

# California Water Supply Outlook Report

## March 2024



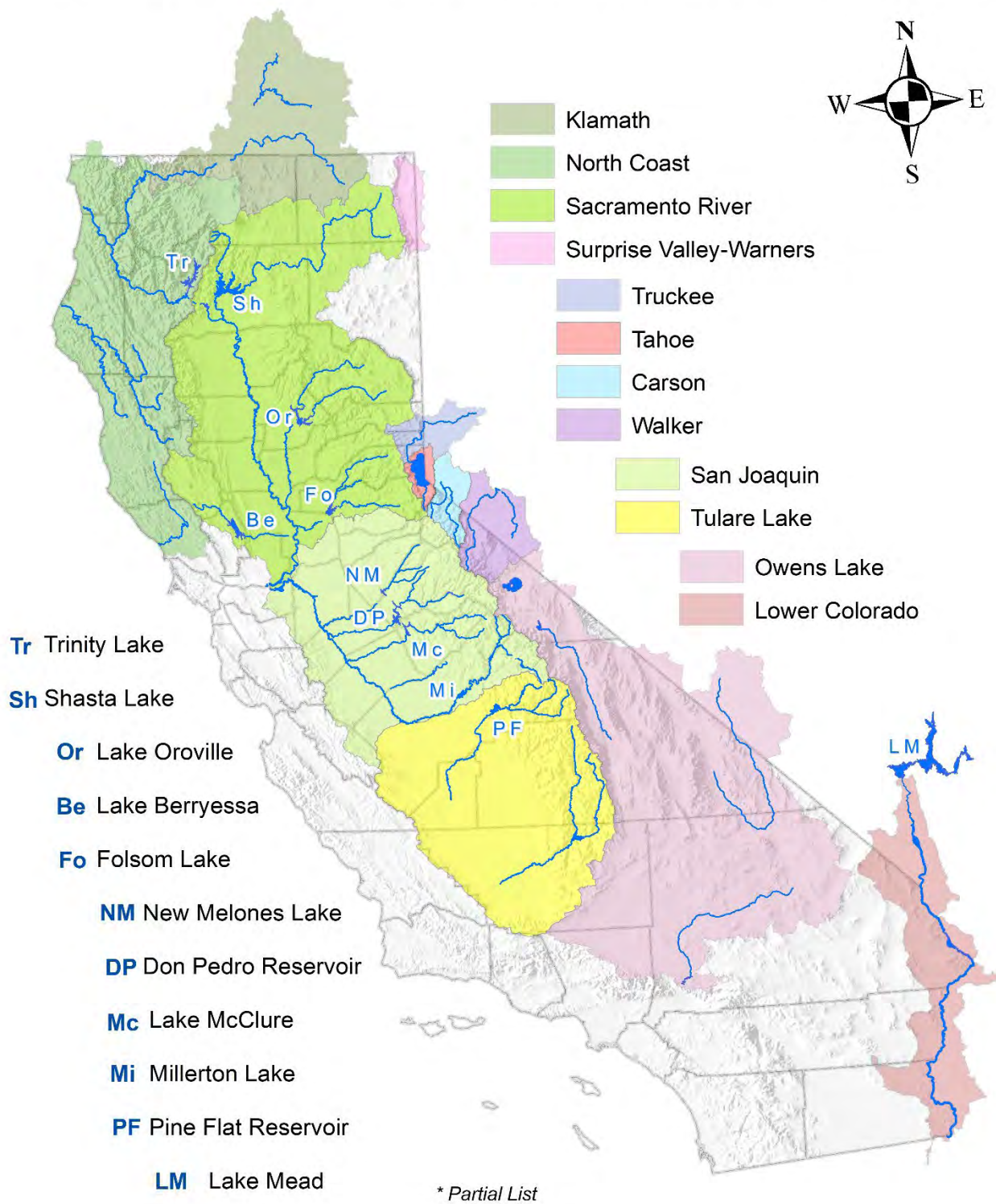
*Photo Credit: Evan Smith and Val Bullard*

March 1 sampling from multiple snow courses near Lake Tahoe (Valerie Bullard, NRCS CA)

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# California Forecast Basins, Major Rivers, and Large Reservoirs\*



# STATE OF CALIFORNIA GENERAL OUTLOOK

## March 2024

### **2024 UPDATES:**

#### **Water Supply Outlook Report Format Updates**

Historically, NRCS CA has displayed data from 2 other agencies: California Department of Water Resources (DWR) and the National Weather Service (NWS) for the western Sierra streamflow predictions. Together with NRCS's forecasting data, the major irrigation watersheds are covered for the whole state. NRCS CA is transitioning to providing links to the most up to date data as opposed to providing a snapshot of the data collected and provided by these Partner agencies. NRCS CA is interested in your feedback on the new format. If you have any comments, please email them to: [NRCS.CA.Engineering@usda.gov](mailto:NRCS.CA.Engineering@usda.gov).

#### **NRCS Water Supply Forecast System for the American West**

This year, the NRCS begins using a new water supply forecast (WSF) system, the Multi-Model Machine-Learning Metasystem, or M4. In comparison to the historic singular WSF model, the new system creates a mean value from six different forecast models. Using the mean of the ensemble of models harnesses the strengths of each technique while insulating against potential individual model vulnerabilities. The original NRCS WSF model remains as part of the suite of ensemble models. Testing shows that the ensemble mean generally equals or exceeds the performance of any individual model member. Application of NRCS water supply probabilistic forecasts remains unchanged.

##### **Contact:**

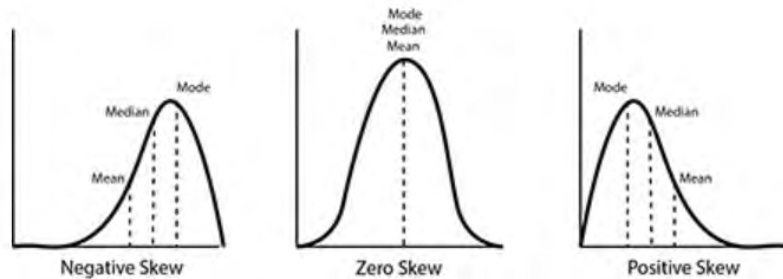
Angus Goodbody, [angus.goodbody@usda.gov](mailto:angus.goodbody@usda.gov), Lead Forecast Hydrologist, USDA NRCS Snow Survey and Water Supply Forecasting Program

##### **Additional reading:**

- [Assessing the new NRCS water supply forecast model for the American West](#)
- [A Machine Learning Metasystem for Robust Probabilistic Nonlinear Regression-Based Forecasting](#)

#### **Analysis Difference: Percent of Median vs Percent of Average**

Median and average are two statistical ways to discuss the center of a dataset. The average is calculated by adding up all of the individual data points and dividing by the total number of data points. The median is the "middle" value of that same data set – meaning that half of the data points would be below the median value and the other half of the points would be above that same value. The data can be represented by bell curves that give a visual of how the data is distributed. If the bell curve is skewed, the average (mean) and the median will not be identical.



<https://study.com/cimages/multimages/16/skewness9001268247718463390.png>

NRCS chooses to use percent of median instead of percent of average because median more accurately depicts the “middle” when data distribution is skewed positively or negatively. More information is available at: <https://www.nrcs.usda.gov/resources/data-and-reports/climatic-and-hydrologic-normals>.

### **Snowpack**

As of March 5<sup>th</sup>, snowpack is 112 percent of normal for the dates in the northern Sierras (up from 82% early last month); 103 percent of normal in the central Sierras (up from 75% early last month); and 93 percent in the southern Sierras (up from 69% early last month). The DWR Daily Statewide Summary of Snow Water Content map is attached at the end of the General Outlook. More information is available online at: <http://cdec.water.ca.gov/snow/current/snow/index2.html>.

### **Precipitation**

As of March 5<sup>th</sup>, the Northern Sierra-, San Joaquin-, and Tulare Basin Index stations received 99-, 87-, and 88 percent of average for this date. A wet February helped bring the precipitation totals closer to an average year to date. More information is available online at: [http://cdec.water.ca.gov/snow\\_rain.html](http://cdec.water.ca.gov/snow_rain.html)

### **Reservoirs**

As of January 31, 2024, total reservoir storage in intrastate California is 115 percent of average. Total interstate reservoir storage, including Lake Powell, Lake Mead and the North Coast watershed is 82 percent of average. As of March 4, 2024, storage at Shasta Reservoir was 113 percent of average, down from 125 percent of average early last month. Oroville Reservoir was 131 percent of average, up slightly from 130 percent of average early last month. Don Pedro Reservoir was 112 percent of average, down slightly from 115 percent of average early last month. The DWR Selected Reservoirs Daily Graph – Water Supply summary chart is attached at the end of the General Outlook. More information is available online at: <https://cdec.water.ca.gov/reservoir.html>.

### **Streamflow**

NRCS forecasts in the Tahoe, Truckee, Carson, and Walker River basins are approximately 68 – 105 percent of the 1991-2020 median. NRCS forecasts for stations in the Klamath Basin are 71 - 164 percent of the 1991-2020 medians between March and September NRCS Forecast summaries are attached after the General Outlook Report.

For the Sacramento, San Joaquin, Tulare, North Coast, and Owens Lake forecasts, please refer to the most up to date information on the DWR and NWS webpages. Links with instructions on how to access the data are provided below.

**Links to Data for Sacramento, San Joaquin and Tulare Lake Basins data:**

Please note that DWR and NWS use percent of average while NRCS uses percent of median to display forecasted stream flows.

- DWR:
  - [B120 \(ca.gov\)](#) This version of DWR’s Bulletin 120 links to the seasonal (April – July) forecasting summary for 18 points in the three watersheds and also provides DWR staff contact information.

**B-120 WATER SUPPLY FORECAST SUMMARY**

UNIMPAIRED FLOW FOR - February 2024  
(Provisional data, subject to change)

Report generated: February 8, 2024 17:48

APRIL - JULY FORECAST SUMMARY (IN THOUSANDS OF ACRE-FEET)			
HYDROLOGIC REGION WATERSHED	APRIL - JULY FORECAST	PERCENT OF AVERAGE	80% PROBABILITY RANGE 90%   10%

- [B120DIST \(ca.gov\)](#) This version of DWR’s Bulletin 120 links to the monthly stream forecasts (Feb – Sept) for 16 points in CA and also provides DWR staff contact information.

**B-120 WATER SUPPLY FORECAST SUMMARY**

UNIMPAIRED FLOW FOR - February 1, 2024  
(Provisional data, subject to change)

Report generated: February 08, 2024 13:31

WATER YEAR FORECAST SUMMARY AND MONTHLY DISTRIBUTION (IN THOUSANDS OF ACRE-FEET)												
WATERSHED	OCT THRU JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	WATER YEAR TOTAL	80% PROBABILITY RANGE 90%   10%	WY % AVERAGE

- NWS: [CNRFC - Water Resources - Daily Water Resources Update \(noaa.gov\)](#) The California Nevada Forecast Center provides Daily Water updates. The report that is closest to the NRCS forecasting report is the “Seasonal %Avg” product in the “Forecast Flow” data type.

