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# Large California wildfires: 2020 fires in historical context

Jon E. Keeley<sup>1,2\*</sup>  and Alexandra D. Syphard<sup>3</sup>

## Abstract

**Background:** California in the year 2020 experienced a record breaking number of large fires. Here, we place this and other recent years in a historical context by examining records of large fire events in the state back to 1860. Since drought is commonly associated with large fire events, we investigated the relationship of large fire events to droughts over this 160 years period.

**Results:** This study shows that extreme fire events such as seen in 2020 are not unknown historically, and what stands out as distinctly new is the increased number of large fires (defined here as > 10,000 ha) in the last couple years, most prominently in 2020. Nevertheless, there have been other periods with even greater numbers of large fires, e.g., 1929 had the second greatest number of large fires. In fact, the 1920's decade stands out as one with many large fires.

**Conclusions:** In the last decade, there have been several years with exceptionally large fires. Earlier records show fires of similar size in the nineteenth and early twentieth century. Lengthy droughts, as measured by the Palmer Drought Severity Index (PDSI), were associated with the peaks in large fires in both the 1920s and the early twenty-first century.

**Keywords:** drought, fire severity, historical fires

## Resumen

**Antecedentes:** En el año 2020, California experimentó un récord al quebrar el número de grandes incendios. Aquí situamos a éste y otros años en un contexto histórico mediante el examen de registros de incendios en el estado desde 1860. Dado que la sequía es frecuentemente asociada a grandes eventos de incendios, investigamos la relación entre grandes incendios y sequías en este período de 160 años.

**Resultados:** Este estudio mostró que eventos extremos como el visto en 2020 no son históricamente desconocidos, y lo que se muestra como distintivamente nuevo es el incremento en el número de grandes incendios (definidos aquí como > 10.000 ha) en el último par de años, y más prominentemente en 2020. Sin embargo, ha habido otros períodos con aún mayores números de incendios (i.e. en 1929 hubo mayor número de incendios que en cualquier otro año del registro). De hecho, la década de 1920, fue una de las que presentó mayor número de grandes incendios.

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**Conclusiones:** En la última década ha habido muchos años con incendios excepcionalmente grandes. Antiguos registros muestran incendios de tamaño similar tanto en el siglo 19 como en el siglo 20. Sequías prolongadas, medidas mediante el Índice de Sequías Severas de Palmer (PDSI), fueron asociadas con los picos de grandes incendios tanto en el siglo 20 como en el 21.

## Introduction

The western US has a long history of large wildfires, and there is evidence that these were not uncommon on pre-EuroAmerican landscapes (Keane et al. 2008; Baker 2014; Lombardo et al. 2009). One of the biggest historical events was the 1910 “Big Blowup,” which reached epic proportions and was an important impetus for fire suppression policy (Diaz and Swetnam 2013). California in particular has had a history of massive wildfires such as the 100,000 ha 1889 Santiago Canyon Fire in Orange County or the similarly large 1932 Matilija Fire or 1970 Laguna Fire (Keeley and Zedler 2009).

While large fires are known in the historical record, in the first few decades of the twenty-first century, the pace of these events has greatly accelerated (Keeley and Syphard 2019). In the last decade, the state has experienced a substantial number of fires ranging from 10,000 ha to more than 100,000 ha, and these have caused massive losses of lives and property. The largest fires on record were recorded in 2018 and then were replaced with even larger fires in 2020, although some of these were the result of multiple fires that coalesced into fire complexes of massive size.

Causes for these fires are multiple, but climate change has been implicated as a critical factor (Williams et al. 2019; Abatzoglou et al. 2019). Historically, drought has often been invoked as a driver of large fires (Keeley and Zedler 2009; Diaz and Swetnam 2013), and California has experienced an unprecedented drought in the last decade (Robeson 2015). However, factors such as management impacts on forest structure and fuel accumulation, made worse by the recent drought, are critically important in some ecosystems (Stephens et al. 2018).

To put these recent fires in a historical context, we have investigated the history of large wildfires in California. “Large” fires is an arbitrary designation, e.g., Nagy et al. (2018) considered it to be 1000 ha or more. Our focus, however, is on those fires that made 2020 particularly noteworthy; so we define large fires as those in the top 1–2% of all fires, which is approximated by fires > 10,000 ha. In addition, we have examined the relationship of large fires to drought.

