BUREAU OF RECLAMATION

Sacramento River Temperature Task Group

Thursday, May 28, 2020 1:00 pm – 3:00 pm

Conference Call:

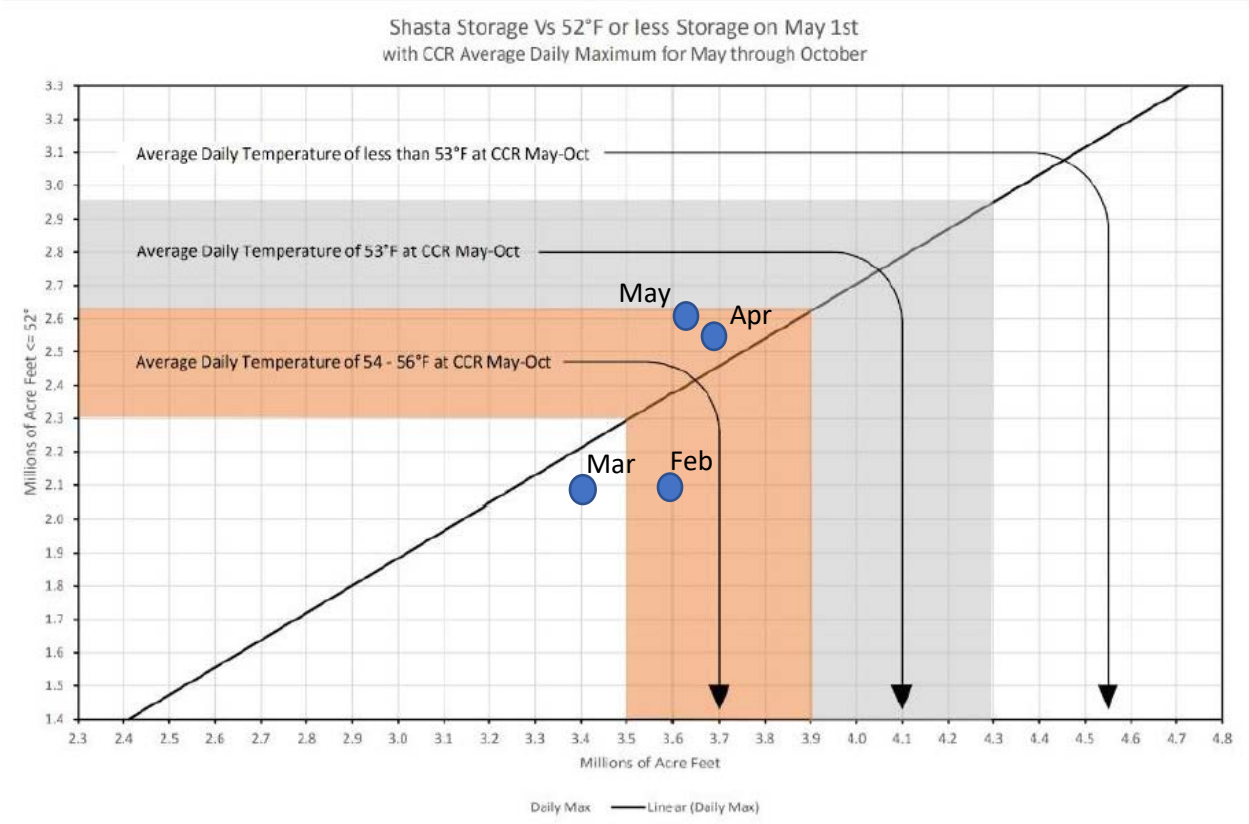
+1(623)4049000

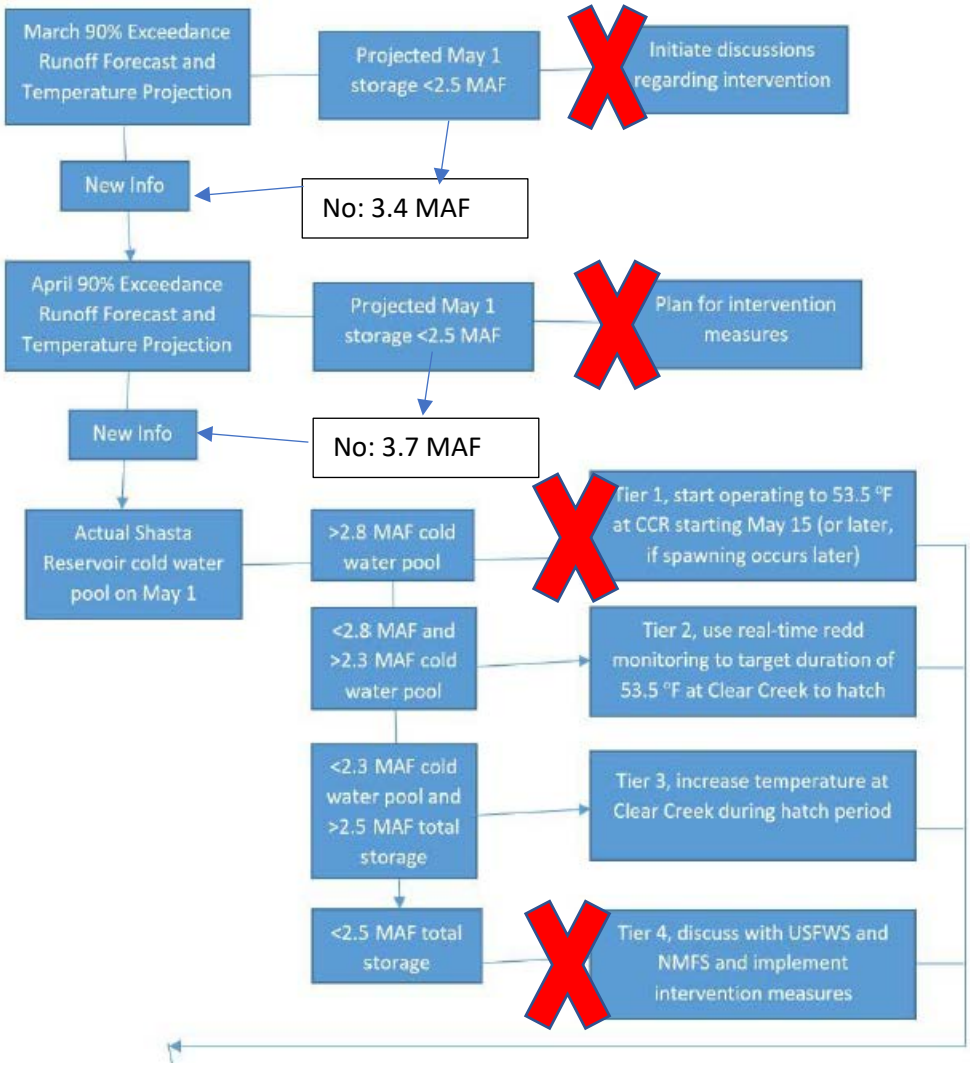
Meeting ID: 1497574502# (US West)

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. 2020 Meeting Logistics
5. Communications
6. Long Term Operations Implementation - Update
7. Hydrology Update
8. Operations Update and Forecasts
    a. Storage/Release Management Conditions
    b. Temperature Management
    c. Temperature Dependent Mortality
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


Shasta Storage Vs 52°F or less Storage on May 1st
with CCR Average Daily Maximum for May through October
Average Daily Temperature of less than 53°F at CCR May-Oct
Average Daily Temperature of 53°F at CCR May-Oct
Average Daily Temperature of 54 - 56°F at CCR May-Oct
May
Apr
Mar
Feb
Millions of Acre Feet <= 52°
Millions of Acre Feet
Daily Max
Linear (Daily Max)


March 90% Exceedance Runoff Forecast and Temperature Projection
Projected May 1 storage <2.5 MAF
Initiate discussions regarding intervention
New Info
No: 3.4 MAF
April 90% Exceedance Runoff Forecast and Temperature Projection
Projected May 1 storage <2.5 MAF
Plan for intervention measures
New Info
No: 3.7 MAF
Actual Shasta Reservoir cold water pool on May 1
>2.8 MAF cold water pool
Tier 1, start operating to 53.5 °F at CCR starting May 15 (or later, if spawning occurs later)
<2.8 MAF and >2.3 MAF cold water pool
Tier 2, use real-time redd monitoring to target duration of 53.5 °F at Clear Creek to hatch
<2.3 MAF cold water pool and >2.5 MAF total storage
Tier 3, increase temperature at Clear Creek during hatch period
<2.5 MAF total storage
Tier 4, discuss with USFWS and NMFS and implement intervention measures

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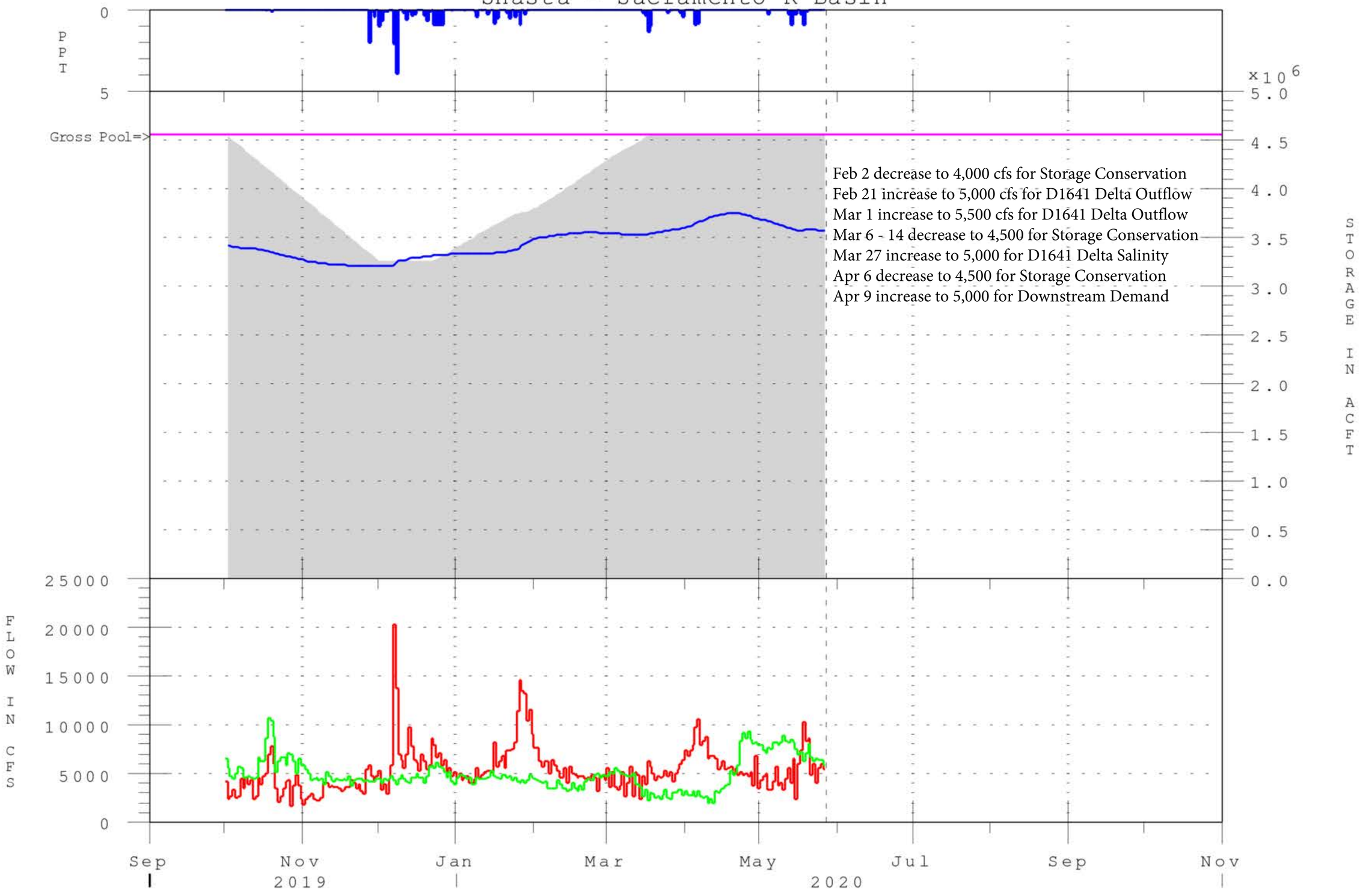
Shasta - Sacramento R Basin



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

DAILY CVP WATER SUPPLY REPORT

MAY 26, 2020

RUN DATE: May 27, 2020

RESERVOIR RELEASES IN CUBIC FEET/SECOND

RESERVOIR	DAM	WY 2019	WY 2020	15 YR MEDIAN
TRINITY	LEWISTON	2,798	881	2,798
SACRAMENTO	KESWICK	8,083	7,956	9,499
FEATHER	OROVILLE (SWP)	6,000	2,050	2,050
AMERICAN	NIMBUS	7,301	1,180	3,179
STANISLAUS	GOODWIN	1,000	1,504	1,000
SAN JOAQUIN	FRIANT	6,487	431	452

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	1,844	2,381	1,874	102
SHASTA	4,552	3,742	4,456	3,567	95
FOLSOM	977	808	928	778	96
NEW MELONES	2,420	1,545	2,028	1,855	120
FED. SAN LUIS	966	589	754	444	75
TOTAL NORTH CVP	11,363	8,527	10,547	8,518	100
MILLERTON	520	370	428	442	120
OROVILLE (SWP)	3,538	2,674	3,430	2,447	91

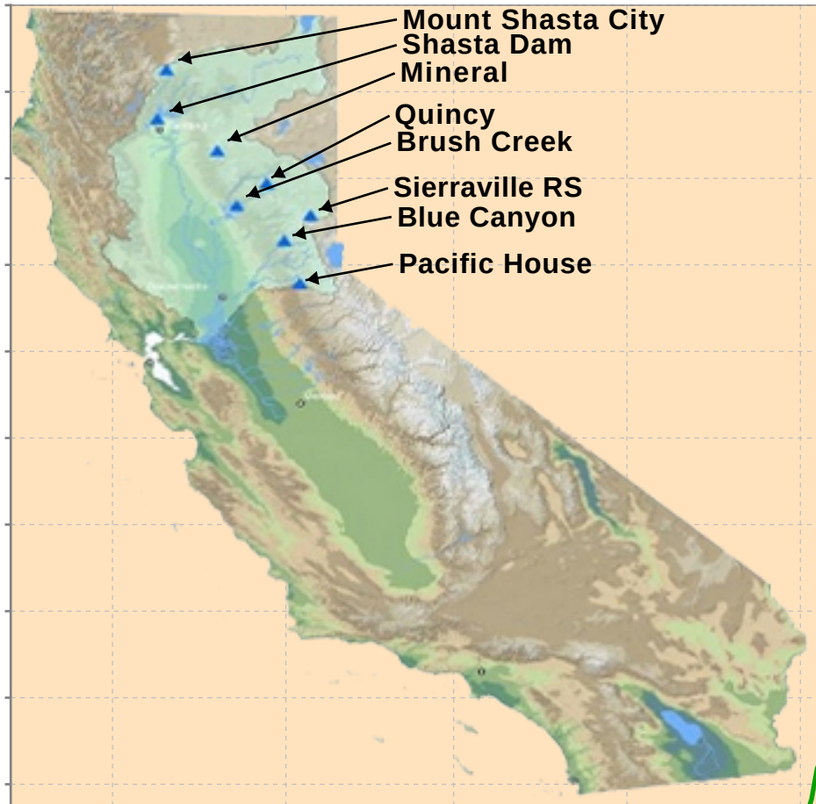
ACCUMULATED INFLOW FOR WATER YEAR TO DATE IN THOUSANDS OF ACRE-FEET

RESERVOIR	CURRENT WY 2020	WY 1977	WY 1983	15 YR AVG	% OF 15 YR AVG
TRINITY	404	156	1,881	973	42
SHASTA	2,521	1,782	9,028	4,245	59
FOLSOM	1,119	264	4,851	2,139	52
NEW MELONES	471	----	1,575	750	63
MILLERTON	599	127	2,349	915	65

