2021 Water Year Recap

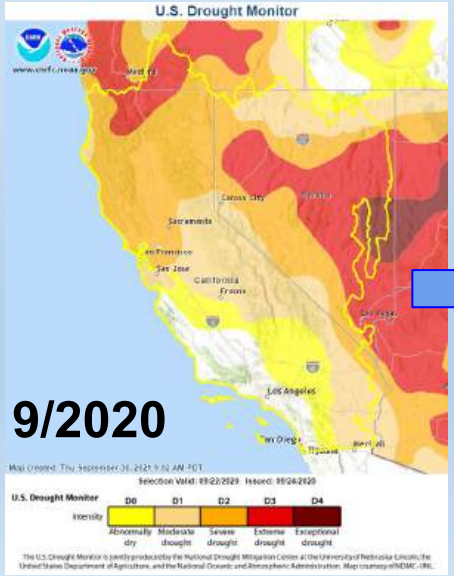
May 4th: Meager snowpack in Tuolumne watershed

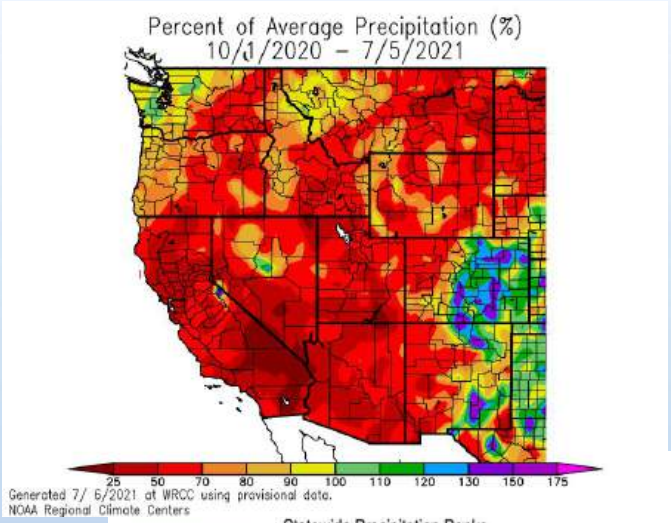
Highlights

- Very dry conditions throughout the water year
- Snowpack well below normal
- Snowmelt peaks were early and modest
- Dry soils and year 2 of drought conditions contributed to poor spring runoff efficiency
- No flood stages observed for WY 2021

Precipitation summary

- WY precipitation near 50% of average for much of the area
- Very dry conditions for much of the WY
- Severe to extreme drought conditions developing
- June 2020 - May 2021 precipitation driest on record in CA; 2nd in NV





Source: ncdc.noaa.gov

WY precipitation summary

- Sierra indices show the 2yr precipitation average for WY 2020 & 2021 rank in the bottom 3 for the 8-, 5- & 6-station

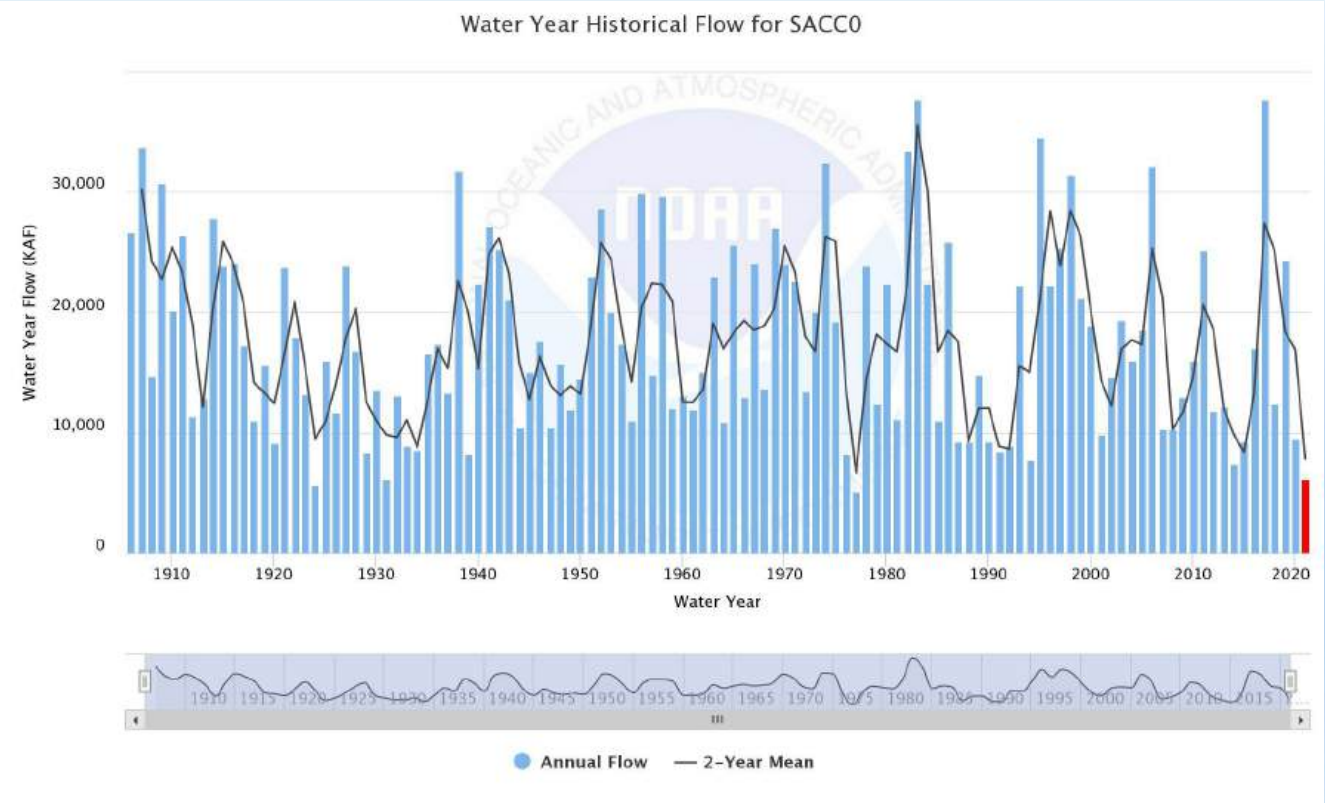
2 Water Years	1 Season 8-Station Avg ~50"	
		8-STATION
RANK	PRECIP	WY RANGE
1	47.34	1976-1977
2	55.73	2020-2021
3	60.09	1923-1924
4	63.42	1987-1988
5	68.14	1990-1991
6	68.18	1991-1992
7	68.54	2014-2015
8	68.58	1933-1934
9	70.05	1931-1932
10	70.15	1924-1925
		1921-2021 WY

