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

1. Executive Summary

a. Operations anticipated during the week

See Weekly Fish and Water Operation Outlook document for March 16 – March 22

b. Winter-run Chinook Salmon summary

Loss of natural winter-run Chinook salmon (LAD) occurred in the past week at the Facilities (Figure 1, Figure 2). Loss of natural winter-run Chinook salmon at the Facilities is likely to occur over the next week. 65-75% of juvenile natural winter-run Chinook salmon from brood year (BY) 2020 are estimated to be present in the Delta. An estimated 20-25% have exited the Delta. This percentage is likely to increase due to anticipated precipitation later this week and behavioral cues from other runs and maturation stage. Acoustic tagged hatchery winter-run Chinook salmon were detected entering the Delta and moving past Benicia.

c. Spring-run Chinook salmon summary

No loss of natural Central Valley (CV) YOY spring-run Chinook salmon has occurred in the past week at the Facilities. Loss of young of year Central Valley spring-run Chinook salmon at the Facilities is unlikely to occur over the next week. 70-75% of spring-run Chinook salmon are estimated to be in the Delta. This percentage is likely to increase due to anticipated precipitation later this week and behavioral cues from other runs and maturation stage.

d. Central Valley Steelhead summary

Loss of natural California CV (CCV) steelhead occurred in the past week at the Facilities (Figure 3, Figure 4). Loss of CCV steelhead at the Facilities may occur over the next week. 35-50% of juvenile CCV Steelhead are estimated to be present in the Delta. An estimated 20-25% have exited the Delta. This percentage is likely to increase due to anticipated precipitation later this week, maturation stage and behavioral cues from hatchery releases.

e. Green Sturgeon summary

Loss of green sturgeon at the Facilities is unlikely to occur over the next week due to their rare presence in the South Delta.

f. Delta Smelt summary

Based on distribution patterns over the past decade and rare detections in this water year, Delta Smelt are unlikely to be prevalent in the South Delta. Limited detection data support Delta Smelt being present in Suisun Marsh, west of the Sacramento-San Joaquin confluence, and in the Sacramento Deep Water Ship Channel. The distribution of Delta Smelt is expected to extend upstream of the confluence which is supported by historical Spring Kodiak Trawl data analysis. The volume of predicted precipitation may influence turbidity at OBI. The likelihood of Delta Smelt adult entrainment is slightly elevated relative to the previous seven days due seasonal timing. The less negative limits of the OMR Index decrease the potential for entrainment of Delta Smelt in the Central Delta, which includes the lower San Joaquin River, into the South Delta.

g. Monitoring Teams summary

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

2. Operational and Regulatory Conditions

See current Weekly Fish and Water Operation Outlook document.

3. Biology, Distribution, and Evaluation

Winter-run Chinook salmon, Spring-run Chinook salmon, Central Valley Steelhead

POPULATION STATUS

Winter-run Chinook salmon

- **Delta Life Stages**:
    - Juveniles, Adults
- **Brood Year 2020 Productivity:**
    - Natural winter-run Chinook salmon: The finalized estimate from the winter-run JPE PWT for total natural production entering the Delta (JPE) is 330,130 winter-run Chinook salmon individuals. Estimated winter-run Chinook salmon passage at Red Bluff Diversion dam (RBDD) is greater than recent years (BY 2014 – 2018) with the exception of BY 2019. By 3/11/2021, 2,094,148 winter-run Chinook salmon were estimated to have passed RBDD compared to a cumulative passage last year of 3,804,532 winter-run Chinook salmon RBDD on 3/10/2020.
    - Hatchery winter-run Chinook salmon: Approximately 302,166 juvenile winter-run Chinook salmon were released from Livingston Stone NFH at Caldwell Park on 1/30/2021. The final estimate for the hatchery JPE released into the Sacramento River from Livingston Stone NFH is 97,888 fish.
    - The JPE for BY 2020 hatchery origin winter-run Chinook salmon juveniles released from Livingston Stone NFH into Battle Creek is 37,232 fish. Approximately 79,024 juvenile winter-run Chinook salmon were released from Livingston Stone NFH at Wildcat Road Bridge (north fork Battle Creek) on 3/8/2021. Approximately 44,105 juvenile winter-run Chinook salmon were released from Coleman NFH at Wildcat Road Bridge (north fork Battle Creek) on 3/10/2021.

Spring-run Chinook salmon

- **Delta Life Stages:**
    - Young-of-year (YOY) and Yearlings
- **Brood Year 2020 Productivity:**
    - Natural spring-run Chinook salmon: No JPE has been established for spring-run Chinook salmon. Approximately 28% of the juvenile spring-run sized Chinook salmon population for BY 20 is expected to have passed passing Red Bluff Diversion dam as of 3/14 (see Ops Outlook) based on historical data.
    - Hatchery spring-run Chinook salmon surrogates: First hatchery releases of yearling spring-run Chinook salmon surrogates from Coleman NFH facility occurred on 1/8/2021, second hatchery releases occurred on 1/22/2021, third hatchery releases occurred on 1/29/2021.
    - First hatchery releases of yearling spring-run Chinook salmon from the SCARF facility occurred on 12/3/2020, a second hatchery releases of BY 2020 fish occurred on 1/26/2021. A third hatchery release of yearling spring-run Chinook salmon from BY 2020 from the SCARF facility occurred 3/2/2021.

- The agencies in the SaMT discussed the thiamine vitamin deficiency that was observed in winter-run Chinook salmon broodstock at the Livingston Stone NFH in BY 2020. Last year the thiamine deficiency appeared to negatively affect survival of juvenile fish as they migrate downstream towards the Delta. The thiamine deficiency issue is also likely impacting spring-run Chinook salmon. The Feather River Fish Hatchery experienced issues with infertile males. It is expected that the Feather River Hatchery will only meet about half of their production goals. On the Feather River, a larger than historical number of spring-run adults that entered the system and were tagged appear to be spawning in-river instead of returning to the hatchery. This is one reason that low returns were being observed at the hatcheries in 2020.

Central Valley Steelhead

- **Delta Life Stages**:
  - Spawning Adults, Kelts, Juveniles
- **Brood Year 2020 Productivity:**
  - Spawner abundance: There is limited information about the adult steelhead population. It is estimated to be small, contributing to the limited productivity of the population.
  - Natural steelhead: No JPE has been established for steelhead. Data are limited.
  - Hatchery steelhead:
    - Approximately 415,000 steelhead from Coleman NFH were released at Red Bluff in the first half of December, part of the CCV Steelhead DPS.
    - Approximately 216,500 steelhead from Coleman NFH were released into the Sacramento River from 12/28/2020-12/29/2020, which are part of the CCV Steelhead DPS.
    - Approximately 220,500 steelhead from Feather River Hatchery were released between 2/8/2021 - 2/12/2021 into the Feather River at Boyd's Pump.
    - Approximately 440,500 hatchery steelhead were released between 2/10/2021 - 2/21/2021 from the Nimbus Fish Hatchery into the American River at Sunrise.
    - Approximately 170,000 BY20 hatchery steelhead were released between 2/16/2021 - 2/17/2021 from the Mokelumne River Fish Hatchery into the Mokelumne River at New Hope Landing.
    - Approximately 120,000 BY20 hatchery steelhead were released 3/11/2021 – 3/12/2021 from the Mokelumne River Fish Hatchery into the Mokelumne River at New Hope Landing.

DISTRIBUTION

Winter-run Chinook Salmon

- **Current Distribution:**
  - On 3/16/2021, SaMT estimated 65-75% of juvenile winter-run Chinook salmon were present in the Delta and 20-25% were estimated to have exited the Delta (Table 1).
  - Natural and hatchery winter-run Chinook salmon were observed in key monitoring locations this past week (Table 2).
- **Historic Trends**
  - Based on historical trends in salvage, 59.9% of winter-run Chinook salmon should have been observed in salvage by this time of the water year (Table 3). If historic trends in salvage were to

continue winter-run Chinook salmon loss is expected to increase over the next week (Figure 1, Figure 2).

- **Forecasted Distribution within Central Valley and Delta regions**
    - Based on the time of year, and the maturation of juvenile fish, downstream migration is expected to continue even without any substantial precipitation events occurring. The STARS model projects route-specific proportion of entrainment, survival, and travel times (Table 4). This model does not estimate entrainment into the lower Sacramento River sloughs (i.e. Three-Mile Slough). The DCC gates were closed 12/1/20 and are expected to remain closed through mid-May 2021.
    - The entrainment tool estimates a median loss of 0 fish and a maximum loss of 74 fish during this week (SacPAS last updated on 3/10/21).
    - For results of entrainment into Delta strata regions from DSM2 model runs (North Delta into Interior and Central Delta, San Joaquin River and Central Delta into South Delta, and South Delta into fish facilities) refer to Attachment A.
    - Additional monitoring efforts show a wide dispersion of winter-run Chinook salmon within the Northern Delta

<u>Spring-run Chinook salmon</u>

- **Current Distribution**
    - On 3/16/2021 SaMT estimated 70-75% of juvenile CV spring-run Chinook salmon were present in the Delta (Table 1).
    - Natural and hatchery spring-run Chinook salmon were observed in key monitoring locations this past week (Table 5).
    - The first, second, and third spring-run surrogate Chinook salmon groups were released into the Sacramento River at Battle Creek on 1/8/2021, 1/22/2021, and 1/29/2021, respectively. Fish from release group number 2 (released on 1/22/2021) have been observed at the Delta facilities, total loss equal to 6.4 fish.
- **Historical Trends**
    - Based on historical trends in salvage, 1.3% of YOY spring-run Chinook salmon should have been observed in salvage by this time of the water year (Table 3). If historic trends in salvage were to continue YOY spring-run Chinook salmon loss could potentially increase over the next week.
- **Forecasted Distribution within Central Valley and Delta regions**
    - For results of entrainment into Delta strata regions from DSM2 model runs (North Delta into Interior and Central Delta, San Joaquin River and Central Delta into South Delta, and South Delta into fish facilities) refer to Attachment A.

<u>Central Valley Steelhead</u>

- **Current Distribution**
    - On 3/16/2021 SaMT estimated 35-50% of juvenile CCV steelhead were present in the Delta (Table 1).
    - Combined total loss of hatchery steelhead equals 88.1 fish as of 3/14/2021.
    - Combined total loss of natural steelhead equals 34.14 fish as of 3/14/21.
- **Historical Trends**

- Based on historical trends in salvage, 53.4% of juvenile CCV steelhead should have been observed in salvage by this time of the water year. If historic trends in salvage were to continue, juvenile CCV steelhead loss is expected to increase over the next week.

- **Forecasted Distribution within Central Valley and Delta regions**
  - Natural and hatchery steelhead were observed in key monitoring locations this past week (Table 6).
  - SaMT estimated that 35-50% of the population of CCV steelhead may be present in the Delta at this time and 20-25% have exited the Delta past Chipps Island. Closure of the DCC gates would reduce exposure and possible entrainment of juvenile CCV steelhead into the interior Delta via the DCC gates. Natural steelhead loss for WY 2021 is 34.14 fish (Figure 3, Figure 4).
  - The entrainment tool predicts a median loss of 0 fish will occur with a maximum loss of 16 fish (SacPAS last updated on 3/10/21).
  - For results of entrainment into Delta strata regions from DSM2 model runs (North Delta into Interior and Central Delta, San Joaquin River and Central Delta into South Delta, and South Delta into fish facilities) refer to Attachment A.

TABLE 1. Salmonid distribution estimates

Location	**Yet to Enter Delta**	**In the Delta**	**Exited the Delta**
Young-of-year (YOY) winter-run Chinook salmon	5-10%	65-75%	20-25%
YOY spring-run Chinook salmon	25-30%	70-75%	0%
YOY hatchery winter-run Chinook salmon*	35-60%	30-45%	10-20%
Natural origin steelhead	30-40%	35-50%	20-25%

* Estimation of YOY hatchery winter-run Chinook salmon is complicated by multiple releases over a long period of time (with additional releases yet to occur).

TABLE 2. Winter-run Chinook salmon weekly observations by monitoring location

	Dates	**Unmarked (natural) winter-run Chinook salmon**	**Marked (hatchery) winter-run Chinook salmon**
GCID*	3/9-3/13	5 (1 juvenile, 4 smolt)	6 (5 juvenile, 1 smolt)
Knights Landing	3/9 – 3/15	0	0
Tisdale	3/9 – 3/14	0	0
Sacramento Trawl	3/7-3/13	0	0
Beach Seines	3/7-3/13	1	0
SKT	Not sampled		
EDSM	3/8-3/15	0	0
Chipps Island Trawl	3/7-3/13	5	1

* GCID raised in anticipation of possible high flows and high volume hatchery releases.

TABLE 3. Historic migration and salvage patterns.

Date (3/14)	Red Bluff Diversion Dam	Tisdale RST	Knights Landing RST	Sac Trawl (Sherwood) Catch Index	Chipps Island Trawl Catch Index	Salvage
Chinook, Winter-run, Unclipped	99.0% (98.3%,99.7%) BY: 2011 - 2019	98.0% (96.1%,99.8%) BY: 2011 - 2019	97.7% (95.9%,99.5%) BY: 2011 - 2019	60.7% (32.5%,88.8%) BY: 2011 - 2019	27.5% (7.3%,47.6%) BY: 2011 - 2019	59.9% (42.9%,76.9%)
Chinook, Spring-run, Unclipped	28.0% (9.3%,46.7%) BY: 2011 - 2019	46.1% (12.9%,79.3%) BY: 2011 - 2019	30.2% (1.2%,59.3%) BY: 2011 - 2019	13.7% (1.0%,26.4%) BY: 2011 - 2019	0.2% (-0.1%,0.5%) BY: 2011 - 2019	1.3% (-1.0%,3.6%)
Steelhead, Unclipped (Dec – March)						53.4% (28.0%,78.8%)

TABLE 4. STARS model output. Note STARS model results have not been updated past 3/12/2021.

Date (3/12)	**DCC**	**Georgiana Slough**	**Sacramento River**	**Sutter and Steamboat**
Proportion of Entrainment	NA	0.29	0.46	0.26
Survival	NA	17%	51%	39%
Travel Time	NA	17.84 d	10.75 d	11.27 d

TABLE 5. Spring-run Chinook salmon weekly observations by monitoring location

	Dates	Unmarked (natural) spring-run Chinook salmon	Marked (hatchery) spring-run Chinook salmon
GCID*	3/9-3/13	9	0
Knights Landing	3/9 – 3/15	1	0
Tisdale	3/9-3/14	0	0
Sacramento Trawl	3/7-3/13	0	0
Beach Seines	3/7-3/13	17	0
SKT	Not sampled		
EDSM	3/8-3/15	0	0
Chipps Island Trawl	3/7-3/13	0	0

* GCID raised in anticipation of possible high flows and high volume hatchery releases.

TABLE 6. Steelhead weekly observations by monitoring location

	Dates	Unmarked (natural) steelhead	Marked (hatchery) steelhead
GCID*	3/9 – 3/13	0	0
Knights Landing	3/9 – 3/15	0	0
Tisdale	3/9-3/14	0	0
Sacramento Trawl	3/7-3/13	0	2
Beach Seines	3/7-3/13	0	0
SKT	Not sampled		
EDSM	3/8-3/15	0	2
Chipps Island Trawl	3/7-3/13	0	2

* GCID raised in anticipation of possible high flows and high volume hatchery releases.

