2023 Wildfire Season: An Overview

Southwestern US

SEPTEMBER 2024

NAU NORTHERN ARIZONA UNIVERSITY

Ecological Restoration Institute

SOUTHWEST FIRE SCIENCE CONSORTIUM

Intermountain West Frequent-Fire Forest Restoration

Ecological restoration is a practice that seeks to heal degraded ecosystems by reestablishing native species, structural characteristics, and ecological processes. The Society for Ecological Restoration International defines ecological restoration as "an intentional activity that initiates or accelerates the recovery of an ecosystem with respect to its health, integrity and sustainability… Restoration attempts to return an ecosystem to its historic trajectory" (Society for Ecological Restoration International Science & Policy Working Group 2004).

Most frequent-fire forests throughout the Intermountain West have been degraded during the last 150 years. Many of these forests are now dominated by unnaturally dense thickets of small trees, and lack their once diverse understory of grasses, sedges, and forbs. Forests in this condition are highly susceptible to damaging, stand-replacing fires and increased insect and disease epidemics. Restoration of these forests centers on reintroducing frequent, low-severity surface fires—often after thinning dense stands—and reestablishing productive understory plant communities.

The Ecological Restoration Institute at Northern Arizona University is a pioneer in researching, implementing, and monitoring ecological restoration of frequent-fire forests of the Intermountain West. By allowing natural processes, such as low-severity fire, to resume self-sustaining patterns, we hope to reestablish healthy forests that provide ecosystem services, wildlife habitat, and recreational opportunities.

The Southwest Fire Science Consortium (SWFSC) gets emerging science on the ground by connecting scientists, land managers, and the public. By facilitating these connections, the SWFSC helps to assure that scientists are addressing the most pressing questions and managers are applying cutting-edge science and diverse knowledge in their efforts to protect communities and critical natural resources. The SWFSC is one of 15 fire science exchange networks in the US funded by the Joint Fire Science Program.

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Cover photo: The Divide Fire burned 26, 514 acres in the Gila National Forest, New Mexico. It threatened 10 homes and cost $1.8 million.

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Table of Contents

Introduction

Wildfire is part of the landscape in the Southwest. It can be a threat to lives and property, but it is also crucial to maintaining healthy ecosystems. Plant communities in the Southwest are adapted to fire. For example, ponderosa pine forests need regular, low-severity fires to remain healthy. Over decades without fire on the landscape, fuel loads accumulated and facilitated more intense, high-severity fire. Each fire is different, and while some burn in ways that increase ecosystem resilience, others burn with greater severity than forests are adapted to, killing even the toughest trees and threatening lives and homes. Weather, climate, vegetation type, fuel conditions, and topography all influence how an individual wildfire burns on the landscape and whether it has beneficial effects. Some fires will leave many unburned patches, creating a mosaic burn pattern, whereas others will burn more contiguously.

This report is the eleventh in a series of annual overviews available from the Southwest Fire Science Consortium and the Ecological Restoration Institute. The goal of this overview is to provide a concise summary of the 2023 fire season and to facilitate comparisons with past fires and fire seasons. It follows the format of past years' overviews[1] and describes the impacts of nine wildfires, each more than 10,000 acres, in Arizona and New Mexico in 2023. As in previous overviews, this report covers when each fire burned, fire management costs, vegetation types, previous wildfires in that area, and burn severity, where available. The conclusion section summarizes these same characteristics for the large wildfires in the region and discusses how tires burned in proximity to human communities. Fire season overview reports provide a unique opportunity to compare fires and fire seasons, which highlight trends and changes as managers and communities adapt to climate change.

Wildfire Management

Managers approach each wildfire with multiple objectives that range from managing the wildfire for public safety to managing the fire to benefit natural resources. Federal wildland fire management policy states:

> "Response to wildland fires is based on ecological, social and legal consequences of the fire. The circumstances under which a fire occurs, and the likely consequences on firefighter and public safety and welfare, natural and cultural resources, and values to be protected, dictate the appropriate response to the fire."[2]

A full range of wildland fire response strategies may be employed to meet these objectives, including containing, confining, or suppressing the wildfire. The national Incident Management Situation Report identifies the percentage of each fire managed with a monitor, confine, point zone protection, or suppression strategy. This report compiles these figures to better explain how fires were managed in 2023.

