Recovery of Coded-Wire Tags from Chinook Salmon in California's Central Valley Escapement and Ocean Harvest in 2010

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NOTE TO READERS

Recovery of Coded-Wire Tags from Chinook Salmon in California's Central Valley Escapement and Ocean Harvest in 2010 presents important data for the improvement of Central Valley salmon management. Until 2007, only experimental releases of fall-run Chinook salmon from Central Valley hatcheries were marked and coded-wire tagged (low, inconsistent numbers), resulting in a lack of data for harvest management, evaluation of hatchery rearing and release practices, hatchery impacts to natural-origin fish, and the success of habitat improvement programs.

The Central Valley Constant Fractional Marking Program (CFM) was initiated in 2007 to estimate in a statistically valid manner the relative contribution of hatchery production and to evaluate the various release strategies being employed in the Central Valley. Beginning with Brood Year 2006 fall-run Chinook, the program has marked and coded-wire tagged a minimum of 25 percent of releases from the Central Valley hatcheries each year (Buttars 2007, 2008, 2009, 2010). The program is a cooperative effort of the California Department of Fish and Game (DFG), the California Department of Water Resources (DWR), the U.S. Bureau of Reclamation, the U.S. Fish and Wildlife Service (FWS), the East Bay Municipal Utilities District (EBMUD), and the Pacific States Marine Fisheries Commission (PSMFC).

In 2010, almost 27,000 Code Wire Tags were recovered from ad-clipped Chinook sampled in Central Valley natural area spawning surveys, at Central Valley hatcheries, Central Valley river creel surveys, and California commercial and recreational ocean fisheries. Almost all of the fall run Chinook Code Wire Tags recovered in the Central Valley were tagged as part of the CFM program, since most Central Valley fish return at ages two, three, or four, and age five Chinook made up a very small fraction (0.01%) of the total Central Valley fall escapement in 2010.

This report evaluates the 2010 Central Valley fall, spring, and late fall runs Chinook Code Wire Tags recovery data in accordance with program objectives. In particular, this report attempts to answer the following questions with this first full year of recovery data from the CFM program:

- What are the proportions of hatchery and natural-origin fish in spawning returns to Central Valley hatcheries and natural areas, and in ocean harvest?
- What are the relative recovery and stray rates for hatchery fish released in-basin versus salmon trucked to and released into the waters of the Carquinez Straits?
- What are the relative recovery rates for fish acclimated in net pens and released in the bay compared to salmon released directly into the waters of the Carquinez Straits?
- What are the relative contribution rates of hatchery fish, by run and release type, to the ocean harvest?

As with all of its products, Fisheries Branch is interested in comments on the utility of this document, particularly regarding its application to monitoring and management decision processes. Therefore, we encourage you to provide us with your comments. Comments should be directed to Ms. Alice Low, Fisheries Branch, 830 S Street, Sacramento, CA 95814, (916) 323-9583, alow@dfg.ca.gov.

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Introduction

Each year, approximately 32 million fall-run Chinook salmon are produced at five hatcheries in California's Central Valley (CV): Coleman National Fish Hatchery (CNFH), Feather River Hatchery (FRH), Nimbus Fish Hatchery (NFH), Mokelumne River Hatchery (MOK), and Merced River Fish Facility (MER). Production from these hatcheries contributes to major sport and commercial fisheries in ocean and inland areas. Prior to 2007, only small experimental releases (generally <100,000 fish) of CV fall-run Chinook were consistently released with microscopic (≤ 1 mm) coded-wire tags (CWT) inserted in their snouts. 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). Any CV salmon containing a CWT is also externally marked with a clipped adipose fin (ad-clipped) to allow for visual identification. Although FRH did mark and tag a portion of their fall-run Chinook during 2000 through 2006, tagging rates were not consistent or representative of the 6-8 million fish produced annually by FRH. Almost all of the fall-run Chinook production releases at the other CV hatcheries were untagged during this time.

In 2004, the CALFED Ecosystem Restoration Program (ERP) funded a study to design a constant fractional marking and coded-wire tagging program for CV fall-run Chinook production at all CV hatcheries. The primary goal of this program was to estimate in a statistically valid manner the relative contribution of hatchery production and to evaluate the various release strategies being employed throughout the CV. The study recommended the implementation of a system-wide marking and tagging program for production releases. Planning studies indicated an optimum marking and tagging rate of 25% for all CV fall-run Chinook production releases (Hicks et al. 2005).

Beginning with brood year 2006, at least 25% of fall-run Chinook production releases at CNFH (12-13 million), FRH (9-10 million), NFH (5-6 million), and MOK (4-5 million) have been marked and tagged each spring-run (Buttars 2007, 2008, 2009, 2010). This Constant Fractional Marking (CFM) program is a cooperative effort of the California Department of Fish and Game (DFG), the California Department of Water Resources (DWR), the U.S. Bureau of Reclamation, the U.S. Fish and Wildlife Service (FWS), the East Bay Municipal Utilities District (EBMUD), and the Pacific States Marine Fisheries Commission (PSMFC).

In addition, 100% of the fall-run Chinook produced at the MER (approximately 50,000-300,000 annually) are marked and coded-wire tagged. Almost 100% of the spring-run Chinook reared at FRH and the late fall-run Chinook reared at CNFH have also been marked and coded-wire tagged. It should be noted that due to their extremely low production numbers, MOK marked and tagged 100% of their fall-run Chinook releases for brood years 2008 and 2009.

During 2010, almost 27,000 CWTs were recovered from ad-clipped Chinook sampled in CV natural area spawning surveys, at CV hatcheries, in CV river creel surveys, and in California ocean commercial and recreational fisheries. Almost all of the fall-run Chinook CWTs recovered in the CV were tagged as part of the CFM program since most CV fish return at ages two, three, or four. Age five Chinook made up a very small fraction (0.01%) of the total CV fall-run escapement in 2010. This report evaluates the 2010 CV fall, spring, and late fall runs Chinook CWT recovery data in accordance with program objectives. In particular, this report attempts to answer the following questions with this first essentially complete year of recovery data:

- What are the proportions of hatchery and natural-origin fish in spawning returns to CV hatcheries and natural areas, and in ocean harvest? Of the hatchery proportions, what proportions originated from in-basin versus out-of-basin CWT recoveries?

- What are the relative recovery and stray rates for hatchery fish released in-basin versus salmon trucked to and released into the waters of the Carquinez Straits? The latter includes salmon acclimated in net pens that are pulled for several hours into San Pablo Bay before fish are released.

- What are the relative recovery rates for fish acclimated in net pens and released in the bay versus salmon released directly into the waters of the Carquinez Straits?

- What are the relative contribution rates of hatchery fish, by run and release type, to the ocean harvest?

Data and Methods

Inland Escapement Monitoring

During 2010, monitoring of Chinook escapement occurred at all five salmon hatcheries and on major rivers and tributaries throughout the CV. In addition, creel surveys were conducted on river fisheries in the Feather, American, and Sacramento River basins. Returning salmon were counted and 100% sampled at CV hatcheries while sample rates and methods (e.g., carcass surveys, weir counts, redd counts) varied among natural spawner surveys (Table 1).

Approximately 26,500 ad-clipped salmon were observed and 25,700 heads collected by various CV projects. Monitoring agencies include DFG, DWR, EBMUD, FWS, and PSMFC. Most heads were processed by DFG at the Santa Rosa CWT lab (15,839 heads) and by FWS staff at CNFH (9,531 heads). Remaining heads were processed by individual projects and their data submitted to the Santa Rosa CWT Lab. Almost 97% (24,838) of these heads contained valid CWTs, 2% of heads had shed their CWTs prior to processing, and 1% contained CWTs that either were lost during processing or too damaged to read.

Total escapement estimates and the number of salmon sampled for ad-clips in this report were provided by individual CV projects or hatcheries. These data, along with their respective CWT recovery data, were uploaded to the Regional Mark Processing Center (RMPC) and are readily accessible at www.rmpc.org.

Ocean Harvest Monitoring

Since 1962, the DFG's Ocean Salmon Project (OSP) has monitored California's ocean salmon fisheries at approximately 20 ports between Point Conception and the California-Oregon border. The goal of OSP is to sample at least 20% of all Chinook landed and to collect the heads from all ad-clipped salmon observed during monitoring. In 2010, the seasons for California sport and commercial ocean salmon fisheries were relatively constrained (Table 2) to protect both

Sacramento River fall-run Chinook and Klamath River fall-run Chinook. Field staff sampled 13,344 salmon and collected 2,211 heads that were processed by the Santa Rosa CWT lab. About 90% (1,987) of these heads contained valid CWTs, 10% were missing CWTs and <1% contained CWTs that were too damaged to read. Although it is generally agreed that CWTs missing from inland head recoveries is the result of salmon "shedding" these tags prior to release, this can not be assumed for heads recovered from mixed-stock ocean fisheries. Oregon and Washington hatcheries have recently begun to "mass-mark" (i.e., ad-clipped salmon that do not contain a CWT) Chinook to support small mark-selective fisheries in the northwest. During the last several years, OSP has noticed a gradual increase in the number of ocean heads collected that do not contain CWTs, especially in California's northern ports, and assume that this is due to the increased production of mass-marked salmon in Oregon and Washington.

CWT Data Analysis

A "Master" release database of CWT codes 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) for all 2010 CWT recoveries. All west coast CWT release data for broods 2006 through 2009 were downloaded from the RMPC. Approximately 105 million CV Chinook were released for these five brood years, of which, 37 million fish were marked and tagged utilizing 500 unique CWT codes. Although a few natural origin salmon are trapped, marked, and tagged each year, salmon produced by hatcheries make up more than 95% of all releases. In 2010, there were 319 individual CWT codes recovered in the CV, primarily from age two-, three-, and four-year old Chinook. The CWT master file was updated with any additional information obtained for these CV Chinook releases (e.g., number of untagged salmon associated with 2008 fall-run CNFH production CWT releases) and the production factor calculated for each CWT code. The production factor, $F_{prod,}$ is the total number of fish released (tagged and untagged) represented by each CWT recovery. $F_{prod,}$ was calculated for each CWT code and is defined as,

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

where Ad.CWT is the number of fish released with ad-clips and CWTs, Ad.noCWT is the number of fish released with ad-clips but without CWTs (i.e., shed tags), noAd.CWT is the number of fish released without ad-clips but with CWTs, and noAd.noCWT is the number of fish 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 CWT release was further classified into "release types" based on the following criteria: run, stock, hatchery or natural, production or experimental, release location, and holding strategy. All CV CWT codes were assigned by brood year into one of 16 fall-run Chinook release types, 4 spring-run Chinook release types, or 2 late fall-run Chinook release types:

Sacramento River Basin Fall-run Chinook Release Types

CFHFe Coleman National Fish Hatchery fall-run experimental releases
CFHFh Coleman National Fish Hatchery fall-run in-basin (at hatchery) releases
CFHFn Coleman National Fish Hatchery fall-run net pen releases

FRHFe Feather River Hatchery fall-run experimental releases
FRHFn Feather River Hatchery fall-run net pen releases
FRHFt Feather River Hatchery fall-run trucked releases (no net pen acclimation)
FRHFtn Feather River Hatchery fall-run Tiburon net pen releases (held 3-4 months; released in fall)
FeaFw Feather River fall-run wild
YubFw Yuba River fall-run wild
NIMF In-basin releases
NIMFn Nimbus Fish Hatchery fall-run net pen releases
NIMFtib Nimbus Fish Hatchery fall-run Tiburon net pen releases (held 3-4 months; released in fall)

San Joaquin River Basin Fall-run Chinook Release Types
MOKF Mokelumne River Hatchery fall-run in-basin releases
MOKFn Mokelumne River Hatchery fall-run net pen releases
MOKFt Mokelumne River Hatchery fall-run trucked releases (no net pen acclimation)
MokFw Mokelumne River fall-run wild
MERF Merced River Fish Facility fall-run releases (primarily in-basin)

Central Valley Spring-run Chinook Release Types
FRHS Feather River Hatchery spring-run in-basin releases
FRHSn Feather River Hatchery spring-run net pen releases
FRHSt Feather River Hatchery spring-run trucked releases (no net pen acclimation)
YubSw Yuba River spring-run wild

Central Valley Late fall-run Chinook Release Types
CFHLe Coleman National Fish Hatchery late fall-run experimental releases
CFHLh Coleman National Fish Hatchery late fall-run in-basin (at hatchery) releases

It should be noted that not all release types occurred every brood year and release sites sometimes varied within a given release type (Table 3). There were also several problem CWT releases where stock origin did not match hatchery origin (e.g., American River fall-run Chinook salmon raised at MOK), stocks or runs were mixed prior to CWT tagging and released utilizing various strategies (e.g., American and Mokelumne fall-run Chinook accidentally mixed and tagged together at MOK, FRH fall-run and spring-run Chinook spawned together and released as experimental "hybrid" salmon for Delta studies), or a percentage of the salmon trucked for net pen acclimation were actually released directly into the waters of the Carquinez Strait.

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 examined for ad-clipped fish, 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). A few heads were collected opportunistically during redd counts and snorkel surveys but are not included in this analysis since they are not representative of the escapement.

To help delineate between raw CWT recoveries, CWT recoveries expanded for production, CWTs expanded for sampling, and CWTs expanded for production and sampling, the following nomenclature will be 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
To determine the contribution of hatchery and natural-origin Chinook for each natural-area escapement survey or hatchery, all hatchery CWT_{total} were summed to produce the total number of hatchery fish. The contribution of natural-origin fish was then determined by subtracting the total number of hatchery fish from the total escapement estimate, as follows:

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

where m = total number of 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 fish tagged and released with this CWT. Since expanded recoveries for several individual CWT groups were less than 0.001% of the numbers 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 were combined and an overall release type-specific CV recovery rate, R_{type}, was calculated as:

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

where: *k* (= 1,2,3,,,n) denotes release group and *j (=1,2,3,,,l)* denotes recovery location.

Determining stray proportions of various release groups in CV escapement
Basin of origin is defined here as the drainage of any major river as it pertains to the geographic region of the CV where a hatchery is located. For this report the CV was segregated into five primary hatchery basins: Battle Creek (including the mainstem of the upper Sacramento River), Feather River (including the Yuba River), American River, Mokelumne River, and the Merced River. Hatchery-origin Chinook returning to streams not included in these five primary basins were considered to be strays. Through discussion with regional biologists it was determined that CNFH stocks are often considered to be analogous to Chinook that originate from the mainstem of the upper Sacramento River and thus are not considered to be strays. Alternatively, FRH stocks are often considered to be strays when they return to the Yuba River, a major tributary in

the basin. As a result of differing opinions of what constitutes a stray throughout the CV any CWTs recovered outside of these defined basins of origin based on their reported stock or hatchery were considered strays. Further evaluation of these definitions is warranted as future CFM recovery data become available.

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

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

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

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

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

Results

General Overview of 2010 CV inland recoveries and California ocean harvest
All but two of the 24,838 valid CWTs recovered in the CV during 2010 were CV Chinook releases; most CWTs originated from brood year 2006 through 2008 releases (Table 6). More than 84% of all expanded CWT recoveries were fall-run Chinook, followed by spring-run (10%) and late fall-run (6%) releases. No Sacramento River winter-run Chinook CWTs were recovered. The majority of fall-run CWTs were age-3 (67%) and age-2 (31%) fish. It should be noted that a few age-1 fall-run CWTs were also sampled which is relatively rare in the CV. Age-3 (92%) fish dominated the spring-run return while age-4 (59%), age-3 (20%), and age-5 (16%) made up most of the late fall-run return. A few age-6 late fall-run fish were also recovered.

All but 141 of the 1,987 valid CWT recoveries from the California ocean harvest in 2010 were CV Chinook releases; most CWTs were brood year 2006 through 2008 releases (Table 7). Approximately 62% of all expanded CWTs in the ocean harvest were fall-run Chinook, followed by late fall-run (30%), spring-run (3%), and winter-run (<1%). The majority of fall-run Chinook CWTs were age-3 (86%) and age-2 (12%) fish. Age-3 (93%) fish dominated the spring-run Chinook harvest while age-4 (62%), age-3 (21%), and age-5 (17%) made up most of the late-fall Chinook catch. A few age-6 late fall-run Chinook were also caught. The remaining 5% of ocean CWT recoveries originated from non-CV rivers, including the Klamath, Trinity, Smith, Chetco and Columbia rivers; most were age-3 (51%) and age-4 (49%) fish.

1. Proportion of hatchery- and natural-origin fish in CV escapement
The proportion of hatchery-origin fish on the natural area spawning grounds varied throughout the CV and by run. The lowest hatchery proportion (1%) was observed in the Butte Creek spring-run

Chinook mark-recapture survey while the highest proportion (78%) was observed in the Feather River fall/spring-run Chinook mark-recapture survey (Figure 1).

The hatchery proportion of fall-run Chinook returning to CV hatcheries ranged from 79% to 95% (Figure 2). The spring-run Chinook return to FRH was 82% hatchery-origin fish whereas the late fall-run return to CNFH was almost 100% hatchery-origin fish.