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	18.12	12.52	54.59	30.24 (58)	60	0.00
SACRAMENTO AT SHASTA DAM	33.26	17.02	112.07	59.35 (63)	56	0.00
AMERICAN AT BLUE CANYON	39.33	15.64	103.28	64.42 (45)	61	0.00
STANISLAUS AT NEW MELONES	22.32	----	45.33	26.79 (42)	83	0.00
SAN JOAQUIN AT HUNTINGTON LK	28.25	16.30	80.80	40.16 (45)	70	0.00

Northern Sierra Precipitation: 8-Station Index, May 27, 2020



Percent of Average for this Date: 63%

2016-2017 Daily Precip (wettest) 94.7

1982-1983 (2nd wettest) 88.5

1997-1998 82.4

2018-2019 Daily Precip 70.7

Average (1966-2015) 51.8

2017-2018 Daily Precip 41.0

2014-2015 Daily Precip 37.2

Current: 31.0

1976-1977(2nd driest & driest thru Aug) 19.0

Cumulative Daily/Monthly Precipitation (inches)

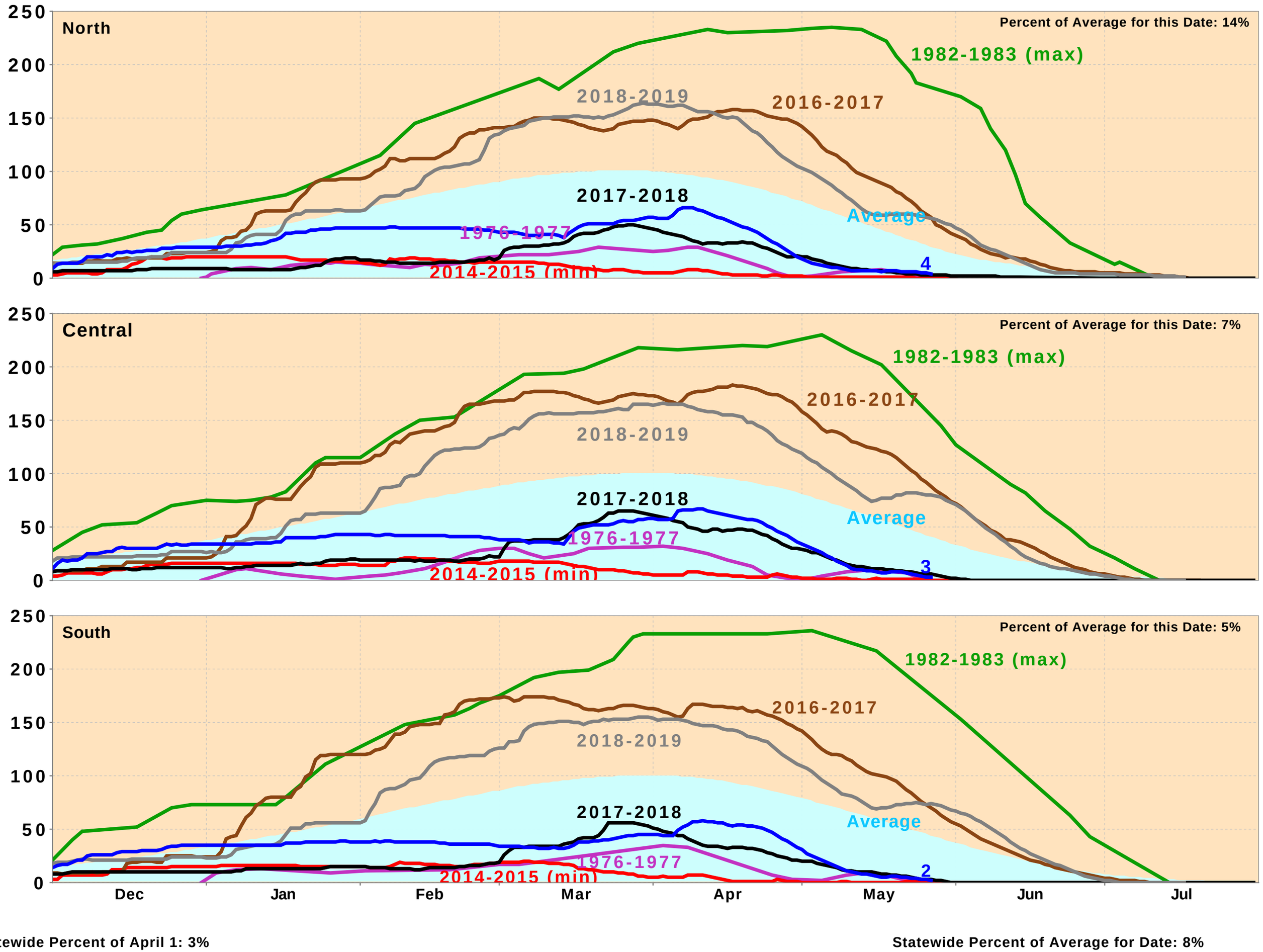
Total Water Year Precipitation

0 5 10 15 20 25 30 35 40 45 50 55 60 65 70 75 80 85 90 95 100

Oct 1 Nov 1 Dec 1 Jan 1 Feb 1 Mar 1 Apr 1 May 1 Jun 1 Jul 1 Aug 1 Sep 1 Oct 1

Water Year (October 1 - September 30)

California Snow Water Content, May 27, 2020, Percent of April 1 Average



Statewide Percent of April 1: 3%

Statewide Percent of Average for Date: 8%

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

Storage/Release Management Conditions:

- Reservoir Inflow Uncertainty: Shorter term forecasts (8-14 day) suggest an above normal chance of precipitation
- Longer term forecasts (three-month outlook) suggest below normal to equal chance of precipitation
- Observed Shasta inflows for May are tracking near the 25% inflow exceedance probability estimates for the month
- Releases from Keswick Dam: Wednesday May 27 increasing from 8,000cfs to 9,000 cfs, Thursday May 28, increasing to 9,500 cfs, and Friday May 29, increasing to 10,000 cfs for Delta requirements and demands
- Long-term conservative (inflow hydrology) projections suggest lower Shasta storage volumes

Temperature Management:

- Temperature management: Active draw on cold water pool for temperature management
- Selective withdrawal: Using cold-water-pool reserves. Three Upper TCD gates open and three Middle TCD 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 (three-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 May 2020

90% Runoff Exceedance Outlook

End of Month Storage/Elevation	May	Jun	Jul	Aug	Sep	Oct
Shasta Volume (TAF)	3504	3024	2473	2079	1903	1805
Shasta Elevation (Feet)	1029	1009	983	962	952	946

Monthly Average River Release	May	Jun	Jul	Aug	Sep	Oct
Sacramento (CFS)	9100	11700	12200	9750	6500	5500
Clear Creek (CFS)	9100	11700	12200	9750	6500	5500

Trinity Diversions	May	Jun	Jul	Aug	Sep	Oct
Carr Power Plant (TAF)	99	99	100	101	100	24
Spring Creek PP (TAF)	90	90	90	90	90	45

50% Runoff Exceedance Outlook

End of Month Storage/Elevation	May	Jun	Jul	Aug	Sep	Oct
Shasta Volume (TAF)	3504	3071	2613	2278	2126	2068
Shasta Elevation (Feet)	1029	1011	990	973	965	961

Monthly Average River Release	May	Jun	Jul	Aug	Sep	Oct
Sacramento (CFS)	3504	3071	2613	2278	2126	2068
Clear Creek (CFS)	265	190	150	150	150	200

Trinity Diversions	May	Jun	Jul	Aug	Sep	Oct
Carr Power Plant (TAF)	91	95	99	100	99	23
Spring Creek PP (TAF)	90	90	90	90	90	45

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)

		May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Trinity	**1921**	**1813**	**1678**	**1549**	**1392**	**1237**	**1196**	**1160**	**1142**	**1141**	**1168**	**1228**	**1285**
	Elev.	2328	2317	2307	2294	2280	2276	2272	2270	2270	2273	2279	2284
Whiskeytown	**239**	**238**	**238**	**238**	**238**	**238**	**206**	**206**	**206**	**206**	**206**	**206**	**238**
	Elev.	1209	1209	1209	1209	1209	1199	1199	1199	1199	1199	1199	1209
Shasta	**3687**	**3504**	**3024**	**2473**	**2079**	**1903**	**1805**	**1792**	**1844**	**1972**	**2165**	**2476**	**2517**
	Elev.	1029	1009	983	962	952	946	945	948	956	967	983	985
Folsom	**697**	**768**	**701**	**540**	**395**	**334**	**295**	**295**	**305**	**318**	**348**	**437**	**542**
	Elev.	446	439	422	402	393	386	386	388	390	395	408	422
New Melones	**1905**	**1814**	**1688**	**1604**	**1532**	**1489**	**1452**	**1453**	**1457**	**1461**	**1461**	**1459**	**1422**
	Elev.	1035	1023	1014	1007	1002	998	998	998	999	999	999	995
San Luis	**370**	**237**	**121**	**72**	**82**	**156**	**225**	**247**	**284**	**476**	**451**	**405**	**326**
	Elev.	465	445	424	411	413	420	434	452	480	466	456	444
Total		8375	7451	6475	5717	5357	5178	5153	5238	5573	5798	6211	6330

Monthly River Releases (TAF/cfs)

Trinity	TAF	92	47	28	53	52	23	18	18	18	17	18	36
	cfs	**1,498**	**783**	**450**	**857**	**870**	**373**	**300**	**300**	**300**	**300**	**300**	**600**
Clear Creek	TAF	16	11	9	9	9	12	12	12	12	11	17	12
	cfs	**265**	**190**	**150**	**150**	**150**	**200**	**200**	**200**	**200**	**200**	**275**	**200**
Sacramento	TAF	559	696	750	599	387	338	260	219	200	194	215	416
	cfs	**9100**	**11700**	**12200**	**9750**	**6500**	**5500**	**4373**	**3557**	**3250**	**3500**	**3500**	**7000**
American	TAF	92	125	208	201	106	78	43	44	49	73	83	101
	cfs	**1500**	**2110**	**3385**	**3276**	**1776**	**1276**	**718**	**710**	**800**	**1310**	**1357**	**1706**
Stanislaus	TAF	55	59	12	12	12	35	12	12	13	12	12	27
	cfs	**887**	**1000**	**200**	**200**	**200**	**577**	**200**	**200**	**213**	**214**	**200**	**460**

Trinity Diversions (TAF)

	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Carr PP	99	99	100	101	100	24	30	21	15	10	7	44
Spring Crk. PP	**90**	**90**	**90**	**90**	**90**	**45**	**20**	**12**	**10**	**10**	**10**	**15**

Delta Summary (TAF)

		May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Tracy		57	153	252	260	249	198	79	74	230	45	50	48
USBR Banks		0	0	9	9	9	0	0	0	0	0	0	0
Contra Costa		4.2	5.1	5.6	5.5	4.2	4.2	3.8	3.8	3.8	3.0	3.4	3.8
Total USBR		62	158	267	275	262	202	83	78	234	48	53	51
COA Balance		11	10	11	18	30	11	11	11	11	-14	-67	-47
Vernalis	TAF	135	90	45	40	46	104	83	83	92	82	82	105
Vernalis	cfs	2194	1521	737	655	772	1700	1393	1355	1498	1475	1339	1767
Old/Middle River Std.													
Old/Middle R. calc.		-835	-2,651	-3,973	-4,122	-4,025	-3,248	-2,899	-2,872	-4,974	-952	-1,282	-1,000
Computed DOI		8052	7447	4994	4636	4118	4994	5009	6019	6214	11400	11403	9497
Excess Outflow		244	0	0	0	0	0	0	16	1708	0	0	0
% Export/Inflow		14%	25%	34%	37%	42%	40%	40%	38%	55%	11%	13%	12%
% Export/Inflow std.		35%	35%	65%	65%	65%	65%	65%	65%	65%	45%	35%	35%

Hydrology

	Trinity		Shasta		Folsom		New Melones	
Water Year Inflow (TAF)	450		3,077		1,414		639	
Year to Date + Forecasted % of mean	37%		56%		52%		60%	

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5/26/2020

Estimated CVP Operations 50% Exceedance

Storages

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

		May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Trinity	**1921**	**1846**	**1724**	**1597**	**1441**	**1287**	**1252**	**1244**	**1274**	**1339**	**1449**	**1578**	**1692**
	Elev.	2330	2321	2311	2298	2284	2281	2280	2283	2289	2299	2310	2319
Whiskeytown	**239**	**238**	**238**	**238**	**238**	**238**	**206**	**206**	**206**	**206**	**206**	**206**	**238**
	Elev.	1209	1209	1209	1209	1209	1199	1199	1199	1199	1199	1199	1209
Shasta	**3687**	**3504**	**3071**	**2613**	**2278**	**2126**	**2068**	**2142**	**2333**	**2730**	**3311**	**3866**	**4172**
	Elev.	1029	1011	990	973	965	961	965	976	995	1021	1043	1054
Folsom	**697**	**765**	**687**	**561**	**458**	**409**	**391**	**392**	**412**	**486**	**592**	**780**	**934**
	Elev.	446	438	424	411	404	402	402	405	415	428	447	462
New Melones	**1905**	**1814**	**1716**	**1636**	**1567**	**1526**	**1495**	**1512**	**1535**	**1568**	**1622**	**1680**	**1664**
	Elev.	1035	1025	1017	1010	1006	1003	1004	1007	1010	1016	1022	1020
San Luis	**370**	**218**	**145**	**94**	**88**	**159**	**239**	**295**	**506**	**729**	**883**	**966**	**887**
	Elev.	462	454	432	419	422	441	470	503	524	536	543	532
Total		8386	7581	6739	6071	5745	5650	5790	6266	7057	8064	9076	9586

Monthly River Releases (TAF/cfs)

Trinity	TAF	67	47	28	53	52	23	18	18	18	17	18	36
	cfs	**1,092**	**788**	**450**	**857**	**870**	**373**	**300**	**300**	**300**	**300**	**300**	**600**
Clear Creek	TAF	16	11	9	9	9	12	12	12	25	11	12	12
	cfs	**265**	**190**	**150**	**150**	**150**	**200**	**200**	**200**	**400**	**200**	**200**	**200**
Sacramento	TAF	559	714	707	575	387	338	238	200	200	180	277	339
	cfs	**9100**	**12000**	**11500**	**9350**	**6500**	**5500**	**4000**	**3250**	**3250**	**3250**	**4500**	**5700**
American	TAF	92	164	184	164	109	93	89	92	77	155	123	268
	cfs	**1503**	**2750**	**3000**	**2670**	**1826**	**1506**	**1502**	**1500**	**1250**	**2800**	**2000**	**4500**
Stanislaus	TAF	55	59	12	12	12	39	12	12	14	13	12	91
	cfs	**887**	**1000**	**200**	**200**	**200**	**635**	**200**	**200**	**226**	**229**	**200**	**1536**

Trinity Diversions (TAF)

	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Carr PP	91	95	99	100	99	23	20	9	0	2	1	55
Spring Crk. PP	**90**	**90**	**90**	**90**	**90**	**45**	**15**	**12**	**10**	**35**	**26**	**35**

Delta Summary (TAF)

		May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
Tracy		57	210	267	265	260	212	115	250	265	230	183	54
USBR Banks		0	0	11	11	11	0	0	0	0	0	0	0
Contra Costa		12.7	9.8	11.1	12.7	14.0	16.8	18.4	18.3	14.0	14.0	12.7	12.7
Total USBR		70	220	289	289	285	229	133	268	279	244	196	66
COA Balance		2	2	-4	-9	-10	-10	-10	-10	-10	-10	-10	-10
Vernalis	TAF	113	106	51	49	54	108	83	83	93	112	57	169
Vernalis	cfs	1833	1790	834	802	906	1758	1393	1355	1511	2012	932	2843
Old/Middle River Std.													
Old/Middle R. calc.	cfs	-1,104	-4,429	-4,462	-4,634	-4,635	-5,183	-5,301	-5,533	-4,770	-5,024	-3,987	-630
Computed DOI		7808	7783	4994	4652	4186	4994	5009	8557	14120	19559	20285	17297
Excess Outflow		0	336	0	0	0	0	0	2554	8117	8159	8882	7800
% Export/Inflow		14%	35%	36%	39%	45%	50%	53%	44%	31%	26%	19%	7%
% Export/Inflow std.		35%	35%	65%	65%	65%	65%	65%	65%	65%	45%	35%	35%

Hydrology

	Trinity		Shasta		Folsom		New Melones	
Water Year Inflow (TAF)	461		3,252		1,493		676	
Year to Date + Forecasted % of mean	38%		59%		55%		64%	

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5/26/2020

BUREAU OF RECLAMATION

CVP May 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: May 1, 2020 Water Supply Forecast Package, DWR
- Sacramento Valley Accretion Depletion Hydrology: Sacramento River at Freeport forecast for May 2020, DWR
- 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 April through June at Emmaton/Collinsville
- Delta controls: 11 Chipps days May, none 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 Critical 75%
- North of Delta Water Service Contractor allocation for agriculture: 50%
- North of Delta Municipal and Industrial allocation: 75%
- North of Delta Refuge allocation: 75%
- American River Water Rights allocation: 75%
- 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:

- 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. In addition, this outlook contains a Shasta Critical assumption which is imbedded within this mass balance calculation and captures a 25% reduction from the Sacramento River Settlement Contractors.
- The Shasta Critical determination assessment is on-going.
- South of Delta Water Rights and Refuge allocations were assumed to be 100% in the April forecast in order to be conservative and ensure that Reclamation would be able to export/pump enough water to supply a 100% allocation should the Shasta Critical designation change to Shasta Non-Critical. 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. If conditions remain Shasta Critical and this water is not allocated to the South of Delta water rights, it will provide additional flexibility in the system. This flexibility may result in additional water in San Luis available for either 2020 or 2021 allocations or, if needed, support meeting the operational objectives at Shasta and Folsom.

