Appendix F, Modeling

Attachment 1-2 Modeled Representation of Old and Middle River Actions

Calculations of the Net Tidal Flow in Old and Middle River (OMR) have been used in recent years as a surrogate for determining the relative influence of water project export rates on Bay-Delta aquatic species listed for Endangered Species Act protection under both Federal and State law.

Proposed Approach

As part of assumptions development for the Proposed Action, previous assumptions that were developed under the 2019 BiOps and 2020 ITP for the Exiting Conditions, were reevaluated for consistency with current understanding of OMR management. This review is especially necessary considering data availability. 2010-2022 data was used to determine new assumptions for Alternative 2 and update assumptions for the No Action Alternative (NAA).

The historical data was used to determine what percentage of the historical month an OMR action would have triggered, herein referred to as the historical percentage of month method. A hypothetical table for 2010-2022 OMR percentages is shown below.

Table 1. 2010-2022 Hypothetical OMR Percentage

Year	Jan	Feb	Mar	Apr	May	Jun
2010	0%	4%	93%	18%	13%	0%
2011	0%	39%	93%	93%	93%	0%
2012	0%	0%	47%	93%	93%	0%
2013	0%	0%	64%	63%	93%	0%
2014	0%	0%	0%	0%	0%	0%
2015	0%	14%	93%	68%	33%	0%
2016	0%	39%	93%	68%	93%	0%
2017	0%	0%	43%	93%	93%	0%
2018	0%	0%	93%	93%	93%	0%
2019	0%	72%	93%	0%	58%	0%
2020	0%	0%	0%	0%	0%	0%
2021	0%	0%	0%	0%	0%	0%
2022	0%	0%	0%	0%	0%	0%

Table 1 was then averaged by water year type. The historical 50% exceedance forecast was used for the water year type for each month. Table 2 below shows the historical 50% exceedance forecasted water year types by year and month.

Table 2. 2010-2022 Historical Water Year Type

Year	Jan	Feb	Mar	Apr	May	Jun
2010	D	BN	D	D	BN	BN
2011	AN	AN	BN	W	W	W
2012	BN	D	D	D	BN	BN
2013	W	BN	D	D	D	D
2014	C	C	C	C	C	C
2015	BN	C	C	C	C	C
2016	D	D	D	BN	BN	BN
2017	AN	W	W	W	W	W
2018	AN	BN	D	BN	BN	BN
2019	BN	BN	W	W	W	W
2020	BN	BN	D	D	D	D
2021	C	C	C	C	C	C
2022	BN	D	C	C	C	C

A breakdown of the data in Table 2 by water year type is shown in Table 3.

Table 3. 2010-2022 Historical Water Year Type Summary

WY Type	Jan	Feb	Mar	Apr	May	Jun
C	2	3	4	4	4	4
D	2	3	6	4	2	2
BN	5	5	1	2	4	4
AN	3	1	0	0	0	0
W	1	1	2	3	3	3

Table 1 and Table 2 were used to determine the average OMR percentage by water year type and month for input into CalSim 3. For example, there are three (3) February D years in the 2010-2022 data: 2012, 2016, and 2022. The OMR percentages from Table 1 are 0%, 39%, and 0% for 2012, 2016, and 2022, respectively. These numbers are averaged to get the D year OMR % for use in CalSim 3 (13%). There are zero AN water year types for the months of March through June as shown in Table 3, therefore, the average of the BN and W was used for these months. The OMR percentage by water year type and month are shown in Table 4 for this hypothetical example.

Table 4. 2010-2022 Historical Water Year Type Summary

WY Type	Jan	Feb	Mar	Apr	May	Jun
C	0%	5%	23%	17%	8%	0%
D	0%	13%	65%	44%	47%	0%
BN	0%	15%	93%	81%	73%	0%
AN	0%	39%	81%	71%	77%	0%
W	0%	0%	68%	62%	81%	0%

No Action Alternative

The U.S. Fish and Wildlife Service and National Marine Fisheries Service issued Biological Opinions for Delta smelt and Central Valley salmonids in 2019 (2019 BiOps) and the California Department of Fish and Wildlife (CDFW) issued the Incidental Take Permit for the State Water Project in 2020 (2020 ITP). The 2019 BiOps and the 2020 ITP included OMR restrictions to minimize potential loss of sensitive fish species due to the Project exports.

Integrated Early Winter Pulse Protection

In modeling the NAA, the 2019 BiOps Integrated Early Winter Pulse Protection or "First Flush" was assumed to be implemented under the following conditions:

- December when the unimpaired Sacramento River Runoff (SRR) is greater than 20,000 cfs,
- January if no First Flush occurred in December and when the SRR is greater than 20,000 cfs

The First Flush action is assumed to restrict OMR to -2,000 cfs for 14 days. Since CalSim utilizes a monthly timestep this 14 day action is implemented using a weighted average with a background level. For December the background level is -8,000 cfs and for January the background level is -5,000 cfs.

These assumptions were developed using Sacramento River at Freeport flow and turbidity data from 2008 to 2019. In addition, turbidity data from Sacramento River at Hood was used to fill-in and confirm turbidity data at Freeport. Since the first flush is limited to the December to January period, the data analyzed was also limited to this timeframe. Turbidity is a parameter that is not simulated in CalSim, and so a flow surrogate was used and consistent with past practice. The SRR represents the unimpaired flow from the major tributaries to the Sacramento River. As shown in Figure 1, the approximate transition where Freeport flow and turbidity levels would trigger a first flush is around an SRR of about 20,000 cfs.