Wildland fire management strategies are based on a thoughtful and systematic risk-based approach that considers firefighter and public safety, cause of the wildfire, location, existing land management plans, availability of resources, values at risk, as well as social and economic factors. Federal policy dictates that "initial action on human-caused wildfire will be to suppress the fire."[3] The same federal policy allows naturally ignited wildfires (or parts of wildfires) to be managed for resource benefits (also called managed wildfires), such as mitigating fuel loads to reduce the risk of high-severity fire, enhancing wildlife habitat, improving watershed health, and reducing risk to neighboring communities. Though multiple strategies are used to manage wildfires, it is important to note that federal agencies only recognize two types of fires: prescribed fire (planned) and wildfire (unplanned).

The 2023 Fire Season

In 2023, wildfire burned 382,165 acres in the Southwest (Arizona and New Mexico), which is 70 percent of the average number of acres burned annually in these two states over the previous 10-year period (562,441 acres). The two states had similar acreage of wildfire (199,597 acres in Arizona and 182,568 in New Mexico). Arizona had fewer wildfire acres than its 10-year average (341,744 acres) while New Mexico had more acres of wildfire than its 10-year average (174,083 acres). Unplanned human ignitions made up 39 percent in Arizona and 2 percent of wildfire acres in New Mexico (though these estimates excluded wildfires with an unknown cause). Based on data from the Southwest Coordination Center, managers were able to use prescribed fire on 77,433 acres across the Southwest, or about half of the average over the previous 10 years (142,550 acres) (Figure 1). The national USDA Forest Service budget justification lists 120,000 acres of prescribed fire treatments from the Forest Service Activity Tracking System, which may include acres of wildfire managed for resource benefit. The Forest Service budget justification also lists 290,000 acres of mechanical fuel reduction treatments in the region. Since wildfire affected at least 30 percent more acres than mechanical treatments in the Southwest, understanding its impacts is critical.

Based on the Incident Status Summary (ICS-209) reports for the nine largest wildfires covered in this report, managers used a full suppression strategy on 40 percent of the acres.

[1] *2022, 2021, 2020, 2019, 2018, 2017, 2016, 2015, 2014, and 2013 Wildfire Season: An Overview, Southwestern U.S.* cdm17192.contentdm.oclc.org

[2] *Guidance for Implementation of Federal Wildland Fire Management Policy, 2009* www.doi.gov/sites/doi.gov/files/uploads/2009-wfm-guidance-for-implementation.pdf

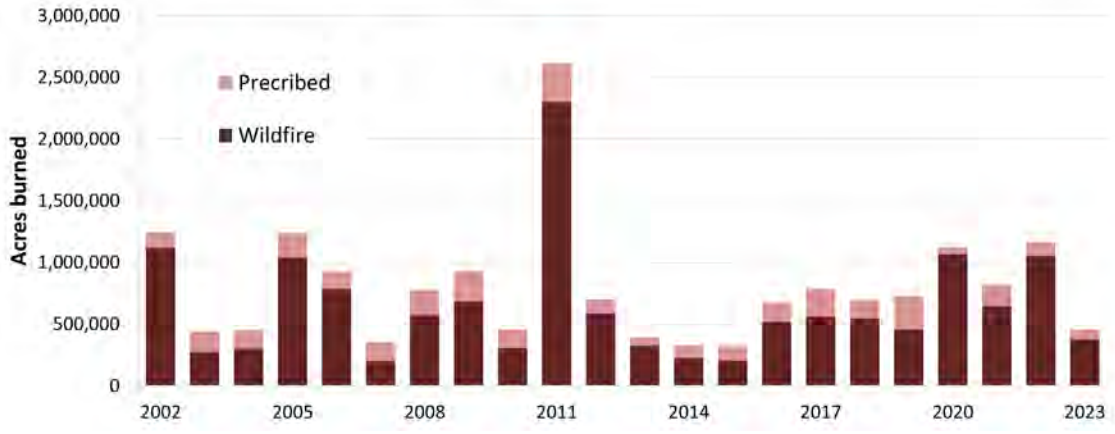


Figure 1. Wildfire and prescribed fire acres burned in Arizona and New Mexico, 2002 to 2023.[3] Wildfire burned 382,165 acres in the Southwest (Arizona and New Mexico), which is a lower than the average number of acres burned annually in these two states over the previous 10-year period (562,441 acres).

