USDA United States Department of Agriculture

Natural Resources Conservation Service

Montana Water Supply Outlook Report

May 1, 2024

Montana Snow Survey hydrologist Florence Miller measures the meager remaining snowpack in the rain at Four Mile snow course during the May 1 survey. April did not deliver the snow and precipitation that were needed for snowpack recovery. During the May 1 survey, 32 of the 98 snow courses measured were completely snow-free. With April's below normal precipitation and warm temperatures, precipitation fell as rain at lower and mid elevations. Several stretches of warm and dry weather initiated melting of the snowpack at the majority of SNOTEL stations across all elevations. Summer is fast approaching, and water users should plan for below normal water supplies in the coming months. (Photo: Joe Kral 4/26/2024)

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Statewide Overview

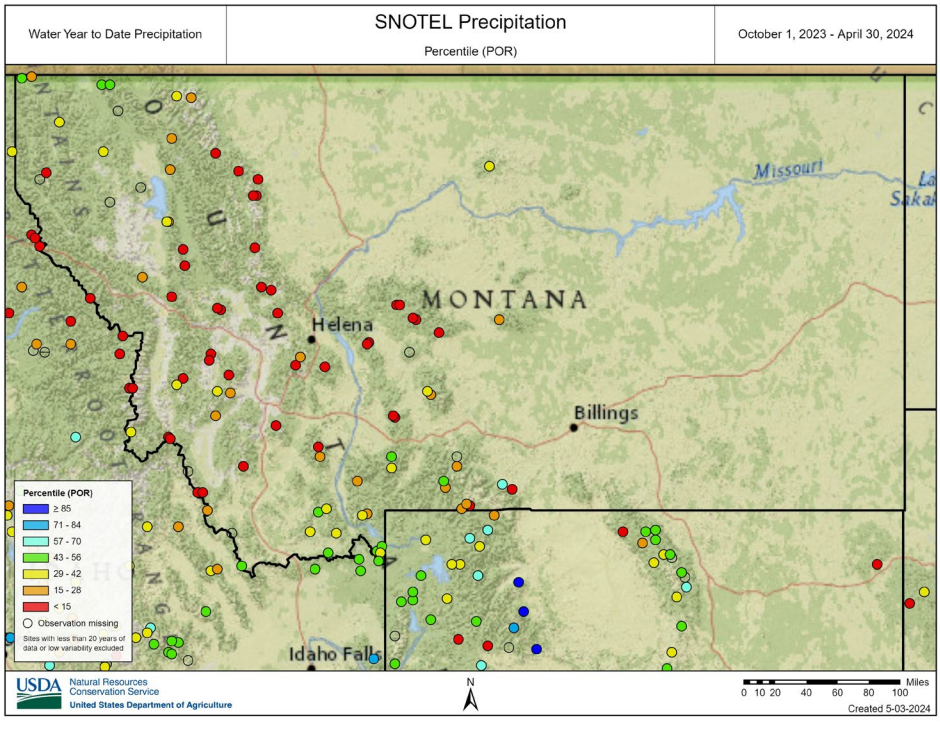
Summary

Well above normal precipitation during April was needed given the meager snowpack conditions experienced this year. Total monthly precipitation was above normal last month in the Powder and Tongue River basins, but was not widespread across Montana. A couple mid-month storms did provide significant snowfall, but April is typically a wet month in Montana, and total precipitation last month did not meet that standard. April precipitation was overall about 65-80% of normal with a couple of isolated locations that were higher. For example, the Gallatin and Bitterroot received about 90-95% of normal April precipitation. Spring weather in Montana can be highly variable, with a storm that is currently adding to the snowpack as this report is being prepared. While this is exactly what is needed, this one storm alone will not likely make up for the water year precipitation deficit across most of western Montana. Water year precipitation is 75-85% of normal for most of the state. Northern Wyoming basins and the upper Madison have fared slightly better and are currently at 90-100% of normal water year precipitation.

Given the insufficient precipitation totals during April, the snowpack has only improved in the Powder and Tongue River basins from last month. Keep in mind that a snowpack percentage only represents today's date (i.e. a given date's snow water equivalent as a percentage of median snow water equivalent for that date). The median snowpack peak date is mid-April in most basins. Median values used for snowpack percentage calculations are currently decreasing each day with spring melting conditions. If the weather stays cool and additional snowpack accumulation occurs, basin wide snowpack percentages will likely increase. If it nears 100% in May, that doesn't mean a full recovery has been achieved. Snowpack percentages were well below normal most of this season. Larger snow water equivalent peaks are likely to occur at the highest elevations, but significant snowmelt has occurred at mid mountain elevations and lower. As of May 1, snowpack percentages range from about 40-75% across Montana and 70-90% in northern Wyoming. This has been one of the lowest statewide snow seasons on record.

May 1 water supply forecasts are available and track with water year precipitation and the resulting snowpack. Currently they indicate runoff will be below normal this summer in most locations. The only exceptions are rivers originating in the southern Absaroka and Wind River mountains, which due to near normal precipitation this year are forecasted to have near to above normal runoff. Areas of greatest concern include the region stretching from Missoula to the Rocky Mountain Front. Even the 10% exceedance forecasts in that region fall below normal observed flows. Meaning that even with well above normal precipitation the next month, runoff will likely be below normal this season. A cool and wet spring could help supplement runoff this summer, but overall runoff will likely be below normal.

The following map shows water year precipitation at SNOTEL sites for water year 2024 (October 1, 2023 - April 30, 2024). Red indicates 15th percentile or lower compared to period of record. Many SNOTELs in the region stretching from Missoula to the Rocky Mountain Front are reporting their lowest water year precipitation in 30-40 years.



Statewide Overview

Precipitation

April precipitation was below normal in all but the Bighorn and southern Absaroka Mountains, which received 110-150% of normal precipitation last month. Several high elevation pockets of Montana and the region extending northeast from Bozeman to Lewistown received 90-100% of normal precipitation last month. The Upper Missouri, Sun-Teton-Marias, and Saint Mary River basins only received 60-70% of normal precipitation, and the rest of Montana received 70-90% of normal precipitation in April.

A couple of large storms produced significant precipitation during April. The first and biggest storm occurred April 6-11 and delivered 4-6" of precipitation to parts of the Bighorn Mountains. SNOTEL sites in the Big Snowy, Mission, and Swan Mountains received 2-4" of precipitation from this storm, elsewhere received 1-2" of precipitation. Round two was isolated to the Bighorns, which received about 1" of precipitation April 17-18. April concluded with a storm April 26-May 1 that delivered 1-2" of precipitation to SNOTELs across the state.

April precipitation was not enough to compensate for lack of precipitation earlier in the water year. The highest elevation SNOTEL stations in the region currently have water year precipitation deficits of 12-16". For example, North Fork Jock SNOTEL in the southern Mission Mountains has received 36.9" of precipitation since October 1, which is the lowest May 1 water year precipitation total in 35 years of record. The May 1 median for North Fork Jock SNOTEL is 53.1", and the highest May 1 value was 74.9" in 2018. Lower elevations generally receive less precipitation and currently have smaller deficits, but are still facing well below normal moisture levels. Translating to percentages, the deficits equate to 75-85% of normal water year precipitation for most of Montana. Northern Wyoming basins and the upper Madison have fared slightly better and are currently at 90-100% of normal precipitation since October 1, 2023.

April - Highest Total Accumulated Precipitation - SNOTEL/SNOLITE

Station	Precipitation (Inches)	Median (Inches)	Elevation	Basin
Crystal Lake	6.7	4.6	6050	Smith-Judith-Musselshell
Shower Falls	6.5	5.7	8100	Upper Yellowstone, Gallatin
Noisy Basin	6.1	5.6	6040	Flathead
Moss Peak	5.5	6.6	6780	Flathead
S Fork Shields	5.4	5.2	8100	Upper Yellowstone

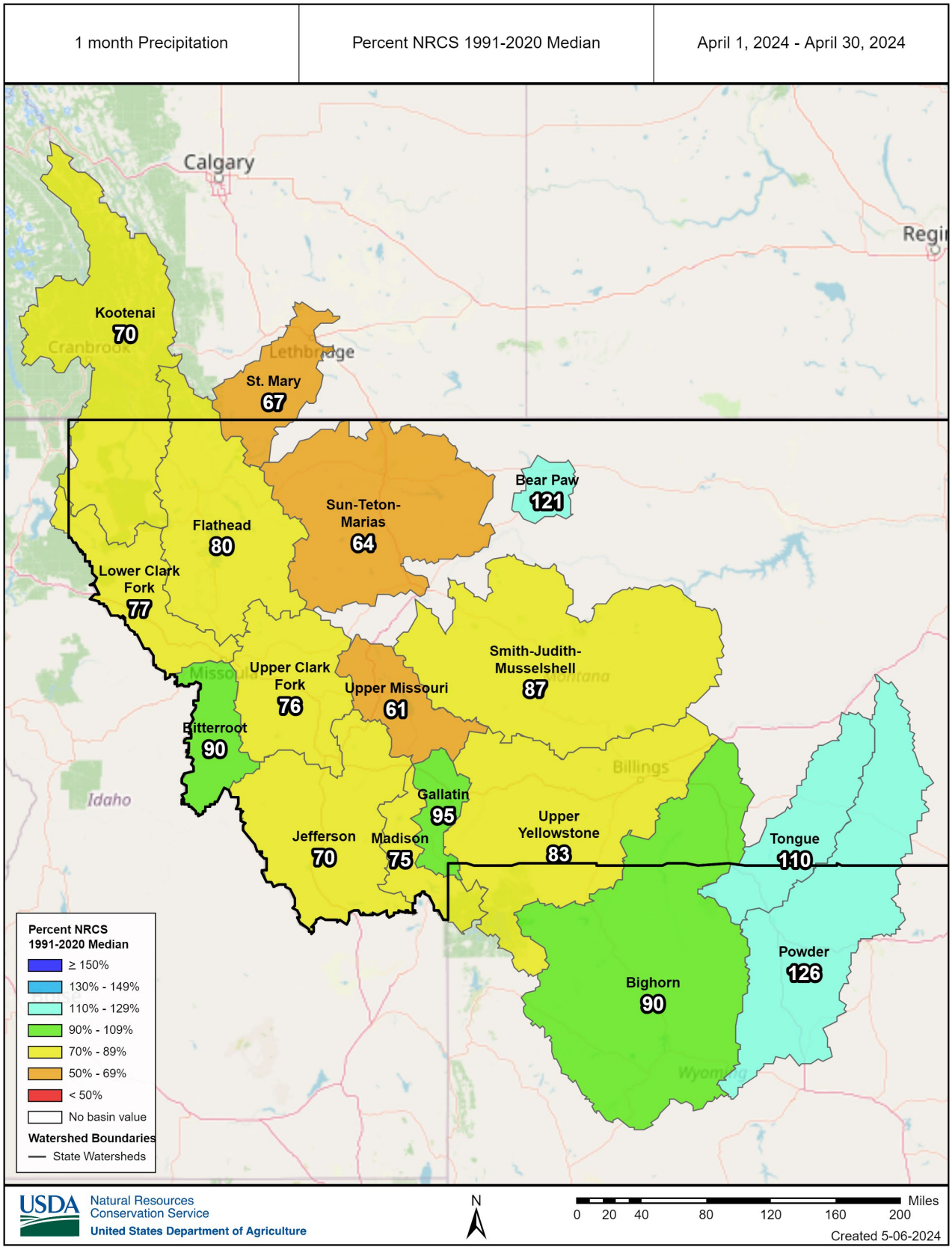
April - Lowest Total Accumulated Precipitation- SNOTEL/SNOLITE

Station	Precipitation (Inches)	Median (Inches)	Elevation	Basin
Divide	0.6*	2.6	7800	Jefferson
Basin Creek	0.9	3.3	7180	Jefferson, Upper Clark Fork
Nevada Ridge	0.9	2.7	7020	Upper Missouri, Upper Clark Fork
Castle Creek	1.1	2.2	8400	Bighorn
West Yellowstone	1.1	2.4	6700	Madison

*Estimated value

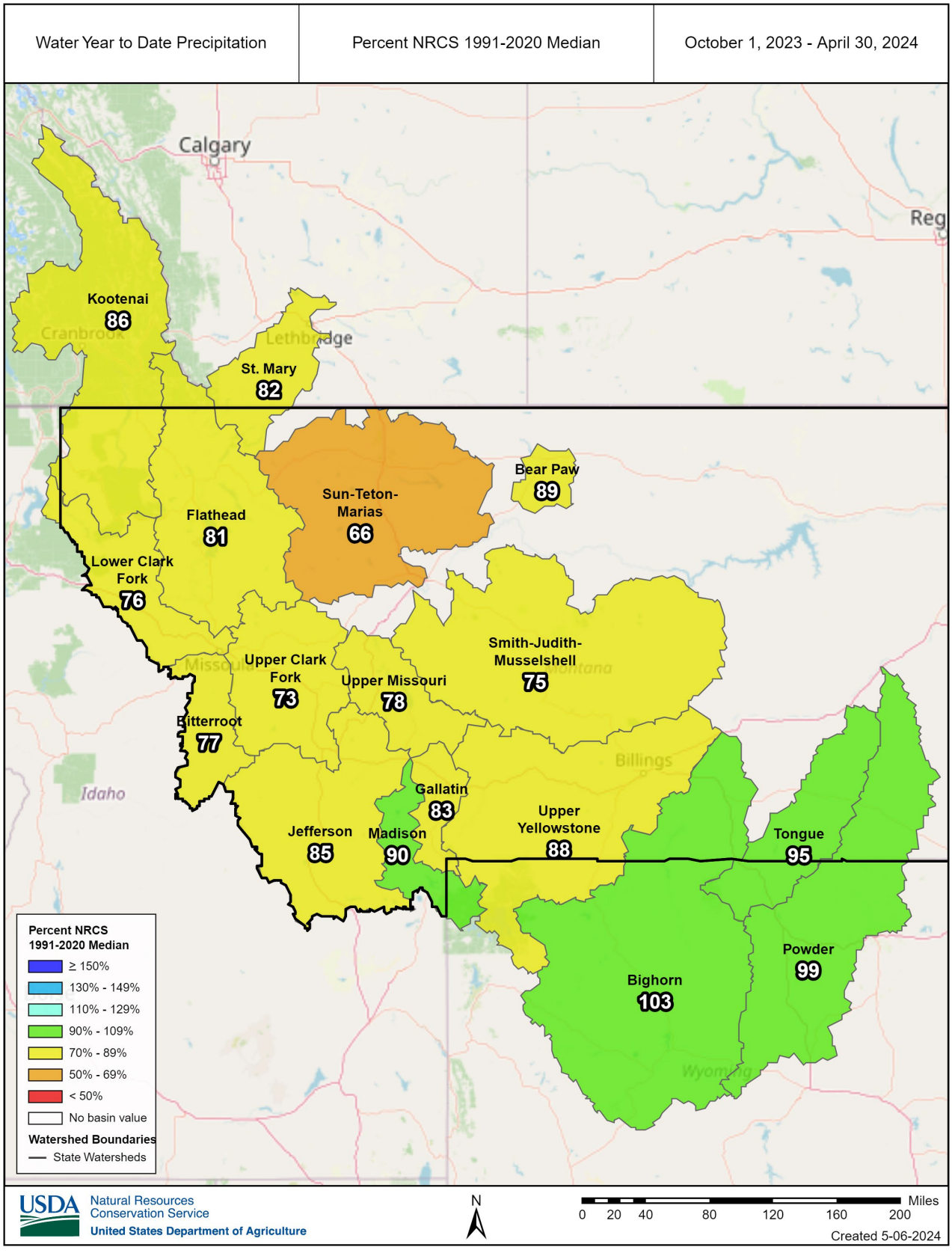
Statewide Overview

Precipitation (Continued)



Statewide Overview

Precipitation (Continued)



Statewide Overview

Snowpack

Basin wide snowpack percentages have decreased from April 1, except for the St. Mary, Powder, and Tongue River basins which increased. The Powder and Tongue increase was the result of above normal precipitation during April. The snowpack percentage increase in the St. Mary was because statistically the basin wide snowpack peaks on April 6, and total snowmelt in the basin was slightly less than normal last month, causing it to appear like the snowpack improved yet precipitation was well below normal in that region during April.

The largest snowpack percentage decreases over the last 30 days occurred in the Upper Missouri, Bitterroot, and Sun-Teton-Marias River basins. These basins experienced significant snowmelt at all elevations over the last month. May 1 snowpack percentages across most of Montana range from about 55-75% of normal. The Upper Missouri and Sun-Teton-Marias are lower at about 40%. The Bighorn and Tongue River basin snowpack is closer to normal at about 80-85%.

During an ideal season the mountain snowpack reaches peak snow water equivalent in late April or early May, which is why snowpack percentages are most relevant for water supply this time of year. Unfortunately, snowpack percentages are currently either the lowest they have been or near to it in many Montana river basins. Several examples of other low snow years in Montana include 2015, 2005, and 2001. In 2015, May 1 snowpack percentages were 50-65% of normal. In 2005, they were 55-80% and in 2001 they were 65-85% on May 1, each not very different than this year's statewide snowpack.

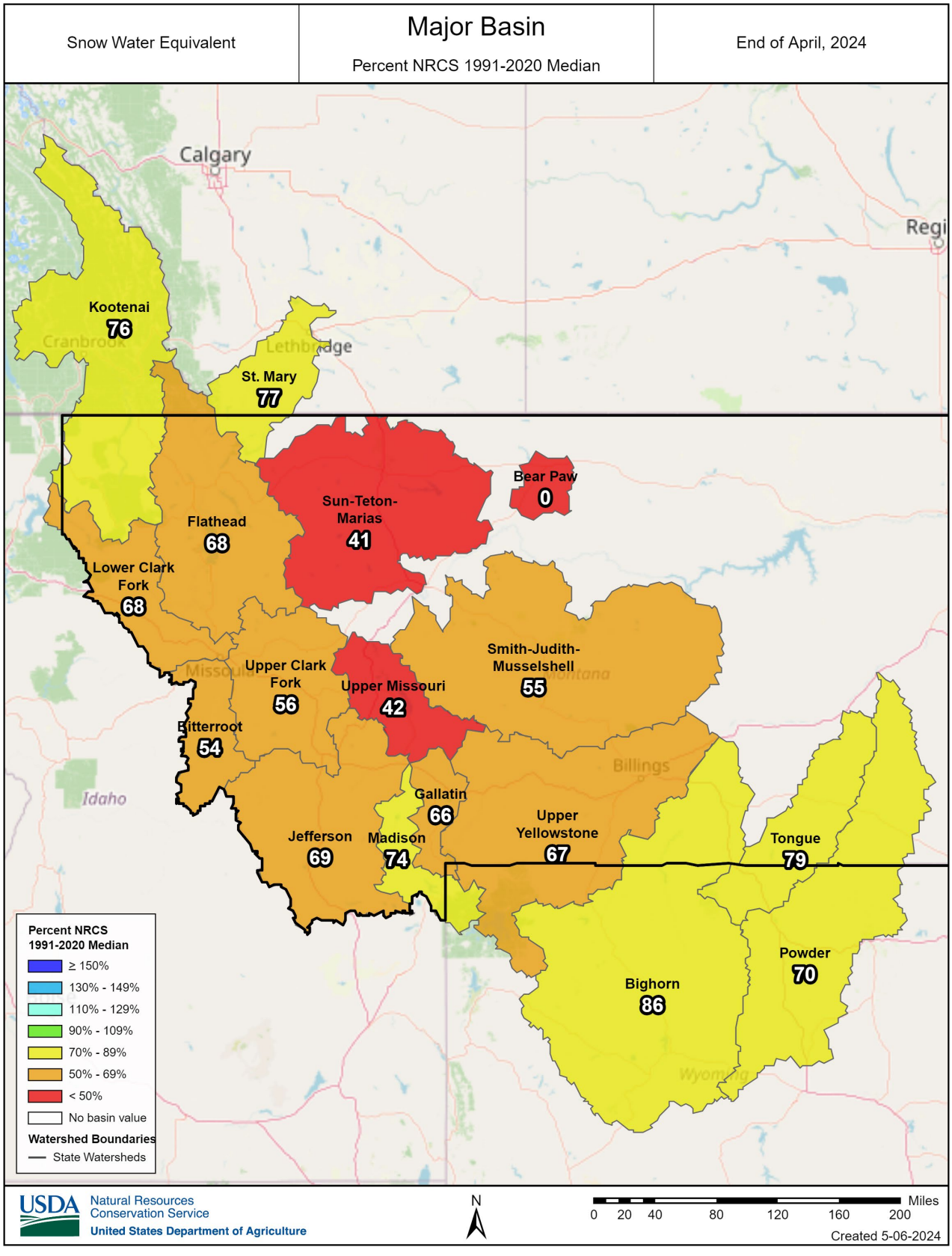
The snowpack peaked for the season at the lowest elevation SNOTEL sites during the second week of April, some peaked even earlier in late March. Since then, 4-8 inches of snow water equivalent has melted at those stations. For many lower elevation SNOTELs that means they melted out, for the rest only 30-40% of the seasonal snowpack remains. The highest elevation SNOTEL stations across Montana saw additional snow accumulation during the last week of April and have not peaked for the season. Pending significant snowfall in May, the basin wide snowpack has likely peaked for the season. Regardless, additional precipitation and slower than normal snowmelt rates this spring would be beneficial for water supplies this upcoming summer.

Water Year 2024 - Major Basin - Snowpack Percent of Normal ('91-'20)

Basin	Nov 1	Dec 1	Jan 1	Feb 1	Mar 1	Apr 1	May 1	Jun 1
Kootenai	62	64	62	67	77	79	76	-
Flathead	67	63	53	65	71	74	68	-
Upper Clark Fork	116	37	36	44	66	67	56	-
Bitterroot	144	35	50	60	73	72	54	-
Lower Clark Fork	90	58	47	55	66	73	68	-
Jefferson	91	48	51	55	73	80	69	-
Madison	86	58	54	57	73	85	74	-
Gallatin	81	52	54	53	65	76	66	-
Upper Missouri	125	41	33	41	71	73	42	-
Smith-Judith-Musselshell	116	63	49	51	65	67	55	-
Sun-Teton-Marias	121	48	26	34	53	57	41	-
St. Mary	77	72	51	55	65	73	77	-
Upper Yellowstone	103	60	55	55	65	79	67	-
Bighorn	117	85	75	74	85	95	86	-
Powder	93	60	51	51	63	67	70	-
Tongue	154	92	66	64	65	73	79	-
Bear Paw	-	-	41	31	50	67	-	-

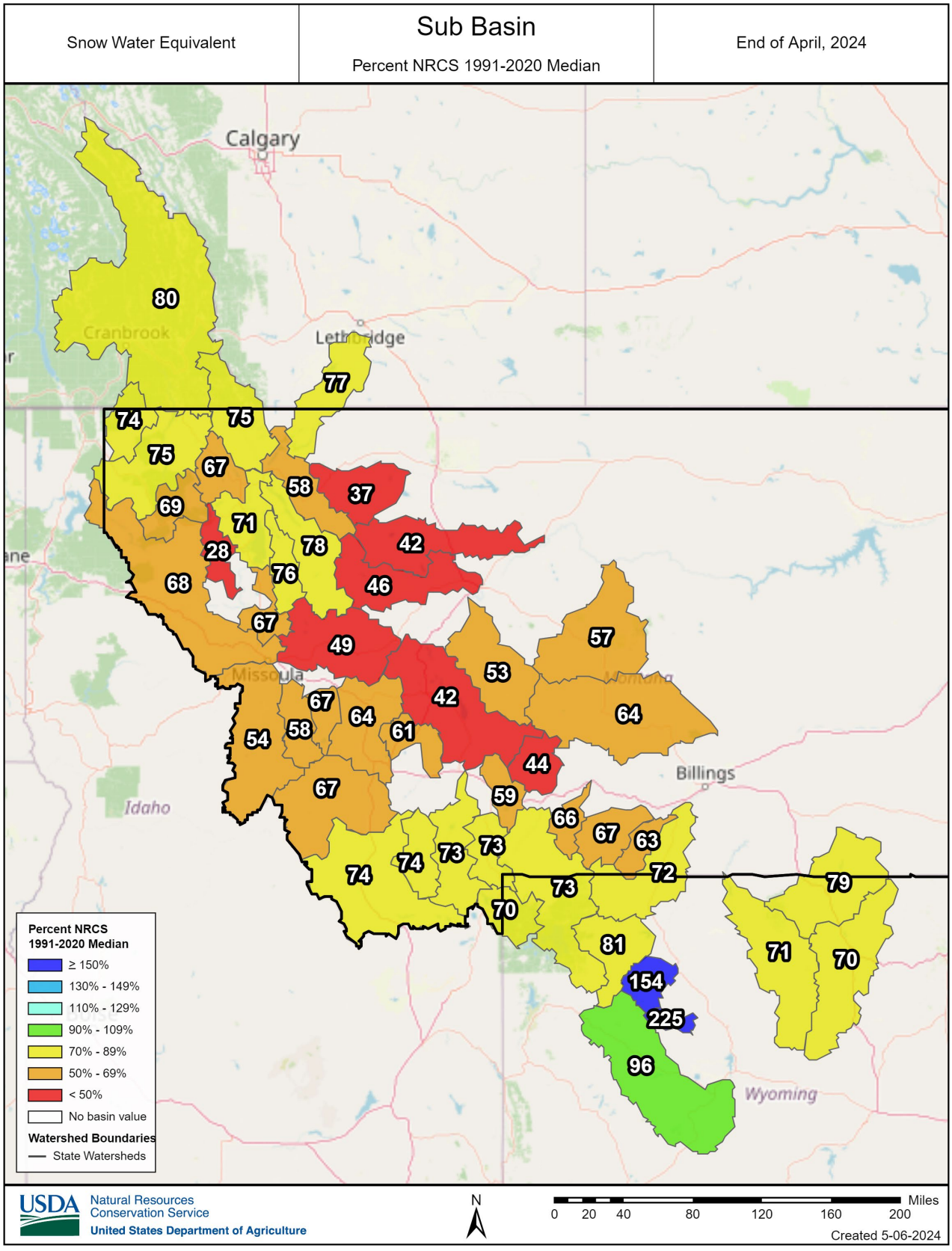
Statewide Overview

Snowpack (Continued)



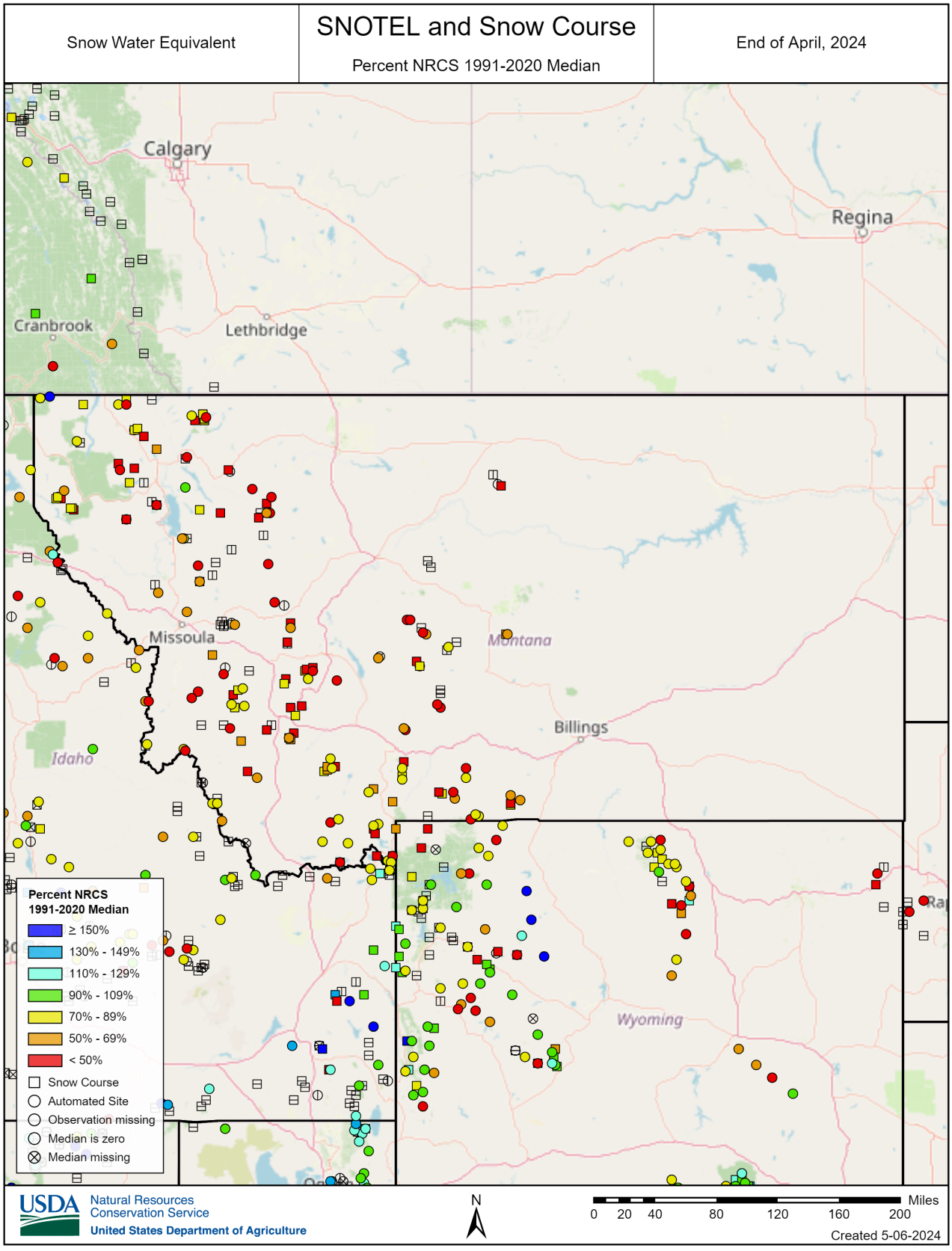
Statewide Overview

Snowpack (Continued)



Statewide Overview

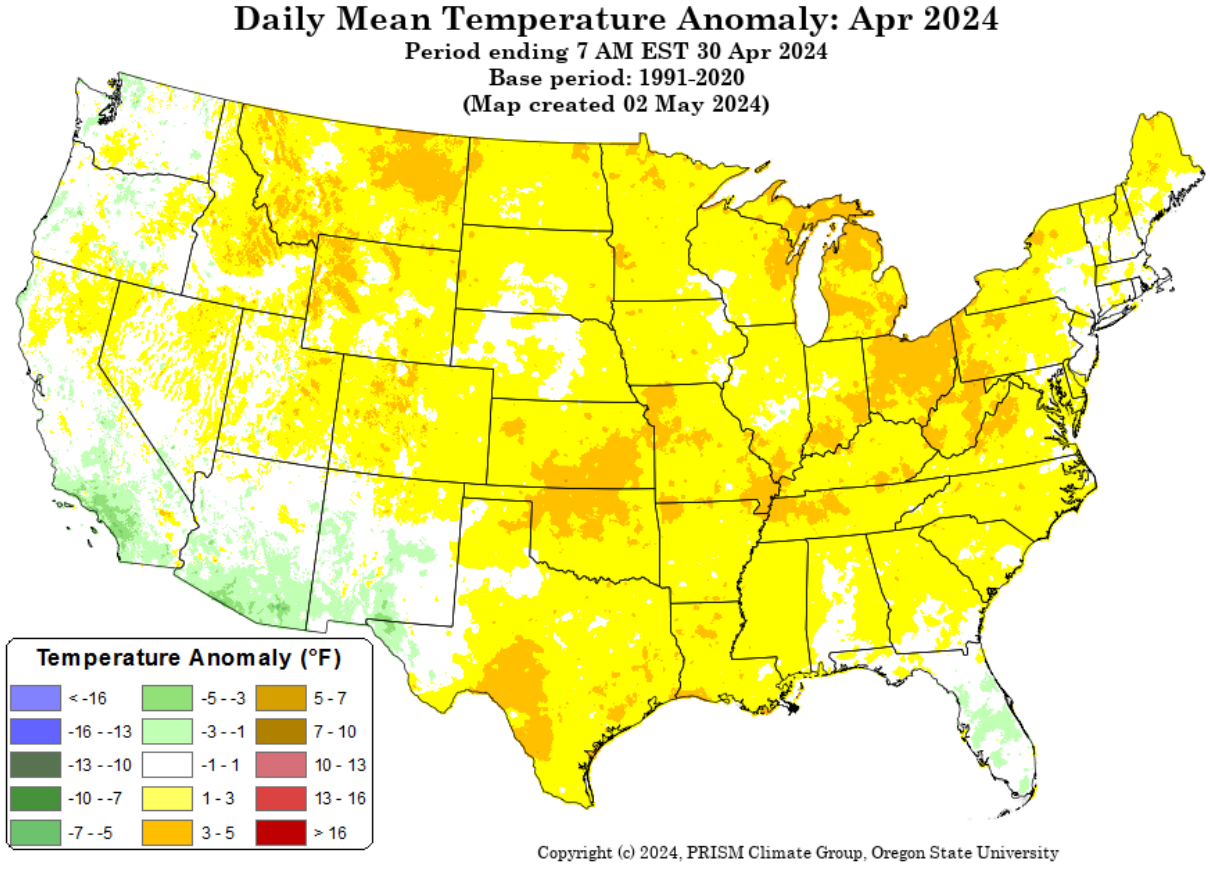
Snowpack (Continued)