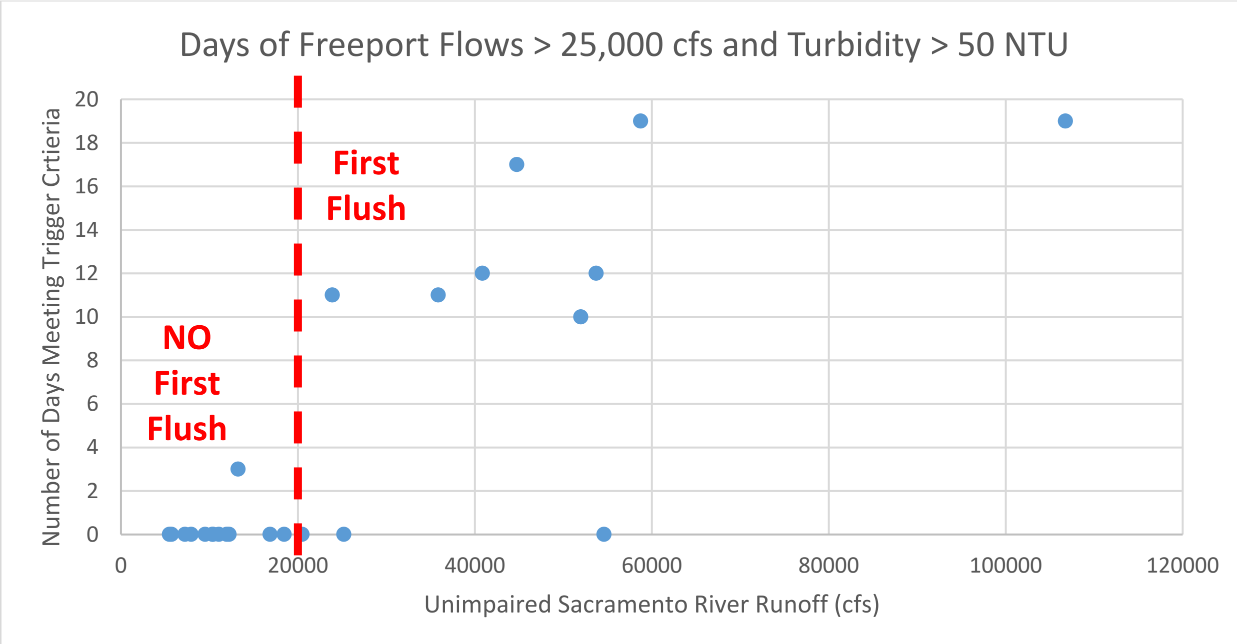

Figure 1. Relationship between Sacramento River Runoff and the flow and turbidity at Freeport exceeding 25,000 cfs and 50 NTU.

Start of OMR Management

If the First Flush action does not occur in December, it is assumed in the model that the OMR management season will start at the beginning of January. Unless Storm Flex is triggered, OMR index must be greater than -5,000 cfs through the OMR Management season.

Turbidity Bridge Avoidance

In modeling the NAA, the turbidity bridge avoidance was assumed to apply an additional OMR requirement of -2,000 cfs for 5 days when the following conditions occur:

- Timeframe under which a turbidity avoidance action may occur
    - January– if First Flush occurs in December,
    - February– if First Flush occurs in January or not at all,
- SRR > 20,000 cfs

Like other turbidity related actions, this one requires the use of a surrogate to determine when an action is triggered. The turbidity station at Old River at Bacon Island (OBI) is in the interior Delta south of the San Joaquin River, which makes it difficult to predict with any great accuracy. However, the SRR is and has been used for other turbidity based actions. Using historical OBI data from 2008 to 2019, daily average values above 12 NTU were summed for months January and February. The resulting number of days per month exceeding 12 NTU were compared to the SRR for the same month (Figure 2). The red line indicates the rough transition point using the SRR.

