United States Department of the Interior

BUREAU OF RECLAMATION
Central Valley Operations Office
3310 El Camino Avenue, Suite 300
Sacramento, California 95821

IN REPLY
REFER TO:

MAY 15 2018

CVO-100
WTR-2.00

VIA ELECTRONIC MAIL

Mr. Erik Ekdahl
Deputy Director
Division of Water Rights
State Water Resources Control Board
P.O. Box 2000
Sacramento, CA 95812

Subject: 2018 Sacramento River Temperature Management Plan Per Water Rights Order 90-5

Dear Mr. Ekdahl:

This letter transmits the Sacramento River Temperature Management Plan (SRTMP) for Water Year 2018 pursuant to Water Rights Order 90-5. The SRTMP represents a balanced approach to management of the cold water pool in Shasta Reservoir during the spring, summer, and fall of 2018. As requested in your letters transmitted on March 14, 2018 and April 10, 2018, Reclamation worked cooperatively on the development of the SRTMP with the State Water Resources Control Board (SWRCB), as well as the National Marine Fisheries Service (NMFS), US Fish and Wildlife Service, California Department of Fish and Wildlife, Western Area Power Administration, and other agencies represented on the Sacramento River Temperature Task Group (SRTTG) throughout the months of February through May.

Reclamation's plan includes input and recommendations from the SRTTG meetings on April 26, 2018 and May 9, 2018, as well as a public stakeholder meeting held on April 25, 2018. Reclamation also held an SRTTG meeting on April 19, 2018 to discuss various operational aspects of the plan, including basis for assumptions for accretions, depletions, and water supply needs for salinity control underlying the projected water operations. The proposed SRTMP approach focuses on utilizing the cold water pool resource available this year, leveraging the Shasta Temperature Control Device capabilities, and maintaining reasonable temperature targets that will maximize protection of the species, while ensuring cold water will be able to be fully utilized through the season. This approach will also help Reclamation meet other obligations and maintain commitments for operation of the Central Valley Project (CVP) and State Water Project (SWP).

Preliminary temperature operation modeling scenarios and results were distributed to the SRTTG this year on February 22, March 22, April 25, April 26, and May 9. In addition, Reclamation has provided additional modeling results and model output files throughout the spring to NMFS as part of the processes outlined under Reasonable and Prudent Alternative (RPA) I.2.3 of the

NMFS 2009 Biological Opinion on the Coordinated Long-term Operation of the CVP and SWP (NMFS 2009 BiOp). Historical information shows this year's cold-water-pool volume of water cooler than 49°F is less than average. In light of this and other conditions, Reclamation solicited feedback from SRTTG members on the proposed operation/simulation results. Reclamation has developed the SRTMP based on recommendations from SRTTG members. Preliminary discussion during the recent SRTTG meeting (April 26, 2018), included suggestions for a compliance point at the existing gaging station located on the Sacramento River above the confluence with Clear Creek (CCR California Data Exchange Center gaging station), using 53°F daily average temperature (DAT) metric from present through May 31 followed by a compliance point at Balls Ferry, using 56°F DAT metric from June 1 through October 31. This calendar-based trigger was preferred over a spawning trigger to implement the switch from 53°F at the Sacramento River above Clear Creek to 56°F at Balls Ferry, as a spawning trigger increases operational/implementation complexity and monitoring. Other more recent suggestions from NMFS included a temperature target at the CCR Gage Station, using a 53.5°F daily average temperature (DAT) metric for the entire management season.

During the May 9, 2018 SRTTG meeting members discussed options and reconciled concerns. The SRTMP consists of a compliance point at Balls Ferry, using a 56°F DAT metric from May 15 through October 31. The proposed temperature management operation also includes an evaluation study targeting 53.5°F DAT at the CCR gaging station during the same time frame. Use of this location provides for targeting consistent temperatures closer to the location of actual anticipated spawning, which is an operational strategy Reclamation and NMFS have discussed over the past several years. Based on recent modeling (provided May 9, 2018), the evaluation study of 53.5°F DAT target requires additional cold-water-pool utilization during later periods of the temperature management season. As a result, managing for cooler temperatures at CCR between May and October produces a tradeoff for increased risk to temperature performance confidence in the fall. Reclamation will monitor the cold-water-pool projections and compare to actual performance. The primary "off-ramp" criterion is defined as a deficient cold-water-pool volume less than 49°F which deviates more than 10% from the projected volume. In addition, ongoing modeling results will be completed for each monthly SRTTG meeting and more often as necessary (potentially as frequently as every two weeks). These results will be considered should those results indicate increased (or decreased) risk to fall temperature performance. In the event that actual cold-water-pool conditions vary from what is projected, and the fall temperature performance appears at risk, Reclamation will reconvene the SRTTG in preparation for an "off-ramp" of the evaluation study. If the "off-ramp" conditions are met and/or other indicators warrant as discussed by the SRTTG, then the evaluation study will conclude and operations will revert to the compliance location at Balls Ferry using 56°F DAT metric for the remainder of the season to protect fall temperatures. As in past years, Reclamation will work with the members of the SRTTG during fall operations to address the potential for redd dewatering.

Please find enclosed (Enclosure 1) the projected operations and latest temperature modeling results targeting 53.5°F DAT at the Sacramento River-Clear Creek (CCR) gaging station May 15 through October 31. The runs include both the April 50% and 90% exceedance hydrology forecasts and operational outlooks, and the temperature modeling results utilize conservative historical meteorological forecasts at 50% and 10% exceedances. Operational release performance was based on the two probabilistic hydrologic assumptions rather than fixed flowrates; actual release operations are expected to be within the specified ranges on an average

monthly basis based on the hydrologic and operational considerations at that time. For this reason, daily operations may vary higher or lower from the projected monthly averages. Conservative results using the 90% exceedance hydrology forecast show end of September storage in Shasta Reservoir of approximately 2.3 million acre-feet. The simulation results indicated confidence in accomplishing temperature management, as proposed, with an end of September cold-water-pool less than 56°F of at least 587,000 acre-feet, and that the first side gate use of the Shasta Reservoir Temperature Control Device would begin between late August and early September, and full side gate use in early October.

Water Rights Order 90-5 requires Reclamation to "report any change in the location where it will meet the temperature requirement" of 56°F on the Sacramento River, and "file an operation plan showing Permittee's strategy to meet the temperature requirement at the new location." Given the terms of Order 90-5 and the commitments above, Reclamation believes the proposed SRTMP will accomplish temperature management of 56°F at a Balls Ferry compliance point, and provide additional information for ongoing refinement of temperature management practices through the aforementioned evaluation study. Enclosed, for your reference, is a concurrence letter from NMFS regarding the SRTMP (Enclosure 2).

We look forward to working with you and your staff as we manage water resources and temperature this water year. Should you have questions or wish to discuss further, please feel free to contact me at 916-979-2197.

Sincerely,

Jeff Rieker
Operations Manager

Enclosures – 2

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Enclosure 1

Estimated CVP Operations Apr 90% Exceedance

Storages

Federal End of the Month Storage/Elevation (TAF/Feet)

		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Trinity	**1844**	**1964**	**1893**	**1782**	**1679**	**1555**	**1439**	**1409**	**1390**	**1400**	**1432**	**1518**	**1615**
	Elev.	2338	2333	2325	2318	2308	2298	2295	2294	2295	2297	2305	2313
Whiskeytown	**207**	**238**	**238**	**238**	**238**	**238**	**230**	**206**	**206**	**206**	**206**	**206**	**206**
	Elev.	1209	1209	1209	1209	1209	1207	1199	1199	1199	1199	1199	1199
Shasta	**3880**	**4132**	**3981**	**3625**	**3046**	**2600**	**2320**	**2196**	**2190**	**2321**	**2518**	**2865**	**3321**
	Elev.	1052	1047	1034	1010	989	975	968	968	975	985	1002	1021
Folsom	**817**	**793**	**904**	**825**	**591**	**449**	**402**	**345**	**296**	**256**	**306**	**412**	**576**
	Elev.	449	459	452	427	410	403	395	386	379	388	405	426
New Melones	**2019**	**1977**	**1946**	**1922**	**1848**	**1784**	**1740**	**1709**	**1721**	**1735**	**1747**	**1770**	**1789**
	Elev.	1050	1047	1045	1038	1032	1028	1025	1026	1027	1028	1031	1033
San Luis	**876**	**773**	**574**	**266**	**88**	**8**	**72**	**198**	**382**	**526**	**666**	**699**	**762**
	Elev.	510	485	445	421	399	414	431	451	476	491	493	505
Total		9877	9536	8658	7491	6634	6204	6063	6185	6443	6874	7470	8268

State End of the Month Reservoir Storage (TAF)

Oroville													
San Luis Total San Luis (TAF)	**1774**	**1622**	**1335**	**919**	**697**	**518**	**638**	**791**	**986**	**1245**	**1411**	**1422**	**1565**

Monthly River Releases (TAF/cfs)

Trinity	TAF	36	92	47	28	53	52	23	18	18	18	17	18
	cfs	**600**	**1,498**	**783**	**450**	**857**	**870**	**373**	**300**	**300**	**300**	**300**	**300**
Clear Creek	TAF	13	13	17	9	9	9	12	12	12	12	11	12
	cfs	**218**	**216**	**288**	**150**	**150**	**150**	**200**	**200**	**200**	**200**	**200**	**200**
Sacramento	TAF	297	523	625	799	645	476	369	268	200	200	180	200
	cfs	**5000**	**8500**	**10500**	**13000**	**10500**	**8000**	**6000**	**4500**	**3250**	**3250**	**3250**	**3250**
American	TAF	506	77	167	293	204	107	92	89	92	61	56	77
	cfs	**8500**	**1250**	**2811**	**4768**	**3311**	**1798**	**1500**	**1500**	**1500**	**1000**	**1005**	**1250**
Stanislaus	TAF	83	96	56	18	18	18	49	12	12	14	13	12
	cfs	**1400**	**1555**	**940**	**300**	**300**	**300**	**797**	**200**	**200**	**232**	**236**	**200**
Feather													
	cfs												

Trinity Diversions (TAF)

	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Carr PP	39	67	85	80	71	62	16	21	12	3	2	15
Spring Crk. PP	**10**	**60**	**70**	**70**	**60**	**60**	**30**	**15**	**12**	**10**	**20**	**30**

Delta Summary (TAF)

		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Tracy		93	61	53	225	260	262	265	250	190	190	120	200
USBR Banks		0	0	0	18	18	18	0	0	0	0	0	0
Contra Costa		12.7	12.7	9.8	11.1	12.7	14.0	16.8	18.4	18.3	14.0	14.0	12.7
Total USBR		106	74	63	254	291	294	282	268	208	204	134	213
State Export													
Total Export		182	105	110	375	355	444	433	374	394	394	261	413
COA Balance		25	25	0	0	0	87	87	87	87	87	46	46
Old/Middle River Std.													
Old/Middle R. calc.		-164	146	-1,354	-4,912	-4,693	-5,945	-5,221	-4,877	-4,978	-4,960	-3,536	-5,040
Computed DOI		30476	10004	7900	6507	4002	3009	4067	4572	6767	9728	11400	12379
Excess Outflow		19079	2098	0	0	0	0	65	67	2261	3725	0	976
% Export/Inflow		8%	11%	13%	35%	40%	54%	54%	52%	47%	41%	29%	34%
% Export/Inflow std.		35%	35%	35%	65%	65%	65%	65%	65%	65%	65%	45%	35%

Hydrology

	Trinity		Shasta		Folsom	New Melones	
Water Year Inflow (TAF)	627		3,621		2,352	972	
Year to Date + Forecasted % of mean	52%		65%		86%	92%	

CVP actual operations do not follow any forecasted operation or outlook; actual operations are based on real-time conditions.
CVP operational forecasts or outlooks represent general system-wide dynamics and do not necessarily address specific watershed/tributary details.
CVP releases or export values represent monthly averages.
CVP Operations are updated monthly as new hydrology information is made available December through May.

5/10/2018

Estimated CVP Operations Apr 50% Exceedance

Storages

Federal End of the Month Storage/Elevation (TAF/Feet)

		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Trinity	**1844**	**1878**	**1860**	**1773**	**1659**	**1514**	**1381**	**1343**	**1330**	**1360**	**1425**	**1535**	**1629**
	Elev.	2332	2331	2325	2316	2304	2293	2290	2288	2291	2297	2306	2314
Whiskeytown	**207**	**238**	**238**	**238**	**238**	**238**	**230**	**206**	**206**	**206**	**206**	**206**	**206**
	Elev.	1209	1209	1209	1209	1209	1207	1199	1199	1199	1199	1199	1199
Shasta	**3880**	**4167**	**4055**	**3739**	**3205**	**2813**	**2586**	**2491**	**2541**	**2731**	**3138**	**3622**	**4179**
	Elev.	1054	1050	1038	1017	999	989	984	986	995	1014	1033	1054
Folsom	**817**	**813**	**937**	**885**	**715**	**604**	**528**	**480**	**451**	**439**	**468**	**521**	**586**
	Elev.	451	462	458	441	429	420	414	410	409	412	419	427
New Melones	**2019**	**1996**	**2014**	**2018**	**1958**	**1894**	**1853**	**1812**	**1829**	**1852**	**1884**	**1938**	**1915**
	Elev.	1052	1054	1054	1048	1043	1039	1035	1036	1039	1042	1047	1044
San Luis	**876**	**816**	**594**	**341**	**152**	**54**	**106**	**224**	**396**	**604**	**748**	**865**	**937**
	Elev.	508	471	418	387	372	409	443	469	498	491	498	503
Total		9908	9698	8994	7927	7117	6684	6556	6752	7192	7868	8687	9452

State End of the Month Reservoir Storage (TAF)

Oroville													
San Luis Total San Luis (TAF)	**1774**	**1596**	**1186**	**676**	**421**	**317**	**598**	**904**	**1164**	**1488**	**1406**	**1487**	**1540**

Monthly River Releases (TAF/cfs)

