BUREAU OF RECLAMATION

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

March 28, 2023

Executive Summary

Operational Conditions

See Weekly Fish and Water Operation Outlook document for March 28 – April 3 which includes the initial CVP and SWP operational intent and biological justification for the next seven days. Any recommended changes or alternatives to those operations made by either monitoring team is captured herein.

Winter-run Chinook Salmon

No loss of natural winter-run Chinook Salmon (by length at date, LAD) has occurred in the past week at the State and Federal fish salvage facilities (WY 2023 total loss = 82.54 fish, as of 3/27/2023). Loss of natural winter-run Chinook Salmon at the Central Valley Project (CVP) and State Water Project (SWP) fish collection facilities may occur over the next week. 52-69% of juvenile natural winter-run Chinook Salmon from brood year (BY) 2022 are estimated to be present in the Delta. The Delta Cross Channel (DCC) gates closure for the season reduces exposure of winter-run Chinook Salmon juveniles that are present in the Sacramento River near the DCC gates into the interior Delta.

Spring-run Chinook Salmon

No loss of natural spring-run Chinook Salmon (by length at date, LAD) has occurred in the past week at the State or Federal fish salvage facilities (WY 2023 total loss = 25.93 fish as of 3/27/2023). Loss of spring-run Chinook salmon at the CVP and SWP fish collection facilities may occur over the next week. 65-80% of juvenile natural spring-run Chinook Salmon from brood year (BY) 2022 are estimated to be present in the Delta. The DCC gates closure for the season reduces exposure of spring-run Chinook Salmon juveniles that are present in the Sacramento River near the DCC gates into the interior Delta.

Central Valley Steelhead

Loss of natural California Central Valley (CCV) steelhead has occurred in the past week at the State and Federal fish salvage facilities (WY 2023 December 1 - March 31 total loss = 1012.44 fish, as of 3/27/2023). Loss of Central Valley steelhead at the CVP and SWP fish collection facilities is likely to occur over the next week. 25-45% of juvenile natural CCV Steelhead from brood year (BY) 2022 are estimated to be present in the Delta. DCC closure for the season reduces exposure to Central Valley steelhead juveniles that are potentially present in the Sacramento River near the DCC gates.

Green Sturgeon Loss of green sturgeon has not occurred in the past week at the State and Federal fish salvage facilities (WY 2023 total loss = 0 fish, as of 3/27/2023). Loss of green sturgeon is unlikely to occur over the next week due to their rare presence in the South Delta.

Delta Smelt

Based on recent detection data and distribution patterns over the past decade, the Delta Smelt population has completed spawning migration and is widely distributed throughout the Delta. Continued movement at a smaller spatial scale is expected. Water temperatures are suitable for spawning (Damon et al. 2016) and for the presence of larval Delta Smelt. Starting 3/13/23, one marked adult Delta Smelt was detected by surveys in the Sacramento Deepwater Ship Channel. The most recent detections of Delta Smelt in salvage were two marked Delta Smelt detected at the CVP and SWP on 3/2/23. Under the PA, the Turbidity Bridge Avoidance Action off-ramped starting 2/9/23 due to detections of ripe Delta Smelt. A turbidity bridge formed on 3/17/23. Three-day average water temperature at Jersey Point exceeded 12˚ C on 3/18/23, and the most recent Secchi depths in the South Delta were below 1m, triggering COA 8.5.2. However, these actions are not controlling OMRI. Due to highly positive QWEST and OMRI, overall risk for entrainment is low for all life stages of Delta Smelt throughout the Delta.

Delta Cross Channel Gates

The DCC gates were closed on 11/28/2022 to meet LTO Proposed Action and are expected to remain closed until May. DCC gates may only be opened to maintain water quality under D-1641 between November and January.

Monitoring Teams summary

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

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

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 2022 Productivity:

- Natural winter-run Chinook salmon: Draft Juvenile production estimate (JPE) calculations have been established for brood year (BY) 2022 winter-run Chinook salmon. The final BY 2022 JPE is 49,924 natural origin juvenile winter run Chinook salmon.
- Mean cumulative weekly passage of winter-run Chinook salmon through 3/25/2023 at Red Bluff Diversion Dam (RBDD) for the last 20 years of passage data is 99.8% (one SD of 0.2%). By 3/25/2023, 236,274 winter-run Chinook salmon were estimated to have passed RBDD compared to the cumulative passage last year of 572,568 winter-run Chinook salmon.
- Hatchery winter-run Chinook salmon:
    - Approximately 432,458 Livingston Stone NFH brood year 2022 winter Chinook salmon were released at dusk on 1/26-1/27/2023 into the Sacramento River at John F. Reginato River Access boat ramp, Redding, CA. This is the first release of LSNFH brood year 2022 hatchery winter Chinook salmon comprising of approximately 58% of the total hatchery production for the Sacramento River supplementation program. The release group is 100% marked (adipose-fin clip and CWT) with an overall estimated average fork length of 85mm. There has been no loss so far this water year with this release group.
    - Approximately 299,866 Livingston Stone NFH brood year 2022 winter Chinook salmon were released at dusk on 3/1/2023 into the Sacramento River at John F. Reginato River Access boat ramp, Redding, CA. This is the final release for the Livingston Stone NFH brood year 2022 winter Chinook Salmon supplementation program. This release group 100% marked (with an adipose-fin clip and CWT) and has an overall estimated average fork length of 85 mm. There has been no loss so far this water year with this release group.
    - Approximately 97,134 Coleman NFH Complex brood year 2022 winter Chinook Salmon were released on March 17, 2023. The release took place on the North Fork Battle Creek at Wilson Hill Bridge near Manton, CA. This is the first release of the brood year 2022 Jumpstart winter Chinook Salmon, and the only release of fish reared at the Mount Lassen Trout Farm, a private aquaculture facility located on North Fork Battle Creek. This group is 100% marked (with an adipose-fin and a left pelvic-fin clip and CWT).

Spring-run Chinook Salmon

- Delta Life Stages:
    - Young-of-year (YOY) and Yearlings
- Brood Year 2022 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 71,057 late-fall Chinook salmon from Coleman National Fish Hatchery were released at Battle Creek on 12/5/2022. This group is 100% marked with adipose-fin clip and CWT and have an estimated average fork length of 145mm. This is the first spring-run Chinook salmon surrogates release group associated with the Proposed Action. There has been no loss this water year of fish associated with the first surrogate release group.
        - Approximately 66,735 late-fall Chinook salmon from Coleman National Fish Hatchery were released at Battle Creek on 12/23/2022. This group is 100% marked with adipose-fin clip and CWT and have an estimated average fork length of 145mm.
        - Approximately 60,712 Coleman NFH brood year 2022 late-fall Chinook Salmon on January 13, 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.
    - There has been loss this water year of fish associated with the first, second, and third surrogate release groups.
    - The agencies in the SaMT discussed the thiamine vitamin deficiency that was observed in winter run Chinook salmon broodstock at the Livingston Stone National Fish Hatchery (LSNFH) in BY 2022. Last year the thiamine deficiency appeared to negatively affect survival of juvenile fish as they migrate downstream towards the Delta. The thiamine deficiency issue is also likely impacting spring-run Chinook salmon.

Central Valley Steelhead

- Delta Life Stages:
    - Spawning Adults, Kelts, Juveniles

- Brood Year 2022 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.
    - Natural steelhead: No JPE has been established for steelhead. Data are limited.
    - Hatchery steelhead: Reclamation's Proposed Action has no hatchery steelhead triggers.

