BUREAU OF RECLAMATION

Water Year 2020 Seasonal Report for Old and Middle River Flow Management

Central Valley Project, California
California-Great Basin Region

Cover Photo: California's Central Valley Project. (Bureau of Reclamation)

U.S. Department of the Interior **December 2020**

Mission Statements

The Department of the Interior (DOI) conserves and manages the Nation's natural resources and cultural heritage for the benefit and enjoyment of the American people, provides scientific and other information about natural resources and natural hazards to address societal challenges and create opportunities for the American people, and honors the Nation's trust responsibilities or special commitments to American Indians, Alaska Natives, and affiliated island communities to help them prosper.

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

Water Year 2020 Seasonal Report for Old and Middle River Flow Management

Central Valley Project, California
California-Great Basin Region

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in coordination with DWR, USFWS, NMFS and CDFW

Contents

Page

Figures

Appendices

Appendix A – Old and Middle River Flow Management Guidance Document

Appendix B – Delta Cross Channel Operations and Fall/Winter Closures Guidance Document

Appendix C – LTO WY2020 Old and Middle River Entrainment Seasonal Report Timeseries Excel File

Appendix D – DWR Memorandum: DWR YSI Turbidity Sensor Measurement Units

Appendix E – USBR Memorandum: Long-Term Operation (LTO) of the Central Valley Project (CVP) and State Water Project (SWP, Additional Real-Time Old and Middle River (OMR) Flow Restrictions for Delta Smelt Larval and Juvenile Entrainment for 2019

Appendix F – Conditions Relevant to the State Water Project's Incidental Take Permit

Appendix G – WOMT Meeting Notes (WY 2020)

Appendix H – DSM2 Modeling Scenarios (WY 2020)

Appendix I – Old and Middle River Management Guidance Document dated December 1, 2020

Appendix J – Delta Cross Channel Operations and Fall/Winter Closures Guidance Document dated November 20, 2020

Purpose

This Water Year 2020 Seasonal Report for Old and Middle River (OMR) Flow Management describes Delta operations and actions in water year (WY) 2020 to support adjustments, if necessary, to the OMR Flow Management Guidance Document (OMR Guidance Document) and the Delta Cross Channel Operations and Fall/Winter Closures Guidance Document (DCC Guidance Document) for WY 2021. While the focus of this report is on OMR flow management, Delta Cross Channel (DCC) operations were included as its operations are related to entrainment performance. Reclamation will produce a Seasonal Report for OMR Flow Management following each OMR management season, with adjustments made to the guidance documents to support the following year's OMR management season. This seasonal report fulfills commitments under the Record of Decision (ROD) signed by the Bureau of Reclamation (Reclamation) for the Reinitiation of Consultation on the Coordinated Long-Term Operations of the Central Valley Project (CVP) and State Water Project (SWP). Additionally, this Seasonal Report will be used to support the development of Reclamation's 2020 Annual Report on the Long-Term Operation of the Central Valley Project and State Water Project (Annual Report). Finally, this document will inform the Four-Year Review Panels adopted under the ROD. In January of 2024 and 2028, Reclamation and the California Department of Water Resources (DWR) will charter an independent panel to review OMR management, among other actions. The purpose of the independent review will be to evaluate the efficacy of actions undertaken to reduce the adverse effects on listed species.

Compliance with the National Marine Fisheries Service (NMFS) and the United States Fish and Wildlife Service (USFWS) 2019 Biological Opinions' (BiOps) Reasonable and Prudent Measures and associated Terms and Conditions adopted by the aforementioned ROD will be documented and discussed in the Annual Report and not in this document. Although this document strives to provide an integrated view of the system and the factors affecting the coordinated operation of the CVP and SWP, evaluation and discussion is focused on actions taken specifically by Reclamation and DWR for OMR flow management and is based on assessments developed through the Salmon Monitoring Team (SaMT) and the Smelt Monitoring Team (SMT).

Background

The Sacramento–San Joaquin River Delta (Delta) is formed by the confluence of the Sacramento and San Joaquin Rivers. Located in the southwestern portion of the Delta is 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), which divert water south through the Delta-Mendota Canal and the California Aqueduct, respectively. The proximity of the CVP and SWP export facilities to the Old and Middle Rivers is shown in Figure 1.

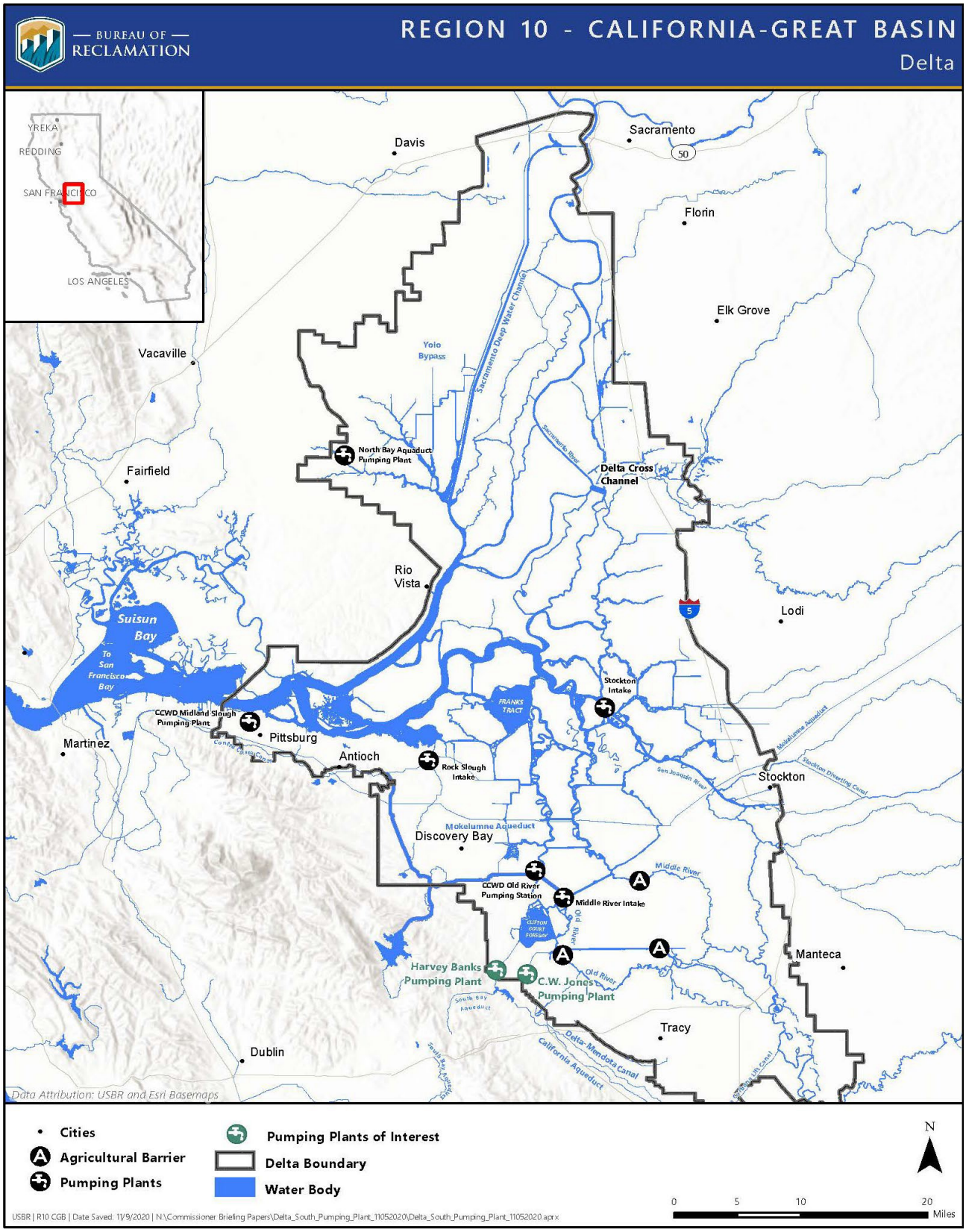


Figure 1. Map of the Delta with CVP and SWP infrastructure.

Net flow within the OMR corridors to the north of the CVP and SWP export facilities provides a surrogate indicator for how export pumping influences 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 CVP and SWP 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 provide protections for fish when necessary and flexibility when possible. Estimates of species spatial and temporal distribution are described by the two multi-agency Delta-focused technical teams, the SaMT and SMT.

Reclamation consulted under the Endangered Species Act (ESA) with the USFWS and NMFS on potential effects of the Proposed Action (PA) on threatened and endangered species and designated critical habitat. Reclamation submitted to these agencies a Biological Assessment (BA) on January 31, 2019, describing the proposed actions that would be taken and the resulting effects. Reclamation updated the PA during consultation (two updates were provided on April 19, 2019 and July 30, 2019) and provided the final BA on October 21, 2019, which included the final PA description. In turn, the USFWS and NMFS issued their BiOps of the PA on October 21, 2019. Previously, management of the CVP and SWP operations was in part governed by BiOps provided in 2008 (USFWS) and 2009 (NMFS). OMR management and DCC operations are a part of the Delta Operations described in the PA, which requires this seasonal report. Reclamation signed the ROD, which included the 2019 BiOps from USFWS and NMFS, and began implementing the PA on February 18, 2020 after the ROD was signed.

The PA, adopted in the ROD (hereafter the PA will be referred to as the ROD when it is described in the context of implementation), included measures that are intended to protect threatened and endangered species. Early Winter Pulse Protection ("First Flush") and net OMR flows no more negative than –5,000 cfs are actions that will 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 that will benefit 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. The Turbidity Bridge Avoidance action may also benefit juvenile Delta Smelt. Another OMR management action that will benefit winter-run Chinook salmon, spring-run Chinook salmon, and steelhead/rainbow trout 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 OMR Guidance Document (Appendix A) and the DCC Guidance Document (Appendix B) describe the implementation guidance on OMR management and DCC gate operation (respectively) in coordination with NMFS, USFWS, and CDFW pursuant to Section 4.10.5.10 of the BA. Both the SMT and SaMT (collectively, "technical teams", weblinks to team notes provided in the Supporting Information section below) prepare weekly assessments of OMR management to help assist Reclamation and DWR's decision making. Reclamation seeks to have a consensus assessment of OMR management and its potential risks. However, if there are differing perspectives within the technical teams, those issues are elevated to the Water Operations Management Team (WOMT),

consisting of agency managers from Reclamation, DWR, NMFS, USFWS, and CDFW. If perspectives continue to differ amongst the agencies, WOMT may then elevate the issue to the directors of the five agencies for a decision.

Under the California Endangered Species Act (CESA), DWR consulted with CDFW to obtain a separate Incidental Take Permit (ITP) for Long-Term Operation 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 Conditions of Approval 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. In addition, the ITP also includes daily loss thresholds for winter-run Chinook salmon and a daily spring-run Chinook salmon hatchery surrogate loss threshold.[1]

State Water Resource Control Board (SWRCB) 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 on December 1 unless water quality issues are present in the Delta. The ROD includes D-1641 requirements including gates closures from February 1 through mid-May, and gates closures up to 45 days from November 1 through December 31.

Effects of the Action

The USFWS 2019 BiOp anticipates that operations will result in adverse effects to Delta Smelt and their designated critical habitat, including incidental take due to hydrodynamic effects caused by the operation of the CVP and SWP export facilities in the South Delta, the CVP and SWP fish salvage facilities in the South Delta, and other CVP or SWP water diversion and water distribution systems in other parts of the Delta and Suisun Marsh. Regarding the CVP and SWP export of water from the Delta, the USFWS anticipates take may occur in the form of harm, or death of all Delta Smelt within the South Delta affected by water operations and other areas of the Delta affected by reduced habitat quality.

The NMFS 2019 BiOp anticipates that operations will result in adverse effects to Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead and southern Distinct Population Segment of North American green sturgeon and their designated critical habitats, including incidental take. The NMFS 2019 BiOp identifies the following effects related to OMR flow management:

- Passage impediments/barriers through operations of the DCC gates and installation of South Delta agricultural barriers. Passage impediments/barrier stressors may include modified routing, modified travel/migration time, and limited habitat.

[1] Requirements of the ITP apply only to DWR.

- Changes to water flow within the Sacramento River, American River, Stanislaus River, interior Delta, and Delta outflow. Flow condition stressors in the Delta include limited habitat and increasing travel/migration time.
- Entrainment or impingement primarily at the DCC gates, the State and Federal pumping facilities in the South Delta, the Contra Costa diversion intakes, and the North Bay Aqueduct intake. Entrainment stressors may include modified routing, modified travel/migration time, and exposure to degraded habitat.

The ITP anticipates that operations at the SWP will result in adverse effects on Longfin Smelt, Delta Smelt, winter-run Chinook salmon, and spring-run Chinook salmon, including incidental take. The effects analysis by CDFW identifies the following effects related to OMR flow management:

- High risk of entrainment of newly hatched Longfin Smelt and Delta Smelt at all but the lowest export levels. Flow conditions may lead to entrainment into poor habitat quality conditions for rearing of juveniles in the south and central Delta and to reduced habitat availability in the low salinity zone.

- High risk of entrainment of juvenile salmon into the interior and South Delta where poor rearing conditions and high predation risk can reduce survival rate. Life history diversity may be constrained by changes to habitat conditions and migration timing and duration.

Seasonal Operations

This Seasonal Operations section describes DCC Operations and OMR Flow Management during WY 2020. Reclamation has included a discussion on winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and Delta Smelt. Reclamation does not have actions related to green sturgeon this year and, thus, a discussion of this species is not included. Fall-run Chinook salmon are not an ESA-listed species but are relevant since they comprise a large portion of the Southern Resident killer whale diet, which is an ESA-listed species. NMFS also completed Essential Fish Habitat Consultation on 1/24/2020 on the effects of the PA on Pacific Coast salmon, Coastal Pelagic species, and Pacific Groundfish species. While fall-run Chinook salmon are not discussed in detail in this report, spring-run Chinook salmon and steelhead are more thoroughly described. The young-of-year (YOY) spring-run Chinook salmon, steelhead, and YOY fall-run Chinook salmon have considerable overlap in migration timing, residency, and migration through the Delta, therefore, OMR no more negative than -5,000 cfs and other actions benefiting spring-run Chinook salmon and steelhead should also benefit fall-run Chinook salmon.

All data used to create figures in this report is provided in Appendix C.

Delta Cross Channel Operations

Photo 1. Delta Cross Channel Gates (Bureau of Reclamation/Todd Plain).

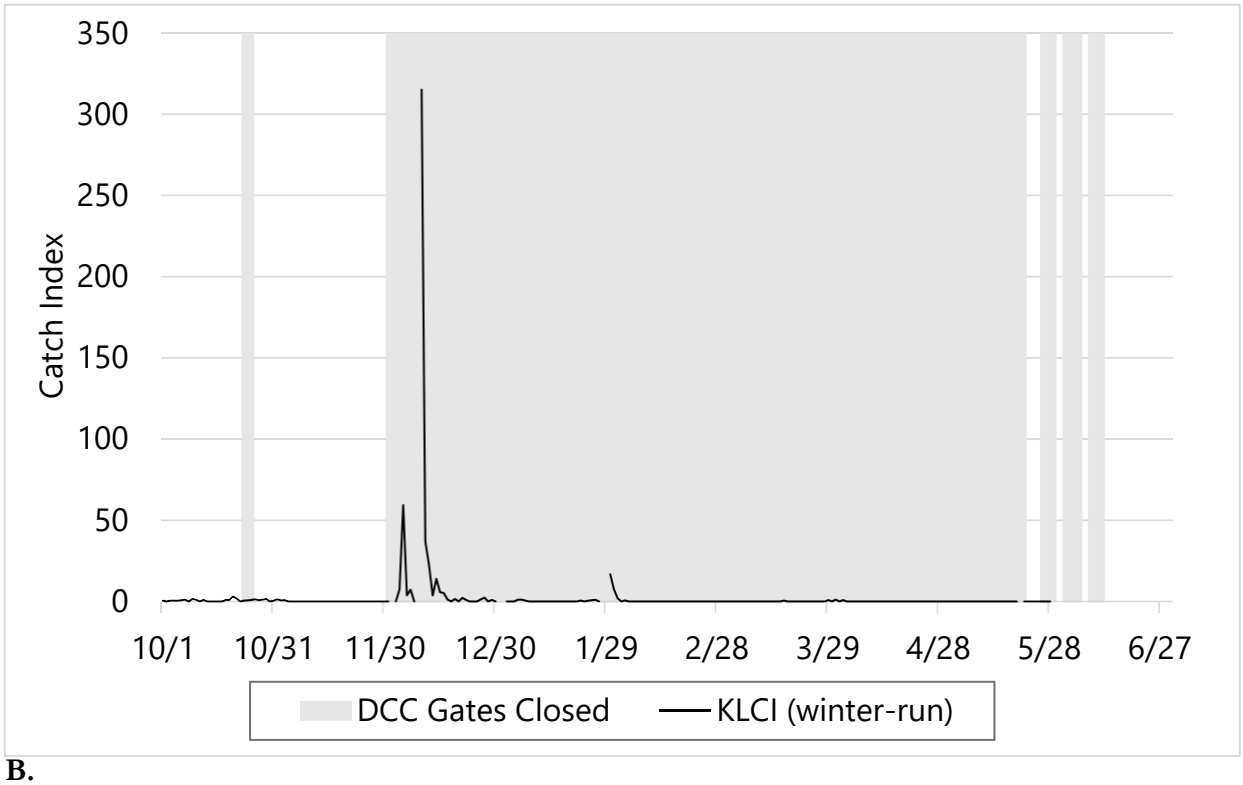
The DCC operation schedule abides by operations described in the ROD, which includes the D-1641 operations requirement. The DCC gates were opened prior to the beginning of WY 2020 on 10/1/2019 and remained open until 10/23/2019. The closure was triggered by the Knight's Landing Catch Index (KLCI) trigger from the NMFS 2009 BiOp (Action IV.1.2). The gates were re-opened on 10/26/2019. On 11/27/2019, DCC gates should have been closed due to the high catch of winter-run Chinook salmon in the Sacramento Catch Index (SCI), but closure was delayed until 12/1/2019. Thanksgiving holiday staffing and notice to boaters were contributing factors to the delay; Reclamation closed the DCC gates at the next opportunity after considering safety issues. DCC gates were closed on 12/1/2019 and remained closed for the OMR management season until 5/22/2020. The gates were then opened each weekend until 6/12/2020. On 6/12/2020, the DCC gates remained open for the duration of the summer season (Figure 2).

Any remaining emigrating salmonids of Sacramento River Basin origin passing through the DCC gates after 5/22/2020 had the potential to be diverted into the interior Delta; however, the likelihood of this occurring was small for juvenile natural winter-run Chinook salmon based on historical monitoring data. Average migration timing characteristics of juvenile winter-run Chinook salmon at Chipps Island Trawls (2005 – 2019) show the average last detection date is April 27 and the median last detection date is April 28 of any given year. During WY 2020 the earliest catch of juvenile winter-run Chinook salmon in the Sacramento River Trawl at Sherwood Harbor was on 12/10/2019 and the latest date was 3/24/2020. Additionally, it is unlikely juvenile natural winter-run

experienced changes in behavior (rearing, foraging, sheltering, or migrating) in the western Delta and Sacramento River corridor. Adult spring-run Chinook salmon may have been attracted into the lower Mokelumne River system by Sacramento River flows passing through the open DCC gates, which has the potential to delay their upstream migration into the Sacramento River basin. Juvenile steelhead loss that occurs between December 1 and June 15 is split into two time-periods: December 1 through March 30 and April 1 through June 15. This is to ensure protection for both Sacramento River Basin and San Joaquin River Basin origin steelhead (NMFS 2019 BiOp, Table 11). Sacramento River Basin steelhead outmigrate earlier in the season, while the DCC gates are closed, and while San Joaquin River Basin steelhead outmigrate later in the season, the route they follow would not lead them past the DCC gates.

During WY 2020, Sacramento River winter-run Chinook salmon presence was highest at the Knights Landing rotary screw trap in mid-December; however, the DCC gates had been closed on 12/1/2019. Therefore, there was reduced potential for fish to be routed into the Central and South Delta regions. Note: natural winter-run Chinook salmon have not been genetically identified and are defined as winter-run Chinook salmon by length-at-date (LAD) measurements.

A.



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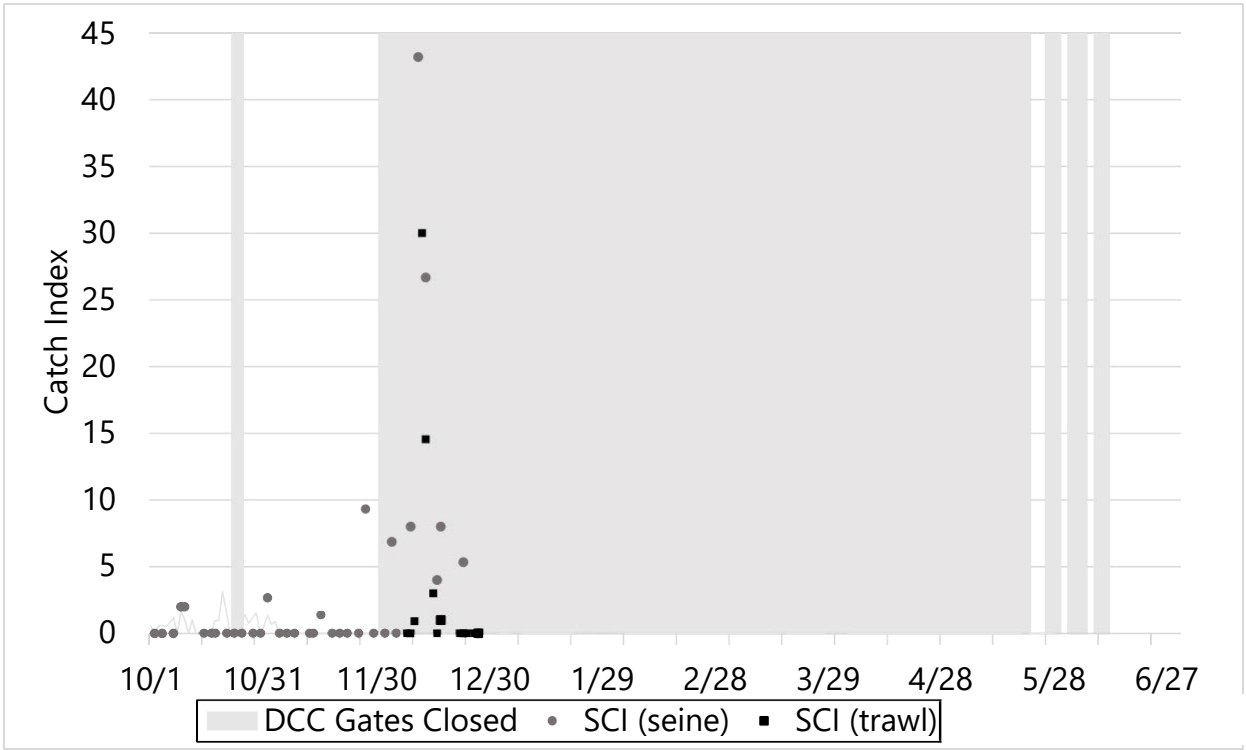

Figure 2. DCC Gate closures and **A.** Knights Landing Catch Index (KCLI) and **B.** Sacramento Catch Index at beach seines (SCI - seine) and Sacramento Catch Index trawl (SCI – trawl) for natural winter-run Chinook Salmon. KLCI was recorded from 10/1/2019 - 6/30/2020; SCI - seine was recorded from 10/1/2019 - 12/28/2019; SCI – trawl recorded from 12/8/2019 – 12/27/2019.