**Daily Water Resources Update** Web content below courtesy of: Other Resources

1 Select data type below:

Precipitation	Snow	Observed Flow	Reservoir Storage	Forecast Flow	Point Forecasts
---------------	------	---------------	-------------------	---------------	-----------------

2 Select product below:

Water Year %Avg	Seasonal %Avg	Spring Peak Flow Dates	Seasonal Volumes (text)	Seasonal Tracker (text)
Water Year Tracker (text)	Seasonal Breakdown (text)	Water Year Breakdown (text)	Next 12 Months (text)	Spring Peaks (text)

**Forecast Seasonal Volume (WY2024)**  
Click for more options  
Data Mode:

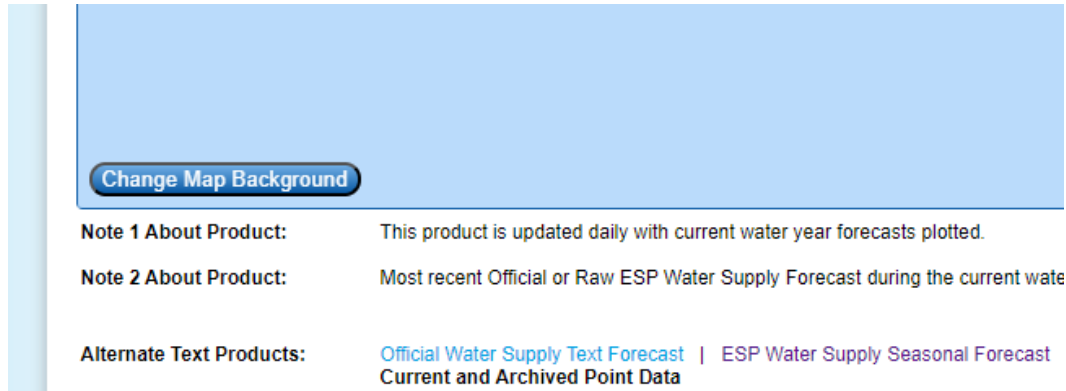
Percent of Normal

Extreme Below	Much Below	Below	Near Normal	Above	Much Above	Extreme Above
50%	70%	90%	110%	130%	150%	

Marker size scaled by average seasonal flow.

Created: Thu Feb 08 2024 at 10:15 AM PST

Seasonal Forecast Volumes (as percentages) can be provided by clicking the “show data table” button on the top right of the interactive map. This value is for the whole water year and is not broken down by month. In order to get monthly forecasting data, text reports are available. The “ESP Water Supply Seasonal Forecast” product is the one NRCS used to report data in its previous products.



**Change Map Background**

**Note 1 About Product:** This product is updated daily with current water year forecasts plotted.

**Note 2 About Product:** Most recent Official or Raw ESP Water Supply Forecast during the current water year.

**Alternate Text Products:** [Official Water Supply Text Forecast](#) | [ESP Water Supply Seasonal Forecast](#)  
[Current and Archived Point Data](#)



# STATEWIDE SNOW WATER CONTENT

## CURRENT REGIONAL SNOWPACK FROM AUTOMATED SNOW SENSORS

% of April 1 Average / % of Normal for This Date



NORTH	
Data as of March 5, 2024	
Number of Stations Reporting	25
Average snow water equivalent (Inches)	29.6
Percent of April 1 Average (%)	103
Percent of normal for this date (%)	112

CENTRAL	
Data as of March 5, 2024	
Number of Stations Reporting	49
Average snow water equivalent (Inches)	25.2
Percent of April 1 Average (%)	94
Percent of normal for this date (%)	103

SOUTH	
Data as of March 5, 2024	
Number of Stations Reporting	28
Average snow water equivalent (Inches)	19.2
Percent of April 1 Average (%)	86
Percent of normal for this date (%)	93

STATE	
Data as of March 5, 2024	
Number of Stations Reporting	102
Average snow water equivalent (Inches)	24.6
Percent of April 1 Average (%)	95
Percent of normal for this date (%)	104

**Statewide Average: 95% / 104%**

Data as of March 5, 2024



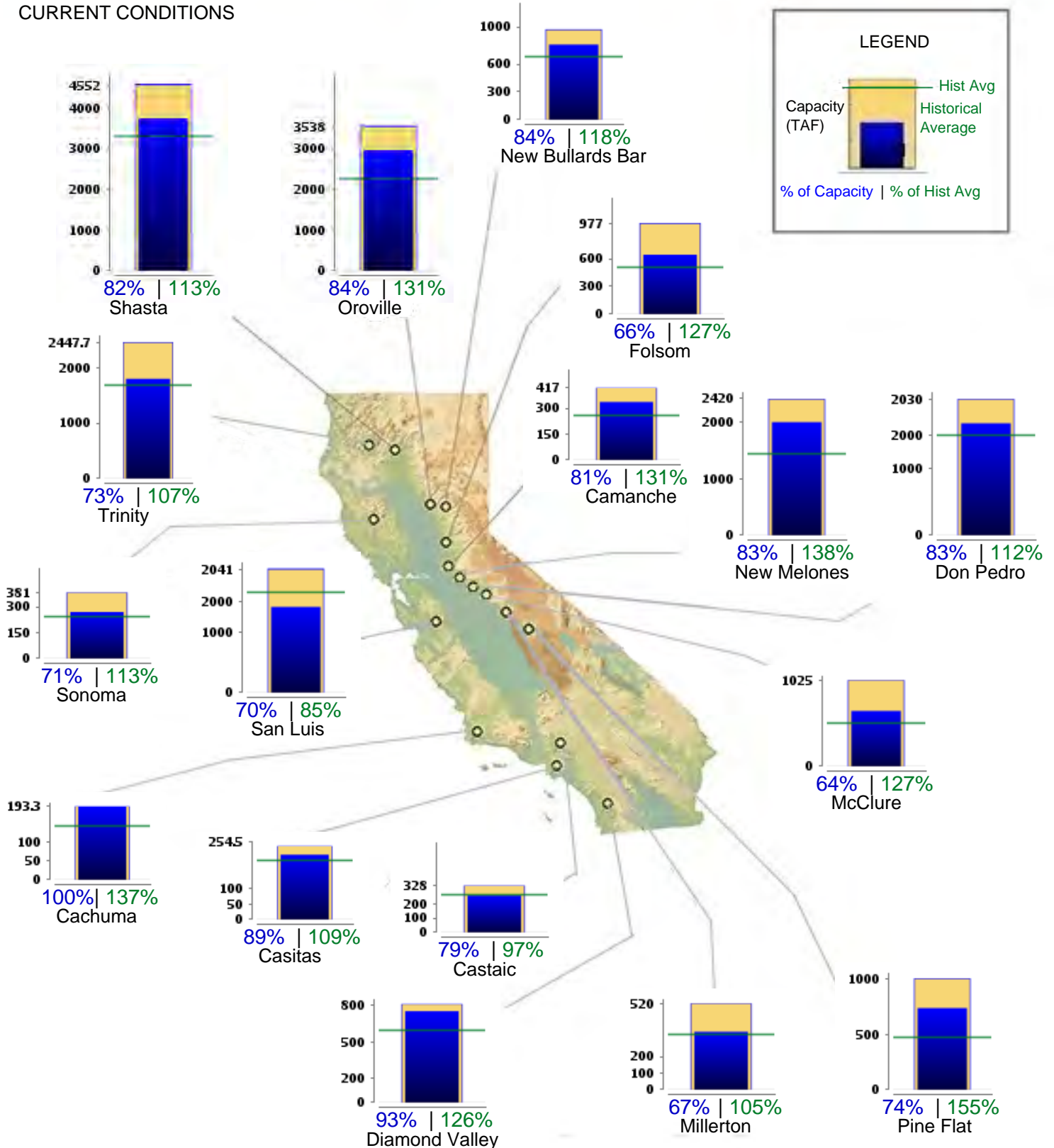


# CURRENT RESERVOIR CONDITIONS

## CALIFORNIA MAJOR WATER SUPPLY RESERVOIRS

Midnight - March 4, 2024

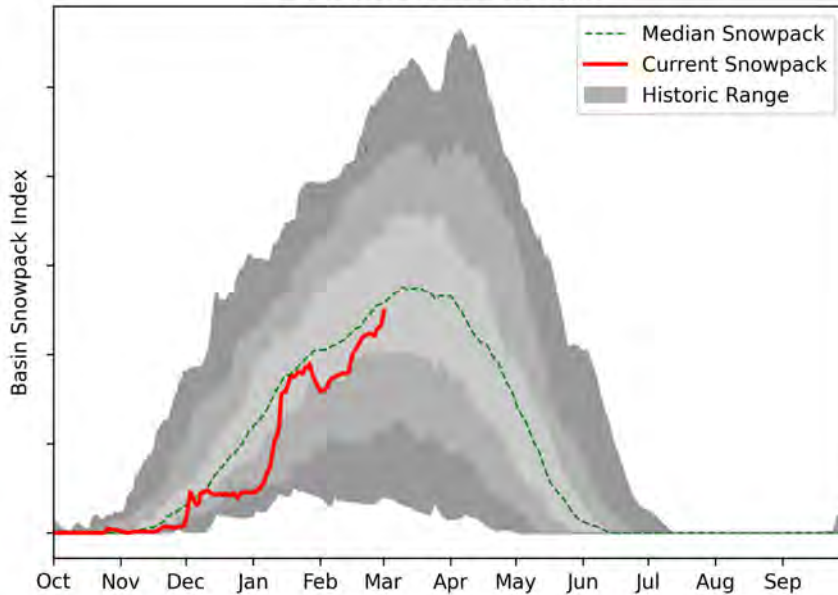
### CURRENT CONDITIONS



# Klamath Basin Summary

## SNOWPACK

**Klamath Basin Snowpack**

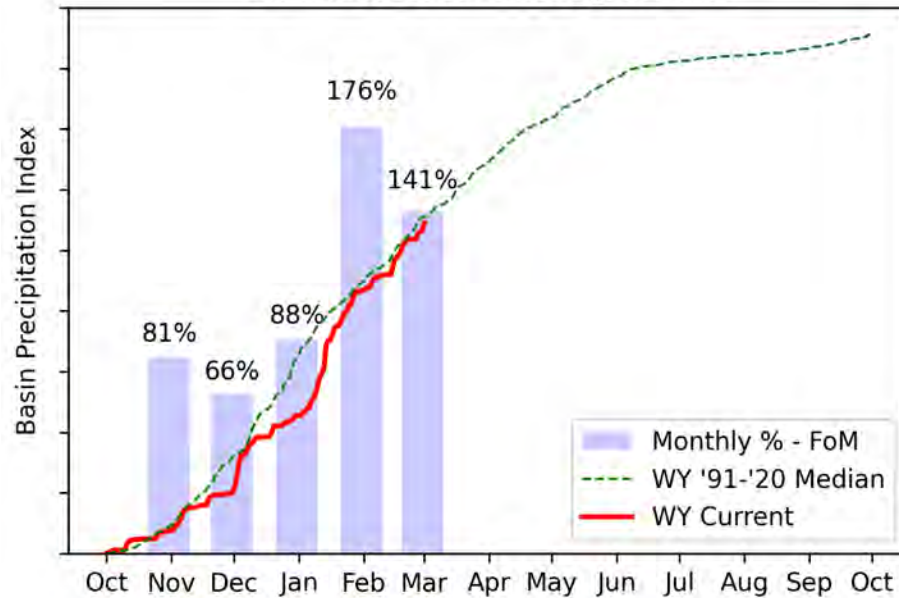


► View snowpack for individual sites by accessing the basin data report [here](#).

As of March 1, the basin snowpack is 90% of median. Last month on February 1 the basin snowpack was 78% of median.

## PRECIPITATION

**Klamath Basin Precipitation**



► View precipitation for individual sites by accessing the basin data re-

March precipitation is above normal at 141% of median. Precipitation since the beginning of the water year (October 1 - March 1) is 98% of median.

