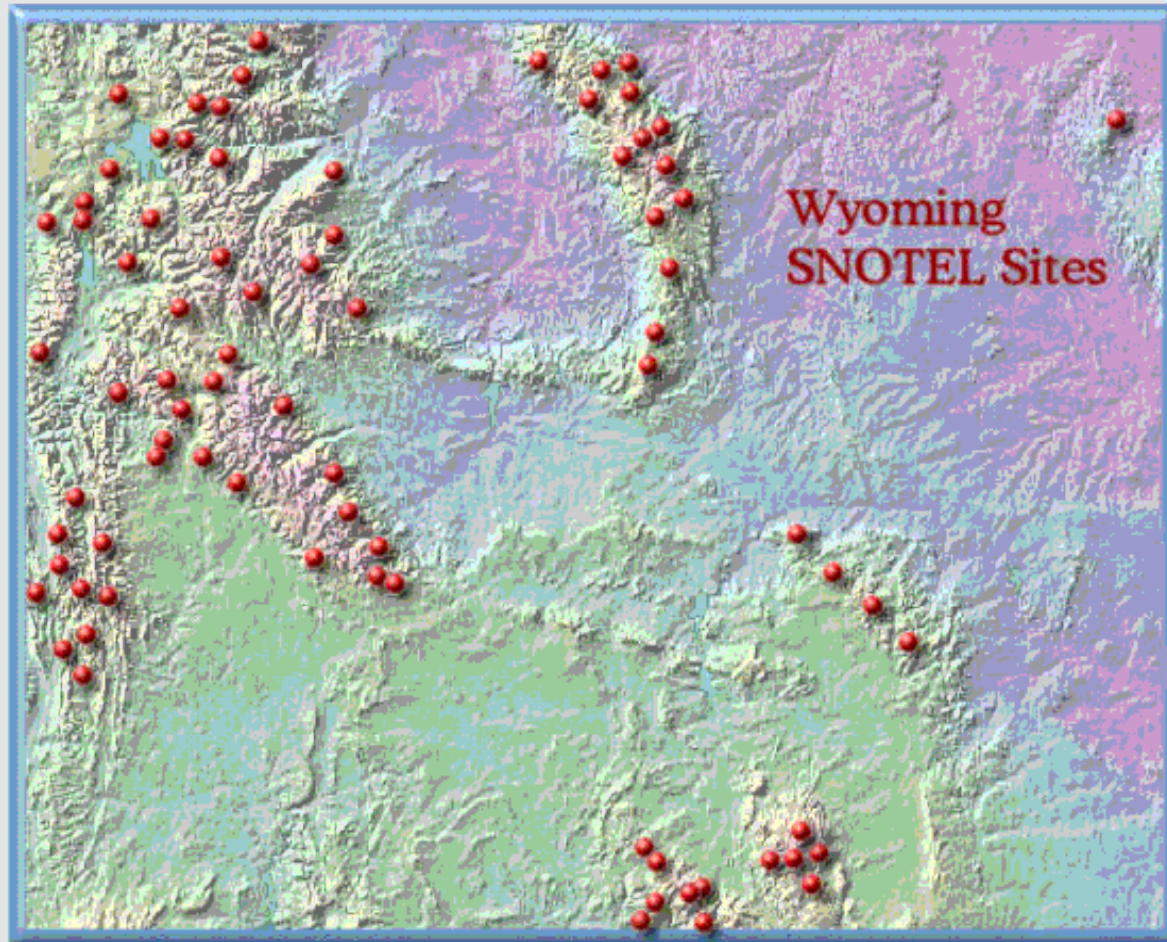


Wyoming Cooperative Snow Survey Program



Lee Hackleman

1. Snow Course & SNOTEL history
2. SWE
3. Basin Outlook Report
4. Daily Forecasts
5. Reservoir Graphs
6. Update Report
7. Projection or Trend Graphs
8. Monday Morning Report
9. WY Soil Moisture Sensors
10. Basin Reports

Brian Domonkos

1. Data Collection (SNOTEL & SC)
2. Report Generator
3. Interactive Map
4. Data Editing
5. SWSI
6. Normals

Cooperative Snow Survey Program

- The first snow survey was conducted in 1906. Started by Dr. Church in the Lake Tahoe Area.
- Congressionally mandated in the 1930s.
- First snow courses in WY installed in 1930 in Teton and Yellowstone Parks about 7 of them
- First SNOTELs in WY installed in 1978 about 11 of them.



Cooperative Snow Survey Program



- There are about 858 SNOTEL sites in the 12 western states plus Alaska.
- Wyoming has 89 SNOTEL sites and 61 manually read snow courses.

Cooperative Snow Survey Program



Standard site

- Shelter for electronics
- snow pillow
- storage precipitation gauge
- snow depth sensor
- temperature sensor.

Cooperative Snow Survey Program



- Other sensors
 - Solar Radiation
 - Relative Humidity
 - Wind speed
 - Wind direction
 - Soil Moisture
 - Tipping Bucket Rain Gage

Cooperative Snow Survey Program



Snow Pillow

- The hexagon shaped snow pillow is an envelope of synthetic rubber, fit into a 10 feet diameter area.
- Pillow contains an antifreeze solution.
- Attached to transducer to measure pressure

Cooperative Snow Survey Program



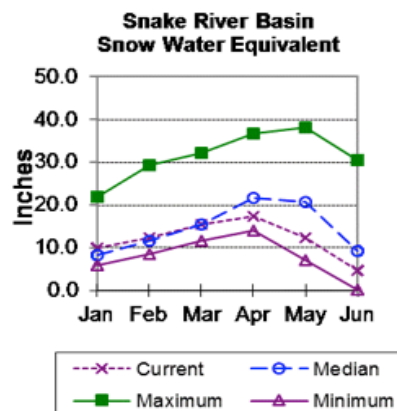
- Basin Outlook Report
 - Prepared January through June
 - 19 basins
 - 63 forecast points

Wyoming Outlook Report

Snake River Basin

Snow

Snake River Basin SWE above Palisades is 51% of median. SWE in the Snake River Basin above Jackson Lake is 22% of median. Pacific Creek Basin SWE is 37% of median. Buffalo Fork SWE is 76% of median. Gros Ventre River Basin SWE is 74% of median. SWE in the Hoback River drainage is 131% of median. SWE in the Greys River drainage is 114% of median. In the Salt River area SWE is 0% of median. *See Appendix A at the end of this report for a detailed listing of snow course information.*



Lake storage is 140% of average (847,500 ac-ft compared to 636,900 ac-ft last year). Palisades Reservoir storage is about 116% of average (1,194,100 ac-ft compared to 847,600 ac-ft last year). *Detailed reservoir data is shown on the following page and Appendix D.*

Streamflow

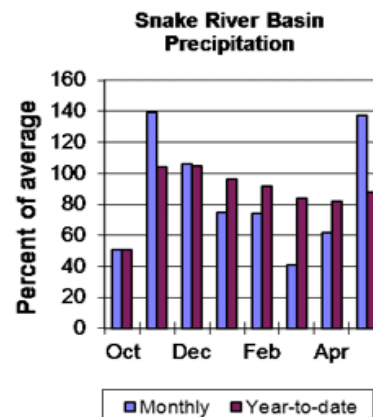
The 50% exceedance forecasts for June through September are below average for this basin. The Snake near Moran is 210,000 ac-ft (42% of average). Snake River above reservoir near Alpine is 1,050,000 ac-ft (65% of average). The Snake near Irwin is 1,330,000 ac-ft (61% of average). The Snake near Heise is 1,450,000 ac-ft (62% of average). Pacific Creek near Moran is 46,000 ac-ft (48% of average). Buffalo Fork above Lava near Moran is 156,000 ac-ft (74% of average). Greys River above Palisades Reservoir is 160,000 ac-ft (63% of average). Salt River near Etna is 119,000 ac-ft (57% of average). *See the following page for further information.*

Precipitation

Last month's precipitation for the Snake River Basin was 144% of average (58% last year). Percentages range from 89-255% of average for the 29 reporting stations. Water-year-to-date precipitation is 89% of average for the Snake River Basin (123% last year). Year-to-date percentages range from 71-114% of average.

Reservoirs

Current reservoir storage is 125% of average for the 3 storage reservoirs in the basin. Grassy Lake storage is about 108% of average (15,400 ac-ft compared to 14,300 last year). Jackson



Snake River Basin Streamflow Forecasts - May 1, 2015

SNAKE RIVER BASIN	Forecast Period	Forecast Exceedance Probabilities for Risk Assessment Chance that actual volume will exceed forecast						30yr Avg (KAF)
		90% (KAF)	70% (KAF)	50% (KAF)	% Avg	30% (KAF)	10% (KAF)	
Snake R nr Moran ²	MAY-JUL	250	320	365	52%	410	480	700
	MAY-SEP	280	360	415	54%	470	550	775
Snake R ab Reservoir nr Alpine ²	MAY-JUL	885	1040	1150	59%	1260	1420	1960
	MAY-SEP	1010	1200	1320	58%	1440	1630	2280
Snake R nr Irwin ²	MAY-JUL	1030	1290	1460	55%	1630	1890	2660
	MAY-SEP	1250	1550	1750	56%	1950	2250	3150
Snake R nr Heise ²	MAY-JUL	1120	1390	1570	55%	1750	2020	2840
	MAY-SEP	1380	1700	1910	56%	2120	2440	3390
Pacific Ck at Moran	MAY-JUL	51	76	92	61%	108	133	152
	MAY-SEP	57	82	99	61%	116	141	161
Buffalo Fk ab Lava Ck nr Moran	MAY-JUL	149	173	189	71%	205	230	265
	MAY-SEP	168	196	215	70%	235	260	305
Greys R ab Reservoir nr Alpine	MAY-JUL	118	147	167	63%	186	215	265
	MAY-SEP	145	179	200	63%	225	260	315
Salt R ab Reservoir nr Etna	MAY-JUL	58	83	102	42%	123	158	245
	MAY-SEP	87	117	140	45%	165	205	310

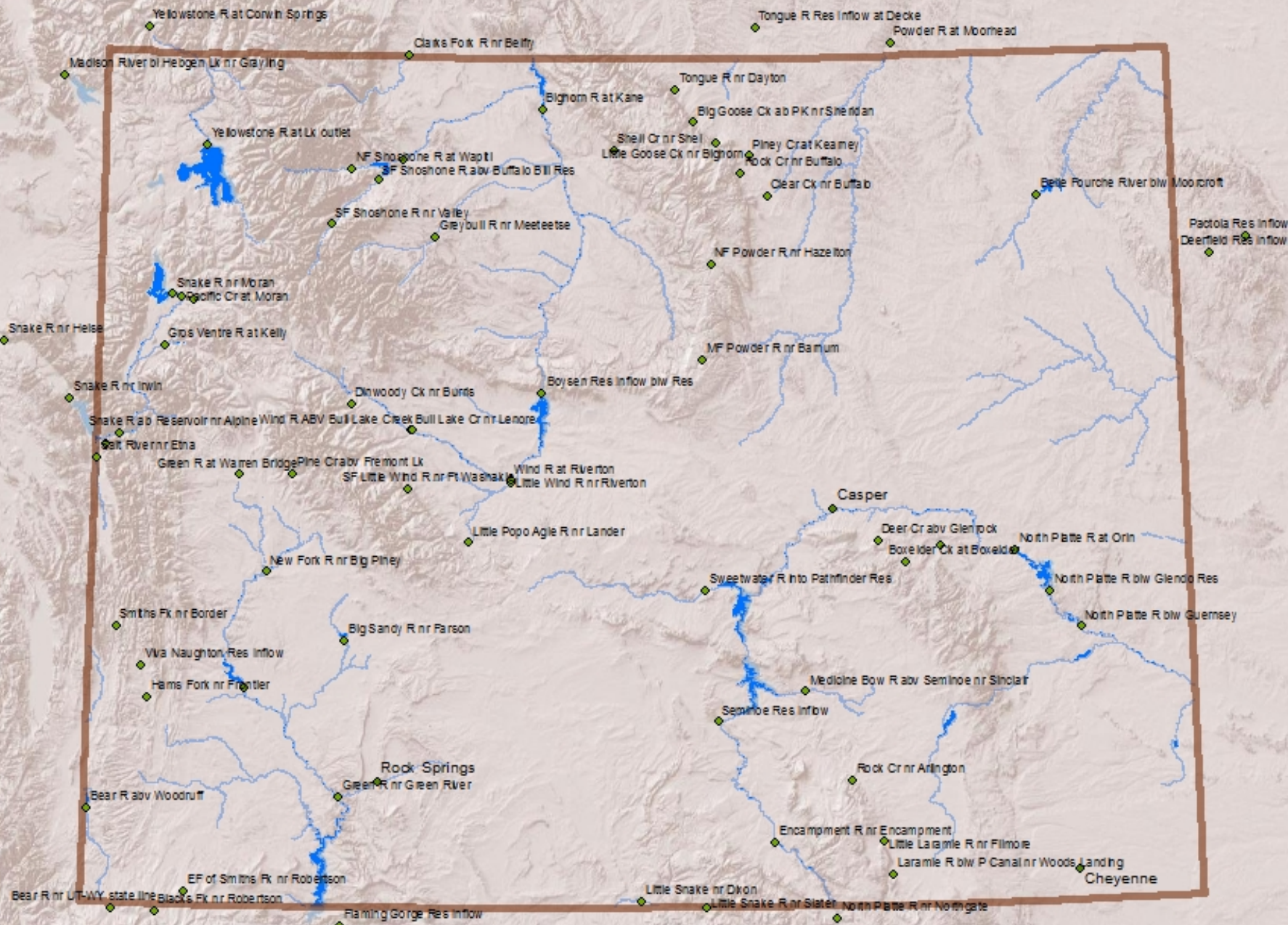
1) 90% and 10% exceedance probabilities are actually 95% and 5%

2) Forecasts are for unimpaired flows. Actual flow will be dependent on management of upstream reservoirs and diversions

3) Median value used in place of average

Reservoir Storage End of April, 2015	Current (KAF)	Last Year (KAF)	Average (KAF)	Capacity (KAF)
Grassy Lake	13.8	14.3	12.8	15.2
Jackson Lake	707.8	297.6	445.7	847.0
Palisades Reservoir	1194.4	509.6	911.7	1400.0
Basin-wide Total	1915.9	821.5	1370.2	2262.2
# of reservoirs	3	3	3	3
Watershed Snowpack Analysis May 1, 2015	# of Sites	% Median	Last Year % Median	
SNAKE above Jackson Lake	6	40%	141%	
PACIFIC CREEK	2	65%	148%	
BUFFALO FORK	2	73%	149%	
GROS VENTRE RIVER	4	75%	145%	
HOBACK RIVER	5	61%	174%	
GREYS RIVER	5	83%	172%	
SALT RIVER	5	44%	174%	
SNAKE RIVER BASIN	27	57%	150%	

Wyoming Forecast Points



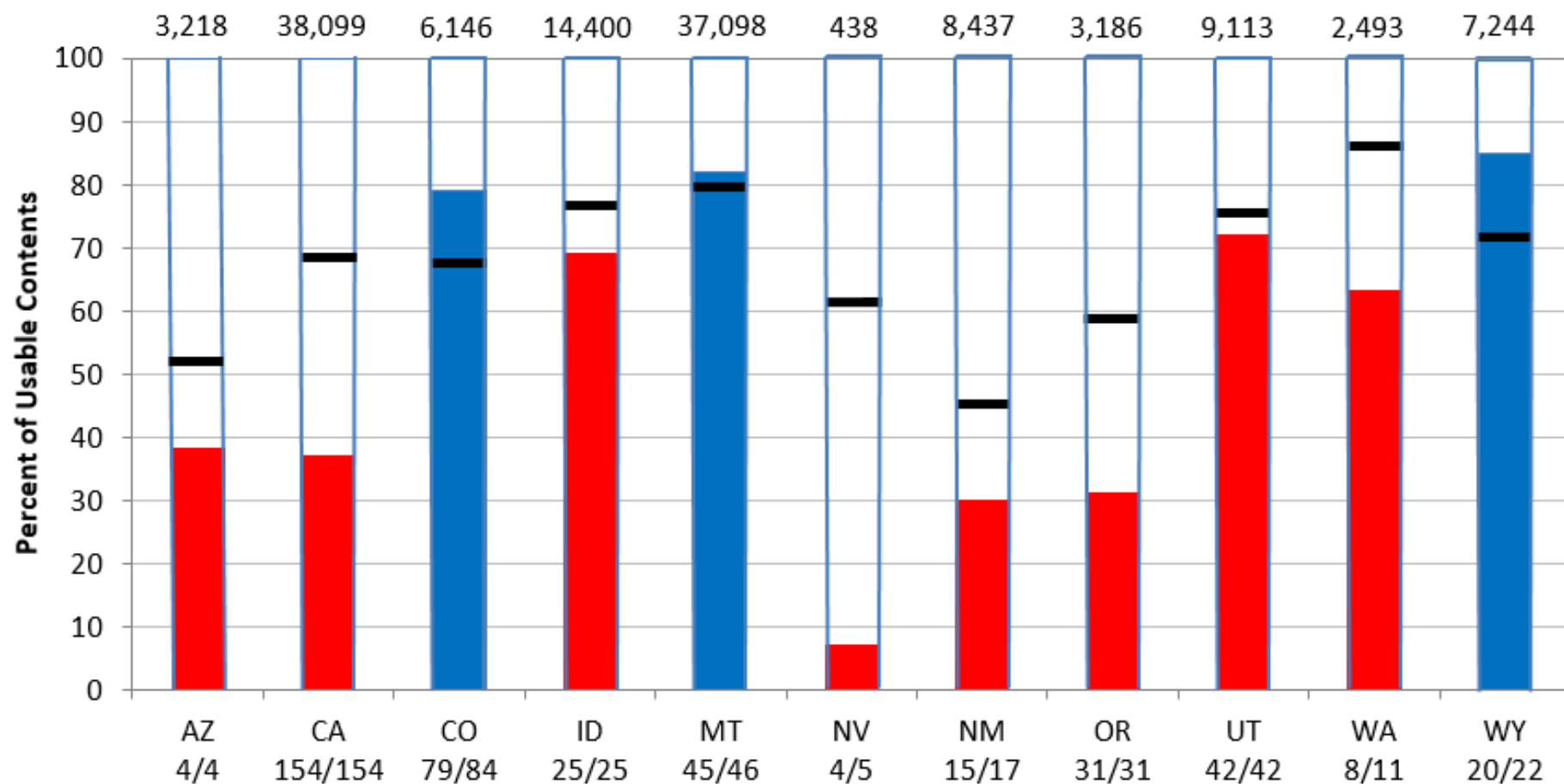
Aug. 1st Reservoir Storages used by WY Snow Survey Program