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.
- There is uncertainty in the identification of some untagged salmonids potentially due to either tag loss or poor quality adipose clipping from hatchery releases made in the South Delta. Lower rates of tagging success were confirmed for by hatchery staff for some releases. Confirmation of origin of these fish will be through genetic identification.
- For fish observed in salvage and genetically analyzed through 3/15/2023, one has been genetically identified as Winter-run Chinook Salmon (see attachment A). The single winter-run LAD Chinook Salmon observed at the CVP facility on 2/23/2023 was genetically identified as a winter-run for a loss of 2.88.

Historic Trends

- For historical winter-run Chinook salmon trends in salvage, see Table 3.
- Loss of natural winter-run Chinook salmon at the CVP and SWP fish collection facilities may occur over the next week based on life history and detections in real-time monitoring locations in the Delta. If historic trends in salvage were to continue, winter-run Chinook salmon loss is expected to increase over the next week.

Forecasted Distribution within Central Valley and Delta regions

- Movement of winter-run Chinook salmon juveniles into the lower reaches of the Sacramento River and upper Delta may continue over the next week.
- 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). The DCC gates were closed 11/28/22 and are expected to remain closed through mid-May 2023.

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. If historic trends in salvage were to continue YOY spring-run Chinook salmon loss is unlikely to increase over the next week.

Forecasted Distribution within Central Valley and Delta regions

- Yearling spring-run Chinook are thought to be migrating through 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.

Historical Trends

- For historical CCV steelhead trends in salvage, see Table 2. If historic trends in salvage were to continue, juvenile CCV steelhead loss may occur over the next week.

Forecasted Distribution within Central Valley and Delta regions

- The entrainment tool estimates of CCV steelhead loss to be moderate (Table 6, Fig. 1).
- Closure of the DCC gates for the season will reduce exposure and possible entrainment of juvenile CCV steelhead from the Sacramento River into the interior Delta via the DCC gates.

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
GCID RST	N/A	N/A	N/A	N/A	N/A	N/A
Butte Creek RST	3/5-3/12	223	0	0	0	0
Tisdale RST	3/20-3/27	2	0	0	0	0

Locations	Reporting Period	SR Chinook	WR Chinook	LFR Chinook	Steelhead (Wild)	Green Sturgeon
Knights Landing RST	3/18-3/26	13	1	0	0	0
Lower Sacramento RST	3/19-3/25	0	0	0	0	0
Beach Seines	3/19-3/25	3	1	0	0	0
Sac. Trawl	3/19-3/25	1	5	0	0	0
Chipps Island Midwater Trawl	3/19-3/25	N/A	N/A	N/A	N/A	N/A
Mossdale Kodiak Trawl	3/19-3/25	2	1	0	5	0
EDSM	3/12-3/20	0	0	0	0	0
Feather River Herringer RST	3/21-3/27	0	0	0	2	0
Feather River Eye Side RST	3/10-3/19	0	0	0	0	0
Lower Feather River	3/10-3/19	0	0	0	0	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: 1-5%	Current: 52-69% Last Week: 60-79%	Current: 30-45% Last Week: 20-35%
YOY spring-run Chinook salmon	Current: 10-30% Last Week: 15-39%	Current: 65-80% Last Week: 65-75%	Current: 5-10% Last Week: 1-10%
YOY hatchery winter-run 15-39 Chinook salmon	Current: 35-55% Last Week: 55-75%	Current: 35-45% Last Week: 20-30%	Current: 10-20% Last Week: 5-15%
Natural origin steelhead	Current: 20-50% Last Week: 20-55%	Current: 25-45% Last Week: 25-50%	Current: 25-35% Last Week: 20-30%

Table 3. Historic migration and salvage patterns. Last updated 3/27/2023.

Species	Red Bluff Diversion Dam	Tisdale Rst	Knights Landing Rst	SacTrawl Sherwood Catch Index	Chipps Island Trawl Catch Index	Salvage
Chinook, Winter-run, Unclipped	99.7%(99.5%, 99.9%) BY: 2013 - 2021	99.4%(98.9%, 100.0%) BY: 2013 - 2021	99.4%(98.5%, 100.3%) BY: 2013 - 2021	81.9%(65.4%, 98.3%) BY: 2013 - 2021	49.4%(28.8%, 69.9%) BY: 2013 - 2021	80.4%(67.9%,92.9%) WY: 2013 - 2022

Species	Red Bluff Diversion Dam	Tisdale Rst	Knights Landing Rst	SacTrawl Sherwood Catch Index	Chipps Island Trawl Catch Index	Salvage
Chinook, Spring-run, Unclipped	46.4%(21.5%, 71.3%) BY: 2013 - 2021	37.3%(15.1%, 59.5%) BY: 2013 - 2021	43.2%(19.9%, 66.5%) BY: 2013 - 2021	19.2%(6.9%,31.5%) BY: 2013 - 2021	0.6%(0.0%,1.2%) BY: 2013 - 2021	6.8%(-2.4%,16.0%) WY: 2013 - 2022
Steelhead, Unclipped (January-December)	4.3%(1.1%,7.4%) BY: 2013 - 2022	47.6%(28.4%, 66.9%) BY: 2014 - 2022	55.1%(31.8%, 78.4%) BY: 2014 - 2022	54.1%(22.1%, 86.2%) BY: 2013 - 2022	55.6%(41.1%, 70.1%) BY: 2013 - 2022	N/A
Steelhead, Unclipped (December-March)	N/A	N/A	N/A	N/A	N/A	84.6%(72.8%,96.5%) WY: 2013 - 2022
Steelhead, Unclipped (April-June)	N/A	N/A	N/A	N/A	N/A	0.0%(0.0%,0.0%) WY: 2013 - 2022

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 temp.(f)	Alert Triggered
3/26/2023	425.8	-13.6%	Flow>95cfs	623.2	-12.0%	Flow>95cfs	22,743.4	N/A	N/A
3/25/2023	492.7	-19.4%	Flow>95cfs	707.9	-15.2%	Flow>95cfs	23,675.2	N/A	N/A
3/24/2023	611.0	-20.5%	Flow>95cfs	834.9	-12.6%	Flow>95cfs	23,997.5	N/A	N/A
3/23/2023	768.3	16.9%	Flow>95cfs	955.6	3.2%	Flow>95cfs	24,263.8	N/A	N/A
3/22/2023	657.5	2.5%	Flow>95cfs	925.8	-4.9%	Flow>95cfs	24,939.1	N/A	N/A
3/21/2023	641.8	-14.6%	Flow>95cfs	973.5	-10.7%	Flow>95cfs	25,217.4	42.7	WLK>7500cfs and KNL<56.3F

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 temp.(f)	Alert Triggered
3/20/2023	751.2	-0.0%	Flow>95cfs	1,090.6	-3.3%	Flow>95cfs	24,486.6	42.6	WLK>7500cfs and KNL<56.3 F

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

Stock	Date	Route	Median Travel Time	Survival	Routing Probability
Winter Chinook	2023-03-26	Overall	5.02	0.75	N/A
Winter Chinook	2023-03-26	Sacramento River	3.9	0.79	0.58
Winter Chinook	2023-03-26	Yolo Bypass	9.26	0.66	0.14
Winter Chinook	2023-03-26	Sutter Slough	4.36	0.68	0.11
Winter Chinook	2023-03-26	Steamboat Slough	4.00	0.79	0.08
Winter Chinook	2023-03-26	Interior Delta	6.66	0.69	0.09
Late-fall Chinook	2023-03-26	Overall	3.11	0.66	N/A
Late-fall Chinook	2023-03-26	Delta Cross Channel	N/A	N/A	0.00
Late-fall Chinook	2023-03-26	Georgiana Slough	4.99	0.38	0.18
Late-fall Chinook	2023-03-26	Sacramento River	2.55	0.72	0.47
Late-fall Chinook	2023-03-26	Sutter and Steamboat Slough	3.18	0.72	0.35

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

Table 6a-b. WY 2023 loss and salvage predictor data: Environmental details, current and forecast. Model results from 3/27/2023.

a) WY 2023 loss and salvage predictor data: Predicted weekly loss of winter-run Chinook salmon and steelhead at CVP and SWP facilities.

