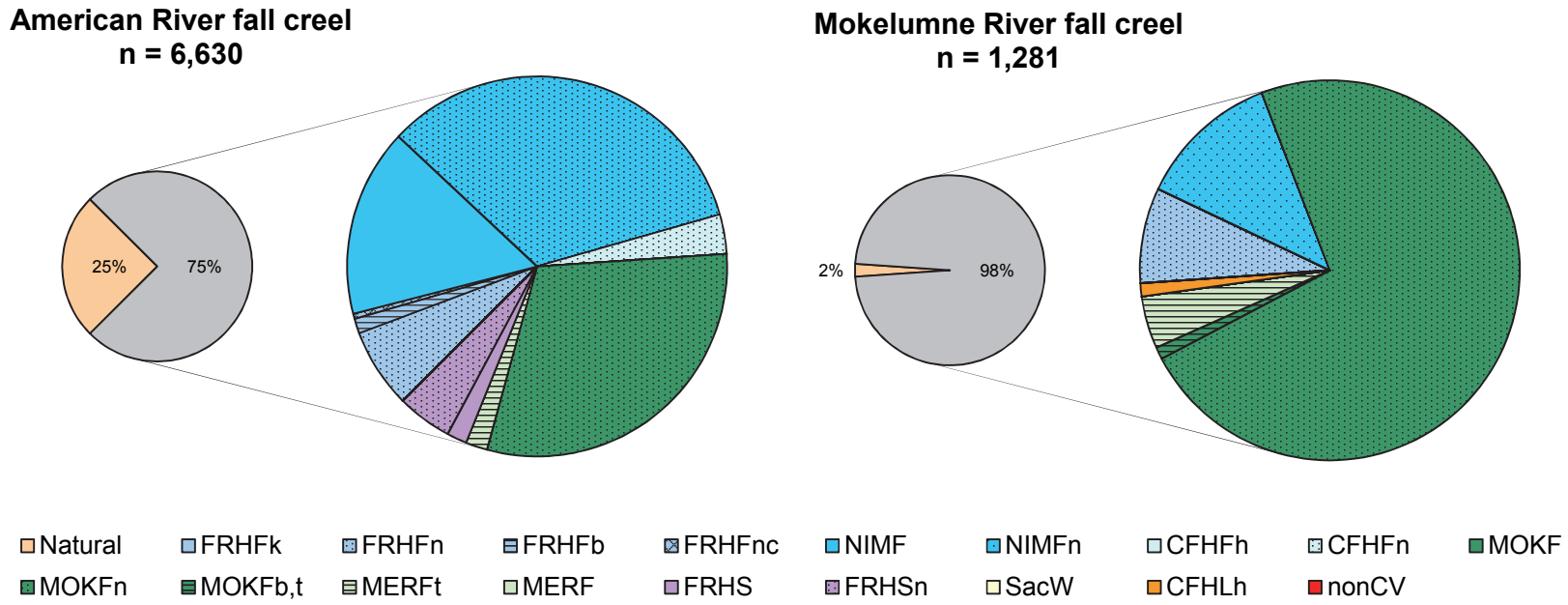


Figure 13. Proportion of hatchery- and natural-origin fish in sport harvest on American & Mokelumne rivers, 2015.

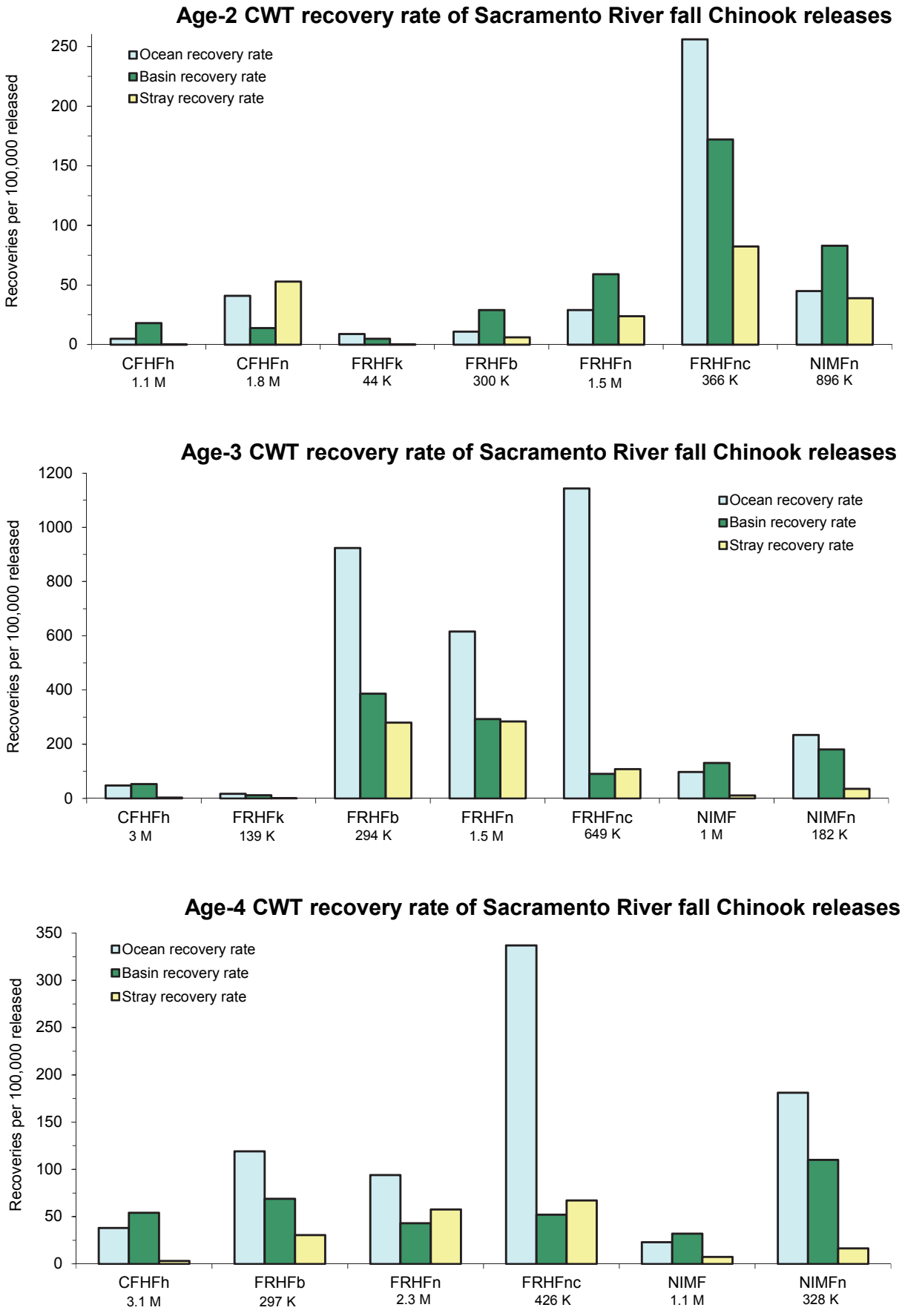


Figure 14. CWT recovery rates of Sacramento River fall Chinook releases by age in 2015.

