

California Department of Fish and Wildlife  
2024-2029 Monitoring Plan for Central Valley  
Fall-run Chinook Salmon in Lagunitas Watershed



California Department of Fish and Wildlife

Fisheries Branch  
1010 Riverside Parkway  
West Sacramento, CA 95605

Bay-Delta Region  
3633 Westwind Blvd.  
Santa Rosa, CA 95403

October 9, 2024

*This monitoring plan was prepared in collaboration with Marin Municipal Water District and the National Park Service. Please direct questions to Colby Hause at [colby.hause@wildlife.ca.gov](mailto:colby.hause@wildlife.ca.gov)*

## Background

Adult returns of Central Valley Fall-run Chinook salmon (CV FRCS) have fluctuated over the past 30 years, with consistently low returns in the most recent decade (Azat 2022). Many factors have contributed to population declines, including drought conditions, loss of habitat, poor ocean conditions, low river flows, water diversions, pollution, and hatchery practices. In an effort to improve survival to adulthood by avoiding the hazards associated with migration, the California Department of Fish and Wildlife (CDFW) transports portions of its hatchery-produced CV FRCS downstream and releases them into net pens in the Sacramento-San Joaquin River Delta or San Pablo Bay for acclimation, or directly into San Francisco Bay. It has been found that hatchery fish released into both the Delta and the Bay, as well as coastal releases, have higher survival and recovery rates in ocean fisheries (Palmer-Zwahlen, et al. 2019a, 2019b; Leet, W.S. et al. 1986) compared to in-river release points, especially in drought years. Releases at Fort Baker within the Golden Gate National Recreation Area (GOGA) have been occurring since 2013, and preliminary monitoring results have indicated a higher rate of ocean recovery for fish released at the Fort Baker release site than those released at other release points in the Delta or Bay (Letvin et al. 2021). While ocean recovery and escapement rates are higher, these off-site releases also increase the potential for CV FRCS to stray into non-natal waters (Palmer-Zwahlen, et al. 2019a, 2019b).

Lagunitas Creek is unique in that it experiences sustained flow year-round, whereas connection to the ocean is typically cut off during the dry summer months by the formation of bars at the river mouths in unregulated coastal streams. This is a result of releases from Kent Lake, which are managed by Marin Municipal Water District (MMWD). Year-round access to the creek mouth creates the opportunity for straying of adult CV FRCS to occur within Lagunitas Creek. The Central California Coast (CCC) coho salmon (*Oncorhynchus kisutch*) evolutionarily significant unit (ESU) and CCC steelhead (*Oncorhynchus mykiss*) distinct population segment (DPS) are listed as either threatened or endangered under Federal (ESA) or State Endangered Species Acts (CESA) and use the Lagunitas Creek watershed during sensitive portions of their life history. While outside of the range of the species, the California Coastal (CC) Chinook salmon (*Oncorhynchus tshawytscha*) ESU has been observed in the Lagunitas Creek watershed and is listed as threatened under the ESA.

The following proposed monitoring plan outlines field sampling/coordination and data sharing protocols necessary to assess potential impacts of Fort Baker Chinook salmon releases on salmonids in the Lagunitas Creek watershed, specifically Lagunitas Creek. CDFW monitoring will focus on Lagunitas Creek

because other streams in the area, including Redwood and Pine Gulch Creeks, are likely not as accessible in most years due to bar formation and the timing of migrating adult CV FRCS. However, early storms during the 2021-2022 adult migration season provided Chinook salmon access to Redwood and Olema Creeks. In Redwood Creek, Chinook salmon were observed to successfully spawn and juveniles were noted (M. Reichmuth, Lagunitas TAC March 3rd, 2022). Five Chinook salmon carcasses were retrieved and indicated that they were released from Fort Baker in 2019 (M. Reichmuth, Lagunitas TAC March 3rd, 2022). Therefore, opportunistic sampling of Chinook salmon in these areas may be warranted, especially in years where high flows are sustained throughout the fall. However, it is unlikely that CV FRCS releases would have significant impact on these streams due to general lack of access and mismatch in adult migration timing compared to coho salmon or steelhead.