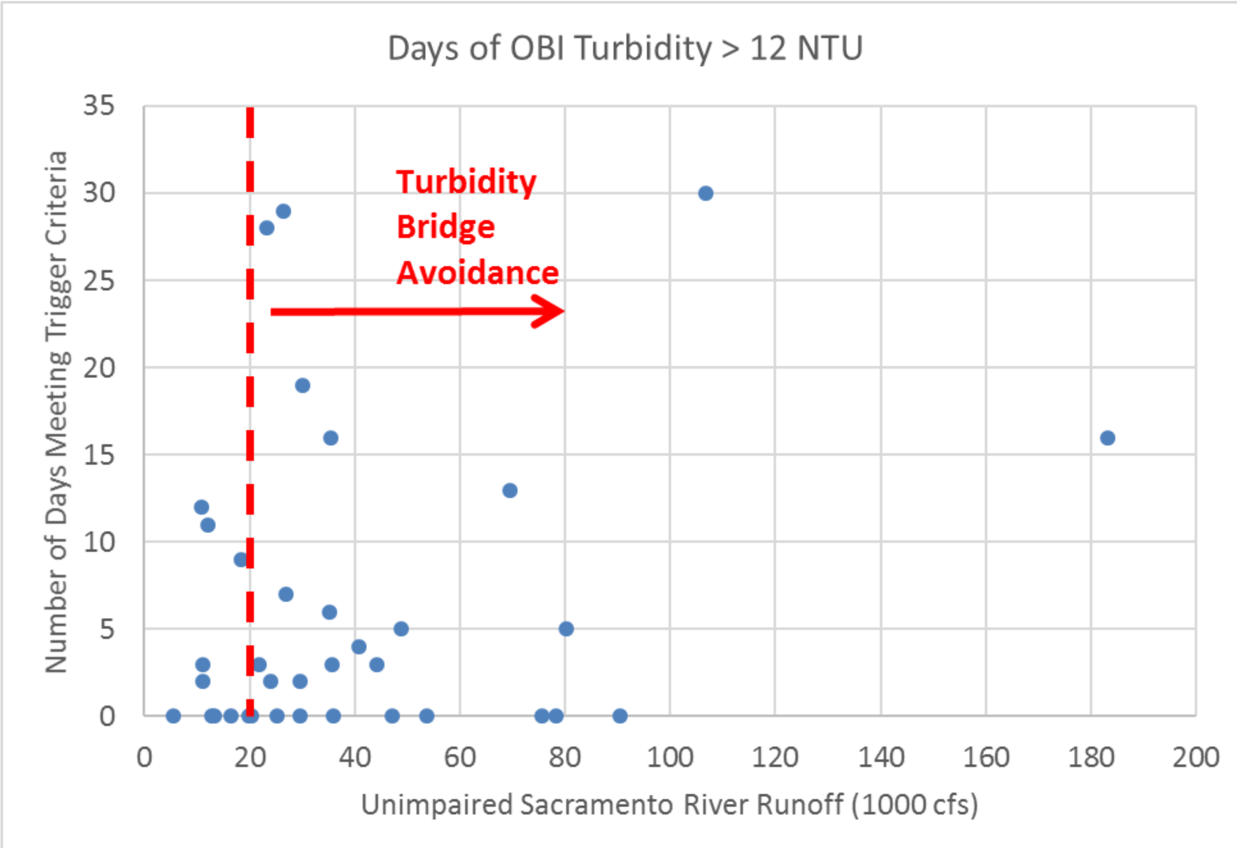

Figure 2. Monthly Comparison of Number of Days in Month Exceeding 12 NTU at OBI and SRR

This relationship could be stronger, but it should be recognized that because of its location, OBI, is subject to many variables, including but not limited to wind driven turbidity and lower turbidity due to proactive Project operations that is embedded in the data. In general, the historic data resulted in a 72% frequency of a triggering event. Using an SRR surrogate of 20,000 cfs results in a 61% triggering frequency.

Salvage Loss Thresholds

The NAA included real-time OMR management actions based on the percent of Winter-Run Chinook Salmon and Central valley Steelhead salvaged relative to proposed Single Year Loss Thresholds. The salvage loss threshold OMR assumption was modified from previous analysis to ensure consistent methodology with the Proposed Action, using the historical percentage of month method.

Winter-Run and Steelhead

Historic salvage data, based on the length at date Delta Model (LAD), at the fish facilities at Banks and Jones Pumping Plants for water years 2010 – 2022, and fish catch data at Chipps Island trawl during water years 2017 – 2021 were analyzed. Historic salvage data provides the potential timing of triggering the 50% levels of the proposed single year loss thresholds. For modeling purposes, it is assumed that if the 50% level is triggered then the 75% level would not be triggered. For Winter-Run loss thresholds were identified for Dec – Jun period. For steelhead, separate loss thresholds were identified for Dec – Mar and Apr – May.

Table 5. 2010-2022 Historical Winter-Run and Steelhead Salvage Loss

Water Year	Steelhead Dec–Mar	Steelhead Apr–Jun	WR Natural	WR Hatchery
2010	10-Feb	-	-	-
2011	15-Feb	7-May	24-Feb	-
2012	22-Mar	-	10-Mar	-
2013	9-Mar	9-Apr	-	-
2014	-	-	-	-
2015	22-Feb	-	-	-
2016	15-Feb	-	-	-
2017	-	-	-	-
2018	5-Mar	6-Apr	-	-
2019	6-Feb	11-May	-	-
2020	-	-	-	-
2021	-	-	-	-
2022	-	-	-	-

The salvage data above was summarized to percent of the month the threshold would trigger. For example, the 2011 Steelhead (Dec – Mar) loss threshold triggered February 15 so the assumption is the OMR would be -3,500 from Feb 16 through the end of the February and continue through March 31. The Steelhead (Apr-Jun) was triggered May 7 so -3,500 would be assumed May 8 through May 31, and the WR was triggered March 29 so it was assumed -3,500 from May 8 through May 31. The monthly percentages for the entire 2010 – 2022 period are summarized in Table 6 below.

Table 6. 2010-2022 Historical Winter-Run and Steelhead Salvage Loss OMR Percentage

Water Year	Jan	Feb	Mar	Apr	May	Jun
2010	0%	64%	100%	23%	23%	0%
2011	0%	46%	100%	100%	100%	0%
2012	0%	0%	39%	100%	100%	0%
2013	0%	0%	71%	70%	100%	0%
2014	0%	0%	0%	0%	0%	0%
2015	0%	21%	100%	77%	23%	0%
2016	0%	46%	100%	77%	100%	0%
2017	0%	0%	52%	100%	100%	0%
2018	0%	0%	84%	80%	100%	0%
2019	0%	79%	100%	50%	65%	0%
2020	0%	0%	0%	0%	0%	0%
2021	0%	0%	0%	0%	0%	0%
2022	0%	0%	0%	0%	0%	0%

Juvenile Delta Smelt

The NAA previously assumed the Juvenile Delta Smelt was covered by the assumption made for the Winter-Run and Steelhead. However, to ensure consistency with the assumptions made for Alternative 2, the NAA assumption was updated. The historical Secchi depth data for Juvenile Delta Smelt data was analyzed and summarized by weeks when the Secchi depth is less than 100 cm. Table 9 summarizes when the Secchi depth is less than 100 cm for Juvenile Delta Smelt and which would have triggered a potential OMR action to protect Juvenile Delta Smelt (1= trigger, 0=No trigger) during the 2010-2022 period.

