BUREAU OF RECLAMATION

2023 Seasonal Report for Shasta Lake Storage Rebuilding and Spring Pulse

Central Valley Project, California

California-Great Basin Region

U.S. Department of the Interior

September 2023

Mission Statements

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2023 Seasonal Report for Shasta Lake Storage Rebuilding and Spring Pulse

Central Valley Project, California

California-Great Basin Region

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California Department of Water Resources, U.S. Fish and Wildlife Service, National Marine Fisheries Service, and California Department of Fish and Wildlife

Cover Photo: Shasta Dam Hydropower (Reclamation)

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Purpose

This is the 2023 Supplement to the 2022 Seasonal Report for Shasta Lake Storage Rebuilding and Spring Pulse describes Shasta Dam operations leading up to and through the 2023 cold water pool management season.

Background

No supplemental information for WY2023.

Seasonal Operations

This section supplements relevant Shasta Lake operations for 2023 and updates key figures and tables. Figures 1, 2, 3, 4, 5, and 10 and Tables 1-7, are not updated for 2023. Figures 6-9 are new. Tables 4 and 8-10 are new.

Operational Background Information

Fall operations at Shasta Dam are dominated by water temperature control and provision of fish spawning habitat. By late fall, the remaining cold water pool in Shasta Lake is usually limited.

Historical Overview

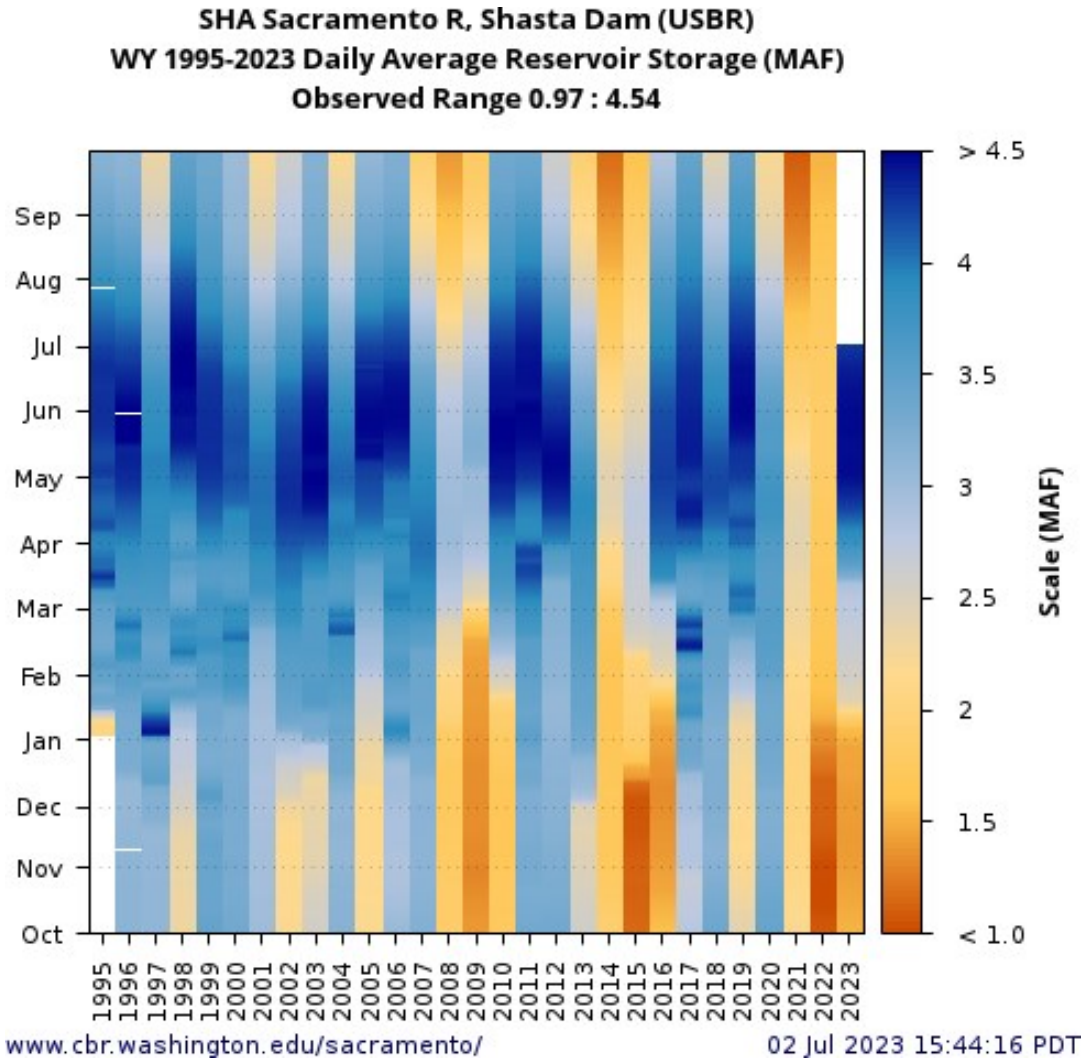

Figure 1 (Updated). Shasta Lake Storage (MAF) from WY 1995-2023, as of July 5, 2023. Source: [SacPAS: Central Valley Prediction & Assessment Salmon]

Figure 1 depicts a graph showing the Daily Average Reservoir Storage (MAF) from 1995 – 2023, with an observed range of 0.97: 4.54.

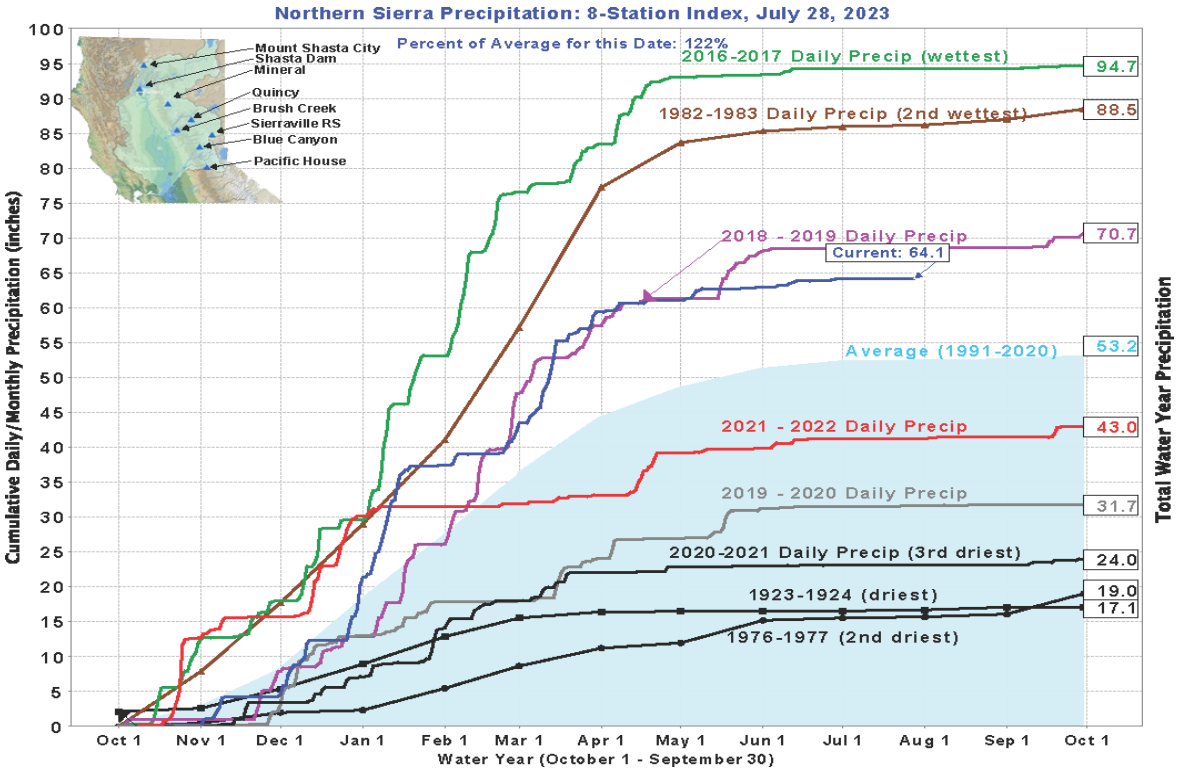

Figure 2 (Updated). Northern Sierra Precipitation: 8-Station Index as of July 28, 2023. Source: [javareports (ca.gov)]