Statewide Overview

Temperature

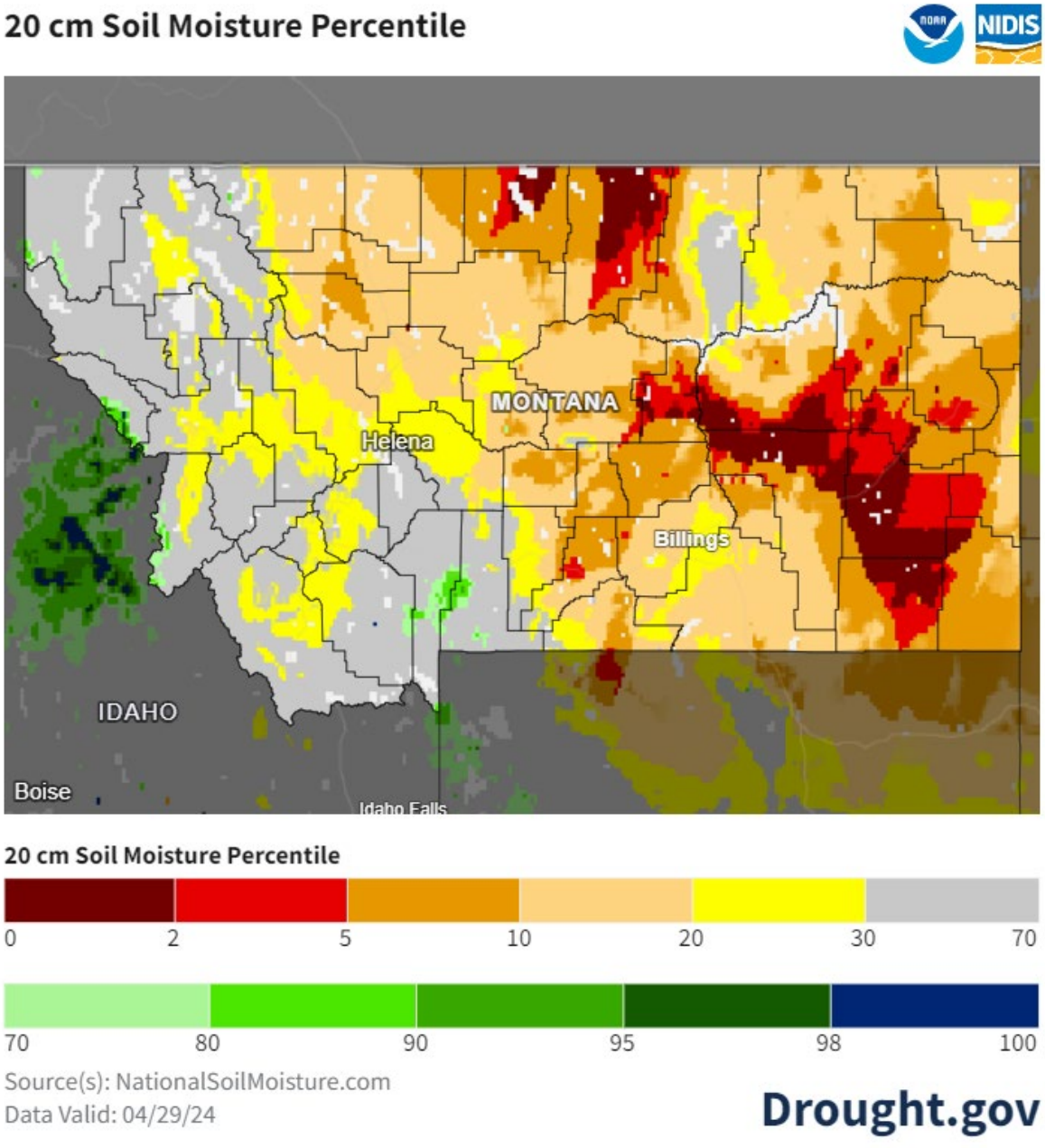
April temperatures in Montana were above normal by 1-3 °F across the state. Northeast Montana and mountainous regions in the western part of the state recorded above normal temperatures by 3-5 °F. Average daily temperatures at Montana SNOTEL sites largely oscillated between normal and warmer than normal temperatures for the month of April. SNOTEL sites recorded above normal temperatures for the periods of April 1-5, April 10-15 and April 23-25. Daily average temperatures for these time periods peaked in the 40-50 °F range depending on elevation, with daily highs reaching 70 °F. SNOTEL sites recorded colder than normal temperatures from April 17-19 with daily average temperatures reaching teens to low 20s °F depending on elevation. Daily lows dropped to about 0 °F at high elevation SNOTEL sites during that time. The frequent warm spells raised the April average monthly temperature, but periods of average or below average temperatures moderated the effect of these warm spells. The above normal temperatures impacted the state's snowpack. Many areas in the valleys and lower elevations had significant snowmelt with some areas completely melting out up to two weeks earlier than normal as a result of below average snowpack coupled with warm temperatures. Many higher elevation snowpacks have begun melting and have observed snow density increases indicative of a ripening snowpack in April.



Statewide Overview

Soil Moisture

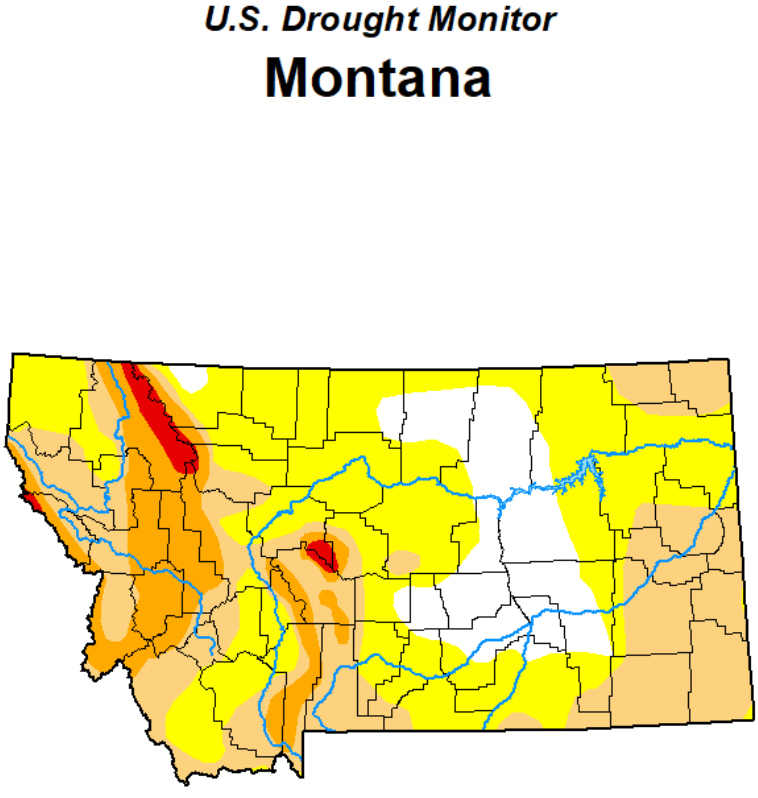
Soil moisture in the top 20cm has decreased significantly across Montana since last month. The western part of the state has normal to below normal soil moisture in the 20th to 70th percentile range. There are small pockets of above normal soil moisture in the 70th to 90th percentile range on the Idaho border and in the Gallatin Range. Moving east, soil moisture decreases to the 5th to 30th percentile range with large swatches of significantly below normal soil moisture in the 0 to 5th percentile. To reverse the trend of decreasing soil moisture, spring precipitation will be essential.



Statewide Overview

Drought Monitor

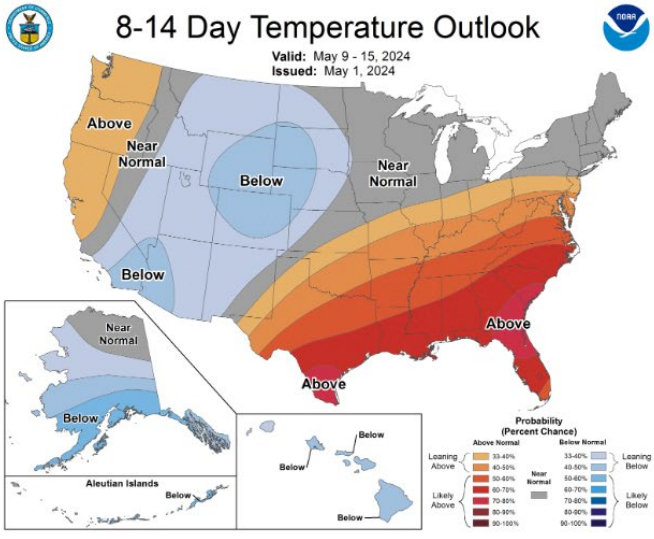
The current U.S. Drought Monitor map, released on Thursday, May 2, 2024, classifies 43% of Montana as moderate (D1) to extreme (D3) drought. Overall, this is not a significant change from last month. The most notable changes are the downgrade to D3 in the eastern portion of Flathead County and the southeast corner of Cascade County, the removal of D3 in Missoula, Powell, Granite and Lewis & Clark counties, and the downgrade of severe (D2) drought to moderate (D1) and abnormally dry (D0) in Big Horn, Rosebud, and Powder River counties. It is worth noting that the percentage of the state that falls into the abnormally dry or D0 category has dropped to 43% this month from 53% last month and the percentage of the state with no drought classification is now at 14%. The state remains without any current exceptional (D4) drought categorizations.

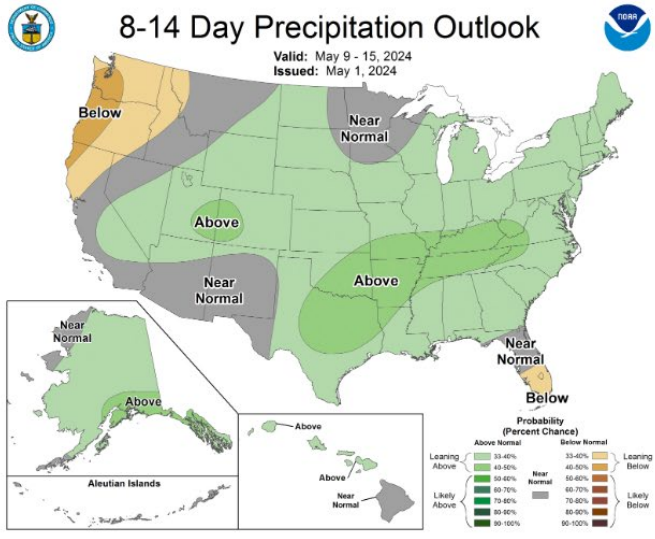


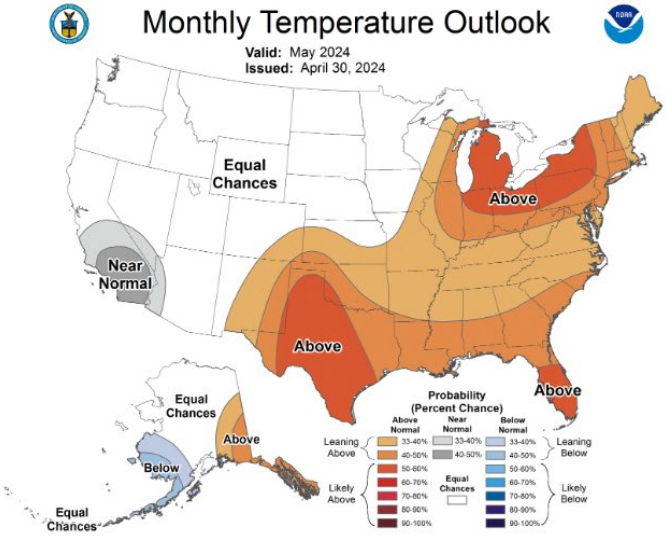
Statewide Overview

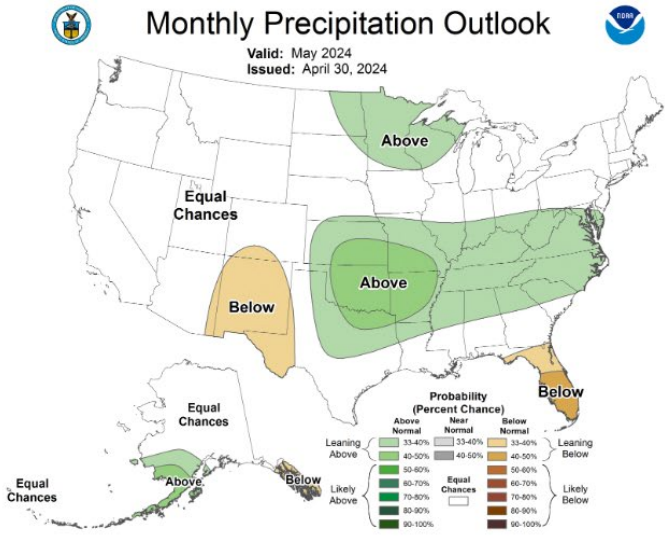
Weather Outlook

The weather outlook from NOAA's Climate Predication Center predicts that temperatures will be leaning below normal for the next 8-14 days across most of Montana. The northwest corner of the state is predicted to have normal temperatures. Precipitation over the next 8-14 days is predicted to be near normal for most of the state, leaning above normal in the southeast corner and below normal in the northwest corner. The monthly temperature and precipitation outlooks for Montana indicate equal chances for above or below normal temperatures and precipitation. Lower temperatures and higher precipitation could help maintain the snowpack's reservoir of water, while higher temperatures and lower precipitation could further accentuate snowpack melt.





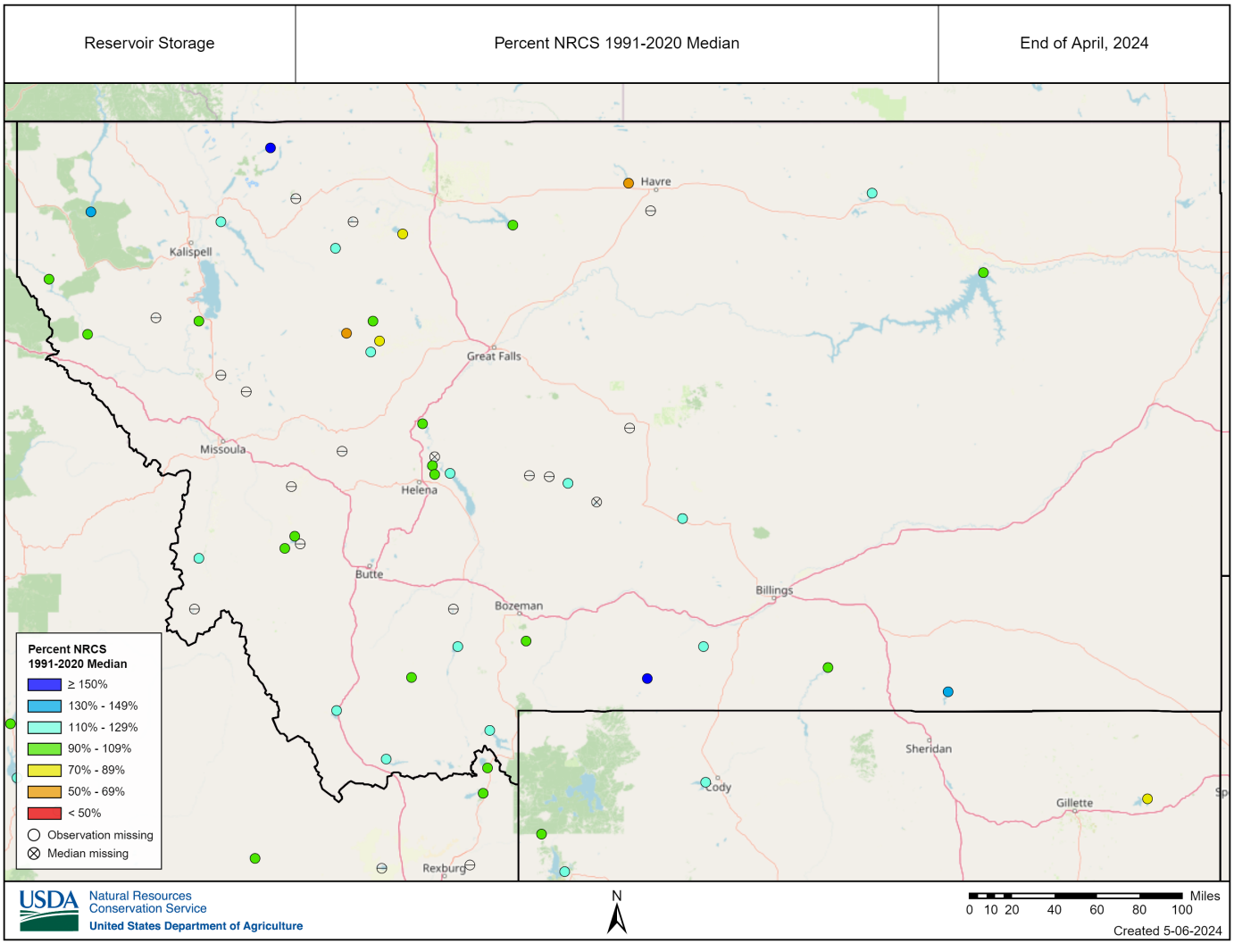




Statewide Overview

Reservoirs

The end of April storage levels for most Montana reservoirs were normal or above normal. Bair, Canyon Ferry, Clark Canyon, Cooney, Deadman's Basin, Ennis Lake, Hebgen Lake, Hungry Horse, Lake Como, Lake Koocanusa, Lima, Mystic Lake, Nelson, Nilan, Swift, and Tongue River Reservoirs were all at or above 110% of normal levels for end of April. Fresno, Gibson, Lake Frances, and Willow Creek Reservoirs were all at or below 80% of normal levels for end of April. The remaining reservoirs across the state were reporting reservoir storage at near normal levels.



Statewide Overview

Reservoirs (Continued)

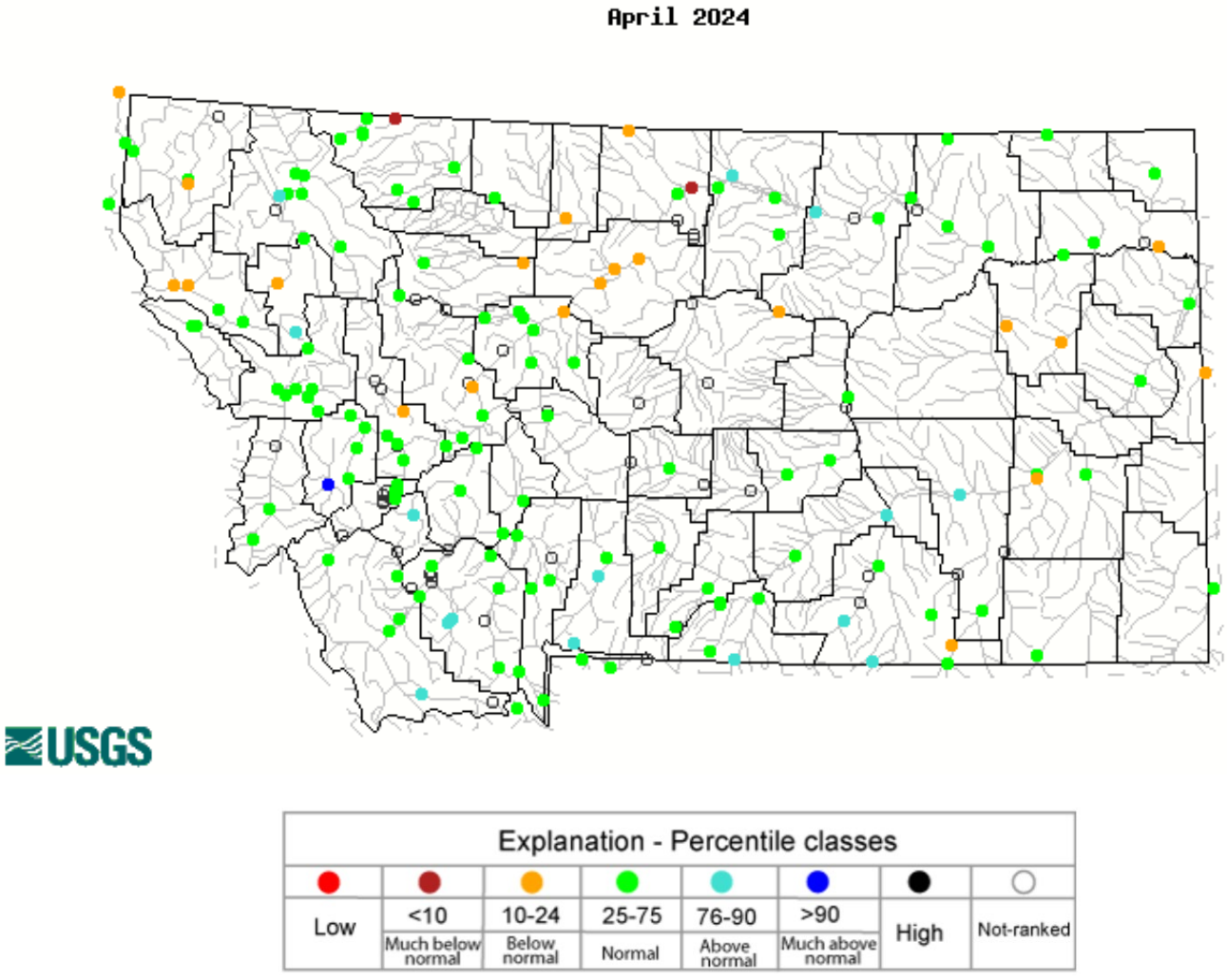
End of April - Reservoir Storage Percent of Capacity

Reservoir	Basin	Current % Capacity	Last Year % Capacity	Median % Capacity
Smith River Res	Smith-Judith-Musselshell	-	80	80
Deadman's Basin Res	Smith-Judith-Musselshell	99	75	89
Bair Res	Smith-Judith-Musselshell	79	62	70
Swift Res	Sun-Teton-Marias	71	68	61
Lake Frances	Sun-Teton-Marias	46	37	58
Lake Elwell (Tiber)	Sun-Teton-Marias	53	52	55
Gibson Res	Sun-Teton-Marias	42	26	62
Mystic Lake	Upper Yellowstone	2	1	1
Cooney Res	Upper Yellowstone	100	95	83
Ruby River Reservoir	Jefferson	97	85	97
Lima Reservoir	Jefferson	91	43	74
Clark Canyon Res	Jefferson	68	47	54
Painted Rocks Lake	Bitterroot	-	39	68
Lake Como	Bitterroot	71	42	62
Bull Lake	Bighorn	51	51	55
Buffalo Bill	Bighorn	72	63	61
Boysen	Bighorn	88	78	85
Bighorn Lake	Bighorn	58	57	57
Lake Helena	Upper Missouri	87	86	87
Holter Lake	Upper Missouri	100	99	99
Helena Valley Reservoir	Upper Missouri	95	96	95
Canyon Ferry Lake	Upper Missouri	80	65	72
Lake Koocanusa	Kootenai	71	61	52
Hungry Horse Lake	Flathead	87	71	72
Flathead Lake	Flathead	60	51	57
Nelson Res	Milk	90	57	75
Fresno Res	Milk	35	70	68
Noxon Rapids Reservoir	Lower Clark Fork	96	89	95
Fort Peck Lake	Lower Missouri	77	67	74
Nevada Creek Res	Upper Clark Fork	-	77	83
Georgetown Lake	Upper Clark Fork	95	90	92
Tongue River Res	Tongue	87	81	61
Lake Sherburne	St. Mary	54	39	32
Hebgen Lake	Madison	88	70	75
Ennis Lake	Madison	88	82	80
Middle Creek Res	Gallatin	68	58	65

Statewide Overview

Streamflow

Streamflow was near normal across most of Montana during April. A handful of gauges recorded above normal or below normal flows for the month, with a couple gauges reading much below normal streamflow. Lower elevation snowpacks experienced widespread melting in April; however, the snowmelt didn't produce enough runoff to increase monthly streamflows to above normal in most places.



Statewide Overview

Water Supply Forecasts

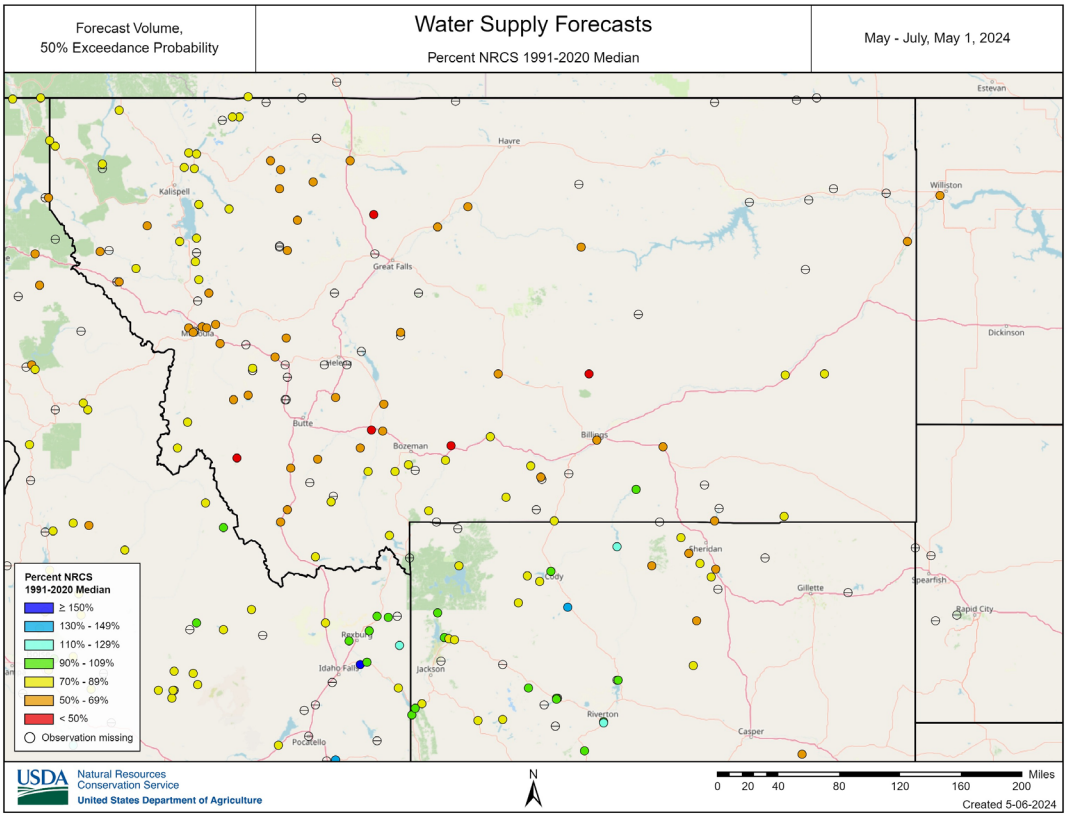
Above normal temperatures and a lack of sufficient precipitation during April led to decreases in the water supply forecasts for many locations. Several SNOTELs and snow courses have already, or are close to melting out, which is up to two weeks early in some cases. Additionally, peak snow water equivalent was significantly below normal for a majority of sites. Water year precipitation and the snowpack are the primary predictors for water supply forecasts, as a result the current 50% exceedance forecasts for most of Montana are well below normal.

The lowest May 1 water supply forecasts are the Shields, Teton, Jefferson, Beaverhead, and Musselshell Rivers which are forecasted to be 35-50% of normal for May-July. The 50% exceedance forecasts for the Smith, Missouri, Blackfoot, Bighole, Clark Fork, and Jefferson are 50-60% of normal. For the Flathead, Clark Fork, Blackfoot, Sun, Missouri, and Yellowstone River basins the entire range of exceedance streamflow forecasts falls below the median May-Jul volume for most streams.

Snowpack is below normal in all subbasins in the Upper Yellowstone, and water year precipitation is generally below normal to normal. Some SNOTEL stations have melted out early. Other stations might continue on to a more typical melt-out date due to anticipated colder and wetter weather patterns across the region. In the Upper Yellowstone, 50% exceedance forecasts are around 70-80% of normal.

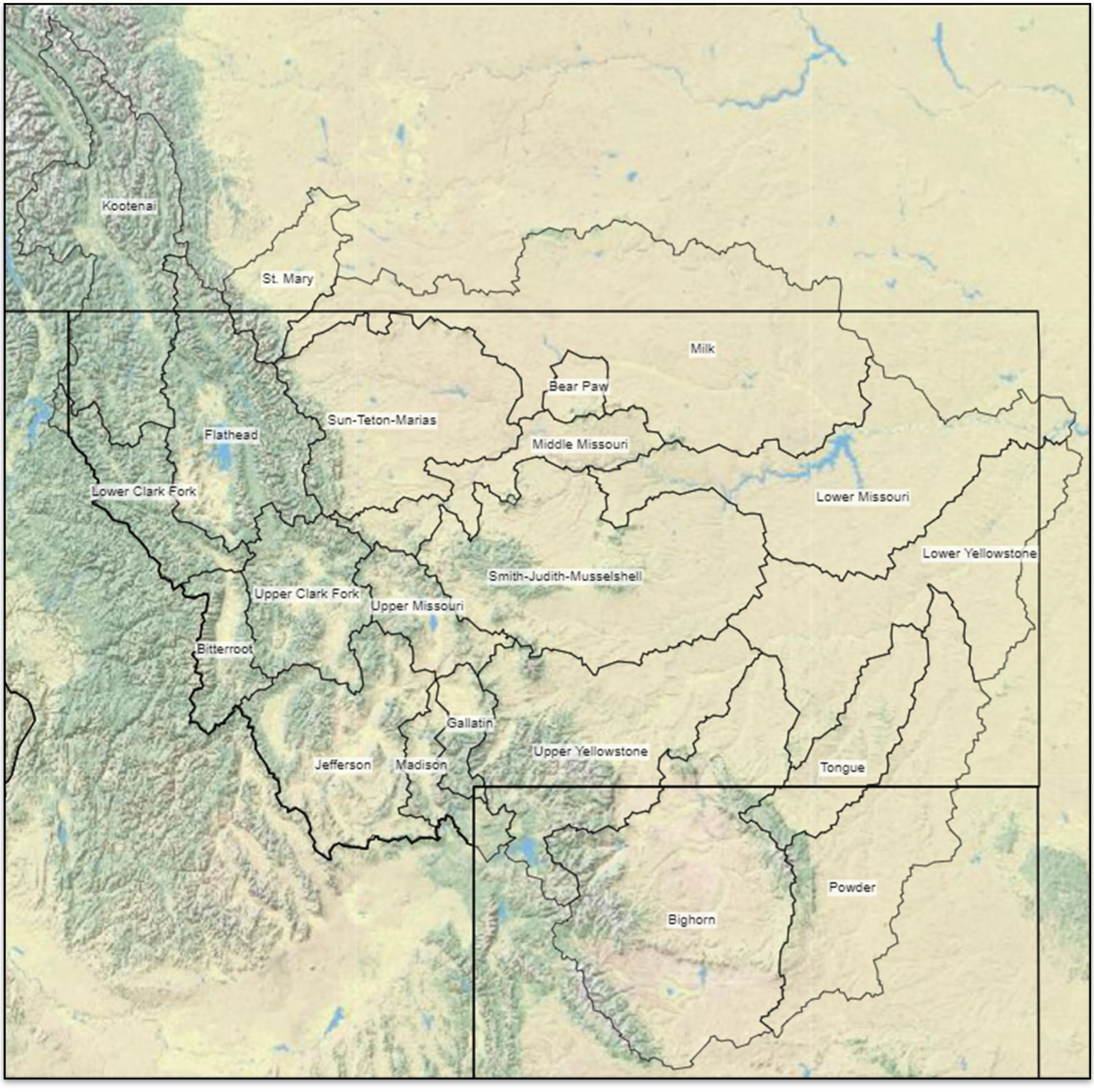
In the Wind River Range and southern Absaroka Mountains precipitation has been normal to above-normal, and many SNOTEL sites are following their normal melt-out patterns. In those locations water supply forecasts are 90-110% of normal. 50% exceedance forecasts for streams originating from the Bighorn and the northern Absaroka Mountains are below normal due to lower-than-normal snowpack and precipitation. The Tongue and Powder basins have below normal forecasts, also tracking with a below normal snowpack.

Significant precipitation is forecasted for Montana and northern Wyoming during the week of May 6, which will add to the snowpack and improve streamflow conditions ahead, however it likely won't be enough to compensate for the lack of precipitation earlier this season. Many rivers and streams will still likely see below normal runoff volumes this season, however with additional precipitation in the coming weeks runoff might end of up closer to the 30% exceedance forecasts. If weather remains active and precipitation is well above normal in the coming weeks then runoff could be greater than the 30% exceedance forecasts. Keep in mind that the 30% exceedance forecasts for May 1 are still only about 65-75% of normal on the Rocky Mountain Front, part of the Flathead, the entire Clark Fork, Blackfoot, and Bitterroot River basins.