Table 7. 2010-2022 Historical Winter-Run Loss OMR Triggers

	2/26-3/4	3/5-3/11	3/12-3/18	3/19-3/25	3/26-4/1	4/2-4/8	4/9-4/15	4/16-4/22	4/23-4/29	4/30-5/6	5/7-5/13	5/14-5/20	5/21-5/27	5/28-6/03
2010	0	0	0	0	0.5	1	1	1	1	1	1	1	1	1
2011	0	0	0	0	0	1	1	1	1	1	1	1	1	1
2012	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2013	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2014	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2015	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2016	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2018	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2019	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2020	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2021	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2022	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 8. 2010-2022 Historical Steelhead Loss OMR Triggers

	1/1-1/7	1/8-1/14	1/15-1/21	1/22-1/28	1/29-2/4	2/5-2/11	2/12-2/18	2/19-2/25	2/26-3/4	3/5-3/11	3/12-3/18	3/19-3/25	3/26-4/1	4/2-4/8	4/9-4/15	4/16-4/22	4/23-4/29	4/30-5/6	5/7-5/13	5/14-5/20	5/21-5/27	5/28-6/03
2010	0	0	0	0	0	0.29	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	
2011	0	0	0	0	0	0	0.43	1	1	1	1	1	1	0	0	0	0	0	1	1	1	1
2012	0	0	0	0	0	0	0	0	0	0	0	0.43	1	0	0	0	0	0	0	0	0	
2013	0	0	0	0	0	0	0	0		0.29	1	1	1	0	1	1	1	1	1	1	1	1
2014	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2015	0	0	0	0	0	0	0	0.43	1	1	1	1	1	0	0	0	0	0	0	0	0	0
2016	0	0	0	0	0	0	0.43	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0
2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2018	0	0	0	0	0	0	0	0		1	1	1	1	0.43	1	1	1	1	1	1	1	1
2019	0	0	0	0		0.86	1	1	1	1	1	1	1	0	0	0	0	0	0	1	1	1
2020	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2021	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2022	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 9. 2010-2022 Juvenile Delta Smelt Loss OMR Triggers

	2/26-3/4	3/5-3/11	3/12-3/18	3/19-3/25	3/26-4/1	4/2-4/8	4/9-4/15	4/16-4/22	4/23-4/29	4/30-5/6	5/7-5/13	5/14-5/20	5/21-5/27	5/28-6/03
2010	1	1	1	1	0	0	0	0	0	0	1	1	1	0
2011	1	1	1	0	0	0	0	0	1	0	0	0	1	0
2012	1	0	0	1	1	1	0	0	0	0	0	0	0	0
2013	0	0	0	0	1	1	0	1	1	1	1	1	1	1
2014	0	0	0	0	0	0	0	0	0	1	1	1	1	1
2015	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2016	1	1	0	1	1	0	1	1	1	1	1	0	0	0
2017	0	1	1	1	1	1	0	1	1	1	1	1	1	1
2018	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2019	0	0	0	0	1	1	1	0	0	0	0	0	0	0
2020	1	1	1	0	0	0	0	0	0	0	0	0	0	0
2021	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2022	0	0	0	0	0	0	0	0	0	0	0	0	0	0

The data in Table 9 was then summarized to percent of the month a trigger would occur and is shown in Table 10 below. For example, in 2011, 2 weeks of March are marked with a “1” indicating half the month an OMR Index was needed in protecting Delta Smelt.

Table 10. 2010-2022 Historical Juvenile Delta Smelt Loss OMR Percentage

Year	Mar	Apr	May	Jun
2010	0%	25%	20%	0%
2011	50%	25%	0%	0%
2012	25%	75%	100%	25%
2013	0%	0%	100%	75%
2014	0%	0%	0%	0%
2015	50%	75%	40%	0%
2016	50%	75%	100%	50%
2017	50%	100%	100%	100%
2018	25%	50%	0%	0%
2019	0%	0%	0%	0%
2020	0%	0%	0%	0%
2021	0%	0%	0%	0%
2022	0%	0%	0%	50%

OMR flex trigger and criteria

In modeling the NAA, OMR Flex was assumed to be -6,250 for up to 6 days under the following conditions dynamically determined in CalSim 3:

- Delta in Excess,
- X2< 81 km,
- Sacramento River Runoff < 20,000 cfs,
- Qwest > +1,000 cfs
- January and February

Historically, the Projects have not operated to the OMR Storm Flex and the criteria above only occurs a handful of times in the NAA CalSim 3 model.

Combined Coverage

Table 6 and Table 10 were combined into one lookup table that was used in CalSim 3. The data was summarized by water year type. Table 11 and Table 12 summarize the combined 2010-2022 OMR percentage and water year type lookup table that was used for CalSim 3, respectively.