[illegible]

Reservoir Storage as of August 1, 2015

Below Average Above Average Average

Capacity of Reservoirs Reported (1000 Acre-Feet)



Update Report for Snotels

Wyoming SNOTEL Snow/Precipitation Update Report

Based on Mountain Data from NRCS SNOTEL Sites

Provisional data, subject to revision

Data based on the first reading of the day (typically 00:00) for Monday, April 06, 2015

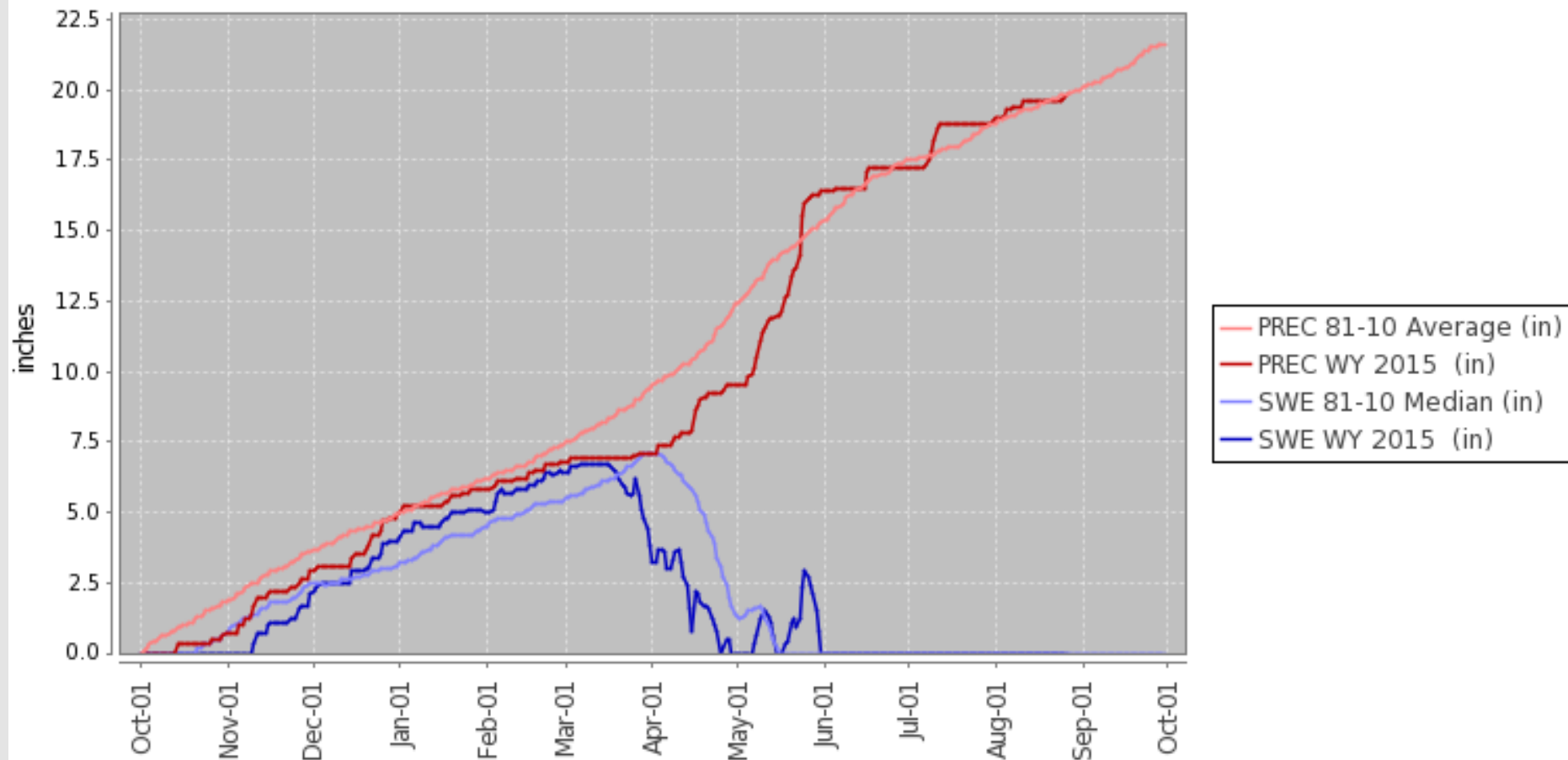
Basin Site Name	Elev (ft)	Snow Water Equivalent			Water Year-to-Date Precipitation		
		Current (in)	Median (in)	Pct of Median	Current (in)	Average (in)	Pct of Average
SNAKE RIVER							
Base Camp	7030	12.8	15.2	84	17.1	20.5	83
Black Bear	8170	25.5	37.2	69	25.7	37.6	68
Blind Bull Sum	8650	22.9	23.1	99	15.7	19.2	82
Cottonwood Creek	7670	19.4	21.0	92	24.2	24.3	100
East Rim Divide	7930	8.3	10.2	81	10.6	11.6	91
Grand Targhee	9260	33.8	38.2 _R	88	27.7	30.4 _R	91
Granite Creek	6770	13.5	14.6	92	16.4	19.4	85
Grassy Lake	7265	23.4	31.5	74	27.1	35.4	77
Gros Ventre Summit	8750	8.9	12.9	69	9.2	12.7	72
Gunsight Pass	9820	11.2	13.7 _C	82	11.9	13.6 _C	88
Lewis Lake Divide	7850	20.8	29.8	70	25.6	34.8	74
Phillips Bench	8200	20.8	25.2	83	23.0	27.7	83
Salt River Summit	7760	8.8	12.9	68	12.9	16.4	79
Snake River Station	6920	10.7	14.9	72	18.0	22.1	81
Spring Creek Divide	9000	23.6	22.5	105	23.0	23.5	98
Thumb Divide	7980	7.2	14.7	49	11.4	18.3	62
Togwotee Pass	9580	21.4	22.0	97	23.6	23.8	99
Two Ocean Plateau	9240	24.8	25.9	96	22.4	26.6	84
Willow Creek	8380	18.9	28.4	67	26.5	33.0	80
Younts Peak	8350	— _M	14.3	*	— _M	15.5	*
Basin Index (%)		81			83		

Update Report for Basins

Basin Site Name	Elev (ft)	Snow Water Equivalent			Water Year-to-Date Precipitation		
		Current (in)	Median (in)	Pct of Median	Current (in)	Average (in)	Pct of Average
SNAKE RIVER							
Basin Index (%)		81			83		
MADISON-GALLATIN							
Basin Index (%)		63			64		
YELLOWSTONE							
Basin Index (%)		85			90		
WIND RIVER							
Basin Index (%)		69			80		
BIGHORN BASIN							
Basin Index (%)		80			86		
SHOSHONE RIVER							
Basin Index (%)		78			94		
POWDER RIVER							
Basin Index (%)		77			84		
TONGUE RIVER							
Basin Index (%)		74			78		
BELLE FOURCHE							
Basin Index (%)		0			76		
CHEYENNE RIVER BASIN							
Basin Index (%)		0			77		
UPPER N. PLATTE							
Basin Index (%)		64			80		
SWEETWATER							
Basin Index (%)		51			64		

Cold Springs Site

Station (405) WATERYEAR=2015 (Daily) NRCS National Water and Climate Center - Provisional Data - subject to revision
Wed Aug 26 12:40:43 PDT 2015



Report #22 Wyoming – NRCS Monday Morning Snow Report

April 6th, 2015

Good morning everyone this is our 22nd Monday Snow Report for the 2014-2015 snow season. Last year at this time the state median was at 139% with a low of 116% and a high of 158%. This year the state median is falling at 62% with a low of 0% and a high of 88% of median. See the table & map below for more information.

For those of you with INTERNET capability, this report and map showing SWE percentages for the state can be found at “<http://www.wrds.uwyo.edu/wrds/nrcs/nrcs.html>”. Go to http://www.wcc.nrcs.usda.gov/normals/median_average.htm for median.

Figure1 -- SNOW WATER EQUIVALENT AS PERCENT OF MEDIAN The following table shows the current last year's ending weeks and 2012 equivalent(SWE) amounts for Wyoming basins. Median is based on all reporting SNOTELs in the basin, not the snow courses. The reference period for average comparison is 191-2010.

DRAINAGE BASIN	4/6/2015	3/30/2015	3/23/2015	4/6/2014	3/30/2014
SNAKE RIVER	81	86	88	144	140
MADISON	66	65	68	122	115
YELLOWSTONE	85	89	93	154	148
WINDRIVER	69	73	80	129	125
BIGHORN BASIN	80	90	97	150	149
SHOSHONE RIVER	77	83	89	155	147
POWDER	77	90	99	158	157
TONGUE	73	80	89	141	141
BELLE FOURCHE	0	0	9	142	121
CHEYENNE	0	13	14	137	127
UPPER N. PLATTE	67	71	76	126	123
SWEETWATER	51	55	60	116	110
LOWER N. PLATTE	55	63	70	130	127
LARAMIE	71	80	82	137	140
S. PLATTE	74	81	86	141	143
LITTLE SNAKE RIVER	61	58	70	126	121
UPPER GREEN	88	95	99	158	158
LOWER GREEN	55	63	71	129	125
UPPER BEAR	49	57	66	116	114
Weighted State Average	62	69	75	139	135

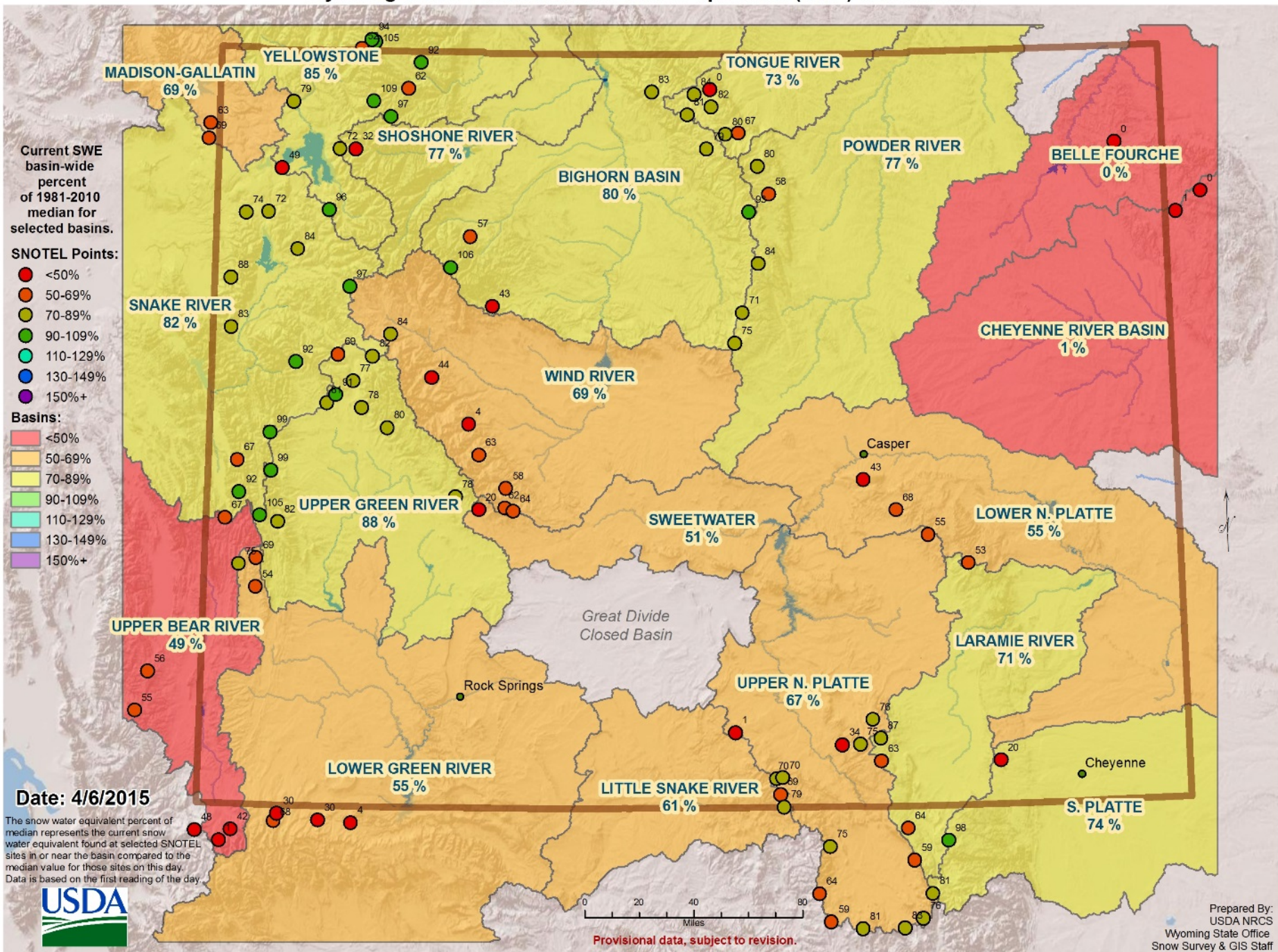
red = down

blue = up

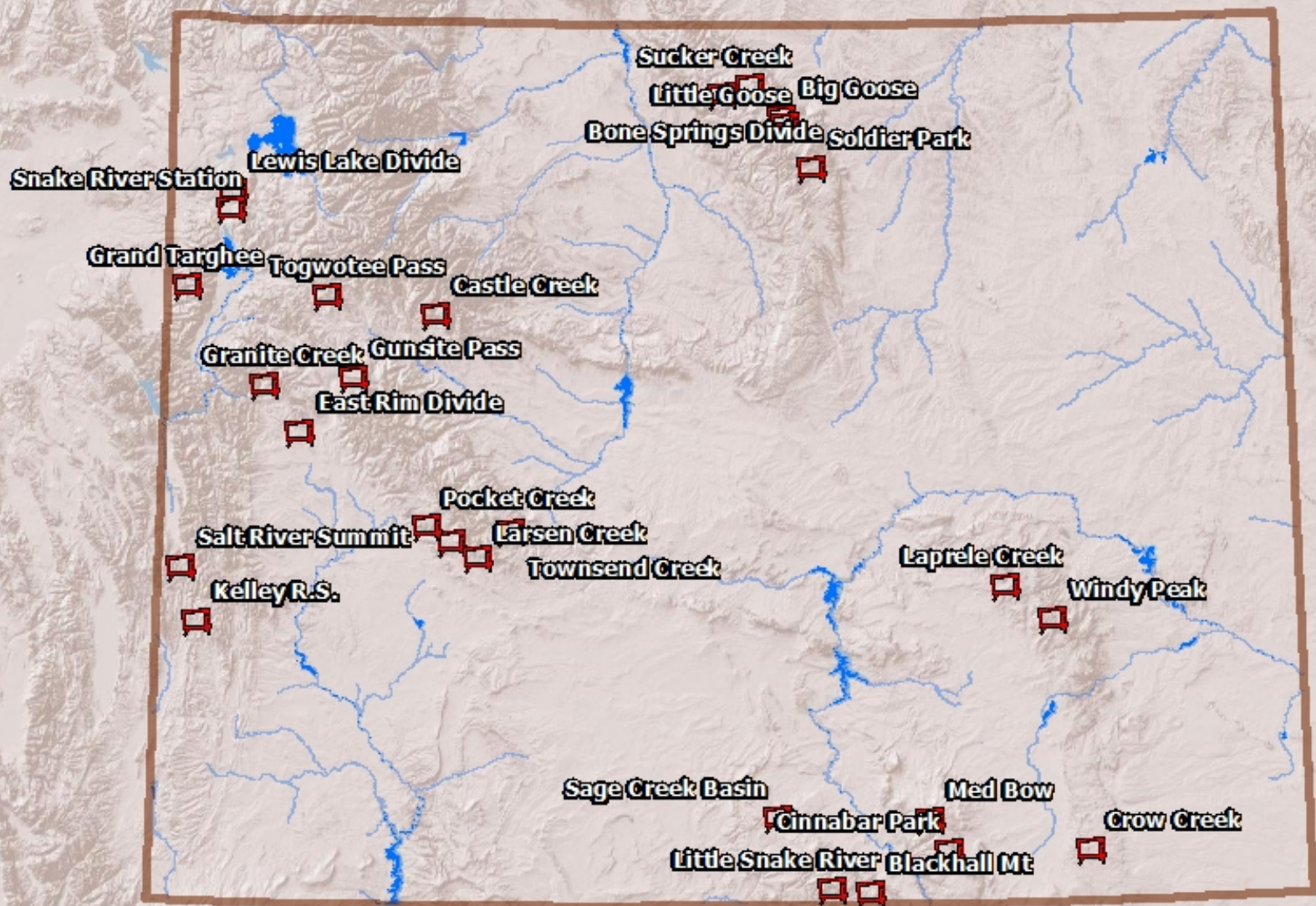
green = even

* data is suspect

Wyoming SNOTEL Current Snow Water Equivalent (SWE) % of Median



Wyoming SNOTEL Soil Moisture Sites



Wyoming (PST) SNOTEL Site Laprele Creek (571) (05G04S) Soil Moisture & Soil Temperature Daily series for month of May 2015

NRCS National Water and Climate Center - Provisional Data - subject to revision as of 2015-August-17. Notes on dates - Daily sensor single observation - taken at the beginning of an interval, which is midnight for a daily timeseries report.