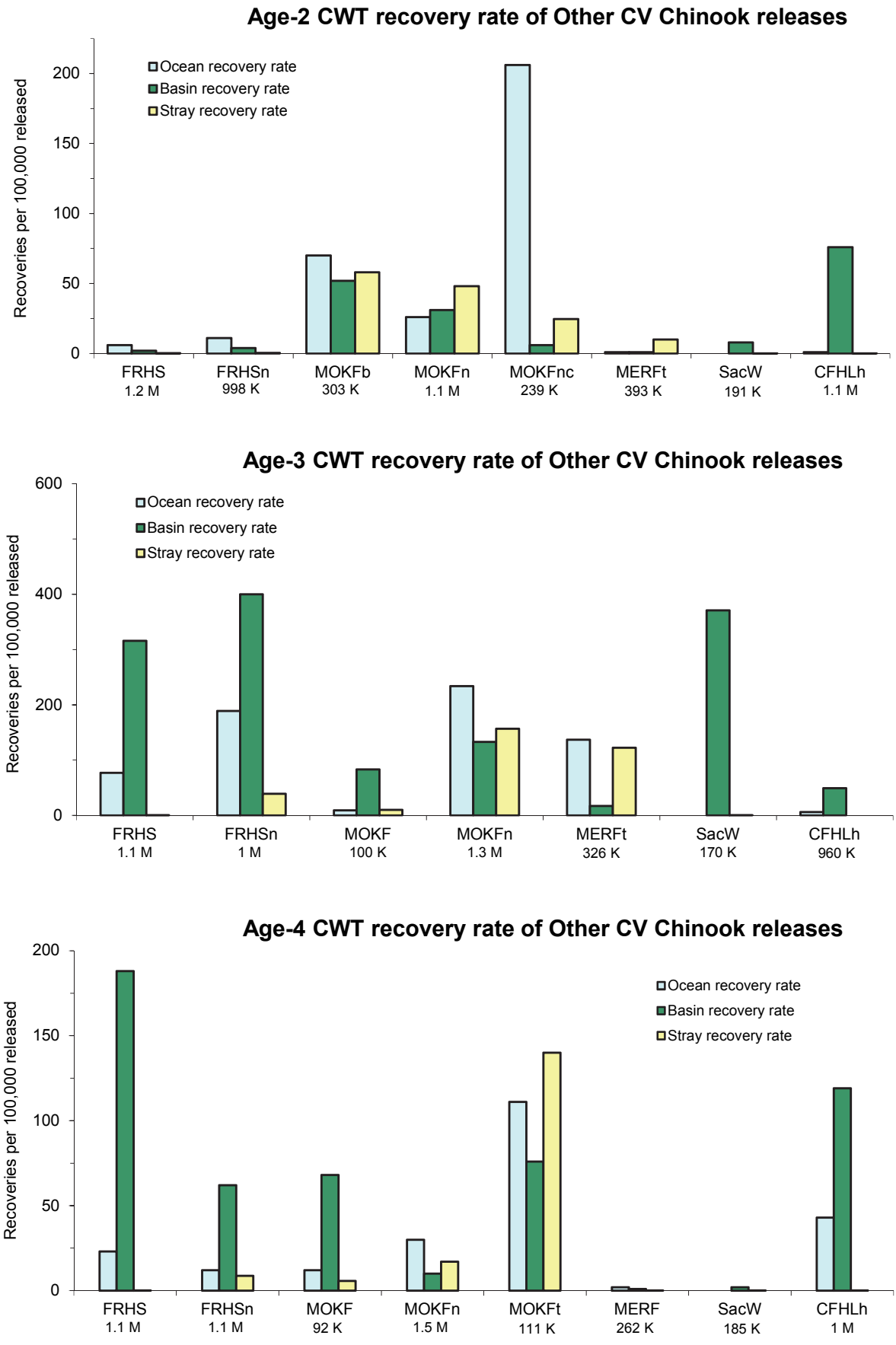
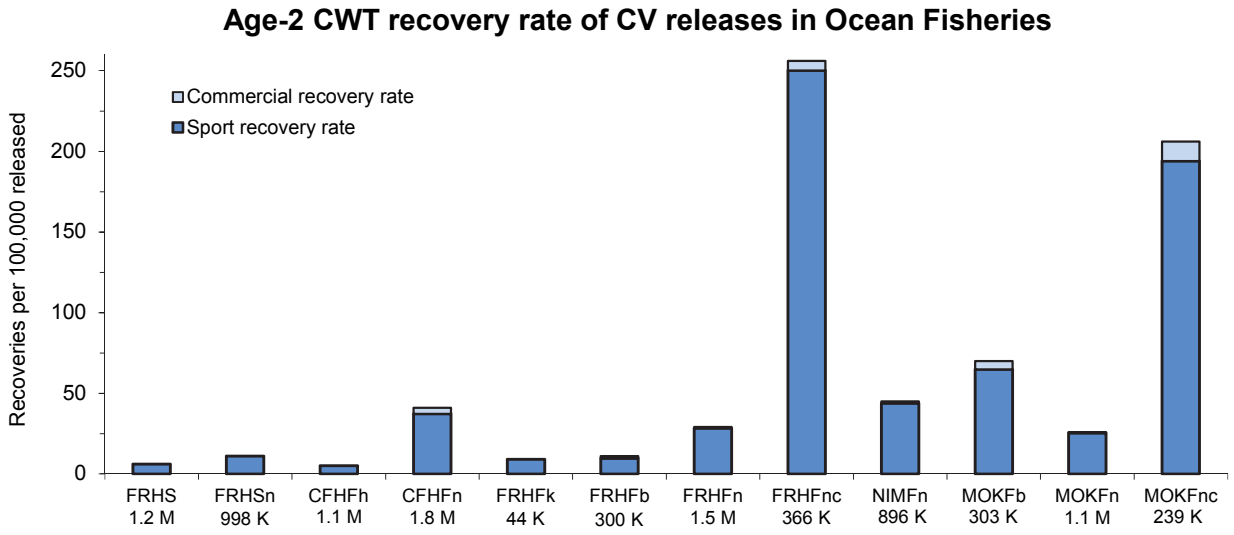
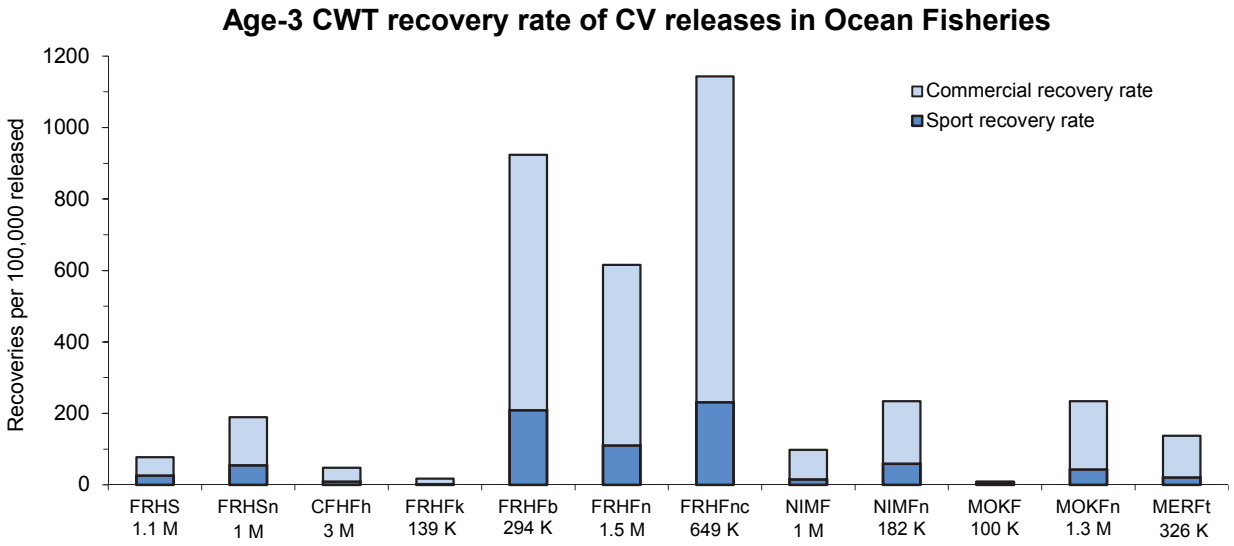


