

It was late on October 8, 2017, after a long, hot, dry day, when one of California's greatest disasters struck: I locked my keys in the van.

Over a hundred UC California Naturalists had gathered for a Regional Rendezvous at Pepperwood Preserve in Sonoma County to do what people do at Pepperwood: observe nature, catch up on the latest environmental science, and share advice on land and water management. The preparations had started early that morning, with muffins and coffee put out and tall banners set up behind the registration table to direct the naturalists to the day's activities. Michael Gillogly, Preserve Manager, warned that the banners might be blown down as the winds picked up later in the afternoon. It was a hot but pleasant day. We didn't finish packing up until late in the evening, which is when I locked the keys in the van. After the tow truck driver retrieved the keys and we were on our way home, we smelled a hint of smoke and it was later still when Gillogly got a call from a neighbor. She smelled smoke, too.

Within minutes, Gillogly saw an orange glow in the eastern sky. A wall of fire was quickly approaching. While Gillogly rushed to secure the preserve's vehicles and property, furious winds were driving the fire west at unprecedented speed. Suddenly an adjacent

hill burst into flame, a towering inferno reaching into the treetops. It was clear Gillogly had to leave immediately. He and a neighbor drove along the small country road honking their horns to warn others. “If we didn’t see lights turn on or anyone come out, we went up to the door.” After his family departed in another vehicle and the neighbors were warned, Gillogly, along with two other vehicles, quickly departed. “For the entire three miles to Calistoga Road, everything was on fire on both sides of us,” he later recalled in a Pepperwood field note. “All the houses, everything we passed, it was all burning. I could feel the heat inside my cab from the fire. Trees had fallen on the road, and in one stretch, rocks dislodged by the fire had rolled down a steep bank and were in the way. Luckily, we were able to get around all of those. My adrenaline was pumping as I dodged everything, and I had to keep my eyes on the road and go fast, but not so fast that I crashed and lost the opportunity to get out. Pretty soon we were through it.”

He rejoined his family in Santa Rosa and fled south on Highway 101, another harrowing experience. “The fire was already on the freeway and jumping over it. People had to get off by going down the on ramp the wrong way; it was the only way you could get out of there. The wind was blowing hard, burning embers were flying across the freeway, and the grass alongside the road was bursting into flames. It was just insane.” Gillogly and his family lost their home on the preserve that night, as did many in the path of the Tubbs fire. Pepperwood’s rangelands were mostly burned over, although the main building was spared.

While Gillogly was trying to get himself and many others to safety that night, his boss, Lisa Micheli, president and CEO of Pepperwood Preserve, was sleeping soundly, having recently figured out how to silence her phone during the wee hours of the night.

The next morning, she awoke to more than 60 messages. The first voicemail she played said that everyone was alive. Once the shock wore off, she was grateful that she got some sleep because she was going to need it. She had to assess the damage at Pepperwood and take care of the staff, neighbors, and larger community demanding information on what to do, from toxic waste to tree removal.

This fire was a game changer because many of the thousands of homes and businesses the fire destroyed were within the urban footprint of Santa Rosa. Now every autumn is tinged with dread for most Californians as part of a new normal. Since the fire, Micheli says, everyone in the Sonoma County environmental community has come together to learn what had happened to Pepperwood, other preserves, county and state parks, and many other special places that were devastated by the 2017 fires, and what each organization needed in order to provide the most help.

There are many nature lovers in the area who wanted to know what happened to the animals during the fire, and fortunately, Pepperwood stewards maintain a whole slew of wildlife cameras set up in a monitoring grid to record wildlife. Sure enough, the animals were there right after the fire, looking for food. That said, first responders reported seeing significant mortality along fence lines where animals had been trapped against the flames. Animals need safe passage across the landscape, especially when they are on the run. Pepperwood's important camera monitoring plots provide information about wildlife before the fire. Scientists and volunteers can now use this information to investigate how the wildlife are recovering after the fire and to prepare for the next one, including adjusting fencing so wildlife can escape. What about the livestock that help Pepperwood keep the exotic grasses under control? They needed water and supplemental feed right away—additional

things that communities need to be prepared to provide after a disaster such as this.

“Even though we knew we are living and working in a fire-adapted landscape, we were still not prepared for this type of extreme event,” Micheli says. Rural residential development spans across much of Sonoma and the surrounding counties. This type of wildland-urban interface is where 82 percent of damage to structures occurred in California from 1985 to 2013. Currently, a third of the homes in California are in the wildland-urban interface and require more comprehensive approaches to living in these increasingly fire-prone areas. Public preparedness can include towns identifying evacuation routes as well as dedicated safety zones where people can take refuge. Residents living in isolated areas with only one evacuation route can learn about sheltering in place and employ building strategies where life support systems, like water and temperature range, are maintained that allow people to survive.

Micheli and the rest of the Pepperwood staff have been pulled this way and that ever since the day after the fire. It started with how to determine how contaminated the surface water was from the huge number of toxins released into the air and across the land and what this meant for health and safety. Basic information like this had to be collected and distributed by Pepperwood and other nonprofit conservation groups in the area to protect the public.

A conservation working group came together in the aftermath of the fire to share information. The group did a lot of work, from figuring out how to measure air and water quality to writing guidelines on toxic waste removal and vegetation management. To prevent unnecessary tree loss, they got the word out to residents that it’s best to wait before cutting native trees down unless they pose

an immediate safety concern. Many oak trees and other hardwoods that seem dead will resprout from the stump in the spring and grow into mature trees again.

