WATER EXTINGUISHES FIRE, BUT HOW DOES FIRE AFFECT WATER?

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Author's Note

An abbreviated version of this work was recently published in the California Water Blog (Part 1, Part 2), but there is more to share. In his novel Jayber Crow, Wendell Berry wrote, "Telling a story is like reaching into a granary full of wheat and drawing out a handful. There is always more to tell than can be told." The two California Water Blog articles were the first few handfuls, and some additional handfuls are included in the full version of the text below. There is certainly still a lot more story to be told though, and I hope this inspires and motivates people to further investigation and work on these important issues.

Abstract

Wildfires in California have been increasing in frequency and intensity in recent years. At a very young age, we learn that water extinguishes fire. Out of professional curiosity, for this analysis, we zoom out and at a much larger scale ask the reverse question: how does fire impact water?

To answer this question, we analyze the 2024 Park Fire's impact on streamflow across three watersheds impacted to varying degrees (Battle Creek, Deer Creek, and Mill Creek) and specifically look at the runoff from large precipitation events and summer baseflows. The results of the precipitation runoff analysis show that fire and water (while opposites) are intimately connected and that fire can have severe impacts on water. Before the Park Fire, as generally expected, peak storm runoff flows increased in accordance with watershed size, from Mill Creek to Deer Creek to Battle Creek. After the Park Fire, this was reversed, in accordance with the percentage of the watershed impacted by fire. Battle Creek (the largest watershed, but least impacted by fire) had the lowest flows, then Deer Creek, and then Mill Creek (the smallest watershed, but most impacted by fire) had a substantially higher peak flow compared to the other two watersheds (and the greatest volume of runoff). The summer baseflow analysis did not yield as strong of results, but relatively higher flows out of burned areas were observed, along with some similarities to results of the precipitation runoff analysis.

Following this evaluation, the conclusion presents a reflection on the lessons learned and the importance of having "good" data about our natural resources ("good" meaning organized, accurate, and readily available). Good data allows us to evaluate these interesting questions in a meaningful way and leverage the insights and answers for improved natural resource management.

Introduction

It is a well-known fact that wildfires in California are increasing in frequency and intensity, resulting in a greater extent of areas being either directly burned or otherwise impacted in recent years (Li & Banerjee, 2021; Turco et al., 2023; Cal Fire, 2025). I work for a company called Davids Engineering (DE), a small water resources consulting firm here in California, and we have an office in the city of Chico up north in the beautiful Sacramento Valley. Our region has been severely impacted by some large fires in recent years. The Camp Fire in 2018 was unprecedented, burning over 18,000 structures (roughly ~85% of all structures) in the nearby foothill town of Paradise (Knapp, et al., 2021) and, propelled by strong winds, roaring out of the foothills right down onto Chico's doorstep before being contained. It was the deadliest wildfire in U.S. history in over 100 years (Martinez, 2018). Other large fires in the area in recent years include the North Complex Fire in 2020 and the Dixie Fire in 2021, which was the largest single fire ever in California history (NPS, 2023). More recently, in 2024, we also experienced the Park Fire, which started on July 24th on the outskirts of Chico in Upper Bidwell Park and very quickly expanded, burning over 429,000 acres to the north (Cal Fire, 2025). Figure 1 below shows a view of flames and smoke rising from the Park Fire the day it began, seen in a photo taken from the outskirts of Chico.

Figure 1. Smoke rising from the Park Fire (and visible flames). Photo taken at 8:30 pm on July 24, 2024 (the day the fire started) from Wildwood Park on the east side of Chico. Photo by Jeff Davids.

At DE, we don't directly work on wildfires or related issues. We often work with irrigated agriculture and environmental water users in the Central Valley (not an area prone to wildfires), but even on the valley floor, the water supplies that we and our clients rely on are impacted by these wildfires.

At a very young age (before we can spell either "water" or "fire"), we learn that water extinguishes fire. Although this is true, directly applying water to put out fire is a relatively small tool in the toolkit that wildland firefighters have at their disposal for the monumentally difficult, dangerous, and important work they do (larger tools include cutting fire control lines, vegetation removal, and even "fighting fire with fire" through controlled low-intensity burns in a wildfire's path to limit its spread). So, at a very small scale, we know water extinguishes fire. Out of professional curiosity, we wanted to zoom out, and at a much larger scale, ask the reverse question: how does fire affect water? How do these large wildfires impact our water systems, supplies, and the water cycle?

We will not address water quality issues related to fire. This has been studied by people more qualified than us (including a recent research study on water quality impacts of the Camp Fire that included two local professors at CSU Chico). However, for "fun" we did collect some water samples from Big Chico Creek to compare visual clarity before, during, and after the first major precipitation/runoff event following the Park Fire in November 2024, with some stark results (DE, 2024). For this evaluation, we will focus solely on water quantity, and ask two specific research questions:

1. **How is storm runoff affected by wildfire?**
2. **How is summer baseflow affected by wildfire?**

The first question is primarily focused on flood risk, and the second question on water supplies available throughout the year, especially the dry summer months with little to no precipitation to provide additional water inputs to these watersheds. We approached our two research questions as follows:

1. **Completed a spatial analysis to evaluate what percentage of watersheds were burned (*both research questions*)**
2. **Evaluated local precipitation records pre- and post-fire to identify similar large precipitation events that would result in substantial runoff and streamflow (*question one*)**
3. **Evaluated hourly streamflow records to compare pre- and post-fire conditions (*question one*).**

4. **Evaluated daily streamflow records pre- and post-fire to evaluate impacts on summer baseflow (*question two*).**

The fire of interest for us was the Park Fire in 2024. The watersheds included in our analysis and most impacted by the Park Fire were Big Chico Creek, Deer Creek, and Mill Creek. The United States Geological Service (USGS) has maintained stream gages on Deer Creek and Mill Creek since the first half of the 20th century and right up through the present, providing a rich historical record of streamflow for our analysis. Big Chico Creek has historical data through 1986 available through the USGS and current data available on the California Data Exchange Center (CDEC), but due to potential data quality concerns with CDEC data, it was excluded from this analysis. The Battle Creek watershed to the north of Mill Creek also has a USGS stream gage and was slightly impacted by the Park Fire; we will evaluate its streamflow record as a control to compare to the Deer and Mill Creek watersheds.