Old and Middle River Flow Management

Old and Middle River Flow Management is summarized in this section for the WY 2020 management season. OMR index values (1-day, 5-day, and 14-day) for WY 2020 were plotted in Figure 3. From January through June, negative OMR flows were managed at no more negative than -5,000 cfs on a 14-day moving average. Combined exports at the CVP and SWP facilities were generally low when OMR flows were less negative and generally higher when OMR flows were more negative (Figure 4).

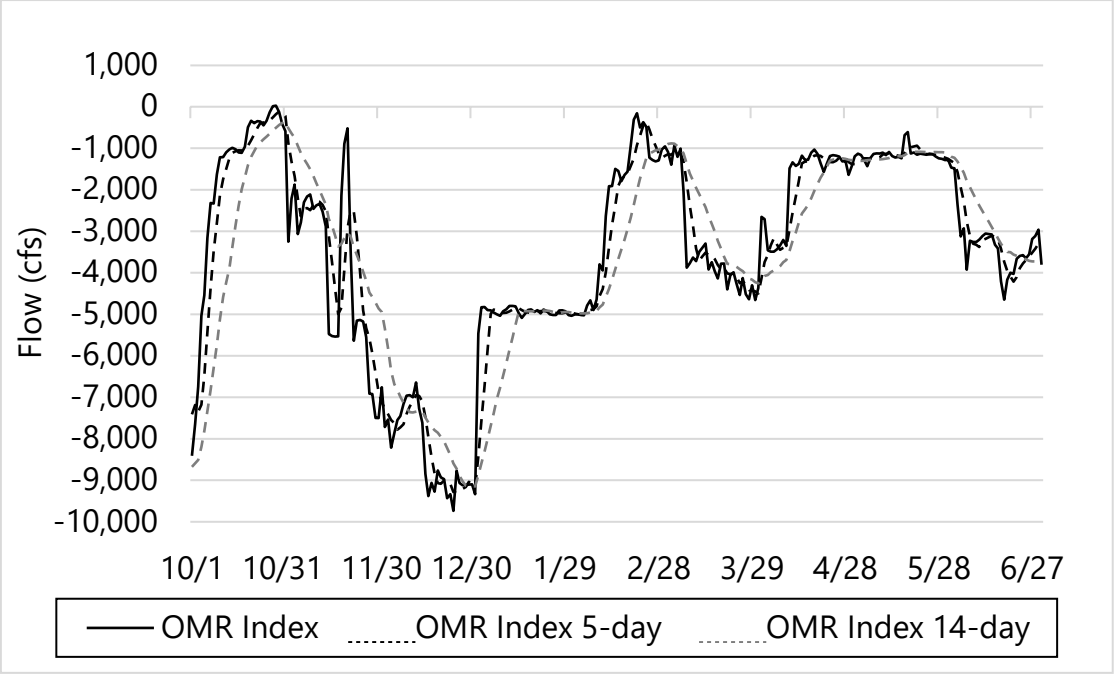

Figure 3. OMR index values (1-, 5-, and 14-day) in WY 2020.

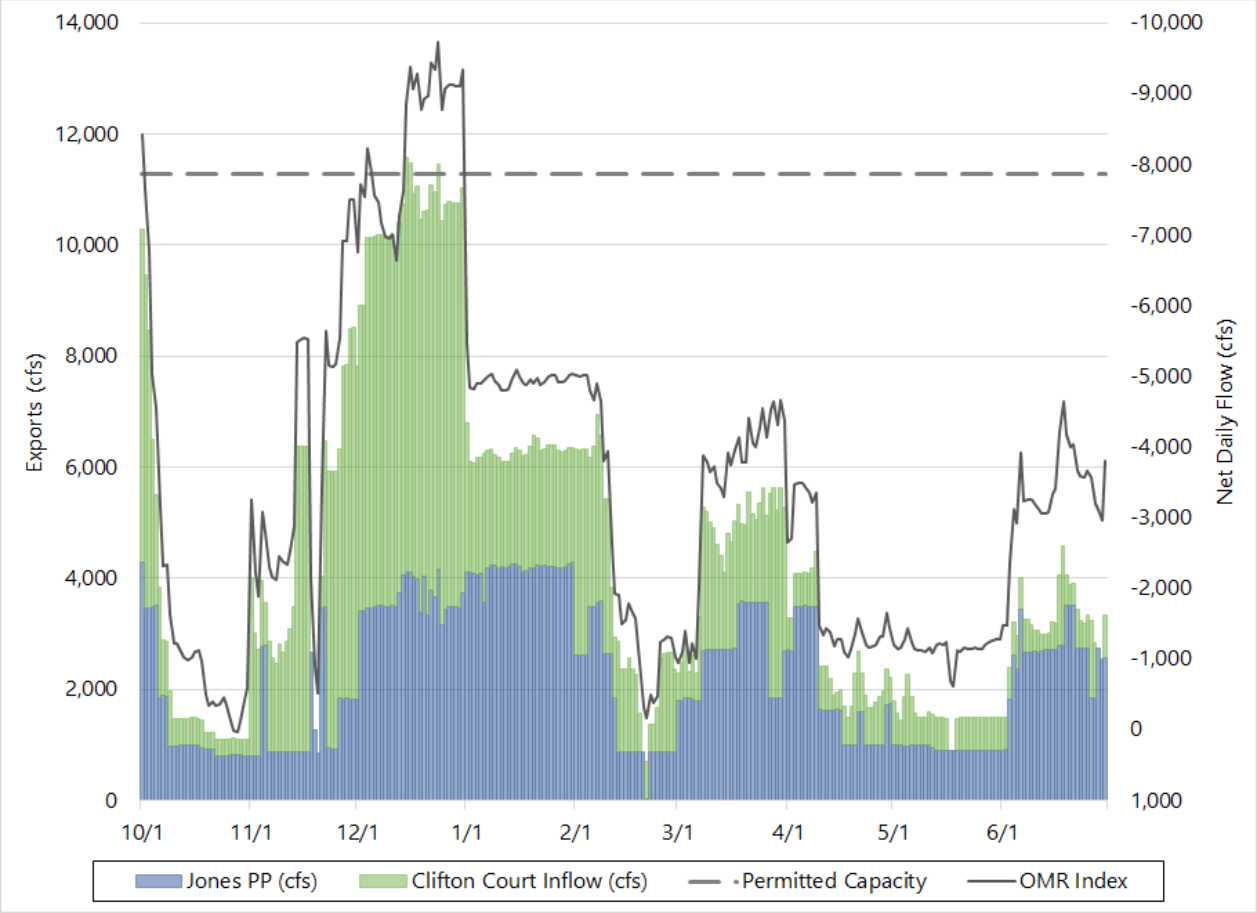

Figure 4. Exports from Clifton Court Forebay Index (for the SWP) and Jones PP (for the CVP) plotted over 1-day OMR index values for WY 2020. Permitted capacity is the combination of the permitted capacity for both facilities (CVP: 4,600 cfs; SWP: 6,680 cfs).

Seasonal operations to manage OMR 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 5. The factors controlling delta operations at the start of WY 2020 were D-1641 delta water quality followed by operational capacity limits. On January 1, 2020 and throughout most of the winter, OMR controlled delta operations. During the early spring of 2020, D-1641 criteria for delta outflow began to be the controlling factor for exports. Later in the spring, D-1641 criteria for export rates to Delta inflow became limiting. Finally, in the early summer of 2020, D-1641 criteria for delta outflow became the controlling factor prior to the end of the management season. Delta hydraulic conditions also change throughout the season, existing in either Balanced or Excess conditions, which can impact management of OMR (Figure 6).

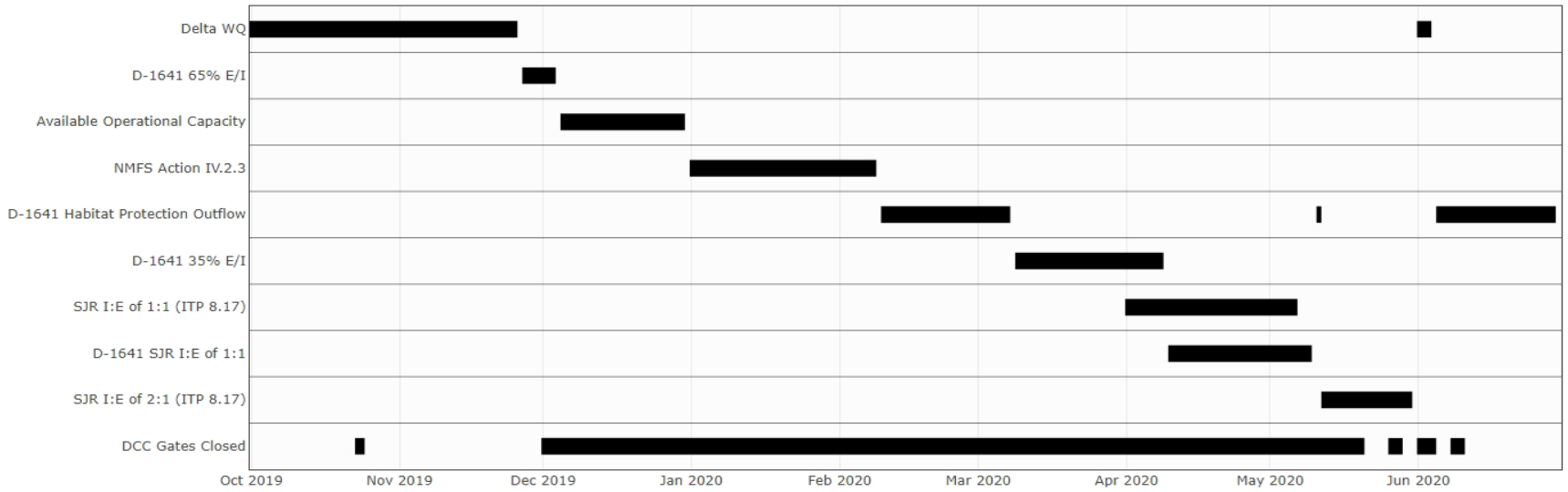

Figure 5. Daily Delta controlling factors for WY 2020. Controlling factors may overlap in time, but only one controlling factor is operated to at a time. OMR was not a factor in 2020 and was not included on this figure, however, the lower OMR flows may inform OMR-related actions in other years. A detailed breakdown of the controlling factors for WY 2020 are provided in Appendix C.

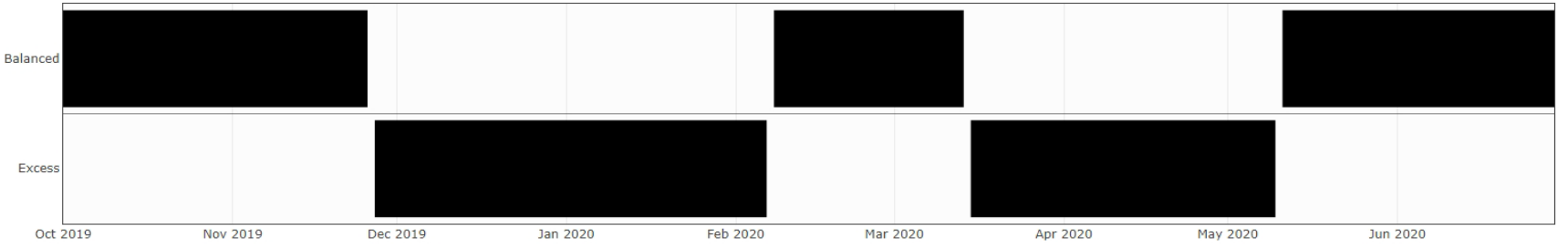

Figure 6. Balanced versus Excess conditions in the Delta for WY 2020.

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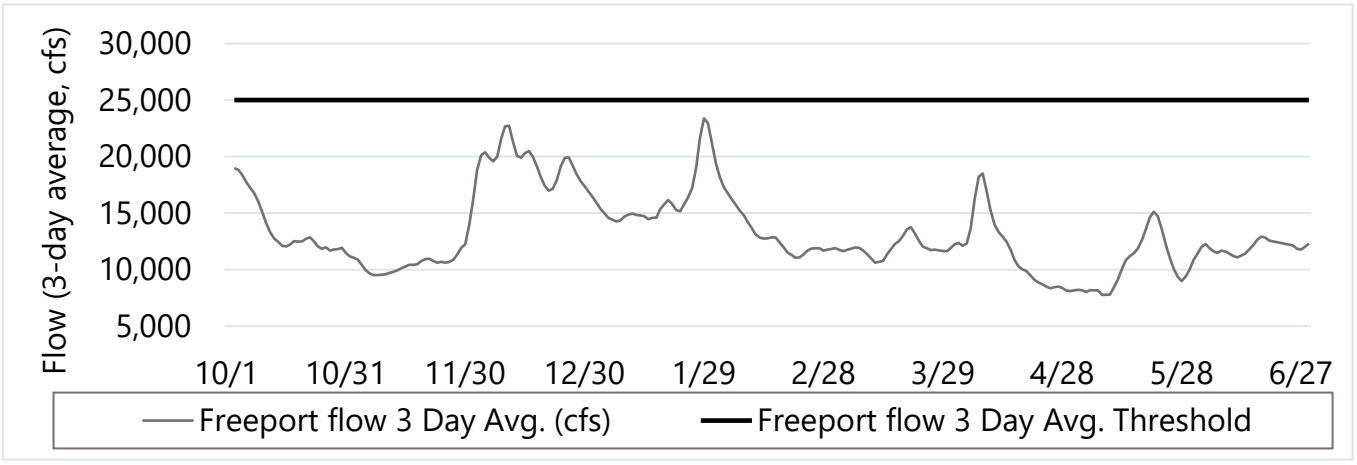
Onset of OMR Flow Management

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

The onset of OMR flow management for Delta Smelt can be triggered by 'First Flush' conditions, which include a 3-day daily average flow at Freeport greater than 25,000 cfs and a 3-day daily average turbidity at Freeport greater than 50 NTU between December 1 and January 31. Even though the ROD was not signed until 2/18/2020, Reclamation analyzed environmental conditions prior to February to see if 'First Flush' conditions would have been met in WY 2020. As shown in Figure 7A and 7B, neither the flow nor the turbidity trigger would have been met in WY 2020. Note that the units for turbidity were updated from NTU (Nephelometric Turbidity Unit) to FNU (Formazin Nephelometric Unit) to reflect actual field measurements (see Appendix D for details).

A.



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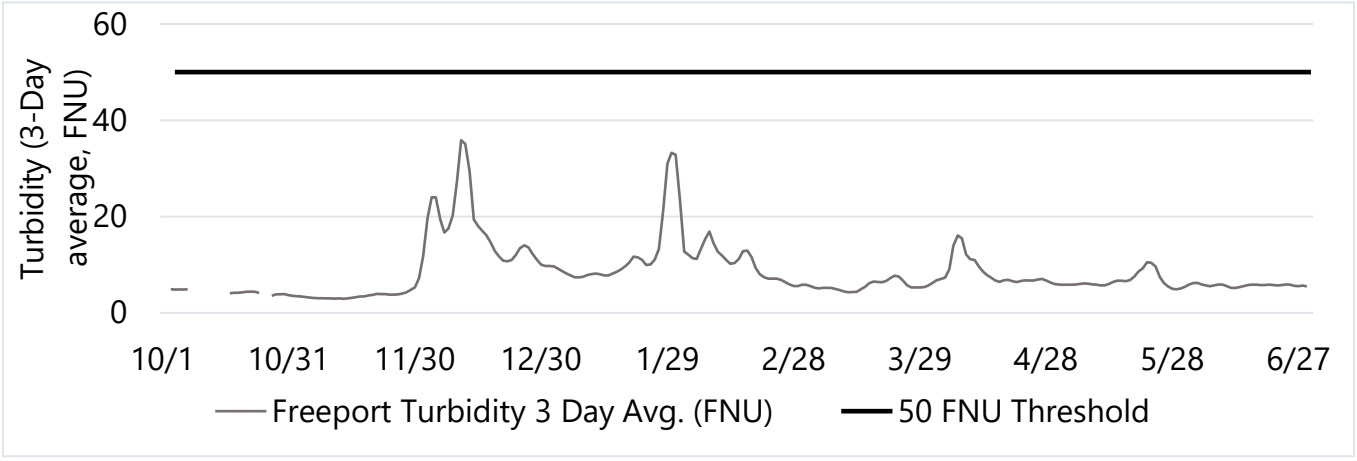


Figure 7. 'First Flush' conditions in WY 2020; **A.** 3-day running average flow (cfs) at Freeport. **B.** 3-day running average turbidity (FNU) at Freeport.

Salmonid Presence: Distribution Estimates

Distribution estimates of salmonids are discussed and agreed upon weekly by SaMT members.

Multiple sources are considered to produce estimates including catch at targeted locations (e.g., Feather River RSTs, GCID RST, Tisdale Weir RST, Knight's Landing RST, Beach Seines, LAR RST, Caswell RST, Sacramento trawls, Chipps Island trawls, and Mossdale Kodiak trawl), historic and current water year salvage numbers, movements of acoustic tagged fish from the current water year, and historic migration patterns at targeted locations (Red Bluff Diversion Dam, Tisdale Weir RST, Knight's Landing RST, Sacramento trawls, and Chipps Island trawls).

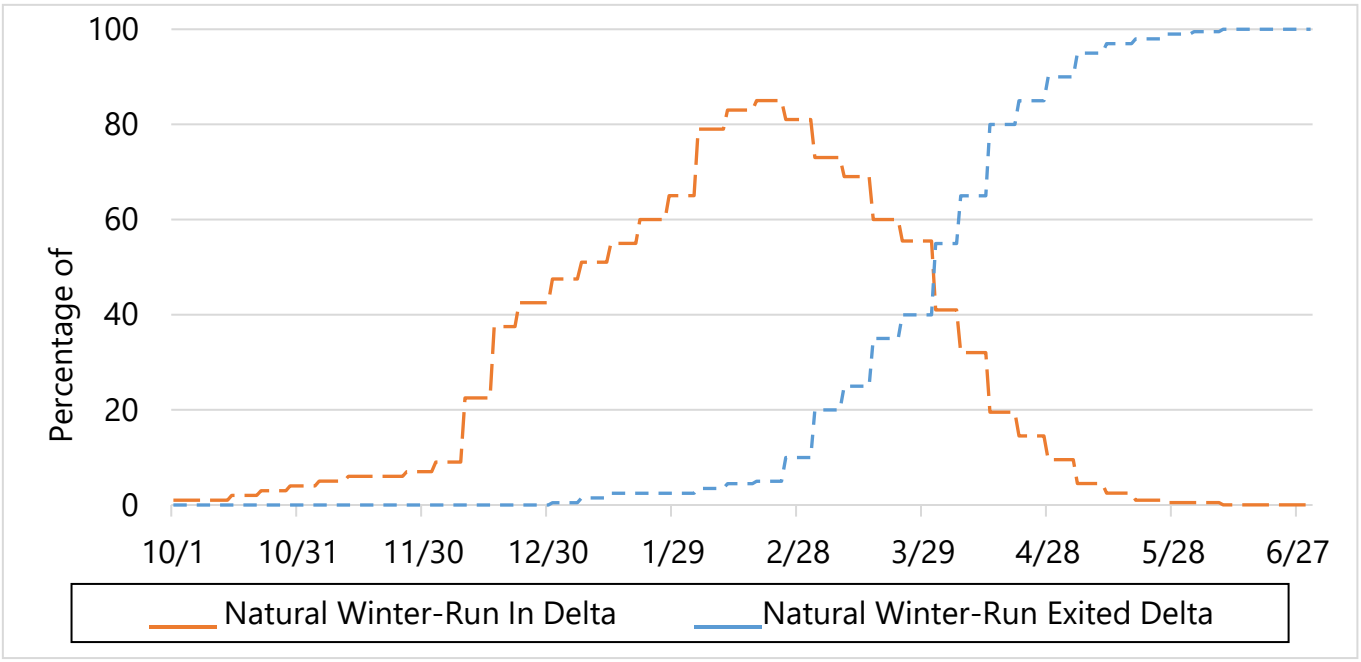
The first distribution estimates under the ROD were made in March 2020. As of 3/1/2020, distribution estimates for natural winter-run Chinook salmon were: 9% yet to enter the Delta, 81% in the Delta, and 10% migrated past Chipps Island. As of 4/1/2020, distribution estimates for natural winter-run Chinook salmon were: 4% yet to enter the Delta, 41% in the Delta, and 55% migrated past Chipps Island (Figure 8A, OMR 1-day index values are included in Figure 8B for reference).

As of 4/1/2020, distribution estimates for wild steelhead were: 52.5% yet to enter the Delta, 40% in the Delta, and 7.5% migrated past Chipps Island. As of 5/1/2020, distribution estimates for wild steelhead were: 22.5% yet to enter the Delta, 48% in the Delta, and 32.5% migrated past Chipps Island (Figure 9A, OMR 1-day index values are included in Figure 9B for reference).

As of 3/1/2020, distribution estimates for young-of-year natural spring-run Chinook salmon were: 41.5% yet to enter the Delta, 58.5% in the Delta, and 0% migrated past Chipps Island. As of 4/1/2020, distribution estimates for natural spring-run Chinook salmon were: 37.5% yet to enter the Delta, 60.5% in the Delta, and 2% migrated past Chipps Island. As of 5/1/2020, distribution estimates for natural spring-run Chinook salmon were: 12.5% yet to enter the Delta, 53% in the Delta, and 34.5% migrated past Chipps Island (Figure 10A, OMR 1-day index values are included in Figure 10B for reference)

After 1/1/2020, OMR 1-day index was more positive than -5,000 cfs 169 out of 182 days (mean: -2,861 cfs; range of -5,468 cfs to -156 cfs).

A.



