BUREAU OF RECLAMATION

Water Year 2024 Seasonal Report for Old and Middle River Flow Management

Central Valley Project, California

California-Great Basin Region

Mission Statements

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The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

Water Year 2024 Seasonal Report for Old and Middle River Flow Management

Central Valley Project, California

California-Great Basin Region

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Cover Photo: A photograph of the Shasta Dam.. (Reclamation)

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Purpose

The Water Year (WY) 2024 Seasonal Report for Old and Middle River (OMR) Flow Management describes Sacramento–San Joaquin River Delta (Delta) operations and actions and recommends adjustments to the OMR Flow Management Guidance Document (OMR Guidance Document) and the Delta Cross Channel (DCC) Operations and Fall/Winter Closures Guidance Document (DCC Guidance Document) for OMR and DCC implementation in WY 2025. This Seasonal Report fulfills commitments under the 2020 Record of Decision (ROD) for the Long-Term Operation (LTO) of the Central Valley Project (CVP) and State Water Project (SWP). It also fulfills the California Department of Water Resources (DWR) reporting commitments for the Smelt Monitoring Team (SMT) and Salmon Monitoring Team (SaMT) to summarize major actions taken to implement the Incidental Take Permit (ITP) Conditions of Approval (COAs) for LTO of the SWP in the Delta (Permit No. 2081-2019-066-00, ITP Conditions 8.1.1 and 8.1.2).

This Seasonal Report will be used to support the development of Reclamation's 2024 Annual Report on the LTO of the CVP and SWP (Annual Report), as well as DWR's 2024 Annual Status Report (ITP COA 7.2). Compliance with National Marine Fisheries Service (NMFS) and United States Fish and Wildlife Service (USFWS) 2019 Biological Opinions' Reasonable and Prudent Measures and associated Terms and Conditions adopted by the ROD and ITP will be documented and discussed in Reclamation's Annual Report and DWR's Annual Status Report, respectively, and not in this document. Finally, this document will inform the independent review panels adopted under the ROD and identified in the SWP actions (ITP COA 3.13.8). Reclamation and the DWR, respectively, have charted the National Academy of Sciences (with support from the Delta Stewardship Council) and the Delta Stewardship Council to convene independent panels to review the monitoring, modeling, and other relevant scientific activities and initiatives that support the LTO of the CVP and the SWP, including review specific to OMR management. The purpose of Reclamation's independent review is to assess the progress of the CVP to meet its goal to develop a long-term operation plan that supports fish and wildlife, delivers water to communities, and generates hydroelectric power.

The SaMT and SMT prepare weekly assessments of fish distribution and the likelihood of entraining fish into the central and south Delta and CVP and SWP export facilities. SaMT provides an evaluation of the likelihood of exceeding a salvage threshold that would automatically restrict OMR operations, and Reclamation and DWR can use that information to assist in decision making regarding changes to export operations. The

procedures used by both monitoring teams are described in the Old and Middle River Flow Management Guidance Document (Appendix A).

Background

The Delta is formed by the confluence of the Sacramento and San Joaquin rivers and their tributary river systems. Reclamation's C.W. "Bill" Jones Pumping Plant and DWR's Harvey O. Banks Pumping Plant (hereafter referred to as the CVP and SWP export facilities) divert water south through the Delta-Mendota Canal and the California Aqueduct, respectively. The CVP and SWP export facilities divert from Old River (Figure 1).

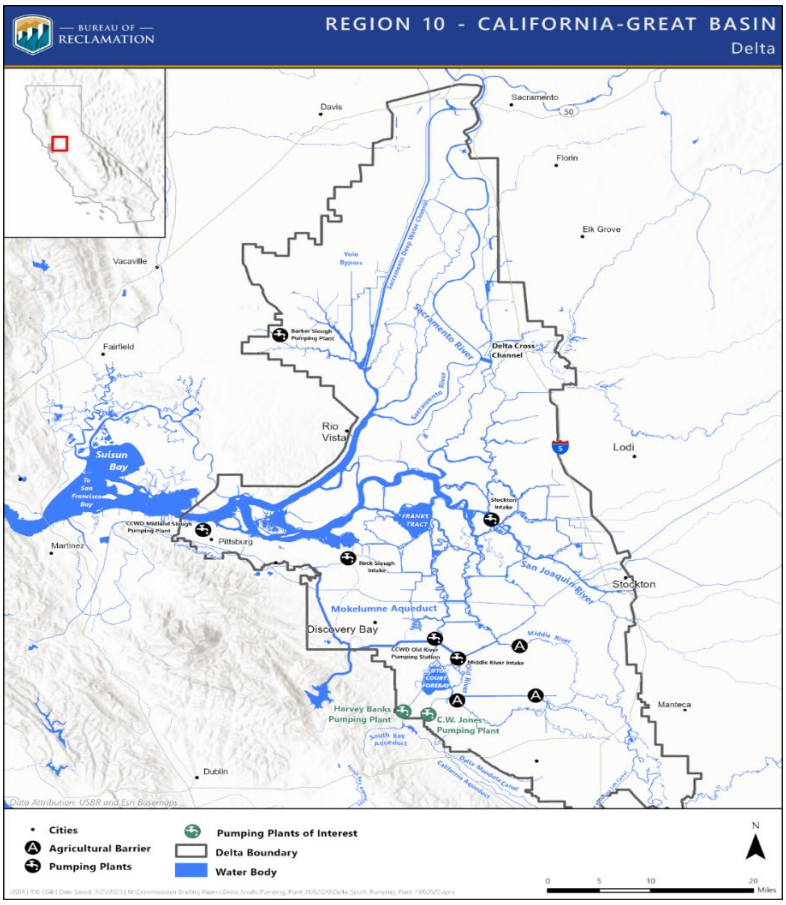

Figure 1. Map of the Delta with CVP and SWP infrastructure.

Figure 1 is a map of the Region 10 California Great Basin Delta, which shows nearby cities, agricultural barriers, pumping plants, the Delta boundary, and water body.

Net flow within the OMR corridor to the north of the CVP and SWP export facilities is affected by export pumping, San Joaquin River inflow at Vernalis, and operational status of barriers in the south Delta. Computed OMR index flows provides a surrogate indicator for hydrodynamics in the south Delta. The management of OMR flow, in combination with other environmental variables, can minimize or avoid the entrainment

of fish into the south Delta and at the fish salvage facilities. Reclamation and DWR manage exports by incorporating real-time monitoring of fish spatial distribution, turbidity, water temperature, and hydrodynamic and entrainment model applications to support decision making for the management of OMR flows to minimize entrainment of fish when necessary and provide operational flexibility when possible.

Reclamation consulted under the Endangered Species Act (ESA) with the USFWS and NMFS on potential effects of the Proposed Action on threatened and endangered species and designated critical habitats. The USFWS and NMFS issued their Biological Opinions of the Proposed Action on October 21, 2019. OMR management and DCC gate operations are a part of the Delta Operations described in the Proposed Action. Integrated Early Winter Pulse Protection ("First Flush") and net OMR flows no more negative than -5,000 cfs are actions expected to minimize adverse effects to Delta smelt (Hypomesus transpacificus), Sacramento River winter-run Chinook salmon (Oncorhynchus tshawytscha), Central Valley (CV) spring-run Chinook salmon (O. tshawytscha) and California Central Valley (CCV) steelhead (O. mykiss). Other OMR management actions expected to reduce or minimize negative effects to Delta smelt include protections for adult Delta smelt based on turbidity (Turbidity Bridge Avoidance) and protections for recruitment of larvae and juveniles based on proportional entrainment loss from the Delta Smelt Life Cycle Model. Another OMR management action expected to reduce adverse effects to winter-run Chinook salmon and steelhead is the management of OMR to avoid exceeding single-year and cumulative loss thresholds for natural and hatchery winter-run Chinook salmon, and CCV steelhead during an early (December 1 – March 31) and late (April 1 – June 15) migratory period. The NMFS Biological Opinion incidental take statement (ITS) also requires monitoring salvage at the Delta fish salvage facilities for the southern Distinct Population Segment (sDPS) of North American green sturgeon (Acipenser medirostris). Fall-run Chinook salmon are not an ESA-listed species but are relevant because they comprise a large portion of the Southern Resident killer whale diet, which is an ESA-listed species. Young-of-year (YOY) spring-run Chinook salmon, steelhead, and YOY fall-run Chinook salmon have considerable overlap in migration timing and residency through the Delta. Therefore, an OMR value of no more negative than -5,000 cfs and other actions that minimize effects to spring-run Chinook salmon and steelhead should have similar effects on fall-run Chinook salmon.

Under the California Endangered Species Act (CESA), DWR consulted with the California Department of Fish and Wildlife (CDFW) to obtain a separate ITP for LTO of the SWP. DWR submitted an application to CDFW in December 2019 and, on March 31, 2020, CDFW issued an ITP (2081-2019-066-00) to DWR that covers four CESA-listed species: Longfin smelt (Spirinchus thaleichthys), Delta smelt, CV spring-run Chinook salmon, and Sacramento River winter-run Chinook salmon. The project description in the ITP

application and COA listed in the ITP included many of the same measures identified in the federal ESA consultation for the management of OMR to reduce the risk of entrainment of listed fish species, as well as some additional measures.

State Water Resources Control Board's (Water Board) Decision 1641(D-1641) influences operations of the CVP and SWP export facilities. Obligations under D-1641 include protections for fish and wildlife, Municipal and Industrial (M & I) water quality, agricultural water quality, and Suisun Marsh salinity. Under the ROD, DCC gates are closed when fish triggers are met in October and November, and closed beginning on December 1 unless water quality concern criteria are exceeded in the Delta in December and January, which allow limited gate operations. The ROD includes D-1641 requirements including gate closures from February 1 through mid-May, and gate closures up to 45 days from November 1 through January. All data used to create figures in this report are provided in Appendix C. Natural winter-run Chinook salmon reported in these figures are based on length-at-date (LAD) measurements, unless otherwise noted.

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New in WY 2024

Transition to Interim Operations Plan (IOP)

On March 14, 2022, the United States District Court for the Eastern District of California ordered the implementation of an interim operations plan (IOP) for the CVP and SWP for WY 2022. The IOP was specific to WY 2022 and expired on September 30, 2022. On February 28, 2023, the Court ordered an extension of the IOP (IOP Extension), with minor changes, through December 31, 2023. The 2023 IOP was extended until through March 31, 2024, or until the Court issued a ruling on the 2024 IOP. The 2024 IOP began on March 28, 2024, and expired on December 20, 2024, when the ROD was signed. Certain provisions of the 2023 and 2024 IOP related to OMR management during WY 2024. Specifically, the 2023 and 2024 IOP stated that Reclamation shall adopt certain aspects of the following provisions of the SWP's ITP:

- 8.1.4 Water Operations Management Team (WOMT) Process
- 8.5.2 Larval and Juvenile Delta Smelt Protection
- 8.6.1 Winter-run Chinook Salmon Single-year Loss Threshold
- 8.6.2 Early-season Natural Winter-run Chinook Salmon Discrete Daily Loss Threshold
- 8.6.3 Mid- and Late-season Natural Winter-run Chinook Salmon Daily Loss Threshold
- 8.6.4 Daily Spring-run Chinook Salmon Hatchery Surrogate Loss Threshold
- 8.7 OMR Flexibility During Delta Excess Conditions
- 8.8 End of OMR Management
- 8.17 Export Curtailments for Spring Outflow.
- 9.1.3.1 Summer-Fall Action Plan

Delta Smelt Experimental Release

In WY 2024, USFWS, Reclamation, DWR, CDFW, U.S. Geological Survey, and University of California, Davis, conducted the third Experimental Release of ≥ 200 days post hatch

captively cultured Delta smelt. Six release events occurred between mid-November 2023 and January 2024, consisting of three paired hard and soft releases, one paired carboy and trailer hard release, and two tanker truck releases (Table 1). A total of 91,468 fish, either adipose fin clipped or Visible Implant Elastomer tagged, were released at Rio Vista (Table 1). Of these fish, 49 were subsequently recaptured in regular monitoring (Figure 2). For the purposes of OMR management for both the CVP and SWP, there is no difference between a wild Delta smelt and a cultured Delta smelt. Given historically low observations of wild origin Delta smelt, these releases influenced the expected distributions of adult fish in assessing the likelihood of entrainment during the preparation of the weekly assessments. The observations of all Delta smelt are summarized in the Delta Smelt Detections section.

Table 1. WY 2024 Delta smelt Experimental Release events.

Release event	FCCL load date	Release date	Release site	Release methods	Release tag	Final number released
LS1	11/15/2023	11/15/2023	Rio Vista	Hard (large scale)	Left/ green/ AD	14,104
1a	12/12/2023	12/12/2023	Rio Vista	Hard (carboy)	Left/ blue/ PD	6,508
1b	12/13/2023	12/14/2023	Rio Vista	Soft (carboy)	Right/ blue/ AD	6,581
2a	12/19/2023	12/19/2023	Rio Vista	Hard (carboy)	Right/ green/ AD	6,430
2b	12/20/2023	12/20/2023	Rio Vista	Hard (trailer)	Left/ green/ PD	6,261
LS2	01/10/2024	01/10/2024	Rio Vista	Hard (large scale)	Ad-clip	25,649
3a	01/24/2024	01/24/2024	Rio Vista	Hard (carboy)	Left/ orange/ PD	6,382
3b	01/23/2024	01/25/2024	Rio Vista	Soft (carboy)	Right/ orange/ AD	6,396
4a	01/31/2024	01/31/2024	Rio Vista	Hard (trailer)	Left/ red/ PD	6,576
4b	01/30/2024	01/30/2024	Rio Vista	Soft (carboy)	Right/ red/ AD	6,581
Total	N/A	N/A	N/A	N/A	N/A	91,468

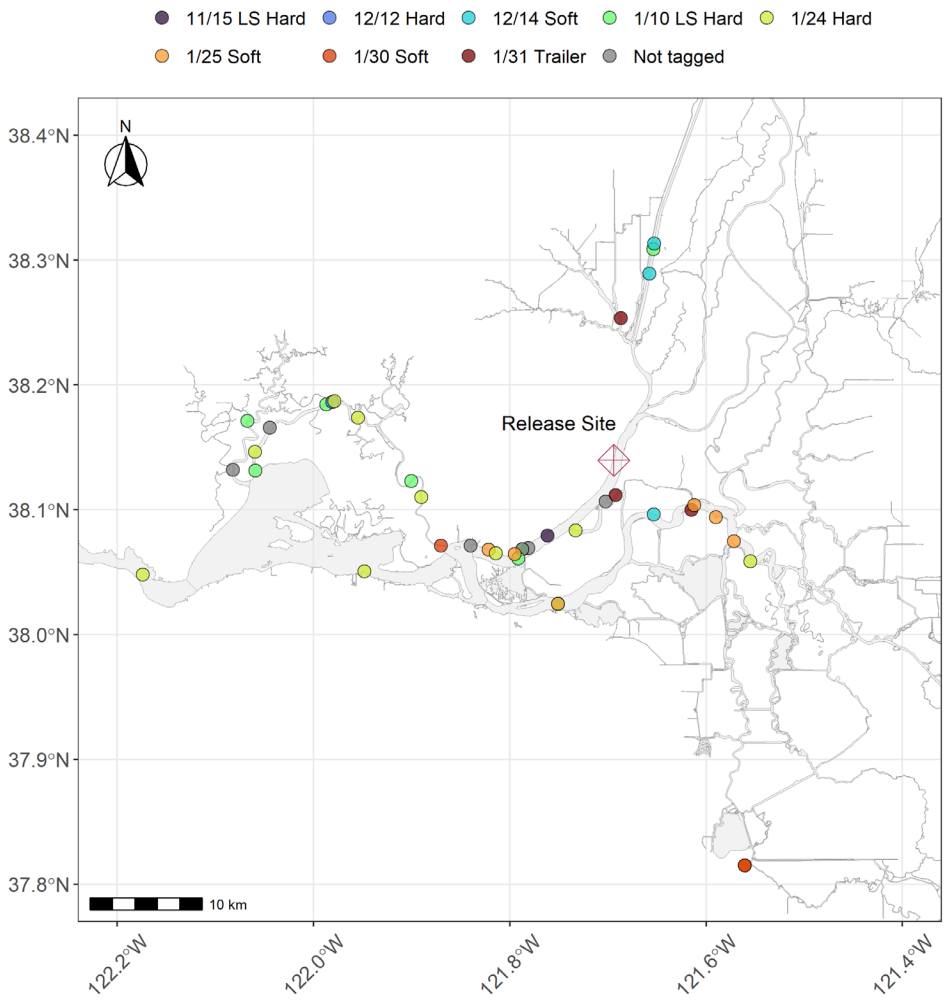

Figure 2. Map of WY 2024 Experimental Release site and subsequent detections of Delta smelt in regular monitoring. Diamond indicates release site for all releases and circles indicate subsequent detections. Points may be occluding detections from other releases as some sites had multiple detections. Full data used to create this plot may be accessed in Appendix C.

Figure 2 is a map showing experimental release sites for WY2024. A diamond on the map indicates a release site for all releases. The map also shows color-coded circles for subsequent detections of 11/15 LS hard, 12/12 hard, 12/14 soft, 1/10 LS hard, 1/24 hard, 1/25 soft, 1/30 soft, 1/31 trailer, and not tagged.

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Seasonal Operations

In contrast to WY 2023's wet conditions, which came in strong in October and early November, WY 2024 had a much drier start. From early October through mid-December of WY 2024, statewide conditions were approximately 50% of average precipitation to date (CNRFC, 2024). Late December and early January storms caused the earlier WY 2024 deficit projections to decrease. Snowpack for the state was also sluggish but improved in mid-February to approximately 50% of the April 1 average (DWR, 2024). A cold and productive early March storm boosted precipitation and snow accumulations across the state improving Sierra estimates to between 90% and 100% of the average seasonal April through July runoff (CNRFC, 2024). Active storms continued through early April, reaching the peak of snow accumulation. An unusually wet and cool early May storm delayed snow melt temporarily, but warmer trends resumed following with the majority of the state reaching peak runoff late April into mid-May (CNRFC, 2024a). Despite a dry start to the water year, late-winter and early spring recovery of snow returned the state to average snow water equivalent (SWE) conditions. The final water year type for May 2024 resulted in an above normal classification for both the Sacramento Valley Index (based on the 50% exceedance forecast) and San Joaquin Valley Index (based on the 75% exceedance forecast; DWR, 2024a).

Although hydrologic conditions for the water year started off dry, CVP and SWP operations reflected WY2023's wet water year type and high carryover storage. The CVP and SWP declared excess conditions January 1, 2024, which persisted through June 11, 2024.

Major project storage facilities from the Sacramento, Feather, American, and San Joaquin River systems experienced reservoir storage fill management resulting in higher downstream releases. Delta conditions also benefited, yielding high Delta outflows; peak Net Delta Outflow reached above 135,000 cfs during the winter. WY 2024 conditions were sufficient to trigger the Port Chicago Delta requirement in April and May, however, Water Board D-1641 requirements were met without significant challenges in the winter and spring. CVP and SWP exports were primarily controlled late winter through early summer by OMR fish protection measures. Controlling factors also included IOP provision 8.17, which describes conditions for Reclamation to reduce exports by 100 TAF if WY 2024 San Joaquin Valley Index is classified as an above normal water year type. Key WY 2024 factors that shaped operational considerations were prior year carryover storage, spring precipitation recovery after a dry fall and winter, and OMR management.

As of June 2024, all major upstream project reservoir storages were at or above historical averages. Trinity reservoir experienced notable storage improvement from WY 2023 conditions, however San Luis Reservoir storage lagged below at 90% of historical average (DWR, 2024b).

Delta Cross Channel Operations

Figure 3. Delta Cross Channel Gates (Bureau of Reclamation/Todd Plain).

Figure 3 is a photograph of the Delta Cross Channel Gates in the open position on the Sacramento River.

The DCC gates operation schedule is described in the ROD, which includes the D-1641 operations requirement. The DCC gates were operated to the "open on weekend and closed on weekday" cycles in September, October, and November for the D-1641 Delta flow Rio Vista and Delta water quality/salinity requirements and afforded weekend recreational opportunities. In WY 2024, no Knights Landing Catch Index (KLCI) or Sacramento Catch Index (SCI) exceedances (>3.0 fish per day) occurred that required action responses of DCC gate closures in October or November (Figure 4). While the ROD doesn't commit to winter DCC closure until December 1, the DCC gates were closed for the season starting on Monday, November 27, 2023. Due to the persistent high flows in the Sacramento River greater than 20,000 cfs, the DCC gates remained closed November 27, 2023, through May 31, 2024, to protect the facility and avoid

scouring inside the Delta Cross Channel. The DCC gates were opened for the summer season, per D-1641, on June 14, 2024.

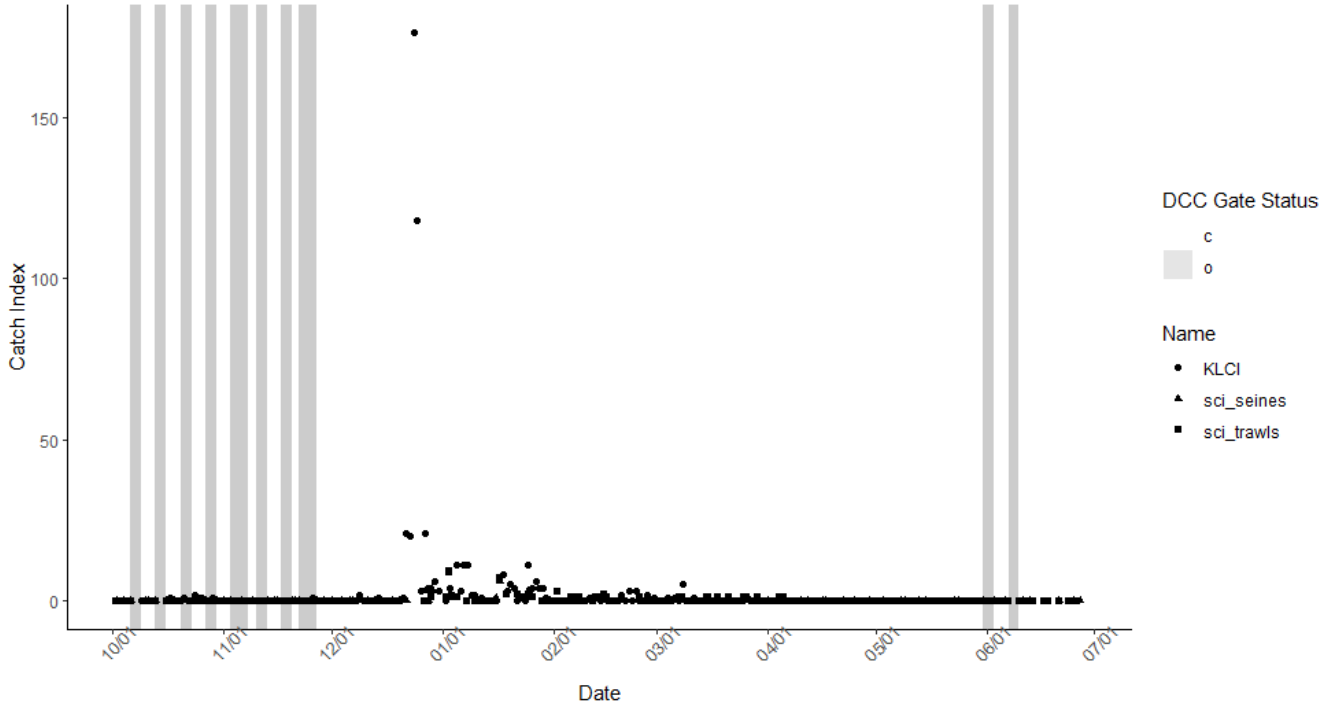


Figure 4. DCC Gate closures (white) and openings (grey), Knights Landing Catch Index (KLCI) and Sacramento Catch Index at beach seines (SCI - seines) and Sacramento Catch Index at trawls (SCI – trawls) for natural winter-run Chinook Salmon.

Figure 4 is a graph comparing DCC Gate closures and openings for each catch index from October 1 to July 1. The graph shows the KLCI, SCI-seines, and SCI-trawls) for natural winter-run Chinook Salmon. Catches stay relatively close to zero regardless of DCC gate closures and openings, with the exception of the KLCI between December and January, which surpasses 150 before dropping close to the 0-50 range while DCC gates are open.

Old and Middle River Flow Management

OMR Flow Management for the WY 2024 management season spanned January 1, 2024, to June 13, 2024. OMR Index (OMRI) values (1-day, 5-day, and 14-day) for WY 2024 are plotted in Figure 5. In WY 2024, the OMR flow management season was initiated on January 1, 2024, due to more than 5% of any one or more salmonid species estimated to be present in the Delta as determined by the Salmon Monitoring Team (PA 4.10.5.10.1; ITP COA 8.3.2). From January 14 through January 22, the CVP was unable to utilize SWP export facilities because of ITP based limits on SWP operations. For January 14 through January 22, SWP exports were limited to the proportional share of a –3,500 cfs OMRI

because of a combination of the Larval and Juvenile Longfin Smelt Entrainment Protection (ITP COA 8.4.2) and 3,500 cfs exceedance to the Winter-run Chinook Salmon Daily Loss Threshold ITP COA 8.6.3). Integrated Early Winter Pulse Protection (IEWPP; PA 4.10.5.10.1; ITP ITP COA 8.3.1) (see Onset of OMR Flow Management) started on January 23 and lasted through February 5 which limited operations to a -2,000 cfs OMRI. After the IEWPP period ended, there was a single day (February 6) of operating to no more negative than –5,000 cfs OMRI on a 14-day average per general OMR Management (PA 4.10.5.10.1) for the CVP and no more negative than -5,000 cfs OMRI on a 7-day average per ITP COA 8.4.2 for the SWP. From February 7 through February 16, the CVP and SWP exports were limited to an OMRI of -3,500 cfs for Larval and Juvenile Delta Smelt Protection (ITP COA 8.5.2). Simultaneously, from February 13 through February 16, the CVP and SWP exports were also limited to an OMRI of -3,500 cfs for exceeding the 50% loss threshold for CCV Steelhead during the early migratory period (December 1 – March 31; PA 4.10.5.10.2). The CVP and SWP further reduced exports to an OMRI of –2,500 cfs from February 17 to February 22 to attempt to slow the loss of CCV Steelhead from at which point the 75% loss threshold for CCV Steelhead during the early migratory period was exceeded and the OMRI limit of –2,500 cfs became prescriptive. From February 23 through March 7 the 75% Annual Loss threshold for CCV Steelhead during the early migratory period limited exports at the CVP and SWP to an OMRI of -2,500 cfs. From March 8 through March 10 the 75% CCV Steelhead early migratory loss threshold and the 75% winter-run Chinook salmon loss threshold limited exports at the CVP and SWP to an OMRI of -2,500 cfs. In ongoing efforts to lower the loss of CCV Steelhead during the early migratory period, from March 11 through March 25, the Directors approved restricting CVP and SWP exports to achieve an OMRI of no more negative than –500 cfs. Operations targeted an OMRI of –1,500 cfs from March 26 through March 31. Starting April 1, which was the start of the late migratory period for CCV steelhead, Directors approved the CVP and SWP facilities to operate to a –2,500 cfs OMRI while also maintaining NDOI above 44,500 cfs. From April 10 through May 31, the SWP operated to the Export Curtailments for Spring Outflow (ITP COA 8.17) (see Export Curtailments for Spring Outflow). At that time, the CVP maintained low exports in response to the 2024 IOP requirements for an Above Normal water year and the WOMT decision to implement a majority of the export curtailments early to protect actively migrating winter- run Chinook salmon and steelhead. On April 3, 2024, WOMT decided that an OMRI limit of –2,500 cfs would be used as the operational reference condition used for calculating the additional export curtailment under the 2024 IOP. Starting June 1, the CVP and SWP began operating to a –3,500 cfs OMRI in response to the 100% (exceeded 4/26/2024) and 75% loss thresholds (exceeded 4/15/24) for CCV Steelhead during the late migratory period likely originating from the San Joaquin River, being exceeded. Starting June 6, the CVP and SWP began operating to a –5,000 cfs OMRI per general OMR Management. On June 12 and 13, the thresholds for the End of OMR

Management for salmonids and smelts respectively were reached and the CVP and SWP no longer had OMRI restrictions on June 14. From January 1, 2024, through June 13, 2024, the daily OMR index was positive for 31 out of 165 days (Figure 5; mean: -1931 cfs; range of 1,210 cfs to -5,239 cfs and Figure 6). See spreadsheet of daily controlling operations in Appendix C (See Controlling Factors Table in Operations section).

