



CLIMATE  CENTRAL

WESTERN WILDFIRES

A Fiery Future

Alyson Kenward, PhD, Todd Sanford, PhD, James Bronzan

June 2016

WESTERN WILDFIRES

A Fiery Future

ABOUT CLIMATE CENTRAL

Climate Central surveys and conducts scientific research on climate change and informs the public of key findings. Our scientists publish and our journalists report on climate science, energy, sea level rise, wildfires, drought, and related topics. Climate Central is not an advocacy organization. We do not lobby, and we do not support any specific legislation, policy or bill. Climate Central is a qualified 501(c)3 tax-exempt organization.

Climate Central scientists publish peer-reviewed research on climate science; energy; impacts such as sea level rise; climate attribution and more. Our work is not confined to scientific journals. We investigate and synthesize weather and climate data and science to equip local communities and media with the tools they need.

June 2016

Princeton: One Palmer Square, Suite 330 Princeton, NJ 08542

Phone: +1 609 924-3800

Toll Free: +1 877 4-CLI-SCI / +1 877 425-4724

www.climatecentral.org

CONTENTS

Summary	4
01. Western Wildfire Trends	6
02. Hotter Temperatures and Changing Snowpack	13
03. Future of Western Wildfires	15
04. State Wildfire Trends	17
05. Methodology	40
06. References	41

SUMMARY

The 2016 wildfire season has barely begun and already dozens of large wildfires have raged through Western states, with hundreds of thousands of acres burned. This comes on the heels of a 2015 wildfire season that was the worst on record in the U.S., with more than 10 million acres burned.

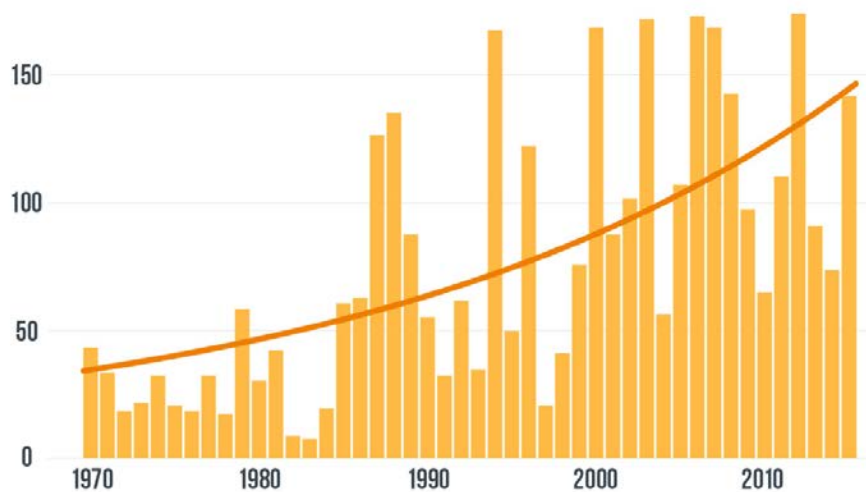
These are not just random events. Climate change is producing conditions ripe for wildfires, tipping the scales in favor of the dramatic increases in large wildfires we have seen across the West since the 1970s. Snowpack is melting earlier as winter and spring temperatures rise, and in most states an increasing percentage of winter precipitation is falling as rain, meaning there is often less snowpack to begin with. Summer temperatures are rising, particularly in Southwestern states, where the number of extremely hot days is steadily increasing, creating more days where forests and grasslands are dried out and ready to burn.

A Climate Central analysis of 45 years of U.S. Forest Service records from the western U.S. show that the number of large fires on Forest Service land is increasing dramatically. The area burned by these fires is also growing at an alarming rate.

- Across the Western U.S., the average annual number of large fires (larger than 1,000 acres) burning each year has more than tripled between the 1970s and the 2010s.
- The area burned by these fires has shown an even larger increase: in an average year, more than six times as many acres across the West were burned in the 2010s than in the 1970s.
- The fire season is 105 days longer than it was in the 1970, and is approaching the point where the notion of a fire season will be made obsolete by the reality of year-round wildfires across the West.

Large Wildfires Increasing Across the West

Number of fires larger than 1,000 acres per year on U.S. Forest Service land



Source: Climate Central analysis of U.S. Forest Service records

CLIMATE CENTRAL

The situation in some individual states is more extreme:

- The average number of large fires burning each year on Forest Service land has increased at least 10-fold in the Northern Rocky Mountain states of Wyoming, Idaho, and Montana.
- In the Pacific Northwest, there are now five times as many large fires burning in a typical year in Washington as there were in the 1970s; in Oregon there are nearly seven times as many.

And the conditions are likely to get worse in the next several decades. Climate Central's [States at Risk](#) project analyzed historical climate data and downscaled climate projections from 29 different global climate models. We found that in most western states, the climate conditions that can stoke summer wildfires are projected to increase substantially in the relatively short period between now and 2050. Arizona is expected to see more than a month of additional high-risk fire days by 2050.

This analysis relies on the Keetch-Byram Drought Index (KBDI), a measure of the dryness of the top 8 inches of the forest floor, which serves as a proxy for the dryness of forest fuels. KBDI is one of a number of indicators of wildfire potential, but is commonly used by the U.S. Forest Service (along with other tools) to predict fire danger. The scale runs from 0 to 800. Our analysis found that the number of days with KBDI above 600 (a level at which the potential for wildfire is high) would increase significantly between now and 2050 in 10 of the western states if greenhouse gas emissions continue unabated. Across these 10 states, the total number of days with KBDI above 600 is projected to increase 46 percent between 2000 and 2050.

Although many factors influence the ignition and spread of wildfires, our KBDI projections suggest that the conditions suitable for more and larger fires will increase in the near- to midterm. This finding is consistent with other research on wildfire potential and burning.

Southwestern states will see the greatest projected increase in high wildfire potential days by 2050, based on a measure of fuel dryness.

Rank	State	More High Wildfire Potential Days
1	Arizona	34
2	California	24
3	New Mexico	23
4	Utah	23
5	Nevada	20
6	Washington	18
7	Oregon	17
8	Idaho	15
9	Wyoming	8
10	Montana	6

01. WESTERN WILDFIRE TRENDS

INTRODUCTION

2015's severe wildfire season comes in the wake of a longer-term trend of more big western wildfires, as illustrated by Climate Central's analysis of 45 years of U.S. Forest Service records. There is strong and growing evidence that the increasing number and frequency of wildfires in the American West and Alaska are largely driven by a hotter and drier climate.

According to the National Climate Assessment, warming temperatures, worsening drought, and changes in snowpack – all linked to human-caused climate change – were major factors for the recent increase in western wildfires.¹ Recent research indicates climate is the largest driver of the increase in the area burned by wildfire in the past century. While climate change may be creating ideal conditions for more western wildfires, no single wildfire can yet be attributed to human-caused climate change.

Projections based on climate models show a continuing increase in fires and area burned in many regions as the favorable conditions for wildfires become more likely, including hotter temperatures, more intense droughts, decreased snowpack and earlier snowmelt.¹ Taken together this research indicates that the West is in for a fiery future, putting lives, property, and infrastructure at risk.

MORE FIRES ARE BURNING MORE LAND ACROSS THE WEST

Climate Central analyzed 45 years of U.S. Forest Service records of large wildfires (those larger than 1,000 acres) to understand how wildfire patterns have changed over that time.² Our analysis found that the number of wildfires burning on this federal land has been increasing dramatically, as has the total area burning each year by these fires.

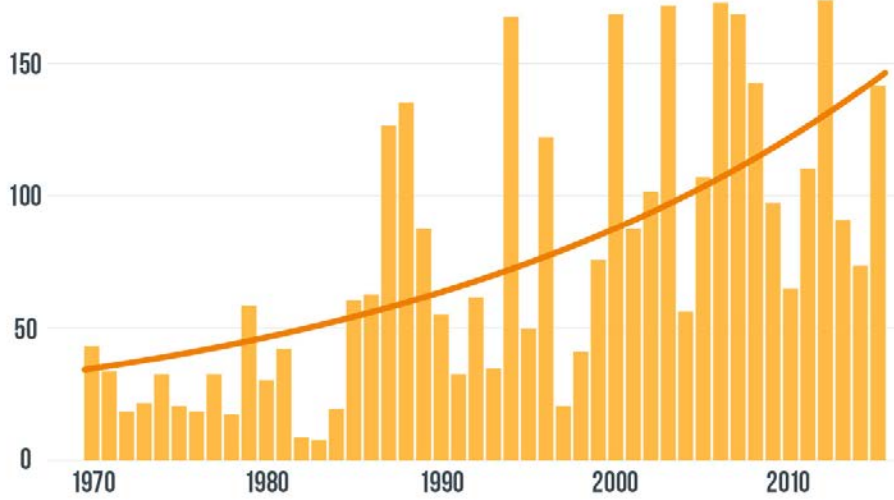
The average number of large fires on burning each year on U.S. Forest Service land has increased at least 10-fold in the Northern Rocky Mountain states of Wyoming, Idaho, and Montana. In the Pacific Northwest, there are now five times as many large fires burning in a typical year in Washington as there were in the 1970s; in Oregon there are nearly seven times as many.

Figures 1 and 2 illustrate the trend towards more large wildfires and more area burned in the West since the 1970s.

01. WESTERN WILDFIRE TRENDS

Large Wildfires Increasing Across the West

Number of fires larger than 1,000 acres per year on U.S. Forest Service land



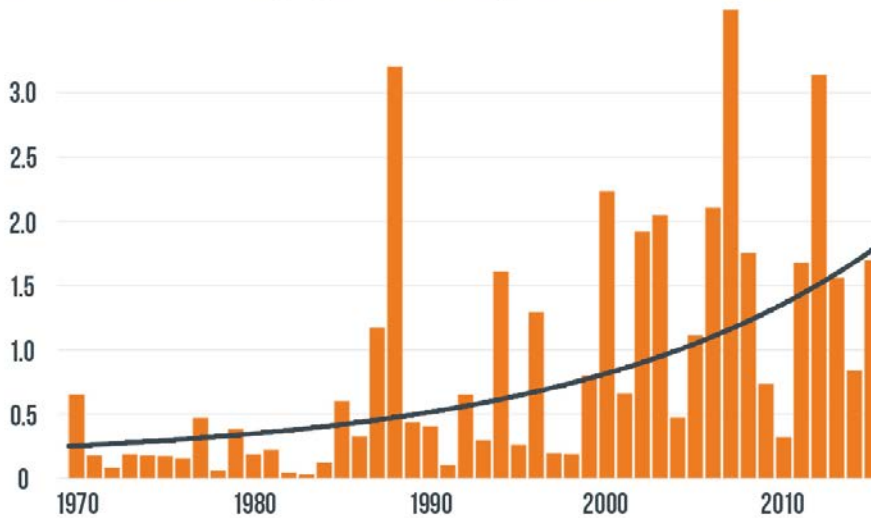
Source: Climate Central analysis of U.S. Forest Service records

CLIMATE CENTRAL

Figure 1. Increasing annual number of large wildfires (larger than 1,000 acres) burning on U.S. Forest Service land in the West since 1970.

More Acres Burning Across the West

Millions of acres burned by large wildfires each year on U.S. Forest Service land



Source: Climate Central analysis of U.S. Forest Service records

CLIMATE CENTRAL

Figure 2. Increasing area burning each year in large wildfires (larger than 1,000 acres) on U.S. Forest Service land in the West since 1970.

01. WESTERN WILDFIRE TRENDS

The situation in some individual states is even more extreme. The number of large fires on U.S. Forest Service land has increased at least 10-fold in the Northern Rocky Mountain states of Wyoming, Idaho, and Montana. In the Pacific Northwest, there are now five times as many large fires in Washington as there were in the 1970s; in Oregon there are nearly seven times as many.