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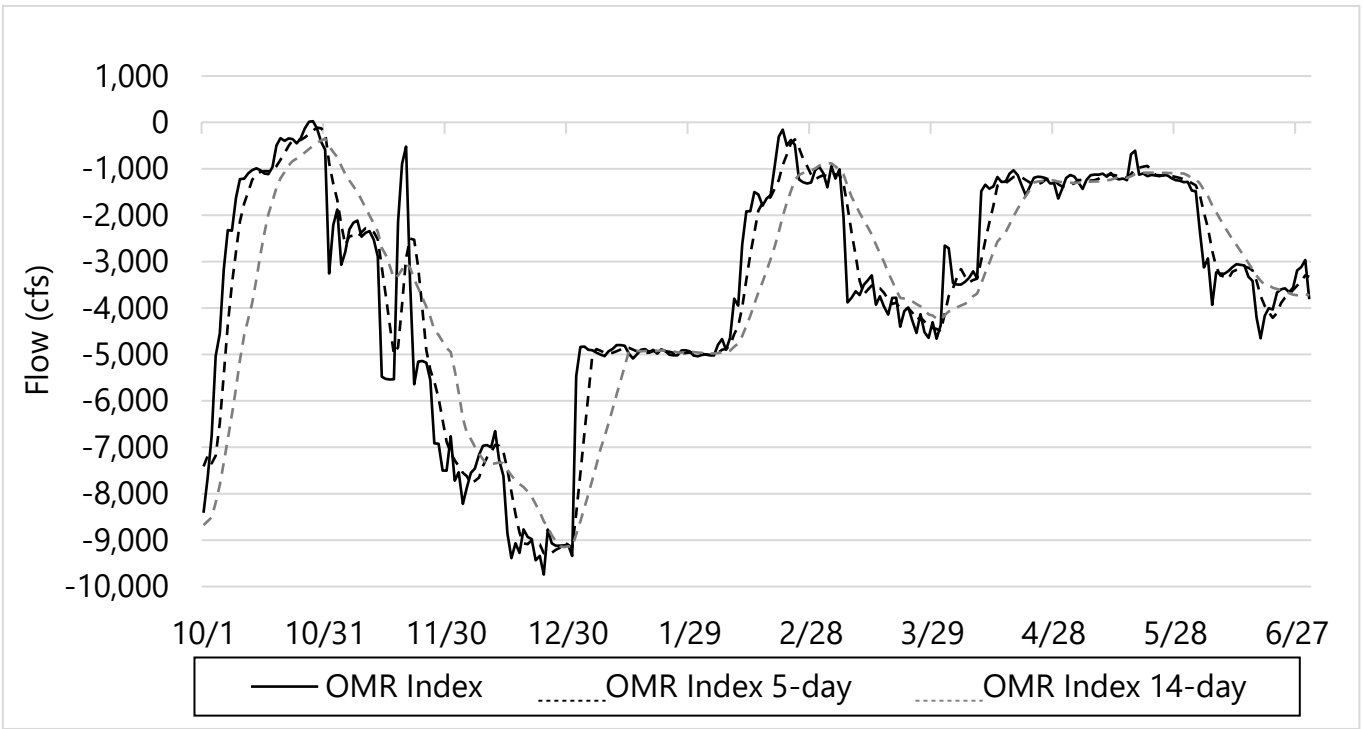
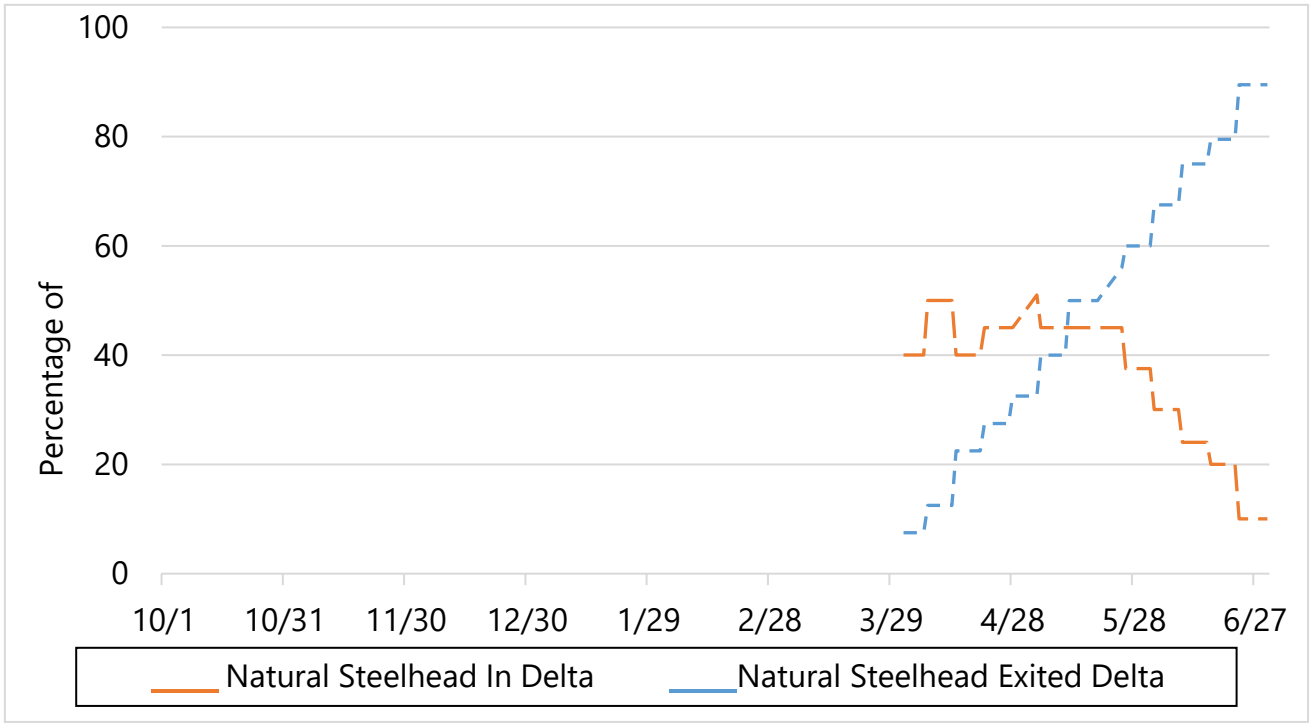


Figure 8. **A.** Distribution estimates for natural winter-run Chinook salmon in WY 2020 and **B.** OMR 1-day index (cfs).

A.



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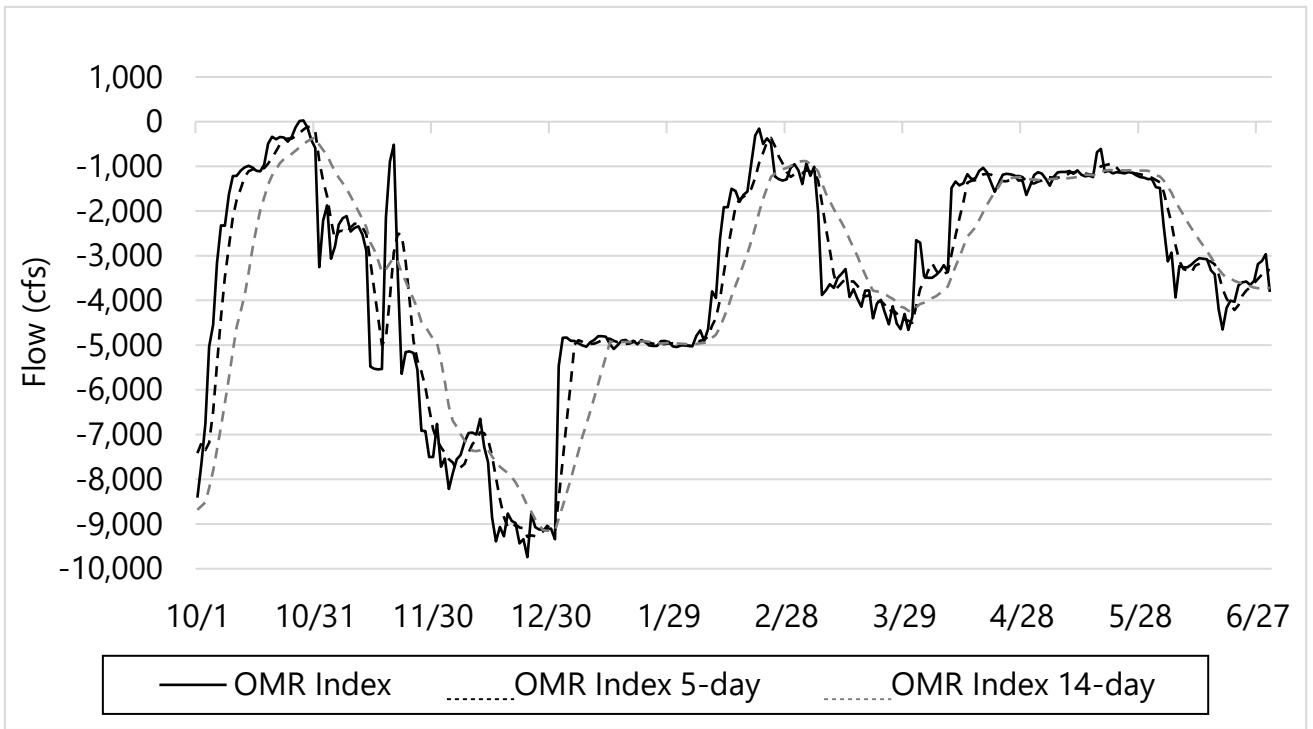
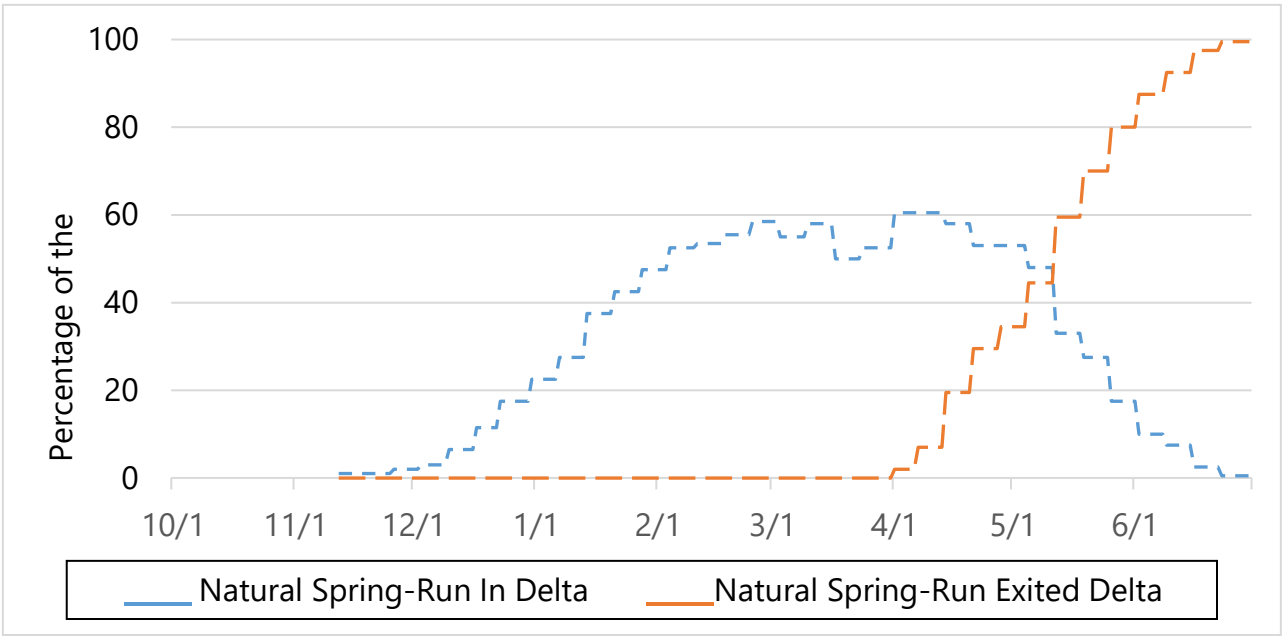


Figure 9. **A.** Distribution estimates for natural steelhead from 4/1/2020 through 6/30/2020 and **B.** OMR 1-day index (cfs).

A.



B.

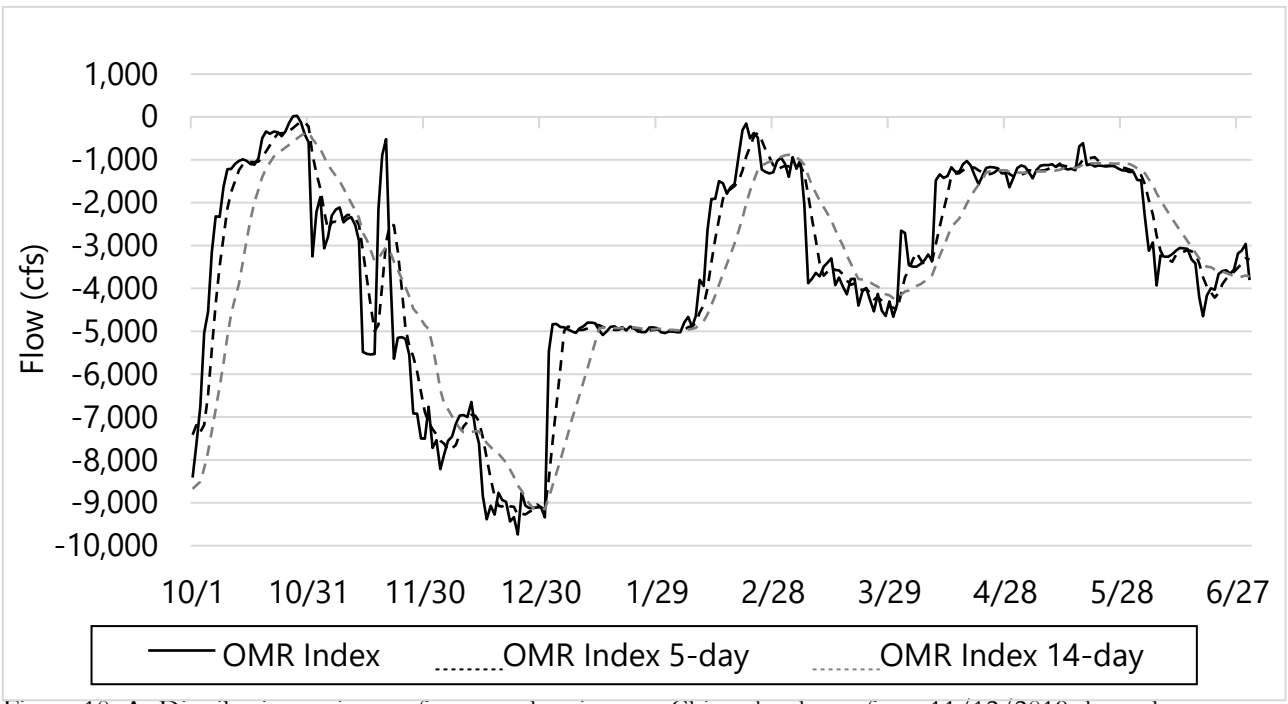


Figure 10. **A.** Distribution estimates for natural spring-run Chinook salmon from 11/12/2019 through 6/30/2020 and **B.** OMR 1-day index (cfs).

Adult Longfin Smelt Entrainment Protection

The ITP includes a third action triggering the onset of OMR management (Condition of Approval 8.3.3). The relevant period for this action was prior to the effective date for the ITP (March 31, 2020), but an assessment is included for completeness. For WY2020, the Integrated Early Winter Pulse Protection (8.3.1) was not initiated, and the cumulative adult Longfin Smelt salvage was zero for the December 1 to February 28 time period.

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 11) and hydrologic data were used as an early warning for migration. For the Chipps Island Survey, Longfin Smelt detections in WY 2020 began in the fall, and increased markedly in late December to late February, after which detections were sparse (Figure 11). Abiotic factors used in the evaluation of risk for this condition of approval include OMR flows (Figure 3), OMR turbidity (Figure 12), QWEST (Figure 13), South Delta secchi depth (Figure 14), and Clifton Court temperature (Figure 21).

The SMT did not make any recommendations to WOMT during this period regarding the need for adult Longfin Smelt protections. However, if the ITP had been in place during this period, it is possible that the DWR and CDFW representative in the SMT may have recommended the protections under 8.3.3 to WOMT in response to the December FMWT detecting an adult Longfin Smelt at station 809 in the San Joaquin River, an indication that some Longfin Smelt had migrated into the zone of influence of the export facilities.

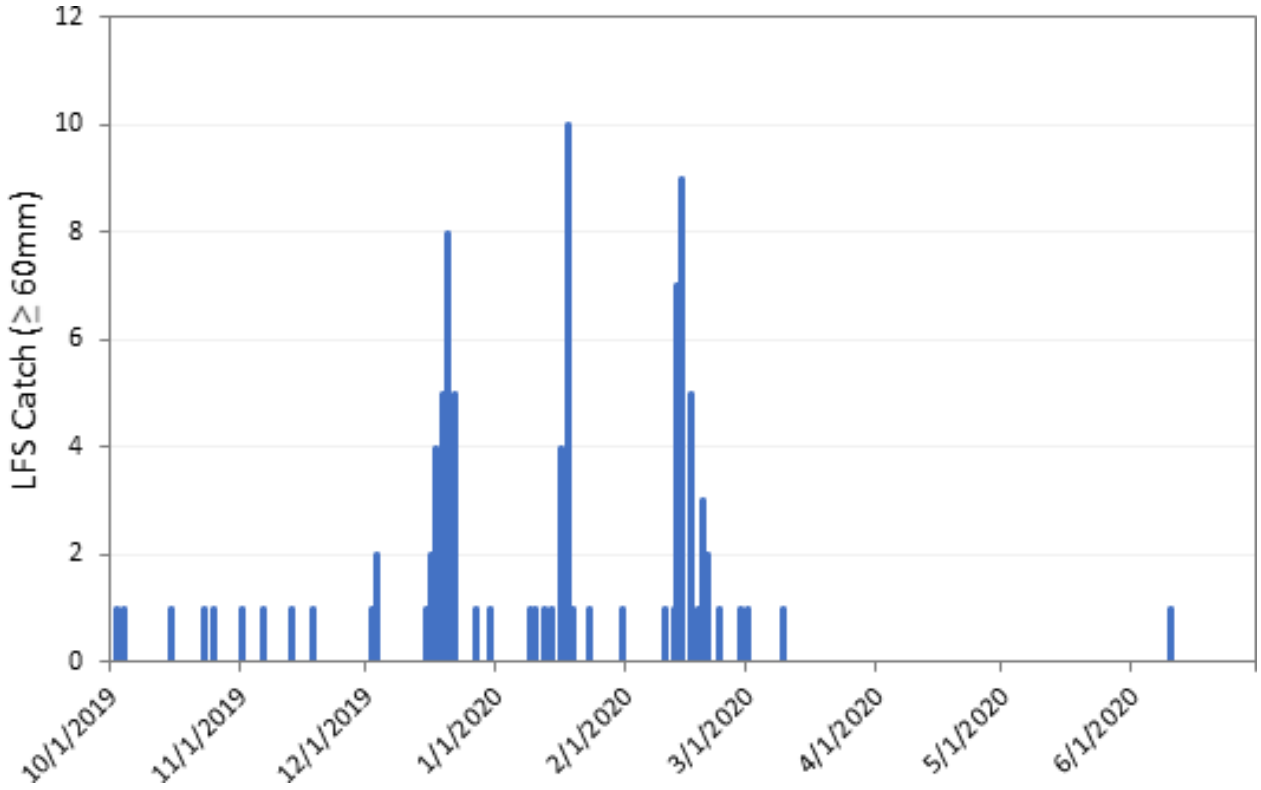


Figure 11. Adult Longfin Smelt (≥60mm) catch from the Chipps Island Trawl from October 2019 through June 2020.

Additional Real-time OMR Restrictions and Performance Objectives

Turbidity Bridge Avoidance ("South Delta Turbidity")

Turbidity Bridge Avoidance ("South Delta Turbidity") would have begun on 2/1/2020 under the ROD since the 'First Flush' trigger would not have occurred; however, this action only became active on 2/18/2020 [when] the ROD was signed. This action will continue until either: April 1, or until a ripe or spent female is detected, whichever is first. During the week of 2/10/2020, the Spring Kodiak Trawl (SKT) caught one female Delta Smelt (65 mm, Stage 4-ripe) on the Lower Sacramento River. The threshold of 12 FNU was met briefly from 2/9/2020 to 2/14/2020 (Figure 12). Due to the timing of the ROD signing, the CVP and SWP export facilities operated to this action until 4/1/2020.

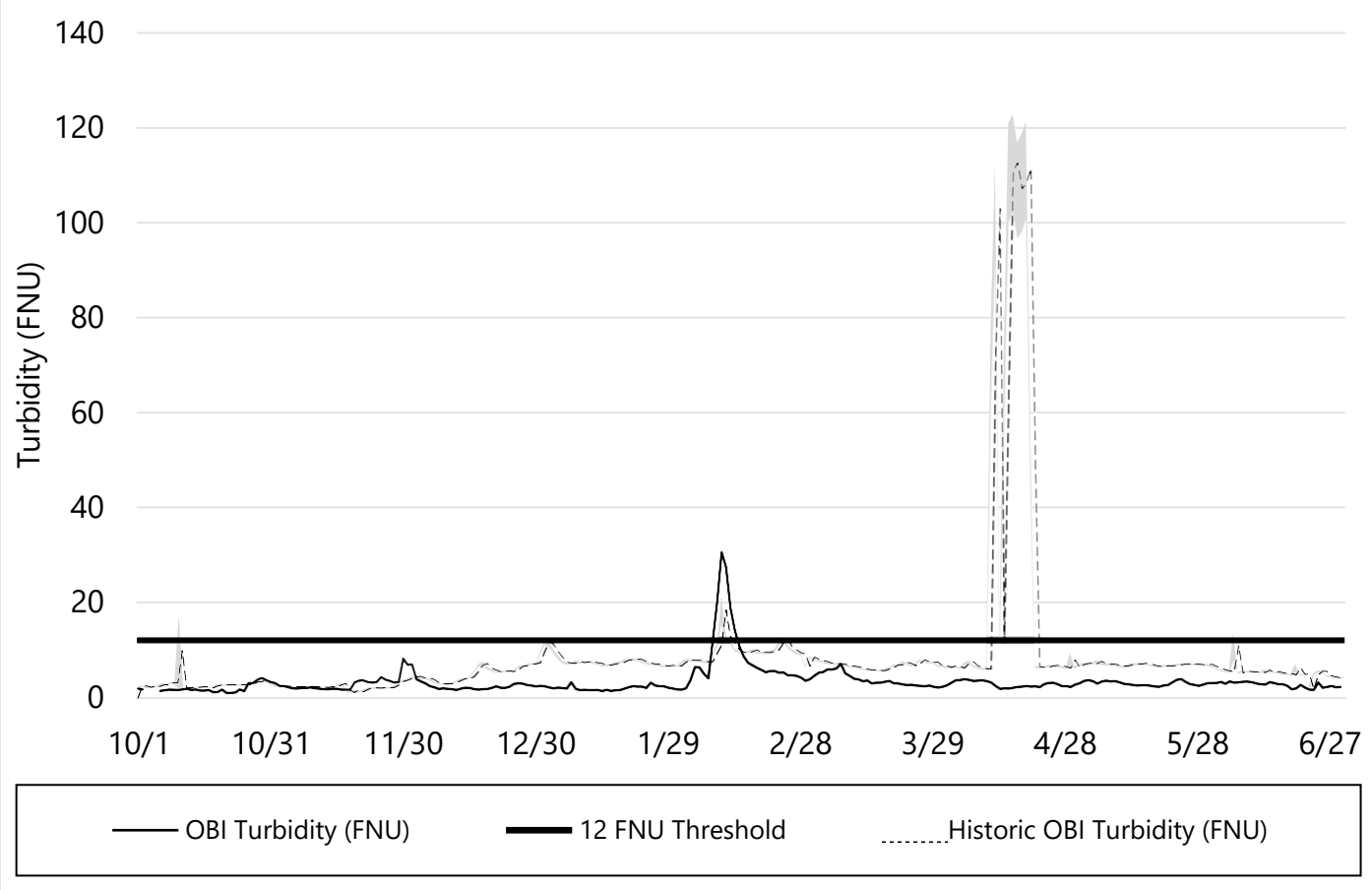


Figure 12. Daily average turbidity (FNU) at Old River at Bacon Island (OBI) in WY 2020 and historic (2009-2020). 90% confidence intervals are shown in gray.

Larval and Juvenile Delta Smelt

The CVP and SWP export facilities transitioned from the Turbidity Bridge Avoidance Action to the Larval and Juvenile Delta Smelt Action on April 1. The Proposed Action identifies that the Turbidity Bridge Avoidance Action shall continue until a ripe or spent female is detected or April 1 (whichever is first). A ripe female Delta Smelt was detected during the week of February 10 in the SKT survey, indicating that the biological and environmental conditions appropriate for adult Delta Smelt spawning were present in February. After the ROD was signed on February 18, 2020, Reclamation provided guidance to the SMT that the detection of a ripe or spent female is a soft

offramp for the Turbidity Bridge Avoidance Action. The projects continued operating to the Turbidity Bridge Avoidance Action until the calendar date offramp occurred on April 1.

The results of the Delta Smelt Life Cycle Entrainment Module (Appendix E) was a contributing factor in setting the OMR operational limit at -5,000 cfs beginning March 13, 2020 and continuing until off ramp criteria were met on 6/26/2020 (Figure 20). Within this time period if QWEST was negative, and Delta Smelt were detected within the entrainment zone of the CVP and SWP export facilities, and the secchi depth in the South Delta was less than one meter, Reclamation would have operated to an OMR no more negative than -3500 cfs. While at times some of the conditions were met, at no point were all conditions met simultaneously (Figure 13 shows QWEST results; Figure 14 shows secchi depth). The COVID-19 pandemic restrictions began on March 17, 2020 and reduced Delta surveys for several weeks but did not impact Reclamation's ability to make real-time decisions under the 2020 ROD.