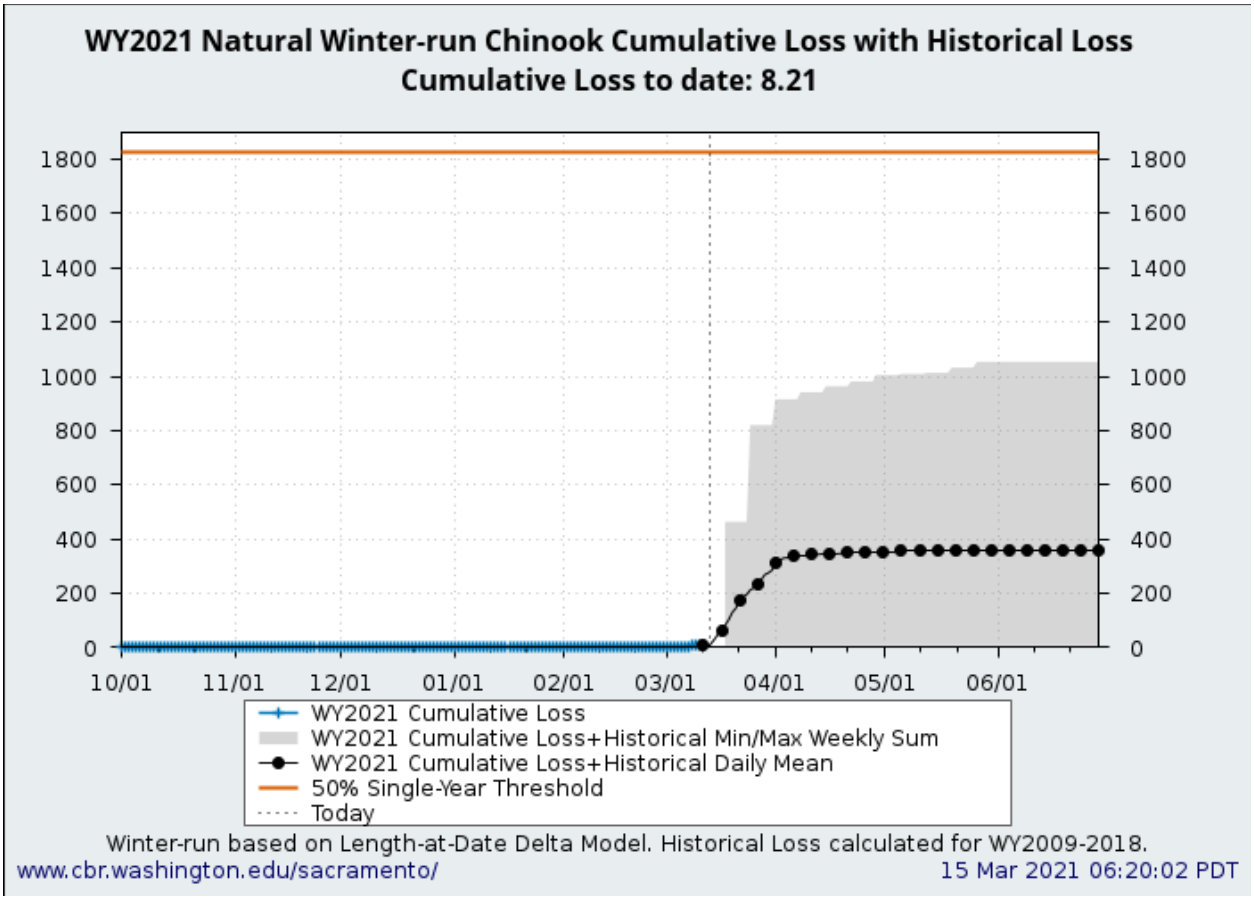


FIGURE 1. WY2021 natural winter-run Chinook salmon cumulative loss values through salvage season. Values depicted are not genetically corrected. No loss has occurred in WY2021. Based on historical cumulative loss values from 2009 – 2018, WY2021 observed loss (and potential future loss) are not likely to exceed the 50% loss threshold this week.

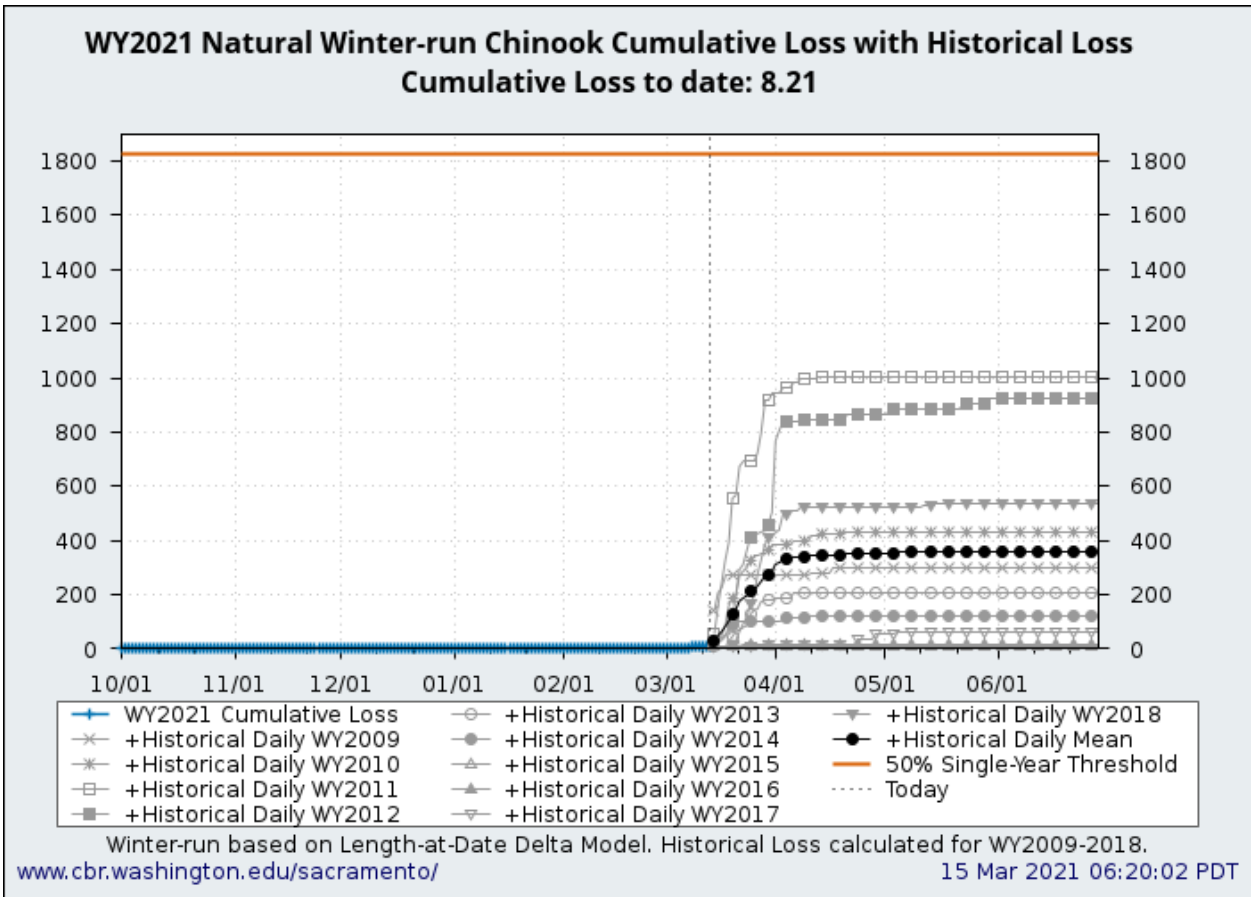


FIGURE 2. Daily natural winter-run Chinook salmon loss accumulates towards single-year loss threshold. Based on historical cumulative loss values from 2009 – 2018, WY2021 observed loss (and potential future loss) are not likely to exceed the 50% loss threshold this week.

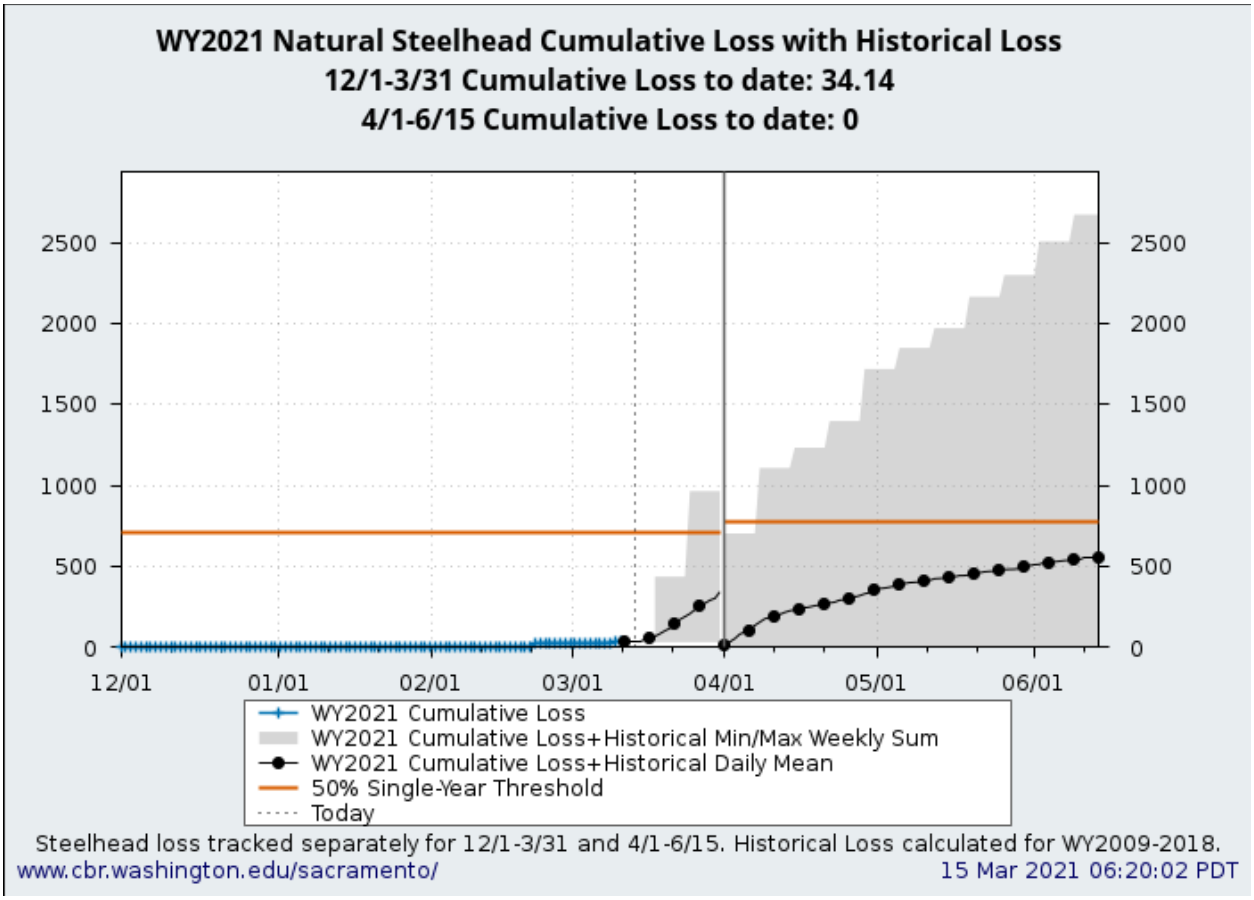


FIGURE 3. WY2021 natural steelhead cumulative loss values through salvage season: December 1 – March 31, April 1 – June 15. Based on historical cumulative loss values from 2009 – 2018, WY2021 observed loss (and potential future loss) are not likely to exceed the 50% loss threshold this week. The first steelhead loss occurred 1/18/2021.

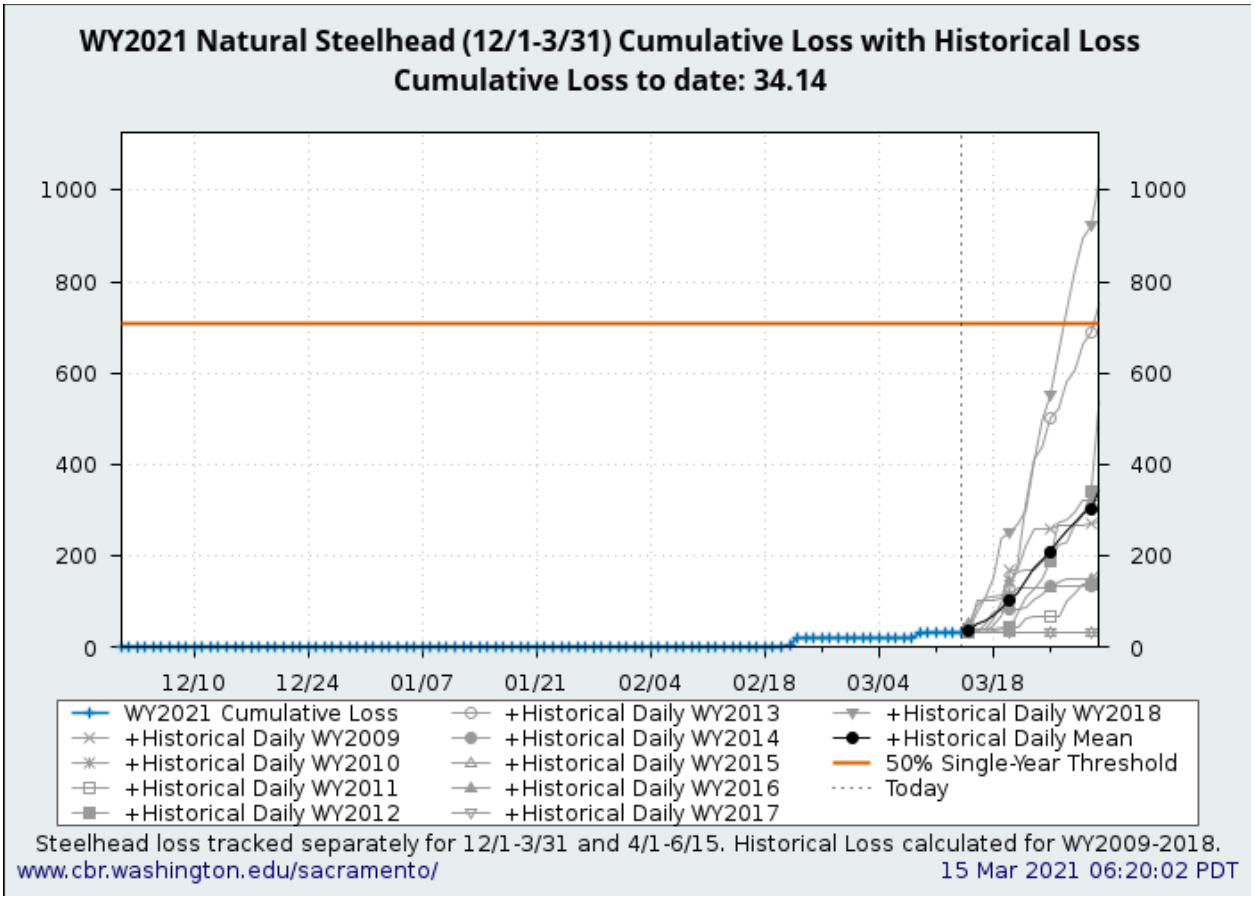


FIGURE 4. Daily natural steelhead loss accumulates towards single-year loss threshold: December 1 – March 31. Based on historical cumulative loss values from 2009 – 2018, WY2021 observed loss (and potential future loss) are not likely to exceed the 50% loss threshold this week.

