Climate trends at the headwaters of the White River, water year 2025

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This report summarizes temperature and precipitation records from the Flat Tops region at the headwaters of the White River for water year 2025. It also includes flow records from the White River near Meeker, CO, along with analysis and brief commentary. The purpose of the report is to update regional climate and hydrologic data for reference by water managers and the public. Some data from the USGS gauging station and snotels are preliminary; USGS and NWCC have not completed data verification as of 11/15/2025.

Temperature and precipitation measurements come from the Ripple Creek Snotel (10,340 ft. elevation, Ripple Creek Snotel); and the Burro Mountain Snotel (9400 ft. elevation, Burro Mountain Snotel). I compare daily mean temperatures for water years 1987-1991 with daily mean temperatures for water years 2021-2025. I also plot trends in yearly accumulated precipitation from 1987 through 2025. Those dates include all available data from the snotels.

I analyze historical trends in White River discharge using data from the USGS continuous real time gauging station near Meeker (station 09304500) from water years 1910 through 2025. A "water year" in runs from October 1 to September 30 with year date in January as the designated water year identifier. Data analysis includes trends in total runoff, peak flow volume, timing of peak flow, April vs. June flow, and September flow.

I evaluate trends using Mann-Kendall statistics. Graphs show trend lines calculated by least squares.

<u>Summary of Results</u>

Mean daily temperatures on the Flat Tops have increased significantly from 1987 to the present (Figures 1 and 2).

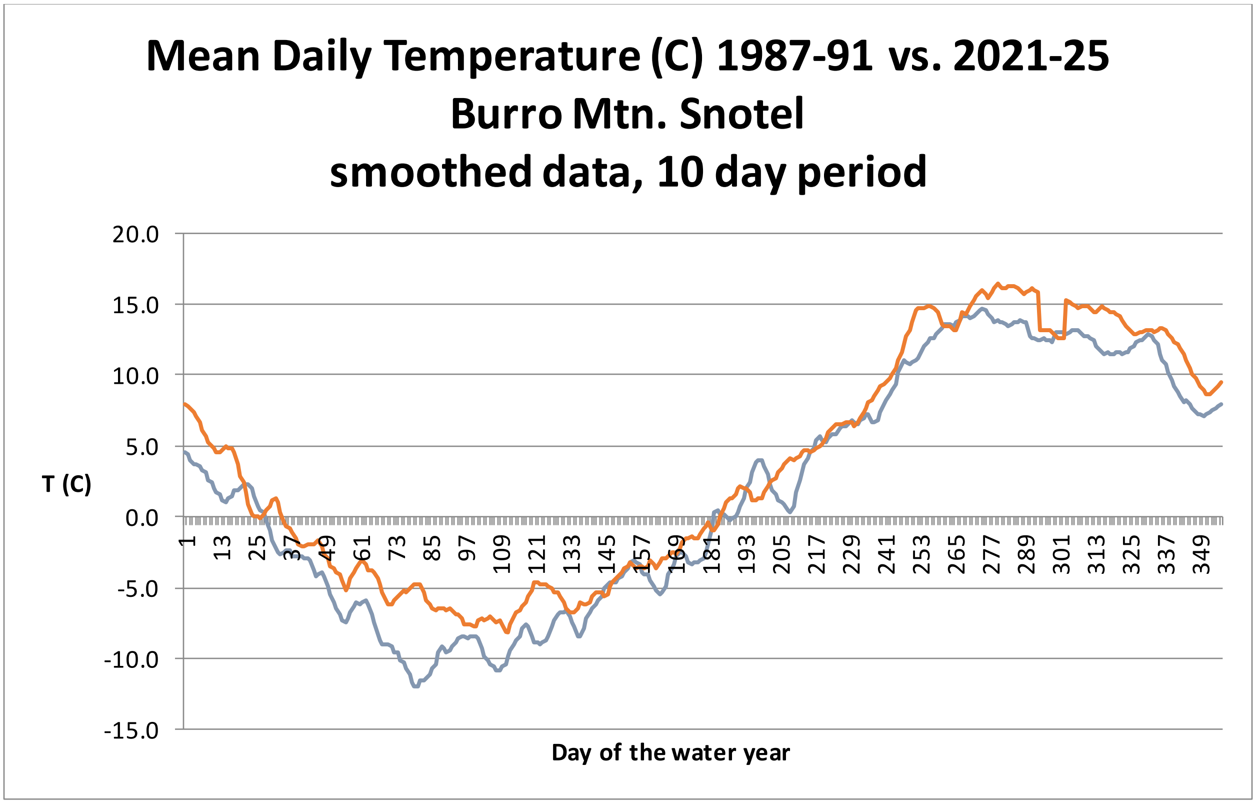
Cumulative yearly precipitation on the Flat Tops is decreasing. (Figure 3). Snowmelt trends earlier (Figure 4).

Peak runoff in the White River occurs earlier in the Spring and is trending toward lower volume (Figures 5, 6 and 7). April runoff is increasing (Figure 8). June runoff is trending downward (Figure 9), and September runoff has dropped dramatically (Figure 10). See comments accompanying the Figures for further analysis.

Our data show significant impact from the Elk Fire. Ash and debris flows into the river after the fire smothered benthic habitat. Those effects are evident in thicker river sediment and in measures of the macroinvertebrate community, especially aquatic insects (Figure 11). The Lee Fire most certainly caused similar damage to the river downstream from Meeker.

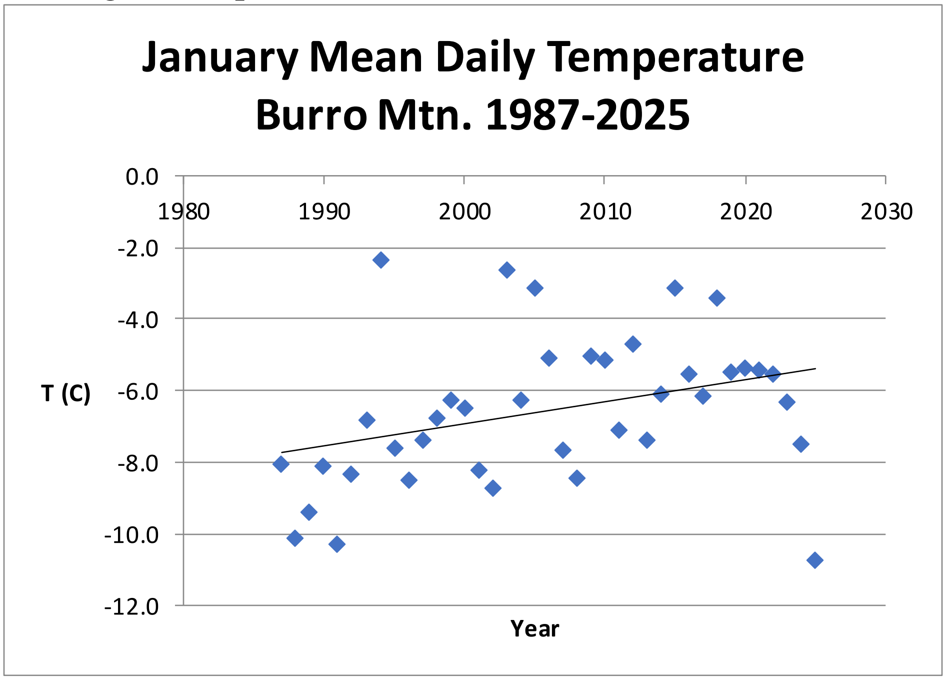
The patterns in temperature, precipitation, and runoff reported here are consistent with global and regional climate trends. See, for example, the *5th National Climate Assessment* (link in references at the end of this report). Global average temperatures are rising. Polar and alpine regions are changing more rapidly than global averages. The American Southwest is experiencing higher temperatures and longer episodes of drought. We start the new water year in persistent drought (Figure 12).