Particle tracking models based on hydrodynamic forecasts of entrainment were performed bi-weekly or as operational changes were made outside of the operational range of scenarios used in previous model runs. These were reviewed in conjunction with the real time catch data.

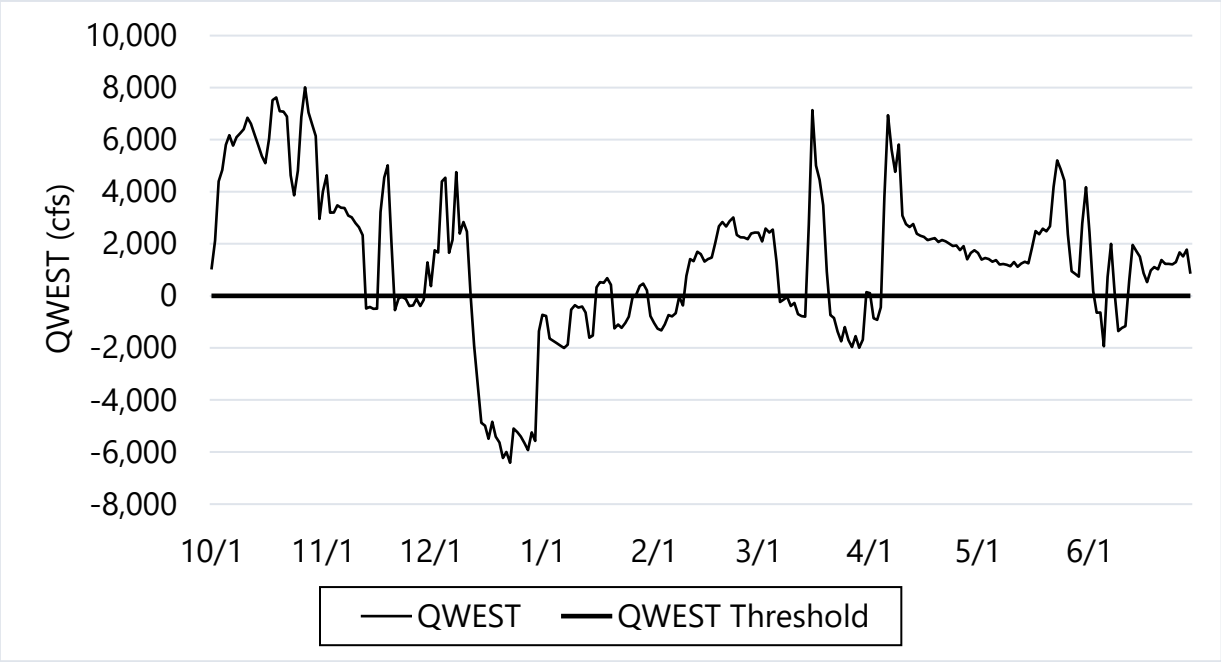


Figure 13. QWEST (cfs) in WY 2020.

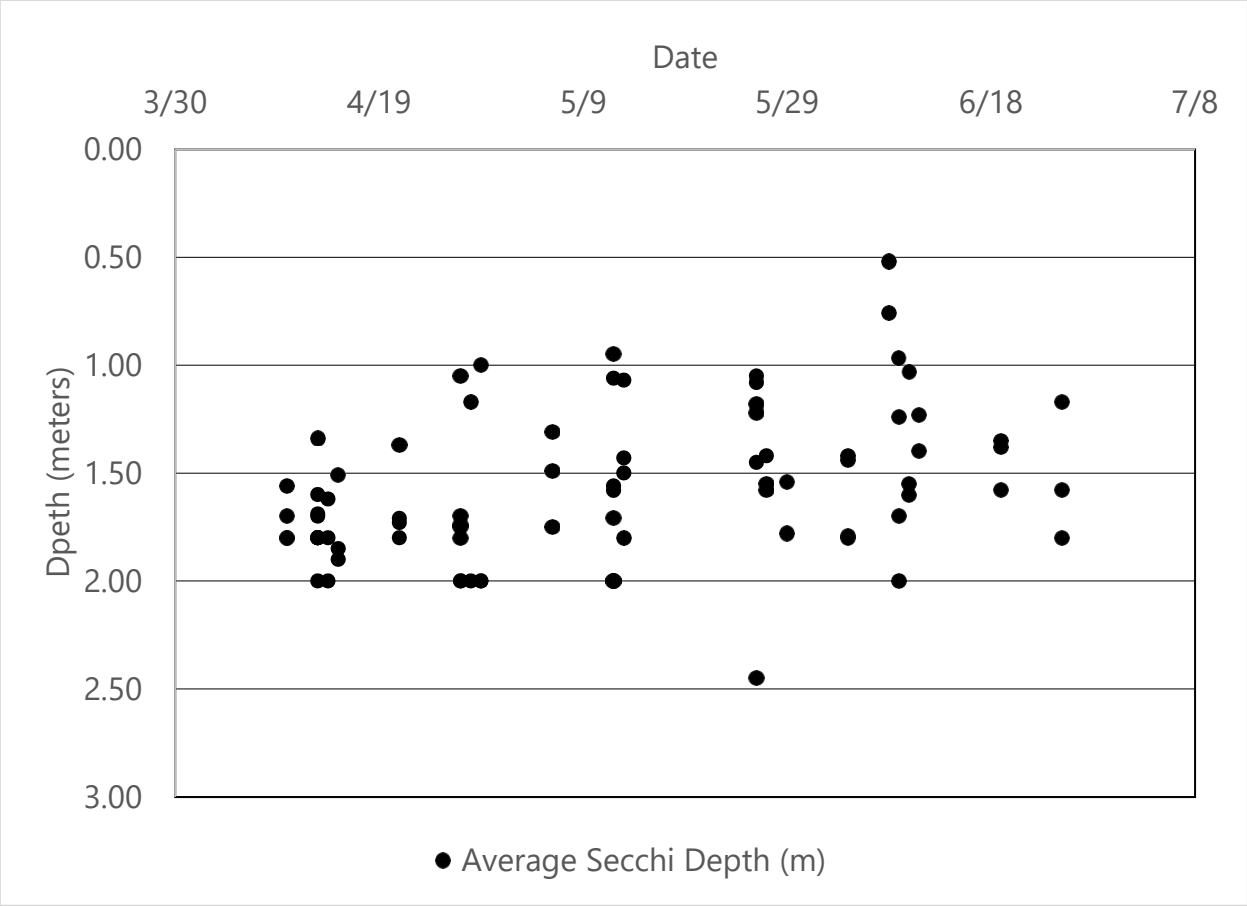


Figure 14. South Delta average secchi depth (m) reported during larval and juvenile Delta Smelt protection.

Salmonid Single-Year and Cumulative Loss thresholds

The ROD sets single-year and cumulative (which lasts the duration of the PA, i.e. ten years) threshold loss values for natural and hatchery winter-run Chinook salmon and steelhead. The single-year and cumulative loss thresholds for winter-run Chinook salmon are also incorporated as Conditions of Approval in the ITP for the SWP. The SaMT tracks daily and cumulative loss to allow recommendations to change of Delta operations throughout the OMR Management Season.

Winter-run Chinook Salmon

The single-year loss threshold for natural winter-run Chinook salmon under OMR flow management is 90% of the greatest annual loss that occurred between 2010 and 2018 which is equivalent to 1.17% of the annually determined juvenile production estimate (JPE). For WY 2020 the JPE was 854,941 natural-origin juvenile winter-run Chinook salmon, with the single-year loss threshold of 1.17% of the JPE equal to 10,002 fish (50% of the single-year loss threshold = 5,001 fish; 75% = 7,502 fish; 90% = 9,002 fish). The cumulative loss threshold over the duration of the ROD (i.e. ten years) is 8,738 fish. Total natural winter-run Chinook salmon (LAD) loss for WY 2020 (10/1/2019 – 7/1/2020) was 197. This loss equaled 3.9% of 50% of the single-year loss threshold;

1.97% of the single-year loss threshold; and 2.3% of the cumulative loss threshold over the duration of the ROD (Figure 15).

Loss did not exceed 50% of the single-year loss threshold during WY 2020. Each week throughout the OMR flow management season, the highest possible cumulative loss was forecasted by using the current cumulative loss combined with the highest historic loss values after the current date. There was no point in the OMR flow management season where the current loss and the highest historic loss would have led to the exceedance of the 50% single-year loss threshold. Freeport flows (cfs) and combined natural winter-run Chinook salmon loss at CVP and SWP fish salvage facilities in WY 2020 are shown in Figure 16. Exports were not decreased as a result of a threshold trigger exceedance.

No hatchery winter-run Chinook salmon were observed in salvage at the CVP and SWP fish salvage facilities WY 2020.

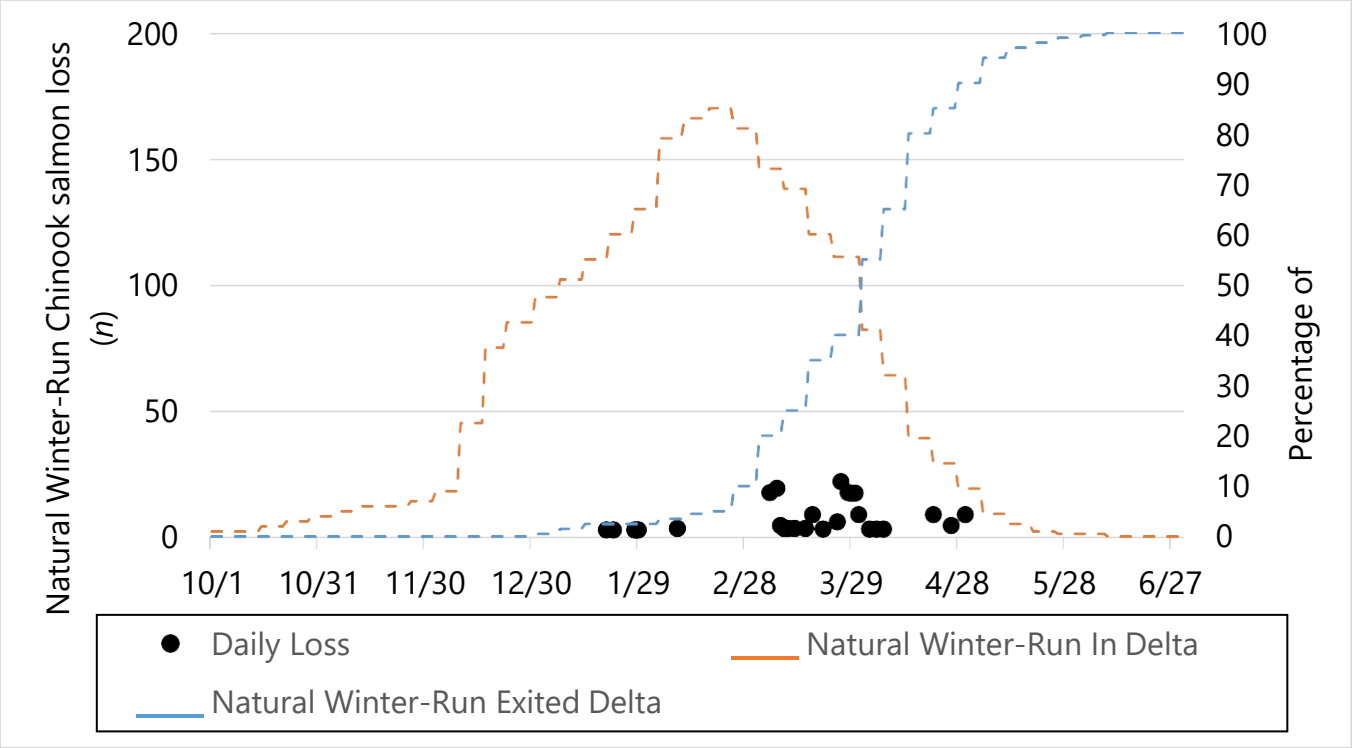


Figure 15. Total loss of natural winter-run Chinook salmon in WY 2020 from 10/1/2019 through 7/1/2020.

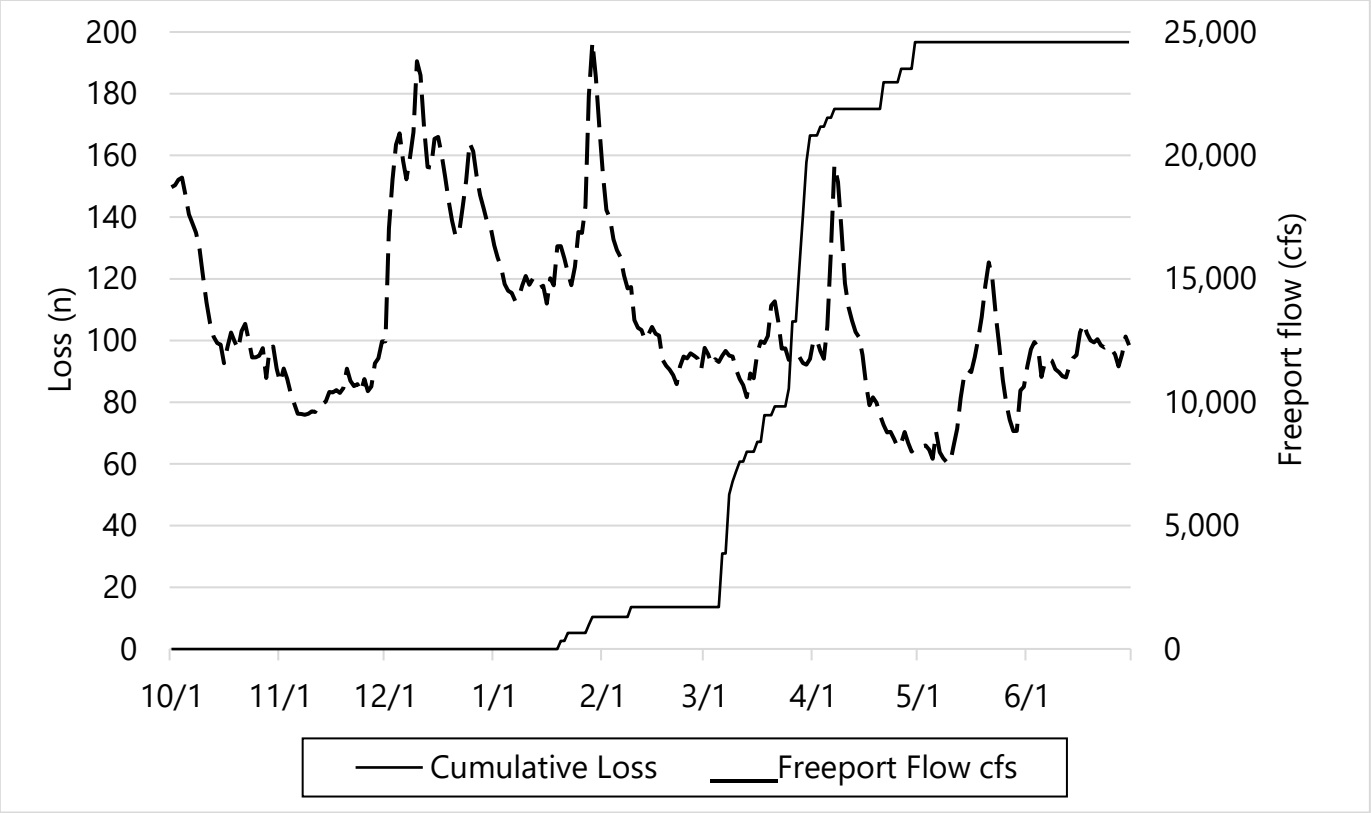


Figure 16. Freeport flows (cfs) and combined natural winter-run Chinook salmon loss at the CVP and SWP fish salvage facilities for WY 2020.

Condition of Approval 8.6.3 in the ITP includes a daily monthly loss threshold for Winter-run Chinook Salmon. The Mid- and Late-season Natural Winter-run Chinook Salmon Daily Loss Threshold protection seeks to minimize entrainment, salvage, and take of natural winter-run Chinook salmon during the peak and end of their migration through the Delta. It requires that DWR restrict south Delta exports for five days to achieve a five-day average OMR index no more negative than -3,500 cfs when daily loss of natural older juveniles at the SWP and CVP salvage facilities exceeds the following thresholds based on the JPE reported in January of the same calendar year:

• January 1 - January 31: 0.00635 % of the winter-run Chinook salmon JPE

• February 1 - February 28: 0.00991 % of the winter-run Chinook salmon JPE

• March 1 - March 31: 0.0146 % of the winter-run Chinook salmon JPE

• April 1 -April 30: 0.00507 % of the winter-run Chinook salmon JPE

• May 1 - May 31: 0.0077 % of the winter-run Chinook salmon JPE

From January to May 2020 monthly loss thresholds were not exceeded at the SWP fish salvage facility (Figure 17).

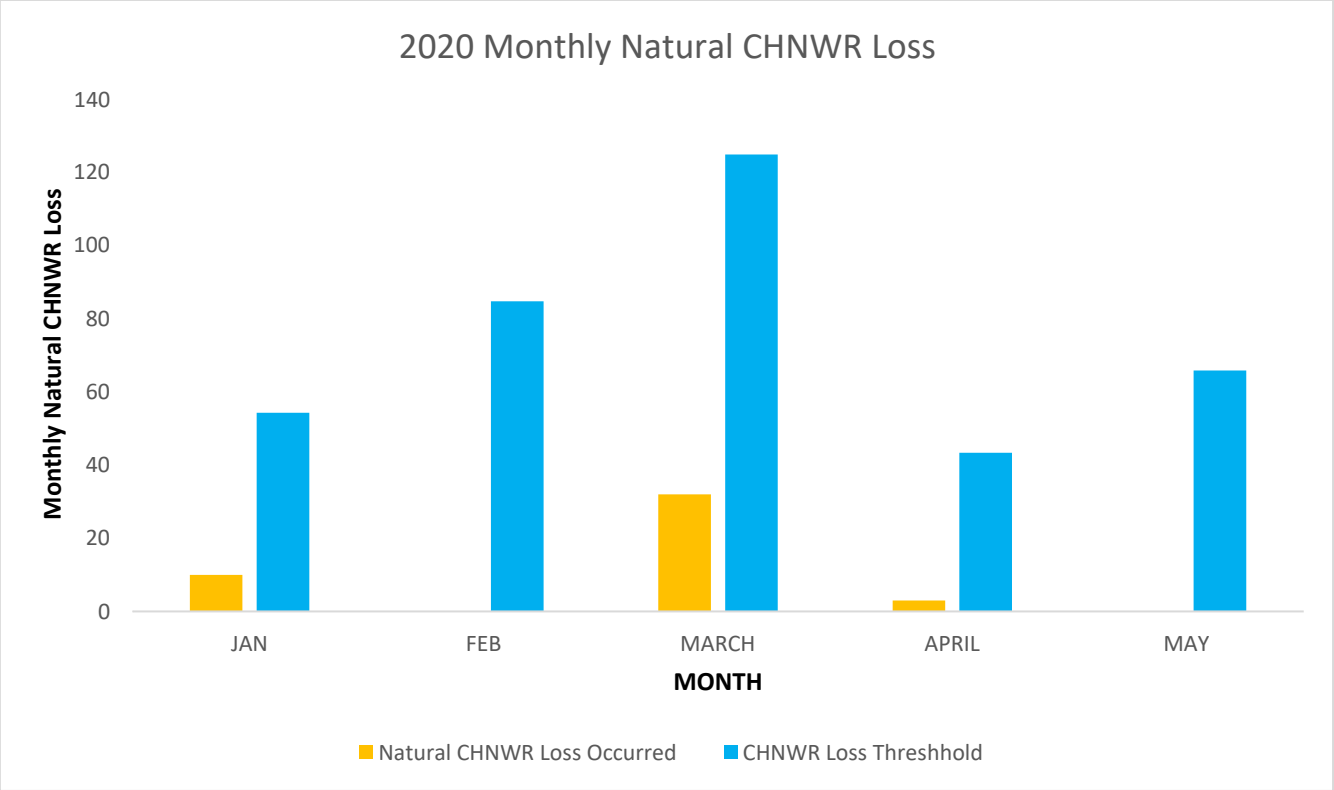


Figure 17. ITP monthly loss thresholds for winter-run Chinook salmon (CHNWR).

Steelhead

There are two single-year loss thresholds set for natural steelhead under OMR flow management conditions: December 1 – March 31 and April 1 – June 15. The ROD was signed on 2/18/2020; however, Reclamation managed to the full season, including the season under the prior BiOp. Since steelhead outmigrate from both the Sacramento and San Joaquin river basins, this split in the season was created to capture those that outmigrate earlier (Sacramento River Basin) and those that outmigrate later (San Joaquin River Basin) (see NMFS 2019 BiOp, Table 11). The single-year loss thresholds for natural steelhead under the ROD's OMR flow management are set at 90% of the greatest annual loss from 2010 through 2018. The single-year loss threshold under the ROD for December 1 – March 31 is equal to 1,414 fish (50% of the single-year loss threshold = 707 fish; 75% = 1,061 fish; 90% = 1,273 fish). The ROD's single-year loss threshold for April 1 – June 15 is equal to 1,552 fish (50% of the single-year loss threshold = 776 fish; 75% = 1,164 fish; 90% = 1,397 fish). The cumulative loss threshold over the duration of the ROD (i.e. ten years) is equal to 6,038 fish for the December 1 -March 31 time period, and 5,826 fish for the April 1 - June 15 time period. For the December 1 – March 31 time period, a total of 402 natural steelhead were lost: this loss equals 56.9% of 50% of the single-year loss threshold under the PA; 28.4% of the single-year loss threshold; and 6.7% of the cumulative loss threshold over the duration of the ROD (Figure 18). For the April 1 – June 15 time period, a total of 324 natural steelhead were lost: this loss equals 41.7% of 50% of the single-year loss threshold; 20.9% of the single-year loss threshold; and 5.6% of the cumulative loss threshold over the duration of the ROD (Figure 18). SaMT did not estimate the distribution of natural steelhead within the Delta prior to 4/1/2020. About 50% of natural steelhead were present within the Delta during the peak of natural steelhead loss at the CVP and SWP fish salvage facilities. Loss did not exceed 50% of either of the single-year loss thresholds during WY

2020. Exports were not decreased as a result of a threshold trigger exceedance for natural steelhead during either the early or later periods of migration.

