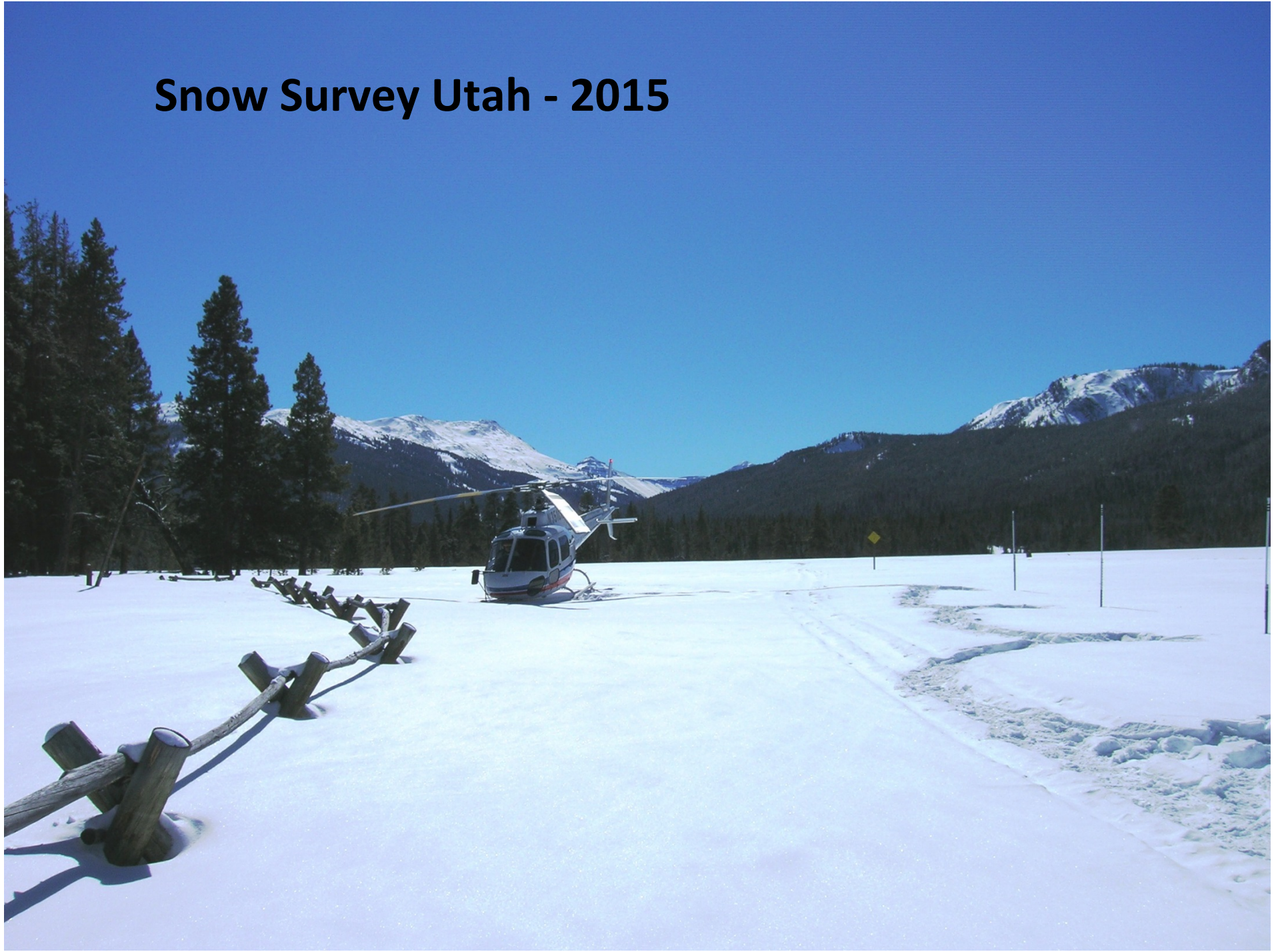
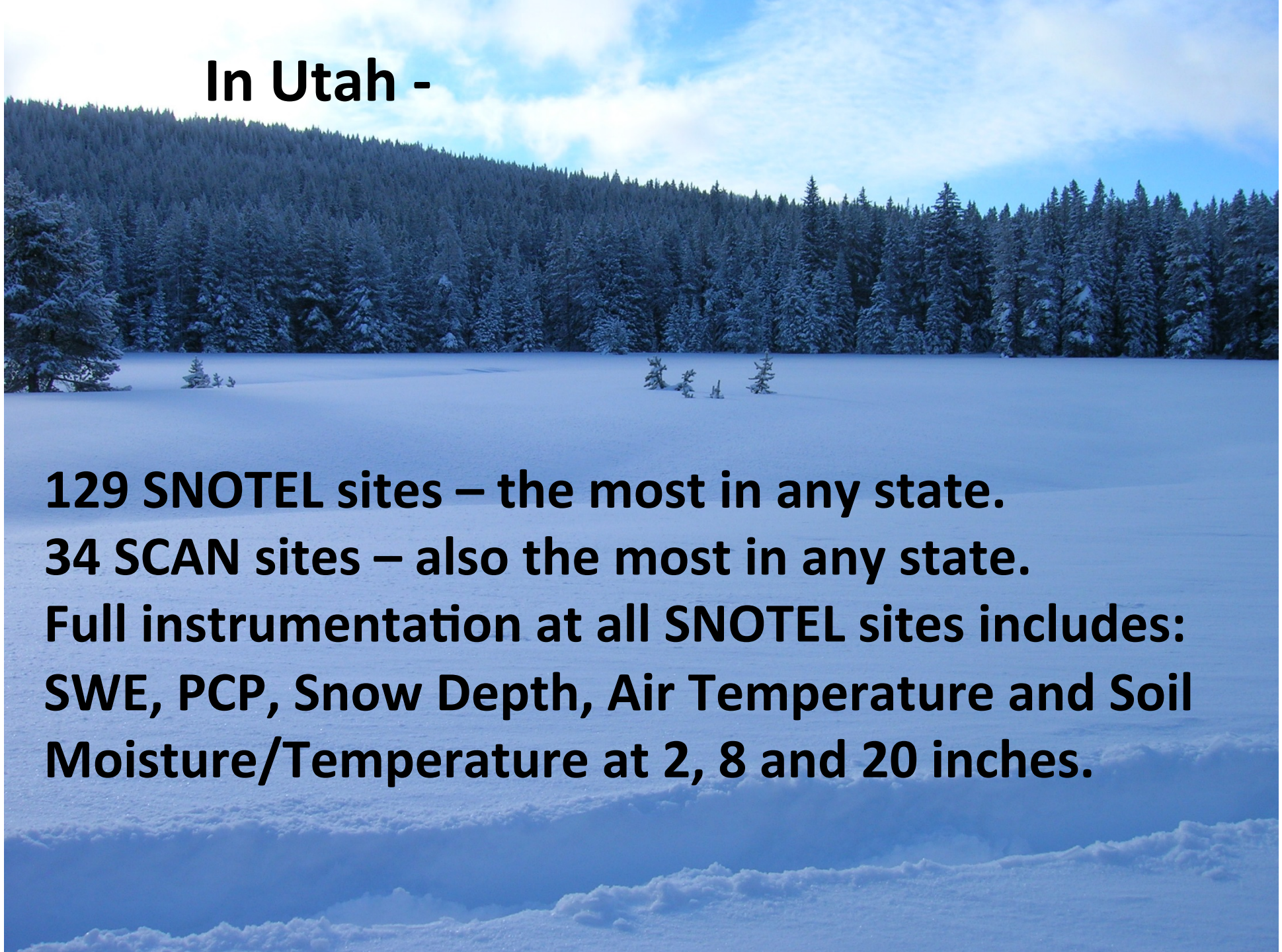
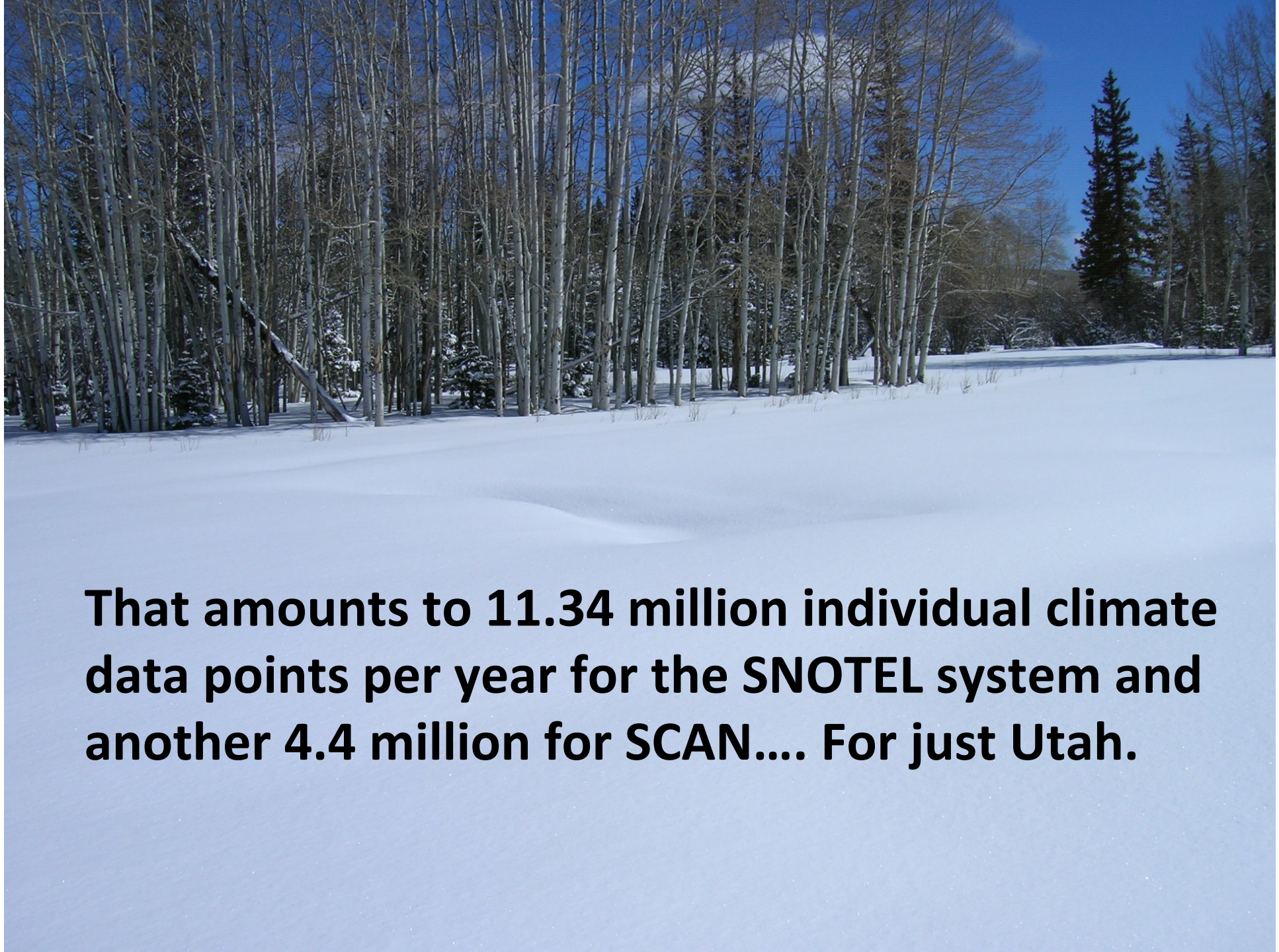
Snow Survey Utah - 2015



In Utah -



129 SNOTEL sites – the most in any state.
34 SCAN sites – also the most in any state.
Full instrumentation at all SNOTEL sites includes: SWE, PCP, Snow Depth, Air Temperature and Soil Moisture/Temperature at 2, 8 and 20 inches.



That amounts to 11.34 million individual climate data points per year for the SNOTEL system and another 4.4 million for SCAN…. For just Utah.

Budgets have been stable and of sufficient magnitude to allow complete automation (SNOTEL) of all snow courses we intend to keep in Utah. We are focusing on 'holes' in the system.

2 new sites this year: Mt Pennell and Summit Creek

New sites are much better than many older ones: better locations, larger data collection area, more stable SWE, more and better sensors, standardization

4												
5		6/19/2015 9:00	0.1	-1	15.7	72	0.1	-1	15.7	72		
6		6/19/2015 10:00	0.1	-1	15.6	74	0.1	-1	15.6	74		
7		6/19/2015 11:00	0.1	-2	15.6	74	0.1	-2	15.6	74		
8		6/19/2015 12:00	0	-1	15.5	76	0	-1	15.5	76		
9		6/19/2015 13:00	0.1	0	15.5	76	0.1	0	15.5	76		
10		6/19/2015 14:00	0	-1	15.5	77	0	-1	15.5	77		
11		6/19/2015 15:00	0	-1	15.6	76	0	-1	15.6	76		
12		6/19/2015 16:00	0	-1	15.6	76	0	-1	15.6	76		
13		6/19/2015 17:00	0	-1	15.6	73	0	-1	15.6	73		
14		6/19/2015 18:00	0	-1	15.7	70	0	-1	15.7	70		
15		6/19/2015 19:00	0	-1	15.7	60	0	-1	15.7	60		
16		6/19/2015 20:00	0	0	15.8	55	0	0	15.8	55		
17		6/19/2015 21:00	0	0	15.8	55	0	0	15.8	55		

Millions of data points have no particular value

DANGER
Data
Products
Action/Decision
Minimize Risk – Maximize Benefit

NRCS monthly streamflow forecasts…

Provo R Utah Lake Jordan R
Streamflow Forecasts - April 1, 2015

Forecast Exceedance Probabilities for Risk Assessment
Chance that actual volume will exceed forecast

Provo R Utah Lake Jordan R	Forecast Period	90% (KAF)	70% (KAF)	50% (KAF)	% Avg	30% (KAF)	10% (KAF)	30yr Avg (KAF)
Salt Ck at Nephi	APR-JUL	0.095	0.28	1.4	15%	4.1	8.1	9.5
Spanish Fk at Castilla	APR-JUL	0.69	2.1	11	16%	42	87	69
Provo R at Woodland	APR-JUL	27	39	48	48%	58	75	100
Provo R at Hailstone	APR-JUL	20	34	45	42%	58	79	108
Provo R bl Deer Ck Dam	APR-JUL	1.16	11.9	28	24%	44	68	116
American Fk ab Upper Powerplant	APR-JUL	0.32	0.96	5	16%	10.2	17.8	32
Utah Lake Inflow	APR-JUL	2.6	8	82	31%	178	289	265
W Canyon Ck nr Cedar Fort	APR-JUL	0.018	0.035	0.35	20%	0.7	1.21	1.76
Little Cottonwood Ck nr SLC	APR-JUL	6.4	9	11	29%	13.2	16.8	38
Big Cottonwood Ck nr SLC	APR-JUL	0.36	3.8	8	22%	12.2	18.4	36
Mill Ck nr SLC	APR-JUL	0.064	0.192	1.3	20%	2.7	4.7	6.4

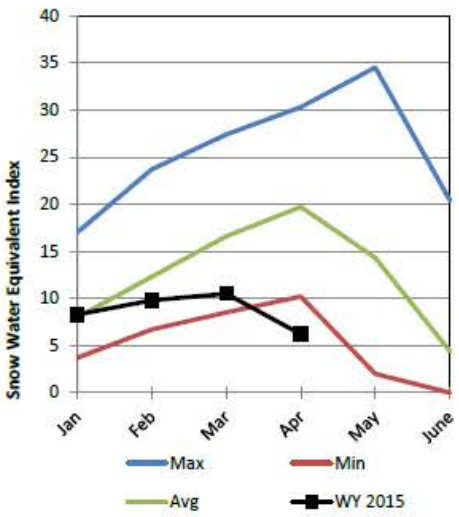
Synthesis of relevant climate information Snow, precipitation and soil moisture

Provo & Jordan River Basins

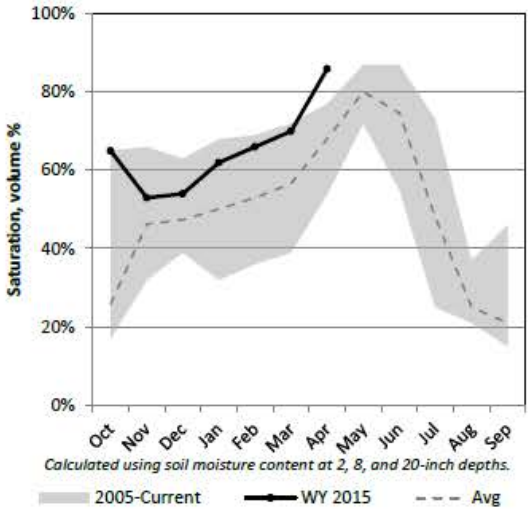
4/1/2015

Snowpack in the Provo & Jordan River Basins is much below normal at 32% of normal, compared to 88% last year. Precipitation in March was much below average at 41%, which brings the seasonal accumulation (Oct-Mar) to 59% of average. Soil moisture is at 86% compared to 70% last year. Reservoir storage is at 71% of capacity, compared to 73% last year. Forecast streamflow volumes range from 11% to 48% of average. The surface water supply index is 14% for the Provo River.

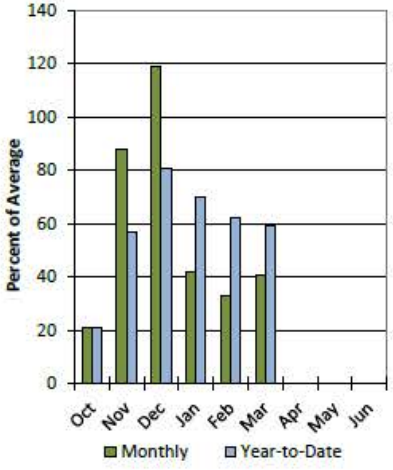
Snowpack



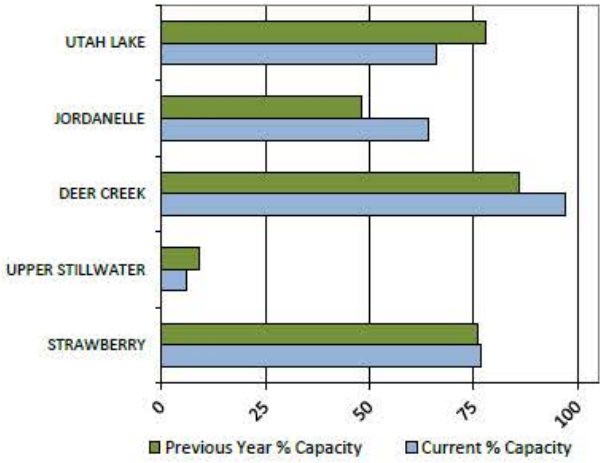
Soil Moisture



Precipitation



Reservoir Storage



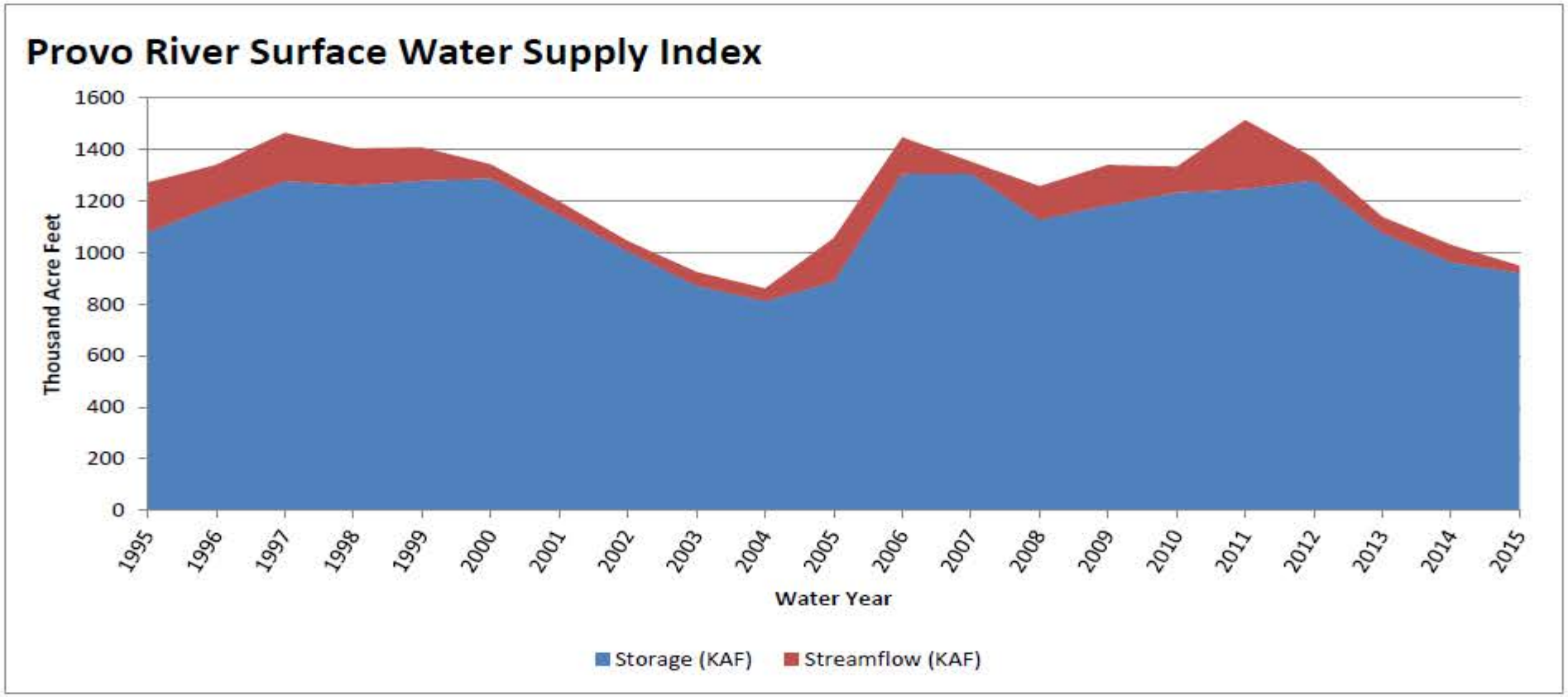
Brought together in a surface water supply index as a summary of current conditions Jan-June

April 1, 2015

Surface Water Supply Index

Basin or Region	Mar EOM* Storage	APR-JUL Forecast	Storage + Forecast	Percentile	SWSI#	Years with similiar SWSI
	KAF^	KAF^	KAF^	%		
Provo River	**920.40**	**28.00**	**948.40**	**14**	**-3.03**	**04, 03, 14, 02**

*EOM, end of month; #SWSI, Surface Water Supply Index; ^KAF, thousand acre-feet.

