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Water Year 2023 Seasonal Report for Old and Middle River Flow Management

Central Valley Project, California

California-Great Basin Region



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Water Year 2023 Seasonal Report for Old and Middle River Flow Management

Central Valley Project, California

California-Great Basin Region

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- Appendix B – Delta Cross Channel Operations and Fall/Winter Closures Guidance Document
- Appendix C – WY 2023 Old and Middle River Entrainment Seasonal Report Data
- Appendix D - NMFS Juvenile Production Estimate (JPE) letter for brood year (BY) 2022 expected to enter the Delta during WY 2023
- Appendix E – Incidental Take Permit Amendment No. 5
- Appendix F – Bureau of Reclamation Memorandum to U.S. Fish and Wildlife Service, Long-Term Operation of the Central Valley Project and State Water Project, Additional Real-Time Old and Middle River Flow Restrictions for Delta Smelt Larval and Juvenile Entrainment for 2019
- Appendix G - Latest genetic analysis results for juvenile Chinook Salmon salvage for the WY

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Purpose

The Water Year (WY) 2023 Seasonal Report for Old and Middle River (OMR) Flow Management describes 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 WY 2024. 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 Sacramento-San Joaquin 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 2023 Annual Report on the LTO of the CVP and SWP (Annual Report), as well as DWR's 2023 Annual Status Report (ITP Condition 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 aforementioned 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 Condition 3.13.8). Reclamation and the DWR, respectively, will charter 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; review specific to OMR management will occur in 2025. 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).

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Background

The Sacramento–San Joaquin River Delta (Delta) is formed by the confluence of the Sacramento and San Joaquin rivers. 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 proximity of the CVP and SWP export facilities to OMR is shown in Figure 1.

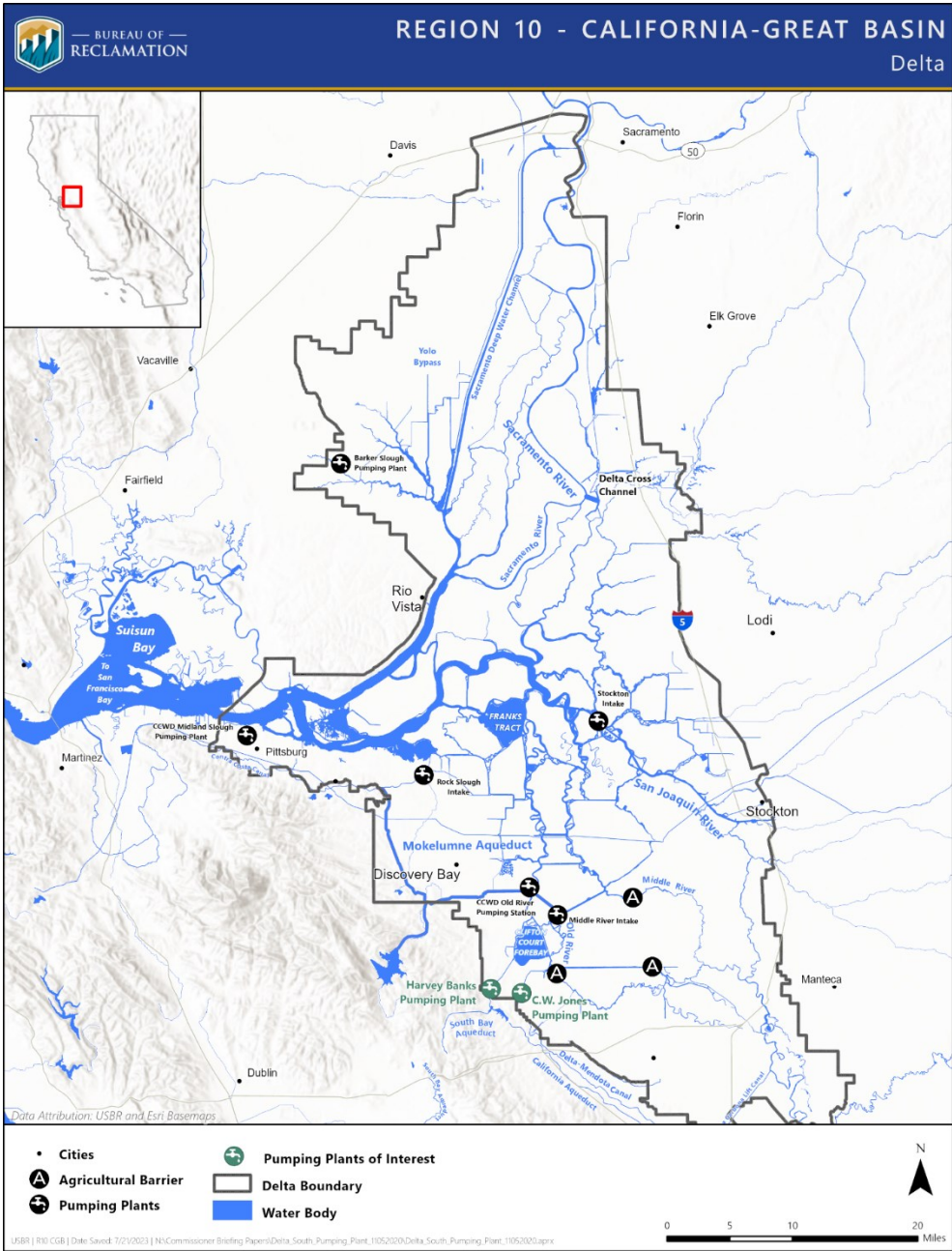


Figure 1. Map of the Delta with CVP and SWP infrastructure.

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 status of barriers in the south Delta and is estimated based on relevant parameters. 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 current application of hydrodynamic and entrainment models to support decision making for the management of OMR flows to minimize entrainment of fish when necessary and provide 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. 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, Sacramento River origin steelhead, and San Joaquin River origin steelhead. 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, including OMR management. 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 2023

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. Certain provisions of the IOP Extension relate to OMR management. The IOP states 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 2023, USFWS, Reclamation, DWR, CDFW, U.S. Geological Survey, and University of California, Davis, conducted the second Experimental Release of ≥ 200 days post hatch captive cultured Delta smelt. Three release events occurred in late November 2022 and January 2023, consisting of two paired hard and soft releases, one hard release, and one experimental trailer release (Table 1). A total of 43,726 fish, either adipose fin clipped or Visible Implant Elastomer tagged, were released across three different sites (Table 1). Of these fish, 47 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.

Experimental Releases of Delta Smelt

Table 1. WY 2023 Delta smelt Experimental Release events.

Date	Location	Adipose Fin Clipped	VIE Tagged	VIE Color	Total Fish Released
11/29/2022-11/30/2022	Sacramento River near Rio Vista	0	~100	Blue	6,584
11/30/2022	Sacramento River near Rio Vista	0	~100	Red	6,556
1/18/2023-1/19/2023	Sacramento River adjacent to channel marker 25, near Rio Vista	0	~100	Orange	14,524
1/18/2023	Sacramento River at Sandy Beach boat ramp in Rio Vista	~100	0	N/A	3,046
1/24/2023-1/26/2023	Sacramento Deepwater Ship Channel near channel marker 51	0%	~100	Orange	6,240
1/25/2023	Sacramento Deepwater Ship Channel near channel marker 53	0	~100	Green	6,775

- 11/30 Hard ● 11/30 Soft ◆ 11/30 Hard Release ◆ 11/30 Soft Release ◆ 1/18 Trailer Release ◆ 1/19 Hard Release ◆ 1/25 Hard Release ◆ 1/26 Soft Release
- 1/18 Trailer ● 1/19 Hard ● 1/25 Hard ● 1/26 Soft
- Unmarked

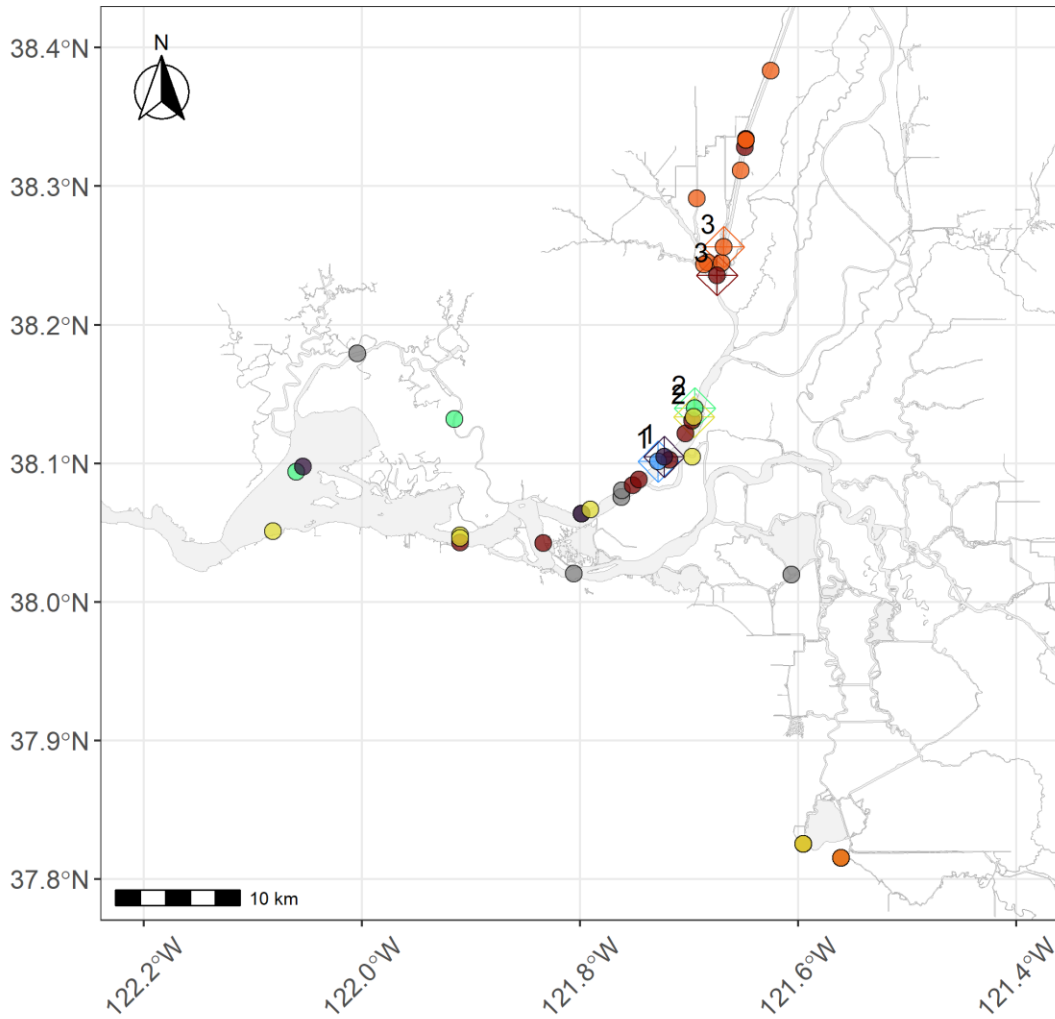


Figure 2. Map of WY 2023 Experimental Release sites and subsequent recaptures of released Delta smelt in regular monitoring. Diamonds indicate release sites and circles indicate subsequent recaptures. Numbers indicate order of paired releases.

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Seasonal Operations

Three years, 2020 through 2022 of extremely dry and persistent drought conditions preceded the current WY 2023 resulting in low reservoir conditions and moisture depleted soils throughout the state. WY 2023 conditions began with a dry October; however, this was followed by two weeks of wet weather in early November. Despite the reprieve, dry conditions returned, ending November with below normal precipitation (CNRFC 2022, November). The first half of December rebounded with record snow and rainfall improving water supply projections with snowpack outlooks in many watersheds “at or near the largest to-date since 1980” (CNRFC, 2022, December). Wet weather resumed late December and persisted into mid-January. Nine atmospheric rivers reached the California and southern Oregon coastlines in a three-week period ranging in magnitude from moderate to exceptional (CNRFC, 2023, January). Widespread precipitation and flooding impacted numerous watersheds. Despite destructive flooding in some basins, water supply conditions improved significantly. Although weather patterns cycled between dry and very wet in the late winter and early spring, water supply conditions were sustained at above average with early season record breaking snowpacks (CNRFC, 2023, February). Wet and dry weather cycling was again experienced in late February/March with active weather patterns followed by driest/near driest on record precipitation in April in some areas. In late April, snowpack in the Sierra Nevada Mountain range hit record marks particularly in the southern reaches rivaling 1983 totals at approximately 200% of April 1st averages and 260% of normal (CNRFC 2023, May). Early in the WY reservoirs were low with ample flood space from drought times. By May, most reservoirs were actively operating for flood space or storage management. High runoff in both the Sacramento and San Joaquin watersheds began in mid-March and persisted through June as a result of high snowpack conditions and impressive spring/early summer snowmelt runoff. All indications suggest higher than average runoff and inflows into the Delta, as a result of record/near record-breaking snowpack, will linger longer than normal into the late summer and reservoirs will end the WY with higher carryover volumes than the previous few years.

Early in WY 2023, CVP and SWP operations were strongly influenced by dire prior year hydrologic conditions, precipitation deficits, poor storage, and drier than normal conditions, which exacerbated the need for available resources to meet water system needs in late winter. The CVP and SWP were again challenged in meeting D-1641 standards. On February 13, 2023, the Governor issued a revised Drought Emergency Declaration. The CVP and SWP submitted a Temporary Urgent Change Petition (TUCP) to the Water Board to modify the Delta outflow requirement. This petition was conditionally approved February 21, 2023¹ and suspended the Port Chicago Delta outflow requirement for the remainder of February 2023 through March 31, 2023. As mentioned above, a series of widespread and strong storm events significantly increased the statewide precipitation, snowpack, and runoff in late February and early March 2023. The TUCO conditions were suspended March 9, 2023 by the Water Board ([State Water Project and Central Valley Project Temporary Urgency Change Petition | California State Water](#)

¹ https://www.waterboards.ca.gov/waterrights/water_issues/programs/drought/tucp/docs/2023/20230213_tucp.pdf

[Resources Control Board](#)). The CVP and SWP declared excess conditions in the Delta on March 10, 2023. High flows and low salinity Delta conditions have persisted; D-1641 flow and water quality requirements have been met to date.

As of May 31, 2023, major reservoirs have significantly recovered from the WY 2020 through WY 2022 drought period, sans Trinity reservoir, with storage conditions projected to reach at or near capacity. Delta conditions have recovered as Delta outflow, QWEST, and OMR metrics have been favorable with high flow or positive value indices and conditions.

Delta Cross Channel Operations



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

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 October and November for the D-1641 Delta flow Rio Vista and Delta water quality/salinity requirements and afforded weekend recreational opportunities. In WY 2023, no Knights Landing Catch Index (KLCI) or Sacramento Catch Index (SCI) exceedances (>3.0 fish per day) occurred (Figure 4 4) required no action responses of DCC gate closures. The DCC gates were closed for the season (as defined in Old and Middle River Flow Management), starting on November 28, 2022. Due to the persistent high flows in the Sacramento River greater than 20,000 cfs, the DCC gates remained closed November 28, 2022, through June 22, 2023, to protect the facility. The DCC gates were opened for the summer season, per D-1641, on June 23, 2023.

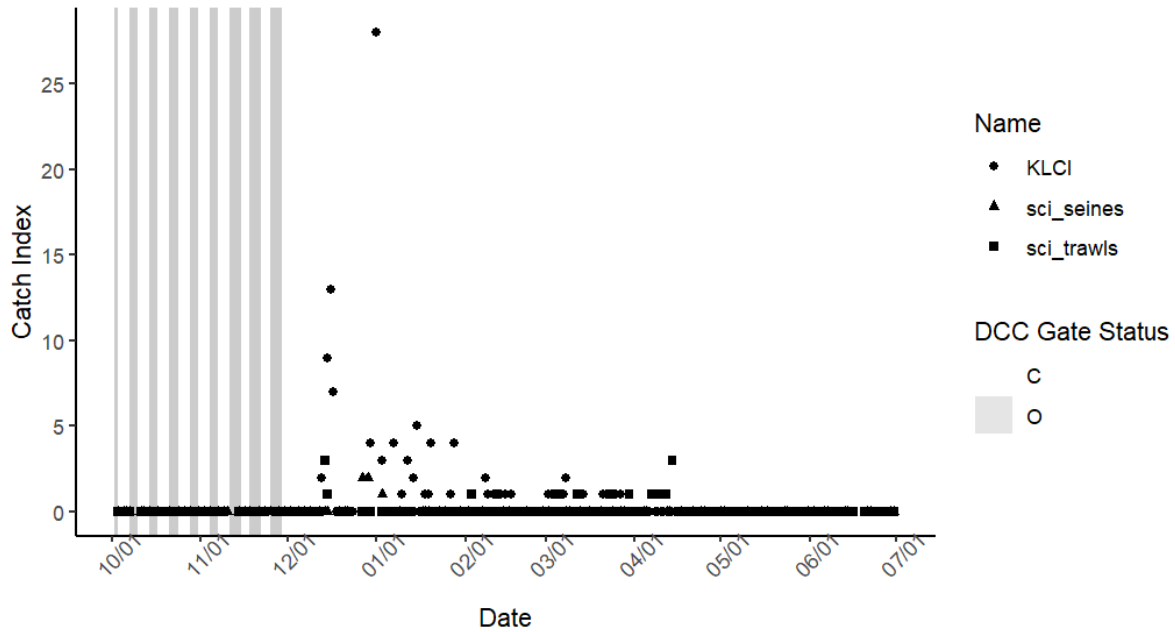


Figure 4. DCC Gate closures (white) and openings (grey), Knights Landing Catch Index (KLCI) and Sacramento Catch Index at beach seines (SCI - seines) and Sacramento Catch Index at trawls (SCI – trawls) for natural winter-run Chinook Salmon.

Figure 4 is a bar graph showing DCC Gate closures and openings, and catch index by category (trawls and seines) at Knights Landing between October 2022 to July 2023. The graph shows DCC gates were opened October to the end of November with a peak Knights Landing Catch Index on January 1st.

Old and Middle River Flow Management

Old and Middle River Flow Management for the WY 2023 management season spanned January 1, 2023, to June 30, 2023. OMR index values (1-day, 5-day, and 14-day) for WY 2023 are plotted in Figure 5. In WY 2023, the OMR flow management season was initiated on January 1, 2023, due to salmonid presence, but was immediately followed by the Integrated Early Winter Pulse Protection (IEWPP) (see Onset of OMR Flow Management) starting on January 3, 2023. After the IEWPP period ended, Turbidity Bridge Avoidance action was immediately triggered and in effect through February 9, 2023, but only uniquely controlled CVP and SWP exports on January 17, 2023. From January 18, 2023, through January 27, 2023, the CVP and SWP exports were limited by the available facility capacity. After January 27, 2023, CVP and SWP exports were controlled by the Turbidity Bridge Avoidance action and the Onset of OMR Management action (PA 4.10.5.10.1 and COA 8.3). Turbidity conditions improved on February 8, 2023, and the Onset of OMR Management action (PA 4.10.5.10.1 and COA 8.3) limited exports through February 17, 2023. From February 18 through February 28, the CVP was unable to utilize SWP export facilities because of ITP based limits on SWP operations. For February 18 and 19, 2023, SWP exports were limited to the proportional share of a –2000 OMRI by agreement from a

February 17 WOMT meeting. For February 20 through 23, 2023, SWP exports were limited to the proportional share of a –3500 OMRI because of longfin smelt action (COA 8.4.2). For February 24 through 26, 2023, SWP exports were limited to the proportional share of a –2000 OMRI because of Turbidity Bridge Avoidance action (COA 8.5.1). For February 27 through March 1, 2023, SWP exports were limited to the proportional share of a –3500 OMR because of longfin smelt action (COA 8.4.2). Onset of OMR Management action (PA 4.10.5.10.1 and COA 8.3) limited exports from March 2, 2023, through March 8, 2023, to an OMRI of -5000. While OMR flow management limits were in effect during the remainder of the OMR management period for WY 2023, after March 9, 2023, the high inflows to the Delta allowed the Projects to operate to other conditions Figure 6. From January 1, 2023, through June 30, 2023, the daily OMR index was positive for 105 out of 181 days (Figure 5; mean: 208 cfs; range of 14,593 cfs to -5,130 cfs and Figure 6).