## Methods

The database of fires > 10,000 ha was assembled from diverse sources. From 1950 to the present, the State of California Fire and Resource Assessment Program

(FRAP) fire history database was relatively complete, but less so prior to 1950 (Syphard and Keeley 2016; Miller et al. 2021). In California, US Forest Service (USFS) annual reports provide statistics on fires by ignition source and area burned back to 1910 and Cal Fire back to 1919 (Keeley and Syphard 2017), and although these reports focused on annual summaries, they often provided descriptions of very large fires. A rich but under-utilized historical record for early years was the exhaustive compilation of fires in a diversity of documents from 1848 to 1937, assembled by a USFS project and brought to our attention by Cermak’s (2005) USFS report on Region 5 fire history. This source presents all documents (including agency reports and newspaper reports on fire, vegetation, timber harvesting and Native Americans) for all counties in the state and comprises 69 bound volumes (USDA Forest Service 1939–1941). We utilized these documents where they presented data on fire size, either an estimate of acres burned or dimensions of the burned area. We did not include fire reports that lacked a clear indication of area burned; e.g., the 1848 fire described in the region of Eldorado County referred to an immense plain on fire and all the hills blackened for an extensive distance (USDA Forest Service 1939–1941), but lacked more precise measures.

Other sources included the following: Barrett (1935), based on USFS records and personal experiences as well as “early-day diaries, historical works, magazines and newspapers.” Greenlee and Moldenke (1982) included fire records from state and federal agencies as well as library and museum archives. Morford (1984) was based on unpublished USFS records accumulated during the author’s 41 years in that agency. Keeley and Zedler (2009) was based on records retrieved from the California State Archives and State Library. Cal Fire (2020) data, not part of the FRAP database, included agency records of individual fire reports (not available to the public but searchable by the State Fire Marshall Kate Dobrinsky). In a few cases, the same fire was reported by more than one source, sometimes with different sizes; when this occurred after 1950, we used the FRAP data and before that either Cermak (2005) or Barrett (1935) over other sources.

Reliability of these data sources is an important question to address. Stephens (2005) contended that USFS data before 1940 were unreliable, an assertion based on Mitchell (1947); but Mitchell (1947) provided no evidence that early data were inaccurate, only that many

states lacked early records. Mitchell (1947) was considering availability of state and federal data for the entire USA; however, California has far better historical records at both the state and federal archives than much of the USA (Keeley and Syphard 2017). USFS records for California were reported annually for all forests beginning in 1910 and for state protected lands by Cal Fire back to 1919. The latter agency had by 1920 several hundred fire wardens strategically placed throughout the state and each warden was held to a strict standard of reporting all fires in their jurisdiction.

Before 1910, data on fires was dependent on unpublished reports available in state and federal archives, observations published in books, data given in newspaper accounts of fire events, and estimates from fire-scar chronology studies. It was suggested by Goforth and Minnich (2007) that early newspaper reports were exaggerations and represented “yellow journalism,” a pejorative term that connoted unethical journalism. This was based on what they considered sensational headlines, but comparison of nineteenth century with more recent newspaper headlines provides no basis for this conclusion (Keeley and Zedler 2009). As a journalist colleague suggested, “a century-old newspaper story is not a precise source ...[but] is the first draft of history and a valuable source of first person account from long past events.” Such information qualifies as scientific evidence, which is defined as evidence that serves to either support or counter a scientific theory or hypothesis, is empirical, and interpretable in accordance with scientific method. The data we present falls within these bounds and that includes newspaper reports as we used data on fire size in terms of acres or dimensions of burned landscape reported. Recently Howard et al. (2021) demonstrated that fire-scar records match newspaper accounts in the

eastern US. To address the issue of how close newspaper accounts used in this study come to accurately depicting fire size, we have compared fires reported in published sources with newspapers where available. We of course appreciate that early accounts lacked the precise technology available today for outlining fire perimeters; however, this lack of precision does not necessarily translate into less accurate accounts and applies to both newspapers as well as state and federal agencies.

Data were presented for the state and by NOAA divisions North Coast (1), North Interior (2), Central Coast (4), Sierra Nevada (5), and South Coast (6). These are the five most fire-prone divisions of NOAA’s National Climatic Data Center categories, defined as climatically homogenous areas (Guttman and Quayle 1996). There of course are other systems that may be useful for comparisons, dependent on the need. For example, the Bailey Ecoregions (Bailey 1980), which separates regions by vegetation type, might be thought preferable, but, for our purposes, there is no necessary advantage as large fires usually burn across a mosaic of different vegetation types. A system that might provide a better presentation would be the recently described Fire Regime Ecoregions (Syphard and Keeley 2020). However, despite limitations to the NOAA divisions (e.g., Vose et al. 2014), it is preferable due to the availability of historical annual data on the Palmer Drought Severity index calculated by NOAA divisions.

Palmer Drought Severity Index (PDSI) was recorded for each year from two sources. From 1895 to 2020, PDSI was the annual mean from NOAA (2020a), and for years prior to 1895, summer PDSI was reconstructed from tree-ring studies (Cook et al. 1999). Statistical analysis and graphical presentation were conducted with Systat software (ver. 13.0, Systat Software, Inc., San Jose, CA, <http://www.systat.com/>).