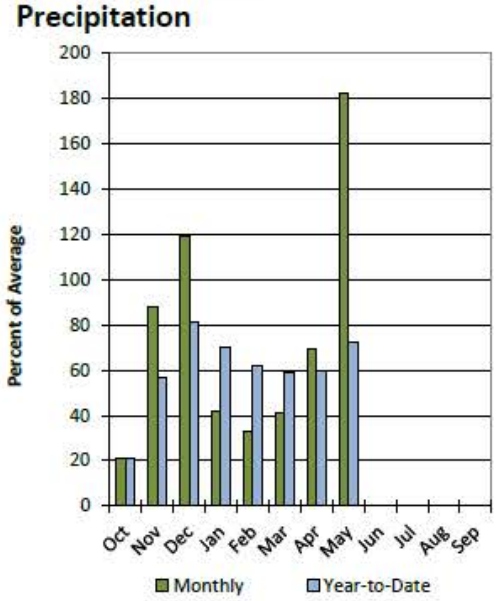


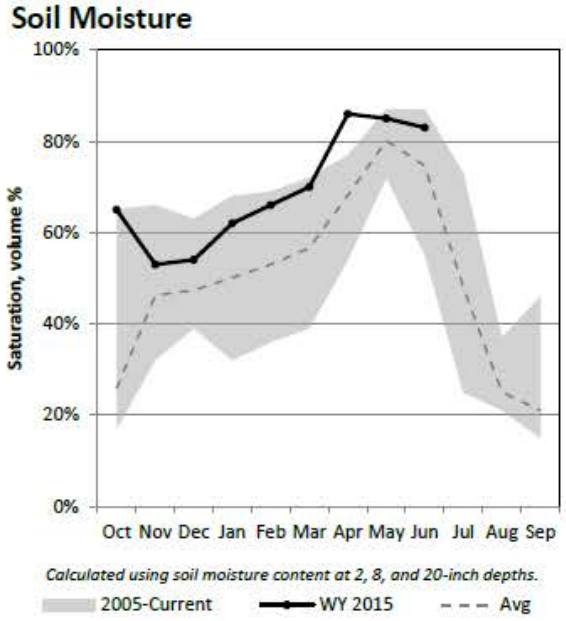
Continued year round with the Utah Climate and Water Report

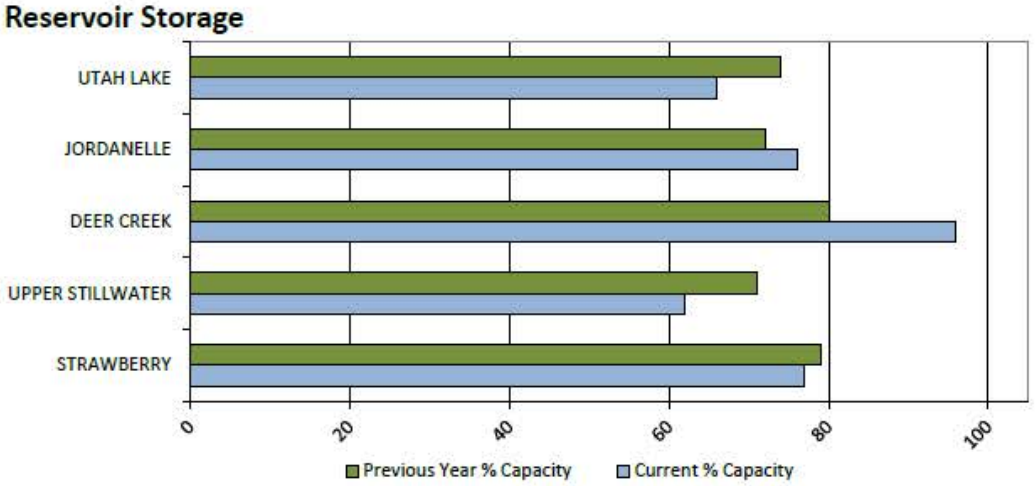
Provo & Jordan River Basins

6/1/2015

Precipitation in May was much above average at 182%, which brings the seasonal accumulation (Oct-May) to 72% of average. Soil moisture is at 83% compared to 68% last year. Reservoir storage is at 74% of capacity, compared to 76% last year. The water availibility index for the Provo River is 48%.







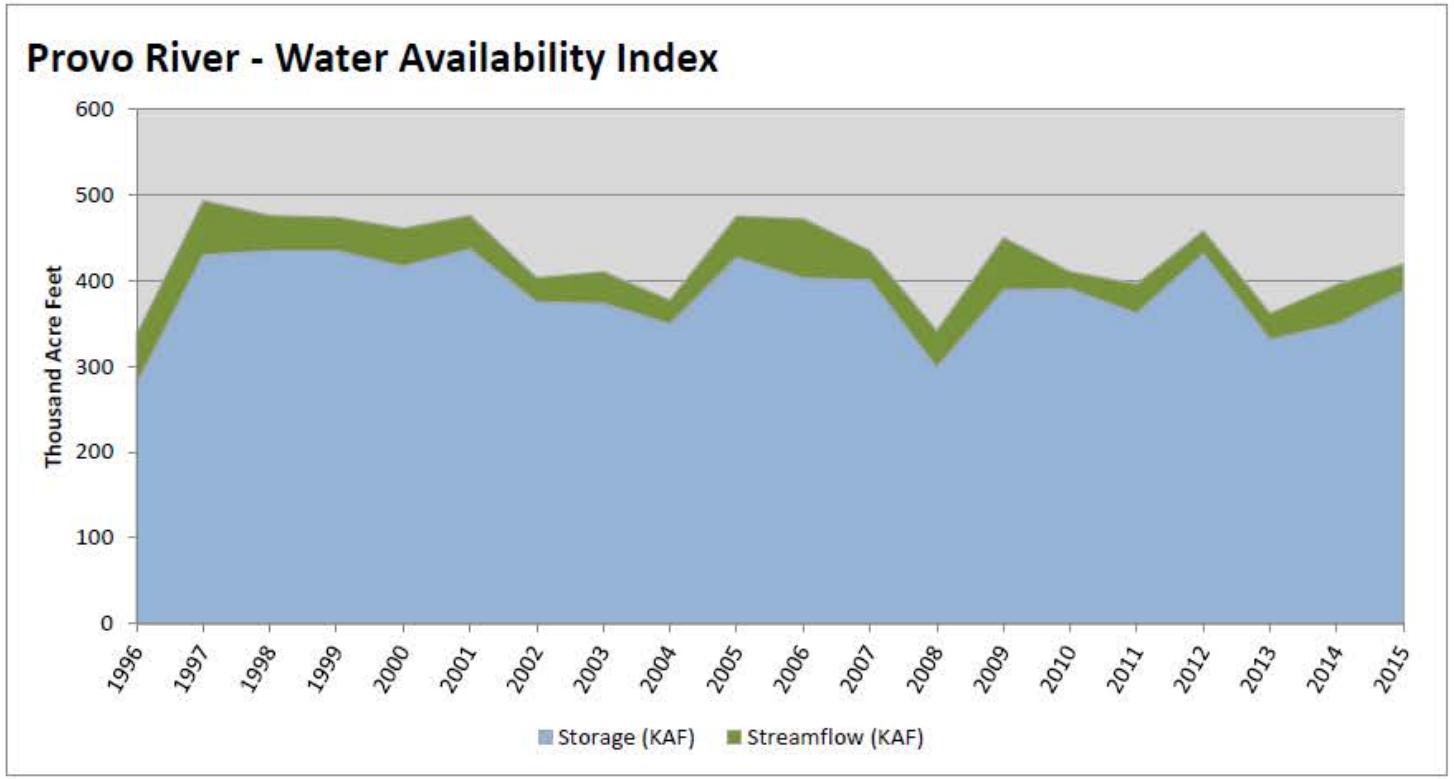
The Water Availability Index – gives a quick summary of current water supply conditions in any given month compared to historical conditions, year round.

June 1, 2015

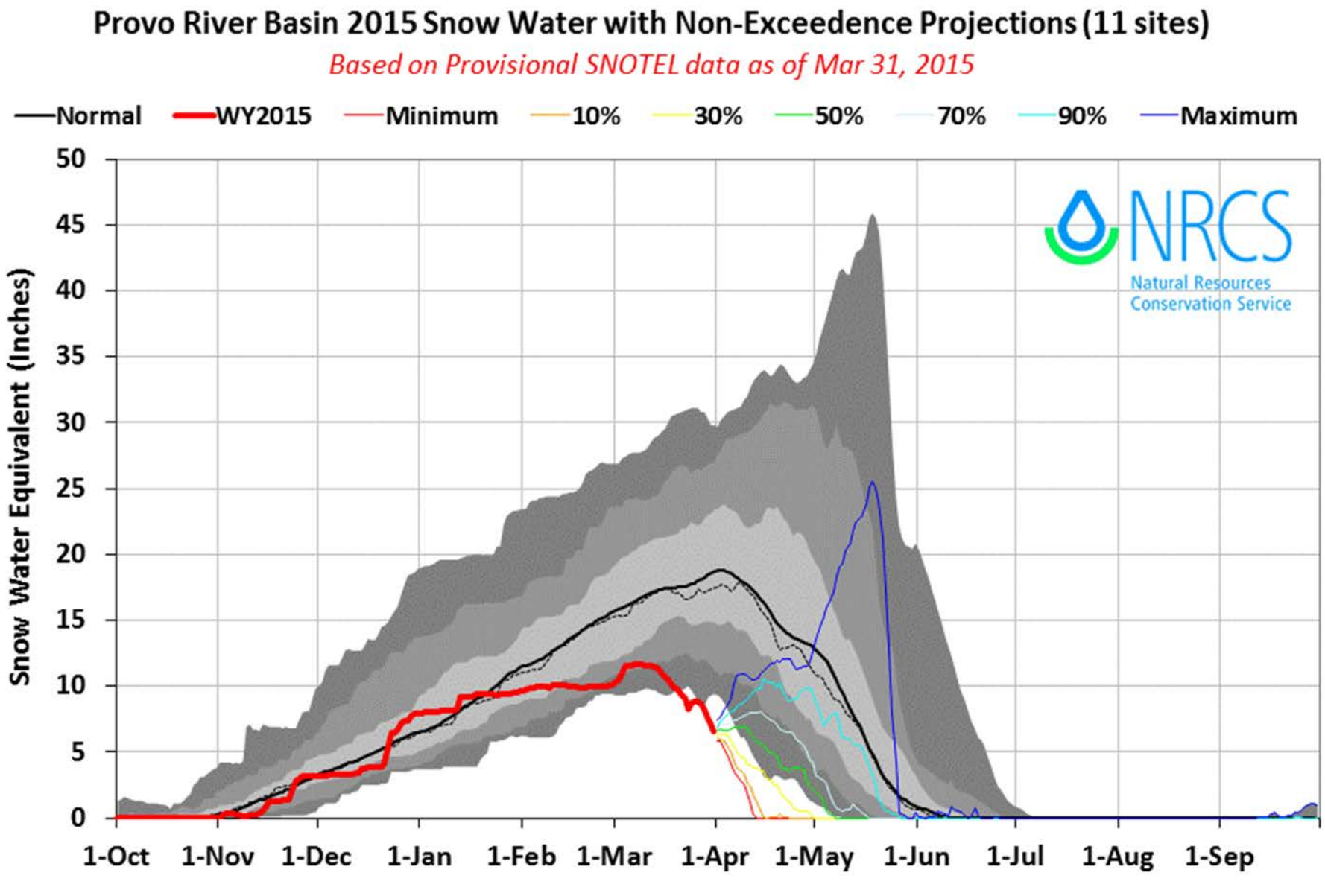
Water Availability Index

Basin or Region	May EOM* Storage	May Flow	Storage + Flow	Percentile	WAI#	Years with similiar WAI
	KAF^	KAF^	KAF^	%		
Provo River	**388.57**	**30.73**	**419.30**	**48**	**-0.2**	**10, 03, 07, 09**

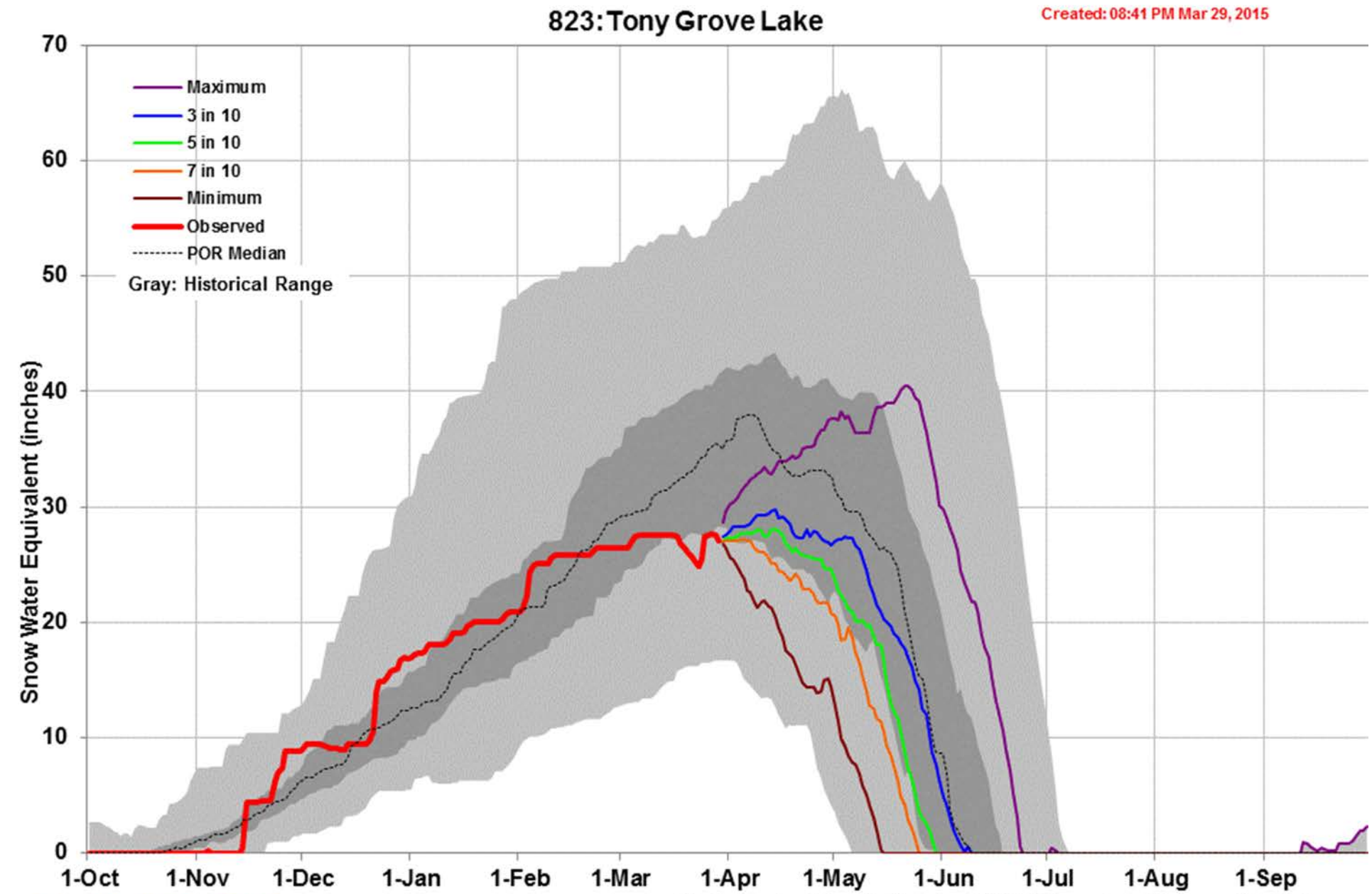
*EOM, end of month; #WAI, Water Availability Index; ^KAF, thousand acre-feet.



Daily updated basin wide snow analyses with future 'what if' scenarios of minimum to maximum probability levels.