Figure 2 is a line graph showing the Northern Sierra Precipitation: 8 Station Index as of July 28, 2023, with a percent average of 122% for this date. The graph shows cumulative daily/monthly precipitation in inches from the wettest year of 2016 – 2017 to the driest year of 1923 – 1924.

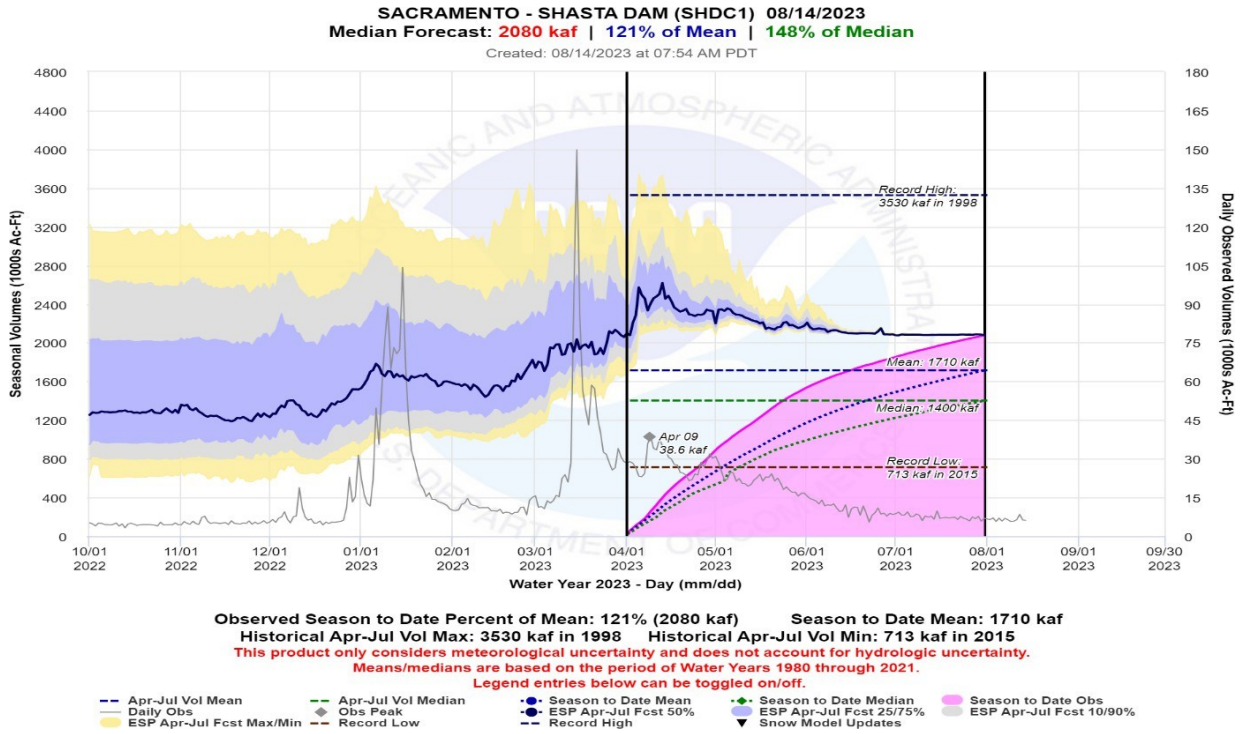

Figure 3 (Updated). WY 2023 (as of August 14, 2023) forecasted (10 percent, 50 percent, 90 percent exceedance) and actual daily and cumulative inflow volume at Shasta Lake. Source: [NOAA California Nevada River Forecast]

Figure 3 is a trend plot for the Sacramento – Shasta Dam beginning on October 1, 2022 and continuing until September 30, 2024. The trend plot shows the observed record high (3530 kaf in 1998), the mean (1719 kaf), the median (1400 kaf), and the record low (713 kaf in 2015).

General Water Year Conditions and Operations

Large storm events occurred in December 2022 and January 2023, resulting in well above average observed monthly precipitation. Per the March 2023 snow survey conducted by DWR at Phillips Station. The annual survey recorded 116.5 inches of snow depth and a snow water equivalent of 41.5 inches, which is 177 percent of average snow depth at that time (DWR 2023).

Snowpack for the Sacramento River region was in good condition and was reflected in an average snow water content for the Northern region of the state, based on the DWR's April B-120 (DWR 2023b).

Water supply indices reported the Sacramento River Unimpaired Runoff was a "Wet" year for the Sacramento Valley Index. The projected median April-July runoff from the major Sacramento River basin ranged from 118% of average for the inflow to Shasta. The unimpaired flows in Percent of Average for Water Year 2023 for Shasta for the Oct-May period are 100%.

Insights to the hydrologic characteristics of WY 2023 shown in Table 1 (DWR 2023c and 2023d).

Table 1 (Updated). WY 2023 Northern Sierra precipitation, Sacramento Basin snowpack, and Sacramento Valley Index statistics by month.

Water Year 2023 Month	Northern Sierra 8-Station Precipitation (Cumulative water year in inches through month)	Northern Sierra 8-Station historic monthly average precipitation (inches)	North Region including Sacramento River Basin Snowpack of April 1 (%)	Sacramento Valley Unimpaired Runoff Index (40-30-30 Index 50 percent Exceedance)
October	0.0	0.01	0	N/A
November	4.7	4.26	9	N/A
December	21.4	15.83	46	12.9
January	37.5	17.36	105	16.3
February	43.5	4.79	128	20.0
March	59.4	17.14	192	20.2
April	61.0	1.64	163	24.9
May	62.9	1.9	67	24.2

The forecasts consider meteorological uncertainty and do not account for hydrologic uncertainties. By May 1, water supply forecasts for Shasta Lake inflow runoff ranged between 23 percent and 24.2 percent of the average for the 90 percent and 50 percent runoff exceedances, respectively (DWR 2023c).

Storage and Flood Conservation Space

Shasta Lake filled in 2023 due to the wet hydrology with peak storage volume reaching 4.467 million acre-feet on May 24, 2023 (Table 2). However, due to the low storage at the beginning of WY 2023, Shasta Lake storage conditions remained below the U.S. Army Corps of Engineers flood control curve and, therefore, flood control releases were not needed at any time during the year. Compared to the last several dry water years, Keswick Dam releases were somewhat higher but similar to WY 2020. (Figure 4).