### **CDFW Lagunitas Creek Watershed Monitoring Objectives**

- Enumerate CV FRCS carcasses and Chinook salmon redds
  - When possible, estimate escapement of CV FRCS
- Conduct genetic and CWT analysis on recovered adult Chinook salmon at CDFW's Genetic Research Laboratory to determine source population.
- Enumerate out-migrating Chinook salmon smolts from rotary screw trap (RST) sampling
  - When possible, determine source population of Chinook smolts via genetic analysis through samples provided to the National Marine Fisheries Service (NMFS)

### **Interagency Monitoring Activities**

Below summarizes monitoring activities conducted by MMWD, CDFW, and the National Park Service (NPS) in pursuit of the monitoring objectives identified above.

*MMWD: Lagunitas Creek*

#### **a. Adult Monitoring**

MMWD conducts surveys for 5 species of salmonids that currently spawn in mainstem Lagunitas creek and some of its tributaries, including Pink salmon, Chum salmon, Chinook salmon, coho salmon, and steelhead trout. Lagunitas Creek and its tributaries are split into reaches, and all reaches upstream of Tocaloma are surveyed weekly unless dry weather and low stream flows inhibit

salmon migration (Fig. 1). Reaches downstream of Tocaloma are surveyed as weather and time allow.

Spawner surveys occur throughout the length of available spawning habitat in Lagunitas Creek, which has been identified as spanning from below Nicasio to Upper San Geronimo (Fig. 1). Typically, surveys begin early November and run through mid-March (depending on flow conditions). The data collected are summarized as follows:

- **Redd identification:** count, reach, and (if possible) associated species and redd information (such as dimensions and notes on appearance).
- **Live salmonids:** count and species (if possible)
- **Salmonid carcasses:** count and species, as well as the following for each carcass:
  - **Operculum sample** (or caudal sample if operculum is missing)
  - **Otoliths**
  - **Spawned** (y/n)
  - **Fork length**
  - **Sex**
  - **Adipose fin** (y/n)
  - **Head taken if adipose absent**
  - **Reach**
  - **Pit tag** (Y/N, and ID)
  - **Geospatial information**

