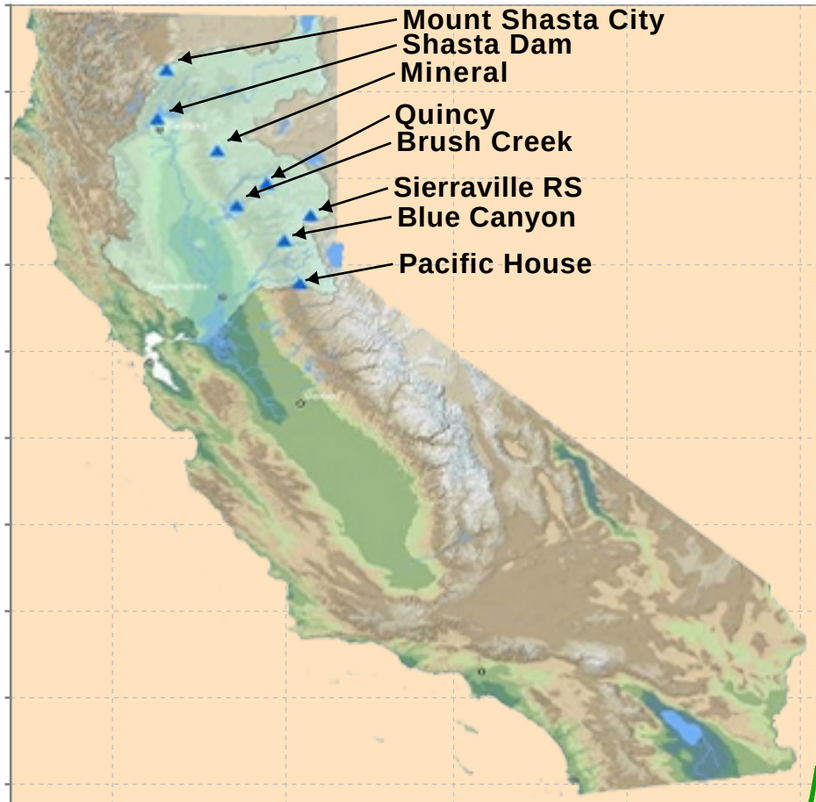
Northern Sierra Precipitation: 8-Station Index, April 21, 2021



Percent of Average for this Date: 49%

2016-2017 Daily Precip (wettest) 94.7

1982-1983 (2nd wettest) 88.5

2018-2019 Daily Precip 70.7

Average (1966-2015) 51.8

2017-2018 Daily Precip 41.0

2014-2015 Daily Precip 37.2

2019-2020 Daily Precip 31.7

Current: 22.4

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

Cumulative Daily/Monthly Precipitation (inches)

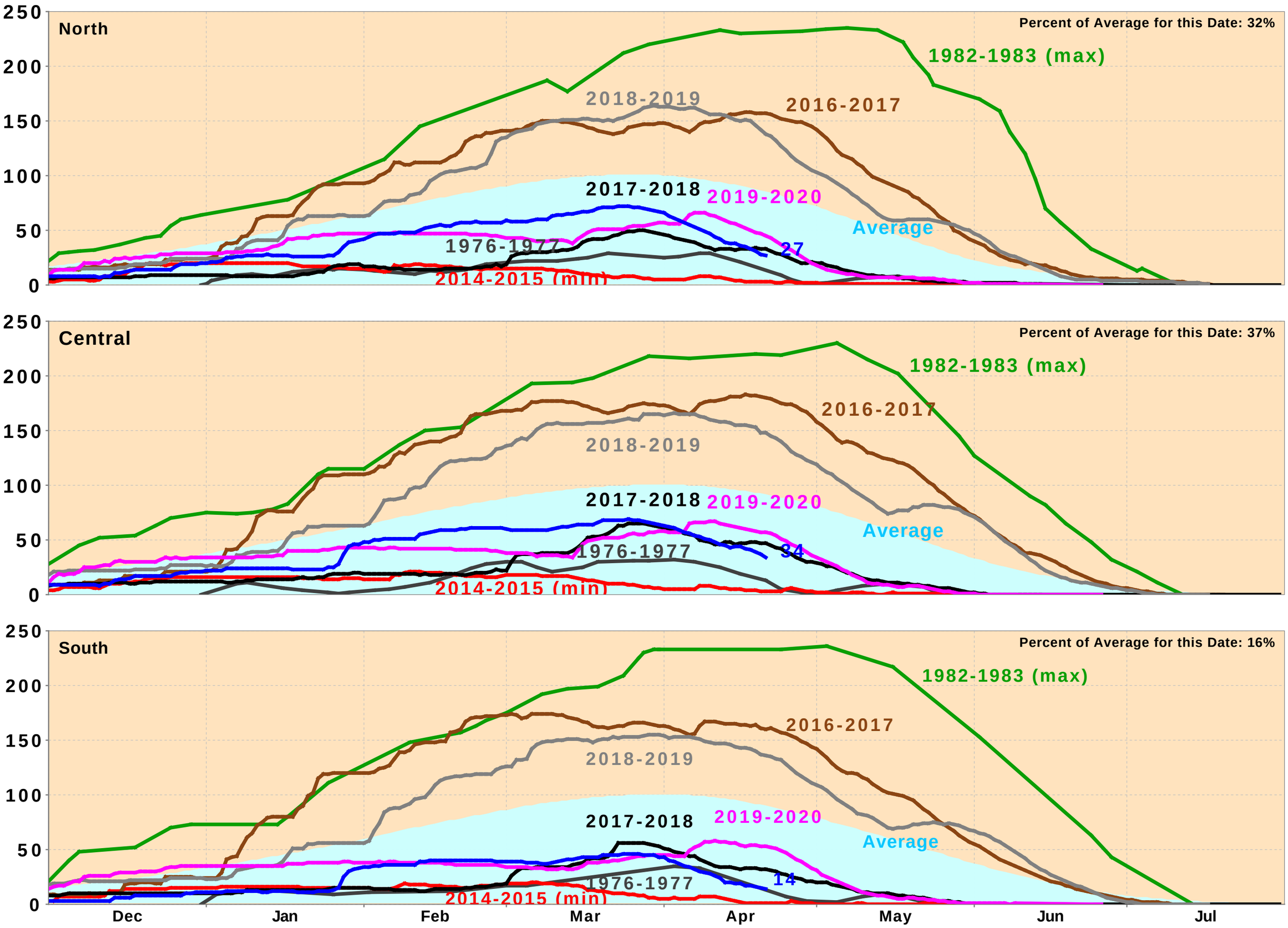
Total Water Year Precipitation

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

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

Water Year (October 1 - September 30)

California Snow Water Content, April 21, 2021, Percent of April 1 Average



Statewide Percent of April 1: 27%

Statewide Percent of Average for Date: 30%

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

DAILY CVP WATER SUPPLY REPORT

APRIL 20, 2021

RUN DATE: April 21, 2021

RESERVOIR RELEASES IN CUBIC FEET/SECOND

RESERVOIR	DAM	WY 2020	WY 2021	15 YR MEDIAN
TRINITY	LEWISTON	1,008	527	317
SACRAMENTO	KESWICK	6,969	6,460	6,460
FEATHER	OROVILLE (SWP)	1,550	1,100	1,550
AMERICAN	NIMBUS	1,472	2,056	2,012
STANISLAUS	GOODWIN	631	669	1,502
SAN JOAQUIN	FRIANT	384	346	384

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	1,775	1,946	1,309	74
SHASTA	4,552	3,628	3,749	2,353	65
FOLSOM	977	680	637	357	52
NEW MELONES	2,420	1,524	1,909	1,495	98
FED. SAN LUIS	966	686	584	413	60
TOTAL NORTH CVP	11,363	8,293	8,825	5,927	71
MILLERTON	520	298	301	212	71
OROVILLE (SWP)	3,538	2,501	2,441	1,493	60

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	218	102	1,380	645	34
SHASTA	1,618	1,527	7,751	3,329	49
FOLSOM	538	217	3,929	1,502	36
NEW MELONES	236	----	1,241	505	47
MILLERTON	283	116	1,825	538	53

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	15.62	9.27	50.99	28.37 (59)	55	0.00
SACRAMENTO AT SHASTA DAM	23.04	11.04	104.29	55.56 (64)	41	0.00
AMERICAN AT BLUE CANYON	30.78	15.64	95.61	59.44 (46)	52	0.00
STANISLAUS AT NEW MELONES	16.65	----	41.89	25.02 (43)	67	0.00
SAN JOAQUIN AT HUNTINGTON LK	17.32	11.50	75.20	37.17 (46)	47	0.00