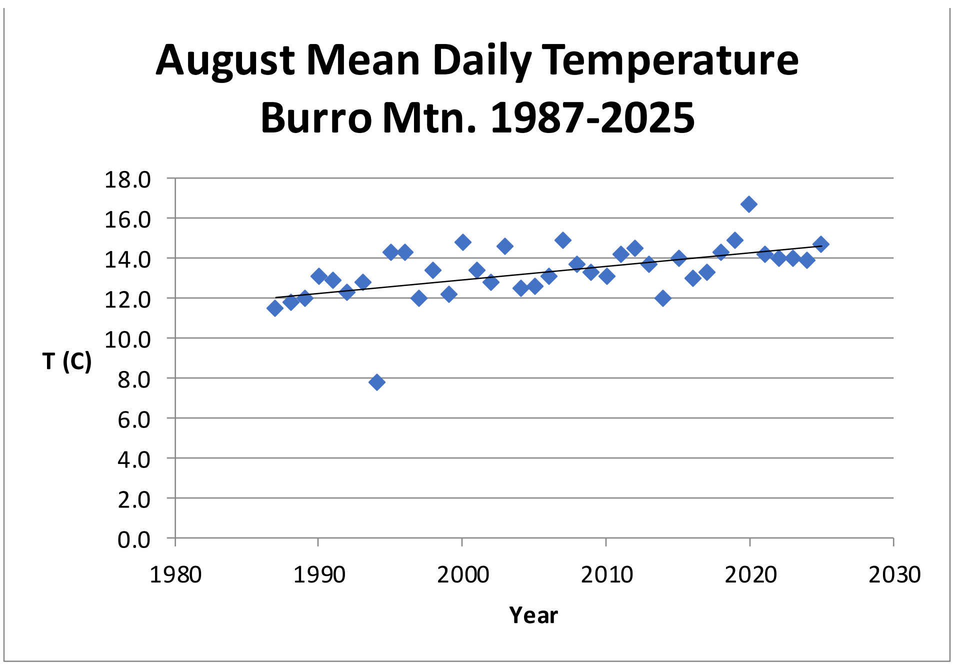
Figure 1a: Mean daily temperatures at Burro Mountain snotel, average of water years 1987-1991 (blue) vs. 2021-2025 (orange). The most recent 5-year average daily temperature is significantly greater than the 1987-91 average; t-stat = 11.4, $p \ll 0.001$, paired t-test, n = 366. Plot shows smoothed ten-day running mean.



Comment: Mean daily temperatures in recent years are significantly higher than when data collection began thirty-seven years ago. Other analyses of these data (not shown) document rising average daily mean temperatures at all three snotels in each successive five-year interval since 1987. The greatest increases in temperature occur in mid-winter and late summer. Temperature at Ripple Creek shows the same pattern as Burro Mountain.

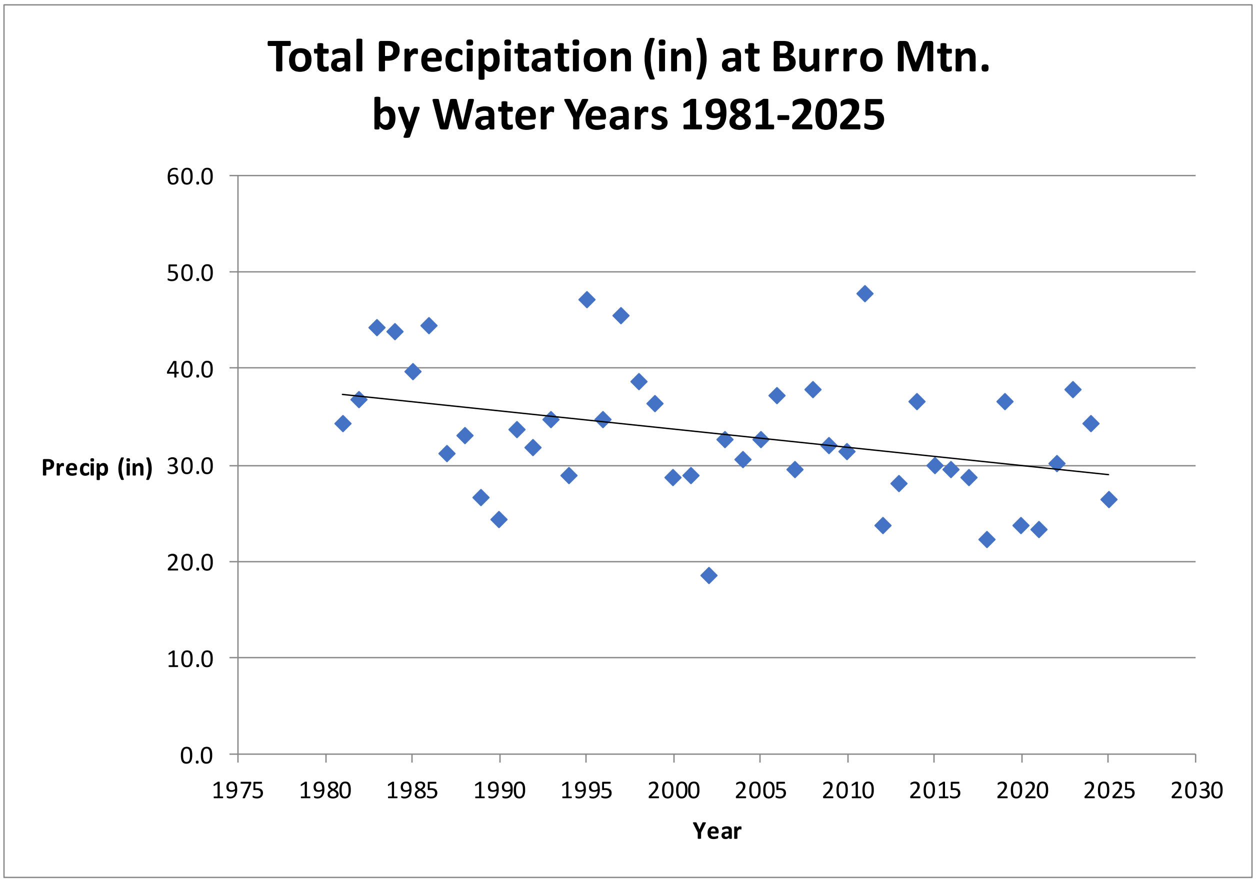
Figure 2. Mean daily temperatures in January and August at Burro Mtn, 1987 – 2025. Upward trend is significant; January Mann-Kendall S = 222, Z = 2.67, $Z_{critical}$ = 1.96, n = 39. August trend Mann-Kendall S = 309, Z = 3.73, n = 39. Trendline is best linear fit by least squares analysis. Ripple Creek shows the same January and August temperature trends as at Burro Mtn.