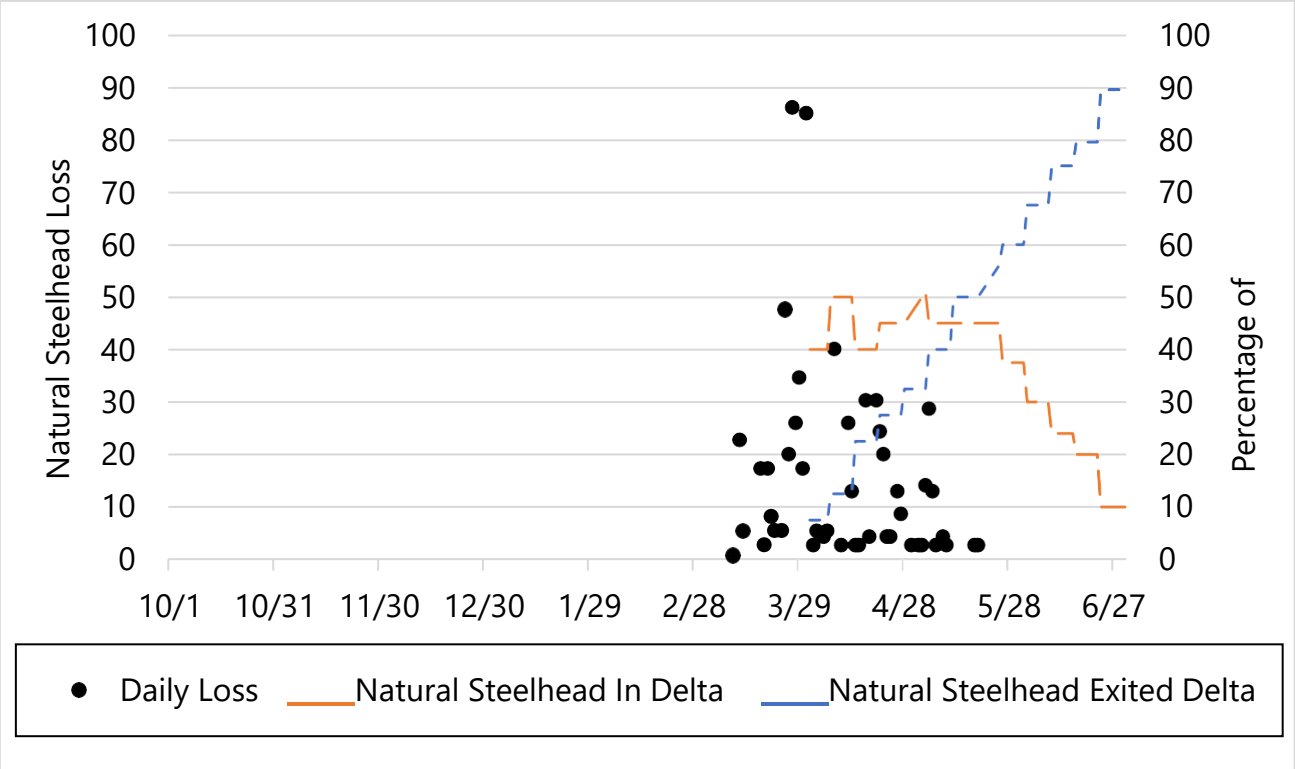
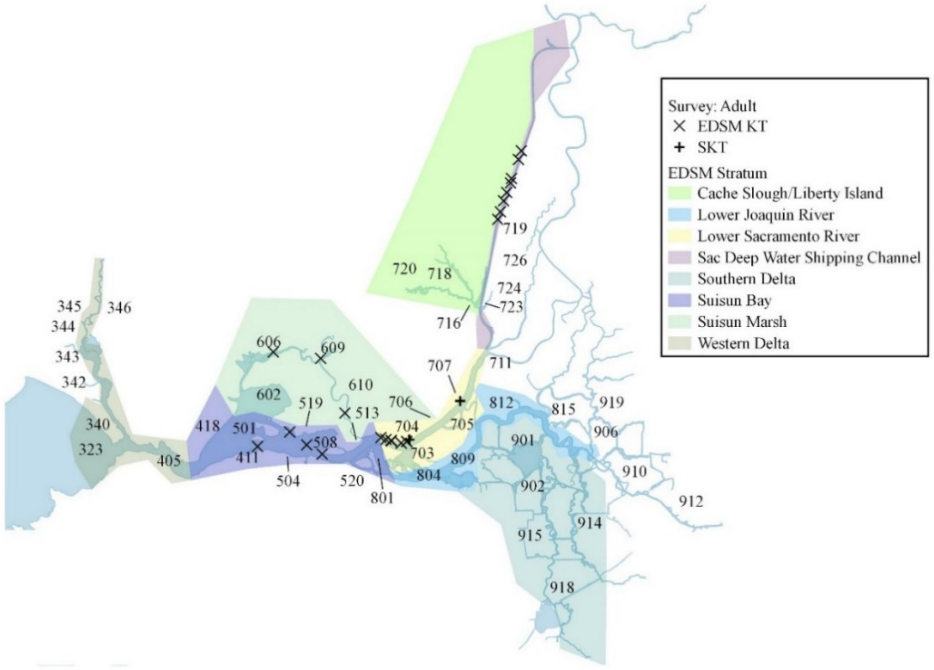


Figure 18. Total loss of natural steelhead loss for WY 2020.

Delta Smelt Detections

All Delta Smelt catch data were reported to the SMT (catch and salvage locations shown in Figure 19) and considered in Reclamation's assessments. A ripe female Delta Smelt was detected by the SKT #2 at station 707 in the Lower Sacramento River on 2/12/2020 prior the signing of the ROD. On 4/13/2020, a larval Delta Smelt was identified in the CVP fish salvage facility larval monitoring activities, indicating that adult Delta Smelt had likely spawned in the south Delta.

A.



B.

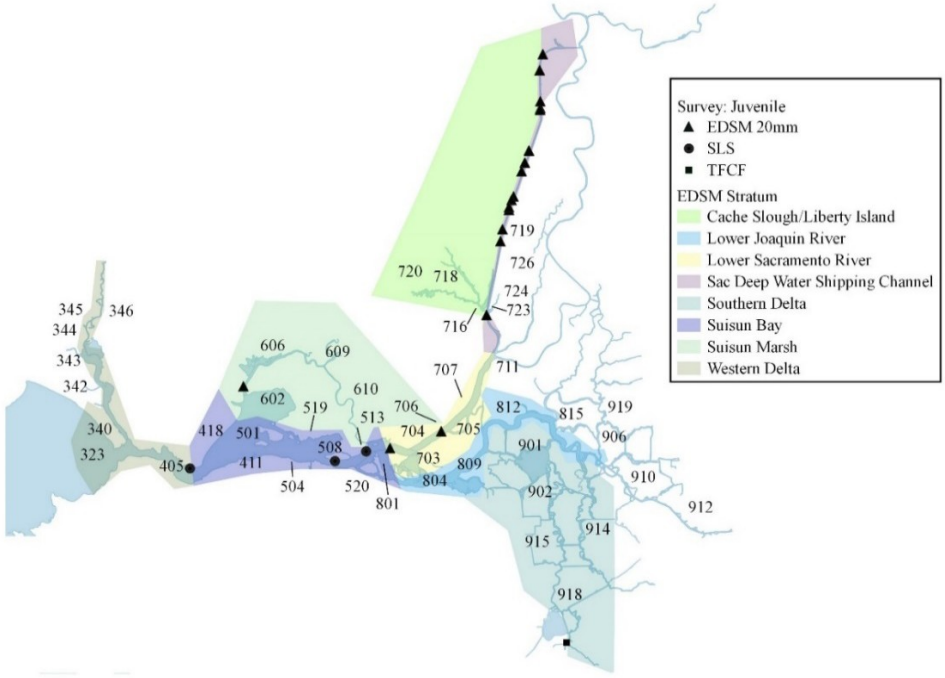


Figure 19. Delta Smelt seasonal catch and salvage locations in WY 2020 (all surveys conducted between 10/1/2019 - 6/31/2020). EDSM: 20mm and KT (Kodiak Trawl), Spring Kodiak Trawl (SKT), Smelt Larva Survey (SLS), Tracy Fish Collection Facility (TFCF). The CDFW 20mm Survey caught no Delta Smelt in WY2020. EDSM Stratum shown as colored polygons, and the number labels are the approximate location of the CDFW Survey Stations. **A.** Surveys targeting adult and late juvenile life stages of Delta Smelt. **B.** Surveys targeting larval and early juvenile life stages of Delta Smelt.

Storm-Related OMR Flexibility

Reclamation and DWR did not determine that the Delta outflow index increased in response to a storm-related event that would indicate a higher level of flow available for export. Thus, none of the additional real-time OMR restrictions prevented or concluded operations under storm-related OMR flexibility conditions.

End of OMR Management

Average daily temperatures at three sites (Clifton Court Forebay (CCFB), Mossdale, and Prisoner's Point) were tracked from 6/1/2020 – 6/30/2020 to mark the end of the OMR flow management season (Figure 20). The offramp criterion for Delta Smelt is met when the daily average water temperature at CCFB reaches 77° F for three consecutive days. The CCFB criterion was met on 6/26/2020, and thus ended the OMR flow management season for Delta Smelt. The offramp criteria for salmonids is met when more than 95% of salmonids have migrated past Chipps Island, or after the daily average water temperature at Mossdale exceed 71.6° F (72° F NMFS BiOp) for seven days during June. Daily average water temperature to meet offramp criteria at Mossdale were not met and, thus, the OMR management season for Chinook salmon ended on 6/30/2020 and for steelhead on 6/15/2020.

In the ITP, OMR Management for the SWP goes through June 30, or until the following species-specific off-ramps occur:

• Longfin Smelt and Delta Smelt: Daily mean water temperature at CCFB is greater than 25°C for three consecutive days.

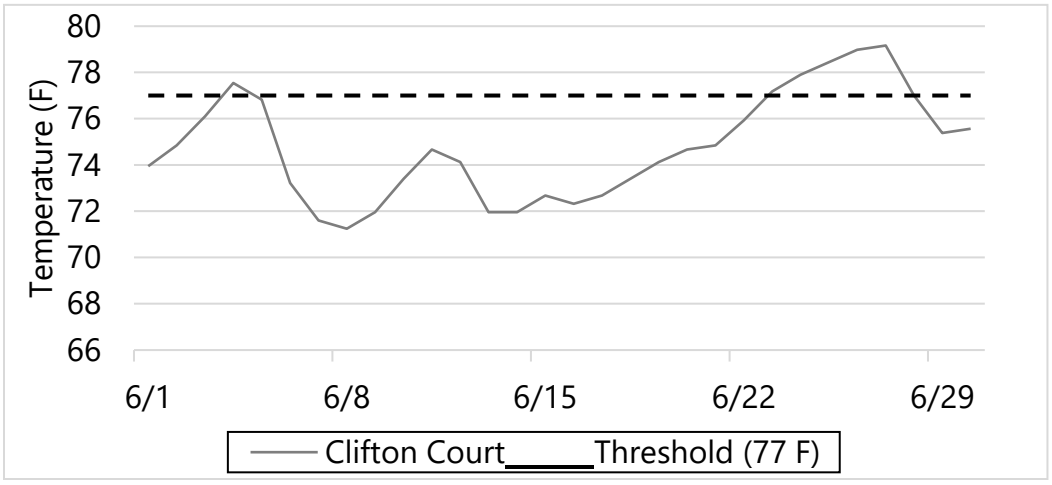
• Winter-run and spring-run Chinook salmon:

  o More than 95% of winter-run and spring-run have migrated past Chipps Island as determined by the SaMT, and

  o Daily average water temperature at Mossdale exceeds 22.2°C for 7 non-consecutive days in June, and

  o Daily average water temperature at Prisoner's Point exceeds 22.2°C for 7 non-consecutive days in June.

A.



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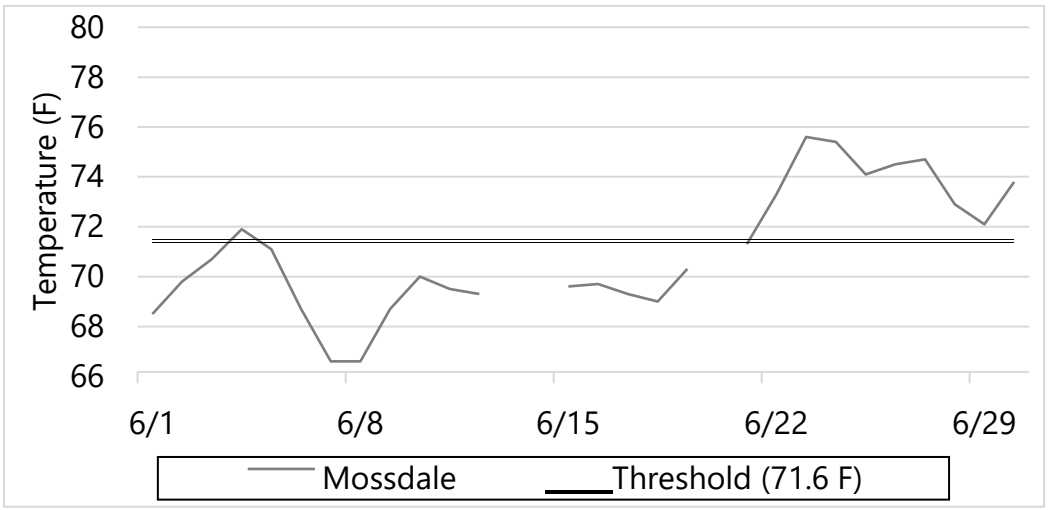

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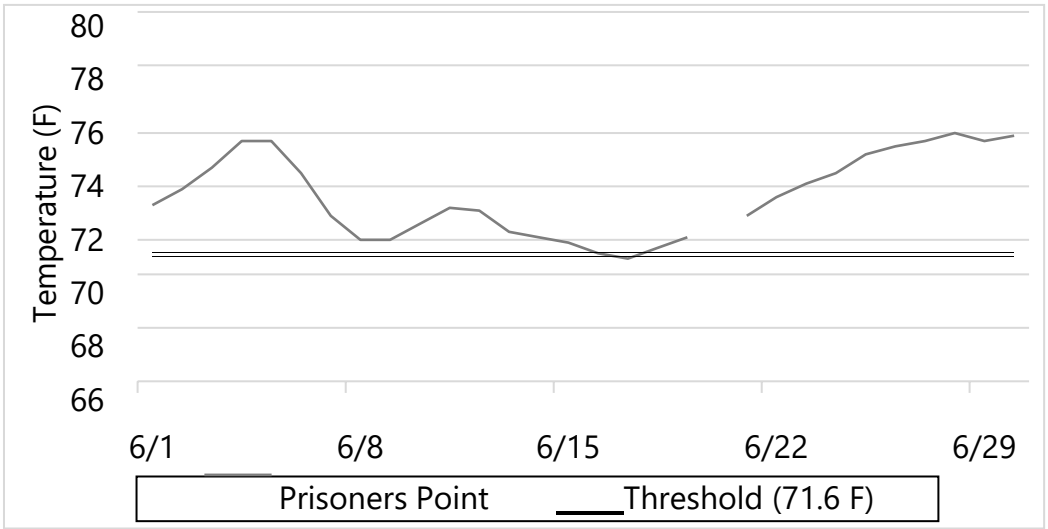


Figure 20. Average daily temperatures (F) at **A.** Clifton Court Forebay, **B.** Mossdale, and **C.** Prisoner's Point in June 2020.

South Delta Agricultural Barriers

Photo 2. Agricultural barrier on Old River near Tracy, California. (DWR)

During WY 2020 the South Delta agricultural barriers were installed. Construction of the Middle River barrier started on 5/1/2020 and ended 5/9/2020. On 6/12/2020, the remaining flap gate was released to tidal operation. The notching of the Middle River barrier for the passage of adult salmon was completed on 9/14/2020. Removal of the barrier began on 11/2/2020. On Old River near Tracy, the in-water construction of the barrier started on 5/4/2020, and the barrier was closed 5/29/2020 with one tidal flap gate remaining tied open and the rest operating tidally. The final tidal flap gate was released on 6/12/2020. The notching of the Old River near Tracy Barrier for the passage of adult salmon was completed on 9/14/2020. Removal of the barrier began on 11/2/2020. Grant Line Barrier in-water construction started 5/11/2020 and the barrier closed on 6/1/2020 with all flap gates tied open. On 6/15/2020 all flap gates were released to tidal operation. The adjustment of the flashboard structure at Grant Line Canal Barrier for the passage of adult salmon was completed on 9/15/2020. Removal of the barrier is tentatively scheduled to begin on 11/12/2020.

Export Curtailments for Spring Outflow

The relevant sections of the ITP are Section 3.8 Minimum Export Rate and Condition 8.17 Export Curtailments for Spring Outflow.

For ITP compliance purposes, the export rate for the SWP is calculated as the inflow to CCFB minus the Byron Bethany Irrigation District (BBID) diversion from the forebay. The diversion by BBID is approximately 30 cfs/day in April and 50 cfs/day in May.

In addition, daily Vernalis flow is unknown at the time SWP exports are scheduled, so a 3-day running averaging period is used for both the San Joaquin flow at Vernalis and SWP exports, to smooth out daily, short-term fluctuations. This provides operators with a reasonable methodology for calculating scheduled SWP exports and is aligned with the SWRCB's compliance methodology for D-1641 regarding exports during the 31-day April-May Vernalis period. The SWRCB's D-1641 specifies (footnotes [17] and [18] on page 186) there shall be a 31 day pulse flow during the April-May period, scheduled in coordination with USFWS, NMFS and CDFW, during which combined CVP and SWP Jones and Banks exports shall be 1500 cfs or the 3 day running average of Vernalis flow, whichever is greater.

Appendix F of this report includes conditions relevant to Section 8.17 in April 2020 and May 2020 including 3-day average Vernalis flow, 3-day average pumping at the SWP export facility, 3-day average SWP exports, 40% Vernalis flow with minimum of 600 cfs, 40% of half of Vernalis flow with minimum of 600 cfs, ratio of Vernalis flows to combined exports, and daily OMR index values.

The San Joaquin River Year Type was Critical at the start of April 2020. From April 1 through April 11, the proportional share of SWP exports were less than 40% of Vernalis flow. The 31-day pulse flow period specified in D-1641 began on April 10 and lasted through May 10. From April 12 through May 7, SWP exports were such that the combined CVP and SWP exports were less than or equal to Vernalis flow (all parameters calculated as a 3-day running average).

On May 8, the hydrologic year type for the San Joaquin River watershed was re-classified as Dry based on updated hydrologic information. Therefore, beginning on May 10, with the change in year type, the allowable proportional share of SWP exports changed to 40% of half of Vernalis flow or 600 cfs. However, because of dry hydrology, Vernalis flow never exceeded 3,000 cfs in May, and SWP exports were less than 600 cfs from May 8 to May 31.

The operations data shown in Appendix F demonstrates that Section 8.17 (Export Curtailments for Spring Outflow) of the ITP was met in April and May of 2020 by limiting SWP exports in accordance with the terms described in the ITP.

WOMT Elevation to Directors

No WOMT member elevated OMR flow management concerns to directors during WY 2020 (Appendix G).

Performance

Delta Cross Channel Closures

The Delta Cross Channel was operated consistent with the ROD during the OMR flow management season (Figure 5). Prior to the ROD signing on 2/18/2020, DCC gate operations were consistent with the 2009 NMFS BiOp.

For winter-run Chinook salmon, Figure 2A shows the Knights Landing Catch Index (KLCI) from 10/1/2019 – 6/30/2020 and Figure 2B shows the Sacramento Catch Index (SCI) seine data for 10/1/2019 – 12/28/2019 and trawl data for 12/8/2019 – 12/27/2019. The last KLCI calculation for WY 2020 was made on 5/26/2020. Trapping ended on 5/26/20 due to high river temperatures reaching 70°F; sampling was completed in late May for the season. During WY 2020, Sacramento River winter-run Chinook salmon presence was highest at the Knights Landing rotary screw trap in mid-December; however, the DCC gates had been closed on 12/1/2019. Therefore, there was reduced potential for fish to be routed into the Central and South Delta regions.

On 11/27/2019, the SCI indicated a high catch of winter-run Chinook salmon; however, there was a delay in closing the DCC gates until 12/1. Thanksgiving holiday staffing and notice to boaters were cited as contributing factors to the delay. Reclamation closed the DCC gates at the next opportunity after considering safety issues.

Early Integrated Winter Pulse (First Flush) and Turbidity Management

First Flush criteria apply from December 1 through January 31 and, therefore, did not apply to WY 2020 as the ROD was not signed until February 18, 2020. A review of flow and turbidity data at Freeport show that First Flush criteria would not have been met in WY 2020 (Figure 7A shows the 3-day running average of flow at Freeport; Figure 7B shows the 3-day running average of turbidity at Freeport).

OMR Onramp and Offramp

The onset of OMR flow management season occurred prior to the signing of the ROD on 2/18/2020. OMR flow restrictions commenced on January 1, 2020 as required by the 2009 NMFS BiOp which required that OMR flow be no more negative than -5,000 cfs. The OMR flow data were given for the daily, 5-day, and 14-day values for both gage and index values. Compliance with RPA action IV.2.3 was applied to the running average of the 14-day OMR flows, with the 5-day average being no more than 25% more negative than the -5,000 cfs threshold. When the ROD was signed, Reclamation transitioned into the Turbidity Bridge Avoidance action.

The OMR flow management season for Delta Smelt ended when the CCFB water temperature offramp criterion (greater than 77°F for three consecutive days) was met on 6/26/2020. The

Mossdale offramp criteria was not met in WY 2020, and thus the OMR flow management season for Chinook salmon ended on 6/30/2020. The OMR flow management season for CCV steelhead was met by the calendar date offramp on 6/15/2020.

Salvage Performance

In WY 2020, none of the single-year loss thresholds (50%, 75%, 90%, and 100%) for salmonids (natural winter-run Chinook salmon and natural steelhead in either December 1 – March 31 or April 1 – June 15 time-periods) were exceeded. No adult Delta Smelt were salvaged during the OMR flow management season.

Winter-run Chinook Salmon

In WY 2020, none of the single-year loss thresholds (50%, 75%, 90%, and 100%) for natural winter-run were exceeded. Zero hatchery winter-run Chinook salmon were lost in WY 2020.

Total natural winter-run Chinook salmon (LAD) loss for WY 2020 (10/1/2019 – 7/1/2020) was 197 fish which represents 3.9% of the 50% single-year loss threshold (5,001 fish) (Figure 21). There is no historic loss rate (2009 – 2020) that would have led to the exceedance of the 50% single-year loss threshold in WY 2020.

In WY 2020, 6.9% of natural winter-run Chinook salmon salvage occurred by 2/29/2020 and 84.6% of salvage occurred by 3/31/2020. On 2/25/2020, the SaMT estimated 81% of natural winter-run Chinook salmon were within the Delta, while 10% were estimated to have exited past Chipps Island. On 4/1/2020, SaMT estimated 41% of natural winter-run Chinook salmon were within the Delta, while 55% were estimated to have exited past Chipps Island. The majority of loss at the CVP and SWP fish salvage facilities occurred before April 1st when approximately 40% of the run was still estimated to be present in the Delta.

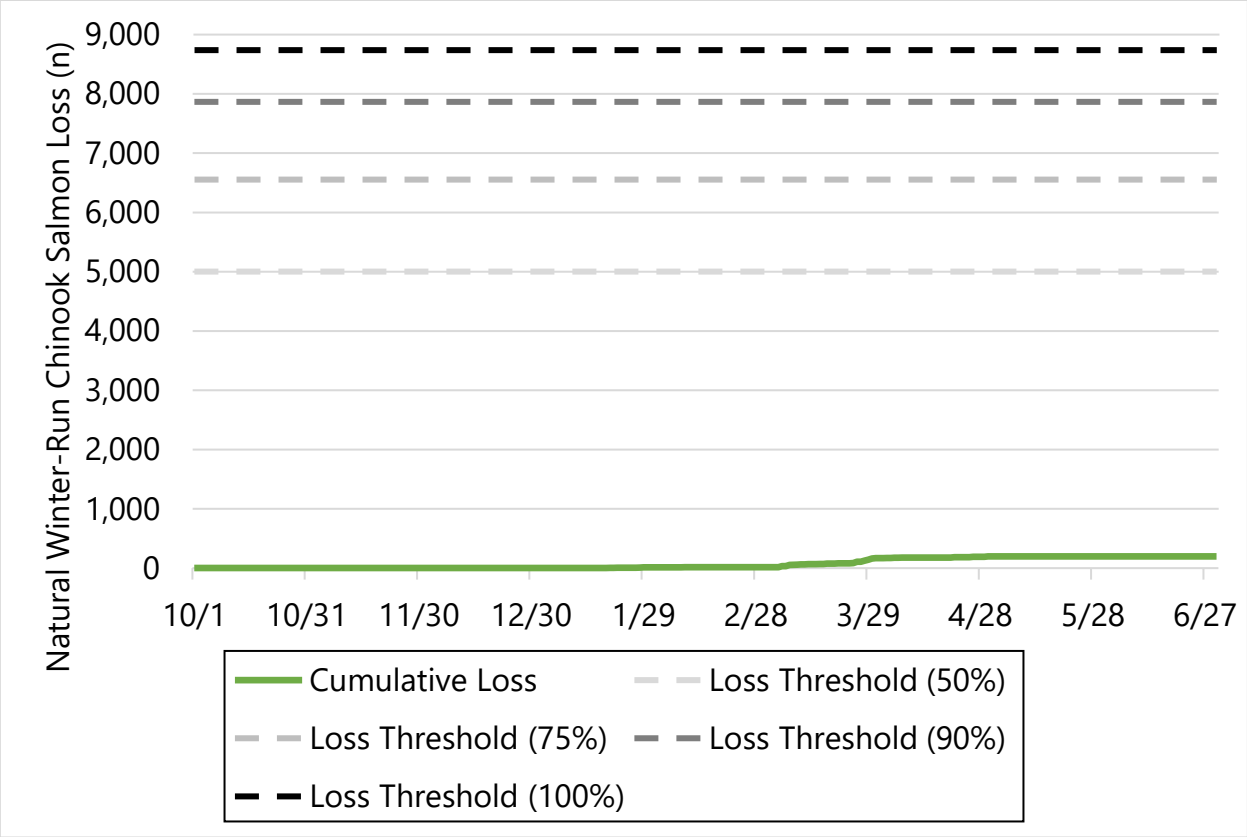


Figure 21. Total natural winter-run Chinook salmon (LAD) loss for WY 2020.