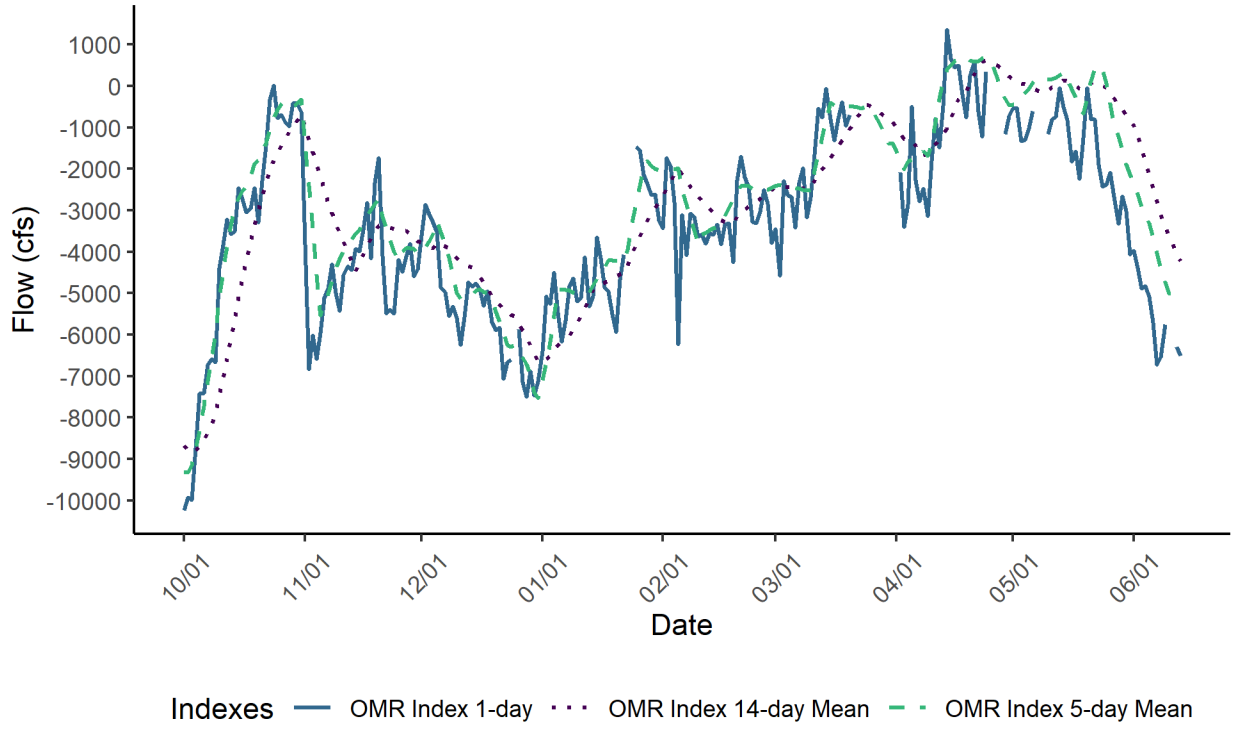


Figure 5. OMR index values measured in cfs (1-day, 5-day, and 14-day) in WY 2024.

Figure 5 is a line graph showing the OMR index values measured in flow (cfs) from October 1 to June 1. The OMR Index 1-day is shown as a solid line. The OMR Index 14-day mean is shown as a dotted line. The OMR index 5-day mean is shown as a dashed line. All three lines remain relatively close and fluctuate over time.

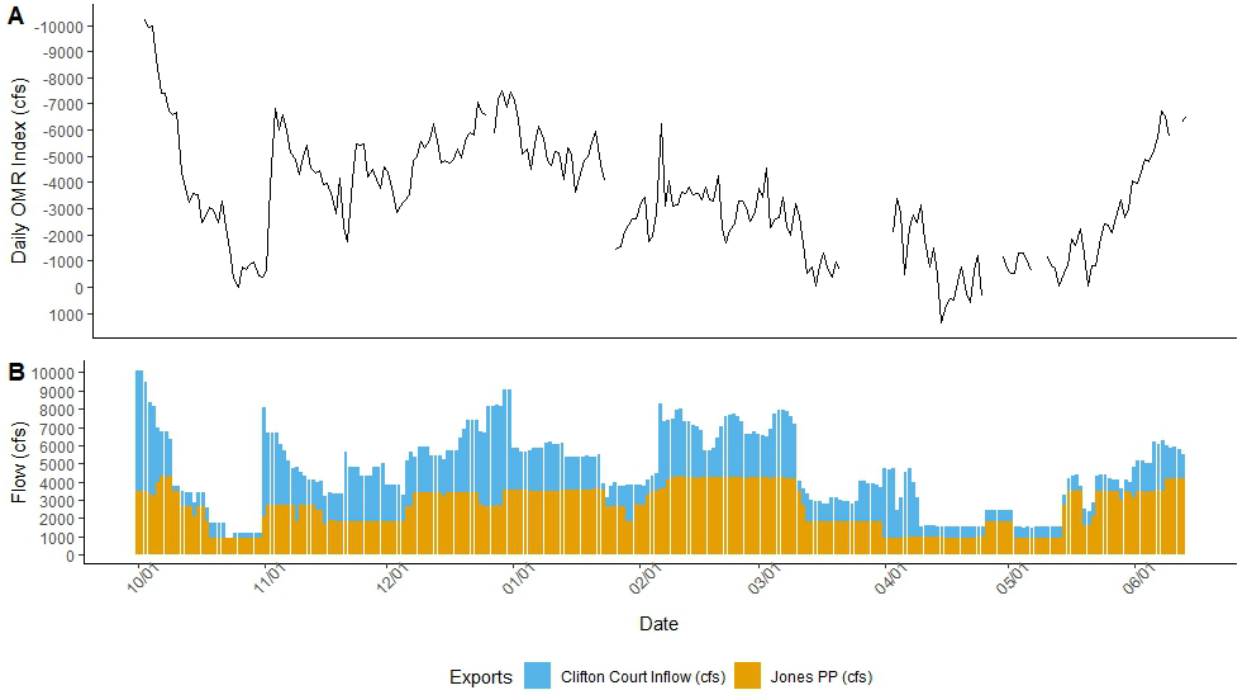


Figure 6 (A, B). Exports from Clifton Court Forebay Inflow (for the SWP) and Jones Pumping Plant (for the CVP) plotted over 1-day OMR index values for WY 2024. Maximum capacity is the combination of the maximum permitted capacity for both facilities per United States Army Corps of Engineers (CVP: 4,600 cfs; SWP: 6,680 cfs except in mid-December through mid-March when exports can increase to 10,300 cfs in 1/3 proportion to Vernalis flow above 1,000 cfs).

Figure 5 is two graphs, a line and bar graph, showing the Exports from Clifton Court Forebay Inflow and Jones Pumping Plant. The line graph shows exports plotted against a 1-day daily OMR Index (cfs). The bar graph shows exports plotted overtime for WY 2024.

Seasonal operations to manage OMR may occur in conjunction with additional controlling factors that change throughout the season. Controlling factors can also overlap in time and may only occur for short periods. Seasonal changes in controlling factors are summarized in Figure 7. The factors influencing export operations at the start of WY 2024 were generally to meet D-1641 outflow and water quality requirements. Beginning in January controlling factors changed to OMR and persisted through June. Delta hydrologic conditions also change throughout the season, which can be characterized as either Balanced or Excess conditions, and this could impact management of export operations. Balanced water conditions are periods when it is agreed that releases from upstream reservoirs plus unregulated flow approximately equal the water supply needed to meet Sacramento Valley in-basin uses, plus exports.

Excess water conditions are periods when it is agreed that releases from upstream reservoirs plus unregulated flow exceed Sacramento Valley in-basin uses, plus exports.

Fall conditions were dry and Balanced conditions persisted until winter storm activity sufficiently increased in January. Excess conditions dominated through much of the late winter, spring, and early summer periods as a result of high carryover storage, storm events, spring snowmelt runoff, and flood management releases (Figure 8).

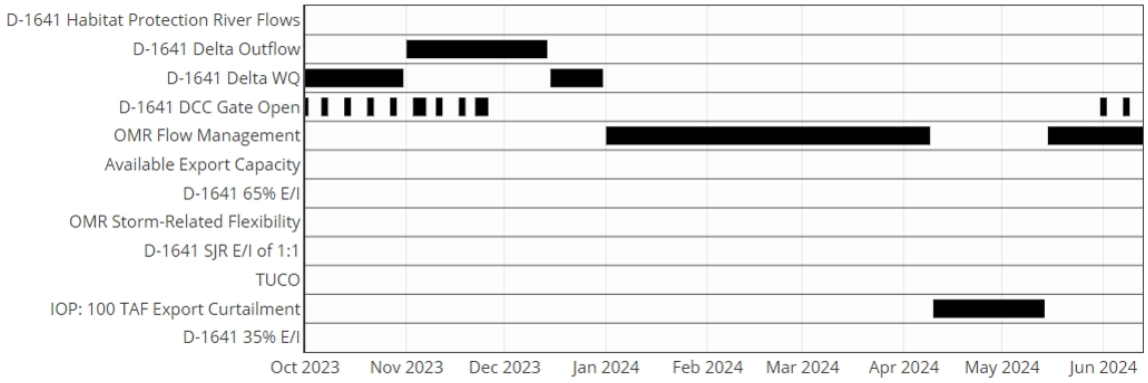


Figure 7. Daily Delta factors influencing export operations for October through mid-June of WY 2024.

Figure 7 is a graph showing the daily Delta factors influencing export operations for WY 2024. Factors included D-1641 Delta Outflow (November – December 2023), D-1641 Delta WQ (October 2023), D-1641 DCC Gate Open (intermittently from October – December 2023), OMR Flow Management (January 2024 – mid-April 2024, June 2024), IOP: 100 TAF Export Curtailment (mid-April – mid-May 2024).

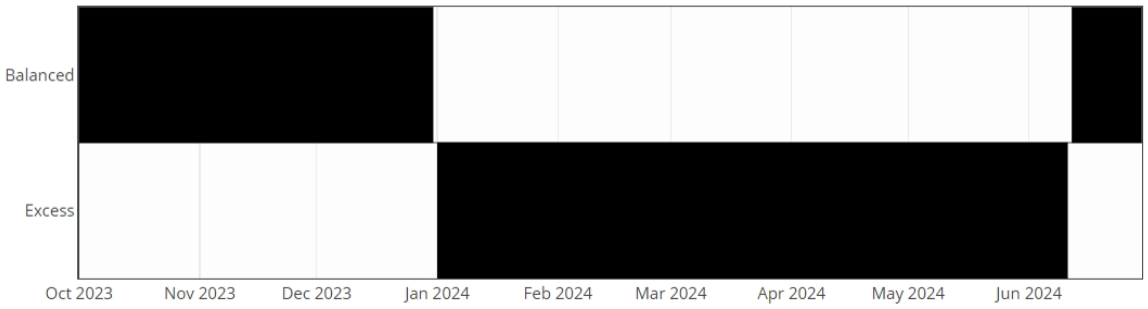


Figure 8. Balanced and Excess conditions in the Delta for October through mid-June of WY 2024.

Figure 8 shows the balanced and excess conditions in the Delta for WY 2024. Conditions were balanced from October 2023 – January 2024 and again beginning in July 2024. Excess conditions were recorded from January 2024 – June 2024.

Onset of OMR Flow Management

Integrated Early Winter Pulse Protection ("First Flush" Turbidity Event)

The onset of OMR flow management can be triggered by IEWPP under 'First Flush' conditions, which requires that both: (1) a 3-day daily average flow at Freeport greater than 25,000 cfs and (2) a 3-day daily average turbidity at Freeport equal to or greater than 50 Formazin Nephelometric Units (FNU) occur between December 1 and January 31. The SWP has an additional trigger for OMR management to begin if the SMT determines that real time monitoring of biotic and abiotic factors indicates a high risk of Delta smelt migration and dispersal into areas at high risk of future entrainment (ITP COA 8.3.1).

Flow and turbidity conditions for IEWPP were met on January 21, 2024 (Figure 9). These conditions are described as the "first flush," a pulse of turbid freshwater following a precipitation event that cues Delta smelt to begin a rapid, population-scale migration to turbid freshwaters. From WY 2009 through WY 2023, IEWPP thresholds would have been met or were met in WYs 2012, 2014, 2017, 2019, 2022 and 2023. During the WY 2024 IEWPP, Reclamation and DWR managed exports to minimize entrainment of adult Delta smelt into the central and south Delta. To minimize CVP and SWP influence on Delta smelt migration, the IEWPP was implemented within three days of the trigger, and the action lasted from January 23 through February 5, 2024. During this period, Reclamation and DWR reduced exports for 14 consecutive days such that the 14-day averaged OMRI for the period was no more negative than -2,000 cfs.

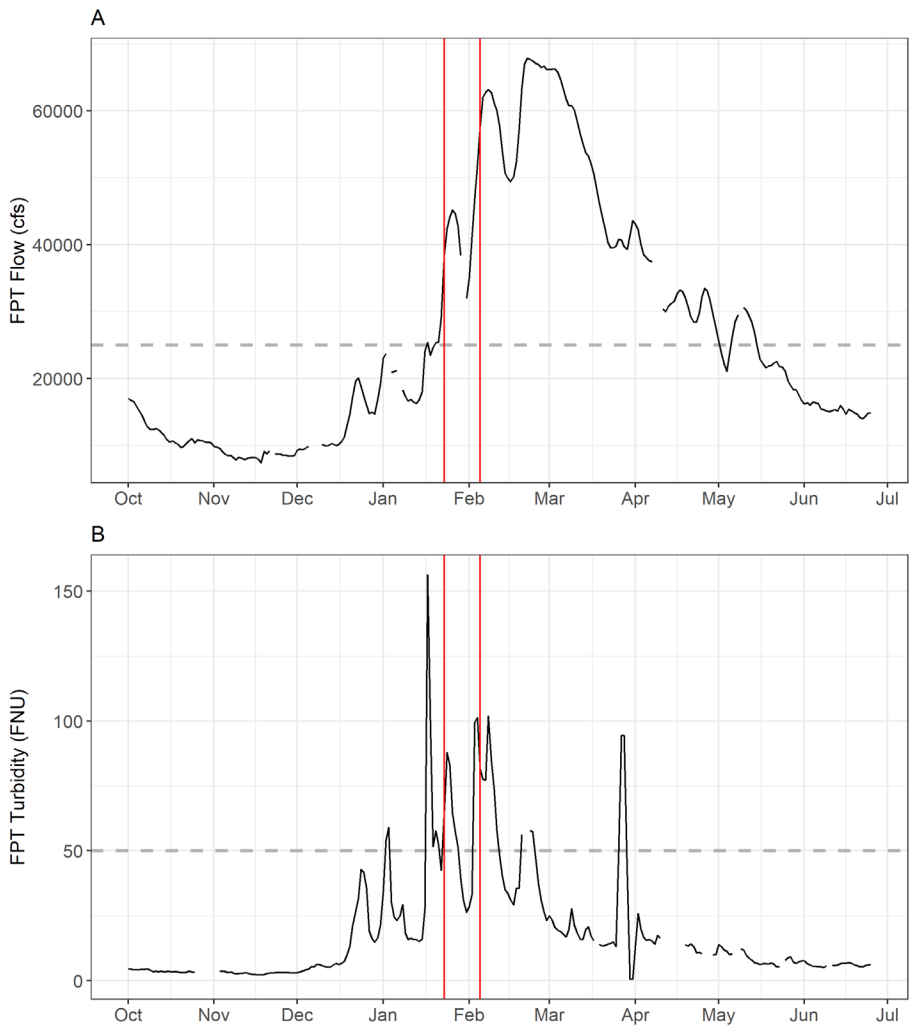


Figure 9. 'First Flush' conditions in WY 2024; A. 3-day running average flow (cfs) at Freeport (FPT). Red lines indicate IEWPP period. Dashed line indicates 25,000 cfs threshold. B. 3-day running average turbidity (FNU) at Freeport. Red lines indicate IEWPP period. Dashed line indicates 50 FNU turbidity threshold. Data obtained from California Department of Water Resources Data Exchange Center.

Figure 9 is two line graphs showing 'First Flush' conditions in WY 2024.

The first line graph (A) shows the 3-day running average flow (cfs) at Freeport. An IEWPP period happens between late January – February 2024. Capacity is also shown as a dashed line at 25,000 cfs. Flow is below capacity until about mid-January, where it then surpasses capacity from February – May 2024 before it declines for the remainder of the water year.

The second line graph (B) shows 3-day running average turbidity (FNU) at Freeport. An IEWPP period happens between late January – February 2024. FNU Turbidity threshold is show as 50 FNU. Turbidity is below the threshold until January 2024, where it spikes and remains high until April 2024. Turbidity spikes again in late March before dropping below the threshold for the remainder of WY 2024.

Salmonid Presence: Distribution Estimates

Distribution estimates of salmonids (yet to enter the Delta, in Delta, and exited the Delta) are developed weekly by SaMT members. The first distribution estimates for WY 2024 were made on October 3, 2023, for natural YOY spring-run and winter-run Chinook salmon and natural steelhead. The Proposed Action states that OMR management season would start after January 1, if more than 5% of any one or more salmonid species are estimated to be present in the Delta. Over 5% of winter-run Chinook salmon were estimated to be in the Delta as of December 26, 2023. As such, in WY 2024, on-ramping of OMR management season for salmonids began on January 1, 2024. The first distribution estimates for hatchery winter-run Chinook salmon were made on January 9, 2024, soon after the first releases of hatchery winter-run Chinook salmon, which occurred on December 28, 2023.

Multiple sources are considered in order to produce distribution estimates, including catch at targeted locations (e.g., Feather River rotary screw traps [RST], Knights Landing RST, Sacramento regional Beach Seines, lower American River RST, lower Sacramento RST, Caswell RST, Sacramento trawls, Chipps Island trawls, and Mossdale Kodiak trawl), historic and current salmonid salvage numbers, movements of acoustic tagged fish from the current WR, and historic migration patterns at targeted locations (see Proposed Action U.S. Bureau of Reclamation 2019a). Some monitoring surveys were disrupted during periods in WY 2024, due to weather, flow conditions, or technical/operational issues (Figure 10).

Figure 10. WY 2024 sampling disruptions by monitoring team for rotary screw traps (bottom), surveys and fish salvage facilities(top). Partial disruptions represent interruptions such as, but not limited to, only a single boat being off the water or partial surveys. Some surveys were added during the season and their full seasonal activity may not have been captured in the figure. These data reflect the information captured in each weekly outlook during the season. See Appendix C for weekly tables of sampling interruptions and cancellations.

Figure 10 is two graphs showing the WY 2024 sampling disruptions by monitoring team for rotary screw traps (second graph) and fish salvage facilities (first graph).

For fish salvage facilities (first graph) there are over twenty-five different factors monitored for disruption; however, operations remained largely uninterrupted. In late October 2023, late January 2024, and mid-March 2024, there were partial interruptions.

For rotary screw traps (second graph), there are eleven different factors that are monitored for disruption; however, operations remained largely uninterrupted. In January 2024 – February 2024, there is a Lower Sacramento RST partial interruption. In February 2024, there are also partial interruptions for Knights Landing RST and Tisdale RST. Tisdale RST has a second partial interruption from mid-March- April 2024.

Distribution estimates made by SaMT in WY 2024 are shown below for natural winter-run Chinook salmon (Figure 11, panel A), natural Steelhead (Figure 12), natural YOY spring-run Chinook salmon (Figure 13), and hatchery winter-run Chinook salmon (Figure 14, panel A). SaMT considers available monitoring data when making distribution estimates. At the end of the juvenile salmonid monitoring season, SaMT also calculates distribution estimates for natural and hatchery winter-run Chinook salmon based on the specific calculations described in Table 2; those distribution estimates are shown in panel B of Figures 11 and 14.

Table 2. Calculations and data sources used post-season to estimate population distributions for winter-run Chinook salmon based on monitoring for comparison with the weekly SaMT distribution estimates.

Distribution	Natural-Origin Winter-Run Chinook Salmon	Hatchery-Origin Winter-Run Chinook Salmon (Acoustic Tag (AT) Data)
Yet to Enter the Delta	100% minus cumulative % Knights Landing RST catch	100% minus cumulative % AT detection at Butte City Bridge array
In Delta	Cumulative % combined Sacramento Trawl & beach seines catch minus cumulative % Chipps Island Trawl catch	Cumulative % AT detection at Tower Bridge array minus Cumulative % AT detection at Benicia Bridge (east) array
Exited the Delta	Cumulative % Chipps Island Trawl catch	Cumulative % AT detection at Benicia Bridge (east) array

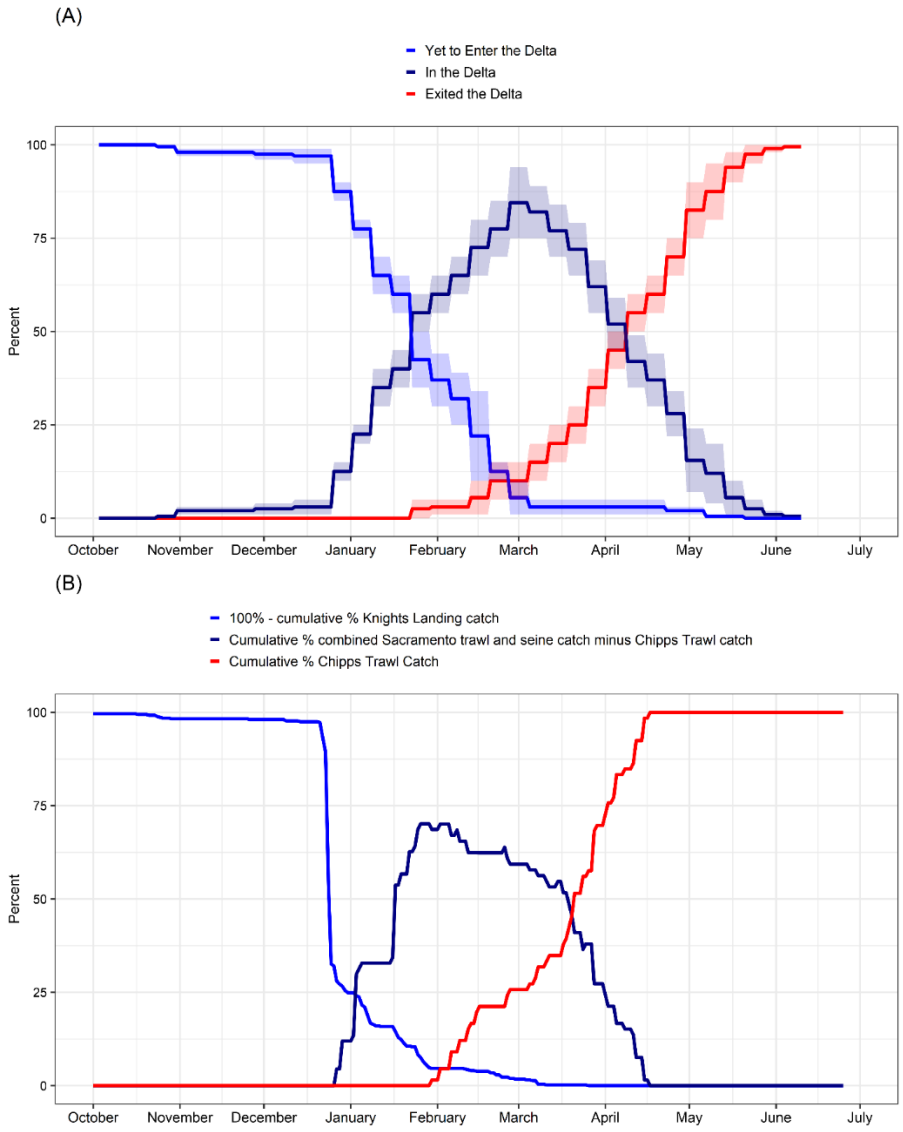


Figure 11. WY 2024 natural-origin winter-run Chinook salmon weekly SaMT distribution estimates (A) compared to length-at-date winter-run Chinook salmon observations in monitoring (B). Shaded areas indicate the upper and lower distribution estimates as described by SaMT. Cumulative catch data in Delta monitoring calculations are described in the legend and Table 2.

Figure 11 is two line graphs showing the WY 2024 natural-origin winter-run Chinook salmon weekly SaMT distribution estimates.

The first graph (A) shows weekly estimates for WY 2024 natural-origin winter-run Chinook salmon for those yet to enter the Delta, in the Delta, and those who have exited the Delta as a percentage.

The second graph (B) shows length-at-date winter-run Chinook salmon weekly observations for WY 2024 comparing 100% -Cumulative % Knights Landing catch, Cumulative % combined Sacramento trawl and seine catch minus Chipps Trawl catch, and Cumulative % Chipps Trawl Catch.