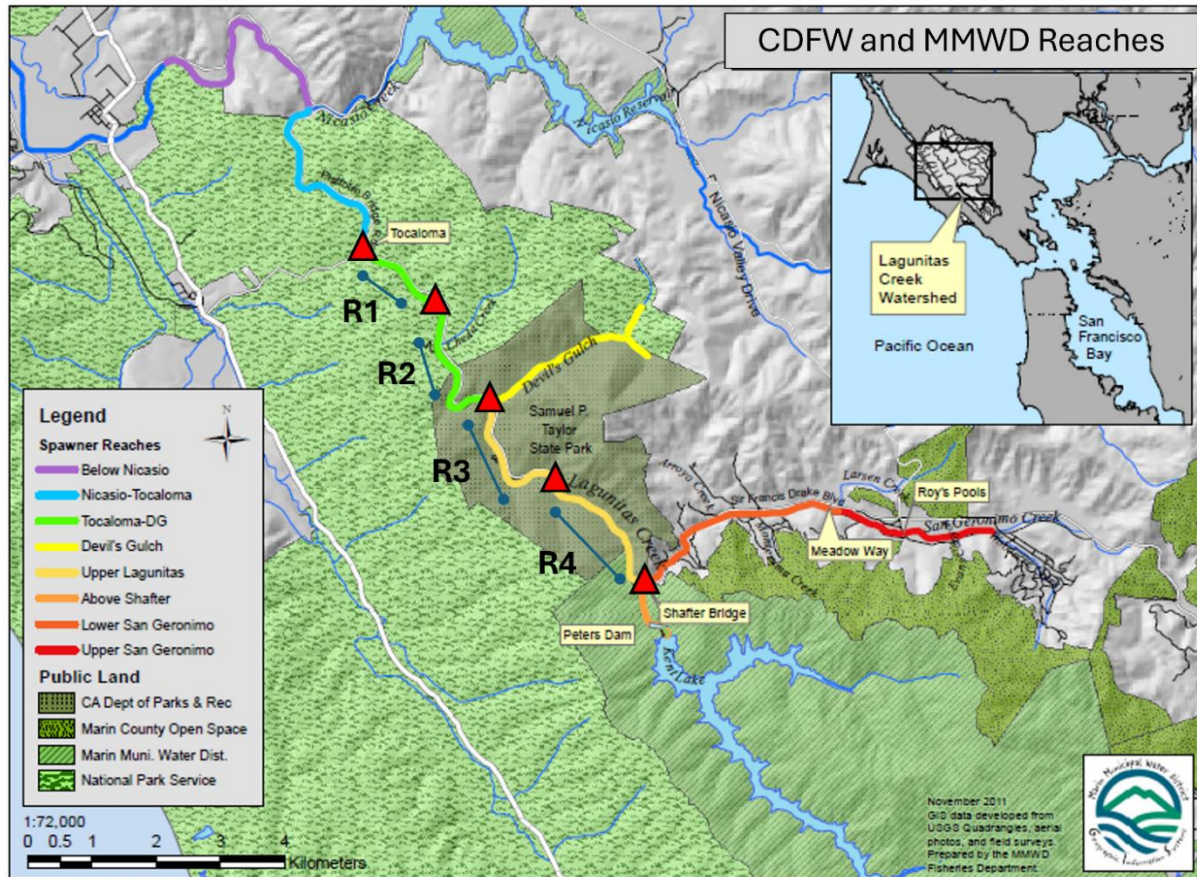


Figure 1. Map of spawner reaches surveyed annually by MMWD (see map legend), overlaid with spawner reaches surveyed by CDFW (start and end points identified by red triangles, reaches denoted as R1-R4). Map provided by MMWD.

## b. Smolt Out-migration Monitoring

MMWD operates an RST for monitoring out-migrating salmonids in Lower Lagunitas Creek, located upstream of Point Reyes Station (approximately two miles above the Highway 1 Bridge crossing in Point Reyes Station). Monitoring spans March- late May/early June, and data collected include:

- **Species**
- **Fork length**
- **Genetic sample**
- **Pit tag** (for coho)

## CDFW: Lagunitas Creek

CDFW monitors 4 individual reaches of Lagunitas Creek, generally surveying 2 reaches at a time (Fig.1). These reaches include:

- R1: Tocaloma Bridge to SPAWN: From just upstream of Tocaloma Bridge (Coordinates: 38.049729, -122.759273) to just upstream of SPAWN headquarters (38.043081, -122.746183)
- R2: SPAWN to Devils Gulch: From just upstream of SPAWN headquarters (38.043081, -122.746183) to just downstream of the Devils Gulch confluence (38.029417, -122.736885)
- R3: Devils Gulch to Samuel P Taylor Campground: From just downstream of the Devils Gulch confluence (38.029417, -122.736885) to the entrance to the Samuel P Taylor state park campground (38.019488, -122.729164)
- R4: Samuel P Taylor Campground to Shafter Bridge: From the entrance to Samuel P Taylor state park campground (38.019488, -122.729164) to the Leo T. Cronin fish viewing area (38.004314, -122.708719)

### a. Adult Monitoring

CDFW conducts spawner surveys starting the first week of November and continues weekly until zero Chinook salmon have been observed for two consecutive weeks (typically around February). At the start of the spawning survey (early November), surveys occur twice a week and cover all four reaches (R1-R4; Fig. 1). Surveys then shift to two-four times a week, covering all four reaches, from mid-November until the end of the Chinook run.