Northern CVP Water Temperature Report

May - 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
Apr	52.1	50.8	49.3	51.2	51.9	52.5	54.2	55.4	55.9	56.6	51.9	49.1	-	4718	1542	6505	62.1	60.4	62.0	-
05/01	53.2	? 51.7	49.8	52.3	52.8	53.4	**55.1**	56.5	57.0	58.2	53.0	49.6	-	7929	1920	9713	65.0	63.3	65.9	-
05/02	52.6	51.4	49.9	52.5	52.8	53.2	**54.7**	55.9	56.5	57.4	52.1	49.0	-	7358	1925	9705	63.5	60.5	63.8	-
05/03	53.2	? 51.5	50.0	52.2	52.7	53.2	**54.7**	55.7	56.1	56.8	52.4	48.8	-	7137	1890	9737	60.5	59.5	61.4	-
05/04	53.1	51.6	50.0	52.7	53.0	53.5	**54.6**	55.7	56.1	57.0	52.9	48.6	-	7614	1919	9724	63.0	61.3	63.8	-
05/05	51.9	50.8	50.2	52.7	53.1	53.7	? **55.2**	56.3	56.7	57.6	53.1	49.0	-	7447	1903	9648	66.5	63.9	66.8	-
05/06	52.9	51.4	50.2	52.4	53.0	53.7	**55.5**	56.6	57.0	57.7	53.8	49.2	-	8172	1671	9712	66.5	66.4	71.2	-
05/07	53.7	52.4	50.3	52.6	52.9	53.4	**54.7**	55.9	56.4	57.7	53.9	49.3	-	8133	1120	9709	76.0	70.5	74.2	-
05/08	53.4	? 52.2	50.4	53.5	53.9	54.6	**56.0**	57.1	57.5	58.2	53.9	49.5	-	7967	1310	9710	73.0	70.9	72.9	-
05/09	53.5	52.2	50.5	53.5	54.0	54.7	**56.2**	57.6	58.1	59.3	51.8	49.5	-	8238	1141	9702	75.5	71.9	73.7	-
05/10	53.9	53.0	50.6	53.7	54.1	54.7	**56.1**	57.3	57.7	58.9	51.9	49.8	-	8953	447	9697	72.0	68.7	69.3	-
05/11	53.2	52.3	50.6	53.6	53.7	54.0	**54.9**	55.9	56.5	57.5	51.5	49.5	-	8264	914	9497	62.5	57.9	58.5	-
05/12	52.9	51.6	50.6	52.8	53.3	53.7	**54.4**	55.1	55.5	56.3	52.7	49.3	-	8144	1014	9494	58.0	56.7	60.5	-
05/13	52.9	52.1	50.7	52.4	52.7	52.8	**54.1**	54.9	55.1	55.6	52.2	48.8	-	8463	943	9490	57.5	56.5	57.8	-
05/14	52.9	51.7	50.7	52.4	52.6	52.8	**54.0**	54.8	55.1	55.4	52.3	48.7	-	8127	1303	9491	59.0	57.8	59.7	-
05/15	53.3	51.9	50.6	52.4	52.9	53.4	**55.0**	56.0	56.2	56.7	53.3	48.7	-	7455	1667	9265	64.5	63.0	65.3	-
05/16	53.1	51.6	50.7	52.9	53.1	53.4	**54.9**	55.9	56.4	57.3	52.8	48.8	-	6899	1666	8994	65.0	62.5	63.4	-
05/17	52.5	51.3	50.8	52.7	53.1	53.6	**55.4**	56.6	57.1	57.4	53.8	49.1	-	7179	1665	8775	65.0	62.9	63.2	-
05/18	52.3	51.2	50.8	52.4	52.8	53.0	**55.0**	55.5	56.0	57.1	52.5	48.8	-	6230	1673	8541	54.5	54.8	56.1	-
05/19	52.8	51.8	50.9	52.2	52.7	53.2	**55.2**	55.9	56.0	56.2	53.2	49.3	-	7129	1006	8542	59.5	59.1	60.5	-
05/20	53.3	51.9	50.9	52.8	53.2	53.9	**55.7**	56.7	57.1	57.9	53.6	49.5	-	8093	519	8257	61.5	61.8	61.8	-
05/21	51.8	51.0	51.0	53.2	53.8	54.6	**56.6**	57.7	58.1	59.0	54.3	49.9	-	6645	1143	8035	68.5	65.4	67.3	-
05/22	51.9	50.5	51.0	53.2	53.9	54.7	**56.7**	57.9	58.4	59.1	53.9	50.3	-	6220	1141	8033	66.0	63.3	65.0	-
05/23	51.2	49.9	51.0	52.2	53.0	53.7	**56.0**	57.4	58.0	59.2	54.0	50.8	-	6574	1665	7966	69.5	66.0	68.5	-
05/24	50.7	49.7	51.1	52.1	52.9	53.7	**55.9**	57.4	58.0	59.1	54.5	50.5	-	6409	1310	7908	77.0	70.9	74.0	-
05/25	50.8	49.8	51.2	51.8	52.7	53.6	**56.2**	57.9	58.5	59.9	55.4	50.6	-	6344	1542	7907	83.0	77.7	79.7	-
05/26	50.9	49.8	51.2	51.7	52.6	53.4	**56.0**	57.9	58.8	60.5	55.5	50.8	-	5899	1722	7956	80.5	77.2	79.7	-
05/27																				
05/28																				
05/29																				
05/30																				
05/31																				
May	52.6	51.4	50.6	52.7	53.1	53.7	55.3	56.5	56.9	57.8	53.2	49.4	-	7424	1390	9046	66.7	64.2	66.3	-
												Total CFS		193022	36139	235208				
												Total AF		382851	71680	466525				

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
05/01	59	82	70.5	48	80	64.0	51	74	62.5	47	74	60.5	45	78	61.5	46	82	64.0	49	86	67.5	54	92	73.0	57	86	71.5	56	91	73.5	57	88	72.5	55	82	68.5
05/02	48	82	65.0	56	73	64.5	42	76	59.0	44	81	62.5	49	83	66.0	49	87	68.0	54	92	73.0	56	95	75.5	59	94	76.5	59	96	77.5	58	85	71.5	54	81	67.5
05/03	51	76	63.5	46	76	61.0	44	82	63.0	50	84	67.0	51	82	66.5	54	92	73.0	56	95	75.5	58	95	76.5	58	90	74.0	56	88	72.0	55	89	72.0	59	90	74.5
05/04	45	76	60.5	45	82	63.5	49	83	66.0	50	83	66.5	54	92	73.0	55	96	75.5	58	96	77.0	60	92	76.0	57	86	71.5	52	84	68.0	55	86	70.5	58	88	73.0
05/05	44	82	63.0	53	83	68.0	50	84	67.0	54	93	73.5	55	97	76.0	59	96	77.5	59	91	75.0	56	82	69.0	53	79	66.0	51	78	64.5	54	80	67.0	56	85	70.5
05/06	50	83	66.5	50	83	66.5	55	93	74.0	56	98	77.0	59	96	77.5	59	90	74.5	55	80	67.5	51	71	61.0	49	73	61.0	51	79	65.0	55	83	69.0	57	88	72.5
05/07	49	84	66.5	65	93	79.0	55	98	76.5	60	97	78.5	59	90	74.5	54	73	63.5	50	68	59.0	48	73	60.5	51	81	66.0	55	84	69.5	57	85	71.0	58	86	72.0
05/08	59	93	76.0	51	97	74.0	59	96	77.5	59	88	73.5	55	75	65.0	51	65	58.0	48	71	59.5	50	76	63.0	52	75	63.5	54	84	69.0	57	81	69.0	56	81	68.5
05/09	50	96	73.0	57	96	76.5	58	89	73.5	55	74	64.5	51	68	59.5	48	71	59.5	49	74	61.5	50	80	65.0	54	86	70.0	57	84	70.5	55	84	69.5	56	85	70.5
05/10	57	94	75.5	56	88	72.0	53	75	64.0	51	68	59.5	50	69	59.5	50	70	60.0	49	80	64.5	52	82	67.0	55	78	66.5	55	79	67.0	54	83	68.5	56	87	71.5
05/11	56	88	72.0	56	69	62.5	50	66	58.0	48	66	57.0	48	72	60.0	48	80	64.0	53	79	66.0	54	71	62.5	53	77	65.0	53	78	65.5	54	84	69.0	57	86	71.5
05/12	54	71	62.5	56	66	61.0	48	64	56.0	48	69	58.5	48	81	64.5	53	77	65.0	53	70	61.5	49	69	59.0	51	78	64.5	54	84	69.0	56	85	70.5	59	87	73.0
05/13	54	62	58.0	54	64	59.0	49	68	58.5	49	81	65.0	53	77	65.0	54	69	61.5	49	67	58.0	47	73	60.0	57	83	70.0	56	88	72.0	59	88	73.5	59	87	73.0
05/14	53	62	57.5	53	63	58.0	48	79	63.5	51	75	63.0	53	69	61.0	49	66	57.5	46	71	58.5	47	75	61.0	55	84	69.5	55	87	71.0	57	88	72.5	59	90	74.5
05/15	52	66	59.0	51	78	64.5	52	78	65.0	54	69	61.5	49	65	57.0	46	72	59.0	48	75	61.5	51	79	65.0	58	88	73.0	59	88	73.5	59	86	72.5	61	87	74.0
05/16	50	79	64.5	56	73	64.5	54	68	61.0	49	64	56.5	46	74	60.0	49	75	62.0	51	81	66.0	51	81	66.0	56	87	71.5	56	88	72.0	59	89	74.0	60	86	73.0
05/17	55	75	65.0	59	71	65.0	49	66	57.5	46	73	59.5	48	75	61.5	49	80	64.5	49	76	62.5	49	80	64.5	54	83	68.5	57	86	71.5	60	89	74.5	61	89	75.0
05/18	58	72	65.0	53	63	58.0	44	73	58.5	48	76	62.0	49	78	63.5	49	78	63.5	50	83	66.5	54	85	69.5	59	88	73.5	60	92	76.0	60	92	76.0	63	92	77.5
05/19	49	60	54.5	46	73	59.5	47	75	61.0	50	81	65.5	49	78	63.5	49	84	66.5	54	87	70.5	58	90	74.0	64	94	79.0	63	96	79.5	63	96	79.5	64	95	79.5
05/20	45	74	59.5	49	77	63.0	50	82	66.0	49	77	63.0	50	85	67.5	54	90	72.0	59	93	76.0	62	96	79.0	63	96	79.5	63	100	81.5	63	92	77.5	61	87	74.0
05/21	49	74	61.5	54	81	67.5	50	76	63.0	50	85	67.5	54	91	72.5	60	97	78.5	63	97	80.0	65	99	82.0	67	101	84.0	63	96	79.5	63	93	78.0	61	87	74.0
05/22	53	84	68.5	56	76	66.0	50	85	67.5	55	93	74.0	61	98	79.5	65	99	82.0	70	101	85.5	70	103	86.5	69	101	85.0	62	89	75.5	59	86	72.5	61	88	74.5
05/23	55	77	66.0	54	84	69.0	56	91	73.5	61	97	79.0	66	100	83.0	67	103	85.0	69	105	87.0	69	94	81.5	62	87	74.5	60	91	75.5	60	84	72.0	59	86	72.5
05/24	54	85	69.5	63	92	77.5	63	98	80.5	65	100	82.5	66	101	83.5	67	104	85.5	69	96	82.5	61	83	72.0	59	87	73.0	60	86	73.0	58	81	69.5	60	87	73.5
05/25	61	93	77.0	67	99	83.0	67	101	84.0	66	102	84.0	68	103	85.5	67	100	83.5	63	86	74.5	57	78	67.5	58	88	73.0	61	87	74.0	61	90	75.5	64	94	79.0
05/26	67	99	83.0	65	99	82.0	67	100	83.5	67	102	84.5	68	100	84.0	62	78	70.0	56	79	67.5	57	79	68.0	59	91	75.0	60	91	75.5	62	90	76.0	61	88	74.5
05/27	65	96	80.5	66	99	82.5	67	103	85.0	68	102	85.0	59	74	66.5	55	80	67.5	57	81	69.0	57	83	70.0	59	85	72.0	61	84	72.5	58	84	71.0	58	86	72.0
05/28																																				
05/29																																				
05/30																																				
05/31																																				