Overall, there were 23 individual CWT release types contributing to CV escapement in 2010. To facilitate the breakout of the hatchery proportion by stock and release strategy, all release types from the same hatchery/basin were given the same color scheme (Figure 3) in Figures 4 through 9. All net pen releases contain black dots while most trucked, experimental, or Tiburon net pen releases are designated by black stripes when possible (i.e., release types did not overlap for a particular basin).

Upper Sacramento River Basin

Ten escapement surveys were conducted in the Upper Sacramento River Basin: fall and late fall runs Chinook counts at CNFH, fall and late fall runs Chinook mark-recapture surveys in the mainstem Sacramento River, a fall-run Chinook mark-recapture survey in Clear Creek, and spring-run and fall-run Chinook mark-recapture surveys in Butte Creek. Spring and fall runs Chinook redd count surveys were conducted in Mill Creek and a spring-run Chinook snorkel survey (maximum count) was conducted in Deer Creek. Representative sampling for ad-clipped salmon did not occur in Mill and Deer Creek. Returns to CNFH were predominantly hatchery-origin fish released from this facility while escapement into natural areas was primarily natural-origin fish (Figures 4 and 5):

- Fall-run returns at CNFH were 89% hatchery-origin fish (96% CFHFh)
- Fall-run spawners in the mainstem Sacramento River were 20% hatchery-origin fish (48% FRHFn, 19% CFHFh, 17% FRHSn)
- Fall-run spawners in Clear Creek were 4% hatchery-origin fish (45% FRHFn, 32% CFHFh)
- Late fall-run returns at CNFH were almost 100% hatchery-origin fish (99% CFHLh)
- Late fall-run spawners in the mainstem Sacramento River were 6% hatchery-origin fish (73% CFHLh)
- Spring-run spawners in Butte Creek were 1% hatchery-origin fish (63% FRHSn)
- Fall-run spawners in Butte Creek were 11% hatchery-origin fish (89% FRHFn)

Feather River Basin

Four escapement surveys were conducted in the Feather River Basin: spring and fall runs Chinook counts at FRH, a combined fall/spring run Chinook mark-recapture survey in the Feather River, and a combined fall/spring run Chinook mark-recapture survey in the Yuba River. Spring and fall runs Chinook returns to FRH and in the natural areas were predominantly of hatchery-origin (Figure 6):

- Spring-run returns at FRH were 82% hatchery-origin (50% FRHS, 39% FRHSn)
- Fall-run returns at FRH were 95% hatchery-origin (87% FRHFn)
- Fall/spring-run spawners in the Feather River were 78% hatchery-origin (88% FRHFn)
- Fall/spring-run spawners in the Yuba River were 71% hatchery-origin (48% FRHFn, 22% FRHS, 21% FRHSn)

American River Basin

Three escapement surveys were conducted in the American River Basin: fall-run Chinook counts at NFH, a fall-run Chinook mark-recapture survey on the American River and a single late fall-run Chinook carcass count on the American River. In addition, dead salmon were recovered from the NFH weir, which is located just upstream from the hatchery and was installed on September 15th to force returning salmon into NFH. Salmon that migrated upstream beyond the hatchery prior to installation of the weir were trapped in the upstream area. Many of those salmon washed back onto the weir upon death. There is minimal spawning habitat above the weir. Spawner returns to natural areas and those from the NFH weir fish were predominantly of natural-origin while returns to NFH were predominantly of hatchery-origin (Figure 7):

- Fall-run returns to NFH were 79% hatchery-origin (81% NIMFn)
- Fall-run spawners in the American River were 32% hatchery-origin (48% NIMFn, 24% FRHFn, 19% CFHFn)
- Late fall-run spawners in the American River were 24% hatchery-origin (97% CFHLe)
- Salmon recovered on the NFH Weir were 38% hatchery-origin (40% NIMFn, 36% FRHFn)

Mokelumne River Basin

Three escapement surveys were conducted in the Mokelumne River Basin: fall-run Chinook counts at MOK, a video weir count at Woodbridge Dam of all fall-run Chinook escapement into Mokelumne River, and a daily collection of salmon carcasses from the MOK weir, which is installed to prevent salmon from bypassing the MOK fish ladder. This barrier was originally installed on October 8th but removed on October 15th to allow for increased water releases from Camanche Reservoir designed to produce attraction flows for upstream migrating Chinook. The weir was then reinstalled on October 19th when flows returned to a rate that would not damage the weir. Any salmon above the weir when it was installed were trapped and many washed back onto the weir after their death.

All adult Chinook salmon migrating upstream into the Mokelumne River to spawn were counted by the video fish counting device operated by EBMUD at Woodbridge Dam. These counts also included the number of ad-clipped salmon entering the system. By subtracting the 5,520 Chinook that returned to MOK and that were collected on the MOK weir from the total video count of 7,196 Chinook, it was assumed that the remaining 1,676 Chinook remained in the Mokelumne River. Utilizing the same logic, it was also assumed that there were 820 ad-clipped Chinook remaining in the river since only 2,866 of the 3,686 ad-clipped Chinook counted in the video monitoring were recovered at MOK and on the weir. After reviewing the CWT codes recovered from 59 heads collected during sporadic surveys on the Mokelumne River, we found that the proportions of the 12 individual CWT codes collected were very similar to the proportion of these codes recovered at MOK and on the weir; however there were 45 additional CWT codes recovered at the hatchery and weir. Because 100% of Chinook salmon observed at MOK and the weir were sampled, we felt that the MOK recoveries best represented the entire run and thus expanded the estimated 820 ad-clips in the Mokelumne River based on their proportions, including heads that lacked a CWT (approx 1.5%). This approach is based on the methodology used by the Klamath River Technical Team (KRTT) to determine the hatchery composition of fall-run Chinook above Willow Creek Weir on the Trinity River (e.g.,KRTT 2011).

Spawner returns to the Mokelumne River Basin were dominated by hatchery-origin fish (Figure 8):

- Fall-run returns at MOK were 90% hatchery-origin (34% MOKFt, 18% MOKFn, 32% NIMFn)
- Salmon carcasses recovered on the MOK weir were 74% hatchery-origin (50% MOKFt, 18% MOKFn, 27% NIMFn)
- Fall-run spawners in the Mokelumne River were 73% hatchery-origin (50% MOKFt, 18% MOKFn, 31% NIMFn)

San Joaquin River Basin Tributaries

Four additional escapement surveys were conducted in tributaries of the San Joaquin River: fall-run Chinook counts at MER, as well as fall-run Chinook mark-recapture surveys conducted on the Stanislaus, Tuolumne, and Merced rivers. Fall-run Chinook returns to the Merced River were dominated by hatchery-origin fish while the Stanislaus and Tuolumne rivers were almost equally split between hatchery- and natural-origin spawners (Figure 9):

- Fall-run returns at MER were 79% hatchery-origin (37% MOKFt, 18% NIMFn, 12% NIMFtib, 11% CFHFn, 10% MERF)
- Fall-run spawners in the Merced River were 78% hatchery-origin (31% NIMFn, 20% FRHFn, 16% MOKFn, 14% MOKFt)
- Fall-run spawners in the Stanislaus River were 50% hatchery-origin (31% NIMFn, 26% MOKFn, 23% MOKFt)
- Fall-run spawners in the Tuolumne River were 49% hatchery-origin (29% CFHFn, 23% MERF, 19% FRHFn)

2. Relative recovery and stray proportions for hatchery-origin Chinook released in-basin versus hatchery-origin Chinook trucked and released into the waters of the Carquinez Strait (includes Chinook salmon acclimated in net pens and released into San Pablo Bay).

Release strategies vary widely among hatcheries from year to year. This variability has often been in response to fluctuating abundances of certain stocks or differing policies among mitigating agencies with respect to "best" release practices. Lack of consistency and "problem releases" among CV hatcheries has limited the number of release groups available for direct comparison of differing release strategies. For these reasons, there are only six release groups recovered in 2010 that allows in-basin releases to be compared directly to trucked/net pen releases.

Table 8 summarizes the recovery rates R_{type} (in-basin, stray, and ocean) for all release groups with representative recoveries from the CV in 2010. Figures 10 and 11 provide a graphical representation of R_{type} for the Sacramento River fall-run Chinook and other CV stocks, respectively. In general, Chinook that were trucked and released directly into the waters of Carquinez Strait or acclimated in bay area net pens had higher relative recovery rates than their respective in-basin releases. These releases also had higher stray proportions than their paired in-basin counterparts.

Coleman National Fish Hatchery Releases - Fall-run Chinook Broods 2007 and 2008

For brood 2008 CNFH fall-run Chinook releases, the CV age-2 recovery rate for net pen CNFHn releases (161.5) was 2.3 times greater than in-basin CFHFh releases (70.9). However, while

CNFHh releases were only recovered in-basin, the proportion of CFHFn recoveries out-of-basin was very high at 89%.

There were three different CNFH release types for brood 2007 fall-run Chinook. The CV age-3 recovery rate for experimental CFHFe releases (164.0) was more than 3.0 times greater than in-basin CFHFh (54.6) and net pen CFHFn (41.2) releases. Less than 1% of CFHFh were recovered out-of-basin compared to straying proportions of 98% and 25% for CFHFn and CFHFe, respectively.

Feather River Hatchery Releases – Spring-run Chinook Broods 2006, 2007, and 2008
For brood 2008 FRH spring-run releases, the CV age-2 recovery rate for net pen FRHSn releases (32.2) was slightly higher than in-basin FRHS (28.0) releases. Approximately 10% of FRHSn were recovered out-of-basin while all FRHS CWTs were recovered in-basin.

For brood 2007 FRH spring-run releases, the CV age-3 recovery rate for net pen FRHSn releases (440.4) was 1.3 times higher than in-basin FRHS (348.4) releases. Approximately 15% of age-3 FRHSn were recovered out-of-basin while all FRHS CWTs were recovered in-basin.

For brood 2006 FRH spring-run releases, the CV age-4 recovery rate for net pen FRHSt releases (19.4) was 3.0 times higher than in-basin FRHS (6.4) releases. Approximately 18% of both FRHSt and FRHS CWTs were recovered out-of-basin.

Nimbus Fish Hatchery Release – Fall-run Chinook Brood 2008
For brood 2008 NFH fall-run releases, the CV age-2 recovery rate for net pen NIMFn releases (86.9) was 2.6 times greater than in-basin NIMF releases (33.5). However, while NIMF releases were only recovered in-basin, the proportion of NIMFn recoveries out-of-basin was very low at 6%.

Feather River Hatchery Releases – Fall-run Chinook Brood 2008
Although FRH did not have any in-basin releases for broods 2006, 2007 or 2008, they did have experimental FRHFe, net pen FRHFn and trucked FRHFt releases that can be compared.

For brood 2008 FRH fall-run releases, the CV age-2 recovery rate for experimental FRHFe releases (135.6) was slightly higher than net pen FRHFn (117.6) releases. The FRHFe releases were actually "hybrid" fish (FRH fall-run x FRH spring-run Chinook). Approximately 5% of both FRHFe and FRHFn were recovered out-of-basin.

For brood 2006 FRH fall-run releases, the CV age-4 recovery rate for net pen FRHFn releases (17.2) was 3.1 times higher than experimental FRHFe (5.6) releases. Recoveries of trucked FRHFt (0.7) releases were too low for comparison purposes. Approximately 10% of FRHFn and 9% of FRFHe releases were recovered out-of-basin. It should be noted that many of the FRHFn releases had some fish released directly into the bay so it is impossible to separate true net pen releases from trucked/direct bay ones.

3. Relative CV recovery and stray rates of bay releases acclimated in net pens and released directly without acclimatization

The same issues related to release practices that limited the available recovery comparisons in the previous section also limited the comparison of net pen releases and direct releases in the Carquinez Strait area. As a result there is only one release type comparison possible.

Feather River Hatchery Release – Fall-run Chinook Brood 2007

For brood 2007 FRH fall-run releases, the CV age-3 recovery rate for net pen FRHFn releases (478.4) was 3.9 times higher than trucked/direct bay FRHFt (122.9) releases. Approximately 19% of FRHFt fish were recovered out-of-basin compared to 8% of FRHFn releases.

4. Relative recovery rate and contribution of CV release groups to ocean harvest

The relative recovery rate of CV hatchery releases in the 2010 ocean salmon fisheries (sport and commercial combined) varied by age and release group (Figure 12). Of the 4,755 CV CWT_{samp} collected in the fisheries, most were age-3 (84%), followed by age-2 (12%), age-4 (4%) and age-5 (<1%) fish.

The majority of age-2 CV Chinook harvested were in the sport fishery due to its lower size limit (20"-24" total length) compared to the commercial fishery (27" total length). For all age-2 CV releases, trucked MOKFt (42.7) had the highest recovery rate per 100,000 fish released, followed by net pen CFHFn (23.6), San Joaquin basin MERF (11.3), and net pen FRHFn (7.9) releases (Table 8).

Net pen releases had the highest recovery rates for age-3 CV fall and spring runs Chinook. The recovery rate for net pen FRHFn (81.2) was more than twice that of NIMFn (37.7) CFHFn, (32.1), FRHSn (29.4) and MOKFn (22.8). There were only in-basin releases of CV late fall-run CFHLh (24.4) for age-3 fish.

Relatively few age-4 or age-5 CWT recoveries were made compared to age-2 and age-3 CV fish. In-basin CV late fall-run Chinook CFHLh had the highest recovery rate for age-4 (16.0) and age-5 (0.6) CV releases.

Contribution of CV release groups to sport ocean harvest

In 2010, anglers harvested an estimated 14,697 Chinook in the California sport ocean salmon fishery. Based on the expanded CWT_{total} collected in the fishery, including non-CV Chinook release types, hatchery-origin fish contributed 31%-63% of the total harvest, depending on major port area (Figure 13). Of the hatchery-origin fish, fall-run net pen FRHFn releases dominated the sport catch in all port areas: Monterey (43%), San Francisco (38%), Fort Bragg (22%), and Eureka/Crescent City (27%). Other CV releases contributing to all sport fisheries were net pen NIMFn (4-8%), in-basin CFHFh (5-10%) and net pen CFHFn (3-5%); however there were no recoveries of CFHFh and CFHFn in the Eureka/Crescent City port area. Non-CV stocks also made up a higher proportion (3%) in this northern area.

Contribution of CV release groups to commercial ocean harvest

Commercial trollers landed an estimated 15,098 Chinook in the California commercial ocean salmon fishery; most salmon (83%) were caught in the Fort Bragg port area. Based on the expanded CWT_{total} collected in the fishery, hatchery-origin fish contributed 22%-74% of the total harvest, depending on major port area (Figure 14). Of the hatchery release types, fall-run net pen FRHFn dominated the commercial catch in all port areas: Monterey (50%), San Francisco (14%), and Fort Bragg (22%). The Eureka / Crescent City port area was completely closed to commercial fishing in 2010. Other CV releases contributing to the California commercial fishery were net pen NIMFn (3%-10%) and in-basin CFHFh (3%-8%). In addition, non-CV stocks contributed at a higher overall proportion in the commercial fishery (6%) than in the sport fishery (1%), especially in Fort Bragg (7%) where most of the commercial season occurred in 2010.

Discussion

Estimates of hatchery contributions that are presented in this report should be viewed simply as a "single year (2010) snapshot" of CV Chinook escapement and the California ocean harvest. This was the first year that the majority of all CWT recoveries from CV releases were representatively marked and tagged at a minimum 25% level. Although there were definite differences observed in recovery rates and straying proportions among runs, brood years, and CV release groups, this is just the first step in many needed to statistically analyze the contribution of hatchery and natural-origin salmon to natural areas throughout the CV, evaluate hatchery release strategies, improve California ocean and river salmon fisheries management, and determine if other goals of the CFM program are being met. It is also important to note that most of the CV CWT release groups in this study were produced, released and/or recovered during a time when Sacramento River fall-run Chinook were at historically low levels. Thus these salmon were not susceptible to "normal" ocean or river salmon fisheries since these fisheries were either completely closed or very constrained during the last three years.

The effect of interannual variation in survival and year-class strength of both hatchery-origin and natural-origin stocks should be considered when evaluating the status of CV Chinook stocks. At this time neither year class strength or age structure of CV natural-original Chinook are known. Scale-aging work done on 2006, 2007, and 2008 CV Chinook escapement by OSP has indicated that there may be different maturation rates for hatchery and natural-origin fish by stock and basin. It is premature to compare hatchery and natural-origin proportions without having complete brood- and/or stock-specific population estimates. While it may appear that total escapement by hatchery fish in the CV may exceed that of natural-origin fish in any given year, comparing age-specific total escapement (hatchery and natural) once broods complete their life cycle may indicate differences in hatchery and natural ratios for specific age groups and stocks. Such analyses may provide the basis for changing hatchery practices to better mimic wild population parameters. They may also further clarify the effects of specific environmental stressors unique to natural-origin fish and/or specific hatchery CWT release groups.

