



# Recent Climate Change in Utah, 1870–2023

Scott Hotaling, Ph.D.<sup>1,2</sup>, Kendall Becker, Ph.D.<sup>1,2</sup>

<sup>1</sup> Department of Watershed Sciences, Utah State University

<sup>2</sup> Climate Resiliency Extension, Utah State University

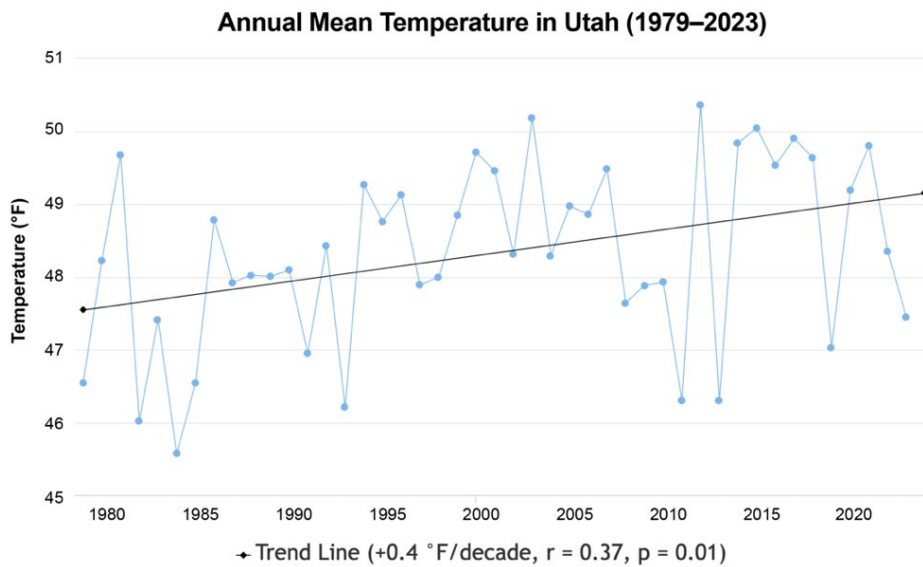
Climate change is impacting Utah. Forty-five years of temperature data show that Utah is steadily warming which, in turn, is driving declines in winter snowpack, shifting the timing and amount of available water, increasing fire risk, and causing ecological change. This link between warming and natural resources stems from the fundamental connection in mountain regions between temperature, precipitation, and water supply. In winter, Utah receives a considerable amount of precipitation, which primarily falls as snow. Snowpack seasonally accumulates at higher elevations, then melts in spring and summer. By acting as a natural water reservoir that is seasonally replenished, snowpack buffers the landscape against dry conditions. Snow cover also acts as a large-scale control on plant growth and animal movement, influencing local ecology. Thus, current and projected shifts in Utah's temperature and precipitation regimes due to climate change will continue to impact its water supply, wildfire risk, and ecosystems.



*Utah's snowpack acts as a natural water reservoir, accumulating in winter and melting in spring and summer.*

## Temperature

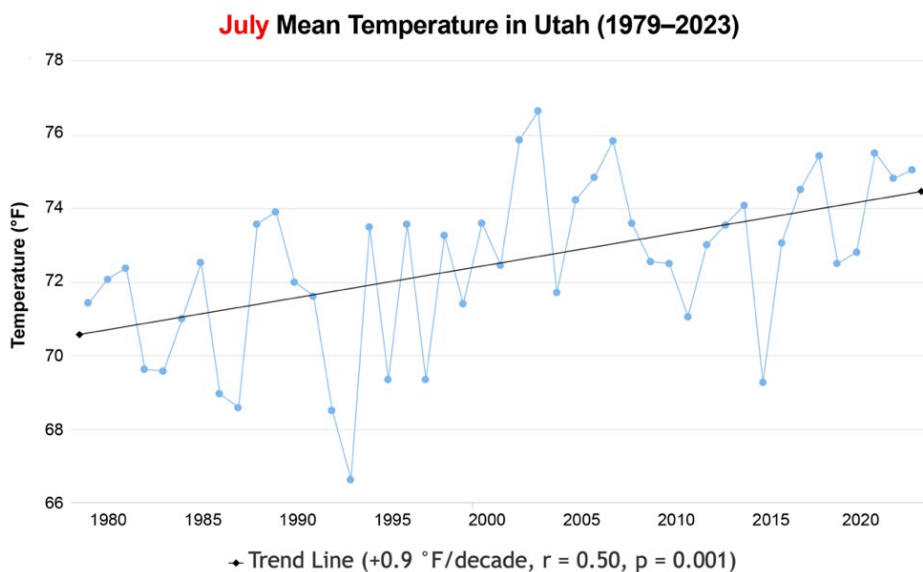
Ambient temperatures strongly influence many aspects of modern life, natural resources, and ecosystems. In a dry state like Utah, annual and seasonal temperatures are closely tied to water demand and availability. Warmer summers increase demand for water. Warmer winters cause more precipitation to fall as rain instead of snow, resulting in a shallower snowpack that contains less water and melts out earlier. Together, warmer summers and winters exacerbate water supply issues, particularly in late summer when water is most needed. Over the past four decades, the annual mean temperature in Utah has increased by around 0.4 °F per decade (Figure 1). This trend is driven by rising summer temperatures and is projected to continue; winter temperatures are also projected to increase (Hegewisch & Abatzoglou, n.d.-a, n.d.-b).