[Describe headers](#)

[Download](#)

[Chart this data](#)

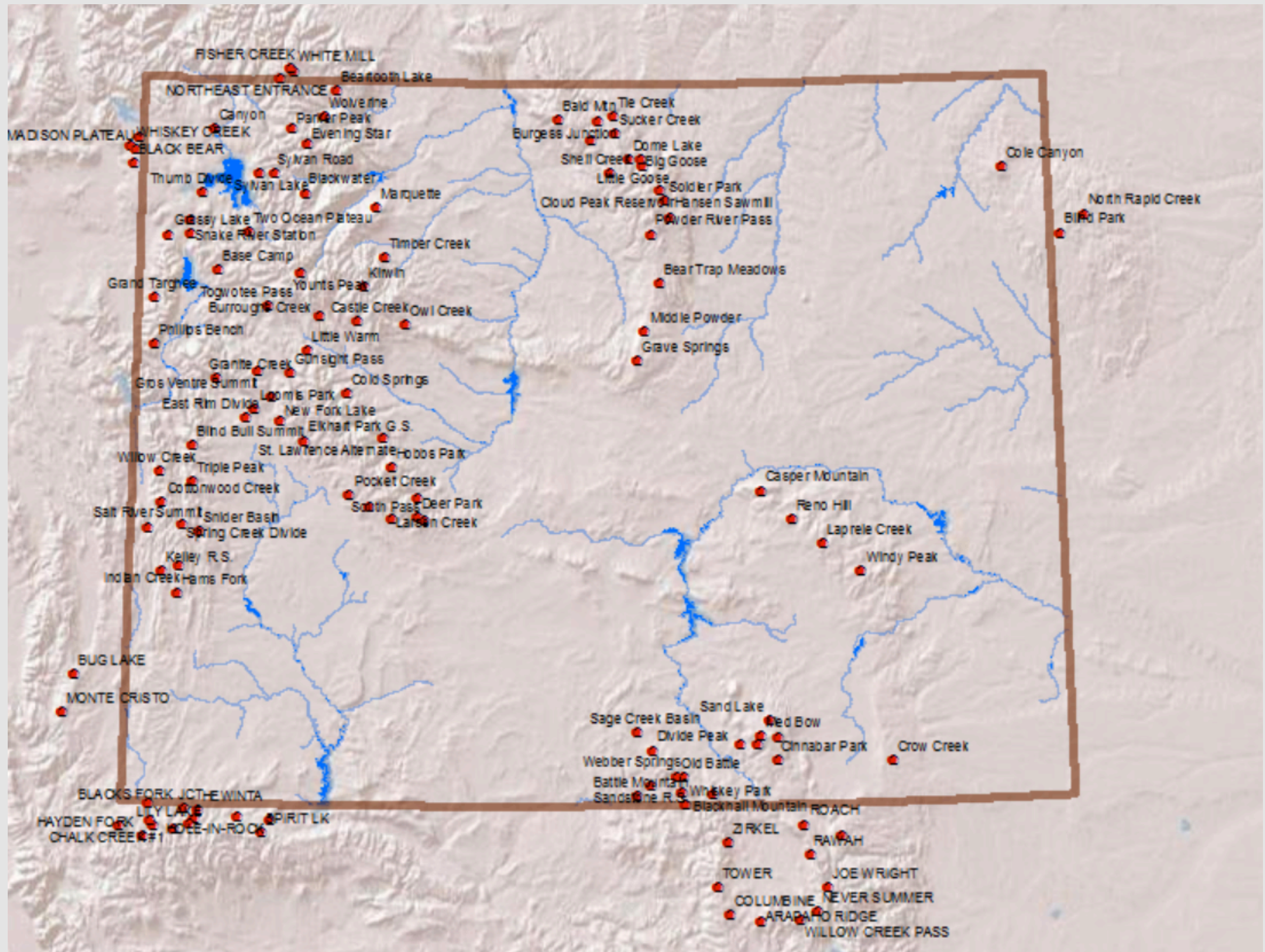
[Prev](#)

[Next](#)

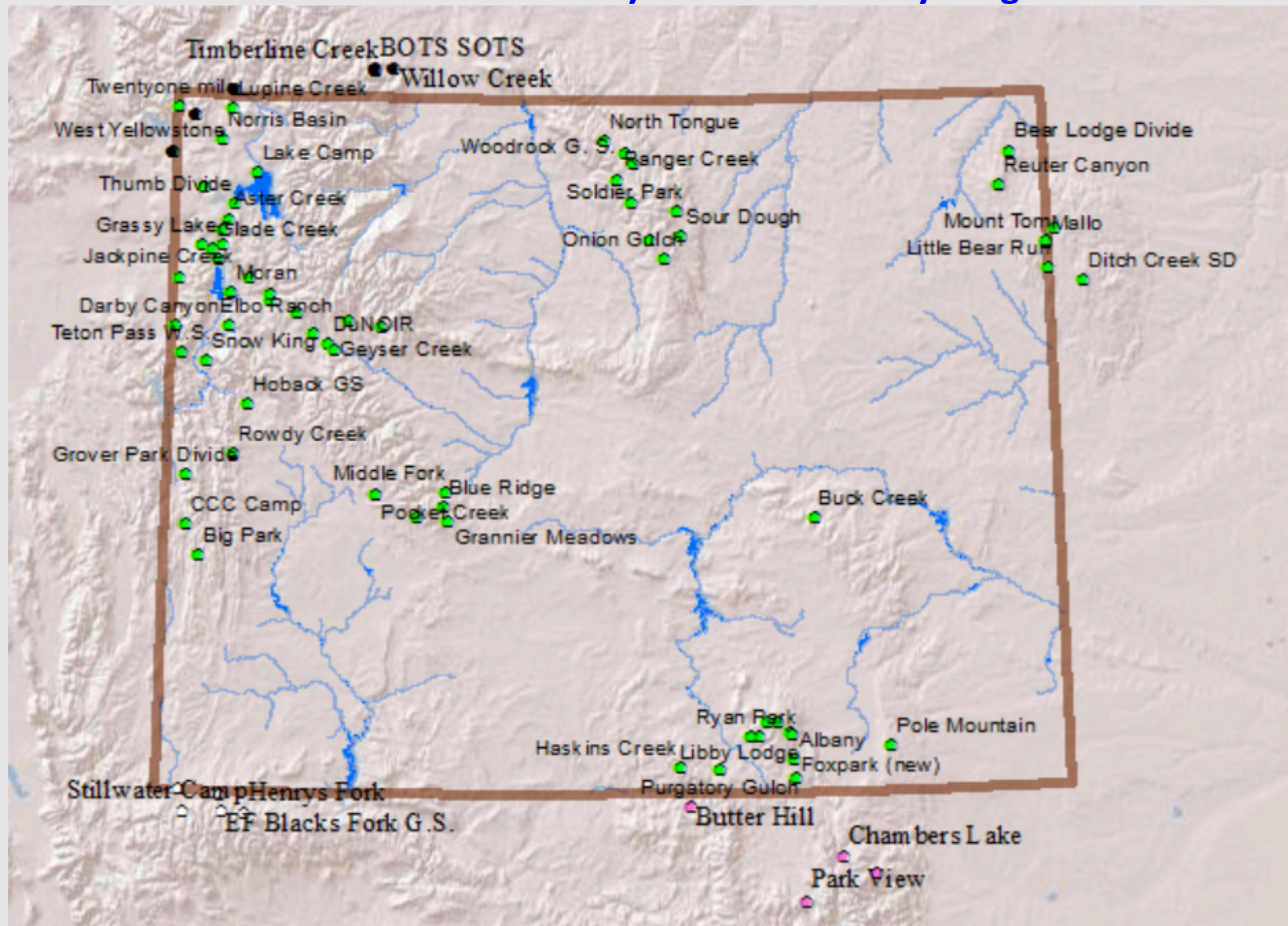
[Return to Site](#)

Site Id	Date	Time	SMS.I-1:-2 (pct) (silt)	SMS.I-1:-8 (pct) (silt)	SMS.I-1:-20 (pct) (silt)	STO.I-1:-2 (degC)	STO.I-1:-8 (degC)	STO.I-1:-20 (degC)
571	2015-05-01		30.7	23.4	25.4	5.9	5.3	3.5
571	2015-05-02		29.9	22.6	24.7	6.2	5.8	4.1
571	2015-05-03		28.7	22.3	24.0	6.7	6.2	4.5
571	2015-05-04		30.1	22.0	25.6	6.0	5.8	4.7
571	2015-05-05		30.1	22.9	24.6	6.1	5.8	4.8
571	2015-05-06		29.6	22.6	25.0	7.4	6.9	5.2
571	2015-05-07		29.2	22.2	24.5	6.0	6.0	5.2
571	2015-05-08		28.9	21.8	23.6	4.4	4.7	4.7
571	2015-05-09		30.7	22.7	23.6	5.0	4.9	4.5
571	2015-05-10		32.1	24.4	24.9	3.2	3.6	4.1
571	2015-05-11		31.7	24.4	25.3	2.7	3.0	3.6
571	2015-05-12		33.1	25.4	27.2	2.3	2.6	3.2
571	2015-05-13		32.2	25.0	26.0	4.9	4.4	3.5
571	2015-05-14		32.7	25.0	25.9	4.4	4.4	3.9
571	2015-05-15		31.6	24.5	26.1	5.7	5.3	4.2
571	2015-05-16		31.9	24.1	25.3	5.1	5.2	4.6
571	2015-05-17		31.7	24.6	25.7	5.8	5.7	4.7
571	2015-05-18		31.8	24.5	25.9	5.5	5.5	4.9
571	2015-05-19		31.3	24.0	25.4	5.1	5.0	4.7
571	2015-05-20		31.8	24.0	25.5	3.9	4.1	4.4
571	2015-05-21		33.7	25.9	27.0	2.9	3.2	3.9
571	2015-05-22		33.4	25.7	27.0	5.3	5.0	4.1
571	2015-05-23		33.5	26.1	27.1	5.3	5.1	4.5
571	2015-05-24		34.4	27.0	27.0	5.3	5.3	4.7
571	2015-05-25		32.9	25.3	27.2	5.8	5.7	4.8
571	2015-05-26		31.9	24.4	26.1	6.0	5.8	5.0
571	2015-05-27		31.4	24.3	25.7	7.1	6.6	5.3
571	2015-05-28		30.8	23.5	25.0	7.3	7.0	5.8
571	2015-05-29		30.6	23.1	25.2	7.6	7.3	6.1
571	2015-05-30		32.9	25.5	26.2	6.0	6.2	5.9
571	2015-05-31		31.9	25.0	25.8	8.2	7.6	6.1
Site Id	Date	Time	SMS.I-1:-2 (pct) (silt)	SMS.I-1:-8 (pct) (silt)	SMS.I-1:-20 (pct) (silt)	STO.I-1:-2 (degC)	STO.I-1:-8 (degC)	STO.I-1:-20 (degC)

SNOTELs used by WY Snow Survey Program



Snow courses used by WY Snow Survey Program



WY Basin Reports next 4 slides

WY Monthly Forecasts (Wind River)

WIND RIVER BASIN	Forecast Period	90% (KAF)	70% (KAF)	50% (KAF)	% Avg	30% (KAF)	10% (KAF)	30yr Avg (KAF)
Dinwoody Ck nr Burris	JUN-JUL	41	46	50	94%	54	59	53
	JUN-SEP	63	71	76	95%	81	89	80
Wind R Ab Bull Lake Ck	JUN-JUL	169	225	265	80%	305	360	330
	JUN-SEP	164	230	275	75%	315	380	365
Bull Lake Ck nr Lenore	JUN-JUL	83	97	107	99%	117	131	108
	JUN-SEP	105	124	137	99%	150	169	139
Wind R at Riverton	JUN-JUL	186	240	280	80%	320	375	350
	JUN-SEP	235	305	350	81%	395	465	430
Little Popo Agie R nr Lander	JUN-JUL	12.5	16.4	19	70%	22	25	27
	JUN-SEP	16.6	21	24	73%	27	31	33
SF Little Wind R nr Fort Washakie	JUN-JUL	30	40	47	89%	54	64	53
	JUN-SEP	37	48	56	90%	64	75	62
Little Wind R nr Riverton	JUN-JUL	44	97	133	73%	169	220	183
	JUN-SEP	50	113	155	74%	197	260	210
Boysen Reservoir Inflow	JUN-JUL	135	245	320	75%	395	505	425
	JUN-SEP	145	280	375	77%	465	600	485

WY Monthly Precipitation Report

Report Created: 8/18/2015 11:47:12 AM

Basinwide Summary: August 1, 2015 (Averages/Medians based on 1981-2010 reference period)			Monthly Total Precipitation for July 2015					Water Year to Date Precipitation through July 2015				
SNAKE above Jackson Lake	Network	Elevation (ft)	Current (in)	Average (in)	% Average	Last Year (in)	Last Year % Avg	Current (in)	Average (in)	% Average	Last Year (in)	Last Year % Avg
Grassy Lake	SNOTEL	7265	2.8	1.5	187%	0.9	60%	36.9	48.4	76%	50.4	104%
Lewis Lake Divide	SNOTEL	7850	2.3	1.5	153%	2.4	160%	34.9	47.1	74%	52.4	111%
Snake River Station	SNOTEL	6920	1.5	1.2	125%	1.9	158%	25.3	31.6	80%	34.5	109%
Thumb Divide	SNOTEL	7980	1.6	0.9	178%	1.4	156%	18.8	27.1	69%	27.5	101%
Two Ocean Plateau	SNOTEL	9240	1.4	1.8	78%	0.8	44%	29.5	39.4	75%	44.5	113%
Basin Index					139%		107%			75%		108%
# of sites					5		5			5		5
PACIFIC CREEK	Network	Elevation (ft)	Current (in)	Average (in)	% Average	Last Year (in)	Last Year % Avg	Current (in)	Average (in)	% Average	Last Year (in)	Last Year % Avg
Base Camp	SNOTEL	7030	1.4	1.3	108%	1.1	85%	24.4	29.1	84%	33.7	116%
Two Ocean Plateau	SNOTEL	9240	1.4	1.8	78%	0.8	44%	29.5	39.4	75%	44.5	113%
Basin Index					90%		61%			79%		114%
# of sites					2		2			2		2
BUFFALO FORK	Network	Elevation (ft)	Current (in)	Average (in)	% Average	Last Year (in)	Last Year % Avg	Current (in)	Average (in)	% Average	Last Year (in)	Last Year % Avg
Togwotee Pass	SNOTEL	9580	3.4	1.7	200%	1	59%	34.2	35.1	97%	41.1	117%
Younts Peak	SNOTEL	8350		2					25.2			
Basin Index					200%		59%			97%		117%
# of sites					1		1			1		1
GROS VENTRE RIVER	Network	Elevation (ft)	Current (in)	Average (in)	% Average	Last Year (in)	Last Year % Avg	Current (in)	Average (in)	% Average	Last Year (in)	Last Year % Avg
Gros Ventre Summit	SNOTEL	8750	2.5	1.4	179%	1.5	107%	17.1	20.4	84%	21.5	105%
Gunsight Pass	SNOTEL	9820	3.9	1.3	300%	2.6	200%	21.8	22.1	99%	27.5	124%
Togwotee Pass	SNOTEL	9580	3.4	1.7	200%	1	59%	34.2	35.1	97%	41.1	117%
Basin Index					223%		116%			94%		116%
# of sites					3		3			3		3
HOBACK RIVER	Network	Elevation (ft)	Current (in)	Average (in)	% Average	Last Year (in)	Last Year % Avg	Current (in)	Average (in)	% Average	Last Year (in)	Last Year % Avg
Blind Bull Sum	SNOTEL	8650	2	1.4	143%	2.3	164%	26.2	27.7	95%	30.2	109%
East Rim Divide	SNOTEL	7930	1.7	0.8	213%	1.3	163%	18.1	17.4	104%	21.2	122%
Granite Creek	SNOTEL	6770	1.3	0.9	144%	0.8	89%	24.9	26.9	93%	31.1	116%
Basin Index					161%		142%			96%		115%
# of sites					3		3			3		3
GREYS RIVER	Network	Elevation (ft)	Current (in)	Average (in)	% Average	Last Year (in)	Last Year % Avg	Current (in)	Average (in)	% Average	Last Year (in)	Last Year % Avg
Blind Bull Sum	SNOTEL	8650	2	1.4	143%	2.3	164%	26.2	27.7	95%	30.2	109%
Cottonwood Creek	SNOTEL	7670	2.3	1.3	177%	1.3	100%	35.1	35.3	99%	43.8	124%
Spring Creek Divide	SNOTEL	9000	1.9	1.3	146%	1.4	108%	33.4	32.5	103%	39.4	121%
Triple Peak	SNOTEL	8500	2.5	1.3	192%	0.9	69%	38.9	35	111%	44.5	127%
Willow Creek	SNOTEL	8380	2.4	1.8	133%	1.6	89%	40.5	47.4	85%	51.8	109%
Basin Index					156%		106%			98%		118%
# of sites					5		5			5		5

WY Snowpack Summary for April

Cottonwood Creek	SNOTEL	7670	49	19.8	21.2	93%	31.1	147%
Spring Creek Divide	SNOTEL	9000	67	23.6	22.5	105%	35.2	156%
Triple Peak	SNOTEL	8500	54	21.5	21.7	99%	35.3	163%
Willow Creek	SNOTEL	8380	40	19.4	27.8	70%	40.4	145%

Basin Index	93%	154%
# of sites	5	5

SALT RIVER	Network	Elevation (ft)	Depth (in)	SWE (in)	Median (in)	% Median	Last Year SWE (in)	Last Year % Median
Ccc Camp	SC	7500	21	8.2	11.0	75%	15.5	141%
Cottonwood Creek	SNOTEL	7670	49	19.8	21.2	93%	31.1	147%
Grover Park Divide	SC	7000	11	3.9	9.5	41%	13.3	140%
Salt River Summit	SNOTEL	7760	24	9.5	12.9	74%	18.5	143%
Willow Creek	SNOTEL	8380	40	19.4	27.8	70%	40.4	145%