Strategies for CV fall-run production releases in any given year are often a result of two conflicting objectives. Increasing survival rates to allow for greater harvest and escapement often favors release strategies that bypass the Sacramento-San Joaquin Delta. Alternatively, in-basin release practices are aimed at maximizing homing rates back to the hatchery of origin to reduce impacts on natural stocks. It is impossible to make a thorough comparison of hatchery release practices at this time due to the large variability that existed among CWT release types within the same CV hatchery broods examined in this study. Most release types included individual CWT codes that were released at numerous locations at different times and under various conditions (e.g., river water flows and temperatures, bay tidal flows for trucked and net pen releases). While some individual CWT codes were recovered at a relatively high rate, others within the same release type were not recovered at all. The recovery rate R_{cwt} for individual CWT codes should be examined on a release type basis and the release strategies (in-basin, trucked, net-pen acclimation) that produce the greatest resource value (i.e., highest recovery rate, lowest straying proportion) adopted for future release strategy evaluation. Coordinated and paired hatchery release types will allow for direct comparisons to be made between them and will enrich the available data set used for subsequent evaluation of the hatchery program in the future. The CDFG Fisheries Branch has performed some very preliminary statistical testing to evaluate the significance of differences noted between the performance of individual pairs of release types (Ferreira 2011).

Prior to the CFM program, the primary purpose of CV Chinook escapement monitoring was to provide basic status information (e.g., grilse and adult escapement counts) by individual stocks and basins for California hatchery and ocean harvest management needs. The marking, tagging, or collection of CV CWT fish was not a high priority. CV escapement monitoring has expanded to provide data for a broad range of management applications related to recovery planning for listed stocks. These applications include assessing recovery efforts, including habitat restoration work, improving ocean and river fisheries management, and evaluating CV salmon hatchery programs to ensure both mitigation and conservation goals are being met. To meet the needs of these various assessment efforts, a review of current methodologies being employed among CV inland escapement monitoring programs was undertaken by DFG in 2008. The goal of this review was to identify needed changes and/or additions to survey protocols that will ensure both statistically valid estimates of escapement and the collection of biological data, including CWTs and scales, needed for assessment efforts. In 2012, DFG completed the Central Valley Chinook Salmon Escapement Monitoring Plan that recommends methods for estimating escapement and collecting biological data necessary for improved stock assessment in the CV (Bergman et al. 2012). Survey modifications included changes in the current mark-recapture models being utilized, changes in sampling protocols to ensure representative sampling and proper accounting, and the use of counting devices in place of some mark-recapture programs. This monitoring plan is now being implemented among CV surveys to provide the basis for sound CV Chinook assessment and subsequent management. The OSP and DFG Fisheries Branch CWT laboratories in Santa Rosa and Sacramento respectively, have both been expanded and additional staff hired to process the 40,000-60,000 tagged Chinook expected to be recovered annually during CV escapement and California ocean salmon fisheries monitoring. The OSP lab has also expanded its scale-aging capability utilizing state-of-the-art digital imaging. If these data are going to be used in a timely manner to manage CV salmon production and ocean/river fisheries, all CWT data and stock-specific age composition of CV escapement will be needed by February each year.

The CV CFM program has been successful in marking and tagging the target numbers of salmon each year at each of the CV hatcheries, and has just begun recovering CWTs in a statistically valid manner throughout the CV. The results from this program, in conjunction with future aging work will provide the best opportunity to manage CV Chinook salmon based on scientifically defensible data. The CFM program should be continued with the current design for several years to provide comparable, consistent data needed for harvest and hatchery management. Current funding for both CFM CWT recovery/processing and scale-aging programs expires in July 2013. Identifying future funding for these programs is essential for the continued enhancement of Chinook management in California's Central Valley.

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List of Acronyms and Abbreviations

Ad-clipped	clipped adipose fin
BOR	U.S. Bureau of Reclamation
CFM	Constant Fractional Marking
CNFH	Coleman National Fish Hatchery
CV	California Central Valley
CWT	coded-wire tag
DFG	California Department of Fish and Game
DWR	California Department of Water Resources
EBMUD	East Bay Municipal Utilities District
ERP	Ecosystem Restoration Program
FRH	Feather River Hatchery
FWS	U.S. Fish and Wildlife Service
MER	Merced River Hatchery
MOK	Mokelumne River Hatchery
NFH	Nimbus Fish Hatchery
OSP	Ocean Salmon Project
PSMFC	Pacific States Marine Fisheries Commission
RMPC	Regional Mark Processing Center
YARMT	Yuba Accord River Management Team

Table 1. Estimation and sampling methods used for the 2010 Central valley Chinook run assessment. (page 1 of 3)

Sampling Location	Estimation and Sampling Methods	Agency
Hatchery Spawners		
Coleman National Fish Hatchery (CNFH) Fall and Late Fall	Direct count. All fish examined for fin-clips, tags, marks. Hatchery takes a one month break in between the fall and late fall run spawning periods. Fish that arrive during this 'break' are counted and excised. Those fish that contain a fall cwt code or have their adipose fin present are later counted as a part of the fall run. Fish containing a late fall CWT code are later counted as late fall. Systematic random bio-sample[a/] of all fish with adipose fin absent. Grilse cutoff: 760 mm.	FWS
Feather River Hatchery (FRH) Spring and Fall	Direct count. All fish examined for fin-clips, tags, marks. All fish arriving at the hatchery April-June tagged with two uniquely-numbered floytags. All fish marked with floytags returning to FRH during August and September are spawned as spring run. All other fish are spawned as fall run. All spring Chinook are bio-sampled. Systematic random bio-sample ~10% of aggregate fall run fish with adipose fin present and absent. All fall run fish with adipose fin absent are bio-sampled. All spawned fall run fish are bio-sampled. Grilse cutoff: 650 mm.	CDFG
Nimbus Fish Hatchery (NFH) Fall	Direct count. All fish examined for fin-clips, tags, marks. Systematic random bio-sample ~10% of aggregate fish with adipose fin present and absent. All fish with adipose fin absent are bio-sampled. Grilse cutoff: 610 mm.	CDFG
Nimbus Weir Fall	Direct count. All fish examined for fin-clips, tags, marks. All fish with adipose fin absent are bio-sampled.	CDFG
Mokelumne River Hatchery (MOK) Fall	Direct count. All fish examined for fin-clips, tags, marks. Systematic random bio-sample ~10% of aggregate fish with adipose fin present and absent. All fish with adipose fin absent are bio-sampled. Grilse cutoff: 680 mm females, 710 males.	CDFG
Mokelumne Weir Fall	Direct count. All fish examined for fin-clips, tags, marks. All fish with adipose fin absent are bio-sampled.	CDFG
Merced River Fish Facility (MER) Fall	Direct count. All fish examined for fin-clips, tags, marks. All fish with adipose fin absent are bio-sampled.	CDFG

Table 1. Estimation and sampling methods used for the 2010 Central valley Chinook run assessment. (page 2 of 3)

Sampling Location	Estimation and Sampling Methods	Agency
<u>Natural Spawners</u>		
Upper Sacramento River Mainstem Fall and Late Fall	Superpopulation modification of the Jolly-Seber mark-recapture estimate applied using large females with adipose fin present within survey area (Keswick Dam to Balls Ferry). Chinook removed during the survey for CWT recovery are added to the J-S estimate. Total escapement estimate (Keswick Dam to Princeton) is derived using expansions for: Fish spawning outside of the survey area (Balls Ferry to Princeton) through aerial redd surveys, large male Chinook based on the sex ratio at CNFH, and grilse based on the rate encountered during the mark recapture survey. All fish examined for fin-clips, tags, marks. Bio-data collected from all fresh fish with adipose fin present and absent. Systematic random bio-sample of aggregate fish with adipose fin present and absent. All fish with adipose fin absent are bio-sampled. Grilse cutoff: 610 mm.	CDFG, FWS
Clear Creek Fall	Modified Schaefer mark-recapture estimate. All fish examined for fin-clips, tags, marks. Bio-data collected from all fresh fish with adipose fin present and absent. Systematic random bio-sample of aggregate fish with adipose fin present and absent. All fish with adipose fin absent are bio-sampled. Grilse cutoff: 610 mm.	CDFG, FWS
Butte Creek Spring and Fall	Modified Schaefer mark-recapture estimate for spring run. Peterson mark-recapture estimate for fall run. All fish examined for fin-clips, tags, marks. Systematic random bio-sample of aggregate fish with adipose fin present and absent. All fish with adipose fin absent are bio-sampled. Grilse cutoff: 610 mm.	CDFG
Feather River Fall	Modified Schaefer mark recapture-estimate. All fish examined for fin-clips, tags, marks. Systematic random bio-sample of aggregate fish with adipose fin present and absent. All fish with adipose fin absent are bio-sampled. Spring run Chinook are included. Grilse cutoff: 650 mm.	DWR
Yuba River Fall	Modified Schaefer mark-recapture estimate. All fish examined for fin-clips, tags, marks. Systematic random bio-sample of aggregate fish with adipose fin present and absent. All fish with adipose fin absent are bio-sampled. Spring Chinook are included in estimate. Grilse cutoff: 650	CDFG, YARMT
American River Fall	Modified Schaefer mark-recapture estimate. All fish examined for fin-clips, tags, marks. Systematic random bio-sample of aggregate fish with adipose fin present and absent. All fish with adipose fin absent are bio-sampled. Grilse cutoff: 680 mm.	CDFG
Mokelumne River Fall	Video count at Woodbridge Irragation District Dam. Additionally, in river survey conducted to collect bio-samples from all fish with adipose fin present and absent. All fish with adipose fin absent are bio-sampled. Grilse cutoff: 680 mm females, 710 males.	EBMUD
Stanislaus River Fall	Pooled-Petersen mark-recapture estimate. All fish examined for fin-clips, tags, marks. All fish with adipose fin absent are bio-sampled.	CDFG
Tuolumne River Fall	Pooled-Petersen mark-recapture estimate. All fish examined for fin-clips, tags, marks. All fish with adipose fin absent are bio-sampled.	CDFG
Merced River Fall	Pooled-Petersen mark-recapture estimate. All fish examined for fin-clips, tags, marks. All fish with adipose fin absent are bio-sampled.	CDFG

Table 1. Estimation and sampling methods used for the 2010 Central valley Chinook run assessment. (page 3 of 3)

Sampling Location	Estimation and Sampling Methods	Agency
<u>Recreational Harvest</u>		
Upper Sacramento River Fall	Open October 9th to October 31st from Highway 113 Bridge to Deschutes Road Bridge. Stratified-random sampling design (one weekday and one weekend sample per week per section during the open season per management zone) that included both roving and access interview components, and the collection of coded-wire tags from adipose fin-clipped salmon for stock identification. Bio-data collected during angler interviews.	CDFG
Feather River Fall	Open July 31st to August 29th below the Thermolito Afterbay Outlet. Stratified-random sampling design (one weekday and one weekend sample per week per section during the open season per management zone) that included both roving and access interview components, and the collection of coded-wire tags from adipose fin-clipped salmon for stock identification. Bio-data collected during angler interviews.	CDFG
American River Fall	Open October 30th to November 28th from the mouth to the SMUD power line crossing at Ancil Hoffman Park. Stratified-random sampling design (one weekday and one weekend sample per week per section during the open season per management zone) that included both roving and access interview components, and the collection of coded-wire tags from adipose fin-clipped salmon for stock identification. Bio-data collected during angler interviews.	CDFG
Lower Sacramento River Fall	Open September 4th to October 3rd from the Carquinez Bridge to the Highway 113 Bridge. Stratified-random sampling design (one weekday and one weekend sample per week per section during the open season per management zone) that included both roving and access interview components, and the collection of coded-wire tags from adipose fin-clipped salmon for stock identification. Bio-data collected during angler interviews.	CDFG
Upper Sacramento River Late Fall	Open November 1st to December 12th from Highway 113 Bridge to Deschutes Road Bridge. Stratified-random sampling design (one weekday and one weekend sample per week per section during the open season per management zone) that included both roving and access interview components, and the collection of coded-wire tags from adipose fin-clipped salmon for stock identification. Bio-data collected during angler interviews.	CDFG

a/ Biological samples ("bio-samples" or "bio-data") of live fish or carcasses generally include: sex, fork length, scales, tags or marks, and CWT recovery from ad-clipped fish.

Table 2. 2010 California ocean sport and commerial salmon fishery seasons by major port area.

	Sport		Commercial		
Major Port Area	Season	Size Limit[a/]	Season	Size Limit[a/]	Quota
Crescent City/Eureka	May 29-Sep 6	24" TL	closed	--	--
Fort Bragg	Apr 3-30	20" TL	July 1-4, 8-11	27" TL	none
	May 1-Sep 6	24" TL	July 15-29	27" TL	18,000
			Aug 1-31	27" TL	9,375
San Francisco	Apr 3-30	20" TL	July 1-4, 8-11	27" TL	none
	May 1-Sep 6 (closed Tue/Wed)	24" TL			
Monterey/Morro Bay	Apr 3-30	20" TL	July 1-4, 8-11	27" TL	none
	May 1-Sep 6 (closed Tue/Wed)	24" TL			

a/ Size limit in total length (TL).

Table 3. Central Valley coded-wire tag (CWT) Chinook releases by age, stock, run and release type, brood years 2006-2009. (page 1 of 2)

Age 2 CWT releases

Release type*	Brood year	Hatchery / wild	Stock origin	Run type	CWT codes	Total fish released	# CWT tagged	% CWT	Release strategy	Release locations / notes
FRHS	2008	FRH	Fea R	Spr	5	1,016,835	1,015,717	100%	Basin	Boyds Pump Ramp
FRHSn	2008	FRH	Fea R	Spr	5	1,007,177	1,005,727	100%	Bay pens	San Pablo Bay net pens
CFHFh	2008	CNFH	Sac R	Fall	27	12,529,146	3,128,111	25%	Basin	CNFH
CFHFn	2008	CNFH	Sac R	Fall	3	1,427,439	371,685	26%	Bay pens	Mare Island net pens, San Pablo Bay net pens
FRHFn	2008	FRH	Fea R	Fall	11	7,760,969	2,061,211	27%	Bay pens	Mare Island net pens, San Pablo Bay net pens, Wickland Oil net pens
FRHFe	2008	FRH	Fea R	Hybrid	30	498,341	481,853	97%	CV exper	Fall x Spr hybrid releases: Benicia, Discovery Pk, Elkhorn Boat Launch, Miller Park, Sac River at Garcia Bend and Pittsburg
FRHFtib	2008	FRH	Fea R	Fall	2	91,631	89,859	98%	Tiberon pens	Held 3-4 mos Tiberon net pens, released as yearlings
FeaFw	2008	wild	Fea R	Fall	37	292,423	289,830	99%	Basin	Feather River Hatchery, Thermalito Bypass
NIMF	2008	NIM	Ame R	Fall	1	267,003	264,006	99%	Basin	American River
NIMFn	2008	NIM	Ame R	Fall	4	3,924,440	976,955	25%	Bay pens	Mare Island net pens
MOKFt	2008	MOK	Mok R	Fall	4	250,969	250,300	100%	Trucked	Sherman Island
MokFw	2008	wild	Mok R	Fall	5	24,911	20,680	83%	Basin	Woodbridge, Mok R Vino farms
MERF	2008	MER	Mer R	Fall	2	34,532	32,978	95%	Basin	Jersey Pt (San Joaquin River)
CFHLh	2009	CNFH	Sac R	Late	16	1,134,119	1,115,378	98%	Basin	CNFH (includes spring surrogate releases)
			Total age 2 releases:		152	30,259,935	11,104,290	37%	1% wild releases	

Age 3 CWT releases

Release type*	Brood year	Hatchery / wild	Stock origin	Run type	CWT codes	Total fish released	# CWT tagged	% CWT	Release strategy	Release locations / notes
ButSw	2007	wild	Butte Ck	Spr	30	317,706	311,061	98%	Basin	Baldwin Construction Yard
FRHS	2007	FRH	Fea R	Spr	8	1,414,343	1,378,941	97%	Basin	Boyds Pump Ramp (on Feather River)
FRHSn	2007	FRH	Fea R	Spr	2	1,271,761	1,242,480	98%	Bay pens	San Pablo Bay net pens, Wickland Oil net pens
CFHFe	2007	CNFH	Sac R	Fall	8	200,619	196,993	98%	CV exper	Clarksburg, Red Bluff Diversion Dam
CFHFh	2007	CNFH	Sac R	Fall	14	11,232,241	2,801,459	25%	Basin	CNFH
CFHFn	2007	CNFH	Sac R	Fall	3	1,266,949	314,681	25%	Bay pens	San Pablo Bay net pens (Conoco Phillips, Mare Island); 75% truck mortality noted for one release
FRHFe	2007	FRH	Fea R	Fall	19	623,567	619,085	99%	CV exper	Elkhorn Boat Ramp,Isleton, Lighthouse Marina, West Sacramento
FRHFn	2007	FRH	Fea R	Fall	9	9,422,521	2,347,396	25%	Bay pens	Mare Island net pens, San Pablo Bay net pens, Wickland Oil net pens
FRHFt	2007	FRH	Fea R	Fall	4	102,225	101,712	99%	Trucked	Benicia
FeaFw	2007	wild	Fea R	Fall	19	208,717	206,683	99%	Basin	Thermalito Bypass
NIMFn	2007	NIM/MOK	Ame R	Fall	7	6,879,664	1,714,858	25%	Bay pens	Raised at both NIM and MOK; San Pablo Bay net pens
NIMFtib	2007	MOK	Ame R	Fall	1	51,600	51,600	100%	Tiberon pens	Raised at MOK; held 3-4 mos Tiberon net pens, released as yearlings
MOKF	2007	MOK	Mok R	Fall	1	406,593	101,458	25%	Basin	New Hope Landing
MOKFn	2007	MOK	Mok R	Fall	2	2,203,488	550,668	25%	Bay pens	San Pablo Bay net pens
MokFw	2007	wild	Mok R	Fall	1	315	315	100%	Basin	Mokelumne River
CFHLh	2008	CNFH	Sac R	Late	14	1,106,673	1,072,854	97%	Basin	CNFH (includes spring surrogate releases)
			Total age 3 releases:		142	36,708,982	13,012,244	35%	1% wild releases	