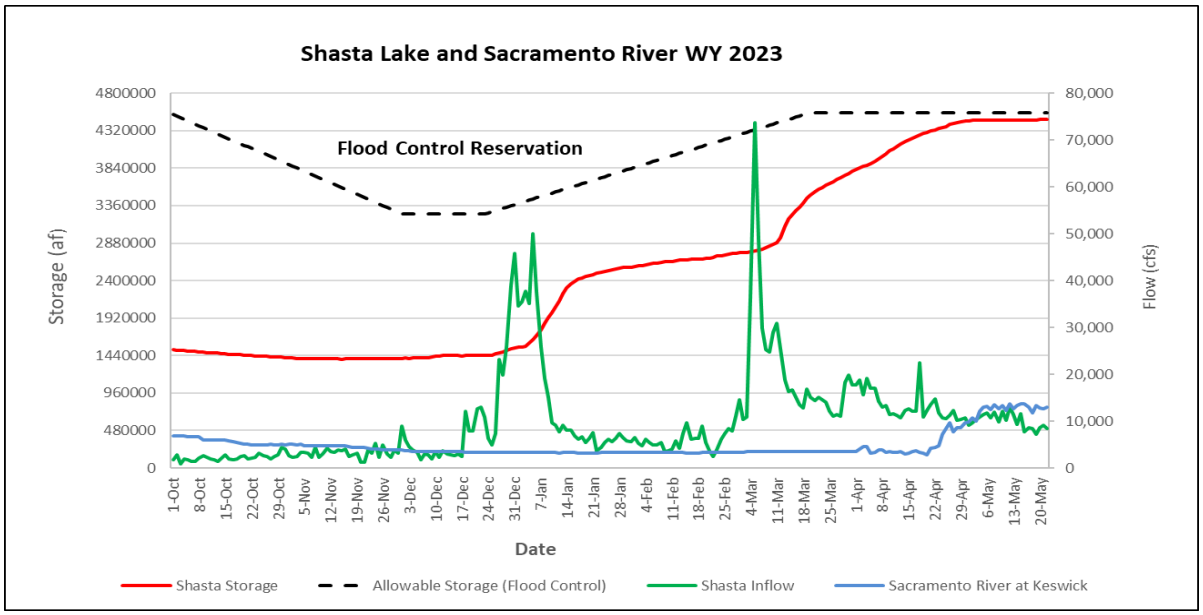

Figure 4 (Updated). Shasta Lake Storage (red line), Allowable Storage for Flood Control (black line), Sacramento River at Keswick (blue line), and Shasta Inflow (green line) for 10/1/2022 – 5/20/2023.

Figure 4 is a line graph that shows the allowable storage for Flood Control, the Sacramento River at Keswick, and Shasta Inflow from October 2022 to May 2023.

Table 2 (Updated). Shasta Lake Storage Volumes and Coldwater Pool Volumes in Thousands of Acre Feet (TAF) from 2012 - 2023.

Water Year	Peak Storage Volume	Peak Storage Date	End of April Volume < 56°F	Date 1st Side Gate Opened	End of Sept. Volume Storage	End of Sept. Volume <56°F	End of Sept. Volume <52°F	End of Sept. Volume <50°F
2012	4483	7-May	3791	21-Sep	2592	765	598	512
2013	3887	18-Apr	2809	11-Sep	1906	425	347	309
2014	2409	28-Apr	1770	7-Aug	1157	107	81	63
2015	2722	15-Apr	1912	13-Sep	1603	358	270	228
2016	4235	1-May	3267	23-Oct	2811	938	730	596
2017	4389	13-May	3975	N/A	3382	1146	806	594
2018	4200	26-Apr	3135	19-Sep	2405	607	485	388
2019	4477	31-May	3441	N/A	3425	1203	907	707
2020	3750	21-Apr	2986	13-Aug	2200	476	344	230
2021	2396	3-Apr	1587	6-Aug	1077	111	81	63
2022	1827	20-May	1361	18-Jul	1515	299	184	136
2023	4467	23-May	4430	N/A	TBD	TBD	TBD	TBD

Fall and Winter Refill

During the summer and fall of 2022, Fall drawdown efforts were coordinated through the SRTTG because: (1) there were requests to combine water operations teams and (2) the drop to baseflows was relatively small in comparison to typical years (Figure 4). Furthermore, Keswick summer releases were mostly defined by the Temperature Management Plan and thus required less input from the USST. SRTTG has similar membership as the USST and includes Reclamation, DWR, NMFS, CDFW, Sacramento CVP Contractors and the SRSCs. As in previous years, participants reviewed proposed alternative fall Keswick flow schedules (Table 3, Appendix A), in addition to the default scenario described in the Sacramento River Temperature Management Plan. Due to lower flows, there were no decisions from SRTTG required in July or August. Scenarios were presented to SRTTG on: September 15, 2022, September 22, 2022, October 11, 2022, and October 27, 2022. Ultimately, the four feasible alternatives were expected to perform relatively similarly in terms of winter-run redd dewatering (Table 4). Alternative 9 was chosen as it maintained higher flows into October than Alternatives 6 and 7, to move the water transfer volume more quickly, then dropped to winter base flows more feasibly than Alternative 8, to reduce redd dewatering impacts to fall run Chinook salmon.

Keswick Dam releases peaked in July at 4,572 cfs and flows in August decreased throughout the month to approximately 4,300 cfs. Fall flow alternatives and actual Keswick Dam releases in September through November 2022 are shown in Figure 9. Around October 12, flows began to ramp down in accordance with Alternative 9. Flows deviated from the flow schedule in mid-to-late October due to flows that reached approximately 3,900 cfs on October 14, 2022. These minimum flows were held through approximately April 2022.

Table 3 (Updated). Fall Flow Reduction Alternatives for 2022.

Alternative	Description
Alternative 6	Met the TMP 4,000 cfs September average flow, but initial forecasting indicated this alternative could result in redd dewatering that would exceed the winter-run Chinook salmon incidental take limit for redd dewatering (1% of the population).
Alternatives 7, 8, 9	Higher average September Keswick flows of 4,150 cfs to minimize winter-run Chinook salmon redd dewatering.

Table 4 (NEW). Average September Keswick (KES) Flow, monthly flows for September and October in TAF, estimated numbers of SRWC redds dewatered (finalized), and percent of population that would be lost under each of the proposed alternatives. Model assumptions included KES flow data used actual to 2022-10-31 and proposed flows for the remainder of the incubation period. Redd dewatering is considered at the actual or estimated dewatering flow and with a 100 cfs buffer applied to the actual/estimated dewatering flow. Percentage of the population lost is based on the September 28, 2022, count of 2607 Winter-run redds.

Metric	Alt 6	Alt 7	Alt 8	Alt 9	Actual
Avg Sept Flow (cfs)	4000	4150	4150	4150	4150
Redds dewatered	4	4	3	4	4
Percent Lost	0.2	0.2	0.1	0.2	0.15
Redds dewatered (w/ 100cfs buffer)	4	4	4	4	4
Percent Lost (w/ 100cfs buffer)	0.2	0.2	0.2	0.2	0.15