Surveys occur on days that are deemed safe for wading, with a cutoff flow of 50 cubic feet per second (cfs). To maximize survey frequency and potential sample recovery, this maximum flow threshold has been increased to 70 cfs if conditions are feasible (i.e., turbidity). On days with high flow, crews may conduct surveys by hiking alongside the bank as a primary means of navigating the creek as opposed to wading. The data collected are summarized as follows:

- **Live salmonids:** count, adipose present (Y/N), and species (if possible)
- **Salmonid carcasses:** count and species, as well as the following for each carcass:
  - **Carcass condition**
  - **Adipose fin** (y/n)
  - **CWT tag** (Y/N)

- If yes, head and tissue sample collected
- **Fork length**
- **Sex**
- **Reach/ geospatial information**
- **Pit tag** (Y/N, and ID)

### *NPS: Lagunitas, Redwood and Olema Creeks*

The Lagunitas Creek Monitoring Project monitors coho salmon and steelhead trout in the Lagunitas Creek watershed using spawning ground surveys, a life cycle monitoring station on Olema Creek, summer juvenile coho salmon surveys, and a DIDSON sonar camera. The NPS, along with the Point Reyes National Seashore Association, perform this monitoring in the watershed. These methods are employed throughout mainstem Lagunitas Creek and major tributaries San Geronimo Creek, Olema Creek, and Devil's Gulch. This project contributes to one of the longest time series of spawning data for coho salmon on one of the most resilient populations of CCC coho salmon towards the southern extent of the specie's range (CMP 2024).

#### **a. Adult Monitoring**

##### *Redwood and Olema Creeks*

NPS conducts weekly spawning ground surveys starting in late November to monitor adult coho salmon in Redwood and Olema Creeks. Under certain environmental conditions (i.e., higher flows in the fall), adult Chinook salmon have been observed in Olema and Redwood Creeks (Fig. 2). While NPS focuses on coho salmon in these creeks, data is collected on all salmonids observed, including Chinook. The data collected are summarized as follows:

- **Redd identification:** count, reach, and (if possible) associated species and redd information (such as dimensions and notes on appearance).
- **Live salmonids:** count and species (if possible)
- **Salmonid carcasses:** count and species, as well as the following for each carcass:
  - **Operculum sample** (or caudal sample if operculum is missing)
  - **Otoliths**
  - **Spawned** (y/n)
  - **Fork length**

- **Sex**
- **Adipose fin** (y/n)
- **Head taken if adipose absent**
- **Reach**
- **Pit tag** (Y/N, and ID)
- **Geospatial information**