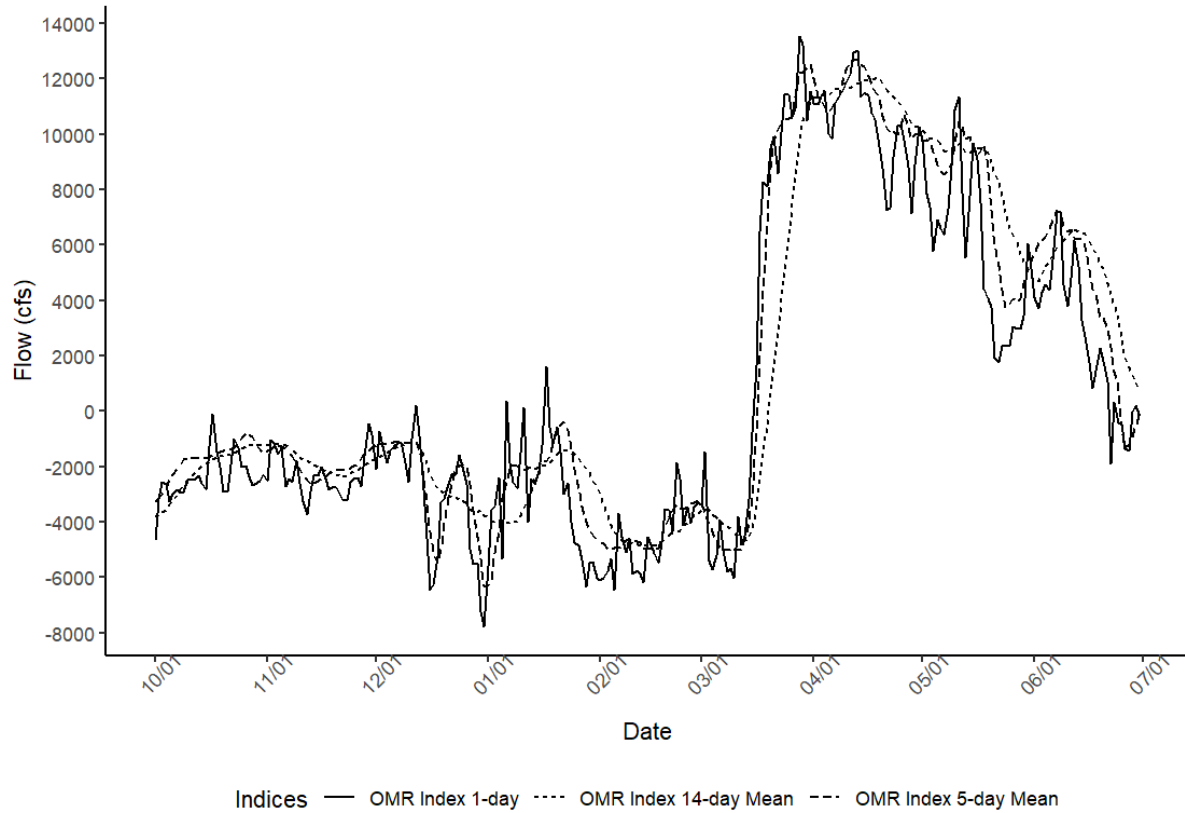


Figure 5. OMR index values measured in cubic feet per second [cfs] (1-day, 5-day, and 14-day) in WY 2023.

Figure 5 is a line graph showing OMR index values measured in cubic feet per second for 1, 5, and 14 day means October 2022 to July 2023. The graph shows a sharp peak in all of the indices in mid-March.

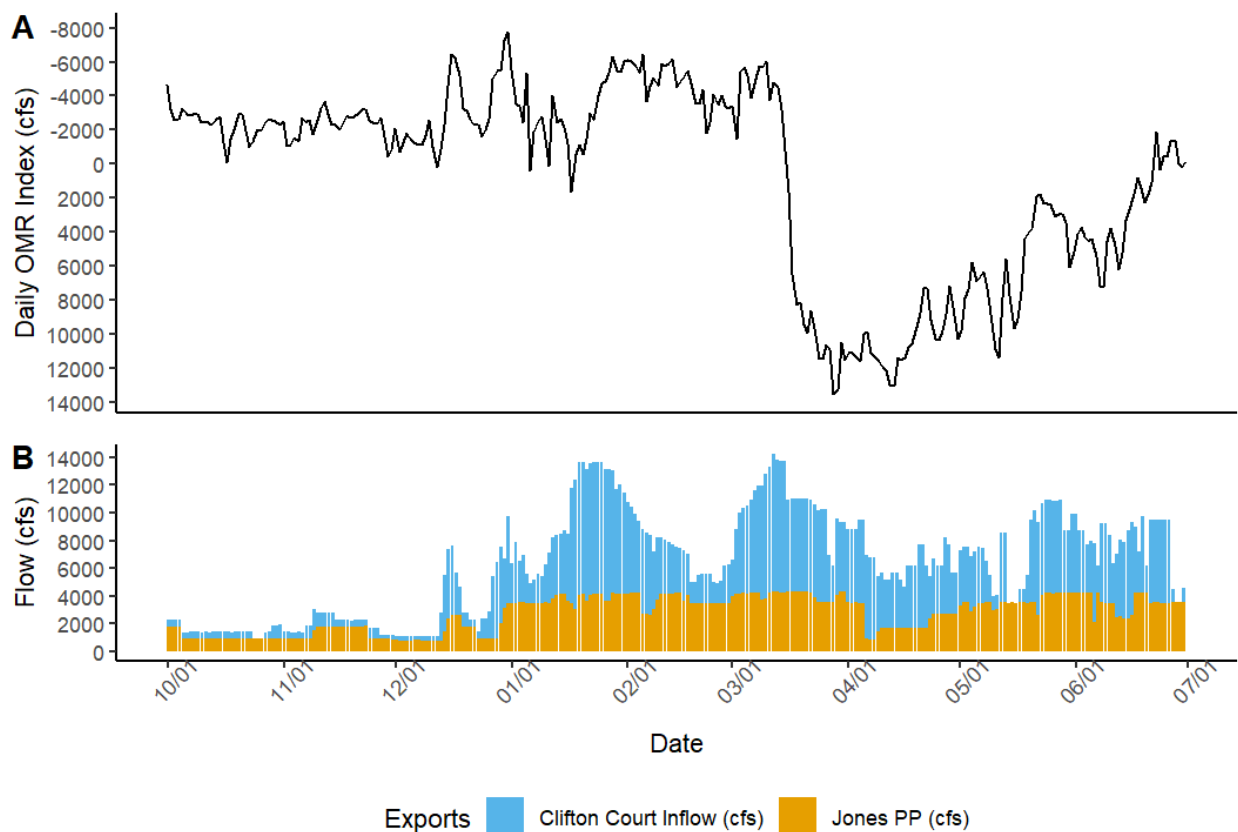


Figure 6 (A,B). Exports from Clifton Court Forebay Index (for the SWP) and Jones PP (for the CVP) plotted over 1-day OMR index values for WY 2023. Maximum capacity is the combination of the maximum permitted capacity for both facilities per United States Army Corps Engineers (CVP: 4,600 cfs; SWP: 6,680 cfs except in mid-December through mid-March when exports can increase to 10,300 cfs).

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 2023 were generally to meet D-1641 outflow and water quality requirements. Figure 7 Delta hydrologic conditions also change throughout the season, which can be characterized as either Balanced or Excess conditions, and this impacted management of export operations. The preceding dry conditions resulted in balanced conditions through late December. Excess conditions occurred from late December through the end of the OMR management period (end of June) due to above normal precipitation and snowmelt runoff (Figure 7).

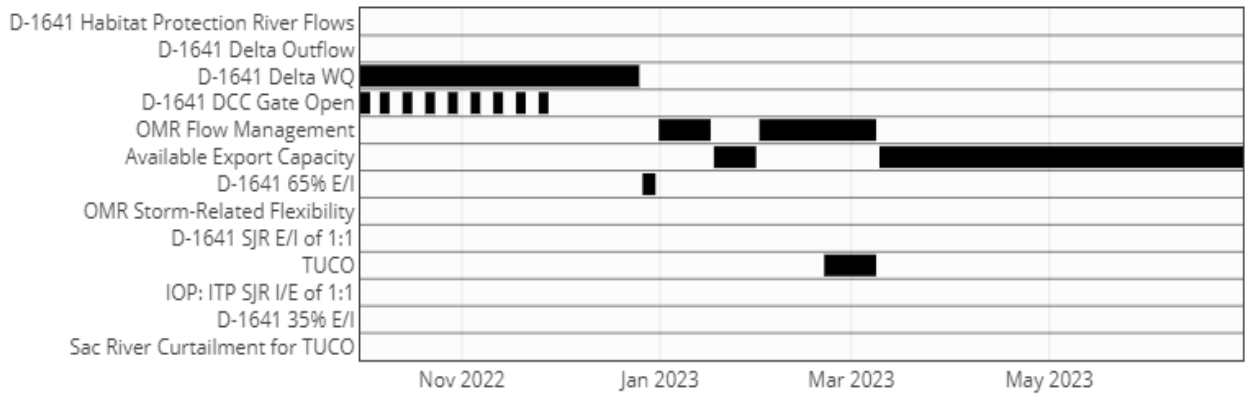


Figure 7. Daily Delta factors influencing export operations for WY 2023.

Figure 7 is a timeline graphic depicting the timing of different factors October 2022 – July 2023.

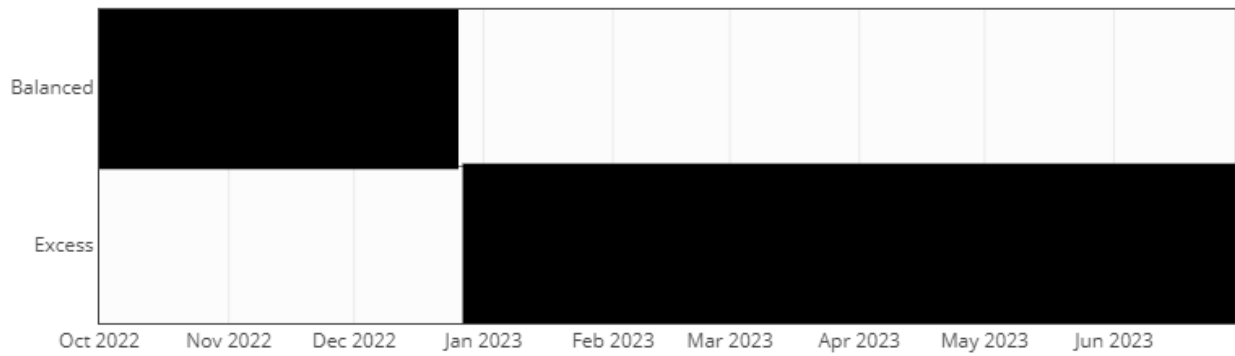


Figure 8. Balanced and Excess conditions in the Delta for WY 2023

Figure 8 is a timeline graphic depicting the timing of balanced and excess conditions in the Delta October 2022 – July 2023. The timeline shows balanced conditions October 2022 – January 2023 and excess January – July 2023.

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 includes a 3-day daily average flow at Freeport greater than 25,000 cfs and a 3-day daily average turbidity at Freeport equal to or greater than 50 Formazin Nephelometric Units (FNU) 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 December 31, 2022. 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 2022, IEWPP thresholds would have been met in WYs 2012, 2014, 2017, 2019 and 2022. During the WY 2023 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 3 through January 16, 2023. During this period, Reclamation and DWR reduced exports for 14 consecutive days such that the 14-day averaged OMR index for the period was no more negative than -2,000 cfs. During the IEWPP, turbidity in the OMR corridor was well above 12 FNU (ranging from 75-222 FNU and flows at Freeport exceeded 25,000 cfs from December 30, 2022, through January 30, 2023 (Figure 9).

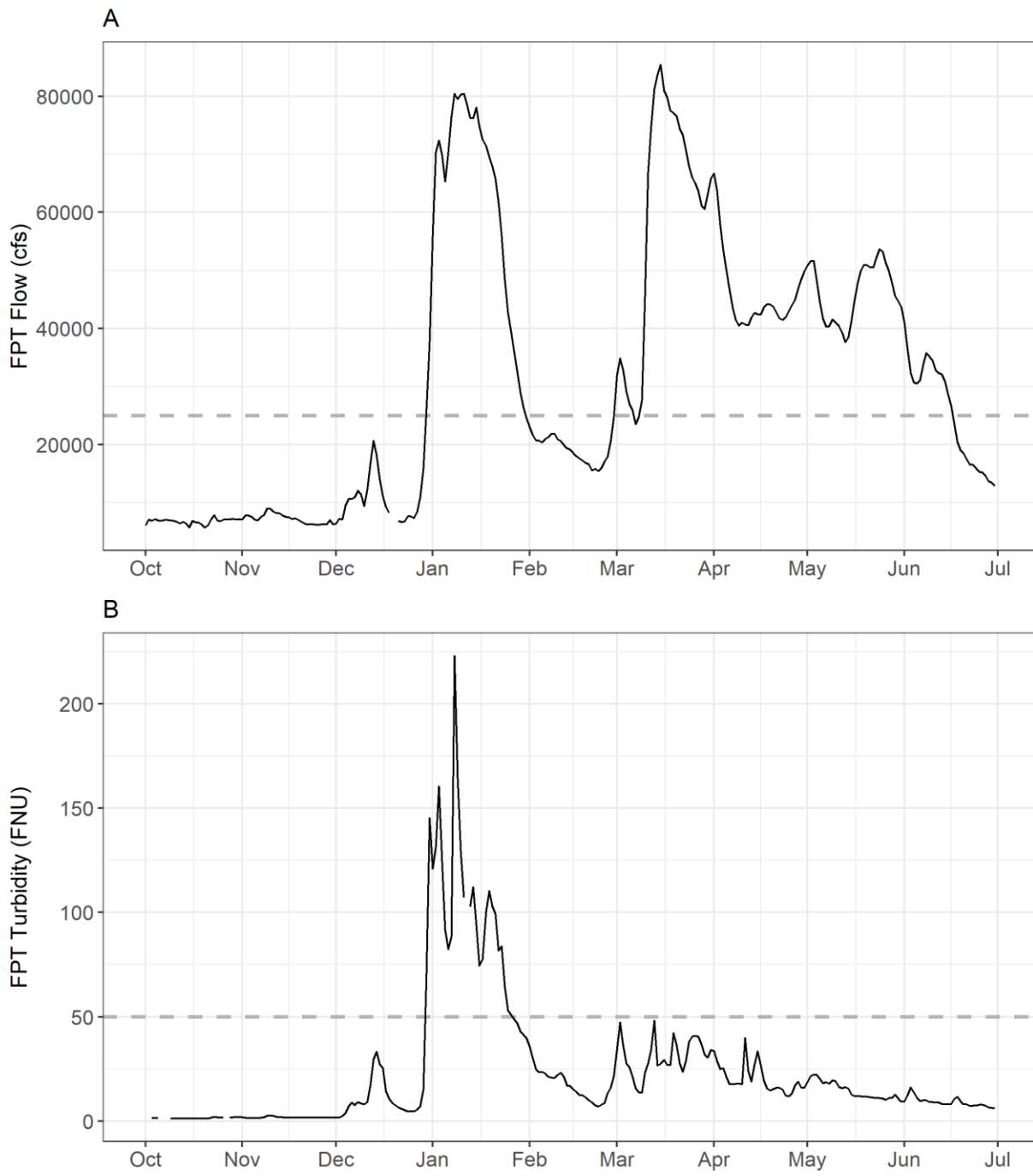


Figure 9. 'First Flush' conditions in WY 2023; A. 3-day running average flow (cfs) at Freeport. Dashed line indicates 25,000 cfs threshold. B. 3-day running average turbidity (FNU) at Freeport. Dashed line 50 FNU turbidity threshold. Data obtained from [California Department of Water Resources](#).

Figure 9 is comprised of two line graphs depicting flow and turbidity during first flush conditions. Both line graphs show a spike in flow and turbidity in January 2023.

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 2023 were made on October 4, 2022, 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 November 15, 2022. As such, in WY 2023, on-ramping of OMR management season for salmonids began on January 1, 2023. The first distribution estimates for hatchery winter-run Chinook salmon were made on February 1, 2023, soon after the first releases of hatchery winter-run Chinook salmon.

Multiple sources are considered in order to produce distribution estimates, including catch at targeted locations (e.g., Feather River rotary screw traps [RST], Glenn Colusa Irrigation District RST, Tisdale Weir 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 WR 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 2023, due to weather, flow conditions, or technical/operational issues (Figure 9).



Figure 10. WY 2023 sampling disruptions by monitoring team for surveys and fish salvage facilities. 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.

Distribution estimates made by SaMT in WY 2023 for natural winter-run Chinook salmon, natural Steelhead, natural YOY spring-run Chinook salmon, and hatchery winter-run Chinook salmon are depicted in Figures 11-14. See Table 2 for data sources used by SaMT to determine the distribution estimates.