EVALUATION

1. **After January 1, are more than 5% of juveniles from one or more salmonid species present in the Delta?**
   Yes. Greater than 5% of juvenile winter-run Chinook salmon, spring-run Chinook salmon, and steelhead are present in the Delta.
2. **Does the operational outlook's ranges impact fish movement and change the potential distribution of fish?**
   i. **Potential effects within the 7 days (near-term) in the operations outlook.**
   It appears that there is an increase in salmonids being exposed to export facilities and OMR flow is expected to remain at or below -5,000 cfs this upcoming week. The SaMT anticipates an increased number of salmonids entering the Delta currently due to recent hatchery releases of steelhead, surrogate hatchery yearling spring-run, and hatchery winter-run Chinook salmon.
   ii. **Potential effects longer than the 7 days (longer-term) in the operations outlook.**
   The members of SaMT are not confident in projecting beyond 7 days due to uncertainty regarding weather forecasting. Furthermore, if current trends were to continue then it is anticipated that more fish may appear at export facilities as fish begin to outmigrate based on historical trends. There is the potential for the hatchery winter-run 50% yearly loss threshold to be exceeded this year.
3. **What is the likelihood of increased loss exceeding the next annual loss threshold (50%, 75% or 90% of threshold) resulting in OMR management actions based on population distribution, abundance, and behavior of fish in the Delta?**
   Winter-run Chinook salmon
   Total juvenile natural winter-run Chinook salmon (LAD) loss is 8.21 fish (as of 3/14/2021). The agencies in the SaMT assessed the likelihood of exceeding the next annual loss threshold and believe that loss occurring in the next week is unlikely to lead to exceedance of the 50% single-year loss threshold.
   Spring-run Chinook salmon
   Loss for yearling spring-run surrogate is low (refer to Ops Outlook Table 2). The agencies in the SaMT assessed the likelihood of exceeding annual loss threshold and believe that loss occurring in the next week is unlikely to lead to exceeding the hatchery spring-run surrogate threshold.
   Central Valley Steelhead
   Total juvenile natural steelhead loss is 34.14 fish (as of 3/14/2021) for the December 1 through March 31 period. The agencies in the SaMT assessed the likelihood of exceeding the next annual loss threshold and believe that loss occurring in the next week is unlikely to lead to exceedance of the 50% single-year loss threshold. Reclamation's Proposed Action has no hatchery steelhead triggers, but hatchery steelhead loss is likely to increase.
4. **If an annual loss threshold has been exceeded, do continued OMR restrictions benefit fish movement and survival based on real-time information?**
   Winter-run Chinook salmon
   The annual loss threshold for natural or hatchery winter-run Chinook salmon has not been exceeded in WY 2021.
   Spring-run Chinook salmon
   No threshold for hatchery spring-run Chinook salmon surrogates has been exceeded in WY 2021.
   Central Valley Steelhead
   The annual loss threshold for steelhead (December 1 – March 31) has not been exceeded in WY 2021.

5. **If OMR is more negative than -5,000 cfs are there changes in spawning, rearing, foraging, sheltering, or migration behavior beyond those anticipated to occur under OMR management at -5,000 cfs?**
   OMR index levels in the upcoming week are not anticipated to be more negative than -5,000 cfs.

Green Sturgeon

POPULATION STATUS

- **Delta Life Stages:**
  - Adults and Juveniles
- **Juvenile Abundance:**
  - No empirical estimates of the juvenile population (ages 0 – 3) in the Delta are available. In 2020, 157 larval green sturgeon and six juvenile green sturgeon were observed at the Red Bluff Diversion Dam fish monitoring RSTs in the upper Sacramento River (this represents approximately 10% of the population distribution because sampling wasn't conducted from March – June due to Covid).

DISTRIBUTION

- **Current Distribution**
  - Information about their rearing and distribution patterns within the Delta is limited.
  - Juvenile and adult green sturgeon present in the San Joaquin and Sacramento rivers and Delta during the next week. Acoustically tagged green sturgeon have been detected and remain in the vicinity of Sherman Island.
  - One dead green sturgeon was collected on the Skinner Delta Fish Protective Facility trash rack (1/22/2021).
- **Historical Trends**
  - Juvenile and adult green sturgeon are historically present in the San Joaquin and Sacramento rivers and Delta.
- **Forecasted Distribution within Central Valley and Delta regions**
  - Juvenile and adult green sturgeon are present in the San Joaquin and Sacramento rivers and Delta during the next week.

EVALUATION

1. **Is there likely to be salvage that may exceed the annual loss limit?**
   Currently, green sturgeon salvage is 0 fish (as of 3/14/2021). The agencies in the SaMT assessed the likelihood of salvage occurring in the next week is unlikely to occur.

Delta Smelt

POPULATION STATUS

- **Delta Smelt Life Stages:**
  - Adult
- **Brood Year 2020:**
  - **Abundance estimate**: The most recent population abundance estimate for Delta Smelt was 1,746 . This estimate was calculated from the sampling between 1/25/2021-1/29/2021. The most recent detection of a Delta Smelt was a 47 mm juvenile collected in the Sacramento Deep

Water Ship Channel by EDSM on 1/26/2021. The most recent collection of a Delta Smelt for FCCL broodstock was on 1/21/2021. FCCL Broodstock collections are complete for WY2021, but EDSM may contribute fish if caught soon.

- **Biological Conditions**: The Smelt Monitoring Team discussed the most recent monitoring data (Table 4) and considered professional opinion on the historical trends in regional distribution. Based on those discussions, the agency participants on SMT estimate Delta Smelt subadult/adults should be holding in the Suisun Marsh and west of the Sacramento-San Joaquin confluence in anticipation of migration but analysis of historic Spring Kodiak Trawl (SKT) supports Delta Smelt distribution being above the confluence and less tightly correlated to X2 position (available upon request from USFWS). They are also present in the Sacramento Deep Water Ship Channel. The three-station daily water temperature has remained near 12 C° which would be conducive for Delta Smelt Spawning to commence.

DISTRIBUTION

- **Current Distribution**
  - Real time detection data is currently limited to EDSM sampling, SKT, and SLS. Since there are only a few recent detections, the Smelt Monitoring Team's capacity to estimate where Delta Smelt are within the Delta is limited.
  - The last Delta Smelt detection was on 1/26/2021 in the Sacramento Deep Water Ship Channel by EDSM.
  - Larval sampling began at the Skinner Fish Facility (SFF) on 2/22/2021 and the Tracy Fish Collection Facility (TFCF) on 2/15/2021. No larval Delta Smelt have been detected.

TABLE 4. Summary of recently reported detections of Delta Smelt by Region and Salvage Facilities between 3/9/2021 and 3/16/2021. Start and End dates reflect period of time between updates to SMT. Regional categories are determined from EDSM sampling. Delta Smelt >58mm FL are considered adults.

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

TABLE 5. Summary of recent Delta Smelt detections reported since last assessment and the total detections for the current water year. Notes reflect latest information on reported detections or completion of survey for the water year and include both larval and adult detections.

Sampling Method	New Detections	WY2021	Notes
EDSM	0	3	Phase 2 begins 3/29/2021 Last Detection: 1/26/2021
SKT	0	0	SKT 3: Complete SKT 4: 3/29/2021
SLS	0	0	Survey 5: Processing Survey 6: 3/15-17/2021
20-mm	0	0	Begins: 3/22/2021
Bay Study	0	0	Started: 3/1-18/2021
FMWT	0	0	Ended 12/15/2020
Chipps Island Trawl	0	0	Ongoing 5 day per week sampling anticipated until mid-May.

Sampling Method	New Detections	WY2021	Notes
Brood Stock Collections	0	2	Last Catch: 1/21/2021 EDSM may retain live Delta Smelt for FCCL Broodstock

- **Historical Trends**
  - Based on historical analysis of SKT, the centroid of Delta Smelt distribution is anticipated to be above the Sacramento-San Joaquin confluence, but less closely correlated to X2 which is currently estimated to be greater than 82 km (Polansky et al 2018).
  - Delta Smelt detections in the Deep Water ship channel are upstream of the confluence, but may be freshwater residents and not representative of the migratory life history patterns in Delta Smelt (Hobbs 2019).
  - The three station temperature remains above 12 degrees Celsius. This temperature is conducive to spawning.

- **Forecasted Distribution within Central Valley and Delta regions**
  - Delta Smelt distribution may change in response to recent and upcoming precipitation. However, predicting the distribution is currently difficult because detection data is limited to a few individuals and historic patterns may not be representative of the low population levels of Delta Smelt. None of the recent detections have been in the central or south delta. The SMT is using turbidity as a surrogate for Delta Smelt presence in making assessments.

ABIOTIC CONDITIONS

- **Turbidity**
  - Changes in Freeport flows and turbidity (Table 6) that would create "First Flush" conditions did not occur in WY 2021.
  - As of 3/16/2021 turbidity continues to be less than 12 FNU at all central and south Delta stations (see Attachment B). Wind and precipitation in the forecast may increase turbidity but a daily average above 12 FNU at OBI is not expected in the next seven days.
  - Precipitation on 3/9/2021 and 3/10/2021 and south eastern wind did not reach a daily average above 12 FNU at OBI.

TABLE 6. Relevant Environmental Factors to the current management actions for Delta Smelt.

Date Reported	OBI Daily Average Turbidity (FNU)
3/16/2021	3.64

- **X2 Conditions**
  - X2 is estimated to be at 84 km.
  - When X2 is above 81 km, the SMT uses the X2_EC_Graph.xlxs tool to estimate the position of X2 for both the Sacramento and San Joaquin Rivers and assumes the average of the two is representative of an approximate X2 position.
- **Other Environmental Conditions**
  - The Smelt Monitoring Team expects environmental conditions to respond to the amount of the predicted precipitation with possible increases in turbidity, but the turbidity is not expected to reach the 12 NTU threshold at OBI.

- The Fish and Water Operation Outlook OMR Index values are expected to range between-800 to –3,500 cfs from 3/16/2021 to 3/22/2021.
- Real time tracking of environmental conditions, relevant thresholds and Delta Smelt catch data are updated daily at: http://www.cbr.washington.edu/sacramento/workgroups/delta_smelt.html

EVALUATION

1. **Between December 1 and January 31, has any first flush condition been exceeded?**
   The running 3-day average flows and running 3-day average turbidity at Freeport did not exceeded the triggers for "First Flush" conditions in WY2021.
2. **Do DSM have a high risk of migration and dispersal into areas at high risk of future entrainment? (December 1- January 31)**
   Delta Smelt were not detected in the South Delta between 12/1/2021 and 1/31/2021. The detection on 11/9/2020 supported Delta Smelt being present in Suisun Marsh and west of the Sacramento-San Joaquin confluence. Additional detections on the 6th, 15th , 21st and 26th of January support a presence of the species in the Sacramento Deep Water Ship Channel, but these fish may represent the freshwater resident population and may not be representative of the migratory life history pattern.
3. **Has a spent female been collected?**
   As of 3/16/2021 no spent female Delta Smelt have been observed.
4. **If OMR of -2000 does not reduce OBI turbidity below 12NTU/FNU, what OMR target is deemed protective between -2000 and -5000?**
   OBI turbidity is currently below 12 FNU. The expected OMR range is –800 to – 3,500 cfs and no turbidity bridge avoidance action has been taken.
5. **If OBI is 12 NTU/FNU, what do other station locations show?**
   OBI turbidity is currently below 12 FNU. The daily average turbidities on 3/16/2021 at Prisoners Point (4.25 NTU), Holland Cut (7.90 FNU) and Victoria Canal (2.27 NTU) are stable, but may increase with upcoming precipitation event.
6. **If OBI is 12 NTU/FNU, is a turbidity bridge avoidance action not warranted? What is the supporting information?**
   The turbidity at OBI is below 12 FNU , but may elevate to or above 12 FNU due to precipitation and wind. A turbidity bridge avoidance action may be warranted in the next 7 days.
7. **After March 15 and if QWEST is negative, are larval or juvenile DSM within the entrainment zone of the CVP and SWP pumps based on surveys?**
   As of 3/16/2021, QWEST is negative, but expected to become positive dependent upon the amount of precipitation over the next seven day period. No larval or juvenile Delta Smelt have been observed in the South Delta as of 3/16/2021.
8. **Based on real-time spatial distribution of Delta Smelt and currently available turbidity information, should OMR be managed to no more negative than -3,500?**
   Delta Smelt are unlikely to be present in the South Delta based on limited detection information this season. Turbidity in the South Delta remains low across most stations (See Attachment B) and there does not appear to be any widespread increases as of 3/16/2021. The OMR index range is between -800 and -3500 cfs for the next seven days and will be protective. This pattern is expected to continue and there is no expected need to manage OMR to no more negative than -3,500 cfs.
9. **What do hydrodynamic models, informed by EDSM or other relevant data, suggest the estimated percentage of larval and juvenile DSM that could be entrained may be?**

With no detection data on Delta Smelt larvae to inform hydrodynamic models the SMT cannot estimate the percentage of larval and juvenile entrainment.

DELTA SMELT REFERENCES

Hobbs, J. A., Lewis, L. S., Willmes, M., Denney, C., & Bush, E. (2019). Complex life histories discovered in a critically endangered fish. Scientific Reports, 9(1). https://doi.org/10.1038/s41598-019-52273-8

Polansky, L., Newman, K.B., Nobriga, M.L. et al. Spatiotemporal Models of an Estuarine Fish Species to Identify Patterns and Factors Impacting Their Distribution and Abundance. Estuaries and Coasts 41, 572–581 (2018). https://doi.org/10.1007/s12237-017-0277-3

Attachment A: DSM2 modeling

Table of Contents

Objective 17
Background 18
DSM2 model results: summary tables 19
DSM2 model results: figures 22
DSM2 model interpretation entrainment in Delta strata regions 38
DSM2 channel locations information 39

Objective

Weekly modeling efforts are conducted to examine the effects of varying OMR conditions on the behavior of salmonids present in the Delta in a one-week "look ahead" or outlook. Members of the Salmon Monitoring Team (SaMT) use DSM2 modeling results to help answer how changing pumping regimes translates to differences in flows and velocities modeled at various channel locations within the Delta and what impact modeled environmental parameters have on rearing, foraging, migrating, and holding salmonids.

Each series of runs consists of three OMR conditions: minimum and maximum scenarios bounded by expected OMR index values for that week (Ops Outlook, Table 1) and a baseline which represents an anticipated operational value. Assumptions are made to best estimate future hydrologic characteristics. These inputs are more confident for the future one, two, and three-day timeframes; days four through six have lower confidence. Model scenarios hold hydrology inputs between runs constant and adjust Delta export pumping rates to compare between scenario OMR index values (unless otherwise noted). Although hydrologic ensembles could be used, a single value or deterministic projection is used for efficiency.

SaMT members use weekly DSM2 model results from a range of scenarios as part of a suite of tools to help assess distribution and changes to behavior of salmonids. At each channel location over a six-day action period, environmental parameters are examined: modeled flow and velocity general statistics (e.g., magnitude, range, percent positive), differences in modeled flow and velocity values compared with the baseline scenario, etc. That information, in conjunction with channel location (e.g., close to the Delta pumping facilities, closer to areas with higher tidal influence, etc.) and other environmental considerations (e.g., tidal cycle, upcoming storms, etc.), is then interpreted from a biological perspective. SaMT explores the possible effects to salmonids of changing OMR index scenarios, assuming each of those potential operations could be that week's controlling factor.

