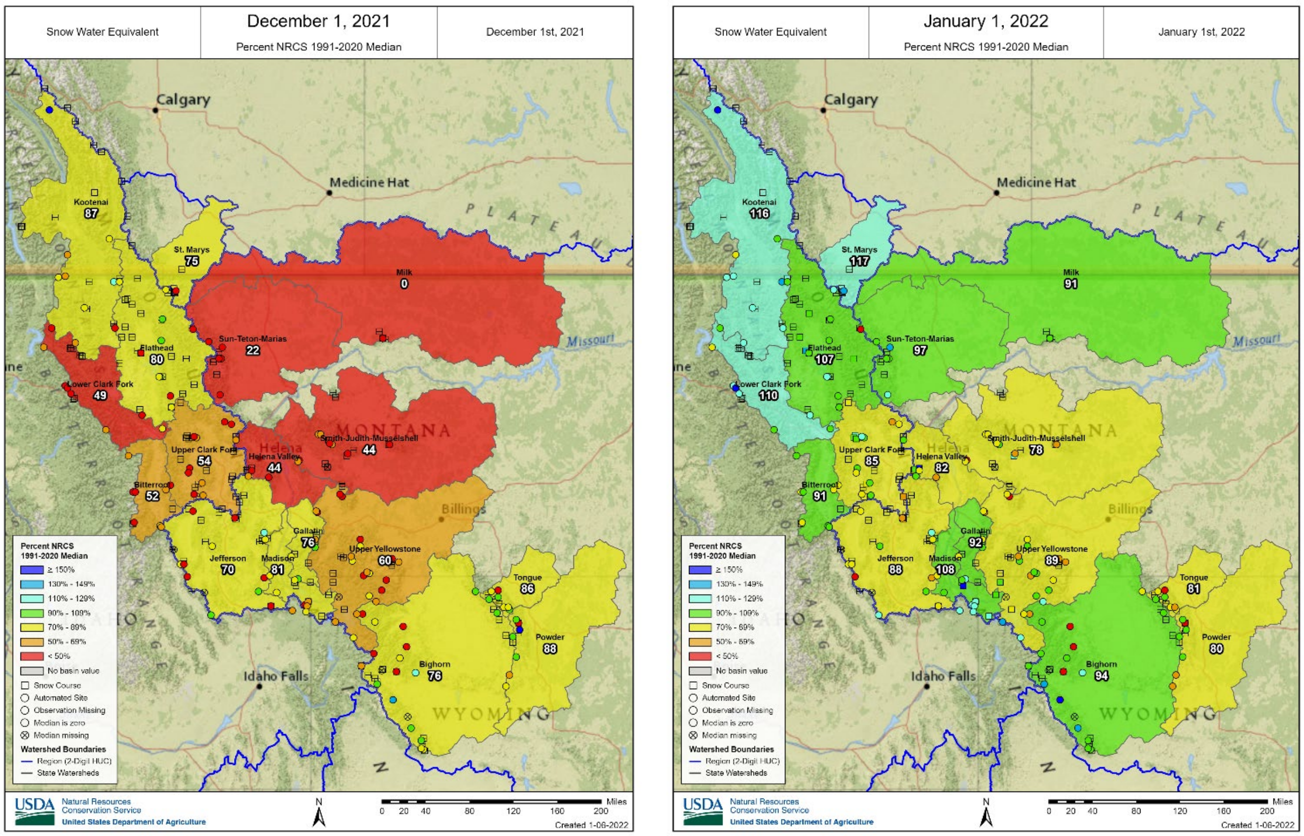
Montana
Water Supply Outlook Report
January 1, 2022



Percent normal SWE on December 1, 2021 (left) and January 1, 2022 (right).

The 2022 Water Year did not begin on a promising note, with drier and warmer than normal conditions across much of Montana in October and November. Snowpack across all basins was below normal on December 1. However, the month of December made up ground, with precipitation and colder temperatures bringing snowpack into the normal range for many basins. Basins in the northwest currently have above normal snowpacks, while many in central and southern Montana are still below normal but much improved from a month ago. Predicted La Niña conditions in the coming months will hopefully continue to add to the snowpack and bolster the water supply outlook for 2022.

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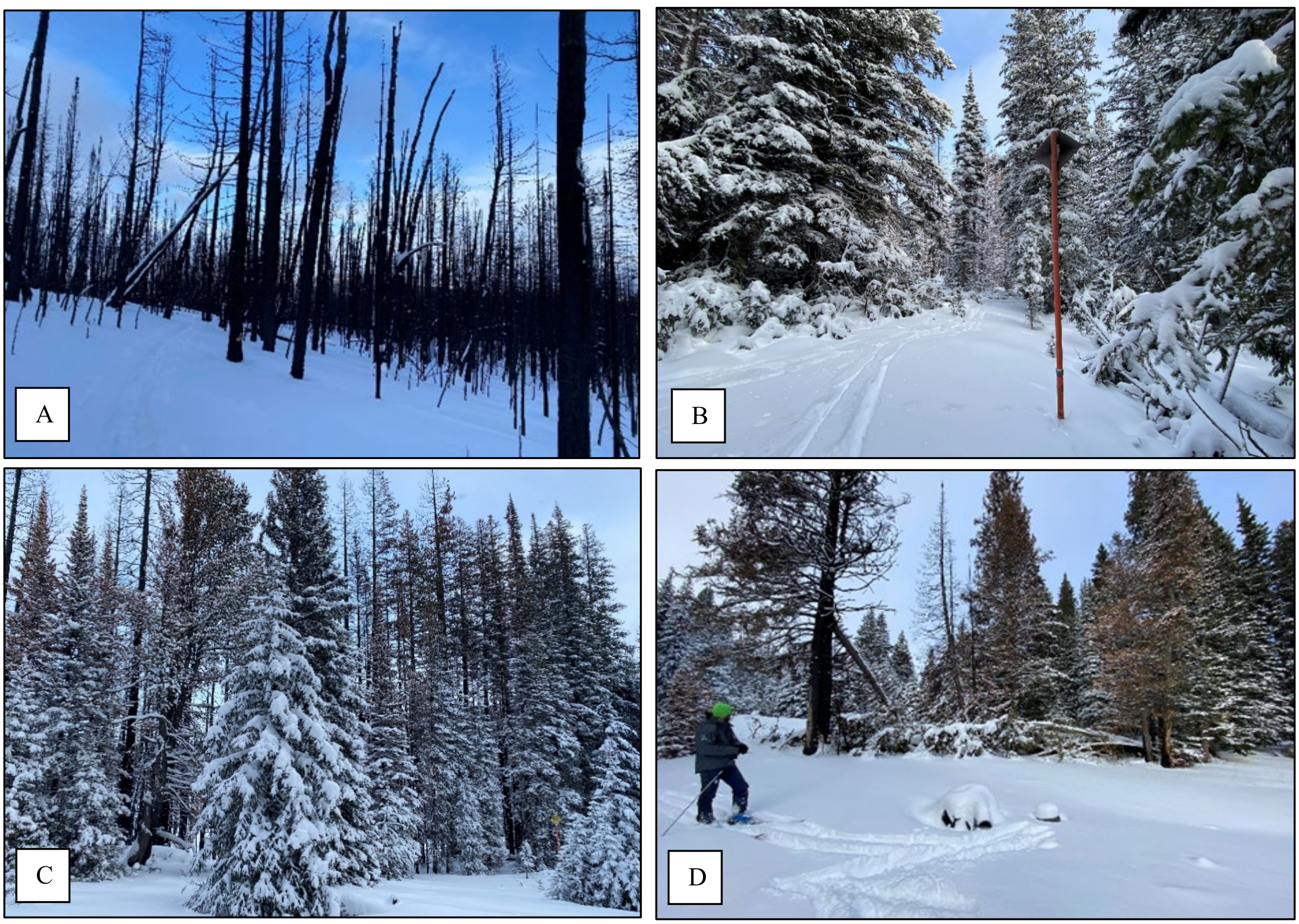
Operational News

Wildfire Impacts on Snowpack Measurements

2021 brought numerous wildfires across the Rocky Mountain West, made obvious by the thick smoke that blanketed Montana for much of the summer. Luckily, no SNOTEL sites burned entirely. Several had ground fires sweep through but larger equipment was spared. In July, two large fires, the Alder Creek and Christensen Fires, were ignited in the Pioneer Mountains, and threatened to burn Foolhen snow course which has been measured since 1961. Data from Foolhen snow course is important in calculating regional water supply forecasts and has been for decades.

In mid-December, two Montana Snow Survey staff visited Foolhen snow course on tracked ATVs and skis to assess fire effects on the snow course and its access routes. Fire maps indicated that all access routes and the snow course itself were within the fire perimeter, so we were prepared to find it entirely burned.

The twelve mile route in revealed a more nuanced story. Some stands of trees had indeed burned intensely, with just blackened trunks remaining, but others were only moderately burned, and some stands hadn't burned



The photos show: A) high intensity burn along the access route; B) east end of the snow course, with moderately burned trees visible in the background; C) west end of snow course, with moderately burned trees visible in the background; D) all that remains of the adjacent Foolhen Ranger Cabin.

at all. We arrived at the snow course to find that miraculously it was entirely unburned. Pockets of fire had swept through sections of forest only 50-100 yards from the snow course, but far enough away that it is unlikely that burned trees will fall into the snow course. A historic Forest Service cabin a few hundred yards away was less lucky, with only a potbelly stove surviving.

These findings mean that crews can continue to survey Foolhen snow course, and the data can continue to be used for forecasting. Accessing the snow course will become increasingly tricky as burned trees start falling across roads and trails. This is one reason why automated snow measuring stations like SNOTELs and SNOLITEs are helpful, as they report data hourly during the winter and can be visited during the summer when daylight is abundant and crews have more time to clear access routes.

The Updated NRCS Snow Survey Climate and Hydrologic Normals

As of October 1, 2021, all NRCS Snow Survey and Water Supply Forecasting (SSWSF) Program's graphs, maps and reports reference recently updated normals for the 1991-2020 time period.

What is a Normal?

