Memorandum to: CVP/SWP operations administrative record, number 151422SWR2006SA00268

From: Brycen Swart, Fisheries Biologist

Subject: Chronology of the Development of the Sacramento River Temperature Management Plan for the 2015 Temperature Management Season

- February 3, 2015 – the State Water Resources Control Board (SWRCB) approved, in part, a Temporary Urgency Change Petition (TUCP) filed by the Bureau of Reclamation (Reclamation) and DWR to temporarily modify water rights for the CVP and SWP due to ongoing drought conditions[1]. The SWRCB's order, among other things, required Reclamation to submit a temperature management plan to the Sacramento River Temperature Task Group (SRTTG) for review no later than March 15, 2015. As part of the Temperature Management Plan, Reclamation shall include three temperature model run scenarios: (a) Reclamation's preferred operations, (b) the fisheries agencies' preferred operations and (c) an optimal operation for which temperature control pursuant to Order 90-5 is the primary objective for operations in Water Year 2015 without consideration for contract deliveries and other demands for water from Shasta Reservoir. It also required Reclamation to meet weekly with the SRTTG to discuss operations and option for reducing or avoiding redd dewatering, stranding and temperature impacts to winter-run Chinook salmon.
- February 20, 2015 – Reclamation submitted their draft February forecast and initial water supply allocations of Central Valley Project (CVP) operations as required under the National Marine Fisheries Service (NMFS) CVP and State Water Project (SWP) Long-term Water Operations Biological Opinion Reasonable and Prudent Alternative (RPA) Action I.2.3.C
  - End of September (EOS) Shasta Storage would be about 1.3 million acre-feet (maf)
  - Sacramento River temperature compliance point (TCP) at Bonneyview Bridge (above Clear Creek or CCR) may only be possible through August or early September; all temperature control device (TCD) flows through the side gates would occur by early September
  - Assumes modification to D-1641 objectives for April through July
  - Wilkins Slough target of 4000 cubic feet per second (cfs)
  - Initial allocation proposal:
    - 0% to North of Delta (NOD) agricultural water service contractors
    - 75% to NOD refuges
    - 75% to Water Rights Settlement Contractors
    - 40-75% to Water Rights Exchange Contractors
    - 0% to South of Delta (SOD) agricultural contractors
    - 75% to SOD refuges

[1] http://www.waterboards.ca.gov/waterrights/water_issues/programs/drought/docs/tucp/2015/tucp_order020315.pdf

90%

Storages

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

		Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
Trinity	874	1112	1177	1178	1017	908	806	702	642	611	578	562	570
	Elev.	2267	2274	2274	2257	2244	2232	2217	2209	2204	2198	2196	2197
Whiskeytown	205	206	206	238	238	238	238	238	230	206	206	206	206
	Elev.	1199	1199	1209	1209	1209	1209	1209	1207	1199	1199	1199	1199
Shasta	2001	2671	2856	2746	2471	2169	1766	1471	1324	1299	1345	1416	1537
	Elev.	993	1001	996	983	967	943	923	912	911	914	919	928
Folsom	448	542	559	554	549	465	293	224	192	182	177	181	196
	Elev.	422	424	423	423	412	386	373	365	362	361	362	366
New Melones	563	600	559	488	385	299	206	119	63	49	54	61	63
	Elev.	878	870	855	831	808	778	741	707	696	700	706	707
San Luis	347	372	392	366	313	219	103	23	72	163	196	324	505
	Elev.	479	475	459	439	414	387	366	369	388	411	443	473
Total		5502	5750	5570	4973	4297	3412	2777	2523	2510	2556	2750	3076

State End of the Month Reservoir Storage (TAF)

Oroville	1444	1740	1828	1761	1633	1408	1176	1012	971	964	871	865	943
	Elev.	757	766	759	745	720	690	666	660	659	643	642	655
San Luis	756	900	839	702	555	423	323	255	227	271	420	578	721
Total San Luis (TAF)	1103	1272	1231	1068	868	642	426	278	299	434	617	902	1225

Monthly River Releases (TAF/cfs)

Trinity	TAF	17	18	32	180	47	28	28	27	23	18	18	18
	cfs	300	300	540	2,924	783	450	450	450	373	300	300	300
Clear Creek	TAF	10	11	9	9	9	7	5	9	11	10	11	11
	cfs	175	175	150	150	150	120	85	150	175	175	175	175
Sacramento	TAF	180	200	350	454	506	589	479	297	251	202	200	200
	cfs	3250	3250	5881	7383	8500	9579	7800	5000	4077	3394	3250	3250
American	TAF	50	49	52	49	98	182	87	48	49	48	50	49
	cfs	900	800	868	800	1645	2964	1418	802	800	800	807	800
Stanislaus	TAF	14	25	30	29	16	19	14	9	35	15	13	18
	cfs	255	403	503	465	270	316	232	153	573	260	205	295
Feather	TAF	53	49	131	49	116	141	108	77	55	54	55	55
	cfs	950	800	2200	800	1950	2300	1750	1300	900	900	900	900

Trinity Diversions (TAF)

	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
Carr PP	2	0	34	18	77	78	77	32	15	28	19	6
Spring Crk. PP	3	9	8	15	70	70	70	30	30	19	12	3

Delta Summary (TAF)

	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
Tracy	50	75	45	61	46	45	45	133	146	65	148	200
USBR Banks	0	0	0	0	0	0	0	0	0	0	0	0
Contra Costa	7	7	11.4	11.4	11.4	9.9	10.6	11.4	7	8.4	9.2	9.2
Total USBR	57	82	56	73	57	55	56	144	153	73	157	209
State Export	225	75	18	15	35	45	45	30	75	165	181	200
Total Export	282	157	74	88	92	100	101	174	228	238	338	409
COA Balance	0	0	-22	-22	-64	-55	-48	-38	-38	-38	-39	-39
Old/Middle River Std.												
Old/Middle R. calc.	-4,070	-2,060	-924	-1,216	-1,536	-1,575	-1,636	-2,635	-2,939	-3,302	-4,492	-5,319
Computed DOI	9527	4604	7396	4425	4001	4002	2993	3009	2993	3496	3497	5482
Excess Outflow	2431	602	0	423	0	0	0	0	0	0	0	1985
% Export/Inflow	36%	35%	11%	17%	16%	15%	18%	32%	44%	48%	60%	58%
% Export/Inflow std.	45%	35%	35%	35%	35%	65%	65%	65%	65%	65%	65%	65%

Hydrology

	Trinity		Shasta		Folsom		New Melones	
Water Year Inflow (TAF)	894		3,792		856		248	
Year to Date + Forecasted % of mean	74%		68%		31%		23%	

50% Forecast

Storages

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

		Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
Trinity	**874**	**1117**	**1279**	**1373**	**1220**	**1028**	**873**	**751**	**636**	**585**	**579**	**617**	**682**
	Elev.	2268	2284	2292	2278	2258	2240	2224	2208	2199	2198	2205	2214
Whiskeytown	**205**	**206**	**206**	**238**	**238**	**238**	**238**	**238**	**230**	**230**	**225**	**206**	**206**
	Elev.	1199	1199	1209	1209	1209	1209	1209	1207	1207	1205	1199	1199
Shasta	**2001**	**2703**	**3129**	**3296**	**3208**	**2843**	**2423**	**2085**	**1954**	**1912**	**1961**	**2164**	**2577**
	Elev.	994	1013	1020	1017	1001	980	962	955	952	955	967	988
Folsom	**448**	**564**	**673**	**704**	**759**	**639**	**450**	**340**	**299**	**298**	**314**	**349**	**424**
	Elev.	424	437	440	445	433	410	394	387	387	390	395	406
New Melones	**563**	**600**	**613**	**588**	**532**	**466**	**384**	**308**	**258**	**249**	**269**	**296**	**327**
	Elev.	878	880	876	864	850	831	810	795	793	799	807	816
San Luis	**347**	**392**	**512**	**427**	**268**	**141**	**55**	**64**	**135**	**285**	**496**	**657**	**815**
	Elev.	473	483	457	420	385	352	340	353	395	441	472	501
Total		5581	6413	6625	6225	5355	4422	3785	3512	3559	3843	4289	5029

State End of the Month Reservoir Storage (TAF)

Oroville	**1444**	**1790**	**2055**	**2185**	**2083**	**1891**	**1677**	**1515**	**1447**	**1412**	**1393**	**1458**	**1715**
	Elev.	762	788	800	790	772	750	732	724	720	718	726	754
San Luis	**756**	**825**	**805**	**617**	**426**	**264**	**142**	**73**	**67**	**198**	**391**	**542**	**700**
Total San Luis (TAF)	**1103**	**1217**	**1317**	**1044**	**694**	**405**	**198**	**136**	**202**	**482**	**887**	**1200**	**1514**

Monthly River Releases (TAF/cfs)

Trinity	TAF	17	18	32	258	126	68	28	27	23	18	18	18
	cfs	**300**	**300**	**540**	**4,189**	**2,120**	**1,102**	**450**	**450**	**373**	**300**	**300**	**300**
Clear Creek	TAF	10	11	10	11	9	7	7	9	12	12	11	11
	cfs	**175**	**175**	**175**	**175**	**150**	**120**	**120**	**150**	**200**	**200**	**175**	**175**
Sacramento	TAF	180	200	268	430	666	679	584	369	307	268	200	200
	cfs	**3250**	**3250**	**4500**	**7000**	**11200**	**11041**	**9500**	**6200**	**5000**	**4500**	**3250**	**3250**
American	TAF	50	111	153	98	195	246	170	101	77	74	77	77
	cfs	**900**	**1800**	**2567**	**1600**	**3273**	**4000**	**2762**	**1690**	**1250**	**1250**	**1250**	**1250**
Stanislaus	TAF	14	25	30	29	16	19	14	9	35	15	13	18
	cfs	**255**	**403**	**503**	**465**	**270**	**316**	**232**	**153**	**573**	**260**	**205**	**295**
Feather	TAF	53	58	57	58	89	127	123	89	58	57	58	61
	cfs	**950**	**950**	**950**	**950**	**1500**	**2070**	**2000**	**1500**	**950**	**950**	**950**	**1000**

Trinity Diversions (TAF)

	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
Carr PP	1	3	42	31	93	97	98	91	40	19	1	1
Spring Crk. PP	**35**	**30**	**23**	**35**	**90**	**90**	**90**	**90**	**30**	**19**	**25**	**25**

Delta Summary (TAF)

	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan
Tracy	60	220	48	49	145	231	278	270	282	270	200	200
USBR Banks	0	0	0	0	11	11	11	0	0	0	0	0
Contra Costa	7	6.35	11.35	11.35	9.9	10.55	11.35	12	8.4	9.2	9.15	7
Total USBR	67	226	59	61	166	253	300	282	290	279	209	207
State Export	200	170	42	43	65	68	74	80	189	235	200	200
Total Export	267	396	101	104	231	321	374	362	479	514	409	407
COA Balance	0	0	-19	-19	-8	1	0	0	0	0	0	0
Old/Middle R. std.												
Old/Middle R. calc.	-3,651	-4,795	-1,265	-1,276	-3,238	-4,243	-4,984	-4,972	-5,934	-6,697	-5,198	-5,131
Computed DOI	23737	18122	10977	7841	7094	4002	2993	3009	3009	3816	9337	13030
Excess Outflow	16641	11013	0	732	0	0	0	0	16	319	5840	9533
% Export/Inflow	17%	26%	11%	14%	27%	38%	47%	51%	63%	65%	41%	35%
% Export/Inflow std.	45%	35%	35%	35%	35%	65%	65%	65%	65%	65%	65%	65%

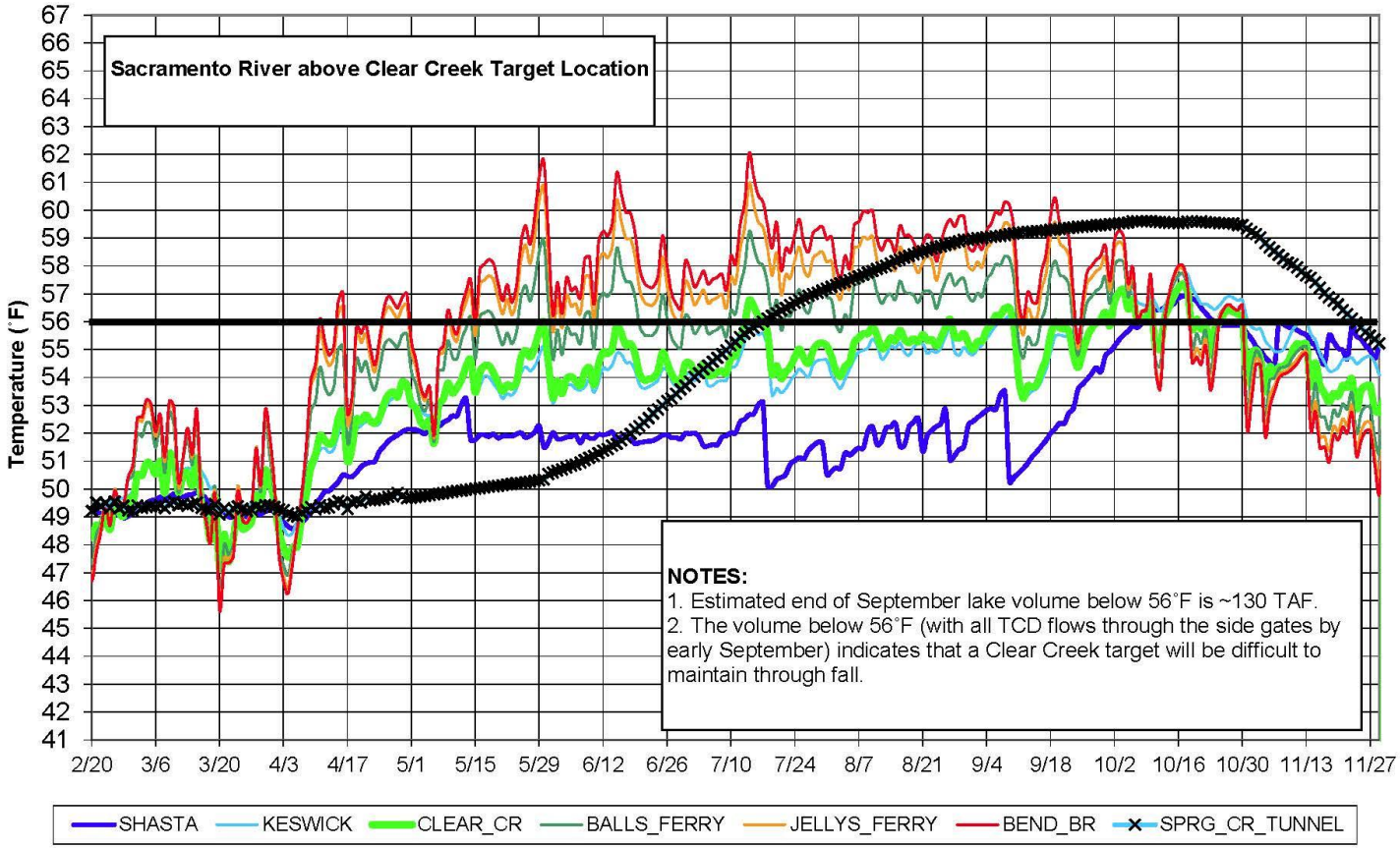
Hydrology

	Trinity	Shasta	Folsom	New Melones
Water Year Inflow (TAF)	1226	4,547	1,479	513
Year to Date + Forecasted % of mean	101%	82%	54%	49%

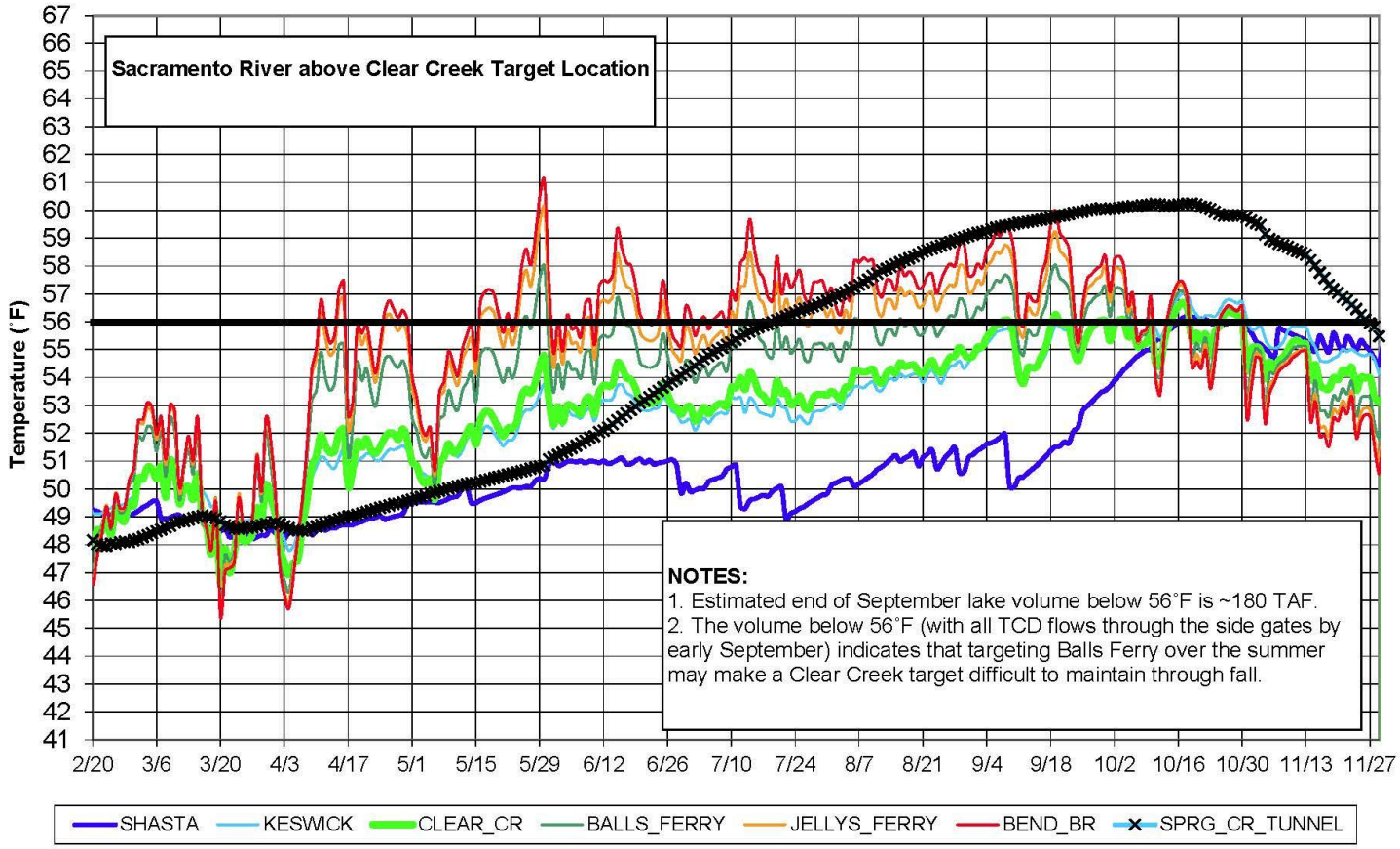
CVP actual operations do not follow any forecasted operation or outlook; actual operations are based on real-time conditions.
CVP operational forecasts or outlooks represent general system-wide dynamics and do not necessarily address specific watershed/tributary details.
CVP releases or export values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

2/20/2015

Sacramento River Modeled Temperature
2015 February 90% -Exceedance Outlook



Sacramento River Modeled Temperature
2015 February 50% -Exceedance Outlook



- February 25, 2015 – Reclamation provided results from an additional 90% exceedance forecast and temperature model run.
  - TCP at CCR may be achievable throughout the temperature management season (until October 31), with limited exceedances in duration and magnitude.
  - Modeling results should be interpreted with caution due to previous experience of the model significantly underestimating actual conditions.
- February 27, 2015 – NMFS concurred with Reclamation's February forecast and initial water supply allocations[2] based on the following consideration and provisions:
  - Reclamation will update these forecasts with revised hydrology, temperature modeling, and interpretation by mid-March. Specifically, an upper and lower bound Keswick release schedule for the 90% and 50% exceedances similar to the April 2014 Drought Operations Plan, with the goal of extending temperature control throughout the season.
  - Reclamation will continue to work with the Sacramento Settlement Contractors to reschedule water and delay their spring flood up depletions from the Sacramento River.
  - Reclamation will relax the Wilkins Slough navigation criteria to at most 3,800 cfs.
  - Reclamation and DWR will submit a TUCP Petition to the SWRCB to relax some of the D-1641 Delta requirements for April and beyond in order to conserve storage in Shasta Reservoir.
- March 18, 2015 – The NMFS, California Department of Fish and Wildlife, and the U.S. Fish and Wildlife Service (fish agencies) submitted a scenario to Reclamation, as required in the SWRCB February 3, 2015. Objectives of this scenario included:
  - Encourage winter run chinook adults to move upstream and spawn as far upstream as possible to provide for efficient use of the cold-water pool in Shasta Reservoir.
  - Provide adequate water temperatures for incubating winter run chinook eggs by maximizing the cold-water pool in Shasta Reservoir.
  - Prevent dewatering of winter run chinook redds.
  - Reduce stranding of winter run chinook fry and reduce dewatering of fall run chinook redds in the Sacramento River.
  - Provide for improved water temperatures for incubating spring run eggs in Clear Creek.
  - Provide for improved water temperatures for incubating fall run eggs in the Sacramento River.
  - Increase carry-over storage for temperature control next year.
  - With the following assumptions:
    - This scenario is limited in focus to the Sacramento River and Clear Creek with no redirected impacts to fisheries on other water bodies (especially Trinity). To the extent possible, redirected impacts should be to water supply deliveries following contract priorities. Transfers should be accomplished in a way that is compatible with temperature control operations.

[2] http://www.westcoast.fisheries.noaa.gov/publications/Central_Valley/Water%20Operations/2015-02-27_nmfs_response_to_bor_s_february_forecast.pdf

- 58 degrees Fahrenheit compliance point at CCR through May 15 (unless there is evidence of winter-run spawning, if there is evidence of spawning change compliance temperature to 56 degrees immediately). It is noted that Reclamation may not have access to the required TCD gates to keep flows at 58 and they may be lower.
- 56 degrees Fahrenheit compliance point at CCR from May 16 until October 31.
- Keep Keswick releases no higher than the minimum flow required for temperature control at CCR until October 31 (i.e. the minimum release from Keswick strictly for temperature management and not blending to increase deliveries).
- Hold Keswick releases constant June through August and do not peak flows to help ensure winter run spawn at flows between 8,000 and 9,000 cfs.
- CDFW will monitor winter run redd dewatering. It is assumed that dewatering could occur starting at 7,000 cfs and will occur at 6,000 cfs. It is assumed that if there is a fisheries benefit, CDFW would consider modifying winter run redds again this year. A combination of holding flows between 7,000 and 6,000 cfs in addition to redd modification could protect alevin and increase carry over storage.
- Trinity River imports and other assumptions should be realistic and should be informed by last year.
- Maintain cold water temperature in Whiskeytown and Clear Creek without increasing Trinity diversions.
- Modify Carr Powerhouse Diversions (TAF) to the following – Feb 2 TAF, Mar 0 TAF, Apr 34 TAF, May 18 TAF, Jun 77 TAF, Jul 78 TAF, Aug 77 TAF, Sep 77 TAF, Oct 2 TAF, Nov 2 TAF, Dec 2 TAF, Jan 6 TAF

Keswick Release Schedule (if temperature control can be made with lower releases, automatically reduce releases in modeling)[3]

Month	Scenario 1 (cfs)	Scenario 2 (cfs)	Scenario 3 (cfs)
March	3,250	3,250	3,250
April	3,250	3,250	3,250
May	6,000	5,000	6,000
June	8,000	8,000	8,500
July	8,000	8,000	9,000
August	8,000	8,000	8,500
September[4]	6,000	6,000	6,000
October	6,000 until 15th, then 5,000	6,000 until 15th, then 5,000	6,000 until 15th, then 5,000
November	5,000	3,250	3,250
December	5,000	3,250	3,250

[3] Water savings from these operations need to clearly be identified and left in Shasta Reservoir to increase storage for this and next year's winter run temperature management.

[4] There is the potential to dewater redds at 7,000 cfs based on historical data. Flow reductions would need to be discussed starting at 7,000 to prevent redd dewatering.

- On March 26, 2015 – Reclamation submitted the three scenarios to the SWRCB required in the February 3, 2015 Order[5].
  - Reclamation's temperature model run [scenario 6b (1)] provides a balance of operations within the Central Valley Project. There is a reasonable storage at Shasta and Folsom and the Sacramento River flows at Wilkins Slough are manageable. There is minimal CVP pumping at the Tracy Pumping Plant. This operation also balances out the Coordinated Operations Agreement (COA) within the system. With this year's Shasta storage, the temperature compliance point is set at 56°F at CCR.
  - The second scenario is labeled the Salmonid Plan, 6b (2). This scenario was submitted to Reclamation on March 17, 2015. In this temperature model run, Shasta storage is higher in September, but Folsom storage reaches dead pool by July. Wilkins Slough is at un-manageable stage with the river potentially running about 450 cfs in April. This model run would result in no Delta pumping at Tracy with no summertime water available for public safety and M&I in the south delta. This operation would also create COA debt for Reclamation. In this study the compliance point would also be 56°F at CCR. This scenario does show that there is more cold water available in the fall.
  - The third scenario is labeled as the "temperature optimal" plan from the SWRCB, 6b (3). This plan was also submitted on March 17, 2015. In this temperature model run, Shasta storage also increases but the Folsom storage drops to dead pool later in the year (November 2015). The Wilkins Slough problem in April continues in this model run, it also runs the river to very low levels. This run results in similar concerns to the salmonid plan where there is no CVP export in the Delta with the same impacts as the previous plan. The COA also develops a debt to Reclamation. In this study the compliance point is also set at 56°F at CCR. This scenario also shows an increase in the coldwater pool available for the fall temperature operations.
  - For this submittal, Reclamation has added a forth scenario, 6b (4). In this scenario Reclamation took the base temperature operation from 6b (1) and increased the temperature release target at Shasta by 1°F. This study had no effect to the broader system operations as compared to the base forecast run 6b (1). However this study indicates that temperature compliance at CCR would exceed 56°F several times for short periods through the summer. This scenario stretches out the seasonal temperature actions similar to the 6b (3) scenario, but does not create the other detrimental system effects identified with 6b (2) and 6b (3).
  - Scenarios 6(b) and 6(c) did not avoid redirected fisheries impacts as requested. Instead, Folsom storage was reduced to zero and exports were reduced to zero at times.

[5] http://www.waterboards.ca.gov/waterrights/water_issues/programs/drought/docs/tucp/2015/item6b_tucp032615.pdf

Scenario Differences

	6 b (1) Reclamation	6 b (2) Salmonid Plan	6 b (3) "Temp Optimal" (SWCB Scenario)	6 b (4) 53 deg target at Shasta Reclamation
	Keswick (cfs)	Keswick (cfs)	Keswick (cfs)	Keswick (cfs)
April	5600	3250	3250	5600
May	7589	5000	6000	7589
June	8549	8000	8500	8549
July	9234	8000	9000	9234
August	7593	8000	8500	7593
September	5000	6000	6000	5000
October	4061	5500	5500	4061
November	3389	5000	3389	9989
December	3250	5000	3250	3250
January	3250	3250	3250	3250
February	3250	3250	3250	3250

	6 b (1) Reclamation	6 b (2) Salmonid Plan	6 b (3) "Temp Optimal" (SWCB Scenario)	6 b (4) 53 deg target at Shasta Reclamation
	Wilkins Slough	Wilkins Slough	Wilkins Slough	Wilkins Slough
April	3800	453	453	3800
May	3800	1211	2211	3800
June	3800	3141	3641	3800
July	3800	2206	3206	3800
August	3800	3987	4487	3800
September	3800	5050	5050	3800
October	3500	4939	4939	3500
November	3500	5110	3500	3500
December	3500	5988	4238	3500

EOS volume below 56	**199**	**399**	**256**	**305**
1st side gate ops	July 26	Aug 18	Aug 10	Aug 23
Side gate ops	Sept 11	Oct 22	Sept 17	Oct 20

90%

Storages

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

		Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Trinity	1147	1192	1158	967	847	740	634	575	544	512	496	503	540
	Elev.	2275	2272	2251	2237	2223	2207	2198	2193	2187	2184	2185	2192
Whiskeytown	207	206	238	238	238	238	238	230	206	206	206	206	206
	Elev.	1199	1209	1209	1209	1209	1209	1207	1199	1199	1199	1199	1199
Shasta	2613	2752	2649	2377	2067	1666	1366	1204	1181	1226	1297	1418	1619
	Elev.	996	992	978	961	937	916	903	901	905	910	920	934
Folsom	564	600	621	625	494	325	246	222	209	204	207	222	233
	Elev.	428	431	431	416	391	377	372	369	368	369	372	374
New Melones	606	583	518	424	349	268	188	132	118	126	133	137	144
	Elev.	874	861	840	822	799	771	747	740	744	748	749	753
San Luis	357	385	372	299	207	94	17	65	156	205	345	566	587
	Elev.	480	470	450	420	375	333	335	357	386	421	462	460
Total		5717	5556	4930	4201	3331	2690	2428	2413	2479	2684	3052	3328

State End of the Month Reservoir Storage (TAF)

Oroville	1735	1783	1785	1656	1465	1223	1049	989	982	894	894	979	1134
	Elev.	761	761	748	726	696	672	662	661	647	647	661	684
San Luis	936	904	803	675	482	246	89	48	70	208	351	523	487
Total San Luis (TAF)	1293	1290	1175	974	689	340	106	113	226	413	696	1089	1074

Monthly River Releases (TAF/cfs)

Trinity	TAF	18	32	180	47	28	28	27	23	18	18	18	17
	cfs	300	540	2,924	783	450	450	450	373	300	300	300	300
Clear Creek	TAF	11	13	13	9	7	5	9	11	10	11	11	10
	cfs	175	218	216	150	120	85	150	175	175	175	175	175
Sacramento	TAF	200	333	467	509	568	467	297	250	202	200	200	180
	cfs	3250	5600	7589	8549	9234	7593	5000	4061	3389	3250	3250	3250
American	TAF	31	30	42	145	180	98	42	49	48	49	49	94
	cfs	500	500	687	2444	2933	1600	706	800	800	800	800	1692
Stanislaus	TAF	17	27	24	9	9	9	9	35	12	13	16	17
	cfs	280	460	384	150	150	150	150	577	200	206	261	309
Feather	TAF	49	48	49	77	141	108	88	55	48	49	49	44
	cfs	800	800	800	1300	2300	1750	1480	900	800	800	800	800

Trinity Diversions (TAF)

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Carr PP	0	38	22	77	78	77	32	15	28	19	6	1
Spring Crk. PP	10	8	15	70	70	70	30	30	19	12	3	3

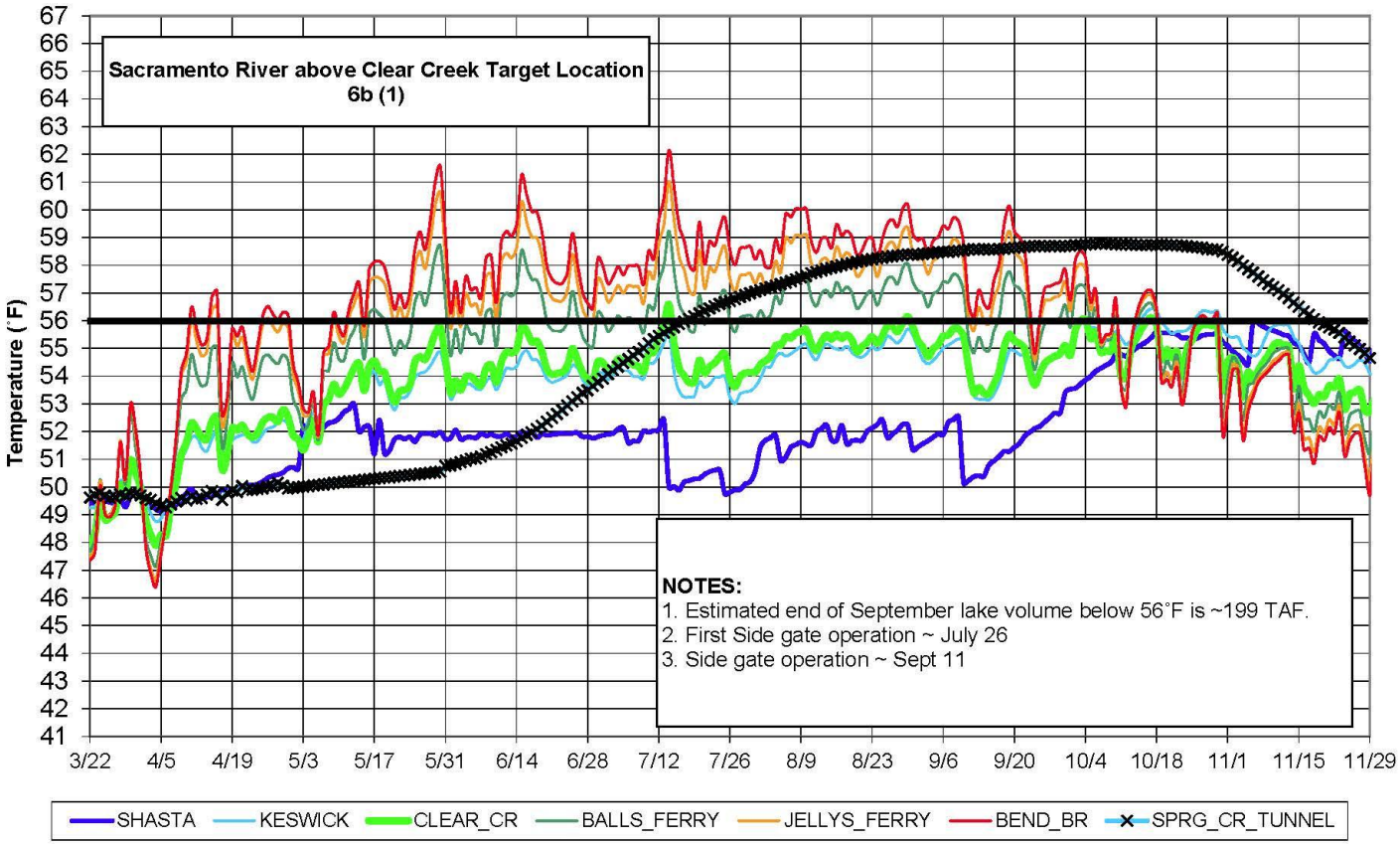
Delta Summary (TAF)

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Tracy	80	45	31	25	25	25	107	133	67	157	229	45
USBR Banks	0	0	0	0	0	0	0	0	0	0	0	0
Contra Costa	3.5	8.7	8.7	8.7	8.0	8.3	8.7	3.5	4.3	4.7	4.7	3.5
Total USBR	84	53	39	34	33	33	116	137	71	162	234	49
State Export	90	45	31	35	35	35	31	60	157	170	215	38
Total Export	174	98	70	69	68	68	147	197	228	332	449	87
COA Balance	0	0	-11	-8	-10	-9	-4	-3	-4	-8	-8	-20
Old/Middle River Std.												
Old/Middle R. calc.	-2,316	-1,431	-1,072	-1,291	-1,250	-1,276	-2,293	-2,543	-3,197	-4,410	-5,829	-1,335
Computed DOI	5905	4085	4002	4001	3904	2993	3009	3497	3496	3497	4701	11400
Excess Outflow	1903	84	0	0	0	0	0	0	0	0	195	0
% Export/Inflow	32%	22%	15%	12%	11%	13%	29%	39%	47%	61%	65%	12%
% Export/Inflow std.	35%	35%	35%	35%	65%	65%	65%	65%	65%	65%	65%	45%

Hydrology

	Trinity	Shasta	Folsom	New Melones
Water Year Inflow (TAF)	830	3,563	867	277
Year to Date + Forecasted % of mean	69%	64%	32%	26%

Sacramento River Modeled Temperature
2015 March 90%-Exceedance Outlook



90% Salmonid Plan

Storages

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

		Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Trinity	1147	1192	1162	975	855	748	642	538	520	507	503	510	546
	Elev.	2275	2272	2252	2238	2224	2209	2191	2188	2186	2185	2187	2193
Whiskeytown	207	206	238	238	238	238	238	230	206	206	206	206	206
	Elev.	1199	1209	1209	1209	1209	1209	1207	1199	1199	1199	1199	1199
Shasta	2613	2752	2785	2667	2389	2063	1736	1558	1433	1363	1315	1436	1637
	Elev.	996	998	992	979	961	941	929	921	915	912	921	935
Folsom	564	600	537	426	296	59	16	-6	-	-	-	-	-
	Elev.	428	421	407	386	313	271	-	-	-	-	-	-
New Melones	606	583	518	424	349	268	188	132	118	126	133	137	144
	Elev.	874	861	840	822	799	771	747	740	744	748	749	753
San Luis	357	385	327	224	107	-31	-132	-17					
	Elev.	480	463	438	401	342 --	--						
Total		5717	5567	4953	4233	3345	2688	2435					

State End of the Month Reservoir Storage (TAF)

Oroville	1735	1783	1758	1630	1438	1196	1022	962	955	868	868	953	1107
	Elev.	761	759	745	723	692	668	658	657	643	643	657	680
San Luis	936	904	776	636	423	177	21	-24	-1	136	279	451	415
Total San Luis (TAF)	1293	1290	1103	860	530	147	-111	-41	161	444	835	1240	1224

Monthly River Releases (TAF/cfs)

Trinity	TAF	18	32	180	47	28	28	27	23	18	18	18	17
	cfs	300	540	2,924	783	450	450	450	373	300	300	300	300
Clear Creek	TAF	11	13	13	9	7	5	9	11	10	11	11	10
	cfs	175	218	216	150	120	85	150	175	175	175	175	175
Sacramento	TAF	200	193	307	476	492	492	357	338	297	307	200	180
	cfs	3250	3250	5000	8000	8000	8000	6000	5500	5000	5000	3250	3250
American	TAF	31	114	158	145	249	67						
	cfs	500	1912	2576	2438	4053	1088						
Stanislaus	TAF	17	27	24	9	9	9	9	35	12	13	16	17
	cfs	280	460	384	150	150	150	150	577	200	206	261	309
Feather	TAF	49	74	49	77	141	108	88	55	48	49	49	44
	cfs	800	1252	800	1300	2300	1750	1480	900	800	800	800	800

Trinity Diversions (TAF)

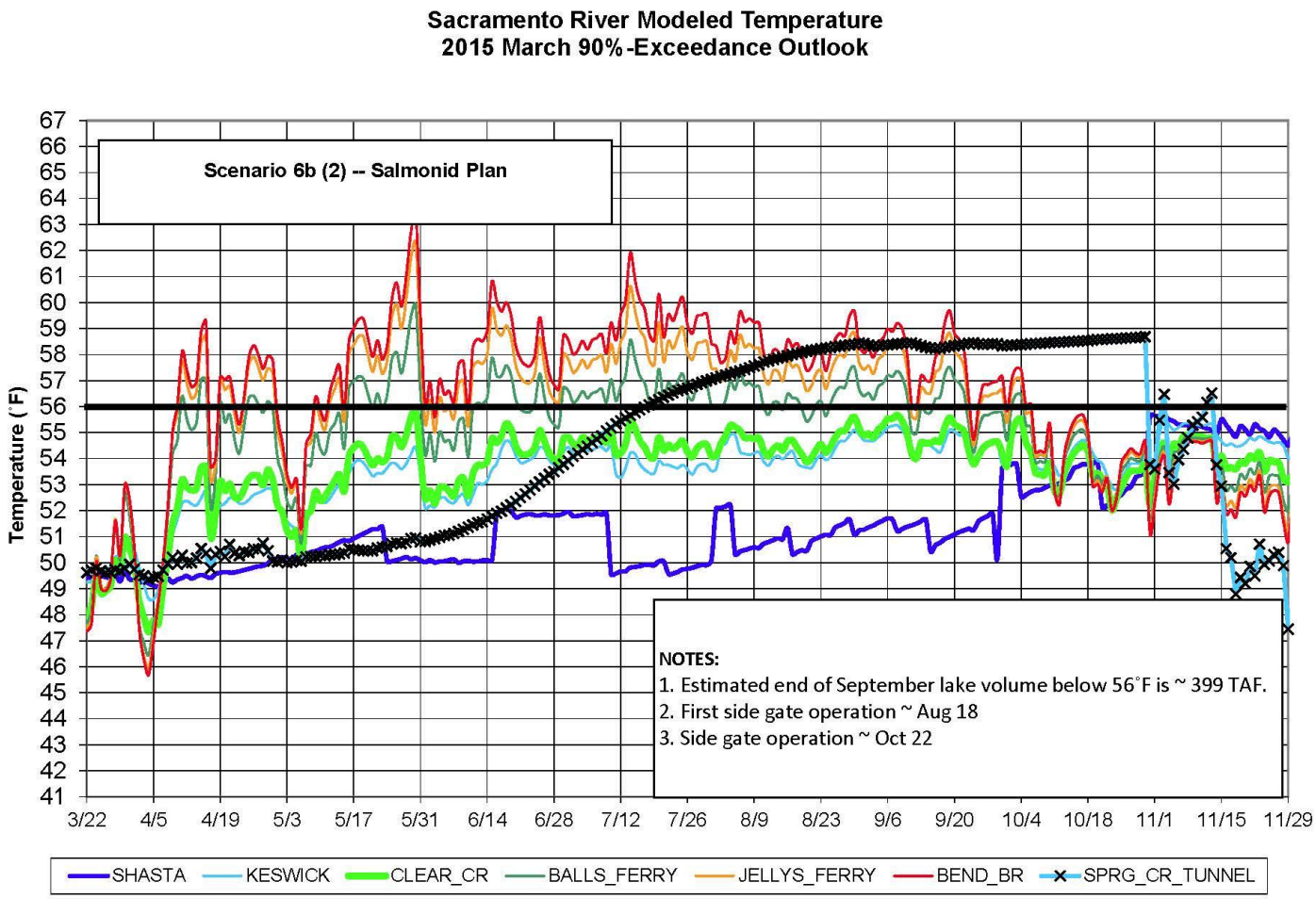
	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Carr PP	0	34	18	77	78	77	77	2	9	7	6	2
Spring Crk. PP	10	4	11	70	70	70	75	17	0	0	3	4

Delta Summary (TAF)

		Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Tracy		80	0	0	0	0	0						
USBR Banks		0	0	0	0	0	0	0	0	0	0	0	0
Contra Costa		3.5	8.7	8.7	8.7	8.0	8.3	8.7	3.5	4.3	4.7	4.7	3.5
Total USBR		84	9	9	9	8	8						
State Export		90	18	18	15	25	35	25	60	157	170	215	38
Total Export		174	27	27	24	33	43						
COA Balance		0	0	-23	-37	-42	-37	-37	-37	-37	-42	-47	-58
Old/Middle River Std.													
Old/Middle R. calc.		-2,316	-506	-533	-709	-811	-963	-3,070	-3,646	-4,440	-5,763	-5,979	-1,335
Computed DOI		5905	4001	4002	4001	3904	2993	3009	3497	3496	3497	4506	11400
Excess Outflow		1903	0	0	0	0	0	0	0	0	0	0	0
% Export/Inflow		32%	5%	5%	3%	5%	8%						
% Export/Inflow std.		35%	35%	35%	35%	65%	65%	65%	65%	65%	65%	65%	45%

Hydrology

		Trinity		Shasta		Folsom		New Melones	
Water Year Inflow (TAF)		830		3,563		867		277	
Year to Date + Forecasted	% of mean	69%		64%		32%		26%	


Sacramento River Modeled Temperature
2015 March 90%-Exceedance Outlook
Scenario 6b (2) -- Salmonid Plan
Temperature (°F)
67
66
65
64
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62
61
60
59
58
57
56
55
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52
51
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49
48
47
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41
3/22
4/5
4/19
5/3
5/17
5/31
6/14
6/28
7/12
7/26
8/9
8/23
9/6
9/20
10/4
10/18
11/1
11/15
11/29
NOTES:
1. Estimated end of September lake volume below 56°F is ~ 399 TAF.
2. First side gate operation ~ Aug 18
3. Side gate operation ~ Oct 22
SHASTA
KESWICK
CLEAR_CR
BALLS_FERRY
JELLYS_FERRY
BEND_BR
SPRG_CR_TUNNEL

90% Temperature optimal SWCB scenario

Storages

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

		Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Trinity	1147	1192	1162	975	855	748	642	538	520	507	503	510	546
	Elev.	2275	2272	2252	2238	2224	2209	2191	2188	2186	2185	2187	2193
Whiskeytown	207	206	238	238	238	238	238	230	206	206	206	206	206
	Elev.	1199	1209	1209	1209	1209	1209	1207	1199	1199	1199	1199	1199
Shasta	2613	2752	2785	2606	2298	1911	1554	1377	1251	1278	1337	1458	1660
	Elev.	996	998	989	974	952	929	916	907	909	913	922	936
Folsom	564	600	537	487	386	210	196	172	159	58	-2		
	Elev.	428	421	415	401	369	366	360	356	312			
New Melones	606	583	518	424	349	268	188	132	118	126	133	137	144
	Elev.	874	861	840	822	799	771	747	740	744	748	749	753
San Luis	357	385	327	224	107	-31	-132	-17	163	308	511	744	764
	Elev.	480	463	438	401	342 --	--		345	390	431	472	470
Total		5717	5567	4953	4233	3345	2686	2431	2416	2482			

State End of the Month Reservoir Storage (TAF)

Oroville	1735	1783	1758	1630	1438	1196	1022	962	955	868	868	953	1107
	Elev.	761	759	745	723	692	668	658	657	643	643	657	680
San Luis	936	904	776	636	423	177	21	-24	-1	136	279	451	415
Total San Luis (TAF)	1293	1290	1103	860	530	147	-111	-41	161	444	790	1195	1180

Monthly River Releases (TAF/cfs)

Trinity	TAF	18	32	180	47	28	28	27	23	18	18	18	17
	cfs	300	540	2,924	783	450	450	450	373	300	300	300	300
Clear Creek	TAF	11	13	13	9	7	5	9	11	10	11	11	10
	cfs	175	218	216	150	120	85	150	175	175	175	175	175
Sacramento	TAF	200	193	369	506	553	523	357	338	202	200	200	180
	cfs	3250	3250	6000	8500	9000	8500	6000	5500	3389	3250	3250	3250
American	TAF	31	114	97	115	188	36	42	49	143			
	cfs	500	1912	1576	1938	3053	588	714	800	2408			
Stanislaus	TAF	17	27	24	9	9	9	9	35	12	13	16	17
	cfs	280	460	384	150	150	150	150	577	200	206	261	309
Feather	TAF	49	74	49	77	141	108	88	55	48	49	49	44
	cfs	800	1252	800	1300	2300	1750	1480	900	800	800	800	800

Trinity Diversions (TAF)

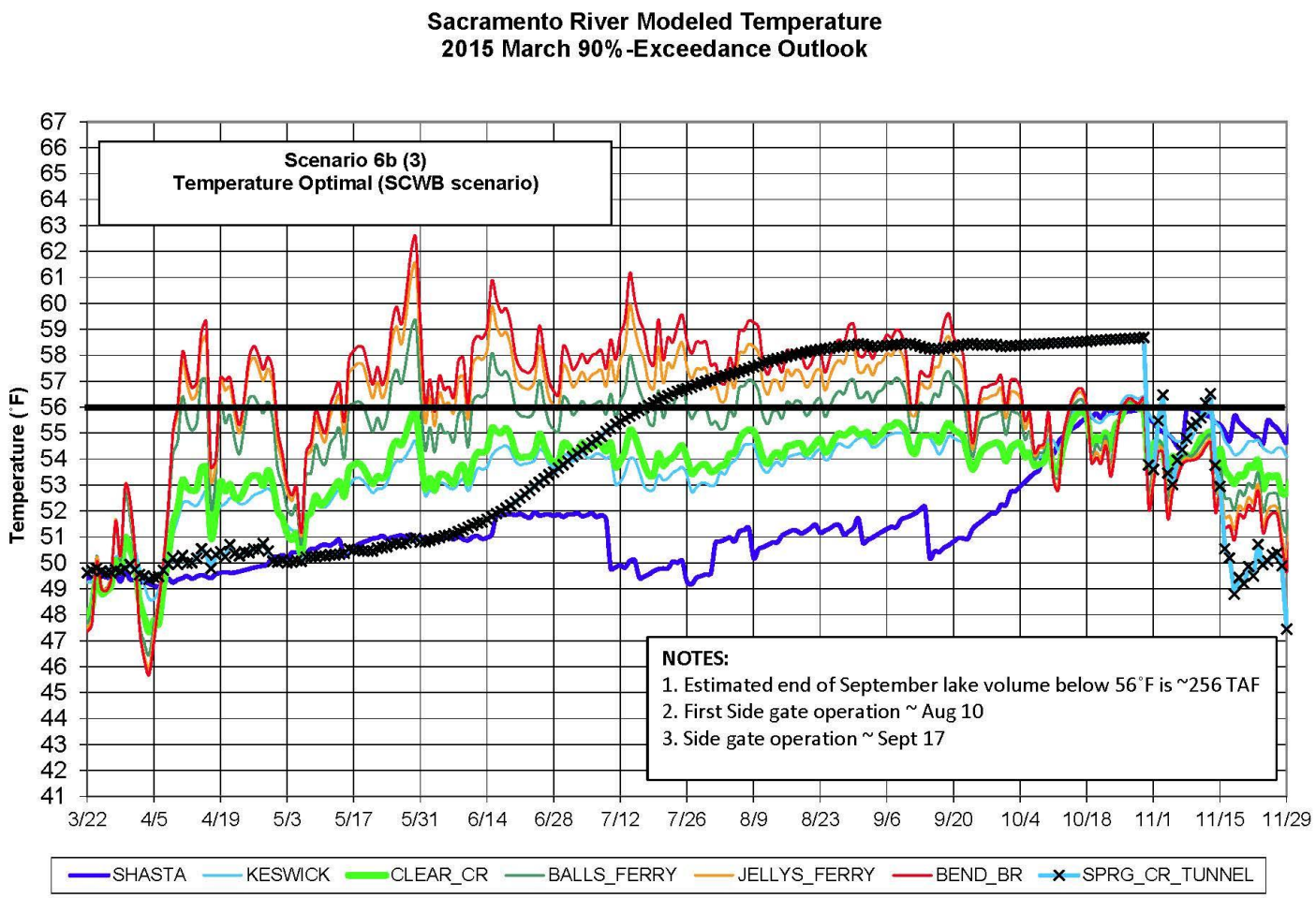
	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Carr PP	0	34	18	77	78	77	77	2	9	7	6	2
Spring Crk. PP	10	4	11	70	70	70	75	17	0	0	3	4

Delta Summary (TAF)