Table 11. 2010-2022 Historical Winter-Run, Steelhead, and Juvenile Delta Smelt Loss OMR Percentage

Water Year	Jan	Feb	Mar	Apr	May	Jun
2010	0%	64%	100%	25%	20%	0%
2011	0%	46%	100%	100%	100%	0%
2012	0%	0%	54%	100%	100%	0%
2013	0%	0%	71%	70%	100%	0%
2014	0%	0%	0%	0%	0%	0%
2015	0%	21%	100%	75%	40%	0%
2016	0%	46%	100%	75%	100%	0%
2017	0%	0%	50%	100%	100%	0%
2018	0%	0%	100%	100%	100%	0%
2019	0%	79%	100%	0%	65%	0%
2020	0%	0%	0%	0%	0%	0%
2021	0%	0%	0%	0%	0%	0%
2022	0%	0%	0%	0%	0%	0%

Table 12. OMR Percentage by Water Year Type for Input Into CalSim 3

Water Year Type	Jan Avg	Feb Avg	Mar Avg	Apr Avg	May Avg	Jun Avg
C	0%	7%	25%	19%	10%	0%
D	0%	15%	71%	49%	50%	0%
BN	0%	29%	100%	88%	80%	0%
AN	0%	46%	88%	77%	84%	0%
W	0%	0%	75%	67%	88%	0%

Table 12 was used as a lookup table in CalSim 3 and the percent shown for each month is the portion of the month operated to greater than a -3,500 OMR Index. For example, Dry March years are assumed to be at -3,500 OMR Index for 71% of the month.

Alternative 2

The following OMR criteria were implemented in the Alternative 2 CalSim 3 model.

Winter-Run Early Season Migration

In modeling Alternative 2, the Winter-Run Early Season Migration not modeled as historical data indicated it did not trigger and there was not enough data to develop an assumption for CalSim 3.

Table 13. 2010-2022 Winter-Run Early Season Migration Loss and Trigger

WR-WY	WYT	November				December			
		Loss	RB Juvenile Total	Limit	Trigger	Loss	RB Juvenile Total	Limit	Trigger
2010	BN	0.00	4237821	559	0	3.78	4302153	1140	0
2011	W	0.00	1102840	146	0	25.21	1234434	327	0
2012	BN	0.00	605098	80	0	0.00	715359	190	0
2013	D	0.00	628082	83	0	4.93	866852	230	0
2014	C	0.00	636764	84	0	0.00	1249821	331	0
2015	C	0.00	279954	37	0	0.00	354876	94	0
2016	BN	0.00	217489	29	0	0.00	252675	67	0
2017	W	0.00	363832	48	0	0.00	484841	128	0
2018	BN	0.00	283674	37	0	0.00	407410	108	0
2019	W	0.00	707433	93	0	0.00	884916	235	0
2020	D	0.00	3217093	425	0	0.00	3684857	976	0
2021	C	0.00	1467024	194	0	0.00	1759210	466	0
2022	C	0.00	434371	57	0	0.00	544541	144	0

OMR Management Season

In modeling Alternative 2, the OMR management begins in December and ends in June with the OMR index no more negative than -5,000 cfs unless Storm Flex is initiated.

First Flush

Like in the NAA, the First Flush action for Alternative 2 is assumed to restrict OMR to -2,000 cfs for 14 days when SRR > 20,000 cfs, and triggering First Flush starts the OMR Management season. The modeling assumptions for First Flush in Alternative 2 differ from the NAA in the following ways:

- First Flush can occur in February in addition to December and January, and
- There is a high-flow offramp that is dynamically triggered in CalSim 3 when flow at Rio Vista is greater than 55,000 cfs or flow at Vernalis is greater than 8,000 cfs.

Start of OMR Management

If First Flush is not triggered in December, it is assumed that the OMR Management season will begin on January 1st.

End of OMR Management

End of OMR Management Season was evaluated by looking at (1) the historical 3-day average water temperature at Clifton Court Forebay (CLC) being 25° C or higher for Delta Smelt and (2) historical daily water temperature at Mossdale (MSD) and Prisoner's Point (PPT) exceeds 22.2°C for 7 non-consecutive days for Salmonids. Table 14 shows that most of these temperature thresholds are met towards the end of June, therefore, the OMR management season goes through June in the CalSim 3 model.

Table 14. 2010-2022 Water Temperature Data for Delta Smelt (CLC) and Salmonids (MSD and PPT)

	Clifton Court Forebay (CLC)	Mossdale (MSD)	Prisoner's Point (PPT)
2010	30-Jun	-	-
2011	30-Jun	30-Jun	-
2012	30-Jun	30-Jun	-
2013	30-Jun	30-Jun	-
2014	9-Jun	30-Jun	-
2015	11-Jun	30-Jun	-
2016	5-Jun	30-Jun	-
2017	23-Jun	30-Jun	-
2018	25-Jun	30-Jun	-
2019	30-Jun	30-Jun	-
2020	26-Jun	30-Jun	2-Jun
2021	21-Jun	30-Jun	7-Jun
2022	27-Jun	30-Jun	22-Jun

Real-Time Adjustments

Adult Delta Smelt Entrainment Protection Action

In modeling Alternative 2, the turbidity bridge avoidance was assumed to apply an additional OMR requirement of -3,500 cfs for 10 days when the following conditions occur:

- Timeframe under which a turbidity avoidance action may occur
    - January – if First Flush occurs in December,
    - February – if First Flush occurs in January or not at all,
- SRR > 20,000 cfs
- Highflow Offramp when Vernalis flows above 10,000 cfs

Like other turbidity related actions, this requires the use of a surrogate to determine when an action is triggered. Like the NAA, the Proposed Action looks at the turbidity station at Old River at Bacon Island (OBI) but also, Holland Cut (HOL) and Old River at Highway 4 (OH4). Using historical OBI, HOL, and OH4 data from 2009 to 2023, daily average values above 12 NTU for all three stations were summed for the months of January and February. The resulting number of days per month exceeding 12 NTU at OBI, HOL, and OH4 were compared to the SRR for the same month (Figure 3). The red line indicates the rough transition point using the SRR. The average days for the points that met the trigger is 10 days.