A total of 197 natural winter-run Chinook salmon were lost in WY 2020; 183 since the ROD was signed on 2/18/2020 and 14 between 10/1/2019 and 2/17/2020. The cumulative loss threshold for natural winter-run Chinook over the duration of the ROD is 8,738 fish. At the end of WY 2020, current loss is 2.1% of total allowed loss (Figure 22). A 45° line is superimposed to track the trajectory of natural winter-run Chinook salmon loss over the duration of the ROD. The line is created assuming each year's natural winter-run Chinook salmon loss is equal to the annual average used to calculate the cumulative loss.

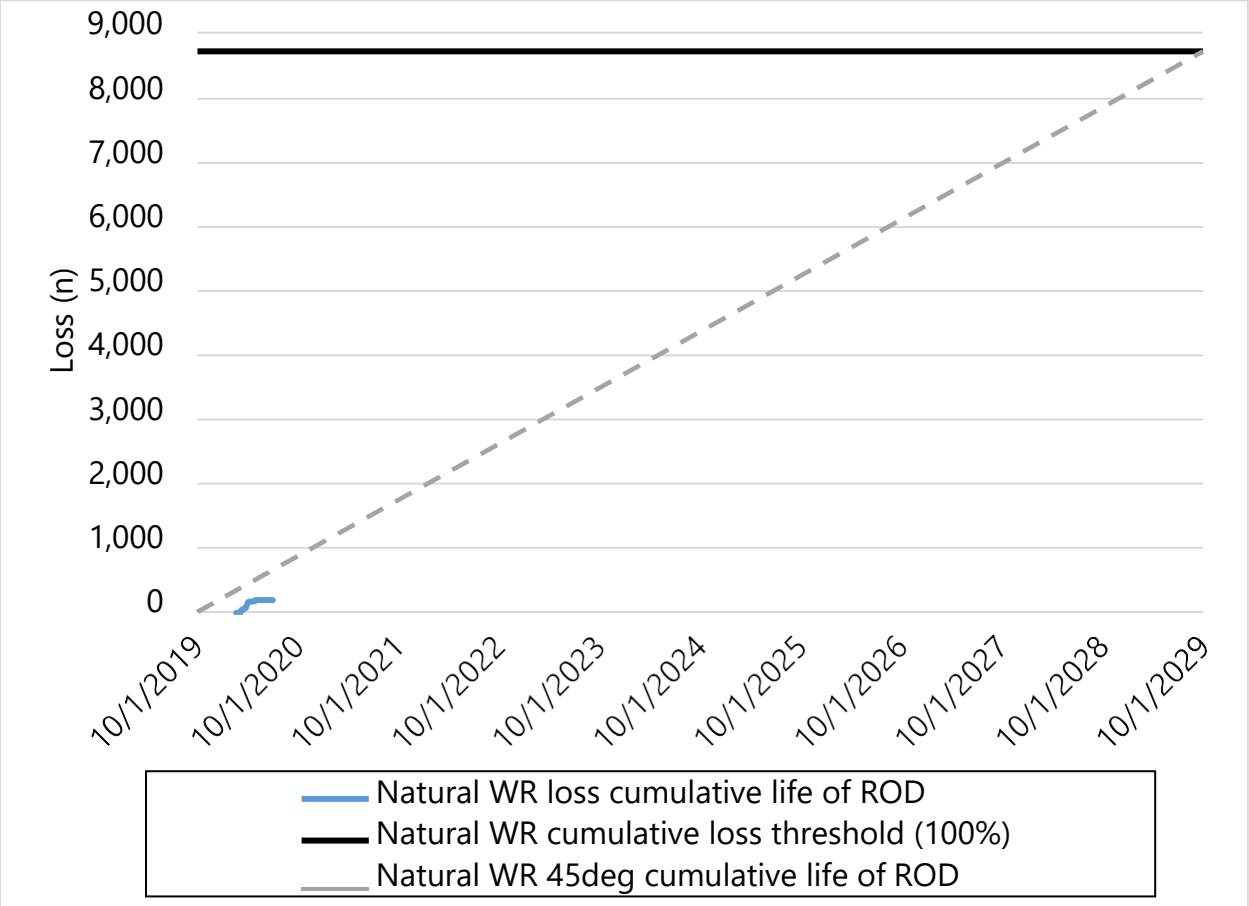


Figure 22. Cumulative loss threshold for natural winter-run Chinook salmon in WY 2020. A 45° line is superimposed to track the trajectory of natural winter-run Chinook salmon loss over the duration of the ROD.

Steelhead

Total natural steelhead loss for WY 2020 (10/1/2019 – 7/1/2020) did not exceed any of the single-year loss thresholds (Figure 23). Total natural steelhead loss was 402 fish between December 1 and March 31 which represents 56.7% of the 50% single-year loss threshold (707 fish). Total natural steelhead loss for WY 2020 was 324 between April 1 and June 15 which represents 41.7% of the 50% single-year loss threshold (776 fish).

In WY 2020, 55.3% of natural steelhead loss occurred by 3/31/2020 and 44.7% of natural steelhead loss occurred after that date, until the end of the OMR flow management season on 6/15/2020. SaMT did not provide natural steelhead population estimates before 4/1/2020. On 4/1/2020, the SaMT estimated the distribution of natural steelhead within the Delta to be 40%, and distribution of natural steelhead that had exited past Chipps Island to be 7.5%. Thus, more than half the season's steelhead loss occurred at the CVP and SWP fish salvage facilities by 3/31/2020 before more than half the population was estimated to have migrated past Chipps Island.

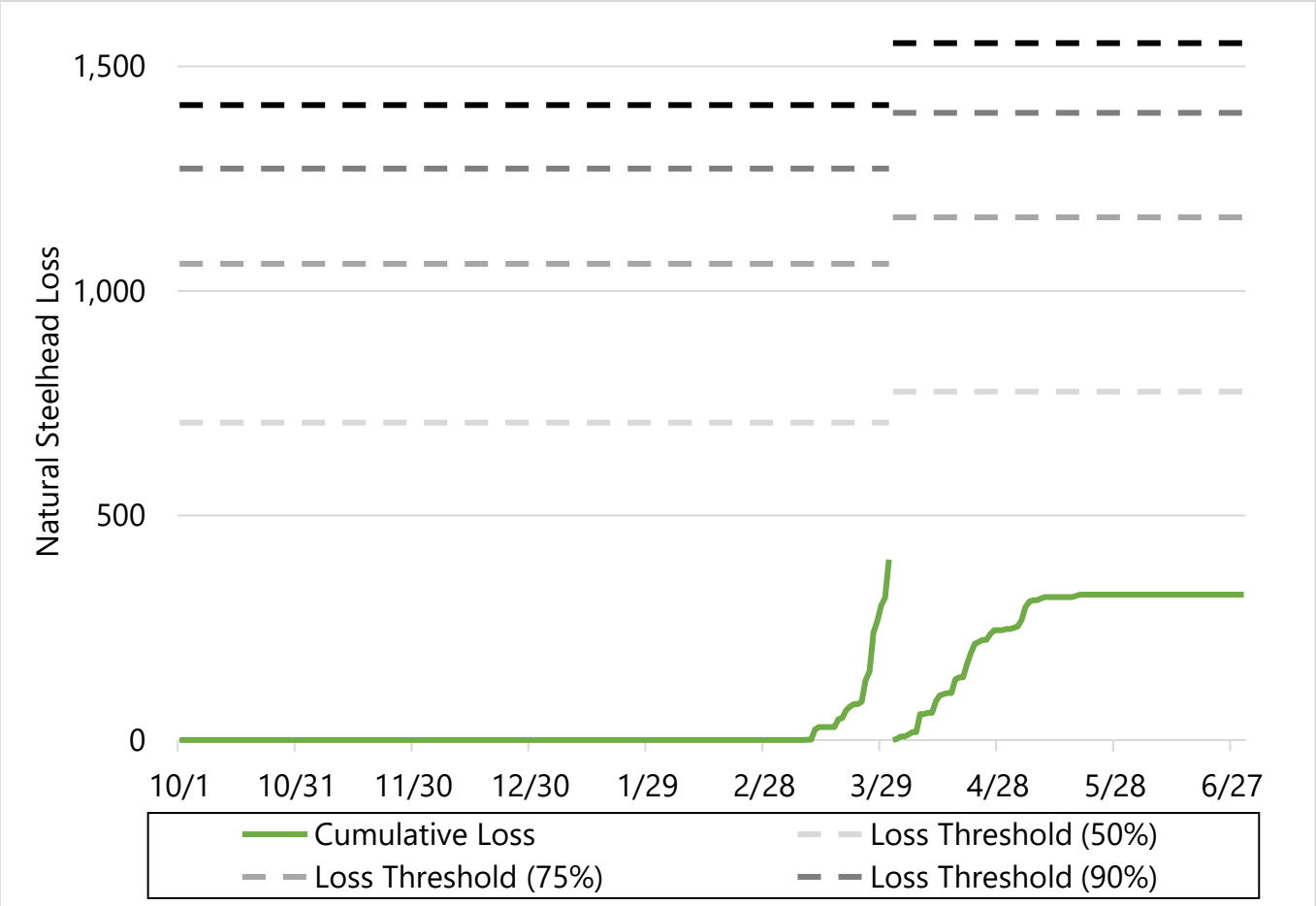
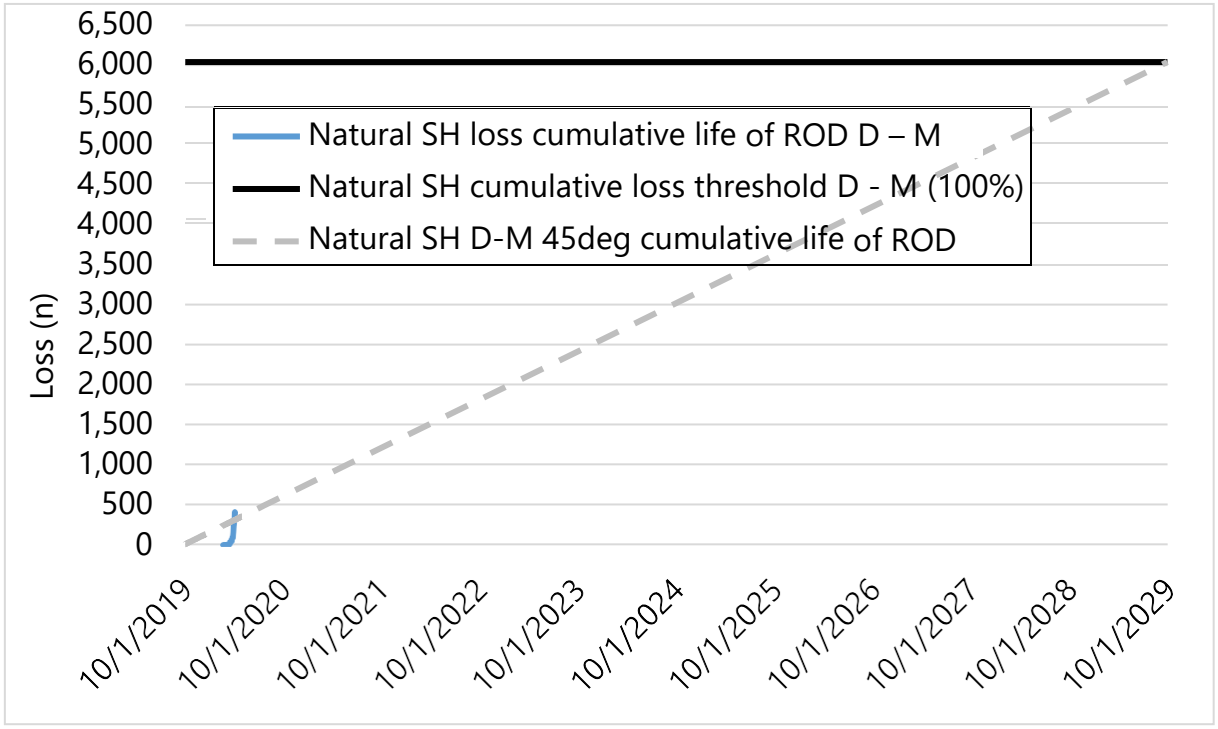


Figure 23. Single-year loss for natural steelhead for WY 2020.

A total of 402 natural steelhead fish were lost in WY 2020 from 2/18/2020 to 3/31/2020. The cumulative loss threshold for steelhead over the 10-year duration of the ROD for the period from December 1 to March 31 is 6,038 fish. At the end of WY 2020, the loss for the first "season" is 6.7% of the cumulative total loss for this period (Figure 24A). A total of 324 natural steelhead fish were lost in WY 2020 from 4/1/2020 to 6/15/2020. The cumulative loss threshold for steelhead over the 10-year duration of the ROD for the period between April 1 and June 15 is 5,826 fish. At the end of WY 2020, the loss for the second "season" is 5.6% of the cumulative total loss for this period (Figure 24B). A 45° line is superimposed to track the trajectory of natural steelhead loss over the duration of the ROD. The line is created assuming each year's steelhead loss is equal to the annual average used to calculate the cumulative loss.

A.



B.

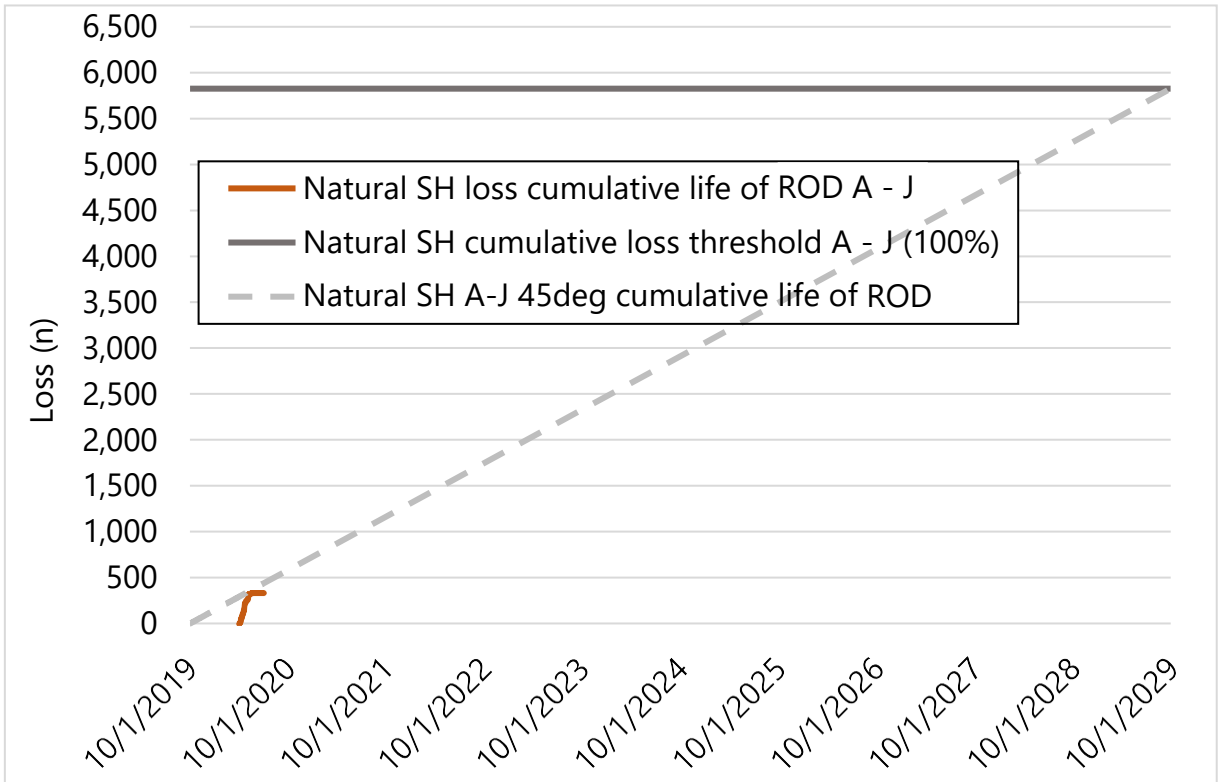


Figure 24. Cumulative loss for natural steelhead in WY 2020 **A.** December 1 – March 30 and **B.** April 1 and June 15. A 45° line is superimposed to track the trajectory of natural winter-run Chinook salmon loss over the duration of the ROD.

Salmonids and Historic Performance

Historic natural winter-run Chinook salmon loss by month by year (2009 – 2019), with loss shown as percentage of total water year loss, is shown in Figure 25. The highest percentage of historic loss occurs in March. In WY 2020, 77.7% of loss occurred in March.

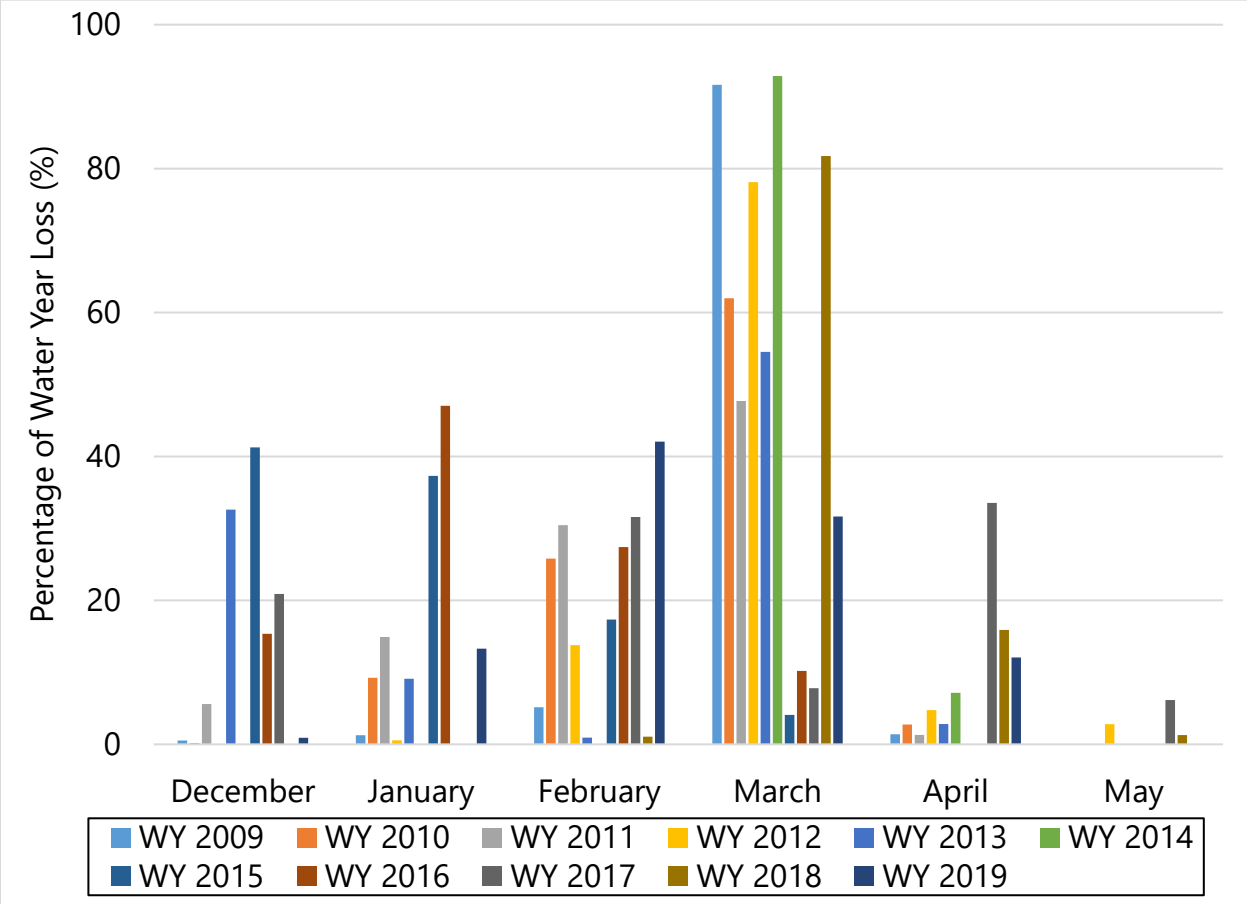


Figure 25. Historic natural winter-run Chinook salmon loss by month by WY (2009 - 2019).

Historic natural steelhead loss by month by year (2009 – 2019) is shown in Figure 26, with loss shown as percentage of total water year loss. Historic loss occurred more frequently from December 1 to March 30 than from April 1 to June 15 in 7 of the last 11 years (2009 – 2019).

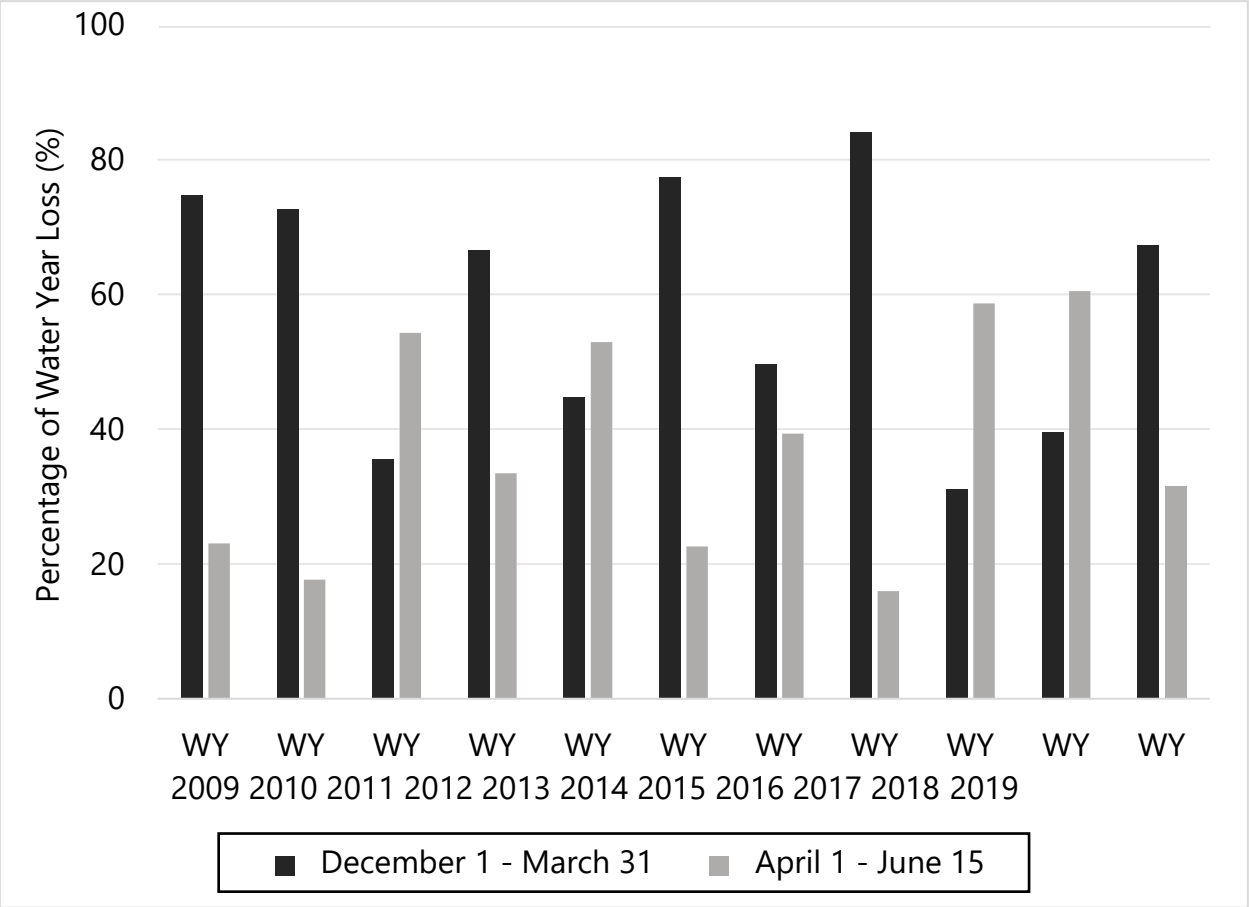


Figure 26. Historic natural steelhead loss by action period "season" (December 1 – March 31, April 1 – June 15) by year (2009 – 2019). Loss shown as percentage of total water year loss. Seven out of the ten years most of natural steelhead loss consistently occur.