“What is going to make us the most adapted to climate change is having healthy ecosystems out there,” Gillogly says. At Pepperwood there is ongoing work to promote more resilient landscapes, including forest thinning, grassland management through grazing, and removing unneeded fencing so that wildlife and livestock have a better chance of escaping the next fire. Land management is important because although fire can give native plants an advantage, on some soil types it can promote the establishment of invasive species. Fire can release nitrogen, phosphorus, and other nutrients in forms that can be readily absorbed. This nutrient boost and increased light streaming through burned tree trunks can allow invasive species to spread into areas once dominated by a diverse shaded understory.

Volunteers are busy planting native plants to restore some of the burned areas at Pepperwood and monitoring the plant communities that burned to document how the preserve is recovering. They are recording the amount of leaf litter on the ground and how much of the cover is made up of grasses versus woody vegetation. They are measuring tree diameter at breast height, the scorch height of the fire, basal sprouts, the presence of fungus on trunk and leaves, and the amount of light that penetrates the canopy as an estimate of canopy leaf density. They did this on a sample of trees in January after the fire and have been revisiting those trees every summer since. What they’ve seen hasn’t always been what they expected. “Apart from the data, monitoring gets you out and noticing changes,” Gillogly says. In some areas the fire was so hot that even though some stand thinning had been done before the fire came through, all the trees died. In some areas where they did

not thin the Douglas firs, the trees didn't serve as ladder fuels, spreading fire from the ground to the tree canopy, as experts would have predicted. Nature can be hard to perfectly predict.

Pepperwood is building a new house for Gillogly and his family to return to on the preserve. It won't have the wall hangings from their trips to Mexico or the family photos, but, he says, "Fire reduces you down to your body and the planet—not you and all your stuff."

"It does my heart good to see the preserve come back—the wildflower displays, the new species, and all the animals that are here and thriving," Gillogly says. Following the fire, 12 previously unseen native plant species showed up, all known as fire followers because they only germinate after fire. "It just makes me think, how our people-made systems need to be more resilient and fire adapted like nature is, and then we can get through these things a lot easier."

The state's fire-adapted ecosystems have a long history of frequent, low- to moderate-intensity ground-level fires, and Indigenous people coexisted with fire. More recently, human suppression of fire has greatly influenced the composition and structure of the vegetation observed today. Fire suppression or exclusion results in crowded stands of young trees that serve as fuel, contributing to high-intensity fires at crown height, as was the case in Sonoma County.

Historically, lightning was a primary source of ignition, while today humans are responsible for more than half of all fires. Shrubs that dominate California's chaparral burn at a high intensity, and with the dramatic increase in population in Southern California, ignition rates are much higher now than they were historically. These fires are difficult to control, and with their increased frequency, some of Southern California's ecosystems are converting to mostly non-native grasslands. Fire did not shape California

desert plant communities, because historically there was very little biomass; therefore, desert species are not adapted to fire. This means fire management is viewed differently depending on which part of the state and which ecosystem it occurs in—from the need to increase the use of fire as a management tool in the more mesic, conifer-dominated landscapes to the need for more vigilant control of fire in the arid southern ecosystems.

There are over 2,000 wildfire starts in California every year, and that number is only going to go up as the population surpasses 40 million and the temperature rises 5.6°F (3.08°C) or up to 8.8°F (4.84°C) by 2100, if we continue business as usual. Recent fires have been far larger than those in the previous century. The extreme fires that we're seeing more frequently are ones that start when the winds blow from the east and the humidity is extremely low. Fuel loads have changed with fire suppression, logging, and homes scattered throughout the urban wildland interface. As Lisa Micheli put it, for some neighborhoods it's "not about protecting houses from trees but trees from houses."

Nowhere has fire been more frequent in California over the past decade than in Lake County, northeast of Pepperwood Preserve. That said, fire is a natural ecosystem process throughout most of California's bioregions, and this is especially true for the vegetation of Lake County. One can think of Lake County as the epicenter of California's new fire normal. Since 2008, the county has been scorched by eight big fires: Valley, Rocky, Jerusalem, Clayton, Sulphur, Wye-Walker, Scotts, and Pawnee. These fires claimed lives, devoured more than 200,000 acres of terrain, and destroyed nearly 2,600 structures, most of them homes.

In the Lake County region, fires can explode after a dry winter or a long hot summer, when winds blow through hilly terrain

covered by dry chaparral and mixed oak woodlands, making the fire burn hot and fast. Yet the scars quickly fade as shrubs regenerate and blue oaks resprout from their burnt bases, and soon the land is ready to burn again. It is a landscape that is accustomed to fire. But even in this area where fire is common, firefighters are surprised by fires in June and the increasing size of the more recent fires. Future wildfire projections suggest a longer fire season, and an increase in wildfire frequency, across California. In fact, models used in California's Fourth Climate Change Assessment project that the area of land consumed by wildfires in the state each year could increase by 77 percent by 2100 if global greenhouse gas emissions continue to rise.

Some residents have lost their homes repeatedly and some have left the area, but many have stayed. So what keeps them there? Lake County is a beautiful, mountainous, natural landscape, so for some it's a choice to stay and rebuild. However, others simply cannot afford to move. According to the US Census Bureau, 21 percent of people in Lake County live below the poverty line, compared to the national average of 10.5 percent. Climate change exacerbates existing inequalities, both because the places that are more vulnerable to extreme events are often more affordable to live in and because disadvantaged communities don't have the money to reduce their exposure to extreme events or minimize adverse outcomes from these events.

Two weeks before the Valley fire started in 2015 and moved quickly across parts of Lake, Sonoma, and Napa Counties, Greg Giusti, a recently retired UC Cooperative Extension advisor, was at a community fire meeting. At the meeting they examined historical fire maps that revealed a fire in the 1940s had burned down the same canyon that was to burn in the Valley fire; similarly,