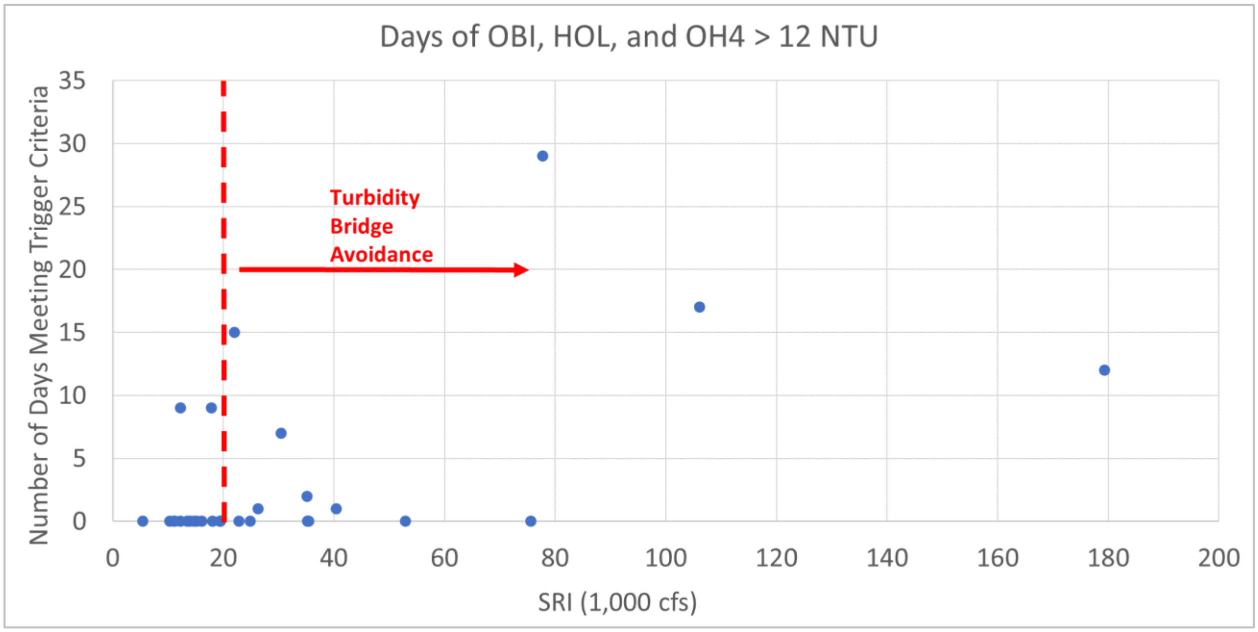

Figure 3. Monthly Comparison of Number of Days in Month Exceeding 12 NTU at OBI, HOL, and OH4 and SRR

This relationship could be stronger, but it should be recognized that because of its location, OBI, HOL, and OH4, is subject to many variables, including but not limited to wind driven turbidity and lower turbidity due to proactive Project operations that is embedded in the data.

Adult Longfin Entrainment Protection Action

In modeling Alternative 2, the Adult Longfin Smelt OMR assumption was based on observed salvage of Longfin Smelt greater or equal to 60 mm at both the CVP and SWP fish salvage facilities. OMR action was triggered in weeks where this observed salvage exceeded the salvage threshold determined by the San Francisco Bay Study Longfin Smelt Index.

Table 15 summarizes the sampling data for the Adult Longfin Smelt, which would have triggered a potential OMR action (1= trigger, 0=No trigger) during the 2010-2022 period.

Table 15. 2010-2022 Historical Adult Longfin Smelt Trigger

Year	1/1-1/7	1/8-1/14	1/15-1/21	1/22-1/28	1/29-2/4	2/5-2/11	2/12-2/18	2/19-2/25	2/26-3/4	3/5-3/11	3/12-3/18	3/19-3/25	3/26-4/1
2010	0	0	0	0	0	0	0	0	0	0	0	0	0
2011	0	0	0	0	0	0	0	0	0	0	0	0	0
2012	0	0	0	0	0	0	0	0	0	0	0	0	0
2013	0	0	0	0	0	0	0	0	0	0	0	0	0
2014	0	0	0	0	0	0	0	0	0	0	0	0	0
2015	0	0	0	0	0	0	0	0	0	0	0	0	0
2016	0	0	0	0	0	0	0	0	0	0	0	0	0
2017	0	0	0	0	0	0	0	0	0	0	0	0	0
2018	0	0	0	0	0	0	0	0	0	0	0	0	0
2019	0	0	0	0	0	0	1	0	0	0	0	0	0
2020	0	0	0	0	0	0	0	0	0	0	0	0	0
2021	0	0	0	0	0	0	0	0	0	0	0	0	0
2022	0	0	0	0	0	0	0	0	0	0	0	0	0

Larval and Juvenile Delta Smelt Protection Action

In modeling Alternative 2, the Juvenile Delta Smelt OMR assumption was the same as the NAA. This action also includes a highflow offramp when Rio Vista flows above 55,000 cfs or Vernalis flows above 8,000 cfs.