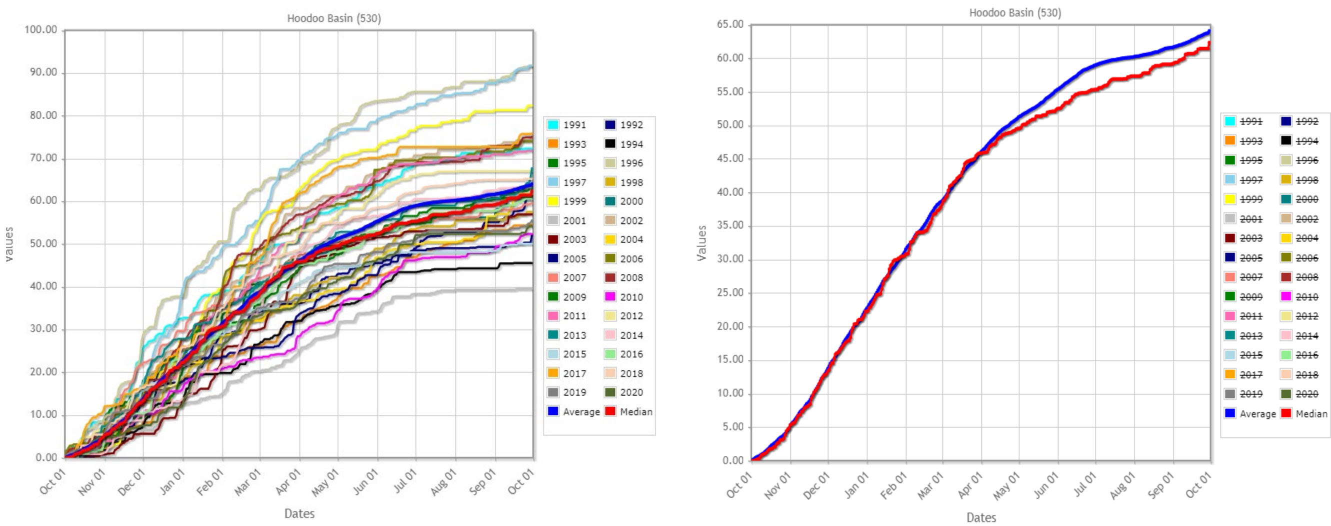
The SSWSF climate and hydrologic normals refer to a measure of central tendency (average or median) calculated over a specific time period. Normals provide a baseline or typical value of what has been previously observed at a specific station at a specific time of year. Normals are a useful reference to compare current (or past) data to; by calculating a percent of normal water users can easily assess how data compares to past conditions.

The SSWSF program calculates normals over a 30-year time period for the following parameters: snow water equivalent (SWE), snow depth, precipitation, streamflow and reservoir storage. The 30-year reference period is updated every 10 years in accordance with World Meteorological Organization (WMO) standards. The need to update normals from the 1981-2010 to 1991-2020 time period prompted the SSWSF program to evaluate the process and make some changes and improvements to the previous methodology.

What has changed?

The median is now used as the default (preferred) measure of central tendency for all data parameters. Prior to this update the median was used to represent the normal for SWE data, while the average was used for snow depth, precipitation, streamflow, and reservoir storage data. Both median and averages have been calculated for 1991-2020 and are available on the interactive map and other SSWSF tools.

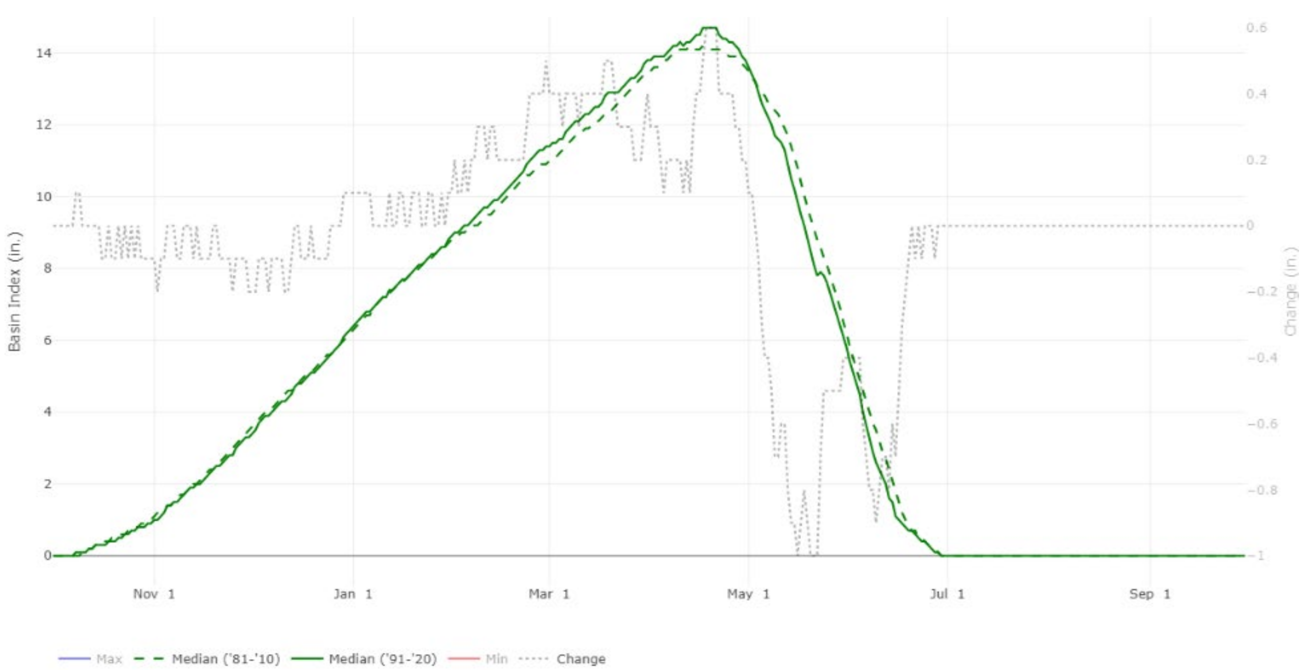
The statistical median of a dataset is the number where half the data points are lower, and half are higher – it's the exact middle of the dataset. The statistical average is the number resulting from the summation of all data points within the dataset divided by the total number of data points. The median and average are often quite similar but when outlier events (such as floods and droughts) are included in a dataset they tend to skew the average higher or lower than the median. The figures below displaying precipitation data at Hoodoo Basin SNOTEL demonstrate how the use of the median can result in lower normal values than using the average.



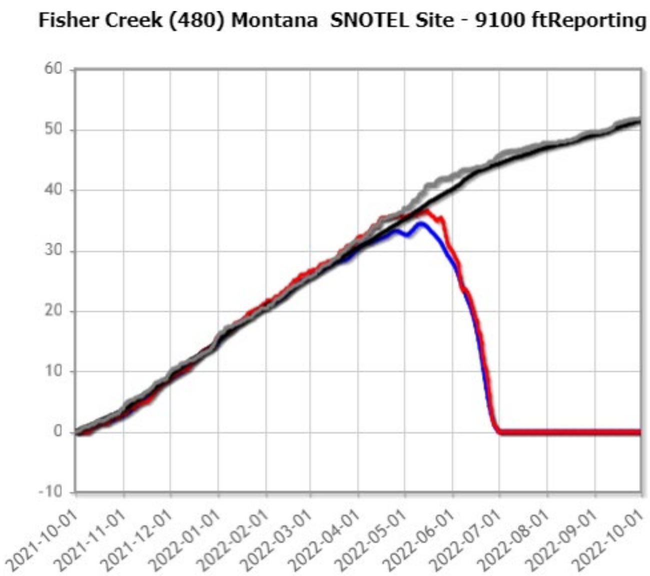
The left figure displays precipitation data for each year of the 1991-2020 period and the figure on the right shows the resulting normals for each day based on average (blue line) and median (red line).

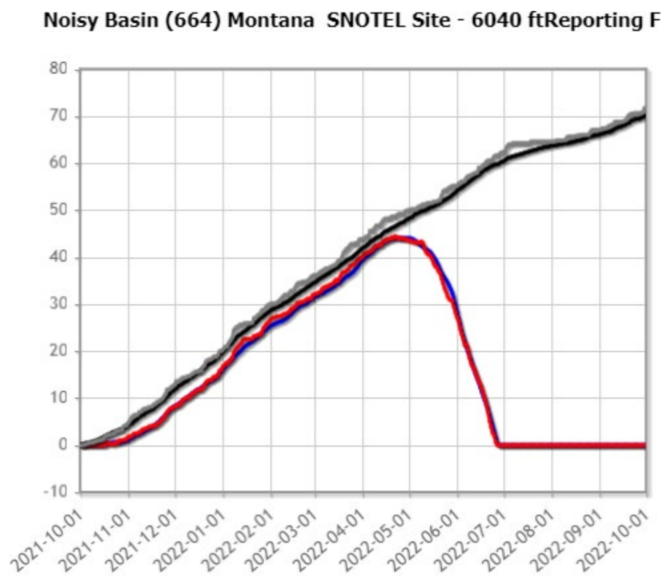
The reference period for all normals has been moved from 1981-2010 to 1991-2020. The impact of this shift in the reference period appears to be minimal when looking at the basin indices for the major basins in Montana. This is demonstrated in the plot below showing basin wide SWE normals for the Jefferson River Basin. The solid green line represents the 1991-2020 normals and the dotted green line represents 1981-2010.

Jefferson River Basin SWE Normals Comparison.



For individual SNOTEL sites, the normal for April 1 SWE, which is frequently used to represent the peak snowpack, has increased at 50 sites, and decreased at 25 sites (no change at 8 sites) for the 1991-2020 period relative to the 1981-2010. Comparing median annual precipitation for the 1991-2020 period to median annual precipitation for the 1981-2010 period provides similar results; the statistic increased at 49 sites and decreased at 31 sites (no change at 6 sites).





In the figures above the 1981-2010 SWE normals (blue line) are compared to the 1991-2020 SWE normals (red line) and the 1981-2010 precipitation normals (black line) are compared with the 1991-2020 precipitation normals (gray line) at two SNOTEL sites in Montana (Fisher Creek & Noisy Basin).

Several improvements were made to the methods used for calculating the 1991-2020 normals. (1) Normals are no longer subjected to a smoothing process. This change produces normals with a more jagged appearance, but the values are more accurate. (2) There is no longer the requirement for a data parameter to have serially complete data to calculate a normal which can mean that the number of observations used for a specific site or sensor may vary. (3) A minimum of 10 years of data for any parameter is required to calculate a normal. This change means that sites or sensors with a period-of-record shorter than 10 years will not have a normal to reference.

There are new snowpack statistics available to aid in snowpack and water resource analysis. This new suite of statistics is available for automated stations (SNOTEL) and provides information about normal seasonal snowpack characteristics. The seasonal statistics include medians and averages for: maximum seasonal SWE (peak SWE), the date of peak SWE, the SWE onset date, and the SWE melt-out date.

Where to find more information.

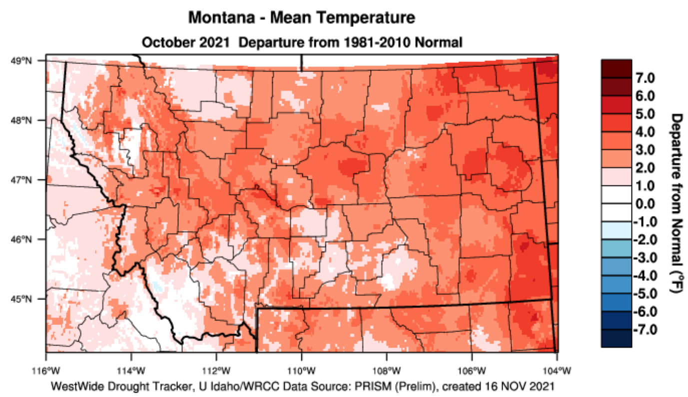
This is a very brief overview of the changes to the calculation methods used to update the SSWSF Climate and Hydrologic Normals. The National Water and Climate Center has developed a comprehensive Reference Guide which contains additional information and resources on this topic.