**Table 1** Comparison of available examples of agency reports and newspaper reports

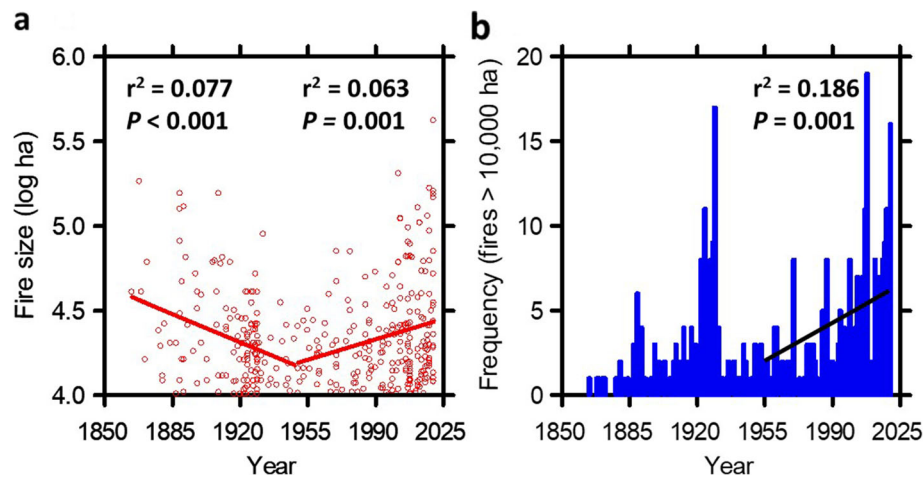
Division/ location	FRAP listing	Newspaper report
1/Marin Co.	Only 1 fire in 1923 at 31,769 ac	San Jose Mercury Herald, September 18, 1923, reported a fire at 19,200 ac
4/Los Padres USFS	Miller et al. (2021) reported start date of July 8, 1921 for fire of 63,910 ac	Fresno Morning Republican July 19, 1921, reported 100,000 ac burned by large fire between Paso Robles and Parkfield
5/Tulare Co NPS	Miller et al. (2021) reported start date of “Kaweah Fire” as August 10, 1926, and 34,358 ac	Fresno Morning Republican August 17, 1926, reported a fire in the Kaweah drainage of 40,000 acres
6/Los Padres USFS	Miller et al. (2021) reported start date of June 15, 1917, for fire of 19,397 ac	Ventura Free Press June 29, 1917, reported a fire that had burned over 20,000 acres of timber and brush
6/Los Angeles Co.	Ridge Fire started September 21, 1928, and was 43,472 ac	Los Angeles Times, September 27, 1928, reported the Ridge Fire consuming 35,000 ac
6/Los Padres USGS	Start date 7 September 1932, 219,999 ac burned in Matilija Fire	Los Angeles Times September 20, 1932, reported 160,000 ac burned by Matilija fire

**Table 2** Data sources for historical fires; FRAP is the State of California Fire and Resource Assessment Program fire history database; for other sources, see References

Year	Decade total	Source total	Source
1860	3	1	USDA 1939: Kern Co
		1	USDA 1939: San Luis Obispo Co
		1	USDA 1939: Tulare Co
1870	4	1	Barrett 1935
		1	FRAP
		1	USDA 1939: Fresno Co
		1	USDA 1939: San Diego Co
1880	13	8	Barrett 1935
		1	Keeley and Zedler 2009
		1	USDA 1939: Calaveras
		1	USDA 1939: Colusa Co
		1	USDA 1939: San Bernardino Co
		1	USDA 1939: Tehama Co
1890	13	6	Barrett 1935
		1	Cermak 2005
		2	USDA 1939: Calaveras Co
		1	USDA 1939: Eldorado Co
		1	USDA 1939: Los Angeles Co
		1	USDA 1939: Tulare Co
		1	USDA 1939: Tuolumne Co
1900	11	2	USDA 1939: Kern Co
		1	USDA 1939: Marin Co
		1	USDA 1939: Mendocino Co
		1	USDA 1939: Monterey Co
		1	USDA 1939: San Bernardino Co
		1	USDA 1939: Santa Cruz Co
		2	USDA 1939: Sonoma Co
		2	USDA 1939: Tuolumne Co
1910	17	3	Cermak 2005
		5	FRAP
		1	USDA 1939: Amador Co
		1	USDA 1939: Fresno Co
		1	USDA 1939: Madera Co
		1	USDA 1939: Monterey Co
		1	USDA 1939: San Bernardino Co
		1	USDA 1939: Santa Cruz Co
		1	USDA 1939: Tehama Co
		1	USDA 1939: Ventura Co
1920	71	1	USDA 1939: Yuba Co
		6	Cermak 2005
		16	FRAP
		1	Greenlee and Moldenke 1982
		1	Morford 1984