Hourly precipitation data was accessed through the California Irrigation Management Information System (CIMIS) website maintained by the Department of Water Resources (DWR). The closest station to the area of interest with both historical and current data was determined to be the Gerber South station (Station No. 222), located south of the City of Red Bluff, directly to the west of the Park Fire burn area. It was established in August 2014 and includes data through the present[1].

Ok, without further ado, here's what we found!

Evaluation of Burn Areas

We calculated the percentage of watersheds burned using delineations of fire perimeters available from Cal Fire and the USGS StreamStats tool to delineate the watershed area above the gaging locations on Deer, Mill, and Battle Creeks (and the historical gage location on Big Chico Creek).

We did not consider burn severity as a factor in this analysis, although it obviously influences storm runoff after wildfires. The USGS has analyzed this (Moody, 2012) and the analytical method they developed is available in a beta-version of StreamStats for fires from 2023 and earlier.

[1] There is also a Gerber station (Station No. 8) very close by to the north that is no longer active, but includes data from 1982 through 2014. There was a coordinated transition from Gerber to South Gerber, as Gerber and South Gerber have a few days of overlapping data in 2014.

For our three impacted watersheds, our evaluation showed the largest impact to the Mill Creek watershed, then the Big Chico Creek watershed, and the smallest impact to the Deer Creek watershed (with most of the upper watershed outside of the Park Fire perimeter). It is worth noting that portions of the upper Mill and Deer Creek watersheds were also within the perimeter of the Dixie Fire (which burned in 2021), and we included the Dixie Fire perimeter in our calculations as well. The Battle Creek watershed (the largest of all included, our control) was least impacted by the Park Fire, with the fire perimeter only crossing its southern edge in a few locations. These results are shown below in Table 1 and Figure 1.

Table 1. Total area and area within fire perimeters for watersheds of interest (rounded to nearest thousand acres).

Watershed	Total Area (above gaging location), Acres	Area within Park Fire Perimeter, Acres	Percentage within Park Fire Perimeter	Percentage within Park and Dixie Fire Perimeters
Mill Creek	84,000	64,000	76%	88%
Deer Creek	134,000	57,000	42%	54%
Big Chico Creek	47,000	35,000	75%	75%
Battle Creek	231,000	12,000	5%	5%

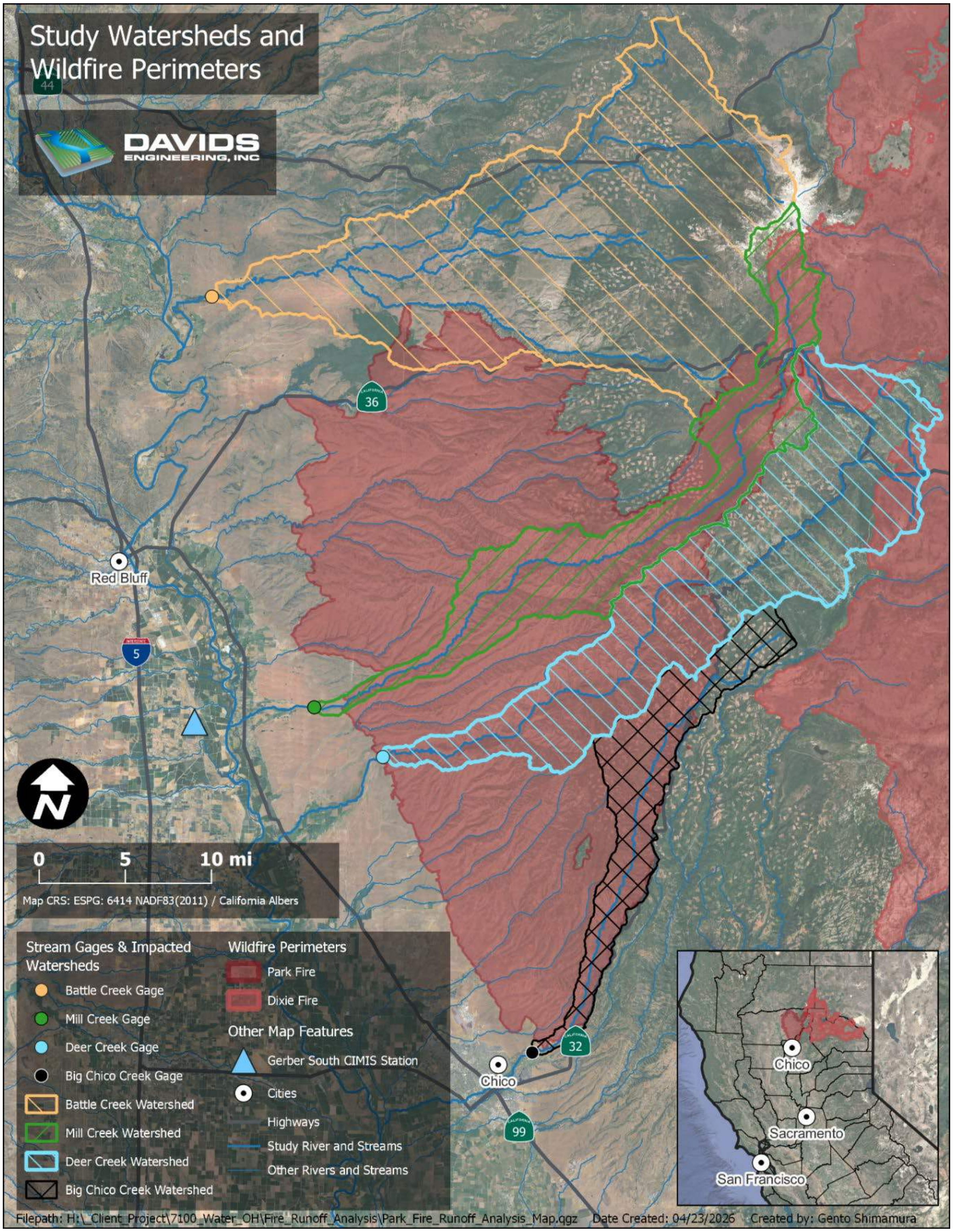

Figure 2. Map of Fire Perimeters and Big Chico Creek, Deer Creek, Mill Creek, and Battle Creek watersheds above gaging stations. Also pictured is the Gerber South CIMIS station location.