## RESERVOIR STORAGE

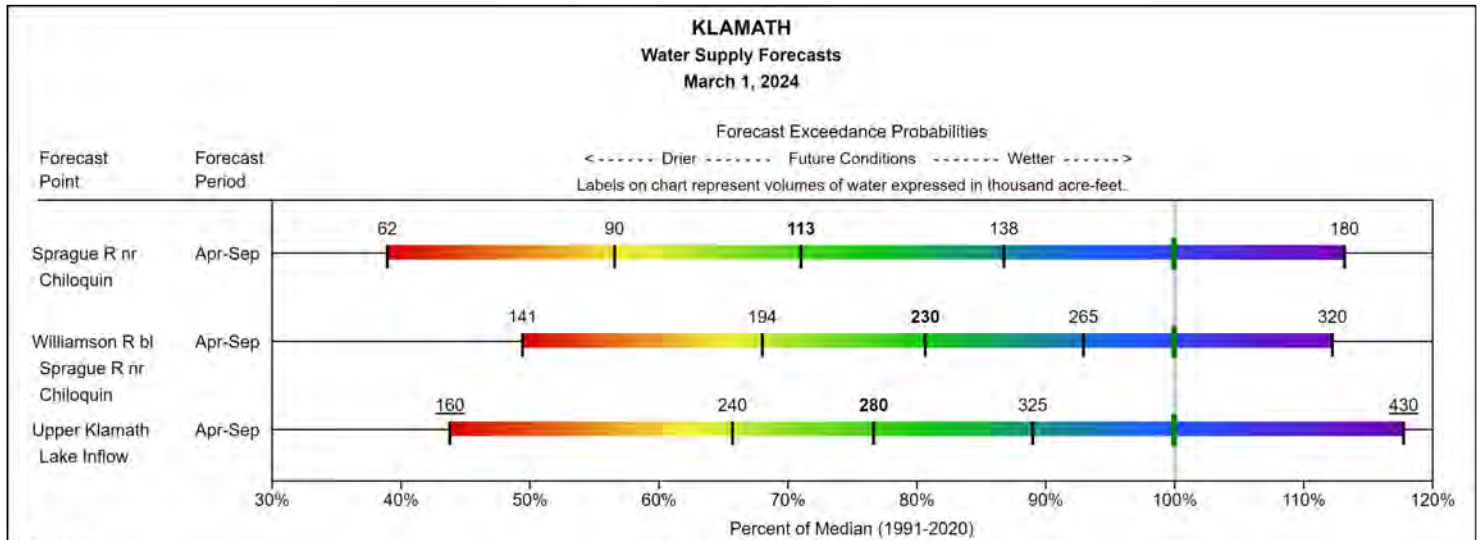
As of March 1, storage at major reservoirs in the basin ranges from 47% of median at Gerber Reservoir to 89% of median at Upper Klamath Lake.

Klamath	Current (KAF)	Last Year (KAF)	Median (KAF)	Capacity (KAF)	Current % Capacity	Last Year % Capacity	Median % Capacity	Current % Median	Last Year % Median
Howard Prairie	24.0	11.0	35.4	62.1	39%	18%	57%	68%	31%
Fourmile Lake	4.7	4.0	6.7	15.6	30%	25%	43%	70%	59%
Upper Klamath Lake	342.3	361.8	385.4	523.7	65%	69%	74%	89%	94%
Clear Lake	82.7	56.3	137.4	513.3	16%	11%	27%	60%	41%
Hyatt Prairie	8.1	2.4	11.1	16.2	50%	15%	69%	73%	22%
Gerber	21.8	9.4	46.0	94.3	23%	10%	49%	47%	21%
<b>Basin Index</b>					<b>39%</b>	<b>36%</b>	<b>51%</b>	<b>78%</b>	<b>72%</b>
# of reservoirs					6	6	6	6	6

## STREAMFLOW FORECAST

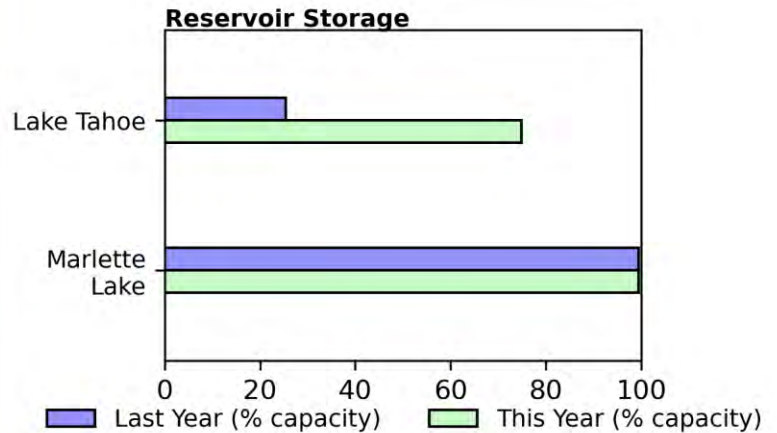
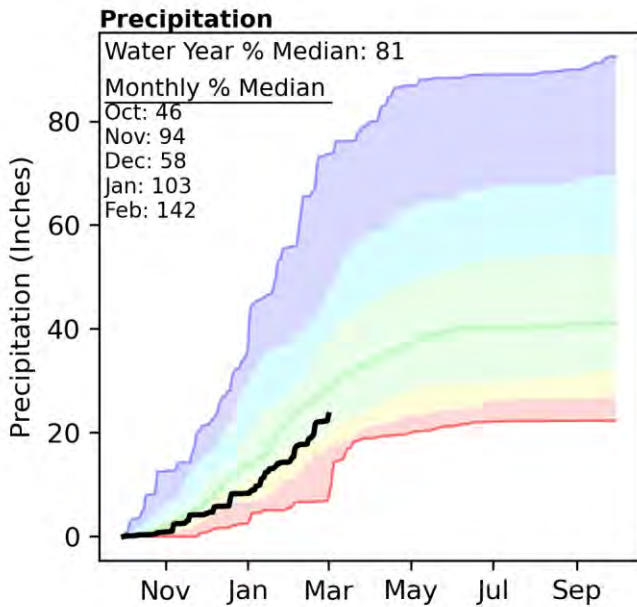
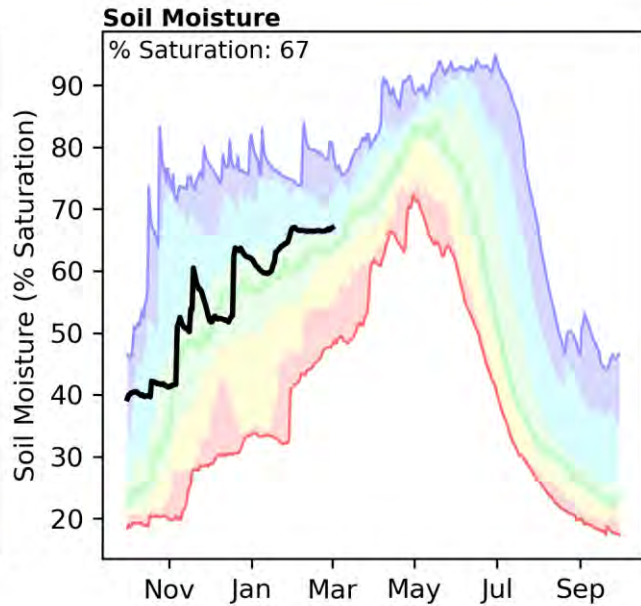
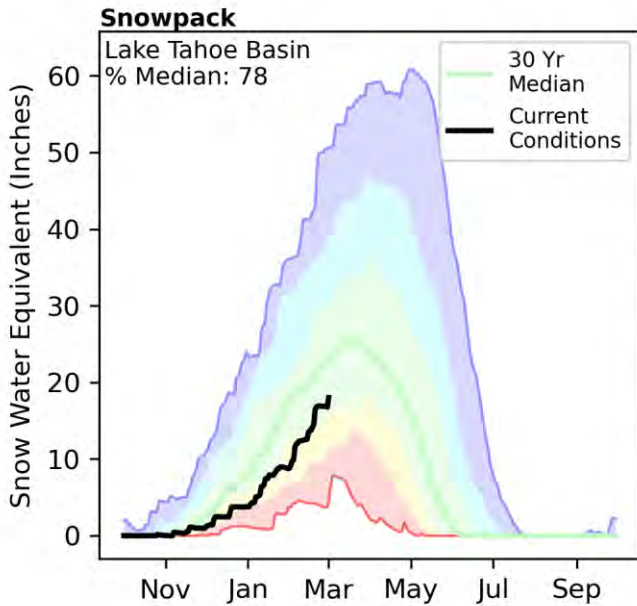
The streamflow forecasts for the primary period in the basin range from 71% to 164% of median.

For data in tabular format, in addition to non-primary period data, please view the basin data reports [here](#).



# Lake Tahoe Basin | March 1, 2024

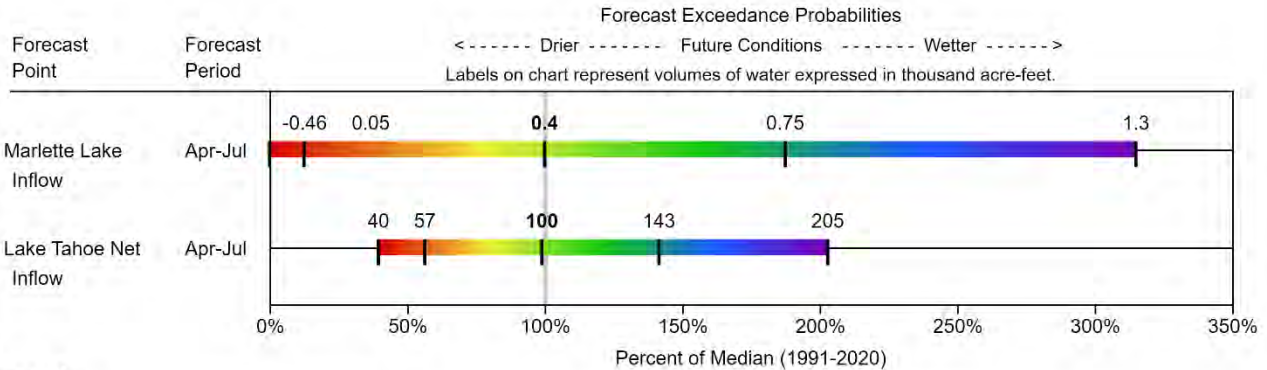
Snowpack in the Lake Tahoe Basin is below normal at 78% of median, compared to 183% at this time last year. Precipitation in February was well above normal at 142%, which brings the seasonal accumulation (October-February) to 81% of median. Soil moisture is at 67% saturation, same as last year at this time. Reservoir storage is 75% of capacity, compared to 27% last year.



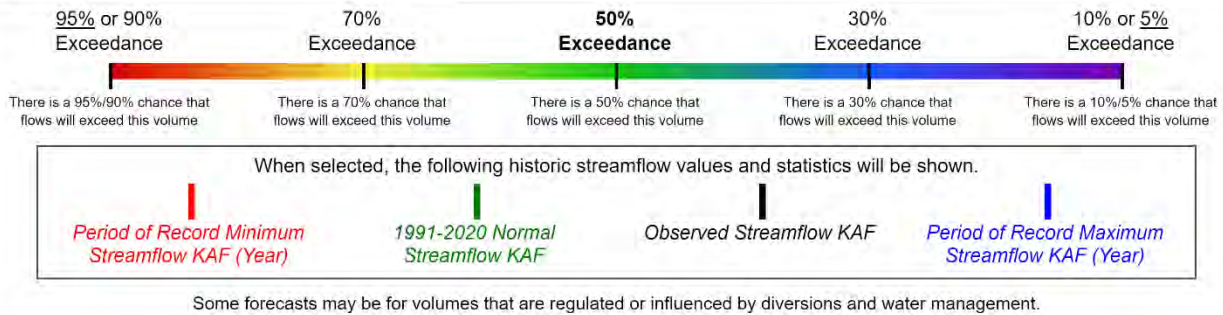
Statistical shading breaks at 10th, 30th, 50th, 70th, and 90th percentiles.  
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**Important Information about Forecast Coordination:** Hydrologists with the NRCS and National Weather Service California Nevada River Forecast Center (CNRFC) coordinate Lake Tahoe Rise, Truckee River at Farad, Little Truckee River near Boca, and the Carson River at Ft. Churchill forecasts (following page) using output of their respective hydrology models at the request of the Bureau of Reclamation. The NRCS model is a statistical model based on the current data as of the first of each month. The CNRFC ensemble forecasting system incorporates near-term weather prediction and climatology into their model. These models can provide different answers because of the nature of the model systems, and from the inclusion of future weather in the CNRFC model. The hydrologists agree on forecast values using guidance from both models to best provide an accurate water supply forecast for these points.