The same for individual stations…

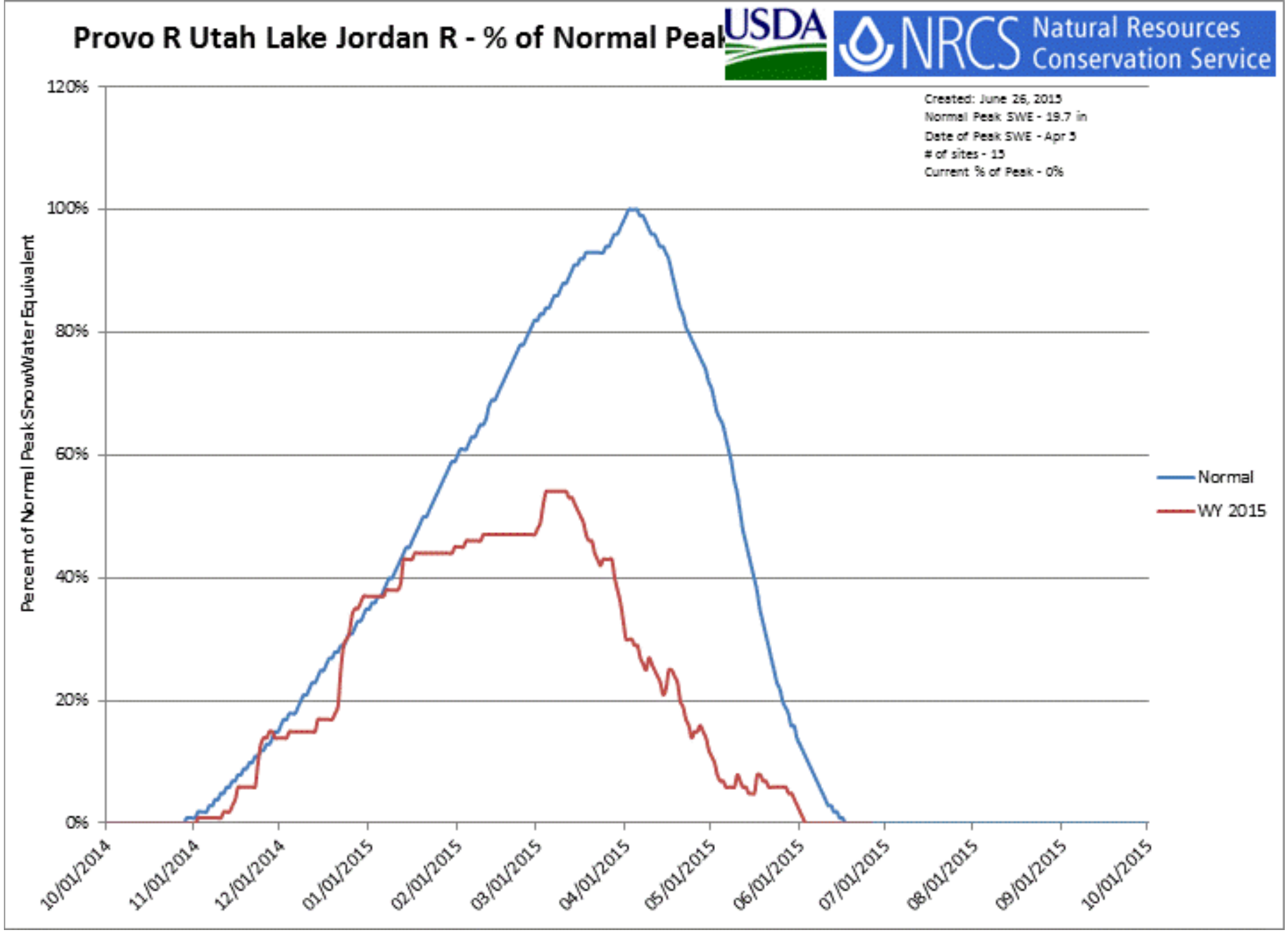


NRCS

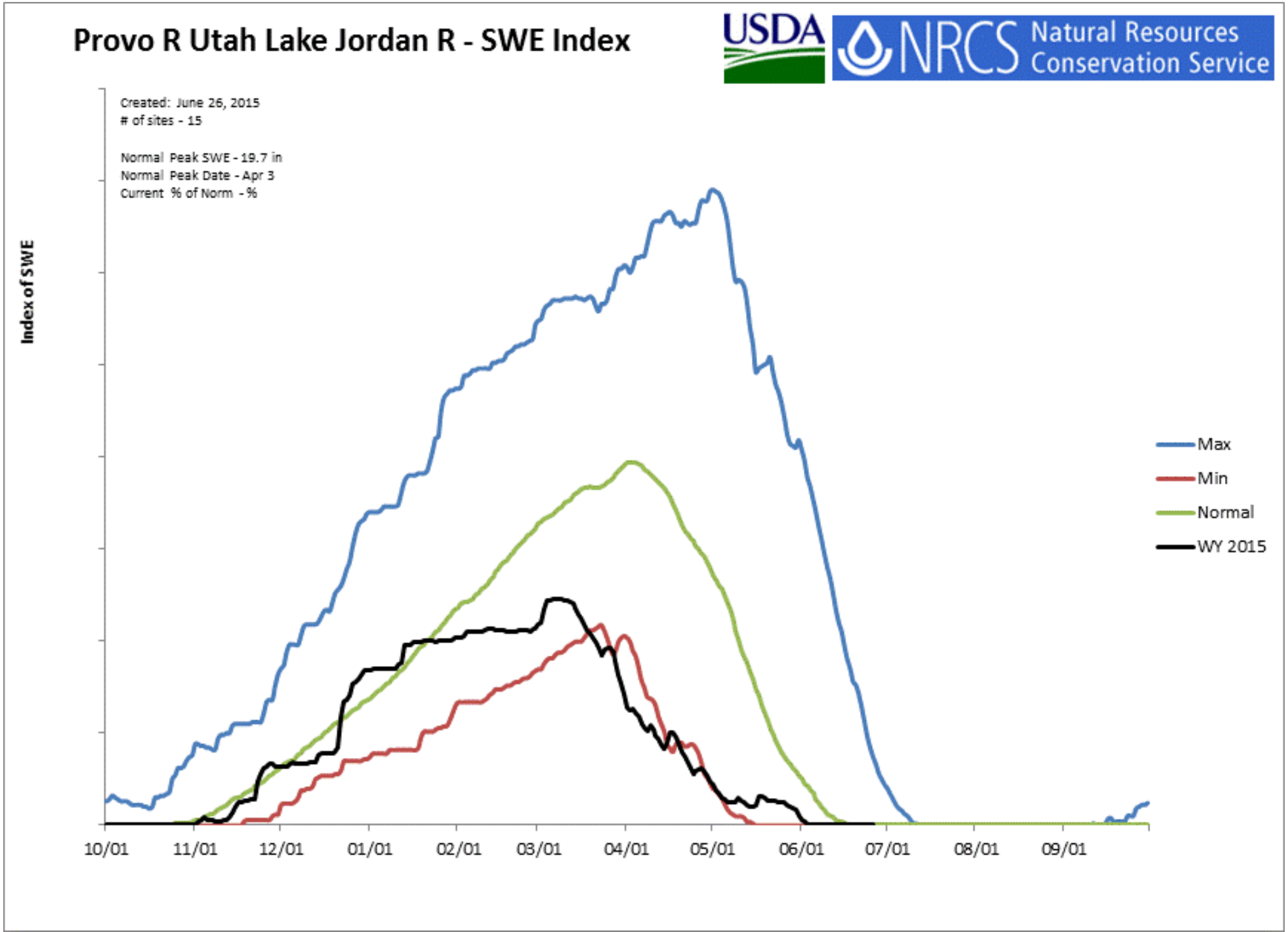
This is an automated product based on SNOTEL data, provisional data are subject to change.
This product combines the historical period of record data (**gray background**) with the recent daily data (**heavy red, left**) to project into the future (**colored lines, right**). This product does not consider climate information such as El Nino or short range weather forecasts and therefore should only be used as a seasonal planning tool. Contact Jim.Marron@por.usda.gov 503 414 3047

We also produce these as a Percent of Peak

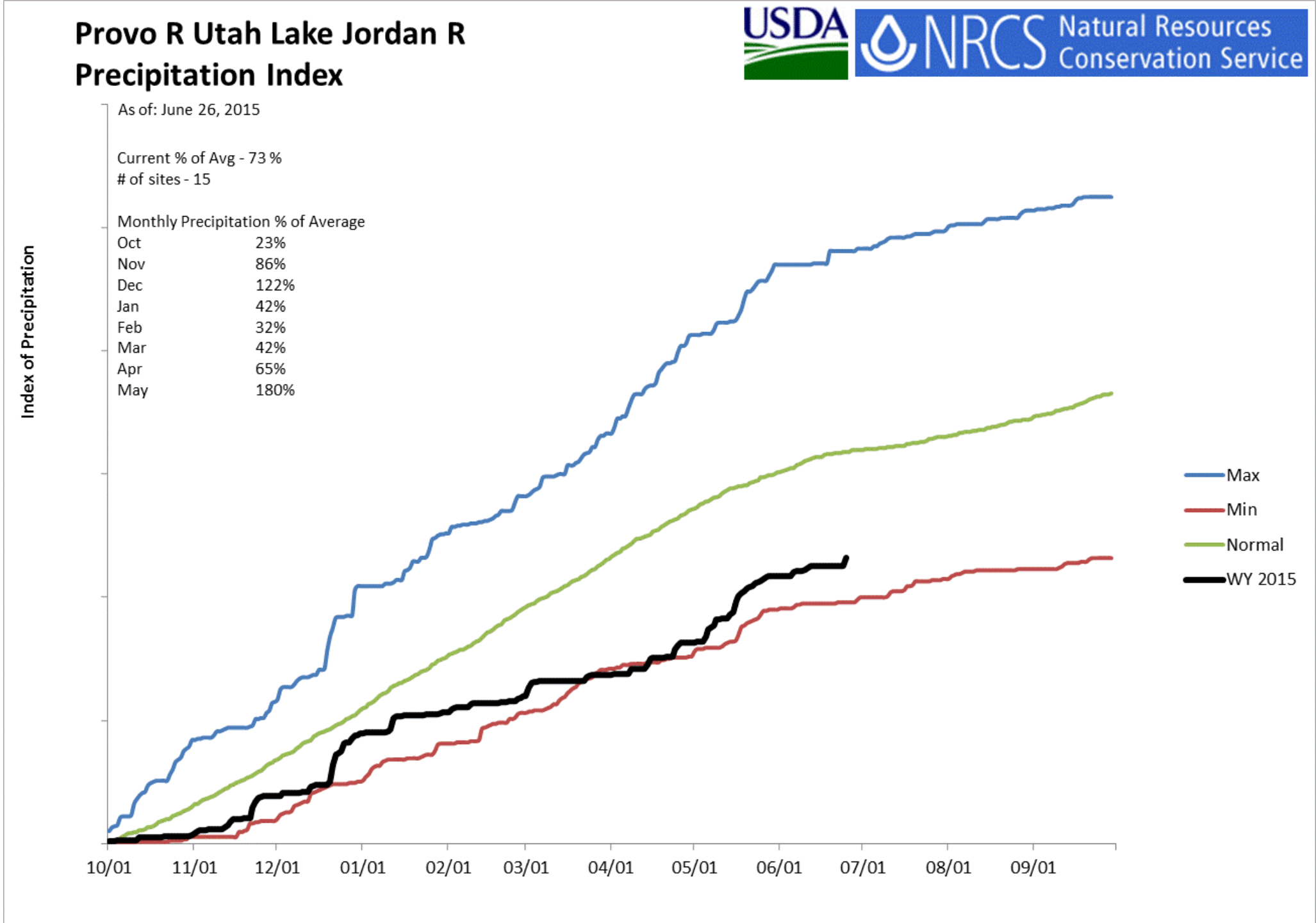
A more relevant metric toward melt out when percent of median blows up…



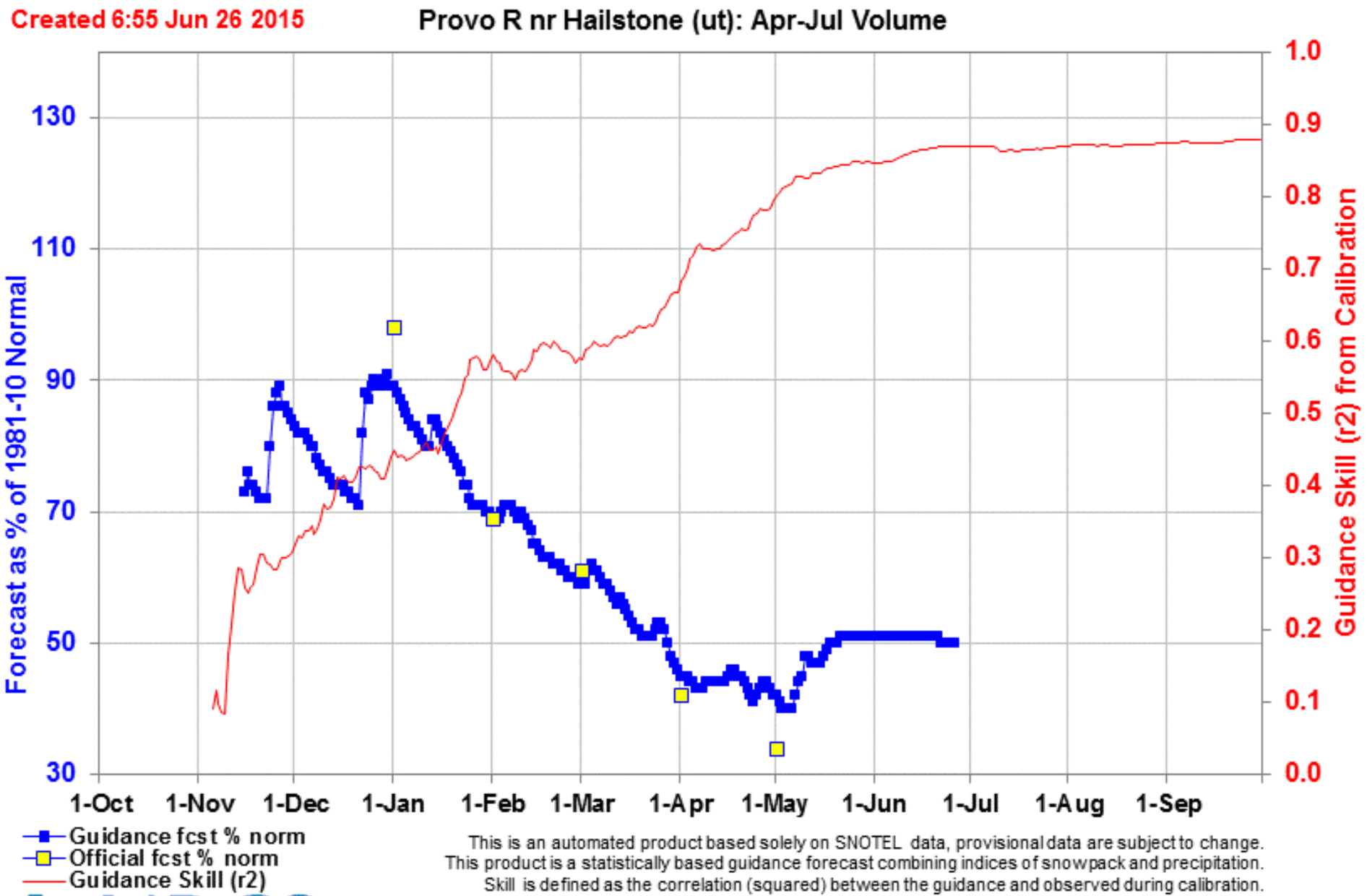
Max, min, normal, current.



Same for precipitation



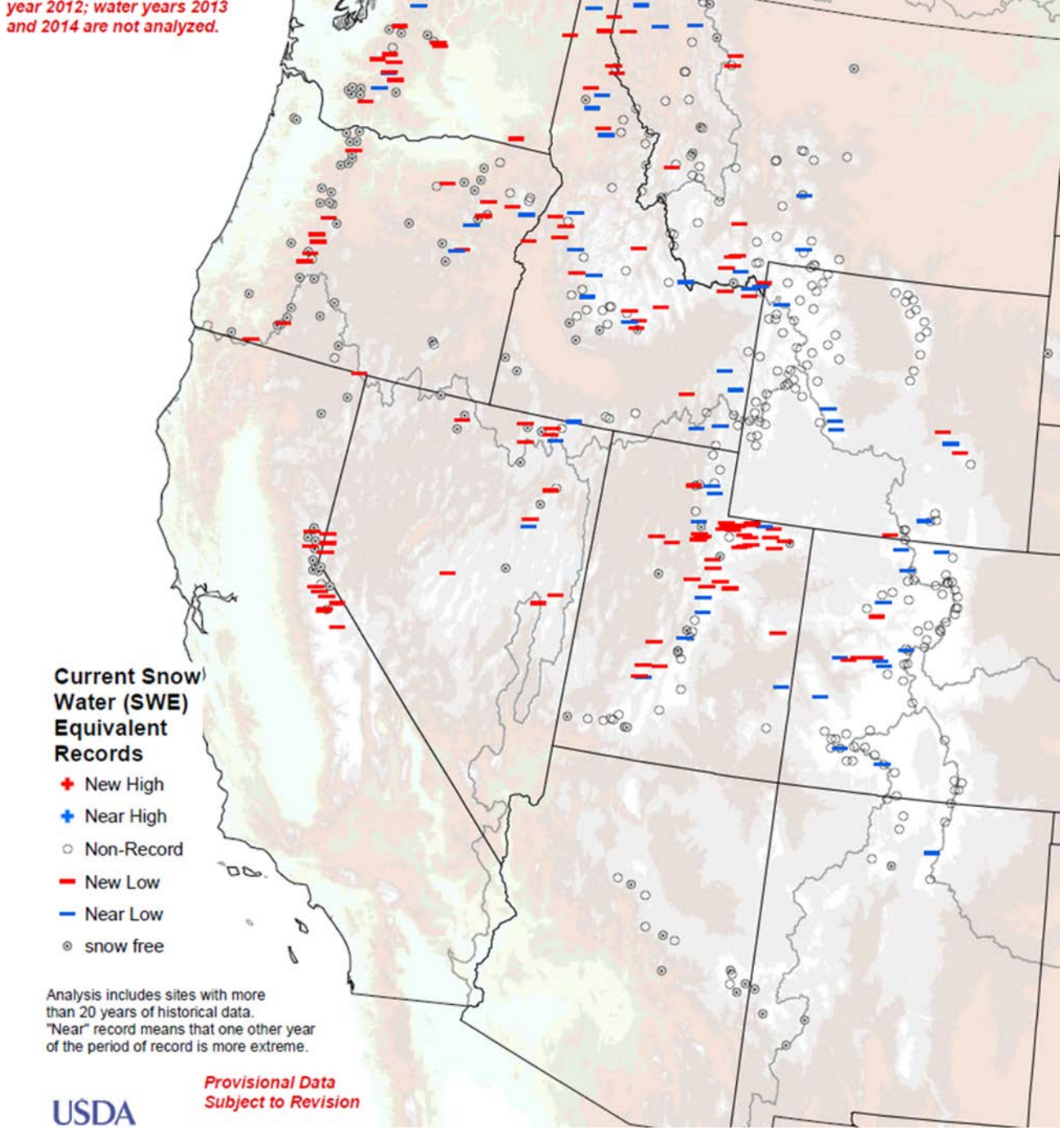
Daily updated April-July water supply forecasts allow a water user to track conditions between months and to see the impact of individual storms.



This is an automated product based solely on SNOTEL data, provisional data are subject to change.
This product is a statistically based guidance forecast combining indices of snowpack and precipitation.
Skill is defined as the correlation (squared) between the guidance and observed during calibration.
This product does not consider climate information such as El Nino or short range weather forecasts, or a variety of other factors considered in the official forecasts. This product is not meant to replace or supercede the official forecasts produced in coordination with the National Weather Service.
Science Contact: Cara.s.McCarthy@por.usda.gov www.wcc.nrcs.usda.gov/wsf/daily_forecasts.html

NRCS

Daily maps on snow, precipitation, temperature and soil moisture. Extremes, percentiles, anomalies, etc.



NRCS Natural Resources Conservation Service

Utah Water Supply Outlook Report

April, 2015

Bryce Canyon Snow Course, March 27, 2015

Photo by Lynn Kitchen, NRCS

NRCS Natural Resources Conservation Service

Utah Climate and Water Report

June 2015

Grantsville Reservoir, June 2015

Photo by Jordan Clayton

Weekly air and soil temperature table

Soil Temperature - Utah Soil Climate Analysis Network - Jun-15-2015									
Site name	County	Weekly* Average Air Temp	Weekly* Maximum Air Temp	Weekly* Minimum Air Temp	Soil Temperature				
					2"	4"	8"	20"	40"
		°F	°F	°F	°F				
WESTERN									
Grouse Creek	*Box Elder*	64	80	41	66	67	66	60	57
Park Valley	*Box Elder*	68	85	46	68	68	71	67	60
Goshute	*Tooele*	66	85	43	67	71	73	66	59
Dugway	*Tooele*	72	90	49	82	82	81	73	74
Tule Valley	*Millard*	73	91	49	79	84	86	81	73
Hal's Canyon	*Millard*	68	87	46	72	73	78	70	63
Enterprise	*Washington*	64	91	40	73	76	75	67	60
DIXIE									
Sand Hollow	*Washington*	79	101	58	92	94	91	80	75
NORTH CENTRAL									
Blue Creek	*Box Elder*	67	83	46	69	71	69	64	58
Cache Junction	*Cache*	66	87	47	63	64	62	57	54
Grantsville	*Tooele*	71	91	52	74	76	74	65	61
SOUTH CENTRAL									
Nephi	*Juab*	68	89	42	72	73	72	66	60
Ephraim	*Sanpete*	64	91	40	62	64	65	61	55
Holden	*Millard*	68	90	40	75	78	78	70	64
Milford	*Beaver*	65	87	42	68	68	66	62	58
Manderfield	*Beaver*	62	85	38	67	68	65	61	56
Circleville	*Piute*	59	83	35	70	72	70	60	54
Panguitch	*Garfield*	57	80	35	59	60	58	52	48
Cave Valley	*Washington*	64	84	42	68	72	73	69	64
Vermillion	*Kane*	62	82	45	64	66	68	62	56
Spooky	*Kane*	66	85	50	71	72	74	68	65
NORTHERN MOUNTAINS									
Chicken Ridge, sagebrush	*Morgan*	59	73	41	57	57	57	54	50
Chicken Ridge, aspen	*Morgan*	59	73	41	55	55	53	50	48
Buffalo Jump	*Rich*	60	77	41	62	63	62	57	na
Morgan	*Morgan*	63	84	42	75	75	74	67	60
UINTAH BASIN									
Mountain Home	*Duchesne*	59	76	41	66	63	63	59	60
Little Red Fox	*Duchesne*	65	86	45	62	69	69	64	58
Split Mountain	*Uintah*	67	86	47	73	74	75	70	64
SOUTHEAST									
Price	*Carbon*	65	85	46	64	70	72	66	62

Weekly soil moisture table with precipitation and comparisons to previous years plus water availability.

