**Climate Change Effects in the Range of Light:**

**What Hikers Need to Know**

By Karl Ford

As a Triple Crown hiker, scientist and writer I’m interested in how climate changes are affecting our mountain ecosystems. I first hiked the John Muir Trail in 2007 and completed the entire PCT in 2015-2016. Earlier this year, I published a book about climate change impacts on the Colorado Trail (*Colorado Trail in Crisis: A Naturalist’s Field Report on Climate Change in Mountain Ecosystems)*.Then, this past summer, I wanted to see if similar changes were occurring in the Sierra so I re-hiked portions of the JMT. It was August, stream-flows were low, daytime temperatures high, and there was no rain. As a snapshot in time, these observations were not unusual. They were an example of the difference between weather and climate. Weather is the recent conditions of days to weeks, but climate is the historical average over years, decades, and even centuries. The climate of the Sierras is definitely changing and there is much data to prove it.

In 2021, Kathryn Low of UC Berkeley researched the ecological effects in Sequoia and Kings Canyon National Parks of greenhouse gases emitted due to human activity. She found average annual temperatures exhibited a statistically significant increase of 0.7 to 0.9℃ per century from 1885 to 2017 within the boundaries of the parks. In my research, I found temperature increases in the Colorado mountains to be even greater.

Low’s research also showed that California’s 2012-2016 drought was the most severe drought in the last century of weather station measurements and perhaps in the last 1200 years. This drought coincided with the hottest annual average temperature during the period 1896–2014 and near-record low rainfall and snowfall.

Other research has identified several additional statistically significant changes including declines in snowpack in the western U.S., a doubling of tree mortality rates in mid-elevation, old growth Sierran mixed-conifer forests from 1983 to 2007, and a doubling of the area burned by wildfires relative to natural levels from 1984 to 2015. These increases are ecologically very significant with effects already observable to scientists and many hikers.

Patrick Gonzales, who held the post of Climate Change Scientist with the National Park Service and is now at UC Berkeley, has stated that in the southern Sierra Nevada drought intensity is likely due to decreased snowpack at higher elevations and subsequent reductions in spring and summer melt-driven soil moisture inputs. Increases in spring temperatures attributed to human-caused climate change have resulted in an average 55% loss of glacial area over the past 100 years in the Sierra Nevada region. The USGS mapped 1,700 very small glaciers and ice masses in the Sierra in 1972, but are disappearing). During my PCT hike, ~~t~~here was little snowpack in June and July.

In the western US, climate change has caused over half of the increases in fuel aridity from 1979 to 2015 and has doubled the area burned by wildfire relative to natural levels from 1984 to 2015. Climate-induced increases in temperature and variability in spring precipitation have led to a 35-50% increase in average and maximum fire size in the Sierra from 1980-2007. At the same time, biome shifts caused by climate change has shifted subalpine forest into high-elevation meadows in Yosemite National Park from 1880 to 2002.

According to Low, based on the highest greenhouse gas emissions scenario of the Intergovernmental Panel on Climate Change, average annual temperatures are projected to increase 4.7-4.9℃by 2100 in Sequoia and Kings Canyon, respectively. Although precipitation predictions remain highly variable, under these projections, the probability of a severe California-wide drought by 2030 increases to nearly 100%. In this high emissions scenario, climate change will likely also increase risk of tree mortality up to 50% in conifer-dominated forests in the southwestern US. Indeed, it’s estimated that 15-20% more trees will die from drought for every 1°C temperature increase in the Sierra Nevada. The number of extreme fire weather days in California will increase by one- to two-thirds by 2050, and peak spring flow in major river systems in Sequoia and Kings Canyon National Parks will increase 400% (due to more rain instead of snow) in the coming decades.

In 2023, Derek Young and others reported in the journal *Ecosphere* that whitebark pine (a keystone high-elevation tree species in the Sierra that defines and sustains the ecosystem) is threatened, as per US Endangered Species Act standards, due to rapid population declines and extensive ongoing pressures from white pine blister rust, mountain pine beetle and increasing temperature and aridity associated with climate change. Indeed, I observed whitebark pine mortality on my JMT hike.

But there are measures we can take to reduce future risks to the Sierra landscape and more adverse widespread ecological changes. Low recommends fuels reduction (through prescribed burns and hand thinning), planting sequoia and other seed stock better adapted to future conditions in areas with projected future suitable habitat, and establishing habitat corridors to assist species in migrating to higher elevations and latitudes.