Figure 15. CWT recovery rates of Other CV Chinook releases by age in 2015.





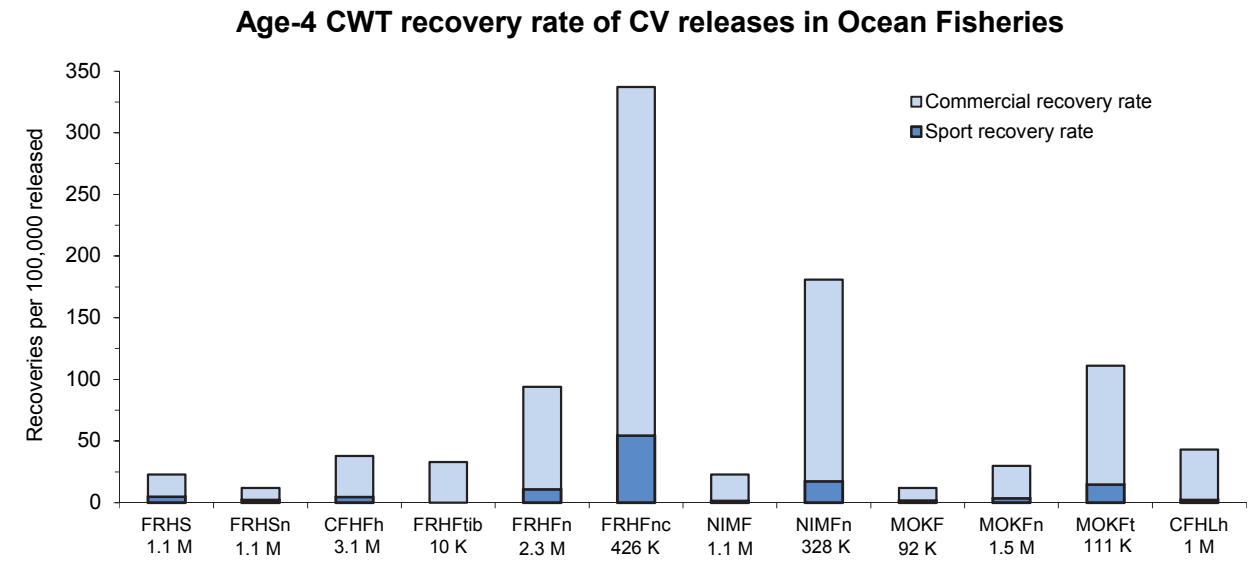


Figure 16. CWT recovery rates by release type in 2015 Ocean Salmon Fisheries.

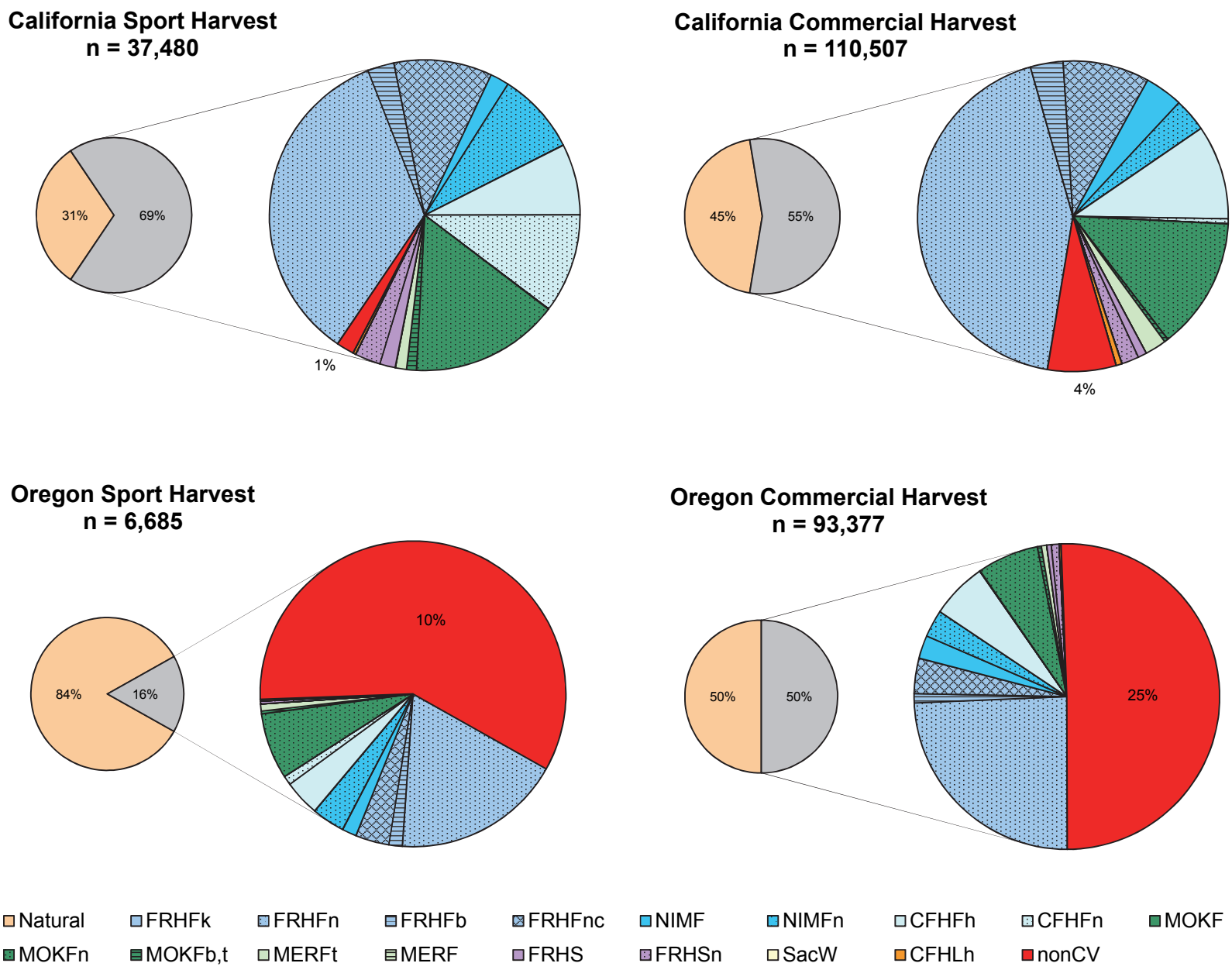


Figure 17. Proportion of hatchery- and natural-origin salmon in 2015 California and Oregon ocean fisheries.