The top 5 western states that have seen the biggest increase in the annual average number of large wildfires burning are listed in Table 1.

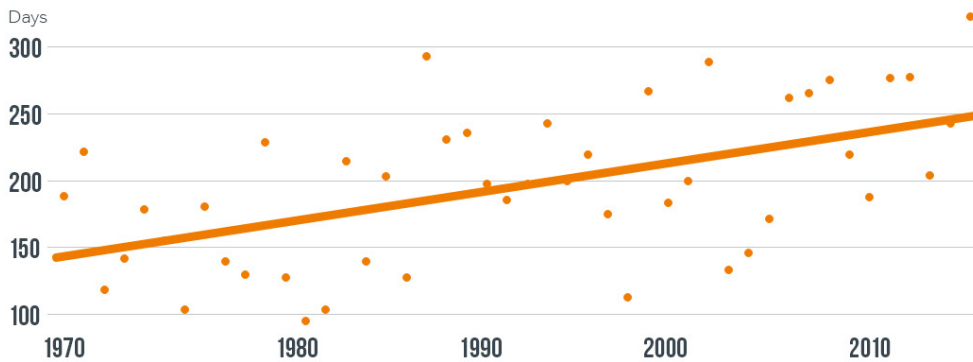
Table 1. Idaho has seen the largest increase in the annual average number of large wildfires from 1970-2015

Rank	State	increase in annual average number of fires since 1970
1	Idaho	21
2	Arizona	11
3	Montana	10
4	Oregon	8
5	Washington	5
5	Wyoming	5

Over the past 45 years, the western U.S. “burn season” each year has been lengthening, starting much earlier in the spring and also extending somewhat later in the fall. Our analysis of the start date of the earliest and latest large fire each year shows that the overall length of the fire season has grown by about 105 days, on average, since 1970, as shown in Figure 3. In the 1970s the fire season was typically under five months. Now it usually lasts more than eight months. Resources for wildfire response will now need to be available over longer stretches of the year or risk not being in place when the fire season begins.

Wildfire Season is Growing Across the West

Length of Annual Burn Season



Source: Climate Central analysis of U.S. Forest Service records

CLIMATE CENTRAL

Figure 3. Lengthening wildfire season in the western U.S., based on difference in start date of first and last large wildfire (larger than 1,000 acres) burning on U.S. Forest Service land.

Climate Central has also studied Alaskan wildfires trends.³ According to our analysis wildfires on state and federal land in Alaska since 1950, the annual average number of large wildfires (those larger than 1,000 acres) burning increased suddenly in the 1990s. The last 25 years have seen, on average, twice as many fires each year as in the previous 40 years. In addition, the Arctic region of Alaska is also seeing an increase in formerly rare large wildfires, potentially putting large stores of carbon in permafrost and tundra soils at risk. Across the entire state, wildfire season is now 40% longer than in the 1950s with an increase of 35 days, on average.

Figures 4 and 5 illustrate the increasing number of large wildfires burning each year, and the area burned in these wildfires, in Alaska since 1950.

01. WESTERN WILDFIRE TRENDS

Decadal Averages of Annual Large Wildfires in Alaska

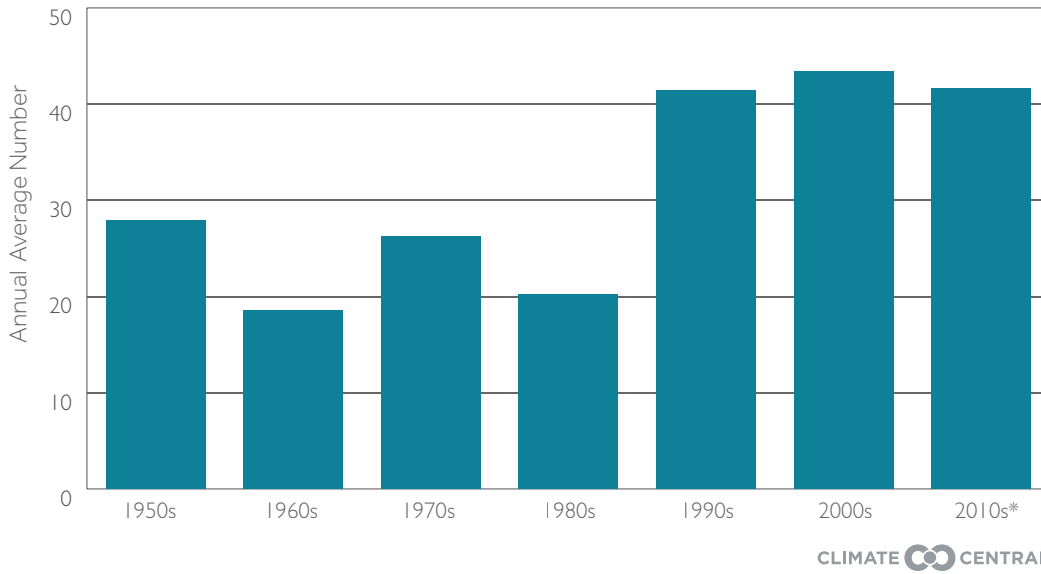


Figure 4. Decadal average of annual number of large wildfires (larger than 1,000 acres) burning in Alaska since 1950.

Area Burned in Fires Between 1,000 and 50,000 Acres in Alaska

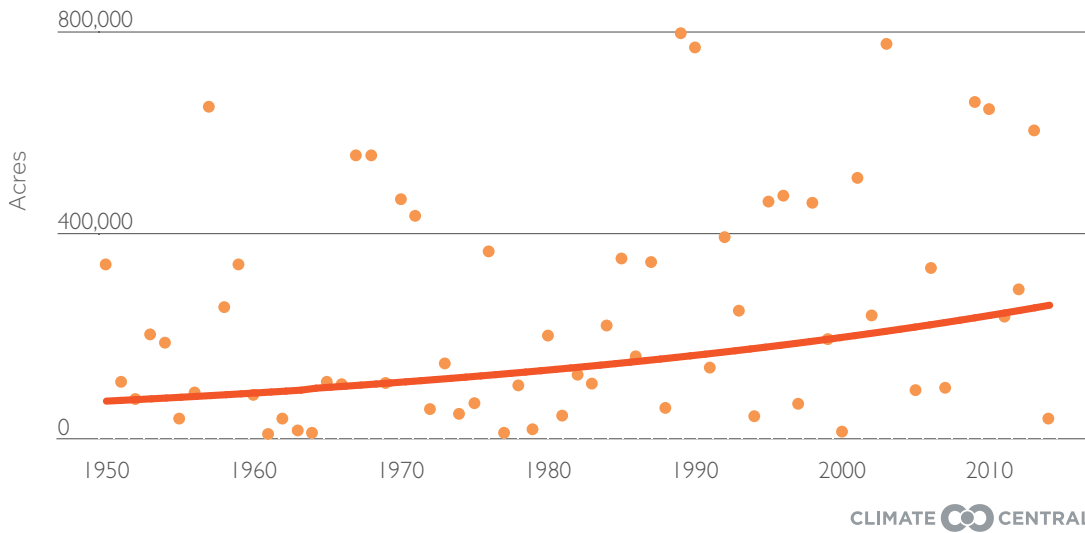


Figure 5. Increasing area burning each year in large wildfires (between 1,000 and 50,000 acres) in Alaska since 1950.

01. WESTERN WILDFIRE TRENDS

WILDFIRE IMPACTS

Wildfires can be costly, both financially and otherwise. Since 1910, almost 1100 firefighters have perished battling wildfires in the U.S.³ Forest Service spending for fighting wildfires has more than tripled over the past 20 years.⁴ Fighting individual wildfires can sometimes cost hundreds of millions of dollars and more. 2015 was the costliest wildfire season on record for the U.S. Forest Service, with total costs reportedly exceeding \$1.7 billion.⁵

More big wildfires are not the only thing driving rising wildfire costs. As the population of the West grows, more people and structures (homes and other buildings) are approaching wildland areas. People living at this wildland urban interface (WUI) are at elevated risk of being exposed to wildfires.⁶ With more development and population in the WUI, wildfires often are now doing more costly damage.

The top 5 states with the greatest population of people living in these at-risk areas for wildfires (WUI) are listed in Table 2. The states with the greatest percentage of state population living within the wildland-urban interface are listed in Table 3.

Table 2. Top 5 states with the largest population living in the wildland-urban interface

Rank	State	population living in the WUI
1	California	11,257,902
2	Arizona	2,886,270
3	Washington	2,397,728
4	Colorado	2,053,660
5	New Mexico	1,435,192

Table 3. Top 5 states with the largest percentage of state population living in the wildland-urban interface

Rank	State	% of state population living in the WUI
1	Wyoming	82%
2	New Mexico	70%
3	Montana	62%
4	Nevada	46%
5	Utah	45%
5	Arizona	45%

01. WESTERN WILDFIRE TRENDS

Wildfires can also impact human health hundreds to thousands of miles from the actual fires. The National Climate Assessment describes these human health impacts from wildfires by pointing out that exposure to smoke can lead to a wide range of respiratory and cardiovascular issues resulting in increased hospitalizations, ER visits, and even deaths.¹ A Climate Central analysis found that in several western U.S. cities, the worst air quality days of the year were usually days when wildfires were burning in the region.⁷ In several cases, wildfires caused local air quality to be as poor as is typical in Beijing, China, a city renowned for its bad air. Bad air quality and health impacts can happen very far from the fires as smoke is carried over long distances. One example of this is Houston, where increased harmful ozone levels in the city were due to wildfires burning the previous week in Alaska and Canada.⁸

02. HOTTER TEMPERATURES AND CHANGING SNOWPACK

WESTERN U.S. TEMPERATURE TRENDS

In the spring and summer, hotter temperatures lead to drying of fire fuels – the duff and downed wood on the forest floor, and the standing trees. Drier fuels are more likely to ignite from lightning strikes and human activity. And in hotter and drier climates those fires that do start are more likely to find ideal fire conditions over larger areas, leading to more area burning.

Across the West, summer temperatures have increased 2.1°F (a rate of half a degree per decade) in the past 45 years. Table 4 ranks the 11 western states according to their spring-summer warming since the 1970s. New Mexico, Arizona and Colorado have experienced the fastest rates of warming since the 1970s. This consistent western warming plays an important role in wildfire risk, and since the 1970s hotter years typically have more large wildfires, as illustrated in Figure 6.

Table 4. Spring-summer (March-August) warming in 11 western states, from 1970-79 to 2010-2015

Rank	State	Spring-Summer Temp. Increase (°F)
1	New Mexico	2.67
2	Arizona	2.34
3	Colorado	2.05
4	Nevada	1.91
5	Utah	1.88
6	Wyoming	1.88
7	California	1.81
8	Idaho	1.72
9	Montana	1.37
10	Oregon	1.32
11	Washington	1.22

02. HOTTER TEMPERATURES AND CHANGING SNOWPACK

Hotter Years Typically Have More Large Fires

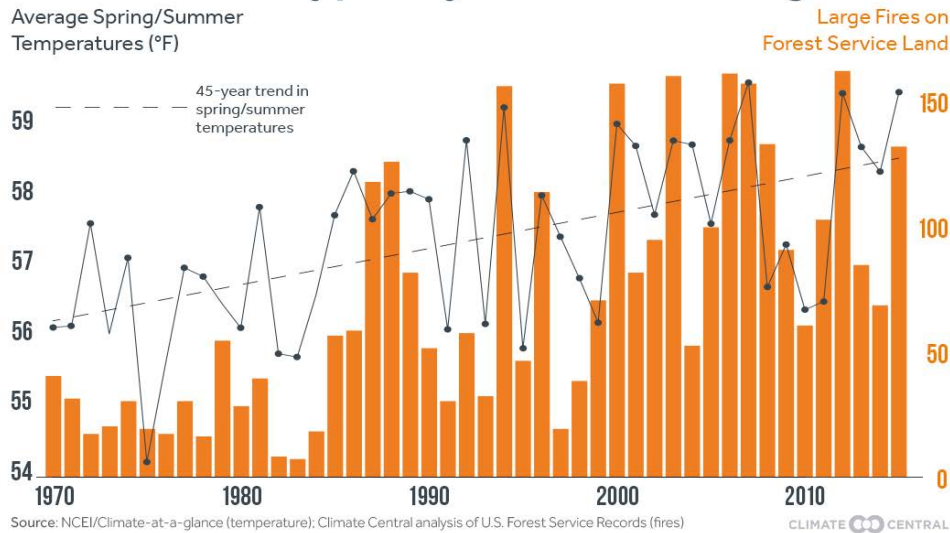


Figure 6. Years with the hottest spring-summer temperatures since 1970 were typically also years with most large wildfires on U.S. Forest Service land.