In other words, 74,547 acres out of the 187,451 acres of the nine largest wildfires were managed with a full suppression strategy. Designation of management strategy remains a metric with significant uncertainty because aggregated summaries of the ICS-209s do not include strategy and because the on-the-ground management strategy does not always align with the strategy listed in the ICS-209s[4]. The letter of intent from the Chief of the Forest Service from June 15, 2023, supported managed wildfire with limitations:

> *We will also continue to use every tool available to reduce current and future wildfire impacts and create and maintain landscape resilience, including using natural ignitions at the right time and place in collaboration with tribes, communities, and partners. Use of natural ignitions as a management strategy will also be approved by Regional Foresters during Preparedness Levels 4 and 5.*

The country was at Preparedness Level (PL) 4 from August 17 to September 6.[5] In 2023, the Southwest region never reached PL 5 and was only at PL 4 for six days.

This overview focuses on the nine largest fires by acreage in the region, which include five Arizona fires (Pilot, Beehive, Wilbur, Still, and Ridge) and four New Mexico fires (Pass, Divide, Prior, and Pasture). The nine large fires in this report represent 49 percent of the acres burned by wildfire in 2023 (Figure 2).

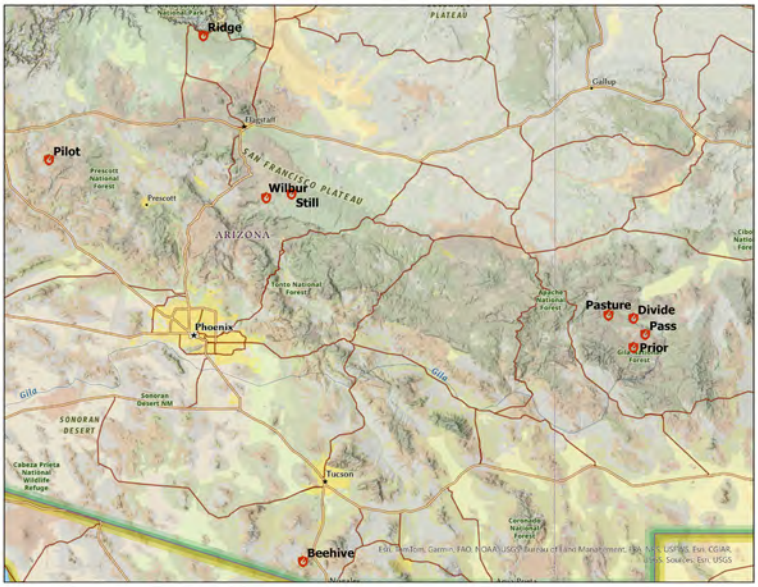


Figure 2. Map indicating the location of the nine large fires from the 2023 fire season that were analyzed in this report.

[3] *National Interagency Coordination Center Wildland Fire Annual Reports* www.nifc.gov/nicc/predictive-services/intelligence

[4] *Davis et al 2022. Managed Wildfire: A Strategy Facilitated by Civil Society Partnerships and Interagency Cooperation.* doi.org/10.1080/08941920.2022.2092803

[5] www.nifc.gov/fire-information

Regional Context

The El Niño weather pattern brought increased moisture to the Southwest starting in late 2022, which encouraged the growth of fine fuels. However, fine fuel loading and continuity was highly variable heading into 2023. Snowpack was above normal across much of the West for the 2022–2023 winter and winter precipitation was above normal or much above normal for Arizona and most of New Mexico. The exception was Eastern New Mexico where there was below normal precipitation and drought lingered. In contrast, many areas in the Upper Colorado River Basin had record-high snow levels for April. A drying and warming trend came to the Southwest later in the spring. Overall, the warming and drying trend observed in recent years continued for the Southwest. For example, in New Mexico, 2023 was 2.5 degrees Fahrenheit warmer and had 3.24 fewer inches of precipitation compared to the average over the last century.[6] Most of the increased warming came in the second half of the year. By June spring precipitation helped drive extreme drought out of the region, but by early August weak monsoon rains pushed the area of "severe drought" to expand and "extreme drought" to return. The paucity of monsoon moisture in 2023 meant that most of the Southwest received less precipitation than the 30-year (1991–2020) average.