As always, the Montana Snow Survey staff is available to answer any questions and assist in any way.

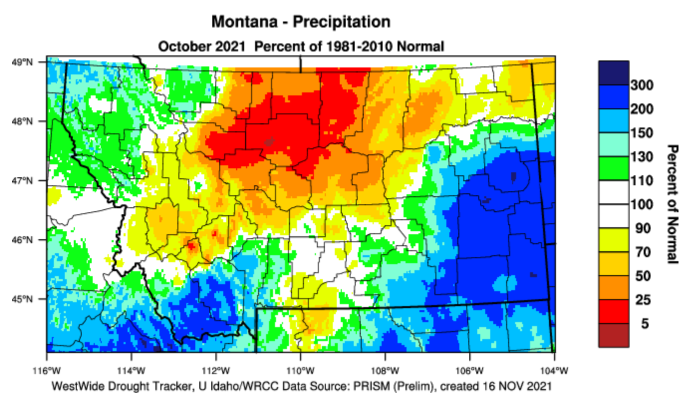
Weather and Climate

2022 is the second La Niña year in a row. La Niña typically brings increased chances of below normal temperatures and slightly increased chances of above normal precipitation to Montana, which together have the potential to benefit snowpack. The first few months of the 2022 water year only somewhat followed this pattern, but December started to see cooler temperatures and increased precipitation across the state, finally starting to build mountain snowpack.

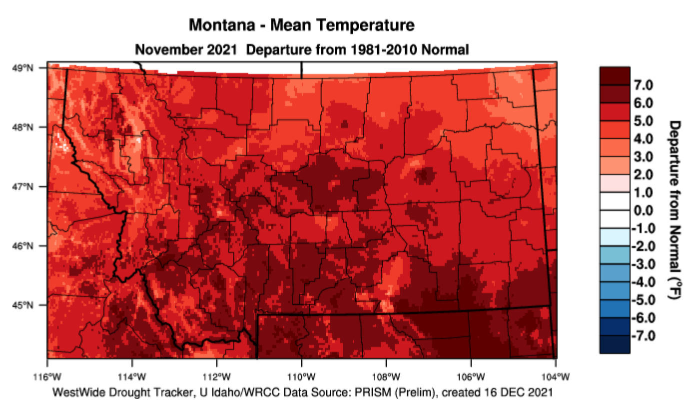
October and November were quite varied across Montana, with some parts of the state mild and dry, and others setting records for monthly precipitation. Circulation patterns in October were predominantly west to southwest flow, which brought warm air to the region. The middle part of the month saw a period of northwest flow, which brought cooler temperatures and the first snow to many parts of the state, though in most areas the snow was short-lived. The vast majority of Montana experienced above average temperatures for the month. The only exception was far southwest Montana, which had near average October temperatures.



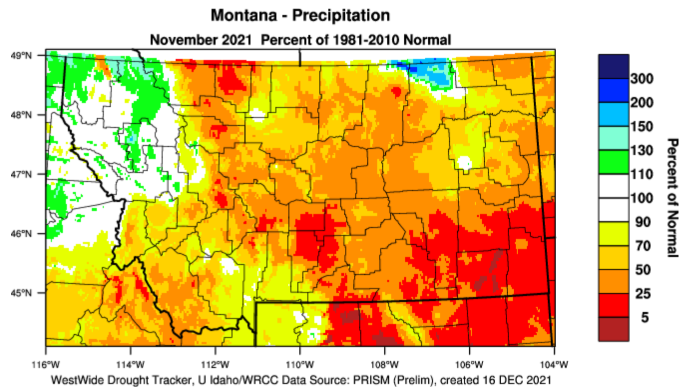
The north and central regions of Montana were very dry in October, which contrasted with the above normal precipitation received in the northwest, southwest, and southeast corners of the state. A handful of SNOTEL sites in the Beaverhead, Ruby, and Madison basins received record high October precipitation, while basins in north-central Montana received just an inch or two. Overall, October's warm temperatures and mostly dry conditions meant that for most of Montana, there was no appreciable snowpack at the end of the month.



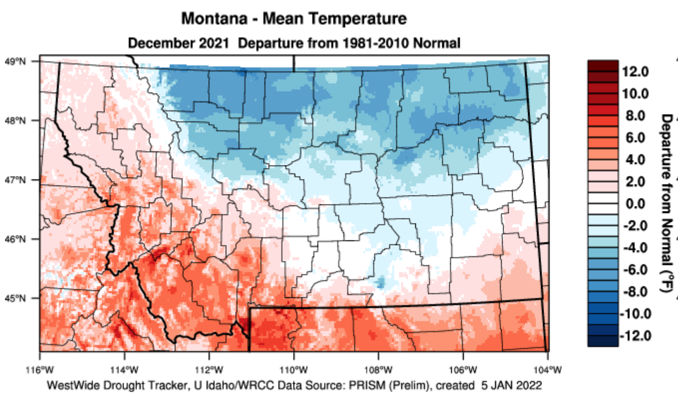
November brough little relief, and in fact was more anomalously warm than October across the entire state. Mountain temperatures were particularly high relative to normal, with many SNOTELs recording above freezing nighttime temperatures for consecutive nights. November was also notably drier than normal, and the precipitation that did fall was mostly rain.

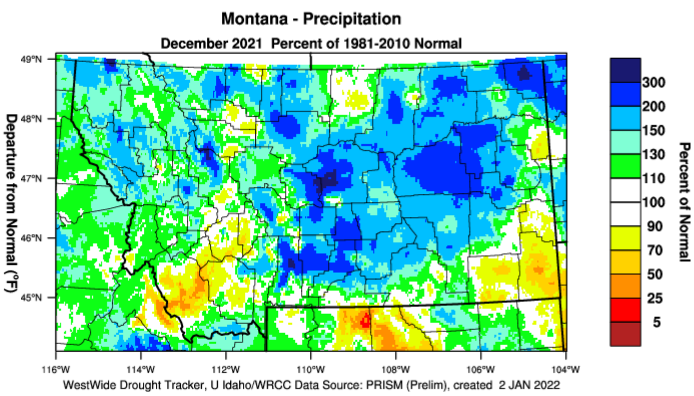


Three separate atmospheric rivers pummeled Washington and British Columbia in November, and some of the moisture made it to the far northwest corner of Montana. As a result, four SNOTEL sites in the Yaak, Kootenai, and Flathead basins recorded November precipitation amounts in the top five on record. This was a very different story from the majority of Montana, which was close to record low precipitation in central and eastern parts of the state.

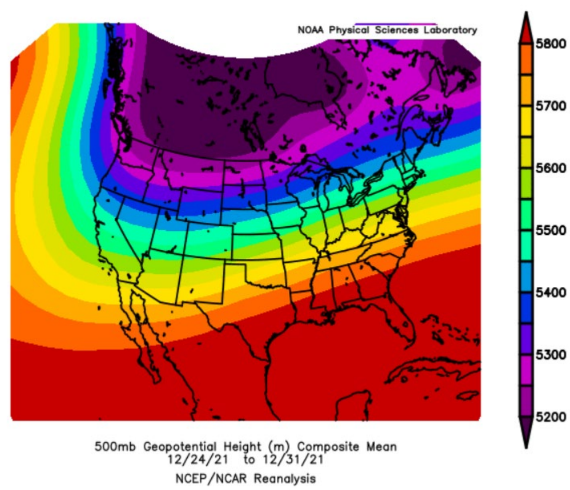


Overall, October and November were warmer and drier than usual, with a few local exceptions. In December, this pattern began to change. Shifting circulation brought Arctic air into the region and collided with moisture from the Pacific, which finally delivered snow and started building the snowpack in earnest.

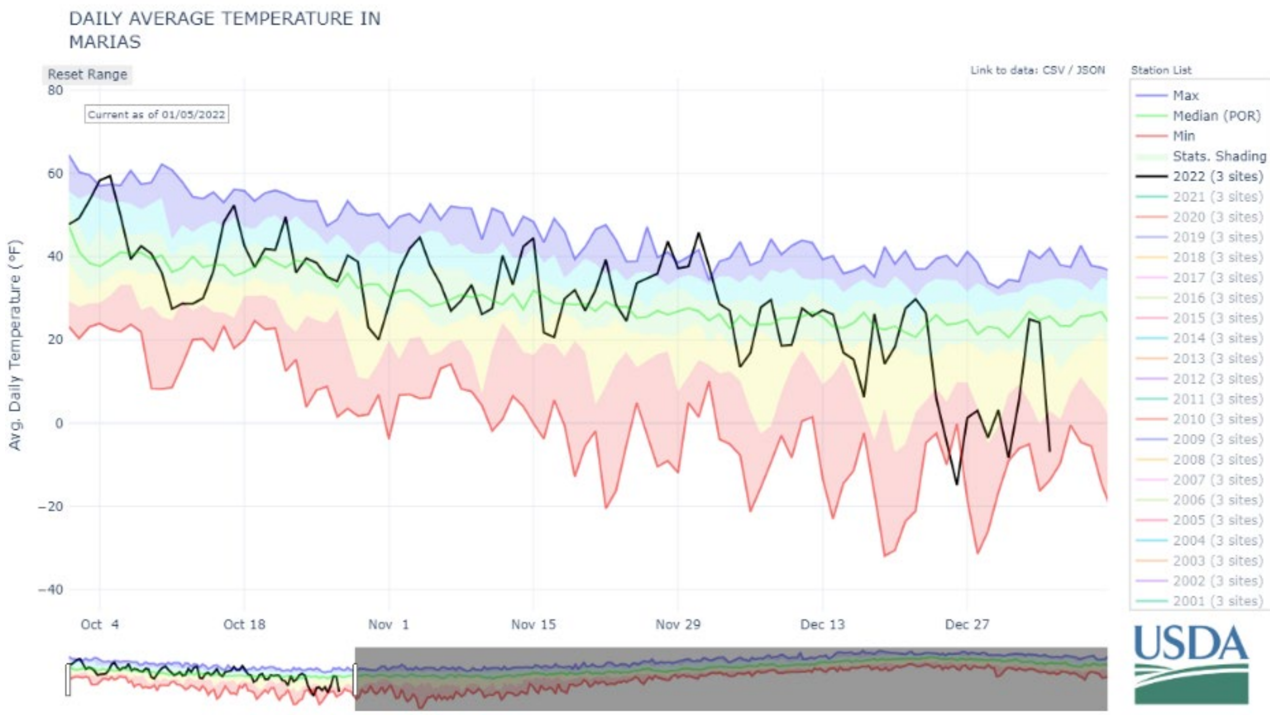




Most of Montana benefitted from the weather patterns in December, with most of the state receiving normal or above normal precipitation. The northern and eastern parts of the state were cooler than normal as Arctic air pushed south and east from Canada. Cold temperatures plus higher than normal precipitation translated to feet of new snow in many areas. The last week of December was particularly cold across the state as a large low-pressure system moved into the northern U.S. Between December 26 and January 1, temperatures were 10 to 25 degrees Fahrenheit lower than average across Montana, with the coldest temperatures in northern part of the state and at high elevations.