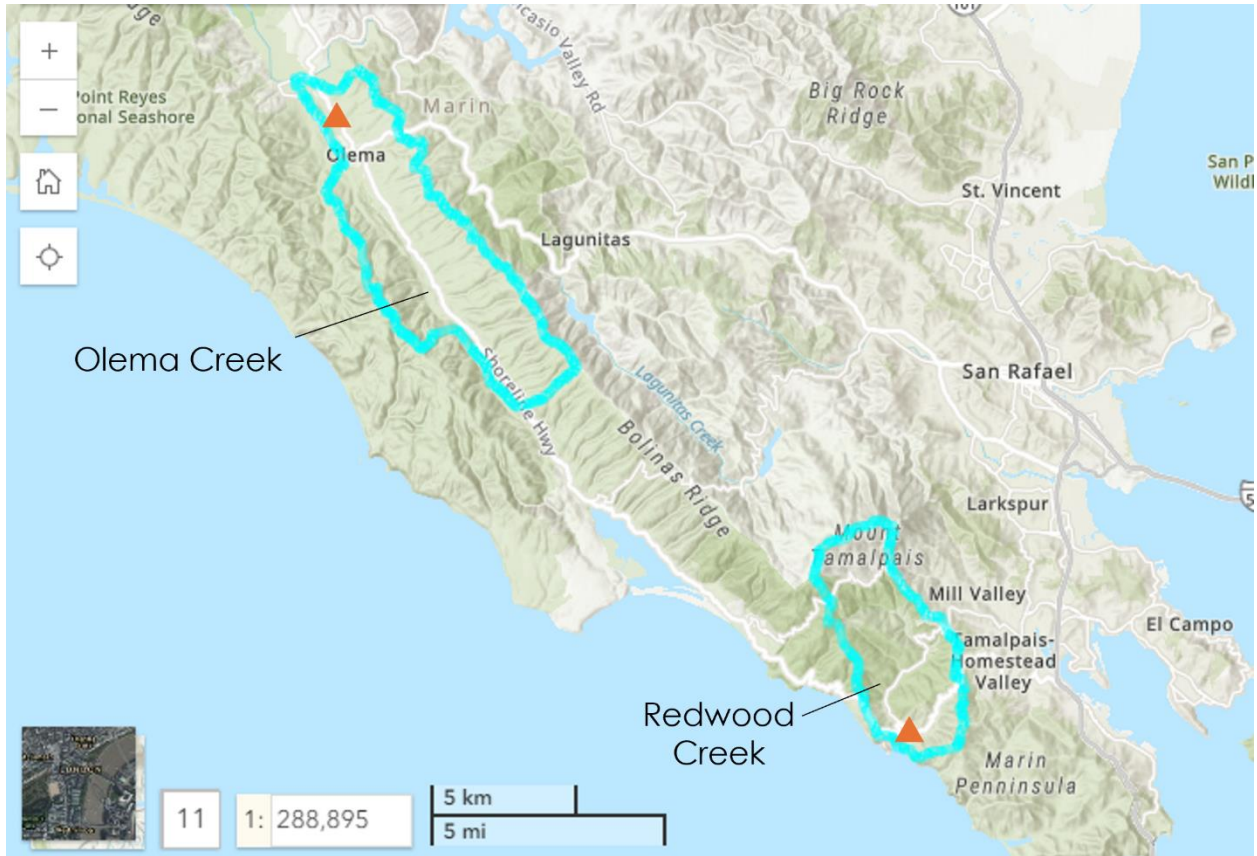


Figure 2. Map of Olema and Redwood Creeks. Triangles identify the approximate location of fyke nets for smolt out-migration trapping on each creek. Data layer and map sourced from BIOS at <https://wildlife.ca.gov/Data/BIOS>.

### *Lagunitas Creek*

In most years, the NPS operates a DIDSON camera on Lagunitas Creek that spans part of the Chinook salmon migration window. The DIDSON is stationed near the MMWD RST (approximately two miles above the Highway 1 Bridge crossing in Point Reyes Station) and is used to estimate escapement of coho and steelhead in Lagunitas Creek. Quantifying Chinook salmon using sonar



imagery provided by NPS may be used in conjunction with adult spawner surveys to improve estimates Chinook salmon escapement in Lagunitas Creek. However, analysis of sonar data will be dependent on CDFW staff time and resources.

## **b. Smolt Monitoring**

NPS operates a fyke net for monitoring out-migrating juvenile salmonids on Olema (38.06101, -122.8067) and Redwood Creeks (37.86097, - 122.57454) (Fig. 2). Conditional on flows (< 50-100 cfs), monitoring begins in March and continues through May. The data collected are summarized as follows,

- **Location**
- **Species**
- **Fork Length**
- **Genetic sample** (for coho in Redwood Creek)
- **Pit tag** (for coho)

## **Proposed Monitoring Plan for 2024- 2029**

The primary goal of the Department, and key interest of the NPS, is to quantify straying of CV FRCS released at Fort Baker into Lagunitas Creek. The primary goal of MMWD and NPS surveys are to estimate adult and juvenile abundances of ESA and CESA-listed salmonids in the Lagunitas Creek watershed. As a result, MWWD and NPS surveys are spatially broad yet temporally scaled to the timing of upstream spawning migrations for CCC coho salmon and CCC steelhead, which typically don't begin until late November- December. CDFW surveys collecting data on Chinook are both temporally and spatially constrained due to staff and resource limitations. Spawning habitat in mainstem Lagunitas Creek extends from below the confluence of Nicassio (purple section, Fig. 1) to above Shafter Bridge (orange section, Fig. 1). CV FRCS can migrate up tributaries to spawn as early as August, yet CDFW surveys begin in November and only cover a portion of the spawning habitat in Lagunitas Creek (R1-R4, Fig. 1). Furthermore, CDFW lacks the staff and resources necessary to expand Chinook salmon monitoring efforts to other creeks in the watershed that might experience adult Chinook salmon spawning in high water years (such as Olema and Redwood Creeks).