From 1996 to 2019, five years were classified with Sacramento Valley (SV) "dry" water year index (2001, 2002, 2007, 2009, 2013) and eight years were classified with SV "wet" water year index (1996, 1997, 1998, 1999, 2006, 2011, 2017, and 2019). Among all of these water years, the loss signatures for natural winter-run Chinook salmon and steelhead varied widely (Table 1).

Table 1. Total loss of natural winter-run Chinook salmon and steelhead by Sacramento Valley (SV) water year type (wet or dry) (1996-2019).

Water Year	Type	Total Loss Natural Winter-Run Chinook Salmon	Total Loss Natural Steelhead
1996	Wet	14539.55	2375.77
1997	Wet	1382.52	629.71
1998	Wet	468.96	1525.19
1999	Wet	4868.49	3715.27
2001	Dry	13895	20062.1
2002	Dry	3566.21	1871.34
2006	Wet	2380.17	2601.28
2007	Dry	5342.87	3297.64
2009	Dry	877.23	1514.79
2011	Wet	2612.21	4359.9
2013	Dry	2263.04	731.72
2017	Wet	193.85	110.65
2019	Wet	1479.51	565.65

Even though the ITP was not signed until March 31, 2020 the Early-season Natural Winter-run Chinook Salmon Discrete Daily Loss Threshold for the SWP was not met in November and December of 2019, nor was the Mid- and Late-season Natural Winter-run Chinook Salmon Daily Loss Threshold exceeded at either the SWP or CVP fish salvage facilities between January and May 2020.

Delta Smelt

Adult Delta Smelt Salvage

No adult Delta Smelt were salvaged during the OMR flow management season.

Larval Delta Smelt Sampling

Larval Delta Smelt sampling methods began on 3/16/2020. A single Delta Smelt (12mm) was detected at the Tracy Fish Collection Facility (TFCF) on 4/13/ 2020. On 6/1/2020, the SMT began evaluating if the labor-intensive process of the larval sampling would continue every week. The

TFCF ended larval sampling methods on 6/17/2020 and the Skinner Delta Fish Protection Facility ended larval sampling methods on 6/19/2020.

Longfin Smelt

Across the entire water year, there was zero salvage of adult Longfin Smelt. Salvage of YOY (>20mm) Longfin Smelt began in April at the SWP fish salvage facility (Figure 27). Once salvage began, it rapidly increased until May 17, when the last Longfin Smelt salvage was observed. For WY 2020, total Longfin Smelt salvage was 1,360 fish for the SWP.

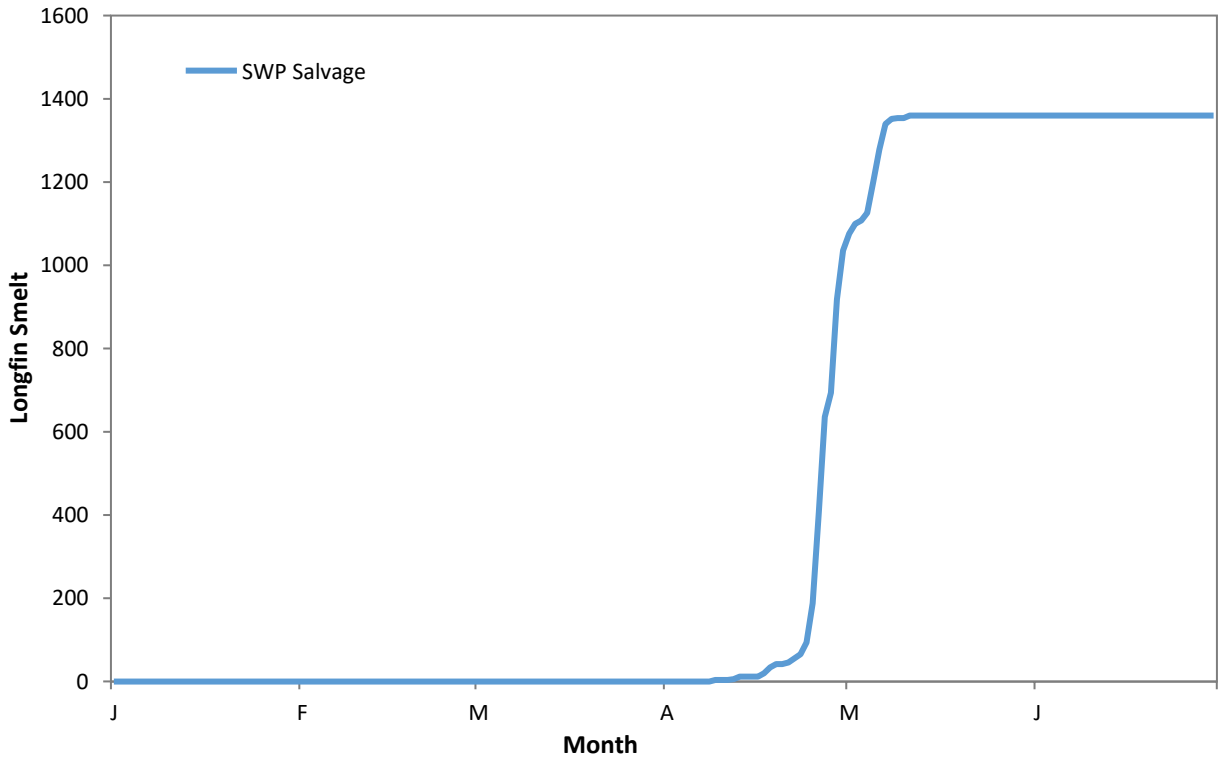


Figure 27.Cumulative salvage of YOY Longfin Smelt at the SWP.

Storm-Related OMR Flexibility

Storm-Related OMR Flexibility did not occur in WY 2020.

Export Curtailments for Spring Outflow

The operations data shown in Appendix F demonstrates that Condition 8.17 (Export Curtailments for Spring Outflow) of the ITP was met in April and May of 2020 by limiting SWP exports in accordance with the terms described in the ITP.

Discussion

Throughout the OMR flow management season, Reclamation and DWR remained well below the loss thresholds for both natural and hatchery winter-run Chinook salmon and natural steelhead. The annual thresholds are set for 90% of maximum loss (as a percentage of JPE) over the sample period for each year. The biological effects of salmonid loss in the CVP and SWP fish salvage facilities were less than those set by the annual and cumulative thresholds in WY 2020. The OMR requirement was not a major factor in controlling operations during WY 2020. Therefore, there is little information gathered on OMR no more negative than -5,000 cfs or reducing OMR to avoid thresholds in evaluating the effects on species.

Delta Cross Channel

Outmigrating 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 OMR flow management season, the DCC gates remained closed during time periods of highest risk for juvenile salmonids. This action provided a high level of protection for juvenile salmonids outmigrating down the Sacramento River. The triggers identified in the ROD (KLCI and SCI values, coupled with other monitoring efforts which indicate pulses of migrating salmonids into the Delta [estimated from weekly fish distribution estimates]) were met once in October and once in November when the DCC gates were open.

On 11/27/2019, DCC gates should have been closed due to the high catch of winter-run Chinook salmon in the SCI but did not close until 12/1/2019. Thanksgiving holiday staffing and notice to boaters were cited as contributing factors to the delay. Reclamation closed the DCC gates at the next opportunity after considering these safety concerns.

After 12/1/2019, the KLCI and SCI trigger thresholds were exceeded several times, but since the DCC gates were already closed this did not result in any operational actions (Figure 2).

Integrated Early Winter Pulse Protection ("First Flush")

While the USFWS 2019 BiOp and the ROD were not in place during the period of the "First Flush" action it is informative to consider whether conditions would have met the thresholds to inform planning for the upcoming season. The flow and turbidity thresholds of the First Flush action would not have been met in the WY 2020 OMR flow management season. Pulses in both turbidity and flow were observed during the month of December (Figure 7A and B) but none of these events exceeded the thresholds required for implementation of the action. A total of only nine Delta Smelt were detected during December in Suisun Bay, Sacramento Deepwater Ship Channel, and the Lower Sacramento stratums (as defined by EDSM) which provides little evidence for or against the occurrence of a migratory response as Delta Smelt appear in all these stratum throughout the year.

Turbidity Bridge Avoidance ("South Delta Turbidity")

Turbidity data at Old River at Bacon Island (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 threshold for determining the conditions necessary for the formation of a turbidity bridge surpassed the threshold of 12 FNU as consequence of a wind driven turbidity event from February 9 to February 14, 2020 (Figure 12). Because the CVP and SWP were already operating to the most positive OMR range possible, no additional recommendation was deemed necessary by the SMT. The examination of other Delta stations isolated the event as the result of wind driven conditions in that location, and no evidence from that event was associated with creating an increase or decrease in the entrainment of adult Delta Smelt was found.

Larval and Juvenile Delta Smelt Protections

Reclamation's operations were based on the Delta Smelt Life Cycle Entrainment Module in WY 2020 for the first time. Use of the Delta Smelt Life Cycle Entrainment Module is an ongoing discussion between the agencies; agencies may refine the use of the module for upcoming OMR flow management seasons. While the state of QWEST is easily examined by the monitoring team, determining the spatial distribution of larval or juvenile smelt in the South Delta is confounded by the EDSM surveys not including the South Delta during Phase 2 sampling, in addition to the extremely low population abundance of Delta Smelt. The Smelt Larval Survey and the 20-mm survey did sample the South Delta and collect secchi depth information during this time period (from March 15 until offramp criteria are met). However, the rarity of Delta Smelt will confound all sampling to detect fish in the South Delta. In addition, current monitoring of secchi depth information in the South Delta is limited to the Smelt Larval Survey's and 20-mm Survey's manual collection; subsequently the real-time reporting of the turbidity will be limited to only a few sites. In the WY 2020 OMR flow management season this is further confounded by the reduction in sampling events to accommodate COVID-19 restrictions (e.g. the cancellation of 20-mm Survey #2); however, this did not impact Reclamation's ability to make real-time decisions under the 2020 ROD. The 2020 ROD does not rely on the 20-mm Survey for real-time decision making.

Salmonid Presence-Based OMR Onramp and Offramp

Salmonid presence (an estimate of >5% of any one or more listed salmonid species in the Delta) is used as a presence-based condition to start the OMR flow management season. OMR flow management actions for listed salmonids will not start prior to January 1, regardless of the percentage of listed salmonids in the Delta. The ROD was signed 2/18/2020; however, as of 1/1/2020 the estimate for natural winter-run Chinook salmon in the Delta was 44-58%, which is greater than the 5% threshold and would have triggered the OMR flow management actions (OMR no more negative than -5,000 cfs).

Beginning 6/1/2020, the Delta Monitoring Teams begin tracking several parameters to mark the end of the OMR flow management season. In the ROD, the OMR flow management season ends on June 30 (Chinook salmon) or June 15 (natural steelhead) or when specific off-ramp criteria thresholds occur, whichever is earlier: > 95% of each listed salmonid group has migrated past

Chipps Island (weekly SaMT distribution estimate), or Mossdale water temperature exceeds 71.6°F (22°C) for seven days in June (does not have to be consecutive). In the ROD, the season ends on June 30 or when a specific off-ramp occurs, whichever is earlier: > 95% of each listed salmonid group migrated past Chipps Island (weekly SaMT distribution estimate), Mossdale water temperature exceeding 72°F (22.2°C) for seven days in June (does not have to be consecutive).

OMR season ended on 6/15/2020 for steelhead and on 6/30/2020 for Chinook salmon. The last natural winter-run Chinook salmon was lost on 4/30/2020. The last natural steelhead lost within the OMR flow management season occurred on 5/19/2020; however, the majority of the loss occurred between 4/1/2020 and 5/6/2020. The last fish were salvaged well before the end of the OMR flow management season. The OMR flow management season under the ROD stayed within take limits for natural steelhead and natural winter-run Chinook salmon.

The CVP and SWP export facilities operated OMR to be 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 (Figure 28). Operations were not constrained by any fishery-related loss restrictions, but other factors such as D-1641 (Figure 5).

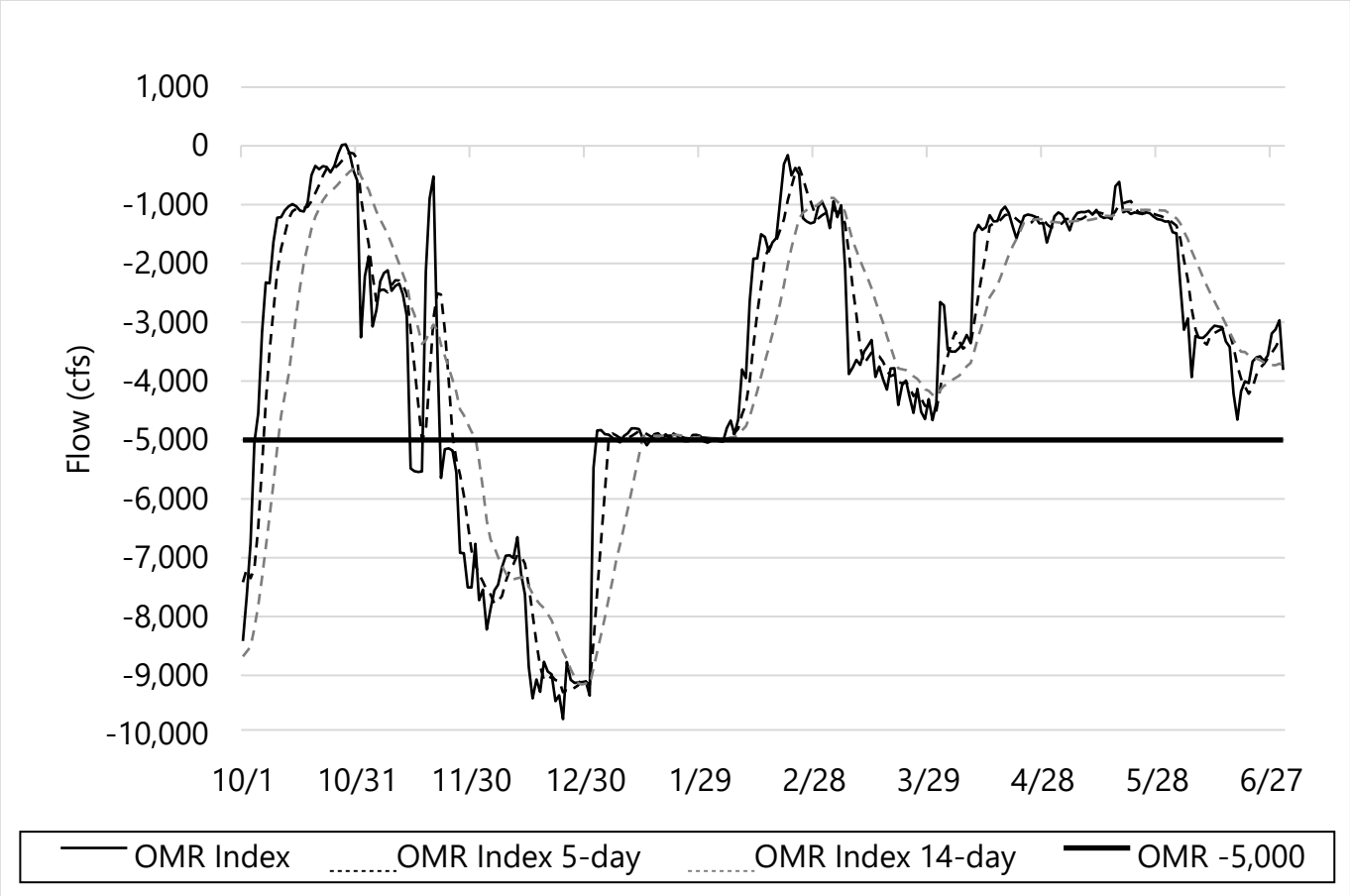


Figure 28. OMR index values (1-, 5-, and 14-day) for WY 2020.

For the ITP for the SWP, OMR flow management goes through June 30, or until the following species-specific off-ramps occur:

• Longfin Smelt and Delta Smelt: Daily mean water temperature at CCF is greater than 25°C (77°F) for three consecutive days.

• Winter-run and spring-run Chinook salmon:

  o More than 95% of winter-run and spring-run Chinook salmon have migrated past Chipps Island as determined by the SaMT, and

  o Daily average water temperature at Mossdale exceeds 22.2°C (72°F) for seven nonconsecutive days in June, and

  o Daily average water temperature at Prisoner's Point exceeds 22.2°C (72°F) for seven nonconsecutive days in June.

Average daily temperatures are tracked at three sites (Clifton Court Forebay, Mossdale, and Prisoner's Point) to mark the end of the OMR flow management season 6/1/2020 – 6/30/2020. Daily average water temperature to meet offramp criteria at Mossdale (72° F in the NMFS 2019 BiOp and 71.6° F in Reclamation's ROD) and CCFB (77° F) were not met in WY 2020 (Figure 20). The distribution estimates of greater than 95% winter-run and spring-run Chinook Salmon juveniles exited past Chipps Island was met on 05/12/2020 and 06/29/2020, respectively. The OMR flow management season ended 6/30/2020 for Delta Smelt and Chinook salmon.

Salvage

Throughout the OMR flow management season, Reclamation and DWR remained well below the loss thresholds for natural steelhead, natural winter-run Chinook salmon, and hatchery winter-run Chinook salmon that would have triggered operational changes leading to more positive OMR flow levels.

One larval Delta Smelt (12 mm) was collected in in larval sampling on 4/13/2020 at the TFCF. Because it was under 20 mm and detected in larval sampling, it does not count towards the official total number of Delta Smelt salvaged during regular fish counts.

Across the entire water year, there was zero salvage of adult Longfin Smelt. There was consistent salvage of YOY Longfin Smelt at the SWP fish salvage facility in April (Figure 27). Once salvage began, it rapidly increased until May 17, when the last Longfin Smelt salvage was observed. For WY 2020, total Longfin Smelt salvage was 1,360 fish for the SWP.

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 change weekly from projections provided by the SaMT. 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 (DSM2 model runs, STARS model projections, entrainment model projections).

DSM2

Throughout the OMR flow management season, weekly DSM2 runs were modeled (Appendix H). Each week, two OMR scenarios representing an operational range were compared to a baseline OMR using a Kolmogorov–Smirnov (K-S) statistical test. The effect of the CVP and SWP export facilities' hydraulic footprint was discussed at the SaMT meetings. To assess the effects of operations, the Delta was subdivided into several regions: (1) the Central Delta from the Sacramento River to the Western Delta; (2) the South Delta from the San Joaquin River to the Central Delta; and (3) facilities in the South Delta. Within each of these regions, fish behavior was assessed. DSM2 modeling of potential operational changes indicated hydraulic changes near the export facilities, however the likelihood of fish presence in those regions was low, thus, no operational changes were required.

SacPAS

SacPAS is a website that provides monitoring, evaluation, and web-based data products for management of salmon and smelt. The SaMT and SMT rely on this publicly accessible, web-based query system to provide data support for real-time decision making during the OMR flow management season. SacPAS has included data queries and alerts used by multiple work groups and teams on topics including, but not limited to, water temperature, salvage, river conditions, escapement, and juvenile monitoring.

An entrainment tool (SacPAS Loss and Salvage Predictor, http://www.cbr.washington.edu/sacramento/lossandsalvage/) has been developed and is available on SacPAS. Reclamation produced weekly figures for salvage of natural winter-run Chinook salmon and steelhead layered onto historic loss data (2009 – 2019). During WY 2020 OMR flow management season, none of the plots for natural winter-run Chinook salmon raised concerns that historic loss would cause WY 2020 loss to exceed the 50% of single-year threshold (Figure 29). Reclamation generated plots and evaluated, on a weekly basis, whether the 50% single-year threshold was likely to be exceeded. Throughout the OMR season, there was never an evaluation which showed the potential for exceedance. For example, Figure 29, which was created on 3/31/2020, demonstrates that even if a cumulative maximum weekly loss (2009 – 2019 data, gray polygon surrounding the dashed black line) were to occur, the 50% of single-year threshold would not have been triggered.

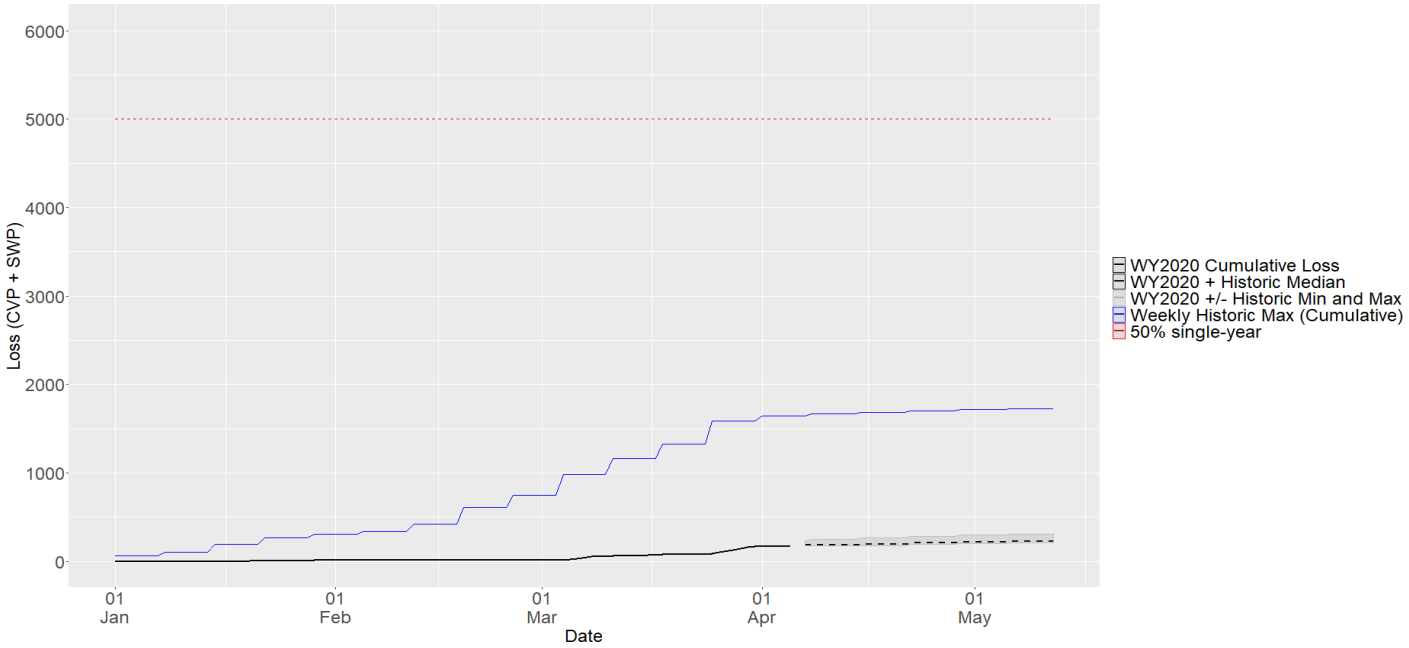


Figure 29. Cumulative natural winter-run Chinook salmon loss plotted mid-season on 3/31/2020 (black line).