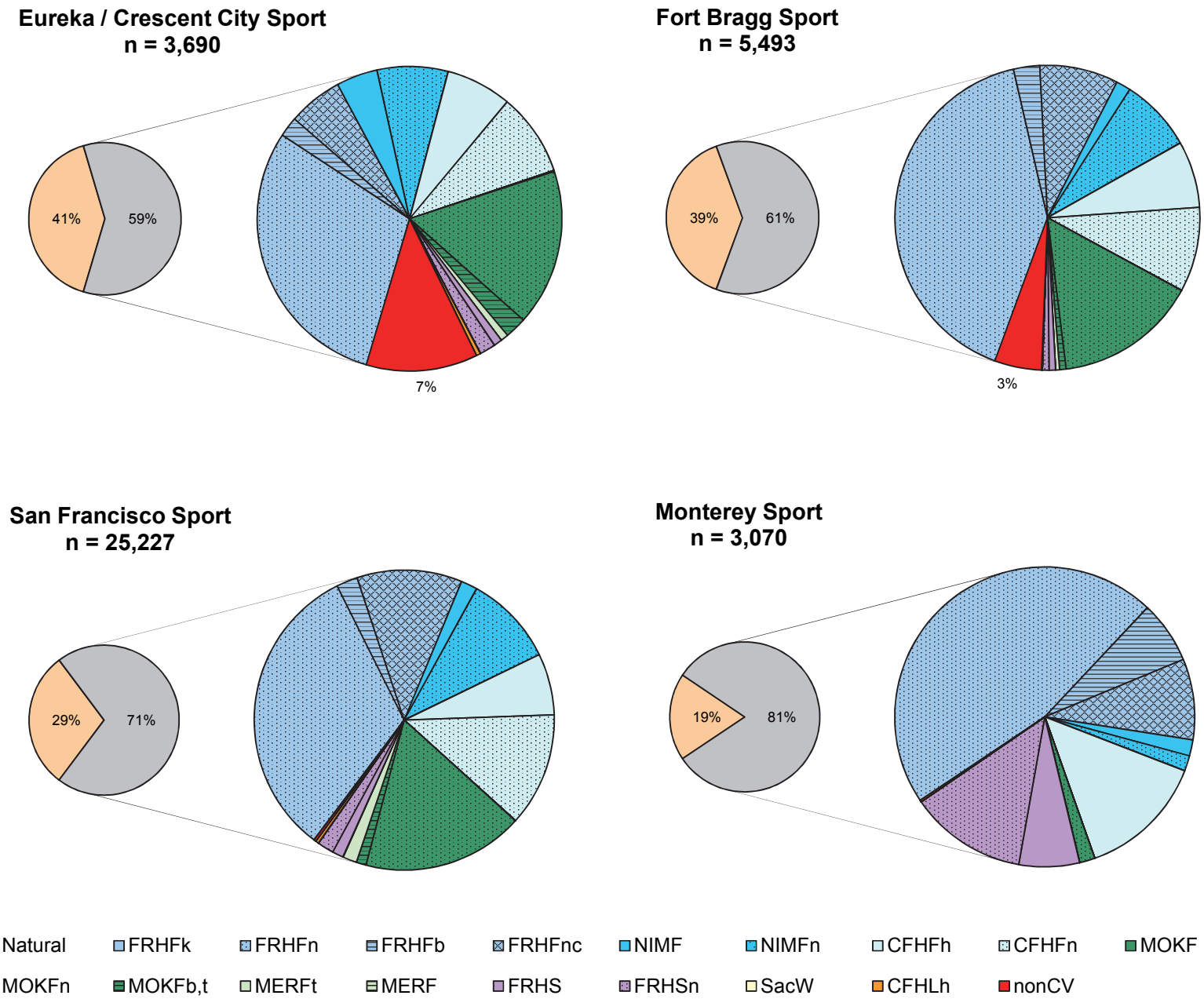


Figure 18. Proportion of hatchery- and natural-origin salmon in the 2015 California ocean sport fishery.

