Sacramento River Temperature Task Group

Thursday, October 22, 2020 1:00 pm – 3:00 pm

Conference Call:

+1(623)4049000

Meeting ID: 1497574502# (US West)

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

Agenda

1:00 pm Introductions

1:10 pm Purpose and Objective

1. Build a common understanding of the distinctions between and assumptions in the Temperature Dependent Mortality Models
2. Generate options for calculating the end of year morality numbers given the distinctions between the models
3. Build agreement around a recommended approach.

1:12 pm Prior Action Items

1:15 pm Current Operations and Temperature Management

1:45 pm Upper Sacramento Scheduling Team – Recommendations for Final Fall Flows Coordination Schedule

2:00 pm Temperature Dependent Mortality

- Review and collaboratively update the Table of Temperature Dependent Modeling Assumptions
- Discuss Calculating End-of-Year Temperature Dependent Mortality

2:55 pm Review Action Items

2:58 pm Next Meeting

Oct 28, 11- 12:00 pm - Weekly SRTTG – Temperature Dependent Mortality

Nov 4 , 11- 12:00 pm - Weekly SRTTG – Temperature Dependent Mortality

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

DAILY CVP WATER SUPPLY REPORT

OCTOBER 20, 2020

RUN DATE: October 21, 2020

RESERVOIR RELEASES IN CUBIC FEET/SECOND

RESERVOIR	DAM	WY 2020	WY 2021	15 YR MEDIAN
TRINITY	LEWISTON	323	292	302
SACRAMENTO	KESWICK	7,396	5,040	6,188
FEATHER	OROVILLE (SWP)	2,450	2,450	2,400
AMERICAN	NIMBUS	2,688	1,510	1,510
STANISLAUS	GOODWIN	824	401	824
SAN JOAQUIN	FRIANT	365	0	350

STORAGE IN MAJOR RESERVOIRS IN THOUSANDS OF ACRE-FEET

RESERVOIR	CAPACITY	15 YR AVG	WY 2020	WY 2021	% OF 15 YR AVG
TRINITY	2,448	1,357	1,986	1,316	97
SHASTA	4,552	2,338	3,337	2,127	91
FOLSOM	977	419	639	381	91
NEW MELONES	2,420	1,340	2,017	1,512	113
FED. SAN LUIS	966	333	380	386	116
TOTAL NORTH CVP	11,363	5,787	8,359	5,722	99
MILLERTON	520	237	291	0	0
OROVILLE (SWP)	3,538	1,632	2,103	1,556	95

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

RESERVOIR	CURRENT WY 2021	WY 1977	WY 1983	15 YR AVG	% OF 15 YR AVG
TRINITY	1	5	5	7	23
SHASTA	126	151	154	131	97
FOLSOM	34	41	68	39	87
NEW MELONES	18	----	33	28	65
MILLERTON	50	21	95	37	135

ACCUMULATED PRECIPITATION FOR WATER YEAR TO DATE IN INCHES

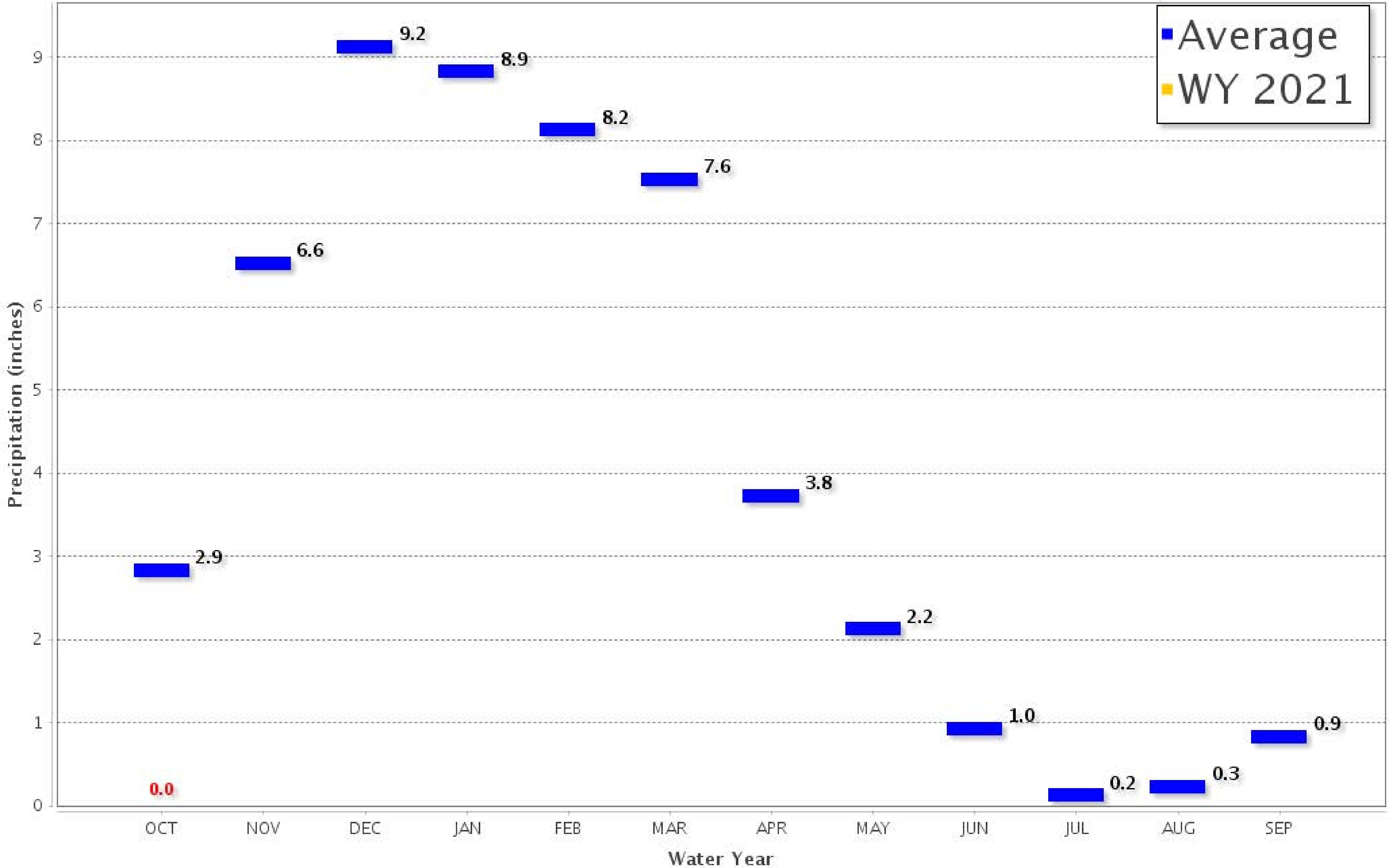
RESERVOIR	CURRENT WY 2021	WY 1977	WY 1983	AVG (N YRS)	% OF AVG	LAST 24 HRS
TRINITY AT FISH HATCHERY	0.10	0.13	0.45	0.82 (58)	12	0.00
SACRAMENTO AT SHASTA DAM	0.20	0.07	0.26	1.34 (63)	15	0.00
AMERICAN AT BLUE CANYON	0.00	0.87	0.73	1.57 (45)	0	0.00
STANISLAUS AT NEW MELONES	0.00	----	0.30	0.63 (42)	0	0.00
SAN JOAQUIN AT HUNTINGTON LK	0.00	1.20	0.00	1.12 (45)	0	0.00

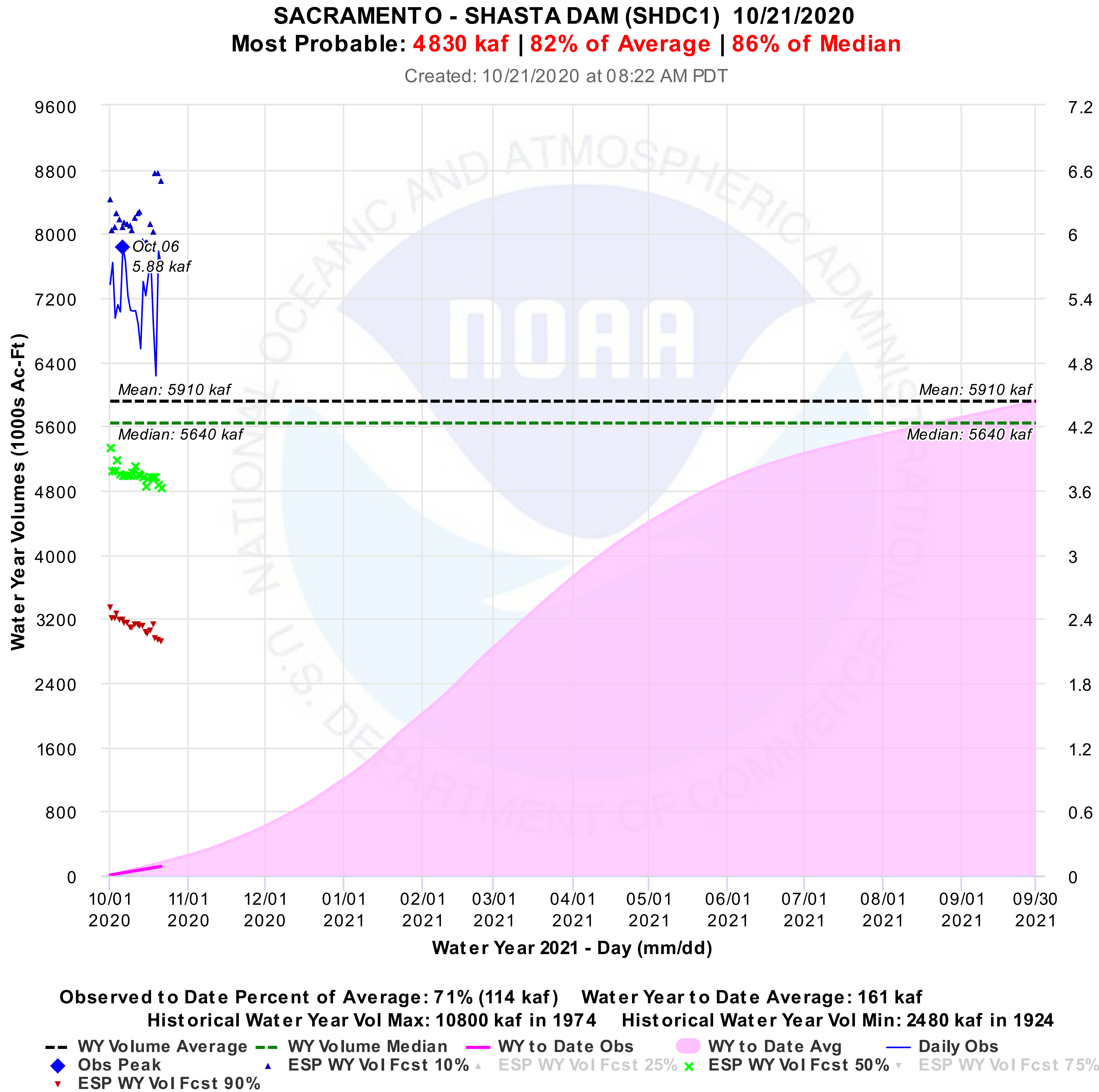
Northern Sierra 8-Station

Precipitation Index for Water Year 2021 - Updated on October 21, 2020 02:48 PM

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

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





SACRAMENTO - SHASTA DAM (SHDC1) 10/21/2020
Most Probable: 4830 kaf | 82% of Average | 86% of Median
Created: 10/21/2020 at 08:22 AM PDT
Water Year Volumes (1000s Ac-Ft)
Daily Observed Volumes (1000s Ac-Ft)
Oct 06
5.88 kaf
Mean: 5910 kaf
Median: 5640 kaf
Water Year 2021 - Day (mm/dd)
Observed to Date Percent of Average: 71% (114 kaf)
Water Year to Date Average: 161 kaf
Historical Water Year Vol Max: 10800 kaf in 1974
Historical Water Year Vol Min: 2480 kaf in 1924
WY Volume Average
WY Volume Median
WY to Date Obs
WY to Date Avg
Daily Obs
Obs Peak
ESP WY Vol Fcst 10%
ESP WY Vol Fcst 25%
ESP WY Vol Fcst 50%
ESP WY Vol Fcst 75%
ESP WY Vol Fcst 90%

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

Storage/Release Management Conditions:

- Reservoir Inflow Uncertainty: Shorter term forecasts (8-14 day) suggest below normal chance of precipitation
- Longer term forecasts (one-month outlook) suggest equal chance of above/below normal precipitation
- Observed Shasta inflow for October is tracking about equal to the 90% historical inflow exceedance probability estimate for the month (200 TAF)
- Releases from Keswick Dam: Current releases are holding at 5,000 cfs to maintain Delta requirements

Temperature Management:

- Temperature management: Active draw on cold water pool for temperature management
- Selective withdrawal: Using cold-water-pool reserves. Both Side Gates were opened as of October 15, 2020
- Meteorological Uncertainty: Shorter term forecasts (8-14 day) suggest above normal temperatures
- Longer term forecasts (one-month outlook) suggest 30%-40%o probability of above normal temperatures

Resources:

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

CVP Northern System Operation Outlooks: Draft October 2020

90% Runoff Exceedance Outlook

End of Month Storage/Elevation	Oct	Nov	Dec	Jan	Feb	Mar
Shasta Volume (TAF)	2085	2066	2131	2259	2432	2722
Shasta Elevation (Feet)	962	961	965	972	981	995

Monthly Average River Release	Oct	Nov	Dec	Jan	Feb	Mar
Sacramento (CFS)	5760	4490	3330	3250	3850	3850
Clear Creek (CFS)	200	200	200	200	200	275

Trinity Diversions	Oct	Nov	Dec	Jan	Feb	Mar
Carr Power Plant (TAF)	27	30	21	15	10	7
Spring Creek PP (TAF)	45	20	12	10	10	10

50% Runoff Exceedance Outlook

End of Month Storage/Elevation	Oct	Nov	Dec	Jan	Feb	Mar
Shasta Volume (TAF)	2129	2174	2349	2746	3328	3882
Shasta Elevation (Feet)	965	967	977	996	1022	1043

Monthly Average River Release	Oct	Nov	Dec	Jan	Feb	Mar
Sacramento (CFS)	5700	4500	3500	3250	3250	4500
Clear Creek (CFS)	200	200	200	400	200	200

Trinity Diversions	Oct	Nov	Dec	Jan	Feb	Mar
Carr Power Plant (TAF)	26	20	9	0	2	1
Spring Creek PP (TAF)	45	15	12	10	35	26

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

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

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

CVP releases represent monthly averages.

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

Estimated CVP Operations 90% Exceedance

Storages

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

			Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Trinity		**1354**	**1310**	**1274**	**1256**	**1254**	**1282**	**1342**	**1398**	**1425**	**1331**	**1214**	**1061**	**910**
	Elev.		2287	2283	2282	2281	2284	2290	2294	2297	2289	2278	2262	2245
Whiskeytown		**235**	**206**	**206**	**206**	**206**	**206**	**206**	**238**	**238**	**238**	**238**	**238**	**238**
	Elev.		1199	1199	1199	1199	1199	1199	1209	1209	1209	1209	1209	1209
Shasta		**2200**	**2085**	**2066**	**2131**	**2259**	**2432**	**2722**	**2774**	**2608**	**2331**	**1992**	**1727**	**1601**
	Elev.		962	961	965	972	981	995	997	990	976	957	941	932
Folsom		**423**	**364**	**332**	**308**	**302**	**342**	**453**	**570**	**636**	**560**	**447**	**364**	**319**
	Elev.		398	393	389	387	394	410	425	433	424	410	398	390
New Melones		**1519**	**1479**	**1481**	**1485**	**1488**	**1488**	**1486**	**1449**	**1391**	**1304**	**1213**	**1139**	**1097**
	Elev.		1001	1001	1001	1002	1002	1002	998	991	981	970	961	955
San Luis		**363**	**453**	**578**	**700**	**886**	**860**	**814**	**732**	**589**	**370**	**262**	**195**	**299**
	Elev.		455	469	495	518	506	498	485	465	427	396	364	374
Total			5897	5937	6086	6395	6610	7023	7161	6887	6133	5366	4723	4463

Monthly River Releases (TAF/cfs)

		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Trinity	TAF	23	18	18	18	17	18	36	92	47	28	53	52
	cfs	**373**	**300**	**300**	**300**	**300**	**300**	**600**	**1,498**	**783**	**450**	**857**	**870**
Clear Creek	TAF	12	12	12	12	11	17	12	16	11	9	9	9
	cfs	**200**	**200**	**200**	**200**	**200**	**275**	**200**	**265**	**190**	**150**	**150**	**150**
Sacramento	TAF	354	267	205	200	214	237	405	510	595	615	523	387
	cfs	**5760**	**4490**	**3330**	**3250**	**3850**	**3850**	**6800**	**8300**	**10000**	**10000**	**8500**	**6500**
American	TAF	98	74	77	69	63	61	89	107	149	154	123	89
	cfs	**1602**	**1250**	**1250**	**1125**	**1132**	**1000**	**1500**	**1740**	**2501**	**2503**	**2000**	**1500**
Stanislaus	TAF	39	12	12	13	12	12	27	25	9	9	9	9
	cfs	**635**	**200**	**200**	**213**	**214**	**200**	**460**	**400**	**150**	**150**	**150**	**150**

Trinity Diversions (TAF)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Carr PP	27	30	21	15	10	7	44	25	99	100	101	100
Spring Crk. PP	**45**	**20**	**12**	**10**	**10**	**10**	**15**	**15**	**90**	**90**	**90**	**90**

Delta Summary (TAF)

		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Tracy		220	182	158	225	44	50	45	46	50	203	191	258
USBR Banks		0	0	0	0	0	0	0	0	0	0	0	29
Contra Costa		10.5	12.6	13.8	13.7	10.5	10.5	9.5	9.5	9.5	7.4	8.3	9.5
Total USBR		231	195	172	239	55	61	54	56	60	210	199	297
COA Balance		112	38	40	40	-9	-136	-99	-38	11	10	24	20
Vernalis	TAF	98	74	75	76	82	98	105	105	40	42	37	43
Vernalis	cfs	1595	1242	1225	1238	1475	1599	1767	1707	671	687	605	722
Old/Middle River Std.													
Old/Middle R. calc.		-3,348	-3,482	-4,458	-5,027	-1,084	-1,355	-881	-904	-1,447	-3,542	-3,190	-5,087
Computed DOI		4002	4505	4506	6361	11400	11403	9245	7109	7094	3839	3497	3009
Excess Outflow		0	0	0	1854	0	0	0	0	0	0	0	0
% Export/Inflow		44%	44%	55%	53%	11%	13%	11%	13%	12%	34%	33%	52%
% Export/Inflow std.		65%	65%	65%	65%	45%	35%	35%	35%	35%	65%	65%	65%

Hydrology

		Trinity	Shasta	Folsom	New Melones
Water Year Inflow (TAF)		600	3,500	1,200	440
Year to Date + Forecasted	% of mean	50%	63%	44%	42%

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.

Estimated CVP Operations 50% Exceedance

Storages

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

			Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Trinity		**1354**	**1316**	**1308**	**1338**	**1403**	**1513**	**1642**	**1756**	**1620**	**1494**	**1347**	**1199**	**1051**
	Elev.		2287	2286	2289	2295	2304	2315	2323	2313	2303	2290	2276	2261
Whiskeytown		**235**	**206**	**206**	**206**	**206**	**206**	**206**	**238**	**238**	**238**	**238**	**238**	**238**
	Elev.		1199	1199	1199	1199	1199	1199	1209	1209	1209	1209	1209	1209
Shasta		**2200**	**2129**	**2174**	**2349**	**2746**	**3328**	**3882**	**4188**	**4252**	**3947**	**3478**	**3164**	**3063**
	Elev.		965	967	977	996	1022	1043	1054	1057	1046	1028	1015	1010
Folsom		**423**	**406**	**406**	**426**	**500**	**556**	**744**	**892**	**952**	**930**	**734**	**597**	**591**
	Elev.		404	404	407	417	423	444	458	464	462	443	428	427
New Melones		**1519**	**1489**	**1506**	**1530**	**1562**	**1616**	**1675**	**1658**	**1717**	**1727**	**1644**	**1576**	**1539**
	Elev.		1002	1004	1006	1010	1015	1021	1020	1026	1027	1018	1011	1007
San Luis		**363**	**450**	**591**	**803**	**966**	**966**	**966**	**886**	**735**	**707**	**643**	**625**	**714**
	Elev.		451	472	510	533	545	544	533	515	514	507	501	506
Total			5996	6191	6651	7384	8185	9114	9619	9514	9043	8084	7397	7197

Monthly River Releases (TAF/cfs)

		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Trinity	TAF	23	18	18	18	17	18	36	258	126	68	53	52
	cfs	**373**	**300**	**300**	**300**	**300**	**300**	**600**	**4,189**	**2,120**	**1,102**	**857**	**870**
Clear Creek	TAF	12	12	12	25	11	12	12	16	12	9	9	9
	cfs	**200**	**200**	**200**	**400**	**200**	**200**	**200**	**265**	**200**	**150**	**150**	**150**
Sacramento	TAF	350	268	215	200	180	277	339	492	678	768	596	387
	cfs	**5700**	**4500**	**3500**	**3250**	**3250**	**4500**	**5700**	**8000**	**11400**	**12500**	**9700**	**6500**
American	TAF	93	89	92	77	205	123	274	400	238	307	227	107
	cfs	**1506**	**1500**	**1500**	**1250**	**3700**	**2000**	**4600**	**6500**	**4003**	**5000**	**3700**	**1800**
Stanislaus	TAF	39	12	12	14	13	12	91	76	22	15	12	12
	cfs	**635**	**200**	**200**	**226**	**229**	**200**	**1537**	**1242**	**363**	**250**	**200**	**200**

Trinity Diversions (TAF)

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Carr PP	26	20	9	0	2	1	55	92	96	99	100	99
Spring Crk. PP	**45**	**15**	**12**	**10**	**35**	**26**	**35**	**90**	**90**	**90**	**90**	**90**

Delta Summary (TAF)

		Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
Tracy		220	200	250	206	75	100	54	57	256	265	265	260
USBR Banks		0	0	0	0	0	0	0	0	0	0	0	30
Contra Costa		16.8	18.4	18.3	14.0	14.0	12.7	12.7	12.7	9.8	11.1	12.7	14.0
Total USBR		237	218	268	220	89	113	66	70	266	276	278	304
COA Balance		44	-12	-12	-12	-12	-12	-12	-12	37	99	132	132
Vernalis	TAF	108	83	83	93	112	57	169	134	69	54	49	54
Vernalis	cfs	1758	1393	1355	1511	2012	932	2844	2188	1153	884	802	906
Old/Middle River Std.													
Old/Middle R. calc.	cfs	-3,028	-4,887	-6,410	-5,046	-5,079	-2,710	-630	-944	-5,544	-5,867	-5,236	-5,321
Computed DOI		4002	4505	7662	13762	20388	21945	17398	15145	7396	6507	4002	4370
Excess Outflow		0	0	3156	7760	8987	10541	6287	6653	0	0	0	1362
% Export/Inflow		41%	53%	51%	33%	25%	12%	7%	8%	40%	40%	44%	48%
% Export/Inflow std.		65%	65%	65%	65%	45%	35%	35%	35%	35%	65%	65%	65%

Hydrology

	Trinity	Shasta	Folsom	New Melones
Water Year Inflow (TAF)	1050	5,100	2,600	1030
Year to Date + Forecasted % of mean	87%	92%	96%	97%

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CVP releases or export values represent monthly averages.
CVP Operations are updated monthly as new hydrology information is made available December through May.