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Tracy	80	0	0	0	0	0	173	221	163			
USBR Banks	0	0	0	0	0	0	0	0	0	0	0	0
Contra Costa	3.5	8.7	8.7	8.7	8.0	8.3	8.7	3.5	4.3	4.7	4.7	3.5
Total USBR	84	9	9	9	8	8	182	225	167			
State Export	90	18	18	15	25	35	25	60	157	170	215	38
Total Export	174	27	27	24	33	43	207	285	324			
COA Balance	0	0	-23	-37	-42	-37	-37	-37	-37	-42	-47	-58
Old/Middle River Std.												
Old/Middle R. calc.	-2,316	-506	-533	-709	-811	-963	-3,070	-3,646	-4,440	-5,199	-5,979	-1,335
Computed DOI	5905	4001	4002	4001	3904	2993	3009	3497	3496	3497	4506	11400
Excess Outflow	1903	0	0	0	0	0	0	0	0	0	0	0
% Export/Inflow	32%	5%	5%	3%	5%	8%	37%	48%	56%			
% Export/Inflow std.	35%	35%	35%	35%	65%	65%	65%	65%	65%	65%	65%	45%

Hydrology

		Trinity		Shasta		Folsom		New Melones	
Water Year Inflow (TAF)		830		3,563		867		277	
Year to Date + Forecasted	% of mean	69%		64%		32%		26%	


Sacramento River Modeled Temperature
2015 March 90%-Exceedance Outlook
Scenario 6b (3)
Temperature Optimal (SCWB scenario)
Temperature (˚F)
67
66
65
64
63
62
61
60
59
58
57
56
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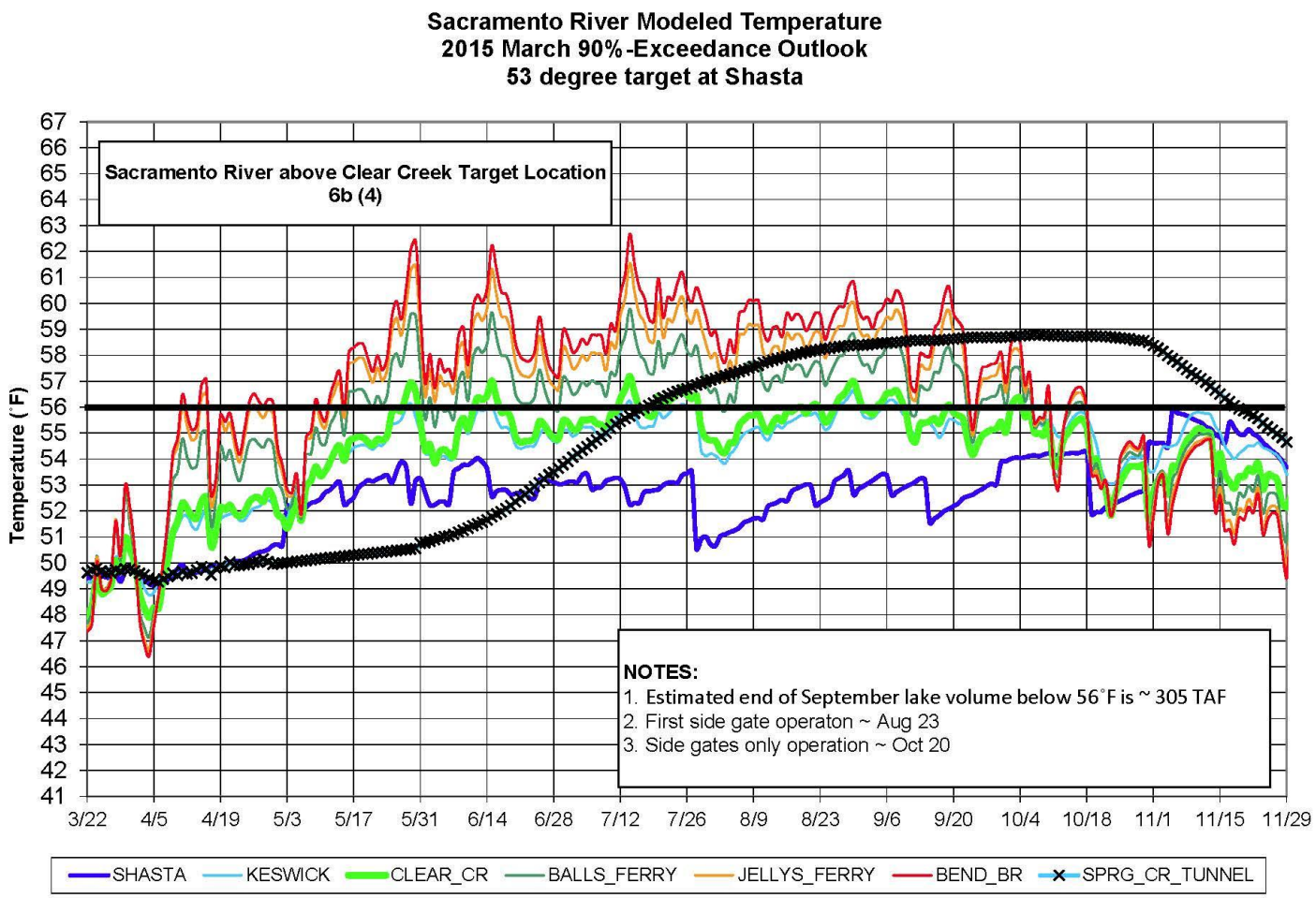
54
53
52
51
50
49
48
47
46
45
44
43
42
41
3/22
4/5
4/19
5/3
5/17
5/31
6/14
6/28
7/12
7/26
8/9
8/23
9/6
9/20
10/4
10/18
11/1
11/15
11/29
NOTES:
1. Estimated end of September lake volume below 56˚F is ~256 TAF
2. First Side gate operation ~ Aug 10
3. Side gate operation ~ Sept 17
SHASTA
KESWICK
CLEAR_CR
BALLS_FERRY
JELLYS_FERRY
BEND_BR
SPRG_CR_TUNNEL


Sacramento River Modeled Temperature
2015 March 90%-Exceedance Outlook
53 degree target at Shasta
Sacramento River above Clear Creek Target Location
6b (4)
Temperature (°F)
67
66
65
64
63
62
61
60
59
58
57
56
55
54
53
52
51
50
49
48
47
46
45
44
43
42
41
3/22
4/5
4/19
5/3
5/17
5/31
6/14
6/28
7/12
7/26
8/9
8/23
9/6
9/20
10/4
10/18
11/1
11/15
11/29
NOTES:
1. Estimated end of September lake volume below 56°F is ~ 305 TAF
2. First side gate operaton ~ Aug 23
3. Side gates only operation ~ Oct 20
SHASTA
KESWICK
CLEAR_CR
BALLS_FERRY
JELLYS_FERRY
BEND_BR
SPRG_CR_TUNNEL

- March 30, 2015 – the SWRCB requested Reclamation for refined Sacramento River temperature modeling information to be submitted by April 10, 2015[6].
  1. Modify the scenario labeled "Salmonid Plan," 6b (2) to distribute the impacts of reduced Shasta releases to depletions from the Sacramento River and/or exports. The impacts to Folsom Reservoir as compared with the scenario labeled "Reclamation March Operations Forecast," 6b (1) should be re-distributed to Sacramento Valley gross depletions and/or export reductions up to health and safety pumping levels.
  2. Modify the scenario labeled "Reclamation March Operations Forecast," 6b (1) to provide an alternate iteration such that Keswick releases are reduced by 1,200 cfs for April and May as well as the value assumed for Keswick Dam to Wilkins Slough depletions. Two iterations of this run should be provided- one that provides for a temperature of 56°F and one that provides for a temperature of 57°F at CCR throughout the temperature control season.
  3. Provide a description of the potential changes to Shasta Reservoir operations that may impact temperature under a March (or April if it is available) 2015 99 percentile exceedance scenario.
- April 3, 2015 – Reclamation responded to the SWRCB's request[7].
  - Analysis in response to request #1 indicates a reduction in overall supply to the Sacramento River Settlement Contractors (SRSC) in the amount of approximately 425 thousand acre-feet (taf) – although reduced supplies are more severe in April and May.
  - Analysis in response to request #2 indicates a reduction in supply to the Sacramento River Settlement Contractors in the amount of approximately 145 taf – although reduced supplies are more severe in April and May.
  - In response to request # 3, Reclamation concluded that the inflow into Shasta is converging more toward the 90% exceedance rather than the 99%.

[6] http://www.waterboards.ca.gov/waterrights/water_issues/programs/drought/docs/tucp/2015/swrcb_request033015.pdf

[7] http://www.waterboards.ca.gov/waterrights/water_issues/programs/drought/docs/tucp/2015/sacrivertemp_040315.pdf

Scenario Differences

Additional Information Request

	6 b (1) Reclamation	6 b (2) Salmonid Plan	6 b (3) "Temp Optimal" (SWCB Scenario)	6 b (4) 53 deg target at Shasta Reclamation	Request #1 - Same as 6b (2) Cut SC to keep Folsom whole	Request #2 (56 deg at CC) Kes-Wilk deplet by 1,200 cfs for April and May	Request #2 (53 deg at Shasta) Kes-Wilk deplet by 1,200 cfs for April and May	Request #3 (56 deg at CC) 6b (1) base with 99% inflows into Shasta	Request #3 (53 deg at Shasta) 6b (1) base with 99% inflows into Shasta
	Keswick (cfs)	Keswick (cfs)	Keswick (cfs)	Keswick (cfs)	Keswick (cfs)	Keswick (cfs)	Keswick (cfs)	Keswick (cfs)	Keswick (cfs)
April	5600	3250	3250	5600	3250	**4400**	**4400**	5582	5582
May	7589	5000	6000	7589	5000	**6389**	**6389**	7589	7589
June	8549	8000	8500	8549	8000	8549	8549	8549	8549
July	9234	8000	9000	9234	8000	9234	9234	9234	9234
August	7593	8000	8500	7593	8000	7593	7593	7593	7593
September	5000	6000	6000	5000	6000	5000	5000	5000	5000
October	4061	5500	5500	4061	5500	4061	4061	4061	4061
November	3389	5000	3389	3389 *	5000	3389	3389	3389	3389
December	3250	5000	3250	3250	5000	3250	3250	3250	3250
January	3250	3250	3250	3250	3250	3250	3250	3250	3250
February	3250	3250	3250	3250	3250	3250	3250	3250	3250

	6 b (1) Reclamation	6 b (2) Salmonid Plan	6 b (3) "Temp Optimal" (SWCB Scenario)	6 b (4) 53 deg target at Shasta Reclamation	Request #1 - Same as 6b (2) Cut SC to keep Folsom whole	Request #2 (56 deg at CC) Kes-Wilk deplet by 1,200 cfs for April and May	Request #2 (53 deg at Shasta) Kes-Wilk deplet by 1,200 cfs for April and May	Request #3 (56 deg at CC) 6b (1) base with 99% inflows into Shasta	Request #3 (53 deg at Shasta) 6b (1) base with 99% inflows into Shasta
	Wilkins Slough	Wilkins Slough	Wilkins Slough	Wilkins Slough	Wilkins Slough	Wilkins Slough	Wilkins Slough	Wilkins Slough	Wilkins Slough
April	3800	453	453	3800	1853	3800	3800	3800	3800
May	3800	1211	2211	3800	3097	3800	3800	3800	3800
June	3800	3141	3641	3800	3041	3800	3800	3800	3800
July	3800	2206	3206	3800	3231	3800	3800	3800	3800
August	3800	3987	4487	3800	3401	3800	3800	3800	3800
September	3800	5050	5050	3800	5067	3800	3800	3800	3800
October	3500	4939	4939	3500	4939	3500	3500	3500	3500
November	3500	5110	3500	3500	5110	3500	3500	3500	3500
December	3500	5988	4238	3500	5988	3500	3500	3500	3500

EO Sep Storage	1204	1558	1377	1204	1558	1347	1347	985	985
EOS vol below 56	**199**	**399**	**256**	**305**	**399**	**273**	**391**	**147**	**244**
1st side gate ops	July 26	Aug 18	Aug 10	Aug 23	Aug 18	Aug 13	Sep 2	Jul 22	Aug 15
Side gate ops	Sep 11	Oct 22	Sep 17	Oct 20	Oct 22	Sep 19	*Never reached side gates only*	Sep 6	Sep 25

** Corrected value- previous submital contained a typo.*

90% Salmonid Plan w Folsom same by cut SC

Storages

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

		Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Trinity	1147	1192	1162	975	855	748	642	538	520	507	503	510	546
	Elev.	2275	2272	2252	2238	2224	2209	2191	2188	2186	2185	2187	2193
Whiskeytown	207	206	238	238	238	238	238	230	206	206	206	206	206
	Elev.	1199	1209	1209	1209	1209	1209	1207	1199	1199	1199	1199	1199
Shasta	2613	2752	2785	2667	2389	2063	1736	1558	1433	1363	1315	1436	1637
	Elev.	996	998	992	979	961	941	929	921	915	912	921	935
Folsom	564	600	621	625	488	313	230	207	193	188	191	206	217
	Elev.	428	431	431	415	389	374	369	365	364	365	368	371
New Melones	606	583	518	424	349	268	188	132	118	126	133	137	144
	Elev.	874	861	840	822	799	771	747	740	744	748	749	753
San Luis	357	385	327	224	107	-31	-132	-17	163	308	556	789	809
	Elev.	480	463	438	401	342 --	--		345	390	436	476	473
Total		5717	5651	5153	4426	3599	2902	2648	2633	2698	2903	3283	3559

State End of the Month Reservoir Storage (TAF)

Oroville	1735	1783	1758	1630	1438	1196	1022	962	955	868	868	953	1107
	Elev.	761	759	745	723	692	668	658	657	643	643	657	680
San Luis	936	904	776	636	423	177	21	-24	-1	136	279	451	415
Total San Luis (TAF)	1293	1290	1103	860	530	147	-111	-41	161	444	835	1240	1224

Monthly River Releases (TAF/cfs)

Trinity	TAF	18	32	180	47	28	28	27	23	18	18	18	17
	cfs	300	540	2,924	783	450	450	450	373	300	300	300	300
Clear Creek	TAF	11	13	13	9	7	5	9	11	10	11	11	10
	cfs	175	218	216	150	120	85	150	175	175	175	175	175
Sacramento	TAF	200	193	307	476	492	492	357	338	297	307	200	180
	cfs	3250	3250	5000	8000	8000	8000	6000	5500	5000	5000	3250	3250
American	TAF	31	30	42	151	186	104	42	49	48	50	49	94
	cfs	500	508	685	2535	3025	1684	700	800	800	806	801	1692
Stanislaus	TAF	17	27	24	9	9	9	9	35	12	13	16	17
	cfs	280	460	384	150	150	150	150	577	200	206	261	309
Feather	TAF	49	74	49	77	141	108	88	55	48	49	49	44
	cfs	800	1252	800	1300	2300	1750	1480	900	800	800	800	800
WLK		3800	1853	3097	3041	3231	3401	5067	4939	5110	5988		

Trinity Diversions (TAF)

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Carr PP	0	34	18	77	78	77	77	2	9	7	6	2
Spring Crk. PP	10	4	11	70	70	70	75	17	0	0	3	4

Delta Summary (TAF)

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Tracy	80	0	0	0	0	0	173	221	163	265	241	45
USBR Banks	0	0	0	0	0	0	0	0	0	0	0	0
Contra Costa	3.5	8.7	8.7	8.7	8.0	8.3	8.7	3.5	4.3	4.7	4.7	3.5
Total USBR	84	9	9	9	8	8	182	225	167	270	246	49
State Export	90	18	18	15	25	35	25	60	157	170	215	38
Total Export	174	27	27	24	33	43	207	285	324	440	461	87
COA Balance	0	-35	-87	-100	-120	-106	-107	-106	-106	-111	-116	-127
Old/Middle River Std.												
Old/Middle R. calc.	-2,316	-506	-533	-709	-811	-963	-3,070	-3,646	-4,440	-5,763	-5,979	-1,335
Computed DOI	5905	4001	4002	4001	3904	2993	3009	3497	3496	3497	4506	11400
Excess Outflow	1903	0	0	0	0	0	0	0	0	0	0	0
% Export/Inflow	32%	5%	5%	3%	5%	8%	37%	48%	56%	67%	67%	12%
% Export/Inflow std.	35%	35%	35%	35%	65%	65%	65%	65%	65%	65%	65%	45%

Hydrology

	Trinity	Shasta	Folsom	New Melones
Water Year Inflow (TAF)	830	3,563	867	277
Year to Date + Forecasted % of mean	69%	64%	32%	26%

90% 1,200 cfs reduction at Kes-Wlk April and May

Storages

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

		Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Trinity	1147	1192	1158	967	847	740	634	575	544	512	496	503	540
	Elev.	2275	2272	2251	2237	2223	2207	2198	2193	2187	2184	2185	2192
Whiskeytown	207	206	238	238	238	238	238	230	206	206	206	206	206
	Elev.	1199	1209	1209	1209	1209	1209	1207	1199	1199	1199	1199	1199
Shasta	2613	2752	2720	2522	2211	1810	1510	1347	1323	1368	1439	1560	1761
	Elev.	996	995	978	969	946	926	914	912	916	921	930	943
Folsom	564	600	621	626	494	325	247	222	209	204	208	222	233
	Elev.	428	431	431	416	391	377	372	369	368	369	372	374
New Melones	606	583	518	424	349	268	188	132	118	126	133	137	144
	Elev.	874	861	840	822	799	771	747	740	744	748	749	753
San Luis	357	385	372	299	207	94	17	65	156	205	345	566	587
	Elev.	480	470	450	420	375	333	335	357	386	421	462	460
Total		5717	5628	5075	4346	3475	2833	2572	2556	2621	2826	3194	3470

State End of the Month Reservoir Storage (TAF)

Oroville	1735	1783	1785	1656	1465	1223	1049	989	982	894	894	979	1134
	Elev.	761	761	748	726	696	672	662	661	647	647	661	684
San Luis	936	904	803	675	482	246	89	48	70	208	351	523	487
Total San Luis (TAF)	1293	1290	1175	974	689	340	106	113	226	413	696	1089	1074

Monthly River Releases (TAF/cfs)

Trinity	TAF	18	32	180	47	28	28	27	23	18	18	18	17
	cfs	300	540	2,924	783	450	450	450	373	300	300	300	300
Clear Creek	TAF	11	13	13	9	7	5	9	11	10	11	11	10
	cfs	175	218	216	150	120	85	150	175	175	175	175	175
Sacramento	TAF	200	262	393	509	568	467	297	250	202	200	200	180
	cfs	3250	4400	6389	8549	9234	7593	5000	4061	3389	3250	3250	3250
American	TAF	31	30	42	145	180	98	42	49	48	49	49	94
	cfs	500	500	683	2444	2933	1600	706	800	800	800	800	1692
Stanislaus	TAF	17	27	24	9	9	9	9	35	12	13	16	17
	cfs	280	460	384	150	150	150	150	577	200	206	261	309
Feather	TAF	49	48	49	77	141	108	88	55	48	49	49	44
	cfs	800	800	800	1300	2300	1750	1480	900	800	800	800	800

Trinity Diversions (TAF)

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Carr PP	0	38	22	77	78	77	32	15	28	19	6	1
Spring Crk. PP	10	8	15	70	70	70	30	30	19	12	3	3

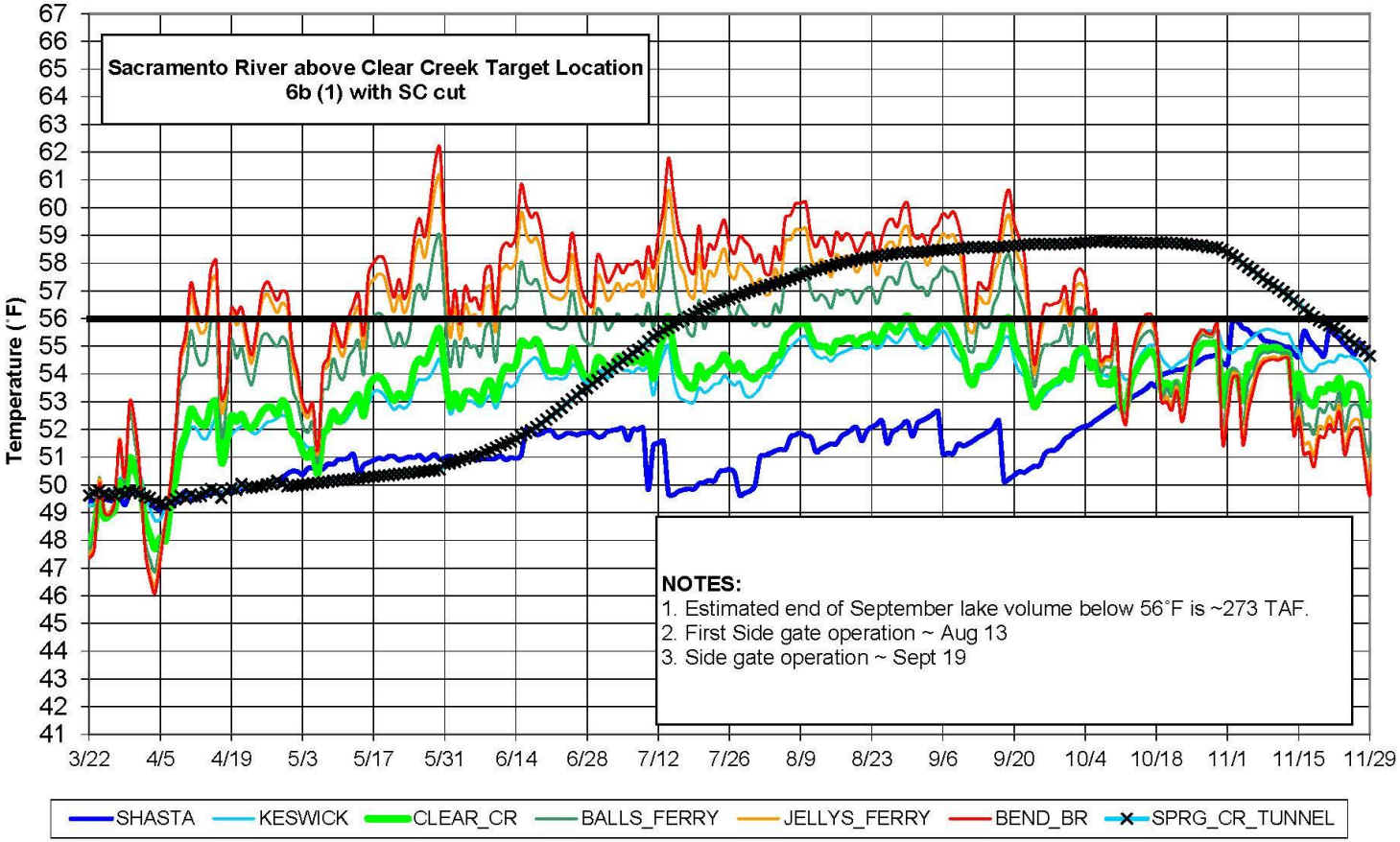
Delta Summary (TAF)

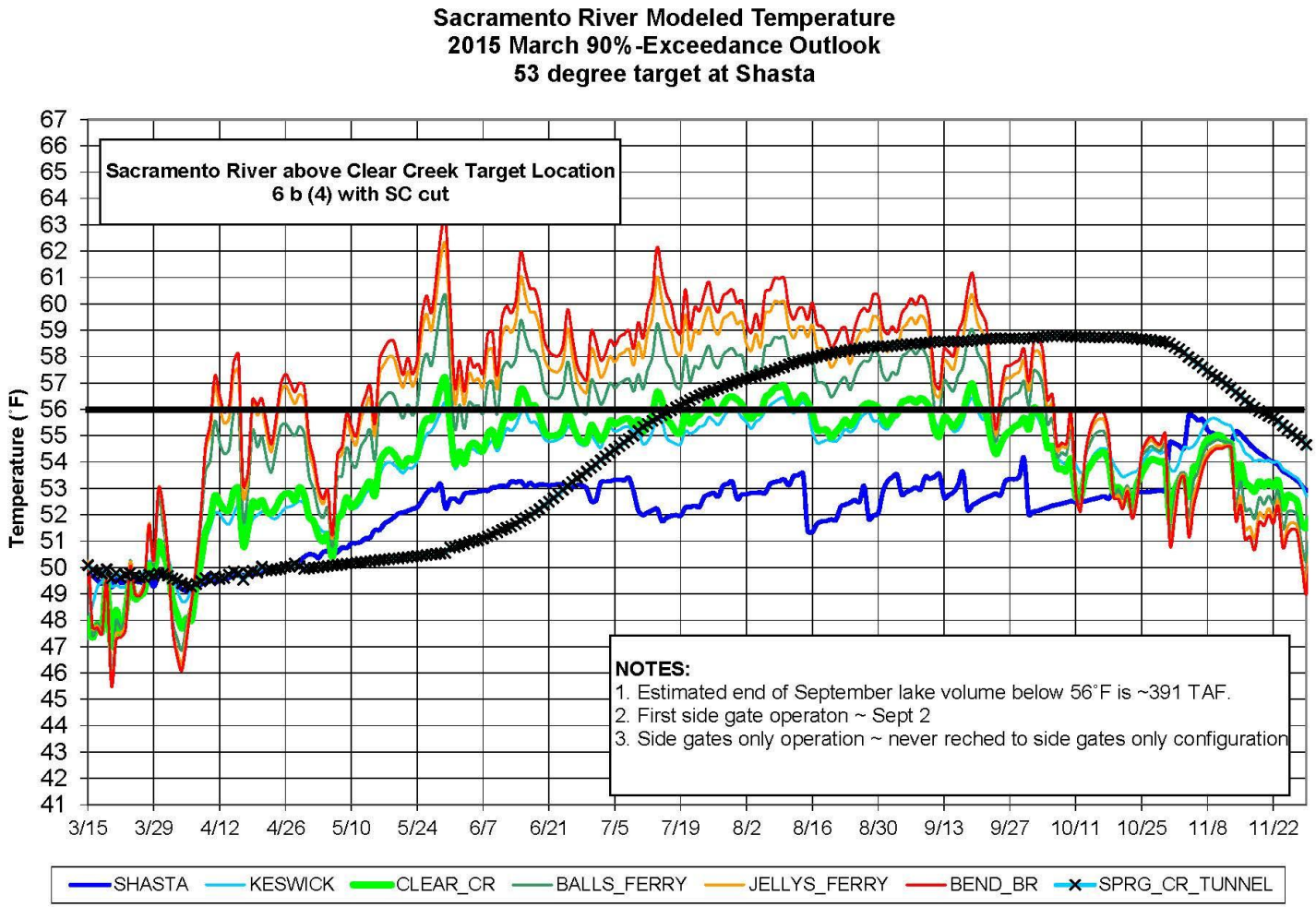
	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Tracy	80	45	31	25	25	25	107	133	67	157	229	45
USBR Banks	0	0	0	0	0	0	0	0	0	0	0	0
Contra Costa	3.5	8.7	8.7	8.7	8.0	8.3	8.7	3.5	4.3	4.7	4.7	3.5
Total USBR	84	53	39	34	33	33	116	137	71	162	234	49
State Export	90	45	31	35	35	35	31	60	157	170	215	38
Total Export	174	98	70	69	68	68	147	197	228	332	449	87
COA Balance	0	0	-29	-26	-28	-28	-22	-22	-22	-27	-27	-38
Old/Middle River Std.												
Old/Middle R. calc.	-2,316	-1,431	-1,072	-1,291	-1,250	-1,276	-2,293	-2,543	-3,197	-4,410	-5,829	-1,335
Computed DOI	5905	4118	4002	4001	3904	2993	3009	3497	3496	3497	4701	11400
Excess Outflow	1903	118	0	0	0	0	0	0	0	0	195	0
% Export/Inflow	32%	22%	15%	12%	11%	13%	29%	39%	47%	61%	65%	12%
% Export/Inflow std.	35%	35%	35%	35%	65%	65%	65%	65%	65%	65%	65%	45%

Hydrology

	Trinity	Shasta	Folsom	New Melones
Water Year Inflow (TAF)	830	3,563	867	277
Year to Date + Forecasted % of mean	69%	64%	32%	26%

Sacramento River Modeled Temperature
2015 March 90%-Exceedance Outlook




Sacramento River Modeled Temperature
2015 March 90%-Exceedance Outlook
53 degree target at Shasta
Sacramento River above Clear Creek Target Location
6 b (4) with SC cut
Temperature (˚F)
67
66
65
64
63
62
61
60
59
58
57
56
55
54
53
52
51
50
49
48
47
46
45
44
43
42
41
3/15
3/29
4/12
4/26
5/10
5/24
6/7
6/21
7/5
7/19
8/2
8/16
8/30
9/13
9/27
10/11
10/25
11/8
11/22
NOTES:
1. Estimated end of September lake volume below 56˚F is ~391 TAF.
2. First side gate operaton ~ Sept 2
3. Side gates only operation ~ never reched to side gates only configuration
SHASTA
KESWICK
CLEAR_CR
BALLS_FERRY
JELLYS_FERRY
BEND_BR
SPRG_CR_TUNNEL

90% with 99% inflow into Shasta

Storages

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

		Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Trinity	1147	1192	1158	967	847	740	634	575	544	512	496	503	540
	Elev.	2275	2272	2251	2237	2223	2207	2198	2193	2187	2184	2185	2192
Whiskeytown	207	206	238	238	238	238	238	230	206	206	206	206	206
	Elev.	1199	1209	1209	1209	1209	1209	1207	1199	1199	1199	1199	1199
Shasta	2613	2681	2539	2237	1908	1477	1164	985	932	928	929	951	1032
	Elev.	993	986	978	952	924	900	884	879	878	879	881	888
Folsom	564	577	583	582	535	436	378	347	303	268	241	196	157
	Elev.	426	427	426	421	408	400	395	388	381	376	366	355
New Melones	606	583	518	424	349	268	188	132	118	126	133	137	144
	Elev.	874	861	840	822	799	771	747	740	744	748	749	753
San Luis	357	385	372	299	207	94	17	65	156	205	345	566	587
	Elev.	480	470	450	420	375	333	335	357	386	421	462	460
Total		5623	5408	4747	4083	3254	2619	2335	2260	2245	2350	2558	2665

State End of the Month Reservoir Storage (TAF)

Oroville	1735	1783	1785	1656	1465	1223	1049	989	982	894	894	979	1134
	Elev.	761	761	748	726	696	672	662	661	647	647	661	684
San Luis	936	904	803	675	482	246	89	48	70	208	351	523	487
Total San Luis (TAF)	1293	1290	1175	974	689	340	106	113	226	413	696	1089	1074

Monthly River Releases (TAF/cfs)

Trinity	TAF	18	32	180	47	28	28	27	23	18	18	18	17
	cfs	300	540	2,924	783	450	450	450	373	300	300	300	300
Clear Creek	TAF	11	13	13	9	7	5	9	11	10	11	11	10
	cfs	175	218	216	150	120	85	150	175	175	175	175	175
Sacramento	TAF	200	332	467	509	568	467	297	250	202	200	200	180
	cfs	3250	5582	7589	8549	9234	7593	5000	4061	3389	3250	3250	3250
American	TAF	31	30	37	56	94	68	42	49	48	49	49	94
	cfs	500	500	600	948	1534	1112	700	800	800	800	800	1692
Stanislaus	TAF	17	27	24	9	9	9	9	35	12	13	16	17
	cfs	280	460	384	150	150	150	150	577	200	206	261	309
Feather	TAF	49	48	49	77	141	108	88	55	48	49	49	44
	cfs	800	800	800	1300	2300	1750	1480	900	800	800	800	800

Trinity Diversions (TAF)

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Carr PP	0	38	22	77	78	77	32	15	28	19	6	1
Spring Crk. PP	10	8	15	70	70	70	30	30	19	12	3	3

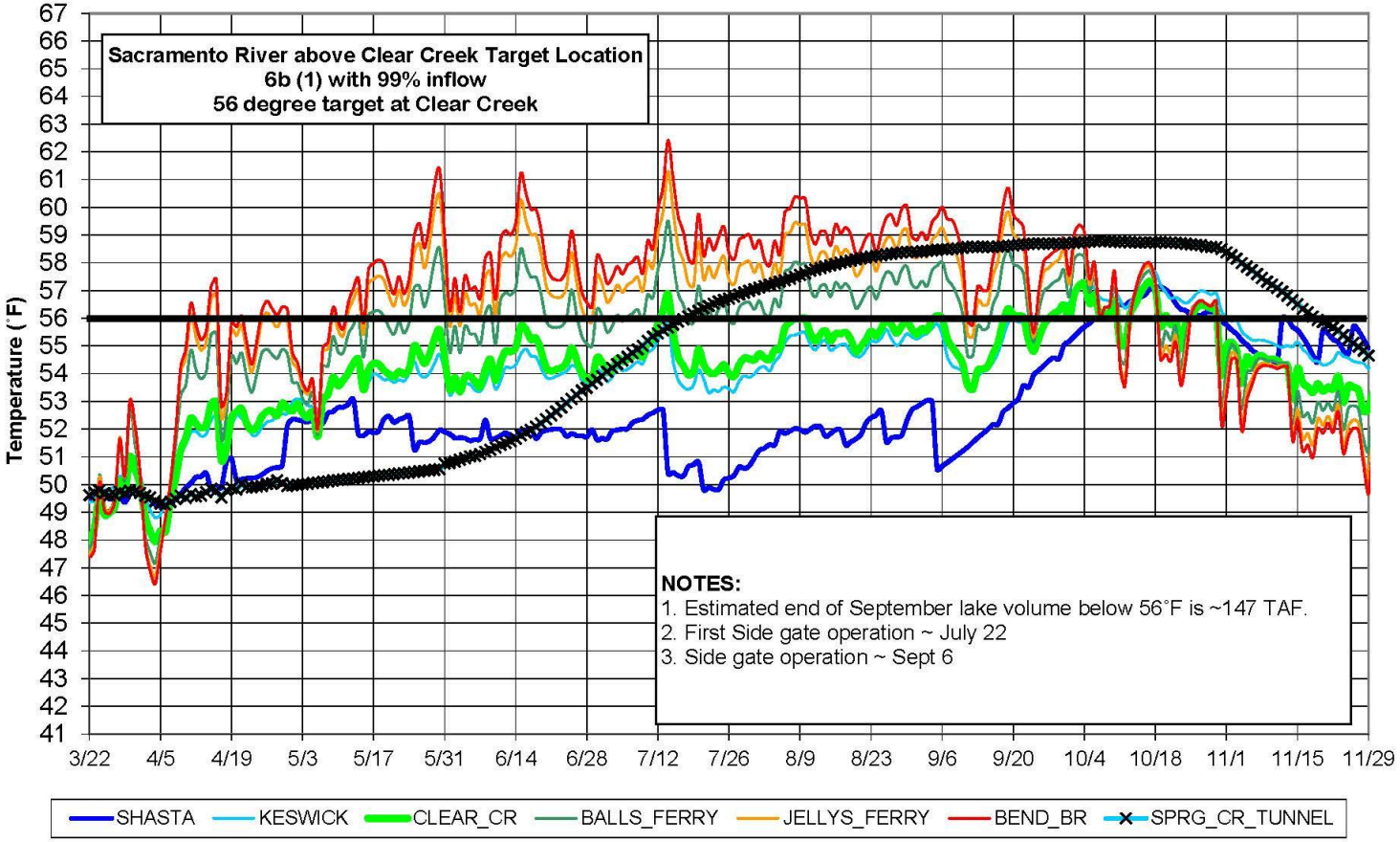
Delta Summary (TAF)

	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Tracy	80	45	31	25	25	25	107	133	67	157	229	45
USBR Banks	0	0	0	0	0	0	0	0	0	0	0	0
Contra Costa	3.5	8.7	8.7	8.7	8.0	8.3	8.7	3.5	4.3	4.7	4.7	3.5
Total USBR	84	53	39	34	33	33	116	137	71	162	234	49
State Export	90	45	31	35	35	35	31	60	157	170	215	38
Total Export	174	98	70	69	68	68	147	197	228	332	449	87
COA Balance	0	0	0	-13	-25	-26	-26	1	37	77	77	142
Old/Middle River Std.												
Old/Middle R. calc.	-2,316	-1,431	-1,072	-1,291	-1,250	-1,276	-2,293	-2,543	-3,197	-4,410	-5,829	-1,335
Computed DOI	5905	4068	3920	2505	2505	2505	3009	3497	3496	3497	4701	11400
Excess Outflow	3400	1563	1415	0	0	0	504	0	0	0	195	0
% Export/Inflow	32%	22%	15%	15%	13%	13%	29%	39%	47%	61%	65%	12%
% Export/Inflow std.	35%	35%	35%	35%	65%	65%	65%	65%	65%	65%	65%	45%

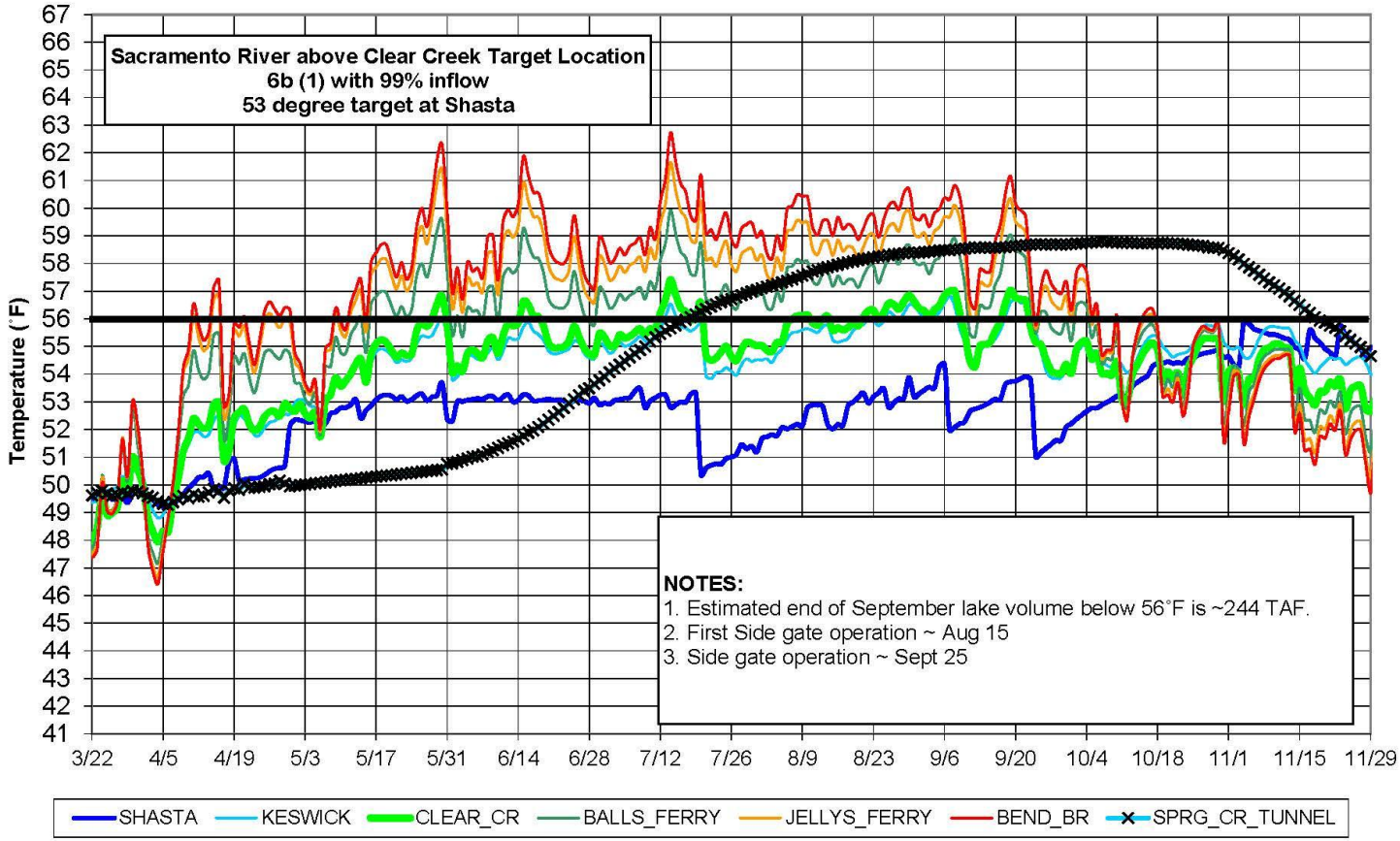
Hydrology

	Trinity	Shasta	Folsom	New Melones
Water Year Inflow (TAF)	830	3,340	783	277
Year to Date + Forecasted % of mean	69%	60%	29%	26%

Sacramento River Modeled Temperature
2015 March 90%-Exceedance Outlook



Sacramento River Modeled Temperature
2015 March 90%-Exceedance Outlook



- April 15, 2015 – Reclamation submitted to the SWRCB a revised scenario that met the temperature target of 56°F at CCR, delayed the full use of side gate operations until well into October, preserved over 300 taf of cold water pool past the end of September, modified SRSCs diversion schedules (especially in April and May), re-operated transfer volumes to the fall to benefit fall-run Chinook, and maintained stable operations down to the Delta.

Scenario Differences

March 2015

	6 b (1) Reclamation	6 b (2) Salmonid Plan	6 b (3) "Temp Optimal" (SWCB Scenario)	6 b (4) 53 deg target at Shasta Reclamation
	Keswick (cfs)	Keswick (cfs)	Keswick (cfs)	Keswick (cfs)
April	5600	3250	3250	5600
May	7589	5000	6000	7589
June	8549	8000	8500	8549
July	9234	8000	9000	9234
August	7593	8000	8500	7593
September	5000	6000	6000	5000
October	4061	5500	5500	4061
November	3389	5000	3389	3389 *
December	3250	5000	3250	3250

April 2015 90% Exceedance Outlook

	April 90% Temp Forecast With SRSC Coordinated Diversions
	Keswick (cfs)
April	4500
May	7500
June	8500
July	9000
August	8500
September	6000
October	5000
November	4000
December	4000

	6 b (1) Reclamation	6 b (2) Salmonid Plan	6 b (3) "Temp Optimal" (SWCB Scenario)	6 b (4) 53 deg target at Shasta Reclamation
	Wilkins Slough	Wilkins Slough	Wilkins Slough	Wilkins Slough
April	3800	453	453	3800
May	3800	1211	2211	3800
June	3800	3141	3641	3800
July	3800	2206	3206	3800
August	3800	3987	4487	3800
September	3800	5050	5050	3800
October	3500	4939	4939	3500
November	3500	5110	3500	3500
December	3500	5988	4238	3500

	April 90% Temp Forecast With SRSC Coordinated Diversions
	Wilkins Slough
April	3722
May	3716
June	3800
July	3787
August	4340
September	4753
October	4425
November	4107
December	4960

EO Sep Storage	1204	1558	1377	1204
EOS vol below 56	**199**	**399**	**256**	**305**
1st side gate ops	July 26	Aug 18	Aug 10	Aug 23
Side gate ops	Sep 11	Oct 22	Sep 17	Oct 20

EO Sep Storage	1164
EOS vol below 56	**386**
1st side gate ops	Aug 23
Side gate ops	Oct 20

** Corrected value- previous submital contained a typo.*

April 2015 90% Exceedance Outlook
With SRSC Coordinated Diversions

Storages

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

		Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar
Trinity	**1191**	**1179**	**1012**	**877**	**754**	**629**	**539**	**508**	**476**	**460**			
	Elev.	2274	2256	2241	2225	2206	2192	2186	2180	2177	2178	2186	2197
Whiskeytown	**205**	**238**	**238**	**238**	**238**	**238**	**230**	**206**	**206**	**206**			
	Elev.	1209	1209	1209	1209	1209	1207	1199	1199	1199	1199	1199	1199
Shasta	**2689**	**2621**	**2325**	**2023**	**1661**	**1341**	**1164**	**1083**	**1093**	**1118**			
	Elev.	990	975	959	936	914	900	893	894	896	908	921	943
Folsom	**572**	**596**	**553**	**429**	**293**	**267**	**238**	**225**	**219**	**222**			
	Elev.	428	423	407	386	381	375	373	371	372	375	379	387
New Melones	**553**	**478**	**388**	**294**	**207**	**124**	**64**	**50**	**58**	**65**			
	Elev.	853	832	806	778	743	708	697	703	709	711	716	720
San Luis	**395**	**393**	**321**	**226**	**110**	**28**	**135**	**301**	**380**	**535**			
	Elev.	476	457	429	385	346	358	388	416	451	461	478	497
Total		5506	4836	4087	3263	2627	2371	2373	2431	2607			

State End of the Month Reservoir Storage (TAF)

Oroville	**1794**	**1776**	**1638**	**1424**	**1180**	**1001**	**937**	**930**	**830**	**784**			
	Elev.	761	746	721	690	664	654	653	636	628	649	679	701
San Luis	**959**	**846**	**718**	**541**	**300**	**137**	**95**	**131**	**275**	**449**			
Total San Luis (TAF)	**1354**	**1239**	**1039**	**767**	**410**	**166**	**230**	**432**	**655**	**984**			

Monthly River Releases (TAF/cfs)

Trinity	TAF	32	180	47	28	28	27	23	18	18			
	cfs	**540**	**2,924**	**783**	**450**	**450**	**450**	**373**	**300**	**300**	300	300	300
Clear Creek	TAF	13	13	9	7	5	9	11	10	11			
	cfs	**218**	**216**	**150**	**120**	**85**	**150**	**175**	**175**	**175**	175	175	175
Sacramento	TAF	268	461	506	553	523	357	307	238	246			
	cfs	**4500**	**7500**	**8500**	**9000**	**8500**	**6000**	**5000**	**4000**	**4000**	3250	3250	3250
American	TAF	30	92	139	151	49	48	49	48	49			
	cfs	**500**	**1497**	**2331**	**2462**	**793**	**800**	**804**	**806**	**800**	801	817	820
Stanislaus	TAF	30	9	9	9	9	9	35	12	13			
	cfs	**500**	**150**	**150**	**150**	**150**	**150**	**577**	**200**	**206**	201	300	200
Feather	TAF	48	49	89	154	123	101	55	48	49			
	cfs	**800**	**800**	**1500**	**2500**	**2000**	**1700**	**900**	**800**	**800**	825	825	800
WLK		3722	3716	3800	3787	4340	4753	4425	4107	4960			

Trinity Diversions (TAF)

	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec			
Carr PP	39	22	97	98	97	62	15	28	19			
Spring Crk. PP	**8**	**15**	**90**	**90**	**90**	**60**	**30**	**19**	**12**	5	5	10

Delta Summary (TAF)

	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec			
Tracy	57	31	23	22	20	166	208	97	173			
USBR Banks	0	0	0	0	0	0	0	0	0			
Contra Costa	8.7	8.7	8.7	8.0	8.3	8.7	3.5	4.3	4.7			
Total USBR	65	39	32	30	28	175	212	101	178			
State Export	33	31	51	30	30	30	74	164	200			
Total Export	98	70	83	60	58	205	286	265	378			
COA Balance	0	0	0	-20	-29	-29	-29	-29	-29			
Old/Middle River Std.												
Old/Middle R. calc.	-1,413	-1,177	-1,472	-1,149	-1,151	-3,044	-3,658	-3,676	-4,986			
Computed DOI	4740	4002	4001	2993	2993	3009	2993	3496	3497			
Excess Outflow	740	0	0	0	0	0	0	0	0			
% Export/Inflow	20%	15%	15%	10%	11%	37%	50%	51%	64%			
% Export/Inflow std.	35%	35%	35%	65%	65%	65%	65%	65%	65%			

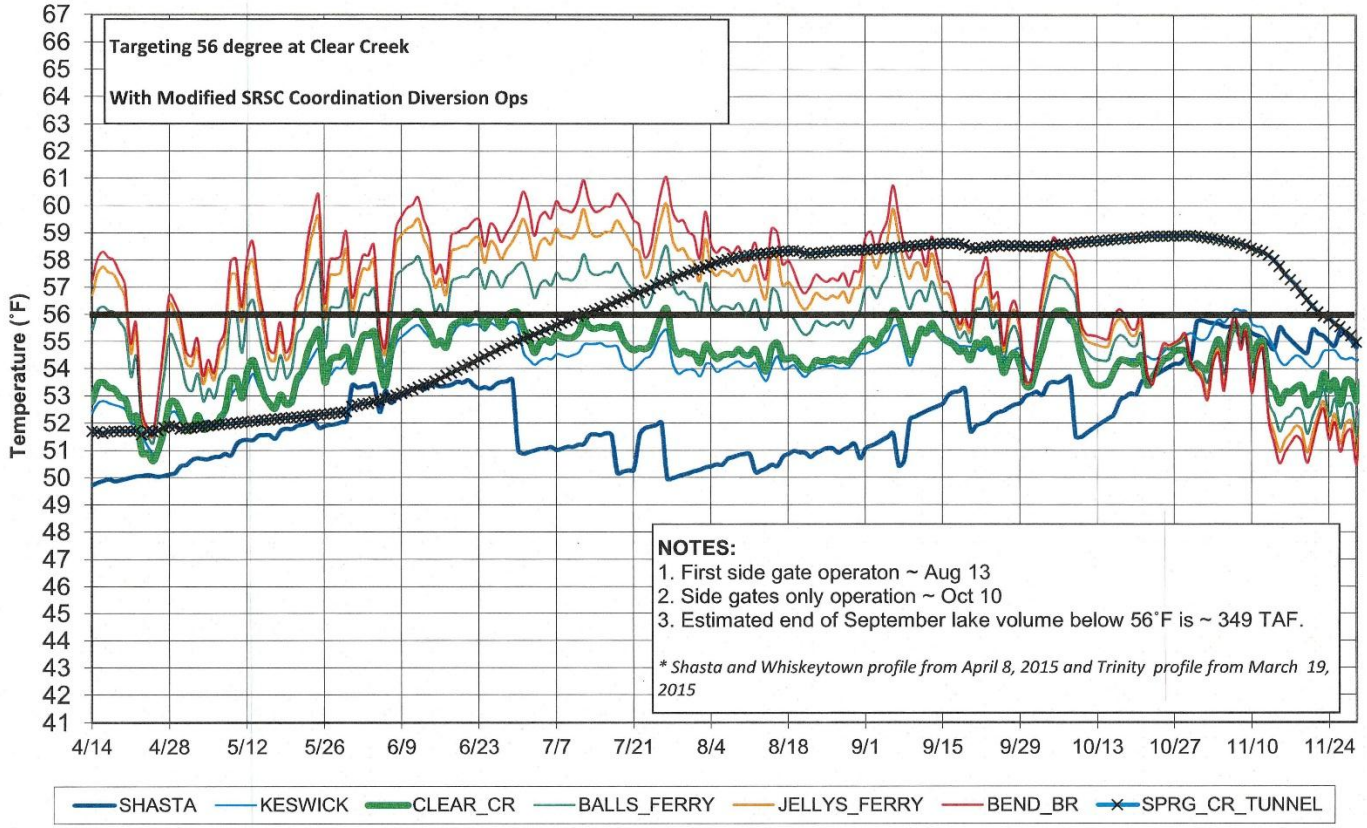
Hydrology

		Trinity		Shasta		Folsom		New Melones	
Water Year Inflow (TAF)		887		3,452		870		229	
Year to Date + Forecasted	% of mean	73%		62%		32%		22%	

