



# Weekly Assessment of CVP and SWP Delta Operations on ESA-listed Species

April 30, 2024

## Executive Summary

### Operational Conditions

See Weekly Fish and Water Operation Outlook document for April 30 – May 6.

### Winter-run Chinook Salmon

Loss of natural winter-run Chinook Salmon (by length at date, LAD) has not occurred in the past week at the State and Federal fish salvage facilities. Loss of genetically confirmed winter-run Chinook Salmon has not occurred at either facility since 3/21/2024. Loss of natural LAD winter-run Chinook Salmon at the Central Valley Project (CVP) and State Water Project (SWP) fish collection facilities is unlikely to occur over the next week. 7-24% of juvenile natural winter-run Chinook Salmon from brood year (BY) 2023 are estimated to be present in the Delta. The 50% single year loss threshold for LAD winter-run Chinook Salmon was exceeded on 2/25/2024. The 75% single year loss threshold for LAD winter-run Chinook Salmon was exceeded on 3/7/2024. The 100% single year loss threshold for LAD winter-run Chinook Salmon was exceeded on 3/20/2024. Loss of natural LAD winter-run Chinook Salmon at the CVP and SWP fish collection facilities is unlikely to occur over the next week due to seasonal timing; however, exceedance of the Incidental Take Limit (ITL) for the season remains a possibility.

### Spring-run Chinook Salmon

Loss of natural YOY LAD spring-run Chinook Salmon has occurred in the past week at the State and Federal fish salvage facilities. 30-50% of juvenile natural YOY spring-run Chinook Salmon was estimated in the Delta. CV spring-run Chinook Salmon fry are rearing and migrating downstream. Loss of natural spring-run Chinook Salmon at the CVP and SWP fish collection facilities is likely to occur over the next week.

### Central Valley Steelhead

Loss of natural CCV steelhead has occurred in the past week at the State and Federal fish salvage facilities. Loss of CCV steelhead at the CVP and SWP fish collection facilities is likely to occur over the next week. 20-40 of CCV steelhead were estimated in the Delta. The 50% single year loss threshold for the December 1 to March 31 period was exceeded on 2/11/2024 the 75% single year loss threshold was exceeded on 2/22/2024, and the 100% single year loss threshold was exceeded on 2/23/2024. The March – December ITL was exceeded on 3/20/2024. Steelhead loss

as of 4/28/2024 for the April 1 – June 16 period is at 53% of the April-June ITL. The 50% single year loss threshold for the April 1 to June 16 period was exceeded on 4/9/2024, the 75% threshold was exceeded on 4/15/2024, and the 100% threshold was exceeded on 4/26/2024

### **DCC gates recommendation**

The DCC gates were closed for the OMR Season on 11/27/2023.

### **Delta Smelt**

Based on recent detection data and distribution patterns over the past decade, adult Delta Smelt spawning is ongoing. Forty-eight confirmed and one preliminary larval Delta Smelt have been detected in Suisun Marsh, Suisun Bay, and the Sacramento River Deep Water Shipping Channel since 4/2/2024. One juvenile Delta Smelt was detected in salvage on 4/29/2024. Risk of entrainment throughout the Delta remains low for all life stages based on low turbidity/ Secchi depth >1m, positive QWEST, and the majority of detections outside of the Central and South Delta. Implementation of salmonid protections and Export Curtailment for Spring Outflow (COA 8.17, IOP 2024) may reduce the chance of entraining Delta Smelt as less negative OMRI tends to entrain less fish. Entrainment risk is expected to remain low between OMRI range of -800 and +700 cfs.

### **Monitoring Teams summary**

There were no non-consensus issues to report from the Smelt Monitoring Team.

CDFW, USFWS, NMFS recommends continuing to operate to a daily average 2 unit operation at the CVP (exports of 1,800 cfs) for the upcoming week for Reclamation's portion of COA 8.17, per the 2024 IOP. The 2 unit operation is likely to increase the number of days that the CVP exports will be curtailed and extend the 100 TAF spring outflow later into May. Spring-run Chinook salmon peak outmigration is likely to occur sometime in mid- to late-May, according to historical data in wet years, and winter-run Chinook salmon outmigration is likely to continue to decrease over the upcoming week due to seasonal timing and estimated OMRI values for the upcoming week. Although fall-run fish are not listed, the fall-run fishery has been officially closed this year; therefore, extending spring outflow later into May would also increase survival of fall-run that are out-migrating.

Reclamation abstains from the recommendation.

## **Operational and Regulatory Conditions**

See current Weekly Fish and Water Operation Outlook document.

# Biology, Distribution, and Evaluation Winter-run Chinook salmon, Spring-run Chinook salmon, Central Valley Steelhead

## Population Status

### *Winter-run Chinook Salmon*

- Delta Life Stages:
  - Juveniles, Adults
- Brood Year 2023 Productivity:
  - Natural winter-run Chinook salmon: The Final WR JPE for BY 2023 is 234,896.
  - Mean cumulative weekly passage of winter-run Chinook salmon through January 14th at Red Bluff Diversion Dam (RBDD) for the last 21 years of passage data is 99.8% (one SD of 0.2%). By 3/24/2024, 1,110,528 winter-run Chinook salmon were estimated to have passed RBDD compared to the total cumulative passage for WY 2023 of 240,059 winter-run Chinook salmon.
  - Hatchery winter-run Chinook salmon:
    - One release of Livingston Stone National Fish Hatchery CWT tagged winter-run Chinook salmon occurred on 12/28/23
    - The second release of LSNFH CWT tagged winter-run Chinook salmon occurred on 1/19/24.
    - A third release of LSNFH CWT tagged winter-run Chinook salmon occurred on 2/16/24. A subset of these fish were acoustically tagged;
    - 47,937 Coleman NFH Complex brood year 2023 winter Chinook Salmon on March 4, 2024. The release took place on the North Fork Battle Creek at Wilson Hill Bridge near Manton, CA. 100% marked (with an adipose-fin and a left pelvic-fin clip and CWT) and has an overall estimated average fork length of 85 mm.
    - 84,994 Coleman NFH Complex brood year 2023 winter Chinook Salmon on March 11, 2024. The release took place on the North Fork Battle Creek at Wilson Hill Bridge near Manton, CA. 100% marked (with an adipose-fin and a left pelvic-fin clip and CWT) and has an overall estimated average fork length of 85 mm.
    - None of the winter-run from the above two Coleman NFH hatchery release groups have been detected in salvage.

### *Spring-run Chinook Salmon*

- Delta Life Stages:
  - Young-of-year (YOY) and Yearlings
- Brood Year 2023 Productivity:
  - Natural spring-run Chinook salmon: No JPE has been established for spring-run Chinook salmon.
  - Hatchery spring-run Chinook salmon surrogates associated with the Proposed Action (PA 4.10.5.10.2 Additional Real-Time OMR Restrictions and Performance Objectives):
    - Approximately 60,764 brood year 2023 late-fall Chinook salmon were released on December 22, 2023 into Battle Creek at the Coleman NFH. This group is 100% marked with an adipose-fin clip and coded-wire tagged.
    - Approximately 71,049 Coleman NFH brood year 2023 late-fall Chinook Salmon were released on December 29, 2023 into Battle Creek at Coleman NFH. This group is 100% marked (with an adipose-fin clip and CWT) and has an overall estimated average fork length of 145 mm.
    - Approximately 67,018 Coleman NFH brood year 2023 late-fall Chinook Salmon were released on January 11, 2024 into Battle Creek at Coleman NFH. This group is 100% marked (with an adipose-fin clip and CWT) and has an overall estimated average fork length of 145 mm.
  - Loss has occurred for the above release group 1, release group 2, and release group 3 of the late-fall hatchery yearling spring-run surrogates released between December 22nd and January 11th.
  - A release of 699,854 brood-year 2023 spring-run Chinook salmon from the Feather River hatchery at Gridley Boat Launch and Boyd's Pump Boat Launch occurred on March 15, 2024. This group was 100% marked (with an adipose fin clip and CWT) and had an overall estimated average fork length of 74 mm.
  - Approximately 712,177 Coleman NFH brood year 2023 fall-run Chinook Salmon were released on March 21, 2024 into Battle Creek at Coleman NFH. This group is 25% marked (with an adipose-fin clip and CWT) and has an overall estimated average fork length of 75 mm.
  - A release of 700,626 brood-year 2023 spring-run Chinook salmon from the Feather River hatchery at Gridley Boat Launch and Boyd's Pump Boat Launch occurred on March 29, 2024. This group was 100% marked (with an adipose fin clip and CWT) and had an overall estimated average fork length of 84 mm.

- A release of 210,351 brood-year 2023 fall-run were release from Nimbus Hatchery on 4/19/24 serving as surrogates for young-of-year spring-run migrants.
- Of the four above young-of-year spring-run surrogate groups released between March 15 and April 19, none have been detected in salvage.

### ***Central Valley Steelhead***

- Delta Life Stages:
  - Spawning Adults, Kelts, Juveniles
- Brood Year 2023 Productivity:
  - Spawner abundance: There is limited information about the adult steelhead population. It is estimated to be small, contributing to the limited productivity of the population.
  - The majority of wild and hatchery steelhead observed at the salvage facilities are between 200 and 300 mm fork length (Figure 8). This is similar to the size distribution of age-1 clipped hatchery steelhead. However, wild steelhead in the 200-300 mm size range are likely to be comprised of both age-1 and age-2 individuals. While the size distribution of steelhead at salvage is similar to the sizes of age-1 O. mykiss at the American River, this is the typical size of age-2 steelhead from the Stanislaus River, Mokelumne River, Clear Creek, and Mill Creek (Satterthwaite et al. 2010, Eschenroeder et al. 2022, Lisa Elliott – unpublished data).
  - Natural steelhead: No JPE has been established for steelhead. Data are limited.
  - Hatchery steelhead: Reclamation’s Proposed Action has no hatchery steelhead triggers, but see Table 7 for information on hatchery steelhead release and annual loss numbers.
  - A release of 240 hatchery steelhead occurred on 3/15/24 at Lighthouse Marina from the Mokelumne hatchery. These fish were acoustically tagged and tracked through CalFishTrack as the Mokelumne Hatchery Steelhead Export Effects Study. The goal of the release is to evaluate the effect of steelhead movement through the Delta at -500 cfs OMR. As of 4/29, 97 of the 250 steelhead released have reached Benicia Bridge East Span and 1 has been observed in salvage.
  - Three hundred and thirty-five 6-year Steelhead study hatchery fish were released on 3/20/24 into the Lower San Joaquin River. There have been 64 fish detected at the CVP trash rack and 73 fish at the Clifton court radial gates; of these 26 were detected at the SWP intake canal and 10 in the CVP. A further 48 fish have reached the Benicia Bridge.

- As of 3/13/24, 56 wild steelhead have been acoustically tagged and released in the Stanislaus River, with 2 of those fish so far being detected at Benicia and 1 being detected at the salvage facilities.
- As of 3/19/24, 32 wild steelhead have been acoustically tagged and released in Mill and Deer Creeks in the Sacramento River. Ten of those fish have been detected entering the Delta. Seven have been detected at Benicia, and none have been detected at the salvage facilities.

## Distribution

### *Winter-run Chinook Salmon*

#### Current Distribution:

- For winter-run Chinook Salmon observations reported to SaMT since previous meeting, see Table 1.
- For SaMT distribution estimates, see Table 2.
- As of 4/29/2024, 16 genetic natural winter-run Chinook Salmon have been identified at the SWP facility. As of 4/29/2024, 7 genetic natural winter-run Chinook Salmon have been identified at the CVP facility.
- The 2024 IOP was implemented on 3/29/2024.
- Under the 2024 IOP, Reclamation and DWR will be operating to the COA 8.6.3 Mid- and Late-season Natural Winter-run Chinook Salmon Daily Loss Threshold:
  - January 1 – January 31:  $0.001200 * 234,896 = 2.91$
  - February 1 – February 28:  $0.002300 * 234,896 = 5.43$
  - March 1 – March 31:  $0.003700 * 234,896 = 8.74$
  - April 1 – April 30:  $0.002300 * 234,896 = 5.31$
  - May 1 – May 31:  $0.000000 * 234,896 = 0.00$
- Daily loss threshold under the 2024 IOP COA 8.6.3 of LAD winter run were not triggered in the past week based on data through 4/28/2024.
- Acoustically tagged hatchery winter-run Chinook salmon have been observed passing receivers at Benicia Bridge and none have been detected in salvage.