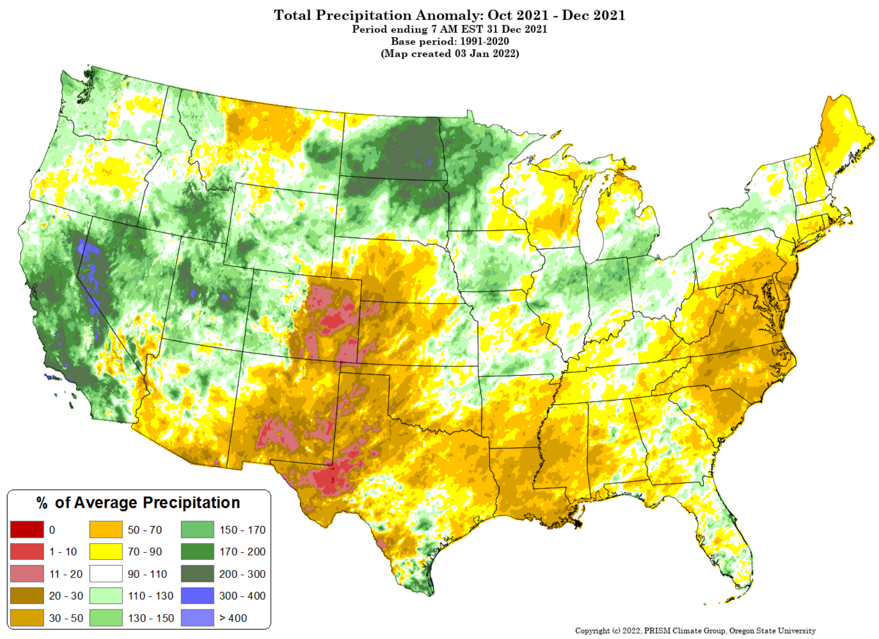


Average temperatures in the Marias Basin in northern Montana were well below average, even briefly dipping into record territory around December 26, as shown in the plot below. Most Montana basins show a similar [pattern](#).



Snowpack and Precipitation Overview

This water year started relatively slowly in terms of precipitation. October and November precipitation were well below normal across most of Montana. Exceptions were northwest Montana, which received above normal precipitation in October and November and portions of southwest Montana, which received above normal precipitation in October. Temperatures were above normal in October and November resulting in rain at all but the highest mountain locations.



Total Precipitation Anomoly. CONUS. Water Year 2022 to-date. Prism Climate Group

As of December 1, the snowpack was well below normal across Montana. At that time many SNOTEL sites across the state reported record low snowpack levels with several of the records dating back over 50 years. Fortunately, cold weather and exceptional precipitation in December improved snowpack conditions across the region.

During the month of December all SNOTEL sites in Montana received over 1 inch of precipitation. Several SNOTEL sites in the Kootenai and Flathead River basins received 10-14 inches of precipitation, which set new records for December. Portions of southwest Montana were also close to setting records for December. The bulk of this precipitation arrived during the second half of the month and it all arrived as snow. As of January 1, snowpack levels in northwest Montana are near normal, while the snowpack across the rest of Montana is overall below normal.

The good news is that there are still many months remaining in the snow accumulation season. The snowpack in Montana typically peaks in mid-April, which leaves plenty of time for snowpack conditions to improve. Many SNOTEL sites east of the continental divide are only 1-2 inches (snow water equivalent) shy of a normal snowpack. That could be recovered in a single storm. Overall, it is still too early to tell what the current snowpack will deliver during snowmelt season.

Basin-wide Snow Water Equivalent - January 1, 2021 vs. January 1, 2022

River Basin Name	January 2021 SWE % normal	January 2022 SWE % normal	Difference
Bear Paw	141%	91%	-50%
Beaverhead	69%	94%	+25%
Big Hole	81%	84%	+3%
Big Horn	78%	84%	+6%
Bitterroot	90%	91%	+1%
Blackfoot	84%	89%	+5%
Boulder (Jefferson)	93%	81%	-12%
Boulder (Yellowstone)	95%	88%	-7%
Clarks Fork Yellowstone	109%	95%	-14%
Fisher	98%	116%	+18%
Flathead Lake	99%	111%	+12%
Flint	83%	87%	+4%
Gallatin ab Gateway	75%	102%	+27%
Greybull-Wood	62%	71%	+9%
Helena Valley	96%	82%	-14%
Judith	86%	85%	-1%
Kootenai in Canada	100%	135%	+35%
Kootenai in Montana	96%	114%	+18%
Little Bitterroot	84%	111%	+27%
Lower Clark Fork	92%	110%	+18%
Madison ab Hebgen	71%	115%	+44%
Madison bw Hebgen	70%	101%	+31%
Marias	106%	91%	-15%
Middle Fork Flathead	114%	97%	-17%
Musselshell	85%	86%	+1%
North Fork Flathead	104%	112%	+8%
Northern Gallatin	82%	80%	-2%
Owl	62%	115%	+53%
Powder	71%	80%	+9%
Rock (Clark Fork)	83%	81%	-2%
Rock (Yellowstone)	97%	69%	-28%
Ruby	68%	78%	+10%
Shields	62%	57%	-5%
Shoshone	92%	90%	-2%
Smith	89%	78%	-11%
South Fork Flathead	90%	102%	+12%
Southern Flathead	98%	112%	+14%
St. Marys	121%	117%	-4%
Stillwater (Flathead)	86%	97%	+11%
Stillwater (Yellowstone)	99%	91%	-8%
Sun	102%	106%	+4%
Swan	95%	109%	+14%
Teton	106%	112%	+6%
Tongue	87%	81%	-6%
Upper Clark	81%	77%	-4%
Wind	86%	107%	+21%
Yaak	98%	106%	+8%
Yellowstone ab Livingston	98%	98%	+0%

Drought Information

The most recent National Drought Monitor map, released on December 28, 2021, shows 89% of the state of Montana in some category of drought designation.

This level of drought designation for the state, at this time of year, is striking. Looking back at the past decade the highest percentage of the state to be in drought designation at the start of the winter season was 52% on December 26, 2017. To find comparisons close to the recent map you have to look back to the early 2000s.

Conditions have improved somewhat from the beginning of the water year. Following an exceptionaly dry summer season 100% of the state was classified as severe to exceptional drought (D2 – D4) as as shown in the map from September 28, 2021.

December finally brought much needed moisture in the form of snow to Montana. As a result many areas have seen drought designation improvements. It is especially noteworthy in the NW region where precipitation has been well above normal.

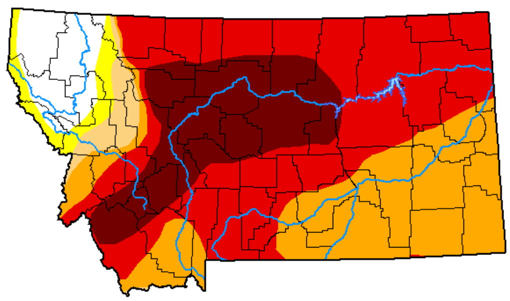
U.S. Drought Monitor

Montana

December 28, 2021

(Released Thursday, Dec. 30, 2021)

Valid 7 a.m. EST



Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	7.38	92.62	89.37	86.35	59.77	20.15
Last Week *12-21-2021*	0.00	100.00	92.53	89.13	61.51	20.15
3 Months Ago *09-28-2021*	0.00	100.00	100.00	100.00	65.68	21.91
Start of Calendar Year *12-29-2020*	36.37	63.63	34.41	8.27	0.36	0.00
Start of Water Year *09-28-2021*	0.00	100.00	100.00	100.00	65.68	21.91
One Year Ago *12-29-2020*	36.37	63.63	34.41	8.27	0.36	0.00

Intensity:

None
D0 Abnormally Dry
D1 Moderate Drought
D2 Severe Drought
D3 Extreme Drought
D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to https://droughtmonitor.unl.edu/About.aspx

Author:
Brad Pugh
CPC/NOAA

droughtmonitor.unl.edu

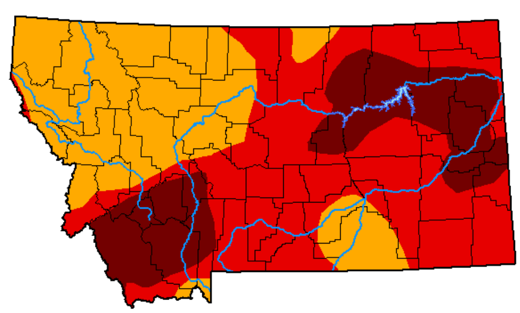
U.S. Drought Monitor

Montana

September 28, 2021

(Released Thursday, Sep. 30, 2021)

Valid 8 a.m. EDT



Drought Conditions (Percent Area)

	None	D0-D4	D1-D4	D2-D4	D3-D4	D4
Current	0.00	100.00	100.00	100.00	65.68	21.91
Last Week *09-21-2021*	0.00	100.00	100.00	98.70	65.18	20.37
3 Months Ago *06-29-2021*	7.49	92.51	78.41	60.96	19.94	0.00
Start of Calendar Year *12-29-2020*	36.37	63.63	34.41	8.27	0.36	0.00
Start of Water Year *09-29-2020*	11.86	88.14	40.59	4.22	0.02	0.00
One Year Ago *09-29-2020*	11.86	88.14	40.59	4.22	0.02	0.00

Intensity:

None
D0 Abnormally Dry
D1 Moderate Drought
D2 Severe Drought
D3 Extreme Drought
D4 Exceptional Drought

The Drought Monitor focuses on broad-scale conditions. Local conditions may vary. For more information on the Drought Monitor, go to https://droughtmonitor.unl.edu/About.aspx

