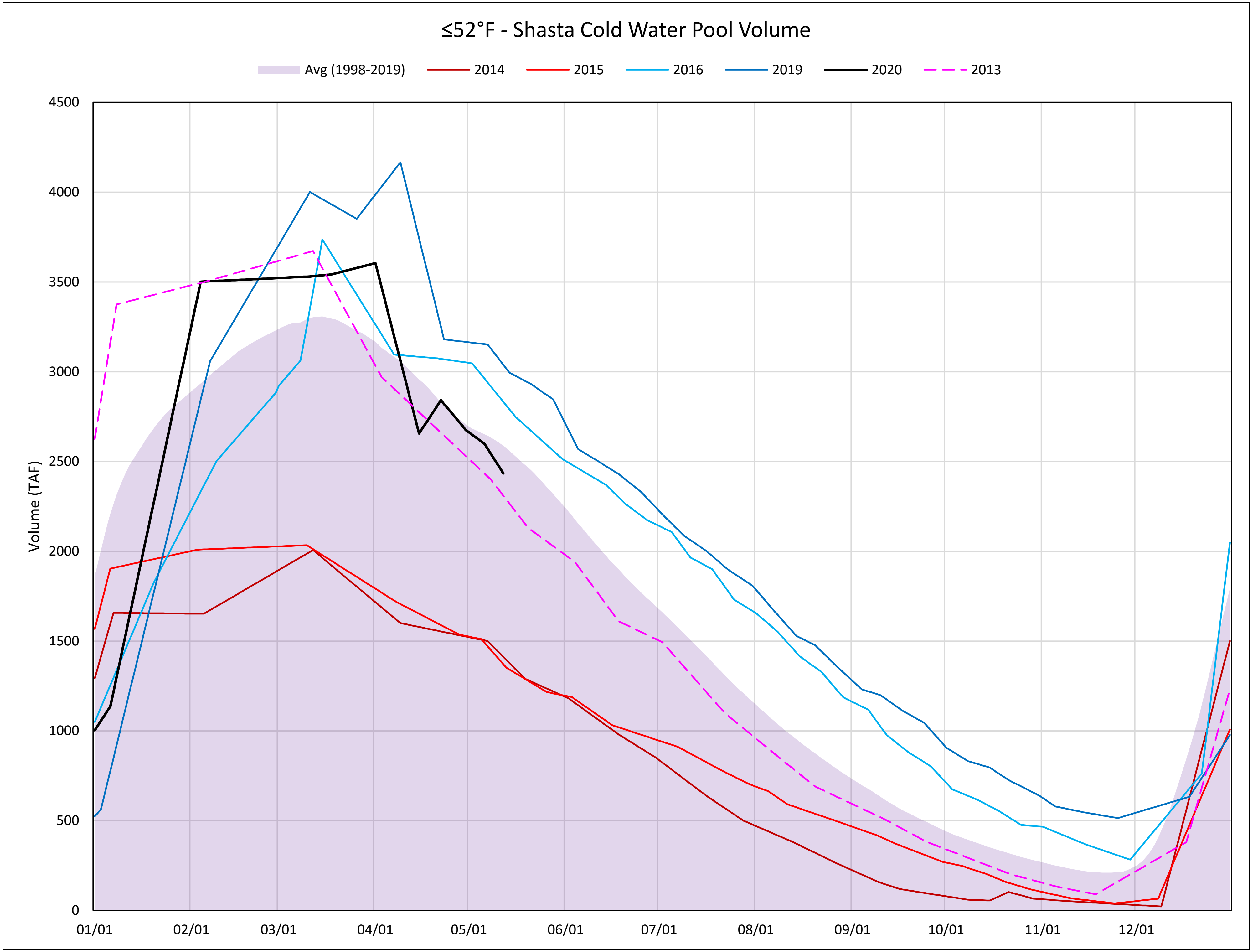
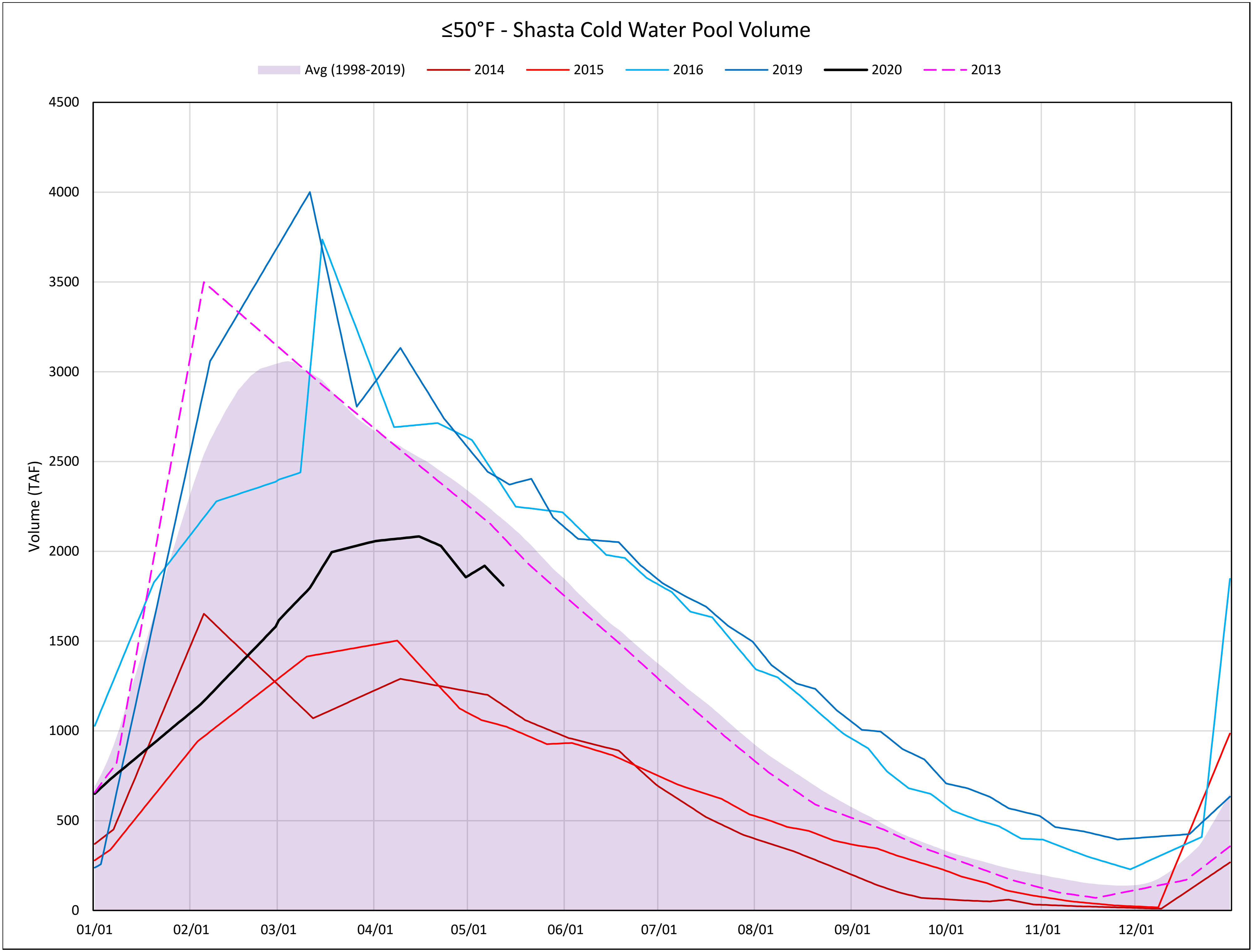
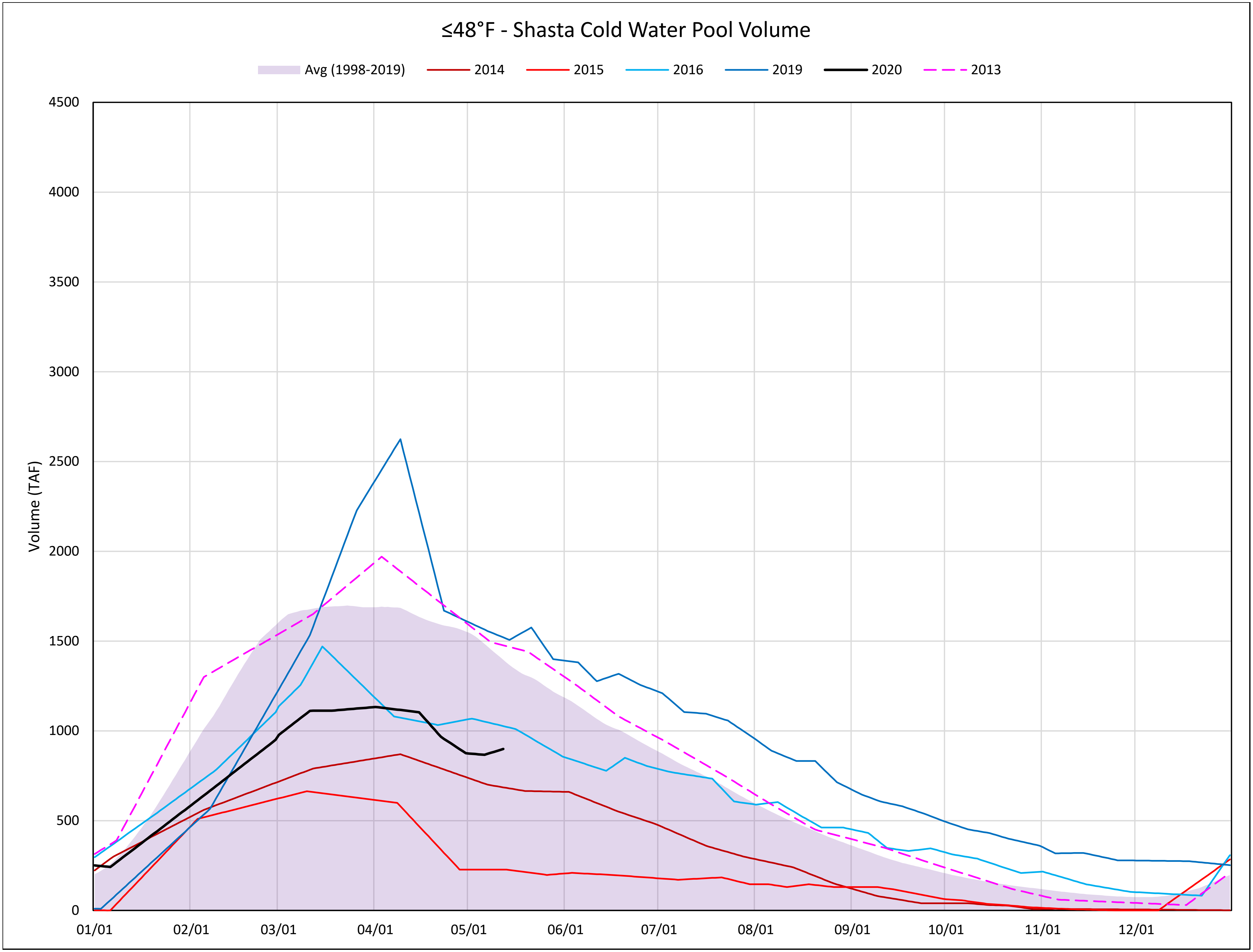
Attachment 1

Water Year 2020 Shasta Cold Water Pool Volume Tracking

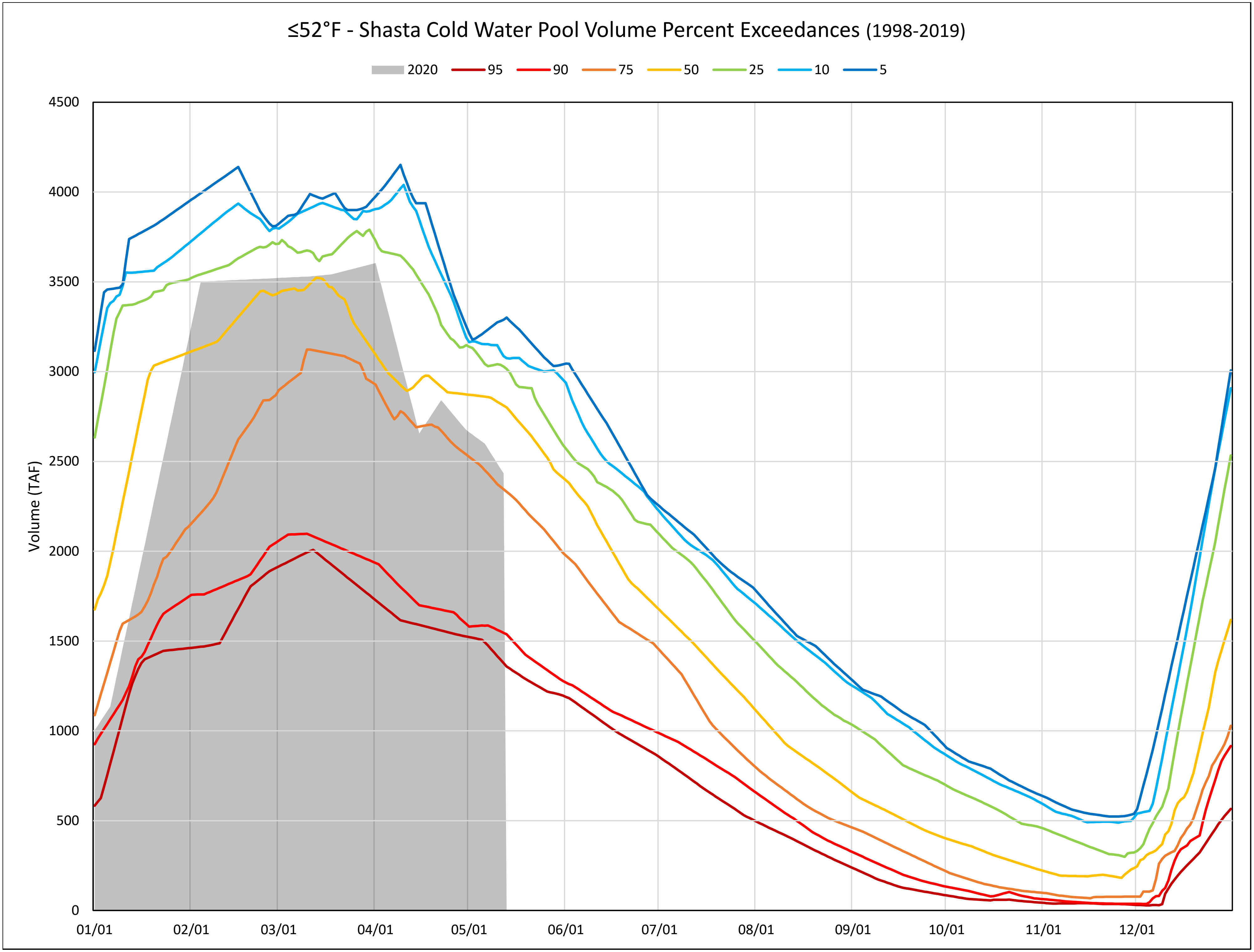

≤52°F - Shasta Cold Water Pool Volume
Avg (1998-2019)
2014
2015
2016
2019
2020
2013
Volume (TAF)
4500
4000
3500
3000
2500
2000
1500
1000
500
0
01/01
02/01
03/01
04/01
05/01
06/01
07/01
08/01
09/01
10/01
11/01
12/01

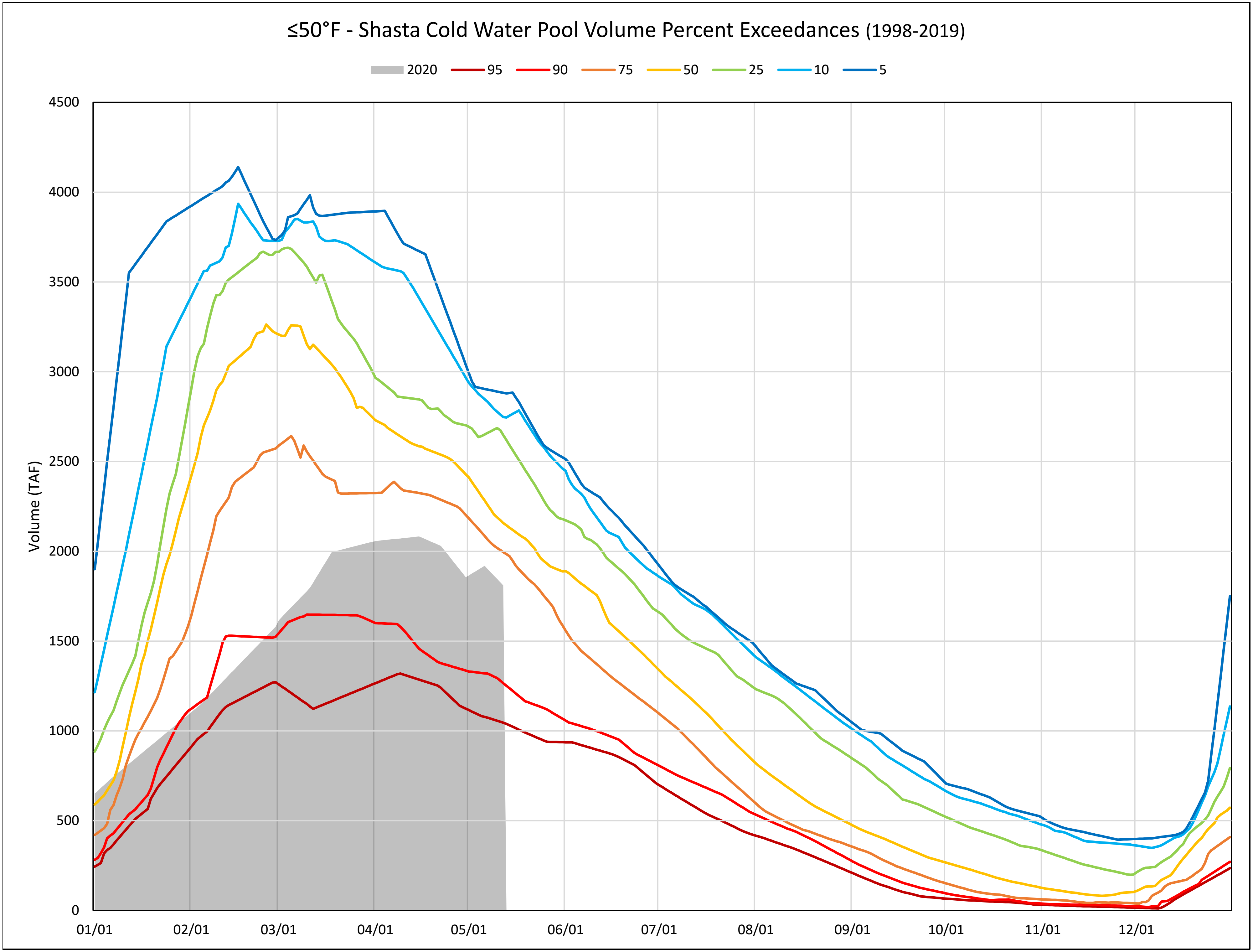


≤50°F - Shasta Cold Water Pool Volume
Avg (1998-2019)
2014
2015
2016
2019
2020
2013
Volume (TAF)
4500
4000
3500
3000
2500
2000
1500
1000
500
0
01/01
02/01
03/01
04/01
05/01
06/01
07/01
08/01
09/01
10/01
11/01
12/01

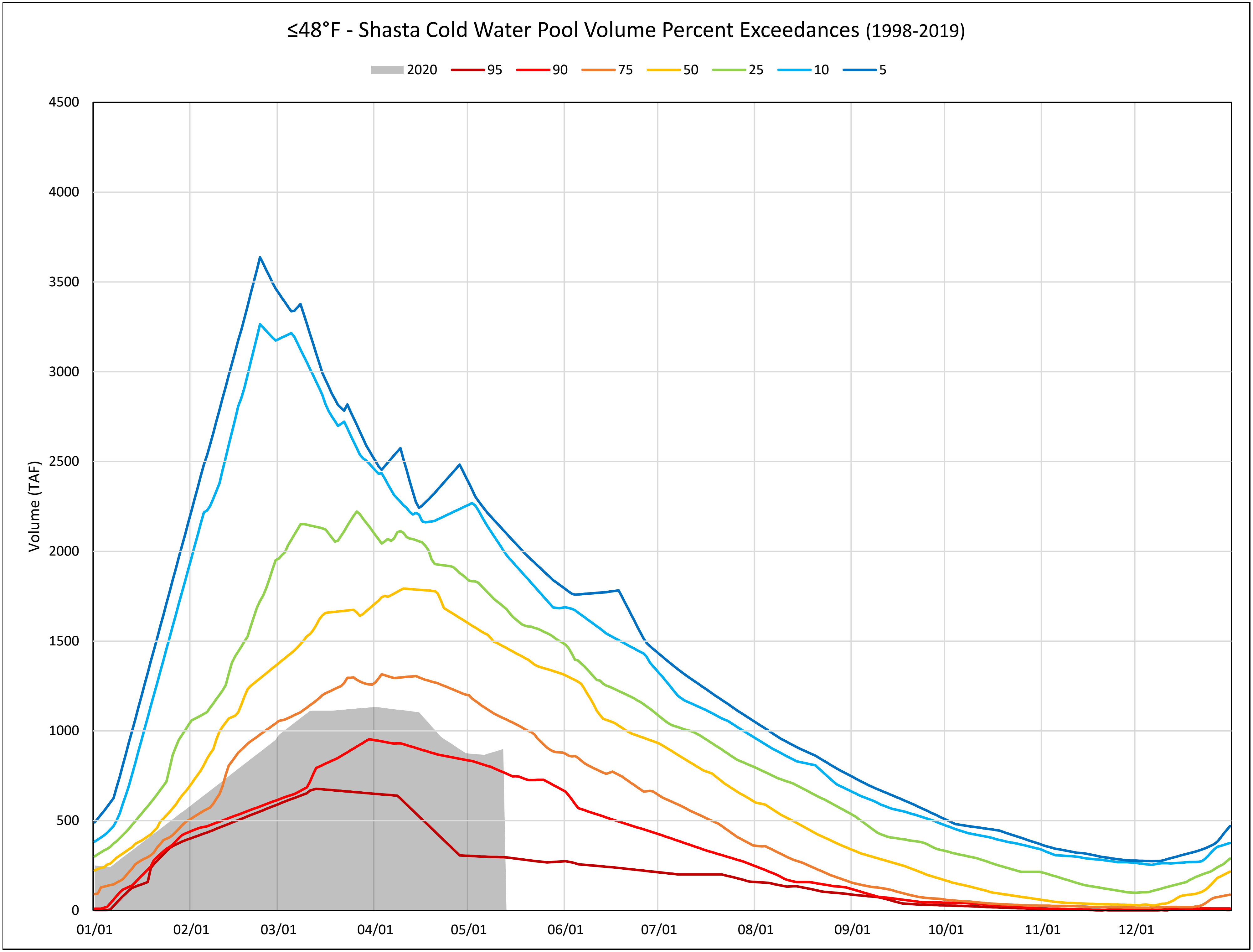


≤48°F - Shasta Cold Water Pool Volume
Avg (1998-2019)
2014
2015
2016
2019
2020
2013
Volume (TAF)
4500
4000
3500
3000
2500
2000
1500
1000
500
0
01/01
02/01
03/01
04/01
05/01
06/01
07/01
08/01
09/01
10/01
11/01
12/01


≤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

Attachment 2

Central Valley Project May 2020 90% Exceedance Operations Outlook

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**	**767**	**699**	**539**	**394**	**337**	**296**	**295**	**305**	**318**	**348**	**437**	**541**
	Elev.		446	439	421	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**	**247**	**145**	**123**	**145**	**223**	**295**	**320**	**360**	**556**	**534**	**493**	**431**
	Elev.		466	447	430	419	421	427	442	460	487	473	465	454
Total			8383	7472	6526	5781	5427	5249	5226	5314	5653	5882	6299	6434

Monthly River Releases (TAF/cfs)

		May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr
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	206	199	104	78	43	44	49	73	83	101
	cfs	**1500**	**2110**	**3353**	**3243**	**1742**	**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**
Feather	TAF												
	cfs												

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	7	7	7	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	265	273	260	202	83	78	234	48	53	51
COA Balance		11	10	12	19	31	12	12	12	12	-12	-65	-45
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	-3,948	-4,097	-3,999	-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%

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

Attachment 3

Central Valley Project May 2020 90% Exceedance Operations Outlook Information

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.

Attachment 4

Department of Water Resources Bulletin 120 May 1,2020 Water Supply Forecast Package

We've finished the May 1, 2020 Water Supply Index (WSI) and Bulletin 120 (B120) forecasts. These forecasts include observed conditions through the end of April.