Trinity	TAF	36	92	47	28	53	52	23	18	18	18	17	18
	cfs	**600**	**1,498**	**783**	**450**	**857**	**870**	**373**	**300**	**300**	**300**	**300**	**300**
Clear Creek	TAF	13	13	17	9	9	9	12	12	12	15	11	12
	cfs	**218**	**216**	**288**	**150**	**150**	**150**	**200**	**200**	**200**	**240**	**200**	**200**
Sacramento	TAF	268	523	625	799	645	476	369	268	200	200	278	307
	cfs	**4500**	**8500**	**10500**	**13000**	**10500**	**8000**	**6000**	**4500**	**3250**	**3250**	**5000**	**5000**
American	TAF	535	154	188	249	184	149	123	119	123	123	208	246
	cfs	**9000**	**2500**	**3158**	**4053**	**3000**	**2500**	**2000**	**2000**	**2000**	**2000**	**3750**	**4000**
Stanislaus	TAF	86	96	56	18	18	18	49	12	12	14	13	93
	cfs	**1454**	**1555**	**940**	**300**	**300**	**300**	**797**	**200**	**200**	**232**	**236**	**1521**
Feather													

Trinity Diversions (TAF)

	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Carr PP	35	24	71	84	85	76	26	25	9	0	2	35
Spring Crk. PP	**15**	**25**	**60**	**75**	**75**	**75**	**40**	**20**	**12**	**20**	**35**	**60**

Delta Summary (TAF)

		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Tracy		113	74	155	273	274	260	265	245	260	205	215	221
USBR Banks		0	0	0	24	24	24	0	0	0	0	0	0
Contra Costa		12.7	12.7	9.8	11.1	12.7	14.0	16.8	18.4	18.3	14.0	14.0	12.7
Total USBR		126	86	165	308	311	298	282	263	278	219	229	234
State Export													
Total Export		231	105	182	528	589	694	686	531	538	269	444	421
COA Balance		25	25	0	0	0	0	0	0	0	0	0	0
Old/Middle River Std.													
Old/Middle R. calc.		-494	281	-1,960	-6,594	-7,419	-8,991	-8,251	-6,720	-6,577	-3,086	-4,826	-3,440
Computed DOI		36611	13892	7900	6507	4018	3026	4018	4522	8085	17325	23701	25588
Excess Outflow		25214	4945	0	0	16	17	16	17	3579	11322	12301	14185
% Export/Inflow		9%	9%	21%	44%	54%	66%	65%	61%	51%	20%	25%	21%
% Export/Inflow std.		35%	35%	35%	65%	65%	65%	65%	65%	65%	65%	45%	35%

Hydrology

	Trinity		Shasta		Folsom		New Melones	
Water Year Inflow (TAF)	539		3,864		2,586		1080	
Year to Date + Forecasted % of mean	45%		70%		95%		102%	

CVP actual operations do not follow any forecasted operation or outlook; actual operations are based on real-time conditions.
CVP operational forecasts or outlooks represent general system-wide dynamics and do not necessarily address specific watershed/tributary details.
CVP releases or export values represent monthly averages.
CVP Operations are updated monthly as new hydrology information is made available December through May.

5/10/2018

May 10, 2018

Upper Sacramento River – April 2018 Preliminary Temperature Analysis

Summary of Temperature Results by Month (Monthly Average Temperature °F)

Location	MAY	JUN	JUL	AUG	SEP	OCT	Late Sep-Oct Uncertainty Estimation
April 90%-Exceedance Outlook – 10% Historical Meteorology 53.5°F CCR							
Keswick Dam KWK	52.8	52.9	53.0	52.9	53.1	52.9	54 - 57
Sac. R. abv Clear Creek CCR	53.5	53.5	53.5	53.4	53.5	53.0	54 - 58
Balls Ferry BSF	57.2	56.5	55.5	55.3	55.3	54.1	55 - 59
April 90%-Exceedance Outlook – 50% Historical Meteorology 53.5°F CCR							
Keswick Dam KWK	52.9	53.0	53.1	53.0	53.0	52.3	54 - 56
Sac. R. abv Clear Creek CCR	53.5	53.5	53.5	53.5	53.4	52.4	54 - 58
Balls Ferry BSF	56.8	56.3	55.3	55.3	55.1	53.5	55 - 58
April 50%-Exceedance Outlook – 10% Historical Meteorology 53.5°F CCR							
Keswick Dam KWK	52.8	52.9	53.0	52.9	53.1	52.9	54 - 57
Sac. R. abv Clear Creek CCR	53.5	53.5	53.5	53.4	53.5	52.9	54 - 58
Balls Ferry BSF	57.4	56.4	55.6	55.3	55.3	54.1	55 - 59
April 50%-Exceedance Outlook – 50% Historical Meteorology 53.5°F CCR							
Keswick Dam KWK	52.9	52.9	53.1	53.0	53.1	52.3	53 - 56
Sac. R. abv Clear Creek CCR	53.5	53.5	53.5	53.4	53.5	52.3	54 - 58
Balls Ferry BSF	56.9	56.2	55.3	55.3	55.2	53.4	55 - 58

* The HEC5Q model output is displayed above for the months April through October. Based on past analysis, the temperature model does not perform well in late September and October. One factor is that the modeled release temperatures are cooler than has

historically been achieved when all release is through the side gates (lowest gates), especially when there's a large temperature gradient between the pressure relief gates (PRG) and the side gates. For the months of September and October, an uncertainty estimate is provided based on the Fall Temperature Index (graphics below). This is based on a historical relationship between end-of-September Lake Shasta Volume less than 56°F and likely downstream temperature performances for the early fall months. The range represents the 90% confidence interval based on that data. Refinement of the concepts for those estimates is underway.

Temperature Model Inputs, Assumptions, Limitations and Uncertainty:

1. The latest available profiles for Shasta, Trinity, and Whiskeytown were taken on May 1, May 3, and May 2 respectively. Model results are sensitive to initial reservoir temperature conditions and the model performs best under highly stratified conditions. The model performs well after the reservoir stratifies, typically in late spring. The concern this year is assuming over or under estimations with variable hydrologic and meteorological conditions and not capturing the stratification with sufficient detail to project.
2. Guidance on forecasted flows from the creeks (e.g., Cow, Cottonwood, Battle, etc.) between Keswick Dam and Bend Bridge are not available beyond 5 days. Creek flows developed from the historical record that most closely reflects current conditions were used for all model runs. The resulting low creek flows can cause significant additional warming in the upper Sacramento River during spring.
3. Operation is based on the April 2018 Operation Outlooks and DWR Bulletin 120 inflow projections (monthly flows, reservoir release, and end-of-month reservoir storage) for the 90%- and 50%-exceedances. Trinity Lake inflows are updated with the CNRFC 90% runoff exceedance for the 90% runoff exceedance studies. The April 2018 Operation Outlook is modified to adjust for real-time operations in early May suggesting the monthly Keswick release may average closer to 8,500 cfs.
4. Although mean daily flows and releases are temperature model inputs, they are based on the mean monthly values from the operation outlooks. Mean daily flow patterns are user defined and are generalized representations. It is important to note that these outlooks do not suggest a certain actual future outcome, but rather the statistical likelihood of an event occurring, including, but not limited to, projected storage and releases. Thus, the outlooks do not provide exact end of month storages or flow rates but general projections that will likely fall within the range of uncertainty based on the different hydrologic runoff conditions between the 90% and 50% runoff exceedance hydrology.
5. Cottonwood Creek flows, Keswick to Bend Bridge local flows, and ACID diversions are mean daily synthesized flows based on the available historical record for a 1922-2002 study period. Inflows were adjusted to a 95% historical exceedance for both the 90% and 50% runoff exceedance studies.
6. Meteorological inputs represent historical (1985 – 2017) monthly mean equilibrium temperature exceedance at 10% and 50% patterned after like months on a 6-hour time-step, or as noted. Assumed inflow temperature remain static inputs and do not vary with the assumed meteorology.

7. Meteorology, as well as the flow volume and pattern, significantly influences reservoir inflow temperatures and downstream tributary temperatures; and consequently, the development of the cold-water pool during winter and early spring.
8. Modified model coefficients more closely represent actual Keswick Dam temperatures. As a result, temperature predictions downstream of Keswick Dam are likely to be warmer than actual. Model re-calibrations efforts are underway.

Model Run Date May 7-10, 2018

Temperature Analysis Results:

Modeling runs explore Sacramento River compliance performance above Clear Creek confluence and Balls Ferry locations by varying hydrology and temperature compliance target location and temperature. The temperature results for the Sacramento River between Keswick Dam and Balls Ferry are shown in Figures 1-4. The fall uncertainty estimation relationship between end-of-September lake volume below 56°F and a Balls Ferry compliance through fall is based on the Figures 5-7.

Model Run	End of September Cold Water Pool <56°F (TAF)	First Side Gate	Full Side Gates
(1) 90% Hydro, 10% Historical Met 53.5 CCR	578	8/27	10/3
(2) 90% Hydro, 50% Historical Met 53.5 CCR	625	9/1	10/4
(3) 50% Hydro, 10% Historical Met 53.5 CCR	610	8/26	10/1
(4) 50% Hydro, 50% Historical Met 53.5 CCR	649	9/1	10/4

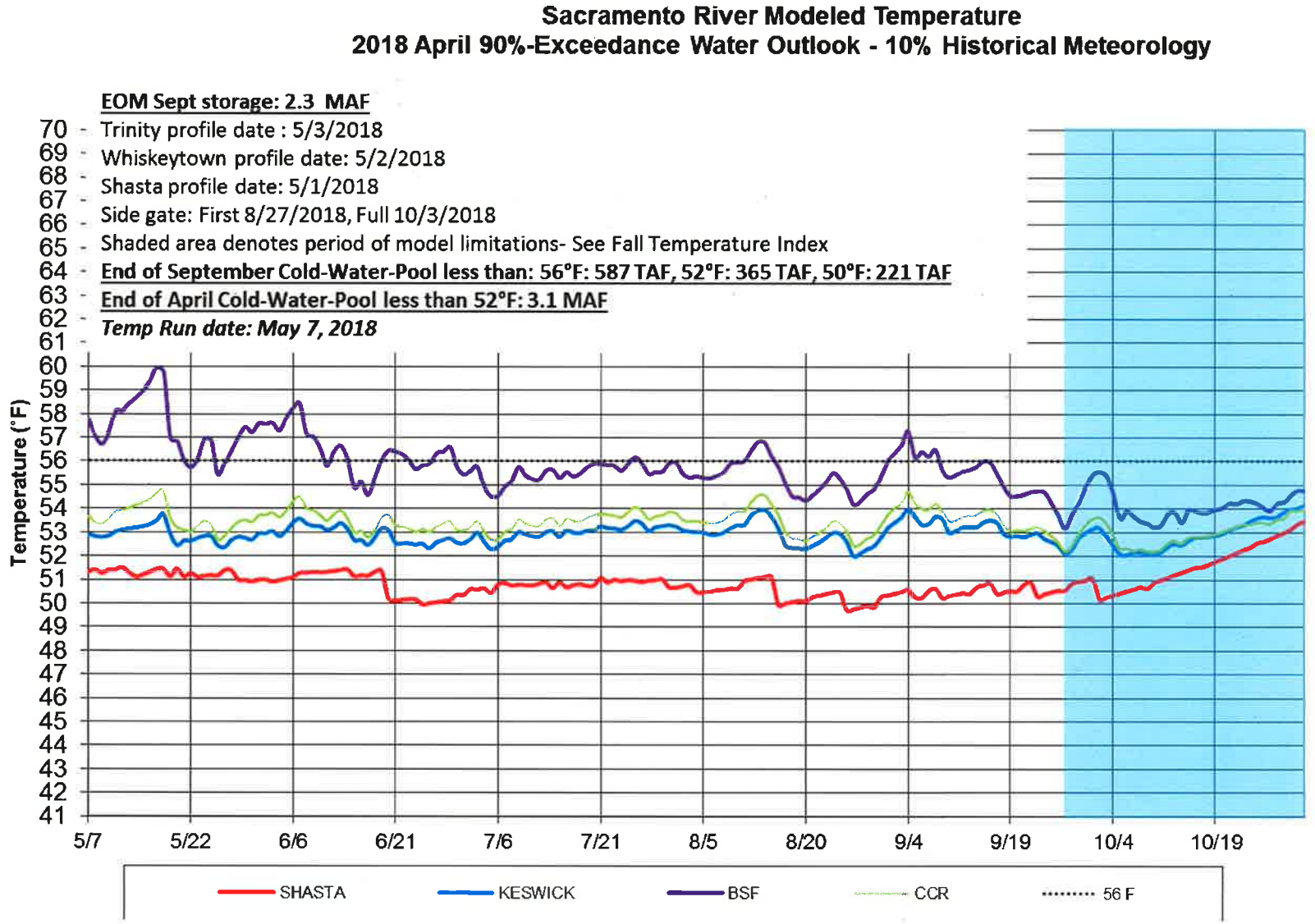

Sacramento River Modeled Temperature
2018 April 90%-Exceedance Water Outlook - 10% Historical Meteorology
EOM Sept storage: 2.3 MAF
Trinity profile date : 5/3/2018
Whiskeytown profile date: 5/2/2018
Shasta profile date: 5/1/2018
Side gate: First 8/27/2018, Full 10/3/2018
Shaded area denotes period of model limitations- See Fall Temperature Index
End of September Cold-Water-Pool less than: 56°F: 587 TAF, 52°F: 365 TAF, 50°F: 221 TAF
End of April Cold-Water-Pool less than 52°F: 3.1 MAF
Temp Run date: May 7, 2018
Temperature (°F)
70 69 68 67 66 65 64 63 62 61 60 59 58 57 56 55 54 53 52 51 50 49 48 47 46 45 44 43 42 41
5/7 5/22 6/6 6/21 7/6 7/21 8/5 8/20 9/4 9/19 10/4 10/19
SHASTA
KESWICK
BSF
CCR
56 F