Identification of Similar Pre- and Post-Fire Precipitation Events

The first major rain event that occurred following the Park Fire was a BIG one, resulting in evacuation warnings and flooding on Highway 99 in Butte County. The South Gerber CIMIS station hourly data showed this event beginning in the early morning hours of November 20, 2024, and it was a slow, steady event running nearly three days through the end of November 22, 2024 (70 hours total). It produced 4.25 inches of rain with an average intensity of 0.06 inches per hour and peak intensity of 0.19 inches per hour.

In order to identify similar precipitation events from before the Park Fire, we classified precipitation events as periods that produce at least 1.5 inches of rain (with no more than 12 consecutive hours of zero rainfall, which would signal the end of the event). The South Gerber CIMIS station was established in August 2014, providing more than 10 years of data for review and comparison. Between August 2014 and November 2024, we identified 22 precipitation events that fulfilled the criteria above. For each of these, we calculated or extracted the total duration, total precipitation, average intensity, and peak hourly intensity and used these four variables to identify the most similar event. The variables were scaled to a common reference system using z-scores, greater weight was applied to total precipitation than the other three variables, and then the Euclidean distance was calculated in four-dimensional space to find the event closest in distance to the 11/20/24 event.

Unfortunately, it is impossible to produce an apples-to-apples (or raindrop-to-raindrop) comparison, as every storm is unique. The 11/20/2024 event was both the longest and had the highest total precipitation. The closest event to it based on the approach above occurred on 2/12/2019. This event produced the second highest total precipitation for all events (3.65 inches of total rainfall), but it only lasted about half as long (37 hours) and thus had a relatively higher average intensity of 0.10 inches per hour. The peak intensity during the event was 0.27 inches over one hour. Another notable difference (not directly factored into the analysis) was that the 11/20/2024 event was first major precipitation event of the water year, while the 2/12/2019 event happened in the middle of the winter (well into the water year). Regardless of discrepancies, these two events produced similar amounts of rainfall (a 0.60 inch difference, 14% relative to 11/20/2024 event's total) and the average and peak intensities had relatively small differences of 0.04 inches and 0.08 inches, respectively. The two events also track closely initially and then show greater divergence later. A plot of the hourly precipitation across both of these events is included in below in Figure 3.

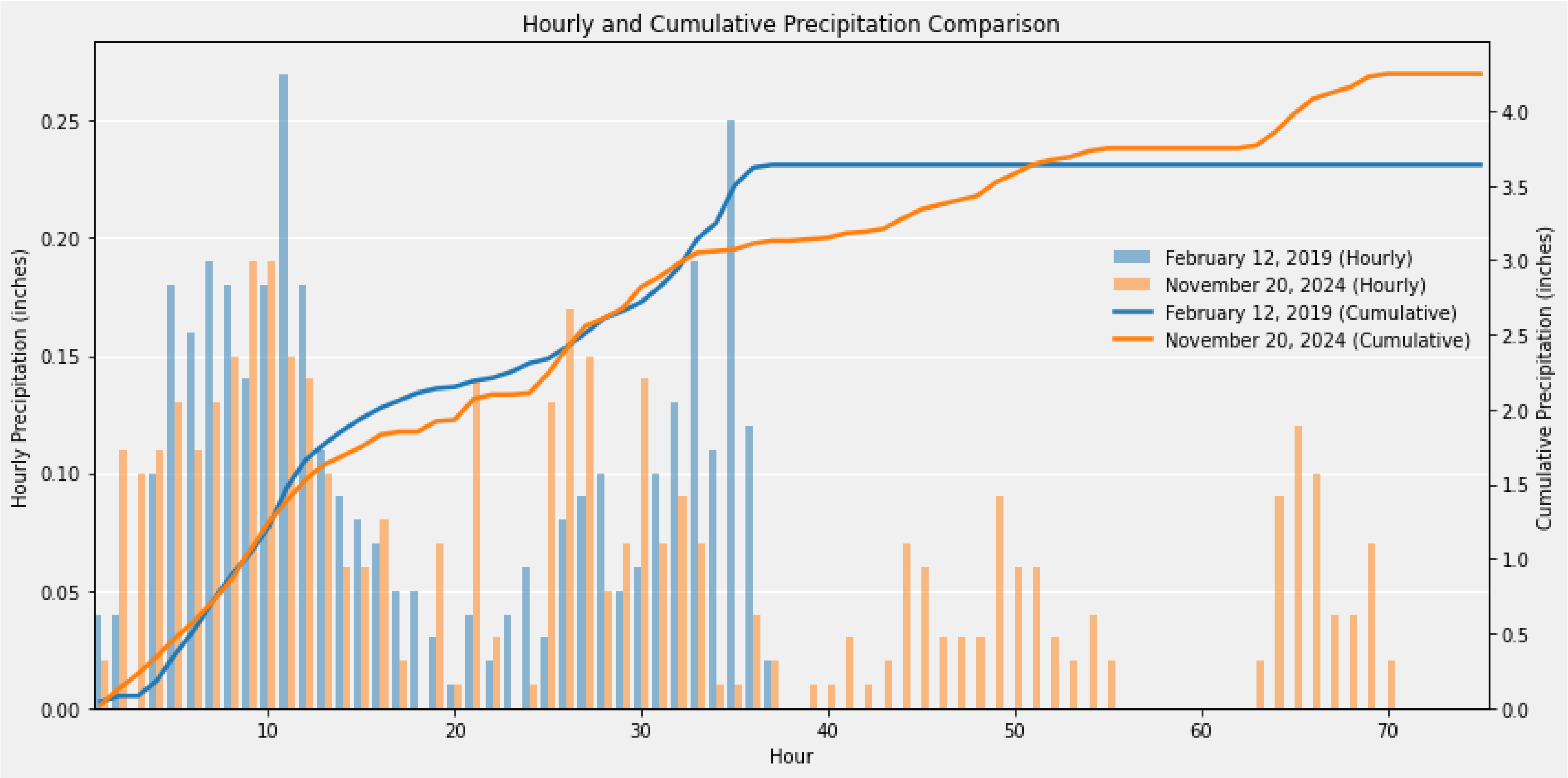

Figure 3. Hourly and cumulative precipitation for the first major precipitation event after the Park Fire and the closest precipitation event before the Park Fire. The two events track closely for first 30 hours or so; then the event before the Park Fire concludes with several hours of more intense precipitation, while the event after the Park Fire continues with lower intensity precipitation for roughly another 30+ hours.