**Figure 1. Annual Mean Temperature in Utah Is Increasing, 1979–2023**

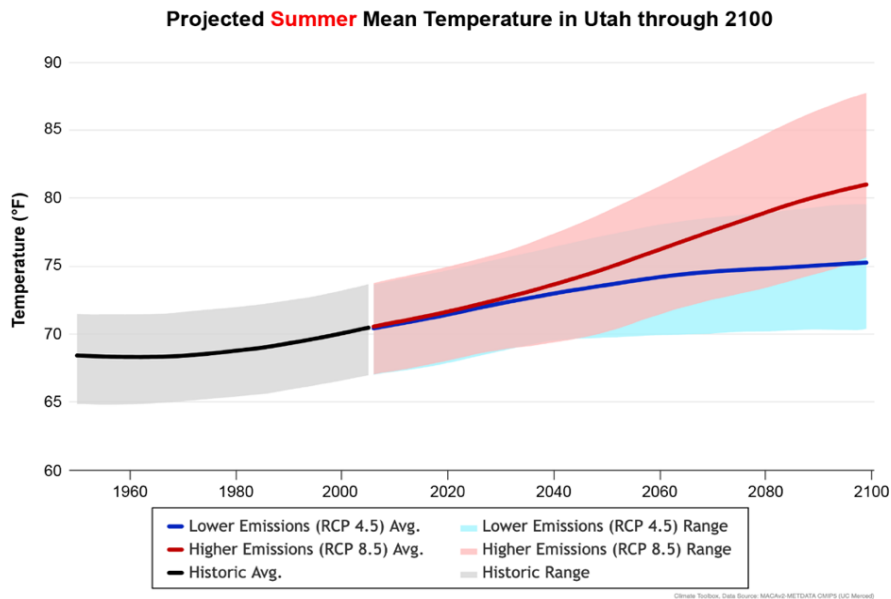
Source: Hegewisch & Abatzoglou, n.d.-a., CC BY 4.0

**Summer temperatures** — In Utah, July temperatures are rising faster than any other month, increasing by nearly 1 °F per decade since 1979 (Figure 2). This warming parallels global patterns of increasing temperatures caused by anthropogenic greenhouse gas emissions, particularly carbon dioxide (Crowley, 2000). Because future greenhouse gas emissions depend on policies and actions, scientists consider a range of future greenhouse gas concentration [scenarios](#) to predict future climates. Two common scenarios are RCP 4.5 and RCP 8.5, where RCP 4.5 is a “lower emissions” scenario based on a future where the concentration of greenhouse gases in the atmosphere stabilizes before 2100. RCP 8.5 is a “higher emissions” scenario where greenhouse gas concentrations continually increase. Looking ahead to 2100, under RCP 4.5 and RCP 8.5, summer temperatures in Utah are expected to rise by 3.4 °F and 9.0 °F, respectively (Figure 3).