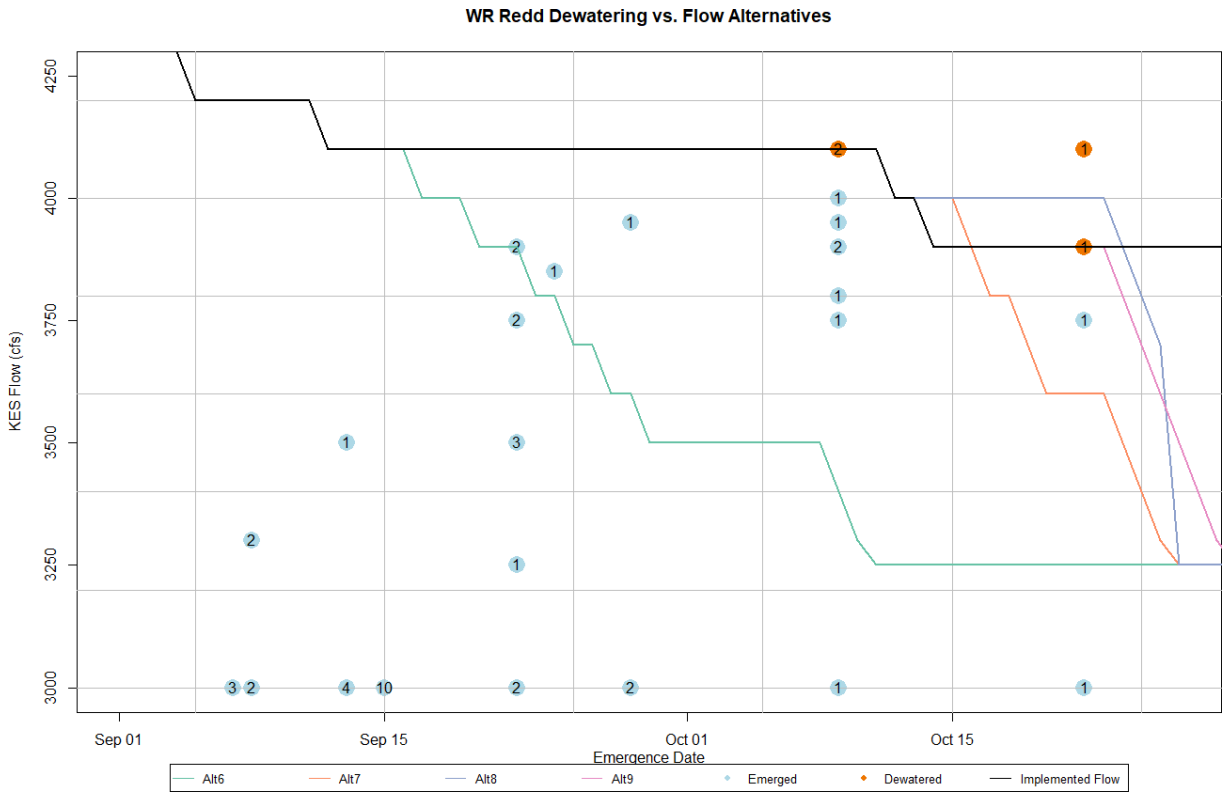

Figure 5 (Update). Fall flow reduction alternatives and actual Keswick Dam releases for September through December 2022.

Figure 5 is a line graph comparing WR redd dewatering and four proposed flow alternatives. Additionally, the graph shows the implemented KES flow.

Spring Pulse Flows

A spring pulse flow was attempted in 2023 but was not fully implemented due to Shasta Storage conservation management needs. The USST met in March and April 2023 to discuss spring pulse flows. The March 90% forecast predicted total May 1 Shasta Reservoir storage would be below 4 MAF. However, the March 50% and April 90% forecasts projected storage greater than 4 MAF. Given the projected conditions, the USST considered scenarios and recommended scenario M4 to the Shasta Planning Group based on greatest expected survival benefits to juvenile salmon.

M4 was then slightly revised to shift the peaks of the pulse volume to occur over the weekday to avoid potential power impacts associated with weekend power generation, with minimal impacts on the expected survival benefits. The updated M4 spring pulse scenario was approved by the Shasta Planning Group on April 13, with the caveat that it should be implemented to the point feasible given potential flood control/storage management operations. Reclamation attempted to follow the updated M4 pulse, beginning with a release of 8,100 cfs at Keswick on April 24, 2003 (Figures 6 and 7). However, shortly after the first pulse flow was initiated, it was realized that storage management had to start occurring and the reduction in flows that defines a pulse could

not be accomplished. At the end, Keswick Dam releases increased in late-April and remained high throughout the study period due to storage management needs. There was variation in Keswick releases and flows further downstream (i.e., Bend Bridge, Verona, Wilkins Slough). Flows remained above the threshold (11,000 cfs) at Wilkins Slough that is associated with increased salmonid survival. Although Keswick releases were increased rapidly on two occasions to mimic pulses, due to high Shasta Lake levels, releases were not ramped back down according to the plans. These Keswick flow releases also occurred earlier than what would have occurred if only considering storage management needs. Modeling of pulse flows indicates that they may be most beneficially in drier water years, but still have potential benefits in wetter years. Therefore, resulting partial implementation was still monitored for fisheries benefits, both to quantify the impacts of the truncated pulses in 2023, and to provide baseline data for future spring pulses. For more information about the Sacramento River Spring Pulse Flow Operations Plan, see Appendix B.

The CalFishTrack web page (CalFishTrack Central Valley Enhanced Acoustic Tagging Project) has preliminary survival, routing, distribution, and travel time for salmonids released in winter and spring 2023 irrespective of implementation of a spring pulse flow, and similar preliminary information juvenile Chinook salmon that were released weekly for five weeks, starting one week prior to the initiation of the updated M4 release. For more information about the Upper Sacramento Spring Pulse Flow Monitoring, please see below section on Fisheries, Chinook Salmon Spring Pulse Study.