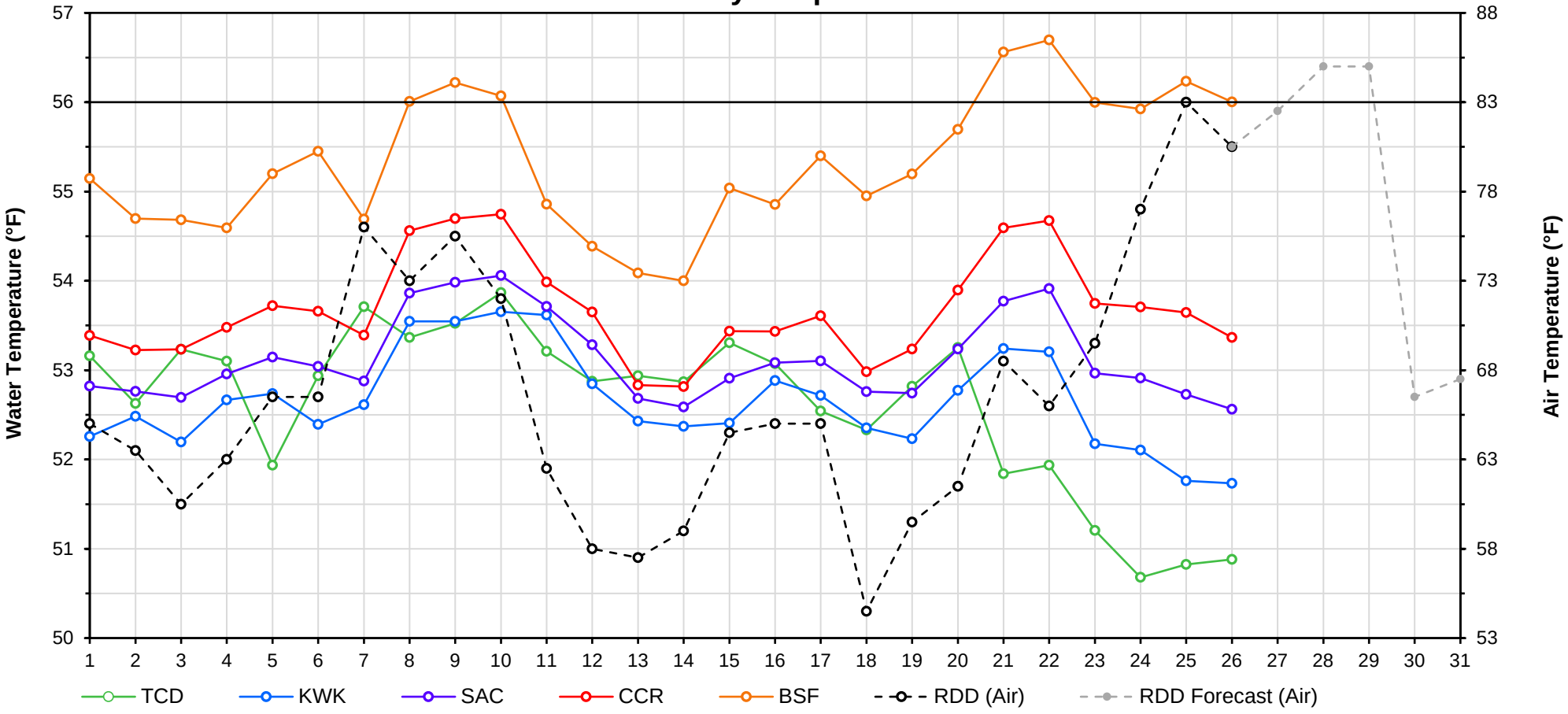
Web Links

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

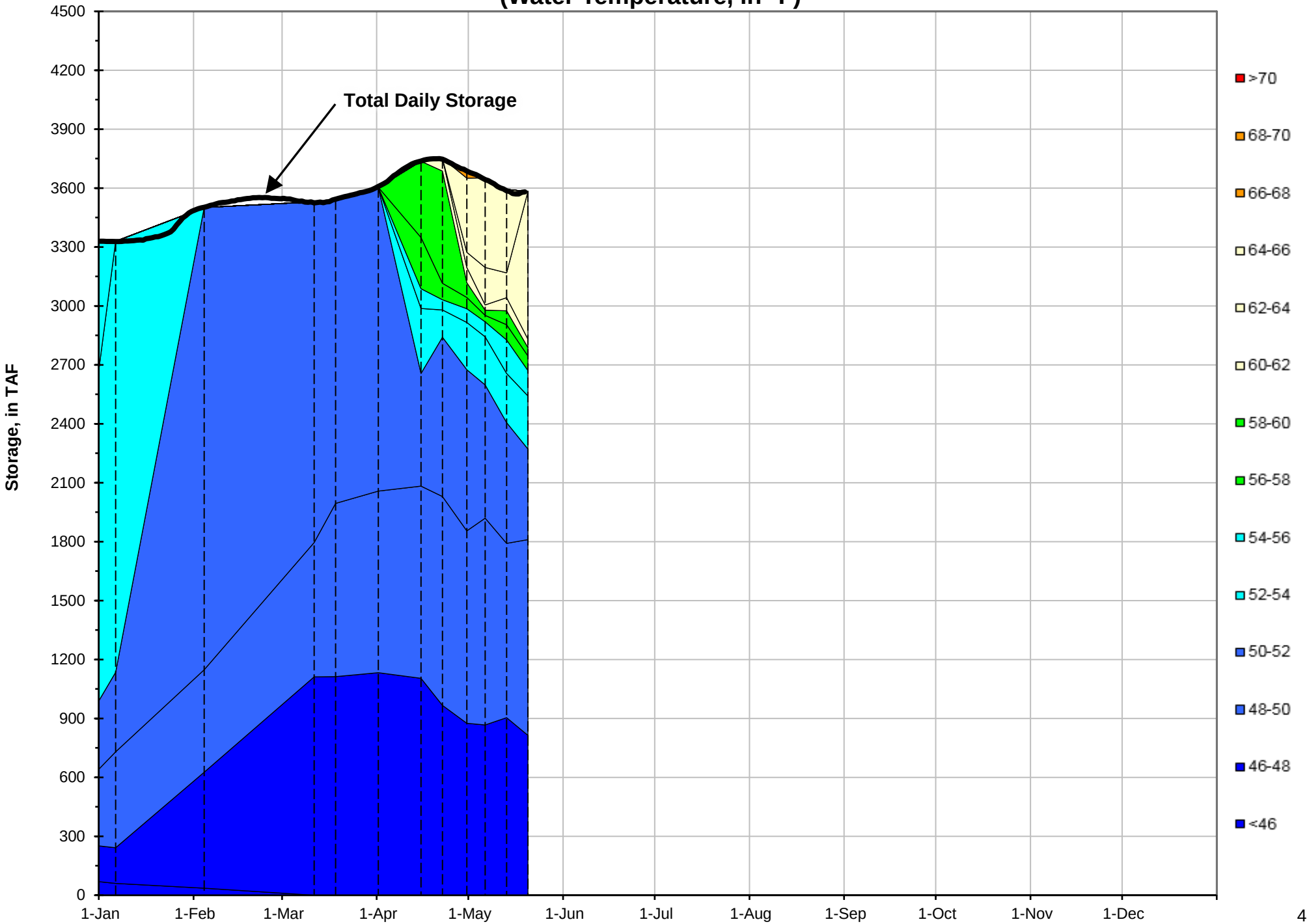
Temperature Control Point		
Point	Temp. (°F)	Begin Date
BSF	**56.0**	**5/25/2018**

Notes

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

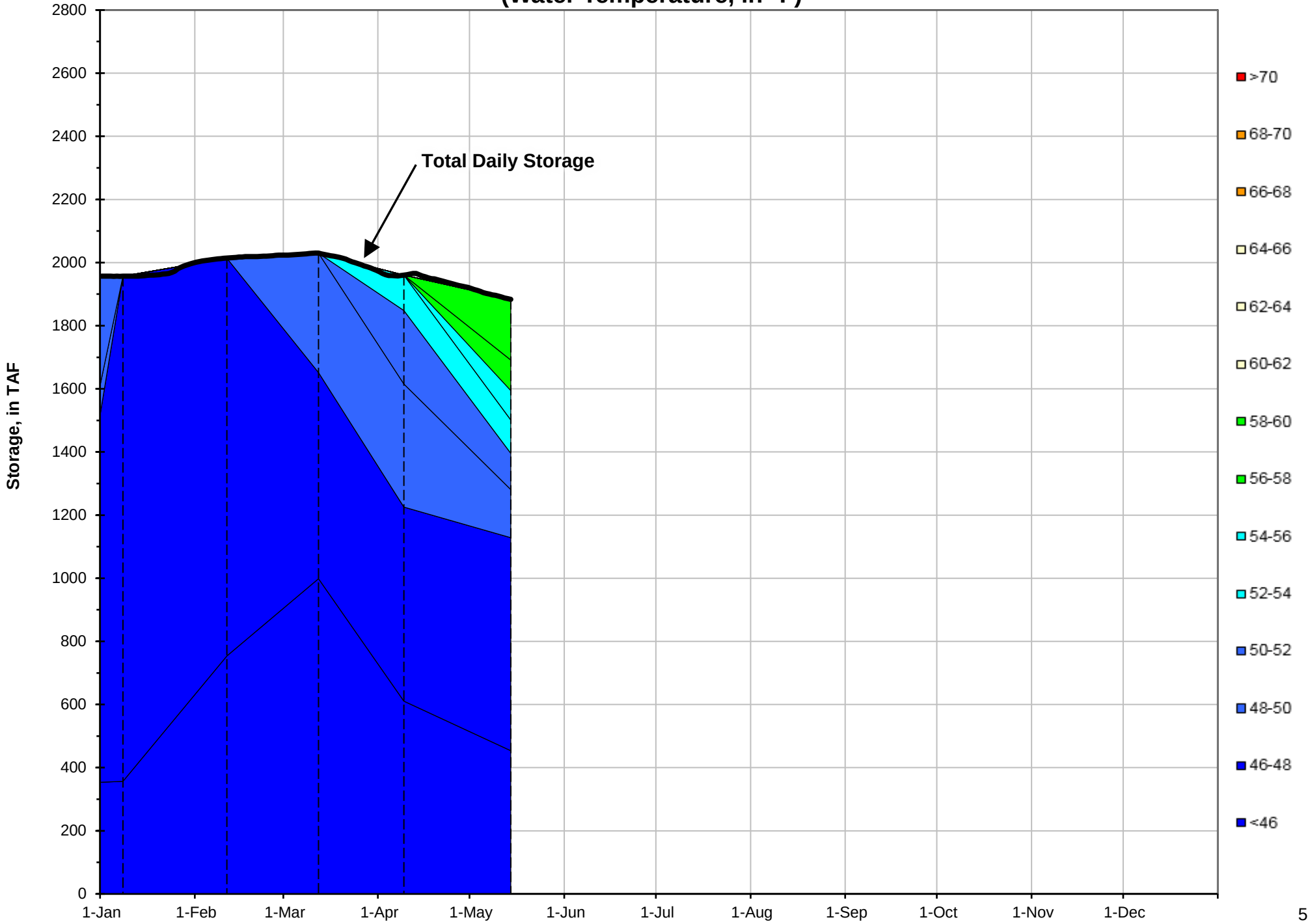
Latest Profile Date: 05/20/2020

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



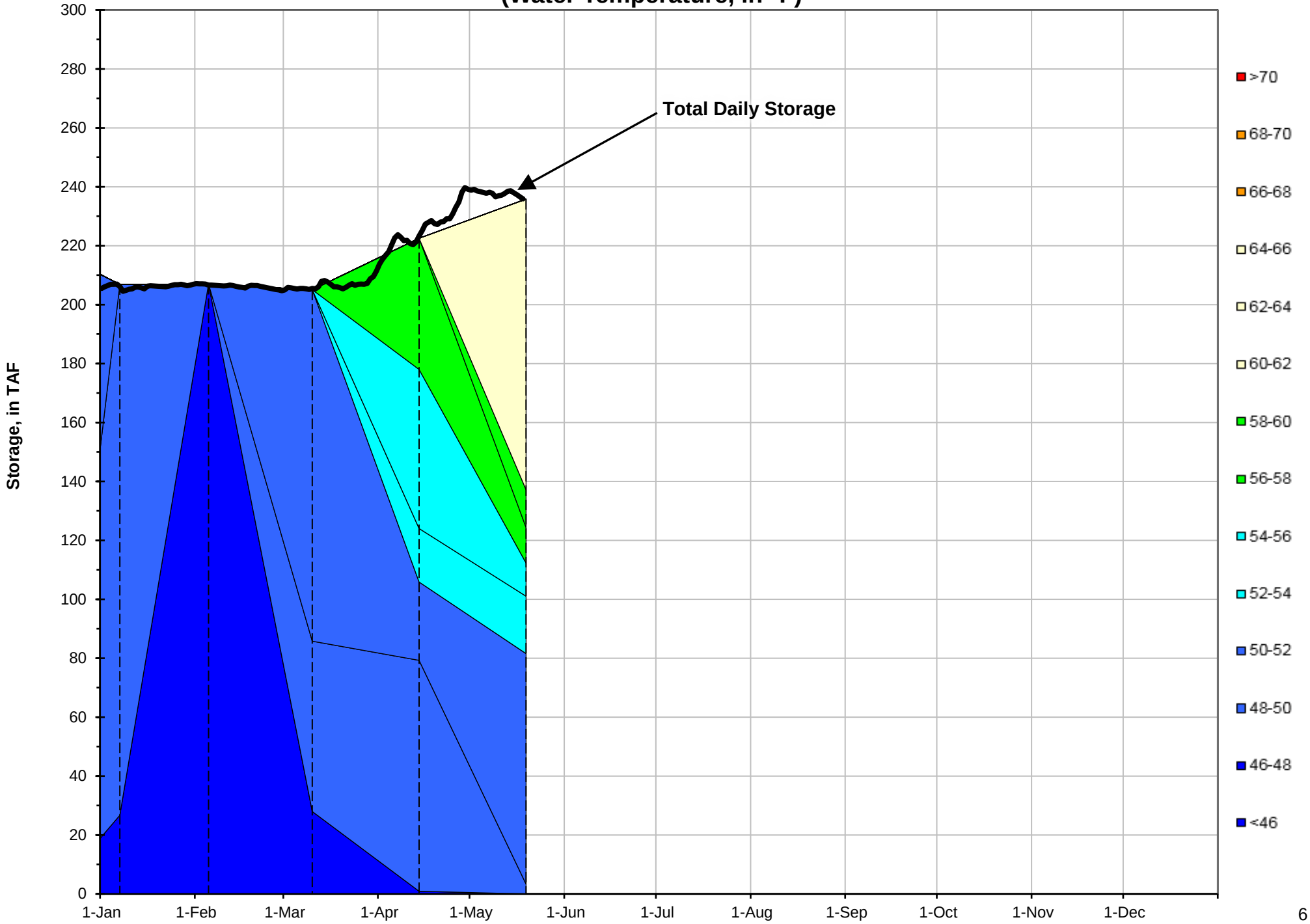
Latest Profile Date: 05/14/2020

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



Latest Profile Date: 05/19/2020

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

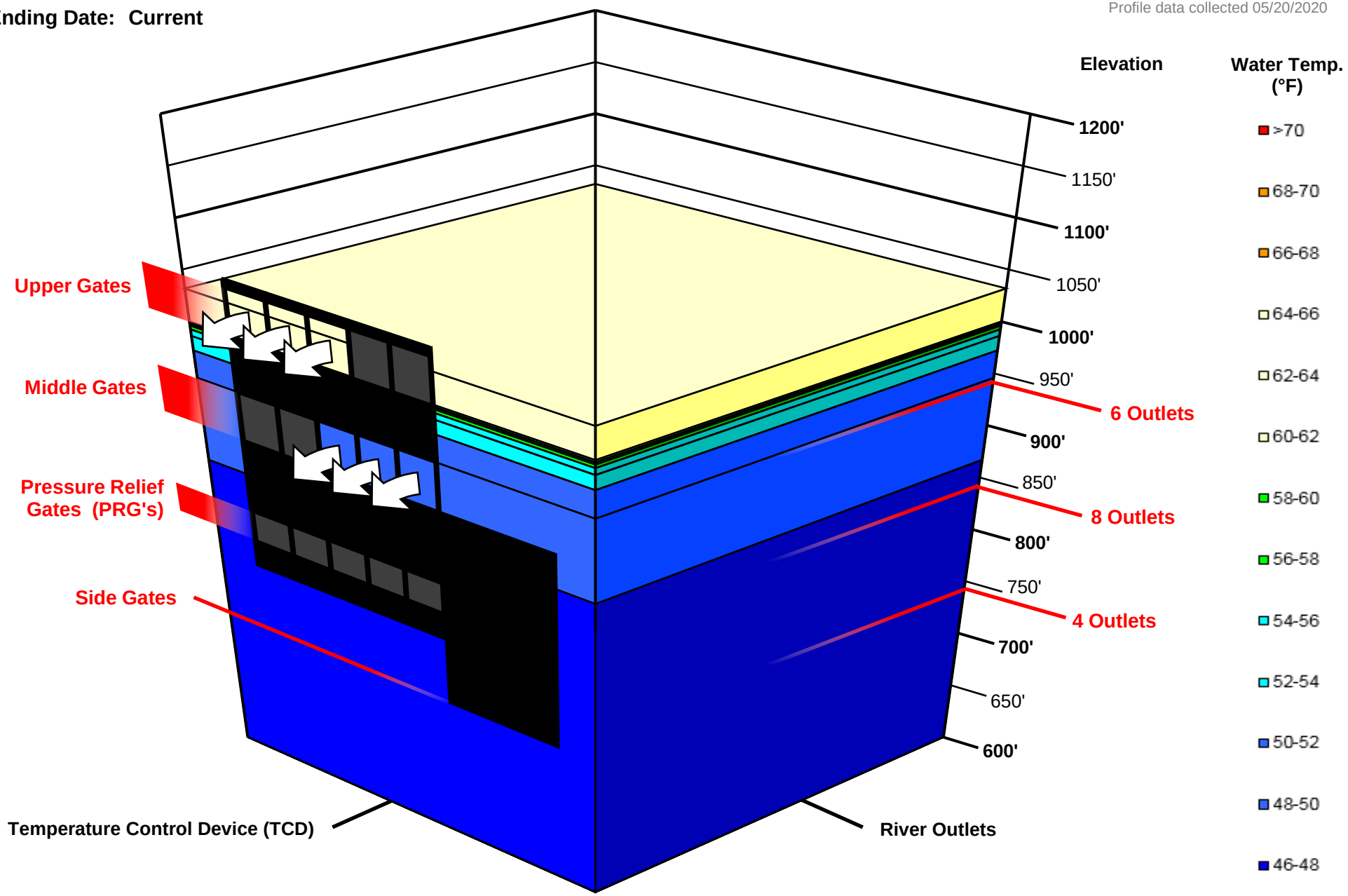


Shasta TCD Configuration

Starting Date: 5/23/2020

Ending Date: Current

Profile data collected 05/20/2020



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

May 27, 2020

Upper Sacramento River – May 2020 Preliminary Temperature Analysis

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

Model Run	Location	May	Jun	Jul	Aug	Sep*	Oct*
90% Hydrology 25% L3MTO Meteorology Targeting CCR Scenario 148	Keswick Dam KWK	53.0	52.8	53.4	53.3	See Fig. 3	See Fig. 3
	Sac. R. abv Clear Creek CCR	53.2	53.2	53.9	53.7	See Fig. 4	See Fig. 4
	Airport Road	53.6	53.7	54.5	54.3	n/a	n/a
	Balls Ferry BSF	54.6	54.8	55.4	55.2	See Fig. 5	See Fig. 5

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.CCR Scenario 148	515	8/16	10/30

Model Run Date May 25, 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 6-8). 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 hydrology and meteorology. The temperature results for the Sacramento River between Keswick Dam and Balls Ferry are shown in Figure 1, the Trinity River in Figure 2. 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 3-5.