**Figure 2. July Mean Temperature in Utah Is Increasing, 1979–2023**

Source: Hegewisch & Abatzoglou, n.d.-a., CC BY 4.0

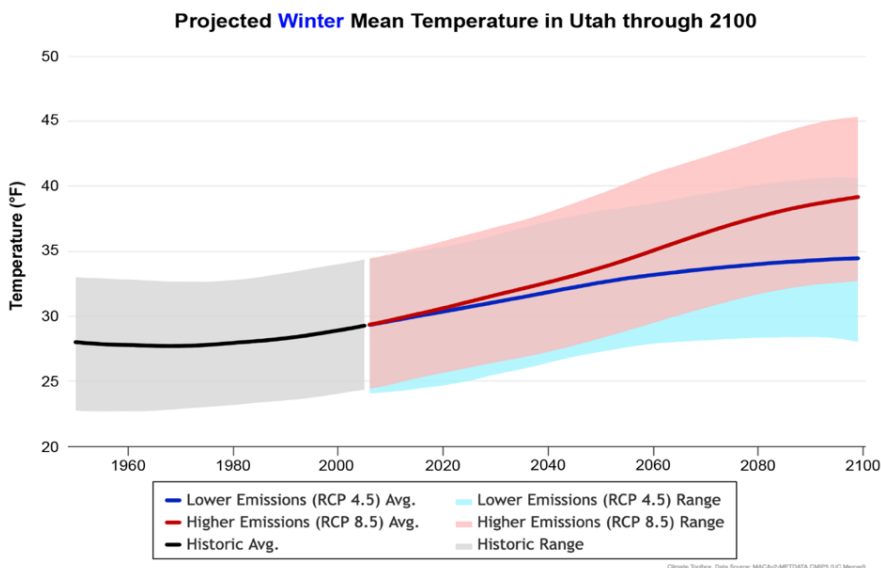


**Figure 3.** Summer Mean Temperature in Utah Is Projected to Rise Through 2100 Under “Lower” (RCP 4.5) and “Higher” (RCP 8.5) Emissions Scenarios

Note. RCP refers to Representative Concentration Pathway; 4.5 and 8.5 refer to the warming influence expected in 2100 from the projected greenhouse gas concentrations.

Source: Hegewisch & Abatzoglou, n.d.-b., CC BY 4.0

**Winter temperatures** — Temperatures in winter also appear to be rising, though not as rapidly as summer temperatures. The trend for January mean temperature in Utah indicates an increase of about 0.7 °F per decade since 1979, but these data are more variable, and the trend is not statistically significant ( $P = 0.12$ ). More warming, however, is anticipated. By 2100, under the RCP 4.5 and RCP 8.5 emissions scenarios, winter temperatures in Utah are expected to rise by 3.8 °F and 8.2 °F, respectively (Figure 4).



**Figure 4.** Winter Mean Temperature in Utah is Projected to Rise Through 2100 Under “Lower” (RCP 4.5) and “Higher” (RCP 8.5) Emissions Scenarios

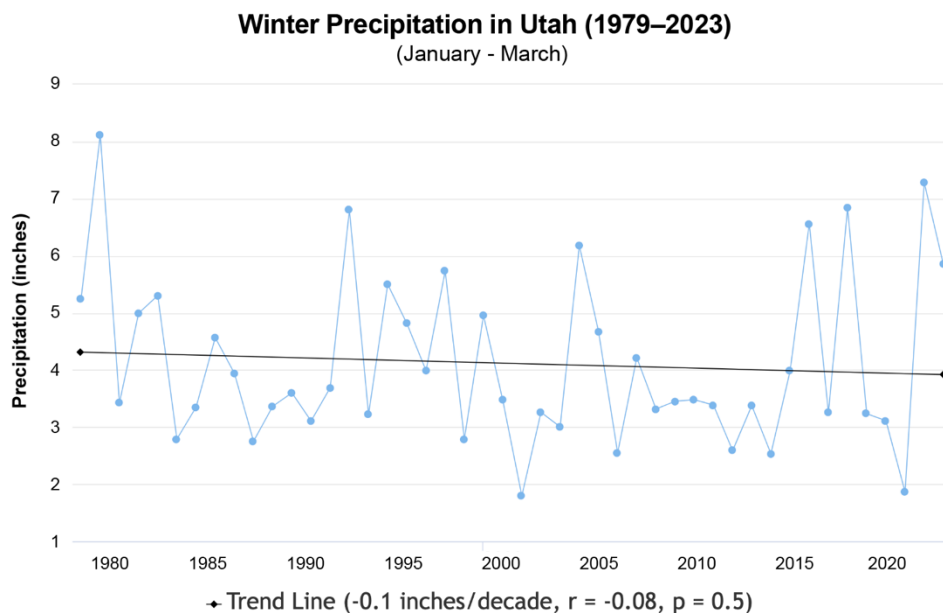
Source: Hegewisch & Abatzoglou, n.d.-b., CC BY 4.0

## Precipitation and Snowpack

The amount of winter precipitation falling in Utah has not meaningfully changed in the last 40 years, nor is it projected to (Figure 5; Hegewisch & Abatzoglou, n.d.-b). However, rising temperatures are impacting Utah's water supply by increasing the percentage of winter precipitation falling as rain rather than snow. Between 1960 and 2010, the proportion of winter precipitation falling as snow declined by about 9% (Gillies et al., 2012), contributing to a 16% decline in peak snowpack statewide from 1979 to 2023 (Figure 6, top). Here, snowpack refers to snow water equivalent—a standard measure that corresponds to the amount of liquid water the snow would yield when melted.