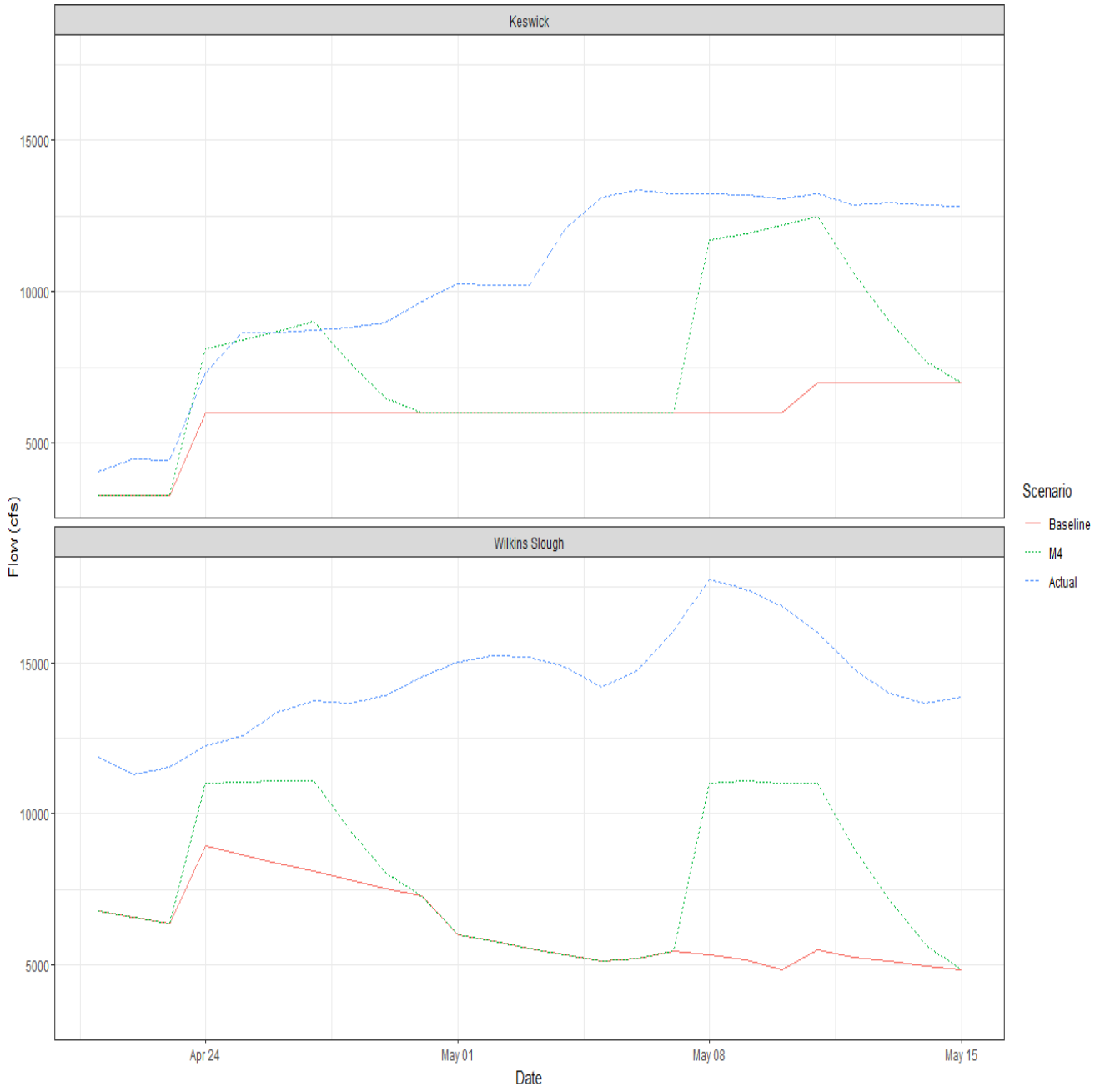

Figure 6 (NEW). Expected flows at Keswick and Wilkins Slough under baseline conditions versus the updated M4 pulse flow scenario.

Figure 6 is two-line graphs that model scenario M4 against the baseline and actuals flows for Keswick and Wilkins Slough. Both graphs show actual flow increasing with higher flows for Wilkins Slough.

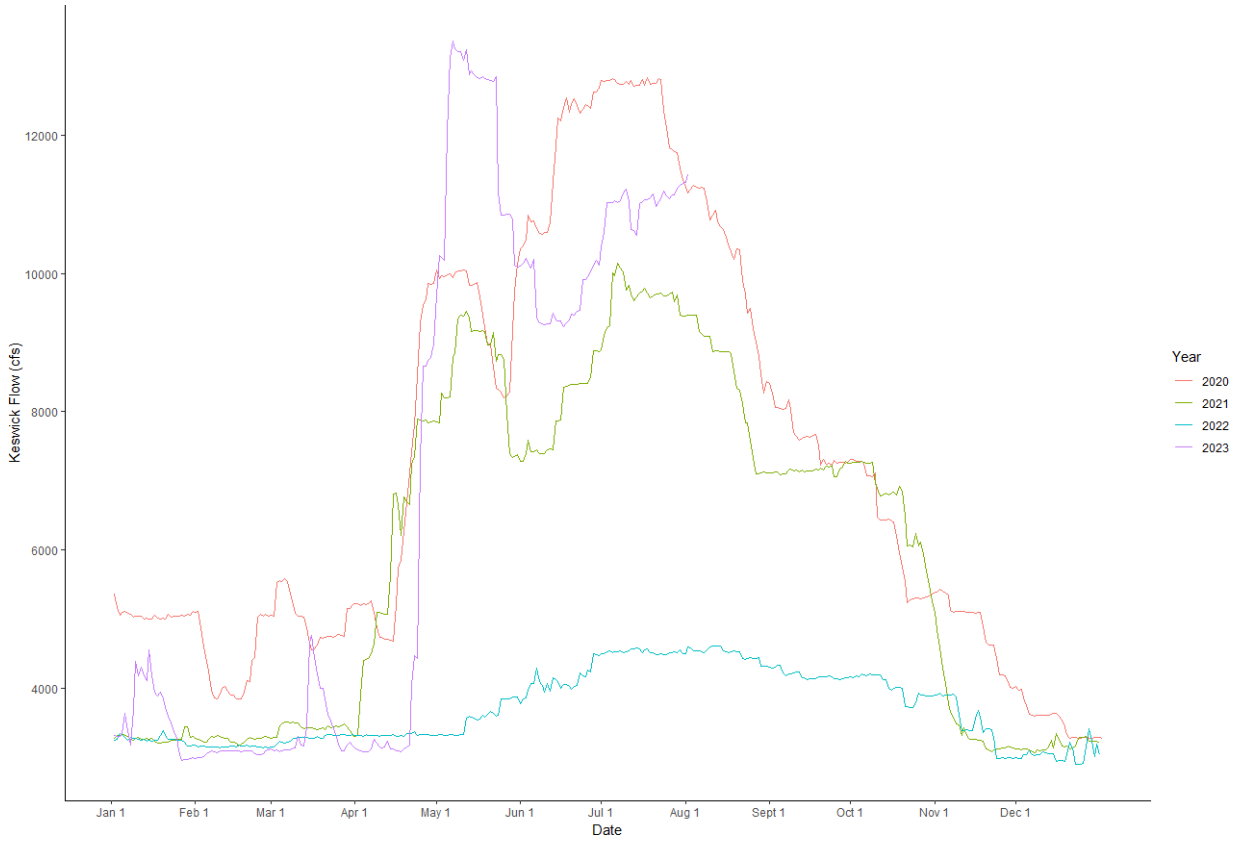

Figure 7 (NEW). Daily Keswick flows from 2020 through August 2023

A line graph compares the Keswick flows with an increase flow from May to September for water years 2020, 2021, and 2023. Water year 2023 is the year with the lowest Keswick Flow.

Fisheries

The following section describes the Chinook salmon monitoring efforts undertaken during WY 2023, including spawning and redd dewatering metrics and the Spring Pulse Study Plan.

Fish Monitoring

During the period of peak spawning for winter-run (mid-June to mid-August) and fall-run Chinook salmon (mid-October to mid-November) in 2022, Keswick Dam releases were steadily declining until reaching the minimum release on November 23, 2022. The proportion of the population of fall-run Chinook salmon redds dewatered in 2022 was similar to the previous year and the average (2011-2021 average = 2.07 percent; 2021 value = 2.45 percent; 2020 value = 3.13 percent; 2021 value = 2 percent; 2022 value = 0%).

Chinook Salmon Demographics

Less than one percent (0.153 percent) of winter-run Chinook salmons redds were dewatered during the summer/fall 2022. Reclamation did not exceed this take limit (Table 5).

In 2022, the estimated total number of winter-run Chinook salmon female spawners that spawned within the Sacramento River was 2,607 (Table 5). In 2022, 52 winter-run Chinook salmon shallow water redds were monitored and four redds were dewatered. The proportion of the population of winter-run Chinook salmon redds dewatered in 2022 was 0.15 percent, assuming one redd per estimated female.

In 2022, the estimated total number of fall-run Chinook salmon female spawners that spawned within the Sacramento River was 2,667(Table 6). In 2022, 66 shallow fall-run Chinook salmon redds, constructed in two feet of water or less, were monitored. The proportion of the population of fall-run Chinook salmon redds dewatered (0 percent) was lower than the average of previous years' data (2 percent; Table 6).

In 2022-2023, the estimated total number of late-fall-run Chinook salmon female spawners that spawned with the Sacramento River was not quantified (Table 7). Shallow and dewatered redd information for the 2022-2023 season was not collected due to river conditions not allowing the annual survey.

Table 5 (Updated). Summary of dewatered redd information for mainstem Sacramento River winter-run Chinook salmon redds from 2013-2022. Total redd estimates are based on post season estimate of all female spawners in the population for a given year (does not include unspawned females).