The Energy Release Component (ERC) is an index that estimates the available energy a wildfire can release at the flaming front. ERC tracks seasonal fire danger based on the amounts and moisture of live and dead fuels. In 2023, ERCs were below average in April and then higher than the historic maximum in July (Figure 3).[7]

Data Sources

Management, Objectives, and Cost

The InciWeb website (inciweb.nwcg.gov) provides background information such as location and start date on most large fires. InciWeb is an interagency information management system designed to provide the public with a single source of incident-related information. Because InciWeb only sporadically reports costs, Incident Status Summary (ICS-209) reports were collected to document suppression or management costs for this report. These costs do not reflect any post-fire costs such as road rehabilitation and soil stabilization. The cost data from each of fires over 10,000 acres is collected in a final table at the end of the document (Appendix I). ICS-209s also provide "strategic objectives," which briefly describe the desired outcome for the incident, high-level objectives, and in some cases, strategic benefits. Strategic objectives often change during a fire, and a review of the most common or persistent strategic objectives for each fire provides insight into the overarching management goals.

Perimeters

Boundaries for each fire were taken from the National Interagency Fire Center Open Data Site archive of fire perimeter maps (data-nifc.opendata.arcgis.com). NIFC Open Data Site also provides perimeters of past wildfires, which gives historical context for the 2023 fires.

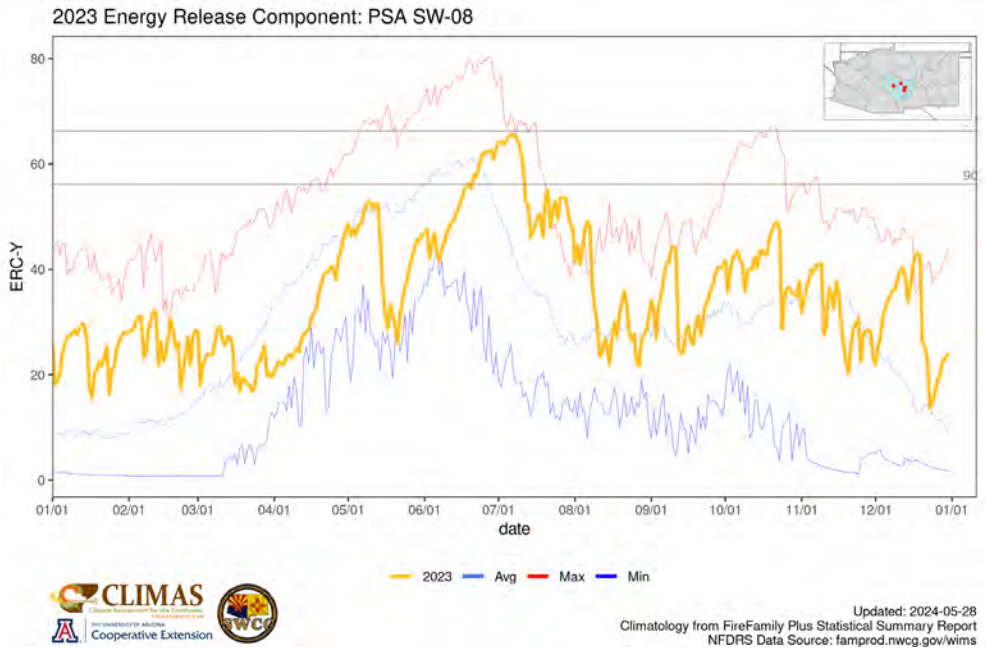


Figure 3. Energy release component (ERC) index for 2023 for western New Mexico (PSA SW-08).

[6] www.weather.gov/media/abq/Briefings/Annual2023_Climate.pdf

[7] gacc.nifc.gov/swcc//predictive/fuels_fire-danger/nfdrs_charts/Areawide.htm

Vegetation

Basic information about vegetation of burned areas was available from LANDFIRE (landfire.gov). LANDFIRE provides nationally consistent, scientifically based maps of existing vegetation as well as Vegetation Condition Class (VCC). VCC shows how existing vegetation has departed from the estimated natural or historical condition. In the Southwest, this departure is generally due to fire exclusion, past logging and grazing, and results in a greater density of trees and less healthy conditions that are more vulnerable to severe fires during dry conditions. VCC is a useful metric because it integrates information on existing vegetation, historical vegetation, and fire regimes into one variable and can be used to help determine where to focus restoration efforts. The most current VCC maps (2016) were used in this report.

Soil Burn Severity

Soil burn severity maps provide Burned Area Emergency Response (BAER) teams a tool to quantify soil impacts and assess potential for post-fire erosion (burnseverity.cr.usgs.gov). In the immediate aftermath of fire on federal lands, BAER teams perform an emergency assessment of post-fire soil conditions based on a combination of field observations and remote sensing change detection. Remote sensing for soil burn severity employs the Normalized Burn Ratio (dNBR), the change in the ratio of near infrared reflected by healthy green vegetation to the shortwave infrared reflected by bare soil and rock. Most soil burn severity maps have four classes: high, moderate, low, and unburned; however, some maps combine the last two categories to low/unchanged. The distribution of soil burn severity is included in this report for the individual fire discussions (where available) as well as in the final summary table.