#### Historical Trends

- For historical winter-run Chinook salmon trends in salvage, see Table 3. See also Attachment 1.

- Loss of natural LAD and genetic winter-run Chinook salmon at the CVP and SWP fish collection facilities is likely to decrease over the next week based on seasonal timing and previous years salvage data.
- Genetic data since 1996 has indicated that there have been zero observations of genetic winter-run Chinook salmon within the Delta past May 1st (Sacramento trawl, Chipp Island trawl, collection at the salvage facilities) (see Brandes et al. 2021, Kevin Reece and Brian Mahardja unpublished data).

#### **Forecasted Distribution within Central Valley and Delta regions**

- The STARS model projects route-specific proportion of entrainment, survival, and travel times (Table 5). This model does not estimate entrainment into the lower Sacramento River sloughs (i.e., Three-Mile Slough).

#### ***Spring-run Chinook salmon***

##### **Current Distribution**

- For spring-run Chinook salmon observations reported to SaMT since previous meeting, see Table 1.
- For SaMT distribution estimates, see Table 2.

##### **Historical Trends**

- For historical spring-run Chinook salmon trends in salvage, see Table 3. Based on historic trends in salvage YOY spring-run Chinook salmon loss may increase over the next week.

#### **Forecasted Distribution within Central Valley and Delta regions**

- YOY spring-run Chinook are migrating into the Delta.

#### ***Central Valley Steelhead***

##### **Current Distribution**

- For CCV Steelhead observations reported to SaMT since previous meeting, see Table 1.
- For SaMT distribution estimates, see Table 2.
- As of 4/28/2024, 684 unclipped CCV steelhead have been observed at the CVP or SWP facilities.
- Loss of CCV Steelhead exceeded the 50%, 75%, 100%, annual loss thresholds and the ITL for the Dec. 1 to March 31 period on 2/11/2024, 2/22/2024, 2/23/2024, and 3/20/2024, respectively.

- Loss of CCV Steelhead exceeded the 50% annual loss thresholds for the April 1 to June 15 period on 4/9/2024, the 75% threshold on 4/15/2024, and the 100% threshold on 4/26/2024.
- Steelhead have been observed within the Delta and at the salvage facilities in the last 7 days.
- Steelhead have also been observed in the Chipps Island Trawl which supports out-migration is occurring.
- Acoustically tagged steelhead from the Stanislaus, Mokelumne, and San Joaquin River have been observed passing receivers at Benicia Bridge.

### Historical Trends

- At Red Bluff Diversion Dam, the estimated passage of BY 2023 steelhead is 57,255, which is the second highest in the last 10 brood years. ([https://www.cbr.washington.edu/sacramento/tmp/hrt\\_1710862871\\_863.html](https://www.cbr.washington.edu/sacramento/tmp/hrt_1710862871_863.html)).
- For historical CCV steelhead trends in salvage, see Table 3. The estimated number of steelhead salvaged for water year 2024 as of 4/28/24 is 2111 and the highest in the last 10 water years. Based on historic trends in salvage, juvenile CCV steelhead loss may occur over the next week.
- Based on historical trends in steelhead observations, salvage is expected to increase and observations of out-migrating steelhead should increase as the season progresses.

### Forecasted Distribution within Central Valley and Delta regions

- The entrainment tool estimates CCV steelhead loss to continue (Table 6, Fig. 1).

Table 1. Fish observation reported since the previous SaMT meeting. NAs represent no data reported. See Operations Outlook for notes on interruptions in any surveys.

Locations	Reporting Period	SR Chinook	WR Chinook	LFR Chinook	Steelhead (Wild)	Green Sturgeon
Butte Creek RST	4/23-4/29	0	0	0	2	0
Tisdale RST	4/7-4/13	32	0	0	0	0
Knights Landing RST	4/23-4/29	9	0	0	0	0
Lower Sacramento RST	4/23-4/29	9	0	0	0	0
Beach Seines	4-21-27	3	0	1	0	0
Sac. Trawl	4/21-4/27	38	0	0	0	0
Chipps Island Midwater Trawl	4/21-4/27	252	0	0	1	0
Mossdale Kodiak Trawl	4/21-4/27	42	0	0	0	0
EDSM	4/21-4/27	0	0	0	0	0



Locations	Reporting Period	SR Chinook	WR Chinook	LFR Chinook	Steelhead (Wild)	Green Sturgeon
Feather River Herrerger RST	4/21-4/28	0	0	7	1	0
Feather River Eye Side RST	4/21-4/28	0	0	34	0	0
Lower Feather River	3/19-3/28	0	0	0	1	0

Table 2. Salmonid distribution estimates

Location	Yet to Enter Delta (%)	In the Delta (%)	Exited Delta past Chipps Island (%)
Young-of-year (YOY) winter-run Chinook salmon	Current: 1-3 % Last Week: 1-3 %	Current: 7-24% Last Week: 22-34 %	Current: 75-90 % Last Week: 65-75%
YOY spring-run Chinook salmon	Current: 5-15% Last Week: 5-15%	Current: 30-50% Last Week: 40-60%	Current: 45-55% Last Week: 35-45%
YOY hatchery winter-run Chinook salmon	Current: 0% Last Week: 1-2%	Current: 2-5% Last Week: 4-8 %	Current: 95-98% Last Week: 90-95%
Natural origin steelhead	Current: 5-15% Last Week: 5-20%	Current: 20-40% Last Week: 20-45%	Current: 55-65% Last Week: 50-60%

Table 3. Historic migration and salvage patterns. Last updated 04/29/2023.

Species	Red Bluff Diversion Dam	TisdaleRst	Knights LandingRst	SacTrawl Sherwood Catch Index	Chipps Island Trawl Catch Index	Salvage
Chinook, Winter-run, Unclipped	100.0%(100.0 %),100.0%) BY: 2014 - 2022	100.0%(100.0 %),100.0%) BY: 2014 - 2022	99.9%(99.6%, 100.2%) BY: 2014 - 2022	100.0%(100.0 %),100.0%) BY: 2014 - 2022	99.2%(98.2%, 100.3%) BY: 2014 - 2022	99.7%(99.3%, 100.2%) WY: 2014 - 2023
Chinook, Spring-run, Unclipped	94.2%(88.2%, 100.3%) BY: 2014 - 2022	99.3%(99.0%, 99.7%) BY: 2014 - 2022	99.1%(98.3%, 99.9%) BY: 2014 - 2022	93.4%(86.7%, 100.1%) BY: 2014 - 2022	82.1%(72.8%, 91.5%) BY: 2014 - 2022	61.8%(39.3%, 84.3%) WY: 2014 - 2023
Steelhead, Unclipped (January-December)	14.5%(4.9%,2 4.0%) BY: 2014 - 2023	75.7%(53.9%, 97.4%) BY: 2014 - 2023	67.4%(47.1%, 87.7%) BY: 2014 - 2023	85.9%(71.7%, 100.2%) BY: 2014 - 2023	75.9%(66.8%, 85.0%) BY: 2014 - 2023	N/A
Steelhead, Unclipped (December-March)	N/A	N/A	N/A	N/A	N/A	100.0%(100.0 %),100.0%) WY: 2015 - 2024

Species	Red Bluff Diversion Dam	TisdaleRst	Knights LandingRst	SacTrawl Sherwood Catch Index	Chippis Island Trawl Catch Index	Salvage
Steelhead, Unclipped (April-June)	N/A	N/A	N/A	N/A	N/A	53.9%(36.1%, 71.8%) WY: 2014 - 2023

Table 4. Mean daily flow and percent change (Wilkins Slough, Deer Creek, Mill Creek; cfs from CDEC) and temperature and percent change (Knights Landing; °F from RST).

Date	Mill Creek (MLM): mean daily flow (cfs)	Mill Creek (MLM): flow percent change	Mill Creek (MLM): Alert	Deer Creek (DCV): mean daily flow (cfs)	Deer Creek (DCV): flow percent change	Deer Creek (DCV): Alert	Wilkins Slough (WLK): mean daily flow (cfs)	Knights Landing RST: water temperature (f)	Alert Triggered
4/28/2024	551.5	-4.2%	Flow>95cfs	545.9	-9.6%	Flow>95cfs	15,672.1	N/A	N/A
4/27/2024	575.6	-16.9%	Flow>95cfs	604.2	-5.7%	Flow>95cfs	16,109.7	N/A	N/A
4/26/2024	693.0	-3.6%	Flow>95cfs	640.8	5.0%	Flow>95cfs	16,463.2	N/A	N/A
4/25/2024	718.9	-1.4%	Flow>95cfs	610.5	-3.8%	Flow>95cfs	16,100.0	N/A	N/A
4/24/2024	729.1	-0.5%	Flow>95cfs	634.3	-1.1%	Flow>95cfs	14,724.2	N/A	N/A
4/23/2024	732.7	3.2%	Flow>95cfs	641.2	2.1%	Flow>95cfs	14,881.8	49.9	WLK>7500 cfs and KNL<56.3F
4/22/2024	710.1	7.4%	Flow>95cfs	627.8	3.8%	Flow>95cfs	15,206.9	49.7	WLK>7500 cfs and KNL<56.3F

Table 5. STARS model simulations for route-specific, travel times, and survival. Travel time is calculated in days.

Stock	Date	Route	Median Travel Time	Survival	Routing Probability
Winter Chinook	2024-04-28	Overall	5.48	0.21	N/A
Winter Chinook	2024-04-28	Sacramento River	5.03	0.23	0.62
Winter Chinook	2024-04-28	Yolo Bypass	9.99	0.52	0.00
Winter Chinook	2024-04-28	Sutter Slough	5.35	0.22	0.13

Stock	Date	Route	Median Travel Time	Survival	Routing Probability
Winter Chinook	2024-04-28	Steamboat Slough	5.00	0.20	0.12
Winter Chinook	2024-04-28	Interior Delta	8.41	0.11	0.12
Late-fall Chinook	2024-04-28	Overall	7.25	0.57	N/A
Late-fall Chinook	2024-04-28	Delta Cross Channel	N/A	N/A	0.00
Late-fall Chinook	2024-04-28	Georgiana Slough	11.03	0.29	0.20
Late-fall Chinook	2024-04-28	Sacramento River	6.23	0.66	0.47
Late-fall Chinook	2024-04-28	Sutter and Steamboat Slough	6.92	0.61	0.32

The entrainment tool estimates a median and maximum loss of winter-run Chinook Salmon and juvenile CCV Steelhead each week (Table 6a).

Table 6a-c. WY 2024 loss and salvage predictor data: Environmental details, current and forecast. Unless values (i.e. OMR and export) are explicitly stated in Table 6c, covariate values are the same as values listed in 6b. Model results from 4/49/2024.

- a) WY 2024 loss and salvage predictor data: Predicted weekly loss of winter-run Chinook salmon and steelhead at CVP and SWP facilities estimated from model developed in Tillotson et al. (2022).

Parameter	Modeled Current Week	Modeled Next Week
Predicted Steelhead, Median %	76	55
Predicted Steelhead, High %	243	118
Predicted Chinook Winter Run, Median %	0	0
Predicted Chinook Winter Run, High %	18	12

- b) Environmental details, current and forecast

Parameter	Data	Forecast
Temperature (Mallard Island, C)	17.4	17.4
Precipitation (5-d running sum, inches)	0.01	0.01
Old and Middle River Flows (cfs)	-334	-334
Sacramento River Flow (Freeport, cfs)	30662	30662
DCC Gates	closed	closed
San Joaquin River Flow (Vernalis, cfs)	5176	5176
Export	1708	1708

- c) Salvage predictor estimates for natural origin Central Valley Steelhead (top) and natural origin Length-at-Date Winter-run (bottom) from model developed in Tillotson et al. (2022)<sup>1</sup> across multiple OMR flow scenarios represented within a range of percentiles. The model with expected discharge values (Discharge Range) in the Sacramento and San Joaquin Rivers through 5/03.

