BUREAU OF RECLAMATION

Sacramento River Temperature Task Group

Thursday, June 25, 2020 1:00 pm – 3:00 pm

Conference Call:

+1(623)4049000

Meeting ID: 1497574502# (US West)

Join from PC, Mac, Linux, iOS or Android: https://meetings.ringcentral.com/j/1497574502

Agenda

1. Introductions
2. Purpose and Objective
3. Prior Action Items
4. Communications
5. Long Term Operations Implementation - Update
6. Hydrology Update
7. Operations Update and Forecasts
    a. Storage/Release Management Conditions
    b. Temperature Management
    c. Temperature Dependent Mortality
8. Temperature Dependent Mortality Sensitivity: Stage independent and stage dependent
9. River Fish Monitoring: carcass surveys, redd counts, stranding and dewatering surveys and sampling at rotary screw traps
10. Fish Distribution/Forecasts: Estimated percentage of the population upstream of Red Bluff Diversion Dam for steelhead, winter-run and spring-run Chinook salmon, steelhead update and Livingston Stone Hatchery.
11. Seasonal Topics
12. Discussion
13. Review Action Items
14. Next Meeting Scheduling

UNITED STATES DEPARTMENT OF THE INTERIOR
U.S. BUREAU OF RECLAMATION-CENTRAL VALLEY PROJECT-CALIFORNIA

DAILY CVP WATER SUPPLY REPORT

JUNE 23, 2020

RUN DATE: June 24, 2020

RESERVOIR RELEASES IN CUBIC FEET/SECOND

RESERVOIR	DAM	WY 2019	WY 2020	15 YR MEDIAN
TRINITY	LEWISTON	2,427	644	1,980
SACRAMENTO	KESWICK	9,992	11,992	11,154
FEATHER	OROVILLE (SWP)	2,000	3,300	3,300
AMERICAN	NIMBUS	5,461	3,000	3,946
STANISLAUS	GOODWIN	804	1,407	476
SAN JOAQUIN	FRIANT	1,629	0	380

STORAGE IN MAJOR RESERVOIRS IN THOUSANDS OF ACRE-FEET

RESERVOIR	CAPACITY	15 YR AVG	WY 2019	WY 2020	% OF 15 YR AVG
TRINITY	2,448	1,783	2,346	1,782	100
SHASTA	4,552	3,511	4,409	3,254	93
FOLSOM	977	775	936	749	97
NEW MELONES	2,420	1,547	2,230	1,742	113
FED. SAN LUIS	966	449	732	313	70
TOTAL NORTH CVP	11,363	8,065	10,653	7,840	97
MILLERTON	520	386	488	0	0
OROVILLE (SWP)	3,538	2,579	3,474	2,245	87

ACCUMULATED INFLOW FOR WATER YEAR TO DATE IN THOUSANDS OF ACRE-FEET

RESERVOIR	CURRENT WY 2020	WY 1977	WY 1983	15 YR AVG	% OF 15 YR AVG
TRINITY	444	188	2,456	1,094	41
SHASTA	2,731	1,972	9,723	4,538	60
FOLSOM	1,236	295	5,620	2,367	52
NEW MELONES	519	----	2,224	887	59
MILLERTON	710	178	3,347	1,210	59

ACCUMULATED PRECIPITATION FOR WATER YEAR TO DATE IN INCHES

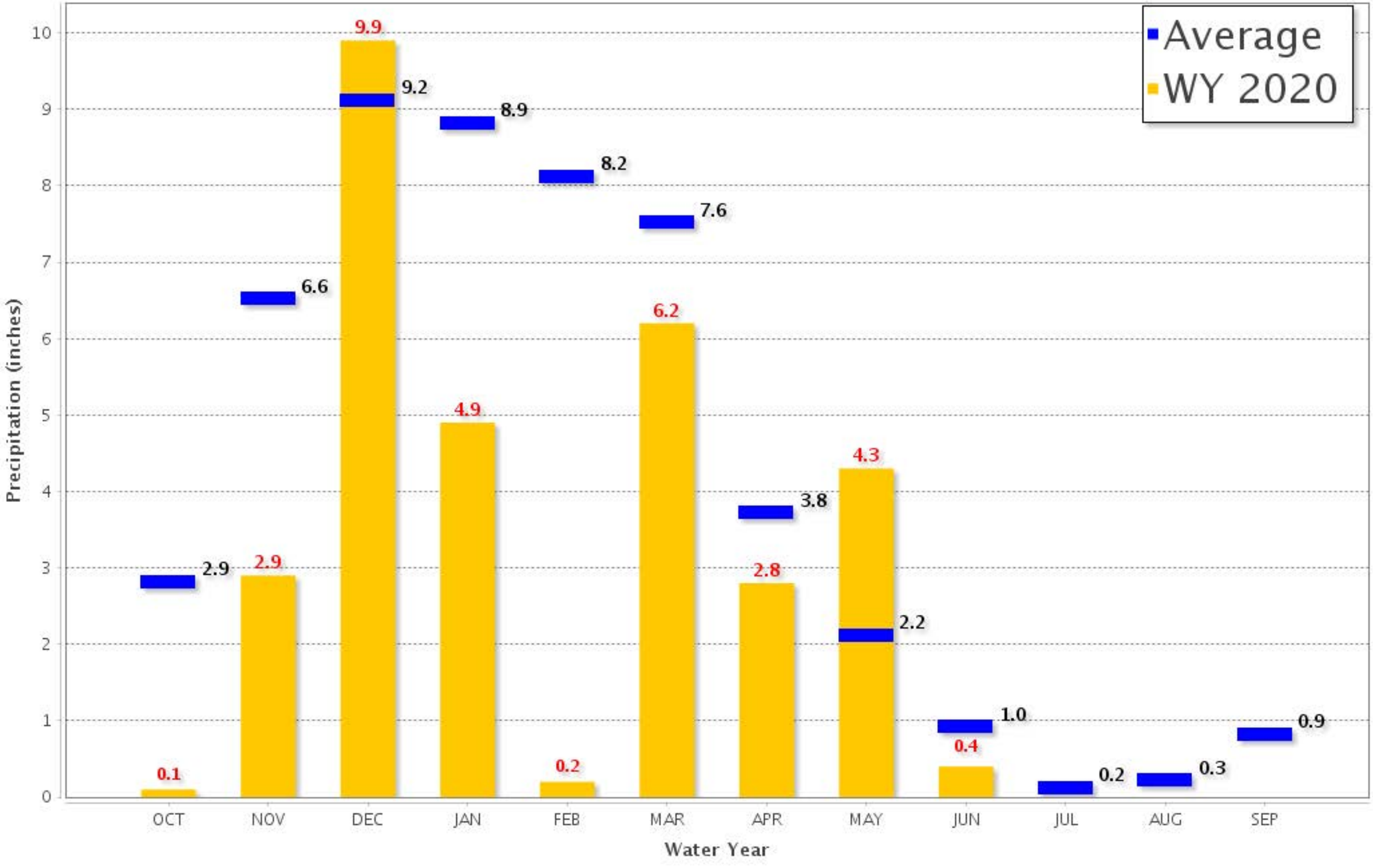
RESERVOIR	CURRENT WY 2020	WY 1977	WY 1983	AVG (N YRS)	% OF AVG	LAST 24 HRS
TRINITY AT FISH HATCHERY	19.31	13.69	54.65	31.01 (58)	62	0.00
SACRAMENTO AT SHASTA DAM	34.55	17.27	112.33	60.51 (63)	57	0.00
AMERICAN AT BLUE CANYON	39.50	15.64	103.88	65.49 (45)	60	0.00
STANISLAUS AT NEW MELONES	22.35	----	45.33	27.15 (42)	82	0.00
SAN JOAQUIN AT HUNTINGTON LK	28.25	17.20	81.40	40.87 (45)	69	0.00

Northern Sierra 8-Station

Precipitation Index for Water Year 2020 - Updated on June 24, 2020 01:48 PM

Note: Monthly totals may not add up to seasonal total because of rounding

Water Year Monthly totals are calculated based on Daily precipitation data from 12am to 12am PST



Upper Sacramento River Summary Conditions – June (On-going):

Storage/Release Management Conditions:

- Reservoir Inflow Uncertainty: Shorter term forecasts (8-14 day) suggest a slightly above normal chance of precipitation
- Longer term forecasts (one-month outlook) suggest equal chance of precipitation
- Observed Shasta inflows for June are tracking between the 90% and 50% inflow exceedance probability estimates for the month
- Releases from Keswick Dam: Wednesday June 24 are 12,000 cfs and increasing to 12,500 cfs, Friday, June 26 for Delta requirements and demands
- Long-term conservative (inflow hydrology) projections suggest improved end of September Shasta storage volumes due to increased hydrology estimates in June

Temperature Management:

- Temperature management: Active draw on cold water pool for temperature management
- Selective withdrawal: Using cold-water-pool reserves. All Upper TCD gates are closed and all five Middle TCD gates are open
- Reclamation is looking for opportunities to conserve cold water pool by modifying the TCD gate configuration as the weather transitions again from warm to cool
- Meteorological Uncertainty: Shorter term forecasts (8-14 day) suggest below normal temperatures
- Longer term forecasts (one month outlook) suggest above normal temperatures

Resources:

- Reclamation Bay Delta website: https://www.usbr.gov/mp/bdo/lto/index.html
- Reclamation SRTTG website: https://www.usbr.gov/mp/bdo/sacramento-river-temperature-task-group.html
- LTO Proposed Action: https://www.usbr.gov/mp/bdo/docs/ba-chapter-4-proposed-action.pdf
- 2019 Biological Opinions: https://www.usbr.gov/mp/bdo/lto/biop.html
- California Nevada River Forecast Center: short term precipitation forecasts, overlay with burn areas, debris flow potential, etc: https://www.cnrfc.noaa.gov/
- CDFW Upper Sacramento fishery information: https://www.calfish.org/ProgramsData/ConservationandManagement/CentralValleyMonitoring/CDFWUpperSacRiverBasinSalmonidMonitoring.aspx
- SacPAS: Central Valley Prediction & Assessment of Salmon: http://www.cbr.washington.edu/sacramento/
- DWR Bulletin 120 Forecast Updates: http://cdec.water.ca.gov/b120up.html

CVP Northern System Operation Outlooks: Draft June 2020

90% Runoff Exceedance Outlook

End of Month Storage/Elevation	Jun	Jul	Aug	Sep	Oct	Nov
Shasta Volume (TAF)	3102	2587	2216	2056	1958	1945
Shasta Elevation (Feet)	1012	989	969	961	955	954

Monthly Average River Release	Jun	Jul	Aug	Sep	Oct	Nov
Sacramento (CFS)	11400	12200	9750	6500	5500	4373
Clear Creek (CFS)	190	150	150	150	200	200

Trinity Diversions	Jun	Jul	Aug	Sep	Oct	Nov
Carr Power Plant (TAF)	98	100	101	100	24	30
Spring Creek PP (TAF)	90	90	90	90	45	20

50% Runoff Exceedance Outlook

End of Month Storage/Elevation	Jun	Jul	Aug	Sep	Oct	Nov
Shasta Volume (TAF)	3157	2709	2381	2237	2179	2253
Shasta Elevation (Feet)	1015	994	978	971	967	971

Monthly Average River Release	Jun	Jul	Aug	Sep	Oct	Nov
Sacramento (CFS)	11400	11500	9350	6500	5500	4000
Clear Creek (CFS)	190	150	150	150	200	200

Trinity Diversions	Jun	Jul	Aug	Sep	Oct	Nov
Carr Power Plant (TAF)	94	99	100	99	23	20
Spring Creek PP (TAF)	90	90	90	90	45	15

Notes: Inflow is based on the DWR B120 90% or 50% inflow exceedance Outlook; Historical inflows are used in the month of October and future months.

CVP actual operations do not follow any forecasted operation or outlook; actual operations are based on real-time conditions.

CVP operational forecasts or outlooks consider general system-wide dynamics and do not necessarily address specific watershed/tributary details.

CVP releases represent monthly averages.

CVP operations are updated monthly as new hydrology information is made available December through May.

Estimated CVP Operations 90% Exceedance

Storages

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

		Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Trinity	**1867**	**1735**	**1606**	**1450**	**1295**	**1254**	**1218**	**1200**	**1198**	**1226**	**1286**	**1342**	**1370**
	Elev.	2322	2312	2299	2285	2281	2278	2276	2276	2279	2284	2290	2292
Whiskeytown	**239**	**238**	**238**	**238**	**238**	**206**	**206**	**206**	**206**	**206**	**206**	**238**	**238**
	Elev.	1209	1209	1209	1209	1199	1199	1199	1199	1199	1199	1209	1209
Shasta	**3530**	**3102**	**2587**	**2216**	**2056**	**1958**	**1945**	**1997**	**2124**	**2317**	**2628**	**2669**	**2454**
	Elev.	1012	989	969	961	955	954	957	964	975	991	993	982
Folsom	**790**	**724**	**546**	**395**	**329**	**303**	**300**	**308**	**322**	**348**	**432**	**532**	**614**
	Elev.	442	422	402	392	388	387	389	391	395	408	421	430
New Melones	**1835**	**1689**	**1604**	**1533**	**1489**	**1448**	**1450**	**1454**	**1457**	**1456**	**1455**	**1418**	**1329**
	Elev.	1023	1014	1007	1002	997	998	998	998	998	998	994	984
San Luis	**217**	**118**	**76**	**87**	**161**	**161**	**195**	**232**	**424**	**399**	**353**	**274**	**143**
	Elev.	441	417	402	402	398	412	431	460	446	435	422	398
Total		7605	6656	5917	5568	5330	5314	5397	5731	5952	6360	6474	6148

Monthly River Releases (TAF/cfs)

Trinity	TAF	47	28	53	52	23	18	18	18	17	18	36	92
	cfs	**783**	**450**	**857**	**870**	**373**	**300**	**300**	**300**	**300**	**300**	**600**	**1,498**
Clear Creek	TAF	11	9	9	9	12	12	12	12	11	17	12	16
	cfs	**190**	**150**	**150**	**150**	**200**	**200**	**200**	**200**	**200**	**275**	**200**	**265**
Sacramento	TAF	678	750	599	387	338	260	219	200	194	215	416	559
	cfs	**11400**	**12200**	**9750**	**6500**	**5500**	**4373**	**3557**	**3250**	**3500**	**3500**	**7000**	**9100**
American	TAF	137	226	208	111	66	45	45	49	77	88	106	92
	cfs	**2311**	**3669**	**3383**	**1865**	**1067**	**759**	**733**	**800**	**1394**	**1433**	**1776**	**1500**
Stanislaus	TAF	80	12	12	12	39	12	12	13	12	12	27	55
	cfs	**1350**	**200**	**200**	**200**	**635**	**200**	**200**	**219**	**221**	**200**	**460**	**887**
Feather	TAF	184	191	154	95	82	58	59	58	53	58	90	117
	cfs	**3100**	**3100**	**2500**	**1600**	**1334**	**975**	**960**	**950**	**950**	**950**	**1513**	**1900**

Trinity Diversions (TAF)

	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Carr PP	98	100	101	100	24	30	21	15	10	7	44	25
Spring Crk. PP	**90**	**90**	**90**	**90**	**45**	**20**	**12**	**10**	**10**	**10**	**15**	**15**

Delta Summary (TAF)

		Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Tracy		170	260	260	249	130	90	74	230	45	50	48	57
USBR Banks		0	9	9	9	0	0	0	0	0	0	0	0
Contra Costa		14.0	15.0	12.1	9.5	7.9	6.3	5.5	6.8	8.0	8.1	8.0	12.0
Total USBR		184	284	281	268	138	96	79	237	53	58	56	69
COA Balance		26	14	12	19	11	0	0	0	-24	-78	-58	-58
Vernalis	TAF	111	45	40	46	108	83	83	92	82	82	105	135
Vernalis	cfs	1871	737	655	772	1758	1393	1355	1504	1482	1339	1767	2194
Old/Middle River Std.													
Old/Middle R. calc.		-2,841	-4,192	-4,205	-4,094	-2,291	-2,931	-2,905	-5,008	-1,019	-1,341	-1,054	-933
Computed DOI		7800	4994	4636	4118	4994	5009	6003	6165	11400	11403	9497	7922
Excess Outflow		0	0	0	0	0	0	0	1659	0	0	0	1057
% Export/Inflow		26%	34%	36%	42%	32%	40%	38%	55%	11%	13%	12%	14%
% Export/Inflow std.		35%	65%	65%	65%	65%	65%	65%	65%	45%	35%	35%	35%

Hydrology

	Trinity		Shasta		Folsom		New Melones	
Water Year Inflow (TAF)	455		3,205		1,447		647	
Year to Date + Forecasted % of mean	38%		58%		53%		61%	

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6/16/2020

Estimated CVP Operations 50% Exceedance

Storages

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

		Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Trinity	**1867**	**1738**	**1611**	**1457**	**1304**	**1268**	**1261**	**1291**	**1356**	**1466**	**1594**	**1709**	**1573**
	Elev.	2322	2312	2300	2286	2283	2282	2285	2291	2300	2311	2320	2309
Whiskeytown	**239**	**238**	**238**	**238**	**238**	**206**	**206**	**206**	**206**	**206**	**206**	**238**	**238**
	Elev.	1209	1209	1209	1209	1199	1199	1199	1199	1199	1199	1209	1209
Shasta	**3530**	**3157**	**2709**	**2381**	**2237**	**2179**	**2253**	**2444**	**2841**	**3422**	**3977**	**4282**	**4278**
	Elev.	1015	994	978	971	967	971	981	1001	1026	1047	1058	1058
Folsom	**790**	**720**	**594**	**491**	**441**	**421**	**421**	**441**	**515**	**621**	**809**	**903**	**963**
	Elev.	441	428	415	409	406	406	409	418	431	450	459	465
New Melones	**1835**	**1739**	**1665**	**1597**	**1557**	**1526**	**1542**	**1566**	**1599**	**1653**	**1711**	**1695**	**1776**
	Elev.	1028	1020	1013	1009	1006	1008	1010	1014	1019	1025	1023	1031
San Luis	**217**	**169**	**118**	**112**	**183**	**296**	**352**	**563**	**771**	**925**	**965**	**886**	**734**
	Elev.	459	445	437	440	459	486	510	527	540	543	532	514
Total		7761	6935	6275	5959	5895	6035	6510	7286	8293	9262	9712	9562

Monthly River Releases (TAF/cfs)

Trinity	TAF	47	28	53	52	23	18	18	18	17	18	36	258
	cfs	**788**	**450**	**857**	**870**	**373**	**300**	**300**	**300**	**300**	**300**	**600**	**4,189**
Clear Creek	TAF	11	9	9	9	12	12	12	25	11	12	12	16
	cfs	**190**	**150**	**150**	**150**	**200**	**200**	**200**	**400**	**200**	**200**	**200**	**265**
Sacramento	TAF	678	707	575	387	338	238	200	200	180	277	339	559
	cfs	**11400**	**11500**	**9350**	**6500**	**5500**	**4000**	**3250**	**3250**	**3250**	**4500**	**5700**	**9100**
American	TAF	137	184	164	109	96	89	92	77	155	123	327	400
	cfs	**2301**	**3000**	**2670**	**1826**	**1555**	**1502**	**1500**	**1250**	**2800**	**2000**	**5500**	**6500**
Stanislaus	TAF	80	12	12	12	39	12	12	14	13	12	91	55
	cfs	**1350**	**200**	**200**	**200**	**635**	**200**	**200**	**226**	**229**	**200**	**1536**	**887**

Trinity Diversions (TAF)

	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Carr PP	94	99	100	99	23	20	9	0	2	1	55	92
Spring Crk. PP	**90**	**90**	**90**	**90**	**45**	**15**	**12**	**10**	**35**	**26**	**35**	**90**

Delta Summary (TAF)

		Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Tracy		235	267	265	260	246	115	250	250	230	140	54	57
USBR Banks		0	11	11	11	0	0	0	0	0	0	0	0
Contra Costa		9.8	11.1	12.7	14.0	16.8	18.4	18.3	14.0	14.0	12.7	12.7	12.7
Total USBR		245	289	289	285	263	133	268	264	244	153	66	70
COA Balance		37	26	19	15	-16	-16	-16	-16	-16	-16	-16	-16
Vernalis	TAF	127	51	49	54	108	83	83	93	112	57	169	113
Vernalis	cfs	2140	834	802	906	1758	1393	1355	1511	2012	932	2843	1833
Old/Middle River Std.													
Old/Middle R. calc.	cfs	-4,595	-4,462	-4,634	-4,635	-5,220	-5,301	-4,656	-4,219	-5,024	-3,449	-630	-1,104
Computed DOI		7447	4994	4652	4186	4994	5009	9695	14836	19559	20985	18289	12640
Excess Outflow		0	0	0	0	0	0	3693	8833	8159	9581	8791	4831
% Export/Inflow		37%	36%	39%	45%	50%	53%	37%	28%	26%	16%	7%	10%
% Export/Inflow std.		35%	65%	65%	65%	65%	65%	65%	65%	45%	35%	35%	35%

Hydrology

	Trinity		Shasta		Folsom		New Melones	
Water Year Inflow (TAF)	457		3,320		1,494		715	
Year to Date + Forecasted % of mean	38%		60%		55%		68%	

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6/16/2020

BUREAU OF RECLAMATION

CVP June 2020 90% Exceedance Operations Outlook Information

General Information:

Central Valley Project (CVP) reservoir operations are re-assessed monthly for a one-year period into the future at varied hydrologic conditions on a monthly time-step. Because future watershed hydrology is not known with certainty, estimates for inflow are typically updated using a spread of likely outcomes. These values can range anywhere from 1 percent to 99 percent runoff exceedance probabilities by using meteorological or historical precipitation and snow trends. The CVP commonly uses a 90 percent and 50 percent runoff exceedance probability hydrology. The 90 percent runoff exceedance probability hydrology suggests a conservative, or relatively "dry" condition in which it's expected that in any particular year, nine out of ten years the conditions for the year will be "wetter" than presented. Similarly, the 50 percent hydrology suggest a less conservative, or relatively "wet" condition in which it's expected that in any particular year, equal chances or five out of ten years will be "wetter" or "drier" than presented. The designation to view the former a "dry" outlook and the latter a "wet" one can be somewhat misleading. For the months of October and November, there is typically little to no data (snowpack), and the inflow hydrology set which is used is derived from a long term average of historic data. In that case, the 90% is dry and 50% is the median of historic data, which is slightly drier than the long term average due to the skew produced by a few very large events. Once National Weather Service (NWS) and California Department of Water Resources (DWR) forecasts become available (usually December through May), the hydrology switches from long term averages to more specific projections pertaining to the current water year. It is derived from monthly snowpack measurements and statistical runoff curves and is published at several probability levels for the current year. It is important to note that for these hydrology sets, a 90% is not necessarily dry, nor is the 50% (median) necessarily anywhere close to the long term average. They are simply runoff projections based upon probabilities. For example, in a parched year with poor snowpack, the 50% (median) runoff forecast might be very dry by any standard, and conversely, in a year high runoff and large snowpack, the 90% (drier) forecast could be very wet. In summary, for the December through May outlooks, the 90% can be viewed as "drier" (but not necessarily dry) and the 50% (median) as "wetter" but not necessarily wet. Generally, the differences between the NWS/DWR 90% and 50% runoff forecasts diminish as the water year progresses, and more and more information becomes available. In December, with little of the annual snowpack in place there are usually very large differences between the 90% and 50% runoff forecasts. By April or May, much (if not all) of the snowpack has accumulated, and the 90% and 50% runoff forecasts typically have relatively small differences between them.

The assumed uncertain hydrology sets are used to simulate, including, but not limited to, projected storage, releases, exports, and features of the Sacramento and San Joaquin Delta performance. These estimates serve as useful operational guides for both CVP and DWR State Water Project (SWP) operations to jointly manage the system according to our shared coordination framework (Coordinated Operations Agreement) for various conditions. This coordinated effort ensures that DWR and Reclamation supply required quantity and quality of water in the Delta to support agricultural, environmental, and water quality goals according to water right permit conditions (D-1641). The CVP system balances available resources to meet regulatory obligations, environmental requirements, senior water right holders, and CVP service contracts including agricultural, municipal and industrial, and wildlife refuge water delivery demands. Reclamation considers the factors that go into the outlooks to guide export opportunities and capabilities. Central Valley Operation staff combine their institutional knowledge and experience, and optimize reservoir and export operations given the system, regulatory, and environmental constraints which are applicable in the current water year. The final step in the analysis process is to select an allocation and demand set which fully utilizes San Luis storage by drawing the reservoir down to absolute minimums in late summer. Per requirements, the 90% outlook is used to determine allocations, and the 50% outlook is provided for informational purposes.

These operation outlooks do not suggest a certain actual future outcome, but rather the statistical likelihood of projected outcomes and represent levels of CVP operational risk. Thus, the outlooks do not provide exact or anticipated end-of-month storages, flow rates, but general projections that would be expected if actual conditions matched this uncertain future hydrology. However, actual operations are generally expected to fall within the bracketed 90 percent and 50 percent hydrology projections. Outlooks represent general system-wide dynamics and do not necessarily address specific watershed/tributary details and releases or export values are represented as monthly averages. Actual operations are based on real-time conditions.