Figure 1

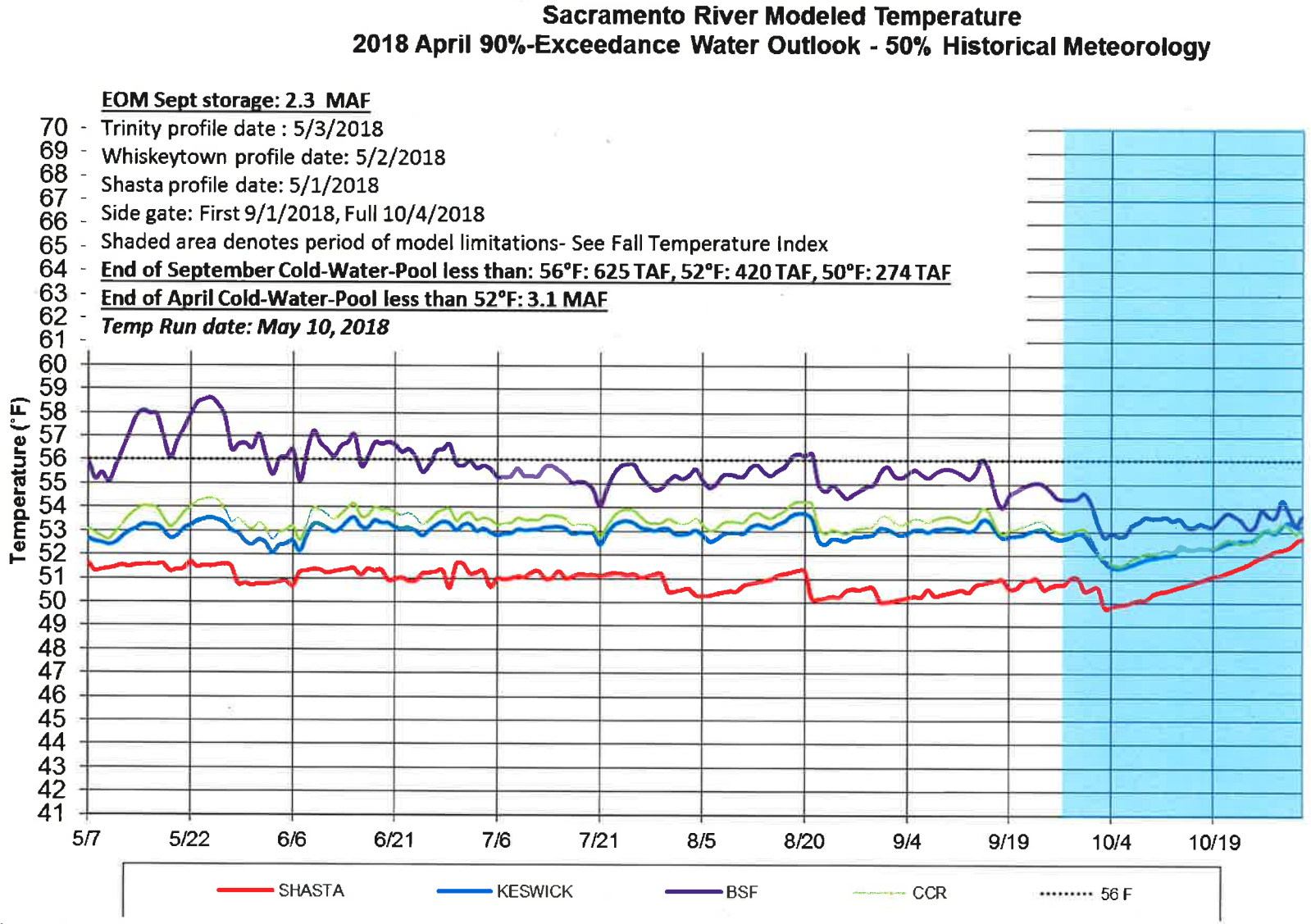

Sacramento River Modeled Temperature
2018 April 90%-Exceedance Water Outlook - 50% Historical Meteorology
EOM Sept storage: 2.3 MAF
Trinity profile date : 5/3/2018
Whiskeytown profile date: 5/2/2018
Shasta profile date: 5/1/2018
Side gate: First 9/1/2018, Full 10/4/2018
Shaded area denotes period of model limitations- See Fall Temperature Index
End of September Cold-Water-Pool less than: 56°F: 625 TAF, 52°F: 420 TAF, 50°F: 274 TAF
End of April Cold-Water-Pool less than 52°F: 3.1 MAF
Temp Run date: May 10, 2018
Temperature (°F)
70 69 68 67 66 65 64 63 62 61 60 59 58 57 56 55 54 53 52 51 50 49 48 47 46 45 44 43 42 41
5/7 5/22 6/6 6/21 7/6 7/21 8/5 8/20 9/4 9/19 10/4 10/19
SHASTA
KESWICK
BSF
CCR
56 F

Figure 2

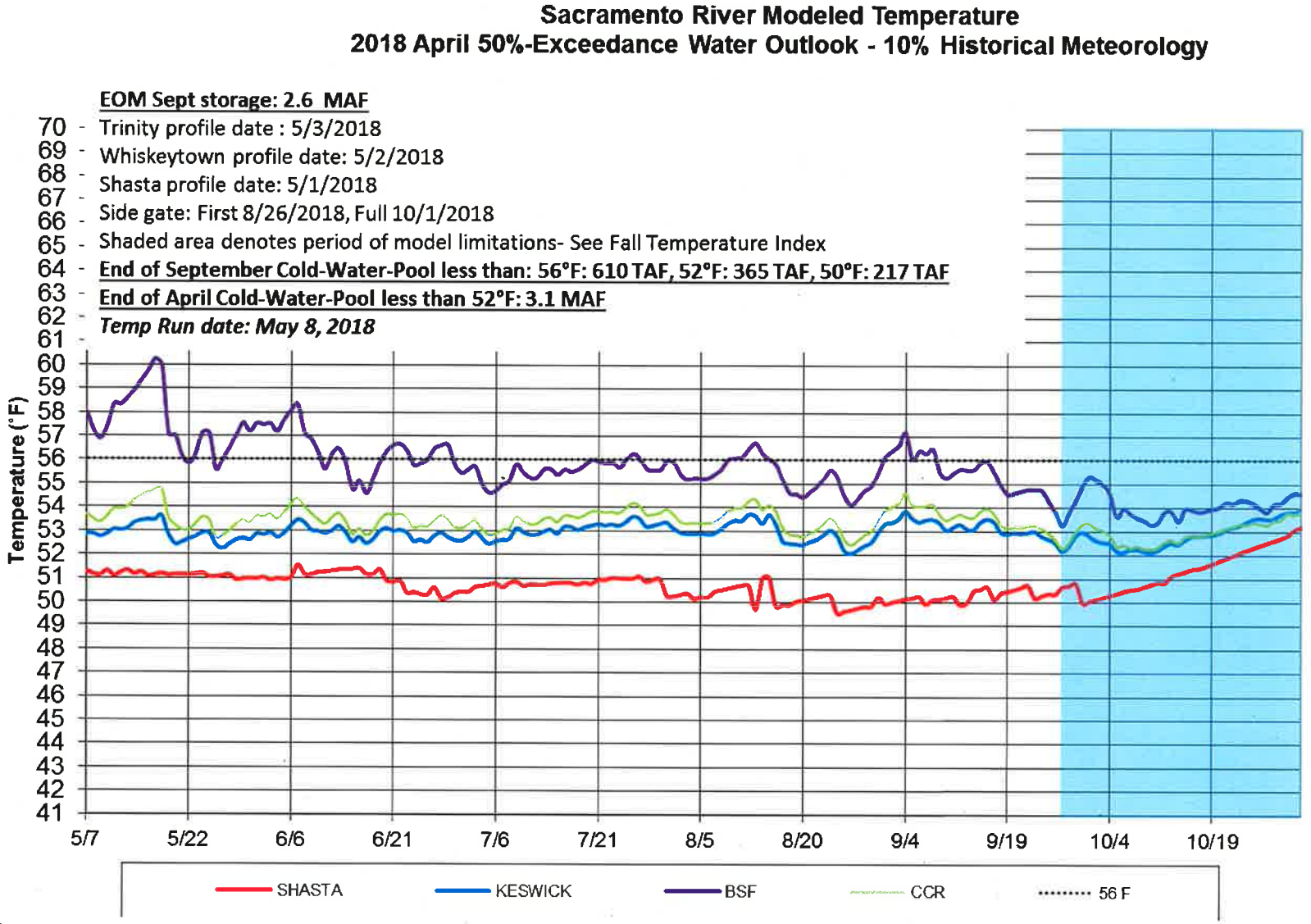

Sacramento River Modeled Temperature
2018 April 50%-Exceedance Water Outlook - 10% Historical Meteorology
EOM Sept storage: 2.6 MAF
Trinity profile date : 5/3/2018
Whiskeytown profile date: 5/2/2018
Shasta profile date: 5/1/2018
Side gate: First 8/26/2018, Full 10/1/2018
Shaded area denotes period of model limitations- See Fall Temperature Index
End of September Cold-Water-Pool less than: 56°F: 610 TAF, 52°F: 365 TAF, 50°F: 217 TAF
End of April Cold-Water-Pool less than 52°F: 3.1 MAF
Temp Run date: May 8, 2018
Temperature (°F)
70 69 68 67 66 65 64 63 62 61 60 59 58 57 56 55 54 53 52 51 50 49 48 47 46 45 44 43 42 41
5/7 5/22 6/6 6/21 7/6 7/21 8/5 8/20 9/4 9/19 10/4 10/19
SHASTA
KESWICK
BSF
CCR
56 F

Figure 3

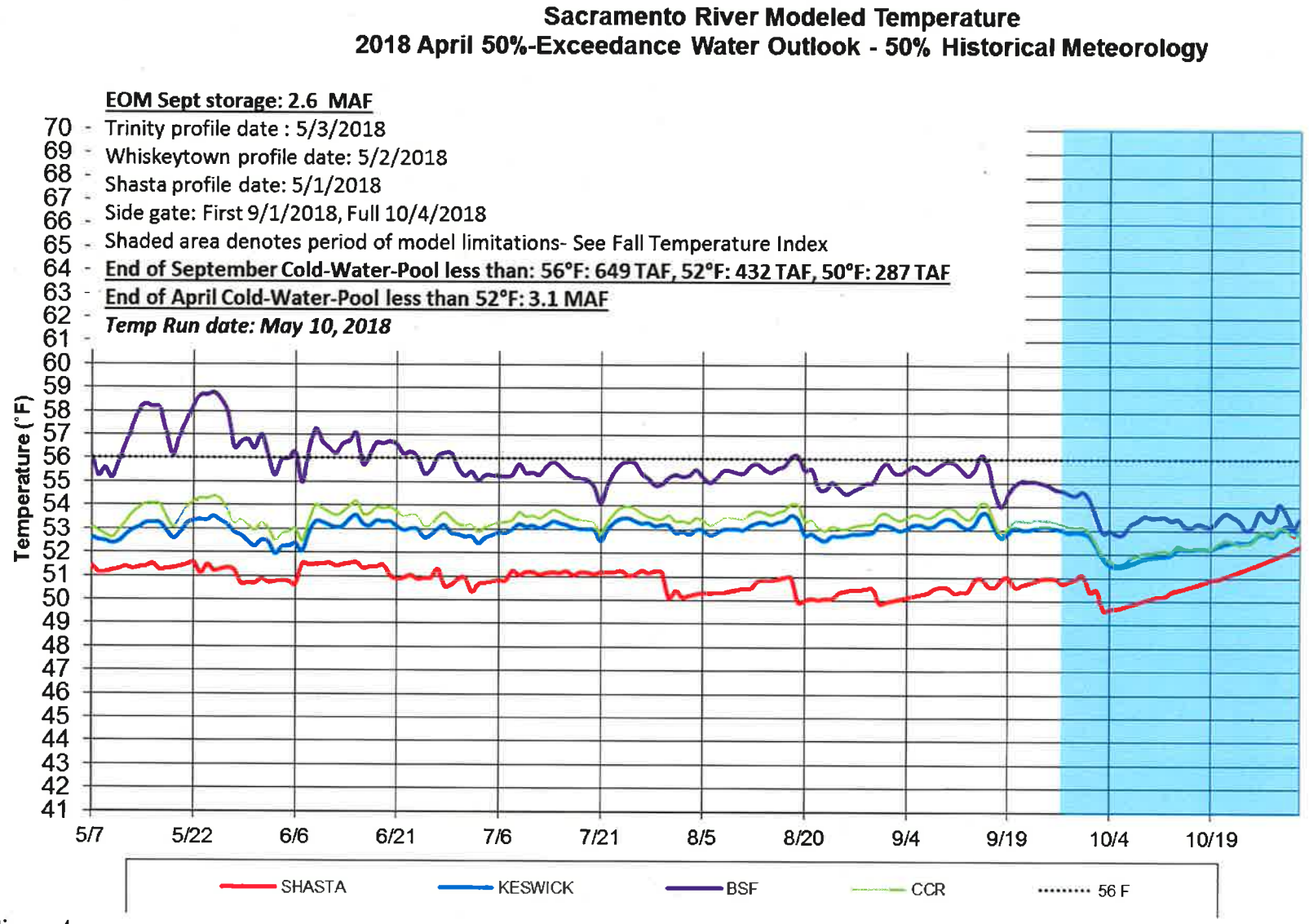

Sacramento River Modeled Temperature
2018 April 50%-Exceedance Water Outlook - 50% Historical Meteorology
EOM Sept storage: 2.6 MAF
Trinity profile date : 5/3/2018
Whiskeytown profile date: 5/2/2018
Shasta profile date: 5/1/2018
Side gate: First 9/1/2018, Full 10/4/2018
Shaded area denotes period of model limitations- See Fall Temperature Index
End of September Cold-Water-Pool less than: 56°F: 649 TAF, 52°F: 432 TAF, 50°F: 287 TAF
End of April Cold-Water-Pool less than 52°F: 3.1 MAF
Temp Run date: May 10, 2018
Temperature (°F)
70 69 68 67 66 65 64 63 62 61 60 59 58 57 56 55 54 53 52 51 50 49 48 47 46 45 44 43 42 41
5/7 5/22 6/6 6/21 7/6 7/21 8/5 8/20 9/4 9/19 10/4 10/19
SHASTA
KESWICK
BSF
CCR
56 F

Figure 4

Figures 5-7 Model Performance and Fall Temperature Index:

1. Based on past analyses, the temperature model does not perform well in late September and October. One factor is that the modeled release temperatures are cooler than has historically been achieved when all release is through the side gates (lowest gates), especially when there's a large temperature gradient between the pressure relief gates (PRG) and the side gates.
2. Based on historical records, the end-of-September Lake Shasta volume below 56˚F can be used as an indicator of fall water temperature in the river reach to Balls Ferry.
3. Based on these records and estimates, the index below illustrates a range of uncertainty in the ability to meet for river temperatures not to exceed 56 ˚F downstream based on the end-of-September lake volume less than 56˚F; see charts below.
4. Refinement of these estimates and concepts is currently underway.