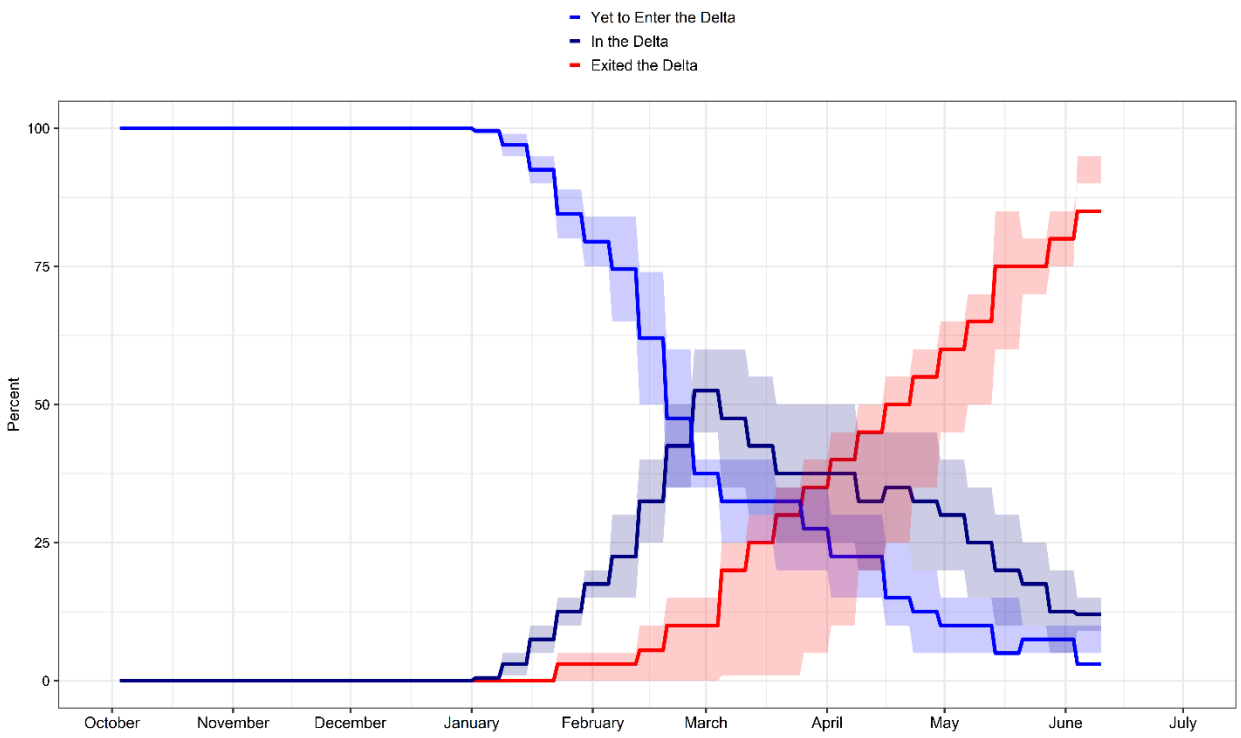


Figure 12. SaMT distribution estimates for natural steelhead in WY 2024. Shaded areas indicate the upper and lower distribution estimates as described by SaMT.

Figure 12 is a line graph showing SaMT distribution estimates (%) for natural steelhead in WY 2024 for those yet to enter the Delta, those in the Delta, and those who have exited the Delta.

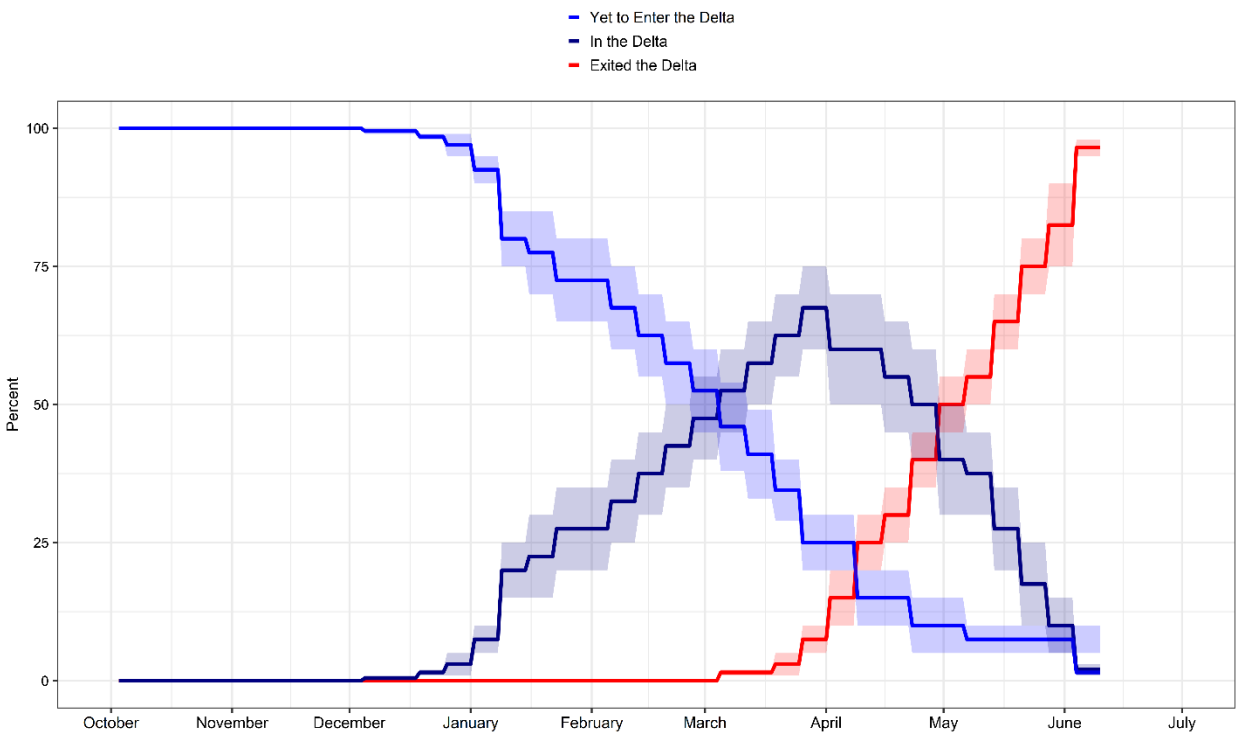


Figure 13.SaMT distribution estimates for natural spring-run Chinook salmon in WY 2024. Shaded areas indicate the upper and lower distribution estimates as described by SaMT.

Figure 13 is a line graph showing SaMT distribution estimates (%) for natural spring-run Chinook salmon in WY 2024 for those yet to enter the Delta, those in the Delta, and those who have exited the Delta.

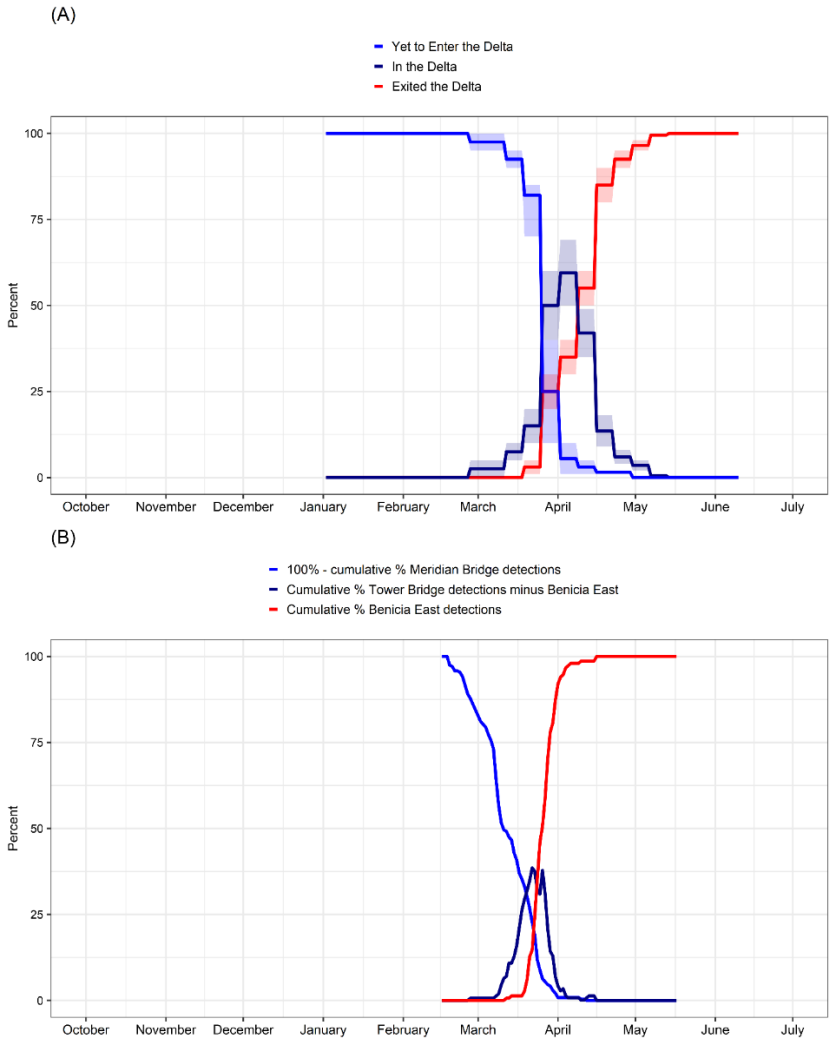


Figure 14. WY 2024 hatchery-origin winter-run Chinook salmon weekly SaMT distribution estimates (A) compared to acoustic tagged winter-run Chinook salmon observations in monitoring (B). Solid lines indicate SaMT distribution estimates for "Yet to Enter the Delta," "In Delta," and "Exiting the Delta." Shaded areas indicate the upper and lower distribution estimates as described by SaMT. Cumulative catch data in Delta monitoring are indicated by the legend and Table 2.

Figure 14 is two line graphs showing the WY 2024 hatchery-origin winter-run Chinook salmon weekly SaMT distribution estimates.

The first graph (A) shows weekly estimates for WY 2024 hatchery-origin winter-run Chinook salmon for those yet to enter the Delta, in the Delta, and those who have exited the Delta as a percentage.

The second graph (B) shows acoustic tagged winter-run Chinook salmon observations in monitoring comparing 100% Cumulative % Meridian Bridge detections, Cumulative % Tower Bridge detections minus Benicia East, and Cumulative % Benicia East detections.

Adult Longfin Smelt Entrainment Protection

The ITP for the SWP includes a third action triggering the onset of OMR management if an IEWPP action (ITP COA 8.3.1) has not yet been initiated. After December 1, if cumulative combined longfin smelt expanded salvage exceeds a threshold or real-time monitoring of abiotic and biotic factors indicates longfin smelt movement into areas at high risk for future entrainment, DWR reduces south Delta exports to maintain a 14-day average OMR index no more negative than -5,000 cfs (ITP COA 8.3.3). The salvage threshold is calculated based on the most recent Fall Midwater Trawl (FMWT) index for longfin smelt. For WY 2024, the threshold was 46, based on a 2023 FMWT index of 464. No longfin smelt were detected in either salvage facility prior to the triggering of ITP COA 8.3.1, thus this action was not triggered during WY 2024. A total of 0 age 1+ longfin smelt were salvaged in WY2024.

The SMT evaluated real-time monitoring data for biotic and abiotic factors to assess risk of longfin smelt migratory movement into areas of high entrainment risk. Adult longfin smelt catch of ≥60 mm (fork length) from the Chipps Island Survey (Figure 15), and hydrologic data were used as an early warning for migration into the south and central Delta. For the Chipps Island Survey, longfin smelt detections in WY 2024 began in October, with regular detections from January through early March (Figure 15); sporadic detections in October, November, December, and late March 2024.

The SMT did not make any recommendations to WOMT between December 1st and the triggering of ITP COA 8.3.1 regarding the need for adult longfin smelt protections.

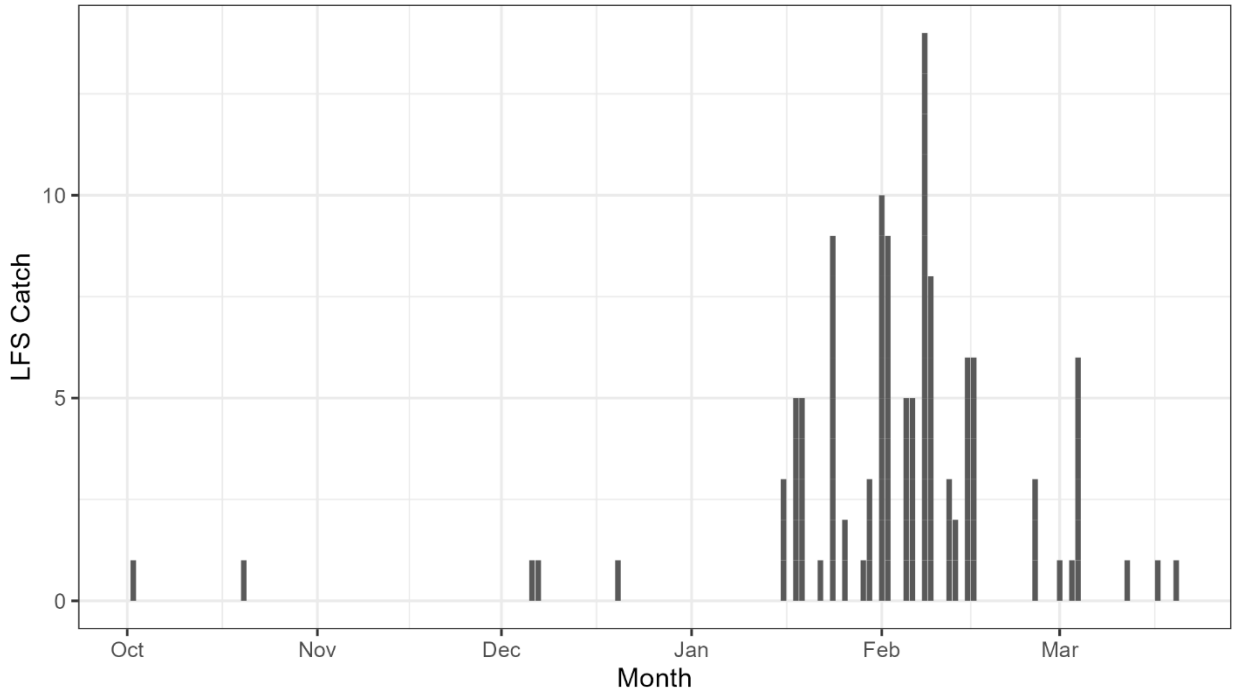


Figure 15. Adult longfin smelt (≥60mm) catch from the Chipps Island Trawl from October 2023 through June 2024. March 20th was the last day an adult longfin smelt was detected during the WY 2024 OMR management season.

Figure 15 is a bar graph showing adult longfin smelt catch (LFS catch) for WY 2024. Catches are relatively low except for January 2024 – February 2024. There is a spike in March before March 20, 2024, which was the last day an adult longfin smelt was detected during this water year.

Additional Real-time OMR Restrictions and Performance Objectives

Delta Smelt

Adult Delta Smelt Protections

The purpose of Turbidity Bridge Avoidance ("South Delta Turbidity") is to minimize the risk of adult Delta smelt entrainment in the Old and Middle rivers into the south Delta export facilities. During this period, Reclamation and DWR operate to maintain a daily average turbidity at Old River at Bacon Island (OBI) at a level of less than 12 FNU. This action may be on-ramped only after the initiation of the OMR management season. For the CVP, this action continues until April 1, or until a ripe or spent female is detected, whichever is first (see Proposed Action U.S. Bureau of Reclamation 2019c). For the SWP, this action continues until April 1 (ITP COA 8.5.1).

During WY 2024, turbidity at OBI remained below the 12 FNU threshold for the entirety of the season (Figure 16). The Turbidity Bridge Avoidance period was in effect February 1st through April 1st for both the CVP and the SWP but was not triggered since the turbidity threshold at OBI was never exceeded. Turbidity conditions are always considered by the SMT in developing the assessments of fish distribution and risk of entrainment.

Forecasted wind conditions in the Delta are considered at each meeting of the SMT because wind can temporarily increase turbidity within Delta waterways. Typically, these wind-driven increases in turbidity are isolated to only a few of the water quality stations, but large widespread increases in turbidity can occur and may potentially influence the distribution of Delta smelt. During WY 2024, wind conditions likely did not contribute to the entrainment of Delta smelt into the south and central Delta since the daily average turbidity at OBI never exceeded 12 FNU (Figure 16).

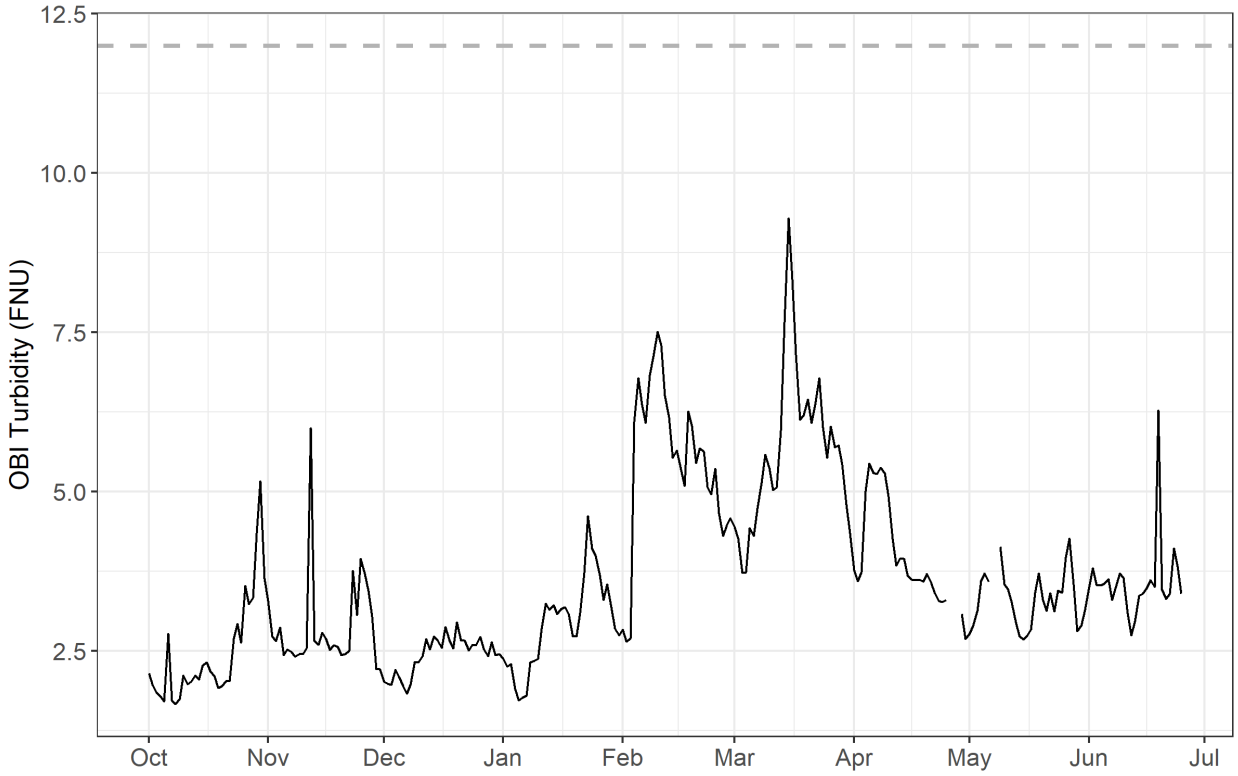


Figure 16. Daily average turbidity (FNU) at Old River at Bacon Island (OBI) in WY 2024. Dashed line indicates 12 FNU threshold.

Figure 16 is a line graph showing daily average turbidity (FNU) at Old River at Bacon Island for WY 2024. All observations fall below the 12 FNU threshold with the largest spike between February – April 2024.

Larval and Juvenile Delta Smelt Protections

Under the ITP COA 8.5.2, if the five-day cumulative salvage of juvenile Delta smelt at the CVP and SWP facilities is greater than or equal to one plus the average prior three years FMWT index (rounded down), DWR and Reclamation (under the IOP) shall restrict south Delta exports for seven consecutive days to maintain a seven-day average OMR index no more negative than -5,000 cfs (Appendix E). Additionally, under Amendment No. 5, when a larval or juvenile Delta smelt is detected in the Smelt Larval Survey (SLS) or 20-mm Survey or the 3-day average water temperature at Jersey Point is greater than or equal to 12°C and the Secchi depth from the most recent SLS or 20-mm Survey is less than or equal to 1 meter, averaged across the 12 south Delta survey stations, DWR and Reclamation (under the IOP) shall restrict south Delta exports to maintain seven-day average OMR index no more negative than -3,500 cfs until average Secchi depth is greater than 1m in the south Delta stations in a subsequent survey. Under the Proposed Action, after March 15 if QWEST is negative and larval or juvenile Delta smelt are within the entrainment zone of the pumps based on real-time sampling of spawning adults or YOY, Reclamation must operate to no more negative than -5,000 cfs on a 14-day moving average. When the Secchi depth in the south Delta is less than 1 meter, Reclamation will operate to OMR no more negative than -3,500 cfs (Appendix F).

On January 31, 2024, the three-day average water temperature at Jersey Point reached 12°C, on-ramping ITP COA 8.5.2, and on February 5, 2024, SLS 3 triggered the action based on Secchi depth. The action remained triggered through March 17 based on Secchi depth. During this period larval and juvenile Delta smelt protections were only controlling between February 7th and February 16th. One juvenile Delta smelt was detected at salvage on April 29, 2024, triggering ITP COA 8.5.2 since the average prior three years FMWT index was zero. However, this action was not controlling. For the PA, larval and juvenile Delta Smelt Protections were not triggered. QWEST was positive for the majority of the larval season, with the exception of the last two weeks where QWEST was negative on June 6 and June 7 at –700 cfs, and again on June 12 at –2,000 cfs (Figure 17). During these periods, Secchi depth was greater than 1m.

DWR limits the operations at the Barker Slough Pumping Plant to protect larval Delta smelt in dry and critical WYs, from March 1 through June 30 (ITP COA 8.12). As WY 2024 was above normal, ITP COA 8.12 was not active at any point during the OMR management season.

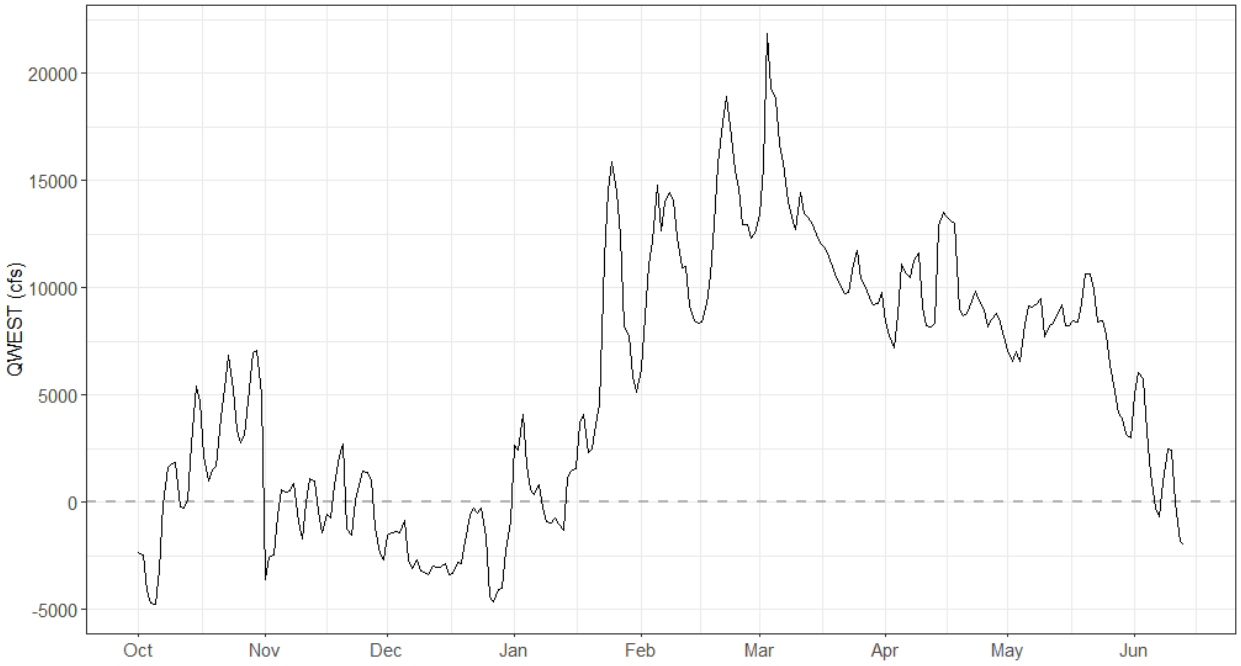


Figure 17.QWEST (cfs) in WY 2024.

Figure 17 is a line graph showing QWEST (cfs) for WY2024. A threshold is marked on the line graph at 0 cfs. The QWEST is primarily above 0 cfs, with an initial period below in October 2023, a short period below in December 2023 – January 2024, and the beginning of a decline in June 2024.

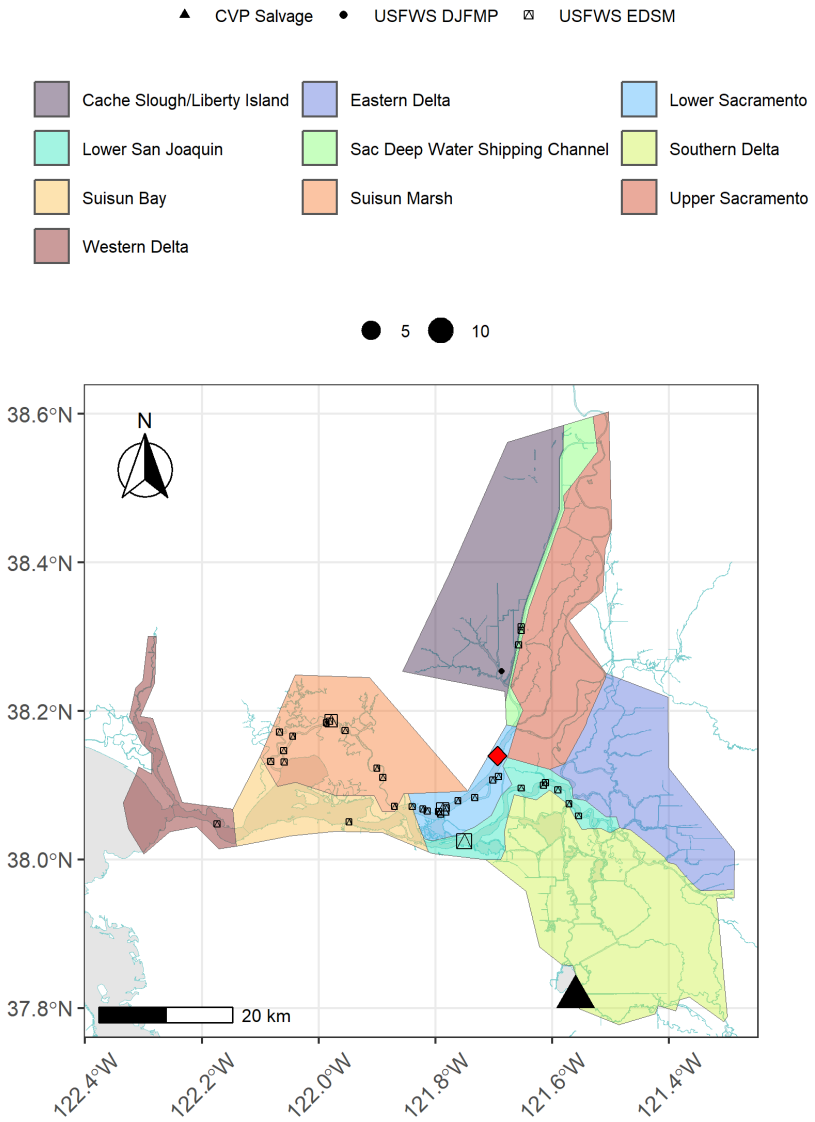
Delta Smelt Detections

All Delta smelt catch data were reported to the SMT and considered each week. Between October 1, 2023 – March 26, 2024, 54 adult and sub-adult Delta smelt were detected. 48 of the 54 adult fish were marked. Adult Delta smelt were caught in the Lower Sacramento, Suisun Marsh, Lower San Joaquin, and Southern Delta strata (salvage included in the Southern Delta strata) (Larval and Juvenile Catch Figure 18A). All detections of adult/sub-adult Delta smelt in the south Delta were at the Tracy Fish Collection Facility (TFCF).