10/20/2020

CVP Oct 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 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 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 and export values are represented as monthly averages. Actual operations are based on real-time conditions.

Inputs:

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

Assumptions:

- Reservoir inflows are adjusted to date of forecasting to approximate actual conditions
- SWRCB D1641 permit conditions for outflow and salinity requirements are met for compliance
- Coordinated Operations Agreement (COA) classification: Dry – CVP 65% Sharing responsibility for meeting Sacramento Valley inbasin use with storage withdrawals during balanced water conditions
- The Delta Outflow requirement for October is 4,000 cfs. The outflow requirement for November is 4,500 cfs.
- Sacramento River water year type classification for requirements: Dry

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

Notes:

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

Northern CVP Water Temperature Report

October - 2020

BUREAU OF RECLAMATION

All Data in this Report is Preliminary and Subject to Change

DATE	Mean Daily Water Temperatures (°F)														Mean Daily Release (CFS)			Mean Daily Air Temperatures (°F)		
	TCD[1]	SHD	SPP[1]	KWK	SAC	CCR[2]	BSF	JLF	BND	RDB	IGO[3]	LWS	DGC	NFH	Shasta Generation	Spring Creek P.P.	Keswick Total	RDD	BSF	RDB
Sep	51.9	50.7	55.6	52.8	53.4	53.9	55.1	56.3	57.1	58.0	56.9	49.6	53.7	57.5	5097	1612	7075	78.1	71.7	74.3
10/01	53.7	? 52.7	54.3	53.6	54.1	**54.6**	55.7	56.6	57.4	58.1	56.1	? 48.9	52.5	55.1	4509	1935	6863	↑ 87.0	73.2	78.0
10/02	53.4	52.5	? 54.3	53.7	54.1	**54.6**	55.5	56.5	57.3	58.2	55.7	48.9	52.1	55.0	5104	1672	6853	78.5	69.1	72.8
10/03	53.5	? 52.9	54.2	53.7	54.2	**54.6**	55.5	56.4	57.1	57.7	55.8	49.1	52.0	55.1	4205	1816	6850	79.0	68.7	70.7
10/04	53.5	52.9	54.2	53.8	54.1	**54.4**	55.1	56.0	56.7	57.5	55.1	49.1	51.7	54.4	5194	1833	6827	73.0	63.9	67.9
10/05	53.6	52.9	54.5	53.6	54.2	**54.6**	55.3	56.0	56.6	57.1	55.2	49.0	51.1	53.8	5737	328	6649	73.0	64.0	69.4
10/06	53.9	53.3	54.4	53.6	54.0	**54.4**	55.2	56.0	56.6	57.3	54.9	48.9	51.1	53.6	5651	527	6651	70.0	62.6	68.1
10/07	54.5	? 53.8	54.4	53.7	54.0	**54.4**	55.1	55.9	56.6	57.2	54.8	49.0	51.0	53.4	5931	380	6650	69.0	62.0	66.9
10/08	54.6	53.8	54.4	54.2	54.3	**54.5**	54.9	55.5	56.2	56.7	54.7	49.2	51.2	53.4	5609	716	6689	67.5	59.1	61.1
10/09	54.8	? 54.3	54.4	54.3	54.6	**55.1**	55.5	? 56.0	56.5	56.6	54.8	49.4	51.2	53.5	4899	658	6056	63.5	58.7	60.4
10/10	54.9	54.4	54.5	54.6	54.6	**55.0**	55.6	56.3	57.0	57.4	54.8	49.6	51.8	53.9	5298	445	6027	64.0	60.0	61.9
10/11	54.6	54.4	54.5	54.6	54.9	**55.5**	55.8	56.3	56.8	57.1	54.9	49.6	51.1	53.8	5262	674	6045	67.0	60.4	65.8
10/12	? 54.6	? 54.2	? 54.6	54.8	55.1	**55.6**	56.0	56.7	57.2	57.6	55.6	49.9	52.0	54.2	5202	774	6044	68.0	61.8	66.7
10/13	54.8	54.4	54.7	54.7	55.1	**55.8**	56.5	57.3	57.8	58.2	56.0	50.0	53.0	55.3	5264	674	6054	72.0	65.8	70.8
10/14	54.4	54.2	54.7	55.0	55.4	**56.0**	56.8	57.6	58.2	58.8	56.1	50.1	53.6	56.3	5017	677	6043	73.0	69.8	75.8
10/15	53.4	53.4	54.7	55.0	55.4	**56.0**	56.6	57.4	58.1	58.6	# -	50.3	52.7	55.6	4744	677	6044	82.5	79.2	80.7
10/16	53.2	? 53.1	54.7	54.8	55.4	**56.1**	? 56.9	57.6	58.2	58.7	# -	50.4	52.7	55.0	4600	840	5815	↑ 84.5	77.1	81.1
10/17	53.3	? 53.0	54.8	54.1	54.9	**55.6**	56.7	57.7	58.5	59.2	# -	50.4	53.1	55.3	4293	835	5611	83.5	74.7	77.7
10/18	53.5	53.2	54.8	53.8	54.5	**55.1**	56.2	57.2	58.0	59.0	# -	50.3	53.3	55.8	4385	748	5410	↑ 76.0	67.8	71.5
10/19	53.7	53.3	54.9	53.9	54.4	**55.0**	55.8	56.6	57.3	58.2	# -	50.3	52.9	55.8	4068	825	5213	72.5	64.9	69.2
10/20	53.8	53.6	54.9	54.0	54.6	**55.3**	56.0	56.8	57.3	57.8	# -	50.4	52.4	55.2	4053	986	5040	77.0	68.7	74.3
10/21																				
10/22																				
10/23																				
10/24																				
10/25																				
10/26																				
10/27																				
10/28																				
10/29																				
10/30																				
10/31																				
Oct	54.0	53.5	54.5	54.2	54.6	55.1	55.8	56.6	57.3	57.8	55.3	49.6	52.1	54.7	4951	901	6172	74.0	66.6	70.5
														Total CFS	99025	18020	123434			
														Total AF	196412	35742	244826			

Legend

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

Notes

[1] Temperatures are weighted averages based on individual penstock flow and temperature
Highlighted cells in the TCD column indicate a TCD change was made on that day
[2] Current Sacramento River control point (see page 4 for more details)
[3] IGO thermistor vandalized and out of commission as of 7/29/2020. Data is from nearby temperature logger. A bias has been applied to better represent the IGO location.

DATE	Redding (RDD) Daily Air Temperatures (°F)																																			
	Actual			**Forecasted**																																
	Previous Day			Current Day			1 Day			2 Days			3 Days			4 Days			5 Days			6 Days			7 Days			8 Days			9 Days			10 Days		
	↓	↑	Avg	↓	↑	Avg	↓	↑	Avg	↓	↑	Avg	↓	↑	Avg	↓	↑	Avg	↓	↑	Avg	↓	↑	Avg	↓	↑	Avg	↓	↑	Avg	↓	↑	Avg	↓	↑	Avg
10/01	57	103	80.0	69	103	86.0	61	100	80.5	61	100	80.5	59	90	74.5	55	92	73.5	56	93	74.5	56	89	72.5	54	85	69.5	56	76	66.0	56	72	64.0	53	77	65.0
10/02	68	**106**	87.0	60	103	81.5	61	101	81.0	59	92	75.5	58	94	76.0	56	94	75.0	55	90	72.5	52	83	67.5	54	78	66.0	57	70	63.5	52	75	63.5	51	76	63.5
10/03	57	100	78.5	60	99	79.5	56	93	74.5	54	92	73.0	54	93	73.5	52	88	70.0	52	83	67.5	51	80	65.5	56	72	64.0	50	75	62.5	51	73	62.0	49	73	61.0
10/04	58	100	79.0	56	96	76.0	53	95	74.0	53	94	73.5	53	88	70.5	52	76	64.0	51	72	61.5	54	69	61.5	53	75	64.0	49	72	60.5	53	77	65.0	49	81	65.0
10/05	56	90	73.0	51	93	72.0	51	92	71.5	52	89	70.5	51	78	64.5	51	70	60.5	52	69	60.5	47	73	60.0	53	84	68.5	54	85	69.5	54	86	70.0	53	84	68.5
10/06	51	95	73.0	49	93	71.0	50	90	70.0	51	80	65.5	51	71	61.0	51	67	59.0	46	70	58.0	49	77	63.0	55	89	72.0	56	84	70.0	52	81	66.5	48	83	65.5
10/07	47	93	70.0	50	91	70.5	50	81	65.5	49	78	63.5	51	68	59.5	45	72	58.5	48	79	63.5	50	82	66.0	51	86	68.5	54	85	69.5	50	83	66.5	50	83	66.5
10/08	48	90	69.0	53	79	66.0	48	78	63.0	52	73	62.5	48	77	62.5	50	85	67.5	51	86	68.5	52	87	69.5	61	93	77.0	58	89	73.5	53	86	69.5	52	81	66.5
10/09	52	83	67.5	49	79	64.0	55	70	62.5	50	77	63.5	47	85	66.0	49	87	68.0	51	87	69.0	54	88	71.0	59	92	75.5	57	89	73.0	54	85	69.5	54	80	67.0
10/10	48	79	63.5	58	70	64.0	45	77	61.0	46	83	64.5	51	89	70.0	55	90	72.5	56	92	74.0	57	93	75.0	56	93	74.5	58	82	70.0	48	72	60.0	47	71	59.0
10/11	56	72	64.0	53	79	66.0	46	83	64.5	49	87	68.0	52	87	69.5	57	91	74.0	55	91	73.0	53	91	72.0	54	93	73.5	54	85	69.5	51	80	65.5	51	81	66.0
10/12	52	82	67.0	48	84	66.0	49	88	68.5	53	87	70.0	58	92	75.0	57	92	74.5	53	90	71.5	51	85	68.0	52	88	70.0	53	83	68.0	50	78	64.0	50	76	63.0
10/13	47	89	68.0	53	90	71.5	53	90	71.5	56	91	73.5	57	93	75.0	55	91	73.0	52	84	68.0	49	82	65.5	52	85	68.5	51	82	66.5	45	80	62.5	46	78	62.0
10/14	53	91	72.0	59	91	75.0	58	91	74.5	57	93	75.0	57	92	74.5	52	87	69.5	50	85	67.5	49	83	66.0	52	89	70.5	53	81	67.0	48	78	63.0	51	77	64.0
10/15	56	90	73.0	72	93	82.5	58	94	76.0	57	93	75.0	52	87	69.5	49	83	66.0	50	83	66.5	47	79	63.0	51	88	69.5	52	80	66.0	43	79	61.0	45	77	61.0
10/16	72	93	82.5	75	97	86.0	58	93	75.5	54	89	71.5	52	88	70.0	52	87	69.5	52	85	68.5	52	82	67.0	51	86	68.5	51	83	67.0	49	78	63.5	49	76	62.5
10/17	71	**98**	84.5	73	97	85.0	59	93	76.0	53	90	71.5	54	90	72.0	56	89	72.5	55	85	70.0	49	83	66.0	47	81	64.0	49	74	61.5	40	76	58.0	42	76	59.0
10/18	69	98	83.5	58	95	76.5	55	92	73.5	56	91	73.5	55	87	71.0	51	80	65.5	46	78	62.0	46	73	59.5	48	79	63.5	46	75	60.5	42	78	60.0	45	76	60.5
10/19	57	**95**	76.0	61	89	75.0	57	90	73.5	54	84	69.0	47	77	62.0	47	79	63.0	45	72	58.5	43	74	58.5	41	83	62.0	49	81	65.0	45	78	61.5	45	76	60.5
10/20	52	93	72.5	61	92	76.5	56	87	71.5	46	75	60.5	45	81	63.0	44	77	60.5	41	73	57.0	40	79	59.5	47	87	67.0	50	81	65.5	44	77	60.5	44	75	59.5
10/21	60	94	77.0	71	87	79.0	49	76	62.5	46	81	63.5	44	75	59.5	38	64	51.0	36	68	52.0	41	75	58.0	43	85	64.0	49	79	64.0	42	76	59.0	42	75	58.5
10/22																																				
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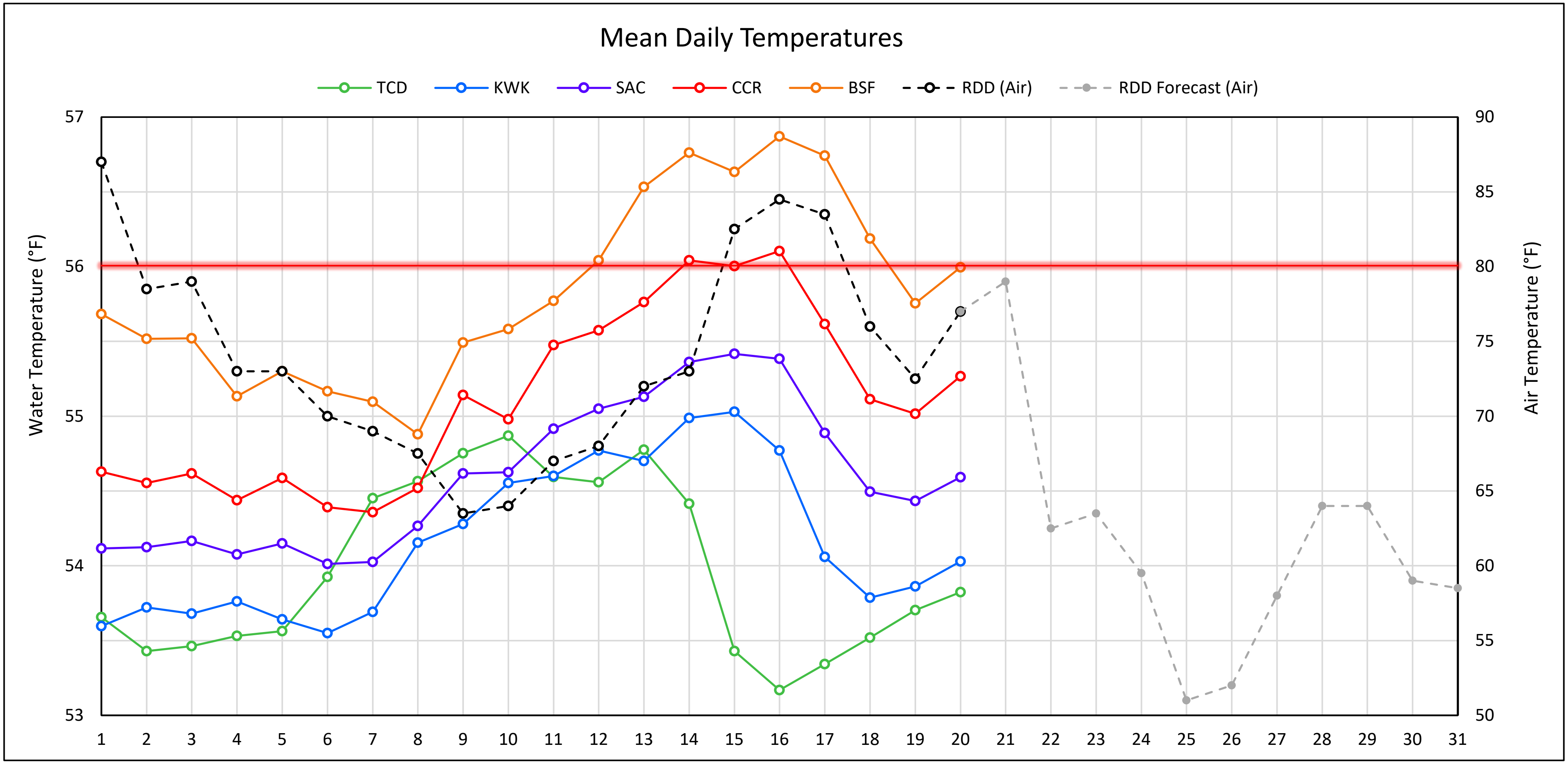
10/29																																				
10/30																																				
10/31																																				

Web Links

10-Day Min/Max Forecast
Previous Days Min/Max Actuals

Legend

NR = Forecasted temperatures not recorded
100 = Previous day actual temperatures in red and bolded indicate a record temperature for that date



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

Water Right Temperature Control Points				
River	Point	Temp. (°F)	Begin Date	End Date
Sacramento	BSF	56	05/15/2019	09/20/2020
Sacramento	CCR	56	09/21/2020	TBD
Trinity	DGC	56	09/15/2020	10/01/2020
Trinity	NFH	56	10/01/2020	12/31/2020

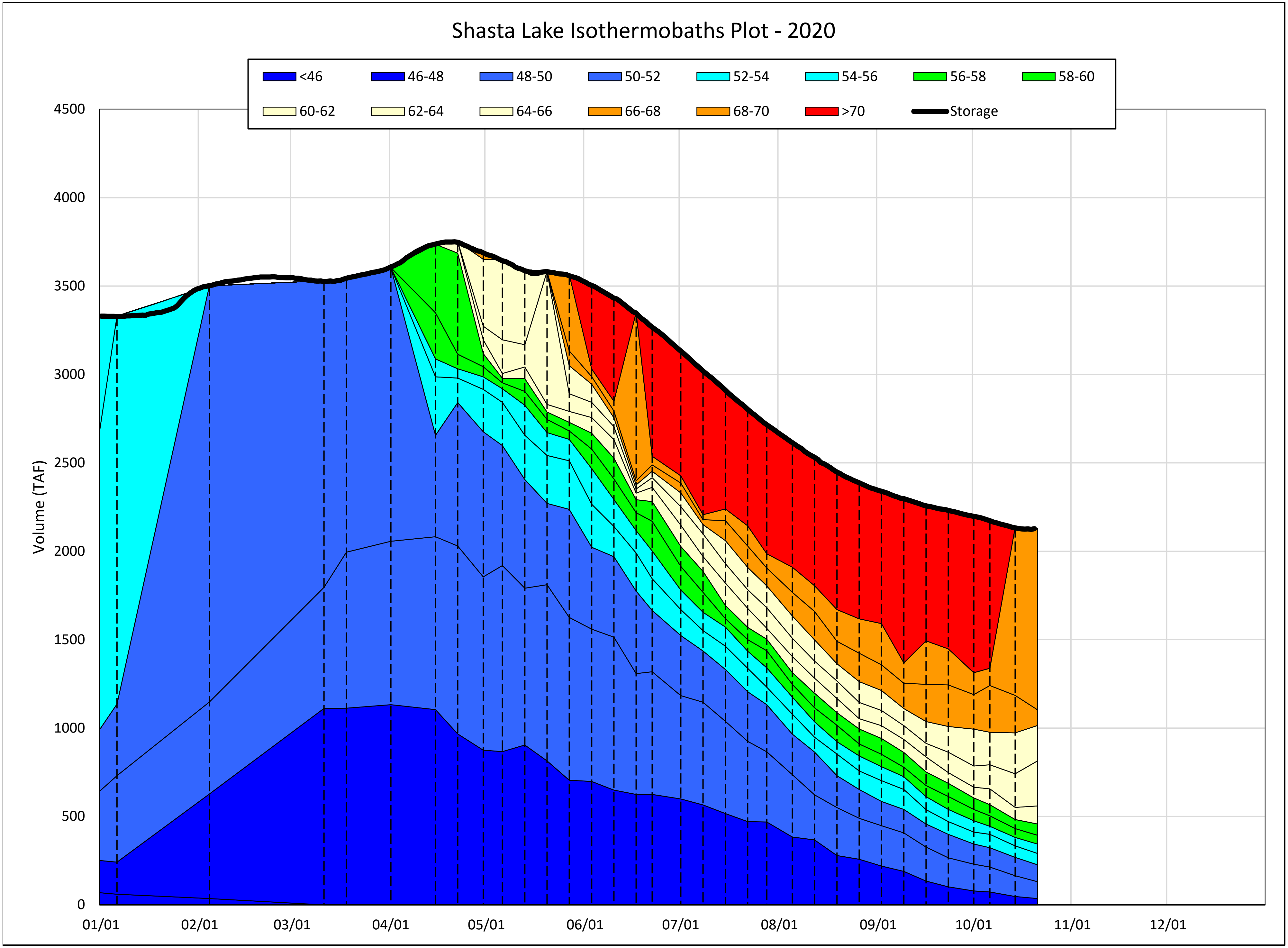
Notes

[1] Distances are approximate

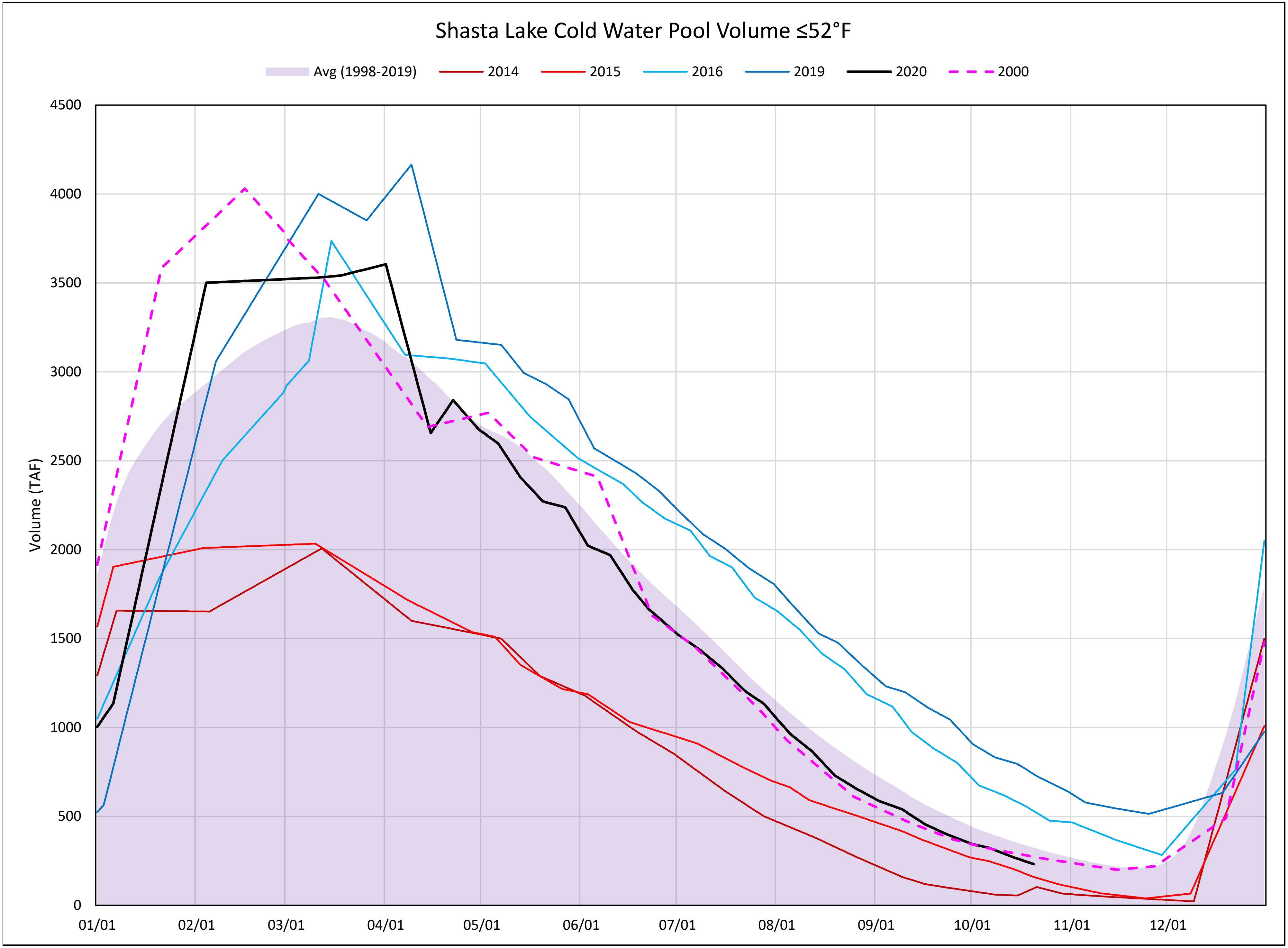
Shasta Lake Isothermobaths & Cold Water Pool Statistics