Table 2. Calculations and data sources used 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

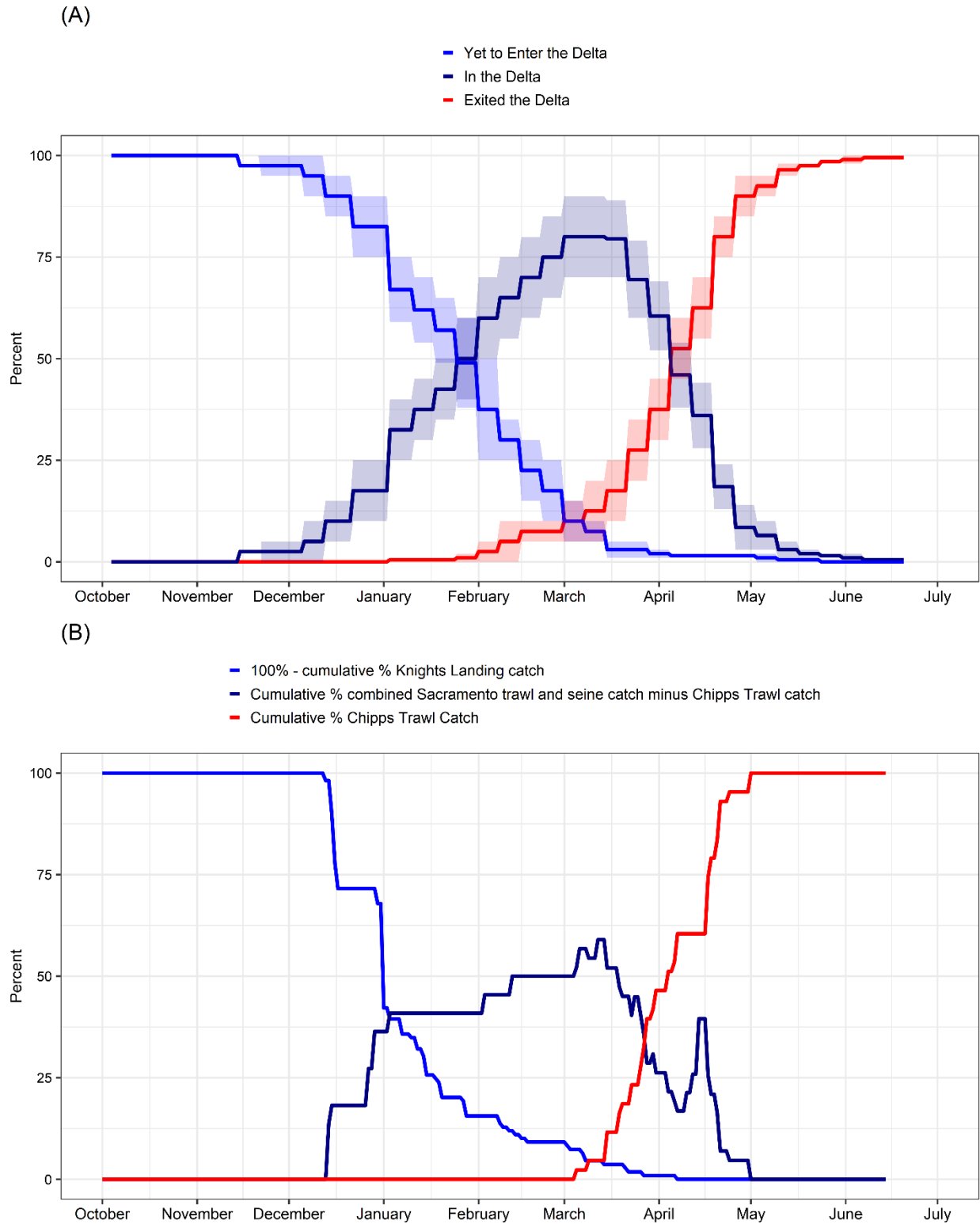


Figure 11. WY 2023 natural-origin winter-run Chinook salmon weekly SaMT distribution estimates (A) compared to length-at-date winter-run Chinook salmon observations in monitoring (B). Shaded areas indicate the upper and lower distribution estimates as

described by SaMT. Cumulative catch data in Delta monitoring calculations are described in the legend and Table 2.

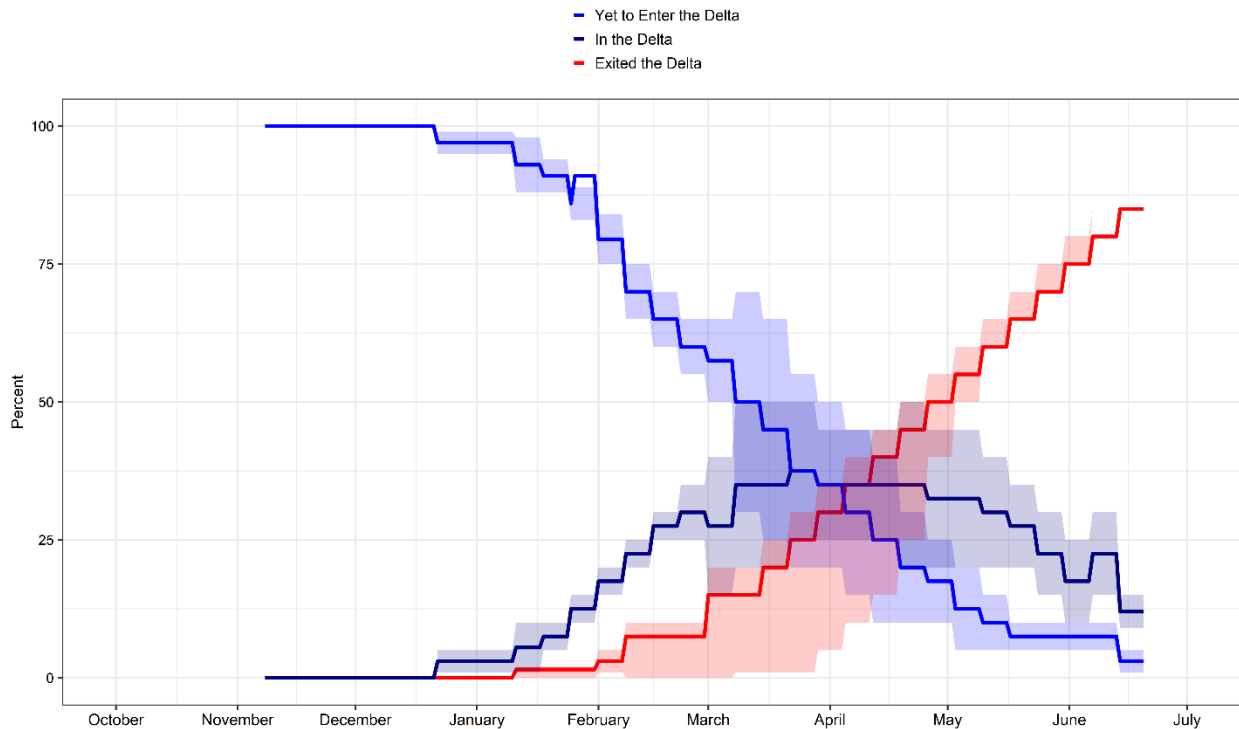


Figure 12. SaMT distribution estimates for natural steelhead in WY 2023. Shaded areas indicate the upper and lower distribution estimates as described by SaMT.

Figure 12 is a line graph showing percentage of distribution estimates for natural steelhead that have yet to enter the Delta, in the Delta, and exited Delta. The graph shows an estimated 100% of natural steelhead were yet to enter the Delta November to mid December 2023 with a stepwise inversion between mid-December to mid-May. Estimates for natural steelhead exiting the Delta remain at or near 0 November to February with a steady increase between February and mid-June, 2023.

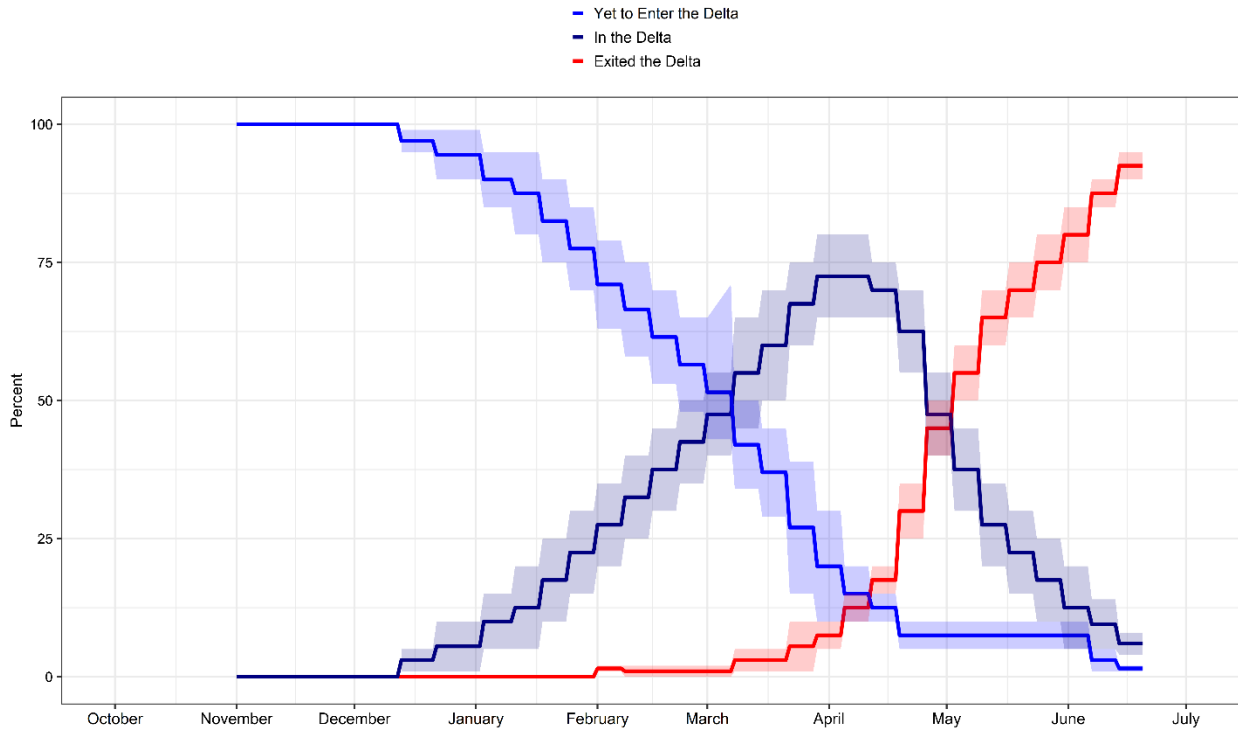


Figure 13. SaMT distribution estimates for natural spring-run Chinook salmon in WY 2023. Shaded areas indicate the upper and lower distribution estimates as described by SaMT.

Figure 13 is a line graph showing percentage of distribution estimates for natural spring-run Chinook that have yet to enter the Delta, in the Delta, and exited Delta. The graph shows an estimated 100% of natural spring-run Chinook were yet to enter the Delta November 2022 to mid December 2023 with a stepwise inversion between mid-December to April. April to June, the percentage estimates for natural spring-run Chinook in the Delta begins to decline while estimates for natural spring-run Chinook increases sharply.

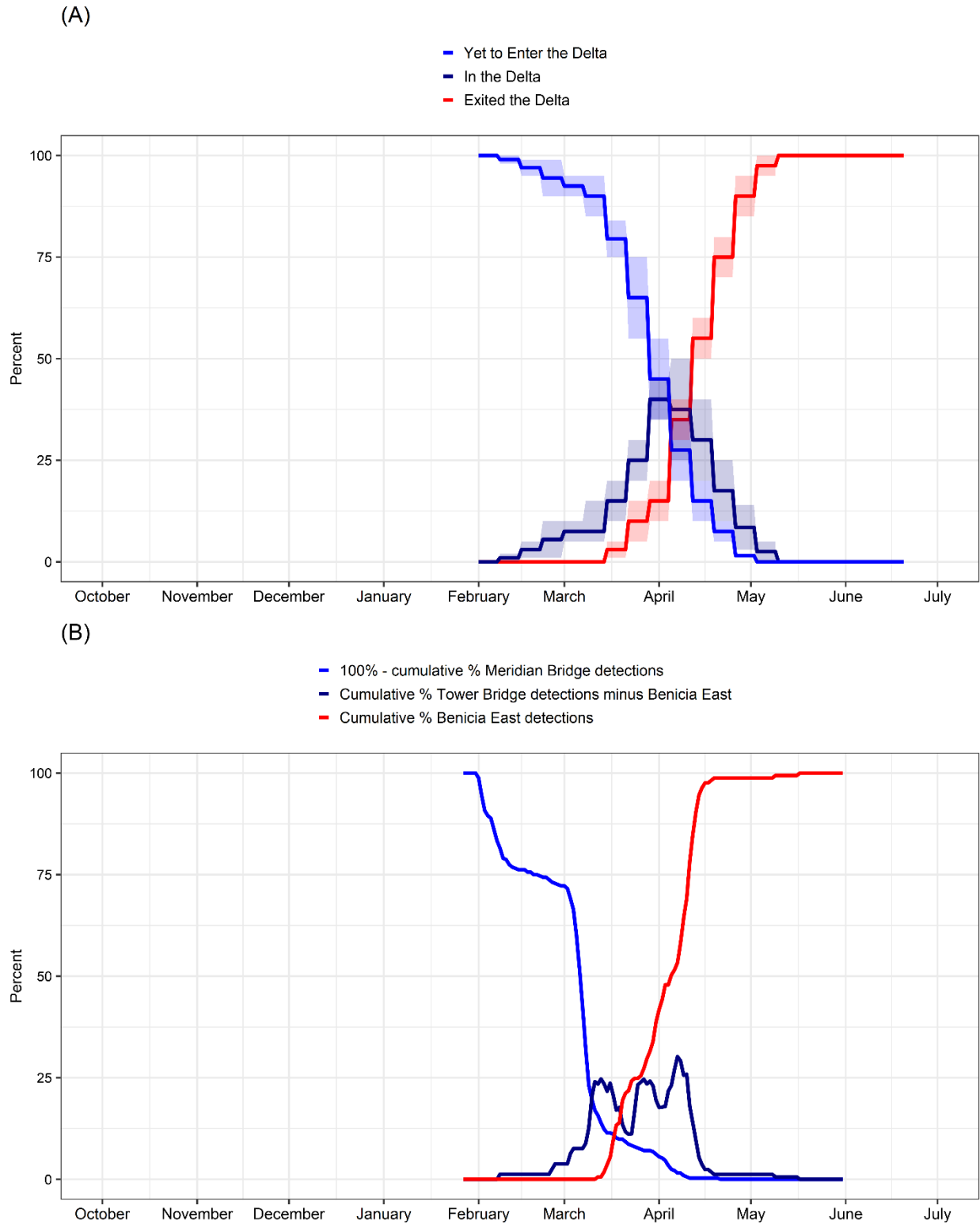


Figure 14. WY 2023 hatchery-origin winter-run Chinook salmon weekly SaMT distribution estimates compared to acoustic tagged winter-run Chinook salmon observations in monitoring. Solid lines indicate SaMT distribution estimates for “Yet to

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.

Adult Longfin Smelt Entrainment Protection

The ITP for the SWP includes a third action triggering the onset of OMR management if an IEWPP action (COA 8.3.1) has not yet been initiated. After IEWPP 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 Mid Water Trawl (FMWT) index for longfin smelt. For WY 2023, the threshold was 40, based on a 2022 FMWT index of 403. No longfin smelt were detected in either salvage facility prior to the triggering of COA 8.3.1, thus this action was not triggered during WY 2023. A total of 26 age 1+ longfin smelt were salvaged in WY2023, 14 adults and 12 sub-adults.

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 2023 began in October, with regular detections from November through March. The SMT did not make any recommendations to WOMT between December 1st and the triggering of COA 8.3.1 regarding the need for adult longfin smelt protections.

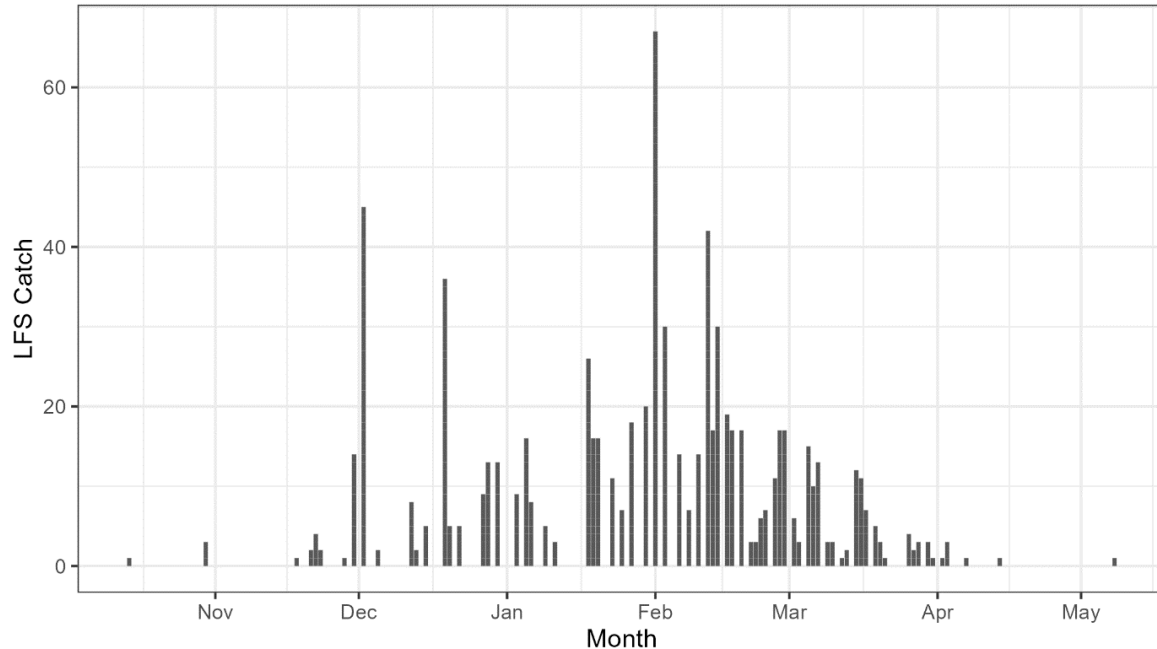


Figure 15. Adult longfin smelt ($\geq 60\text{mm}$) catch from the Chipps Island Trawl from October 2023 through June 2023 (no catch in June). May 8 was the last day an adult longfin smelt was detected.

Figure 15 is a bar graph that shows a high number of catches of adult longfin smelt from the Chipp Island Trawl in December and February.

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 2023, a record-setting series of atmospheric rivers drenched the state from late December through January, elevating turbidities in the south Delta (Figure 15). After the 14-day period of IEWPP, turbidity remained elevated at OBI and a turbidity bridge was formed from the lower San Joaquin River to the south Delta export facilities, triggering the Turbidity Bridge Avoidance action on January 17, 2023. Two ripe female Delta smelt, cultured fish released in Sacramento River near Rio Vista on January 18 or 19, 2023 and Sacramento Deepwater Ship Channel on January 25, 2023, were collected by Spring Kodiak Trawl (SKT) on February 9,

2023, which off-ramped turbidity bridge avoidance for the CVP. ITP COA 8.5.1 does not contain an offramp for the detection of a ripe female Delta smelt, so the Turbidity Bridge Avoidance action for the SWP did not offramp until April 1, 2023. Turbidity Bridge Avoidance triggered again on February 15 through February 16, February 21 through February 25, and March 17 through the end of the Turbidity Bridge Avoidance action period. While Turbidity Bridge Avoidance was in effect for much of the winter season, other factors generally took precedence in controlling exports (see Old and Middle River Flow Management for details). 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 of its potential to temporarily increase turbidity within waterways of the Delta. 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. Daily average turbidity at OBI repeatedly exceeded 12 FNU in WY 2023. Under the wet conditions of WY 2023, notable increases in turbidity at OBI were driven by multiple large precipitation/flow events during the Turbidity Bridge avoidance period, rather than wind (Figure 16). Increases in turbidity in the Delta were observed over the course of the season by the SMT and turbidity values are always considered when assessing the likelihood of entrainment. Figure 16.

