Climate Change and the Logan River: Past, Present, and Future

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The Logan River runs through Idaho and northern Utah, beginning in the Bear River Mountains and flowing through Logan Canyon to Cutler Reservoir. The river is socially and ecologically significant to the Cache Valley community. Throughout its history, the Logan River's water and energy have sustained life within the valley. However, climate change is threatening the Logan River's support of both human and animal communities. Rising water temperatures and reduced flow caused by declining snowpack may impair the river's ability to maintain healthy ecosystems.

Past: River History and Uses

The Logan River has long been significant to the residents of Cache Valley, since early Shoshone settlement around 3000 B.C. (Figure 1; Walters et al., 2024). During the thousands of years that people have lived alongside the river, it has served as a place for recreation and sustenance, an irrigation source, a hydroelectric energy generator, a research subject, and a thriving aquatic ecosystem.

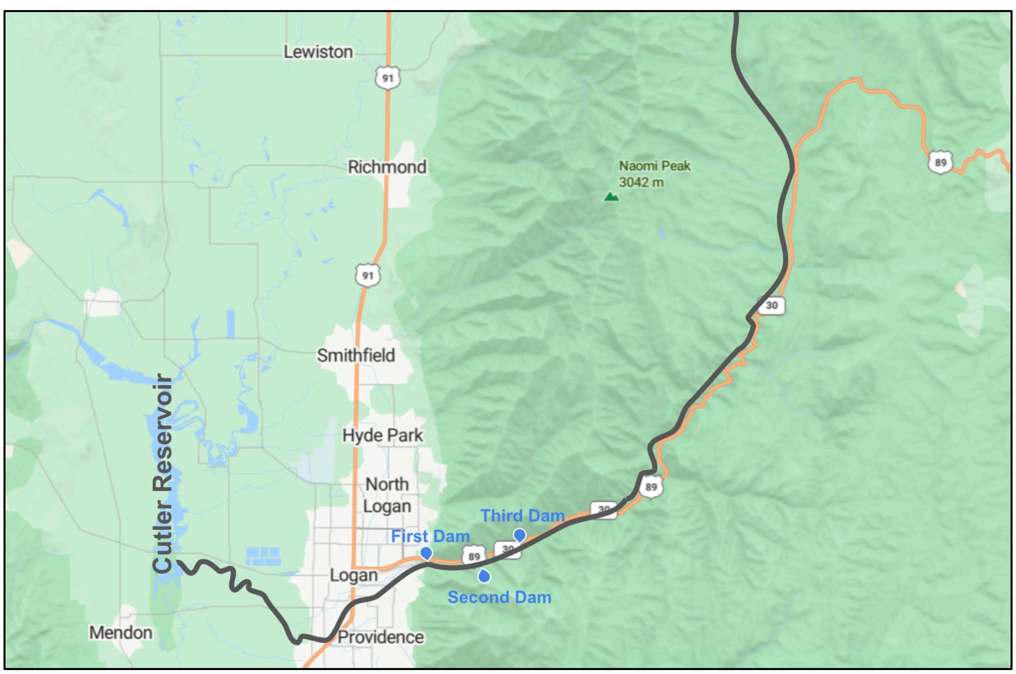


Figure 1. *The Logan River's Course Within Utah (dark line), Including Its Three Major Dam Locations*

Base map source: Google Maps, n.d.

The Shoshone name for Cache Valley is “Willow Creek” or “Willow River” (Utah State University [USU] Libraries, 2024). For centuries, the willows, grasses, and cattails that grew alongside the Logan River provided food and shelter for nearby Shoshone communities (USU Libraries, 2024). In these years before Anglo-American settlement, the river meandered through the valley, forming an alluvial fan across the valley floor. Beavers built dams that slowed water flow and increased ground saturation (Leavitt, 2019a).

The Logan River changed significantly with the arrival of Mormon settlers in 1855 (Walters et al., 2024). With increasing development, the river was restricted and channelized to support irrigation and make way for new structures. Over time, these changes led to increased erosion, impaired nutrient deposition downstream, and degraded habitat for fishes and other aquatic organisms (Leavitt, 2020).