Table 3. Central Valley coded-wire tag (CWT) Chinook releases by age, stock, run and release type, brood years 2006-2009. (page 2 of 2)

Age 4 CWT releases

Release type*	Brood year	Hatchery / wild	Stock origin	Run type	CWT codes	Total fish released	# CWT tagged	% CWT	Release strategy	Release locations / notes
ButSw	2006	wild		Spr	27	283,749	279,936	99%	Basin	Baldwin Construction Yard
FRHS	2006	FRH	Fea R	Spr	1	1,043,284	1,004,683	96%	Basin	Fea R Hatchery
FRHSt	2006	FRH	Fea R	Spr	9	1,036,931	1,026,561	99%	Trucked	Wickland Oil Terminal (no pens)
YubSw	2006	wild	Yub R	Spr	16	182,730	179,853	98%	Basin	Yuba River
CFHFe	2006	CNFH	Sac R	Fall	8	201,812	196,108	97%	CV exper	Clarksburg, Red Bluff Diversion Dam
CFHFh	2006	CNFH	Sac R	Fall	8	12,113,781	3,032,082	25%	Basin	CNFH
FRHFe	2006	FRH	Fea R	Fall	34	573,386	564,904	99%	CV exper	Elkhorn Boat Ramp,Isleton, Lighthouse Marina, West Sacramento, Yolo Bypass
FRHFn	2006	FRH	Fea R	Fall	8	8,154,003	1,995,912	24%	Bay pens, Trucked	Wickland Oil net pens - proportion of trucked fish placed in pens, varies from 35%-100%; remainder dumped directly into bay
FRHFt	2006	FRH	Fea R	Fall	9	1,018,073	305,755	30%	Trucked	Benicia, Wickland Oil Terminal (no pens)
FeaFw	2006	wild	Fea R	Fall	17	188,293	186,478	99%	Basin	Thermalito Bypass
YubFw	2006	wild	Yub R	Fall	14	62,426	61,295	98%	Basin	Yuba River
NIMFn	2006	NIM	Ame-Mok	Fall	5	6,128,032	1,527,846	25%	Coastal & Bay pens, Trucked	Amer-Moke fish accidentally mixed, released into multiple net pens: 18% coastal (Avila, Santa Cruz), 82% Bay net pens. American stock trucked to Wickland Oil net pens (approx 87% placed into pens)
MOKF	2006	MOK	Mok R	Fall	7	3,706,436	925,826	25%	Basin	New Hope Landing
MOKFn	2006	MOK	Mok R	Fall	2	227,412	55,427	24%	Coastal & Bay pens	Coastal and ocean net pens (Port San Luis,Santa Cruz, Moss Landing & Selby/Wickland net pens)
MOKFt	2006	MOK	Mok R	Fall	1	1,127,138	281,582	25%	Trucked	Wickland Oil Terminal (no pens)
MokFw	2006	wild	Mok R	Fall	2	13,903	10,968	79%	Basin	Mok R
MERF	2006	MER	Mer R	Fall	12	312,294	304,121	97%	Basin	Hatfield State Area, MER
CFHLe	2007	CNFH	Sac R	Late	17	309,829	299,292	97%	CV exper	Sac R (Colusa to RBDD), Georgianna Slough, Port Chicago, Ryde-Koket
CFHLh	2007	CNFH	Sac R	Late	9	738,638	723,091	98%	Basin	CNFH (includes spring surrogate releases)
			Total age 4 releases:		206	37,422,150	12,961,720	35%	2% wild releases	

***CV CWT release types:**

Sacramento River Basin Fall Chinook CWT release groups

CFHFe	Coleman National Fish Hatchery (CNFH) fall experimental releases
CFHFh	Coleman National Fish Hatchery fall hatchery releases
CFHFn	Coleman National Fish Hatchery fall net pen releases
FRHFe	Feather River Hatchery fall experimental (2008 brdyr includes spring x fall hybrids)
FRHFn	Feather River Hatchery fall net pen releases
FRHFt	Feather River Hatchery fall trucked releases (no net pens)
FRHFtn	Feather River Hatchery fall Tiburon net pen releases (released as yearlings following fall)
FeaFw	Feather River fall wild
YubFw	Yuba River fall wild
NIMFn	Nimbus Fish Hatchery fall net pens
NIMFtib	Nimbus Fish Hatchery fall Tiburon net pens (released as yearlings following fall)

Sacramento River Basin Late Fall Chinook CWT release groups

CFHLe	Coleman National Fish Hatchery late fall experimental releases
CFHLh	Coleman National Fish Hatchery late fall hatchery releases

San Joaquin Basin Fall Chinook CWT release groups

MOKF	Mokelumne Hatchery fall basin releases
MOKFn	Mokelumne Hatchery fall net pen releases
MOKFt	Mokelumne Hatchery fall trucked releases
MokFw	Mokelumne River fall wild
MerF	Merced Hatchery fall releases

Central Valley Spring Chinook CWT release groups

FRHS	Feather River Hatchery spring basin releases
FRHSn	Feather River Hatchery spring net pen releases
FRHSt	Feather River Hatchery spring trucked releases
ButSw	Butte Creek spring wild
YubSw	Yuba River spring wild

Table 4. Escapement estimates and sample data for 2010 CV escapement.

Escapement Survey	Run	Total Escapement	Chinook Sampled[a/]	Observed Ad-Clips	Valid CWTs	Sample Fractions[b/] fe	fa	fd	Sample Expansion
Hatcheries									
Feather River Hatchery	Spring	1,661	1,661	1,279	1,234	1.000	1.000	0.998	1.00
Coleman National Fish Hatchery	Fall	17,238	17,238	4,140	4,040	1.000	1.000	0.990	1.01
Feather River Hatchery	Fall	19,972	19,972	6,373	6,049	1.000	1.000	0.969	1.03
Nimbus Fish Hatchery	Fall	9,095	9,095	2,060	2,025	1.000	1.000	0.997	1.00
Nimbus Weir	Fall	7,115	7,115	999	948	1.000	1.000	0.999	1.00
Mokelumne River Hatchery	Fall	5,276	5,276	2,747	2,707	1.000	1.000	1.000	1.00
Mokelumne Weir	Fall	244	244	119	115	1.000	1.000	1.000	1.00
Merced River Fish Facility	Fall	146	146	83	81	1.000	1.000	0.988	1.01
Coleman National Fish Hatchery	Late Fall	5,505	5,505	5,391	5,258	1.000	1.000	0.995	1.00
Natural Areas									
Mill Creek	Spring	482	482	1	1	1.000	1.000	1.000	1.00
Butte Creek	Spring	1,979	1,113	21	16	0.562	1.000	1.000	1.78
Sacramento River-Above Red Bluff	Fall	16,372	1,415	130	117	0.086	0.992	1.000	11.66
Mill Creek	Fall	144	144	1	1	1.000	1.000	1.000	1.00
Deer Creek	Fall	166	166	2	2	1.000	1.000	1.000	1.00
Clear Creek	Fall	7,192	1,496	19	19	0.208	1.000	1.000	4.81
Butte Creek	Fall	370	83	3	3	0.224	1.000	1.000	4.46
Feather River	Fall	44,914	5,077	1,388	1,276	0.113	0.964	0.998	9.20
Yuba River	Fall	13,097	789	341	330	0.060	1.000	1.000	16.60
American River	Fall	7,573	1,435	142	134	0.189	1.000	0.985	5.36
Mokelumne River	Fall	1,920	1,920	820	808 [c/]	1.000	1.000	0.999	1.00
Stanislaus River	Fall	1,086	155	38	36	0.143	1.000	1.000	7.01
Tuolumne River	Fall	540	85	27	24	0.157	1.000	1.000	6.35
Merced River	Fall	651	132	49	46	0.203	1.000	1.000	4.93
American River	Late Fall	162	162	37	37	1.000	1.000	1.000	1.00
Sacramento River-Above Red Bluff	Late Fall	4,282	811	47	43	0.189	0.979	0.977	5.52
Inland Sport Harvest									
Sacramento River-Above Feather Confluence	Fall	2,080	187	23	21	0.090	1.000	1.000	11.12
Feather River	Fall	1,194	111	26	26	0.093	1.000	1.000	10.76
Sacramento River-Below Feather Confluence	Fall	2,008	126	45	44	0.063	1.000	1.000	15.94
American River	Fall	248	14	7	6	0.056	1.000	1.000	17.71
Sacramento River-Above Feather Confluence	Late Fall	1,117	144	87	86	0.129	1.000	0.989	7.85
	Total	**173,829**	**82,299**	**26,445**	**24,838**				

a/ Number of salmon visually checked for an ad-clip.

b/ Sample Fractions:

fe = fraction of total salmon escapement sampled and examined for ad-clipped fish.

fa = fraction of heads from ad-clipped salmon collected and processed.

fd = fraction of observed CWTs that were successfully decoded.

c/ Mokelumne River natural area includes expanded CWTs based on ad-clip count at Woodbridge dam weir.

Table 5. Catch estimates and sample data for 2010 ocean salmon sport and commercial fisheries by major port area.

Major Port Area	Total Harvest Estimate	Chinook Sampled[a/]	Observed Ad-Clips	Valid CWTs	Sample Fractions[b/] fe	fa	fd	Sample Expansion
Commercial								
Fort Bragg	12,577	7,563	1,018	858	0.601	0.993	1.000	1.67
San Francisco	1,086	856	81	69	0.788	1.000	1.000	1.27
Monterey	1,435	677	158	152	0.472	0.987	1.000	2.15
Sport								
Eureka/Crescent	720	168	36	25	0.233	1.000	1.000	4.29
Fort Bragg	1,702	499	95	89	0.293	0.989	1.000	3.45
San Francisco	5,927	2,149	478	454	0.363	0.985	0.998	2.81
Monterey	6,348	1,432	358	340	0.226	0.992	0.997	4.48
Total	**29,795**	**13,344**	**2,224**	**1,987**				

a/ Number of salmon visually checked for ad-clip

b/ Sample fractions:

fe = fraction of the total salmon sampled and examined for ad-clipped fish.

fa = fraction of heads from ad-clipped salmon collected and processed.

fd = fraction of observed CWTs that were successfully decoded.

Table 6. Raw and expanded CV coded-wire-tag (CWT) recoveries by stock and age, brood years 2004-2010.

Fall	2009	2008	2007	2006	2005	2004	Total CV	
Age	1	2	3	4	5	6	CWTs	Total CV %
Raw CWT Recoveries	36	7,087	8,022	272	2		15,419	62%
	(< 1%)	(46%)	(52%)	(2%)	(< 1%)			
Expanded CWTtotal	**137**	**29,451**	**63,868**	**2,197**	**2**		95,655	84%
	(< 1%)	(31%)	(67%)	(2%)	(< 1%)			

Spring	2009	2008	2007	2006	2005	2004	Total CV	
Age	1	2	3	4	5	6	CWTs	Total CV %
Raw CWT Recoveries		306	3,340	91	1		3,738	15%
		(8%)	(89%)	(2%)	(< 1%)			
Expanded CWTtotal		**608**	**10,582**	**308**	**1**		11,499	10%
		(5%)	(92%)	(3%)	(< 1%)			

Late Fall	2010	2009	2008	2007	2006	2005	Total CV	
Age	1	2	3	4	5	6	CWTs	Total CV %
Raw CWT Recoveries		153	781	3,824	918	5	5,681	23%
		(3%)	(14%)	(67%)	(16%)	(< 1%)		
Expanded CWTtotal		**334**	**1,358**	**4,093**	**1,122**	**5**	6,912	6%
		(5%)	(20%)	(59%)	(16%)	(< 1%)		

All Runs							Total CV	
Age	1	2	3	4	5	6	CWTs	Total CV %
Raw CWT Recoveries	36	7,546	12,143	4,187	921	5	24,838	100%
	(< 1%)	(30%)	(49%)	(17%)	(4%)	(< 1%)		
Expanded CWTtotal	**137**	**30,392**	**75,809**	**6,597**	**1,125**	**5**	114,066	100%
	(< 1%)	(27%)	(66%)	(6%)	(1%)	(< 1%)		

Table 7. Raw and expanded ocean coded-wire-tag (CWT) recoveries by stock and age, brood years 2004-2009.

Fall	2008	2007	2006	2005	2004	Total CV CWTs	Total CV %
Age	2	3	4	5	6		
Raw CWT Recoveries	183	1,282	34			1,499	75%
	(12%)	(86%)	(2%)				
Expanded CWTtotal	**1,603**	**11,704**	**250**			13,557	62%
	(12%)	(86%)	(2%)				

Spring	2008	2007	2006	2005	2004	Total CV CWTs	Total CV %
Age	2	3	4	5	6		
Raw CWT Recoveries	10	162	3			175	9%
	(6%)	(93%)	(1%)				
Expanded CWTtotal	**35**	**575**	**9**			619	3%
	(6%)	(93%)	(1%)				

Late Fall	2009	2008	2007	2006	2005	Total CV CWTs	Total CV %
Age	2	3	4	5	6		
Raw CWT Recoveries		111	56	1	2	170	9%
		(65%)	(33%)	(< 1%)	(1%)		
Expanded CWTtotal		**1,358**	**4,093**	**1,122**	**5**	6,578	30%
		(21%)	(62%)	(17%)	(< 1%)		

Winter	2008	2007	2006	2005	2004	Total CV CWTs	Total CV %
Age	2	3	4	5	6		
Raw CWT Recoveries	1	1				2	< 1%
	(50%)	(50%)					
Expanded CWTtotal	**4**	**2**				6	< 1%
	(67%)	(33%)					

Non CV Rivers	2008	2007	2006	2005	2004	Total CV CWTs	Total CV %
Age	2	3	4	5	6		
Raw CWT Recoveries		84	56		1	141	7%
		(60%)	(40%)		(< 1%)		
Expanded CWTtotal		**523**	**509**		**2**	1,034	5%
		(51%)	(49%)		(< 1%)		

All Runs						Total CV CWTs	Total CV %
Age	2	3	4	5	6		
Raw CWT Recoveries	194	1,640	149	1	3	1,987	100%
	(10%)	(83%)	(7%)	(< 1%)	(< 1%)		
Expanded CWTtotal	**1,642**	**14,162**	**4,861**	**1,122**	**7**	21,794	100%
	(8%)	(65%)	(22%)	(5%)	(< 1%)		

Table 8. 2010 CWT recovery rate (recoveries per 100,000 CWTs released) by release type, brood year, and recovery location. (page 1 of 2)

Age 2 CV recoveries

Release	Brood	Run	# CWT	Central Valley CWT_{samp} recoveries by location								CV CWT_{samp} totals			Ocean	Recovery Rate per 100,000 released				CV Stray
type	year	type	tagged	Battle ck	Up Sac	Nat crks*	Fea/Yub	Amer	Moke	Merc	Stan	CV total	Basin	Stray	CWT_{samp}	Basin	Stray	CV total	Ocean	Proportion
FRHS	2008	Spr	1,015,717				284					284	284		12	28.0		28.0	1.2	0.00
FRHSn	2008	Spr	1,005,727		23		291	8	1			323	291	33	23	28.9	3.2	32.2	2.3	0.10
CFHFh	2008	Fall	3,128,111	2,196	23							2,219	2,219		102	70.9		70.9	3.3	0.00
CFHFn	2008	Fall	371,685	44	23	14	213	221	44	7	33	600	68	533	88	18.2	143.3	161.5	23.6	0.89
FRHFn	2008	Fall	2,061,211	17	12		2,297	70	13	1	13	2,423	2,297	126	163	111.4	6.1	117.6	7.9	0.05
FRHFe	2008	Fall	481,853				623	30				653	623	30	27	129.3	6.3	135.6	5.6	0.05
FRHFtib	2008	Fall	89,859	7			48	11				67	48	18	5	53.6	20.5	74.1	5.1	0.28
FeaFw	2008	Fall	289,830				12					12	12			4.2		4.2		0.00
NIMF	2008	Fall	264,006					88				88	88			33.5		33.5		0.00
NIMFn	2008	Fall	976,955		12		3	800	33	1		849	800	49	34	81.9	5.0	86.9	3.5	0.06
MOKFt	2008	Fall	250,300	2		4	3	151	2,176	111	158	2,606	2,176	430	107	869.4	171.8	1041.2	42.7	0.17
MokFw	2008	Fall	20,680						4			4	4		2	18.7		18.7	7.4	0.00
MERF	2008	Fall	32,978	4		6	36	23	100	31	78	278	31	247	4	93.5	749.6	843.0	11.3	0.89
CFHLh	2009	Late	1,115,378	130				1		2		133	130	3		11.7	0.3	12.0		0.02