Background

Process	
Weekly process	• DSM2 model runs use a historic and forecasted hydrological input dataset with no assumptions provided by DWR Thursdays and updated by Reclamation Mondays. • Input File updated Monday after initial distribution from DWR for removal of forecasted in lieu of historic input. • Reclamation provides scenarios based on expected OMR index values for the upcoming week. • DSM2 model runs produced Monday and distributed to SaMT members.
Hydraulic footprint information	
Baseline and Scenarios updated	3/15/2021
DSM2 modeling results range	3/16/2021 to 3/22/2021
OMR index value scenarios	
Baseline	-2,400 cfs
Scenario 1	-800 cfs (decreasing from Baseline; Δ 1,600 cfs)
Scenario 2	-2,550 cfs (increasing from Baseline; Δ 150 cfs)
Changes between scenarios	
Hydrology	No
Delta Exports	Yes
Common assumptions	
DSM2 run results based on the following assumptions	• CCFB Gates are operating to Priority 2 throughout the forecast period. • The Delta Cross Channel gates are closed throughout the forecast period. • Suisun Marsh salinity control flashboards are in, and 2 of the Suisun Marsh Salinity Control gates are in tidal operation and 1 gate is closed for maintenance. • San Joaquin River flow at Vernalis is at 1,142 cfs at the beginning of the forecast period and is estimated to decrease to 970 cfs by the end of the forecast period. (Figure A1) • Sacramento River flow at Freeport is at 10,150 cfs at the beginning of the forecast period and is expected to decrease to 9,850 cfs by the end of the forecast period. (Figure A1). • Clifton Court Forebay and Tracy Pumping Plant pumping is shown for model runs in Figure A2a-A2c.
Additional information	
Considerations for current DSM2 model run	No special considerations for this week's DSM2 model runs.
Caveats	• Time-step: DSM2 generates results at 15-minute time-steps. Visualizations of DSM2 model run results are aggregated over daily time-steps. Operations function on a more granular scale than daily time-step. • Salmonid behavior: DSM2 provides flow fields which salmonids may encounter but salmonids are not neutrally buoyant particles. Models which incorporate behavior from acoustic tagged salmonids are being developed for South Delta (ePTM, ecoPTM).

DSM2 model results: summary tables

Table A1. Summary of minimum, maximum, mean, and percent positive flows (cfs) and velocities (ft/s) by DSM2 channel for OMR scenarios over a 6-day time period. For scenario values refer to "Hydraulic Footprint Information" in the conditions / assumptions section above.

Scenario (cfs)	DSM2 Channel	Flow Min.	Flow Max.	Flow Mean	Flow % Positive	Velocity Min.	Velocity Max.	Velocity Mean	Velocity % Positive
Baseline	6	-49.9	1786.5	1090.4	99	0.0	1.1	0.6	99
Scenario 2	6	-57.1	1786.4	1090.3	98	0.0	1.1	0.6	98
Scenario 1	6	-230.8	1799.8	1089.7	95	-0.1	1.1	0.6	95
Baseline	21	-6998.9	6135.7	365.5	53	-0.5	0.4	0.0	53
Scenario 2	21	-6999.2	6135.0	363.0	53	-0.5	0.4	0.0	53
Scenario 1	21	-6988.9	6208.0	439.2	53	-0.5	0.4	0.0	53
Baseline	49	-145769.0	128129.9	135.1	51	-1.8	1.7	0.0	51
Scenario 2	49	-145770.4	128087.4	91.0	51	-1.8	1.7	0.0	51
Scenario 1	49	-145739.0	129077.3	1342.8	52	-1.8	1.7	0.0	52
Baseline	81	-4864.4	2236.8	-849.4	46	-1.3	0.7	-0.2	46
Scenario 2	81	-5014.6	2509.3	-849.6	45	-1.3	0.7	-0.2	45
Scenario 1	81	-3619.8	1909.2	-688.8	48	-1.0	0.6	-0.2	48
Baseline	94	-13766.9	9342.3	-989.8	50	-1.9	1.4	-0.1	50
Scenario 2	94	-13985.0	9341.2	-1022.7	49	-1.9	1.4	-0.1	49
Scenario 1	94	-11918.1	9502.6	-185.7	52	-1.6	1.4	0.0	52
Baseline	107	-5833.3	3897.9	-489.7	50	-1.6	1.1	-0.1	50
Scenario 2	107	-5854.9	3897.4	-497.8	50	-1.6	1.1	-0.1	50
Scenario 1	107	-5593.8	3963.0	-256.5	51	-1.6	1.2	-0.1	51
Baseline	124	-18129.6	11278.7	-2364.7	44	-0.6	0.4	-0.1	44
Scenario 2	124	-18135.2	11277.7	-2378.1	44	-0.6	0.4	-0.1	44
Scenario 1	124	-18007.9	11368.8	-1960.2	45	-0.6	0.4	-0.1	45
Baseline	148	-7892.8	5551.0	-582.7	51	-0.9	0.6	-0.1	51

Scenario (cfs)	DSM2 Channel	Flow Min.	Flow Max.	Flow Mean	Flow % Positive	Velocity Min.	Velocity Max.	Velocity Mean	Velocity % Positive
Scenario 2	148	-7996.9	5550.1	-595.6	50	-0.9	0.6	-0.1	50
Scenario 1	148	-7184.6	5639.1	-210.9	51	-0.8	0.7	0.0	51
Baseline	160	-4360.6	3450.3	-140.5	52	-0.5	0.5	0.0	52
Scenario 2	160	-4413.1	3450.3	-148.7	52	-0.5	0.5	0.0	52
Scenario 1	160	-4353.7	3450.3	15.0	53	-0.5	0.5	0.0	53
Baseline	434	-153577.3	145757.2	5038.6	52	-1.7	1.7	0.1	52
Scenario 2	434	-153577.3	145755.4	5025.7	52	-1.7	1.7	0.1	52
Scenario 1	434	-153577.3	145828.0	5365.0	52	-1.7	1.7	0.1	52

Table A2. Summary of KS statistic values (comparison of distribution of each scenario model results with baseline; KS statistic closer to 1 distributions are dissimilar and closer to 0 distributions are similar). For scenario values refer to "Hydraulic Footprint Information" in the conditions / assumptions section above.

DSM2 Channel	Flow: Baseline vs Scenario 1	Flow: Baseline vs Scenario 2	Velocity: Baseline vs Scenario 1	Velocity: Baseline vs Scenario 2
6	0.12	0.02	0.04	0.01
21	0.05	0.01	0.05	0.01
49	0.03	0.01	0.03	0.01
81	0.10	0.02	0.13	0.02
94	0.11	0.02	0.12	0.03
107	0.08	0.03	0.08	0.02
124	0.05	0.01	0.05	0.01
148	0.10	0.02	0.11	0.03
160	0.08	0.01	0.09	0.02
434	0.01	0.00	0.01	0.00

DSM2 model results: figures

Figure A1. Daily forecasted Vernalis and Freeport flows (cfs)