Received 4/15/15 PM

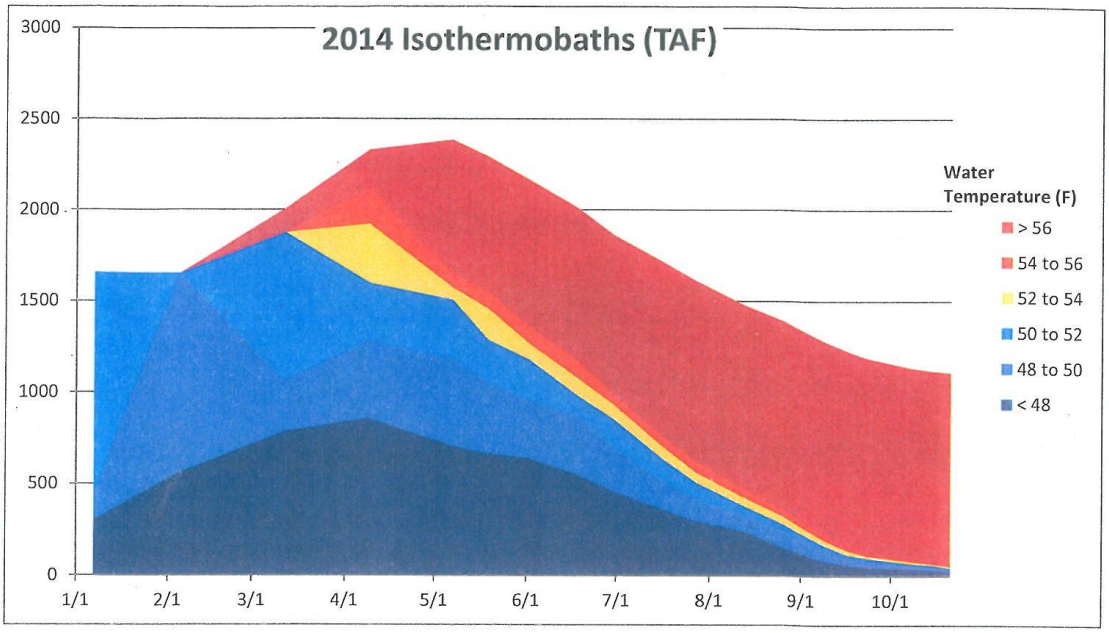
Provisional

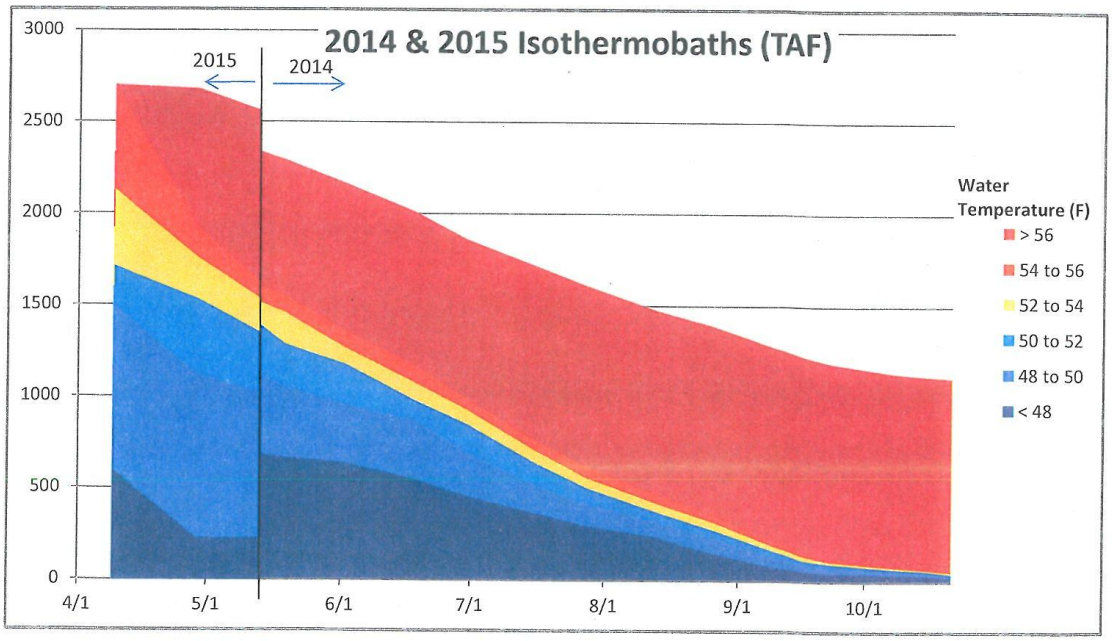
Sacramento River Modeled Temperature
2015 April 90%-Exceedance Outlook

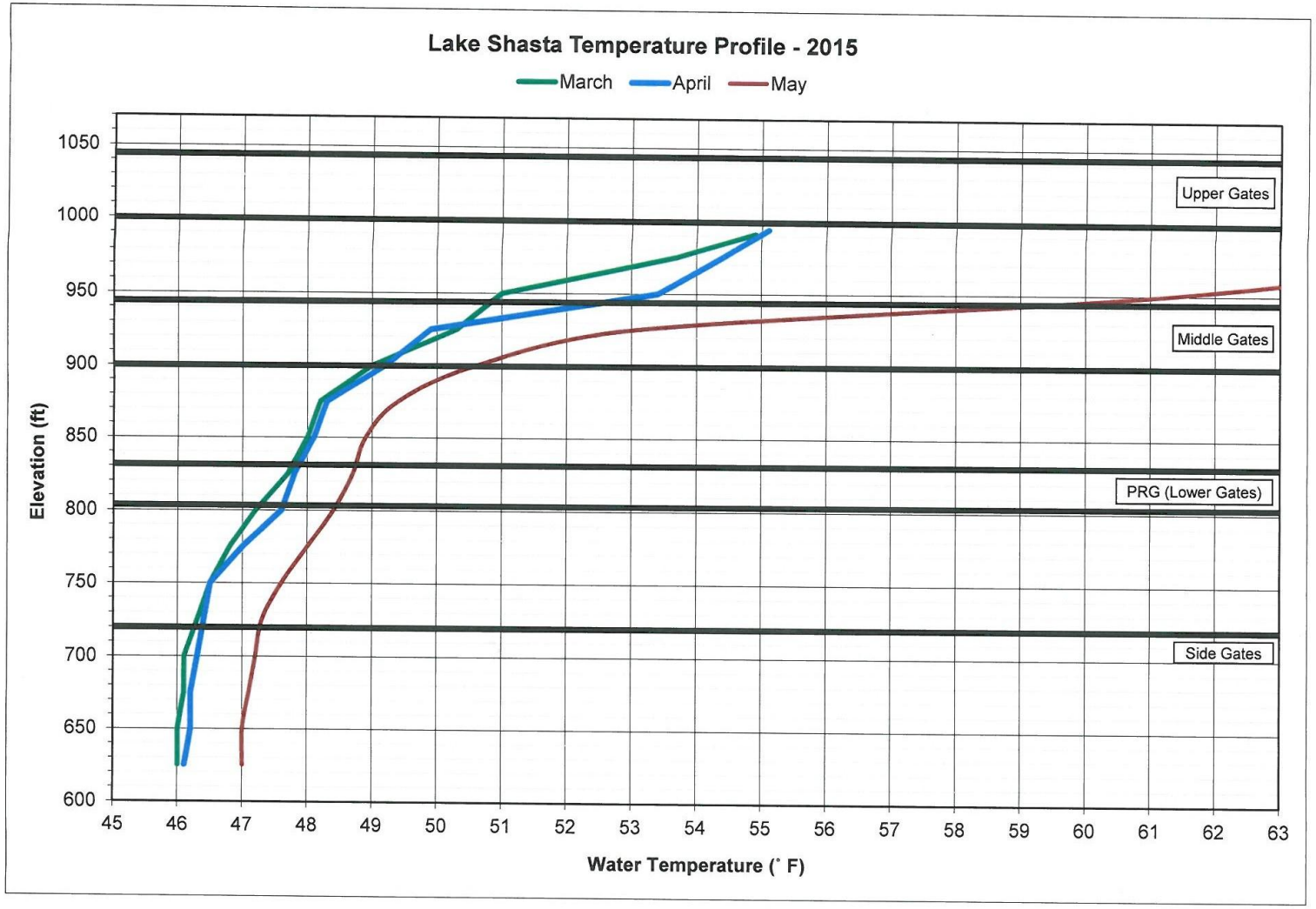


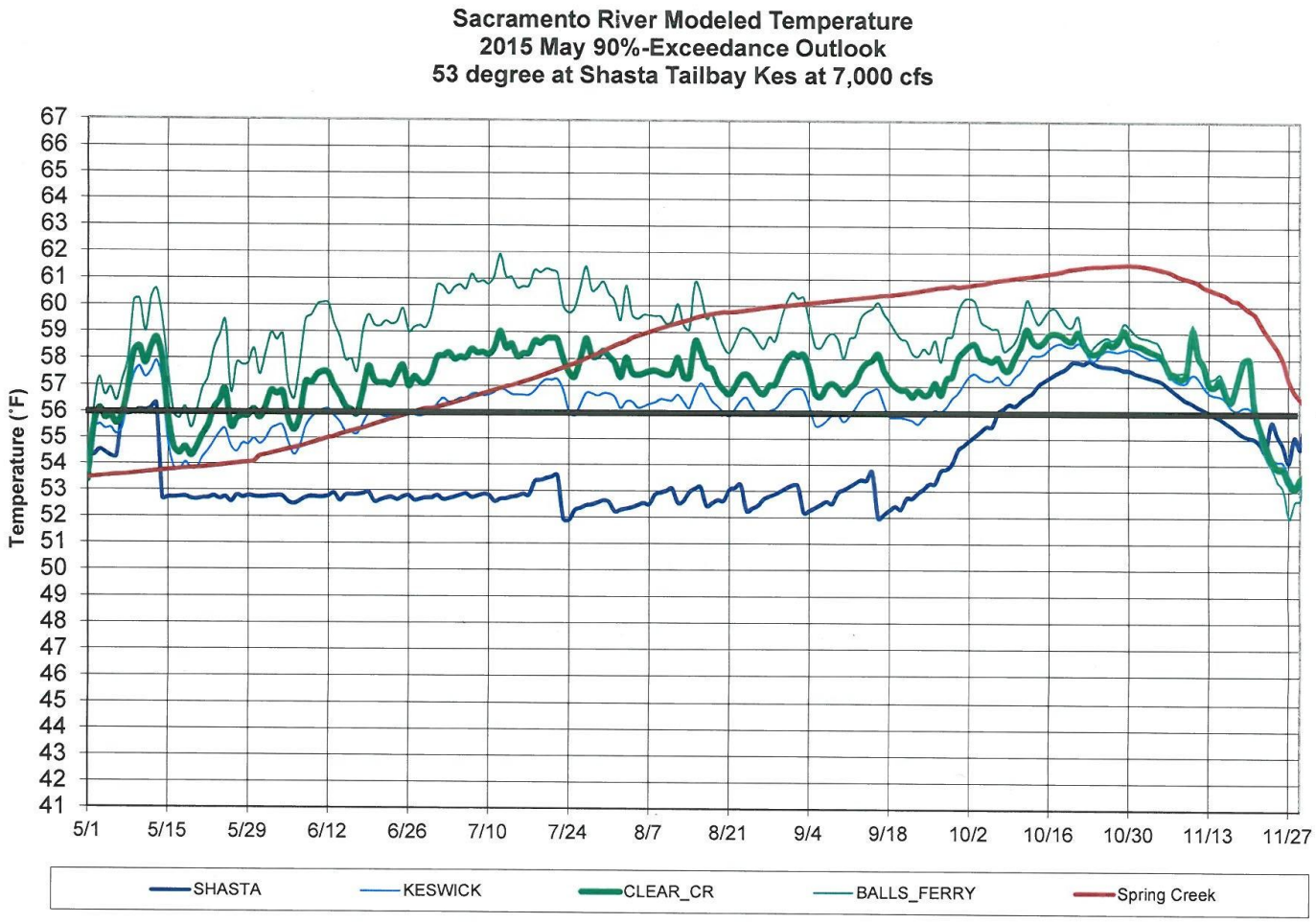
- April 15, 2015 – NMFS submitted to the SWRCB an evaluation of alternatives for Sacramento River temperature compliance for winter-run Chinook salmon[8]. Based on upon the scientific literature and uncertainly in Reclamation's Sacramento River temperature modeling, the fish agencies cannot support proposals to target daily average water temperature releases from Shasta Dam or 58ºF water at the CCR compliance point after the eggs hatch, and do not think that these alternatives would result in negligible impacts and/or little likelihood of adverse impacts to incubating winter-run eggs and alevins in redds than the current requirement of 56ºF daily water temperature at CCR.
- May 14, 2015 – SWCRB provisionally approved Reclamation's proposal[9].
- May 20, 2015 – SWCRB held a workshop and the SWCRB was interested in creating a buffer for a targeting 56°F and the use of side gates as late as possible so the event of 5% survival of winter-run fry to Red Bluff Diversion Dam (RBDD) of last year wouldn't happen again this year.
- May 29, 2015 – Reclamation informed the six resource agencies (Reclamation, US Fish and Wildlife Service, NMFS, DWR, California Department of Fish and Wildlife, and SWRCB) that based on the May Forecast, temperatures were looking worse than they thought compared to the April Forecast. The Lake Shasta Temperature Profile indicated that it was 1°F warmer at the bottom of the reservoir than in April. It was an unprecedented warmer temperature. Results indicated that Shasta Reservoir would run out of cold water in mid-August. As a result of this new information, the SWRCB suspended the Sacramento Temperature Management Plan[10].

[8] http://www.waterboards.ca.gov/waterrights/water_issues/programs/drought/docs/tucp/2015/nmfs_sacrtemp041515.pdf
[9] http://www.waterboards.ca.gov/waterrights/water_issues/programs/drought/docs/tucp/sac_temp_ltr.pdf
[10] http://www.waterboards.ca.gov/waterrights/water_issues/programs/drought/docs/tucp/comments/thoward_temppla n_ltr.pdf


2014 Isothermobaths (TAF)
3000
2500
2000
1500
1000
500
0
1/1
2/1
3/1
4/1
5/1
6/1
7/1
8/1
9/1
10/1
Water Temperature (F)
> 56
54 to 56
52 to 54
50 to 52
48 to 50
< 48


2014 & 2015 Isothermobaths (TAF)
2015
2014
3000
2500
2000
1500
1000
500
0
4/1
5/1
6/1
7/1
8/1
9/1
10/1
Water Temperature (F)
> 56
54 to 56
52 to 54
50 to 52
48 to 50
< 48

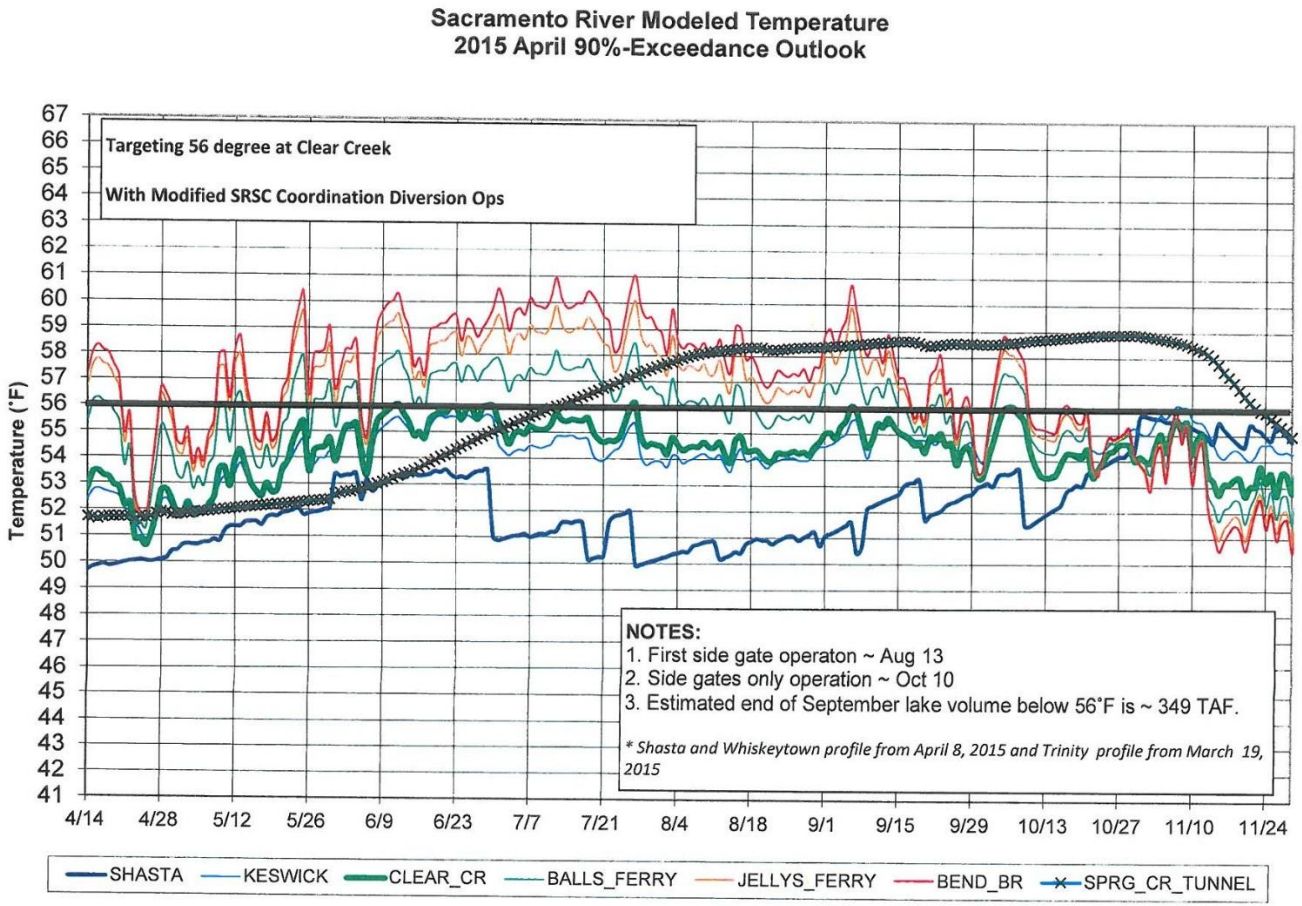

Lake Shasta Temperature Profile - 2015
March
April
May
Upper Gates
Middle Gates
PRG (Lower Gates)
Side Gates
Elevation (ft)
1050
1000
950
900
850
800
750
700
650
600
45
46
47
48
49
50
51
52
53
54
55
56
57
58
59
60
61
62
63
Water Temperature (˚ F)

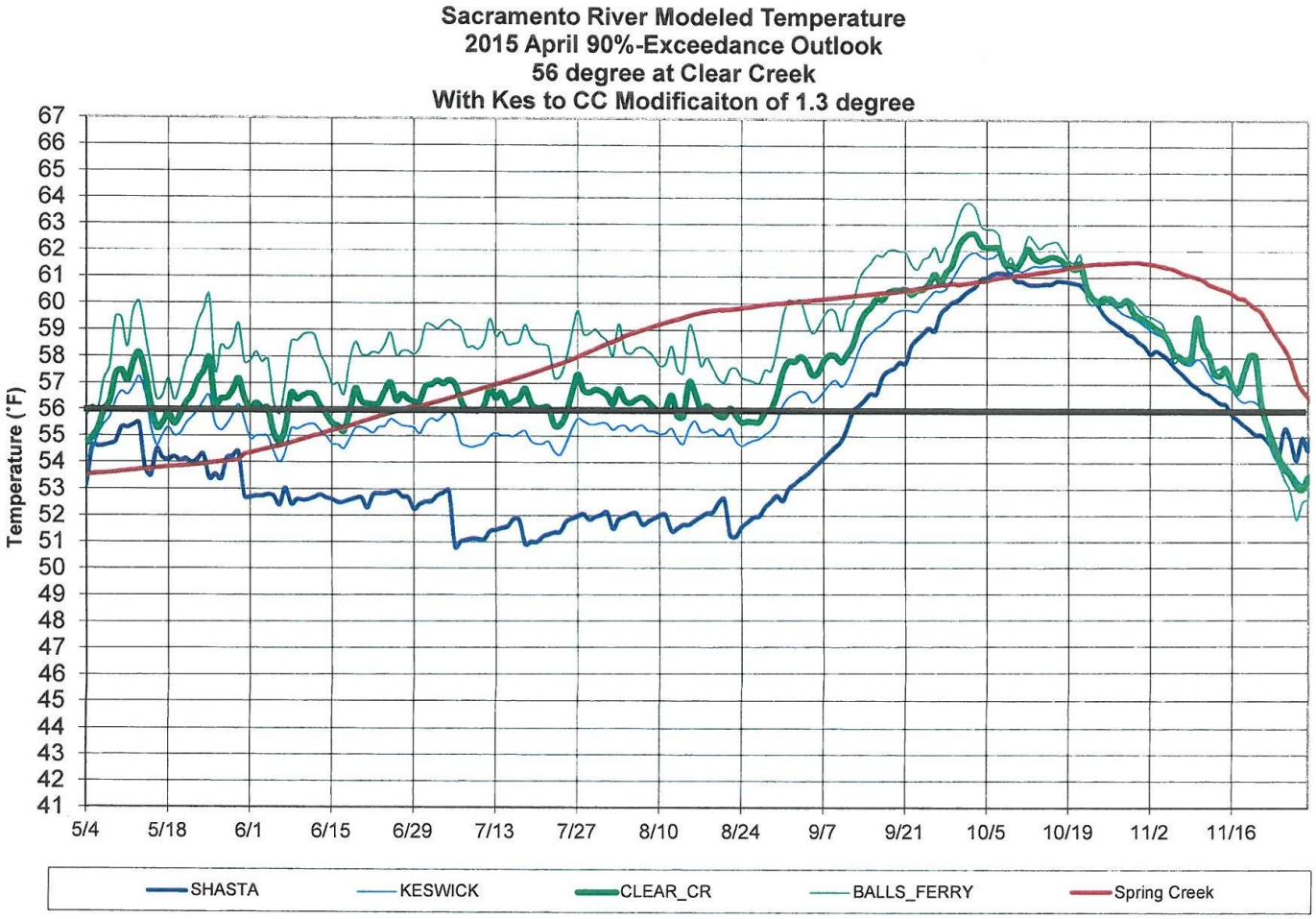

Sacramento River Modeled Temperature
2015 May 90%-Exceedance Outlook
53 degree at Shasta Tailbay Kes at 7,000 cfs
Temperature (°F)
67
66
65
64
63
62
61
60
59
58
57
56
55
54
53
52
51
50
49
48
47
46
45
44
43
42
41
5/1
5/15
5/29
6/12
6/26
7/10
7/24
8/7
8/21
9/4
9/18
10/2
10/16
10/30
11/13
11/27
SHASTA
KESWICK
CLEAR_CR
BALLS_FERRY
Spring Creek

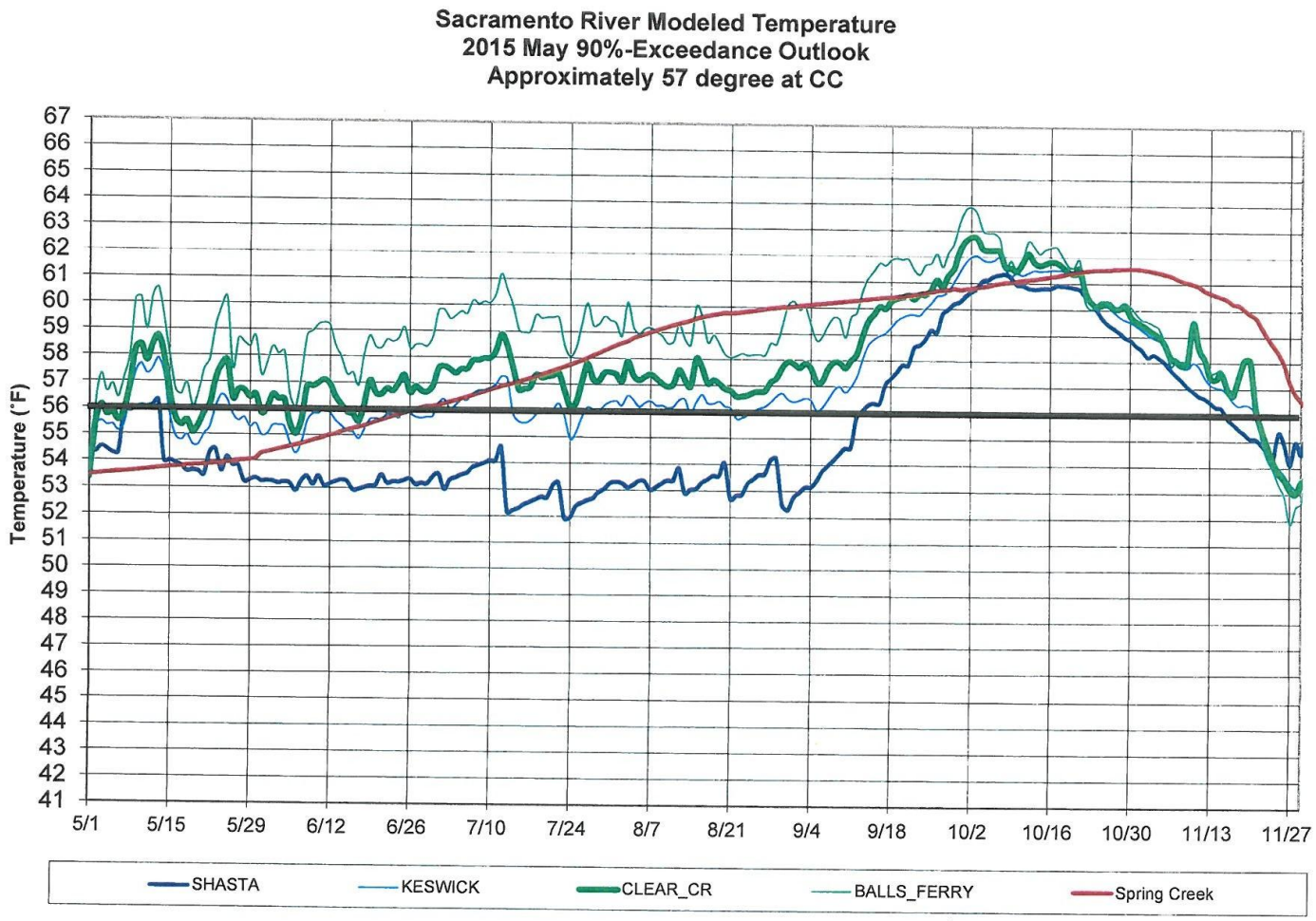
- June 1, 2015 – the six agencies met to discuss a new Sacramento River temperature management plan based upon the new information. Reclamation submitted 7 additional models with different CCR TCP targets (56-59°F) and Keswick (KES) targeted flows (57.5°F CCR @ 8,000 cfs, 58°F CCR @ 7,000 cfs, and 57°F CCR @ 5,000 cfs). Each had its own different side gate operations, EOS storage volume, and monthly average temperatures.
    - When releasing lower flows, there is more sensitivity to other variables (air temp); less buffer, harder to manage from an operations perspective.
    - Once full side gate operation is implemented, there is a sharp increase in temperature and a likelihood that temperature control is lost.

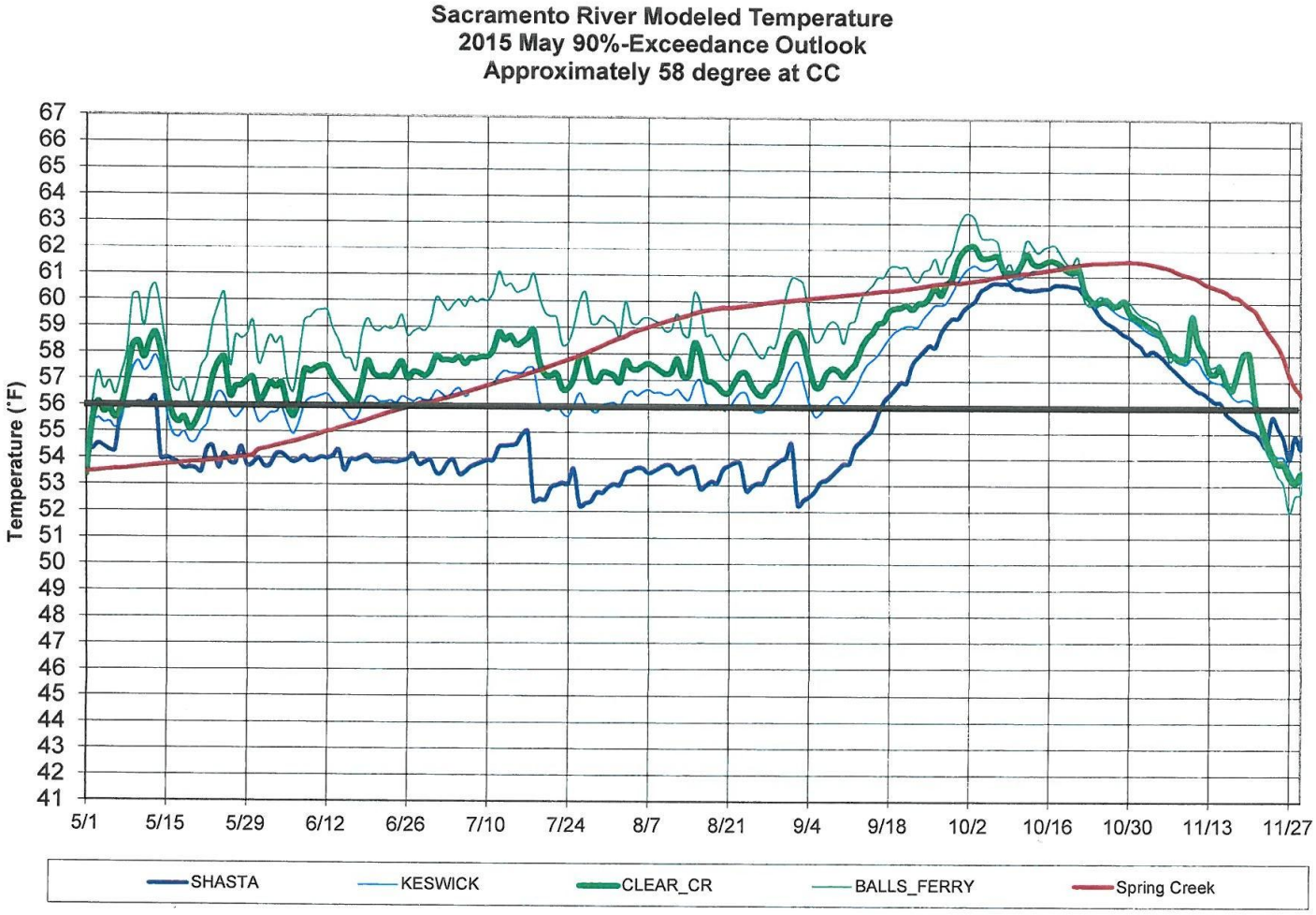
	April Temp Model	May 56 degree Target at Clear Creek (With Kes to CC Modification of 1.3 degree)	May 57 degree Target at Clear Creek (With Kes to CC Modification of 1.3 degree)	May 58 degree Target at Clear Creek (With Kes to CC Modification of 1.3 degree)	May 59 degree Target at Clear Creek (With Kes to CC Modification of 1.3 degree)	May 57 degree Target at Clear Creek (With Kes to CC Modification of 1.3 degree) KES at 8,000 cfs (June - Aug)	May 58 degree Target at Clear Creek (With Kes to CC Modification of 1.3 degree) KES at 7,000 cfs (June - Aug)	May 58 degree Target at Clear Creek (With Kes to CC Modification of 1.3 degree) KES at 5,000 cfs (June - Aug)
Projected Date of side gate operation	October 13	August 23	August 30	September 2	September 19	September 1	September 16	August 11
Estimated end of Sept Lake Volume below 56 degree	349 TAF	52 TAF			149 TAF			
Projected Monthly Average June temperature	55.5	56.2	56.5	57	57.3	56.4	56.8	56.9
Projected Monthly Average July temperature	55.23	56.5	57.5	57.8	58.5	57.6	58.3	58.2
Projected Monthly Average August temperature	54.5	56.2	57.2	57.3	57.8	57.1	57.5	57.5
Projected Monthly Average September temperature	54.9	59.5	59.4	59.0	58.5	58.8	57.3	56.6
Projected Monthly Average October temperature	54.4	61.3	61.4	61.0	59.9	59.4	58.5	57.3
Projected Monthly Average November temperature	53.9	56.9	56.8	56.8	56.6	56.6	56.5	56.1

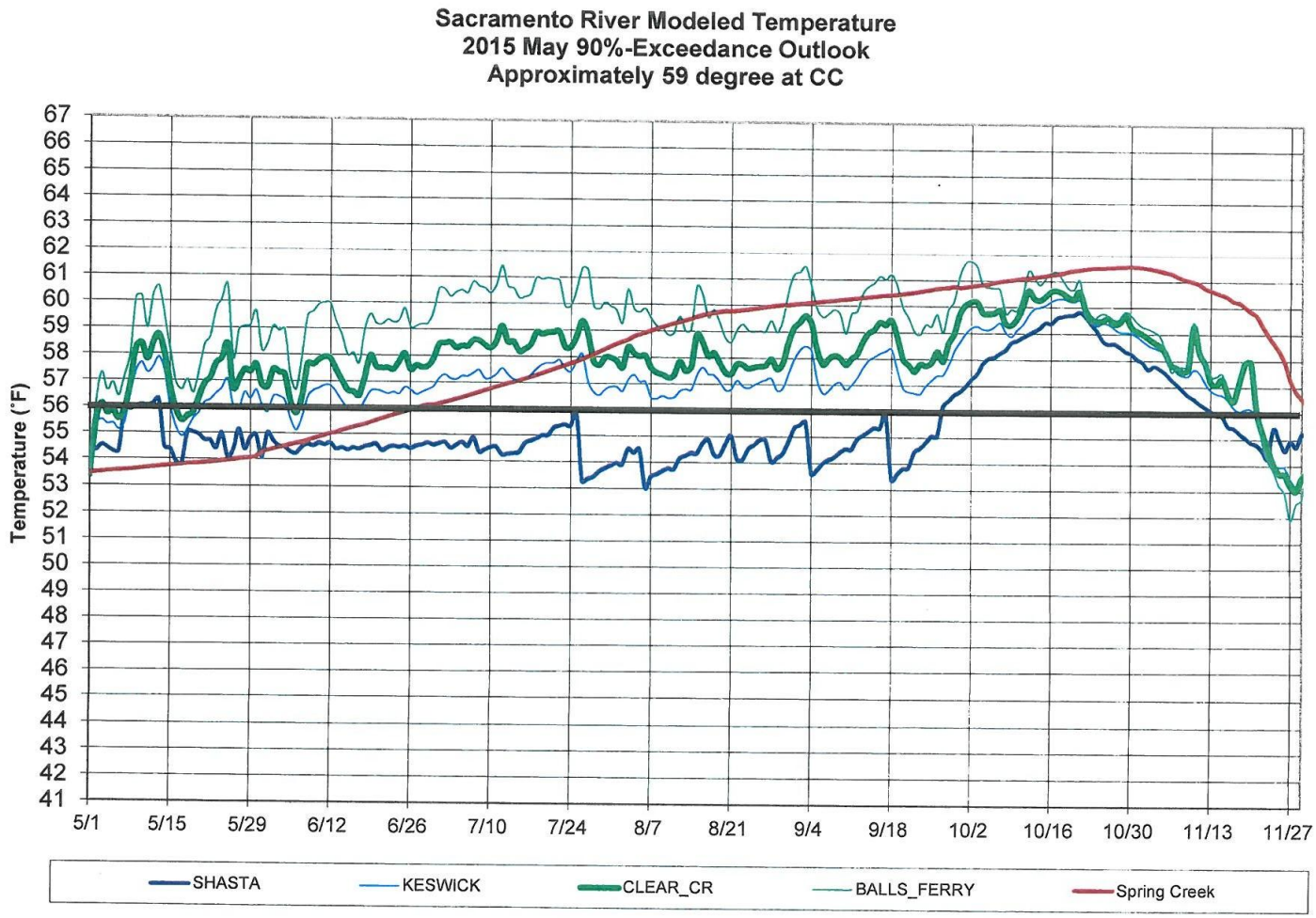
Effect to Delta Water quality
Effect to CVP/SWP operations
Effect to other parties (i.e. SRSC)

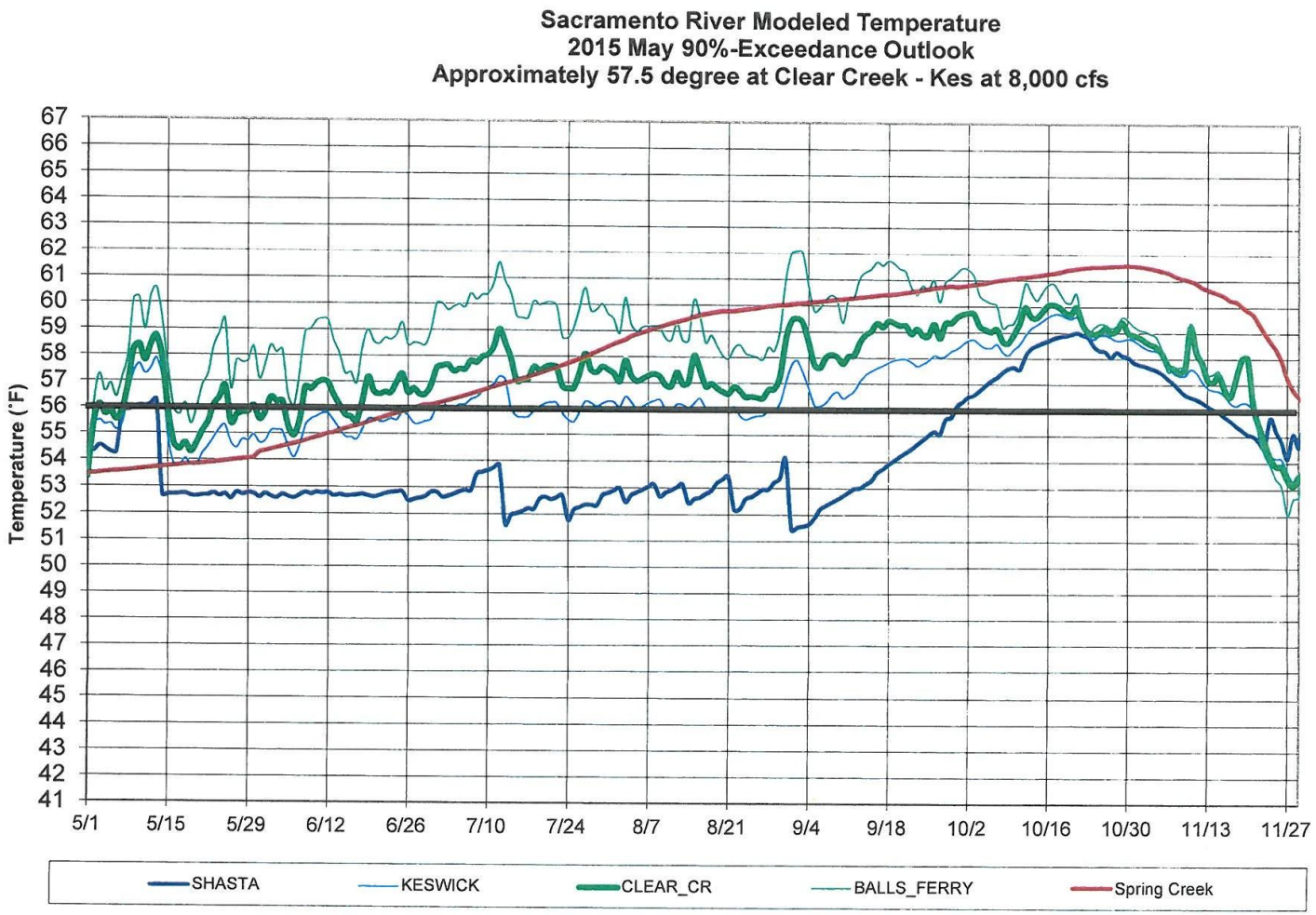

Sacramento River Modeled Temperature
2015 April 90%-Exceedance Outlook
Targeting 56 degree at Clear Creek
With Modified SRSC Coordination Diversion Ops
Temperature (°F)
67
66
65
64
63
62
61
60
59
58
57
56
55
54
53
52
51
50
49
48
47
46
45
44
43
42
41
4/14
4/28
5/12
5/26
6/9
6/23
7/7
7/21
8/4
8/18
9/1
9/15
9/29
10/13
10/27
11/10
11/24
NOTES:
1. First side gate operaton ~ Aug 13
2. Side gates only operation ~ Oct 10
3. Estimated end of September lake volume below 56°F is ~ 349 TAF.
* Shasta and Whiskeytown profile from April 8, 2015 and Trinity profile from March 19, 2015
SHASTA
KESWICK
CLEAR_CR
BALLS_FERRY
JELLYS_FERRY
BEND_BR
SPRG_CR_TUNNEL

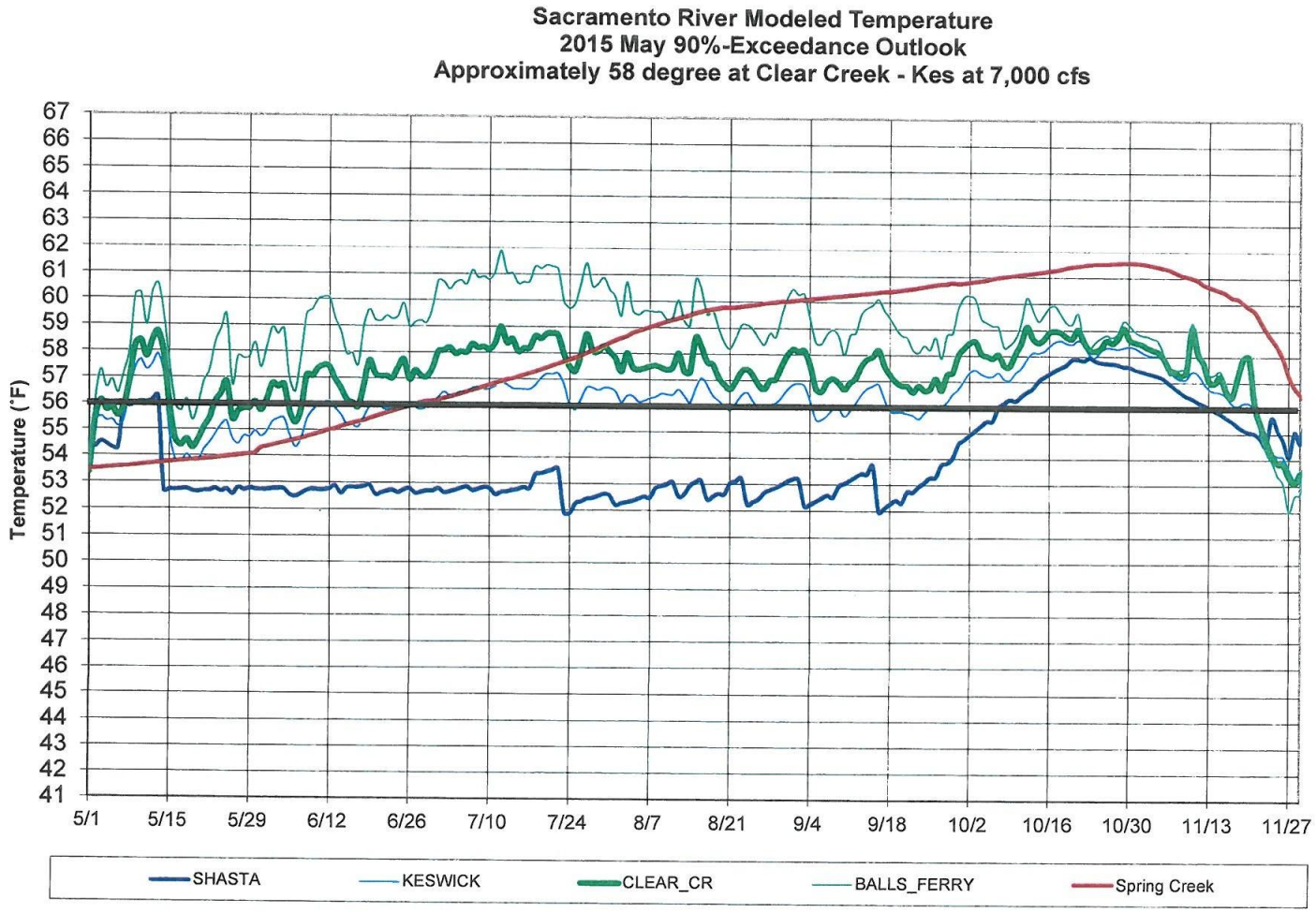

Sacramento River Modeled Temperature
2015 April 90%-Exceedance Outlook
56 degree at Clear Creek
With Kes to CC Modificaiton of 1.3 degree
Temperature (°F)
67
66
65
64
63
62
61
60
59
58
57
56
55
54
53
52
51
50
49
48
47
46
45
44
43
42
41
5/4
5/18
6/1
6/15
6/29
7/13
7/27
8/10
8/24
9/7
9/21
10/5
10/19
11/2
11/16
SHASTA
KESWICK
CLEAR_CR
BALLS_FERRY
Spring Creek

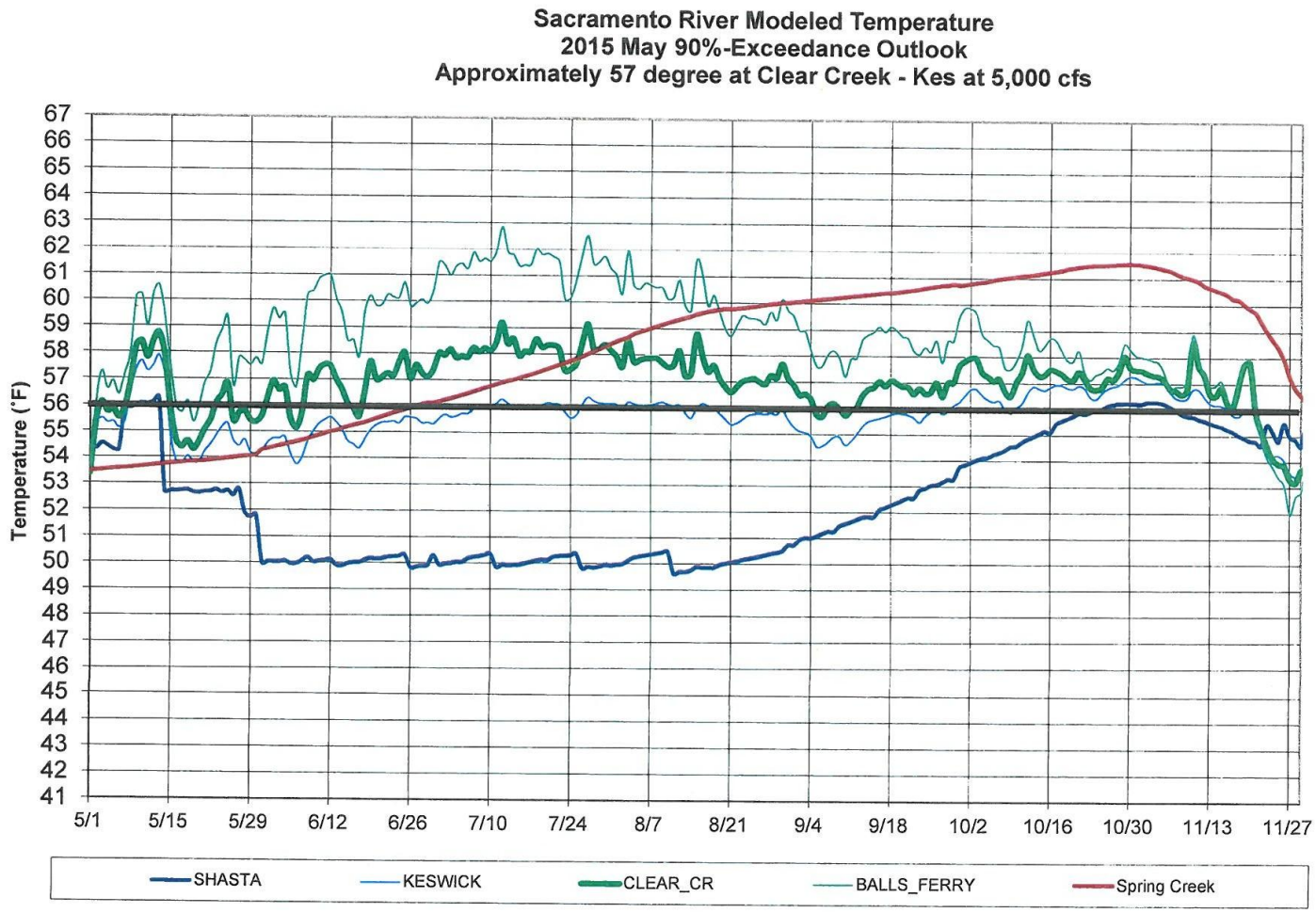

Sacramento River Modeled Temperature
2015 May 90%-Exceedance Outlook
Approximately 57 degree at CC
Temperature (°F)
67
66
65
64
63
62
61
60
59
58
57
56
55
54
53
52
51
50
49
48
47
46
45
44
43
42
41
5/1
5/15
5/29
6/12
6/26
7/10
7/24
8/7
8/21
9/4
9/18
10/2
10/16
10/30
11/13
11/27
SHASTA
KESWICK
CLEAR_CR
BALLS_FERRY
Spring Creek


Sacramento River Modeled Temperature
2015 May 90%-Exceedance Outlook
Approximately 58 degree at CC
Temperature (°F)
67
66
65
64
63
62
61
60
59
58
57
56
55
54
53
52
51
50
49
48
47
46
45
44
43
42
41
5/1
5/15
5/29
6/12
6/26
7/10
7/24
8/7
8/21
9/4
9/18
10/2
10/16
10/30
11/13
11/27
SHASTA
KESWICK
CLEAR_CR
BALLS_FERRY
Spring Creek


Sacramento River Modeled Temperature
2015 May 90%-Exceedance Outlook
Approximately 59 degree at CC
Temperature (°F)
67
66
65
64
63
62
61
60
59
58
57
56
55
54
53
52
51
50
49
48
47
46
45
44
43
42
41
5/1
5/15
5/29
6/12
6/26
7/10
7/24
8/7
8/21
9/4
9/18
10/2
10/16
10/30
11/13
11/27
SHASTA
KESWICK
CLEAR_CR
BALLS_FERRY
Spring Creek


Sacramento River Modeled Temperature
2015 May 90%-Exceedance Outlook
Approximately 57.5 degree at Clear Creek - Kes at 8,000 cfs
Temperature (°F)
67
66
65
64
63
62
61
60
59
58
57
56
55
54
53
52
51
50
49
48
47
46
45
44
43
42
41
5/1
5/15
5/29
6/12
6/26
7/10
7/24
8/7
8/21
9/4
9/18
10/2
10/16
10/30
11/13
11/27
SHASTA
KESWICK
CLEAR_CR
BALLS_FERRY
Spring Creek


Sacramento River Modeled Temperature
2015 May 90%-Exceedance Outlook
Approximately 58 degree at Clear Creek - Kes at 7,000 cfs
Temperature (°F)
67
66
65
64
63
62
61
60
59
58
57
56
55
54
53
52
51
50
49
48
47
46
45
44
43
42
41
5/1
5/15
5/29
6/12
6/26
7/10
7/24
8/7
8/21
9/4
9/18
10/2
10/16
10/30
11/13
11/27
SHASTA
KESWICK
CLEAR_CR
BALLS_FERRY
Spring Creek


Sacramento River Modeled Temperature
2015 May 90%-Exceedance Outlook
Approximately 57 degree at Clear Creek - Kes at 5,000 cfs
Temperature (°F)
67
66
65
64
63
62
61
60
59
58
57
56
55
54
53
52
51
50
49
48
47
46
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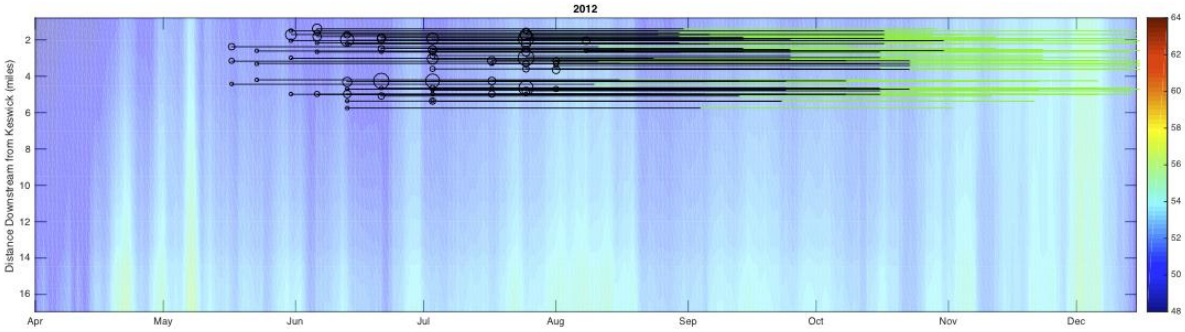
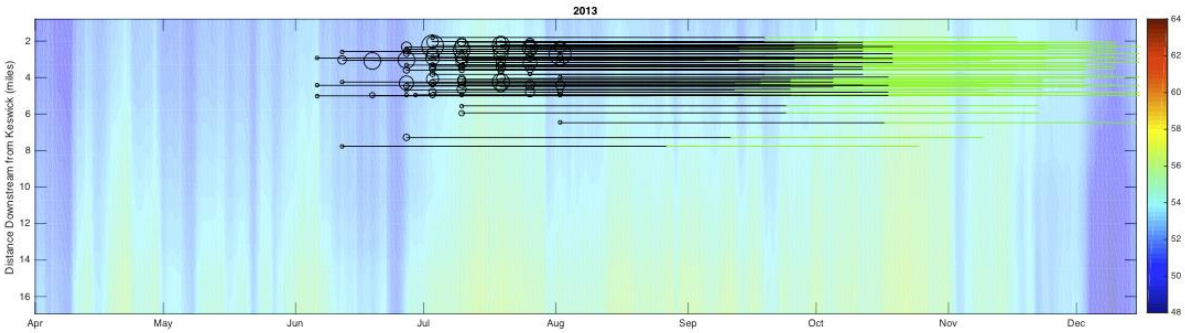
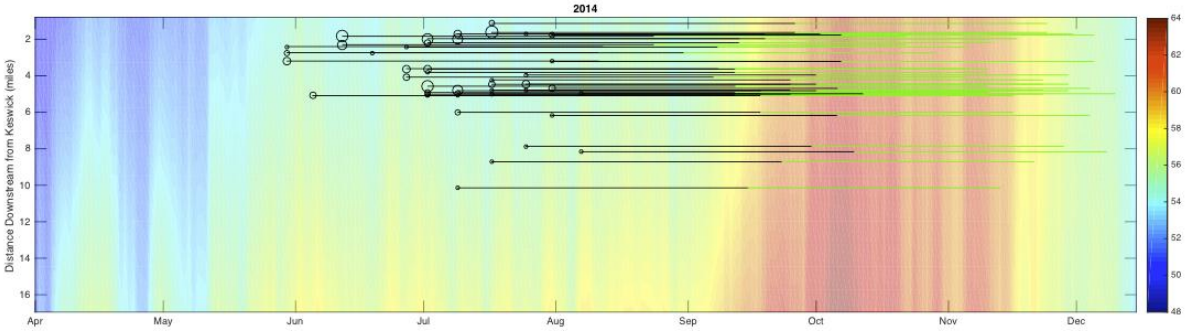
43
42
41
5/1
5/15
5/29
6/12
6/26
7/10
7/24
8/7
8/21
9/4
9/18
10/2
10/16
10/30
11/13
11/27
SHASTA
KESWICK
CLEAR_CR
BALLS_FERRY
Spring Creek

- NMFS Southwest Fisheries Science Center (SWFSC) presented a temperature redd landscape image developed from their River Assessment for Forecasting Temperatures (RAFT) model that showed last year most redds were constructed at times when the 56°F CCR TCP was met; about half of the fry emerged before temperatures spiked in September. However, all stages of juvenile winter-run were susceptible to those warmer temperatures in September and October. Not only could temperature-related effects lead to direct mortality of winter-run but also to indirect mortality due to sub-lethal effects of temperature on winter-run (*i.e.*, slower growth leading to higher predation risk, higher transmission of pathogens, *etc*.).