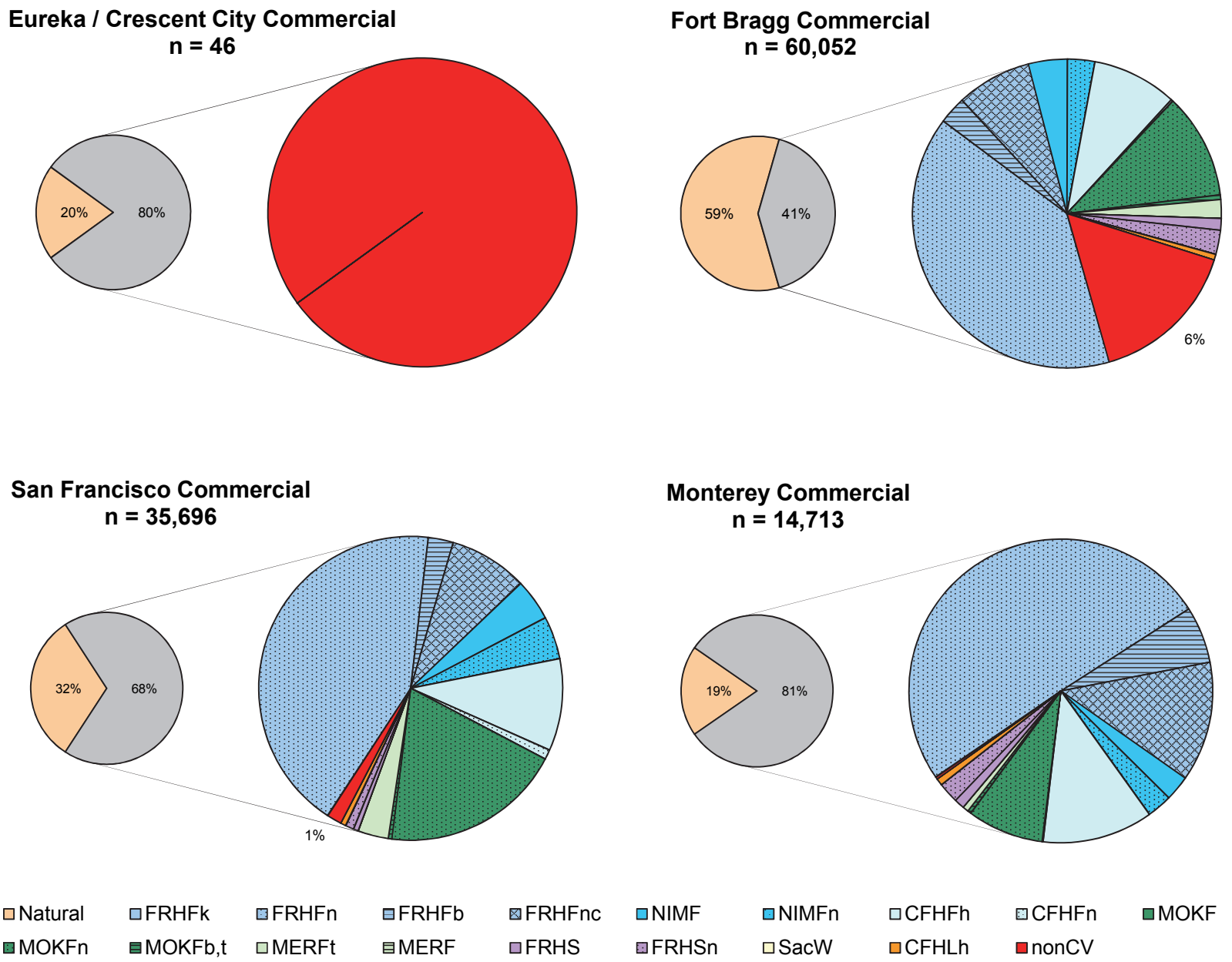


Figure 19. Proportion of hatchery- and natural-origin salmon in the 2015 California ocean commercial fishery.

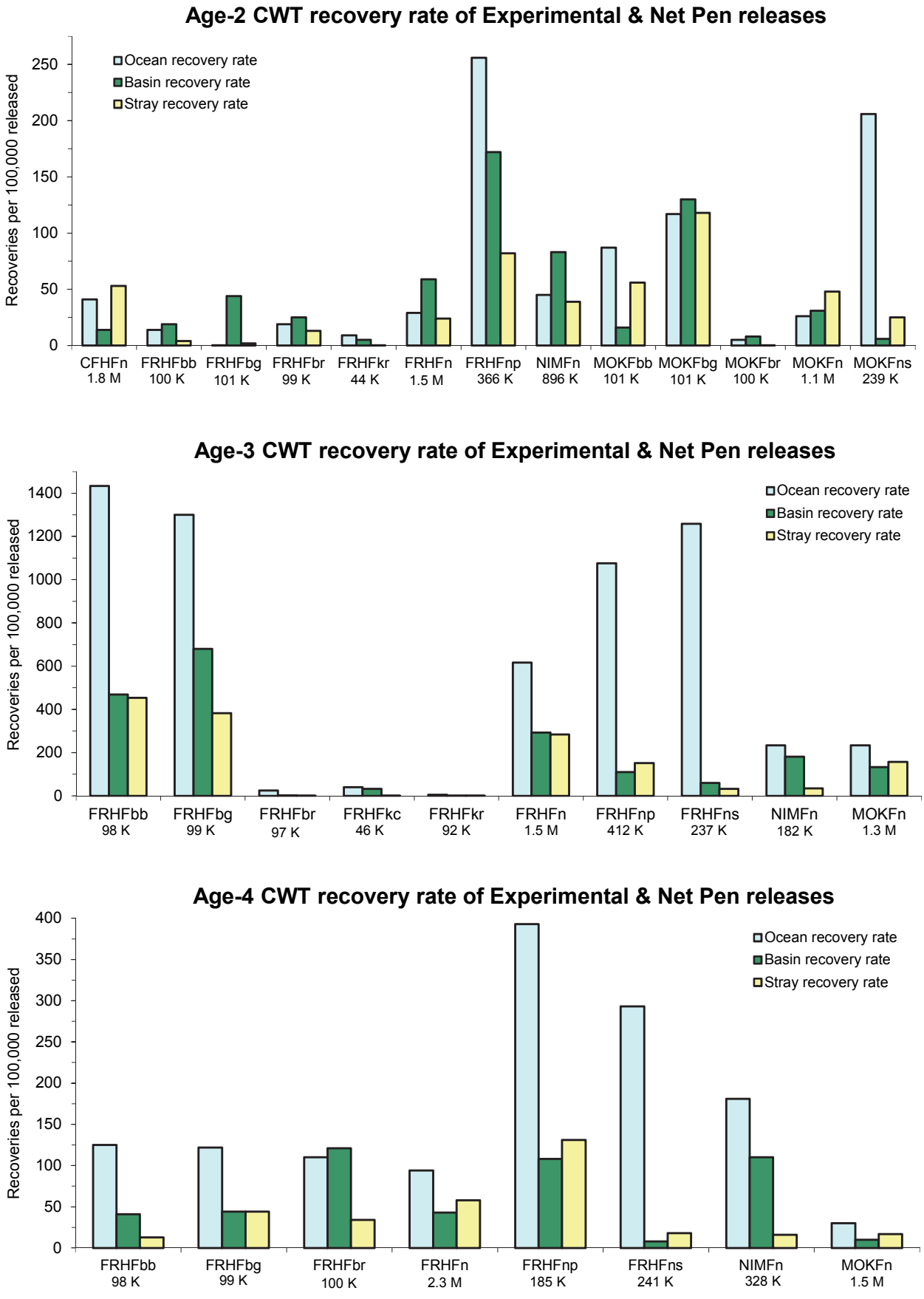


Figure 20. CWT recovery rates of Experimental and Net Pen releases by age in 2015.