Basin Index	74%	144%
# of sites	5	5

SNAKE RIVER BASIN	Network	Elevation (ft)	Depth (in)	SWE (in)	Median (in)	% Median	Last Year SWE (in)	Last Year % Median
Aster Creek	SC	7750	34	14.4	25.7	56%	30.3	118%
Base Camp	SNOTEL	7030	33	13.8	14.8	93%	24.5	166%
Black Bear	SNOTEL	8170	63	25.0	36.3	69%	41.3	114%
Blind Bull Sum	SNOTEL	8650	60	22.9	22.4	102%	36.2	162%
Ccc Camp	SC	7500	21	8.2	11.0	75%	15.5	141%
Cottonwood Creek	SNOTEL	7670	49	19.8	21.2	93%	31.1	147%
East Rim Divide	SNOTEL	7930	23	9.1	10.0	91%	17.6	176%
Elbo Ranch	SC	7100	30	10.6	10.2	104%	14.8	145%
Four Mile	SC	6900	6	2.4	7.0	34%	11.8	169%
Glade Creek	SC	7040	38	16.5	21.2	78%	29.1	137%
Grand Targhee	SNOTEL	9260	83	33.0	36.5	90%	49.6	136%
Granite Creek	SNOTEL	6770	33	14.1	14.9	95%	23.9	160%
Grassy Lake	SNOTEL	7265	50	23.7	31.6	75%	41.2	130%
Gros Ventre Summit	SNOTEL	8750	30	9.1	12.9	71%	14.8	115%
Grover Park Divide	SC	7000	11	3.9	9.5	41%	13.3	140%
Gunsight Pass	SNOTEL	9820	31	11.4	13.4	85%	20.2	151%
Hoback GS	SC	6664	19	7.1	8.5	84%	16.1	189%
Huckleberry Divide	SC	7300	32	13.5	18.5	73%	23.4	126%
Lewis Lake Divide	SNOTEL	7850	46	19.9	29.5	67%	39.0	132%
Loomis Park	SNOTEL	8240	31	13.3	14.3	93%	24.9	174%
Moran	SC	6750	36	10.2	10.6	96%	16.6	157%
Phillips Bench	SNOTEL	8200	52	21.0	24.2	87%	34.8	144%
Salt River Summit	SNOTEL	7760	24	9.5	12.9	74%	18.5	143%
Snake River Station	SNOTEL	6920	26	11.7	15.5	75%	22.6	146%
Snow King Mountain	SC	7660	28	10.0	13.0	77%	17.4	134%
Spring Creek Divide	SNOTEL	9000	67	23.6	22.5	105%	35.2	156%
Thumb Divide	SNOTEL	7980	18	6.4	14.9	43%	20.4	137%
Togwotee Pass	SNOTEL	9580	56	21.5	21.6	100%	31.8	147%
Turpin Meadows	SC	6900	22	9.8	9.0	109%	14.5	161%
Two Ocean Plateau	SNOTEL	9240	61	23.9	25.6	93%	39.8	155%
Willow Creek	SNOTEL	8380	40	19.4	27.8	70%	40.4	145%
Younts Peak	SNOTEL	8350			14.1			

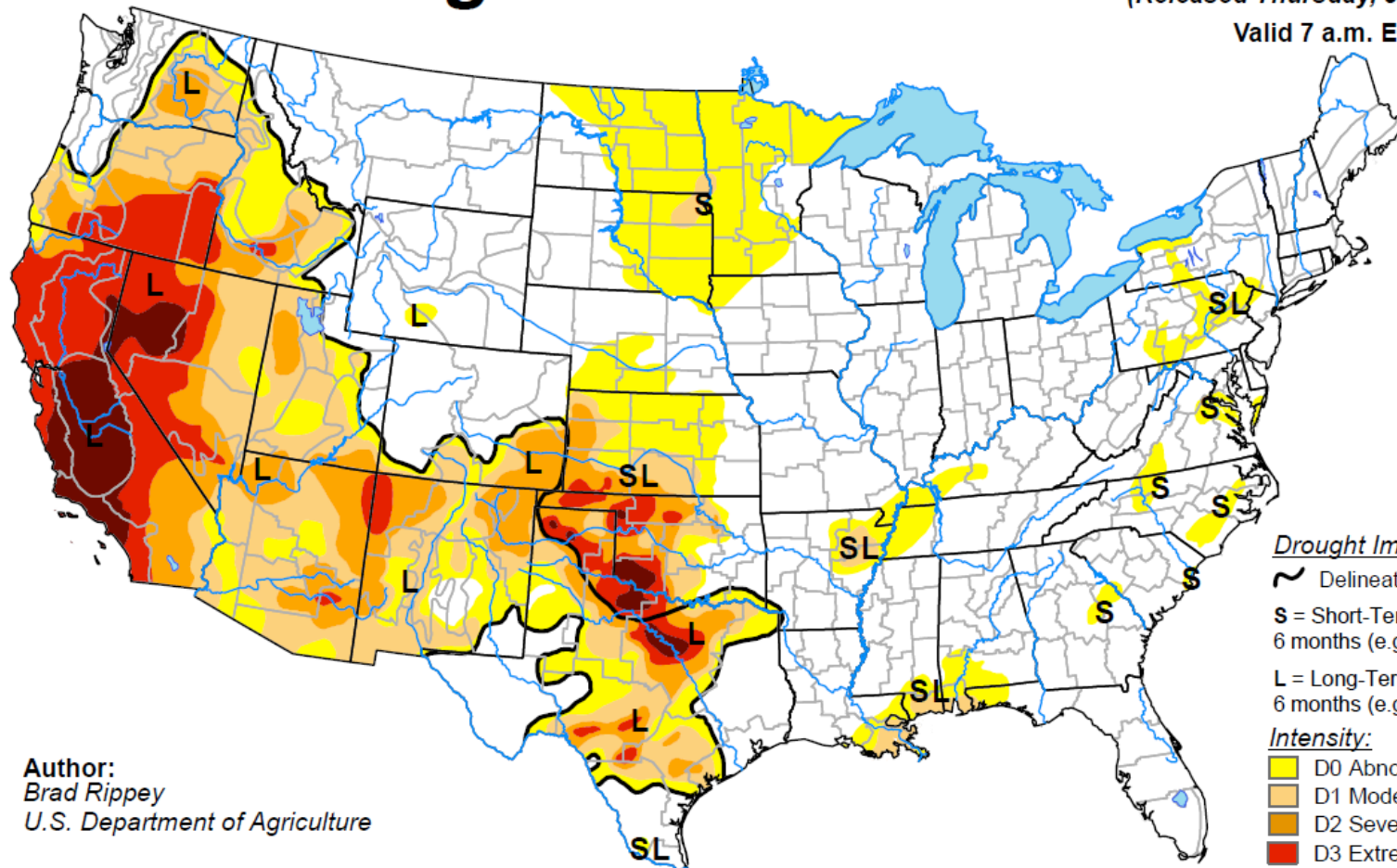
Basin Index	81%	143%
# of sites	31	31

U.S. Drought Monitor

January 6, 2015

(Released Thursday, Jan. 8, 2015)

Valid 7 a.m. EST



Author:
Brad Rippey
U.S. Department of Agriculture

Drought Impact Types:

~ Delineates dominant impacts

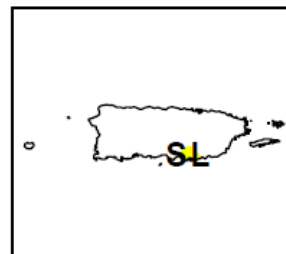
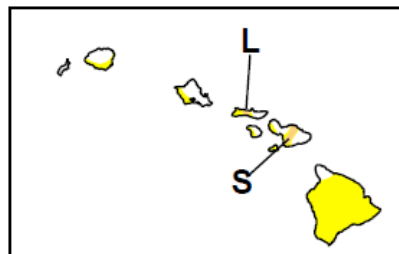
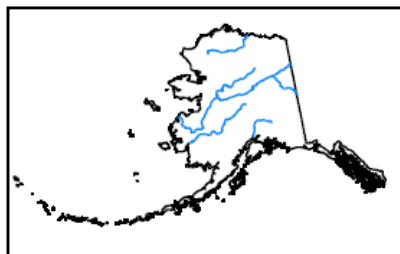
S = Short-Term, typically less than 6 months (e.g. agriculture, grasslands)

L = Long-Term, typically greater than 6 months (e.g. hydrology, ecology)

Intensity:

- Yellow: D0 Abnormally Dry
- Light Orange: D1 Moderate Drought
- Orange: D2 Severe Drought
- Red: D3 Extreme Drought
- Dark Red: D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.



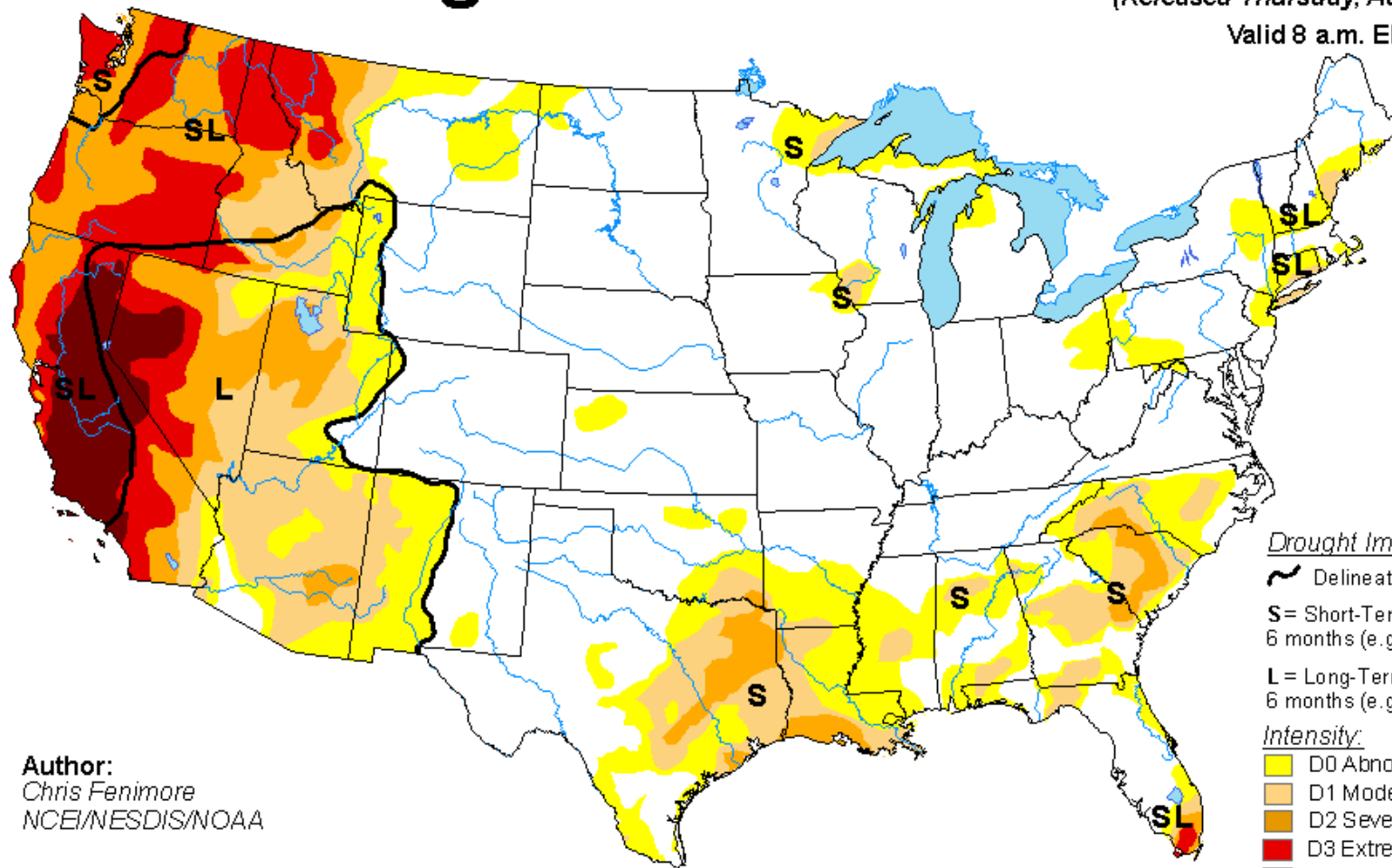
<http://droughtmonitor.unl.edu/>

U.S. Drought Monitor

August 18, 2015

(Released Thursday, Aug. 20, 2015)

Valid 8 a.m. EDT



Author:
Chris Fenimore
NCEI/NESDIS/NOAA

Drought Impact Types:

~ Delineates dominant impacts

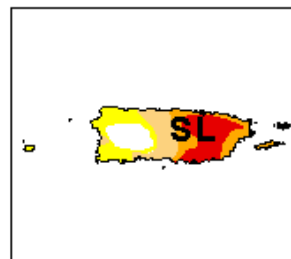
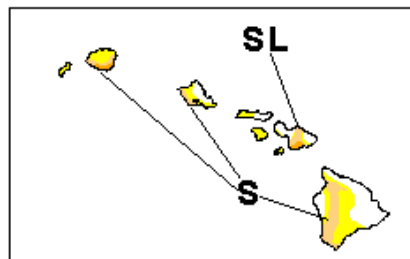
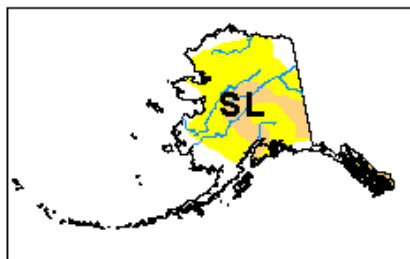
S = Short-Term, typically less than 6 months (e.g. agriculture, grasslands)

L = Long-Term, typically greater than 6 months (e.g. hydrology, ecology)

Intensity:

- D0 Abnormally Dry
- D1 Moderate Drought
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- D3 Extreme Drought
- D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. See accompanying text summary for forecast statements.



<http://droughtmonitor.unl.edu/>

Snowpack Monitoring for Water Supply Forecasting and Drought Planning

USDA-NRCS Colorado Snow Survey

Brian Domonkos
Hydrologist, Data Collection
Officer



Who is Colorado Snow Surveys?

- USDA NRCS Colorado – We are aligned under CO NRCS
- Brian Domonkos – Snow Survey Supervisor
- Vacant – Asst. Snow Survey Supervisor
- Lexi Landers – Hydrologist
- Karl Wetlaufer – Hydrologist
- Butch Horner – Electronics Technician
- Mike Ardison – Hydrologic Technician
- Zack Wilson – Hydrologic Technician
- 3 Seasonal hires to aid in summer SNOTEL and Snow Course maintenance
- Seven full time employees

By the Numbers - Snow Surveys

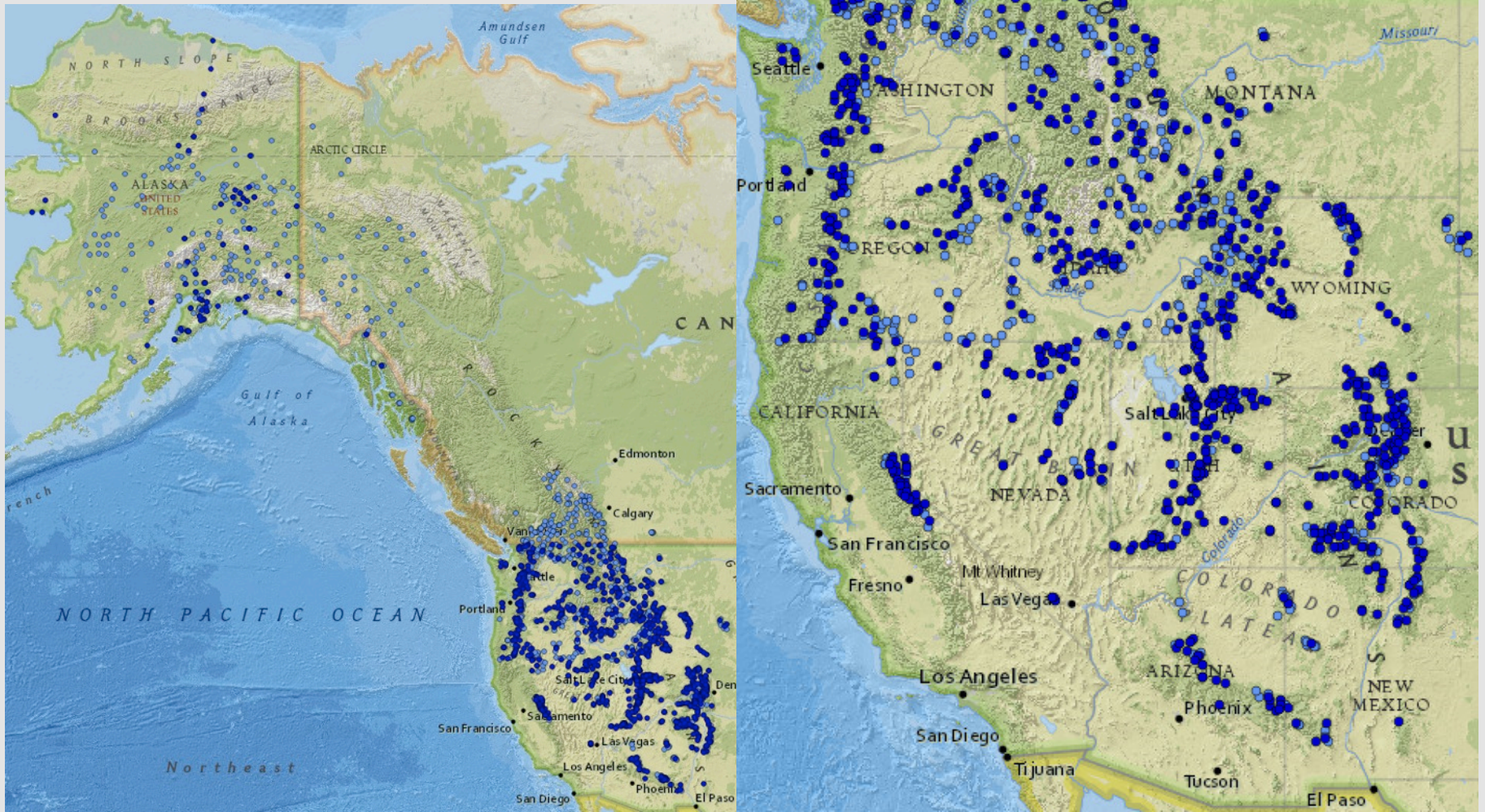
- Across west, seasonal snowpack in place Nov – May/Jun
- Snow Surveys is a Federally funded program
 - 858 Automated SNOTELs
 - 1113 Manual Snow Courses including Canada
 - 219 Soil Climate Analysis Network (SCAN)
 - Staffing
 - 62 Fulltime positions
 - 10 Vacant positions
 - Work in coordination with Canada as watersheds
 - Agreements with Mexico & Canada
- Colorado Snow Surveys
 - 7 fulltime employees
 - 3 Summer employees