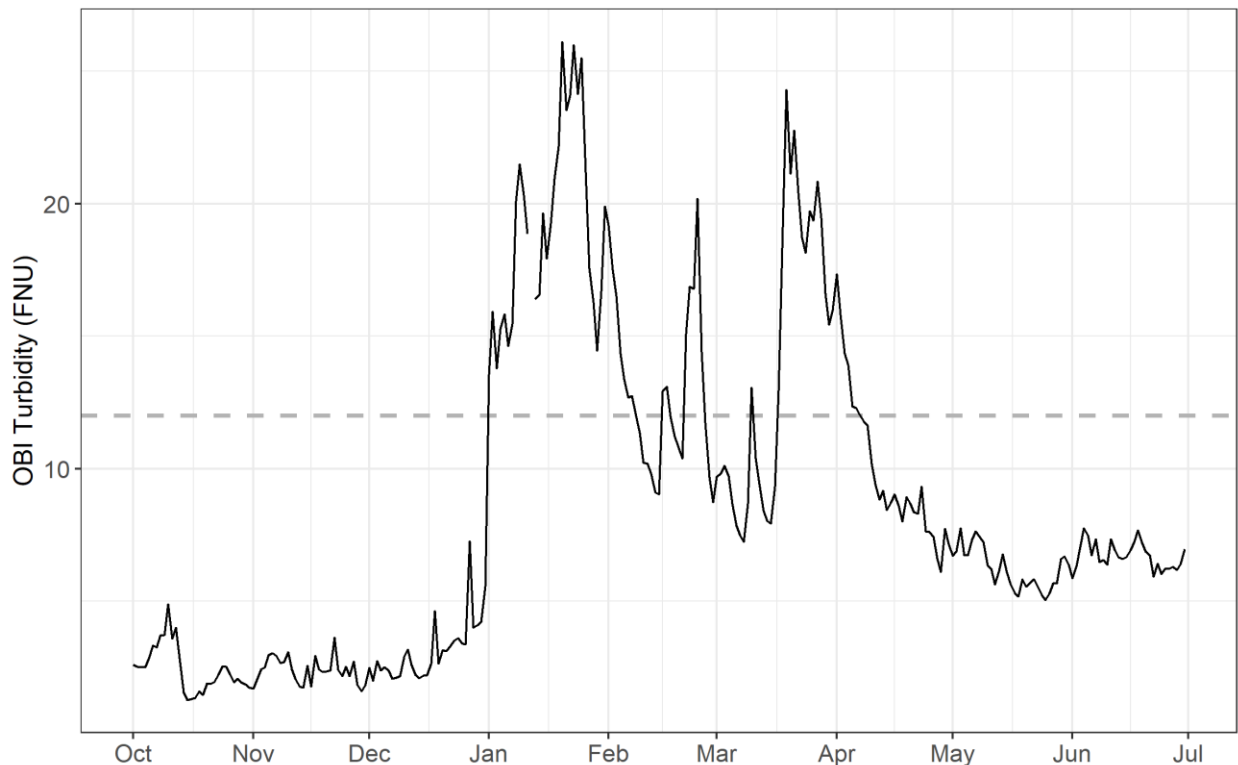


Figure 16 Daily average turbidity (FNU) at Old River at Bacon Island (OBI) in WY 2023. Dashed line indicates 12 FNU threshold.

Figure 16 is a line graph showing average turbidity (FNU) above the 12 FNU threshold in January 2023 and several times in February, March, and April. The peaks of turbidity occurred in mid-January and mid-March.

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 SLS or 20mm survey or the 3-day average water temperature at Jersey Point is greater than or equal to 12°C and Secchi depth from the most recent SLS or 20mm 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 PA, 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 March 18, 2023, the three-day average water temperature at Jersey Point reached 12°C, on-ramping COA 8.5.2, and immediately triggering the action based on the Secchi depth. The action remained triggered through May 9, 2023, and was triggered again based on Secchi depth between June 6, 2023, and June 20, 2023. Due to excess conditions through the end of June, larval and juvenile Delta smelt protections were not controlling. During WY 2023, no larval or juvenile Delta smelt were detected at either the SWP or CVP in regular salvage or qualitative larval sampling. QWEST was also positive for the entire duration of the larval and juvenile season (March 15 – June 30) (Figure 17).

DWR operates the Barker Slough Pumping Plant to protect larval Delta smelt in dry and critical WRs, from March 1 through June 30 (ITP COA 8.12). As WY 2023 was wet, 8.12 was not active at any point during the OMR management season.

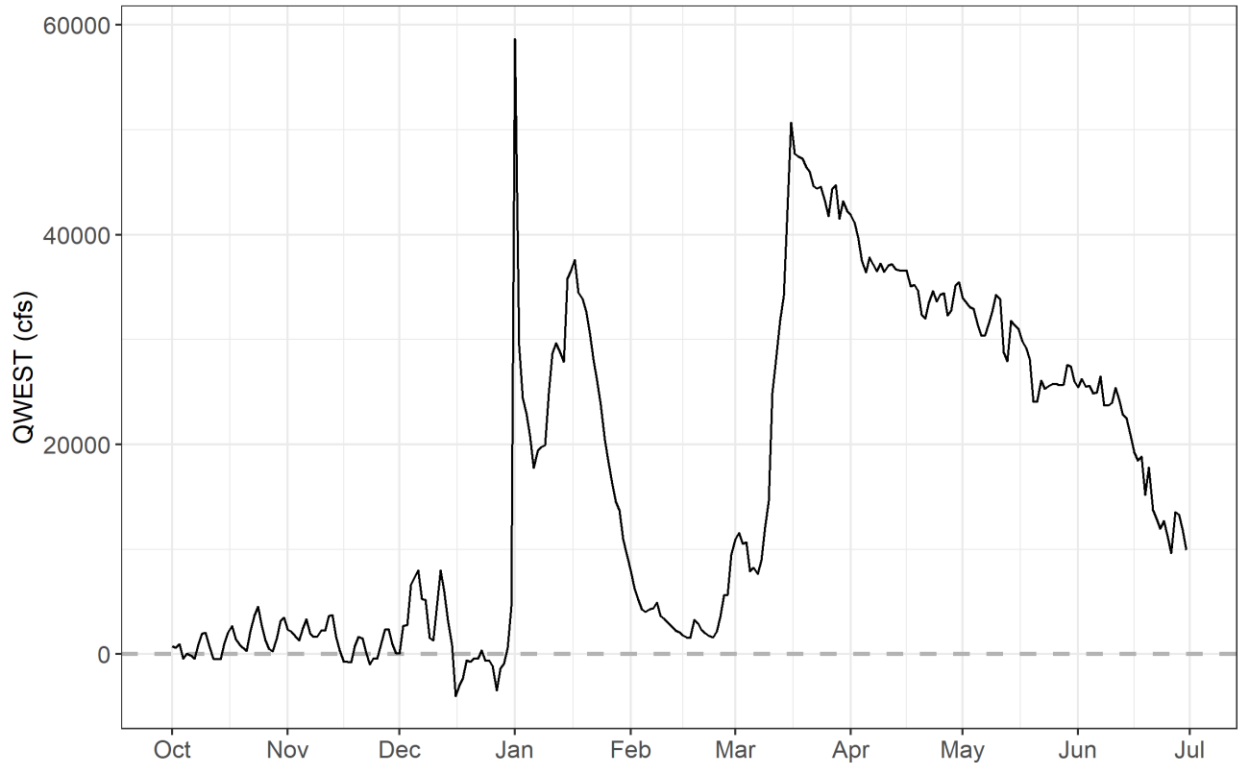
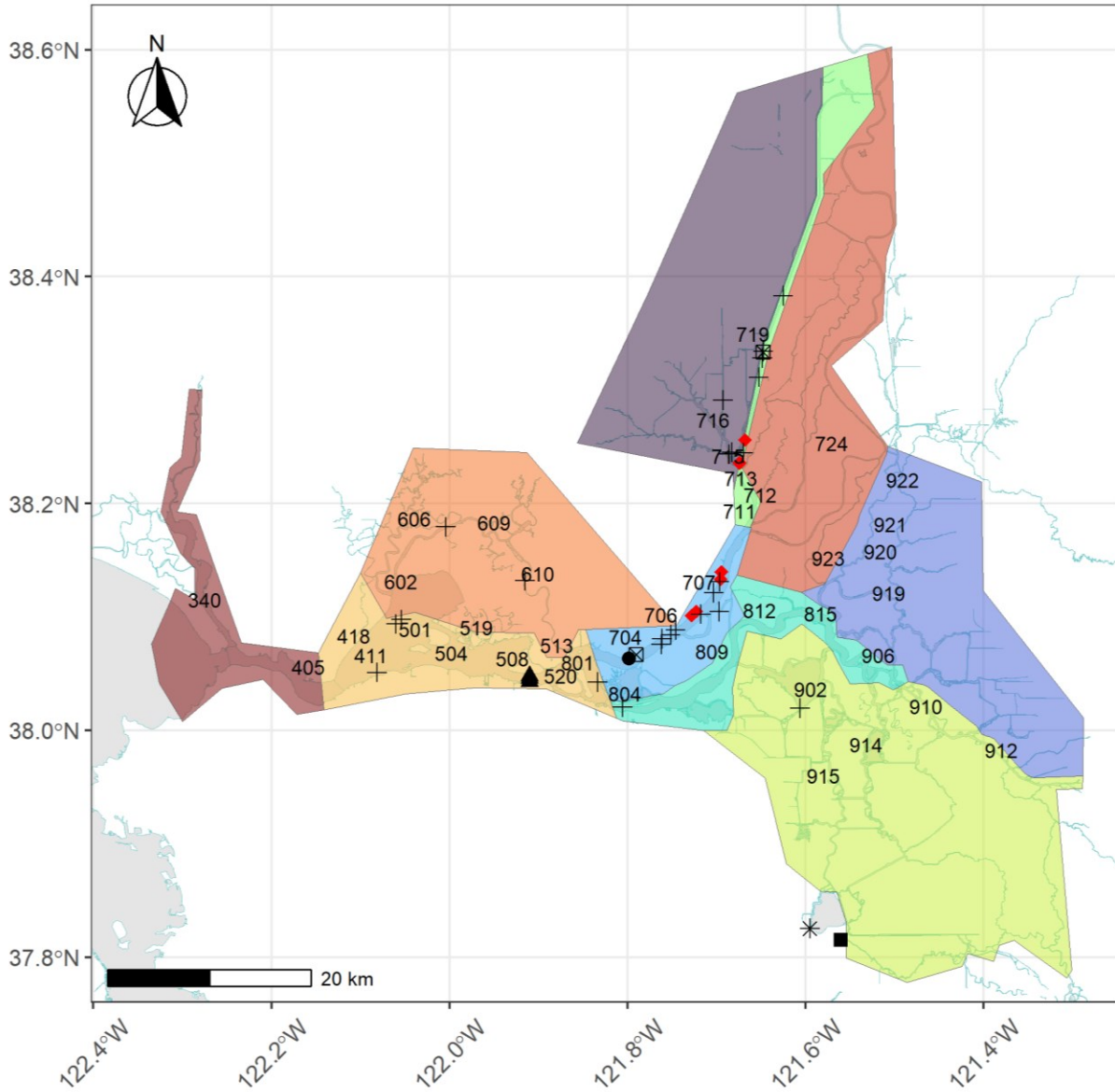


Figure 17. QWEST (cfs) in WY 2023.

Figure 17 is a line graph depicting QWEST flow October 2022 to July 2023. The graph shows large spikes in QWEST flow in January and March 2023.

Delta Smelt Detections All Delta smelt catch data were reported to the SMT and considered each week. In WY 2023, 50 adult and sub-adult Delta smelt, 36 larval and one juvenile Delta smelt were reported to the SMT. 42 of the 49 fish were marked. Because of high flows this year, adult Delta smelt catch was widely distributed, with higher numbers of catch in the Lower Sacramento, Sacramento Deepwater Ship Channel, and Southern Delta strata (salvage included in the Southern Delta strata) (Figure 18). One unmarked adult Delta smelt was observed in the South Delta on January 17, 2023, while all other detections of adult/sub-adult Delta smelt in the South Delta were at the Tracy Fish Collection Facility (TFCF) or the Skinner Delta Fish Protection Facility. Notably, while most of the adult/sub-adult Delta smelt were caught between December and March, one marked adult Delta smelt was caught at Chipps Island on June 28, 2023. Larval and juvenile Delta smelt detections occurred between March 13, 2023 and June 7, 2023, and were most frequently in Suisun Bay and Suisun Marsh, though several observations also occurred in the Cache Slough/Liberty Island, Sacramento Deep Water Ship Channel, Lower Sacramento, and Lower San Joaquin strata (Figure 18). No larval or juvenile detections occurred in the South or Central Delta.

A.



B.

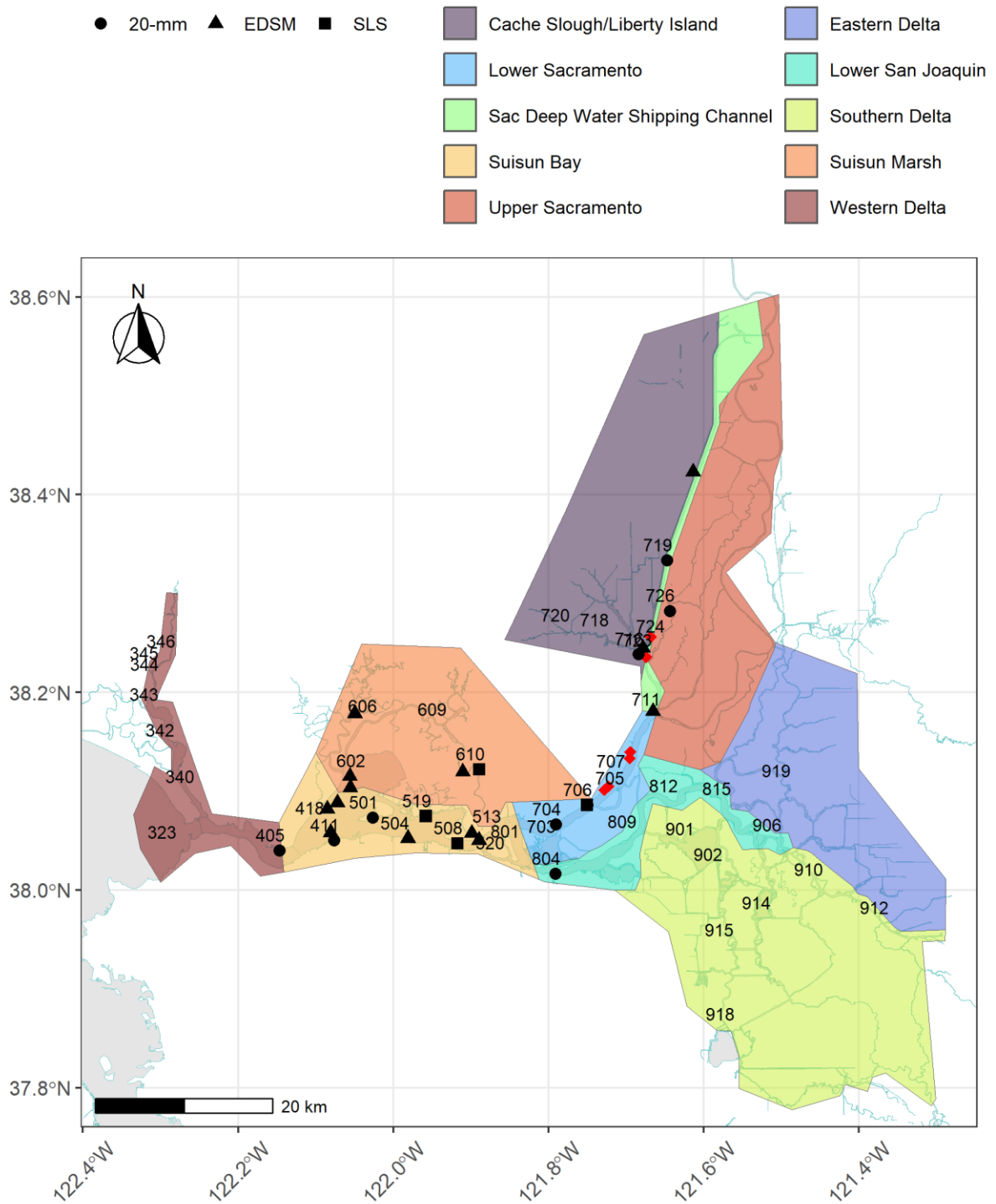


Figure 18. Delta smelt seasonal catch locations in WY 2023 (all reported between November 1, 2022 – June 30, 2023). EDMSM Stratum shown as colored polygons. Red diamonds indicate Delta smelt release locations. Figures do not indicate the number of detections at a particular location, so some points may represent multiple fish. A. Adult Delta smelt catch by EDMSM, Broodstock, Chipps, Salvage, and SKT. B. Larval and juvenile

Delta smelt catch from SLS, 20mm and EDSM. Some larval and juvenile identifications were under QA/QC, and the final data should be sought from the specific survey.

Longfin Smelt

Adult Longfin Smelt Protections SWP includes protections for adult longfin smelt from the onset of OMR management through February 28 (ITP COA 8.4.1). However, during WY 2023, the SMT did not make recommendations for OMR management based on COA 8.4.1. The opportunity for 8.4.1 to be activated off-ramped on December 20, 2022, prior to the onset of OMR management, with the detection of longfin smelt larvae in the December Smelt Larva Survey #12 (ITP COA 7.6.1).

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 20mm) reach thresholds for detection of longfin smelt larvae and juveniles, DWR implements ITP COA 8.4.2. During WY 2023, COA 8.4.2 distribution and/or density triggers were exceeded in SLS surveys #4 and #5 (Figure 19) The 20-mm survey did not trigger any protections, with one single larval longfin smelt detected at a south and central Delta station (#901) in 2023. Following SLS #4, a turbidity bridge formed in the south Delta, restricting exports to no more negative than -2,000 cfs. The SMT was unable to reach a consensus on recommended operations should the turbidity bridge be resolved, and the issue was elevated to WOMT. On February 17, 2023, state agencies agreed to operate to the SWP's proportional share for an OMR index no more negative than -3,500 cfs should turbidities fall below 12 FNU. The turbidity bridge resolved the next day and operations were limited to the SWP share of an OMR index no more negative than -3,500 for seven consecutive days, February 18 – 24, 2023. At the February 28 meeting, the SMT was unable to reach a consensus on recommended operations due to uncertainty interpreting results from the PTM and the issue was elevated to WOMT. High flows on the San Joaquin River at Vernalis (COA 8.4.3) exceeded 8,000 cfs on March 2, 2023, and off-ramped larval and juvenile longfin smelt protections through the end of June.