Year	Shallow Redds Actively Monitored	Dewatered	Total Redds	Proportion of Shallow Water Redds Dewatered	Proportion of Population Redds Dewatered
2013	30	5	3,645	17%	0.14%
2014	32	1	1,727	3%	0.06%
2015	19	0	2,022	0%	0%
2016	28	0	653	0%	0%
2017	24	0	367	0%	0%
2018	31	2	1,080	6%	0.19%
2019	109	5	4,884	5%	0.10%
2020	65	26	3,904	40%	0.67%
2021	68	2	5,860	3%	0.03%
2022	52	4	2,607	7%	0.15%

Table 6 (Updated). Dewatered redd information for mainstem Sacramento River for fall-run Chinook salmon redds. Total redd estimates are based on post season estimate of all female spawners in the population for a given year (does not include unspawned females).

Year	Shallow Redds Actively Monitored	Dewatered	Total Redds	Proportion of Shallow Water Redds Dewatered	Proportion of Population Redds Dewatered
2002	N/A	145	4,420	N/A	3.28%
2003	N/A	9	3,832	N/A	0.23%
2008	N/A	189	N/A	N/A	N/A
2009	N/A	92	205	N/A	45%
2010	228	23	2,166	10%	1.06%
2011	83	25	1,900	30%	1.32%
2012	348	123	4,783	35%	2.57%
2013	743	538	17,368	72%	3.10%
2014	311	44	13,814	14%	0.32%
2015	774	291	13,771	38%	2.11%
2016	101	0	2,415	0%	0%
2017	36	15	772	42%	1.94%
2018	407	202	3,702	50%	5.46%
2019	433	35	10,557	8%	0.33%

Year	Shallow Redds Actively Monitored	Dewatered	Total Redds	Proportion of Shallow Water Redds Dewatered	Proportion of Population Redds Dewatered
2020	620	171	5,455	28%	3.13%
2021	145	98	4,001	68%	2.45%
2022	66	0	2,667	0%	0%

Table 7 (Updated). Dewatered redd information for mainstem Sacramento River for late-fall-run Chinook salmon redds. Total redd estimates are based on post season estimate of all female spawners in the population for a given year (does not include unspawned females). 2021-2022 data on total redds is not available because no surveys took place due to river conditions.

Year	Shallow Redds Actively Monitored	Dewatered	Total Redds	Proportion of Shallow Water Redds Dewatered	Proportion of Population Redds Dewatered
2010-2011	23	23	1,748	100%	1.32%
2011-2012	4	0	1,183	0%	0%
2012-2013	81	12	1,891	15%	0.63%
2013-2014	45	31	2,830	69%	1.10%
2014-2015	3	2	1,008	67%	0.20%
2015-2016	0	0	1,216	N/A	0%
2016-2017	1	0	1,693	0%	0%
2017-2018	47	1	667	2%	0.15%
2018-2019	46	2	1,245	4%	0.16%
2019-2020	N/A	N/A	675	N/A	N/A
2020-2021	N/A	N/A	676	N/A	N/A
2021-2022	N/A	N/A	TBD	N/A	N/A
2022-2023	N/A	N/A	N/A	N/A	N/A

Chinook Salmon Spring Pulse Study

The acoustic telemetry study in WY 2023 moved forward as it has in previous years. The intention was to time the study to coincide with the Spring Pulse Flow, but the Spring Pulse flow could not be fully implemented as planned. Five release groups were released into the Sacramento River at Red Bluff Diversion Dam (RBDD) beginning one week prior to the planned pulse (Table 8), with one group released each week, intended to align with before, during, and after each of two planned pulses. Survival of released fish was monitored with acoustic telemetry and analyzed with a Cormack-Jolly-Seber (CJS) survival model. Detections at Tower Bridge peaked on April 18. The minimum estimate of survival to Tower Bridge for all five release groups was 41.3% (Table 9), with the group released one week prior to the first planned pulse flow having the highest survival (53.8%) and the group released during the first pulse having the lowest survival (25.1%). Survival to Benicia Bridge was 29.4% across all release groups (Table 10), ranging from 40.6% for the before-pulse release group to 17.6% for the first pulse release group. Survival was higher in 2023 than in 2019, and higher for travel to Benicia Bridge than in 2022 (Figure 9). The fish released in the week prior to the first pulse took the longest to reach both Tower Bridge and Benicia Bridge (Table 9,10). Based on mean travel times (8.5 days to Tower Bridge and 11.8 days to Benicia Bridge), many of the fish released before the first pulse were still in the system when the first pulse began and appear to have benefitted from that first pulse more than the group released during the week of the first pulse.

Table 8 (New). Releases of juvenile Chinook Salmon as part of the 2023 Spring Pulse Flow Study Plan (CalFishTrack (noaa.gov)). The Study began on 2023-04-18 09:05:00, see tagging details in the table.

Release	First Release Time	Last Release Time	Number Fish Released	Release Location	Release rkm	Mean Length	Mean Weight
Before Pulse	2023-04-18 09:05:00	2023-04-19 10:05:00	251	RBDD_Rel	461.579	84.1	7.5
First Pulse	2023-04-24 10:10:00	2023-04-25 09:45:00	250	RBDD_Rel	461.579	84.8	6.9
Second Pulse-Week 1	2023-05-02 09:07:00	2023-05-03 09-07-00	250	RBDD_Rel	461.579	86.2	7.5
Second Pulse – Week 2	2023-05-09 09:05:00	2023-05-10 08:25:00	250	RBDD_Rel	461.579	86.6	7.2
Second Pulse – Week 3	2023-05-16 08:26:00	2023-05-17 08:50:00	250	RBDD_Rel	461.579	88.5	7.5

Table 9 (New). Minimum survival to Tower Bridge (using CJS survival model), and travel time (CalFishTrack (noaa.gov)).

Release	Survival (%)	SE	95% lower C.I.	95% Upper C.I.	Detection efficiency (%)	Mean time to Tower (days)	SD of time to Tower (days)	Count
ALL	41.3	1.4	38.6	44.1	88.2	6.2	4.5	510
Before Pulse	53.8	3.2	47.5	59.9	N/A	8.5	2.8	134
First Pulse	25.1	2.8	20.0	30.9	N/A	5.5	6.0	62
Second Pulse-Week 1	34.5	3.0	28.8	40.7	N/A	7.0	6.1	85
Second Pulse – Week 2	48.6	3.2	42.3	55.0	N/A	4.8	3.8	119
Second Pulse – Week 3	44.8	3.2	38.6	51.1	N/A	4.6	2.7	110

Table 10 (New). Minimum survival to Benicia Bridge East Span (using CJS survival model), and travel time (CalFishTrack (noaa.gov).