A SNOTEL Site

- Cost between \$25,000 and \$35,000 depending on the sensor suite
- About \$3,000 to maintain annually
- Ideally would have 30 years in the period of record
 - For the purposes of normals or averages
 - Have used a 10 year period of record to generate averages
- May often be back estimated/correlated from data gathered by a collocated snow course
- Most sites are facilitated by correlating with a streamflow gauge for snowmelt runoff forecasting purposes
 - Uses and purposes for sites do vary greatly
- Manual Snow Courses
 - Cost about \$3,500 annually to measure when you consider
 - Staff time
 - Training – safety & procedural techniques

Nationally

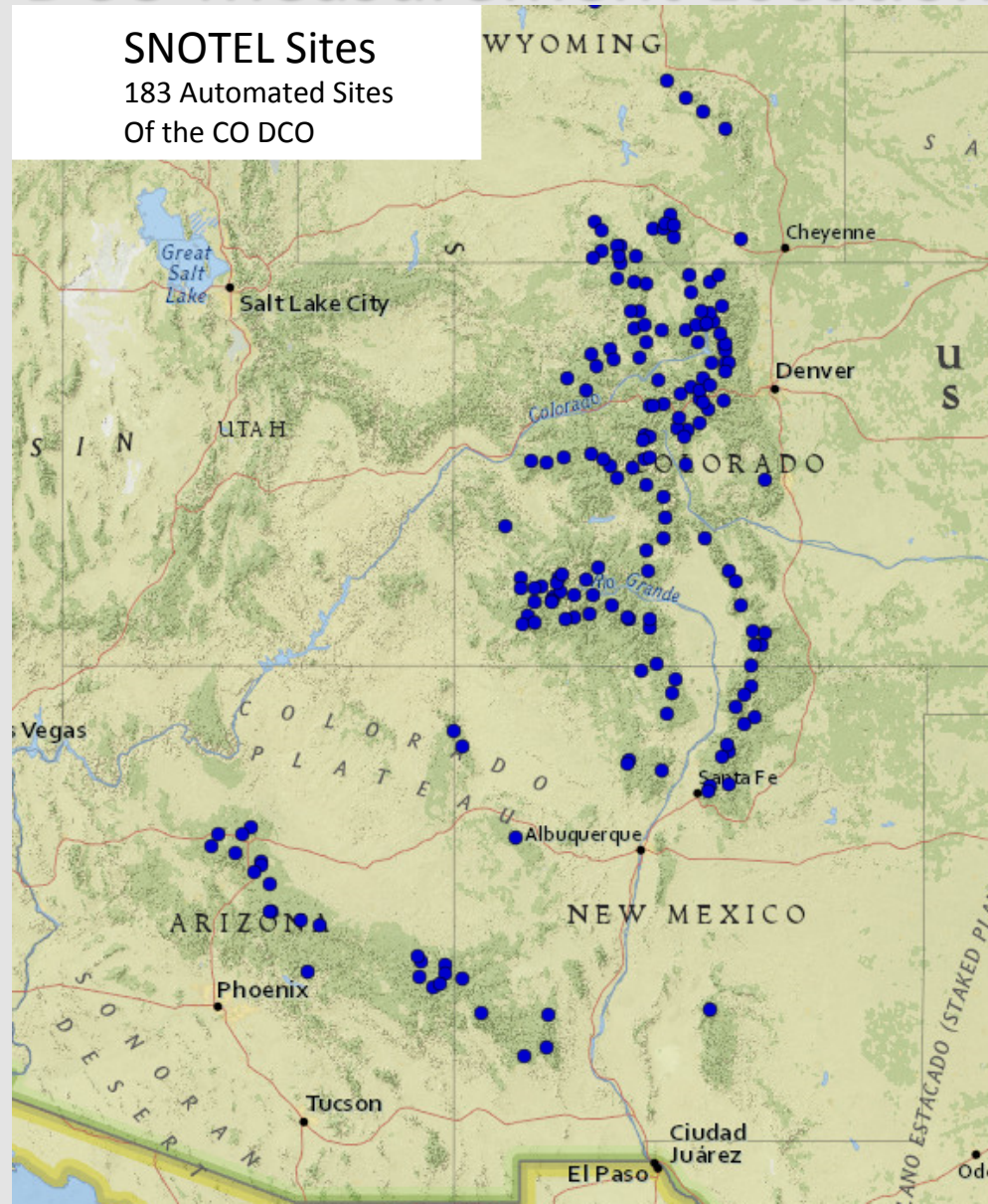
- 855 Automated SNOTELs
- 1113 Manual Snow Courses including Canada



Colorado DCO Measurement Locations - 2015

SNOTEL Sites

183 Automated Sites
Of the CO DCO



How do I access SNOTEL data: Daily Data?

Individual Site Data

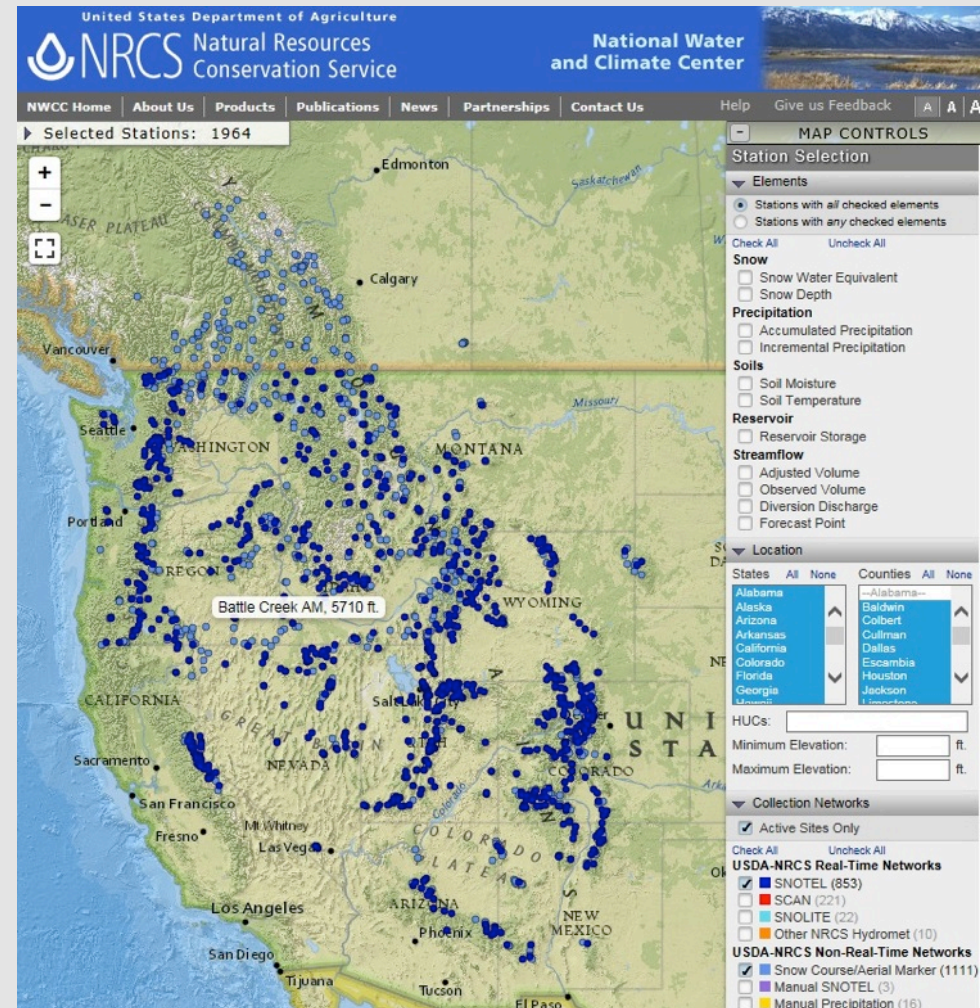
Site Selection Map

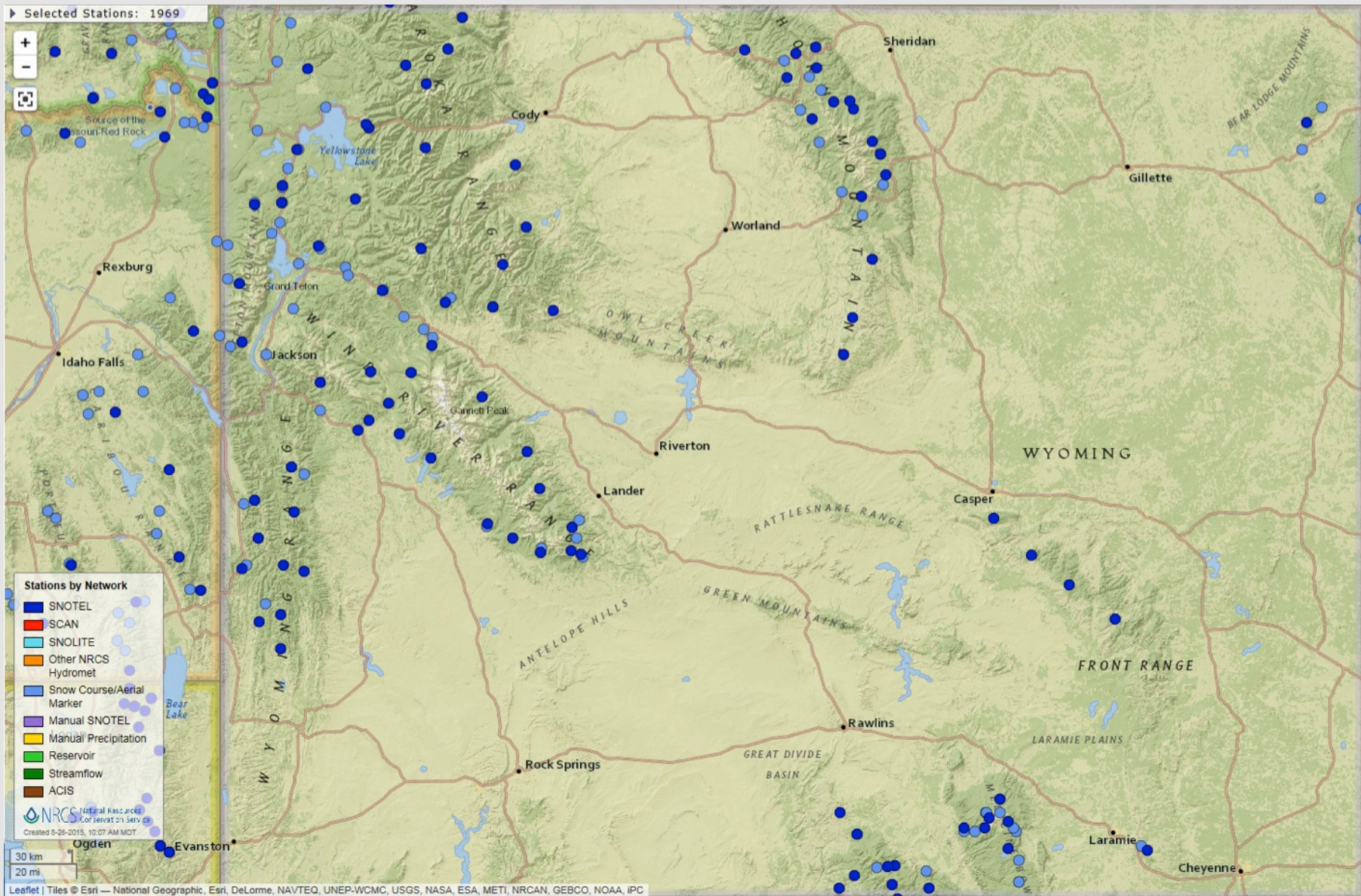
<http://www.wcc.nrcs.usda.gov/snow/index.html>

Then Click on “Open the Map” otherwise web address is too big, then you can save that to your favorites

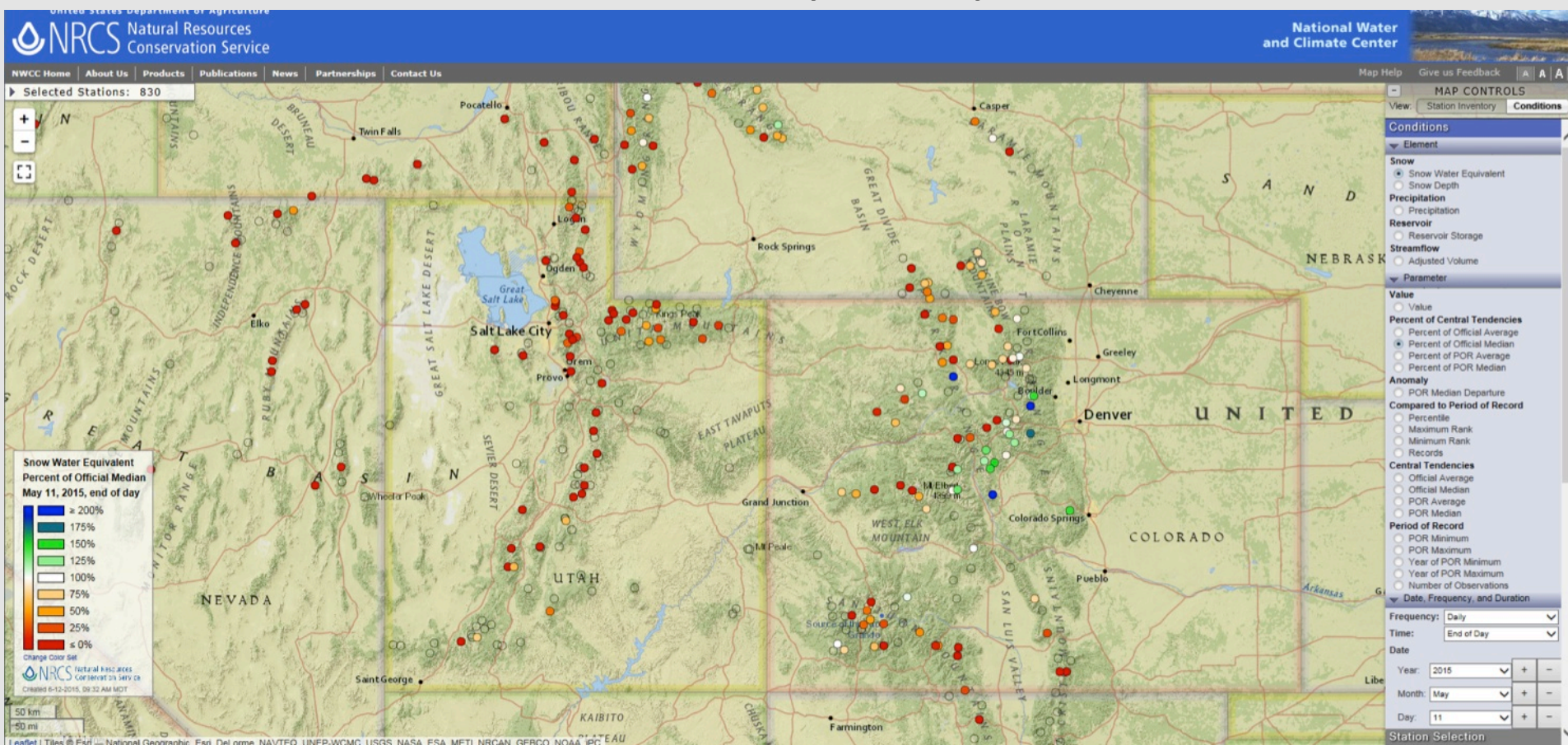
The web based map will provide access:

- Daily and Hourly data for an individual SNOTEL site
- Current Water Year Data (Oct 1st – Sept 30th)
- Historical Data for a SNOTEL site





Visualization of daily data parameters



You can save ANY map or data table in your favorites in your browser so every time you click on the favorite the most recent data populates in the color filled map, or even data tables. (there is a quick trick to enable this so feel free to contact me and we can set it up for you)

Data Quality Control

Hourly Data

- Not quality controlled by Colorado Snow Survey Staff
- Automated profiles flag data as suspect if out of a defined range or daily change
 - Suspect data is not publicly available
- Should be used for guidance purposes only
- All values, including sensor errors are published

Daily Data

- Midnight readings (00:00) quality controlled and reviewed on business days by office staff
- Data edits are completed on a weekly basis on Friday and may spill over into Monday
- Should be used primarily
- Year-end edits for previous year's data– are often started in November and are typically finalized in February

Quality Assurance/Control

- Majority of SNOTEL sites on hourly reporting
- Some on 3-hr reports b/c of batteries levels
- Automated Data Trapping - Data profiles suspect data in database and restrict data from being available
- On top of automated editing routines, personnel quality check data and edit regularly and when necessary
- Data Editing Frequency
 - Typically data is edited weekly every Friday

Hourly SWE vs Hourly Precip.