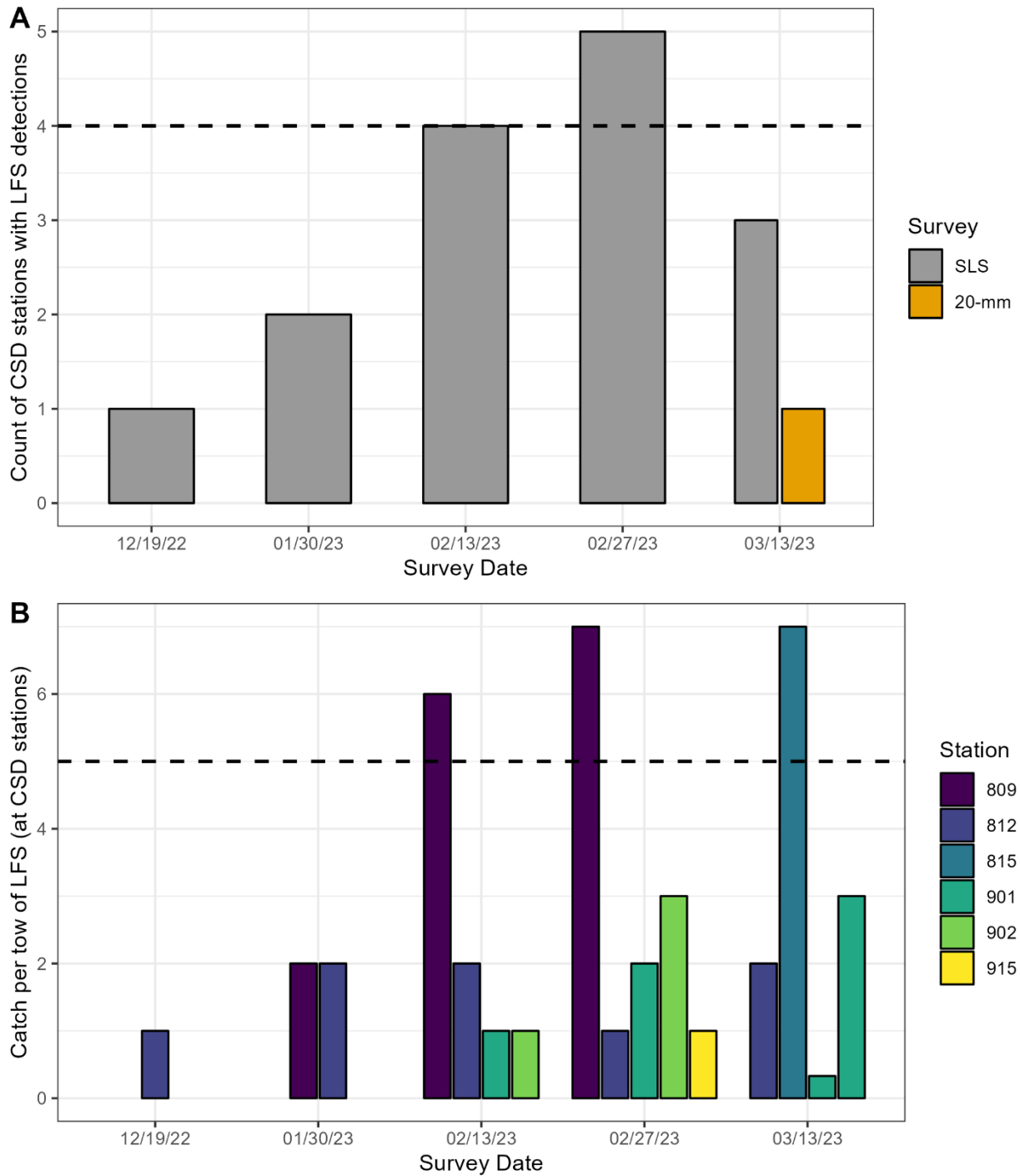


Figure 19. A. Number of Central and South Delta (CSD) stations with longfin smelt detections from the Smelt Larva Survey (SLS) and 20mm Survey (20-mm), and B. catch per tow of longfin smelt at the 12 CSD stations (809, 812, 815, 901, 902, 906, 910, 912, 914, 915, 918, and 919). The black dashed lines 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

20mm). Duplicate bars are present where survey seasons overlapped (week of March 13, 2023). 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 July 11, 2023.

Larval and Juvenile Longfin Smelt Detections During WY 2023, larval longfin smelt sampling started on December 5, 2022, in compliance with ITP COA 7.6.1, which directed DWR to fund additional Smelt Larva Surveys (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, a further 16 stations were added to SLS and 20mm to better sample larval longfin smelt in Carquinez Strait and San Pablo Bay.

The December WY2023 sampling detected larval longfin smelt starting on December 6, 2022, highlighting the potential that the initiation of hatching may have been missed in previous years. Throughout the WY 2023 longfin smelt spawning season, the majority of larvae and juveniles detected in regular monitoring were at downstream stations, with the Napa River being the most prevalent region for catch, followed by Suisun Bay and West (Figure 20). No larval longfin were detected in qualitative larval sampling, in contrast with recent years. Regular larval and juvenile fish monitoring detected the lowest numbers of longfin smelt catch in the Central and South Delta, compared with other regions of the estuary (Figure 20). April saw the highest catches of larval longfin smelt in regular monitoring (n=6,627), with March (n=3,356) and May (n=2,115) having the second and third highest catch, respectively.

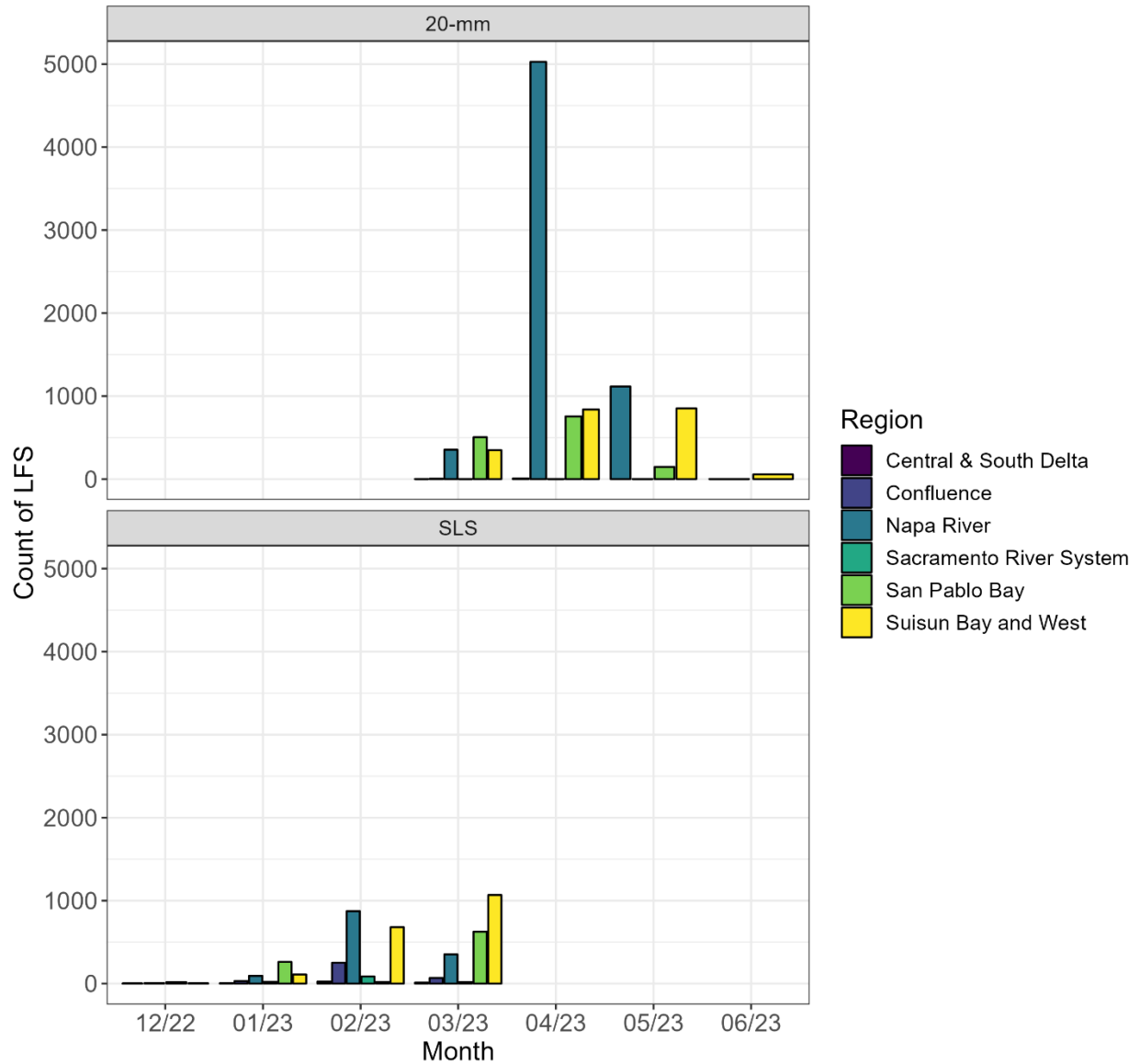


Figure 20. Catch of larval longfin smelt in the Smelt Larva Survey and 20mm Survey during WY 2023 sampling. SLS includes completed end-of-year QAQC data. 20-mm samples are still being processed and end-of-year data validation is pending. Data displayed here are the most up-to-date available as of July 11, 2023.

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 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 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:

- January 1 – January 31: 0.00635% of the winter-run Chinook salmon JPE (3.17)
- February 1 – February 28: 0.00991% of the winter-run Chinook salmon JPE (4.95)
- March 1 - March 31: 0.0146% of the winter-run Chinook salmon JPE (7.29)
- April 1 -April 30: 0.00507% of the winter-run Chinook salmon JPE (2.53)
- May 1 - May 31: 0.0077% of the winter-run Chinook salmon JPE (3.84)

COA 8.6.2 COA 8.6.3 Exceedance of a daily threshold requires restriction of south Delta exports for five days to achieve a five-day average OMR index no more negative than -5,000 cfs for Early-season thresholds (COA 8.6.2), and -3,500 cfs for Mid- and Late-season thresholds (COA 8.6.3). The proportional share applies to DWR daily threshold triggers that occurred before the adoption of the IOP on February 28, 2023. In WY 2023, daily loss thresholds were triggered multiple days for winter-run Chinook salmon in January, February, March and April. The daily loss thresholds were triggered on the following dates: January 1, 2023, January 2, 2023, January 4, 2023, January 5, 2023, January 6, 2023, January 12, 2023, January 17, 2023, January 29, 2023, February 28, 2023, March 8, 2023, April 3, 2023, April 12, 2023, and April 25, 2023. ITP COA 8.6.3 trigger notifications were based on the classification of salvaged winter-run according to the LAD chart used at both SWP and CVP fish facilities. However, effective from January 20, 2023, CDFW the SWP ITP COA 8.6.3 was amended in response to an unexpected error in adipose fin clipping and coded-wire tagging of hatchery produced late-fall run Chinook salmon from the Coleman National Fish Hatchery released in Battle Creek in December 2022. Because these fish were expected to fall within the older juvenile size classification, they could have been mistakenly identified as natural origin older juvenile Chinook Salmon if observed in salvage. Therefore, use genetic analysis by Cramer Fish Sciences to indicate whether or not a salvaged LAD winter-run was a true winter-run was the most appropriate tool to identify natural origin winter-run Chinook salmon given the unexpected error in hatchery operations for WY 2023. COA 8.6.3 was initially be triggered by a LAD winter-run; however, if genetic analysis determined that a daily threshold trigger was not exceeded by a true winter-run, then COA 8.6.3 was off ramped. After the SWP ITP amendment went into effect, COA 8.6.3 was not exceeded due to no LAD winter-run being genetically confirmed as true winter-run.

Single Year Loss The ROD and ITP COA 8.6.1 set the same single-year threshold loss values for natural and hatchery winter-run Chinook salmon. These values are calculated as 1.17% of the JPE for natural origin winter-run Chinook salmon, which was loss of 584.11 for WY 2023, and 0.12% of the JPE for the Sacramento hatchery production group, which was loss of 229.15 for WY 2023. The incidental take limit for the Battle Creek hatchery winter-run Chinook salmon release is 1% of the Battle Creek release JPE, equal to loss of 40 fish. However, the SWP ITP does not include Battle Creek releases as a threshold for ITP COA 8.6.1.

Combined LAD natural winter-run Chinook salmon loss for WY 2023, (October 1, 2022 – June 30, 2023) was 109.88 fish. This loss equaled 18.8% of the single-year loss threshold. Total loss of hatchery winter-run Chinook salmon was 0 fish for the Sacramento River release and 0 fish from the Battle Creek release. In WY 2023, neither LAD natural winter-run Chinook salmon (Figure 21) nor the hatchery winter-run Chinook salmon single-year loss threshold was triggered.

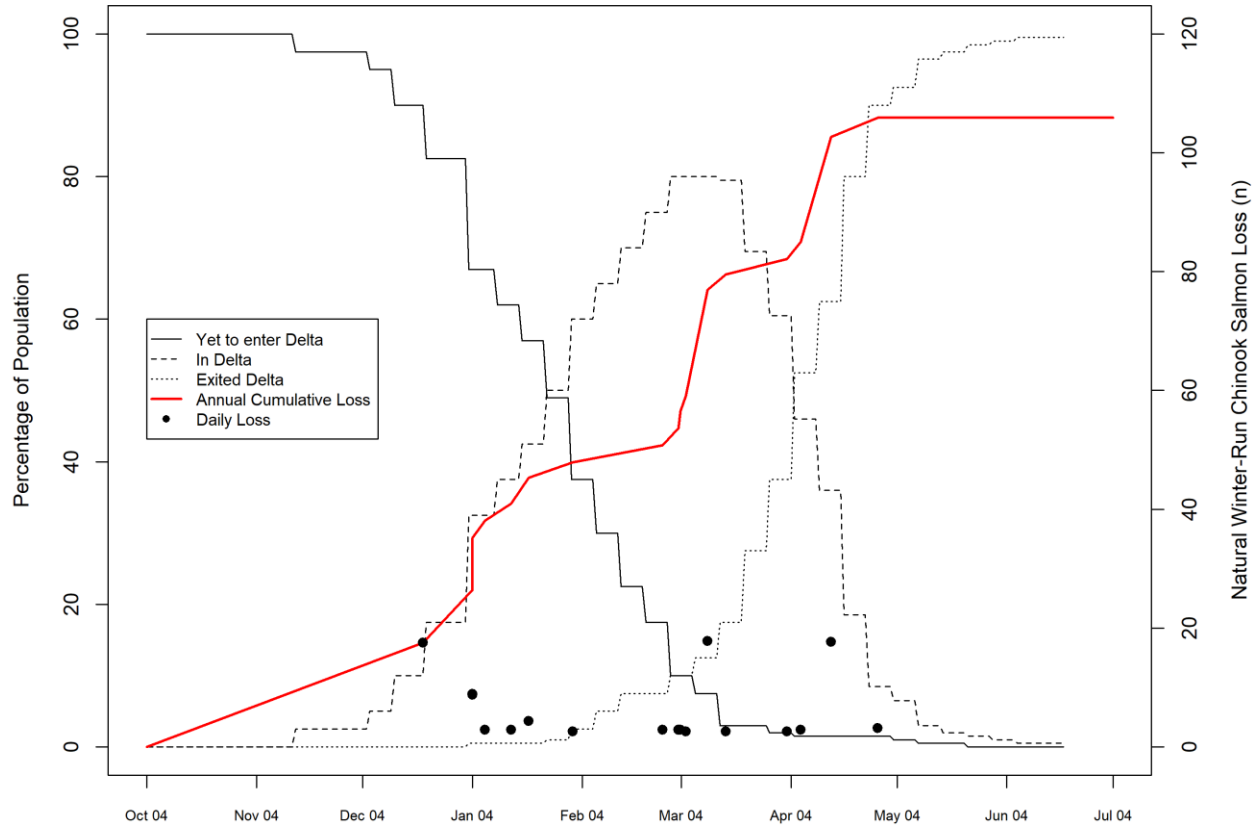


Figure 21. Combined loss of natural LAD winter-run size Chinook salmon in WY 2023 (31% occurred at SWP, 75% occurred at CVP) plotted along SaMT distribution estimates.

Figure 21 is a line graph showing a percent of population on the left axis for distribution estimates of yet to enter Delta, in Delta, and exited Delta of natural LAD winter-run size Chinook salmon. The graph shows the fish begin to enter the Delta in November 2022 and begin exiting in March 2023. The graph also shows annual cumulative loss of over 100 peaking in June 2023.

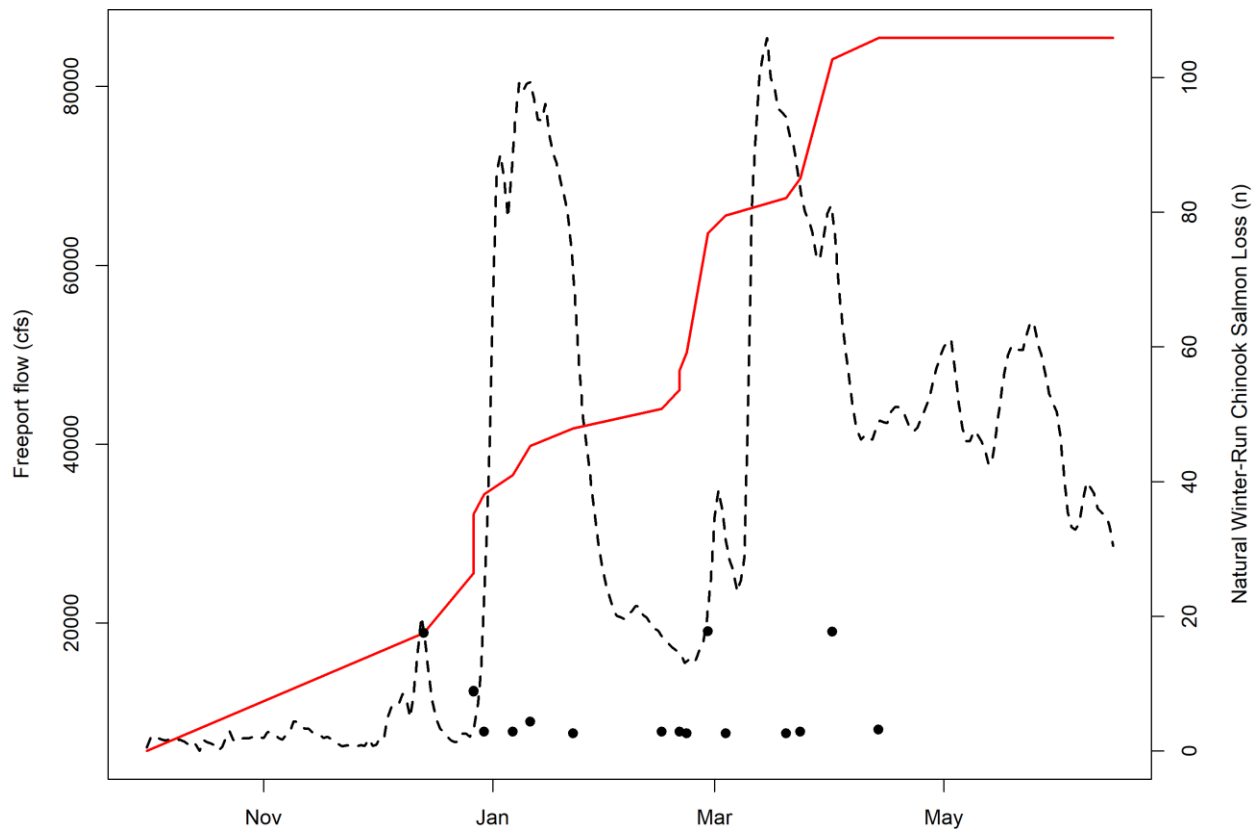


Figure 22. Freeport flows (cfs, black dotted line), cumulative (red solid line), and daily (points) natural winter-run size Chinook salmon loss at the CVP and SWP fish salvage facilities for WY 2023.

Cumulative Loss The cumulative loss threshold for natural 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 370.25 fish, or 4.2% of the threshold. The cumulative loss threshold for hatchery winter-run Chinook salmon over the duration of the ROD and the ITP is 5,356 fish. Total cumulative loss to date of hatchery winter-run Chinook salmon over the duration of the ROD is 6.71 fish, or 0.13% of the threshold. Neither cumulative loss thresholds were triggered in WY 2023.