Rapid Assessment of Vegetation Condition after Wildfire

Rapid Assessment of Vegetation Condition after Wildfire (RAVG) maps estimate canopy mortality (burnseverity.cr.usgs.gov/ravg) and is another estimate of the effect of the fire on the vegetation. The USDA Forest Service Remote Sensing Applications Center provides RAVG analysis as a first approximation of areas that may require reforestation treatments because of the amount of canopy killed by high-severity fire. RAVG maps are created for wildfires that burn greater than 1,000 acres of wooded Forest Service land or other fires by request. The maps are produced by measuring the change between a satellite image before and immediately after a wildfire using the relative differenced Normalized Burn Ratio (RdNBR), which is sensitive to vegetation mortality resulting from the wildfire event. The RdNBR is derived directly from the dNBR that is used in Soil Burn Severity but is more sensitive to vegetation mortality than the dNBR.

While soil burn severity maps and RAVG canopy mortality maps use similar satellite change detection methods, they measure fundamentally different forest attributes. In many areas, canopy mortality and soil burn severity patterns are similar. However, in some vegetation types, such as chaparral or grass, it is possible for a fire to cause complete canopy mortality with little effect on the soils.

Caveats

There are important caveats for all of the data used in this summary. First, the fire information presented here was taken from official sources between November 2023 and February 2024 and may not include updates or revisions. Second, the geospatial data used to generate the maps and tables are also based on the best available information, however these data contain errors and uncertainties. For example, the remote sensing data used in all these datasets can include errors introduced during collection, processing, and interpretation. As noted for specific fires in this report, soil burn severity and RAVG maps are not available for every wildfire.

Individual Fire Summaries

This section describes the impacts of the nine wildfires over 10,000 acres in Arizona (five fires) and New Mexico (four fires) in 2023. This section covers when each fire burned, fire management costs, vegetation types, previous burn footprints, and burn severity, when available. The fires are ordered based on their ignition date and represent 49 percent of the acres burned by wildfire in Southwest during 2023.

Pass Fire, New Mexico

- Cause: Lightning
- Location: Catron County, NM
- Incident start: 05/18/2023
- Incident close: 09/07/2023
- Acreage: 59,833
- Cost: $7 million

The Pass Fire was a lightning-caused wildfire that started in the Black Range Ranger District of the Gila National Forest, about 100 miles northwest of Truth or Consequences, New Mexico. The fire was initially reported on May 18 and burned nearly 60,000 acres before it was fully contained on September 7. This was the largest fire in Arizona and New Mexico during the 2023 season but was significantly smaller than the largest fires of the past few years.

The Gila National Forest is a fire-adapted ecosystem that relies on frequent low-severity fire. According to the ICS-209 reports, fire managers took advantage of the unseasonably cool and wet spring conditions to manage

this naturally ignited wildfire with a combination of monitor, confine, point zone protection, and full suppression approaches that allowed the fire to play its role in removing hazardous fuels, promote healthy vegetation, and improve forest health. The fire was primarily a backing fire that spread from north to south against the prevailing winds and downslope. The low to moderate fire behavior was described in the ICS-209 reports as "creeping with generally low flame lengths, some individual torching." The southern portion of the Pass Fire burned into the Aldo Leopold Wilderness. Wildfire management costs associated with the Pass Fire were estimated at $7 million, or about $117 per acre.

Vegetation and Past Fires

The primary vegetation types included ponderosa pine (46 percent), piñon-juniper (38 percent), and conifer-oak (7 percent). Most of the area affected by the Pass Fire had not burned in the past 10 years, except approximately 3,600 acres in the northern portion of the fire that had burned in the 2016 Black Range Complex Fire (see 2016 fire overview for a description of this fire). Nearly 45 percent of the area within the Pass Fire perimeter was classified as high departure from historical vegetation conditions according to the LANDFIRE Vegetation Condition Class analysis.