Temperature Model Inputs, Assumptions, Limitations and Uncertainty:

1. The latest available profiles for Shasta, Trinity, and Whiskeytown were taken on May 20, May 14, and May 19, respectively. 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 May 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 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).

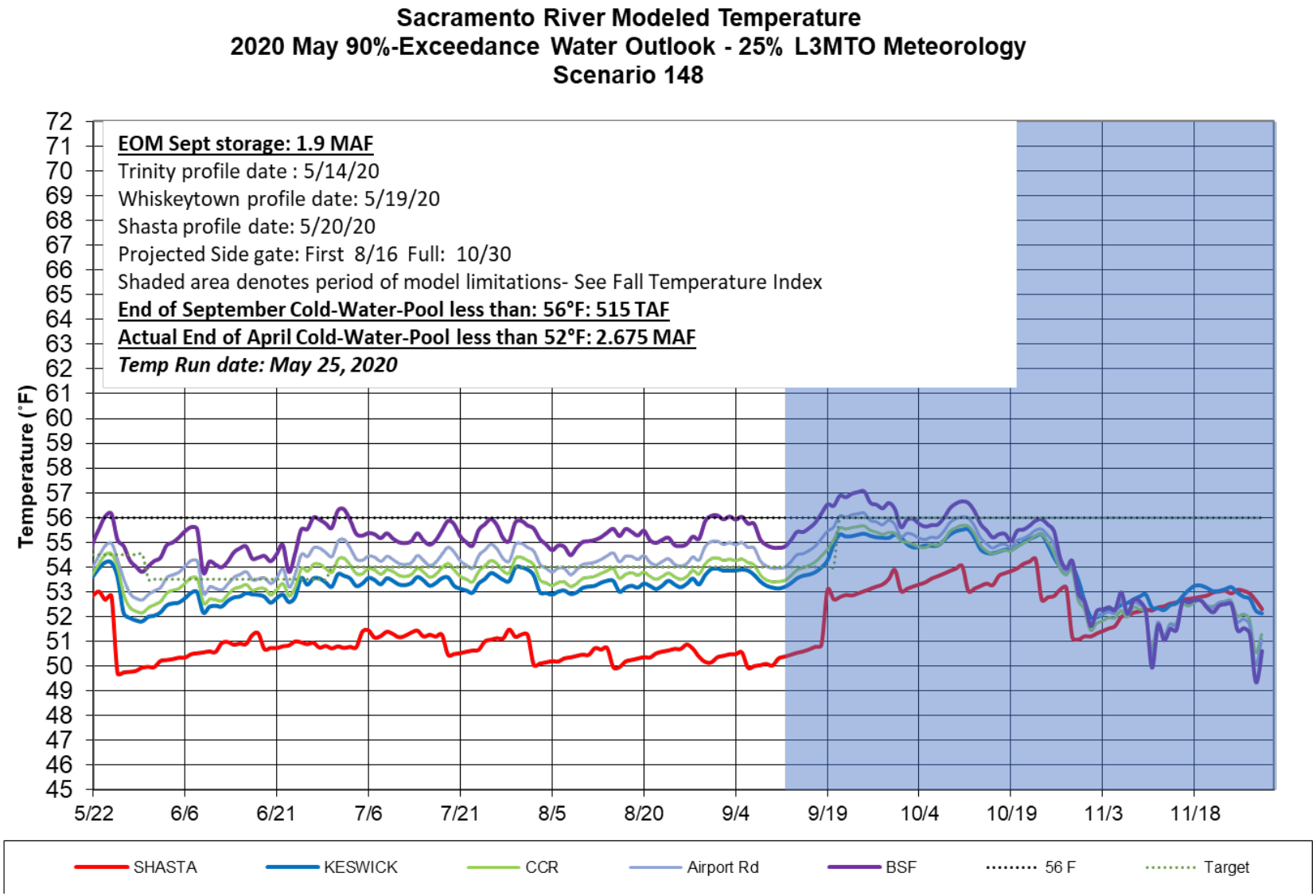


Figure 1. May 2020 simulated Sacramento River temperatures 90% runoff exceedance hydrology and 25% L3MTO meteorology targeting CCR.

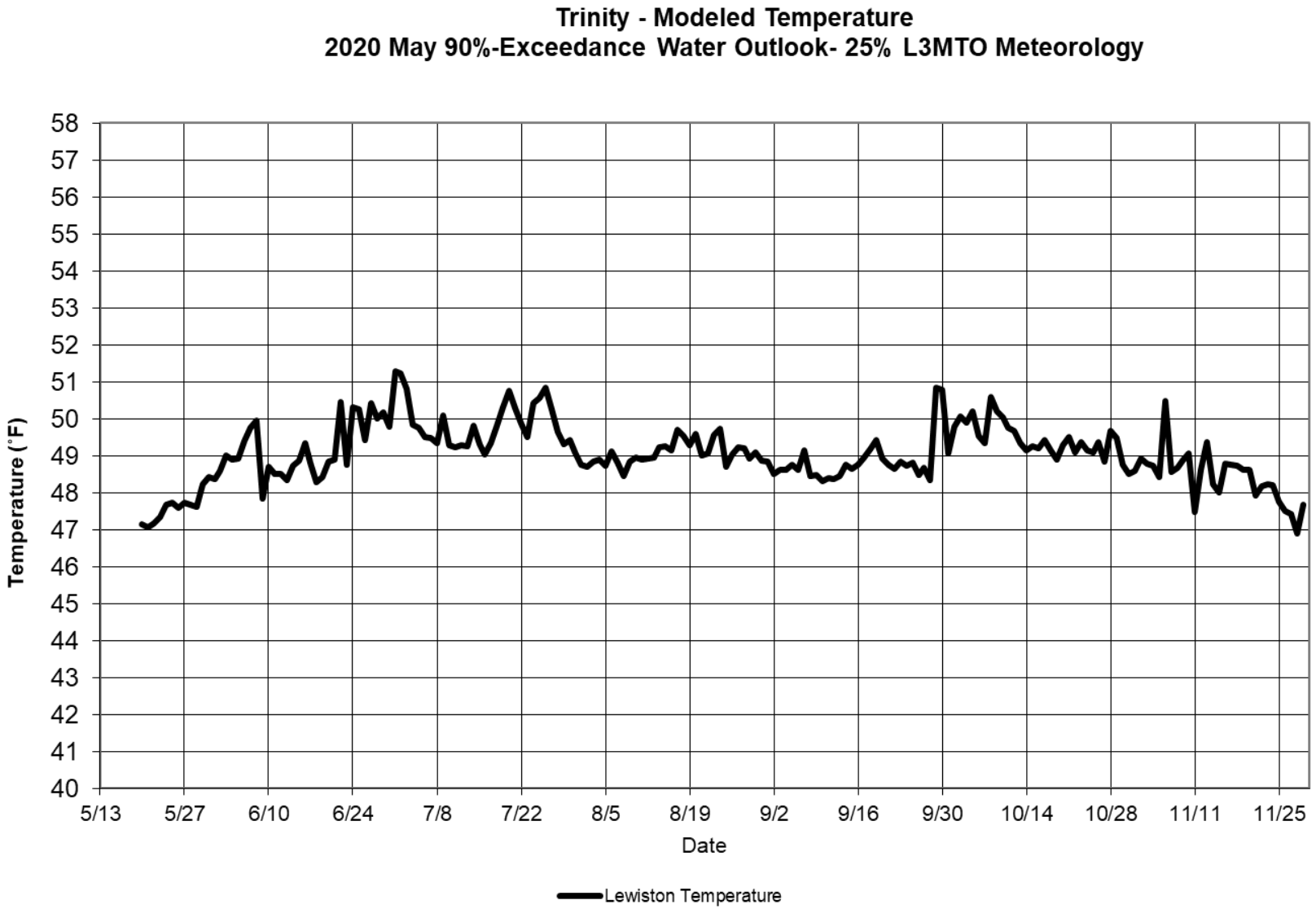


Figure 2. May 2020 simulated Trinity River temperatures 90% runoff exceedance hydrology and 25% L3MTO meteorology

Figures 3-5 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 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.

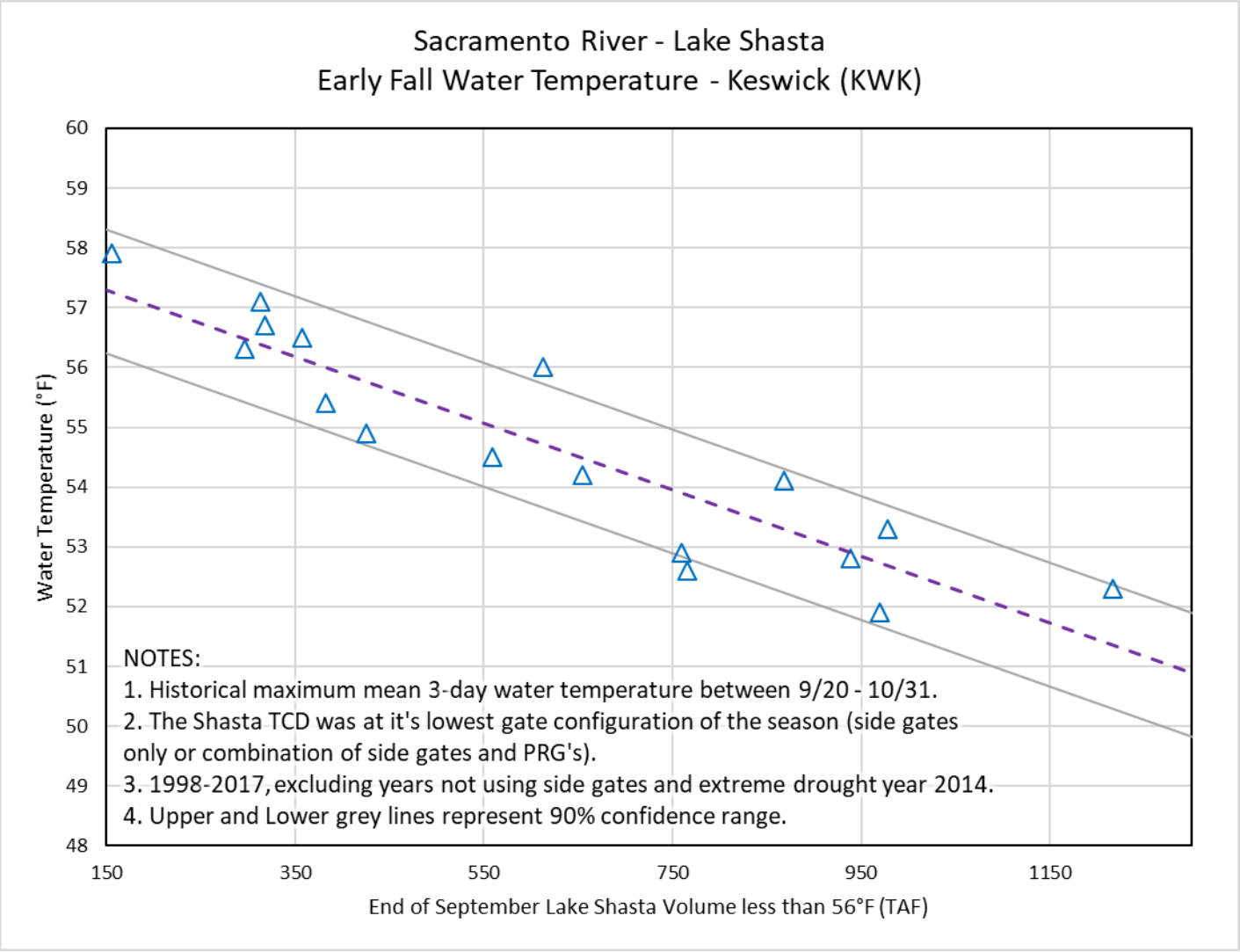


Figure 3. Historical relationship between Lake Shasta cold-water-pool characteristics and early fall Keswick water temperature.