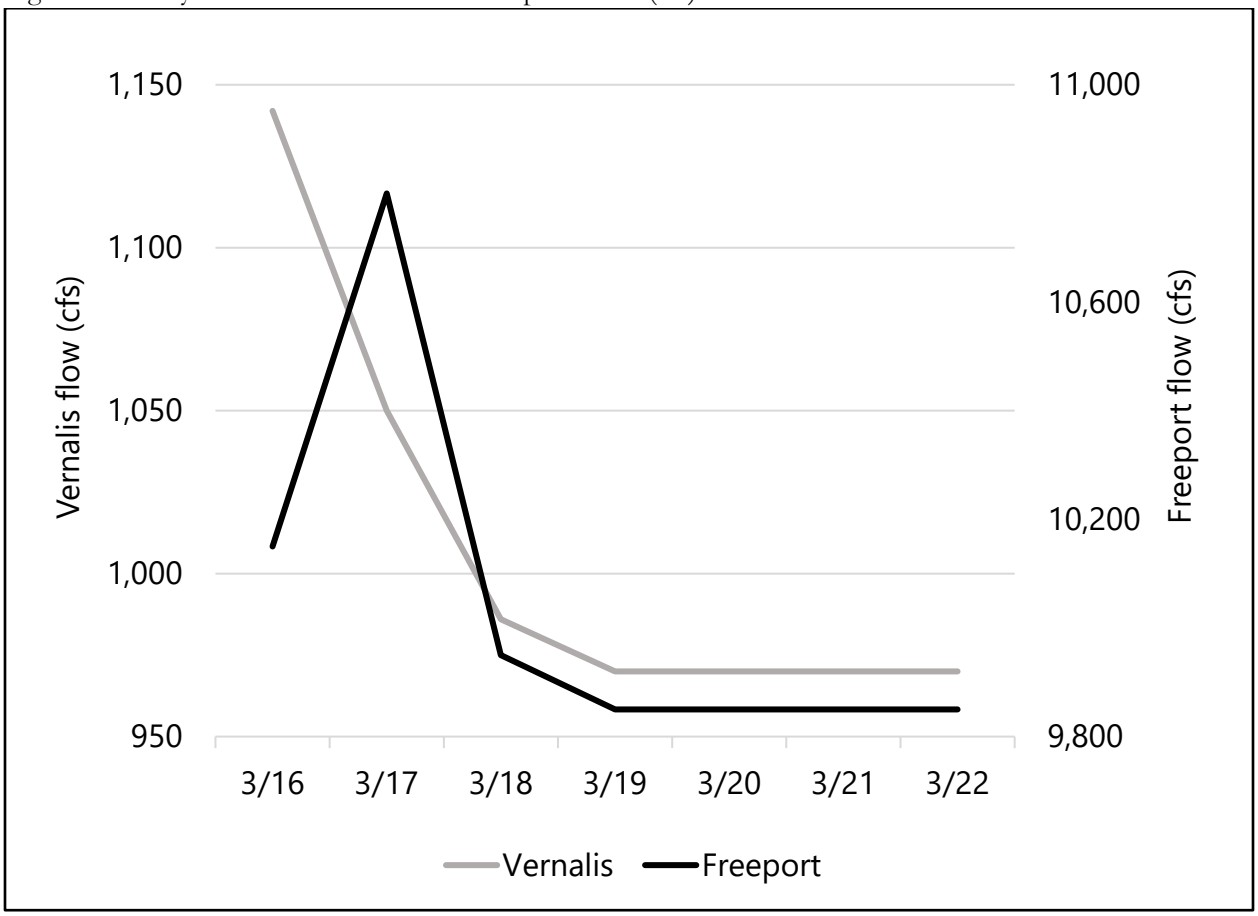


Figure A2a. Daily forecasted pumping: Jones and Banks (cfs), Baseline

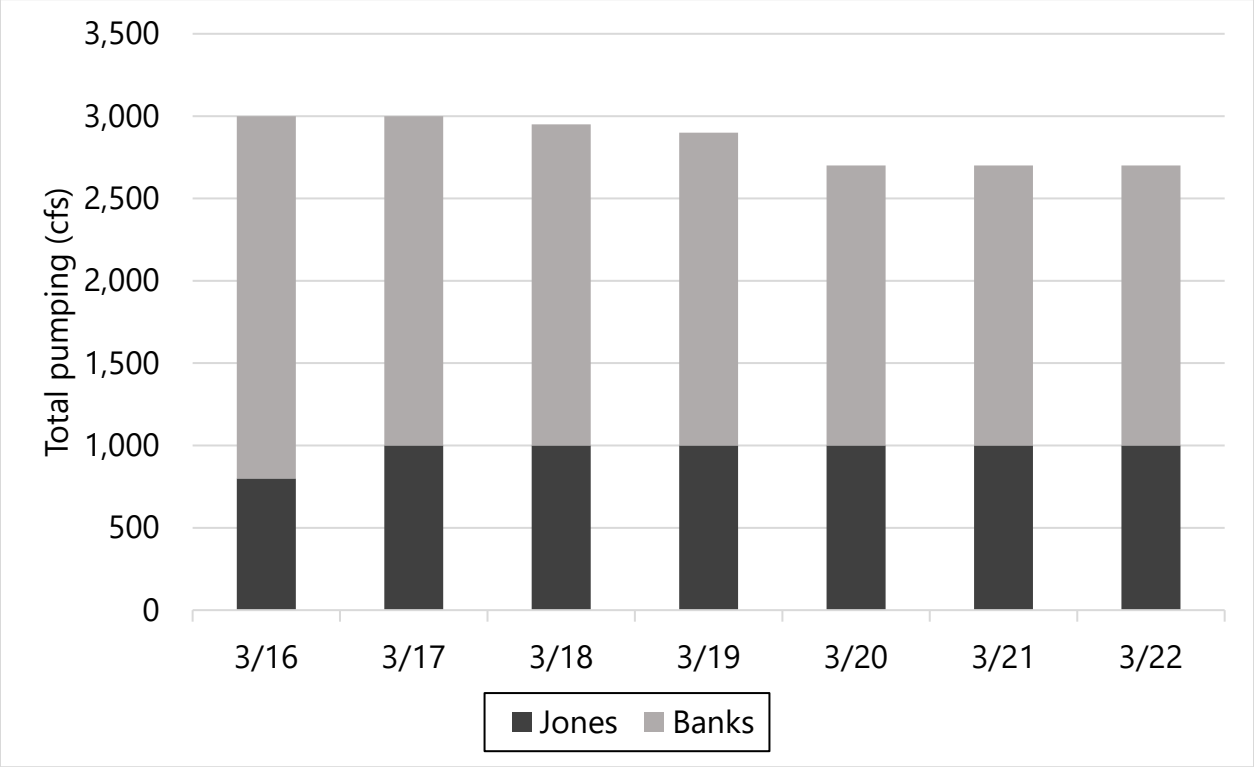


Figure A2b. Daily forecasted pumping: Jones and Banks (cfs), Scenario 1

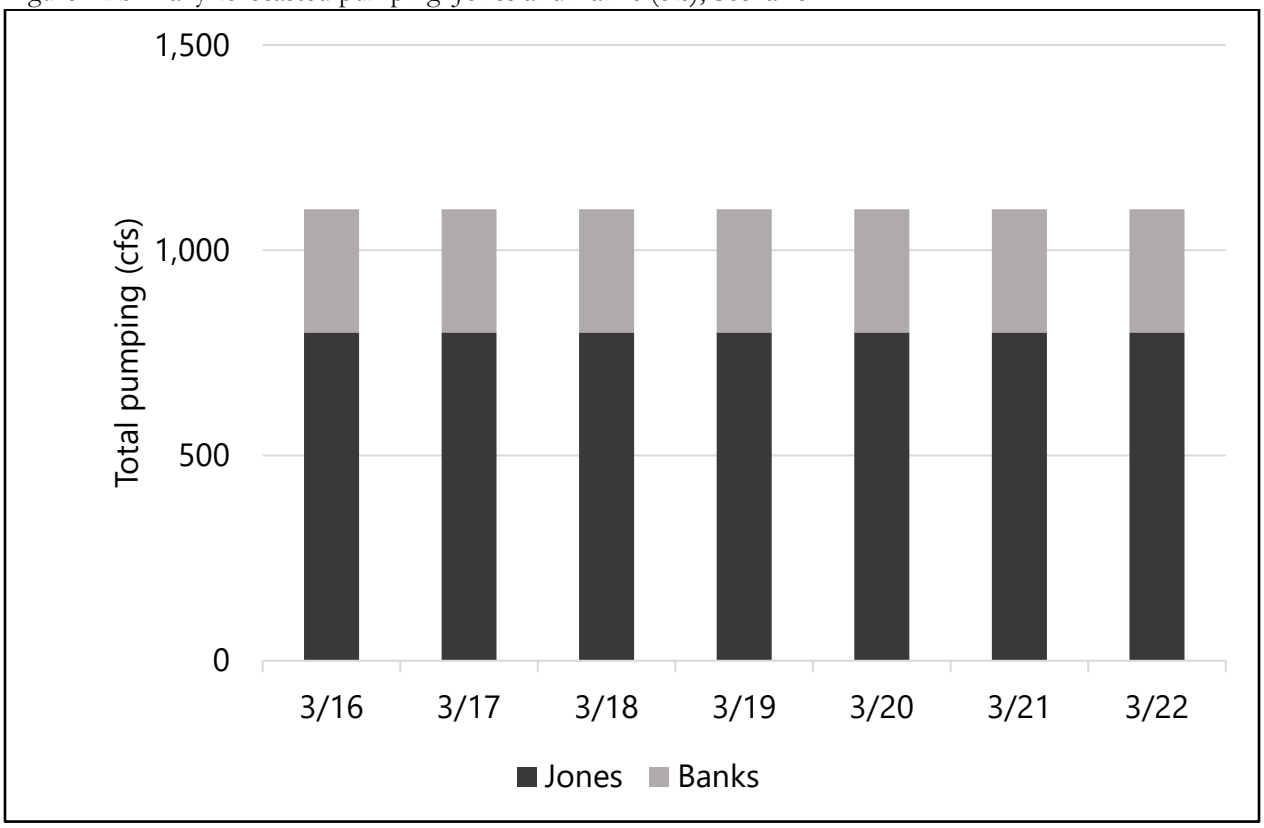


Figure A2c. Daily forecasted pumping: Jones and Banks (cfs), Scenario 2

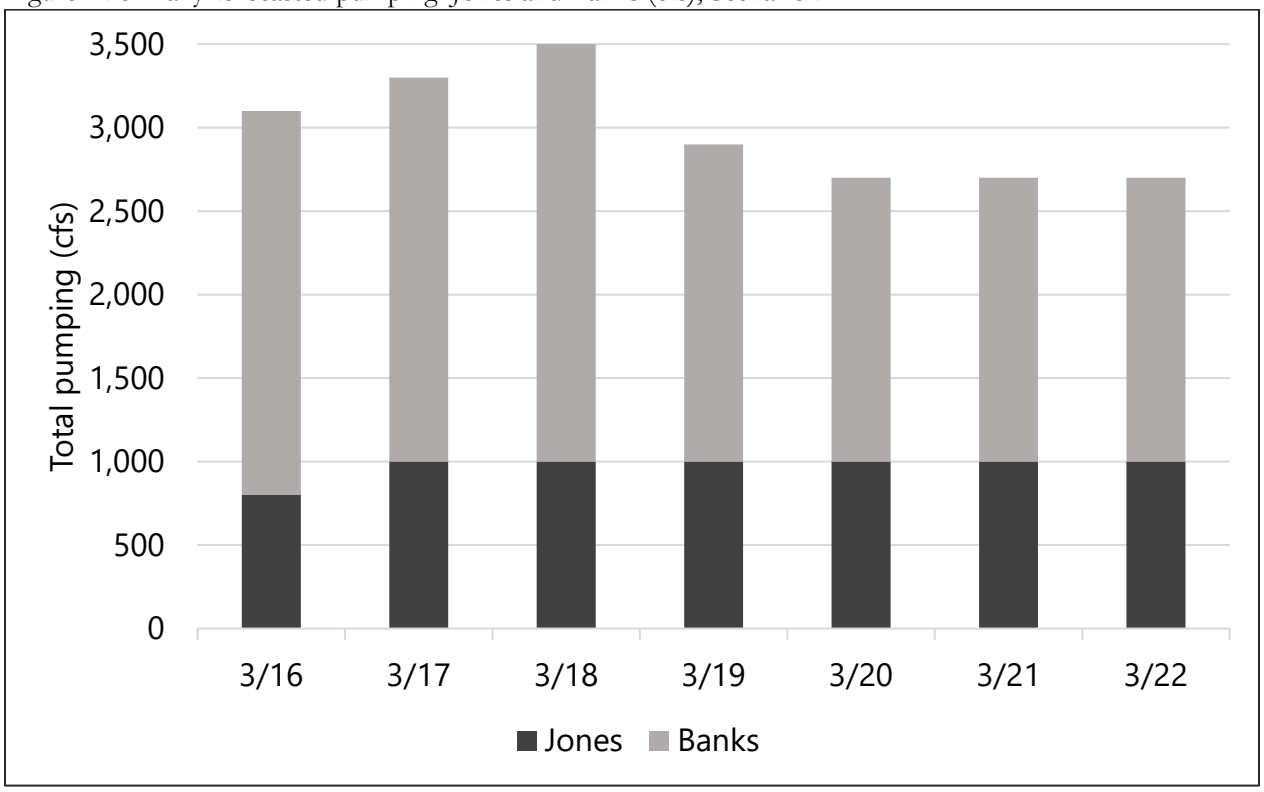
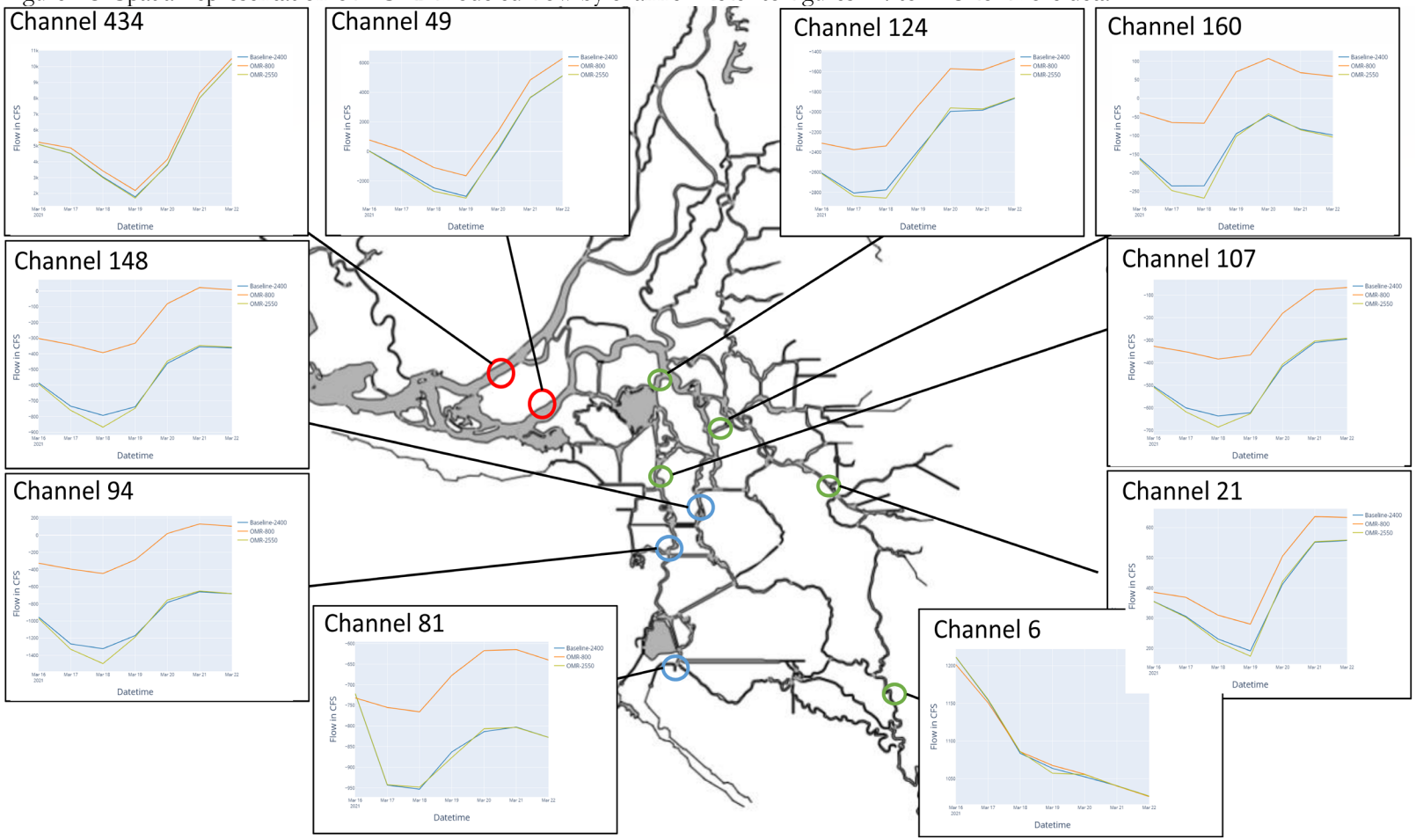


Figure A3: Spatial representation of DSM2 modeled flow by channel. Refer to figures A4 to A13 for more detail.

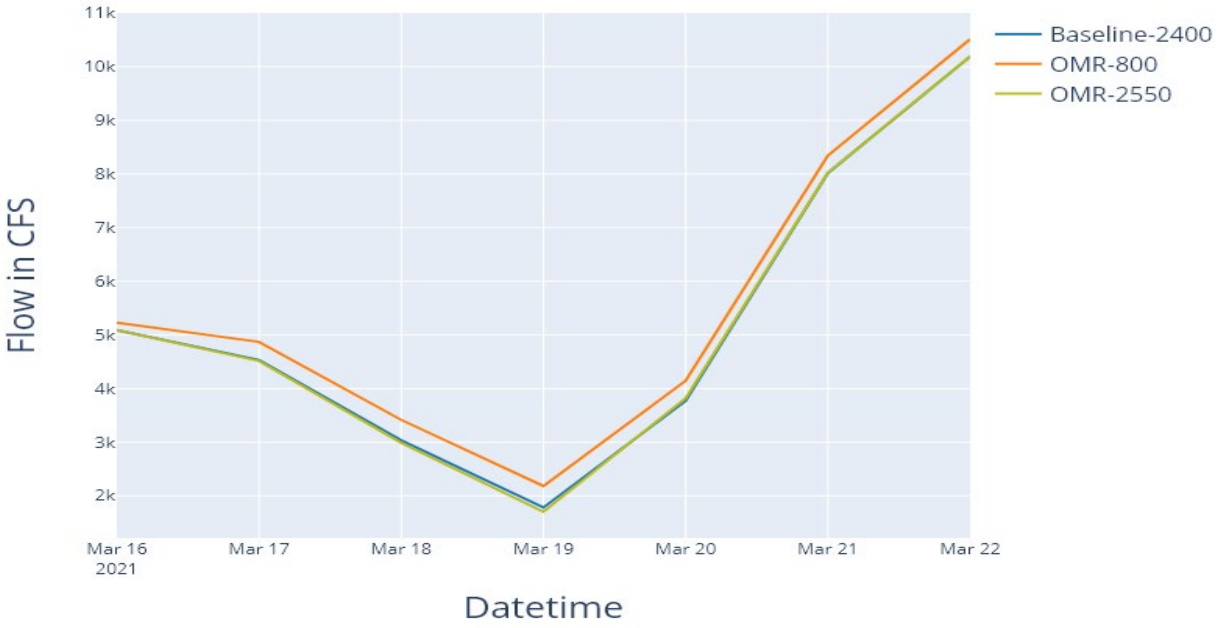


The following captions apply to the time-series plots for flow and velocity in selected locations (see Figure A14 and Table A3 for channel location information) below:

(a) Time-series plot (1-day aggregated): Baseline, Scenario 1 OMR, and Scenario 2 OMR. X-axis represents daily time steps and y-axis represents flow (cfs) values. For Baseline, Scenario 1, and Scenario 2 values refer to "Hydraulic Footprint Information" in the section above. Reported summary statistics (minimum, maximum, etc.) are found in Table A1.

(b) Time-series plot (1-day aggregated): Baseline, Scenario 1 OMR, and Scenario 2 OMR. X-axis represents daily time steps and y-axis represents velocity (cfs) values. For Baseline, Scenario 1, and Scenario 2 values refer to "Hydraulic Footprint Information" in the section above. Reported summary statistics (minimum, maximum, etc.) are found in Table A1.

Figure A4: Sacramento River at Sherman Island (CHAN434)
(a)



(b)

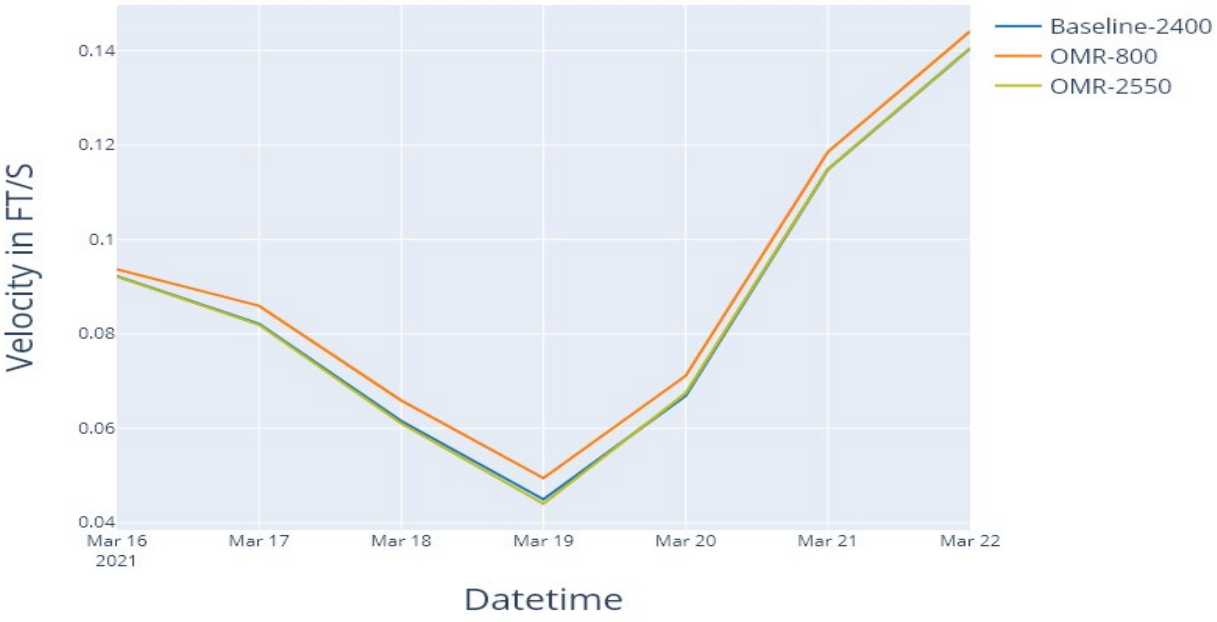
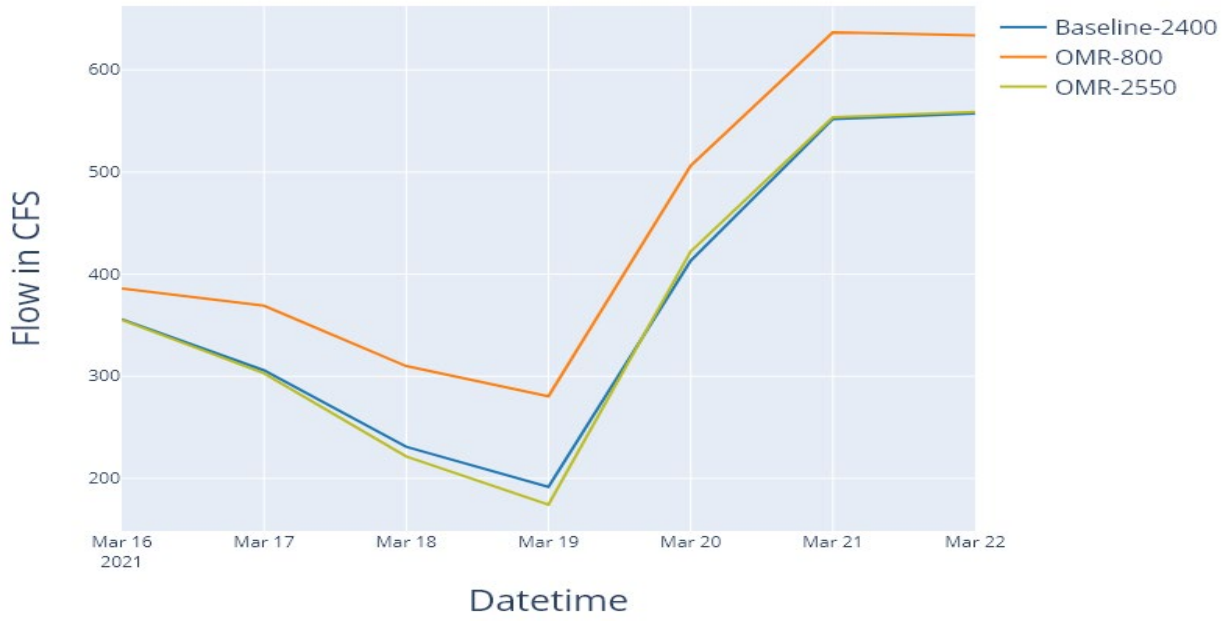