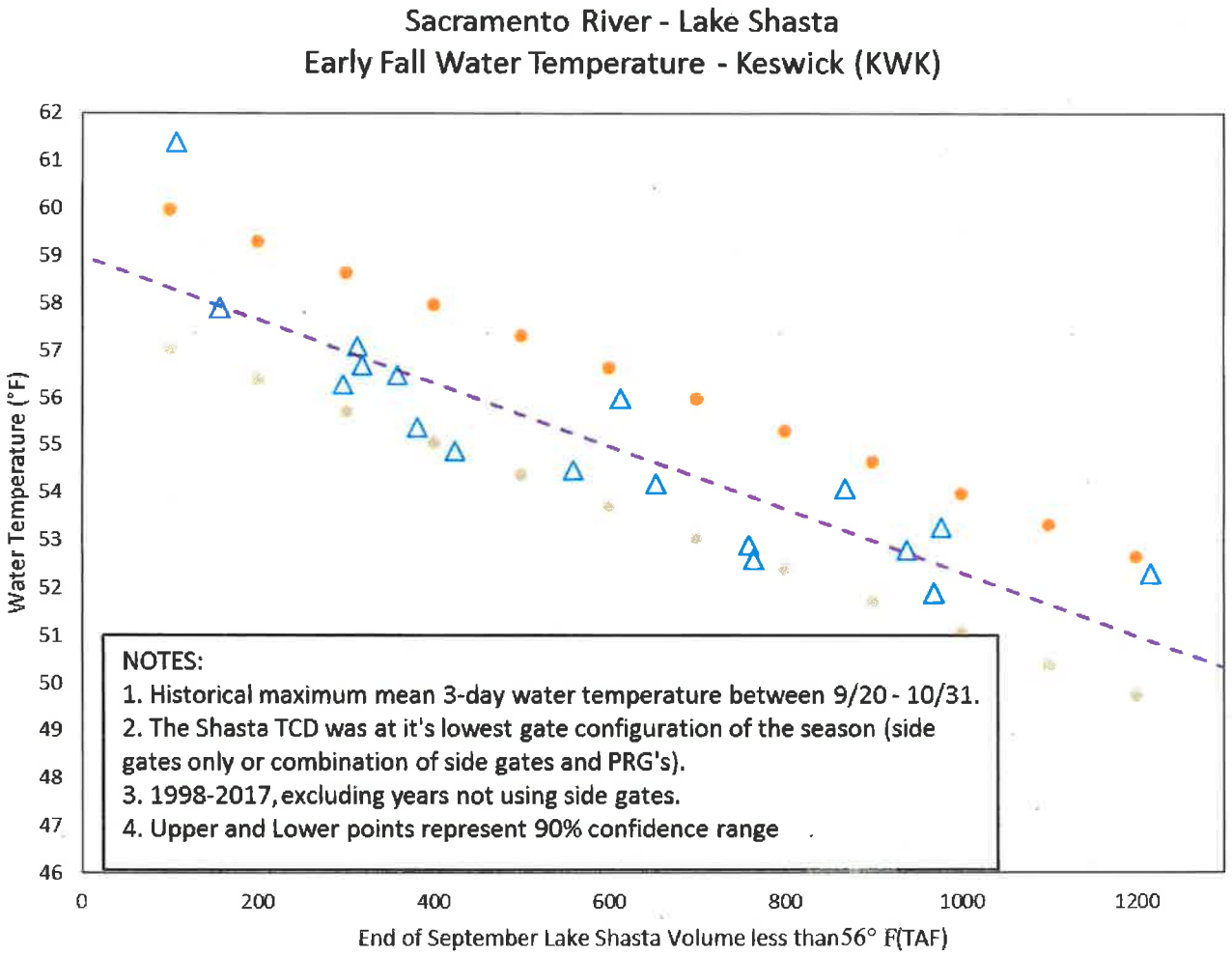

Sacramento River - Lake Shasta
Early Fall Water Temperature - Keswick (KWK)
Water Temperature (°F)
62
61
60
59
58
57
56
55
54
53
52
51
50
49
48
47
46
0
200
400
600
800
1000
1200
End of September Lake Shasta Volume less than 56° F (TAF)
NOTES:
1. Historical maximum mean 3-day water temperature between 9/20 - 10/31.
2. The Shasta TCD was at it's lowest gate configuration of the season (side gates only or combination of side gates and PRG's).
3. 1998-2017, excluding years not using side gates.
4. Upper and Lower points represent 90% confidence range

Figure 5

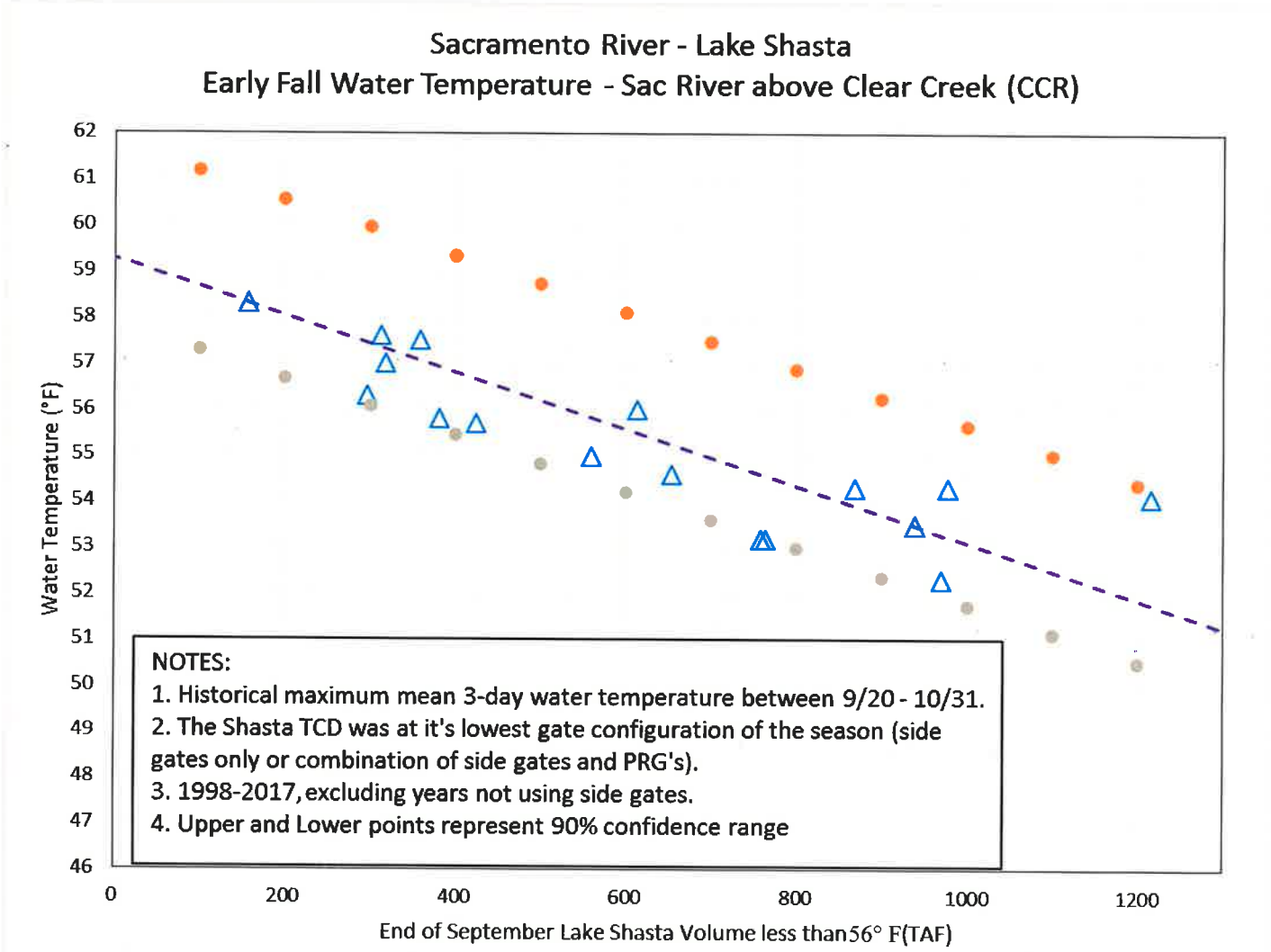

Sacramento River - Lake Shasta
Early Fall Water Temperature - Sac River above Clear Creek (CCR)
Water Temperature (°F)
62
61
60
59
58
57
56
55
54
53
52
51
50
49
48
47
46
0
200
400
600
800
1000
1200
End of September Lake Shasta Volume less than 56° F(TAF)
NOTES:
1. Historical maximum mean 3-day water temperature between 9/20 - 10/31.
2. The Shasta TCD was at it's lowest gate configuration of the season (side gates only or combination of side gates and PRG's).
3. 1998-2017, excluding years not using side gates.
4. Upper and Lower points represent 90% confidence range

Figure 6

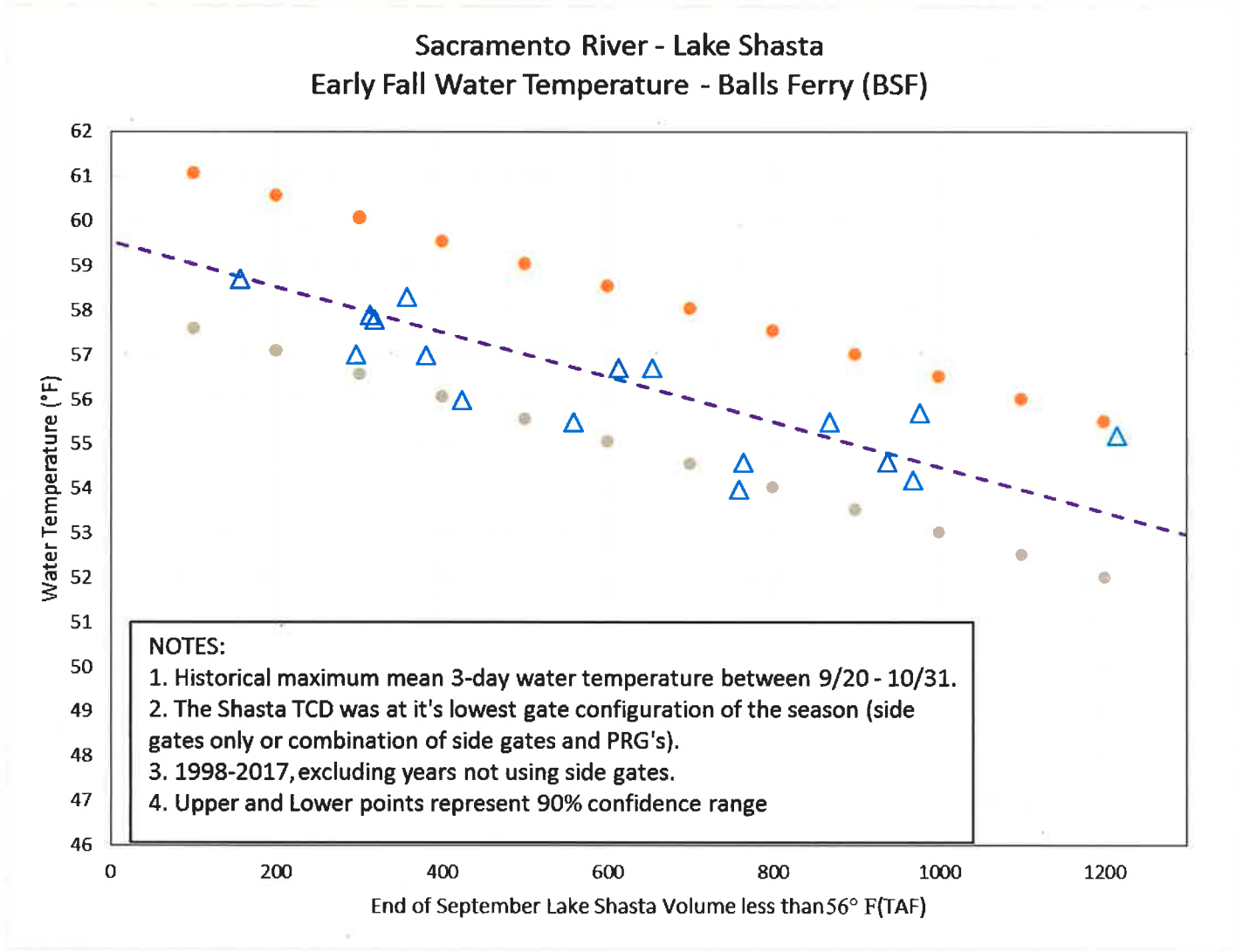

Sacramento River - Lake Shasta
Early Fall Water Temperature - Balls Ferry (BSF)
Water Temperature (°F)
62
61
60
59
58
57
56
55
54
53
52
51
50
49
48
47
46
0
200
400
600
800
1000
1200
End of September Lake Shasta Volume less than 56° F(TAF)
NOTES:
1. Historical maximum mean 3-day water temperature between 9/20 - 10/31.
2. The Shasta TCD was at it's lowest gate configuration of the season (side gates only or combination of side gates and PRG's).
3. 1998-2017, excluding years not using side gates.
4. Upper and Lower points represent 90% confidence range

Figure 7

May 10, 2018

Upper Sacramento River – April 2018 Preliminary Temperature Analysis

Summary of Temperature Results by Month (Monthly Average Temperature °F)

Location	MAY	JUN	JUL	AUG	SEP	OCT	Late Sep-Oct Uncertainty Estimation
April 90%-Exceedance Outlook – 10% Historical Meteorology 53°F CCR (May) 56°F BSF (Jun-Oct)							
Keswick Dam KWK	52.3	52.3	53.5	53.6	53.5	52.4	54 - 57
Sac. R. abv Clear Creek CCR	53.0	53.0	54.0	54.1	53.9	52.5	54 - 58
Balls Ferry BSF	56.8	56.0	56.0	56.0	55.6	53.7	55 - 58
April 90%-Exceedance Outlook – 50% Historical Meteorology 53°F CCR (May) 56°F BSF (Jun-Oct)							
Keswick Dam KWK	52.4	52.7	53.8	53.6	53.2	52.0	53 - 56
Sac. R. abv Clear Creek CCR	53.0	53.2	54.2	54.0	53.6	52.1	54 - 57
Balls Ferry BSF	56.4	56.0	56.0	55.9	55.3	53.2	55 - 58
April 50%-Exceedance Outlook – 10% Historical Meteorology 53°F CCR (May) 56°F BSF (Jun-Oct)							
Keswick Dam KWK	52.3	52.3	53.4	53.6	53.6	52.4	53 - 56
Sac. R. abv Clear Creek CCR	53.0	53.0	53.9	54.1	54.0	52.5	54 - 58
Balls Ferry BSF	57.0	56.0	55.9	56.0	55.8	53.7	55 - 58
April 50%-Exceedance Outlook – 50% Historical Meteorology 53°F CCR (May) 56°F BSF (Jun-Oct)							
Keswick Dam KWK	52.3	52.7	53.8	53.8	53.4	52.0	53 - 56
Sac. R. abv Clear Creek CCR	53.0	53.2	54.2	54.2	53.7	52.1	54 - 57
Balls Ferry BSF	56.5	56.0	56.0	56.0	55.4	53.2	55 - 58

* The HEC5Q model output is displayed above for the months April through October. Based on past analysis, the temperature model does not perform well in late September and October. One factor is that the modeled release temperatures are cooler than has

historically been achieved when all release is through the side gates (lowest gates), especially when there's a large temperature gradient between the pressure relief gates (PRG) and the side gates. For the months of September and October, an uncertainty estimate is provided based on the Fall Temperature Index (graphics below). This is based on a historical relationship between end-of-September Lake Shasta Volume less than 56°F and likely downstream temperature performances for the early fall months. The range represents the 90% confidence interval based on that data. Refinement of the concepts for those estimates is underway.