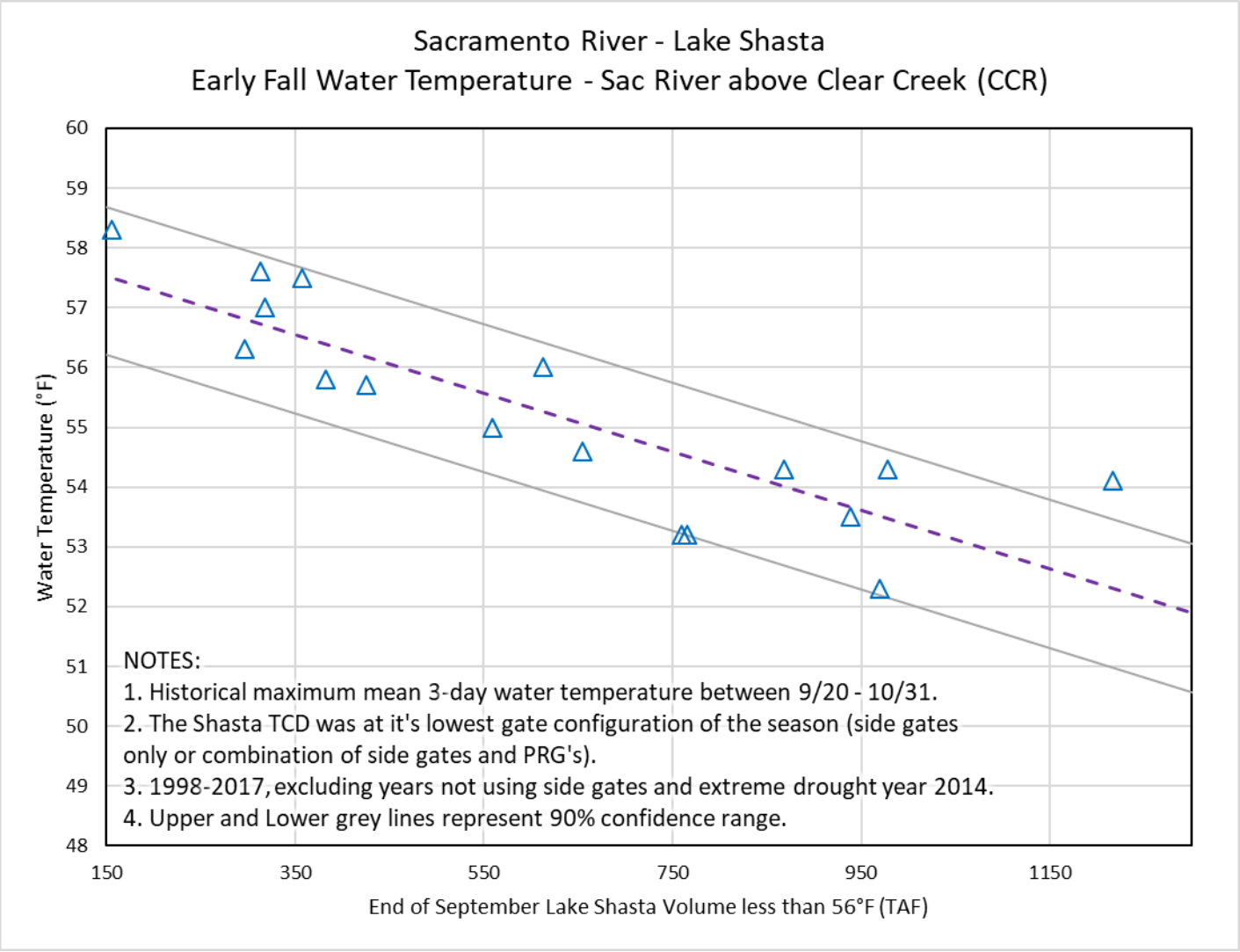


Figure 4. Historical relationship between Lake Shasta cold-water-pool characteristics and early fall Sacramento River above Clear Creek confluence water temperature.

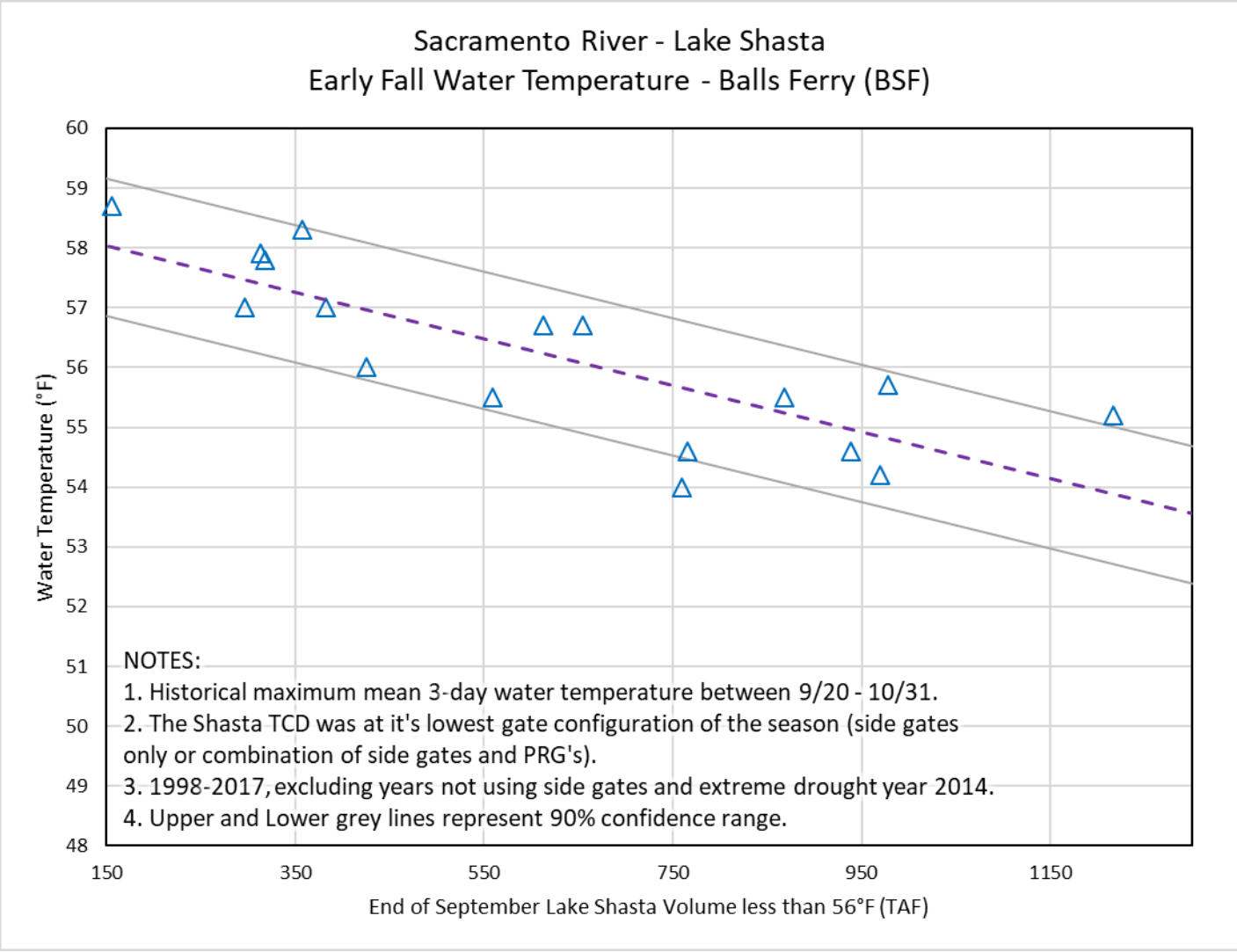


Figure 5. Historical relationship between Lake Shasta cold-water-pool characteristics and early fall Balls Ferry water temperature.

Summary Document for temperature-dependent egg mortality
Prepared by the Southwest Fisheries Science Center on May 27th, 2020

Below are results comparing one USBR scenario ran May 27th 2020. 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. Additionally, a set of mortality model runs were generated using USBR's HEC-5Q model output for comparison purposes, where the RAFT model was not used, but temperatures from the HEC-5Q nodes were linearly interpolated in space.

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

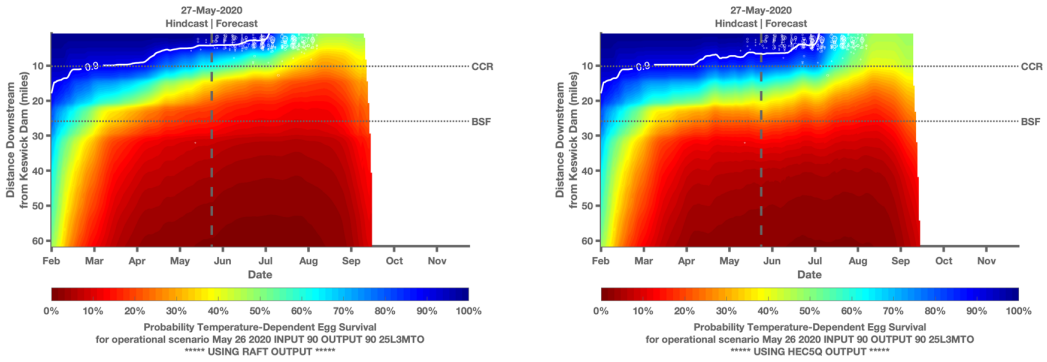


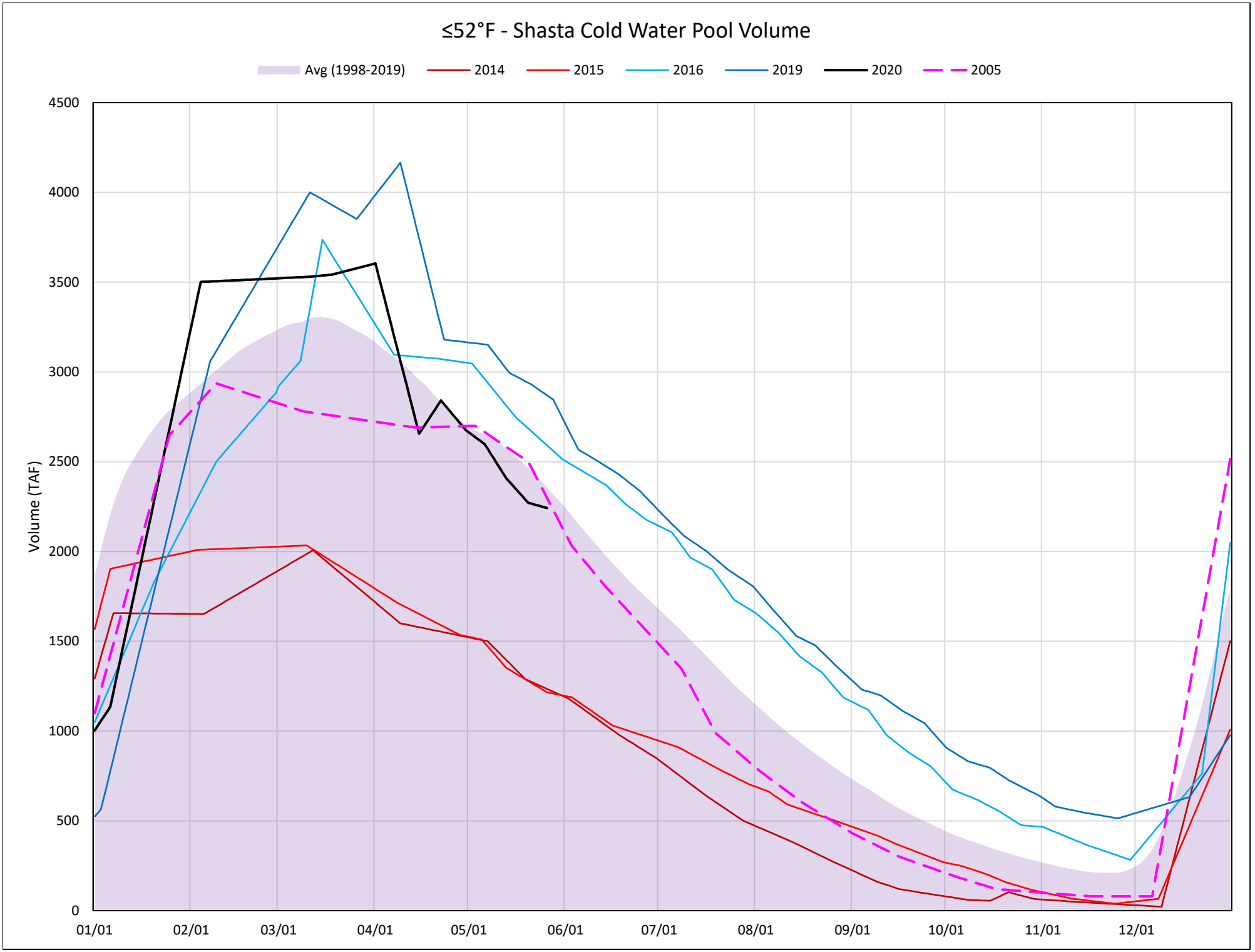
Figure1: Estimated temperature-dependent egg survival produced by the NMFS temperature mortality model (left plot) and interpolated HEC-5Q model output (right plot) under the one May 26th 2020 scenario. Note that plots are using 2012-2019 redd distributions.

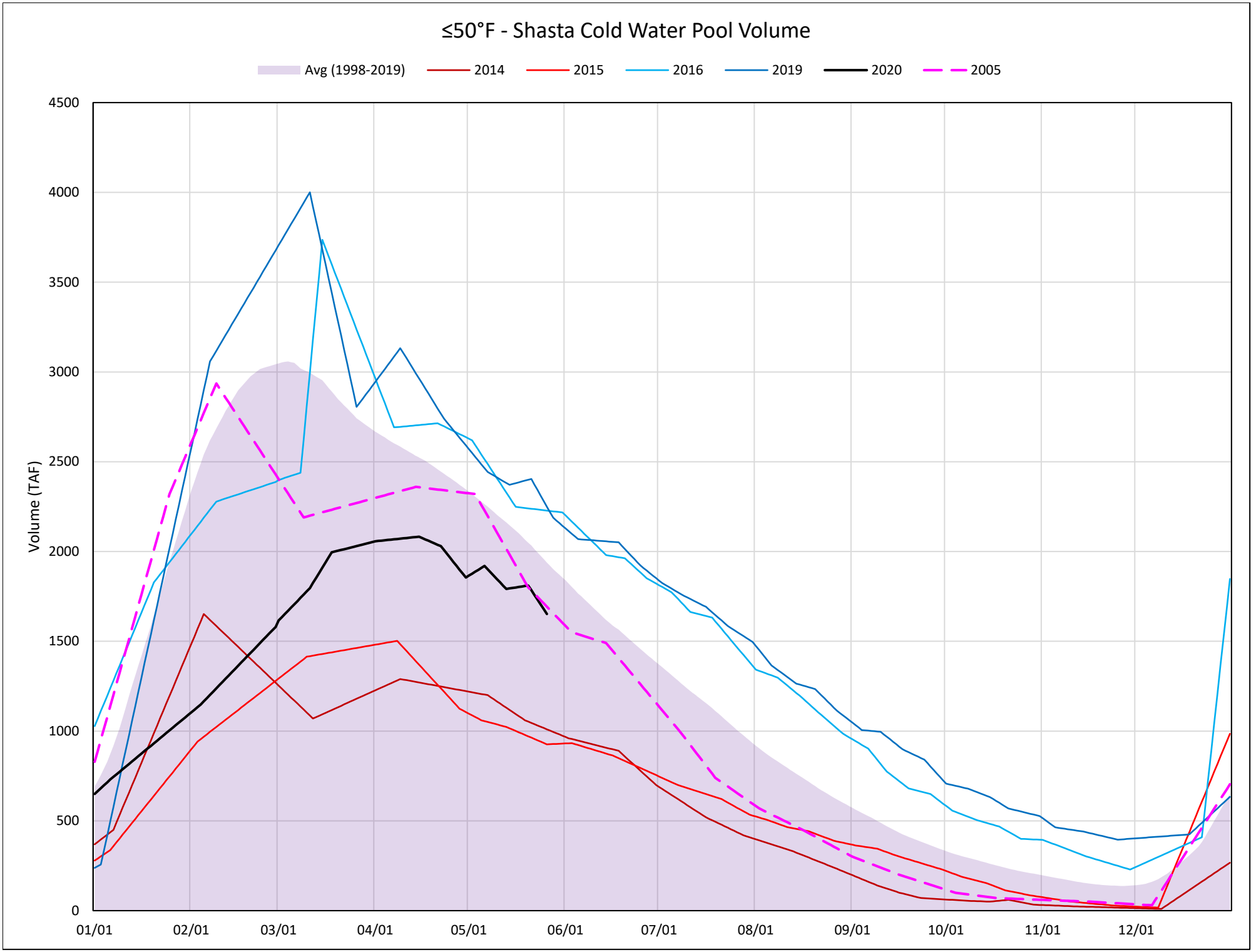
Table 1: Estimated temperature-dependent egg mortality under different scenarios assuming a 2012-2019 spatial and temporal redd distribution using output from RAFT and interpolated HEC-5Q water temperature models.