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 is 1% of each release group (Section

13.3.5.3). During WY 2023, three groups of brood year 2022 late-fall-run Chinook salmon were released into Battle Creek from the Coleman National Fish Hatchery. The first group of 71,057 fish was released on December 5, 2022 (loss threshold = 710.6). The second group of 66,735 fish was released on December 23, 2022 (loss threshold = 667.4). The third group of 60,712 fish was released on January 13, 2023 (loss threshold = 607.2). Combined loss for WY 2023 was 161.93 fish (22.8% of the loss threshold) for the first release group, 141.26 fish (21.2% of loss threshold) for the second release group, and 32.05 for the third release group (5.3% of the loss threshold). Therefore, during WY 2023 no spring-run Chinook salmon surrogate loss thresholds were exceeded, and no OMR restrictive action was required (Table 3).

Table 3. Confirmed hatchery (adipose-fin clipped and marked with CWT) spring-run yearling surrogate Chinook salmon lost at the SWP and CVP for WY 2023.

Release Date	CWT Race	Hatchery	Release Site	Release Type	Loss	CWT Number Released	% CWT Marked of Total Number Released	% Loss CWT number released	First Loss	Last Loss
12/5/2022	Late-Fall	Coleman National Fish Hatchery	Battle Creek	Spring Surrogate	161.93	71,057	100.0	0.228	2022-12-29	2023-01-05
12/23/2022	Late-Fall	Coleman National Fish Hatchery	Battle Creek	Spring Surrogate	141.26	66,735	100.0	0.210	2023-01-05	2023-01-14
1/13/2023	Late-Fall	Coleman National Fish Hatchery	Battle Creek	Spring Surrogate	32.05	60,712	100.0	0.053	2023-02-07	2023-03-01

ITP 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 (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. Six surrogate release groups of YOY spring-run or fall-run hatchery 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 2023. No fish from any of these release groups were detected at the export facilities; therefore, annual cumulative loss thresholds were not 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 4.

Table 4. Confirmed SWP and CVP Spring-run Chinook Salmon sub-yearling surrogate loss for WY 2023.

Release Date	CWT Race	Hatchery	Release Site	CWT Number Released	Loss Limit	Total Season Loss
3/16/23	Spring	Feather	Feather River	731,457	1828.64	0
3/24/23	Spring	Feather	Feather River	728,586	1821.47	0
3/29/23	Fall	Coleman	Battle Creek	400,897	1002.24	0
4/11/23	Spring	Feather	Feather River	881,880	2204.7	0
4/24/23	Fall	Coleman	Battle Creek	2,348,768	5871.92	0
5/16/23	Fall	Nimbus	American River	213,847	534.62	0

Steelhead

A total of 1,015 natural steelhead were lost for the December 1-March 31 period of WY 2023. This loss was 71.8% of the December 1-March 31 single-year loss threshold which was 1,414

fish. Over the duration of the ROD, to date total cumulative loss of natural steelhead between December and March is 1,576 fish, which is 26.1% of the cumulative loss threshold of 6,038 fish (Figure 23). From April 1-June 15, an estimated total of 408 natural steelhead were lost. This loss was 26.3% of the single-year loss threshold of 1,552 fish. Over the duration of the ROD to date, total cumulative loss of natural steelhead from April 1-June 15 is 1,012.5 fish, which is 17.4% of the cumulative loss threshold of 5,826 fish (Figure 23). The 50% single year loss threshold for the December 1-March 31 period was exceeded on March 15, 2023; however, OMR was largely positive after this exceedance and the steelhead loss threshold was reset shortly after for the April-June period. Therefore, export reductions were not necessary.

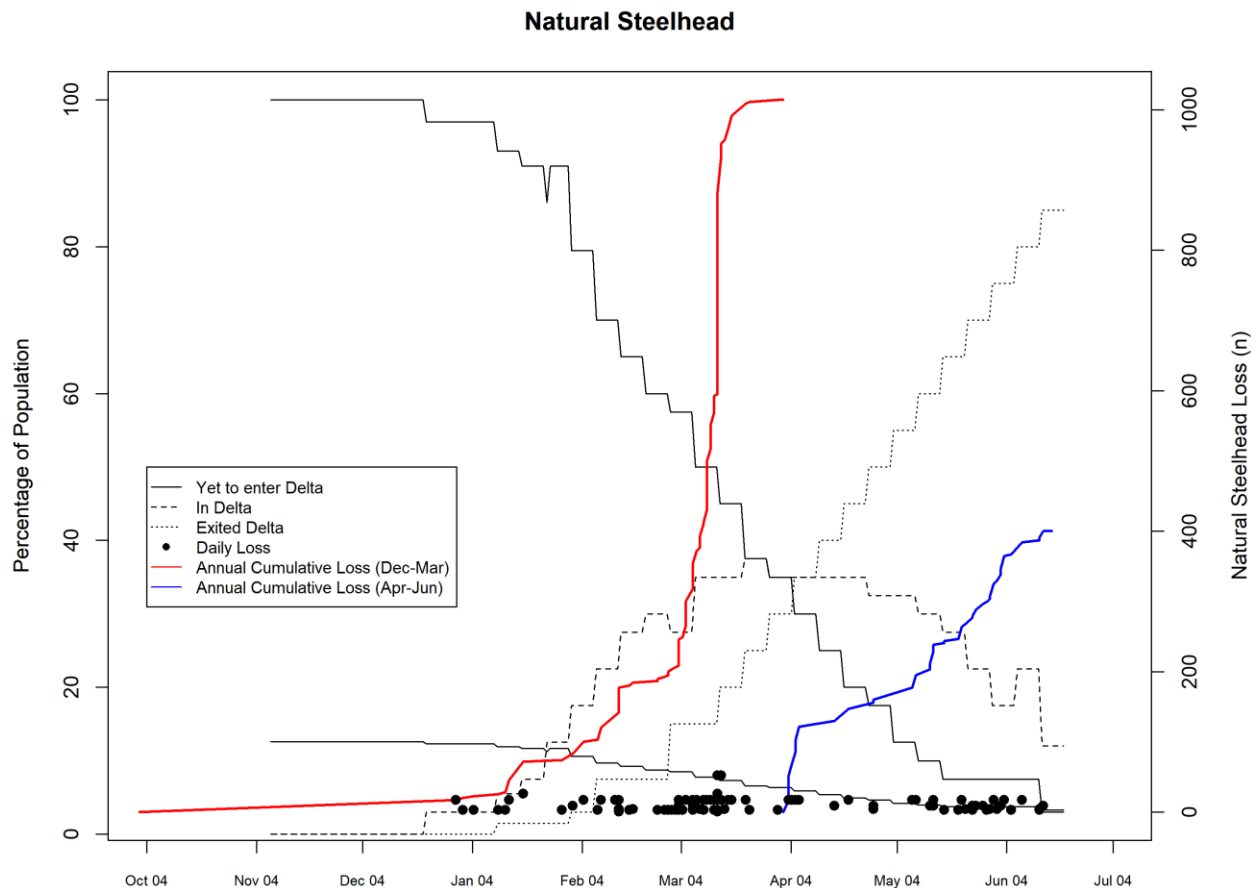


Figure 23. Estimated combined loss of natural steelhead for WY 2023 (December-March: 92.2% at SWP, 7.8% at CVP; April-June: 95.2% at SWP, 4.8% at CVP).

Figure 23 is a line graph showing a percent of population on the left axis for distribution estimates of yet to enter Delta, in Delta, and exited Delta of natural steelhead. The graph shows the fish begin to enter the Delta in December 2022 and begin exiting in January 2023. The graph also shows an annual cumulative loss of over 1000 and 400 for December to March and April to June, respectively.

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 2023 Reclamation and DWR did not use this flexibility.

End of OMR Management CCF monitoring station (CLC) criterion for Delta smelt and longfin smelt was not met, thus OMR management season for these species ended on June 30, 2023 (Figure 24). OMR flow management season for steelhead ended on June 15, 2023. SaMT estimated that more than 95% of YOY natural winter-run and YOY natural spring-run Chinook salmon had exited the Delta by June 27, 2023; however, daily average water temperature at Mossdale and Prisoners Point did not meet offramp criteria for Chinook salmon (Figure 24). As such, the OMR management season for salmonids ended on June 30, 2023.

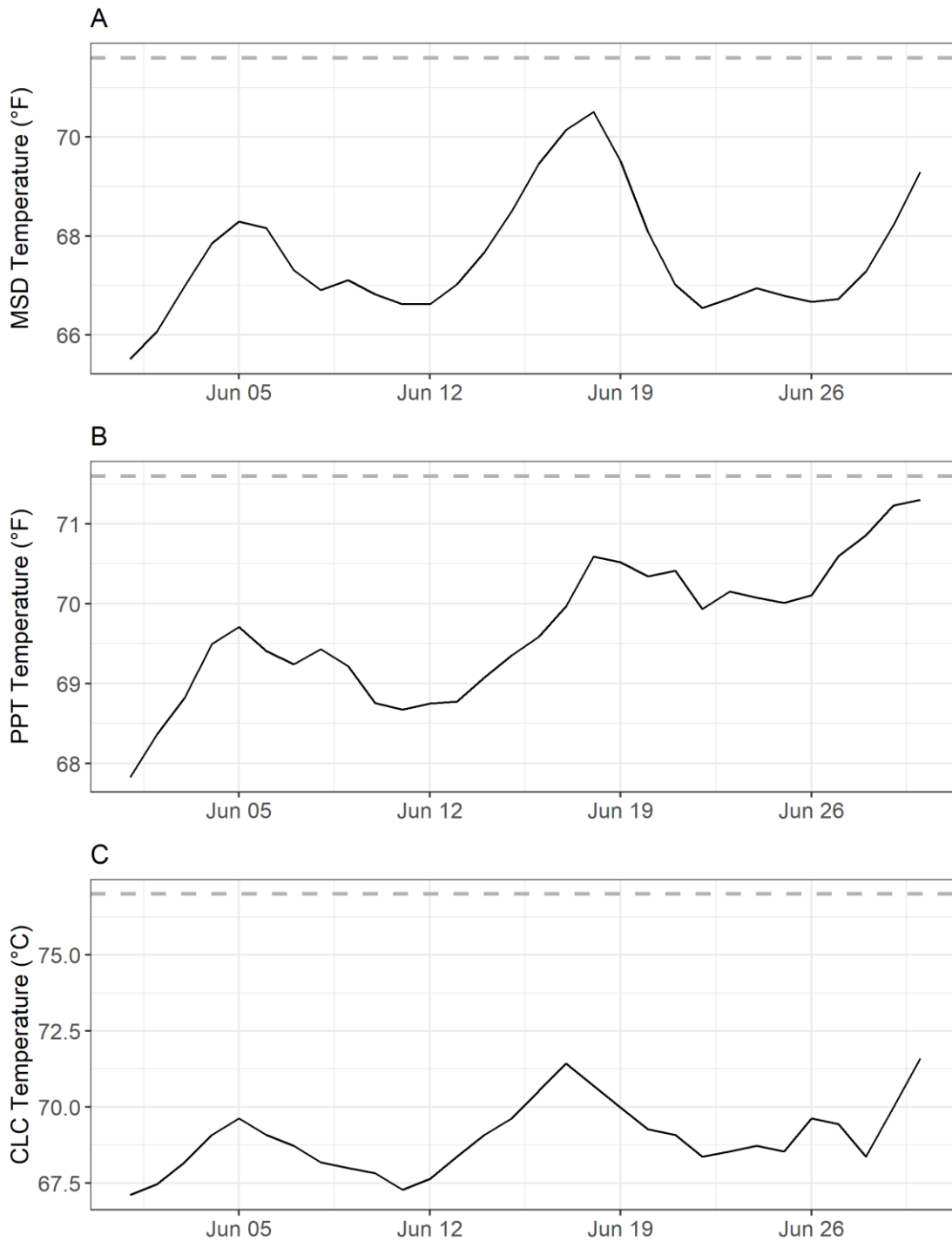


Figure 24. Average daily temperatures (°F) at stations: A) Mossdale (MSD), B) Prisoners Point (PPT), and Clifton Court Forebay (CLC) in June 2023. Dashed lines indicate 71.6 °F thresholds for MSD and PPT and 77°F (25°C) threshold for CLC.

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Export Curtailments for Spring Outflow

Export curtailments 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 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 2023, the BBID diversion varied daily, but the monthly average was approximately 22 cfs/day in April and 40 cfs/day in May.

The ITP issued by the CDFW (ITP COA 8.17) for SWP operations specifies that “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 WR type “In an above normal or wet year, the ratio of Vernalis flow to CVP and SWP combined exports shall be 4 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 4 to 1 inflow to export ratio. On April 1, 2023, , the WR was forecasted to be a wet WR, which would require a Vernalis flow to export ratio of 4:1. However,, the three-day average NDOI did not go below 44,500 for the entire April through May period. As a result, exports were not curtailed in the April and May of 2023 in relation to ITP COA 8.17.

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Issues Elevated in WY 2023

The SMT failed to reach a consensus on a few items in January and February 2023 and elevated these issues to WOMT. The SaMT did not elevate any issues to WOMT during WY 2023. Recommendations to WOMT made under COA 8.4.2 and 8.5.1 are also discussed in “Additional Real-time OMR Restrictions and Performance Objectives.”

January 19: The agencies did not reach consensus on what OMR target was deemed protective for Delta smelt for Turbidity Bridge Avoidance Action (OMRI of -2,000 cfs or -3,500 cfs). WOMT decided to move forward with -3,500 cfs.

January 24: The agencies did not reach consensus on what OMR target was deemed protective for Delta smelt for Turbidity Bridge Avoidance Action (OMRI between -2,000 to -5,000 cfs). WOMT decided to move forward with -5,000 cfs.

February 14: Reclamation and USFWS needed clarification on ripe female offramp as ripe females were detected from releases. They received clarification that offramp conditions were met.

February 17: 8.4.2 triggered risk assessment by SMT, state agencies did not reach consensus on protective flows for longfin smelt should the turbidity bridge resolve prior to the following meeting. However, at WOMT, the CDFW and the DWR agreed to operate to a -3,500 OMR over the weekend, in the event that turbidity at OBI dropped below 12 FNU, with a reassessment planned for the following SMT meeting on February 21.

February 19: Agreement that turbidity event was not isolated. No recommendation on turbidity from Federal agencies.

February 24: State agencies did not reach consensus on duration of -3,500 OMR index under 8.4.2 for larval and juvenile longfin smelt (7 days or no end point) - decision was 7 days, ending February 22, 2023.

February 28: The Agencies did not reach consensus on what OMR target is deemed protective for larval and juvenile longfin smelt under ITP 8.4.2 (-2,000 or -5,000 cfs). Longfin protections were off-ramped due to high flows under 8.4.3; flows exceeded 8,000 cfs on the San Joaquin River near Vernalis on March 2, 2023.

WOMT members did not elevate any OMR flow management concerns to the directors during WY 2023 (See Supporting Information Sections).

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Performance

Delta Cross Channel Gate Closures

For winter-run Chinook salmon, Figure 4 shows the KLCI and the SCI seine data from October 1, 2022, through July 1, 2023. During WY 2023, KLCI and SCI values did not trigger any DCC gate closures prior to December 1, 2022, 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 December 1, 2022, for the rest of the OMR flow management season during WY 2023. 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

Twelve marked and one unmarked adult/sub-adult Delta smelt were salvaged between February 8, 2023, and March 2, 2023, during the OMR flow management season, resulting in an expanded salvage of fifty-two. Eight of the thirteen fish came from January releases in Rio Vista. Notably, two of the fish released in the Deep Water Ship Channel were salvaged at the TFCF and the Skinner Delta Fish Protection Facility. No juvenile or larval Delta smelt were salvaged during the OMR flow management season. CVP and SWP operations do not distinguish between wild and cultured Delta smelt for salvage-based thresholds.

Qualitative Larval Sampling

Larval Delta smelt sampling methods began at the CVP and SWP on March 1, 2023. No larval Delta smelt were detected at the TFCF or the Skinner Delta Fish Protection Facility during WY 2023. The TFCF and the Skinner Delta Fish Protection Facility ended larval sampling methods on June 6, 2023.

Longfin Smelt Salvage

Adult and Juvenile Salvage

A total of 26 age 1+ longfin smelt, 14 adults (fork length ≥ 84 mm) and 12 sub-adults (fork length < 84 mm), were detected in salvage in WY 2023 (Figure 25). The first adult longfin was detected at the CVP fish salvage facility on January 1, 2023, and the last adult longfin salvaged in WY

2023 was detected at the SWP on March 2, 2023. Zero juvenile longfin smelt were detected at either facility in WY 2023.

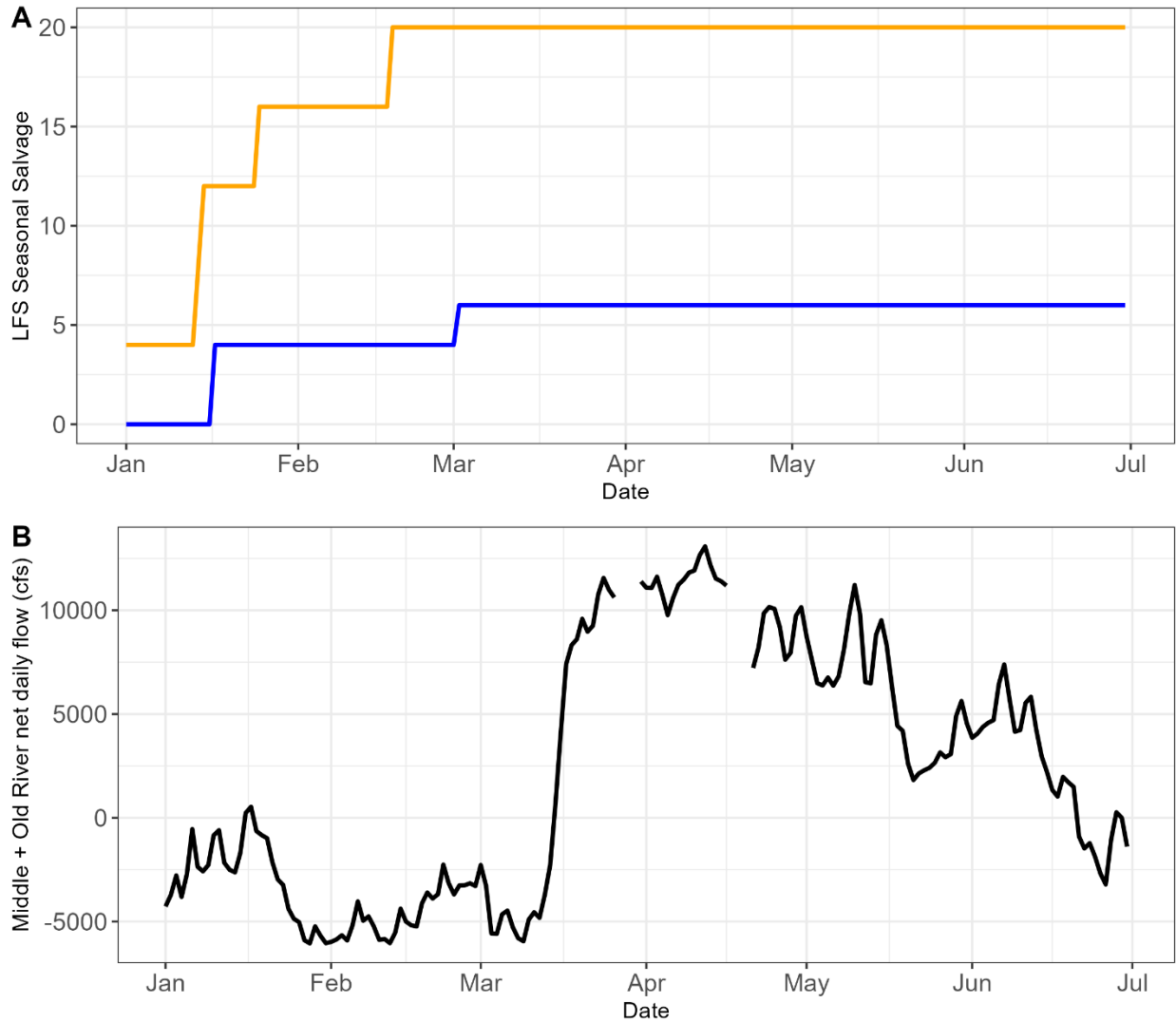


Figure 25. A) Cumulative longfin smelt seasonal salvage for SWP (blue line) and CVP (orange line). B) Corresponding Middle plus Old River net daily flow.