**Table 2** Data sources for historical fires; FRAP is the State of California Fire and Resource Assessment Program fire history database; for other sources, see References (*Continued*)

Year	Decade total	Source total	Source
		1	USDA 1939: Alameda Co
		1	USDA 1939: Colusa Co
		1	USDA 1939: Contra Costa Co
		3	USDA 1939: Fresno Co
		1	USDA 1939: Glenn Co
		4	USDA 1939: Kern Co
		3	USDA 1939: Lassen Co
		2	USDA 1939: Los Angeles Co
		2	USDA 1939: Madera Co
		2	USDA 1939: Marin Co
		4	USDA 1939: Mariposa Co
		1	USDA 1939: Merced Co
		3	USDA 1939: Monterey Co
		1	USDA 1939: Napa Co
		1	USDA 1939: Placer Co
		1	USDA 1939: Riverside Co
		1	USDA 1939: San Benito Co
		1	USDA 1939: San Bernardino Co
		4	USDA 1939: San Luis Obispo Co
		2	USDA 1939: Santa Barbara Co
		2	USDA 1939: Santa Clara Co
		1	USDA 1939: Solano Co
		1	USDA 1939: Stanislaus Co
		1	USDA 1939: Tulare Co
		2	USDA 1939: Tuolumne Co
		1	USDA 1939: Yolo Co
1930	12	9	FRAP
		1	Cermak <a href="#">2005</a>
		2	Greenlee and Moldenke <a href="#">1982</a>
1940	9	5	Cermak <a href="#">2005</a>
		4	FRAP
1950	12	12	FRAP
1960	14	14	FRAP
1970	18	18	FRAP
1980	22	22	FRAP
1990	26	26	FRAP
2000	62	62	FRAP
2010	56	56	FRAP
2020*	16	16	FRAP
			*based on a single year



**Fig. 1** **a** Fire size for large fires from 1860 to 2020. **b** Frequency of large fires over this same time period

## Results

Since some of the fires came from data reported in newspapers, not a typical scientific data base, we did an initial investigation comparing FRAP reported fire size with size reported in newspaper reports. This was not an exhaustive study since FRAP data before 1950 presents relatively few fires by date or fire name making it difficult to match up fires with newspaper reports; however, we found half a dozen potential comparisons (Table 1). As to be expected these different reports are not identical in fire size, however, they were quite similar; sometimes, newspapers over reported area burn but other times under reported, although most importantly, they were of similar magnitude as those in the FRAP database. Data sources varied over time (Table 2); from 1950 to the present, large fires were all recorded in the FRAP database. Prior to that year, sources were mostly from USFS (1939–1941).

Fire size of all fires over 10,000 ha during the last 160 years are shown in Fig. 1a. Exceptionally large fires followed a bimodal pattern with peaks in the nineteenth century and again in the twenty-first century, separated by a low point in the 1950s. From 1860 to 1950, there was a significant decrease in large fire size followed by a significant increase in the second half of the record. Although the trends were highly significant, the great year to year variation in size of large fires, gave low  $r^2$  values, indicating limited ability to predict fire size for any given year.

To illustrate the temporal distribution of record-breaking fires, we picked the top 3% ( $n = 12$ ) of all fires based on size, and these are shown in (Table 3). Not surprisingly, 5 occurred in the year 2020; however, four occurred in the nineteenth century.

The data presented in this paper greatly expands our understanding of the history of large fires in California.

To date, our dependence has been on the FRAP database and they clearly acknowledge their records are for fires from 1950 to the present, and this is borne out by our analysis (Table 2), but the records presented here extend the fire history back nearly a century. Over the period from 1860 to the present, yearly frequency of fires over 10,000 ha exhibited several prominent peaks (Fig. 1b). A few peak years occurred in the 1920s, with one of the highest frequencies recorded throughout the entire 160 year record in 1929. There were also peaks in 2007 and 2008 and again in 2018 and 2020.

Through time, the distribution of fire size varied between NOAA divisions (Fig. 2). The North Interior (2), Sierra Nevada (5), and South Coast (6) divisions all exhibited a significant decline in fire size from the nineteenth century till 1950. Although all the regions exhibited the largest fires in the last decade, only in the Central Coast (4) was this significant for the years 1950–2020.