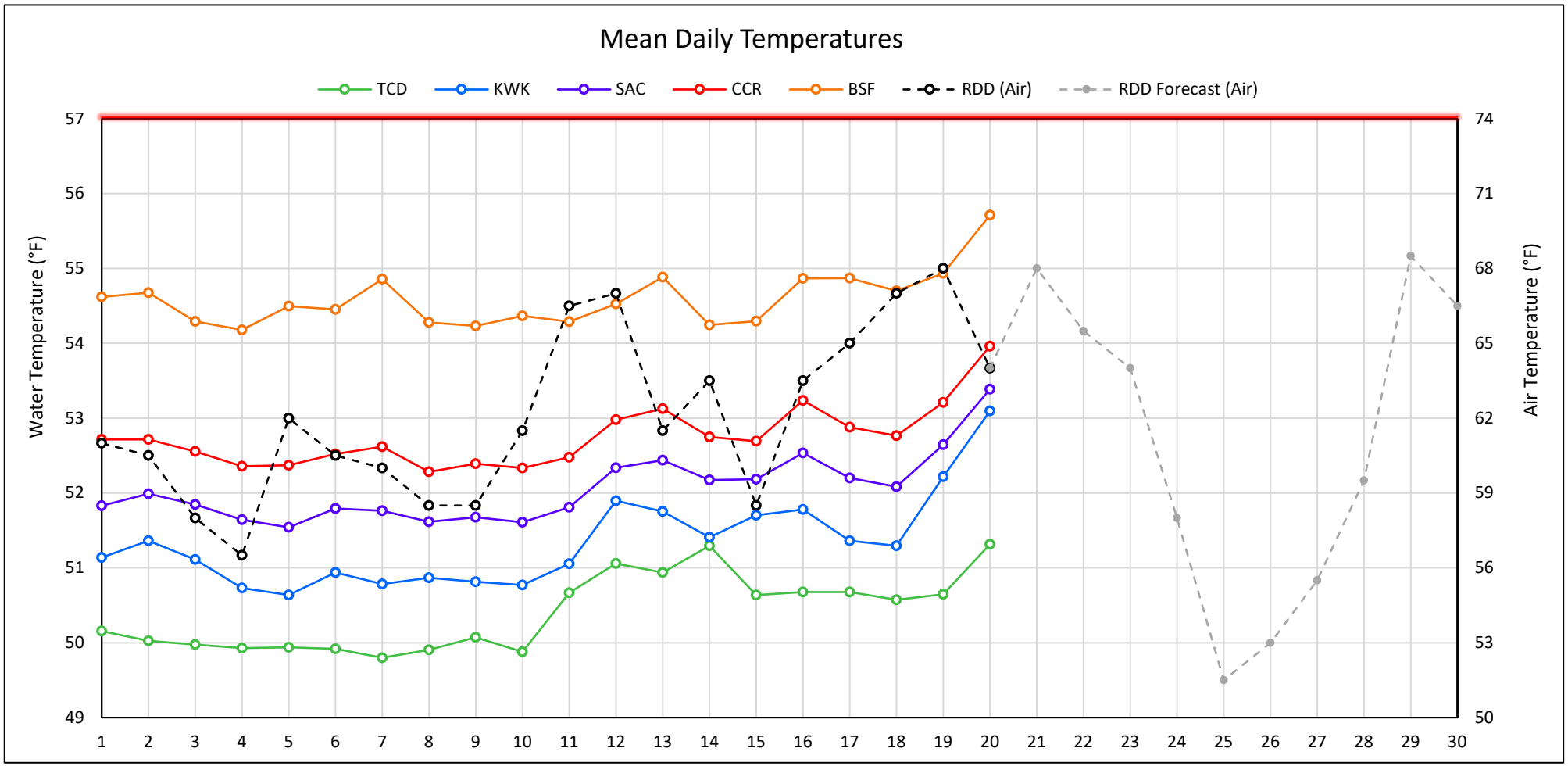
DATE	Mean Daily Water Temperatures (°F)														Mean Daily Release (CFS)			Mean Daily Air Temperatures (°F)		
	TCD[1]	SHD	SPP[1]	KWK	SAC	CCR[2]	BSF	JLF	BND	RDB	IGO[3]	LWS	DGC	NFH	Shasta Generation	Spring Creek P.P.	Keswick Total	RDD	BSF	RDB
Mar	49.7	49.1	48.5	49.7	50.1	50.5	51.4	51.9	52.6	52.5	48.4	48.0	48.0	47.8	3089	172	3644	53.0	51.3	53.2
04/01	50.2	49.7	49.7	51.1	51.8	**52.7**	54.6	55.8	56.8	57.0	50.7	50.5	52.7	52.0	3597	77	3456	61.0	59.2	62.3
04/02	50.0	49.4	49.5	51.4	52.0	**52.7**	54.7	55.9	56.8	57.3	50.6	50.5	53.0	52.3	3644	139	4037	60.5	58.5	61.5
04/03	50.0	49.5	49.4	51.1	51.8	**52.6**	54.3	55.4	56.2	56.8	50.6	50.7	52.6	52.2	3998	168	4496	58.0	56.9	59.5
04/04	49.9	49.5	49.1	50.7	51.6	**52.4**	54.2	55.4	56.3	56.7	50.9	51.4	53.1	52.7	4164	497	4495	56.5	56.1	57.6
04/05	49.9	49.3	49.7	50.6	51.5	**52.4**	54.5	55.9	56.8	57.2	51.5	51.3	55.4	54.1	4252	74	4496	62.0	59.1	58.9
04/06	49.9	? 49.4	-	50.9	51.8	**52.5**	54.5	55.8	56.8	57.4	51.3	51.0	55.1	54.2	3791	0	4500	60.5	58.5	60.9
04/07	49.8	49.5	-	50.8	51.8	**52.6**	54.9	56.2	57.1	57.6	51.4	51.2	55.2	54.1	3723	0	4551	60.0	58.0	58.8
04/08	49.9	? 49.6	50.2	50.9	51.6	**52.3**	54.3	55.7	56.7	57.4	50.9	51.4	54.1	53.1	4445	45	4968	58.5	58.1	59.2
04/09	50.1	? 49.8	49.8	50.8	51.7	**52.4**	54.2	55.4	56.3	56.9	51.2	51.9	54.3	53.1	4761	76	4956	58.5	57.2	59.1
04/10	49.9	50.2	49.8	50.8	51.6	**52.3**	54.4	55.7	56.7	57.2	51.2	51.2	54.4	52.9	2505	754	4951	61.5	60.1	62.5
04/11	50.7	51.7	49.6	51.1	51.8	**52.5**	54.3	55.5	56.6	57.1	51.4	50.4	54.5	53.5	4697	398	4944	66.5	63.7	65.3
04/12	51.1	50.5	49.9	51.9	52.3	**53.0**	? 54.5	55.7	56.7	57.1	51.4	50.3	54.4	53.9	4253	52	4950	67.0	67.7	67.2
04/13	50.9	50.3	50.2	51.8	52.4	**53.1**	54.9	55.9	56.7	57.0	51.2	50.0	54.1	53.8	4739	50	5485	61.5	59.5	61.4
04/14	51.3	50.7	50.1	51.4	52.2	**52.8**	? 54.2	55.2	56.1	56.7	51.1	50.0	53.7	53.2	5031	39	6007	63.5	63.1	63.2
04/15	50.6	? 50.2	49.3	51.7	52.2	**52.7**	54.3	55.3	56.3	56.8	51.1	49.5	57.0	53.7	5308	217	6014	58.5	57.3	59.2
04/16	50.7	? 50.3	50.1	51.8	52.5	**53.2**	54.9	55.9	56.8	57.1	51.6	49.3	57.9	54.8	5603	40	6011	63.5	61.5	64.8
04/17	50.7	? 50.1	50.4	51.4	52.2	**52.9**	54.9	56.2	57.2	57.9	51.7	49.8	55.9	53.0	5526	40	6015	65.0	63.5	67.7
04/18	50.6	? 52.2	50.4	51.3	52.1	**52.8**	54.7	56.0	57.0	57.7	51.9	49.4	56.9	53.6	4752	40	6562	67.0	64.6	67.5
04/19	? 50.6	52.3	? 50.2	52.2	52.6	**53.2**	54.9	56.2	57.2	57.9	52.4	49.4	57.8	54.5	4232	40	6481	68.0	66.5	67.6
04/20	51.3	55.1	50.5	53.1	53.4	**54.0**	55.7	56.9	57.8	58.3	52.1	49.5	55.4	53.7	2736	62	6460	64.0	61.3	64.7
04/21																				
04/22																				
04/23																				
04/24																				
04/25																				
04/26																				
04/27																				
04/28																				
04/29																				
04/30																				
-																				
Apr	50.4	50.5	49.9	51.3	52.1	52.7	54.6	55.8	56.7	57.2	51.3	50.4	54.9	53.4	4288	140	5192	62.1	60.5	62.4
													Total CFS		85757	2808	103835			
													Total AF		170096	5570	205952			

Legend

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

Notes

[1] Temperatures are weighted averages based on individual penstock flow and temperature
Highlighted cells in the TCD column indicate a TCD change was made on that day
[2] Current Sacramento River control point (see page 4 for more details)