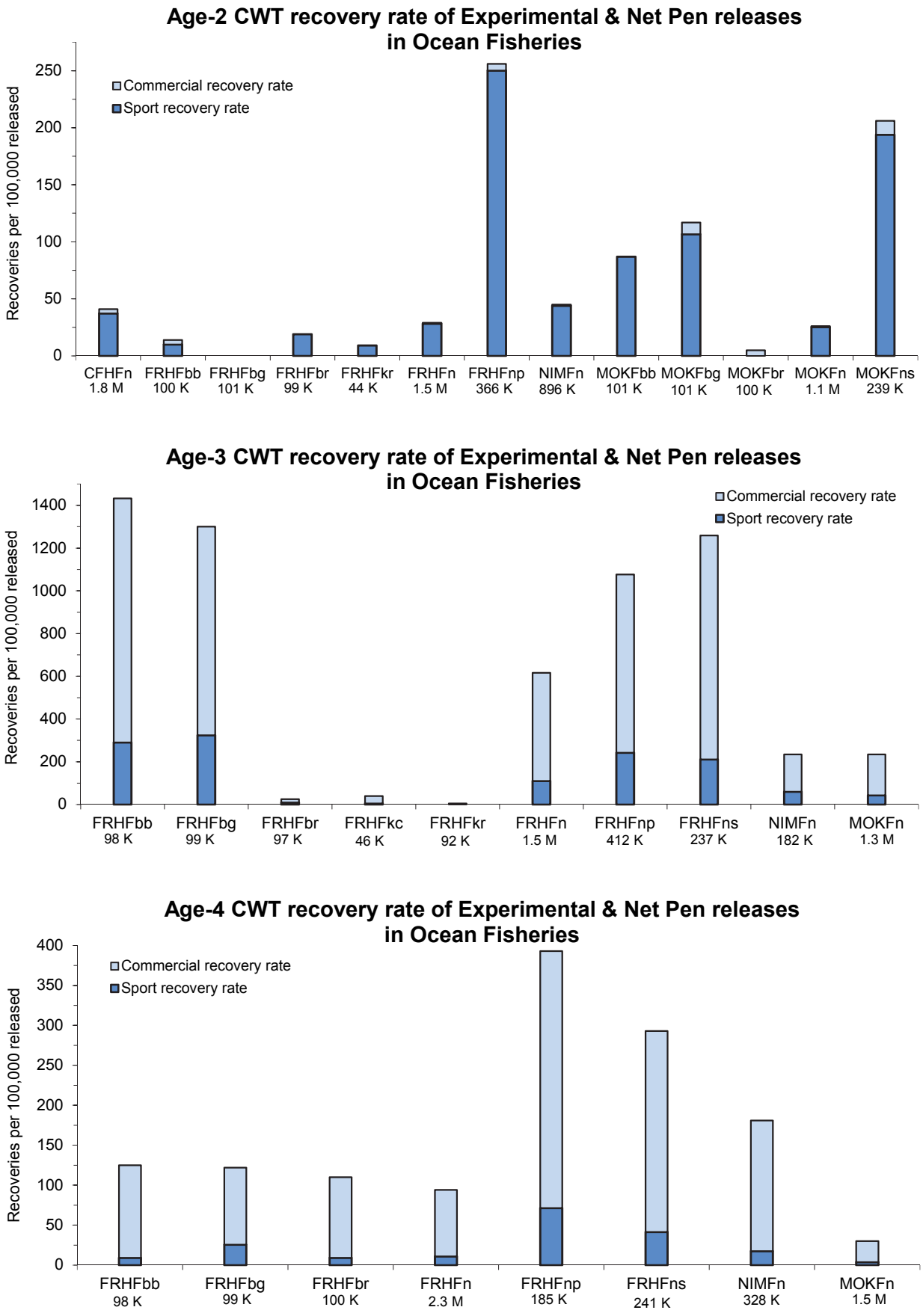


Figure 21. CWT recovery rates of Experimental and Net Pen releases in 2015 ocean sport and commercial fisheries

Appendix 1. Sample expansion factors for Central Valley salmon carcass surveys collecting fish condition in 2015. (page 1 of 2)

Upper Sacramento River fall-run Chinook salmon carcass survey

Condition	Escapement N	Chinook sampled (n)	Sample rate	Observed ad-clips	Ad-clips processed	CWTs recovered	Valid CWTs	*p_adc*	*p_cwt|adc*	F_{samp}	Avg F_{prod}	$\sum_{i=1}^{m} CWT_{total,i}$	% hatchery
fresh	22%	708	2.5%	154	154	151	151	**0.22**	**0.98**	40.49	3.17	19,374	67.6%
nonfresh	78%	2,467	8.6%	251	250	240	230	0.10	0.96				
total	**28,668**	3,175	11.1%	405	404	391	**381**			**16.05**	**3.17**	19,374	**67.6%**

Clear Creek fall-run Chinook salmon carcass survey

Condition	Escapement N	Chinook sampled (n)	Sample rate	Observed ad-clips	Ad-clips processed	CWTs recovered	Valid CWTs	*p_adc*	*p_cwt|adc*	F_{samp}	Avg F_{prod}	$\sum_{i=1}^{m} CWT_{total,i}$	% hatchery
fresh	30%	539	6.1%	130	129	124	114	**0.24**	**0.96**	17.91	3.18	6,488	73.7%
nonfresh	70%	1,239	14.1%	141	141	136	132	0.11	0.96				
total	**8,809**	1,778	20.2%	271	270	260	**246**			**8.30**	**3.18**	6,488	**73.7%**

Mill Creek fall-run Chinook salmon carcass survey

Condition	Escapement N	Chinook sampled (n)	Sample rate	Observed ad-clips	Ad-clips processed	CWTs recovered	Valid CWTs	*p_adc*	*p_cwt|adc*	F_{samp}	Avg F_{prod}	$\sum_{i=1}^{m} CWT_{total,i}$	% hatchery
fresh	53%	33	3.2%	5	5	4	4	**0.15**	**0.80**	31.30	3.64	455	44.0%
nonfresh	47%	29	2.8%	4	4	4	4	0.14	1.00				
total	**1,033**	62	6.0%	9	9	8	**8**			**15.65**	**3.64**	455	**44.0%**

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%	3,578	17.4%	1,323	1,323	1,279	1238	**0.37**	**0.97**	5.94	2.31	16,978	82.6%
nonfresh													
total	**20,566**	3,578	17.4%	1,323	1,323	1,279	**1,238**			**5.94**	**2.31**	**16,978**	**82.6%**

Lower Yuba River (below DPD) 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	100%	237	9.2%	35	35	31	31	**0.15**	**0.89**	10.84	3.48	1,168	45.5%
random	0%	1		1	1	1	1						
total	**2,569**	237	9.2%	36	36	32	**32**			**10.50**	**3.48**	**1,168**	**45.5%**

Appendix 1. Sample expansion factors for Central Valley salmon carcass surveys collecting fish condition in 2015. (page 2 of 2)

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	9%	714	5.2%	134	134	127	122	**0.19**	**0.95**	20.11	3.66	8,972	65.0%
nonfresh	91%	6,802	49.3%	1,240	1,108	1,010	978	0.18	0.91				
total	**13,793**	7,516	54.5%	1,374	1,242	1,137	**1,100**			**2.23**	**3.66**	**8,972**	**65.0%**

Merced 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	63%	277	22.2%	60	60	58	55	**0.22**	**0.97**	4.75	3.89	1,014	81.3%
nonfresh	37%	166	13.3%	15	15	15	14	0.09	1.00				
total	**1,247**	443	35.5%	75	75	73	**69**			**3.78**	**3.89**	**1,014**	**81.3%**

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	100%	794	12.9%	163	163	161	153	**0.21**	**0.99**	8.13	3.85	4,797	78.2%
weir CWTs				37	37	37	37						
total	**6,136**	794	12.9%	200	200	198	**190**			**6.55**	**3.85**	**4,797**	**78.2%**

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	47%	502	15.8%	100	100	82	82	**0.20**	**0.82**	6.34	1.07	558	17.5%
nonfresh	53%	574	18.0%	95	94	79	79	0.17	0.84				
total	**3,182**	1,076	33.8%	195	194	161	**161**			**3.23**	**1.07**	**558**	**17.5%**

Upper Sacramento River late-fall-run Chinook salmon carcass survey 2016

Condition	Escapement N	Chinook sampled (n)	Sample rate	Observed ad-clips	Ad-clips processed	CWTs recovered	Valid CWTs	*p_adc*	*p_cwt|adc*	F_{samp}	Avg F_{prod}	$\sum_{i=1}^{m} CWT_{total,i}$	% hatchery
fresh	23%	145	4.7%	9	9	9	8	**0.06**	**1.00**	23.94	1.31	251	8.1%
nonfresh	77%	492	15.9%	7	7	6	5	0.01	0.86				
total	**3,085**	637	20.6%	16	16	15	**13**			**14.73**	**1.31**	**251**	**8.1%**