	1 Season 5-Station Avg ~40"	
		5-STATION
RANK	PRECIP	WY RANGE
1	39.37	2014-2015
2	40.35	1976-1977
3	43.40	2020-2021
4	46.83	2013-2014
5	47.21	1987-1988
6	47.68	1912-1913
7	49.21	1930-1931
8	49.34	1960-1961
9	51.37	2012-2013
10	51.83	1923-1924
		1905-2021 WY

	1 Season 6-Station Avg ~30"	
		6-STATION
RANK	PRECIP	WY RANGE
1	27.66	2014-2015
2	28.50	2020-2021
3	30.22	2013-2014
4	31.75	1976-1977
5	33.65	1959-1960
6	35.93	1960-1961
7	37.25	2012-2013
8	39.30	2015-2016
9	39.51	1987-1988
10	39.80	1971-1972
		1922-2021 WY

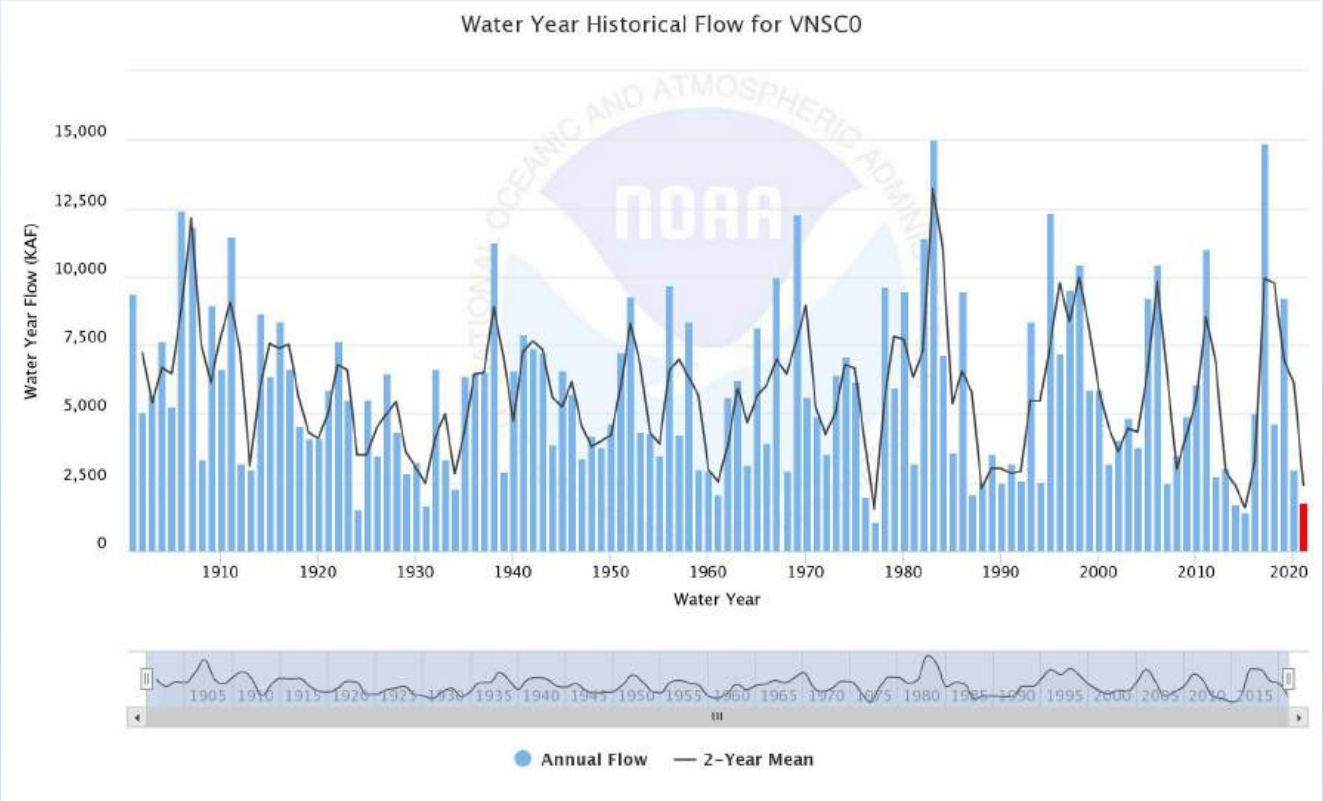
Long-term drought

- Sacramento basin index 2yr WY mean near record low



Long-term drought cont.

- San Joaquin basin index 2yr WY mean near record low



2nd Lowest - AJ Precipitation

Northern Sierra 8-Station Precipitation (inches)

Water Year 2021

Wednesday, August 25, 2021

Month	Average (Inches)	Observed (Inches)	Observed (as Percent of Avg)
October-2020	2.9"	0.0"	0%
November-2020	6.6"	3.5"	53%
December-2020	9.2"	3.6"	39%
January-2021	8.9"	7.0"	78%
February-2021	8.2"	3.9"	47%
March-2021	7.6"	4.1"	53%
April-2021	3.8"	0.8"	21%
May-2021	2.2"	0.1"	4%
June-2021	1.0"	0.1"	10%
July-2021	0.2"	0.1"	50%
August-2021	0.3"	0.0"	0%
September-2021	0.9"		
April – July	7.2"	1.1" (1985= 1.06")	15%

Record Low – AJ Precipitation

San Joaquin 5-Station Precipitation (inches)