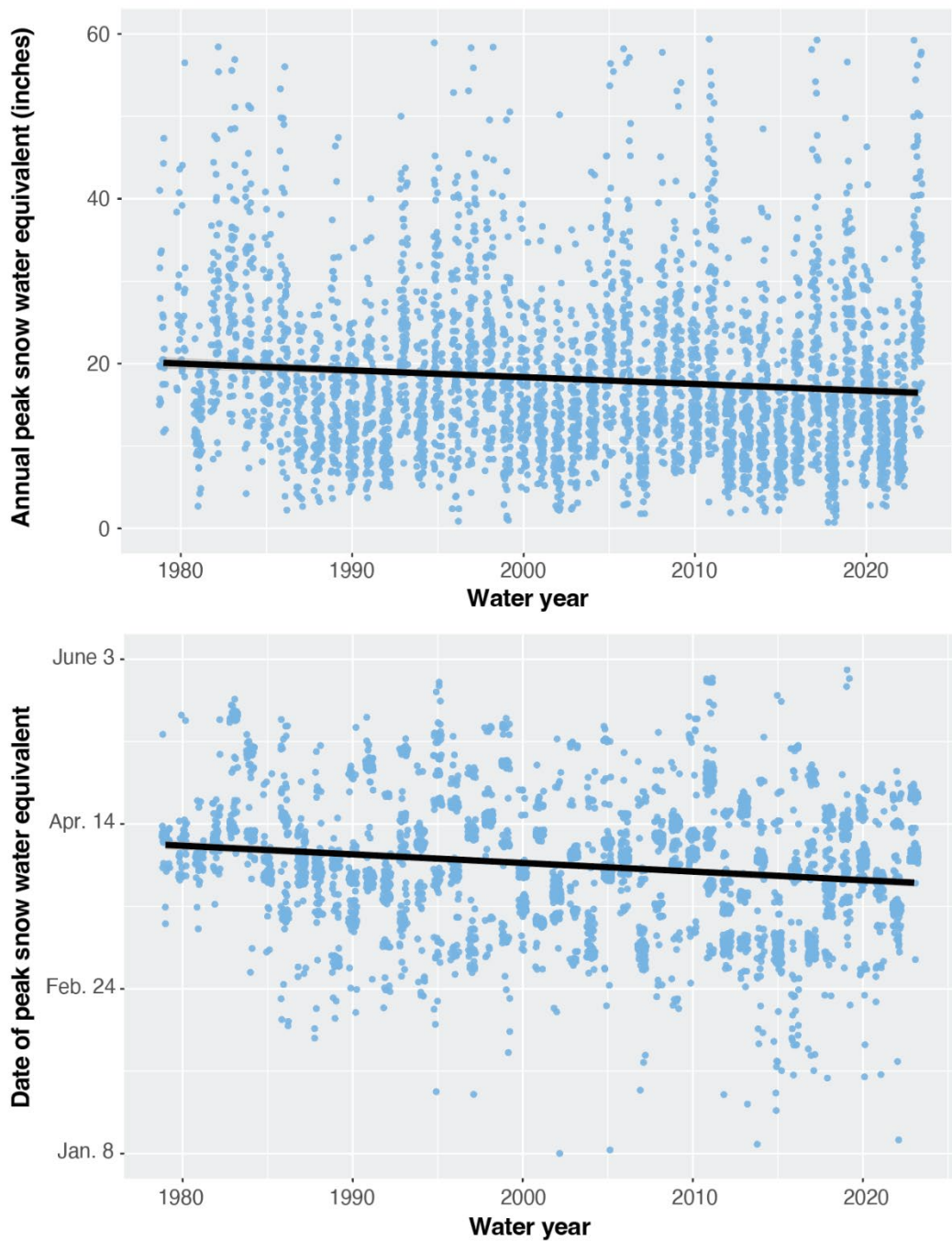
*Projections indicate that by 2062, Utah will start seeing years where seasonal snowpack does not accumulate.*

The timing of snowpack accumulation is also changing. Since 1979, the date of peak snowpack in Utah has advanced by roughly 9 days (Figure 6, bottom). Looking ahead, projections indicate that by 2062, the Upper Colorado Basin, which includes much of eastern Utah, will begin seeing years where seasonal snowpack does not accumulate, i.e., less than 10% of the current typical spring snow water equivalent is expected (Siirila-Woodburn et al., 2021). This lack of snowpack will remove the massive natural, frozen reservoir that steadily melts, filling lakes and keeping streams flowing in late summer.