Basin Overview

Montana River Basin Definitions

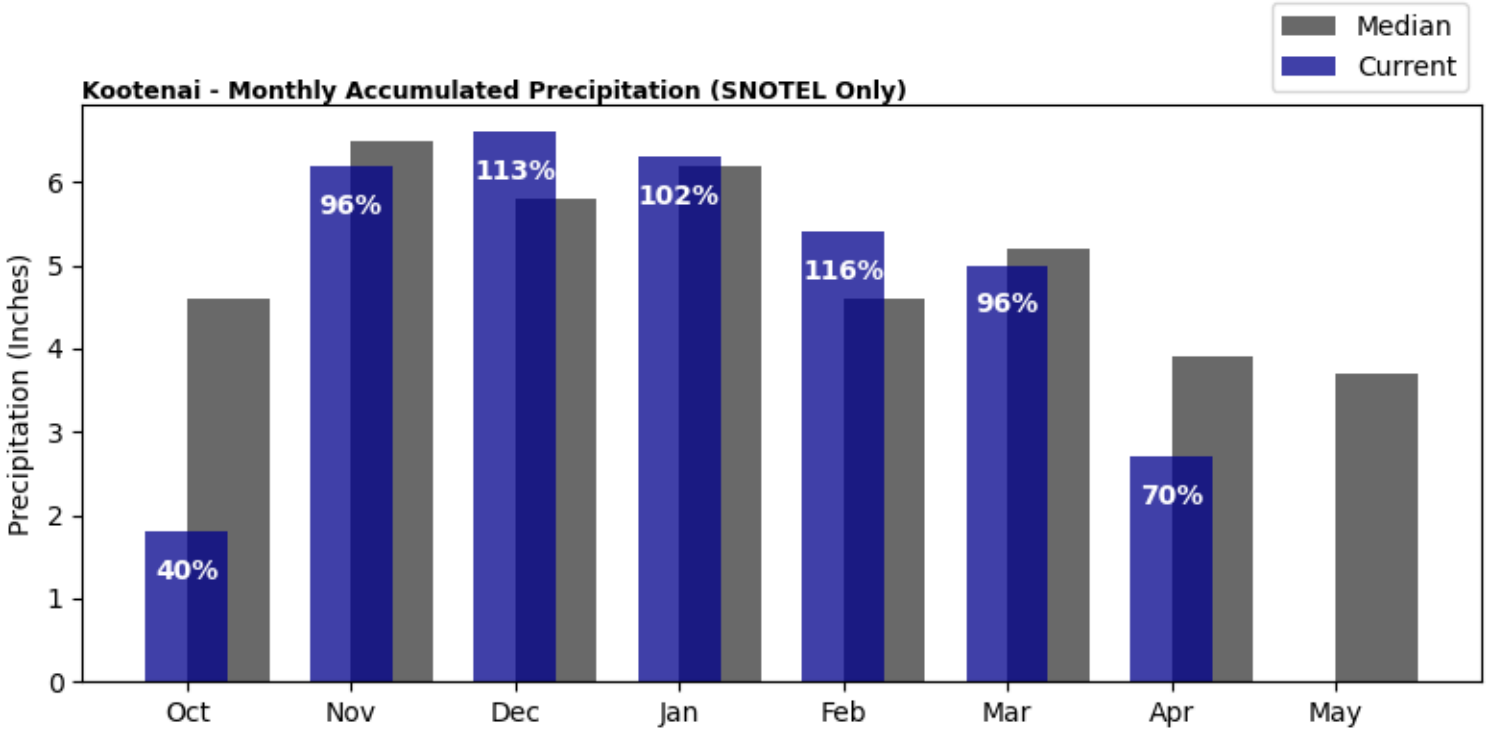


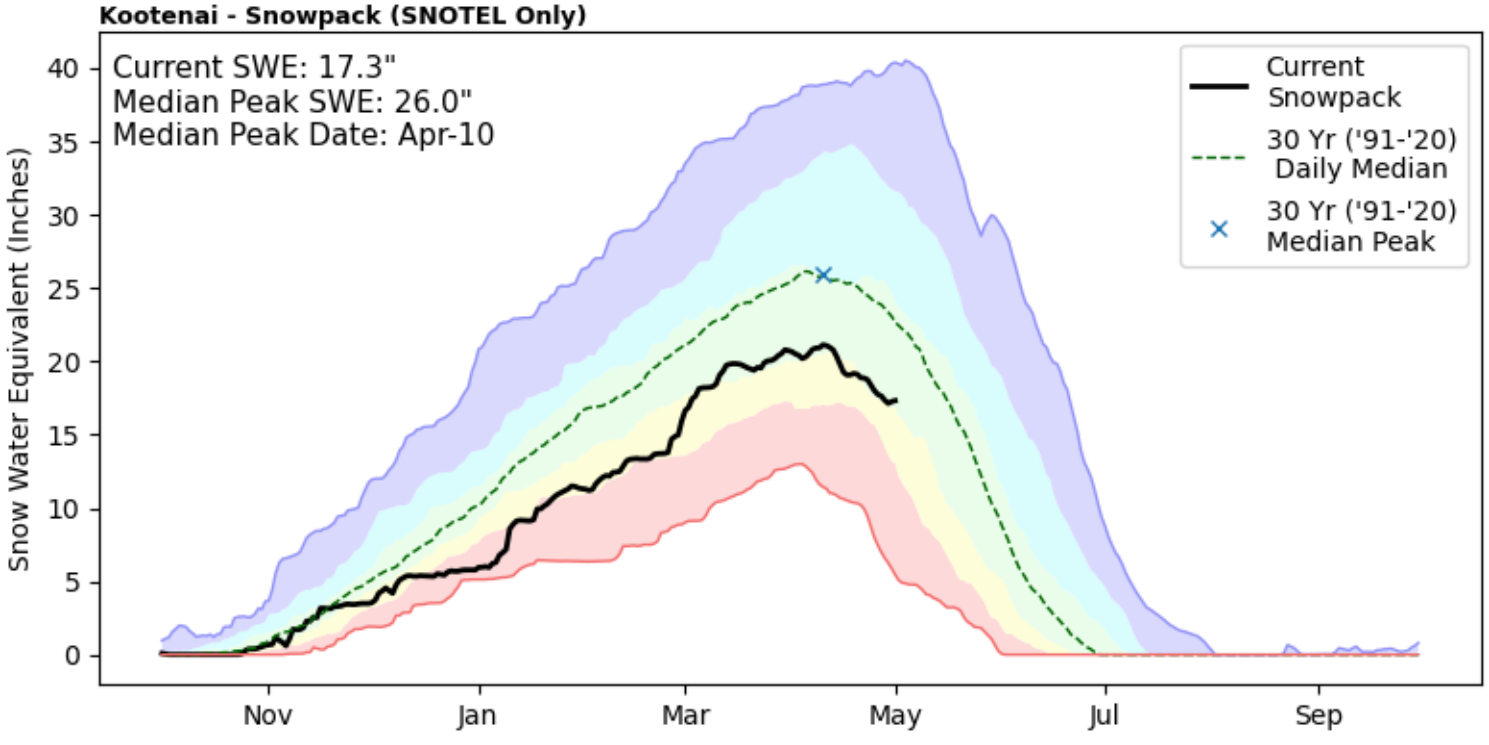
The following basin overview sections only include basins that have SNOTEL sites. For example, there is no basin overview for the Lower Yellowstone, because there are no SNOTEL sites associated with that basin. Water supply information for basins not included in the following sections can be found at https://nwcc-apps.sc.egov.usda.gov/

Basin Overview

Kootenai

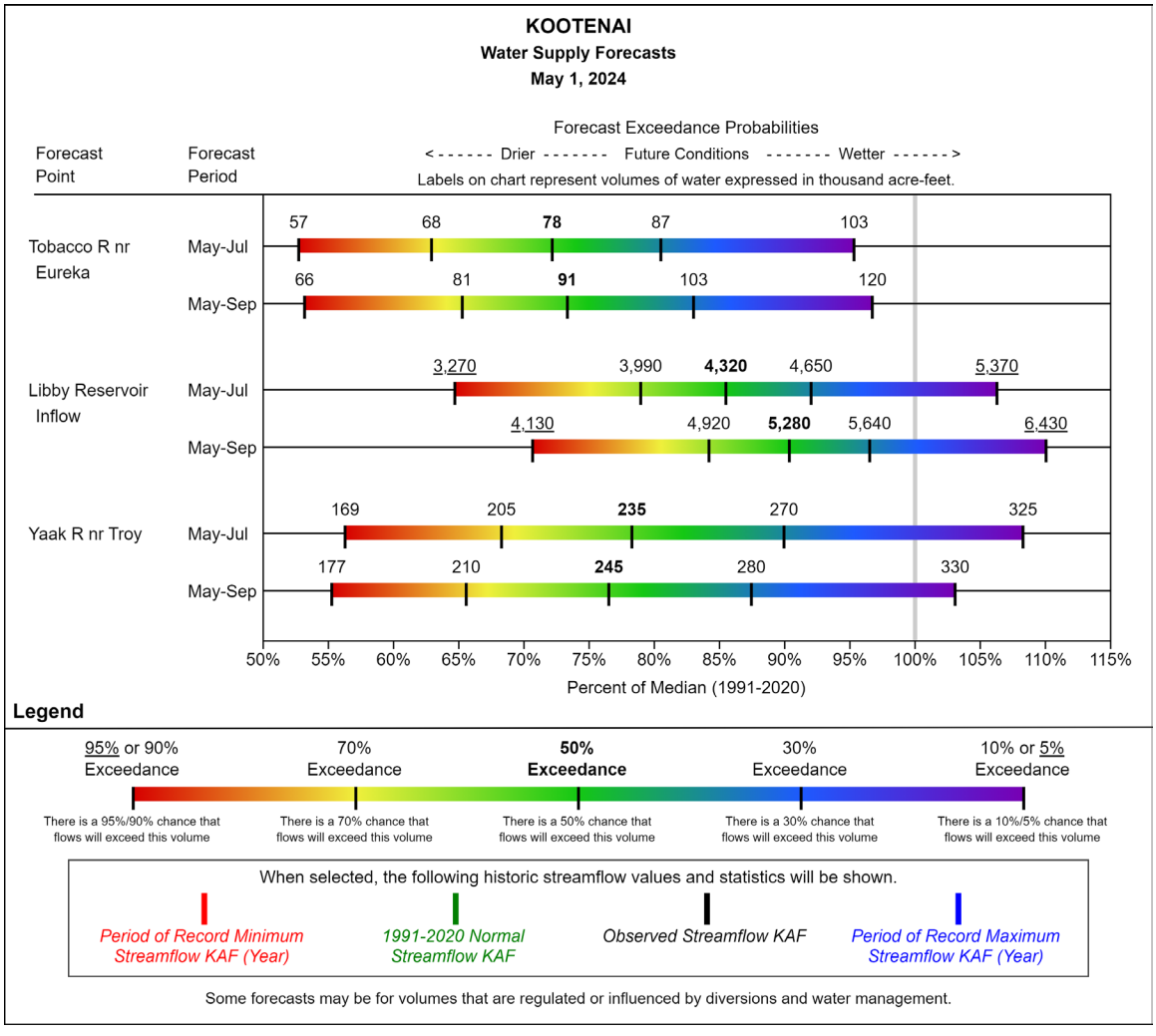
Precipitation in April was well below normal at 70%, which brings the seasonal accumulation (October-April) to 86% of median. The snowpack in the Kootenai is well below normal at 76% of median, compared to 81% at this time last year.





Basin Overview

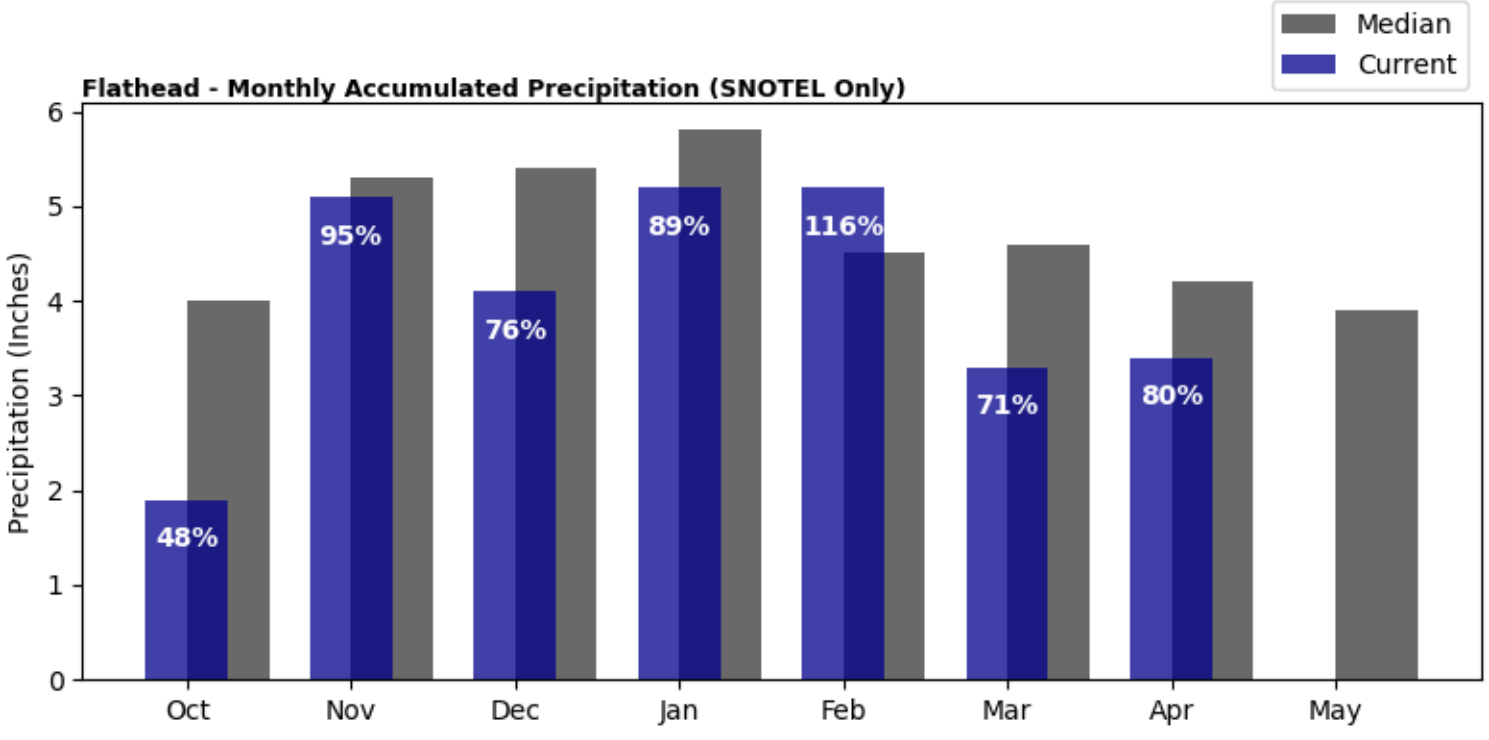
Kootenai (Continued)

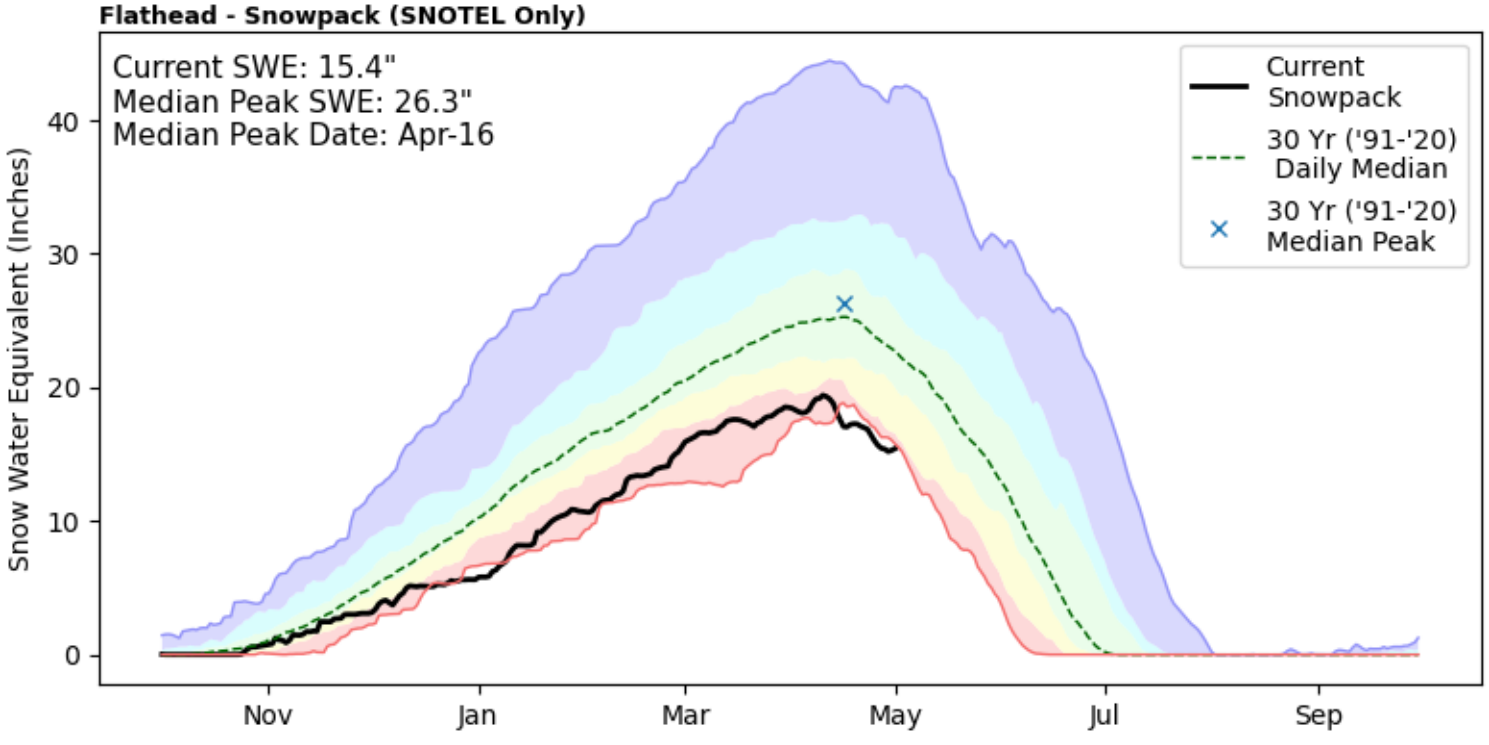


Basin Overview

Flathead

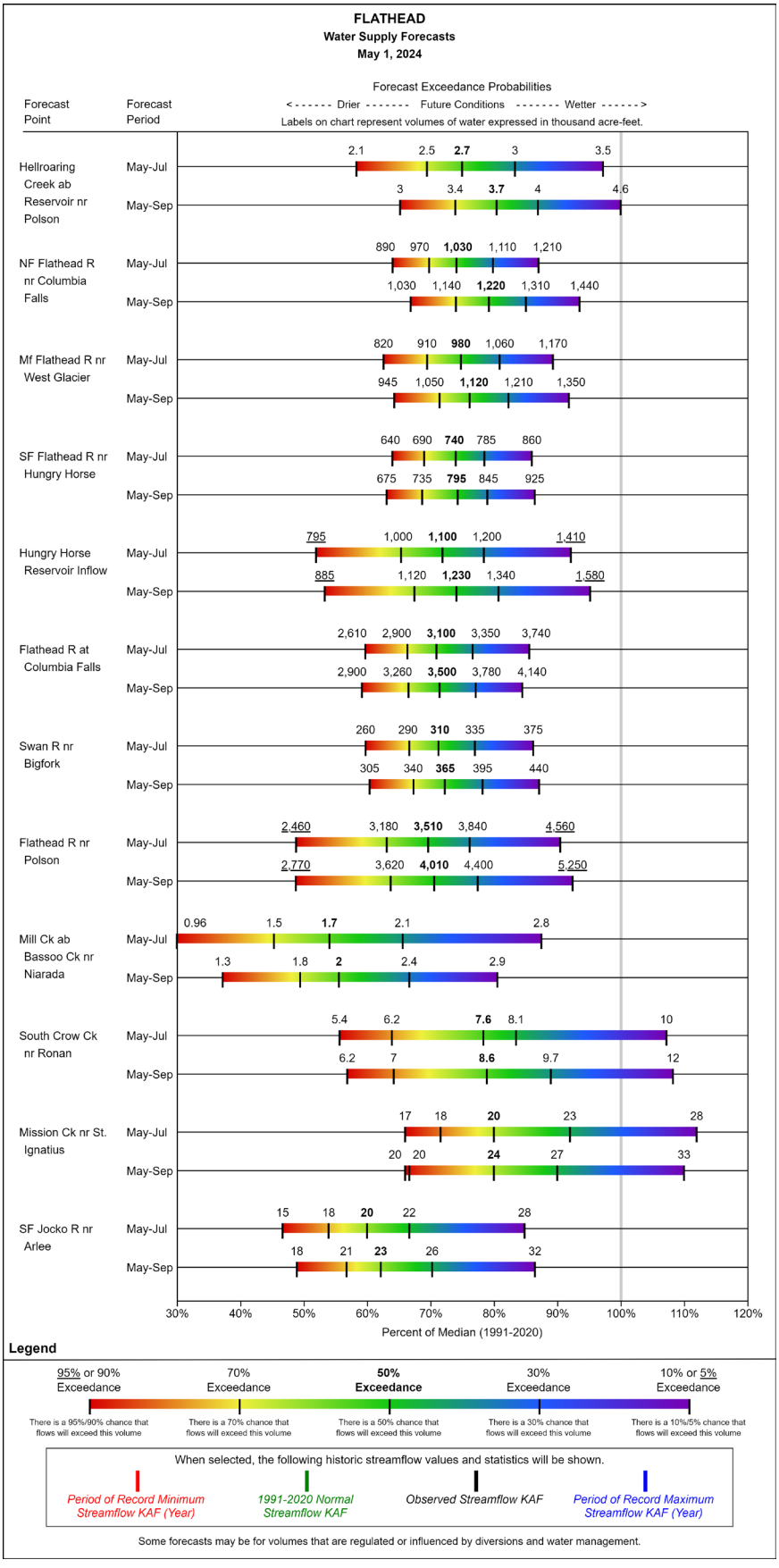
Precipitation in April was below normal at 80%, which brings the seasonal accumulation (October-April) to 81% of median. The snowpack in the Flathead is well below normal at 68% of median, compared to 88% at this time last year.





Basin Overview

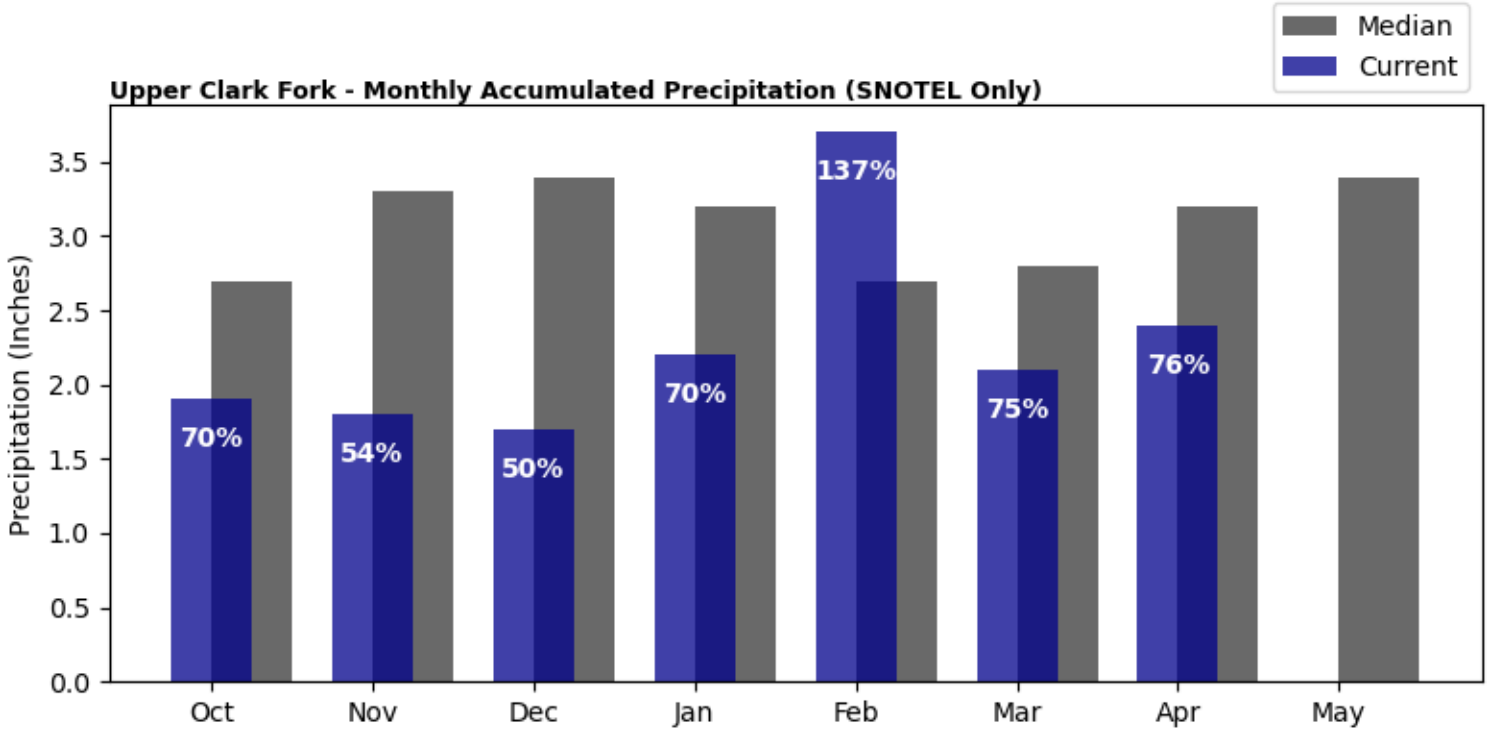
Flathead (Continued)

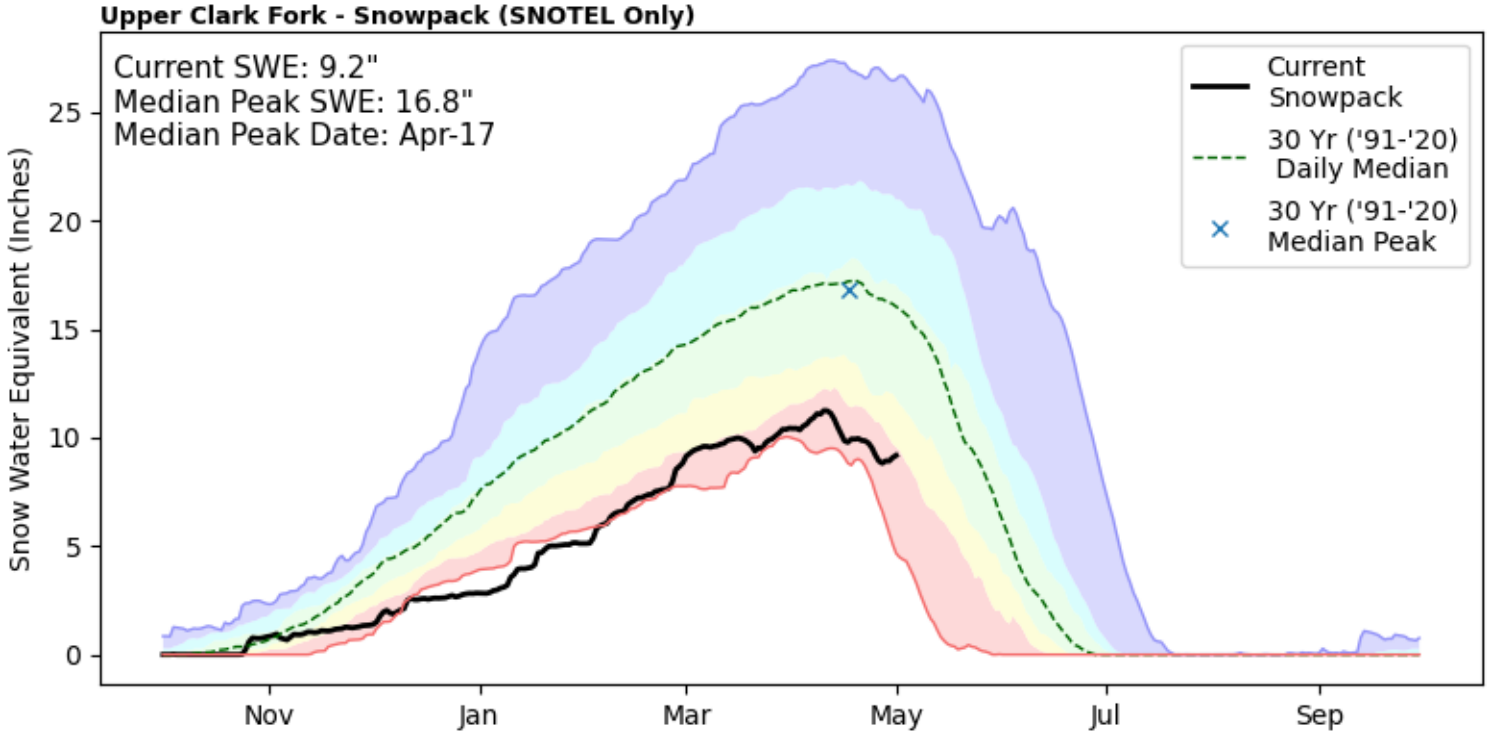


Basin Overview

Upper Clark Fork

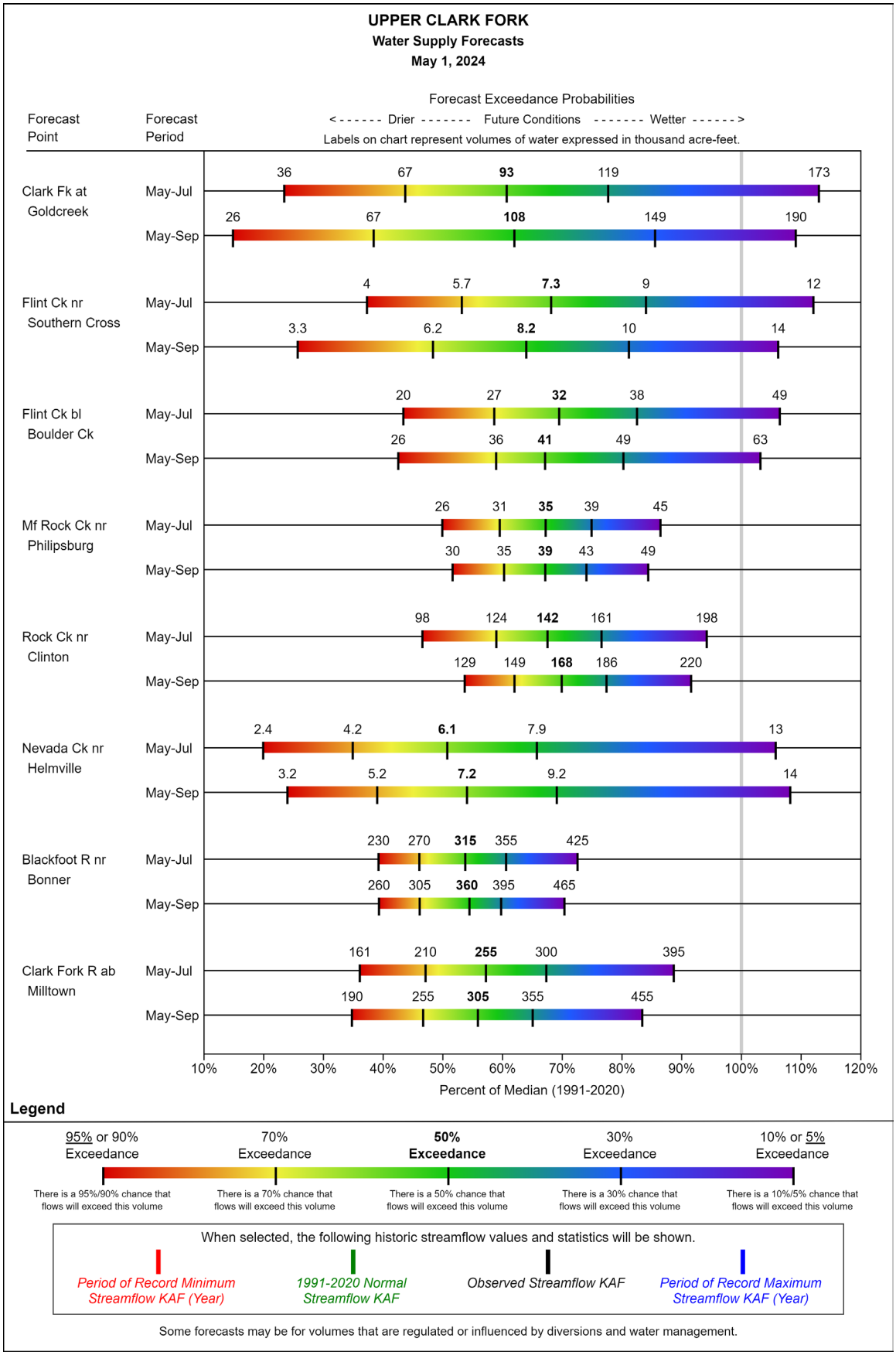
Precipitation in April was well below normal at 76%, which brings the seasonal accumulation (October-April) to 73% of median. The snowpack in the Upper Clark Fork is well below normal at 56% of median, compared to 123% at this time last year.