Fire Severity

Canopy mortality varied across the fire but was primarily (97 percent) under 25 percent mortality (Figure 4). Nearly 31,000 acres (51 percent) of the burn area were identified as having zero percent mortality. Scattered pockets of near-complete canopy mortality were found throughout the burn area but only accounted for 150 acres (<1 percent) of the fire. These high mortality areas were split evenly across the vegetation community types. The soil burn severity analysis also showed a relatively low intensity fire (Figure 5). Nearly 98 percent of the burn area was low severity or unburned/undetected (60 percent and 38 percent respectively). None of the Pass Fire was identified as high severity and the 1,450 acres of moderate severity was predominantly on the north slope of Black Mountain.

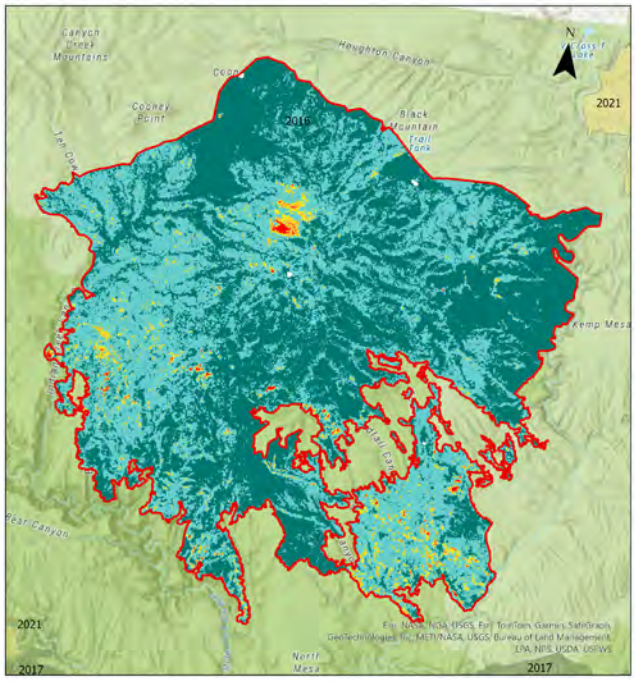


Figure 4. Canopy mortality in the Pass Fire.

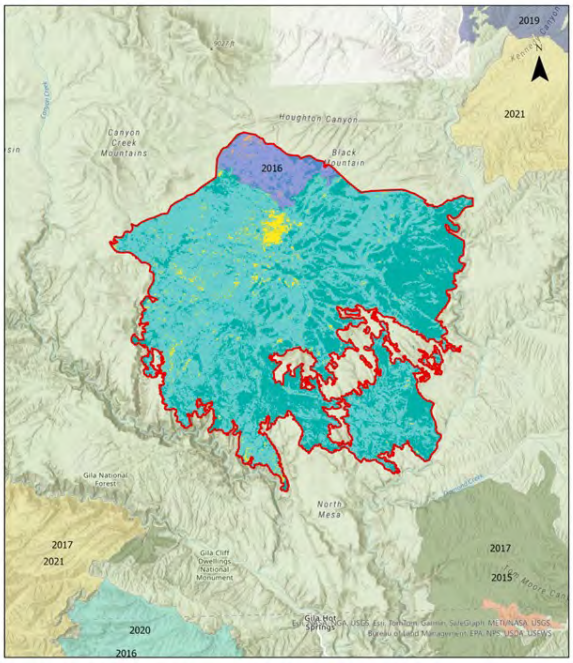


Figure 5. Soil burn severity in the Pass Fire.

Wilbur Fire, Arizona

- Cause: Undetermined
- Location: Coconino County, AZ
- Incident start: 05/22/2023
- Incident close: 07/11/2023
- Acreage: 10,279
- Cost: $3 million

The Wilbur Fire was reported on May 22 in the Coconino National Forest south of Flagstaff, Arizona burning in forests with a grass understory. The fire burned for 50 days, eventually encompassing nearly 10,300 acres. Initial reports stated that the cause of the Wilbur Fire was lightning, but it was later listed as unknown.

The ICS-209 reports indicated fire managers considered the location and values at risk and decided to use the Wilbur Fire to return fire to the ecosystem as a managed wildfire. Managers used a combination of monitor and confine approaches that allowed them to secure and continually monitor the fire's perimeter while allowing the interior to burn. The fire was located near the junction of Arizona State Highways 87 and 260 which necessitated effective work in collaboration with the Arizona Department of Transportation traffic control to ensure firefighter and motorist safety. Prescribed burnout operations along the roads allowed for better control of the fire and for the fire to be managed to improve management options for West Clear Creek Wilderness, critical infrastructure, private property, and the Long Valley Experimental Forest. Due to this approach, roughly nine miles of the western and southern fire perimeter were Arizona State Highways 87 and 260. Fire personnel made progress toward containment on June 15 and the final report was entered on July 11.