In the 2023-2024 spawning survey season, CDFW and MMWD crews communicated regularly to share information on environmental conditions and coordinate sampling schedules in order to avoid surveying the same reach on

the same day. Because data collection is not standardized across each agency, this coordination has not been efficiently leveraged to gather data on CV FRCS in mainstem Lagunitas Creek throughout the full extent of spawning habitat and during the entire duration of the spawning migration. While data summaries of Chinook salmon spawning on Redwood and Olema Creeks can be extracted from the California Monitoring Plan (CMP) database, CDFW lacks genetic samples from Chinook salmon encountered in these tributaries for both adult and juvenile life stages. Therefore, CDFW proposes the following monitoring plan to address these information gaps in a way that maximizes data collection and sharing amongst agencies while minimizing overlapping effort throughout the watershed.

### *Timeline of Tasks*

#### **a. Early August: Pre-season coordination meeting**

Annually from 2024-2029, CDFW will organize a pre-season monitoring coordination meeting with NPS and MMWD staff in early August, prior to the start of CDFW field surveys. At this meeting, CDFW will communicate the (1) the dates and frequency of planned surveys and (2) any changes to data collection.

#### **b. September – Early November: CDFW Spawner Surveys in Lagunitas Creek**

CDFW will plan to survey the full extent of the spawning reaches (Below Nicassio to Above Shafter, Fig. 1) starting the first week of September through early November, or ending once MWDD surveys begin. CDFW staff will record all data collected in MMWD surveys for all MMWD survey reaches (Lagunitas Creek only), in addition to data currently included in monitoring CDFW protocols. Therefore, additional data collection will include:

- *Redd identification*: count, reach, and (if possible) associated species and redd information (such as dimensions and notes on appearance).
- From each carcass:
  - *Operculum sample* (or caudal sample if operculum is missing)
  - *Otoliths*
  - *Spawned* (y/n)

Additional survey reaches will include (see Fig. 1):

- *Below Nicassio*
- *Nicassio-Tocaloma*
- *Above Shafter*

**c. Early November – March: MMWD Spawner Surveys in Lagunitas Creek**

MMWD will continue spawner surveys following their established protocols starting early November through March.

**d. Late November – March: NPS Spawner Surveys in Redwood and Olema Creeks**

NPS will conduct spawner surveys for all salmonids, including Chinook salmon, in Redwood and Olema Creeks following their established protocols starting in late November through March.

**e. Mid-March – May: MMWD Smolt Out-migration Monitoring in Lagunitas Creek and NPS Smolt Out-migration Monitoring in Redwood and Olema Creeks**

MMWD and NPS will continue monitoring for out-migrating salmonids, including Chinook salmon, following their established protocols starting mid-March through May.

*Sample Processing and Data Sharing Coordination*

**a. Adult Monitoring**

CDFW and MMWD will be responsible for coordinating the timely transfer of Lagunitas Creek Monitoring data sheets (hard copy and/or electronic) between groups such that each group possesses field data for the entire survey period (September- March). CDFW will be responsible for coordinating sample/data transfers with NPS for adult monitoring data collected on Redwood and Olema Creeks, as well as sonar imagery files collected on Lagunitas Creek (if available).