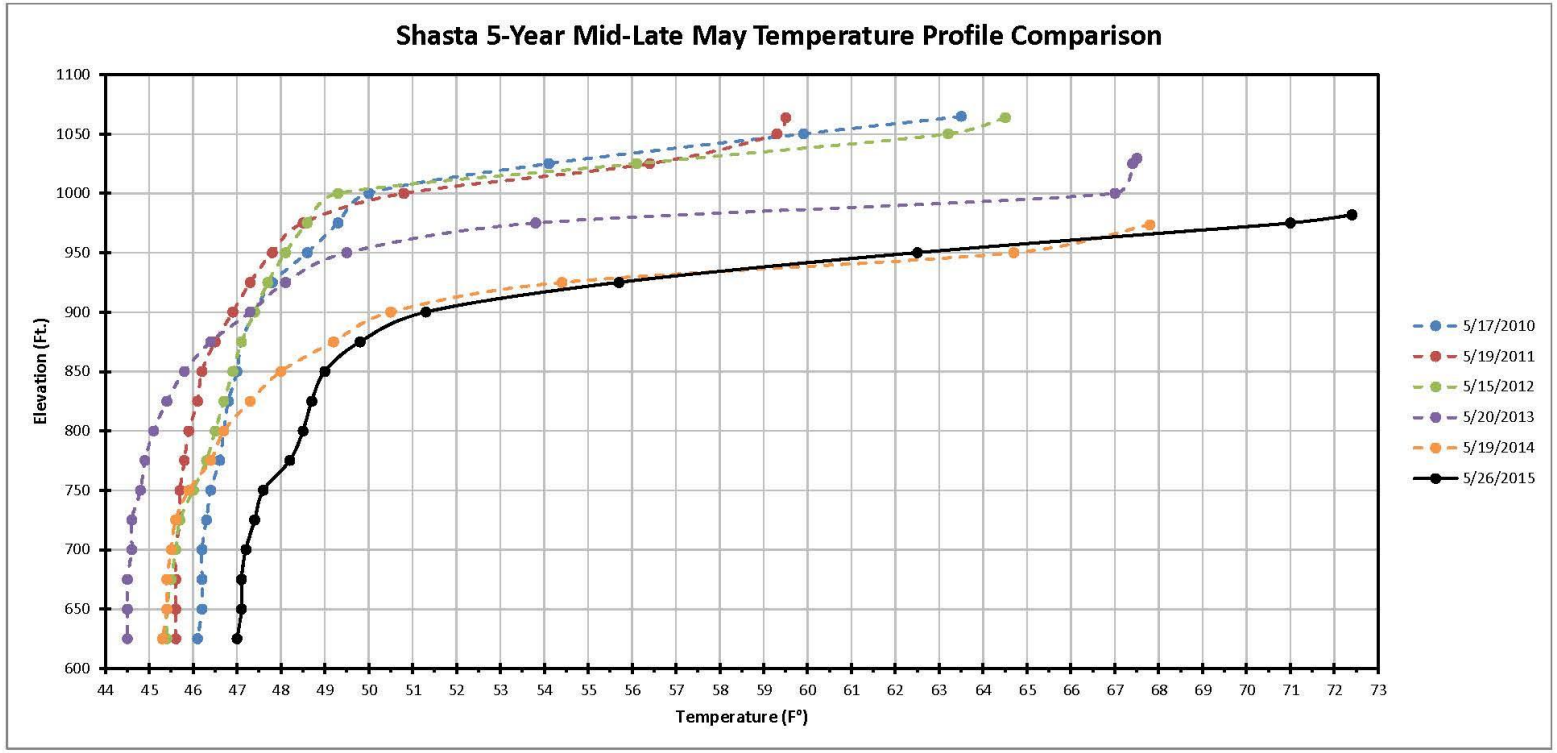


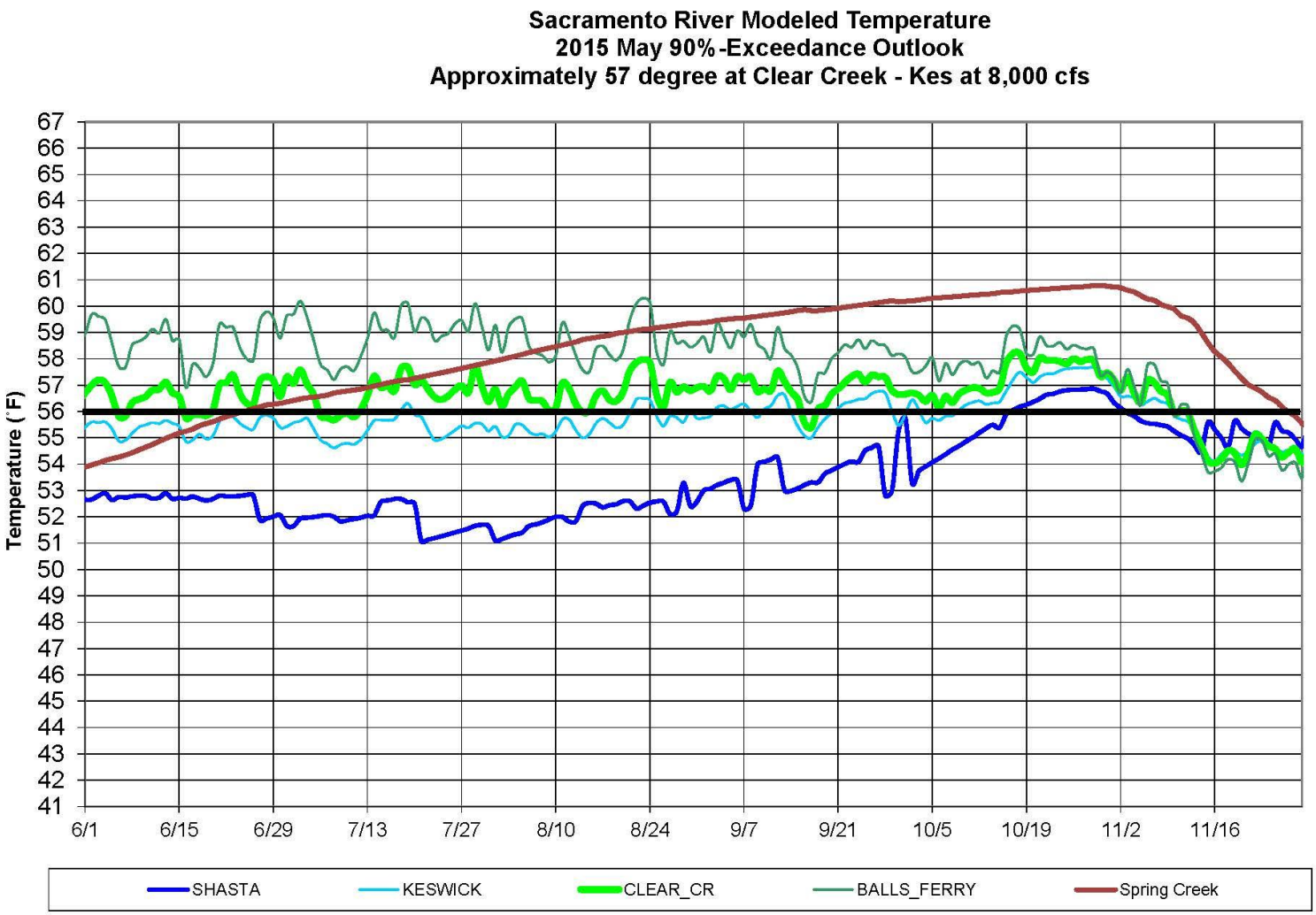
- Reclamation is prepared to install a real-time temperature monitor at Bella Vista pumps, which is just downstream of ACID at RM 297 (*i.e.*, upstream end of Turtle Bay and 5 miles downstream of Keswick); needs to be calibrated.
- Representative of the six agencies (group) proposed that Reclamation run three more models with a temperature target at CCR of 58°F for the first two weeks in June, 57.5°F for the last two weeks in June and all of July (45 days), and 58.5°F for August through October at flows of 8,000 cfs, 7,000 cfs, and 6,000 cfs.
- Other water operation ideas included lowering Keswick Reservoir to reduce heating (flows through quicker); changing pattern of Trinity diversions (change in timing); power bypass (offramps). Ron was to look into these suggestions.
- Non-Operations (hatchery, etc.)
  - LSNFH was initially taking every fish they could get ahold of but the sex ratio was not ideal (more females than males) so they started returning hatchery females back into the Sacramento River; looks like they won't reach capacity, catches are slowing down – perhaps capture more females; ACID trap is not catching any winter-run when it is operating.
  - Mt. Shasta Hatchery – McCloud redband trout are already rearing there so there are capacity issues for winter-run to rear there.
  - Predation – not much of an issue in the Upper Sacramento River and there are not a lot of options to reduce predation.
  - The Interagency Ecological Program (IEP) winter-run project work team has talked about doing a fish health monitoring study. Josh Israel to follow up.
  - Increase count time at the RBDD rotary screw traps – This year should be fully staffed compared to last year and the year before; also look into monitoring RBDD/TCCA fish screen.

- June 2, 2015 – Reclamation responded with results of temperature runs of targeting 57°F at CCR for 8,000 cfs, 7,000 cfs, and 6,000 cfs.
  - Results showed projected full side gate operations of October 2 for 8,000 cfs, October 14 for 7,000 cfs, and October 18 for 6,000 cfs.

	Kes 8000 June - Aug 57 degree at CCR	Kes 7000 June - Aug 57 degree at CCR	Kes 6000 June - Aug 57 degree at CCR
Projected Date of side gate operation	Oct 2	Oct 14	Oct 18
Estimated end of Sept Lake Volume below 56 degree	228 TAF	240 TAF	256 TAF
Projected Monthly Average June temperature	56.6	56.3	56.4
Projected Monthly Average July temperature	56.7	56.4	56.7
Projected Monthly Average August temperature	56.7	57	56.6
Projected Monthly Average September temperature	56.9	56.6	56.1
Projected Monthly Average October temperature	57.2	56.7	56.6
Projected Monthly Average November temperature	55.4	55.1	55.1

Effect to Delta Water quality
Effect to CVP/SWP operations
Effect to other parties (i.e. SRSC)


Shasta 5-Year Mid-Late May Temperature Profile Comparison
Elevation (Ft.)
1100
1050
1000
950
900
850
800
750
700
650
600
Temperature (F°)
44 45 46 47 48 49 50 51 52 53 54 55 56 57 58 59 60 61 62 63 64 65 66 67 68 69 70 71 72 73
5/17/2010
5/19/2011
5/15/2012
5/20/2013
5/19/2014
5/26/2015


Sacramento River Modeled Temperature
2015 May 90%-Exceedance Outlook
Approximately 57 degree at Clear Creek - Kes at 8,000 cfs
Temperature (°F)
67
66
65
64
63
62
61
60
59
58
57
56
55
54
53
52
51
50
49
48
47
46
45
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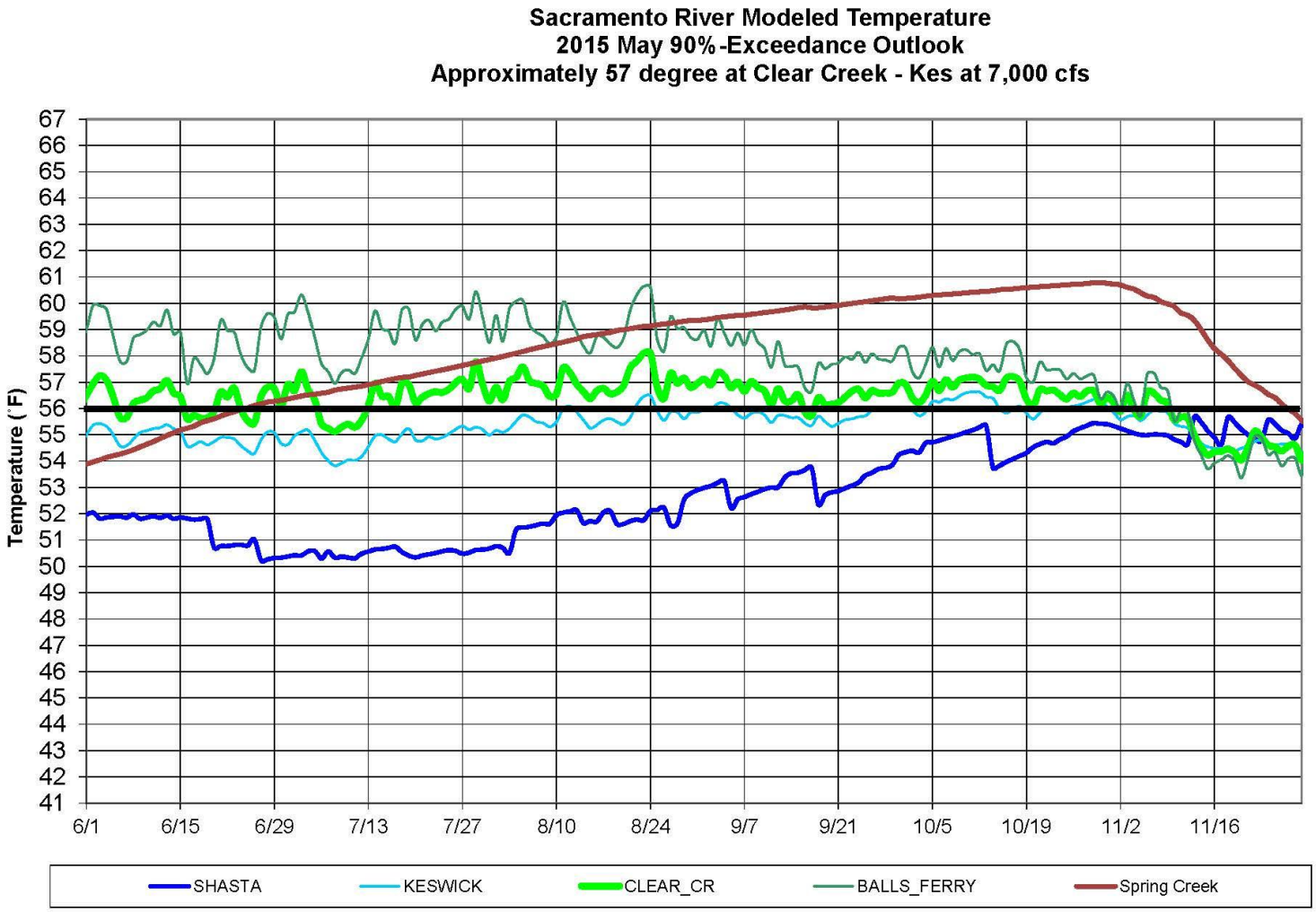
43
42
41
6/1
6/15
6/29
7/13
7/27
8/10
8/24
9/7
9/21
10/5
10/19
11/2
11/16
SHASTA
KESWICK
CLEAR_CR
BALLS_FERRY
Spring Creek


Sacramento River Modeled Temperature
2015 May 90%-Exceedance Outlook
Approximately 57 degree at Clear Creek - Kes at 7,000 cfs
Temperature (°F)
67
66
65
64
63
62
61
60
59
58
57
56
55
54
53
52
51
50
49
48
47
46
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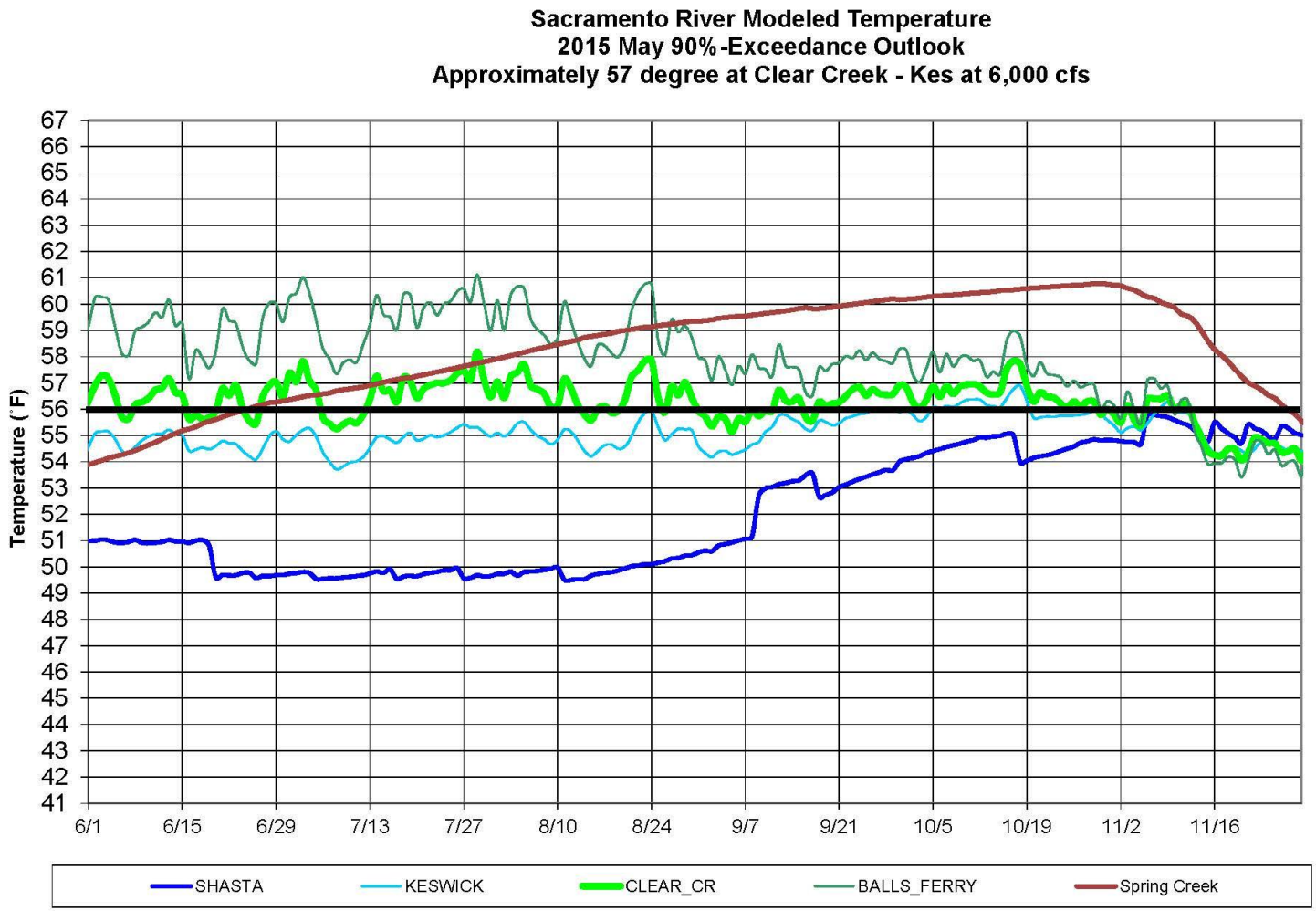
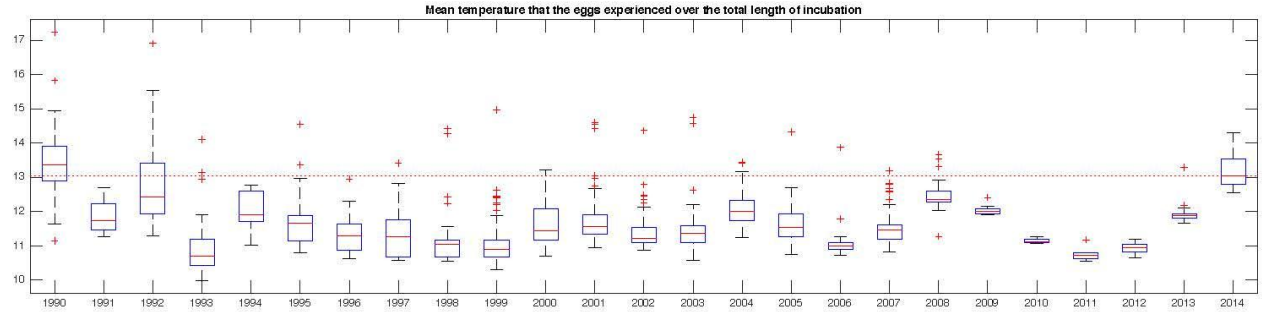
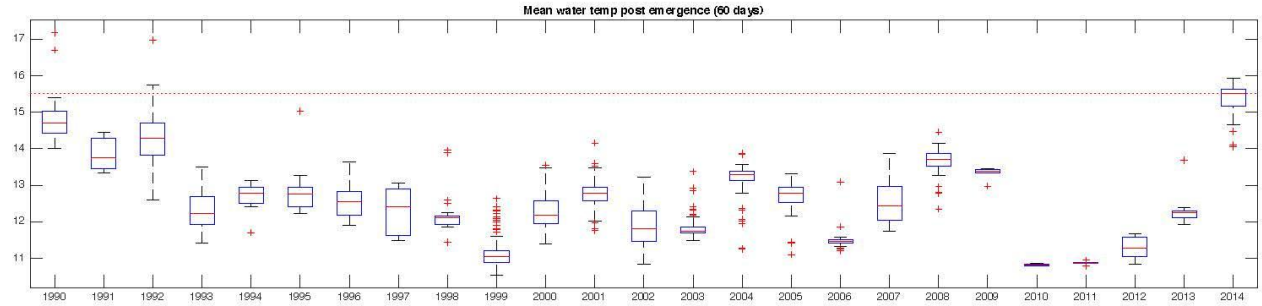
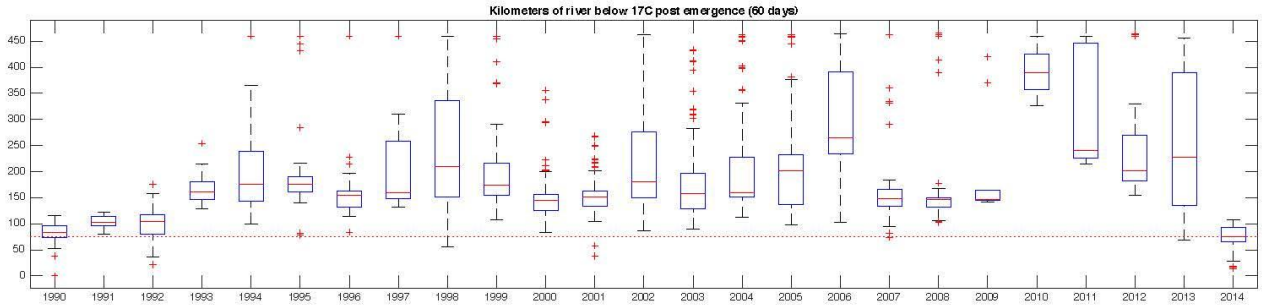
43
42
41
6/1
6/15
6/29
7/13
7/27
8/10
8/24
9/7
9/21
10/5
10/19
11/2
11/16
SHASTA
KESWICK
CLEAR_CR
BALLS_FERRY
Spring Creek


Sacramento River Modeled Temperature
2015 May 90%-Exceedance Outlook
Approximately 57 degree at Clear Creek - Kes at 6,000 cfs
Temperature (°F)
67
66
65
64
63
62
61
60
59
58
57
56
55
54
53
52
51
50
49
48
47
46
45
44
43
42
41
6/1
6/15
6/29
7/13
7/27
8/10
8/24
9/7
9/21
10/5
10/19
11/2
11/16
SHASTA
KESWICK
CLEAR_CR
BALLS_FERRY
Spring Creek

- SWFSC provided results from the RAFT model that showed mean temperatures that eggs experienced over the total length of incubation (~13.1^{o}C) and mean water temperatures post emergence (~16.5^{o}C) were the highest last year (2014) compared to the last 25 years. In addition, 2014 had the lowest stretch of rearing habitat below 17°C post emergence (~75 km) compared to the last 25 years.


Mean temperature that the eggs experienced over the total length of incubation
17
16
15
14
13
12
11
10
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014


Mean water temp post emergence (60 days)
17
16
15
14
13
12
11
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014


Kilometers of river below 17C post emergence (60 days)
450
400
350
300
250
200
150
100
50
0
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014

- Air temperature was the most sensitive variable in the water temperature model; currently all of the forecast are based on the 50% local 3-month temperature outlook (L3MTO).
- The group requested Reclamation to do 8,000 cfs and 7,000 cfs temperature model runs using the 10% L3MTO.
- Operating at 8,000 cfs would result in an approximate 100 taf cut, 7,000 cfs would result in a 300 taf cut, and 6,000 cfs would result in a 500 taf cut compared to current proposed operations. At 7,000 cfs, Reclamation indicated that delta outflow for August and September would likely not be met.

- June 3, 2015 – Reclamation presented results using the 10% L3MTO and 50% L3MTO for 58°F, 57.5°F, 58.5°F target at CCR with flows at 8,000 cfs and the 10% L3MTO and 50% L3MTO for 57°F target at CCR with flows at 7,000 cfs and 6,000 cfs. Note that the 10% L3MTO did not adjust for shutter changes, it used the same as the 50% L3MTO scenario.
  - These model runs showed the same full side gate operation dates as the June 2 temperature modeling results.

Shasta temperature scenarios. June 3, 2015

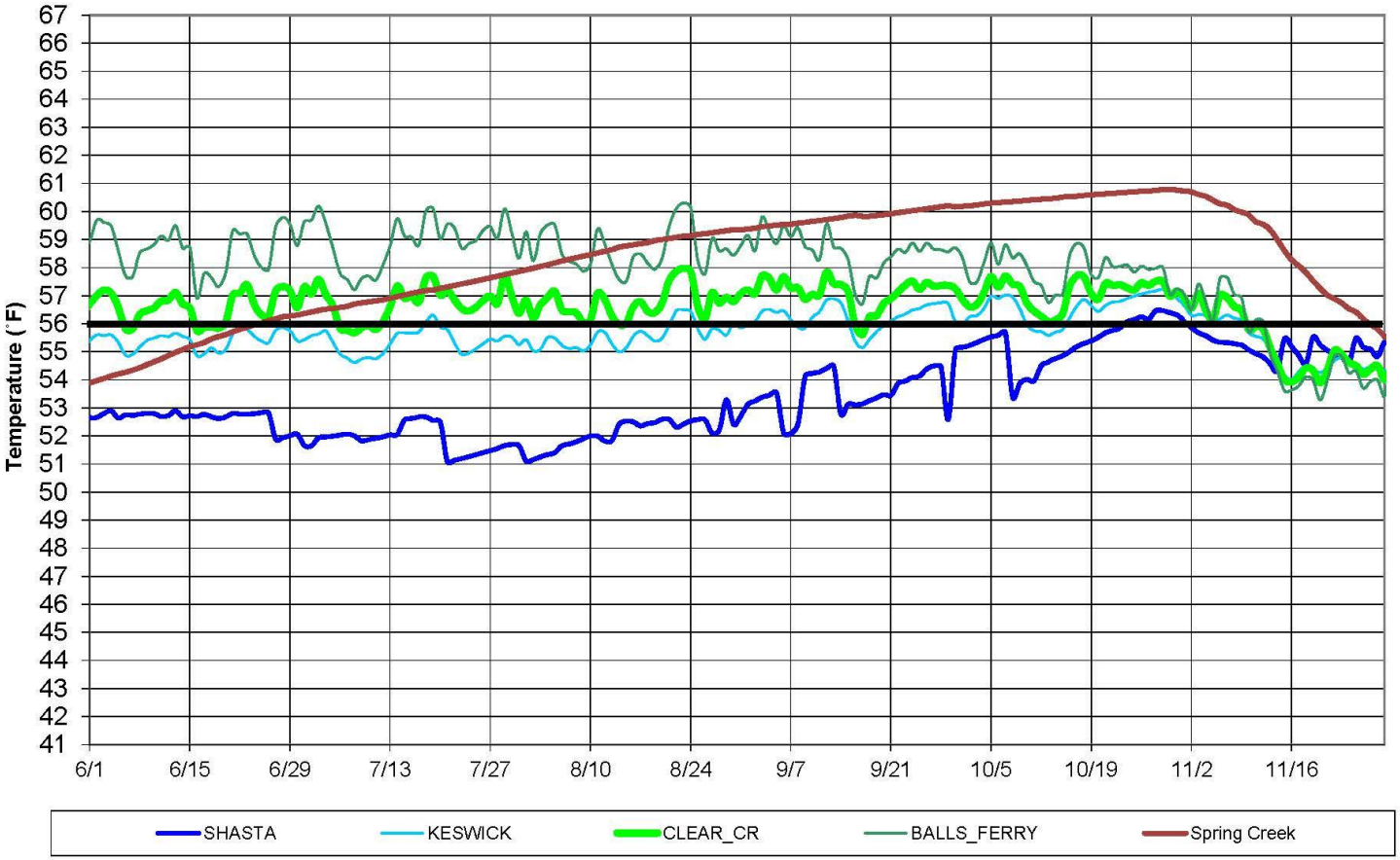
Notes: -- The scenarios depicted in this row do not crosswalk tightly with the subsequent graphs. -- CCR is at the CDEC gaging station at Bonneview Bridge, not the confluence of Clear Creek	Kes 8000 June - Aug 57 degree at CCR (from June 2 meeting)	Kes 8000 June - Aug June 58, July 57.5 Aug 58.5 at CCR	Kes 7000 June - Aug June 58, July 57.5 Aug 58.5 at CCR	Kes 6000 June - Aug June 58, July 57.5 Aug 58.5 at CCR
Projected Date of side gate operation	Oct 2	Oct 14	Oct 14	Oct 18
Projected Monthly Average June temperature	56.6	57.7	56.3	56.4
Projected Monthly Average July temperature	56.7	57.6	56.4	56.7
Projected Monthly Average August temperature	56.7	57.5	57	56.6
Projected Monthly Average September temperature	56.9	57.6	56.6	56.1
Projected Monthly Average October temperature	57.2	56.9	56.7	56.6
Projected Monthly Average November temperature	55.4	55	55.1	55.1

Effect to Delta Water quality
Effect to CVP/SWP operations
Effect to other parties (i.e. SRSC)

Notes:
-- 50% Local 3-Month Temperature Outlook (L3MTO)
-- September 1-October 15 flow adjustment to 6,000 cfs

June 3, 2015: Scenario 1

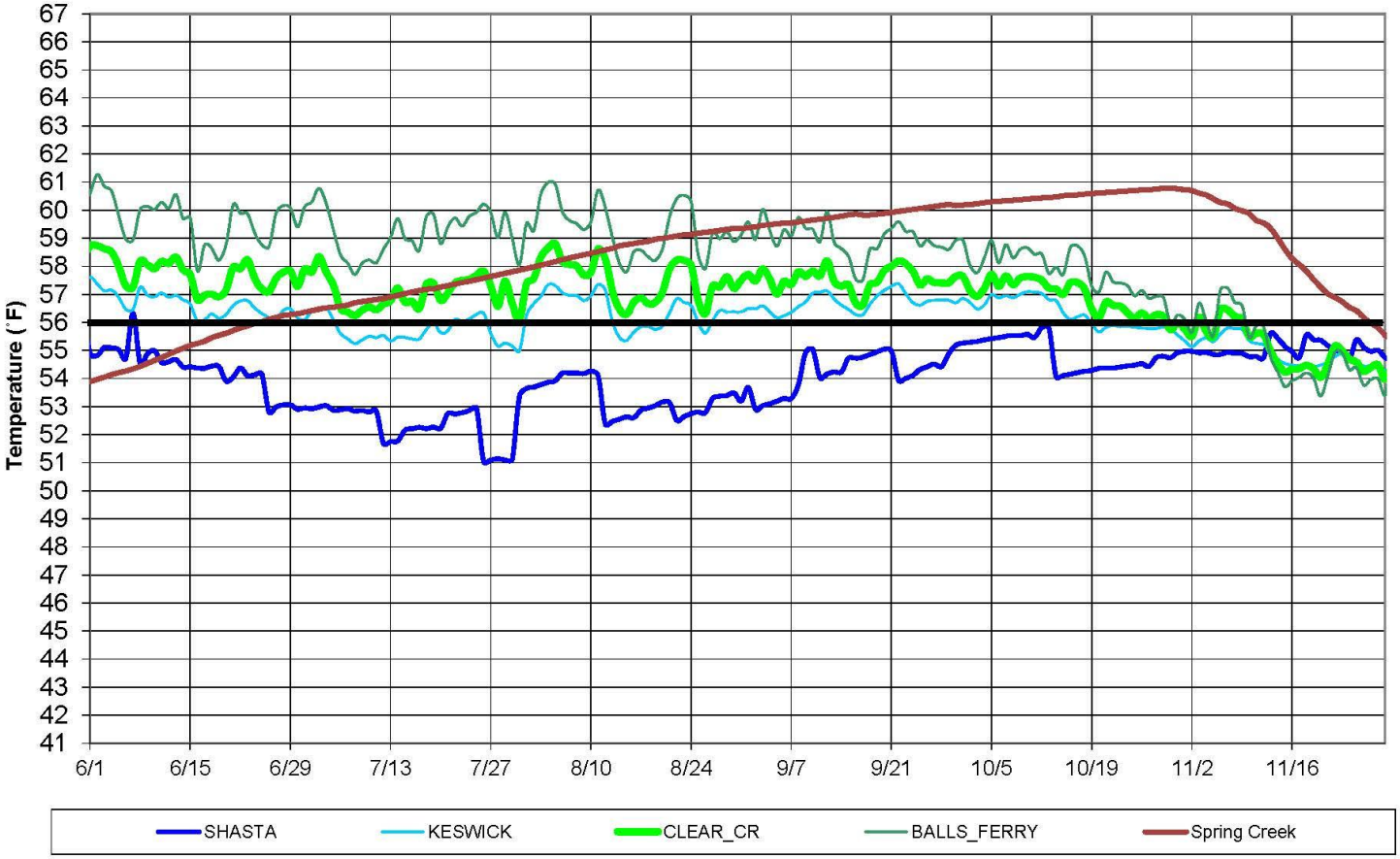
Sacramento River Modeled Temperature
2015 May 90%-Exceedance Outlook
Approximately 57 degree at Clear Creek - Kes at 8,000 cfs



Notes:
-- 58 °F June 1-15,
-- 57.5 °F June 16-July 31,
-- 58.5 °F August 1 on, and
-- September-October 15: 6,000 cfs

June 3, 2015: Scenario 2

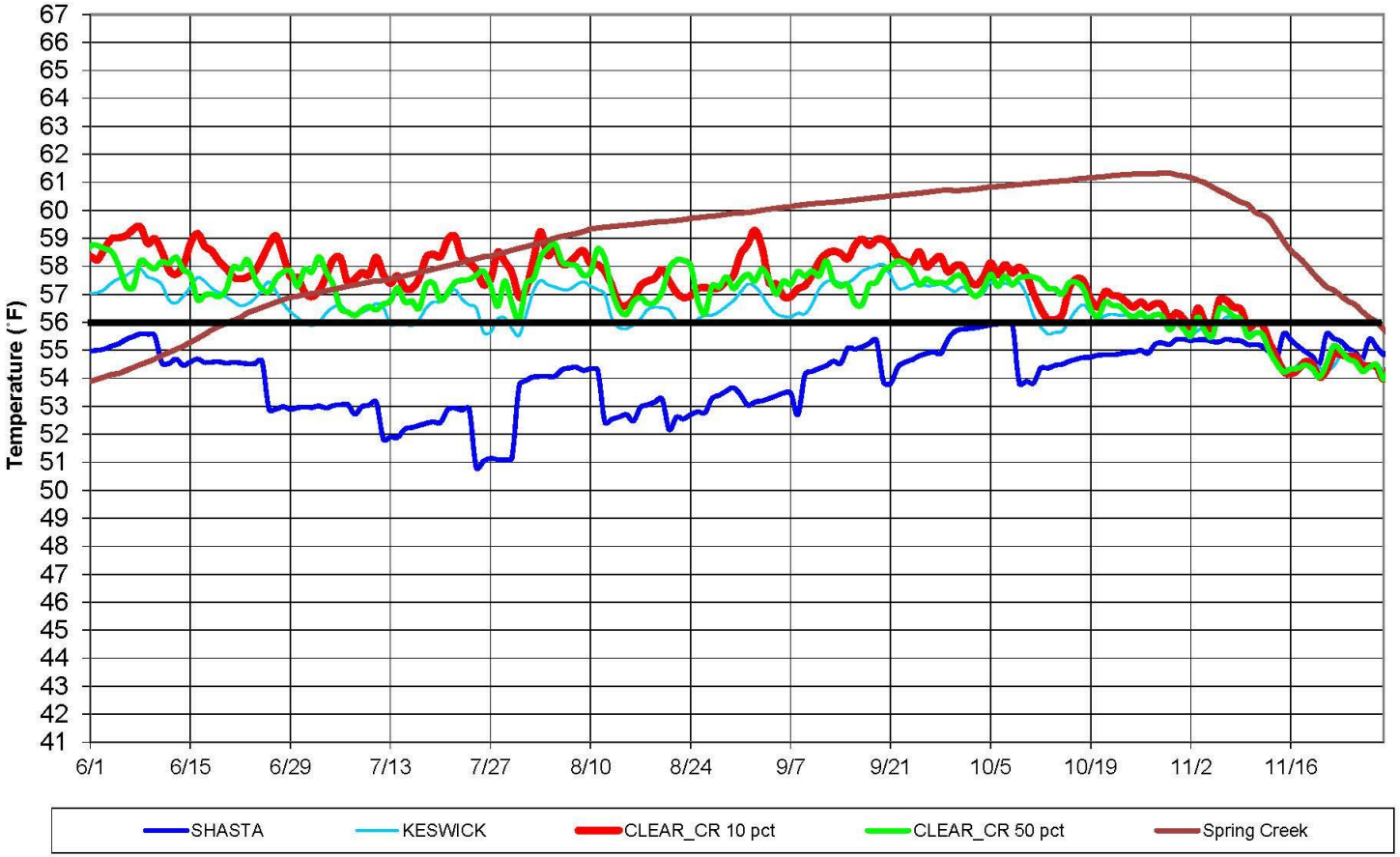
Sacramento River Modeled Temperature
2015 May 90%-Exceedance Outlook - 50% L3MTO
58, 57.5, 58.5 degree at Clear Creek - Kes at 8,000 cfs



Notes:
-- 58 °F June 1-15,
-- 57.5 °F June 16-July 31,
-- 58.5 °F August 1 on, and
-- September-October 15: 6,000 cfs
-- 10% L3MTO is the warmer scenario

June 3, 2015: Scenario 3

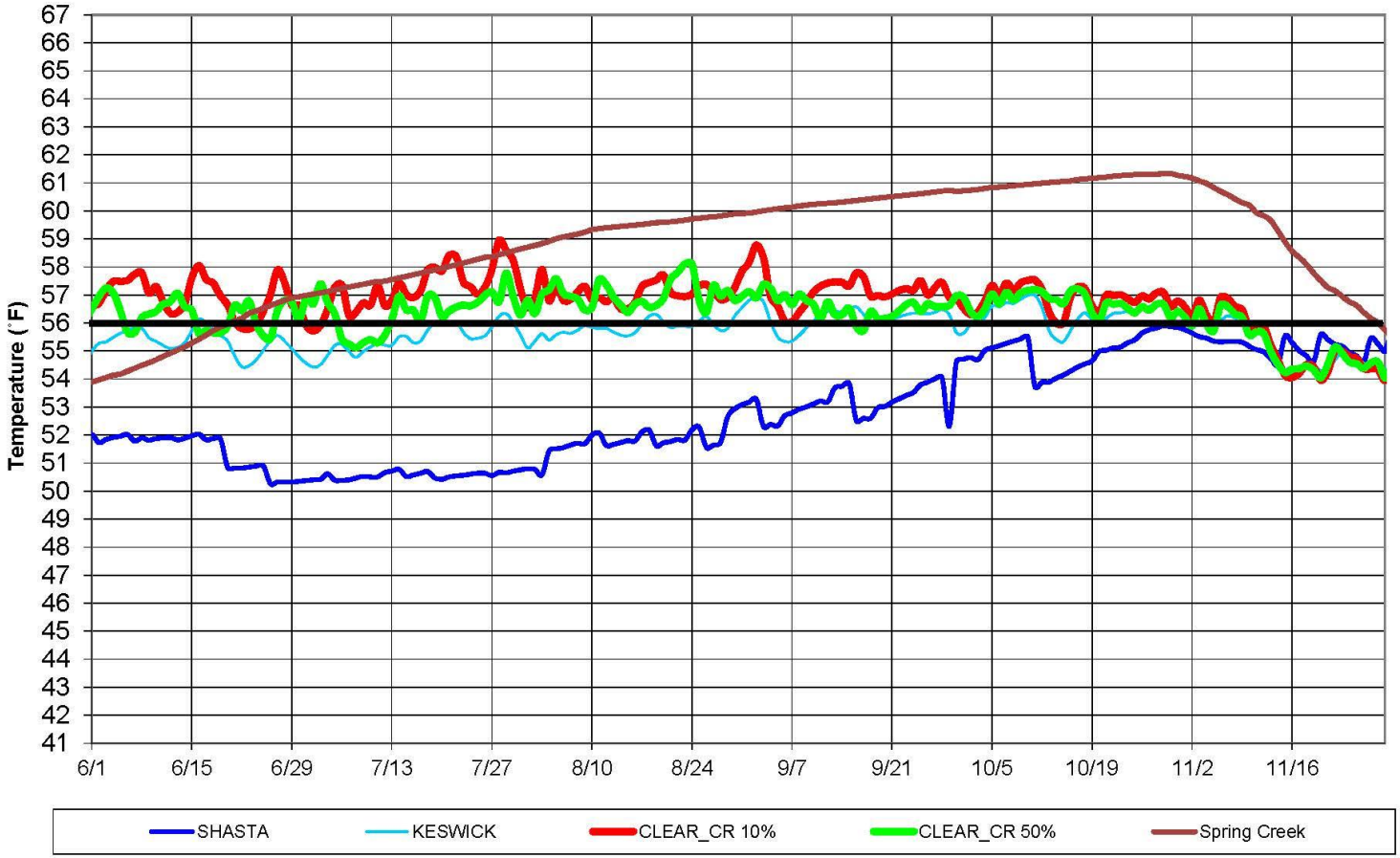
Sacramento River Modeled Temperature
2015 May 90%-Exceedance Outlook - 10% L3MTO
58, 57.5, 58.5 degree at Clear Creek - Kes at 8,000 cfs



Notes:
-- 10% L3MTO scenario for Keswick and red CCR curves.
-- Green CCR curve at 50% L3MTO added for comparison.
-- Shutter configuration same as the 50% L3MTO from June 2 run.

June 3, 2015: Scenario 4

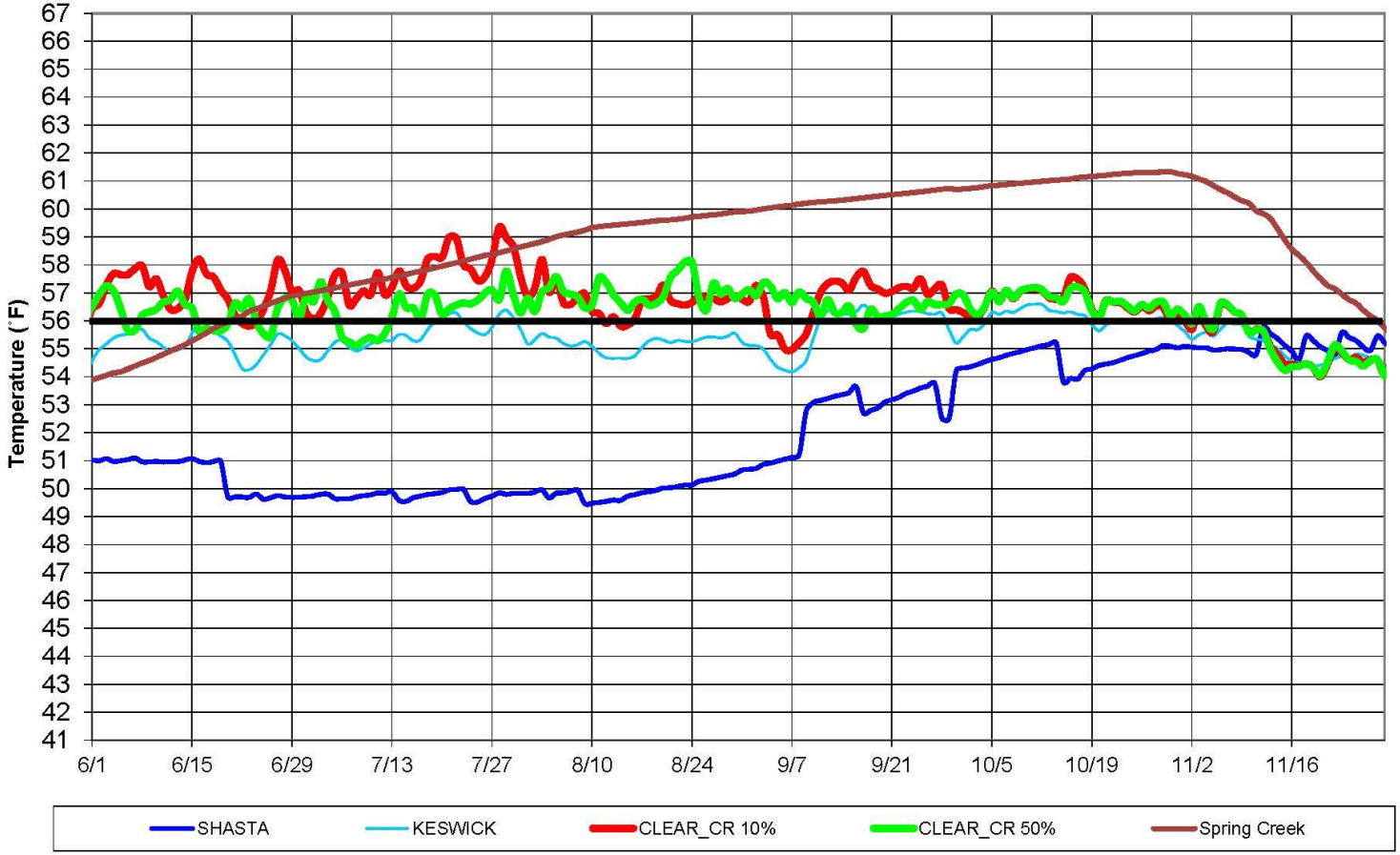
Sacramento River Modeled Temperature
2015 May 90%-Exceedance Outlook - 50% and 10% L3MTO
Approximately 57 degree at Clear Creek - Kes at 7,000 cfs



Notes:
-- 10% L3MTO scenario for Keswick and red CCR curves.
-- Green CCR curve at 50% L3MTO added for comparison.
-- Shutter configuration same as the 50% L3MTO from June 2 run.