Inputs:

- Reservoir Inflow Hydrology: Final Issue of the Bulletin 120 Water Supply Forecast Update June 10, 2020, DWR
- Sacramento Valley Accretion Depletion Hydrology: Sacramento River at Freeport forecast for June 2020, DWR. Per personal communication with DWR, values were adjusted conservatively due to late season toolset limitations.
- Operations: Personal communication with DWR, SWP Operations

Assumptions:

- Reservoir inflows are adjusted to date of forecasting to approximate actual conditions
- SWRCB D1641 permit conditions for outflow and salinity requirements are met for compliance
- Coordinated Operations Agreement (COA) classification: Dry – CVP 65% Sharing responsibility for meeting Sacramento Valley inbasin use with storage withdrawals during balanced water conditions
- Delta salinity requirements control through June 15 at Emmaton/Collinsville, Delta Outflow 7,800 cfs
- Delta controls: Zero Chipps days assumed in June

- Sacramento River water year type classification for requirements: Dry
- San Joaquin River water year type classification for requirements: Dry
- Stanislaus River classification for minimum release: Dry
- American River classification for minimum release: based on forecasted inflows to Folsom reservoir
- Trinity River Record of Decision (ROD) water year type classification: Critically Dry
- Sacramento River Settlement Contractors allocation classification: Shasta Non-Critical 100%
- North of Delta Water Service Contractor allocation for agriculture: 50%
- North of Delta Municipal and Industrial allocation: 75%
- North of Delta Refuge allocation: 100%
- American River Water Rights allocation: 100%
- South of Delta Water Rights allocation: 100%
- South of Delta Water Service Contractor allocation for agriculture: 20%
- CVP South of Delta Municipal and Industrial allocation: 70%
- South of Delta Refuge allocation: 100%
- Feather River Service Area allocation: 100%

Notes:

- A Shasta Non-Critical determination was made June 8, 2020 based on DWR Bulletin 120 Forecast Update June 2, 2020.
- Based on the COA and year classification, the CVP is responsible for 65% of water released from storage to meet all inbasin uses (entitlements) in the Sacramento River watershed under balanced conditions (SWP is responsible for 35%). To determine the magnitude of this responsibility, DWR estimates the Sacramento River watershed inbasin use by applying a mass balance calculation over the entire basin. This is because specific or individual diversion and return flows from the Sacramento River are not metered or measured and an aggregate based on historical information is used instead. Historical water gains (returns or accretion) and uses (diverted, losses or depleted) out of the Sacramento River watershed contain water year type associated patterns. This outlook contains an updated accretion/depletion calculation. The Shasta Non-Critical assumption is imbedded within this mass balance calculation and captures a 100% allocation to the Sacramento River Settlement Contractors (SRSC).
- Sacramento River accretion/depletion assumptions have been crossed checked with diversion estimates from the SRSC. Per personal communication with the SRSC, year 2020 summer (June through September) diversion patterns are similar between the 100% and 75% allocations due to the late season determination. Discussions are on-going to adjust an increase in SRSC demand in October for rice decomposition.
- South of Delta Water Rights and Refuge allocations are assumed to be 100%.
- The North of Delta water service contractor's allocation for agriculture (50%) was set by provisions of the WIIN Act, Section 4005 (e)(1)(A)(iv), which states that allocations shall be not less than 50% of the contract quantity in a Dry year preceded by a Below Normal, Above Normal or Wet year.

Northern CVP Water Temperature Report

June - 2020

BUREAU OF RECLAMATION

All Data in this Report is Preliminary and Subject to Change

DATE	Mean Daily Water Temperatures (°F)													Mean Daily Release (CFS)			Mean Daily Air Temperatures (°F)			
	TCD[1]	SHD	SPP[1]	KWK	SAC	CCR	BSF[2]	JLF	BND	RDB	IGO	LWS	-----	Shasta Generation	Spring Creek P.P.	Keswick Total	RDD	BSF	RDB	LWS
May	52.4	51.2	50.7	52.5	53.0	53.6	55.3	56.5	57.0	58.0	53.6	49.7	-	7533	1362	9142	68.3	65.8	67.7	-
06/01	51.2	50.2	51.5	51.8	52.3	52.9	**54.7**	56.2	56.7	57.6	56.3	50.4	-	8331	1306	10037	76.0	72.0	72.3	-
06/02	51.4	50.5	51.6	51.8	52.6	53.3	**55.4**	57.1	57.7	58.8	56.9	50.9	-	9095	1392	10490	80.5	76.7	78.0	-
06/03	51.3	50.4	51.8	52.1	52.6	53.3	**55.4**	57.1	57.8	59.1	57.2	50.9	-	7986	1770	10508	81.5	77.4	78.7	-
06/04	51.6	50.5	51.8	52.2	52.9	53.7	? **55.8**	57.5	58.2	59.4	57.4	51.0	-	8395	1844	10515	82.5	79.5	80.7	-
06/05	51.8	51.1	51.9	52.2	52.8	53.5	**55.6**	57.3	58.1	59.6	56.5	51.1	-	9006	1447	10383	75.0	72.7	72.6	-
06/06	51.2	50.4	52.1	52.1	52.6	53.2	**55.1**	56.5	57.2	58.3	55.6	51.4	-	8024	1667	10355	71.0	63.3	62.8	-
06/07	51.8	50.6	52.2	51.9	52.5	53.0	**54.5**	55.5	56.1	57.0	54.6	51.6	-	7765	1917	10360	60.5	58.0	62.6	-
06/08	51.8	? 50.9	52.3	51.8	52.3	52.7	**54.2**	55.4	55.9	56.9	55.3	51.4	-	8481	1801	10358	66.5	64.1	65.2	-
06/09	51.9	50.8	52.4	52.3	52.8	53.5	**55.0**	56.1	56.8	57.5	56.0	51.3	-	8742	1549	10357	72.5	70.5	72.0	-
06/10	51.0	50.2	52.4	52.4	53.0	53.7	**55.5**	56.8	57.7	58.6	57.0	51.0	-	8874	1455	10417	77.5	74.8	76.7	-
06/11	51.0	50.2	52.5	52.0	52.7	53.3	**55.3**	56.8	57.7	58.7	56.9	51.1	-	8704	1567	10976	77.5	74.5	76.3	-
06/12	50.8	50.1	52.7	51.4	52.0	52.5	**54.2**	55.6	56.6	57.7	55.5	50.7	-	9380	1690	11530	70.5	67.7	70.7	-
06/13	51.0	50.3	52.7	51.1	51.6	52.0	**53.4**	54.7	55.5	56.5	55.0	50.8	-	10113	1226	11917	65.0	63.5	63.1	-
06/14	51.4	50.6	52.8	51.4	51.9	52.4	**54.1**	55.2	55.8	56.4	56.8	50.5	-	10845	1049	11973	73.0	71.1	71.0	-
06/15	51.3	50.6	52.9	51.8	52.0	52.3	**53.5**	54.5	55.3	56.2	55.3	50.2	-	10354	1658	12050	71.5	69.1	68.7	-
06/16	51.3	50.5	53.0	51.6	52.2	52.7	**54.0**	54.9	55.5	55.8	56.1	50.8	-	10152	1645	11978	67.5	66.0	69.5	-
06/17	51.5	50.7	53.1	51.9	52.4	52.9	**54.5**	55.5	56.2	56.8	56.4	50.6	-	9813	1498	11858	76.0	72.8	74.5	-
06/18	50.6	50.1	53.1	52.3	52.6	53.2	**54.7**	55.9	56.6	57.4	57.0	50.6	-	9656	1647	11936	84.0	75.0	78.8	-
06/19	50.7	50.0	53.1	51.6	52.2	52.9	**54.8**	56.1	57.0	58.0	56.4	50.8	-	10231	1546	11976	80.0	78.5	79.8	-
06/20	50.9	50.2	53.3	51.5	52.0	52.8	**54.5**	55.8	56.5	57.6	54.2	51.3	-	10550	1276	11890	82.0	78.6	78.4	-
06/21	51.1	50.4	53.5	51.8	52.2	53.0	**54.7**	56.0	56.9	57.9	54.4	51.5	-	11489	814	11822	84.0	81.3	82.1	-
06/22	51.0	50.4	53.5	51.8	52.3	53.0	**54.8**	56.3	57.1	58.2	55.4	52.0	-	11008	1075	11961	↑ 89.0	85.7	84.8	-
06/23	51.1	50.3	53.5	52.0	52.4	53.2	**55.0**	56.5	57.4	58.7	56.8	52.1	-	10354	1437	11992	90.0	84.9	84.4	-
06/24																				
06/25																				
06/26																				
06/27																				
06/28																				
06/29																				
06/30																				
-																				
Jun	51.2	50.4	52.6	51.9	52.4	53.0	54.7	56.1	56.8	57.8	56.0	51.0	-	9450	1490	11202	76.2	72.9	74.1	-
													Total CFS	217348	34276	257639				
													Total AF	431101	67985	511016				

Legend

- ? = 1-9 hours of data missing (Average includes estimations)
- ! = 10 or more hours of data missing (Average not calculated)
- # = Station out of service
- ↑ = Record high air temperature
- ↓ = Record low air temperature
- = Monthly Averages

Notes

[1] Temperatures are weighted averages based on individual penstock flow and temperature
Highlighted cells in the TCD column indicate a TCD change was made on that day

[2] Current control point (see page 3 for more details)

[3] Column not used this month

DATE	Redding (RDD) Daily Air Temperatures (°F)																																			
	Actual			Forecasted																																		
	Previous Day			Current Day			1 Day			2 Days			3 Days			4 Days			5 Days			6 Days			7 Days			8 Days			9 Days			10 Days		
	↓	↑	Avg	↓	↑	Avg	↓	↑	Avg	↓	↑	Avg	↓	↑	Avg	↓	↑	Avg	↓	↑	Avg	↓	↑	Avg	↓	↑	Avg	↓	↑	Avg	↓	↑	Avg	↓	↑	Avg
06/01	58	81	69.5	58	85	71.5	60	96	78.0	63	98	80.5	63	97	80.0	63	89	76.0	57	79	68.0	50	75	62.5	54	83	68.5	58	87	72.5	61	92	76.5	63	95	79.0
06/02	65	87	76.0	65	97	81.0	64	100	82.0	64	99	81.5	63	91	77.0	56	76	66.0	49	75	62.0	49	81	65.0	57	88	72.5	60	92	76.0	63	91	77.0	62	92	77.0
06/03	65	96	80.5	65	99	82.0	65	99	82.0	64	94	79.0	58	73	65.5	49	72	60.5	47	79	63.0	51	85	68.0	64	94	79.0	64	95	79.5	61	90	75.5	60	89	74.5
06/04	65	98	81.5	69	99	84.0	64	90	77.0	56	74	65.0	47	73	60.0	47	81	64.0	53	88	70.5	58	94	76.0	61	88	74.5	58	86	72.0	60	83	71.5	59	90	74.5
06/05	67	98	82.5	65	88	76.5	55	73	64.0	47	71	59.0	47	80	63.5	52	88	70.0	57	93	75.0	60	92	76.0	59	84	71.5	57	84	70.5	59	87	73.0	62	92	77.0
06/06	64	86	75.0	56	70	63.0	45	72	58.5	47	82	64.5	53	90	71.5	59	94	76.5	60	90	75.0	57	82	69.5	62	86	74.0	60	89	74.5	63	90	76.5	62	89	75.5
06/07	56	86	71.0	49	71	60.0	46	82	64.0	53	90	71.5	58	93	75.5	59	91	75.0	59	83	71.0	55	81	68.0	57	88	72.5	62	93	77.5	64	94	79.0	63	92	77.5
06/08	48	73	60.5	52	82	67.0	54	89	71.5	58	92	75.0	59	90	74.5	58	81	69.5	52	78	65.0	54	87	70.5	61	94	77.5	65	97	81.0	64	96	80.0	63	92	77.5
06/09	50	83	66.5	55	89	72.0	58	93	75.5	61	92	76.5	59	80	69.5	52	78	65.0	52	86	69.0	58	91	74.5	61	89	75.0	60	86	73.0	59	84	71.5	61	91	76.0
06/10	55	90	72.5	60	97	78.5	61	94	77.5	60	82	71.0	54	75	64.5	54	85	69.5	59	91	75.0	60	91	75.5	62	90	76.0	63	95	79.0	63	93	78.0	63	93	78.0
06/11	60	95	77.5	62	93	77.5	59	80	69.5	53	73	63.0	52	85	68.5	57	92	74.5	57	90	73.5	58	91	74.5	59	86	72.5	60	89	74.5	64	92	78.0	64	94	79.0
06/12	62	93	77.5	61	81	71.0	52	72	62.0	52	85	68.5	57	89	73.0	56	91	73.5	60	96	78.0	62	98	80.0	66	99	82.5	67	100	83.5	66	97	81.5	66	95	80.5
06/13	59	82	70.5	57	73	65.0	52	84	68.0	57	85	71.0	56	88	72.0	59	96	77.5	63	99	81.0	65	101	83.0	67	100	83.5	67	102	84.5	67	100	83.5	68	99	83.5
06/14	56	74	65.0	61	84	72.5	56	81	68.5	52	84	68.0	56	93	74.5	61	99	80.0	64	102	83.0	65	101	83.0	68	98	83.0	66	98	82.0	66	94	80.0	67	96	81.5
06/15	60	86	73.0	51	80	65.5	52	81	66.5	55	92	73.5	60	98	79.0	64	102	83.0	65	102	83.5	66	101	83.5	70	102	86.0	69	100	84.5	67	96	81.5	68	99	83.5
06/16	63	80	71.5	53	80	66.5	56	90	73.0	62	97	79.5	63	102	82.5	65	102	83.5	66	102	84.0	67	103	85.0	70	104	87.0	69	103	86.0	67	98	82.5	68	99	83.5
06/17	53	82	67.5	62	90	76.0	62	98	80.0	64	101	82.5	65	102	83.5	67	103	85.0	68	104	86.0	69	104	86.5	69	104	86.5	69	103	86.0	66	97	81.5	66	95	80.5
06/18	62	90	76.0	72	97	84.5	64	101	82.5	66	100	83.0	66	101	83.5	68	106	87.0	69	106	87.5	69	106	87.5	73	106	89.5	72	104	88.0	71	98	84.5	65	95	80.0
06/19	71	97	84.0	61	101	81.0	66	101	83.5	66	101	83.5	67	107	87.0	71	108	89.5	72	107	89.5	72	107	89.5	70	104	87.0	69	104	86.5	68	98	83.0	67	97	82.0
06/20	60	100	80.0	66	100	83.0	66	101	83.5	69	108	88.5	71	108	89.5	73	107	90.0	71	105	88.0	71	107	89.0	71	107	89.0	70	103	86.5	67	96	81.5	64	94	79.0
06/21	65	99	82.0	69	100	84.5	69	108	88.5	72	109	90.5	73	107	90.0	72	107	89.5	72	110	91.0	72	109	90.5	73	108	90.5	70	104	87.0	67	98	82.5	64	96	80.0
06/22	67	101	84.0	69	107	88.0	72	108	90.0	72	106	89.0	72	107	89.5	72	110	91.0	73	106	89.5	70	99	84.5	66	91	78.5	65	95	80.0	67	97	82.0	67	98	82.5
06/23	69	**109**	89.0	74	107	90.5	72	106	89.0	71	108	89.5	72	110	91.0	72	102	87.0	67	92	79.5	61	91	76.0	66	95	80.5	66	97	81.5	68	96	82.0	66	97	81.5
06/24	73	107	90.0	75	106	90.5	72	110	91.0	73	111	92.0	73	104	88.5	65	90	77.5	59	88	73.5	61	91	76.0	66	100	83.0	67	100	83.5	67	97	82.0	66	98	82.0
06/25																																				
06/26																																				
06/27																																				
06/28																																				
06/29																																				
06/30																																				
-																																				

Web Links

10-Day Min/Max Forecast

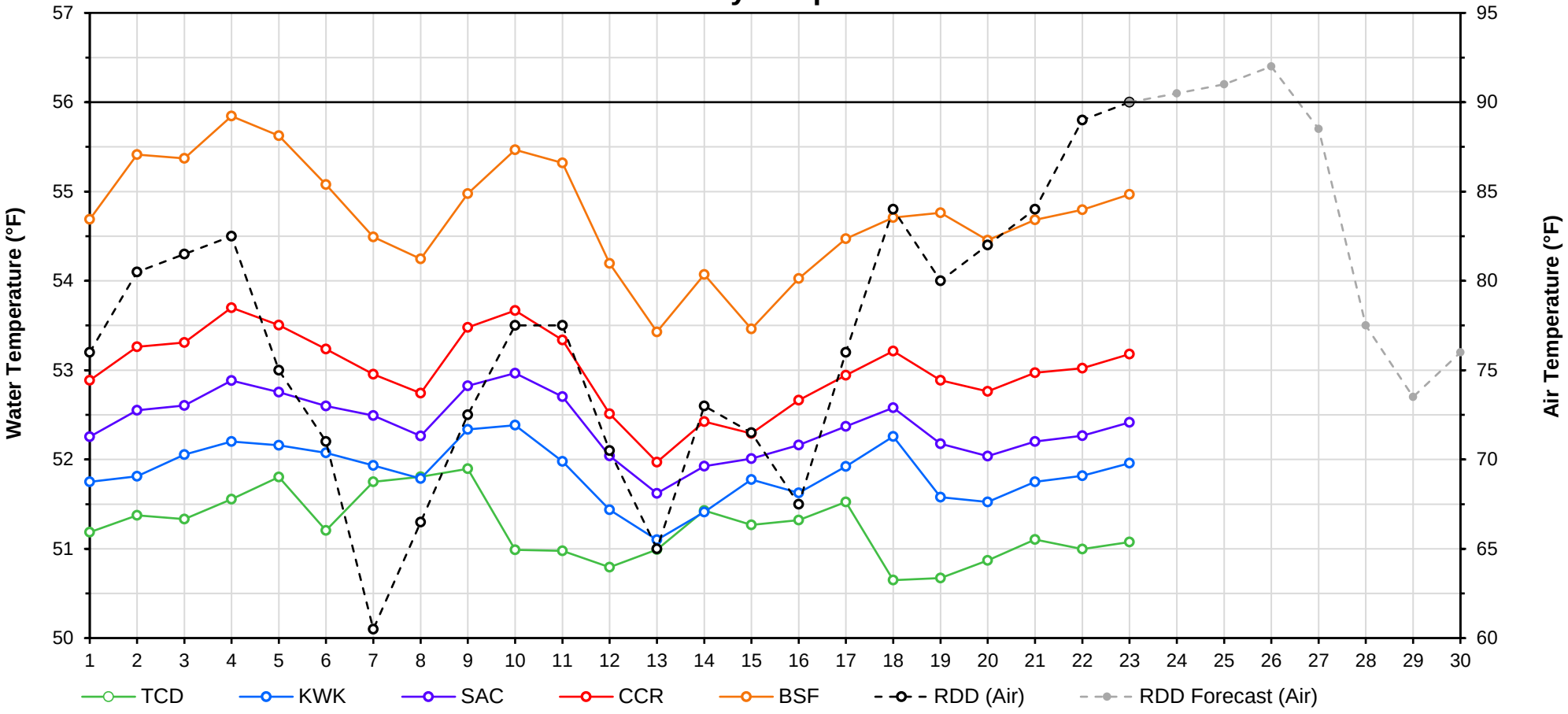
Previous Days Min/Max Actuals

Legend

NR = Forecasted temperatures not recorded

100 = Previous day actual temperatures in red and bolded indicate a record temperature for that date

Mean Daily Temperatures



Station Details			
Code	Body of Water	Location[1]	CDEC Link
TCD	N/A	Shasta Power Plant	N/A
SHD	Sacramento River	0.3 miles downstream of Shasta Power Plant	Click Here
SPP	N/A	Spring Creek Power Plant	N/A
KWK	Sacramento River	0.8 miles downstream of Keswick Dam	Click Here
SAC	Sacramento River	4.8 miles downstream of Keswick Dam	Click Here
CCR	Sacramento River	9.7 miles downstream of Keswick Dam	Click Here
BSF	Sacramento River	25 miles downstream of Keswick Dam	Click Here
JLF	Sacramento River	34 miles downstream of Keswick Dam	Click Here
BND	Sacramento River	41 miles downstream of Keswick Dam	Click Here
RDB	Sacramento River	58 miles downstream of Keswick Dam	Click Here
IGO	Clear Creek	7.3 miles downstream of Whiskeytown Dam	Click Here
LWS	Trinity River	1.1 miles downstream of Lewiston Dam	Click Here
DGC[2]	Trinity River	19 miles downstream of Lewiston Dam	Click Here
NFH[3]	Trinity River	38 miles downstream of Lewiston Dam	Click Here

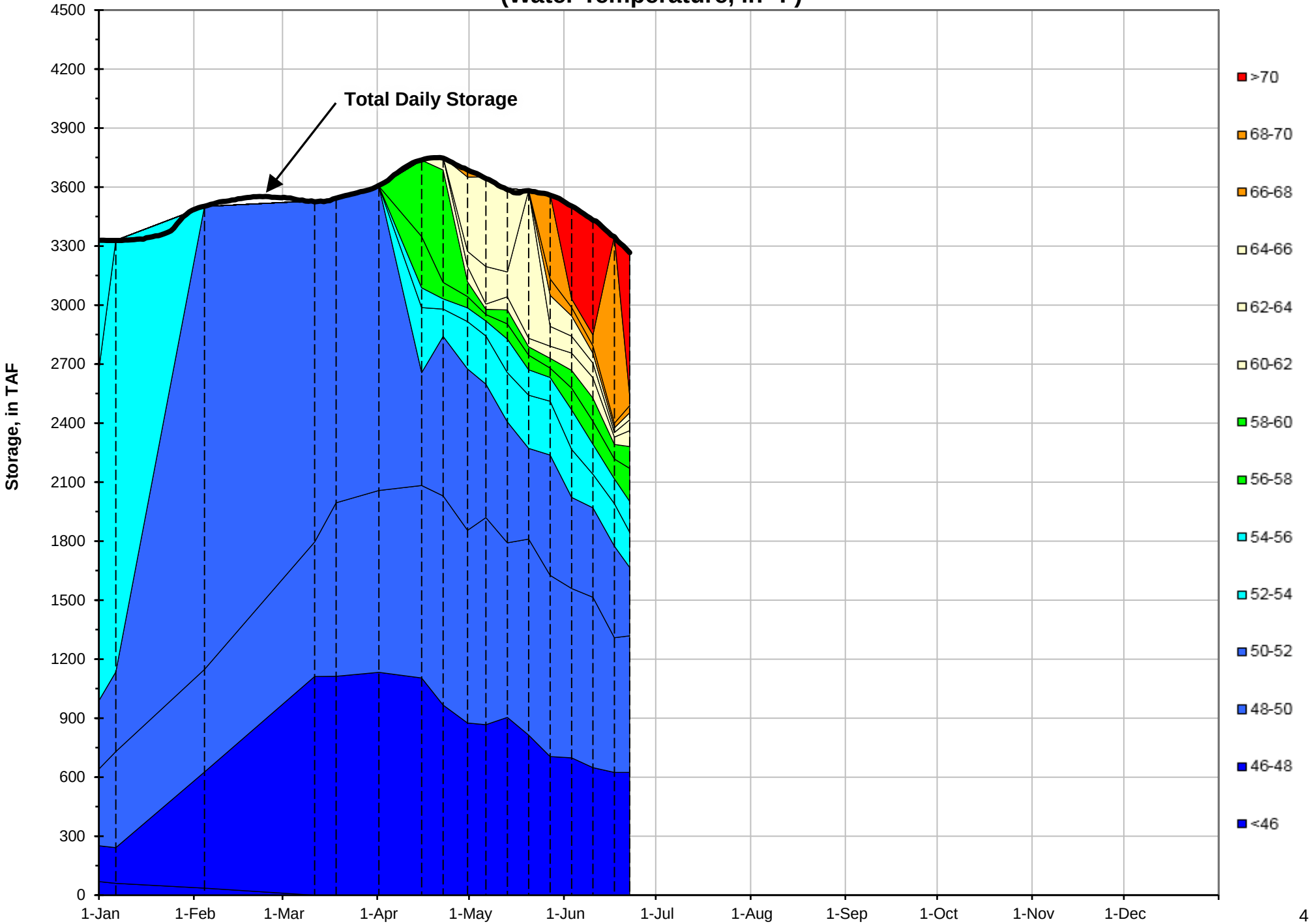
Temperature Control Point		
Point	Temp. (°F)	Begin Date
BSF	56.0	5/25/2018

Notes

[1] Distances are approximate
[2] DGC is only reported in September
[3] NFH is only reported in October, November and December