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

Appendix 2. Alternative 2015 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[a/]	Fea	Yub	Ame	Mok	Mer	SJ	In-basin	Stray	CV total			In-basin	Stray	CV total	Ocean
CFHFh	2013	Fall	1,125,706	201									201	0	201	0%	61	18	0	18	5
CFHFn	2013	Fall	1,810,972	147	112	138	228	309	134	91	14	46	147	1,073	1,220	88%	736	8	59	67	41
CFHLh	2014	Late	1,056,322	789	15					1			789	16	805	2%	7	75	1	76	1
FRHFk	2013	Fall	44,127				2						2	0	2	0%	4	5	0	5	9
FRHFtib	2013	Fall	11,791	5			9			1			9	6	15	40%	30	76	6	82	255
FRHFb	2013	Fall	300,145	6		8	88		2	2			88	19	106	18%	33	29	6	35	11
FRHFn	2013	Fall	1,459,468	52	144	77	801	67	27	36	6	7	801	417	1,217	34%	422	55	29	83	29
FRHFnc	2013	Fall	366,033	44	80	84	607	21	34	35	4	20	607	322	930	35%	938	166	88	254	256
FRHS	2013	Spr	1,217,640				26		2				26	2	28	7%	68	2	0	2	6
FRHSn	2013	Spr	997,962				36		4				36	4	40	10%	105	4	0	4	11

Age 3 CWT recoveries

Release type	Brood year	Run type	# CWT tagged	Central Valley total recoveries (CWT_{samp}) by basin									CV CWT_{samp} totals			% CV Stray	Ocean CWT_{samp}	Recovery rate per 100K released			
				Bat Cr	Up Sac	Nat crks[a/]	Fea	Yub	Ame	Mok	Mer	SJ	In-basin	Stray	CV total			In-basin	Stray	CV total	Ocean
CFHFh	2012	Fall	2,956,348	1,473	80	90	1						1,473	172	1,645	10%	1,418	50	6	56	48
CFHFn	2013	Fall	1,810,972	147	112	138	228	309	134	91	14	46	147	1,073	1,220	88%	736	8	59	67	41
CFHLh	2013	Late	960,075	467					3				467	3	470	1%	58	49	0	49	6
FRHFk	2012	Fall	138,888				16						16	0	16	0%	23	12	0	12	17
FRHFtib	2012	Fall	9,918			17	14						14	17	31	54%	81	141	17	157	817
FRHFb	2012	Fall	293,784	92	546	174	1,057	78	8	1			1,057	899	1,956	46%	2,714	360	306	666	924
FRHFn	2012	Fall	1,453,105	360	2,520	1,080	4,101	162	75	51	18	20	4,101	4,286	8,386	51%	8,957	282	295	577	616
FRHFnc	2012	Fall	649,160	57	465	168	482	111	6	2	6		482	816	1,298	63%	7,418	74	126	200	1,143
FRHS	2012	Spr	1,106,679				3,495		1				3,495	1	3,496	0%	848	316	0	316	77
FRHSn	2012	Spr	1,015,285	2	305	66	4,026	34	20	2			4,026	429	4,455	10%	1,916	397	42	439	189

Age 4 CWT recoveries

Release type	Brood year	Run type	# CWT tagged	Central Valley total recoveries (CWT_{samp}) by basin									CV CWT_{samp} totals			% CV Stray	Ocean CWT_{samp}	Recovery rate per 100K released			
				Bat Cr	Up Sac	Nat crks[a/]	Fea	Yub	Ame	Mok	Mer	SJ	In-basin	Stray	CV total			In-basin	Stray	CV total	Ocean
CFHFh	2011	Fall	3,117,042	1,208	465	91	10						1,208	567	1,775	32%	1,172	39	18	57	38
CFHLh	2012	Late	1,031,419	1,061	166								1,061	166	1,227	14%	440	103	16	119	43
FRHFtib	2011	Fall	9,933	1									0	1	1	100%	3	0	12	12	33
FRHFb	2011	Fall	297,089	2	48	33	206		5	1			206	90	296	30%	354	69	30	100	119
FRHFn	2011	Fall	2,293,211	41	1,011	250	984		16	2			984	1,321	2,304	57%	2,163	43	58	100	94
FRHFnc	2011	Fall	426,190	27	209	50	220						0	506	506	100%	1,435	0	119	119	337
FRHS	2011	Spr	1,088,286				2,051		1				2,051	1	2,052	0%	254	188	0	189	23
FRHSn	2011	Spr	1,125,189		80	17	698		1				698	98	796	12%	132	62	9	71	12

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

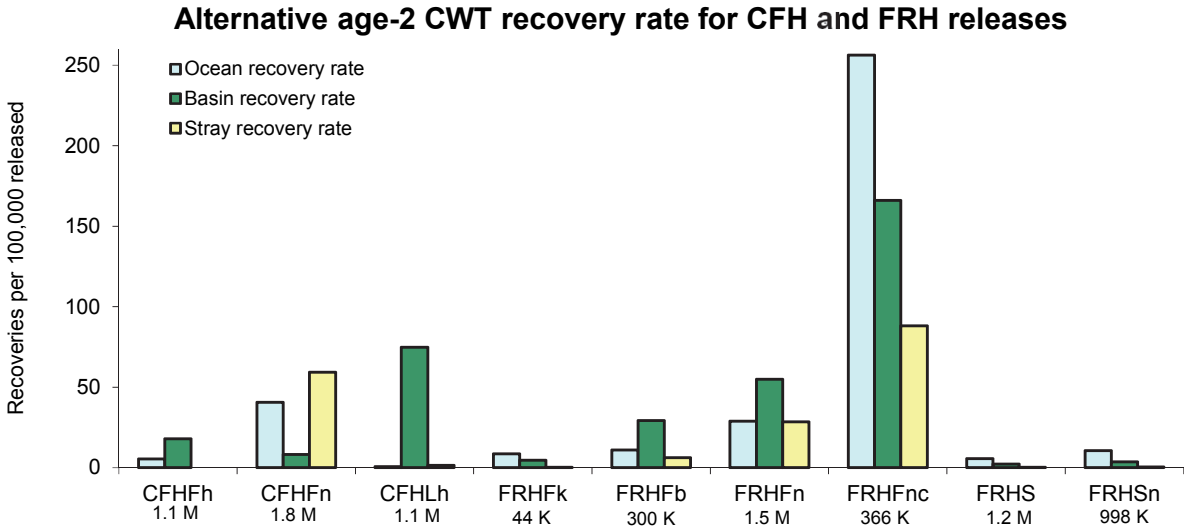
b/ Natural creeks can include Clear Creek, Cow Creek, Cottonwood Creek, Paynes Creek, Mill Creek, Deer Creek and Butte Creek, depending on survey year.