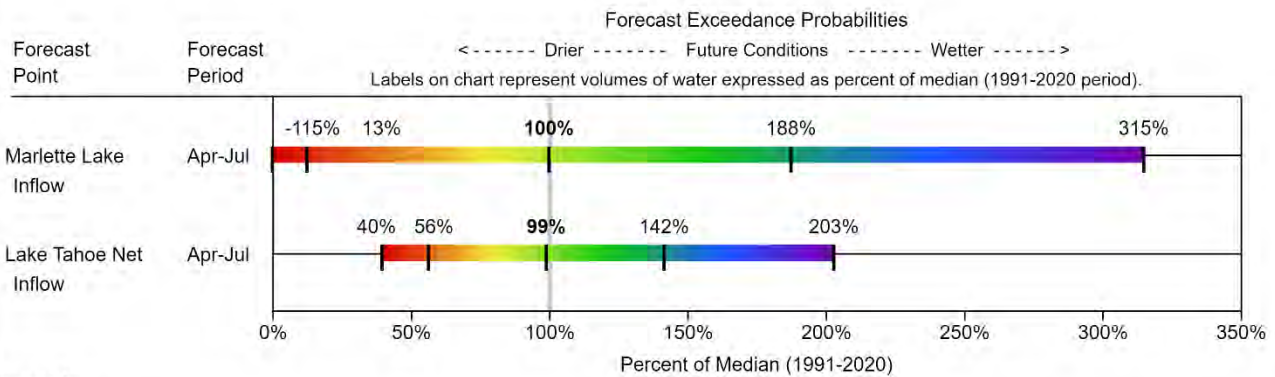
**TAHOE**  
**Water Supply Forecasts**  
**March 1, 2024**



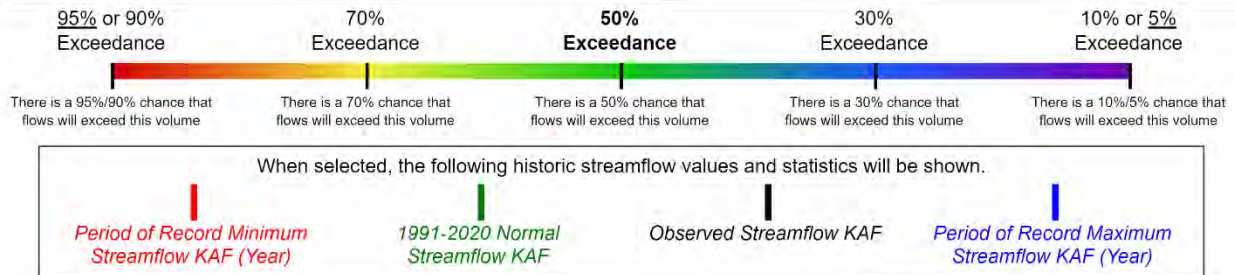
**Legend**



**TAHOE**  
**Water Supply Forecasts**  
**March 1, 2024**

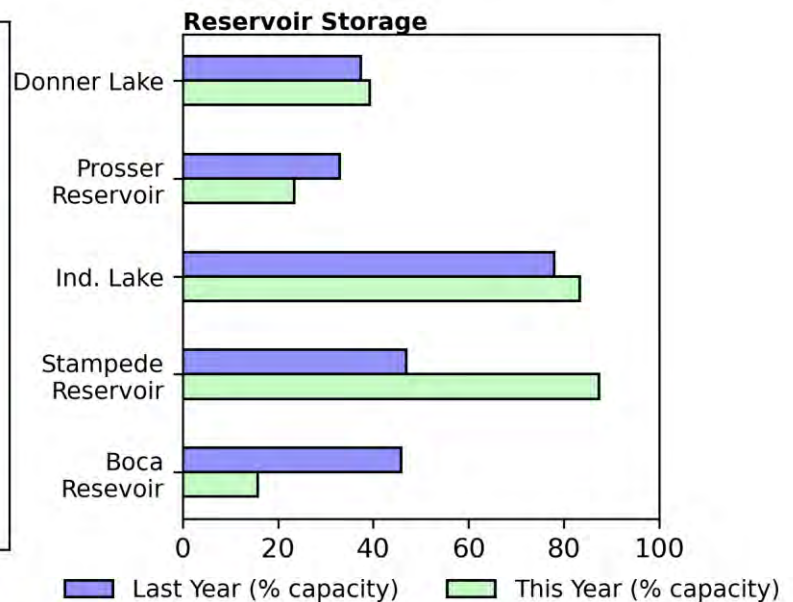
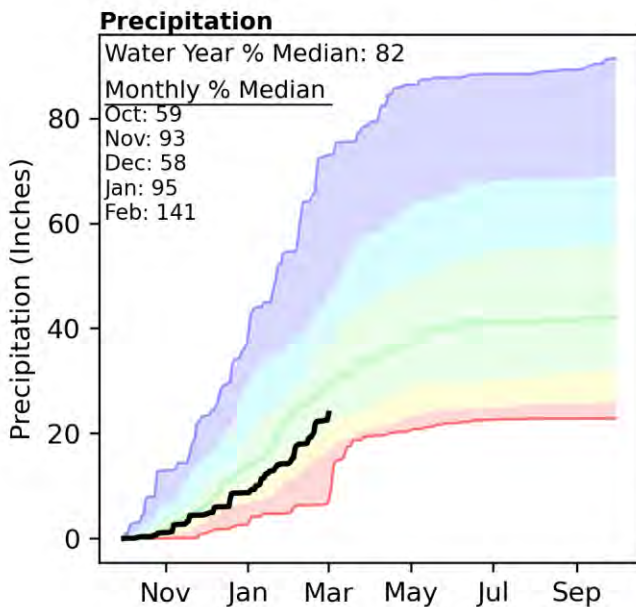
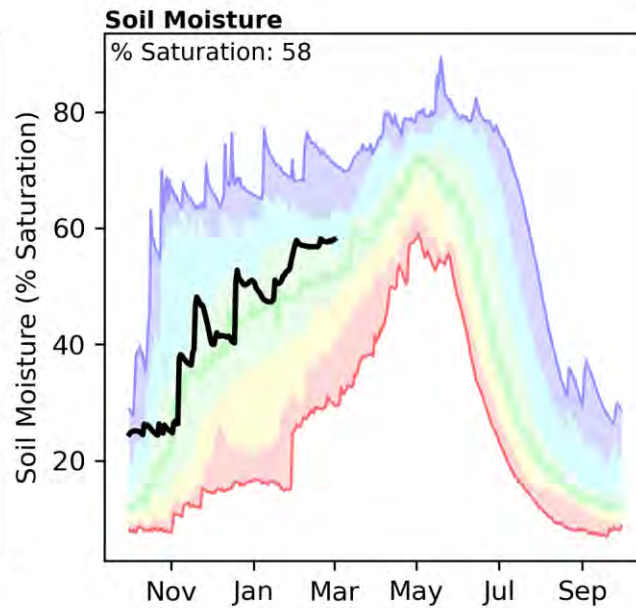
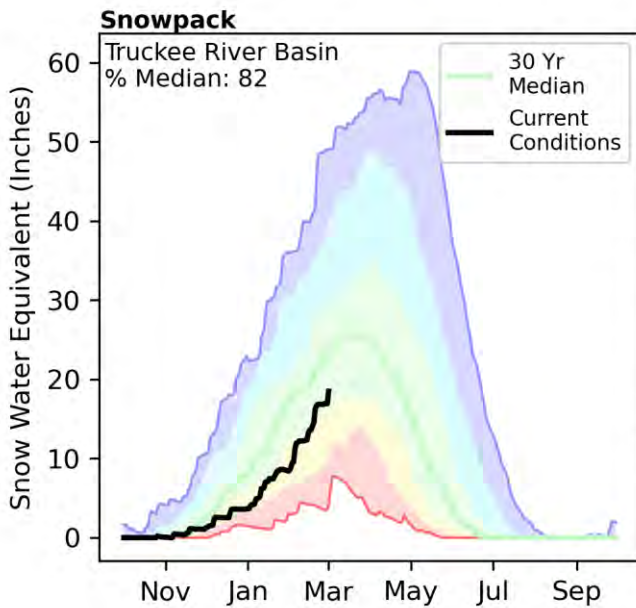


**Legend**



# Truckee River Basin | March 1, 2024

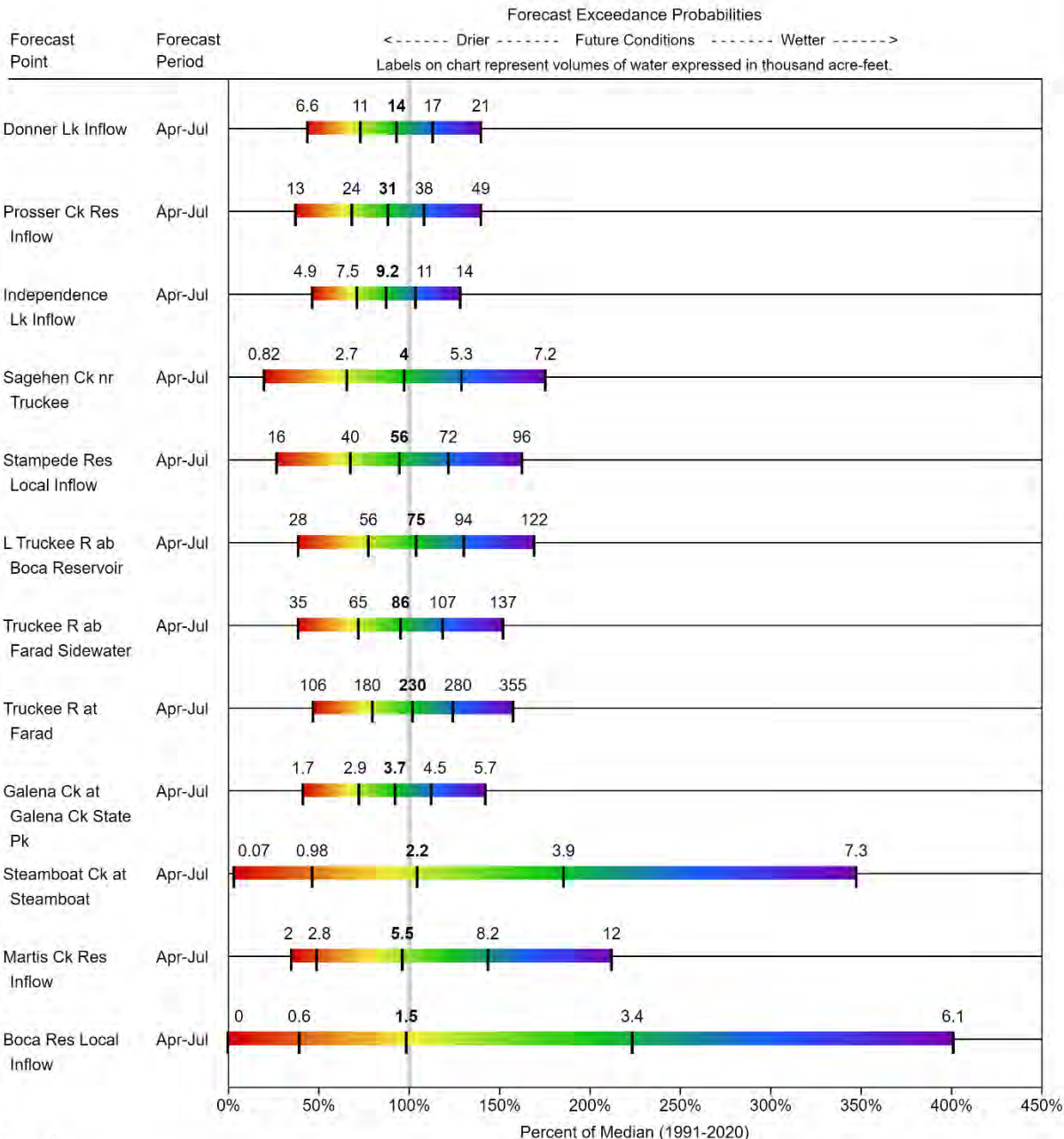
Snowpack in the Truckee River Basin is below normal at 82% of median, compared to 170% at this time last year. Precipitation in February was well above normal at 141%, which brings the seasonal accumulation (October-February) to 82% of median. Soil moisture is at 58% saturation compared to 57% saturation last year. Reservoir storage is 71% of capacity, compared to 47% last year.