Electrical Needs

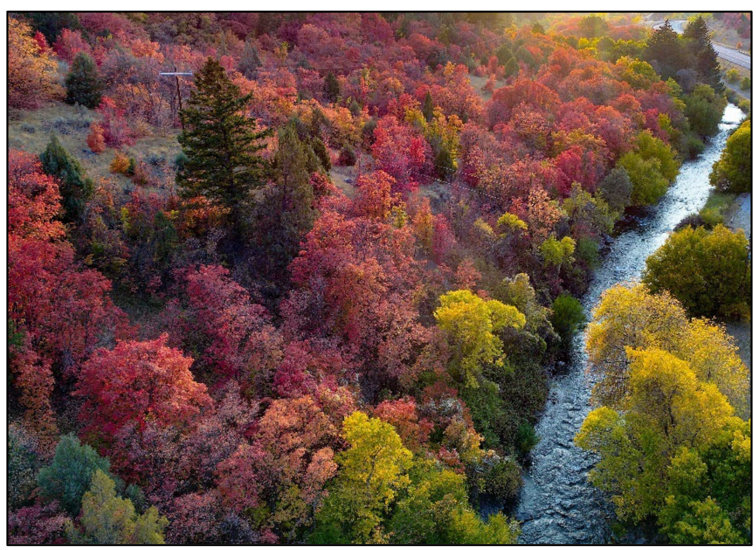
In 1893, 1903, and 1911, the Logan River was dammed at three locations near the mouth of Logan Canyon, further altering the river’s natural flow (Figure 1; Haws, 1984). These dams were created to generate electricity for the valley’s growing population. Today, the hydroelectric dams continue to provide power for the local community (Logan City, n.d.). Electricity generated at First Dam helps to power Utah State University, while hydroelectric plants at Second Dam and Ray Hugie Hydro Park can meet up to 15% of Logan’s energy demands when the river has sufficient flow (Logan City, 2022; Facilities, n.d.). This maximum power, however, is typically only reached in the spring following winters with heavy snowfall (Logan City, 2022). Along with producing energy, First Dam has supplied water to the Utah Water Research Laboratory since its founding in 1965 (Fitch et al., 2002). This laboratory is one of the largest water research facilities in the U.S. and supports scientists studying hydrology, hydraulics, and water quality (Utah Water Research Laboratory, n.d.).

Agricultural Needs

Water from the Logan River is also used to sustain Cache Valley’s strong agricultural enterprise. Dozens of canal companies have water rights to the Logan River and use the water for irrigation (Fitch et al., 2002; Cache Water District, 2024). For example, a diversion from the river just downstream from Second Dam provides water to the Logan, Hyde Park, and Smithfield canal systems (Cache County, n.d.).

Recreational Needs

Beyond its roles in energy generation, research, and irrigation, the Logan River also serves aesthetic and recreational purposes. It is a central community feature, flowing through local neighborhoods and parks. The adjacent Logan River trail system supports biking, hiking, and running communities. Additionally, the river provides popular areas for recreational fishing.



The Logan River in Autumn
Photo credit: D. Hinkamp, USU Extension

Ecological Needs

In contrast to many mountain rivers in Utah, the Logan River remains relatively pristine and unobstructed, with a largely natural flow regime in the mid to upper sections; this allows native fauna to persist and thrive. For example, the Logan River is home to the largest remaining population of Bonneville cutthroat trout (*Oncorhynchus clarkii utah*), which is Utah's state fish, the only trout species native to the Bonneville Basin, and a popular sport fish (Leavitt, 2019b; Budy et al., 2020). The river also supports a robust community of other fishes, their food (e.g., aquatic insect larvae), and their predators (e.g., river otters and birds such as the Belted Kingfisher). Surrounding wetlands are home to the northern leopard frog (*Lithobates pipiens*), a species of conservation concern in Utah, and the Ute ladies'-tresses orchid (*Spiranthes diluvialis*), which is federally listed as threatened under the U.S. Endangered Species Act (U.S. Fish & Wildlife Service, 2024; Tatenhove & Juhline, 2022; Utah Division of Wildlife Resources, 2021). Birds, including terns, orioles, and yellowthroats, live in habitat surrounding the Logan River (Figure 2; Bridgerland Audubon Society, 2024).