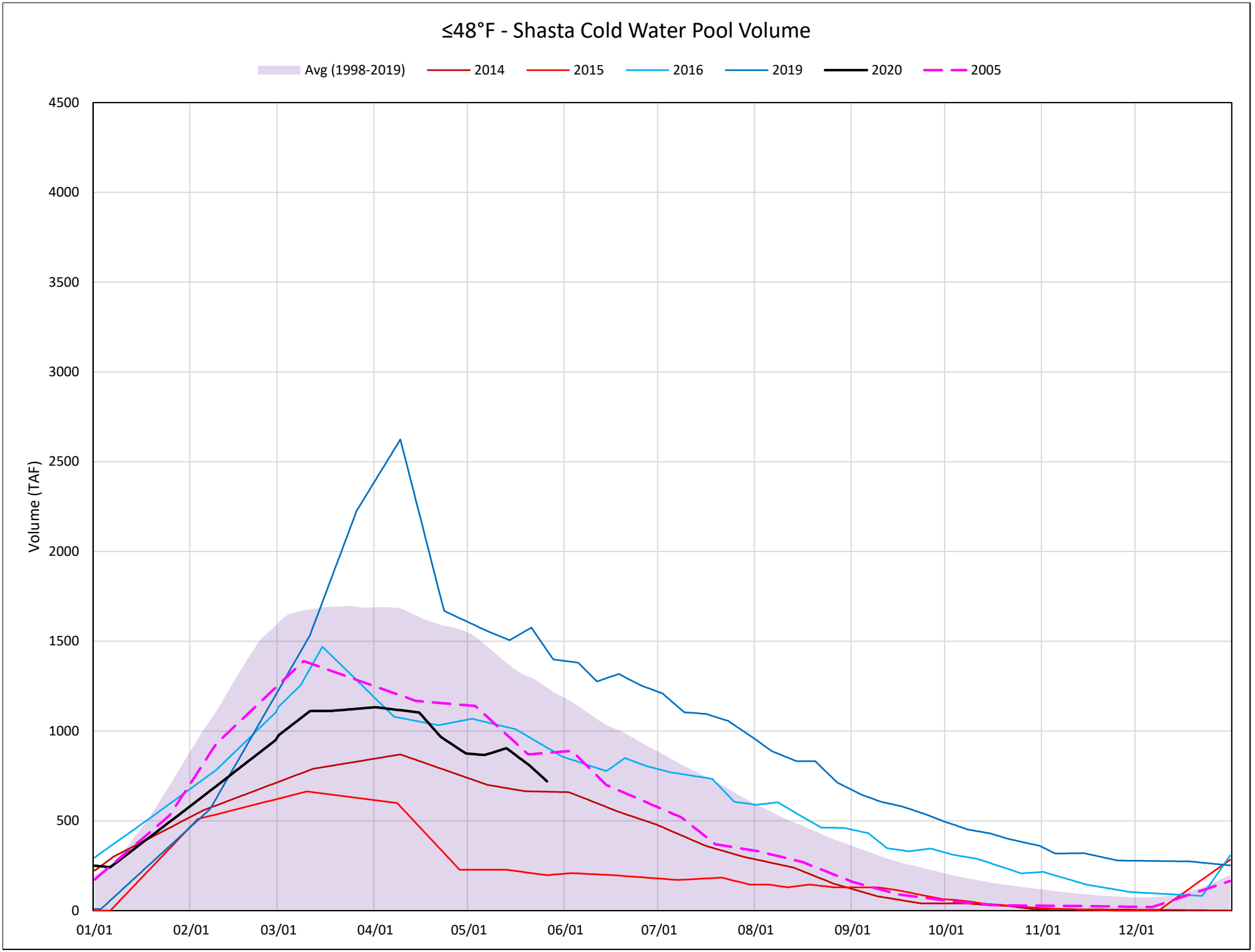
Scenario	MODEL	Mean (%)	Median (%)	Lower (%)	Upper (%)
MAY_26_2020_INPUT_90_OUTPUT_90_25L3MTO	RAFT	30.63	27.57	0.08	69.6
MAY_26_2020_INPUT_90_OUTPUT_90_25L3MTO	HEC-5Q	26.46	22.16	0.11	67.22

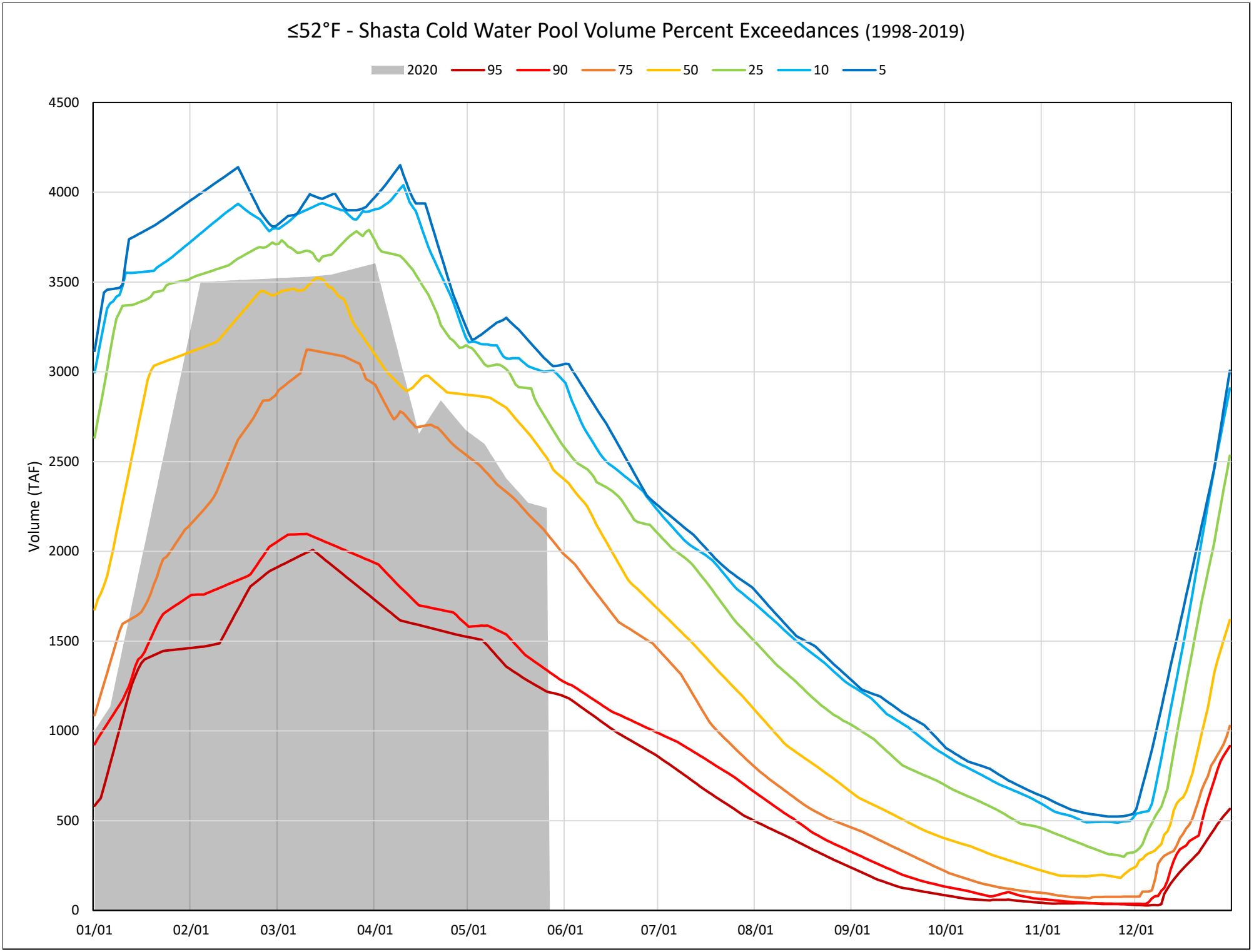
Reference:

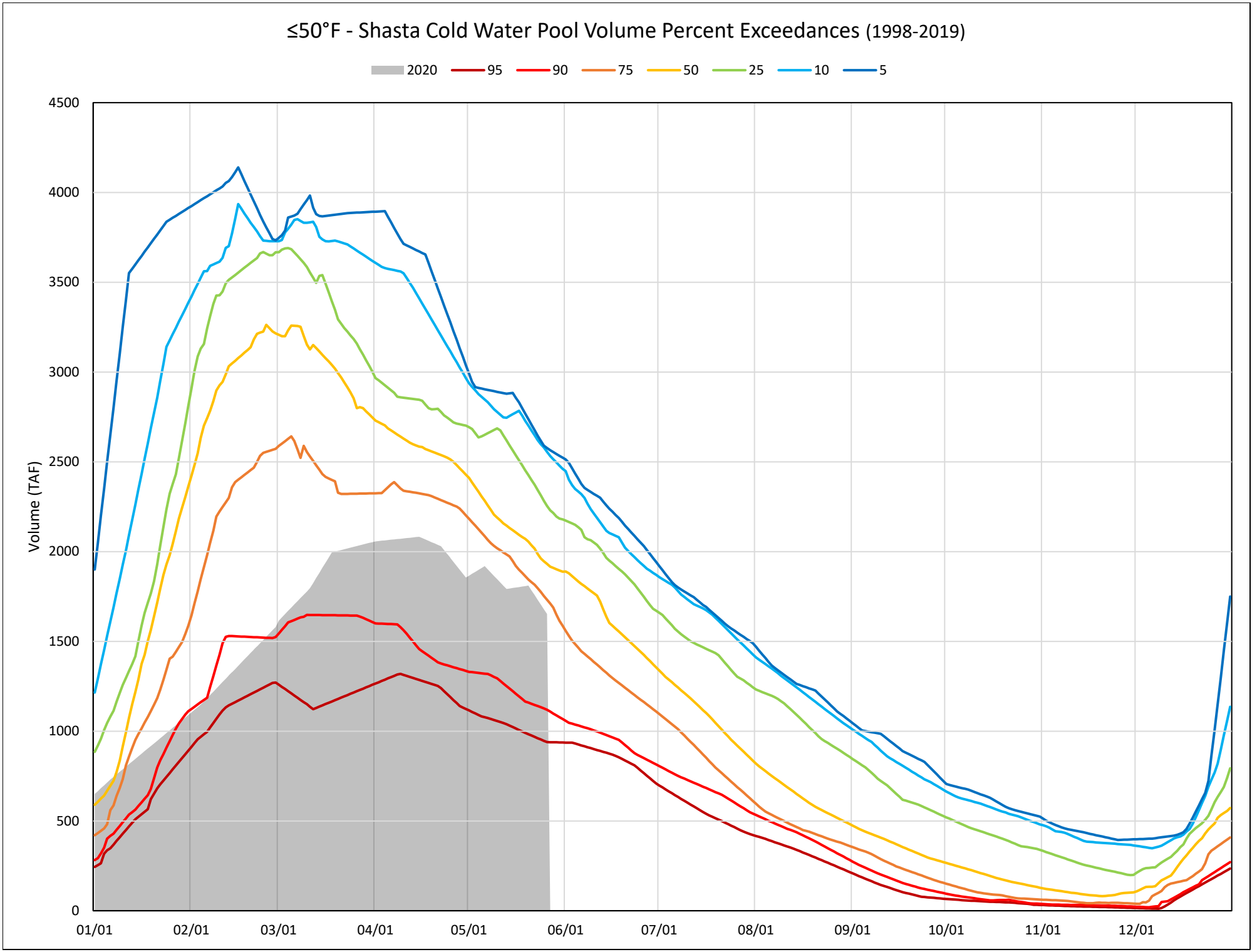
Martin, B. T., Pike, A., John, S. N., Hamda, N., Roberts, J., Lindley, S. T. and Danner, E. M. (2017), Phenomenological vs. biophysical models of thermal stress in aquatic eggs. Ecology Letters 20: 50–59. doi:10.1111/ele.12705

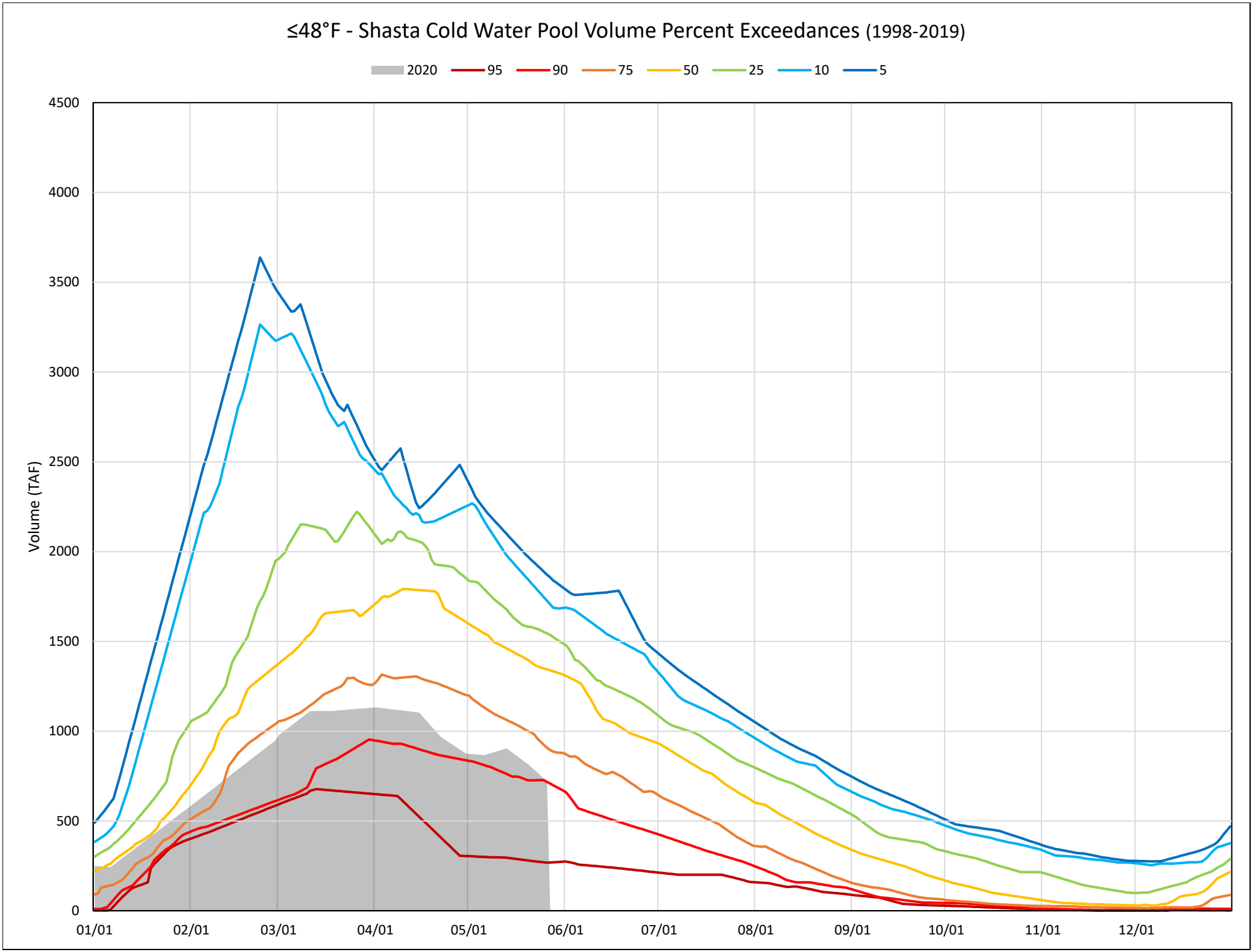

≤52°F - Shasta Cold Water Pool Volume
Avg (1998-2019)
2014
2015
2016
2019
2020
2005
Volume (TAF)
4500
4000
3500
3000
2500
2000
1500
1000
500
0
01/01
02/01
03/01
04/01
05/01
06/01
07/01
08/01
09/01
10/01
11/01
12/01