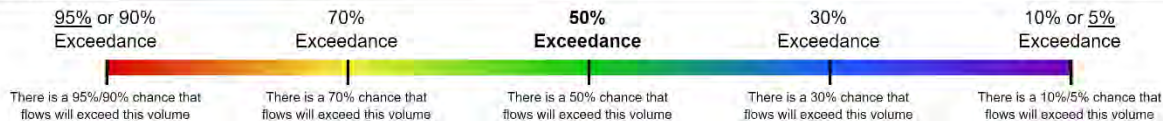
Statistical shading breaks at 10th, 30th, 50th, 70th, and 90th percentiles.  
For more information visit: [30 year normal calculation description](#)

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**TRUCKEE**  
**Water Supply Forecasts**  
**March 1, 2024**



**Legend**

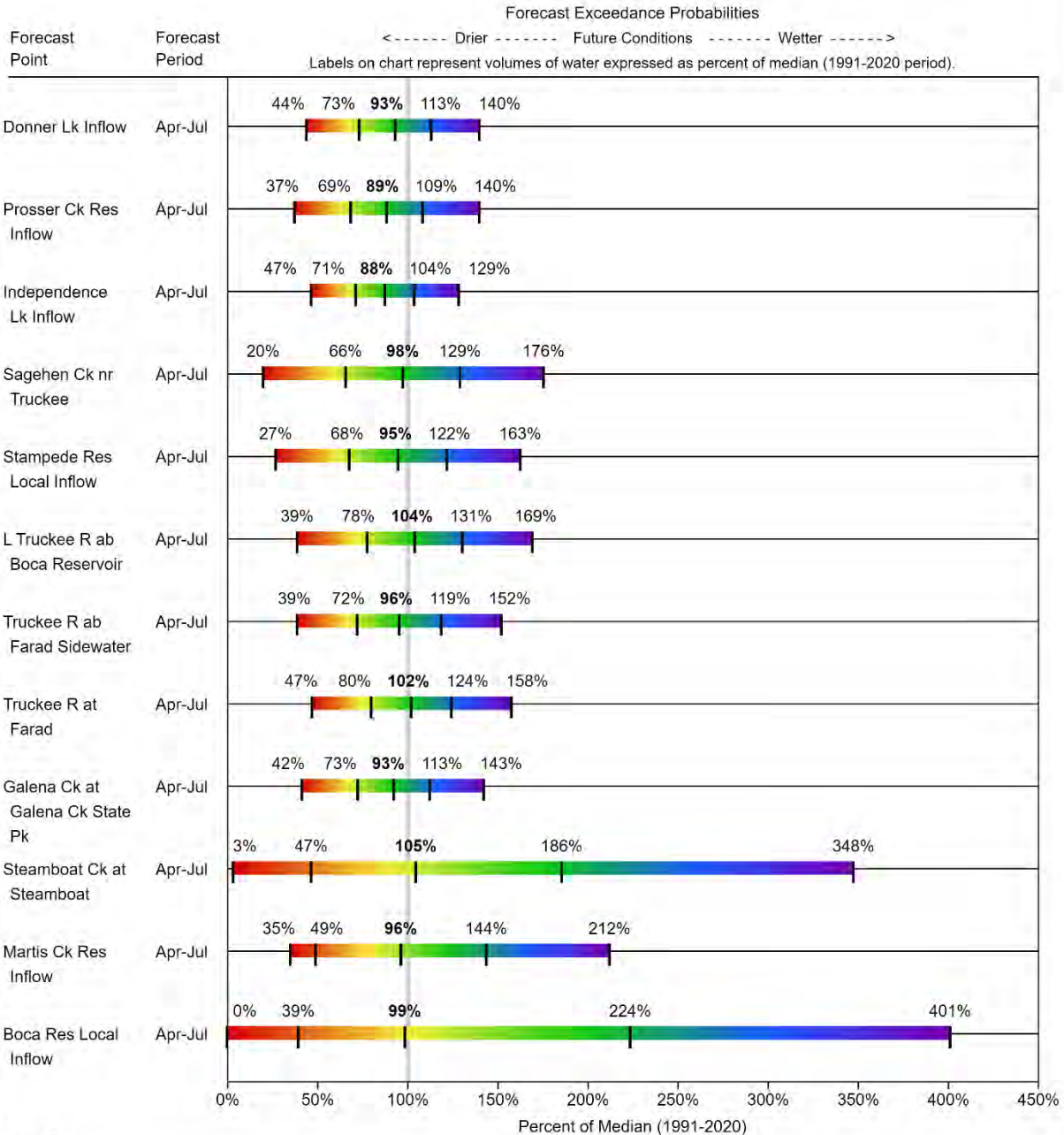


When selected, the following historic streamflow values and statistics will be shown.

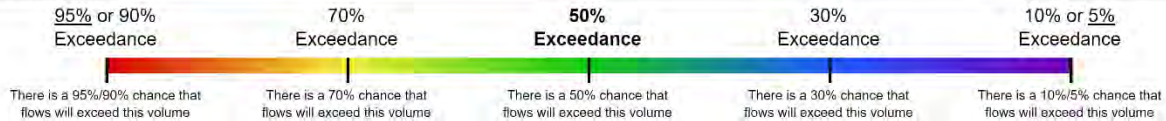
<i>Period of Record Minimum Streamflow KAF (Year)</i>	<i>1991-2020 Normal Streamflow KAF</i>	<i>Observed Streamflow KAF</i>	<i>Period of Record Maximum Streamflow KAF (Year)</i>

Some forecasts may be for volumes that are regulated or influenced by diversions and water management.

**TRUCKEE**  
**Water Supply Forecasts**  
**March 1, 2024**



**Legend**



When selected, the following historic streamflow values and statistics will be shown.

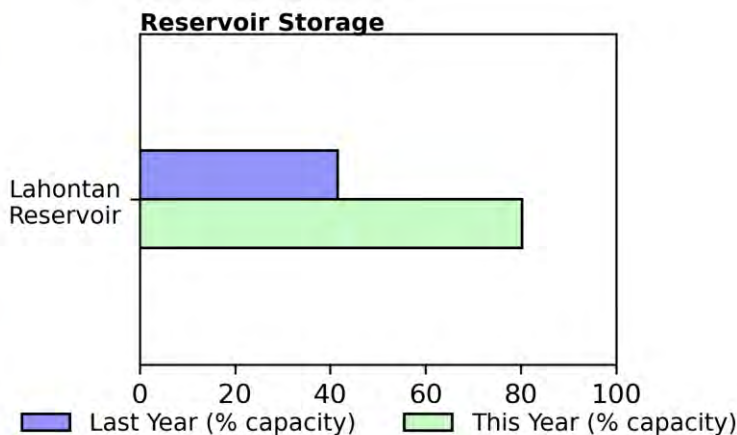
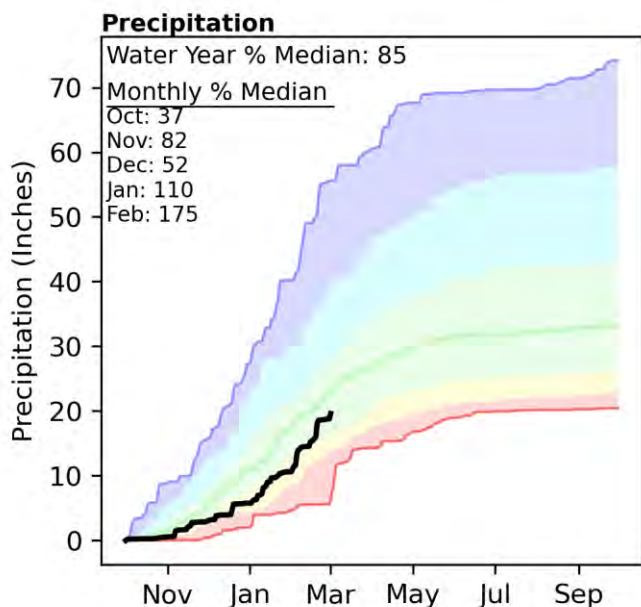
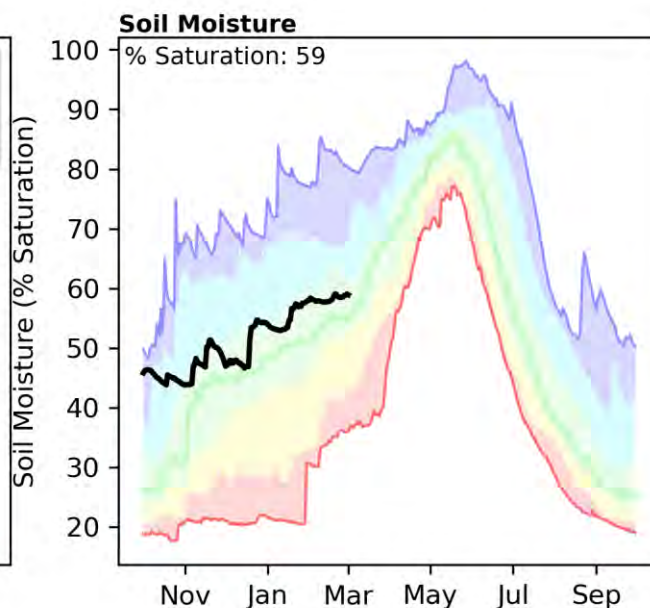
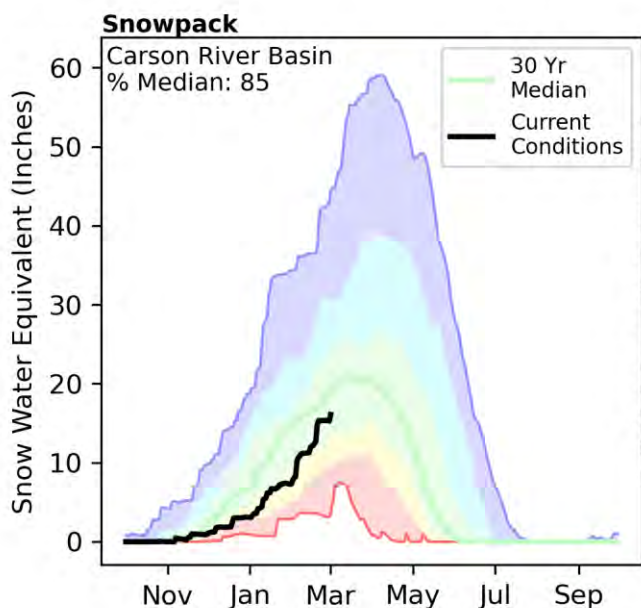
| *Period of Record Minimum Streamflow KAF (Year)*     
 | *1991-2020 Normal Streamflow KAF*     
 | *Observed Streamflow KAF*     
 | *Period of Record Maximum Streamflow KAF (Year)*

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# Carson River Basin | March 1, 2024