Age 3 CV recoveries

Release	Brood	Run	# CWT	Central Valley CWT_{samp} recoveries by location								CV CWT_{samp} totals			Ocean	Recovery Rate per 100,000 released				CV Stray
type	year	type	tagged	Battle ck	Up Sac	Nat crks*	Fea/Yub	Amer	Moke	Merc	Stan	CV total	Basin	Stray	CWTs	Basin	Stray	CV total	Ocean	Proportion
ButSw	2007	Spr	311,061			5						5	5			1.7		1.7		0.00
FRHS	2007	Spr	1,378,941				4,804					4,804	4,804		195	348.4		348.4	14.1	0.00
FRHSn	2007	Spr	1,242,480	11	501	24	4,650	245	22		19	5,471	4,650	822	365	374.2	66.1	440.4	29.4	0.15
CFHFe	2007	Fall	196,993	68	175	5	55	20	1			323	243	81	30	123.1	40.9	164.0	15.2	0.25
CFHFh	2007	Fall	2,801,459	1,392	117	20						1,529	1,508	20	311	53.8	0.7	54.6	11.1	0.01
CFHFn	2007	Fall	314,681	2			33	73	15	6		130	2	128	101	0.6	40.5	41.2	32.1	0.98
FRHFe	2007	Fall	619,085		12		203	8				223	203	20	22	32.8	3.2	36.0	3.6	0.09
FRHFn	2007	Fall	2,347,396	18	373	39	10,339	390	39	25	6	11,230	10,339	891	1905	440.4	38.0	478.4	81.2	0.08
FRHFt	2007	Fall	101,712		12		101	10	3			125	101	24	15	99.1	23.8	122.9	14.7	0.19
FeaFw	2007	Fall	206,683				29					29	29			14.0		14.0		0.00
NIMFn	2007	Fall	1,714,858	2	12		6	1,159	457	43	48	1,727	1,159	568	646	67.6	33.1	100.7	37.7	0.33
NIMFtib	2007	Fall	51,600				3	140	386	59	7	594	140	454		270.8	880.7	1151.5		0.76
MOKF	2007	Fall	101,458					1	21			22	21	1	3	20.3	1.0	21.3	2.6	0.05
MOKFn	2007	Fall	550,668	2			29	148	278	22	35	514	278	236	126	50.4	42.9	93.3	22.8	0.46
MokFw	2007	Fall	315																	
CFHLh	2008	Late	1,072,854	711	6				1			718	717	1	261	66.8	0.1	66.9	24.4	0.00

Table 8. 2010 CWT recovery rate (recoveries per 100,000 CWTs released) by release type, brood year, and recovery location. (page 2 of 2)

Age 4 CV recoveries

Release	Brood	Run	# CWT	Central Valley CWT_{samp} recoveries by location								CV CWT_{samp} totals			Ocean	Recovery Rate per 100,000 released				CV Stray
type	year	type	tagged	Battle ck	Up Sac	Nat crks*	Fea/Yub	Amer	Moke	Merc	Stan	CV total	Basin	Stray	CWTs	Basin	Stray	CV total	Ocean	Proportion
ButSw	2006	Spr	279,936			5						5	5		2	1.9		1.9	0.6	0.00
FRHS	2006	Spr	1,004,683		12		53					65	53	12	6	5.3	1.2	6.4	0.6	0.18
FRHSt	2006	Spr	1,026,561		12		164	23				199	164	35		16.0	3.4	19.4		0.18
YubSw	2006	Spr	179,853				33					33	33		3	18.5		18.5	1.6	0.00
CFHFe	2006	Fall	196,108	1			9					10	1	9	2	0.5	4.7	5.2	0.8	0.90
CFHFh	2006	Fall	3,032,082	82	12	5						98	93	5	8	3.1	0.2	3.2	0.3	0.05
FRHFe	2006	Fall	564,904				29	3				32	29	3		5.1	0.5	5.6		0.09
FRHFn	2006	Fall	1,995,912	1	12	5	308	17	1			343	308	35	45	15.4	1.8	17.2	2.2	0.10
FRHFt	2006	Fall	305,755				2					2	2		5	0.7		0.7	1.5	0.00
FeaFw	2006	Fall	186,478																	
YubFw	2006	Fall	61,295																	
NIMFn	2006	Fall	1,527,846					36	8			44	36	8	4	2.4	0.5	2.9	0.3	0.18
MOKF	2006	Fall	925,826																	
MOKFn	2006	Fall	55,427					1				1		1	2		1.8	1.8	2.9	1.00
MOKFt	2006	Fall	281,582				1		1			2	1	1	2	0.5	0.4	0.8	0.6	0.44
MokFw	2006	Fall	10,968																	
MERF	2006	Fall	304,121																	
CFHLe	2007	Late	299,292	7	6			16	4			32	13	20	12	4.2	6.6	10.8	3.8	0.61
CFHLh	2007	Late	723,091	3,770	72			1				3843	3842	1	115	531.3	0.1	531.4	16.0	0.00

Age 5 CV recoveries

Release	Brood	Run	# CWT	Central Valley CWT_{samp} recoveries by location								CV CWT_{samp} totals			Ocean	Recovery Rate per 100,000 released				CV Stray
type	year	type	tagged	Battle ck	Up Sac	Nat crks*	Fea/Yub	Amer	Moke	Merc	Stan	CV total	Basin	Stray	CWT_{samp}	Basin	Stray		Ocean	Proportion
FRHS	2005	Spr	762,021				1					1	1			0.1				
FRHFt	2005	Fall	1,000,606				1	1				2	1	1		0.1	0.1			0.49
CFHLe	2006	Late	264,277	8	61			24				93	69	24		26.0	9.1			0.26
CFHLh	2006	Late	854,496	858	94							952	952		5	111.4			0.6	

* - Natural creeks include Clear Creek, Butte Creek, and Deer Creek.

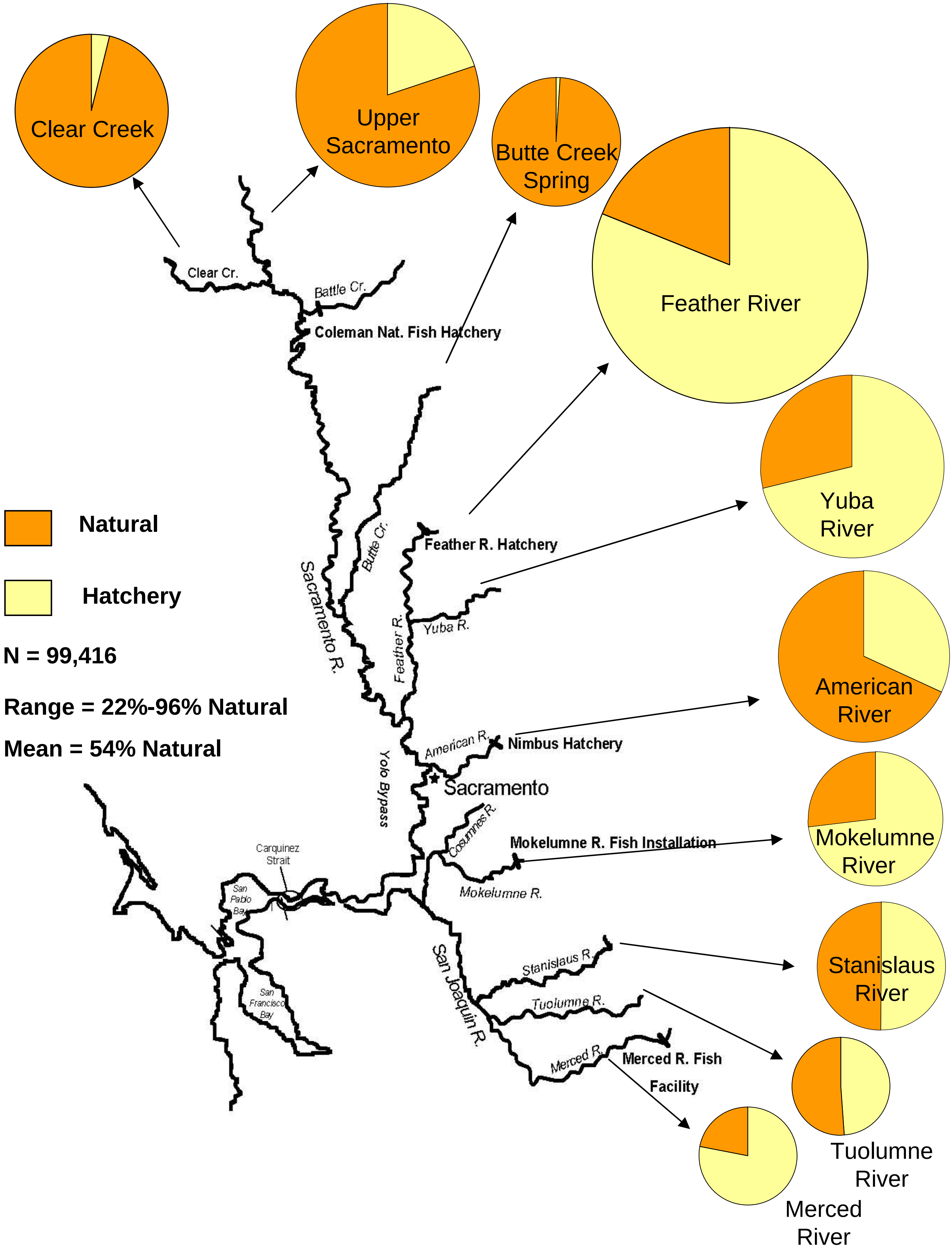


Figure 1. 2010 Fall Chinook Natural Area Escapement, Hatchery and Natural Proportions

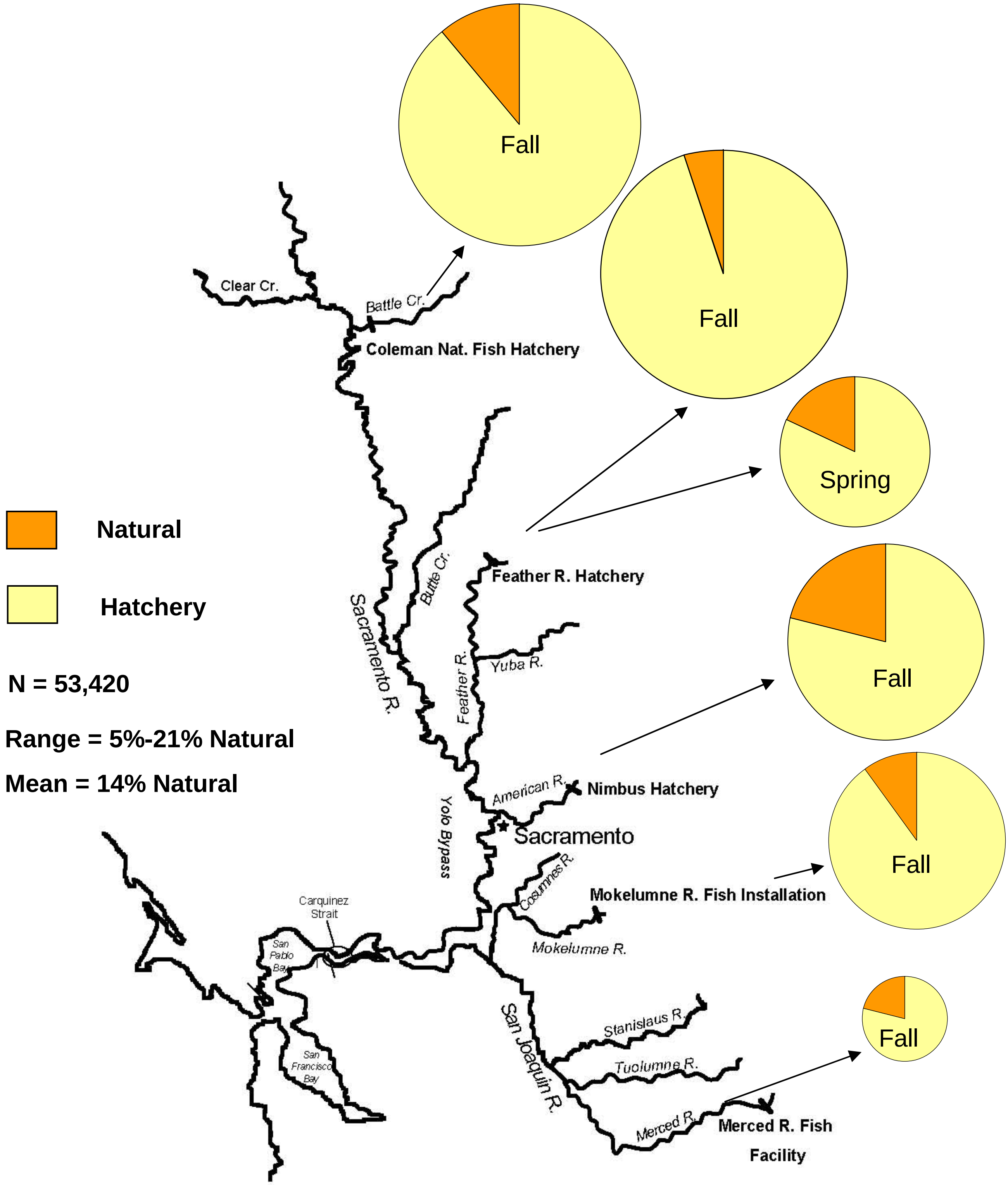


Figure 2. 2010 Fall Chinook Hatchery Escapement, Hatchery and Natural Proportions

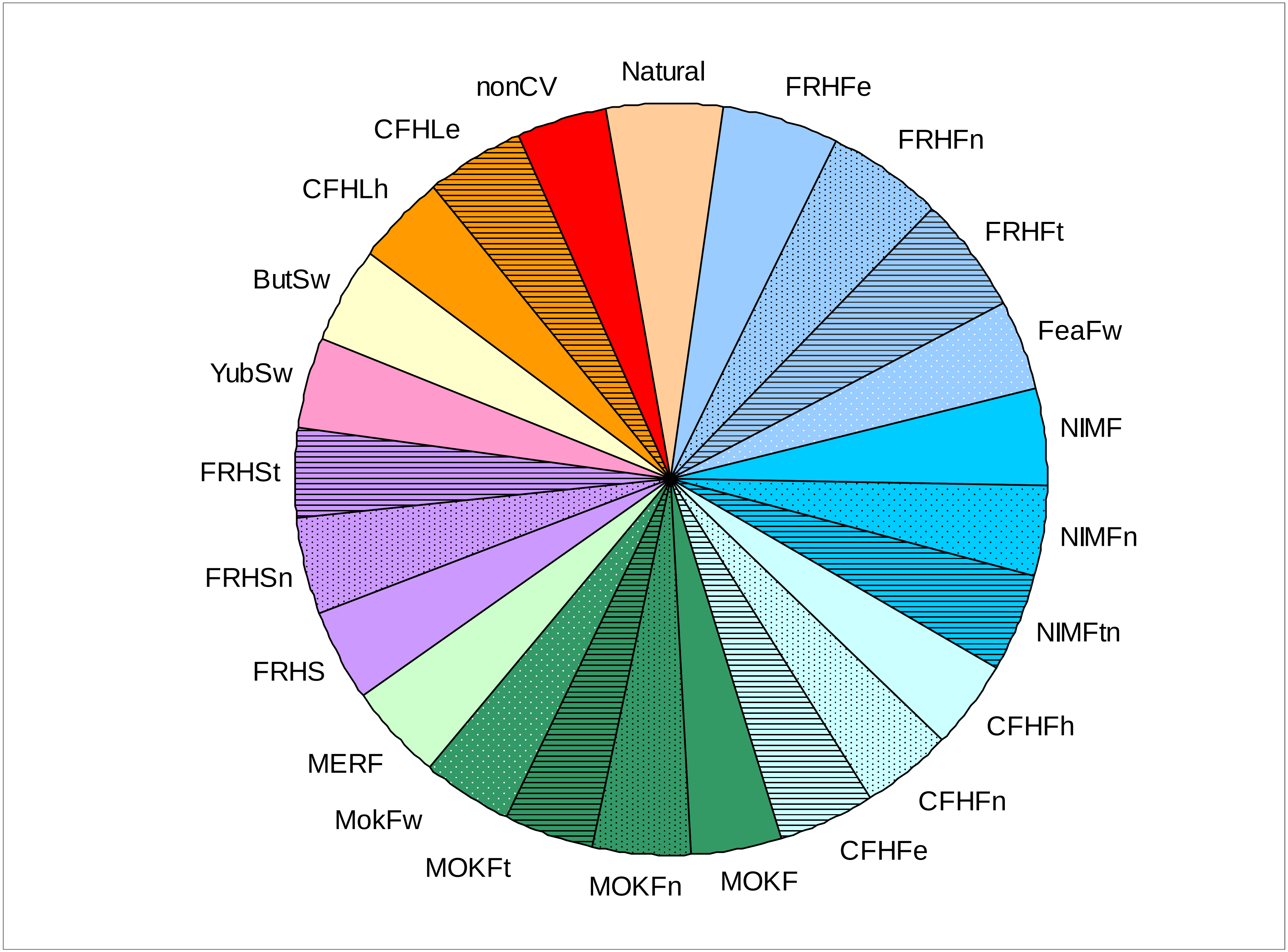


Figure 3. 2010 Central Valley hatchery release types color scheme.