Table 16. 2010-2022 Historical Larval Delta Smelt Trigger

	2/26-3/4	**3/5-3/11**	**3/12-3/18**	**3/19-3/25**	**3/26-4/1**	**4/2-4/8**	**4/9-4/15**	**4/16-4/22**	**4/23-4/29**	**4/30-5/6**	**5/7-5/13**	**5/14-5/20**	**5/21-5/27**	**5/28-6/03**	**6/04-6/10**	**6/11-6/17**	**6/18-6/24**	**6/25-7/1**
2010	1	1	1	0	0	0	0	0	1	0	0	0	1	0	0	0	0	0
2011	1	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0
2012	0	0	0	0	1	1	0	1	1	1	1	1	1	1	1	0	0	0
2013	0	0	0	0	0	0	0	0	0	1	1	1	1	1	0	1	1	1
2014	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2015	1	1	0	1	1	0	1	1	1	1	1	0	0	0	0	0	0	0
2016	0	1	1	1	1	1	0	1	1	1	1	1	1	1	0	0	1	1
2017	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
2018	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0
2019	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2020	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2021	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2022	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1

Larval and Juvenile Longfin Smelt Protection Action

In modeling Alternative 2, the Juvenile Longfin Smelt OMR assumption was based on the historical SLS or 20mm survey at stations 809 and 812 exceeding the threshold set by the San Francisco Bay Study Longfin Smelt Index. Table 17 summarizes when the surveys would have triggered a potential OMR action to protect Juvenile Longfin Smelt (1= trigger, 0=No trigger) during the 2010-2022 period. This action also includes a highflow offramp when Rio Vista flows above 55,000 cfs or Vernalis flows above 8,000 cfs.

Table 17. 2010-2022 Historical Larval Longfin Smelt Trigger

	1/1-1/7	1/8-1/14	1/15-1/21	1/22-1/28	1/29-2/4	2/5-2/11	2/12-2/18	2/19-2/25	2/26-3/4	3/5-3/11	3/12-3/18	3/19-3/25	3/26-4/1	4/2-4/8	4/9-4/15	4/16-4/22	4/23-4/29	4/30-5/6	5/7-5/13	5/14-5/20	5/21-5/27	5/28-6/03
2010	1	1	1	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2011	0	0	0	0	1	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2012	0	1	0	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2013	0	0	0	0	1	0	1	1	1	0	0	0	1	0	1	0	0	0	1	0	0	0
2014	1	0	0	1	1	1	0	1	0	0	0	1	0	0	0	0	0	0	0	0	0	0
2015	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0
2016	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2018	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2019	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2020	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0
2021	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2022	0	0	0	1	0	1	0	1	0	1	1	1	1	1	0	1	0	0	0	0	0	0

Winter-Run Chinook Salmon Annual Loss Threshold

In modeling Alternative 2, the Winter-Run Chinook Salmon Annual Loss Threshold OMR assumption was the same as the NAA. Table 18 summarizes when the loss threshold would have triggered a potential OMR action to protect Winter-Run Chinook Salmon (1= trigger, 0=No trigger) during the 2010-2022 period.

Table 18. 2010-2022 Historical Winter-Run Chinook Salmon Annual Loss Threshold Trigger

	1/1-1/7	1/8-1/14	1/15-1/21	1/22-1/28	1/29-2/4	2/5-2/11	2/12-2/18	2/19-2/25	2/26-3/4	3/5-3/11	3/12-3/18	3/19-3/25	3/26-4/1	4/2-4/8	4/9-4/15	4/16-4/22	4/23-4/29	4/30-5/6	5/7-5/13	5/14-5/20	5/21-5/27	5/28-6/03
2010	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2011	0	0	0	0	0	0	0	0	0	0	1	1	1	0	0	0	0	0	0	0	0	0
2012	0	0	0	0	0	0	0	0	0	1	1	1	1	0	0	0	0	0	0	0	0	0
2013	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2014	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2016	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2018	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2019	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2020	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2021	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2022	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Winter-Run Chinook Salmon Weekly Distributed Loss Threshold

In modeling Alternative 2, the Winter-Run Chinook Salmon Weekly Loss Threshold OMR assumption was based on historical loss data of genetically confirmed natural origin juvenile winter-run Chinook salmon and for water year 2022, loss of two LAD juvenile winter-run samples that failed during the analysis process. Table 19 summarizes when the loss threshold would have triggered a potential OMR action to protect Winter-Run Chinook Salmon (1= trigger, 0=No trigger) during the 2010-2022 period.

Table 19. 2010-2022 Historical Winter-Run Chinook Salmon Weekly Loss Threshold Trigger

	1/1-1/7	**1/8-1/14**	**1/15-1/21**	**1/22-1/28**	**1/29-2/4**	**2/5-2/11**	**2/12-2/18**	**2/19-2/25**	**2/26-3/4**	**3/5-3/11**	**3/12-3/18**	**3/19-3/25**	**3/26-4/1**	**4/2-4/8**	**4/9-4/15**	**4/16-4/22**	**4/23-4/29**	**4/30-5/6**	**5/7-5/13**	**5/14-5/20**	**5/21-5/27**	**5/28-6/03**
2010	0	0	0	1	0	0	0	0	1	1	0	0	1	1	0	0	0	0	0	0	0	0
2011	1	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0	0	0	0
2012	0	0	0	0	0	0	0	0	1	1	0	1	1	1	0	0	0	0	0	0	0	0
2013	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2014	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2016	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2018	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0
2019	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	1	0	0	0	0	0	0
2020	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0
2021	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2022	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0

Steelhead Annual Loss Threshold

In modeling Alternative 2, the Steelhead Annual Loss Threshold OMR assumption was not modeled as it was assumed the annual loss threshold was covered by the Steelhead Weekly loss threshold.