2020

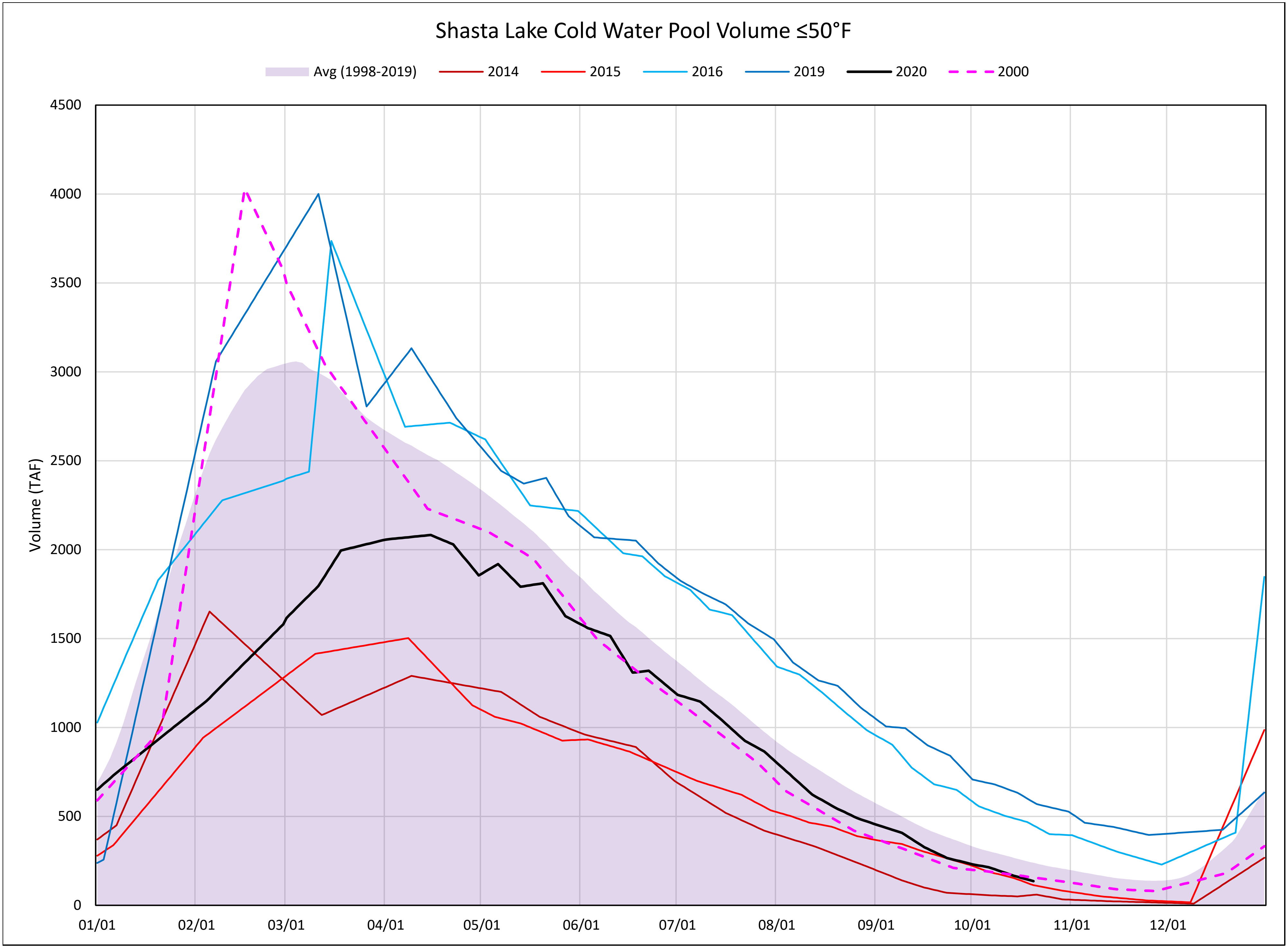
Page Description



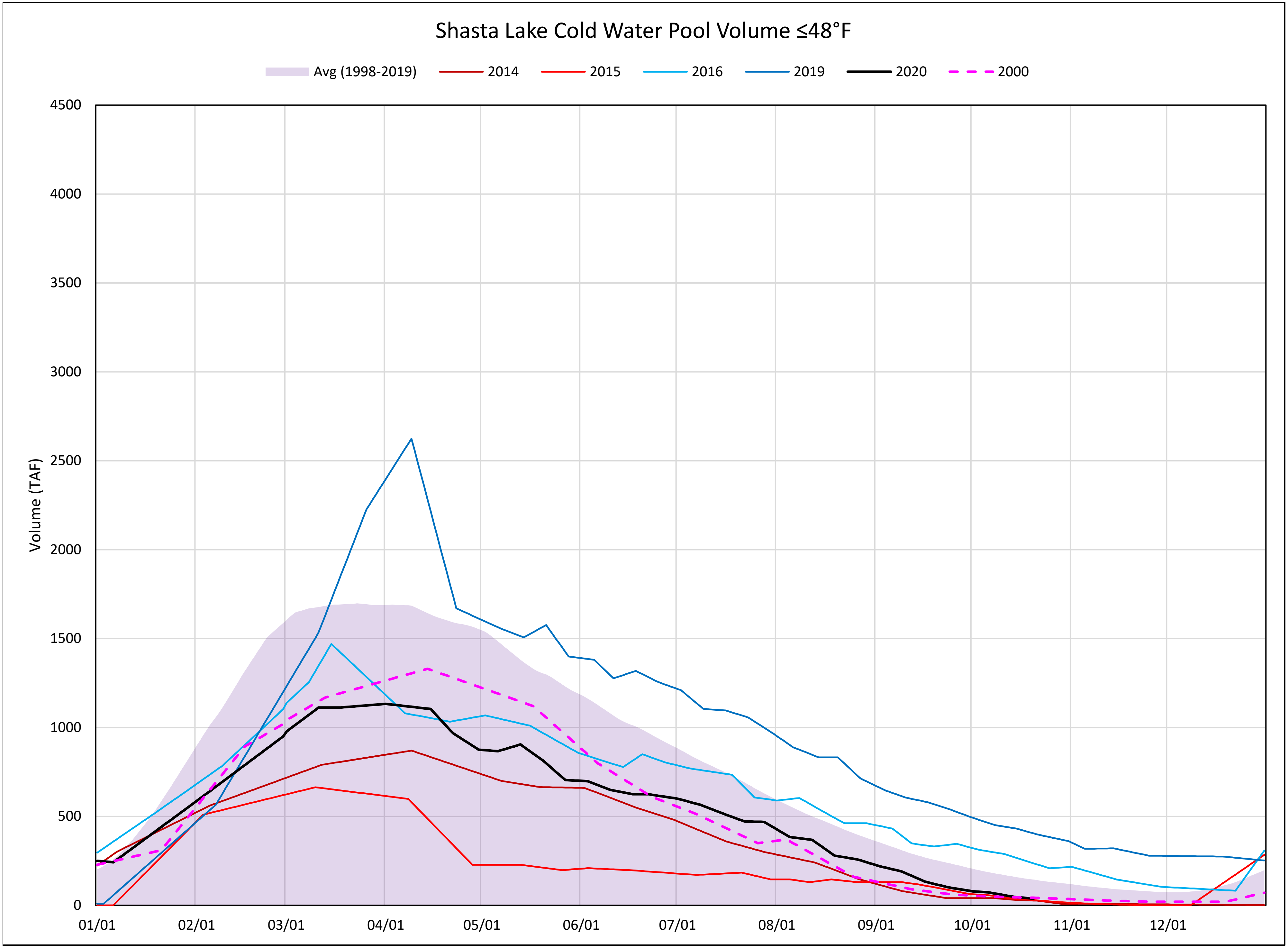
Shasta Lake Isothermobaths Plot - 2020
<46
46-48
48-50
50-52
52-54
54-56
56-58
58-60
60-62
62-64
64-66
66-68
68-70
>70
Storage
Volume (TAF)
4500
4000
3500
3000
2500
2000
1500
1000
500
0
01/01
02/01
03/01
04/01
05/01
06/01
07/01
08/01
09/01
10/01
11/01
12/01



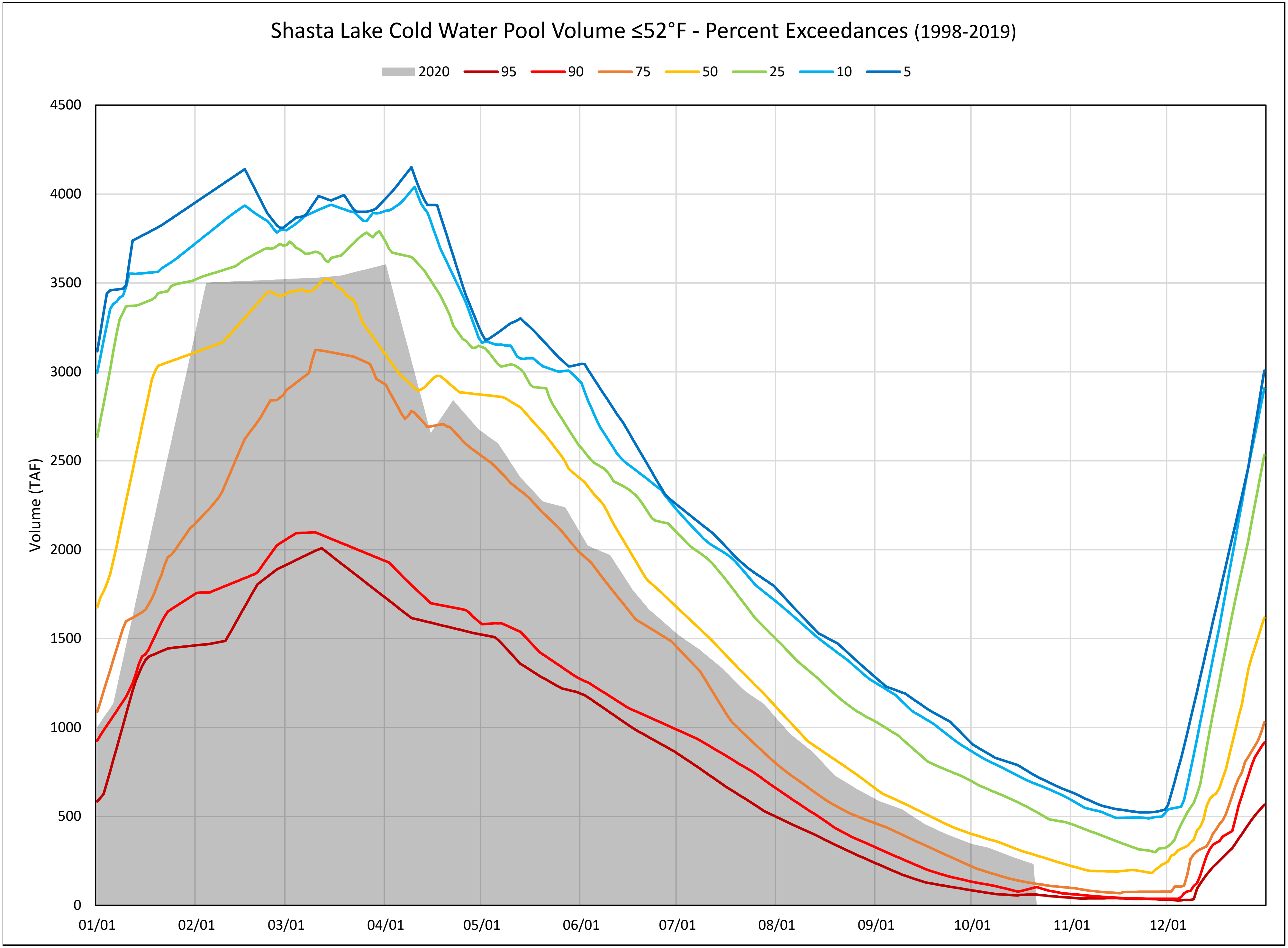
Shasta Lake Cold Water Pool Volume ≤52°F
Avg (1998-2019)
2014
2015
2016
2019
2020
2000
Volume (TAF)
4500
4000
3500
3000
2500
2000
1500
1000
500
0
01/01
02/01
03/01
04/01
05/01
06/01
07/01
08/01
09/01
10/01
11/01
12/01

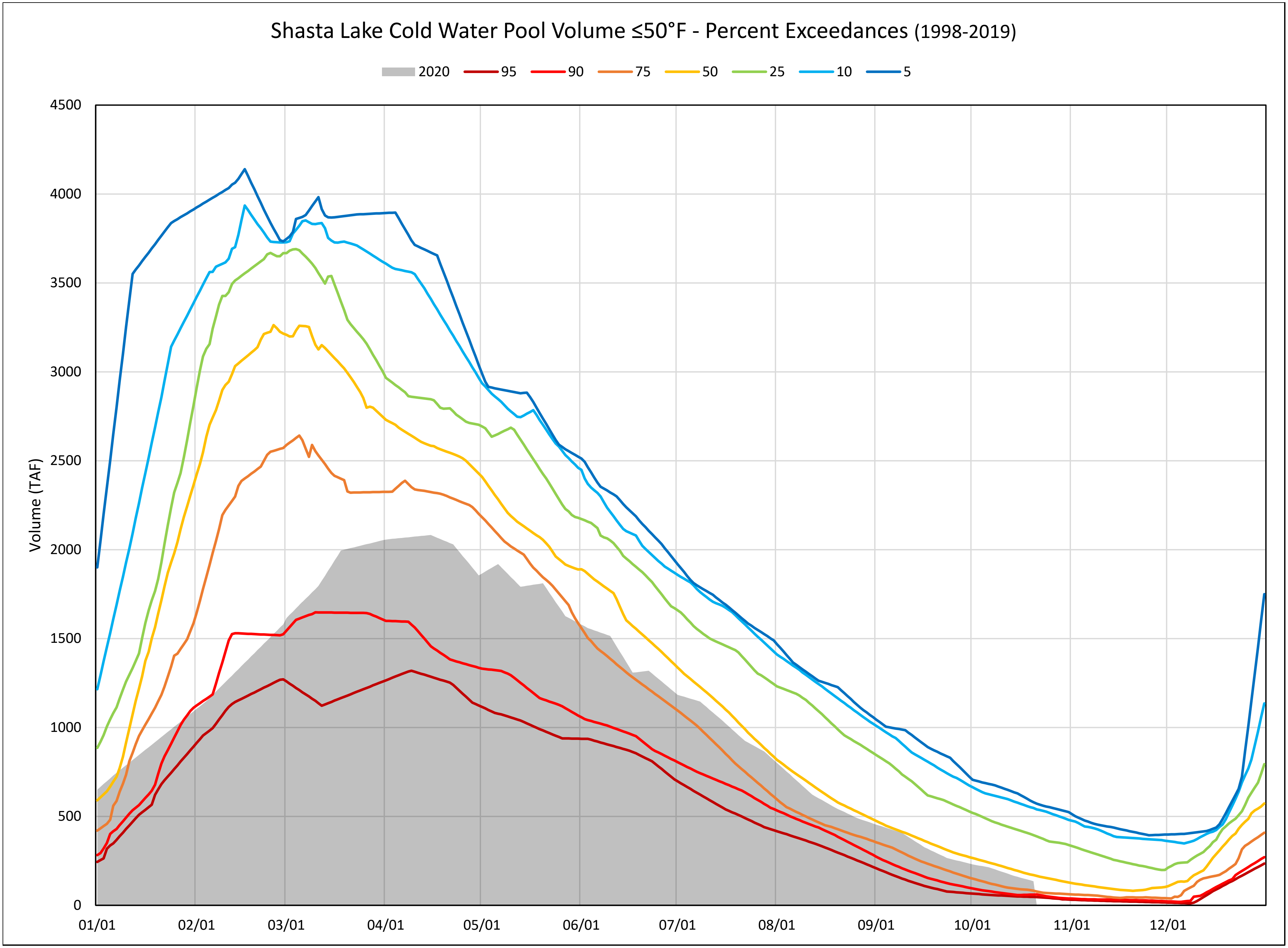


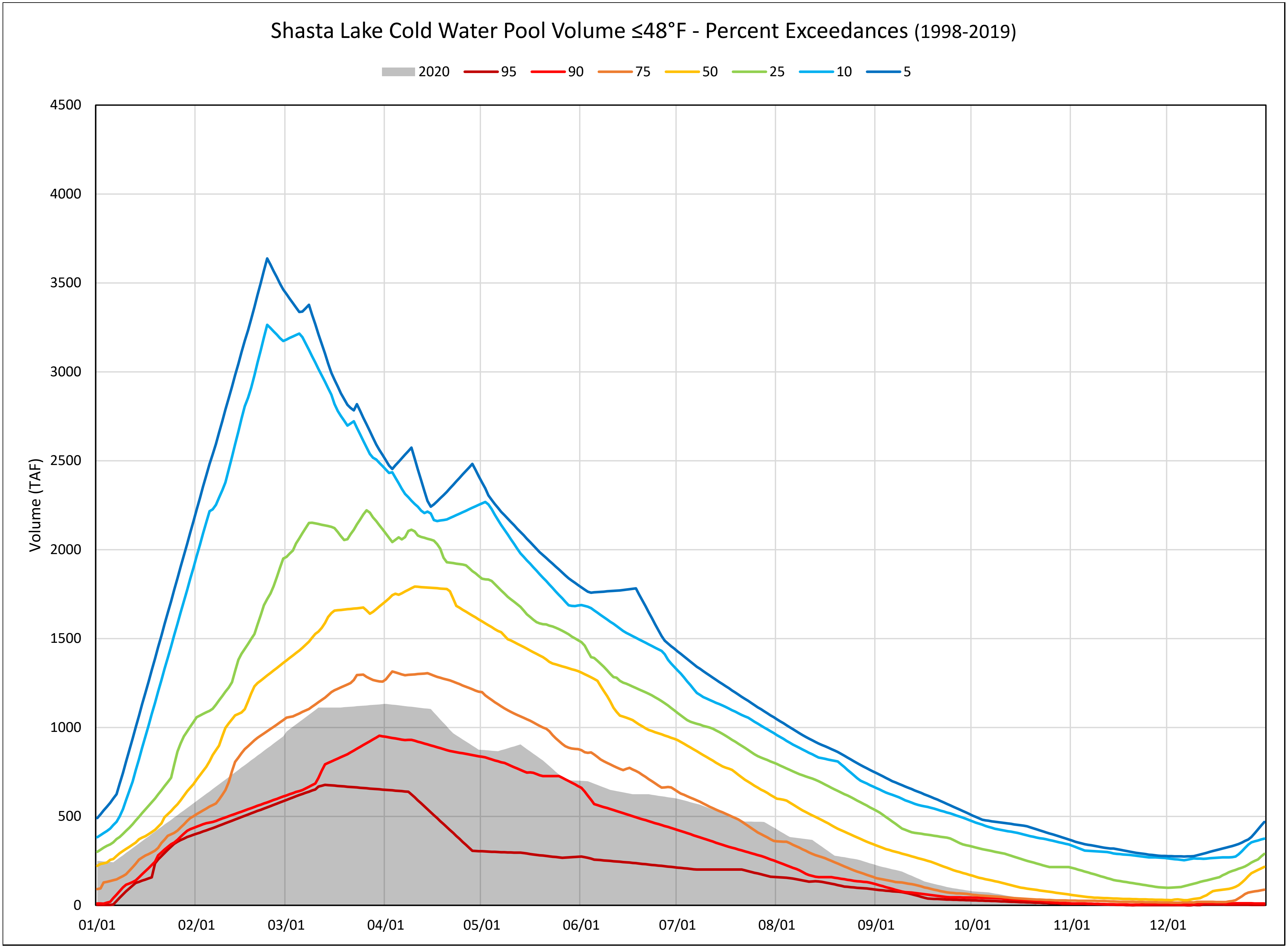
Shasta Lake Cold Water Pool Volume ≤50°F
Avg (1998-2019)
2014
2015
2016
2019
2020
2000
Volume (TAF)
4500
4000
3500
3000
2500
2000
1500
1000
500
0
01/01
02/01
03/01
04/01
05/01
06/01
07/01
08/01
09/01
10/01
11/01
12/01



Shasta Lake Cold Water Pool Volume ≤48°F
Avg (1998-2019)
2014
2015
2016
2019
2020
2000
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


Shasta Lake Cold Water Pool Volume ≤52°F - 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


Shasta Lake Cold Water Pool Volume ≤50°F - 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