Parameter	Modeled Current Week	Modeled Next Week
Predicted Steelhead, Median %	243	110
Predicted Steelhead, High %	705	185
Predicted Chinook Winter Run, Median %	6	17
Predicted Chinook Winter Run, High %	104	104

b) Environmental details, current and forecast.

Parameter	Data	Forecast
Temperature (Mallard Island, C)	12.1	12.1
Precipitation (5-d running sum, inches)	0.14	0.14
Old and Middle River Flows (cfs)	9583	9583
Sacramento River Flow (Freeport, cfs)	73939	73939
DCC Gates	closed	closed
San Joaquin River Flow (Vernalis, cfs)	36078	36078
Export	10859	10859

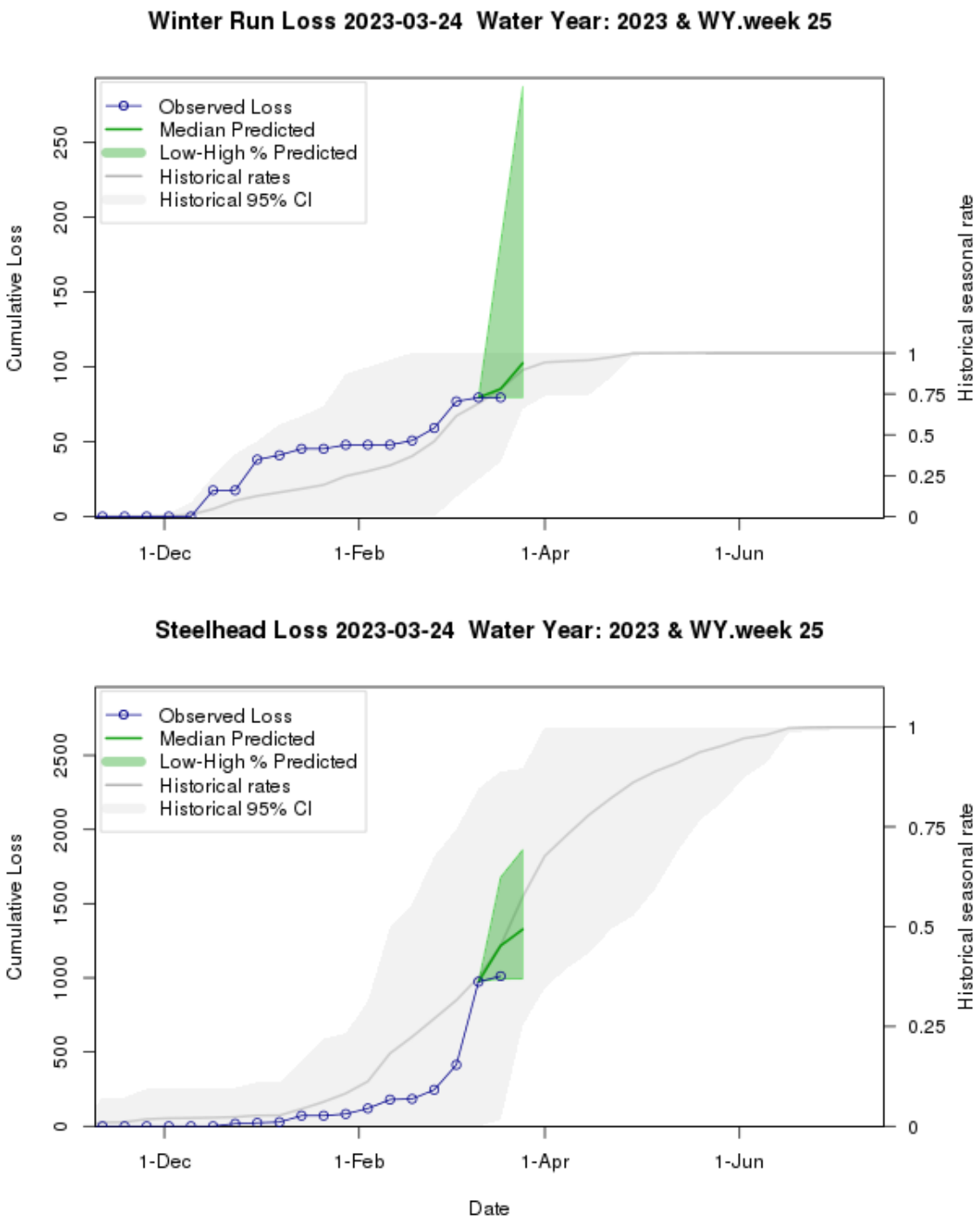
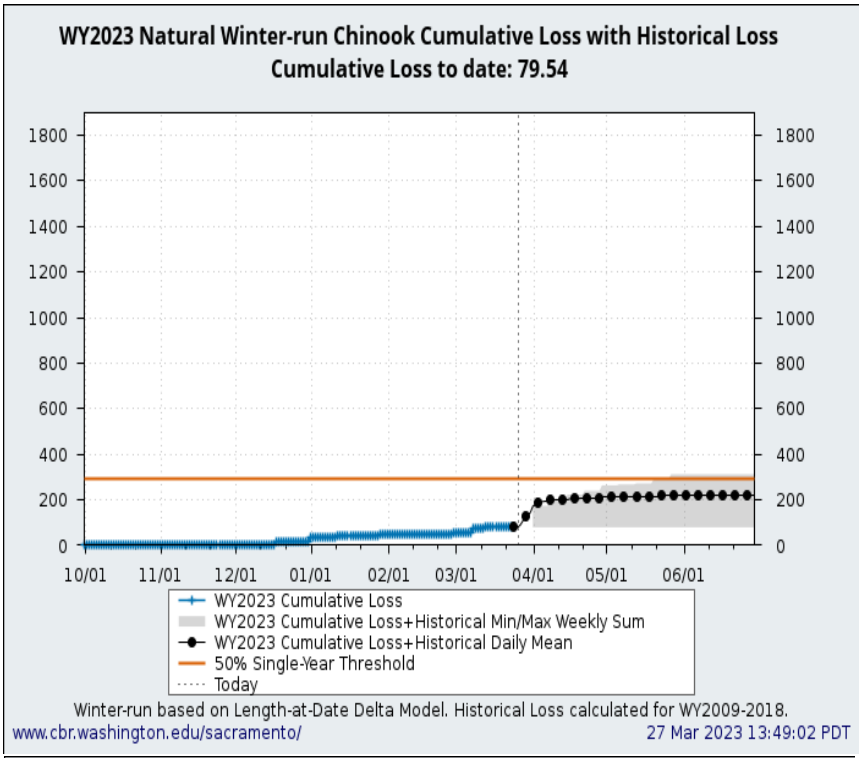


Figure 1. Predicted weekly loss of steelhead and winter-run Chinook salmon at the CVP and SWP facilities