Steelhead Weekly Distributed Loss Threshold

In modeling Alternative 2, the Steelhead Weekly Loss Threshold OMR assumption was based on historical loss data from the CVP and SWP fish protection facilities for Water Years 2010-2022. The threshold was set as a rolling cumulative 7-day loss of 120 or more fish. Table 20 summarizes when the loss threshold would have triggered a potential OMR action to protect Steehead (1= trigger, 0=No trigger) during the 2010-2022 period.

Table 20. 2010-2022 Historical Steelhead Weekly Loss Threshold Trigger

	1/1-1/7	1/8-1/14	1/15-1/21	1/22-1/28	1/29-2/4	2/5-2/11	2/12-2/18	2/19-2/25	2/26-3/4	3/5-3/11	3/12-3/18	3/19-3/25	3/26-4/1	4/2-4/8	4/9-4/15	4/16-4/22	4/23-4/29	4/30-5/6	5/7-5/13	5/14-5/20	5/21-5/27	5/28-6/03
2010	0	0	0	0	1	1	1	0	0	1	0	1	1	0	0	0	0	0	0	0	0	1
2011	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2012	0	0	0	0	0	0	0	0	0	0	0	1	1	1	0	1	1	0	0	1	0	0
2013	0	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	1	1	0	0	0
2014	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2015	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2016	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2017	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2018	0	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	0	0	0	1	1	1
2019	0	0	0	0	0	1	1	1	1	1	0	0	1	1	0	0	0	0	0	0	0	0
2020	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0
2021	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2022	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Spring-Run Chinook Salmon and Surrogate Threshold

In modeling Alternative 2, the Spring-Run Chinook Salmon was not modeled as it was assumed it is covered by other actions.

Combined Coverage

Tables 15, 16, 17, 18, 19, and 20 were combined into one weekly table that can be used in CalSim 3 for the No Highflow Offramp conditions. Tables 15, 18, 19, and 20 were combined into one weekly table that can be used in CalSim 3 for the With Highflow Offramp conditions. For a week where multiple species would have triggered an OMR action, it was counted as only a single occurrence of triggering an action to ensure these actions weren't double counted while the effects of the actions would overlap. Table 21 and Table 22 summarize the combined 2010 – 2022 OMR percentage for the No Highflow Offramp and With Highflow Offramp conditions, respectively and Table 23 and Table 24 summarize by water year the OMR percentages for the No Highflow Offramp and With Highflow Offramp conditions, respectively, based on Table 21 and Table 22, respectively.

Table 21. 2010-2022 Historical Delta Smelt, Longfin, Winter-Run, and Steelhead OMR Percentage, No Highflow Offramp

Water Year	Jan	Feb	Mar	Apr	May	Jun
2010	100%	75%	100%	50%	25%	20%
2011	25%	75%	100%	25%	0%	0%
2012	50%	50%	100%	75%	100%	40%
2013	0%	75%	60%	100%	100%	80%
2014	50%	75%	20%	0%	0%	0%
2015	0%	0%	80%	75%	50%	0%
2016	25%	25%	80%	75%	100%	60%
2017	0%	0%	100%	100%	100%	100%
2018	0%	0%	60%	75%	50%	20%
2019	0%	75%	80%	50%	0%	0%
2020	0%	0%	60%	75%	0%	0%
2021	0%	0%	0%	0%	0%	0%
2022	25%	50%	80%	75%	0%	40%

Table 22. 2010-2022 Historical Delta Smelt, Longfin, Winter-Run, and Steelhead OMR Percentage, With Highflow Offramp

Water Year	Jan	Feb	Mar	Apr	May	Jun
2010	25%	75%	80%	25%	0%	20%
2011	25%	0%	80%	0%	0%	0%
2012	0%	0%	100%	75%	25%	0%

Water Year	Jan	Feb	Mar	Apr	May	Jun
2013	0%	0%	40%	100%	50%	0%
2014	0%	0%	0%	0%	0%	0%
2015	0%	0%	0%	0%	0%	0%
2016	25%	0%	0%	0%	0%	0%
2017	0%	0%	0%	0%	0%	0%
2018	0%	0%	60%	75%	50%	20%
2019	0%	75%	60%	50%	0%	0%
2020	0%	0%	20%	75%	0%	0%
2021	0%	0%	0%	0%	0%	0%
2022	25%	0%	0%	25%	0%	0%

Table 23. OMR Percentage by Water Year Type for Input Into CalSim 3, No Highflow Offramp

Water Year Type	Jan Avg	Feb Avg	Mar Avg	Apr Avg	May Avg	Jun Avg
C	25%	25%	45%	38%	13%	10%
D	63%	42%	77%	75%	50%	40%
BN	15%	45%	100%	75%	69%	35%
AN	8%	75%	95%	67%	51%	34%
W	0%	0%	90%	58%	33%	33%

Table 24. OMR Percentage by Water Year Type for Input Into CalSim 3, With Highflow Offramp

Water Year Type	Jan Avg	Feb Avg	Mar Avg	Apr Avg	May Avg	Jun Avg
C	0%	0%	0%	6%	0%	0%
D	25%	0%	50%	69%	25%	0%
BN	5%	30%	80%	38%	19%	10%
AN	8%	0%	55%	27%	9%	5%
W	0%	0%	30%	17%	0%	0%

Table 23 and Table 24 were used as a lookup table in CalSim 3 and it was assumed the percent shown for each month is the portion of the month operated to greater than a -3,500 OMR Index. For example, from Table 24, Dry March years was assumed to be at a -3,500 OMR Index for half the month (50%).

Storm-Flex

In modeling Alternative 2, OMR Flex was assumed to be the same as the NAA.