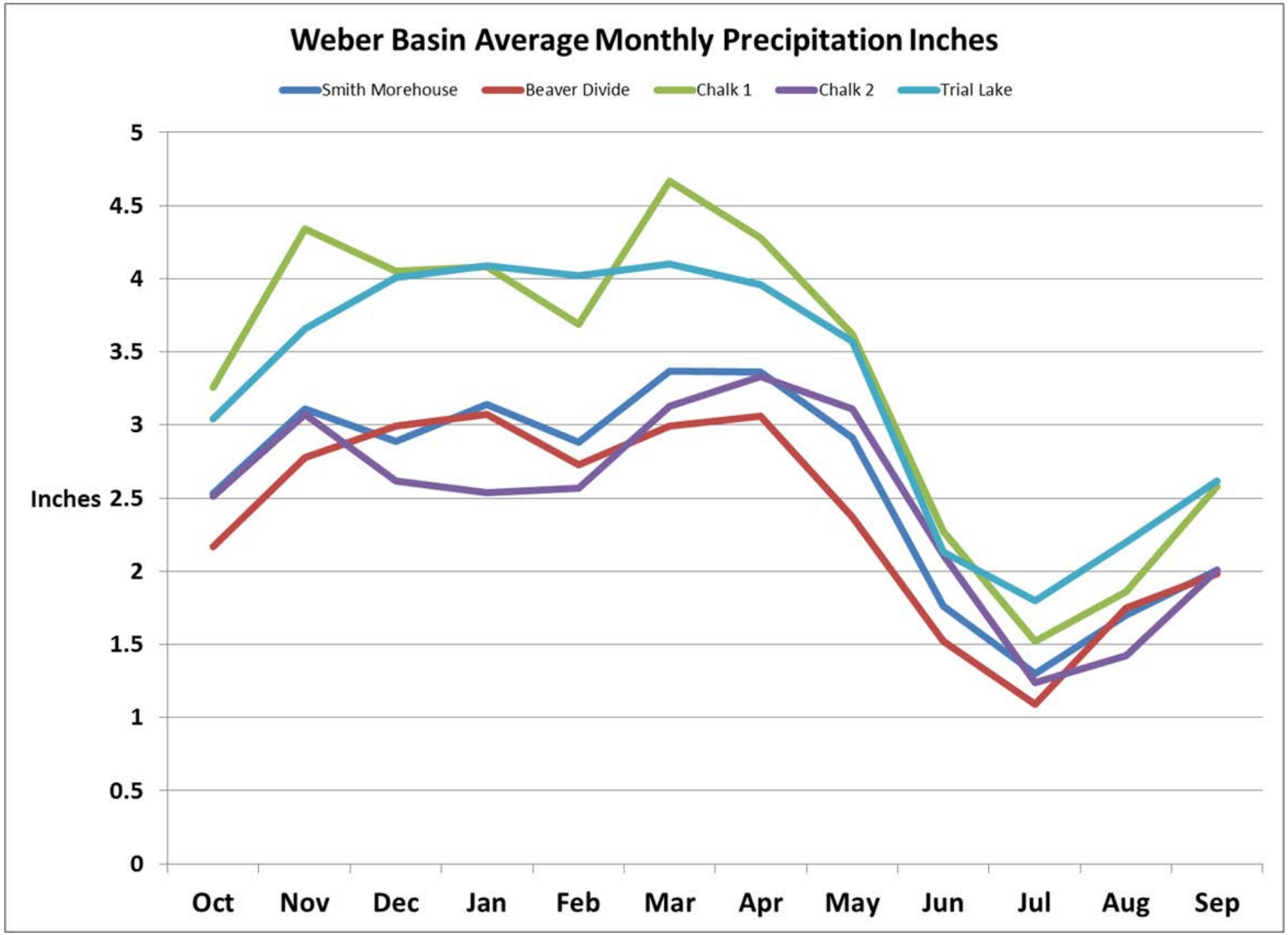
Soil Moisture - Utah Soil Climate Analysis Network - Jun-15-2015

Site name	Weekly Precip	Current Precip[1]	Prev. Yr. Precip[2]	Soil Moisture 2"	4"	8"	20"	40"	Current Avail. Water**	Current Avail. Water % of AWC*	Prev. Yr. Avail. Water**	Prev. Yr. Avail. Water % of AWC*
	in	*in*	*in*	*volume %*					*in*	*%*	*in*	*%*
WESTERN												
Grouse Creek	0.24	11.0	8.5	3	12	19	23	27	4.7	69	2.3	33
Park Valley	0.00	7.7	6.1	1	3	13	nd	20	1.6	36		
Goshute	0.13	6.5	6.1	nd	nd	nd	nd	nd				
Dugway	0.00	7.2	4.2	nd	nd	nd	nd	nd				
Tule Valley	0.03	4.2	3.7	15	16	21	18	10	4.7	74	4.9	77
Hal's Canyon	0.49	4.7	2.9	7	8	11	12	9	1.2	22	1.1	21
Enterprise	0.14	9.1	4.1	6	27	26	17	16	1.9	48	1.0	26
DIXIE												
Sand Hollow	0.07	4.9	5.9	0	1	0	1	0	0.1	5	0.3	12
NORTH CENTRAL												
Blue Creek	0.08	10.8	8.8	17	21	29	32	19	4.1	80	4.0	79
Cache Junction	0.18	16.2	11.6	31	22	40	37	40	4.2	107	1.4	35
Grantsville	0.18	8.4	6.9	5	11	19	nd	nd				
SOUTH CENTRAL												
Nephi	0.01	8.7	7.3	13	17	16	8	6	0.7	16	0.6	12
Ephraim	0.73	8.6	6.8	30	38	38	40	36	9.1	98		
Holden	0.23	5.2	5.7	7	7	14	14	14	0.8	13	0.7	12
Milford	0.02	6.8	3.9	13	21	19	31	17	2.4	37	2.4	36
Manderfield	0.10	7.9	5.9	18	13	13	11	5	0.7	12	0.6	11
Circleville	0.06	5.2	2.9	0	12	8	10	15	1.0	15	1.1	17
Panguitch	0.73	7.0	4.1	12	23	13	22	32	2.1	36	1.3	22
Cave Valley	0.07	11.7	7.7	1	1	2	4	6	1.1	20	0.1	2
Vermillion	0.97	9.6	6.7	0	7	4	9	15	1.5	31	0.0	0
Spooky	1.00	7.8	4.5	7	9	5	17	2	1.4	57	0.7	27
NORTHERN MOUNTAINS												
Chicken Ridge, sagebrush	0.22	11.5	5.4	10	13	16	23	23	4.4	61	2.5	34
Chicken Ridge, aspen	0.22	11.5	5.4	11	17	17	15	16	2.0	34	1.0	17
Buffalo Jump	0.25	9.4	6.0	12	15	16	18	na	1.5	35	0.2	5
Morgan	0.08	11.8	11.8	27	22	29	35	21	7.2	87	6.9	83
UINTAH BASIN												
Mountain Home	0.48	8.0	4.1	11	13	16	13	7	0.1	2	0.8	14
Little Red Fox	0.04	6.2	2.6	5	20	25	27	23	3.1	43	2.0	28
Split Mountain	0.21	6.2	4.9	13	25	22	14	13	2.6	39	1.5	23

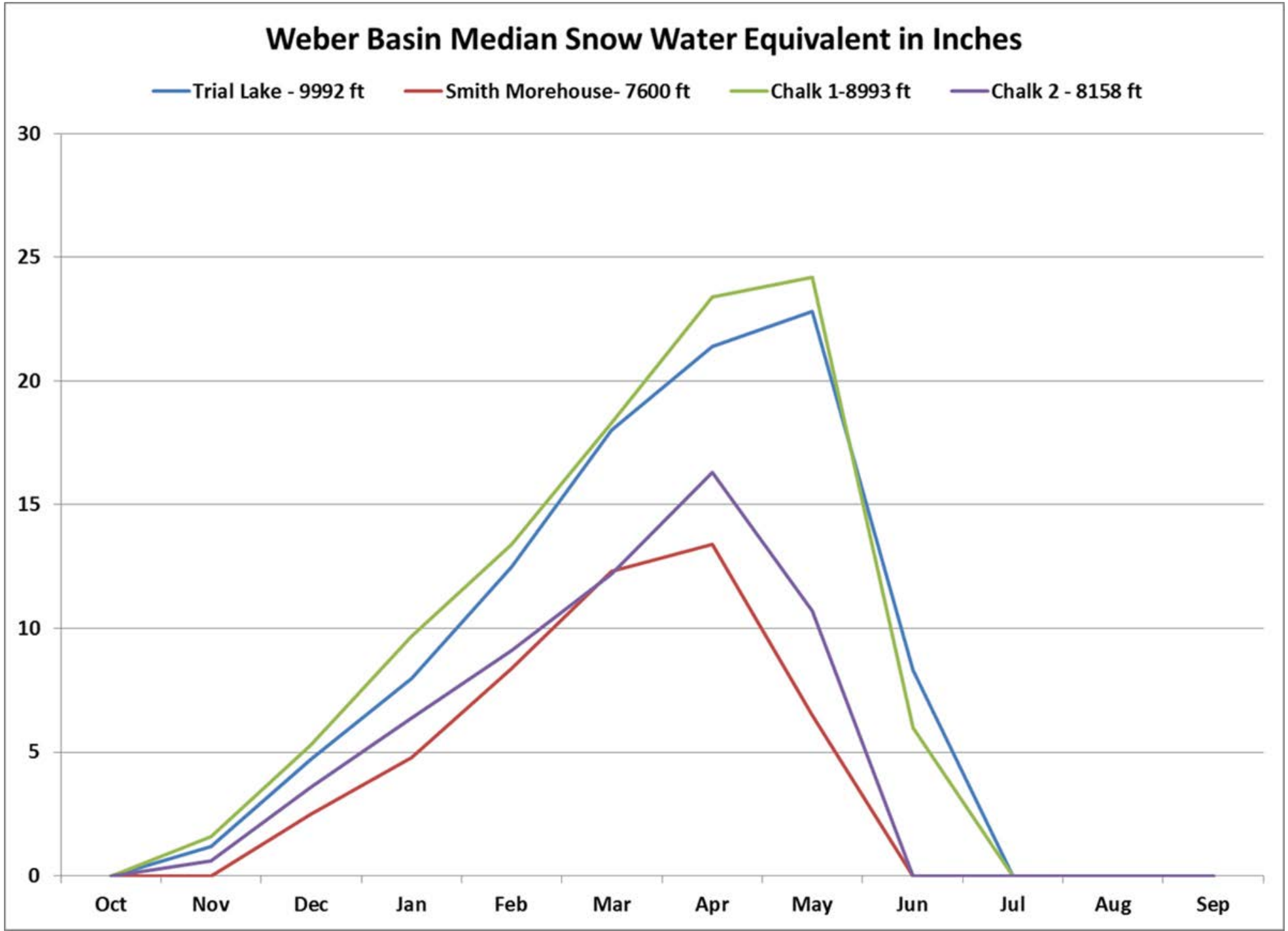
For Water Management We are in the process of creating "The Hydrology of"

Various basins across the state

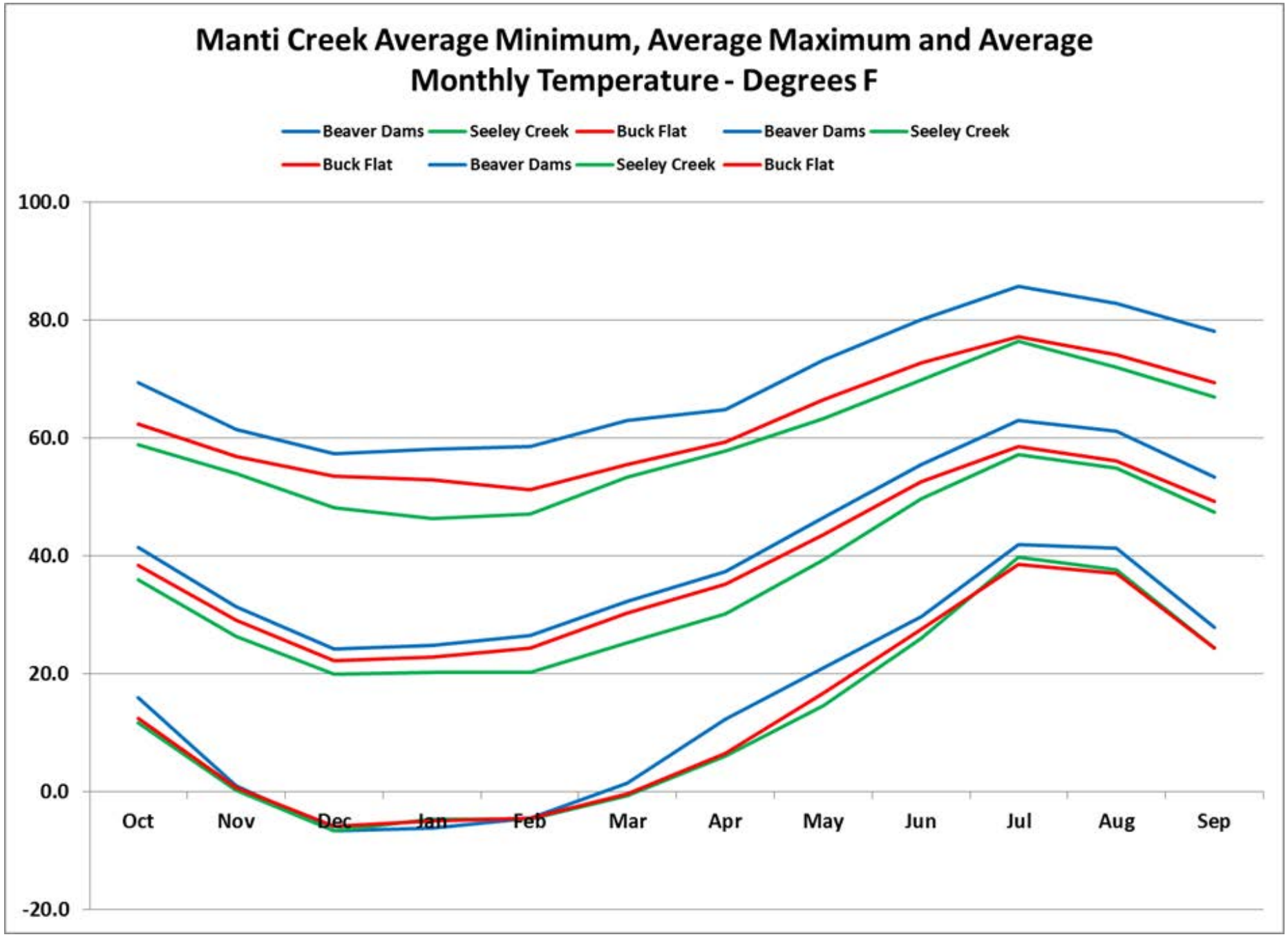
To include: precipitation



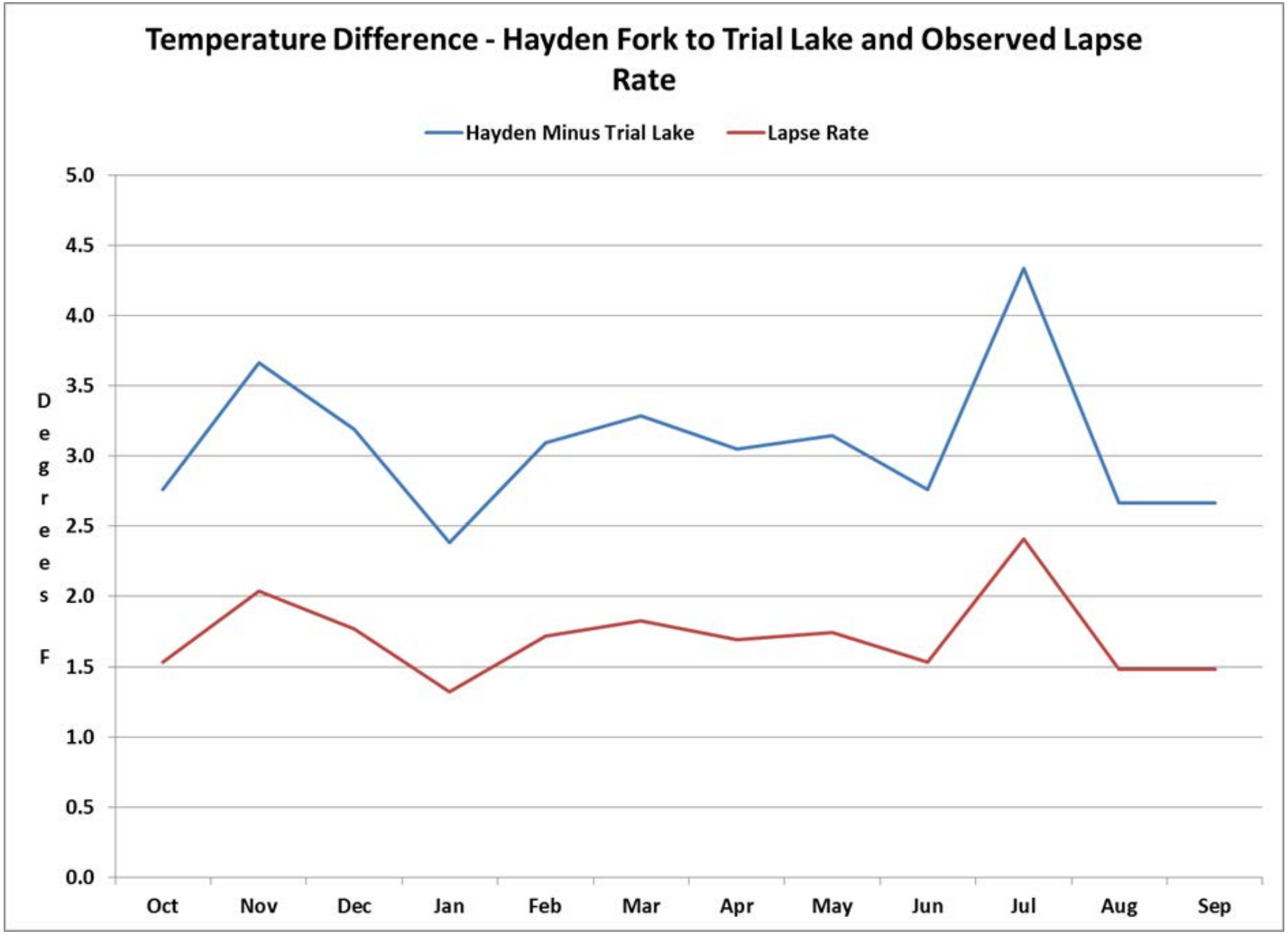
Snow


Weber Basin Median Snow Water Equivalent in Inches
Trial Lake - 9992 ft
Smith Morehouse- 7600 ft
Chalk 1-8993 ft
Chalk 2 - 8158 ft
30
25
20
15
10
5
0
Oct
Nov
Dec
Jan
Feb
Mar
Apr
May
Jun
Jul
Aug
Sep