June 3, 2015: Scenario 5

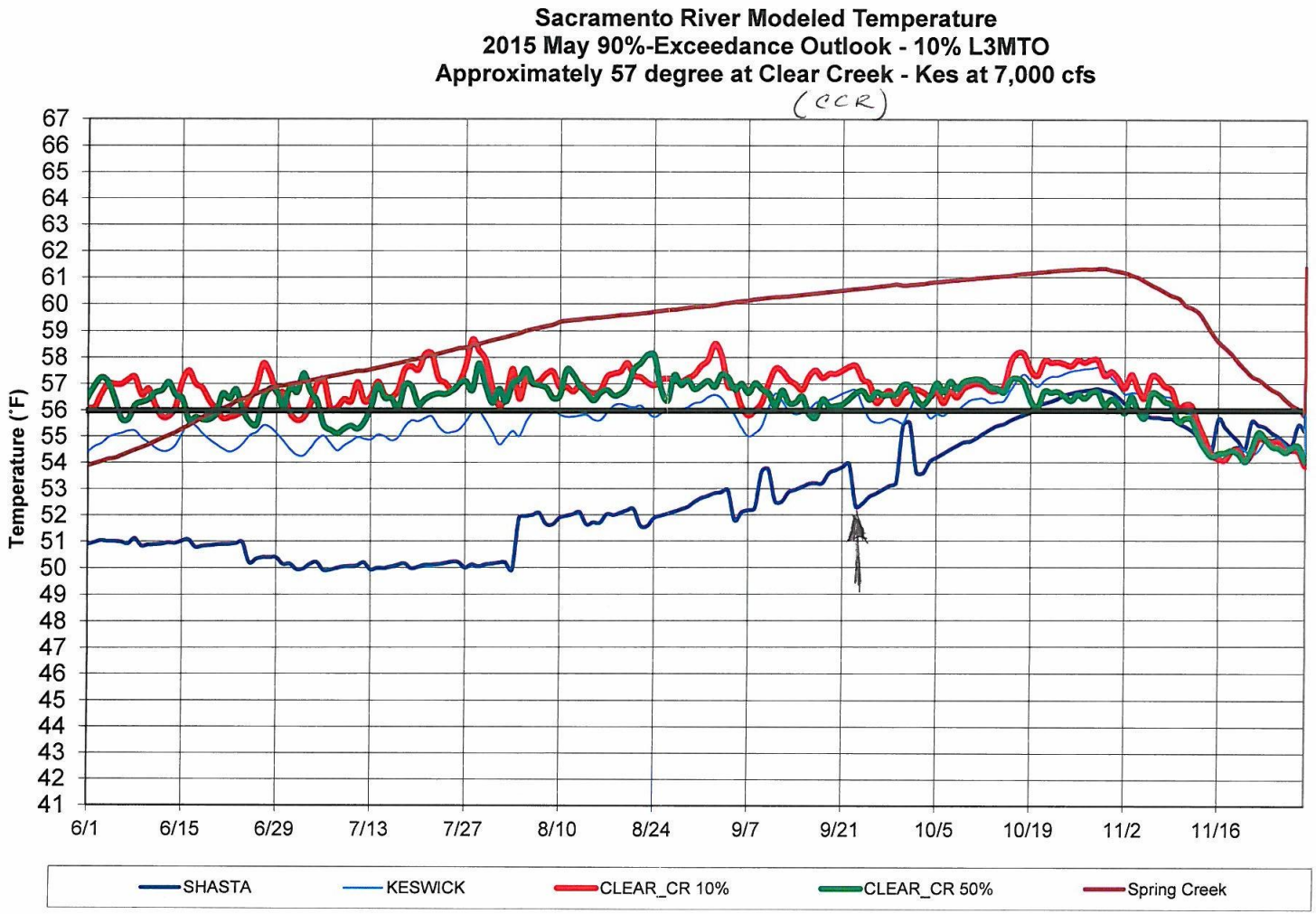
Sacramento River Modeled Temperature
2015 May 90%-Exceedance Outlook- 50% and 10% L3MTO
Approximately 57 degree at Clear Creek - Kes at 6,000 cfs



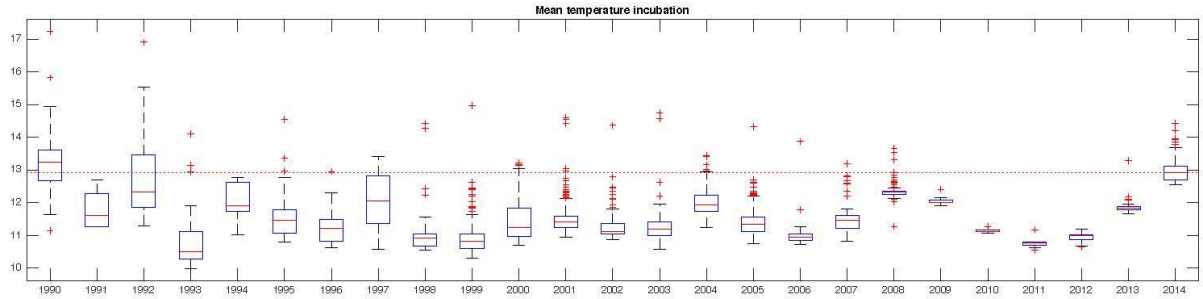
- The group requested Reclamation re-run the temperature model for flows of 8,000, 7,000, and 6,000 cfs while targeting 57°F at CCR using the 10% L3MTO.
- Josh Israel would run the Cramer Fish Sciences egg mortality model and David Swank would run his egg mortality model based on these modeling results.

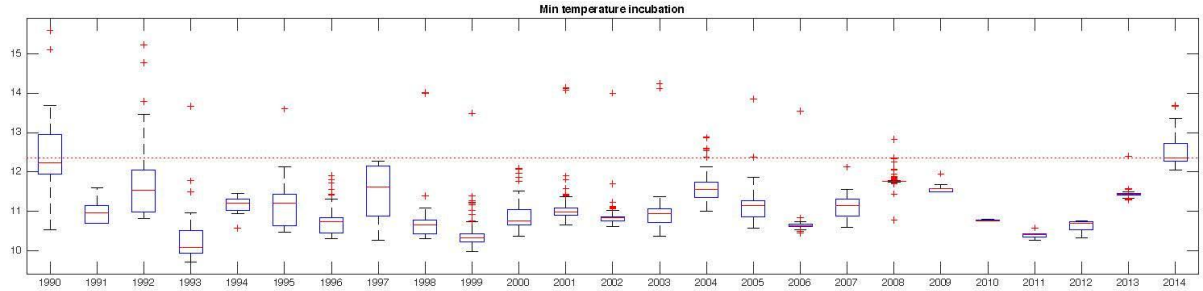
- June 4, 2015 – Reclamation only had time to run a temperature model of 7,000 cfs Keswick release targeting 57°F at CCR using the 10% L3MTO with adjusted shutter operations. The full side gate operation changed from October 14 to approximately September 23.

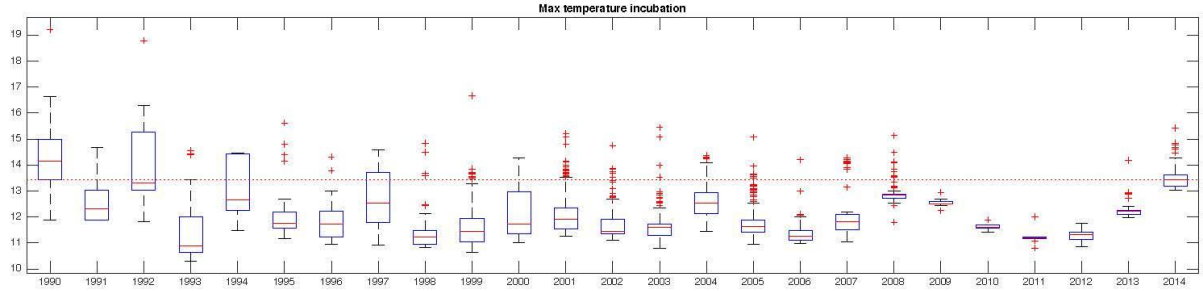
4 Jun 2015

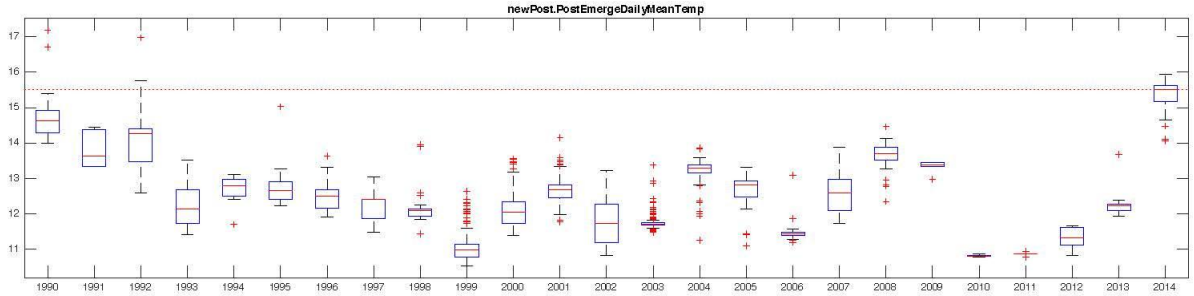

Sacramento River Modeled Temperature
2015 May 90%-Exceedance Outlook - 10% L3MTO
Approximately 57 degree at Clear Creek - Kes at 7,000 cfs
(CCR)
Temperature (°F)
67
66
65
64
63
62
61
60
59
58
57
56
55
54
53
52
51
50
49
48
47
46
45
44
43
42
41
6/1
6/15
6/29
7/13
7/27
8/10
8/24
9/7
9/21
10/5
10/19
11/2
11/16
SHASTA
KESWICK
CLEAR_CR 10%
CLEAR_CR 50%
Spring Creek

- SWFSC's RAFT modeling results show mean, minimum, and maximum incubation and post emergence daily average temperatures for 2014 were warmer than any year over the last 25 years.


Mean temperature incubation
17
16
15
14
13
12
11
10
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014


Min temperature incubation
15
14
13
12
11
10
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014


Max temperature incubation
19
18
17
16
15
14
13
12
11
10
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014


newPost.PostEmergeDailyMeanTemp
17
16
15
14
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12
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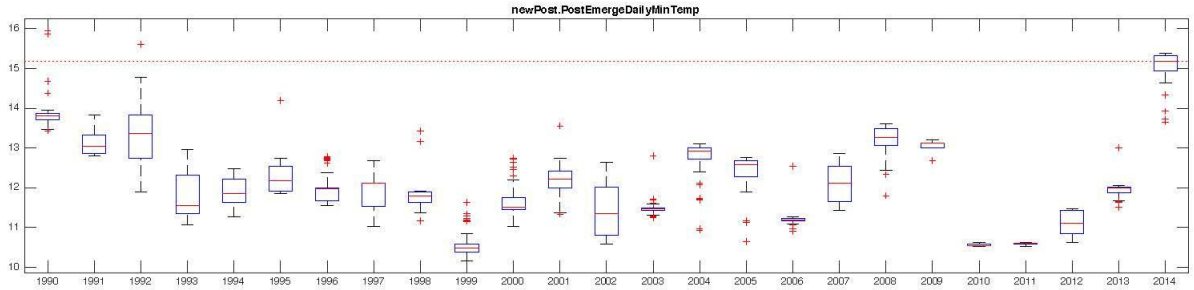
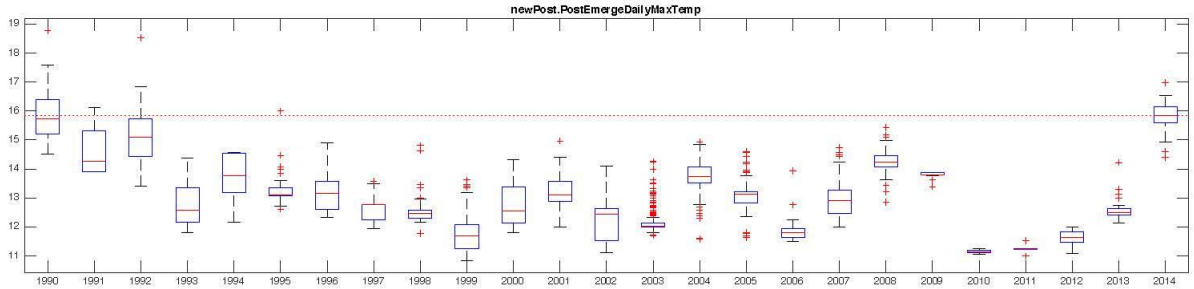
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014


newPost.PostEmergeDailyMinTemp
16
15
14
13
12
11
10
1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014


newPost.PostEmergeDailyMaxTemp
19
18
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1990 1991 1992 1993 1994 1995 1996 1997 1998 1999 2000 2001 2002 2003 2004 2005 2006 2007 2008 2009 2010 2011 2012 2013 2014

- Draft winter-run screening level assessment:

Scenario	Range daily average June – Oct at Keswick	Peak 7DADM CCR	Likely date of full side gate operation[11]	Egg Survival CCR (Cramer)	Egg Survival CCR (Swank)	Fry Survival CCR (Cramer)	Fry Survival BND (Cramer)
8000cfs @ 10%	55-58.2	~61.1	Oct. 2	84.3%	78.3%	19.3%	6.9%
7000 cfs @ 10%	54.4-57.0	~61.0	Oct. 14	88.5%	78.0%	18.7%	7.3%
6000 cfs @ 10%	54.2- 56.6	~61.4	Oct. 18	91.1%	78.8%	17.8%	7.6%

  - The Bend Bridge location (BND) may be more accurate for understanding fry survival since this includes locations downstream of the temperature control point where fry are likely to rear and influence this life stage's survival), and CCR may be more accurate for understanding egg mortality since all redds are likely to be above this location.

- June 5, 2015 – Directors' meeting; no decision was made. Directors would like to see the results of the temperature model runs for 8,000 and 6,000 cfs targeting 57°F at CCR using the 10% L3MTO with new shutter operations.
  - Winter-run risk assessment:
    - Of these 8,000, 7,000, and 6,000 cfs runs, the team of biologists thinks that the 7,000 cfs run is preferred because it results in somewhat cooler temperatures throughout the season and creates the greatest potential to delayed full side gate operations.
    - It is most desirable biologically, given limited cold water, to target warmer temperatures earlier in the season (57°F or even higher), in order to reduce the risk of running out of cold water later in the season resulting in year class failure similar to last year.
    - The 6,000 cfs had some minimal marginal improvement over the 7,000 cfs run, but at a high additional water cost.
    - The model outputs are sensitive to meteorology, and using a 10% L3MTO (warmest values) forecast creates some certainty that the plan will not need to be adjusted again mid-season. A monthly "truing up" in additional to real-time operations is advised.
    - Real-time operations will be an important component of implementing the operational plan going forward. A process and sideboards need to be defined.
    - Additional refinement of temperature objectives (*i.e.*, higher water temperatures now and later in the season given meteorology) could improve the ability to maintain cold

[11] Based on the 50% local 3-month temperature outlook (L3MTO), not the 10% L3MTO. The 10% L3MTO at 7,000 targeting 57°F shifted the full side gate operation to Sept 23, indicating how sensitive the model is to meteorology. Additional flow scenario runs at the 10% L3MTO are being completed.

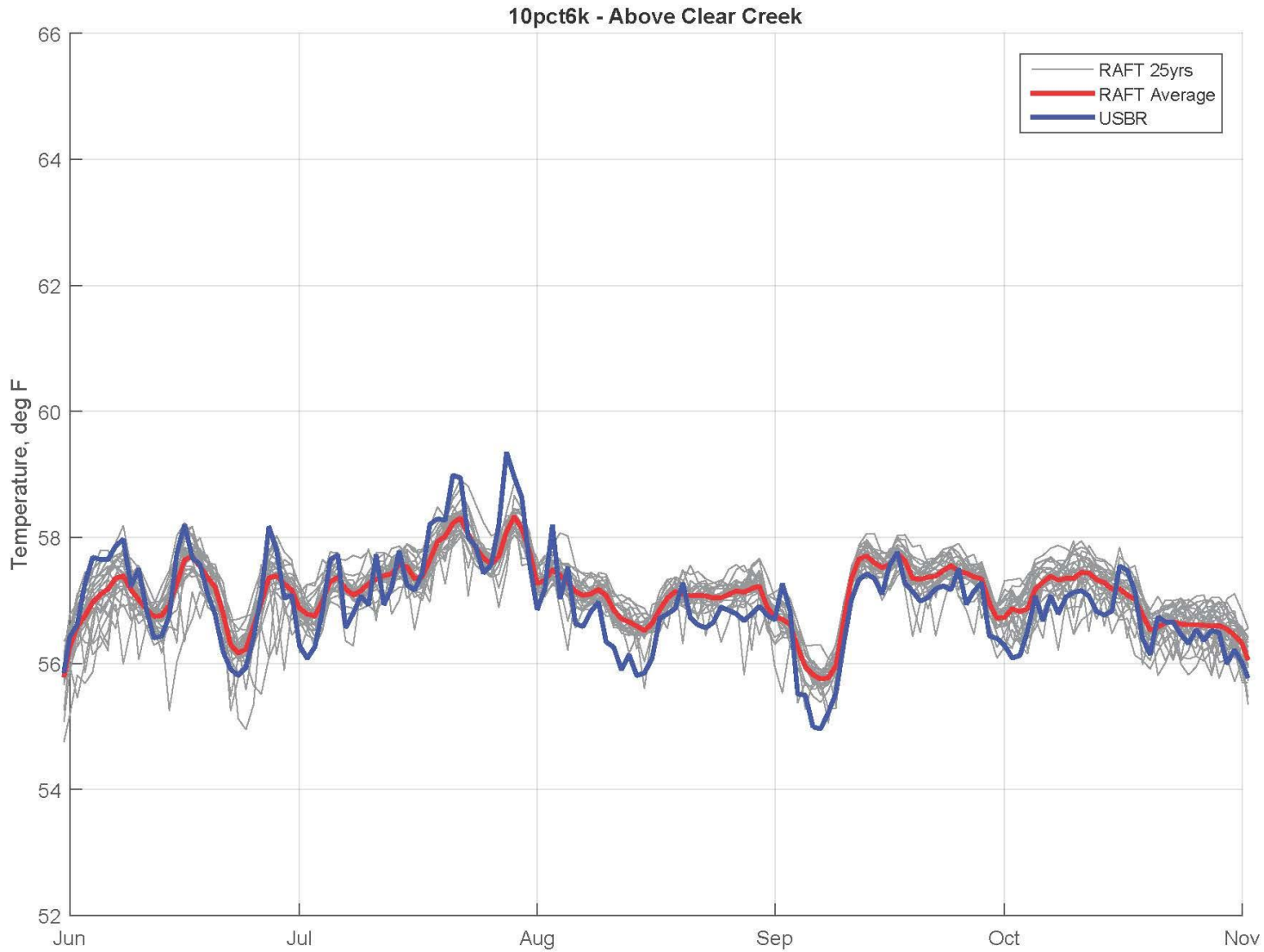
water resources and the probability of assuring a reasonable level of natural production.

- The biological models (Cramer and Swank egg mortality models) were helpful in assessing the effects of the various operating runs, but are limited in their ability to differentiate or predict survival between those runs. Additional analysis is ongoing.
- The literature is generally consistent regarding optimal incubation requirements for Chinook salmon. Based on Central Valley salmonid studies, Myrick and Cech (2004)[12] concluded that temperatures between 43 and 54°F appear best suited to Chinook salmon embryo and alevin development. US Fish and Wildlife Service (1999)[13] reported that winter-run egg mortality increased at temperatures over 56°F; specifically that cumulative mortality through fry emergence nearly doubled from 56°F to 58°F (18% to 33%). Both Healey (1979)[14] and USFWS (1999) found >75% egg mortality of Central Valley Chinook salmon at temperatures of 60°F and total loss by 62°F. Note that these study results come from laboratory studies under constant temperature conditions through fry emergence that allow both acclimation and exposure temperatures to be precisely controlled. In natural stream systems, temperatures fluctuate hourly and from day to day, resulting in continually changing conditions, making it difficult to predict thermal effects.
- There are water temperatures that may not cause direct mortality to embryos, but alevins developed under those temperatures may be subjected to higher mortality at the next developmental stage. Studies indicate that elevated water temperatures earlier in development may reduce the size and weight of alevins, fry, and smolts leading to delayed mortality prior to reproduction (Beacham and Murray 1990[15], Seymour 1956[16], USFWS 1999). These effects could result in reduced productivity of a stock and reduced population size.
- The 8,000 cfs run often predicts temperatures of 0.5 to 2°F warmer than the 7,000 cfs run.
- The group also looked at the ability to bring more fish into hatcheries. Given current conditions, what is currently planned for Livingstone Stone is the best that can be expected. Other hatcheries in the system face temperature management, fish health and capacity issues.

- Operations assessment:

[12] Myrick, C. A. and J. J. Cech. 2004. Temperature effects on juvenile anadromous salmonids in California's central valley: what don't we know? Reviews in Fish Biology and Fisheries 14:113-123.
[13] USFWS. 1999. Effect of temperature on early-life survival of Sacramento River fall- and winter-run chinook salmon. Red Bluff, CA: Northern Central Valley Fish and Wildlife Office, January 1999.
[14] Healey, T.P. 1979. The effect of high temperature on the survival of Sacramento River chinook (king) salmon, Oncorhynchus tshawystscha, eggs and fry. Sacramento: California Department of Fish and Game, 1979.
[15] Beacham, T. D. and C. B. Murray. 1990. Temperature, Egg Size, and Development of Embryos and Alevins of 5 Species of Pacific Salmon - a Comparative-Analysis. Transactions of the American Fisheries Society 119:927-945.
[16] Seymour. A.H. 1956. Effects of temperature upon young Chinook salmon. PhD thesis, University of Washington, Seattle, WA. 127 pp.

    - Although the reduced Keswick releases will improve storage levels at Shasta Reservoir, the storage at Oroville and Folsom reservoirs will be very low by the end of September.
    - Reduced supplies to the SRSCs can be absorbed to a point, but the larger cuts will result in more widespread supply cuts and shortages.
    - For the 8,000 cfs and 7,000 cfs scenarios, Delta outflow objectives could be marginal, but at 6,000 cfs, maintenance of Delta outflow would likely result in severely reduced storage levels at Oroville and Folsom reservoirs.
    - Keswick releases at 8,000 cfs would allow for minimal Delta supplies for the CVP and SWP, but Delta supplies would be severely limited at 7,000 cfs, including supplies to Exchange Contractors, south of Delta Refuges, and other CVP contractors.
  - SWFSC ran the six Reclamation scenarios through the RAFT model using meteorological data from each of the past 25 years. Reclamation's temperature model under predicts on average compared to RAFT, with the magnitude of the difference increasing with distance downstream.


10pct6k - Above Clear Creek
RAFT 25yrs
RAFT Average
USBR
Temperature, deg F
66
64
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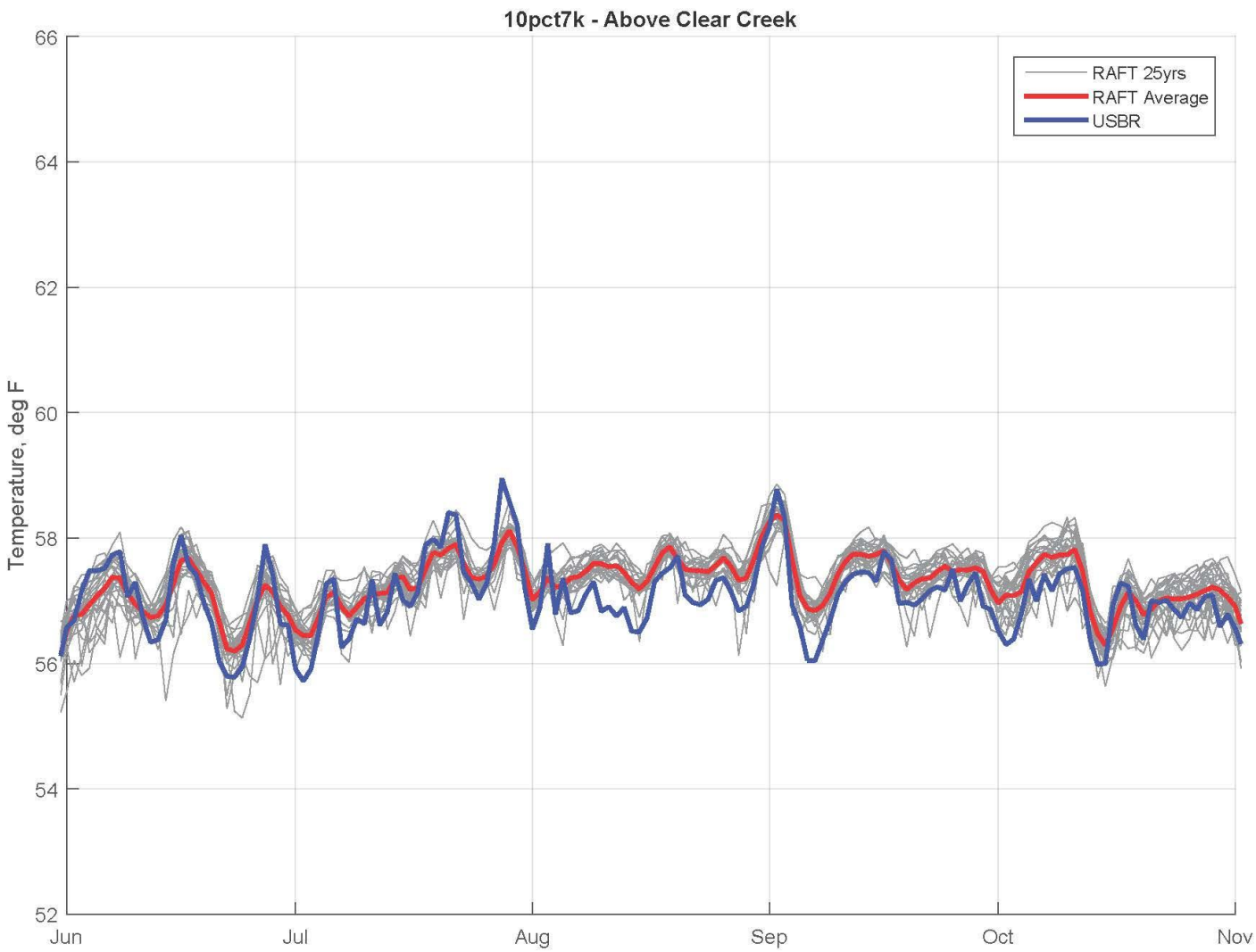
Jun
Jul
Aug
Sep
Oct
Nov


10pct7k - Above Clear Creek
RAFT 25yrs
RAFT Average
USBR
Temperature, deg F
66
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62
60
58
56
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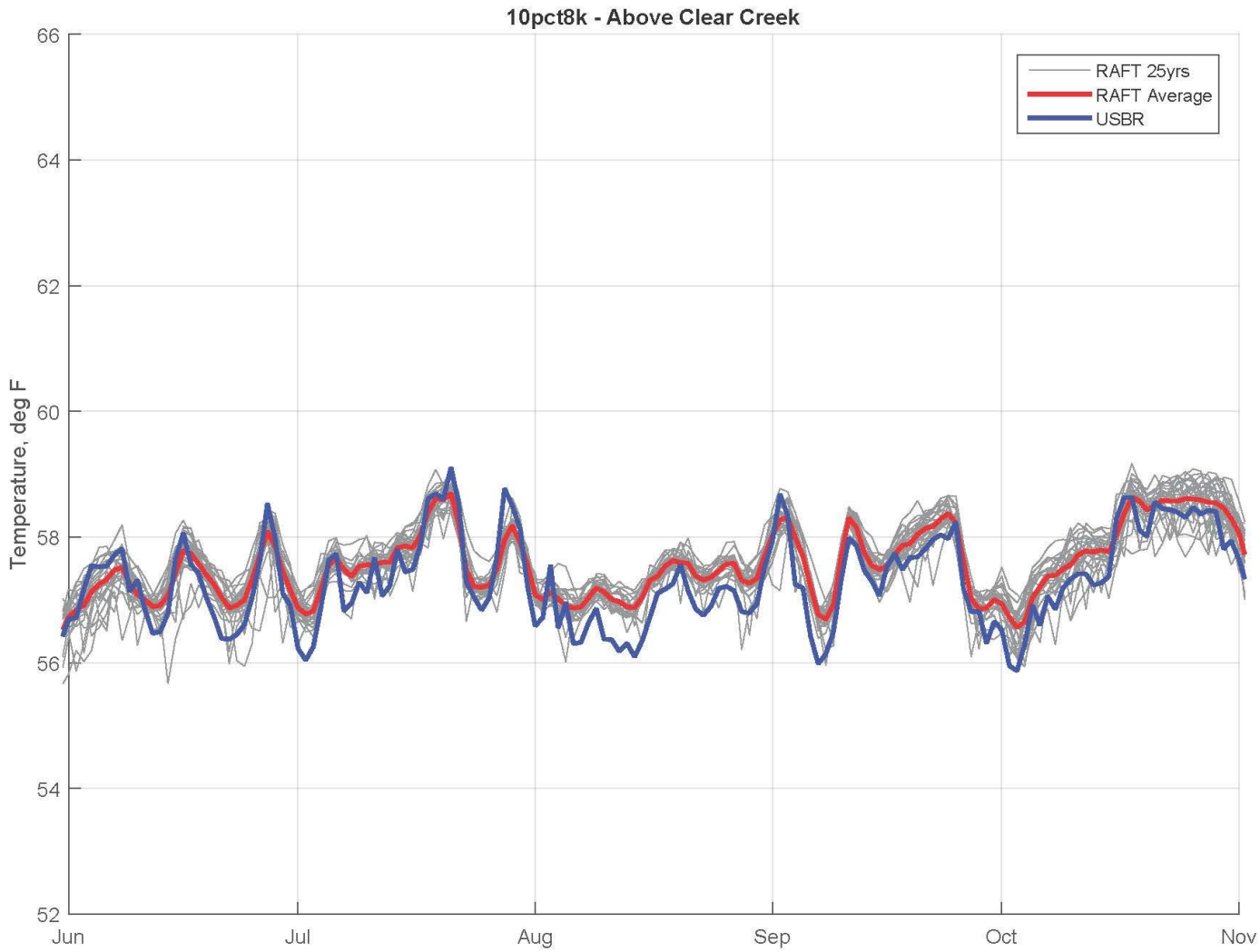
Oct
Nov


10pct8k - Above Clear Creek
RAFT 25yrs
RAFT Average
USBR
Temperature, deg F
66
64
62
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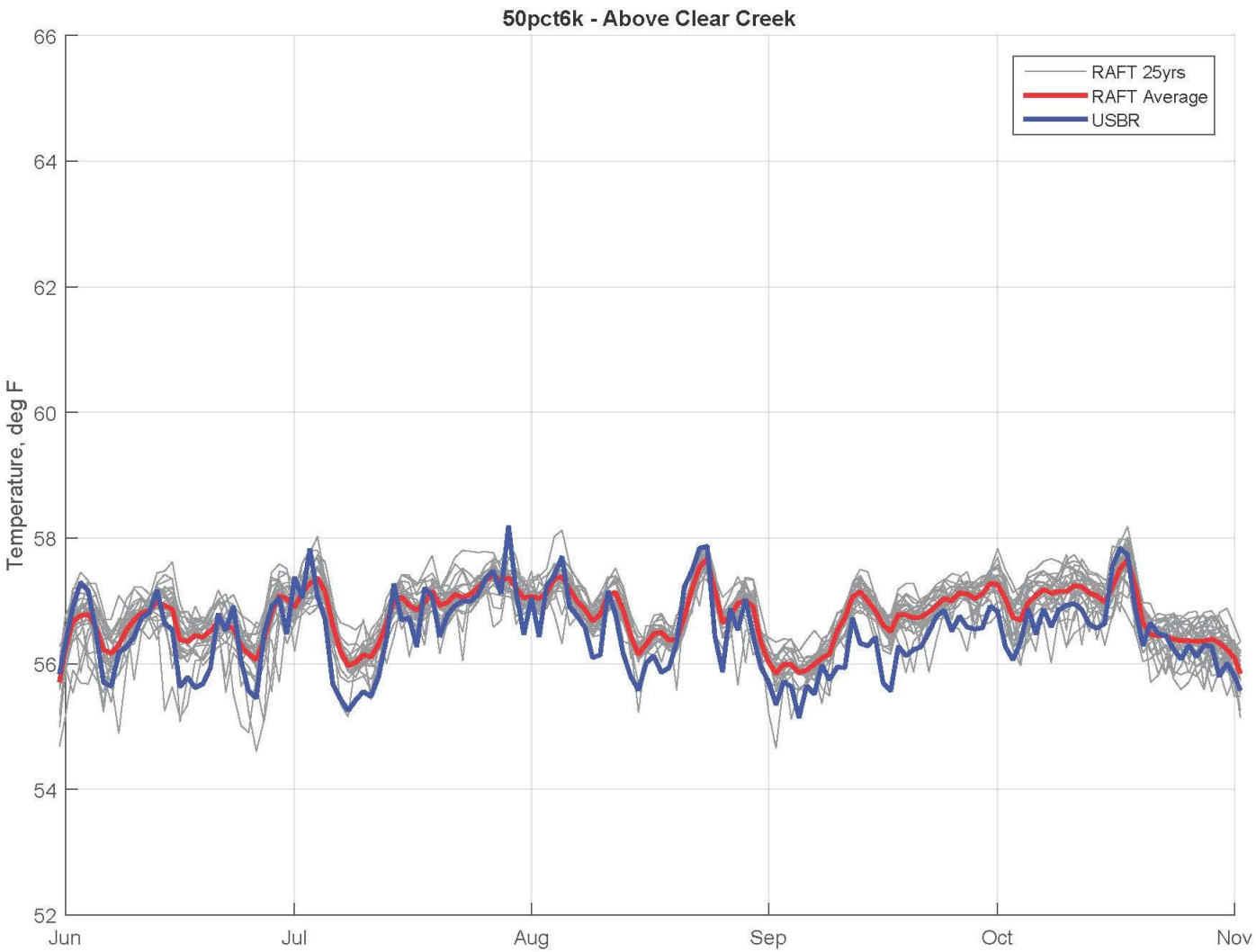
Oct
Nov


50pct6k - Above Clear Creek
RAFT 25yrs
RAFT Average
USBR
Temperature, deg F
66
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60
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Jun
Jul
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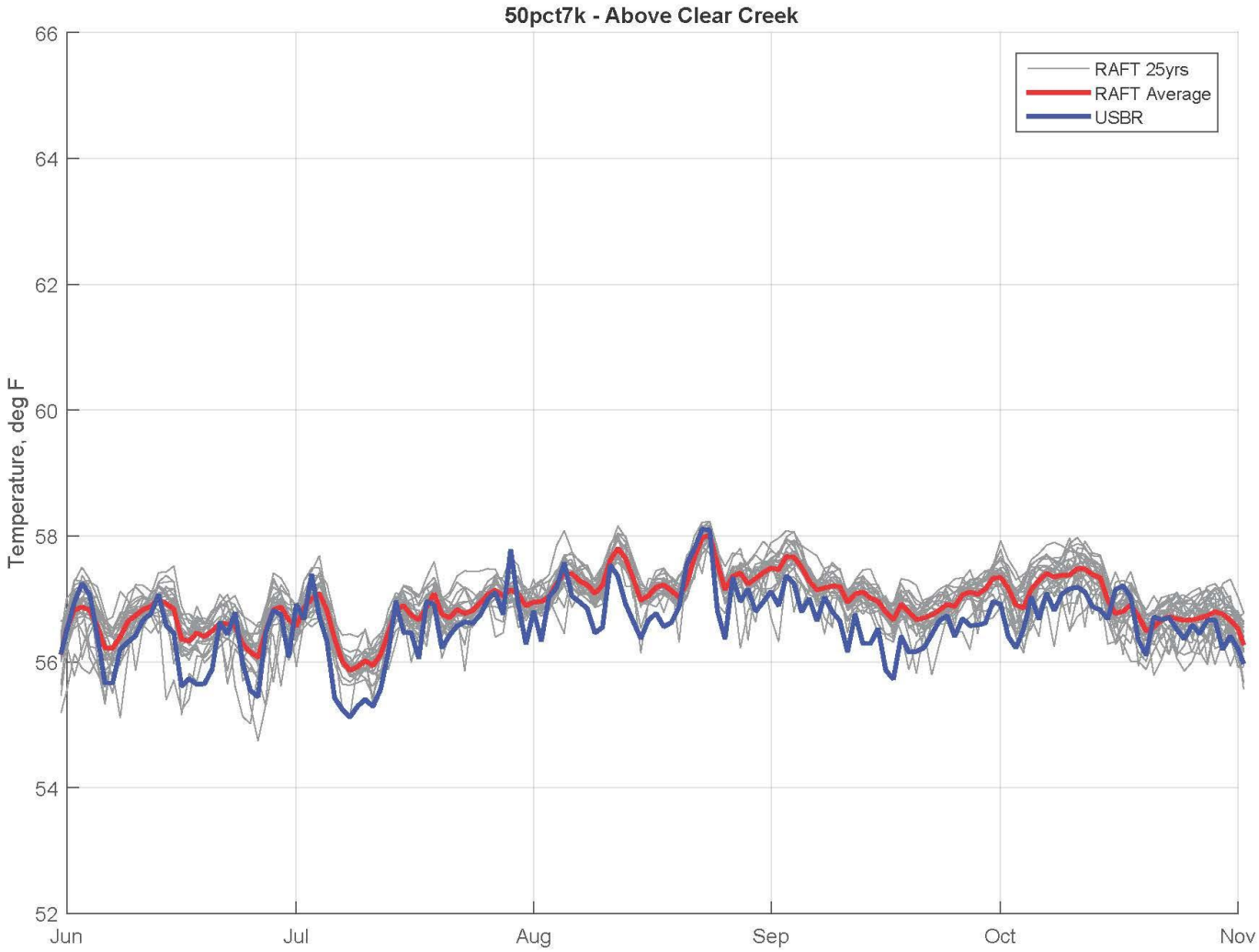
Oct
Nov


50pct7k - Above Clear Creek
RAFT 25yrs
RAFT Average
USBR
Temperature, deg F
66
64
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Jun
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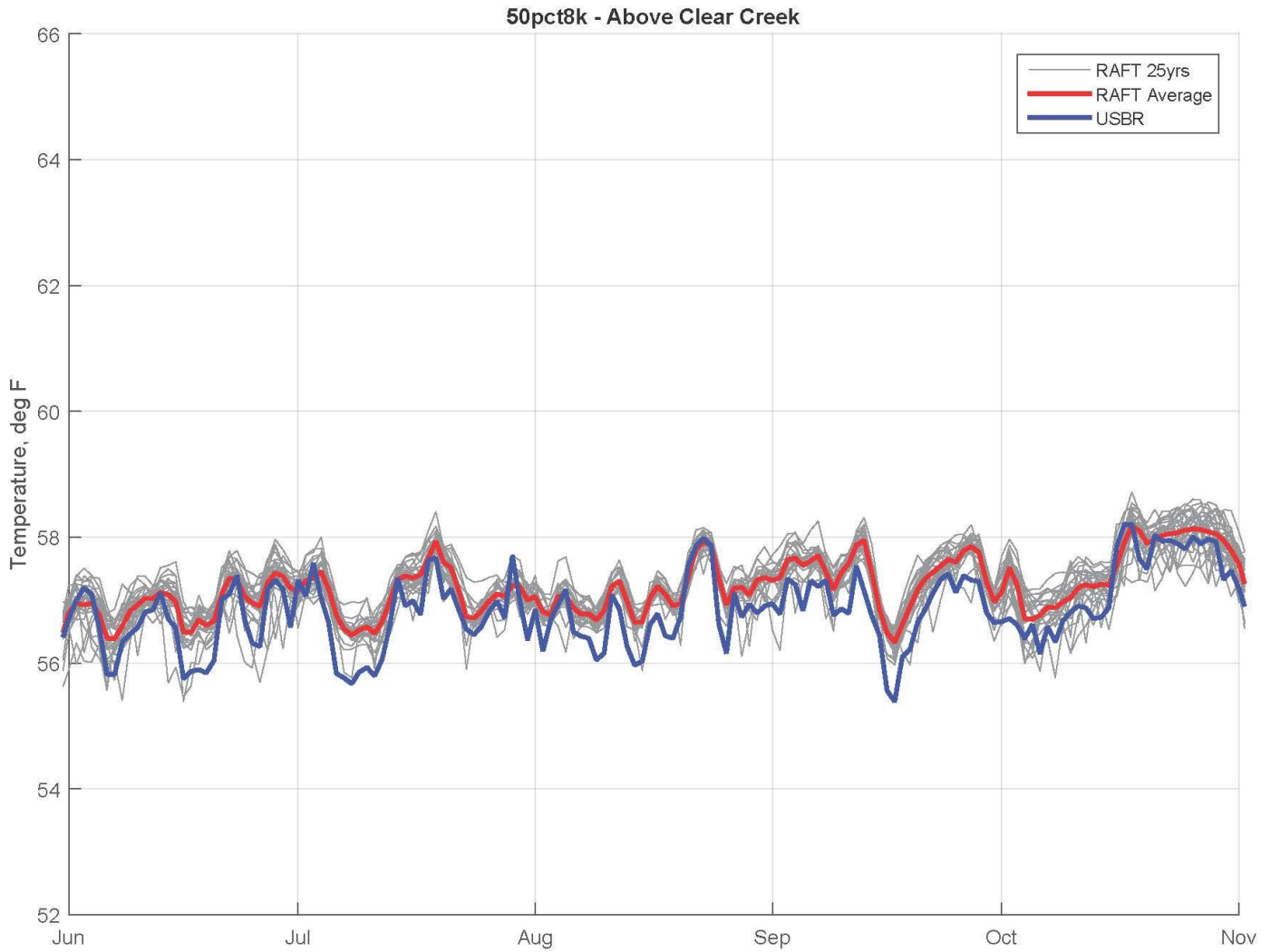
Nov


50pct8k - Above Clear Creek
RAFT 25yrs
RAFT Average
USBR
Temperature, deg F
66
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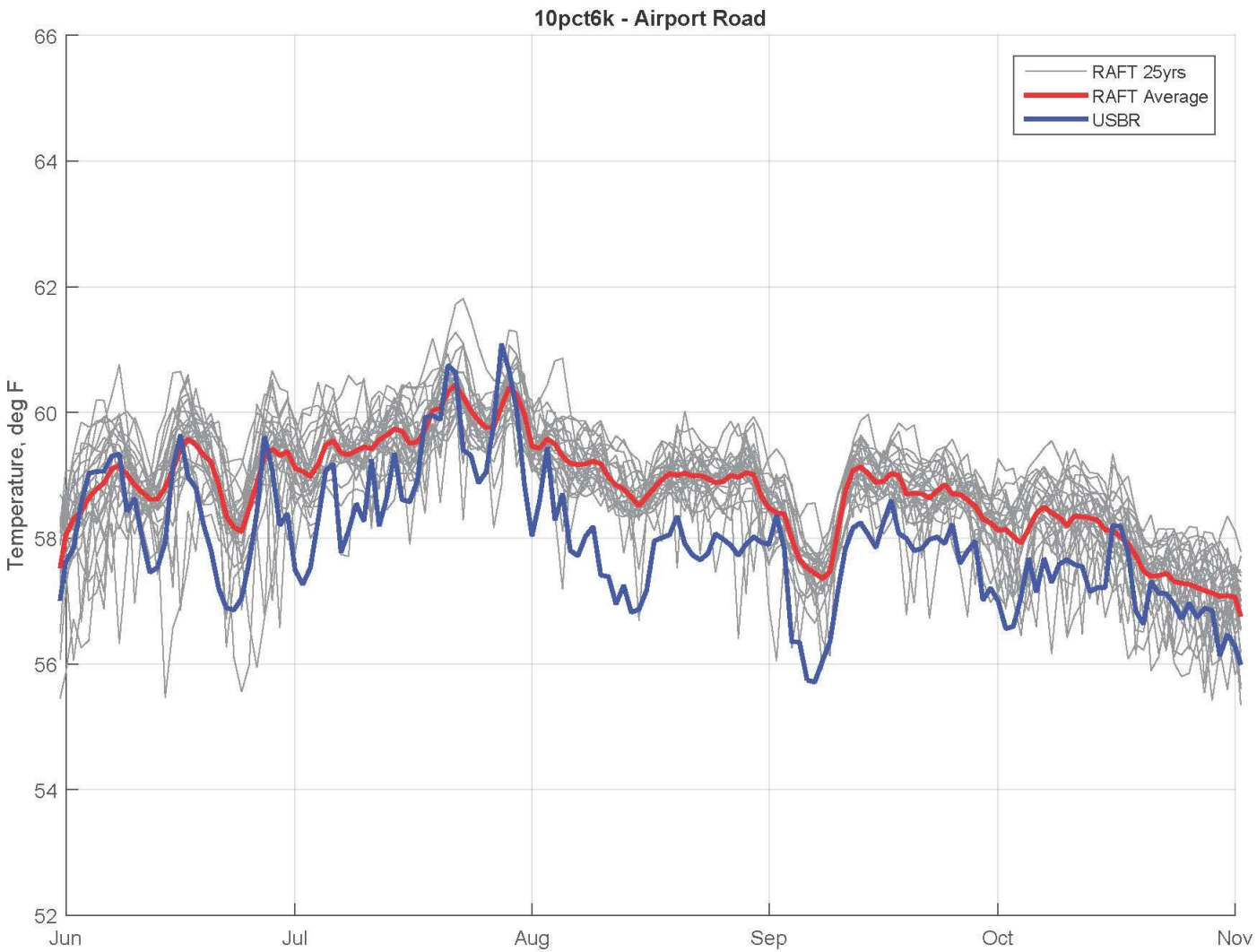
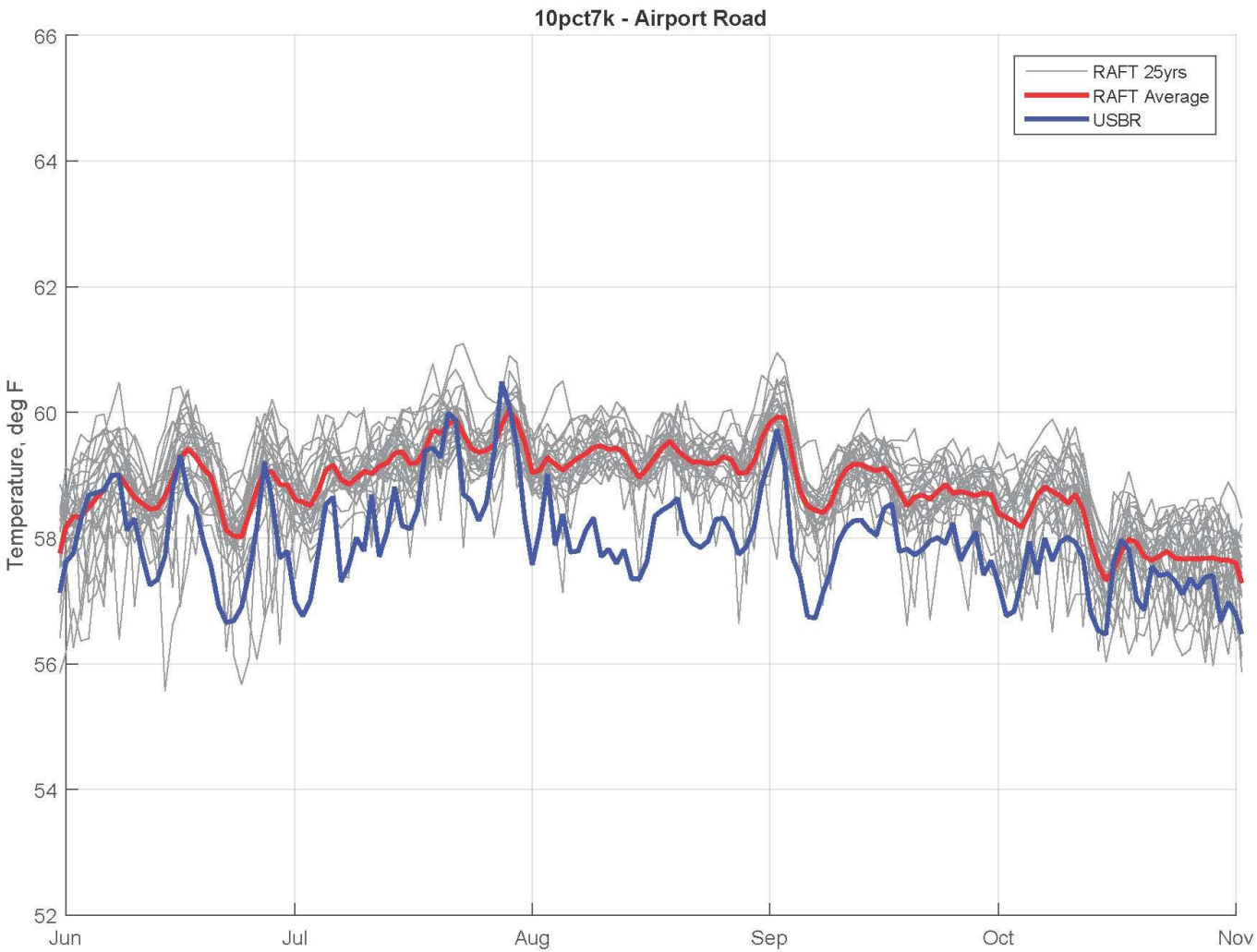

10pct6k - Airport Road
RAFT 25yrs
RAFT Average
USBR
Temperature, deg F
66
64
62
60
58
56
54
52
Jun
Jul
Aug
Sep
Oct
Nov