Evaluation of Pre- and Post-Fire Precipitation Runoff

After identifying our pre- and post-fire precipitation events for comparison, we assembled hourly streamflow data from the USGS gages and aligned the flows to correspond to the start of each precipitation event (as measured at the South Gerber CIMIS station). Figure 4 below shows the hourly precipitation for each event and the streamflow at each gage for several hours preceding each event and several days following the start of each event.

One of the first observations from the comparison is that the rising limb of the hydrograph and peak flow from the pre-fire event occurred more quickly than for the post-fire event, which was the opposite of what we anticipated. Due to the fire burning through vegetation that would otherwise capture precipitation and slow the resulting runoff, we hypothesized that runoff from the post-fire event would occur more quickly and result in greater runoff. However, despite these two precipitation events being the "most similar" in the period of record, there are still some key differences. One consideration is that the pre-fire event had a higher intensity, so (all else equal) we would expect pre-fire runoff to occur more quickly and have a higher peak flow. Perhaps the more important consideration though is of initial conditions within these watersheds at the start of each precipitation event. The pre-fire event occurred in February 2019 (a Wet year on the Sacramento Valley Water Year Index) and conditions in the upper watershed were likely well-saturated at that point, resulting in a greater percentage of precipitation immediately resulting in runoff. In contrast, the November 2024 post-fire event was the first major precipitation event following several months of dry conditions preceding the event, so the ground was likely very dry and able to soak up more rainfall than in the saturated conditions of the pre-fire event. The same trend of later runoff occurring in the post-fire event is seen across all three watersheds (which were all impacted by the Park Fire to varying degrees), so factors apart from the Park Fire, such as the two described above, are likely influencing this observed trend.

When we begin observing the runoff flows themselves, some interesting differences emerge. The post-fire event has two distinct peak flow occurrences, corresponding to precipitation timing over the 70-hour event. As described above, the first is delayed and occurs roughly 10-12 hours after the peak flow from the pre-fire event, and the shape of the hydrograph curve differs between Battle Creek (least impacted by the Park Fire) and Deer and Mill Creeks (more severely impacted). Within this first peak, Deer and Mill Creeks both have two peak flows within several hours of one another, whereas Battle Creek only has one main peak flow (similar to the pre-fire runoff). The first peak of Deer and Mill Creeks occur at the same hour (preceding Battle Creek's peak flow by 2 hours), flows decrease afterwards, but then increase again to a higher peak flow several hours later (a substantially higher flow on Deer Creek, 48% higher than the first peak). It is also worth noting that this first peak flow from the post-fire event on Mill Creek (the most severely impacted by the Park Fire) already exceeds the peak flow from the pre-fire event.

The largest and most interesting differences though are those associated with the second peak flow, which occurred roughly a day after the first peak flow. Here differences between watersheds are most pronounced. The pre-fire precipitation event lasted 37 hours; for the 70-hour post-fire precipitation event, the majority of the precipitation occurred during the first 37 hours with 3.13 of 4.25 total inches falling during this period (74% of the event total). However, the post-fire event continued and another 1.12 inches of precipitation (26% of event total) fell over the next 33 hours. At this point, the dry initial conditions across the three watersheds had been altered by the first half of the storm, and as another rising limb on the hydrograph took shape, the magnitude of this second peak flow differed widely between watersheds. For Battle Creek (least impacted by the Park Fire), the second peak flow was markedly lower than the first (29% lower, relative to the first peak). However, for Deer Creek (partially burned by Park Fire) the second peak flow was 20% higher than the first (relative to the first peak), and for Mill Creek (which was nearly 90% burned by the Park and Dixie Fires), the second peak was 66% higher than the first. These second peaks were likely primarily influenced by the minority of total precipitation that occurred during the latter portion of the event. These flow increases are not insubstantial. The second peak on Deer Creek is more than 1,000 cfs higher than both the first peak of the same event and the peak flow from the pre-fire event. On Mill Creek, the second peak flow is more than 7,000 cfs higher than the first peak and pre-fire event. In contrast, in Battle Creek (where the Park Fire had little impact), this second peak was more than 3,000 cfs lower than the first peak and pre-fire event.

The timing of these second peak flows also differed between watersheds, with the relatively higher peak flows at Deer and Mill Creek occurring two to three hours before the relatively lower peak flow on Battle Creek. For flood risk, this is a two-punch combo, as the peak flows hit earlier and were much higher in magnitude.

Lastly, a calculation of the total volume of water produced through these events and flowing past the stream gages reveals that, for the pre-fire events, the smallest to largest volumes correspond to watershed size, with Mill, Deer, and Battle Creeks having the smallest to largest outflows, respectively. For the post-fire event, the largest outflow occurs from the smallest watershed: Mill Creek. This further illustrates the impact the Park Fire had on immediate runoff from the first major precipitation event after the fire.