The forecasts are posted at:

WSI: http://cdec.water.ca.gov/reportapp/javareports?name=WSI

B120: http://cdec.water.ca.gov/b120.html

Forecast Summary:
The projected median April-July (AJ) runoff in the major Sierra river basins ranges from around 34 percent for the East Walker to 76 percent for the Cosumnes River. The statewide seasonal AJ median forecast is 7.85 MAF which is 56 percent of the historic average. This value is a 3 percent increase from the April 1 Bulletin 120 Forecast.

The projected median Water Year (WY) runoff in the major Sierra river basins ranges from 36 percent on the Trinity River to 68 percent for the Pit River. The projected Statewide median WY runoff is 51 percent of the historic average.

The WSI forecast is based on precipitation, snow, and flows observed through April 2020 and can be summarized as follows:

Sacramento River Unimpaired Runoff Water Year Forecast (50 percent exceedance)	**9.2 MAF** **(52 percent of average)**
Sacramento Valley Index (SVI) (50 percent exceedance)	**6.0** **(Dry)**
San Joaquin Valley Index (SJI) (75 percent exceedance)	**2.2** **(Dry)**

Runoff:
Unimpaired flows in Percent of Average for Water Year 2020 are as follows:

Hydrologic Region	Oct Runoff	Nov Runoff	Dec Runoff	Jan Runoff	Feb Runoff	Mar Runoff	Apr Runoff	Oct-Apr Runoff
Sacramento River Region	84	45	74	45	33	31	74	50
San Joaquin River Region	92	33	84	26	26	41	96	57
Tulare Lake Region	110	77	91	42	41	38	78	62

The American, Cosumnes, Mokelumne, Stanislaus, Tuolumne, and Merced watersheds all flowed greater than 90 percent of average for the month of April. All other watersheds in the Sierra Nevada flowed less than 90 percent of average.

With increasing temperatures and ripe isothermal snowpack, most snowmelt runoff is expected to peak within the next week if it has not already.

April full natural flow rates updated through May 6-7, 2020:

River Basin	Percent of Historic Average
Trinity	38
Shasta Inflow	53
Sacramento at Bend Bridge	55
Feather	62
Yuba	76
American	85
Cosumnes	89
Mokelumne	90
Stanislaus	85
Tuolumne	85
Merced	77
San Joaquin	83
Kings	93
Kaweah	76
Tule	56
Kern	68

Precipitation:
Precipitation for Water Year 2020 accumulated at the following rates of average

Region	WY accumulated precipitation (%) through April 30, 2020
Sacramento River Valley	57
San Joaquin River Valley	72
Tulare Lake Basin	73
Statewide	70
Regional Precipitation Indices	**WY average to date as of May 7, 2020**
Northern Sierra 8-Station Index	56 (27.1 inches)
San Joaquin 5-Station Index	60 (22.4 inches)
Tulare Basin 6-Station Index	65 (17.4 inches)

The San Joaquin 5-Station and Tulare 6-Station Precipitation Indices both accumulated more precipitation during March-April than during December-February; typically, these three are the wettest months of a water year.

Monthly Precipitation to date in Percent of Average for Water Year 2020 for Regional Precipitation Indices

Regional Precipitation Indices	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Northern Sierra 8-Station Index	3	43	107	55	2	81	73	4
San Joaquin 5-Station Index	0	69	109	19	4	101	125	0
Tulare Basin 6-Station Index	0	106	91	12	12	76	208	0

Snowpack:
Snowpack is monitored using two complementary methods: automatic snow sensor (or "pillow") readings and manual snow course measurements. The snow sensors give us a daily snapshot of snow conditions while the manual snow course measurements provide a monthly verification of snow conditions in locations where snow has been measured in the same manner as far back as 100 years.

May snow course measurements show the statewide average at 39 percent of average to date. The results of the May 2020 statewide snow surveys are as follows:

Region	No. of Courses Measured	Average Snow Water Content (inches)	% Average April 1	% Average May 1
North Coast	8	3.8	11	15
Sacramento	46	9.3	29	40
San Joaquin Valley	35	12.8	36	43
Tulare Lake	32	9.0	33	43
North Lahontan	3	6.2	20	23
South Lahontan	1	11.5	52	61
Statewide Average (weighted)			30	39

As of May 7, the statewide snowpack based on the automated snow sensor network is 25 percent of average to date and 17 percent of the April 1 average. The snowpack as of the morning of May 7, 2020 stands at the following (based on snow sensors):

Region	Snow Water Content (inches)	% of Average (Apr 1)	% of Average (May 7)
Northern	3.1	10	16
Central	6.2	21	29
Southern	4.6	18	25
Statewide	4.9	17	24

The statewide snowpack snow water content has decreased by 3.1 inches from 8.0 inches on May 1. On May 1, the snow sensor statewide snowpack was at 36 percent of average to date, similar to the percent of average as determined by the April snow course measurements.

Weather and Climate Outlooks:
According to the CNRFC 6-day forecast, there are chances of precipitation in northern California over the last two days of the forecast. The North Coast basin is forecasted to receive the greatest amount of precipitation at an average of 1.3 inches. Between 0.4 and 0.8 inches of precipitation is predicted in the Klamath, Russian, Sacramento, Yuba, and American basins. Light precipitation between 0.1 and 0.3 inches is predicted in the San Joaquin and North San Joaquin basins. Forecasted precipitation in all other basins is negligible.

Freezing elevations range from 11,000 feet in northern California to 15,000 feet in southern California to start the period; by the end of the 6-day forecast, freezing elevations decrease to 5,000 feet in northern California and 13,000 feet in southern California.

The NWS Climate Prediction Center (CPC) one-month revised outlook for May 2020 issued on April 30, 2020, points to chances of above normal temperatures across the state. This same outlook suggests equal chances of above or below normal precipitation for all of California.

The CPC three-month (May-June-July) outlook, issued on April 16, 2020, points to increased chances of above normal temperatures across the State. The same outlook forecasts equal chances of above or below normal precipitation in central and southern California, and chances of below normal precipitation in northern California.

According to the latest El Niño/Southern Oscillation (ENSO) discussion issued by the Climate Prediction Center on May 4, 2020, ENSO-neutral conditions are present. Equatorial sea surface temperatures (SSTs) are near-to-above average across most of the Pacific Ocean. The tropical atmospheric circulation is consistent with ENSO-neutral. ENSO-neutral is favored for Northern Hemisphere summer 2020 (~60% chance), remaining the most likely outcome through autumn.

Next Update:
A Bulletin 120 update for conditions as of May 12 will be available by Thursday, May 14. This is the last issuance of the Water Supply Index (WSI) forecasts for Water Year 2020. The next WSI will be available in December 2020. If you have any questions regarding this forecast, please contact a member of the Snow Surveys and Water Supply Forecasting Section.

Important Links:

Full Natural Flow Data:
Daily FNF
http://cdec.water.ca.gov/reportapp/javareports?name=FNF
Monthly FNF
http://cdec.water.ca.gov/reportapp/javareports?name=FNFSUM
Seasonal FNF
http://cdec.water.ca.gov/reportapp/javareports?name=FLOWOUT
NEW Tableau Dashboard – Historical FNF Comparison (Interactive Data Visualization)
https://tableau.cnra.ca.gov/t/DWR_Snow_WSFcast/views/FNF_V11/MonthlyFNFDashboard?iframeSizedToWindow=true&:embed=y&:showAppBanner=false&:display_count=no&:showVizHome=no

Precipitation Data:
Latest Northern Sierra 8-Station Precipitation Index
http://cdec.water.ca.gov/cgi-progs/products/TAB_ESI.pdf
Latest San Joaquin 5-Station Precipitation Index
http://cdec.water.ca.gov/cgi-progs/products/TAB_FSI.pdf
Latest Tulare Basin 6-Station Precipitation Index
http://cdec.water.ca.gov/cgi-progs/products/TAB_TSI.pdf

Snow Data:
Latest Snow Sensor Report
http://cdec.water.ca.gov/reportapp/javareports?name=PAGE6
Latest Statewide Summary of Snow Water Equivalents
http://cdec.water.ca.gov/reportapp/javareports?name=DLYSWEQ
NEW Tableau Dashboard – Regional Snow Water Equivalent Comparison (Interactive Data Visualization)
https://tableau.cnra.ca.gov/t/DWR_Snow_WSFcast/views/SWE_v2/SWEDashboard?iframeSizedToWindow=true&:embed=y&:showAppBanner=false&:display_count=no&:showVizHome=no
NEW Tableau Dashboard – Snow Product Comparison (Interactive Data Visualization)
https://tableau.cnra.ca.gov/t/DWR_Snow_WSFcast/views/SnowProductComparisons_V2/Dashboard1?iframeSizedToWindow=true&:embed=y&:showAppBanner=false&:display_count=no&:showVizHome=no

Extended Regional Forecasts:
California Nevada River Forecast Center 6 Day QPF and Snow Level Forecast
http://www.cnrfc.noaa.gov/awipsProducts/RNOHD6RSA.php
Climate Prediction Center One-Month Outlook Forecasts
https://www.cpc.ncep.noaa.gov/products/predictions/30day/
Climate Prediction Center Three-Month Outlook Forecasts
https://www.cpc.ncep.noaa.gov/products/predictions/long_range/seasonal.php?lead=01
U.S. Seasonal Drought Outlook
http://www.cpc.ncep.noaa.gov/products/expert_assessment/sdo_summary.html
Weather Forecast Office California Service Area-Products
http://www.cnrfc.noaa.gov/forecasts.php
El Niño Southern Oscillation (ENSO) Conditions and Weekly Discussion (including La Niña)
http://www.cpc.ncep.noaa.gov/products/analysis_monitoring/lanina/enso_evolution-status-fcsts-web.pdf

Bulletin 120:

NEW Tableau Dashboard – Bulletin 120 Forecast Performance Over Time (Interactive Data Visualization)
https://tableau.cnra.ca.gov/t/DWR_Snow_WSFcast/views/B120_Fct_Error/Story?iframeSizedToWindow=true&:embed=y&:showAppBanner=false&:display_count=no&:showVizHome=no
Historical Forecast Error Plots
http://cdec.water.ca.gov/snow/bulletin120/B120_error_fcast_plots.html

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2020 SACRAMENTO RIVER WATER YEAR FORECAST BREAKDOWN
May 1, 2020

Shasta Lake Unimpaired Inflow [taf]

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	WY	Apr-Jul	WY % avg
99%	229	224	401	433	298	290	384	200	130	115	115	117	2,935	829	
90%	229	224	401	433	298	290	384	210	140	126	130	131	2,995	860	
75%	229	224	401	433	298	290	384	250	170	150	145	147	3,120	954	
50%	229	224	401	433	298	290	384	285	205	176	165	156	3,245	1,050	56%
25%	229	224	401	433	298	290	384	320	235	195	177	165	3,350	1,134	
10%	229	224	401	433	298	290	384	355	256	215	190	181	3,455	1,210	
												1966-2015 avg	5,831	1,756	

Sacramento River above Bend Bridge Unimpaired Flow [taf]

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	WY	Apr-Jul	
99%	273	245	618	647	446	430	547	265	195	170	155	159	4,150	1,177	
90%	273	245	618	647	446	430	547	290	213	180	165	171	4,225	1,230	
75%	273	245	618	647	446	430	547	350	250	205	185	189	4,385	1,352	
50%	273	245	618	647	446	430	547	410	288	235	200	206	4,545	1,480	53%
25%	273	245	618	647	446	430	547	470	335	260	225	224	4,720	1,612	
10%	273	245	618	647	446	430	547	535	383	285	241	240	4,890	1,750	
												1966-2015 avg	8,544	2,421	

Feather River at Oroville Unimpaired Flow [taf]

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	WY	Apr-Jul	
99%	98	100	327	258	180	214	408	175	79	55	50	45	1,990	717	
90%	98	100	327	258	180	214	408	217	90	65	60	52	2,070	780	
75%	98	100	327	258	180	214	408	260	115	75	66	58	2,160	858	
50%	98	100	327	258	180	214	408	300	142	90	73	64	2,255	940	51%
25%	98	100	327	258	180	214	408	330	165	105	82	72	2,340	1,008	
10%	98	100	327	258	180	214	408	365	185	122	92	80	2,430	1,080	
												1966-2015 avg	4,407	1,704	

Yuba River near Smartville plus Deer Creek Unimpaired Flow [taf]

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	WY	Apr-Jul	
99%	30	27	141	103	75	109	309	95	20	6	2	3	920	430	
90%	30	27	141	103	75	109	309	135	28	8	4	6	975	480	
75%	30	27	141	103	75	109	309	175	45	12	6	8	1,040	541	
50%	30	27	141	103	75	109	309	215	60	16	9	10	1,105	600	49%
25%	30	27	141	103	75	109	309	245	78	23	15	15	1,170	655	
10%	30	27	141	103	75	109	309	275	96	30	20	20	1,235	710	
												1966-2015 avg	2,268	968	

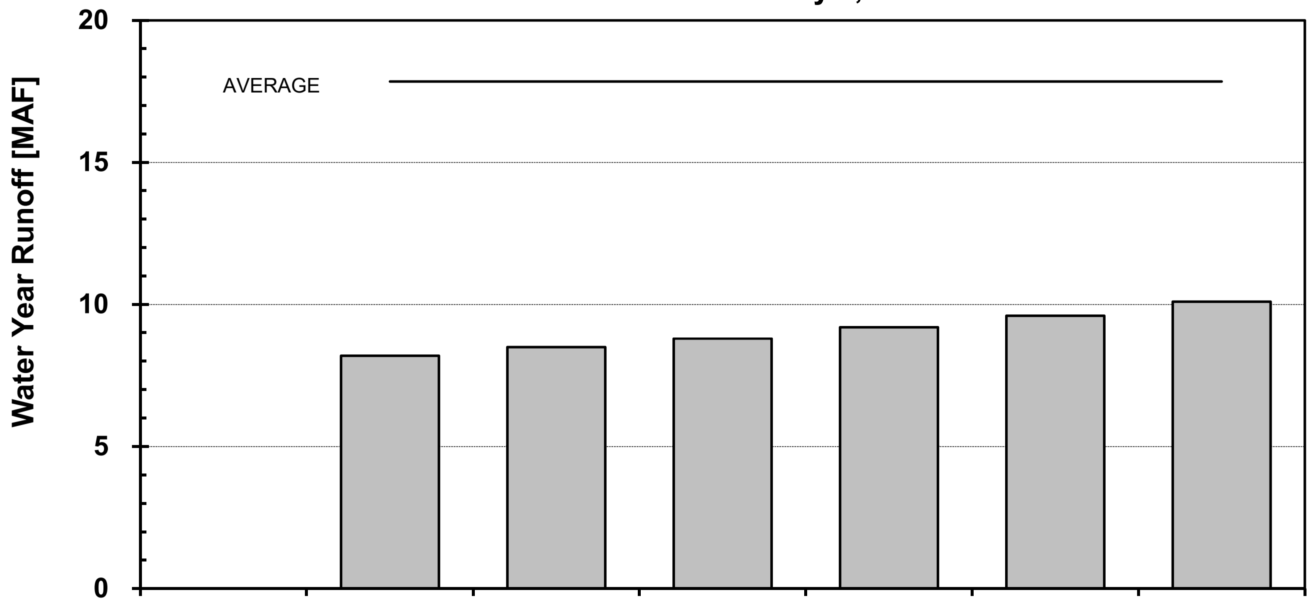
American River below Folsom Lake Unimpaired Flow [taf]

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	WY	Apr-Jul	
99%	18	17	151	102	77	160	446	115	30	3	0	0	1,120	594	
90%	18	17	151	102	77	160	446	154	42	8	2	2	1,180	650	
75%	18	17	151	102	77	160	446	209	55	11	4	4	1,255	721	
50%	18	17	151	102	77	160	446	260	70	14	4	5	1,325	790	50%
25%	18	17	151	102	77	160	446	290	110	25	7	6	1,410	871	
10%	18	17	151	102	77	160	446	330	140	34	10	9	1,495	950	
												1966-2015 avg	2,626	1,199	

Sacramento River Unimpaired Runoff (Northern Sierra Four Rivers or SRI) [taf]

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	WY	Apr-Jul	
99%	420	389	1237	1111	779	913	1711	650	324	233	207	207	8,180	2,918	
90%	420	389	1237	1111	779	913	1711	796	373	260	231	231	8,450	3,140	47%
75%	420	389	1237	1111	779	913	1711	994	465	302	261	259	8,840	3,472	
50%	420	389	1237	1111	779	913	1711	1185	560	354	286	285	9,230	3,810	52%
25%	420	389	1237	1111	779	913	1711	1335	688	412	329	317	9,640	4,146	
10%	420	389	1237	1111	779	913	1711	1505	804	470	363	349	10,050	4,490	56%
												1966-2015 avg	17,845	6,293	

SACRAMENTO RIVER
UNIMPAIRED RUNOFF
2020 Water Year Forecast as of May 1, 2020



	Probability of Exceedance					
Date of Forecast	**99%**	**90%**	**75%**	**50%**	**25%**	**10%**
Average	17.8	17.8	17.8	17.8	17.8	17.8
December 1, 2019	5.2 (29%)	7.6 (43%)	9.8 (55%)	13.6 (76%)	18.4 (103%)	23.1 (129%)
January 1, 2020	7.0 (39%)	9.3 (52%)	11.3 (63%)	14.3 (80%)	18.5 (104%)	22.6 (127%)
February 1, 2020	8.1 (45%)	9.3 (52%)	10.4 (58%)	11.6 (65%)	12.9 (72%)	14.1 (79%)
March 1, 2020	7.0 (39%)	7.7 (43%)	8.4 (47%)	9.1 (51%)	9.8 (55%)	10.5 (59%)
April 1, 2020	7.5 (42%)	8.1 (45%)	8.6 (48%)	9.2 (52%)	9.7 (54%)	10.2 (57%)
May 1, 2020	**8.2 (46%)**	**8.5 (48%)**	**8.8 (49%)**	**9.2 (52%)**	**9.6 (54%)**	**10.1 (57%)**

Water Year Runoff in million acre feet & (percent of average)

Sacramento River Runoff is the sum of unimpaired flow in million acre-feet at:

- Sacramento River above Bend Bridge
- Feather River at Oroville (aka inflow to Lake Oroville)
- Yuba River near Smartville
- American River below Folsom Lake

Water Year Runoff through end of last month:

2020 (current year) =	6.6	MAF	50% of avg.
2019 (last year) =	17.8	MAF	136% of avg.

Previous Water Year Total Runoff:

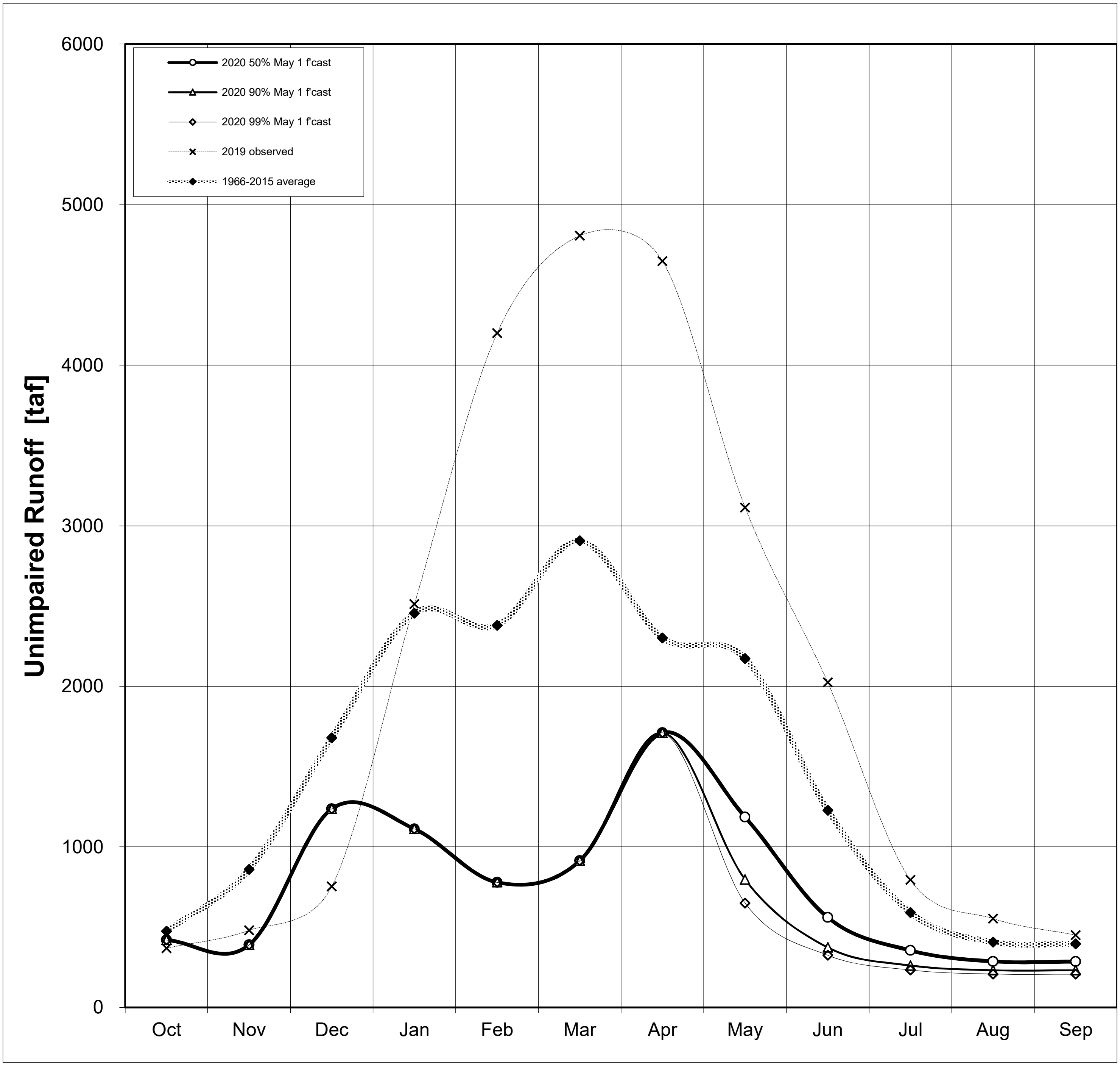
2019 =	24.7	MAF	138% of avg.
1977 (Min) =	5.1	MAF	29% of avg.
2017 (Max) =	37.8	MAF	212% of avg.
1966-2015 average =	17.8	MAF	

Sacramento River Monthly Runoff

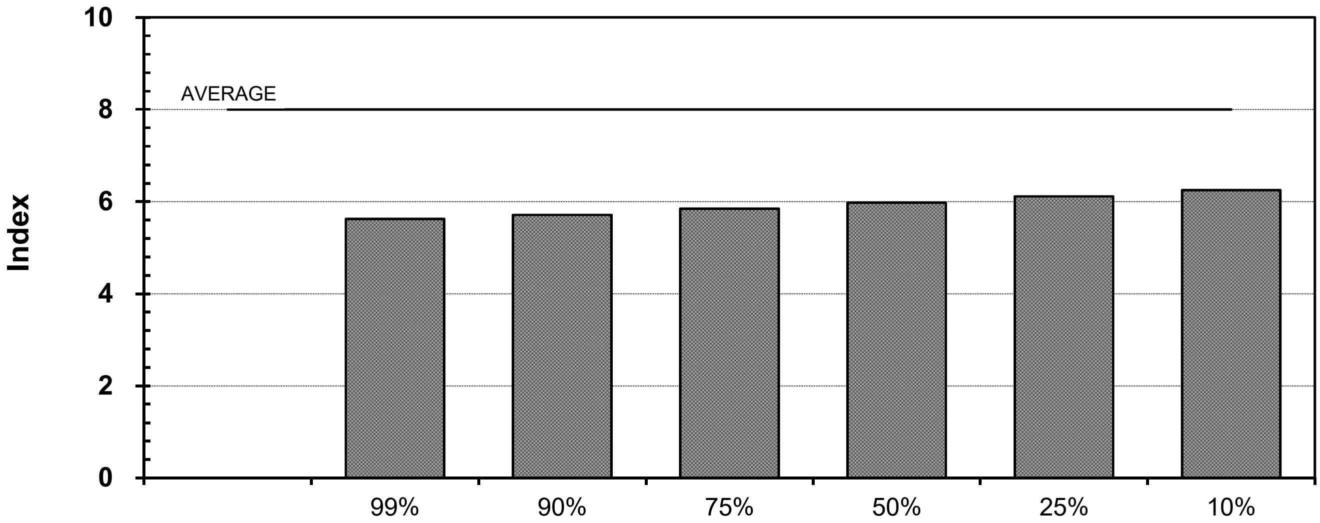
5/1/2020

Sum of unimpaired flow in [taf] of Sacramento abv Bend Bridge, Feather at Oroville, Yuba nr Smartville, & American blw Folsom