10pct7k - Airport Road
RAFT 25yrs
RAFT Average
USBR
Temperature, deg F
66
64
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Jun
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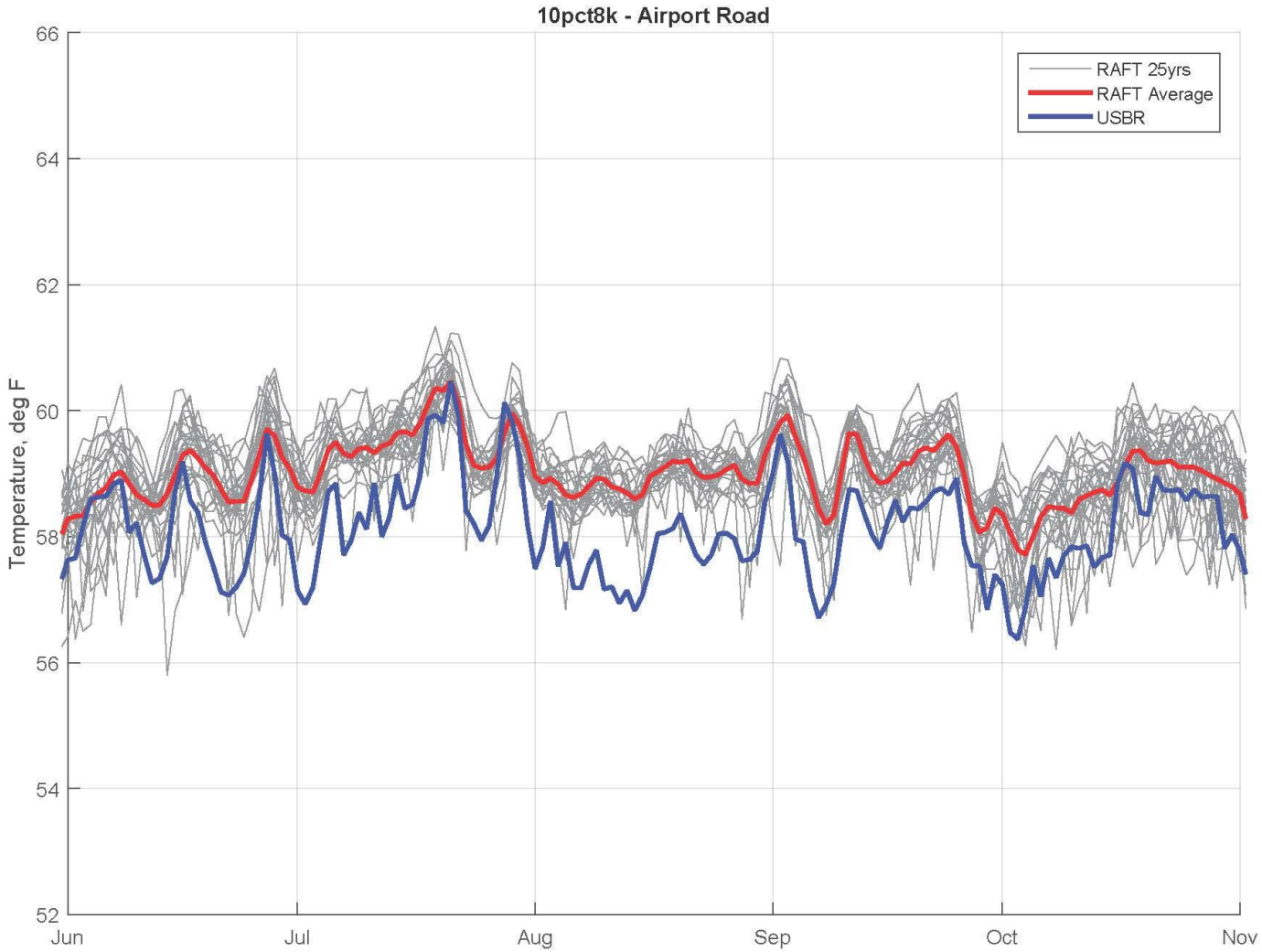
Nov


10pct8k - Airport Road
RAFT 25yrs
RAFT Average
USBR
Temperature, deg F
66
64
62
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Jun
Jul
Aug
Sep
Oct
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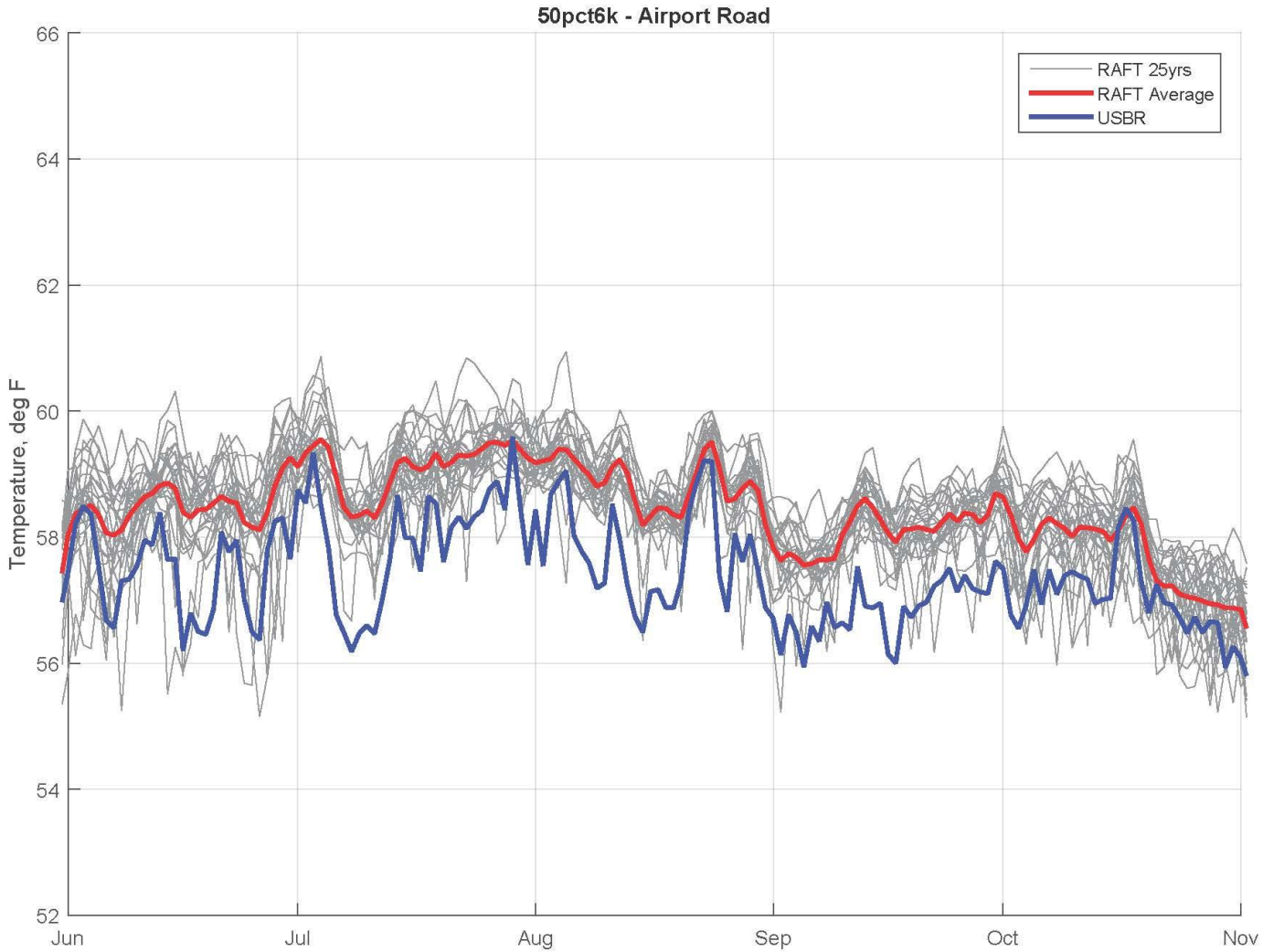
50pct6k - Airport Road
RAFT 25yrs
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Temperature, deg F
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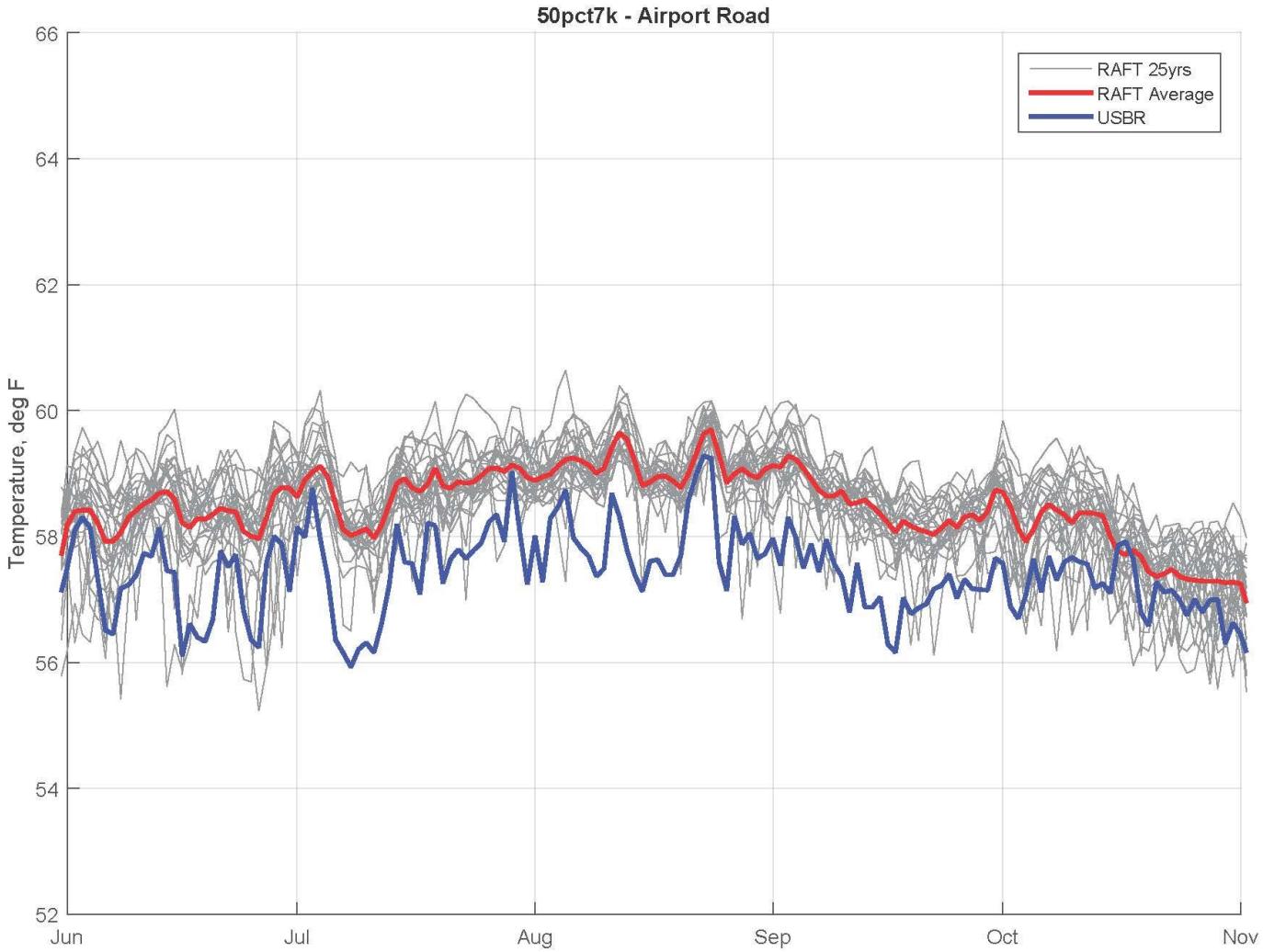
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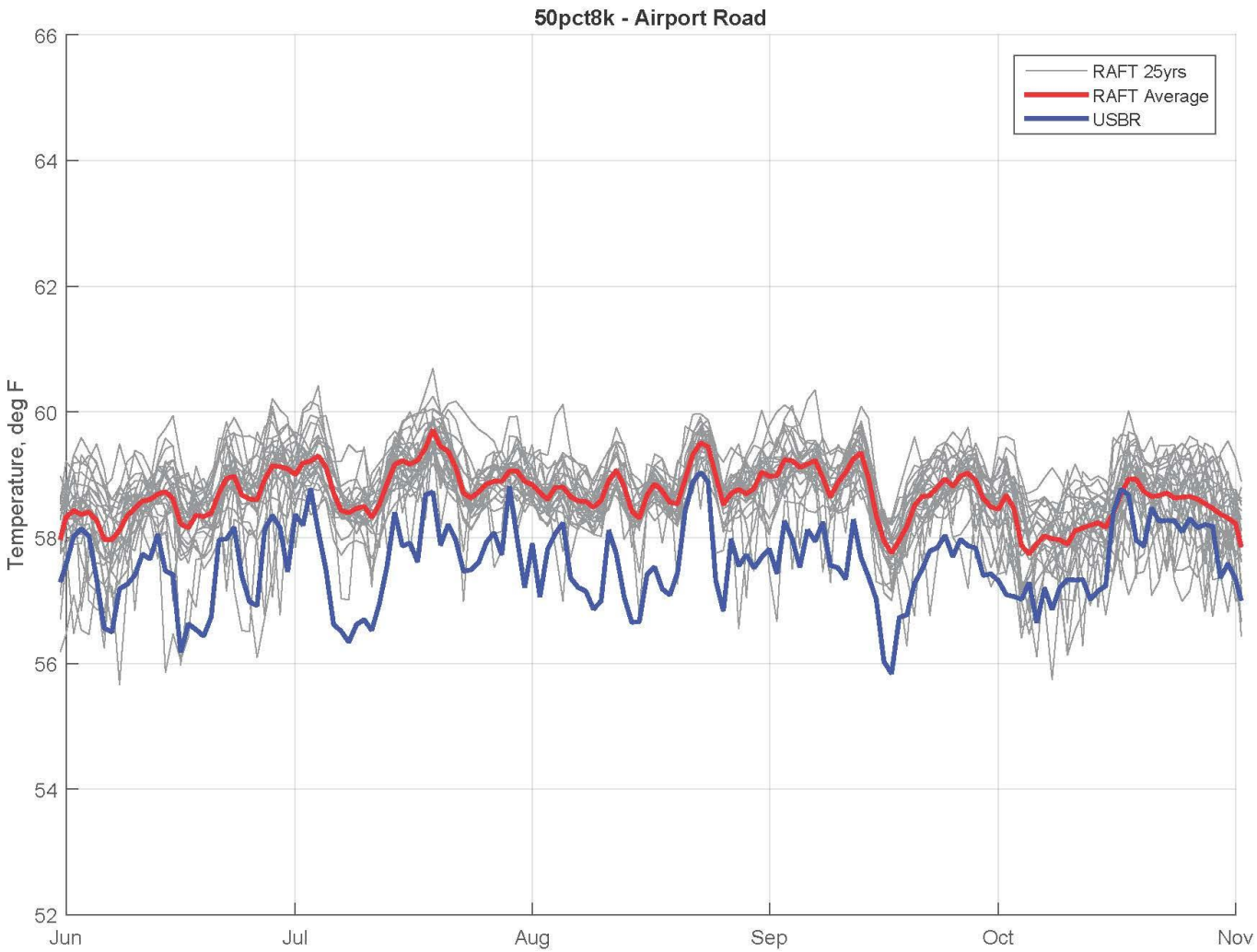
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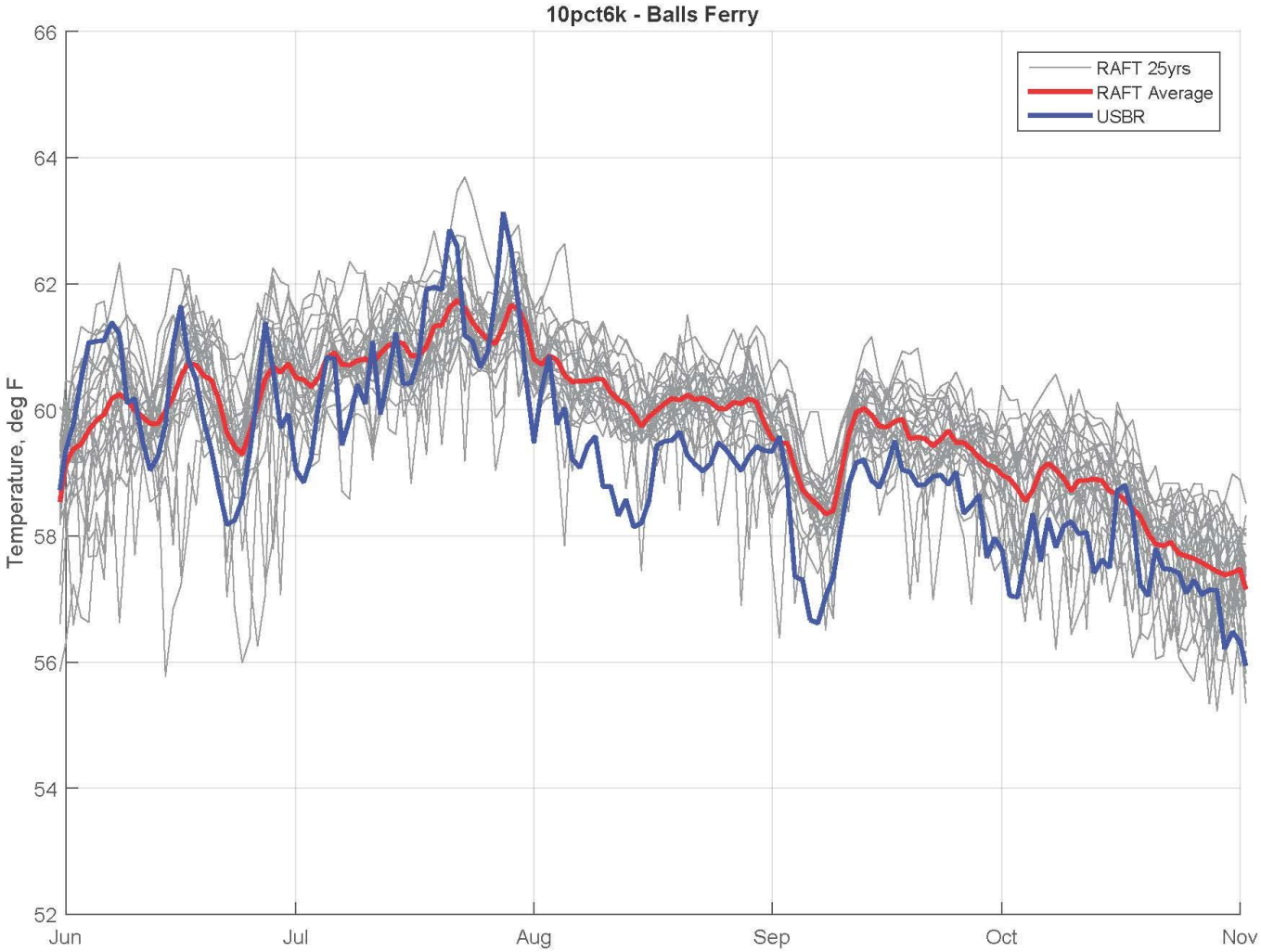
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RAFT Average
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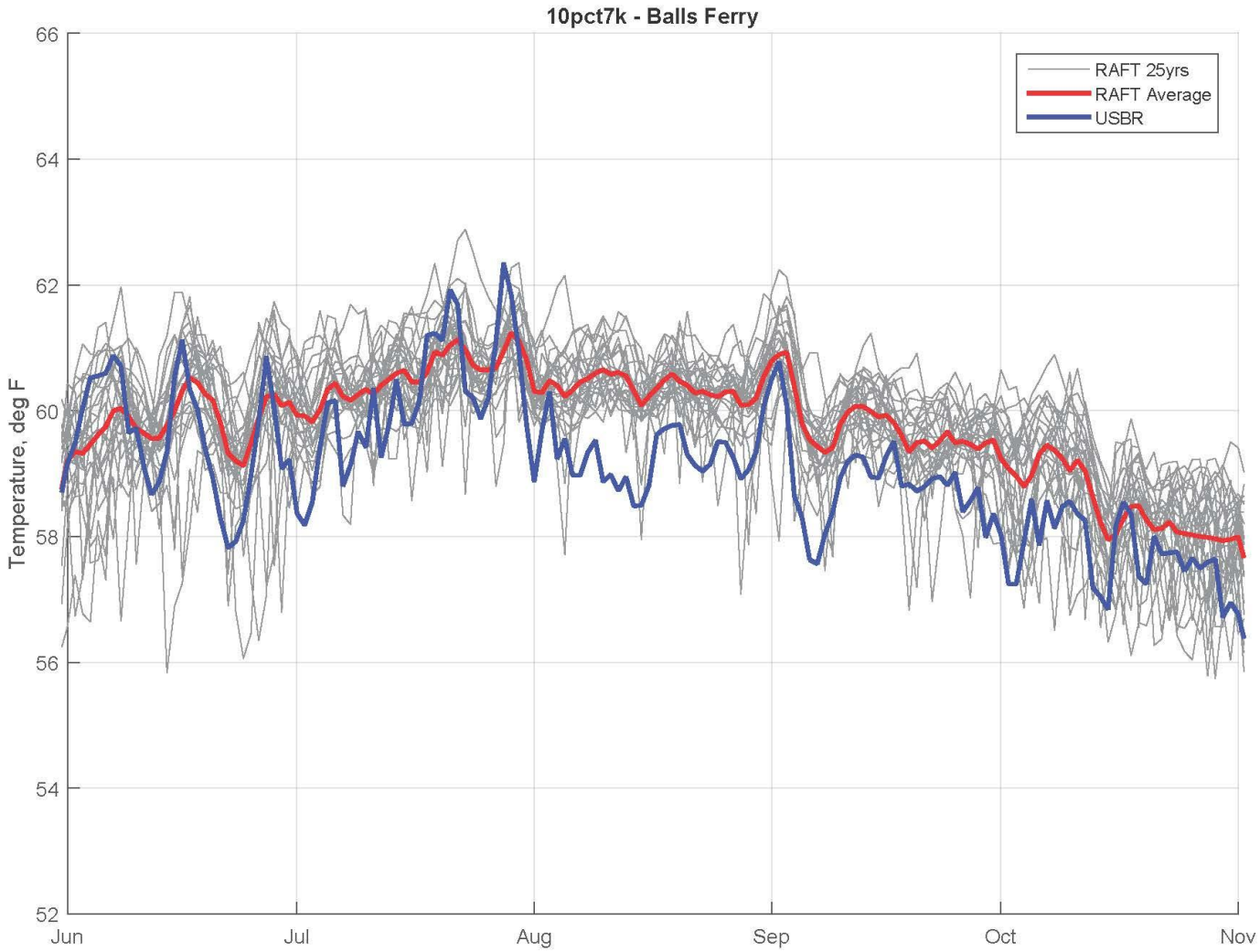
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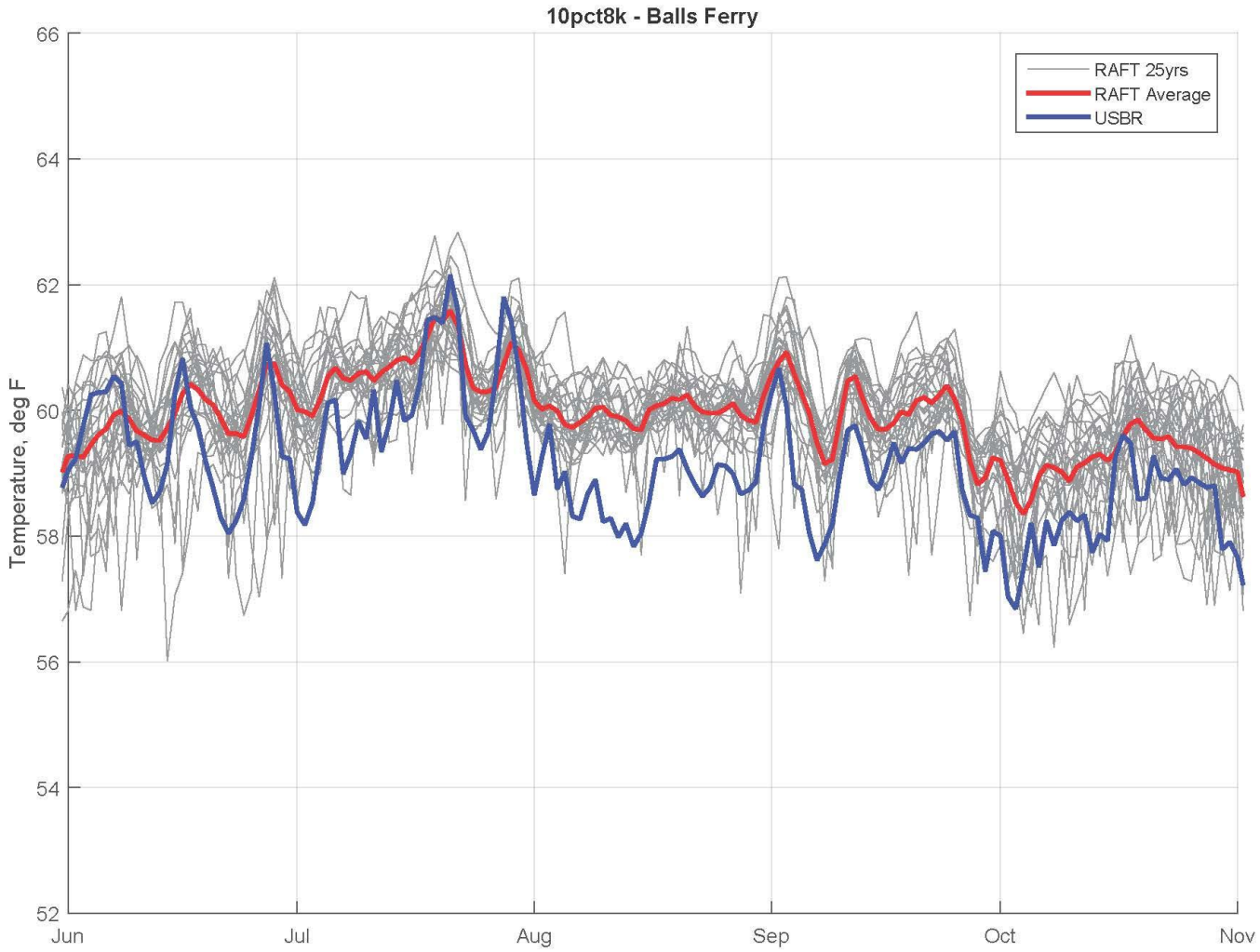
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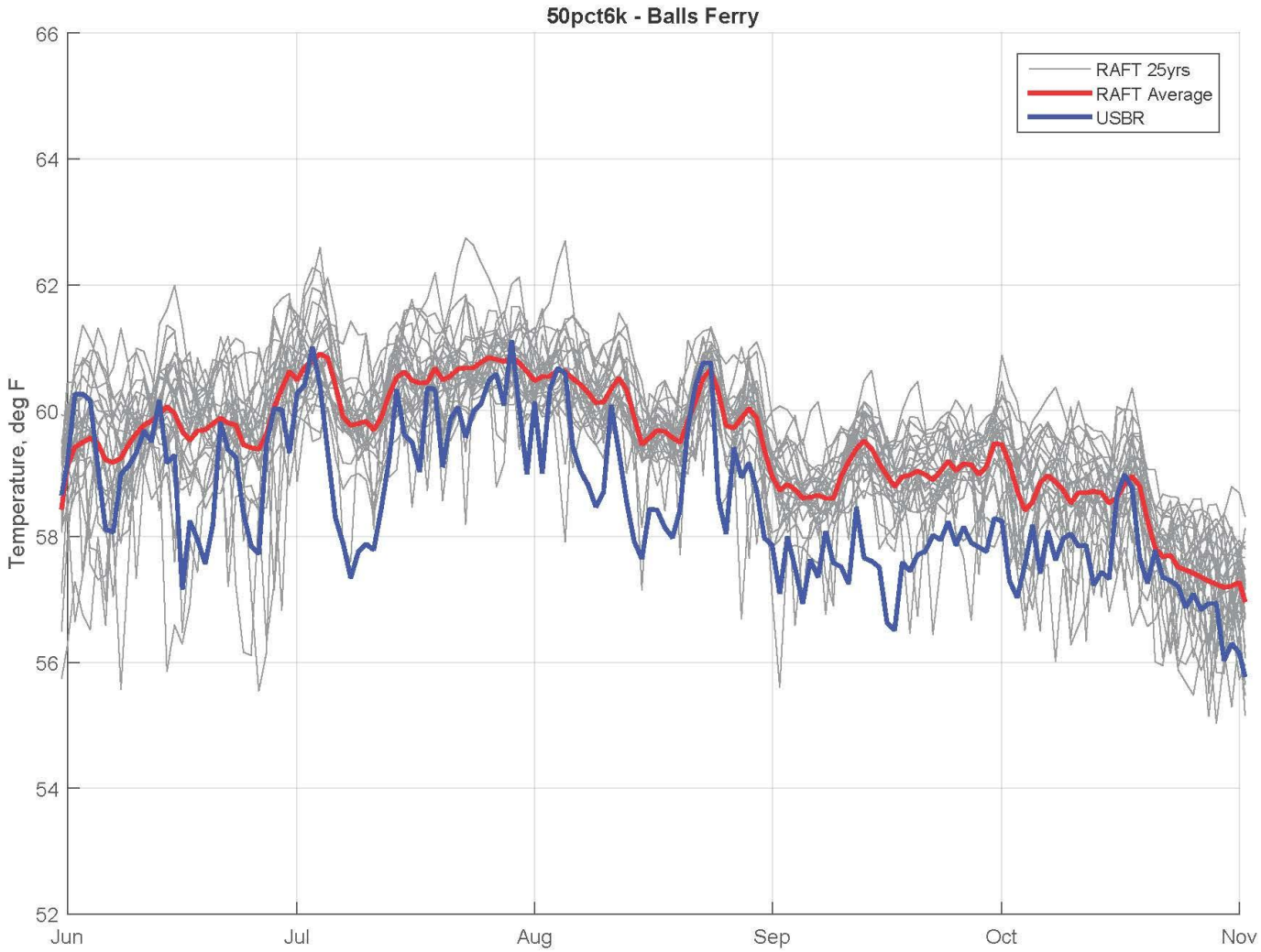
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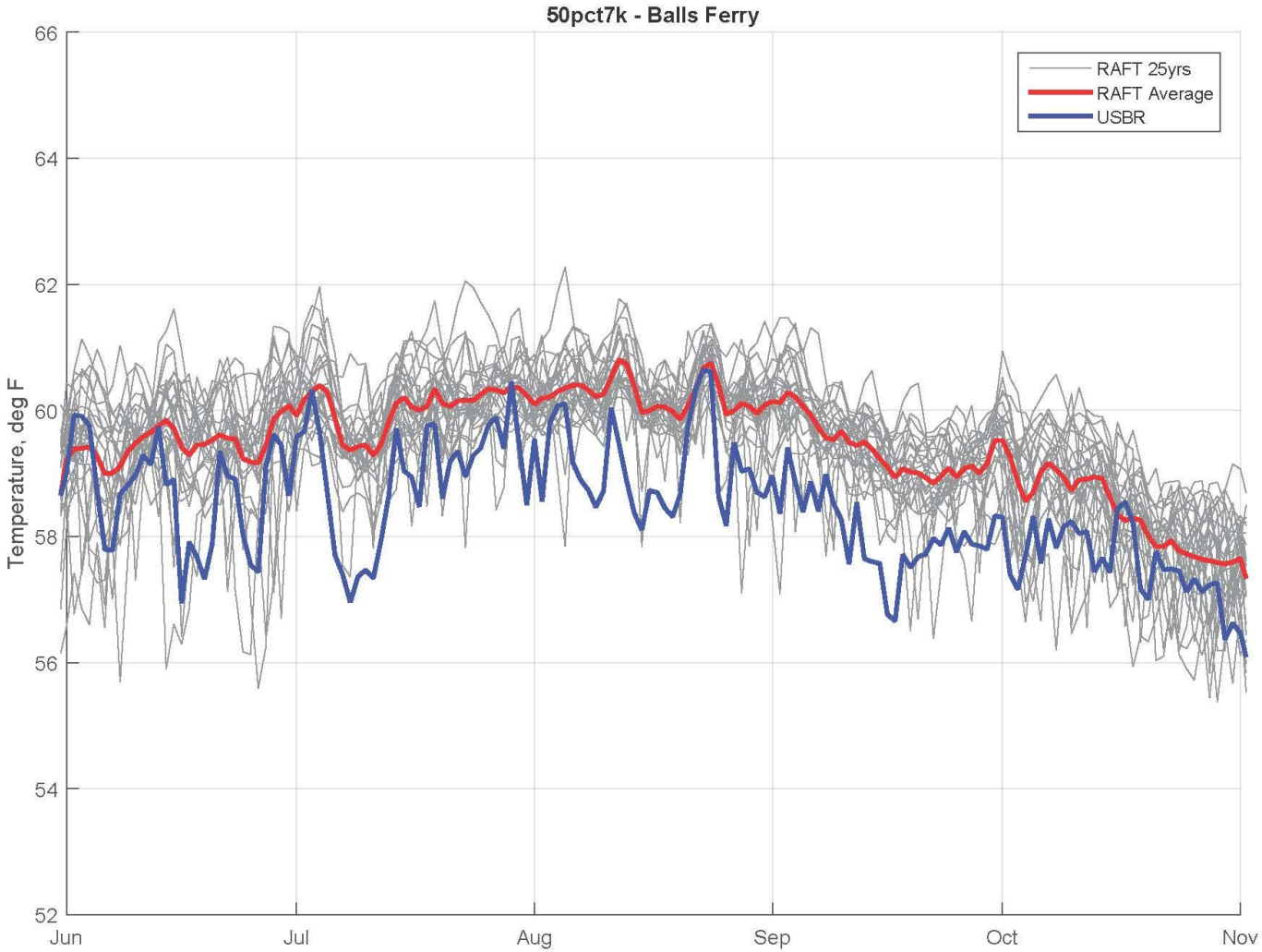
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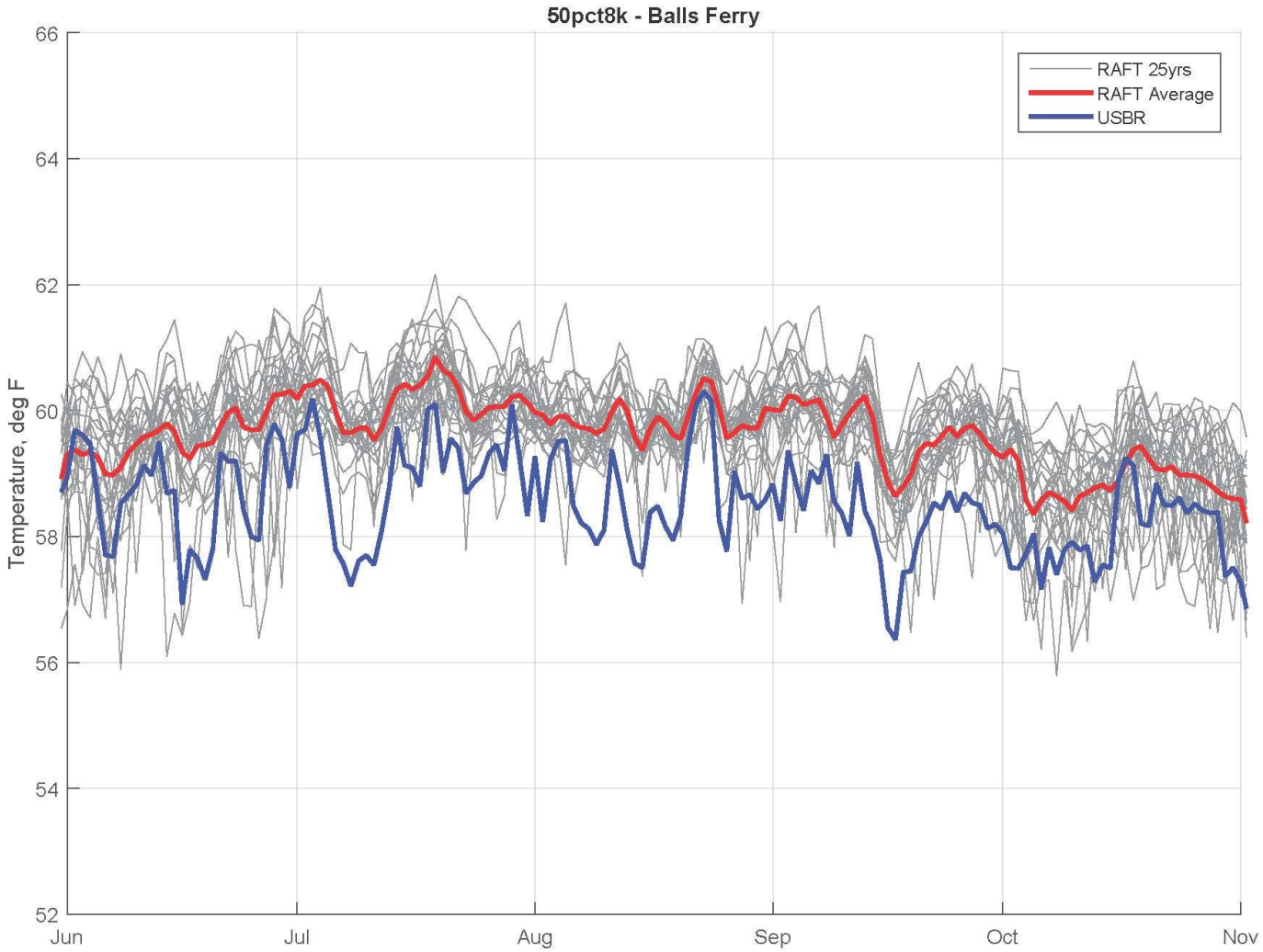
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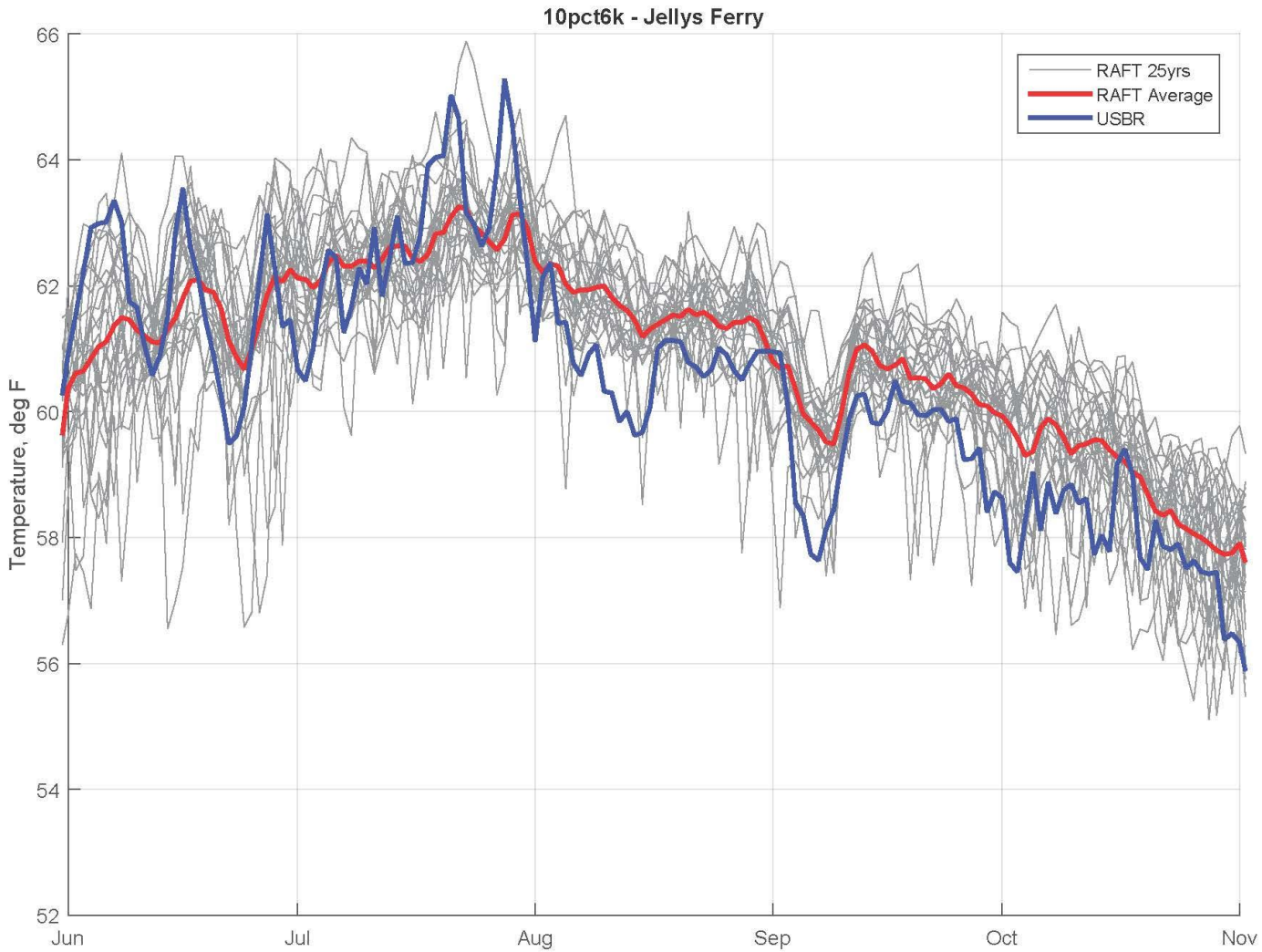
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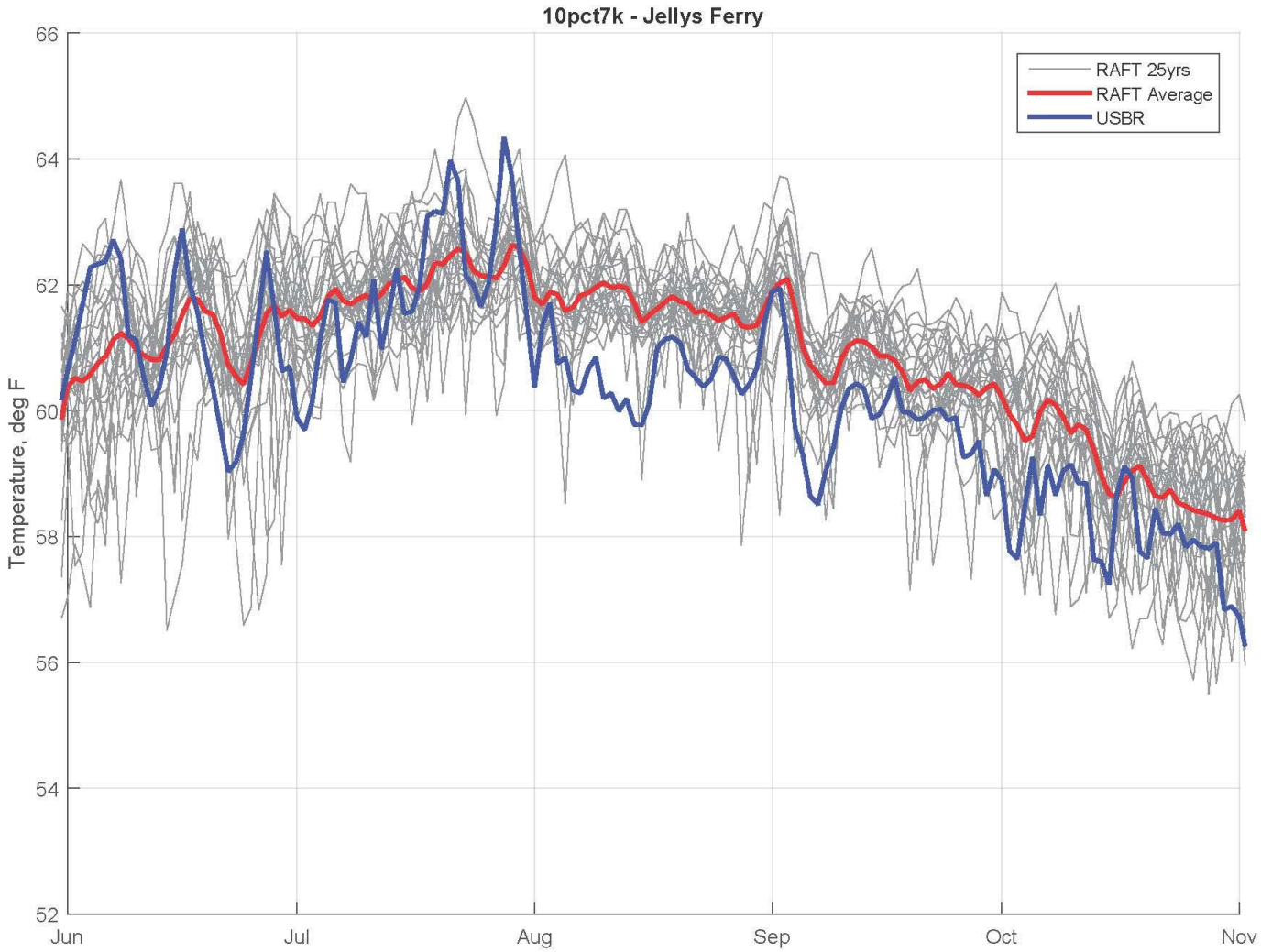
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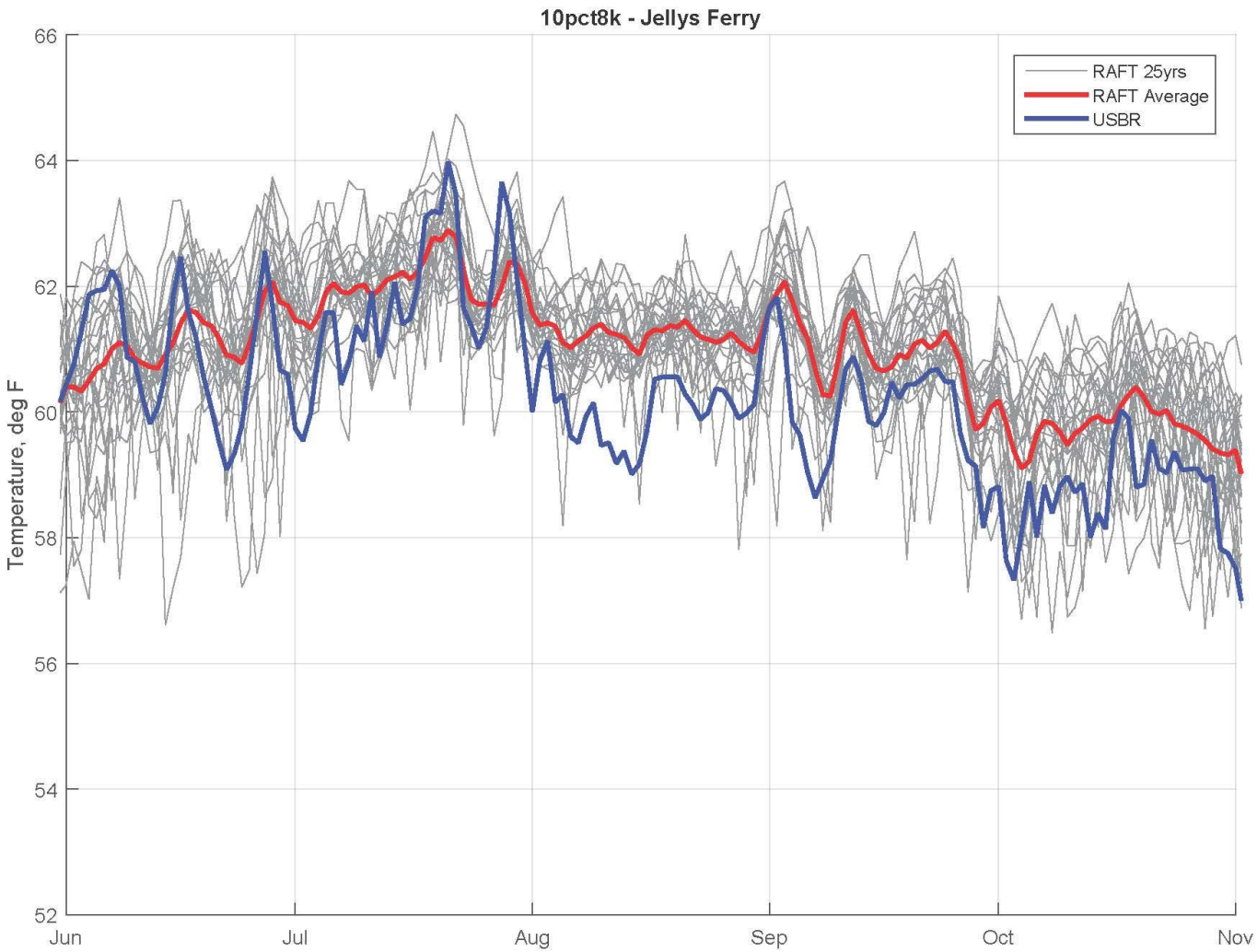
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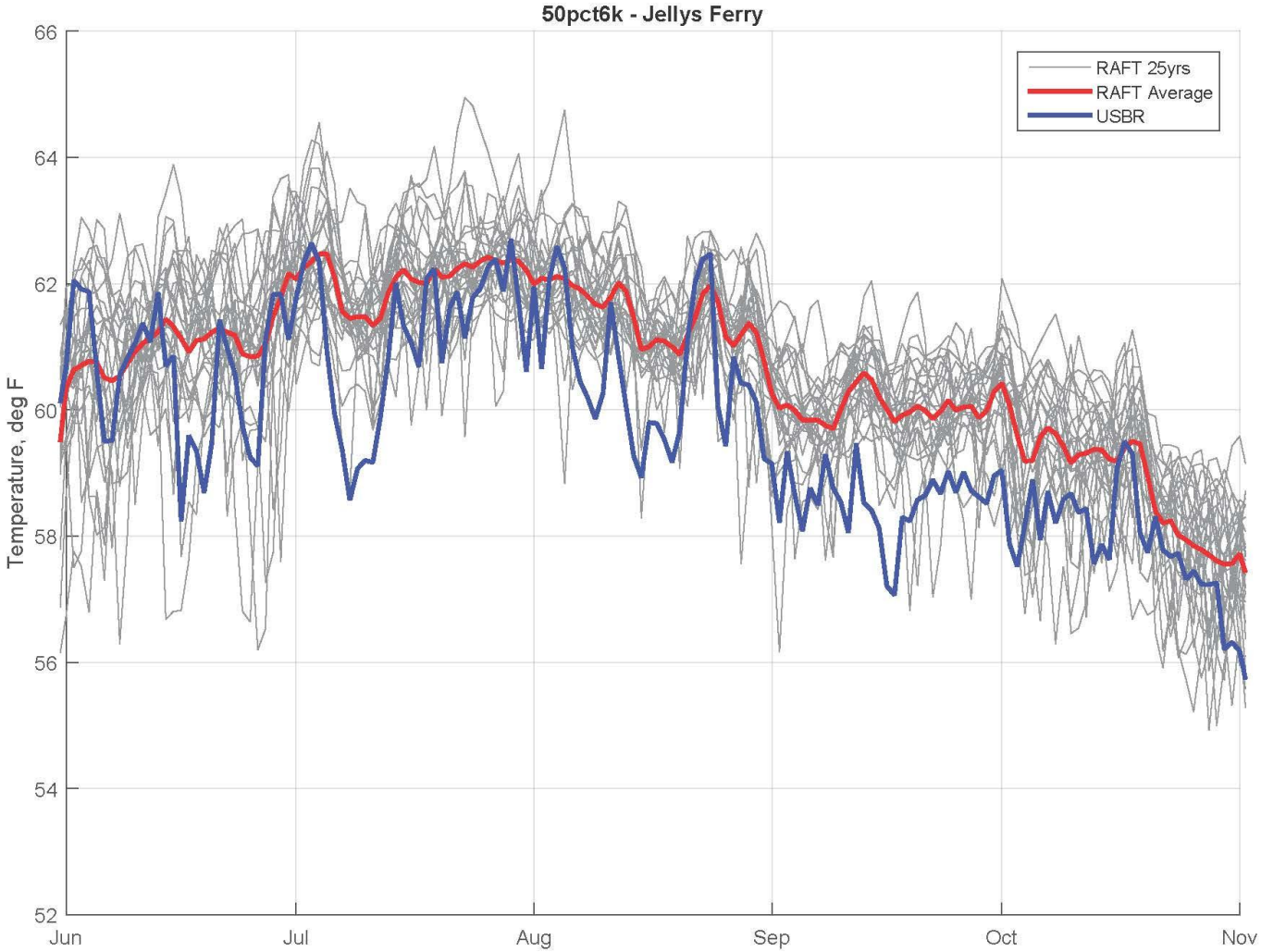
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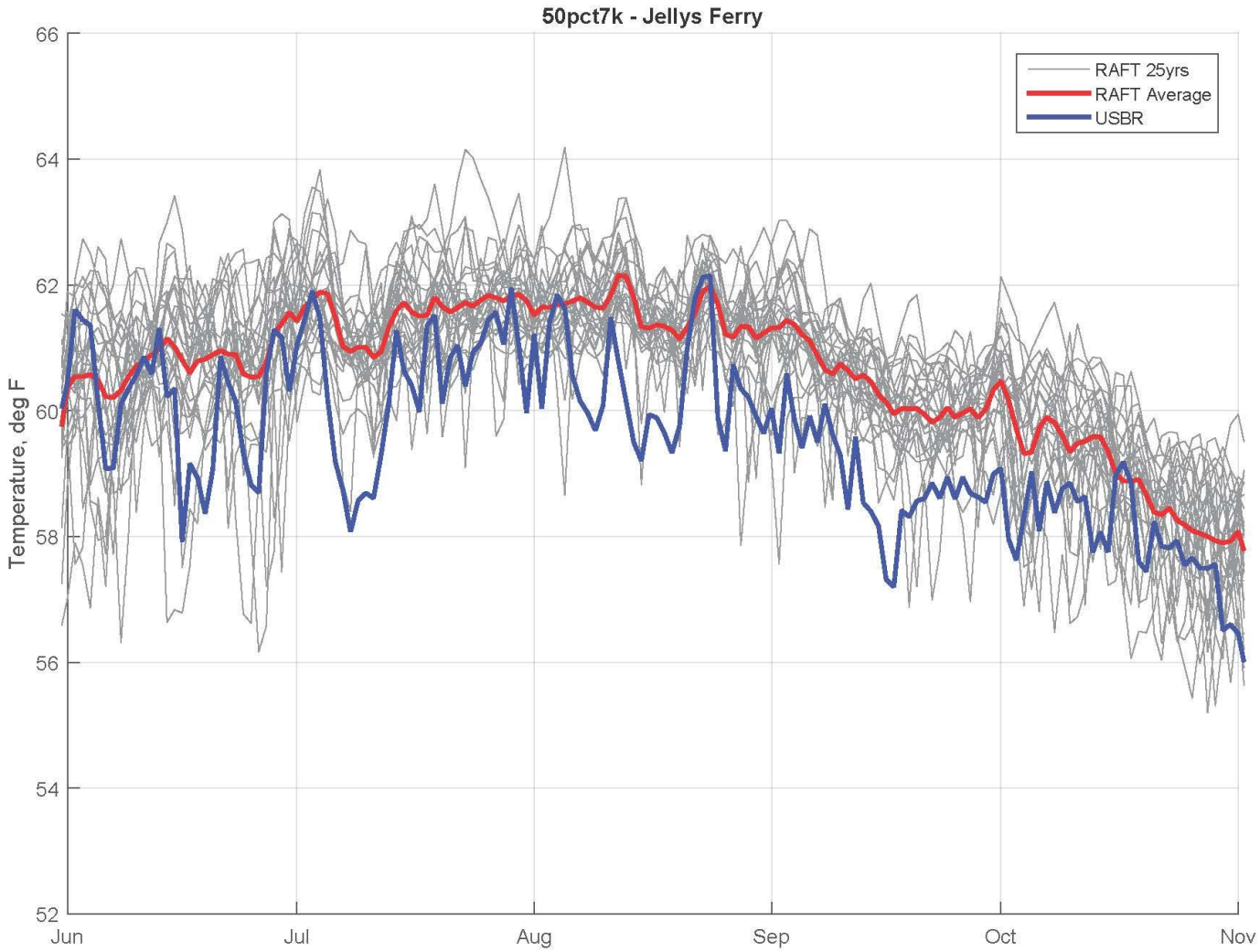
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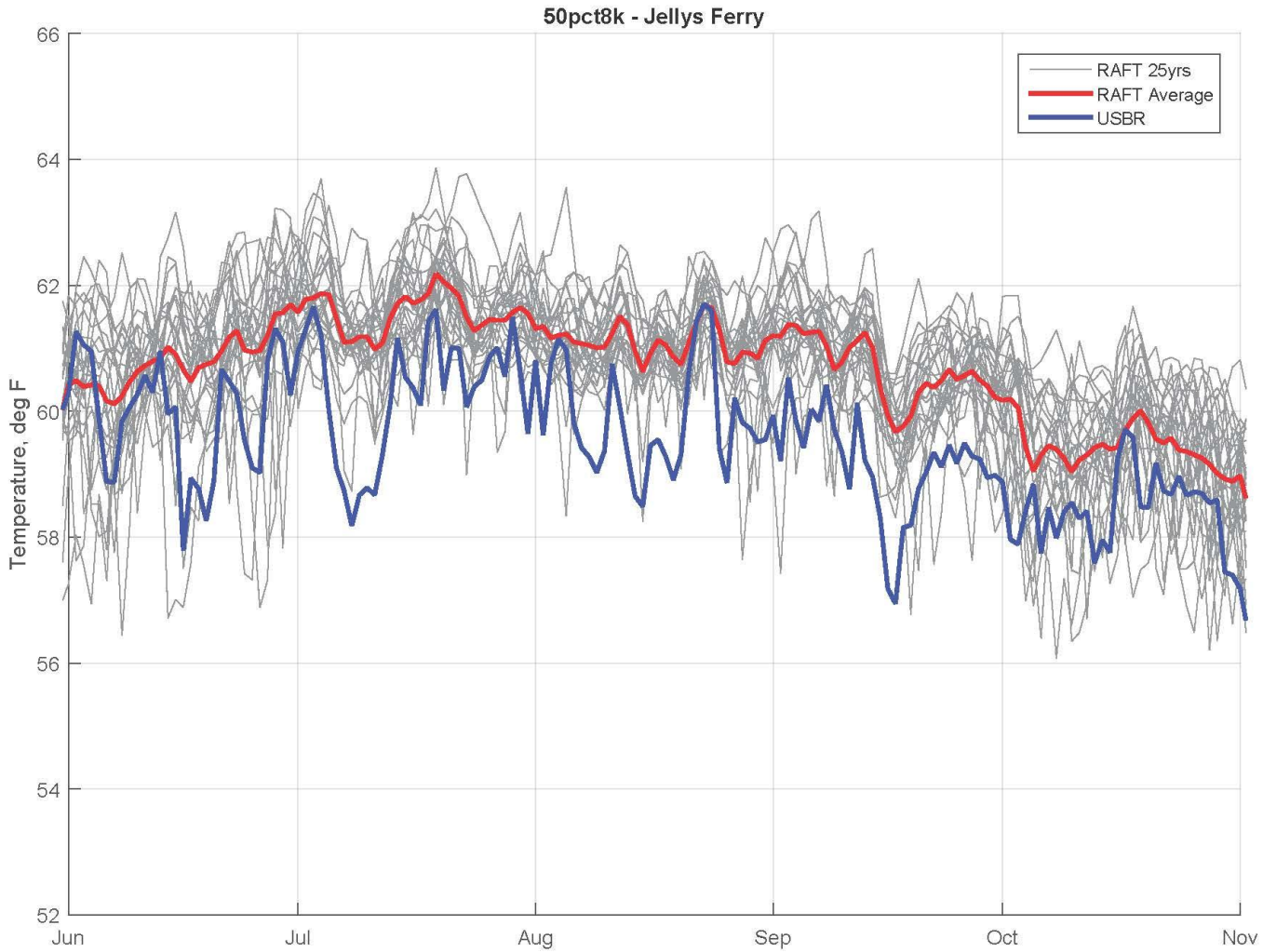
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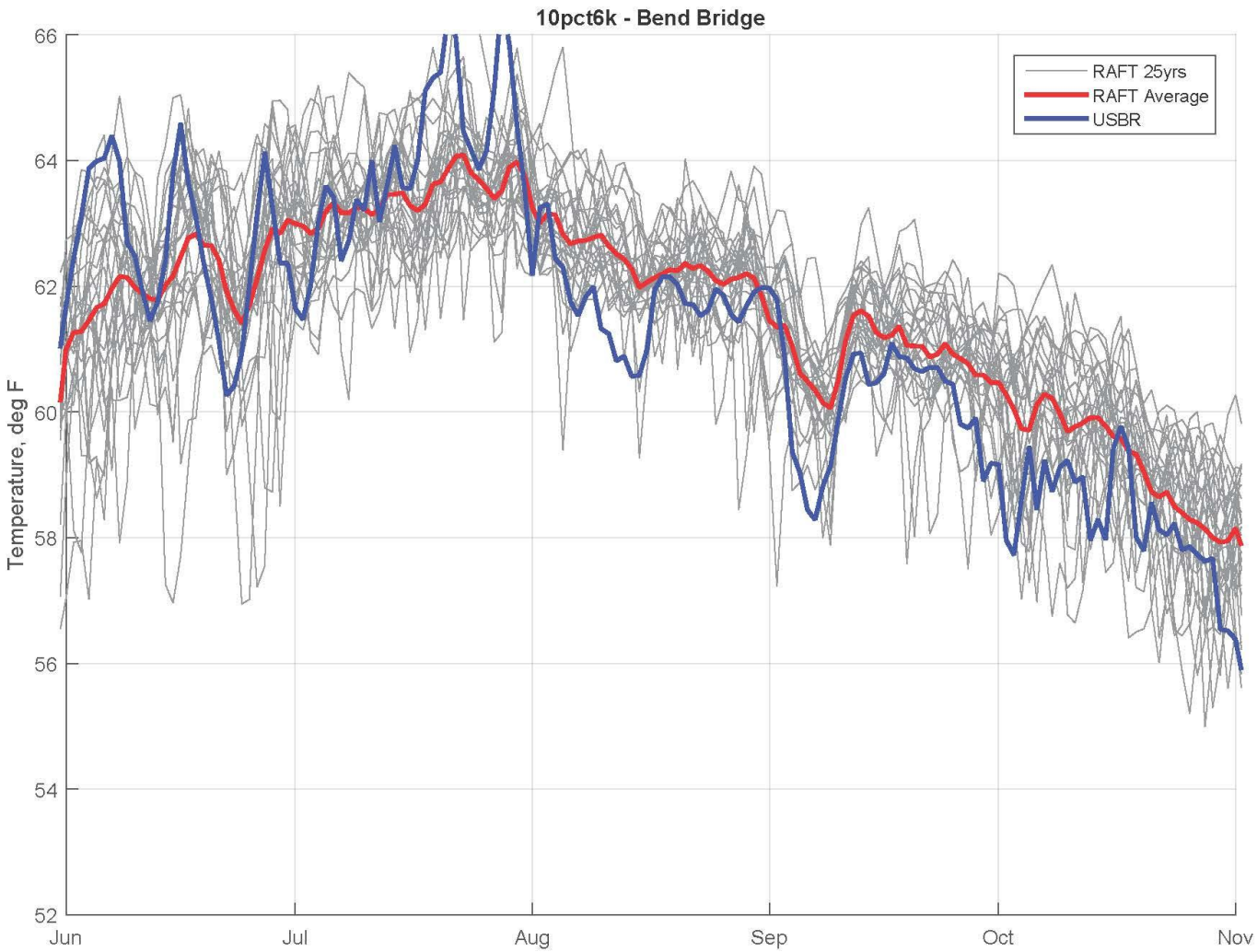
10pct6k - Bend Bridge
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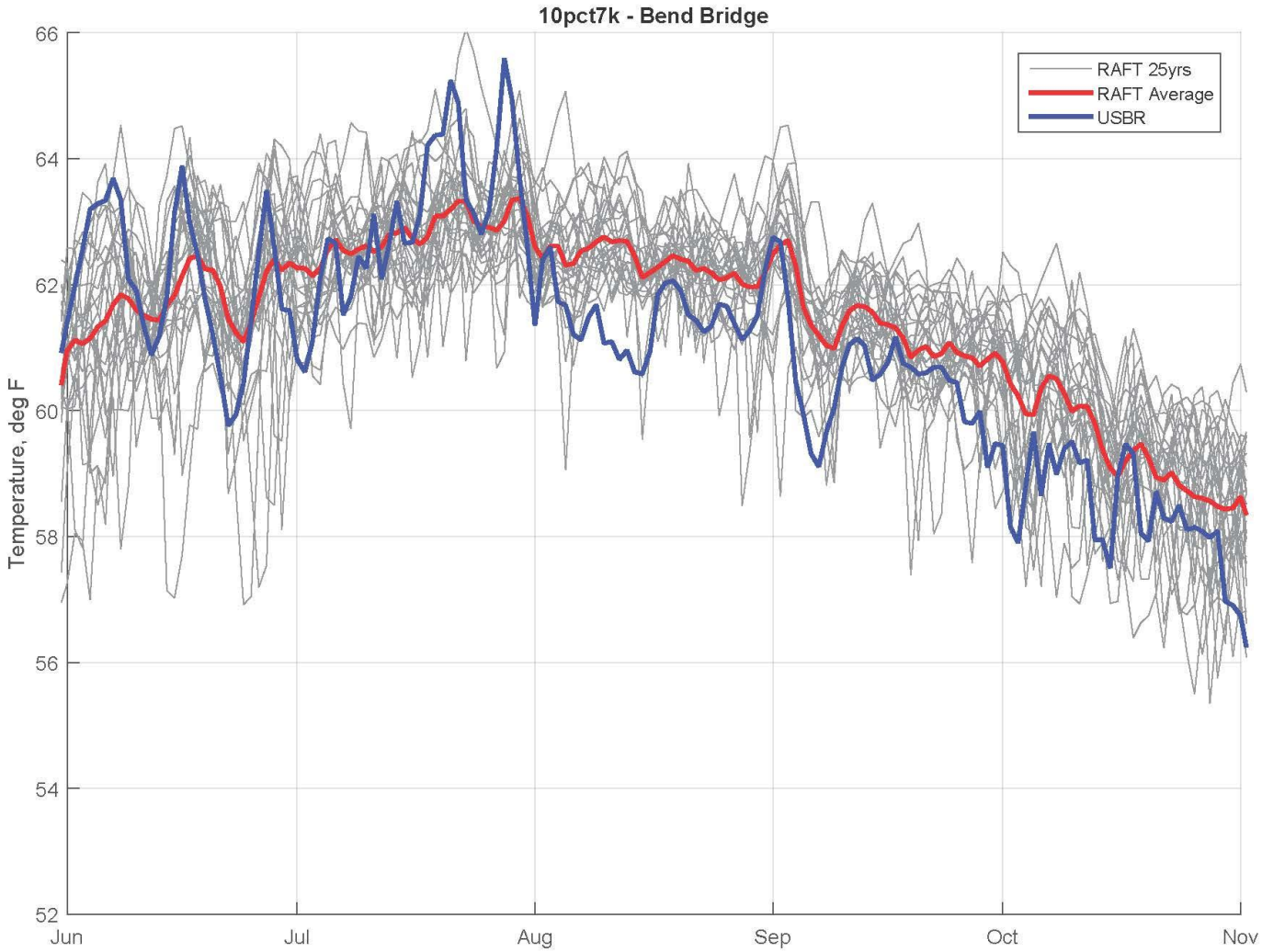
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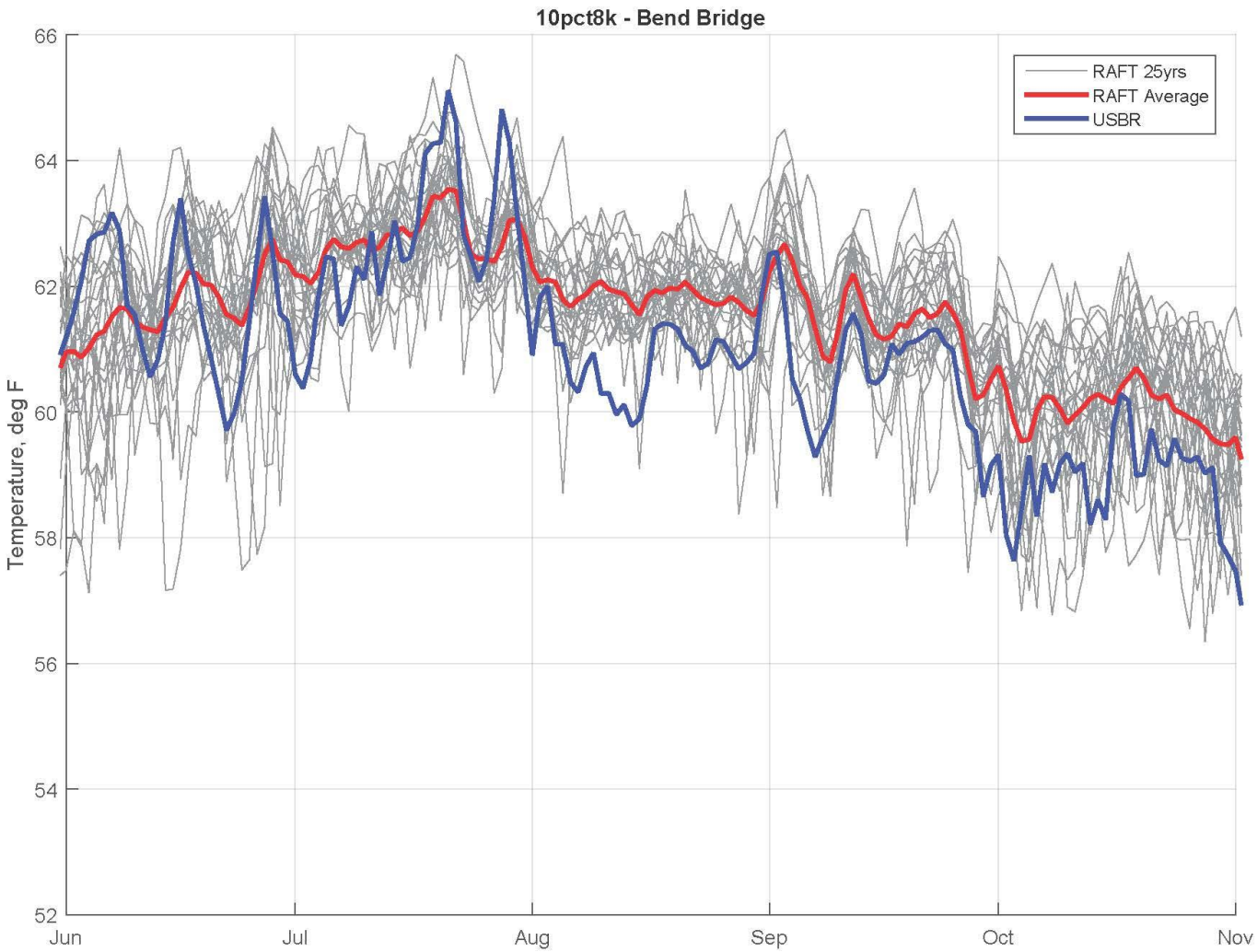
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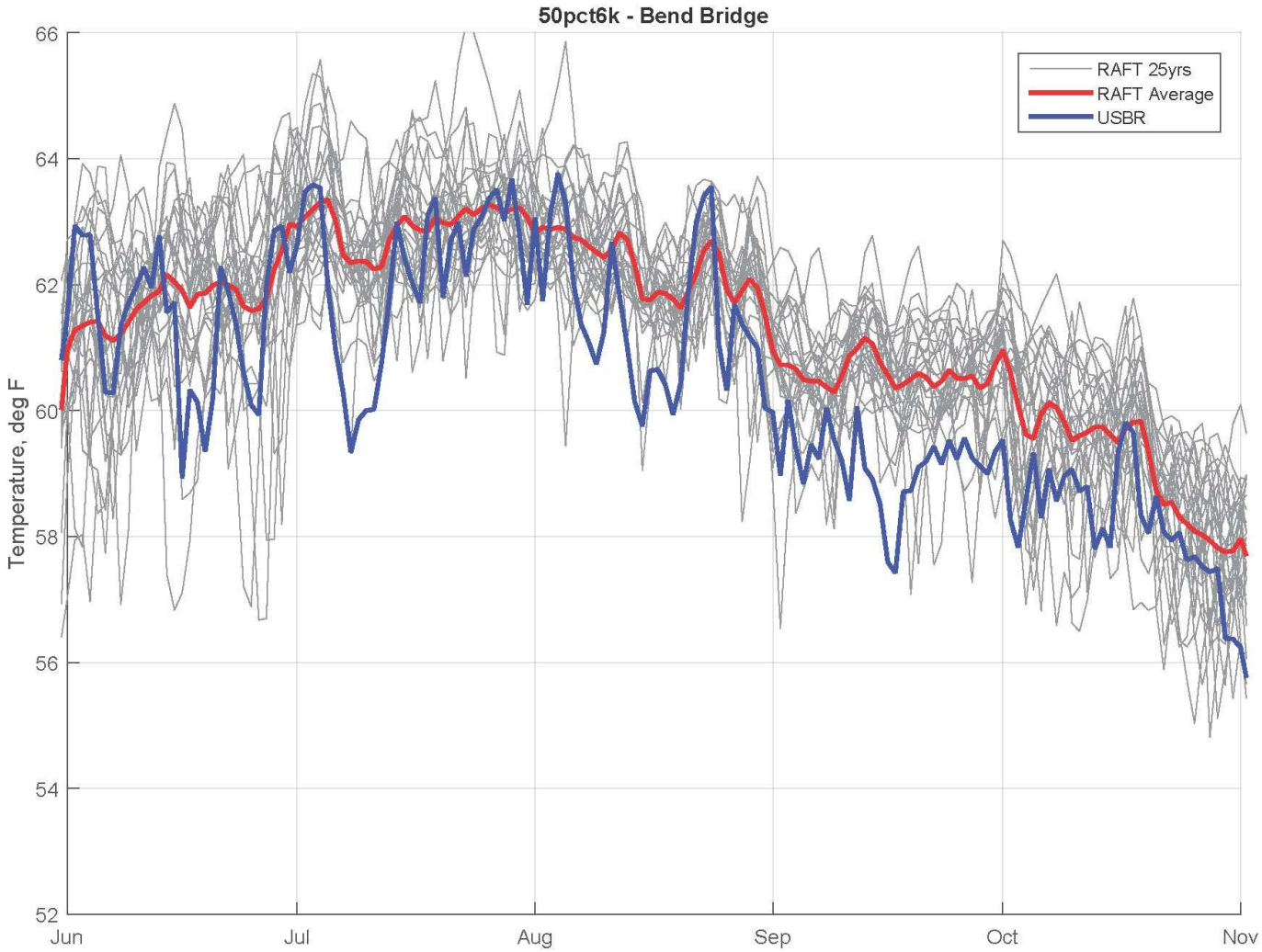
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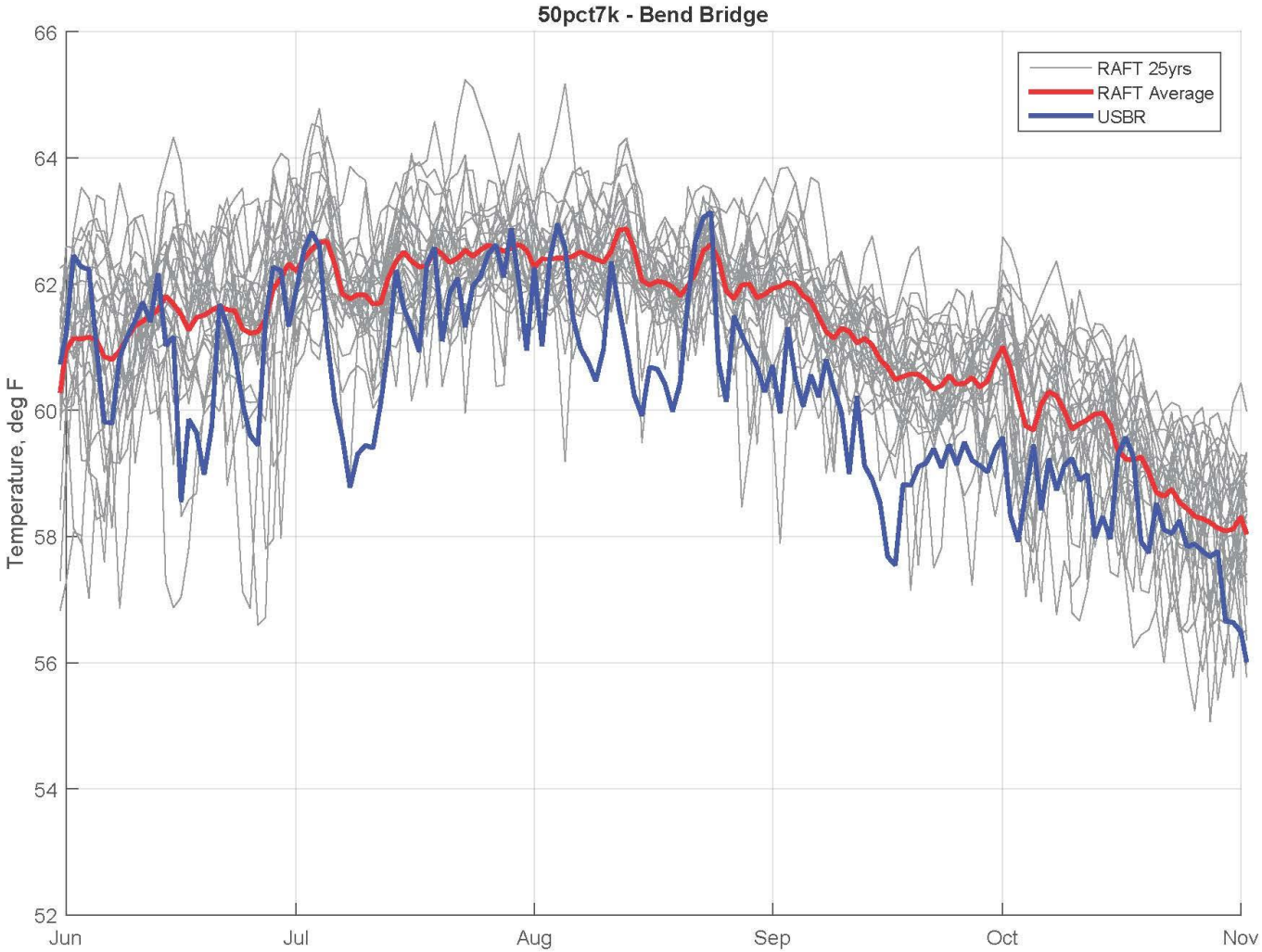
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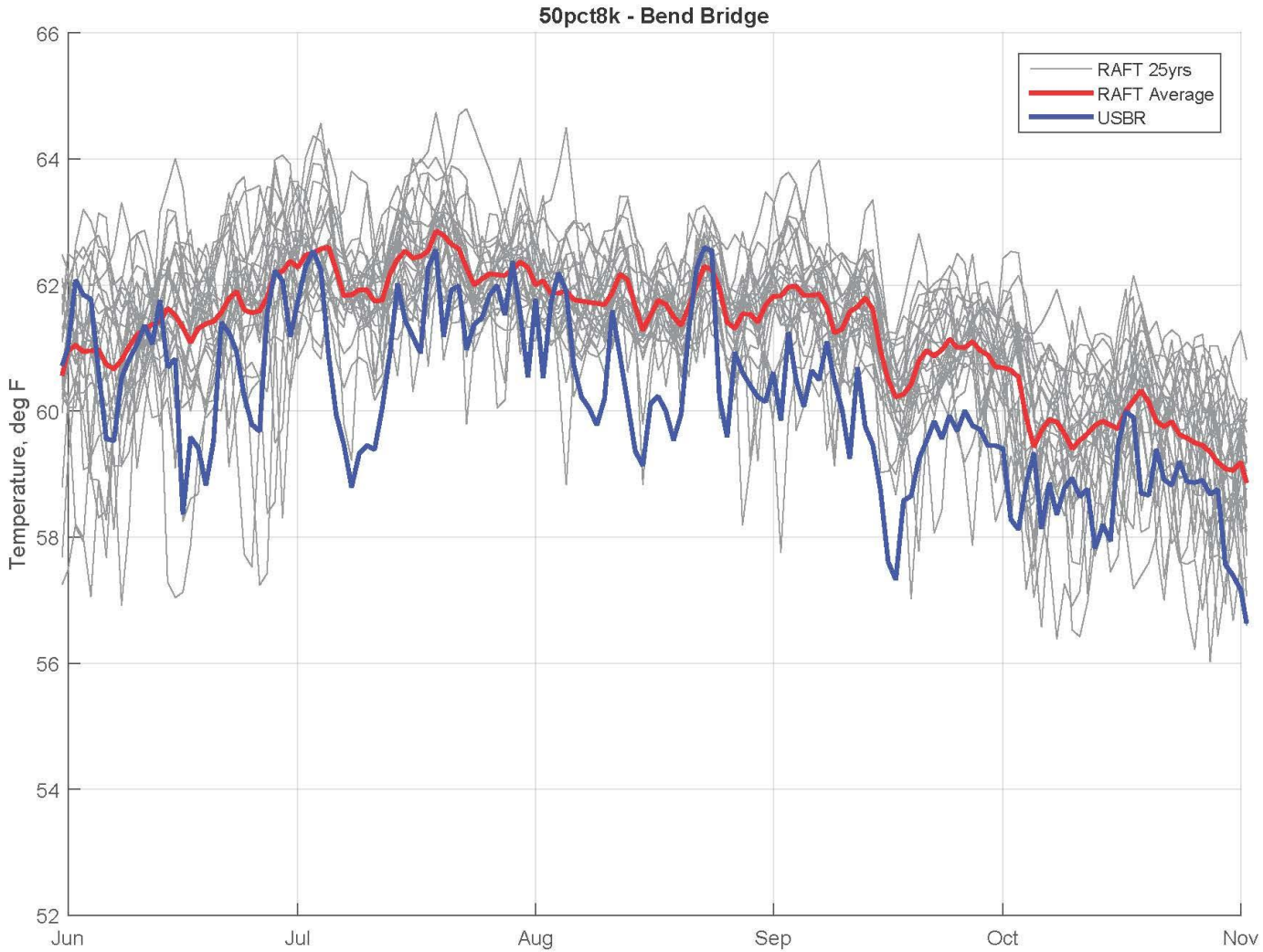
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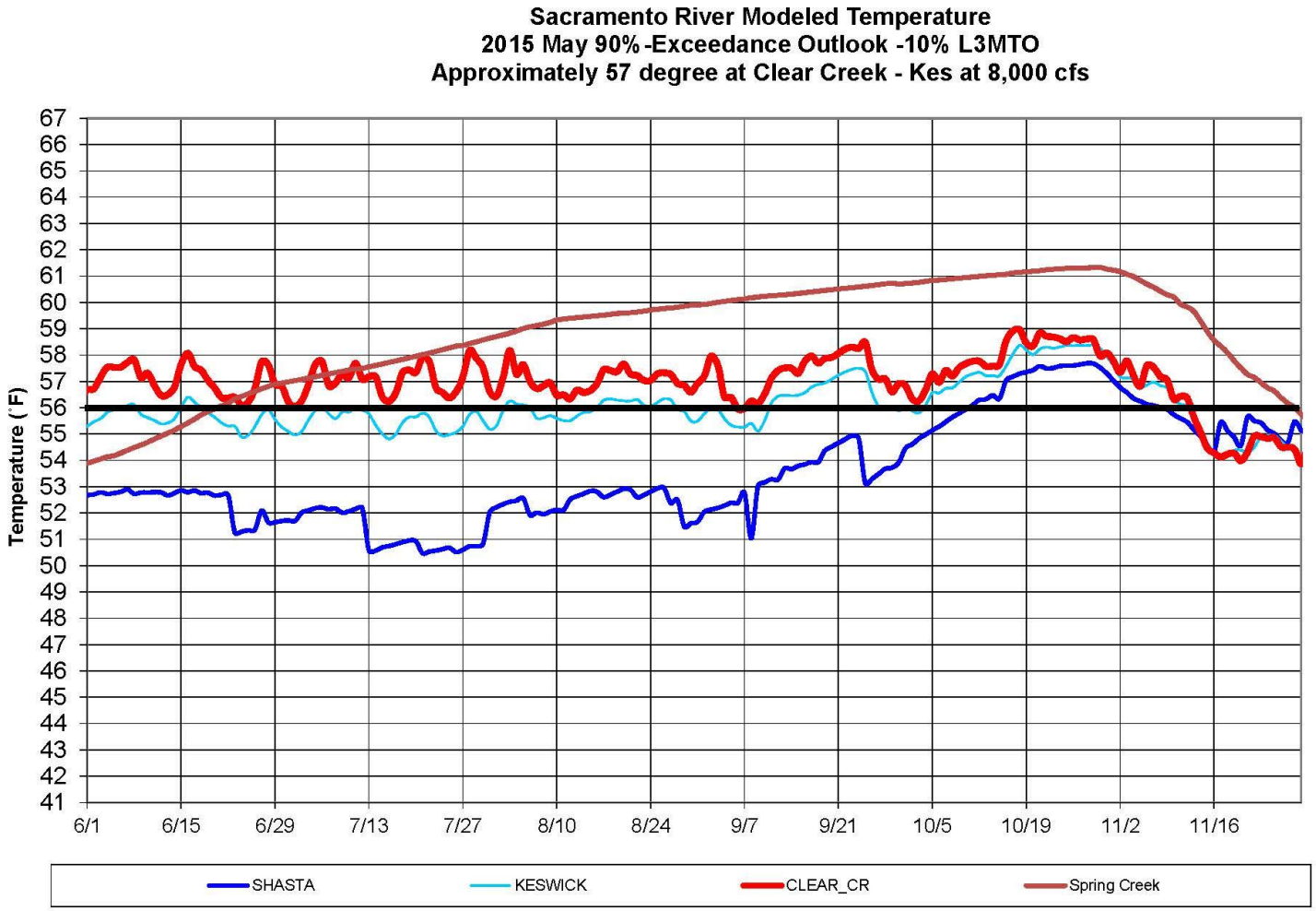
- June 9, 2015 – Reclamation presented results of revised runs of 6,000, 7,000, and 8,000 cfs at the 10% L3MTO with the appropriate shutter changes.