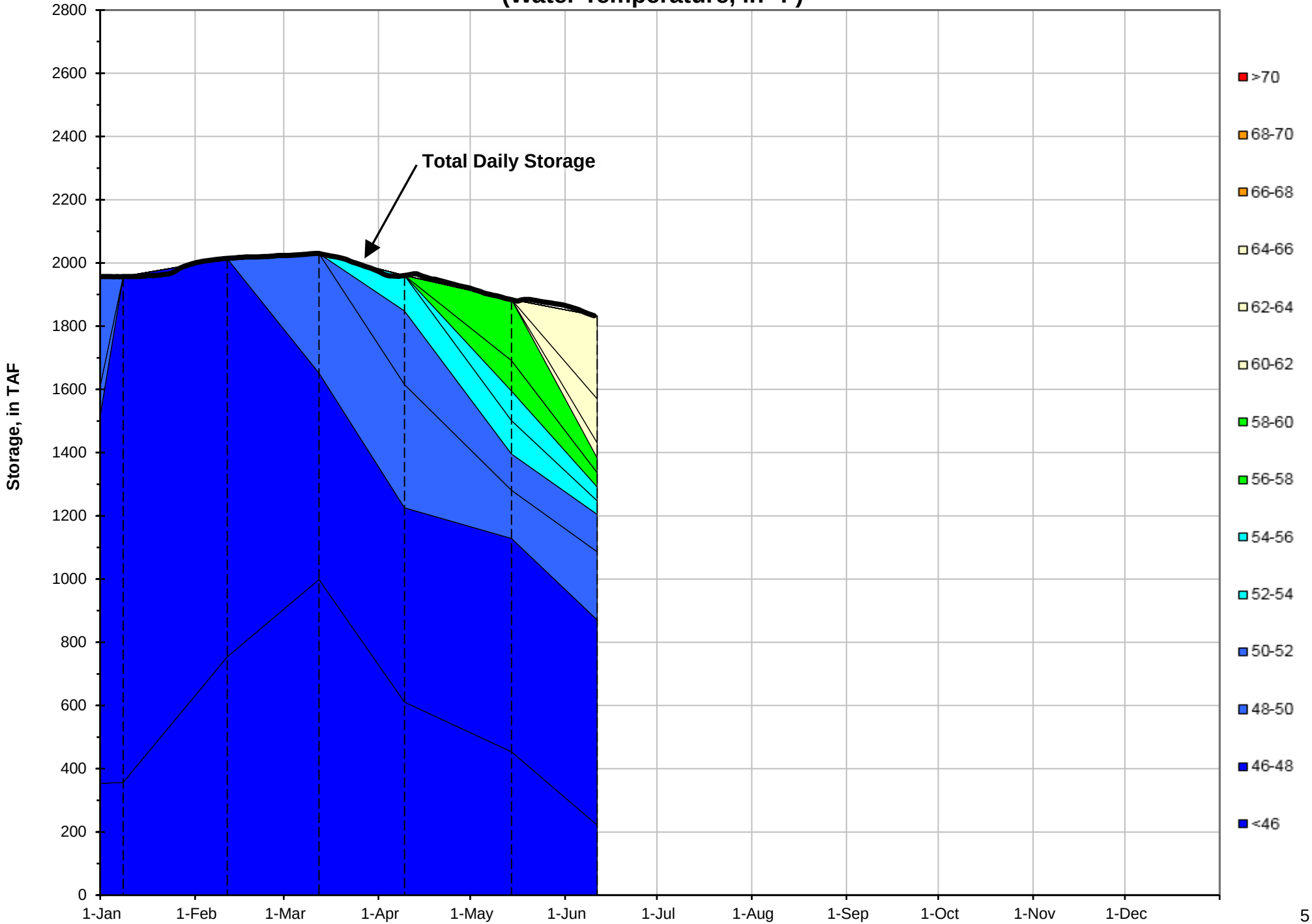
Latest Profile Date: 06/22/2020

Shasta Lake Isothermobaths - 2020
(Water Temperature, in °F)



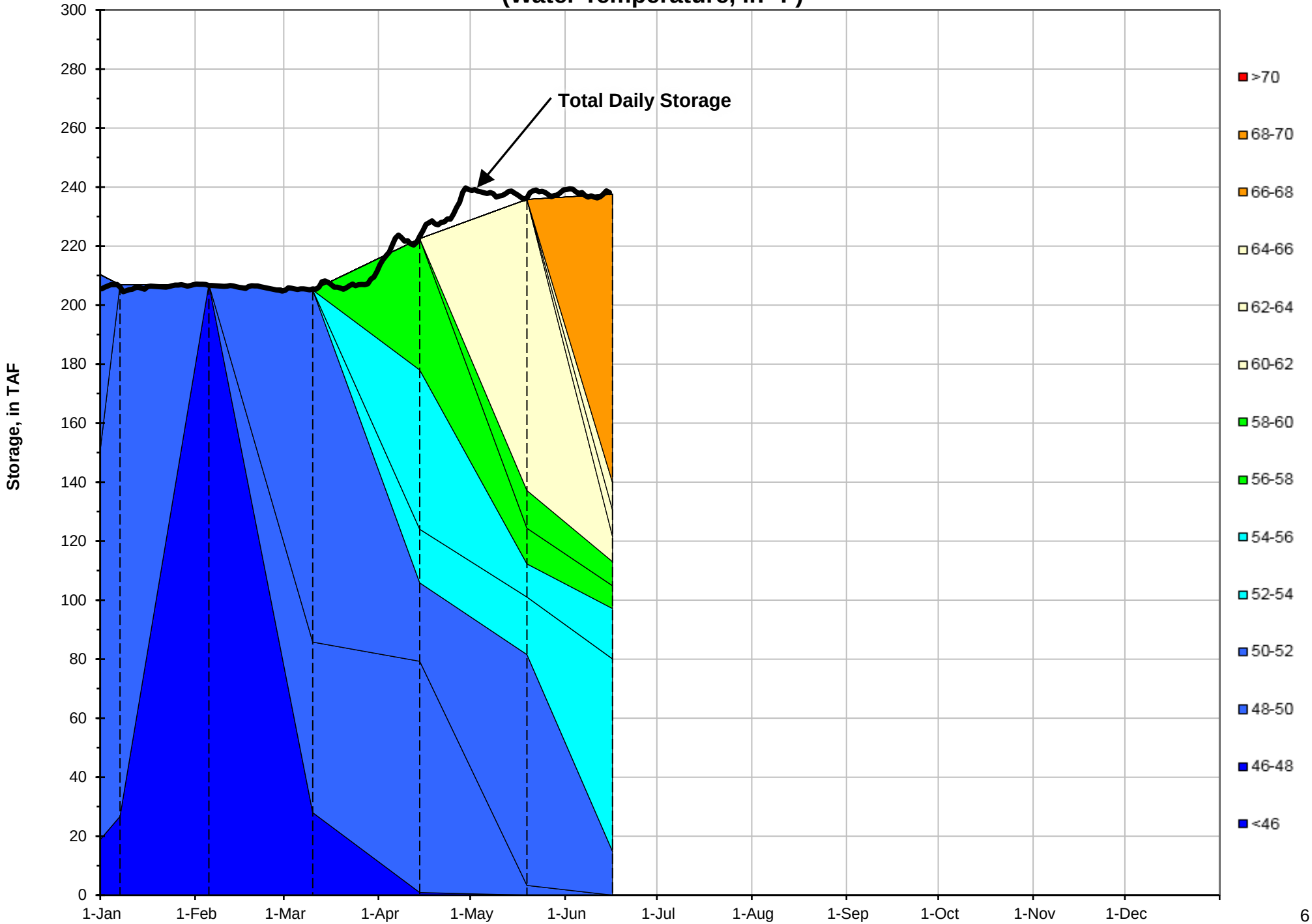
Latest Profile Date: 06/11/2020

Trinity Lake Isothermobaths - 2020
(Water Temperature, in °F)



Latest Profile Date: 06/16/2020

Whiskeytown Lake Isothermobaths - 2020
(Water Temperature, in °F)

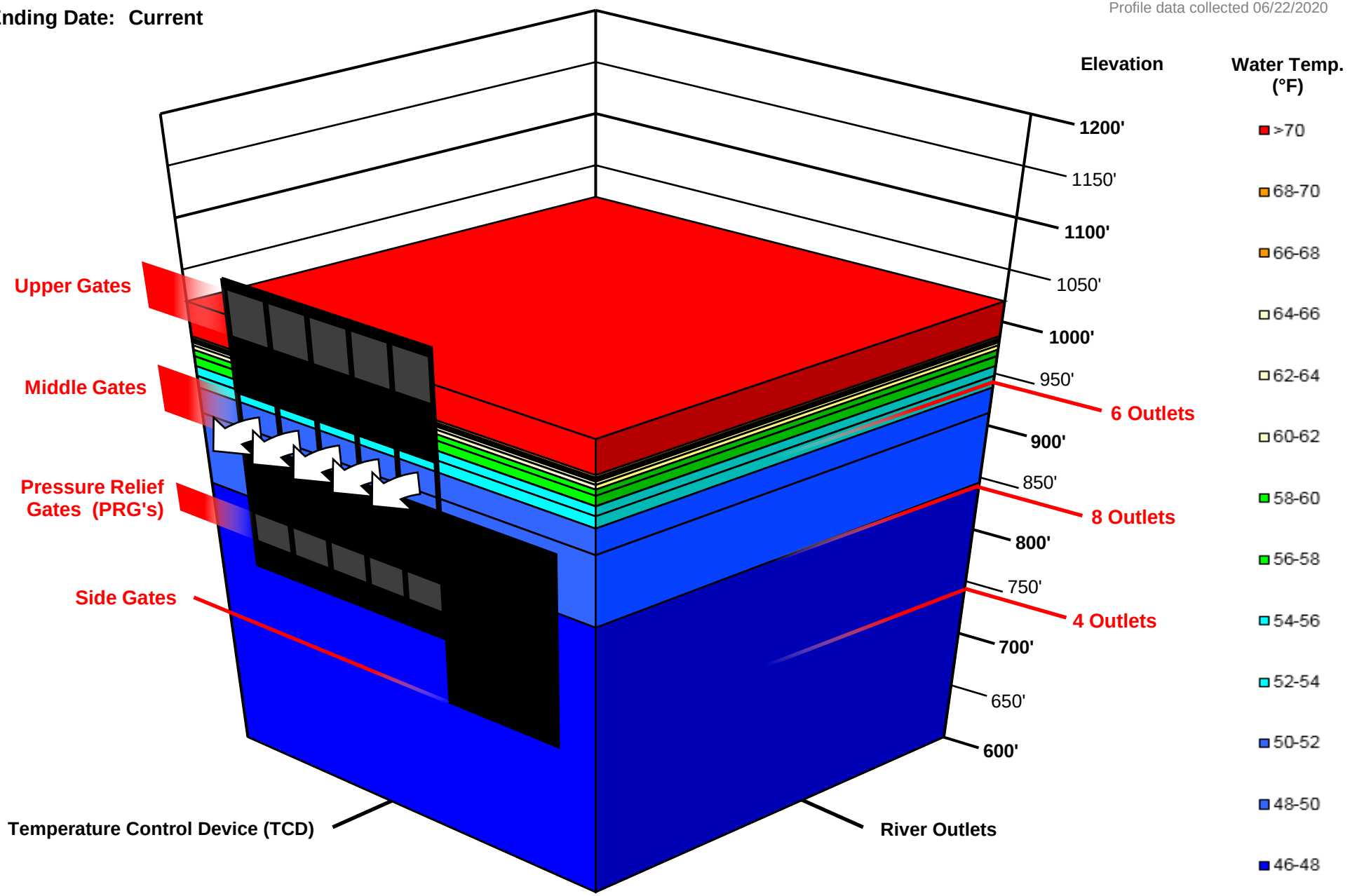


Shasta TCD Configuration

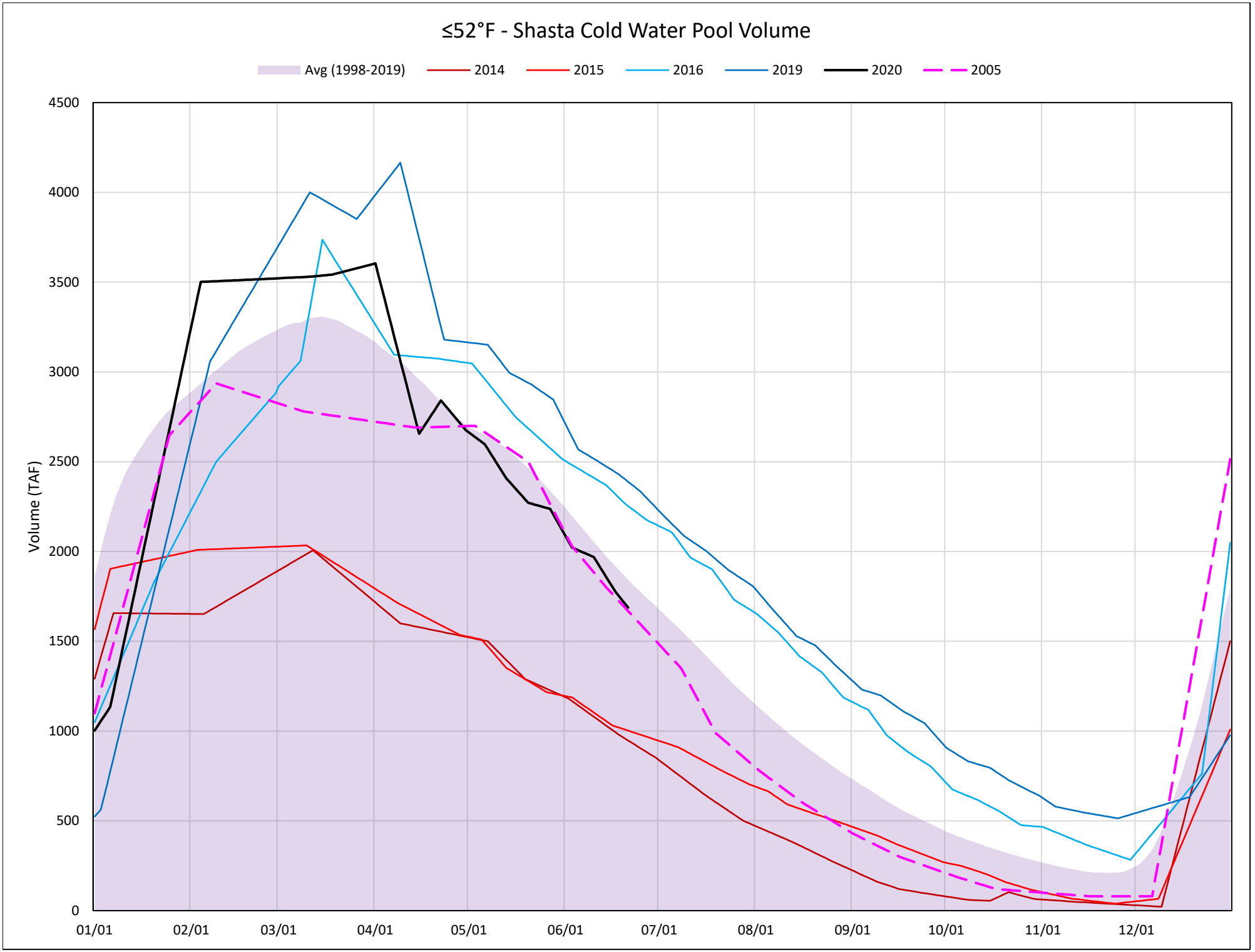
Starting Date: 6/24/2020

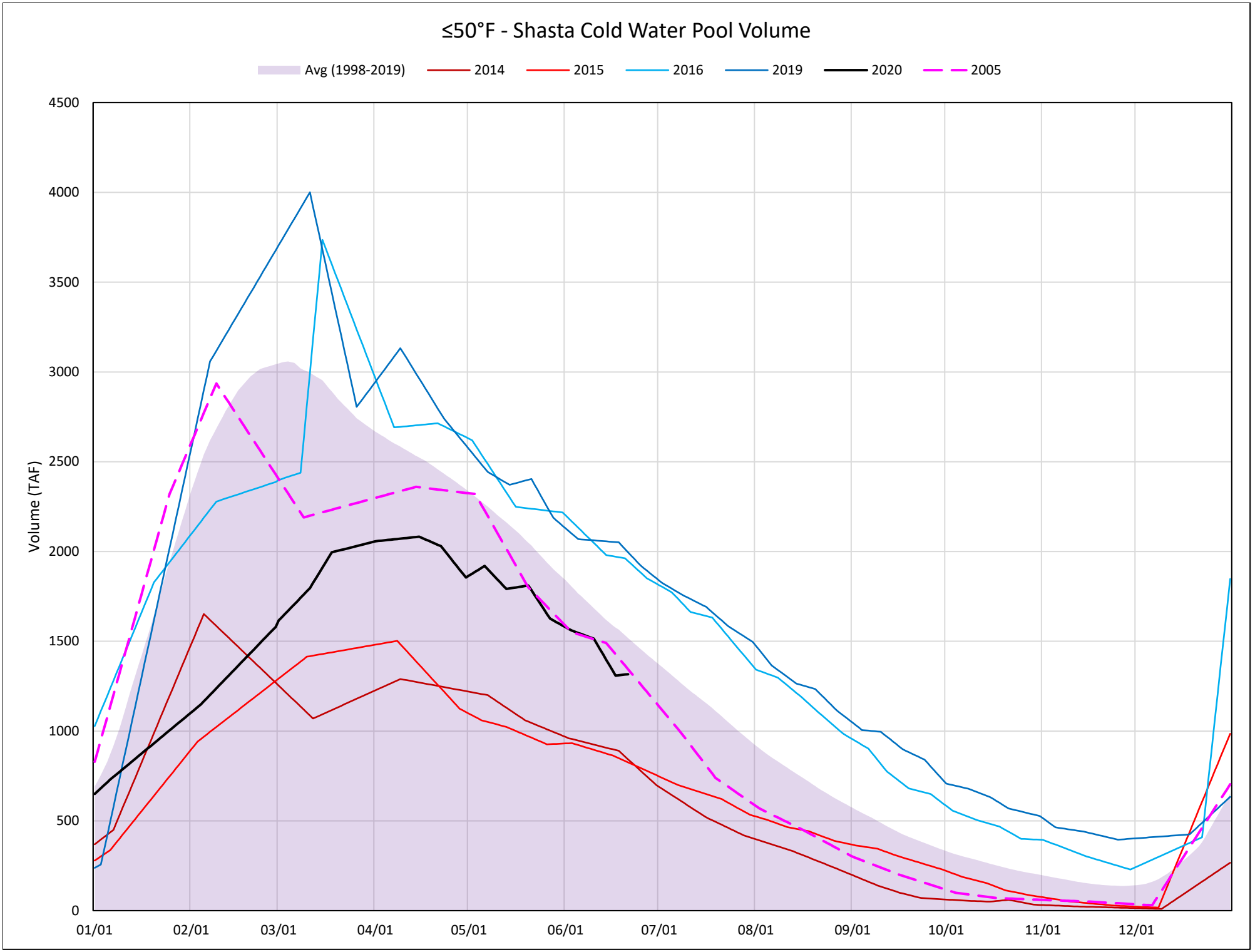
Ending Date: Current

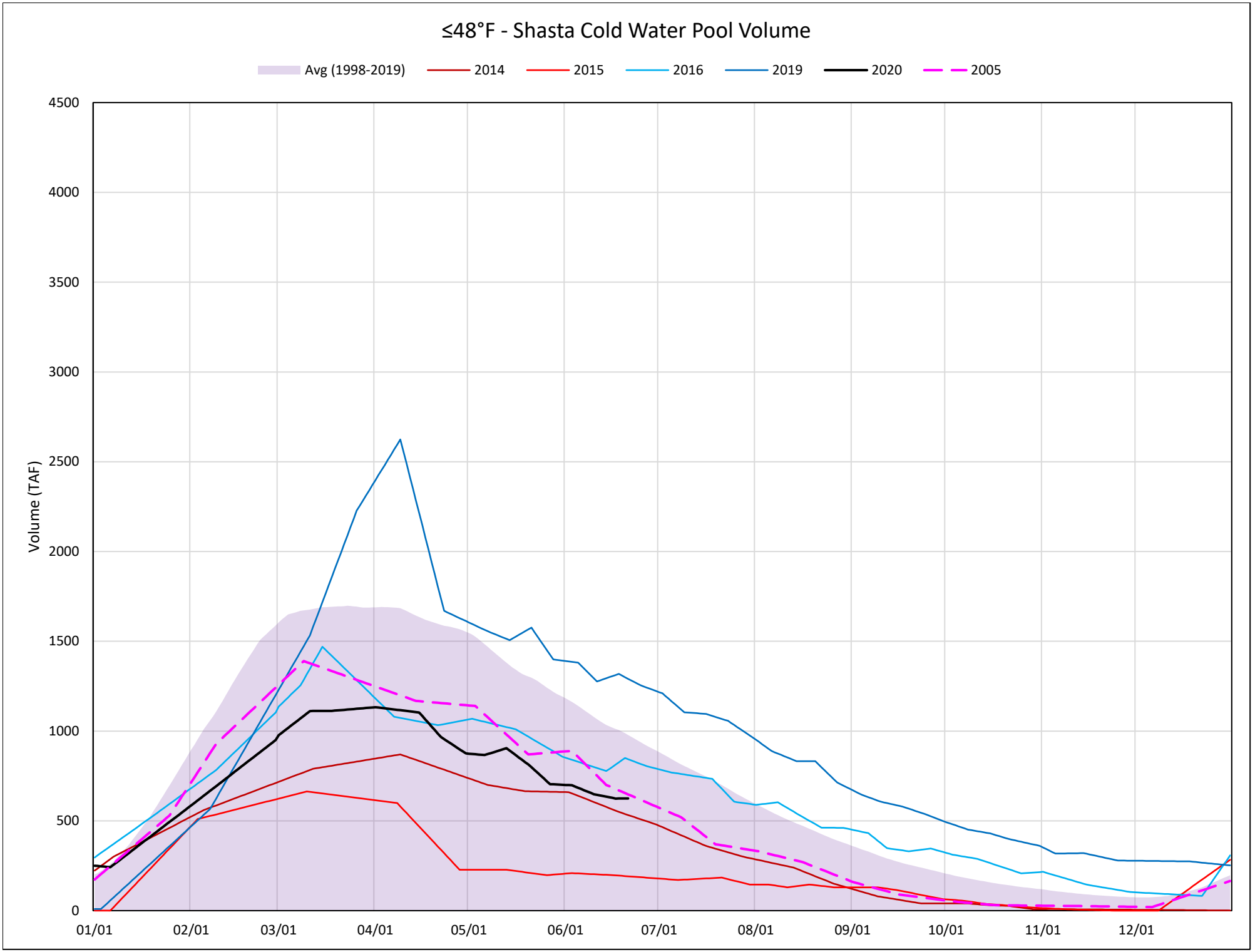
Profile data collected 06/22/2020

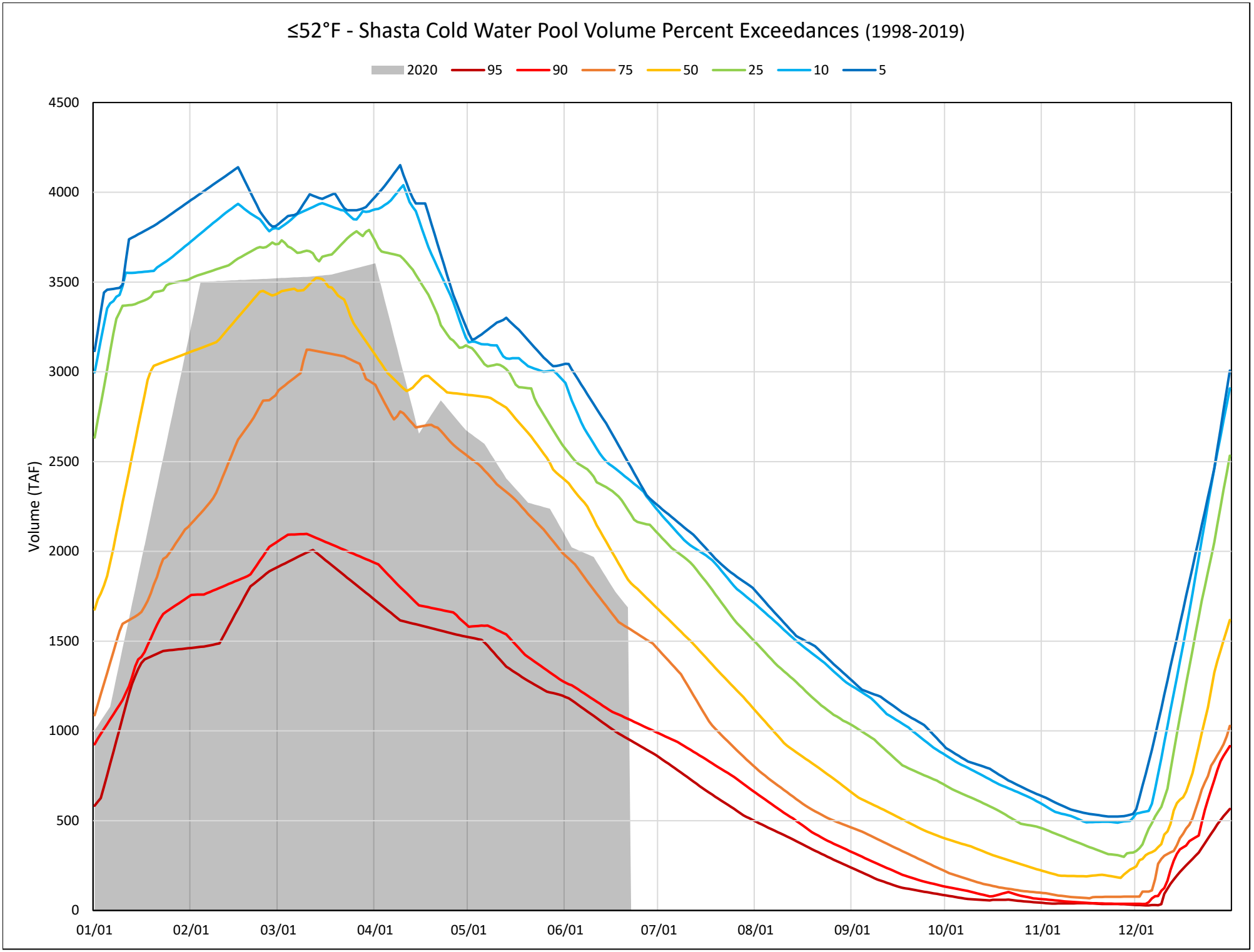


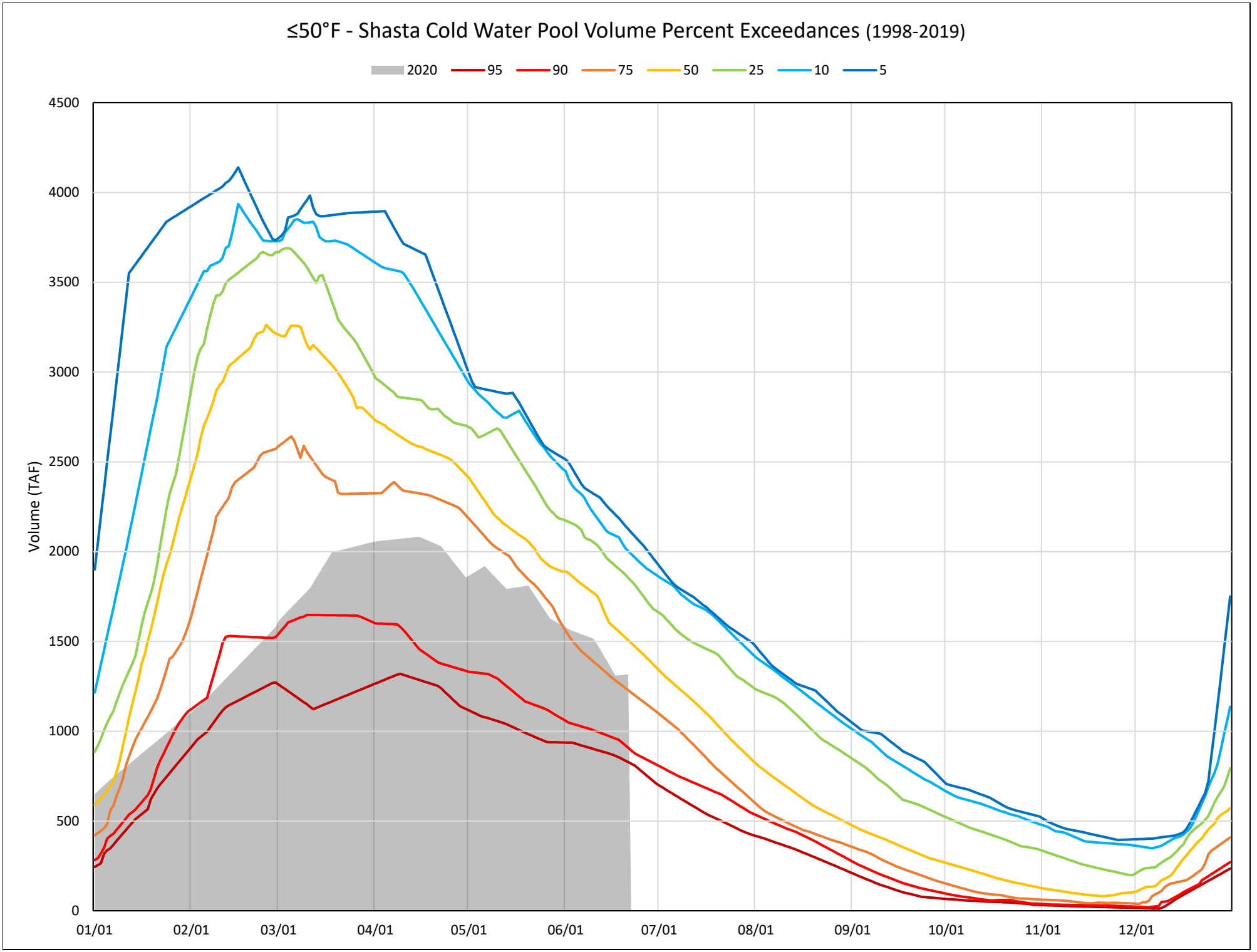
Arrows indicate open Gate or Outlet (i.e. Water flowing from this location)