Water Year	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	WY
2020 50% May 1 f'cast	420	389	1237	1111	779	913	1711	1185	560	354	286	285	9,230
2020 90% May 1 f'cast	420	389	1237	1111	779	913	1711	796	373	260	231	231	8,450
2020 99% May 1 f'cast	420	389	1237	1111	779	913	1711	650	324	233	207	207	8,180
2019 observed	369	480	753	2513	4200	4807	4649	3114	2024	794	553	450	24,706
1966-2015 average	474	859	1679	2455	2380	2906	2302	2173	1228	590	407	396	17,848



SACRAMENTO VALLEY
WATER YEAR TYPE INDEX (40-30-30)
2020 Water Year Forecast as of May 1, 2020



	Probability of Exceedance					
Date of Forecast	**99%**	**90%**	**75%**	**50%**	**25%**	**10%**
December 1, 2019	4.6	5.4	6.1	7.3	8.9	10.4
January 1, 2020	5.2	6.0	6.6	7.6	8.9	10.2
February 1, 2020	5.6	6.0	6.3	6.7	7.2	7.6
March 1, 2020	5.2	5.4	5.6	5.9	6.1	6.3
April 1, 2020	5.4	5.6	5.8	6.0	6.1	6.3
May 1, 2020	**5.6**	**5.7**	**5.8**	**6.0**	**6.1**	**6.3**

Water Year Index based on flow in million acre feet

Index = 0.4 * Current Apr-Jul Runoff [(1)]
+ 0.3 * Current Oct-Mar Runoff [(1)]
+ 0.3 * Previous Year's Index [(2)]

Notes:

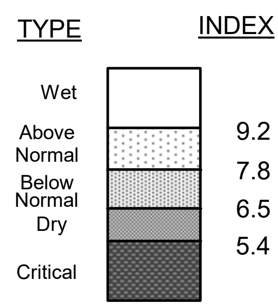
(1) Runoff is the sum of unimpaired flow in million acre-feet at:
- Sacramento River above Bend Bridge
- Feather River at Oroville (aka inflow to Lake Oroville)
- Yuba River near Smartville
- American River below Folsom Lake

(2) Maximum 10.0 for previous year index term

Previous Water Year Indices:

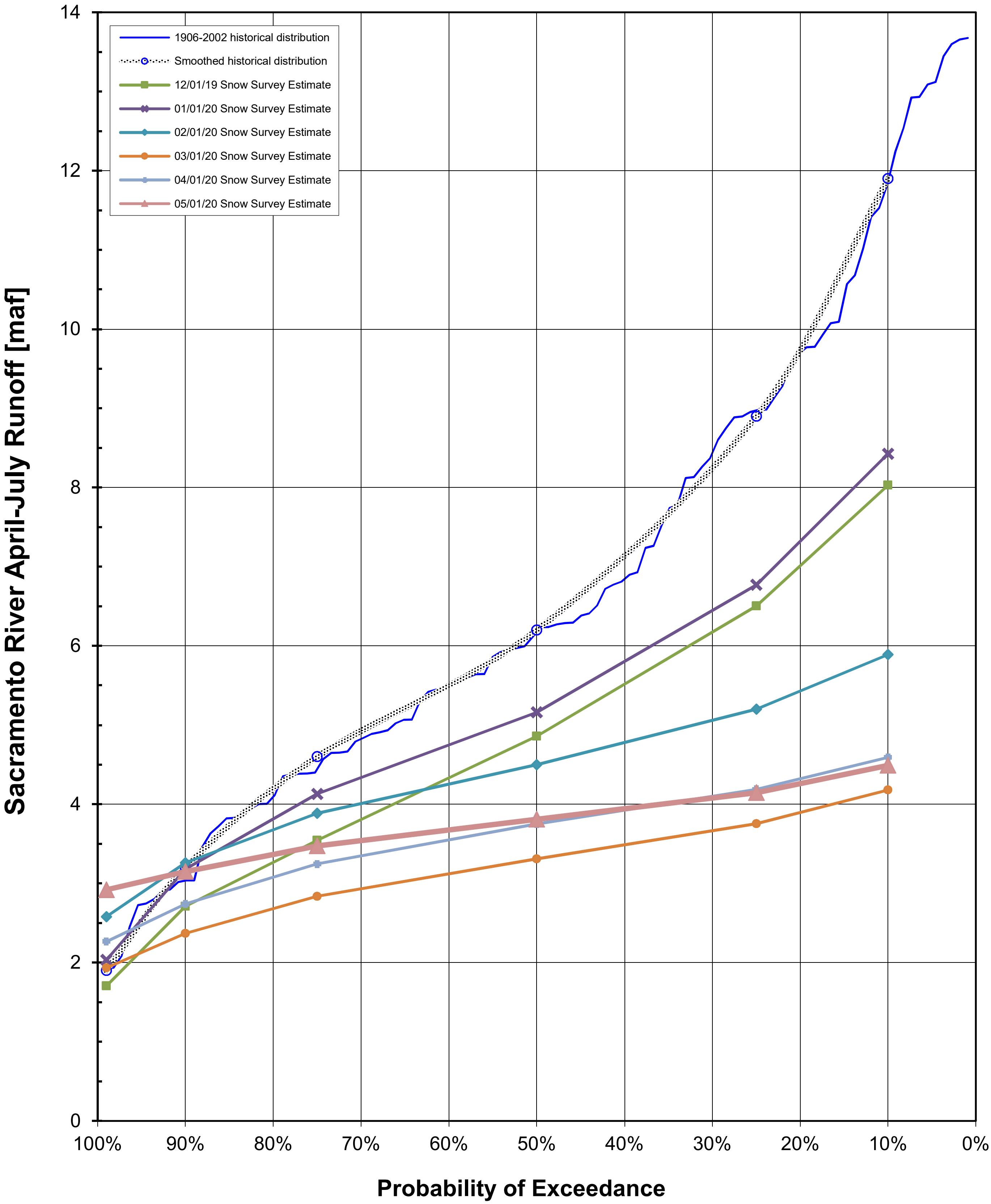
2019 =	10.3	129% of avg.
1977 (Min) =	3.1	39% of avg.
1983 (Max) =	15.3	191% of avg.
1966-2015 average =	8.0	

Year Classification



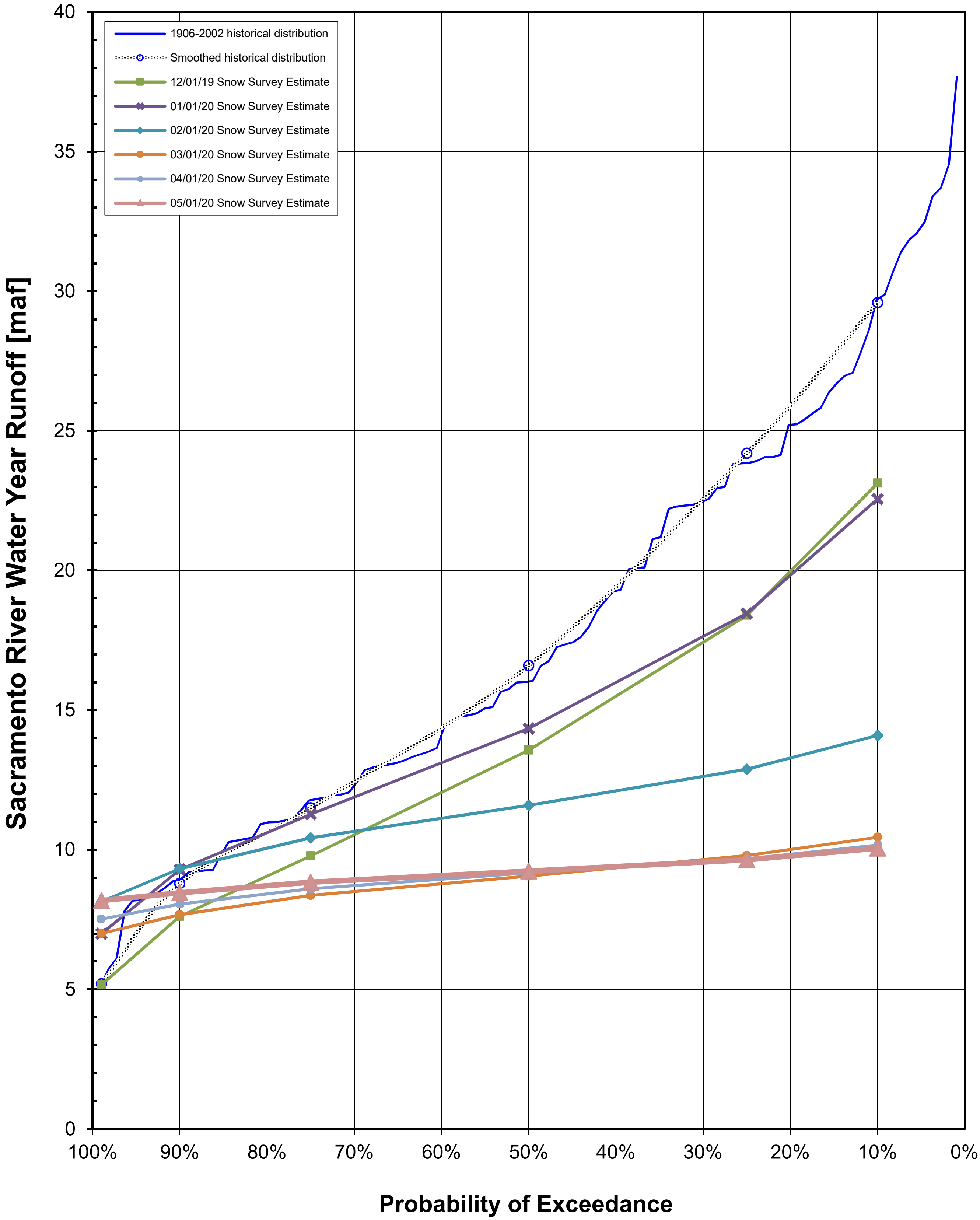
Historical vs. Forecast Sacramento River Apr-Jul Runoff

Sum of unimpaired flow in [taf] of Sacramento above Bend Bridge, Feather at Oroville,
Yuba near Smartville, & American below Folsom



Historical vs. Forecast Sacramento River WY Runoff

Sum of unimpaired flow in [taf] of Sacramento above Bend Bridge, Feather at Oroville,
Yuba near Smartville, & American below Folsom



2020 SAN JOAQUIN RIVER WATER YEAR FORECAST BREAKDOWN
May 1, 2020

Stanislaus River below Goodwin Reservoir Unimpaired Flow [taf]

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	WY	Apr-Jul	WY % of avg
99%	12	11	61	31	32	69	190	64	26	4	0	0	500	284	
90%	12	11	61	31	32	69	190	106	34	10	3	1	560	340	
75%	12	11	61	31	32	69	190	130	42	12	4	1	595	374	
50%	12	11	61	31	32	69	190	155	50	15	6	3	635	410	55%
25%	12	11	61	31	32	69	190	187	70	21	7	4	695	468	
10%	12	11	61	31	32	69	190	200	80	30	9	5	730	500	
												1966-2015 avg	1,149	682	

Tuolumne River below La Grange Reservoir Unimpaired Flow [taf]

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	WY	Apr-Jul	
99%	24	13	71	36	36	90	261	142	56	14	2	0	745	473	
90%	24	13	71	36	36	90	261	205	77	17	4	2	835	560	
75%	24	13	71	36	36	90	261	230	95	18	5	2	880	604	
50%	24	13	71	36	36	90	261	250	100	19	7	4	910	630	48%
25%	24	13	71	36	36	90	261	281	112	24	8	5	960	678	
10%	24	13	71	36	36	90	261	300	130	29	10	6	1,005	720	
												1966-2015 avg	1,909	1,193	

Merced River below Merced Falls Unimpaired Flow (below Lake McClure) [taf]

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	WY	Ap-Jly	
99%	11	8	31	16	16	42	137	41	13	5	0	0	320	196	
90%	11	8	31	16	16	42	137	75	22	6	1	0	365	240	
75%	11	8	31	16	16	42	137	94	30	9	1	0	395	270	
50%	11	8	31	16	16	42	137	108	35	10	3	0	415	290	42%
25%	11	8	31	16	16	42	137	126	41	13	3	1	445	317	
10%	11	8	31	16	16	42	137	143	45	15	4	2	470	340	
												1966-2015 avg	992	623	

San Joaquin River inflow to Millerton Lake Unimpaired Flow [taf]

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	WY	Ap-Jly	
99%	16	14	46	31	32	53	203	145	87	25	12	5	670	460	
90%	16	14	46	31	32	53	203	181	110	36	14	8	745	530	
75%	16	14	46	31	32	53	203	216	130	42	16	10	810	591	
50%	16	14	46	31	32	53	203	250	150	47	17	10	870	650	49%
25%	16	14	46	31	32	53	203	280	169	53	21	11	930	705	
10%	16	14	46	31	32	53	203	305	195	57	25	12	990	760	
												1966-2015 avg	1,793	1,228	

Sum of above Unimpaired Flows in San Joaquin River Tributaries [taf]

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	WY	Ap-Jly	
99%	63	45	209	114	117	255	792	392	182	48	14	5	2,235	1,413	
90%	63	45	209	114	117	255	792	567	243	69	22	10	2,505	1,670	
75%	63	45	209	114	117	255	792	670	297	80	26	13	2,680	1,839	
50%	63	45	209	114	117	255	792	763	335	91	33	17	2,830	1,980	48%
25%	63	45	209	114	117	255	792	874	392	110	39	20	3,030	2,168	
10%	63	45	209	114	117	255	792	948	450	131	48	25	3,195	2,320	
												1966-2015 avg	5,843	3,726	

Eight River Index [taf]

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	WY	Ap-Jly	
99%	482	434	1446	1225	895	1168	2502	1042	506	281	221	212	10,415	4,331	
90%	482	434	1446	1225	895	1168	2502	1363	616	329	253	242	10,955	4,810	46%
75%	482	434	1446	1225	895	1168	2502	1664	762	383	287	272	11,520	5,311	
50%	482	434	1446	1225	895	1168	2502	1948	895	445	319	302	12,060	5,790	51%
25%	482	434	1446	1225	895	1168	2502	2209	1080	523	368	337	12,670	6,314	
10%	482	434	1446	1225	895	1168	2502	2453	1254	601	411	374	13,245	6,810	56%
												1966-2015 avg	23,688	10,019	

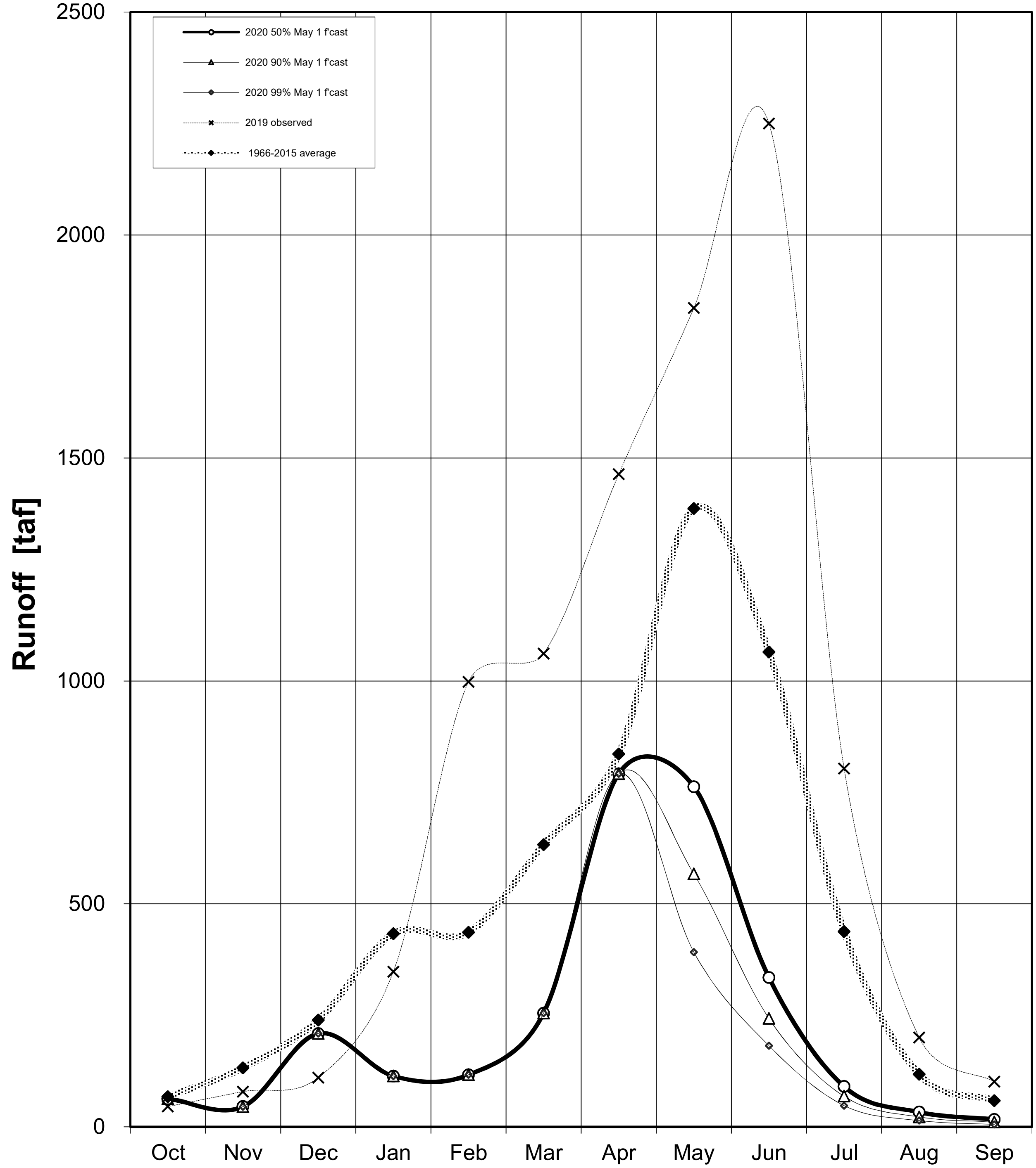
Previous Month 8 River Index Apr 2502 taf

San Joaquin River Monthly Runoff

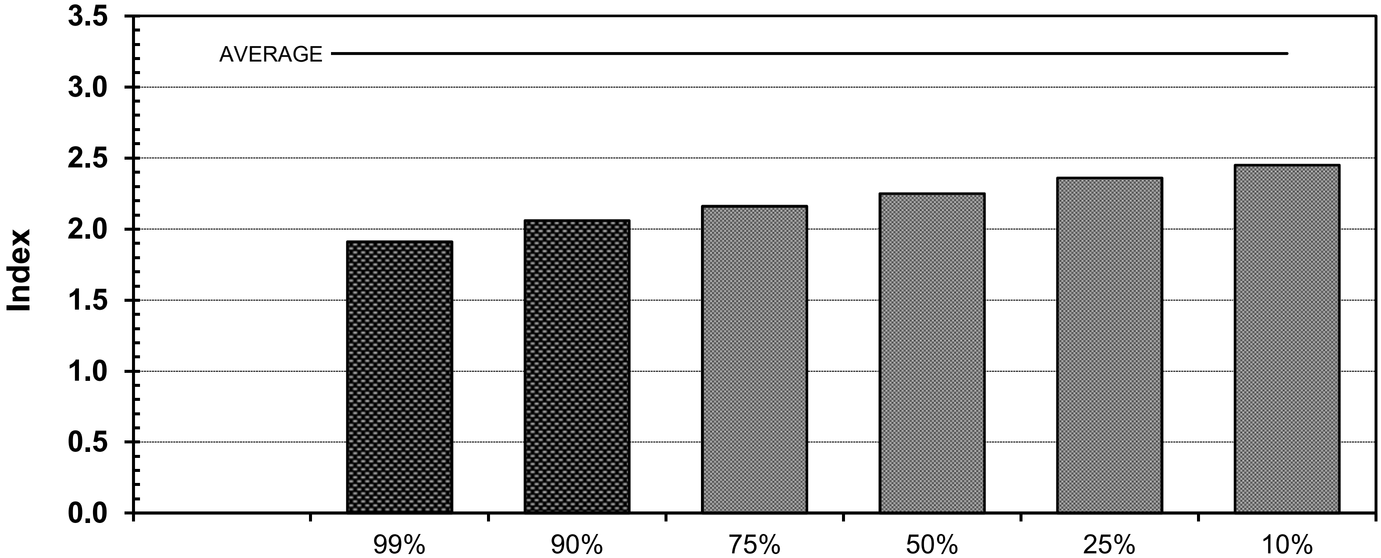
5/1/2020

Sum of unimpaired flow in [taf] of Stanislaus blw Goodwin, Tuolumne blw La Grange, Merced blw Merced Falls, & S. Joaquin blw Millerton

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	WY
2020 50% May 1 f'cast	63	45	209	114	117	255	792	763	335	91	33	17	2,830
2020 90% May 1 f'cast	63	45	209	114	117	255	792	567	243	69	22	10	2,505
2020 99% May 1 f'cast	63	45	209	114	117	255	792	392	182	48	14	5	2,235
2019 observed	45	79	110	348	998	1062	1464	1836	2250	804	200	101	9,298
1966-2015 average	68	132	239	433	436	633	836	1387	1065	438	118	59	5,844



SAN JOAQUIN VALLEY
WATER YEAR TYPE INDEX (60-20-20)
2020 Water Year Forecast as of May 1, 2020



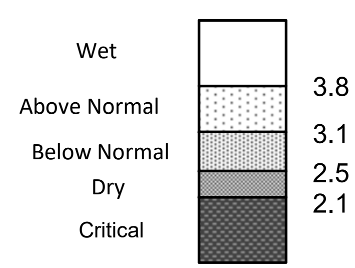
	Probability of Exceedance					
Date of Forecast	**99%**	**90%**	**75%**	**50%**	**25%**	**10%**
December 1, 2019	1.5	1.9	2.2	2.9	3.7	4.7
January 1, 2020	1.8	2.2	2.7	3.1	3.9	4.7
February 1, 2020	2.2	2.4	2.5	2.7	2.9	3.2
March 1, 2020	1.6	1.7	1.9	2.0	2.2	2.3
April 1, 2020	1.8	1.9	2.1	2.2	2.3	2.4
May 1, 2020	**1.9**	**2.1**	**2.2**	**2.3**	**2.4**	**2.5**

Water Year Index based on flow in million acre feet

Index = 0.6 * Current Apr-Jul Runoff (1)
+ 0.2 * Current Oct-Mar Runoff (1)
+ 0.2 * Previous Year's Index (2)