**Table 3** The top 3% of largest fires in the historical record

Ha	Year	Mon	Day	County	Fire
417,913	2020	8	16	Mendocino	August Complex
182,115	1868	7	8	Tulare	
166,009	2018	7	27	Lake, Napa	Ranch
160,514	2020	8	18	Santa Clara	SCU Lightning Fire Complex
155,405	1909	9	24	Santa Cruz	
155,405	1889	9		Plumas	
153,744	2020	9	4	Madera	Creek
146,995	2020	8	16	Napa	LNU Lightning Complex
129,504	1891	8	16	El Dorado	
125,504	1889	9	28	Orange	Santiago Cyn
114,041	2017	12	4	Ventura	Thomas
109,812*	2012	8	31	Modoc	Rush

\*Including area burned outside California = 127,688 ha



Frequency of fires over 10,000 ha are presented by decade for each of the five divisions (Fig. 3). Consistent with the statewide pattern (Fig. 1b), all showed a spike in number of large fires in the 1920s and again after 2000. The 1920s peak was particularly prominent in the Sierra Nevada (5) and South Coast. Also, for the Central Coast and Central Sierra Nevada regions, the number of fires in the 1920s was higher than that for recent years. For the years 1860 to 1949 and for the years 1950 to 2020 separately, there was no significant change in frequency over time.

One aspect of climate over the entire period is captured by the PDSI, a drought index that includes patterns of both precipitation and temperature. There have been several periods of drought over the past 160 years, the most severe being in the decades 1920–1930 and 1990–2020 (Fig. 4a). These periods also correlate with periods of large amounts of area burned by large fires (Fig. 4b). Bivariate regression analysis showed that over the period from 1860 to 2020, there was a significant relationship between PDSI and area burned ( $\text{adj } r^2 = 0.429$ ,  $P = 0.003$ ).