**Figure 5.** *Winter Precipitation in Utah Is Not Significantly Increasing or Decreasing, 1979–2023*

Source: Hegewisch & Abatzoglou, n.d.-a., CC BY 4.0



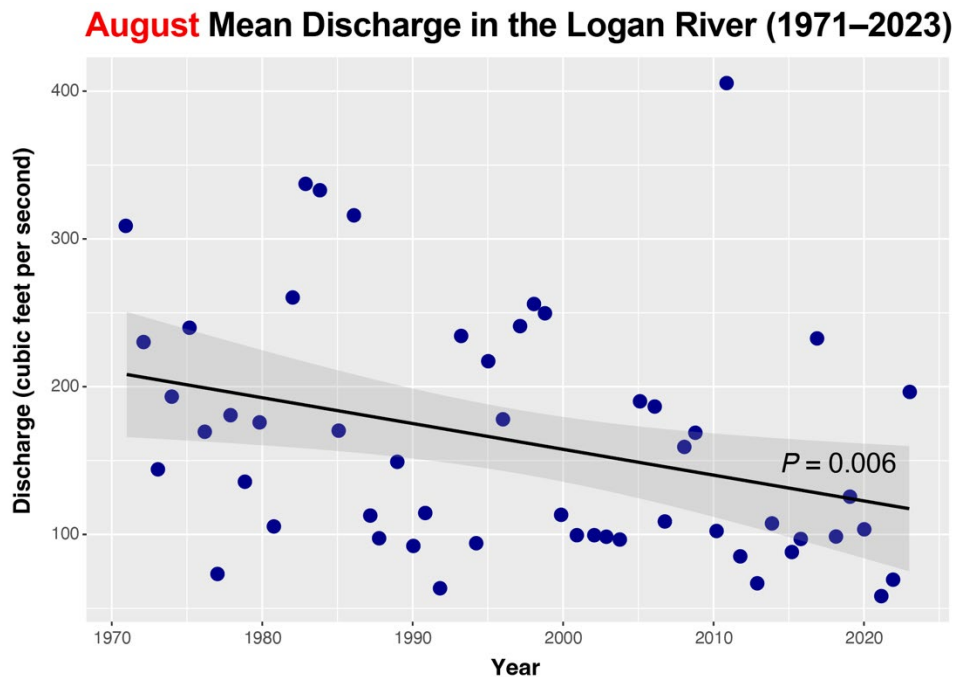
**Figure 6.** (top) *Peak Snowpack in Utah Is Declining, 1979–2023, and (bottom) Date of Peak Snowpack in Utah Is Earlier, 1979–2023*

*Notes.* A water year begins on October 1 of the previous year and ends on September 30 of the named year. Each circle represents one water year of data for a SNOpack TELEmetry (SNOTEL) station in Utah.

Data sources: Natural Resource Conservation Service (NRCS) and National Water and Climate Center, n.d.; NRCS, n.d.

## Streamflow

In mountain regions, summer streamflows are linked to the amount of snowpack that accumulated during the preceding winter and the timing of snowmelt. Thus, reduced peak snowpack and shifts toward an earlier peak—a response to warmer temperatures—can change stream baseflows. For example, August discharge in northern Utah’s Logan River has declined since 1979 (Figure 7). While this decline has not been directly attributed to climate change, it parallels expectations that consider regional temperature increases and snowpack declines during this period (Figures 2 and 6).



**Figure 7.** August Mean Discharge in Utah’s Logan River Is Declining, 1971–2023

Data source: U.S. Geological Survey, n.d.



The Colorado River (Figure 8)—one of the most iconic and influential rivers in the American West—is also impacted by climate change. From 1916 to 2014, streamflow in the Upper Colorado River Basin, which includes eastern Utah, declined by over 16% despite a slight increase in precipitation over the same period (Xiao et al., 2018). Over half of the decline (about 9%) was directly attributed to warming in the region.