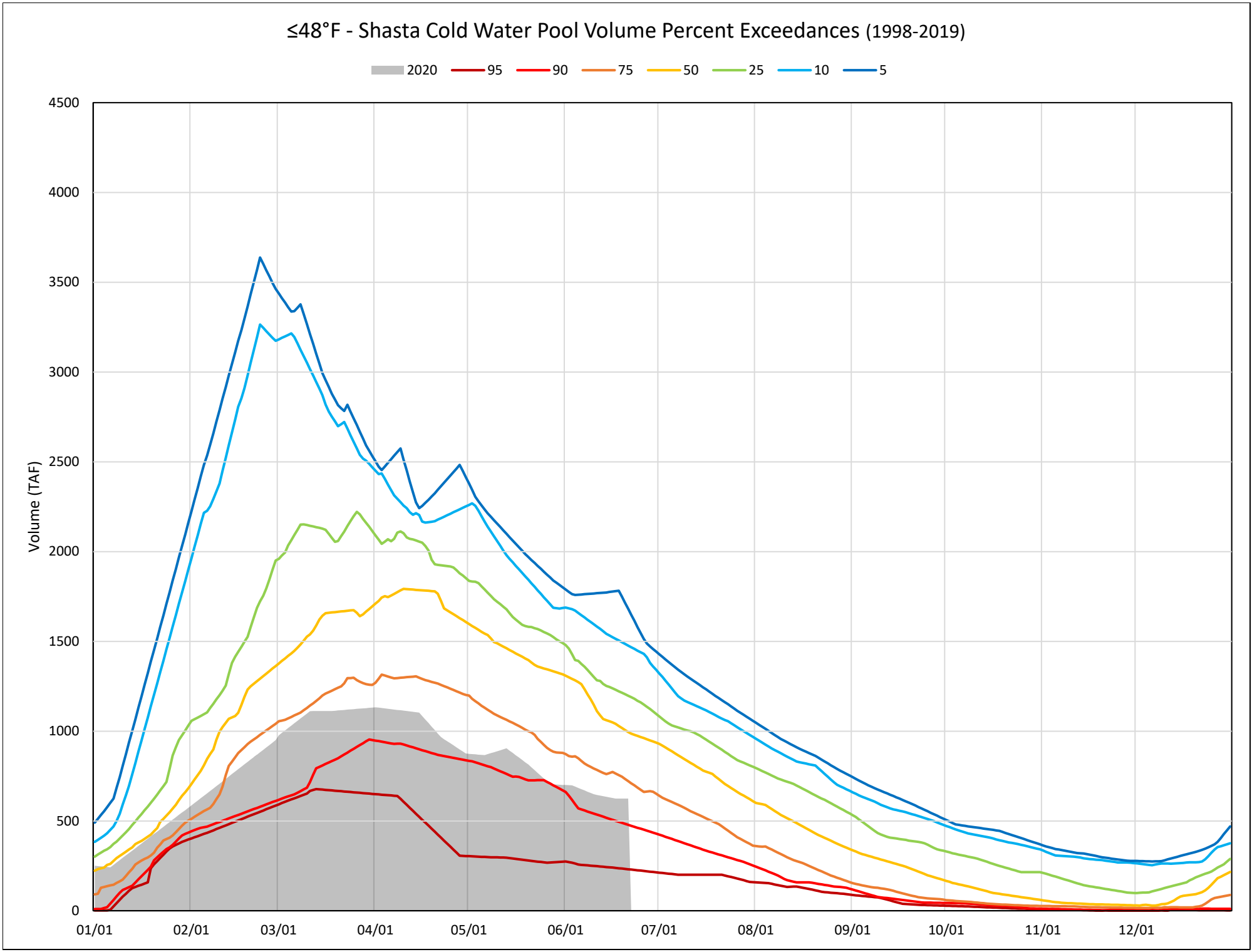

≤52°F - Shasta Cold Water Pool Volume
Avg (1998-2019)
2014
2015
2016
2019
2020
2005
Volume (TAF)
4500
4000
3500
3000
2500
2000
1500
1000
500
0
01/01
02/01
03/01
04/01
05/01
06/01
07/01
08/01
09/01
10/01
11/01
12/01


≤50°F - Shasta Cold Water Pool Volume
Avg (1998-2019)
2014
2015
2016
2019
2020
2005
Volume (TAF)
4500
4000
3500
3000
2500
2000
1500
1000
500
0
01/01
02/01
03/01
04/01
05/01
06/01
07/01
08/01
09/01
10/01
11/01
12/01


≤48°F - Shasta Cold Water Pool Volume
Avg (1998-2019)
2014
2015
2016
2019
2020
2005
Volume (TAF)
4500
4000
3500
3000
2500
2000
1500
1000
500
0
01/01
02/01
03/01
04/01
05/01
06/01
07/01
08/01
09/01
10/01
11/01
12/01

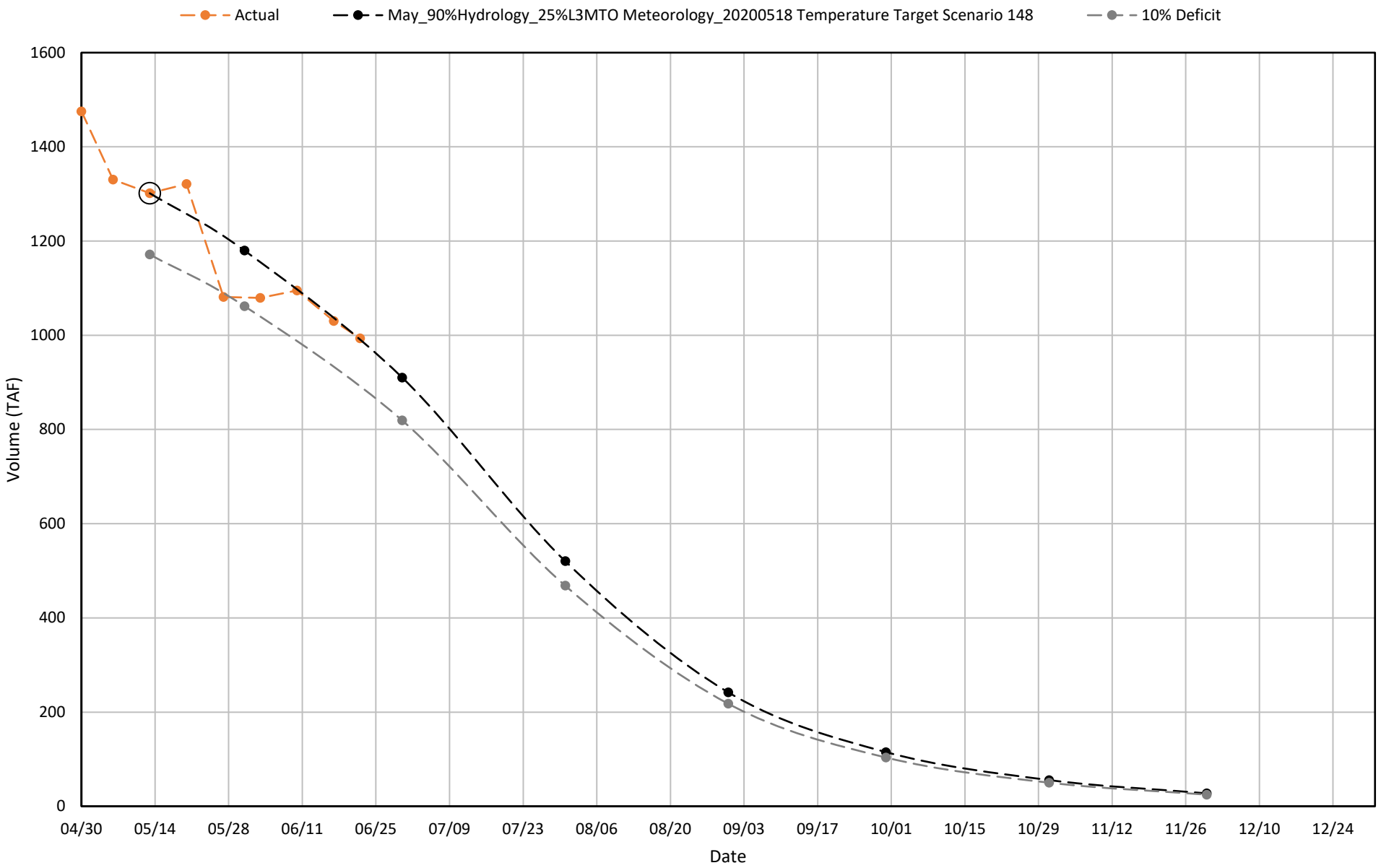

≤52°F - Shasta Cold Water Pool Volume Percent Exceedances (1998-2019)
2020
95
90
75
50
25
10
5
Volume (TAF)
4500
4000
3500
3000
2500
2000
1500
1000
500
0
01/01
02/01
03/01
04/01
05/01
06/01
07/01
08/01
09/01
10/01
11/01
12/01


≤50°F - Shasta Cold Water Pool Volume Percent Exceedances (1998-2019)
2020
95
90
75
50
25
10
5
Volume (TAF)
4500
4000
3500
3000
2500
2000
1500
1000
500
0
01/01
02/01
03/01
04/01
05/01
06/01
07/01
08/01
09/01
10/01
11/01
12/01


≤48°F - Shasta Cold Water Pool Volume Percent Exceedances (1998-2019)
2020
95
90
75
50
25
10
5
Volume (TAF)
4500
4000
3500
3000
2500
2000
1500
1000
500
0
01/01
02/01
03/01
04/01
05/01
06/01
07/01
08/01
09/01
10/01
11/01
12/01

Printed: 2020.06.23

2020 Shasta Cold Water Pool Volume ≤49°F



June 24, 2020

Upper Sacramento River – June 2020 Preliminary Temperature Analysis

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

Model Run	Location	Jun	Jul	Aug	Sep*	Oct*
90% Hydro. - 25% L3MTO Met. Scenario 148 – Delay Side Gate Use	Keswick Dam KWK	52.9	53.5	53.2	See Fig. 7	See Fig. 7
	Sac. R. abv Clear Creek CCR	53.3	54.0	53.6	See Fig. 8	See Fig. 8
	Airport Road	53.7	54.6	54.1	n/a	n/a
	Balls Ferry BSF	54.7	55.5	55.0	See Fig. 9	See Fig. 9
90% Hydro. - 25% L3MTO Met. Scenario 148 – Extend 53.5°F in August	Keswick Dam KWK	52.9	53.3	53.2	See Fig. 7	See Fig. 7
	Sac. R. abv Clear Creek CCR	53.2	53.7	53.5	See Fig. 8	See Fig. 8
	Airport Road	53.7	54.3	54.1	n/a	n/a
	Balls Ferry BSF	54.6	55.3	55.0	See Fig. 9	See Fig. 9
90% Hydro. - 25% L3MTO Met. Scenario 148 – Extend 54°F in September	Keswick Dam KWK	52.9	53.5	53.2	See Fig. 7	See Fig. 7
	Sac. R. abv Clear Creek CCR	53.3	54.0	53.6	See Fig. 8	See Fig. 8
	Airport Road	53.7	54.6	54.1	n/a	n/a
	Balls Ferry BSF	54.7	55.5	55.0	See Fig. 9	See Fig. 9

Summary of Shasta Lake Cold Water Pool and TCD Operation

Model Run	End of September Cold Water Pool <56°F (TAF)	First Side Gate Use (Date)	Full Side Gate Use (Date)
90% Hydro. - 25% L3MTO Met. Scenario 148 – Delay Side Gate Use	469	8/16	10/30
90% Hydro. - 25% L3MTO Met. Scenario 148 – Extend 53.5°F in August	444	8/11	9/11
90% Hydro. - 25% L3MTO Met. Scenario 148 – Extend 54°F in September	450	8/16	9/14

Model Run Date June 22, 2020

* The HEC5Q model output is displayed for the months April through August. 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, ranges in possible outcomes are illustrated with the Fall Temperature Index (graphics above Figures 7-9). This relationship is an end of September Lake Shasta Volume less than 56°F and likely downstream temperature performance for the early fall months. Estimated temperatures for September and October may fall into a range indicated within the Fall Temperature Index (graphical chart), illustrating historical performance. However, this range should be viewed as an element of uncertainty based on past performance, not a simulation or projection of temperature management operations or results.

Temperature Analysis Results:

Modeling runs explore Sacramento River compliance performance above Clear Creek confluence and Balls Ferry locations by varying Shasta tailbay temperature targets. The temperature results for the Sacramento River between Keswick Dam and Balls Ferry and the Trinity River are shown in Figures 1-6. The relationship between end-of-September lake volume below 56°F and a downstream Sacramento River compliance location through fall is based on the Figures 7-9.

Temperature Model Inputs, Assumptions, Limitations and Uncertainty:

1. The latest available profiles for Shasta, Trinity, and Whiskeytown were taken on June 17, June 11, and June 16, respectively. Initial temperature profiles are adjusted and noted at Whiskeytown and Trinity using simulated results if the length of time between monitoring is large. Model results are sensitive to initial reservoir temperature conditions and the model performs best under highly stratified conditions. The temperature profiles prior to May do not yet exhibit conditions for ideal model computations (still nearly isothermal conditions). The model performs well after the reservoir stratifies, typically in late spring (i.e. end of April). 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 into the future with confidence.
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 creek flows can cause significant additional warming in the upper Sacramento River during spring.
3. Operation is based on the June 2020 Operation Outlooks (monthly flows, reservoir release, and end-of-month reservoir storage) for the 90%- and 50%-exceedances (when available), with minor modifications to accommodate for within month real-time operations (e.g. flood operations, underestimated system demands/requirements, etc.). After September, historical information is used for inflow. Trinity Lake inflows are updated with the CNRFC 90% runoff exceedance for the 90% and DWR Bulletin 120 for the 50% runoff exceedance studies. The Operation Outlook assumes a representation of the State and Federal regulatory environment under NMFS and FWS 2019 Biological Opinions.
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. Side-flows 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 non-exceedance at 25% and 50% (when available) patterned after like months on a 6-hour time-step (for months prior to April). Assumed inflows temperature remain static inputs and do not vary with the assumed meteorology. Tools to use local three-month-temperature outlooks (L3MTO), driven by the NOAA NWS Climate Prediction Center (CPC) are used beginning in April.
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, which is still

uncertain prior to the end of April.
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.
9. The model is specifically being applied to generate the most accurate results at the Sacramento River above Clear Creek confluence location (CCR).

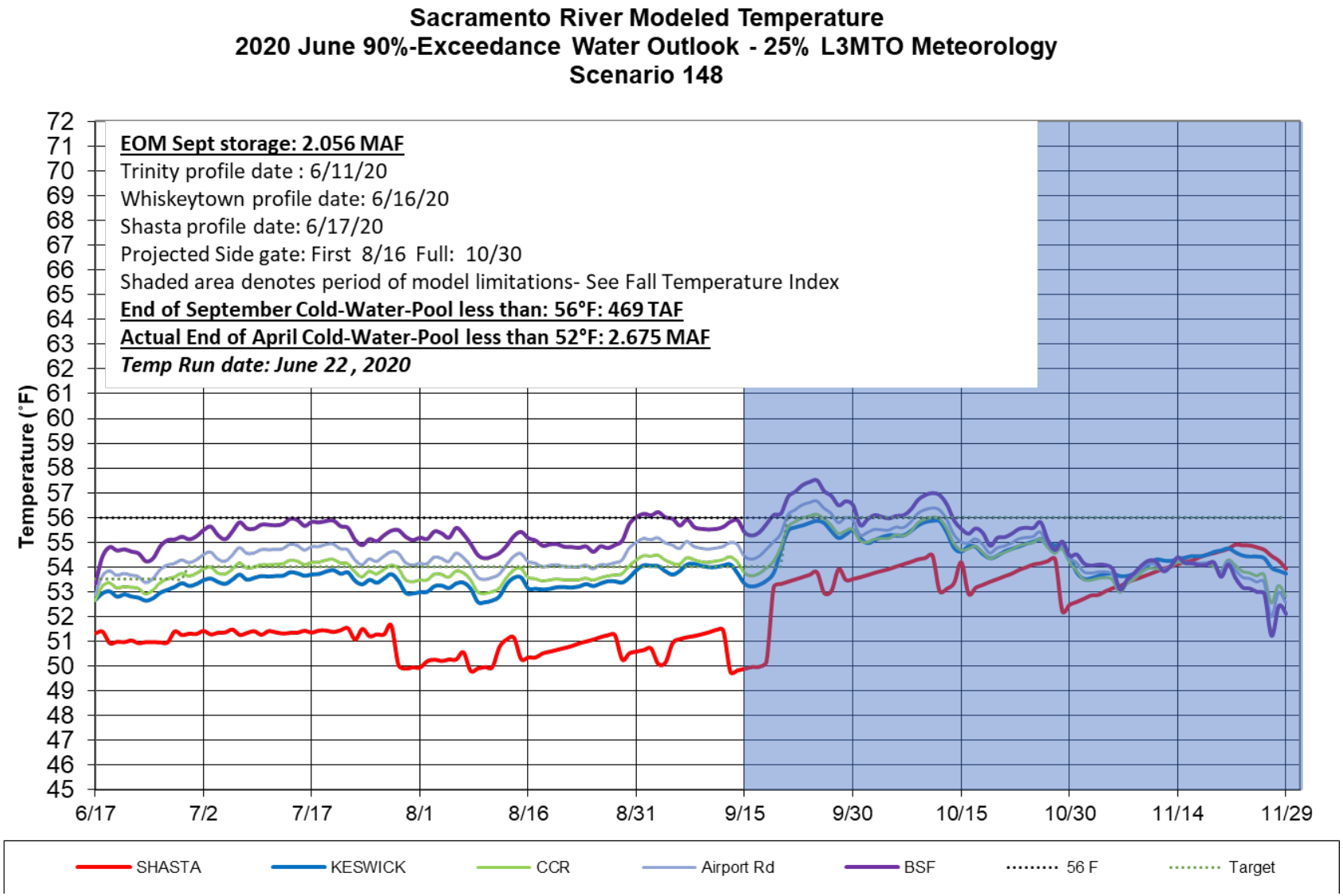


Figure 1. June 2020 simulated Sacramento River temperatures 90% runoff exceedance hydrology and 25% L3MTO meteorology delaying the side gate use in August.

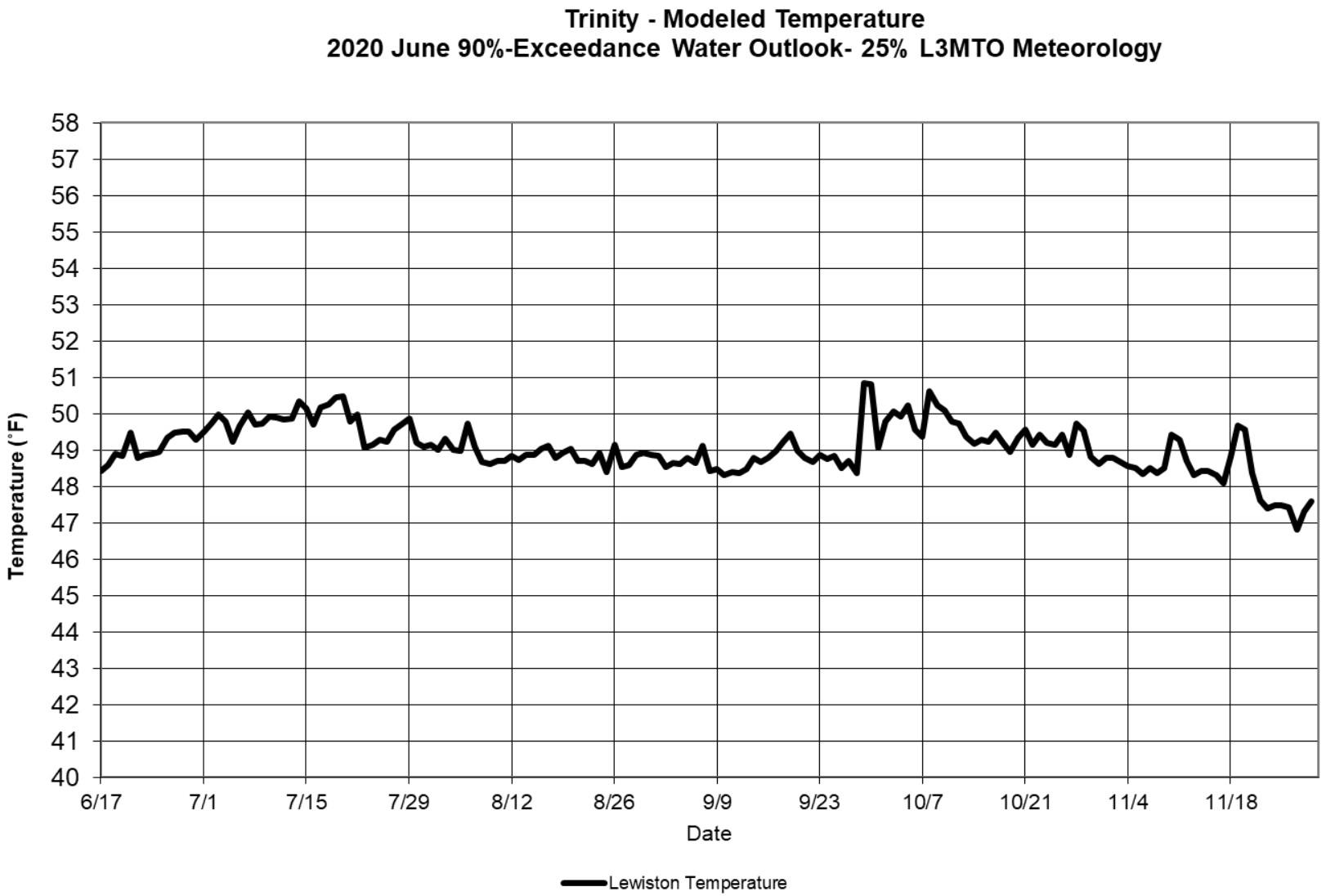


Figure 2. June 2020 simulated Trinity River temperatures 90% runoff exceedance hydrology and 25% L3MTO meteorology delaying the side gate use in August.