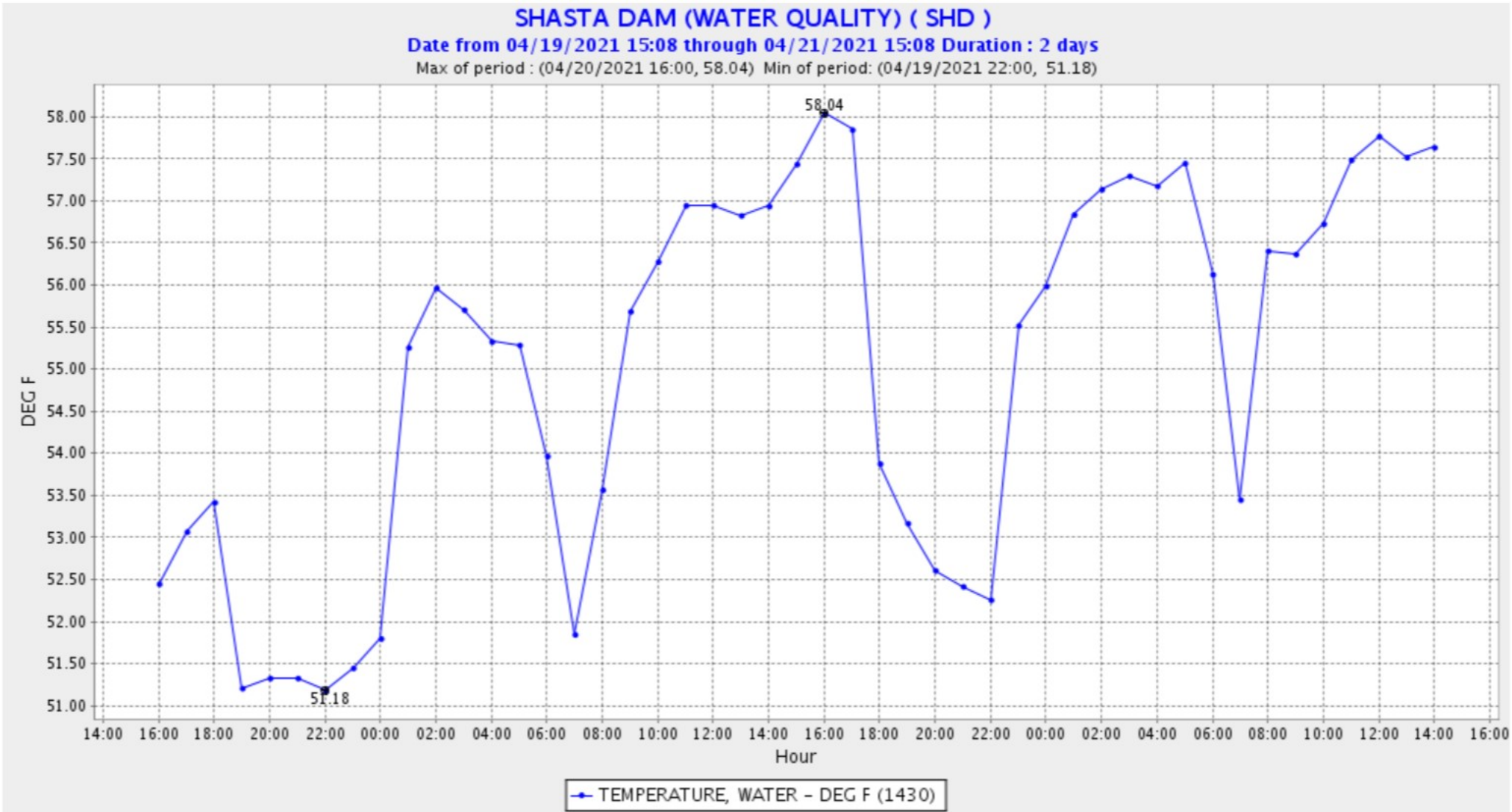


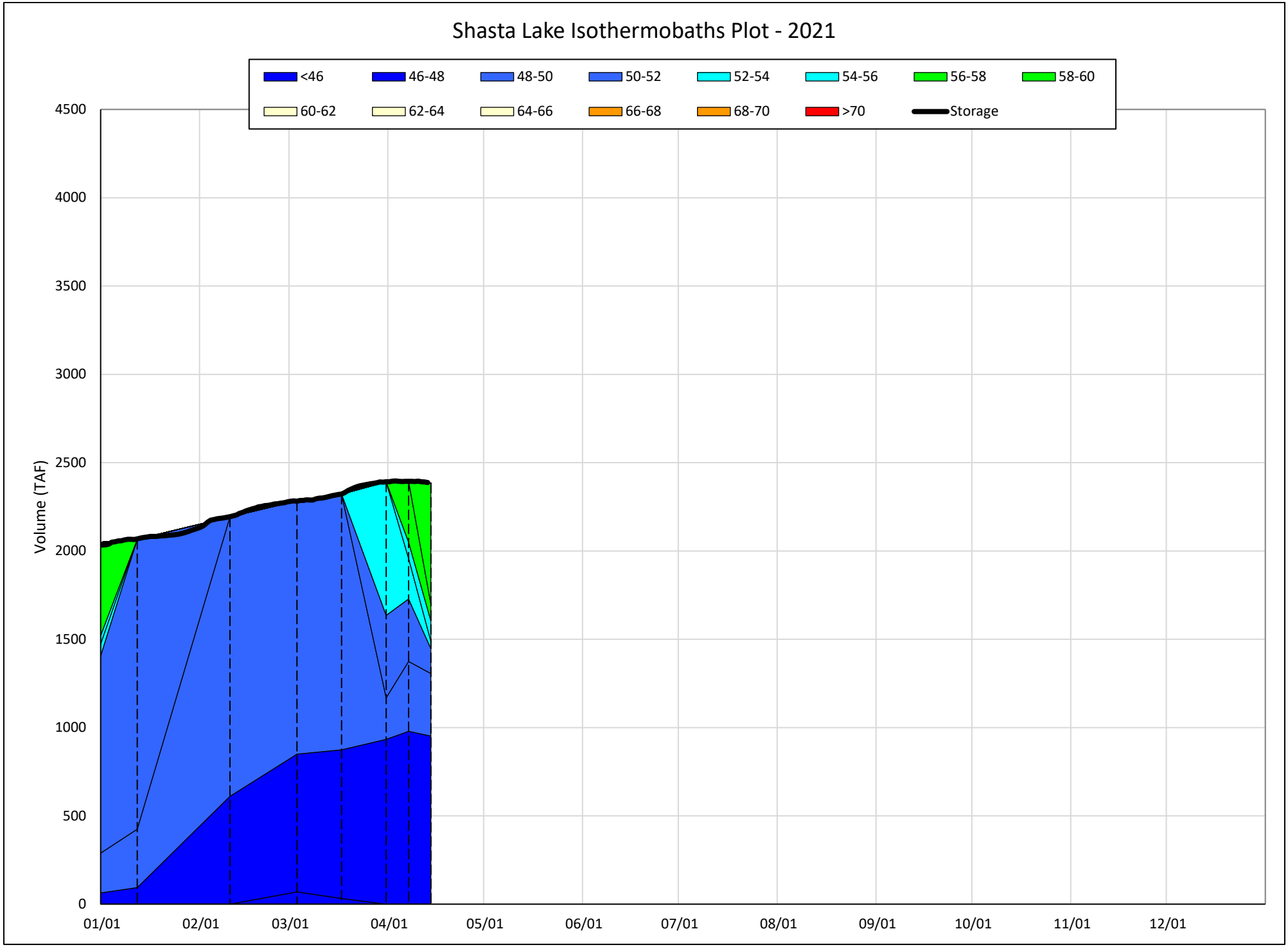
Station Details			
Code	Body of Water	Location[1]	CDEC Link
TCD	N/A	Shasta Power Plant	N/A
SHD	Sacramento River	0.3 miles downstream of Shasta Power Plant	Click Here
SPP	N/A	Spring Creek Power Plant	N/A
KWK	Sacramento River	0.8 miles downstream of Keswick Dam	Click Here
SAC	Sacramento River	4.8 miles 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

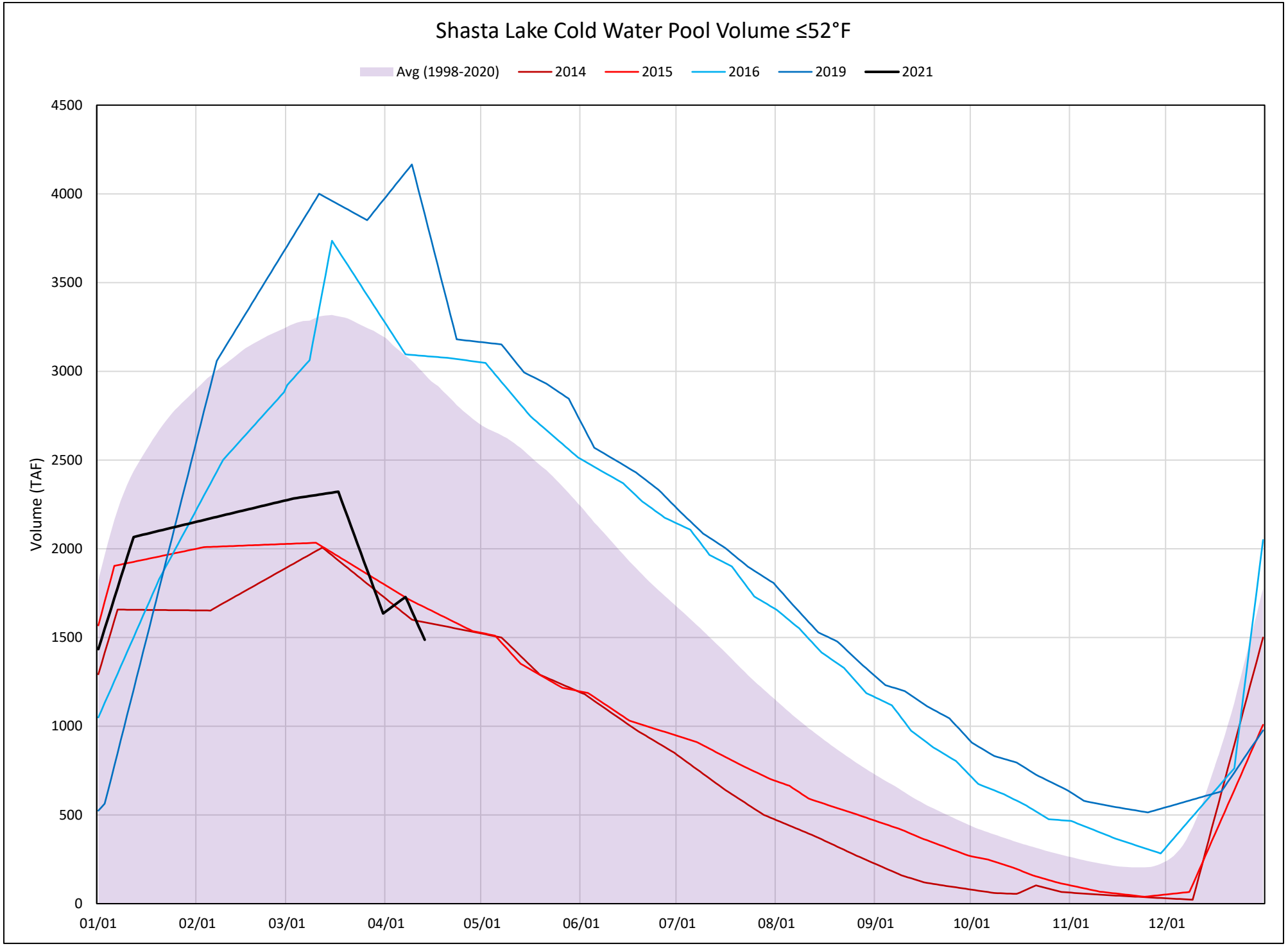
Water Right Temperature Control Points				
River	Point	Temp. (°F)	Begin Date	End Date
Sacramento	BSF	56	05/15/2019	09/20/2020
Sacramento	CCR	56	09/21/2020	TBD
Trinity	DGC	56	09/15/2020	10/01/2020
Trinity	NFH	56	10/01/2020	12/31/2020