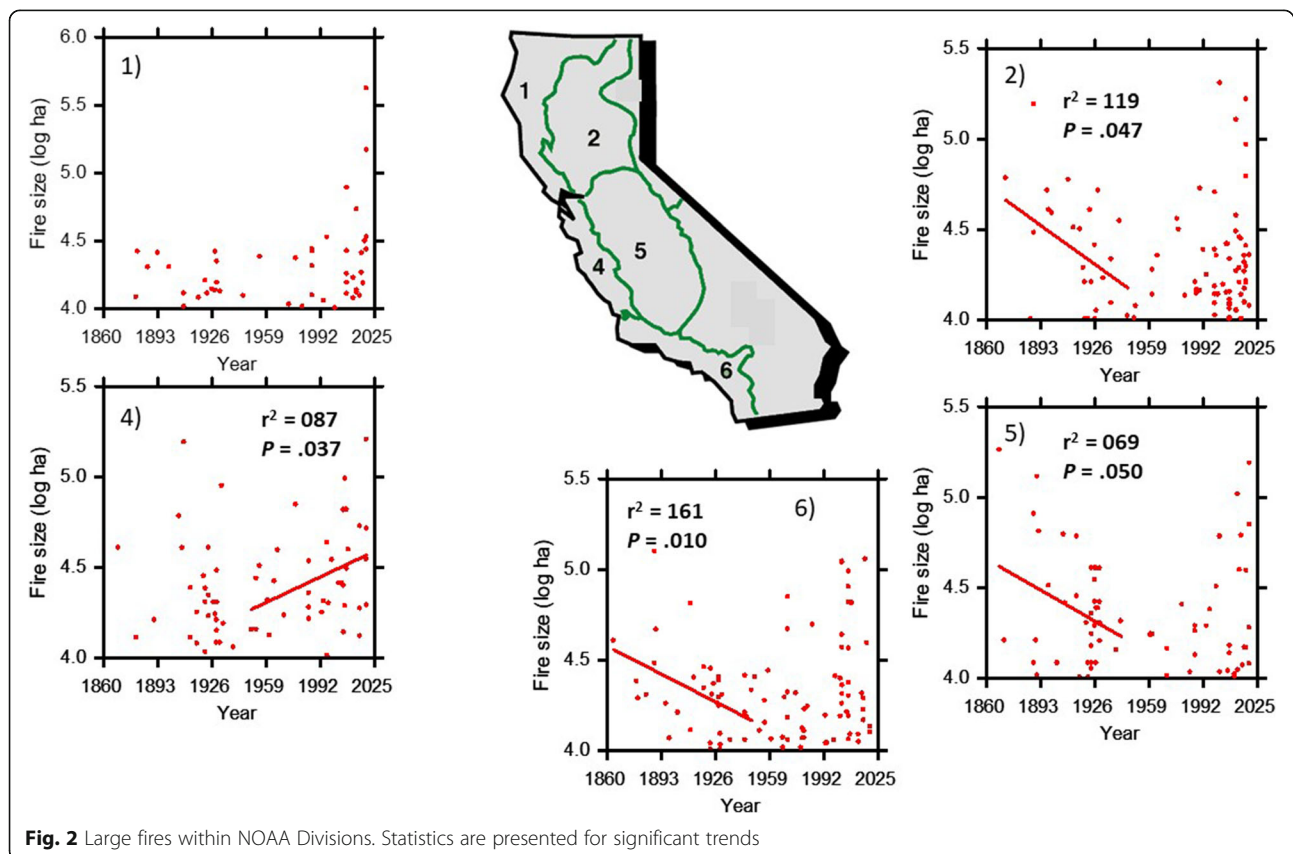
## Discussion

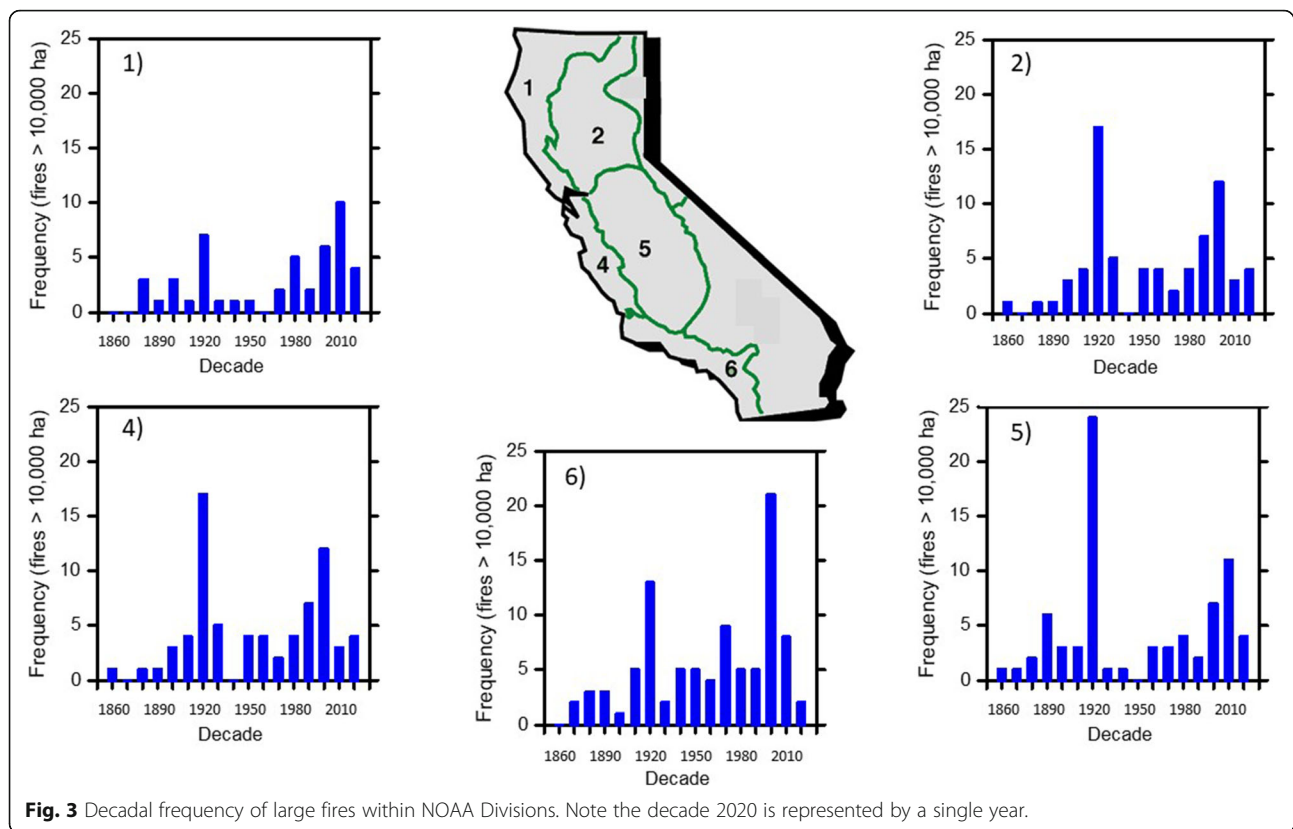
Clearly, 2020 was a phenomenal fire year in California for record breaking large fires. However, this study

shows that such extreme fire events are not unknown historically, and what stands out as distinctly new is the increased number of large fires (defined here as > 10,000 ha) in the last couple of years, most prominently in 2020. Given that historically we have seen years with even greater number of large fire events, e.g., 1929, a comprehensive evaluation of the factors leading up to large fire event years is clearly needed.

The largest fire in recorded history for the state is the 2020 August Complex Fire, which comprised 38 separate fires that were considered a single massive 418,000 ha fire (Cal Fire 2020). Thus, the merging of these multiple fires into a larger event is certainly a factor affecting “fire” size. Indeed, some 2020 fire complexes included multiple fires that never actually merged; for example, the LNU Complex Fire, which ranked within the top 12 fires (Table 3), actually comprised several distinctly separate fires that apparently did not merge (San Francisco Chronicle 2020).