Between March 22, 2023, and June 26, 2024, an additional 12 larval Delta smelt, and 255 larval and 6 juvenile Hypomesus were detected. While originally identified as Delta smelt, a subsample of fish caught in the enhanced Delta smelt monitoring survey (EDSM) were subsequently genetically identified as Wakasagi (Hypomesus nipponensis). Since not all fish were genetically identified, all larval and juvenile detections from EDSM are considered Hypomesus (e.g. could be Hypomesus nipponensis or Hypomesus transpacificus). The majority of larval Delta smelt were caught in Suisun Marsh and Bay, with a few individuals in the Upper and Lower Sacramento and the Sacramento Deep Water Ship Channel. The majority of larval and juvenile Hypomesus detections occurred in the Sacramento Deep Water Ship Channel, though several observations also occurred

in the Cache Slough/Liberty Island, Lower Sacramento, Suisun Marsh, and Suisun Bay strata (Larval and Juvenile Catch Figure 18B). One juvenile Delta smelt was detected in salvage at the TFCF and one larval Delta smelt was detected in the south Delta. Larval/juvenile detections from EDSM are considered tentative as they are undergoing QA/QC and genetic verification. USFWS plans to conduct GTseq-based genotyping of a subset of Hypomesus from EDSM, which may influence changes to data in the future.

A. Adult Catch



B. Larval and Juvenile Catch

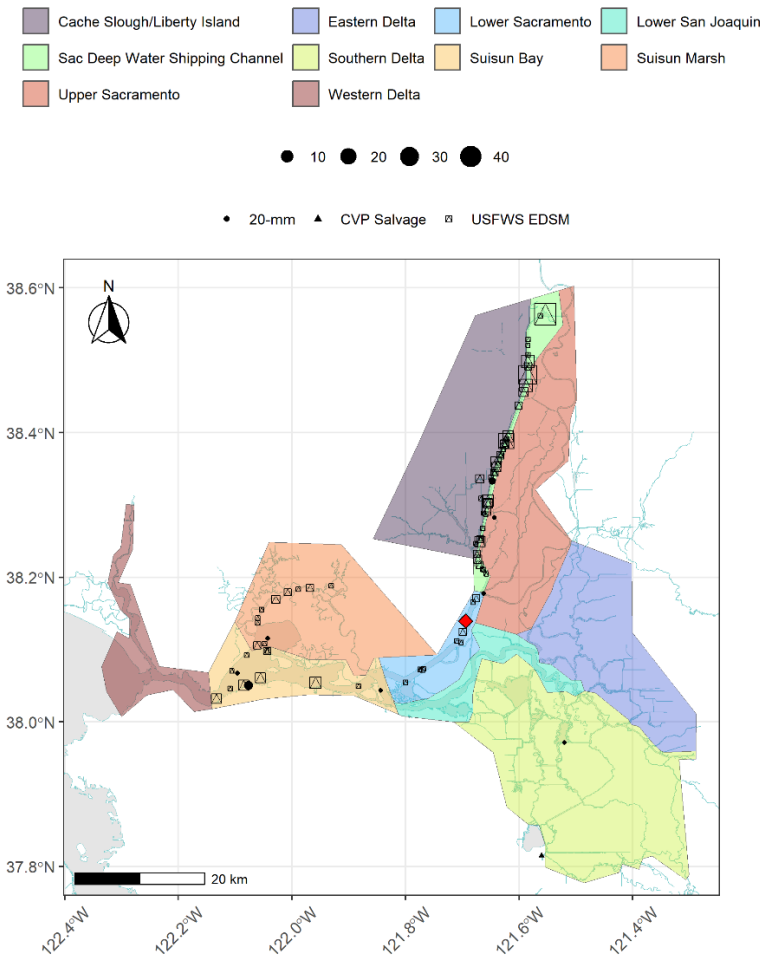


Figure 18. Delta smelt seasonal catch locations in WY 2024 (all reported between October 1, 2023 – June 30, 2024). EDSM Stratum shown as colored polygons. Red diamonds indicate Delta smelt release location. Larger size of points indicate greater number of detections at a particular location. A. Adult catch B. Larval and juvenile catch. USFWS EDSM larval/juvenile detections are considered Hypomesus. Larval and juvenile detections are undergoing QA/QC and genetic verification, and the final data should be sought from the specific survey.

Figure 18 is two maps showing Delta smelt seasonal catch locations for WY 2024. The first map (A) shows adult catch, while the second map (B) shows Larval and juvenile catch. Each map shows the Cache Slough/Liberty Island, Lower San Joaquin, Suisun Bay, Western Delta, Eastern Delta, Sac Deep Water Shipping Channel, Suisun Marsh, Lower Sacramento, Southern Delta, and Upper Sacramento. CVP Salvage (triangle), USFWS DJFMP (circle), and USFWS EDSM (square with an x) are plotted on the map.

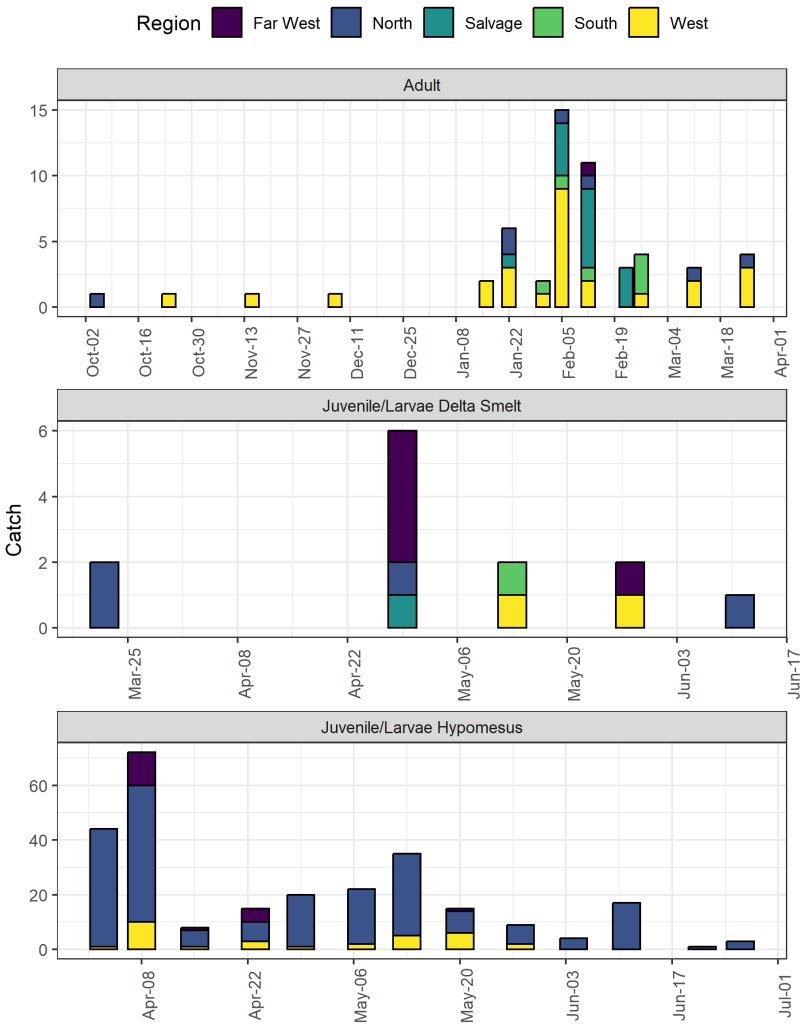


Figure 19. Delta smelt catch by week, region, and life stage in WY 2024 (between October 1, 2023 – June 30, 2024). EDSM Region was used as regional designation for all catch. Salvage represents pre-expansion counts. Scales are different on each y axis. Larval and juvenile detections are undergoing QA/QC and genetic verification, and the final data should be sought from the specific survey.

Figure 19 is three bar graphs showing the Delta smelt catch by week, region, and life stage in WY 2024.

The first graph shows adult catches by region. The highest catch was recorded in February 2024 of 15, with the majority of adults being caught in the West and Salvage regions.

The second graph shows Juvenile/Larvae Delta Smelt by region. The highest catch was recorded in mid-April 2024 with 6 in the Far West region.

The third graph shows Juvenile/Larvae Hypomesus by region. The highest catch was April 8, 2024 of over 60 with the majority being caught in the North region.

Longfin Smelt

Adult Longfin Smelt Protections

The Incidental Take Permit (ITP) for the SWP includes protections for adult longfin smelt from the onset of OMR management through February 28 (ITP COA 8.4.1). In WY 2024, the SMT did not make recommendations for OMR management based on ITP COA 8.4.1. The opportunity for ITP COA 8.4.1 to be activated off-ramped on December 18, 2023, prior to the onset of OMR management, with the detection of longfin smelt larvae in the December SLS #12.

Larval and Juvenile Longfin Smelt Protections

Between January 1 and June 30, or until the temperature offramp occurs, when real-time monitoring surveys (SLS or 20-mm Survey) reach thresholds for detection of longfin smelt larvae and juveniles, DWR implements ITP COA 8.4.2. During WY 2024, ITP COA 8.4.2 distribution and/or density triggers were exceeded in SLS #1 and #2 (Figure 20). The SMT recommended limiting the State's share of OMRI no more negative than -3,500 cfs in response to SLS #1 triggering ITP COA 8.4.2 and was controlling SWP operations from January 14 through January 17. Although ITP COA 8.4.2 was triggered through February 12, other protections were controlling operations during this time. The 20-mm Survey did not trigger any protections, with one single larval longfin smelt detected at a south and central Delta station (#809) in 2024. Flows on the Sacramento River at Rio Vista exceeded 55,000 cfs on February 2, triggering High Flow Off-Ramp from Longfin Smelt OMR Restrictions (ITP COA 8.4.3), and temporarily off-ramped larval and juvenile protections through late March. However, Steelhead protections were controlling during this whole period.

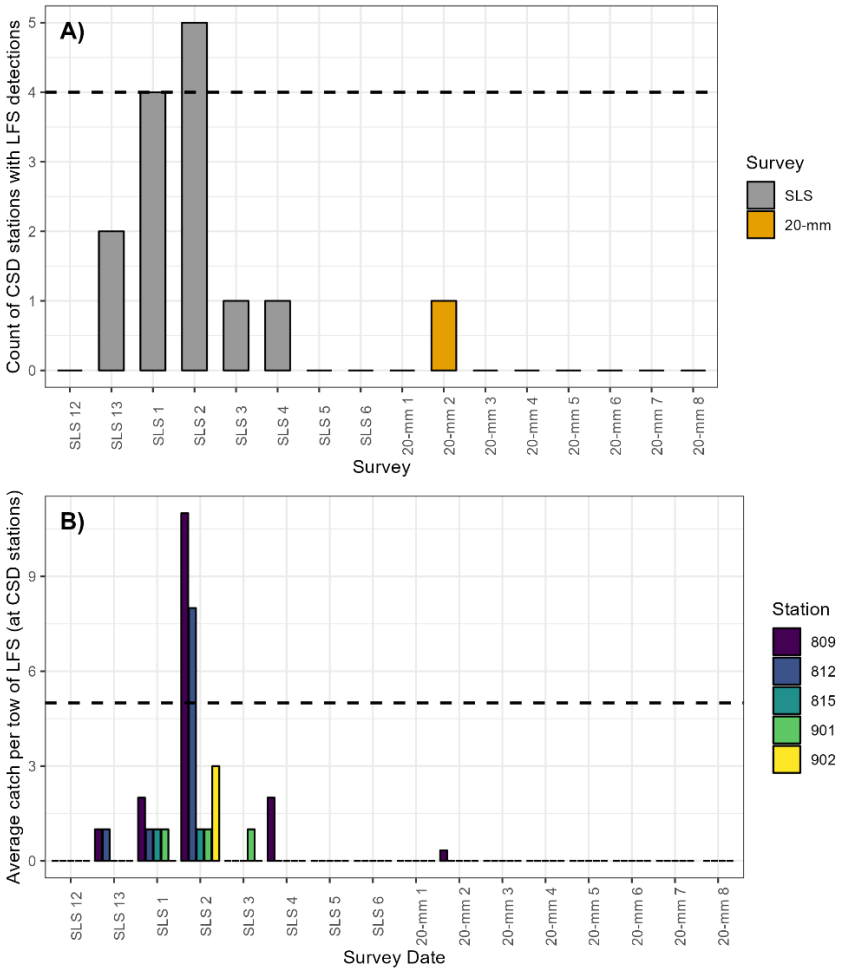


Figure 20. A. Number of Central and South Delta (CSD) stations with longfin smelt detections from the Smelt Larva Survey (SLS) and 20-mm Survey (20-mm), and B. catch per tow of longfin smelt at the 12 CSD stations (809, 812, 815, 901, 902, 906, 910, 912, 914, 915, 918, and 919; only stations with catch > 0 are visualized here). The black dashed lines indicate thresholds (ITP COA 8.4.2) of A: Longfin smelt larvae or juveniles at ≥ 4 SLS or 20mm CSD stations or B: catch per tow of >5 longfin smelt larvae or juveniles in ≥ 2 CSD stations (as the average of three tows for 20-mm). SLS includes completed end-of-year QAQC data. 20-mm samples are still being processed and end-of-year data validation is pending. Data displayed here are the most up-to-date available as of August 19, 2024.

Figure 20 is two bar graphs showing the number of Central and South Delta (CSD) stations with longfin smelt detections and catch per tow of longfin smelt at the 12 stations.

The first graph shows the count of CSD stations with LFS detections during each survey period. The highest detection came during SLS2, which surpasses the threshold of ≥ 4 SLS or 20mm CSD stations.

The second graph shows the average catch per two of LFS (at CSD stations) during each survey period. The highest detection came at station 809 during SLS2 surpassing the threshold of catch per tow of >5 longfin smelt larvae or juveniles in ≥ 2 CSD stations (as the average of three tows for 20-mm).

Larval and Juvenile Longfin Smelt Detections

During WY 2024, larval longfin smelt sampling started on December 11, 2023, in compliance with ITP COA 7.6.1, which directed DWR to fund additional SLS in the Central and South Delta in December. This additional sampling is meant to more completely cover the period of larval longfin smelt presence, as SLS previously did not begin until the first week in January. Starting in WY 2022, these December SLS surveys were extended to the full suite of 35 regular SLS stations, per coordination with the longfin smelt Technical Team (ITP COA 7.6.3). Starting in WY 2023, 16 stations were added to SLS and 20-mm Survey to better sample larval longfin smelt in Carquinez Strait and San Pablo Bay.

The WY2024 sampling first detected larval longfin smelt on December 26, 2023. Throughout the longfin smelt spawning season in WY 2024, the majority of larvae and juveniles detected in regular monitoring were at downstream stations, predominately in the Napa River region, Suisun Bay and West stratum (Figure 21). No larval longfin smelt were detected in qualitative larval sampling. Smelt Larva and 20-mm surveys detected the lowest larval longfin catch in the central and south Delta, compared with other regions of the estuary (Figure 21). April saw the highest catches of larval longfin smelt in regular monitoring (n=15,083), with March (n=7,814) and February (n=1,249) having the second and third highest catch, respectively. Sample processing for the 20-mm Survey is ongoing, and this represents totals as of August 19, 2024.

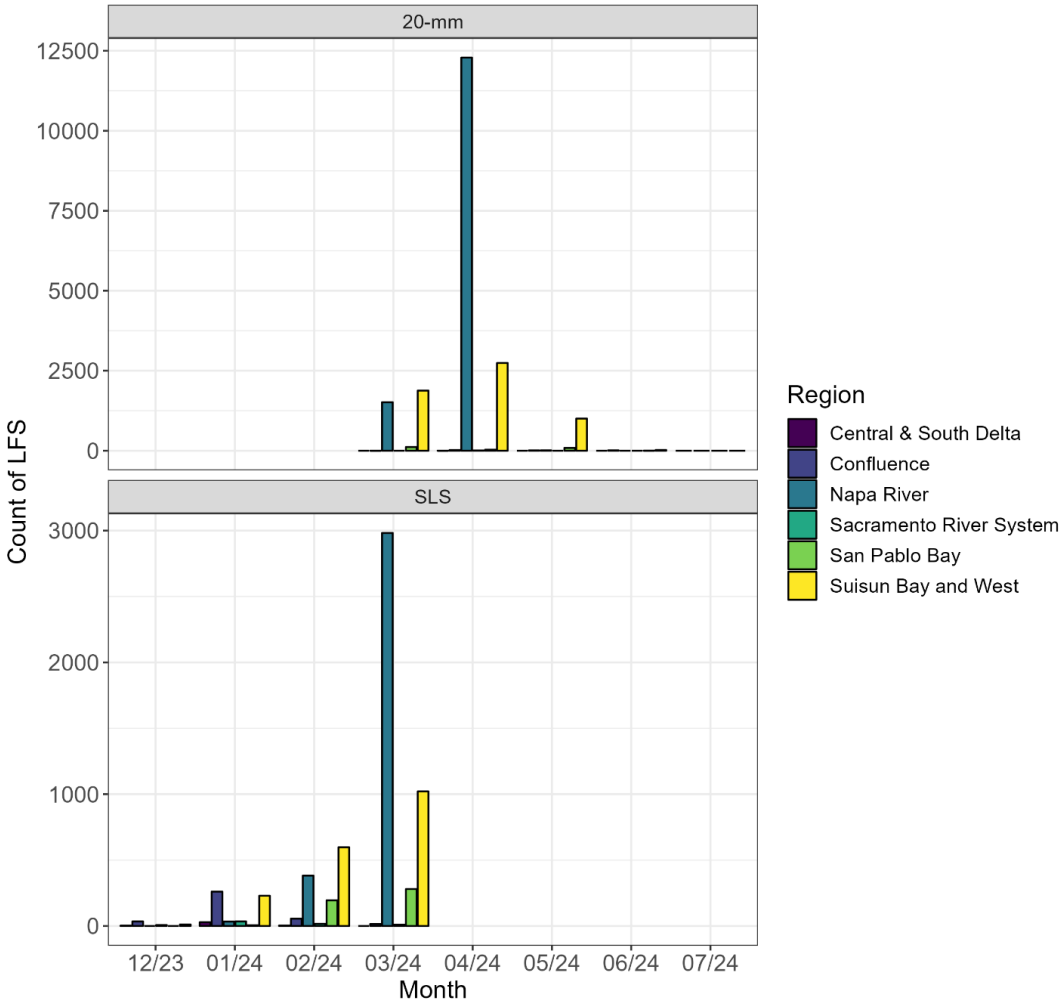


Figure 21. Catch of larval longfin smelt in the Smelt Larva Survey and 20-mm Survey during WY 2024 sampling; note the y axis scale differs by survey. SLS includes completed end-of-year QAQC data. 20-mm samples are still being processed and end-of-year data validation is pending. Data displayed here are the most up-to-date available as of August 19, 2024.

Figure 21 is two bar graphs showing the catch of larval longfin smelt in the Smelt Larva Survey and 20-mm Survey during WY 2024.

The first bar graph shows 20-mm by region over time as compared to the count of LFS. The highest recorded was in the Napa River region in early April 2024.

The second bar graph shows the SLS by region over time as compared to the count of LFS. The highest recorded was in Napa River region around March 24, 2024.

Winter-run Chinook Salmon

Daily Loss

The ITP includes a separate daily loss threshold for winter-run Chinook salmon for each month of the migratory season from November through May, described in ITP COA 8.6.2 and 8.6.3. The November and December Early-season Natural Origin Winter-run Chinook Salmon Discrete Daily Loss Thresholds are intended to minimize CVP and SWP operations impact on the earlier migrating juvenile winter-run Chinook salmon to preserve life history diversity at the leading edge of the migration timing distribution. They are set fixed thresholds for loss of older juvenile Chinook salmon. The January through May Mid- and Late-season Natural Winter-run Chinook Salmon Daily Loss Thresholds are intended to minimize entrainment, salvage, and take of natural winter-run Chinook salmon during the peak and end of their migration through the Delta. They are calculated each year as set percentages of the winter-run Juvenile Production Estimate (JPE) for that management season. The ITP was amended in December 2023; however, the CVP continued to operate under the unamended ITP from the 2023 IOP prior to the transition to the 2024 IOP on April 1, 2024, thus the CVP and SWP were operating under different thresholds under ITP COA 8.6.3 from January through March, as described in Table 3.

Table 3. ITP COA 8.6.3 Mid- and Late- Season Daily Loss thresholds that were operated to in WY 2024. The SWP was operated to the COA 8.6.3 Amended ITP thresholds from January through May. The CVP was operated to 2023 IOP thresholds for January through March, and the 2024 IOP thresholds for April and May.

Date	COA 8.6.3 Amended ITP Threshold[1]	2023 IOP (COA 8.6.3 Unamended ITP Threshold)	2024 IOP Threshold (COA 8.6.3 Amended ITP Threshold)[2]
January 1-January 31	0.00124% of JPE (2.91)	0.00635% of JPE (14.92)	N/A
February 1-February 28	0.00231% of JPE (5.43)	0.00991% of JPE (23.28)	N/A
March 1- March 31	0.00372% of JPE (8.74)	0.0146% of JPE (34.29)	N/A
April 1- April 30	0.00226% of JPE (5.31)	N/A	0.00226% of JPE (5.31)
May 1- May 31	>0% of JPE (0)	N/A	>0% of JPE (0)

[1] COA 8.6.3 was amended on 12/22/23 to allow Permittee to use CDFW-approved genetic analyses to determine whether older juvenile Chinook salmon observed in salvage at the SWP and CVP south Delta facilities are CHNWR

[2] 2024 IOP thresholds adopted the COA 8.6.3 amended ITP thresholds once the 2024 IOP was signed on March 29, 2024. Reclamation operated under COA 8.6.3 unamended ITP thresholds until the 2024 IOP was signed (January through March).

In WY 2024, from January through March, the amended ITP for COA 8.6.3 daily loss threshold was initially triggered 62 times based on length-at-date (LAD) run identification. However, implementation by the SWP of its proportional share of the OMR index no more negative than -3,500 cfs only occurred 6 times based on genetic testing that confirmed a loss of genetic winter-run exceeding the threshold (specifically on 1/16/24, 2/21/24, 3/3/24, 3/5/24, 3/6/24, 3/7/24).

For WY 2024, from January through March, the unamended ITP for COA 8.6.3 daily loss threshold was triggered 40 times based on length-at-date (LAD) run identification. However, implementation by the CVP of it's proportional share of the OMR index no more negative than -3,500 cfs did not occur since, after genetic testing, confirmed genetic loss of winter-run never exceeded the threshold.

From April through May, the amended ITP for COA 8.6.3 daily loss threshold 2024 IOP thresholds were being operated to and ITP COA 8.6.3 daily loss threshold was triggered 10 times. Of the total 10 times that it was triggered from April through May, joint CVP and SWP implementation of the OMR index no more negative than -3,500 cfs did not occur since, after genetic testing, confirmed genetic loss of winter-run never exceeded the threshold.

Table 4. Daily observed genetic winter-run loss with 2024 IOP threshold (COA 8.6.3 amended ITP threshold), 2023 IOP threshold (COA 8.6.3 unamended ITP threshold) and whether each threshold was triggered yes (Y) or no (N). No genetic winter-run Chinook salmon loss occurred after 3/31/2024, when both CVP and SWP facilities were operating under the COA 8.6.3 amended ITP threshold in the 2024 IOP.

Date	Genetic Winter-run Loss	2024 IOP Threshold	2023 IOP Threshold	2024 IOP Trigger	2023 IOP Trigger
1/16/2024	4.33	2.91	14.92	Y	N
2/12/2024	2.33	5.43	23.28	N	N
2/21/2024	8.33	5.43	23.28	Y	N
2/23/2024	4.33	5.43	23.28	N	N
2/28/2024	2.60	5.43	23.28	N	N
2/29/2024	4.33	5.43	23.28	N	N
3/1/2024	2.60	8.74	34.29	N	N
3/2/2024	6.93	8.74	34.29	N	N
3/3/2024	17.71	8.74	34.29	Y	N
3/4/2024	2.60	8.74	34.29	N	N
3/5/2024	17.14	8.74	34.29	Y	N
3/6/2024	12.99	8.74	34.29	Y	N
3/7/2024	21.77	8.74	34.29	Y	N

Date	Genetic Winter-run Loss	2024 IOP Threshold	2023 IOP Threshold	2024 IOP Trigger	2023 IOP Trigger
3/9/2024	4.33	8.74	34.29	N	N
3/10/2024	2.60	8.74	34.29	N	N
3/13/2024	3.52	8.74	34.29	N	N
3/16/2024	4.33	8.74	34.29	N	N
3/21/2024	8.66	8.74	34.29	N	N

Single Year Loss

The ROD and ITP COA 8.6.1 set the same single-year threshold loss values for natural and hatchery-origin winter-run Chinook salmon. These values are calculated as 1.17% of the JPE (234,896) for LAD natural-origin winter-run Chinook salmon, equal to a loss of 2748.28 for WY 2024, and 0.12% of the JPE (193,582) for the Sacramento hatchery production group, equal to a loss of 232.30 for WY 2024. In the event of exceedance of the single-year threshold, under the NMFS incidental take statement (ITS) in Section 13.3.5.3, the maximum annual quantity or incidental take limit (ITL) allowed before reinitiation of consultation is either 1.3% of the JPE on a three-year rolling average equal to 1,776, or 2.0% of the JPE in any single year, equal to 4,698, whichever number is smallest. For the three-year rolling average, LAD winter-run losses in WYs 2022 and 2023 were 73.04 and 109.88 respectively, so maximum allowable loss for WY 2024 would equal 5,145 (i.e. (1779*3)-73.04-109.88), thus the 2.0% of the JPE in the single year was controlling. The ITL for the Battle Creek hatchery winter-run Chinook salmon release was 1% of the Battle Creek release JPE (3,359), equal to loss of 33.59 fish. However, the SWP ITP does not include Battle Creek releases in the threshold for ITP COA 8.6.1.