PARKER PEAK		WY	MTDCO	683.1	Elev. 9400	Lat. 44.73403	Lon. -109.91482																
Date	Time	#	1 BATT I-1 volt	2 WTEQ I-1 in	3 PREC I-1 in	4 TOBS I-1 degC	5 TMAX D-1 degC	6 TMIN D-1 degC	7 TAVG D-1 degC	8 SNWD I-1 in	9 WTEQ I-2 in	10 PREC I-2 in	11 BA H-1 vol										
2011-03-16	00:00	1	13.05	V	25.9	V	18.6	S	-1.0	V	2.4	V	-8.5	V	-3.0	V	101	S	26.1	V	18.6	V	14.38
2011-03-16	03:00	2	12.83	V	26.0	V	18.7	S	-2.3	V	2.4	V	-8.5	V	-3.0	V	103	S	26.4	V	18.6	V	14.38
2011-03-16	06:00	3	12.79	V	26.2	V	18.7	S	-2.3	V	2.4	V	-8.5	V	-3.0	V	169	S	26.4	V	18.6	V	14.38
2011-03-16	09:00	4	13.03	V	26.3	V	18.7	S	-2.7	V	2.4	V	-8.5	V	-3.0	V	103	S	26.6	V	18.6	V	14.38
2011-03-16	12:00	5	14.33	V	26.4	V	18.7	S	-2.3	V	2.4	V	-8.5	V	-3.0	V	105	S	26.7	V	18.7	V	14.38
2011-03-16	15:00	6	14.31	V	26.5	V	18.7	S	-2.5	V	2.4	V	-8.5	V	-3.0	V	102	S	26.8	V	18.7	V	14.38
2011-03-16	18:00	7	13.42	V	26.5	V	18.7	S	-4.5	V	2.4	V	-8.5	V	-3.0	V	105	S	26.8	V	18.7	V	14.38
2011-03-16	21:00	8	13.21	V	26.5	V	18.6	S	-7.2	V	2.4	V	-8.5	V	-3.0	V	105	S	26.8	V	18.7	V	14.38
2011-03-17	00:00	1	13.05	V	26.8	V	18.5	S	-8.9	V	-1.0	V	-8.9	V	-3.5	V	111	S	27.1	V	18.6	V	14.34
2011-03-17	03:00	2	12.93	V	26.9	V	18.6	S	-9.2	V	-1.0	V	-8.9	V	-3.5	V	108	S	27.3	V	18.6	V	14.34
2011-03-17	06:00	3	12.79	V	26.9	V	18.5	S	-9.9	V	-1.0	V	-8.9	V	-3.5	V	108	S	27.3	V	18.6	V	14.34
2011-03-17	09:00	4	12.88	V	27.0	V	18.6	S	-5.2	V	-1.0	V	-8.9	V	-3.5	V	109	S	27.3	V	18.6	V	14.34
2011-03-17	12:00	5	14.35	V	27.1	V	18.7	S	-0.4	V	-1.0	V	-8.9	V	-3.5	V	170	S	27.4	V	18.7	V	14.34
2011-03-17	15:00	6	14.35	V	27.2	V	18.7	S	-4.4	V	-1.0	V	-8.9	V	-3.5	V	169	S	27.5	V	18.7	V	14.34
2011-03-17	18:00	7	13.43	V	27.2	V	18.7	S	-10.4	V	-1.0	V	-8.9	V	-3.5	V	112	S	27.5	V	18.7	V	14.34
2011-03-17	21:00	8	13.17	V	27.1	V	18.6	S	-10.7	V	-1.0	V	-8.9	V	-3.5	V	112	S	27.5	V	18.6	V	14.34
2011-03-18	00:00	1	13.02	V	27.0	V	18.5	S	-11.8	V	0.3	V	-11.8	V	-8.1	V	111	S	27.5	V	18.5	V	14.38
2011-03-18	03:00	2	12.81	V	27.0	V	18.4	S	-14.1	V	0.3	V	-11.8	V	-8.1	V	111	S	27.4	V	18.4	V	14.38
2011-03-18	06:00	3	12.79	V	26.9	V	18.3	S	-12.1	V	0.3	V	-11.8	V	-8.1	V	111	S	27.5	V	18.4	V	14.38

1.1" SWE
In 48 hours

-0.2" Prec
In 48 hours?

Precipitation Gauge is plugged!

Why is the SWE decreasing???

Drops in Temperature
impacts the fluid based SWE
sensor

- SNOTEL site physical issues:
 - Plugged precipitation gauges
 - Bridging of snow pillow
 - Wind drifted snow on/off pillow
 - Wind induced precip under-catch

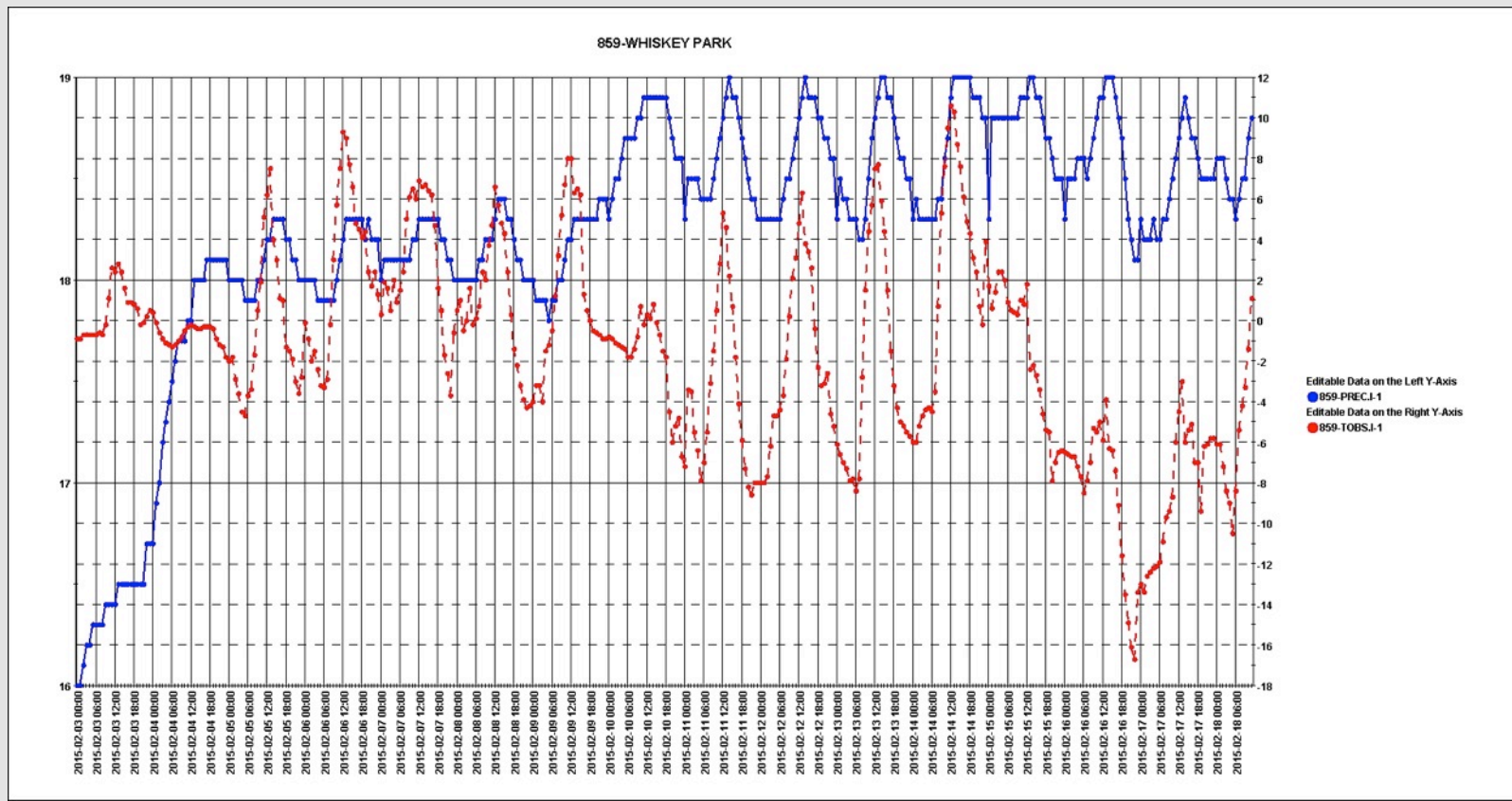
Solution:

- Utilize data from other sensors to help determine what the correct data is most likely to be
- Graphical tools can be very helpful in this process!!



SNOTEL Data Issues: SWE and Precipitation

- Temperature induced diurnal fluctuations
 - Commonly due to air in the line or transducer itself
- Can complicate obtaining accurate estimates of storm totals using hourly data



1981 – 2010 Normals

- Normals are simply a way to compare the current value to a baseline.
- Every decade, normals are recalculated to reflect the current climactic conditions because we are most familiar with the last 30 years.
- Addition of 2001 – 2010 and removal of 1971-1980 has shifted the new normal down several percentage points.
- Daily averages and medians were smoothed with a 7-day running average except at the truncation to zero and at the beginning and end of the year.

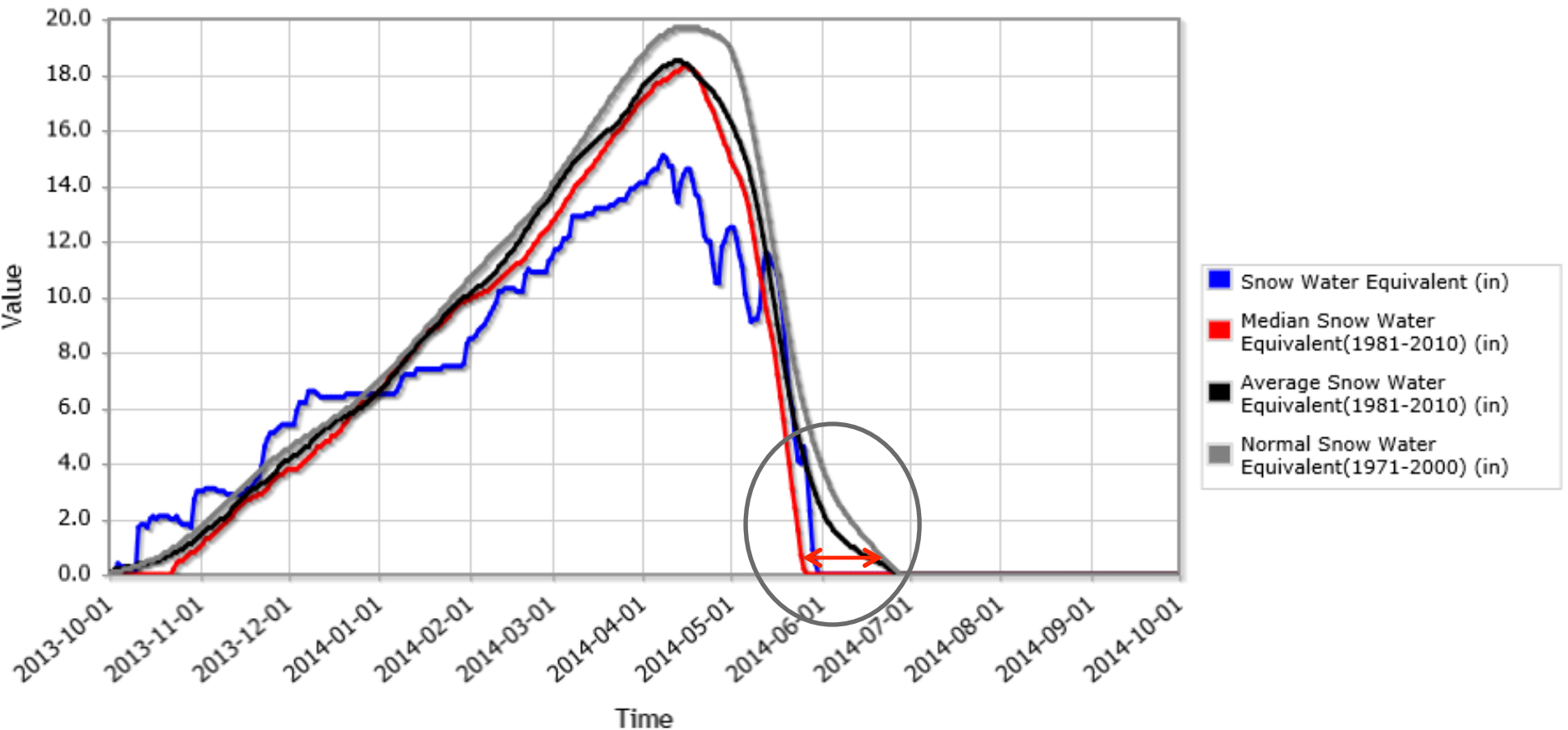
1981 – 2010 Normals

- Default is the value that will be most frequently represented in reports and graphs unless otherwise stated.
- “Yes” specifies those values have been calculated and stored in our database.
- Elements not specified here have no calculated normals for this 30yr period.

Element	Default	Average	Median
Temperature	Average	Yes	No
Precipitation	Average	Yes	Yes
Snow Water Eq.	Median	Yes	Yes
Snow Depth	Median	Yes	Yes
Streamflow	Average	Yes	Yes
Reservoir Storage	Average	Yes	No

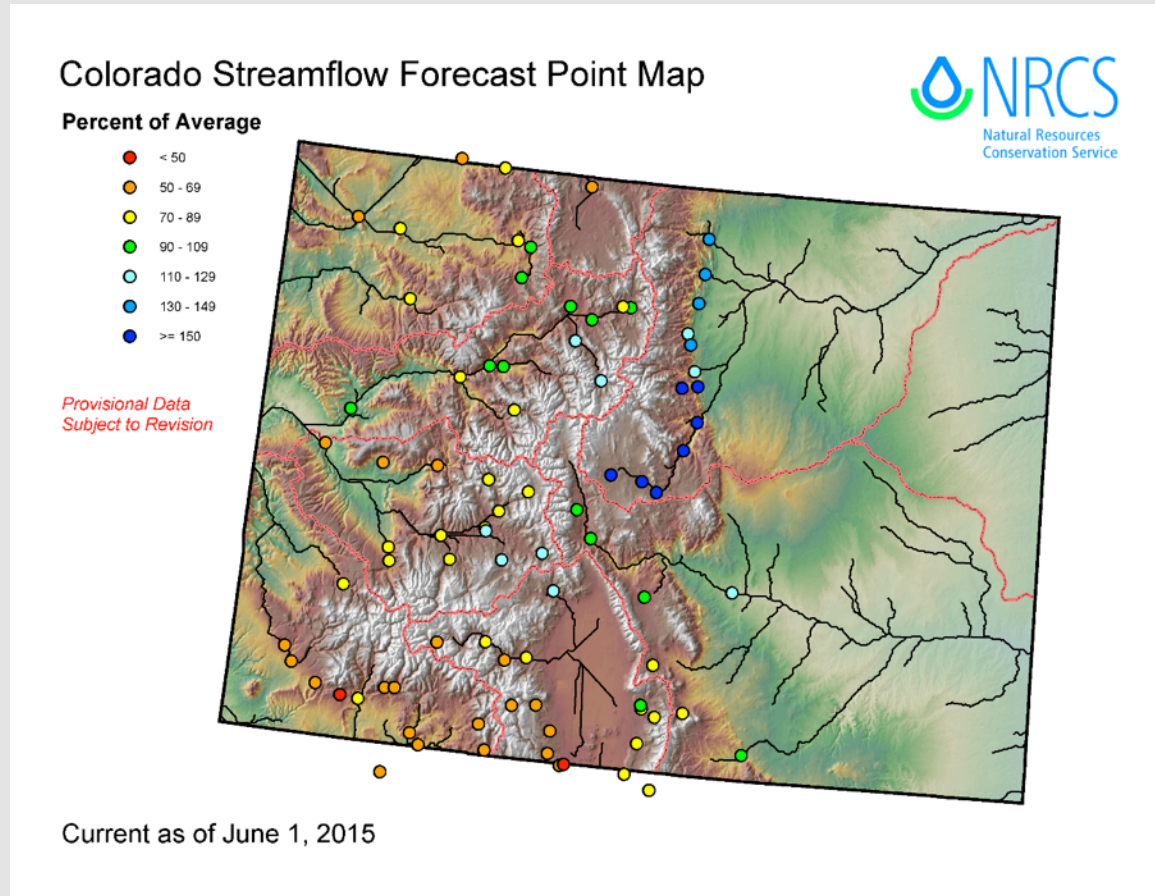
So why did we use medians?