Basin Overview

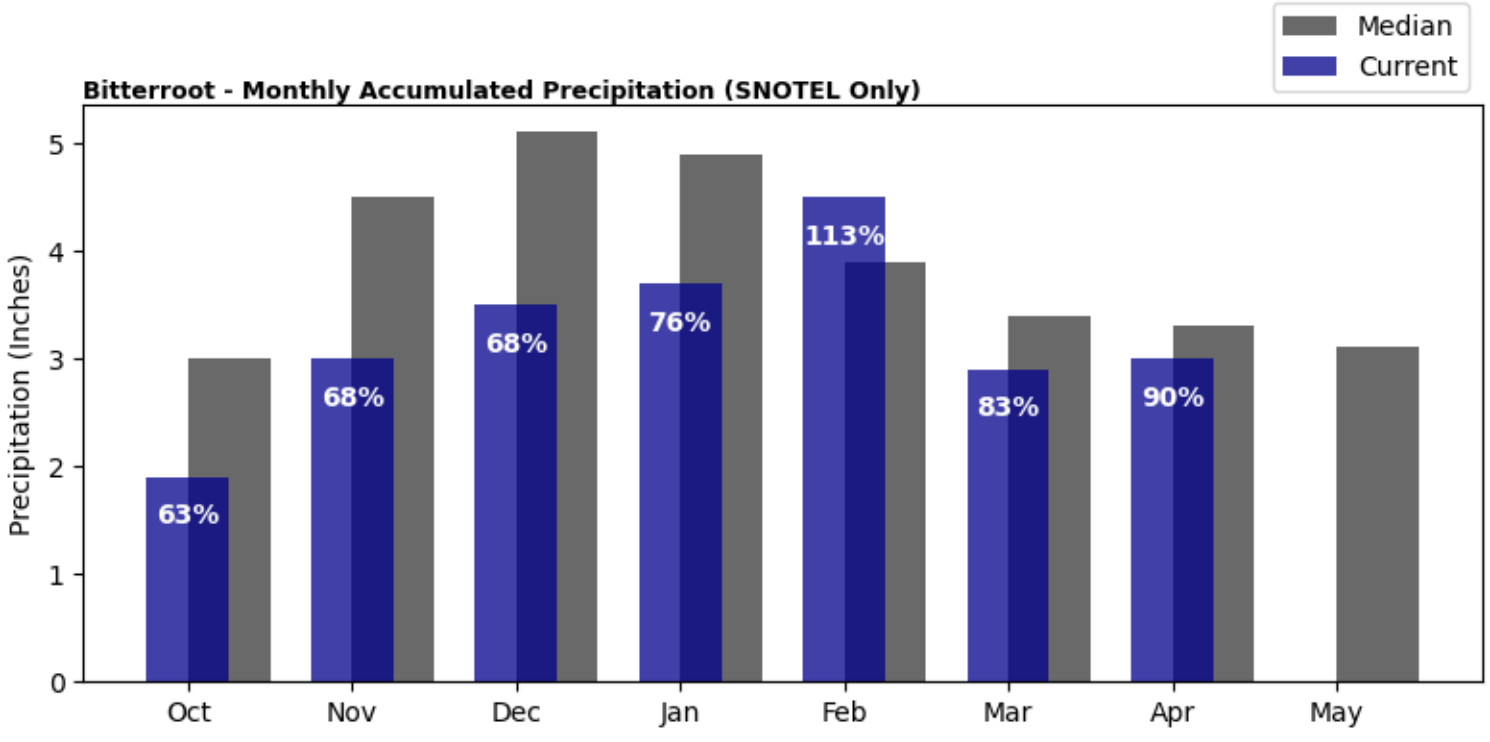
Upper Clark Fork (Continued)

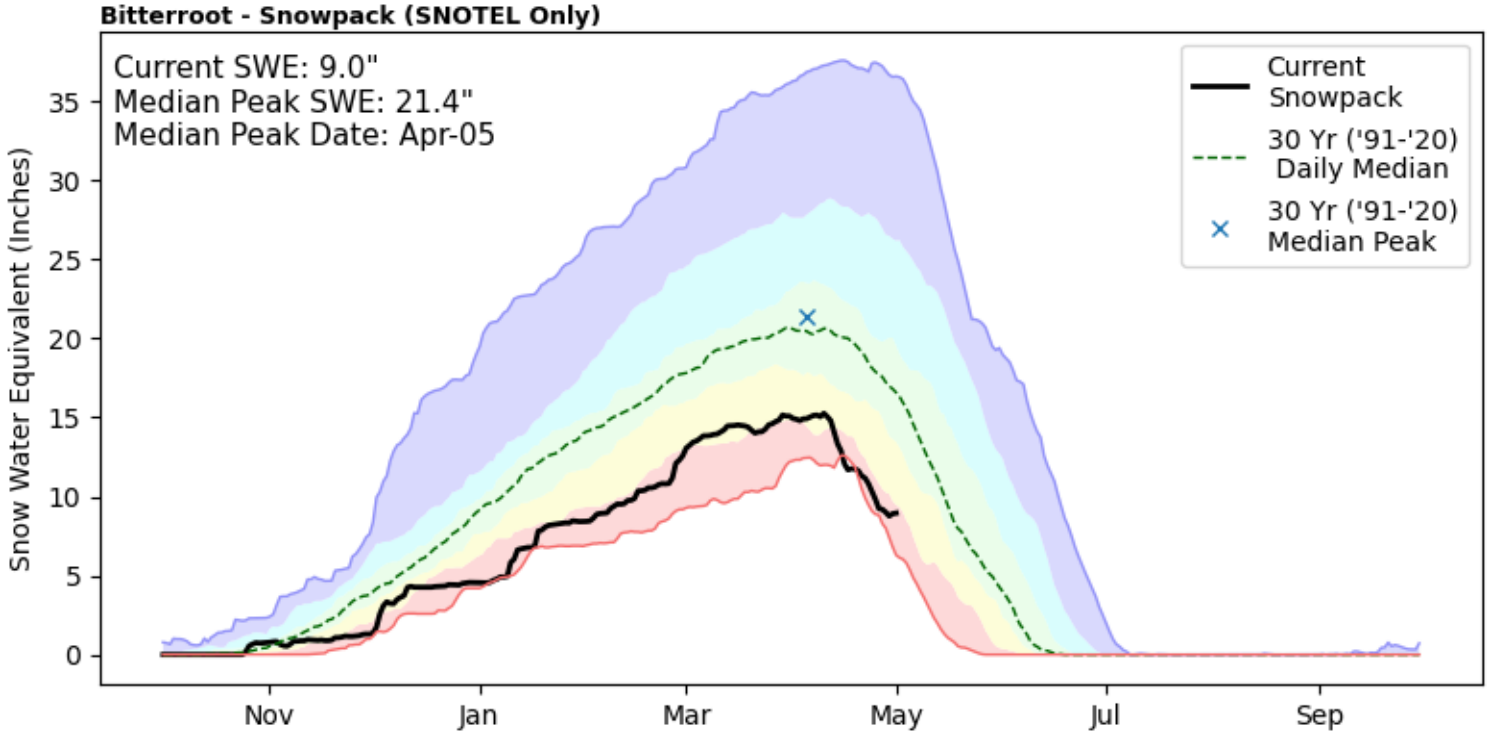


Basin Overview

Bitterroot

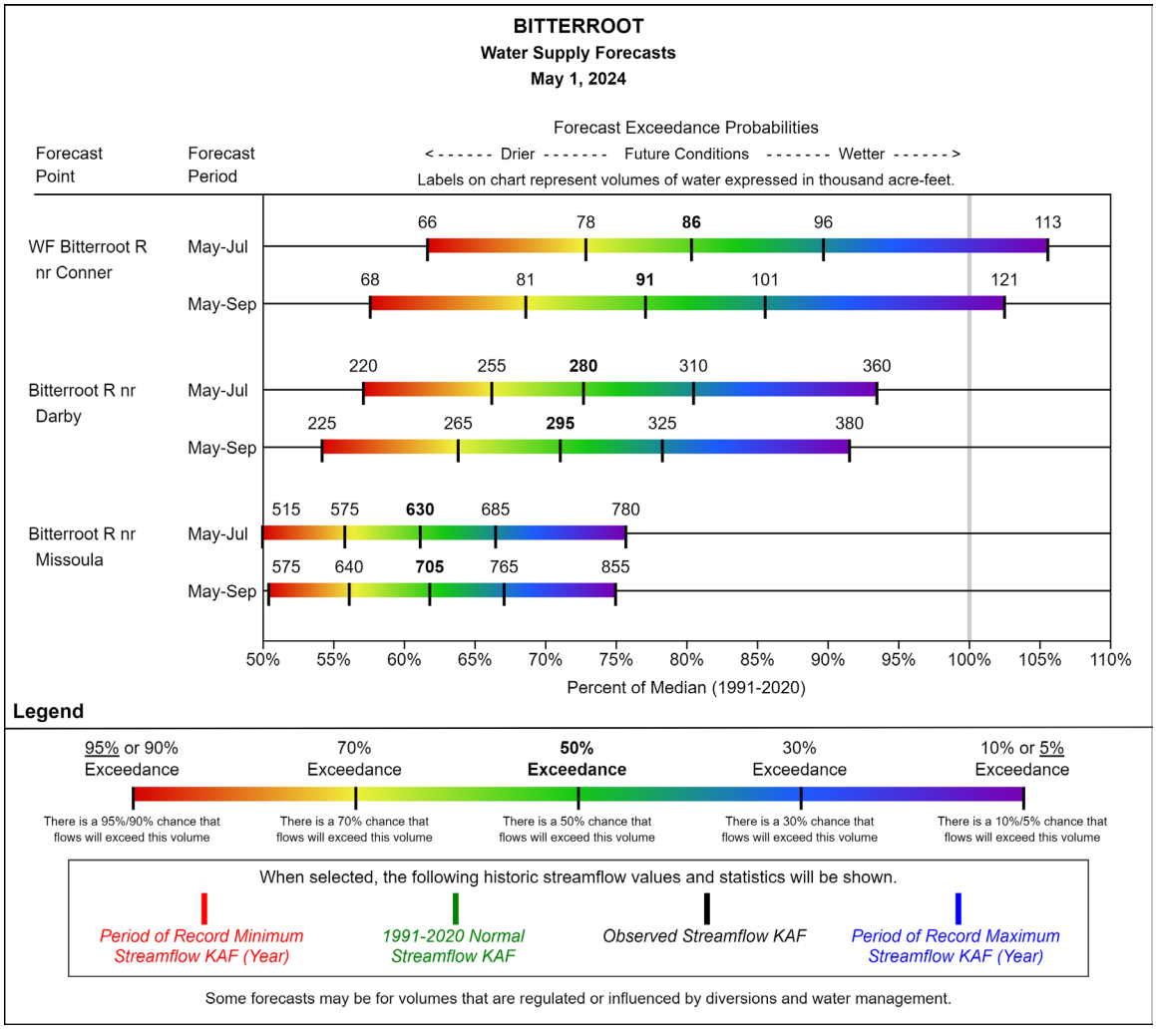
Precipitation in April was below normal at 90%, which brings the seasonal accumulation (October-April) to 77% of median. The snowpack in the Bitterroot is well below normal at 54% of median, compared to 103% at this time last year.





Basin Overview

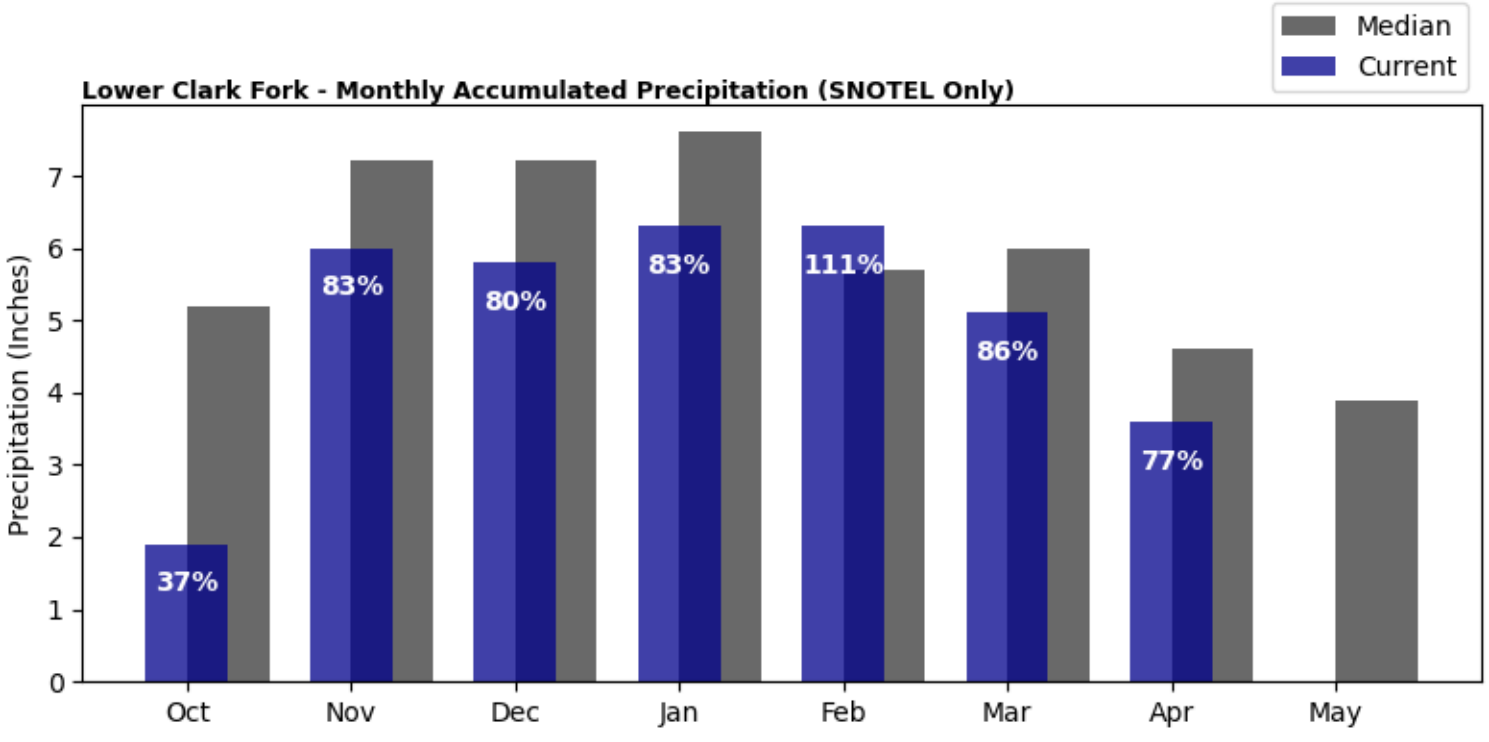
Bitterroot (Continued)

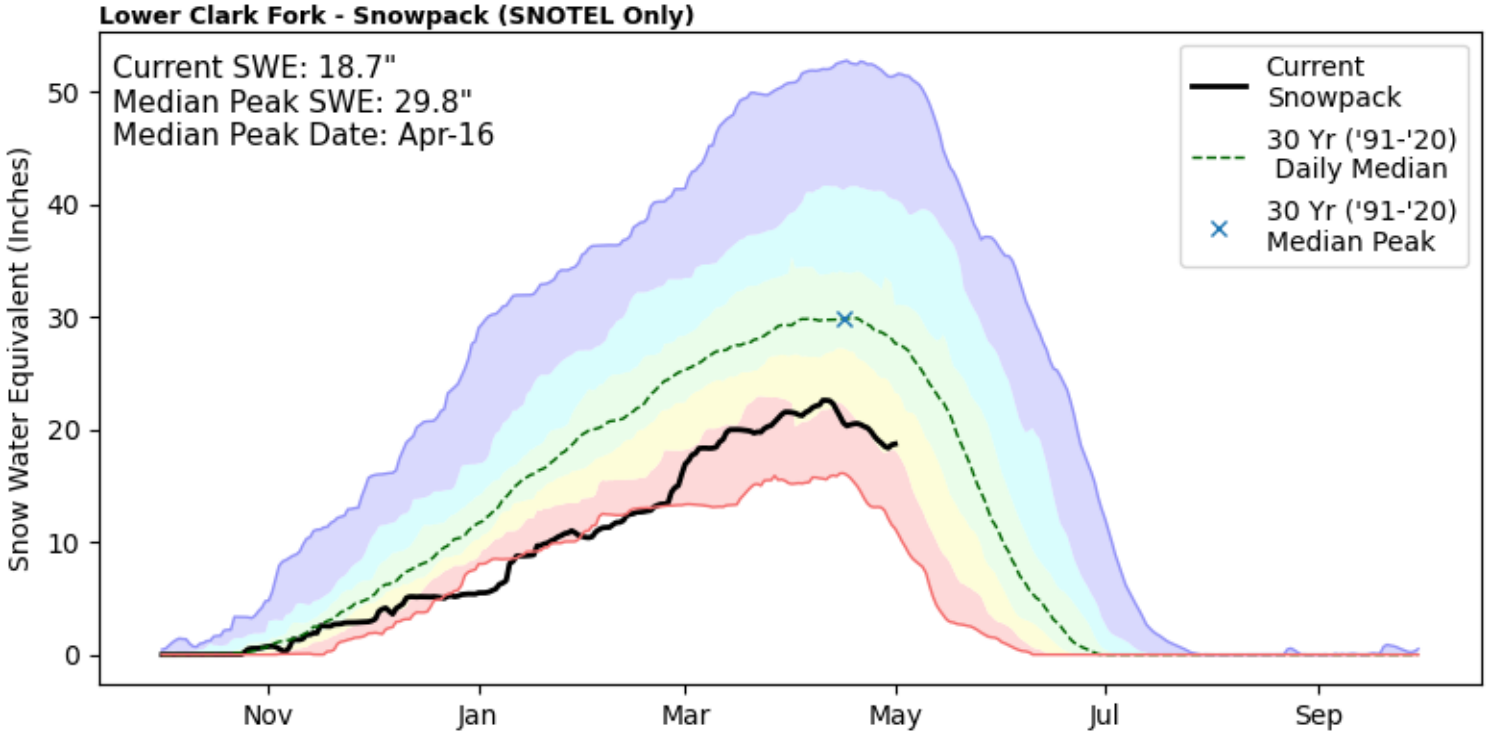


Basin Overview

Lower Clark Fork

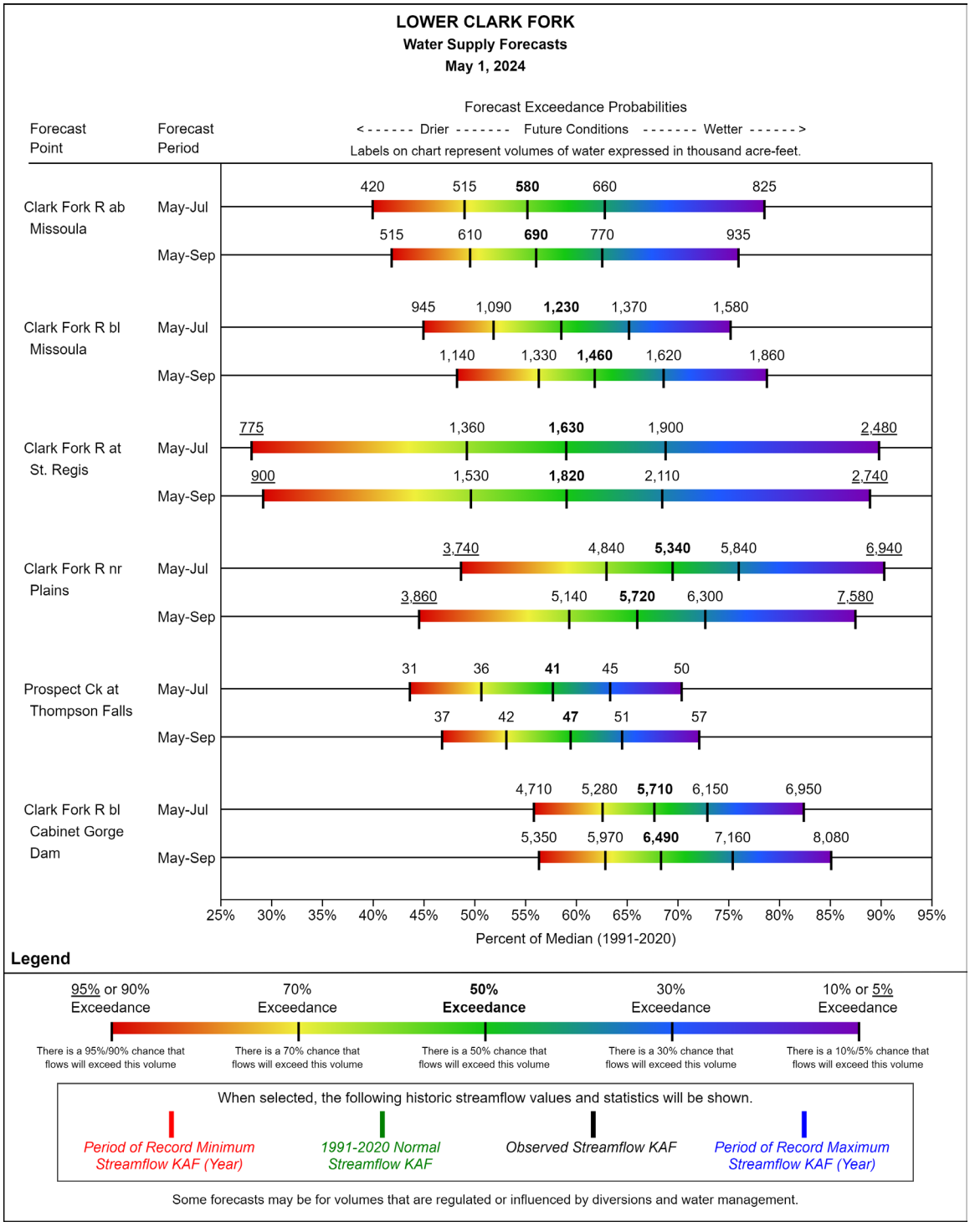
Precipitation in April was well below normal at 77%, which brings the seasonal accumulation (October-April) to 76% of median. The snowpack in the Lower Clark Fork is well below normal at 68% of median, compared to 93% at this time last year.





Basin Overview

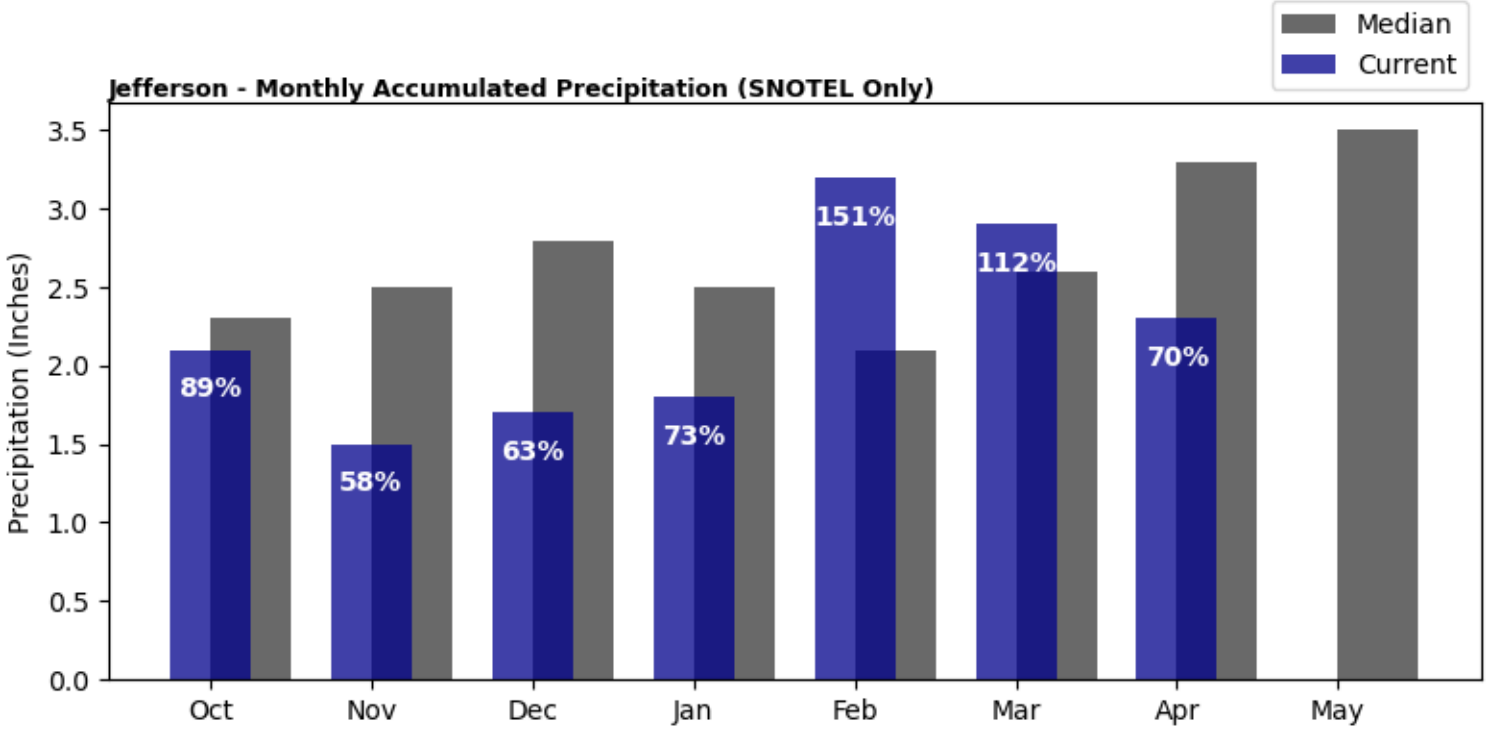
Lower Clark Fork (Continued)

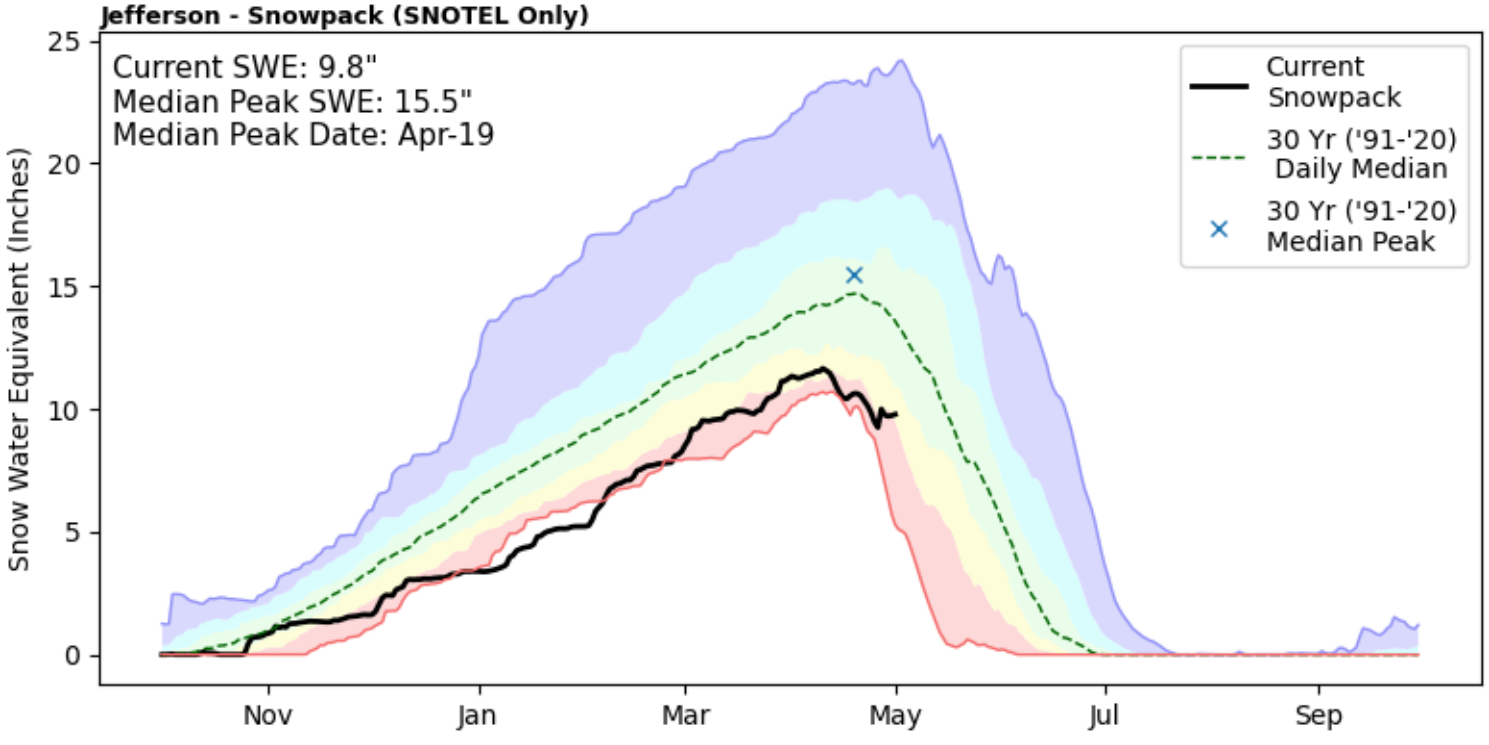


Basin Overview

Jefferson

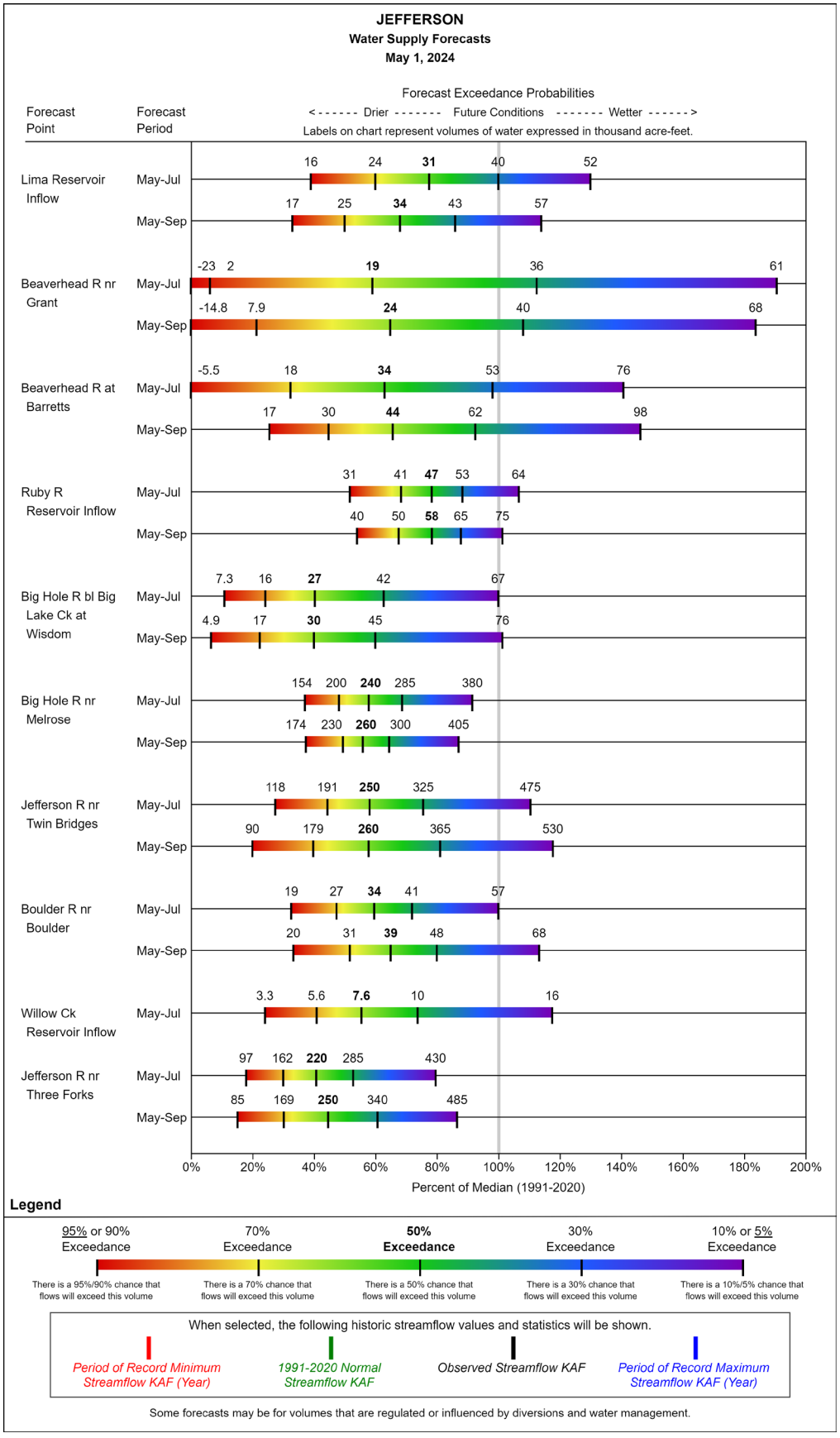
Precipitation in April was well below normal at 70%, which brings the seasonal accumulation (October-April) to 85% of median. The snowpack in the Jefferson is well below normal at 69% of median, compared to 127% at this time last year.