Water Year 2021

Wednesday, August 25, 2021

Month	Average (Inches)	Observed (Inches)	Observed (as Percent of Avg)
October-2020	2.2"	0.0"	0%
November-2020	4.6"	1.8"	39%
December-2020	6.4"	2.8"	43%
January-2021	7.2"	7.8"	108%
February-2021	6.7"	1.7"	25%
March-2021	6.1"	3.6"	59%
April-2021	3.5"	0.5"	14%
May-2021	1.7"	0.1"	5%
June-2021	0.6"	0.0"	0%
July-2021	0.3"	0.4"	133%
August-2021	0.2"	0.0"	0%
September-2021	0.7"		
April – July	6.1"	1.0" (2004=1.57")	16%

2nd Lowest - AJ Precipitation

Tulare Basin 6-Station Precipitation (inches)

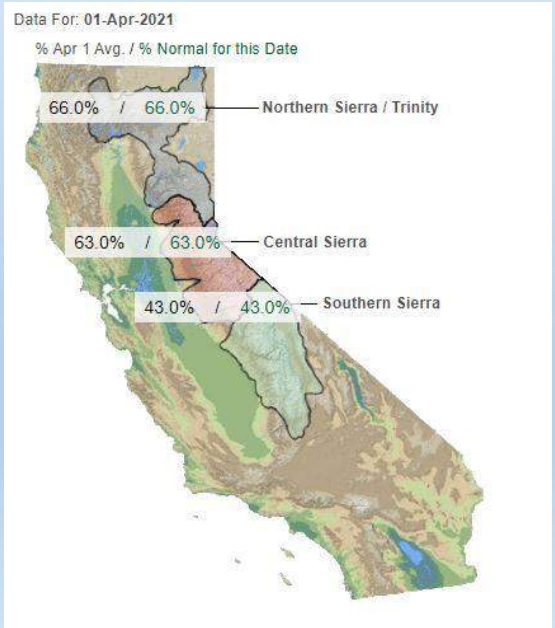
Water Year 2021

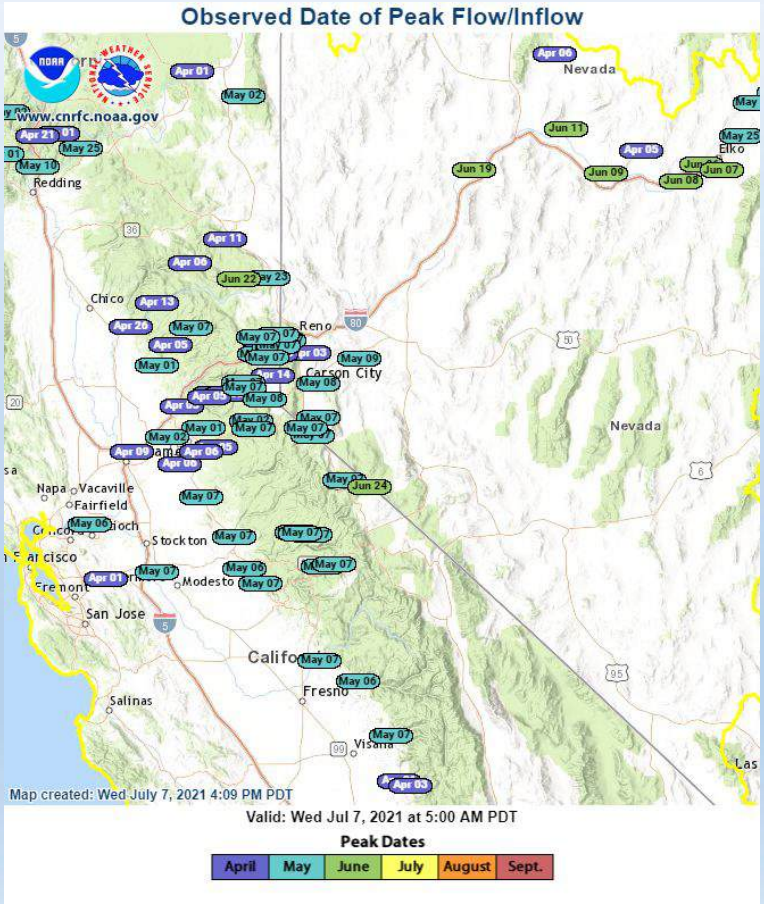
Wednesday, August 25, 2021

Month	Average (Inches)	Observed (Inches)	Observed (as Percent of Avg)
October-2020	1.2"	0.0"	0%
November-2020	3.0"	0.8"	26%
December-2020	4.7"	1.8"	38%
January-2021	5.4"	4.1"	75%
February-2021	5.0"	0.9"	18%
March-2021	4.6"	1.7"	36%
April-2021	2.5"	0.3"	12%
May-2021	1.1"	0.0"	0%
June-2021	0.4"	0.0"	0%
July-2021	0.3"	0.2"	66%
August-2021	0.1"	0.0"	0%
September-2021	0.5"		
April – July	4.3"	0.5" (2004=0.37")	12%

Snowpack

- April 1st snowpack well below normal despite mostly low snow events
- Modest snowmelt peaks with highly variable peak dates
- Many high Sierra basins peaked on May 7th





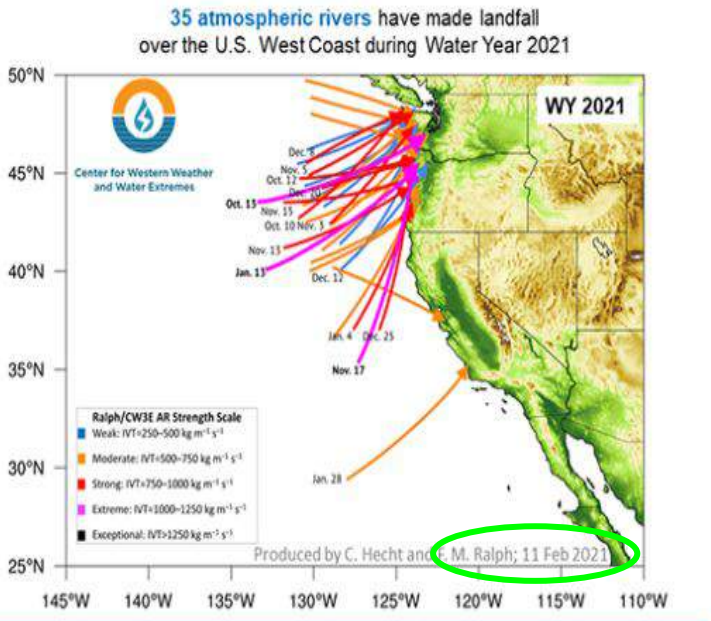
Atmospheric rivers WY 2021

- One large AR in late January impacted the Central Coast and central Sierra.
- 5 Station index: 6.27” in 3 days (33% of WY total!)