Mesa Lakes (622) Colorado SNOTEL Site - 10000 ft



Streamflow Forecasting

- Volumetric – the total amount of water predicted to pass through a gauge, example; April 1 – July 31
 - Use various forecast periods
 - Water Supply forecasts updated monthly Jan 1 – Jun 1
- Forecasts produced using multiple regression analysis
- Forecast inputs optimized with principal components analysis



Streamflow Forecasting

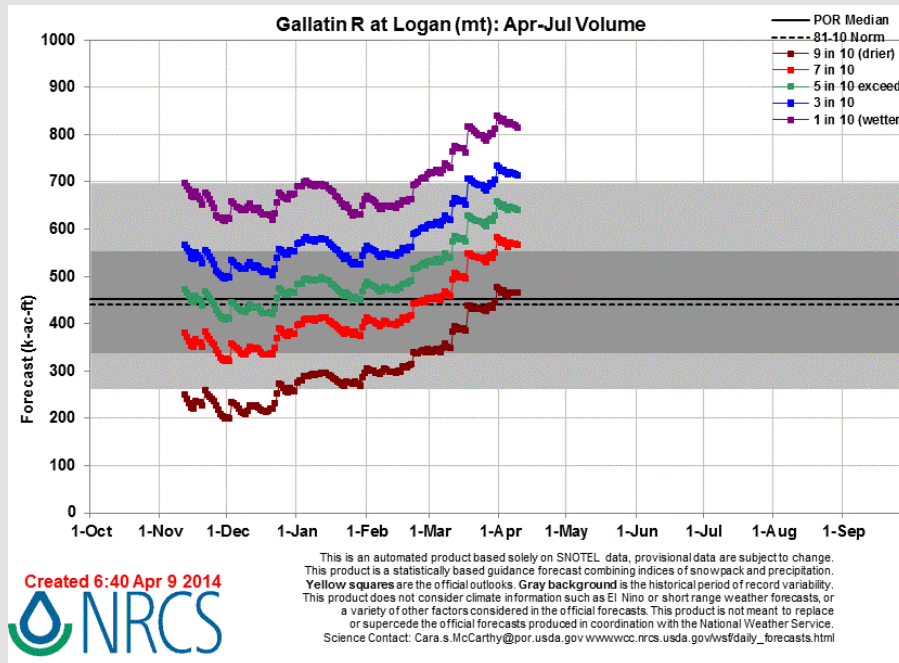
- Forecasts are provided in exceedances to provide probability of occurrence for each volumetric forecast
- Coordinate our forecasts with other federal agencies
- Also provide daily “guidance” forecasts for select locations

Flow & Forecasts in 1000*Ac-ft

Period	Forecasts					Avg	Last Year's Observed Flow	% of Avg	% of Last Year
	Min (90%)	70	50	30	Max (10%)				

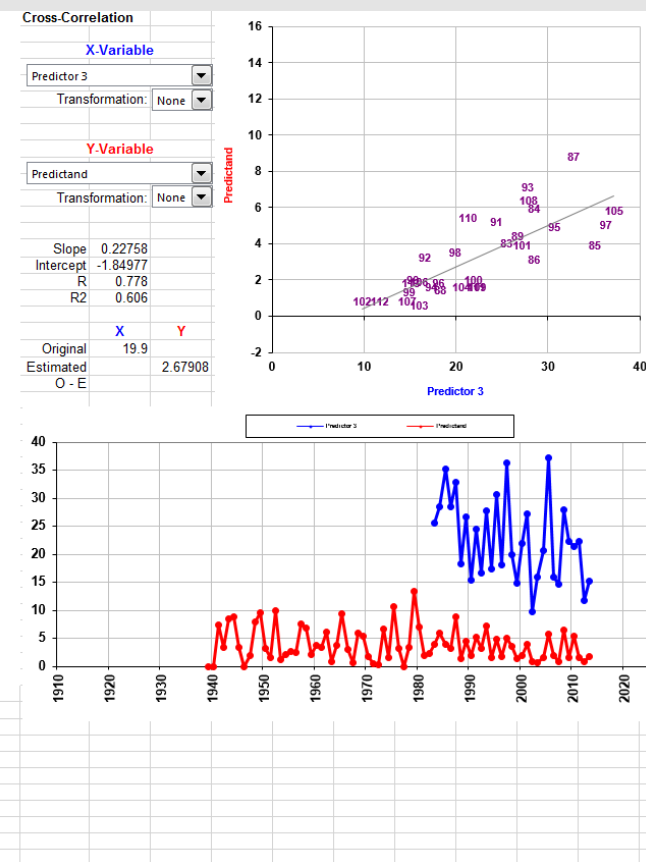
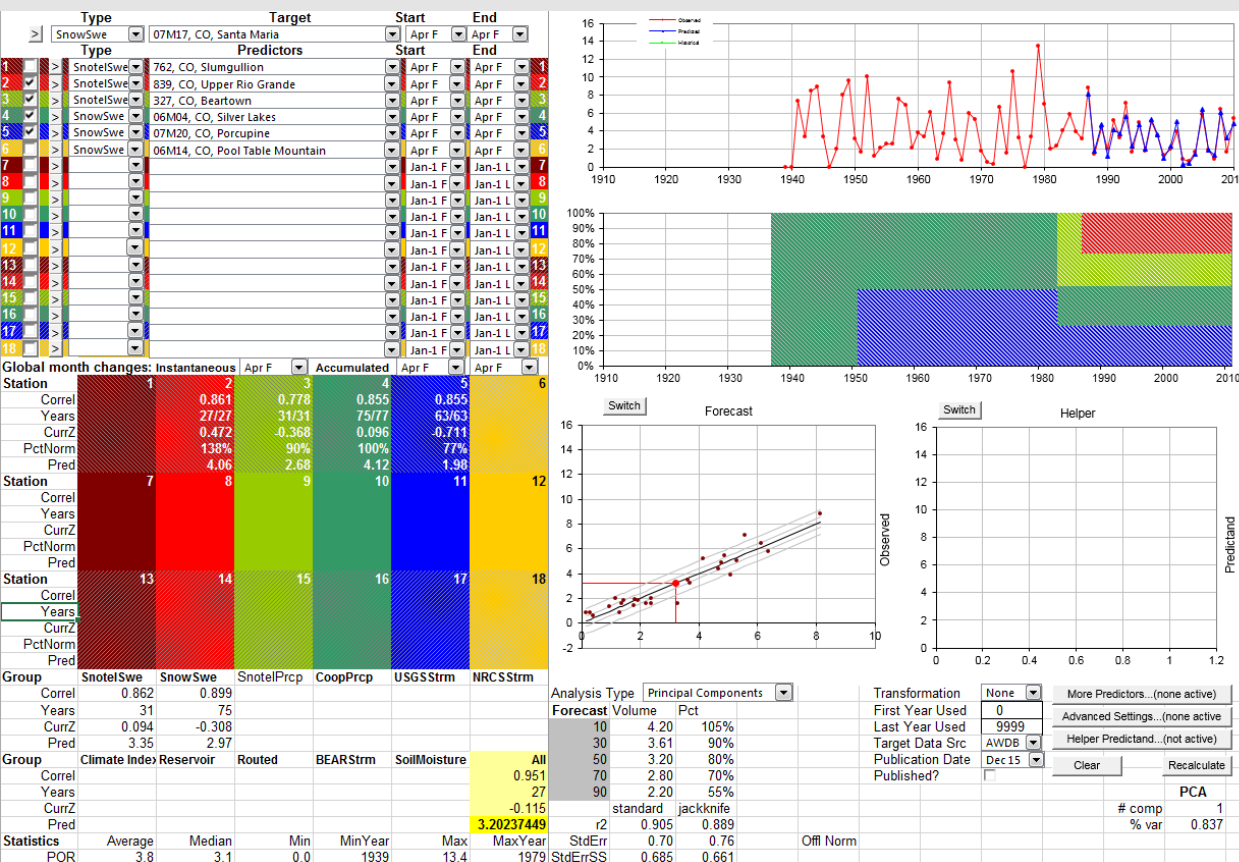
Dillon Reservoir Inflow

APR-JUL	168	210	235	260	300	330	282.18207	71%	83%
APR-SEP	275	325	360	395	445	485	420.33338	74%	86%

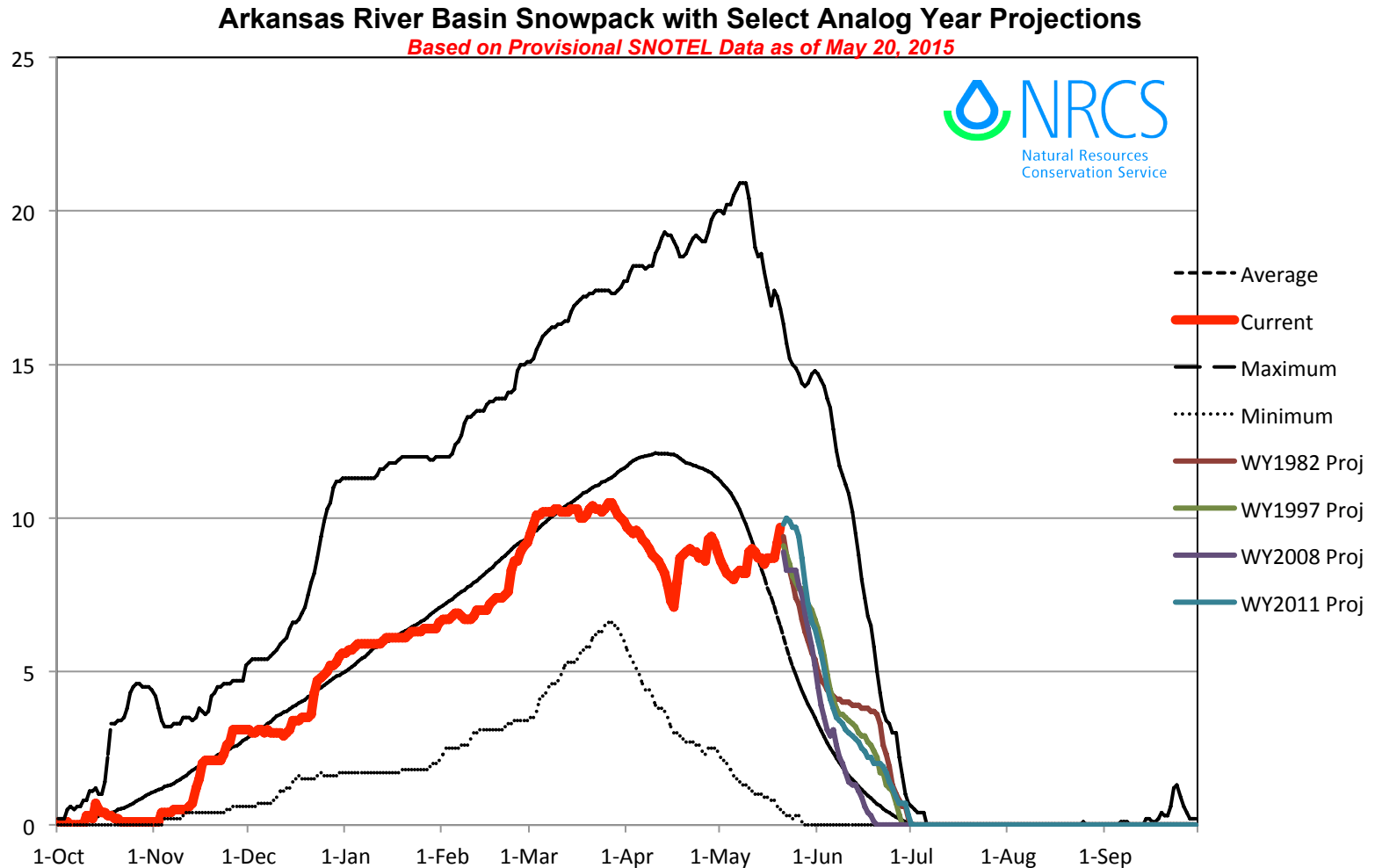


VIPER – NRCS Forecasting Model

- Multiple Regression Analysis w/ many input options



Analog Year Snowpack Projections



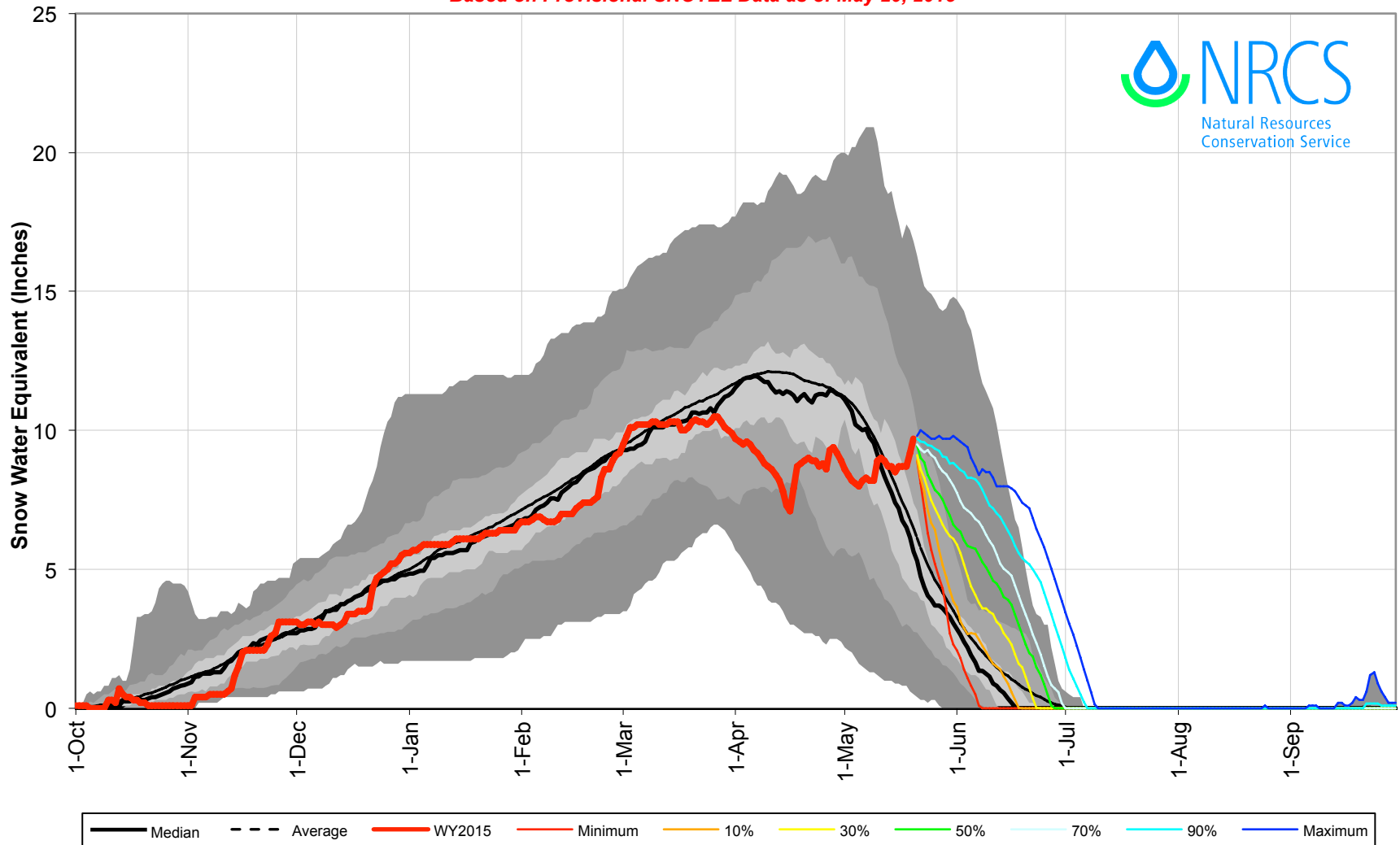
Arkansas River Basin Snowpack with Non-Exceedence Projections
Based on Provisional SNOTEL Data as of May 20, 2015

NRCS
 Natural Resources
 Conservation Service

Snow Water Equivalent (Inches)

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

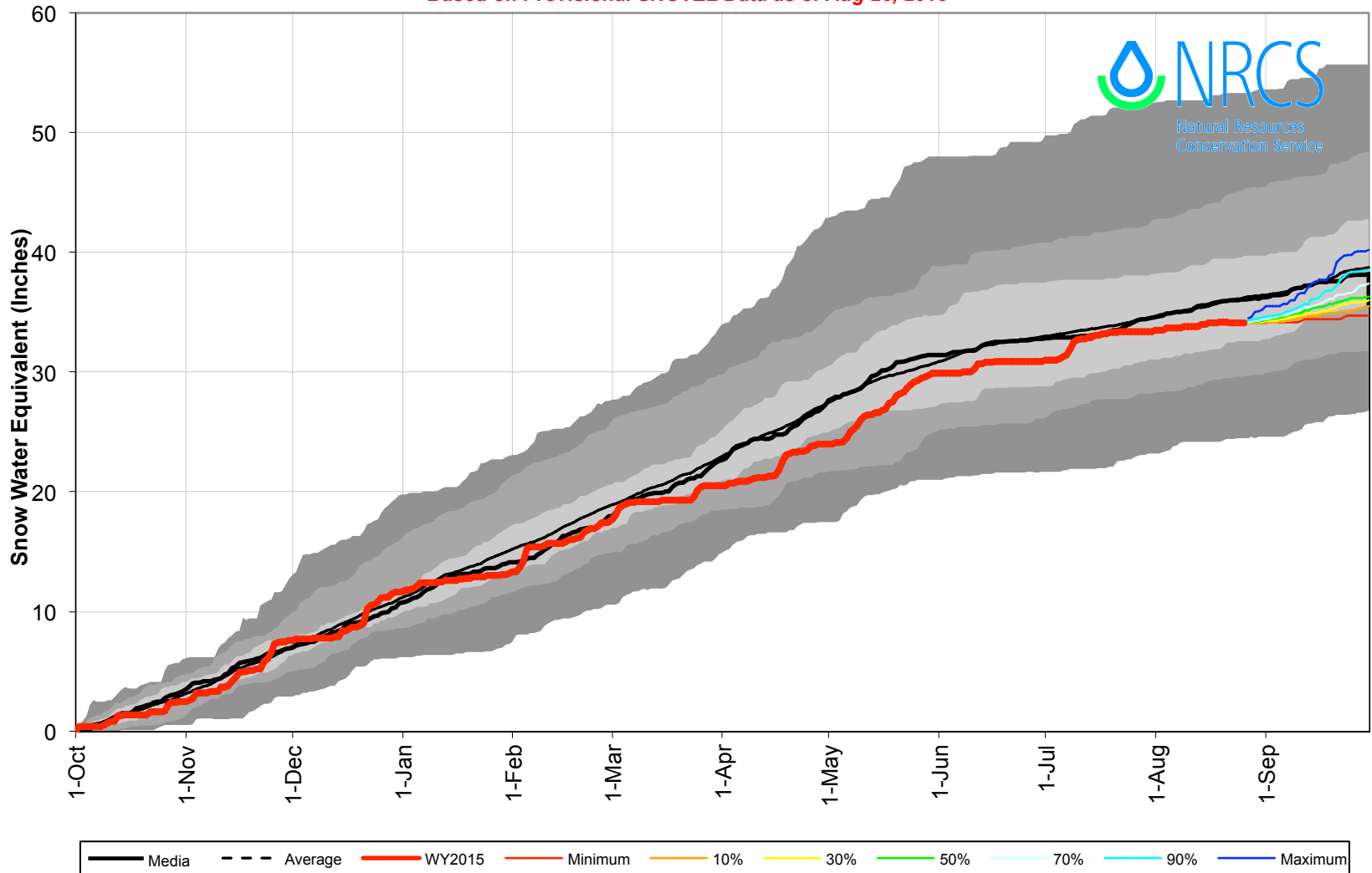
Median Average WY2015 Minimum 10% 30% 50% 70% 90% Maximum