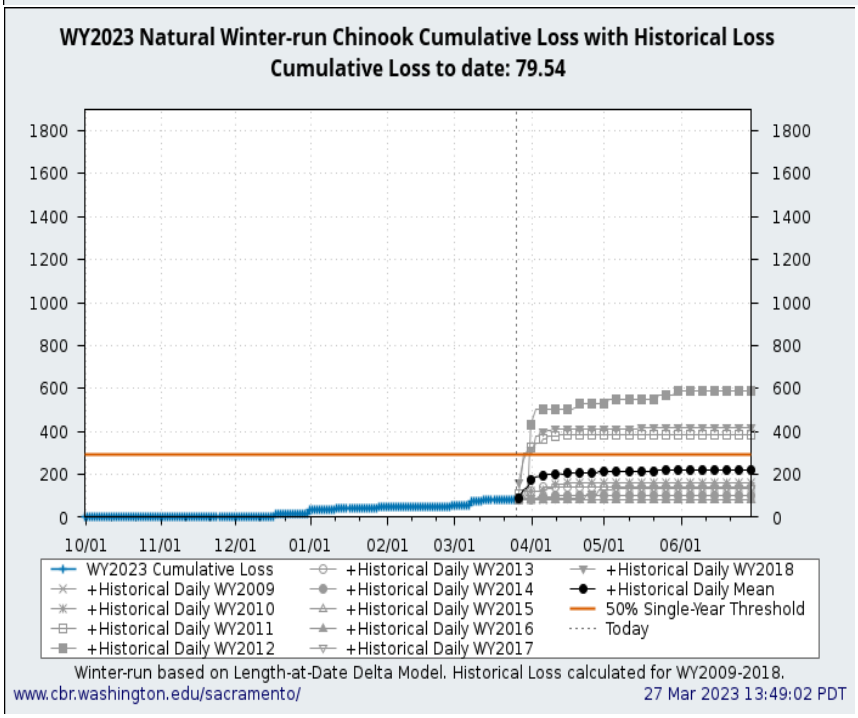


Figure 2. Predicted weekly loss of steelhead and winter-run Chinook salmon at the CVP and SWP facilities

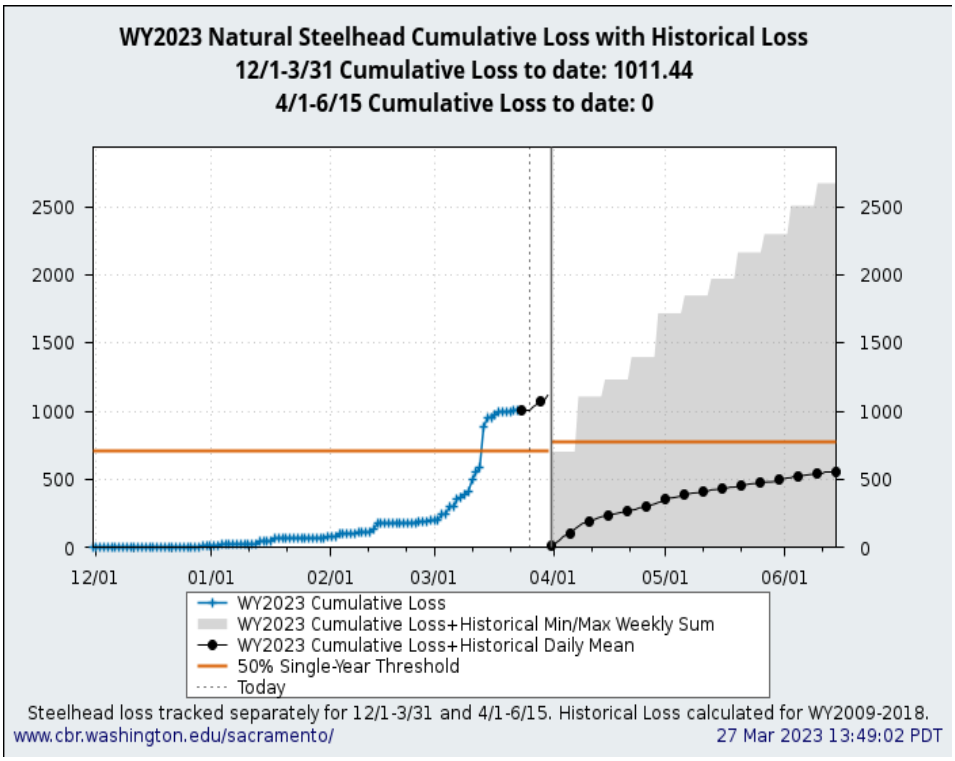


Figure 3. Cumulative natural steelhead loss for the year (blue) and 2009 – 2018 historic cumulative loss (gray, different symbols). Historic daily mean plotted in black circles

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 juvenile salmonids are 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 remain at or more positive than -5,000 cfs this upcoming week. OMR flows more positive than -5,000 cfs are hypothesized to have minimal impact on movement and distribution of salmonids in the South Delta.

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

Not applicable, see response above.

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 82.54 fish (as of 03/27/2023). Loss of juvenile winter-run LAD Chinook salmon has occurred in the past week at the CVP and SWP fish salvage facilities. Final JPE calculations have been established for brood year (BY) 2022 winter-run Chinook salmon. The agencies in the SaMT assessed the likelihood of exceeding the next annual loss threshold and are uncertain if loss occurring in the next week will lead to exceedance of the 50% single-year loss threshold. It is possible that the 50% annual loss threshold (292), 75% annual loss threshold (438), 90% annual loss threshold (525.7) and incidental take limit (998.5) will be exceeded this year, based on length at date.

The winter-run juvenile production estimate is low this year, leading to a low annual loss threshold. The length-at-date model is used for tracking exceedance of these thresholds; however, this year hatcheries experienced errors in clipping late-fall run Chinook salmon that are within the older juvenile size range and may be mistakenly identified as natural winter-run because they lack the typical markings of a hatchery-produced fish. Figures 1 and 2 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 2 may be relevant this year. Genetic methods provide a more accurate measure of identifying winter-run Chinook salmon than length-at-date. DNA results indicate a loss of 2.88 winter-run Chinook salmon so far this year.

Spring-run Chinook salmon

Total natural young of year spring-run Chinook salmon (LAD) loss is 25.93 fish (as of 3/27/2023). Loss of natural juvenile spring-run LAD Chinook salmon has occurred in the past week at the CVP and SWP fish salvage facilities. 7 genetically confirmed spring-run have been caught in salvage this WY with a total loss of 42.23. Loss for yearling spring-run surrogate has not exceeded the 0.5 % threshold for any release group (refer to Ops Outlook Table 2). The agencies in the SaMT assessed the likelihood of exceeding annual loss threshold and believe that loss occurring in the next week is unlikely to lead to exceeding the hatchery spring-run surrogate threshold.

Central Valley Steelhead

Total natural juvenile steelhead loss (December 1 through March 31) is 1012.44 fish (as of 3/27/2023). Loss of natural juvenile has occurred in the past week at the CVP and SWP fish salvage facilities. The December-March 50% annual loss threshold (707) was exceeded on 3/15/2023. See table 6a for predicted weekly loss of steelhead at the CVP and SWP facilities. Information is limited on steelhead population, so it is not possible to assess the effects on steelhead at a population level. Salmonid survival increases when flows are high (Michel et al. 2021). Acoustic telemetry studies indicated that survival is correlated with increased flows at Vernalis for San-Joaquin origin Steelhead (Buchanan et al. 2021). Increased turbidity decreases predation risk because predators are unlikely to detect juvenile fish. The agencies in the SaMT assessed the likelihood of exceeding the next annual loss threshold and believe that loss occurring in the next few weeks can exceed the 75% single-year loss threshold (see Figures 1 and 3).

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 annual loss threshold for winter-run Chinook salmon has not been exceeded in WY 2023.

   Spring-run Chinook salmon

   The annual loss threshold for spring-run Chinook salmon has not been exceeded in WY 2023.