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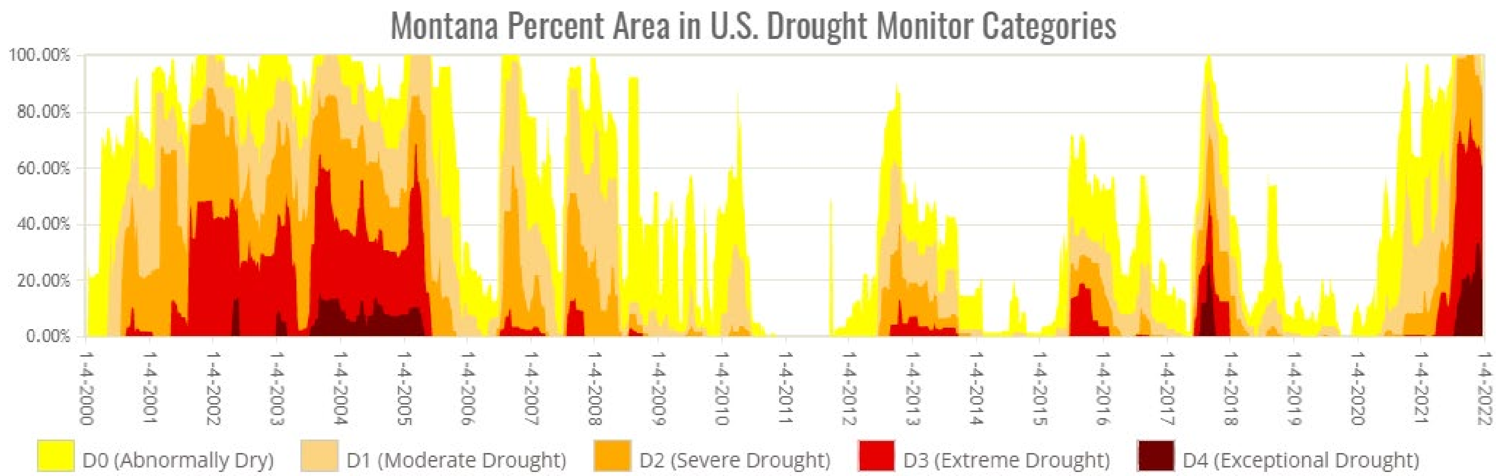
The time series plot below shows the history of the U.S. Drought Monitor which began in 2000. As indicated by the plot the period in the early 2000s brought severe and prolonged drought to Montana as well as most regions of the West. Late 2001 was the first time that 100% of the state of Montana was categorized in drought status (D1-D4) and the state reached 100% drought designation numerous times from 2001 to 2005.

What is notable about the drought that Montana experienced this past summer (and is still experiencing) is that September 2021 was the first time that 100% of the state was categorized as **severe to exceptional** drought (D2-D4). The state also saw the highest percentages of extreme to exceptional drought classification (up to 79%) in the history of the drought monitor.



If you would like more information about current drought conditions or require assistance due to drought, the links below can help you gather information and assist you in getting in touch with the appropriate agencies.

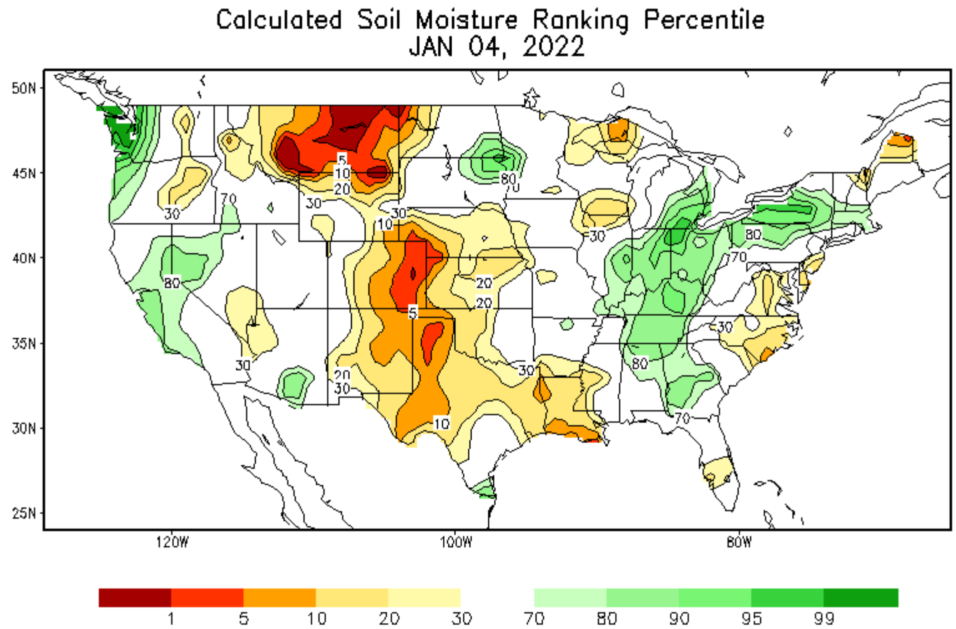
Drought Links:

- U.S. Drought Monitor
- National Integrated Drought Information System
- 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

Soil Moisture

Modeled Soil Moisture, shown to the right, for January 4, 2022, indicates that soils are in the lowest percentiles regarding moisture content for this date across the state. The largest deficits are in SW Montana and the northern plains region.

Soil moisture deficits can have significant impacts on surface water runoff come spring and summer as any accumulated snowpack will first be used to infiltrate and recharge dry soils



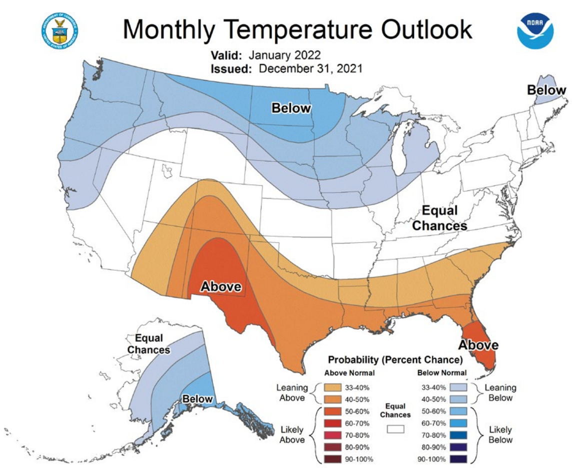
Reservoirs - Overview

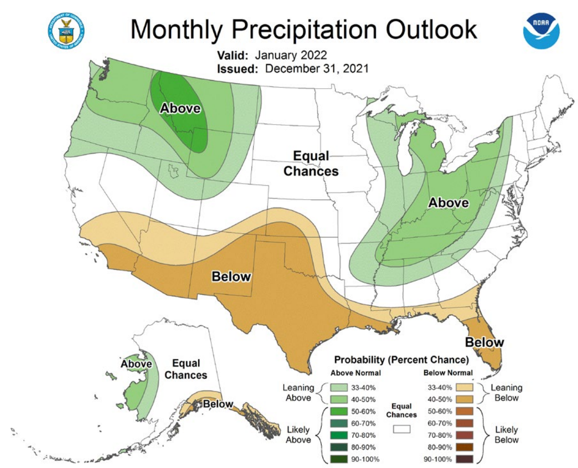
Currently reservoir storage levels range from [well below normal to above normal](). Gibson, Swift, Fresno, and Nelson reservoirs are at lower end of the range (60-70%). Mystic, Como, Hungry Horse, and Lake Frances are all above normal (110-130%). All other reservoirs in the region are near normal. In general reservoir levels are slightly lower than [last year at this time](), but higher than the last several months.

Weather and Climate Predictions

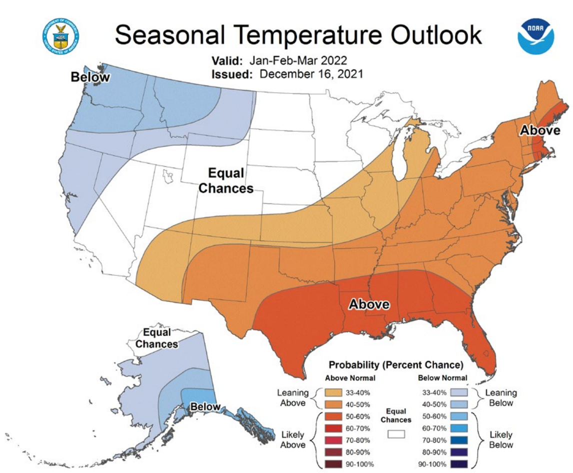
As we dive into the bulk of the winter season, the NOAA Climate Prediction Center is calling for a continuation of La Niña conditions into spring. This is reflected in long range predictions: both the one month and three month outlooks show Montana having increased chances of cooler than normal temperatures and higher than normal precipitation. These are probabilistic predictions and thus not a guarantee of any specific conditions, but the long range weather patterns do look to favor a snowier winter than usual, particularly in the next month.

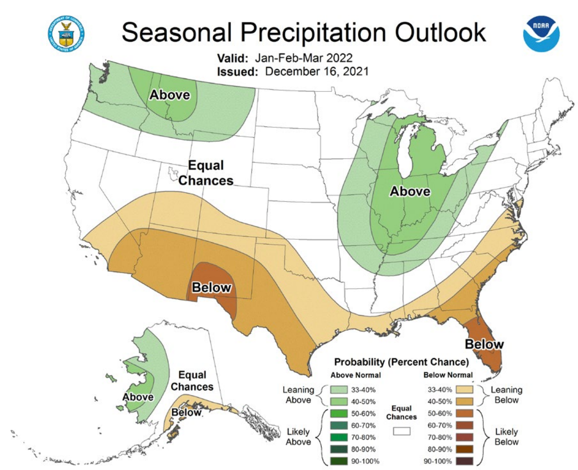
One Month Outlook





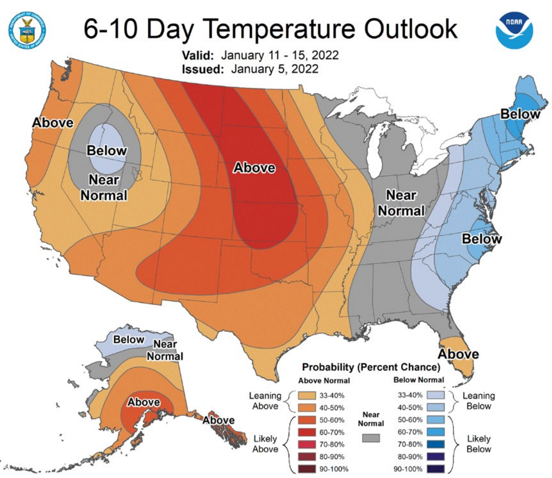
Three Month Outlook

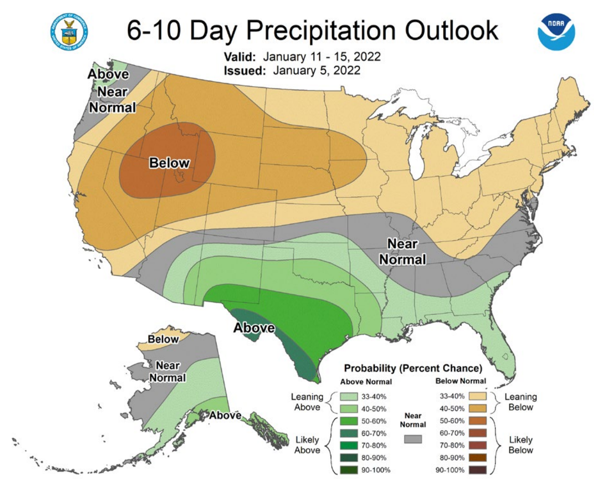




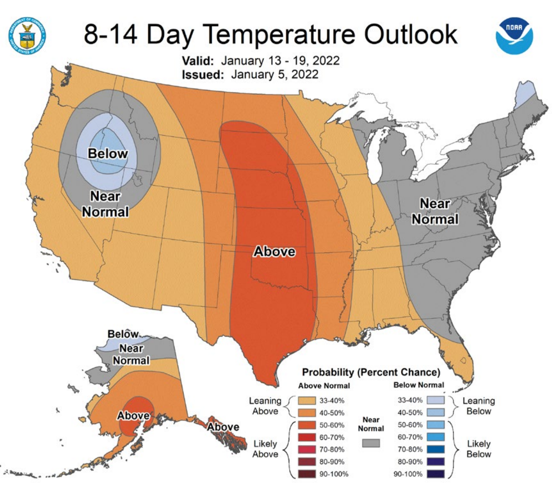
The short term 6-10 day outlook shows the opposite of the long term outlook: higher probability of warmer than normal temperatures and lower than normal precipitation. Looking just a few days further out and the 8-14 day outlook looks more like the long range prediction, with elevated chances for above normal precipitation. However, the 8-14 day outlook still shows an increased chance of above normal temperatures across Montana.