Year Classification

TYPE INDEX



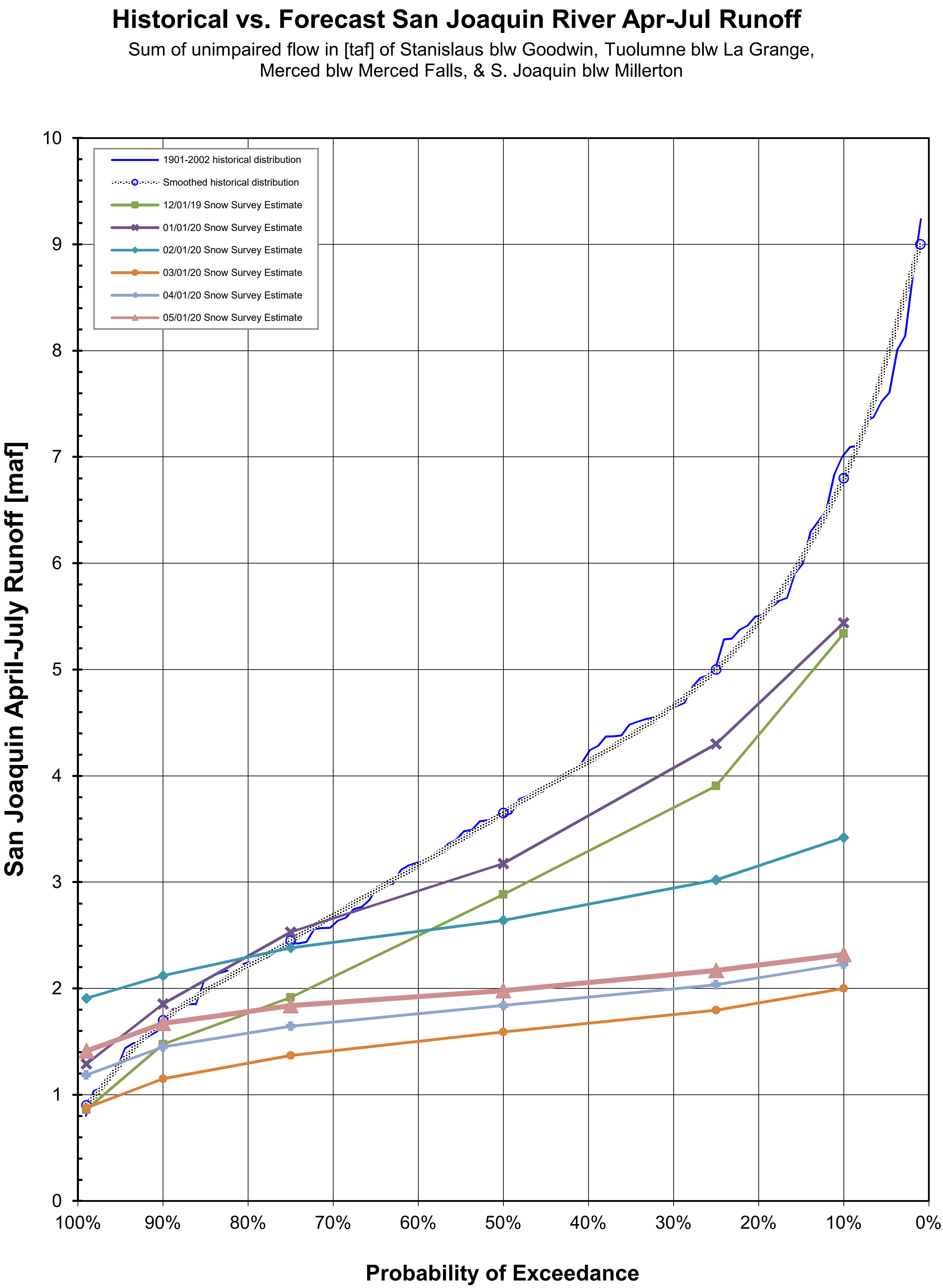
Notes:

(1) Runoff is the sum of unimpaired flow in million acre-feet at:
Stanislaus River below Goodwin Reservoir (aka inflow to New Melones Res.)
Tuolumne River below La Grange (aka inflow to New Don Pedro Reservoir)
Merced River below Merced Falls (aka inflow to Lake McClure)
San Joaquin River inflow to Millerton Lake

(2) Maximum 4.5 for previous year index term

Previous Water Year Indices:

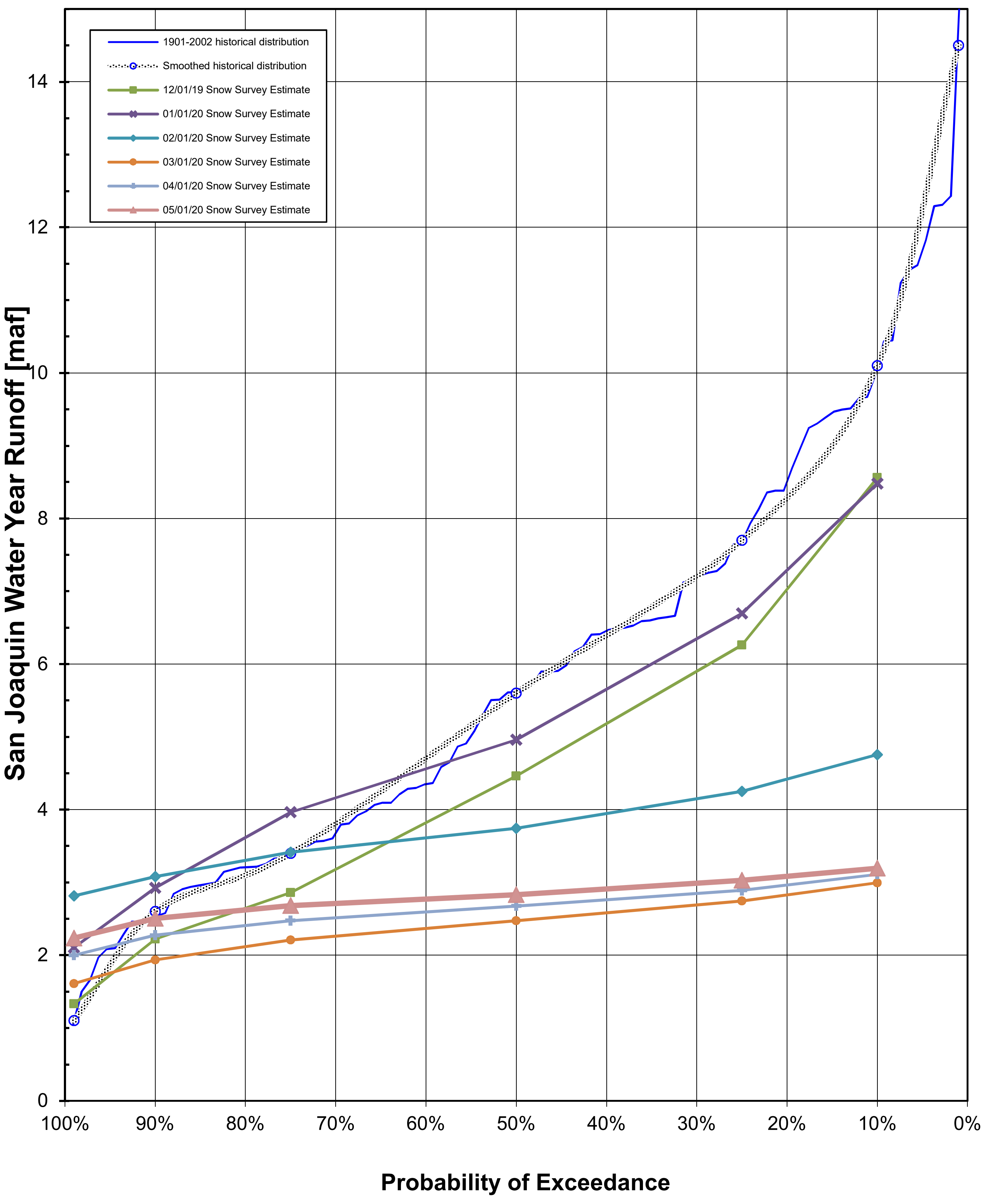
2019 =	4.9	153% of avg.
2015 (Min) =	0.8	25% of avg.
1983 (Max) =	7.2	223% of avg.
1966-2015 average =	3.2	



Historical vs. Forecast San Joaquin River Apr-Jul Runoff
Sum of unimpaired flow in [taf] of Stanislaus blw Goodwin, Tuolumne blw La Grange,
Merced blw Merced Falls, & S. Joaquin blw Millerton
1901-2002 historical distribution
Smoothed historical distribution
12/01/19 Snow Survey Estimate
01/01/20 Snow Survey Estimate
02/01/20 Snow Survey Estimate
03/01/20 Snow Survey Estimate
04/01/20 Snow Survey Estimate
05/01/20 Snow Survey Estimate
San Joaquin April-July Runoff [maf]
0
1
2
3
4
5
6
7
8
9
10
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Probability of Exceedance

Historical vs. Forecast San Joaquin River WY Runoff

Sum of unimpaired flow in [taf] of Stanislaus blw Goodwin, Tuolumne blw La Grange, Merced blw Merced Falls, & S. Joaquin blw Millerton



Attachment 5

Department of Water Resources Forecast of Sacramento Valley Accretions at Freeport

Forecast of Sacramento Valley Accretions at Freeport

Water Year 2020

(Freeport + Fremont Weir + Sacramento Weir) - (Keswick [lag 4 days] + Oroville & Thermalito to Feather [lag 2 days] + Nimbus [lag 1 day])

WY Accretions = 2.0305*(bend-shasta WYRO) + 1.349*(folsom WYRO) + 0.0406*(last year accretions) - 3181

version 1200

Apr-Sep Accretions = 2.561*(ben-sha AJRO) + 1.059*(fols AJRO) - 8.417*(1980) + 14327

Foreca: 8.1 (45% 9.3 (52% 10.4 (58% 11.6 (65% 12.9 (72% 14.1 (79%)

[taf]	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Apr-Sep	WY
99%	-11	-2	543	433	307	210	158	-280	-300	-390	-210	20	-1002	478
90%	-11	-2	543	433	307	210	158	-230	-290	-360	-200	30	-892	588
75%	-11	-2	543	433	307	210	158	-180	-240	-320	-160	40	-702	778
50%	-11	-2	543	433	307	210	158	-120	-180	-270	-150	50	-512	968
25%	-11	-2	543	433	307	210	158	30	-150	-240	-130	60	-272	1208
10%	-11	-2	543	433	307	210	158	200	-100	-210	-120	70	-2	1478

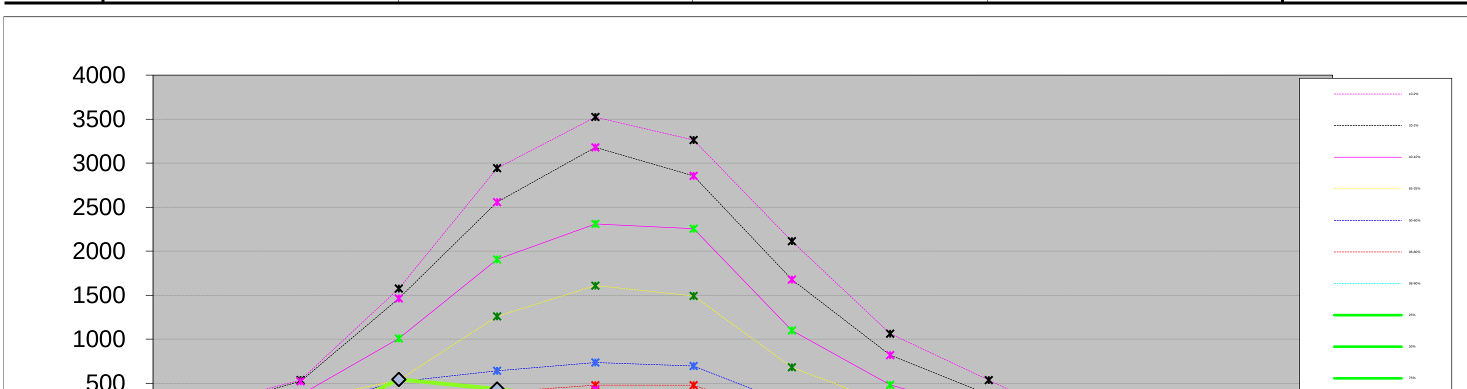
Smoothed monthly distribution for bands of years surrounding given exceedence [% of annual]

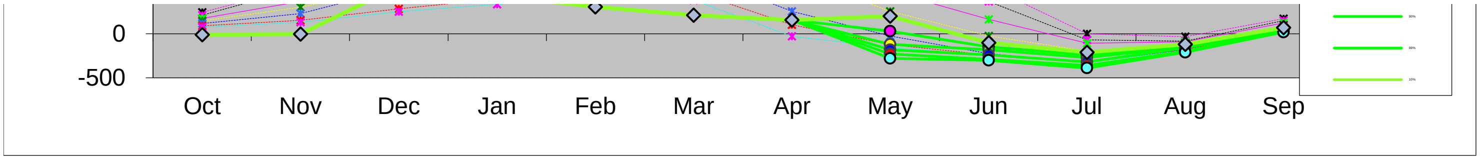
%exc	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Apr-Sep	WY
98-90%	20%	19%	36%	44%	57%	56%	-4%	-23%	-34%	-47%	-27%	3%	-132%	100%
98-80%	8%	13%	25%	32%	39%	47%	12%	-11%	-21%	-29%	-17%	2%	-65%	100%
90-60%	3%	8%	18%	24%	30%	34%	12%	0%	-9%	-13%	-9%	2%	-16%	100%
65-35%	2%	4%	12%	18%	25%	25%	13%	6%	0%	-4%	-2%	2%	15%	100%
40-10%	2%	4%	14%	26%	22%	17%	10%	4%	1%	-2%	-1%	2%	15%	100%
20-2%	1%	4%	11%	23%	21%	19%	12%	6%	3%	0%	-1%	1%	21%	100%
10-2%	1%	3%	8%	18%	21%	22%	15%	7%	4%	0%	0%	1%	27%	100%

%exc	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Apr-Sep	WY
98-90%	-9.0%		1.0%	5.0%	5.0%				-1.0%	-1.0%			-2.0%	0.0%
98-80%	-0.1%		-0.5%	2.5%	3.0%	-5.0%	-2.5%	0.5%	0.5%		1.5%		0.0%	0.0%
90-60%	2.0%	1.3%	3.0%	2.0%	-1.0%	-6.0%	-2.0%	-0.8%			1.5%		-1.3%	0.0%
65-35%	0.2%	1.5%	-2.7%	2.6%	2.0%	0.2%	-2.0%	-2.0%	-0.4%	0.8%	0.2%	-0.4%	-3.8%	0.0%
40-10%	0.1%	-0.2%	-3.5%	-6.0%	1.4%	6.0%	1.0%	0.5%	0.5%	0.5%		-0.3%	2.2%	0.0%
20-2%	0.5%	0.3%	-0.4%	-4.6%	2.0%	2.2%							0.0%	0.0%
10-2%	0.5%	0.5%	2.0%	0.0%	1.0%	-1.2%	-2.0%	-0.5%	-0.5%		0.2%		-2.8%	0.0%

%exc	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Apr-Sep	WY
98-90%	11%	19%	37%	49%	62%	56%	-4%	-23%	-35%	-48%	-27%	3%	-134%	100%
98-80%	8%	13%	25%	35%	42%	42%	9%	-11%	-21%	-29%	-16%	2%	-65%	100%
90-60%	5%	9%	21%	26%	29%	28%	10%	-1%	-9%	-13%	-7%	2%	-17%	100%
65-35%	2%	5%	9%	21%	27%	25%	11%	4%	0%	-3%	-2%	2%	11%	100%
40-10%	2%	4%	10%	20%	24%	23%	11%	5%	2%	-1%	-1%	1%	17%	100%
20-2%	2%	4%	11%	19%	23%	21%	12%	6%	3%	0%	-1%	1%	21%	100%
10-2%	2%	3%	10%	18%	22%	20%	13%	7%	3%	0%	0%	1%	24%	100%

[taf]	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Apr-Sep	WY
98-90%	75	131	251	335	425	383	-27	-154	-242	-329	-187	23	-917	683
98-80%	90	152	284	397	478	476	104	-123	-238	-327	-182	27	-738	1138
90-60%	117	229	516	642	734	695	255	-23	-225	-327	-177	61	-436	2498
65-35%	145	303	534	1260	1609	1493	680	256	-24	-197	-129	92	679	6024
40-10%	175	367	1008	1908	2309	2254	1100	479	163	-107	-92	124	1667	9687
20-2%	211	522	1461	2556	3179	2855	1677	819	367	-68	-84	151	2863	13647
10-2%	244	536	1575	2943	3523	3261	2112	1061	536	0	-33	172	3848	15930





Statistical Summary (for individual months, 1949-2002)

[taf]	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Apr-Sep	WY
Min	-55	23	75	121	27	0	-241	-250	-346	-434	-270	-35	-1196	-804
Mean	127	293	806	1478	1556	1353	716	284	19	-210	-140	108	778	6394
Max	1135	1151	3865	6002	6557	5956	3015	1505	1486	136	36	310	4776	18138
%exc														
98%	-55	23	75	121	27	0	-241	-250	-346	-434	-270	-35	-1196	-804
90%	2	76	139	275	314	338	27	-203	-309	-360	-240	23	-986	1267
75%	40	137	255	429	639	687	246	-47	-221	-303	-206	48	-366	2619
50%	100	179	533	732	1299	1066	506	128	-51	-241	-146	91	220	5165
25%	165	322	1016	2439	2006	1837	993	583	123	-133	-96	149	1566	9154
10%	225	643	2097	3292	2965	2441	1603	878	492	-39	-35	242	3131	12168
2%	1135	1151	3865	6002	6557	5956	3015	1505	1486	136	36	310	4776	18138

Prior year accretions = 11317

Upstream forecasts:

Raw Forecast:		Water Year			April-July		
Apr-Sep	**WY**	Bend	Shasta	Folsom	Bend	Shasta	Folsom
-818	**1256**	4150	2935	1120	1177	829	594
-702	**1368**	4225	2995	1180	1230	860	650
-555	**1540**	4385	3120	1255	1352	954	721
-400	**1706**	4545	3245	1325	1480	1050	790
-192	**1962**	4720	3350	1410	1612	1134	871
51	**2209**	4890	3455	1495	1750	1210	950

Attachment 6

Upper Sacramento River – May 2020 Preliminary Temperature Analysis

May 18, 2020

Upper Sacramento River – May 2020 Preliminary Temperature Analysis

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

Model Run	Location	Apr	May	Jun	Jul	Aug	Sep*	Oct*
90% Hydrology 25% Historical Meteorology Targeting CCR Scenario 148	Keswick Dam KWK	52.9	53.0	53.3	53.1	52.9	See Fig. 3	See Fig. 3
	Sac. R. abv Clear Creek CCR	53.1	53.4	53.7	53.5	53.1	See Fig. 4	See Fig. 4
	Airport Road	53.5	54.0	54.3	54.1	53.5	n/a	n/a
	Balls Ferry BSF	54.7	55.0	55.3	55.0	54.7	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%Hist. Met.CCR Scenario 148	502	8/9	10/30

Model Run Date May 18, 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 13, April 9, and April 14, respectively (profiles for Trinity and Whiskeytown are adjusted based on previous model output to account for changes likely to have occurred since the last sampling date). 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).

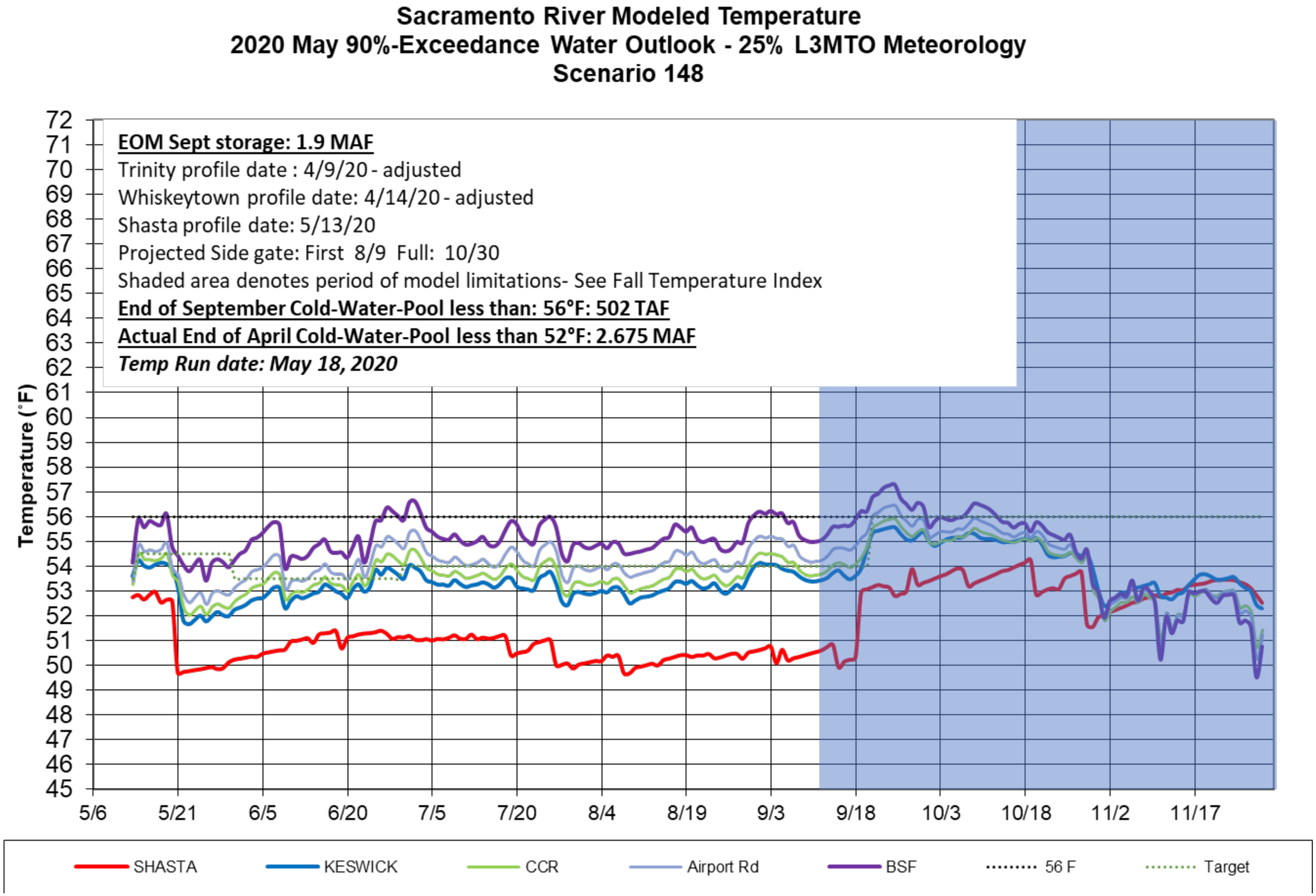


Figure 1. May 2020 simulated Sacramento River temperatures 90% runoff exceedance hydrology and 25% historical meteorology targeting CCR.

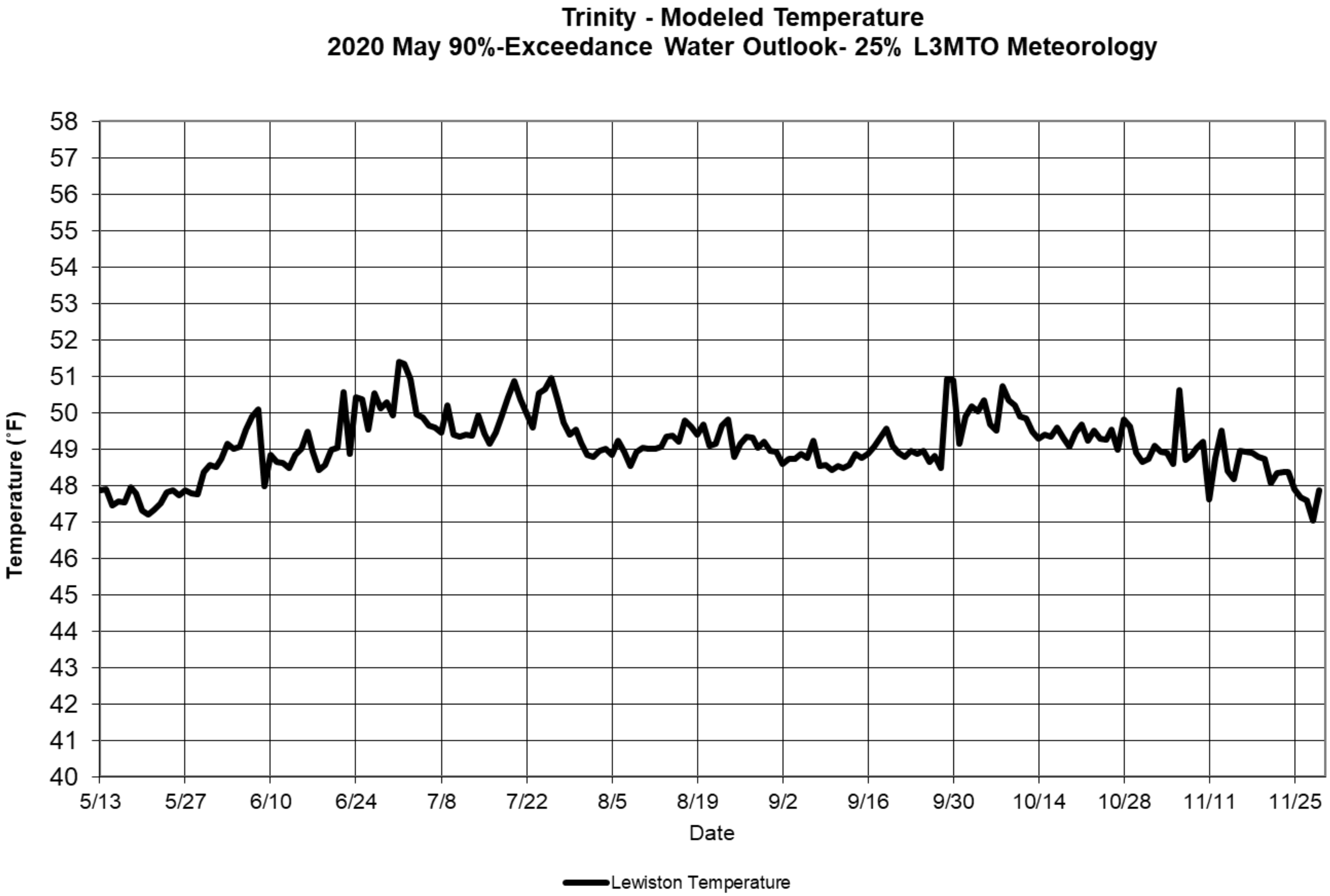


Figure 2. May 2020 simulated Trinity River temperatures 90% runoff exceedance hydrology and 25% historical meteorology

Figures 3-5 **<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.