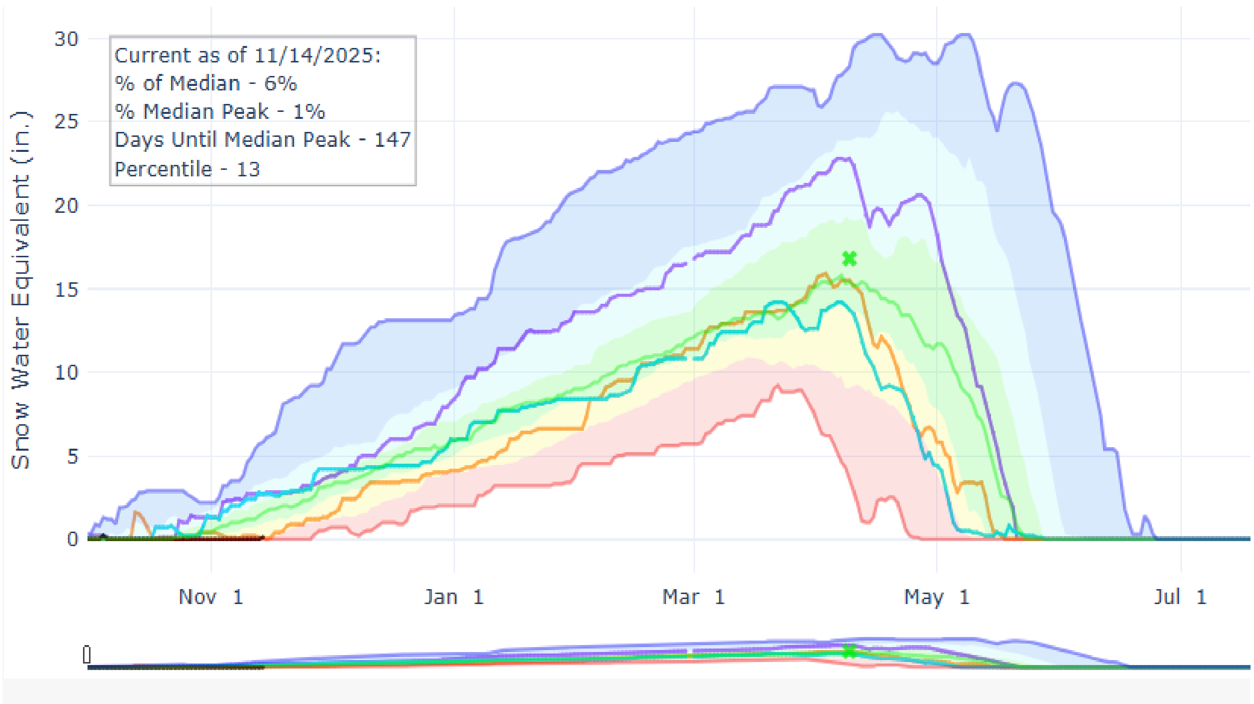
Comment: Mean daily temperatures in the Flat Tops are increasing. These observations are consistent with larger climate studies.

Figure 3. Cumulative yearly precipitation at Burro Mtn, water years 1981-2025. Burro Mtn Mann-Kendall S = -242, Z = -2.38, $Z_{critical}$ = -1.96, n = 45. Ripple Creek shows similar trends and statistics.



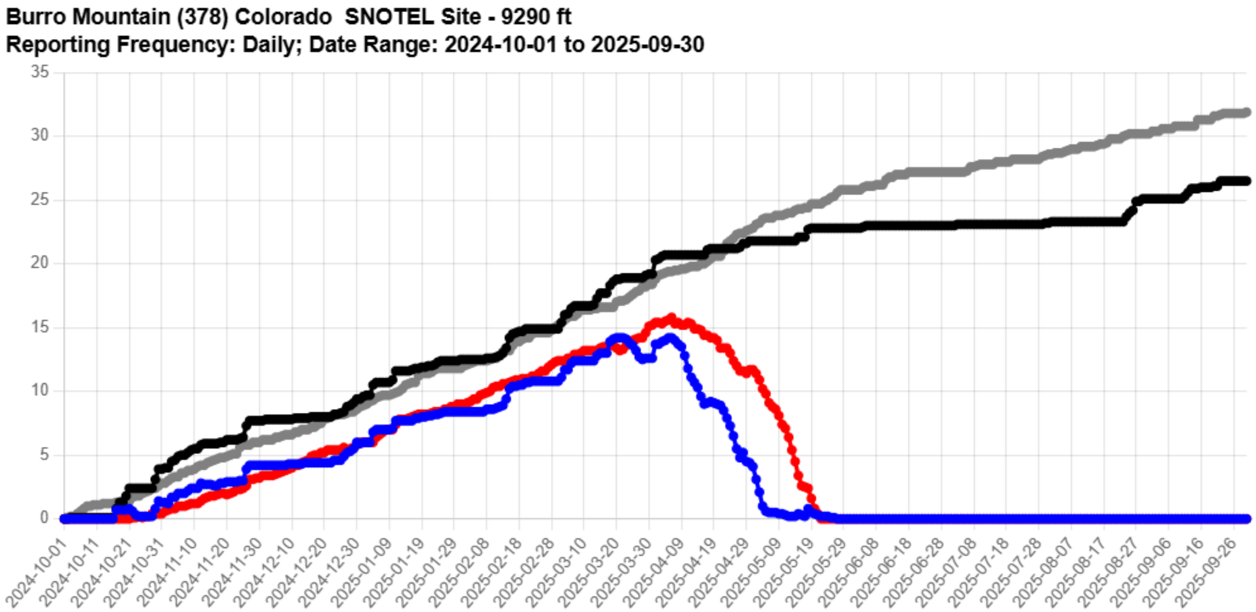
Comment: Precipitation on the Flat Tops is decreasing. There is less water, primarily from snowpack, for runoff into the headwaters of the White River.

Figure 4a. Snow water equivalent at Burro Mtn water years 2023 (purple), 2024 (orange), 2025 (green), and 2026 (black). Rainbow shading shows 20-percentile intervals for the period of record 1986-24: red shading (bottom 20th percentile) through blue (top 20th percentile). Graph source: USDA Natural Resources Conservation Service, NWCC Interactive Map. Data from Burro Mtn snotel.