≤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

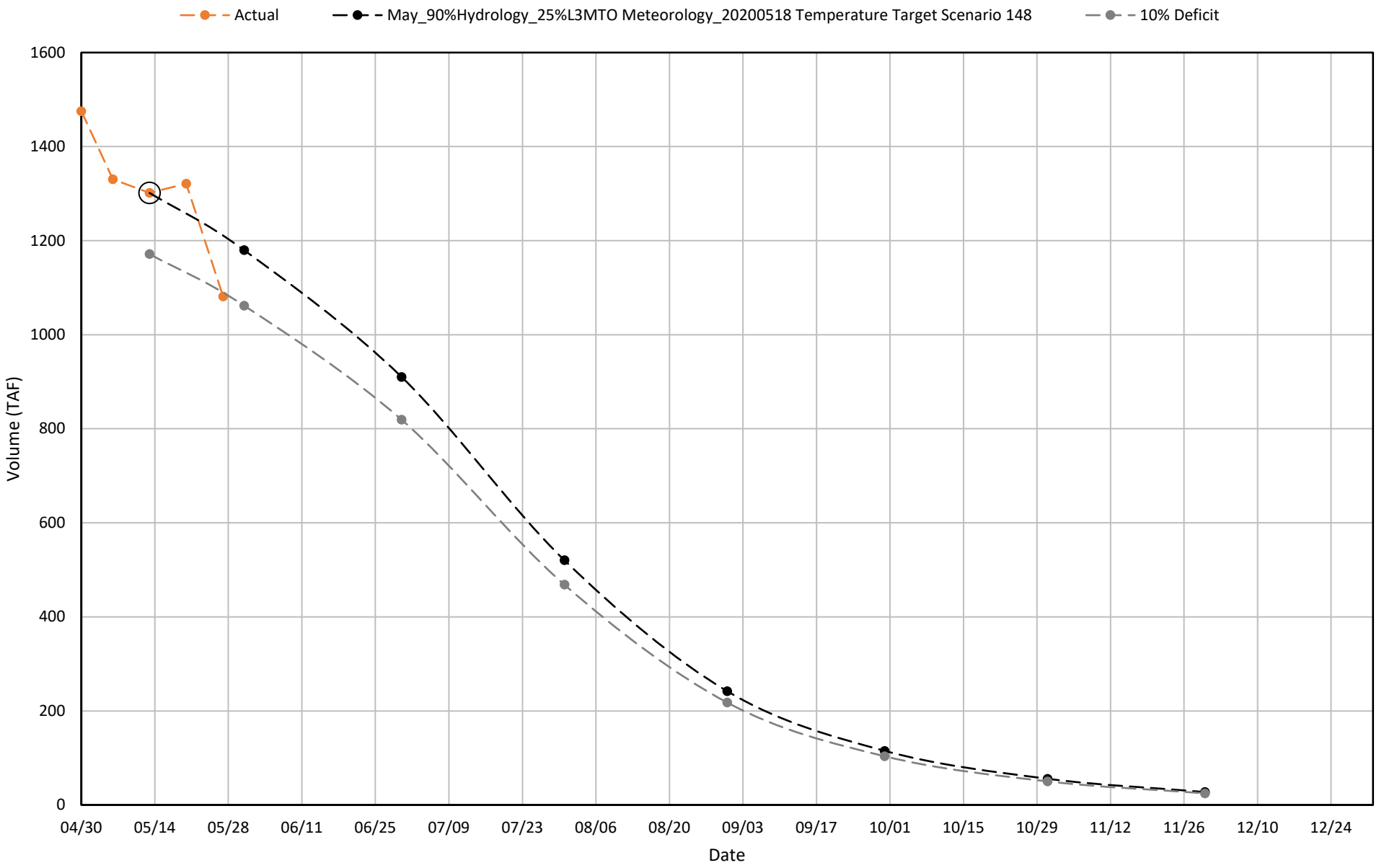

≤52°F - Shasta Cold Water Pool Volume Percent Exceedances (1998-2019)
2020
95
90
75
50
25
10
5
Volume (TAF)
4500
4000
3500
3000
2500
2000
1500
1000
500
0
01/01
02/01
03/01
04/01
05/01
06/01
07/01
08/01
09/01
10/01
11/01
12/01


≤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: 2020.05.27

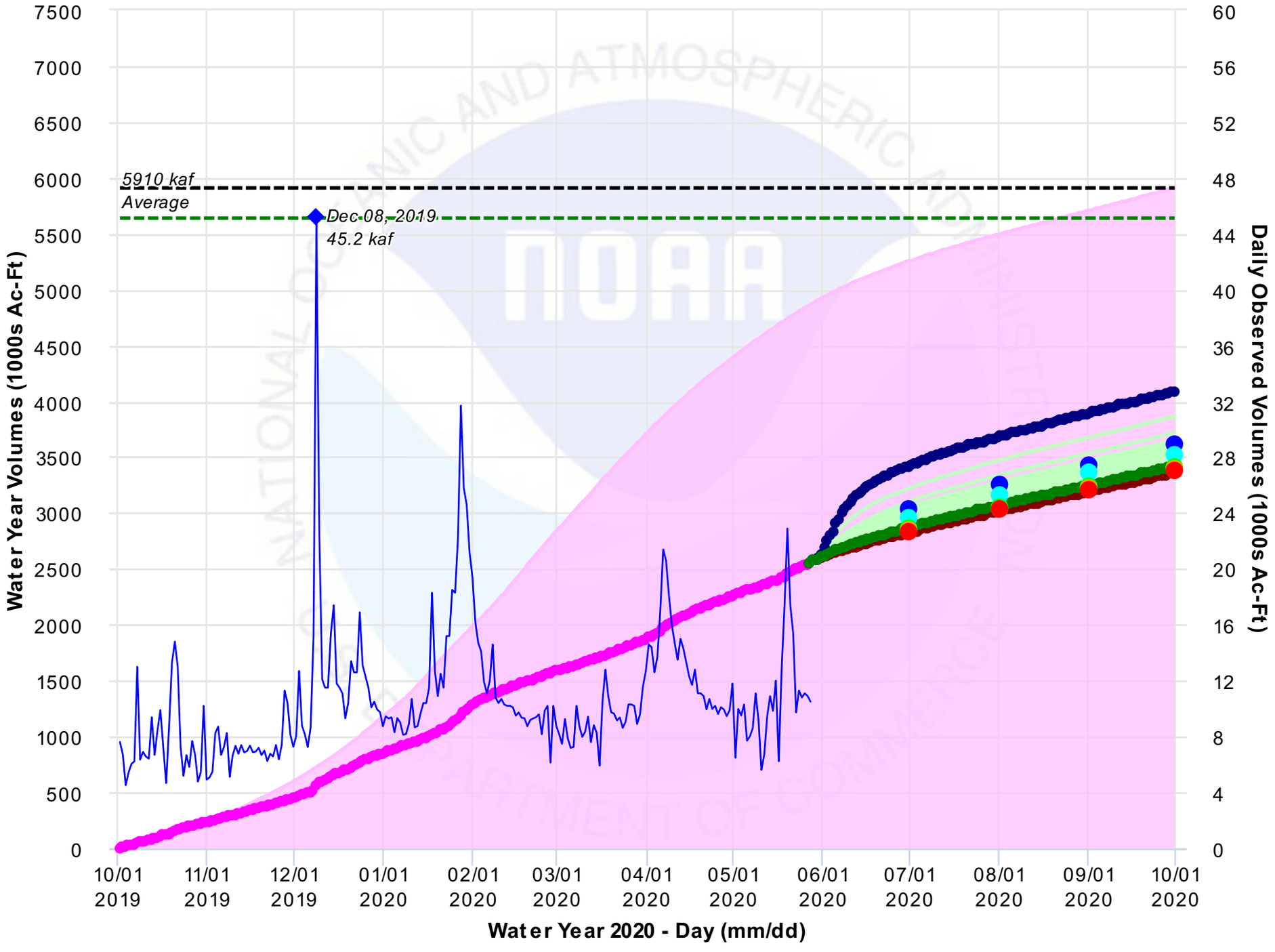
2020 Shasta Cold Water Pool Volume ≤49°F



SACRAMENTO - SHASTA DAM (SHDC1) 05/27/2020

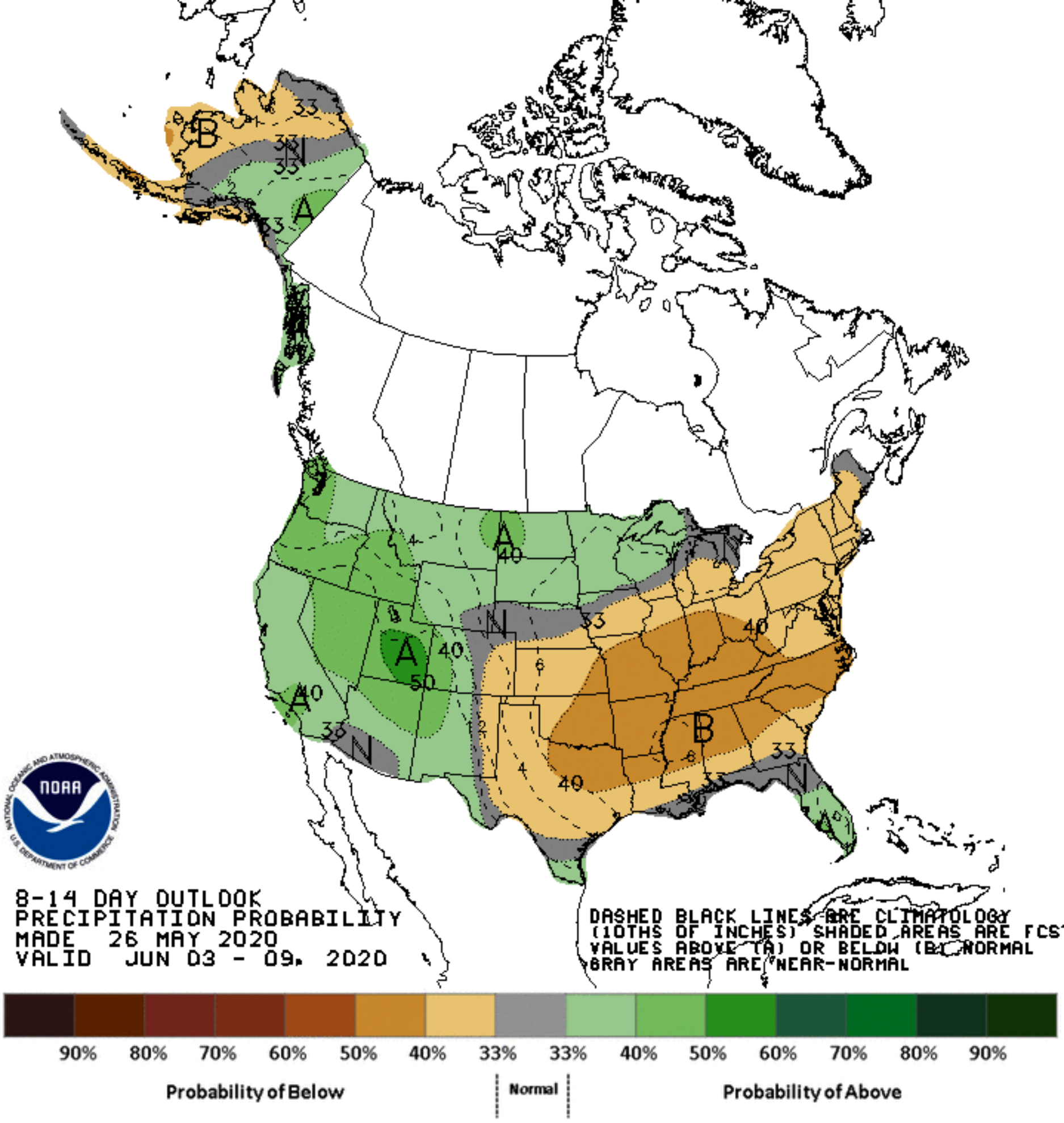
Most Probable: 3420 kaf | 58% of Average | 61% of Median

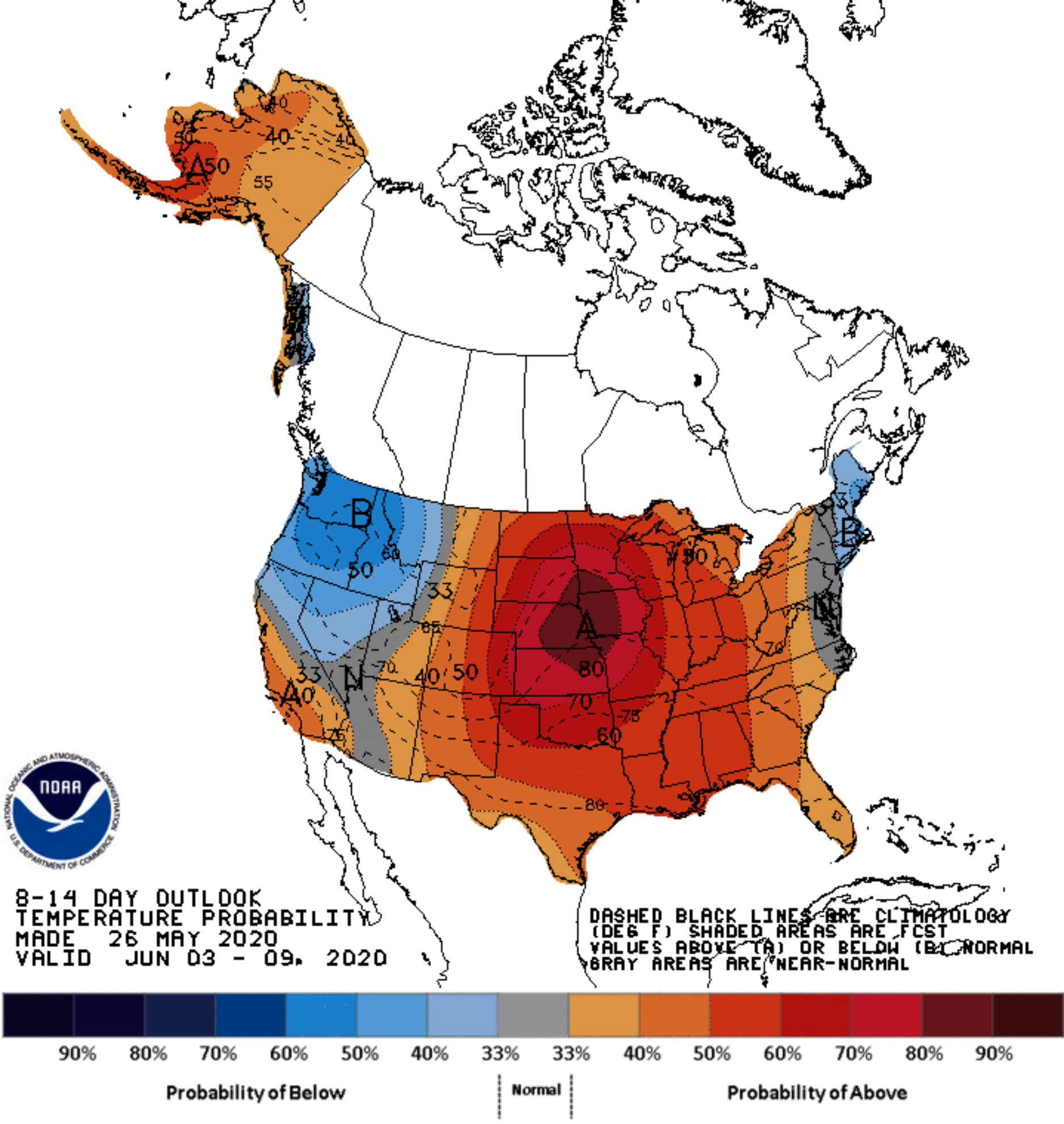
Created: 05/27/2020 at 08:22 AM PDT



Observed to Date Percent of Average: 52% (2550 kaf) **Water Year to Date Average: 4870 kaf**

- 90%: 3380 kaf
- 75%: 3390 kaf
- 50%: 3420 kaf
- 25%: 3530 kaf
- 10%: 3610 kaf
- Min Trace (1960: 3360 kaf)
- Median Trace (1991: 3420 kaf)
- Max Trace (1993: 4090 kaf)
- Volume Med
- Volume Avg
- Traces (1950-2017)
- Record High
- Record Low
- Accum to Date Avg
- Accum to Date Obs
- Daily Obs
- Obs Peak


8-14 DAY OUTLOOK
PRECIPITATION PROBABILITY
MADE 26 MAY 2020
VALID JUN 03 - 09, 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
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 26 MAY 2020
VALID JUN 03 - 09, 2020
DASHED BLACK LINES ARE CLIMATOLOGY (DEG F) SHADED AREAS ARE FCST 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