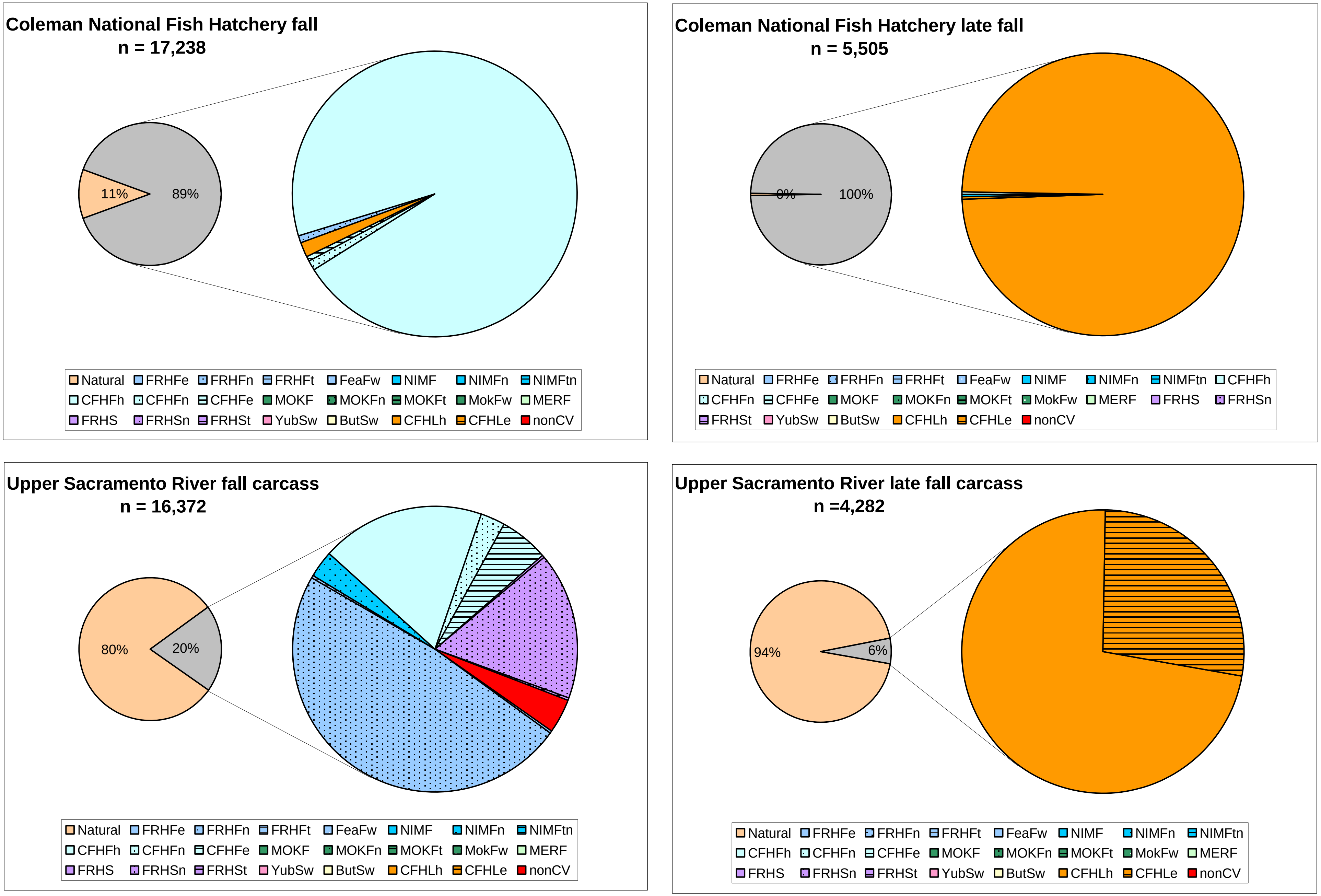
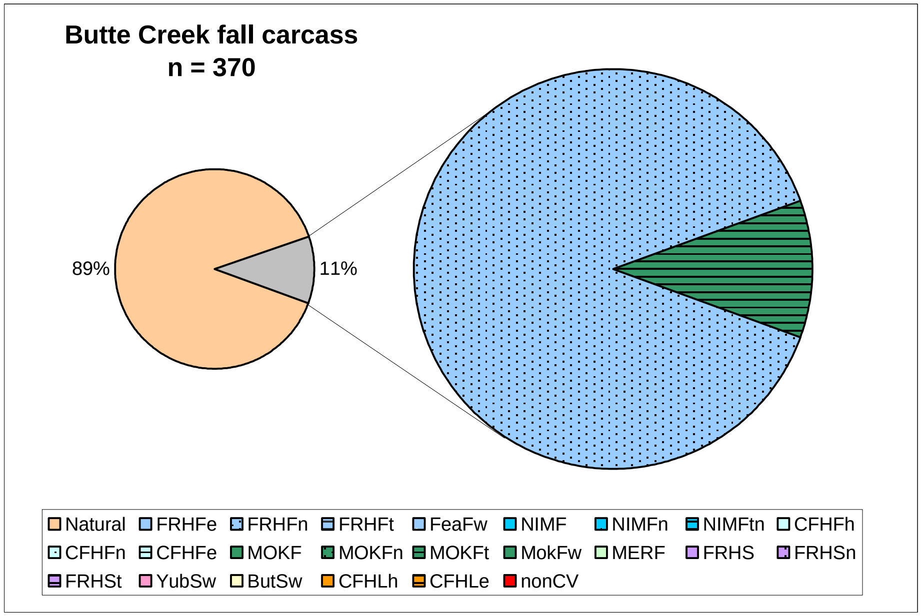
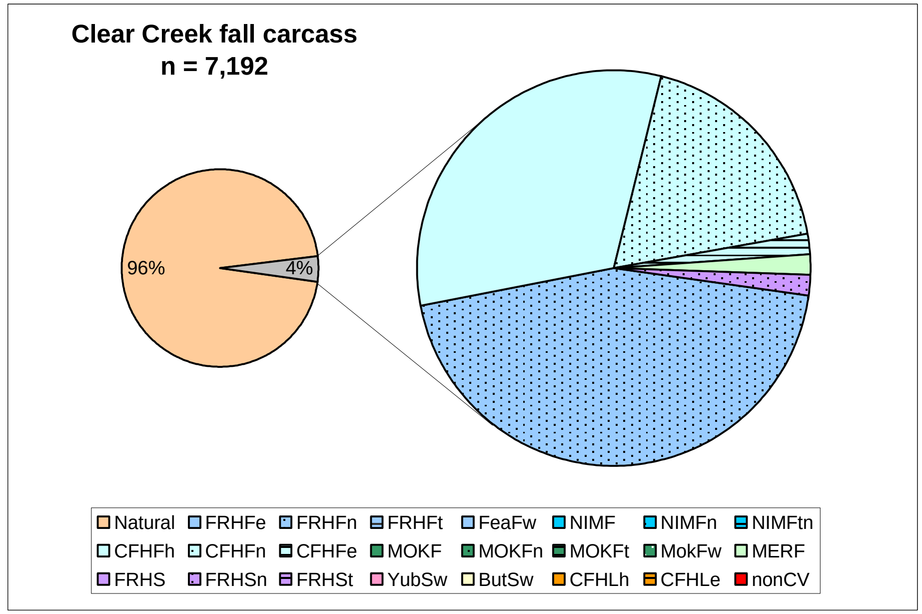


Figure 4. Proportion of hatchery and natural-origin fish in the Upper Sacramento River Basin.





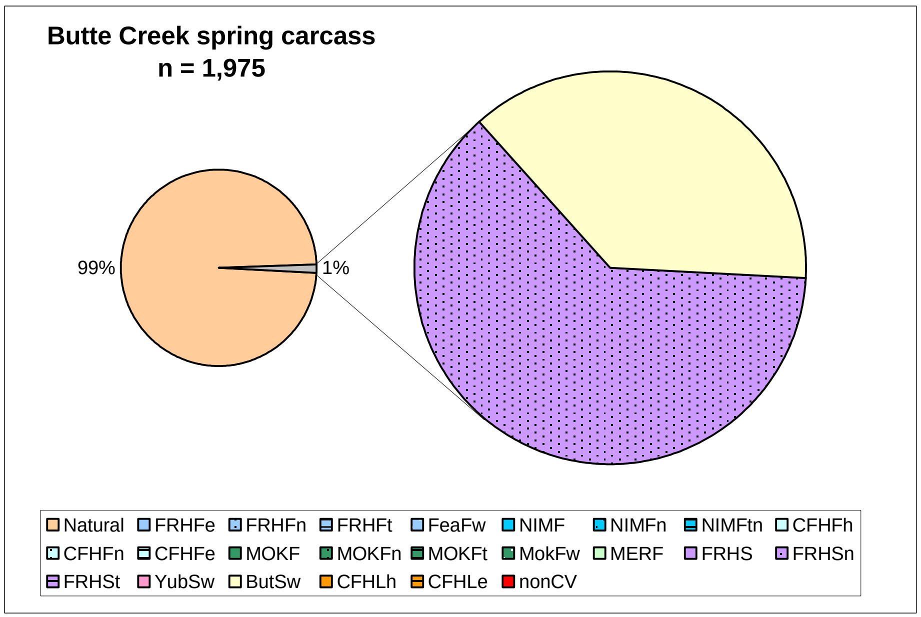


Figure 5. Proportion of hatchery and natural-origin fish in the Upper Sacramento River Basin.

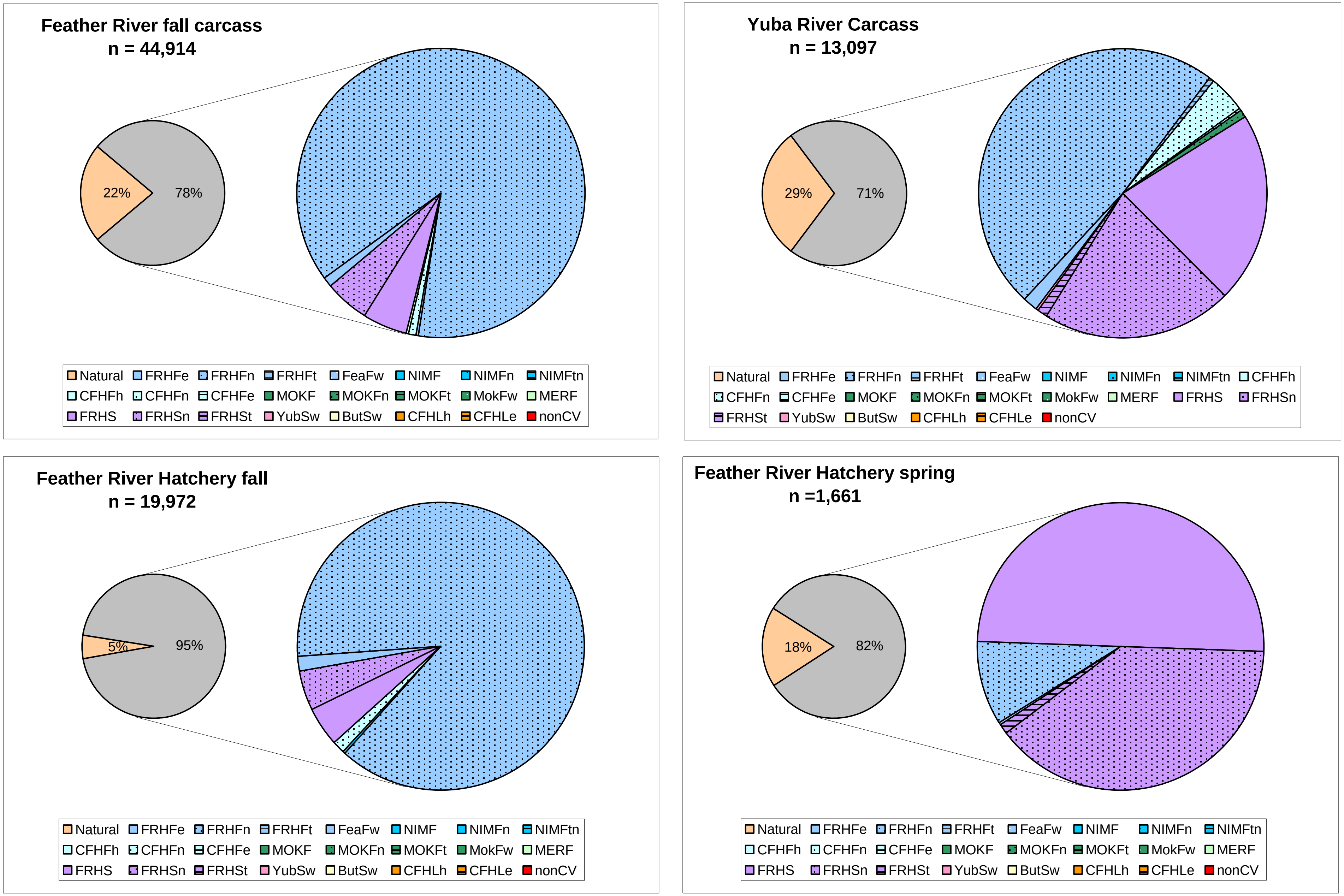


Figure 6. Proportion of hatchery and natural-origin fish in the Feather River Basin.

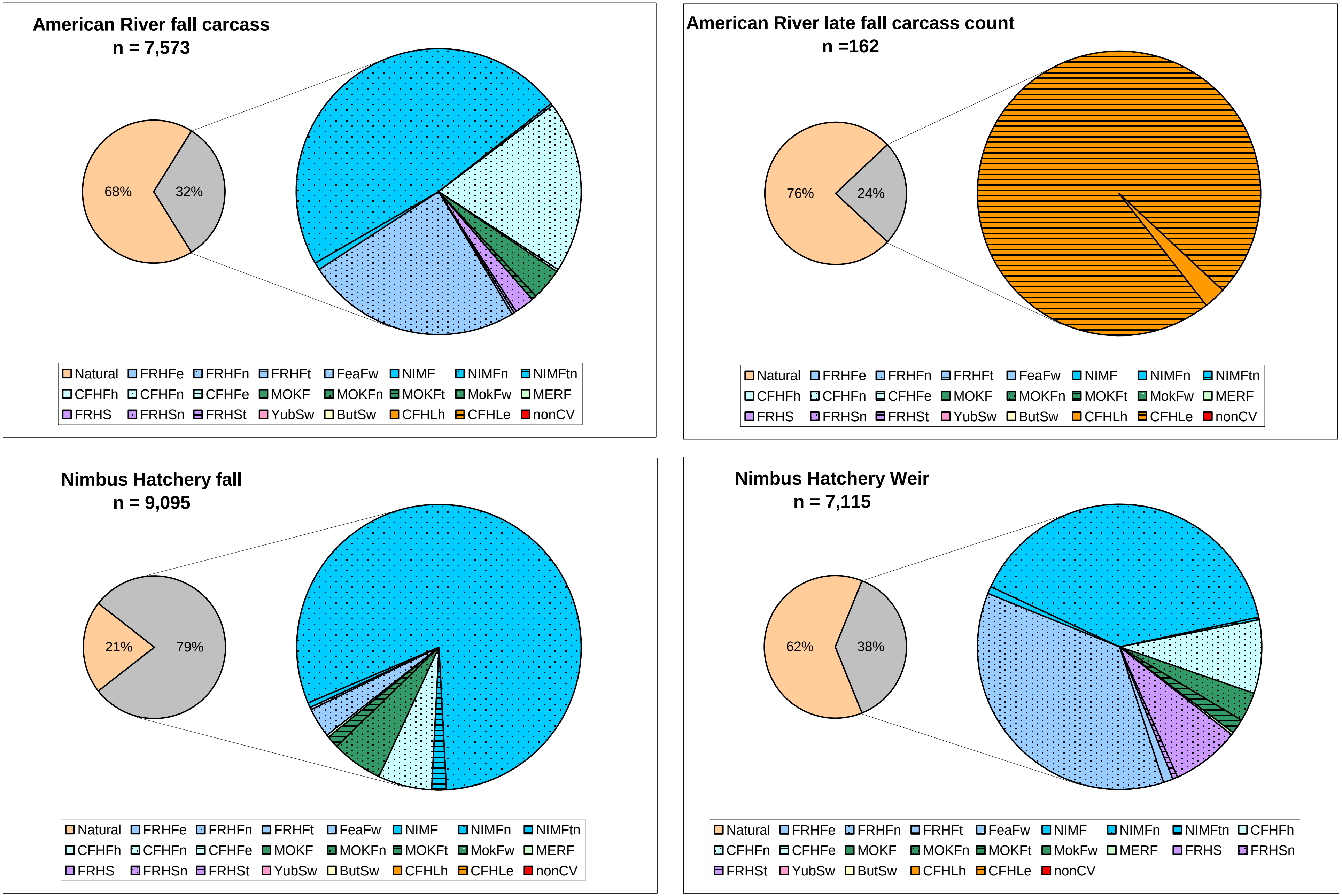


Figure 7. Proportion of hatchery and natural-origin fish in the American River Basin.