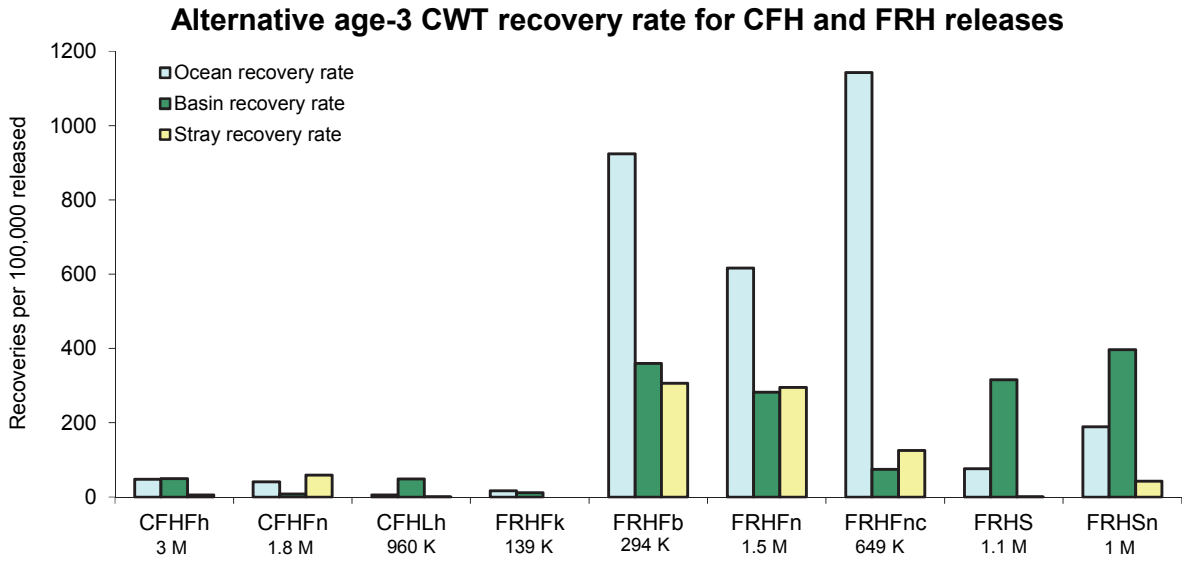
Sacramento River fall Chinook release types (SFC)

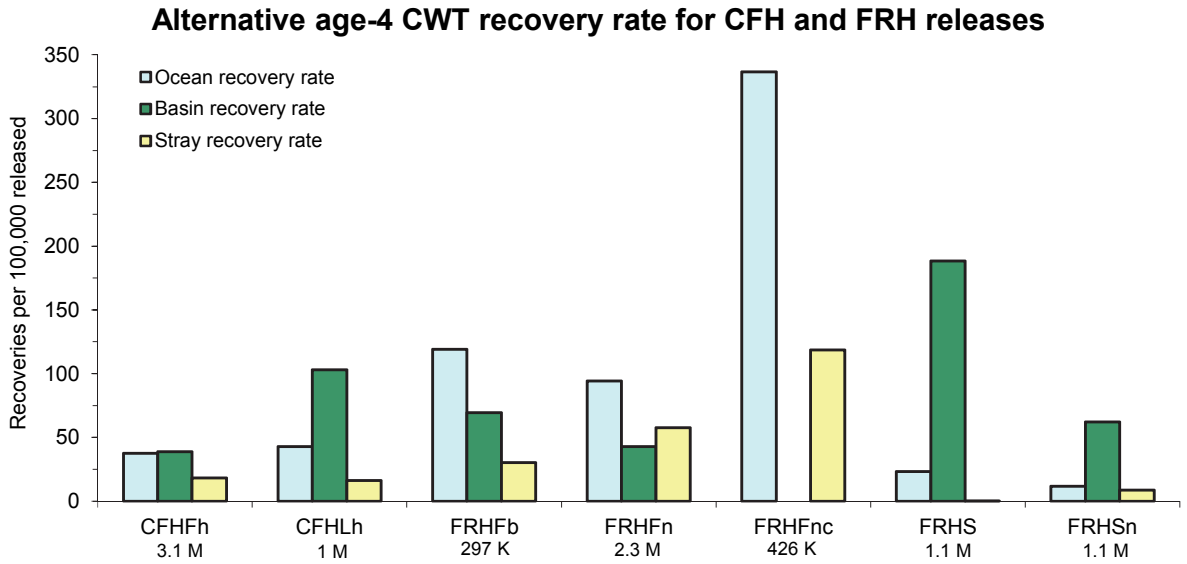
CFHFh	Coleman National Fish Hatchery fall hatchery releases
CFHFn	Coleman National Fish Hatchery fall bay net pen releases
FRHFk	Feather River Hatchery fall Knaggs Ranch experimental releases
FRHFtib	Feather River Hatchery fall Tiburon net pen releases
FRHFb	Feather River Hatchery fall barge study releases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

Other CV Chinook release types (OCV)

FRHS	Feather River Hatchery spring in-basin releases
FRHSn	Feather River Hatchery spring bay net pen releases
MOKF	Mokelumne River Hatchery fall in-basin releases
MOKFb	Mokelumne River Hatchery fall barge study releases
MOKFn	Mokelumne River Hatchery fall bay net pen releases
MOKFnc	Mokelumne River Hatchery fall coastal net pen releases (Santa Cruz)
MOKFt	Mokelumne River Hatchery fall trucked releases
MERF	Merced River Hatchery fall in-basin releases
MERFt	Merced River Hatchery fall trucked releases
SacW	Livingston Stone Hatchery winter in-basin releases
CFHLh	Coleman National Fish Hatchery late fall hatchery releases







Appendix 3. Alternative CWT recovery rates for CFH and FRH releases by age in 2015.

Appendix 4. Sample expansion for CWTs recovered in Yuba River above Daguerre Point Dam (DPD) based on carcass survey vs video data, 2015.

Yuba River natural escapement above DPD: carcass survey (fresh fish only)

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
4,981	**148**	**3%**	**28**	**28**	**28**	**28**	**0.189**	**1.000**	**33.66**	**3.16**	**2,978**	**59.8%**
video count												

DPD Vaki video	**Total**	**% adclip**
no clip	3,877	
adclip	999	20.5%
unknown clip	105	20.5%
total	4,981	

Estimated total adclips	average *p_cwt|adc**	Estimated total CWTs	CWTs collected	Estimated CWT expansion factor
999				
22				
1,021	0.924	943	28	33.68

*average p_cwt/adc observed for fresh ad-clipped salmon recovered in Feather River and lower Yuba carcass surveys (n=1,358)

Appendix 5. Sample expansion for CWTs recovered in Mokelumne River above Woodbridge Dam (WD) based on video data, 2015.

	Total	**Known ad status**	**% adclip**
Woodbridge Dam video	12,879	3,456	26.8%
MRFI return	8,298	2,227	26.8%
Natural Escapement Mokelume River	**4,581**	**1,229**	26.8%

Mokelume River natural escapement above WD: Total video count minus MRFI 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
4,581	4,581	100%	**1,229**	**194**	**179**	**178**	**0.268**	**0.923**	**6.37**	**3.82**	**4,329**	**94.5%**
video count			video count		carcass survey							