Shasta Lake Cold Water Pool Volume ≤48°F - 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

Shasta Lake Cold Water Pool Comparison by Year (for Specified Date)

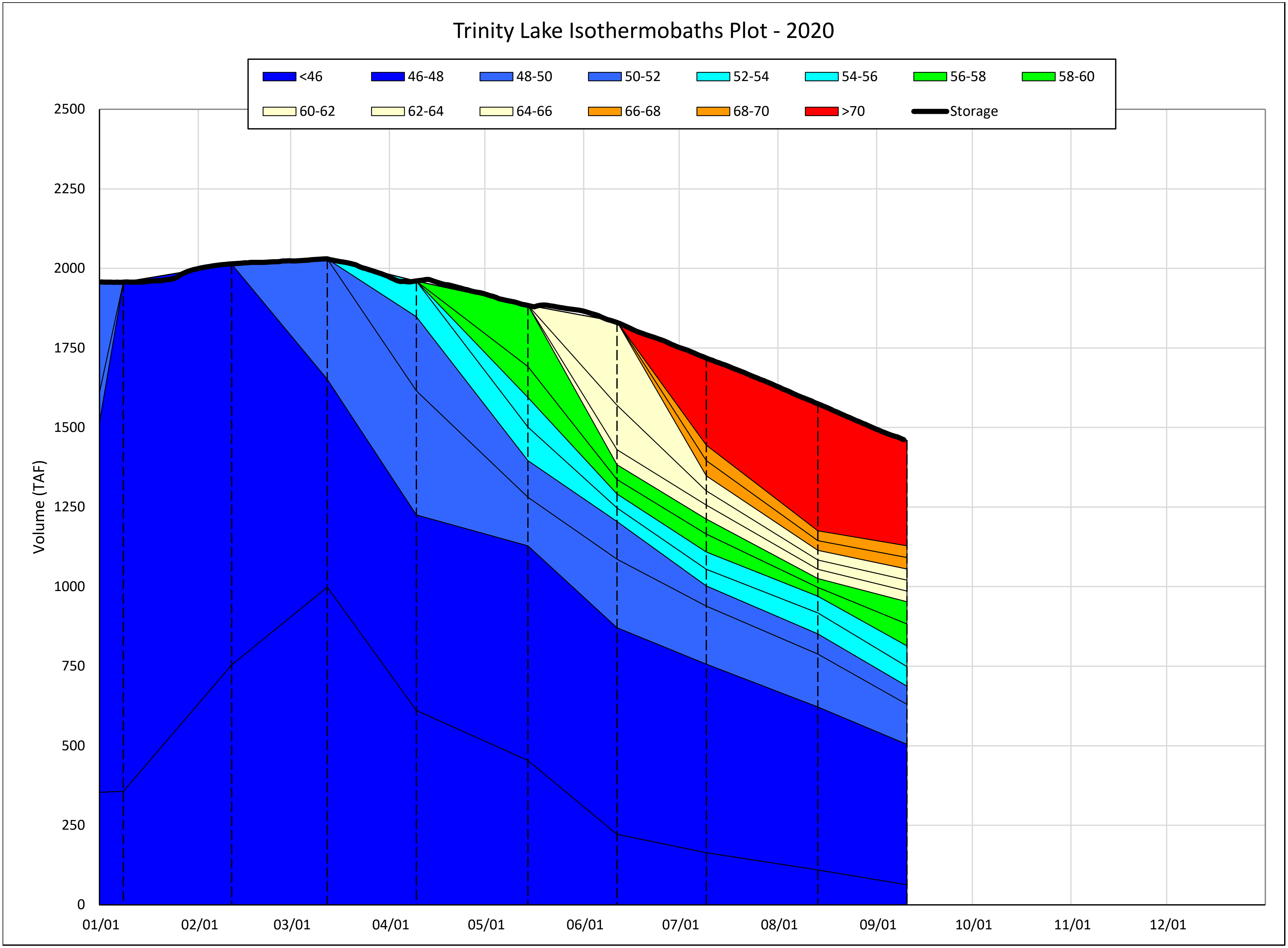
Oct-21 2020	Δ TAF				% Δ			
	≤52°	≤50°	≤48°	Abs. Avg.	≤52°	≤50°	≤48°	Abs. Avg.
1998	-66	-71	-24	54	-28	-52	-65	49
1999	310	312	295	305	133	229	789	384
2000	41	21	5	22	18	15	13	15
2001	-37	11	60	36	-16	8	161	61
2002	113	142	143	133	49	105	381	178
2003	123	16	-10	50	53	12	-27	31
2004	-107	-48	8	54	-46	-35	21	34
2005	-117	-68	-8	64	-50	-50	-21	40
2006	130	129	120	126	56	95	321	157
2007	-124	-52	18	65	-53	-38	48	46
2008	-179	-91	-2	91	-77	-67	-6	50
2009	-126	-61	17	68	-54	-45	46	48
2010	342	241	129	238	147	178	345	223
2011	484	442	401	442	208	326	1070	535
2012	204	225	213	214	88	166	570	274
2013	-19	47	94	53	-8	34	250	98
2014	-138	-77	-10	75	-59	-57	-28	48
2015	-73	-23	-8	35	-32	-17	-20	23
2016	298	313	199	270	128	231	532	297
2017	388	340	301	343	167	250	805	407
2018	65	77	43	62	28	57	114	66
2019	505	444	367	439	217	327	981	508
2020	0	0	0	0	0	0	0	0

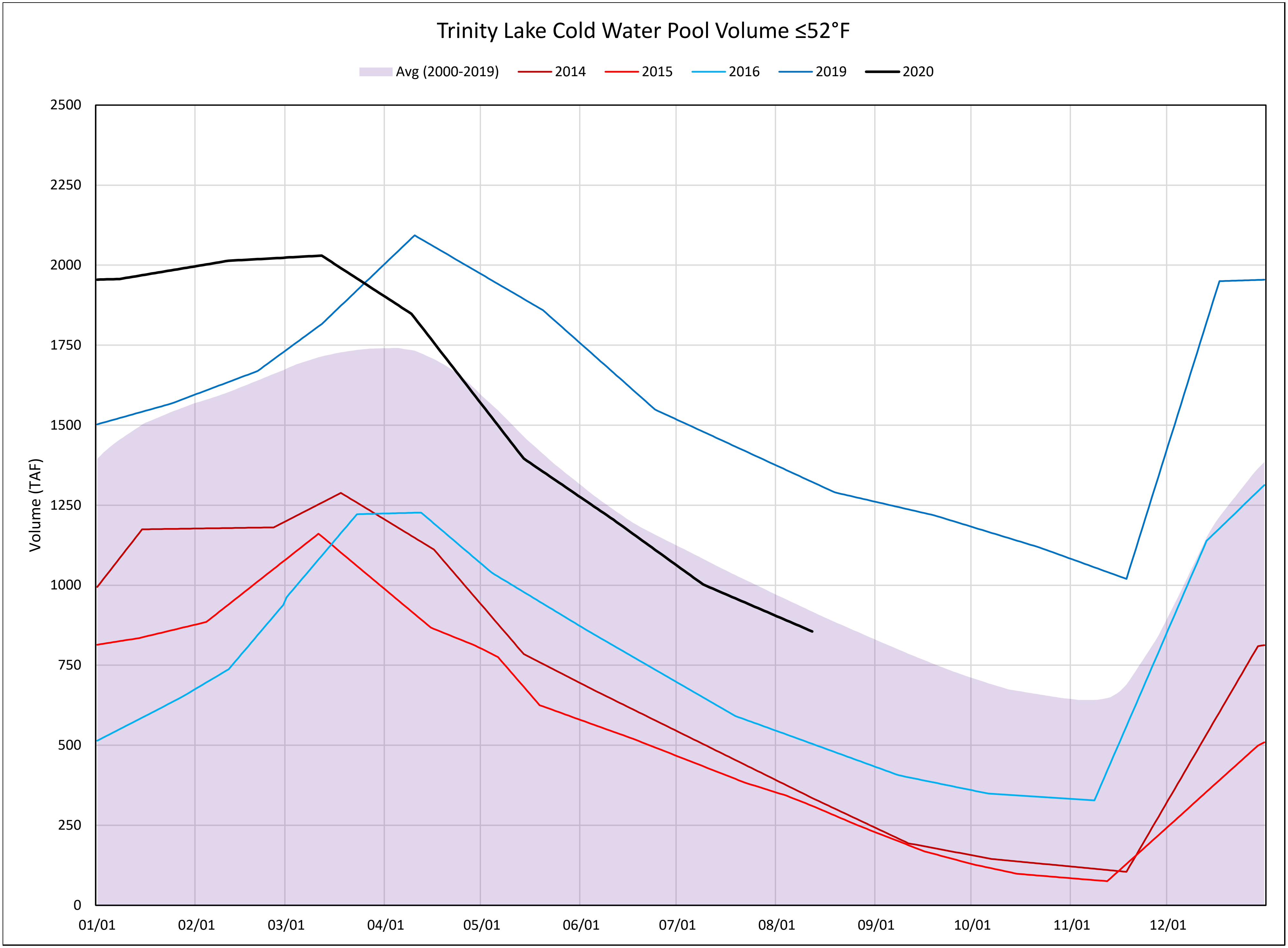
Historic - Current

(Historic - Current) / Current

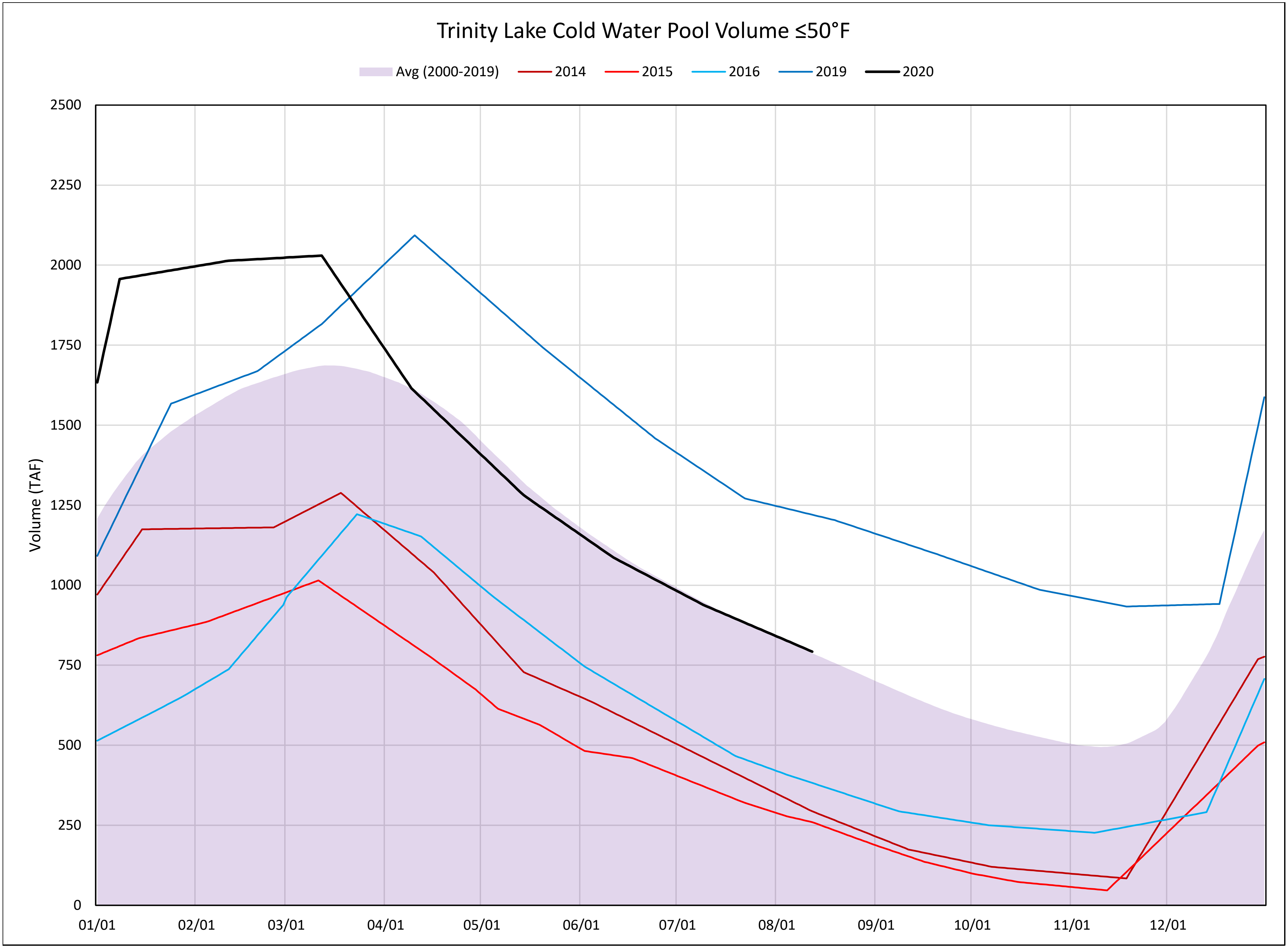
Trinity Lake Isothermobaths & Cold Water Pool Statistics

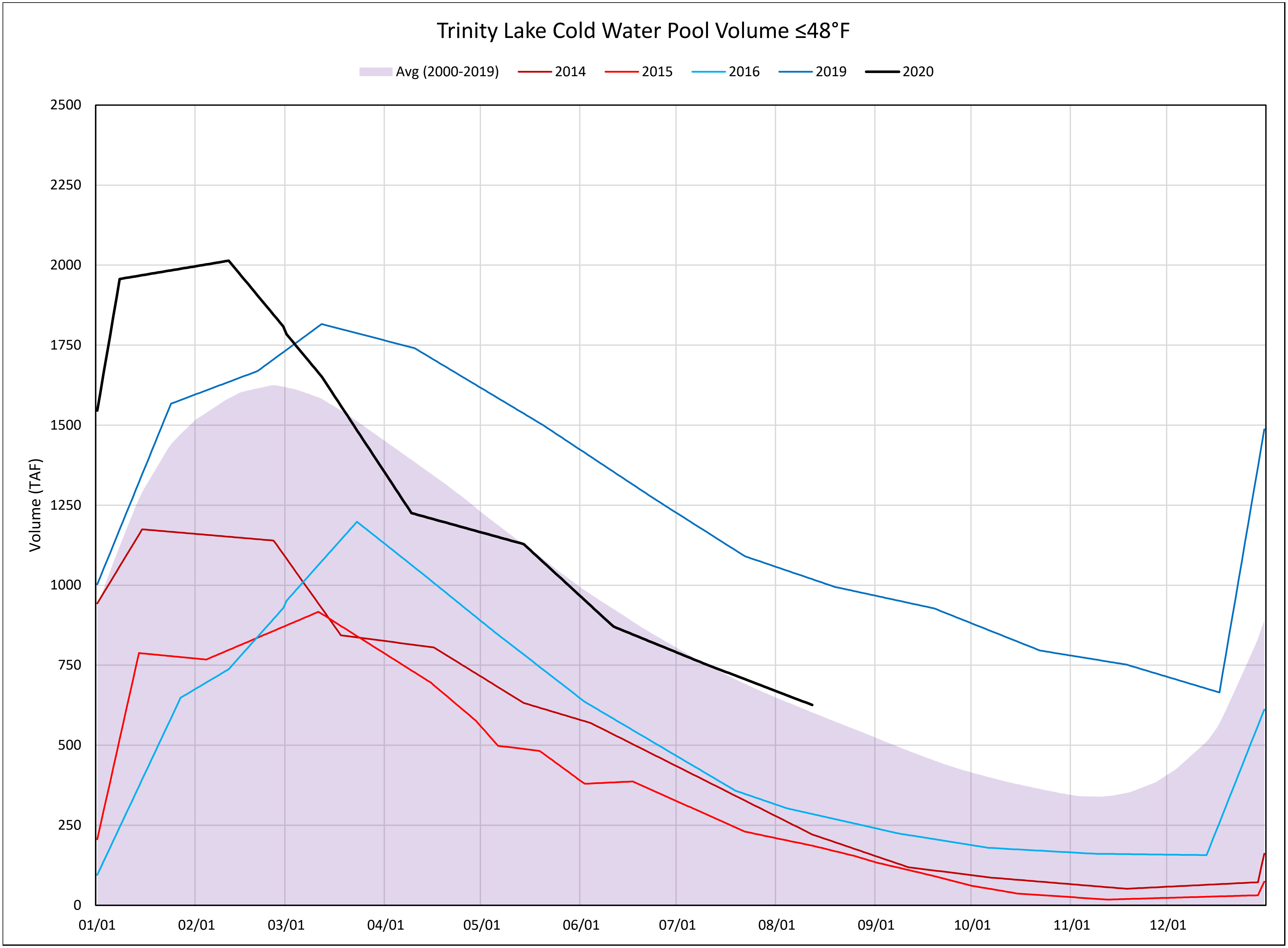
2020


Trinity Lake Isothermobaths Plot - 2020
<46
46-48
48-50
50-52
52-54
54-56
56-58
58-60
60-62
62-64
64-66
66-68
68-70
>70
Storage
Volume (TAF)
2500
2250
2000
1750
1500
1250
1000
750
500
250
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

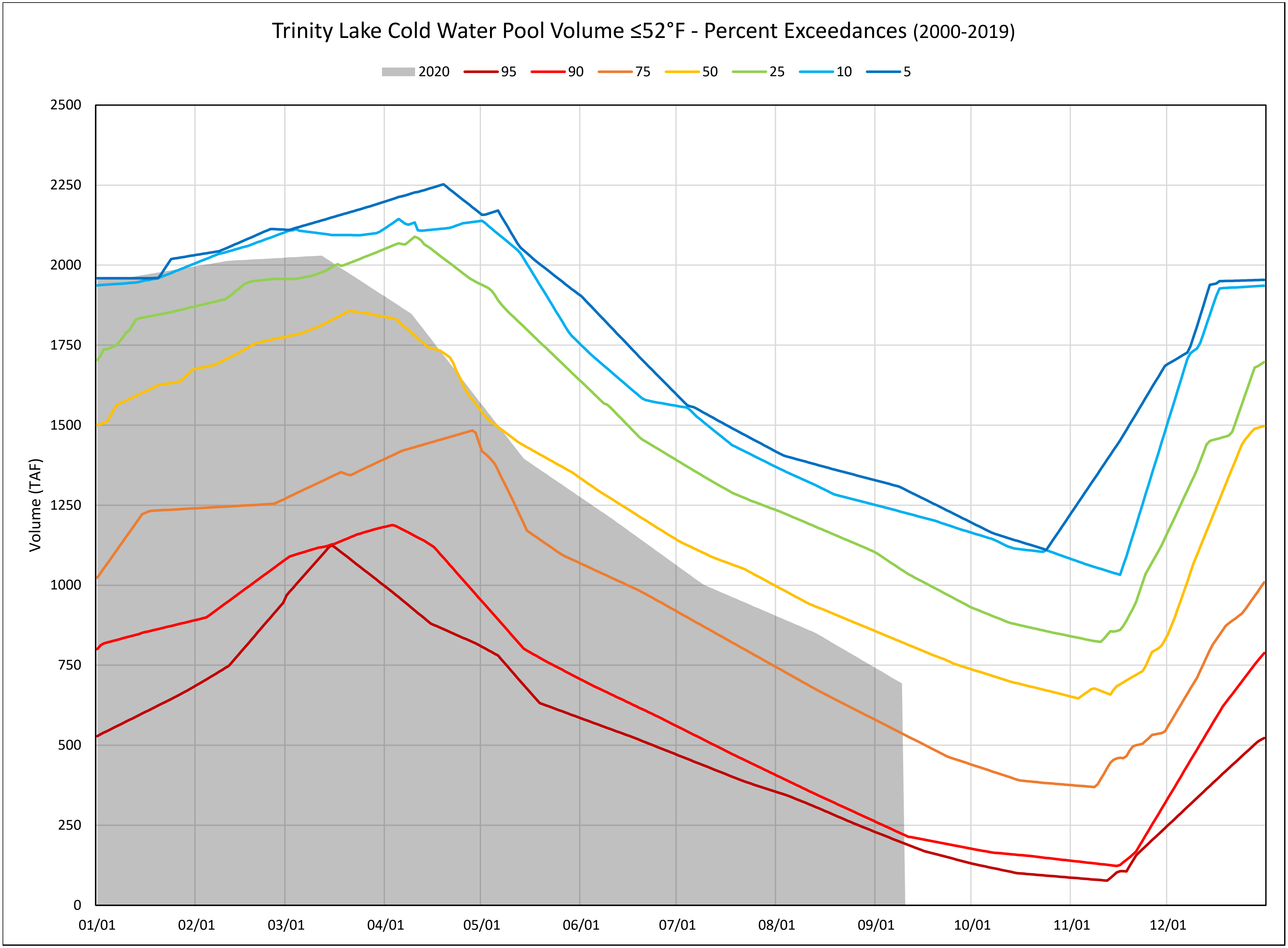


Trinity Lake Cold Water Pool Volume ≤52°F
Avg (2000-2019)
2014
2015
2016
2019
2020
Volume (TAF)
2500
2250
2000
1750
1500
1250
1000
750
500
250
0
01/01
02/01
03/01
04/01
05/01
06/01
07/01
08/01
09/01
10/01
11/01
12/01