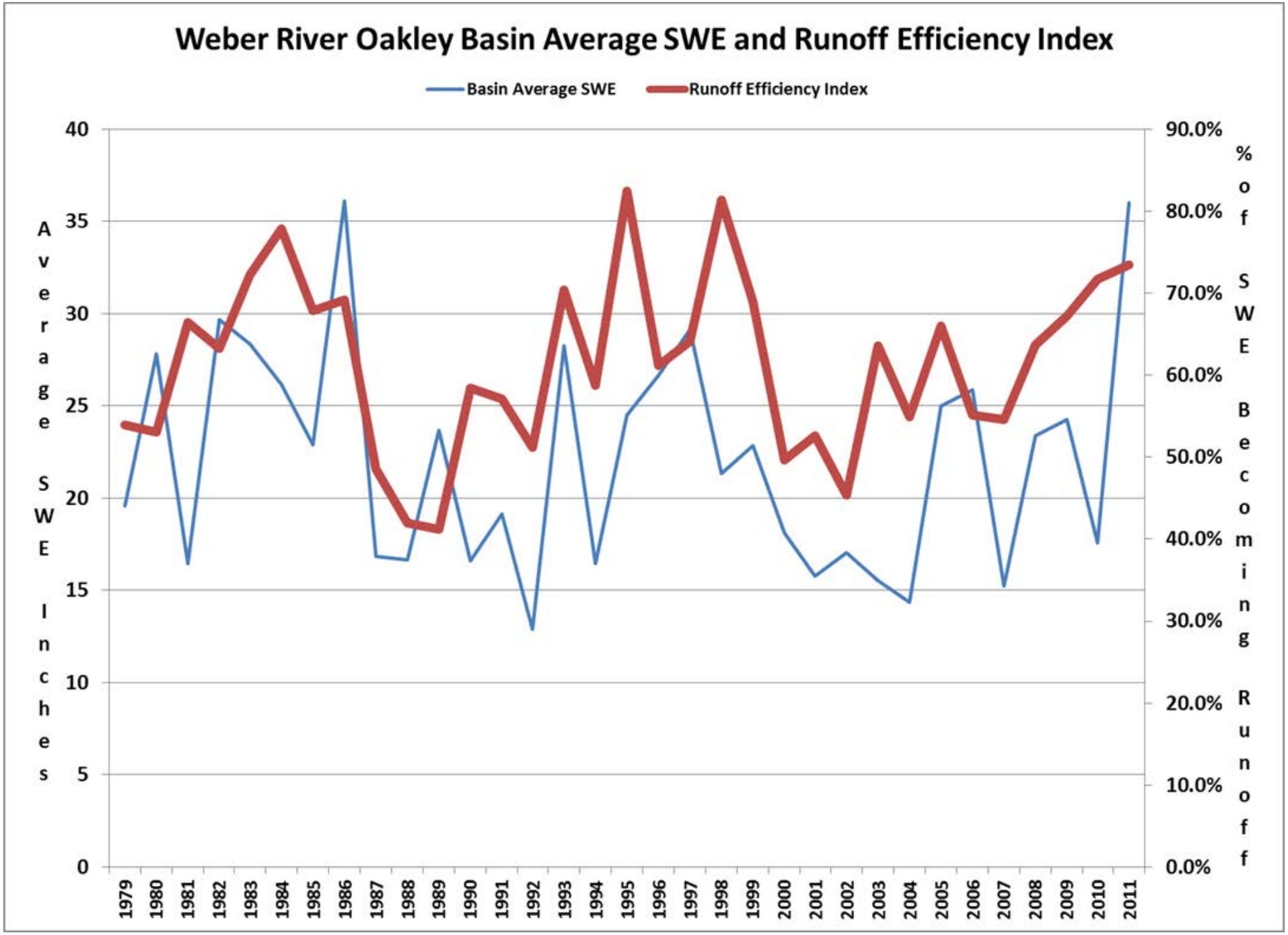
Temperature

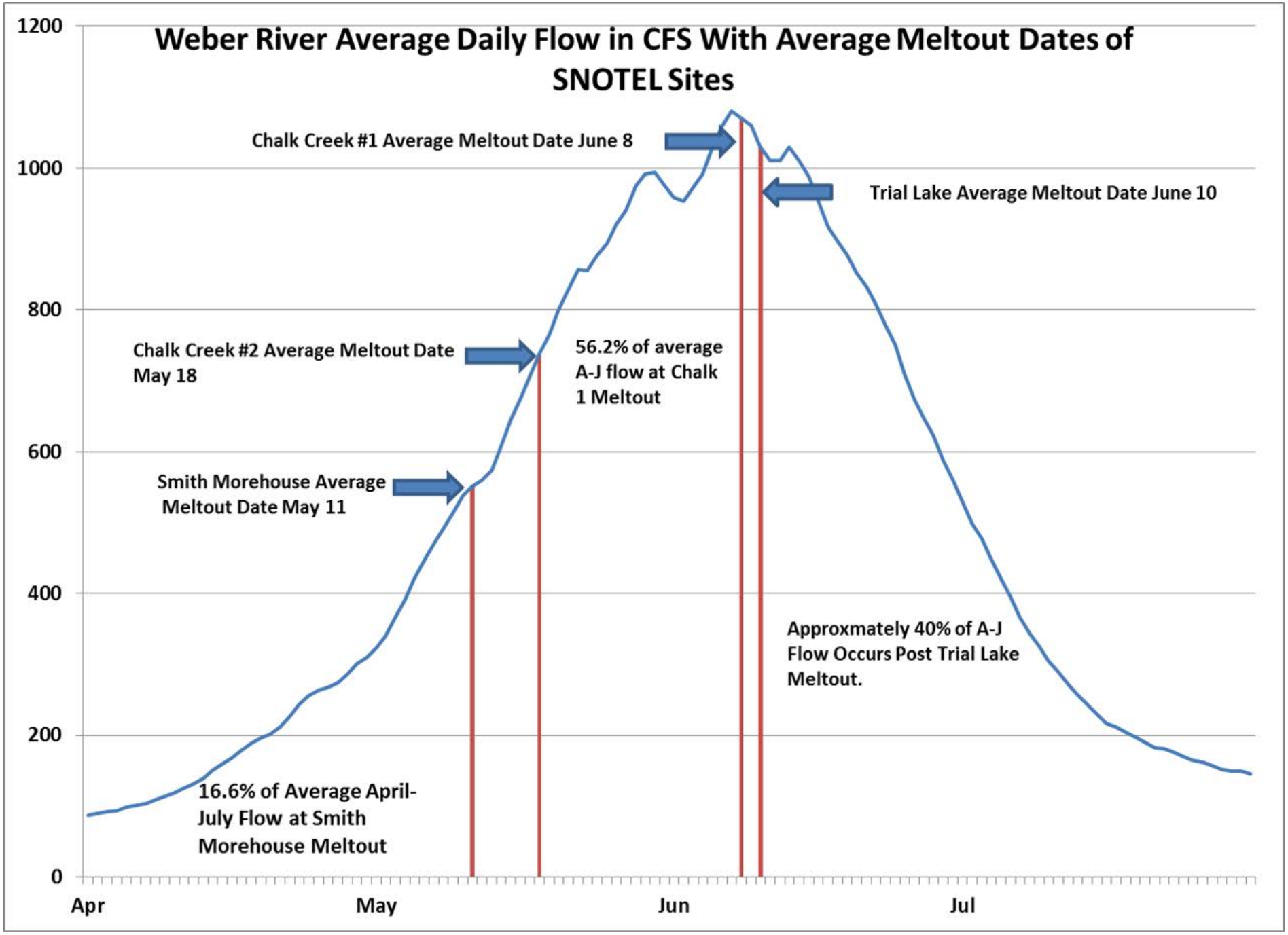


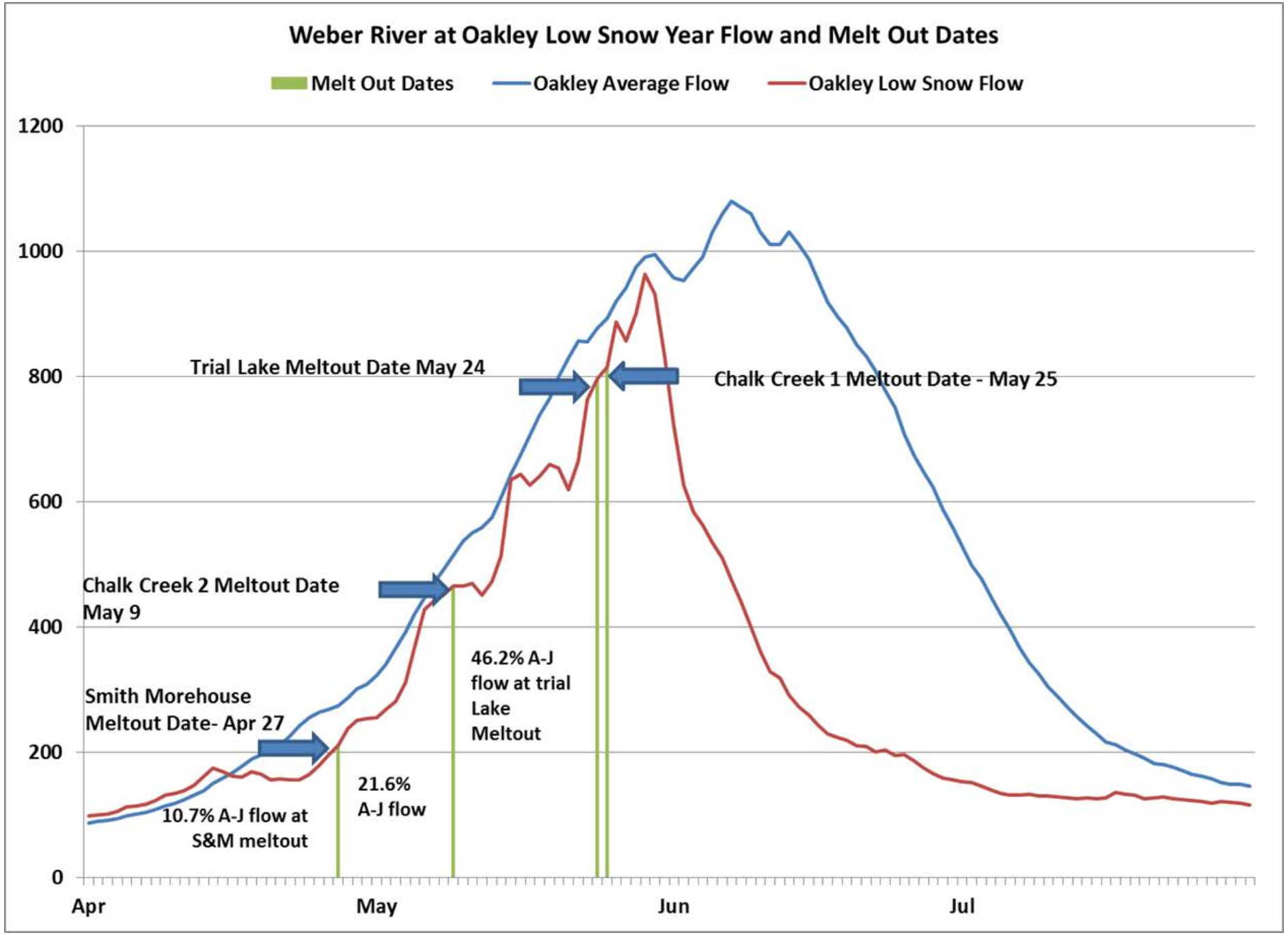
Observed temperature lapse rates

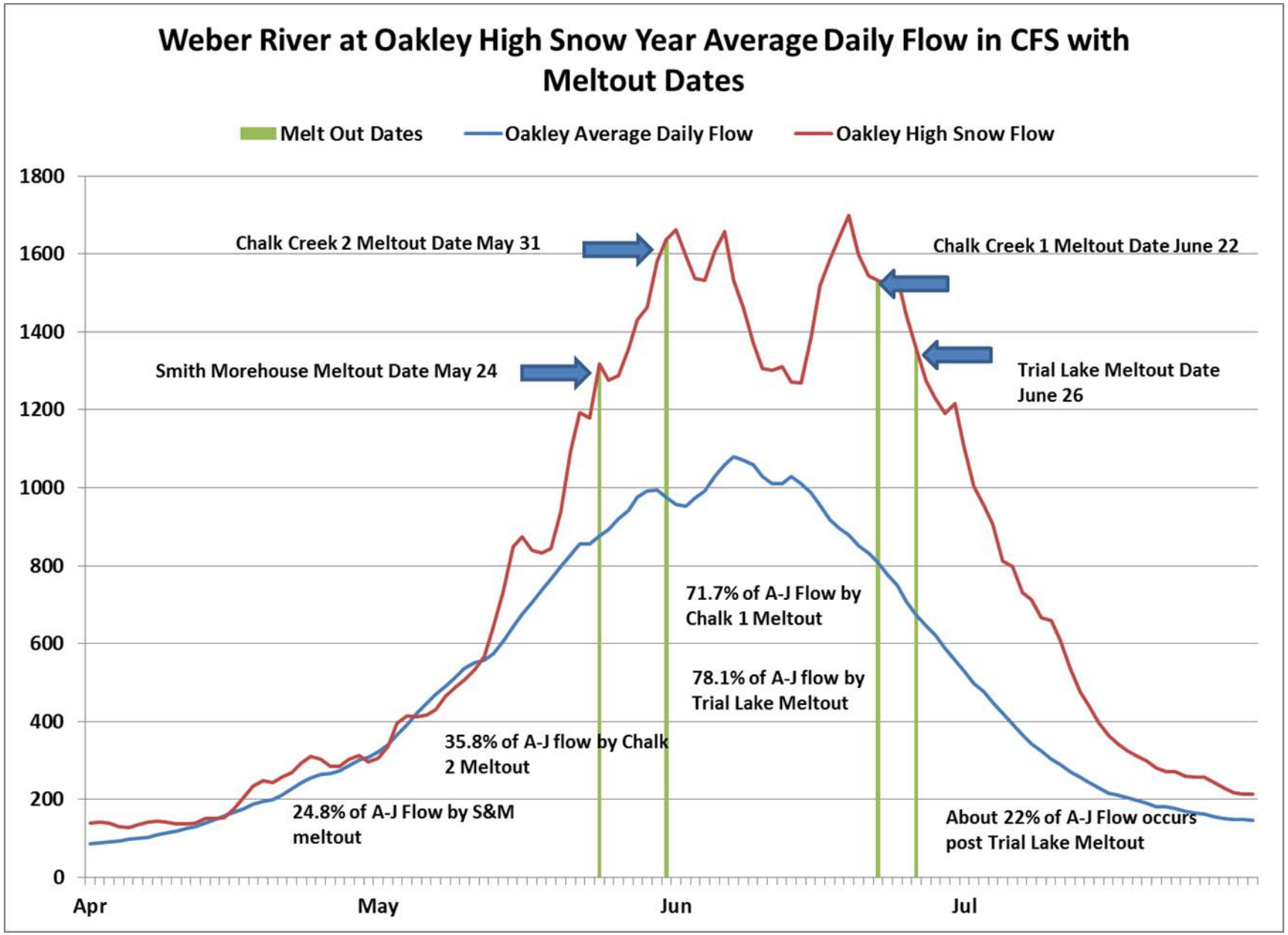


Runoff characteristics

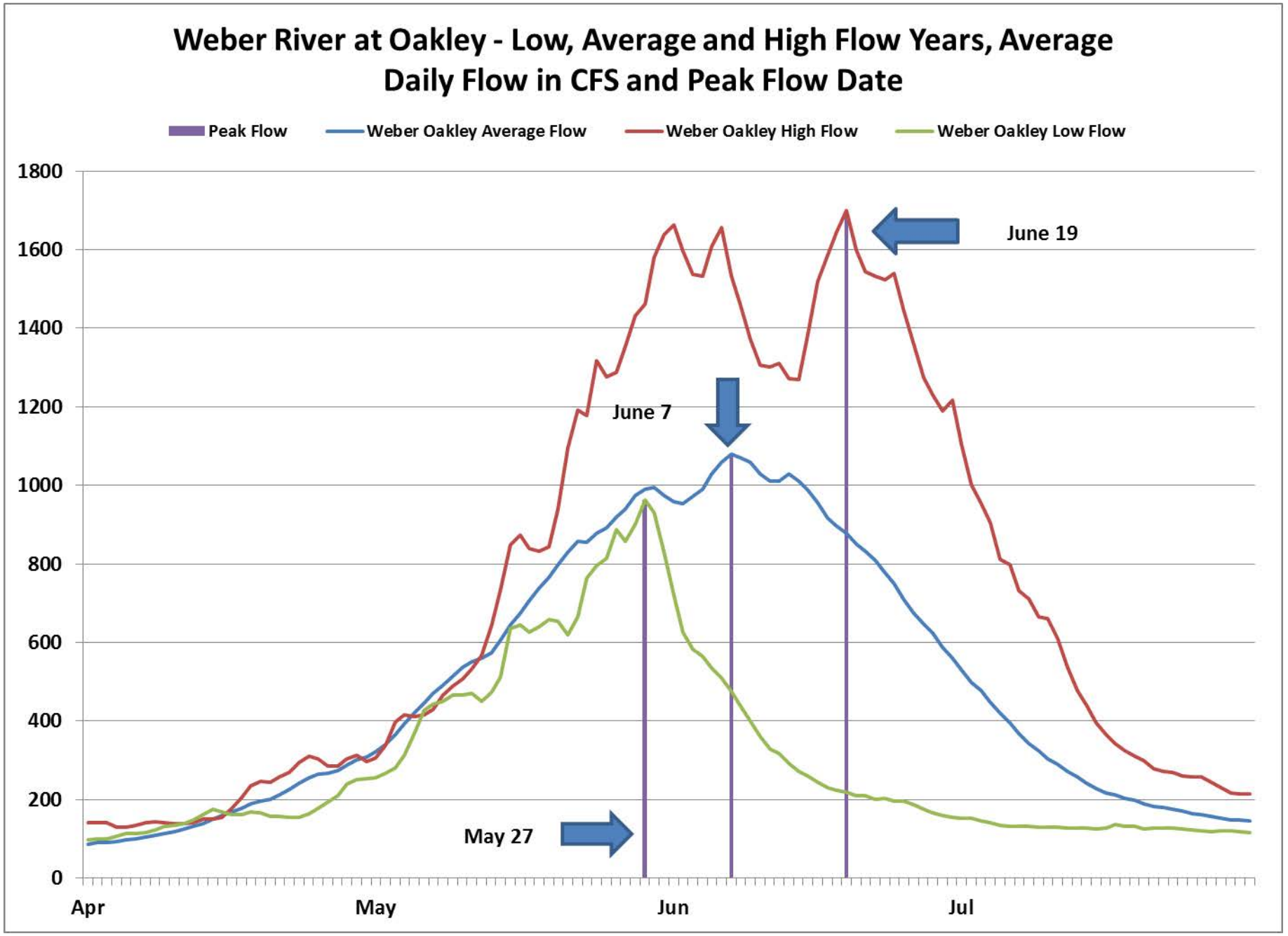


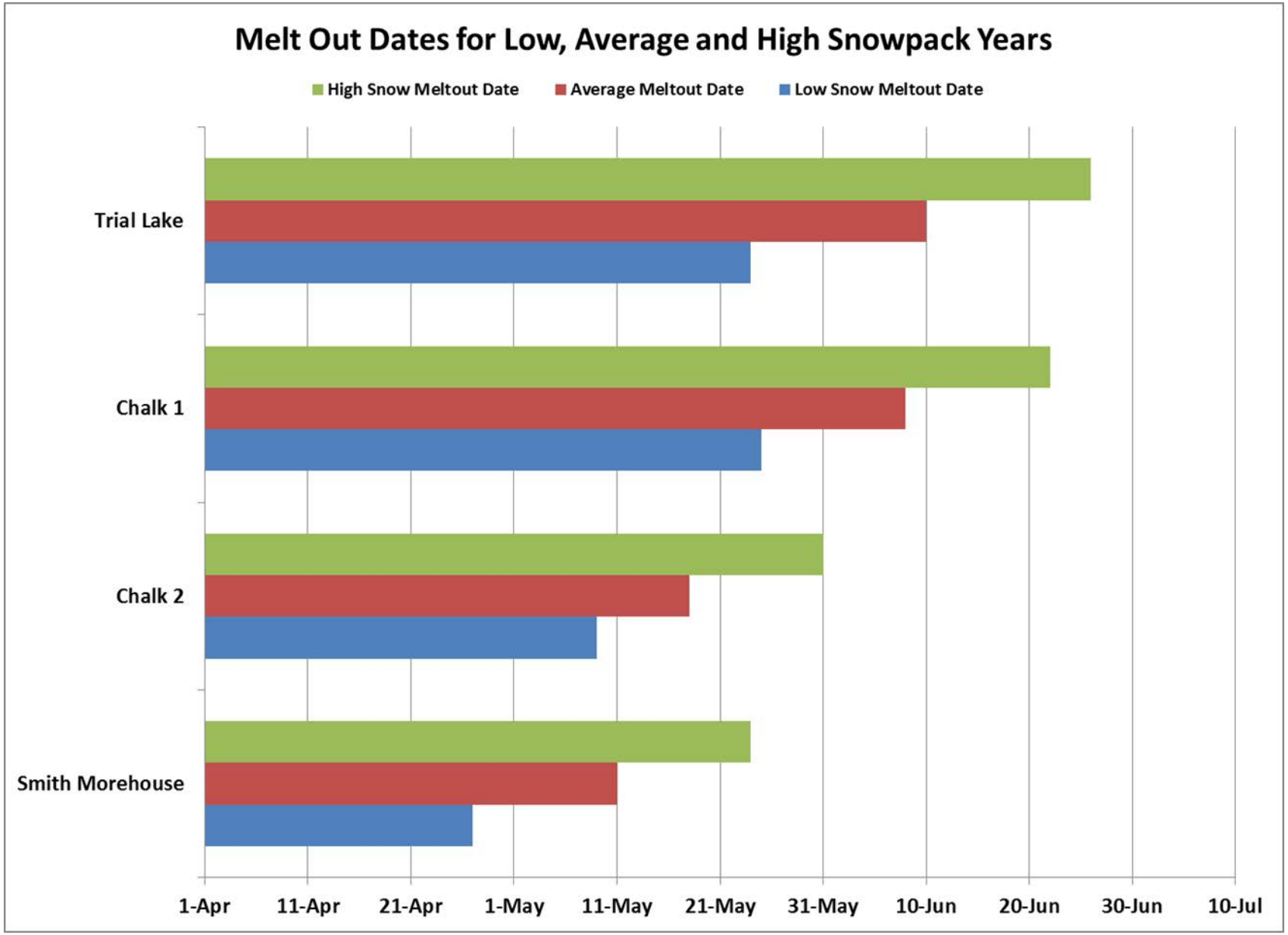

Weber River Average Daily Flow in CFS With Average Meltout Dates of SNOTEL Sites
1200
1000
800
600
400
200
0
Apr
May
Jun
Jul
Chalk Creek #1 Average Meltout Date June 8
Trial Lake Average Meltout Date June 10
Chalk Creek #2 Average Meltout Date May 18
56.2% of average A-J flow at Chalk 1 Meltout
Smith Morehouse Average Meltout Date May 11
Approxmately 40% of A-J Flow Occurs Post Trial Lake Meltout.
16.6% of Average April-July Flow at Smith Morehouse Meltout