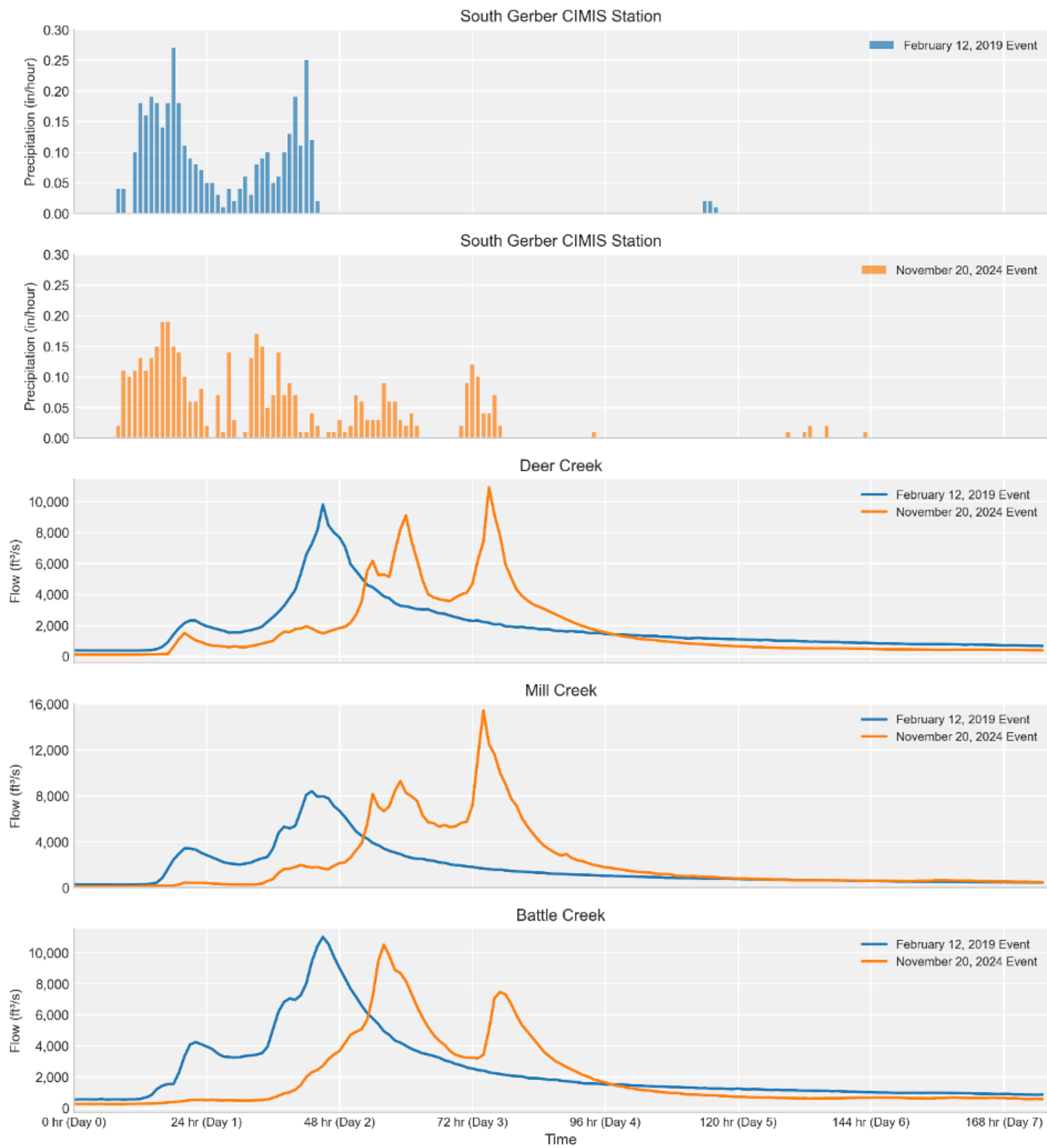

Figure 4. Pre- and post-fire precipitation events and resulting runoff in the Deer, Mill, and Battle Creek watersheds. Pre-fire materials are depicted in blue and post-fire in orange. Due to the lower intensity of the post-fire precipitation event and drier antecedent conditions (the November 20th event was the first major precipitation event of the 2025 water year), the initial rising limb on the hydrograph for the post-fire event occurs later than for the pre-fire event. However, after flows had begun to decrease again, additional precipitation resulted in another increase in flow. For this second rising limb, the peak flows were noticeably lower than the first peak flow in Battle Creek (least impacted by Park Fire), noticeably higher than the first in Deer Creek (54% burned in Dixie and Park Fires), and tremendously higher in Mill Creek (88% burned, most impacted by Dixie and Park Fires). For the post-fire event, Mill Creek also had the greatest outflow volume of the three watersheds, despite being the smallest in size.

Evaluation of Summer Baseflows

In considering how summer baseflow conditions would be impacted by wildfire, we thought two conflicting factors may be at play that could increase and decrease summer baseflows, respectively. First, with a substantial portion of the vegetation in the watershed burned, we'd expect evapotranspiration (ET) from these watersheds to be lower, which would increase streamflow out of the watershed. Recent work has shown that forest thinning and prescribed fire can increase streamflow out of a watershed (Boardman et al., 2025). However, the timing of this increased flow is another factor. A fire (and the corresponding vegetation loss) may also reduce a watershed's ability to store and slowly release water over time. The trend of quicker and higher runoff after a fire (see Research Question 1 materials above) may play out over the course of a water year such that flows in winter and spring are relatively higher, but summer baseflows are relatively lower.

For our analysis, we extracted and analyzed daily average streamflow data for our three watersheds for the 25 years from 2000 to 2024, and we used the Sacramento Valley Water Year Index (WYI) to categorize similar years from a hydrologic perspective and compare flows from April 1st (typically, at least historically, the date of maximum snowpack in the California mountains[2]) to September 30th (the end of the water year). We calculated a mean daily flow for all Critical and Dry (C/D) years during this period (a total of 11 years, 44% of 25-year period), and a mean daily flow for all Above Normal and Wet (AN/W) years (a total of nine years, 36%). For the AN/W years, we also calculated one standard deviation in either direction from the mean to assess overall variability and where the 2025 flows fall relative to a broader swath of historical flows than just the mean value (at the time of analysis, the 2025 WYI value was not officially posted yet, but we knew it would either be AN or W). Finally, we extracted 2025 daily average streamflows (the year following the 2024 Park Fire) for comparison to these prior periods. All of these results are depicted below in Figure 4.

Starting with the simplest observations, as expected, the mean flows in the C/D years are the lowest on the chart throughout this period while the AN/W years are noticeably higher. Also, the AN/W years also show more variability during the spring months of April and May; when the shaded standard deviation is plotted, this trend is shown to be influenced by spikes in streamflow (caused by spring precipitation events and subsequent runoff), and it may also be influenced by differing timing of snowmelt and runoff from the upper

[2] Similar to the low snowpack in 2022 reported by DWR, there is very little snowpack in California again in Spring 2026 as of the time of writing. This is, once again, raising fire concerns for this coming fire season.

watersheds. This April and May streamflow variability is notably absent, or at least less pronounced, in C/D years in all three watersheds. By June, C/D and AN/W streamflows in all three watersheds have largely steadied out, and they then proceed to decrease over time towards a minimum summer baseflow condition. Deer Creek decreases to a baseflow condition most rapidly, potentially influenced by being lower in elevation than the other two and having less overall snowpack and subsequent melt and runoff to maintain higher flows into the late Spring and early Summer. For 2025, flows in all three watersheds begin near the AN/W average flows in April, but decrease more quickly than average AN/W conditions. This is influenced by a lack of precipitation during these months in 2025, although it is interesting to note the variability in flows in the Mill Creek watershed (the most severely burned) during this Spring period relative to the other two. There is also a spike in flow in Mill Creek of unknown cause in early June that did not occur in the other two watersheds (there was no precipitation recorded at the South Gerber station at this time). Overall, apart from the variability observed in Mill Creek, the trend of flows decreasing to summer baseflow match each other across watersheds and are similar to historical trends, so it is difficult to discern impacts the Park Fire had during this period of the year from this visualization alone. It seems likely that hydrology has a much bigger influence on flows during this period. Influencing hydrologic factors include the timing and amount of precipitation during the preceding winter and spring period (along with how much was rain vs. snow), weather conditions during this period (i.e., temperatures influencing the timing of snowmelt in the upper watersheds), the absence or occurrence of spring rainfall events, and more.