- Biological sample analysis/timeline:
  - All adipose-clipped Chinook salmon heads collected by MMWD and NPS will be submitted to CDFW for CWT analysis no later than 4 weeks after the final day of sampling (roughly early April).
  - Tissue samples (operculum or fin):
    - *Adipose-clipped Chinook salmon*: no tissue sample needed, heads are submitted to CDFW
    - *Adipose-intact Chinook salmon*: two tissue samples will be required: one submitted to the CDFW Genetics Laboratory, one submitted to NMFS (if required by permit)

- *All other salmonid species:* tissue samples collected by CDFW from all other salmonid species in mainstem Lagunitas Creek will be provided to MMWD for genetic analysis by NMFS.
- *Timeline:* Tissue samples will be submitted to the appropriate agency (according to the designations above) no later than 4 weeks after the final day of sampling.
- o Otolith samples:
  - CDFW will collect otoliths from all coho salmon carcasses encountered in mainstem Lagunitas Creek.
  - *Timeline:* Samples collected by CDFW will be submitted to MMWD no later than 4 weeks after the final day of sampling (roughly mid-December).
- Data sharing timeline:
  - o CDFW will provide MMWD copies of Lagunitas Creek spawner survey datasheets and all electronic data no later than 4 weeks after the final day of CDFW sampling (roughly mid-December).
  - o MMWD and NPS will provide CDFW with spawner survey data in electronic format no later than mid-June.

#### **b. Smolt Out-migration Monitoring**

MMWD and NPS will continue to monitor out-migrating smolts at their established sampling locations from March – May. CDFW will be responsible for coordinating genetic sample/metadata transfers with the appropriate agency, as outlined below.

- Biological sample analysis/timeline:
  - o Lagunitas Creek: MMWD will send all genetic samples to NMFS by July of each survey year. CDFW will coordinate with NMFS on data analysis and reporting for Chinook salmon smolt samples from Lagunitas Creek.
  - o Redwood and Olema Creeks: Following established protocols, NPS will collect a tissue sample from each juvenile Chinook salmon encountered in the fyke nets. Metadata for each sample will include, but is not limited to:
    - Date, location, fork length, genetic sample (yes/no; sample ID if 'yes'), environmental data (if collected)

- *Timeline:* CDFW will coordinate the pick-up of genetic samples collected by NPS no later than 4 weeks after the final date of sampling (roughly early July).
- Data sharing timeline:
  - No later than 8 weeks after the final day of smolt out-migration trapping (roughly August), MMWD and NPS will provide CDFW with the following data:
    - Total number of Chinook salmon counted in the gear (RST or fyke net, depending on creek), by month, including all associated metadata

### *Deliverables*

To assess habitat use of Fort Baker-released FRCS in Lagunitas Creek and potential impacts to salmonids, CDFW will provide NPS and NMFS with an annual report no later than June of the following survey year. The report will include, but is not limited to:

- Size and release dates of Chinook release groups (in the form of a running totals table since first Fort Baker releases in 2013)
- Summary of environmental conditions and monitoring activities
- Results from the following surveys on Lagunitas, Redwood, and Olema Creeks:
  - Adult monitoring:
    - Estimate of Chinook salmon redds
    - Total number of Chinook salmon carcasses recovered
      - Total number of adipose-clipped Chinook salmon carcasses
      - Origin of CWTs recovered in Lagunitas creek
      - Stock identification (CC or CCV) of unmarked Chinook salmon (resulting from genetic sequencing of tissue sample, if available)
  - Smolt Monitoring:
    - Total number of Chinook salmon observed in trapping gear, by week

- Estimated minimum abundance of Chinook salmon smolts
- Total number of genetic samples taken from Chinook smolts
- Stock identification (CC or CCV) of Chinook smolts sampled (if possible, depending on NMFS and CDFW analysis timeline)

## Literature Cited

Azat, J. 2022. GrandTab 2022.07.20 California Central Valley Chinook Escapement Database Report. California Department of Fish and Wildlife.

California Monitoring Plan (CMP). 2024. "California Monitoring Plan for Salmon and Steelhead". <https://wildlife.ca.gov/Conservation/Fishes/Salmonid-Monitoring/CMP>.

Leet, S. L., Green, R.E., and Ralph, D. 1986. Pen Rearing Pacific Salmon, *Oncorhynchus* spp., in San Francisco Bay. *Marine Fisheries Review*, 48(1), 24-31.

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

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

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