**Figure 8.** The Colorado River Flowing Through Glen Canyon

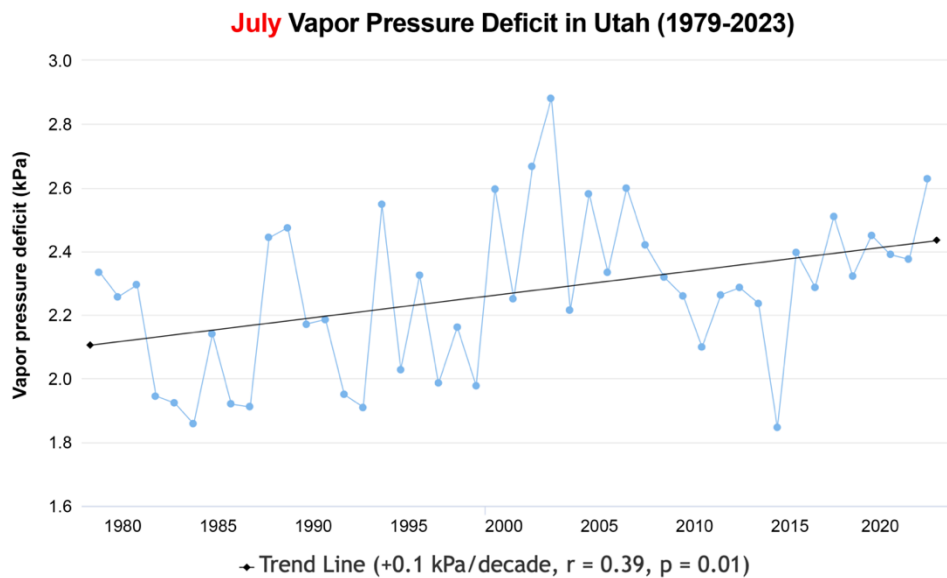
Photo credit: Adrille, 2007, CC BY-SA 3.0

In the central Rocky Mountains, an analysis of August discharge for 153 streams from 1950 to 2008 found that 89% of all nonregulated streams are experiencing declines. Furthermore, “pristine” sites—those without

diversions or land-use change during the study period—are experiencing the most rapid decline, with an average 23% decline in August discharge (Leppi et al., 2012). Reduced streamflow can transform streams from perennial, where they flow all year, to ephemeral, where they only flow intermittently, thereby altering the communities of plants, animals, and other organisms the streams can support.

## Wildfire

In addition to reducing water availability, higher temperatures affect fire risk by increasing vapor pressure deficit, which draws moisture out of fuel, making it more flammable (Figure 9). Across the western United States, contemporary climate change accounted for about 55% of the observed increase in fuel aridity from 1979 to 2015 (Abatzoglou & Williams, 2016). In July 2007, the largest wildfire in Utah’s recent history occurred—the Milford Flat Fire. The fire was ignited by lightning and, in less than two weeks, burned about 363,000 acres. As temperatures continue to rise and fuel becomes drier, the frequency and severity of large fires in Utah will likely increase. Changes in fire regime affect habitat by altering the structure and type of vegetation (Agee, 1993).