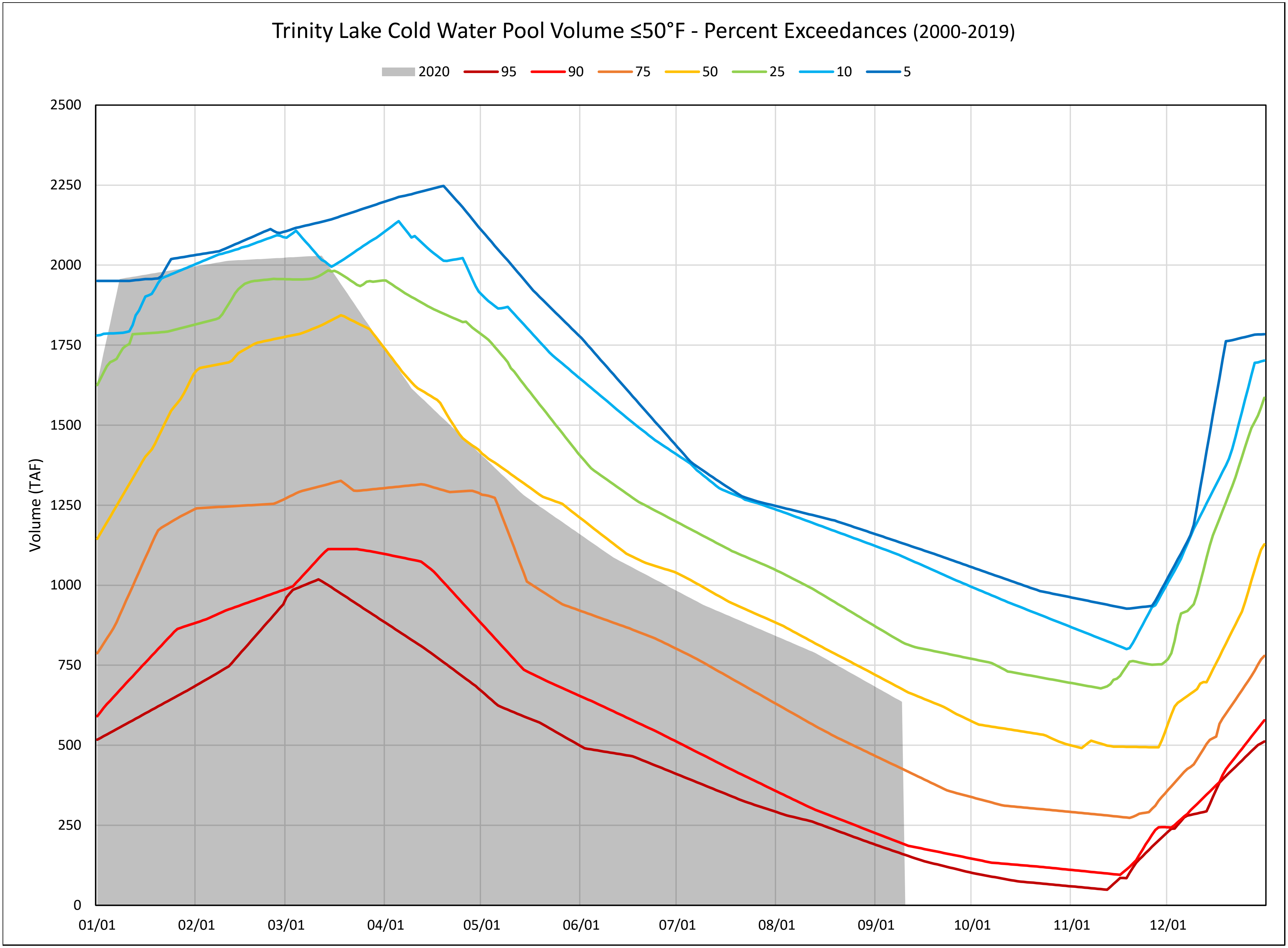

Trinity Lake Cold Water Pool Volume ≤50°F
Avg (2000-2019)
2014
2015
2016
2019
2020
Volume (TAF)
2500
2250
2000
1750
1500
1250
1000
750
500
250
0
01/01
02/01
03/01
04/01
05/01
06/01
07/01
08/01
09/01
10/01
11/01
12/01



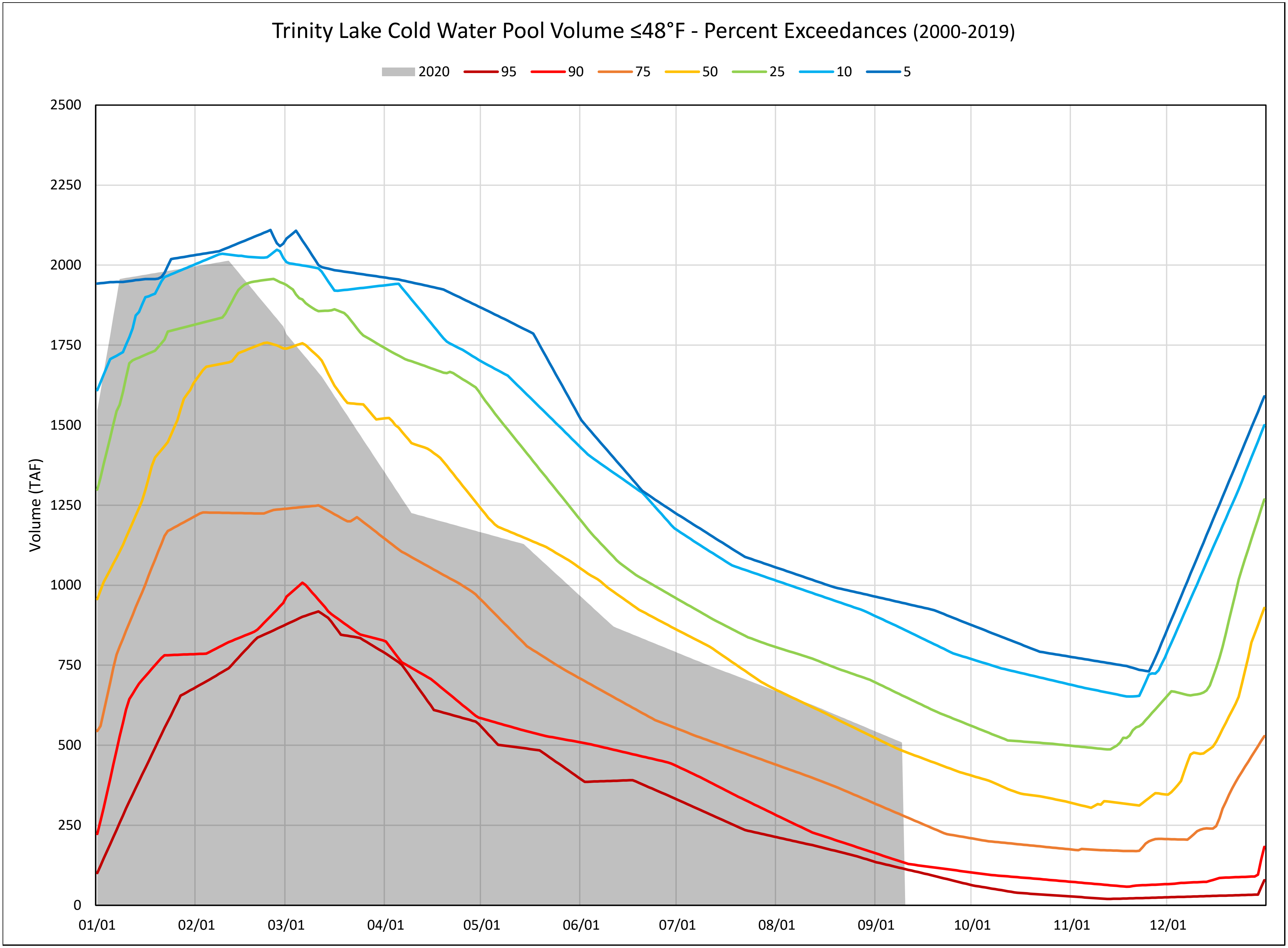
Trinity Lake Cold Water Pool Volume ≤48°F
Avg (2000-2019)
2014
2015
2016
2019
2020
Volume (TAF)
2500
2250
2000
1750
1500
1250
1000
750
500
250
0
01/01
02/01
03/01
04/01
05/01
06/01
07/01
08/01
09/01
10/01
11/01
12/01



Trinity Lake Cold Water Pool Volume ≤52°F - Percent Exceedances (2000-2019)
2020
95
90
75
50
25
10
5
Volume (TAF)
2500
2250
2000
1750
1500
1250
1000
750
500
250
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



Trinity Lake Cold Water Pool Volume ≤50°F - Percent Exceedances (2000-2019)
2020
95
90
75
50
25
10
5
Volume (TAF)
2500
2250
2000
1750
1500
1250
1000
750
500
250
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



Trinity Lake Cold Water Pool Volume ≤48°F - Percent Exceedances (2000-2019)
2020
95
90
75
50
25
10
5
Volume (TAF)
2500
2250
2000
1750
1500
1250
1000
750
500
250
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

Trinity Cold Water Pool Comparison by Year (for Specified Date)

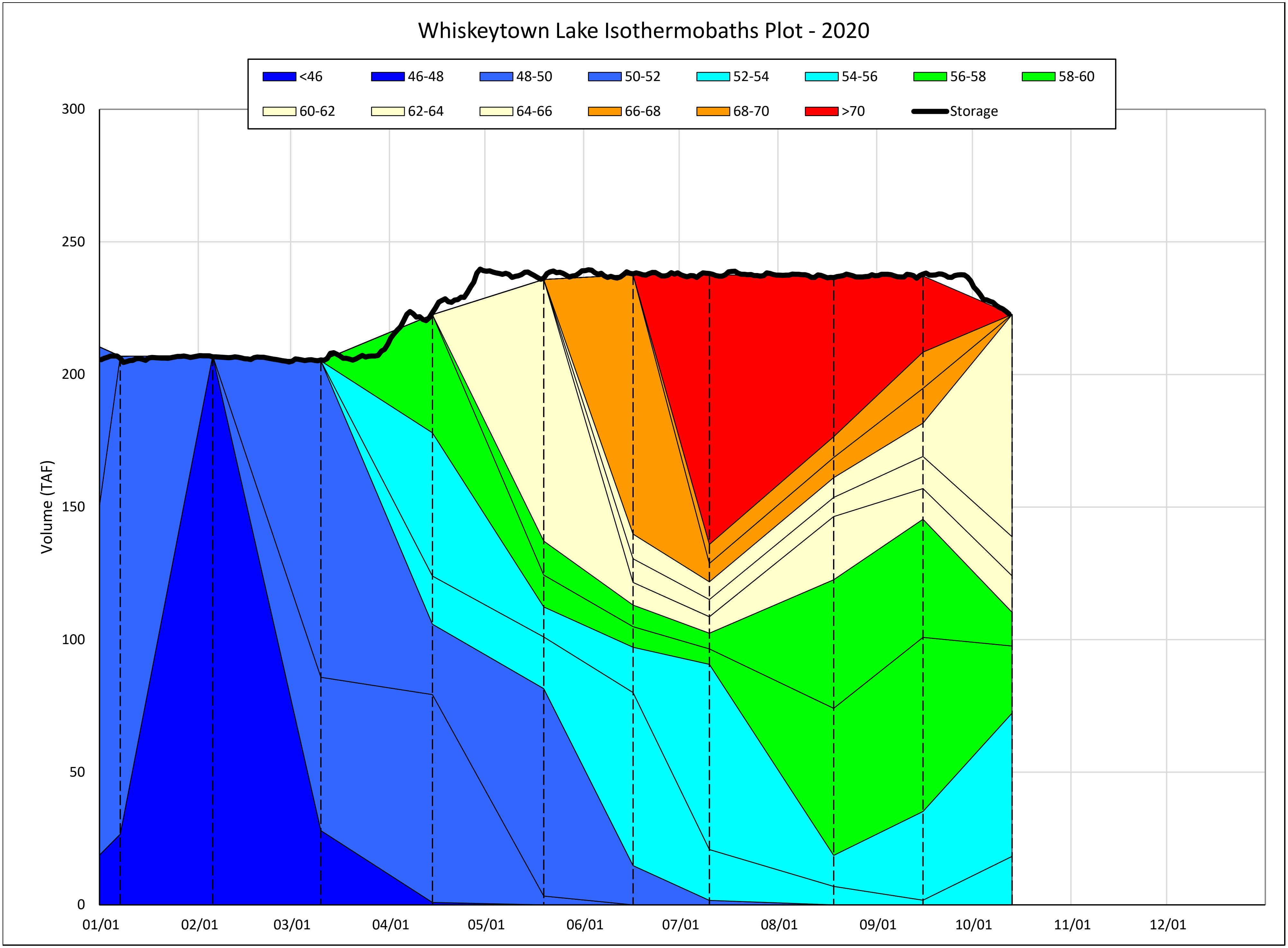
Sep-10 2020	Δ TAF				% Δ			
	≤52°	≤50°	≤48°	Abs. Avg.	≤52°	≤50°	≤48°	Abs. Avg.
2000	186	39	-41	89	27	6	-8	14
2001	61	16	-12	29	9	2	-2	5
2002	73	40	44	53	11	6	9	9
2003	369	186	48	201	53	29	9	31
2004	130	35	-61	75	19	5	-12	12
2005	311	183	-39	178	45	29	-8	27
2006	421	299	166	295	61	47	33	47
2007	128	87	91	102	18	14	18	17
2008	-183	-244	-248	225	-26	-38	-49	38
2009	-255	-275	-284	272	-37	-43	-56	45
2010	120	-15	-162	99	17	-2	-32	17
2011	614	465	337	472	89	73	66	76
2012	393	367	358	373	57	58	70	62
2013	-75	-103	-110	96	-11	-16	-22	16
2014	-490	-453	-383	442	-71	-71	-75	72
2015	-497	-476	-394	456	-72	-75	-77	75
2016	-289	-344	-286	306	-42	-54	-56	51
2017	244	86	9	113	35	13	2	17
2018	216	186	167	190	31	29	33	31
2019	548	498	441	496	79	78	87	81
2020	0	0	0	0	0	0	0	0

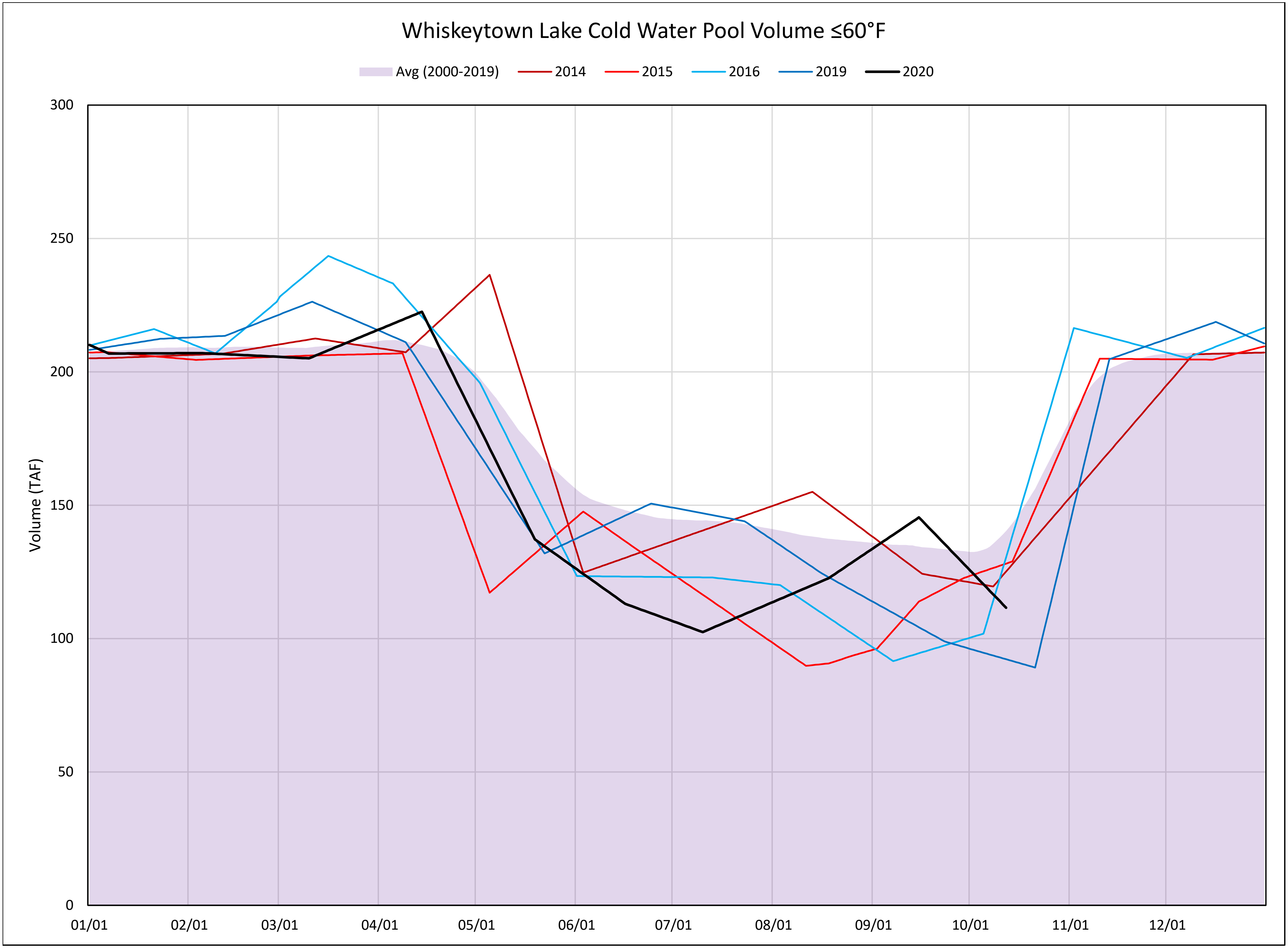
Δ TAF (≤52°, ≤50°, ≤48°): Historic - Current

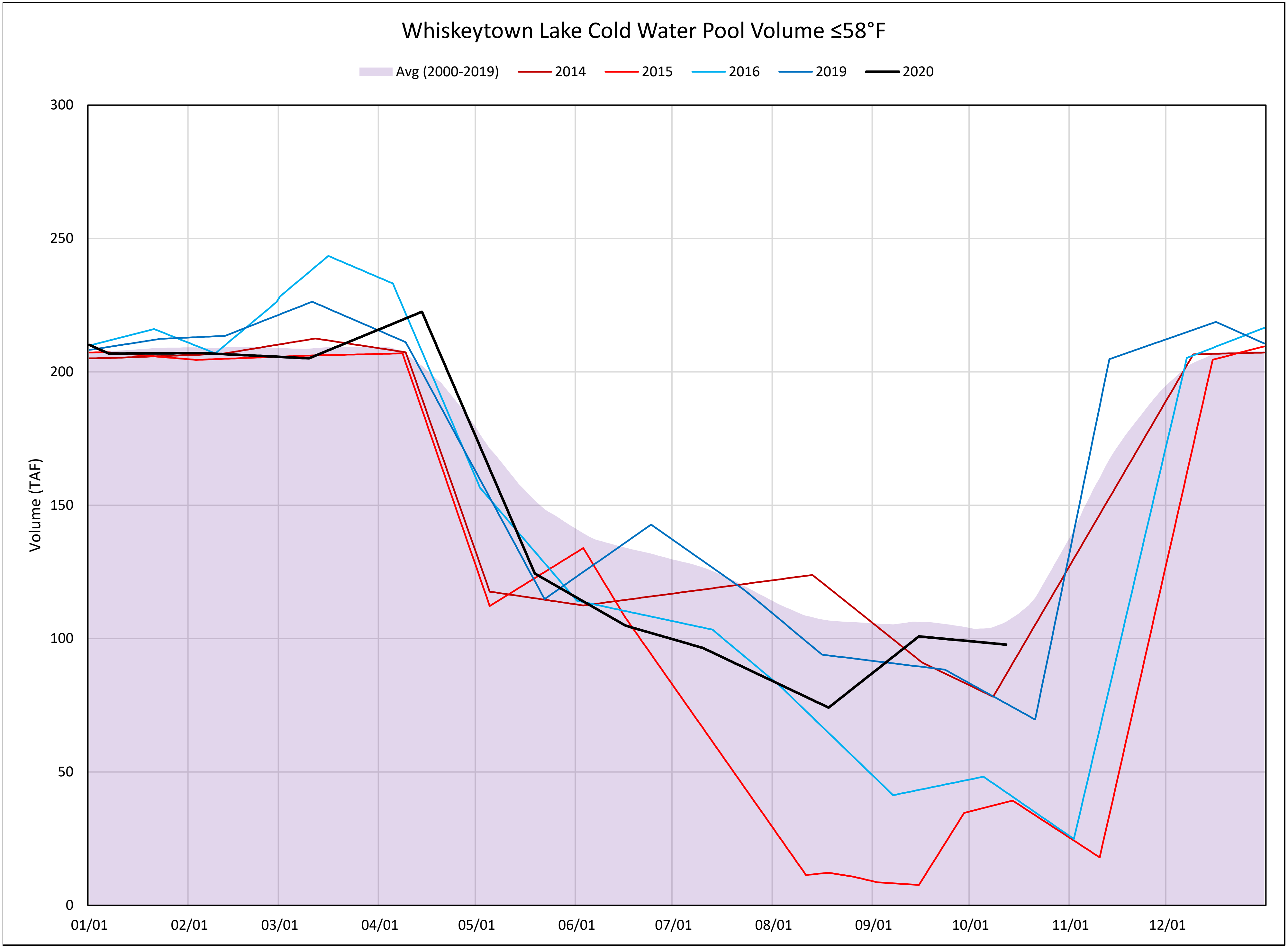
% Δ (≤52°, ≤50°, ≤48°): (Historic - Current) / Current

Whiskeytown Lake Isothermobaths & Cold Water Pool Statistics

2020


Whiskeytown Lake Isothermobaths Plot - 2020
<46
46-48
48-50
50-52
52-54
54-56
56-58
58-60
60-62
62-64
64-66
66-68
68-70
>70
Storage
Volume (TAF)
300
250
200
150
100
50
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


Whiskeytown Lake Cold Water Pool Volume ≤60°F
Avg (2000-2019)
2014
2015
2016
2019
2020
Volume (TAF)
300
250
200
150
100
50
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