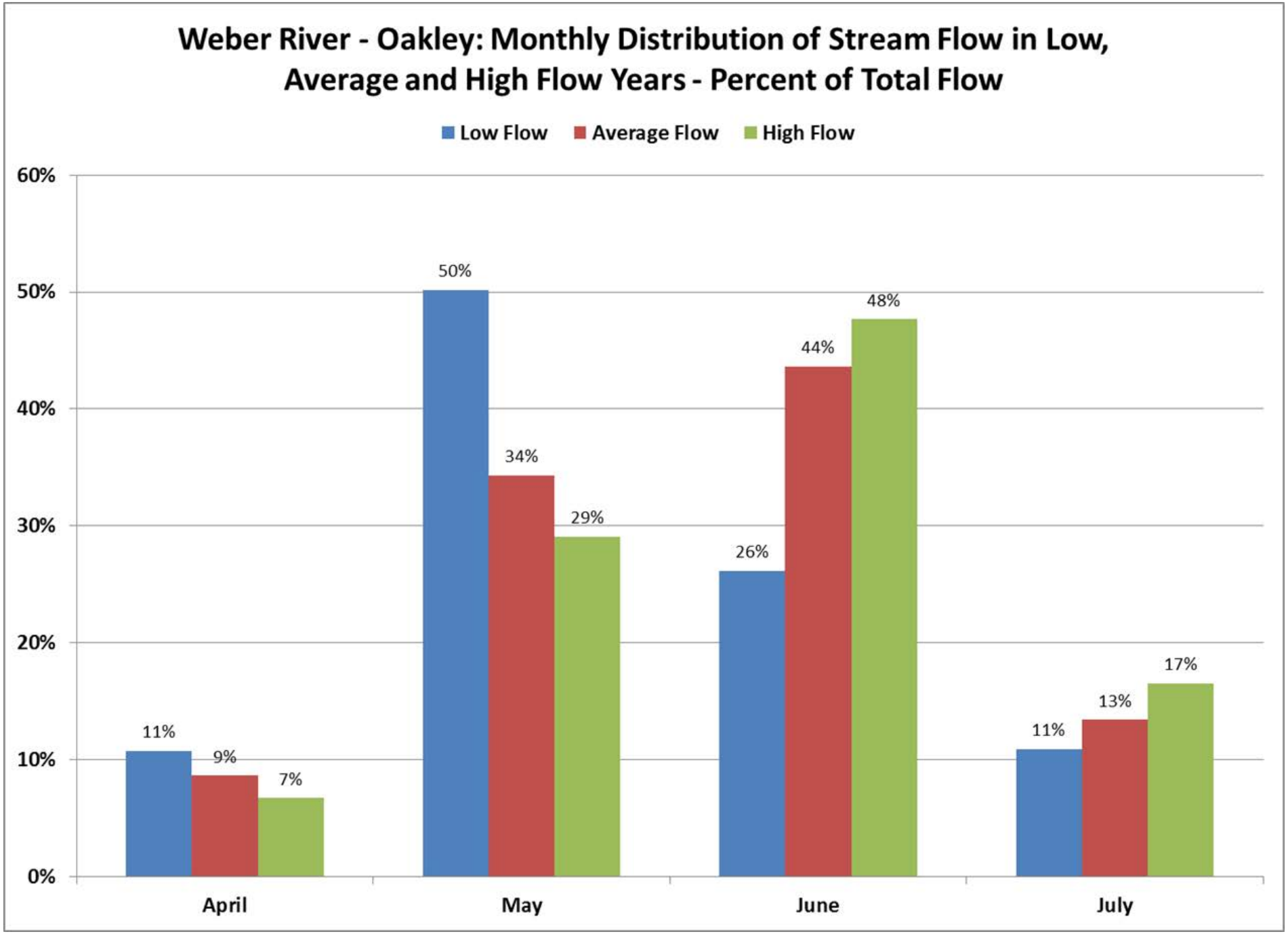

Weber River at Oakley Low Snow Year Flow and Melt Out Dates
Melt Out Dates
Oakley Average Flow
Oakley Low Snow Flow
1200
1000
800
600
400
200
0
Apr
May
Jun
Jul
Trial Lake Meltout Date May 24
Chalk Creek 1 Meltout Date - May 25
Chalk Creek 2 Meltout Date
May 9
Smith Morehouse
Meltout Date- Apr 27
46.2% A-J
flow at trial
Lake
Meltout
21.6%
A-J flow
10.7% A-J flow at
S&M meltout


Weber River at Oakley High Snow Year Average Daily Flow in CFS with Meltout Dates
Melt Out Dates
Oakley Average Daily Flow
Oakley High Snow Flow
1800
1600
1400
1200
1000
800
600
400
200
0
Apr
May
Jun
Jul
Chalk Creek 2 Meltout Date May 31
Chalk Creek 1 Meltout Date June 22
Smith Morehouse Meltout Date May 24
Trial Lake Meltout Date June 26
71.7% of A-J Flow by Chalk 1 Meltout
78.1% of A-J flow by Trial Lake Meltout
35.8% of A-J flow by Chalk 2 Meltout
24.8% of A-J Flow by S&M meltout
About 22% of A-J Flow occurs post Trial Lake Meltout

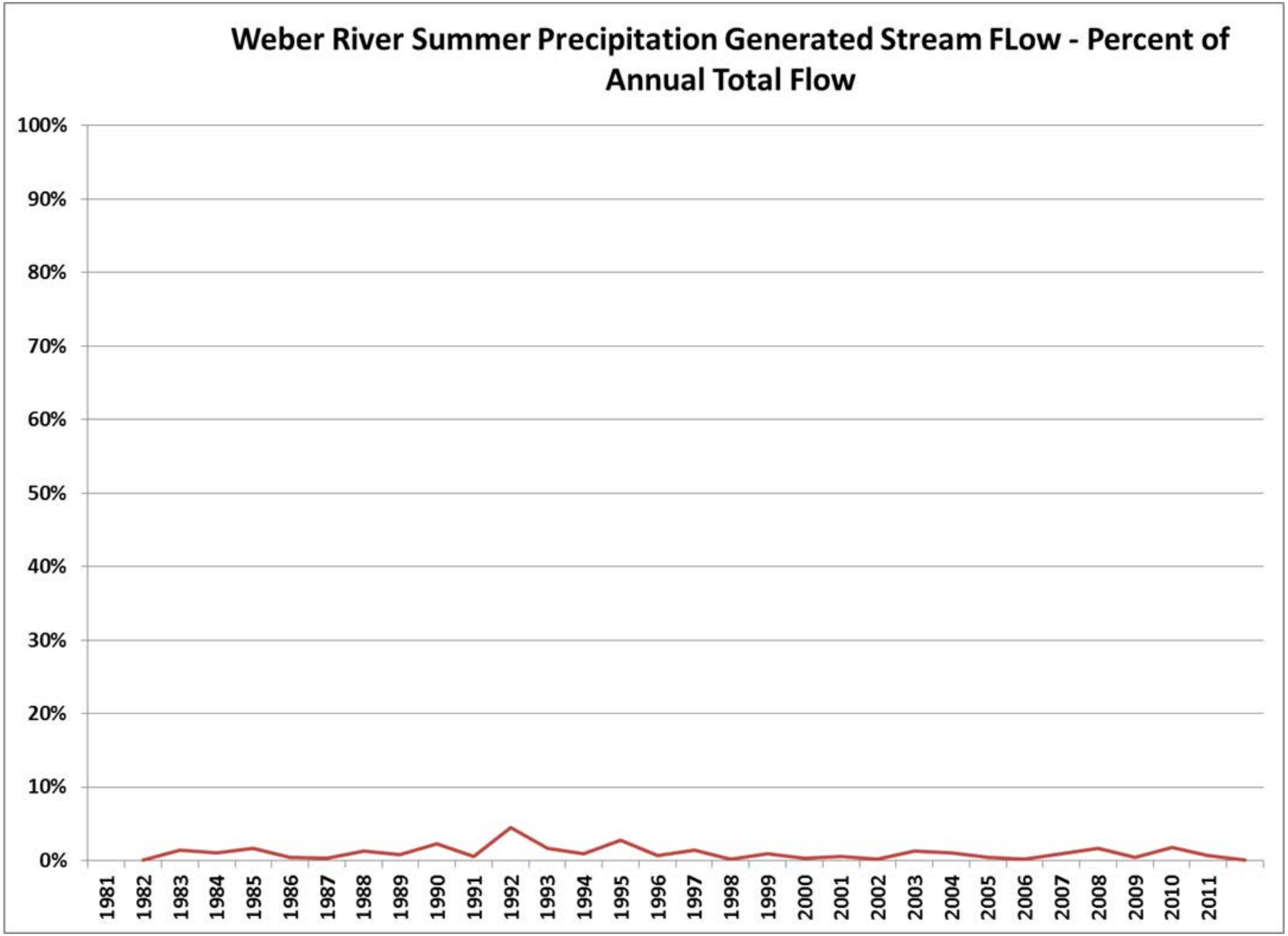
Timing of flow based on category: low, average or high



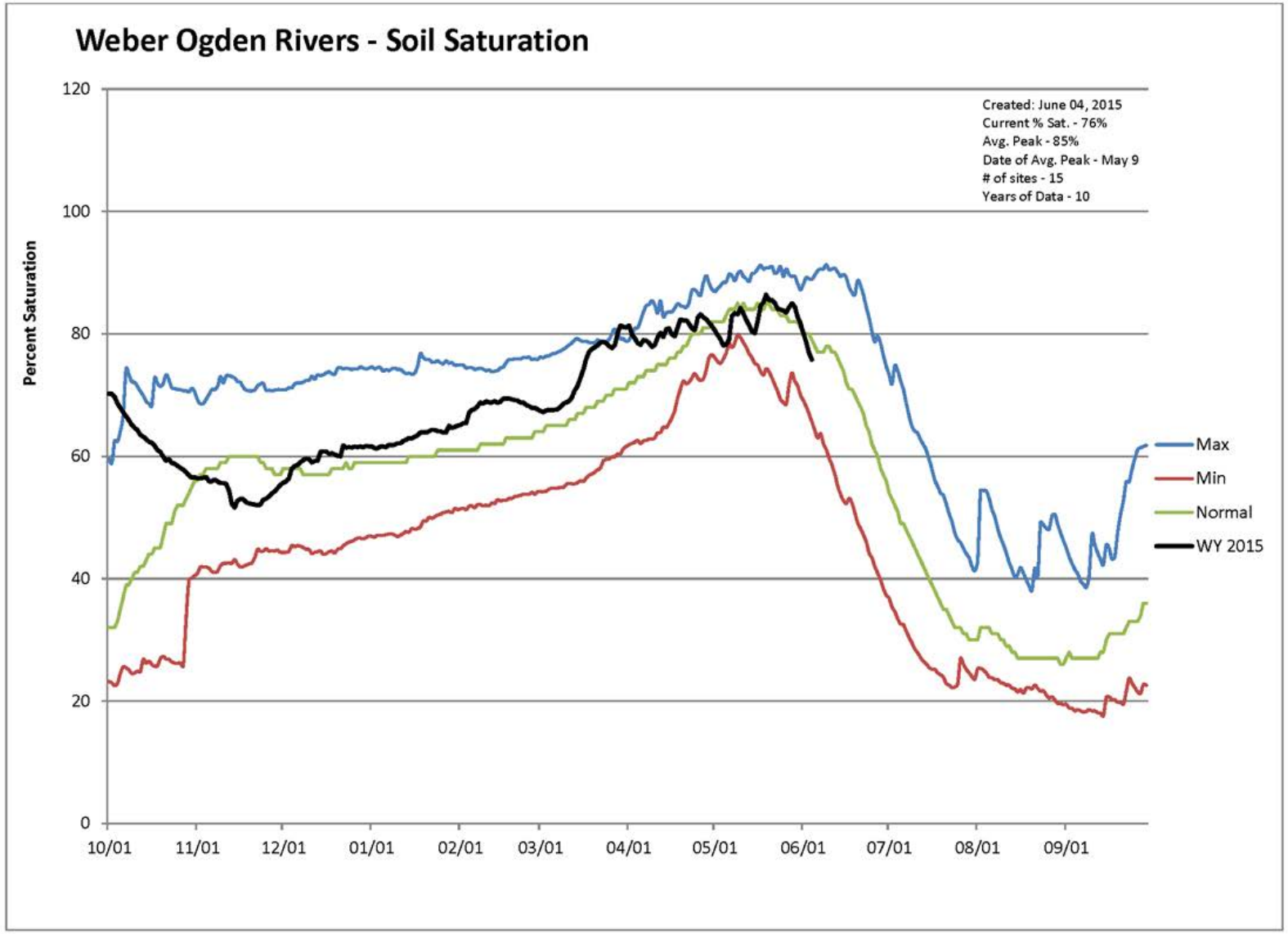

Melt Out Dates for Low, Average and High Snowpack Years
High Snow Meltout Date
Average Meltout Date
Low Snow Meltout Date
Trial Lake
Chalk 1
Chalk 2
Smith Morehouse
1-Apr
11-Apr
21-Apr
1-May
11-May
21-May
31-May
10-Jun
20-Jun
30-Jun
10-Jul


Weber River - Oakley: Monthly Distribution of Stream Flow in Low, Average and High Flow Years - Percent of Total Flow
Low Flow
Average Flow
High Flow
60%
50%
40%
30%
20%
10%
0%
11%
9%
7%
50%
34%
29%
26%
44%
48%
11%
13%
17%
April
May
June
July

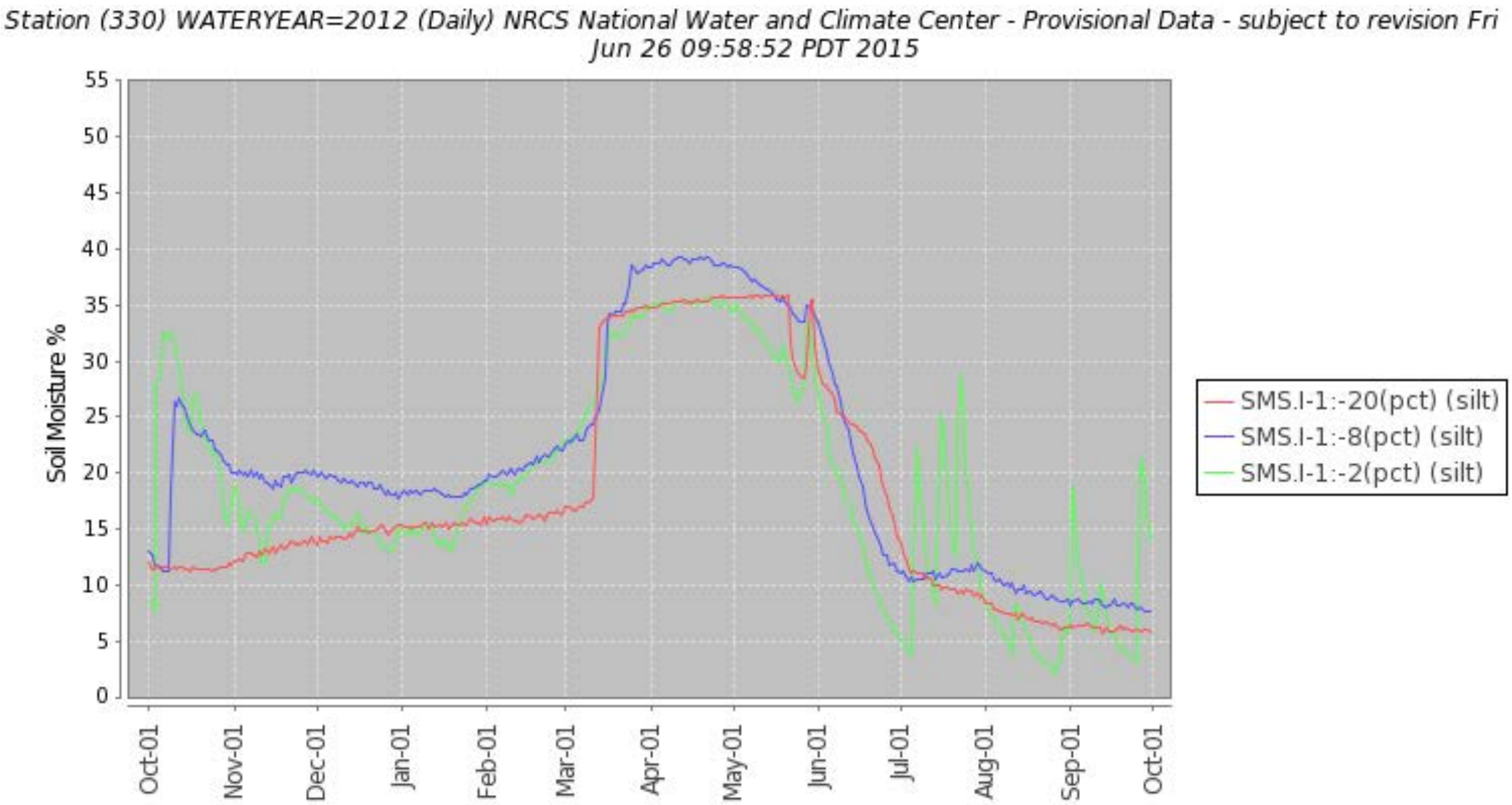
How much annual streamflow is generated by summer precipitation



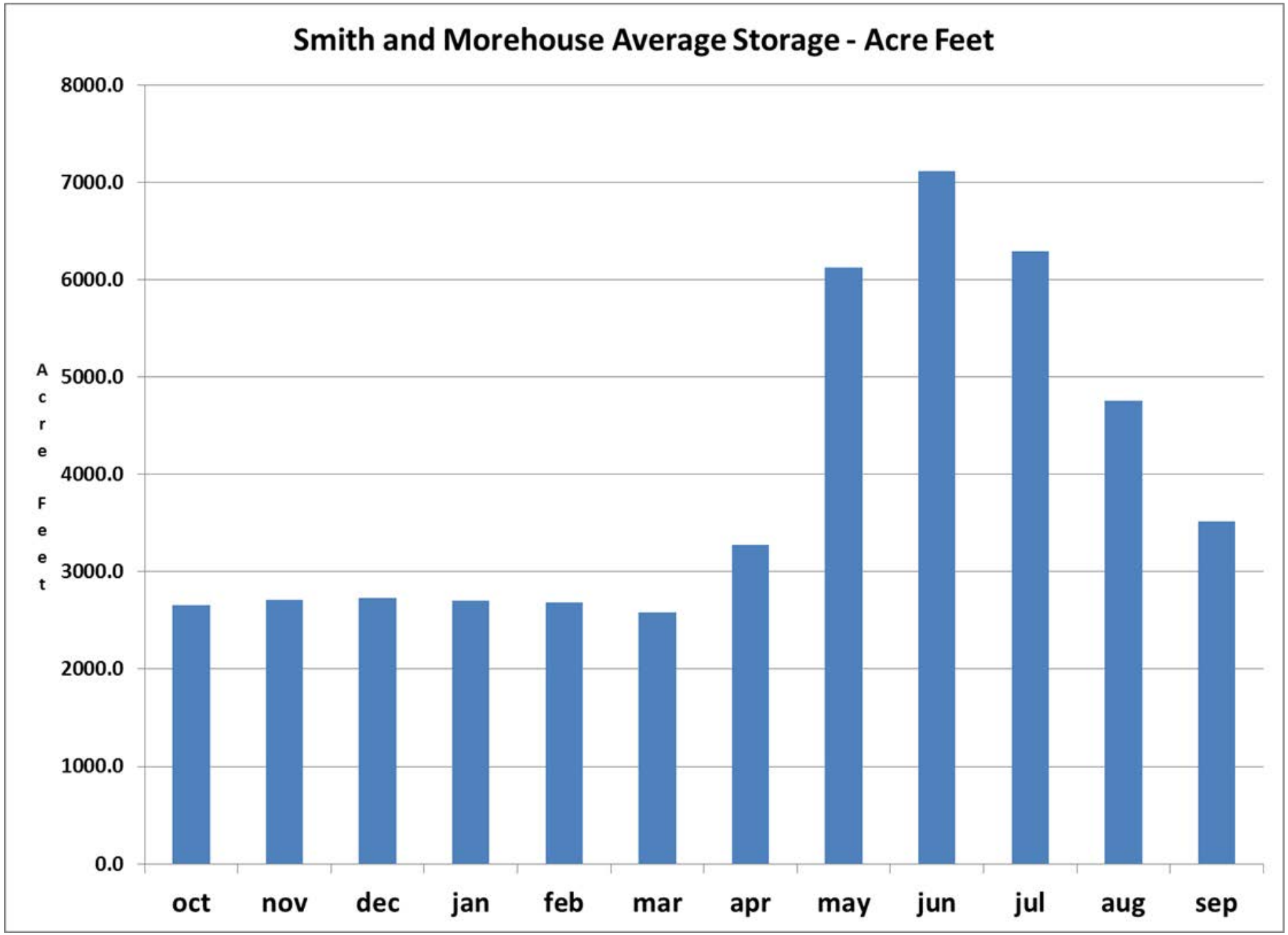
Soil Moisture characteristics of the basin.