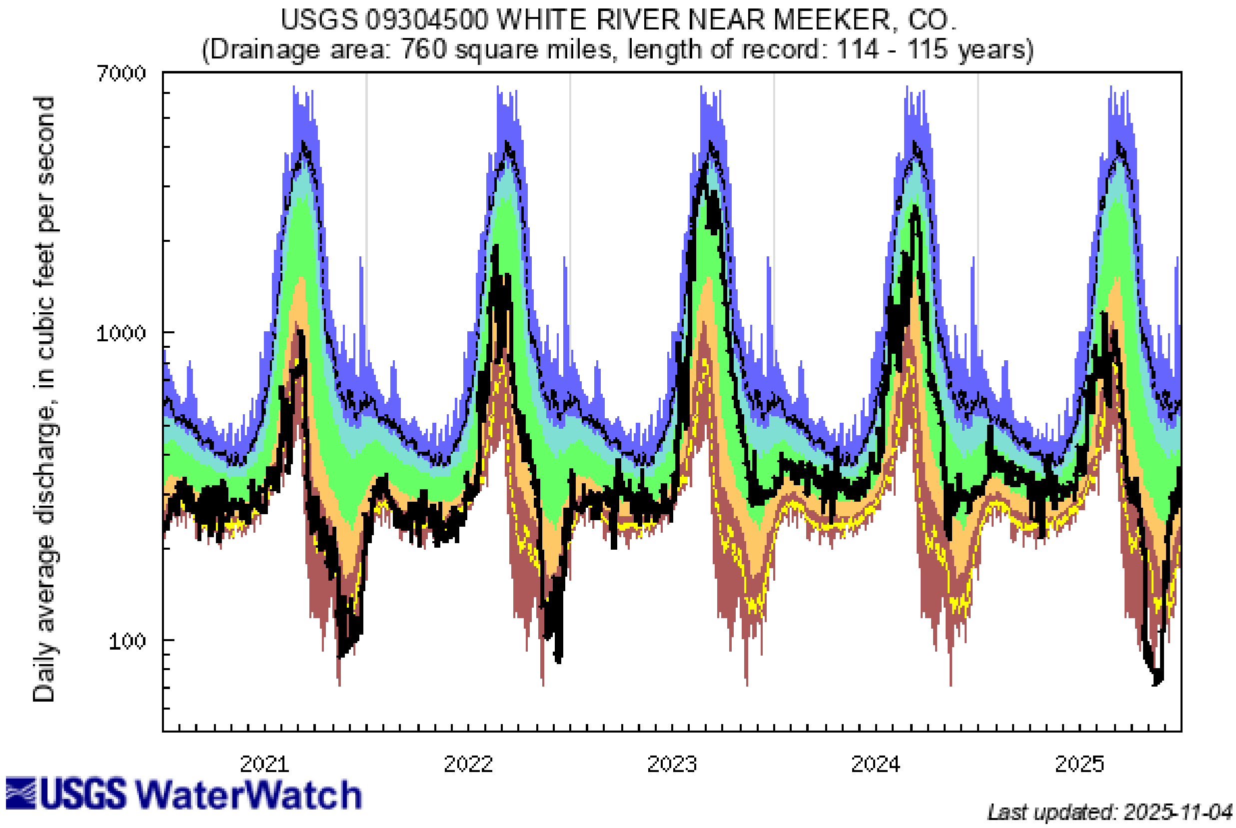
Comment: Snow water equivalent shows considerable year-to-year variability. Snow melt is trending earlier in the Spring.

Figure 4b. Burro Mtn 2025 daily snow water equivalent (blue) vs. 30-year median (red) and 2025 accumulated precipitation (black) vs. 30-year median (gray).



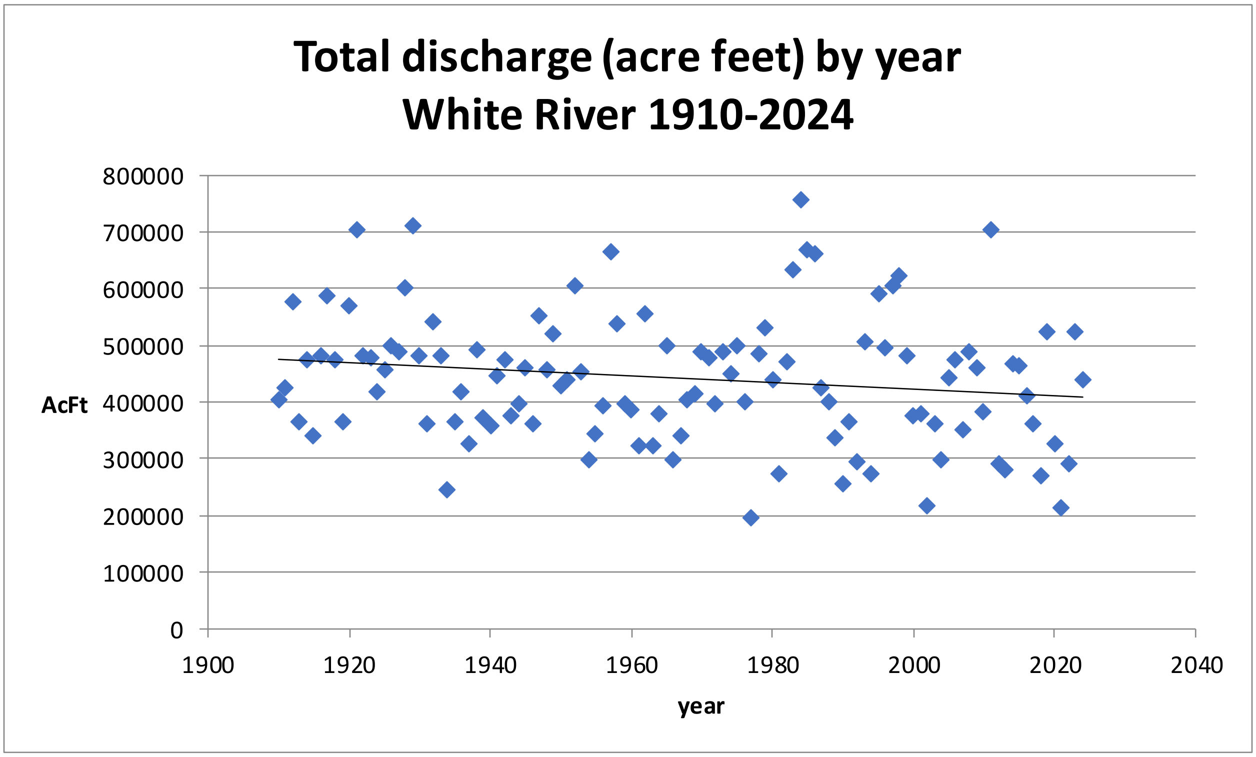
Comment: 2025 snow water equivalent and total precipitation fell considerably below the thirty-year medians.

Figure 5a. Daily flow (black line) in the White River near Meeker vs. historical percentiles during water years 2021-25. See the Water Watch web page for complete historical record of streamflow.