CHANGING SNOWPACK TRENDS

According to Climate Central's *Meltdown* analysis, an increasing percentage of winter precipitation is falling as rain rather than snow across much of the West.⁹ As a result, less water is stored in the West's mountain snowpack, and less water is available to keep fuels moist during the hotter and drier parts of fire season. For example, 77 percent of Oregon's mountainous weather stations (those between 2,000 and 5,000 feet) report a decrease in the percentage of precipitation falling as snow; 63 percent in Washington's mountain stations report a decrease. At higher elevations (5,000 to 8,000 feet), the decreasing trend was equally strong in the Northern Rocky states of Idaho and Montana (78 and 75 percent, respectively).

Likewise, hotter spring temperatures lead to earlier melting of the snowpack, causing a similar loss of water available during the hotter and drier times of the year. Across the West, average springtime temperatures have increased 2 °F over the course of the last 45 years, with the largest increases in Arizona, New Mexico, and California.

Earlier melting compounds the problem of less precipitation falling as snow. Although there is significant variation from year to year, the historically low snowpack in the Pacific Northwest in recent years (and the correspondingly extreme fire seasons) are consistent with this overall trend. Research has found that years with higher wildfire frequency, especially in the Northern Rockies, were also years with low snowpack.¹⁰

03. FUTURE OF WESTERN WILDFIRES

WARMING TEMPERATURES

Climate models are uniform in their projections that temperatures will continue to increase significantly across all of the Western states, and Alaska, although the amount of warming will depend on the rate of future emissions.¹ These increases are projected across the entire year, but some seasons will likely warm faster than others. Temperatures in the spring and summer have been shown to be important factors in wildfire activity (see Figure 6).

The increase in temperature projected by climate models would then lead to an increase in the temperature-dependent effects already found in the historical record, from lower snowpack levels and earlier melting, changing precipitation patterns during fire season, and drier fuels, all of which increase the likelihood of active and widespread fire seasons.

GROWING WILDFIRE POTENTIAL

The Climate Central *States at Risk* analysis of historical climate data and climate projections examined how wildfire risk could change in the coming decades.¹¹ We found that in most of the western states the conditions suitable for summer wildfires are projected to increase substantially in the relatively short period between now and 2050.

The analysis relies on the Keetch-Byram Drought Index (KBDI), which is a measure of the dryness of the top 8 inches of the forest floor (the duff layer). The KBDI serves as a proxy for the dryness of forest fuels. It is one of a number of indicators of wildfire potential and the U.S. Forest Service uses it (among other tools) to predict fire danger.¹² The scale runs from 0 to 800, where low numbers indicate that the fuel moisture is high (and less likely to burn) and high numbers represent more severe drought and higher likelihood of wildfires.

Our analysis found that the number of days with KBDI above 600 (a level at which the potential for wildfire is high) would increase significantly between now and 2050 in 10 of the western states if greenhouse gas emissions continue unabated (according to the high emission scenario RCP 8.5). The KBDI projections are calculated from an ensemble of 29 climate models, downscaled across the U.S..

Across these 10 states (Colorado did not see a projected increase in KBDI through 2050), the total number of days with KBDI above 600 is projected to increase 46 percent between 2000 and 2050.

The top 10 states that are projected to see the biggest increase in the number of high wildfire potential days through 2050 are shown in Table 5.

03. FUTURE OF WESTERN WILDFIRES

Table 5. Southwestern states will see the biggest increase in high wildfire potential days by 2050.

Rank	State	More High Wildfire Potential Days
1	Arizona	34
2	California	24
3	New Mexico	23
4	Utah	23
5	Nevada	20
6	Washington	18
7	Oregon	17
8	Idaho	15
9	Wyoming	8
10	Montana	6

These KBDI projections suggest that the dry conditions suitable for more and larger wildfires in the western U.S. will increase in the next few decades. The finding is consistent with other research that projects higher wildfire risk in the West.¹

Our projections do not account for other factors that influence wildfires in any given year, including sources of wildfire ignition or the availability of fuels. Future wildfire trends will on more than just the dryness of western forests and grasslands (driven by changes in temperature and precipitation) in any given year. Changing ignition patterns (from both lightning and human activity), overall fuel availability, and forest and wildfire management practices will also all influence that frequency, size, and severity of future wildfires.

04. STATE WILDFIRE TRENDS

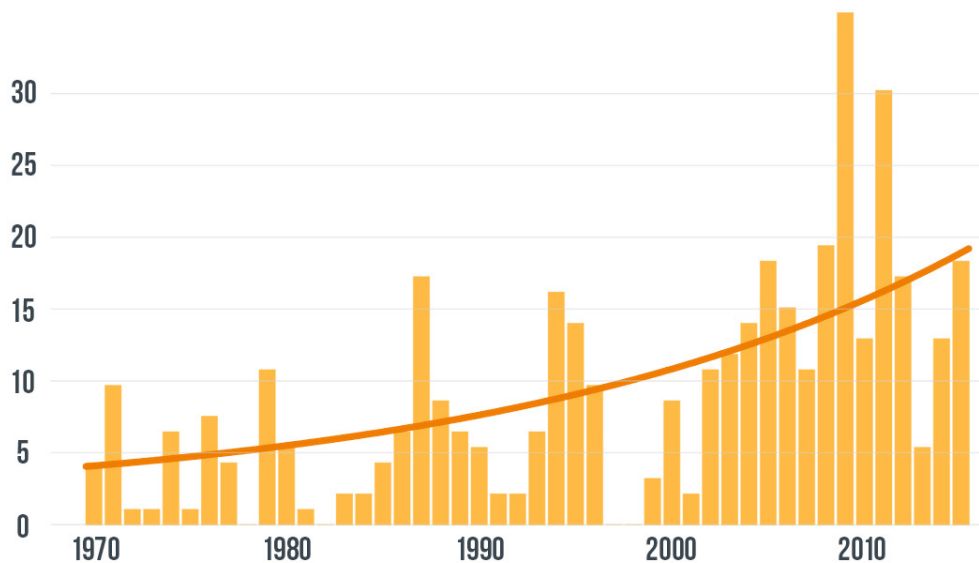
ARIZONA

Arizona has faced one of the largest increases in the number of large fires and the area burned by such fires over the past 45 years. According to an analysis of large wildfires (larger than 1,000 acres) on U.S. Forest Service land in Arizona:

- Over the last five years, Arizona is seeing an average of 11 more large wildfires each year than it did in the 1970s. This is the second largest increase among the western states.
- Arizona also has the second-largest increase in the area burned by large wildfires with 186,000 more acres burned each year in the last five years, compared to 1970s.
- Arizona has the second-largest population (2.9 million) living in the wildland-urban interface of any state. This is the area where development abuts and intersperses with wild lands and homes are more at risk from wildfire than in urban areas. However, much of Arizona's development abuts desert, where the risk of wildfire is low.

Large Wildfires Increasing in Arizona

Number of fires larger than 1,000 acres per year on U.S. Forest Service land



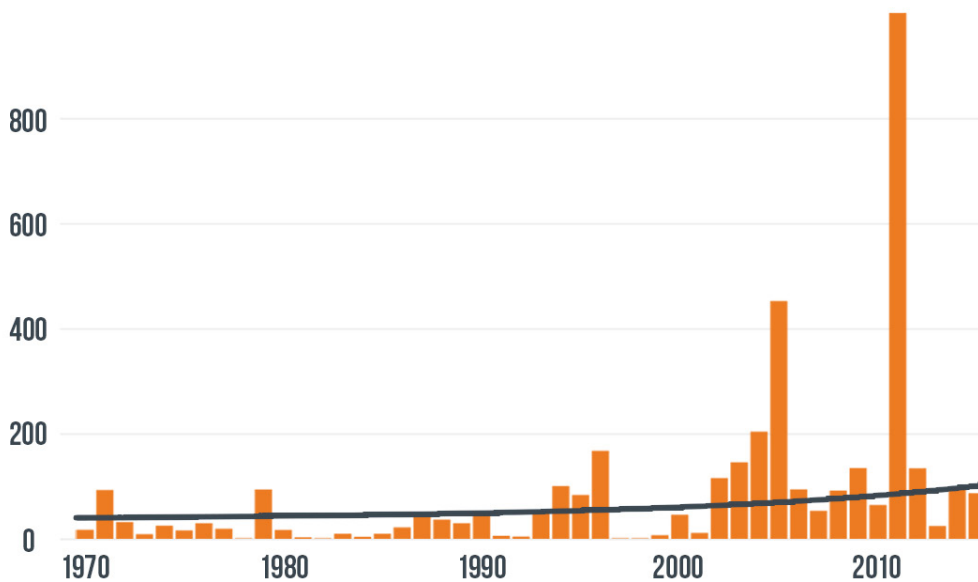
Source: Climate Central analysis of U.S. Forest Service records

CLIMATE CENTRAL

04. STATE WILDFIRE TRENDS - ARIZONA

More Acres Burning in Arizona

Thousands of acres burned by large wildfires each year on U.S. Forest Service land



Source: Climate Central analysis of U.S. Forest Service records

CLIMATE CENTRAL

- 45 percent of Arizona's population lives in the wildland-urban interface.
- The average spring and summer temperatures in Arizona have increased 2.3 degrees F since the 1970s, the second largest increase among the western states. Higher temperatures have been associated with increased frequency and severity of wildfire.
- Arizona is projected to see the largest increase among the western states in days with high wildfire potential between now and 2050. By 2050, Arizona is projected to face 34 more days with high wildfire potential each year than it did in 2000.