Qualitative Larval Sampling

Longfin smelt qualitative larval sampling began at both the SWP and CVP on March 1, 2023. In contrast with recent years, zero larval longfin smelt or Delta smelt (<20mm) were detected at either the CVP or SWP. This lack of detection was likely due to favorable hydrology. The TFCF and the Skinner Delta Fish Protection Facility ended larval sampling methods on June 6, 2023.

Winter-run Chinook Salmon

Daily Loss

The Early-Season Natural Winter-run Chinook Salmon Discrete Daily Loss Threshold (COA 8.6.2) was not met in November and December of 2022. The Mid and Late Season Natural winter-run Chinook salmon Daily Loss Threshold (COA 8.6.3) was triggered multiple times from January through April for winter-run Chinook salmon as the loss threshold were relatively low this season due to the low JPE (see previous sections). A single LAD winter-run Chinook salmon, sampled on February 23, 2023, was confirmed as a true winter-run Chinook salmon based on genetic analysis. This event did not require alteration of water operations because other requirements in the Delta were more restrictive.

Single Year Loss

Total LAD natural winter-run Chinook salmon loss for WY 2023 (October 1, 2022, through June 30, 2023) was 109.88 fish which represents 18.8% of the single-year loss threshold (584.11 fish) (Figure 26). Zero hatchery winter-run Chinook salmon were salvaged in WY 2023. As such, neither the natural or hatchery winter-run Chinook salmon single-year loss threshold was triggered in WY 2023. Weekly plots were produced through SacPAS, which incorporate both current and historic loss data: current cumulative WY 2023 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 2023, all loss of LAD natural winter-run Chinook salmon salvage occurred between December 18, 2022, and April 25, 2023, according to LAD criteria. One genetic winter-run Chinook salmon was salvaged at the fish salvage facilities in WY 2023; this fish was sampled at the CVP facility on February 23, 2023.

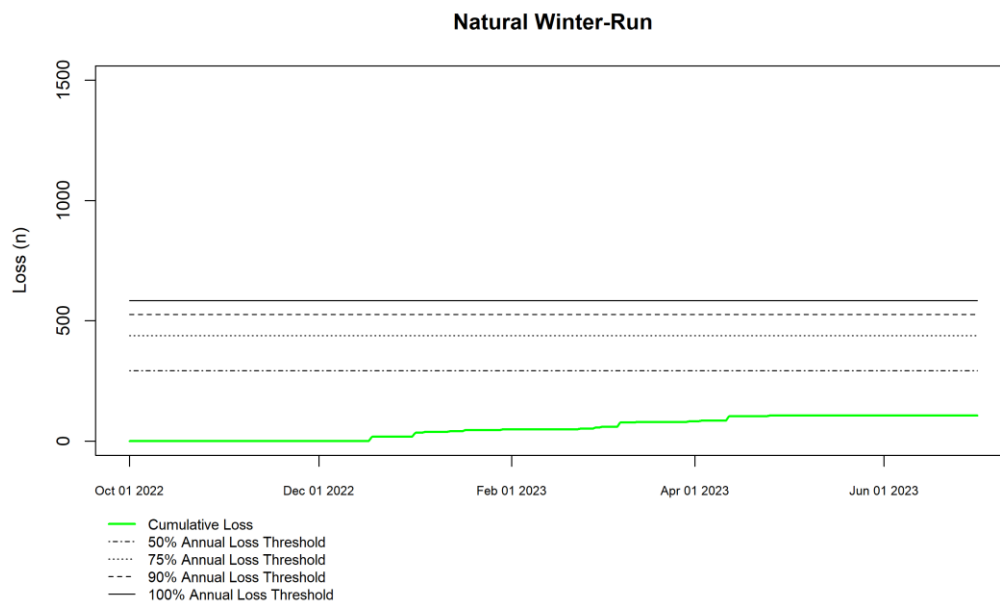


Figure 26. Total natural winter-run Chinook salmon (LAD) loss for WY 2023.

Figure 26 is a line graph showing the cumulative, 50%, 75%, 90%, and 100% annual loss threshold for natural winter-run Chinook salmon October 2022 to June 2023. The graph shows the cumulative loss is much lower than the 50% annual loss threshold.

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 2023, cumulative loss (calculated here as total since February 19, 2020) is 4.2% of total loss limit over the duration of the ROD (Figure 27).

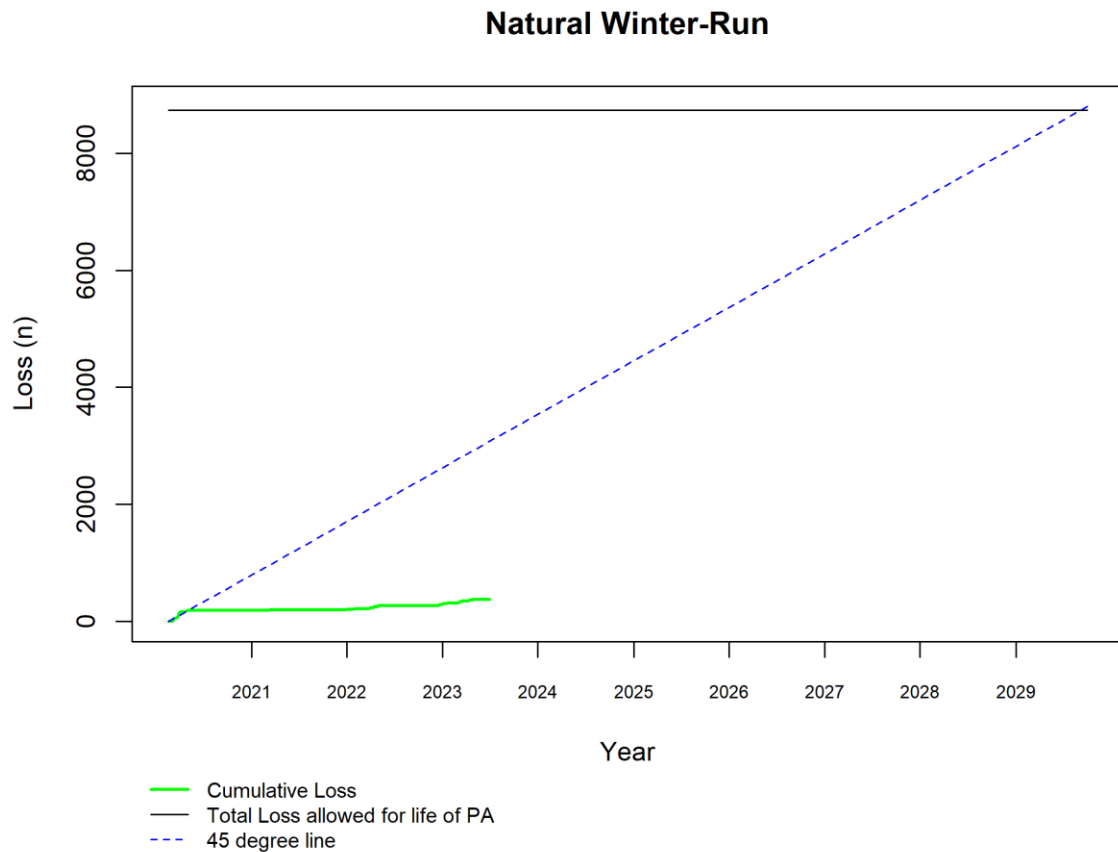


Figure 27. Cumulative loss threshold for natural winter-run Chinook salmon up to WY 2023. A 45-degree line is superimposed to track the trajectory of natural winter-run Chinook salmon loss over the duration of the ROD if we are to assume that each year’s loss is equal.

Steelhead

Combined loss of natural steelhead was 1015.16 fish for the “December 1 through March 31” period, which represents 71.8% of the single-year loss threshold (1,414 fish). Combined loss of natural steelhead for WY 2023 was 408.24 for the “April 1 through June 15” period, which

represents 26.3% of the single-year loss threshold (1,552 fish). On March 28, 2023, the SaMT estimated the distribution of natural steelhead within the Delta to be 25-45%, and distribution of natural steelhead that had exited past Chipps Island to be 25-35%. Similar to previous WRs, December-March steelhead loss was higher than April-June loss in WY 2023 (Figure 28).

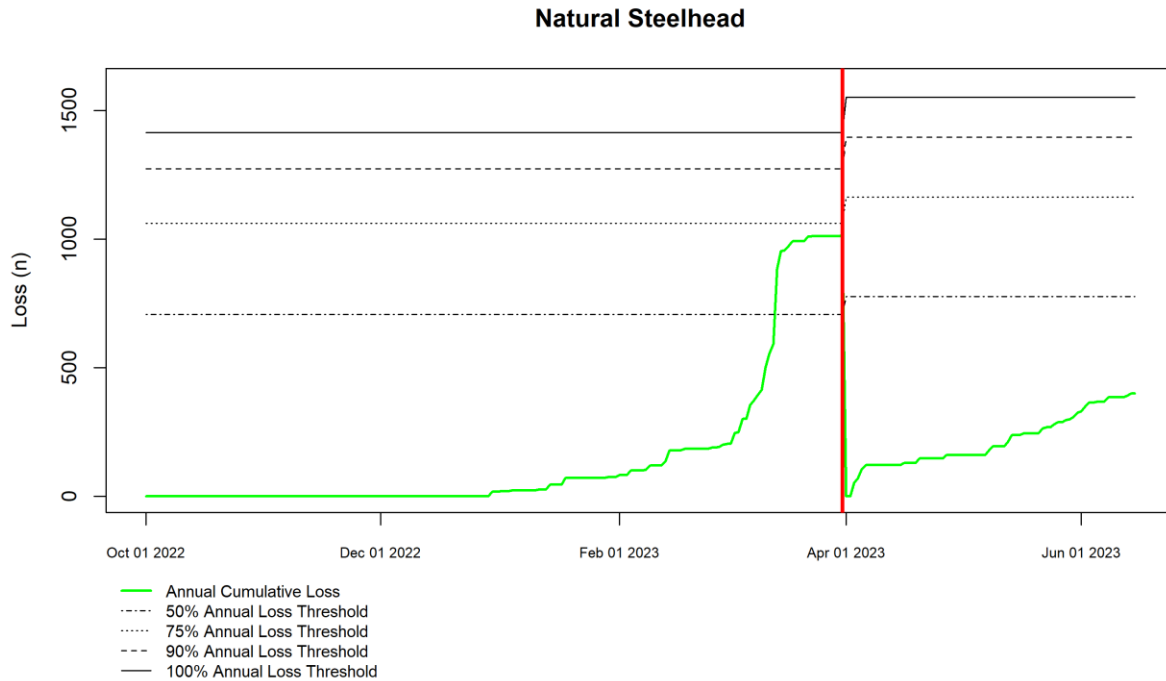


Figure 28. Trajectory of the annual cumulative loss for natural steelhead for WY 2023 for the two time periods (December-March, April-June), with their respective annual loss thresholds.

Figure 28 is a line graph showing the annual cumulative loss December to March exceeds the 50% annual loss threshold of 750 natural steelhead.

At the end of the WY 2023 OMR flow management season, the loss for the first four “seasons” is 26.1% of the 10-year duration cumulative total loss for this December-March period. A total of 408.24 natural steelhead fish were lost in WY 2023 from April 1, 2023, to June 15, 2023. At the end of WY 2023, the loss for the first three “seasons” is 17.4% of the cumulative total loss for this April-June period (Figure 29).

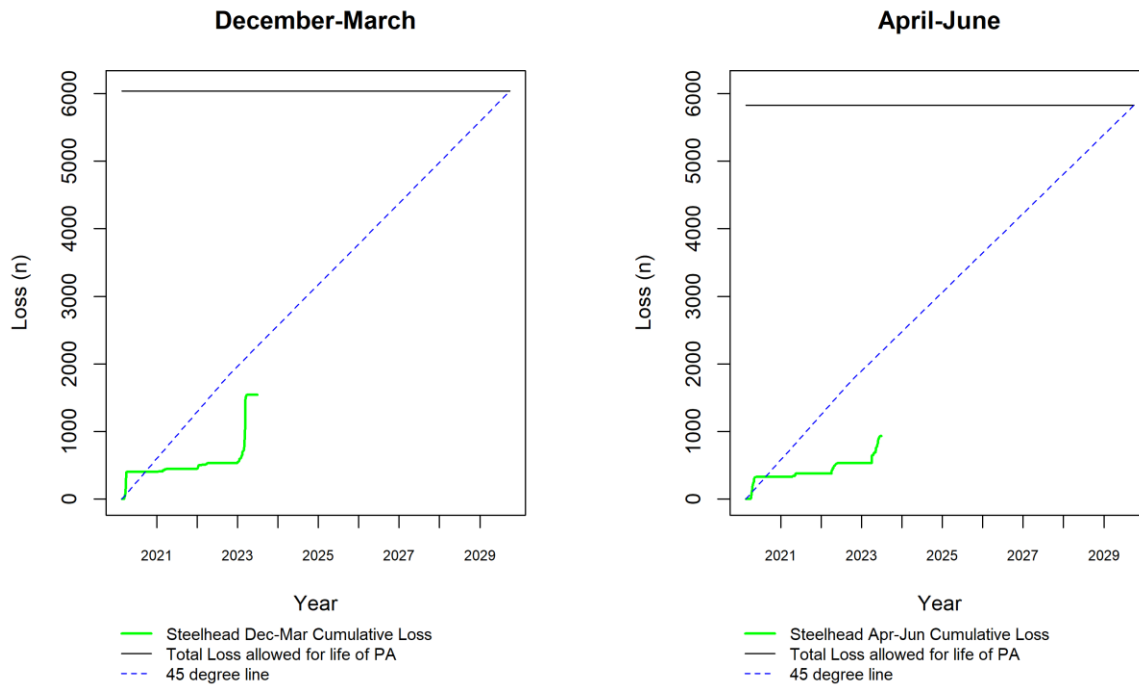


Figure 29. Cumulative loss for natural steelhead for December 1 – March 31 and April 1 and June 15. 45-degree lines are superimposed to track the trajectories of natural steelhead loss over the duration of the ROD, assuming each year’s natural steelhead loss is equal.

Salmonids and Historic Performance

Historic natural 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 2023, the majority of loss occurred in the month of January.

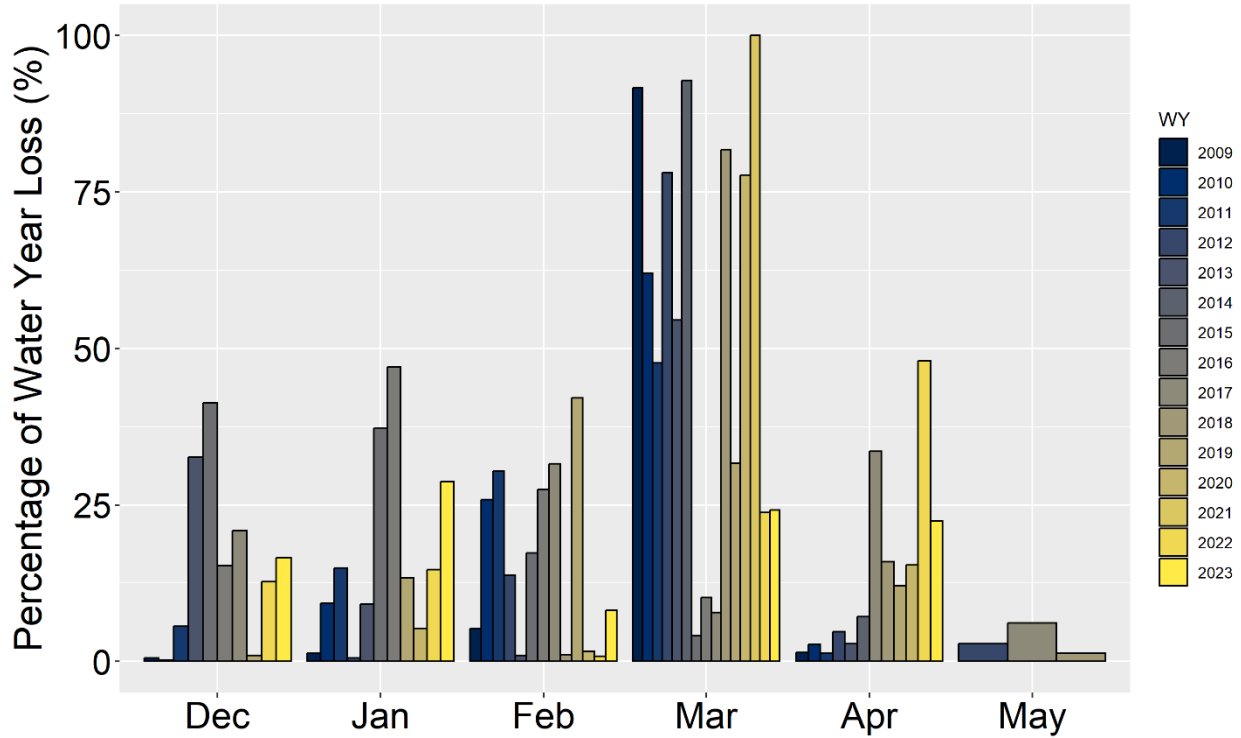


Figure 30. Historic natural winter-run Chinook salmon (LAD) loss by month by WY (2009 - 2023).

Figure 30 is a bar graph showing a majority of the percentage of loss for a water year occurs in March with the exception of water years 2015, 216, and 2017.

Historic natural steelhead loss by season and water year is shown in Figure 31, 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 9 of the last 15 years (2009 – 2023).