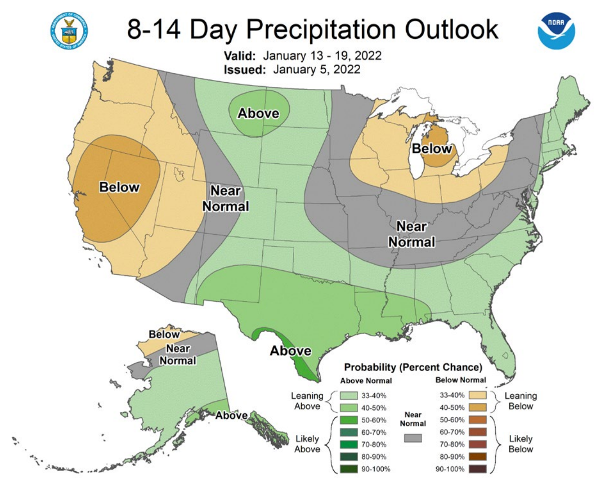
6-10 Day Outlook (as of Jan. 5, 2022)



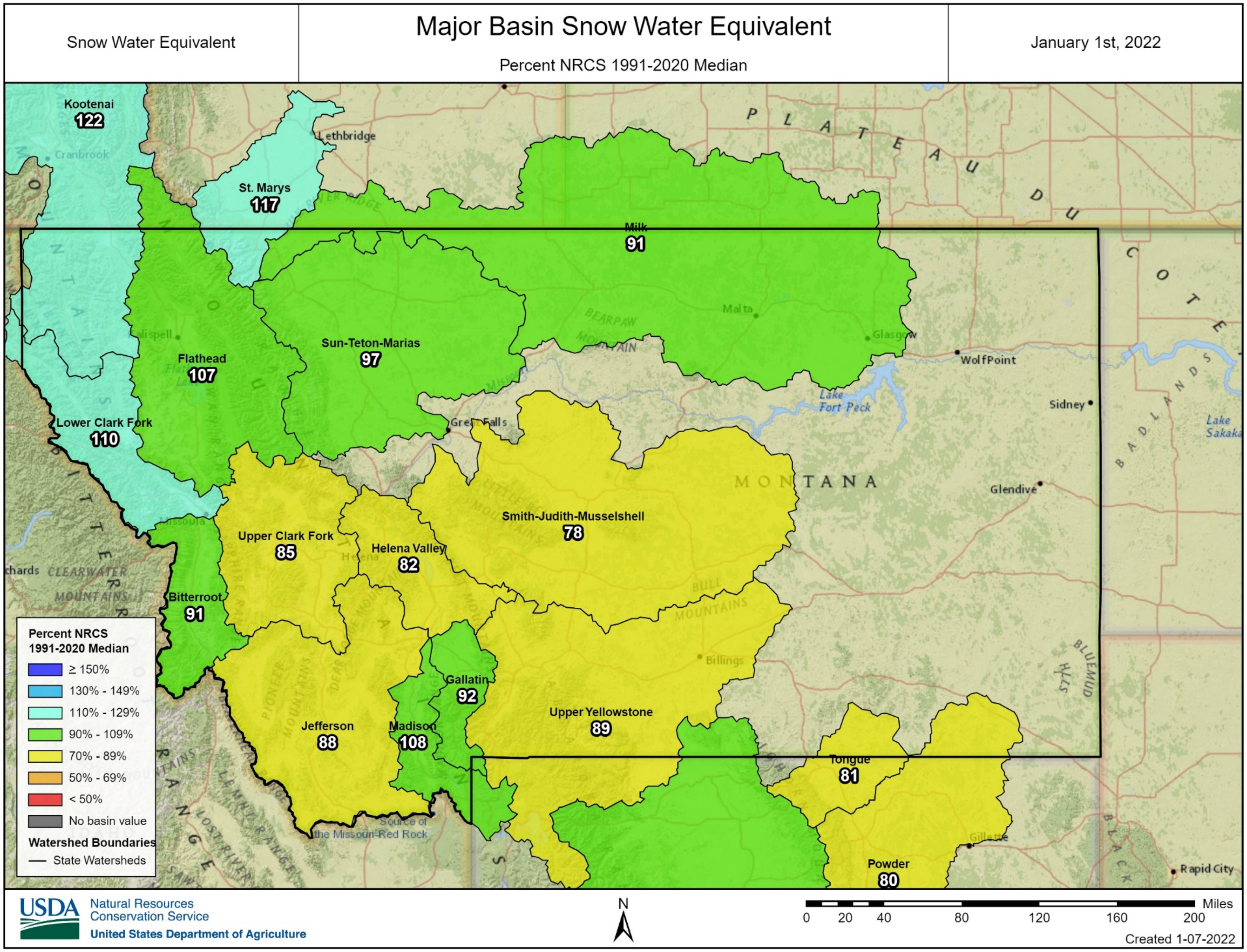


8-14 Day Outlook (as of Jan. 5, 2022)

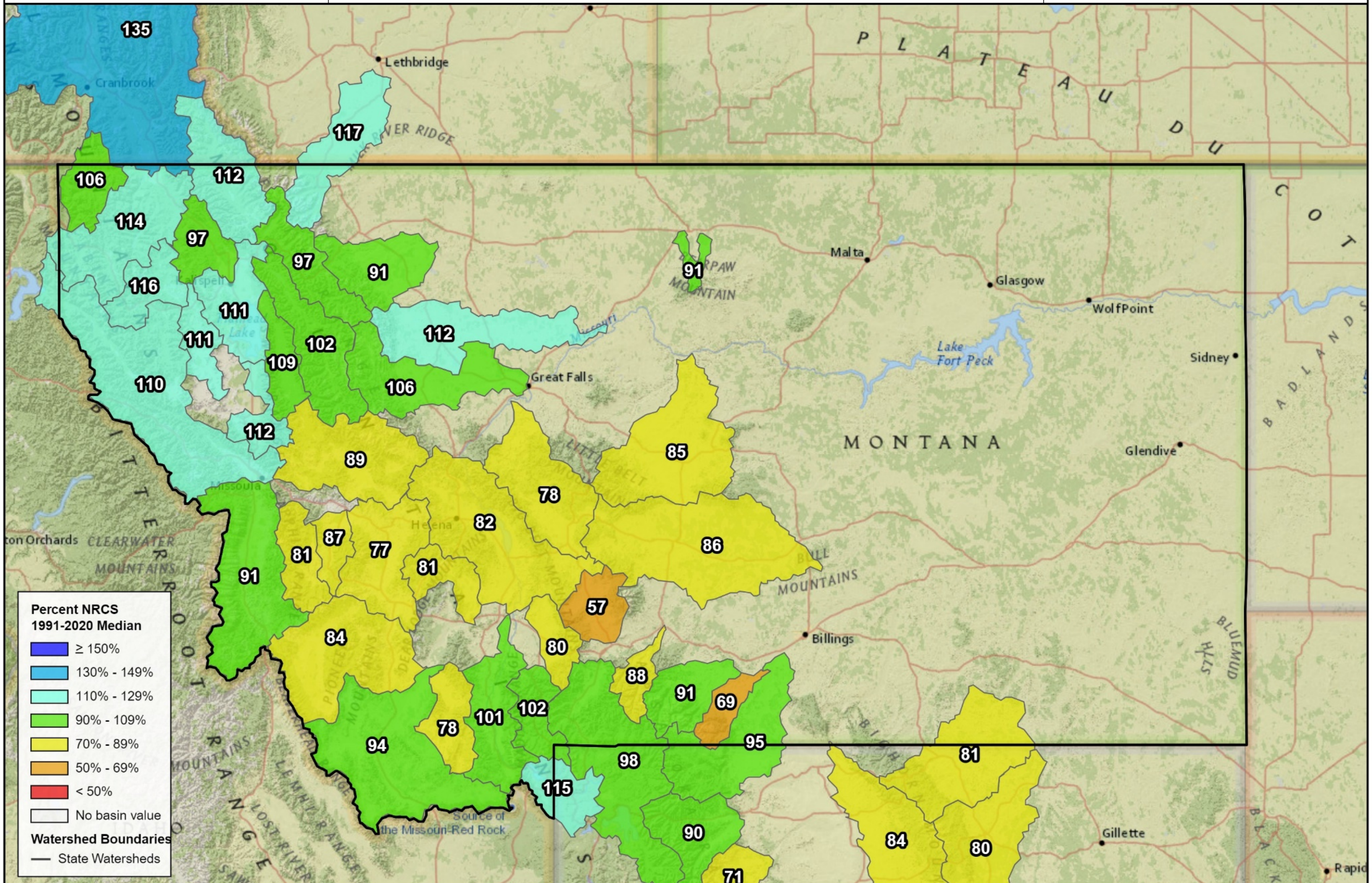




Maps


Snow Water Equivalent
Major Basin Snow Water Equivalent
Percent NRCS 1991-2020 Median
January 1st, 2022
Kootenai
122
St. Marys
117
Milk
91
Sun-Teton-Marias
97
Flathead
107
Lower Clark Fork
110
Smith-Judith-Musselshell
78
Upper Clark Fork
85
Helena Valley
82
Bitterroot
91
Gallatin
92
Upper Yellowstone
89
Jefferson
88
Madison
108
Tongue
81
Powder
80
Lethbridge
Cranbrook
Kalispell
Malta
Glasgow
Wolf Point
Sidney
Great Falls
Glendive
Helena
Missoula
Billings
Gillette
Rapid City
Lake Fort Peck
MONTANA
PLATEAU DU COTEAU
BADLANDS
BEARPAW MOUNTAIN
BULL MOUNTAINS
CLEARWATER MOUNTAINS
Source of the Missouri-Red Rock
Percent NRCS 1991-2020 Median
≥ 150%
130% - 149%
110% - 129%
90% - 109%
70% - 89%
50% - 69%
< 50%
No basin value
Watershed Boundaries
State Watersheds
USDA Natural Resources Conservation Service
United States Department of Agriculture
N
Miles
0 20 40 80 120 160 200
Created 1-07-2022