Water Year 2021 Landfalling Atmospheric Rivers: Oct-Feb Summary

AR Strength	AR Count
Weak	8
Moderate	13
Strong	11
Extreme	3
Exceptional	0

Regions Impacted by Each AR	
State/Region	AR Conditions
Washington	33
Oregon	34
Northern CA	20
Central CA	9
Southern CA	14

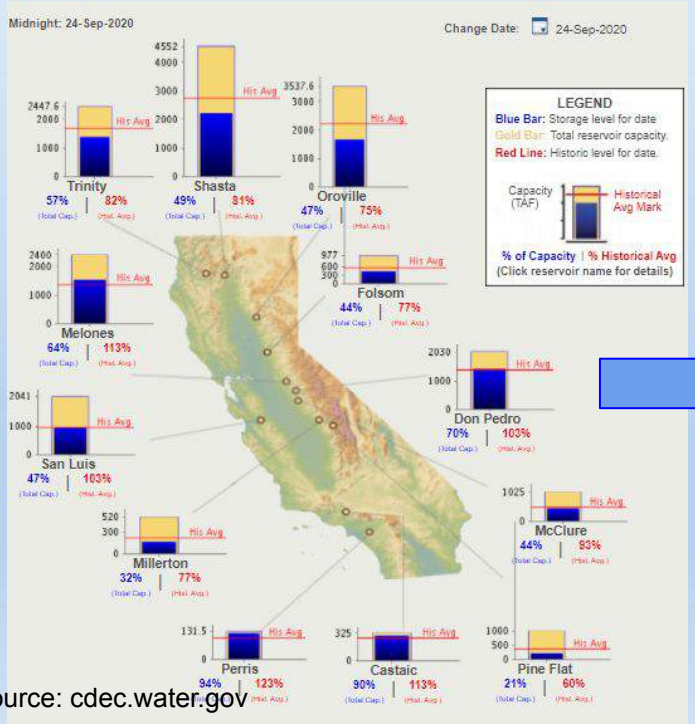


Source: https://cw3e.ucsd.edu

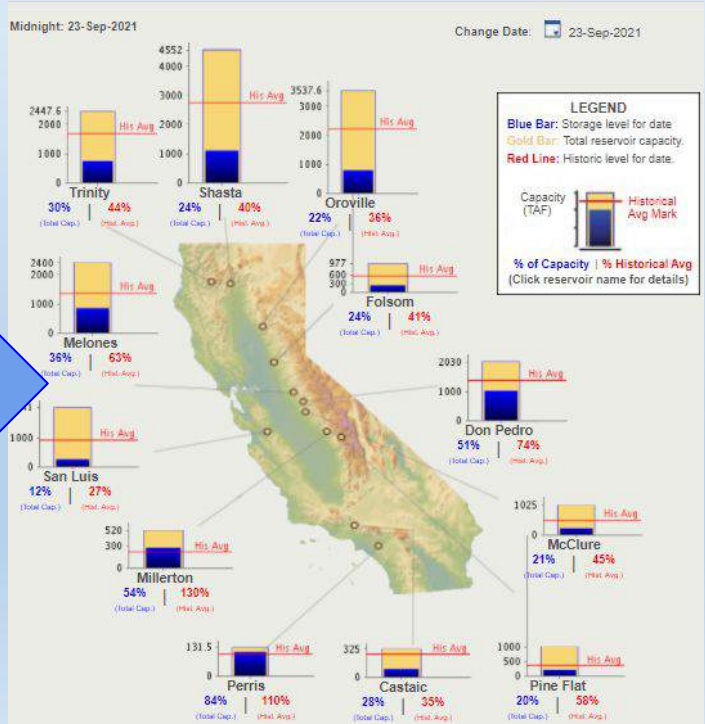
Reservoir conditions

- Significant decline in reservoir storage
- Central Sierra reservoirs in the best shape, but still well below average

Sept 24th, 2020



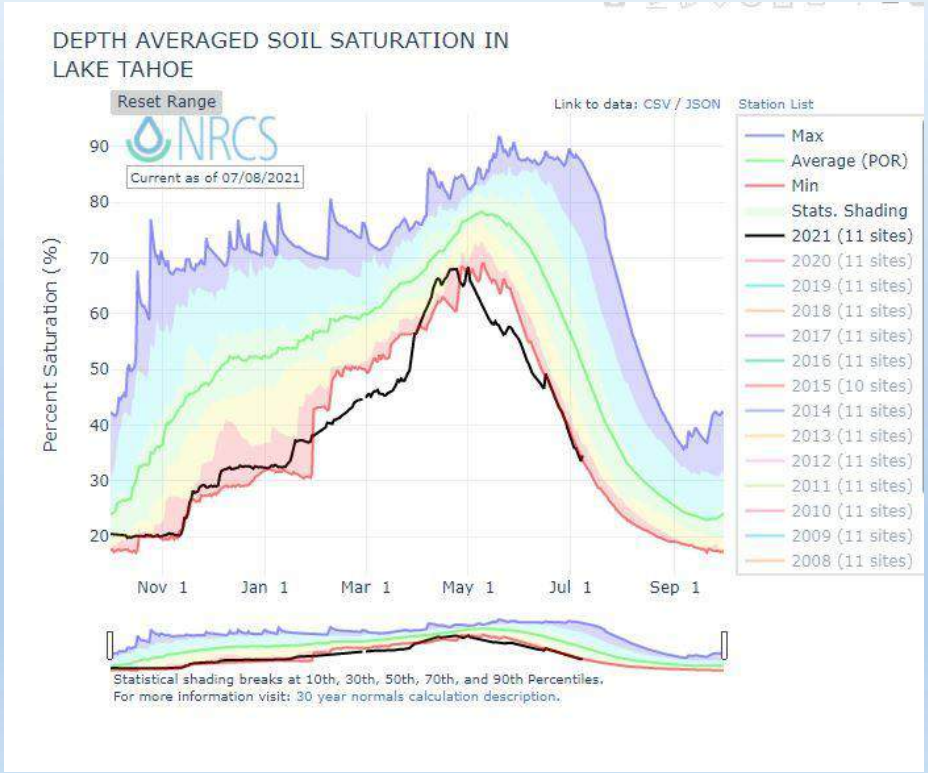
Sept 24, 2021



Source: cdec.water.gov

Soil moisture

- Near record low soil moisture reported in watersheds throughout the WY*
- Prolonged warm period in late March/early April boosted soil moisture
  - Snow pillows recorded significant melt during this time, but little response on the rivers
- Dry soils appear to have played a significant role in reducing runoff efficiency