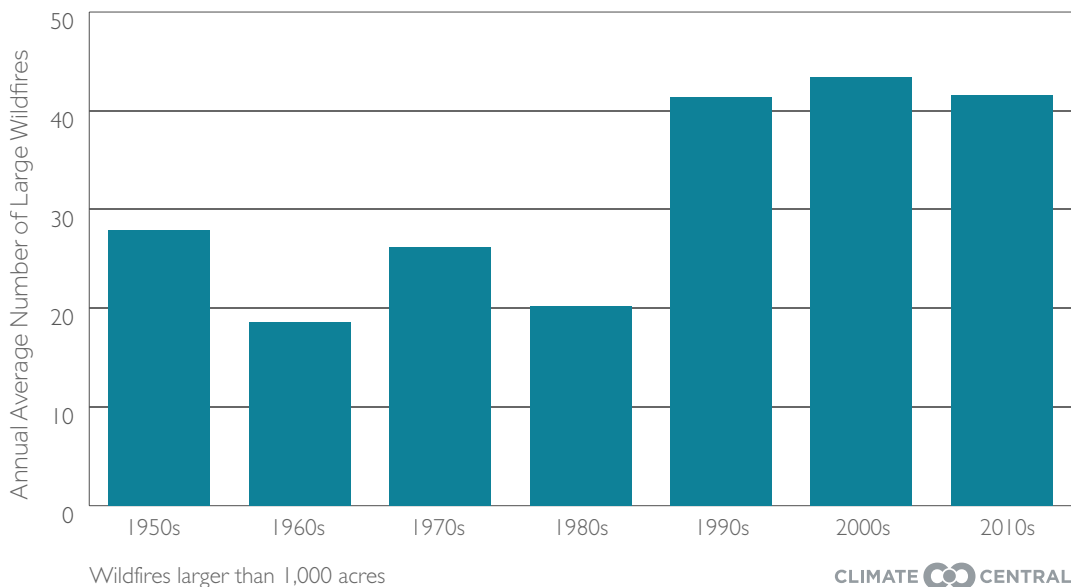
04. STATE WILDFIRE TRENDS

ALASKA

Alaska sees more area burning in wildfires than any other state, and Alaska has seen dramatic increases both in the number of large fires and the area burned over the last several decades. According to an analysis of large wildfires (larger than 1,000 acres) on all federal land in Alaska:

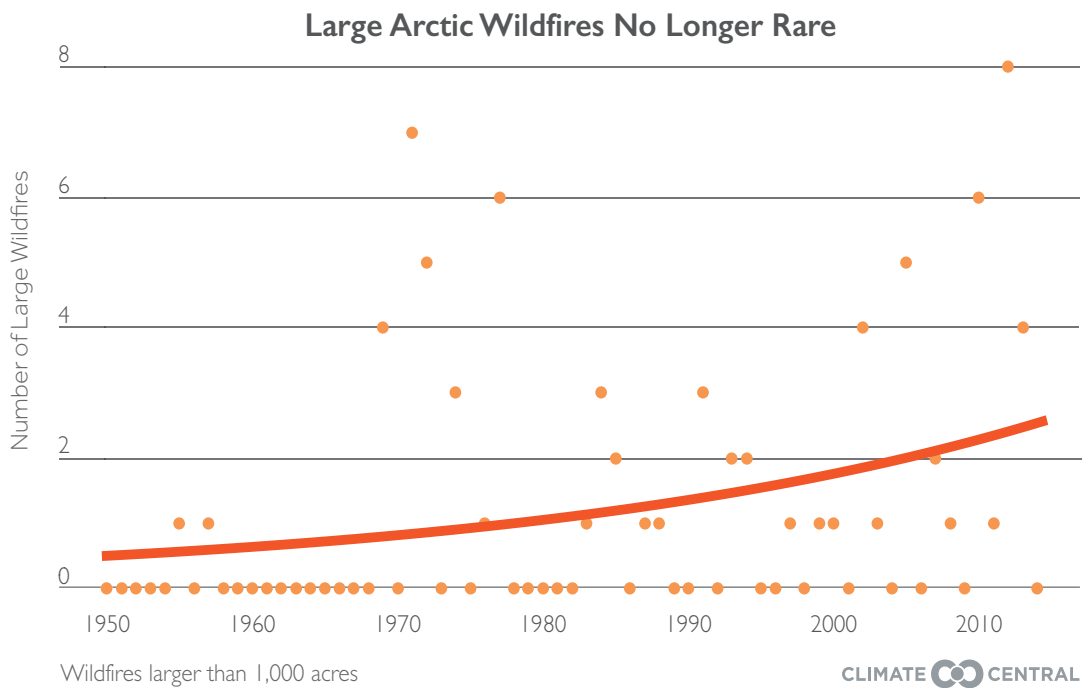
- Alaska now sees an average of 42 more large wildfires each year on all federal land than it did in the 1950s, more than twice as many as 60 years ago. Most of these wildfires occur in the interior, boreal forest region of the state.
- The number of large wildfires burning in an average year increased suddenly in the 1990s compared to the earlier decades beginning in the 1950s.
- Nearly 350,000 more acres burn in Alaska each year now, on average, than did in the 1950s. This is about double the number of acres burning in a typical year in the 1950s.
- Average May-July temperatures in Alaska have increased 2.4°F since the 1950s. Years with higher temperatures during these months have usually been years with more large wildfires.

Alaska Wildfires Have Increased Dramatically Since 1990



04. STATE WILDFIRE TRENDS - ALASKA

- In Alaska's Arctic region, large wildfires are no longer rare events. In recent years the Arctic has had more than two wildfires, on average, each season compared to less than one each year in the 1950s. This potentially puts the vast stores of carbon stored in the tundra at risk of being emitted.
- Alaska's wildfire season is about 40 percent longer now than it was in the 1950s. Wildfires start earlier in the year now and they are also burning longer into the fall. Overall, the wildfire season has increased more than 35 days and is now more than three months long, running from May through early August.



04. STATE WILDFIRE TRENDS

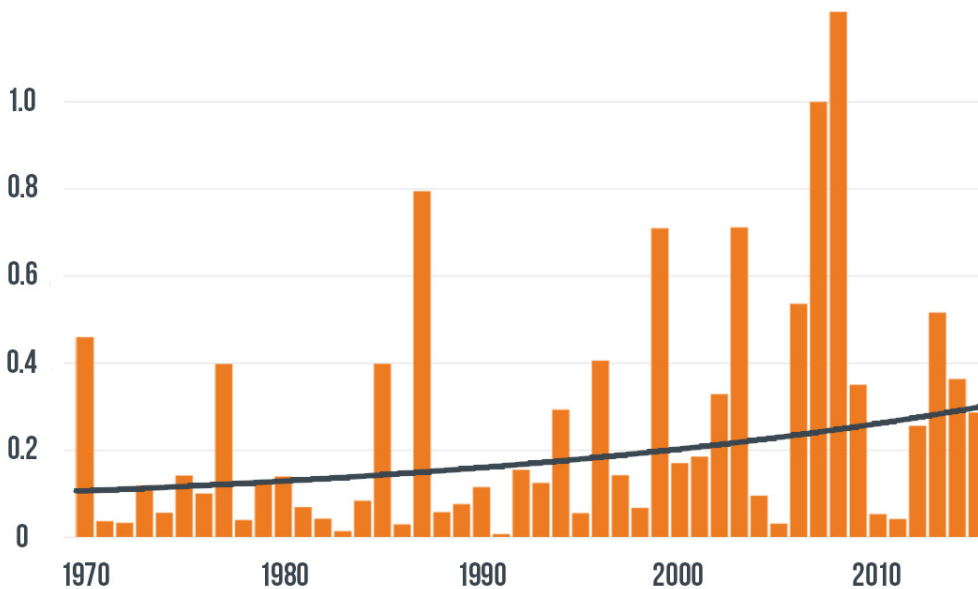
CALIFORNIA

California's size, prevalence of wildlands, and large population make it one of the states most affected by wildfire. According to an analysis of large wildfires (larger than 1,000 acres) on U.S. Forest Service land in California:

- California has the largest population (11.3 million) living in the wildland-urban interface of any state. This is the area where development abuts and intersperses with wild lands like forests and grasslands and where homes are more at risk from wildfire than in urban areas.
- 30 percent of California's population lives in the wildland-urban interface.
- Over the last five years, California has seen an average of 94,000 acres more acres burn each in large wildfires on U.S. Forest Service land than was typical in the 1970s.
- Since 2010, there are now an average of 3 more large wildfires in California burning each year than there were in the 1970s.

More Acres Burning in California

Millions of acres burned by large wildfires each year on U.S. Forest Service land

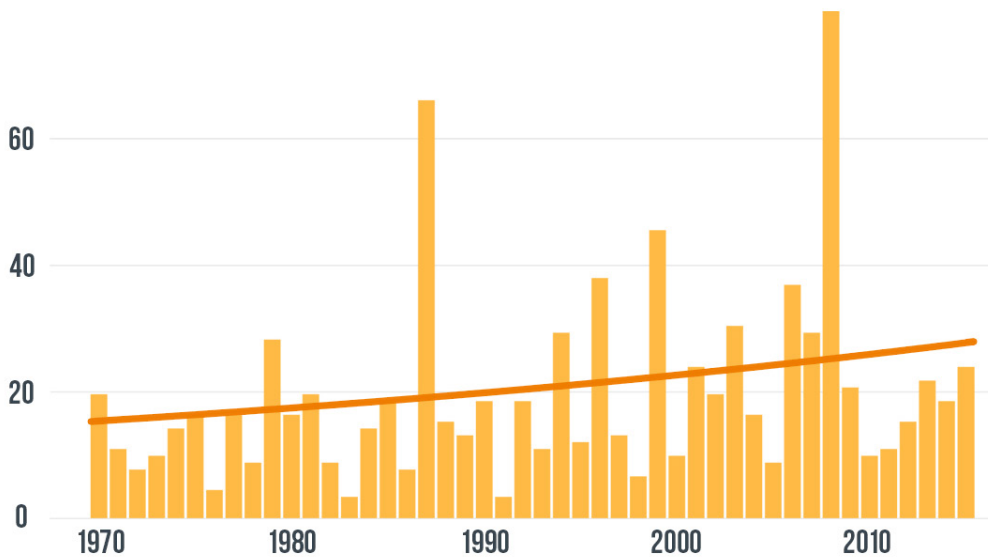


Source: Climate Central analysis of U.S. Forest Service records

CLIMATE CENTRAL

Large Wildfires Increasing in California

Number of fires larger than 1,000 acres per year on U.S. Forest Service land



Source: Climate Central analysis of U.S. Forest Service records

CLIMATE CENTRAL

- The average spring and summer temperatures in California have increased 1.8 °F since the 1970s. Higher temperatures have been associated with increased frequency and severity of wildfire.
- By 2050, California is projected to face 24 more days with high wildfire potential than it did in 2000.

04. STATE WILDFIRE TRENDS

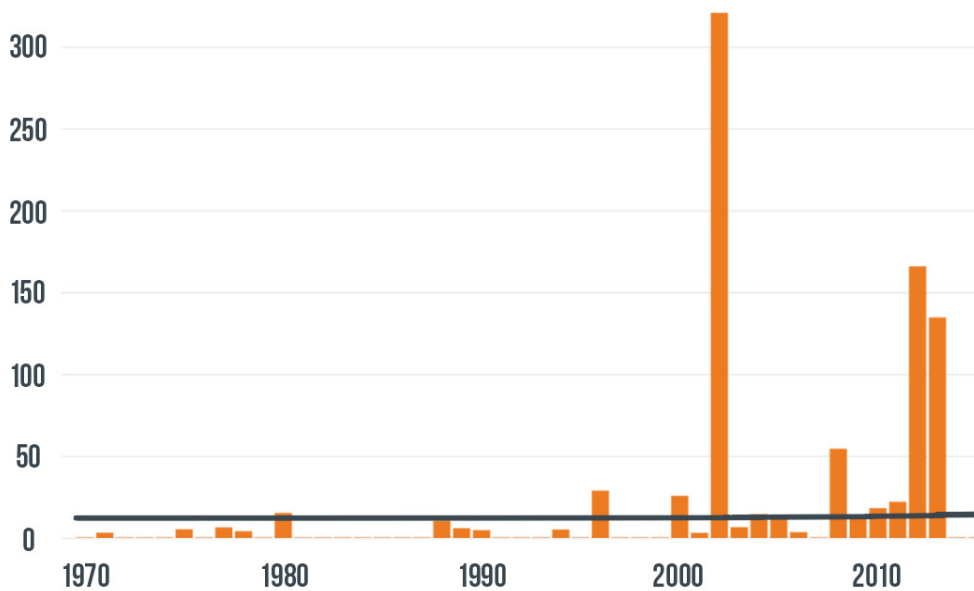
COLORADO

Colorado has seen some of the largest increases in the number of large fires and the acreage burned by them since the 1970s. According to an analysis of large wildfires (larger than 1,000 acres) on U.S. Forest Service land in Colorado:

- Colorado has the fourth-largest population (2.1 million) living in the wildland-urban interface among the western states. This is the area where development abuts and intersperses with wild lands like forests and grasslands and where homes are more at risk from wildfire than in urban areas.
- 41 percent of Colorado's population lives in the wildland-urban interface.
- The average spring and summer temperatures in California have increased 2.05 degrees F since the 1970s, the third-largest increase among the western states. Higher temperatures have been associated with increased frequency and severity of wildfire.
- The average year in the 2010s saw 30 times more acres burned by large wildfires in Colorado as the average year in the 1970s.