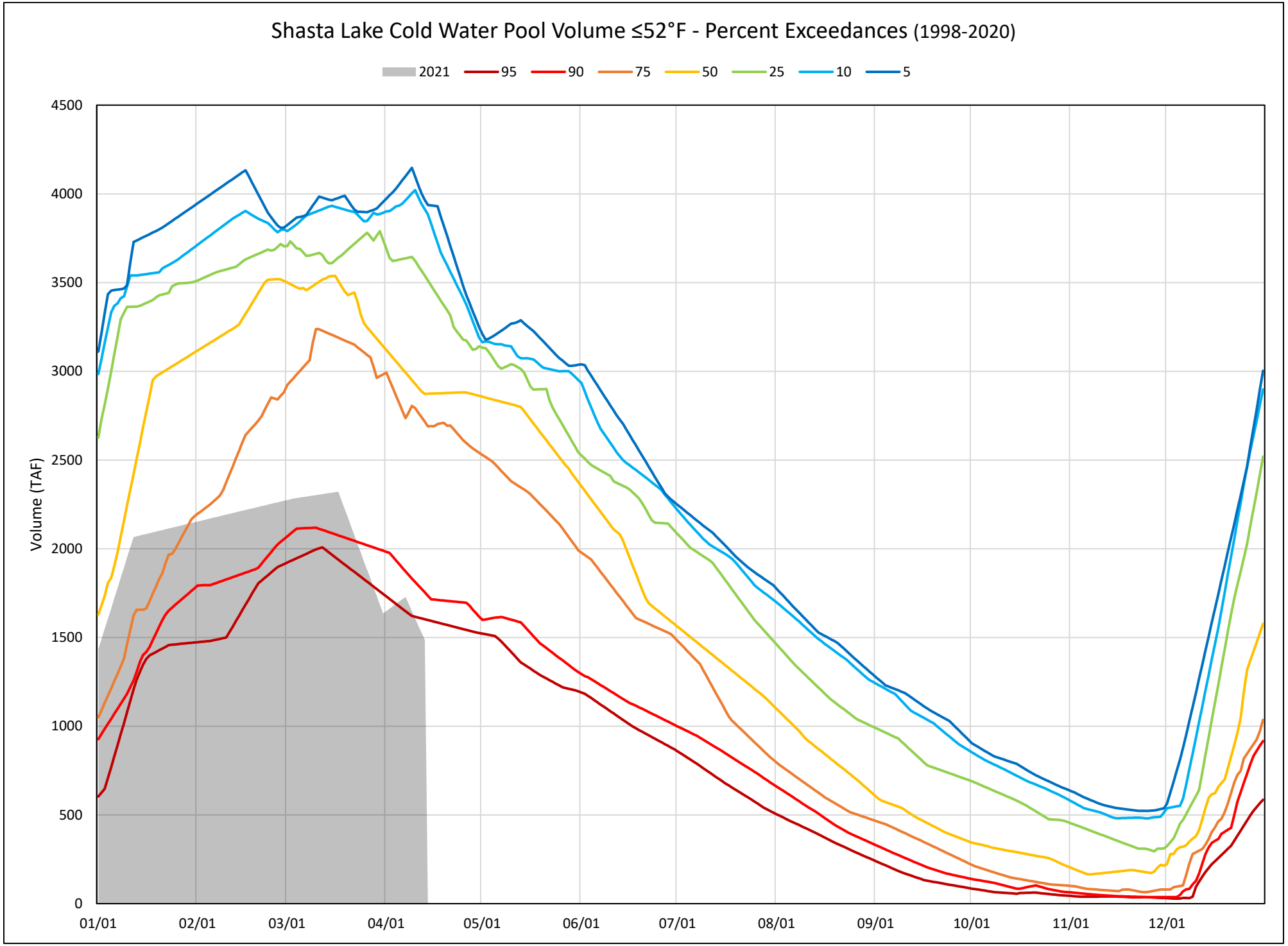
Notes

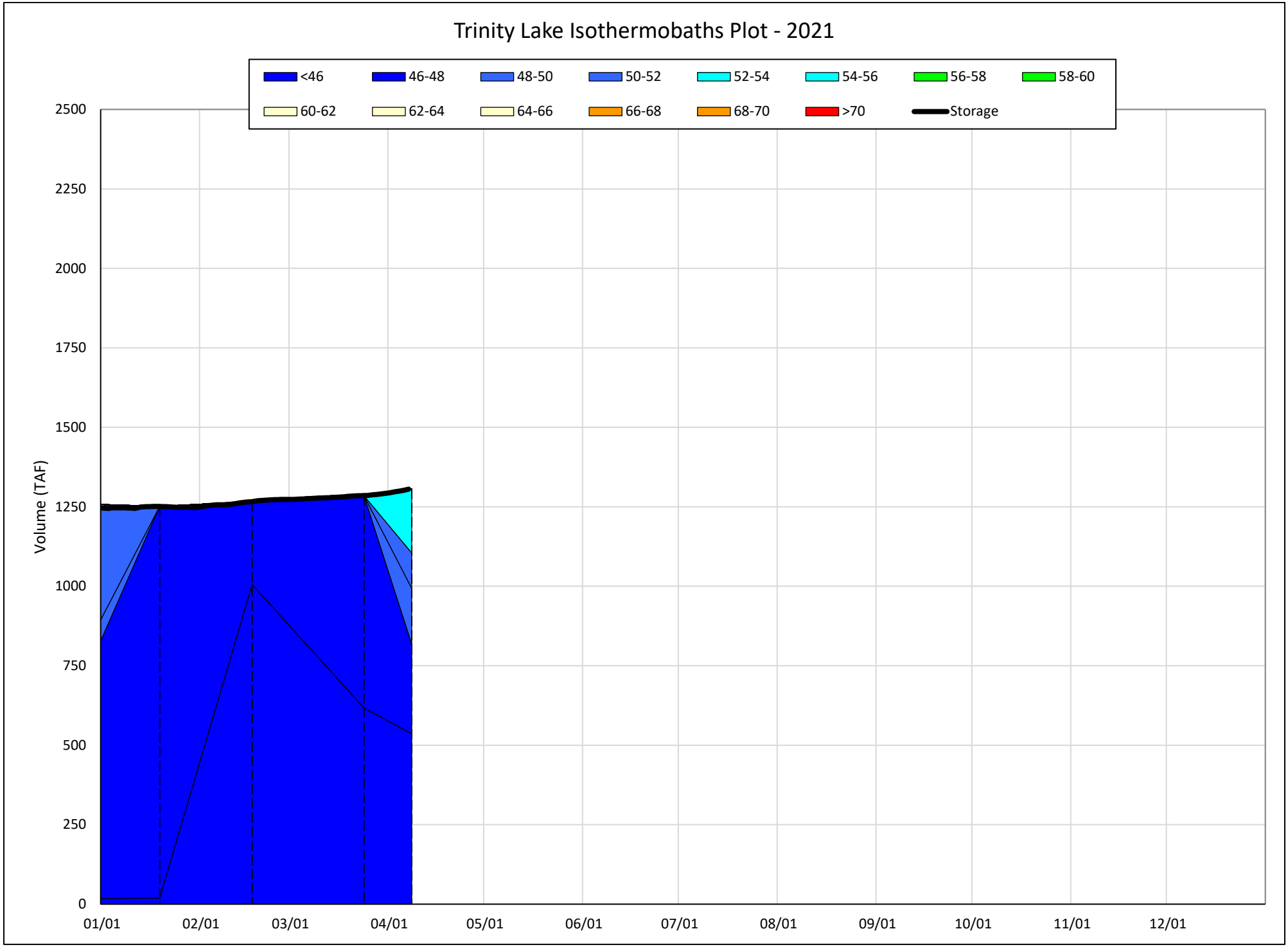
[1] Distances are approximate

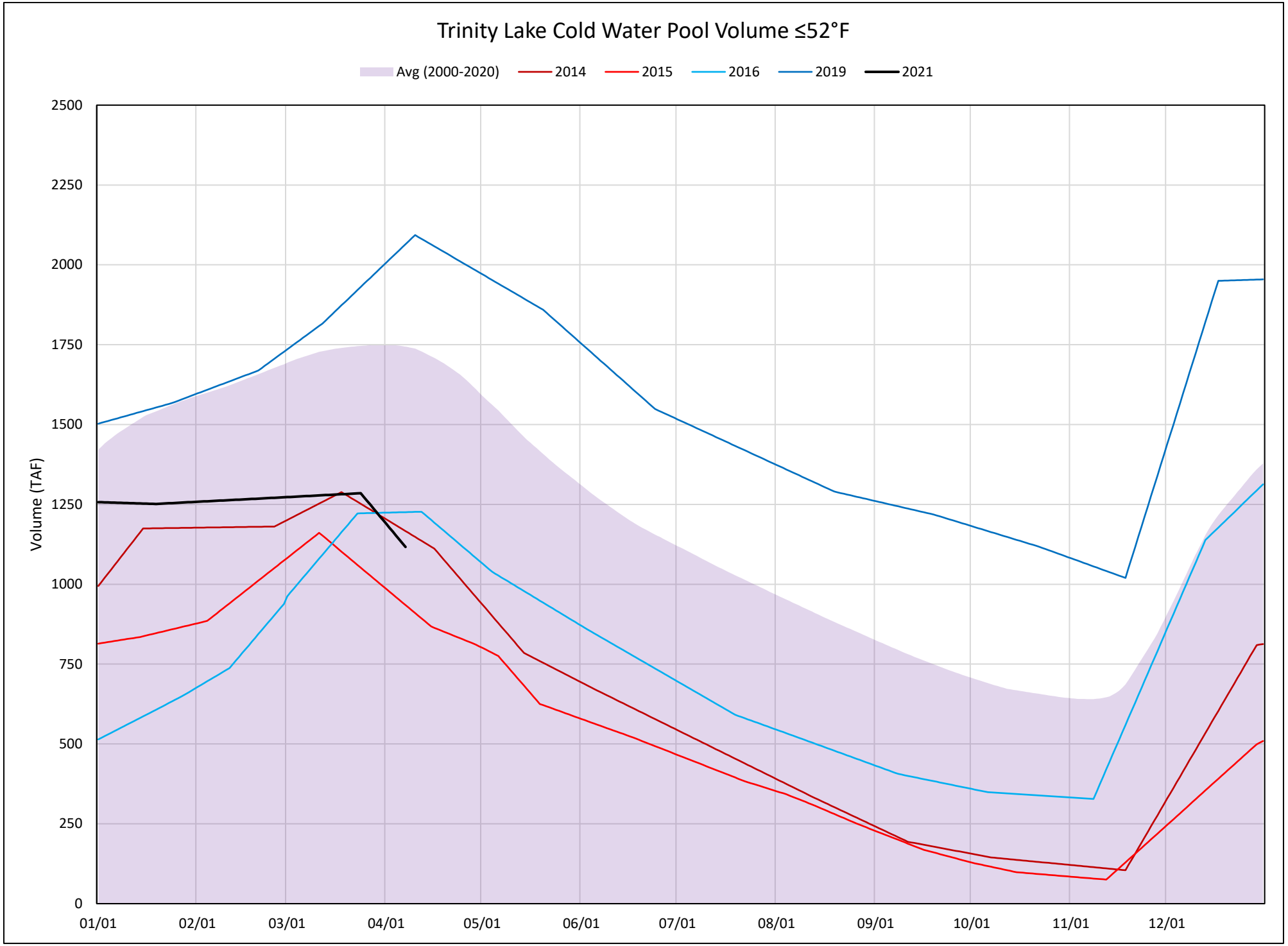

SHASTA DAM (WATER QUALITY) (SHD)
Date from 04/19/2021 15:08 through 04/21/2021 15:08 Duration : 2 days
Max of period : (04/20/2021 16:00, 58.04) Min of period: (04/19/2021 22:00, 51.18)
58.04
51.18
DEG F
58.00
57.50
57.00
56.50
56.00
55.50
55.00
54.50
54.00
53.50
53.00
52.50
52.00
51.50
51.00
14:00 16:00 18:00 20:00 22:00 00:00 02:00 04:00 06:00 08:00 10:00 12:00 14:00 16:00 18:00 20:00 22:00 00:00 02:00 04:00 06:00 08:00 10:00 12:00 14:00 16:00
Hour
TEMPERATURE, WATER - DEG F (1430)

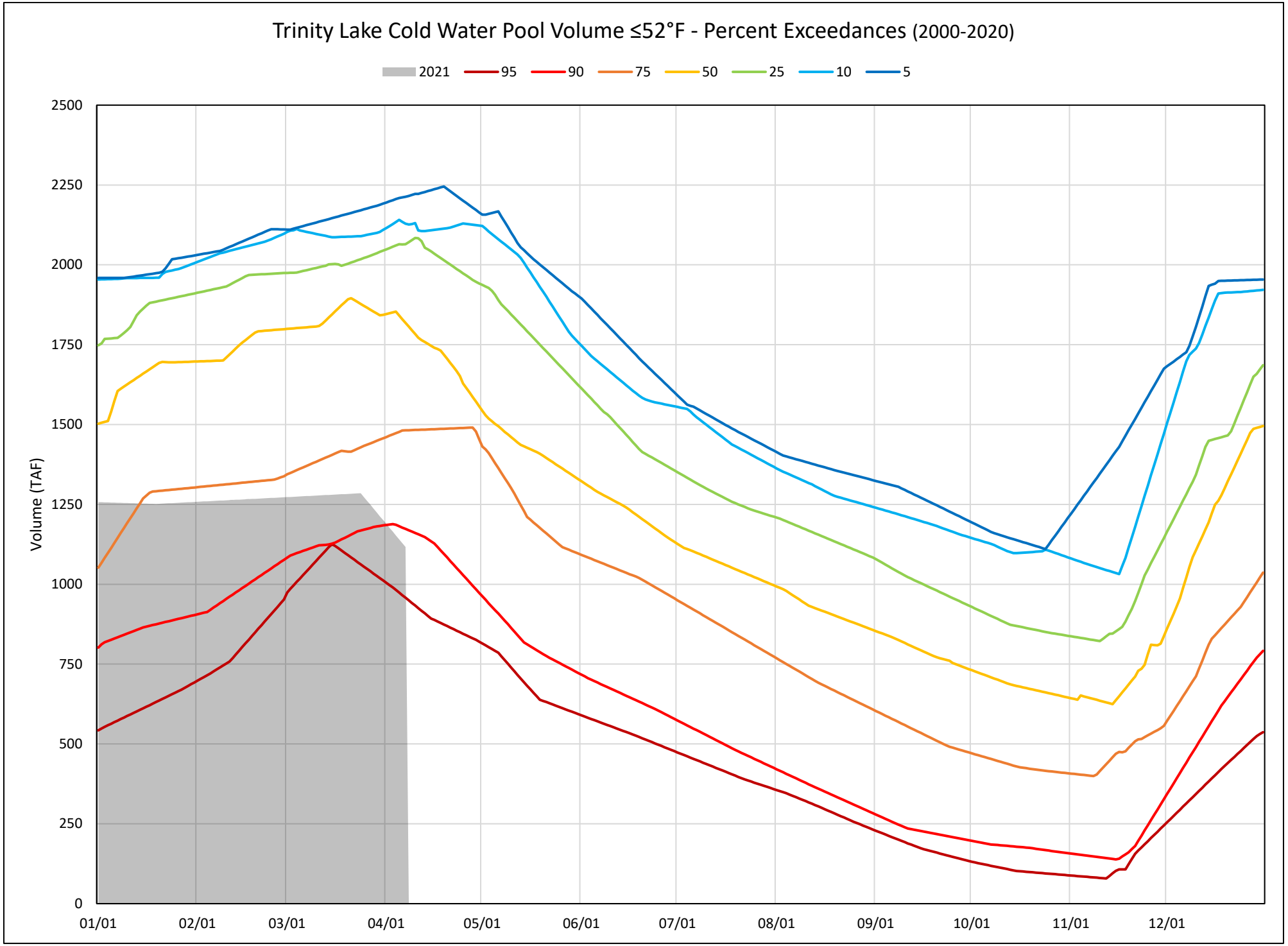

Shasta Lake Isothermobaths Plot - 2021
<46
46-48
48-50
50-52
52-54
54-56
56-58
58-60
60-62
62-64
64-66
66-68
68-70
>70
Storage
Volume (TAF)
4500
4000
3500
3000
2500
2000
1500
1000
500
0
01/01
02/01
03/01
04/01
05/01
06/01
07/01
08/01
09/01
10/01
11/01
12/01