   Central Valley Steelhead

   The 50% annual loss threshold for steelhead (December 1 – March 31) has been exceeded in WY 2023. It is uncertain if additional OMR restrictions benefit fish movement and survival. Reclamation and partner agencies continue to study survival and routing of San Joaquin-origin steelhead through the Delta that would help inform this question with real-time information. Studies indicate that high flows increase survival (Buchanan et al. 2021). Higher exports under conditions in which OMR was no more negative than –5,000 cfs were not associated with decreased survival during the study timeframe. (Buchanan et al. 2021).

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 OMR flows are 5,000 to 17,000 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

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. doi:10.1139/cjfas-2020-0467.

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). doi:10.1002/ecs2.3498.

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 but likely.

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 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 3/27/2023). 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
- Brood Year 2022:
- Abundance estimate:
    - The most recent abundance estimate is from March 24, 2023, and was 1,575 (95% CI: 218 to 5,692).
- Biological Conditions:
    - Adult Delta Smelt are expected to be present in the Sacramento Deepwater Ship Channel, and the Southern Delta and Suisun Marsh based on the most recent survey detections. The large-scale population Delta Smelt migration has completed and the population is distributed widely in the Delta (Sommer et al. 2011). High variability in localized movement of spawning fish is likely (Polansky et al. 2017). The response of cultured fish to environmental cues typically applied to wild Delta Smelt is highly uncertain. Water temperatures are suitable for spawning (Damon et al. 2016) and for the presence of larval Delta Smelt. The Smelt Monitoring Team discussed the most recent monitoring data (Table 4) and considered published literature and professional judgement on the historical trends in regional distribution.

Distribution

Current Distribution

- Real time detection data is currently limited to EDSM, Chipps Island Trawl and SLS; Bay Study, SKT, and 20mm survey provide data as available.
- One marked adult Delta Smelt has been detected by surveys in the Sacramento Deepwater Ship Channel starting 3/13/2023.
- One adult Delta Smelt detected in salvage on 2/22/2023 was expressing eggs and one detected in salvage on 3/2/2023 was ripe, which could indicate spawning in OMR corridor.
- No Delta Smelt have been detected in salvage at the SWP and CVP since 3/2/2023. Cumulative seasonal salvage is 52.
- Experimental release of hatchery Delta Smelt occurred at Rio Vista on November 30, 2022, and January 18-19, 2023, and in the Deepwater Shipping Channel on January 25-26, 2023. Forty-two fish from the experimental release have been caught or salvaged since 12/14/22.
- Larval sampling at the Skinner Fish Facility (SFF) and the Tracy Fish Collection Facility (TFCF) was initiated by the SMT at 0400 on March 1.
- COA 8.5.2: No larval or juvenile Delta Smelt have been detected in the system.

Table 7. 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.

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

Table 8. 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 detections that have undergone preliminary ID, QA/QC,

and genetic confirmation. Numbers are updated as QA/QC and genetic confirmation become available.

Sampling Method	Frequency	New Prelim-inary Detections	Prelim-inary to Date	QA/QC to Date	Genetically Confirmed to Date	Total WY2023	Notes
EDSM	Weekly	1	N/A	27	1	28	Phase 1 began 12/5/22
SKT	Monthly	0	N/A	4	N/A	4	Ongoing
SLS	Biweekly	0	N/A	N/A	N/A	0	Ongoing
20-mm	Biweekly	0	N/A	N/A	N/A	0	Ongoing
Summer Townet	Biweekly	0	N/A	N/A	N/A	0	Begins: June
Bay Study	Monthly	0	N/A	N/A	N/A	0	Ongoing
FMWT	Monthly	0	N/A	N/A	N/A	0	Complete
Chipps Island Trawl	Weekly	0	N/A	2	N/A	2	Ongoing
FCCL Brood Stock Collections	Weekly	0	N/A	2	N/A	2	Ongoing
LEPS	As available	0	N/A	N/A	N/A	0	Ongoing
FRP	Daily	0	N/A	N/A	N/A	0	Ongoing
Tracy Fish Collection Facility (CVP)	Daily	0	N/A	9	N/A	9	Ongoing
Skinner Fish Facility (SWP)	Daily	0	N/A	4	N/A	4	Ongoing
Total	N/A	N/A	N/A	N/A	N/A	49	Sum of all Delta Smelt observed during the OMR Manageme nt Season

Cultured Delta Smelt Experimental Releases

- Experimental releases included:
    - 13,140 fish on November 30, 2022,
    - 17,570 fish on January 18-19, 2023, both at Rio Vista,
    - 12,995 in the Sacramento Deep Water Ship Channel.
- Experimental releases are complete.
- Details of Delta Smelt releases are available at: SacPAS: Central Valley Prediction & Assessment of Salmon

Table 9. 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
N/A	N/A	N/A	N/A	N/A	N/A	N/A

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 (Figure 4; Table 12; 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/tmp/hrtsalvage_1676407207_694.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

- Precipitation is forecasted today through Wednesday (1-2") , with temperatures below normal throughout the week. Near Stockton, SSE winds 11-21 mph, with gusts up to 26 mph through Wednesday. Near Antioch, S to WSW winds 13-26 mph, with gusts up to 40 mph becoming SE at 10-15 mph with gusts up to 20 mph on Wednesday.
- Turbidity is above 12 FNU at OBI and above 12 FNU across central and south Delta stations. Turbidity is expected to remain stable or increase over the next week due to recent precipitation and anticipated precipitation and wind this week.

Table 10. Relevant Environmental Factors to the current management actions for Delta Smelt.

Date Reported	OBI Daily Average Turbidity (FNU)	SJJ 3-day Average Water temperature (°C)	SLS 6 Avg Secchi Depth (m)	20 mm 1 Avg Secchi Depth (m)
3/27/2023	20.85	12.4	0.46*	0.54*

*Updated 3/13/2023

X2 Conditions

- As of 3/20/2023, X2 is estimated to be well west of Martinez (< 56 km).
- When X2 is above 81 km, the SMT uses the X2_EC_Graph.xlxs tool to estimate the position of X2 for both the Sacramento and San Joaquin Rivers and assumes the average of the two is representative of an approximate X2 position.

Other Environmental Conditions

- The Fish and Water Operation Outlook OMR Index values are expected to range between +5,000 to +17,000 cfs from 3/28/2023 to 4/4/2023.
- QWEST was estimated at 44,000 cfs on 3/27/2023 and is expected to remain above 30,000 cfs this week.
- Water temperature at Rio Vista was 11.8°C and at Antioch 12.4°C on 3/27/2023.
- Real time tracking of environmental conditions, relevant thresholds and Delta Smelt catch data are updated daily at: http://www.cbr.washington.edu/sacramento/workgroups/delta_smelt.html.

Evaluation

USBR and DWR Proposed Operations:

- 3/28-4/4: The 3-day average water temperature at Jersey Point is greater than 12 degrees Celsius and the average Secchi depth at the 12 central and south Delta stations is less than 1 meter, requiring a 7-day average OMR index limit of less negative than or equal to –3,500 cfs for larval Delta smelt protection under the amended ITP COA 8.5.2 and Interim Operations. The CVP and SWP also will operate to a 14-day moving average OMRI of no more negative than -3,500 cfs until March 31, due to exceedance of the 50% of the annual loss threshold for Steelhead. Due to very high flows, the Bay/Delta is in excess conditions and the OMRI limit is
- Interim Operations have been adopted. USBR will be adhering to ITP Protections for Larval & Juvenile Delta Smelt (COA 8.5.2) or the PA's Larval and Juvenile Smelt Protections, whichever is more protective.