Temperature Model Inputs, Assumptions, Limitations and Uncertainty:

1. The latest available profiles for Shasta, Trinity, and Whiskeytown were taken on May 1, May 3, and May 2 respectively. Model results are sensitive to initial reservoir temperature conditions and the model performs best under highly stratified conditions. The model performs well after the reservoir stratifies, typically in late spring. The concern this year is assuming over or under estimations with variable hydrologic and meteorological conditions and not capturing the stratification with sufficient detail to project.
2. Guidance on forecasted flows from the creeks (e.g., Cow, Cottonwood, Battle, etc.) between Keswick Dam and Bend Bridge are not available beyond 5 days. Creek flows developed from the historical record that most closely reflects current conditions were used for all model runs. The resulting low creek flows can cause significant additional warming in the upper Sacramento River during spring.
3. Operation is based on the April 2018 Operation Outlooks and DWR Bulletin 120 inflow projections (monthly flows, reservoir release, and end-of-month reservoir storage) for the 90%- and 50%-exceedances. Trinity Lake inflows are updated with the CNRFC 90% runoff exceedance for the 90% runoff exceedance studies. The April 2018 Operation Outlook is modified to adjust for real-time operations in early May suggesting the monthly Keswick release may average closer to 8,500 cfs.
4. Although mean daily flows and releases are temperature model inputs, they are based on the mean monthly values from the operation outlooks. Mean daily flow patterns are user defined and are generalized representations. It is important to note that these outlooks do not suggest a certain actual future outcome, but rather the statistical likelihood of an event occurring, including, but not limited to, projected storage and releases. Thus, the outlooks do not provide exact end of month storages or flow rates but general projections that will likely fall within the range of uncertainty based on the different hydrologic runoff conditions between the 90% and 50% runoff exceedance hydrology.
5. Cottonwood Creek flows, Keswick to Bend Bridge local flows, and ACID diversions are mean daily synthesized flows based on the available historical record for a 1922-2002 study period. Inflows were adjusted to a 95% historical exceedance for both the 90% and 50% runoff exceedance studies.
6. Meteorological inputs represent historical (1985 – 2017) monthly mean equilibrium temperature exceedance at 10% and 50% patterned after like months on a 6-hour time-step, or as noted. Assumed inflow temperature remain static inputs and do not vary with the assumed meteorology.

7. Meteorology, as well as the flow volume and pattern, significantly influences reservoir inflow temperatures and downstream tributary temperatures; and consequently, the development of the cold-water pool during winter and early spring.
8. Modified model coefficients more closely represent actual Keswick Dam temperatures. As a result, temperature predictions downstream of Keswick Dam are likely to be warmer than actual. Model re-calibrations efforts are underway.

Model Run Date May 10, 2018

Temperature Analysis Results:

Modeling runs explore Sacramento River compliance performance above Clear Creek confluence and Balls Ferry locations by varying hydrology and temperature compliance target location and temperature. The temperature results for the Sacramento River between Keswick Dam and Balls Ferry are shown in Figures 1-4. The fall uncertainty estimation relationship between end-of-September lake volume below 56°F and a Balls Ferry compliance through fall is based on the Figures 5-7.

Model Run	End of September Cold Water Pool <56°F (TAF)	First Side Gate	Full Side Gates
(1) 90% Hydro, 10% Historical Met 53 CCR (May) & 56 BSF (Jun-Oct)	618	9/8	10/5
(2) 90% Hydro, 50% Historical Met 53 CCR (May) & 56 BSF (Jun-Oct)	707	9/13	10/14
(3) 50% Hydro, 10% Historical Met 53 CCR (May) & 56 BSF (Jun-Oct)	641	9/8	10/7
(4) 50% Hydro, 50% Historical Met 53 CCR (May) & 56 BSF (Jun-Oct)	707	9/18	10/14

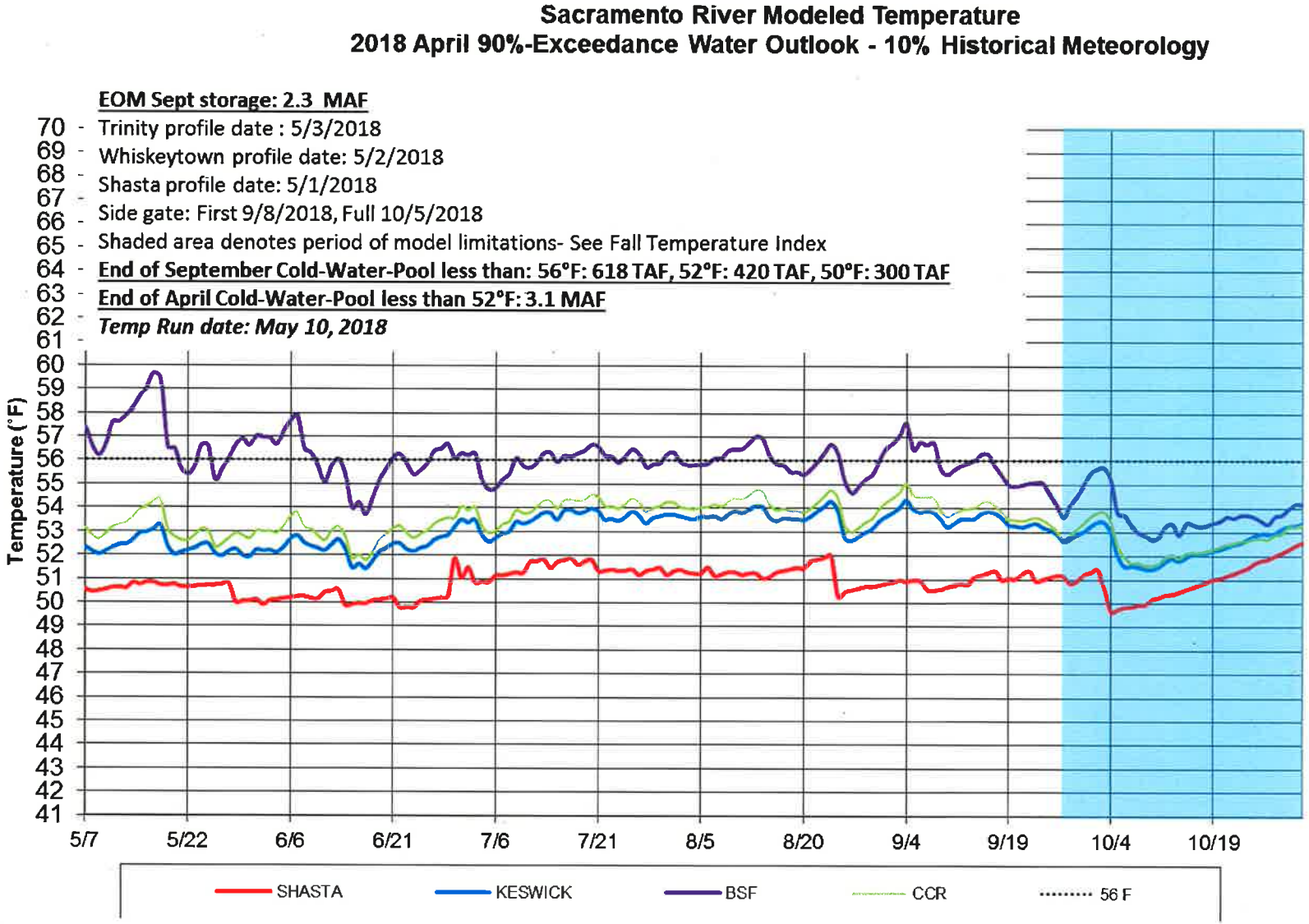

Sacramento River Modeled Temperature
2018 April 90%-Exceedance Water Outlook - 10% Historical Meteorology
EOM Sept storage: 2.3 MAF
Trinity profile date : 5/3/2018
Whiskeytown profile date: 5/2/2018
Shasta profile date: 5/1/2018
Side gate: First 9/8/2018, Full 10/5/2018
Shaded area denotes period of model limitations- See Fall Temperature Index
End of September Cold-Water-Pool less than: 56°F: 618 TAF, 52°F: 420 TAF, 50°F: 300 TAF
End of April Cold-Water-Pool less than 52°F: 3.1 MAF
Temp Run date: May 10, 2018
Temperature (°F)
70
69
68
67
66
65
64
63
62
61
60
59
58
57
56
55
54
53
52
51
50
49
48
47
46
45
44
43
42
41
5/7
5/22
6/6
6/21
7/6
7/21
8/5
8/20
9/4
9/19
10/4
10/19
SHASTA
KESWICK
BSF
CCR
56 F

Figure 1

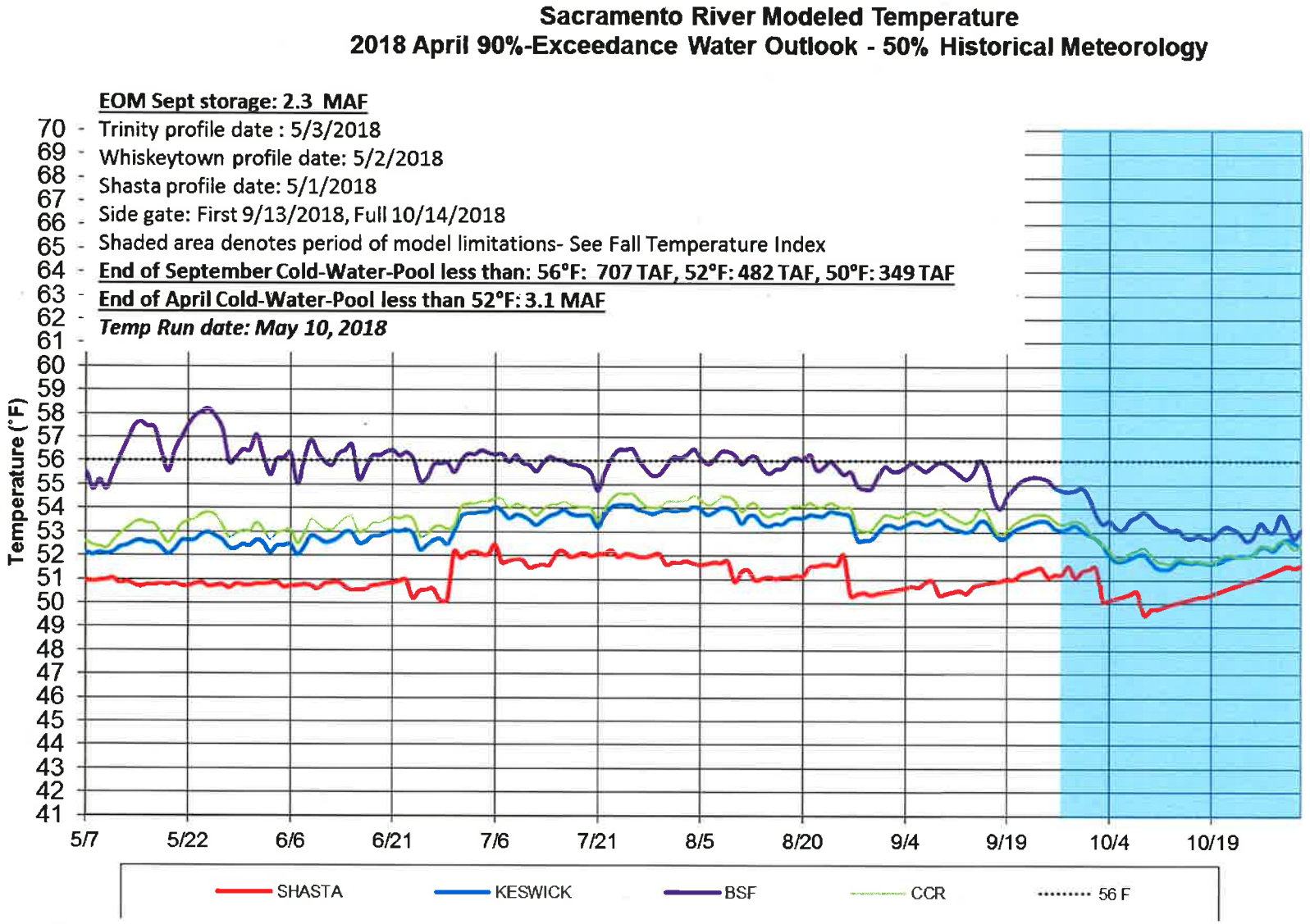

Sacramento River Modeled Temperature
2018 April 90%-Exceedance Water Outlook - 50% Historical Meteorology
EOM Sept storage: 2.3 MAF
Trinity profile date : 5/3/2018
Whiskeytown profile date: 5/2/2018
Shasta profile date: 5/1/2018
Side gate: First 9/13/2018, Full 10/14/2018
Shaded area denotes period of model limitations- See Fall Temperature Index
End of September Cold-Water-Pool less than: 56°F: 707 TAF, 52°F: 482 TAF, 50°F: 349 TAF
End of April Cold-Water-Pool less than 52°F: 3.1 MAF
Temp Run date: May 10, 2018
Temperature (°F)
70
69
68
67
66
65
64
63
62
61
60
59
58
57
56
55
54
53
52
51
50
49
48
47
46
45
44
43
42
41
5/7
5/22
6/6
6/21
7/6
7/21
8/5
8/20
9/4
9/19
10/4
10/19
SHASTA
KESWICK
BSF
CCR
56 F