More Acres Burning in Colorado

Thousands of acres burned by large wildfires each year on U.S. Forest Service land



Source: Climate Central analysis of U.S. Forest Service records

CLIMATE CENTRAL

04. STATE WILDFIRE TRENDS

IDAHO

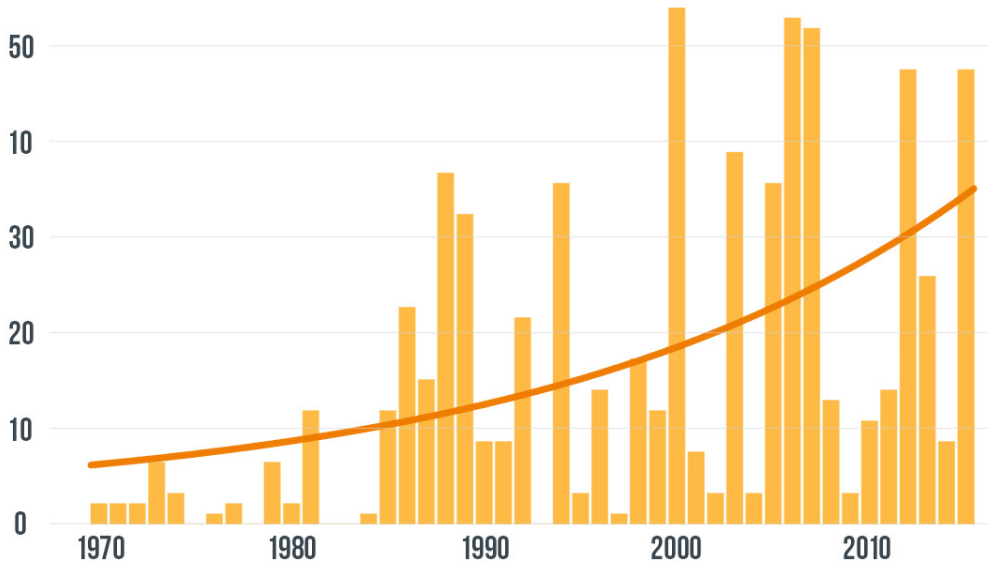
Over the past 45 years, Idaho has seen a larger increase in the number of large fires and the area burned by them than any other western state. According to an analysis of large wildfires (larger than 1,000 acres) on U.S. Forest Service land in Idaho:

:

- Over the last five years, Idaho has seen an average of 21 more large fires each year than it did in the 1970s, the largest increase among the western states, which is a 10-fold increase in its annual number of large wildfires.
- Idaho also ranks first in the increase in the area burned by large wildfires. 305,00 more acres burn in an average year now than did in the 1970s.
- The number of days with high wildfire potential in Idaho is projected to quadruple between now and 2050, the third largest percentage increase among the western states.

Large Wildfires Increasing in Idaho

Number of fires larger than 1,000 acres per year on U.S. Forest Service land



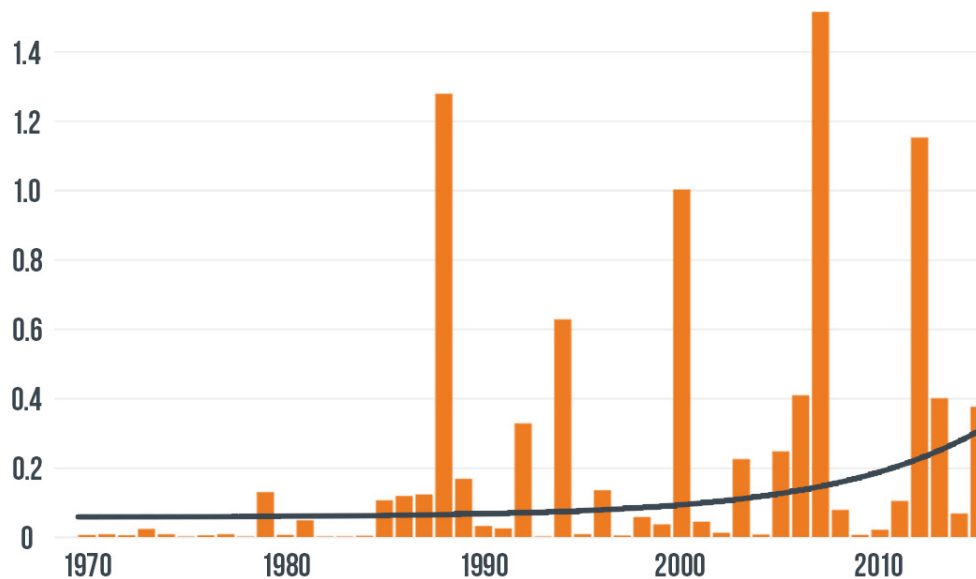
Source: Climate Central analysis of U.S. Forest Service records

CLIMATE CENTRAL

04. STATE WILDFIRE TRENDS - IDAHO

More Acres Burning in Idaho

Millions of acres burned by large wildfires each year on U.S. Forest Service land



Source: Climate Central analysis of U.S. Forest Service records

CLIMATE CENTRAL

- Idaho has a relatively low population – 564,000, or 36 percent – living in the wildland-urban interface, where development and wild lands abut or intersperse. More of Idaho’s wildfires occur in remote forested land where their impact is on the timber industry.
- The average spring and summer temperatures in Idaho have increased 1.72°F since the 1970s. Higher temperatures have been associated with increased frequency and severity of wildfire.

04. STATE WILDFIRE TRENDS

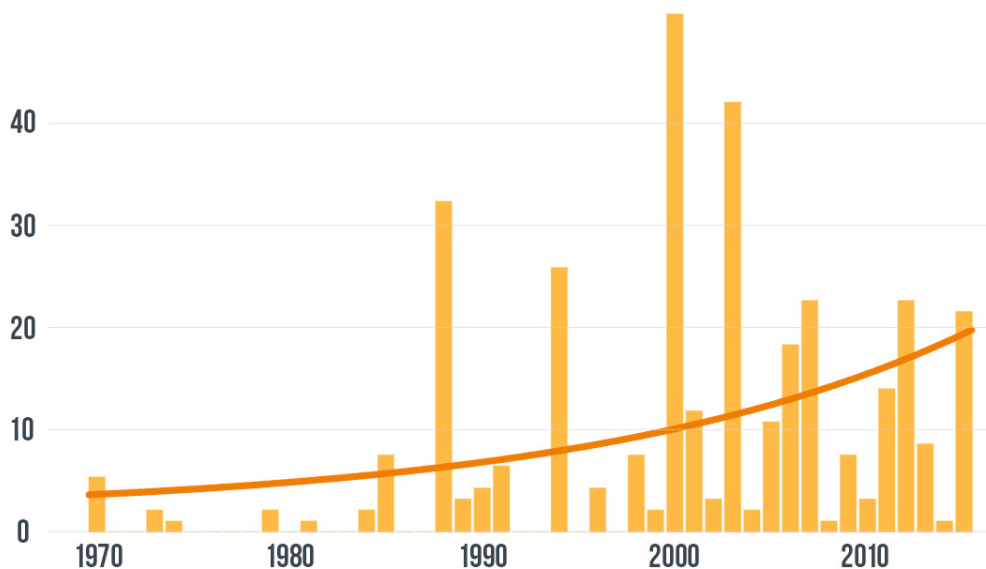
MONTANA

Over the past 45 years, Montana has seen a larger percentage increase in the number of large fires than any other western state. According to an analysis of large wildfires (larger than 1,000 acres) on U.S. Forest Service land in Montana:

- Over the last 5 years, Montana has seen an average of 10 more large wildfires burning each year than it did in the 1970s, the third-largest increase among the western states.
- Montana now sees 134,000 more acres burned by wildfires each year, compared to in the 1970s, a 40-fold increase, which ranks second among the western states.
- 62 percent of Montana citizens (617,000) live in the wildland-urban interface, where development and wild lands abut or intersperse. The risk of wildfires burning developed land is higher in the wildland-urban interface than in urban or rural areas.
- Average spring and summer temperatures in Montana have increased 1.37°F since the 1970s. Higher temperatures have been associated with increased frequency and severity of wildfire.

Large Wildfires Increasing in Montana

Number of fires larger than 1,000 acres per year on U.S. Forest Service land



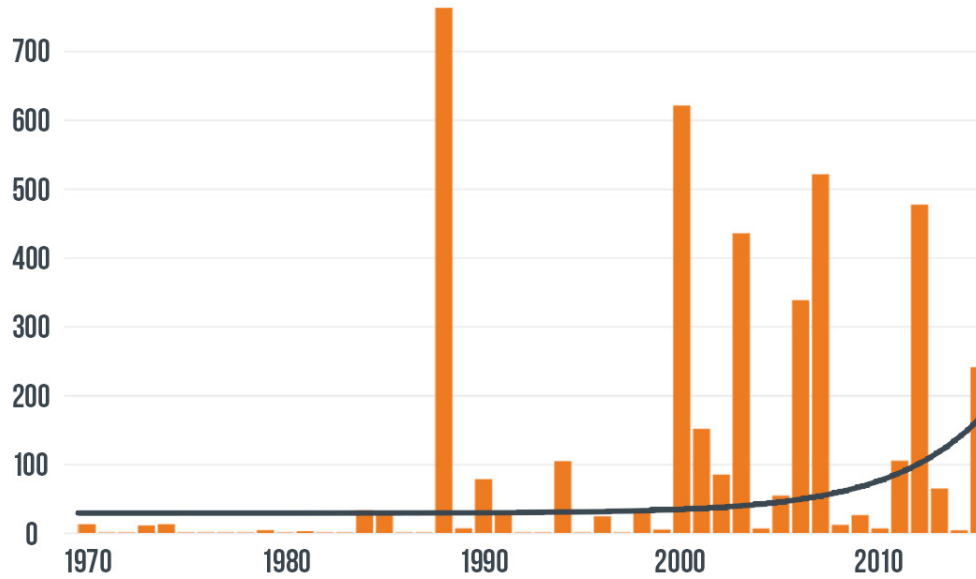
Source: Climate Central analysis of U.S. Forest Service records

CLIMATE CENTRAL

04. STATE WILDFIRE TRENDS - MONTANA

More Acres Burning in Montana

Thousands of acres burned by large wildfires each year on U.S. Forest Service land