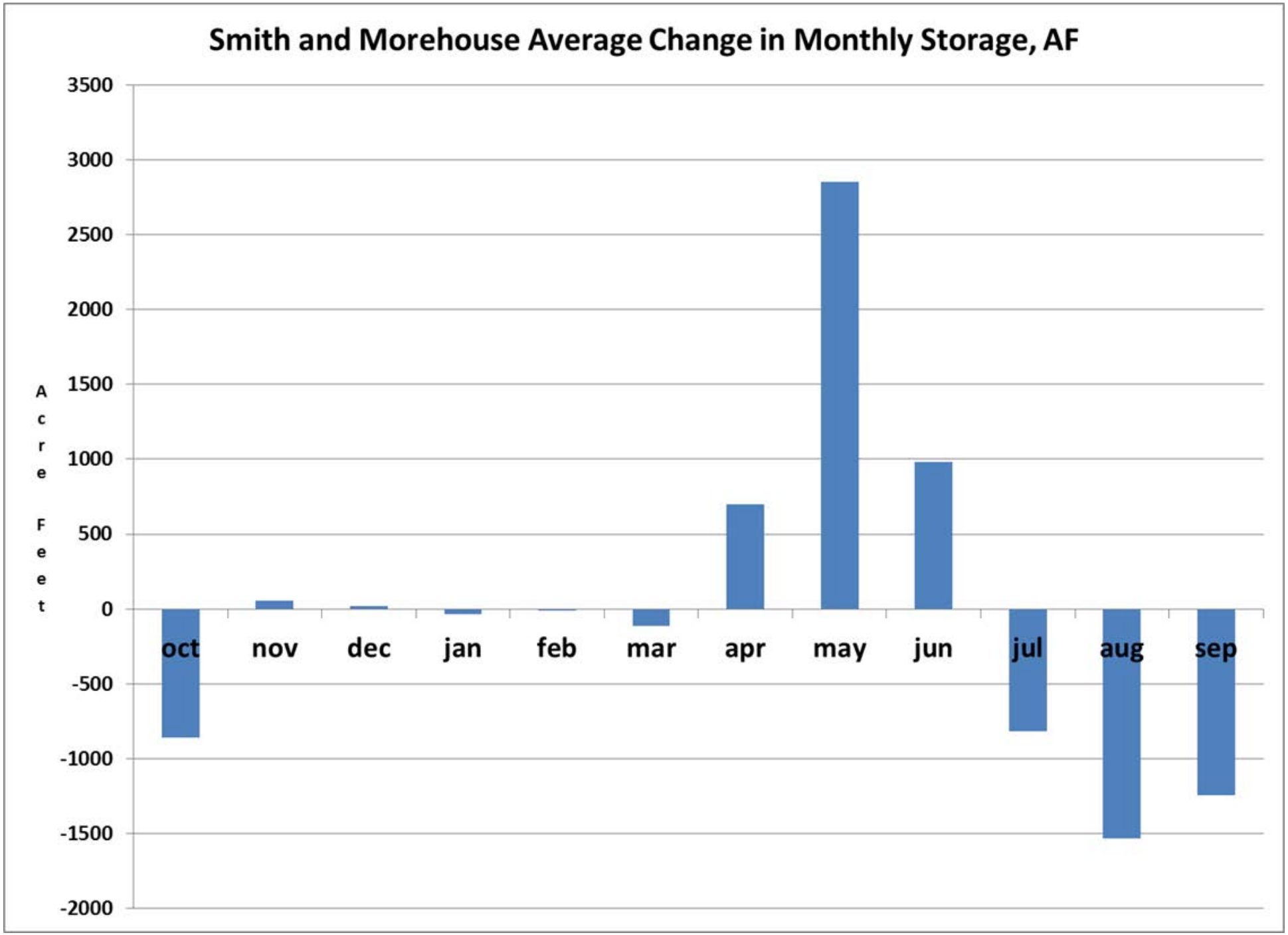


Soil moisture by individual site

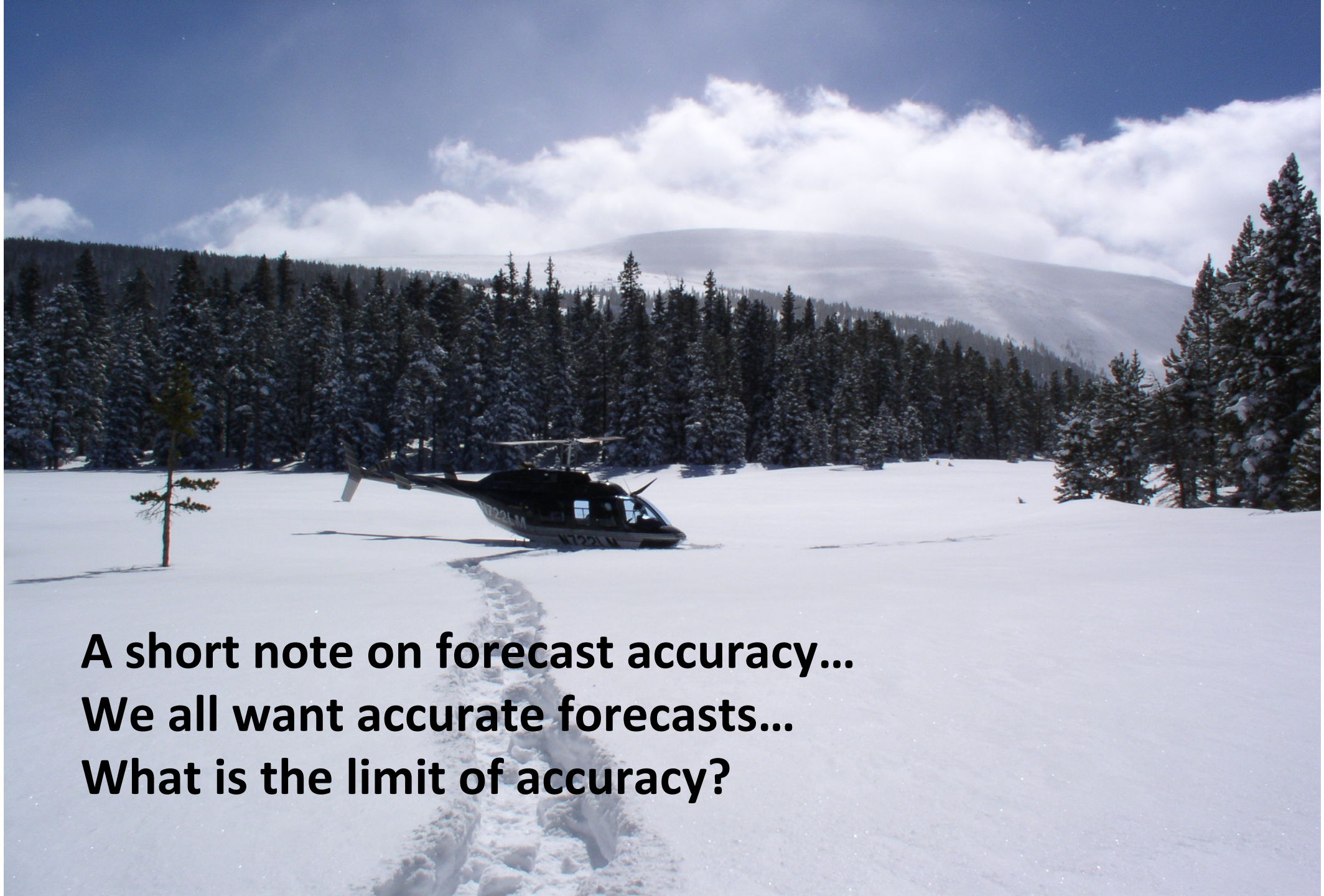


Reservoir management characteristics

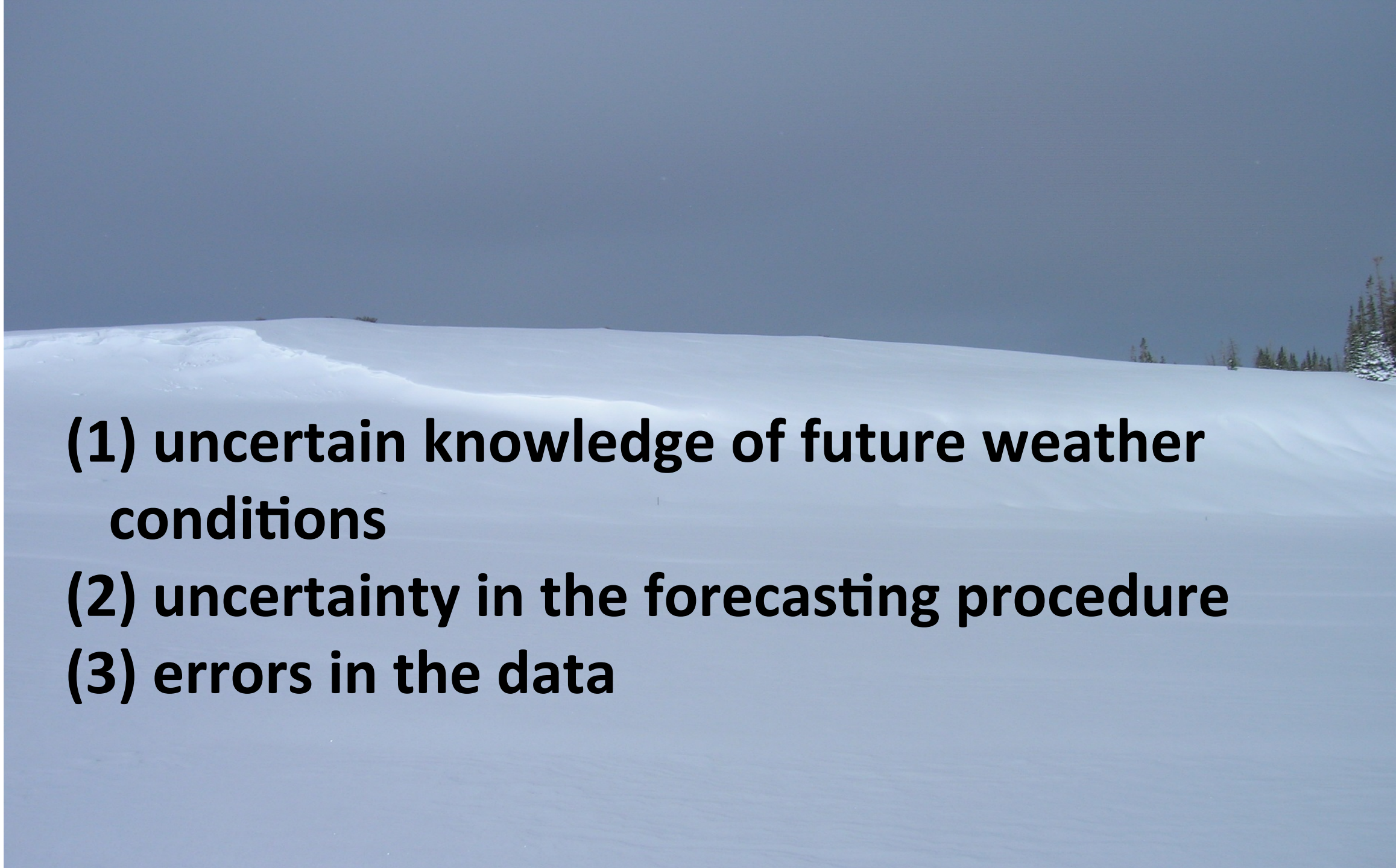



Smith and Morehouse Average Change in Monthly Storage, AF
3500
3000
2500
2000
1500
1000
500
0
-500
-1000
-1500
-2000
Acre Feet
oct
nov
dec
jan
feb
mar
apr
may
jun
jul
aug
sep

We have drafts available for: Weber Oakley, Chalk Creek, East Canyon Creek, Ogden River, Bear Stateline, Logan, Lakefork, Big Brush Creek, Sevier Hatch, Manti Creek, Fish Creek, Beaver River, Salina Creek and Coal Creek.



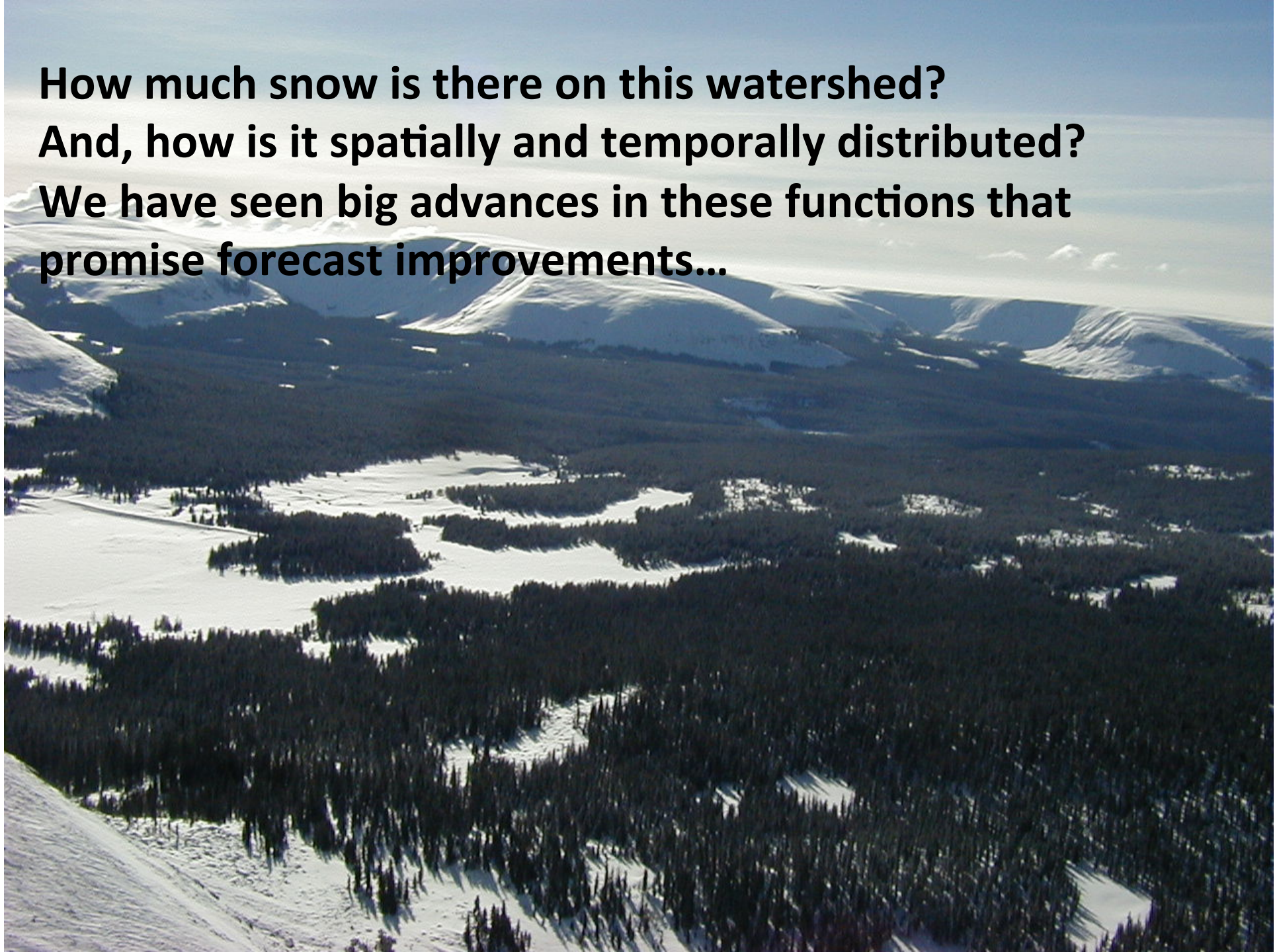
A short note on forecast accuracy…
We all want accurate forecasts…
What is the limit of accuracy?

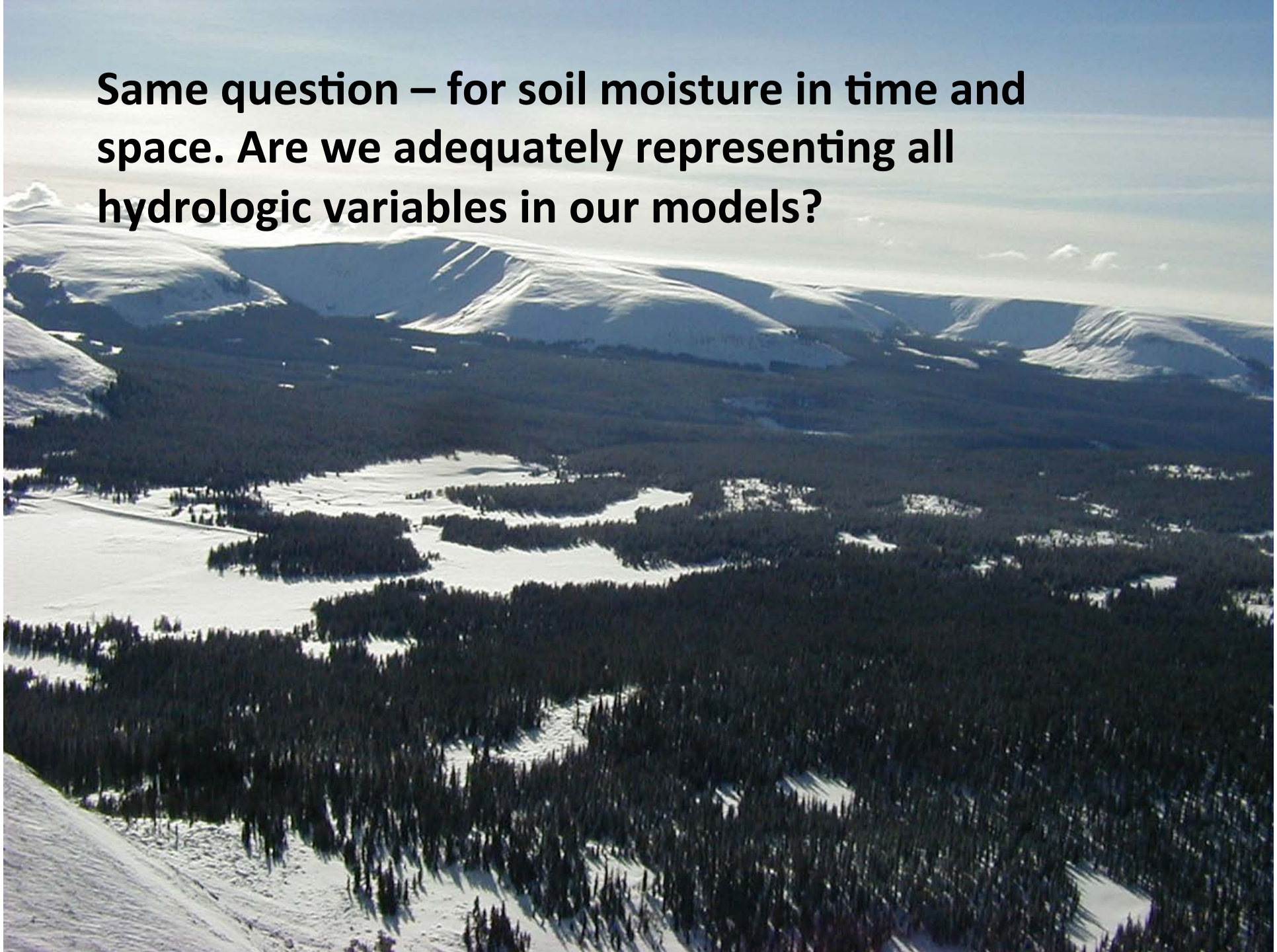


(1) uncertain knowledge of future weather conditions

(2) uncertainty in the forecasting procedure

(3) errors in the data


How much snow is there on this watershed?
And, how is it spatially and temporally distributed?
We have seen big advances in these functions that
promise forecast improvements…



Same question – for soil moisture in time and space. Are we adequately representing all hydrologic variables in our models?