Figure 2

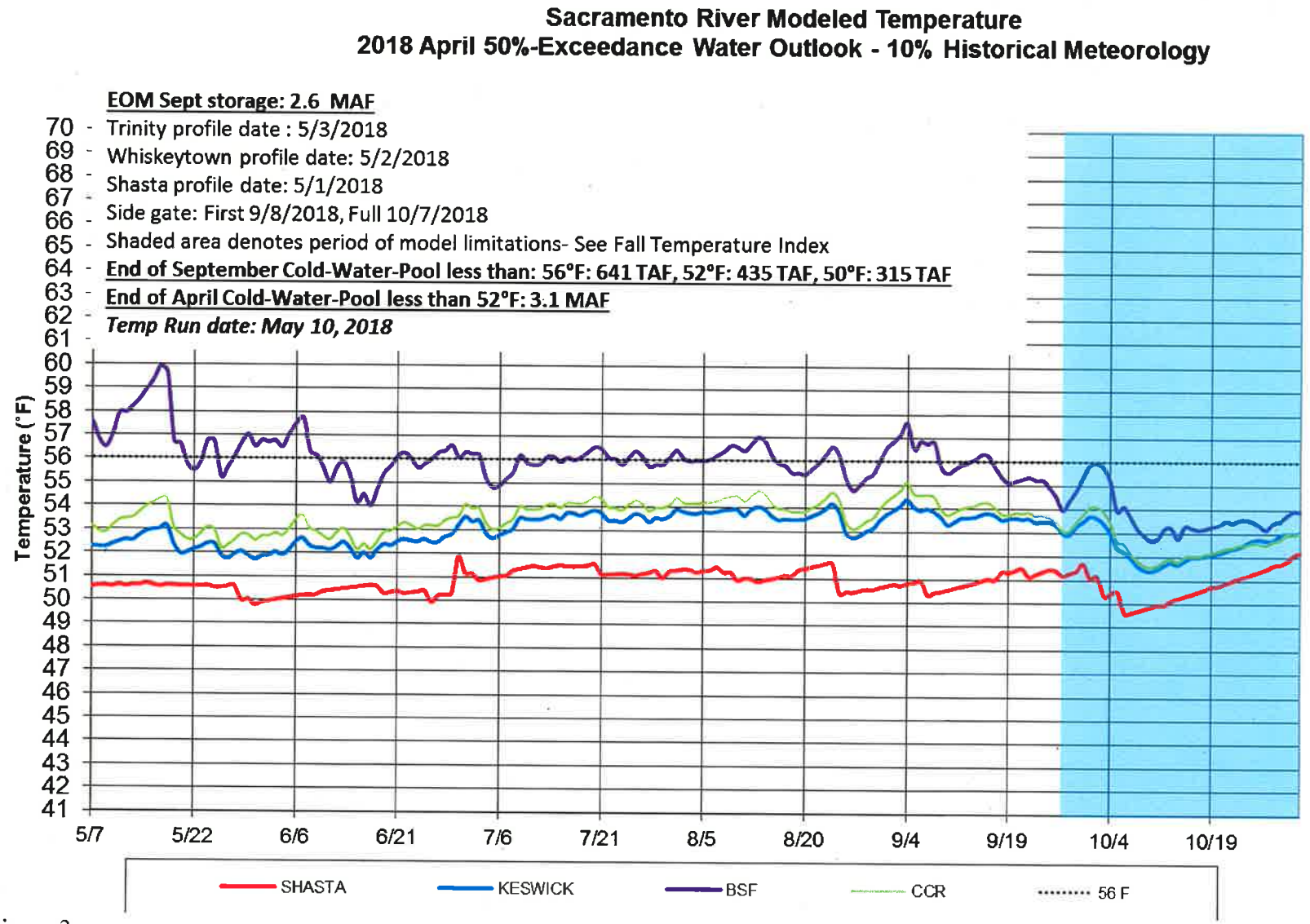

Sacramento River Modeled Temperature
2018 April 50%-Exceedance Water Outlook - 10% Historical Meteorology
EOM Sept storage: 2.6 MAF
Trinity profile date : 5/3/2018
Whiskeytown profile date: 5/2/2018
Shasta profile date: 5/1/2018
Side gate: First 9/8/2018, Full 10/7/2018
Shaded area denotes period of model limitations- See Fall Temperature Index
End of September Cold-Water-Pool less than: 56°F: 641 TAF, 52°F: 435 TAF, 50°F: 315 TAF
End of April Cold-Water-Pool less than 52°F: 3.1 MAF
Temp Run date: May 10, 2018
Temperature (°F)
70 69 68 67 66 65 64 63 62 61 60 59 58 57 56 55 54 53 52 51 50 49 48 47 46 45 44 43 42 41
5/7 5/22 6/6 6/21 7/6 7/21 8/5 8/20 9/4 9/19 10/4 10/19
SHASTA
KESWICK
BSF
CCR
56 F

Figure 3

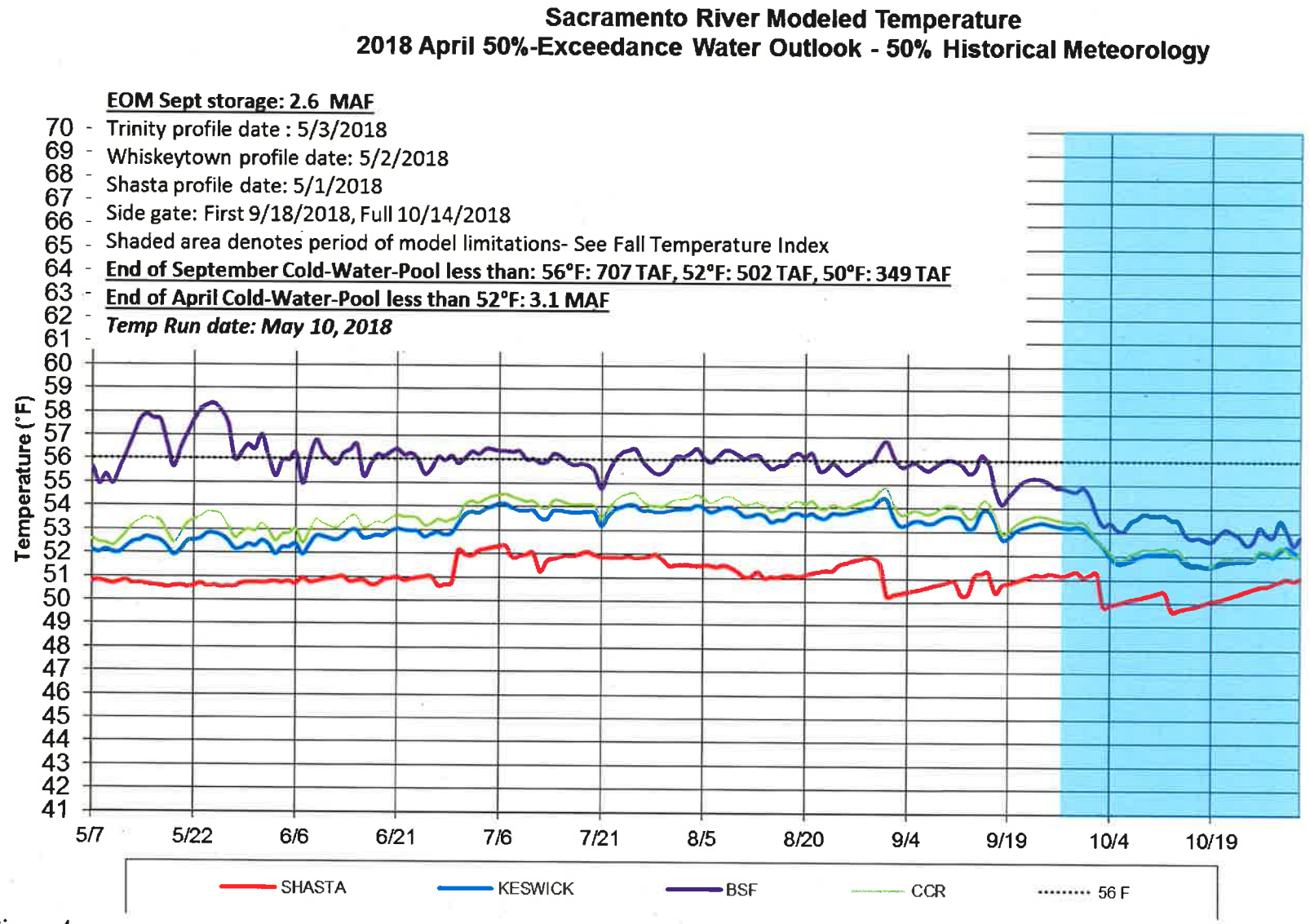

Sacramento River Modeled Temperature
2018 April 50%-Exceedance Water Outlook - 50% Historical Meteorology
EOM Sept storage: 2.6 MAF
Trinity profile date : 5/3/2018
Whiskeytown profile date: 5/2/2018
Shasta profile date: 5/1/2018
Side gate: First 9/18/2018, Full 10/14/2018
Shaded area denotes period of model limitations- See Fall Temperature Index
End of September Cold-Water-Pool less than: 56°F: 707 TAF, 52°F: 502 TAF, 50°F: 349 TAF
End of April Cold-Water-Pool less than 52°F: 3.1 MAF
Temp Run date: May 10, 2018
Temperature (°F)
70 69 68 67 66 65 64 63 62 61 60 59 58 57 56 55 54 53 52 51 50 49 48 47 46 45 44 43 42 41
5/7 5/22 6/6 6/21 7/6 7/21 8/5 8/20 9/4 9/19 10/4 10/19
SHASTA
KESWICK
BSF
CCR
56 F

Figure 4

Figures 5-7 Model Performance and Fall Temperature Index:

1. Based on past analyses, the temperature model does not perform well in late September and October. One factor is that the modeled release temperatures are cooler than has historically been achieved when all release is through the side gates (lowest gates), especially when there's a large temperature gradient between the pressure relief gates (PRG) and the side gates.
2. Based on historical records, the end-of-September Lake Shasta volume below 56˚F can be used as an indicator of fall water temperature in the river reach to Balls Ferry.
3. Based on these records and estimates, the index below illustrates a range of uncertainty in the ability to meet for river temperatures not to exceed 56 ˚F downstream based on the end-of-September lake volume less than 56˚F; see charts below.
4. Refinement of these estimates and concepts is currently underway.