Source: Climate Central analysis of U.S. Forest Service records

CLIMATE CENTRAL

04. STATE WILDFIRE TRENDS

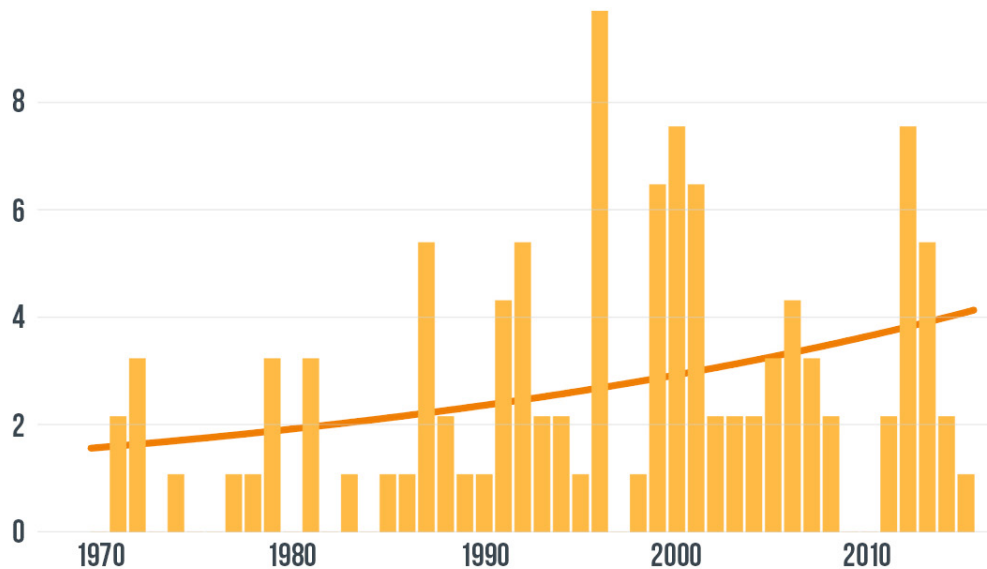
NEVADA

Since the 1970s, the increase in large wildfire activity has been relatively mild in Nevada compared to other western states, but a large proportion of the state's population lives in at-risk areas. Projections into Nevada's future indicate a large increase in the number of days with high wildfire potential. According to an analysis of large wildfires (larger than 1,000 acres) on U.S. Forest Service land in Nevada:

- Nevada is projected to see 20 more days with high wildfire potential each year by 2050. This is the fifth-largest increase among western states.
- 46 percent of Nevada citizens (1.2 million) live in the wildland-urban interface, where development and wild lands abut or intersperse. This is the fourth-largest proportion among the western states. The risk of wildfires burning developed land is higher in the wildland-urban interface than in urban or rural areas.
- Over the last five year, Nevada has seen an average of 2 more large wildfires burning each year compared to what was typical in the 1970s.

Large Wildfires Increasing in Nevada

Number of fires larger than 1,000 acres per year on U.S. Forest Service land



Source: Climate Central analysis of U.S. Forest Service records

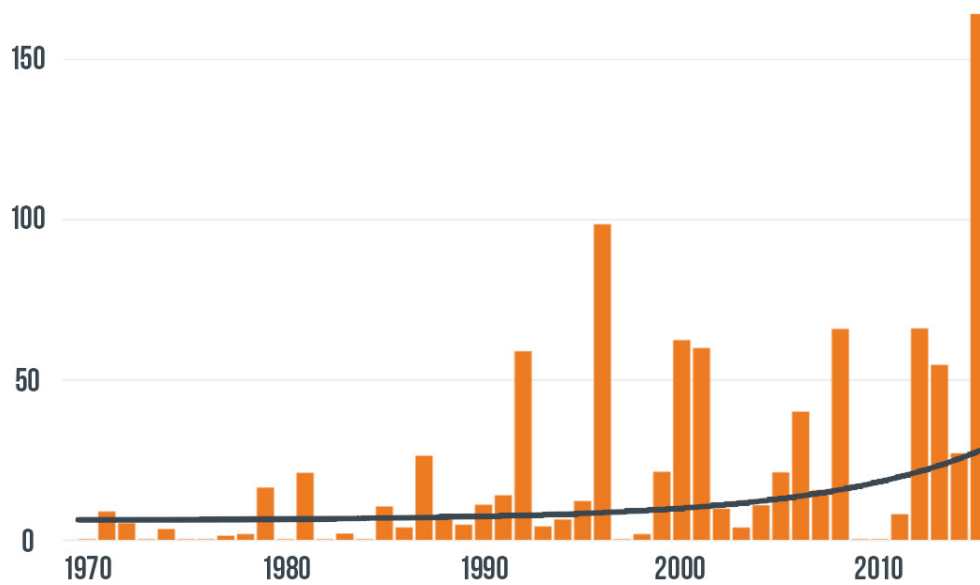
CLIMATE CENTRAL

04. STATE WILDFIRE TRENDS - NEVADA

- The average spring and summer temperatures in Nevada have warmed 1.91°F since the 1970s the fourth-largest increase. Higher temperatures have been associated with increased frequency and severity of wildfire.
- Today in Nevada, an average of 45,000 more acres burned in wildfires each year than was typical in the 1970s.

More Acres Burning in Nevada

Thousands of acres burned by large wildfires each year on U.S. Forest Service land



Source: Climate Central analysis of U.S. Forest Service records

CLIMATE CENTRAL

04. STATE WILDFIRE TRENDS

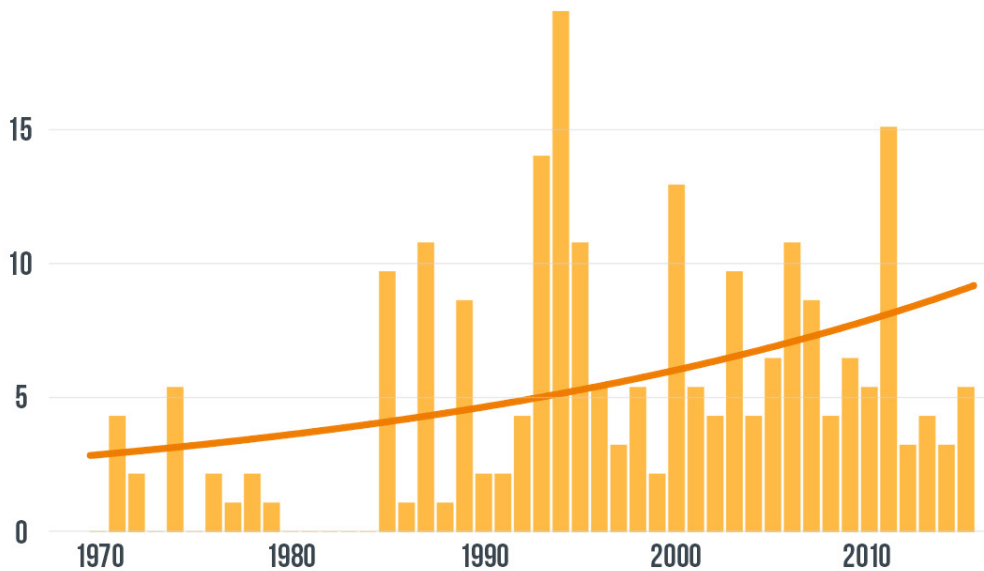
NEW MEXICO

Since the 1970s, the number of acres burning in New Mexico wildfires each year has increased significantly, and a very large proportion of the state's population lives in at-risk areas. According to an analysis of large wildfires (larger than 1,000 acres) on U.S. Forest Service land in New Mexico:

- New Mexico is projected to see 23 more days with high wildfire potential by 2050, compared to 2000. This is the tied for the third-largest increase among western states.
- 70 percent of New Mexico citizens (1.4 million) live in the wildland-urban interface, where development and wild lands abut or intersperse. This is the second-largest proportion among the western states. The risk of wildfires burning developed land is higher in the wildland-urban interface than in urban or rural areas.
- Over the last five years, New Mexico has seen an average of 4 more large wildfires burning each year than it did in the 1970s.

Large Wildfires Increasing in New Mexico

Number of fires larger than 1,000 acres per year on U.S. Forest Service land



Source: Climate Central analysis of U.S. Forest Service records

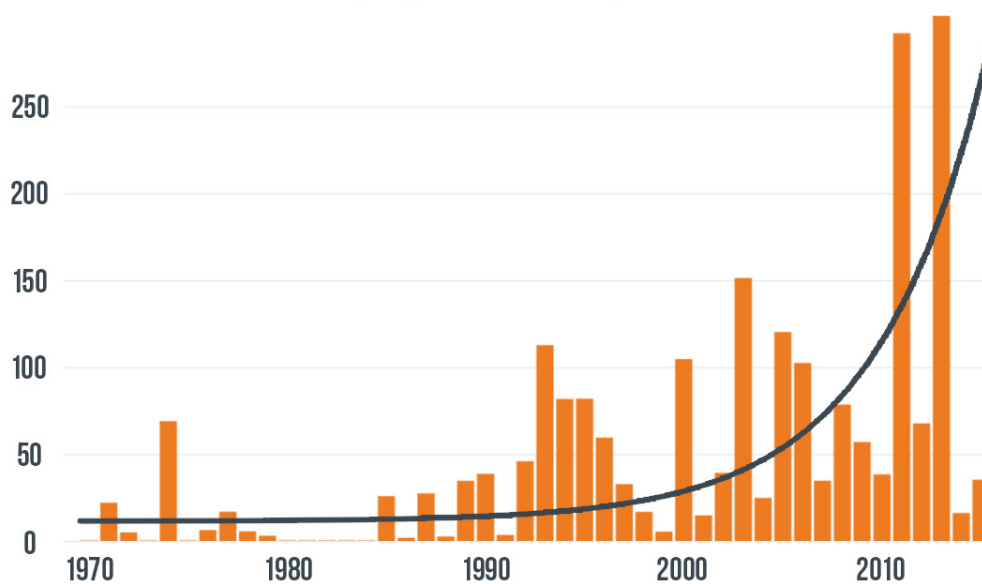
CLIMATE CENTRAL

04. STATE WILDFIRE TRENDS - NEW MEXICO

- The average spring and summer temperatures in New Mexico have increased 2.67°F since the 1970s –the largest increase among all the western states. Higher temperatures have been associated with increased frequency and severity of wildfire.
- Since 2010, there are an average of 104,000 more acres burning each year in large wildfires in New Mexico than was typical in the 1970s, which is the fifth-largest increase among western states.

More Acres Burning in New Mexico

Thousands of acres burned by large wildfires each year on U.S. Forest Service land



Source: Climate Central analysis of U.S. Forest Service records

CLIMATE CENTRAL

04. STATE WILDFIRE TRENDS

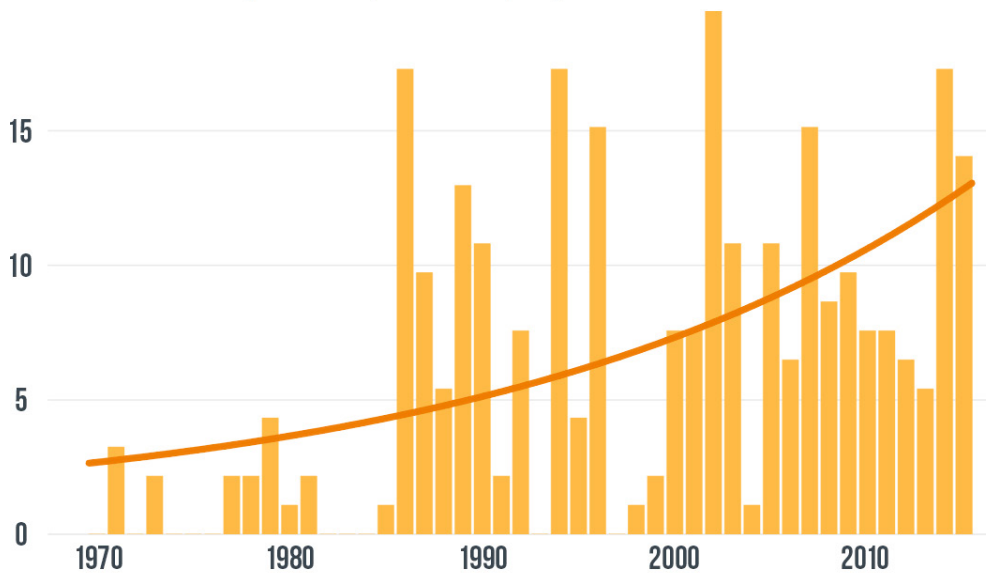
OREGON

Oregon ranks fourth among the 11 western continental states for its increase since the 1970s in both the number of fires and the number of acres burned in an average year. According to an analysis of large wildfires (larger than 1,000 acres) on U.S. Forest Service land in Oregon:

- Since 2010, Oregon has seen an average of 8 more large wildfires burning each year than was typical in the 1970s – the fourth-largest increase among the western states.
- There are also now an average of 114,000 more acres burning each year on Forest Service land in Oregon than in an average year in the 1970s.
- Oregon is projected to see 17 more days each year with high wildfire potential by 2050, compared to 2000.