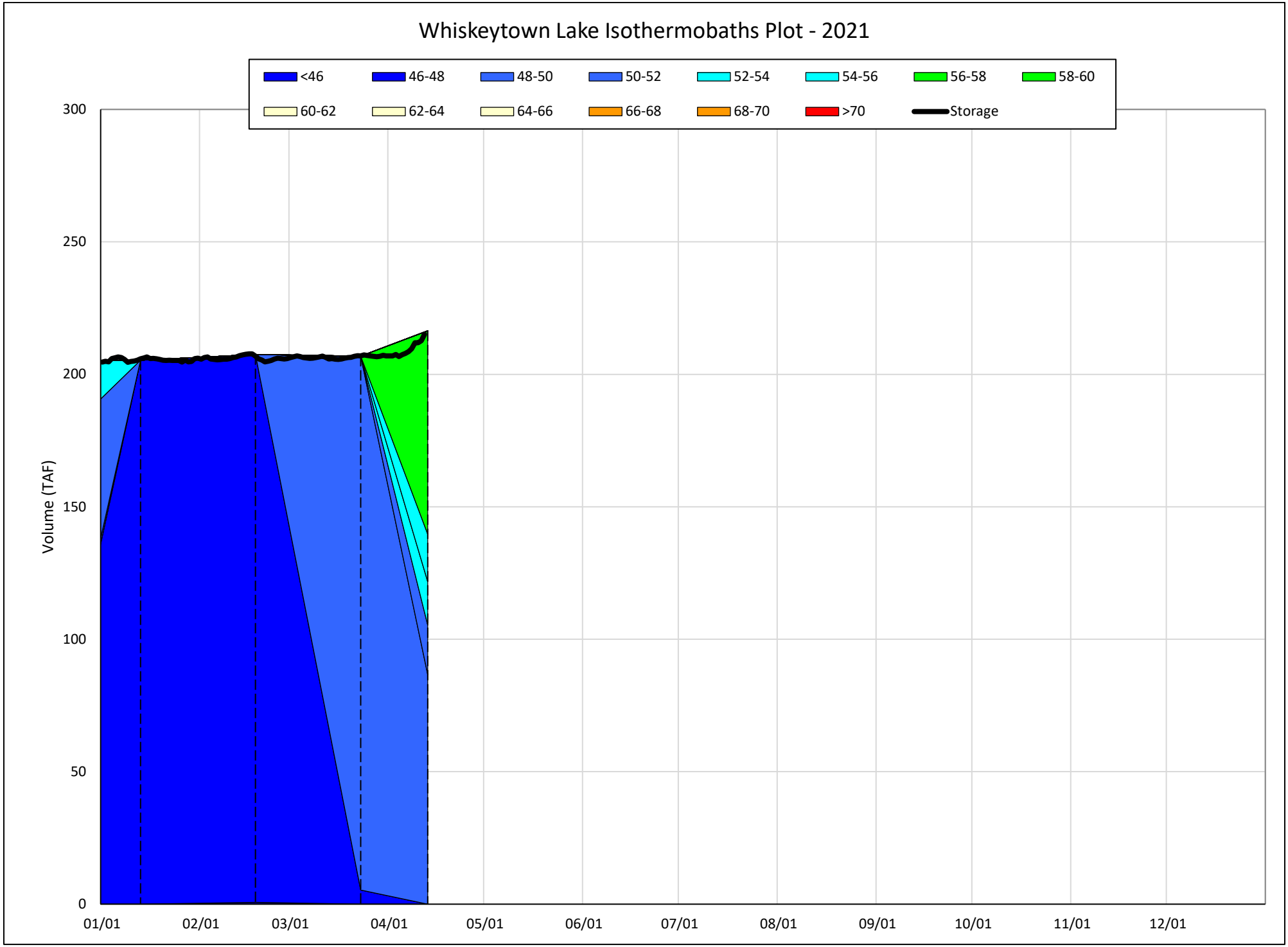

Shasta Lake Cold Water Pool Volume ≤52°F
Avg (1998-2020)
2014
2015
2016
2019
2021
Volume (TAF)
4500
4000
3500
3000
2500
2000
1500
1000
500
0
01/01
02/01
03/01
04/01
05/01
06/01
07/01
08/01
09/01
10/01
11/01
12/01


Shasta Lake Cold Water Pool Volume ≤52°F - Percent Exceedances (1998-2020)
2021
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


Trinity Lake Isothermobaths Plot - 2021
<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 (2000-2020)
2014
2015
2016
2019
2021
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 (2000-2020)
2021
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


Whiskeytown Lake Isothermobaths Plot - 2021
<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

Estimated CVP Operations 50% Exceedance

Storages

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

		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Trinity	**1292**	**1347**	**1232**	**1099**	**973**	**820**	**667**	**631**	**613**	**624**	**644**	**715**	**818**
	Elev.	2290	2279	2266	2252	2233	2212	2207	2204	2206	2209	2219	2233
Whiskeytown	**207**	**238**	**238**	**238**	**238**	**238**	**238**	**206**	**206**	**206**	**206**	**206**	**206**
	Elev.	1209	1209	1209	1209	1209	1209	1199	1199	1199	1199	1199	1199
Shasta	**2392**	**2363**	**2428**	**2261**	**1912**	**1646**	**1573**	**1496**	**1485**	**1601**	**1799**	**2161**	**2614**
	Elev.	977	981	972	952	935	930	925	924	932	945	966	990
Folsom	**361**	**375**	**476**	**501**	**410**	**360**	**322**	**309**	**301**	**313**	**376**	**493**	**684**
	Elev.	399	413	417	404	397	391	389	387	389	399	416	438
New Melones	**1539**	**1475**	**1403**	**1314**	**1227**	**1156**	**1113**	**1077**	**1089**	**1103**	**1117**	**1132**	**1156**
	Elev.	1000	992	982	972	963	958	953	954	956	958	960	963
San Luis	**192**	**178**	**142**	**11**	**3**	**61**	**132**	**298**	**503**	**708**	**882**	**967**	**1092**
	Elev.	426	411	382	370	369	375	409	442	481	509	523	543
Total		5977	5919	5423	4763	4281	4045	4017	4197	4555	5023	5674	6569

State End of the Month Reservoir Storage (TAF)

Oroville	**1435**	**1555**	**1601**	**1480**	**1249**	**1104**	**1096**	**1110**	**1173**	**1274**	**1446**	**1742**	**2061**
	Elev.	737	742	728	700	680	679	681	689	703	724	757	788
San Luis	**680**	**570**	**473**	**374**	**303**	**239**	**208**	**295**	**389**	**586**	**735**	**815**	**937**
Total San Luis (TAF)	**872**	**748**	**615**	**385**	**306**	**300**	**340**	**593**	**893**	**1294**	**1617**	**1783**	**2029**
	Elev.	426	411	382	370	369	375	409	442	481	509	523	543

Monthly River Releases (TAF/cfs)

Trinity	TAF	36	92	47	28	53	52	23	18	18	18	17	18
	cfs	**600**	**1,498**	**788**	**450**	**857**	**870**	**373**	**300**	**300**	**300**	**300**	**300**
Clear Creek	TAF	12	16	12	9	9	9	12	12	12	25	11	12
	cfs	**200**	**265**	**200**	**150**	**150**	**150**	**200**	**200**	**200**	**400**	**200**	**200**
Sacramento	TAF	357	349	476	615	523	327	338	274	215	200	180	200
	cfs	**6000**	**5685**	**8000**	**10000**	**8500**	**5500**	**5500**	**4600**	**3500**	**3250**	**3250**	**3250**
American	TAF	119	77	63	151	113	98	49	48	49	49	44	49
	cfs	**2000**	**1250**	**1065**	**2461**	**1831**	**1650**	**805**	**808**	**800**	**800**	**800**	**800**
Stanislaus	TAF	27	11	9	9	9	9	39	12	12	13	12	12
	cfs	**460**	**185**	**150**	**150**	**150**	**150**	**635**	**200**	**200**	**213**	**214**	**200**
Feather	TAF	65	49	89	226	172	68	74	57	58	58	53	58
	cfs	**1100**	**800**	**1500**	**3680**	**2800**	**1150**	**1200**	**950**	**950**	**950**	**950**	**950**

Trinity Diversions (TAF)

	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Carr PP	54	92	96	99	100	99	23	21	12	15	17	11
Spring Crk. PP	**35**	**90**	**90**	**90**	**90**	**90**	**45**	**15**	**12**	**10**	**35**	**26**

Delta Summary (TAF)

		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Tracy		60	105	48	212	235	211	260	256	235	195	129	180
USBR Banks		0	0	0	0	0	0	0	0	0	0	0	0
Contra Costa		10.0	10.0	9.8	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0	10.0
Total USBR		70	115	58	222	245	221	270	266	245	205	139	190
State Export		30	26	13	24	21	22	128	115	200	195	135	180
Total Export		99	140	71	246	266	243	398	381	445	400	274	370
COA Balance		65	65	69	66	55	53	74	69	69	69	69	69
Vernalis	TAF	117	110	56	48	46	51	108	83	83	92	111	120
Vernalis	cfs	1961	1785	940	784	752	856	1758	1393	1355	1498	1997	1957
Old/Middle River Std.													
Old/Middle R. calc.	cfs	-992	-1,544	-1,083	-3,318	-3,584	-3,350	-4,784	-4,894	-5,554	-4,926	-3,491	-4,344
Computed DOI		7094	4490	4001	4002	2993	3009	2993	3496	5157	9760	11418	12477
Excess Outflow		0	488	0	0	0	0	0	0	1659	5254	18	1074
% Export/Inflow		15%	24%	12%	31%	36%	39%	55%	58%	57%	41%	30%	32%
% Export/Inflow std.		35%	35%	35%	65%	65%	65%	65%	65%	65%	65%	45%	35%

Hydrology

	Trinity		Shasta		Folsom		New Melones	
Water Year Inflow (TAF)	406		2,870		1,167		440	
Year to Date + Forecasted % of mean	34%		52%		43%		42%	

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

4/20/2021

Estimated CVP Operations 90% Exceedance

Storages

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

		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Trinity	**1292**	**1336**	**1256**	**1116**	**968**	**813**	**660**	**613**	**578**	**561**	**559**	**588**	**648**
	Elev.	2289	2282	2268	2251	2233	2211	2204	2198	2195	2195	2200	2210
Whiskeytown	**207**	**238**	**238**	**238**	**238**	**238**	**238**	**206**	**206**	**206**	**206**	**206**	**206**
	Elev.	1209	1209	1209	1209	1209	1209	1199	1199	1199	1199	1199	1199
Shasta	**2392**	**2343**	**2174**	**1923**	**1566**	**1303**	**1230**	**1191**	**1209**	**1280**	**1408**	**1615**	**1943**
	Elev.	976	967	953	930	911	905	902	903	909	919	933	954
Folsom	**361**	**378**	**417**	**342**	**246**	**246**	**246**	**239**	**234**	**238**	**252**	**275**	**399**
	Elev.	400	406	394	377	377	377	376	375	375	378	383	403
New Melones	**1539**	**1490**	**1396**	**1307**	**1223**	**1154**	**1112**	**1071**	**1073**	**1077**	**1080**	**1075**	**1059**
	Elev.	1002	992	981	971	963	957	952	952	953	953	953	950
San Luis	**205**	**188**	**153**	**62**	**-61**	**-142**	**-77**	**20**	**66**	**171**	**347**	**362**	**367**
	Elev.	429	412	388	363	342	354	370	389	413	447	444	439
Total		5973	5634	4988	4180	3613	3409	3339	3365	3533	3853	4122	4621

State End of the Month Reservoir Storage (TAF)

Oroville		**1532**	**1510**	**1315**	**1079**	**903**	**807**	**825**	**846**	**886**	**968**	**1097**	**1300**
	Elev.	734	732	708	676	649	632	635	639	646	659	679	706
San Luis		**583**	**467**	**372**	**325**	**286**	**284**	**283**	**369**	**455**	**594**	**547**	**494**
Total San Luis (TAF)	**885**	**772**	**620**	**434**	**264**	**145**	**206**	**303**	**435**	**627**	**942**	**909**	**861**

Monthly River Releases (TAF/cfs)