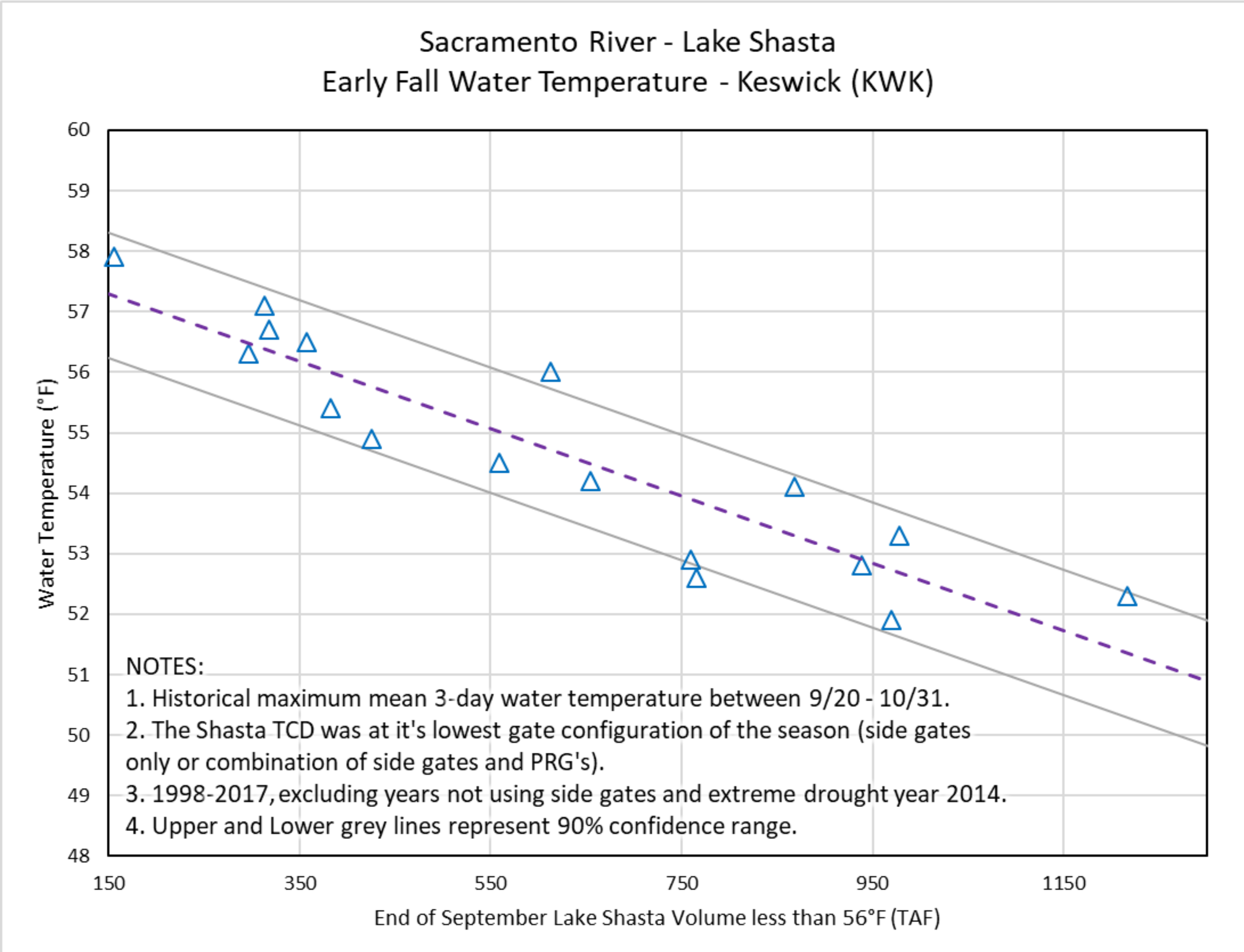


Figure 3. Historical relationship between Lake Shasta cold-water-pool characteristics and early fall Keswick water temperature.

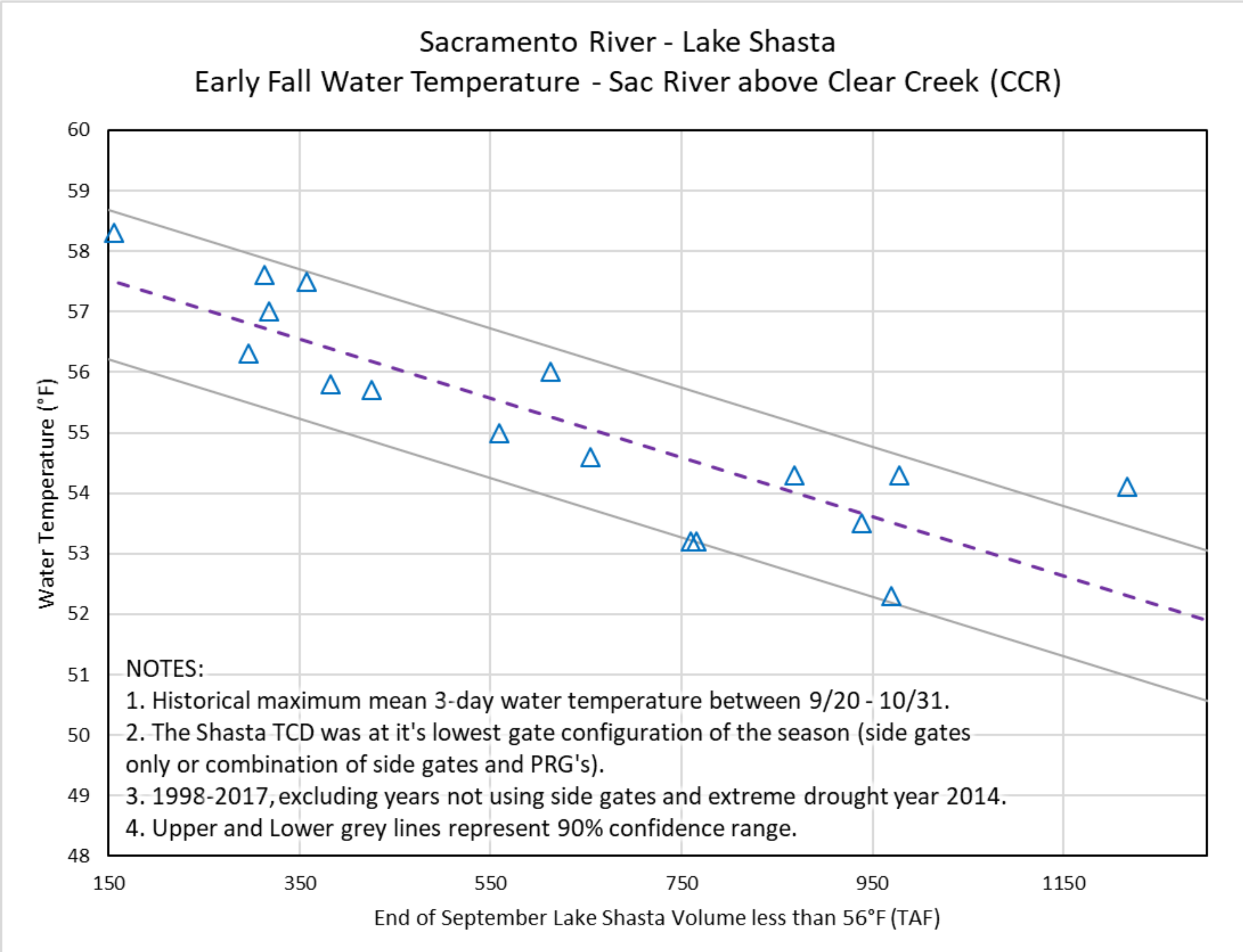


Figure 4. Historical relationship between Lake Shasta cold-water-pool characteristics and early fall Sacramento River above Clear Creek confluence water temperature.

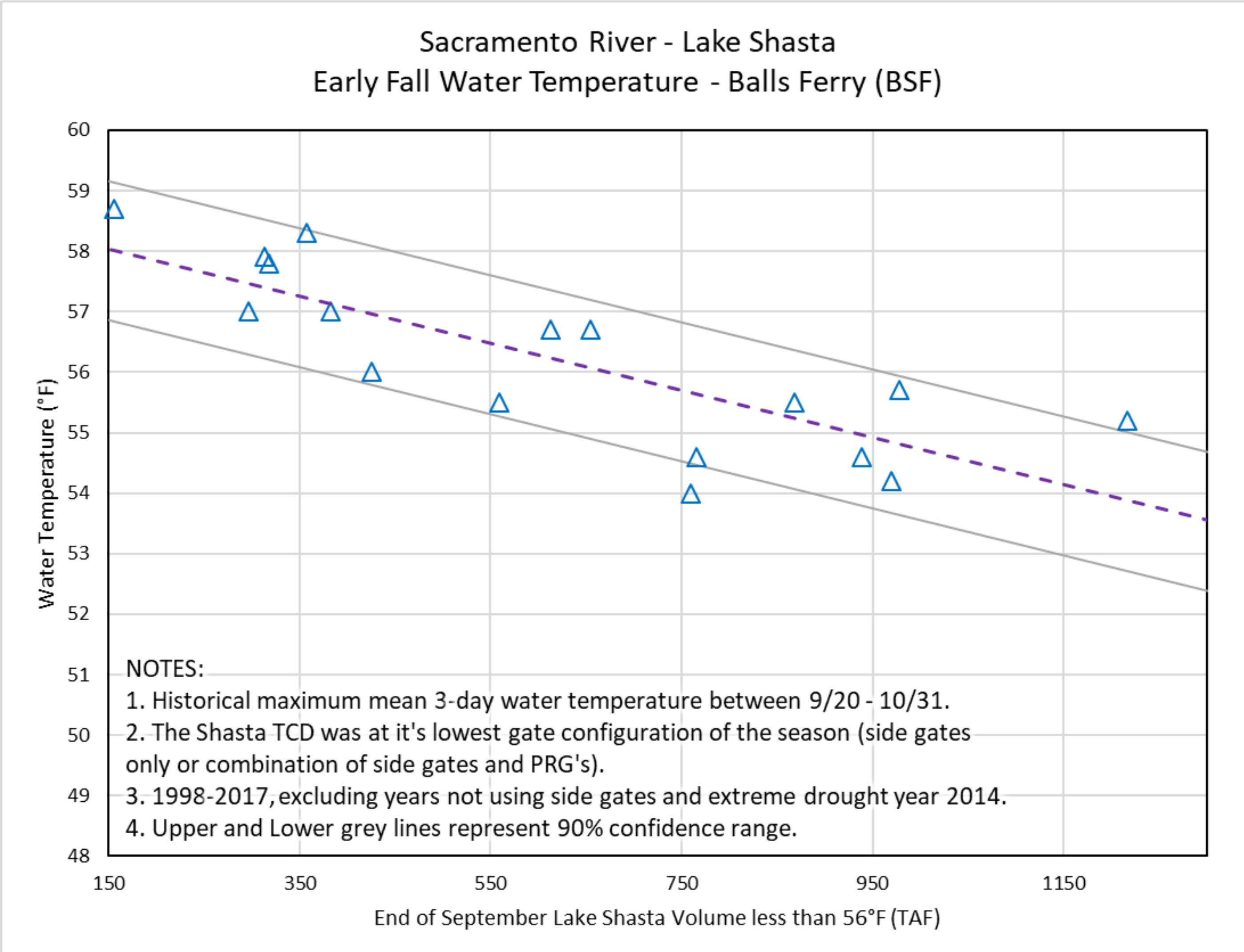


Figure 5. Historical relationship between Lake Shasta cold-water-pool characteristics and early fall Balls Ferry water temperature.

Attachment 7

Inputs to Reclamation Central Valley Project Northern System Upper Sacramento HEC-5Q Temperature Model

Revised: 5/17/2020

Inputs to Reclamation CVP Northern System Upper Sacrameto HEC-5Q Model

Category	Parameter	Units	Description	Range	Source
Initial Conditions	Shasta, Trinity, and Whiskeytown Reservoir Volumes	TAF	Initial simulation storage volume - actual observations	Beginning Date	Reclamation Database: Historical Archive and Reports (HAR)
Initial Conditions	Shasta, Trinity, and Whiskeytown Reservoir Temperature Profiles	°F	Initial simulation vertical reservoir temperature at regular intervals (Shasta 5 feet, Trinity and Whiskeytown 25 feet) - actual observations	Beginning Date	Reclamation NCAO Reservoir Temperature Profile Program
Meteorology	Short Wave Radiation	BTU per square foot	Historical Data (six hour interval)	Beginning Date through November 30	Gerber to Shasta relationship April - July derived from most recent NOAA Climate Prediction Center air temperature tercile projections mapped to a similar historical year (1961-2017) varied by air temperature percent exceedance, otherwise historical equilibrium temperature percent exceedance. See "Point Application of Local Three-Month Temperature Outlooks to enhance Sacramento River Stream Temperature Management" documentation.
Meteorology	Equilibrium Temperature	°F	Historical Data (six hour interval)	Beginning Date through November 30	Gerber to Shasta relationship April - July derived from most recent NOAA Climate Prediction Center air temperature tercile projections mapped to a similar historical year (1961-2017) varied by air temperature percent exceedance, otherwise historical equilibrium temperature percent exceedance. See "Point Application of Local Three-Month Temperature Outlooks to enhance Sacramento River Stream Temperature Management" documentation.
Meteorology	Heat Exchange Rate	BTU per °F	Historical Data (six hour interval)	Beginning Date through November 30	Gerber to Shasta relationship April - July derived from most recent NOAA Climate Prediction Center air temperature tercile projections mapped to a similar historical year (1961-2017) varied by air temperature percent exceedance, otherwise historical equilibrium temperature percent exceedance. See "Point Application of Local Three-Month Temperature Outlooks to enhance Sacramento River Stream Temperature Management" documentation.
Meteorology	Wind Speed	Knots	Historical Data (six hour interval)	Beginning Date through November 30	Gerber to Shasta relationship April - July derived from most recent NOAA Climate Prediction Center air temperature tercile projections mapped to a similar historical year (1961-2017) varied by air temperature percent exceedance, otherwise historical equilibrium temperature percent exceedance. See "Point Application of Local Three-Month Temperature Outlooks to enhance Sacramento River Stream Temperature Management" documentation.
Hydrology	Shasta, Trinity, and Whiskeytown Inflows	Daily average flow rate (cfs)	Forecasted monthly data (disaggregated to daily average on pattern)	Beginning Date through November 30	Based on DWR Bulletin 120/CNRFC future inflow forecasts varied by inflow percent exceedance
Hydrology	Cottonwood Creek	Daily average flow rate (cfs)	Historical data: percent exceedance	Beginning Date through November 30	Based on early season trend
Hydrology	Bend Bridge	Daily average flow rate (cfs)	Historical data: percent exceedance	Beginning Date through November 30	Based on early season trend
Temperature	Shasta, Trinity, and Whiskeytown Inflow Temperatures	°F	Fixed Assumption (does not change with Meteorology inputs)	Beginning Date through November 30	See documentation source code: contact RMA
Water Demands	Carr Power Plant	Daily average flow rate (cfs)	Forecasted monthly data (disaggregated to daily average)	Beginning Date through November 30	Reclamation CVO Water Operations Outlook varied by inflow percent exceedance
Water Demands	Keswick Release	Daily average flow rate (cfs)	Forecasted monthly data (disaggregated to daily average)	Beginning Date through November 30	Reclamation CVO Water Operations Outlook varied by inflow percent exceedance
Water Demands	Shasta Release	Daily average flow rate (cfs)	Forecasted monthly data (disaggregated to daily average)	Beginning Date through November 30	Reclamation CVO Water Operations Outlook varied by inflow percent exceedance
Water Demands	Spring Creek Power Plant Diversion	Daily average flow rate (cfs)	Forecasted monthly data (disaggregated to daily average)	Beginning Date through November 30	Reclamation CVO Water Operations Outlook varied by inflow percent exceedance
Water Demands	Anderson Cottonwood Irrigation District	Daily average flow rate (cfs)	Forecasted monthly data (disaggregated to daily average)	Beginning Date through November 30	Values based on historical use
Water Demands	Trinity Release	Daily average flow rate (cfs)	Forecasted monthly data (disaggregated to daily average)	Beginning Date through November 30	Reclamation CVO Water Operations Outlook varied by inflow percent exceedance
Water Demands	Lewiston Release	Daily average flow rate (cfs)	Forecasted monthly data (disaggregated to daily average)	Beginning Date through November 30	Reclamation CVO Water Operations Outlook varied by inflow percent exceedance
Water Demands	Whiskeytown Release	Daily average flow rate (cfs)	Forecasted monthly data (disaggregated to daily average)	Beginning Date through November 30	Reclamation CVO Water Operations Outlook varied by inflow percent exceedance
Operation	Temperature Tailbay Targets	°C	Specify Seasonal Target Temperature by date	Beginning Date through November 30	User - trial and error

Attachment 8

National Weather Service Climate Prediction Center Local Three-Month Temperature Outlook

weather.gov

National Weather Service Forecast Office
Sacramento, CA

Home News Organization Search for: [ ] (•) NWS ( ) All NOAA Go

Local forecast by "City, St"
City, St Go

RSS Feeds
Current Hazards
- Watches/Warnings
- Local Outlook
- National Outlooks

Current Conditions
- Observations
- Radar Imagery
- Satellite Imagery
- Soundings/Profilers
- Rivers & Lakes
- AHPS
- River Levels
- Precipitation
- Buoy Reports
- Road Conditions

Forecasts
- Forecast Discussion
- Local Area
- Activity Planner
- Aviation Weather
- Fire Weather
- Marine Weather
- Severe Weather
- Hurricane Center
- Weather Tables

Hydrology
- Rivers and Lakes
- Other Hydro Info

Climate
- Local
- National
- Drought
- More...
- Climate Portal

Weather Safety
- Preparedness
- Weather Radio
- SkyWarn™
- StormReady
- Weather Spotters

Additional Info
- Items of Interest
- Other Useful Links
- Education
- Resources
- COOP Observer
- Our Office
- Computer models

Contact Us
- Contact Info
- Feedback
- Ask Questions

Home > Climate > NWS Sacramento > Climate Prediction > Local Temperature Outlook

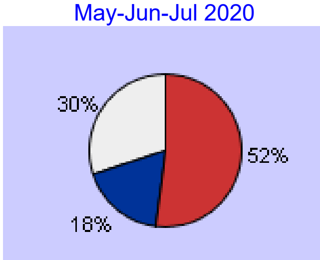
Three-Month Temperature Outlook (Issued: April 2020)

National Outlook | Local Outlook | Background Information | Questions and Feedback

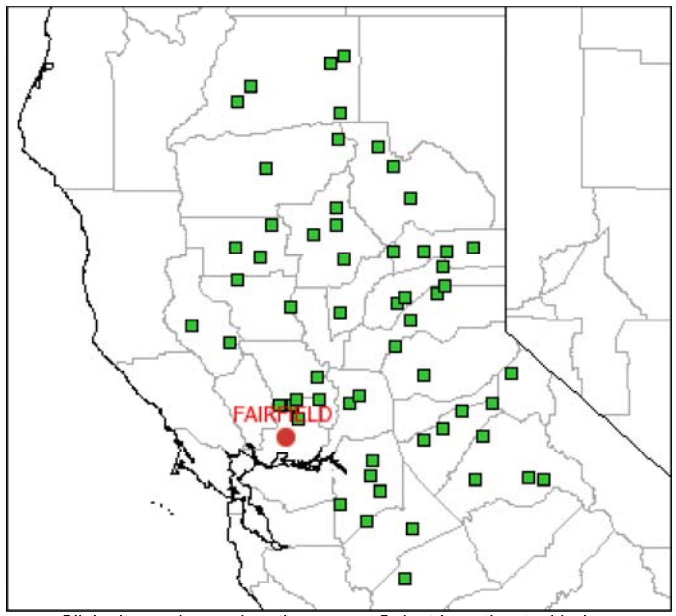
FAIRFIELD, CA
SOLANO County, Coop ID: 42934
Elevation: 40 ft.
Latitude: 38° 16' N Longitude: 122° 4' W

NOAA Online Weather Data Help

Three Category Temperature Outlook
May-Jun-Jul 2020

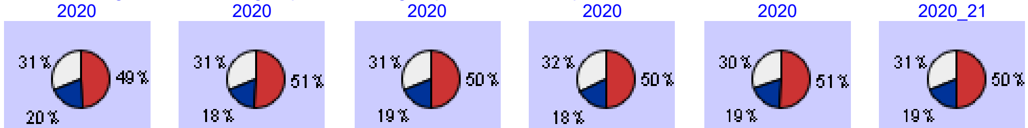


Above Normal
Near Normal
Below Normal

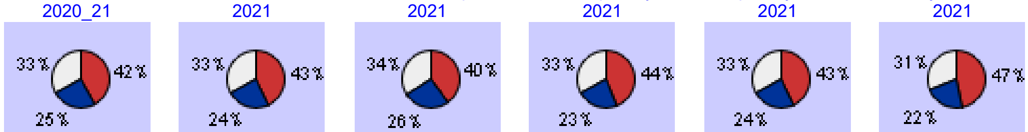


Click site to change location or use Select Location tool below.

Jun-Jul-Aug 2020 | Jul-Aug-Sep 2020 | Aug-Sep-Oct 2020 | Sep-Oct-Nov 2020 | Oct-Nov-Dec 2020 | Nov-Dec-Jan 2020_21



Dec-Jan-Feb 2020_21 | Jan-Feb-Mar 2021 | Feb-Mar-Apr 2021 | Mar-Apr-May 2021 | Apr-May-Jun 2021 | May-Jun-Jul 2021



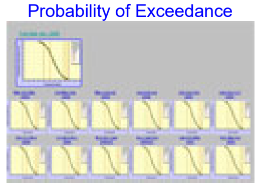
Click on individual chart to view outlook details.
*Outlooks are calculated using the 1981-2010 climatological reference period.

Select Location: SACRAMENTO AP
Select Product: Three Category Calendar Go

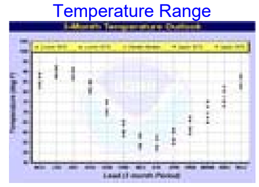
Outlook Evaluation

Outlook Table

Probability of Exceedance



Temperature Range



Click here to provide comments on this service.

Attachment 9

Shasta Lake Temperature Profile 5/13/2020

Department of the Interior
Bureau of Reclamation
NCAO

Shasta Lake Profile

Date: 5/13/2020 Time: 10:00 Observer: Gotham, Ward

Precipitation Last 48 Hours: 1.4 Weather: overcast and calm

Thermometer ID: YSI 6600A Air Temperature (Degrees F): 56 Storet Code: SH21

Lake Surface Elevation: 1,032.35

All Elevations in M.S.L.
(Mean Sea Level)

Elevation	Temperature 400 Feet Upstream of Dam	Turbidity 400 Feet Upstream of Dam
Surface:	64.1	0.7
Elevation 1050':		
1025':	64.1	0.7
1000':	56.0	0.8
975':	51.7	0.7
950':	50.3	0.8
925':	49.3	0.7
900':	48.8	0.7
875':	48.0	0.9
850':	47.4	1.2
825':	47.1	1.6
800':	46.9	1.8
775':	46.8	2.2
750':	46.7	2.4
725':	46.6	2.6
700':	46.6	2.7
675':	46.5	2.8
650':	46.5	2.9
625':	46.5	3.1

Spillway Outlet (Elevation = 942'):	0
Spillway Outlet (Elevation = 842'):	0
Spillway Outlet (Elevation = 742'):	0
Power (Elevation = 815'):	8269
Tailbay Water Surface Elevation:	581.96
Tailbay Water Temperature:	52
Tailbay Water Turbidity:	0.7

Remarks: TCD Gates: All upper open. Middle #4 open. All others closed. Secchi depth = 24 feet.