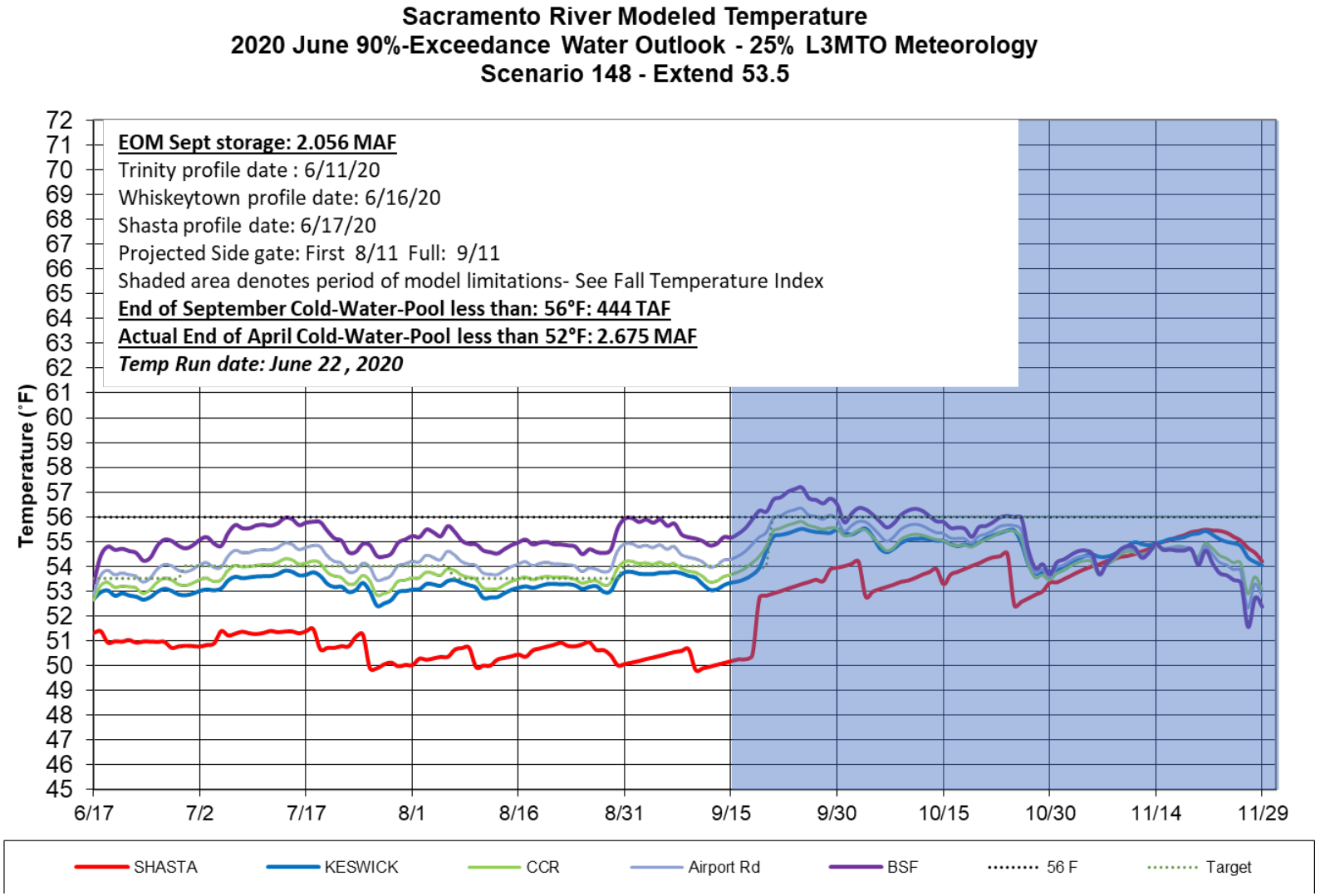


Figure 3. June 2020 simulated Sacramento River temperatures 90% runoff exceedance hydrology and 25% L3MTO meteorology Extending 53.5 at CCR in August.

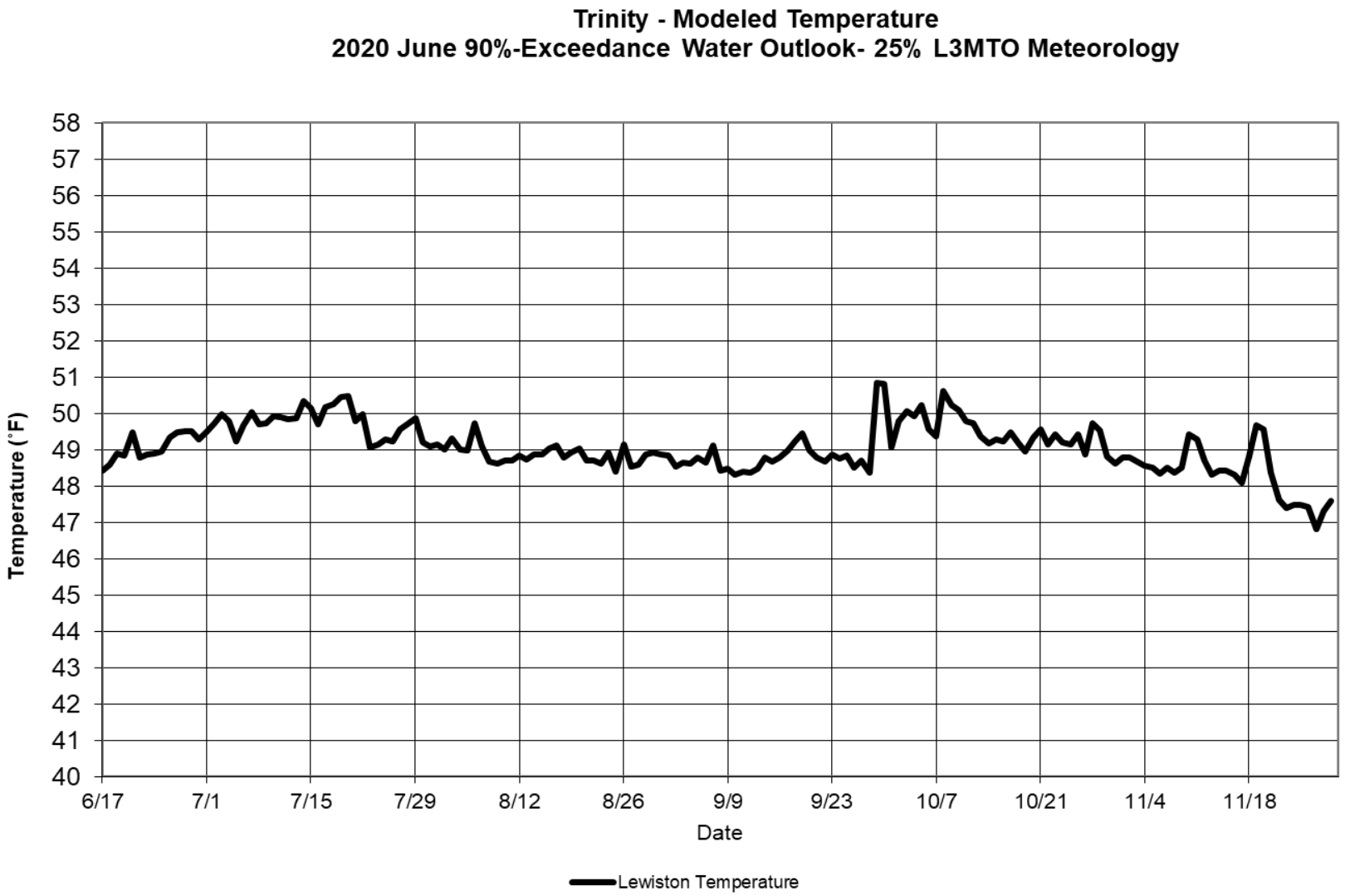


Figure 4. June 2020 simulated Trinity River temperatures 90% runoff exceedance hydrology and 25% L3MTO meteorology Extending 53.5 at CCR in August.

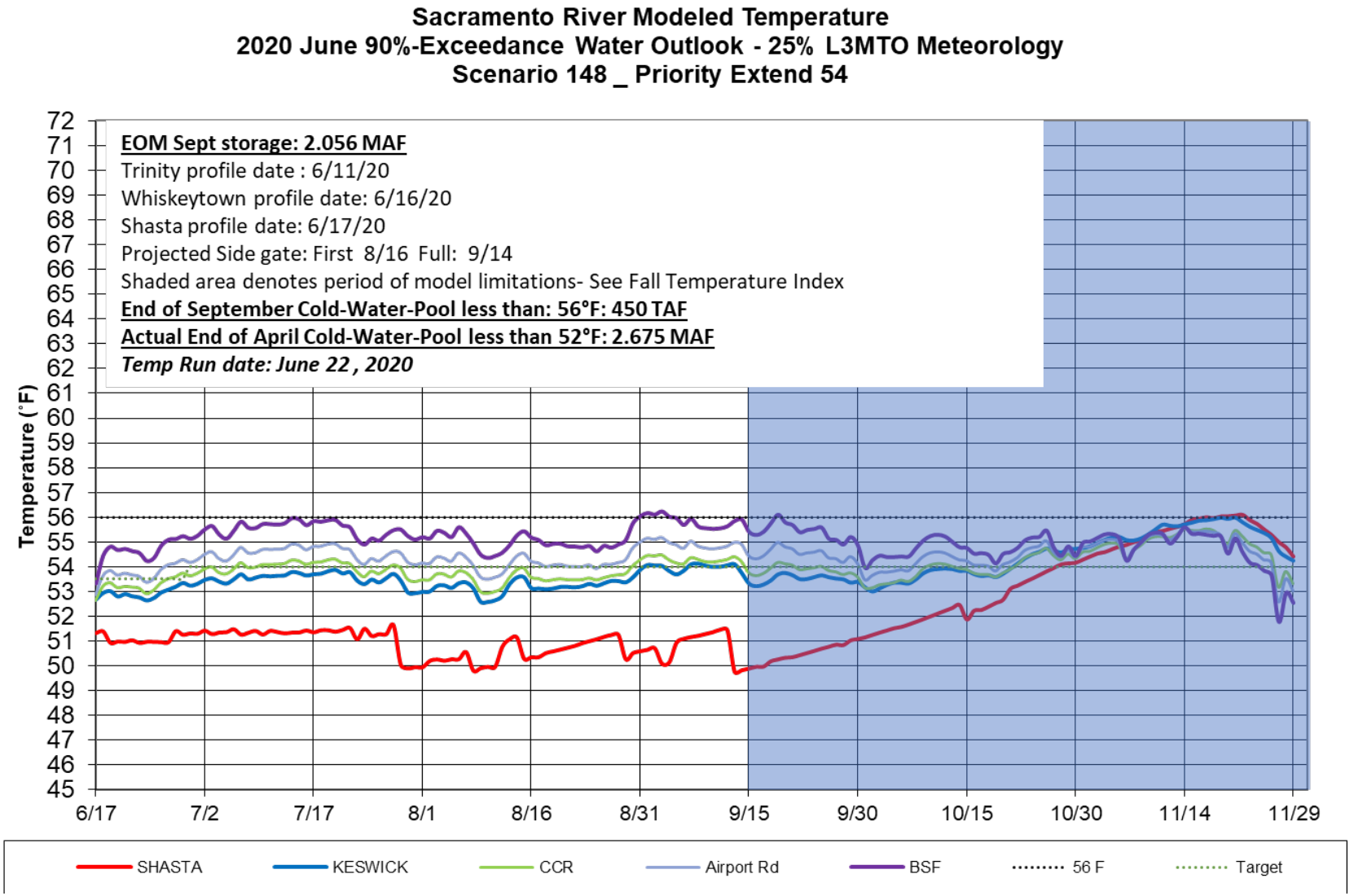


Figure 5. June 2020 simulated Sacramento River temperatures 90% runoff exceedance hydrology and 25% L3MTO meteorology Extending 54 at CCR in September.

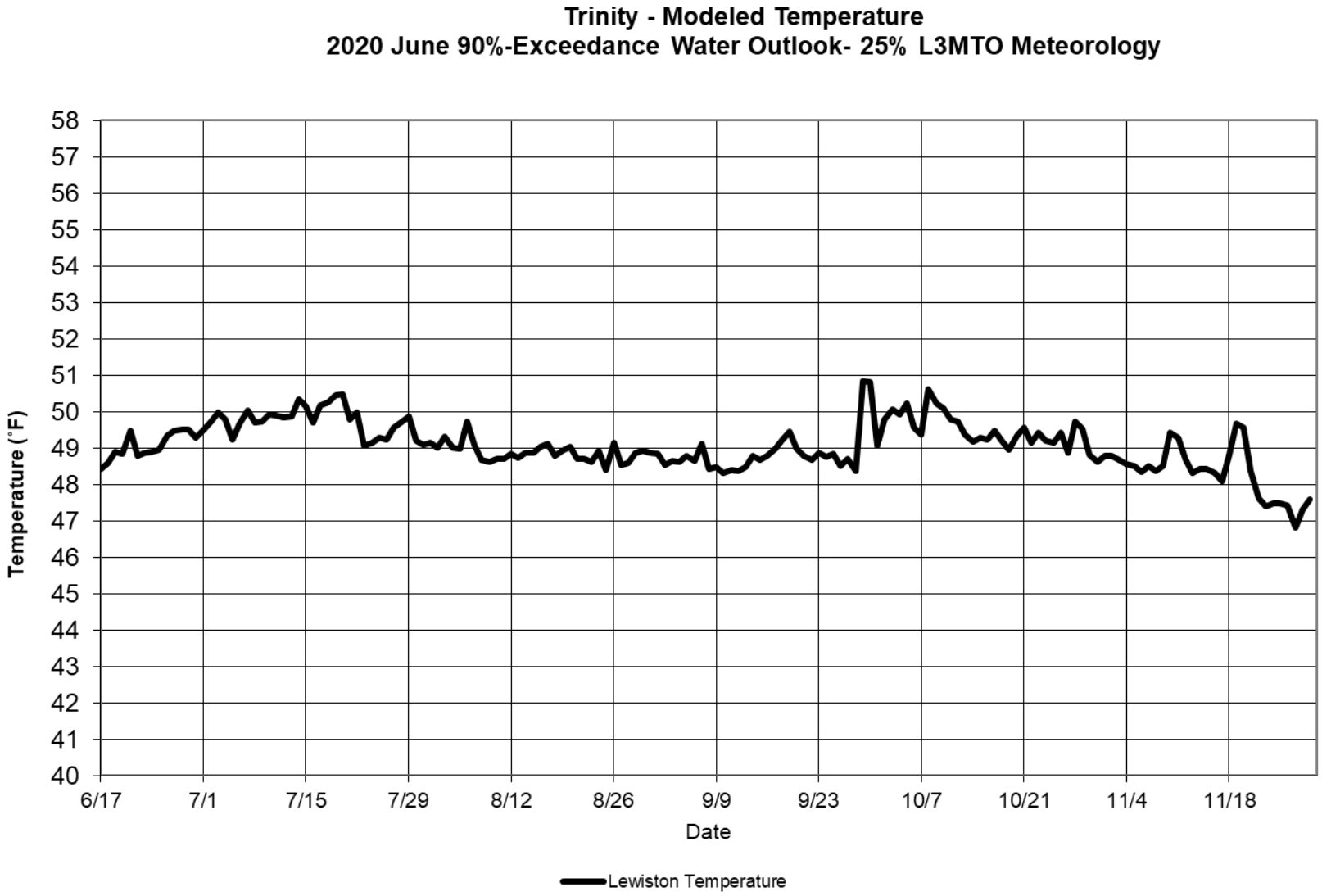


Figure 6. June 2020 simulated Trinity River temperatures 90% runoff exceedance hydrology and 25% L3MTO meteorology Extending 54 at CCR in September.

Figures 7-9 <u>Model Performance and Fall Temperature Index</u>:

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 is a good indicator of fall water temperature in the river reaches.
3. Based on these records and estimates, the charts below illustrate a range of uncertainty in the expected river temperatures based on the end-of-September lake volume less than 56˚F.

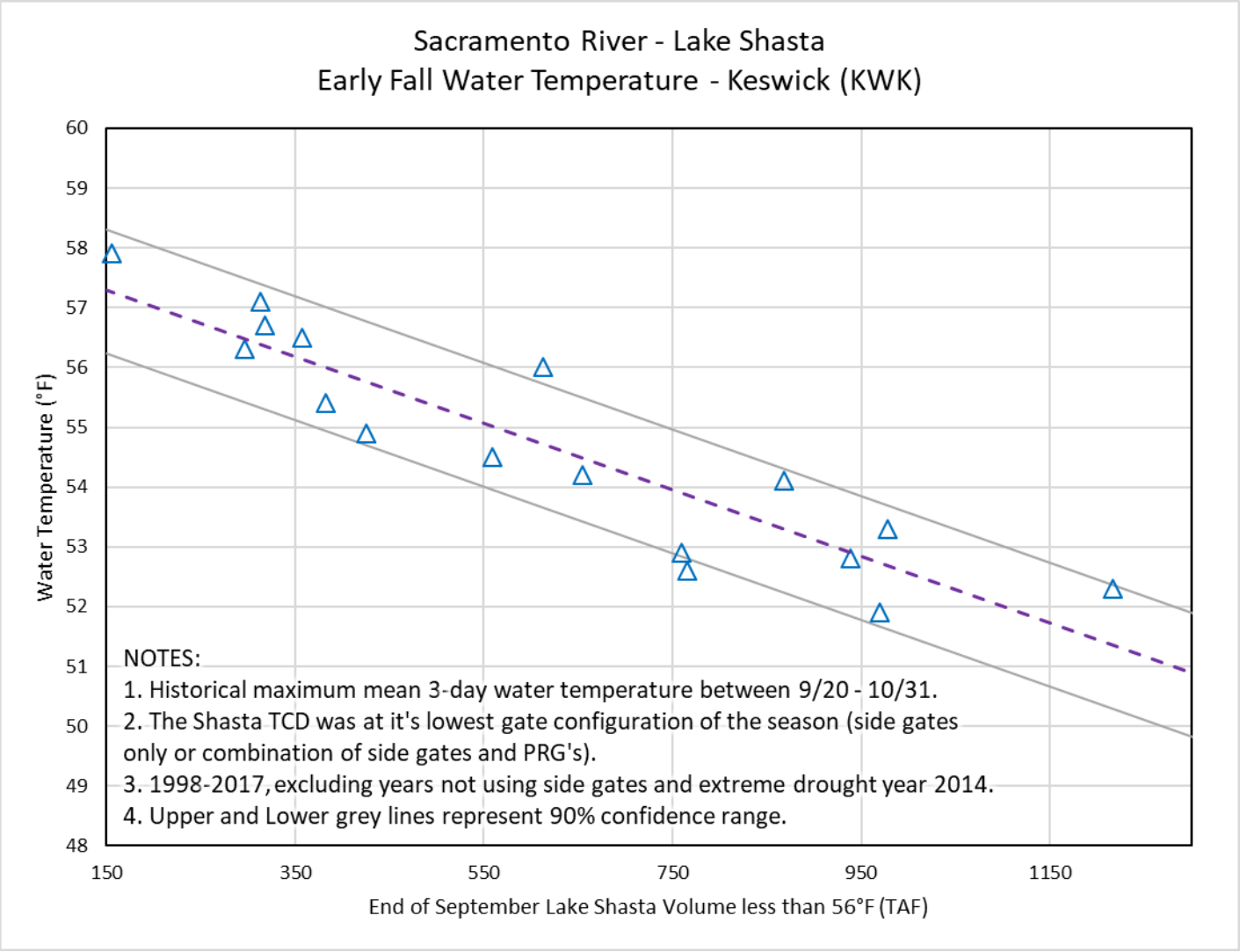


Figure 7. Historical relationship between Lake Shasta cold-water-pool characteristics and early fall Keswick water temperature.

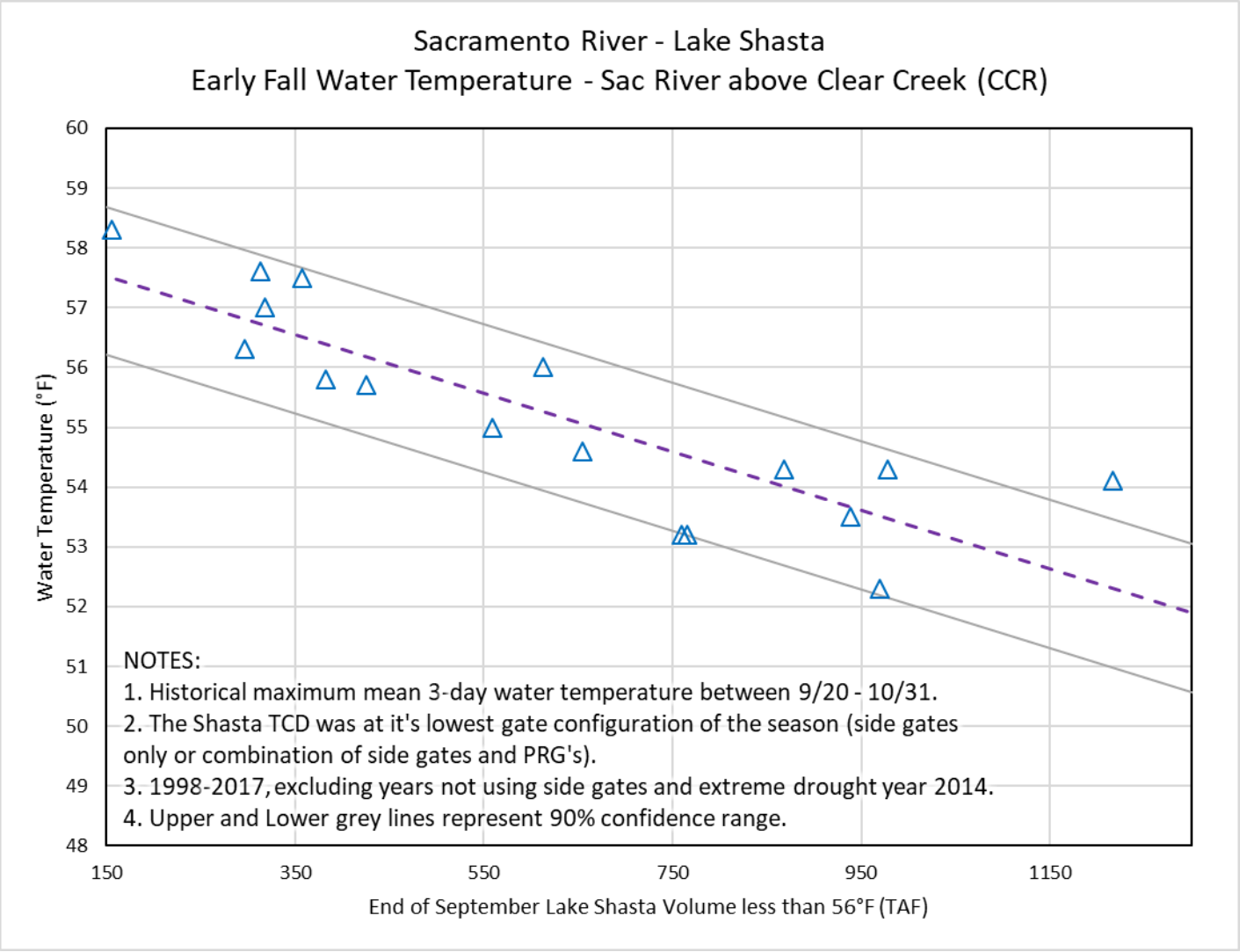


Figure 8. Historical relationship between Lake Shasta cold-water-pool characteristics and early fall Sacramento River above Clear Creek confluence water temperature.