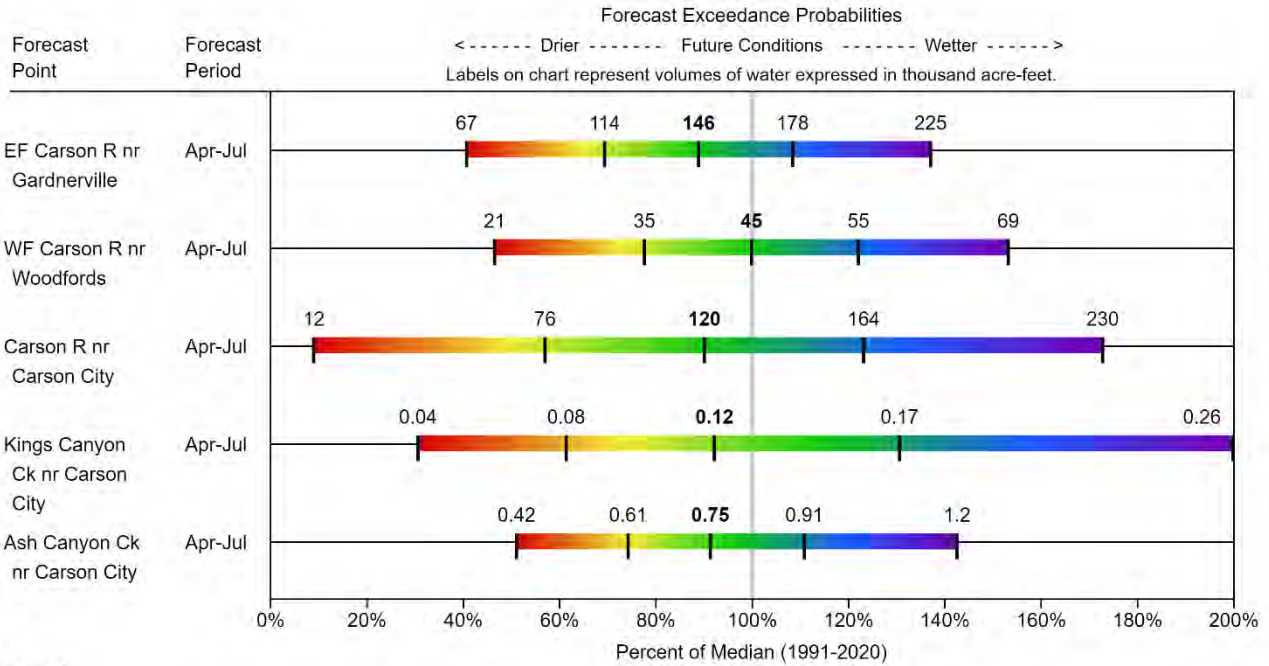
Snowpack in the Carson River Basin is below normal at 85% of median, compared to 232% at this time last year. Precipitation in February was well above normal at 175%, which brings the seasonal accumulation (October-February) to 85% of median. Soil moisture is at 59% saturation compared to 63% saturation last year. Reservoir storage is 80% of capacity, compared to 42% last year.



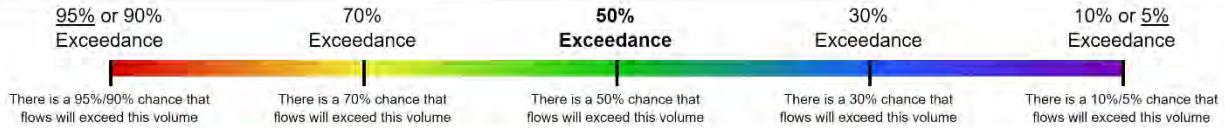
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## CARSON Water Supply Forecasts March 1, 2024



### Legend



When selected, the following historic streamflow values and statistics will be shown.

Period of Record Minimum  
Streamflow KAF (Year)

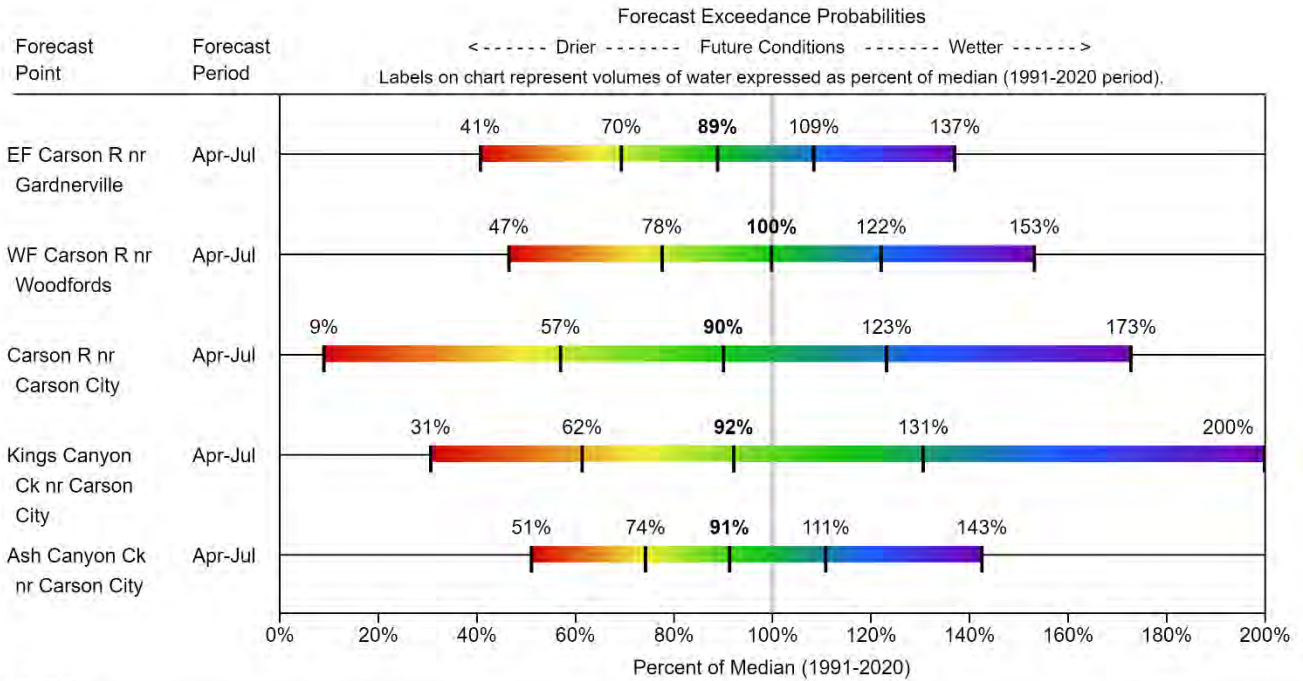
1991-2020 Normal  
Streamflow KAF

Observed Streamflow KAF

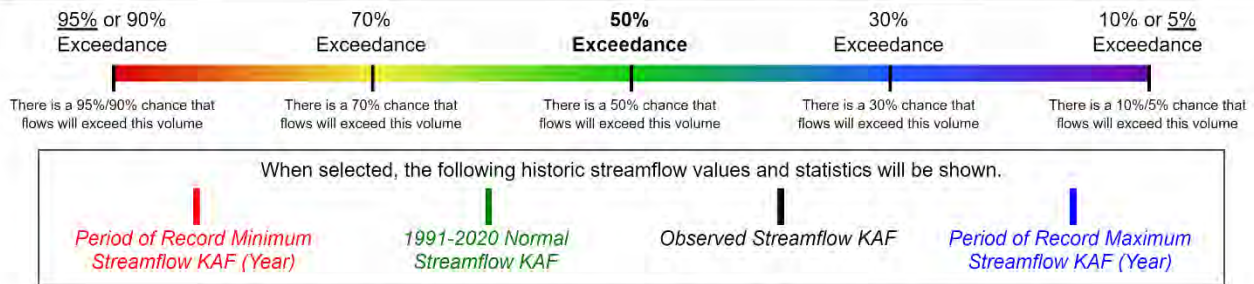
Period of Record Maximum  
Streamflow KAF (Year)

Some forecasts may be for volumes that are regulated or influenced by diversions and water management.

**CARSON**  
**Water Supply Forecasts**  
**March 1, 2024**



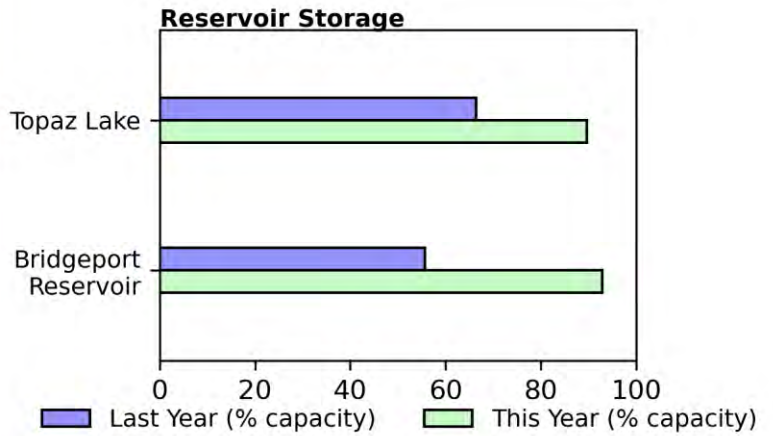
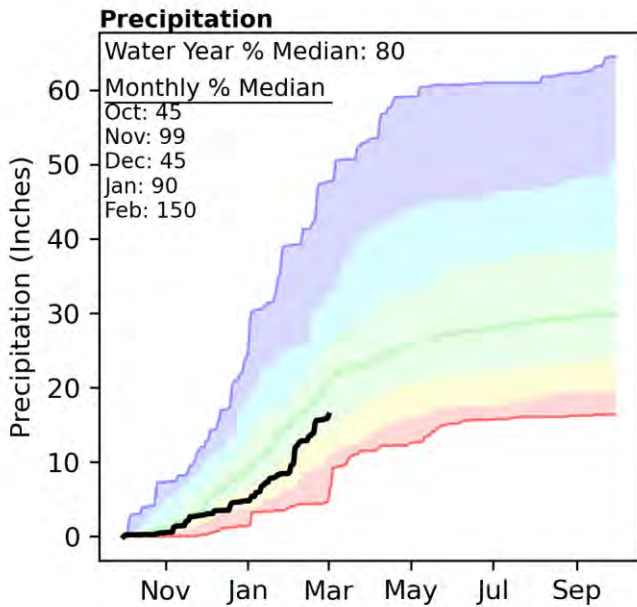
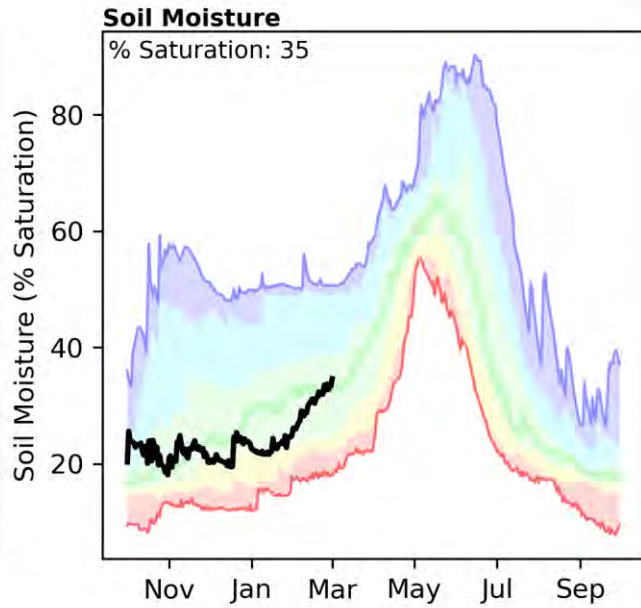
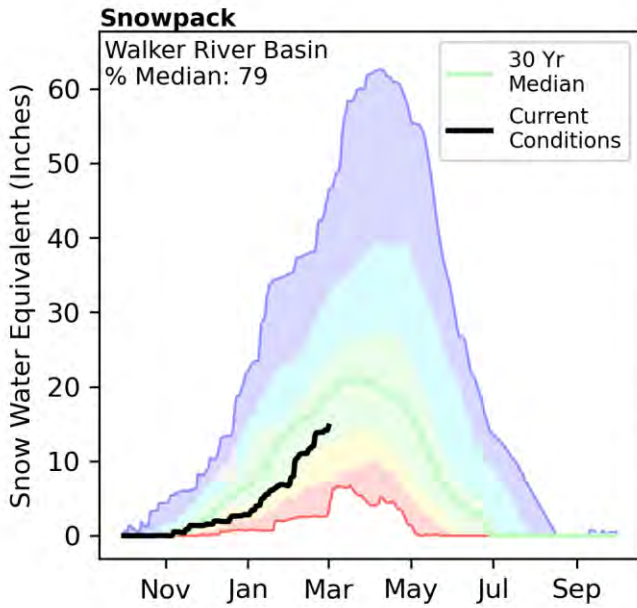
**Legend**



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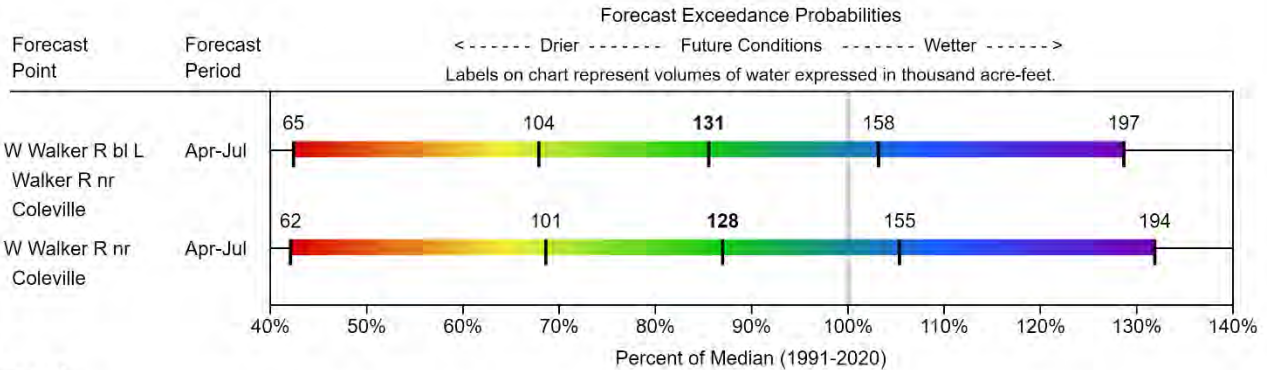
# Walker River Basin | March 1, 2024

Snowpack in the Walker River Basin is below normal at 79% of median, compared to 248% at this time last year. Precipitation in February was well above normal at 150%, which brings the seasonal accumulation (October-February) to 80% of median. Soil moisture is at 35% saturation compared to 44% saturation last year. Reservoir storage is 91% of capacity, compared to 62% last year.