Combined LAD natural-origin winter-run Chinook salmon loss for WY 2024, (October 1, 2023 – June 30, 2024) was 4,205.05 fish. This loss equaled 153% of the single-year loss threshold, which exceeded the single year loss threshold for both the ROD and ITP. The 50%, 75%, and 100% single-year loss thresholds were exceeded on 2/25/24, 3/7/24, and 3/20/24, respectively. Once the single-year loss threshold was triggered on 3/20/24, SaMT convened on 3/22/24 to discuss potential OMR index scenarios, determine if WR were still present near the facilities, and minimize subsequent loss of winter-run Chinook salmon. Advice was given to WOMT and moved up to the Directors for a final decision in which the Directors determined that the CVP and SWP export facilities will operate to an OMR index of -1,500 cfs from 3/26/24 to 3/31/24 for steelhead and winter-run Chinook salmon protections (the winter-run Chinook salmon ITL was not exceeded in WY 2024). Total loss of hatchery-origin winter-run Chinook salmon was 4.33 fish for the Sacramento River release and 0 fish from the Battle Creek release (Table 5). Hatchery-origin winter-run Chinook salmon single-year loss threshold was not triggered.

Table 5. Confirmed hatchery-origin (adipose-fin clipped and marked with CWT) winter-run Chinook Salmon loss observed at SWP and CVP export facilities for WY 2024.

Release Date	CWT Race	Hatchery	Facility Where Loss Occurred	Date Loss Occurred	Loss	CWT Tag Code	CWT Release Type	Release Site
12/28/23	Winter	LSNFH	SWP	3/10/24	4.33	050031	Production	Sacramento River; John F. Reginato River Access; Redding; CA

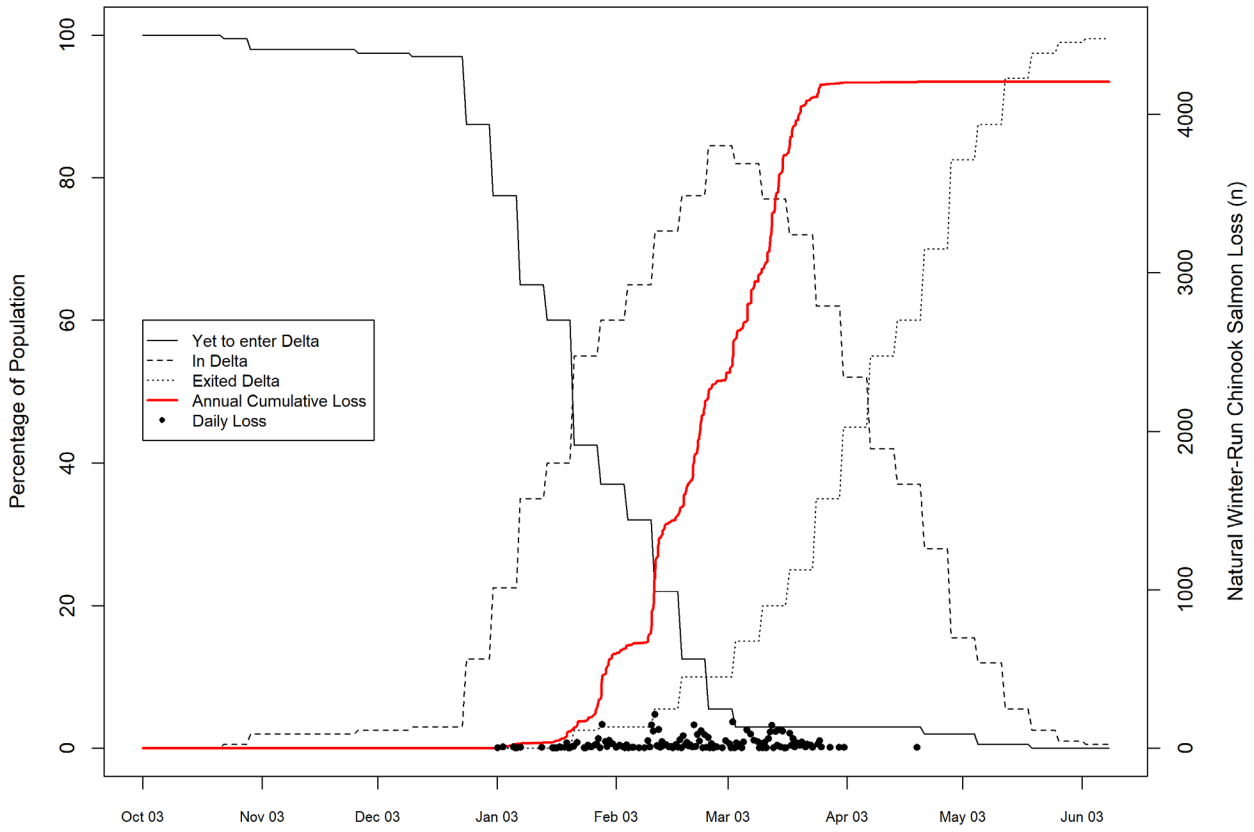


Figure 22. Combined CVP and SWP loss of natural LAD winter-run size Chinook salmon in WY 2024 (90% occurred at SWP, 10% occurred at CVP) plotted along with SaMT distribution estimates.

Figure 22 is a line graph showing the combined CVP and SWP loss of natural LAD winter-run size Chinook salmon in WY 2024. The graph compares percentage of population to natural Winter-Run Chinook salmon Loss (n) from October 3, 2023 to June 3, 2024. The graph plots those yet to enter the Delta, those in the Delta, those who have exited the Delta, Annual Cumulative Loss, and daily loss.

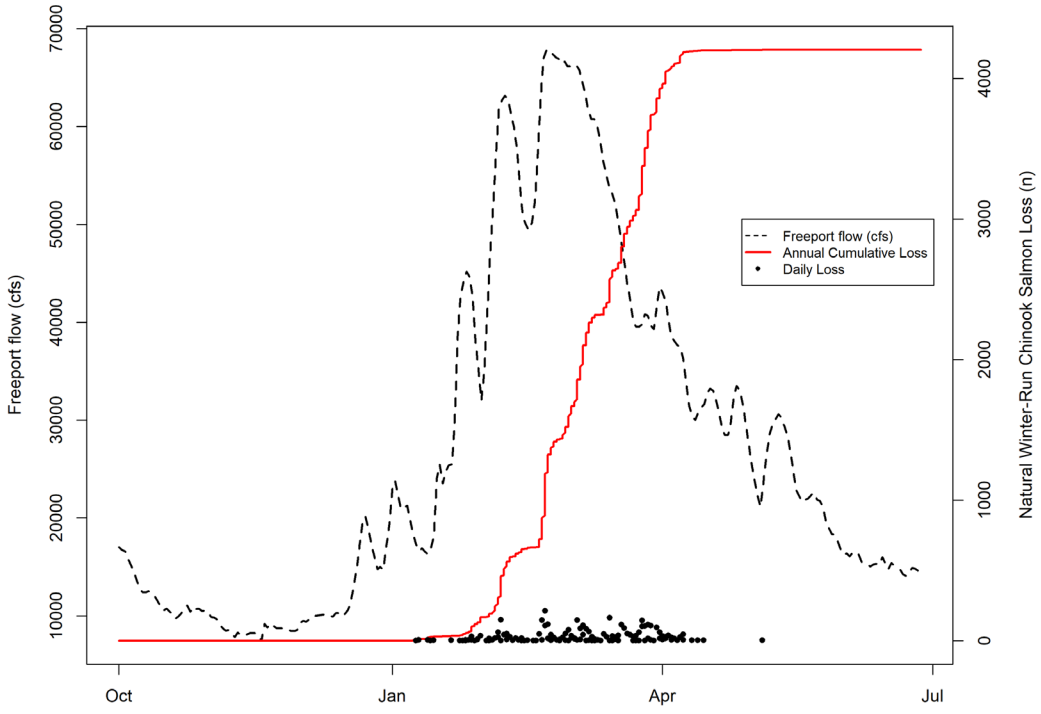


Figure 23. Freeport flows (cfs, black dotted line), cumulative (red solid line), and daily (points) natural winter-run size Chinook salmon loss at the CVP and SWP fish salvage facilities for WY 2024.

Figure 23 is a line graph that compares Freeport flows (cfs) and Natural Winter-Run Chinook salmon Loss (n) over time from October 2023 to July 2024. The graph plots freeport flows (cfs), Annual Cumulative loss, and daily loss.

Cumulative Loss

The cumulative loss threshold for natural-origin winter-run Chinook salmon over the duration of the ROD and the SWP ITP (ITP Project Description 3.5) is 8,738 fish. Total cumulative loss to date (calculated here as total since February 19, 2020) of natural winter-run Chinook salmon over the duration of the ROD and ITP (10 years) is 4575.30 fish, or 52.36% of the threshold. The cumulative loss threshold for hatchery-origin winter-run Chinook salmon over the duration of the ROD and the ITP is 5,356 fish. Total cumulative loss to date of hatchery-origin winter-run Chinook salmon over the duration of the ROD is 11.04 fish, or 0.21% of the threshold. Neither cumulative loss thresholds were triggered in WY 2024.

Additional Information

Additional information comparing the WY 2024 winter-run cohort to previous water year cohorts is included in Appendix H.

Spring-Run Chinook Salmon

ROD Spring-Run Chinook Salmon Surrogates

As part of the NMFS 2019 Biological Opinion, the ITS annual loss threshold for late fall-run Chinook salmon hatchery release groups serving as yearling spring-run Chinook salmon surrogates was 1% of each release group (Section 13.3.5.3). During WY 2024, three groups of brood year 2023 late-fall-run Chinook salmon were released into Battle Creek from the Coleman National Fish Hatchery. The first group of 60,764 fish was released on December 22, 2023 (maximum estimated incidental take= 607.6). The second group of 71,049 fish was released on December 29, 2023 (maximum estimated incidental take = 710.5). The third group of 67,018 fish was released on January 11, 2024 (maximum estimated incidental take = 670.2). Combined loss for WY 2024 was 36.83 fish (6.1% of maximum estimated incidental take) for the first release group, 38.95 fish (5.5% of the maximum estimated incidental take) for the second release group, and 94.16 for the third release group (14.1% of the maximum estimated incidental take). Therefore, during WY 2024 loss of spring-run Chinook salmon surrogates did not exceed the maximum estimated incidental take (Table 6).

Table 6. Confirmed hatchery (adipose-fin clipped and marked with CWT) spring-run yearling surrogate Chinook salmon lost at the SWP and CVP export facilities for WY 2024.1Loss numbers may slightly differ from other reporting agencies due to minor differences in methodology for calculating loss.

Release Date	CWT Race	Hatchery	Release Site	Release Type	Loss1	CWT Number Released	% CWT Marked of Total Number Released	% Loss CWT number released	First Loss	Last Loss
12/22/2023	Late-Fall	Coleman NFH	Battle Creek at CNFH	Experimental	36.83	60,764	100	0.061	1/9/2024	2/6/2024
12/29/2023	Late-Fall	Coleman NFH	Battle Creek at CNFH	Experimental	38.95	71,049	100	0.055	1/10/2024	3/15/2024
1/11/2024	Late-Fall	Coleman NFH	Battle Creek at CNFH	Experimental	94.16	67,018	100	0.141	1/22/2024	4/16/2024

ITP Young of Year (YOY) Spring-Run Chinook Salmon Surrogates

To minimize entrainment of emigrating natural YOY juvenile spring-run Chinook salmon from the Sacramento River and tributaries, including the Feather and Yuba rivers, into the channels of the central Delta, south Delta, Clifton Court Forebay (CCF), and the Banks Pumping Plant, the ITP (ITP COA 8.6.4) requires DWR to restrict exports based on the presence of hatchery produced spring-run Chinook salmon surrogate groups at the CVP and SWP fish salvage facilities. These release groups are separate from the three release groups proposed by the ROD because these release groups are protective of YOY spring-run rather than yearling spring-run. Six surrogate release groups of YOY spring-run or fall-run hatchery-origin Chinook salmon are expected to occur each year, spread across the spring-run migration season. Release groups consist of Chinook salmon from the Coleman National Fish Hatchery, Feather River Hatchery, and the Nimbus Fish Hatchery. From February 1 through June 30 of each WR, DWR is required to reduce south Delta exports for five consecutive days to achieve a five-day average OMR index no more negative than -3,500 cfs when Feather River Hatchery, Coleman National Fish Hatchery, or Nimbus Fish Hatchery coded wire tagged (CWT) spring-run Chinook salmon surrogates (includes both spring- and fall-run hatchery release groups) cumulative loss at the CVP and SWP fish salvage facilities is greater than 0.25% for each release group.

All six YOY spring-run Chinook salmon surrogate release groups were successfully released in-river during WY 2024. Only one YOY spring-run surrogate from the Feather River release group was detected at the SWP export facility on 4/2/24 resulting in a loss of 4.33. No other YOY spring-run surrogates were observed in salvage. No loss thresholds were exceeded for any of these release groups. Release group, release date, hatchery origin, location, number, loss limit, and total season loss are detailed in Table 7.

Table 7. Confirmed SWP and CVP Spring-run Chinook Salmon YOY surrogate loss for WY 2024.

Release Date	Race	Hatchery	Release Site	CWT Number Released	Loss Limit	Total Season Loss
3/15/24	Spring	Feather	Feather River	669,854	1,749.64	4.33
3/21/24	Fall	Coleman	Battle Creek	712,177	1,780.44	0
3/29/24	Spring	Feather	Feather River	700,626	1,751.57	0
4/19/24	Fall	Coleman	Battle Creek	210,351	525.88	0
4/23/24	Spring	Feather	Feather River	560,304	1,400.76	0
5/1/24	Fall	Coleman	Battle Creek	106,531	266.33	0

Steelhead

Single-year Loss

Single-year loss thresholds for natural steelhead remain the same every year and are equal to 1,414 fish for the December 1-March 31 (early) period and are equal to 1,552 for the April 1-June 15 (late) period. Juvenile steelhead outmigating from the Sacramento basin are expected during both periods; juvenile steelhead outmigrating from the San Joaquin basin may also occur during both periods but are expected to be concentrated in the late period based on historical juvenile steelhead catch patterns at the Mossdale trawl. Under the NMFS incidental take statement (ITS) in Section 13.3.5.3, the maximum annual ITL allowed before reinitiation of consultation is either a three-year rolling average of annual loss of 1,571 juveniles or a single-year loss of 2,760 juveniles for the December-March period and a three-year rolling average loss of 1,725 juveniles or a single-year loss of 3,040 juveniles for the April to mid-June period, whichever number is lowest for each period. For both periods the single-year total loss was lower than the allowable loss for WY2024 based on the three-year rolling average and were 2,760 and 3,040 fish respectively for the early and late periods.

A loss of 3,375 natural steelhead was observed for the December 1-March 31 period of WY 2024. This loss was 239% of the December 1-March 31 single-year loss threshold (3,375/1,414) and 122% of the ITL (3,375/2,760), exceeding both thresholds. A loss of 1,919 natural steelhead was observed for the late period of WY 2024. This loss was 124% of the December 1-March 31 single-year loss threshold (1,919/1,552) and 63% of the ITL (1,919/3,040), exceeding the single-year loss threshold but not the ITL. Export reductions were made in response to exceedances of the early and late season single-year thresholds and the early season ITL, as described in detail in the Old and Middle River Flow Management section.

Cumulative Loss

The cumulative loss threshold for natural steelhead over the duration of the ROD and the SWP ITP (ITP Project Description 3.5) is 6,038 fish for the December 1-March 31 period and 5,826 fish for the April 1-June 15 period. Over the duration of the ROD, to date total cumulative loss of natural steelhead is 4,951 fish, or 82% of the cumulative loss threshold for December 1-March 31 period and 2,923 fish, or 50.2% of the cumulative loss threshold for April 1 – June 15 period (Figure 23).

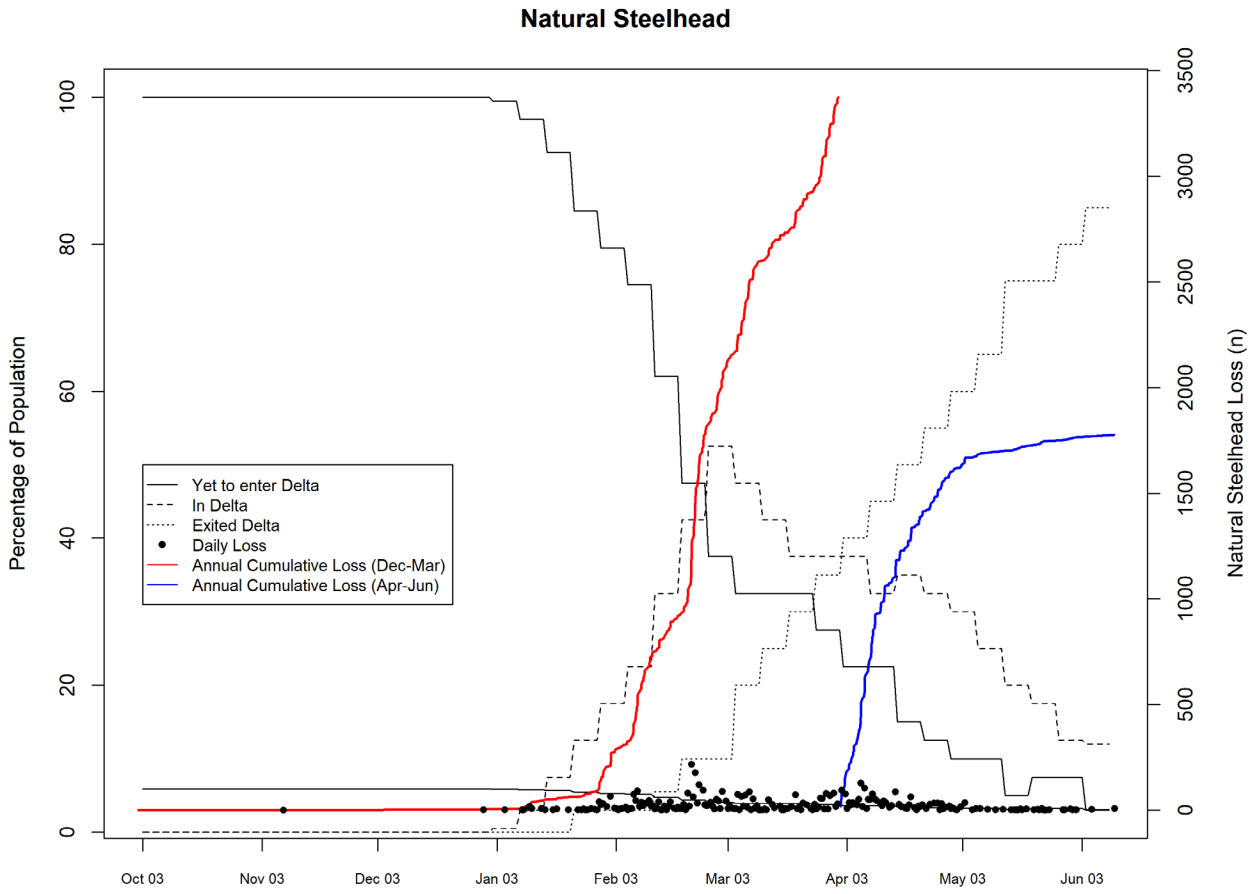


Figure 24. Estimated combined CVP and SWP loss of natural steelhead for WY 2024 (December-March: 81% at SWP, 19% at CVP; April-June: 74% at SWP, 26% at CVP).

Figure 24 is a line graph showing the percentage of the natural steelhead population, the natural steelhead loss (n) from October 3, 2023 – July 3, 2024. The graph plots those yet to enter the Delta, those in the Delta, those who have exited the Delta, Annual Cumulative Loss (Dec-Mar), Annual Cumulative Loss (Apr-Jun), and daily loss.

Additional Information

Additional information for the WY2024 steelhead cohort and the Steelhead Science Plan are included in appendices I and J. Appendix I compares the WY 2024 steelhead cohort to cohorts in previous years. The Steelhead Science Plan in Appendix J describes a plan for developing and implementing a steelhead JPE that will, in part, aid in management decisions during the OMR season.

Storm-Related OMR Flexibility

The CVP and SWP can increase exports during the OMR flow management season to capture peak flows in the Delta during storm-related events (see Proposed Acton section 4.10.5.10.3, U.S. Bureau of Reclamation 2019c, ITP COA 8.7). In WY 2024 Reclamation and DWR did not request the use of this flexibility.

End of OMR Management

CCF monitoring station (CLC) criterion for Delta smelt and longfin smelt was met on June 13, 2024, when daily average water temperature exceeded 25°C for three consecutive days (Figure 25). OMR flow management season for steelhead ended on June 12, 2024, when temperature criteria were met. SaMT estimated that more than 95% of YOY natural-origin winter-run had exited the delta by May 21, 2024. SaMT estimated that more than 95% of YOY natural-origin spring-run Chinook salmon were estimated to exit the Delta by June 4, 2024. Daily average water temperature at Mossdale and Prisoners Point met the offramp criteria for Chinook salmon on June 12, 2024, ending OMR management season for salmonids (Figure 25).

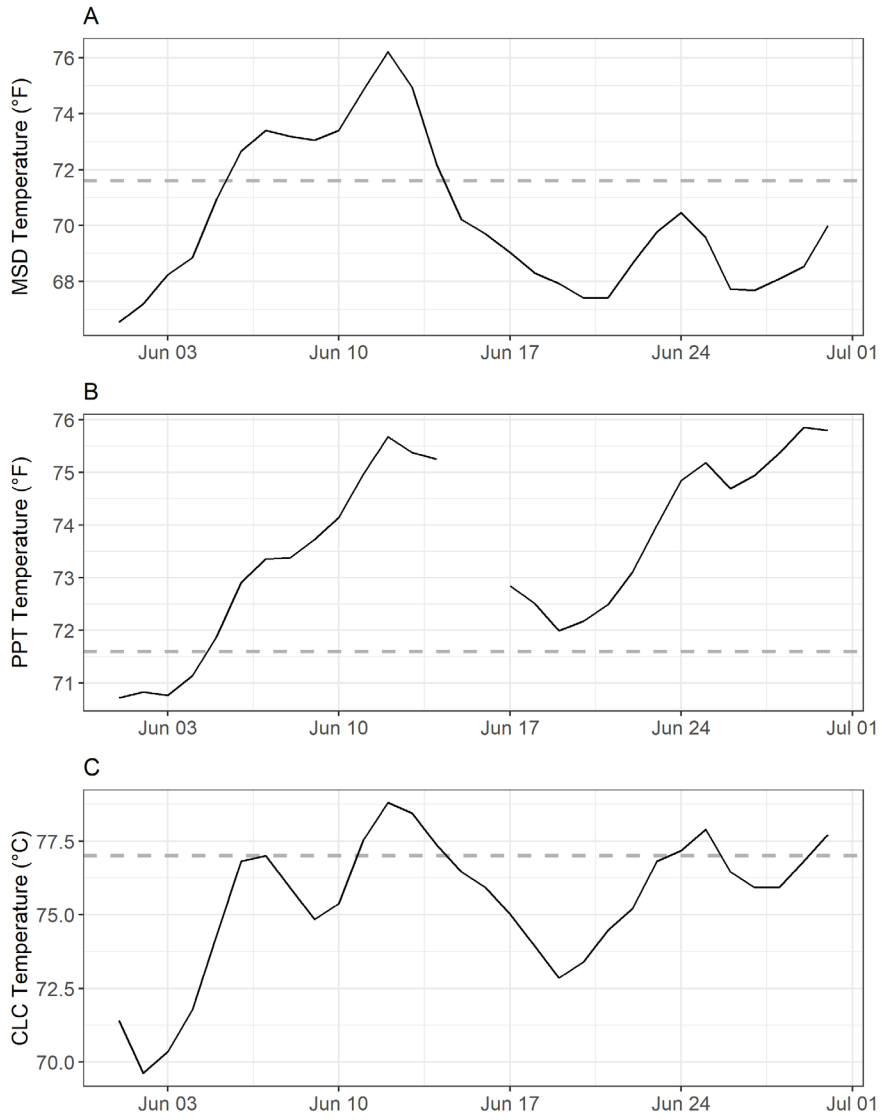


Figure 25. Average daily temperatures (°F) at stations: A) Mossdale (MSD), B) Prisoners Point (PPT), and Clifton Court Forebay (CLC) in June 2024. Dashed lines indicate 71.6°F thresholds for MSD and PPT and 77°F (25°C) threshold for CLC.

Figure 25 is three line graphs showing average daily temperatures (°F) at three locations in June 2024.

The first graph (A) shows the average daily temperature for MSD, with the highest temperature being close to 76 °F. This surpassed the 71.6 °F threshold for this location.

The second graph (B) shows the average daily temperature for PPT, with the highest temperature being close to 76 °F. This surpassed the 71.6 °F threshold for this location.

The third graph (C) shows the average daily temperature for CLC, with the highest temperature being above 77.5 °F. This surpassed the 77.5 °F threshold for this location.

Export Curtailments for Spring Outflow

Export curtailments in the ITP during April and May are designed to improve Delta Outflow during these months and improve habitat for delta smelt and longfin smelt, as well as migratory conditions for winter-run Chinook salmon and spring-run Chinook salmon.

The daily export rate for the SWP is the daily inflow to CCF minus the daily Byron Bethany Irrigation District (BBID) diversion from the CCF. For 2024, the BBID diversion varied daily, but the monthly average was approximately 33 cfs/day in April and 71 cfs/day in May. The CVP exports was shaped by the 2024 IOP and water year type classification.

The ITP issued by the CDFW (ITP COA 8.17) for SWP operations specifies:

> Permittee shall reduce exports from April 1 to May 31 each year to achieve the SWP proportional share of export reductions established by the ratio of Vernalis flow (cfs) to combined CVP and SWP exports, scaled by WY type, to provide incidental spring outflow…" such that in an above normal or wet year, the ratio of Vernalis flow to CVP and SWP combined exports shall be 4 to 1. In a below normal year, the ratio of Vernalis flow to CVP and SWP combined exports shall be 3 to 1.