Release	Survival (%)	SE	95% lower C.I.	95% Upper C.I.	Detection efficiency (%)	Mean time to Tower (days)	SD of time to Tower (days)	Count
ALL	29.4	1.3	26.9	31.9	99.1	9.2	3.7	367
Before Pulse	40.6	3.1	34.7	46.8	N/A	11.8	1.8	102
First Pulse	17.6	2.4	13.4	22.8	N/A	8.1	3.4	44
Second Pulse-Week 1	26.4	2.8	21.3	32.2	N/A	10.3	4.8	66
Second Pulse – Week 2	37.2	3.1	31.4	43.4	N/A	7.4	2.6	93
Second Pulse – Week 3	24.8	2.7	19.9	30.6	N/A	7.2	3.5	62

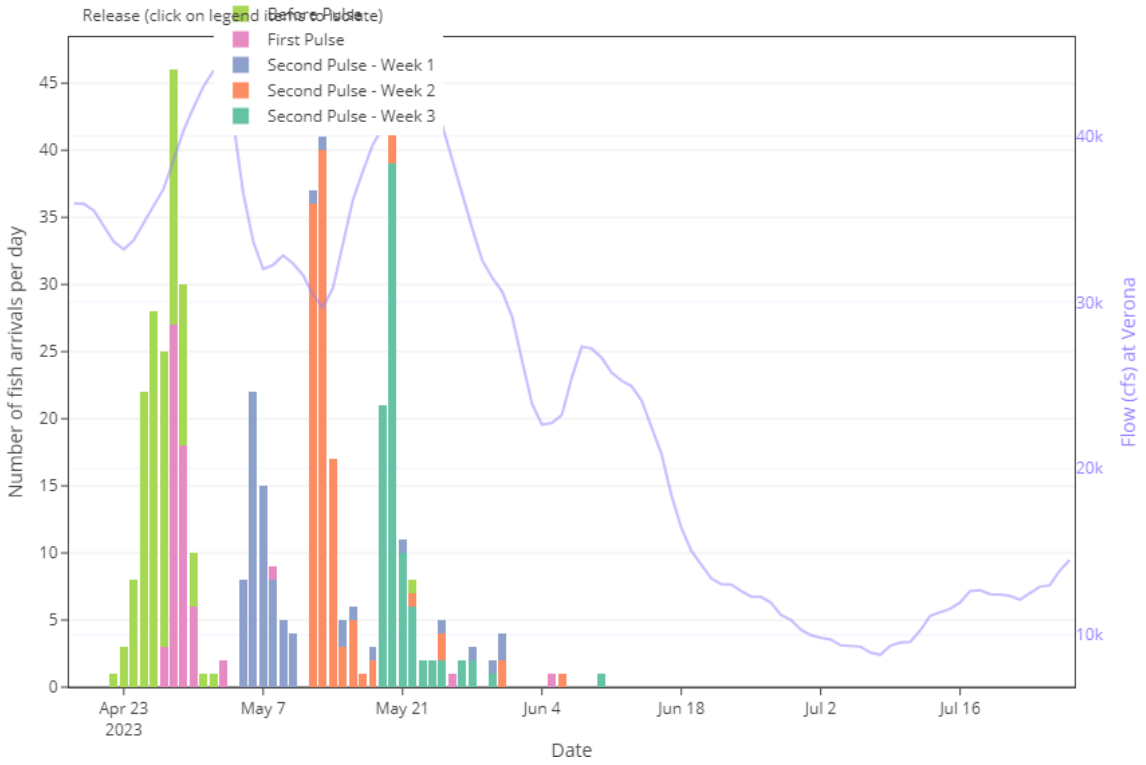

Figure 8 (New). Detections at Tower Bridge (downtown Sacramento) versus Sacramento River flows at Verona for duration of tag life ([CalFishTrack (noaa.gov).]())

Figure 8 is a bar graph that shows the number of fish arrivals per day compared the flows at Verona from April 23, 2023 to July 16, 2023.

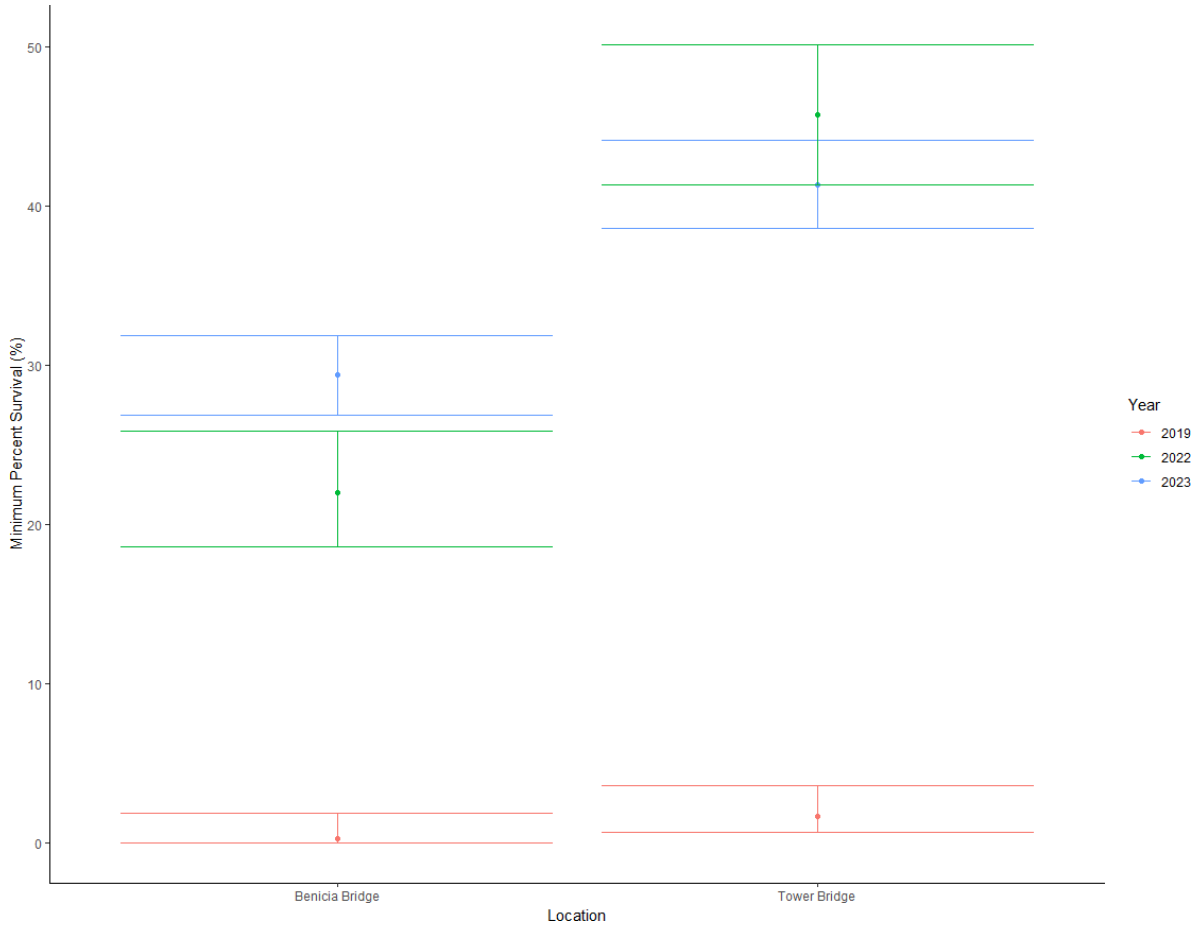

Figure 9 (New). Comparison of 2023 spring pulse flow minimum estimated percent survival to other years

Figure 9 is a graph showing the minimum percent survival for the years 2019, 2022, and 2023 at Benicia Bridge and Tower Bridge.

Conservation Measures

The purpose of this section is to provide a status update on the conservation measures identified in the ROD related to Shasta Lake storage rebuilding and the spring pulse flow action.

- Rice Decomposition Smoothing: no rice decomposition water was used.
- Drought and Dry Year Toolkit: The 2022 Drought and Dry Year Actions Report can be found at: 2021 Drought and Dry Year Actions Report

Operations Summary

The key events and decisions that influenced the Fall and Winter Refill and Redd Maintenance action and the Spring Pulse Flow action include:

- August Keswick fall flow reductions as described in Sacramento River Temperature Management Plan.