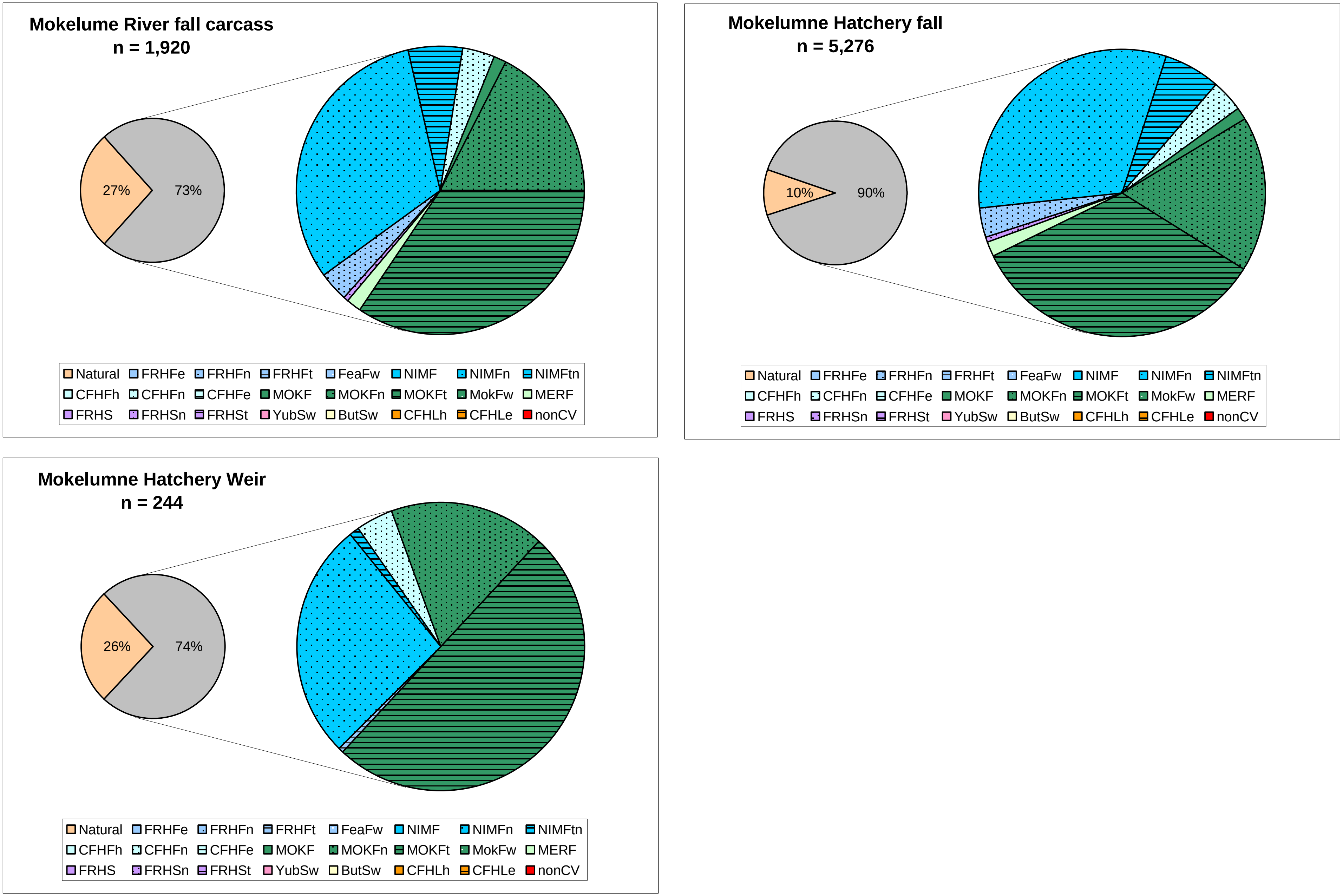


Figure 8. Proportion of hatchery and natural-origin fish in the Mokelumne River Basin.

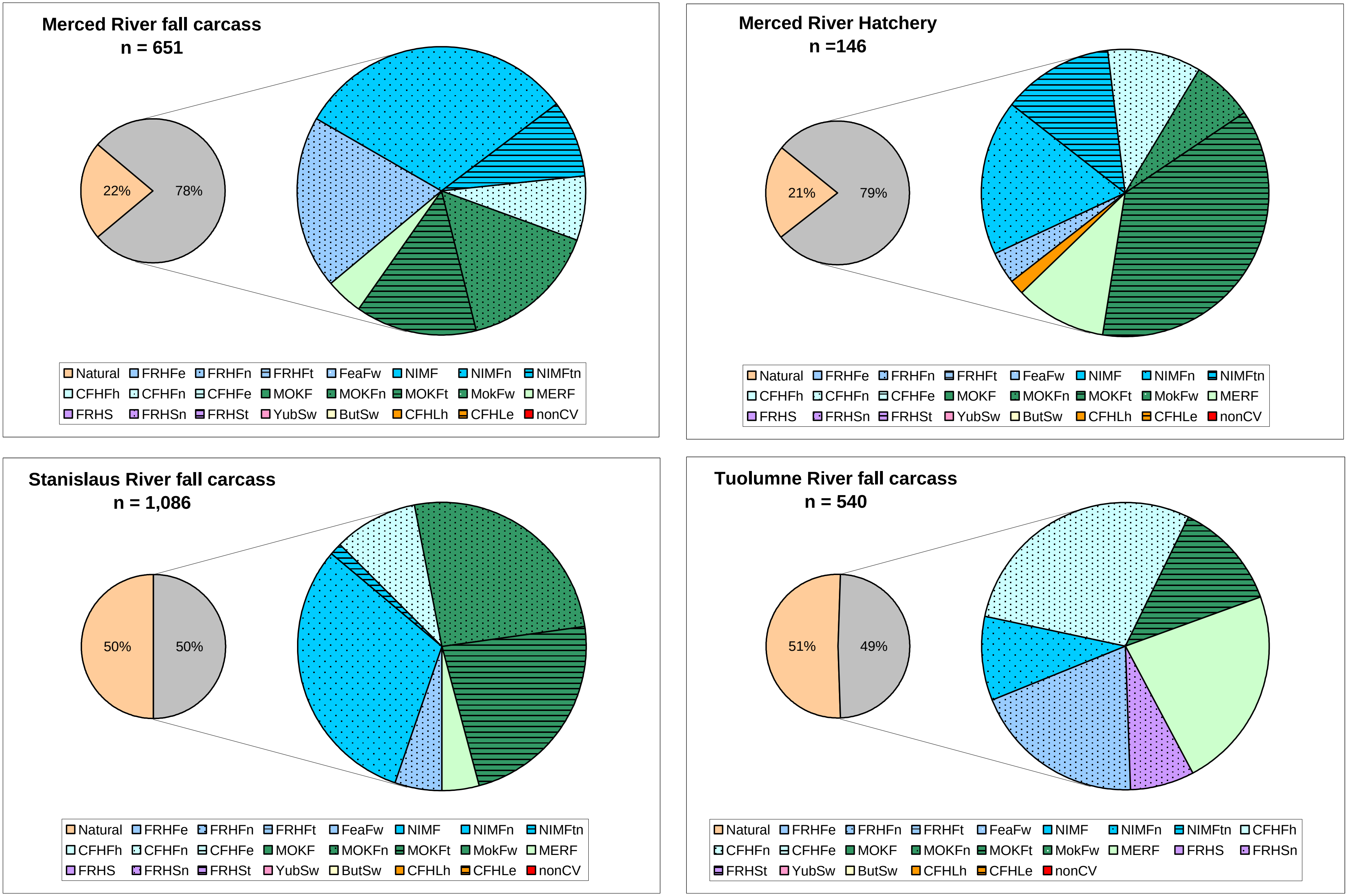


Figure 9. Proportion of hatchery and natural-origin fish in other San Joaquin River tributaries.

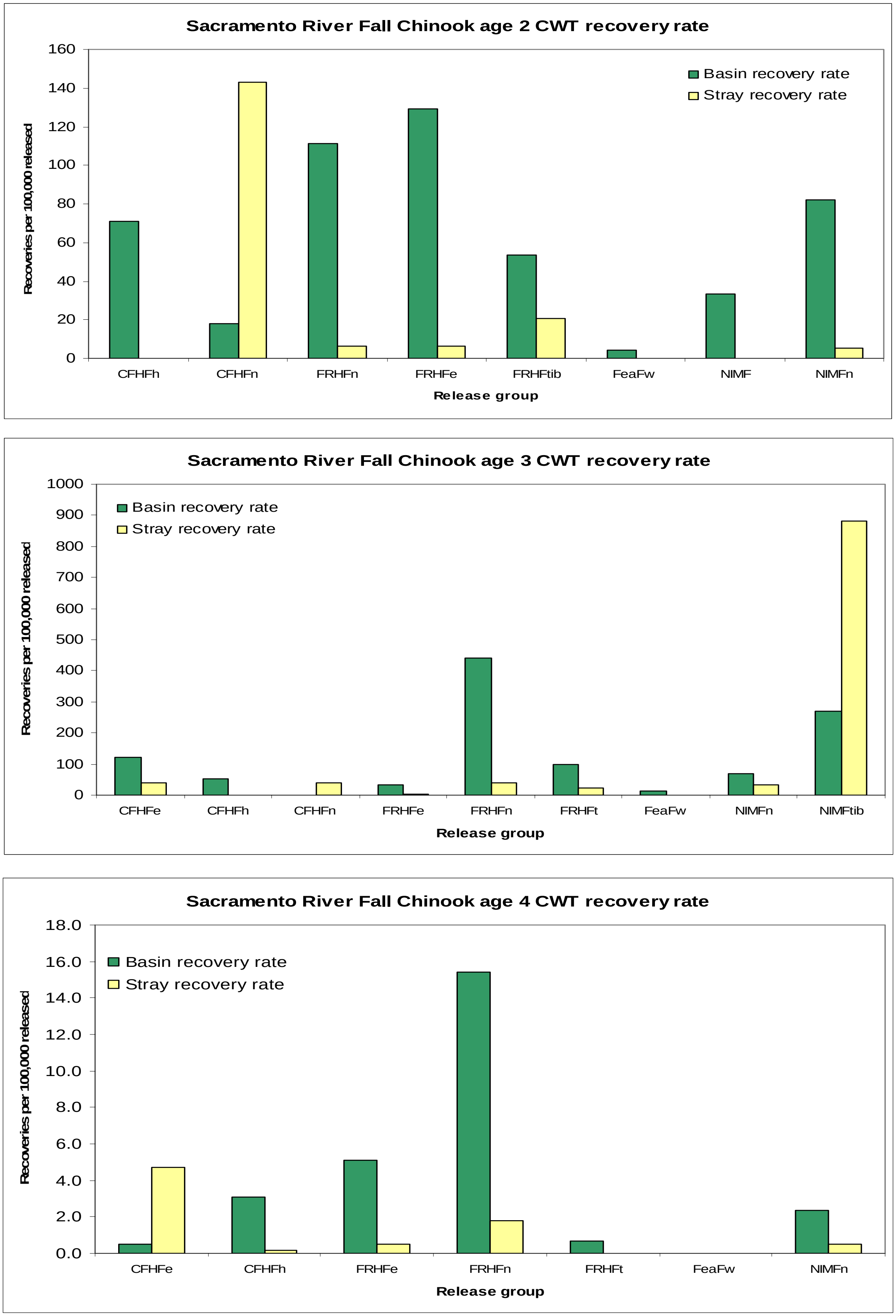
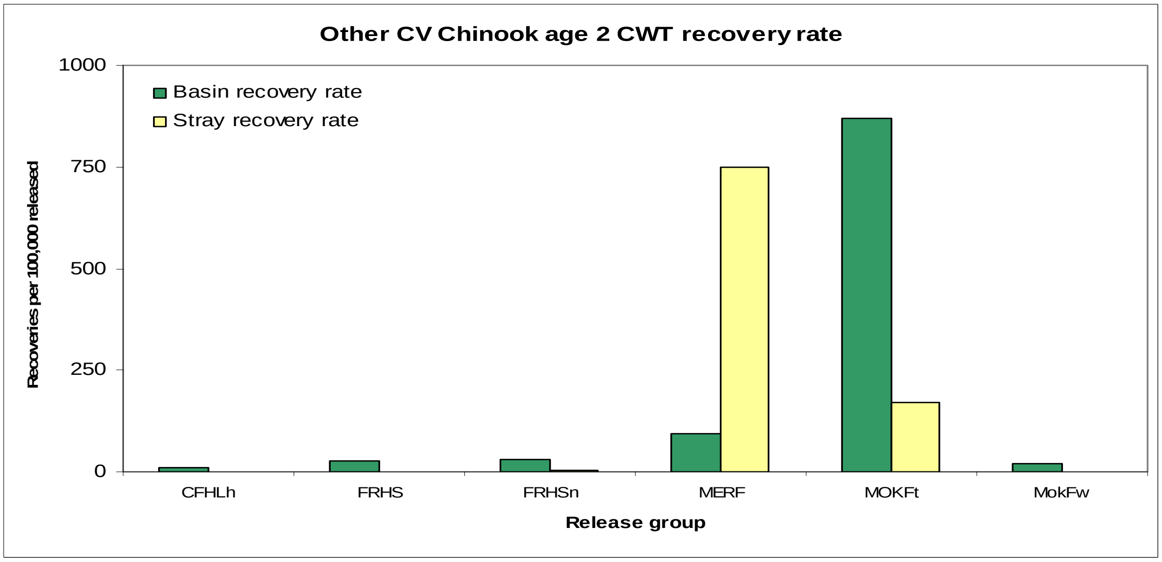
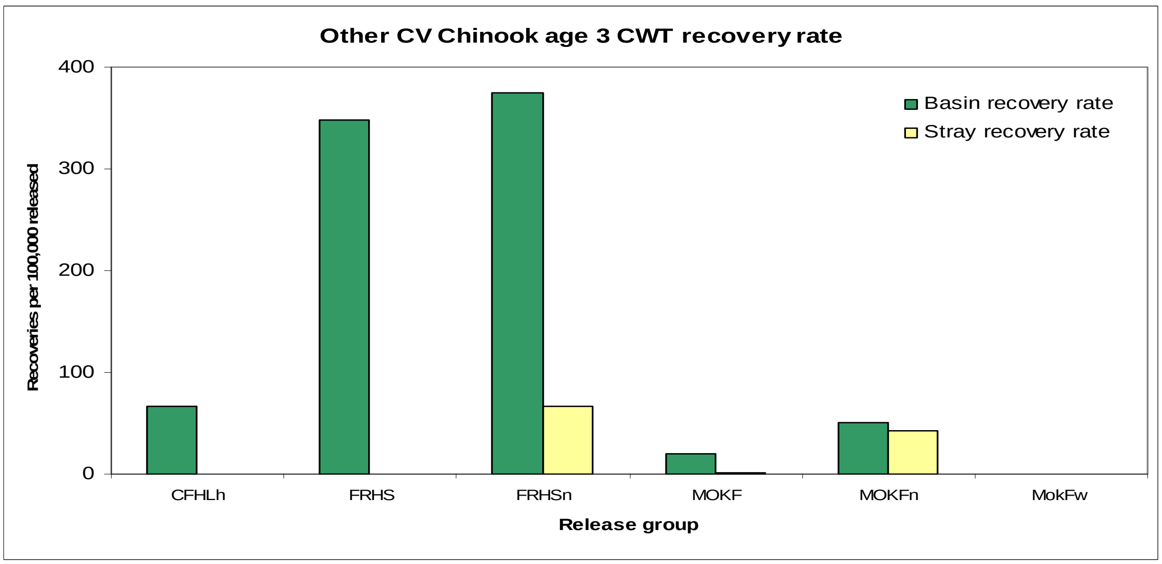


Figure 10. 2010 fall run Chinook recovery and stray rates in the Central Valley.