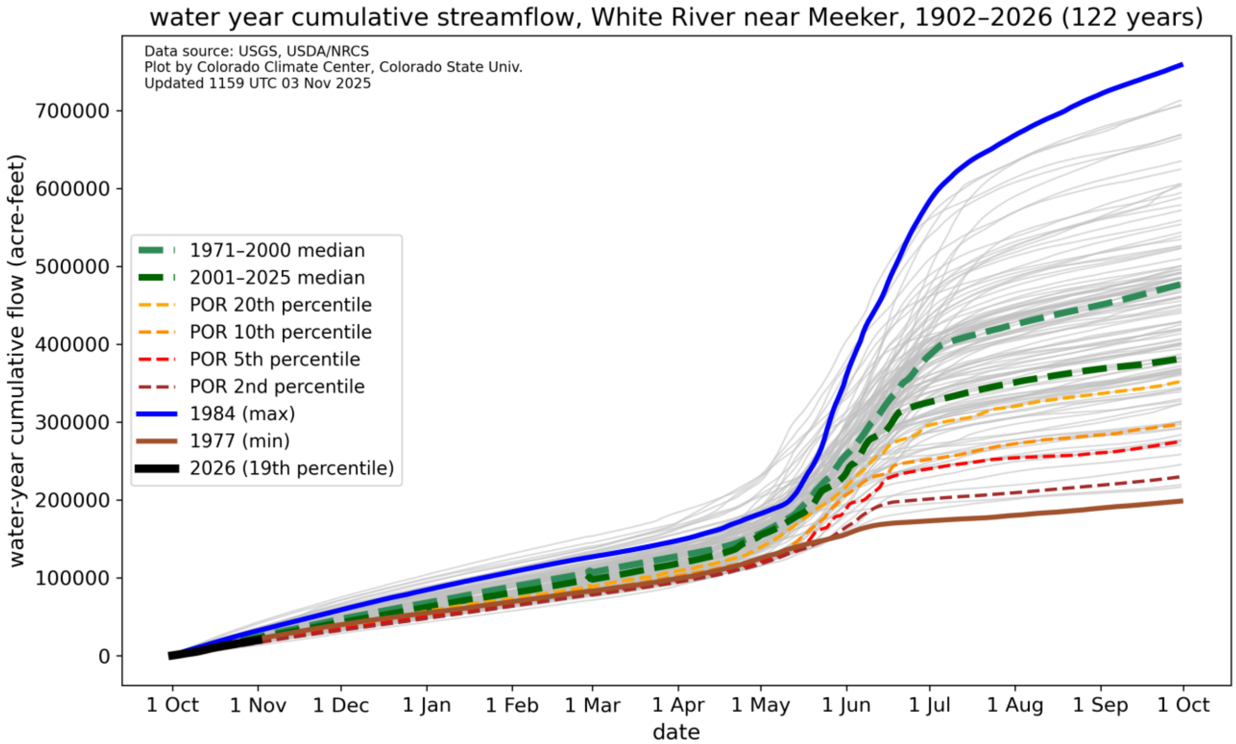
Comment: 2021, 2022, and 2025 saw exceptionally low flows, with record low flow in late summer this year. The river peaked high in water year 2023 after near record snowpack, then ran about average through water year 2024. Data in the following Figures indicate that despite the exceptional snowpack in 2023, exceedingly dry soils soaked up runoff and kept peak flows moderate.

Figure 5b. Total runoff (acre feet) down the White River by year from 1910 to 2024. Trend is downward. Mann-Kendall $S = -902$, $Z = -2.15$. $Z_{crit} = -1.96$.



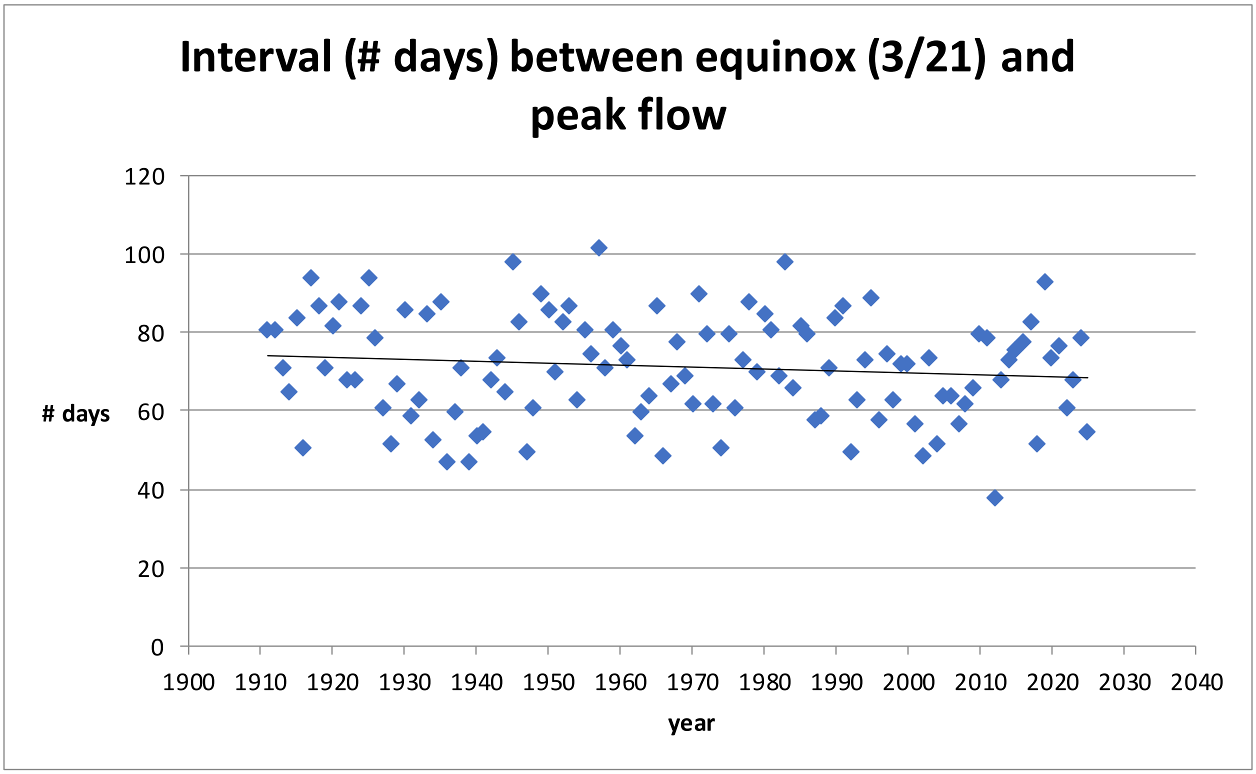
Comment: Total yearly runoff in the White River is decreasing, down by about 70,000 acre feet on average over the period of record. That represents about a 14% loss in water volume.

Figure 5c. Historical trends in runoff.



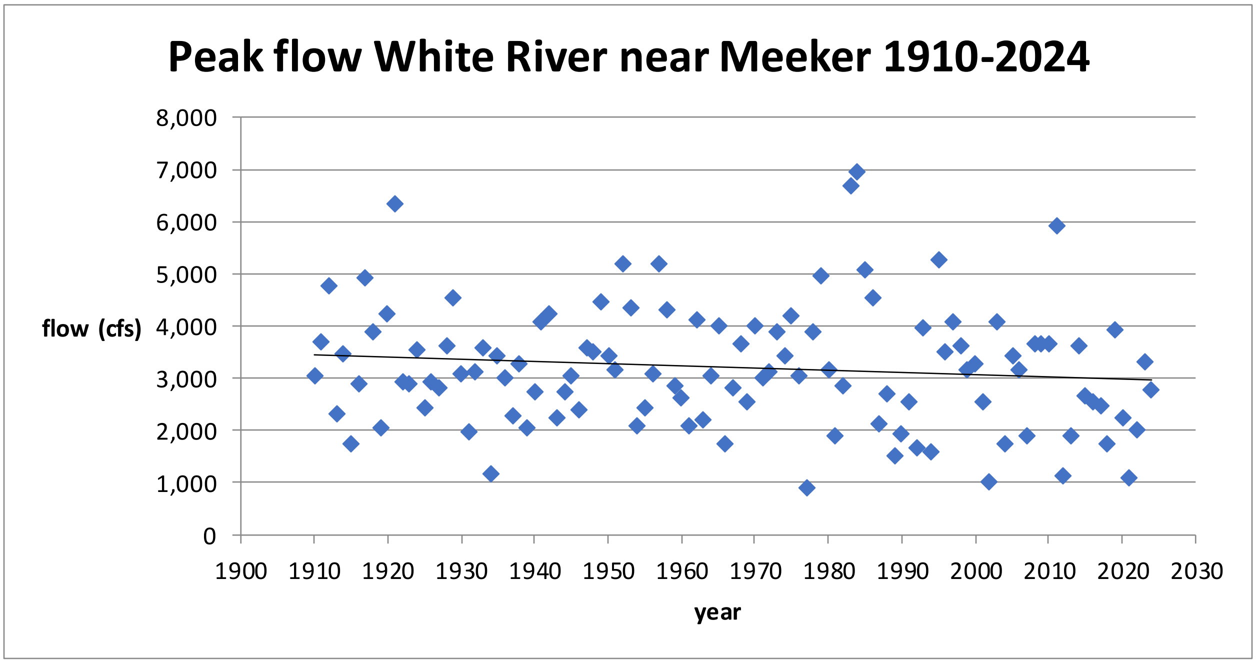
Comment: Cumulative discharge in the White River is trending downward. Note particularly the 2001-25 median compared to 1971-2000.