Our ability to significantly increase forecast accuracy may ultimately reside in our ability to measure streamflow….

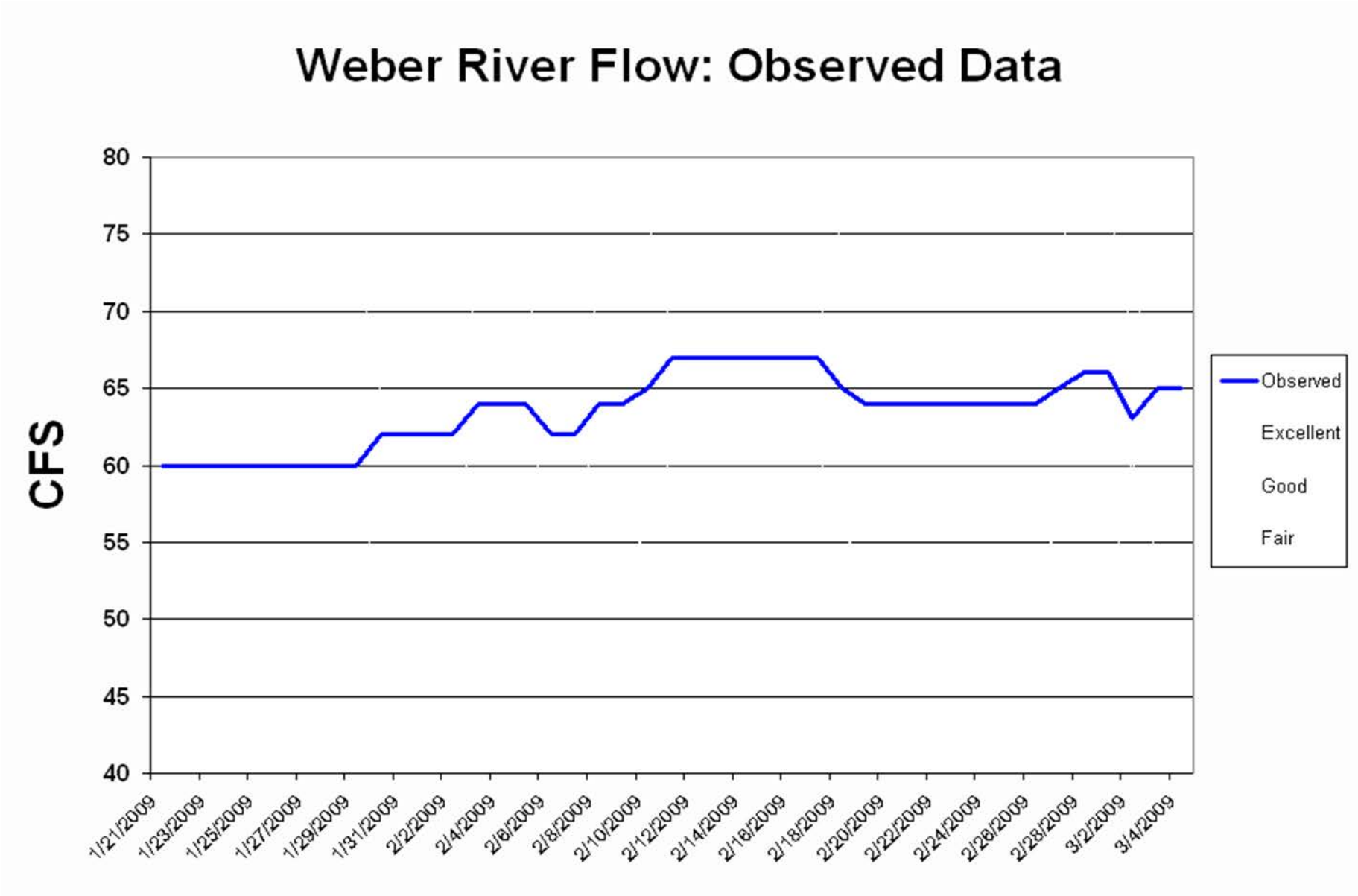
Forecast hydrology is pretty simple…

Streamflow = m*snow + b

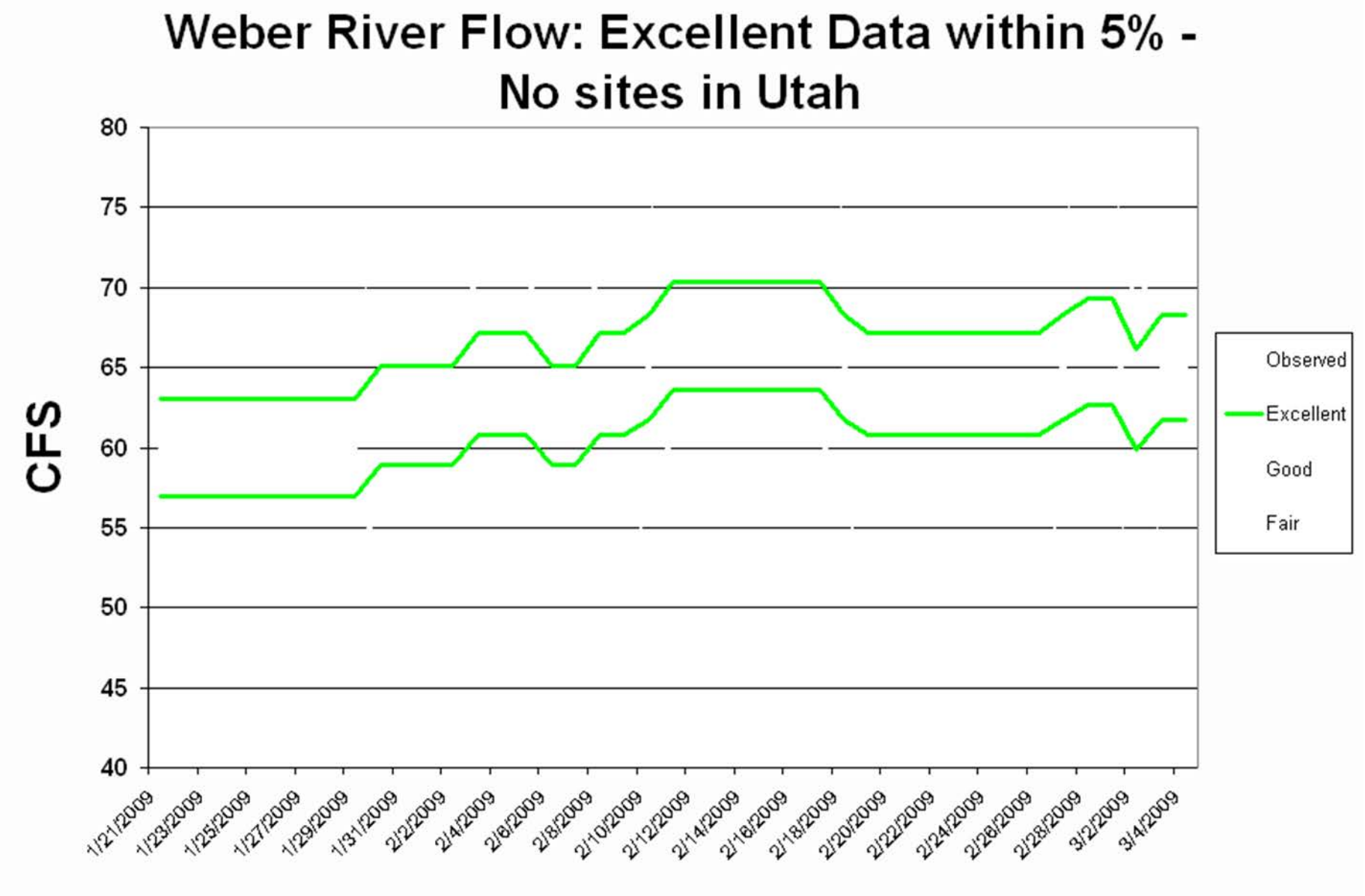
Or
Flow = percent of snowmelt getting to stream (C) times a degree day factor (a)
times the number of degree day adjusted by elevation and zone (T) times the ratio of snow cover to non snow cover plus precipitation
Qn+1=Cn(an(Tn+^Tn)Sn+Pn)

Very simple equations….

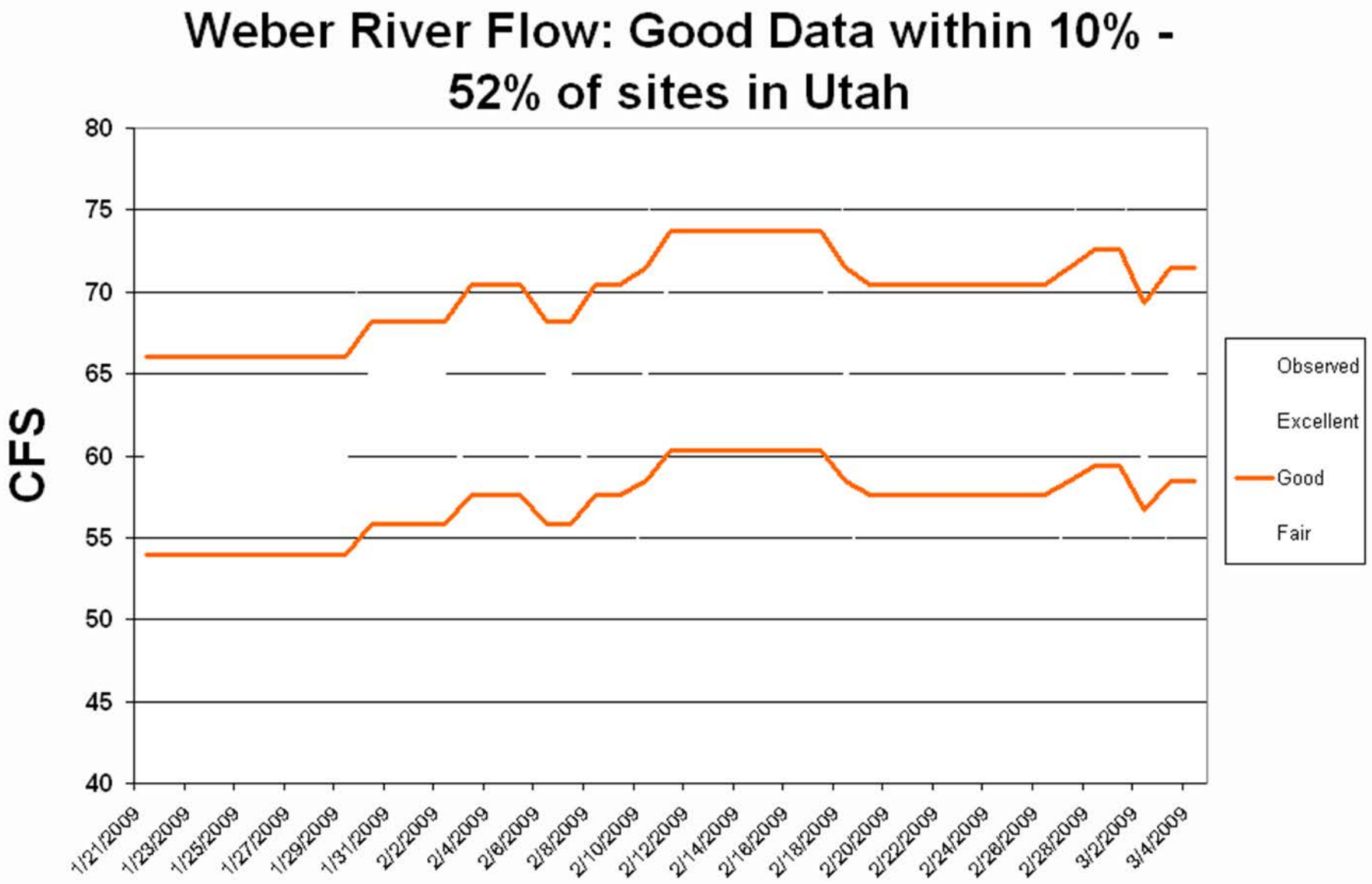
This is what most people believe streamflow is… on any given day…



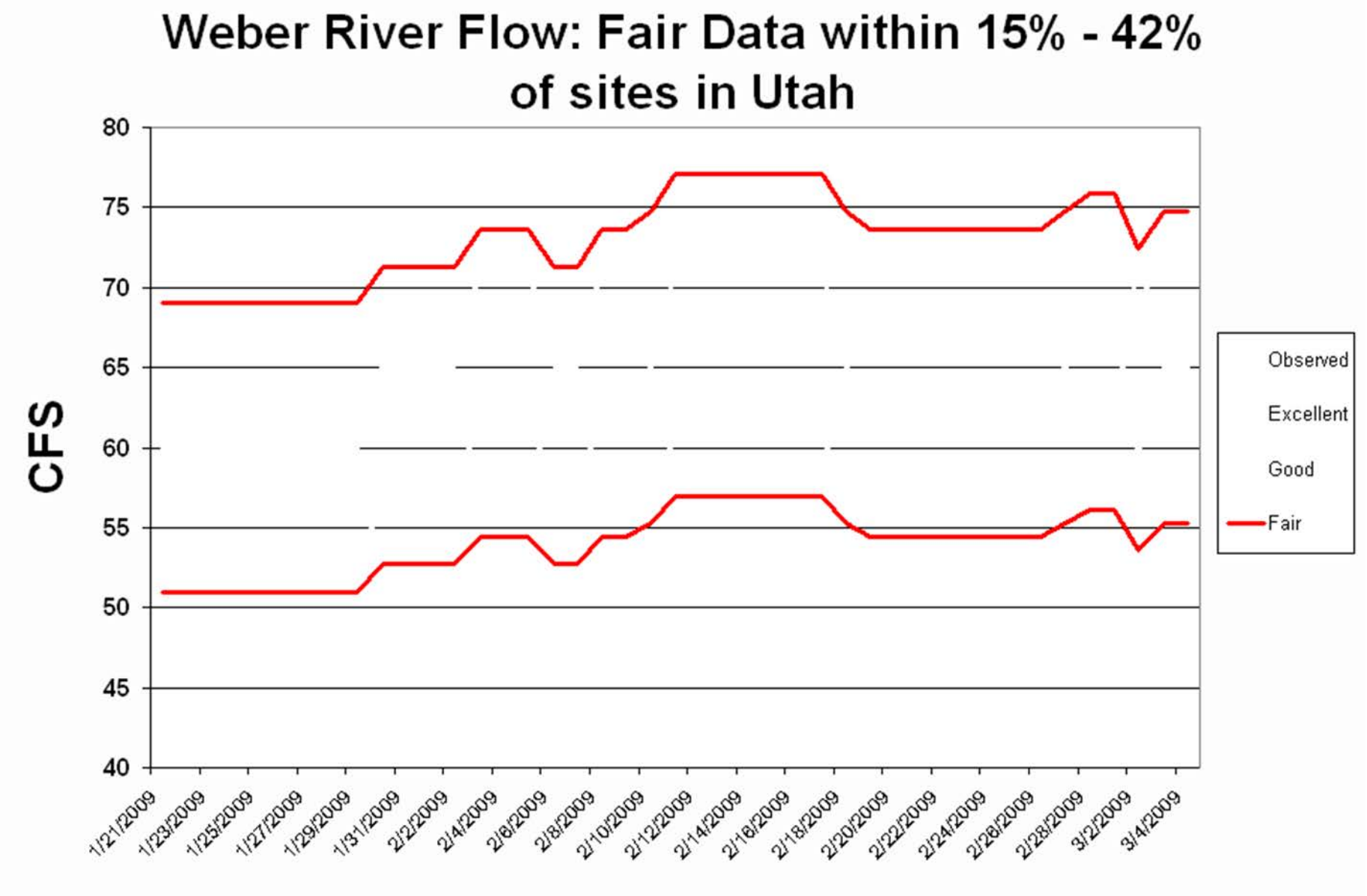
Reality check….



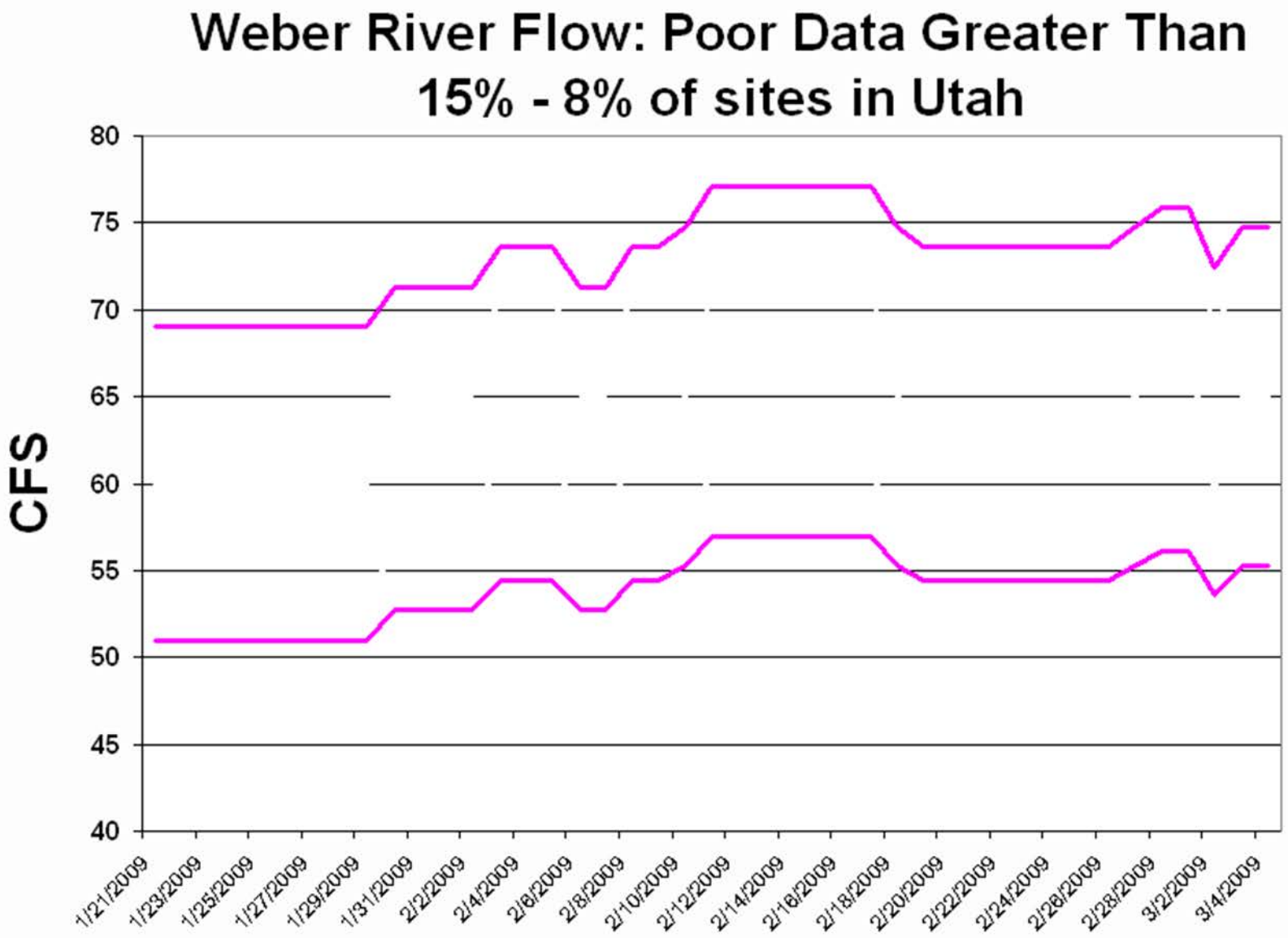
This is your most probable condition…



Seriously? This many sites are this bad? +/- 15%?



Uff da.


Weber River Flow: Poor Data Greater Than
15% - 8% of sites in Utah
CFS
80
75
70
65
60
55
50
45
40
1/21/2009
1/23/2009
1/25/2009
1/27/2009
1/29/2009
1/31/2009
2/2/2009
2/4/2009
2/6/2009
2/8/2009
2/10/2009
2/12/2009
2/14/2009
2/16/2009
2/18/2009
2/20/2009
2/22/2009
2/24/2009
2/26/2009
2/28/2009
3/2/2009
3/4/2009

You cannot forecast a variable more accurately than it can be measured…