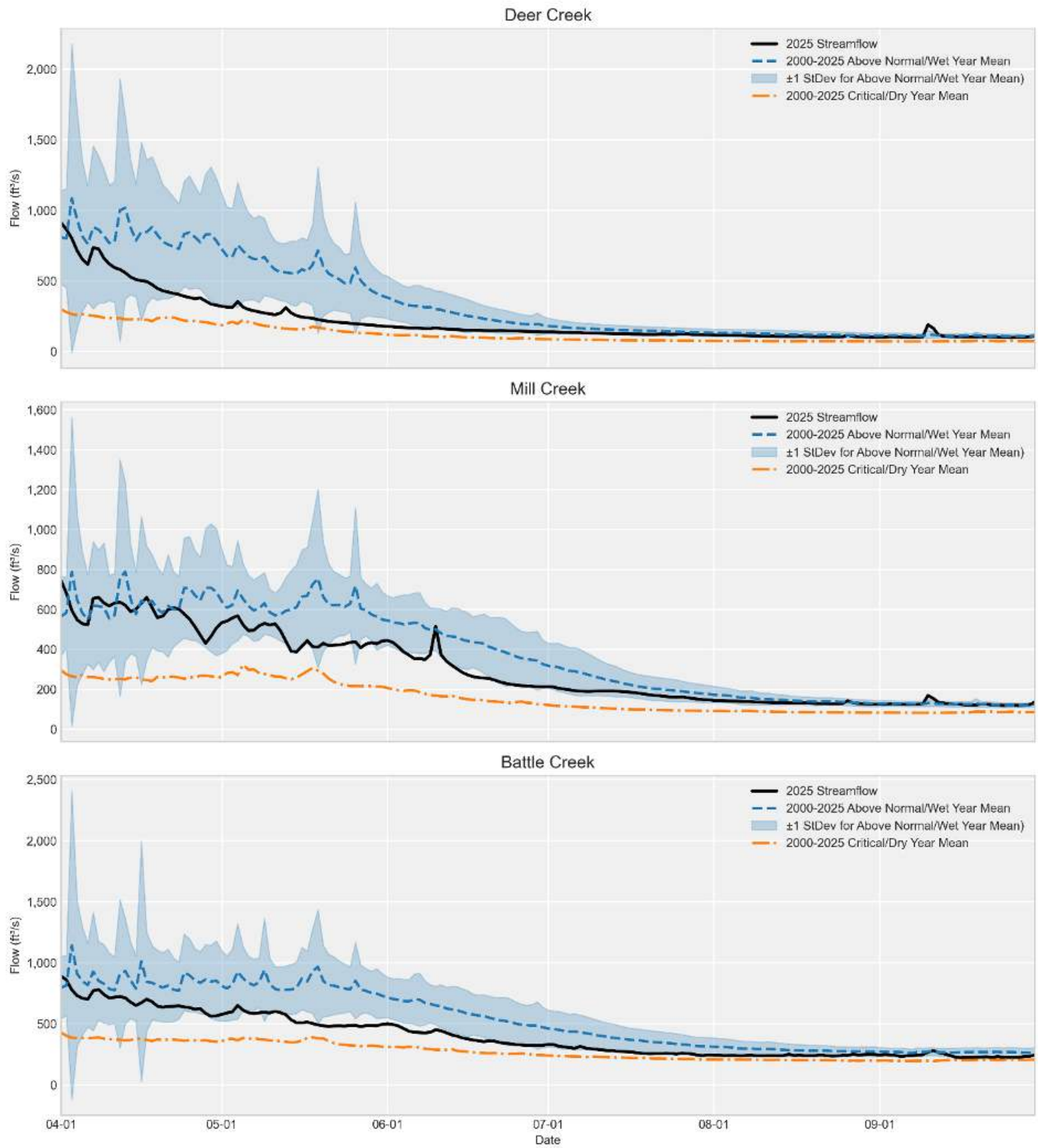

Figure 5. Flows in Deer, Mill, and Battle Creeks from April 1st (generally acknowledged as the date of maximum snowpack in the mountains of California) through September 30th (the end of the water year). The mean flow for all Critical and Dry (C/D) years (orange dash-dot line) is the lowest on the chart, as expected. The mean flow for Above Normal and Wet (AN/W) years (blue dashed line) is substantially higher and shows more variability (including spikes from precipitation and subsequent runoff events during the spring months, which are notably absent from C/D years). The shaded blue area represents one standard deviation in either direction from the mean flow for AN/W Years. Flows in 2025 (black line), after the Park Fire, generally follow expected trends from AN/W years. Flow in all three watersheds begins above the mean but quickly decreases to below the mean, although this takes a period of days after April 1st in the Deer and Battle Creek watersheds and a period of weeks in the Mill Creek watershed (the most severely burned)...

(caption continued from prior page) The flows in the Mill Creek watershed also show more variability as they decrease to summer base flows than the other two watersheds, including a brief spike in flow in early June of unknown cause. As the flows decrease to baseflow conditions in the summer months, they tend to generally match historical trends, making it difficult to discern impacts the Park Fire may have had on summer baseflow conditions. It seems likely that hydrology has a much bigger influence on flows during this period; hydrologic factors at play include the timing and amount of precipitation during the preceding winter/spring period (along with how much was rain vs. snow), weather conditions during this period (i.e., temperatures influencing the timing of snowmelt in the upper watersheds), the absence/occurrence of spring rainfall events, and more.