ITP COA 8.17 also stipulates that if the Net Delta Outflow Index (NDOI) is greater than 44,500 cfs on a three-day average, the CVP and SWP operations need not be confined by the inflow to export ratio. In the ITP, the SWP export rate is never required to be less than 600 cfs per day. On April 1, 2024, the forecast was for a below normal WY, which would require a Vernalis flow to export ratio of 3:1. However, the three-day average NDOI did not go below 44,500 until April 10, 2024. On April 9, 2024, the forecast was updated to an above normal WY, which would require a Vernalis flow to export ratio of 4:1. Beginning 4/10/24, SWP exports remained at 600 cfs in April (after April 10) and May except for the period of May 16 to May 26 during which flows at Vernalis were above 6,000 cfs and SWP exports increased to operate to its proportional share of ITP COA 8.17 under excess conditions of a 4:1 ratio of Vernalis flow to export.

The 2024 IOP for CVP operations specifies:

> Export Curtailments for Spring Outflow (ITP Cond. Of Approval 8.17): DWR will implement ITP Cond. Of Approval 8.17 and Reclamation shall reduce exports in the event Water Year 2024 is classified, based on the San Joaquin Valley 60-20-20 index, as Critical, Dry, or Below Normal to ensure a volumetric reduction consistent with DWR's implementation. In the event Water Year 2024 is classified as Above Normal, Reclamation shall reduce exports by 100,000-acre feet to contribute to Spring outflow except the action will be suspended during a high Delta outflow condition

described in ITP Condition of Approval 8.17. This Spring outflow action is intended to benefit the survival of Longfin Smelt, Spring-run Chinook Salmon, Winter-run Chinook Salmon and Central Valley Steelhead. Documentation of biological rationale for scheduling and shaping of volumetric share or export reduction will be recorded in WOMT notes. Nothing herein shall require Reclamation and DWR to reduce exports to less than minimum health and safety.

The 2024 IOP began on April 1, 2024, and the accounting for CVP export curtailments under this new IOP began on April 10, 2024, when the water year type was officially determined to be above normal. However, this was not officially agreed upon until April 17 by WOMT so accounting was retroactive to April 10. For calculating the additional curtailment, an OMRI limit of -2,500 cfs was assumed as the operational reference condition from April 10 – April 14 and D-1641 was the operation reference condition from April 15 to May 15, with the 100 TAF export curtailment being fully implemented on May 15, 2024.

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Issues Elevated in WY 2024

The SMT did not elevate any issues to WOMT during WY 2024. The SaMT elevated issues to WOMT several times during WY 2024. Recommendations to WOMT made under ITP COA 8.4.2 and 8.5.1 are also discussed in "Additional Real-time OMR Restrictions and Performance Objectives." The following are elevated issues to WOMT from SaMT:

- February 27: SaMT elevated the alterations of the operational plan due to exceeding the steelhead 100% single-year threshold to WOMT. SaMT recognized any change to an OMRI more positive than –2,500 cfs may reduce salvage and loss. WOMT decided to continue operating OMRI to -2,500 cfs.
- March 5: SaMT elevated a recommendation of an OMRI from 0 cfs to -500 cfs to WOMT to avoid exceeding the annual ITL for CCV Steelhead; then reassess the following week to see if a decrease in salvage has occurred and compare loss rates relative to the Tillotson Model predictions. WOMT members were not able to reach a consensus so two proposals were elevated to the Directors. Directors decided on an OMRI of -500 cfs for steelhead protection beginning 3/11/24.
- March 19: SaMT discussed Reclamation's proposal to operate to an OMRI no more negative than –1,500 cfs due to the steelhead 100% annual loss threshold exceedance and potential exceedance of the ITL (PA 4.10.5.10.2). SaMT acknowledges that this change in OMRI will likely increase loss per day based on the Tillotson Model which would not be beneficial to the steelhead population and would increase the likelihood of exceeding the ITL at an earlier date. Reclamation elevated the proposal to WOMT on 3/20/2024. WOMT members were not able to reach a consensus so two proposals were elevated to the Directors. Directors approved an OMRI of -1,500 cfs.
- March 22: An off-cycle SaMT meeting occurred on 3/22/24 in response to the SWP's ITP COA 8.6.1 100% single-year loss threshold exceedance. SaMT met to discuss an appropriate path forward for minimizing any subsequent loss of winter-run Chinook salmon. SaMT concluded that a decrease in exports through a more positive OMRI is expected to decrease future loss relative to higher export rates, therefore lowering exports would contribute to minimizing subsequent loss in WY 2024. This was elevated to WOMT on 3/22/24 and WOMT met on 3/25/24 where it was discussed.

- March 26: CDFW elevated to WOMT a recommendation of an OMRI more positive than –500 cfs to WOMT to minimize winter-run Chinook salmon loss due to the 100% annual loss threshold exceedance. Reclamation elevated any operational changes to OMRI between –500 cfs and –2,500 cfs for WOMT to decide. Reclamation disagreed that discussion in the off-cycle meeting on March 22 represented consensus of all the agencies in SaMT. WOMT members were not able to reach a consensus, so the recommendation was elevated to the Directors. Directors approved an OMRI of -2,500 cfs beginning 4/1/24.
- April 9: CDFW recommended to WOMT that OMRI should remain more positive than –500 cfs in order to minimize subsequent loss of winter-run Chinook salmon due to the 100% winter-run Chinook salmon annual loss threshold exceedance, as required by the ITP COA 8.6.1. Reclamation and DWR elevated CDFW's proposed operational changes for WOMT to decide. NMFS acknowledged that increase in exports would likely increase loss. WOMT did not make a decision that week on OMRI operation changes based on the recommendation that was elevated by CDFW at SaMT, but rather based on spring exports (ITP COA 8.17 and 2024 IOP).
- April 16: CDFW recommended to WOMT to continue operating to a positive OMRI due to the 100% winter-run Chinook salmon annual loss threshold exceedance. The positive OMRI recommendation was due to decreased salvage of LAD WR that was observed since operations targeted a positive OMRI over the previous week. NMFS, DWR, and USFWS acknowledged that steelhead were still being observed in salvage and increasing exports would likely increase steelhead loss, which would increase the risk of exceeding the steelhead annual loss threshold and ITL. WOMT decided to continue to operate to the proposed operational plans, which was a positive OMRI.
- April 23: CDFW, USFWS, and NMFS recommended to WOMT to operate to a 2-unit operation (exports of 1,800 cfs) at CVP to meet the export curtailment action and to extend the 100 TAF outflow requirement (2024 IOP) later into May to benefit spring-run Chinook salmon, steelhead, and fall-run Chinook salmon. Other SaMT members agreed with the rationale of the recommendation but chose to abstain from the recommendation. WOMT decided on operating CVP to a 2-unit operation to extend the 100 TAF later into May.

- April 30: CDFW, USFWS, and NMFS recommended to WOMT operating to a 2-unit operation at the CVP to meet the export curtailment action and to extend the 100 TAF towards outflow later into May benefiting spring-run and fall-run Chinook salmon. Reclamation abstained and deferred deliberation on operations to WOMT. WOMT did not make a decision on operations. Reclamation decided to operate to 1 unit to expend the 100 TAF requirement per the 2024 IOP as there was increased risk of not meeting the requirement with a 2-unit operation.
- May 7: CDFW, USFWS, and NMFS recommended operating to a 2-unit operation at the CVP to meet the export curtailment action and to extend the 100 TAF towards outflow later into May benefiting spring-run and fall-run Chinook salmon. Reclamation abstained from the recommendation and deferred deliberation on operations to WOMT. WOMT did not make a decision on operations. Reclamation decided to operate to 1 unit to expend the 100 TAF requirement per the 2024 IOP as there was increased risk of not meeting the requirement with a 2-unit operation.
- May 28: NMFS recommended continuing to target an OMRI of –2,500 cfs to be most protective of CCV Steelhead. CDFW recommend an OMRI of –2,500 cfs beginning 6/1/24 to be protective of any winter-run Chinook salmon remaining in the system. Reclamation elevated any operational changes within an OMRI range of –2,000 cfs to –5,000 cfs for WOMT to decide. WOMT decided on operating to OMRI of –2,500 cfs until 6/1/24 and then reassessing.
- June 4: NMFS and CDFW recommended continuing to target an OMRI of –2,500 cfs to be most protective of CCV Steelhead due to the 100% annual loss threshold being exceeded for steelhead. CDFW assumed winter-run Chinook salmon presence in June was unlikely; therefore, also proposed offramping ITP COA 8.6.1 and operating to an OMRI of -5,000 cfs with the exception of having an off-cycle SaMT meeting, if a LAD winter-run was observed in salvage, to discuss a more positive OMRI recommendation than -5,000 cfs. This recommendation was only in regard to ITP COA 8.6.1. Reclamation abstained from providing a recommendation and elevated any operational changes within an OMRI range of –2,000 cfs to –5,000 cfs for WOMT to decide. WOMT decided to operate to an OMRI of -5,000 cfs; therefore, offramping the single year loss thresholds for both steelhead and winter-run Chinook salmon.

WOMT members elevated OMR flow management concerns to the directors a few times in WY 2024 (See Supporting Information Sections):

- February 15: An off-cycle meeting in which WOMT elevated information on the natural-origin steelhead threshold trigger and associated OMR flow management operations.
- March 6: A regularly scheduled meeting where WOMT elevated two proposals to directors in response to the exceedance of the annual steelhead loss threshold: 1) As soon as possible operate to Health and Safety levels for a minimum of 5 days and reassess; or 2) Stay at -2,500 cfs OMRI and continue to evaluate steelhead loss conditions.
- March 25: An ad-hoc meeting to regular scheduled meetings where water operation proposals were elevated due to continued salvage of steelhead and exceedance of the winter-run single year loss threshold.
- March 29: An ad-hoc meeting to regular scheduled meetings where two recommendations were elevated: 1) A proposal to immediate use of genetic run identification information to inform real-time operations under the 2019 100% single-year loss threshold for winter-run and ITP COA 8.6.1 (which is not currently based on genetic identification); and 2) DWR proposed targeting a -2,500 cfs OMRI for 3 days (April 1-3), citing the high flow offramp.

Performance

Delta Cross Channel Gate Closures

For winter-run Chinook salmon, Figure 4 shows the KLCI and the SCI seine data from October 1, 2023, through July 1, 2024. During WY 2024, KLCI and SCI values did not trigger any DCC gate closures prior to December 1, 2023, but the DCC gates were sometimes closed during October and November to help meet water quality standards in D-1641. The DCC gates were closed on November 27, 2023, for the rest of the OMR flow management season during WY 2024. Therefore, fish were likely protected from routing through the DCC into the Central and South Delta regions. Salmonid presence was evaluated by the SaMT and is addressed in the Seasonal Operations section above. Additionally, a process was implemented between CDFW (KLCI indices), USFWS (SCI indices), and SacPAS (University of Washington) staff for daily reporting of indices for agency biologists and the interested public.

Salvage and Loss Performance

Delta Smelt Salvage

Adult and Juvenile Salvage

Fourteen marked adult/sub-adult Delta smelt were salvaged between January 27, 2024, and February 23, 2024, and one juvenile Delta smelt was salvaged on April 29, 2024, resulting in an expanded salvage of sixty (Figure 26). All of the adult/sub-adult salvaged fish were from January supplemental releases. CVP and SWP operations do not distinguish between wild and cultured Delta smelt for ITP salvage-based thresholds.

Qualitative Larval Sampling Larval Delta smelt sampling methods began at the CVP on February 19, 2024, and at the SWP on March 11, 2024. No larval Delta smelt were detected at the TFCF or the Skinner Delta Fish Protection Facility during WY 2024. The TFCF and the Skinner Delta Fish Protection Facility ended larval sampling methods on June 11, 2024.

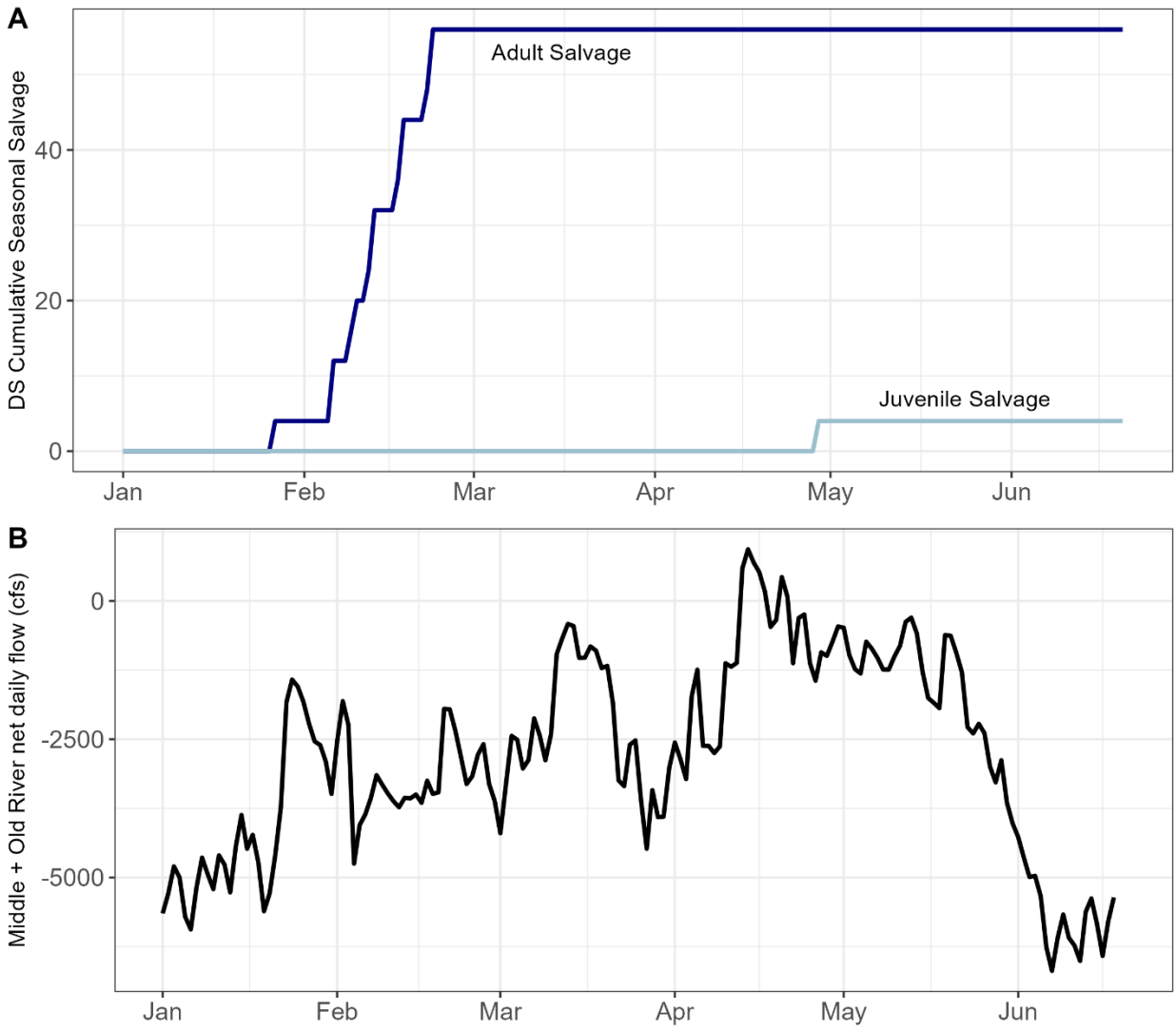

Figure 26. A) Cumulative Delta smelt seasonal salvage in WY 2024. B) Corresponding Middle plus Old River net daily flow. All salvage in WY 2024 came from the federal facility (TFCF).

Figure 26 is two line graphs that compare Cumulative Delta smelt seasonal salvage and corresponding net daily flow for Middle and Old River.

The first graph shows the Cumulative Delta smelt seasonal salvage in WY 2024 for adult salvage and juvenile salvage. Adult salvage was recorded much higher than juvenile salvage.

The second graph shows corresponding net daily flow for Middle and Old River (cfs) from January 2024 to June 2024. Highest flow was recorded between April – May 2024.

Longfin Smelt Salvage

Adult and Juvenile Salvage

A total of 2 (n=8 expanded salvage) juvenile longfin smelt were detected in salvage in WY 2024 (Figure 25A). The first juvenile longfin smelt (40 mm) was detected at the CVP fish salvage facility on April 10, 2024, and the second and last juvenile longfin smelt (22 mm) salvaged in WY 2024 was detected at the CVP on April 26, 2024. Zero larval, sub-adult, or adult longfin smelt were detected at either facility in WY 2024.

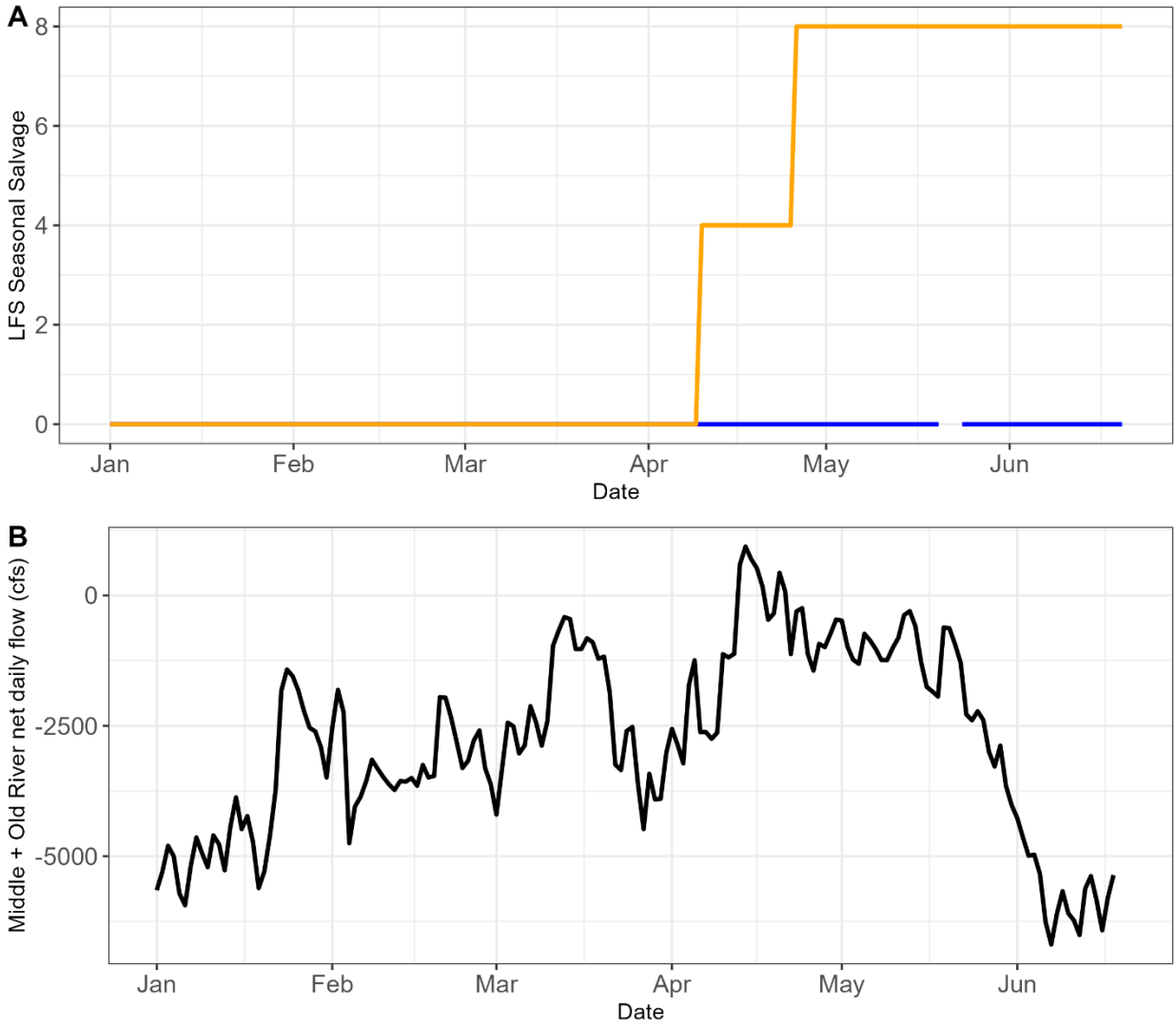

Figure 27. A) Cumulative longfin smelt seasonal salvage for SWP (blue line) and CVP (orange line). B) Corresponding Middle plus Old River net daily flow. Note that in panel A lines overlap as both the SWP and CVP had no salvage between January 1st and April 9th, 2024.

Figure 27 is two line graphs that compare Cumulative longfin smelt seasonal salvage and corresponding net daily flow for Middle and Old River.

The first graph shows the Cumulative longfin smelt seasonal salvage in WY 2024 for SWP and CVP. Both remain around zero, until April, when the CVP spikes and stabilizes around 8.

The second graph shows corresponding net daily flow for Middle and Old River (cfs) from January 2024 to June 2024. Highest flow was recorded between April – May 2024.

Qualitative Larval Sampling

Longfin smelt qualitative larval sampling began at the CVP on February 19, 2024, and at the SWP on March 11, 2024. As in WY 2023, zero larval longfin or Delta smelt (<20 mm) were detected at either the CVP or SWP in WY 2024. The TFCF (CVP) and the Skinner Delta Fish Protection Facility (SWP) ended larval sampling methods on June 11, 2024.

Winter-run Chinook Salmon

Daily Loss

The Early-Season Natural Winter-run Chinook Salmon Discrete Daily Loss Threshold (ITP COA 8.6.2) was not met in November and December of 2023. The Mid- and Late-Season Natural winter-run Chinook salmon Daily Loss Threshold (based on the amended ITP COA 8.6.3 governing SWP operations January through May, and CVP operations under the 2024 IOP from April through May) was exceeded 62 times from January through May based on LAD winter-run Chinook salmon loss. However, the amended ITP COA 8.6.3 threshold was only on ramped 6 times throughout the season after genetic analysis confirming that, at least a portion of LAD winter-run were genetic winter-run and the genetically confirmed fish exceeded the threshold (see previous sections). . The Mid- and Late- Season Natural winter-run Chinook salmon Daily Loss Threshold (based on the unamended ITP COA 8.6.3 governing CVP operations under the 2023 IOP from January through March) was exceeded 40 times from January through March based on LAD winter-run Chinook salmon loss. However, the unamended ITP COA 8.6.3 threshold was never on ramped after genetic analysis. Generally, these events did not require alteration of water operations because other requirements in the Delta were already in place and equally or more restrictive

Single Year Loss

Total LAD natural-origin winter-run Chinook salmon loss for WY 2024 (October 1, 2023, through June 30, 2024) was 4205.05 fish which represents 153% of the single-year loss threshold (2748 fish). Loss for Sacramento River hatchery-origin winter-run Chinook salmon in WY 2024 was 4.33 and no hatchery-origin winter-run released in Battle Creek were observed in salvage. As such, the natural-origin winter-run Chinook salmon single year loss threshold was exceeded and neither hatchery-origin winter-run Chinook salmon single-year loss threshold was exceeded in WY 2024. Weekly plots were produced through SacPAS, which incorporate both current and historic loss data: current cumulative WY 2024 loss to the creation date of the plot and historic loss added to the current cumulative loss to visualize historic loss from the creation date of the plot to the end of the season. In WY 2024, all loss of LAD natural-origin winter-run Chinook salmon salvage occurred between January 9, 2024, and May 7, 2024. Twenty-four genetic winter-run Chinook salmon were salvaged at the fish salvage facilities in WY 20244 between January 16, 2024, and March 21, 2024, with loss totaling 130.05 fish.

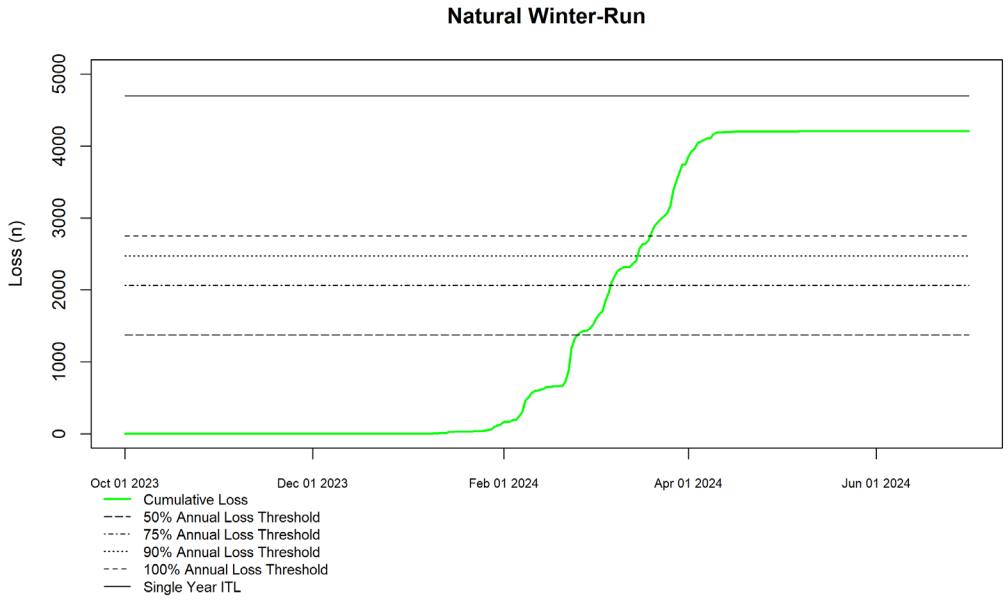

Figure 28. Total natural winter-run Chinook salmon (LAD) loss for WY 2024.

Figure 28 is a line graph showing total natural winter-run Chinook salmon (LAD) loss (n) from October 1, 2023, to June 1, 2024. The graph shows the cumulative loss, 50% annual loss threshold, 75% annual loss threshold, 90% annual loss threshold, 100% annual loss threshold, and single year ITL.

Cumulative

The cumulative loss threshold for natural winter-run Chinook salmon over the duration of the ROD is 8,738 fish. At the end of the OMR flow management season in WY 2024, cumulative loss (calculated here as total since February 19, 2020) is 52.4% of total loss limit over the duration of the ROD.