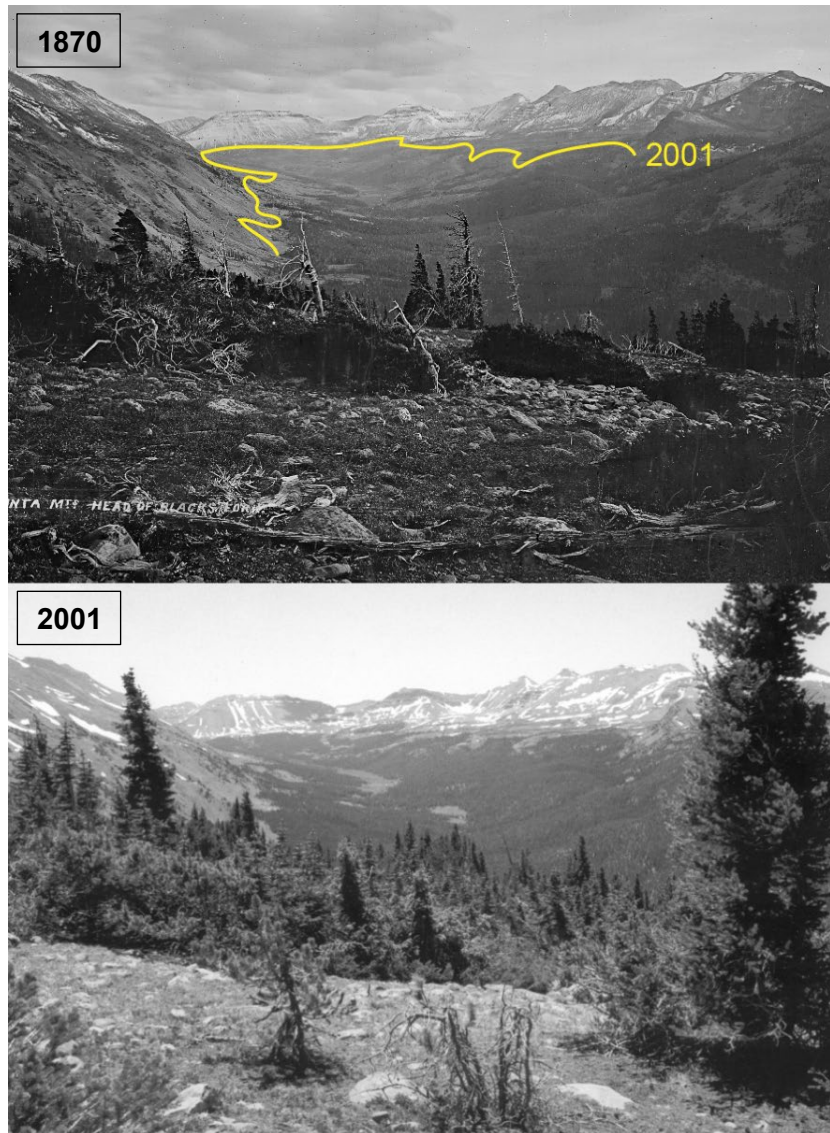


**Figure 9.** July Vapor Pressure Deficit in Utah Is Increasing, 1979–2023

Source: Hegewisch & Abatzoglou, n.d.-a, CC BY 4.0

## Ecological Change

Climate change is also driving ecological changes in Utah; however, given the long timescale of the change and the difficulty of collecting long-term data, specific examples for Utah are rare. Using repeat photographs spanning 131 years (1870–2001), Munroe (2003) documented a roughly 100-meter uphill shift of tree line in the Uinta Mountains (Figure 10). When tree lines shift uphill, which can occur in response to climate warming, alpine habitats shrink. Warmer temperatures can also threaten species diversity. In northwestern Montana, warming mountain streams are driving a rise in hybridization between non-native rainbow trout and native westslope cutthroat trout (Mulhfeld et al., 2014). Given the similar dynamics between non-native rainbow trout and Bonneville cutthroat trout in Utah (e.g., Meyer et al., 2022), climate change may also contribute to hybridization of these species in local fisheries.



**Figure 10.** (top) Historical (1870) and (bottom) Modern (2001) Repeat Photographs of the Little East Fork Blacks Fork, Uinta Mountains

*Note.* The yellow line on the 1870 photograph shows that tree line moved 100 m uphill by 2001, reducing alpine habitat.

Photo credits: (top) Jackson, W. H., 1870, and (bottom) Munroe, J. S., 2003, used with permission

Generally, higher temperatures, declining snowpack, and reduced late-summer streamflow in Utah will alter the mosaic of existing habitats. For instance, these conditions will likely extend the Great Basin desert to higher elevations and expand its geographic range. At the same time, habitats above tree line will contract as downslope tree species shift uphill. Long-term data sets are needed to track these changes and their effects.

## Acknowledgments

This publication was supported by the “Secure Water Future” project that is funded by an Agriculture and Food Research Initiative Competitive Grant (#2021-69012-35916) from the USDA National Institute of Food and Agriculture. To learn more, visit USU Extension’s [Climate Adaptation & Resiliency](#) website.

For correspondence, contact Scott Hotaling: [scott.hotaling@usu.edu](mailto:scott.hotaling@usu.edu).