Figure A5: San Joaquin River downstream of confluence with Calaveras River (CHAN021)
(a)



(b)

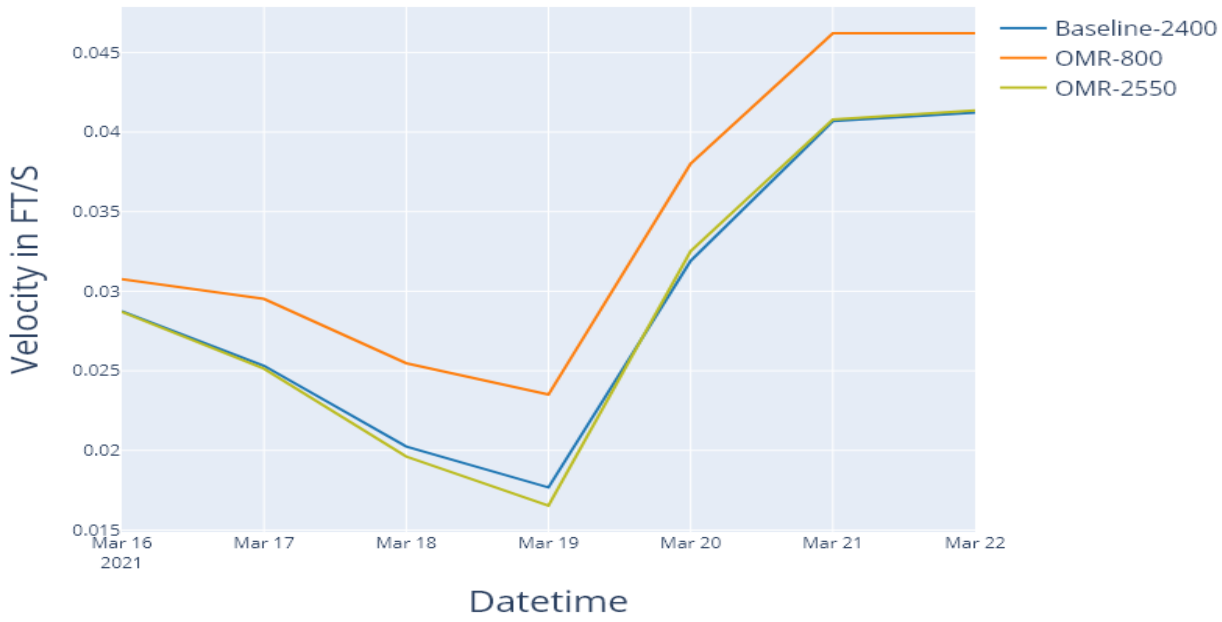
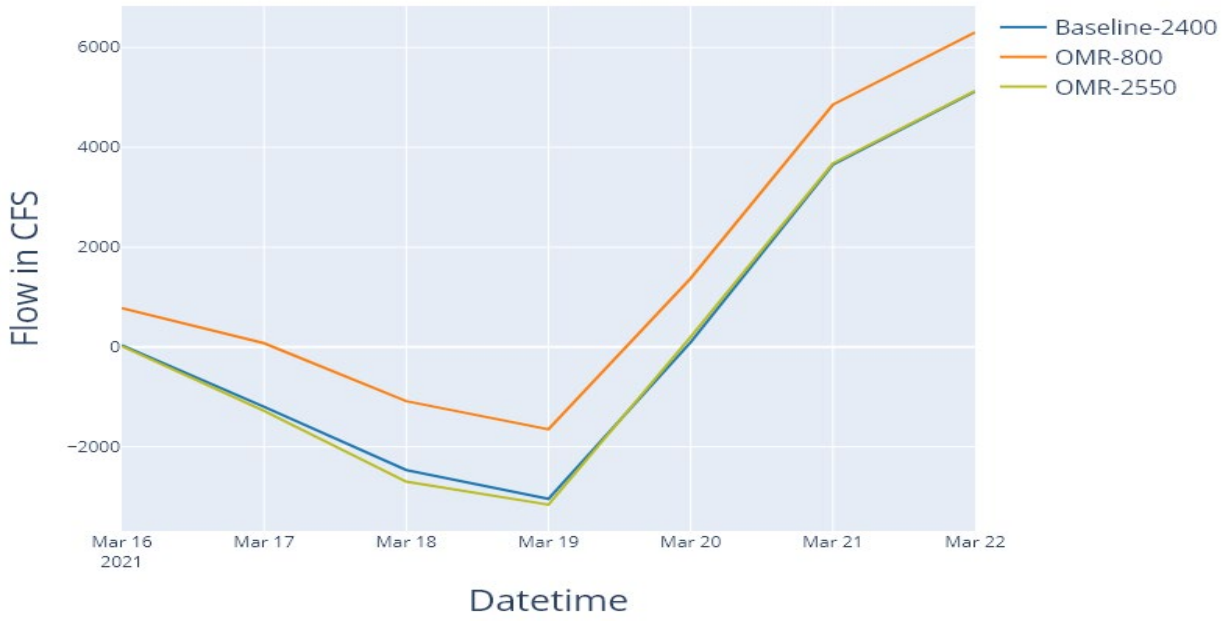


Figure A6: San Joaquin River at Sherman Island (CHAN049)
(a)



(b)

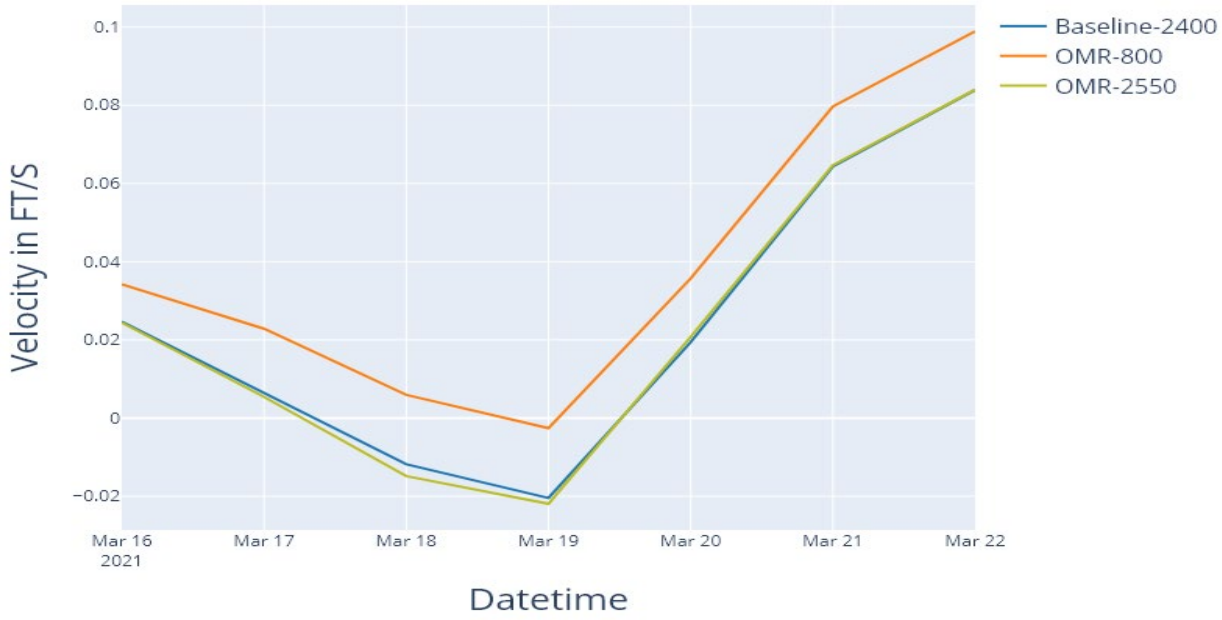
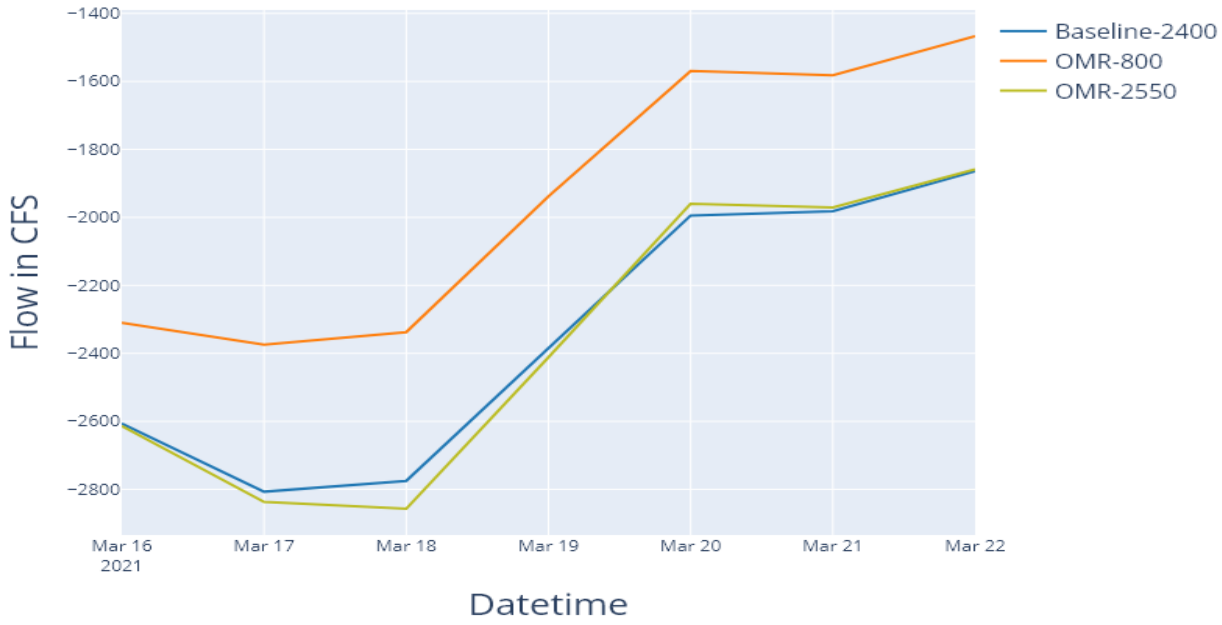


Figure A7: Old River between Franks Tract and San Joaquin River (CHAN124)
(a)



(b)

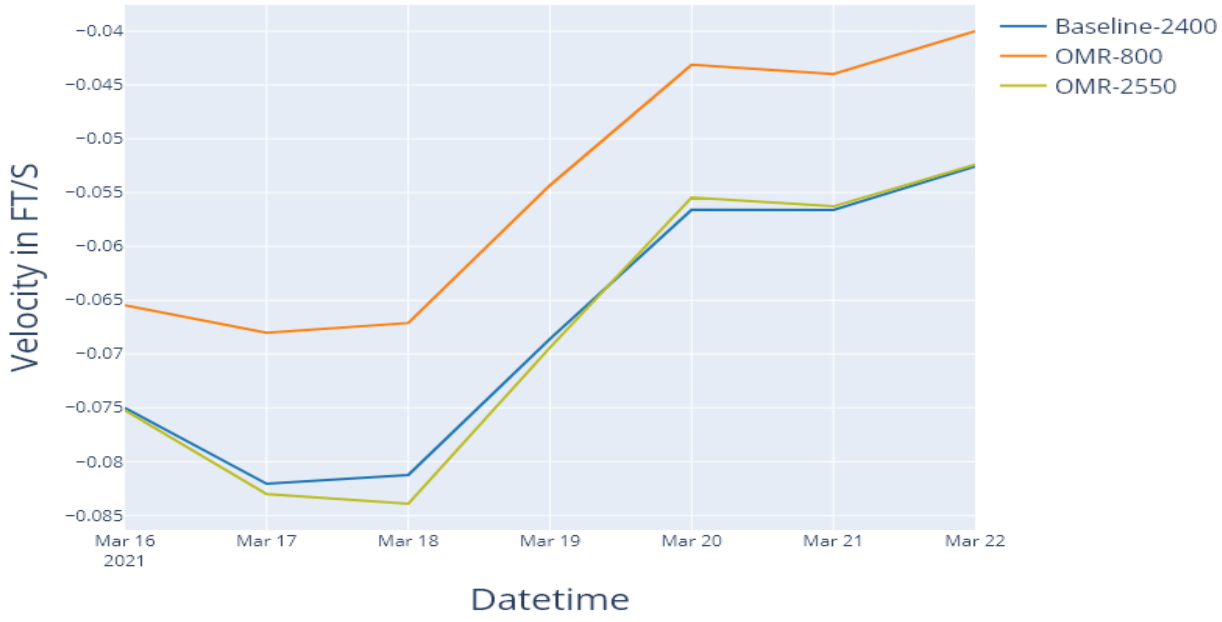


Figure A8: Lower San Joaquin River at Columbia Cut (CHAN160)
(a)

(b)