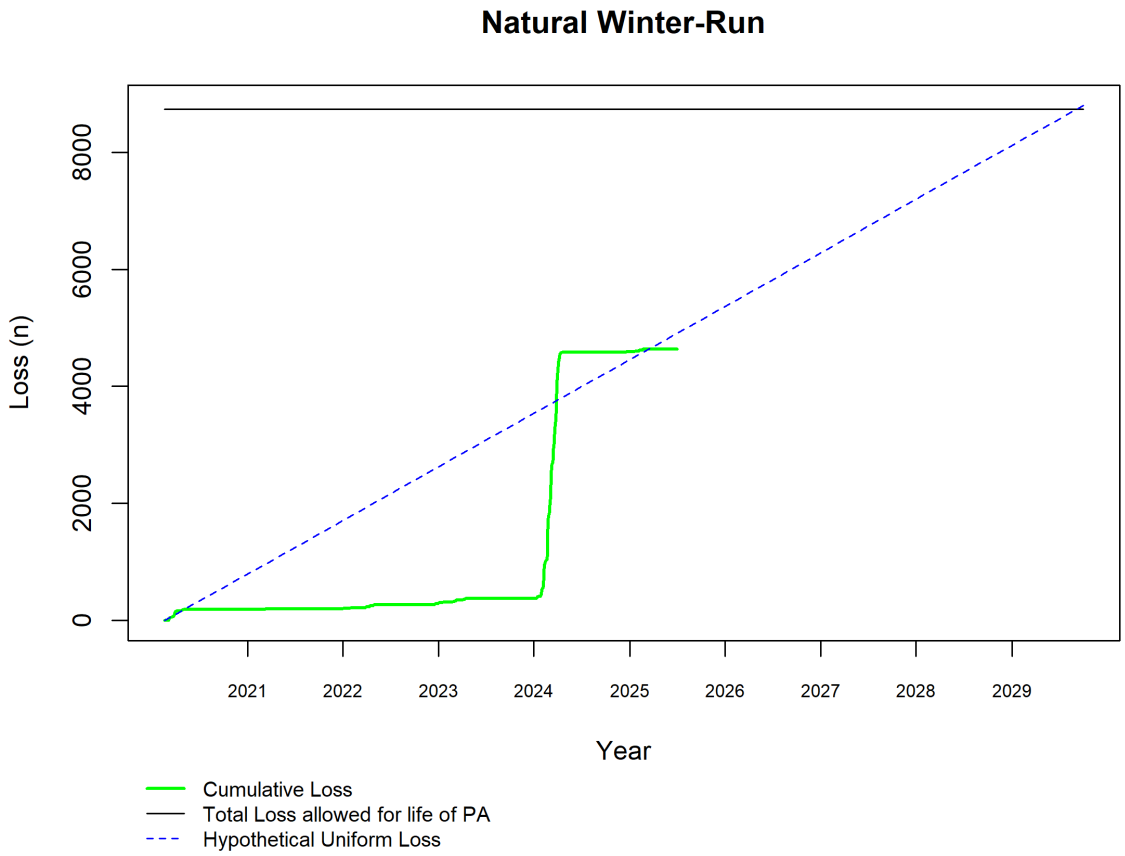

Figure 29. Cumulative loss (green line) for natural winter-run Chinook salmon through WY 2024. The blue dashed line represents the hypothetical trajectory of uniform annual loss up to the cumulative loss threshold over the duration of the ROD.

Figure 29 is a line graph showing the cumulative loss for natural winter-run Chinook salmon (n) by year from 2021 to 2029. The graph shows cumulative loss, total loss allowed for life of PA, and hypothetical uniform loss.

Steelhead

Combined loss of natural steelhead was 3,374.71 fish for the early (December 1 through March 31) period, which represents 239% of the single-year loss threshold (1,414 fish). Combined loss of natural steelhead for WY 2024 was 1919.44 for the late (April 1 through June 15) period, which represents 124% of the single-year loss threshold (1,552 fish). 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. On March 26, 2024, the SaMT estimated the distribution of natural steelhead within the Delta to be 25-50%, and distribution of

natural steelhead that had exited past Chipps Island to be 30-40% indicated that the majority of steelhead had yet to exit the system past Chipps Island. This was evident in April when the 50% single year loss threshold for the April 1 to June 15 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. Steelhead loss for the April 1-June 15 period was 63% of the April-June ITL. Similar to previous WYs, December-March steelhead loss was higher than April-June loss in WY 2024.

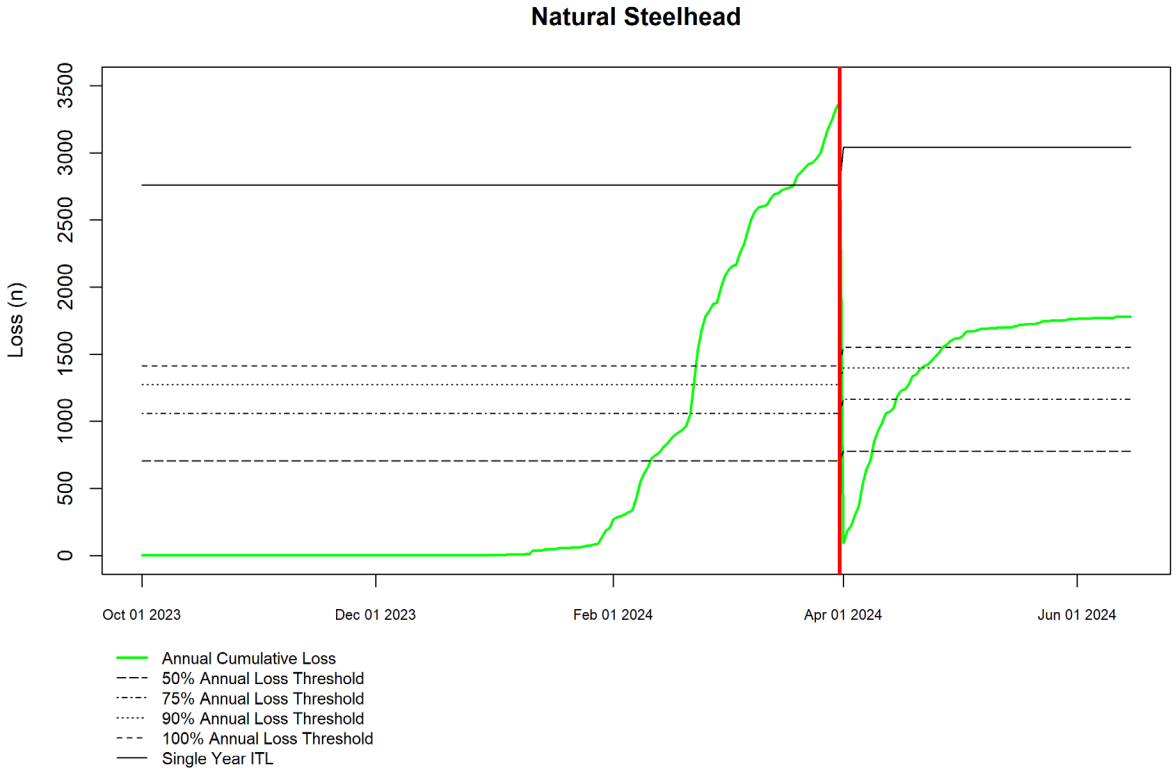

Figure 30. Trajectory of the annual cumulative loss for natural steelhead for WY 2024 for the two time periods (December-March, April-June 15), with their respective annual loss thresholds.

Figure 30 is a line graph showing the annual cumulative loss for natural steelhead (n) from October 1, 2023 to June 1, 2024. The graph shows the cumulative loss, 50% annual loss threshold, 75% annual loss threshold, 90% annual loss threshold, and 100% annual loss threshold, and single year ITL.

At the end of the WY 2024 OMR flow management season, the loss for the first five "seasons" under the 2020 ROD is 82% of the 10-year duration cumulative total loss for the December-March period (6,038 threshold) and 50.2% of the 10-year duration cumulative total loss for the April-June period. (5,826 threshold).

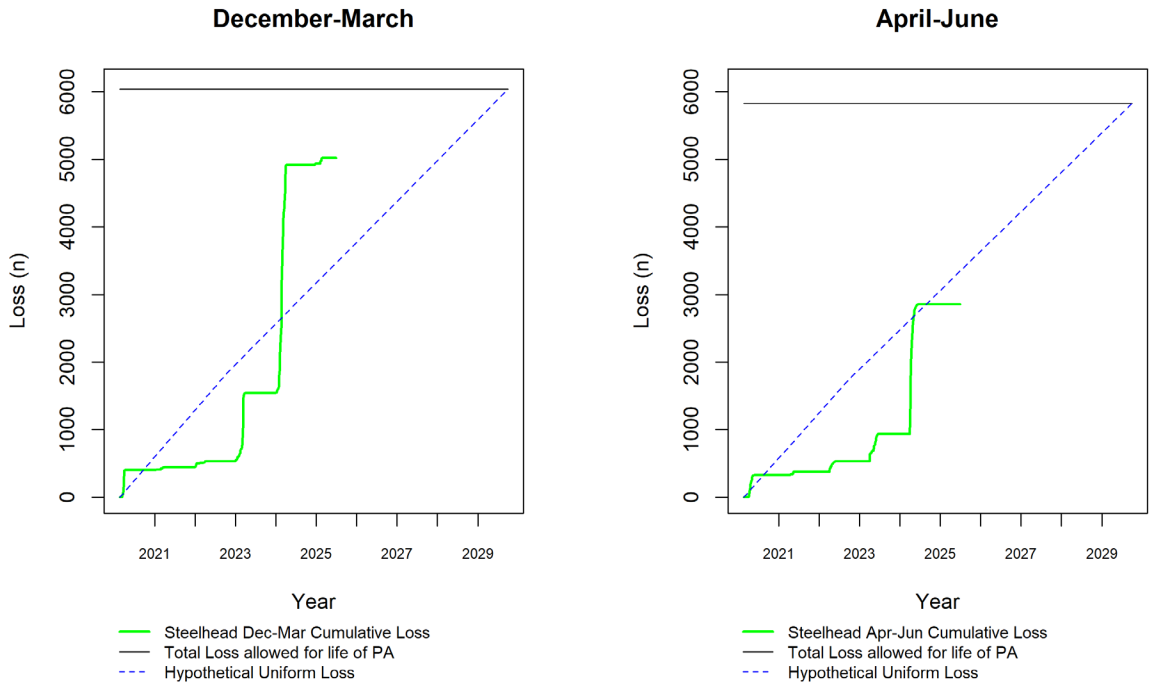

Figure 31. Cumulative loss (green line) for natural steelhead for December 1 – March 31 and April 1 and June 15. The blue dashed line represents the hypothetical trajectory of natural steelhead loss over the duration of the ROD, assuming each year's natural steelhead loss is equal.

Figure 31 is two line graphs showing the cumulative loss for natural steelhead.

The first graph shows natural steelhead loss (n) for December to March in years 2021-2029. The graph shows steelhead Dec-Mar cumulative loss, total loss allowed for life of PA, and hypothetical uniform loss.

The second graph shows natural steelhead loss (n) for April to June in years 2021-2029. The graph shows steelhead Apr-Jun cumulative loss, total loss allowed for life of PA, and hypothetical uniform loss.

Salmonids and Historic Performance

Historic natural-origin winter-run Chinook salmon LAD loss by month by year (2009-2023), with loss shown as percentage of total WR loss, is shown in Figure 30. The highest percentage of historic loss typically occurs in March. In WY 2024, the majority of loss also occurred in the month of March.

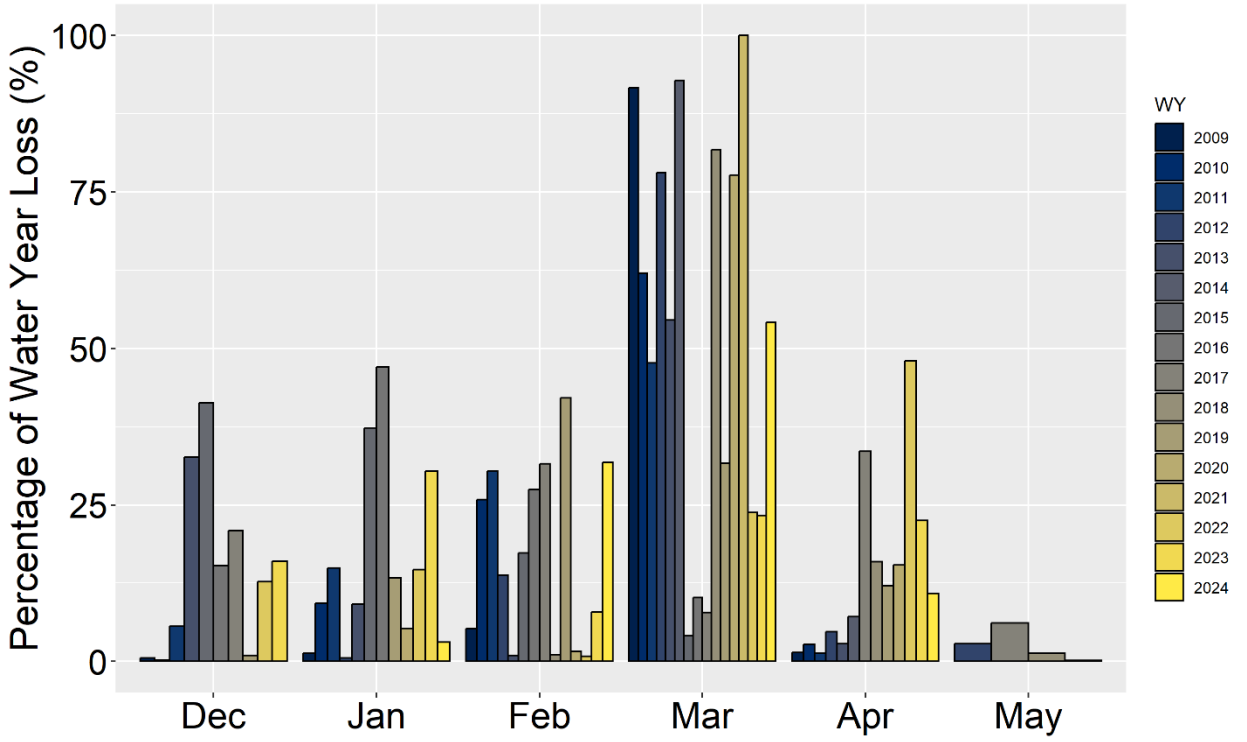

Figure 32. Historic natural winter-run Chinook salmon (LAD) loss by month by WY (2009 - 2024).

Figure 32 shows historic natural steelhead loss by season and water year, with loss shown as percentage of total water year loss. Historic loss occurred more frequently from December 1 to March 31 than from April 1 to June 15 in 10 of the last 15 years (2009 – 2024).

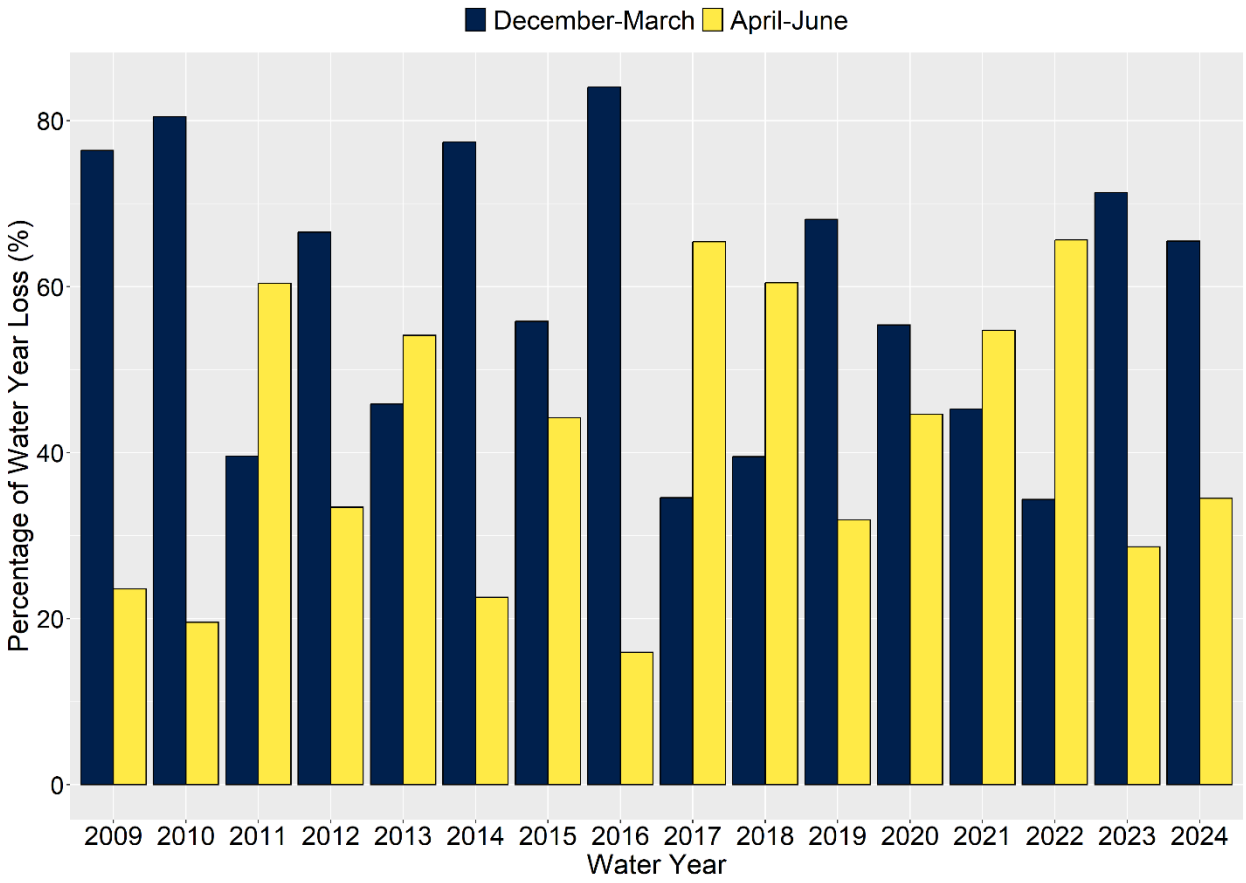

Figure 33. Historic natural steelhead loss by action period "season" (December 1 – March 31, April 1 – June 15) by water year (2009 – 2024). Loss shown as percentage of combined loss per water year.

Figure 33 is a bar graph showing historic natural steelhead loss (%) by action period. For each year (2009-2024), loss is recorded for December – March and April – June.

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Discussion

Delta Cross Channel

Throughout the WY 2024 OMR flow management season, the DCC gates remained closed per the ROD during time periods of highest risk for juvenile salmonids. Historic migration patterns at Knights Landing RST show an average of 50% of natural winter-run Chinook salmon have migrated past Knights Landing by December 26th and an average of 75% of natural winter-run Chinook salmon have migrated past Knights Landing by January 7th (2006 – 2019). In WY 2024, the first natural-origin winter-run Chinook salmon was observed at Knights Landing on September 26, 2023, and the last on March 26, 2024. There were no actions needed to close the DCC gates based on KLCI and SCI triggers (Figure 4) during October to the end of November 2023, and the seasonal closure starting November 27, 2023, provided a high level of protection for juvenile salmonids out-migrating down the Sacramento River. With the DCC gates WY 2024 operations, salmonids were less vulnerable to entrainment into the interior Delta and potentially farther into the South Delta and survival through the Delta was increased, based on relationships derived from tagged fish studies.

Integrated Early Winter Pulse Protection ("First Flush")

During the IEWPP (ITP COA 8.3.1), the turbidity field did not reach the central and south Delta (Figure 9, Figure 16). High flow conditions continued past IEWPP, with 3-day average Freeport flows persisting above 25,000 cfs through April, however, the 3-day average Freeport turbidity decreased below 50 FNU during the IEWPP. With turbidity remaining low in the central and south Delta during the WY24 IEWPP operation, adult Delta smelt were less likely to move into the south Delta channels and become entrained, as suggested by Grimaldo et al 2009. During the IEWPP one marked Delta smelt was salvaged at the TFCF.

Turbidity Bridge Avoidance ("South Delta Turbidity")

The turbidity threshold of 12 FNU at OBI was not reached during the Turbidity Bridge Avoidance (ITP COA 8.5.1) period (February 1st - April 1st). As a result, no actions were taken to keep turbidity below the threshold. Thirteen adult Delta smelt were salvaged

during this period, all of hatchery origin. The SMT made no recommendations to reduce OMR index during this period.

Delta Smelt Larval and Juvenile Protections

During the period of Larval and Juvenile Delta Smelt Protection (ITP COA 8.5.2), the SMT received data on salvage, survey detections, and Secchi depth data to assess the likelihood of larval and juvenile entrainment. While adult Delta smelt were salvaged this season (Figure 26) and larvae were expected to be in the south Delta and appear at the fish salvage facilities, only one juvenile and one larval Delta smelt were observed in the south Delta. ITP COA 8.5.2 was triggered between February 5 and March 17 based on Secchi depth; however, was only controlling between February 7th and February 16th. Secchi depth increased starting March 18 and entrainment actions were no longer triggered the rest of the season.

Longfin Smelt Protections

Zero adult longfin smelt observed in salvage in WY2024. Adult longfin smelt were not considered as being at a high risk of entrainment prior to the initiation of OMR management season, so Adult Longfin Smelt Protection (ITP COA 8.3.3) was not triggered. As larval longfin smelt were detected in December, OMR Management for Adult Longfin Smelt (ITP COA 8.4.1) was not active in WY 2024.

Zero larval and two juvenile longfin smelt were salvaged in WY 2024; both juveniles were detected at the CVP on April 10 and April 26, respectively. This is similar to WY 2023, when zero larval or juvenile longfin smelt were detected in salvage. A general downstream distribution of longfin smelt is to be expected during wet conditions experienced in 2023 and 2024, and thus a generally lower risk of entrainment is to be expected. Further analysis and modeling will be helpful to understand patterns in longfin smelt entrainment during wet and above normal years. Additional years of data will be necessary to analyze the full effectiveness of ITP actions over a broad range of OMR flows and hydrology.

Qualitative Larval Fish Sampling at Salvage Facilities

Despite detections of adult delta smelt and longfin smelt in the south Delta, qualitative larval sampling did not detect any delta smelt or longfin smelt larvae.

Quantitative Larval Smelt Sampling near Clifton Court Forebay

In WY 2024, a pilot larval smelt entrainment monitoring program (Larval Entrainment Study (LES), ITP COA 7.6.2) entered its third year of sampling. The first year of LES detected 85 larval longfin smelt and 23 larval longfin were detected in the second year (Figure 34). Data for this year are not yet complete. Zero Delta smelt have been detected by the program to date. Three wakasagi have been detected, one on March 28, 2022, and two on May 2, 2023.

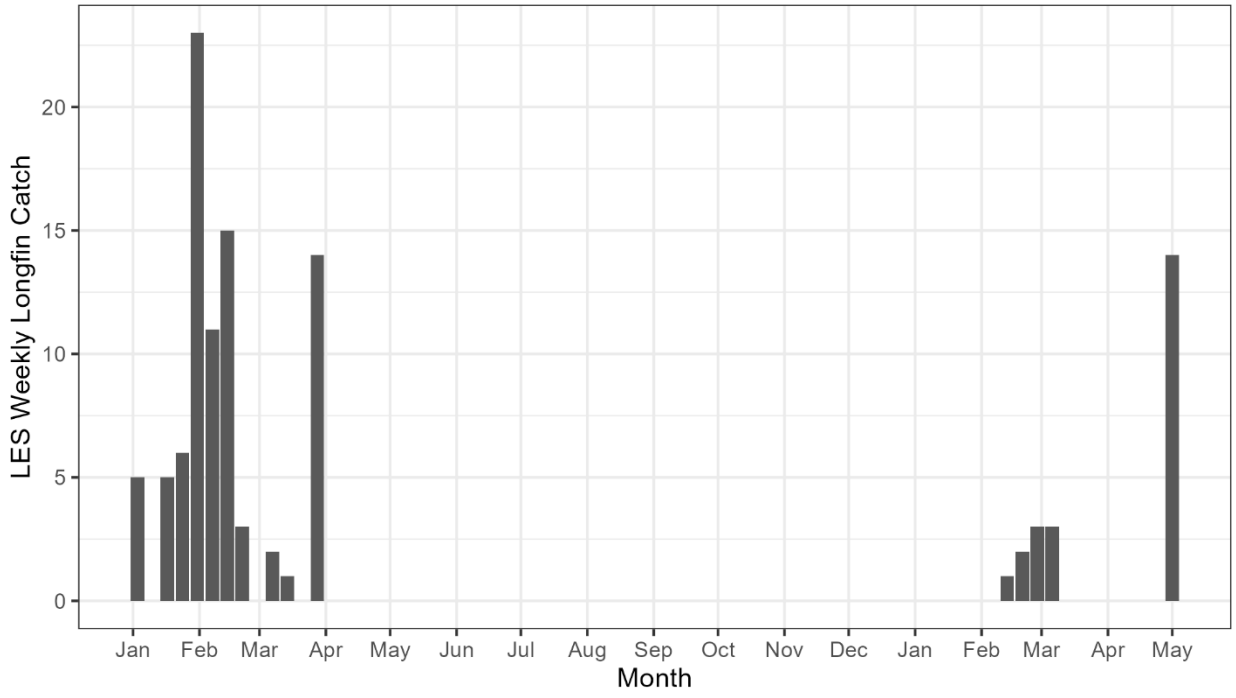

Figure 34. Weekly catch of larval longfin smelt in 2022 and 2023 in the Larval Entrainment Study (LES). All sampling in 2022 and 2023 was conducted in West Canal. Data from 2024 are being processed and will be made available on EDI once finalized.

Figure 34 is a bar graph showing the weekly catch of larval longfin smelt in 2022 and 2023 as part of the Larval Entrainment Study (LES). Catches were recoded in January 2022 – April 2022, and then again in February – March 2023 and May 2023.

To increase detection likelihood, LES changed the sampling location on January 16, 2024, from West Canal near the CCF radial gates to a transect of four South Delta stations monitored by the SLS and 20-mm surveys: 809, 812, 902, and 915. Sampling was conducted by CDFW between 9am and 4pm from January through March 2024. Paired tows and a bongo frame, both using two SLS sleds and SLS-size nets in two

different mesh sizes were used to compare gear efficiency of 900-micron mesh versus the 1600-micron mesh used for SLS. 2022 and 2023 data continue to be processed and will be posted to the Environmental Data Initiative (EDI) website once review is complete, anticipated in October 2024. There is no estimated time for processing and posting of 2024 data. Together, CDFW and DWR will continue refining the study design, and are evaluating eDNA sampling as a complementary methodology for understanding of larval smelt entrainment into CCF. In WY 2024, pilot eDNA sampling in West Canal entered its second year. Experiments focused on validating and testing eDNA methods and sampling protocols for Delta smelt eDNA. This upcoming year, eDNA studies will focus on method validation for longfin smelt eDNA sampling, building towards the ultimate goal of developing methods for co-sampling for osmerids with fish trawl surveys, including LES.