Snow Water Equivalent	Sub-Basin Snow Water Equivalent Percent NRCS 1991-2020 Median	January 1st, 2022



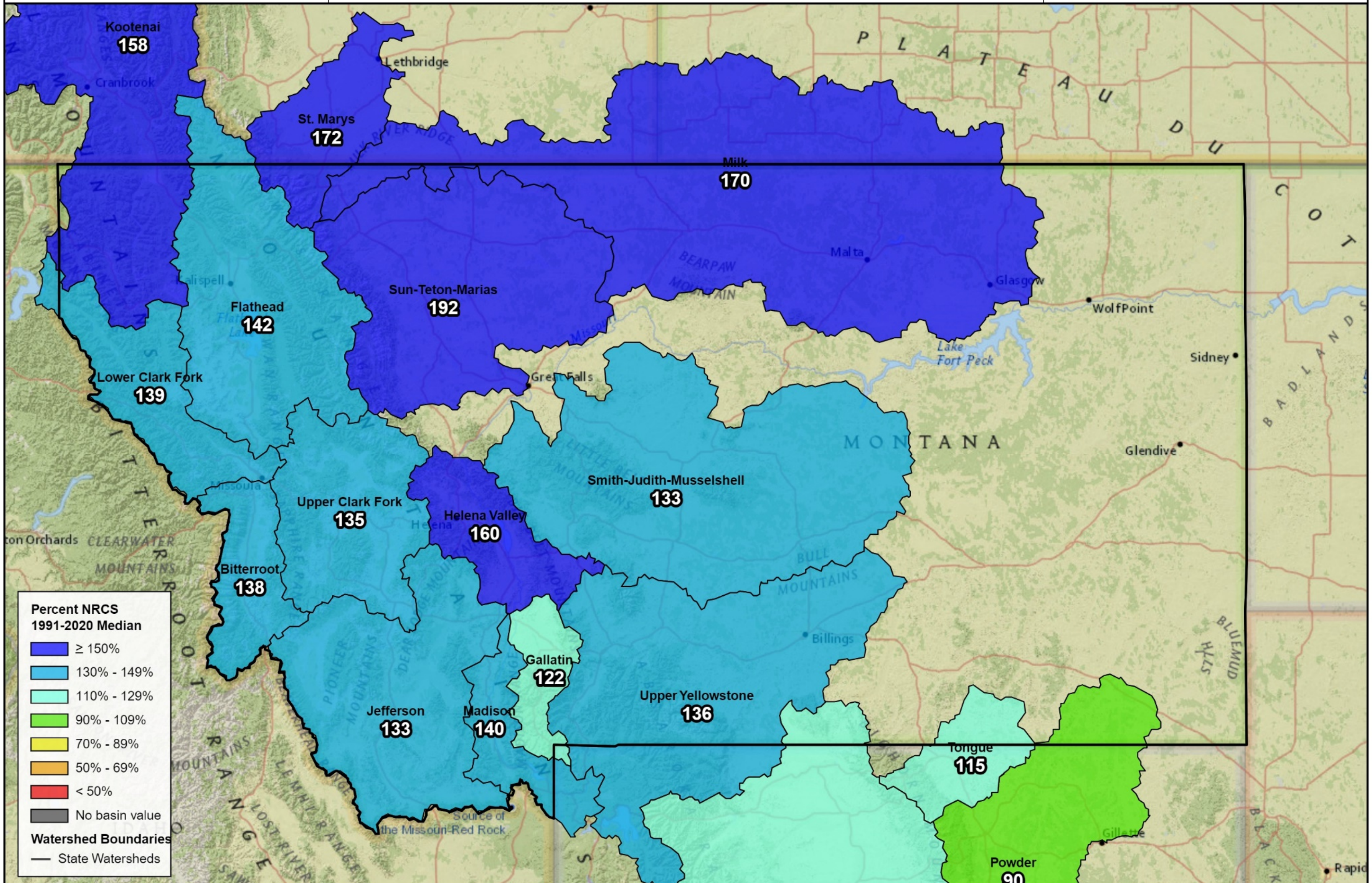
USDA Natural Resources Conservation Service
United States Department of Agriculture

N

0 20 40 80 120 160 200 Miles

Created 1-07-2022

1 month Precipitation	Monthly Basin Precipitation Percent NRCS 1991-2020 Median	December 1, 2021 - December 31, 2021



USDA Natural Resources Conservation Service
United States Department of Agriculture

N

Miles 0 20 40 80 120 160 200

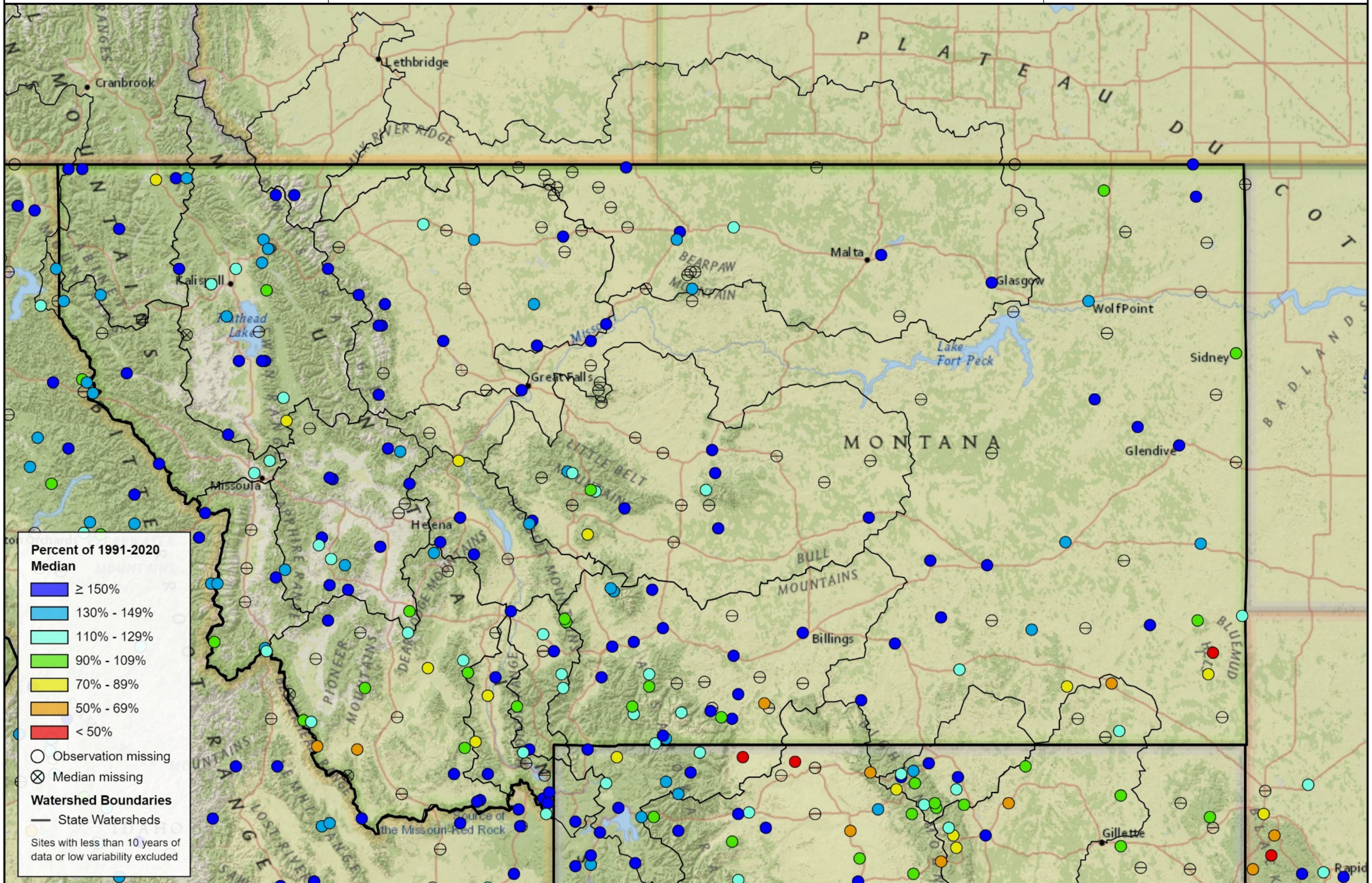
Created 1-07-2022

1 month Precipitation

Monthly Precipitation

Percent of 1991-2020 Median

December 1, 2021 -
December 31, 2021



USDA Natural Resources Conservation Service
United States Department of Agriculture