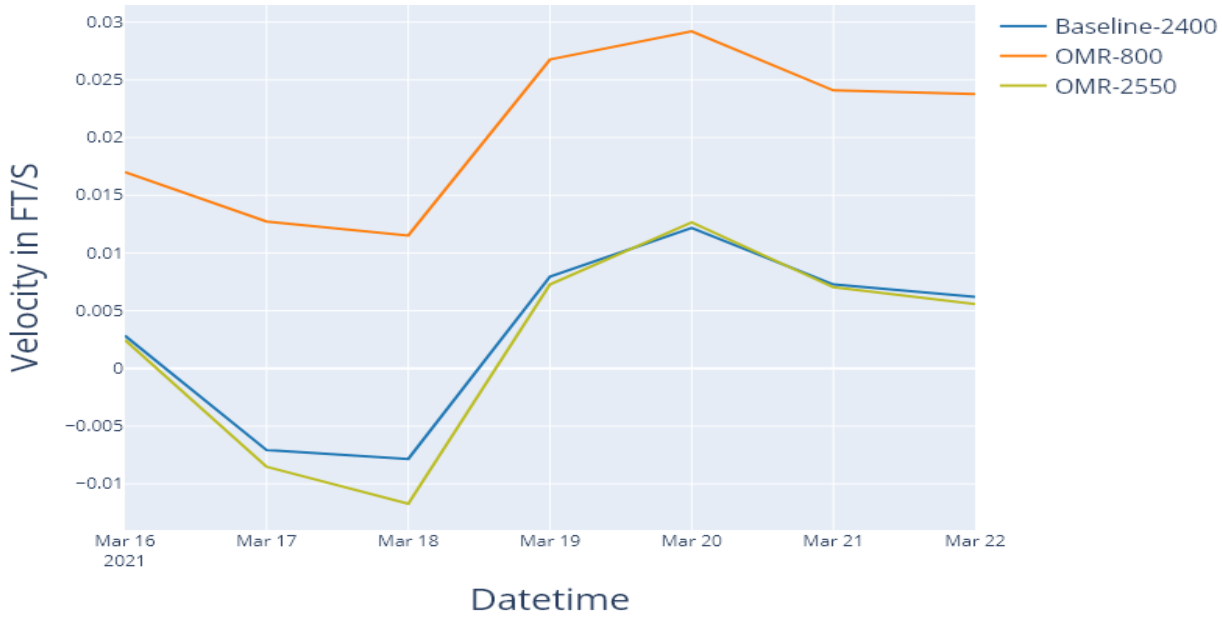
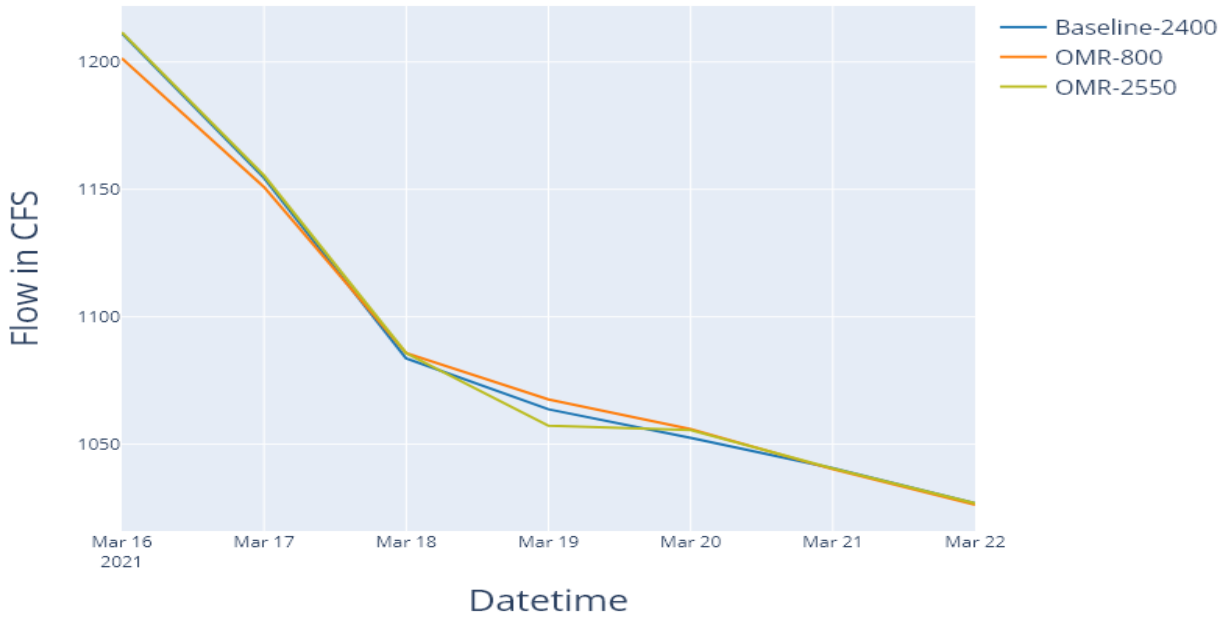


Figure A9: Slightly upstream of Head of Old River (CHAN006)
(a)



(b)

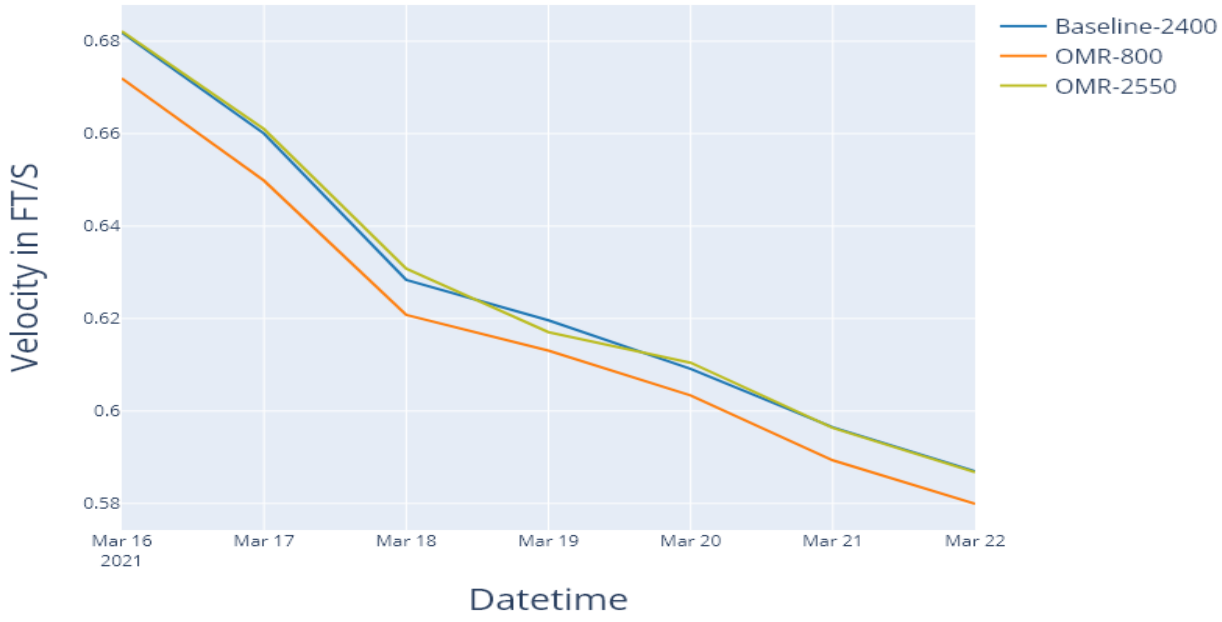
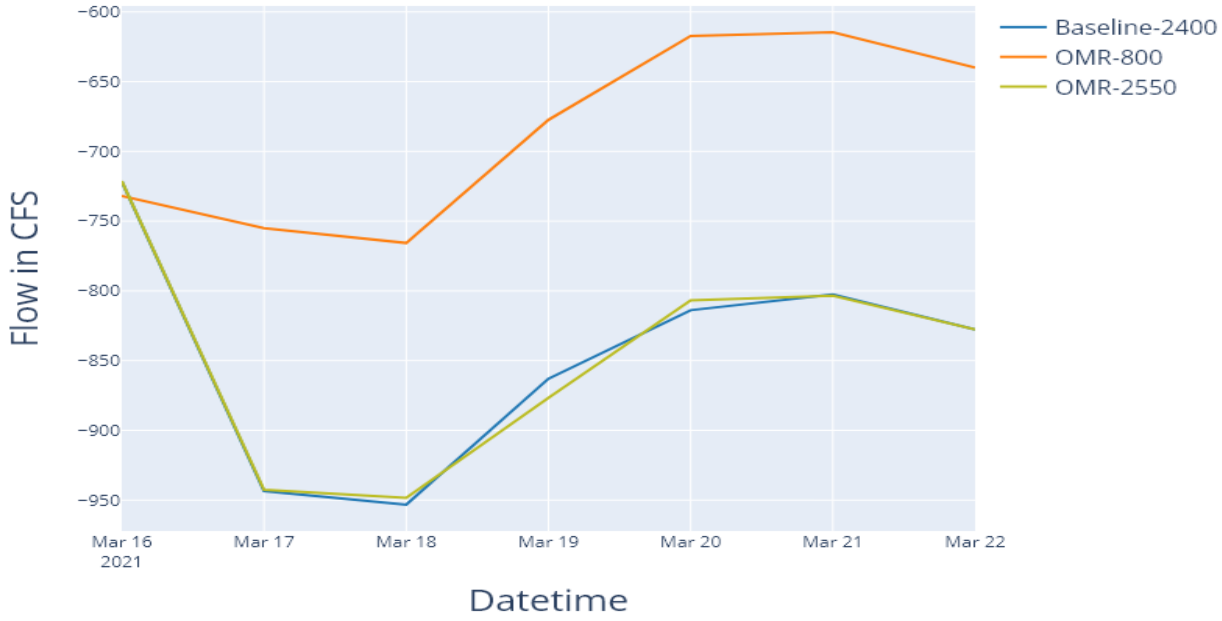


Figure A10: Old River adjacent to Grant Line Canal (CHAN081 – Old River between Grant Line and CVP)
(a)



(b)

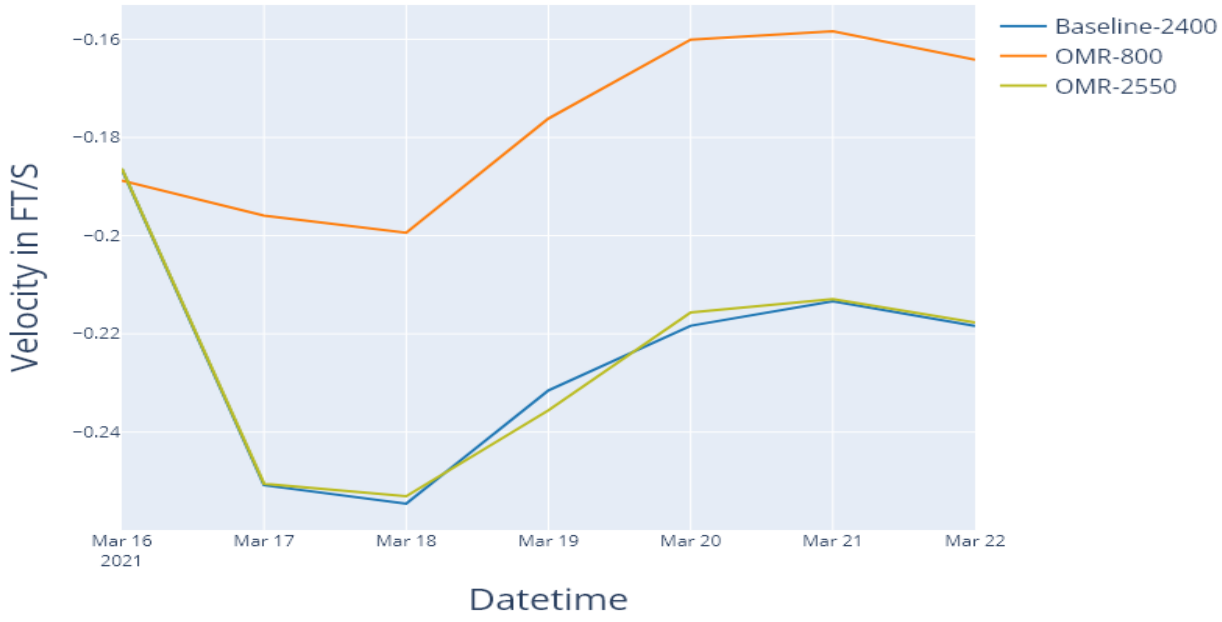


Figure A11: South Delta along Old River (CHAN094 – Old River/HW4)
(a)

(b)

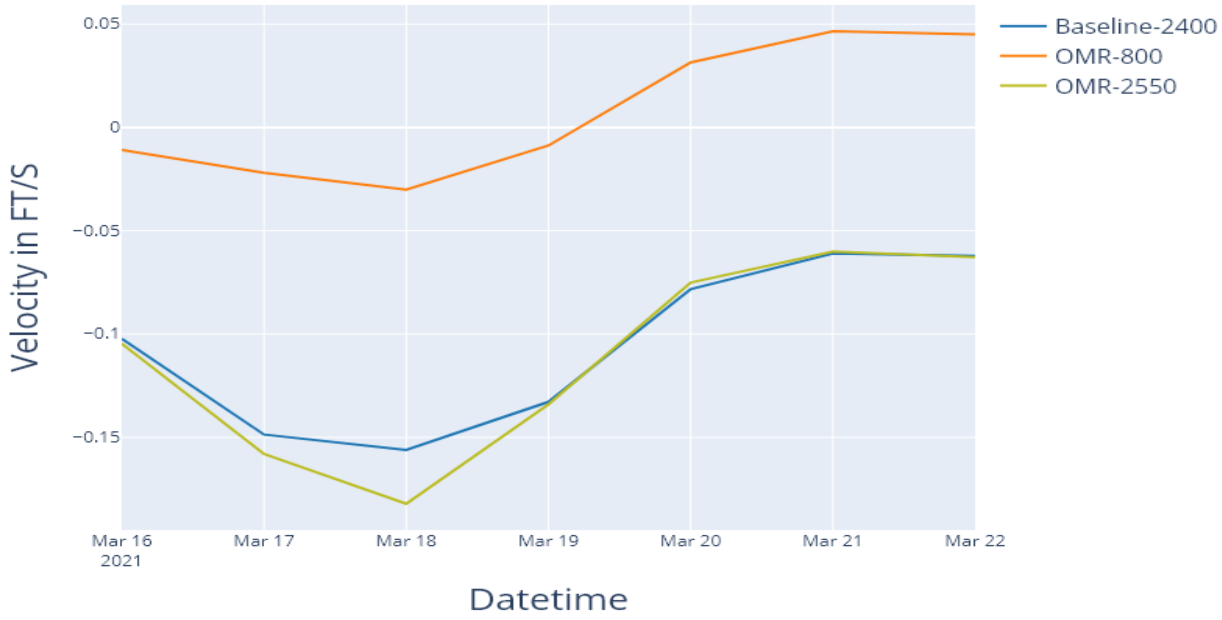


Figure A12: South Delta along Middle River (CHAN148 – Middle River/ Woodward Cut)
(a)

(b)