Table 6.c.1. Natural Origin Steelhead

OMR	Exports	San Joaquin Flow	Sacramento Flow	25th Percentile Weekly Loss	Median Weekly Loss	75th Percentile Weekly Loss	Median Daily Loss
481	1570	4938	24037	25.98	57.40	116.95	8.20
0	2100	4938	24037	25.98	73.61	130.21	10.52
-500	2650	4938	24037	45.27	112.08	171.27	16.01
-1000	3200	4938	24037	77.44	163.98	198.18	23.43
-1500	3750	4938	24037	81.95	144.72	198.18	20.67
-2000	4300	4938	24037	49.63	129.90	198.18	18.56
-2500	4850	4938	24037	54.17	129.90	198.18	18.56
-3000	5400	4938	24037	34.14	129.90	198.18	18.56
-3500	5950	4938	24037	34.52	129.90	198.18	18.56
-4000	6500	4938	24037	28.70	132.55	198.68	18.94
-4500	7000	4938	24037	22.76	122.50	198.18	17.50
-5000	7600	4938	24037	19.36	134.56	216.00	19.22
-5500	8100	4938	24037	14.11	133.23	216.00	19.03
-6000	8700	4938	24037	9.34	132.62	216.00	18.95
-6500	9200	4938	24037	9.34	134.45	216.00	19.21

Table 6.c.2. Length-at-date Winter run

OMR	Exports	San Joaquin Flow	Sacramento Flow	25th Percentile Weekly Loss	Median Weekly Loss	75th Percentile Weekly Loss	Median Daily Loss
481	1570	4938	24037	0	0	0	0
0	2100	4938	24037	0	0	0	0
-500	2650	4938	24037	0	0	0	0
-1000	3200	4938	24037	0	0	0	0
-1500	3750	4938	24037	0	0	0	0
-2000	4300	4938	24037	0	0	0	0

<sup>1</sup> Tillotson, M.D., J. Hassrick, A.L. Collins, & C. Phillis. 2022. Machine Learning Forecasts to Reduce Risk of Entrainment Loss of Endangered Salmonids at Large-Scale Water Diversions in the Sacramento-San Joaquin Delta, California. *San Francisco Estuary & Watershed Science* 20(2):1-21

OMR	Exports	San Joaquin Flow	Sacramento Flow	25th Percentile Weekly Loss	Median Weekly Loss	75th Percentile Weekly Loss	Median Daily Loss
-2500	4850	4938	24037	0	0	0	0
-3000	5400	4938	24037	0	0	0	0
-3500	5950	4938	24037	0	0	0	0
-4000	6500	4938	24037	0	0	0	0
-4500	7000	4938	24037	0	0	0	0
-5000	7600	4938	24037	0	0	0	0
-5500	8100	4938	24037	0	0	0	0
-6000	8700	4938	24037	0	0	0	0
-6500	9200	4938	24037	0	0	0	0

Table 7. Annual loss of clipped juvenile steelhead at the salvage facilities and total hatchery juvenile steelhead release numbers for brood years 2016 to 2023\*. From 2016 to 2024, average annual % lost to the facilities was 0.153%. Note that release locations and dates, which vary by year, were not considered for this calculation. Hatchery release numbers were acquired from: CDFW hatchery releases- Calfish.org and USFWS hatchery releases data provided by Kevin Offill, 3/13/2024. Water facility loss data acquired from: SacPAS and reflects Water Year 2017 - 3/12/2024. \* BY23 includes all fish released prior to 3/14/2024 (data is preliminary)

Brood Year	Total Hatchery Steelhead Release Number (BY)	Loss of clipped steelhead at the facilities (WY)	% Total Hatchery Number Lost to the Facilities	Water Year
2016	1,019,501	164.29	0.016	2017
2017	811,379	2,462.90	0.304	2018
2018	1,264,939	5,777.70	0.457	2019
2019	1,084,899	659.44	0.061	2020
2020	1,853,751	341.69	0.018	2021
2021	1,676,701	639.79	0.038	2022
2022	1,623,483	3,650.30	0.225	2023
2023*	1,517,998	1,581.93	0.104	2024

“Today, the Central Valley O. mykiss population complex is dominated by hatchery-origin fish” (NMFS 2003; Lindley et al. 2007). Best available information indicates that natural-origin O. mykiss comprise only 6% to 16% of the O. mykiss in the northern Sacramento-San Joaquin Delta and San Francisco Estuary. While diversifying the portfolio of release practices is expected to benefit stock complex resiliency and stability, it is also important to consider the potential genetic

and ecological impacts of releasing hatchery-origin pre-smolts on natural-origin *O. mykiss* and other life stages of hatchery-origin *O. mykiss*." See Eric R. Huber, Rachael E. Ryan, Rachel C. Johnson, Anna M. Sturrock, Robert A. Lusardi, and Stephanie M. Carlson. Seventy years of diminishing biocomplexity of California Central Valley hatchery steelhead, *Oncorhynchus mykiss*. *Canadian Journal of Fisheries and Aquatic Sciences*.

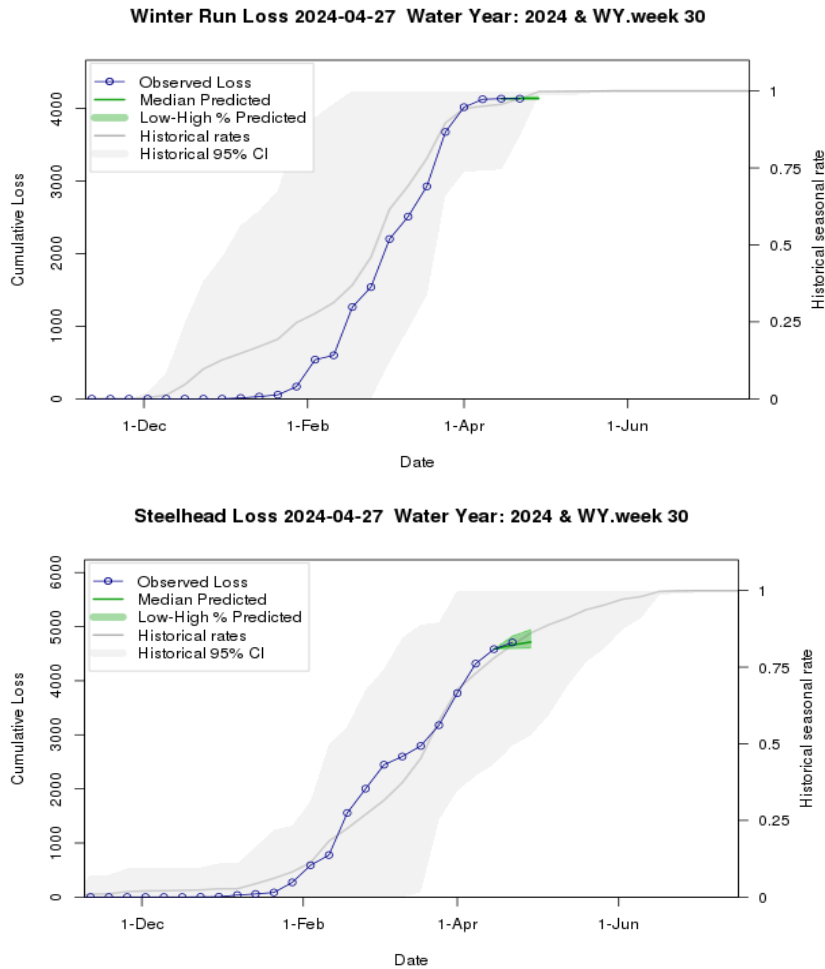
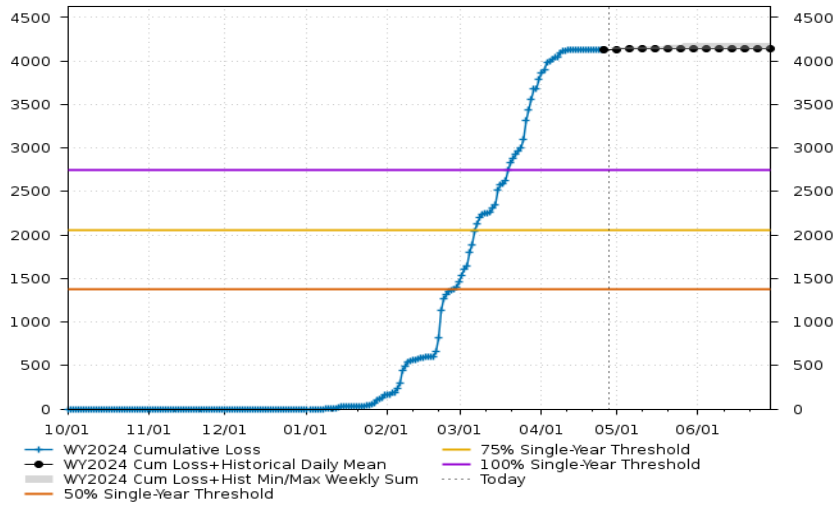


Figure 1. Predicted weekly loss of steelhead and winter-run Chinook salmon at the CVP and SWP facilities based on historical loss

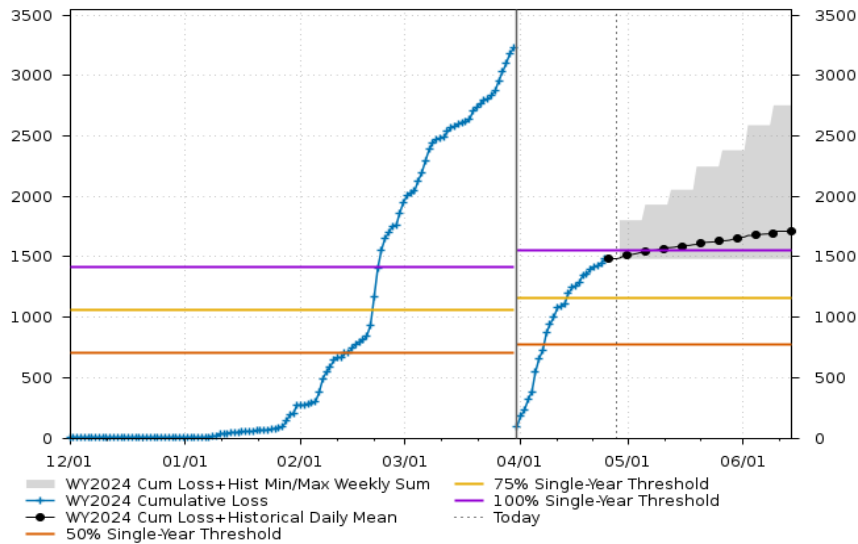
Figure 1 is two-line graphs of the predicted weekly loss of steelhead and winter-run Chinook salmon for water year 2024 beginning on December 1, 2023. The first line graph shows the cumulative loss of winter-run Chinook salmon comparing the predicted loss of 4100 and the observed loss of 4100. The second line graph shows the cumulative loss of Steelhead salmon comparing the median predicted loss of about 4600 and the observed loss of about 4600.

**WY2024 Natural Winter-run Chinook Cumulative Loss with Historical Loss**  
**Cumulative Loss to date: 4135.8**



Winter-run based on Length-at-Date Delta Model. Historical Loss calculated for WY2009-2018.  
[www.cbr.washington.edu/sacramento/](http://www.cbr.washington.edu/sacramento/) 29 Apr 2024 14:49:02 PDT

**WY2024 Natural Steelhead Cumulative Loss with Historical Loss**  
**12/1-3/31 Cumulative Loss to date: 3225.55**  
**4/1-6/15 Cumulative Loss to date: 1482.19**



Steelhead loss tracked separately for 12/1-3/31 and 4/1-6/15. Historical Loss calculated for WY2009-2018.  
[www.cbr.washington.edu/sacramento/](http://www.cbr.washington.edu/sacramento/) 29 Apr 2024 14:49:02 PDT

Figure 2. Cumulative natural winter-run Chinook salmon (Top) and natural Steelhead (Bottom) loss for the year (blue) and 2009 – 2018 historic cumulative loss (gray, different symbols). Historic daily mean plotted in black circles.