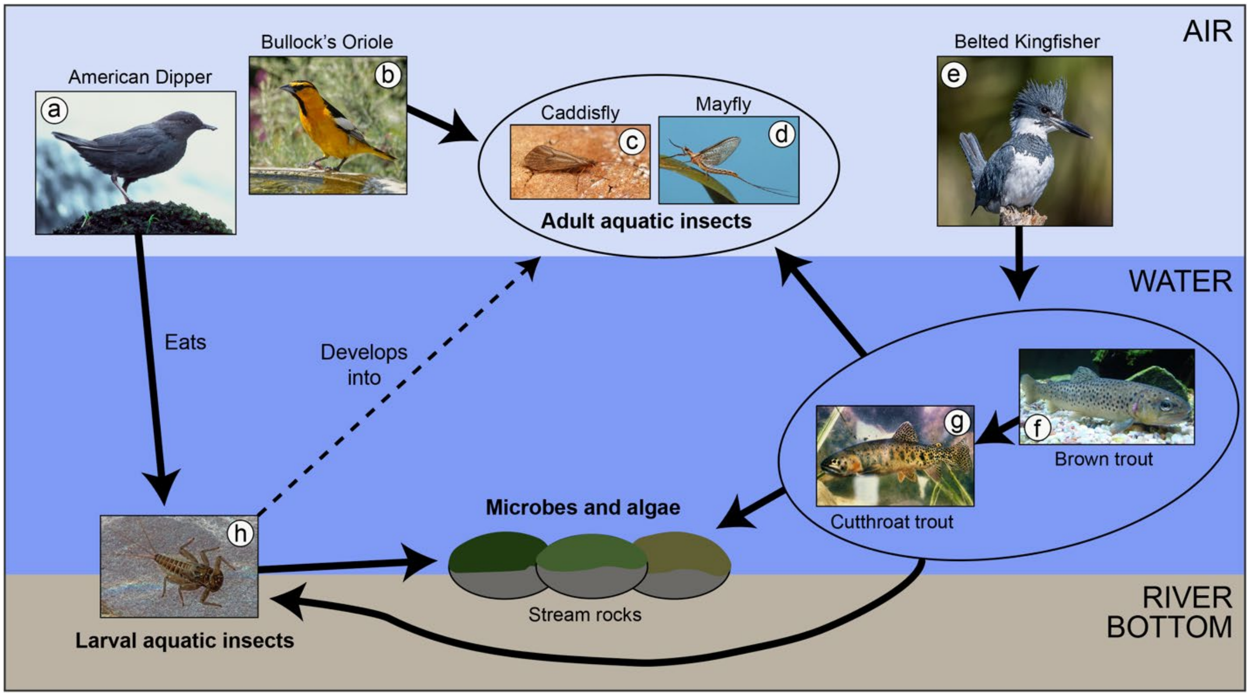


Figure 2. *Examples of Food Chain Interactions in Utah's Logan River*

Note. Microbes and algae provide food for insect larvae, which in turn are eaten by birds and fish. Birds such as Belted Kingfishers also prey directly on fish. Disturbances to one area of the food chain can alter others.

Photo credits: (a) D. Menke, 2016; (b) Mike's Birds, 2020 CC-BY-2.0; (c) B. Sale, 2020; (e) A. Morffe, 2016 CC-BY-SA-3.0; (d) F. F. Salles, 2014; (g) L. Hazzard, 2001 CC-BY-SA-4.0; (f) Z. Le Zouave, 2007; (h) V. Lubini, 2023

Present: Climate Change Threats to the Logan River

The Logan River is currently facing threats due to human activity and climate change. The channelization of the river for infrastructure and irrigation has led to faster-moving water and eroded riverbanks (Figure 3). The dams in Logan Canyon trap river sediments and prevent them from being deposited downstream (Leavitt, 2020). Furthermore, drought, warmer air temperatures, and decreasing snowpack in Utah may be reducing flow rates of the river (Neilson et al., 2020; Siirila-Woodburn et al., 2021; Kaya et al., 2023; Hotaling & Becker, 2024). The amount of water flowing through the urban section of the river is already sometimes too low to support fish populations (Peikes, 2016). These factors increase flood risk, reduce hydroelectric energy returns, and impede the river's ability to support healthy ecosystems. As climate change progresses, these environmental threats may be exacerbated, and new issues may arise.