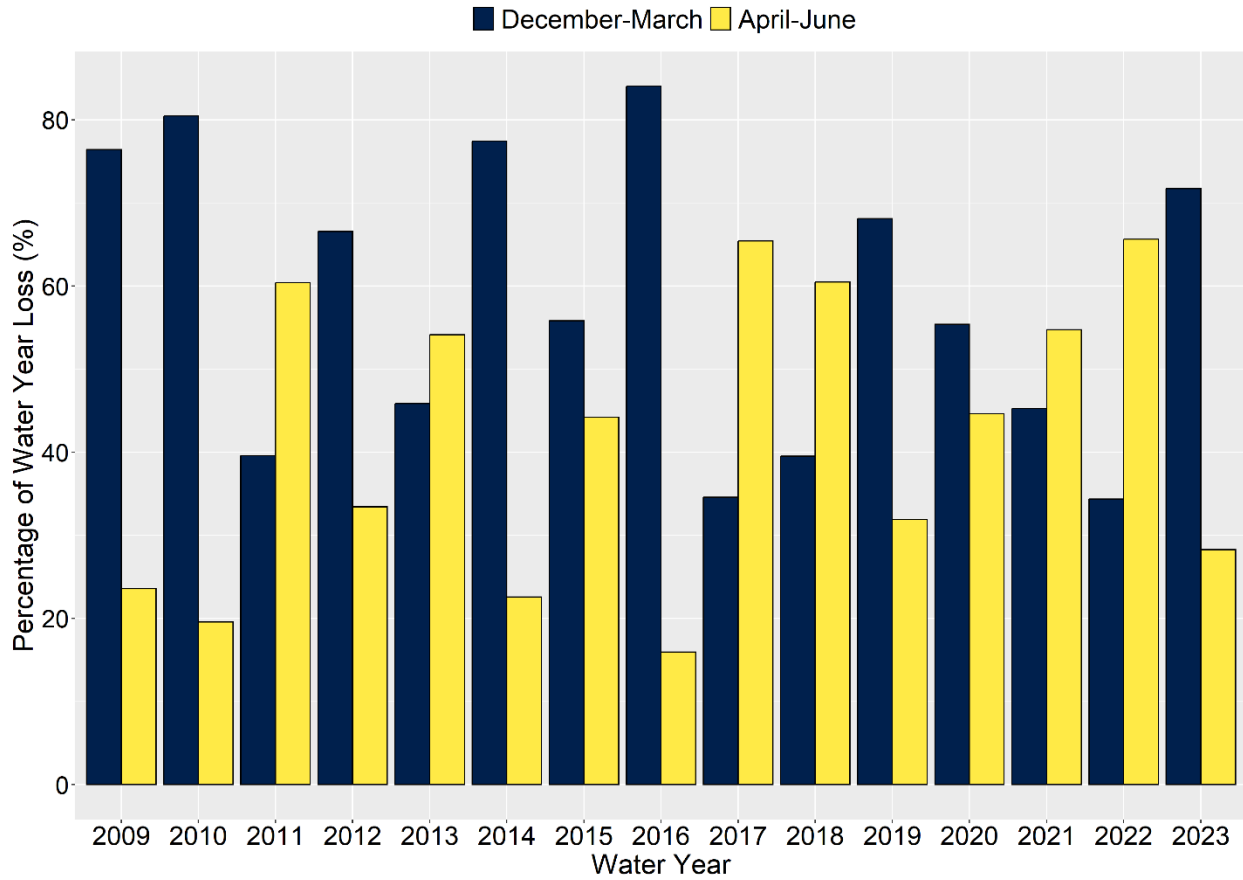


Figure 31. Historic natural steelhead loss by action period “season” (December 1 – March 31, April 1 – June 15) by water year (2009 – 2023). Loss shown as percentage of combined loss per water year.

Discussion

Delta Cross Channel

Out-migrating Sacramento River Basin origin salmonids traveling downstream through the Sacramento River have the potential to encounter the junction with the DCC gates. When the DCC gates are open, salmonids are vulnerable to entrainment into the interior Delta and potentially farther into the South Delta. Survival within the South Delta, as estimated from tagged fish studies, is less than survival through the Sacramento River to Chipps Island. Throughout the WY 2023 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 2023, the first natural winter-run Chinook salmon was observed at Knights Landing on December 13, 2022, and the last on March 7, 2023. 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 2022, and the seasonal closure starting November 28, 2022, provided a high level of protection for juvenile salmonids out-migrating down the Sacramento River.

Integrated Early Winter Pulse Protection (“First Flush”)

During the IEWPP, the turbidity field was widespread, reaching the Central and South Delta (Figure 9, Figure 15). High flow and high turbidity conditions continued past IEWPP, with 3-day average Freeport flows decreasing below 25,000 cfs after January 31, 2023, and 3-day average Freeport turbidity decreasing below 50 FNU after January 27, 2023. When turbidity of more than 12 FNU is present in Old and Middle rivers, adult Delta smelt may be more likely to move into these channels and become entrained (Grimaldo et al 2009). During the IEWPP one marked Delta smelt was salvaged at the TFCF.

Turbidity Bridge Avoidance (“South Delta Turbidity”)

Turbidity data at OBI is used to assess the formation of a turbidity bridge within the Old River corridor between the San Joaquin River shipping channel and the CVP and SWP fish salvage facilities. The turbidity threshold of 12 FNU was reached January 1, 2023 (during IEWPP) and lasted through February 8, 2023. Turbidity remained widespread through other parts of the Delta after February 8 and increased above 12 FNU at OBI several more times in February and March, including an extended period from March 17 until the end of the Turbidity Bridge Avoidance Action Period (Figure 15). The SMT recommended reductions in OMR index during these periods. Due to widespread turbidity, reductions in exports were not able to dissolve the turbidity bridge but were aimed at preventing further entrainment of Delta smelt into the South Delta.

Several adult Delta smelt salvage events occurred in February and early March, often right after turbidity cleared below 12 FNU at OBI.

Delta Smelt Protections

During the period of Larval and Juvenile Delta smelt protection, the SMT received daily salvage reports, the DWR Delta Turbidity Conditions Report, and available catch data each week to assess the likelihood of larval and juvenile entrainment. While adult Delta smelt were salvaged this season and larvae were expected to be in the South Delta and appear at the fish salvage facilities, no larval or juvenile Delta smelt were observed at either fish salvage facility, or in the Central or South Delta. Turbidity in the south Delta fluctuated between high and low through the larval and juvenile season, but due to high outflow, QWEST was positive from December 30 through June 30 (**Error! Reference source not found.**), and OMR index was positive between March 15 and June 24, thus protections were not controlling exports.

Longfin Smelt Protections

The first adult longfin smelt observed in salvage was detected on January 1, 2023, immediately after first flush conditions were met, so adult longfin smelt protections were not active in WY 2023. A total of 26 adult and sub-adult longfin smelt were observed in salvage in WY 2023. The last of these was observed on March 2, 2023.

In contrast to recent years, zero larval or juvenile longfin smelt were salvaged or observed through qualitative larval sampling at the CVP and SWP export facilities. A general downstream distribution of longfin smelt is to be expected during wet conditions experienced in 2023, 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 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

During the WY 2023 season, temperatures were cooler, thus the SMT agreed to delay the start of qualitative larval fish to March 1. 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

During WY 2023, a pilot larval smelt entrainment monitoring program (Larval Entrainment Pilot Study (LEPS), ITP COA 7.6.2) entered its second year of sampling in West Canal, near the

radial gates for CCF. Sampling was conducted by CDFW between 9am and 4pm from January through May 2023. A third gear type, using 900-micron mesh, was introduced to compare with SLS (early season), and 20mm (late season) gears. While data are not yet complete, CDFW and DWR plan to continue refining the study design and evaluating additional sampling methods, such as eDNA sampling, with the goal of improving our understanding of larval smelt entrainment into CCF.

Salmonid Presence-Based OMR Onramp and Offramp

OMR flow management season ended on June 30, 2023, for Chinook Salmon based on the date cutoff due to the relatively cool water temperatures and juvenile Chinook Salmon remaining in the Delta late into June. Note that steelhead OMR flow management season ended earlier, on June 15, 2023, as that is the date cutoff for the species. The last natural LAD winter-run Chinook salmon was salvaged on April 25, 2023. The last natural steelhead was salvaged on June 14, 2023. Salvage occurrences for steelhead were heavily skewed towards the December to March period with the vast majority of loss occurring at the SWP facility (December-March: 92.2% at SWP, 7.8% at CVP; April-June: 95.2% at SWP, 4.8% at CVP). During the OMR flow management season under the IOP, the December-March steelhead 50% annual loss threshold (707) was exceeded on March 15, 2023. The December-March steelhead 75% annual loss threshold was also nearly exceeded right before the April-June steelhead period started. For Chinook Salmon and April-June period for steelhead, losses stayed within the annual and cumulative limits described in the ROD as well as the annual take limits from the ITS in the NMFS Biological Opinion and limits set in the SWP ITP.

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 remained positive overall (i.e., above zero) from mid-March to late June, primarily due to wet conditions and snowmelt in this WY (Figure 6).

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 not met for winter-run and spring-run Chinook salmon by June 30, 2023 in WY 2023. The distribution estimates of greater than 95% for both natural YOY winter-run Chinook salmon and natural YOY spring-run Chinook salmon juveniles exited past Chipps Island was met on June 20, 2023.

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 2023 before the DCC gate closures on November 28, 2022, weekly reports of KLCI and SCI values were received from CDFW and USFWS and Reclamation (Figure 3).

DSM2

During WY 2023, the SaMT did not request any DSM2 model runs as there are currently no means to link DSM output to changes in behavior or large-scale movement patterns of juvenile salmonids. During late January through mid-February, when turbidity was widespread throughout the Delta, DSM2 model runs were requested by Reclamation and discussed by the SMT to better understand changes in Central and South Delta flows under OMRI scenarios of no more negative than -2,000 cfs, -3,500 cfs, and -5,000 cfs. Neither flow nor velocity output could be directly related to adult Delta smelt behavior or movement or to the proportion of the Delta smelt population vulnerable to entrainment. However, the SMT felt the flow output was informative for considering locations at which adult Delta smelt might be more vulnerable to entrainment into the South Delta under extended turbidity bridge conditions, based on statistical relationships showing a greater probability of adult entrainment under high turbidity conditions (Grimaldo et al. 2009; Smith et al. 2021). DSM2 model output was provided to and discussed by the SMT during special sessions on January 19, 2023, and February 17, 2023, and during regular meetings on January 24, 2023 and January 31, 2023. Of the available output, the SMT determined that the following channels were most useful: 49 (San Joaquin River near Jersey Point), 310 (Threemile Slough), 117 (Holland Cut), 94 (Old River east of Discover Bay), and 148 (Middle River, southeast side of Bacon Island).

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.

Acoustic Tagging

Acoustically tagged salmonids were tracked throughout the Delta in WY 2023 (<https://calfishtrack.github.io/real-time/index.html>, Table 5). 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 2023, hatchery-origin winter-run Chinook salmon survival to Benicia from Caldwell Park was relatively high at 19.6% (Table 5 and Table 6). The projected survival rate used for development of the hatchery-origin winter-run Chinook salmon JPE was 25.77% (Appendix D).

Table 5. WY 2023 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	1/26/2023, 3/1/2023	869	<i>n</i> = 2 release groups 1 – 2	LSNFH	Bonnyview
Hatchery-origin Battle Creek winter-run Chinook salmon	4/24/2023	588	<i>n</i> = 2 release groups 1 – 2	Mt. Lassen Trout Farm, Coleman	North Fork Battle Creek
Stanislaus River wild steelhead	3/7/2023	198	<i>n</i> = 1	N/A	Knights Ferry
Mill and Deer Creek wild steelhead, Fall Releases	11/4/2022 – 6/6/2023	62	<i>n</i> = 2	N/A	Mill Creek, Deer Creek
Upper Sacramento spring-run Chinook salmon surrogates	4/20/2023 - 6/1/2023	681	<i>n</i> = 7 release groups 1 – 7	Coleman	Red Bluff Diversion Dam
Butte Creek wild spring-run Chinook salmon	4/12/2023 – 5/11/2023	287	<i>n</i> = 7 release groups 1 – 7	N/A	Butte Sink
Feather River hatchery spring-run Chinook salmon	4/11/2023	497	<i>n</i> = 1	Feather River	Gridley Boat Launch

Table 6. WY 2023 Acoustic Tagging: minimum survival, SE, 90% 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 June 21, 2023.

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	19.6	1.4	17.1	22.4	83.2	3.6	74.9	89.1
Hatchery-origin Battle Creek winter-run Chinook salmon	5.9	1.0	4.3	8.2	66.0	6.5	52.4	77.4
Stanislaus River wild steelhead	0.5	0.5	0.1	3.5	N/A	N/A	N/A	N/A
Mill and Deer Creek wild steelhead, Fall Releases	29.0	5.8	19.1	41.4	85.0	8.0	62.4	95.1
Upper Sacramento spring-run Chinook salmon surrogates	14.5	1.3	12.0	17.3	50.0	4.3	41.7	58.3

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
Butte Creek wild spring-run Chinook salmon	28.7	2.7	23.8	34.3	82.0	4.1	72.6	88.6
-Feather River hatchery spring-run Chinook salmon	25.7	2	22	29.7	57.8	3.8	50.2	65.1

Genetic Information

Due to the inaccuracy of the LAD criteria, genetic information is used to validate loss of true winter-run and spring-run Chinook salmon at the salvage facilities (Appendix G). In WY 2023, only one genetically confirmed winter-run Chinook salmon was observed in salvage (February 23, 2023 salvage at CVP), despite the multiple exceedances of ITP daily loss thresholds based on LAD criteria. One potential reason for this overestimation using LAD data is that there was large number of untagged hatchery-origin juvenile Chinook Salmon in the Delta due to either tag loss or poor quality adipose clipping from hatchery releases. The lower rates of tagging success were confirmed by hatchery staff for some releases (e.g., late-fall-run Chinook salmon releases at Battle Creek in December 2022). This led to an ITP amendment on January 20, 2023, that restricted exports in response to the initial -at-date identification of natural older juvenile Chinook salmon and the thresholds described. However, if genetic analysis of an individual natural older juvenile Chinook salmon observed in salvage at the SWP or CVP indicates that it is not a Chinook winter-run, that individual shall not count toward the daily loss threshold and continued export restrictions under COA 8.6.3. This Condition of Approval are not required if the daily loss threshold has consequently not been met.

Genetic assignments for WY2023 also identified two (2) yearling spring-run that met the acceptability threshold, one salvaged on December 17, 2022, at the CVP (LAD fall-run), the other on December 18, 2022, at the SWP (LAD winter-run). Three (3) additional yearling spring-run (all LAD winter-run) were salvaged at the CVP in January 2023.

High flows in WY 2023 also provided access to flood bypasses on the Sacramento and San Joaquin rivers and LAD criteria performed poorly with riverine juvenile salmonids entering the Delta and being present in salvage, which were larger in size due to increased food productivity and availability from the flood bypasses. Loss of YOY LAD spring-run Chinook salmon at both export facilities was also relatively high in WY 2023 (>10,000 fish). However, genetic results from salvaged Chinook Salmon in WY 2023 indicated that a large majority of these YOY spring-run LAD Chinook salmon were fall-run Chinook salmon (Appendix G). The low accuracy of YOY LAD criteria for spring-run Chinook salmon in WY 2023 may be due to floodplain inundation and other favorable conditions that could lead to higher growth rates for fall-run Chinook salmon.

Juvenile Production Estimate (JPE) and Delta Survival

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, utilizing 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 WR 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 7. 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

WY	WRCH BY	WR JPE	Sac Basin WYT
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
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

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. As of WY 2022 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 SMT requested PTM runs for the purpose of evaluating the risk of longfin smelt larval entrainment on two occasions in WY 2023: on February 16, 2023, for an off-cycle meeting on February 17, and for the SMT meeting on February 28, 2023. All runs were conducted after the onset of spawning, with particle injection locations at Stations 812, 815, and 902 to simulate larvae in Central and South Delta. On February 17, 2023, state agencies analyzed results from the PTM run and did not come to consensus at the SMT meeting but did come to a consensus later at WOMT to advise an OMR index no more negative than -3,500 in the event of a turbidity bridge resolving ahead of the next meeting. On February 28, 2023, state agencies analyzed PTM

results that had been requested under drier conditions. At the time of analysis, conditions were wetter than had been expected and dynamic forecasts predicted continued favorable hydrology for fish. Due to uncertainty in how to best interpret PTM results in light of improved conditions, state agencies did not reach a consensus on OMR advice. State agencies discussed the issue further at WOMT on March 1 and independently on March 2. Also on March 2, San Joaquin River flows exceeded 8,000 cfs at Vernalis as forecasted. Longfin smelt protections were off ramped by high flows under ITP 8.4.3 ahead of the following meeting. On March 7, 2023, state agencies concurred to modify particle injection locations for future PTM run requests to use stations 812, 815, and 809, because larvae at station 902 are considered as already having been entrained.

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 (California 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.

A pilot study is taking place 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.

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 within the effects anticipated by the 2019 USFWS and NMFS Biological Opinions. The CVP and SWP did not exceed the amount of annual take specified in the ITSs of listed fish species described in the 2019 USFWS and NMFS Biological Opinions. As detailed above, the December-March steelhead 50% annual loss threshold was exceeded; however, this did not trigger OMR reverse flow reductions and none of the other annual loss thresholds were exceeded. OMR flow management-controlled Delta operations from January 1-17, 2023, due to IEWPP / COA 8.3.1, which was immediately followed by triggering of Turbidity Bridge Avoidance / COA 8.5.1 through February 9, 2023; however, it only uniquely controlled Delta operations on January 17, 2023. Subsequently, OMR flow management limits were controlling from February 1 – March 9, 2023, except for larval and juvenile longfin smelt protection/COA 8.4.2 controlling SWP exports from February 18-23, 2023, and COA 8.5.1 controlling SWP exports from February 24-26, 2023. After March 9, sustained high flows in the Delta resulted in positive QWEST and OMRI values no more negative than – 5,000 cfs through the end of the OMR season, and OMR flow management in the ROD was not controlling. OMR flows did not exceed those prescribed by the ITS in the 2019 USFWS Biological Opinion. No need was identified by the agencies for an independent panel review for WY 2023.

The SMT met at the close of the WY23 OMR Management Season to discuss items for consideration and development as part of the Guidance Document review prior to the start of WY 2024 OMR Management Season meetings in fall 2023. The following items were submitted (additional details are available in end of season meeting notes from June 20 and 27, 2023):

- Interested SMT members to conduct a literature review for various regulatory actions and associated life stages;
- Interested SMT members to revisit assumptions related to environmental correlations;
- Reclamation to create a SharePoint site for housing resources for SMT members to reference; and
- SMT members to compile an ongoing record of what triggers occurred, what dates actions were taken, and other key information across previous and current years.

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:

- CDFW to separate the steelhead loss total calculations based on the two time periods listed under the 2020 ROD (December to March and April to mid-June) in their weekly salvage reports.

Outcomes of WY 2022 SMT and SaMT Recommendations for WY 2023

Recommendations adopted or in progress:

- Joint SMT and SaMT operations update at 9:00 a.m.;
- CDFW and DWR converted SMT ITP Risk Assessment sections 1-A and 1-B to a tabular format;
- CDFW included identification status information and tracked seasonal catch totals in survey update emails to the SMT;
- SMT provided an optional, 15-minute break after live editing to distribute the draft assessments via email for SMT members to have the opportunity to provide any final edits;
- CDFW is supporting development of an SMT sub-group to identify abiotic and biotic factors indicating Delta smelt may move into areas at high risk of entrainment in the absence of a first flush;
- 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.

Recommendations not adopted:

- The SMT’s suggestion to move the Delta Monitoring Workgroup meetings to Wednesday mornings was not adopted due to scheduling conflicts.

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](#)

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