Figure 2 is two line graphs showing the natural winter-run Chinook salmon and natural steelhead loss and the 2009-2018 cumulative loss.

The first line graph shows the WY 2024 natural winter-run Chinook salmon cumulative loss to date at 4135.8, with a cumulative loss and historic daily mean of just over 4100.

The second graph shows the WY 2024 cumulative loss from December 1, 2023 until March 31, 2024 at 3225.55. The WY 2024 cumulative loss for the period of April 1, 2024 until June 15, 2024 is 1482.19.

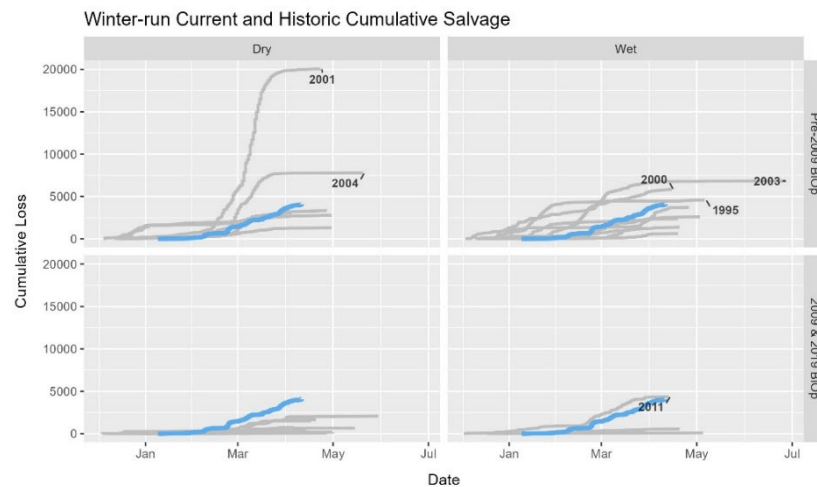
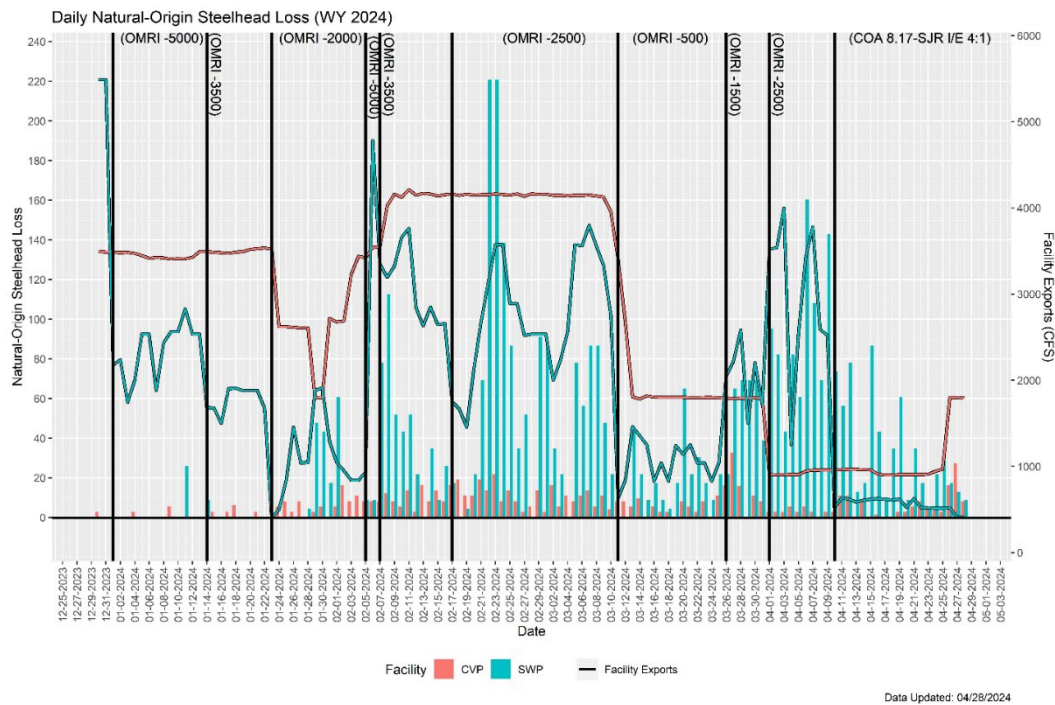


Figure 3. (Top) Daily LAD natural-origin winter-run Chinook salmon (CVP=red bars and SWP=blue bars) with daily exports at both the CVP (red line) and SWP (blue line). Vertical black bars are approximate dates when OMRI controlling factors change. (Bottom) LAD winter-run historic cumulative loss from salvage facilities from water year (WY) 1994-2024. The solid blue line represents 2024 and to ensure readability, only cumulative loss curves that have exceeded current 2024 cumulative loss were labeled by WY (updated through 3/21). The 3 overlapping years are 1999, 2002, and 2007.

Figure 3 is two line graphs, the first of which shows daily LAD natural origin winter-run Chinook salmon loss for WY 2024, and the second shows LAD winter-run current and historic cumulative loss from salvage facilities from WY 1994-2024.

The first graph shows daily exports at the CVP and SWP facilities, and highlights the approximate dates when OMRI factors change.

The second graph shows 2024 cumulative loss at around 4000 and highlights years that have exceeded this number which include 1995, 2000, 2001, 2003, 2004, and 2011. Cumulative loss is broken down into wet and dry as well as pre-2009 BiOp and following the 2009 and 2019 BiOps.

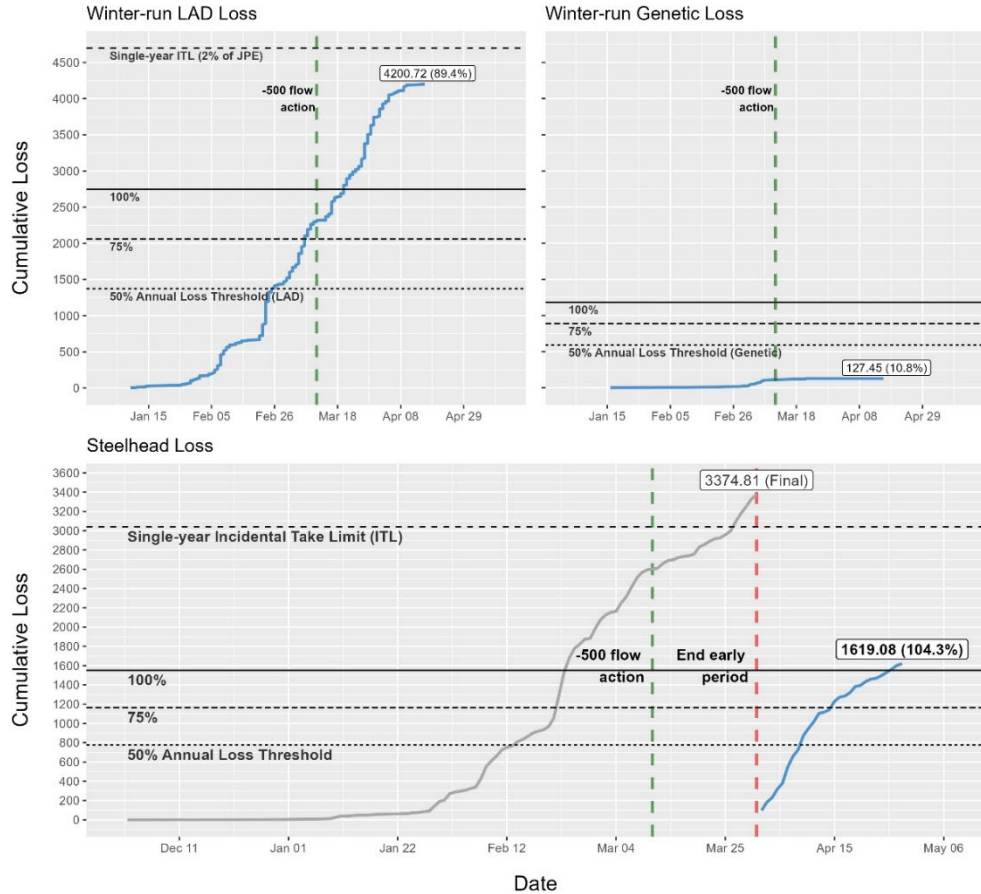


Figure 4. (Top-right) Cumulative natural LAD winter-run, (Top-left) natural genetic winter-run, and (Bottom) natural Steelhead with relevant loss thresholds. Genetic loss thresholds are purely for informative purposes to SaMT and WOMT, and are based on an unimplemented proposed action in which a 100% loss threshold is equal to 0.5004% of the JPE and 75% and 50% of that threshold respectively. The unimplemented PA and subsequent 0.5004% of the JPE threshold are a product of the reinitiation of consultation on the long-term operation of the Central Valley Project and State Water Project and may represent annual thresholds if the proposed action resulting from the consultation is implemented.

Figure 4 is three line graphs, the first of which shows cumulative natural LAD winter-run loss, the second shows natural genetic winter-run loss, and the third shows natural steelhead loss.

The first line graph shows the WY 2024 cumulative natural LAD winter-run loss at 4200.72 or 89.4 percent of the single year incidental take limit.

The second line graph shows the WY 2024 winter-run genetic loss at 127.45 or 10.8 percent of the annual loss threshold.

The third line graph shows the WY 2024 cumulative loss at 3374.81 at the end of the early period. Since then the loss has reached 1619.08 or 104.3% percent of the annual loss threshold.

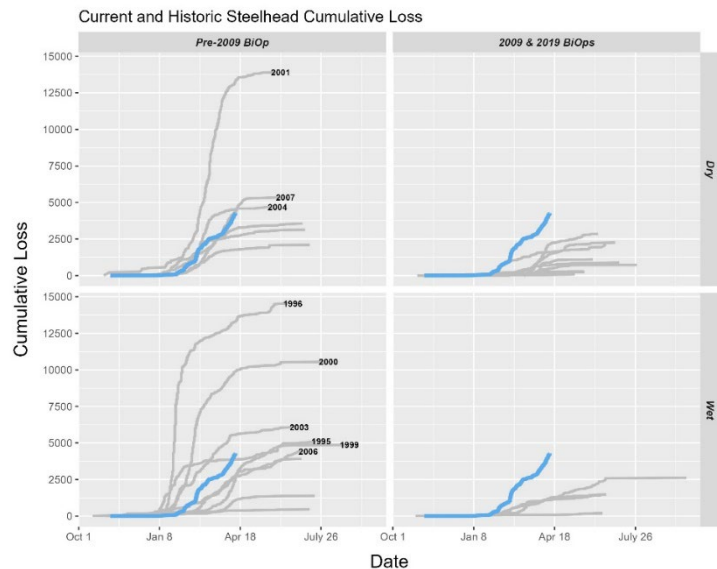
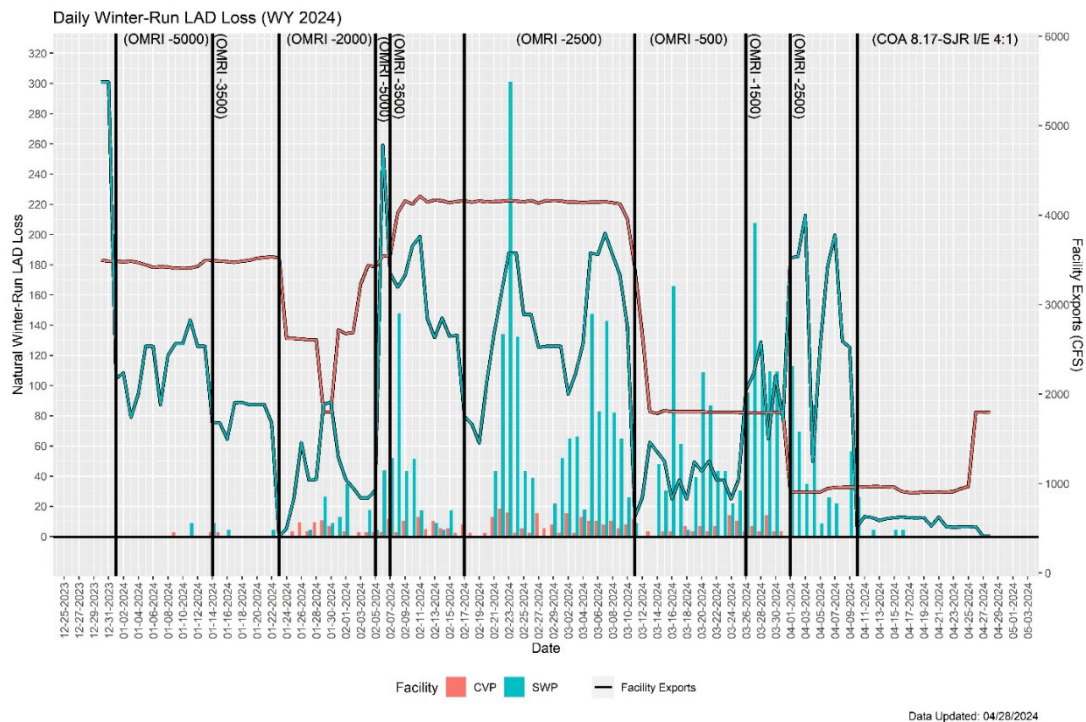