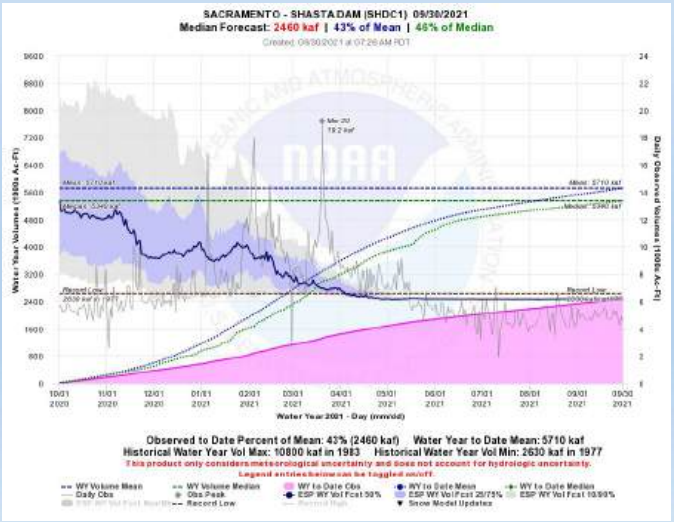


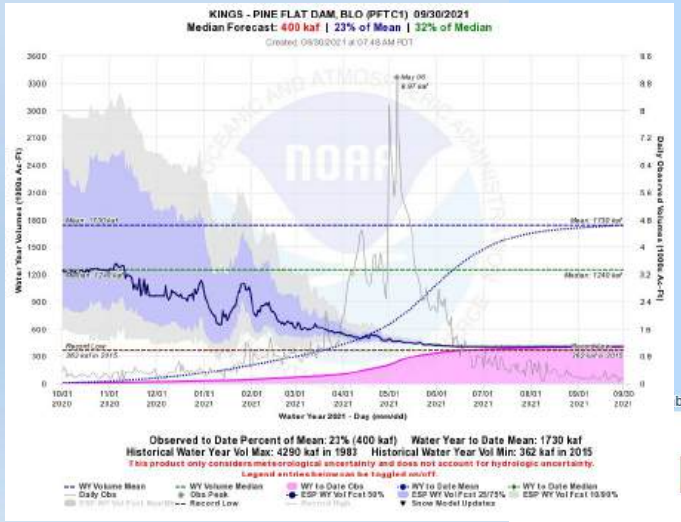
*Data collection began circa 2004

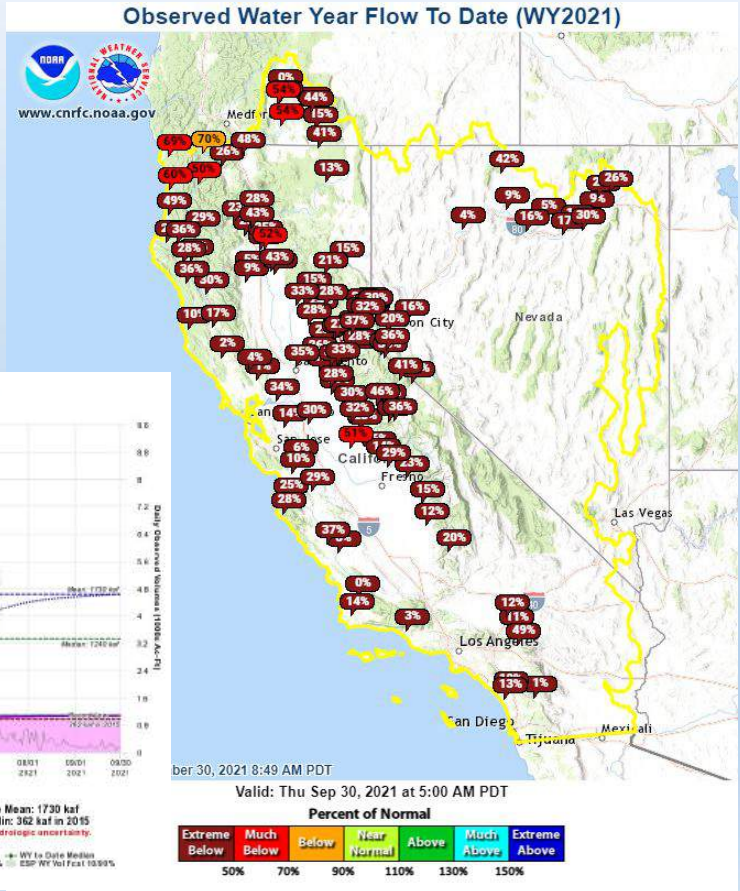
Source: nrcs.usa.gov

Water year runoff

- WY 2021 runoff was 10-40% of average throughout much of the area
- Most extreme across southern Sierra and NV
- Numerous locations experienced record or near record low WY runoff