It has been contended that large fires in the past were often very different in nature from contemporary large fires. For example, many southwestern US mixed conifer forest large fire events in the nineteenth century were low-intensity surface fires, unlike contemporary large fires that are dominated by high-intensity crown fire (Keane et al. 2008). This contention, however, varies





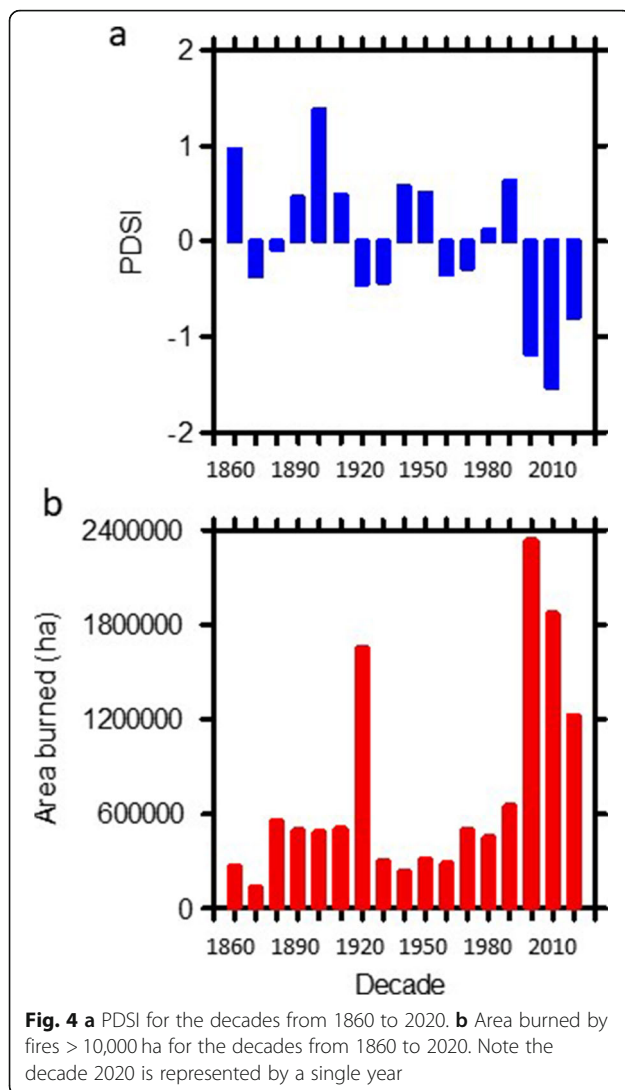
from descriptions of the top 12 fires recorded here (Table 3). For example, when describing the 1889 Plumas fire, newspaper reports state “A large amount of timber and fire wood [were] destroyed.” One report describes the 1891 Eldorado fire as “the most terrible forest fire ever experienced in California...fanned by a strong north wind has swept over almost the entire stretch of country between Georgetown and Salmon Falls...Magnificent forests of a few days ago have been burned over and blackened and lofty pines seared and killed. The scene at night baffles all powers of description, there being a moving mass of fire as far as the eye can reach.” The 1909 Santa Cruz fire was described as “this large conflagration spread... [and] the country is entirely burned over; the entire growth on Loma Prieta Peak and its sides down to Los Gatos Creek is a charred area.”

In general, very few of the large fires reported in (USDA Forest Service 1939–1941) were described as low-intensity surface fires. This source described forest fires up and down the state as high intensity conflagrations. For instance, in San Diego County, the 19,000 ha fire of 1870 was described as “the fires which have been raging in the mountains ...are wholly unprecedented in extent and ...destruction of timber”; in the San Luis Obispo 1869 40,000 ha fire “a great deal of timber and grass has been destroyed”; in Calaveras County in 1889, an 81,000 ha fire was described “A large forest fire has

been raging...a large scope of timber country has been laid in waste”; a description of the Tehama 1889 30,000 ha fire was “The forest fire that has raged...was very destructive”, etc. In short, there is little in these records to suggest that nineteenth century large fires were normally less destructive of natural resources than twenty-first century fires. This of course is not meant to negate the commonly accepted paradigm that California forests in the past frequently burned with low-intensity surface fires (Skinner and Chang 1996), but that once fires reached epic proportions, and consequently burned through a mosaic of vegetation types, fire behavior appears to have been quite different.