Figure 5. (Top) Daily natural-origin steelhead (CVP=red bars and SWP=blue bars) with daily exports at both the CVP (red line) and SWP (blue line). Vertical black bars are approximate dates when OMRI controlling factors change. (Bottom) Central Valley Steelhead historic cumulative loss from salvage facilities from water year (WY) 1994-2024. The solid blue line represents 2024 and to ensure readability, only cumulative loss

curves that have exceeded current 2024 cumulative loss were labeled by WY (updated through 3/21/24).

Figure 5 is two line graphs, the first of which shows the daily natural-origin steelhead exports at each facility, and the second shows current and historic cumulative steelhead loss.

The first graph shows the natural-origin steelhead exports at the CVP and SWP facilities by approximate dates when OMRI controlling factors change.

The second graph shows current and historic cumulative steelhead loss prior to the 2009 BiOP and following the 2009 and 2019 BiOPs, broken down by wet and dry.

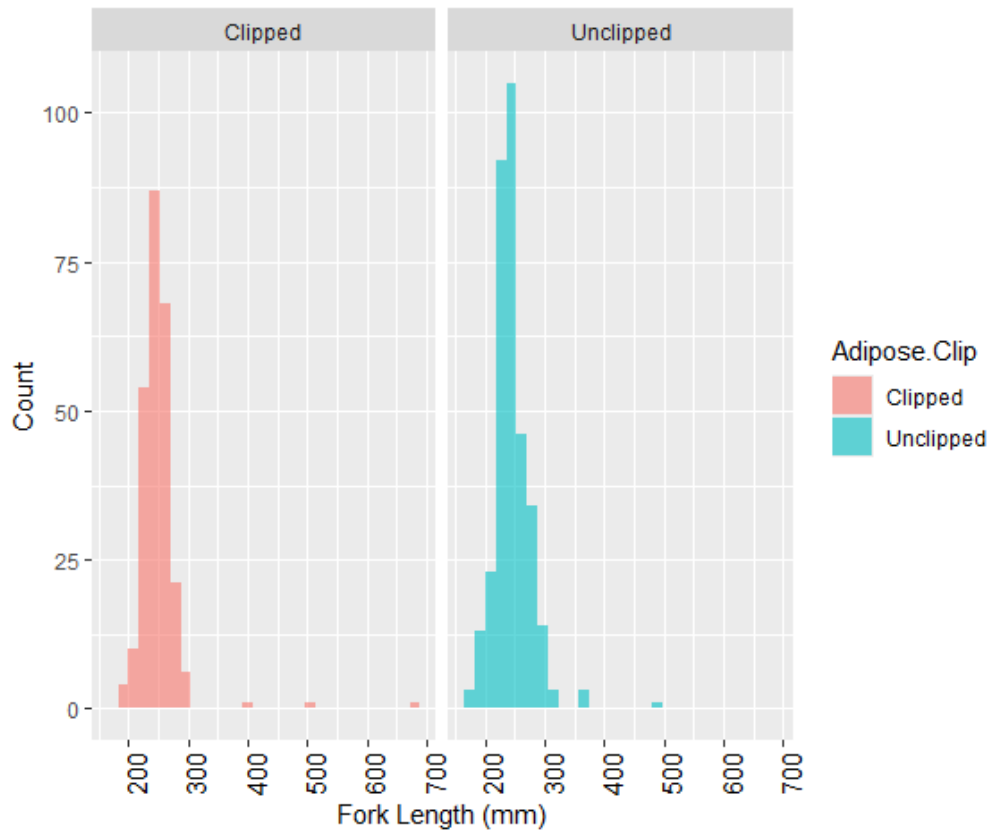


Figure 6. Fork length distribution of wild and hatchery steelhead collected at the CVP and SWP salvage facilities in WY 2024. Data included steelhead through 3/17/2024.

Figure 6 is a bar chart which shows the fork length distribution of wild and hatchery steelhead collected at the CVP and SWP facilities in WY 2024. The data is broken down into fish collected with 'clipped' and 'unclipped' adipose fins, with unclipped having a greater fork length and being collected in higher numbers.

## Evaluation

1. After January 1, are more than 5% of juveniles from one or more salmonid species present in the Delta?

Greater than 5% of all salmonid species are estimated to be present in the Delta.

2. Does the operational outlook's ranges impact fish movement and change the potential distribution of fish?

Potential effects within the 7 days (near-term) in the operations outlook.



OMR flow is expected to be more positive than -5,000 cfs this upcoming week. OMR flows more positive than -5,000 cfs are hypothesized to have a less negative impact on movement and distribution of salmonids in the South Delta (NMFS 2009, SST 2017, Perry et al. 2016).

Potential effects longer than the 7 days (longer-term) in the operations outlook.

Not applicable, see response above to (2) (i).

3. What is the likelihood of increased loss exceeding the next annual loss threshold (50%, 75% or 90% of threshold) resulting in OMR management actions based on population distribution, abundance, and behavior of fish in the Delta?

#### Winter-run Chinook salmon

Total juvenile natural winter-run Chinook salmon (LAD) loss is 4200.72 fish (as of 4/28/2024). Loss of juvenile winter-run Chinook salmon (LAD) has occurred in the past week at the CVP and SWP fish salvage facilities. The 50% single-year loss threshold was exceeded on 2/25/2024, the 75% single-year loss threshold was exceeded on 3/7/2024, and the 100% single-year loss threshold was exceeded on 3/20/2024. It is possible that the ITL (4,698), which is based on length-at-date winter-run, will be exceeded this year.

The Delta Model length-at-date (LAD) criteria is used for tracking the exceedance of these thresholds; however, only a small fraction of the winter-run LAD salmon observed at the salvage facilities have been genetically identified as winter-run to date. Figures 2 and 4 also provide a forecast of winter-run loss for the year and indicate possible exceedance of these salvage based winter-run triggers. It is uncertain how well the historical data described in Figure 4 may be relevant this year. Genetic methods provide a more accurate measure of identifying winter-run Chinook salmon than length-at-date. According to the genetic data, peak outmigration of natural winter-run Chinook Salmon in the Delta typically occurs in March and ends sometime in mid- to late-April, with no detection of genetic winter-run in the Delta past May 1st (Brandes et al. 2021, Kevin Reece and Brian Mahardja unpublished data). DNA results through 4/1/2024 indicate a loss of 127.45 winter-run Chinook salmon so far this year in the LAD older juvenile size range representing 3.0% of LAD loss (130.05 loss or 3.1% of LAD loss if LAD winter-run that failed to be genetically analyzed is included in the loss calculation). Relative to total annual genetic loss in recent years, this is the highest genetic loss observed in the previous 4 years and the sixth highest genetic loss in the previous 14 years. Relative to the JPE, genetic winter-run loss at the salvage facilities in WY 2024 so far is comparable to WY 2018 and WY 2019 (~0.05%), and remains substantially lower than WY 2011 (0.44%) and WY 2012 (0.56%) (the two highest genetic winter-run annual loss at salvage facilities since 2008). Genetic analysis has prioritized older juvenile Chinook salmon (LAD winter-run, late fall-run, and

yearling fall-run) so far and results on Chinook salmon from other runs (LAD young-of-year fall-run and young-of-year spring-run) are being analyzed as capacity permits. All fish have been analyzed through April 2 with no additional genetic winter-run being detected through that date; however, fish smaller than older juvenile Chinook salmon from April are still awaiting analyses, and, while unlikely, there is the possibility of additional genetic winter-run Chinook salmon when the analysis is completed through the current date.

The CVP and SWP operating under combined pumping described in the outlook with combined exports of 2,400 cfs. Weekly loss of LAD winter-run is unlikely to occur over the next week.

Below are data from the previous 4 weeks (including the most up to date week):

- 4/1/24-4/7/24: 360.55
- 4/8/24-4/14/24: 86.81
- 4/15/24-4/21/24: 8.66
- 4/22/24-4/28/24: 0

Given seasonal timing, the loss of both LAD and genetic winter-run Chinook salmon are likely beginning to decrease at the salvage facilities. Although loss can continue throughout April, it is likely to be lower than what was observed in March, according to historical loss estimates. Nevertheless, so far this year in April, loss of LAD WR has totaled 456.02, which is higher than LAD WR loss for all of April from WY 2010 to WY 2023, as well as the second highest total LAD WR loss for WY 2010 - WY 2023. Loss of genetic winter-run in April of WY 2024 is 0, which is consistent with past water years (WY 2010-2023) in which genetic loss is usually not observed in April with the exception of WY 2018, 2019, and 2020; however, genetic results have not been completed for April with the possibility of genetically confirmed winter-run when the analysis is complete.

Although CVP and SWP are operating under combined pumping as described in the outlook and weekly loss is decreasing, SaMT members note that any increase in loss would not be beneficial to the winter-run population and would likely lead to an earlier exceedance of the incidental take limit. However, SaMT members disagree on the magnitude of such impact on the winter-run evolutionarily significant unit and merit for using LAD winter-run as a way to manage winter-run.

- CDFW notes the reason for using LAD winter-run rather than genetic winter-run is due to the SWP ITP that was signed and agreed to by DWR and CDFW, and with the current IOP, also Reclamation and NMFS. Since we do not have specific thresholds for genetic winter-run at the moment, the SWP ITP thresholds that are

based on LAD are the only thresholds we have at this time that have been thoroughly analyzed to be protective enough for the winter-run population.