Basin Overview

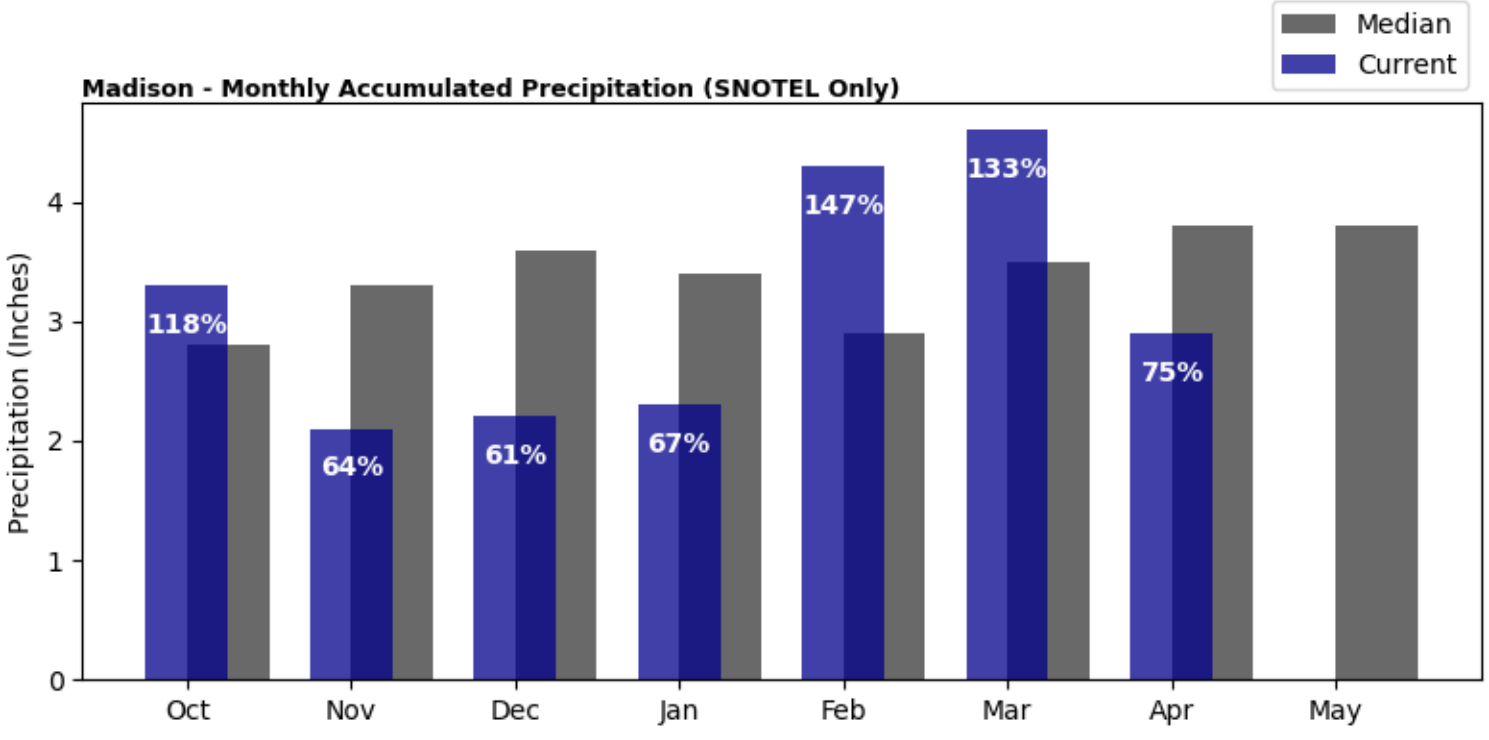
Jefferson (Continued)

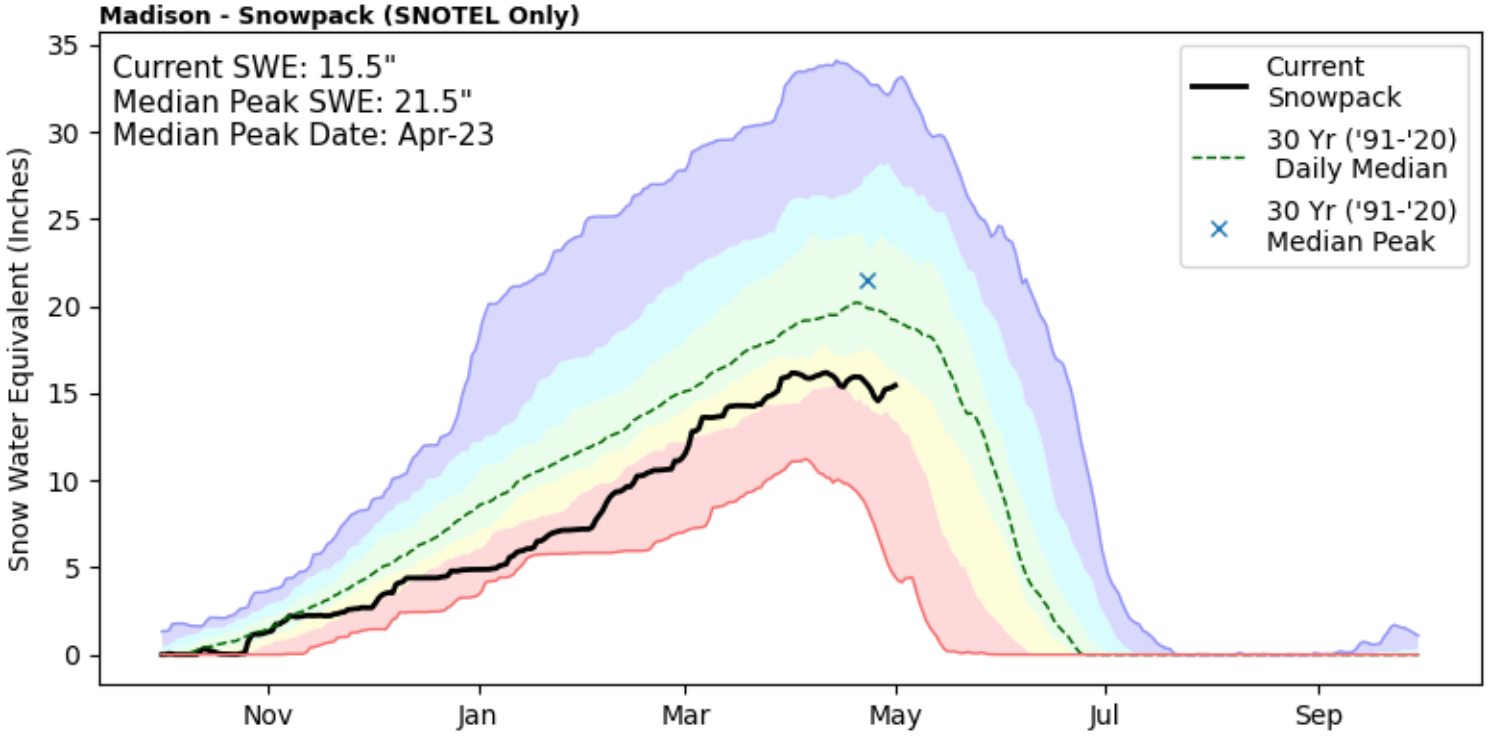


Basin Overview

Madison

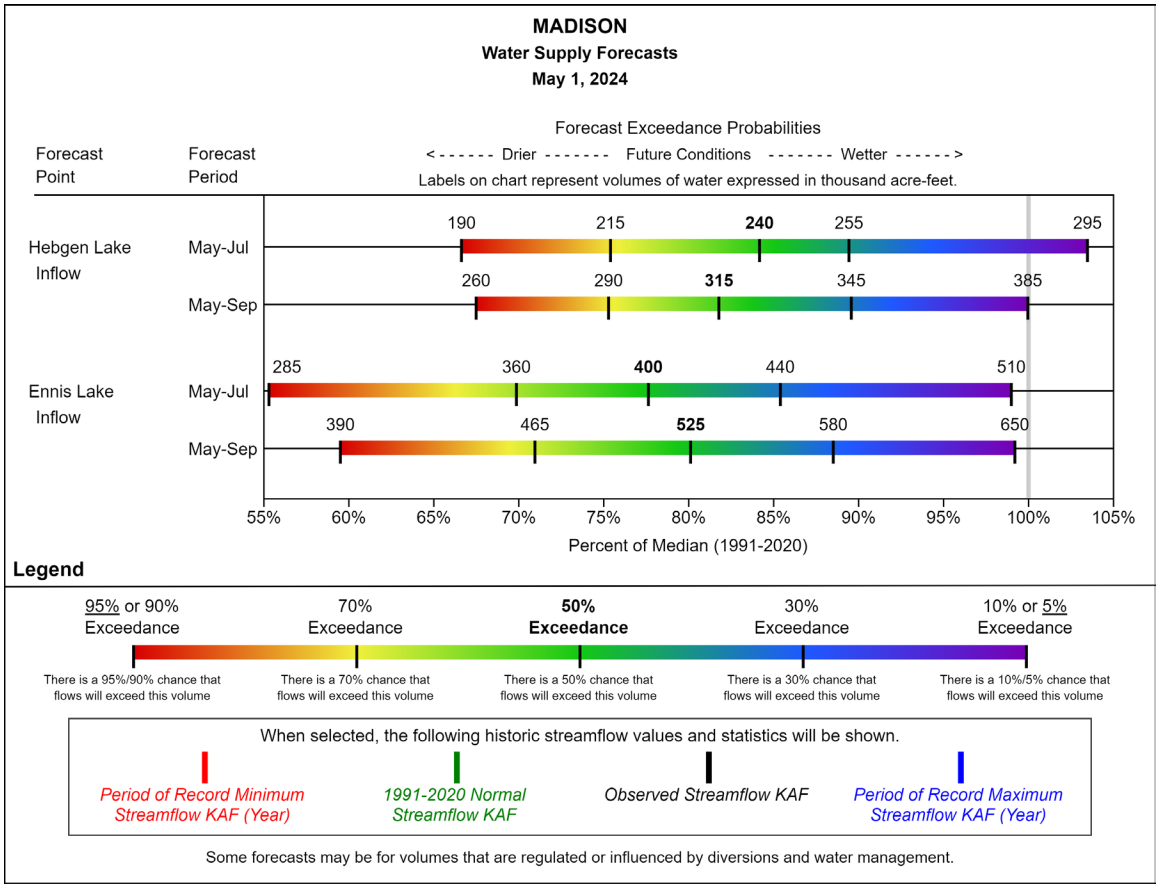
Precipitation in April was well below normal at 75%, which brings the seasonal accumulation (October-April) to 90% of median. The snowpack in the Madison is well below normal at 74% of median, compared to 135% at this time last year.





Basin Overview

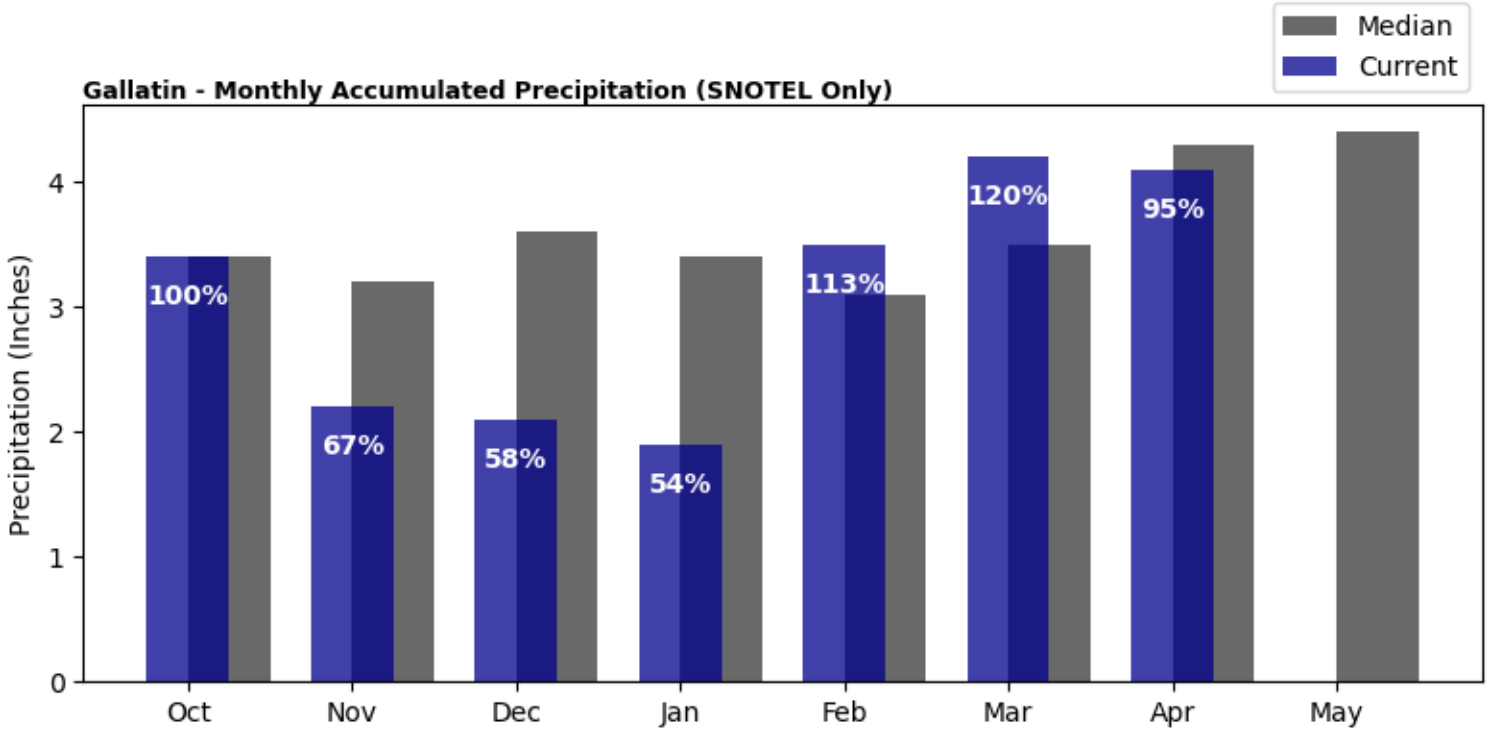
Madison (Continued)

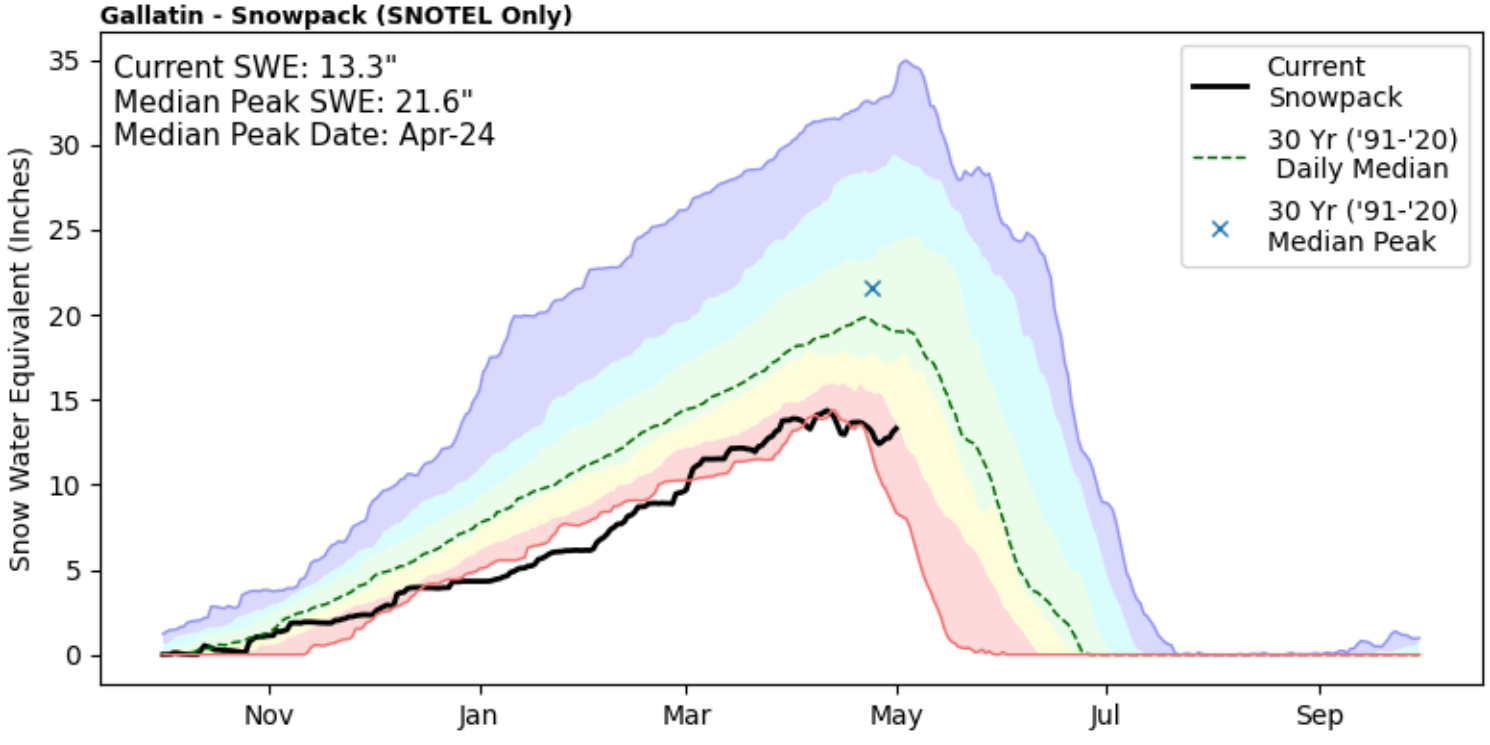


Basin Overview

Gallatin

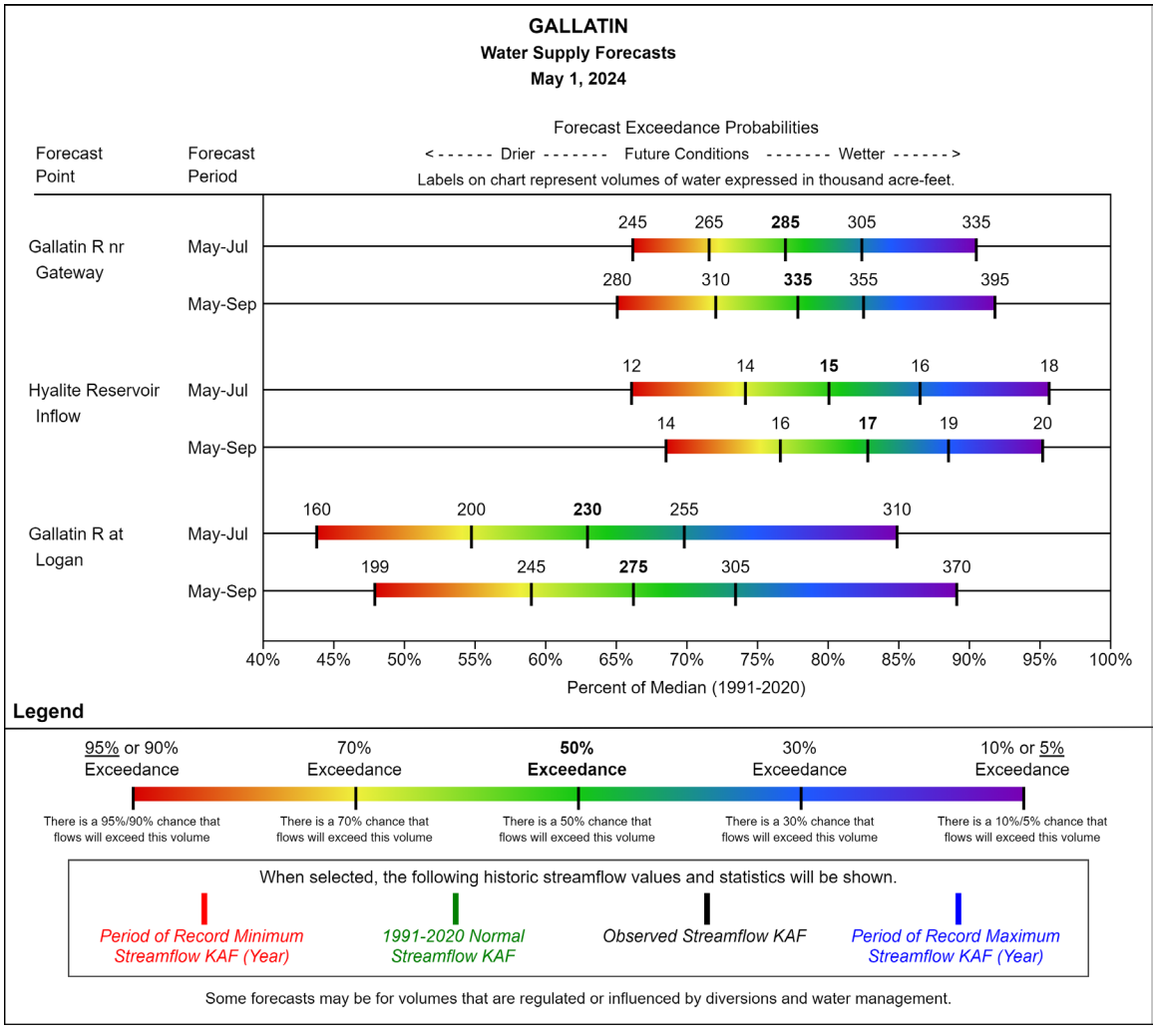
Precipitation in April was near normal at 95%, which brings the seasonal accumulation (October-April) to 83% of median. The snowpack in the Gallatin is well below normal at 66% of median, compared to 118% at this time last year.





Basin Overview

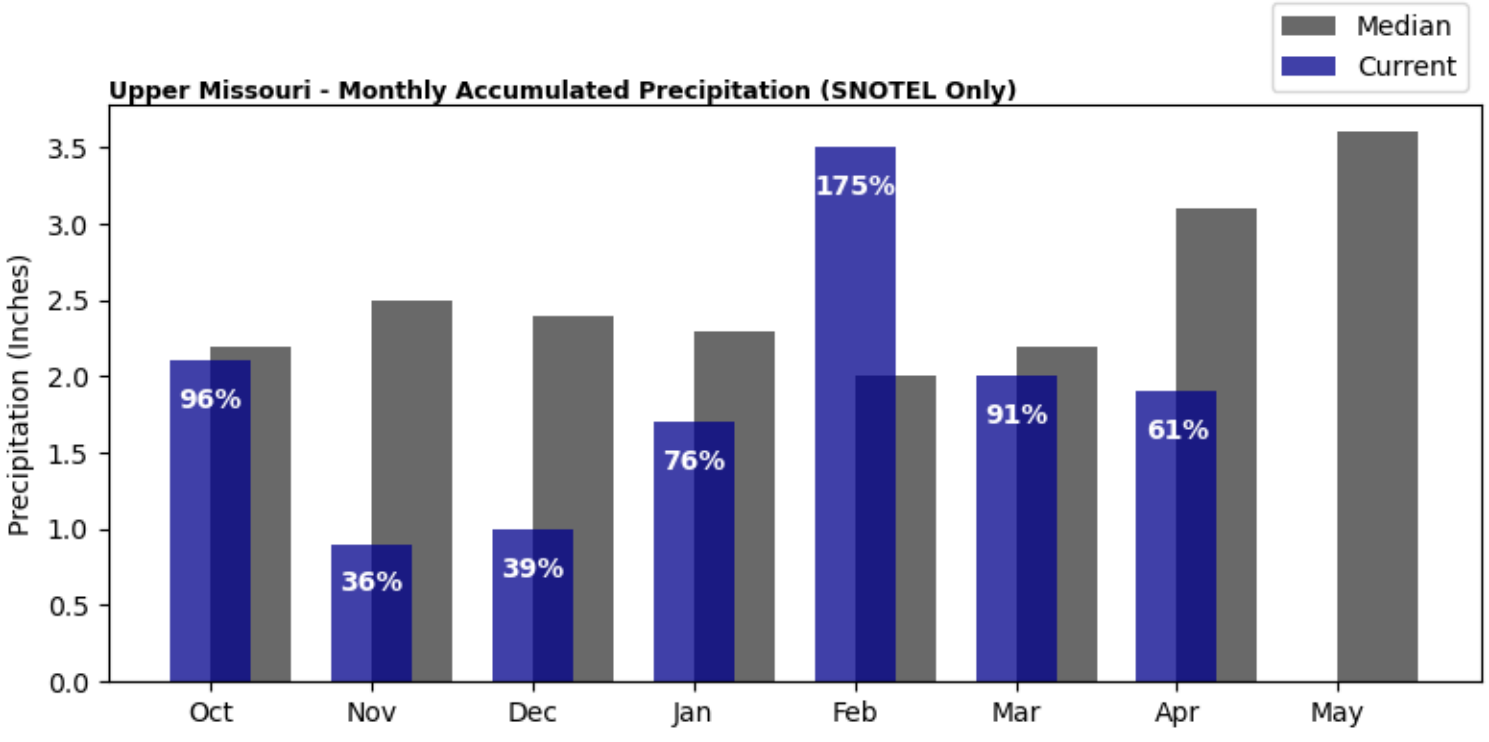
Gallatin (Continued)

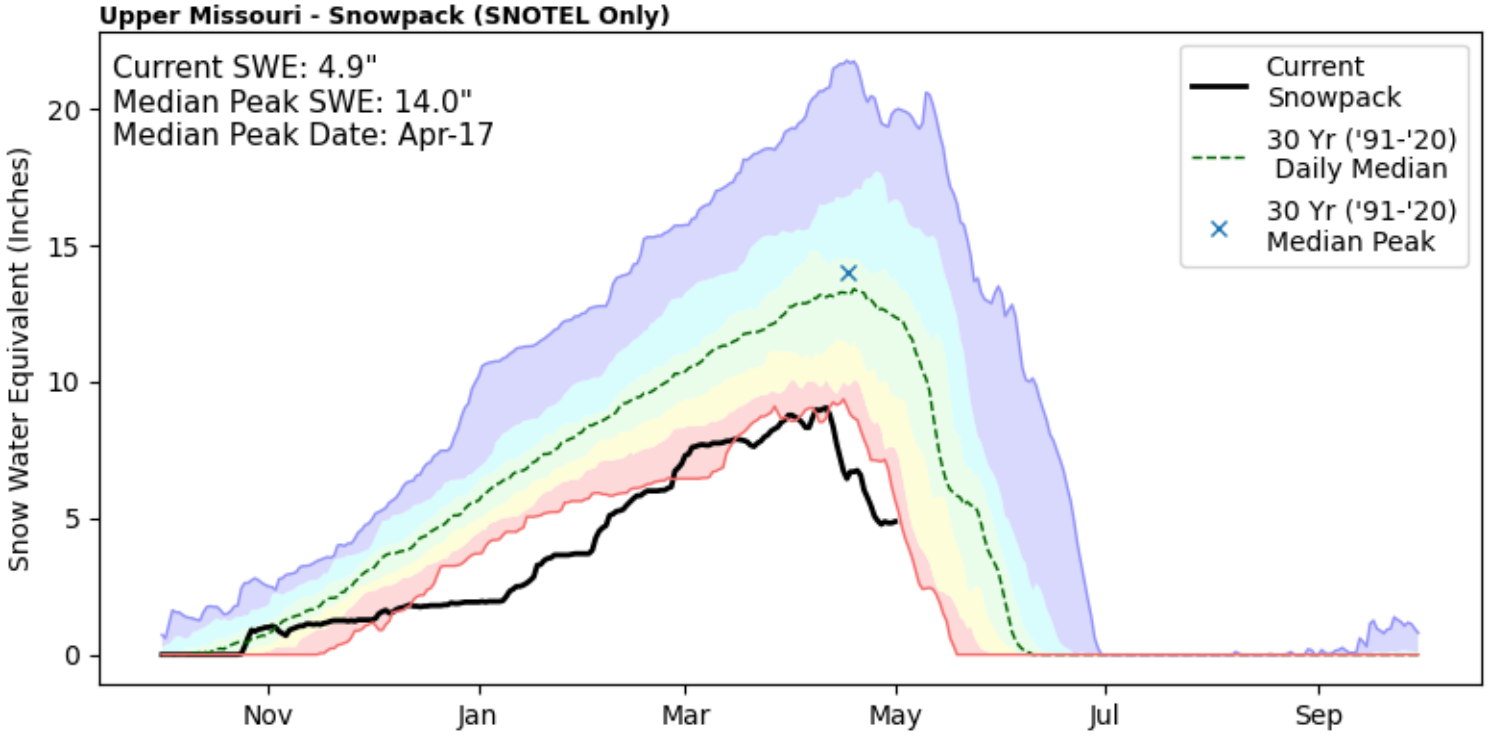


Basin Overview

Upper Missouri

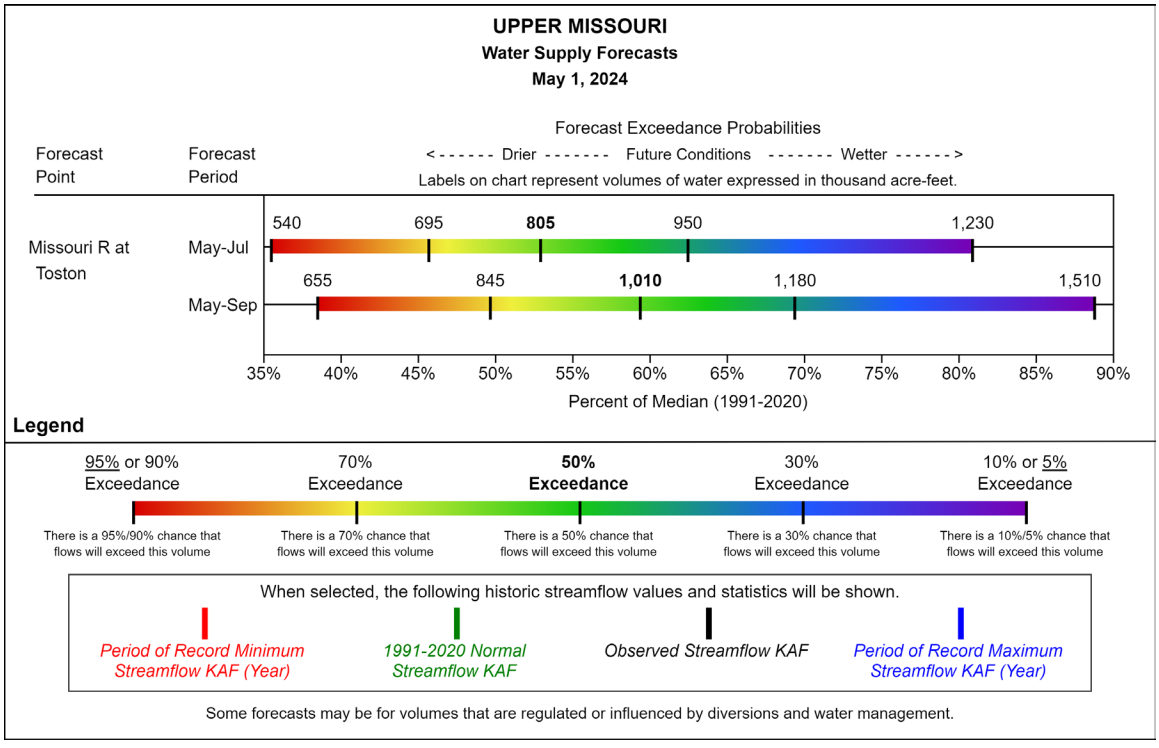
Precipitation in April was well below normal at 61%, which brings the seasonal accumulation (October-April) to 78% of median. The snowpack in the Upper Missouri is well below normal at 42% of median, compared to 155% at this time last year.