Figure 3. *Steep, Eroded Riverbank Along the Logan River*

Photo credit: S. Hotaling

Warming Temperatures

Climate change is currently affecting temperature, weather patterns, and seasonal variation worldwide (U.S. Global Change Research Program, 2023). Average global temperatures have already increased by about 2.4 °F compared to the 1850–1900 average (Lindsey & Dahlman, 2024). Utah is an arid state, and climate change has worsened drought in the region (Environmental Protection Agency, 2024; Williams et al., 2022; Williams, 2021). Since 1979, Utah's mean annual air temperature has increased by about 1.6 °F, and peak snowpack has declined by 16% (Hegewisch & Abatzoglou, 2024; Hotaling & Becker, 2024). These climate changes threaten the health of Utah's aquatic habitats because drought, warm air temperatures, and low snowpack can decrease stream flow (Neilson et al., 2020). And, when low flow is coupled with warm air temperatures, higher water temperatures can result. For example, in the spring of 2021, the Logan River had its lowest peak flow since 1992, and this coincided with unusually high in-stream temperatures (Figures 4 and 5; U.S. Geological Survey, n.d.; Logan River Observatory, 2024). In a future with warmer air temperatures, less snowpack, and lower streamflow, stream temperatures are likely to increase.

Warm water temperatures can reduce biodiversity because species have different temperature tolerances depending on their native habitat. For example, juvenile Bonneville cutthroat trout—which are native to the Logan River—grow best in water temperatures of 56–63 °F (Wagner et al., 1998) and cannot survive above 77 °F (Johnstone & Rahel, 2003). In contrast, juvenile brown trout (*Salmo trutta*)—a non-native species in the Logan River—grow best in water temperatures of 57–67 °F (Ojanguren et al., 2001) and cannot survive above 84 °F (Richards et al., 2020). Thus, water temperatures between 63 and 77 °F give non-native brown trout a competitive advantage over Bonneville cutthroat trout, and this advantage is exacerbated because brown trout prey includes native cutthroat trout (Figure 2).

In the Logan River, the warmest temperatures occur in summer when in-stream flows are low and air temperatures peak (Neilson et al., 2020). At present, a lower elevation section of the Logan River that flows by the Utah Water Research Laboratory can reach temperatures as high as 65 °F in summer (Figure 5; Logan River Observatory, 2024), exceeding the optimal growth temperature of cutthroat trout while promoting growth of non-native brown trout.