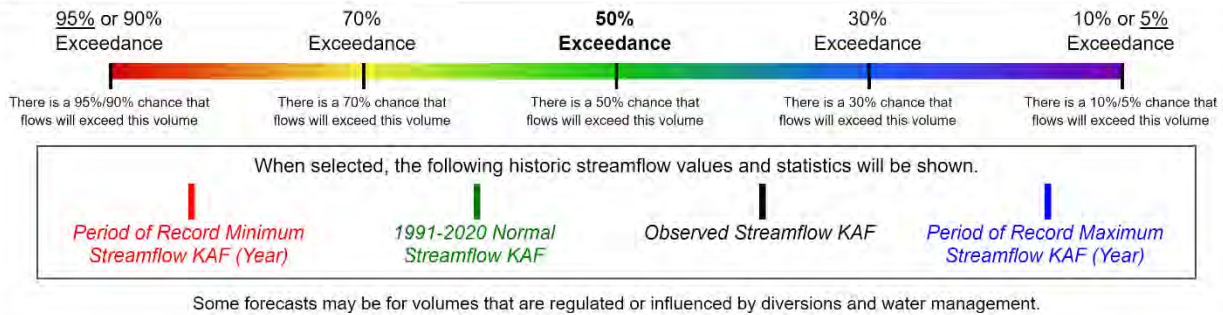


Statistical shading breaks at 10th, 30th, 50th, 70th, and 90th percentiles.  
For more information visit: [30 year normal calculation description](#)

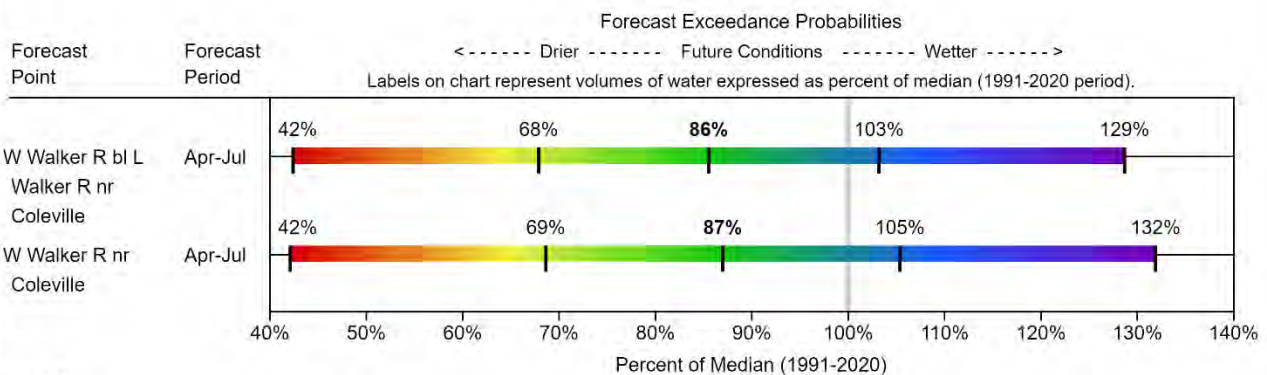
**WALKER**  
**Water Supply Forecasts**  
**March 1, 2024**



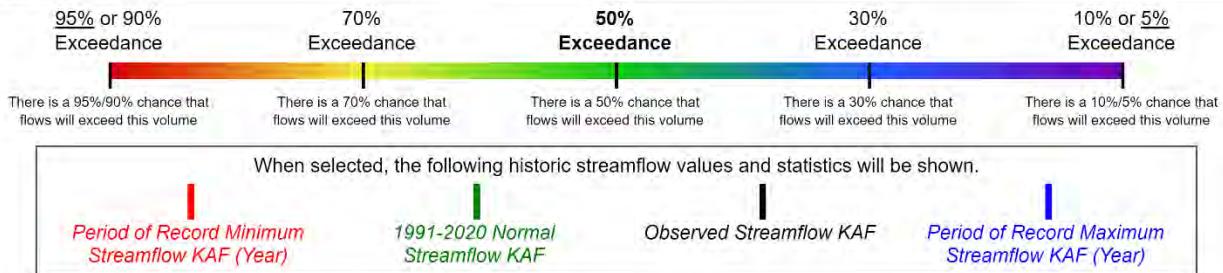
**Legend**



**WALKER**  
**Water Supply Forecasts**  
**March 1, 2024**

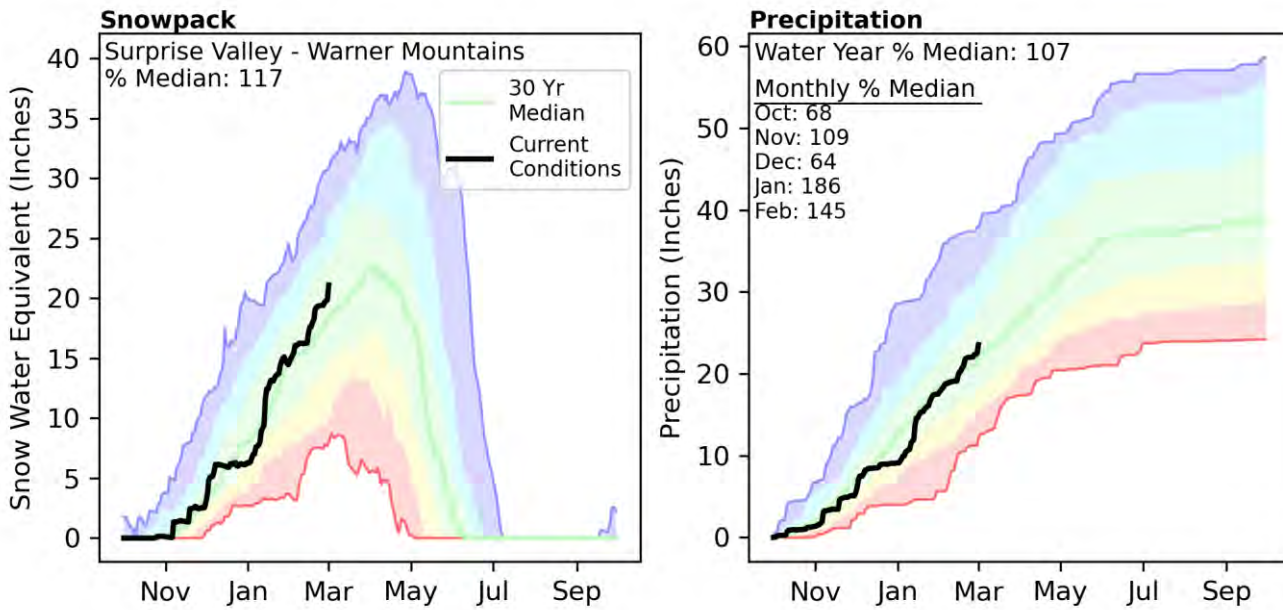


**Legend**

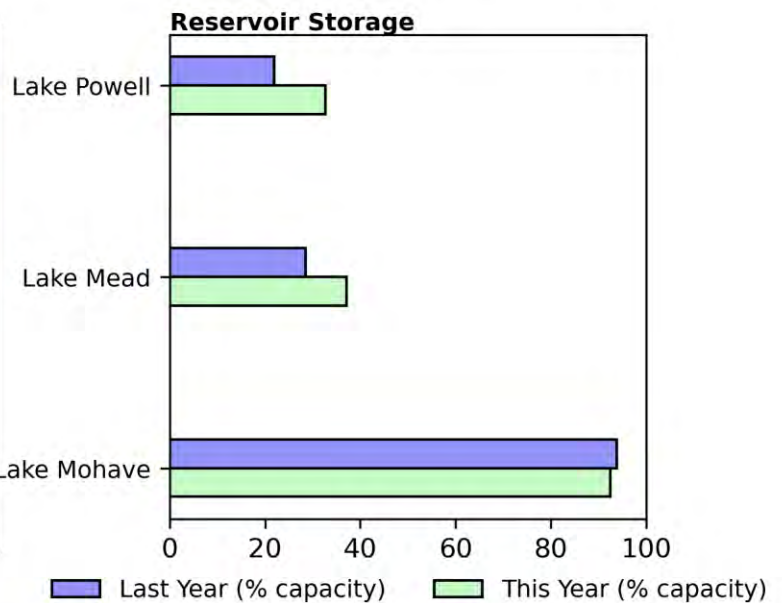
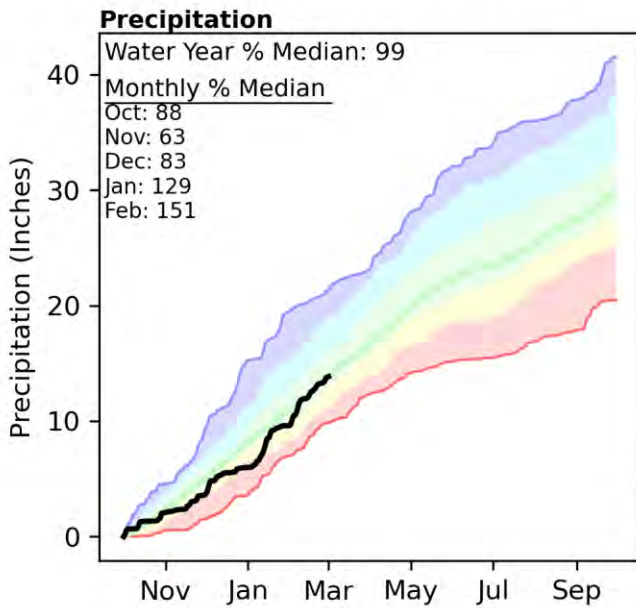
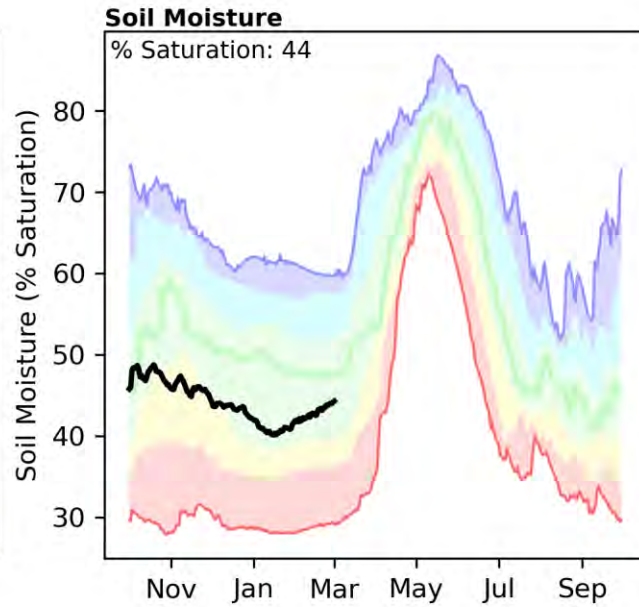
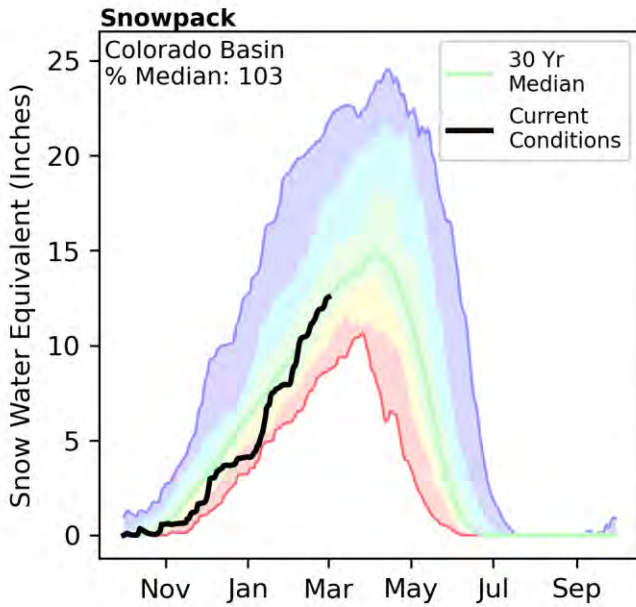