	Kes 8000 10% L3MTO 57 degree at CCR	Kes 7000 10% L3MTO Target 57 degree at CCR	Kes 6000 10% L3MTO Target 57 degree at CCR
Sept and Oct Keswick flows	6000, 5000	6000, 5000	5000, 4500
Coldest Gate Config (side gate and 1 lower)	Sept 26	Sept 19	Sept 23
Projected Monthly Average June temperature	57.01	57.1	58.7
Projected Monthly Average July temperature	57.01	57.0	57.7
Projected Monthly Average August temperature	57.0	57.0	57.3
Projected Monthly Average September temperature	57.3	56.7	58.8
Projected Monthly Average October temperature	57.9	57.2	57.3
Projected Monthly Average November temperature	55.6	55.4	55.1


Sacramento River Modeled Temperature
2015 May 90% -Exceedance Outlook -10% L3MTO
Approximately 57 degree at Clear Creek - Kes at 8,000 cfs
Temperature (°F)
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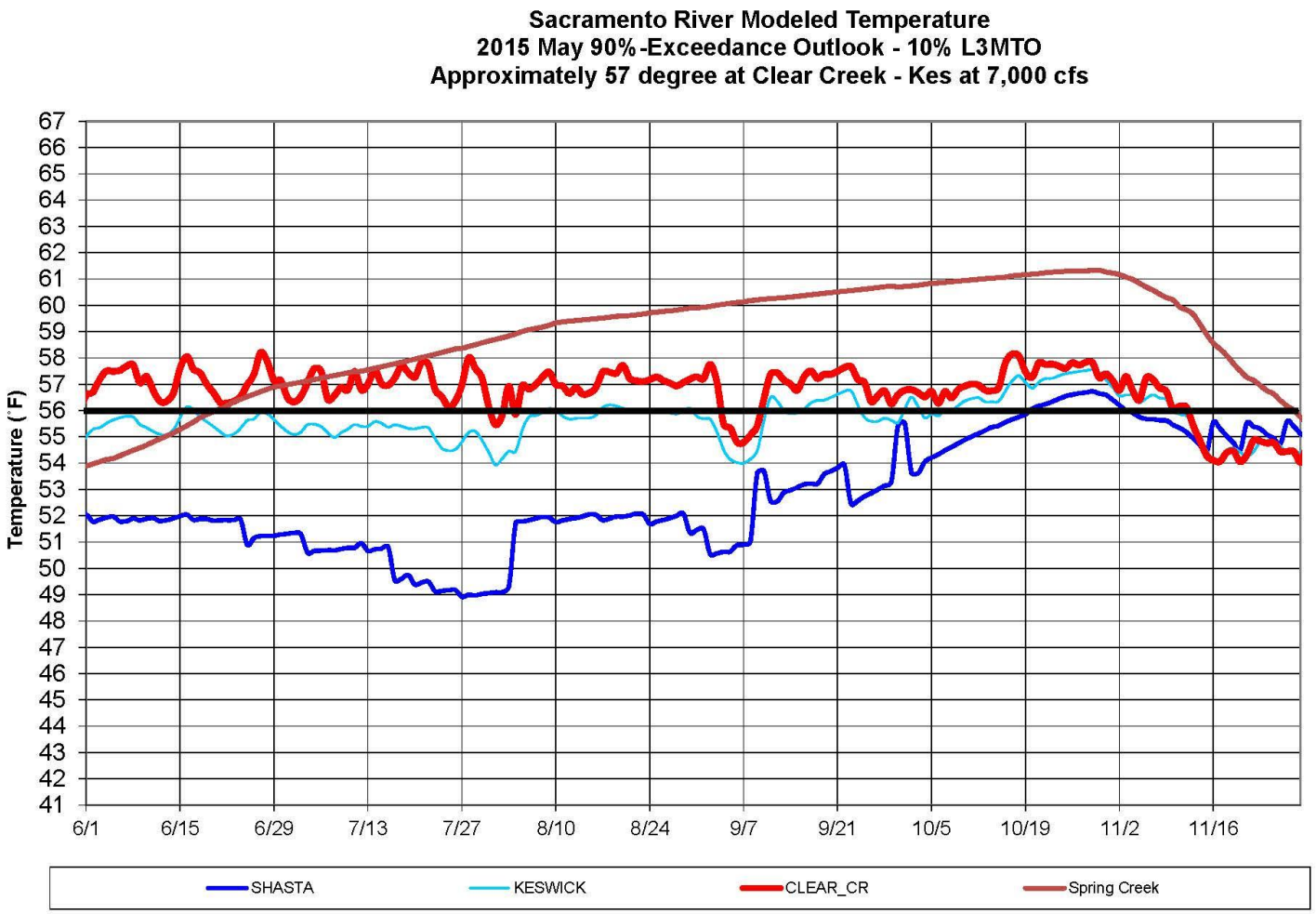
10/19
11/2
11/16
SHASTA
KESWICK
CLEAR_CR
Spring Creek


Sacramento River Modeled Temperature
2015 May 90%-Exceedance Outlook - 10% L3MTO
Approximately 57 degree at Clear Creek - Kes at 7,000 cfs
Temperature (°F)
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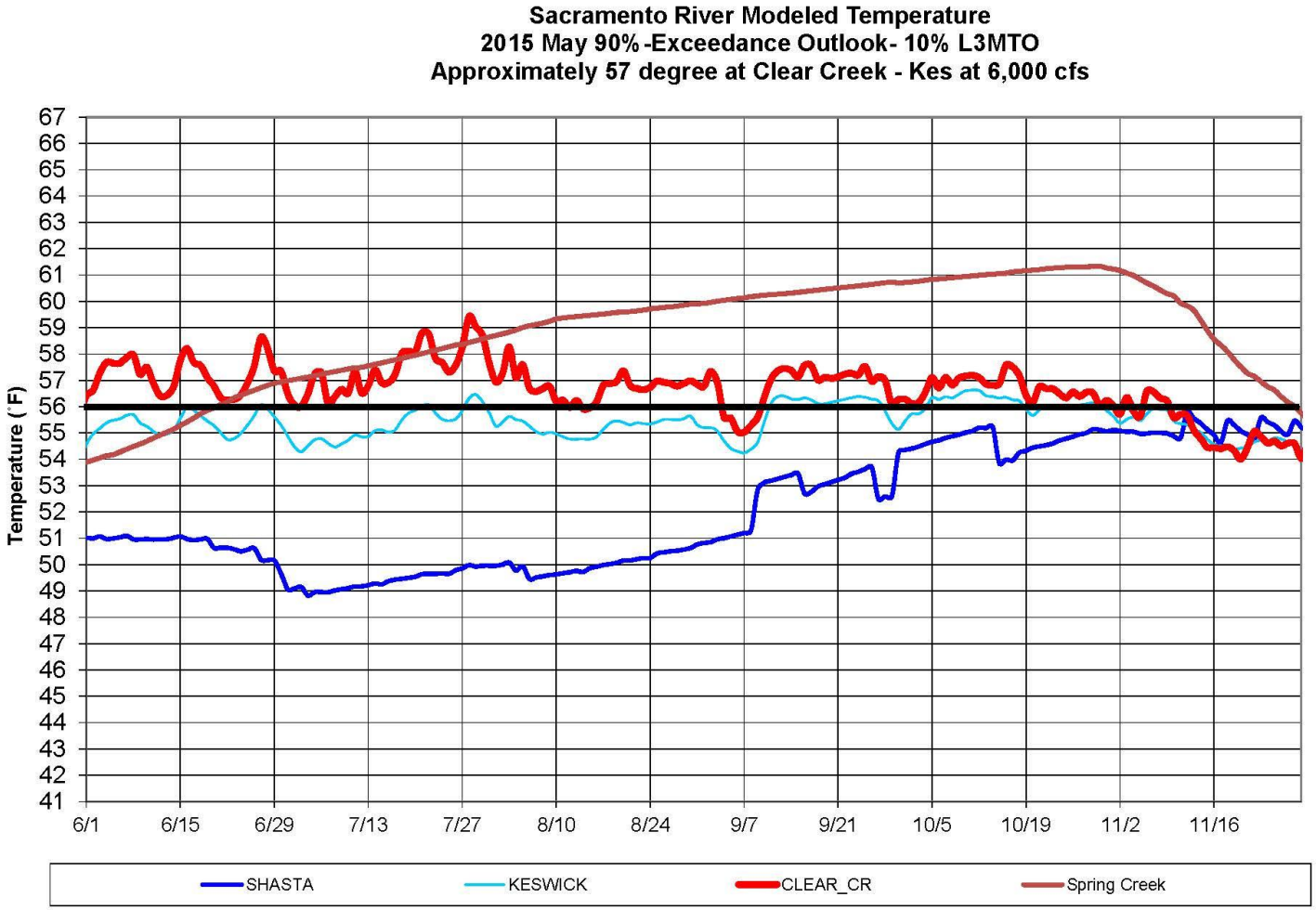
Sacramento River Modeled Temperature
2015 May 90% -Exceedance Outlook- 10% L3MTO
Approximately 57 degree at Clear Creek - Kes at 6,000 cfs
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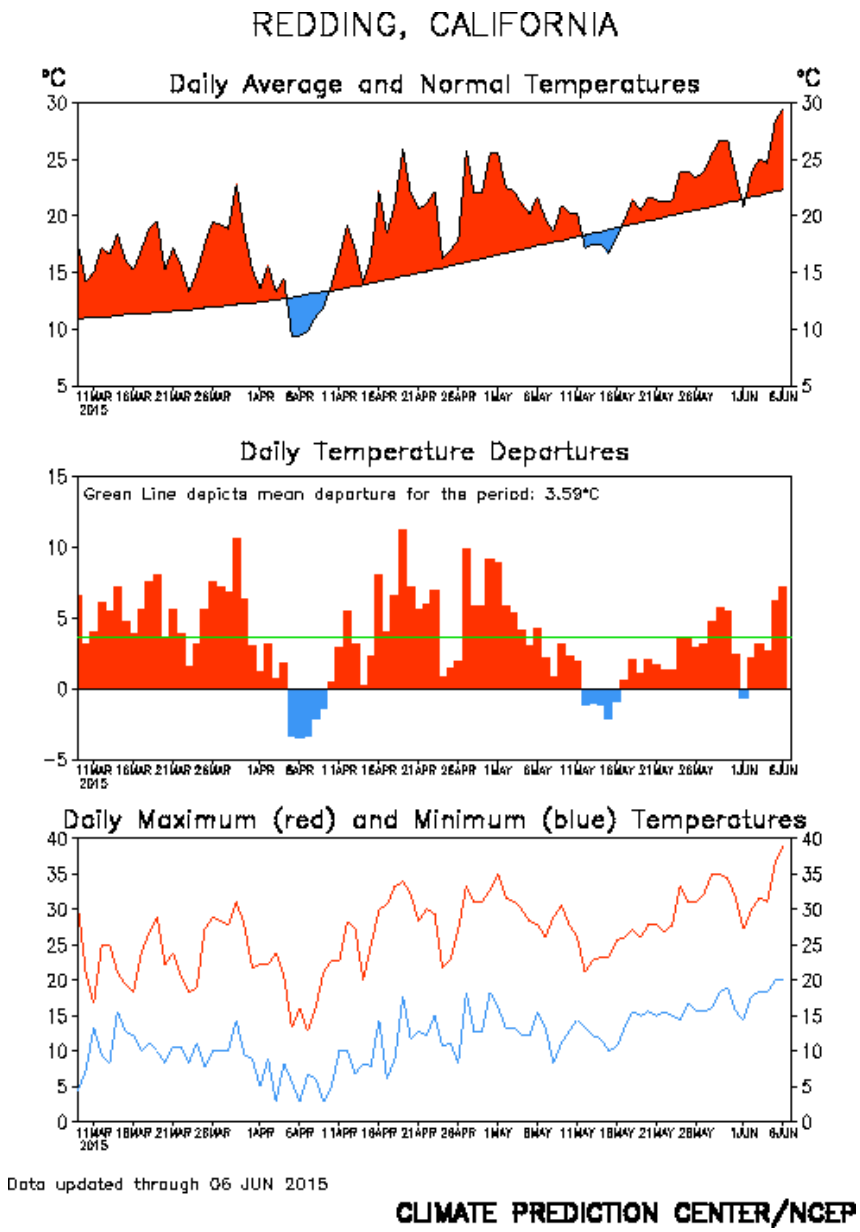
SHASTA
KESWICK
CLEAR_CR
Spring Creek

- Results of Reclamation's temperature model showed the beginning of full side gate operations occurring towards the end of September for all three scenarios.
- In general, the 6,000 cfs scenario had exceedance days of 58°F (even exceeding 59°F) and utilized colder Shasta releases than compared to the 7,000 cfs and 8,000 cfs scenarios. The June through August water temperature forecast for the 7,000 cfs and 8,000 cfs appeared to be very similar. The September and October water temperature forecast for 7,000 cfs appeared to be cooler than the 8,000 cfs.
- Reclamation suggested the optimal scenario lied somewhere between 7,000 and 8,000 cfs. They still want to run a 7,500 cfs scenario and ramp down flows when there are cooler water temperatures. Real-time operations could increase or decrease 500 cfs to manage for temperatures or change shutters.
- NMFS was wondering if operations could target 57°F at the Hwy 44 Bridge (RM 298; ~ 6 miles upstream of CCR) to delay full side gate operations to a later date.
- Reclamation ran the scenarios utilizing the Cramer Fish Science JPE model. The survival results combined the CCR egg mortality (based on spawning distribution above CCR) with the egg-to-fry survival of fish above Bend Bridge (based on exposure of fry to temperature as far as downstream of Bend Bridge). Bend Bridge is the lowest place temperature is forecasted with the model:

Scenario	**Cumulative Egg and Egg to Fry Survival**
6000 10% L3MTO adj 57 deg	7.35%
7000 10% L3MTO adj 57 deg	6.89%
8000 10% L3MTO adj 57 deg	5.49%

- SWFSC presented meteorological results from the National Weather Service[17] that showed air temperatures in Redding have been 3.59°C warmer than average over the last 3 months, indicating that the Upper Sacramento Valley may be in for a warmer than average summer (and corresponding warmer Sacramento River water temperatures) if the trend continues.

[17] http://www.cpc.ncep.noaa.gov/products/global_monitoring/temperature/tn72592_90.gif



- June 10, 2015 – Reclamation sent out a draft summary sheet using the May 90% Exceedance forecast:

Estimated CVP Operations Jun 90% Exceedance - 8000 cfs Keswick Jun, Jul, Aug

Storages

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

		Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Trinity	1024	870	745	620	530	499	467	451					
	Elev.	2240	2224	2205	2190	2185	2178	2175					
Whiskeytown	239	238	238	238	230	206	206	206					
	Elev.	1209	1209	1209	1207	1199	1199	1199					
Shasta	2404	2152	1852	1551	1354	1273	1282	1338					
	Elev.	966	948	929	915	909	909	914					
Folsom	535	422	265	187	171	177	189	211					
	Elev.	406	381	364	360	361	364	370					
New Melones	453	369	286	216	173	159	149	138					
	Elev.	827	804	781	765	759	755	750					
San Luis	305	205	87	16	-31	15	5	63					
	Elev.	442	409	380	362	358	375	403					
Total		4256	3473	2828	2428	2329	2297	2406					

State End of the Month Reservoir Storage (TAF)

Oroville	1565	1363	1138	993	935	924	816	761					
	Elev.	714	684	663	654	652	634	624					
San Luis	786	684	507	357	286	219	336	487					
Total San Luis (TAF)	1091	890	594	372	255	234	341	550					

Monthly River Releases (TAF/cfs)

Trinity	TAF	47	28	28	27	23	18	18					
	cfs	783	450	450	450	373	300	300					
Clear Creek	TAF	9	7	5	9	11	10	11					
	cfs	150	120	85	150	175	175	175					
Sacramento	TAF	476	492	492	357	307	238	215					
	cfs	8000	8000	8000	6000	5000	4000	3500					
American	TAF	145	184	101	30	31	30	31					
	cfs	2435	2997	1641	500	500	504	500					
Stanislaus	TAF	9	9	9	9	12	12	13					
	cfs	150	150	150	150	200	200	206					
Feather	TAF	125	154	86	71	58	57	58					
	cfs	2100	2500	1400	1200	950	950	950					

Trinity Diversions (TAF)

	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Carr PP	116	98	97	62	15	28	19					
Spring Crk. PP	110	90	90	60	30	19	12					

Delta Summary (TAF)

	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Tracy	10	12	23	83	136	26	74					
USBR Banks	0	0	0	0	0	0	0					
Contra Costa	8.7	8.0	8.3	8.7	3.5	4.3	4.7					
Total USBR	19	20	31	92	140	30	79					
State Export	30	12	13	34	33	131	167					
Total Export	49	32	44	126	173	161	246					
COA Balance	-14	-41	-30	0	0	0	0					
Old/Middle River Std.												
Old/Middle R. calc.	-1,085	-857	-1,012	-2,082	-2,412	-2,330	-3,333					
Computed DOI	4001	2798	2798	3009	4197	5093	4994					
Excess Outflow	0	0	0	0	0	0	0					
% Export/Inflow	8%	5%	8%	25%	33%	31%	44%					
% Export/Inflow std.	35%	65%	65%	65%	65%	65%	65%					

Hydrology

		Trinity		Shasta		Folsom		New Melones	
Water Year Inflow (TAF)		877		3,468		864		285	
Year to Date + Forecasted	% of mean	73%		63%		32%		27%	

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.