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

   First flush conditions based on running 3-day average flow and running 3-day average turbidity at Freeport were met on December 31, 2022, triggering IEWPP regulations. The CVP and SWP reduced exports beginning on 1/3/2023 through 1/16/2023.

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

   This is no longer applicable.

3. Has a spent female been collected?

   A spent female has not been collected, but two cultured ripe females were caught by SKT on 2/8/2023. Some of the fish released in January were observed to be ripe and releasing eggs upon release. This could be due to warmer water temperatures at culture facilities, or due to stress from releases.

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

   This question is not applicable as the turbidity bridge avoidance action was offramped starting 2/9/2023 with the capture of two ripe, marked female Delta Smelt.

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

   OBI turbidity is currently above 12 NTU/FNU (Average of 20.8 FNU on 3/27/2023). The daily average turbidities on 3/27/2023 at Prisoners Point (16.9 NTU), Holland Cut (16.7 FNU) and Victoria Canal (26.4 NTU) are likely to remain stable or increase over the next seven days.

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

   This question is not applicable as OBI turbidity is < 12 NTU/FNU, and the action was off-ramped starting 2/9/2023 with the capture of two ripe, marked female Delta Smelt.

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 positive and anticipated to remain positive through the week and no larval or juvenile DSM have been detected this water year. One adult DSM salvaged on 3/2/2023 was ripe, which could indicate spawning in the South Delta.

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?

   Turbidity and temperature conditions: On 3/13/2023 SLS Survey #6 and 20 mm Survey #1 mean Secchi depths at the South Delta stations were below 1m (0.46m and 0.54m respectively). Mean secchi depth across strata (EDSM) between 3/21/23 and 3/27/23 was 0.30m, and mean secchi depth in the South Delta on 3/24 was 0.46m. The 3-day mean water temperature at Jersey Point exceeded 12°C on 3/18/23.

   Real-time biological conditions: While no larval or juvenile DSM have been detected, they are considered present based on environmental conditions.

   Current OMRI management: Yes, larval protection of an OMRI no more negative than -3500 cfs was triggered on 3/18/23 based on temperature and secchi depth data.

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?

   OMRI values are anticipated to be between +5,000 cfs and +17,000 cfs throughout the week. Daily and 3-day average water temperatures have exceeded 12˚ C at multiple stations. The majority of spawning typically occurs between 11-14° C (Damon et al. 2016; Attachment A, Figure 4). Adult fish are in the South Delta based on detections in salvage. The extent to which spawning has occurred and larvae are present in the South Delta is unknown but historical monitoring data from the past few years indicate larval detections typically begin around March 15. No larvae have been detected. The likelihood of larval DSM entrainment is low, given positive and high OMRI and QWEST values.

Delta Smelt References

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Attachment A.

Table 11. Salmonid Genetic testing results for WY 2023 as of this assessment. Genetic identification of salmon is not used in calculating loss.

ID	Sample Date	Fork Length	Julian	ots28	sexid	Assignment	PosProb1	Group	Model	Facility	OriginalID
C220127CVP	12/17/2022 22:00	185	171	late	male	Non-winter	1.000	Spring	Fall	CVP	C220127CVP
C220098SWP	12/18/2022 13:00	137	172	late	female	Non-winter	1.000	Spring	Winter	SWP	C220098SWP
C220099SWP	12/28/2022 5:00	154	181	late	male	Non-winter	1.000	Spring	Late Fall	SWP	C220099SWP
C220128CVP	12/30/2022 23:59	163	184	late	female	Non-winter	1.000	Fall	Late Fall	CVP	C220128CVP
C220180SWP	12/31/2022 3:00	180	184	late	male	Non-winter	1.000	Fall	Late Fall	SWP	C220180SWP
C230082SWP	1/1/2023 10:00	150	185	late	male	Non-winter	1.000	Fall	Winter	SWP	C230082SWP
C230083SWP	1/1/2023 11:00	113	185	late	female	Non-winter	1.000	Fall	Winter	SWP	C230083SWP
C230082CVP	1/2/2023 14:00	212	187	early	male	Non-winter	1.000	Fall	Fall	CVP	C230082CVP
C230001CVP	1/3/2023 10:00	35	187	late	female	Non-winter	1.000	Fall	Fall	CVP	C230001CVP
C230002CVP	1/3/2023 10:00	34	187	late	male	Non-winter	1.000	Fall	Fall	CVP	C230002CVP
C230003CVP	1/3/2023 10:00	33	187	late	female	Non-winter	1.000	Fall	Fall	CVP	C230003CVP
C230004CVP	1/3/2023 10:00	34	187	late	male	Non-winter	1.000	Fall	Fall	CVP	C230004CVP
C230005CVP	1/3/2023 12:00	35	188	late	male	Non-winter	1.000	Unassigned	Fall	CVP	C230005CVP

ID	Sample Date	Fork Length	Julian	ots28	sexid	Assignment	PosProb1	Group	Model	Facility	OriginalID
C230006CVP	1/4/2023 8:00	38	188	late	female	Non-winter	1.000	Fall	Fall	CVP	C230006CVP
C230007CVP	1/4/2023 12:00	36	189	late	female	Non-winter	1.000	Fall	Fall	CVP	C230007CVP
C230008CVP	1/4/2023 12:00	38	189	late	female	Non-winter	1.000	Fall	Fall	CVP	C230008CVP
C230009CVP	1/4/2023 12:00	36	189	late	female	Non-winter	1.000	Spring	Fall	CVP	C230009CVP
C230010CVP	1/4/2023 14:00	38	189	late	male	Non-winter	1.000	Fall	Fall	CVP	C230010CVP
C230084SWP	1/4/2023 15:00	162	189	late	male	Non-winter	1.000	Fall	Late Fall	SWP	C230084SWP
C230012CVP	1/4/2023 22:00	148	189	late	male	Non-winter	1.000	Spring	Winter	CVP	C230012CVP
C230011CVP	1/5/2023 10:00	37	189	late	female	Non-winter	1.000	Fall	Fall	CVP	C230011CVP
C230013CVP	1/5/2023 14:00	163	190	late	female	Non-winter	1.000	Fall	Late Fall	CVP	C230013CVP
C230015CVP	1/11/2023 6:00	38	195	late	male	Non-winter	1.000	Fall	Fall	CVP	C230015CVP
C230016CVP	1/12/2023 8:00	166	196	late	female	Non-winter	1.000	Spring	Winter	CVP	C230016CVP
C230019CVP	1/12/2023 10:00	42	196	late	male	Non-winter	1.000	Spring	Fall	CVP	C230019CVP
C230018CVP	1/12/2023 12:00	34	197	late	female	Non-winter	1.000	Fall	Fall	CVP	C230018CVP
C230020CVP	1/12/2023 23:59	31	197	late	male	Non-winter	1.000	Fall	Fall	CVP	C230020CVP
C230021CVP	1/13/2023 6:00	35	197	late	male	Non-winter	1.000	Fall	Fall	CVP	C230021CVP
C230022CVP	1/13/2023 10:00	35	197	late	male	Non-winter	1.000	Spring	Fall	CVP	C230022CVP