- Only one winter-run from the three LSNFH hatchery release groups has been detected in salvage. Preliminary minimum estimated survival of the acoustically tagged fish from release in the upper Sacramento River to the Delta is 35.3%, a higher survival than the previous five years. Approximately 25% of the acoustically tagged fish have exited past Chipps Island and none have been detected in salvage. This survival is 3.5 percent higher than the forecast survival of 31.8% used to calculate the winter-run JPE, and would have resulted in a JPE 11.0% higher than the current JPE (an increase of 25,853.58 projected winter-run entering the Delta). Historic observations of survival have a mean survival of 0.295 from 2013-2023 with a range of 10.2%-50.5%. The 2024 hatchery release survival estimate is based on a single release group and there is uncertainty in how representative hatchery fish behavior will be of the natural origin winter-run chinook. Hatchery fish are typically at larger size at release than natural origin fish and have been observed to out-migrate more quickly through the river into the delta compared to natural origin salmon. Even with an additional 25,853.58 winter-run entering the Delta based on the higher survival estimate mentioned above, COA 8.6.1 thresholds still would have been exceeded this year. There is inherent uncertainty in the JPE that stems from multiple sources of uncertainty besides the survival forecast. The BY2023 JPE 95% confidence intervals (159,951—309,841) accounts for the variability observed this season.
- Due to the lack of evidence of any genetic winter-run in the Delta past May 1st, Reclamation believes that OMR operations will have minimal impacts on the brood year 2023 winter-run Chinook Salmon evolutionarily significant unit after May 1st and that entrainment risk into the facilities will approximately be zero through the rest of the OMR season.
- CDFW recognizes that winter-run Chinook salmon are not observed in the Delta past April according to historical genetic data; however, historical genetic data at real time monitoring sites in the Delta are limited to select years with only select fish being sampled. Since observations of fish in real time monitoring stations are less likely to occur if there are low numbers of fish in the system and since May is typically nearing the end of juvenile migration for winter-run, winter-run observations in the Delta are expected to be low during this timeframe. Real-time monitoring sites also have limitations, including low capture efficiency and short sampling timeframes, which suggests that genetic winter-run are less likely to be observed in these monitoring sites when there are low numbers of them in the system. Therefore, if real-time monitoring stations have not observed genetic winter-run, it does not imply that winter-run are not continuing to rear and migrate through the Delta. This year specifically, there is more water in the system, which also means that there is more habitat for rearing. Due to all the fish that have been observed already this year in the salvage facilities, the above average water year

that creates more habitat for rearing, and the distribution of winter-run in the Delta in Table 2, CDFW assumes that winter-run presence in the Delta will likely occur through May or until temperatures rise above the lethal limit for survival.

### Central Valley Steelhead

Total natural juvenile steelhead loss for WY 2024 is 4993.89 fish (as of 4/28/2024).

Total Juvenile loss for the April 1 -June 15 period is 1619.08 fish (as of 4/28/2024). Loss of natural juvenile steelhead has occurred in the past week at the CVP and SWP fish salvage facilities.

Total Juvenile loss for the Dec 1 to March 31 period in WY 2024 is 3374.81 through 03/31/2024. The 50% single year loss threshold for the Dec 1 to March 31 period was exceeded on 2/11/2024, the 75% loss threshold was exceeded on 2/22/2024, the 100% loss threshold was exceeded on 2/23/2024, and the incidental take limit was exceeded on 3/20/2024.

A means of calculating a juvenile production estimate currently does not exist for steelhead, limiting the ability of SaMT members to assess the impact of loss on the basin-wide or genetically distinct populations of *Oncorhynchus mykiss*. Information on steelhead abundance and distribution in the Delta is also limited, as the existing fish surveys do not target steelhead and may be ineffective at catching these larger-sized fish (yearling or older). Although the proportion of wild steelhead population lost at the salvage facilities is unknown due to lack of WY 2024 population size, the proportion of hatchery or tagged steelhead observed at the facilities relative to release or tagged fish numbers can potentially offer insight into the proportional entrainment of wild steelhead. Annual loss of clipped steelhead at the salvage facilities represent between 0.02 to 0.46% of total hatchery release numbers between water year 2017 and 2024 (Table 7).

Based on telemetry studies from this water year ([CalFishTrack Central Valley Enhanced Acoustic Tagging Project](#)), a substantial proportion of *Oncorhynchus mykiss* from the San Joaquin River and Stanislaus River have been contacted in the vicinity of the salvage facilities, whereas none from the Sacramento River (Mill Creek and Deer Creek) have been found in the vicinity of the salvage facilities. Moreover, only one of the 240 tagged Mokelumne River hatchery *Oncorhynchus mykiss* released into the central Delta have been detected at the salvage facilities.

Telemetry data from this year suggests that the majority of salvaged Steelhead were of San Joaquin origin.

Salmonid species are expected to have increased survival when flows are high (Michel et al. 2021) and acoustic telemetry studies indicated that survival is correlated with increased flows at Vernalis for San-Joaquin origin Steelhead

(Buchanan et al. 2021), potentially influencing the number of fish observed at the salvage facilities.

However, the agencies in SaMT recognize that while there seems to be no export level that would lead to zero loss, reduction of export or a more positive OMR should generally lead to a reduction in salvage and loss of steelhead. Loss over the previous week decreased when a more positive OMRI was operated to and exports decreased; however, there may be other factors that may have contributed to a lower loss that are not being accounted for. (Table 6c, Figure 7).

The CVP and SWP have been operating to OMRI of no more negative than -500 cfs beginning on 3/11/2024. Weekly loss of natural-origin steelhead has decreased significantly since OMRI of -500 cfs has been targeted. The CVP and SWP may target an OMRI as negative as -800 cfs this week. Below are data from the previous 4 weeks (including the most up to date week)

- 4/1/24-4/7/2024: 360.55-
  - 4/8/24-4/14/24: 485.68
  - 4/15/24-4/21/24: 289.36
  - 4/22/24-4/28/24: 163.22
4. If an annual loss threshold has been exceeded, do continued OMR restrictions benefit fish movement and survival based on real-time information?

#### Winter-run Chinook salmon

The 100% annual loss threshold for winter-run Chinook salmon was exceeded in WY 2024 on 3/20/2024. Because the 50% and 75% single year loss thresholds have been exceeded and export facilities would operate such that the fourteen-day average OMRI flow is no more negative than -2,500 cfs through the end of OMR management season or until the risk of entrainment is no longer present based on a SaMT risk assessment. Coordination between all agencies that are SaMT members is expected to address the operations after exceeding the 100% annual loss threshold.

Observations of acoustically tagged winter-run, the STARS models, and a low to zero salvage of hatchery winter-run and recent Feather River hatchery spring-run releases respectively show that Sacramento River fish are moving through the Sacramento instead of the interior Delta.

Loss over the previous week decreased when a more positive OMRI was operated to and exports decreased; however, seasonal timing may be a greater factor in explaining decreasing loss.

## Central Valley Steelhead

The 100% annual loss threshold for steelhead (December 1 – March 31) has been exceeded for WY 2024. Steelhead loss exceeded the 50% annual loss threshold on 4/9/2024, the 75% single year loss threshold on 4/15/2024, and the 100% single year loss threshold on 4/26/2024 for the April 1 – June 15 period.

It is uncertain if additional OMR restrictions benefit fish movement and survival. Buchanan et al.'s (2021) study indicated that high flows increase through-Delta survival of steelhead, with little to no association between Delta export and survival. However, this study was conducted in 2011-2016 when OMR was restricted to be no more negative than -5,000 cfs, and therefore does not necessarily suggest that OMR flow more negative than -5,000 cfs cannot be associated with lower survival.

STARS model output indicates higher survival for Sacramento River-origin salmon in the Delta relative to the past several years due to hydrological conditions ([Columbia Basin Research San Francisco Bay Delta Survival, Travel time, and Routing Simulation](#)). Steelhead appear to be outmigrating at a larger sizes than Chinook salmon based on salvage data (~200-300 mm fork length) and therefore may have even higher survival than Chinook salmon. Although the December-March period is expected to reflect the Delta outmigration timing of Sacramento-basin steelhead, real-time data from CalFish Track indicate that the majority of steelhead entrained at the salvage facilities have been and continue to be from the San Joaquin basin.

Mokelumne hatchery steelhead were released on 3/15/2024 at the Lighthouse Resort in the Delta to evaluate the effects of export on steelhead. To date, the majority of detections after release have occurred downstream at Benicia.

Changes in water exports do not appear to significantly affect routing and survival of San Joaquin-origin steelhead (Buchanan et al. 2021), and there seems to be no export level that would lead to zero loss of steelhead this week (Table 6c). Nevertheless, reduction of export or a more positive OMR should generally lead to a reduction in salvage and loss (Table 6c, Figure 7). Agencies in SaMT acknowledge that any decrease in loss of steelhead would benefit the species.

5. If OMR is more negative than -5,000 cfs, are there changes in spawning, rearing, foraging, sheltering, or migration behavior beyond those anticipated to occur under OMR management at -5,000 cfs?

Expected OMRI flows are targeting between -800 and +700 cfs for the next week. Under OMR flows more negative than -5,000 cfs the SaMT expects impacts to rearing, foraging, sheltering, or migration of salmonids present in the south Delta. Salmonid presence in the south Delta is difficult to assess because of limited

observations and there is uncertainty in how much of the population might be impacted.

## Salmonid References

- Brandes PL, Pyper B, Banks M, Jacobson D, Garrison T, Cramer S. 2021. Comparison of Length-at-Date Criteria and Genetic Run Assignments for Juvenile Chinook Salmon Caught at Sacramento and Chipps Island in the Sacramento-San Joaquin Delta of California. *San Fr Estuary Watershed Sci.* 19(3).  
<https://doi.org/10.15447/SFEWS.2021V19ISS3ART2>
- Buchanan RA, Buttermore E, Israel J. 2021. Outmigration survival of a threatened steelhead population through a tidal estuary. *Can J Fish Aquat Sci.* 78(12):1869–1886.  
<https://doi.org/10.1139/cjfas-2020-0467>
- Eschenroeder J, Peterson M, Hellmair M, Pilger TJ, Demko D, Fuller A. 2022. Counting the Parts to Understand the Whole: Rethinking Monitoring of Steelhead in California’s Central Valley. *San Fr Estuary Watershed Sci.* 20(1).  
<https://doi.org/10.15447/sfew.2022v20iss1art2>
- Michel CJ, Notch JJ, Cordoleani F, Ammann AJ, Danner EM. 2021. Nonlinear survival of imperiled fish informs managed flows in a highly modified river. *Ecosphere.* 12(5).  
<https://doi.org/10.1002/ecs2.3498>
- Tillotson M, Hassrick J, Collins A, Phillis C. 2022. Machine Learning Forecasts to Reduce Risk of Entrainment Loss of Endangered Salmonids at Large-Scale Water Diversions in the Sacramento–San Joaquin Delta, California. *San Fr Estuary Watershed Sci.* 20(2):0–21.  
<https://doi.org/10.15447/sfew.2022v20iss2art3>
- Satterthwaite WH, Beakes MP, Collins EM, Swank DR, Merz JE, Titus RG, Sogard SM, Mangel M. 2010. State-dependent life history models in a changing (and regulated) environment: Steelhead in the California Central Valley. *Evol Appl.* 3(3):221–243.  
<https://doi.org/10.1111/j.1752-4571.2009.00103.x>

## Biology Distribution and Evaluation of Green Sturgeon

### Population Status

- Delta Life Stages:
  - Adults and Juveniles

### Distribution

#### *Current Distribution*

- Adults: Most abundant during spring spawning migration period of March through May, and post spawning out-migration periods May through June; October through January depending on first winter storm event resulting in significant Sacramento River flow increases. Adult presence year-round to a lesser extent mainly in San Pablo Bay.
- Juveniles: Age-1 through Age-3 juveniles present year-round and widely distributed. Juveniles tagged with acoustic tags in the main channel Sacramento River near Sherman Island detected in the Sacramento River as far upstream as the Cache Slough complex, in the San Joaquin River at the Antioch Bridge, in Threemile, Horseshoe Bend, and Montezuma Sloughs. Seasonal abundance at the primary sampling site (near Sherman Island) appears to be highest during summer in based on capture and telemetry data. Residence time at the primary sampling site for individual fish ranges from one day to over one year but telemetry data show outmigration from the primary sampling site to the Pacific Ocean ranges from 27 to 552 days. Recent capture data shows diurnal depth preference in the main channel of the Sacramento River. No recent documentation of shallow water habitat presence or foraging.

### *Historical Trends*

- Juvenile and adult green sturgeon are historically present in the San Joaquin and Sacramento rivers and Delta.