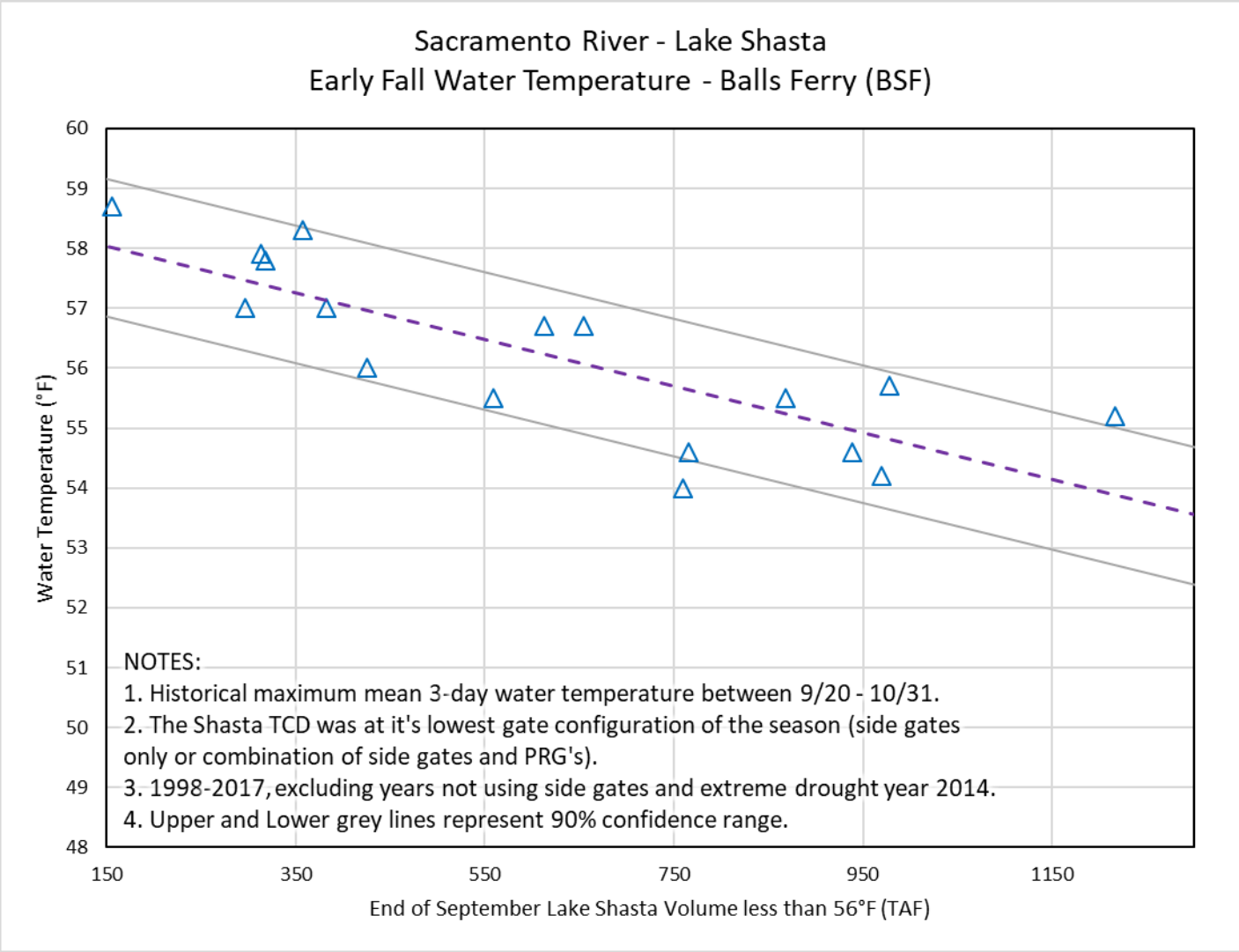


Figure 9. Historical relationship between Lake Shasta cold-water-pool characteristics and early fall Balls Ferry water temperature.

June 24, 2020

Upper Sacramento River – June 2020 Preliminary Temperature Analysis

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

Model Run	Location	Jun	Jul	Aug	Sep*	Oct*
90% Hydro. - 25% L3MTO Met. Scenario 148 -Reduce Keswick Release by 100 TAF in July	Keswick Dam KWK	52.9	53.5	53.2	See Fig. 2	See Fig. 2
	Sac. R. abv Clear Creek CCR	53.3	54.0	53.5	See Fig. 3	See Fig. 3
	Airport Road	53.7	54.7	54.1	n/a	n/a
	Balls Ferry BSF	54.7	55.8	55.0	See Fig. 4	See Fig. 4

Summary of Shasta Lake Cold Water Pool and TCD Operation

Model Run	End of September Cold Water Pool <56°F (TAF)	First Side Gate Use (Date)	Full Side Gate Use (Date)
90% Hydro. - 25% L3MTO Met. Scenario 148 -Reduce Keswick Release by 100 TAF in July	522	8/17	9/15

Model Run Date June 22, 2020

* The HEC5Q model output is displayed for the months April through August. 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.

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Temperature Analysis Results:

Modeling runs explore Sacramento River compliance performance above Clear Creek confluence and Balls Ferry locations by varying Shasta tailbay temperature targets. The temperature results for the Sacramento River between Keswick Dam and Balls Ferry are shown in Figures 1. The relationship between end-of-September lake volume below 56°F and a downstream Sacramento River compliance location through fall is based on the Figures 2-4.

Temperature Model Inputs, Assumptions, Limitations and Uncertainty:

1. The latest available profiles for Shasta, Trinity, and Whiskeytown were taken on June 17, June 11, and June 16, respectively. Initial temperature profiles are adjusted and noted at Whiskeytown and Trinity using simulated results if the length of time between monitoring is large. Model results are sensitive to initial reservoir temperature conditions and the model performs best under highly stratified conditions. The temperature profiles prior to May do not yet exhibit conditions for ideal model computations (still nearly isothermal conditions). The model performs well after the reservoir stratifies, typically in late spring (i.e. end of April). 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 into the future with confidence.
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6. Meteorological inputs represent historical (1985 – 2017) monthly mean equilibrium temperature non-exceedance at 25% and 50% (when available) patterned after like months on a 6-hour time-step (for months prior to April). Assumed inflows temperature remain static inputs and do not vary with the assumed meteorology. Tools to use local three-month-temperature outlooks (L3MTO), driven by the NOAA NWS Climate Prediction Center (CPC) are used beginning in April.

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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.

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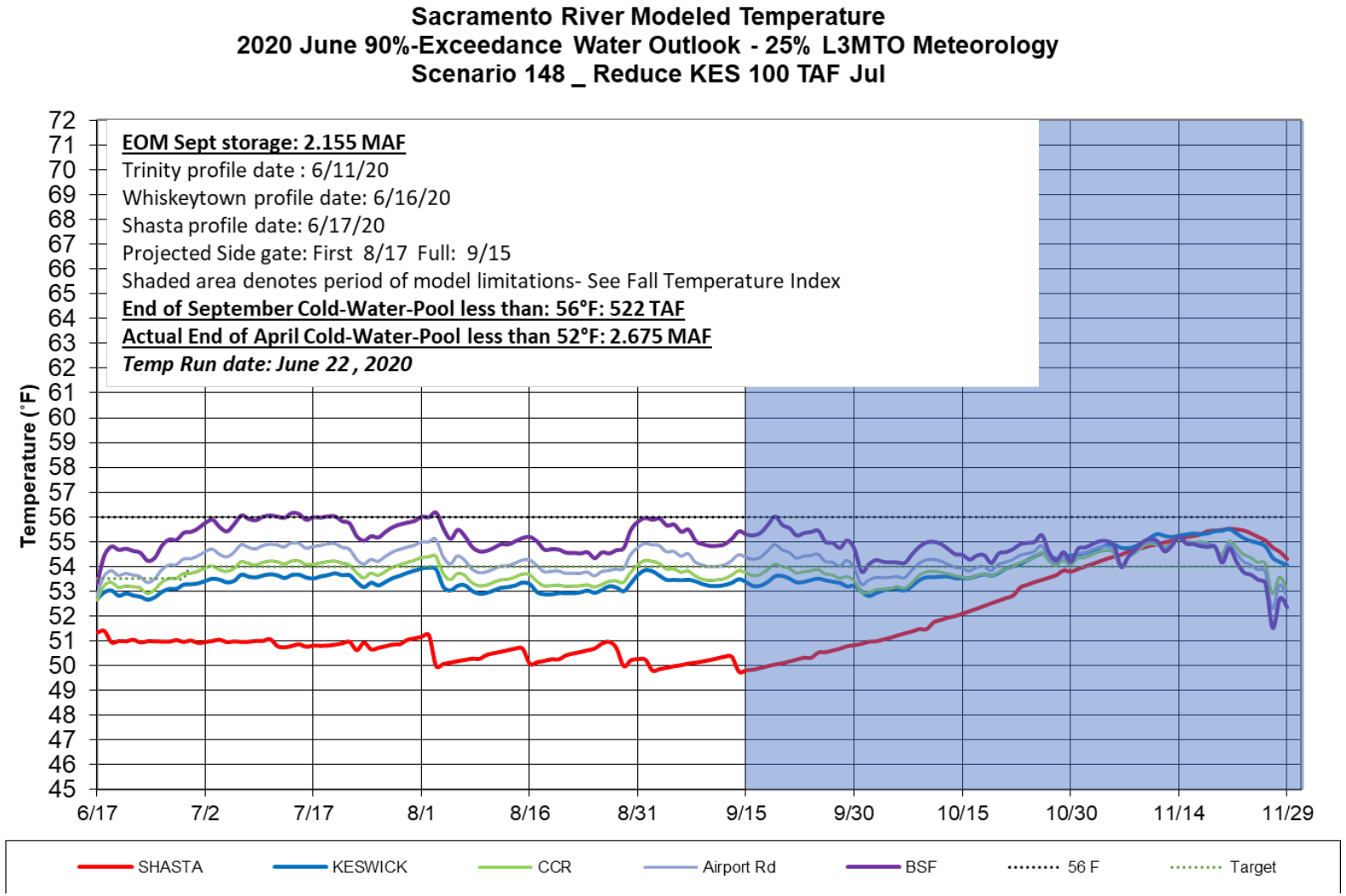

Figure 1. June 2020 simulated Sacramento River temperatures 90% runoff exceedance hydrology and 25% L3MTO meteorology Reduce Keswick release in July by 100 TAF.

Figures 2-4 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.
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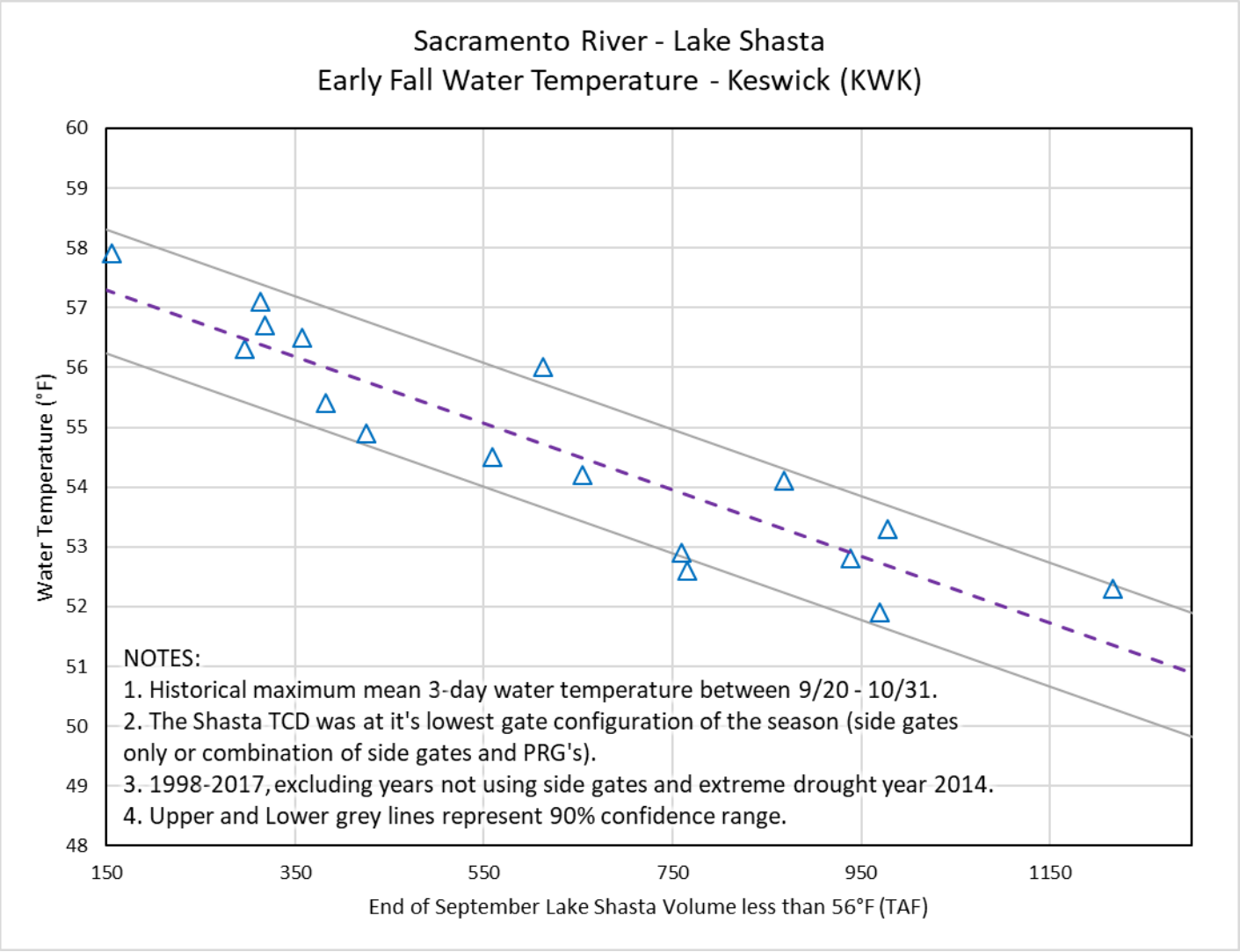


Figure 2. Historical relationship between Lake Shasta cold-water-pool characteristics and early fall Keswick water temperature.

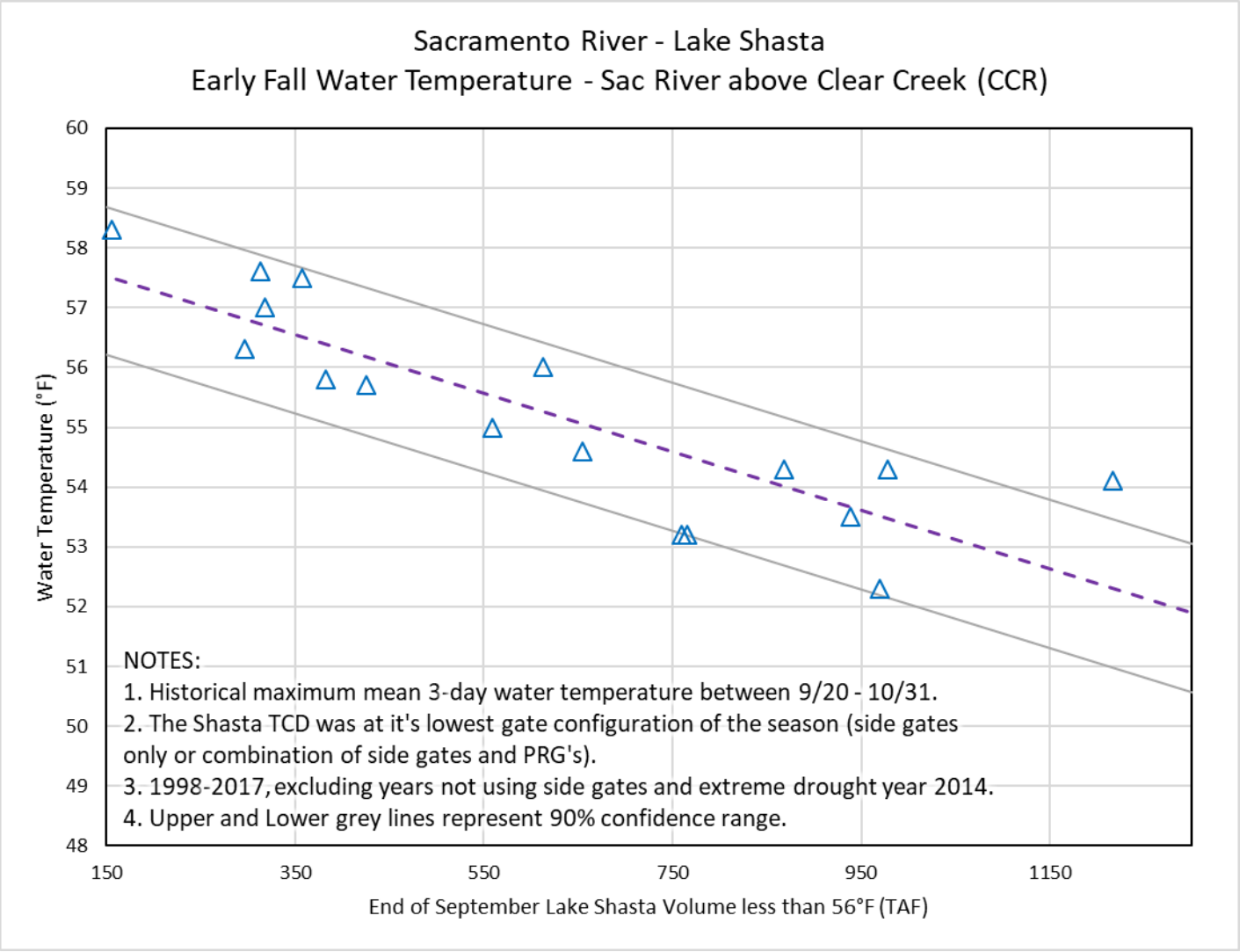


Figure 3. Historical relationship between Lake Shasta cold-water-pool characteristics and early fall Sacramento River above Clear Creek confluence water temperature.

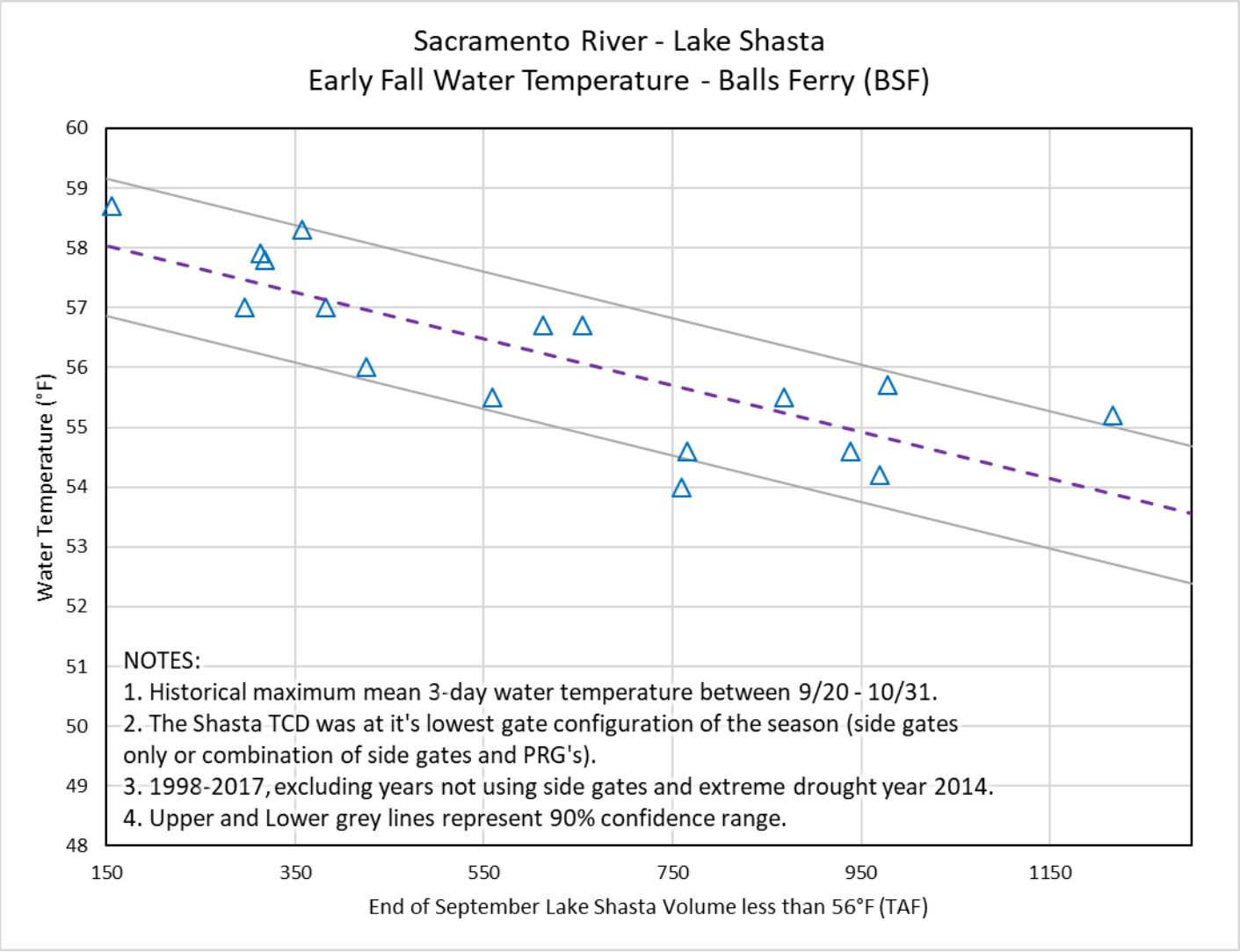


Figure 4. Historical relationship between Lake Shasta cold-water-pool characteristics and early fall Balls Ferry water temperature.

Summary Document for temperature-dependent egg mortality

Prepared by U.S. Bureau of Reclamation, Bay-Delta Office on June 24, 2020

Below are biological results from the temperature management scenarios run June 22, 2020. Spatially-explicit daily average Sacramento River water temperatures forecasts from the HEC-5Q model results are used as input to generate temperature-dependent egg mortality estimates. Water temperatures between Keswick (RKM 486) and Clear Creek (RKM 470) were linearly interpolated in space. At the State Board's request, redd data from 2007-2014 was used to estimate the average proportion of redds between rkm 480 and 414 for each two week period between May 15 and August 16 assuming spatial percentages applied the same to each period. Egg mortality estimates are calculated with the SacPAS Spawning to Emergence and In-River Migration model using the stage dependent temperature mortality method (Anderson 2018) and stage independent temperature mortality method (Martin et al. 2017) for the 2020 temperature management season.

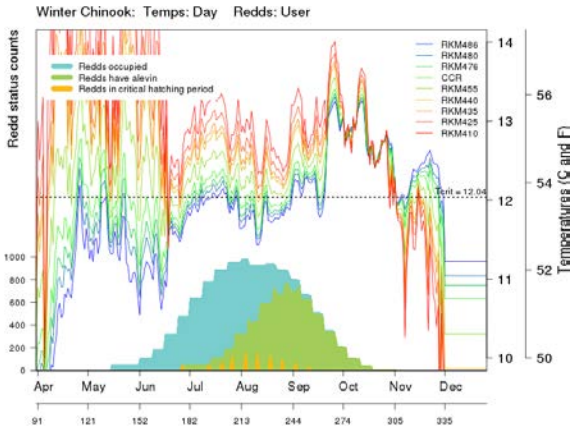
To run the model or review further details of modeling methods, visit:
http://www.cbr.washington.edu/sacramento/fishmodel/index.html

Table 1: Estimated temperature dependent egg mortality using Hec-5Q interpolated temperature model output and 2007-2014 spatial and temporal redd distribution.

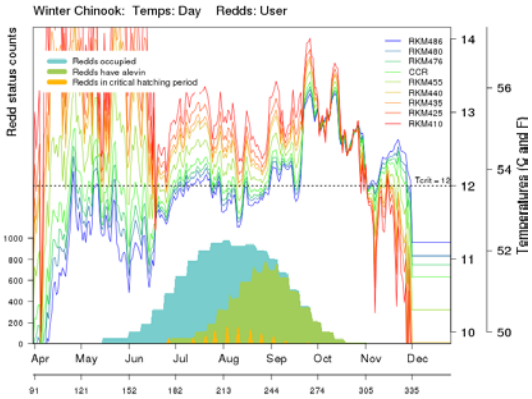
Scenario	**Stage Dependent Egg Mortality (%)**	**Stage Independent Egg Mortality (%)**
Scenario 148 – Delay Side Gate Use	12.4	25.1
Scenario 148 – Extend 53.5°F in August	7.3	19.1
Scenario 148 – Extend 54°F in September	11.3	17
Reduce Keswick Release by 100 TAF in July	15.3	12.8

Scenario 148- Delay Side Gate Use

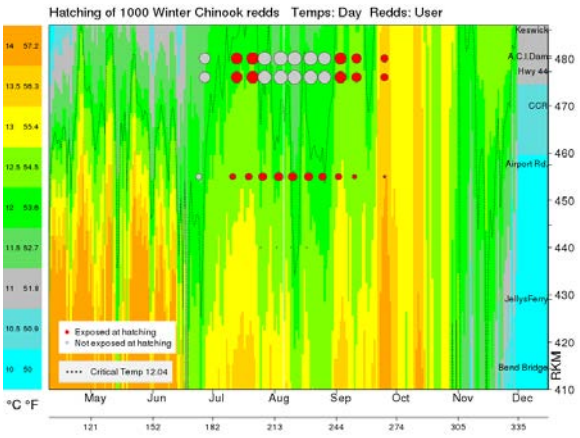
Plot 1. Modeled temperature and life stage development based on stage-dependent mortality method.



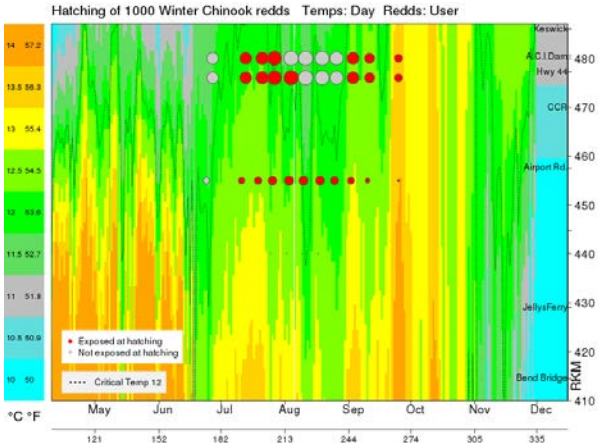
Plot 2. Modeled temperature and life stage development based on stage-independent mortality method.



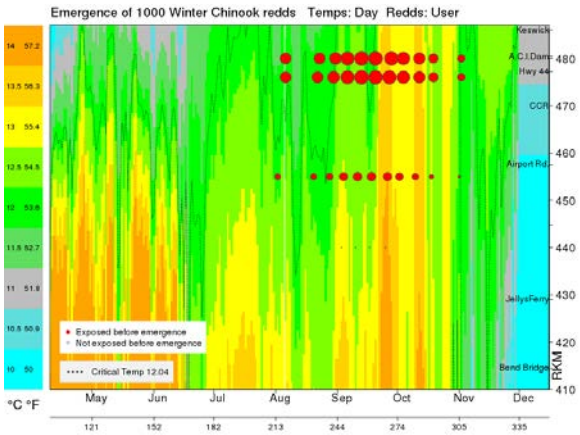
Plot 3. Stage-dependent mortality- exposure before hatch.