- A projected exceedance of 1% Incidental Take Limit for Winter-run Chinook Salmon dewatered redds led to slight deviation from the Keswick flow schedule for September, as described in the Temperature Management Plan.
- Spring Pulse Determination: Since the projected May 1 storage of Shasta Lake was greater than 4 MAF (indicating insufficient cold-water pool for a Tier 1 year), a Spring Pulse flow was pursued to improve juvenile salmon outmigration survival and investigate the effects of managed pulse flows compared to flow pulses occurring during storm events. Ultimately, the Spring Pulse could not be implemented as planned due to storage management, although the acoustic telemetry study was implemented as in previous years.
- Shasta storage management became a driving factor, and the pulses flow releases were not able to be fully implemented as planned.

Performance

In Water Year 2023, a Spring Pulse was not fully implemented due to Shasta Storage conservation management needs. However, the acoustic telemetry study moved forward, and results are described in this report.

Shasta Lake Storage

Cumulative inflow (TAF) to Shasta Lake from October 1 to May 1 compared to the increase in storage (TAF) from October 1 to May 1 for a period of record of WY 2009 – WY 2023 is shown in Figure 10. In WY 2023, Shasta Lake had slightly more cumulative inflow than WY 2016; however, WY 2020 and 2021 have two of the lowest cumulative inflow volumes for the period of record 2009 – 2023. As of May 2023, cold water pool volumes in Shasta Lake were around 4.44 MAF.

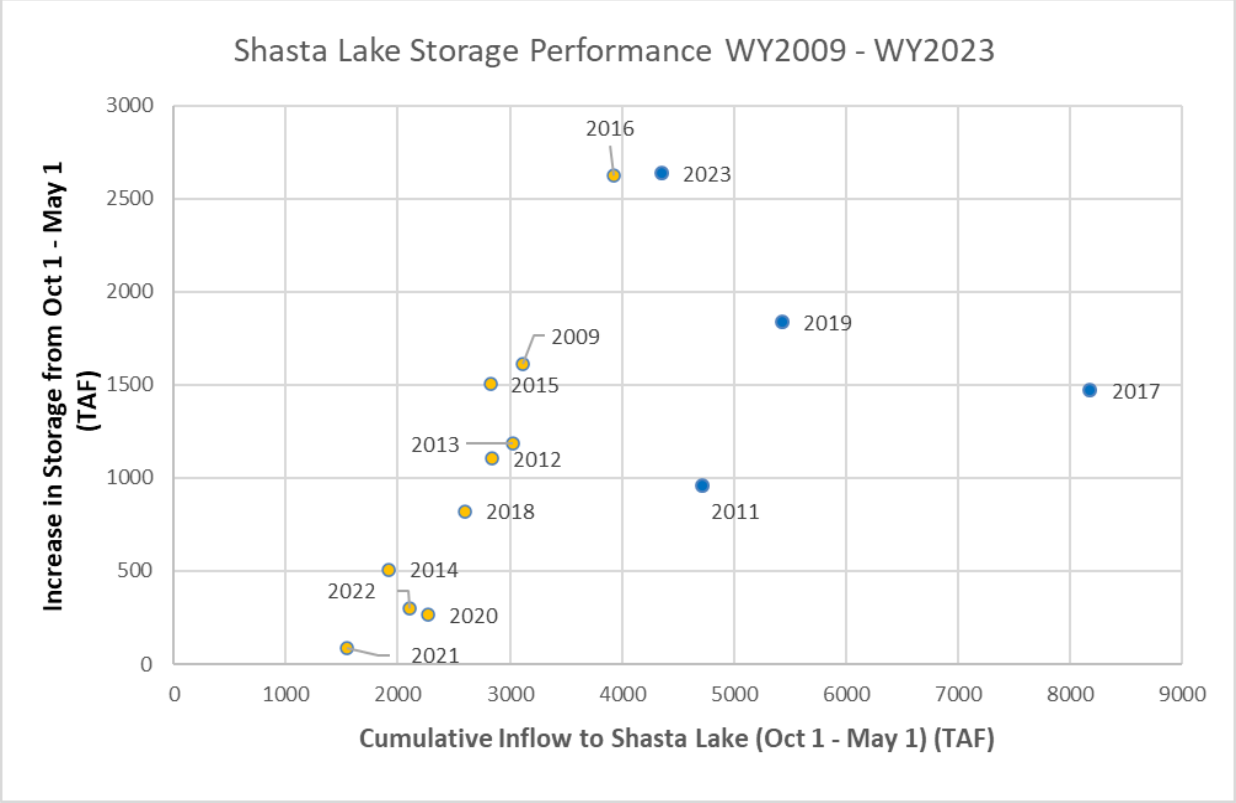

Figure 10 (Updated). Shasta Lake Storage Performance from WY 2009 – WY 2023. Wet water year types are shown in blue; all others are shown in orange.

Figure 10 is a graph comparing the increase in storage from October to May 2023, as compared to the cumulative inflow to Shasta Lake in the same time period. Wet water years include 2011, 2017, 2019, and 2023, all other years are other in the range from 2009 – 2023.

Discussion

Shasta storage was low in summer 2022. Keswick flows were low to conserve cold water pool and carryover storage. Few winter-run redds were dewatered; however, the population was so low that monitoring of shallow water redds indicated that the 1% incidental take limit would be exceeded, so Keswick flows operations were adjusted to be slightly higher than what was in the Temperature Management Plan. Few fall-run redds were dewatered.

In WY 2023, the spring pulse flow action was not fully implemented due to Shasta Storage conservation management needs. Reclamation may implement a spring pulse flow in future years when conditions are met.

Improvements

WY 2023 improvements are listed in this section. There were no improvements to Pilot Projects, Recent Study Results, Modeling Improvements, Monitoring Improvements, and Analytical Tools.

Coordination Improvements

USST

Coordination for fall flow reduction operations was reduced in summer/fall 2022 due to the drop to baseflows being relatively small in comparison to typical years and Keswick flow operations were mostly defined by the Temperature Management Plan. It would be valuable to have regular coordination in the late summer and fall time period and to use the Keswick Flow Reduction Schedule Tool, including reviewing the stakeholder interests diagram.

Conclusion

Shasta storage was low in summer 2022. Keswick flows were low to conserve cold-water pool and carryover storage. Few winter-run redds were dewatered; however, the population was so low that monitoring of shallow water redds indicated that there was potential that the incidental take for winter-run could exceed one percent, so Keswick flows operations were adjusted to be slightly higher than prescribed by the Temperature Management Plan. Few fall-run redds were dewatered.

In summary, these are takeaways for Shasta Dam water year 2023 operations and spring pulse flows action:

- In WY 2023, the spring pulse flow action was not fully implemented due to Shasta Storage conservation management needs. Reclamation may implement a spring pulse flow in future years when conditions are met.
- This was a wet year for Shasta which led to Shasta filling to capacity. The wet year conditions help improve the reservoir flows release and operations conditions. The high flows in the spring-time improved conditions for out-migrating salmonids. Higher relative survival was observed for the spring pulse flow study fish than in previous years with lower flows. A wet year such as this does not offer optimal conditions for a spring pulse flow action because pulses need to be of short duration. Future years with sufficient water to spare for a pulse flow action, but not so much water that additional releases are required to keep reservoir capacity available would be better suited to a spring-pulse study. Such a future spring-pulse study may clarify whether the higher survival of fish released before the first pulse is correlated with distance traveled into the system prior to the start of the pulse, as well as whether a true, short-duration pulse has a positive relationship with survival. Finer scale data analyses might be warranted for the week prior to pulse release group as it is interesting how they had the longest travel times, but highest survival of all the groups.

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Supporting Links

Reclamation's Central Valley Office

Upper Sacramento Scheduling Team

SacPAS

CVTEMP

CalFishTrack