Basin Overview

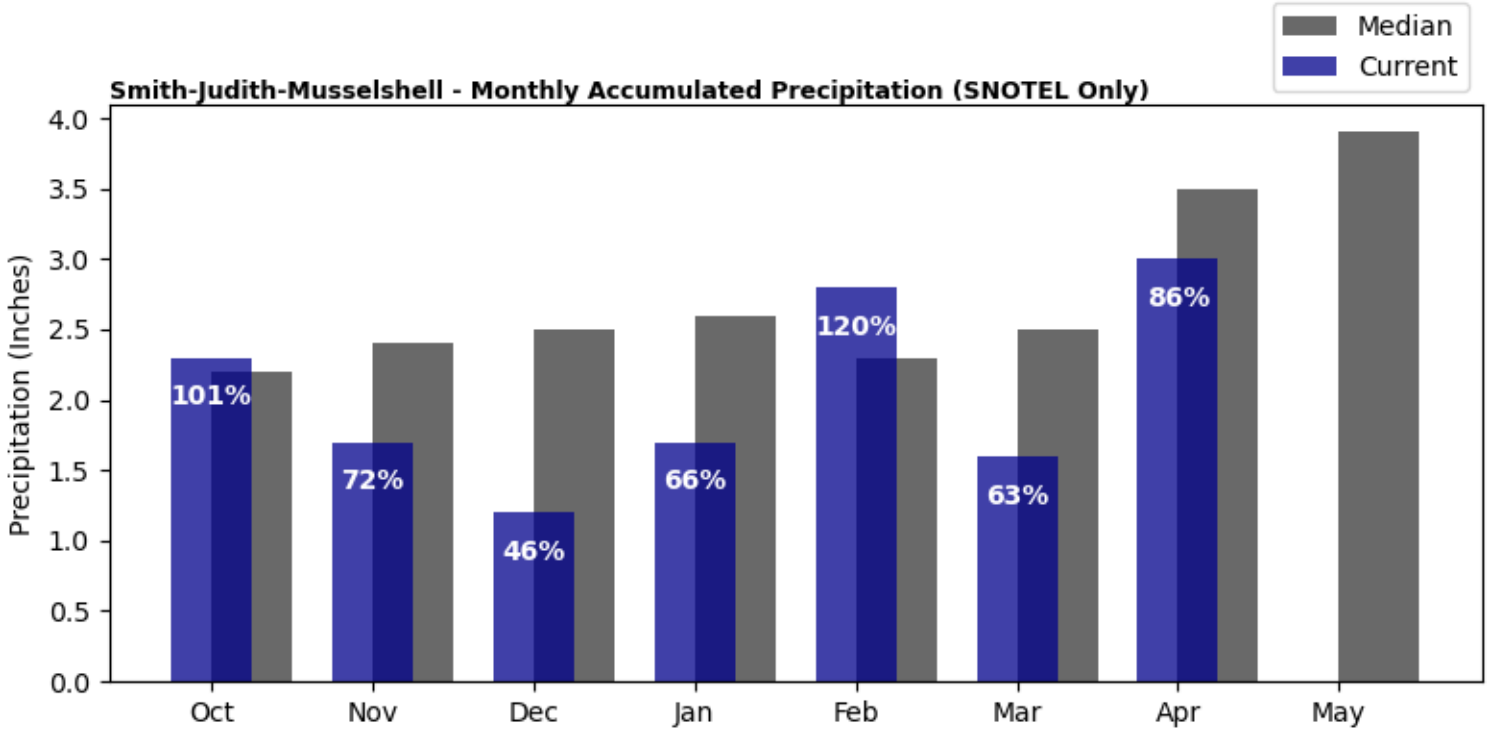
Upper Missouri (Continued)

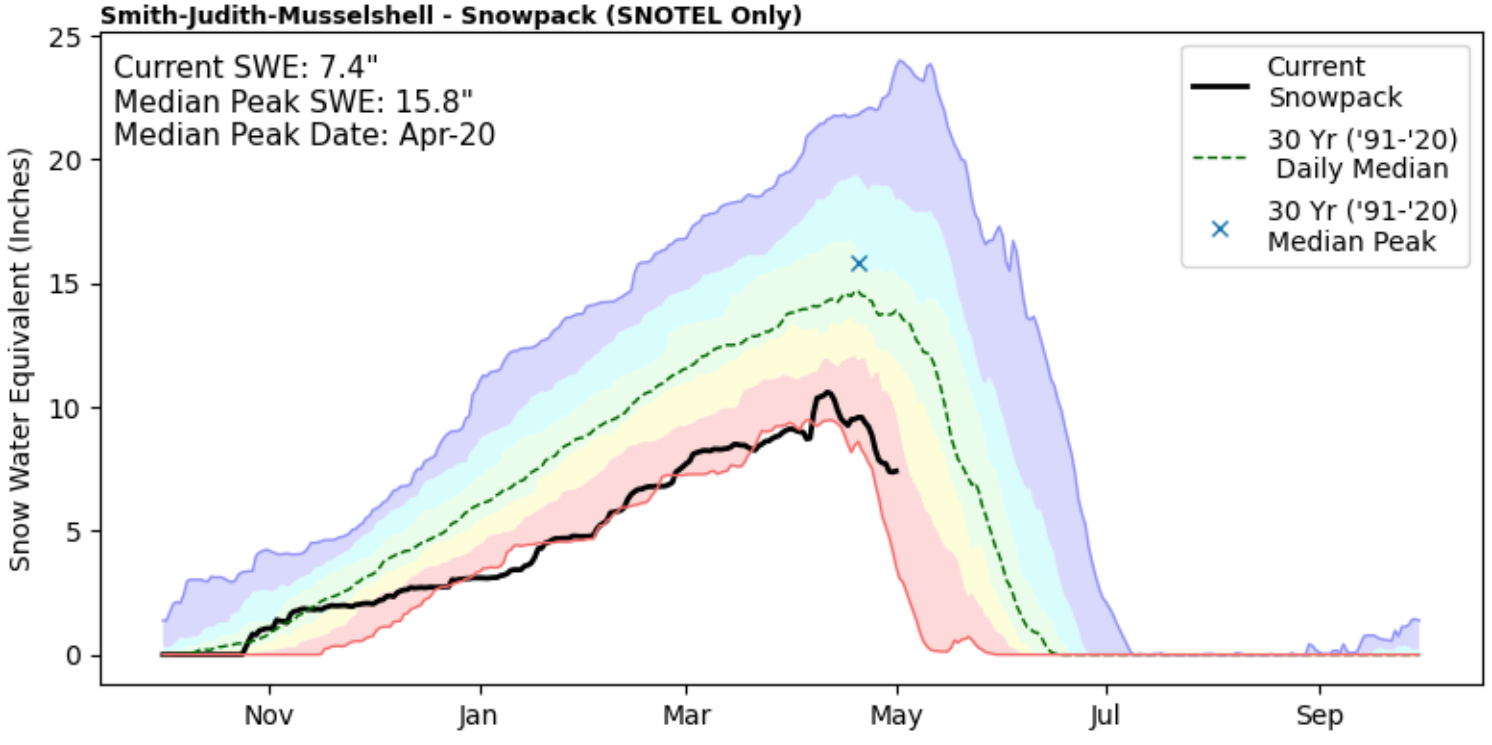


Basin Overview

Smith-Judith-Musselshell

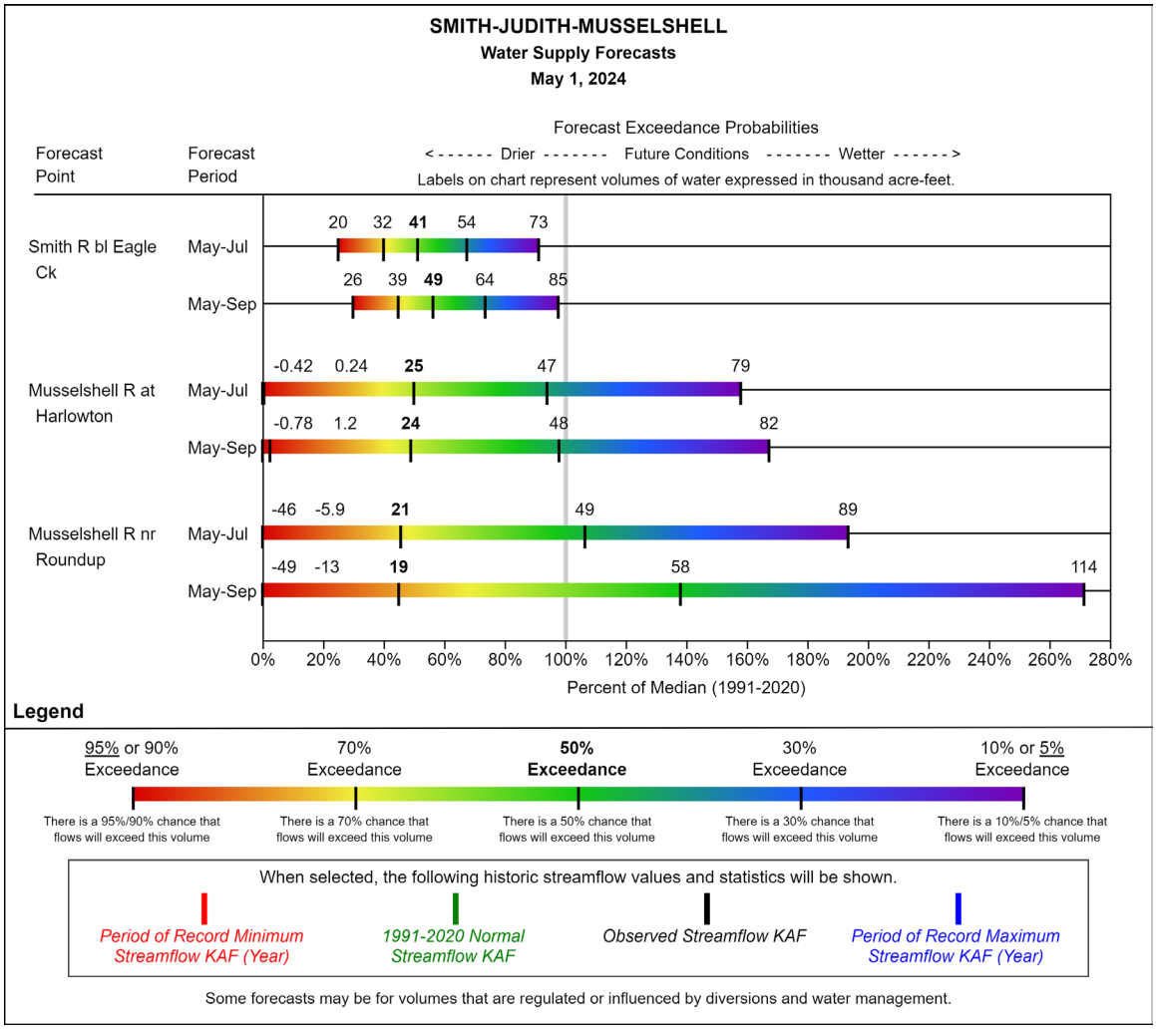
Precipitation in April was below normal at 87%, which brings the seasonal accumulation (October-April) to 75% of median. The snowpack in the Smith-Judith-Musselshell is well below normal at 55% of median, compared to 135% at this time last year.





Basin Overview

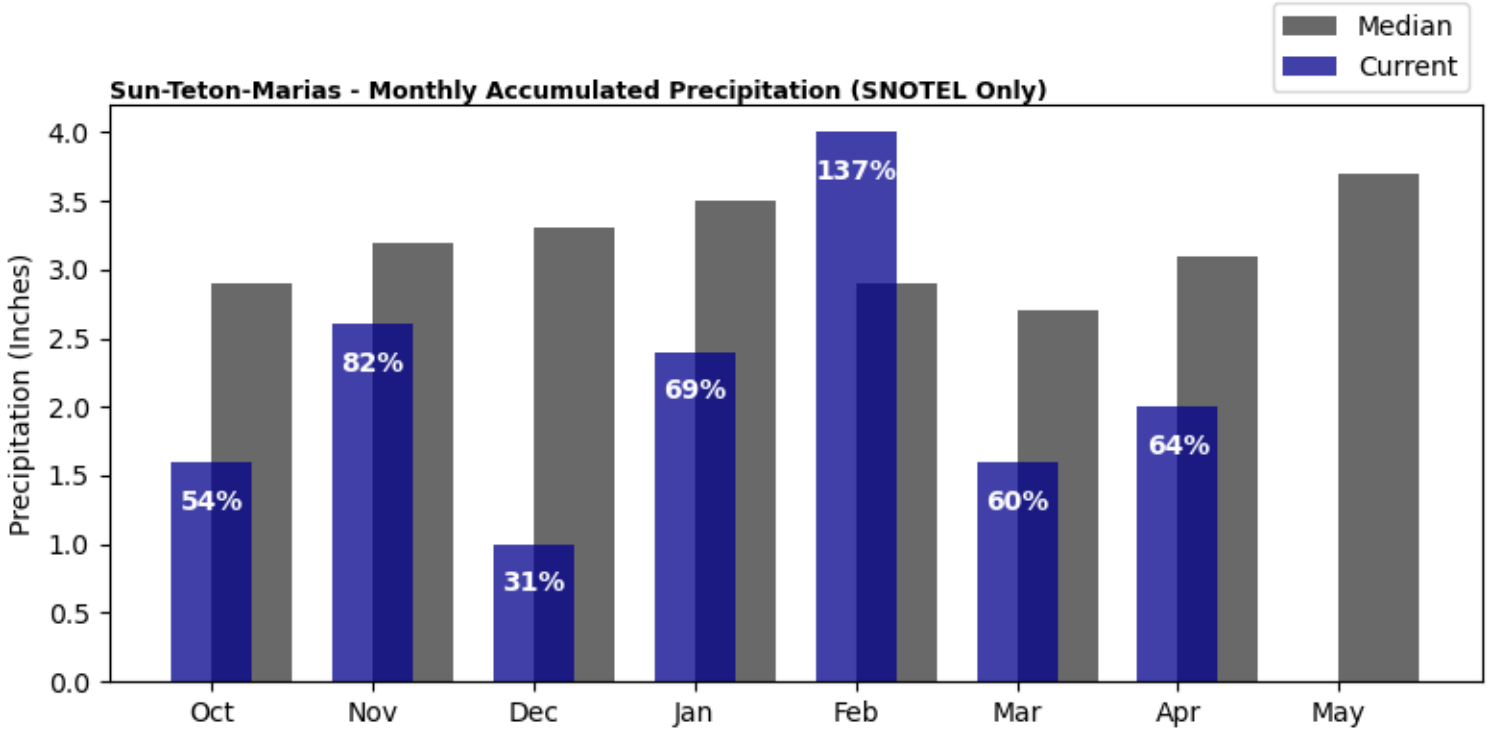
Smith-Judith-Musselshell (Continued)

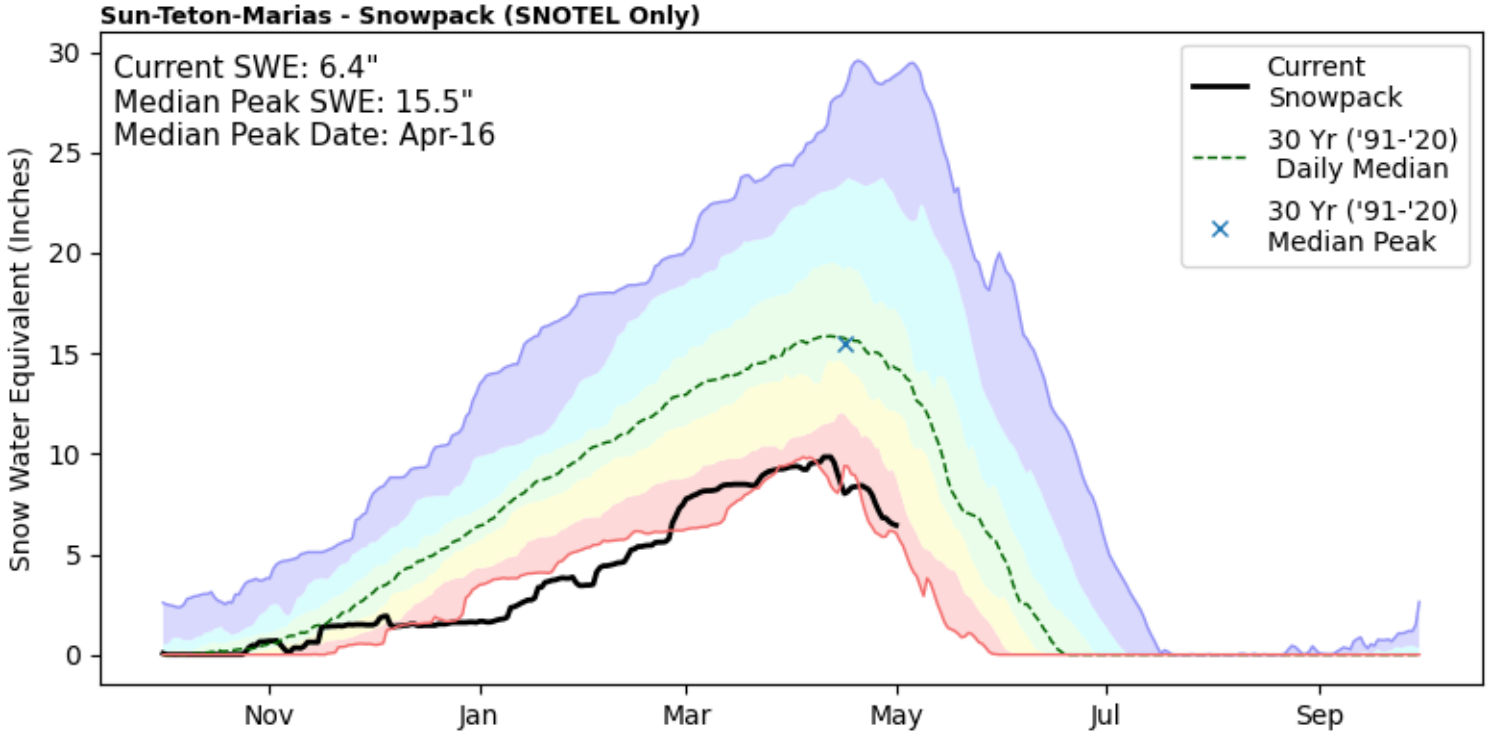


Basin Overview

Sun-Teton-Marias

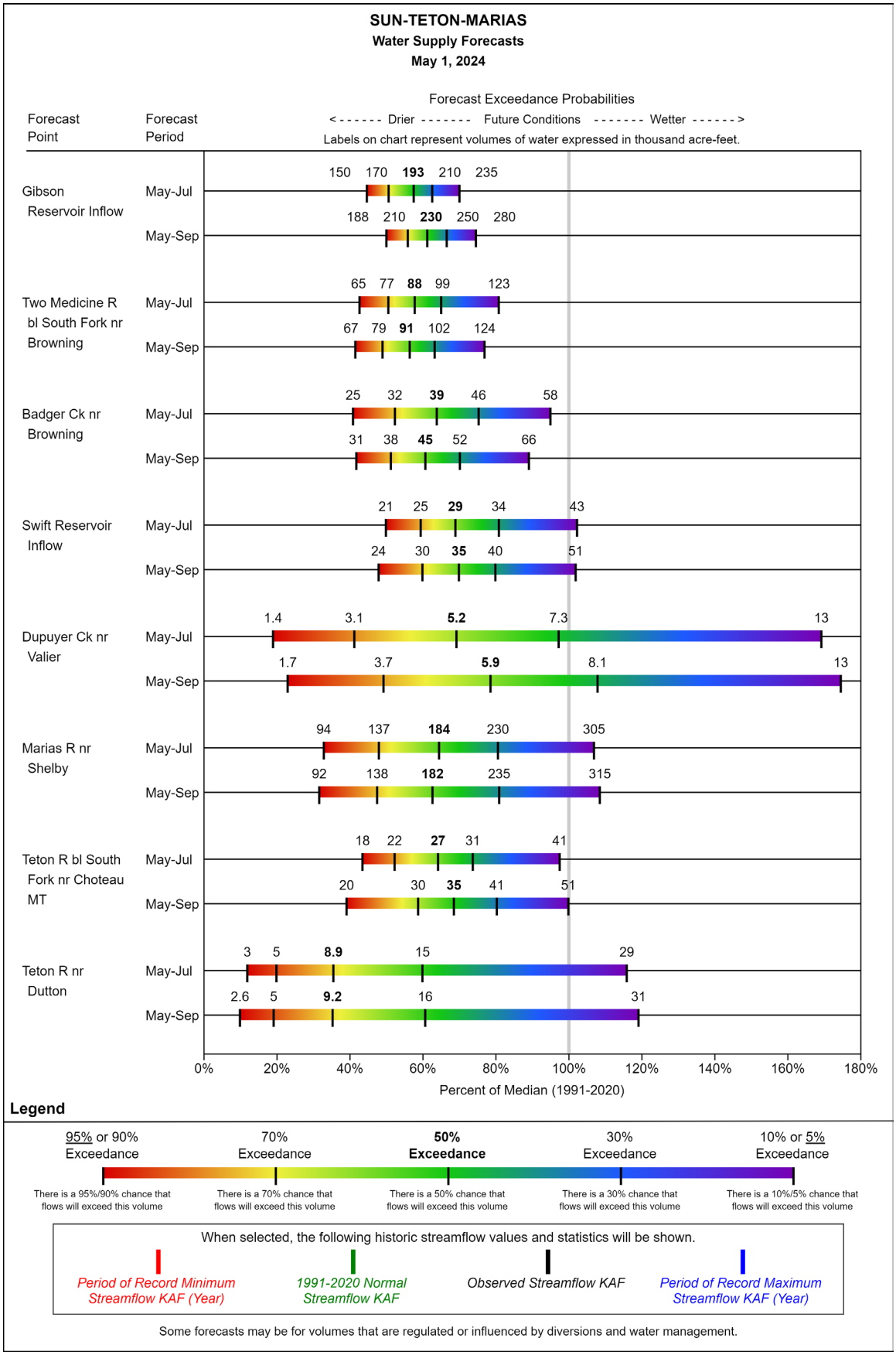
Precipitation in April was well below normal at 64%, which brings the seasonal accumulation (October-April) to 66% of median. The snowpack in the Sun-Teton-Marias is well below normal at 41% of median, compared to 105% at this time last year.





Basin Overview

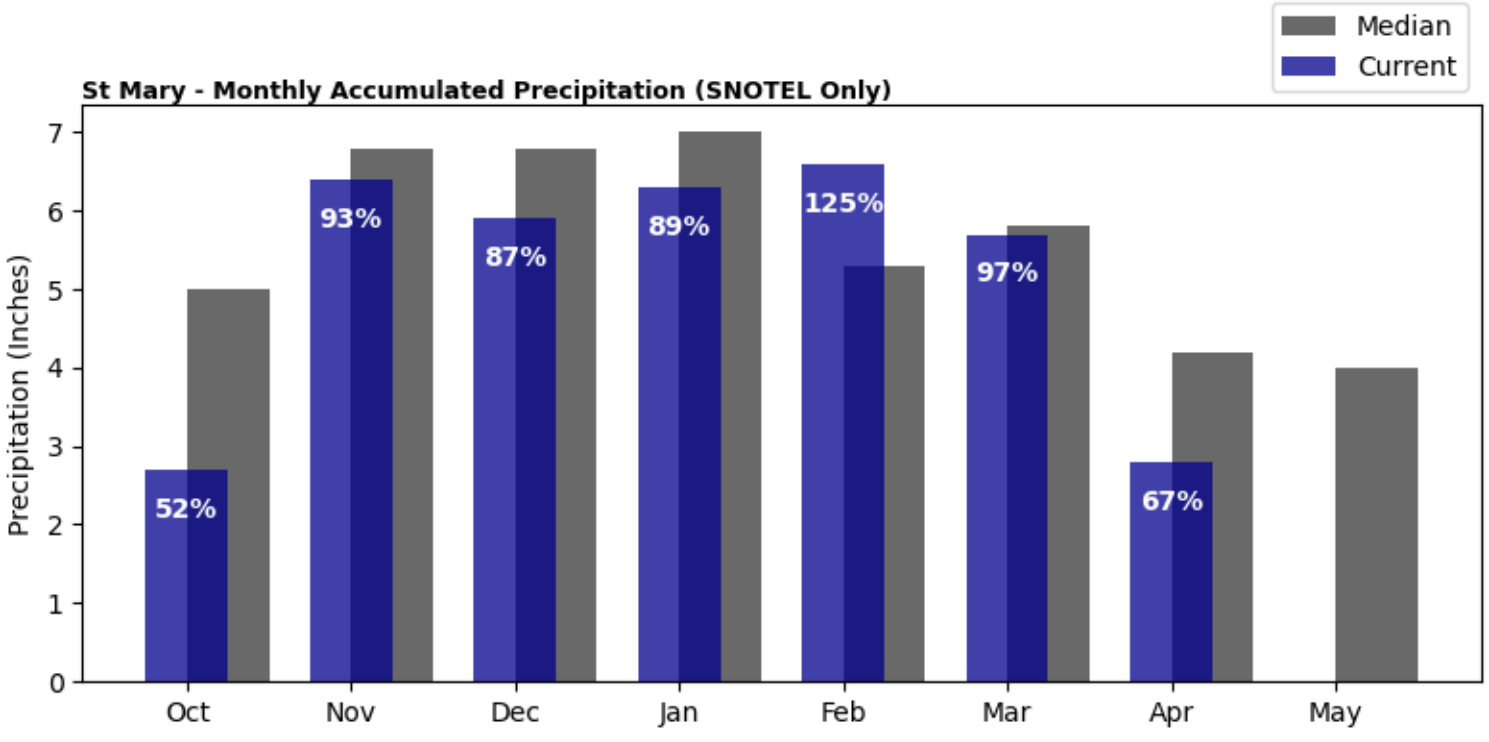
Sun-Teton-Marias (Continued)

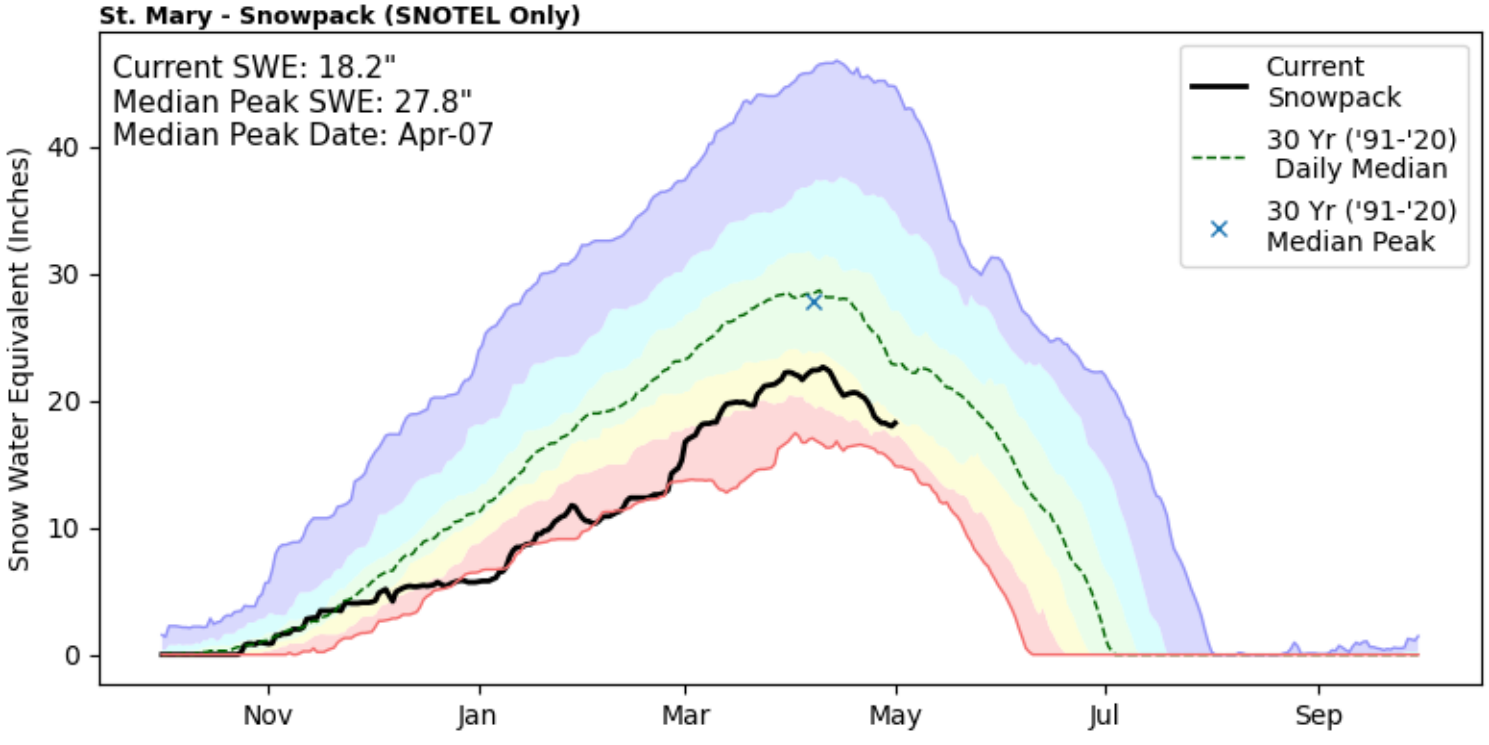


Basin Overview

St. Mary

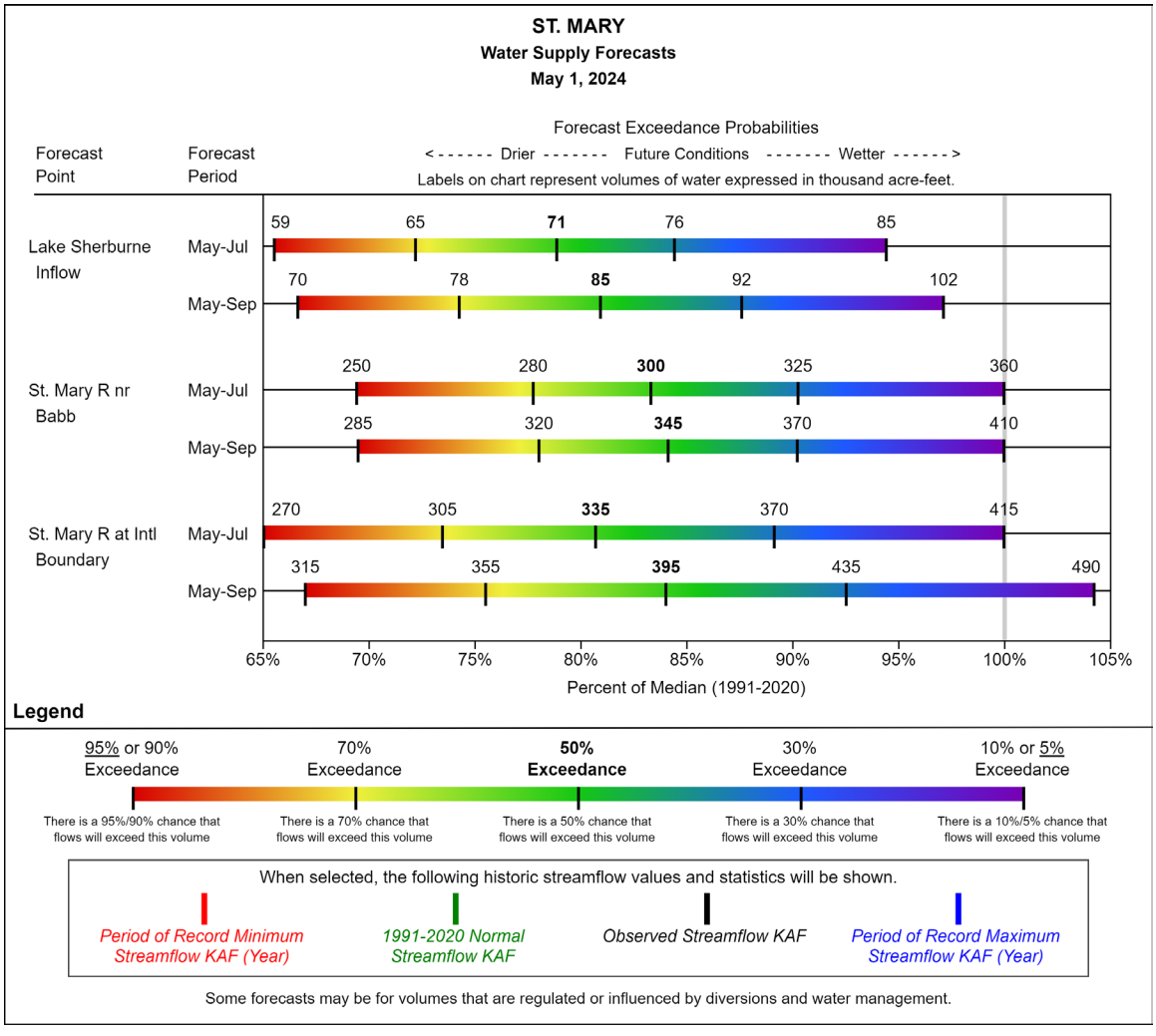
Precipitation in April was well below normal at 67%, which brings the seasonal accumulation (October-April) to 82% of median. The snowpack in the St. Mary is well below normal at 77% of median, compared to 94% at this time last year.