Salmonid Presence-Based OMR Onramp and Offramp

OMR flow management season ended on June 12, 2024, for winter-run and spring-run Chinook Salmon based on temperatures at Prisoners Point and Mossdale (per 2024 IOP: daily average water temperatures at Mossdale exceed 71.6°F for 7 days). CCV Steelhead OMR flow management season also ended on June 12, 2024, due to a similar temperature off-ramp. The last natural-origin LAD winter-run Chinook salmon was salvaged on May 7, 2024. Salvage occurrences for LAD and genetic winter-run occurred predominantly in February, March, and April with the majority of loss occurring at the SWP facility (90% at SWP and 10% at CVP). The last natural-origin steelhead was salvaged on June 11, 2024. Salvage occurrences for steelhead were moderately skewed towards the December to March period (64% compared to 36% for the April to June 15 period) with the majority of loss occurring at the SWP facility (December-March: 81% at SWP, 19% at CVP; April-June: 74% at SWP, 26% at CVP). During the OMR flow management season under both the 2023 and 2024 IOP, the LAD winter-run Chinook Salmon 50% (1374), 75% (2061), and 100% (2748) annual thresholds were exceeded on February 25, 2024, March 7, 2024, and March 20, 2024, respectively. For steelhead, the December-March 50% (707),75% (1061), and 100% (1414) annual loss thresholds were exceeded on February 11, 2024, February 22, 2024, and February 23, 2024, respectively. The December-March steelhead ITL (2760) was also exceeded on March 20, 2024. For the April-June 15 period, the 50% (776), 75% (1163), and 100% (1551) annual loss thresholds for steelhead were exceeded on April 9, 2024, April 15, 2024, and April 26, 2024, respectively. For both species, losses stayed within the cumulative limits described in the ROD, and LAD winter-run and April-June period steelhead stayed below the ITLs described in the ITS section of the NMFS Biological Opinion.

OMR was more positive than -5,000 cfs during the period when the majority of salmonids were estimated by the SaMT to be present in the Central and South Delta regions and was positive (i.e. above zero) for a few weeks from mid-April (April 10-April 24) to early May (May 3-May 14) but was negative in between that timeframe.

Average daily water temperatures were tracked at two sites (Mossdale and Prisoners Point) to evaluate the end of the OMR flow management season. Daily average water temperatures to meet offramp criteria at Mossdale (72°F in the NMFS 2019 Biological Opinion and 71.6°F in Reclamation's ROD, 22.2°C in the ITP) and Prisoners Point (22.2°C in the ITP) were met for winter-run and spring-run Chinook salmon before June 30, 2024 in WY 2024 (Figure 25). The distribution estimates of greater than 95% for both natural-origin YOY winter-run Chinook salmon and natural-origin YOY spring-run Chinook salmon juveniles exited past Chipps Island were met on May 31, 2024, and June 4, 2024, respectively.

Real-Time Decision-Making Tools

The SaMT and SMT utilize real-time data and various modeling tools to provide information for consideration by Reclamation for OMR flow management. These real-time decision-making tools are discussed in this section.

Salmonids

Distribution estimates of salmonids are provided by the SaMT weekly. The distributions are grounded in real-time operations data (i.e., KLCI, Mossdale Trawl, salvage and loss numbers, acoustically tagged juveniles, etc.) and modeling tools (STARS model predictions, entrainment model predictions). During WY 2024 before the DCC gate closures on November 28, 2022, weekly reports of KLCI and SCI values were received from CDFW, USFWS, and Reclamation (Figure 3).

Delta STARS Model

The Delta STARS model (survival, travel time, and routing simulation) predicts survival, travel time, and routing of migrating juvenile Chinook Salmon through the Delta. Simulated fish enter the Delta on a given day at Freeport and the model examines conditions fish are likely to encounter. STARS accounts for DCC gates opening and closings and Delta inflow at Freeport and produces estimates of route specific survival through the Delta. STARS does not evaluate potential changes to export operations or changes to OMR. The model is used as a tool similar to historical data providing predictions on fish parameters (survival, travel time, and routing) based on what happened to late-fall-run Chinook salmon that migrated through the Delta from November through mid-March 2007 – 2011. In WY 2023, the STARS model was updated

to incorporate winter-run Chinook salmon information for providing winter-run specific predictions. Results help guide SaMT on what might be expected of out-migrating juveniles based on the past. A similar tool is in development for steelhead in both the San Joaquin and Sacramento basins with the intention of guiding SaMT on steelhead outmigration survival and routing. A hindcast of daily survival for winter-run Chinook salmon is presented in Appendix H.

Acoustic Tagging

Acoustically tagged salmonids were tracked throughout the Delta in WY 2024 (CalFishTrack Central Valley Enhanced Acoustic Tagging Project; Table 8; Table 9). Real-time detections of tagged fish inform routing, entrainment, and survival. Information at critical junctions (Georgiana Slough, Tower Bridge, Old River, Benicia Bridge) helps inform management decisions. The SaMT used tagged project data, along with other datasets (salvage, RST monitoring locations, etc.), to provide weekly distribution estimates for hatchery winter-run Chinook salmon.

In WY 2024, hatchery-origin winter-run Chinook salmon survival to Benicia from Caldwell Park was relatively high at 26.3% (& Table 9). The projected survival rate used for development of the hatchery-origin winter-run Chinook salmon JPE was 25.77% (Appendix D).

In WY 2024, acoustic tagged wild O. mykiss were released in Deer and Mill Creek in the Sacramento Basin, Mokelumne River and the Stanislaus River in the San Joaquin Basins in fall and spring. Deer and Mill fish had a total survival of 39.6%, Mokelumne River release had a total survival of 42.2%, and fall and spring Stanislaus releases had a survival of 12.3% and 1.1% respectively (& Table 9). It should be noted that while smolt sized individuals were targeted for tagging in these studies, survival estimates assume only fish that out migrate survived, but in reality, at least some of the fish likely remained as freshwater residents and could have biased the survival estimates. The fall Stanislaus release was a new addition in WY2024 and provided valuable insight on outmigration timing of San Joaquin origin steelhead.

In WY 2024, due to steelhead loss threshold exceedances, a special study was implemented to study the effect of steelhead movement at an OMRI of -500 cfs.. Two hundred and forty hatchery-origin steelhead from the Mokelumne River Hatchery were acoustically tagged and released at Lighthouse Resort in the Delta on 3/15/24. Survival to Benicia was higher and entrainment in export facilities was lower than other San Joaquin hatchery steelhead releases (Table 8).

Table 8. WY 2024 Acoustic Tagging: CVP/SWP details

Project	Release Date(s)	# of Fish Tagged	Groups (n) and description	Hatchery	Release Location(s)
Hatchery-origin winter-run Chinook salmon	2/16/2024	581	n = 1	LSNFH	Bonnyview
Mokelumne Hatchery steelhead export effects	3/15/2024	240	n = 1	Mokelumne	Lighthouse Resort
Stanislaus River wild steelhead (Fall Release)	11/13/2023 - 12/12/2023	198	n = 7	N/A	Goodwin Dam, Knights Ferry, Wildcat, Two Mile, Honolulu, Lake Right, Orange Blossom
Stanislaus River wild steelhead (Spring Release)	3/7/2023	198	n = 1	N/A	Knights Ferry
San Joaquin hatchery steelhead (March)	3/20/2024 - 3/22/2024	335	n = 3	Mokelumne	Dos Reis, Head of Old River, Durham Ferry
San Joaquin hatchery steelhead (April)	4/17/2024 - 4/19/2024	335	n = 3	Mokelumne	Dos Reis, Head of Old River, Durham Ferry
San Joaquin hatchery steelhead (May)	5/8/2024 - 5/9/2024	236	n = 3	Mokelumne	Dos Reis, Head of Old River, Durham Ferry
Mill and Deer Creek wild steelhead, Spring Releases	1/10/2024 – 5/20/2024	236	n = 2	N/A	Mill Creek, Deer Creek

Project	Release Date(s)	# of Fish Tagged	Groups (n) and description	Hatchery	Release Location(s)
Upper Sacramento spring-run Chinook salmon surrogates	4/06/2024 - 5/2/2024	996	n = 7 release groups 1 – 7	Coleman	Red Bluff Diversion Dam
Butte Creek wild spring-run Chinook salmon	4/10/2024 – 4/19/2024	259	n = 3 release groups 1 – 3	N/A	Sanborn Slough, North Weir, Butte below Sanborn
Feather River hatchery spring-run Chinook salmon	4/23/2023	598	n = 1	Feather River	Gridley Boat Launch

Table 9. WY 2023 Acoustic Tagging: minimum survival, SE, 95% confidence intervals (CI) to Benicia Bridge East Span and minimum through-Delta survival (City of Sacramento to Benicia) estimated using a Cormack-Jolly-Seber (CJS) survival model. Updated July 12, 2024. *Wild steelhead survival numbers may be biased as survival estimates do not account for individuals remaining freshwater residents.

Project	Benicia Bridge Survival (%)	Benicia Bridge SE	Benicia Bridge 95% lower CI	Benicia Bridge 95% upper CI	Through-Delta Survival (%)	Through-Delta SE	Through-Delta 95% lower CI	Through-Delta 95% upper CI
Hatchery-origin winter-run Chinook salmon	26.3	1.8	22.8	30	68.6	3.3	61.7	74.8
Mokelumne Hatchery steelhead export effects	42.2	3.2	31.6	48.6	N/A	N/A	N/A	N/A
Stanislaus River wild steelhead (Fall release)*	12.3	2.4	8.4	17.7	N/A	N/A	N/A	N/A
Stanislaus River wild steelhead (Spring release)*	1.1	0.8	0.3	4.4	N/A	N/A	N/A	N/A
San Joaquin hatchery steelhead (March)	18.5	2.1	14.7	23.1	N/A	N/A	N/A	N/A

Project	Benicia Bridge Survival (%)	Benicia Bridge SE	Benicia Bridge 95% lower CI	Benicia Bridge 95% upper CI	Through-Delta Survival (%)	Through-Delta SE	Through-Delta 95% lower CI	Through-Delta 95% upper CI
San Joaquin hatchery steelhead (April)	11.4	1.7	8.4	15.3	N/A	N/A	N/A	N/A
San Joaquin hatchery steelhead (May)	9.3	1.9	6.2	13.8	N/A	N/A	N/A	N/A
Mill and Deer Creek wild steelhead, Fall Releases*	39.6	3.2	33.5	46	88.8	3.2	80.8	93.7
Upper Sacramento spring-run Chinook salmon surrogates	8.9	0.9	7.3	10.8	26.4	2.5	21.8	31.6
Butte Creek wild spring-run Chinook salmon	8.1	1.7	5.3	12.1	45.7	7.3	32	60

Project	Benicia Bridge Survival (%)	Benicia Bridge SE	Benicia Bridge 95% lower CI	Benicia Bridge 95% upper CI	Through-Delta Survival (%)	Through-Delta SE	Through-Delta 95% lower CI	Through-Delta 95% upper CI
–Feather River hatchery spring-run Chinook salmon	4.6	0.9	3.2	6.8	14.2	2.7	9.6	20.5

Genetic Information

Due to the inaccuracy of the LAD criteria, genetic information is used to validate loss of genetically confirmed winter-run and spring-run Chinook salmon at the SWP and CVP salvage facilities (Appendix G). In WY 2024, 7 genetically confirmed winter-run Chinook salmon, and 1 unconfirmed LAD winter-run in which the sample was lost and thus was considered a true winter-run were observed in salvage at CVP and 16 at SWP from January to March. These genetic confirmations resulted in off-ramping multiple exceedances of ITP COA 8.6.3, which is initially triggered based on LAD criteria, since only genetically confirmed winter-run count towards daily loss criteria under ITP COA 8.6.3. One potential reason for this overestimation using LAD data are the size of individuals from other runs overlapping with winter-run LAD criteria which was confirmed from genetic analysis in which the majority of LAD winter-run were in fact other runs.

Genetic assignments are not 100% accurate, however. For example, a portion of older juveniles were genetically identified as spring-run but had a later returning assignment which is usually associated with fall- and late fall-run Chinook salmon. California Department of Wildlife Resources and CDFW conducted another analysis of the material using additional techniques and determined that these fish were predominately fall-run Chinook salmon. However, it was determined that winter-run designation for winter-run LAD individuals was highly accurate between techniques and current methodology was adequate for winter-run assignment.

Genetic assignments for WY 2024 also identified six yearling spring-run Chinook salmon (all initially identified as LAD winter-run; 1 at the SWP and 5 at the CVP). These were determined to be yearlings due to their size being larger than LAD YOY spring-run and genetics confirming that they were spring-run Chinook salmon. It is likely that yearling spring-run Chinook salmon have been assigned as LAD winter-run Chinook salmon in prior years due to their size being similar to that of LAD winter-run.

Juvenile Production Estimate (JPE) and Delta Survival

The JPE is the number of the annual cohort of juvenile winter-run Chinook salmon forecasted to enter the Delta, which helps inform monthly and annual thresholds associated with the operation of the CVP and SWP (For more information see California Central Valley Water Operations: Biological Opinion Actions | NOAA Fisheries). NMFS issues to Reclamation and DWR natural- and hatchery-origin winter-run Chinook salmon JPEs, using recommendations from the winter-run JPE subteam of the IEP Winter-run Chinook salmon Project Work Team (WR PWT) after reviewing and updating the factors and methods with any new improvements (Appendix D). Recent data from monitoring surveys and survival estimates from acoustically tagged salmonids are incorporated into

abundance and survival estimates for the JPE calculations. These data are typically evaluated during the annual WR PWT review of the factors and methods used to calculate a JPE that represents the best available science given the available data.

The JPE varies considerably by WY type and cohort size (Table 7) suggesting that many abiotic and biotic processes affect its value through their influence on both survival (actual Chinook Salmon abundance) and the efficiency of sampling gear (apparent Chinook Salmon abundance). As discussed in the Salmonids and Historic Performance section of this report, annual loss values vary widely by year.

Table 10. Winter-run Chinook salmon JPE by brood year (BY) and WR type (WYT, 2009 – 2022).

WY	WRCH BY	WR JPE	Sac Basin WYT
2009	2008	JPE: 617,783 Hatchery JPE:82,050	Dry
2010	2009	JPE: 1,179,633 Hatchery JPE: 108,725	Below Normal
2011	2010	JPE 332,012 Hatchery JPE: 66,734	Wet
2012	2011	JPE: 162,051 Hatchery JPE: 96,525	Below Normal
2013	2012	JPE: 532,809 Hatchery JPE: 96,525	Dry
2014	2013	JPE: 1,196,387 Hatchery JPE: 30,880	Critical
2015	2014	JPE: 124,521 Hatchery JPE: 188,500	Critical
2016	2015	JPE: 101,716 Hatchery JPE: 155,400	Below Normal
2017	2016	JPE: 166,189 Hatchery JPE: 58,188	Wet
2018	2017	JPE: 201,409 Hatchery JPE 92,904 Battle Creek JPE: 90,924	Below Normal
2019	2018	JPE: 433,176 Hatchery JPE: 86,699 Battle Cr JPE: 82,366	Wet
2020	2019	JPE: 854,941 Hatchery JPE: 94,528 Battle Cr JPE: 67,257	Dry
2021	2020	JPE: 330,130 Hatchery JPE: 97,888 Battle Cr JPE: 37,232	Critical

WY	WRCH BY	WR JPE	Sac Basin WYT
2022	2021	JPE: 125,038 Hatchery JPE: 151,544 Battle Cr JPE: 7,311	Dry
2023	2022	JPE: 49,924 Hatchery JPE: 190,956 Battle Cr JPE: 3,976	Wet
2024	2023	JPE: 234,896 Hatchery JPE: 193,582 Battle Cr JPE: 3,359	Above Normal

Particle Tracking Models

Delta smelt environmental surrogates, such as turbidity and OMR flows, are now used in conjunction with Particle Tracking Models (PTM) to help assess risk of entrainment (USFWS 2019 Biological Opinion, p 394). Longfin smelt risk assessments also use PTM results, in conjunction with in-Delta distributions of longfin smelt and other information, to help evaluate potential movement of longfin smelt larvae and juveniles between Delta regions resulting from operational scenarios (ITP 8.1.5.2 C and D).

PTMs are used to plot the flow of neutrally buoyant particles from an insertion point in the Delta and estimate the percentage that will be entrained by the operational scenario used in the model. As of WY 2022, the SMT requests three outflow scenarios representing the expected upper, mid, and lower OMR limits for the next week's operations. The PTM runs track particle fate weekly for three weeks, categorizing particles in three regions: entrained by CVP and SWP export facilities, OMR corridor, and downstream of Chipps Island. The insertion points used for the buoyant particles were standardized in WY 2023 and represent stations where catch by SLS or 20mm surveys has historically been associated with increased salvage.

The CDFW requested PTM runs for the purpose of evaluating the risk of longfin smelt larval entrainment on two occasions in WY 2024: on January 10, 2024, for the off-cycle meeting on January 11, 2024, and on January 11, 2024, for the SMT meeting January 16, 2024. All runs were conducted after the onset of spawning, with particle injection locations at Stations 809, 812, and 815 to simulate larvae in Central and South Delta. On January 11, 2024, the SMT advised an SWP share of exports target a 7-day average OMR index no more negative than -3500 cfs and this recommendation was continued at the SMT meeting on January 16. At the off-cycle meeting on January 18, 2024, the SMT advised an OMR index no more negative than –5000 cfs so long as Qwest was at least 3000 on a 3-day average, and an OMR average 7-day index no more negative than –3500 cfs should QWEST drop below 3000 on a 3-day average. Longfin protections were no longer controlling once IEWPP was triggered on January 21, 2024.

Machine-learning Models

Tillotson et al. (2022) developed a boosted regression tree model in a machine-learning environment to aid in predicting steelhead and winter-run Chinook salmon loss at delta export facilities. The model estimated the next week's weekly loss based on a set of 10 covariates. It found that prior week's loss was the best predictor for both species, but OMR and total exports had more influence on predicting steelhead loss more so than winter-run loss. The tool proved useful with predicting and assessing loss in the face of different OMRI scenarios, particularly with steelhead, and was valuable for making management decisions.

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Improvements

Improvements listed in this section may be evaluated as potential future updates to OMR flow management, including the OMR Guidance Document and DCC Guidance Document, which could assist operations in upcoming OMR flow management seasons. See updated version of the OMR Flow Management Guidance Document (Appendix A) and the DCC Operations and Fall/Winter Closures Guidance Document (Appendix B). Improvements may also be considered or evaluated by the four-year independent review panels.

Proposed Drought Actions

To address reducing uncertainty regarding salmon distributions, presumably due to poor survival and/or low detection efficiency in current monitoring during drought conditions, DWR has proposed to add Drought Toolkit items which will augment ongoing monitoring with Environmental DNA (eDNA) monitoring at the point of Delta entry. This information is intended to improve understanding of whether salmon are present but undetected in current monitoring, or simply not present. Currently eDNA monitoring cannot distinguish between Chinook Salmon races, and until new assays are developed to overcome these challenges, monitoring will have to be interpreted cautiously until models are developed to characterize the relationship between eDNA detection distribution and probable salmon distributions.

Ecological Particle Tracking: ePTM and ECO-PTM

Several models are in development for modeling juvenile salmonid survival and migration patterns, ECO-PTM (DWR) and ePTM (NMFS SWFSC). Unlike DSM2 which tracks neutrally buoyant particles, particle models which incorporate fish behavior can be a more effective tool for quantitatively assessing fish parameters. These models have been calibrated and validated with acoustic tagged fish data. When available, pilot implementation of these models with weekly DSM2 runs may provide additional information of important biological response prediction such as fish reaching Chipps Island, the Central Delta, South Delta, and/or fish Salvage facilities to the SaMT to provide more realistic information regarding effects on migratory juvenile salmonids.

SHERLOCK Rapid Genetic Testing

Chinook salmon entering the CVP and SWP salvage facilities in the Delta are assigned to a run type for incidental take reporting and loss threshold triggers. Since 1997, run type at salvage has been determined using the delta model LAD criteria. Inaccurate assumptions underlying the model combined with overlapping juvenile length distributions across runs have prompted increasing use of genetic approaches for run assignment (Harvey et al. 2014, Brandes et al. 2021). Currently, most genetic approaches use many neutral markers to assign run type based on population structure (e.g., Clemento et al. 2014, Meek et al. 2016). An alternative approach is to use a small number of diagnostic markers (e.g., region associated with adult migration timing (Prince et al. 2017, Thompson et al. 2020)) in combination with CRISPR-based technology (SHERLOCK; Baerwald et al. 2023). A migration-associated marker/SHERLOCK approach has advantages, including the potential to obtain results within a few hours after fish are collected at salvage facilities.

The pilot study is continuing for a second year at both CVP and SWP salvage facilities. Results from SHERLOCK will be compared with existing genetic methods (e.g., GT-seq) to verify high concordance. Full scale adoption by both CVP and SWP are dependent on the results of this pilot and approved use for regulatory decisions by NMFS and CDFW.

Georgiana Slough Salmonid Migratory Barrier (GSSMB)

In 2019, Reclamation prepared an Environmental Impact Statement (EIS) and completed FESA reinitiation of consultation with the USFWS and NMFS on the long-term reoperation of the SWP and CVP. Biological Opinions for the project were issued by USFWS and NMFS on October 21, 2019, and the Final Environmental Impact Statement was published on December 19, 2019, and the Record of Decision signed on February 19, 2020. The NMFS Biological Opinion described the 2009 RPA Action IV.1.3 (Consider Engineering Solutions to Further Reduce Diversion of Emigrating Juvenile Salmonids to the Interior and Southern Delta and Reduce Exposure to CVP and SWP Export Facilities (including Georgiana Slough Non-Physical Barrier)) as part of the environmental baseline and recommended its continuation as a conservation measure.

Under the California Endangered Species Act (CESA), the CDFW issued the 2020 ITP for Long-term Operation of the SWP. SWP ITP minimization measure 8.9.1 included a requirement for construction and operation of a migratory barrier at Georgiana Slough.

In response to the 2019 NMFS Biological Opinion conservation measure, the 2020 CDFW SWP ITP, Coordinated Operation Agreement (COA) and based on results from the

previous Bio-Acoustic Fish Fence™ (BAFF) and Floating Fish Guidance Study studies, DWR proposed the Georgiana Slough Salmonid Migratory Barrier Project (GSSMB; project). The first year of installation and operation occurred in Water Year 2024. The project includes the installation and operation of a non-physical barrier using BAFF technology at the divergence of Georgiana Slough and the Sacramento River each year through the juvenile Chinook salmon migration season in 2030. Operations begin following the closure of the Delta Cross Channel gates in the winter, or no later than January 1, through April 30. BAFF operations in additional months, November, December, and May, will be adaptively managed each Project year by DWR in coordination with CDFW, NMFS, and USFWS.

The BAFF is a multi-stimulus fish barrier that combines high-intensity light-emitting diode (LED) modulated intense lights (MILs), an air bubble "curtain," and sound emitted at frequencies and levels that are repellent to Chinook salmon. The BAFF sound is trapped by refraction within the bubble curtain, producing a sharply defined sound field that fish do not detect until within a few meters of the barrier. The flashing MILs are aligned such that the light beam projects onto the bubble curtain. This helps identify the bubbles so that the source of the sound can be determined by the fish. The narrow, vertical MIL beam minimizes light saturation within the experimental area. The BAFF would be used as a behavioral deterrent for juvenile listed salmonids from entering Georgiana Slough and, ultimately, the interior Delta during outmigration.

The effectiveness of the BAFF is monitored by acoustically tagging and releasing hatchery-reared juvenile Chinook salmon and/or steelhead each year in the Delta Survival Study. Other acoustically tagged salmonid studies that occur upstream of the Georgiana Slough junction will also provide additional information on its effectiveness for keeping juvenile outmigrating salmonids in the Sacramento River.

Previous studies have shown that BAFF operations in 2011/2012 and Georgiana Slough Fish Fence Guidance Structure (GSFFGS) in 2014 reduced the number of juvenile salmonids from entering Georgiana Slough by one-third to one-half of the acoustically tagged fish. Preliminary results from real-time detections of acoustic tagged fish in 2024 using hatchery-reared late-fall Chinook salmon, hatchery juvenile fall-run Chinook salmon, wild and hatchery spring-run Chinook salmon and hatchery winter-run Chinook salmon, indicate the probability of fish staying in the mainstem Sacramento River was between 82.1% and 99.1%. Data collection is ongoing and final routing probability and survival results will be available in late 2024.

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Conclusion and Management Summary

Exports at the CVP and SWP export facilities and operations of the DCC Gates were consistent with the ROD, consistent with implementation of the IOP, and in most cases within the effects anticipated by the 2019 USFWS and NMFS Biological Opinions. The CVP and SWP exceeded the amount of annual take estimated in the ITS for Steelhead but not for any other listed fish species described in the 2019 USFWS and NMFS Biological Opinions. As detailed above, annual loss thresholds for Steelhead and LAD Winter-run Chinook Salmon were exceeded and triggered OMR reverse flow reductions. During the December to March Steelhead period the single year ITL was exceeded and operations of the CVP and SWP were coordinated among all agencies. OMR flow management controlled Delta operations from January 23 – February 5, 2024, due to IEWPP / ITP COA 8.3.1, which was immediately followed by triggering Larval and Juvenile Delta Smelt Protections / ITP COA 8.5.2 through March 17, 2024; however, these protections only controlled Delta operations through February 16, 2024.

The SMT met at the close of the WY 2024 OMR Management Season to discuss items for consideration and development as part of the Guidance Document review prior to the start of WY 2025 OMR Management Season meetings in fall 2024. The following items were submitted (additional details are available in end of season meeting notes from June 25, 2024):

- K&W and Reclamation to update the standing agenda to better align with SMT practice and to incorporate relevant updates when new PA and ITP regulations are public
- Request for a formal mechanism for timely communication from WOMT to SMT for WOMT operations decisions, including communication of decisions, time range for relevant or controlling decisions, rationale for decisions
- Review and revision of SMT page on SacPAS when new PA and ITP regulations are public
- K&W to keep track of controlling factors in the new WY.

The SaMT submitted the item below for consideration and development as part of the guidance document review prior to the WY 2024 OMR Management Season:

- Reclamation proposed improving the SaMT guidance documents, including the development of a Statement of Purpose from the LTO group to assist the various monitoring teams. This would consist of a concise statement that includes each team's purpose, objectives, and responsibility with the intention of helping the teams operate more efficiently.

Outcomes of WY 2023 SMT and SaMT Recommendations for WY 2024

Recommendations adopted or in progress:

- Reclamation created a SharePoint site for housing SMT presentations, Smelt literature, Definitions used for SMT discussions, and other resources. This site will be hosted by Kearns & West next year and material will continue to be added.
- Kearns & West has created a template for tracking Controlling Factors for the subsequent water year.
- SaMT membership developed a "fish distribution rules & process" document that clarified the 95% exit language in the ITP off-ramp; and
- SaMT included the compiled fish monitoring table for the weekly assessment

Supporting Information

- Salmon Monitoring Team Notes and Proposed Action Assessments
- Salmon Monitoring Team webpage
- Smelt Monitoring Team Notes
- Smelt Monitoring Team webpage
- Smelt and Salmon Monitoring Teams ITP Risk Assessments
- Water Operations Management Team Notes
- Bay Delta Live webpage
- CalFishTrack Central Valley Enhanced Acoustic Tagging Project webpage

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