Reducing emissions in our national parks is, of course, also vital. According to its website, Yosemite National Park produces 22,000 metric tons of greenhouse gases per year. Replacing diesel-powered park vehicles with fully electric vehicles, designing more extensive public transportation systems in parks, limiting energy consumption at all facilities, and reducing waste produced by park operations can reduce fossil fuel consumption and park emissions. I would also suggest timed entry policies to restrict the number of vehicles entering parks and better mass transit systems to enable park visitors to access amenities and recreation enter without bringing a vehicle.

On a larger scale, it’s also crucial to for the entire world to drastically reduce emissions. Reducing human sources of emissions by (low emissions scenario could reduce projected warming by two-thirds in the Sequoia and Kings Canyon National Parks and beyond.

Governments at all levels can implement polices and funding to increase climate resilience. All land owners and managers can play a part in reducing fire risk and drought mortality through fuels reduction. Prescribed burns and hand thinning of small- and medium-diameter trees are known to increase resilience in Sierran mixed-conifer forests. Properly designed programs have already effectively reduced fire-caused tree mortality in extreme fire weather conditions. Regional reductions of stand density have increased the vigor of remaining trees and reduced forests vulnerability to bark beetles. Forest thinning can also increase resistance to drought among Sierran mixed conifers. By improving individual tree resistance to drought and stand resistance to wildfire, we can help maintain the forests’ ecological integrity and ecosystems including wildlife habitat, soil stability, and carbon sequestration. Conservation organizations are monitoring governmental efforts, and you can support them with your donations, voting, and advocacy.

Ultimately, as individuals, we can only control our personal carbon footprint. We can recognize that , as Americans, we have one of the largest per capita carbon footprints in the world, about 12-15 tons per person per year. Imagine 15 one-ton or 7 cubic yard blocks of cement on your driveway and that is what each of us emits into the air on average, per year. Personally, I’m trying to transition to a net-zero fossil fuel life. It isn’t easy and it isn’t cheap, and I may never fully succeed, but if we can all transition away from gas-powered vehicles, furnaces, hot water heaters, stoves, and most plastics, we can make a real difference. Two other important sources of greenhouse gases are air travel and the food we eat (especially beef). Still, the single most important thing you can do is vote for officials who will support meaningful carbon reductions.

Hikers can try to use mass transit to get to trailheads as much as possible. This a real option on the JMT and much of the PCT using trains and Eastern Sierra Transit.

I am not the first to say that trip-ending wildfire along the trail is becoming more and more likely, and the risk of heat-related illness and dehydration is increasing. Hiking in temperatures over 100°F will become exceedingly common by the end of the 21st century — which may make continuous southbound PCT thru-hikes dangerous, if not impossible, to complete due to extreme heat and lack of water in the Southern California desert.

Currently one of the longest stretches along the PCT without reliable water is about 42 miles in California’s Section F from Landers Meadow to Walker Pass (Willow, Yellow Jacket and McIvers Springs are often dry, and it is dangerous to rely upon water caches). In a drier and hotter climate, where PCT travelers will need even more water to sustain physical needs, that distance could easily double in a future drought as more springs dry up. Finally, In this century there almost certainly will be years when hikers see little to no snow in the Sierras.

Thru-hikers will need to adapt by starting earlier or section hiking, with the choice of section dictated by the time of year to avoid climate extremes. With an expanded fire season, it is more likely, also, that a long-distance PCT journey will be disrupted by wildfire and unhealthy smoke. Hikers must know their bail-out options and keep abreast of fire closures. Not only might fire end a trip, it will alter the trail experience through the burned section for decades into the future. For example, the 2021 Dixie Fire, which burned vast swaths of Plumas and Lassen National Forests and Lassen Volcanic National Park, burned across more miles of the PCT than any fire since the establishment of the trail. Heat exposure can be a deadly threat in these areas to unprepared or unacclimated hikers

Just recently, hurricane Helene caused massive trail damage to the Appalachian Trail and similarly, the PCT could be damaged by atmospheric rivers and flooding in the future. Volunteer for or donate to PCTA as a trail steward or restoration work if you can.

Let’s do what we can to save our forests, wildlife and watersheds from catastrophe so that our children and grandchildren have the PCT to enjoy and provide inspiration in their lives.

\*\*\*\*

Karl Ford is a Triple Crowner and author of two books: *Triple Crown Hiking Adventures* and *Colorado Trail in Crisis: A Naturalist’s Field Report on Climate Change in Mountain Ecosystems.* Ford is an environmental scientist and was a project manager for the Bureau of Land Management responsible for ecoregional-climate assessments for the southwestern U.S. Working with Wild Connections, a Colorado conservation organization, Ford has mapped out climate refuge corridors for central Colorado For more on this topic Ford recommends the book *Requiem for America’s Best Idea; National Parks in the Era of Climate Change* by Michael Yochim.