However, one thing that is different between historical large fires and recent ones is that contemporary large fire events are often much more destructive in terms of loss of lives and property. For example, the 2018 Butte County Camp Fire driven by extreme foehn winds killed 85 people and destroyed over 18,000 buildings, however, a similar foehn wind driven fire occurred in Eldorado County in 1891 (Table 3), and there were no reports of fatalities and relatively few structures were lost (USFS 1939–1941). The difference is due to changes in human demography, e.g., California population throughout the nineteenth century was fewer than 2 million people in contrast to 2020 with a population approaching 40 million. Pressure to find affordable housing has resulted in





urban sprawl into watersheds of dangerous fuels (Syphard et al. 2007, 2019). In addition, population growth has played a role in increasing ignitions as most fires that result in human losses are of human origin (Keeley and Syphard 2018).

Another factor that is very different in recent decades, when compared to the middle of the century, is the frequency of large fires, with 2007, 2008, 2017, 2018, and 2020 all being peak years for number of large fire events. However, the 1920s were comparable to these recent decades, and in fact, 1929 was a peak year for frequency of large fire events (Fig. 1b). The 1920s decade was also a peak in most regions (Fig. 3). Although there was less structure loss in the 1920s, demographic changes could have been involved in terms of frequency of large fires, as the 1920s saw a major influx of people. In this decade, there were increased anthropogenic ignitions driven by greater access to wildlands due to rapid road construction

and an order of magnitude increase in car licenses (Keeley and Fotheringham 2001).

Climate is widely viewed as a determining factor in fire size, and in particular, drought has been a major driver historically (Little et al. 2016; Madadgar et al. 2020; Huang et al. 2020). One of the important factors behind the 2020 fire events was the anomalously long and intense drought the region experienced beginning in 2012. This drought was experienced across the southern US (Rippey 2015) and lasted 3–5 years in California; it was considered to be one of the most severe droughts in California history (Robeson 2015; Jacobsen and Pratt 2018). The greatest number of recent large fires and size of these fires have been concentrated in the years since this drought (Fig. 4). Drought has also been implicated as a factor in other large California fires during the first decade of the twenty-first century (Keeley and Zedler 2009) as well as with large fire events in the 1920s, as shown in this study.

While a clear climate signal in terms of drought is a likely driver of big fire events in the state, an emerging issue is the role of anthropogenic climate change (Williams et al. 2019). While droughts have historically been a natural occurrence in California's Mediterranean climate ecosystems, it has been postulated that global warming has made these droughts more severe. Estimates are that the 2012–2014 drought in the Sierra Nevada was perhaps 10–15% more severe due to global warming (Williams et al. 2015). This has important implications for the impact of drought on tree and shrub dieback that increases hazardous fuels and contributes to increased fire risk (Stephens et al. 2018). However, the relationship between drought and tree dieback in the state is complicated and impacted by competition and other factors (Das et al. 2011; Young et al. 2017).

The severity of the 2020 fire season in California is not the result of any one factor such as climate change but the result of the “perfect storm” of events. Winter and spring precipitation in the northern part of the state was only about 50% of average, August had a stream of dry lightning storms in northern California that ignited over 5000 fires (Cal Fire 2020), there was an intense heat wave in early September that elevated temperatures to record breaking levels (NOAA 2020b), and forests in the northern half of the state had anomalous fuel loads due to a century of fire suppression and greatly exacerbated by the intense drought of 2012–2015 (Stephens et al. 2018).

It is a major challenge to parse out the role of anthropogenic climate change in driving 2020 fires. Certainly, the below normal rainfall year in the north fell within the natural range of variation. The extraordinary lightning storm was perhaps more severe than what is seen in most years, but was not at all unprecedented;

e.g., in 2008 northern California experienced a similar event with over 6000 lightning strikes and burning over 400,000 ha from these fires alone, and this is a common phenomenon at a decadal scale, e.g., 1999, 1987, 1977, 1955 (Cal Fire 2008). Further contributing to the 2020 fires was the intense heat wave that may be linked to climate change (Gershunov and Guirguis 2012; Hully et al. 2020). The role of anomalous fuel accumulation due to more than a century of fire suppression and made much worse by 2012–2016 drought was also a major contributor to the size of these fires.

## Conclusions

Historically, California fires as big as some of the largest fires in 2020 year have occurred as evident from records beginning in 1860. However, without question, 2020 was an extraordinary year for fires in California. This was driven by a multitude of factors but prominently is the extraordinary droughts the state has experienced in the last couple decades. Peaks in the number of large fires have occurred in the 1920s as well as in the twenty-first century and both occurred in decades with extended droughts.

## Abbreviations

Cal Fire: California Department of Forestry and Fire Protection; FRAP: Cal Fire's Fire and Resource Assessment Program; NOAA: National Oceanic and Atmospheric Administration; PDSI: Palmer Drought Severity Index

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Any use of trade, product, or firm names is for descriptive purposes only and does not imply endorsement by the US government. We appreciate the comments on an earlier draft of this manuscript by Keith Lombardo.

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Not applicable.

## Consent for publication

Not applicable

## Competing interests

The authors declare that they have no competing interests.

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