Basin Overview

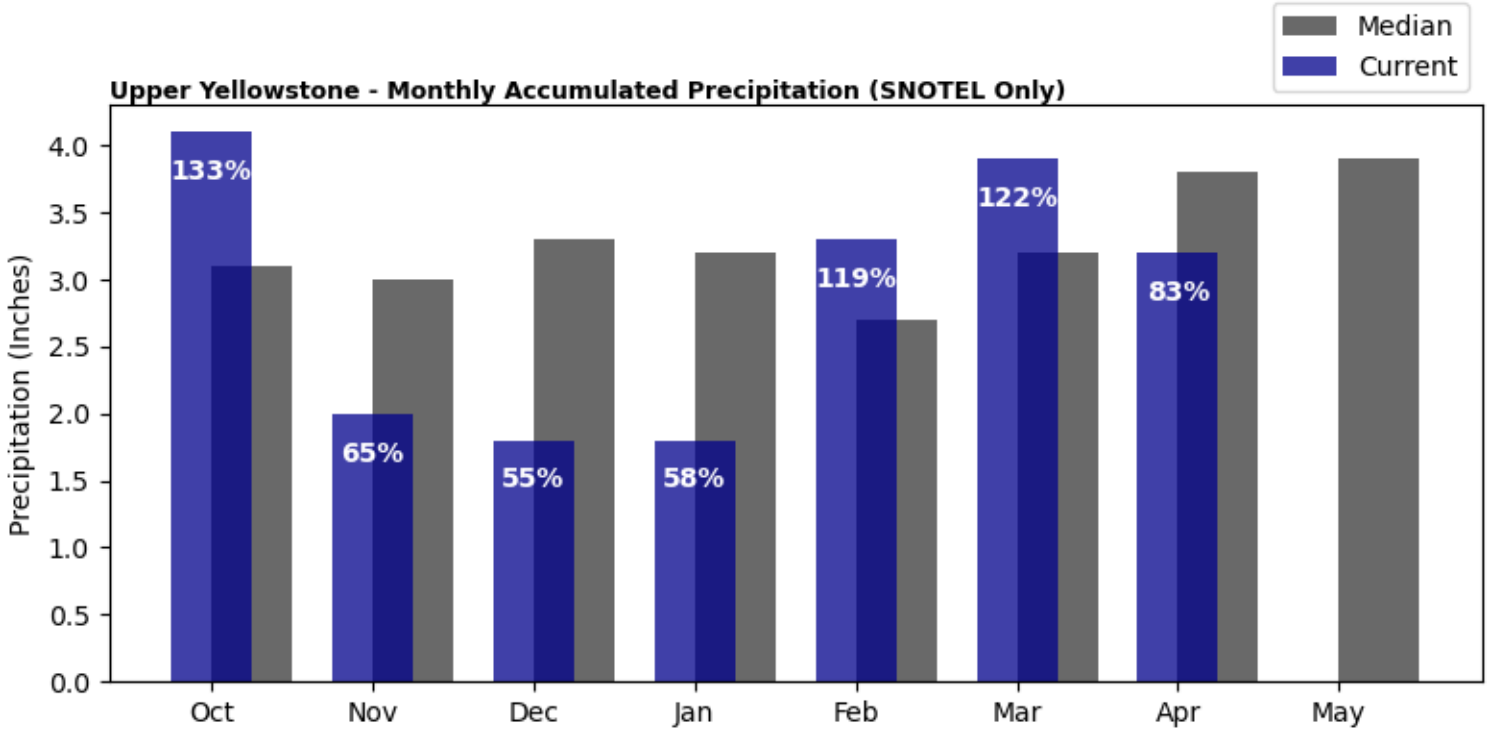
St. Mary (Continued)

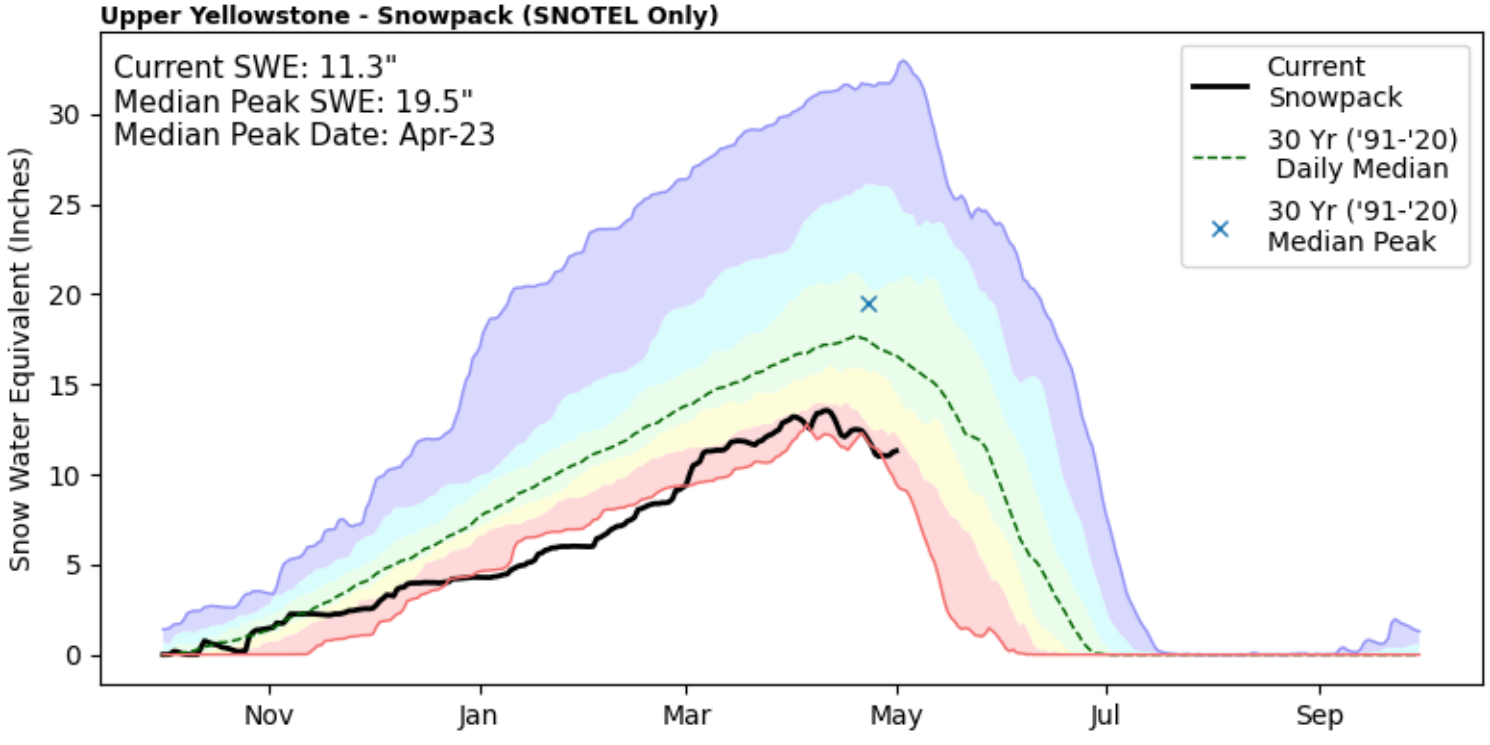


Basin Overview

Upper Yellowstone

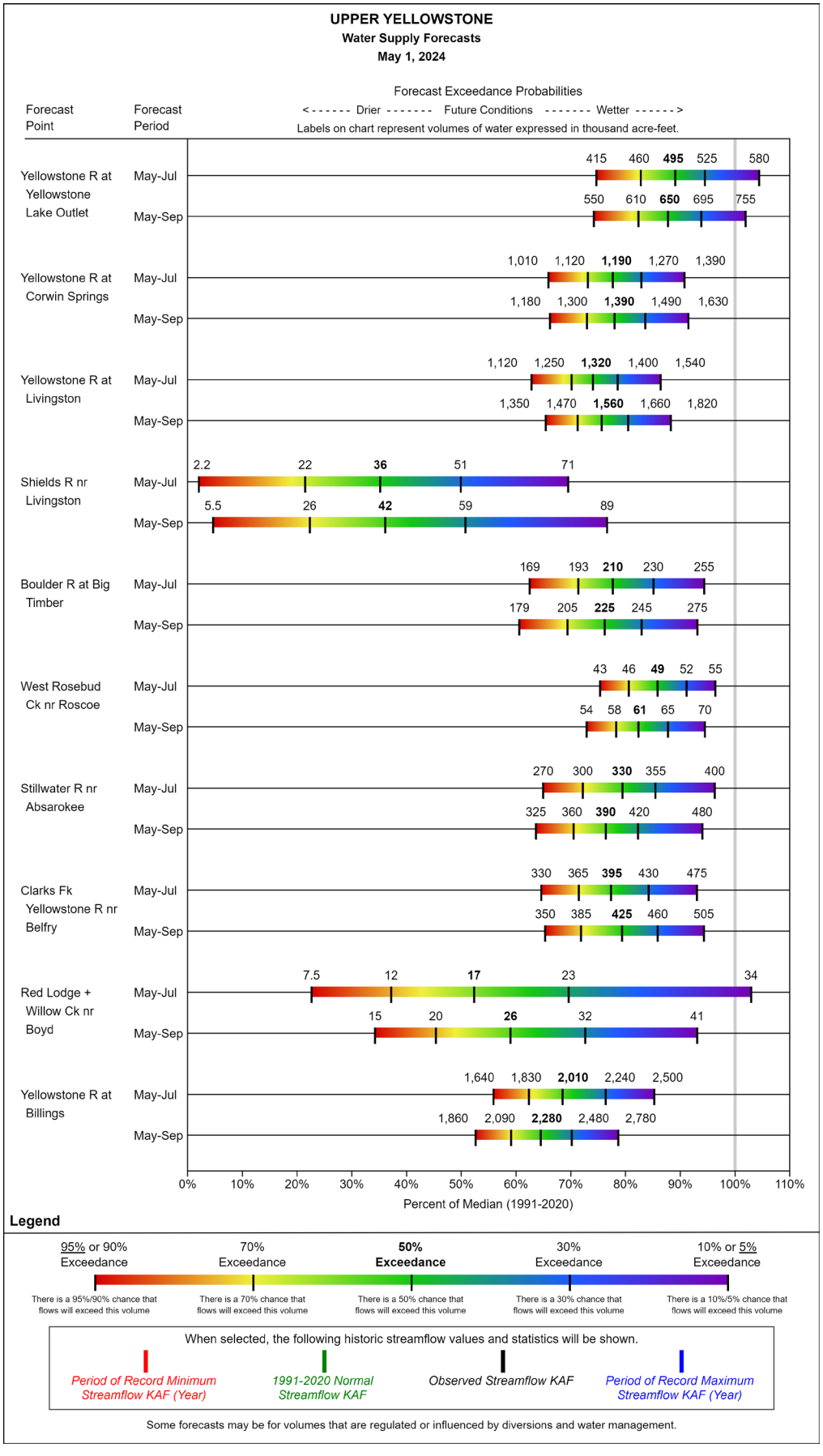
Precipitation in April was below normal at 83%, which brings the seasonal accumulation (October-April) to 88% of median. The snowpack in the Upper Yellowstone is well below normal at 67% of median, compared to 113% at this time last year.





Basin Overview

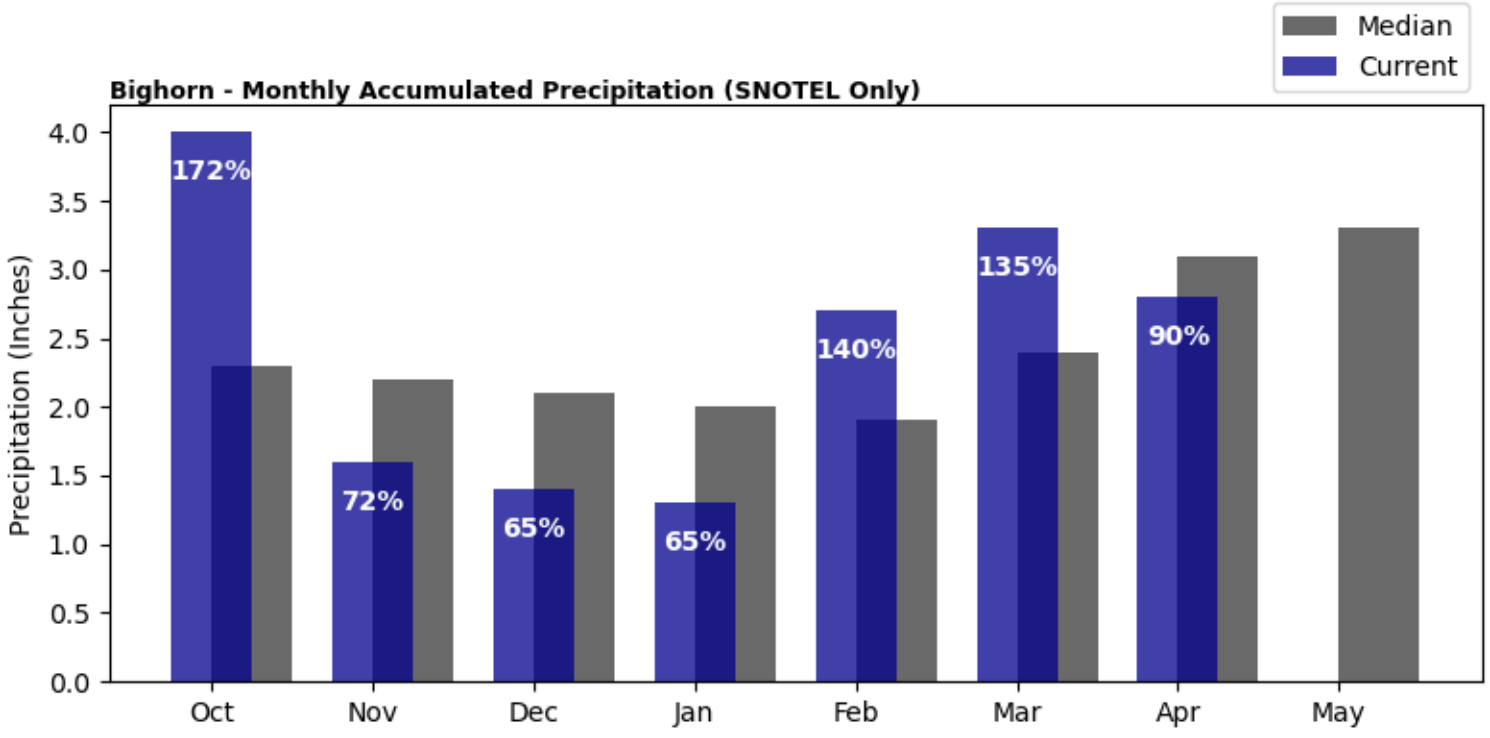
Upper Yellowstone (Continued)

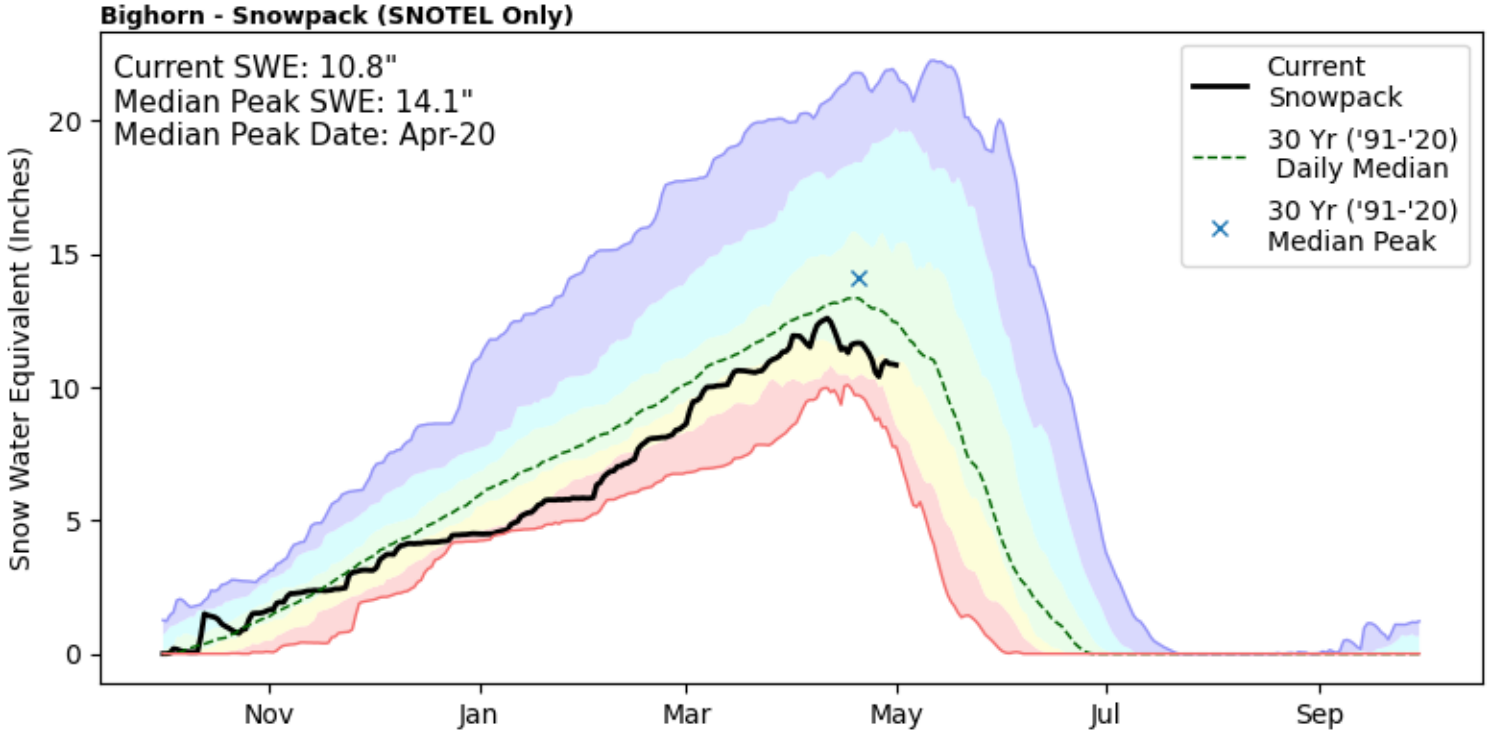


Basin Overview

Bighorn

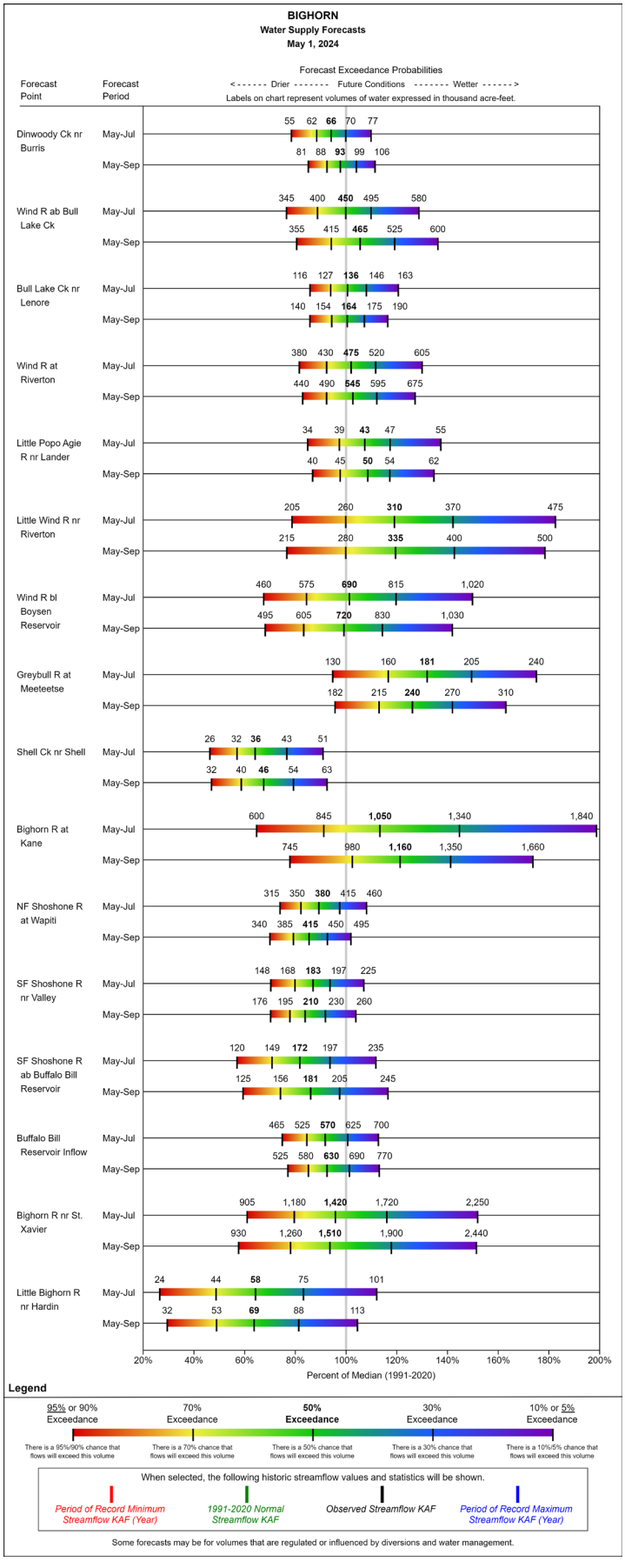
Precipitation in April was below normal at 90%, which brings the seasonal accumulation (October-April) to 103% of median. The snowpack in the Bighorn is below normal at 86% of median, compared to 114% at this time last year.





Basin Overview

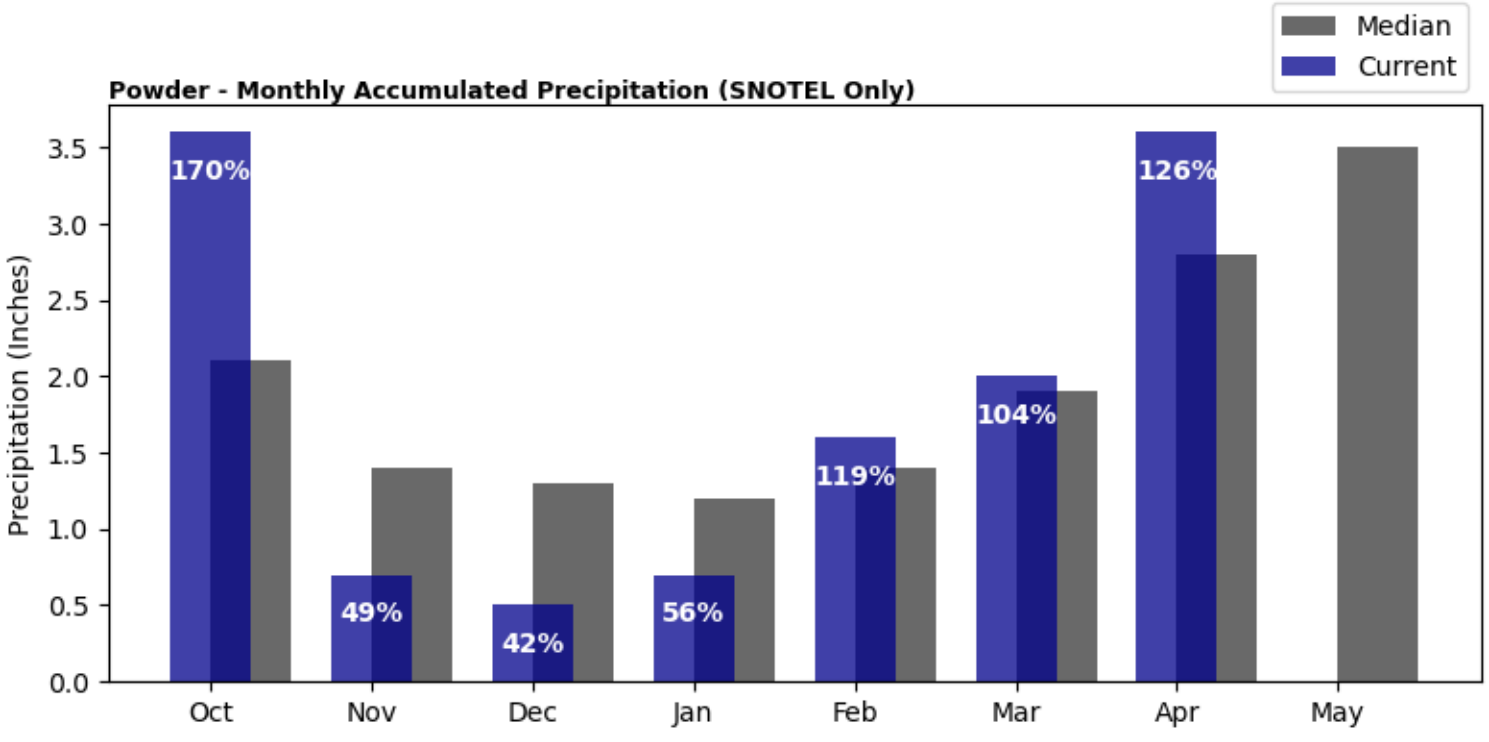
Bighorn (Continued)

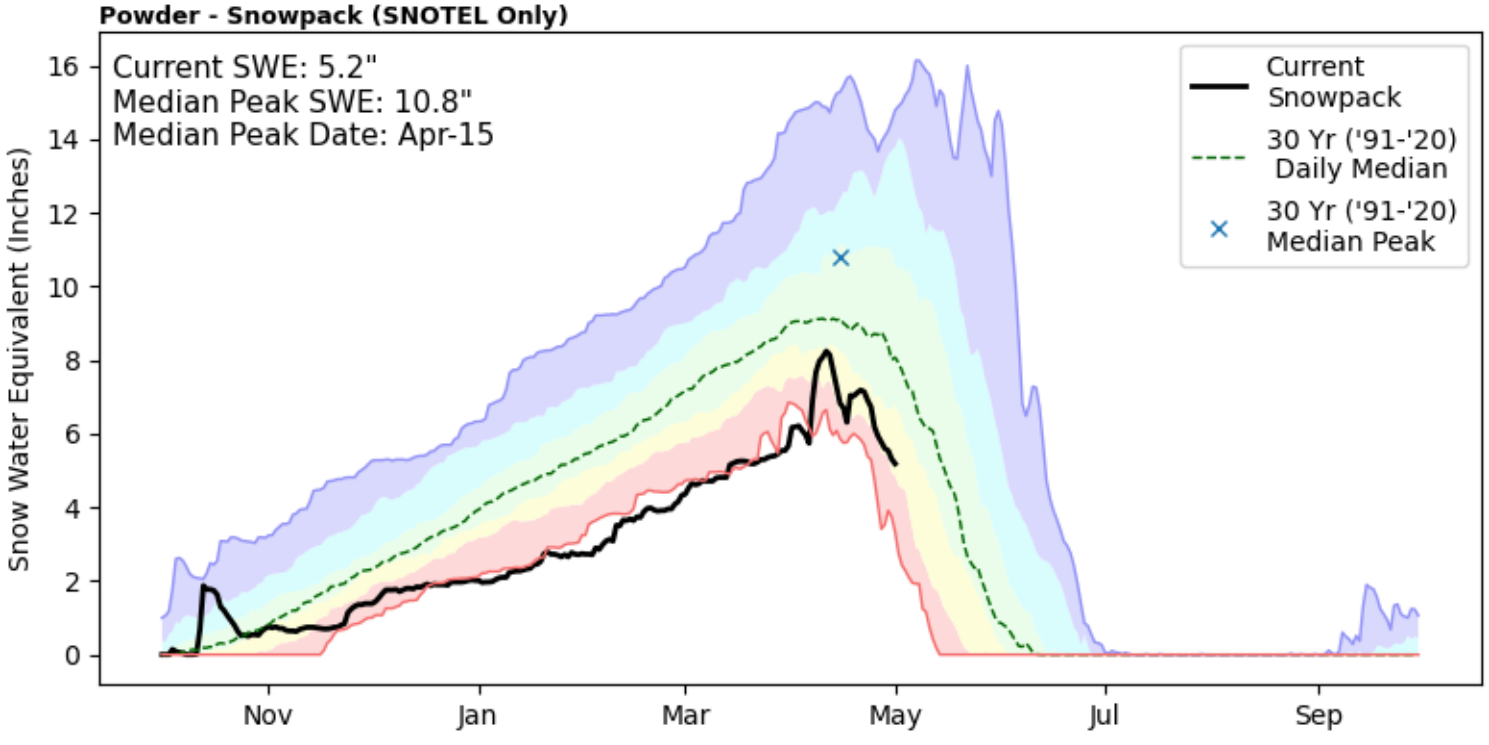


Basin Overview

Powder

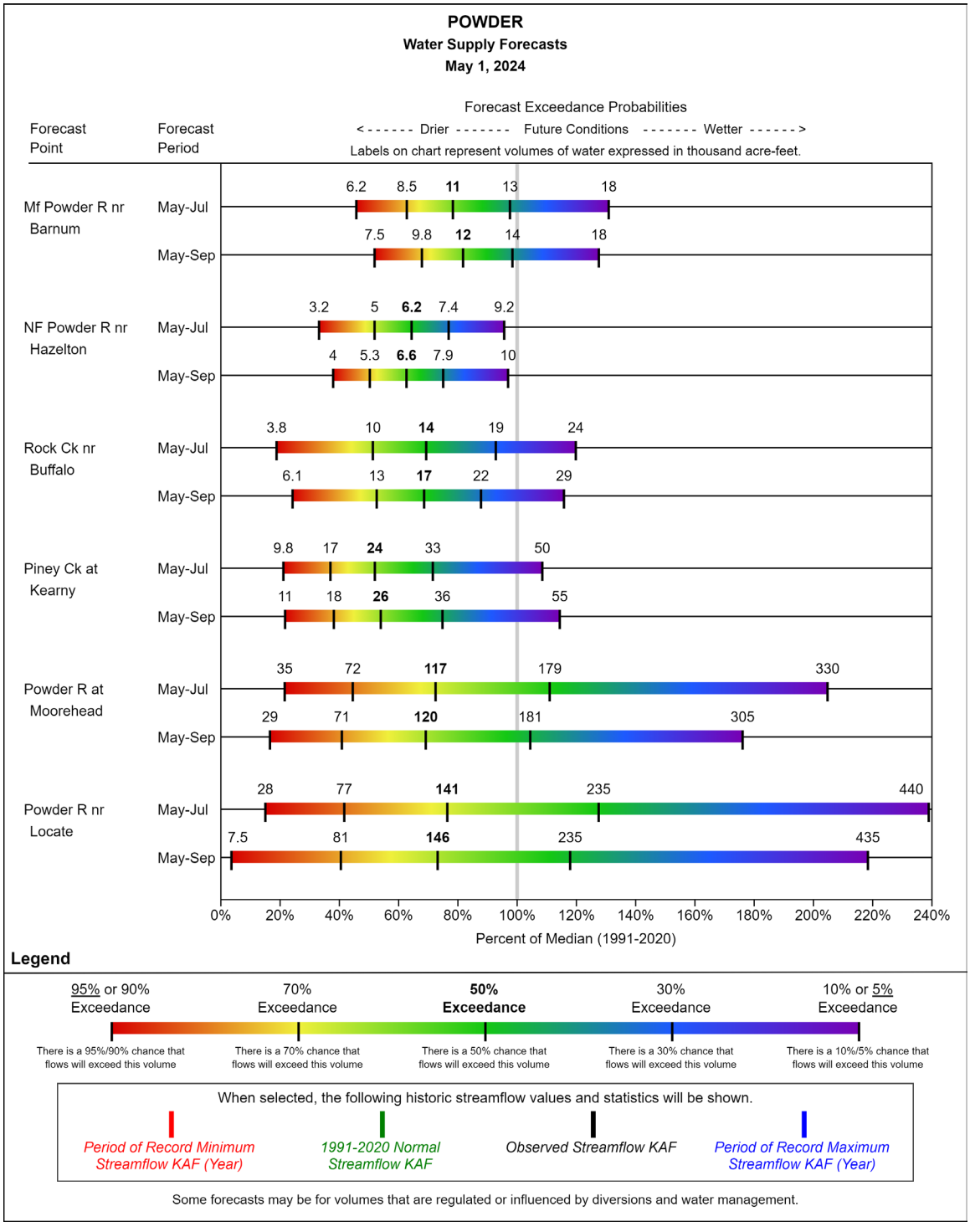
Precipitation in April was well above normal at 126%, which brings the seasonal accumulation (October-April) to 99% of median. The snowpack in the Powder is well below normal at 70% of median, compared to 113% at this time last year.