We also compared and contrasted flows from these watersheds at baseflow conditions during the final month of the water year in September 2025. It is difficult to distinguish in Figure 4 above, but once again there are differences observed between the three watersheds. Table 2 below compares the mean daily average flow for September between 2025 and the nine AN/W years between 2000 and 2024, and also includes a count of days that 2025 daily average flow is greater than the AN/W mean. The 2025 mean September flow in Battle Creek was about 12% lower than the average for recent AN/W years, and only one day in 2025 had a higher daily average flow. In contrast, Deer Creek and Mill Creek (which were more impacted by fire) had 2025 flows roughly equal to recent AN/W years at the 3% lower and 1% higher, respectively. Mill Creek (the most severely impacted by fire) had highest 2025 flows relative to recent AN/W years, with the flow in September 2025 higher on 10 of the 30 days (33%).

Table 2. Comparison of September baseflow conditions between 2025 and 2000-2024 average conditions for Above Normal and Wet (AN/W) years.

Watershed	Percentage Burned Since 2021	2025 Mean Flow, CFS	2000-2024 AN/W Mean Flow, CFS	Difference, CFS (%)	2025 Days with Higher Flow, Count (% of month)
Mill Creek	88%	127	125	+2 (+1%)	10 (33%)
Deer Creek	54%	108	111	-3 (-3%)	3 (10%)
Battle Creek	5%	238	270	-33 (-12%)	1 (3%)

The September 2025 flows were impacted by a storm event from September 9th to 10th that resulted in 0.13 inches of precipitation measured at the Gerber South CIMIS station. The increase in flow from runoff of this event is evident in all three watersheds, although differences in runoff continue to be observed here as well. Only evaluating daily average flow (rather than hourly flows evaluated under *question one*):

1. The Deer Creek watershed experienced a peak daily average flow of 189 cfs on the 10th. This is a 81 cfs (76%) increase over monthly average flow of 108 cfs.

2. The Mill Creek watershed experienced a peak daily average flow of 169 cfs on the 10th. This is a 42 cfs (33%) increase over monthly average flow of 127 cfs.
3. The Battle Creek watershed experienced a peak daily average flow of 280 cfs on the 11th. This is a 42 cfs (18%) increase over monthly average flow of 238 cfs.

In line with the pre- and post-fire precipitation runoff analysis, the flows out of the Deer and Mill Creek watersheds were relatively higher from this rainfall event and peak flow occurred more quickly than in the Battle Creek watershed. The water-related impacts of recent wildfires such as the Park and Dixie Fires will likely continue to be observed in data such as these (and felt by people and the environment within these watersheds) for many years to come.

Conclusions

We began with two research questions:

1. **How is storm runoff affected by wildfire in the upper watershed?**
2. **How is summer baseflow affected by wildfire?**

However, one of our first and primary conclusions, before we even get to potential answers to our research questions, is that this analysis demonstrates the importance of easy-to-find, accurate, publicly available data about our natural environment. In order to answer our research questions, we needed data to review and analyze. In this case, we were able to easily obtain publicly available data from a variety of state and federal agencies (these are listed in Resources at the end).

These datasets are often developed and maintained through partnerships between local stakeholders and agencies and larger state or federal agencies. In order to make these data available, folks need to see the value in them from a local level all the way up to the state and federal government levels. Recent concerns about changes to longstanding state-federal partnerships and staffing cuts have shown that even if the collection and provision of these data were taken for granted in the past, conditions can change at any time (Börk, 2025; James, 2025; Grenier and Mount, 2025). These data provide important information about our natural resources and the continuing development and maintenance of these datasets is worth investing in (from the local level up to the state and federal levels).

Related to the research questions specifically (and addressing them in reverse order), we did observe differences in spring and summer flows across these three watersheds and over time, but these differences were not as substantial as the storm-runoff flow differences. The fire obviously impacted spring and summer flows, but teasing out specific impacts was difficult from this streamflow analysis alone; flows during this period are influenced by a number of additional hydrologic factors that we anticipate having relatively greater impact. However, the September baseflow for Deer and Mill Creeks being relatively higher in comparison to prior years and to Battle Creek does align with the findings of Boardman et al. (2025). Also, runoff from a precipitation event in September 2025 resulted in higher, quicker runoff in the Deer and Mill Creek watersheds, which is a nice segue to our first research question...

The results of the storm runoff analysis from pre- and post-fire precipitation events were more striking. Before the fires occurred, as generally expected, peak storm runoff flows increased in accordance with watershed size, from Mill Creek to Deer Creek to Battle Creek. After the fires, this was reversed, in accordance with the percentage of the watershed impacted by fire. Battle Creek (the largest watershed, but least impacted by fire) had the lowest flows, then Deer Creek, and then Mill Creek (the smallest watershed, but most impacted by fire) had a substantially higher peak flow compared to the other two watersheds (and the greatest volume produced). Additionally, the post-fire runoff happened more quickly with peak flows in Deer and Mill Creeks occurring earlier than Battle Creek. This dramatic shift from pre- to post-fire conditions demonstrates the impact that fire can have on water, and this impact consequently has literal ripple effects on everyone and everything downstream.

There is a relatively small human population within the Deer, Mill, and Battle Creek watersheds and their adjacent floodplains that may be inundated during flood (but it is important to note that although the population in these areas is small and total flooding impacts may be correspondingly small, effects on these communities could still be severe). All three creeks are tributaries to the mighty Sacramento River, and even if local flows are extreme, once they hit the Sacramento River, they are but a drop in the proverbial bucket (although every drop increases flood risk to the flood-prone Sacramento area downstream). However, to close this out, we wanted to briefly circle back around to the Big Chico Creek watershed (which was included in our introductory materials, but was not included in the analysis due to lack of recent accurate streamflow data) and to the importance of having accurate data about our natural resources.

When the Big Chico Creek watershed empties out of the hills into the Sacramento Valley, it is pointed directly at the city of Chico, whose population recently crossed the 100,000 person mark (making it one of the biggest cities in the Sacramento Valley) (USCB, 2024). Due to this higher population, flooding from Big Chico Creek has the potential for a much larger overall impact on the city of Chico and its residents, as the creek flows right through the middle of the city on its way to the Sacramento River.