Large Wildfires Increasing in Oregon

Number of fires larger than 1,000 acres per year on U.S. Forest Service land

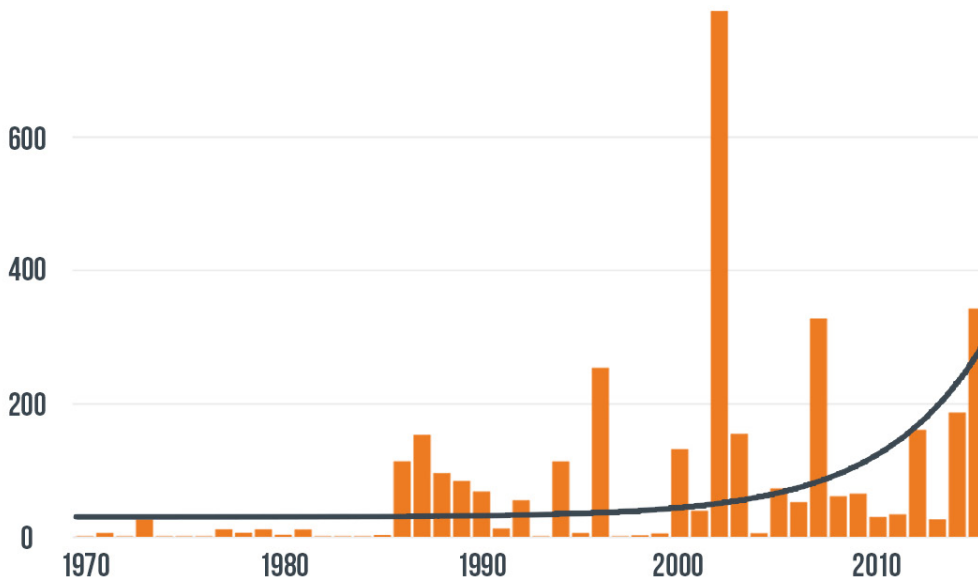


Source: Climate Central analysis of U.S. Forest Service records

CLIMATE CENTRAL

More Acres Burning in Oregon

Thousands of acres burned by large wildfires each year on U.S. Forest Service land



Source: Climate Central analysis of U.S. Forest Service records

CLIMATE CENTRAL

- 33 percent of Oregon's citizens (1.2 million) live in the wildland-urban interface, where development and wild lands abut or intersperse. The risk of wildfires burning developed land is higher in the wildland-urban interface than in urban or rural areas.
- The average spring and summer temperatures in Oregon have increased 1.32°F since the 1970s. Higher temperatures have been associated with increased frequency and severity of wildfire.

04. STATE WILDFIRE TRENDS

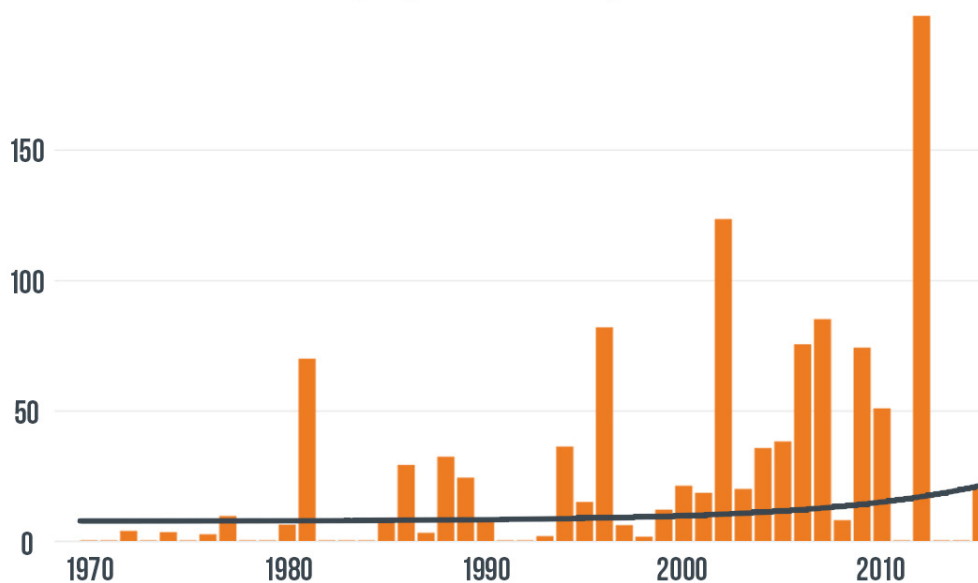
UTAH

Compared with the 1970's Utah now sees an average of more than 20 times more acres burned by large wildfires each year. According to an analysis of large wildfires (larger than 1,000 acres) on U.S. Forest Service land in Utah:

- Since 2010, Utah has seen an average of two more large wildfires burning each year on Forest Service land compared to in the 1970s.
- Compare to in the 1970s, Utah now sees an average of 40,000 more acres burning each year in large wildfires. This represents more than 20 times the typical number of acres burning each year in the 1970s, fourth among the western states.

More Acres Burning in Utah

Thousands of acres burned by large wildfires each year on U.S. Forest Service land



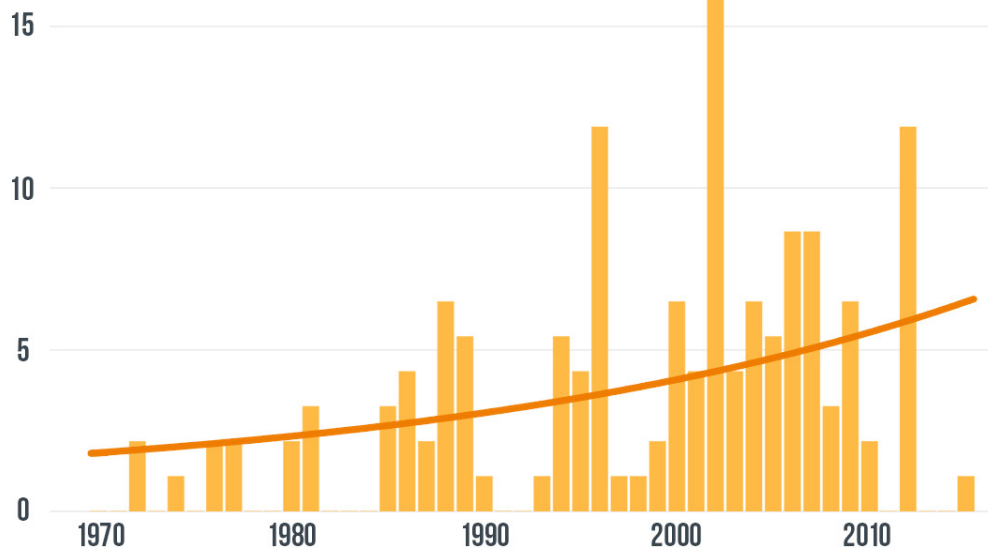
Source: Climate Central analysis of U.S. Forest Service records

CLIMATE CENTRAL

04. STATE WILDFIRE TRENDS - UTAH

Large Wildfires Increasing in Utah

Number of fires larger than 1,000 acres per year on U.S. Forest Service land



Source: Climate Central analysis of U.S. Forest Service records

CLIMATE CENTRAL

- Utah is projected to see 23 more days each year with high wildfire potential by 2050 – tied for the third largest increase among western states.
- 45 percent of Utah's citizens (1.3 million) live in the wildland-urban interface, where development and wild lands abut or intersperse. The risk of wildfires burning developed land is higher in the wildland-urban interface than in urban or rural areas.
- The average spring and summer temperatures in Utah have increased 1.88°F since the 1970s – tied for fifth largest increase among the western states. Higher temperatures have been associated with increased frequency and severity of wildfire.

04. STATE WILDFIRE TRENDS

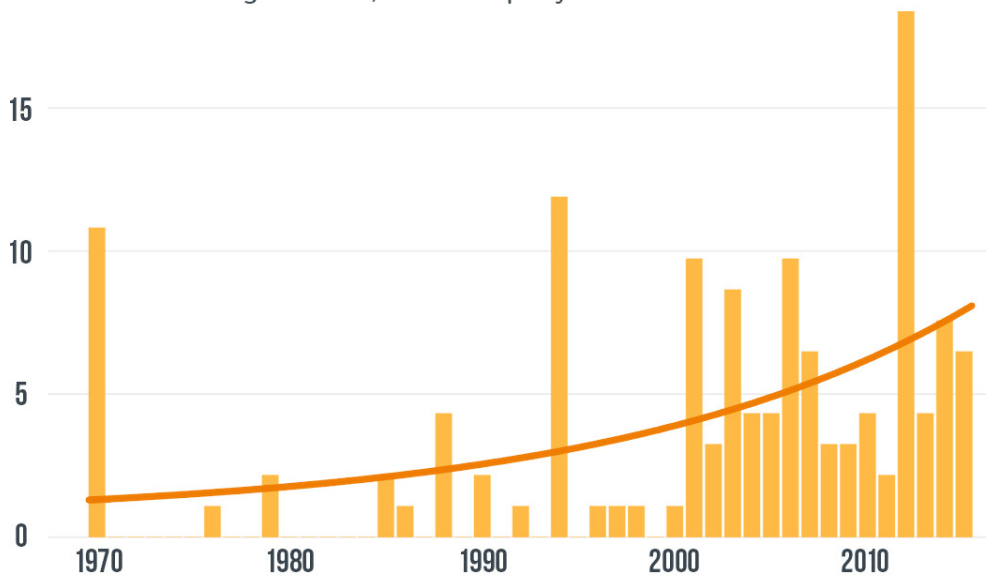
WASHINGTON

Projections of the conditions suitable for wildfires indicate that by 2050 Washington will face more than triple the number of days with high wildfire potential as it did in 2000. According to an analysis of large wildfires (larger than 1,000 acres) on U.S. Forest Service land in Washington:

- Since 2010, Washington has seen an average of 5 more large wildfires burning each year than it did in the 1970s – tied for fifth-largest increase among the western states.
- Washington now sees an average of 49,000 more acres burning each year on Forest Service land than it did in the 1970s.
- Washing is projected to see 18 more high wildfire potential days each year by 2050 than it did in 2000.