Figure 6. Date of peak flow in White River near the Town of Meeker (USGS gauging station 09304500) 1910-2025 plotted as interval number of days after the Spring equinox. Mann-Kendall S = -529, Z = -1.26, $Z_{critical}$ = -1.96, n = 116. Trendline is best linear fit by least squares analysis.



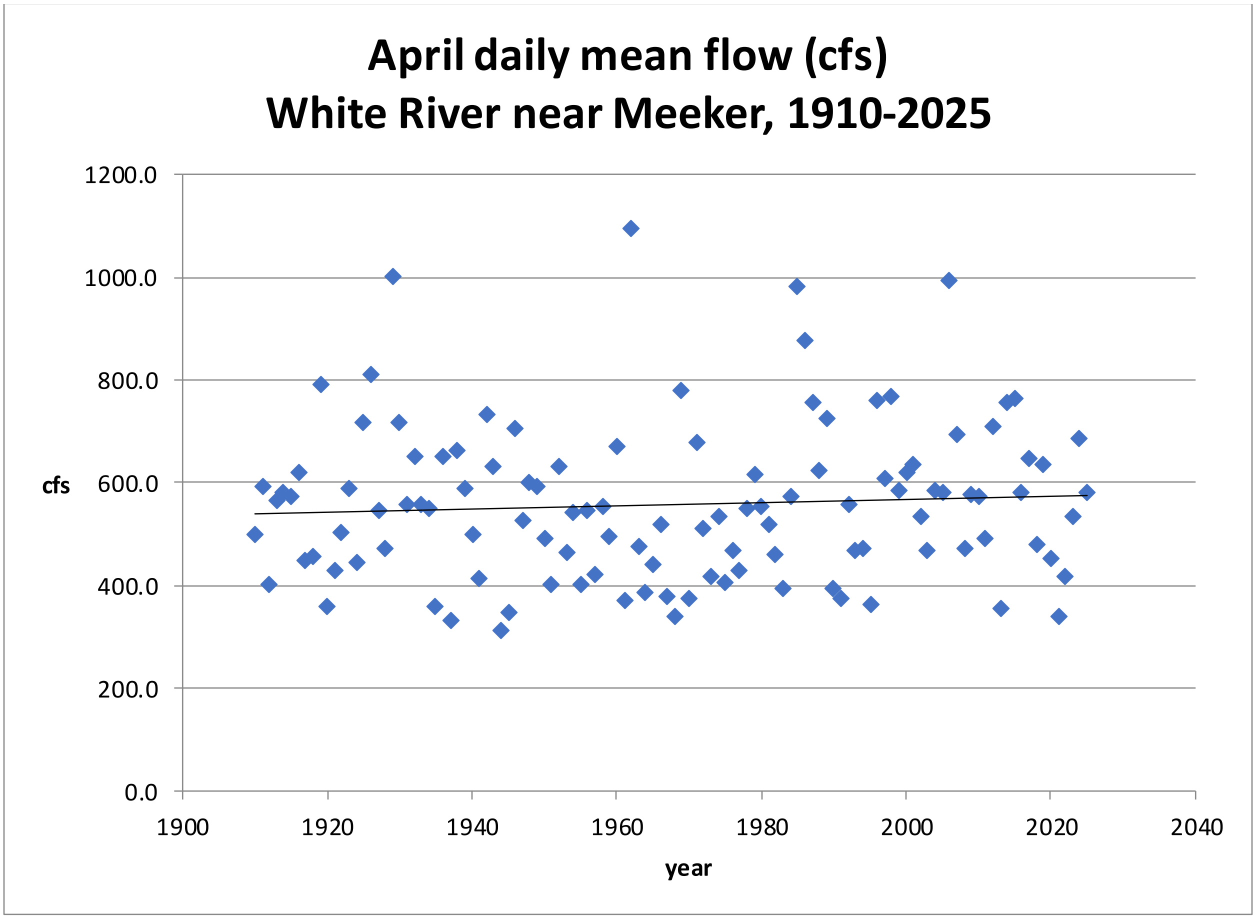
Comment: Spring runoff today occurs earlier than it did in the past. Earlier peak flow results in longer period of low flow in the summer and, potentially, higher water temperatures. Both effects may contribute to algae bloom and to fish stress.

Figure 7. Peak flow (cfs) in White River near Meeker (USGS gauging station 09304500) water years 1910-2025. Mean flow for the period is 3209 cfs. Mann-Kendall S = -559, Z = -1.35, $Z_{critical}$ = -1.96, n = 115. Trendline is best linear fit by least squares analysis.