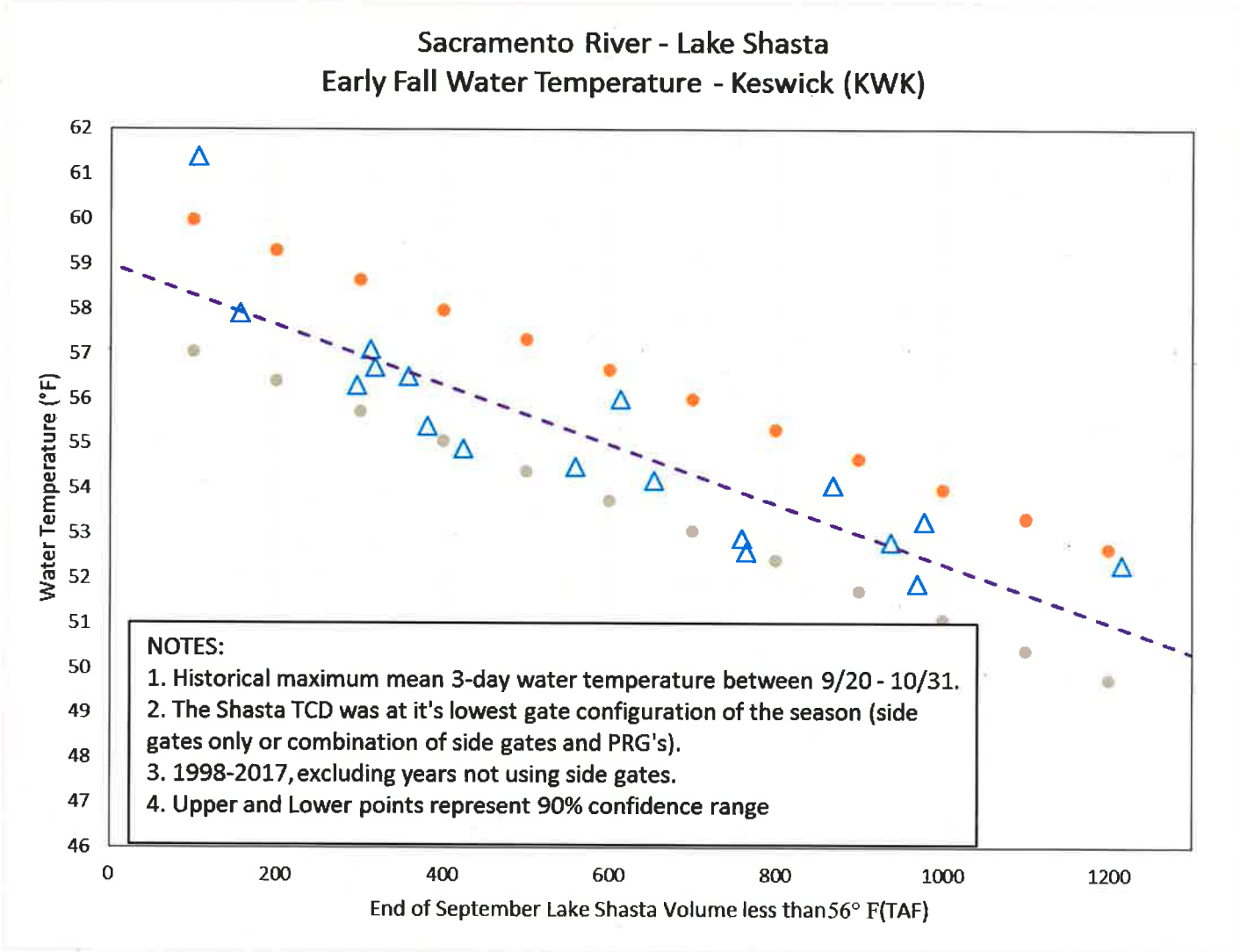
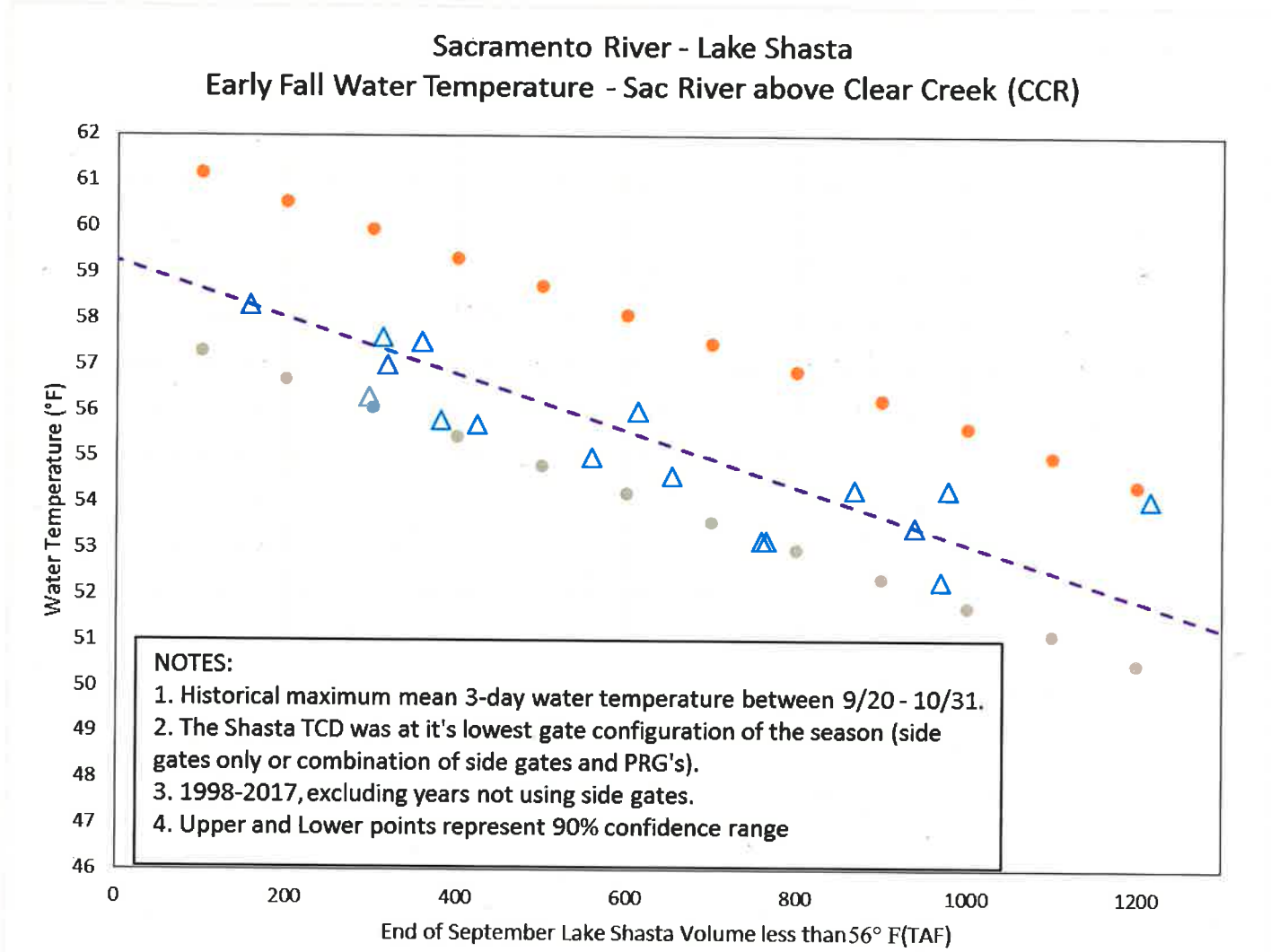

Sacramento River - Lake Shasta
Early Fall Water Temperature - Keswick (KWK)
Water Temperature (°F)
62
61
60
59
58
57
56
55
54
53
52
51
50
49
48
47
46
0
200
400
600
800
1000
1200
End of September Lake Shasta Volume less than 56° F(TAF)
NOTES:
1. Historical maximum mean 3-day water temperature between 9/20 - 10/31.
2. The Shasta TCD was at it's lowest gate configuration of the season (side gates only or combination of side gates and PRG's).
3. 1998-2017, excluding years not using side gates.
4. Upper and Lower points represent 90% confidence range

Figure 5


Sacramento River - Lake Shasta
Early Fall Water Temperature - Sac River above Clear Creek (CCR)
Water Temperature (°F)
62
61
60
59
58
57
56
55
54
53
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51
50
49
48
47
46
0
200
400
600
800
1000
1200
End of September Lake Shasta Volume less than 56° F(TAF)
NOTES:
1. Historical maximum mean 3-day water temperature between 9/20 - 10/31.
2. The Shasta TCD was at it's lowest gate configuration of the season (side gates only or combination of side gates and PRG's).
3. 1998-2017, excluding years not using side gates.
4. Upper and Lower points represent 90% confidence range

Figure 6

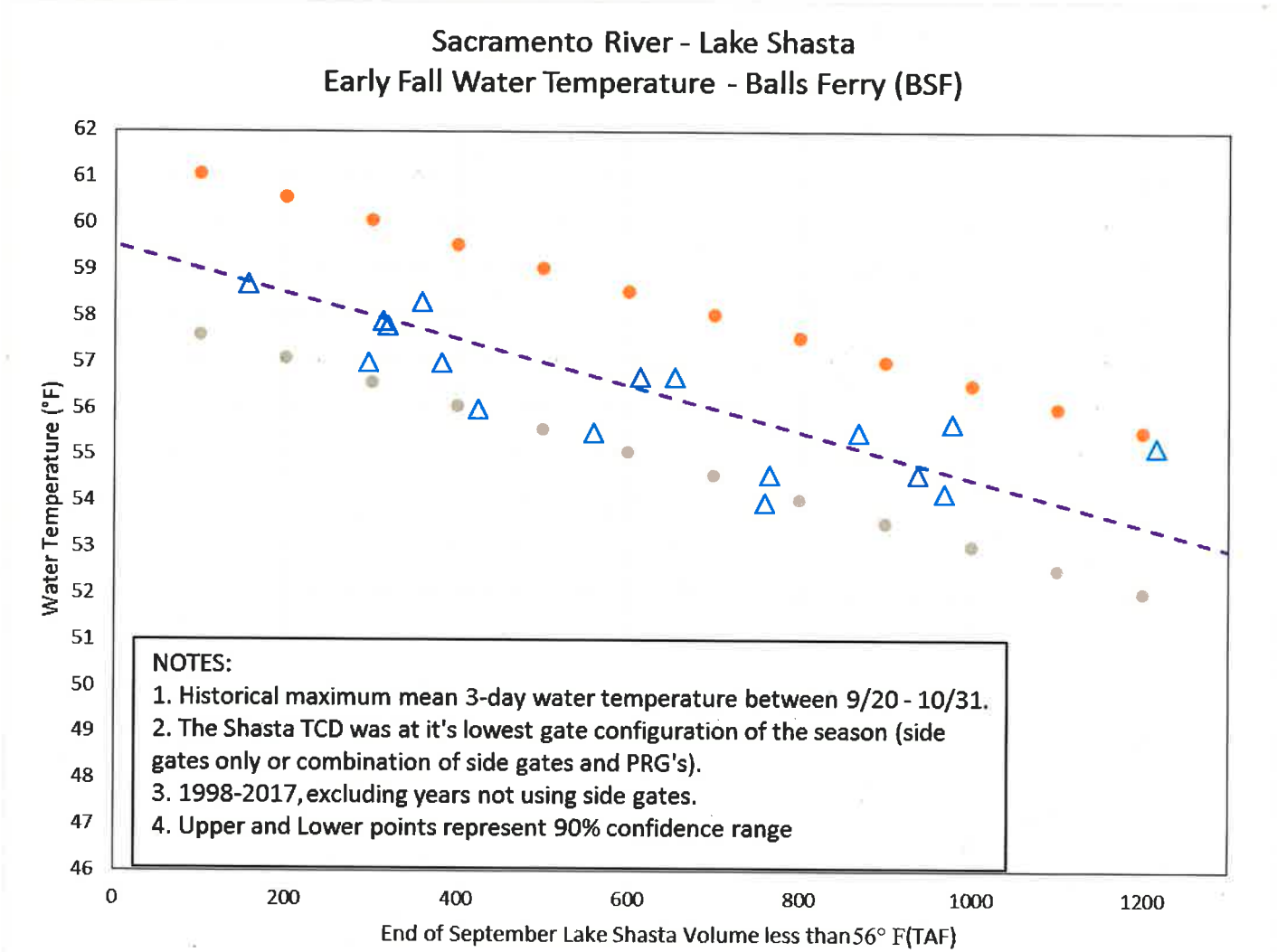
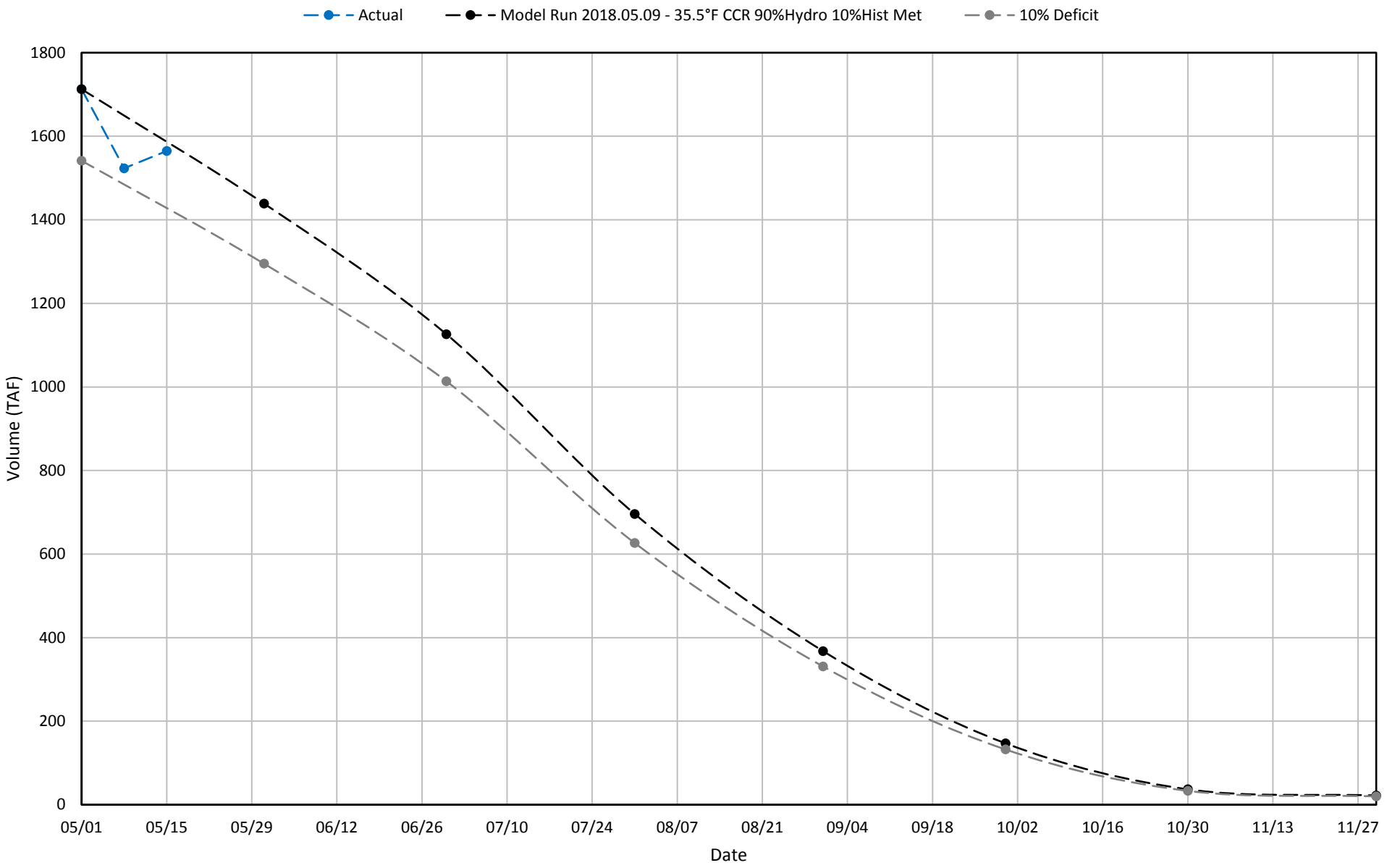

Sacramento River - Lake Shasta
Early Fall Water Temperature - Balls Ferry (BSF)
Water Temperature (°F)
62
61
60
59
58
57
56
55
54
53
52
51
50
49
48
47
46
0
200
400
600
800
1000
1200
End of September Lake Shasta Volume less than 56° F (TAF)
NOTES:
1. Historical maximum mean 3-day water temperature between 9/20 - 10/31.
2. The Shasta TCD was at it's lowest gate configuration of the season (side gates only or combination of side gates and PRG's).
3. 1998-2017, excluding years not using side gates.
4. Upper and Lower points represent 90% confidence range