Trinity	TAF	36	92	47	28	53	52	23	18	18	18	17	18
	cfs	**600**	**1,498**	**783**	**450**	**857**	**870**	**373**	**300**	**300**	**300**	**300**	**300**
Clear Creek	TAF	12	16	11	9	9	9	12	12	12	12	11	17
	cfs	**200**	**265**	**190**	**150**	**150**	**150**	**200**	**200**	**200**	**200**	**200**	**275**
Sacramento	TAF	357	454	521	615	492	297	281	230	200	200	180	200
	cfs	**6000**	**7379**	**8750**	**10000**	**8000**	**5000**	**4570**	**3873**	**3250**	**3250**	**3250**	**3250**
American	TAF	120	77	137	149	61	49	49	48	49	49	80	49
	cfs	**2013**	**1256**	**2307**	**2422**	**988**	**821**	**800**	**800**	**800**	**800**	**1442**	**801**
Stanislaus	TAF	27	24	9	9	9	9	39	12	12	13	12	18
	cfs	**460**	**384**	**150**	**150**	**150**	**150**	**635**	**200**	**200**	**219**	**214**	**300**
Feather	TAF	57	54	121	161	125	138	59	58	59	59	70	65
	cfs	**950**	**878**	**2034**	**2619**	**2033**	**2320**	**960**	**975**	**960**	**960**	**1261**	**1057**

Trinity Diversions (TAF)

	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Carr PP	43	25	99	120	101	100	24	30	21	15	10	7
Spring Crk. PP	**15**	**15**	**90**	**110**	**90**	**90**	**45**	**20**	**12**	**10**	**10**	**10**

Delta Summary (TAF)

		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Tracy		45	76	50	48	60	193	184	93	132	190	49	52
USBR Banks		0	0	0	0	0	0	0	0	0	0	0	0
Contra Costa		9.5	9.5	9.5	7.4	8.3	9.5	10.5	12.6	13.8	13.7	10.5	10.5
Total USBR		54	86	60	55	68	203	195	106	146	204	60	63
State Export		18	20	15	17	18	31	17	88	88	190	20	67
Total Export		72	106	75	72	86	234	212	194	234	394	80	130
COA Balance		56	78	113	184	204	150	126	145	125	125	80	0
Vernalis	TAF	84	84	40	42	37	43	98	74	75	76	82	104
Vernalis	cfs	1419	1359	671	687	605	722	1595	1242	1225	1244	1475	1699
Old/Middle River Std.													
Old/Middle R. calc.		-884	-1,304	-1,253	-1,187	-1,399	-3,288	-2,521	-2,537	-2,967	-4,962	-1,029	-1,448
Computed DOI		7094	4002	4001	4002	2993	3009	4181	4942	4994	6214	11400	11403
Excess Outflow		0	0	0	0	0	0	0	0	0	1708	0	0
% Export/Inflow		11%	20%	12%	11%	16%	40%	36%	34%	39%	52%	10%	15%
% Export/Inflow std.		35%	35%	35%	65%	65%	65%	65%	65%	65%	65%	45%	35%

Hydrology

	Trinity		Shasta		Folsom		New Melones	
Water Year Inflow (TAF)	347		2,685		1,022		357	
Year to Date + Forecasted % of mean	29%		48%		38%		34%	

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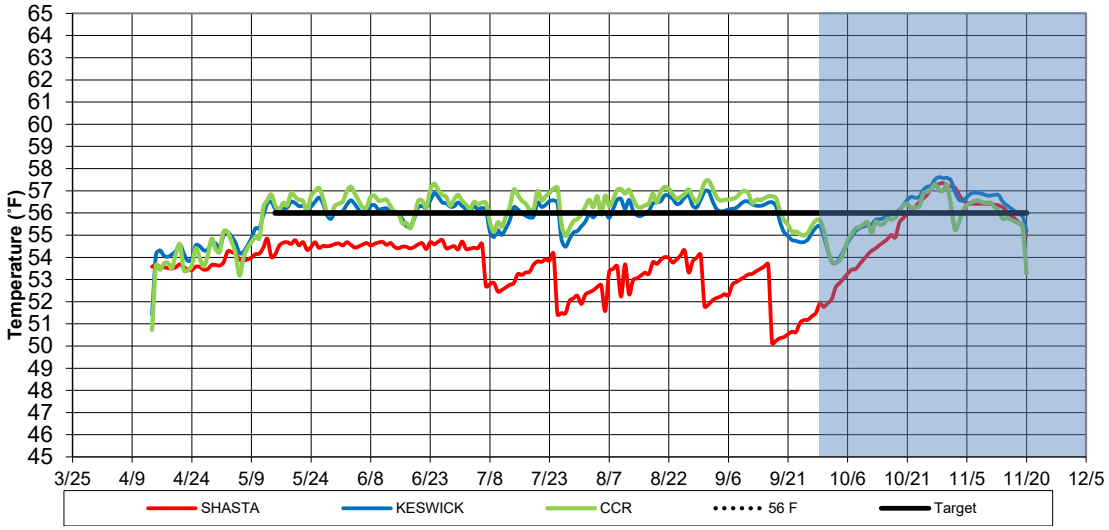
CVP Operations are updated monthly as new hydrology information is made available December through May.

4/20/2021

Sacramento River Modeled Temperature
2021 Apr 90%-Exceedance Water Outlook - L3MTO Meteorology



	Shasta	Keswick	Clear Creek	Igo	Trinity	Lewiston
	deg F	deg F	deg F	deg F	deg F	deg F
Apr	53.6	54.1	53.7	49.6	45.7	48.1
May	54.3	55.7	55.8	50.3	45.9	49.1
Jun	54.5	56.2	56.5	52.6	46.1	49.6
Jul	53.1	55.8	56.2	56.5	46.6	50.3
Aug	53.3	56.3	56.7	58.4	47.4	50.8
Sep	51.9	55.8	56.2	57.5	49.2	50.9
Oct	54.9	55.9	55.7	56.7	50.8	52.6
Nov	54.8	55.0	54.3	53.9	51.7	51.8

Run date: 4/20/21

EOM Sept storage: 1.2 MAF

Trinity profile date: 4/8/21

Whiskeytown profile date: 4/13/21

Shasta profile date: 4/14/21

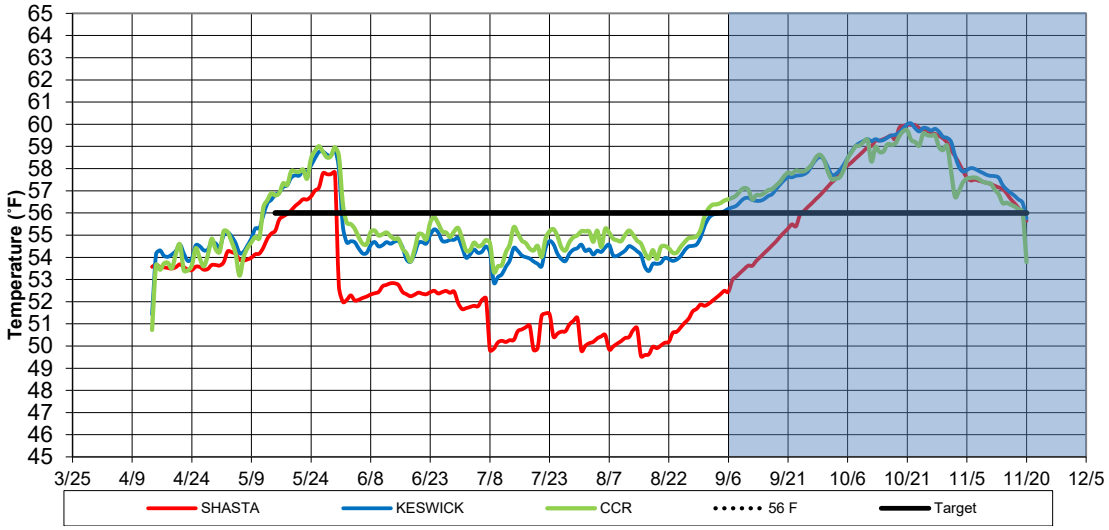
Projected Side gates: First Aug 13 Full Sep 18

Shaded area denotes period of model limitations - see Fall Temperature Index

End of September Cold-Water-Pool less than 56 deg F: 220 TAF

End of April Cold-Water-Pool less than 52 deg F: 1.4 MAF

Sacramento River Modeled Temperature
2021 Apr 90%-Exceedance Water Outlook - L3MTO Meteorology



	Shasta	Keswick	Clear Creek	Igo	Trinity	Lewiston
	deg F	deg F	deg F	deg F	deg F	deg F
Apr	53.6	54.1	53.7	49.6	45.7	48.1
May	55.4	56.7	56.7	50.3	45.9	49.1
Jun	52.4	54.6	55.0	52.6	46.1	49.6
Jul	50.9	54.1	54.6	56.5	46.6	50.3
Aug	50.5	54.2	54.7	58.4	47.4	50.8
Sep	54.4	57.0	57.3	57.5	49.2	50.9
Oct	59.0	59.2	58.9	56.7	50.8	52.6
Nov	55.4	55.7	54.9	53.9	51.7	51.8

Run date: 4/20/21

EOM Sept storage: 1.2 MAF

Trinity profile date: 4/8/21

Whiskeytown profile date: 4/13/21

Shasta profile date: 4/14/21

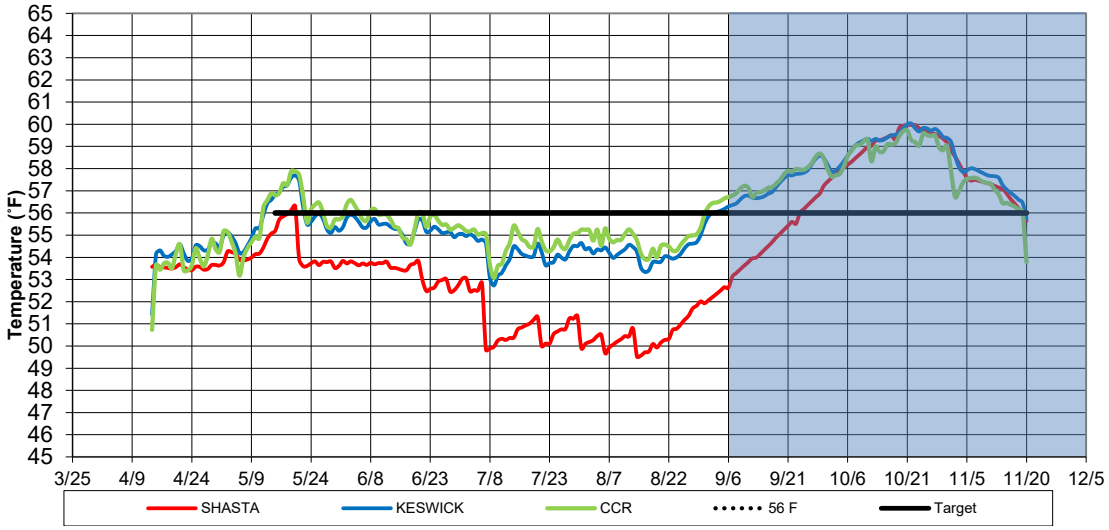
Projected Side gates: First Jul 25 Full Aug 16

Shaded area denotes period of model limitations - see Fall Temperature Index

End of September Cold-Water-Pool less than 56 deg F: 87 TAF

End of April Cold-Water-Pool less than 52 deg F: 1.4 MAF

Sacramento River Modeled Temperature
2021 Apr 90%-Exceedance Water Outlook - L3MTO Meteorology



	Shasta	Keswick	Clear Creek	Igo	Trinity	Lewiston
	deg F	deg F	deg F	deg F	deg F	deg F
Apr	53.6	54.1	53.7	49.6	45.7	48.1
May	54.3	55.8	55.8	50.3	45.9	49.1
Jun	53.4	55.3	55.7	52.6	46.1	49.6
Jul	51.0	54.2	54.7	56.5	46.6	50.3
Aug	50.5	54.2	54.8	58.4	47.4	50.8
Sep	54.5	57.1	57.3	57.5	49.2	50.9
Oct	59.1	59.3	58.9	56.7	50.8	52.6
Nov	55.4	55.7	54.9	53.9	51.7	51.8