## References

- Abatzoglou, J. T. & Williams, A. P. (2016). Impact of anthropogenic climate change on wildfire across western US forests. *Proceedings of the National Academy of Sciences*, 113(42), 11770–11775. <https://doi.org/10.1073/pnas.1607171113>
- Adrille. (2007, June). File: *Colorado River edit2.jpg*. Wikimedia Commons. <https://commons.wikimedia.org/w/index.php?curid=3204619>
- Agee, J. K. (1993). *Fire ecology of Pacific Northwest forests*. Island Press, Washington DC.
- Crowley, T. J. (2000). Causes of climate change over the past 1000 years. *Science*, 289, 270–277. <https://www.science.org/doi/10.1126/science.289.5477.270>
- Gillies, R. R., Wang, S. Y., & Booth, M. R. (2012). Observational and synoptic analyses of the winter precipitation regime change over Utah. *Journal of Climate*, 25(13), 4679–4698. <https://doi.org/10.1175/JCLI-D-11-00084.1>
- Jackson, W. H. (1870). *Head of Black's Fork, Uinta Mountains, Summit County, Utah* [Photograph No. 516926]. Hayden Survey, Records of the U.S. Geological Survey, Record Group 57. National Archives at College Park—Still Pictures. <https://catalog.archives.gov/id/516926?objectPage=3>
- Hegewisch, K. C. & Abatzoglou, J. T. (n.d.-a). *Historical climate tracker* [Web tool]. Climate Toolbox, University of California. Accessed on July 20, 2024, from <https://climatetoolbox.org/tool/Historical-Climate-Tracker>
- Hegewisch, K. C. & Abatzoglou, J. T. (n.d.-b). *Future time series* [Web tool]. Climate Toolbox, University of California. Accessed on July 25, 2024, from <https://climatetoolbox.org/tool/future-time-series>
- Leppi, J. C., DeLuca, T. H., Harrar, S. W., & Running, S. W. (2012). Impacts of climate change on August stream discharge in the Central-Rocky Mountains. *Climatic Change*, 112, 997–1014. <https://doi.org/10.1007/s10584-011-0235-1>
- Meyer, K. A., Hillyard, R. W., & Campbell, M. R. (2022). Detecting rainbow trout introgression in Bonneville cutthroat trout of the Bear River basin using field-based phenotypic characteristics. *Western North American Naturalist*, 82(1), 117–127. <https://doi.org/10.3398/064.082.0111>
- Muhlfeld, C. C., Kovach, R. P., Jones, L. A., Al-Chokhachy, R., Boyer, M. C., Leary, R. F., Lowe, W. H., Luikart, G., & Allendorf, F. W. (2014). Invasive hybridization in a threatened species is accelerated by climate change. *Nature Climate Change*, 4(7), 620–624. <https://www.nature.com/articles/nclimate2252>
- Munroe, J. S. (2003). Estimates of Little Ice Age climate inferred through historical rephotography, northern Uinta Mountains, USA. *Arctic, Antarctic, and Alpine Research*, 35(4), 489–498. <http://www.jstor.org/stable/1552352>
- National Resource Conservation Service (NRCS) and National Water and Climate Center. (n.d.). *SNOTEL sensor data*. U.S. Department of Agriculture. <https://www.nrcs.usda.gov/wps/portal/wcc/home/snowClimateMonitoring/snowpack/snotelSensorData/>
- NRCS. (n.d.). *Report generator*. U.S. Department of Agriculture. <https://wcc.sc.egov.usda.gov/reportGenerator/>
- Siirila-Woodburn, E. R., Rhoades, A. M., Hatchett, B. J., Huning, L. S., Szinai, J., Tague, C., Nico, P. S., Feldman, D. R., Jones, A. D., Collins, W. D., & Kaatz, L. (2021). A low-to-no snow future and its impacts on water resources in the western United States. *Nature Reviews Earth & Environment*, 2(11), 800–819. <https://doi.org/10.1038/s43017-021-00219-y>
- U.S. Geological Survey (USGS). (n.d.). *National water information system: Web interface*. U.S. Department of the Interior. Retrieved on July 31, 2024, from [https://waterdata.usgs.gov/nwis/dv?referred\\_module=sw&site\\_no=10109000](https://waterdata.usgs.gov/nwis/dv?referred_module=sw&site_no=10109000)
- Xiao, M., Udall, B., & Lettenmaier, D. P. (2018). On the causes of declining Colorado River streamflows. *Water Resources Research*, 54(9), 6739–6756. <https://doi.org/10.1029/2018WR023153>

In its programs and activities, including in admissions and employment, Utah State University does not discriminate or tolerate [discrimination](#), including harassment, based on race, color, religion, sex, national origin, age, genetic information, sexual orientation, gender identity or expression, disability, status as a protected veteran, or any other status protected by University policy, Title IX, or any other federal, state, or local law. Utah State University is an equal opportunity employer and does not discriminate or tolerate discrimination including harassment in employment including in hiring, promotion, transfer, or termination based on race, color, religion, sex, national origin, age, genetic information, sexual orientation, gender identity or expression, disability, status as a protected veteran, or any other status protected by University policy or any other federal, state, or local law. Utah State University does not discriminate in its housing offerings and will treat all persons fairly and equally without regard to race, color, religion, sex, familial status, disability, national origin, source of income, sexual orientation, or gender identity. Additionally, the University endeavors to provide reasonable accommodations when necessary and to ensure equal access to qualified persons with disabilities. The following office has been designated to handle inquiries regarding the application of Title IX and its implementing regulations and/or USU's non-discrimination policies: The Office of Equity in Distance

Education, Room 400, Logan, Utah, [titleix@usu.edu](mailto:titleix@usu.edu), 435-797-1266. For further information regarding non-discrimination, please visit [equity.usu.edu](http://equity.usu.edu), or contact: U.S. Department of Education, Office of Assistant Secretary for Civil Rights, 800-421-3481, [ocr@ed.gov](mailto:ocr@ed.gov) or U.S. Department of Education, Denver Regional Office, 303-844-5695 [ocr.denver@ed.gov](mailto:ocr.denver@ed.gov). Issued in furtherance of Cooperative Extension work, acts of May 8 and June 30, 1914, in cooperation with the U.S. Department of Agriculture, Kenneth L. White, Vice President for Extension and Agriculture, Utah State University.

August 2024

Utah State University Extension

Suggested citation: Hotaling, S. & Becker, K. M. L. (2024). *Recent climate change in Utah, 1870–2023* [Fact sheet]. Utah State University Extension.