Whiskeytown Lake Cold Water Pool Volume ≤58°F
Avg (2000-2019)
2014
2015
2016
2019
2020
Volume (TAF)
0
50
100
150
200
250
300
01/01
02/01
03/01
04/01
05/01
06/01
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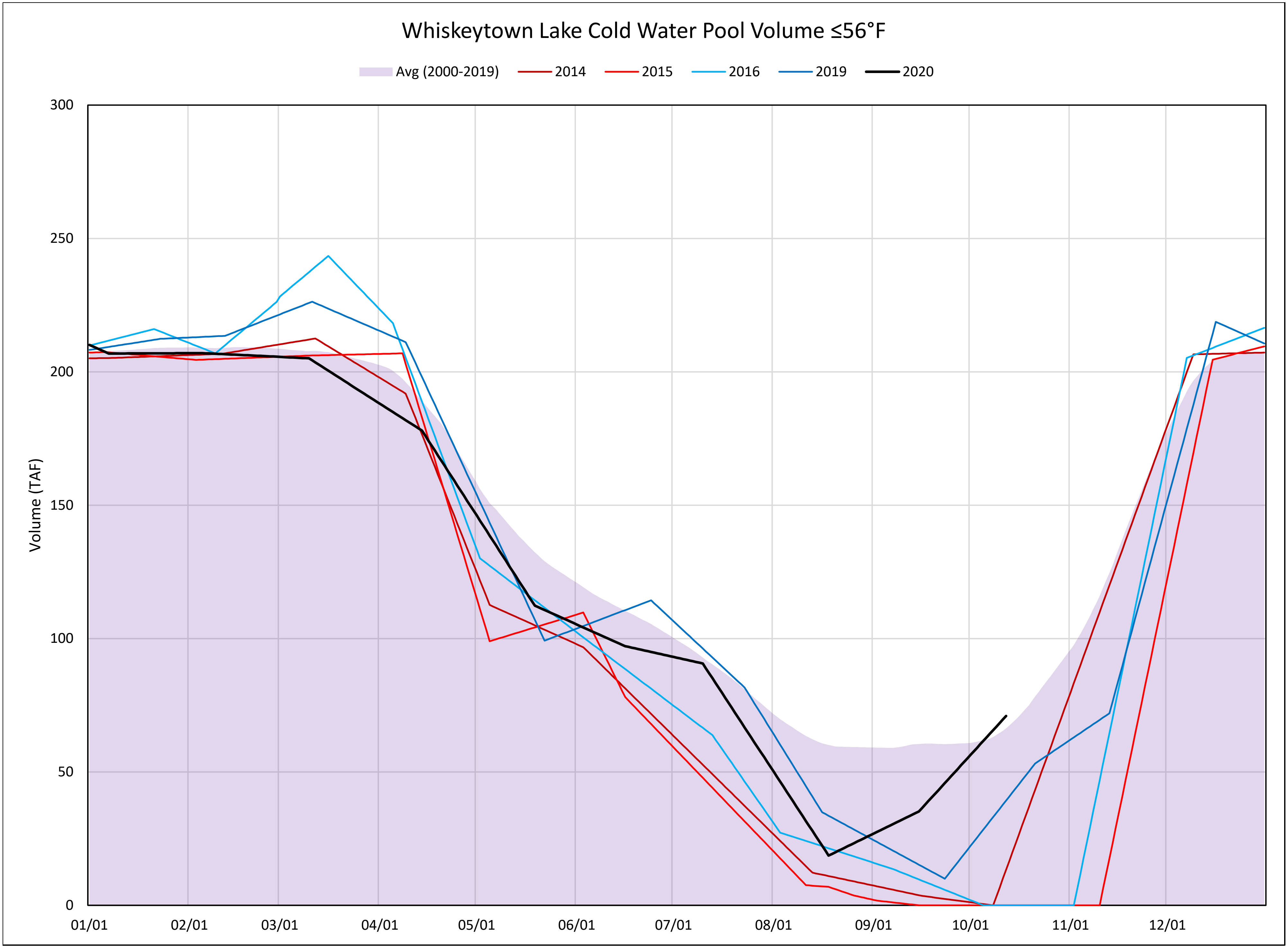
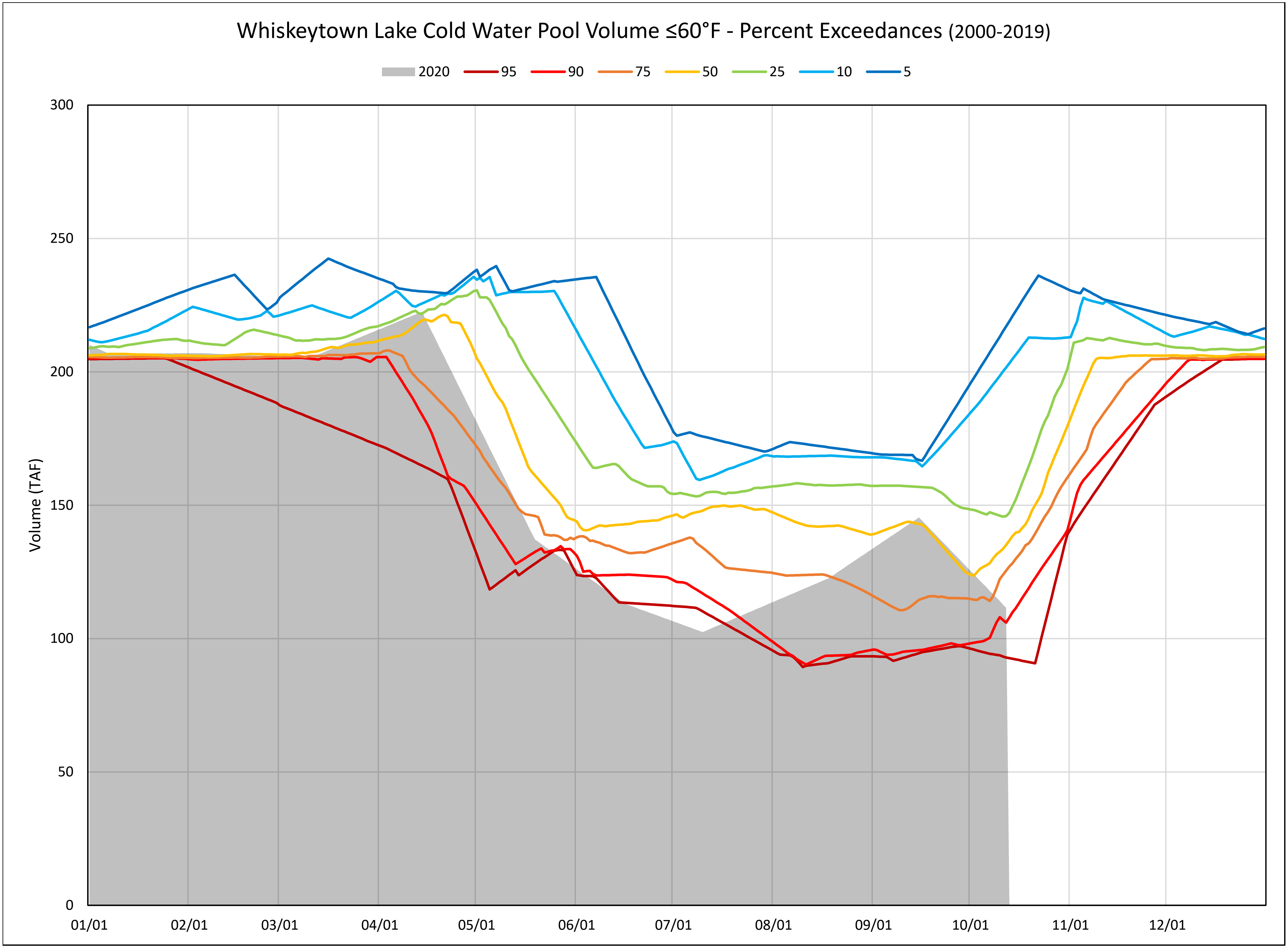
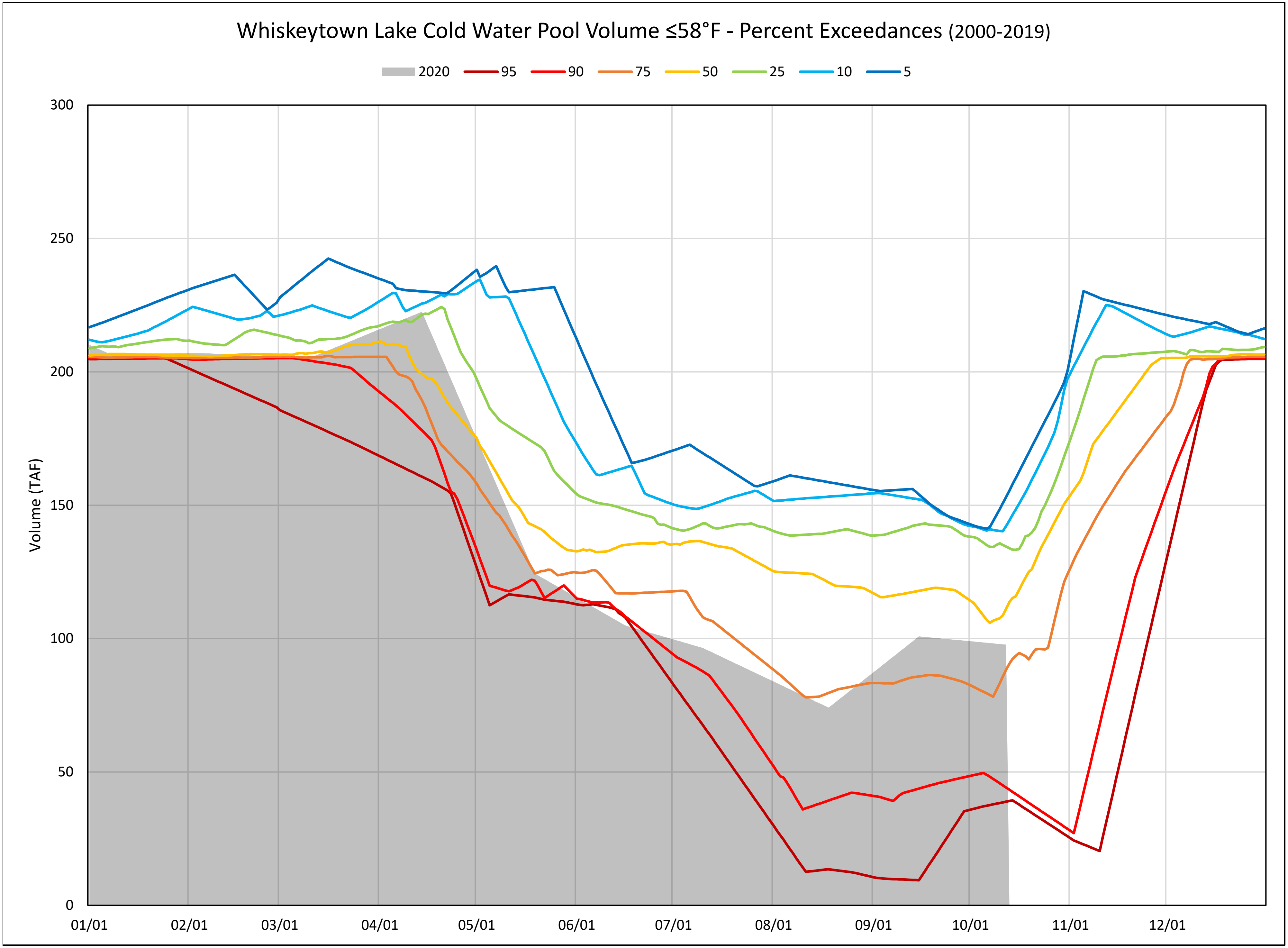
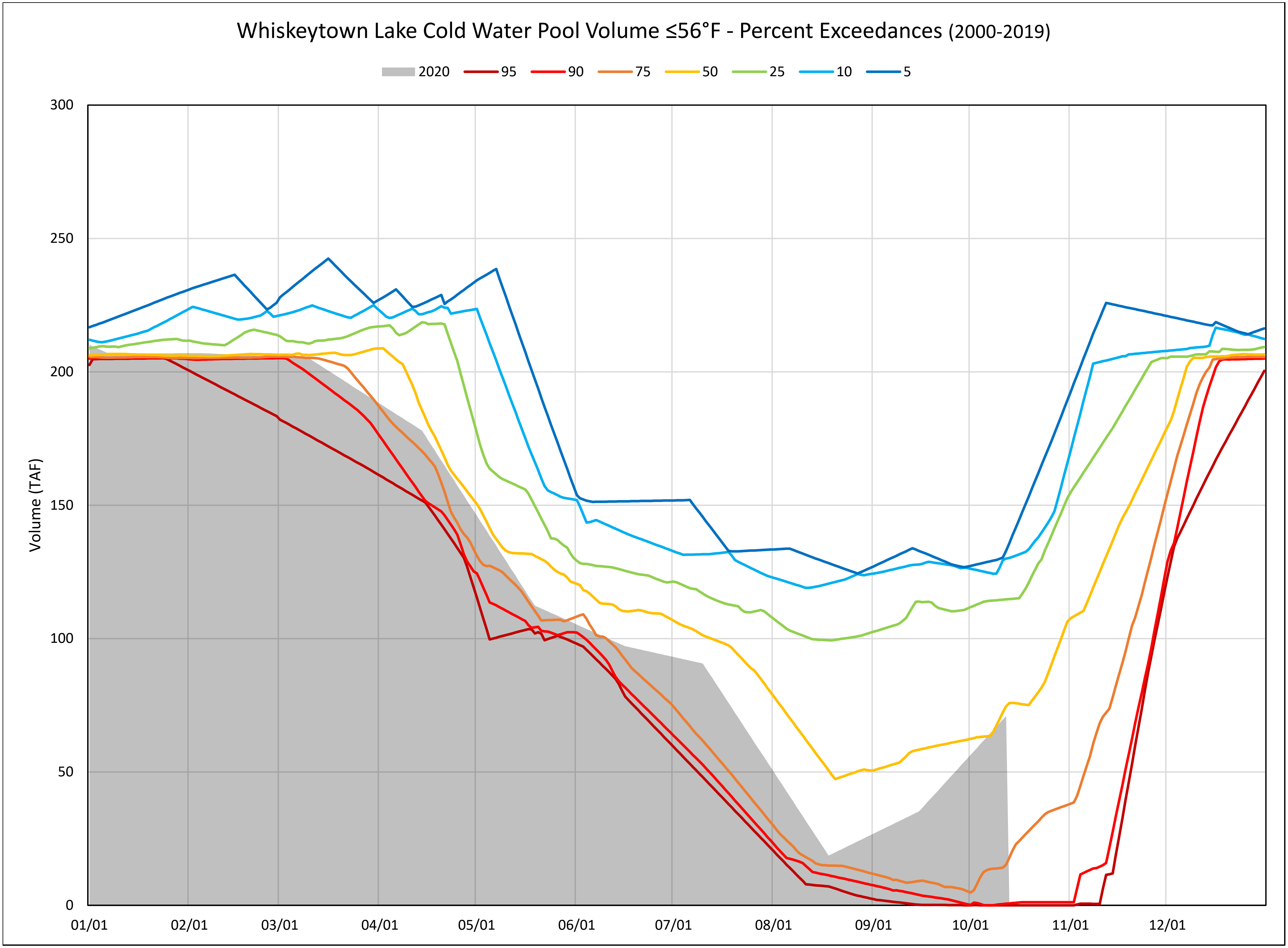
08/01
09/01
10/01
11/01
12/01


Whiskeytown Lake Cold Water Pool Volume ≤56°F
Avg (2000-2019)
2014
2015
2016
2019
2020
Volume (TAF)
300
250
200
150
100
50
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


Whiskeytown Lake Cold Water Pool Volume ≤60°F - Percent Exceedances (2000-2019)
2020
95
90
75
50
25
10
5
Volume (TAF)
300
250
200
150
100
50
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



Whiskeytown Lake Cold Water Pool Volume ≤58°F - Percent Exceedances (2000-2019)
2020
95
90
75
50
25
10
5
Volume (TAF)
300
250
200
150
100
50
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


Whiskeytown Lake Cold Water Pool Volume ≤56°F - Percent Exceedances (2000-2019)
2020
95
90
75
50
25
10
5
Volume (TAF)
300
250
200
150
100
50
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

Whiskeytown Cold Water Pool Comparison by Year (for Specified Date)

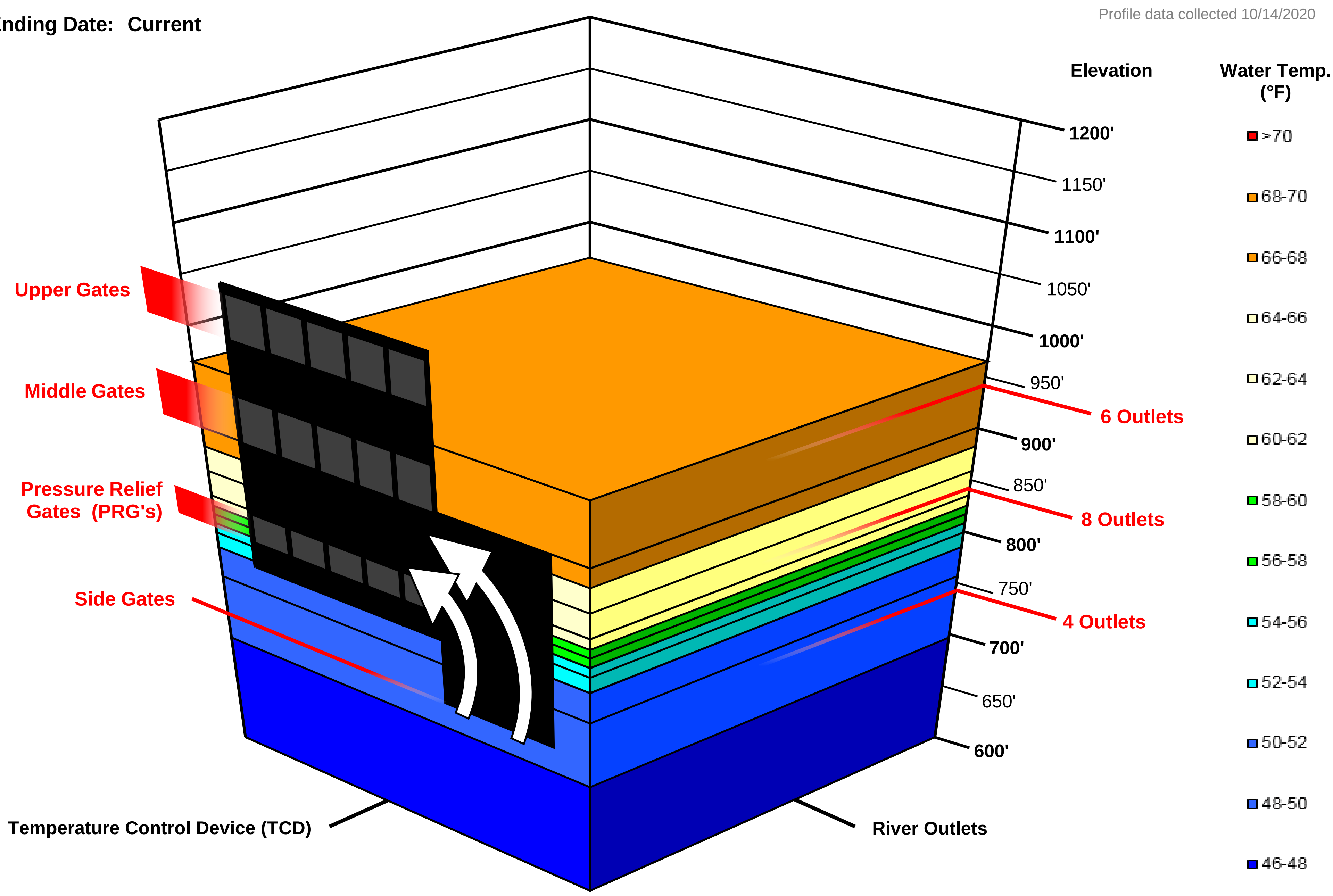
Oct-13 2020	Δ TAF				% Δ			
	≤60°	≤58°	≤56°	Abs. Avg.	≤60°	≤58°	≤56°	Abs. Avg.
2000	-7	-3	4	4	-6	-3	5	5
2001	28	38	53	40	25	39	74	46
2002	34	40	44	40	31	41	62	45
2003	31	42	60	44	28	43	84	52
2004	49	56	62	56	43	57	87	63
2005	4	-4	-50	19	3	-4	-70	26
2006	18	30	50	33	17	30	71	39
2007	34	45	3	27	30	46	5	27
2008	12	19	34	22	11	20	48	26
2009	16	13	-34	21	14	13	-48	25
2010	30	-38	-65	44	27	-39	-92	52
2011	15	22	4	14	13	23	6	14
2012	52	8	-17	26	46	8	-24	26
2013	106	34	43	61	95	35	60	63
2014	14	-11	-58	27	12	-11	-81	35
2015	17	-59	-71	49	15	-60	-100	58
2016	19	-55	-71	48	17	-57	-100	58
2017	94	3	7	35	85	3	10	32
2018	29	14	-59	34	26	14	-83	41
2019	-19	-22	-32	24	-17	-23	-45	28
2020	0	0	0	0	0	0	0	0

Historic - Current (≤60°, ≤58°, ≤56° of Δ TAF); (Historic - Current) / Current (≤60°, ≤58°, ≤56° of % Δ)

Shasta TCD Configuration

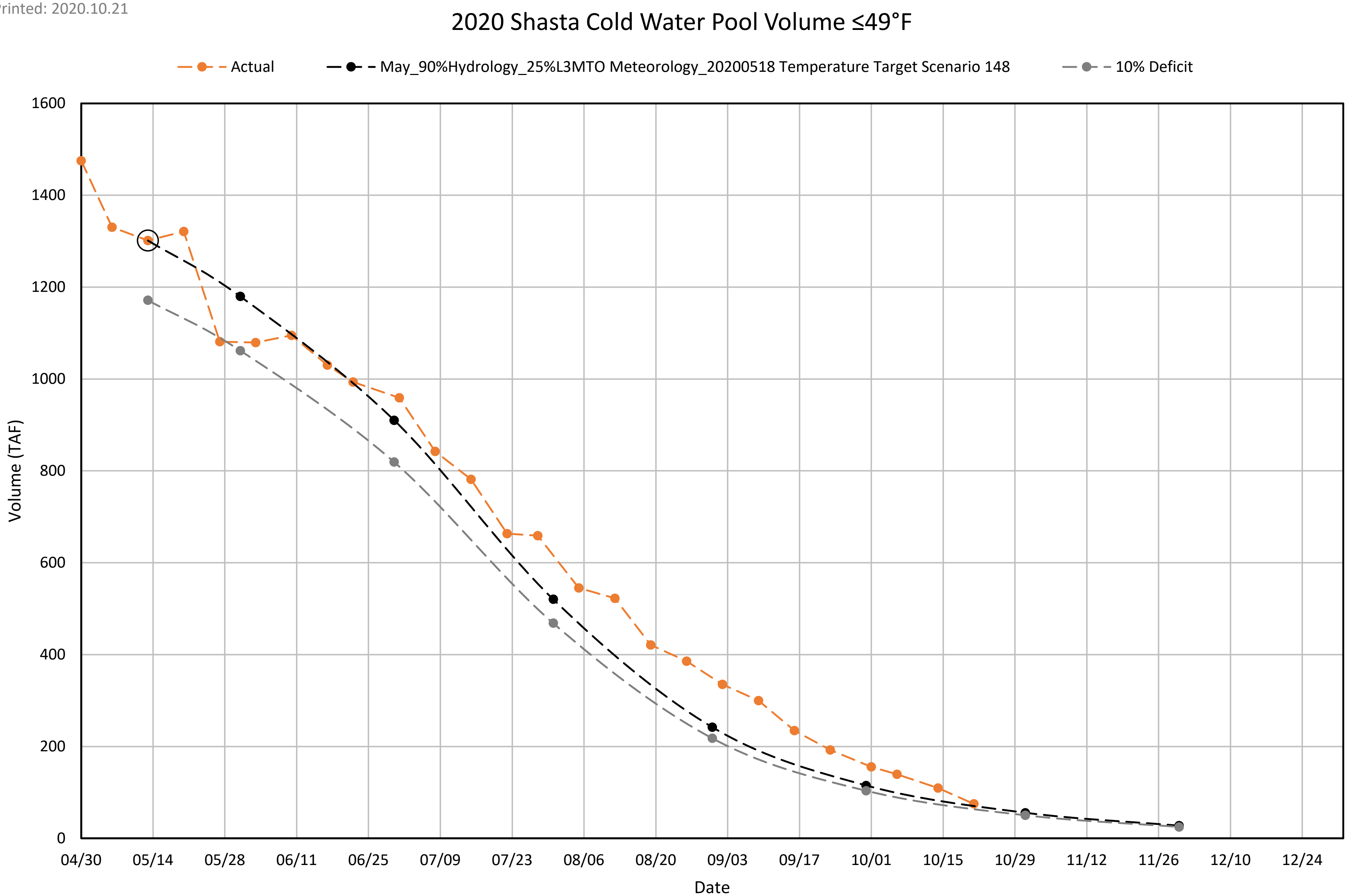
Starting Date: 10/15/2020

Ending Date: Current



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

Printed: 2020.10.21



October 22, 2020

Upper Sacramento River – September 2020 Preliminary Temperature Analysis

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

Model Run	Location	Oct 14-31*
90% Hydro. - 25% L3MTO Met. Scenario 148 Alt 6a	Keswick Dam KWK	54.4
	Sac. R. abv Clear Creek CCR	54.4
	Airport Road	54.6
	Balls Ferry BSF	54.9

Summary of Shasta Lake Cold Water Pool and TCD Operation

Model Run	End of September Cold Water Pool <56°F (TAF)	First Side Gate Use (Date)	Full Side Gate Use (Date)
90% Hydro. - 25% L3MTO Met. Scenario 148 Alt 6a	Actual: 476	Actual: 8/13	Actual: 10/15

Model Run Date October 19, 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 3-5). This relationship is an end of September Lake Shasta Volume less than 56°F and likely downstream temperature performance for the early fall months. Estimated temperatures for September and October may fall into a range indicated within the Fall Temperature Index (graphical chart), illustrating historical performance. However, this range should be viewed as an element of uncertainty based on past performance, not a simulation or projection of temperature management operations or results.