Run date: 4/20/21

EOM Sept storage: 1.2 MAF

Trinity profile date: 4/8/21

Whiskeytown profile date: 4/13/21

Shasta profile date: 4/14/21

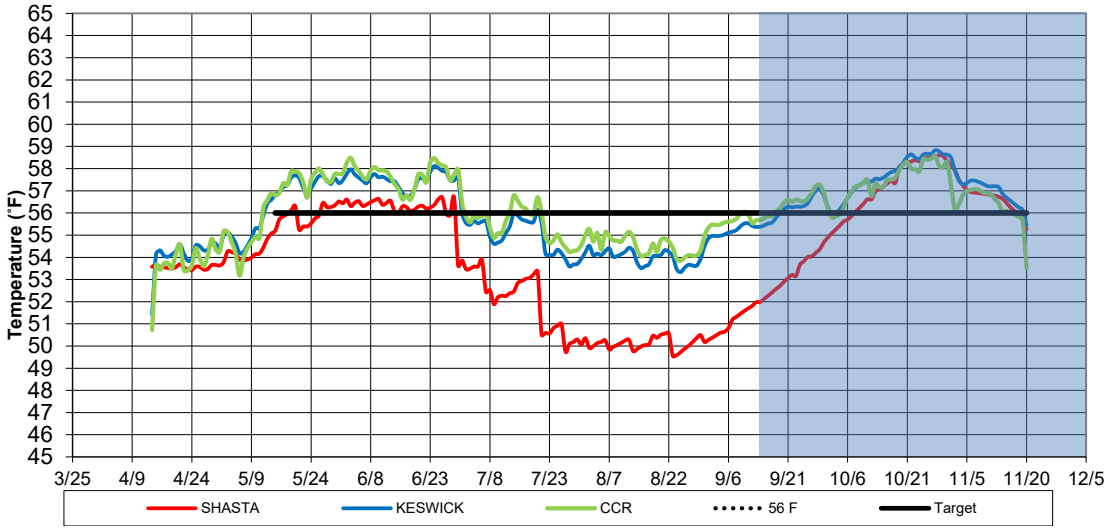
Projected Side gates: First Jul 22 Full Aug 15

Shaded area denotes period of model limitations - see Fall Temperature Index

End of September Cold-Water-Pool less than 56 deg F: 87 TAF

End of April Cold-Water-Pool less than 52 deg F: 1.4 MAF

Sacramento River Modeled Temperature
2021 Apr 90%-Exceedance Water Outlook - L3MTO Meteorology



	Shasta	Keswick	Clear Creek	Igo	Trinity	Lewiston
	deg F	deg F	deg F	deg F	deg F	deg F
Apr	53.6	54.1	53.7	49.6	45.7	48.1
May	55.1	56.3	56.3	50.3	45.9	49.1
Jun	56.3	57.5	57.7	52.6	46.1	49.6
Jul	52.0	55.0	55.5	56.5	46.6	50.3
Aug	50.1	54.0	54.6	58.4	47.4	50.8
Sep	52.3	55.8	56.1	57.5	49.2	50.9
Oct	57.2	57.7	57.4	56.7	50.8	52.6
Nov	55.1	55.3	54.6	53.9	51.7	51.8

Run date: 4/20/21

EOM Sept storage: 1.2 MAF

Trinity profile date: 4/8/21

Whiskeytown profile date: 4/13/21

Shasta profile date: 4/14/21

Projected Side gates: First Jul 28 Full Aug 24

Shaded area denotes period of model limitations - see Fall Temperature Index

End of September Cold-Water-Pool less than 56 deg F: 150 TAF

End of April Cold-Water-Pool less than 52 deg F: 1.4 MAF

Figures 3-5 Model Performance and Fall Temperature Index:

1. Based on past analyses, the temperature model does not perform well in late September and October. One factor is that the modeled release temperatures are cooler than has historically been achieved when all release is through the side gates (lowest gates), especially when there's a large temperature gradient between the pressure relief gates (PRG) and the side gates.
2. Based on historical records, the end-of-September Lake Shasta volume below 56˚F is a good indicator of fall water temperature in the river reaches.
3. Based on these records and estimates, the charts below illustrate a range of uncertainty in the expected river temperatures based on the end-of-September lake volume less than 56˚F.

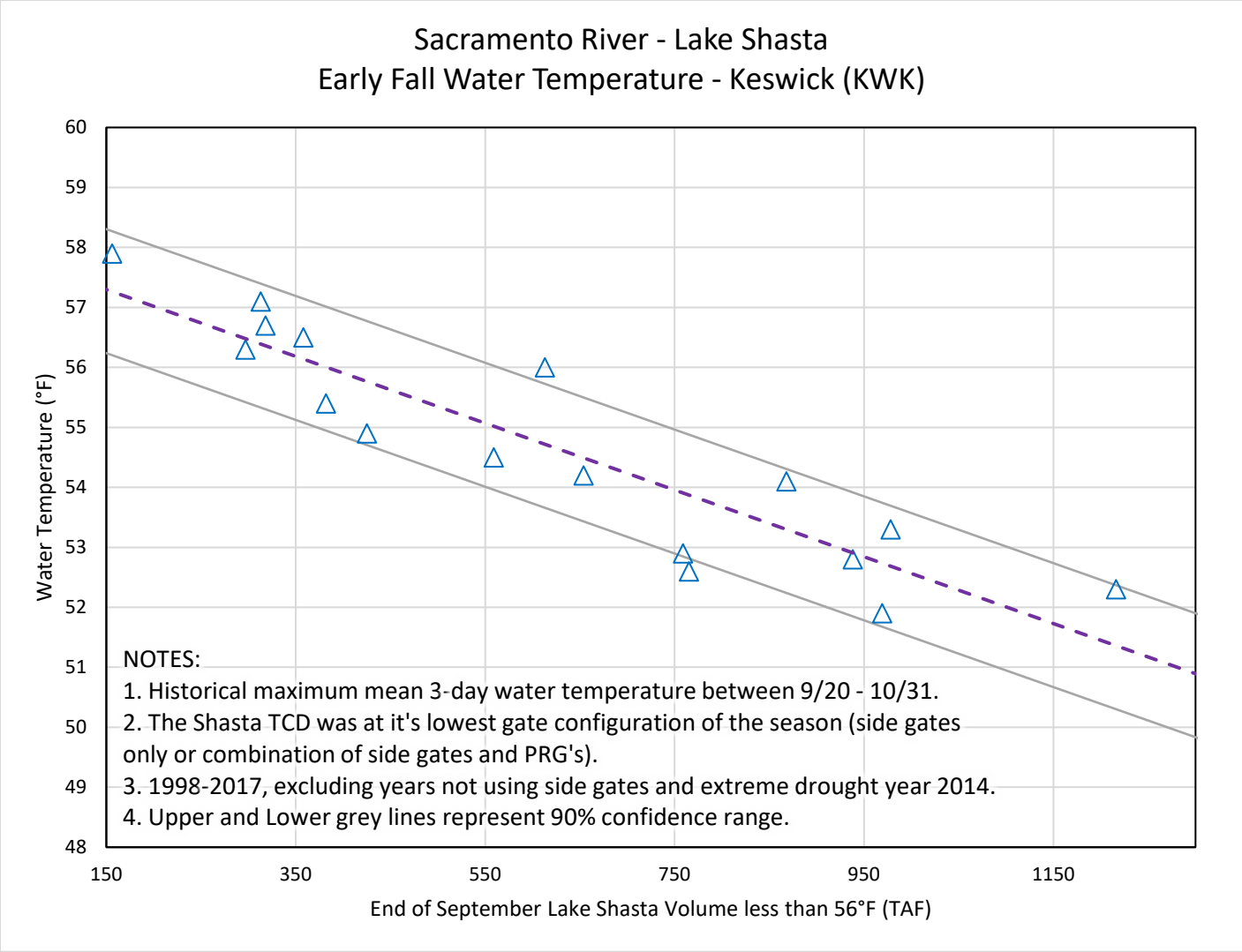


Figure 3. Historical relationship between Lake Shasta cold-water-pool characteristics and early fall Keswick water temperature.

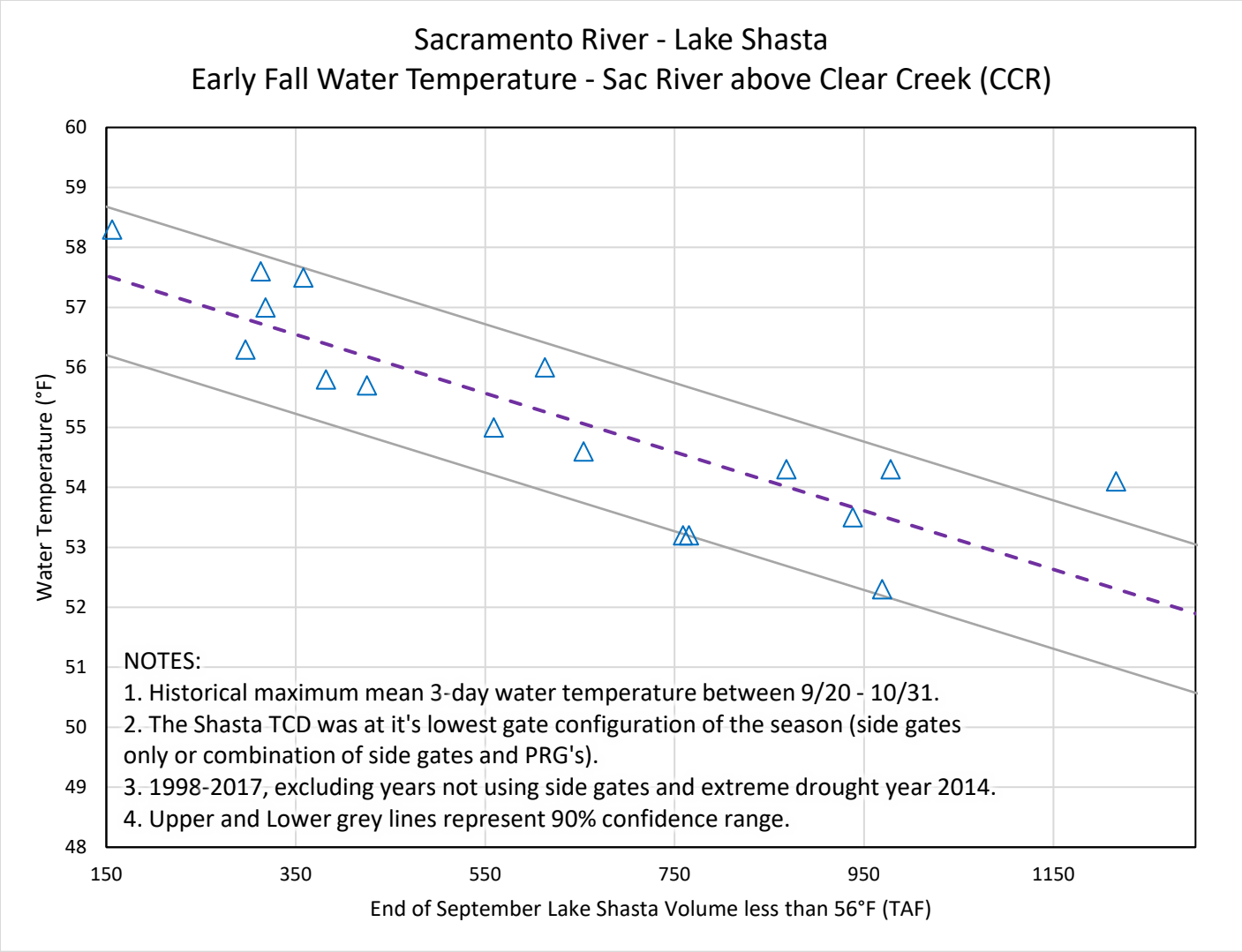


Figure 4. Historical relationship between Lake Shasta cold-water-pool characteristics and early fall Sacramento River above Clear Creek confluence water temperature.