### *Forecasted Distribution within Central Valley and Delta regions*

- Juvenile and adult green sturgeon are likely present in the San Joaquin and Sacramento rivers and Delta during the next week.

## Evaluation

1. Is there likely to be salvage that may exceed the annual loss limit?

Green sturgeon salvage is 0 fish (as of 4/28/2024). The agencies in the SaMT assessed the likelihood of salvage occurring in the next week is unlikely to occur.

## Biology, Distribution, and Evaluation of Delta Smelt

### Population Status

- Delta Smelt Life Stages:
  - Adults, Larvae, Juveniles
- Brood Year 2023:
- Abundance estimate:



- The most recent non-zero abundance estimate for postlarval/juvenile Delta Smelt is from the week of April 8, 2024 and is 3,102,995 (95% CI: 525,032 to 10,302,502).
- Biological Conditions:
  - Delta Smelt are spawning and larval and juvenile Delta Smelt are present. Adult Delta Smelt have not been detected since 3/26/2024. Larval and juvenile Delta Smelt are expected to be present in the Sacramento River Deep Water Shipping Channel, Suisun Bay, Suisun Marsh, and the South Delta based on the most recent survey detections. The Smelt Monitoring Team discussed the most recent monitoring data (TABLE 7) and considered published literature and professional judgement on the historical trends in regional distribution.

## Distribution

### *Current Distribution*

- Real time detection data are currently limited to EDSM, Chipps Island Trawl, and 20 mm Survey. Bay Study provides data as available.
- One hundred and six Delta Smelt (54 adult; 51 larvae, 1 juvenile) have been detected this water year (surveys and salvage). Forty-eight of these have been from experimental releases.
- Adult Delta Smelt have not been detected by surveys since 3/26/2024.
- Forty-nine larval Delta Smelt (48 confirmed; 1 preliminary) have been detected by surveys in Suisun Marsh, Suisun Bay, and the Sacramento Deep Water Shipping Channel since 4/2/2024.
- One juvenile Delta Smelt was salvaged on 4/29/2024. No adult Delta Smelt have been salvaged after 2/23/2024. Cumulative seasonal salvage is 60.
- Qualitative Larval sampling began on 2/20/2024 at 0400 at the Tracy Fish Collection Facility (TFCF) and began at 1100 on 3/11/2024 at the Skinner Fish Facility (SFF).
- COA 8.5.2: Triggered 2/5/2024 by SLS survey 3 and implemented starting 2/7/2024; it was retriggered on 2/21/2024 by SLS survey 4, and on 3/4/2024 by SLS survey 5. It was not triggered by SLS survey 6 or 20 mm surveys 1-3. First larval detection was 3/22/2024.

Table 8. Summary of newly reported detections of Delta Smelt by Region and Salvage Facilities since the last assessment. Regions are those defined by EDSM sampling. Delta Smelt >58mm FL are considered adults. Subadult fish are considered by the SMT to be fish from the previous year’s cohort based on size and timing of collection. Young of year are considered juveniles and larvae. Salvage values reflect pre-expansion salvage.

Life Stage	North	South	West	Far West	Salvage
Adult	0	0	0	0	0
Subadult	0	0	0	0	0
Larvae/Juvenile	0	0	1	0	1

Table 9. Summary of recent Delta Smelt detections reported since last assessment and the total detections for the current water year. Notes reflect latest information on reported detections or completion of survey for the water year and include both larval and adult detections. Total Fish counts do not distinguish between hatchery origin and wild Delta Smelt. Table indicates new detections and previously reported detections that have undergone preliminary ID, QA/QC, and genetic confirmation. Numbers are updated as QA/QC and genetic confirmation become available. Tracy and Skinner facility counts reflect pre-expansion salvage.

Sampling Method	Frequency	New Detections	Preliminary Detections	QA/QC Detections	Genetically Confirmed to Date	Total WY2024	Notes
EDSM	Weekly	1	1	85	1	88	Ongoing. Phase 2 began on 4/1/2024
SKT	Monthly	0	N/A	N/A	N/A	0	not occurring this year
SLS	Biweekly	0	N/A	N/A	N/A	0	Complete
20-mm	Biweekly	0	2	N/A	N/A	2	Ongoing
Summer Townet	Biweekly	0	N/A	N/A	N/A	0	Begins:
Bay Study	Monthly	0	N/A	N/A	N/A	0	Ongoing
FMWT	Monthly	0	N/A	N/A	N/A	0	Complete
Chippis Island Trawl	Weekly	0	N/A	N/A	N/A	0	Ongoing
DJFMP	Monthly	0	N/A	1	N/A	1	Ongoing

Sampling Method	Frequency	New Detections	Preliminary Detections	QA/QC Detections	Genetically Confirmed to Date	Total WY2024	Notes
Electrofishing survey							
FCCL Brood Stock Collections	Weekly	0	N/A	N/A	N/A	0	Complete
LEPS	As available	0	N/A	N/A	N/A	0	Began 1/2/2024
FRP	Daily	0	N/A	N/A	N/A	0	Ongoing
Tracy Fish Collection Facility (CVP)	Daily	1	N/A	14	N/A	15	Ongoing
Skinner Fish Facility (SWP)	Daily	0	N/A	N/A	N/A	0	Ongoing
Total	N/A	N/A	N/A	N/A	N/A	106	Sum of all Delta Smelt observed during the water year

### ***Cultured Delta Smelt Experimental Releases***

- Experimental releases completed in Water Year 2024 include:
  - Release 1: 14,104 fish released at Sacramento River at Rio Vista (truck release)
  - Release 2: 13,089 fish released at Sacramento River at Rio Vista (hard and soft releases)
  - Release 3: 12,691 fish released at Sacramento River at Rio Vista (hard carboy and trailer release)
  - Release 4: 25,649 fish released at Sacramento River at Rio Vista (truck release)
  - Release 5: 12,778 fish released at Sacramento River at Rio Vista (hard and soft releases)
  - Release 6: 13,157 fish released at Sacramento River at Rio Vista (hard trailer and soft release)
- See additional details at: [SacPAS Central Valley Prediction & Assessment of Salmon](#)

Table 10. Weekly summary of the origin of Delta Smelt. These identifications are considered tentative and additional genetic testing will confirm the identity of individuals. Individuals with no tags are provided alive to the FCCL as potential additions to the FCCL Broodstock.

Date	Survey	Stratum/Station	Total Caught	Ad. Clipped	VIE	No Tag
4/9/2024	EDSM	Suisun Bay	1	N/A	N/A	X
4/29/2024	Salvage	South Delta	1	N/A	N/A	X

### ***Historical Trends***

- Upstream migration for Delta Smelt occurs between September and December and in response to “first flush” conditions (Sommer et al. 2011, Grimaldo et al. 2009). Migration typically ranges one to four weeks after flow and turbidity increases, based on salvage data (Sommer et al. 2011).
- Historically, detections of ripe Delta Smelt began in January and peaked in February and March and the majority of Delta Smelt spawning occurs within a temperature range of 9-18°C (Damon et al. 2016).
- Based on historical monitoring data from the past few years (<https://github.com/Delta-Stewardship-Council/deltafish>), first detection of larvae in the Central and South Delta has typically occurred by mid to late March. ([https://www.cbr.washington.edu/sacramento/data/query\\_salvage\\_hrt.html](https://www.cbr.washington.edu/sacramento/data/query_salvage_hrt.html)).
- Salvage data as presented on SacPas indicates that adult Delta Smelt salvage in recent years has reached the 50th percentile at the end of February – beginning of March.
- Historically, the highest peak in salvage is in May and the second highest is in June (Grimaldo et al 2009).

### ***Forecasted Distribution within Central Valley and Delta regions***

- Predicting the distribution of Delta Smelt is currently difficult because detection data is limited to a few wild individuals and historic patterns may not be representative of the low population levels.
- The SMT uses turbidity as a surrogate for Delta Smelt presence and in making assessments of the likelihood of entrainment for larval Delta Smelt after spawning begins.
- The potential of experimentally released Delta Smelt to distribute from their release site is unknown at this time and SMT cannot predict their distribution beyond the original

release site and subsequent recaptures. There is a high degree of uncertainty regarding the response of cultured fish to environmental cues typically applied to wild Delta Smelt.

## Abiotic Conditions

### *Turbidity*

- Sunny and clear for most of the week. Slight chance of showers Saturday. In Stockton, NW, WNW and NNW winds today through Thursday up to 16 mph, and gusts as high as 24 mph. In Antioch, WNW and NNW winds today through Thursday up to 18 mph, with gusts as high as 24 mph.
- Turbidity is below 12 FNU at OBI and at other stations in the central and south Delta.

Table 11. Relevant Environmental Factors to the current management actions for Delta Smelt.

Date Reported	12-station average Secchi Depth (m) 20mm 3
4/15/2024-4/16/2024	1.53 (11 of 12 stations)

### *X2 Conditions*

- As of 4/29/2024, X2 was estimated to be 59 km.

### *Other Environmental Conditions*

- The Fish and Water Operation Outlook OMR Index values are expected to range between -800 to +700 cfs this week.
- QWEST was +8,400 cfs as of 4/29/2024 and is estimated to decrease to +5,000 cfs.
- Real time tracking of environmental conditions, relevant thresholds and Delta Smelt catch data are updated daily at: [SacPAS Central Valley Prediction & Assessment of Salmon](#)
- Water temperature was 16.9°C at Rio Vista and 17.9°C at Antioch as of 4/29/2024.
- Anticipated Vernalis Flows: 4,000 to 5,000 cfs

## Evaluation

### USBR and DWR Proposed Operations:

- Effective 4/1, CVP and SWP project operations are limited to a 14-day average OMRI flow no more negative than -2,500 cfs per the Director’s decision on 3/29.
- The 2024 IOP is expected to control CVP exports this week.

- I/E ratio export constraints per Section 8.17 of State ITP will control SWP exports for this week.

### Questions and Discussion:

1. Between December 1 and January 31, has any first flush condition been exceeded?

First flush conditions were exceeded on 1/21/2024. Integrated Early Winter Pulse Protection (IEWPP) was implemented from 01/23/2024 through 2/5/2024.

2. Do DSM have a high risk of migration and dispersal into areas at high risk of future entrainment? (December 1- January 31)

No longer relevant.

3. Has a spent female been collected?

Neither a ripe nor spent female were collected before April 1, 2024.

4. If OMR of -2000 cfs does not reduce OBI turbidity below 12 NTU/FNU, what OMR target is deemed protective between -2000 and -5000 cfs?

No longer relevant.

5. If OBI is 12 NTU/FNU, what do other station locations show?

No longer relevant.

6. If OBI is 12 NTU/FNU, is a turbidity bridge avoidance action not warranted? What is the supporting information?

No longer relevant.

7. After March 15 and if QWEST is negative, are larval or juvenile DSM within the entrainment zone of the CVP and SWP pumps based on surveys?

QWEST is highly positive and expected to remain positive throughout the week. One juvenile DSM has been detected in Salvage, but the majority of fish have been detected outside of the South and Central Delta.

Due to following the 2024 IOP, we are also following COA 8.5.2. Temperature became suitable for spawning on 1/31/2024 ( $> 12^{\circ}\text{C}$  three-day average at SJJ; Damon et al. 2016). One juvenile DSM has been detected in Salvage, but the majority of fish have been detected outside of the South and Central Delta. Mean Secchi depth for South Delta stations is  $> 1$  m as of 4/15/2024-4/16/2024.

Implementation of salmonid protections, COA 8.17, and the 2024 IOP is expected to reduce the chance of entraining DSM.

8. Based on real-time spatial distribution of Delta Smelt and currently available turbidity information, should OMR be managed to no more negative than -3,500?

No. COA 8.5.2 and PA protections were not triggered by the most recent 20mm surveys (20 mm 3) and QWEST is positive. Water temperatures became suitable for spawning on 1/31/2024, however mean Secchi depth for South Delta stations was >1 m as of 4/15/2024-4/16/2024. One juvenile Delta Smelt has been detected in Salvage, but the majority of fish have been detected outside of the South and Central Delta, thus risk is low for DSM. Implementation of salmonid protections, COA 8.17, and the 2024 IOP is expected to keep OMRI values between -800 and +700 cfs and reduce the chance of entraining DSM.