Distribution Estimates and Cumulative Salvage

The SaMT provides weekly distribution estimates for three categories: (1) species yet to enter the Delta; (2) species within the Delta; and (3) species that have exited the Delta past Chipps Island. These weekly estimates are made by incorporating the best available real-time data (salvage, hatchery releases, catch at important monitoring sites, DSM2 hydrodynamic modeling, etc.). Water year 2020 surveys for real-time fish distribution data were challenged by many surveys not being completed after the statewide COVID shelter-in-place order, which resulted in quite a few of these surveys being reduced or cancelled from March to June. Reclamation maintained its fish salvage monitoring throughout water year 2020, and provided regular daily sampling to the SaMT to track percentage of fish salvaged in conjunction with percentage of fish estimates to be within the Delta and percentage of fish estimated to have exited the Delta. Considering these two variables, life history strategy and salvage, allowed SaMT to consider risk (e.g., 15% of 50% of single year threshold and 40% of the population within the Delta would result in less risk than 40% of 50% of single year threshold and 80% of the population within the Delta).

In WY 2020, there were low detections of salmonids at locations considered by SaMT to produce distribution estimates (e.g., Knights Landing and other sampling stations sampled few winter-run Chinook salmon). Given conditions (high production of juvenile winter-run Chinook salmon indicated by a large return of spawning adults, and high number of juvenile winter-run Chinook salmon migrating past Red Bluff Diversion Dam), historic trends would suggest higher numbers of winter-run Chinook salmon were expected at all locations, including the CVP and SWP fish salvage facilities. The challenge of the shelter-in-place restrictions on monitoring was compounded with other potential sources of uncertainty in WY 2020. Some other possible causes for low detection of juvenile salmonids in WY 2020 include assumptions about sampling bias and effort at each survey location, potential impacts due to thiamine-deficient early life stages, and different and unique hydrologic conditions. Data from monitoring multiple key locations as well as tracking acoustic

tagged salmonids may reduce uncertainty in the JPE. Also, understanding how to improve our estimates of temperature-dependent versus temperature-independent mortality and how the full range of management actions potentially affect survival can further improve our estimates of the JPE. These data could be evaluated during the annual Interagency Ecological Program winter-run Chinook salmon Project Work Team review and recommendations of the JPE methodology.

The JPE varies considerably by water year type (Table 2) suggesting many abiotic and biotic processes influence its value. As discussed in the Salmonids and Historic Performance section of this report, loss signatures vary widely by water year type.

Table 2. Winter-run Chinook salmon JPE by brood year (BY) and water year type (2009 – 2020).

Year	**WRCH BY**	**WR JPE**	**Sac Basin Year Type**
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: 82366	Wet
2020	2019	JPE: 854,941 Hatchery JPE: 94,528 Battle Cr JPE: 67,257	Dry

The single-year loss for natural steelhead was projected through the end of the OMR flow management season on a weekly basis using historic losses from 2009 – 2019. For example, on 4/8/2020, loss combined with historic loss projections for 4/9 through 6/15 were utilized, and it appeared there was the potential for natural steelhead to exceed 50% of the single-year loss threshold (Figure 30A). Two of the years within the historic timeframe (2011 and 2013) had a loss trace that, if it occurred in 2020, would have caused WY 2020 natural steelhead loss to exceed the 50% of single-year threshold. As a later season example, the risk of crossing the 50% of single-year loss threshold decreased. On 5/15/2020, the analysis was re-run and showed only one of the historic years (2011) had a loss trace that would have caused WY 2020 natural steelhead loss to

exceed the 50% of single-year threshold (Figure 30B). Since the signing of the ROD on 2/18/2020, Reclamation and DWR did not exceed the single-year threshold.

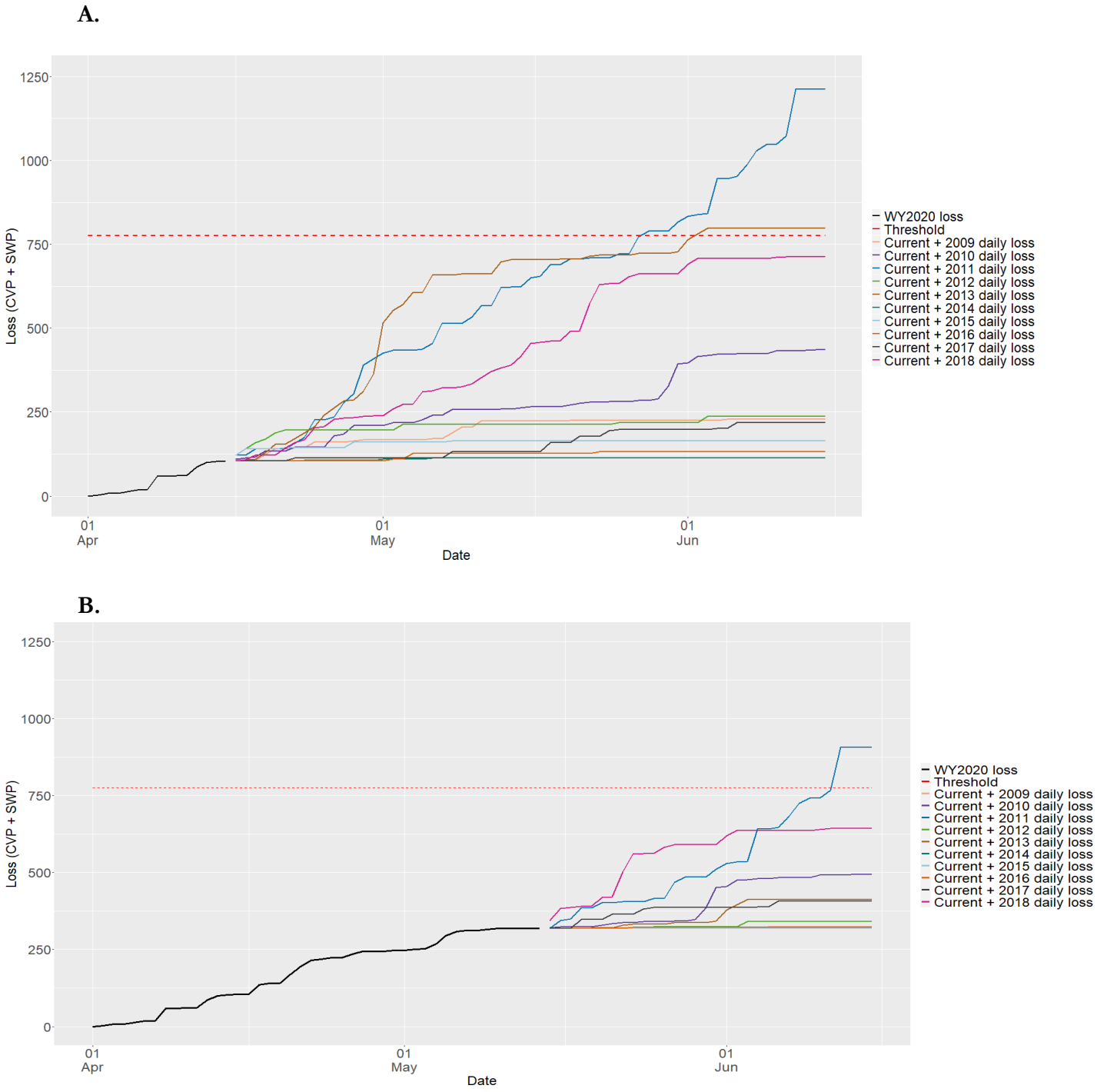


Figure 30. Cumulative WY 2020 natural steelhead loss (black) line and historic loss by year (colored lines) mid-season in **A.** mid-April (4/18/2020) and **B.** mid-May (5/15/2020).

Delta STARS Model

The Delta STARS model (survival, travel time, and routing simulation) models survival, travel time, and routing of migrating juvenile salmon through the Delta. Simulated fish enter the Delta on a given day at Freeport and the model examine conditions fish were 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.

Acoustic Tagging

Acoustically tagged salmonids were tracked throughout the Delta in WY 2020 (https://calfishtrack.github.io/real-time/index.html, Table 3). Real-time detections of tagged fish inform routing, entrainment, and survival. Information at critical junctions (Georgiana Slough and DCC) helps inform management decisions. The SaMT used tagging project data, along with other datasets (salvage, RST catch at locations, etc.), to provide weekly distribution estimates for hatchery winter-run Chinook salmon.

Table 3. Selected WY 2020 telemetry study results: detections and percent arrival for all releases combined (when multiple releases occurred within a study); loss and percent loss of CWT number released.

Telemetry Study	Georgiana Slough	Sacramento River (below Georgiana Slough)	Middle River	Confirmed Hatchery Loss at SWP and CVP	Benicia	Study Information
Hatchery late-fall-run salmon	52 (8.62%)	171 (28.36%)	1 (0.17%)	64.1 (0.01%)	100 (16.58%)	n = 603; 12/5/2019; Battle Creek (CNFH)
Hatchery winter-run salmon	12 (2.39%)	17 (3.39%)	0 (0%)	0 (0%)	12 (2.39%)	n = 502; 3/11/2020 and 3/24/2020; Caldwell Park
Battle Creek jump-start winter-run	1 (0.53%)	3 (1.59%)	0 (0%)	3.01 (0.003%)	0 (0%)	n = 198; 3/23/2020 and 5/18/2020; NF Battle Creek (CNFH)

Delta Smelt

Delta Smelt surrogates, such as turbidity and OMR flows, are now used in conjunction with Particle Tracking models because it is impossible to accurately quantify and monitor the amount or number of individuals that are incidentally taken, due to the variability associated with the declining population size of Delta Smelt, and the difficulty in detecting individuals (USFWS 2019 BiOp, p 394).

Environmental conditions are reported to the SMT at weekly meetings and Particle Tracking model outputs are provided as requested by the team.

Particle Tracking Models

Particle Tracking models were run routinely to accompany changes to operational scenarios and to predict the likelihood of particles (representing neutrally buoyant larval individuals) being entrained as means to consider modifying OMR operations. With only a single larval Delta Smelt detected in the South Delta during the OMR flow management season, there is not enough evidence to dependably assess the models' reliability when compared to actual fish salvage at this time.

Effects of Operation

The effects of operations on protected species using various tools and metrics (velocity density modeling/exposure, pre-screen loss, and salvage of yearling late-fall-run Chinook salmon from Coleman National Fish Hatchery) is described in this section.

Velocity Density Modeling/ Exposure

Weekly DSM2 hydrodynamic modeling was conducted to assess the effects of different OMR scenarios within certain selected channels throughout the Delta region (see text above, see Appendix C below). Behavior of fish in different Delta locations (e.g., Western Delta, Central Delta, South Delta) was assessed weekly based on model run outputs. None of the model runs during OMR flow management season caused the SaMT concern or identified issues that needed to be elevated to WOMT.

Pre-screen loss (predation rate within the primary channel)

Staff at the TFCF proposed and began a "proof of concept" study using Predation Detection Acoustic Tags (PDAT) which alter their tag signal after reacting to the digestive acids of predators. Chinook salmon with PDAT tags were released at the trash boom upstream of the TFCF and then tracked to estimate participation (fish that passed the TFCF trash rack and entered the primary channel), facility efficiencies (whole facility efficiency, primary louver efficiency, and secondary screen efficiency), total predation, predation in the primary channel (between the TFCF trash rack and primary louver array), pre-facility loss to predation (upstream of the TFCF trash rack), and passage time of salvaged fish (from the trash boom to the holding tanks) under a range of pumping conditions at the CVP export facility. Results of this study were analyzed in WY 2020 and the report have been submitted for peer review. The document is anticipated to be published in early 2021. This action is subject to its own non-flow action charter and guidelines, but it was included in this report as it may impact salvage in future management years. The primary deliverable will be an article published as a Tracy Series Report.

Tracy/Skinner Fish Salvage

The TFCF used dry ice placed into the waters of the primary channel to increase the level of dissolved carbon dioxide (CO_2) for removing predators in the bypasses and downstream on a monthly basis throughout WY 2020. For the larger primary channel, CO_2 is used once a year to remove predators due to the necessary coordination with the SWP export facility operations for curtailing pumping to one pump. In 2020, the Technical Service Center/Denver was funded to develop a hydrodynamic model of the primary channel, which will lead to the installation of CO_2 injectors that will reduce labor needs of the current process.

This action is subject to its own non-flow action charter and guidelines, but it was included in this report as it may impact salvage in future management years. Full study results will be described in different documents.

Salvage of Yearling (Coleman National Fish Hatchery) Late-Fall Run

The first spring-run Chinook salmon surrogate hatchery group of approximately 84,869 Coleman National Fish Hatchery (CNFH) late fall-run Chinook salmon was released on December 12, 2019. A total (SWP & CVP) confirmed loss of 20.21 fish was estimated from this group from the fish salvaged at the Delta fish facilities. The percent loss from the first release group was calculated to be 0.024%, which was below the maximum anticipated annual incidental take level in the NMFS BiOp. On December 18, 2019, CNFH released the second spring-run Chinook salmon surrogate hatchery group of approximately 77,672 late fall-run Chinook salmon into Battle Creek. The total (SWP & CVP) confirmed loss from this group was 25.03 fish. The percent loss was calculated to be 0.032%, which was also below the maximum anticipated annual incidental take level in the NMFS BiOp. On January 13, 2020, CNFH released the third spring-run Chinook salmon surrogate hatchery group of approximately 77,866 late fall-run Chinook salmon into Battle Creek. No loss occurred from this group at the CVP and SWP fish salvage facilities (Table 4).

Table 4. Confirmed SWP and CVP adipose-fin clipped Chinook lost from 10/1/2019 through 7/31/2020.

CONFIRMED HATCHERY (ADIPOSE-FIN CLIPPED) CHINOOK SALMON LOSS AT THE SWP & CVP DELTA FISH FACILITIES From 10/1/2019 through 7/31/2020

Release Date	CWT Race	Hatchery	Release Site	Release Type	Confirmed Loss	Number Released[1]	Total Entering Delta	% Loss of Number Released[2]	First Stage Trigger	Date of First Loss[3]	Date of Last Loss[3]
12/9/2019	LF	Coleman NFH	Battle Creek	Spring Surrogate	20.21	84,869	n/a	0.024	0.5%	12/22/2019	1/9/2020
12/18/2019	LF	Coleman NFH	Battle Creek	Spring Surrogate	25.03	77,672	n/a	0.032	0.5%	1/1/2020	1/4/2020
1/13/2020	LF	Coleman NFH	Battle Creek	Spring Surrogate		77,866	n/a		0.5%		

[1]Number released with the adipose-fin clipped and a coded-wire tag (CWT).
[2]% Loss of Number Released = (Confirmed Loss/Number Released)*100.
[3]Date of first and last loss accounts for all CWT loss even those from special studies where salvage and loss=0.

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, that could assist operations in upcoming OMR flow management seasons. Updated versions of the OMR Guidance Document (Appendix I, dated December 1, 2020) and the DCC Guidance Document (Appendix J, dated November 20, 2020) are attached. Improvements may also be considered or evaluated by the four-year independent review panels.

Delta Smelt Larval and Juvenile Entrainment Improvements

OMR flow management should consider the conditions described in the Reclamation Memorandum on the life cycle model (CGB-1000 2.2.4.21 dated March 13, 2020). In addition, reporting of secchi depth data as required by the memorandum could be reviewed and optimized to get the widest

distribution of data from across the South Delta. Once methods are finalized, the OMR Guidance Document should be updated, as appropriate.

DCC Improvements

Decisions about DCC gate operations frequently occur rapidly, as happened in November 2019. Reclamation is currently in the process of modernizing and improving the DCC gates. Reclamation will increase coordination between area offices to ensure gates are operated in a timely manner and will require a test run of the closure protocol prior to the beginning of each OMR flow management season. Ideally a daily notification in the fall with catch index information, provided by the monitoring program, will be emailed to CVO. This notification will allow CVO real-time information on catch index exceedance to schedule a DCC gates closure. A phone tree among the biologists, operators, and operations staff involved in closing the DCC based on KLCI/SCI indices may reduce the likelihood of delays, and the DCC Guidance Document should be updated, as appropriate.

DSM2 Modeling Improvements

Reclamation, with assistance from DWR, conducted a study to explore sensitivity of DSM2 modeling visualization tools. Model run scenarios were generated for a one-week period beginning 6/8/2020 assuming a drier year type with balanced June conditions. Two Vernalis flow regimeswere modeled: Vernalis (VNS) 1,500 cfs and 65% State/35% Federal split, Vernalis 2,500 cfs and 60% State/40% Federal split. For each Vernalis regime scenario, OMR conditions between -1,500 cfsand -5,000 cfs (in increments of 500 cfs) were modeled. Between each regime VNS, Clifton Court Forebay (CCF), and Contra Costa Canal (CCC) were held constant, Head of Old River Barrier (HORB) was not installed, and Grant Line Canal (GLC) was installed.

The results of the pilot exercise demonstrated that the method used to compare model runs in WY 2020 (K-S statistic) and the resulting visualizations (Empirical Cumulative Distribution Function plots, or ECDF plots) can be improved. ECDF figures plot observations directly (with no binning like in a histogram) and are able to differentiate scenarios with at least a 1,000 cfs difference between OMR conditions. Visualizations comparing less than a 1,000 cfs difference are not useful due to how tails affect the data distribution. It is unknown what the sensitivity of fish movement is to changes in OMR conditions less than 1,000 cfs.

The deliverables of the exercise will be new daily-averaged time-series plots of flow and velocity for each OMR scenario, which allow for easier interpretation compared to previous ECDF plots as an improvement of DSM2 modeling in WY 2021. Additionally, in WY 2021, the channels assessed in DSM2 modeling will change as a function of time throughout the OMR flow management season to more accurately accommodate fish distribution.

Salmon and Smelt Monitoring Teams Improvements

Implementing the ROD presented many logistical challenges, including new leaders running the SaMT and SMT meetings, changes to the format of the traditional weekly notes, addition of a weekly distribution of the assessment (draft Monday, final Tuesday), implementation of the

coordinated weekly Fish and Water Operations document, and the inclusion of Kearns and West for facilitation and/or help with documentation. The SWP also received a new ITP that also required changes to processes.

An interagency interest-based training occurred on 9/17/2020 and 9/22/2020. The agencies participating in the SaMT and SMT would benefit from incorporating the principles of interest-based training into their discussions.

The agencies participating in the SMT meetings could benefit from including a written description of the start and end of larval smelt sampling at the CVP and SWP salvage facilities, which to-date has only been handled through verbal discussion. Once a process for this description is finalized, the OMR Guidance Document should be updated as appropriate.

SacPAS Improvements

The University of Washington is working on developing a SaMT-specific webpage and a SMT-specific webpage on SacPAS. Data on each of these team webpages will include previously reported data, new information and modeling, and tools to assist in real-time decision-making. Monitoring surveys can increase use of file sharing platforms (e.g. Calfish and agency ftp sites) to post information for availability to the agencies participating in the SaMT and SMT meetings for efficient and open information sharing. The SaMT and SMT webpages on SacPAS went live in WY 2020. The SMT webpage is organized by chronological monitoring throughout the OMR flow management season and includes monitoring survey data for catch and salvage for historic intervals. Longfin Smelt catch and salvage data are included. The SMT webpage also includes a summary of environmental thresholds and surrogate conditions. Both webpages are expected to be improved as data visualization tools are developed.

Additional SaMT webpage visualizations anticipated to be developed may include:

- Single-year loss thresholds: figures for current loss (daily and cumulative) and historic loss (cumulative) and thresholds for the following salmonids:
    - Natural winter-run Chinook salmon
    - Hatchery winter-run Chinook salmon
    - Natural steelhead (December 1 – March 31)
    - Natural steelhead (April 1 – June 15)
- DCC operations:
    - Operations by KLCI or SCI: daily figures of catch indices and thresholds
    - Operations by electrical conductivity water quality targets: daily figures of EC at four locations, including thresholds
- End of OMR flow management season:
    - Daily average water temperatures at threshold sites including thresholds
    - Salmonid presence (distribution estimates from SaMT)
- Other:
    - Alerts for the following topics (tracked from 2009 BO, still useful for decisions): Mill Creek flow, Deer Creek flow, Wilkins Slough flow, Knights Landing temperature

- Real-time operations conditions reporting (e.g., balance / excess conditions, current Delta controlling factors) to benefit Delta Monitoring Teams members receive most current information

Monitoring Team Assessment Improvements

The weekly assessment was developed in the WY 2020 OMR flow management season as a means of reporting the conclusions and providing supporting information about the range of weekly OMR operations to WOMT. The contents of the document are reviewed annually at the close of the season and recommendations from the WY 2020 season are included below.

- Changes to the Weekly Assessment document:
  - Include a section at the end of the assessment on issues that were recommended for discussion at WOMT / Director Elevation. This section would be similar to the "Recommendations to WOMT" section in the weekly SaMT notes. (Note: This improvement was incorporated into the WY2021 OMR Guidance Document).
  - Evaluate whether the format of the Weekly Assessment could be modified in the future to better inform the writing of future Seasonal OMR flow management reports. Once a format is finalized, the OMR Guidance Document should be updated, as appropriate.

Conclusion and Management Summary

The CVP and SWP did not exceed the amount of take specified in the incidental take statement of listed fish species described in the 2019 USFWS and NMFS BiOps. Exports at the CVP and SWP export facilities and operations of the Delta Cross Channel Gates were consistent with the ROD and within the effects anticipated by the 2019 USFWS and NMFS BiOps. As detailed above, salmonid entrainment levels did not trigger OMR reverse flow reductions and losses did not exceed thresholds. Many other factors controlled the operation and reductions in exports and were not necessarily due to OMR flow management. OMR flows did not exceed those prescribed by the incidental take statement in the 2019 USFWS BiOp. No need was identified by the agencies for an independent panel review for WY 2020.

Improvement recommendations to the guidance documents that were considered include:

- OMR conditions described in Reclamation's Memorandum on the Delta Smelt life cycle model
- DCC gate closure protocol test run at the beginning of the OMR flow management season
- Include the offramp criteria based on larval smelt sampling at the CVP and SWP fish salvage facilities.
- For the weekly assessments from the monitoring teams, include a section for issues that were recommended for discussion at WOMT / Director Elevation.

Supporting Information

- Salmon Monitoring Team Notes: https://www.usbr.gov/mp/bdo/salmon-monitoring-team.html
- Salmon Monitoring Team webpage: http://www.cbr.washington.edu/sacramento/workgroups/salmon_monitoring.html
- Smelt Monitoring Team Notes: https://www.usbr.gov/mp/bdo/smelt-monitoring-team.html
- Smelt Monitoring Team webpage: http://www.cbr.washington.edu/sacramento/workgroups/delta_smelt.html
- Water Operations Management Team Notes: https://www.usbr.gov/mp/bdo/water-operations-management.html