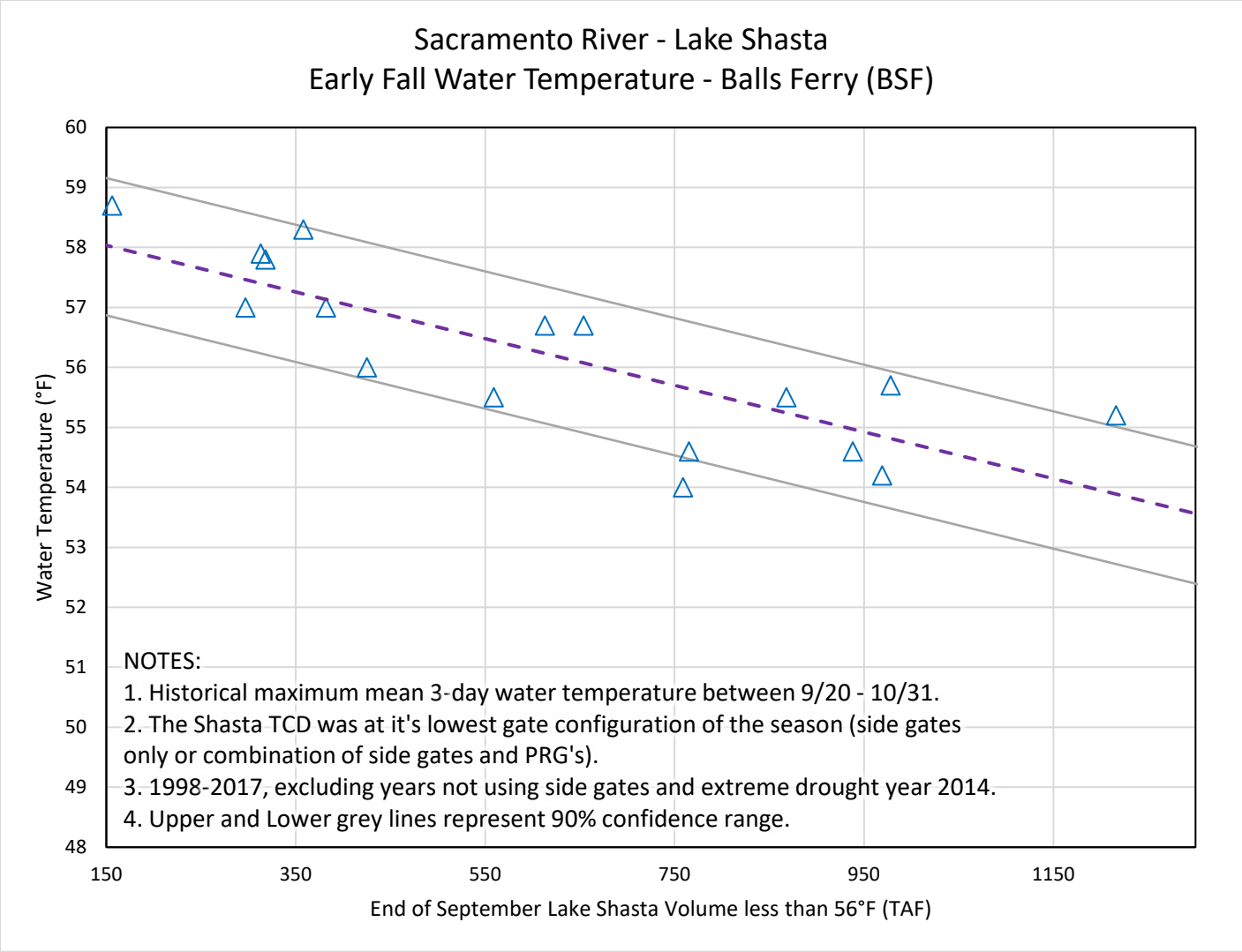


Figure 5. Historical relationship between Lake Shasta cold-water-pool characteristics and early fall Balls Ferry water temperature.

Summary Document for Shasta/Keswick Operational Scenarios
Prepared by the Southwest Fisheries Science Center on April 21st, 2021

Below are results for four USBR scenario ran April 21st 2021. 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 2021 temperature management season.

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

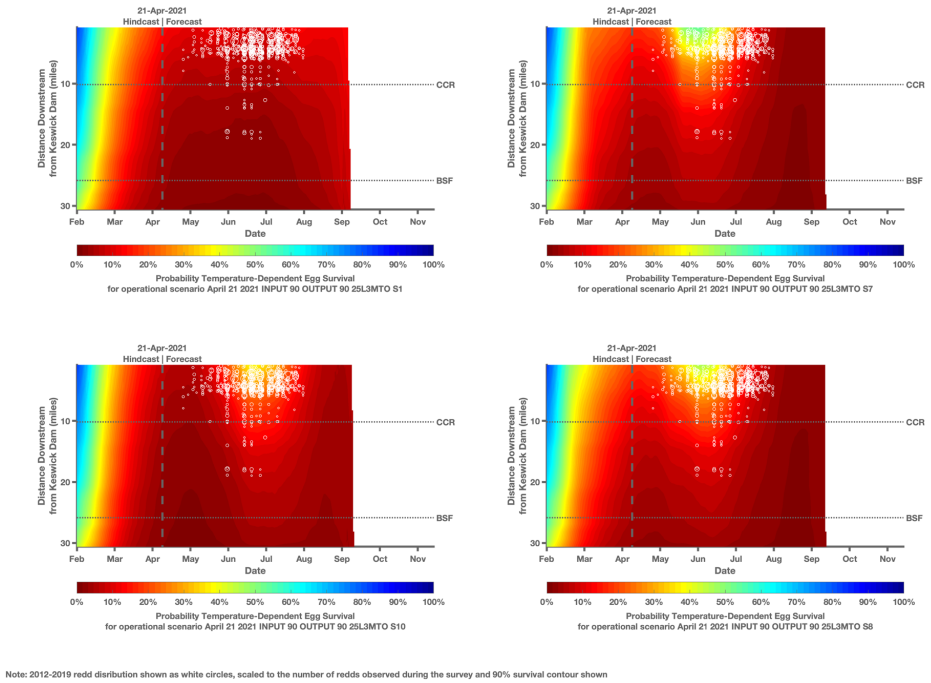


Figure1: Estimated temperature-dependent egg survival produced by the NMFS stage-independent temperature mortality model under the four April 21st 2021 scenario. 2012-2019 redd distributions are used for all plots.

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

Scenario	RIVER MODEL	Mean (%)	Median (%)
APR_21_2021_INPUT_90_OUTPUT_90_25L3MTO S1	RAFT	90	91
APR_21_2021_INPUT_90_OUTPUT_90_25L3MTO S7	RAFT	76	76
APR_21_2021_INPUT_90_OUTPUT_90_25L3MTO S10	RAFT	77	78
APR_21_2021_INPUT_90_OUTPUT_90_25L3MTO S8	RAFT	77	78

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

DRAFT

4/21/21

DRAFT Scenarios for Sacramento River Temperature Management

Table 1. Scenario descriptions Keswick (KWK; RKM 483) and Clear Creek (CCR; RKM 470) water temperature target in degrees Fahrenheit. Peak winter-run Chinook salmon egg incubation timing indicated in orange. HEC-5Q does not perform well after September 14. Water temperatures will likely be warmer than these targets and HEC-5Q results.

Month/ Scenario	KWK 1	CCR 1	KWK 7	CCR 7	KWK 8	CCR 8	KWK 10	CCR 10
April	54.1	53.7	54.1	53.7	54.1	53.7	54.1	53.7
May	55.7	55.8	56.7	56.7	55.8	55.8	56.3	56.3
June	56.2	56.5	54.6	55.0	55.3	55.7	57.5	57.7
July	55.8	56.2	54.1	54.6	54.2	54.7	55.0	55.5
August	56.3	56.7	54.2	54.7	54.2	54.8	54.0	54.6
September	55.8	56.2	57.0	57.3	57.1	57.3	55.8	56.1
October	55.9	55.7	59.2	58.9	59.3	58.9	55.7	57.4

Table 2. TDM, Storage, and first side gate usage for different scenarios.

Metric/Scenario	1	7	8	10
USBR TDM - Anderson (%)	98.8	66.2	68.1	72.9
USBRTDM - Martin (%)	93.4	69.6	73.4	81.3
NOAA TDM Mean – Martin (%)	90	76	77	77
End of Sept CWP Storage, <56 F (TAF)	220	87	87	150
First Side Gate Use	8/13	7/25	7/22	7/28
Full Side Gate Use	9/18	8/16	8/15	8/24

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Methods and Assumptions

Spatially-explicit daily average Sacramento River water temperatures forecasts from the HEC-5Q model results are used as inputs to generate temperature-dependent egg mortality estimates. 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 October 31, 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. These temperatures are indicated in the table below.

Table 3. Forecasted water temperatures in degrees Fahrenheit at Keswick (KWK; RKM 483) and Clear Creek (CCR; RKM 470) after 9/14/2021 for each scenario. These water temperatures were used for TDM modelling, instead of HEC-5Q modelled temperatures for dates after 9/14/2021.

Scenario	KWK	CCR
1	59.22	60.41
7	60.11	61.23
8	60.11	61.23
10	59.69	60.84

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 2000-2020 and the results summarized on a seasonal level for comparison.

Further information about the model's assumptions are documented in Table 4 below.

[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.

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Table 4. Water temperature and winter-run Chinook temperature-dependent mortality assumptions.

Parameter	Scenarios 1, 7, 8, 10 Run Date 04/21/21	Scenarios 1, 7, 8, 10 Run Date 04/21/21
Meteorology source	Forecasted Meteorology 50% L3MTO	Forecasted Meteorology 50% L3MTO
Time period	4/14/21-11/29/21	4/14/21-11/29/21
Reservoir Model used	HEC-5Q	HEC-5Q
River Model used	HEC-5Q until 9/14 then historic relationship to end of September storage below 56 degrees F	HEC-5Q until 9/14 then historic relationship to end of September storage below 56 degrees F
Shasta Profile date	4/14/21	4/14/21
TCD Gate operations	HEC-5Q	HEC-5Q
Sacramento water temperatures used	HEC-5Q output at locations specified by SacPAS. These are the same locations where SacPAS simulates redds.	HEC-5Q output at locations specified by SacPAS. These are the same locations where SacPAS simulates redds.
Biological Model used	SacPAS Fish model	SacPAS Fish model
Temperature Mortality Model	Stage-independent mortality using the following temperature user input files: • S1 adjusted with 2014.csv • S7 adj with 2014.csv • S8 adj with 2014.csv • 10 adj with 2014.csv	Stage-dependent mortality using the following temperature user input files: • S1 adjusted with 2014.csv • S7 adj with 2014.csv • S8 adj with 2014.csv • 10 adj with 2014.csv
Egg emergence timing model	Linear. 958 ATUs (degrees C), as indicated for Zeug et al. on SacPAS under Egg to emergence timing model.	487 (degree C days)
TDM redd time distribution	Observed 2000-2020	Observed 2000-2020
TDM redd space distribution	Observed 2000-2020	Observed 2000-2020
TDM Tcrit (50th percentile)	12.04 degrees C	12.14 degrees C
TDM bT (50th percentile)	0.026 °C-1d-1	1.17 °C-1d-1
Critical Days	All	3
TDM estimate	See Table 2	See Table 2