No evacuation orders were issued. Available reports do not indicate any human injuries or structures damaged or destroyed. Management of the Wilbur Fire was estimated at $3 million, or about $292 per acre.

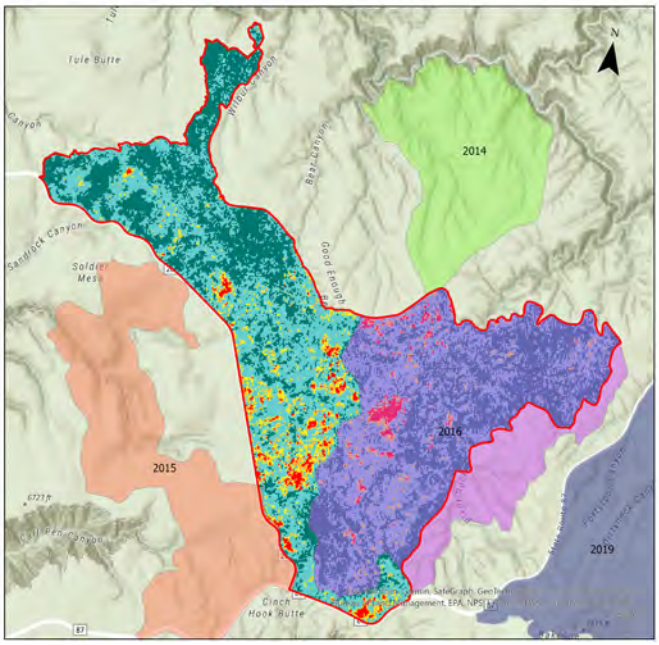


Figure 6. Canopy mortality in the Wilbur Fire.

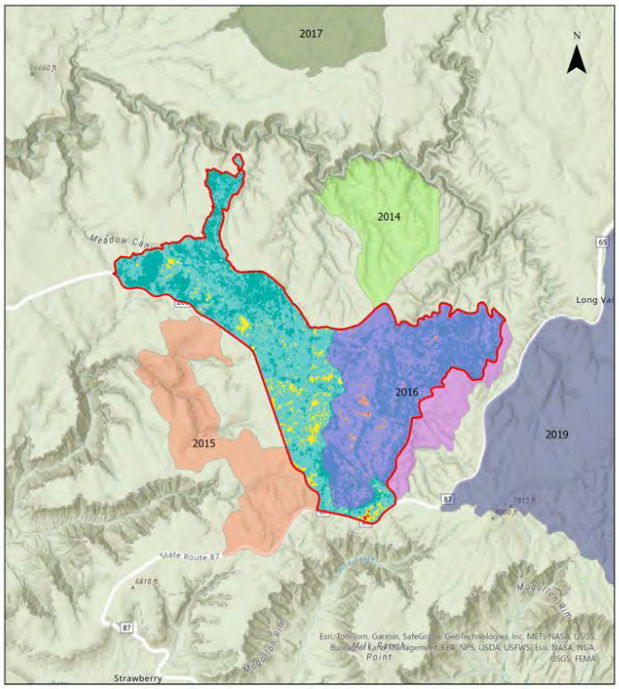
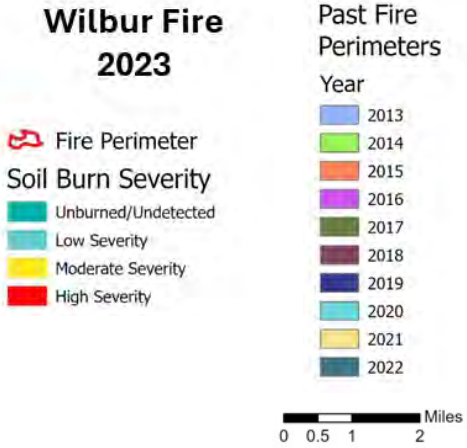


Figure 7. Soil burn severity in the Wilbur Fire.



Vegetation and Past Fires

The Wilbur Fire burned through an area of predominantly ponderosa pine (84 percent) with pockets of grass (7 percent), along with several other vegetation types. Fifty-five percent (5,550 acres) of the vegetation within the Wilbur Fire had high departure from historical conditions. Nearly half (4,600 acres) of the Wilbur Fire burned in 2016 as part of the 6,000-acre Pivot Rock Fire. The southwest corner of the Wilbur Fire also shared a perimeter with the 2015 Hover Tank Fire along Arizona State Highway 260.