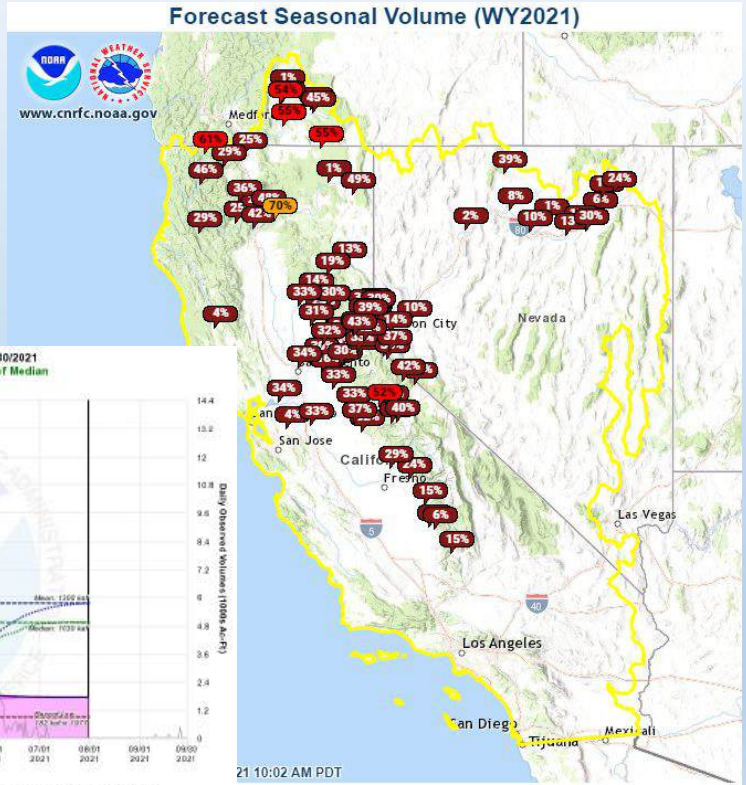


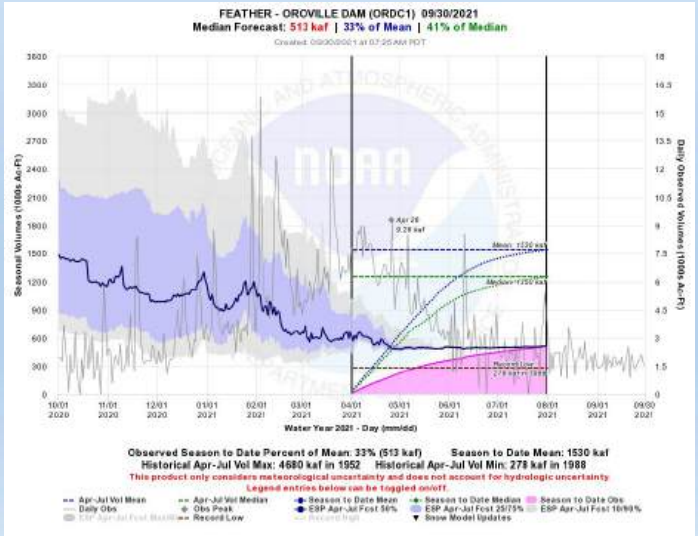


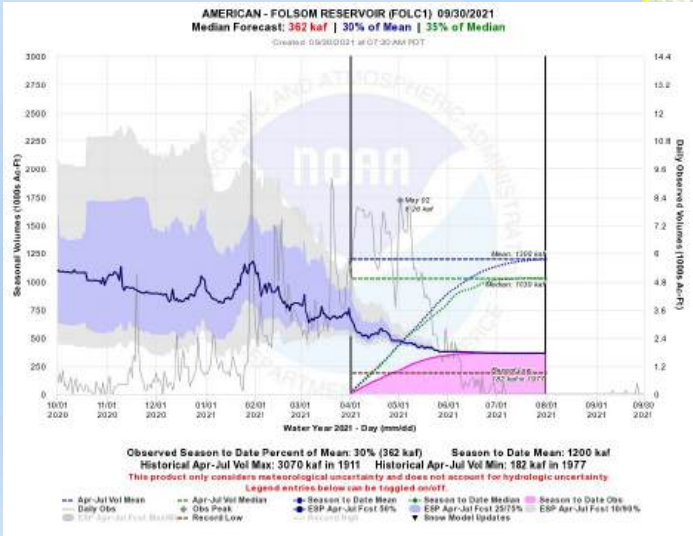


AJ runoff

- Similar story as WY runoff with 10-40% of average runoff throughout much of the area
- AJ runoff was quite a bit higher than previous drought years in most basins.