N

0 20 40 80 120 160 200 Miles

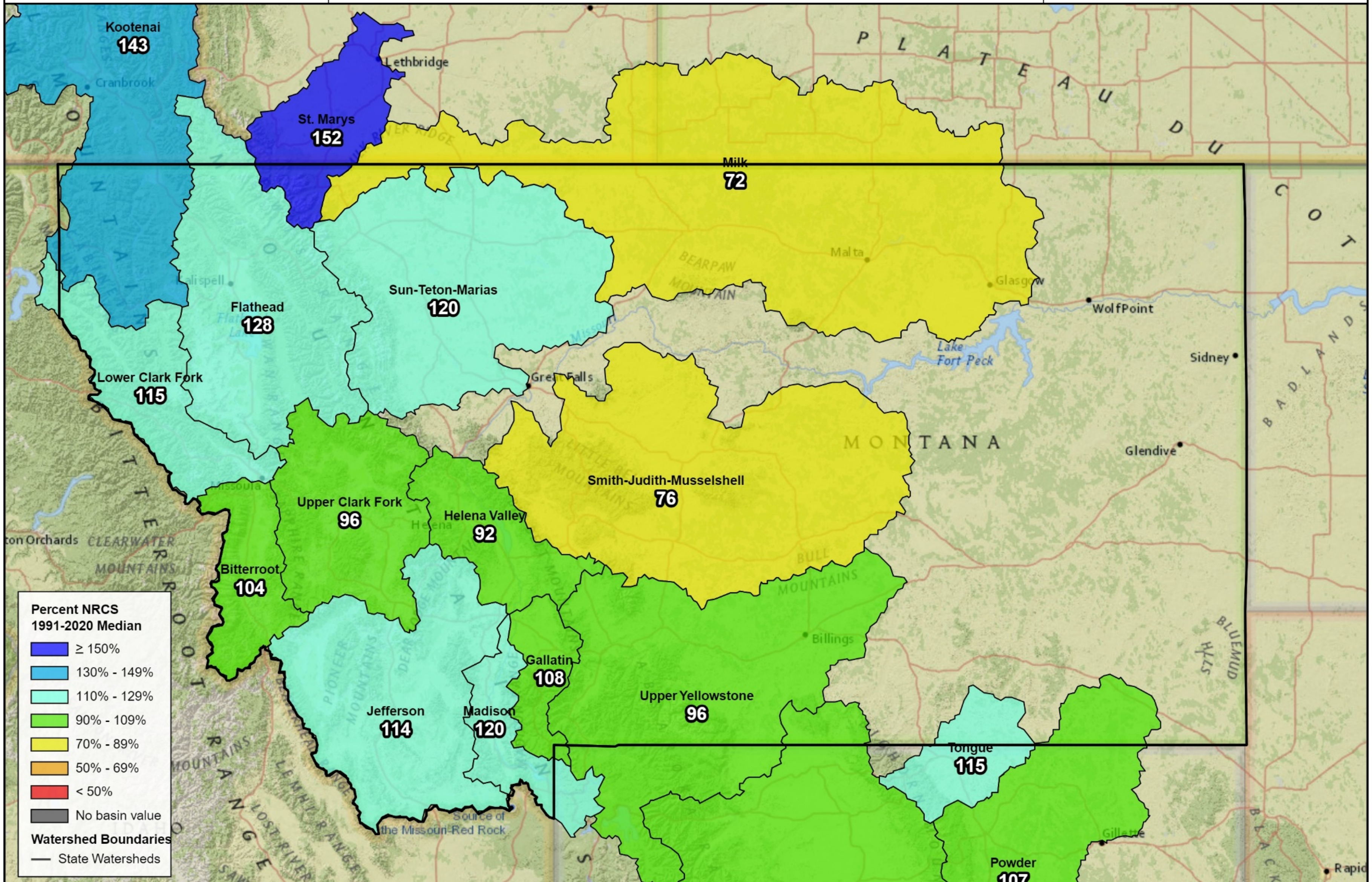
Created 1-07-2022

Water Year to Date Precipitation

Water Year Precipitation

Percent NRCS 1991-2020 Median

October 1, 2021 - December 31, 2021



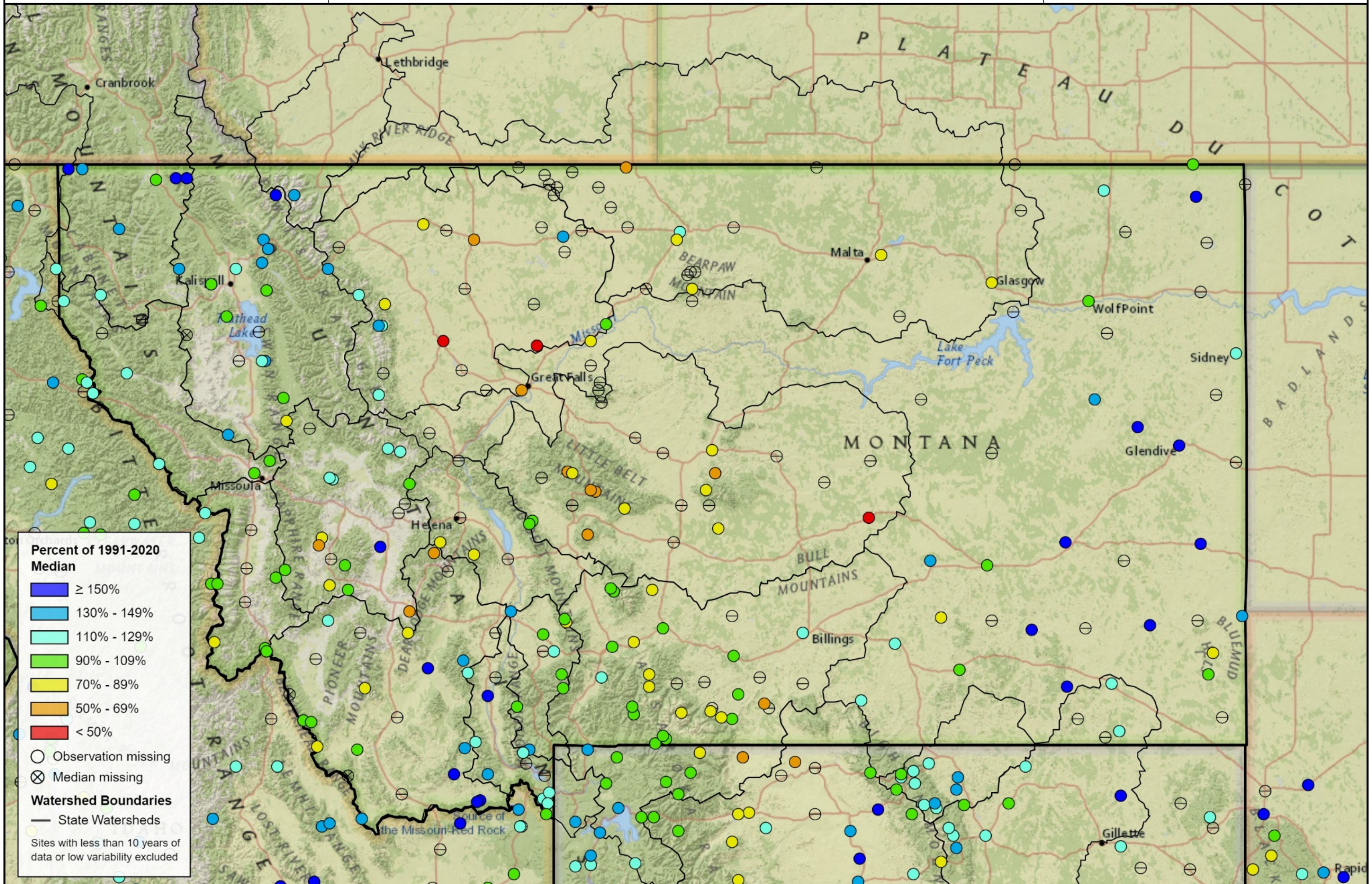
USDA Natural Resources Conservation Service
United States Department of Agriculture

N

0 20 40 80 120 160 200 Miles

Created 1-07-2022

Water Year to Date Precipitation	Water Year Precipitation Percent of 1991-2020 Median	October 1, 2021 - December 31, 2021



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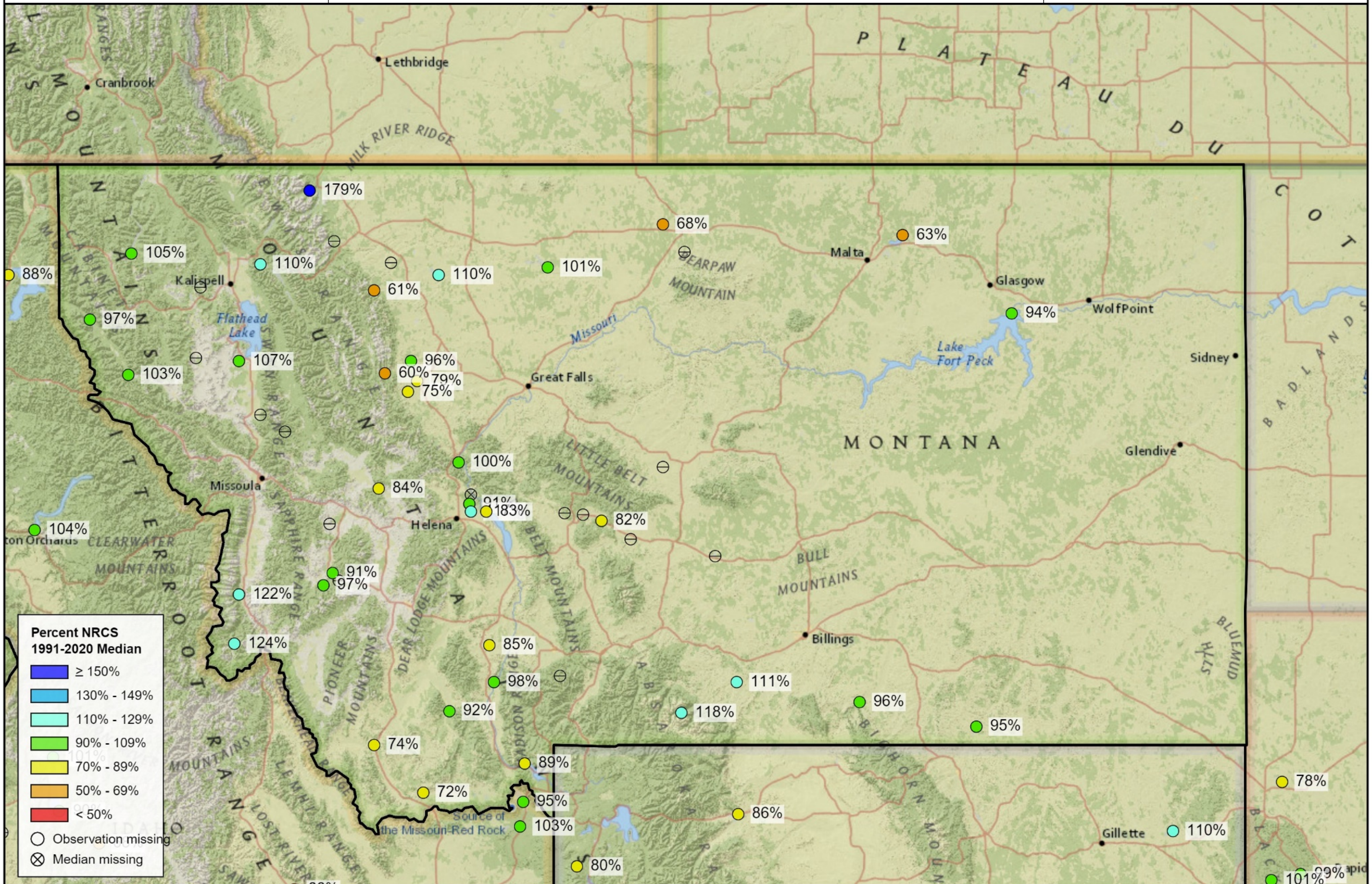
Reservoir Storage	Reservoir Storage Percent NRCS 1991-2020 Median	January 1st, 2022



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WSOR Web Page Access

The links below will take you to web pages dedicated to the individual river basins and statewide overview for presenting the monthly data. Users are encouraged to interact with the maps presented, select different maps using the drop-down menu, and hover over or click on points or basins of interest to view data and plots.

Monthly Data - Interactive Web Pages		
Monthly Data - Statewide Overview		
Monthly Statewide Overview		
Monthly Data - River Basin Summaries		
Columbia River Basin	**Missouri River Basin**	**Yellowstone River Basin**
Kootenai	Jefferson	U. Yellowstone
Flathead	Madison	Wyoming
Upper Clark	Gallatin	
Bitterroot	Helena Valley	
Lower Clark	Smith-Judith	
	Sun-Teton	
	St. Mary	
	Milk	

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Montana Water Supply Outlook Report

Natural Resources Conservation Service