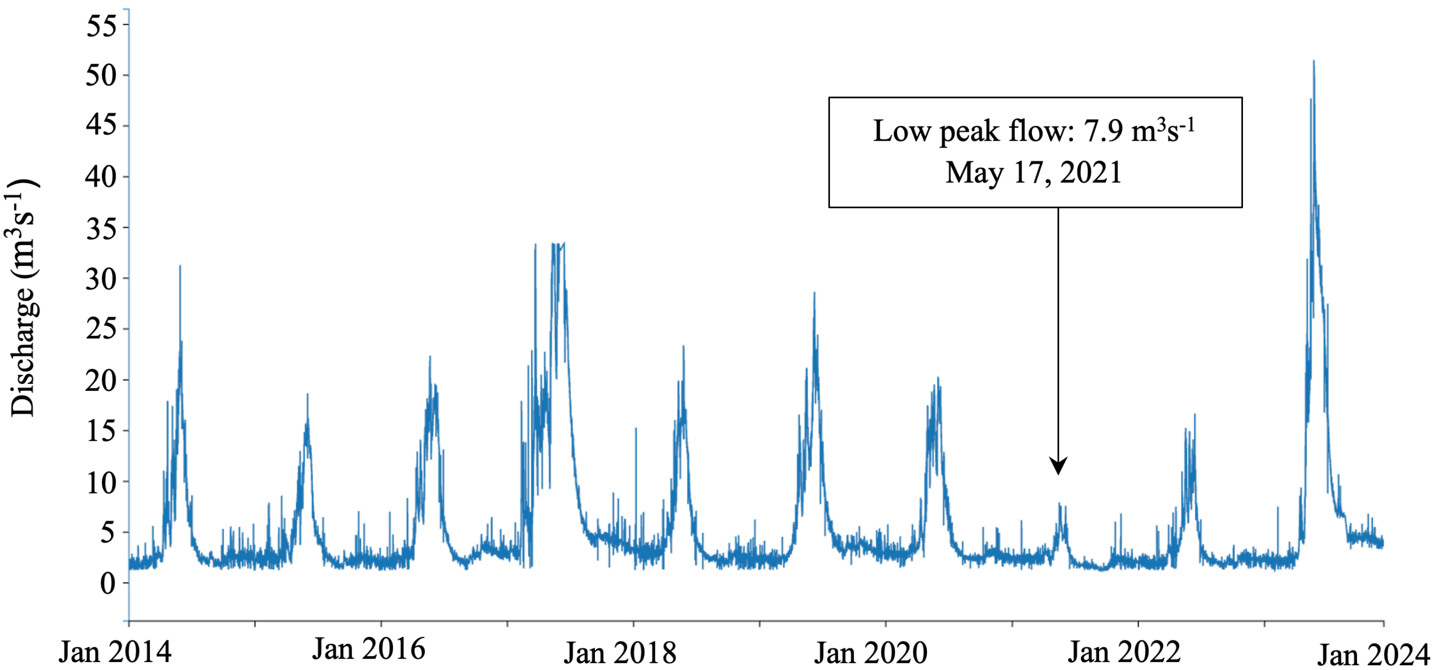


Figure 4. *Logan River Daily Water Discharge Since January 2014, USU Utah Water Research Laboratory*