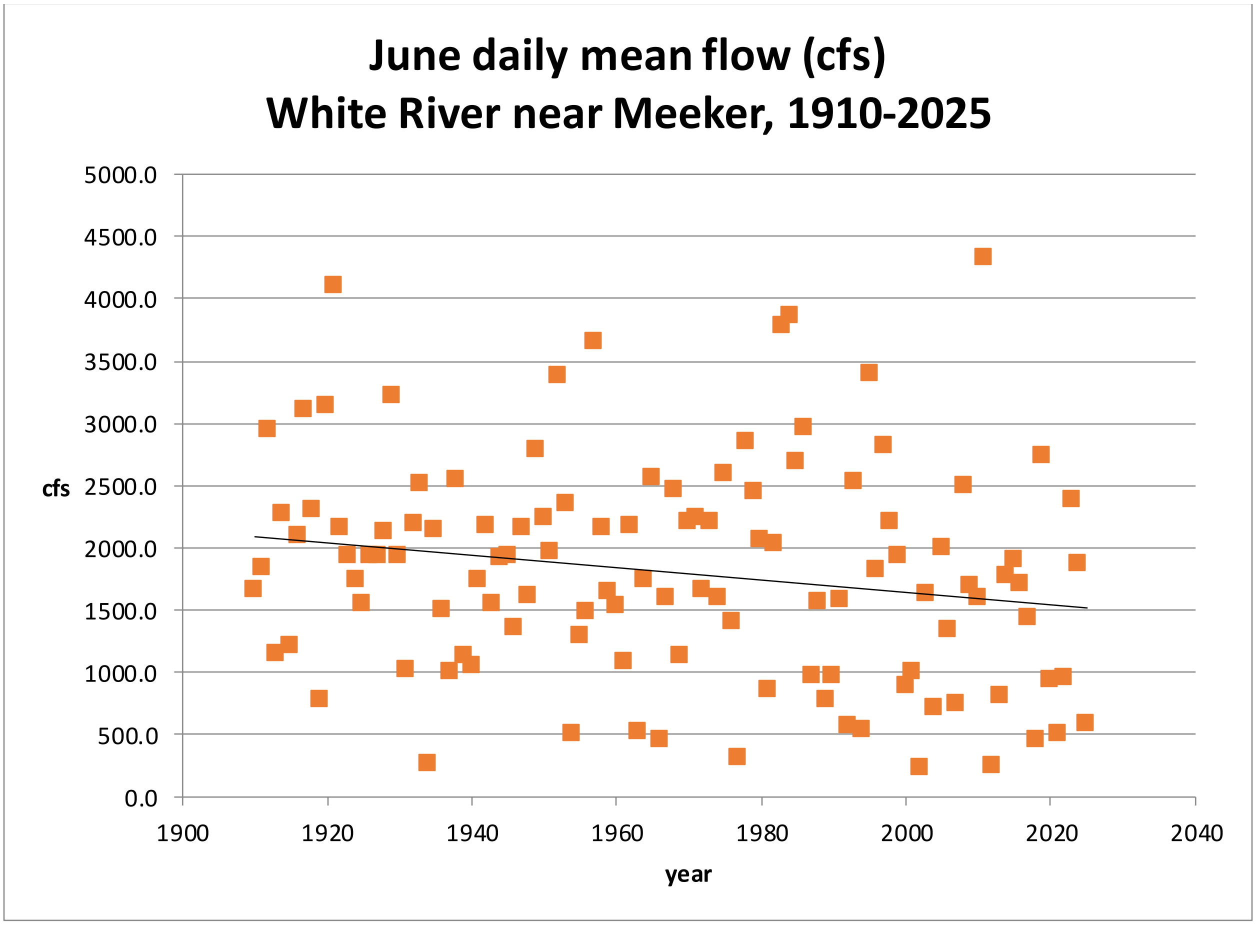
Comment: Peak flow is decreasing, now roughly 500 cfs lower on average than it was in 1910. Lower peak flow is less effective at scouring algae off the stream bed, and decreased flow changes sediment transport and fish habitat.

Figure 8. Daily mean flow in the White River near the Town of Meeker in the month of April, water years 1910-2025. Mann-Kendall S = 301. Z = 0.72, $Z_{critical}$ = 1.96, n = 115 . Trendline is best linear fit by least squares analysis.



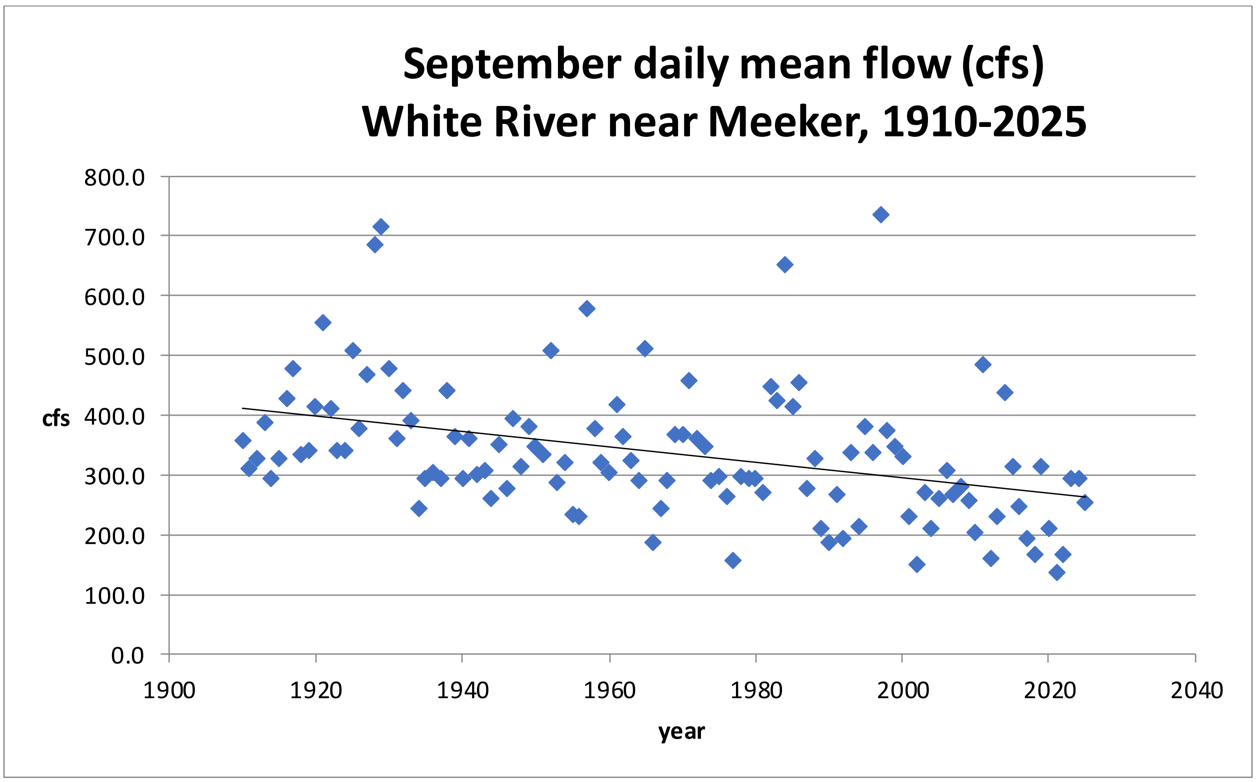
Comment: April flows are increasing. This reflects earlier Spring runoff. As shown in Figures 9 and 10, the tradeoff is lower flow in June and on through the summer.

Figure 9. Daily mean flow in the White River near the Town of Meeker in the month of June, water years 1910-2025. Mann-Kendall S = -885, Z = -2.11, $Z_{critical}$ = -1.96, n = 115. Trendline is best linear fit by least squares analysis.