Attachment 10

Trinity Lake Temperature Profile 4/9/2020

Department of the Interior
Bureau of Reclamation
NCAO

Trinity Lake Profile

Date: 4/9/2020 Time: 13:00 Observer: Gotham & Martin

Precipitation Last 48 Hours: 0 Weather: Windy & clear

Thermometer ID: YSI6600A Air Temperature (Degrees F): 60 Storet Code: SH26

Temperature

~ 2000 Feet Upstream of Dam

All Elevations in M.S.L. (Mean Sea Level)

Elevation	Temperature
Lake Surface Elevation: 2,338.13	52.8
2350':	
2325':	51.5
2300':	48.5
2275':	47.9
2250':	46.9
2225':	46.3
2200':	46.0
2175':	45.8
2150':	45.7
2125':	45.6
2100':	45.5
2075':	45.5
2050':	45.3
2025':	45.2
2000':	45.2
1975':	45.2
1950':	45.2
Lake Bottom: 1950	45.2

Main / Outlet Release (Elevation = 2160'):	0
Power (Elevation = 2160'):	758
AUX / Outlet (Elevation = 1999'):	0
Spillway (Elevation = 2370'):	0

Top of Trinity Outlet intake at 2225 feet.Penstock intake at 2100 ft. Location at N40 48' 19.76, W122 45' 34.9

Comments: Secchi = 20'.

Attachment 11

Whiskeytown Lake Temperature Profile 4/14/2020

Department of the Interior
Bureau of Reclamation
NCAO

Whiskeytown Lake Profile

Date: 4/14/2020 Time: 10:00 Observer: Martin Ward

Precipitation Last 48 Hours: 0 Weather: Clear and calm

Thermometer ID: YSI 6600A Air Temperature (Degrees F): 64

Lake Surface Elevation: 1204.07
All Elevations in M.S.L.
(Mean Sea Level)

Outlet (Upper) Release (Elevation = 1110'): 0
Outlet (Lower) Release (Elevation = 975'): 200
Spill Release (Elevation = 1210'): 0
Spring Creek / PWR (Elevation = 1085'): 1926
Carr PP Release: 2000

2 Miles Upstream of Dam (W3)			1000' Upstream of Dam (W2)		
Surface Temperature:		57.2	Surface Temperature:		56.2
1200' elevation:		55.9	1200' elevation:		56.1
1175':		52.0	1175':		55.9
1150':		50.1	1150':		50.2
1125':		49.2	1125':		49.4
1100':		48.6	1100':		48.8
1075':		48.2	1075':		48.5
1050':		48.0	1050':		48.2
1025':			1025':		48.0
Lake Bottom Elevation:	1034	48.0	1000':		47.9
			Lake Bottom Elevation:	996	47.9

Department of the Interior
Bureau of Reclamation
NCAO

Whiskeytown Lake Profile

Spring Creek PWR Intake Structure (W1)

Surface Temperature:		56.0
1200':		55.9
1175':		53.1
1150':		50.0
1125':		49.3
1100':		48.9
1075':		
Lake Bottom Elevation:	1078	48.3

Comment: Secchi = 30 feet @ W2

Attachment 12

Sacramento River Temperature Management Planning: Proposed Temperature Tier Selection Protocol 4/20/20

BUREAU OF RECLAMATION

Sac River Temperature Management Planning

Proposed Temperature Tier Selection Protocol

April 20, 2020

Outline

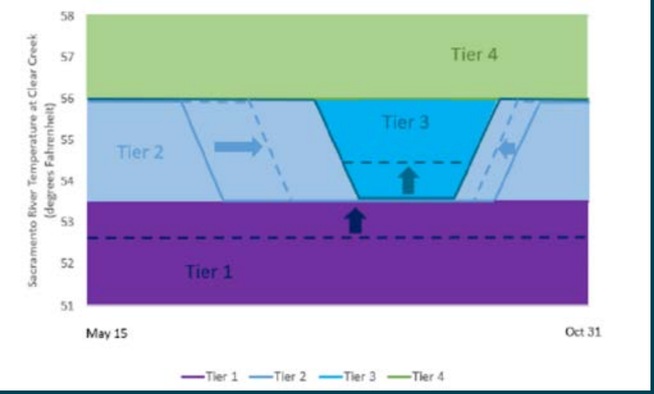
- Schedule
- Preliminary Definition of Tier 2
- Preliminary Definition of Tier 3
- Proposed Tier 2 or 3 Selection Process
- Proposed Iterative Process
- Results

Schedule

- Mon – 4/20 – Distribute TMP Scenarios
- Tues – 4/22 Noon – Send Technical Assistance (feedback) to Reclamation
- Wed – 4/22 – Distribute SRTTG Meeting Materials
- Thurs – 4/23 – SRTTG Meeting/Draft TMP

TMP – Temperature Management Plan

Why a Preliminary Definition of Tier 2 and 3?

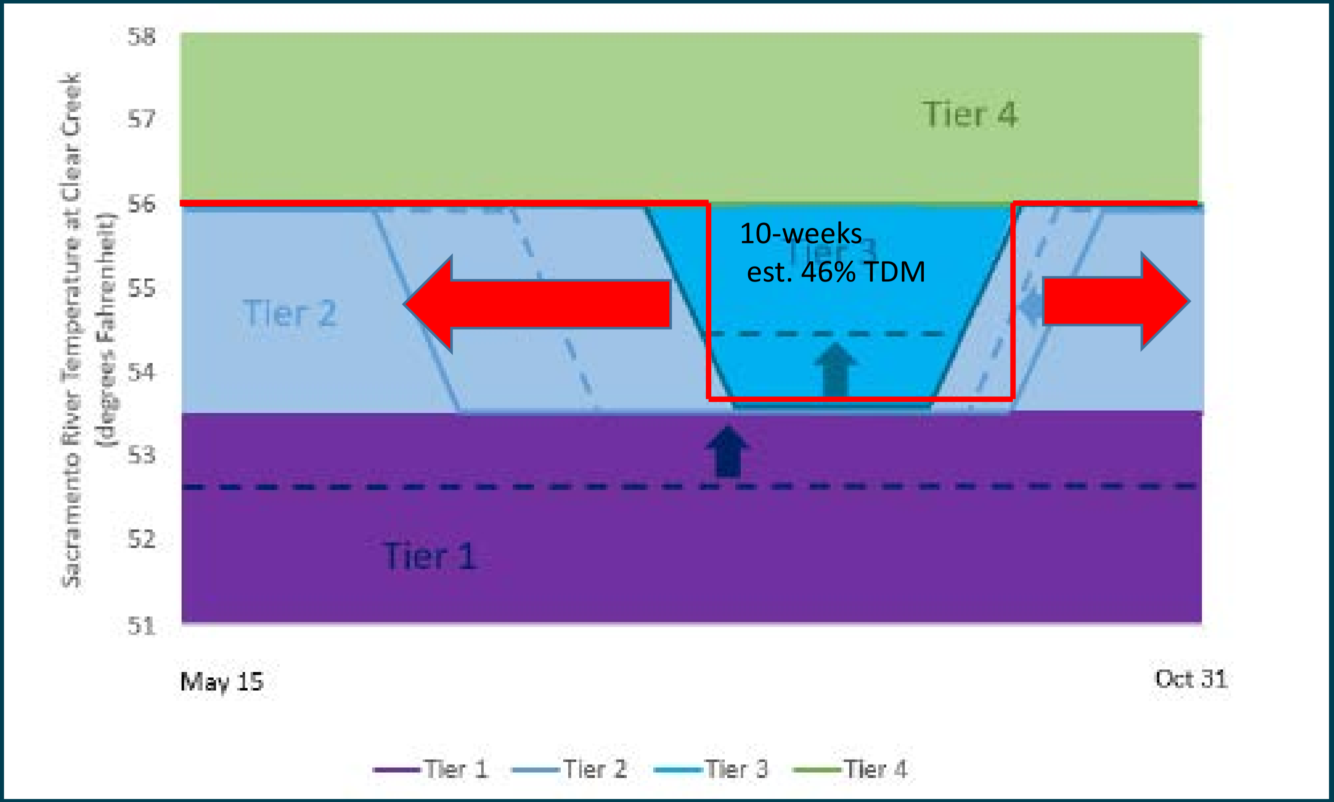


- In Reclamation's Proposed Action the Tier graphic (at right) didn't specify the timing or duration of the critical period (period of time at 53.5°F) for Tier 2 and 3 – only a temperature dependent mortality target. Therefore, Reclamation is suggesting preliminary definitions in the following slides. These are not finalized to allow sufficient time for feedback.

Tier 2 Preliminary Definition

- Tier 2:
  1. Infeasible simulation achieving May 15 – Oct 31 period at 53.5 (Screens out the possibility of Tier 1)
  2. Feasible simulation achieving May 15 – Oct 31 period at 56 (Screens out the possibility of Tier 4)
  3. Feasible simulation achieving a critical period of a minimum of 10 weeks at 53.5°F (and 56° F for the remainder of the temperature management period) to achieve a Temperature Dependent Mortality (TDM) of approximately 46%

Tier 2 Minimum



Why 10 weeks at 53.5°F?

- Reclamation's Proposed Action specifies the following biological performance for Tier 2:

  Performance TDM metric: Max(46%); Ave(15%); Med(9%); Min(1%); StdDev(+/-16%)

- TDM performance (next slide), developed by NMFS using the Martin model, illustrates 10 weeks of 53.5°F centered around August 8 (and 56°F for remaining management window - fuchsia curve) results in a TDM of approximately 46%

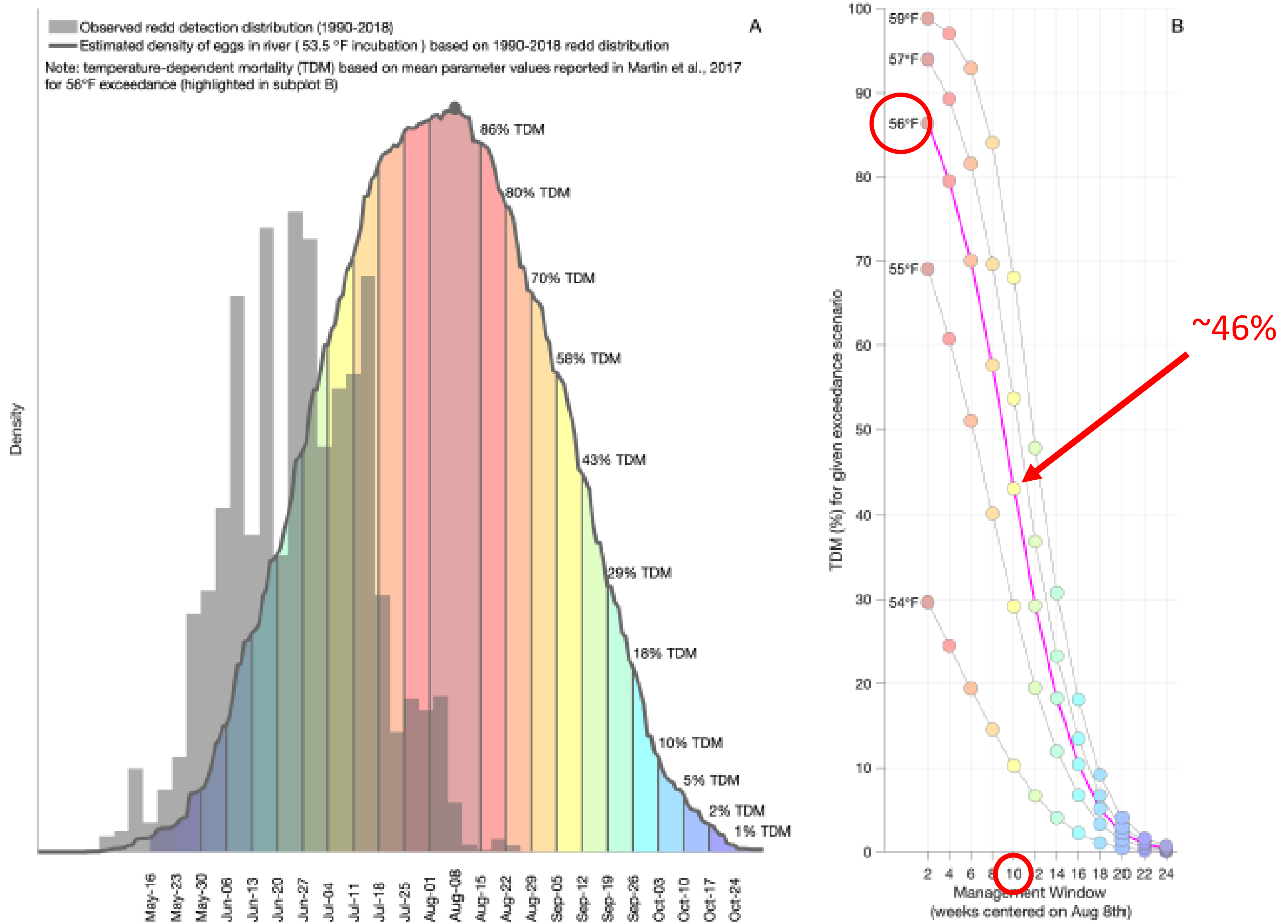
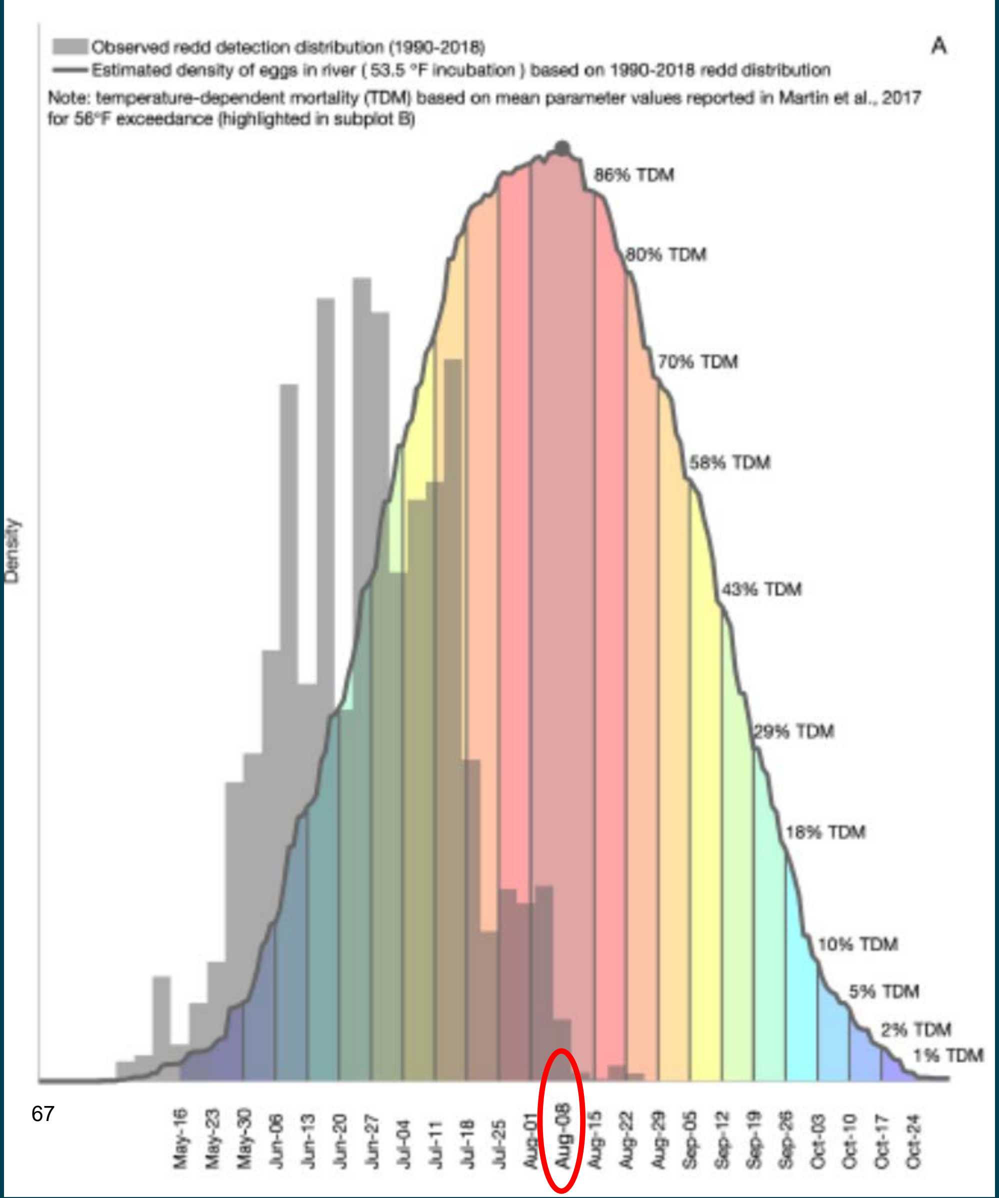


Figure: Temporal distribution of redds detection from 1990-2018, with the maximum density of eggs incubating in river estimated from the 1990-2018 dataset, with various temperature management windows (shaded colors) and associated values of temperature-dependent egg mortality (TDM) displayed assuming temperature compliance of 53.5 °F and exceedance of 56 °F (subplot A). Subplot B shows the relationship between TDM, temperature compliance, and various exceedance temperatures under the same temperature management windows as subplot A.

Why center around Aug 8th?

- This maximum egg density assumption in NMFS' graphic was based on redd distribution data collected between 1990 and 2018



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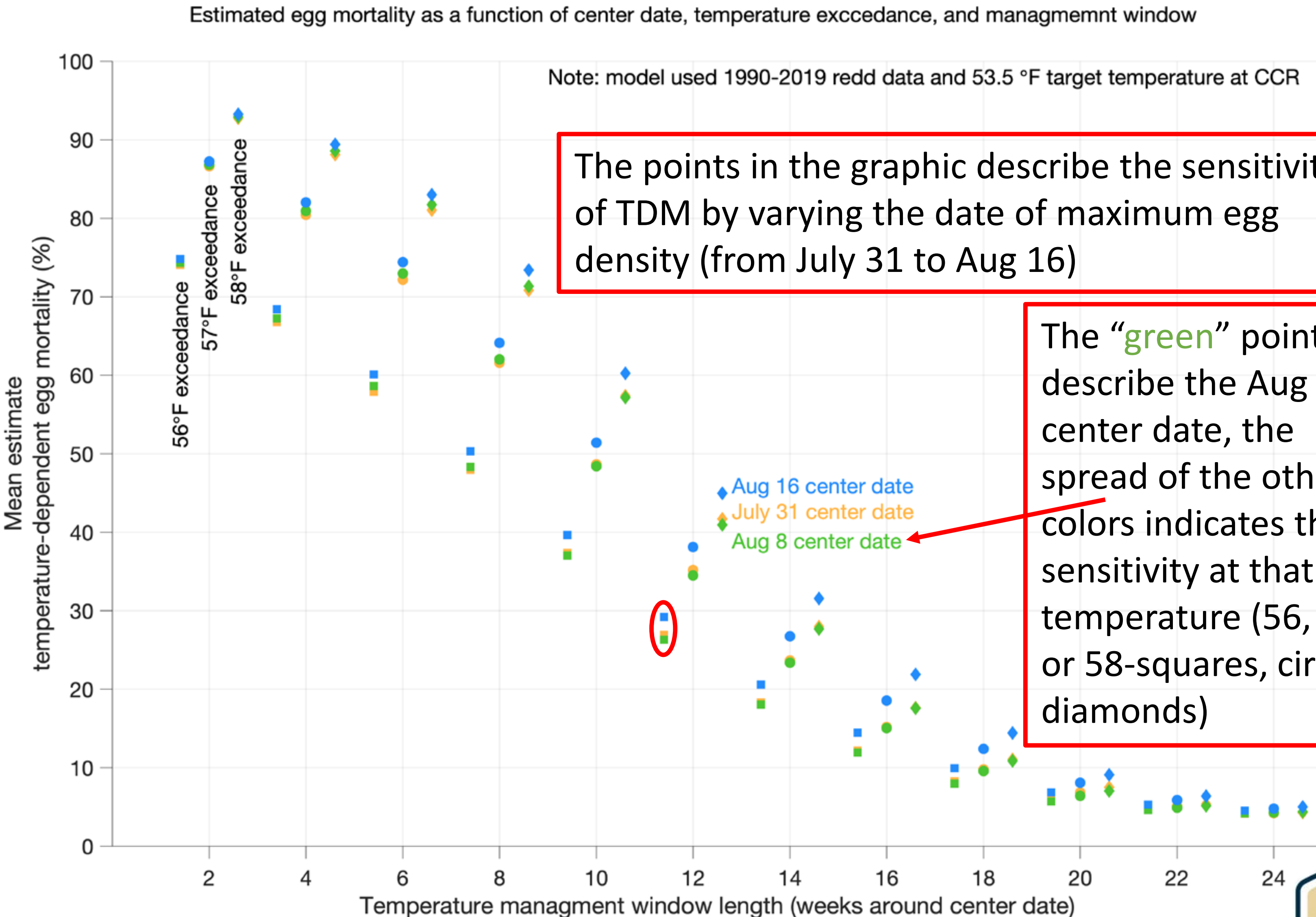
Questions

- What if Aug 8 isn't the actual date of maximum density? How sensitive is the timing of maximum egg density?
  - See next slide
- What is the likelihood, based on historical data, of reaching a maximum egg density centered about July 31, Aug 8, and Aug 16?
  - NMFS is working on this

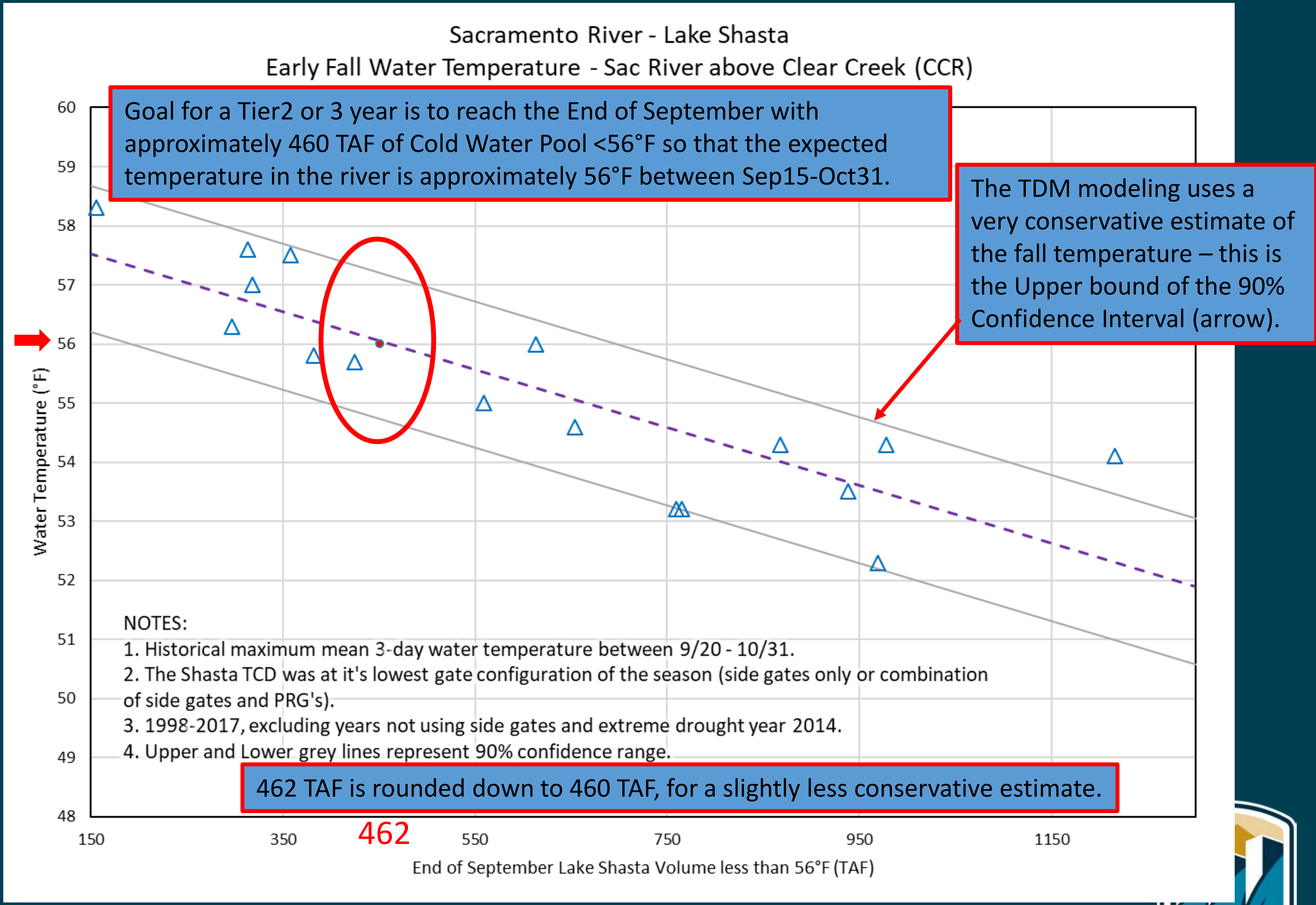


The points in the graphic describe the sensitivity of TDM by varying the date of maximum egg density (from July 31 to Aug 16)

The "green" points describe the Aug 8 center date, the spread of the other colors indicates the sensitivity at that temperature (56, 57, or 58-squares, circle, diamonds)

What defines a feasible simulation?