Temperature Analysis Results:

Modeling runs explore Sacramento River compliance performance above Clear Creek confluence and Balls Ferry locations by varying Shasta tailbay temperature targets. The temperature results for the Sacramento River between Keswick Dam and Balls Ferry and the Trinity River are shown in Figures 1-2. 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 October 14, October 8, and October 13, respectively. Initial temperature profiles are adjusted and noted at Whiskeytown and Trinity using simulated results if the length of time between monitoring is large. Model results are sensitive to initial reservoir temperature conditions and the model performs best under highly stratified conditions. The temperature profiles prior to May do not yet exhibit conditions for ideal model computations (still nearly isothermal conditions). The model performs well after the reservoir stratifies, typically in late spring (i.e. end of April). The concern this year is assuming over or under estimations with variable hydrologic and meteorological conditions and not capturing the stratification with sufficient detail to project into the future with confidence.
2. Guidance on forecasted flows from the creeks (e.g., Cow, Cottonwood, Battle, etc.) between Keswick Dam and Bend Bridge are not available beyond 5 days. Creek flows developed from the historical record that most closely reflects current conditions were used for all model runs. The resulting creek flows can cause significant additional warming in the upper Sacramento River during spring.
3. Operation is based on the October 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.). A preliminary version of the October 90% Operation Outlook was used, minor flow and volume variations should be expected for Oct – Dec. After September, historical information is used for inflow. Trinity Lake inflows are updated with the CNRFC 90% runoff exceedance for the 90% and DWR Bulletin 120 for the 50% runoff exceedance studies. The Operation Outlook assumes a representation of the State and Federal regulatory environment under NMFS and FWS 2019 Biological Opinions.
4. Although mean daily flows and releases are temperature model inputs, they are based on the mean monthly values from the operation outlooks. Mean daily flow patterns are user defined and are generalized representations. It is important to note that these outlooks do not suggest a certain actual future outcome, but rather the statistical likelihood of an event occurring, including, but not limited to, projected storage and releases. Thus, the outlooks do not provide exact end of month storages or flow rates but general projections that will likely fall within the range of uncertainty based on the different hydrologic runoff conditions between the 90%

and 50% runoff exceedance hydrology.
5. Cottonwood Creek flows, Keswick to Bend Bridge local flows, and ACID diversions are mean daily synthesized flows based on the available historical record for a 1922-2002 study period. Side-flows were adjusted to a 95% historical exceedance for both the 90% and 50% runoff exceedance studies.
6. Meteorological inputs represent historical (1985 – 2017) monthly mean equilibrium temperature non-exceedance at 25% and 50% (when available) patterned after like months on a 6-hour time-step (for months prior to April). Assumed inflows temperature remain static inputs and do not vary with the assumed meteorology. Tools to use local three-month-temperature outlooks (L3MTO), driven by the NOAA NWS Climate Prediction Center (CPC) are used beginning in April.
7. Meteorology, as well as the flow volume and pattern, significantly influences reservoir inflow temperatures and downstream tributary temperatures; and consequently, the development of the cold-water pool during winter and early spring, which is still uncertain prior to the end of April.
8. Modified model coefficients more closely represent actual Keswick Dam temperatures. As a result, temperature predictions downstream of Keswick Dam are likely to be warmer than actual.
9. The model is specifically being applied to generate the most accurate results at the Sacramento River above Clear Creek confluence location (CCR).

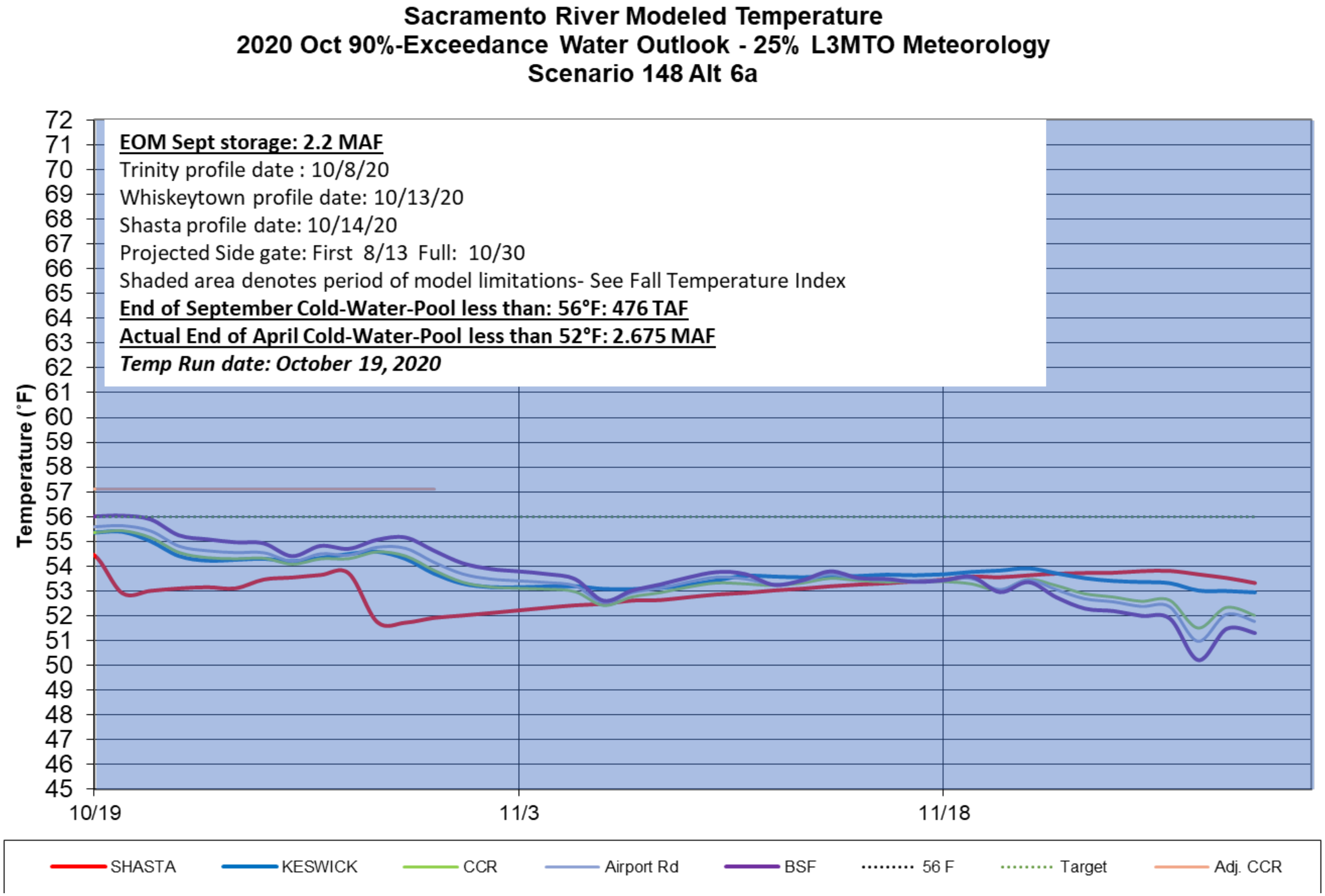


Figure 1. October 2020 simulated Sacramento River temperatures 90% runoff exceedance hydrology and 25% L3MTO meteorology with Scenario 148 Alt 6a.

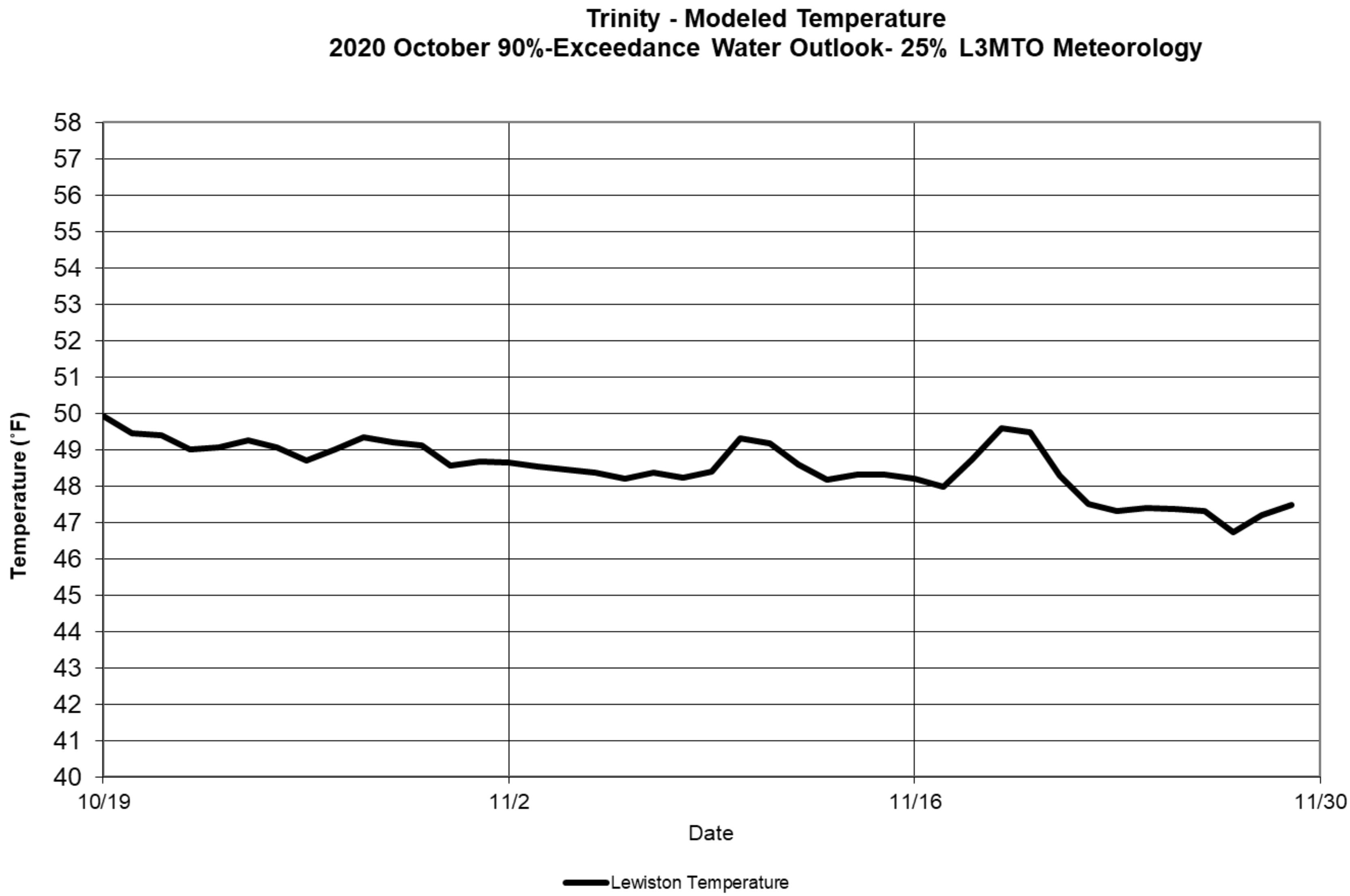


Figure 2. October 2020 simulated Trinity River temperatures 90% runoff exceedance hydrology and 25% L3MTO meteorology with Scenario 148 Alt 6a.

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.

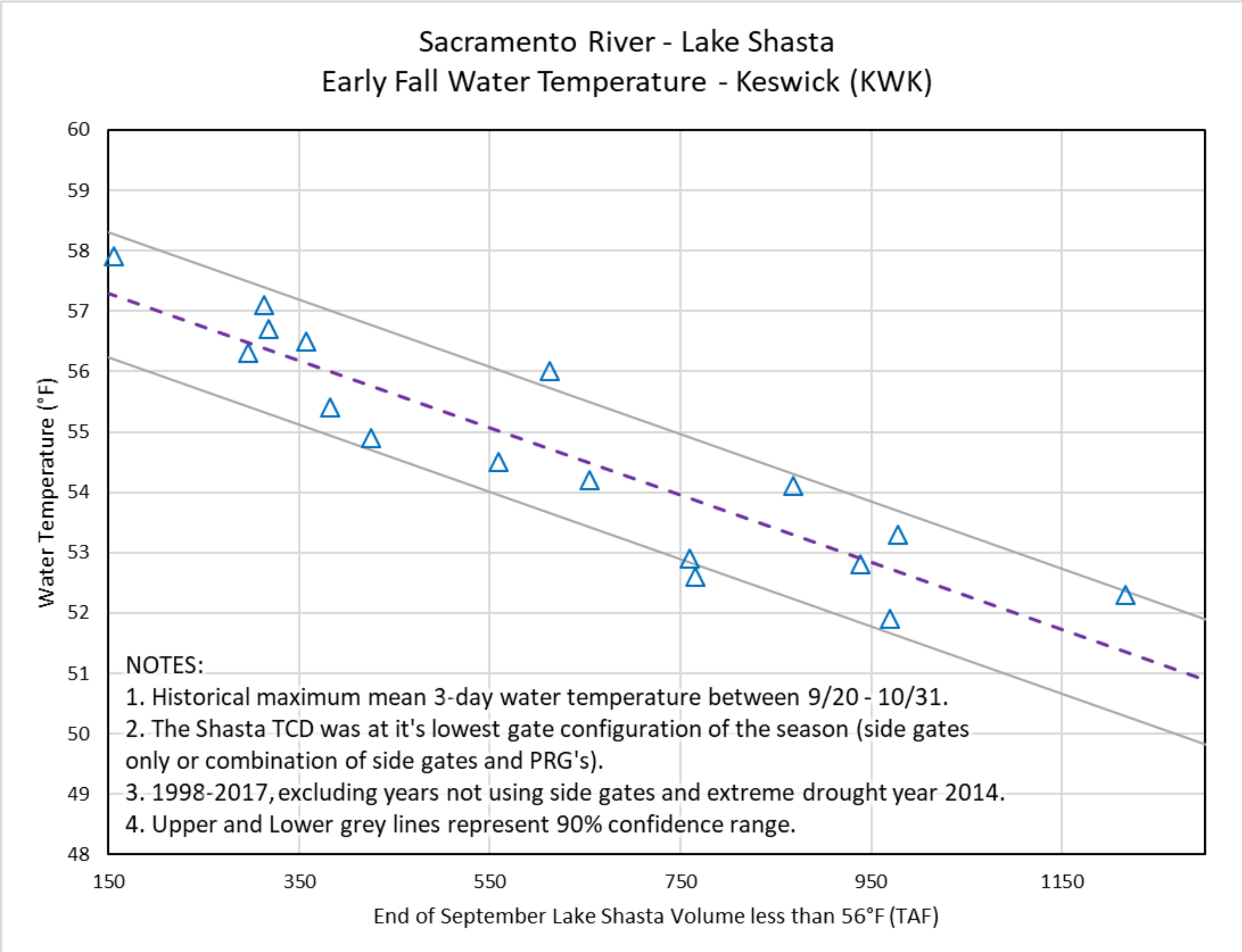


Figure 3. Historical relationship between Lake Shasta cold-water-pool characteristics and early fall Keswick water temperature.

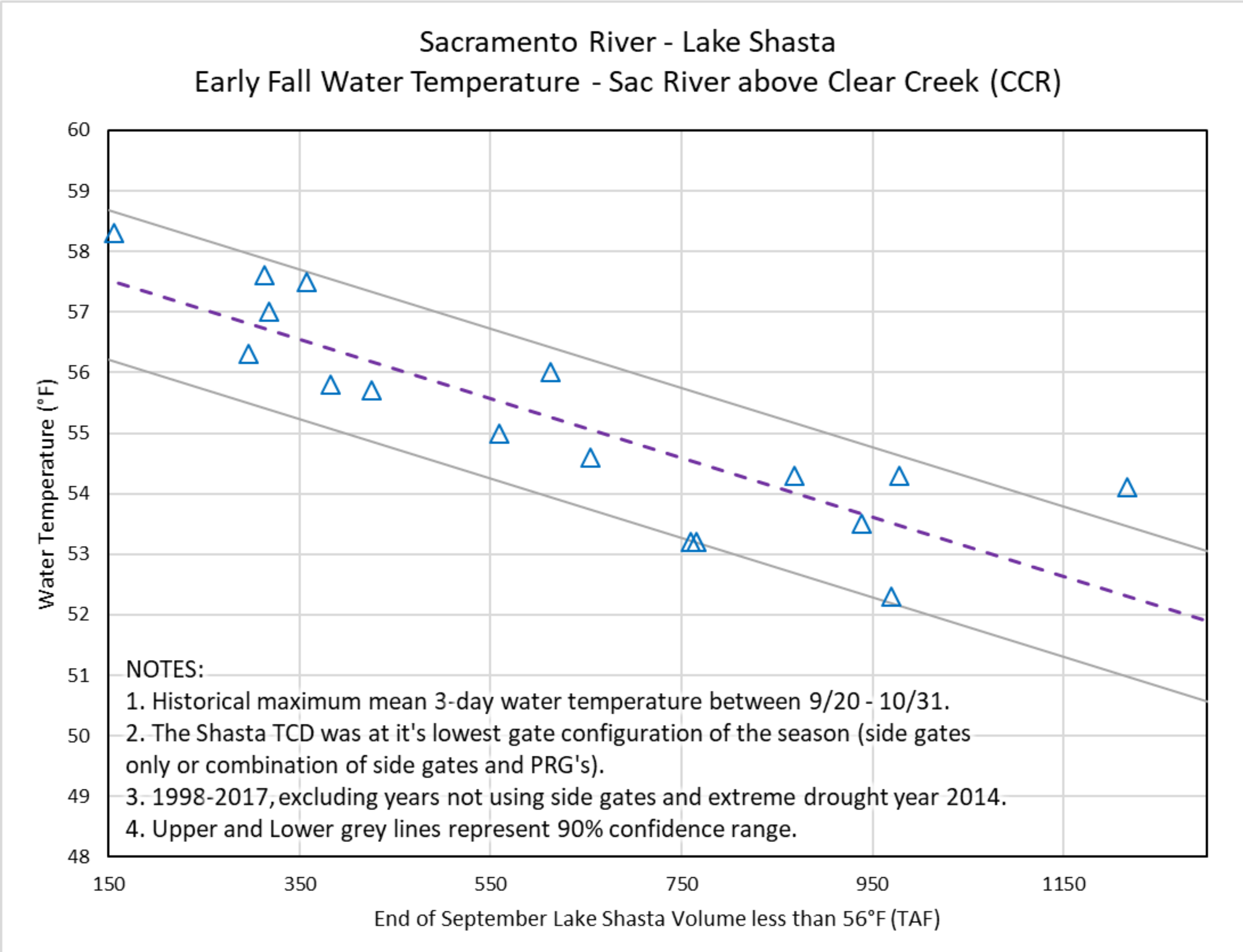


Figure 4. Historical relationship between Lake Shasta cold-water-pool characteristics and early fall Sacramento River above Clear Creek confluence water temperature.