Basin Overview

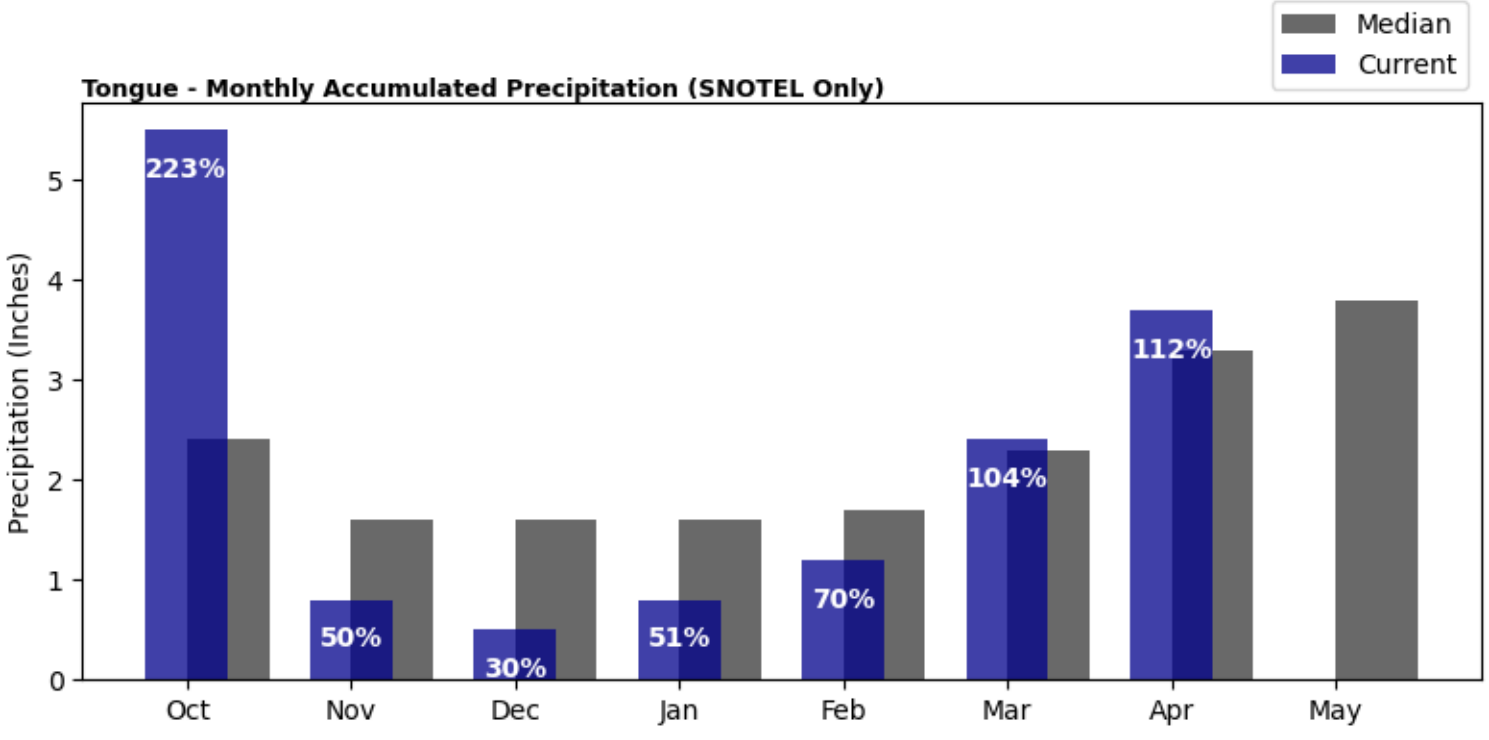
Powder (Continued)

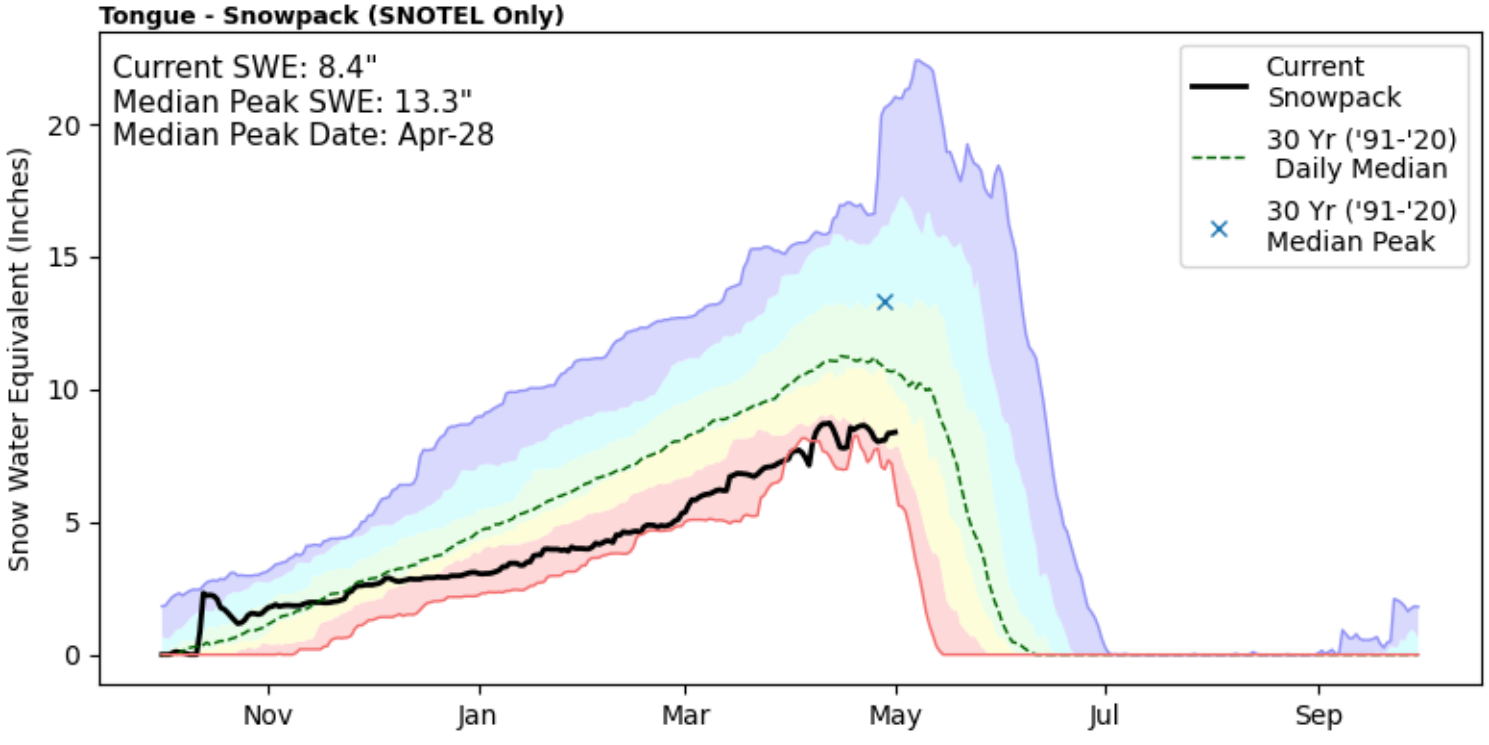


Basin Overview

Tongue

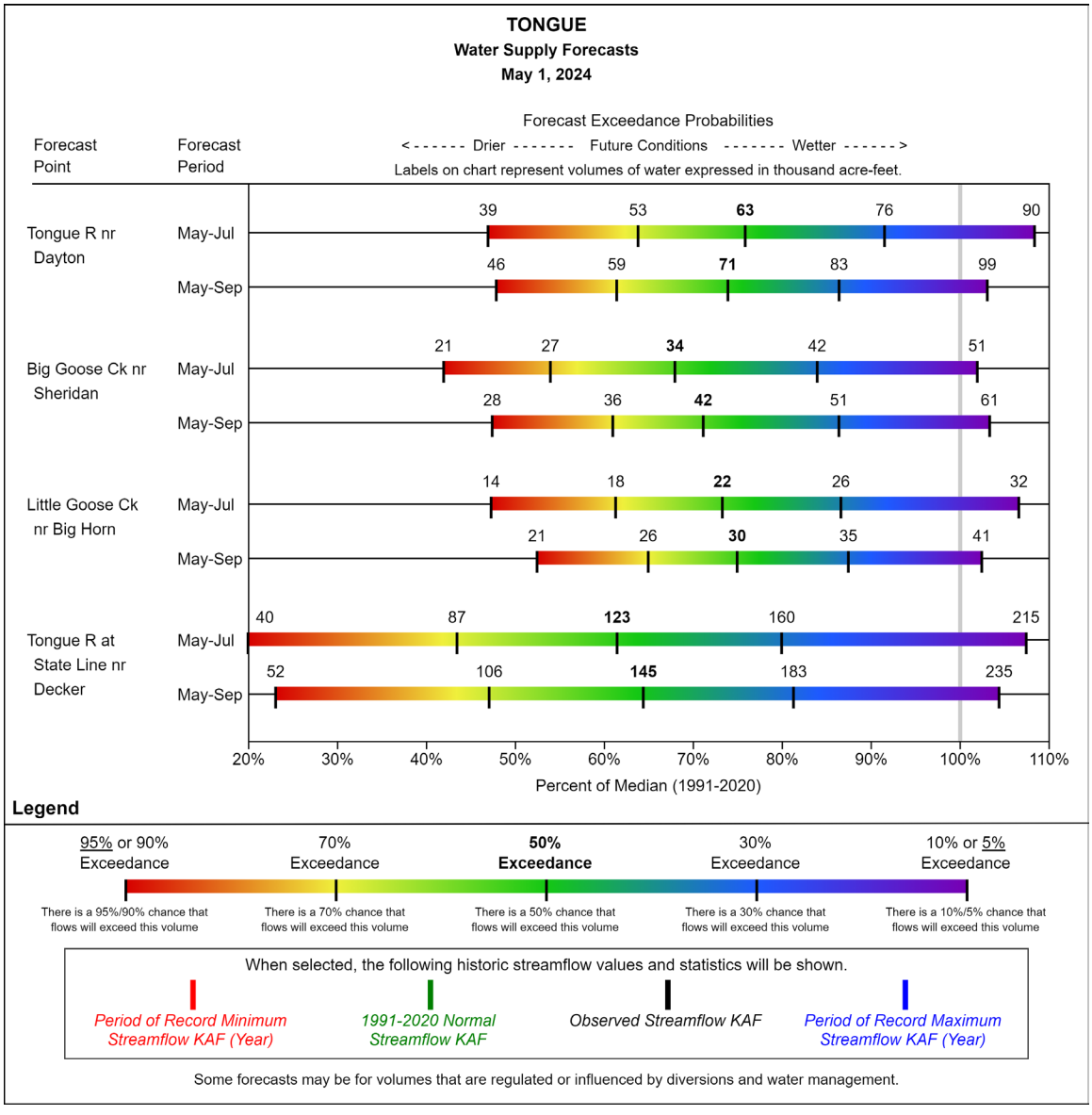
Precipitation in April was above normal at 110%, which brings the seasonal accumulation (October-April) to 95% of median. The snowpack in the Tongue is well below normal at 79% of median, compared to 105% at this time last year.





Basin Overview

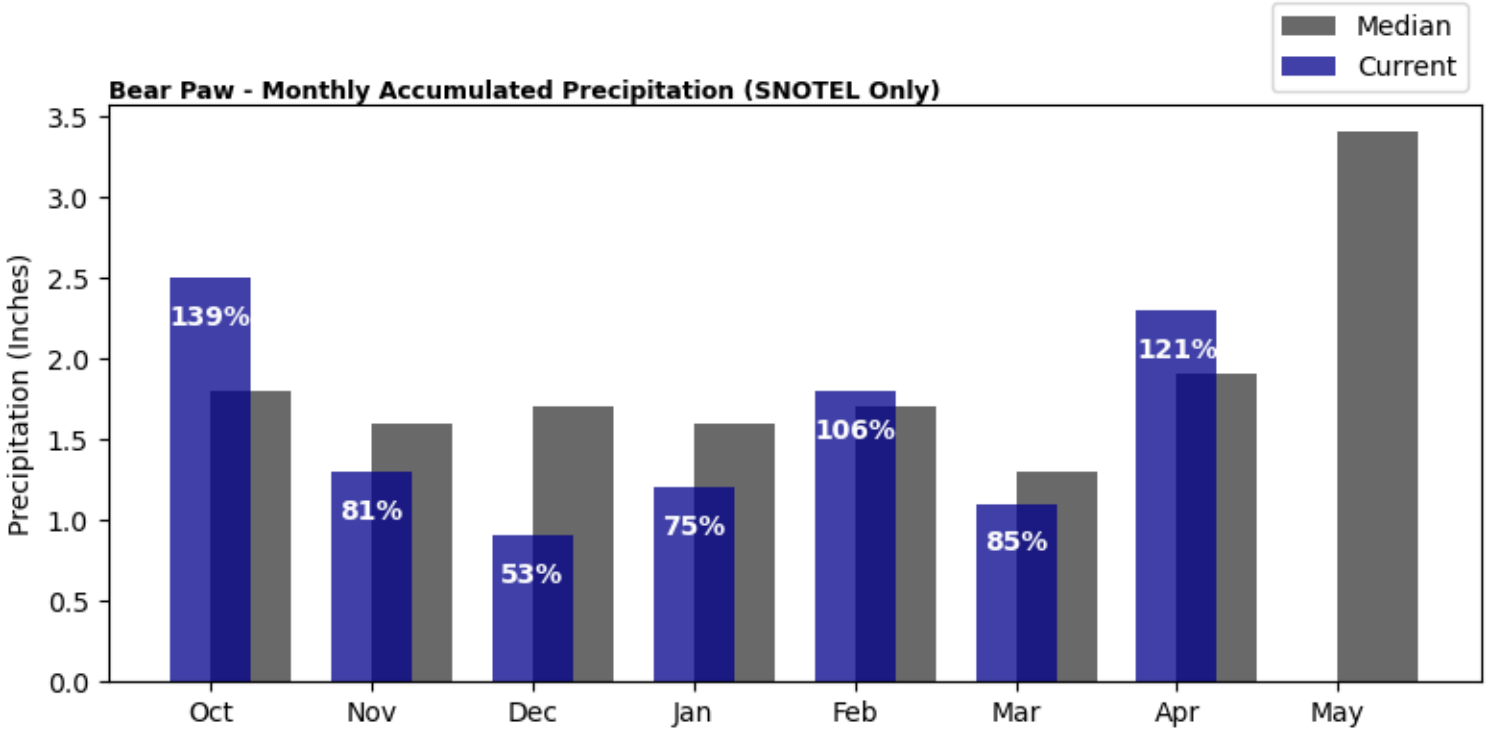
Tongue (Continued)

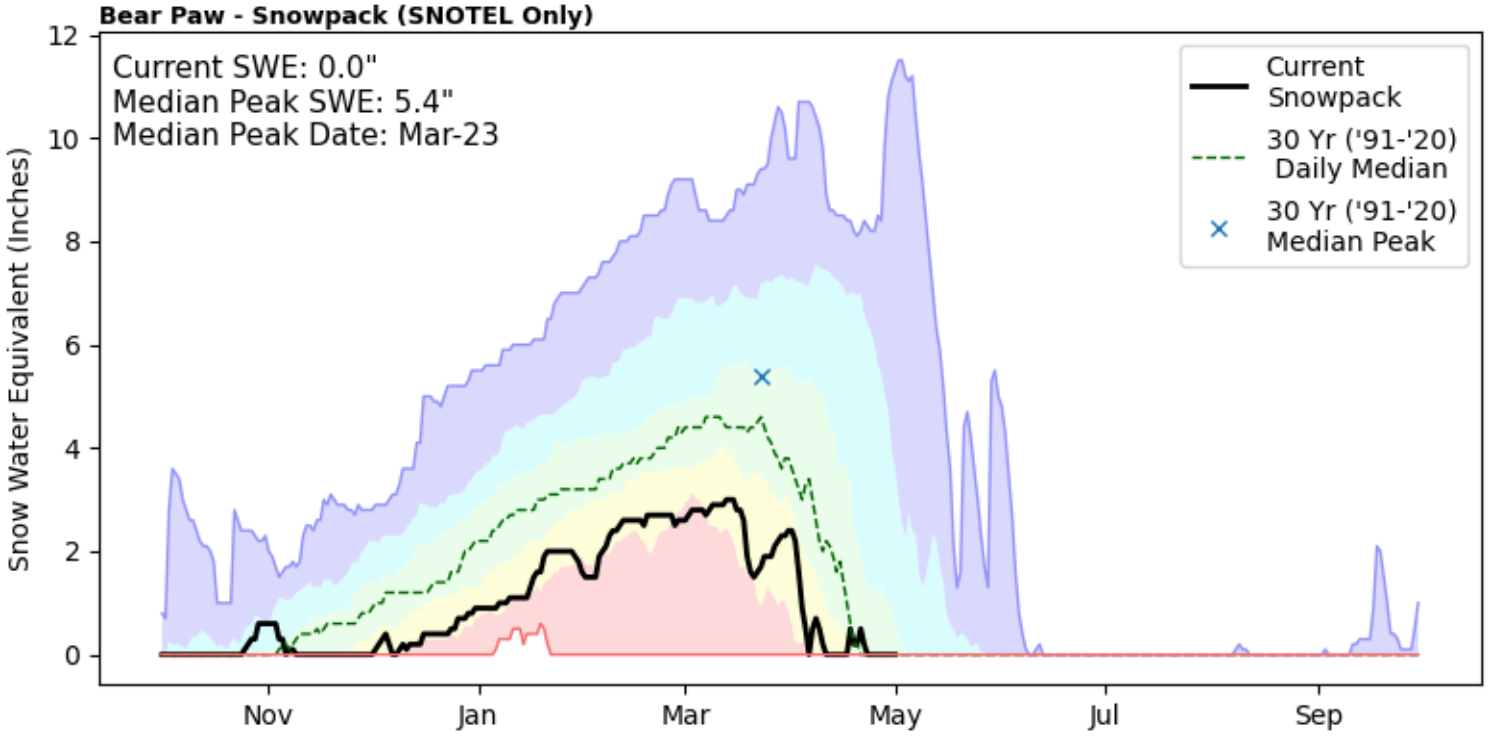


Basin Overview

Bear Paw

Precipitation in April was well above normal at 121%, which brings the seasonal accumulation (October-April) to 89% of median. The snowpack in the Bear Paw is None at None% of median, compared to 1180% at this time last year.





Appendix

Water Supply Forecast Information

Most of the annual streamflow in the Western United States originates as snowfall that has accumulated high in the mountains during winter and early spring. As the snowpack accumulates, hydrologists estimate the runoff that will occur when it melts. Predictions are based on careful measurements of snow water equivalent at selected index points. Precipitation, temperature, soil moisture and antecedent streamflow data are combined with snowpack data to prepare runoff forecasts.

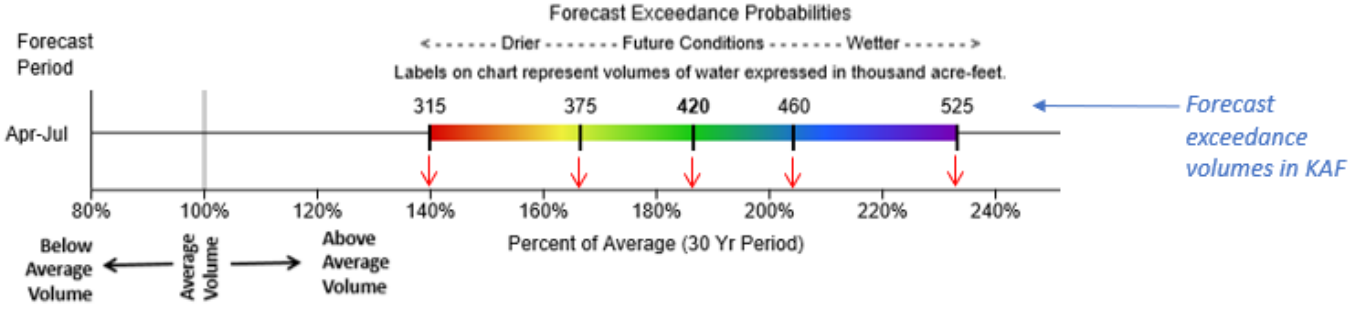
Forecast uncertainty originates from two sources: (1) uncertainty of future hydrologic and climatic conditions, and (2) error in the forecasting procedure. To express the uncertainty in the most probable forecast, four additional forecasts are provided. The actual streamflow can be expected to exceed the most probable forecast 50% of the time. Similarly, the actual streamflow volume can be expected to exceed the 90% forecast volume 90% of the time. The same is true for the 70%, 30%, and 10% forecasts. Generally, the 90% and 70% forecasts reflect drier than normal hydrologic and climatic conditions in the coming months; the 30% and 10% forecasts reflect wetter than normal conditions. As the forecast season progresses, a greater portion of the future hydrologic and climatic uncertainty will become known, and the additional forecasts will move closer to the most probable forecasts.

Interpreting Water Supply Forecast Charts

Typically, the Natural Resources Conservation Service (NRCS) has presented streamflow forecasts as a table format showing the five exceedance probabilities compared to the 30-year average as follows:

	Forecast Exceedance Probabilities for Risk Assessment Chance that actual volume will exceed forecast						
Forecast Period	90% (KAF)	70% (KAF)	50% (KAF)	% Avg	30% (KAF)	10% (KAF)	30yr Avg (KAF)
APR-JUL	315	375	420	187%	460	525	225

The Forecast Chart provides a visual alternative to the table. The forecast range is represented by a colored bar. Vertical lines on the bar signify the five forecast exceedances. Below is an example. The numbers above the forecast bar are the five exceedance probability volumes in thousand acre-feet (KAF). Each exceedance forecasts percent of median can be estimated by looking at the horizontal axis. The gray line centered above 100% on the horizontal axis represents the 1991-2020 historical median streamflow for the forecast period.



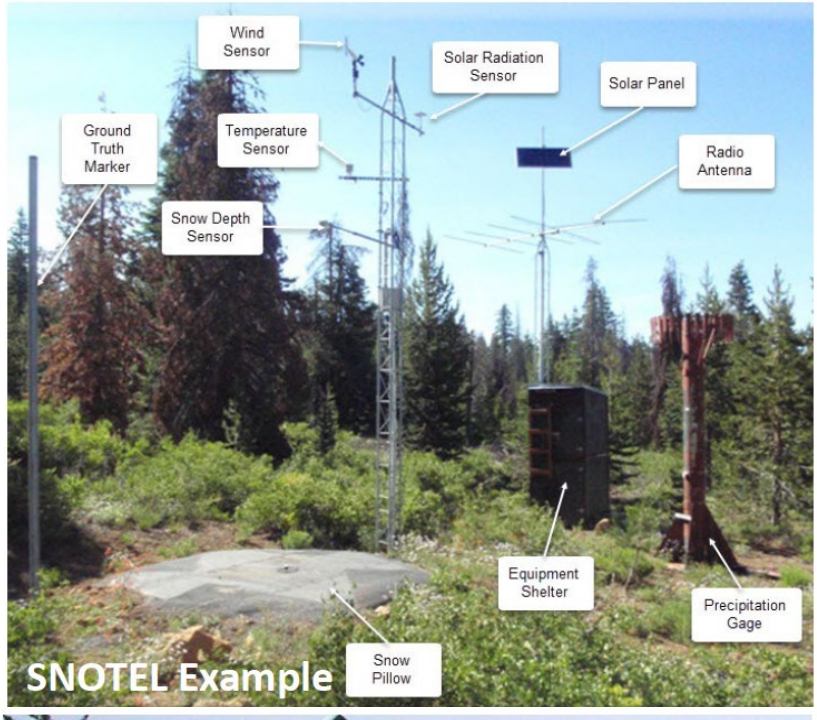
In the example, the entire forecast bar is shifted right of the gray line indicating a forecast for above normal streamflow. The 50% exceedance is represented by the black line in the green portion of the colored bar. This represents a forecast volume of 420KAF which is ~185% of average. If drier than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

Appendix

Monitoring Station 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. The earliest NRCS SNOTEL sites have data back to the mid-1970s.



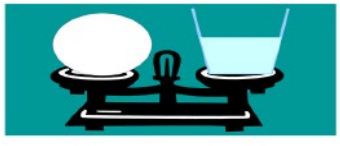
Snow Course

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 or 10. Snow courses are measured on a monthly basis typically between January 1 and June 1. Snow courses provide a longer record than SNOTEL. The earliest snow courses in the Montana have data back to the 1920s.

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 a snowpack containing 12 inches of SWE melted instantaneously, there would be 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

Appendix

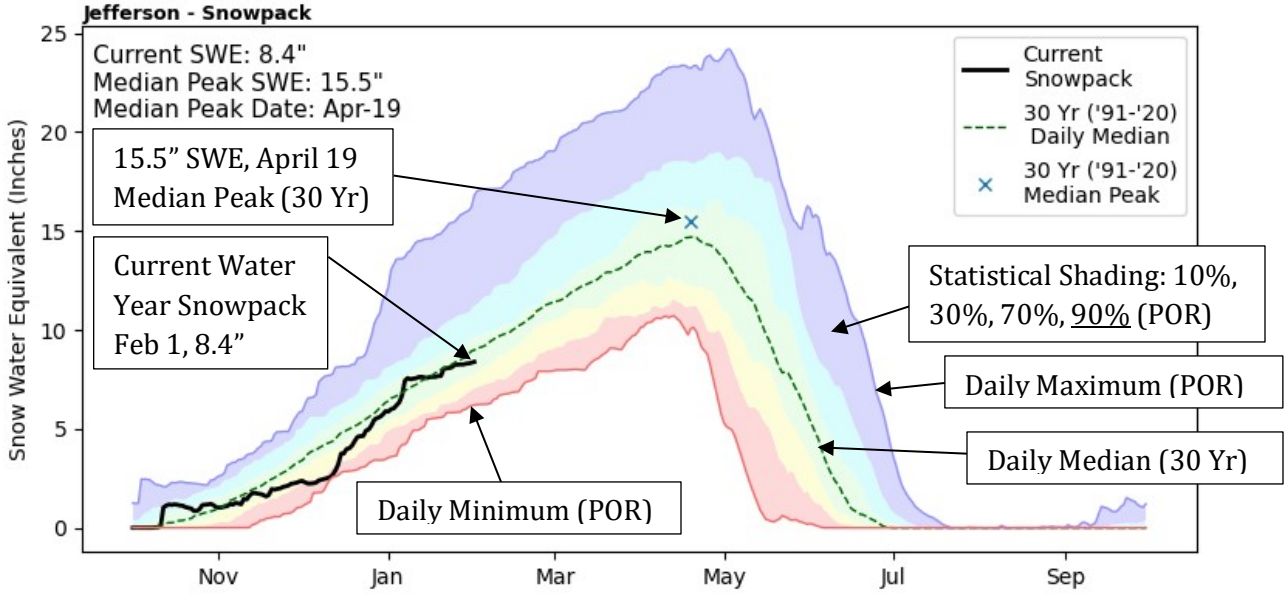
Additional Information

Climatic and Hydrologic Normals

The Snow Survey and Water Supply Forecasting (SSWSF) normals are site-specific measures of central tendency (either the median or average) for a data type, such as snow water equivalent (SWE). The statistics are calculated over a 30-year period and updated each decade, in agreement with World Meteorological Organization (WMO) standards. This 30-year reference period was chosen to characterize the current hydroclimatology at each station. The most recent medians and averages have been updated to include data for the water years 1991-2020. The National Water and Climate Center (NWCC) also provides medians and averages for the 1981-2010 and 1971-2000 reference periods for stations with sufficient data. The normals available from the NWCC include the median and average for SWE, snow depth (snow courses only), precipitation, volumetric streamflow, and reservoir storage. Values are calculated from data collected by NRCS-managed stations and external agencies such as the U.S. Geological Survey (USGS), National Weather Service (NWS), state agencies, and private organizations. Normal is calculated for various durations including daily, month-to-date, semi-monthly, monthly, seasonal, and annual based on the data type. More information is available here: https://www.nrcs.usda.gov/resources/data-and-reports/climatic-and-hydrologic-normals

Interpreting Snowpack Charts

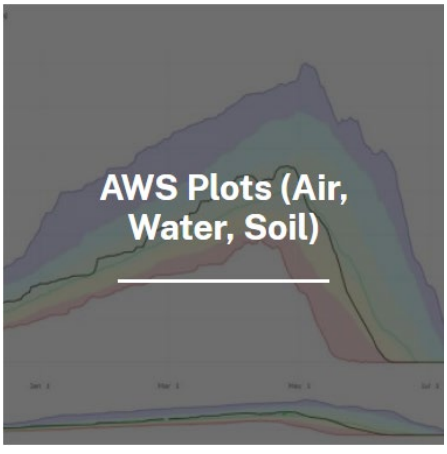
Snowpack charts displayed in this report are created using daily (midnight) snow water equivalent (SWE) values at SNOTEL sites determined to represent the basin. Snow Course data is not included. Plotted lines are the average of each SNOTEL's individual values. For example, the "Current Snowpack" on January 1st is the average all SNOTEL SWE values in that basin for that day. The "30 Yr. ('91-'20) Daily Median" is the average of each SNOTEL's median SWE value for a given day. The upper and lower extent (blue/red lines) show the maximum/minimum daily SWE values, which is determined using the "Current Snowpack" SWE value for all days in the period of record (POR). Snowpack peak SWE dates differ from season to season, as a result the high point on the "30 Yr. ('91-'20) Daily Median" line is not the true median peak SWE. The point "X" is plotted by calculating the median peak date and median peak value independently. Similar charts with other basin definitions are available here: https://nwcc-apps.sc.egov.usda.gov/basin-plots/#mt

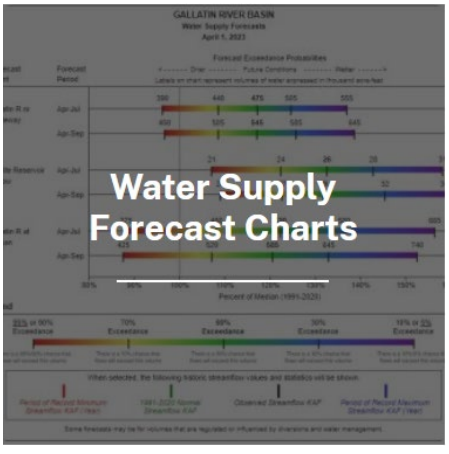


Appendix

Links and Resources

Products and Reports (click image)





Interactive Map Predefined Links

Snow

- Snow Water Equivalent > Daily > Percent of 1991-2020 Median > **Stations** | **Basins**
- Snow Water Equivalent > End of Previous Month (SNOTEL and Snow Course) > Percent of 1991-2020 Median > **Stations** | **Basins**
- Snow Depth > Daily > **Stations**
- Snow Density > End of Previous Month (SNOTEL and Snow Course) > **Stations**

Precipitation

- Month-to-Date > Daily > **Stations**
- Water Year-to-Date > Daily > Percent of 1991-2020 Median > **Stations** | **Basins**
- Previous Month > Percent of 1991-2020 Median > **Stations** | **Basins**
- Previous 3 Months > Percent of 1991-2020 Average > **Stations** | **Basins**

Streamflow

- Observed (Adjusted Volume) > Previous Month > Percent of 1991-2020 Median > **Stations** | **Basins**
- Forecast (Adjusted Volume) > Most Recent (Available March 1 through June 1) > Percent of 1991-2020 Median > **Stations** | **Basins**

Reservoir Storage

- End of Previous Month > Percent of 1991-2020 Median > **Stations**

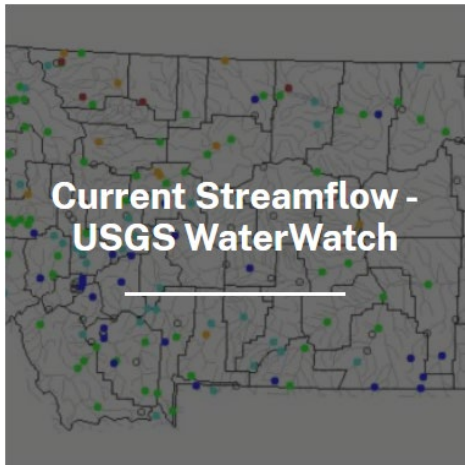
Other

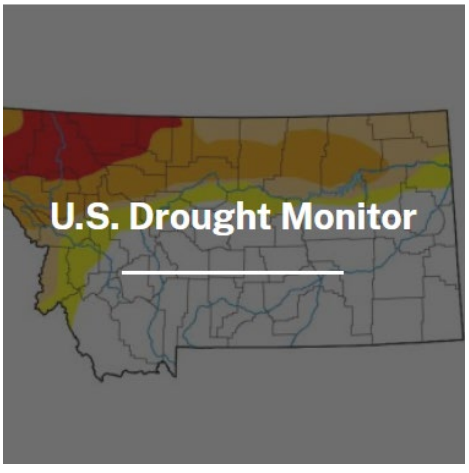
- Snow Water Equivalent > Daily > Compared to POR > **Stations**
- Snow Water Equivalent > End of Previous Month (SNOTEL and Snow Course) > Percentile > **Stations**
- Water Year-to-Date Precipitation > Daily > Compared to POR > **Stations**

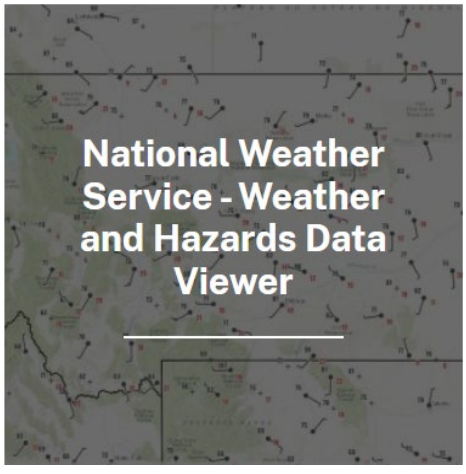
Appendix

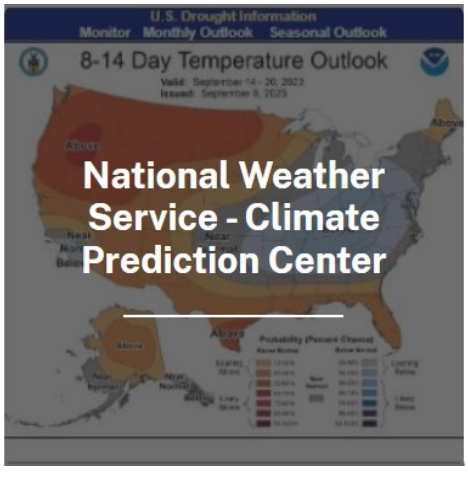
Links and Resources (Continued)

External Agencies (click image)









Additional Drought Information

- U.S. Drought Monitor
- National Integrated Drought System (Drought.gov)
- USDA Drought Portal (News and Resources)
- Farm Services Agency Montana News Releases (Information on Programs and Deadlines)
- Farm Services Agency Disaster Assistance Programs
- Montana Department of Natural Resources and Conservation Drought Management

Snow Survey Program FAQ

Frequently Asked Snow Survey Questions - Montana | Natural Resources Conservation Service (usda.gov)

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Montana Water Supply Outlook Report

Natural Resources Conservation Service