Large Wildfires Increasing in Washington

Number of fires larger than 1,000 acres per year on U.S. Forest Service land



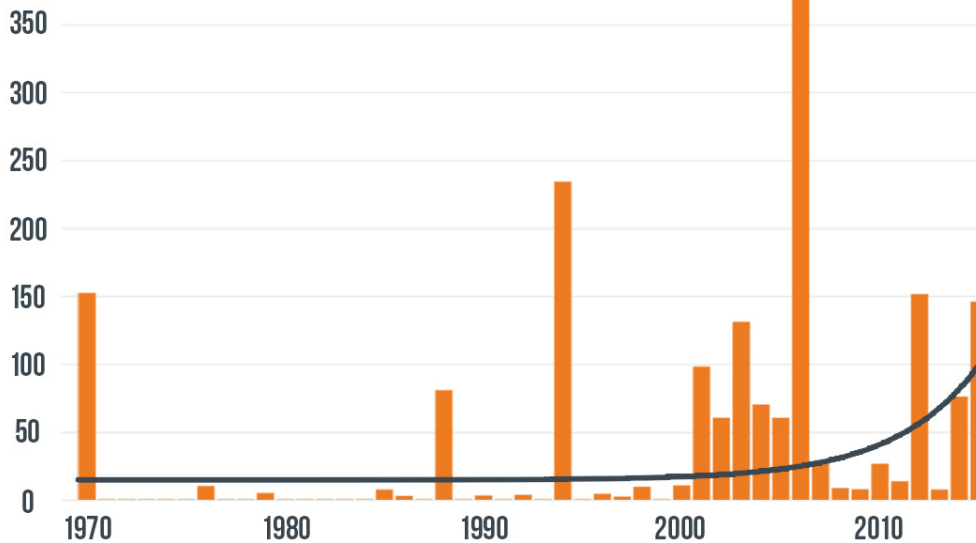
Source: Climate Central analysis of U.S. Forest Service records

CLIMATE CENTRAL

04. STATE WILDFIRE TRENDS - WASHINGTON

More Acres Burning in Washington

Thousands of acres burned by large wildfires each year on U.S. Forest Service land



Source: Climate Central analysis of U.S. Forest Service records

CLIMATE CENTRAL

- 2.4 million Washingtonians – third-most among the western states – live in the wildland-urban interface, where development and wild lands abut or intersperse. This represents 36% of the state’s population. The risk of wildfires burning developed land is higher in the wildland-urban interface than in urban or rural areas.
- The average spring and summer temperatures in Washington have increased 1.22°F since the 1970s. Higher temperatures have been associated with increased frequency and severity of wildfire.

04. STATE WILDFIRE TRENDS

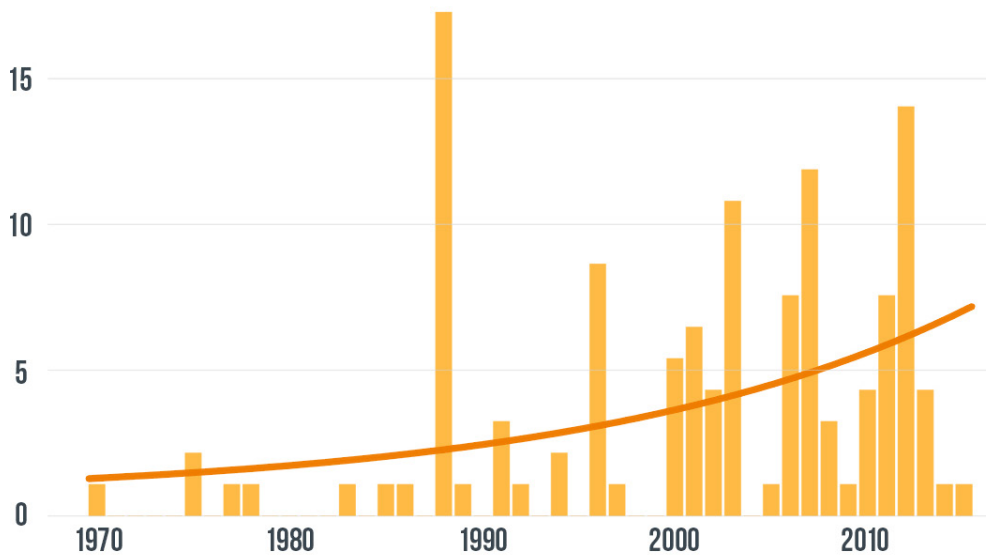
WYOMING

Wyoming now faces an average of 10 times more large wildfires each year than it did in the 1970s and the number of acres burned has jumped dramatically. According to an analysis of large wildfires (larger than 1,000 acres) on U.S. Forest Service land in Wyoming:

- Since 2010, Wyoming has seen an average of 5 more large wildfires burning each year than it did in the 1970s – tied for fifth-largest increase among the western states.
- There are now an average of 63,000 more acres burning each year in large wildfires on Forest Service land in Wyoming than was typical in the 1970s. This is nearly a 50-fold increase.
- Wyoming is projected to see 8 more high wildfire potential days each year by 2050 than it faced in 2000.

Large Wildfires Increasing in Wyoming

Number of fires larger than 1,000 acres per year on U.S. Forest Service land

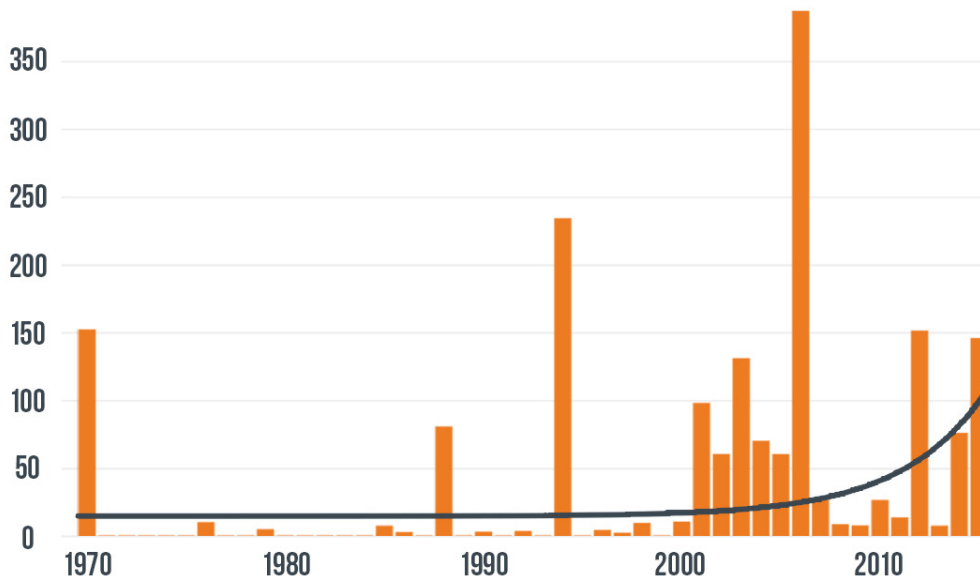


Source: Climate Central analysis of U.S. Forest Service records

CLIMATE CENTRAL

More Acres Burning in Washington

Thousands of acres burned by large wildfires each year on U.S. Forest Service land



Source: Climate Central analysis of U.S. Forest Service records

CLIMATE CENTRAL

- 82 percent of Wyoming's citizens live in the wildland-urban interface, where development and wild lands abut or intersperse, by far the largest proportion among the western states. The risk of wildfires burning developed land is higher in the wildland-urban interface than in urban or rural areas.
- The average spring and summer temperatures in Wyoming have increased 1.88°F since the 1970s – tied for fifth-largest increase among the western states. Higher temperatures have been associated with increased frequency and severity of wildfire.

05. METHODOLOGY

The wildfires trend analyses in this report follows our previously published methods from *The Age of Western Wildfires* and *The Age of Alaskan Wildfires*. Trends for wildfires in the 11 western states of the contiguous U.S. are calculated on large wildfires (those larger than 1,000 acres) occurring on U.S. Forest Service land between 1970-2015. As previously described, these wildfires represent a significant percent of the total area burned each year in western wildfires, and thus they are a suitable representative of overall wildfire trends. Trends for Alaskan fires are based on large wildfires burning on both federal and state land across Alaska between 1950-2015.

Ranked lists of state trends only include the 11 western states of the contiguous U.S. Because a different wildfire dataset was used for Alaska, it's trends were not included in state-by-state comparisons.

The linear, exponential, and Poisson regression fits for the wildfire and climate data were calculated using the R software package (R Core Team, 2014). Poisson fits were carried out for large wildfire frequency. Area burned was analyzed using an exponential regression, where appropriate.

Temperature trends were calculated on data collected by the National Centers for Environmental Information. Methodology for the snow and precipitation analysis is previously published in the Climate Central report, *Meltdown*.

Future changes in high wildfire potential days is based on the Keetch-Byram Drought Index (KBDI), which is a measure of the dryness of the top 8 inches of the forest floor. It serves as a proxy for the dryness of forest fuels. Using an ensemble of 29 climate models, downscaled across the U.S., we projected the change in high wildfire potential days (those with KBDI above 600) through 2050, based on the high emissions RCP8.5 scenario. More specific details on our projected wildfire risks can be found in *States at Risk*.

05. REFERENCES

1. Melillo, Jerry M., Terese (T.C.) Richmond, and Gary W. Yohe, Eds., 2014: *Climate Change Impacts in the United States: The Third National Climate Assessment*. U.S. Global Change Research Program, 841 pp. doi:10.7930/J0Z31WJ2.
2. Climate Central, 2012: *The Age of Western Wildfires*. Princeton, NJ. <http://www.climatecentral.org/wgts/wildfires/Wildfires2012.pdf>
3. Climate Central, 2015: *The Age of Alaskan Wildfires*. Princeton, NJ. <http://assets.climatecentral.org/pdfs/AgeofAlaskanWildfires.pdf>
4. National Interagency Fire Center. 2015: *Historical Wildland Firefighter Fatality Reports*. https://www.nifc.gov/safety/safety_HistFatality_report.html
5. U.S. Forest Service, 2015: *The Rising Costs of Wildfire Operations: Effects on the Forest Service's Non-Fire Work*. <http://www.fs.fed.us/sites/default/files/2015-Fire-Budget-Report.pdf>
6. Rice, D., December 17, 2015: *2015 now USA's costliest wildfire season on record*. USA Today. <http://www.usatoday.com/story/news/nation/2015/12/16/costliest-wildfire-season-record/77417982/>
7. Radeloff, V.C., R.B. Hammer, S.I Stewart, J.S. Fried, S.S. Holcomb, and J.F. McKeefry. 2005. *The Wildland Urban Interface in the United States*. *Ecological Applications* 15: 799-805.
8. Climate Central, 2014: *Wildfires and Air Pollution: The Hidden Health Hazards of Climate Change*. Princeton, NJ. <http://assets.climatecentral.org/pdfs/WildfiresAndAirPollution.pdf>
9. Morris, G. A., et al., 2006: *Alaskan and Canadian forest fires exacerbate ozone pollution over Houston, Texas, on 19 and 20 July 2004*. *J. Geophys. Res.*, 111, D24S03, doi:10.1029/2006JD007090.
10. Climate Central, 2016: *Meltdown: Increasing Rain as a Percentage of Total Winter Precipitation*. Princeton, NJ. <http://assets.climatecentral.org/pdfs/Meltdown.pdf>
11. Westerling, A.L., H.G. Hidalgo, D.R. Cayan, and T.W. Swetnam, 2006: *Warming and Earlier Spring Increases Western U.S. Forest Wildfire Activity*. *Science*. 313: 940-943.
12. Climate Central, 2015: *States at Risk: America's Preparedness Report Card*. Princeton, NJ. <http://reportcard.statesatrisk.org/>
13. U.S. Forest Service, 2016: *Effects of Drought on Forests and Rangelands in the United States: A Comprehensive Science Synthesis*. Ed. J. M. Vose, J. S. Clark, C. H. Luce, and T. Patel-Weynand. <http://www.fs.fed.us/science-technology/climate-change/drought-forests-and-rangelands>

Princeton: One Palmer Square, Suite 330 Princeton, NJ 08542
Phone: +1 609 924-3800
Toll Free: +1 877 4-CLI-SCI / +1 877 425-4724
www.climatecentral.org