9. What do hydrodynamic models, informed by EDSM or other relevant data, suggest the estimated percentage of larval and juvenile DSM that could be entrained may be?

No PTM runs were requested by the SMT in advance of the SMT meeting. Flows at Vernalis and QWEST are and will remain positive throughout the week. The Fish and Water Operation Outlook OMR Index values are expected to range between -800 to +700 cfs this week.

Conditions are good for Delta Smelt, the majority of fish have been detected outside of the South and Central Delta, and turbidity is low in the Central and South Delta. Thus, we continue to expect low entrainment risk between OMRI range of -800 and +700 cfs.

## Delta Smelt References

- Damon, L. J., S. B. Slater, R. D. Baxter, and R. W. Fujimura. 2016. Fecundity and reproductive potential of wild female Delta smelt in the upper San Francisco Estuary, California. *California Fish and Game* 102(4):188–210.
- Hobbs, J. A., Lewis, L. S., Willmes, M., Denney, C., & Bush, E. (2019). Complex life histories discovered in a critically endangered fish. *Scientific Reports*, 9(1).  
<https://doi.org/10.1038/s41598-019-52273-8>
- Grimaldo, L. F., T. Sommer, N. Van Ark, G. Jones, E. Holland, P. B. Moyle, B. Herbold & P. Smith (2009) Factors Affecting Fish Entrainment into Massive Water Diversions in a Tidal Freshwater Estuary: Can Fish Losses be Managed? *North American Journal of Fisheries Management*, 29:5, 1253-1270, DOI: 10.1577/M08-062.1
- Gross, E. S. (2021). Modeling Delta Smelt Distribution for Hypothesized Swimming Behaviors. *San Francisco Estuary and Watershed Science*, 19(1).

- Kimmerer, W. J. (2008). Losses of Sacramento River Chinook Salmon and Delta Smelt to Entrainment in Water Diversions in the Sacramento-San Joaquin Delta. *San Francisco Estuary and Watershed Science*, 6(2).
- Polansky, L., Newman, K.B., Nobriga, M.L. et al. Spatiotemporal Models of an Estuarine Fish Species to Identify Patterns and Factors Impacting Their Distribution and Abundance. *Estuaries and Coasts* 41, 572–581 (2018). <https://doi.org/10.1007/s12237-017-0277-3>
- Smith, W. E., Polansky, L., and M. L Nobriga. 2021. Disentangling risks to an endangered fish: using a state-space life cycle model to separate natural mortality from anthropogenic losses. *Canadian Journal of Fisheries and Aquatic Sciences*, 78: 1008-1029.
- Sommer, T., F. Mejia, M. Nobriga, and L. Grimaldo. 2011. The Spawning Migration of Delta Smelt in the Upper San Francisco Estuary. *San Francisco Estuary and Watershed Science* 9(2).



# Attachment 1:

## Winter-run Chinook Salmon Historical Data

Below are a series figures of containing historical information on Winter-run Chinook Salmon.

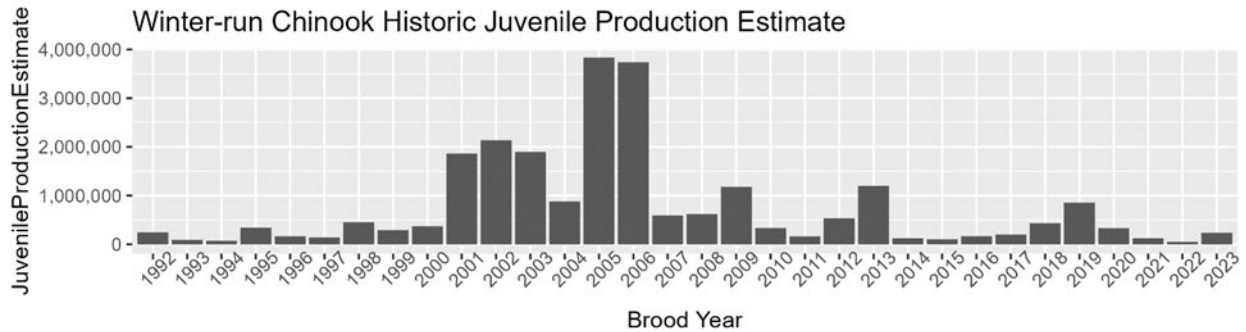


Figure A1. Historic juvenile production estimates (JPEs) from brood years 1992 through 2023. Method 2 (O’Farrell et al 2018) used from 2019 onward.

Figure A1 is a bar graph that shows winter-run Chinook historic juvenile production estimates from brood years 1992 through 2023. The years 2005 and 2006 show the highest estimates at roughly 3,800,000 and 3,750,000 respectively.

Genetic vs LAD Historical Loss Comparison

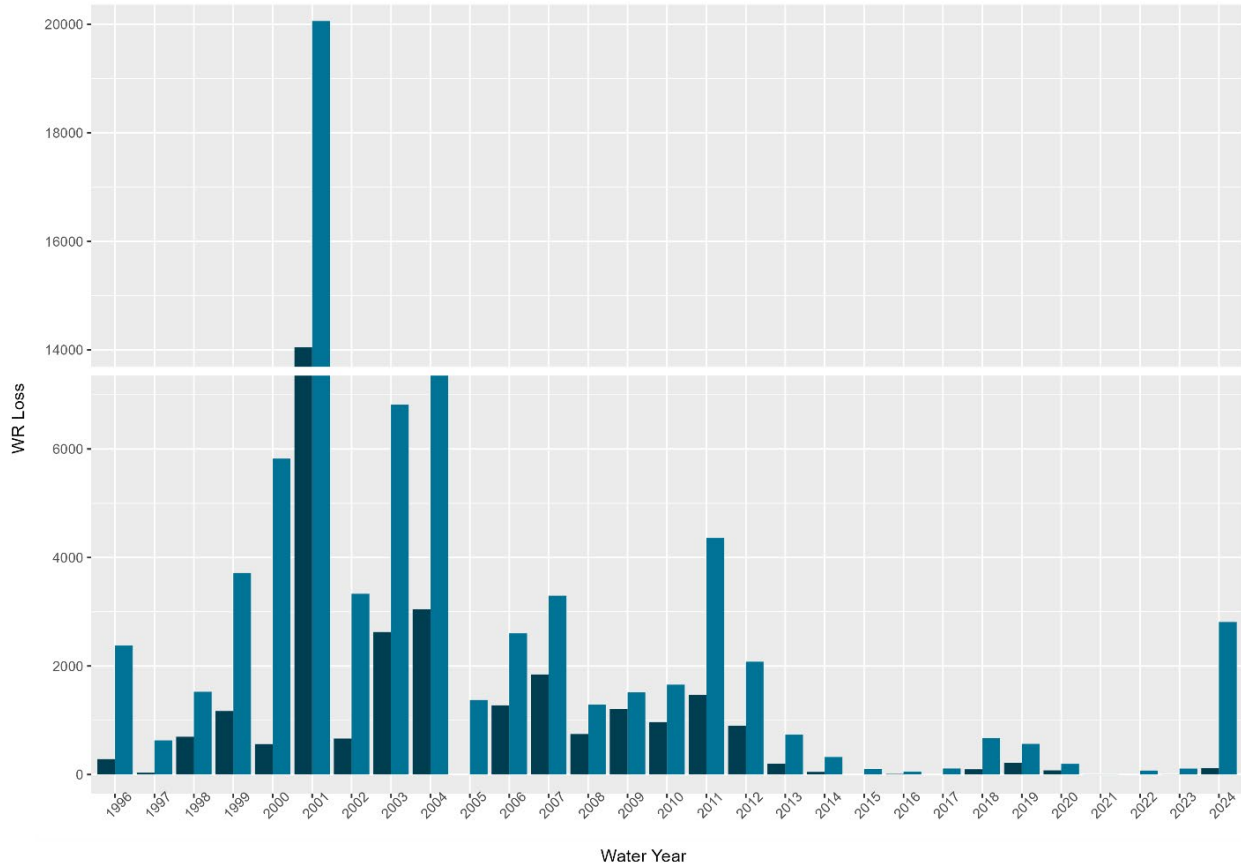


Figure A2. Comparison of the of the loss between annual loss calculated from genetically confirmed loss versus LAD only loss calculation. Break between 7000 and 13000 used to accommodate high loss values observed in Water Year 2001. Genetic loss through 3/21/2024.

Figure A2 is a bar graph that compares genetic and LAD historical loss from 1996 through March 21, 2024.

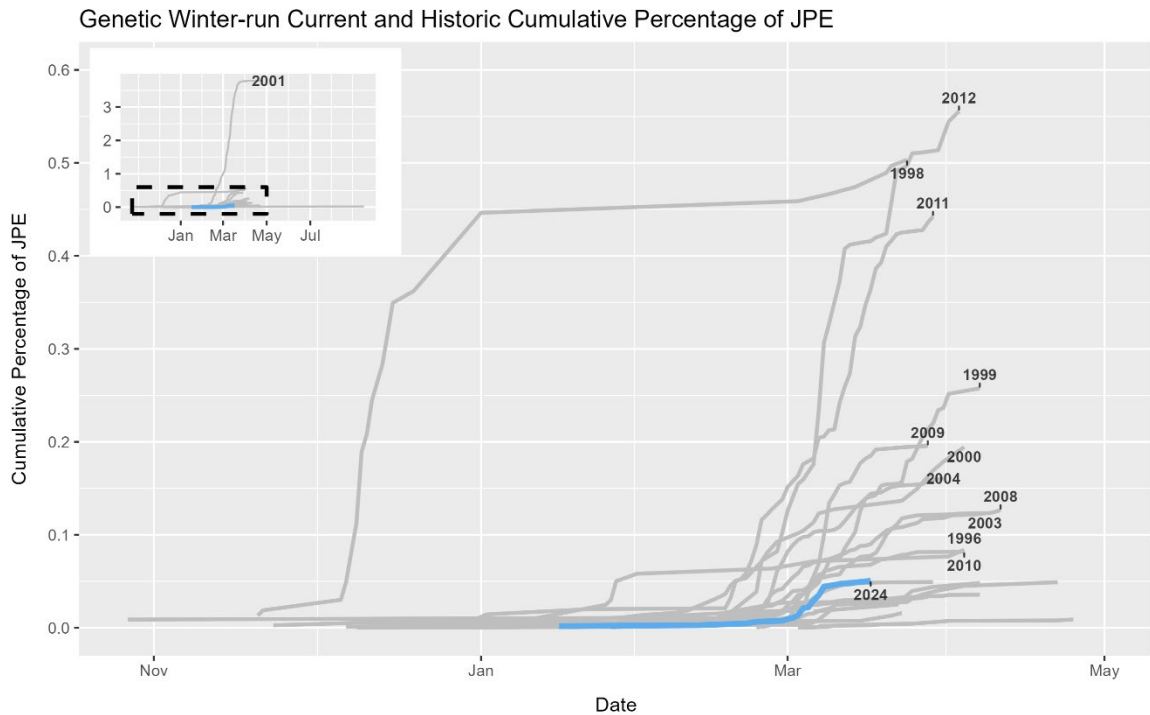


Figure A3. Cumulative loss of genetic winter-run as a percentage of the Juvenile Production Estimate for each Water Year. Inset graph represents all years and main graph excludes 2001 which is an order of magnitude greater than all other years. Only those years that are greater than 2024 are labeled.

Figure A3 is a line graph that shows cumulative loss of genetic winter-run as a percent of the Juvenile Production Estimate for each Water Year. The years that are greater than the percentage in 2024 are labeled, and include: 1996, 1998, 1999, 2000, 2003, 2004, 2008, 2009, 2010, 2011, 2012. An inset map shows the percentage in 2001 which is an order of magnitude greater than all other years.