# Surprise Valley - Warner Mountains | March 1, 2024

Snowpack in the Surprise Valley - Warner Mountains is above normal at 117% of median, compared to 133% at this time last year. Precipitation in February was well above normal at 145%, which brings the seasonal accumulation (October-February) to 107% of median.



Snowpack in the Colorado Basin above Lake Powell is about normal at 103% of median, compared to 132% at this time last year. Precipitation in February was well above normal at 151%, which brings the seasonal accumulation (October-February) to 99% of median. Soil moisture is at 44% saturation compared to 52% saturation last year. Reservoir storage in the Lower Colorado Basin is 36% of capacity, compared to 27% last year.



Statistical shading breaks at 10th, 30th, 50th, 70th, and 90th percentiles.  
For more information visit: [30 year normal calculation description](#)

# Appendix: Interpreting the Streamflow Forecast Chart

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

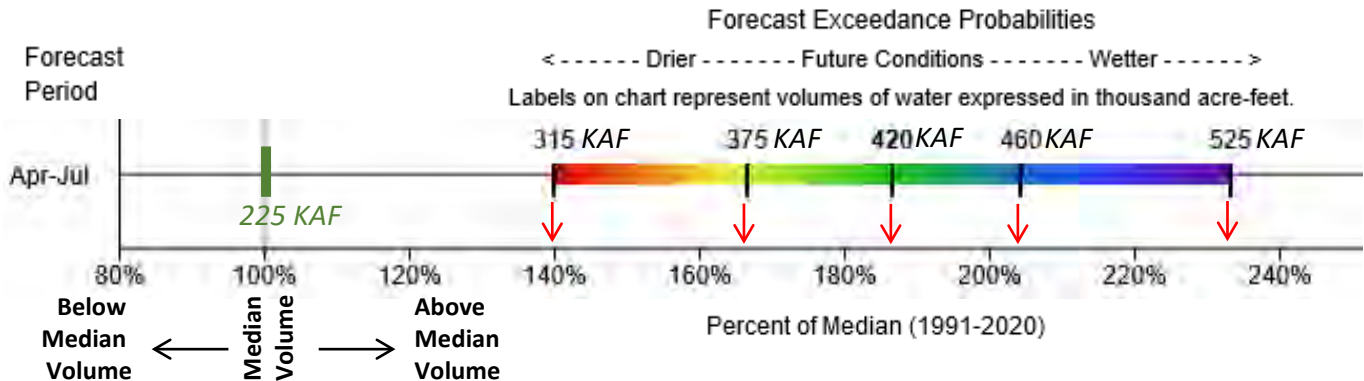
Provided by:  
 NRCS NV

Forecast Period	90% (KAF)	70% (KAF)	50% (KAF)	% Median	30% (KAF)	10% (KAF)	30yr Median (KAF)
APR-JUL	315	375	420	187%	460	525	225

The Forecast Chart (below) provides an alternative to the tables (above) used in the basin summaries. The chart displays the forecast exceedance range as a colored bar. The vertical lines on the bar signify the five forecast exceedances.

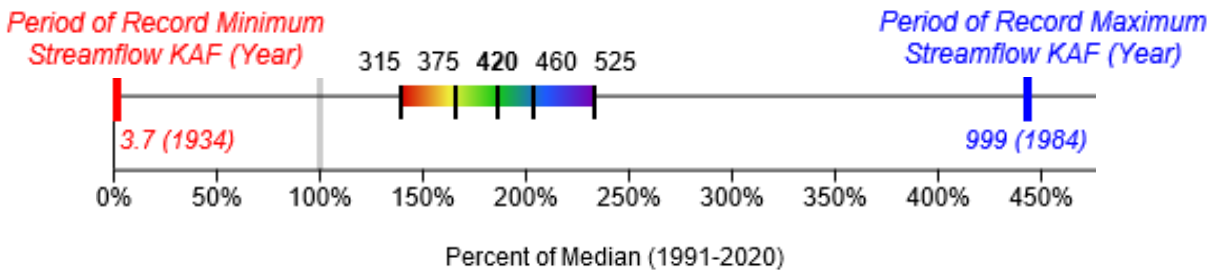


The numbers above the forecast bar are the five exceedance probability volumes in thousand acre-feet (KAF). Each exceedance forecast's percent of median can be estimated by looking at the horizontal axis. The green line and number centered above 100% on the horizontal axis represents the 1981-2010 historical median streamflow for the forecast period in KAF.



In the example above, the entire forecast bar is shifted right of the green bar indicating a forecast for above the median Apr-Jul streamflow of 225KAF. The 50% exceedance is represented by the black line in the green portion of the colored bar. This represents a forecast volume of 420KAF which is ~185% of median. If drier than normal future conditions occur the 70% exceedance forecast may be more likely (375KAF or ~165% of median). If future conditions turn wetter than normal, the 30% exceedance forecast may be more likely (460KAF or ~205% of median). Water users are encouraged to consider the range of forecast exceedances instead of relying solely only on the 50% forecast.

In very wet or dry years forecasts may approach historical records. In these cases the period of record minimum or maximum may be displayed. The minimum is represented by a heavy red line, while the maximum is represented by a heavy blue line. The numbers below the red and blue lines represent the volume in KAF and the year it occurred in parentheses.



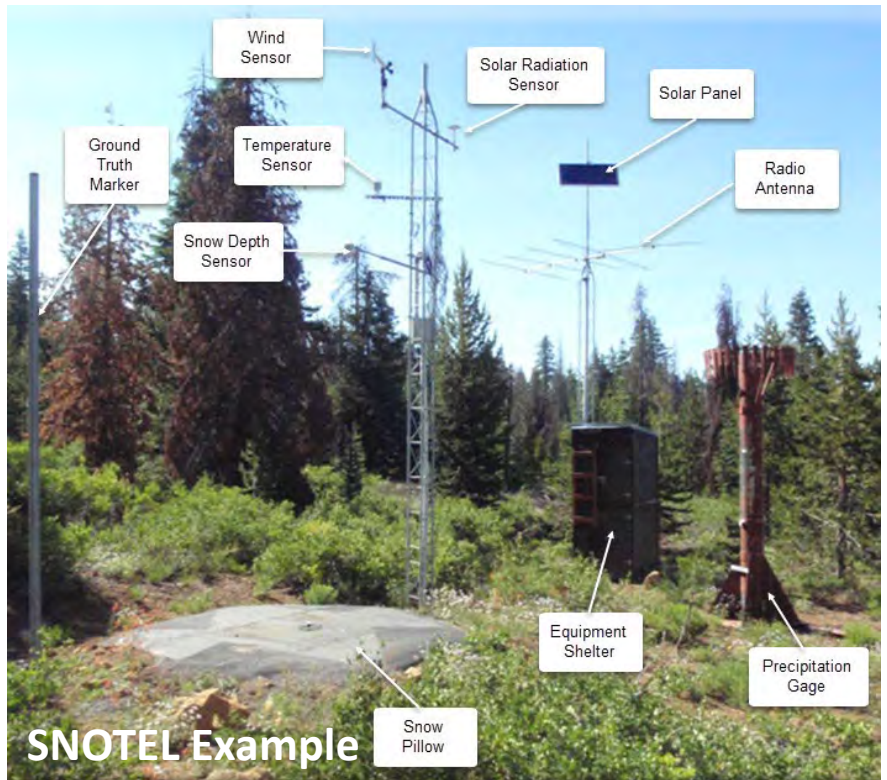
[Click here](#) for an online version which allows users to see averages instead of medians, as well as historic forecasts.



# Appendix - SNOTEL and Snow Course Overview

## SNOTEL

The NRCS operates an extensive, automated data collection network called SNOTEL (short for Snow Telemetry). SNOTEL sites are designed to operate unattended in remote mountain locations. Data are collected and transmitted hourly and available on the internet. Daily data (midnight values) are quality checked by NRCS hydrologists on at least a weekly basis. SNOTEL sites provide snowpack water content data via a pressure-sensing snow pillow. Other data include snow depth, water year precipitation accumulation, air temperature with daily maximums, minimums, and averages, soil moisture and soil temperature at depths of 2, 8 and 20 inches. The earliest NRCS SNOTEL sites have data back to 1981 or a bit earlier.



## Snow Course

Snow courses are measurement transects where snow tubes are used by snow surveyors during the winter season to determine the depth and water content of the snowpack. Hollow snow tubes are used to vertically core the snowpack. The tubes are then weighed to determine the water content of the snow. Generally, snow courses are situated in meadows or forest openings protected from the wind. A snow course measurement is the average of a number of sample points, typically 5 to 10. Snow courses are measured on a monthly basis typically between February 1 and April 1. Snow courses provide a longer record than SNOTEL. The earliest snow courses in the Lake Tahoe and Truckee basins have data back to 1910.



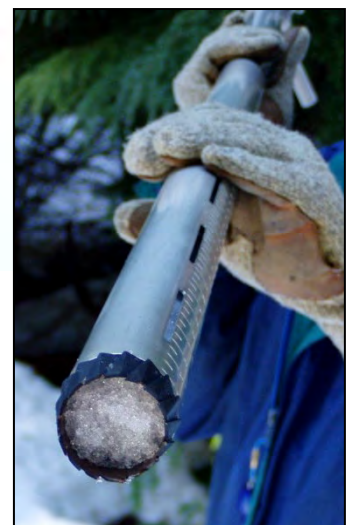
## Snow Water Equivalent (SWE):

Sometimes also called snow water content, this is the amount of water contained within the snowpack. It can be thought of as the depth of water (in inches) that would result if you melted the snowpack. For example, if the snowpack was contained 12 inches of SWE, then when melted there would a puddle of water 12 inches deep on the ground.

SWE measurements made by snow pillows or snow tubes rely on the fact that water weighs the same whether it is liquid or frozen.



Weight of frozen water = Weight of liquid water



Snow core inside snow tubes

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YOU MAY OBTAIN THIS PRODUCT AS WELL AS  
CURRENT SNOW, PRECIPITATION, TEMPERATURE  
AND SOIL MOISTURE, RESERVOIR, SURFACE  
WATER SUPPLY INDEX, AND OTHER DATA BY  
VISITING OUR WEB SITE:  
<https://www.nrcs.usda.gov/resources/data-and-reports/california-snow-survey>



## **California Water Supply Outlook**