This is where we'd like to end this story with some good news. In recent years, the State of California has recognized the importance of this streamflow data and planned to increase investment in it, as outlined in Senate Bill 19, or SB 19 (find more information in Pitzer, 2019). The wheels of government often turn slowly, which can be frustrating when problems need to be addressed and solved, but this pace also (ideally, although not always in reality) allows for strategic planning, consideration of multiple opposing viewpoints and building consensus, and wise decision-making. SB 19, in turn, has resulted in the California Stream Gage Improvement Program (CalSIP), managed by DWR, which includes installation of new stream gages in locations deemed high-priority by DWR on a statewide basis and a grant program providing funding to local agencies for locations deemed high-priority locally. Big Chico Creek was designated as high-priority and work is underway now to install and commission a stream gage, not only on the creek to the east of Chico in Upper Bidwell Park, but also downstream at the 5-Mile Diversion Structure (an important location with flood control infrastructure built by the US Army Corps of Engineers, USACE) to divert and direct flood flows away from the City of Chico. The USACE infrastructure can send water down three different channels; it was well-designed and has successfully prevented catastrophic flooding in Chico. However, improved data and understanding of when and how the infrastructure directs water into these channels is important, along with an evaluation of the current condition of the infrastructure (and potential risk of failure). This is becoming increasingly important as climate change has already been observed to and is projected to further make rainfall events (and subsequent runoff) more extreme and severe (Zamora-Reyes et al., 2021; Swain et al., 2025).

Davids Engineering is well-versed in environmental monitoring work and is proud to be supporting CalSIP implementation for both some of the statewide high-priority sites under DWR and local high-priority sites alongside local agencies to install these stations and collect and provide these critical data. Our work at DE often involves measuring and accounting for water and its movement across the landscape over time, and we often refer back to an idea attributed to Lord Kelvin (a Scottish mathematician from the 19th century[3]). The simplification of his larger idea into a simple phrase is that "you can't manage

[3] Lord Kelvin is also someone whose word should carry more weight because if you've ever taken a Chemistry course, you'll remember why his name sounds familiar and recall that he has a unit of measurement named after him! He's in the same class as Isaac Newton and Blaise Pascal. You can learn more about Lord Kelvin here: https://physicsworld.com/a/in-praise-of-lord-kelvin/

something you can't measure" or "if you can't measure it, you can't improve it." The quantification of water over space and time is critical; without it, we're just stumbling around in the dark with our management decisions.

Studies have shown that climate change is influencing our natural environment in California and impacting both water (Liu et al., 2021; Zamora-Reyes et al., 2021; Dobbin et al., 2023; Swain et al., 2025; etc.) and fire (Davis, 2021; Turco et al., 2023; Chen et al., 2025; etc.), along with the people and ecosystems dependent on water and impacted by wildfires. Our analysis demonstrates that water and fire (while opposites) are intimately connected. How we approach and handle both water and fire will be critical for the wise management and stewardship of California's abundant natural resources as far into the future as any of us can imagine (i.e., our kids' kids' kids' kids, etc.). In order to do this well, we first need good data to understand them well. These data (and the understanding built from them) are worth investing in now (and continuing to invest in over time). Even if we don't see or realize the immediate benefits of this investment, I believe our kids' kids' kids' kids one day will be thankful we made it.

Author Bio

Brandon Ertis is a Senior Engineer at Davids Engineering and a proud UC Davis graduate. After living in Chico for the better part of a decade, he now lives in the Sierra Nevada mountains of California within walking distance of Lake Tahoe (albeit a pretty long walk) with his beautiful wife and two wonderful kids. He thinks life is a big messy adventure that is full of meaning and purpose.

Study design, data analysis, and development of materials were led by Brandon Ertis but with notable contributions from Davids Engineering team members Ji Yeow Law, Dylan Diep, and Gento Shimamura.

Additional Notes

For the pre- and post-fire analysis:

1. A simplifying assumption in the analysis is that the precipitation measured at the South Gerber station is representative of precipitation across all three of these watersheds over the course of each precipitation event. The southernmost point of the Deer Creek watershed is more than 40 miles from the northernmost point of the Battle Creek watershed, so precipitation patterns and intensity across them likely varied to some degree and correspondingly influenced the runoff patterns observed.

2. As described above, burn severity and timing within the water year were also not directly considered as factors in this analysis, although both also impact runoff patterns.
3. Some minor precipitation was measured at South Gerber in the days following each event, but it had negligible impact on streamflow.
4. All USGS streamflow data were marked as final (rather than provisional), meaning they had been reviewed and finalized, per USGS standards.

For the summer baseflow analysis:

1. The USGS streamflow data for 2025 was marked as provisional at the time it was downloaded (not yet reviewed and finalized, per USGS standards). All prior years of streamflow data were marked as final.

Resources

1. California Department of Forestry and Fire Protection (Cal Fire) Resources:
   a. Fire and Resource Assessment Program (FRAP): California Historical Wildland Fire Perimeters: https://data.ca.gov/dataset/explore-california-historical-wildland-fire-perimeters-app
      i. There is also a PDF map available plotting California wildfires by decade here.
   b. Incident Reports:
      i. Camp Fire: https://www.fire.ca.gov/incidents/2018/11/8/camp-fire
      ii. Park Fire: https://www.fire.ca.gov/incidents/2024/7/24/park-fire
2. California Irrigation Management Information System (CIMIS) Resources
   a. CIMIS website (including data access): https://cimis.water.ca.gov/
   b. CIMIS resources: https://cimis.water.ca.gov/Resources.aspx
3. California Water Year Type, available via the California Open Data Portal at: https://data.ca.gov/dataset/cdec-water-year-type-dataset
4. United States Geological Survey (USGS) Resources:
   a. StreamStats: https://streamstats.usgs.gov/ss/
   b. StreamStats Beta (with fire hydrology tool): https://streamstats.usgs.gov/national-beta/
   c. Streamgaging data:
      i. Deer Creek: https://waterdata.usgs.gov/monitoring-location/USGS-11383500

ii. Mill Creek: https://waterdata.usgs.gov/monitoring-location/USGS-11381500
iii. Battle Creek: https://waterdata.usgs.gov/monitoring-location/USGS-11376550
iv. Big Chico Creek: https://waterdata.usgs.gov/monitoring-location/USGS-11384000

For additional information and another perspective on California fire (and occasionally water, and from another Chico local), check out The Lookout:

- https://the-lookout.org/
- https://www.youtube.com/c/thelookout1

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