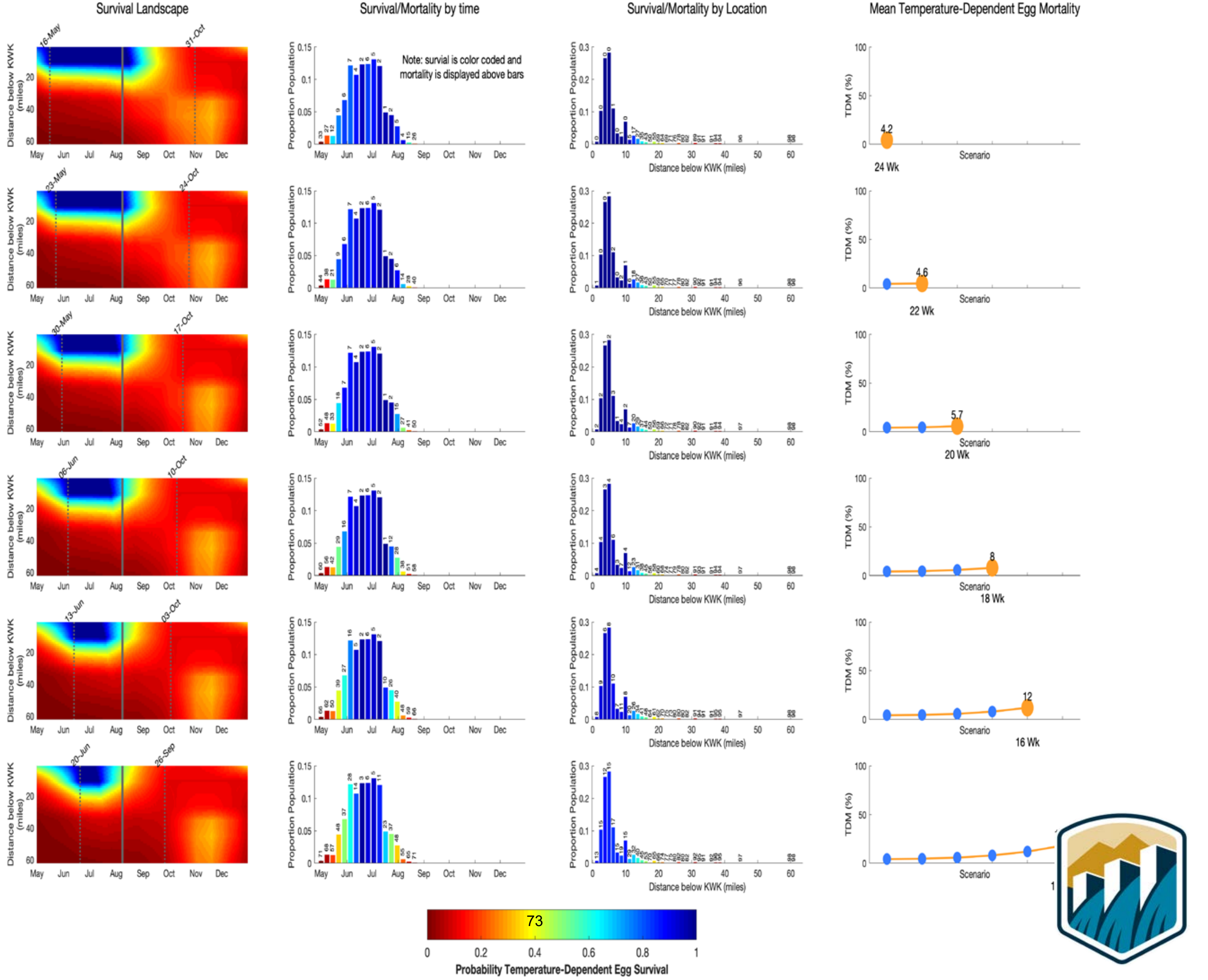
- Both Tier 2 and Tier 3 may suggest a temperature performance of 56ºF at CCR for the end of the temperature management period
- To achieve this, Reclamation is interpreting a feasible temperature simulation based on an end of September cold water pool (EOS CWP) less than 56ºF of approximately 460 TAF (This was previously incorrectly reported as 400 TAF)
- The next slide shows how this was found by using a more confident historical relationship with a 90% Confidence Interval – this information supplements the less confident Sept15-Oct31 results from the temperature model


Sacramento River - Lake Shasta
Early Fall Water Temperature - Sac River above Clear Creek (CCR)
Goal for a Tier2 or 3 year is to reach the End of September with approximately 460 TAF of Cold Water Pool <56°F so that the expected temperature in the river is approximately 56°F between Sep15-Oct31.
The TDM modeling uses a very conservative estimate of the fall temperature – this is the Upper bound of the 90% Confidence Interval (arrow).
Water Temperature (°F)
60
59
58
57
56
55
54
53
52
51
50
49
48
NOTES:
1. Historical maximum mean 3-day water temperature between 9/20 - 10/31.
2. The Shasta TCD was at it's lowest gate configuration of the season (side gates only or combination of side gates and PRG's).
3. 1998-2017, excluding years not using side gates and extreme drought year 2014.
4. Upper and Lower grey lines represent 90% confidence range.
462 TAF is rounded down to 460 TAF, for a slightly less conservative estimate.
150
350
462
550
750
950
1150
End of September Lake Shasta Volume less than 56°F (TAF)

Tier 3 Preliminary Definition

- Definition of Tier 3:
  1. Infeasible simulation achieving May 15 – Oct 31 period at 53.5 (Screens out the possibility of Tier 1)
  2. Feasible simulation achieving May 15 – Oct 31 period at 56 (Screens out the possibility of Tier 4)
  3. Infeasible simulation achieving a minimum 10 week period at 53.5 (Screens out the possibility of Tier 2)
  4. Goal is to target a TDM Performance metric based on Reclamation's Proposed Action: Max(77%); Ave(34%); Med(24%); Min(6%); StdDev(+/-31%)
  5. The details of Tier 3 are currently being evaluated (e.g. single temperature target or incremental warming about the "critical period"). See next slide for preliminary evaluation with NMFS' Martin model results.

Scenario = temperature target 53.5 °F at CCR, 56 °F exceedance and Aug 8th center date and varying temperature management window



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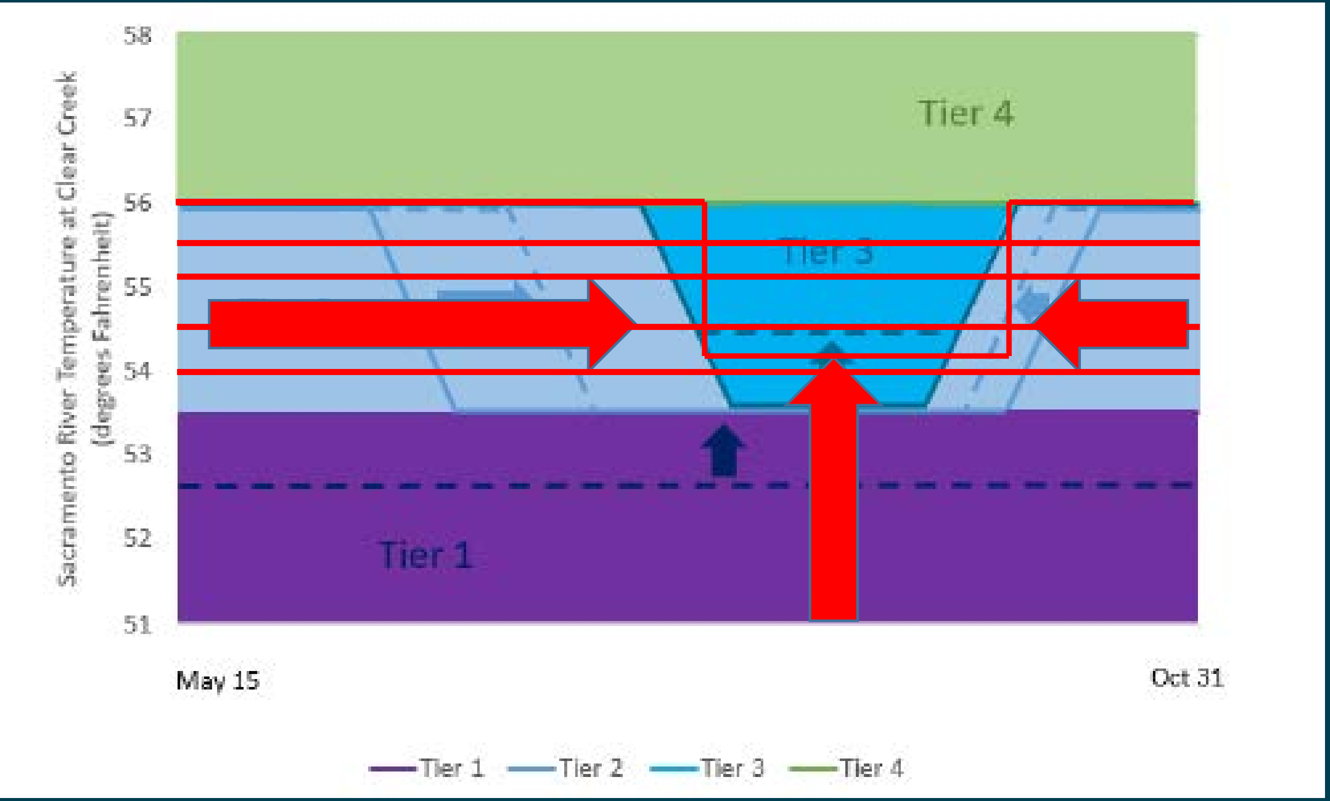
"Visualization" of Tier 3 details under evaluation

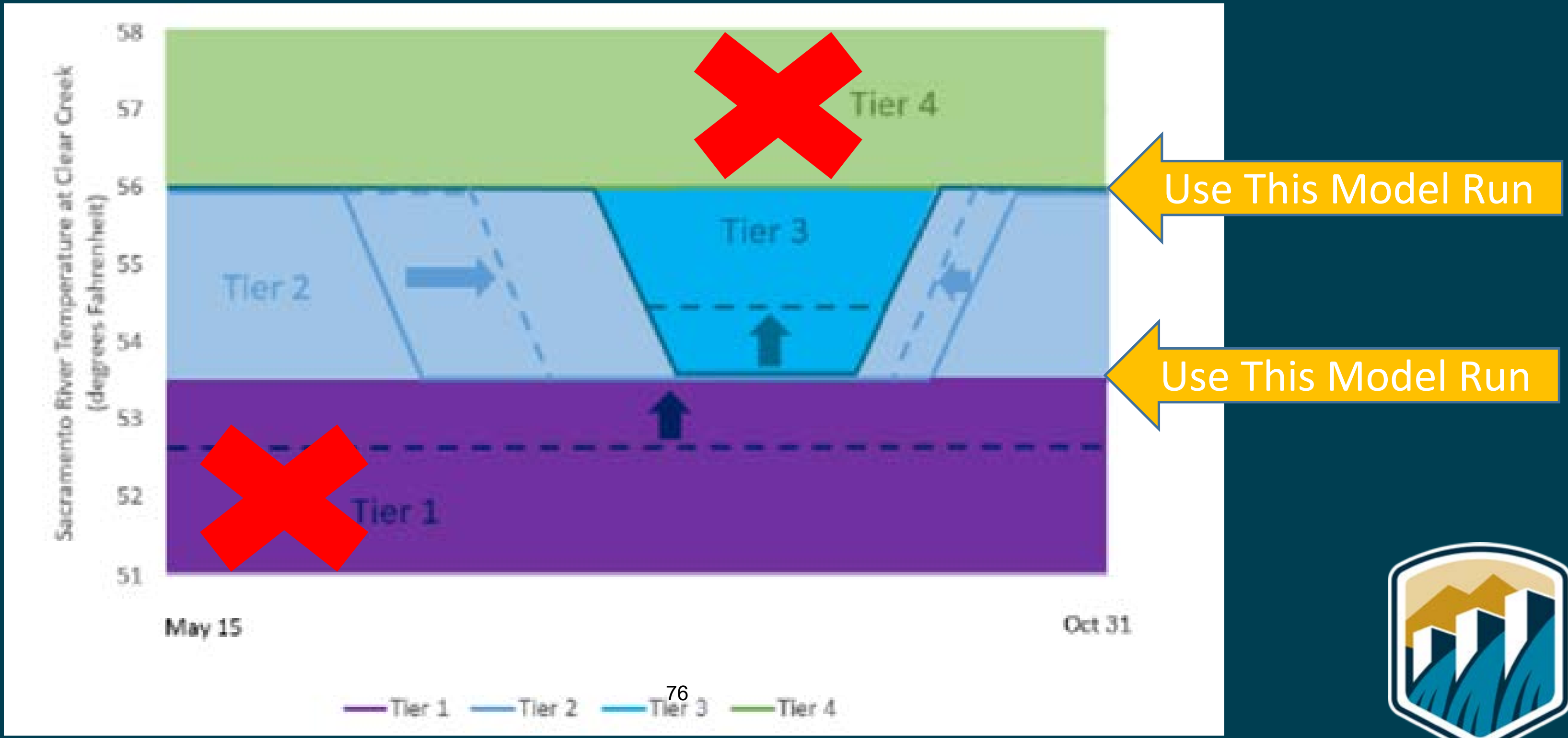


Proposed Tier 2 or 3 Selection Process

- Reclamation has proposed to use a process similar to the American River's Temperature Management approach.
- The American River process (also known as the Automated Temperature Selection Process or ATSP) assesses the available cold water pool resource and incrementally trades off the benefits between stealhead and fall run on a pre-determined weekly timestep to determine a feasible temperature management plan. The weekly priority and trade off scenario set has already been vetted with the American River biologists in advance. The Sacramento River Temperature Task Group has not been afforded time to vet scenarios, but there will be opportunities in the future if desired.
- The next slides explain how the proposed scenarios were incrementally determined for the Sacramento River.

Proposed Iterative Process

- Tier 2 and 3 were initially defined by "Screening" out the possibility of Tier 1 and Tier 4
- These Model Runs are used to bound the scenarios and iteratively explore Tier 2 or 3



Potential Tier 2 Scenarios

- The next two graphics illustrate the transition from the Proposed Action Tier 2 and 3 to "Temperature Target Scenarios" (Scenarios) to model. Changing in 2 week increments: where 53.5°F is coded "Blue" and 56 °F is coded "Red"

Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
T1																								
T2																								
T2																								
T2																								
T2																								
T2																								
T2																								
Min T2																								
Week	16-May	23-May	30-May	6-Jun	13-Jun	20-Jun	27-Jun	4-Jul	11-Jul	18-Jul	25-Jul	1-Aug	8-Aug	15-Aug	22-Aug	29-Aug	5-Sep	12-Sep	19-Sep	26-Sep	3-Oct	10-Oct	17-Oct	24-Oct

Potential Tier 3 Scenarios

Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Min T2																								
T3																								
T3																								
T3																								
T3																								
T3																								
Max T3																								
Week	16-May	23-May	30-May	6-Jun	13-Jun	20-Jun	27-Jun	4-Jul	11-Jul	18-Jul	25-Jul	1-Aug	8-Aug	15-Aug	22-Aug	29-Aug	5-Sep	12-Sep	19-Sep	26-Sep	3-Oct	10-Oct	17-Oct	24-Oct

Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
T3																								
T3																								
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Week	16-May	23-May	30-May	6-Jun	13-Jun	20-Jun	27-Jun	4-Jul	11-Jul	18-Jul	25-Jul	1-Aug	8-Aug	15-Aug	22-Aug	29-Aug	5-Sep	12-Sep	19-Sep	26-Sep	3-Oct	10-Oct	17-Oct	24-Oct

Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
T3																								
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Week	16-May	23-May	30-May	6-Jun	13-Jun	20-Jun	27-Jun	4-Jul	11-Jul	18-Jul	25-Jul	1-Aug	8-Aug	15-Aug	22-Aug	29-Aug	5-Sep	12-Sep	19-Sep	26-Sep	3-Oct	10-Oct	17-Oct	24-Oct

- Explore additional Scenarios by continuing incremental warming within the "critical period" with incrementally warmer temperatures (represented by "Tan" and "Gold")

Potential Tier 3 Scenarios

- Or, continue incremental warming for the entire temperature management period (where the colors represent incrementally warmer temperatures between 53.5°F and 56°F)

Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
T3																								
T3																								
T3																								
T3																								
T3																								
T3																								
T3																								
Week	16-May	23-May	30-May	6-Jun	13-Jun	20-Jun	27-Jun	4-Jul	11-Jul	18-Jul	25-Jul	1-Aug	8-Aug	15-Aug	22-Aug	29-Aug	5-Sep	12-Sep	19-Sep	26-Sep	3-Oct	10-Oct	17-Oct	24-Oct

Proposed Tier 2 or 3 Selection Process

Evaluate Screening Level Temperature at 53.5 and 56 → Populate Pre-determined Scenarios in spreadsheet → Run Temperature and TDM Models → Sort by: TDM, EOS CWP, and Side Gate Use. Report Fall temperature performance

Deliverable

- Reclamation plans to deliver a set of simulated outcomes sorted in a spreadsheet which contains:
  - TDM Performance
  - EOS CWP <56
  - Side Gate Timing
  - Simulated Temperature Performance based on predetermined temperature target scenarios

Temperature Tier Selection Protocol (TTSP)

- TTSP Excel Spreadsheet
- Tab TTSP Scenarios contain the predetermined set of “Temperature Target Scenarios” (and also contains all model results)

Temperature Tier Selecti		Tier 1	Pre-Tier Tradeoff Exploration (Column D:J)							Tier 3	Pre-Tier Tradeoff Exploration (Column L:R)						
		53.5	53.5	53.5	53.5	53.5	53.5	53.5	53.5	56	56	56	56	56	56	56	56
Row	Date	1	2	3	4	5	6	7	8	9	10	11					16
4	20200201	20	20	20	20	20	20	20	12	20	20	20					12
5	20200331	20	20	20					12	20	20	20					12
6	20200407	13	20	20					12	13	20	20					11.9
7	20200414	13	20	20					11	13	20	20					11
8	20200421	12	20	20					11	12	20	20					10.8
9	20200430	12	20	10.2					10.2	12	20	11.5					11.5
10	20200507	12	10.2	10.2					10.2	12	11.5	11.5					11.5
11	20200514	10.2	10.2	10.2					10.2	12	12	12					12
12	20200521	10.2	10.2	10.2					10.2	12	12	12					12
13	20200531	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	12	12	12					12
14	20200607	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	12	12	12					12
15	20200614	10.9	10.9	10.9	10.9	10.9	10.9	10.9	10.9	12	12	12					12
16	20200621	10.5	10.5	10.5	10.5	10.5	10.5	10.5	10.5	12.1	12.1	12.1					12.1
17	20200630	10.5	10.5										12	12	12	12	12
18	20200707	10.2	10.2										12	12	12	12	12
19	20200714	10.2	10.2										12	12	12	12	12
20	20200721	10.2	10.2										11.6	11.6	11.6	11.6	11.6
21	20200731	9.3	9.3										11.2	11.2	11.2	11.2	11.2
22	20200807	9.9	9.9										11.6	11.6	11.6	11.6	11.6
23	20200814	9.3	9.3										11.6	11.6	11.6	11.6	11.6
24	20200821	9.9	9.9										11.6	11.6	11.6	11.6	11.6
25	20200831	9.3	9.3										11.3	11.3	11.3	11.3	11.3
26	20200907	9.3	9.3										11.6	11.6	11.6	11.6	11.6
27	20200915	10	10										11.6	11.6	11.6	11.6	11.6
28	20200921	10	10										11.6	11.6	11.6	11.6	11.6
29	20200930	10	10										11.9	11.9	11.9	11.9	11.9
30	20201007	10	10										11.9	11.9	11.9	11.9	11.9
31	20201014	10	10	10	10	10	10	10	10	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
32	20201021	10	10	10	10	10	10	10	10	11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
33	20201031	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
34	20201107	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11	11
35																	
36	EOS CWP <5	432037.3	442882.5	425068.7	405490.9	405005.3	405005.3	405005.3	405005.3	671248.9	680747.1	671965.7	663246.8	656616.8	656616.8	656616.8	656616.8
37																	
38																	
39	ccr monthly a	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
40	Apr	54.1	56.0	55.3	53.0	52.8	52.8	52.8	52.8	54.1	56.0	55.6	53.0	52.9	52.9	52.9	52.9
41	May	53.4	53.4	52.5	52.5	52.5	52.5	52.5	52.5							54.1	54.1
42	Jun	53.1	53.0	53.1	53.2	53.2	53.2	53.2	53.2							53.4	53.4
43	Jul	53.4	53.4	53.4	53.4	53.4	53.4	53.4	53.4							55.7	55.7
44	Aug	53.3	53.3	53.3	53.3	53.3	53.3	53.3	53.3							55.7	55.7
45	Sep	55.8	55.8	55.9	56.0	56.0	56.0	56.0	56.0							56.1	56.1
46	Oct	57.3	57.3	57.4	57.5	57.5	57.5	57.5	57.5							56.2	56.2
47																	
48																	
49	**Est. Fall (Sep 15 - Oct 31) CCR Temp**																
50	Max 90% CI	57.3	57.3	57.4	57.5	57.5	57.5	57.5	57.5							56.2	56.2
51	EV	56.1	56.1	56.2	56.3	56.3	56.3	56.3	56.3							55.0	55.0
52	Min 90% CI	54.8	54.8	54.9	55.0	55.0	55.0	55.0	55.0							53.7	53.7
53																	
54																	
55	**Side gate use**																
56	First side gate	30-Jul	30-Jul	30-Jul	30-Jul	30-Jul	30-Jul	30-Jul	30-Jul	16-Oct	16-Oct	16-Oct	16-Oct	15-Oct	15-Oct	15-Oct	15-Oct
57	Full side gate	29-Aug	30-Aug	29-Aug	27-Aug	27-Aug	27-Aug	27-Aug	27-Aug	31-Dec	31-Dec	31-Dec	31-Dec	31-Dec	31-Dec	31-Dec	31-Dec
58																	
59																	
60																	
61	Martin	0.2571	0.251781	0.260484	0.267669	0.268977	0.268977	0.268977	0.268977	0.809948	0.804362	0.808502	0.812448	0.813711	0.813711	0.813711	0.813711
62	Anderson	0.102036	0.095777	0.10678	0.107293	0.110339	0.110339	0.110339	0.110339	0.928243	0.923744	0.927138	0.930072	0.929761	0.929761	0.929761	0.929761

Row 3: Scenario Number

Row 1: Designates Tier Category or Exploration

Rows 4 through 34: "Shasta Tailbay Temperature Target" in deg. C. Colors suggest the magnitude of desired change and may be more meaningful.