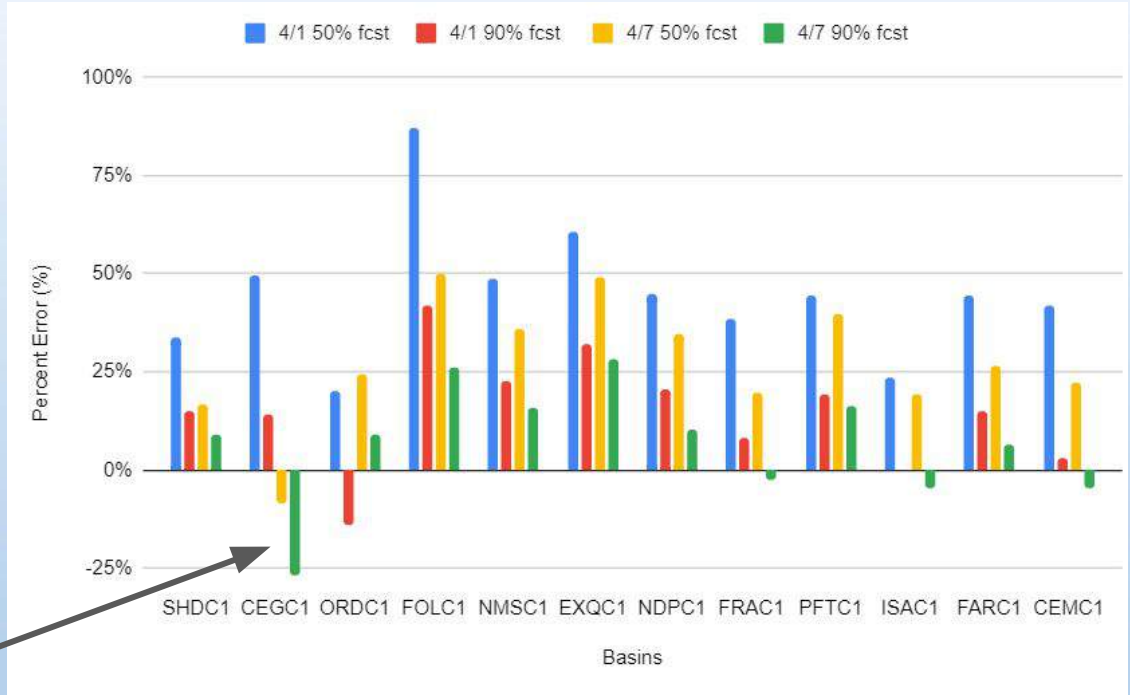






AJ runoff forecasts

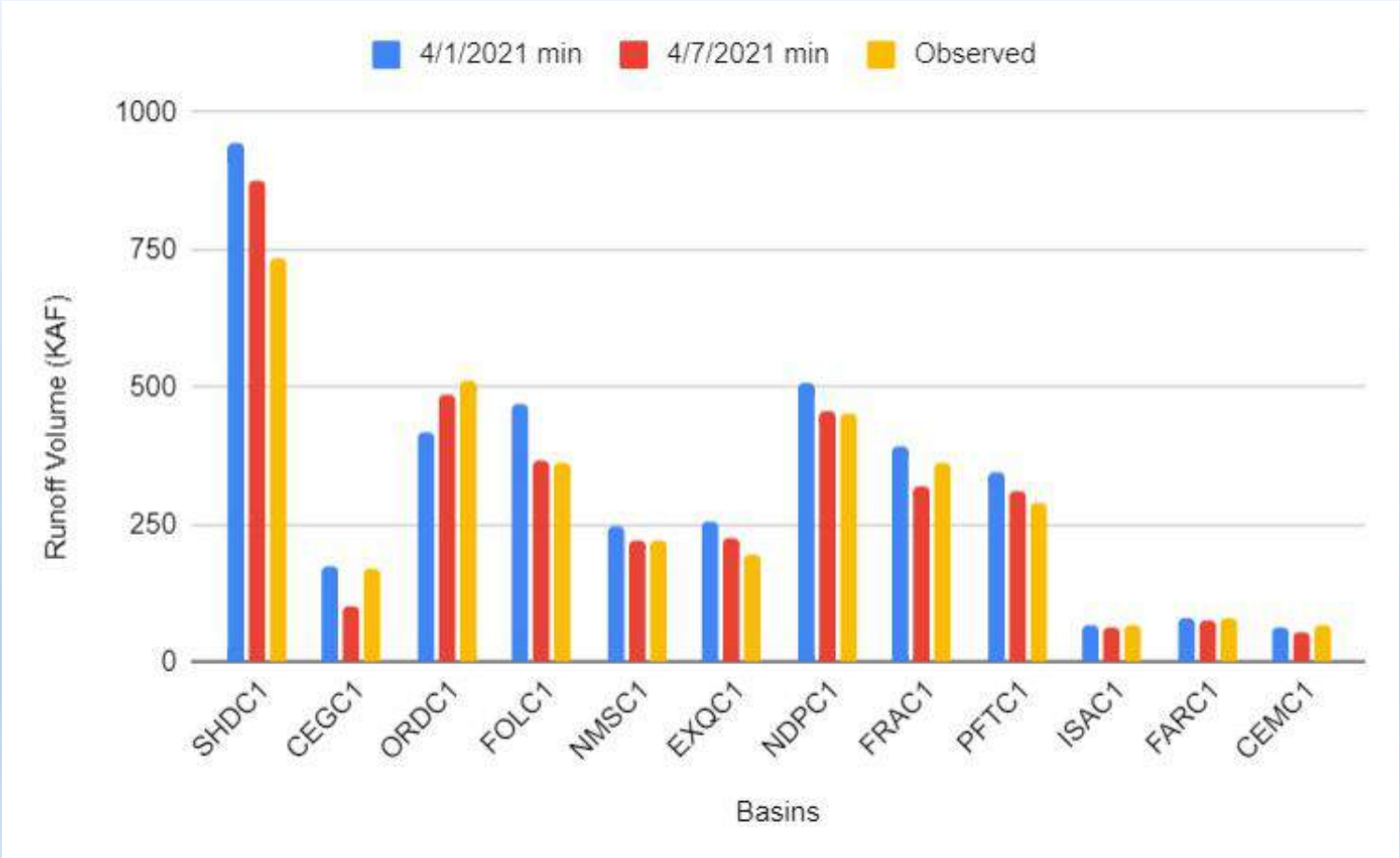
- 50% & 90% runoff forecasts from April 1st and 7th
  - April 7th forecasts incorporate April snow updates in models
- Most observed volumes were below the 90% forecasts
  - Expected result due to record/near record low spring precip and dry soils



Percent error computed as: (forecast - observed)/observed

Negative errors indicate April forecasts were too low.

Minimum runoff



Drought highlights

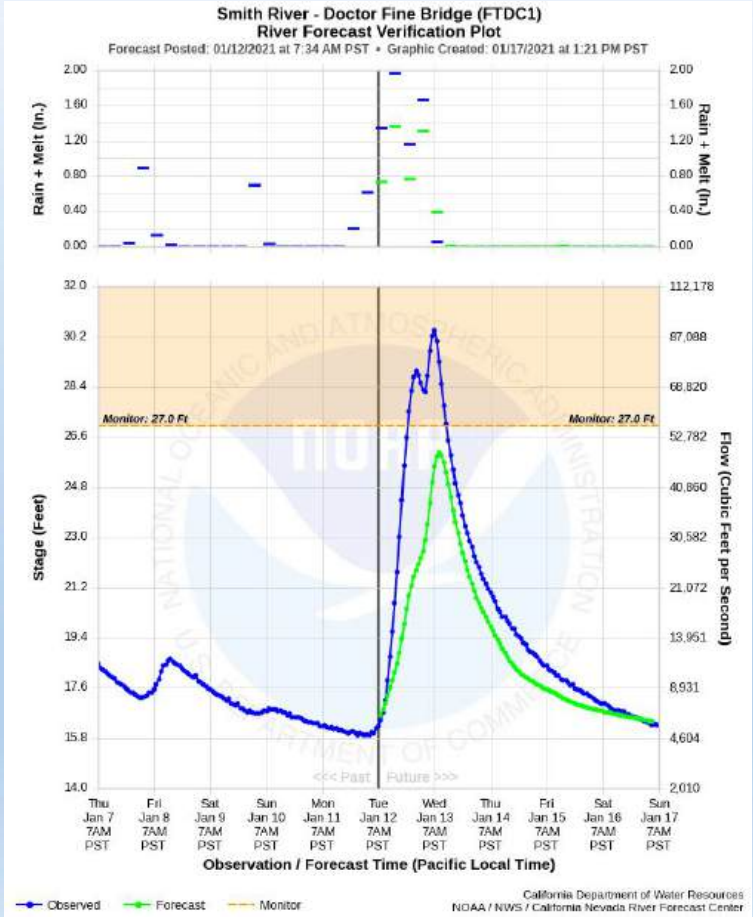
- Oroville reaches lowest level in history in early August
  - Hyatt power plant no longer able to generate electricity
- Many other reservoirs near historical lows heading into WY 2022