Figure 7

Printed: 2018.05.15

2018 Shasta Cold Water Pool Volume ≤49°F



Enclosure 2

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
650 Capitol Mall, Suite 5-100
Sacramento, California 95814-4700

MAY 15 2018

Refer to NMFS No. WCR-2018-9762
Refer to NMFS No. WCR-2018-9763

Mr. Jeff Rieker
Operations Manager
U.S. Bureau of Reclamation
Central Valley Operations Office
3310 El Camino Avenue, Suite 300
Sacramento, California 95821

Re: 2018 Final Sacramento River Temperature Management Plan

Dear Mr. Rieker:

Thank you for your April 18, 2018, letter transmitting the April forecast and temperature model runs, and the May 11, 2018, letter transmitting the 2018 Final Sacramento River Temperature Management Plan (SRTMP), pursuant to reasonable and prudent alternative (RPA) Actions I.2.3 and I.2.4, respectively, described in NOAA's National Marine Fisheries Service's (NMFS) biological opinion (issued June 4, 2009) on the long-term operations of the Central Valley Project and State Water Project (CVP/SWP Opinion) [1]. RPA Action I.2.3 requires updates of water delivery commitments based on monthly forecasts at least as conservative as the 90% probability of exceedance. The U.S. Bureau of Reclamation (Reclamation) is required to submit a SRTMP to NMFS for concurrence, and by May 15, Reclamation and NMFS are required to jointly submit a final Temperature Management Plan to meet the State Water Resources Control Board (SWRCB) Order 90-5 requirements using the Sacramento River Temperature Task Group (SRTTG). The SRTMP is required to meet a daily average water temperature (DAT) not in excess of 56°F at a compliance location between Balls Ferry and Bend Bridge from May 15 through September 30 for protection of Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*), and not in excess of 56°F DAT at the same compliance location from October 1 through October 31 for protection of Central Valley spring-run Chinook salmon (*O. tshawytscha*), whenever possible. The objective of RPA Action I.2.4 is to manage the cold water storage within Shasta Reservoir and make cold water releases from Shasta Reservoir to provide suitable habitat temperatures for winter-run Chinook salmon, spring-run Chinook salmon, California Central Valley steelhead (*O. mykiss*), and the Southern distinct population segment of North American green sturgeon (*Acipenser medirostris*) in the Sacramento River between Keswick Dam and Bend Bridge, while retaining sufficient carryover storage to manage for next year's cohorts.

[1] The 2009 RPA was amended on April 7, 2011, and can be found at http://www.westcoast.fisheries.noaa.gov/publications/Central_Valley/Water%20Operations/Operations,%20Criteria%20and%20Plan/040711_ocap_opinion_2011_amendments.pdf.

During and since the 2012-2016 drought, the cohort replacement rate for Sacramento River winter-run Chinook salmon (winter-run, *Oncorhynchus tshawytscha*) indicated an overall population decline. Juvenile winter-run from brood years 2014 and 2015 had very poor survival due to drought conditions and unfavorable temperatures on the spawning grounds. Adults returning in 2017 were the progeny from 2014, when winter-run eggs suffered high mortality, and there were approximately 3 times the production of hatchery winter-run from Livingston Stone National Fish Hatchery (LSNFH). Despite the lower adult returns in 2017 (estimated to be 1,155), juvenile winter-run Chinook salmon survival of the 2017 brood year was relatively high as a result of favorable hydrology, a large cold water pool in Shasta Reservoir, and the implementation of a pilot study to provide additional thermal protections for winter-run. This pilot study included a temperature target closer to actual redd locations and management of flows in the fall to minimize the potential for dewatering of winter-run Chinook salmon redds. Brood year 2018 is expected to be low as well, as they will be the adults of the progeny from 2015, when winter-run eggs suffered high mortality, and there were approximately 2 times the production of hatchery winter-run from LSNFH.

On April 18, 2018, Reclamation provided NMFS with updated CVP operational outlooks at the 50% and 90% exceedance hydrologic forecasts, and associated temperature modeling results using 10% and 50% long-term 3-month temperature outlooks (L3MTO)[2] and a Shasta Reservoir profile from April 3, 2018 (enclosure 1). Based on the 90 percent exceedance hydrologic forecast for April 1 and Keswick Dam monthly average release schedule, Reclamation indicated (through its HEC-5Q temperature modeling software) that a temperature compliance point of 56°F DAT at Balls Ferry could be met through October 31, 2018. The NMFS-Southwest Fisheries Science Center (SWFSC) ran the four scenarios through the temperature-dependent egg mortality model. Results are provided in enclosure 2, and summarized in Table 1.

Reclamation indicated that it had received an updated Shasta Reservoir profile on April 17, 2018, however, it did not have the temperature model runs completed in time to include in its April 18, 2018, letter and package. Therefore, on April 20, 2018, Reclamation provided an additional model run based on the conservative 90% exceedance hydrologic forecast and associated temperature modeling results using the 10% L3MTO (enclosure 3). The April 17, 2018, Shasta Reservoir profile was better than the April 3, 2018, profile, and as such, illustrated greater confidence in the ability to meet a 56°F DAT Balls Ferry compliance point. This was also reflected in the relatively lower temperature-dependent egg mortality (Table 1). NMFS requested the additional model runs (i.e., 90% exceedance hydrologic forecast and 50% L3MTO, and 50% exceedance hydrologic forecast and 10% and 50% L3MTO) using the updated Shasta Reservoir profile. However, following April 19 and 26, 2018, SRTTG meetings, and a Reclamation 2018 Sacramento River Temperature Planning Workshop on April 25, 2018, Reclamation and NMFS agreed that we should focus our efforts on developing the Sacramento River temperature management plan.

[2] L3MTO is the long-term 3-month temperature outlook based on historical 1961-2005 monthly mean equilibrium temperature exceedances patterned after like months on a 6-hour time-step.

The following additional model scenarios were developed:

- to fulfill a request of the SWRCB and also distributed to the SRTTG for its April 26, 2018, SRTTG meeting[3] (enclosure 4):
    - 55.5°F DAT at Balls Ferry
    - 53°F DAT at the CCR California Data Exchange Center gaging station
    - The NMFS-SWFSC's temperature-dependent egg mortality model results are provided in enclosure 5 and summarized in Table 1

- for the May 9, 2018, SRTTG meeting[4] (enclosure 6):
    - 53.5°F DAT at CCR
    - 53°F DAT at CCR through May, then 56°F DAT at Balls Ferry June through October
    - The NMFS-SWFSC's temperature-dependent egg mortality model results are provided in enclosure 7 and summarized in Table 1

On April 26, 2018, Reclamation held a SRTTG meeting to share the new modeling results and discuss formulating the development of the 2018 Sacramento River Temperature Management Plan. An alternative temperature management scenario was discussed to address early spring cold-water-pool use and risk to fall cold-water-pool resources. Historical information shows this year's cold-water-pool volume of water cooler than 49°F is less than average. Additional concerns were discussed as it related to attempting to achieve 56°F DAT at Balls Ferry coincident with warm tributary side-flow contributions in the spring. In this case, early mining of the cold-water-pool may increase the risk to a poor fall period temperature management performance. Reclamation agreed to model the additional scenario of 53°F DAT at CCR through May 31, and 56°F DAT at Balls Ferry from June 1 through October 31.

In addition, following the April 26, 2018, SRTTG meeting, NMFS requested that Reclamation run the scenario of 53.5°F DAT at CCR. On May 9, 2018, at a follow-up SRTTG meeting, Reclamation presented the temperature modeling results from 2 scenarios: (1) 53°F DAT at CCR through May 31, and 56°F DAT at Balls Ferry from June 1 through October 31, and (2) 53.5°F DAT at CCR through October 31 (enclosure 6). As Reclamation, NMFS, and the SRTTG have been discussing various temperature management scenarios, Reclamation was issuing change orders to increase releases from Keswick Dam. Although the monthly average Keswick release was still below 8,000 cfs, Reclamation adjusted the monthly average Keswick release to 8,500 cfs in its 90% and 50% exceedance hydrologic forecasts, partly to incorporate another layer of conservatism in its temperature modeling, and partly because of the possibility of an

[3] See agenda and handout packet at http://www.westcoast.fisheries.noaa.gov/publications/Central_Valley/Water%20Operations/Sacramento%20River%20Temperature%20Task%20Group/SRTTG%202018/sacramento_river_temperature_task_group_april_26__2018__meeting_agenda_and_handouts.pdf

[4] See agenda and handout packet at http://www.westcoast.fisheries.noaa.gov/publications/Central_Valley/Water%20Operations/Sacramento%20River%20Temperature%20Task%20Group/SRTTG%202018/sacramento_river_temperature_task_group_may_9__2018__meeting_agenda_and_handouts.pdf

increased monthly average Keswick release in May. Therefore, the above scenarios presented at the SRTTG's May 9, 2018, meeting reflected a monthly average Keswick release of 8,500 cfs in May.

On May 11, 2018, Reclamation submitted its SRTMP to NMFS (supported with updated CVP operational outlooks and associated temperature modeling results in enclosure 8), and requested concurrence that it was consistent with RPA Action I.2.4 in NMFS' CVP/SWP Opinion. In summary, Reclamation's plan consists of:

- A 56°F DAT temperature compliance point at Balls Ferry from May 15 through October 31.

- An evaluation study that will target 53.5°F DAT at CCR during the same time frame. This acts as a surrogate location for the most downstream winter-run redd.

- Reclamation will monitor the cold-water-pool projections and compare to actual performance. The primary "off-ramp" criterion is defined as a deficient cold-water-pool volume less than 49°F which deviates more 10% than projected. If the "off-ramp" conditions are met and/or other indicators warrant, as discussed by the SRTTG, then the evaluation study will conclude and operations will revert to the compliance location at Balls Ferry using 56°F DAT metric for the remainder of the season to protect fall temperatures.

- Ongoing modeling results will be completed for each monthly SRTTG meeting, and more often as necessary (potentially as frequently as every 2 weeks).

- As in past years, Reclamation will work with NMFS and the other members of the SRTTG during fall operations to address the potential for redd dewatering.

Summary and Expectations

The following are NMFS' summary conclusions and expectations based on Reclamation's proposed SRTMP:

- NMFS has reviewed Reclamation's proposed SRTMP. Within the range of hydrologic and meteorological scenarios modeled, the SRTMP is expected to provide generally suitable water temperatures for incubating winter-run Chinook salmon eggs and fry in brood year 2018. The NMFS-SWFSC's temperature-dependent egg mortality model results are provided in enclosure 9 and summarized in Table 1.

- NMFS expects temperature modeling to be conducted approximately every 2 weeks (for each monthly SRTTG meeting, and also approximately halfway in between the SRTTG meetings). If Reclamation has difficulty meeting the modeling frequency, NMFS and Reclamation will discuss a reasonable schedule in order to accommodate the need to track the volume of the cold water pool at 49°F.

- If the "off-ramp" conditions are met, or other indicators warrant, then the evaluation study will conclude and operations will revert to the temperature compliance location at Balls Ferry using 56.0°F DAT metric for the remainder of the season.

- Reclamation will operate in a manner to avoid any exceedance of 56.0°F DAT at Balls Ferry, and Reclamation will promptly implement steps to reduce the temperature to the compliance criterion to deal with any unforeseen transitions to periods of high air temperatures.

- NMFS expects timing for reductions in flows in September and October will be scheduled in coordination with the fish agencies to reduce the risk of dewatering existing winter-run or spring-run Chinook redds, and to discourage, to the extent possible, the spawning of fall-run Chinook redds in areas that could be dewatered when Keswick releases are reduced further later in the year.

- NMFS expects Reclamation to implement the following monthly average Keswick release schedule (in cubic feet per second). Should Reclamation need to change the monthly average Keswick release schedule, NMFS expects close coordination between our agencies to ensure that the habitat needs (i.e., cold water, stable flows) of winter-run Chinook salmon continue to be met. In addition, NMFS will work with Reclamation on real-time management during the temperature management season.

Exceedance	May	June	July	Aug	Sept	Oct	Nov	Dec	Jan	Feb
90%	8500	10500	13000	10500	8000	6000	4500	3250	3250	3250
50%	8500	10500	13000	10500	8000	6000	4500	3250	3250	5000

In conclusion, NMFS concurs that Reclamation's proposed SRTMP is consistent with RPA Action I.2.4. We are making this finding based on Reclamation's May 11, 2018, letter, our understanding of the water temperature needs of winter-run Chinook salmon, and our conclusion that the potential effects of implementing the Sacramento River temperature management plan in water year 2018 were considered in the underlying analysis of the CVP/SWP Opinion. Furthermore, the best available scientific and commercial data indicate that implementation of the Sacramento River temperature management plan will not exceed levels of take anticipated for implementation of the RPA specified in the CVP/SWP Opinion.

We look forward to continued close coordination with you and your staff throughout this water year.

If you have any questions regarding this letter, please contact me at barry.thom@noaa.gov or (503) 230-5400, or Maria Rea at maria.rea@noaa.gov or (916) 930-3600.

Sincerely,

Maria Rea for

Barry A. Thom
Regional Administrator

Enclosures:

1: Reclamation's April 18, 2018, operations outlook and temperature model results using a Shasta profile from April 3, 2018
2: NMFS-SWFSC's temperature-dependent egg mortality model results from the April 18, 2018, scenarios
3: Reclamation's April 19, 2018, operations outlook and temperature model results using a Shasta profile from April 17, 2018
4: Reclamation's April 24, 2018, temperature model results provided to the SRTTG for its April 26, 2018, meeting
5: NMFS-SWFSC's temperature-dependent egg mortality model results from the April 24, 2018, scenarios
6: Reclamation's May 8, 2018, temperature model results provided to the SRTTG for its May 9, 2018, meeting
7: NMFS-SWFSC's temperature-dependent egg mortality model results from the May 8, 2018, scenario
8: Reclamation's updated CVP operational outlooks and associated temperature modeling results in support of its Sacramento River Temperature Management Plan
9: NMFS-SWFSC's temperature-dependent egg mortality model results from the scenarios provided in Reclamation's Sacramento River Temperature Management Plan

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