Row 36: End of September cold water pool volume less than <56°F in AF

Temperature Tier Selecti		Tier 1	Pre-Tier Tradeoff Exploration (Column D:J)							Tier 3	Pre-Tier Tradeoff Exploration (Column L:R)						
		53.5	53.5	53.5	53.5	53.5	53.5	53.5	53.5	56	56	56	56	56	56	56	56
Row	Date	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
4	20200201	20	20	20	20	20	20	20	12	20	20	20	20	20	20	20	12
5	20200331	20	20	20	20	20	20	12	12	20	20	20	20	20	20	12	12
6	20200407	13	20	20	20	20	12	12	12	13	20	20	20	20	11.9	11.9	11.9
7	20200414	13	20	20	20	11	11	11	11	13	20	20	20	11	11	11	11
8	20200421	12	20	20	11	11	11	11	11	12	20	20	10.8	10.8	10.8	10.8	10.8
9	20200430	12	20	10.2	10.2	10.2	10.2	10.2	10.2	12	20	11.5	11.5	11.5	11.5	11.5	11.5
10	20200507	12	10.2	10.2						12	11.5	11.5	11.5	11.5	11.5	11.5	11.5
11	20200514	10.2	10.2	10.2						12							12
12	20200521	10.2	10.2	10.2						12							12
13	20200531	10.5	10.5	10.5						12							12
14	20200607	10.9	10.9	10.9						12							12
15	20200614	10.9	10.9	10.9						12							12
16	20200621	10.5	10.5	10.5						12.1	1						12.1
17	20200630	10.5	10.5	10.5						12							12
18	20200707	10.2	10.2	10.2						12							12
19	20200714	10.2	10.2	10.2						12							12
20	20200721	10.2	10.2	10.2						11.6	1						11.6
21	20200731	9.3	9.3	9.3						11.2	1						11.2
22	20200807	9.9	9.9	9.9						11.6	1						11.6
23	20200814	9.3	9.3	9.3						11.6	1						11.6
24	20200821	9.9	9.9	9.9						11.6	1						11.6
25	20200831	9.3	9.3	9.3						11.3	1						11.3
26	20200907	9.3	9.3	9.3						11.6	1						11.6
27	20200915	10	10	10						11.6	1						11.6
28	20200921	10	10	10	10	10	10	10	10	11.6	1						11.6
29	20200930	10	10	10	10	10	10	10	10	11.9	1						11.9
30	20201007	10	10	10	10	10	10	10	10	11.9	1						11.9
31	20201014	10	10	10	10	10	10	10	10	11.9	1						11.9
32	20201021	10	10	10	10	10	10	10	10	11.9	1						11.9
33	20201031	11	11	11	11	11	11	11	11	11							11
34	20201107	11	11	11	11	11	11	11	11	11							11
35																	
36	EOS CWP <	432037.3	442882.5	425068.7	405490.9	405005.3	405005.3	405005.3	405005.3	671248.9	68074						56616.8
37																	
38																	
39	ccr monthly a	1	2	3	4	5	6	7	8	9	10						6
40	Apr	54.1	56.0	55.3	53.0	52.8	52.8	52.8	52.8	54.1	56.0						52.9
41	May	53.4	53.4	52.5	52.5	52.5	52.5	52.5	52.5	54.4	54.8	54.2	54.1	54.1	54.1	54.1	54.1
42	Jun	53.1	53.0	53.1	53.2	53.2	53.2	53.2	53.2	53.3	53.2	53.3	53.4	53.4	53.4	53.4	53.4
43	Jul	53.4	53.4	53.4	53.4	53.4	53.4	53.4	53.4	55.6	55.6	55.6	55.7	55.7	55.7	55.7	55.7
44	Aug	53.3	53.3	53.3	53.3	53.3	53.3	53.3	53.3	55.7	55.8	55.8	55.7	55.7	55.7	55.7	55.7
45	Sep	55.8	55.8	55.9	56.0	56.0	56.0	56.0	56.0	56.1	56.1	56.1	56.1	56.1	56.1	56.1	56.1
46	Oct	57.3	57.3	57.4	57.5	57.5	57.5	57.5	57.5	56.2	56.1	56.2	56.2	56.2	56.2	56.2	56.2
47																	
48																	
49	**Est. Fall (Sep 15 - Oct 31) CCR Temp**																
50	Max 90% CI	57.3	57.3	57.4	57.5	57.5	57.5	57.5	57.5	56.2	56.1	56.2	56.2	56.2	56.2	56.2	56.2
51	EV	56.1	56.1	56.2	56.3	56.3	56.3	56.3	56.3	55.0	54.9	55.0	55.0	55.0	55.0	55.0	55.0
52	Min 90% CI	54.8	54.8	54.9	55.0	55.0	55.0	55.0	55.0	53.7	53.6	53.7	53.7	53.7	53.7	53.7	53.7
53																	
54																	
55	**Side gate use**																
56	First side gate	30-Jul	30-Jul	30-Jul	30-Jul	30-Jul	30-Jul	30-Jul	30-Jul	16-Oct	16-Oct	16-Oct	16-Oct	15-Oct	15-Oct	15-Oct	15-Oc
57	Full side gate	29-Aug	30-Aug	29-Aug	27-Aug	27-Aug	27-Aug	27-Aug	27-Aug	31-Dec	31-Dec	31-Dec	31-Dec	31-Dec	31-Dec	31-Dec	31-Dec
58																	
59																	
60																	
61	Martin	0.2571	0.251781	0.260484	0.267669	0.268977	0.268977	0.268977	0.268977	0.809948	0.804362	0.808502	0.812448	0.813711	0.813711	0.813711	0.813711
62	Anderson	0.102036	0.095777	0.10678	0.107293	0.110339	0.110339	0.110339	0.110339	0.928243	0.923744	0.927138	0.930072	0.929761	0.929761	0.929761	0.929761

Rows 40 through 45: Monthly average water temperature at CCR from HEC5Q model – April through Sep 15

Rows 45 and 46: Monthly average water temperature at CCR from historical linear model based on EOS CWP <56. Sep 15 through Oct 31 (See Rows 49 through 52)

Rows 49 through 52: Monthly average water temperature at CCR from historical linear model based on EOS CWP <56. The expected value (EV) is bounded by the maximum and minimum 90% confidence interval (CI). The maximum 90% CI is used in the estimate of CCR monthly temperature to evaluate the TDM (already incorporated in Rows 45 and 46).

Rows 56 and 57: Report simulated first and full TCD Side Gate usage

Temperature Tier Selecti		Tier 1	Pre-Tier Tradeoff Exploration (Column D:J)							Tier 3	Pre-Tier Tradeoff Exploration (Column L:R)						
		53.5	53.5	53.5	53.5	53.5	53.5	53.5	53.5	56	56	56	56	56	56	56	56
Row	Date	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
4	20200201	20	20	20	20	20	20	20	12	20	20	20	20	20	20	20	12
5	20200331	20	20	20	20	20	20	12	12	20	20	20	20	20	20	12	12
6	20200407	13	20	20	20	20	12	12	12	13	20	20	20	20	11.9	11.9	11.9
7	20200414	13	20	20	20	11	11	11	11	13	20	20	20	11	11	11	11
8	20200421	12	20	20	11	11	11	11	11	12	20	20	10.8	10.8	10.8	10.8	10.8
9	20200430	12	20	10.2	10.2	10.2	10.2	10.2	10.2	12	20	11.5	11.5	11.5	11.5	11.5	11.5
10	20200507	1	10.2	10.2	10.2	10.2	10.2	10.2	10.2	12	11.5	11.5	11.5	11.5	11.5	11.5	11.5
11	20200514	10.								12	12	12	12	12	12	12	12
12	20200521	10.								12	12						12
13	20200531	10.								12	12						12
14	20200607	10.								12	12						12
15	20200614	10.								12	12						12
16	20200621	10.								12.1	12.1						12.1
17	20200630	10.								12	12						12
18	20200707	10.								12	12						12
19	20200714	10.								12	12						12
20	20200721	10.								11.6	11.6						11.6
21	20200731	9.								11.2	11.2						11.2
22	20200807	9.								11.6	11.6						11.6
23	20200814	9.								11.6	11.6						11.6
24	20200821	9.								11.6	11.6						11.6
25	20200831	9.								11.3	11.3						11.3
26	20200907	9.								11.6	11.6						11.6
27	20200915	1								11.6	11.6						11.6
28	20200921	1								11.6	11.6						11.6
29	20200930	1								11.9	11.9						11.9
30	20201007	1								11.9	11.9						11.9
31	20201014	1								11.9	11.9						11.9
32	20201021	1								11.9	11.9						11.9
33	20201031	1								11	11						11
34	20201107	1								11	11						11
35																	
36	EOS CWP <5	432037.								71248.9	680747.1						16.8
37																	
38																	
39	ccr monthly a	1									10						
40	Apr	54.								54.1	56.0						52.9
41	May	53.								54.4	54.8						54.1
42	Jun	53.								53.3	53.2	53.3	53.4	53.4	53.4	53.4	53.4
43	Jul	53.								55.6	55.6	55.6	55.7	55.7	55.7	55.7	55.7
44	Aug	53.								55.7	55.8	55.8	55.7	55.7	55.7	55.7	55.7
45	Sep	55.								56.1	56.1	56.1	56.1	56.1	56.1	56.1	56.1
46	Oct	57.								56.2	56.1	56.2	56.2	56.2	56.2	56.2	56.2
47																	
48																	
49	**Est. Fall (Sep 15 - Oc**																
50	Max 90% CI	57.3	57.3	57.4	57.5	57.5	57.5	57.5	57.5	56.2	56.1	56.2	56.2	56.2	56.2	56.2	56.2
51	EV	56.1	56.1	56.2	56.3	56.3	56.3	56.3	56.3	55.0	54.9	55.0	55.0	55.0	55.0	55.0	55.0
52	Min 90% CI	54.8	54.8	54.9	55.0	55.0	55.0	55.0	55.0	53.7	53.6	53.7	53.7	53.7	53.7	53.7	53.7
53																	
54																	
55	**Side gate use**																
56	First side gate	30-Jul	30-Jul	30-Jul	30-Jul	30-Jul	30-Jul	30-Jul	30-Jul	16-Oct	16-Oct	16-Oct	16-Oct	15-Oct	15-Oct	15-Oct	15-Oc
57	Full side gate	29-Aug	30-Aug	29-Aug	27-Aug	27-Aug	27-Aug	27-Aug	27-Aug	31-Dec	31-Dec	31-Dec	31-Dec	31-Dec	31-Dec	31-Dec	31-Dec
58																	
59																	
60																	
61	Martin	0.2571	0.251781	0.260484	0.267669	0.268977	0.268977	0.268977	0.268977	0.809948	0.804362	0.808502	0.812448	0.813711	0.813711	0.813711	0.813711
62	Anderson	0.102036	0.095777	0.10678	0.107293	0.110339	0.110339	0.110339	0.110339	0.928243	0.923744	0.927138	0.930072	0.929761	0.929761	0.929761	0.929761

Rows 61 and 62: Simulated Temperature Dependent Mortality based on HEC5Q (Apr – Sep 15) and Est. Fall water temperature (Sep 16-Oct31) for both the Martin and Anderson models. Redd distribution assumption spreadsheet included.

Temperature Tier Selecti		Tier 1	Pre-Tier Tradeoff Exploration (Column D:J)							Tier 3	Pre-Tier Tradeoff Exploration (Column L:R)						
		53.5	53.5	53.5	53.5	53.5	53.5	53.5	53.5	56	56	56	56	56	56	56	56
Row	Date	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
4	20200201	20	20	20	20	20	20	20	12	20	20	20	20	20	20	20	12
5	20200331	20	20	20	20	20	20	12	12	20	20	20	20	20	20	12	12
6	20200407	13	20	20	20	20	12	12	12	13	20	20	20	20	11.9	11.9	11.9
7	20200414	13	20	20	20	11	11	11	11	13	20	20	20	11	11	11	11
8	20200421	12	20	20	11	11	11	11	11	12	20	20	10.8	10.8	10.8	10.8	10.8
9	20200430	12	20	10.2	10.2	10.2	10.2	10.2	10.2	12	20	11.5	11.5	11.5	11.5	11.5	11.5
10	20200507	1	10.2	10.2	10.2	10.2	10.2	10.2	10.2	12	11.5	11.5	11.5	11.5	11.5	11.5	11.5
11	20200514	10.								12	12	12	12	12	12	12	12
12	20200521	10.								12	12	12	12	12	12	12	12
13	20200531	10.								12	12	12	12	12	12	12	12
14	20200607	10.								12	12	12	12	12	12	12	12
15	20200614	10.								12	12	12	12	12	12	12	12
16	20200621	10.								12.1	12.1	12.1	12.1	12.1	12.1	12.1	12.1
17	20200630	10.								12	12	12	12	12	12	12	12
18	20200707	10.								12	12	12	12	12	12	12	12
19	20200714	10.								12	12	12	12	12	12	12	12
20	20200721	10.								11.6	11.6	11.6	11.6	11.6	11.6	11.6	11.6
21	20200731	9.								11.2	11.2	11.2	11.2	11.2	11.2	11.2	11.2
22	20200807	9.								11.6	11.6	11.6	11.6	11.6	11.6	11.6	11.6
23	20200814	9.								11.6	11.6	11.6	11.6	11.6	11.6	11.6	11.6
24	20200821	9.								11.6	11.6	11.6	11.6	11.6	11.6	11.6	11.6
25	20200831	9.								11.3	11.3	11.3	11.3	11.3	11.3	11.3	11.3
26	20200907	9.								11.6	11.6	11.6	11.6	11.6	11.6	11.6	11.6
27	20200915	1								11.6	11.6	11.6	11.6	11.6	11.6	11.6	11.6
28	20200921	1								11.6	11.6	11.6	11.6	11.6	11.6	11.6	11.6
29	20200930	1								11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
30	20201007	1								11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
31	20201014	1								11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
32	20201021	1								11.9	11.9	11.9	11.9	11.9	11.9	11.9	11.9
33	20201031	1								11	11	11	11	11	11	11	11
34	20201107	1								11	11	11	11	11	11	11	11
35																	
36	EOS CWP <5	432037.								71248.9	680747.1	671965.7	663246.8	656616.8	656616.8	656616.8	656616.8
37																	
38																	
39	ccr monthly a	1									10	11	12	13	14	15	16
40	Apr	54.								54.1	56.0	55.6	53.0	52.9	52.9	52.9	52.9
41	May	53.								54.4	54.8	54.2	54.1	54.1	54.1	54.1	54.1
42	Jun	53.								53.3	53.2	53.3	53.4	53.4	53.4	53.4	53.4
43	Jul	53.								55.6	55.6	55.6	55.7	55.7	55.7	55.7	55.7
44	Aug	53.								55.7	55.8	55.8	55.7	55.7	55.7	55.7	55.7
45	Sep	55.								56.1	56.1	56.1	56.1	56.1	56.1	56.1	56.1
46	Oct	57.								56.2	56.1	56.2	56.2	56.2	56.2	56.2	56.2
47																	
48																	
49	**Est. Fall (Sep 15 - Oc**																
50	Max 90% CI	57.3	57.3	57.4	57.5	57.5	57.5	57.5	57.5	56.2	56.1	56.2	56.2	56.2	56.2	56.2	56.2
51	EV	56.1	56.1	56.2	56.3	56.3	56.3	56.3	56.3	55.0	54.9	55.0	55.0	55.0	55.0	55.0	55.0
52	Min 90% CI	54.8	54.8	54.9	55.0	55.0	55.0	55.0	55.0	53.7	53.6	53.7	53.7	53.7	53.7	53.7	53.7
53																	
54																	
55	**Side gate use**																
56	First side gate	30-Jul	30-Jul	30-Jul	30-Jul	30-Jul	30-Jul	30-Jul	30-Jul	16-Oct	16-Oct	16-Oct	16-Oct	15-Oct	15-Oct	15-Oct	15-Oc
57	Full side gate	29-Aug	30-Aug	29-Aug	27-Aug	27-Aug	27-Aug	27-Aug	27-Aug	31-Dec	31-Dec	31-Dec	31-Dec	31-Dec	31-Dec	31-Dec	31-Dec
58																	
59																	
60																	
61	Martin	0.2571	0.251781	0.260484	0.267669	0.268977	0.268977	0.268977	0.268977	0.809948	0.804362	0.808502	0.812448	0.813711	0.813711	0.813711	0.813711
62	Anderson	0.102036	0.095777	0.10678	0.107293	0.110339	0.110339	0.110339	0.110339	0.928243	0.923744	0.927138	0.930072	0.929761	0.929761	0.929761	0.929761

Results Tabs

- Model simulation results are organized by tab and sorted based on subject of tab. Columns are described below:

	Rank	Scenario	Martin	Anderson	EOS CWP	1st side g8	all side g8
Description	Priority Sorted by Tab Name	Temp Target Scenario	Martin Model results TDM	Martin Model results TDM	End of Sep Cold Water Pool Volume less than 56°F	Timing of First TCD Side Gate Use	Timing of Full TCD Side Gate Use
Units	N/A	Number	%	%	AF	Date	Date

Results continued

- Remaining columns are described below:

	Apr ave	May ave	Jun ave	Jul ave	Aug ave	Sep ave	Oct ave
Description	Monthly average water temp. at CCR	Monthly average water temp. at CCR	Monthly average water temp. at CCR	Monthly average water temp. at CCR	Monthly average water temp. at CCR	Monthly average water temp. at CCR	Monthly average water temp. at CCR
Units	°F	°F	°F	°F	°F	°F	°F

Example: Martin Sorted Tab

Rank	Scenario	Martin	Anderson	EOS CWP	1st side g8	all side g8	Apr avg	May avg	Jun avg	Jul avg	Aug avg	Sep avg	Oct avg
1	2	25%	10%	442883	7/30/2020	8/30/2020	56.0	53.4	53.0	53.4	53.3	55.8	57.3
2	71	25%	9%	469114	7/30/2020	10/27/2020	54.1	54.4	53.0	53.4	53.3	55.7	57.2
3	50	26%	10%	449714	7/30/2020	10/23/2020	54.1	53.4	53.1	53.4	53.3	55.8	57.3
4	24	26%	10%	442759	7/30/2020	8/30/2020	54.1	53.9	53.0	53.4	53.3	55.8	57.3
5	67	26%	10%	442759	7/30/2020	8/30/2020	54.1	53.9	53.0	53.4	53.3	55.8	57.3
6	25	26%	9%	455200	7/30/2020	8/30/2020	54.1	54.4	53.0	53.4	53.3	55.7	57.2
7	26	26%	9%	455200	7/30/2020	8/30/2020	54.1	54.4	53.0	53.4	53.3	55.7	57.2
8	27	26%	9%	455200	7/30/2020	8/30/2020	54.1	54.4	53.0	53.4	53.3	55.7	57.2
9	28	26%	9%	455200	7/30/2020	8/30/2020	54.1	54.4	53.0	53.4	53.3	55.7	57.2
10	319	26%	10%	461046	7/30/2020	10/18/2020	54.1	54.4	53.2	53.4	53.3	55.7	57.2
11	320	26%	10%	461046	7/30/2020	10/18/2020	54.1	54.4	53.2	53.4	53.3	55.7	57.2
12	321	26%	10%	461046	7/30/2020	10/18/2020	54.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	57.2
13	322	26%	10%	461046	7/30/2020	10/18/2020	54.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	57.2
14	68	26%	9%	455200	7/30/2020	10/17/2020	54.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	57.2
15	166	26%	9%	455200	7/30/2020	10/17/2020	54.1	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	57.2
16	167	26%	9%	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	57.2
17	168	26%	9%	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	57.2
18	169	26%	9%	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	57.2
19	69	26%	9%	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	57.2
20	70	26%	9%	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	57.2
21	277	26%	10%	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	57.2
22	278	26%	10%	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	57.2
23	279	26%	10%	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	57.2
24	280	26%	10%	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	57.2
25	217	26%	10%	[illegible]	[illegible]	[illegible]	[illegible]	54.4	53.2	53.4	53.3	55.7	57.2

Column B is the Scenario; details can be found in the TTSP Scenario Tab Row 3

Column C contains the Sorted Parameter and changes based on the Tab subject

Reclamation Requests your Technical Assistance

- Reclamation will propose a Temperature Management Plan for 2020, we will consider your feedback in this decision
- Review the set of simulated temperature and temperature dependent mortality outcomes
- Provide suggestions if a "Temperature Target Scenario" you are interested in is not represented
- Please explain the criteria used to select your best scenario
- Please select your best scenario for this year's temperature management plan
- In addition, please choose a scenario that: minimizes TDM, achieves approximately 460 TAF EOS CWP <56°F to ensure fall temperatures are approximately 56°F at CCR, and delays opening the first side gate until as late as possible to ensure fall temperatures are approximately 56[illegible] CCR

Reclamation Requests your Technical Assistance

- Your response is requested by noon on Wednesday, April 22

Questions

- How does the TCD configuration influence early and late season temperatures? Example: The "Temperature Target Scenario" for Tier 2 looks like:

Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
T2																								
Week	16-May	23-May	30-May	6-Jun	13-Jun	20-Jun	27-Jun	4-Jul	11-Jul	18-Jul	25-Jul	1-Aug	8-Aug	15-Aug	22-Aug	29-Aug	5-Sep	12-Sep	19-Sep	26-Sep	3-Oct	10-Oct	17-Oct	24-Oct

- But the simulated Temperature Results look like:

Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
T2																								
Week	16-May	23-May	30-May	6-Jun	13-Jun	20-Jun	27-Jun	4-Jul	11-Jul	18-Jul	25-Jul	1-Aug	8-Aug	15-Aug	22-Aug	29-Aug	5-Sep	12-Sep	19-Sep	26-Sep	3-Oct	10-Oct	17-Oct	24-Oct

If Shasta storage elevations are lower than 1035 ft, then warmer temperatures can't be achieved through the upper Temperature Control Device (TCD) gates due to structural restrictions; the model delivers cooler water available through the TCD middle gates instead.

- The "Temperature Target Scenario" for Tier 2 looks like:

Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
T2																								
Week	16-May	23-May	30-May	6-Jun	13-Jun	20-Jun	27-Jun	4-Jul	11-Jul	18-Jul	25-Jul	1-Aug	8-Aug	15-Aug	22-Aug	29-Aug	5-Sep	12-Sep	19-Sep	26-Sep	3-Oct	10-Oct	17-Oct	24-Oct

- But the simulated Temperature Results look like:

Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
T2																								
Week	16-May	23-May	30-May	6-Jun	13-Jun	20-Jun	27-Jun	4-Jul	11-Jul	18-Jul	25-Jul	1-Aug	8-Aug	15-Aug	22-Aug	29-Aug	5-Sep	12-Sep	19-Sep	26-Sep	3-Oct	10-Oct	17-Oct	24-Oct

If simulated cold water is exhausted prematurely, temperatures warm even if the "target scenario" desired cooler temperatures.

Questions

- Some of the “Temperature Target Scenarios” don’t identify themselves as Tier 2 or Tier 3, what are they?

- Some of the Scenarios were included to explore the “feasible solution space” and were retained to help define the Tiers.

Questions

- Why is the monthly average temperature performance in September and October warmer than 56°F even when the EOS CWP <56°F is at or greater than 460 TAF?

- The upper 90% Confidence Interval (CI) of the historical relationship using EOS CWP <56°F and CCR temperature performance is applied Sept15-Oct31. The 90% CI for 460 TAF is approximately 57.2 °F

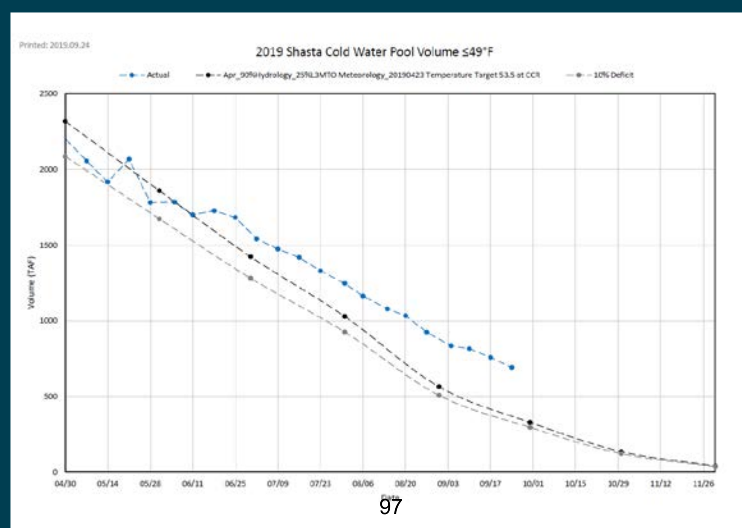
Questions

- Should Upper Sac River temperatures be warmer than 56°F prior to May 15?
- What are the benefits?
- How warm is too warm?

- Reclamation's Proposed Action p4-40: "Spring Management of Spawning Locations: Reclamation will coordinate with NMFS to establish experiments to refine the state of the science and determine if keeping water colder earlier induces earlier spawning, or if keeping April/May Sacramento River temperatures warmer induces later spawning."

Questions

- **Will Reclamation monitor the performance of the temperature management plan?**
- **Yes, as in past years, Reclamation will track the cold water pool through time comparing the actual to the expected performance. If the cold water pool exceeds a 10% deficit of the expected, Reclamation will reconvene the SRTTG for a temperature management plan adjustment.**



Questions

- Is this the final definition of Tiers and process?
- No, Reclamation expects this will evolve as more feedback is received.

Attachment 13

Temperature Tier Selection Protocol Excel Spreadsheet

See attached file: TTSP_20200518_FinalProposal.xlsm