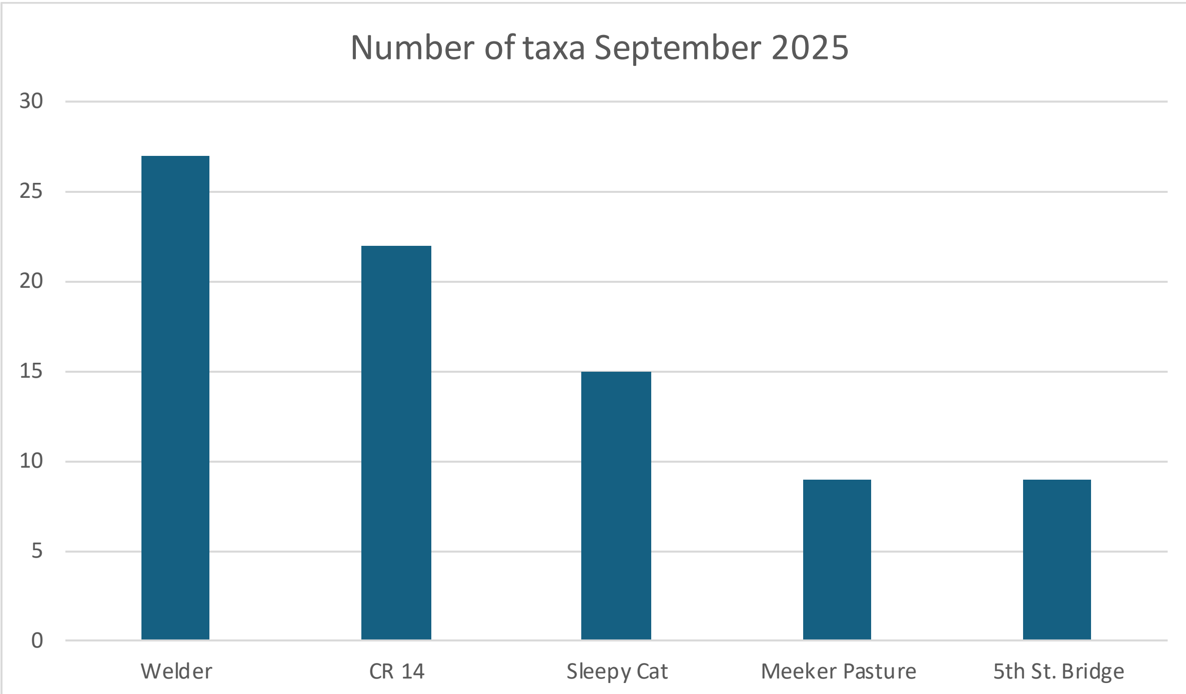
Comment: Peak runoff historically occurred in early June, but peak is trending earlier. Downward trend is particularly evident in late summer, as the river returns to base flow. Longer periods of low flow in the summer provide favorable conditions for algae growth, increase stress on fish, and decrease available irrigation and municipal water supplies.

Figure 10. Mean flow in the White River near the Town of Meeker in the month of September, water years 1910-2025. Mann-Kendall S = -2109, Z = -5.03, $Z_{critical}$ = -1.96, n = 115. Trendline is best linear fit by least squares analysis.



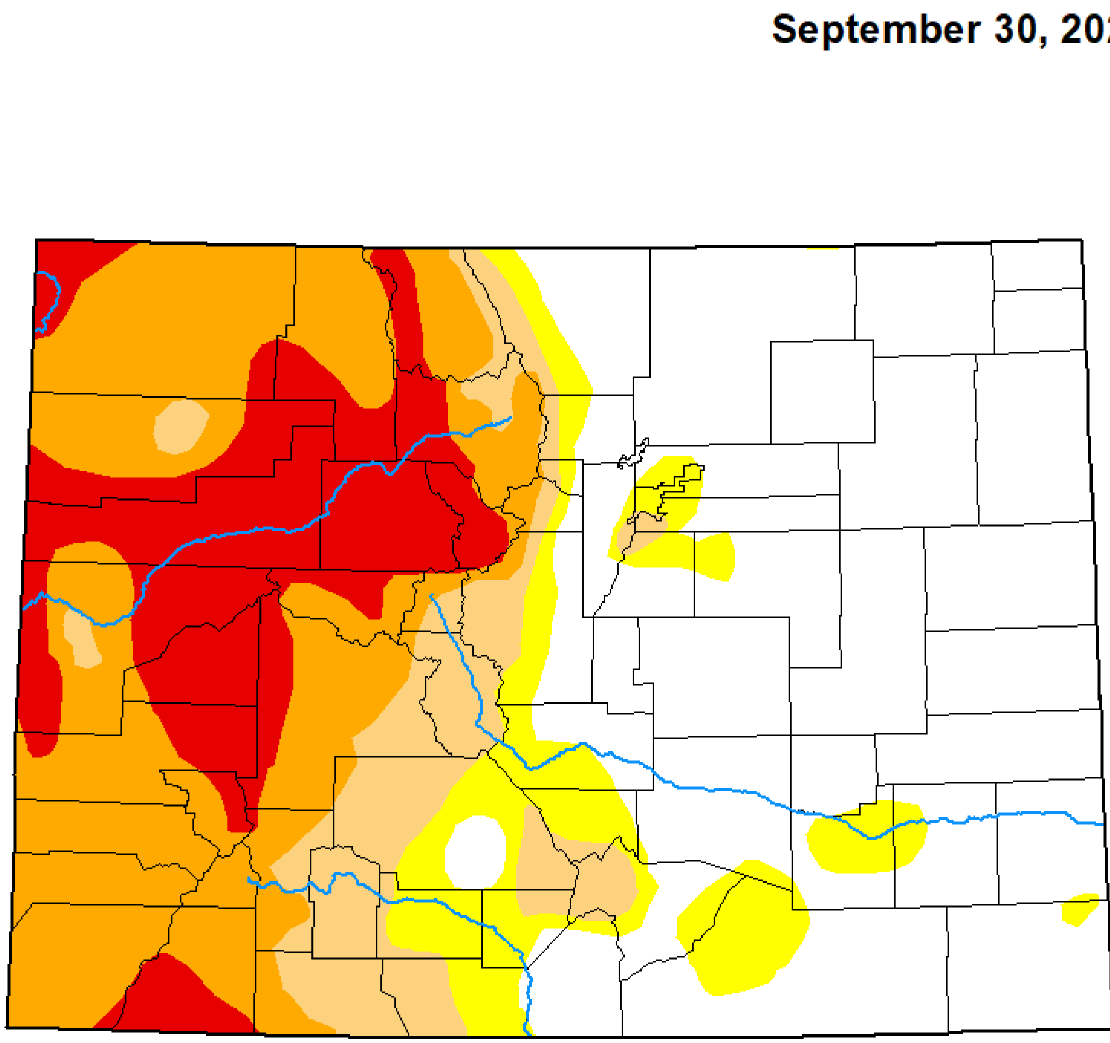
Comment: September daily mean flow is decreasing dramatically. On this trend we can expect to see the river run dry in September in some years before the end of the century.

Figure 11. Total number of macroinvertebrate taxa at sample sites above Meeker in September 2025.



Comment: We found fewer macroinvertebrate taxa, measured at Family level, at the downstream sites than near the headwaters. Counts at Meeker Pasture and 5th St. Bridge were most certainly impacted by debris from the Elk Fire. A greater variety of macroinvertebrates, as represented in the number of different Families, represents a healthier benthic ecosystem. Especially sensitive are the mayflies, stoneflies, and caddisflies, which were historically prevalent.

Figure 12. USDA Drought Monitor, end of water year 2025. We are starting the new water year with persistent moderate (orange) to severe drought (red). Source: USDA drought monitor.



Comment: Persistent drought results from higher temperature and decreased precipitation, both the result of a changing climate. Drier soils and reduced ground water absorb runoff that would otherwise replenish the river and provide water on downstream.

References:

Snotels:
Burro Mountain Snotel. https://wcc.sc.egov.usda.gov/nwcc/site?sitenum=378
Ripple Creek Snotel. https://wcc.sc.egov.usda.gov/nwcc/site?sitenum=717
Trappers Snotel. https://wcc.sc.egov.usda.gov/nwcc/site?sitenum=827

USDA Natural Resources Conservation Service. iMap. https://nwcc-apps.sc.egov.usda.gov/imap/

USGS Gauging Station: White River Near Meeker. https://waterdata.usgs.gov/co/nwis/uv?site_no=09304500

USGS Water Watch. https://waterwatch.usgs.gov/

U.S. Global Change Research Program. 2023. 5th National Climate Assessment. https://nca2023.globalchange.gov/