Source: Logan River Observatory, 2024

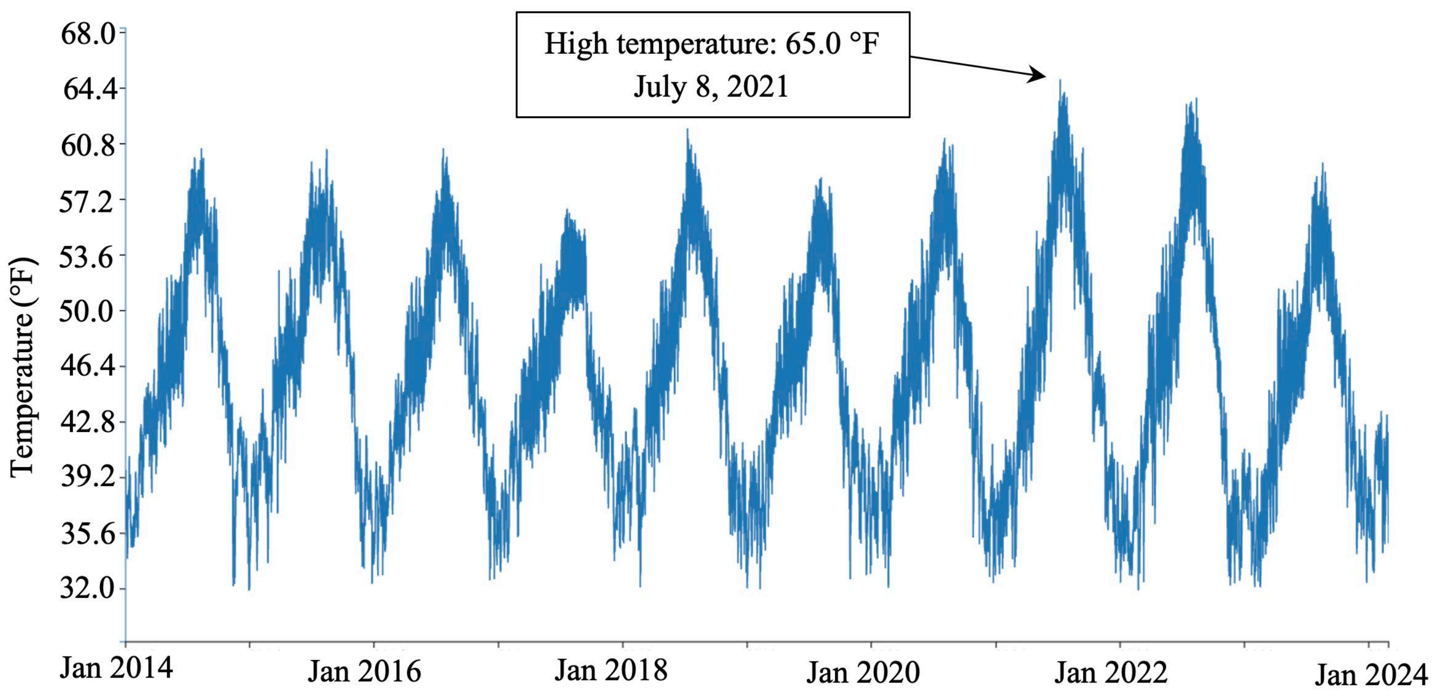


Figure 5. *Logan River Daily Water Temperature Since January 2014, USU Utah Water Research Laboratory*

Source: Logan River Observatory, 2024

Water temperature also indirectly affects ecosystems by altering physical and chemical processes. Warmer water can dissolve more minerals, increasing the water's erosive capacity (Water Science School, 2018). Conversely, warm water has less capacity for dissolving gases, so it contains less dissolved oxygen than cold water (Water Science School, 2018; Neilson et al., 2020). Warmer water also increases oxygen demand in all respiring organisms because metabolic processes run faster at higher temperatures (Peirce, 1998). Since most aquatic organisms, from microbes to fish, rely on oxygen within the water to survive, warmer water with less dissolved oxygen can threaten animal survival and ecosystem function.

Warmer water contains less dissolved oxygen, which is problematic because respiring organisms need more oxygen at higher temperatures.

Future: Ongoing Conservation Efforts

The Logan River Observatory, a monitoring network run by USU faculty, provides comprehensive hydrologic and climate data dating back to 2012 that support ongoing research (Logan River Observatory, n.d.-a). These data facilitate current and future analyses of how the Logan River responds to climate-driven changes in water temperature, aquatic chemistry, and food chain interactions (Logan River Observatory, n.d.-a). The Observatory also supports the Logan River Task Force, a local organization of professors, government officials, and interest group representatives that has developed a long-term conservation action plan for the Logan River (Logan River Observatory, n.d.-b). One aspect of this plan is the ongoing Logan River Restoration project, which has rerouted the river around the Logan River Golf Course and created a riffle pool for improved sediment deposit (Figure 6). Another restoration project was implemented at Denzil Stewart Nature Park in 2016. The previously steep riverbank was flattened out and revegetated to prevent erosion and improve water quality (Logan River Task Force, n.d.). The Logan River Task Force has published *Taking Care of Streams and Rivers in Cache Valley*, a guide to help streamside landowners create and maintain healthy riparian zones.

Figure 6. *The Logan River's course in 2017 (pink) before the reroute and riffle pool creation, and the present-day route and riffle pool (orange).*

Source: Google, 2024; Logan River Task Force, n.d.

In addition to implementing restoration projects, the Logan River Task Force works with the Logan River Observatory to monitor aquatic health parameters within the Logan River. These parameters, such as spring peak flow, summer base flow, water temperature, water quality, trout density and size, bird species diversity, amphibian population size, and riparian vegetation cover, help evaluate the short- and long-term success of conservation and restoration projects (Logan River Task Force, 2016).

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Acknowledgments

This publication was produced as part of the Climate Adaptation Intern Program (CAIP) at Utah State University. CAIP was supported by the “Secure Water Future” project funded by an Agriculture and Food Research Initiative Competitive Grant (#2021-69012-35916) from the USDA National Institute of Food and Agriculture, as well as funding from USU Extension and a USU Extension Water Initiative Grant. This fact sheet was improved based on input from Timothy Walsworth, Ph.D., Phaedra Budy, Ph.D., Edd Hammill, Ph.D., Andrea Snarr, and CAIP interns.

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October 2024
Utah State University Extension