ID	Sample Date	Fork Length	Julian	ots28	sexid	Assignment	PosProb1	Group	Model	Facility	OriginalID
C230023CVP	1/13/2023 23:59	38	198	late	male	Non-winter	1.000	Fall	Fall	CVP	C230023CVP
C230024CVP	1/14/2023 2:00	38	198	late	female	Non-winter	1.000	Fall	Fall	CVP	C230024CVP
C230025CVP	1/14/2023 6:00	35	198	late	male	Non-winter	1.000	Fall	Fall	CVP	C230025CVP
C230026CVP	1/14/2023 6:00	195	198	late	male	Non-winter	1.000	Fall	Late Fall	CVP	C230026CVP
C230027CVP	1/14/2023 14:00	36	199	late	female	Non-winter	1.000	Fall	Fall	CVP	C230027CVP
C230086SWP	1/17/2023 7:45	149	201	late	female	Non-winter	1.000	Fall	Winter	SWP	C230086SWP
C230029CVP	1/17/2023 8:00	36	201	late	female	Non-winter	1.000	Fall	Fall	CVP	C230029CVP
C230031CVP	1/17/2023 23:59	36	202	late	male	Non-winter	1.000	Fall	Fall	CVP	C230031CVP
C230032CVP	1/17/2023 23:59	35	202	late	male	Non-winter	1.000	Fall	Fall	CVP	C230032CVP
C230033CVP	1/17/2023 23:59	35	202	late	male	Non-winter	1.000	Fall	Fall	CVP	C230033CVP
C230034CVP	1/18/2023 4:00	35	202	late	male	Non-winter	1.000	Fall	Fall	CVP	C230034CVP
C230035CVP	1/18/2023 4:00	35	202	late	male	Non-winter	1.000	Fall	Fall	CVP	C230035CVP
C230036CVP	1/18/2023 12:00	38	203	late	female	Non-winter	1.000	Fall	Fall	CVP	C230036CVP
C230037CVP	1/18/2023 14:00	37	203	late	male	Non-winter	1.000	Fall	Fall	CVP	C230037CVP
C230038CVP	1/18/2023 16:00	34	203	late	male	Non-winter	1.000	Fall	Fall	CVP	C230038CVP
C230039CVP	1/19/2023 10:00	32	203	late	female	Non-winter	1.000	Fall	Fall	CVP	C230039CVP

ID	Sample Date	Fork Length	Julian	ots28	sexid	Assignment	PosProb1	Group	Model	Facility	OriginalID
C230040CVP	1/19/2023 10:00	37	203	late	male	Non-winter	1.000	Fall	Fall	CVP	C230040CVP
C230041CVP	1/19/2023 14:00	37	204	late	female	Non-winter	1.000	Fall	Fall	CVP	C230041CVP
C230042CVP	1/19/2023 18:00	35	204	late	female	Non-winter	1.000	Fall	Fall	CVP	C230042CVP
C230043CVP	1/19/2023 18:00	30	204	late	male	Non-winter	1.000	Fall	Fall	CVP	C230043CVP
C230044CVP	1/19/2023 18:00	38	204	late	male	Non-winter	1.000	Fall	Fall	CVP	C230044CVP
C230045CVP	1/20/2023 2:00	35	204	late	female	Non-winter	1.000	Fall	Fall	CVP	C230045CVP
C230046CVP	1/20/2023 2:00	35	204	late	female	Non-winter	1.000	Fall	Fall	CVP	C230046CVP
C230047CVP	1/20/2023 2:00	34	204	late	male	Non-winter	1.000	Fall	Fall	CVP	C230047CVP
C230048CVP	1/20/2023 6:00	35	204	late	female	Non-winter	1.000	Fall	Fall	CVP	C230048CVP
C230049CVP	1/20/2023 10:00	37	204	late	female	Non-winter	1.000	Fall	Fall	CVP	C230049CVP
C230050CVP	1/20/2023 18:00	30	205	late	female	Non-winter	1.000	Fall	Fall	CVP	C230050CVP
C230051CVP	1/21/2023 12:00	34	206	late	female	Non-winter	1.000	Fall	Fall	CVP	C230051CVP
C230052CVP	1/22/2023 2:00	38	206	late	male	Non-winter	1.000	Fall	Fall	CVP	C230052CVP
C230053CVP	1/22/2023 12:00	35	207	late	female	Non-winter	1.000	Fall	Fall	CVP	C230053CVP
C230054CVP	1/22/2023 14:00	36	207	late	female	Non-winter	1.000	Fall	Fall	CVP	C230054CVP
C230055CVP	1/23/2023 12:00	37	208	late	male	Non-winter	1.000	Fall	Fall	CVP	C230055CVP

ID	Sample Date	Fork Length	Julian	ots28	sexid	Assignment	PosProb1	Group	Model	Facility	OriginalID
C230056CVP	1/24/2023 14:00	37	209	late	male	Non-winter	1.000	Fall	Fall	CVP	C230056CVP
C230057CVP	1/26/2023 14:00	35	211	late	female	Non-winter	1.000	Fall	Fall	CVP	C230057CVP
C230058CVP	1/26/2023 23:59	37	211	early	male	Non-winter	1.000	Fall	Fall	CVP	C230058CVP
C230060CVP	1/27/2023 8:00	42	211	late	female	Non-winter	1.000	Fall	Fall	CVP	C230060CVP
C230061CVP	1/27/2023 10:00	37	211	early	male	Non-winter	1.000	Fall	Fall	CVP	C230061CVP
C230062CVP	1/27/2023 14:00	35	212	late	male	Non-winter	1.000	Fall	Fall	CVP	C230062CVP
C230063CVP	1/27/2023 18:00	52	212	late	female	Non-winter	1.000	Fall	Spring	CVP	C230063CVP
C230064CVP	1/27/2023 18:00	36	212	late	female	Non-winter	1.000	Fall	Fall	CVP	C230064CVP
C230065CVP	1/27/2023 18:00	30	212	late	female	Non-winter	1.000	Fall	Fall	CVP	C230065CVP
C230066CVP	1/28/2023 12:00	36	213	late	male	Non-winter	1.000	Fall	Fall	CVP	C230066CVP
C230067CVP	1/28/2023 14:00	35	213	late	female	Non-winter	1.000	Fall	Fall	CVP	C230067CVP
C230068CVP	1/29/2023 8:00	37	213	late	female	Non-winter	1.000	Fall	Fall	CVP	C230068CVP
C230069CVP	1/29/2023 8:00	39	213	late	female	Non-winter	1.000	Fall	Fall	CVP	C230069CVP
C230070CVP	1/29/2023 8:00	38	213	late	female	Non-winter	1.000	Fall	Fall	CVP	C230070CVP
C230071CVP	1/29/2023 8:00	39	213	late	male	Non-winter	1.000	Fall	Fall	CVP	C230071CVP
C230072CVP	1/29/2023 8:00	37	213	late	male	Non-winter	1.000	Fall	Fall	CVP	C230072CVP

ID	Sample Date	Fork Length	Julian	ots28	sexid	Assignment	PosProb1	Group	Model	Facility	OriginalID
C230073CVP	1/29/2023 8:00	38	213	late	female	Non-winter	1.000	Fall	Fall	CVP	C230073CVP
C230074CVP	1/30/2023 6:00	38	214	late	female	Non-winter	1.000	Fall	Fall	CVP	C230074CVP
C230075CVP	1/30/2023 6:00	36	214	early	male	Non-winter	1.000	Fall	Fall	CVP	C230075CVP
C230076CVP	1/30/2023 8:00	145	214	late	male	Non-winter	1.000	Spring	Winter	CVP	C230076CVP
C230077CVP	1/30/2023 8:00	36	214	late	male	Non-winter	1.000	Fall	Fall	CVP	C230077CVP
C230078CVP	1/30/2023 18:00	45	215	early	male	Non-winter	1.000	Fall	Fall	CVP	C230078CVP
C230079CVP	1/30/2023 18:00	36	215	late	male	Non-winter	1.000	Fall	Fall	CVP	C230079CVP
C230080CVP	1/30/2023 20:00	37	215	late	female	Non-winter	1.000	Fall	Fall	CVP	C230080CVP
C230081CVP	1/30/2023 22:00	34	215	late	female	Non-winter	1.000	Fall	Fall	CVP	C230081CVP
C230084CVP	1/31/2023 8:00	40	215	late	female	Non-winter	1.000	Fall	Fall	CVP	C230084CVP
C230085CVP	1/31/2023 8:00	40	215	early	female	Non-winter	1.000	Fall	Fall	CVP	C230085CVP
C230086CVP	1/31/2023 16:00	34	216	late	male	Non-winter	1.000	Fall	Fall	CVP	C230086CVP
C230087CVP	1/31/2023 20:00	44	216	early	female	Non-winter	1.000	Fall	Fall	CVP	C230087CVP
C230088CVP	2/1/2023 8:00	38	216	late	female	Non-winter	1.000	Fall	Fall	CVP	C230088CVP
C230089CVP	2/1/2023 10:00	35	216	late	male	Non-winter	1.000	Fall	Fall	CVP	C230089CVP
C230090CVP	2/1/2023 10:00	37	216	late	male	Non-winter	1.000	Fall	Fall	CVP	C230090CVP