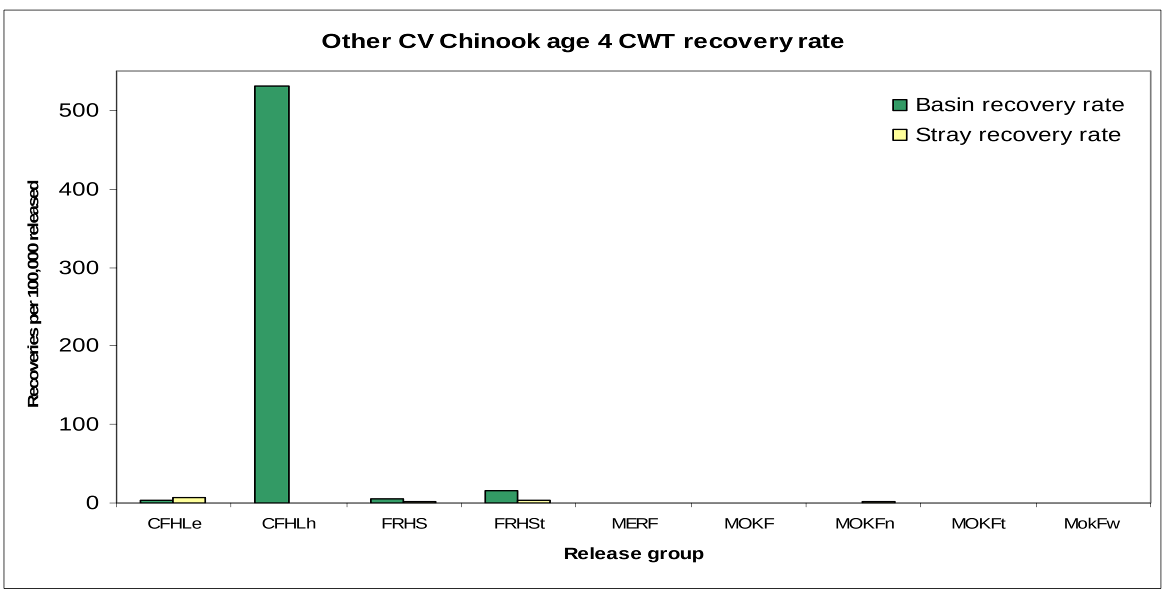
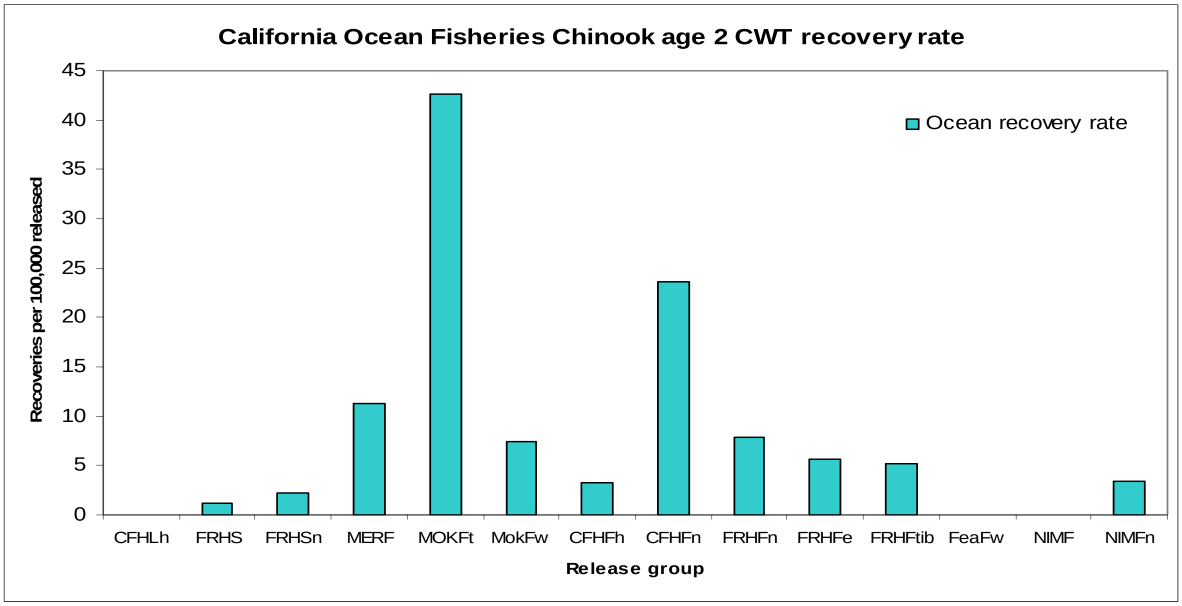
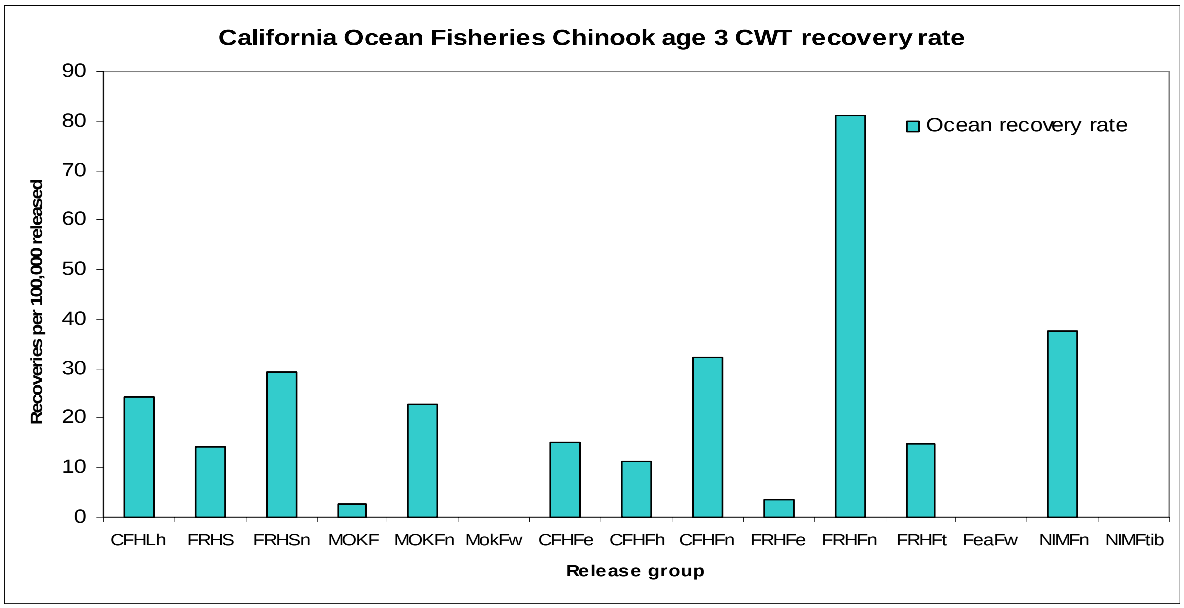


Figure 11. 2010 recovery and stray rates for other CV Chinook





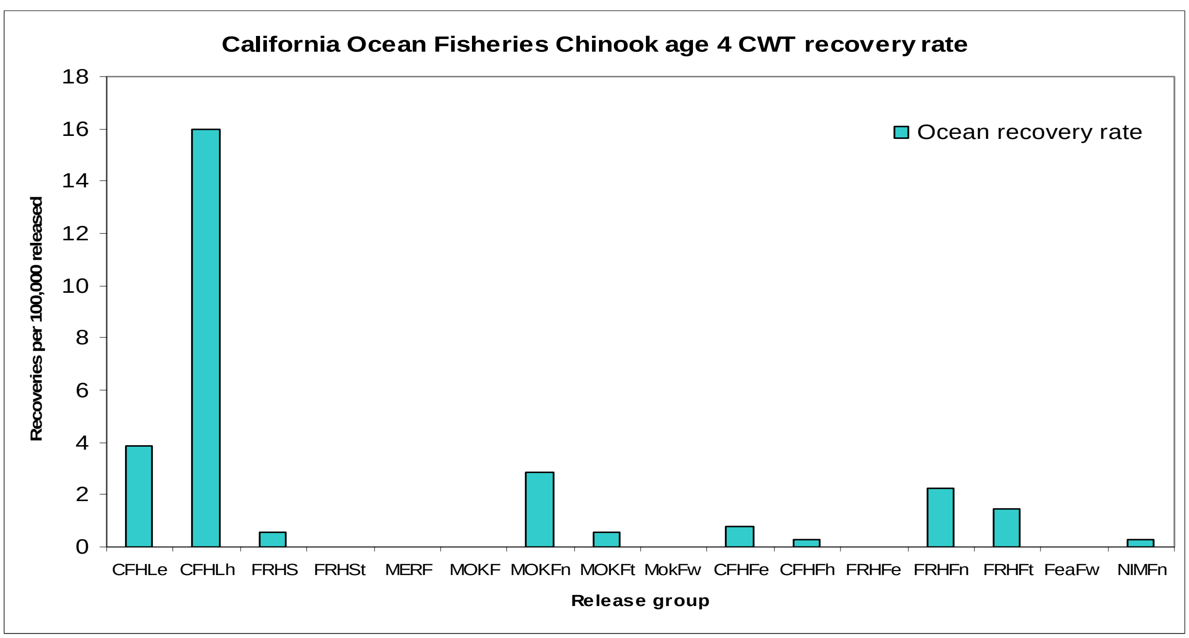


Figure 12. 2010 CV Chinook recovery rates in the ocean fishery.

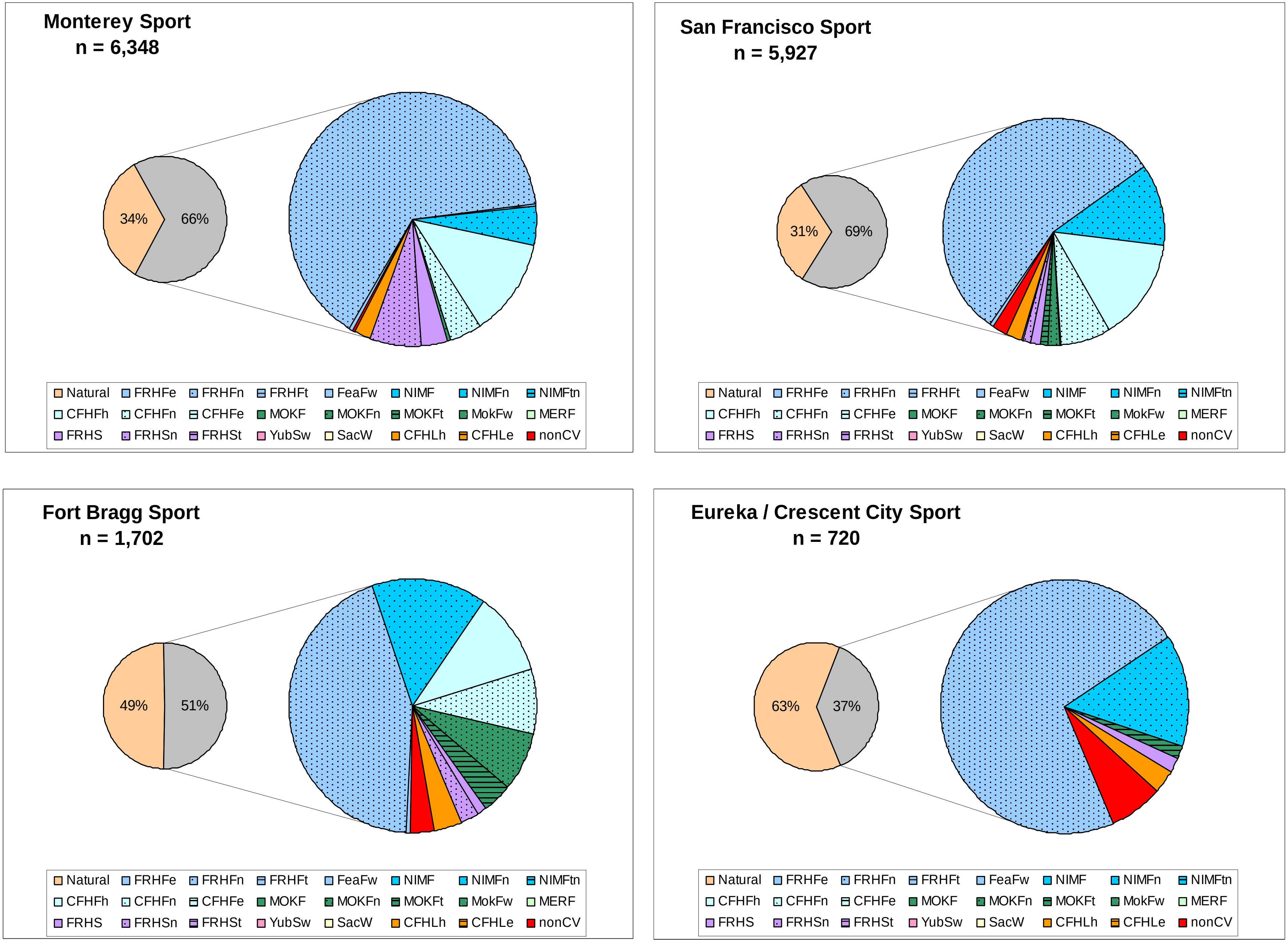


Figure 13. Proportion of hatchery and natural-origin fish in the 2010 ocean sport fishery.

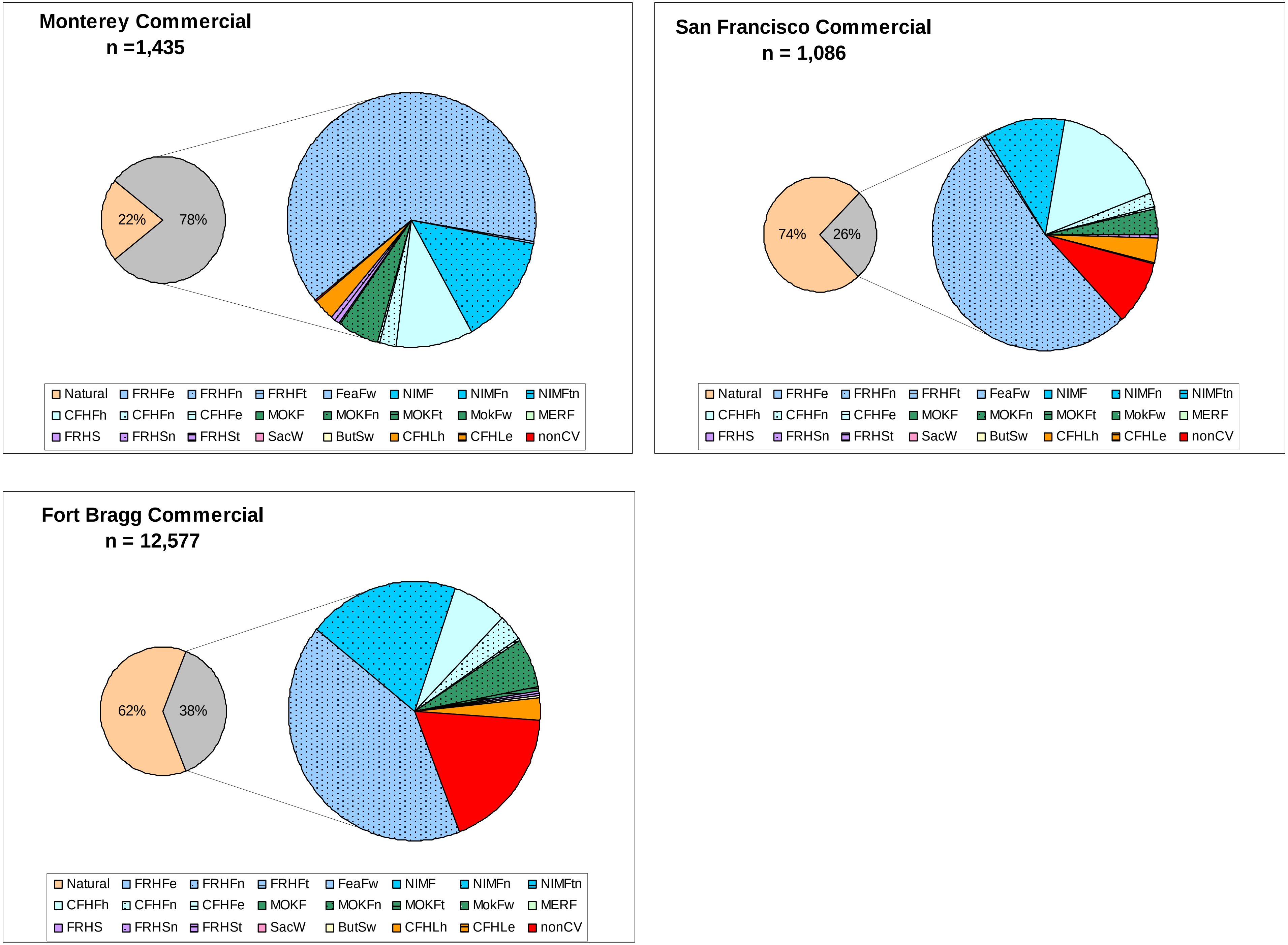


Figure 14. Proportion of hatchery and natural-origin fish in the 2010 ocean commercial fishery.