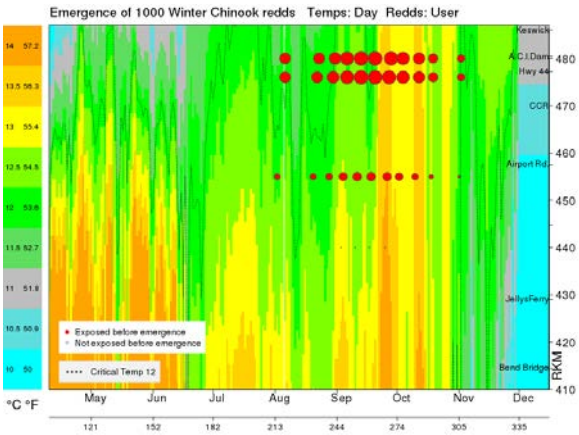
Plot 4. Stage-independent mortality- exposure before hatch.



Plot 5. Stage-dependent mortality- exposure before emergence.

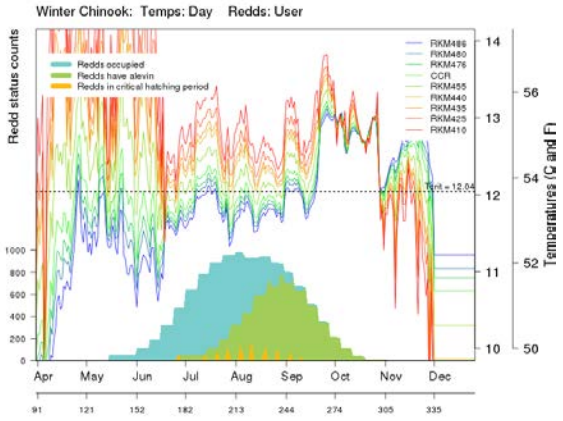


Plot 6. Stage-independent mortality- exposure before emergence.

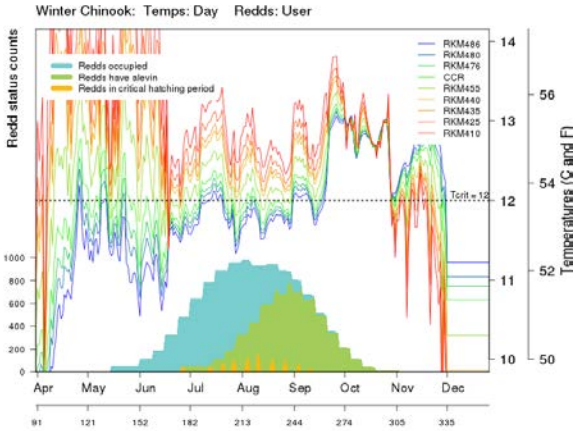


Scenario 148 – Extend 53.5°F in August

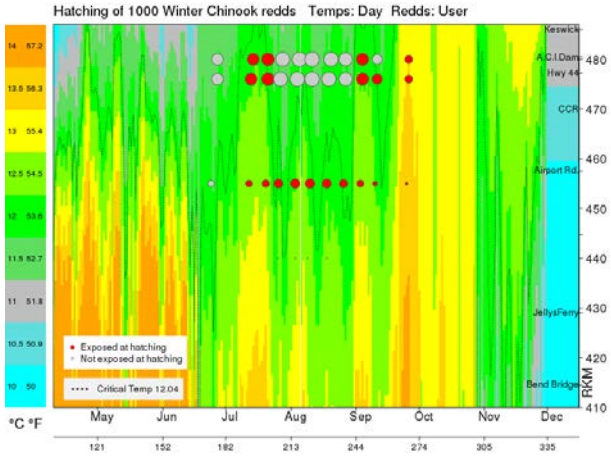
Plot 1. Modeled temperature and life stage development based on stage-dependent mortality method.



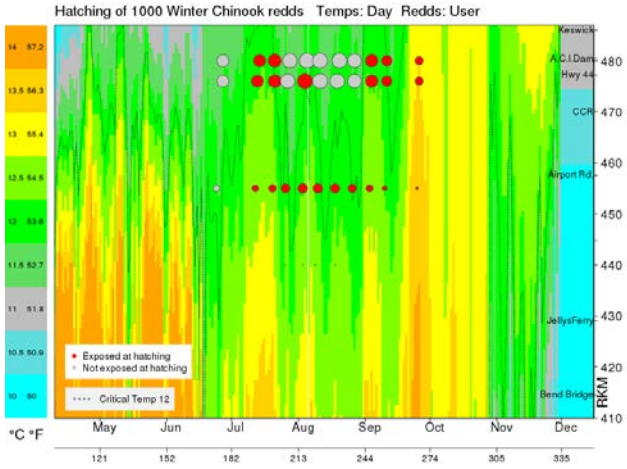
Plot 2. Modeled temperature and life stage development based on stage-independent mortality method.



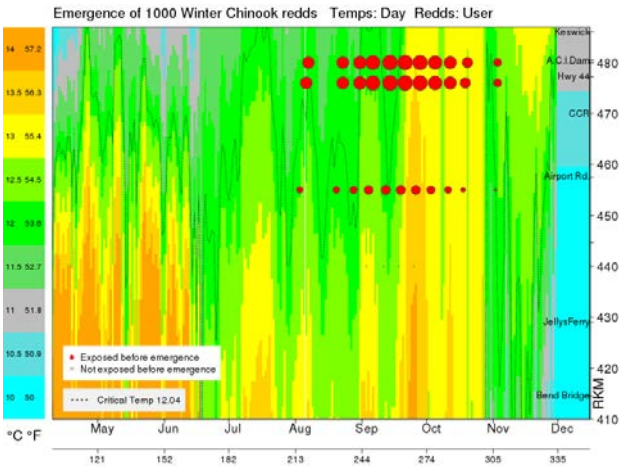
Plot 3. Stage-dependent mortality- exposure before hatch.



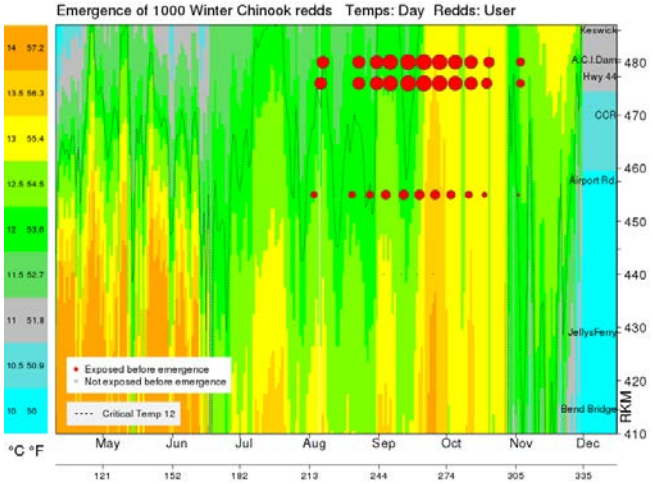
Plot 4. Stage-independent mortality- exposure before hatch.



Plot 5. Stage-dependent mortality- exposure before emergence.

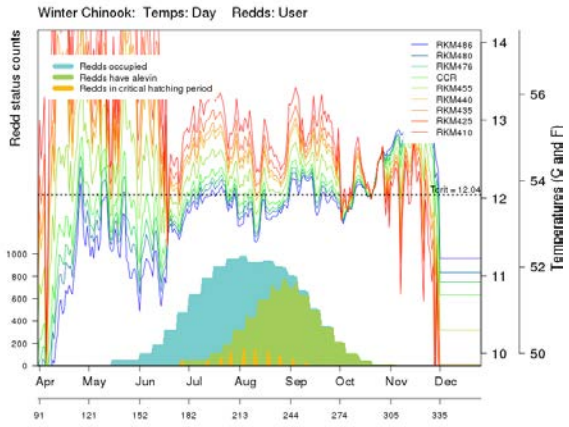


Plot 6. Stage-independent mortality- exposure before emergence.

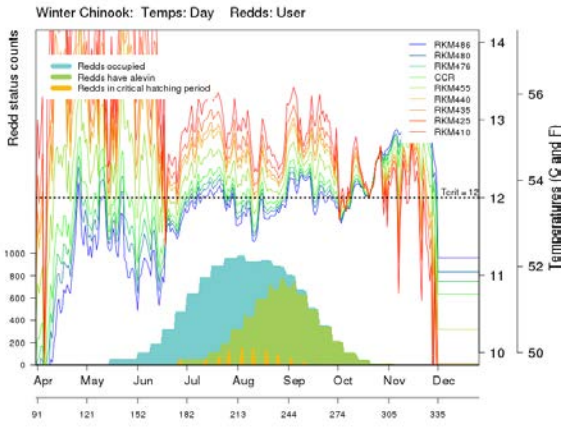


Scenario 148 – Extend 54°F in September

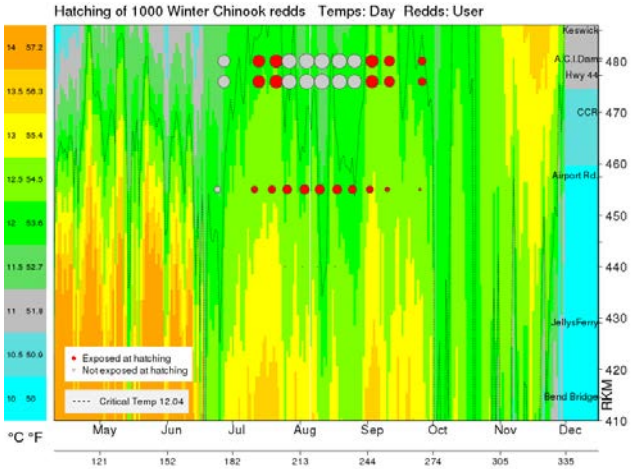
Plot 1. Modeled temperature and life stage development based on stage-dependent mortality method.



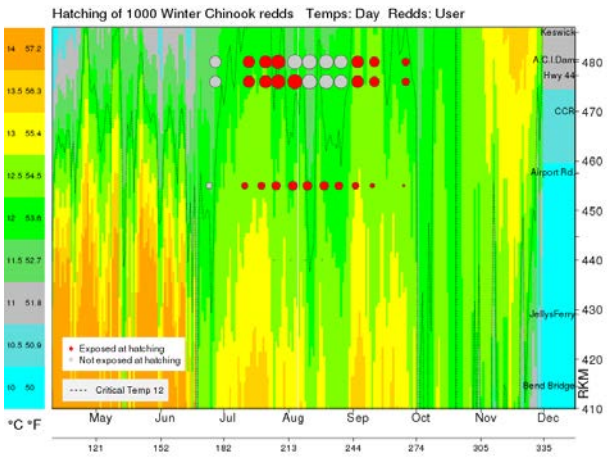
Plot 2. Modeled temperature and life stage development based on stage-independent mortality method.



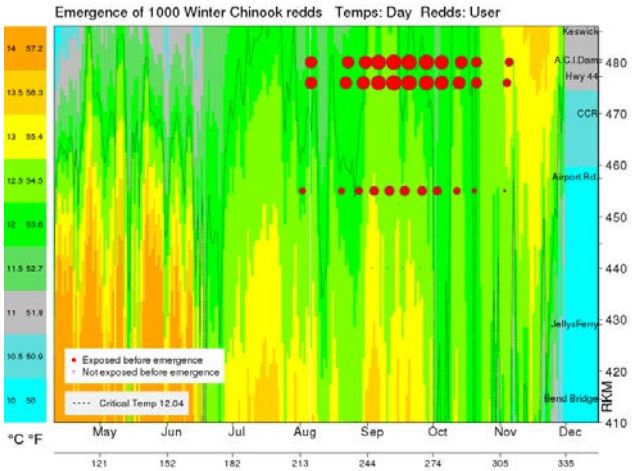
Plot 3. Stage-dependent mortality- exposure before hatch.



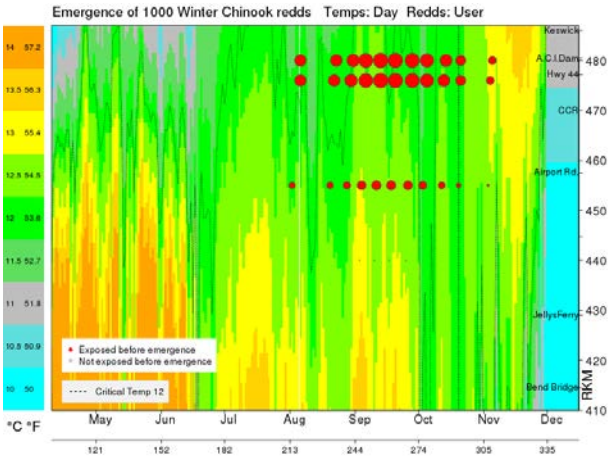
Plot 4. Stage-independent mortality- exposure before hatch.



Plot 5. Stage-dependent mortality- exposure before emergence.

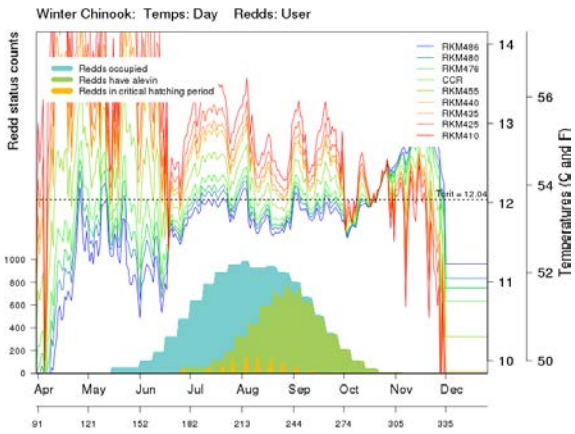


Plot 6. Stage-independent mortality- exposure before emergence.

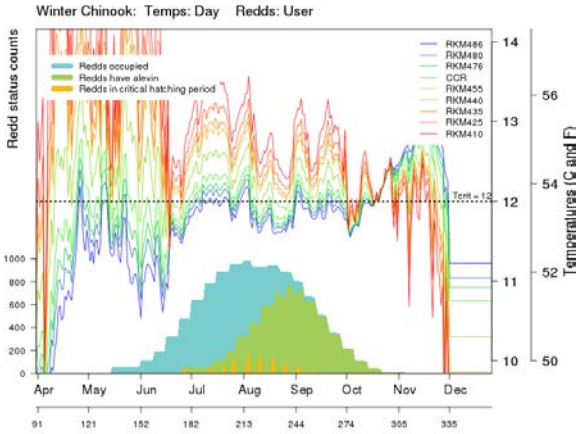


Reduce Keswick Release by 100 TAF in July

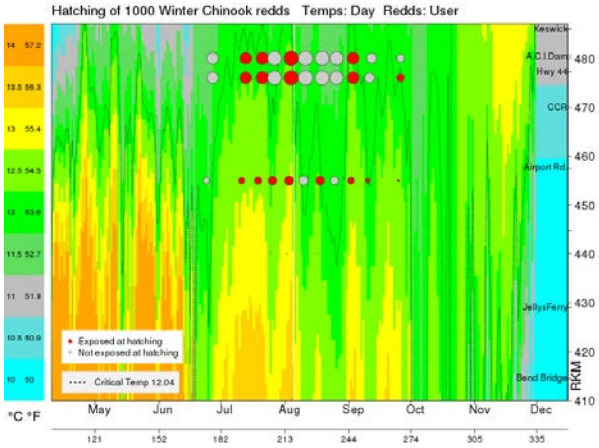
Plot 1. Modeled temperature and life stage development based on stage-dependent mortality method.



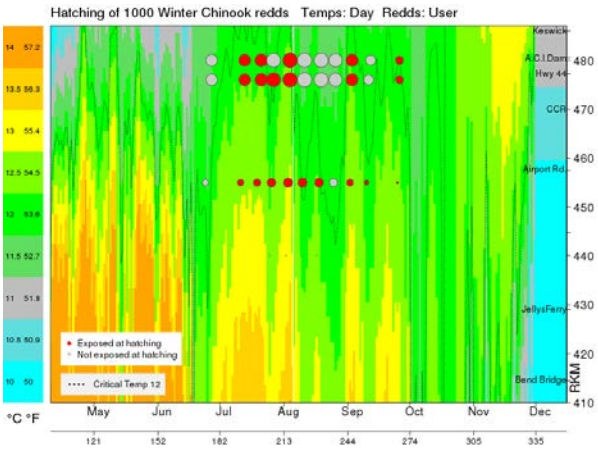
Plot 2. Modeled temperature and life stage development based on stage-independent mortality method.



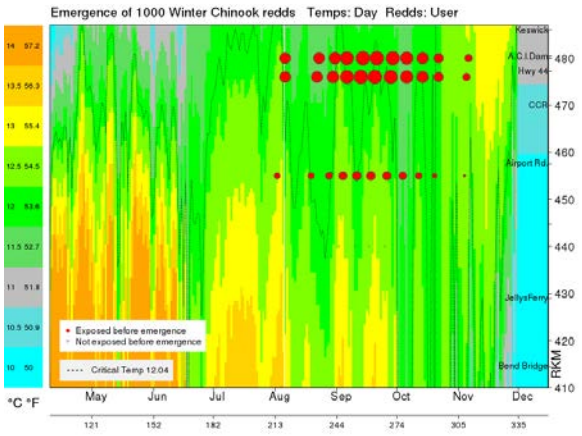
Plot 3. Stage-dependent mortality- exposure before hatch.



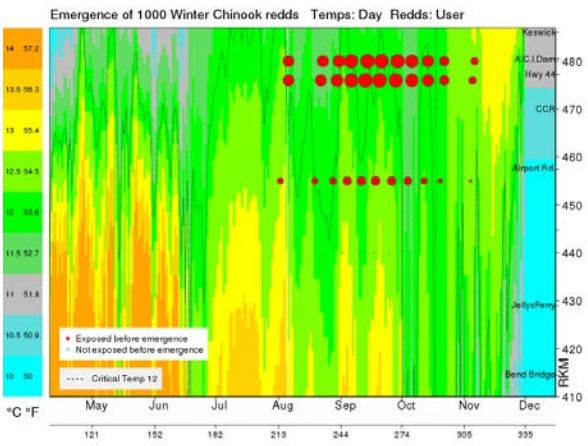
Plot 4. Stage-independent mortality- exposure before hatch.



Plot 5. Stage-dependent mortality- exposure before emergence.



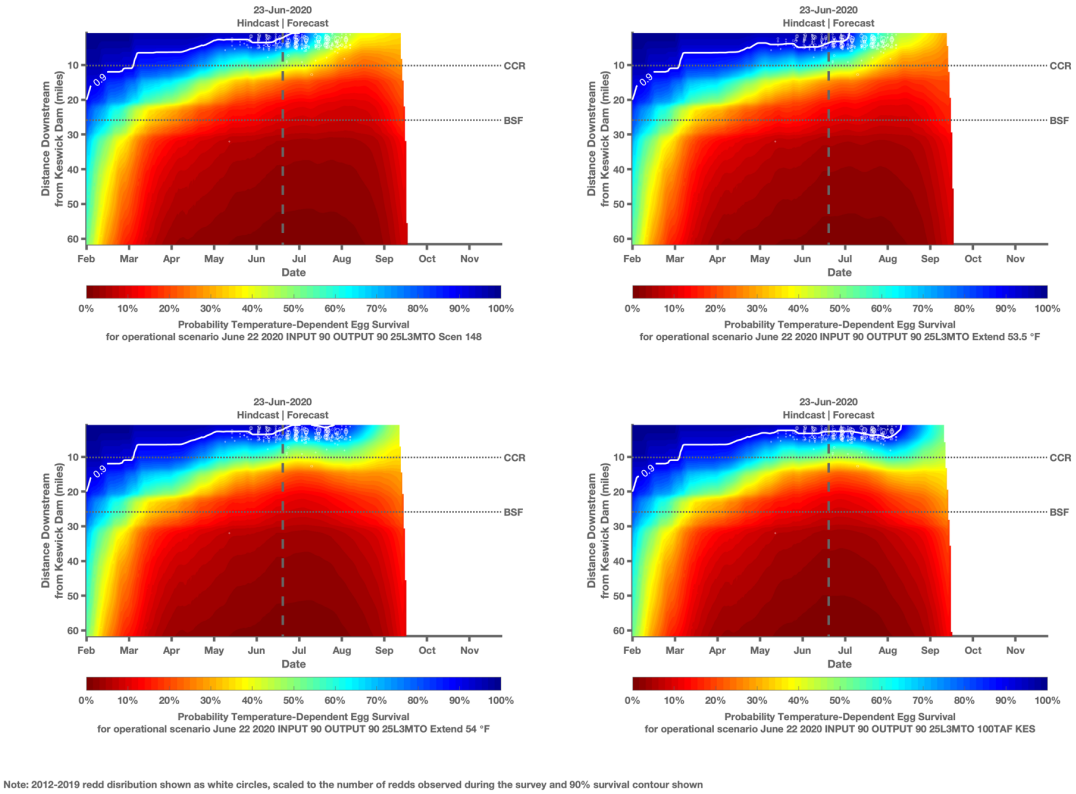
Plot 6. Stage-independent mortality- exposure before emergence.



Summary Document for Shasta/Keswick Operational Scenarios
Prepared by the Southwest Fisheries Science Center on June 23rd, 2020

Below are results comparing four USBR scenarios ran June 23rd 2020. Scenarios have the same hydrology (Input 90% exceedance) and air temperature (25% exceedance of L3MTO) inputs. Inputs from scenarios are used to generate daily average Sacramento River water temperatures using the RAFT model and associated temperature-dependent egg mortality and survival estimates using the NMFS temperature mortality model (Martin et al. 2017) for the 2020 temperature management season.

Further details of modeling methods are at: https://oceanview.pfeg.noaa.gov/CVTEMP/



Note: 2012-2019 redd disribution shown as white circles, scaled to the number of redds observed during the survey and 90% survival contour shown

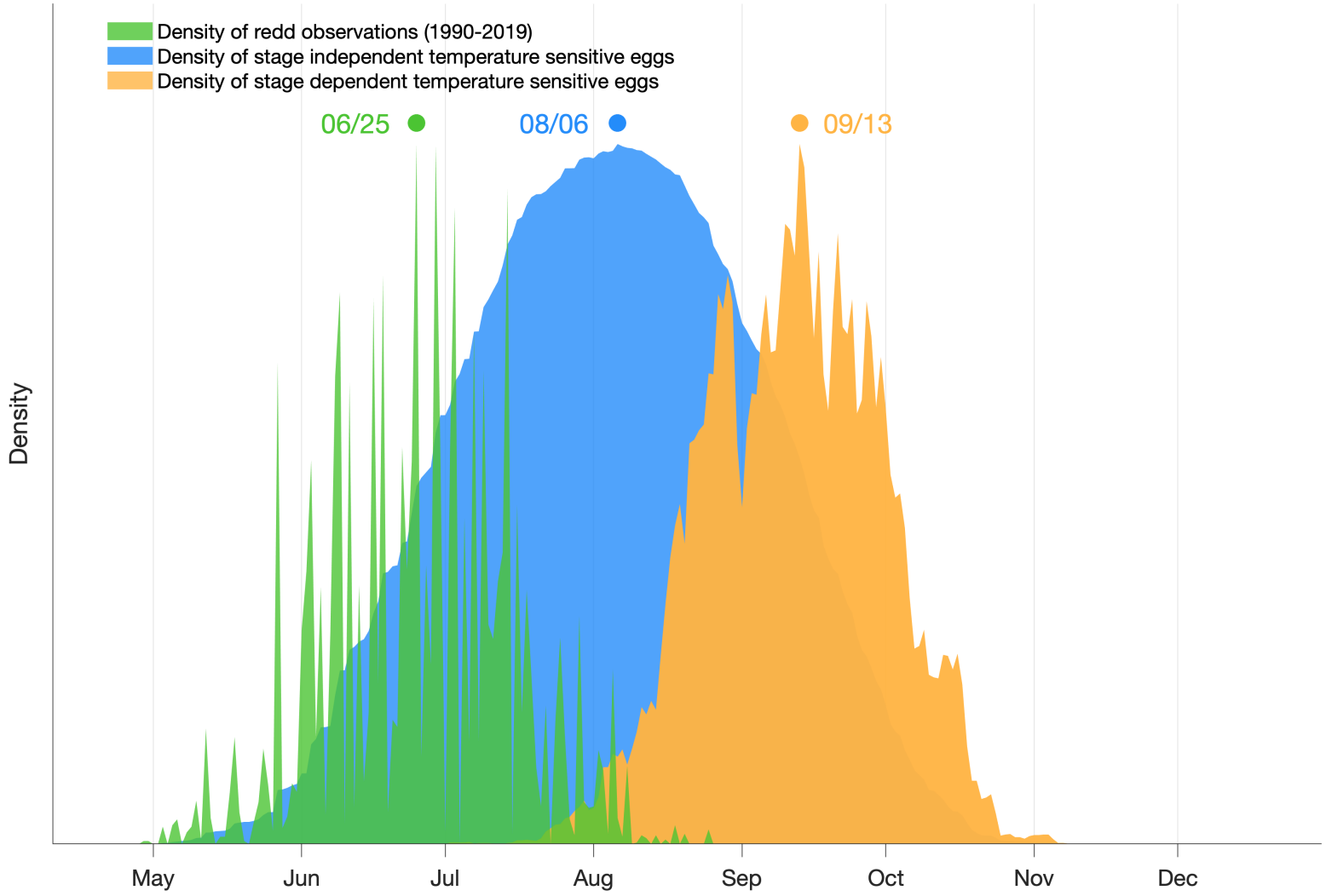
Figure1: Estimated temperature-dependent egg survival produced by the NMFS temperature mortality model under the four June 22nd 2020 scenarios. Note that plots are using 2012-2019 redd distributions.