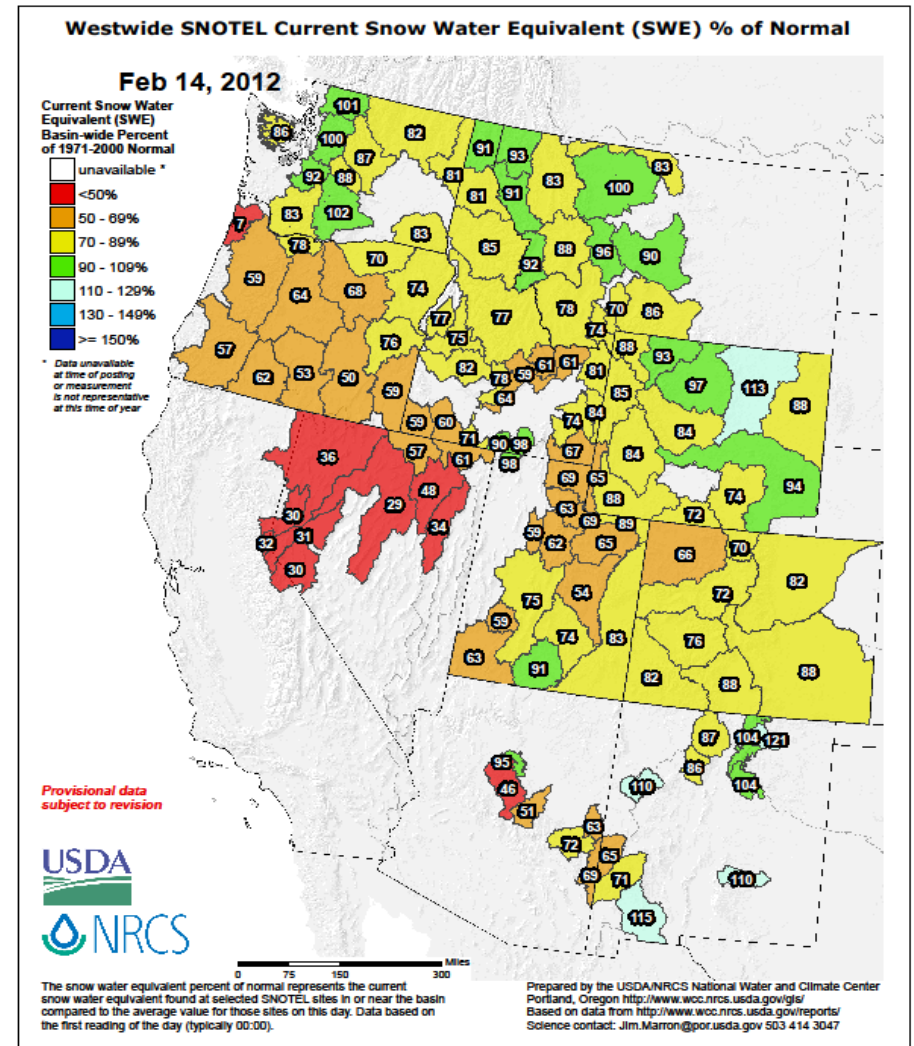
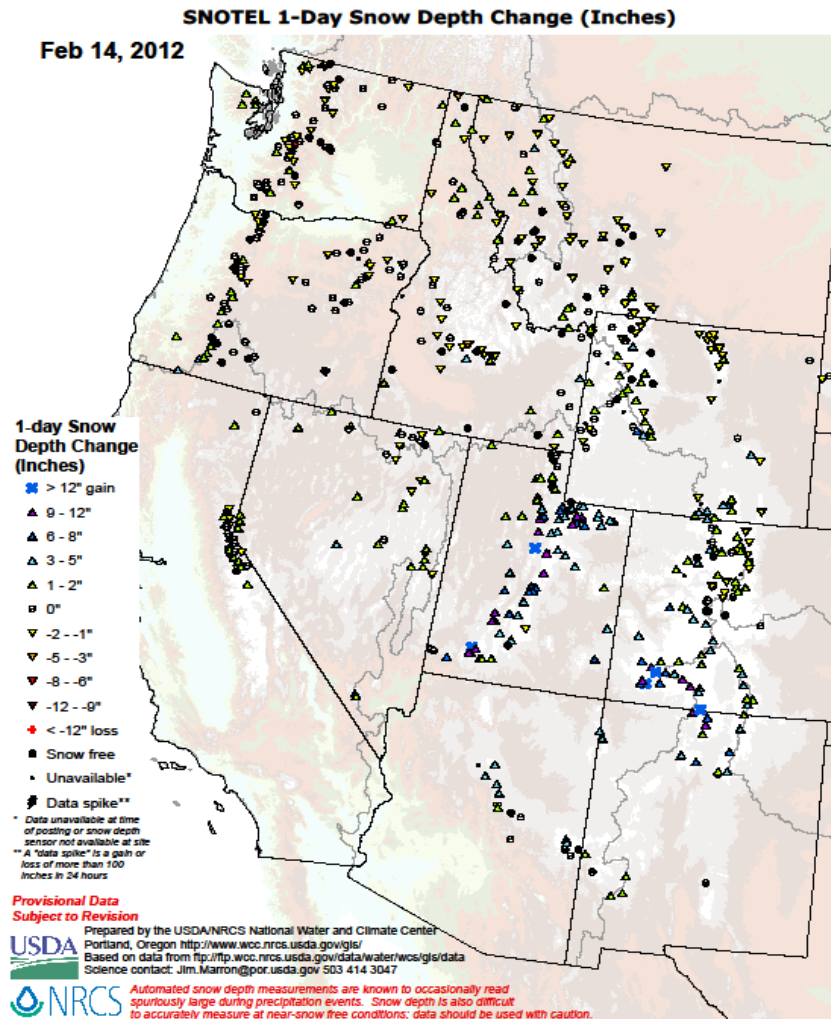
Non-Exceedance YTD Precip Projections

Laramie & North Platte River Basins Precipitation with Non-Exceedance Projections

Based on Provisional SNOTEL Data as of Aug 26, 2015



Products – Westwide



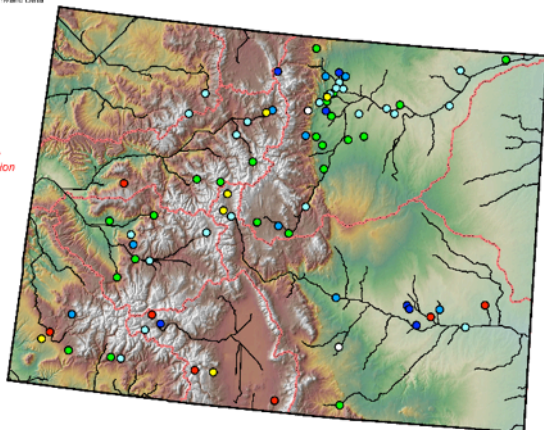
Products – Aggregated Reservoir Data

Colorado Reservoir Storage Point Map

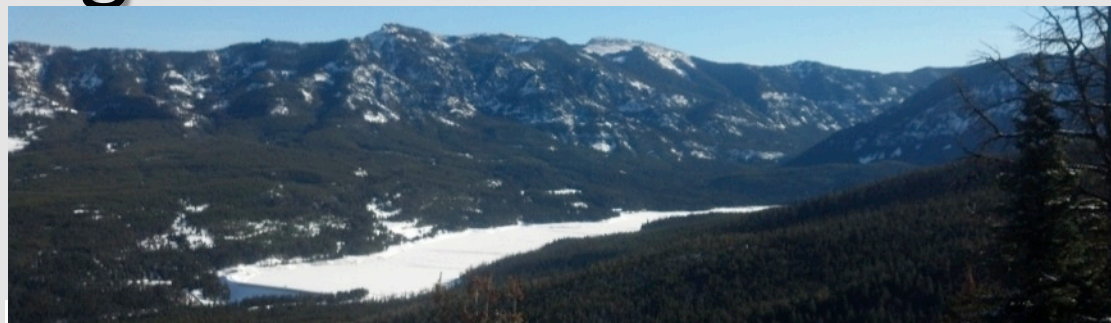
Percent of Average

- Missing or Invalid Data
- < 50
- 50 - 69
- 70 - 89
- 90 - 109
- 110 - 129
- 130 - 149
- ≥ 150

Provisional Data
Subject to Revision



End of May 2015

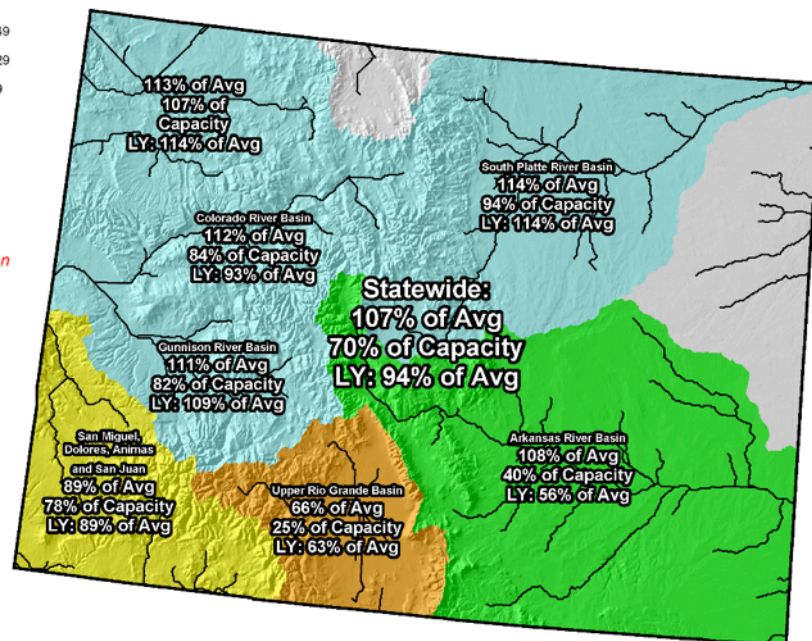


Colorado Reservoir Storage Map

Percent of Average

- ≥ 150
- 130 - 149
- 110 - 129
- 90 - 109
- 70 - 89
- 50 - 69
- < 50

Provisional Data
Subject to Revision

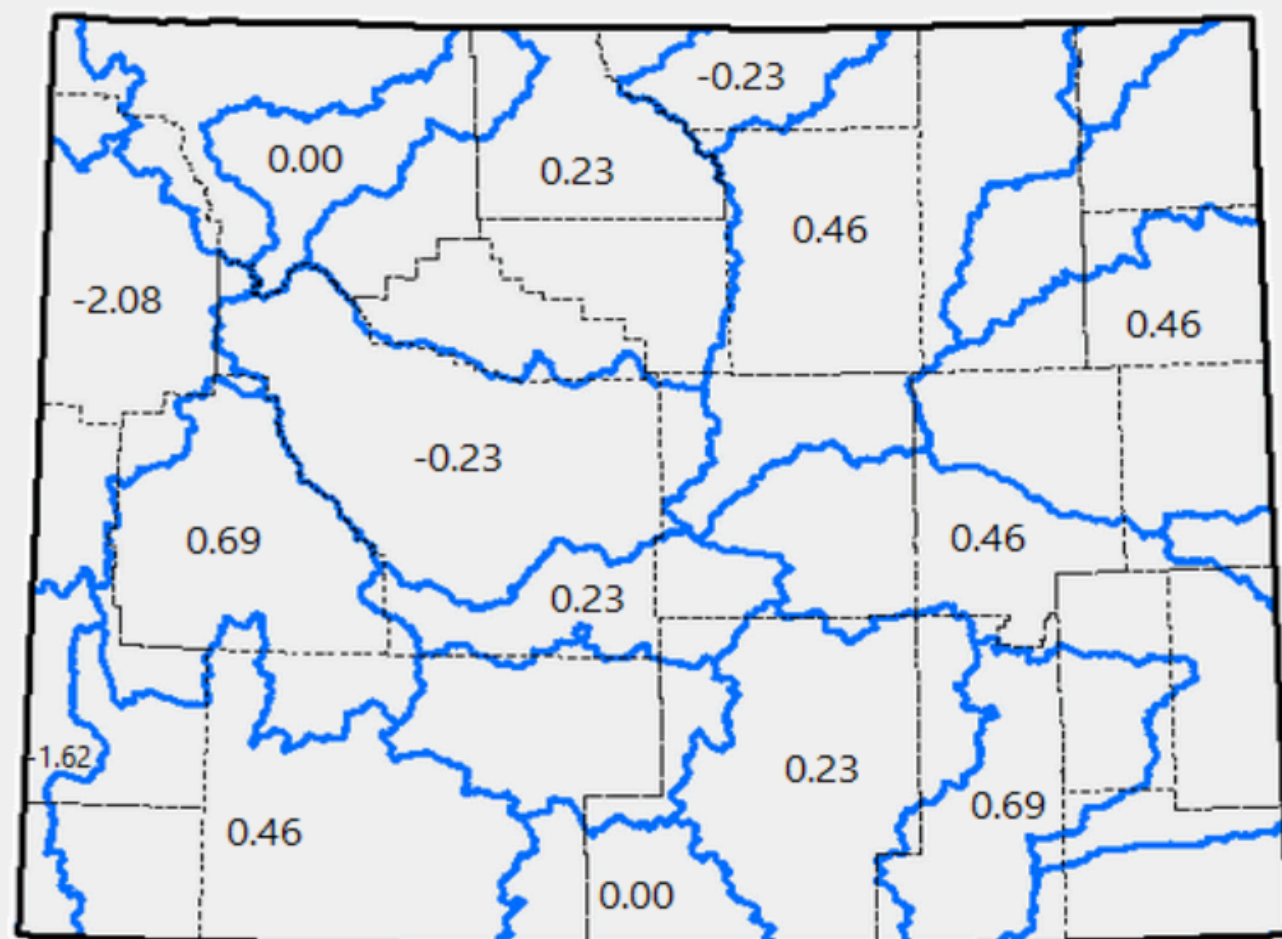


End of May 2015



Wyoming Surface Water Supply Index

Surface Water Supply Index - June 2015



SWSI Classification System

- >4.0 Extremely Wet
- 3.0 Very Wet
- 2.0 Moderately Wet
- 1.0 Slightly Wet
- 0.5 Incipient Wet Spell
- 0.0 Near Normal
- 0.5 Incipient Dry Spell
- 1.0 Mild Drought
- 2.0 Moderate Drought
- 3.0 Severe Drought
- <-4.0 Extreme Drought

June, 8 2015

Surface Water Supply Index

	Basin or Region	May EOM Storage	JUN-JUL Forecast	Storage + Forecast	Percentile	SWSI*	Years with similar SWSI
ID		KAF**	KAF**	KAF**	%		
1	Belle Fourche	413.1	0.0	413.1	81	2.55	98, 00, 14, 01
2	Big Horn	1631.3	909.0	2540.3	53.00	0.23	81, 05, 14, 08
3	Cheyenne	183.9	8.7	192.6	56.00	0.46	91, 83, 01, 94
4	Laramie	89.0	80.0	169.0	58.00	0.69	93, 88, 98, 85
5	Little Snake	21.0	85.0	106.0	50.00	0	81, 06, 90, 91
6	Lower Green	3534.6	527.0	4061.6	56.00	0.46	87, 10, 05, 91
7	Lower n Platte	1471.1	574.1	2045.2	56.00	0.46	93, 88, 85, 08
8	Madison-Gallatin	414.4	219.0	633.4	14.00	-3.01	87, 88, 94, 13
9	Powder		239.2	239.2	56.00	0.46	98, 05, 92, 91
10	Shoshone	566.9	864.0	1430.9	50.00	0	05, 12, 03, 81
11	Snake	2057.0	3348.0	5405.0	25.00	-2.08	88, 04, 03, 02
12	Sweetwater	724.4	19.1	743.5	53.00	0.23	82, 89, 81, 01
13	Tongue	83.4	188.0	271.4	47.00	-0.23	82, 91, 81, 93
14	Upper Bear	55.5	68.0	123.5	31.00	-1.62	04, 03, 88, 89
15	Upper Green	332.2	809.0	1141.2	58.00	0.69	93, 08, 91, 05
16	Upper N Platte	804.8	474.1	1278.9	53.00	0.23	05, 88, 08, 93
17	Wind River	843.0	1221.0	2064.0	47.00	-0.23	90, 81, 89, 08
18	Yellowstone		1710.0	1710.0	19.00	-2.55	88, 85, 04, 13

EOM end of month; * SWSI, surface water supply index; KAF, thousand acre-feet

What Is a Surface Water Supply Index?

The Surface Water Supply Index (SWSI) is a predictive indicator of total surface water availability within a watershed for the spring and summer water use seasons. The index is calculated by combining pre-runoff reservoir storage (comprised) with forecasts of spring and summer streamflow which are based on current snowpack and other hydrologic variables. SWSI values are scaled from +4.1 (abundant supply) to -4.1 (extremely dry) with a value of zero (0) indicating median water supply as compared to historical analysis. SWSI's are calculated in this fashion to be consistent with other hydroclimatic indicators such as the Palmer Drought Index and the Precipitation Index.

Data Feeds – Web Services

- Written in:
 - Java
 - Visual Basic for Applications (VBA)
- Near Real-Time Data
- Provides direct feed to database
- Data profiles auto QC data and blank out if data is suspect
- Database updated as soon as live person QCs data
- Database provides latest 30-year normals for select data types

Questions? Comments?

Global Warming Protest



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