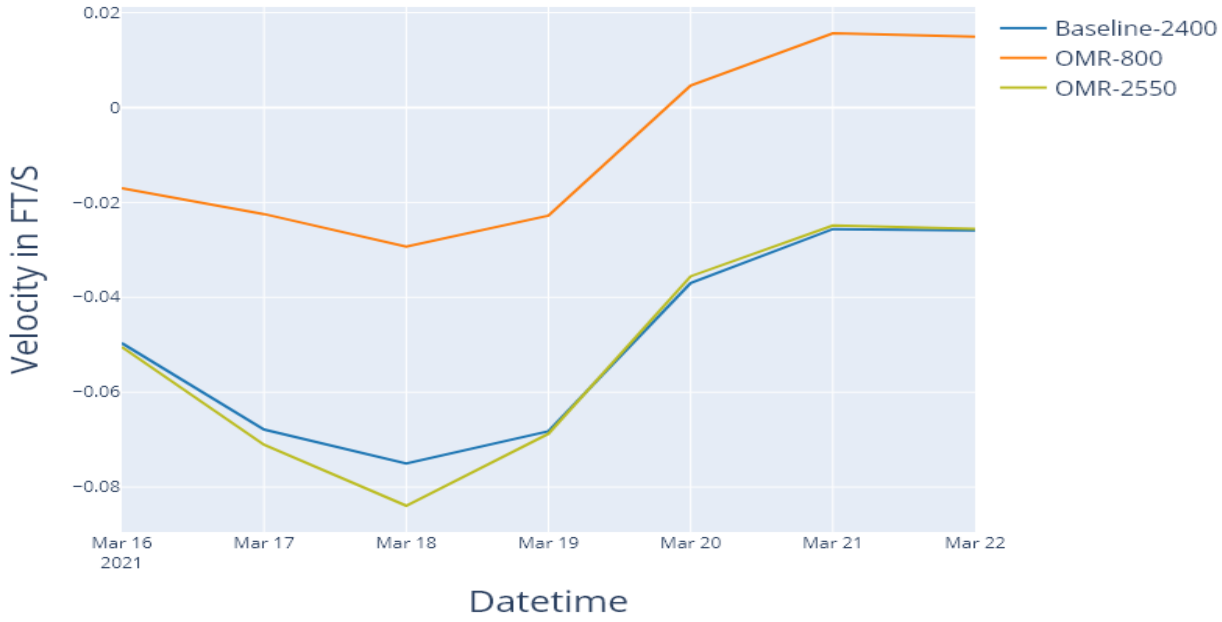
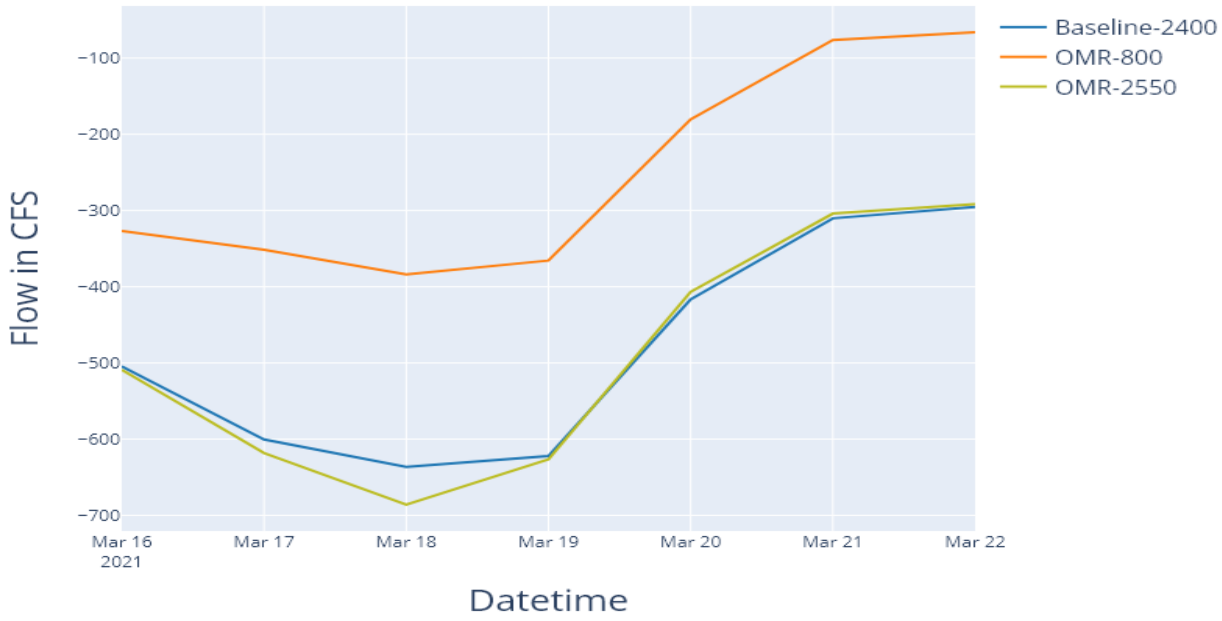
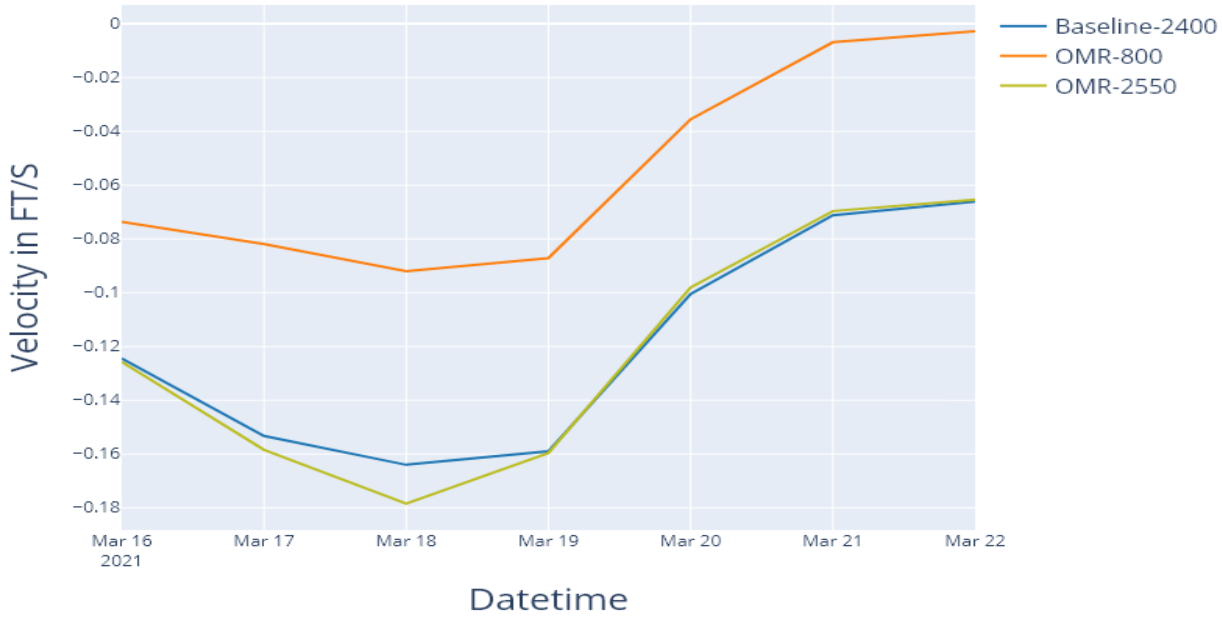


Figure A13: South Delta along Middle River (CHAN107 – Old River-Bacon Isl.)
(a)



(b)



DSM2 model interpretation entrainment in Delta strata regions

North Delta into Interior and Central Delta

Channels: 49 and 434

Low to slight measurable changes to flow and velocity related to modeled OMR conditions are anticipated. It is unlikely that listed salmonids would experience behavioral changes related to modeled OMR conditions this week. Despite low exports the zone of influence has expanded further south due to the low hydrology.

San Joaquin River and Central Delta into South Delta

Channels: 6, 21, 107, 124, and 160

There will be measurable changes to flow and velocity related to modeled OMR conditions. Based on recent survey data, listed salmonids are present. Hydrological changes may be detectable by fish. Cumulative net flows within the channels of the South Delta are negative in magnitude. Fish moving from the San Joaquin mainstem would have an increased transit time towards the western Delta. Despite low exports the zone of influence has expanded further north due to the low hydrology.

South Delta into facilities

Channels: 81, 94, and 148

There will be measurable changes to flow and velocity related to modeled OMR conditions. Based on recent survey data, listed salmonids are present. Hydrological changes may be detectable by fish. Cumulative net flows within the channels of the South Delta are negative in magnitude. Fish moving from the San Joaquin mainstem into the head of Old River would have a decreased transit time towards the fish salvage facilities.

DSM2 channel locations information

Figure A14. Highlighted DSM2 channels by Delta Strata.

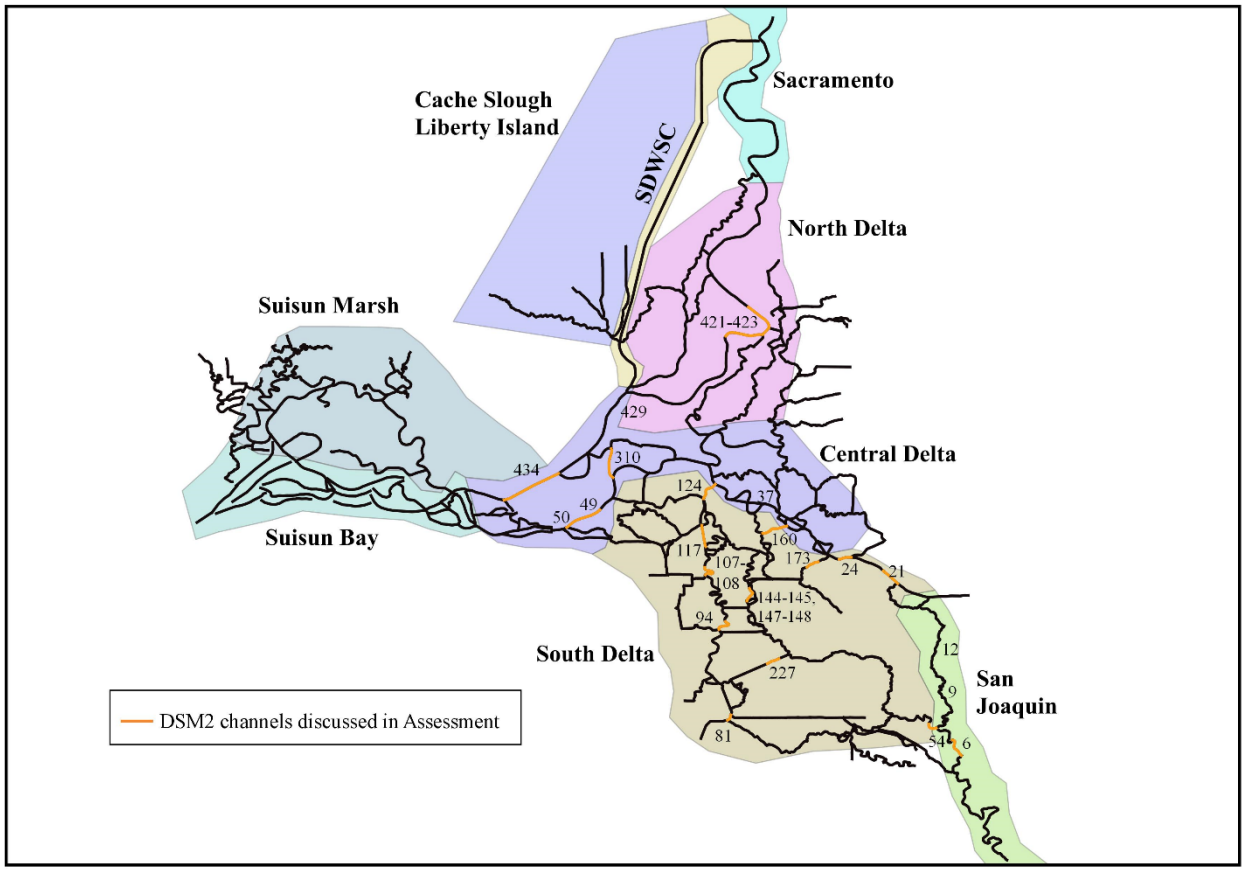


Table A3. Description of channel location, by Delta Strata region. Not all listed channels have model results presented in every weekly Proposed Action Assessment.

DSM2 Channel	**Description**
North Delta into Interior and Central Delta	
CHAN049	San Joaquin River at Sherman Island
CHAN310	Three-Mile Slough
CHAN421	Sacramento River at Delta Cross Channel
CHAN422	Sacramento River at Delta Cross Channel
CHAN423	Sacramento River at Delta Cross Channel
CHAN434	Sacramento River at Sherman Island
San Joaquin River and Central Delta into South Delta	
CHAN006	San Joaquin River at Head of Old River (HOR)
CHAN021	San Joaquin River downstream from confluence with Calaveras River
CHAN024	San Joaquin River upstream of Turner Cut
CHAN054	Old River at confluence with San Joaquin River (HOR)
CHAN107	Old River north of Rock Slough
CHAN117	Old River south of Franks Tract
CHAN124	Old River between Franks Tract and San Joaquin River
CHAN160	Columbia Cut
CHAN173	Turner Cut
South Delta into Facilities	
CHAN148	Middle River
CHAN227	Victoria Canal
CHAN081	Grant Line Canal
CHAN094	Old River

Attachment B: Delta Turbidity Report

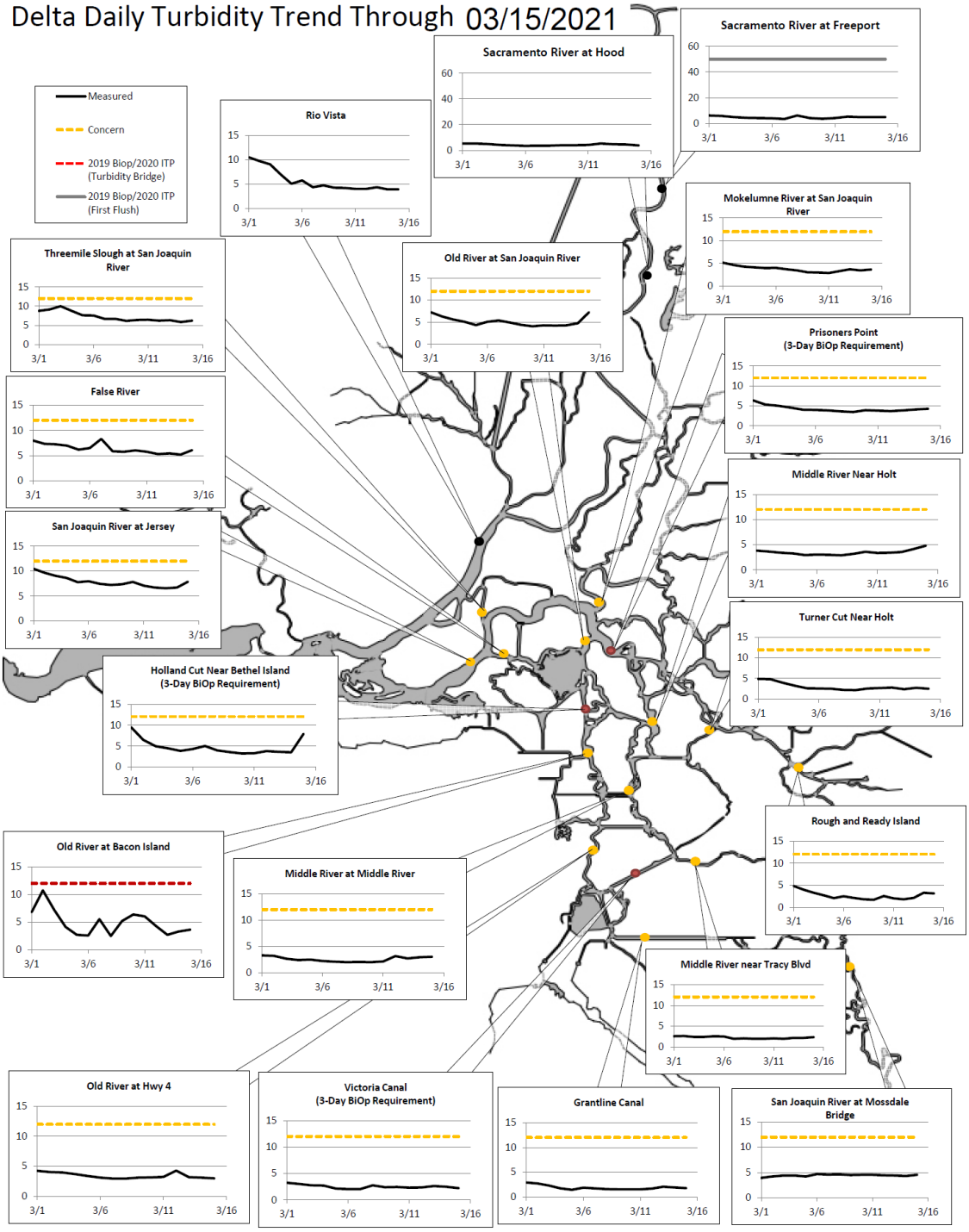
Department of Water Resources
Division of Operations and Maintenance
SWP Water Operations Office

Delta Turbidity Conditions Report

For conditions through: **March 15, 2021**

General Conditions:

Inflows:		
	Freeport	9995 CFS
	Yolo Bypass	34 CFS
	Vernalis	1118 CFS
	Cosumnes	174 CFS
	Mokelumne	118 CFS
	Calaveras	44 CFS
Exports:		
	Clifton Court	1370 CFS
	Jones	406 CFS
Other:		
	OMR (Index)	-1360 CFS
	QWEST	1464 CFS
	NDOI	10051 CFS



OBI station Turbidity values are CDEC daily data.
All other sations Turbidity values are daily average calculated from CDEC event data.