Table 1: Estimated temperature-dependent egg mortality under different scenarios assuming a 2012-2019 spatial and temporal redd distribution using output from RAFT model.

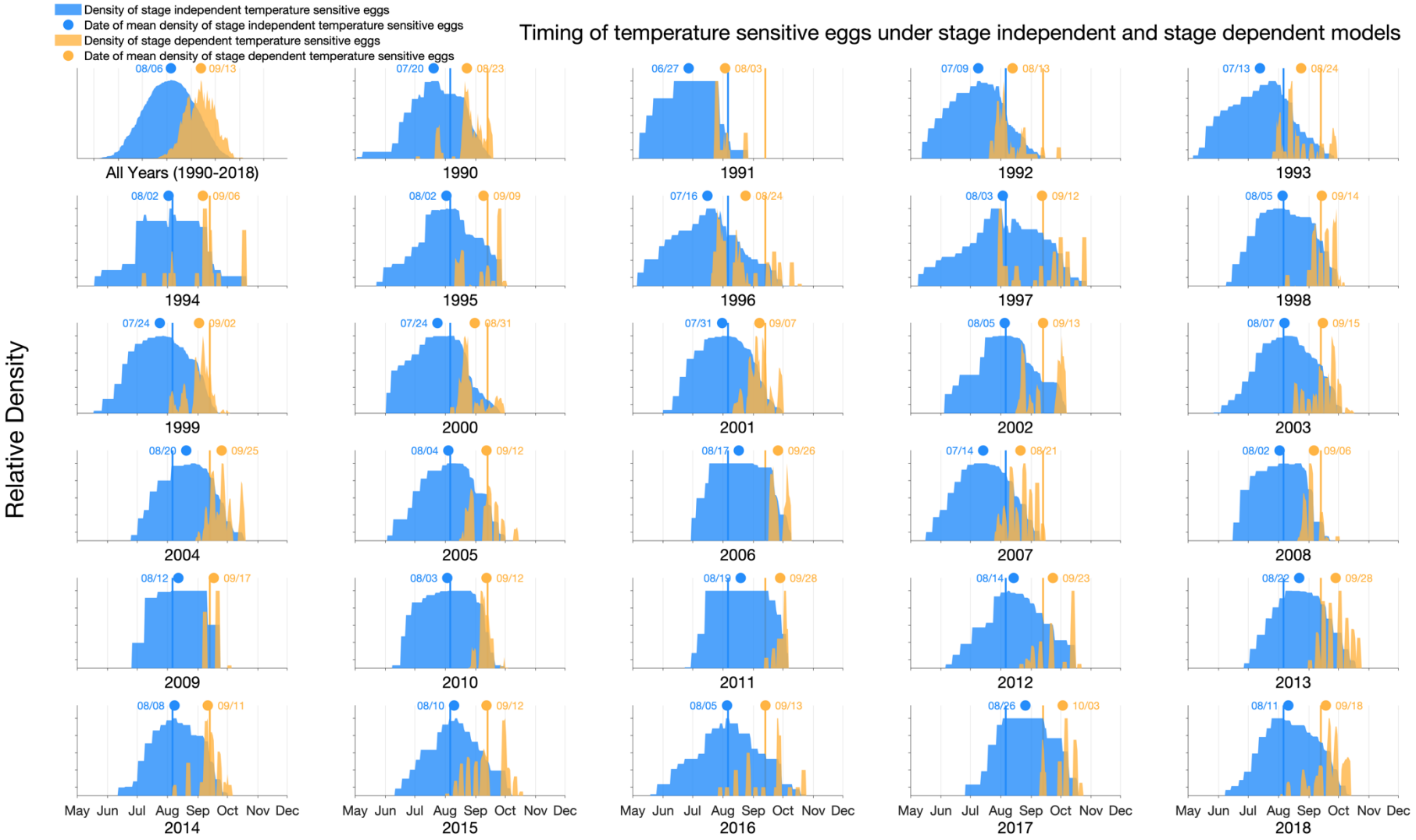
Scenario	MODEL	Mean (%)	Median (%)	Lower (%)	Upper (%)
JUNE_22_2020_INPUT_90_OUTPUT_90_25L3MTO **Scenario 148**	RAFT	34.9	33.83	0.27	71.34
JUNE_22_2020_INPUT_90_OUTPUT_90_25L3MTO **Scenario Extend 53.5 °F**	RAFT	29.92	26.96	0.18	68.83
JUNE_22_2020_INPUT_90_OUTPUT_90_25L3MTO **Scenario Extend 54 °F**	RAFT	26.23	22.43	0.11	68.88
JUNE_22_2020_INPUT_90_OUTPUT_90_25L3MTO **100TAF KES**	RAFT	22.1	16.33	0.11	66.96

Reference: Martin, B. T., Pike, A., John, S. N., Hamda, N., Roberts, J., Lindley, S. T. and Danner, E. M. (2017), Phenomenological vs. biophysical models of thermal stress in aquatic eggs. Ecology Letters 20: 50–59. doi:10.1111/ele.12705

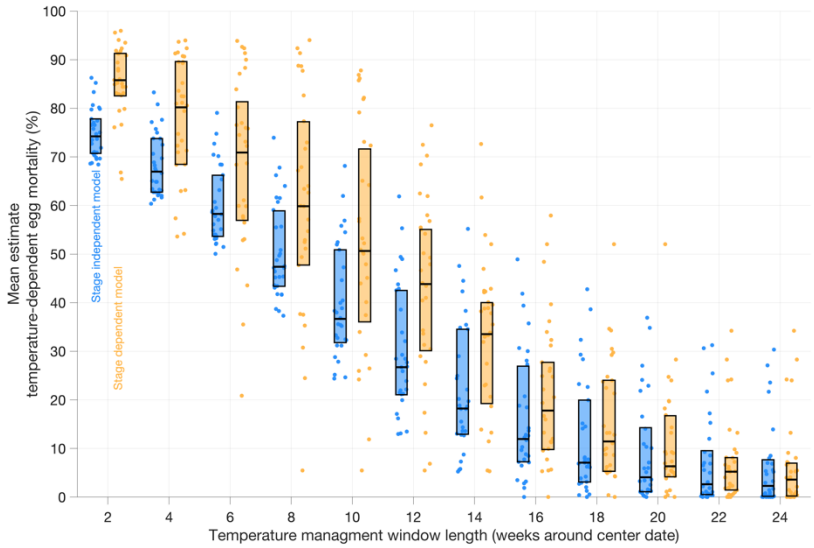
Three dates or "peaks" to keep in mind related to temperature-dependent mortality (TDM) models



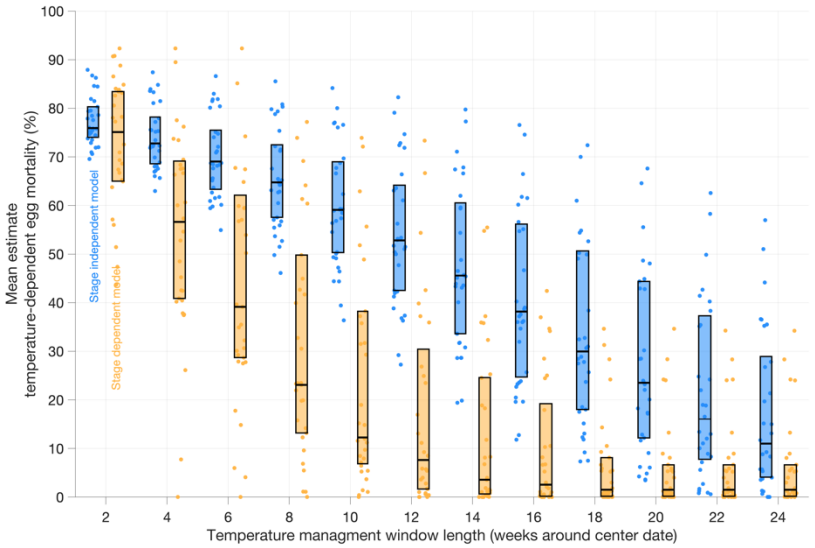
Peaks for center dates vary over 1990-2018 redd distributions



Disagreement between TDM models is greatest when managing to stage dependent center date



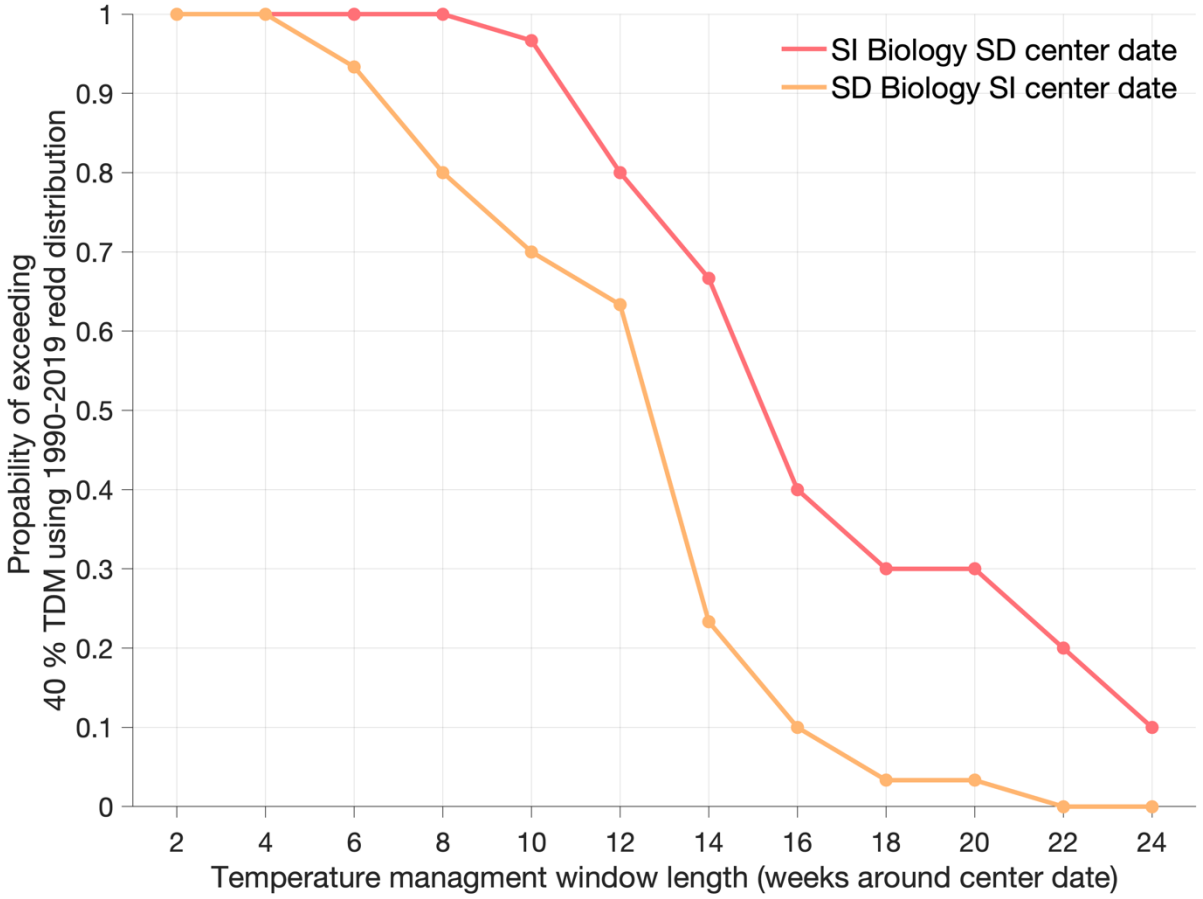
Managed to stage independent center date (Aug 6th)



Managed to stage dependent center date (Sept 13th)

*variability associated with 1990-2019 redd distribution under CCR 53.5 ˚F target and 56 ˚F exceedance

If biology of alternate model is correct, the probably of exceeding a given TDM value is larger when using a stage dependent center date



CEQUAL-W2 Shasta Lake Temperature Analysis: Scenario 148

Watercourse Engineering Inc. June 8, 2020

REVISED Figure 1 to include TCD leakage. June 23, 2020

As part of an on-going collaborative effort in partnership with Sacramento River Settlement Contractors and members of the Upper Sacramento River Temperature Technical Modeling Committee, Watercourse Engineering Inc. has developed a calibrated CEQUAL-W2 temperature model of Shasta Lake and Keswick Reservoir. These models do not simulate Sacramento River water temperatures downstream of Keswick Dam. By request of U.S. Bureau of Reclamation, a comparison simulation of the final 2020 Temperature Management Plan Scenario 148 was performed using the Shasta Lake model to simulate tailbay temperatures. The CEQUAL-W2 simulation utilizes the information available to the May 20, 2020 HEC-5Q temperature simulation:

- Simulation period: 5/13/20 – 11/30/20
- Shasta temperature profile: 5/13/20
- Hydrology: 90% inflow exceedance
- Operations: CVP 90% May 2020 Operations Outlook
- Meteorology: Meteorology was based on calculated thermal loading conditions and represents "adverse" meteorological conditions as they relate to water temperature season in years 2000-2018. Out of this period 2009 represented the most adverse conditions and was used as an analog for 25% exceedance
- Shasta Tailbay Temperature target: Scenario 148

The results (Figure 1) describe the performance of Shasta Lake outflow temperature (Sim.) compared to the Shasta Tailbay temperature target (Twtrgt) (Primary y-axis). The results also describe the utilization of the Shasta Temperature Control Device (TCD) Upper gates (TCDU), TCD Middle gates (TCDM), TCD Lower or Pressure Relief gates (TCDL), and TCD Side gates (TCDS) (Secondary y-axis). The final parameter presented is total Shasta Dam outflow (Tot. Qout) (Secondary y-axis). The projected first Side gate use is on 8/25/20.

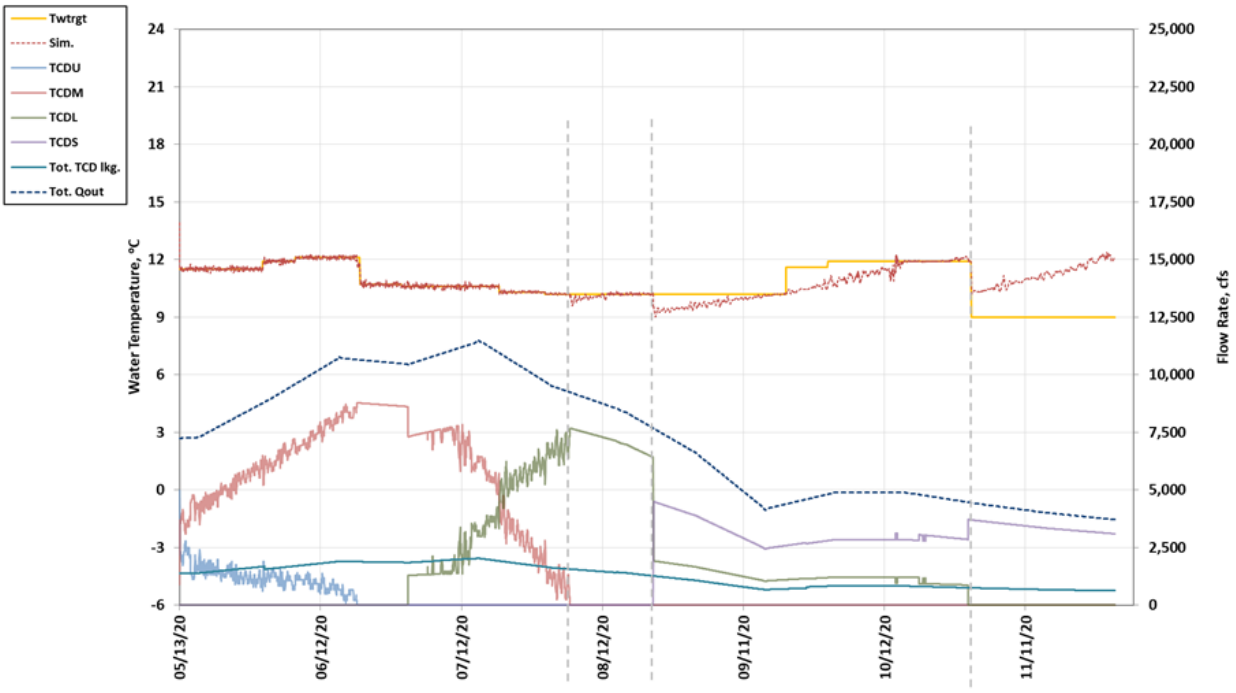
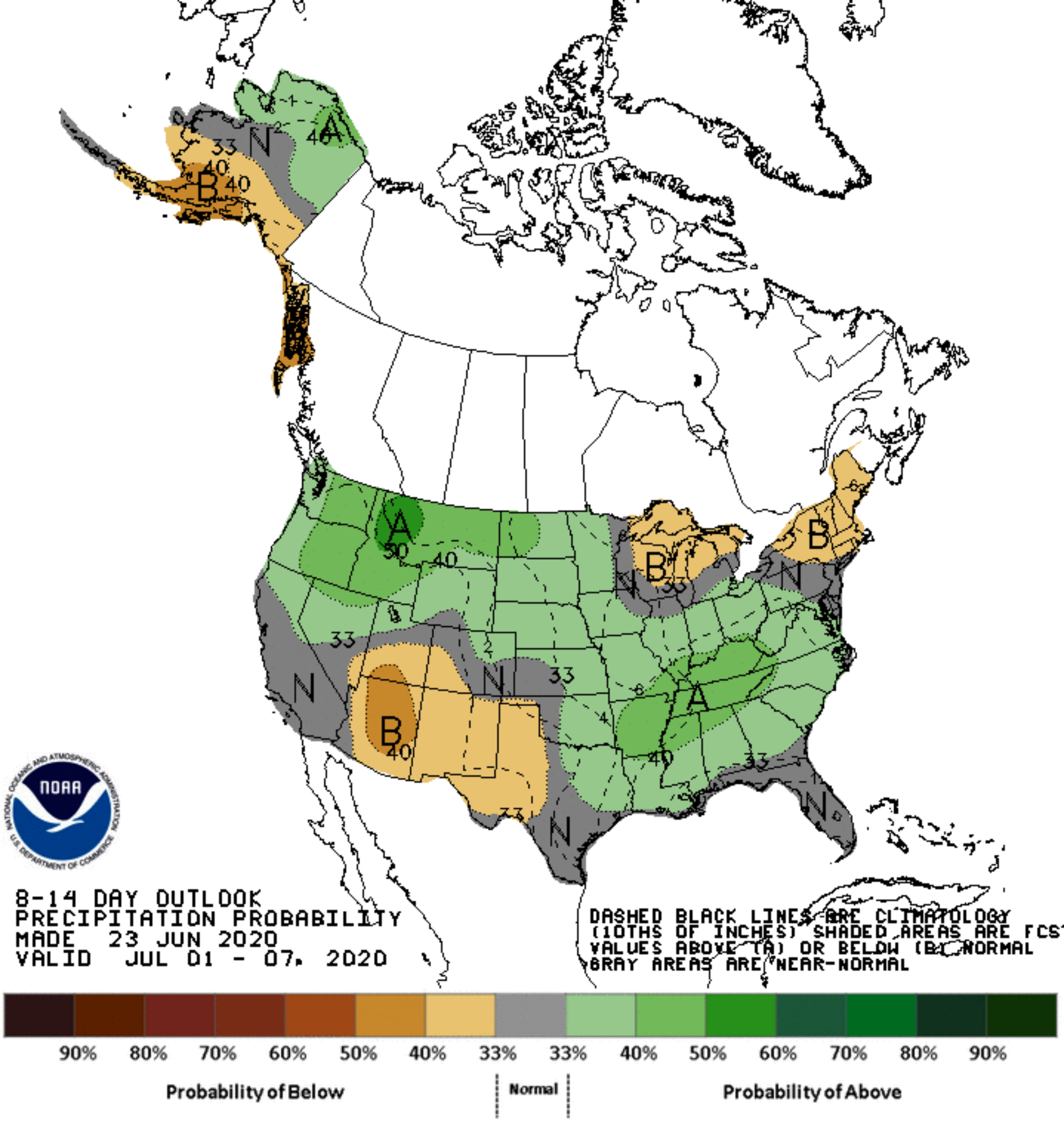
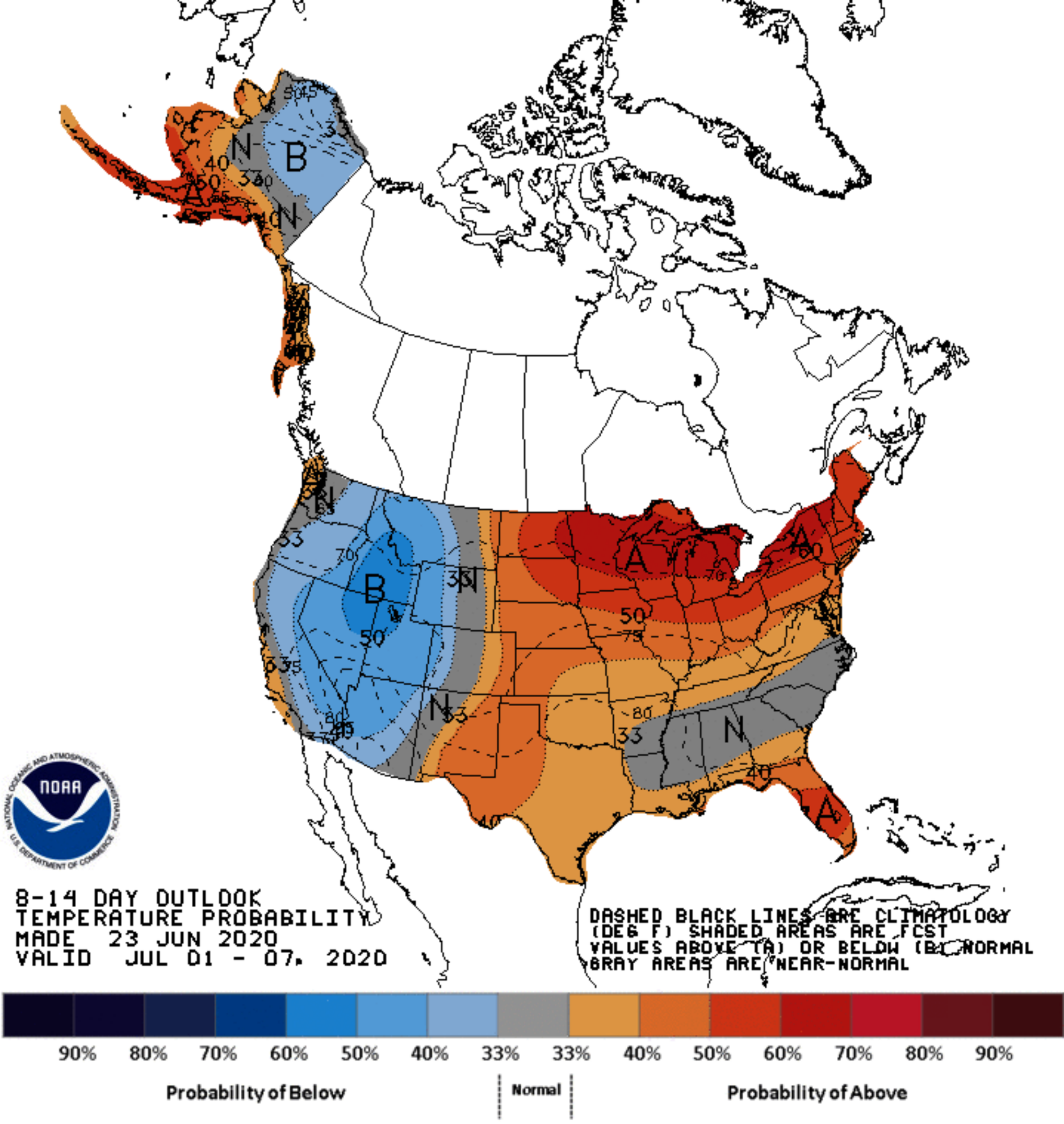


Figure 1. CEQUAL-W2 Shasta Lake Simulation of Scenario 148


8-14 DAY OUTLOOK
PRECIPITATION PROBABILITY
MADE 23 JUN 2020
VALID JUL 01 - 07, 2020
DASHED BLACK LINES ARE CLIMATOLOGY
(10THS OF INCHES) SHADED AREAS ARE FCS
VALUES ABOVE (A) OR BELOW (B) NORMAL
GRAY AREAS ARE NEAR-NORMAL
NOAA
90% 80% 70% 60% 50% 40% 33% 33% 40% 50% 60% 70% 80% 90%
Probability of Below
Normal
Probability of Above


8-14 DAY OUTLOOK
TEMPERATURE PROBABILITY
MADE 23 JUN 2020
VALID JUL 01 - 07, 2020
DASHED BLACK LINES ARE CLIMATOLOGY (DEG F) SHADED AREAS ARE FCST VALUES ABOVE (A) OR BELOW (B) NORMAL
GRAY AREAS ARE NEAR-NORMAL
90% 80% 70% 60% 50% 40% 33% 33% 40% 50% 60% 70% 80% 90%
Probability of Below
Normal
Probability of Above