- 8,000 cfs – would result in low pumping in the delta but some; could meet delta outflow requirements of 4,000 cfs in June and 3,000 cfs in July through August; voluntary curtailments in the Delta = 200 cfs increase in outflow; EOS storage in Shasta = 1.35 maf, Folsom = 170 taf, Oroville = 935 taf, and Trinity = 530 taf; SRSC could manage at this level.

Estimated CVP Operations Jun 90% Exceedance - 7000 cfs Keswick Jun, Jul, Aug

Storages

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

		Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Trinity	1024	870	745	620	530	499	467	451					
	Elev.	2240	2224	2205	2190	2185	2178	2175					
Whiskeytown	239	238	238	238	230	206	206	206					
	Elev.	1209	1209	1209	1207	1199	1199	1199					
Shasta	2404	2211	1973	1732	1565	1514	1523	1594					
	Elev.	969	956	941	930	926	927	932					
Folsom	535	397	196	98	83	89	101	123					
	Elev.	403	366	334	327	330	336	344					
New Melones	453	369	286	216	173	159	149	138					
	Elev.	827	804	781	765	759	755	750					
San Luis	305	195	65	-29	-124	-137	-146	-103					
	Elev.	439	404	371	345	334	356	385					
Total		4280	3504	2875	2457	2329	2299	2408					

State End of the Month Reservoir Storage (TAF)

Oroville	1565	1357	1126	966	907	897	789	734					
	Elev.	713	683	659	649	648	629	619	641	666	696	725	719
San Luis	786	666	489	338	286	247	364	514					
Total San Luis (TAF)	1091	862	554	309	162	110	217	411					

Monthly River Releases (TAF/cfs)

Trinity	TAF	47	28	28	27	23	18	18
	cfs	783	450	450	450	373	300	300
Clear Creek	TAF	9	7	5	9	11	10	11
	cfs	150	120	85	150	175	175	175
Sacramento	TAF	416	430	430	327	277	238	200
	cfs	7000	7000	7000	5500	4500	4000	3250
American	TAF	170	228	123	30	31	30	31
	cfs	2864	3702	2001	500	500	504	503
Stanislaus	TAF	9	9	9	9	12	12	13
	cfs	150	150	150	150	200	200	206
Feather	TAF	131	160	101	71	58	57	58
	cfs	2200	2600	1650	1200	950	950	950

Trinity Diversions (TAF)

	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Carr PP	116	98	97	62	15	28	19					
Spring Crk. PP	110	90	90	60	30	19	12					

Delta Summary (TAF)

	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May
Tracy	0	0	0	35	76	27	59					
USBR Banks	0	0	0	0	0	0	0					
Contra Costa	8.7	8.0	8.3	8.7	3.5	4.3	4.7					
Total USBR	9	8	8	44	80	31	64					
State Export	12	12	12	52	62	130	167					
Total Export	21	20	20	96	142	161	231					
COA Balance	-38	-71	-76	-29	0	0	-1					
Old/Middle River Std.												
Old/Middle R. calc.	-723	-707	-711	-1,694	-2,024	-2,330	-3,145					
Computed DOI	4001	2798	2798	3009	4197	5093	4994					
Excess Outflow	0	0	0	0	0	0	0					
% Export/Inflow	3%	3%	3%	19%	28%	31%	43%					
% Export/Inflow std.	35%	65%	65%	65%	65%	65%	65%					

Hydrology

		Trinity		Shasta		Folsom		New Melones	
Water Year Inflow (TAF)		877		3,468		864		285	
Year to Date + Forecasted	% of mean	73%		63%		32%		27%	

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.

- 7,000 cfs – EOS storage in Shasta = 1.5 maf, Folsom = 83 taf, Oroville = 907 taf; delta pumping would be near zero; there would be COA issues; crop abatement for SRSC, they would be reduced 500 to 600 cfs; M&I issues/reductions.

- No results for 7,500 cfs, but Reclamation suggested it would probably put some water back in Folsom and Oroville reservoirs and would provide some buffer for delta outflow and a very small amount of delta pumping.
- The debate centers on whether Reclamation should start with higher releases and adaptively manage to lower releases, or start with lower releases and adaptively manage to higher releases.
- NMFS developed and sent around a fish agency perspective Shasta Operations Goals, Biological Goals, and Real-time Operations Framework.

June - October Shasta Operations Goals

- Minimize Keswick releases in June, July, and August to those that will provide relatively consistent daily average water temperatures at Bonnyview Bridge temperature compliance point (CCR CDEC gaging station)
- Target 57°F at CCR
- Minimize potential spikes in water temperature
- Delay use of full side gates as long as possible
- Minimize the potential for winter-run redd dewatering in September and October
- Minimize water temperature increases to fry habitat downstream of CCR

June - October Biological Goals

Based on the above screening level analysis, the following operations are proposed:

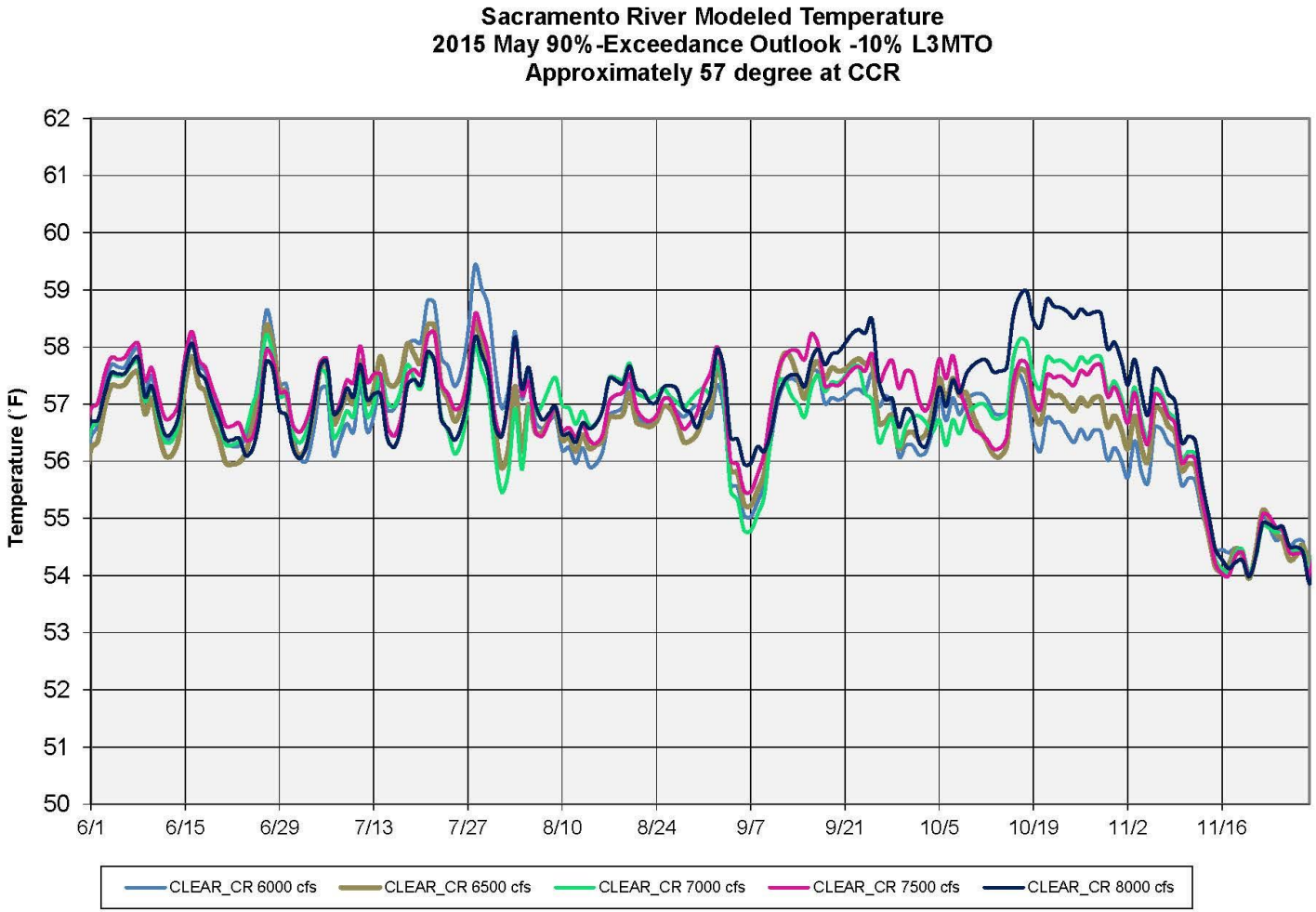
- Keswick releases will be made for the sole purpose of optimizing temperatures for winter-run, using real-time decision-making, given very limited cold water pool and need to reduce risk of year-class failure.
- Base operation of 7,000 cfs from Keswick in June, July, and August, and in general, temperatures will run warmer during the majority of the incubation period (above 56°F and below 58°F) in order to reduce risk of running out of cold water during the latter part of the incubation, emergence and rearing periods later in the season.
- Delay full side gate operation to October 15th or, if not possible, as late as possible. This biological objective is to ensure that most of the winter-run have emerged from the redds before a potential loss of control of water temperatures.

June - October Real-Time Operational Framework

- Attain temperatures close to 57°F as possible at CCR, while monitoring in real-time temperatures at the Highway 44 bridge to assess what temperatures the majority of redds are actually exposed to (assuming spawning will be at or upstream of the Highway 44 bridge).
- If projected temperatures appear they will exceed 58°F at CCR, Reclamation will call a real-time meeting to determine what actions are most advisable. These actions for consideration may include: TCD gate changes, bypassing power and other operational adjustments, allowing short-term exceedances above 58°F at CCR as long as evening temperatures are low, and possibly increasing releases to 7,500 cfs. Releases greater than 7,000 cfs have a negative cumulative effect on thermal mass and cold water, and are therefore a last option.

- Because future side-gate operations appear very sensitive to managing through heat-storms, additional consideration will be given to optimal procedures for longer heat spells which are most likely to occur in July.
- If air temperatures are cooler, and 57°F is attainable at CCR, real-time adjustments may be made to reduce Keswick releases to 6,500 cfs, in order to conserve thermal mass and cold water for later in the season, as long as 58°F at CCR is not exceeded.
- Releases in September and Oct will continue to be made to target temperatures and reduce risks of running out of cold water prior to October 31st. Because the forecast is highly sensitive to ambient air temperatures, if actual cumulative monthly temperatures from June through August are substantially below what was forecast, then there may be additional opportunities to optimize releases in the fall for other purposes, while still meeting temperature objectives.
- Reclamation will call real-time decision making meetings as needed, but at least weekly.
- CDFW will monitor observed redd locations, particularly the most downstream redd and redds at risk of being dewatered and report results on a weekly basis. While this is not a comprehensive survey due to redds that are in deep water above Highway 44, it will provide a general distribution of redds.
- NMFS will track temperature exposures and report on cumulative estimated mortalities on at least a bi-weekly basis
- On at least a monthly basis, or as needed, Reclamation and DWR will host a workshop to review integrated operations on all tributaries and the Delta to compare actual conditions to the forecasting plan of operations and make adjustments, as necessary to balance operational and biological goals on a system-wide basis.

- June 12, 2015 – Reclamation submitted the temperature model results of 6,000, 6,500, 7,000, 7,500, and 8,000 cfs scenarios at the 10% L3MTO targeting 57ºF at CCR. They also included operational forecast results for the 7,000, 7,500, and 8,000 cfs scenarios.


Sacramento River Modeled Temperature
2015 May 90%-Exceedance Outlook -10% L3MTO
Approximately 57 degree at CCR
Temperature (°F)
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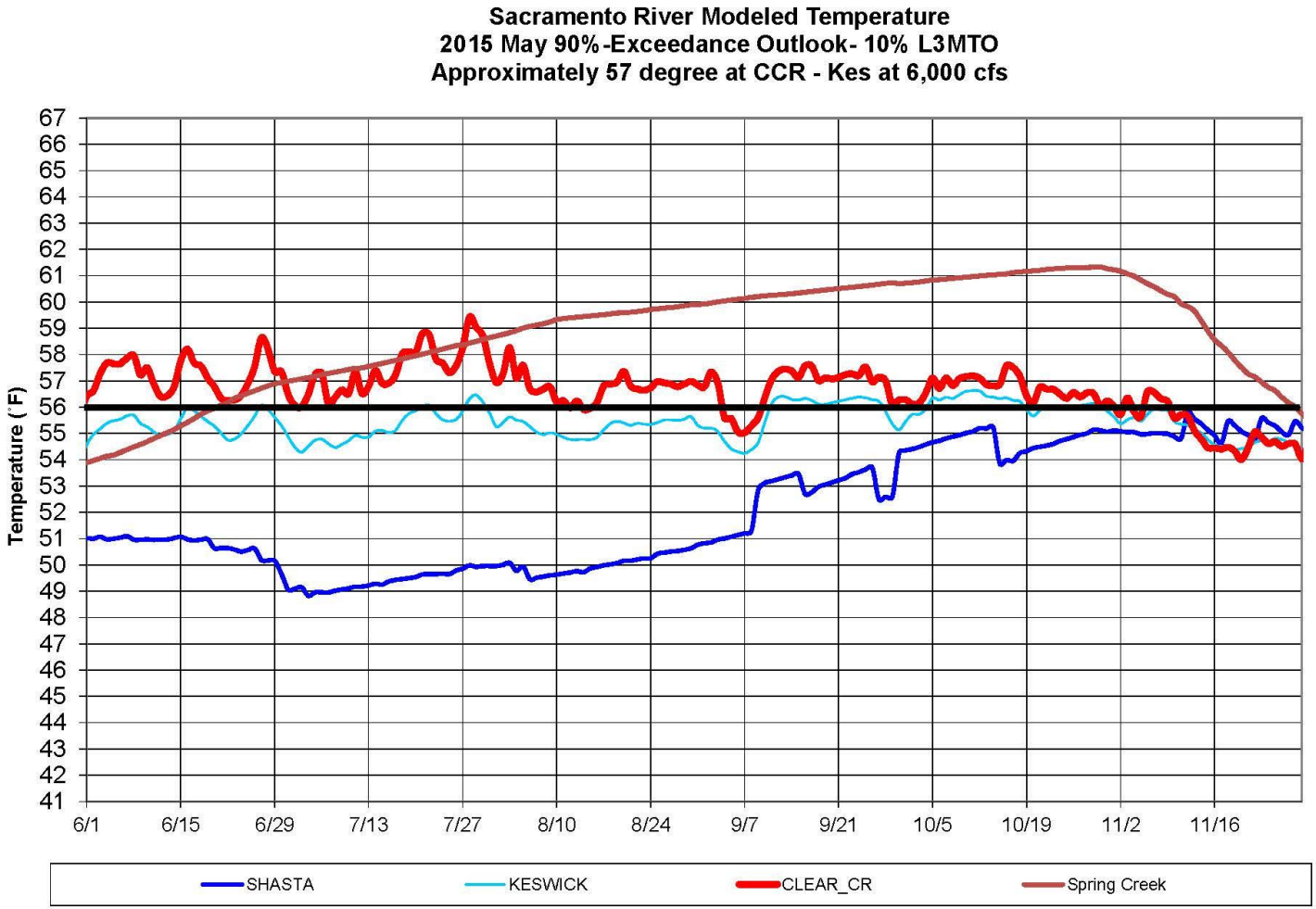
CLEAR_CR 6000 cfs
CLEAR_CR 6500 cfs
CLEAR_CR 7000 cfs
CLEAR_CR 7500 cfs
CLEAR_CR 8000 cfs


Sacramento River Modeled Temperature
2015 May 90%-Exceedance Outlook- 10% L3MTO
Approximately 57 degree at CCR - Kes at 6,000 cfs
Temperature (°F)
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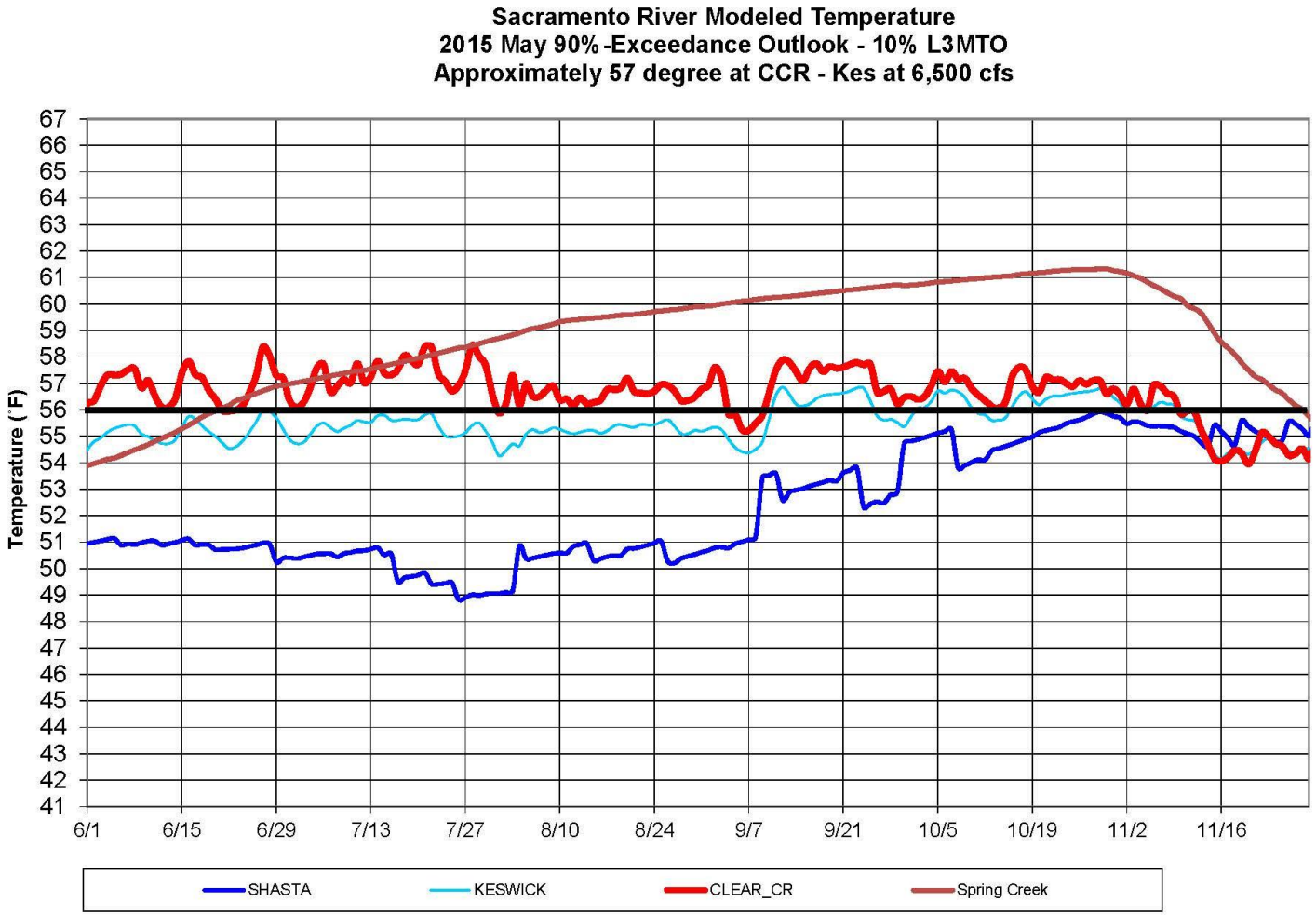
SHASTA
KESWICK
CLEAR_CR
Spring Creek


Sacramento River Modeled Temperature
2015 May 90% -Exceedance Outlook - 10% L3MTO
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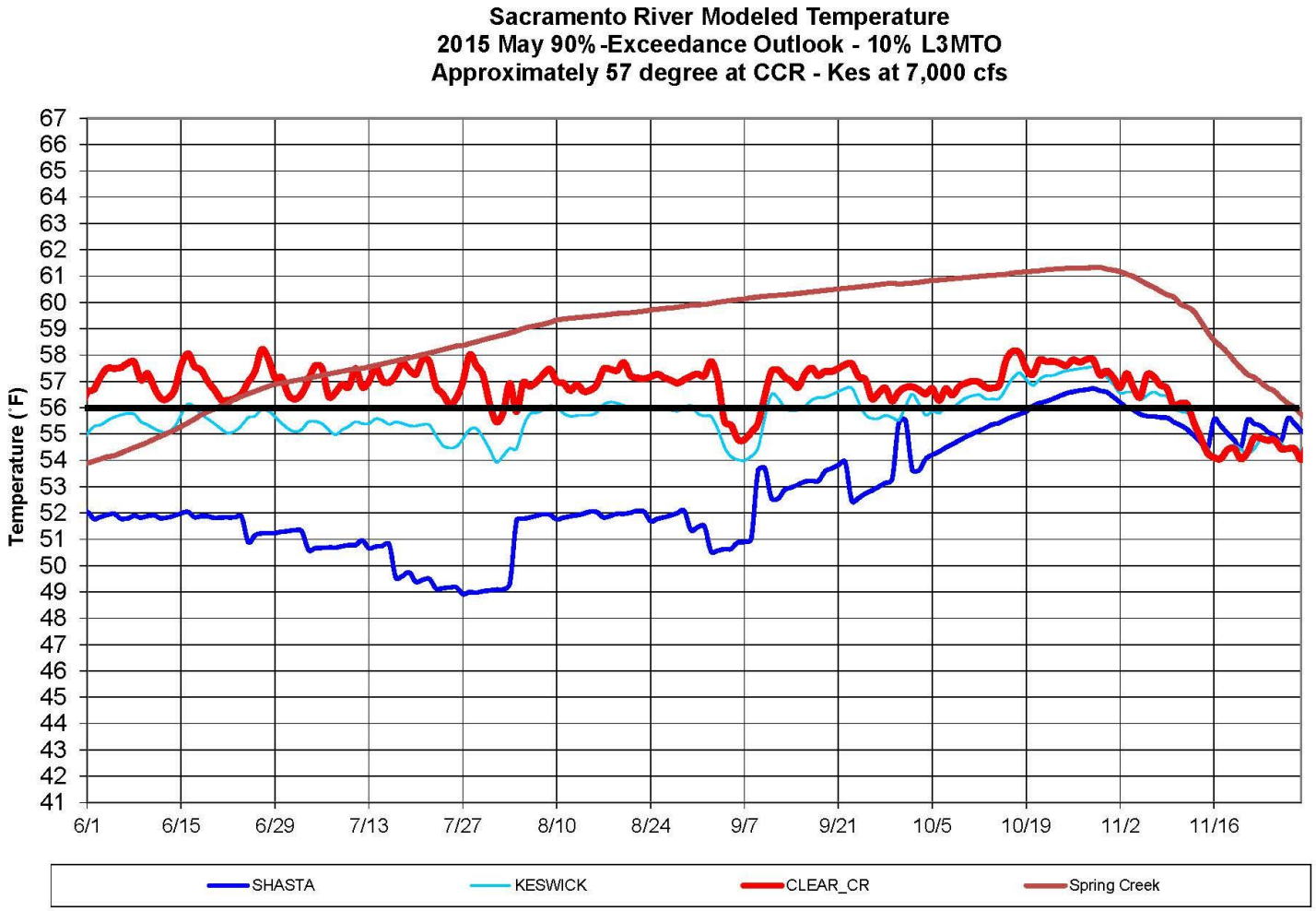
CLEAR_CR
Spring Creek


Sacramento River Modeled Temperature
2015 May 90% -Exceedance Outlook - 10% L3MTO
Approximately 57 degree at CCR - Kes at 7,000 cfs
Temperature (°F)
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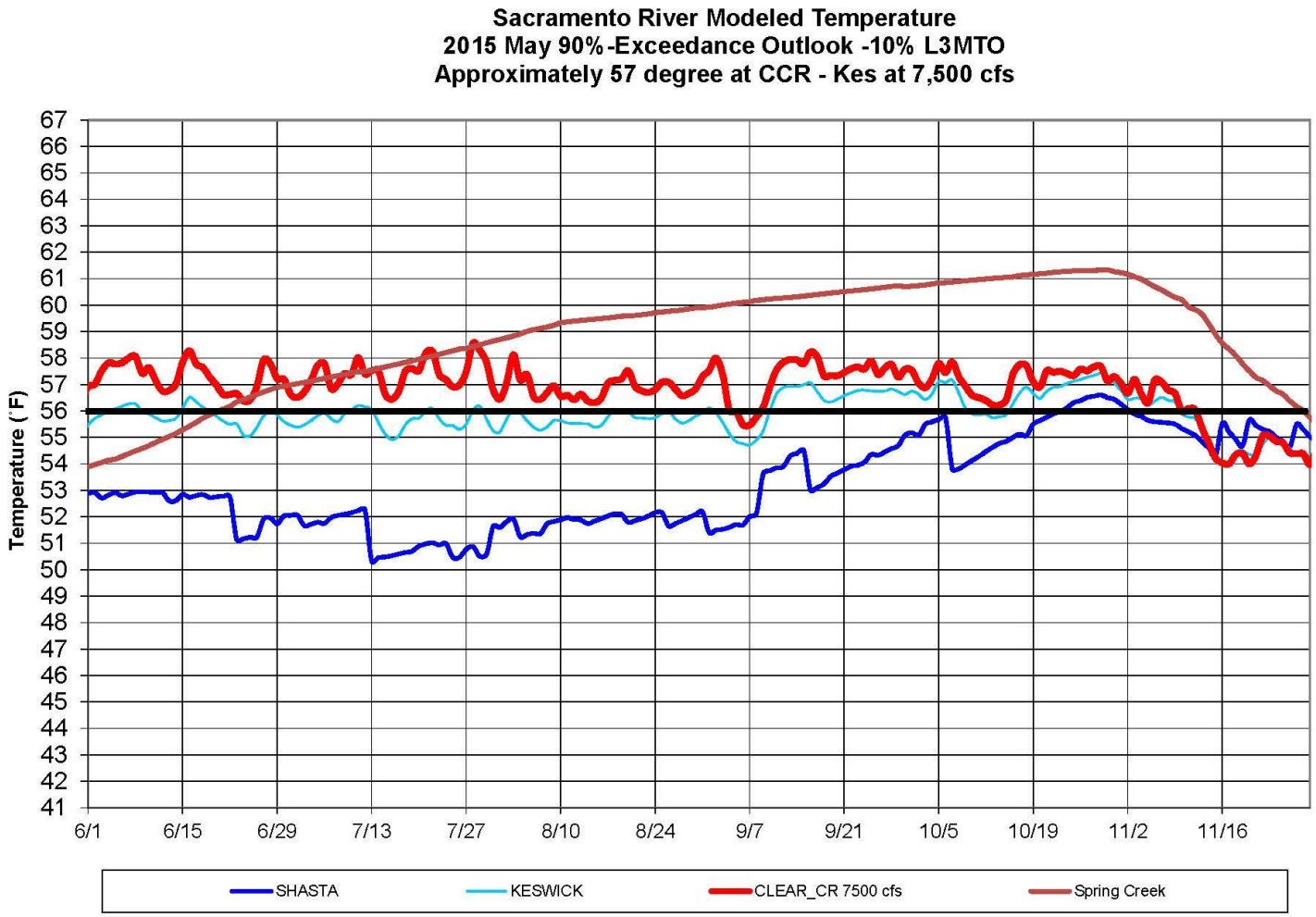
CLEAR_CR
Spring Creek


Sacramento River Modeled Temperature
2015 May 90%-Exceedance Outlook -10% L3MTO
Approximately 57 degree at CCR - Kes at 7,500 cfs
Temperature (°F)
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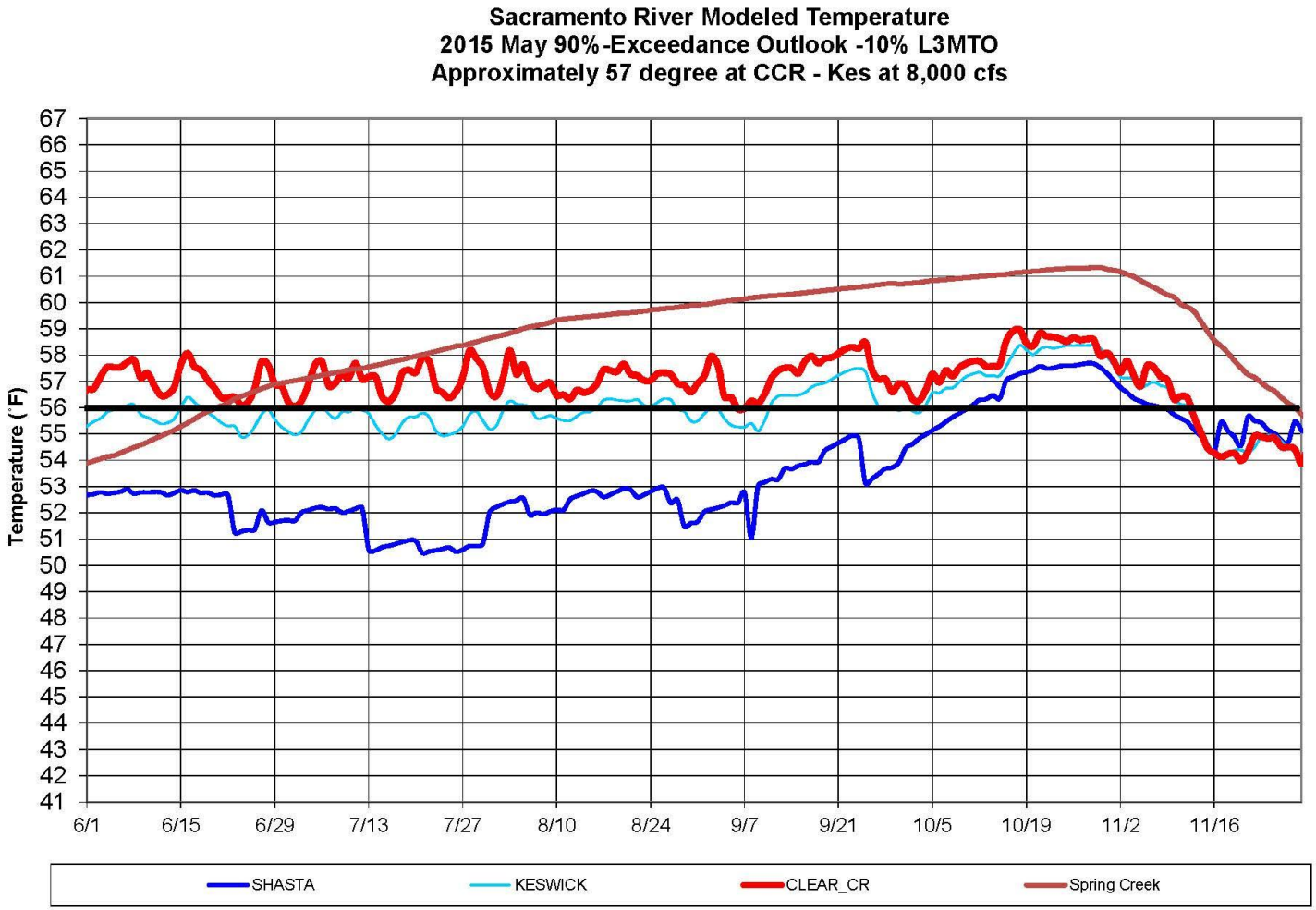
SHASTA
KESWICK
CLEAR_CR 7500 cfs
Spring Creek


Sacramento River Modeled Temperature
2015 May 90%-Exceedance Outlook -10% L3MTO
Approximately 57 degree at CCR - Kes at 8,000 cfs
Temperature (°F)
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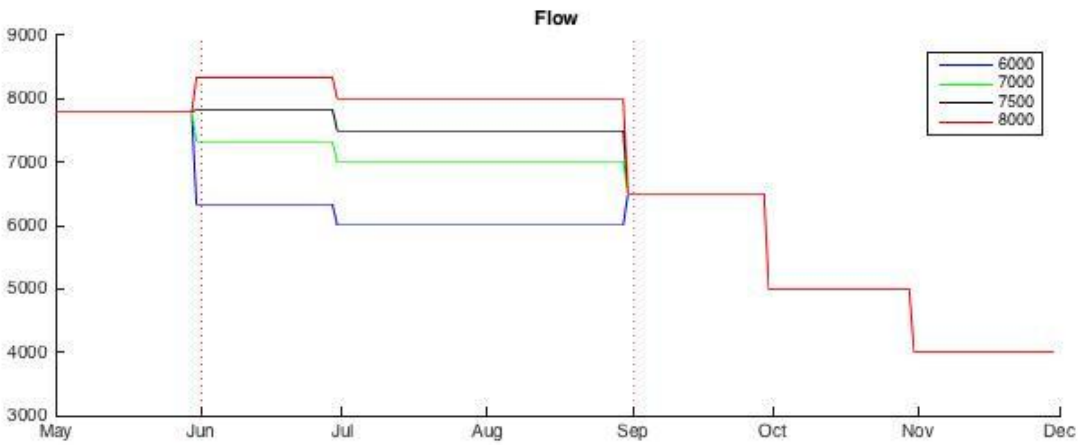
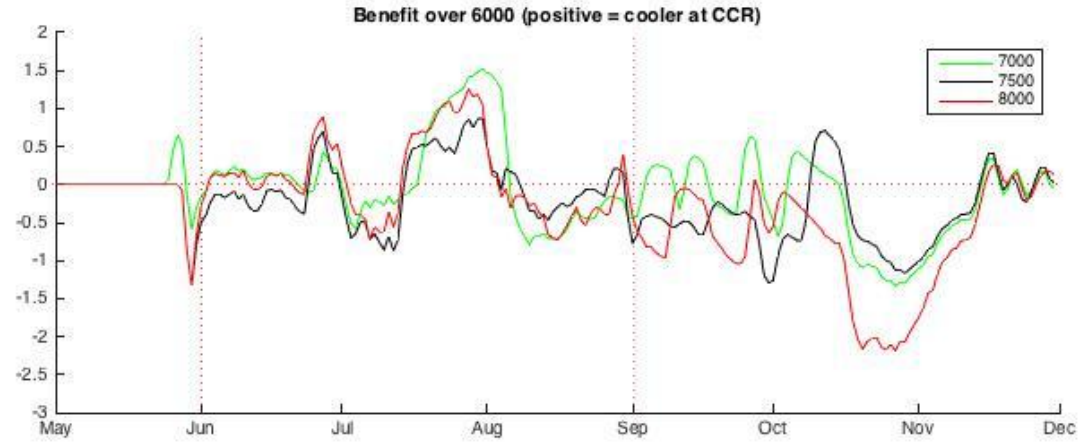
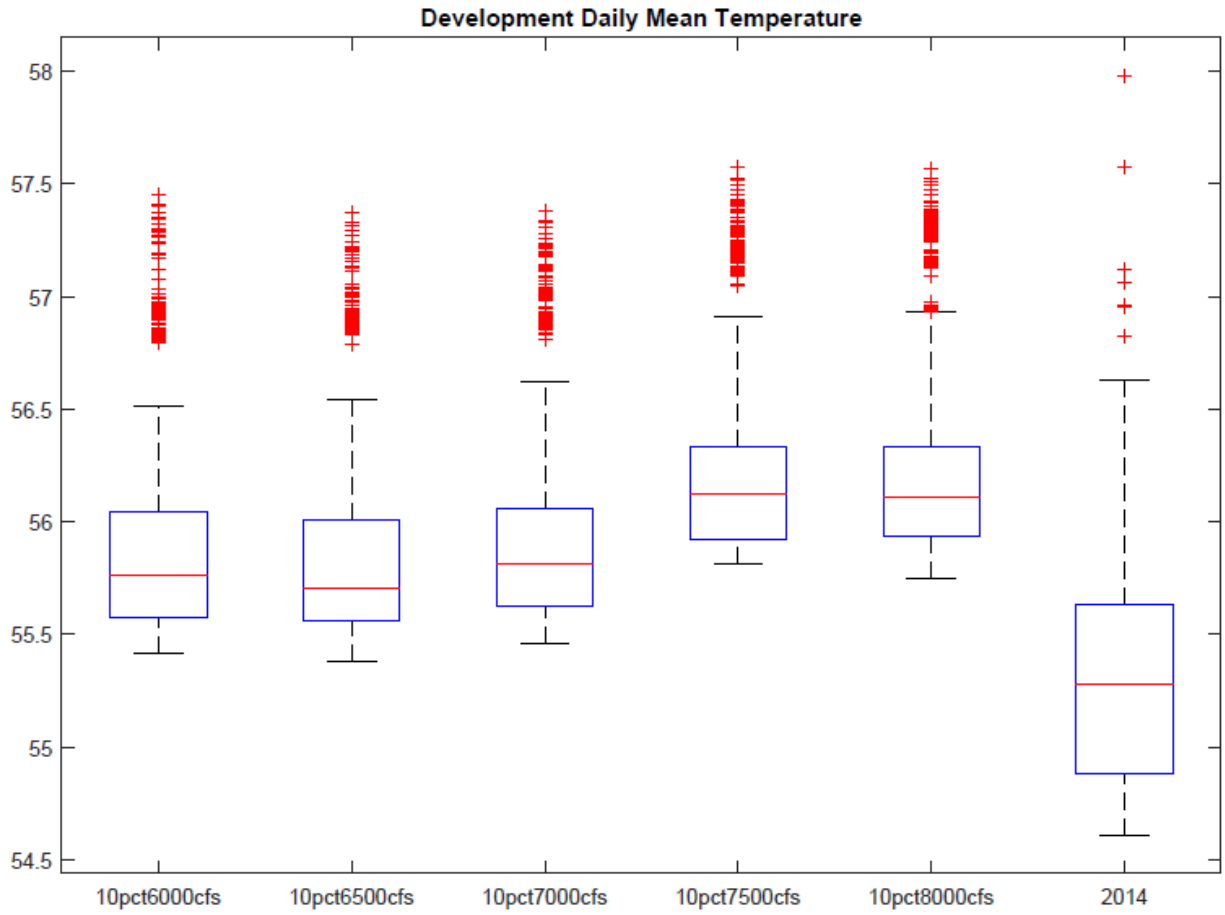
11/16
SHASTA
KESWICK
CLEAR_CR
Spring Creek

- The SWFSC used the temperature outputs for these five scenarios and created a number of graphs:
  - The first graphic identifies the benefits of 7,000, 7,500, and 8,000 cfs over 6,000 cfs during the temperature management season, with 7,000 cfs clearly having the most benefit.

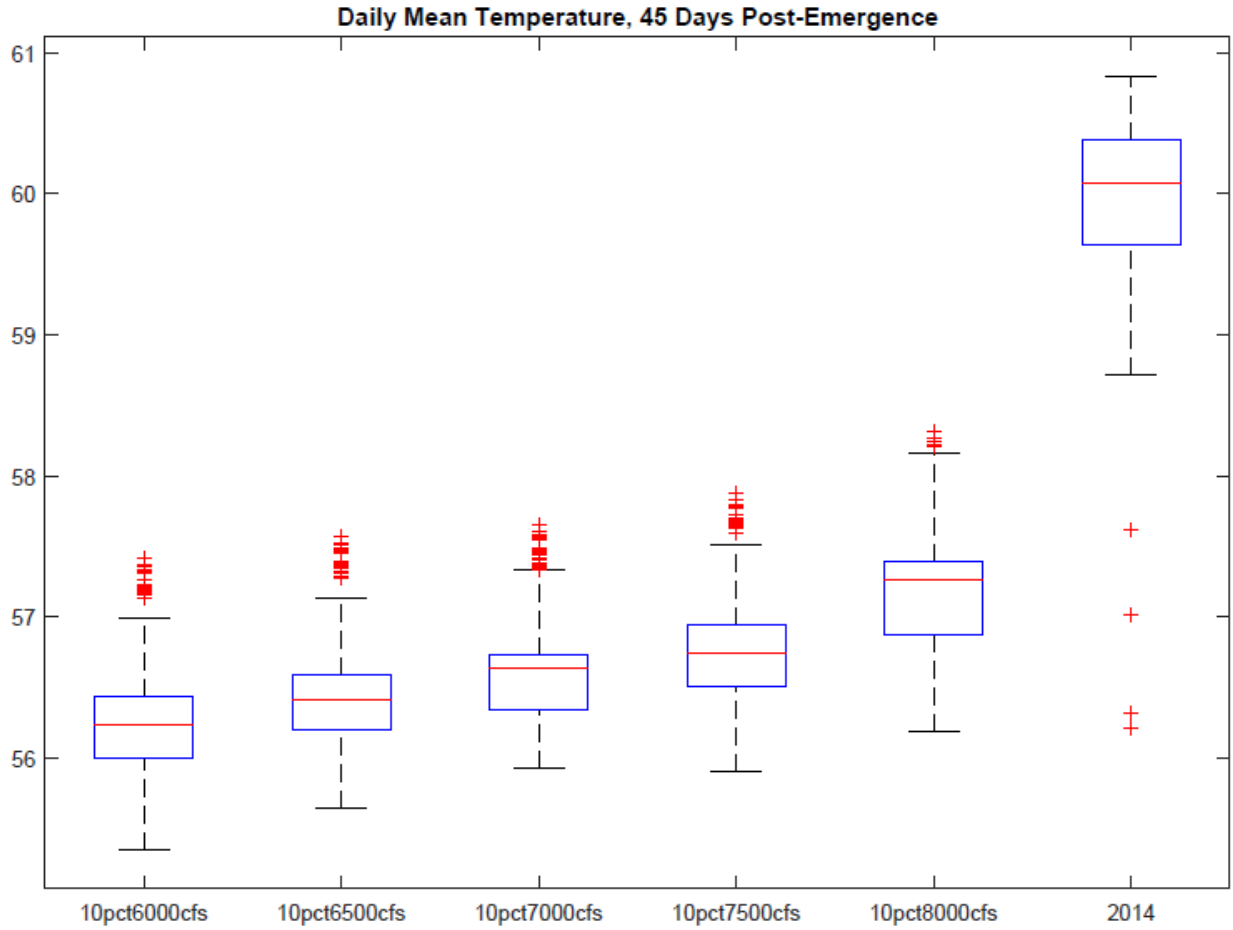




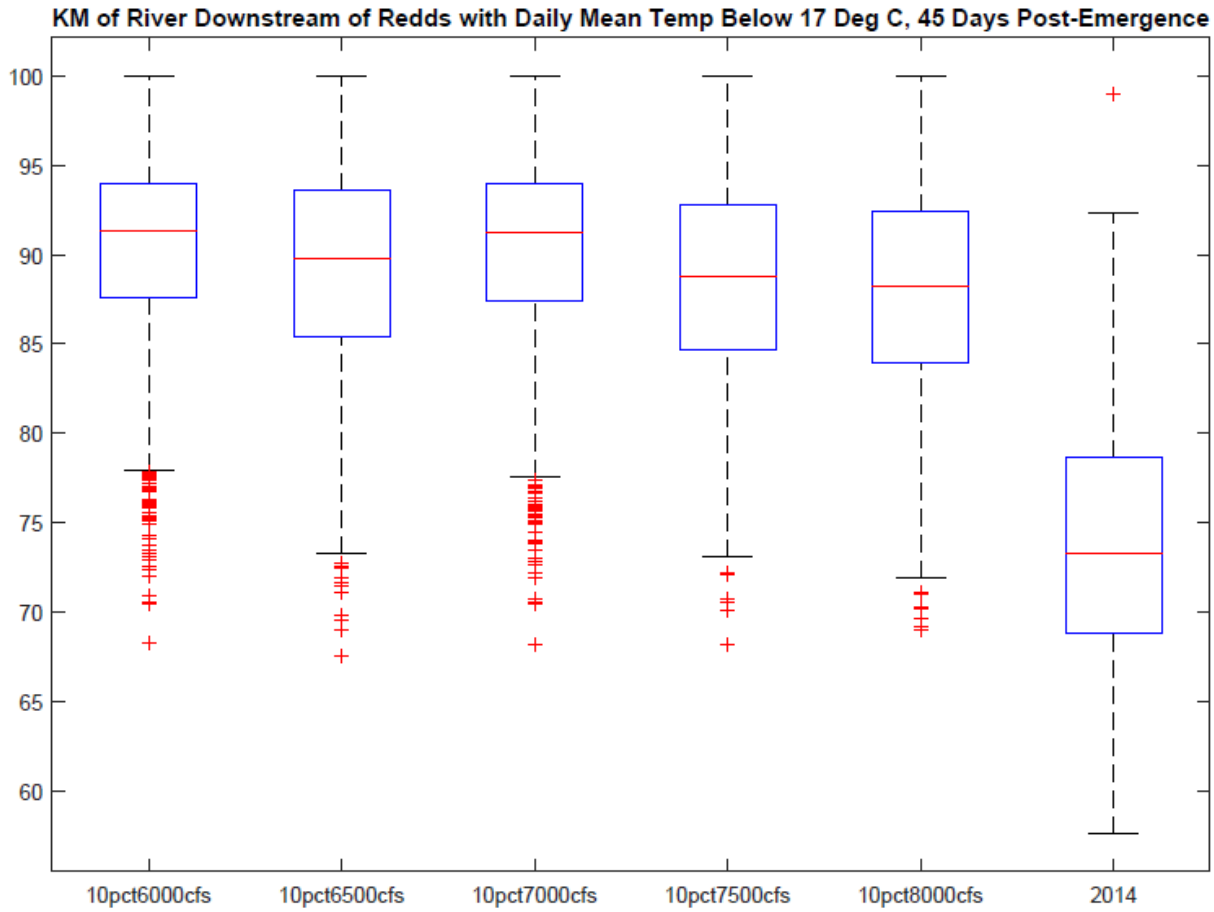
- The second graphic shows the egg and alevin development daily mean temperature amongst the different flow scenarios. 2014 had lower development temperatures compared with the forecasted 2015 scenarios with 6,000, 6,500, and 7,000 cfs slightly cooler than 7,500 and 8,000 cfs.



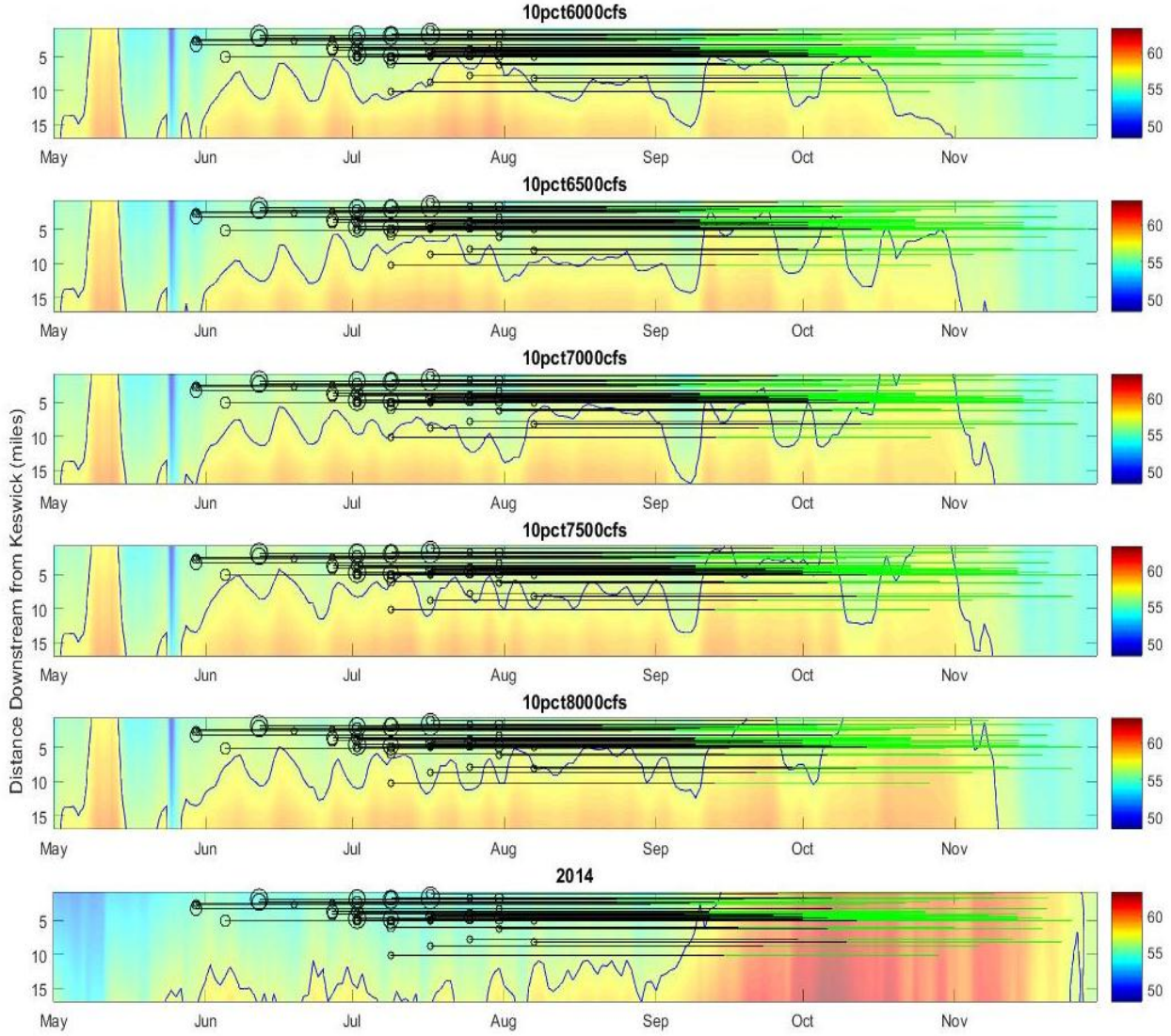
- The third graphic is the daily mean temperature 45 days post-emergence amongst the different flow scenarios. 2014 had significantly higher rearing temperatures compared with the forecasted 2015 scenarios with 6,000, 6,500, and 7,000 cfs slightly cooler than 7,500 and 8,000 cfs.



- The fourth graphic identifies the kilometers of downstream habitat suitable for rearing juvenile winter-run amongst the different flow scenarios. All are better than 2014 with 6,000 and 7,000 cfs slightly better than 7,500 and 8,000 cfs.



- The fifth graphic is a temperature landscape profile over space and time for the five scenarios compared to 2014. The isoline shows 57°F. The circles indicate 2014 redd timing and location. The black represents winter-run egg and alevin development time in the gravel and the green line represents fry rearing phase. The y-axis indicates miles of downstream habitat suitable for rearing juvenile winter-run amongst the different flow scenarios.



- June 13 and 14, 2015 – The Directors of the six agencies met twice over the weekend and settled on a scenario of 7,250 cfs that struck the balance of 7,000 cfs and 7,500 cfs scenarios.
- June 18, 2015 – The six agencies developed the major components of the Sacramento River temperature management plan.[18]
- June 19, 2015 – Reclamation submitted the draft biological review to NMFS which included the 7,250 cfs scenario.

[18] http://www.waterboards.ca.gov/waterrights/water_issues/programs/drought/docs/tucp/tempmgmtplan061815.pdf