ID	Sample Date	Fork Length	Julian	ots28	sexid	Assignment	PosProb1	Group	Model	Facility	OriginalID
C230091CVP	2/1/2023 20:00	34	217	late	male	Non-winter	1.000	Fall	Fall	CVP	C230091CVP
C230092CVP	2/1/2023 20:00	33	217	late	female	Non-winter	1.000	Fall	Fall	CVP	C230092CVP
C230093CVP	2/2/2023 10:00	41	217	late	female	Non-winter	1.000	Fall	Fall	CVP	C230093CVP
C230094CVP	2/2/2023 12:00	39	218	late	male	Non-winter	1.000	Fall	Fall	CVP	C230094CVP
C230097CVP	2/3/2023 6:00	42	218	late	female	Non-winter	1.000	Fall	Fall	CVP	C230097CVP
C230098CVP	2/3/2023 6:00	48	218	late	male	Non-winter	1.000	Fall	Fall	CVP	C230098CVP
C230099CVP	2/5/2023 6:00	38	220	late	female	Non-winter	1.000	Fall	Fall	CVP	C230099CVP
C230100CVP	2/5/2023 6:00	36	220	late	female	Non-winter	1.000	Fall	Fall	CVP	C230100CVP
C230102CVP	2/5/2023 14:00	41	221	early	male	Non-winter	1.000	Fall	Fall	CVP	C230102CVP
C230103CVP	2/6/2023 8:00	38	221	late	male	Non-winter	1.000	Fall	Fall	CVP	C230103CVP
C230104CVP	2/6/2023 8:00	38	221	late	female	Non-winter	1.000	Fall	Fall	CVP	C230104CVP
C230105CVP	2/6/2023 8:00	34	221	late	male	Non-winter	1.000	Fall	Fall	CVP	C230105CVP
C230106CVP	2/7/2023 6:00	38	222	late	male	Non-winter	1.000	Fall	Fall	CVP	C230106CVP
C230107CVP	2/7/2023 18:00	39	223	late	female	Non-winter	1.000	Fall	Fall	CVP	C230107CVP
C230108CVP	2/9/2023 12:00	38	225	late	male	Non-winter	1.000	Spring	Fall	CVP	C230108CVP
C230109CVP	2/9/2023 12:00	40	225	early	male	Non-winter	1.000	Fall	Fall	CVP	C230109CVP

ID	Sample Date	Fork Length	Julian	ots28	sexid	Assignment	PosProb1	Group	Model	Facility	OriginalID
C230087SWP	2/10/2023 9:00	35	225	late	female	Non-winter	1.000	Fall	Fall	SWP	C230087SWP
C230110CVP	2/15/2023 10:00	53	230	early	male	Non-winter	1.000	Fall	Fall	CVP	C230110CVP
C230111CVP	2/16/2023 23:59	48	232	late	female	Non-winter	1.000	Fall	Fall	CVP	C230111CVP
C230112CVP	2/18/2023 6:00	44	233	late	female	Non-winter	1.000	Spring	Fall	CVP	C230112CVP
C230113CVP	2/22/2023 12:00	48	238	late	male	Non-winter	1.000	Spring	Fall	CVP	C230113CVP
C230114CVP	2/23/2023 18:00	34	239	late	male	Non-winter	1.000	Spring	Fall	CVP	C230114CVP
C230115CVP	2/23/2023 23:59	130	239	early	male	Winter	1.000	Winter	Winter	CVP	C230115CVP
C230116CVP	2/28/2023 10:00	138	243	late	male	Non-winter	1.000	Spring	Winter	CVP	C230116CVP
C230117CVP	2/28/2023 23:59	148	244	late	female	Non-winter	1.000	Spring	Winter	CVP	C230117CVP
C230118CVP	3/3/2023 4:00	171	246	late	female	Non-winter	1.000	Late Fall	Winter	CVP	C230118CVP
C230088SWP	3/8/2023 15:00	156	252	late	female	Non-winter	1.000	Fall	Winter	SWP	C230088SWP
C230152CVP	3/13/2023 18:00	137	257	late	female	Non-winter	1.000	Fall	Winter	CVP	C230152CVP

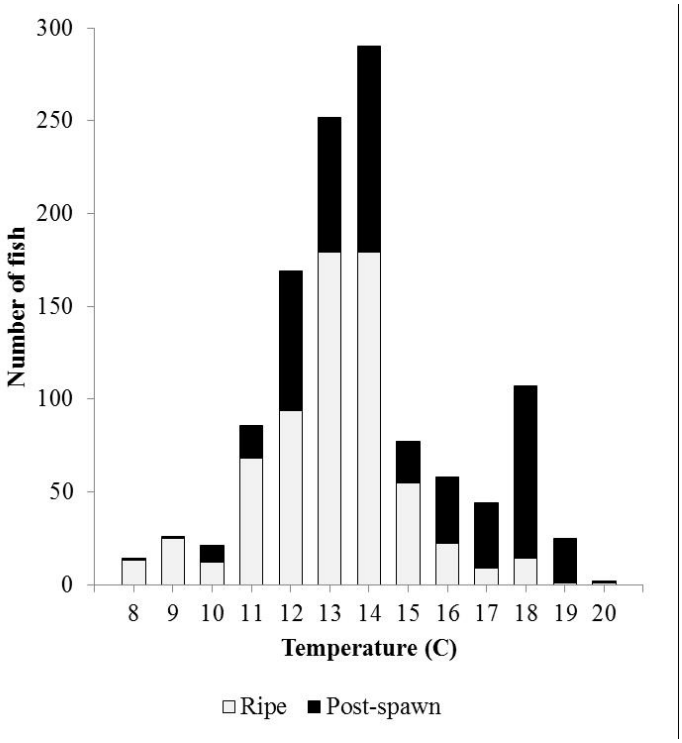

Figure 4. The number of ripe (grey) or post-spawn (black) delta smelt caught in a specific temperature range during routine monthly sampling in the upper San Francisco Estuary during January-May for years 2002-2015 (Figure 8 from Damon et al. 2016).

Table 12. Number and size range (mm FL) of near-ripe female delta smelt on their first or subsequent clutch of eggs by month of collection. Delta smelt were used in this study's fecundity analysis and collected during routine monthly sampling during January-May for years 2012-2015 (Table 3 from Damon et al. 2016).

Month	First	Subsequent	Total
January	2 (72-73)	0	2 (72-73)
February	41 (56-84)	2 (65-85)	43(56-85)
March	37 (63-77)	5 (63-81)	42 (63-81)
April	6 (62-82)	9 (65-90)	15 (62-90)
May	7 (68-78)	20 (69-83)	27 (68-83)