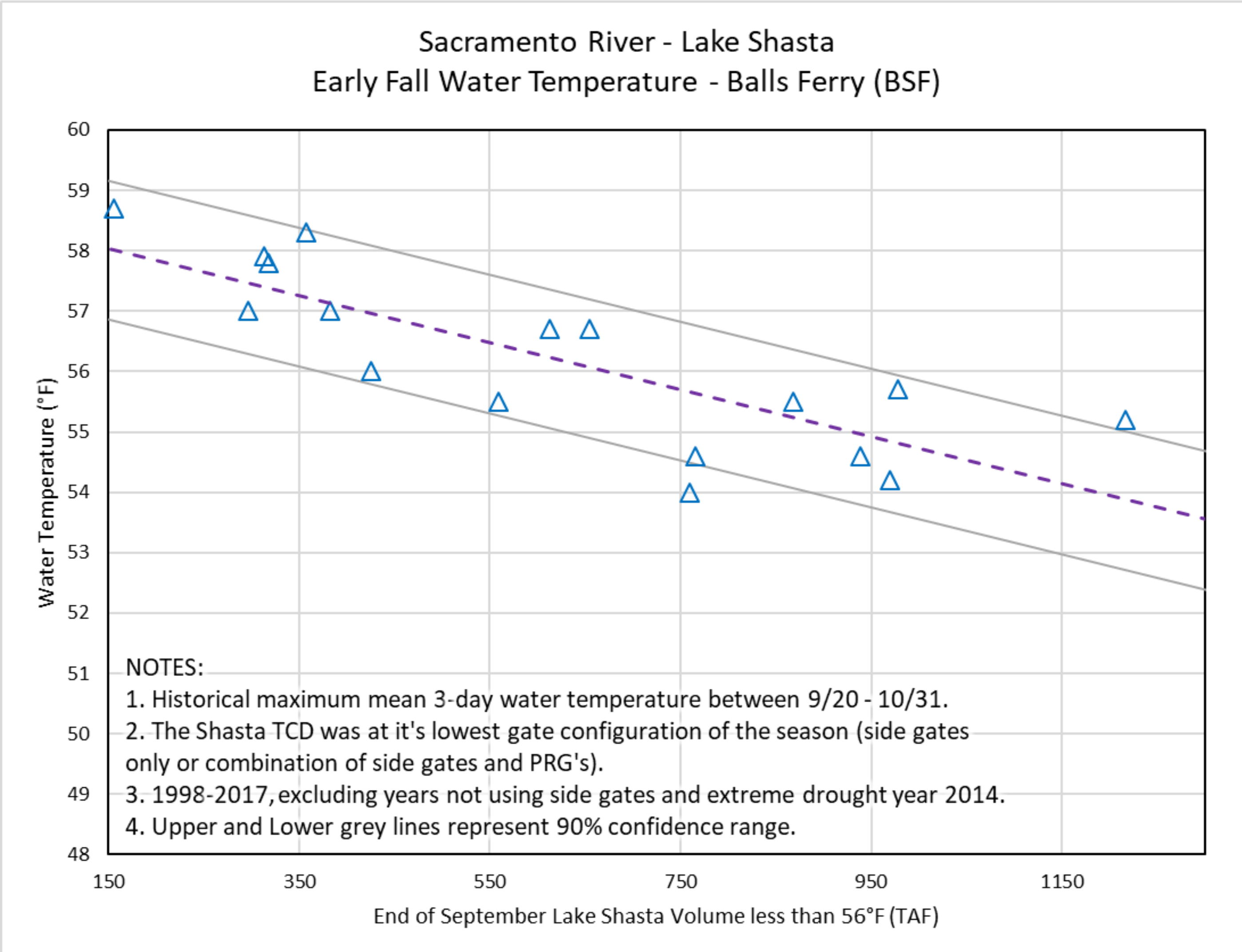
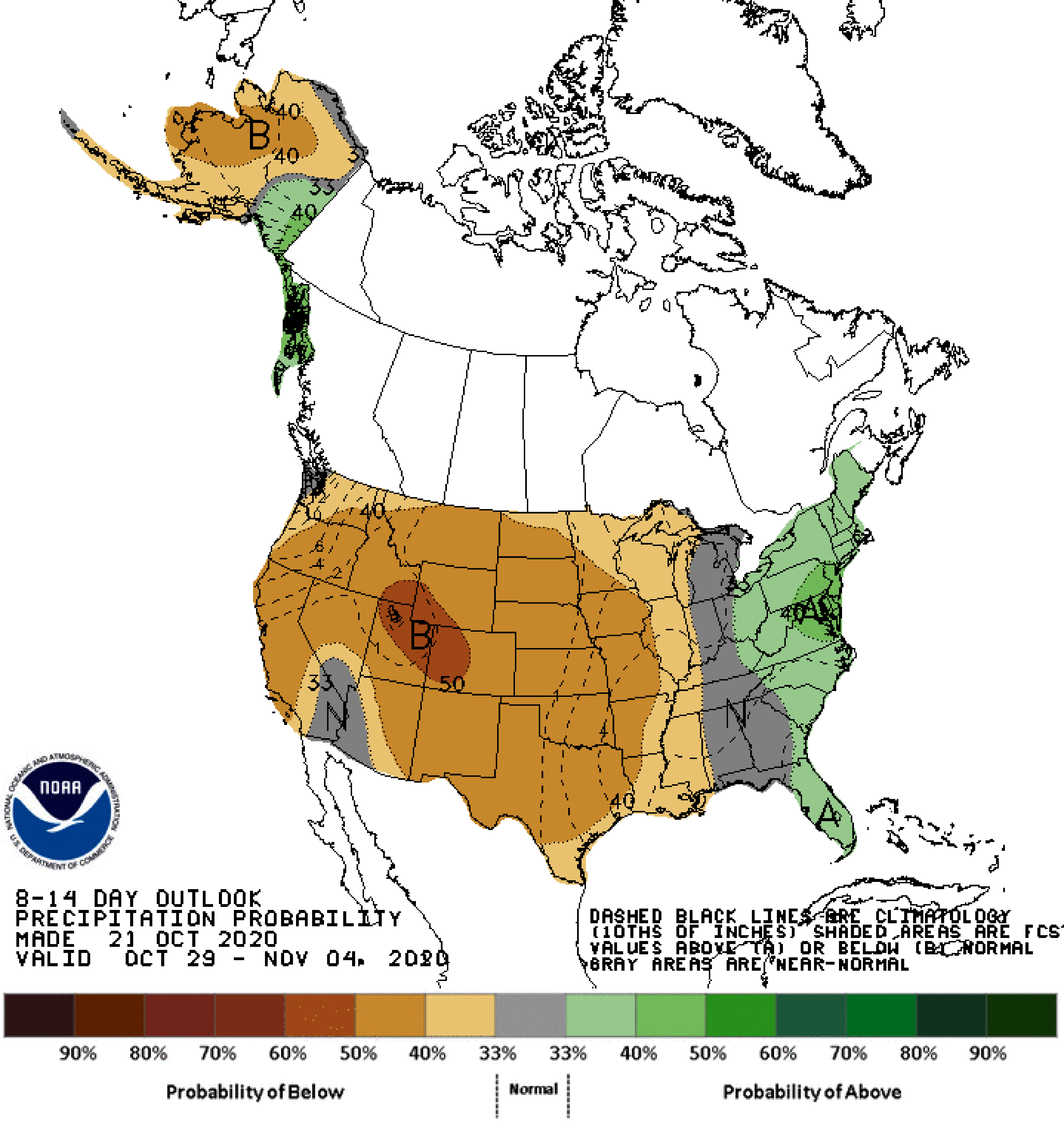
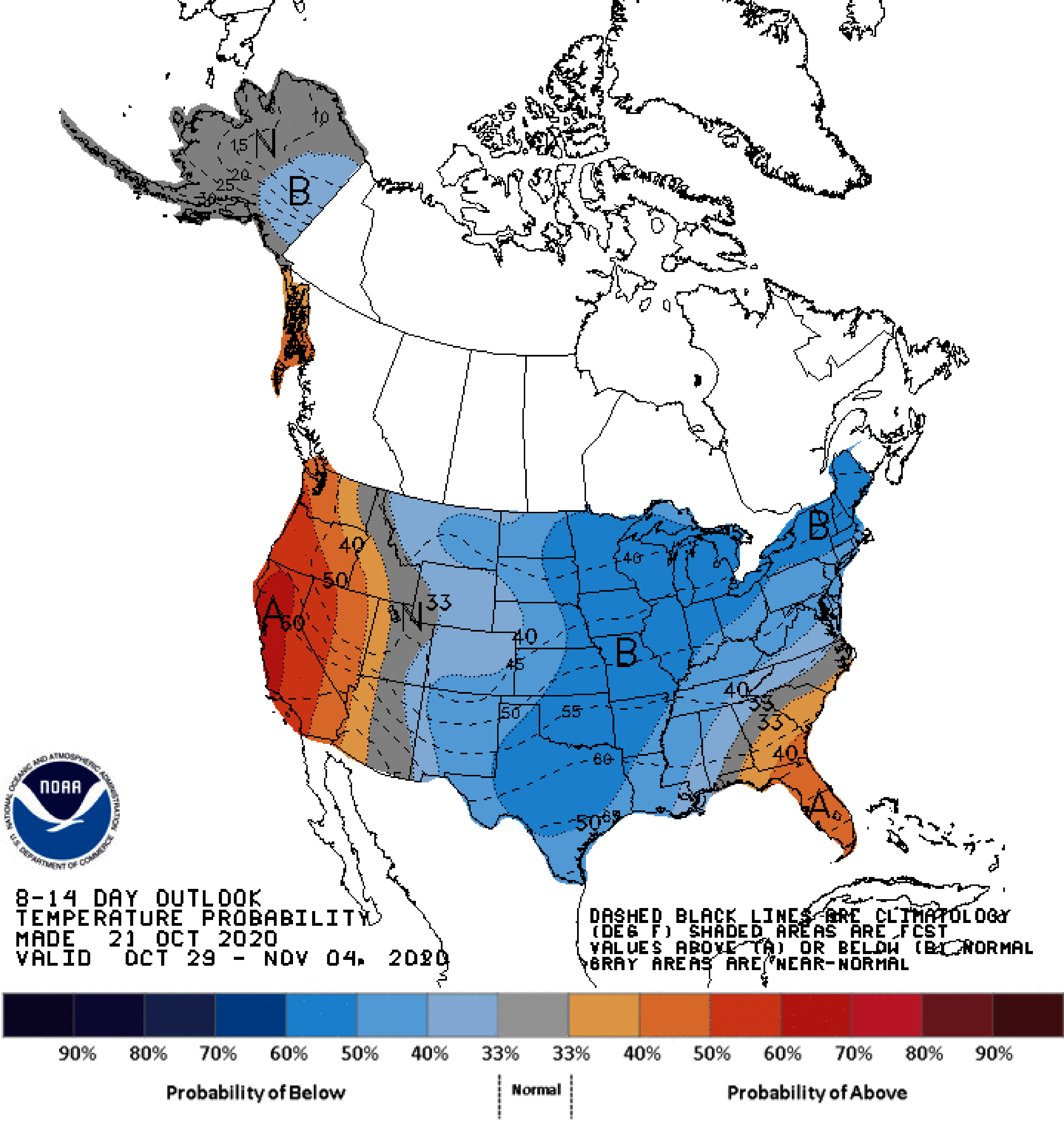


Figure 5. Historical relationship between Lake Shasta cold-water-pool characteristics and early fall Balls Ferry water temperature.


8-14 DAY OUTLOOK
PRECIPITATION PROBABILITY
MADE 21 OCT 2020
VALID OCT 29 - NOV 04, 2020
DASHED BLACK LINES ARE CLIMATOLOGY
(10THS OF INCHES) SHADED AREAS ARE FCS
VALUES ABOVE (A) OR BELOW (B) NORMAL
GRAY AREAS ARE NEAR-NORMAL
90% 80% 70% 60% 50% 40% 33% 33% 40% 50% 60% 70% 80% 90%
Probability of Below
Normal
Probability of Above


8-14 DAY OUTLOOK
TEMPERATURE PROBABILITY
MADE 21 OCT 2020
VALID OCT 29 - NOV 04, 2020
DASHED BLACK LINES ARE CLIMATOLOGY
(DEG F) SHADED AREAS ARE FCST
VALUES ABOVE (A) OR BELOW (B) NORMAL
GRAY AREAS ARE NEAR-NORMAL
90% 80% 70% 60% 50% 40% 33% 33% 40% 50% 60% 70% 80% 90%
Probability of Below
Normal
Probability of Above

Summary Document for temperature-dependent egg mortality

Prepared by U.S. Bureau of Reclamation, Bay-Delta Office on October 21, 2020

Below are biological results from the temperature management scenario run October 20, 2020 based on October 14, 2020 Shasta temperature profile. These estimates are from the same planning model used in the Temperature Tier Selection Protocol this spring and summer and used in the May 20 Temperature Management Plan.

Actual and modeled inputs are used to generate temperature-dependent egg mortality estimates for brood year 2020 winter-run Chinook salmon. Between May 12 and September 14, historical temperature data is used to capture actual observed temperature during the majority of the temperature management period. For this period, historical temperatures on the Sacramento River at Shasta Dam, Keswick Dam, above Clear Creek, Balls Ferry, Jelly's Ferry, and Bend Bridge are interpolated to estimate temperatures at river miles where simulated redds were located. Between September 15 and November 29, daily temperatures at the simulated redds' river miles are estimated based on a relationship between cold water pool volume less than 56 degrees F at the end of September in Shasta Lake and water temperatures above Clear Creek derived by Central Valley Operations. Reclamation thinks this relationship is more reliable in that time period than outputs from the HEC-5Q model. The 90% confidence interval value from this analysis was used as a conservative estimate. The average difference between the simulated temperatures above Clear Creek and the simulated temperatures at the redds' river miles during this period are used to adjust above Clear Creek estimated temperatures for each river mile. Temperature-dependent egg mortality estimates are calculated by modeling a redd's lifetime based on the days required to cross a known cumulative degree-day threshold and estimating mortality as an increasing function of temperature past a temperature threshold. Two models were used: 1. Martin et al (2017)[1] for stage independent modeling whereby a single temperature threshold is used from spawning and incubation through emergence; and 2. Anderson et al. (2018)[2] for stage dependent modeling for targeting different temperatures before, during, and after the most sensitive stages during egg incubation. The methods are applied to a set of simulated redds representative of redd construction timing and location from 2007-2014 and the results summarized on a seasonal level for comparison.

Further information about the model's assumptions and methods are described in Reclamation's Final EIS for the Reinitiation of Consultation on the Coordinated LTO of the CVP and SWP: Appendix F- Modeling.

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[1] Martin B.T. et al. (2017). Phenomenological vs. biophysical models of thermal stress in aquatic eggs. Ecology Letters 10:50-59.

[2] Anderson, J. (2018). Using river temperature to optimize fish incubation metabolism and survival: a case for mechanistic models. ResearchGate Preprint. 10.1101/257154.

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

Scenario	Stage Dependent Egg Mortality – Anderson Model (%)	Stage Independent Egg Mortality – Martin Model (%)
Scenario 148	9.5	24.9

Summary Document for Shasta/Keswick Operational Scenarios
Prepared by the Southwest Fisheries Science Center on October 21st, 2020

Below are results for one USBR scenario ran October 20th 2020. The scenario has hydrology (Input 90% exceedance) and air temperature (25% exceedance of L3MTO) as inputs. Inputs from the scenario are used to generate daily average Sacramento River water temperatures using the RAFT model and associated temperature-dependent egg mortality and survival estimates using the NMFS stage-independent temperature mortality model (Martin et al. 2017) for the 2020 temperature management season.

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

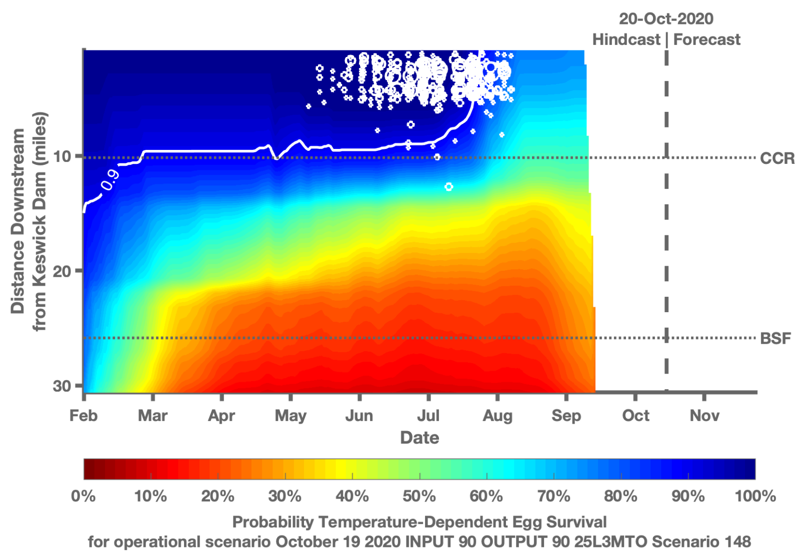

Figure1: Estimated temperature-dependent egg survival produced by the NMFS stage-independent temperature mortality model under the one October 19th 2020 scenario. 2012-2019 redd distributions are used for all plots.

Table 1: Estimated temperature-dependent egg mortality under the one October 19th 2020 scenario assuming a 2012-2019 spatial and temporal redd distribution using output from RAFT model.

Scenario	MODEL	Mean (%)	Median (%)	Lower (%)	Upper (%)
OCTOBER_19_2020_INPUT_90_OUTPUT_90_25L3MTO **Scenario 148**	RAFT	11.78	6.36	0.11	53.31

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

		Example run input data, Michael Wright inputs for R code developed 2017.	
		Hindcast May-1-2020 to Aug-30-2020	Forecast Sep-3-2020 to Nov-30-2020
	Model Type	Martin Model (stage independent)	Martin Model (stage independent)
	Egg emergence time to hatch	958 ATUs (degrees C), as indicated for Zueg et al. on SacPAS under Egg to emergence timing model. This is meant to calculate time to emergence, not hatch; my understanding was that the Martin model calculates mortality from laying of eggs to emergence. Zeug parameters used are cumulative sum of 0.00058*Daily temperature (F) - 0.018 = 1.	958 ATUs (degrees C), as indicated for Zueg et al. on SacPAS under Egg to emergence timing model. This is meant to calculate time to emergence, not hatch; my understanding was that the Martin model calculates mortality from laying of eggs to emergence. Zeug parameters used are cumulative sum of 0.00058*Daily temperature (F) - 0.018 = 1.
Temperature-dependent egg mortality model	TDM redd time distribution	2020	Average of 2007-2014
	TDM redd space distribution	2020	Average of 2007-2014
	TDM Tcrit (50th percentile)	11.96 degrees C (53.53 degrees F) from Matlab code transmitted by Dr. Martin Jul 28 2017.	11.96 degrees C (53.53 degrees F) from Matlab code transmitted by Dr. Martin Jul 28 2017.
	TDM bT (50th percentile)	0.024 $°C^{-1}d^{-1}$ = 0.0133 $°F^{-1}d^{-1}$; bT is from Matlab code transmitted by Dr. Martin Jul 28 2017.	0.024 $°C^{-1}d^{-1}$ = 0.0133 $°F^{-1}d^{-1}$; bT is from Matlab code transmitted by Dr. Martin Jul 28 2017.
	Critical Days	All	All
In-River Temperature	Water Temperature	Historic Daily Average Temperature (calculated by linear interpolation from locations in ObsTw spreadsheet) at the following locations: River miles 229, 257, 266, 271, 275, 284, 296, and 298.	HEC 5Q Output (See HEC5Q Assumptions) at the following locations: River miles 229, 257, 266, 271, 275, 284, 296, and 298.
	TDM Output		

Commented [USBR1]: Martin model parameters from July 2017 e-mails with Dr. Martin and Matlab code he sent - MJW

		Example run input data, Michael Wright inputs for R code developed 2018.	
		Hindcast May-1-2020 to Aug-30-2020	Forecast Sep-3-2020 to Nov-30-2020
	Model Type	Anderson Model (stage dependent)	Anderson Model (stage dependent)
	Egg emergence time to hatch	Calculated using power law (Alderdice-Velson 1978), cumulative sum of exp(log(0.08646) + 1.23473*log(daily temps (C) - -2.26721)) = 100, used because Dr. Anderson attached it to an e-mail Dec 3 2018 as “Method to compute time to hatching”. This is meant to calculate time to hatching, not emergence; my understanding was that the Anderson model uses critical days before hatching.	Calculated using power law (Alderdice-Velson 1978), cumulative sum of exp(log(0.08646) + 1.23473*log(daily temps (C) - -2.26721)) = 100, used because Dr. Anderson attached it to an e-mail Dec 3 2018 as “Method to compute time to hatching”. This is meant to calculate time to hatching, not emergence; my understanding was that the Anderson model uses critical days before hatching.
Temperature-dependent egg mortality model	TDM redd time distribution	2020	Average of 2007-2014
	TDM redd space distribution	2020	Average of 2007-2014
	TDM Tcrit (50^{th} percentile)	11.9 degrees C (53.42 degrees F) from Anderson 2018 Table 2 for model III	11.9 degrees C (53.42 degrees F) from Anderson 2018 Table 2 for model III
	TDM bT (50^{th} percentile)	0.5 $°C^{-1}d^{-1}$= 0.278 $°F^{-1}d^{-1}$	0.5 $°C^{-1}d^{-1}$= 0.278 $°F^{-1}d^{-1}$
	Critical Days	5, from e-mail with Dr. Anderson, Dec 3 2018. SacPAS was then set to this value at that time, and the bT on SacPAS was 0.5.	5, from e-mail with Dr. Anderson, Dec 3 2018. SacPAS was set to this value at that time, and the bT on SacPAS was 0.5.
In-River Temperature	Water Temperature	Historic Daily Average Temperature (calculated by linear interpolation from locations in ObsTw spreadsheet) at the following locations: River miles 229, 257, 266, 271, 275, 284, 296, and 298.	HEC 5Q Output (See HEC5Q Assumptions) at the following locations: River miles 229, 257, 266, 271, 275, 284, 296, and 298.
	TDM Output		

Commented [USBR2]: Anderson model parameters from November-December 2018 phone call and e-mails with Dr. Anderson - MJW

Memo: Computing time to hatching

Date: 9 Feb. 2018

From: CBR/SAFS/UW Seattle, WA 98195

Time to hatching is based on the exposure of the eggs to daily temperatures, where a given temperature results in a small percentage in crease in development. When the accumulated percentage is 100%, that day is the hatching day.

The daily accumulated percentage formula is based on the log-inverse form of the Bělehrádek equation, calibrated for Chinook salmon eggs (Alderdice and Velsen 1978):

$$\ln(P) = \ln(k) + b(\ln(t - c))$$

where:

k = 0.08646
b = 1.23473
c = -2.26721

P = daily development rate

t = daily temperature

Alderdice, D. F., and F. P. J. Velsen. 1978. Relation between temperature and incubation time for eggs of Chinook Salmon (*Oncorhynchus tshawytscha*). Journal of the Fisheries Research Board of Canada 35(1):69-75.

```
close all

clear


load('reddMeanTemps.mat') % matrix of temp exposure profiles for a population of redds. Each row is the time series of the daily mean temps experienced by a redd from fertilization to emergence, calculated using Zueg development model


Temp=reddMeanTemps;

% Parameter values

Tcrit=11.96;% critical temperature (C)

BT=0.024; %tem-dependent mortality slope parameter

S_0=0.3662; % expected egg to fry survival probability in theabsence of temperature or density-dependent survival

K=9107.88; % Bev-Holt carring capacity

FemaleN=2000; %number of female spawners


%calculate survival of indivdual redds

HazardMat=BT*(max((Temp)-Tcrit,0)); %calculate daily temp-dependent mortality hazard

HazardMat(isnan(HazardMat)) = 0;

Sb_field=1./(1+(FemaleN./K)); %density dependent background survival

ETF_S = (S_0*Sb_field).*prod(exp(-HazardMat),2); % vector with predicted egg-to-fry survival for each redd

Tmort=1-(prod(exp(-HazardMat),2)); % vector with predicted temp-dependent mortality for each redd


% Compute average annual ETF survival and temp-dependent mortality from redds

Population_Temp_dependent_mortality=mean(Tmort)

Population_Egg_to_fry_survival=mean(ETF_S)
```