Graphic courtesy of Sacramento WFO


Lake Oroville, the second largest reservoir in California, shown here July 22, 2021, is now just 24% full due to the extreme drought, its lowest level in history. State water officials say the hydroelectric plant at Oroville Dam will shut down in a matter of days because there is not enough water to run through its turbines. (Photo by Justin Sullivan/Getty Images)

Flooding… or lack thereof

- No forecast points reached flood stage in WY 2021
- CREC1 & FTDC1 only points to reach monitor stage
- No weir flow on the Sac River for a second straight year



Fire season

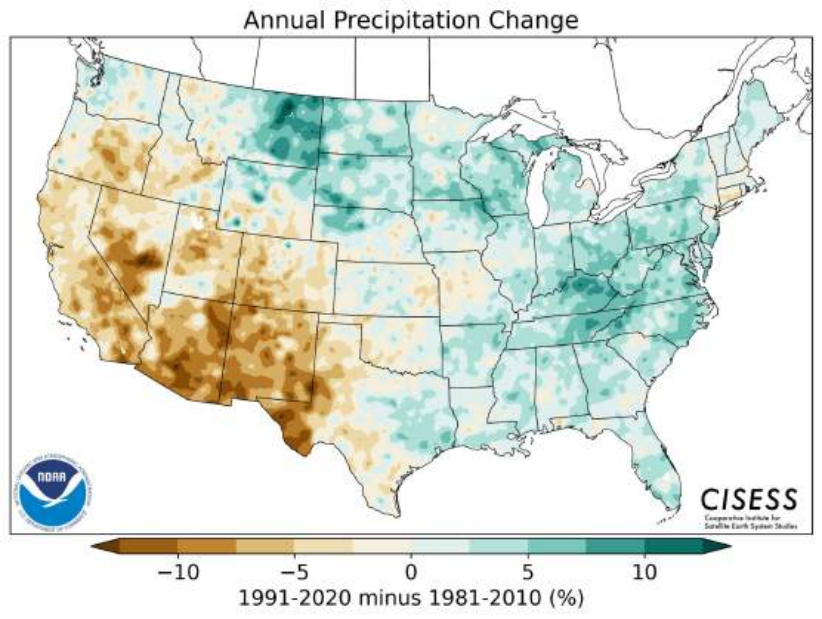
- Another big fire year across the West
  - Early start to the fire season due to drought conditions
- Dixie Fire started on July 13 in Plumas County and burned through Sept
  - Nearly 1mil acres burned and currently CA 2nd largest fire in history
- Caldor Fire started on August 14th near Sly Park Reservoir. The fire burned across the Sierra Crest and threatened Lake Tahoe communities.

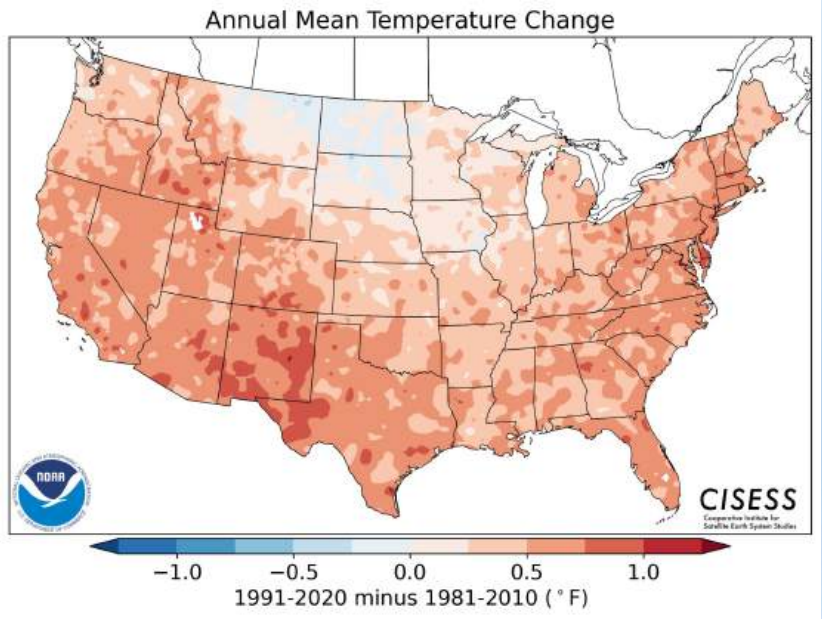
USFS webcam showing explosive growth from the Caldor Fire 3 days after ignition

Fire perimeters for last 3 years (Figure current as of early Sept 2021)

New 30yr climate normals

- Average precipitation 5-10% lower across much of CA
- Average temperatures 0.5-1.0°F warmer





Summary thoughts

The biggest storyline for much of the fall/winter was not only the lack of precipitation, but the lack of liquid precipitation in the mountains. This left soils below the snowpack very dry heading into spring, adding an additional layer of uncertainty to the runoff forecasts. During a prolonged warm period in late March/early April, it was evident from observations that much of the early runoff in lower elevation basins (<8kft) was lost to the soil. Snow pillows were reporting high melt rates, but the rivers were showing minimal response. Overall, runoff efficiency quite poor throughout the spring and early summer, which was noted by forecasters at other agencies as well.

Most runoff forecasts were good, with many observations reporting about 10-20% below the early April 90% runoff forecasts. This is an expected result given that the AJ precip was one of the driest on record. Dry soils and a 2nd year of drought also contributed to poor runoff efficiency. We are encouraged that our newly calibrated models, with all new model forcings, performed well given the extremely dry conditions experienced this WY.