Fire Severity

Like several fires reviewed in this report, the Wilbur Fire had a low level of canopy mortality (Figure 16). Ninety-one percent (9,300 acres) of the burn area experienced less than 25 percent canopy mortality. Only 2 percent of the burn area had canopy mortality greater than 75 percent. The soil burn severity analysis also indicated the Wilbur Fire was a relatively low intensity fire (Figure 17). More than 95 percent of the burn area was low severity (58 percent) or unburned/undetected (37 percent). Only six acres of the Wilbur Fire were identified as high severity and 475 acres were determined to be moderate severity.

Ridge Fire, Arizona

- Cause: Lightning
- Location: Coconino County, AZ
- Incident start: 06/04/2023
- Incident close: 08/03/2023
- Acreage: 10,210
- Cost: $2 million

The Ridge Fire burned more than 10,200 acres after starting from a lightning strike on June 4 eight miles southeast of Tusayan, Arizona in the Tusayan Ranger District of the Kaibab National Forest. This location is approximately four miles south of the Grand Canyon and one mile east of Red Butte. Fire managers chose a combination of monitor and full suppression approaches on the Ridge Fire. The ICS-209 reports explained that the general approach was to allow the fire to spread to the southwest in the 18,000-acre planning area while holding the fire on roads where necessary. The fire was continuously staffed by several engines to monitor activity and make sure assets such as cell towers, archaeology sites, wildlife trick tanks, and livestock fences were protected. The northern progression of the Ridge Fire was suppressed while spread to the southwest was monitored.

This wildfire was managed over 61 days and the final ICS-209 report appeared on August 3. No injuries or damaged buildings were reported. Management of the Ridge Fire was estimated at $2 million, or $196 per acre.

Vegetation and Past Fires

The Ridge Fire burned mostly through ponderosa pine (47 percent) and piñon-juniper (45 percent) with pockets of scrub (7 percent). Seventy-four percent (7,400 acres) of the vegetation within the Ridge Fire had high departure from historical conditions, which was the highest percentage of high departure of any of the fires covered in this report. The area burned by the Ridge Fire had seen fire in the preceding ten years, however, nearly half of the Ridge Fire perimeter was shared by previous fires. The northern boundary line was shared with 2013 and 2014 wildfires and a 2021 prescribed burn (the Skinner Ridge North prescribed burn). A large part of the eastern boundary is shared with the 2015 Mason-Jar Complex Fire.

Fire Severity

The Ridge Fire had areas of high and low canopy mortality (Figure 18). More than 2,300 acres (23 percent) of the area experienced over 75 percent canopy mortality. This high mortality class was most common in the piñon-juniper communities in the southwestern portion of the fire. This comprised forty-one percent of the piñon-juniper

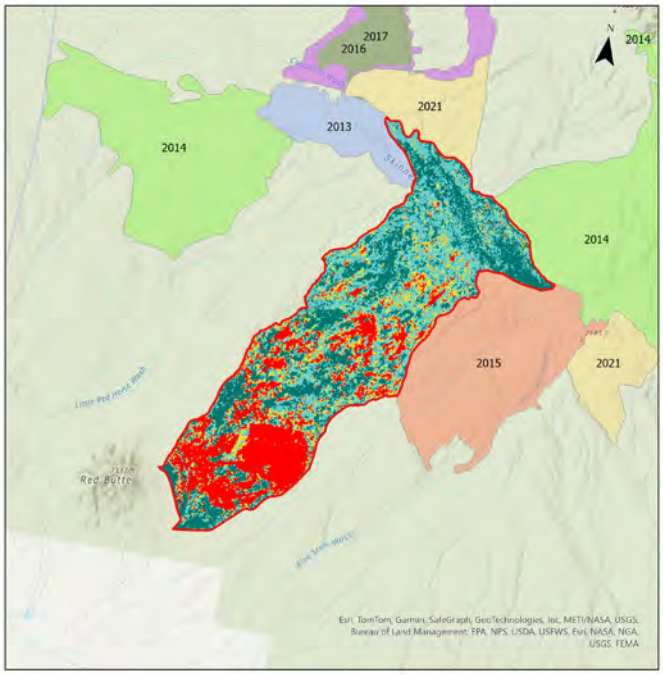


Figure 8. Canopy mortality in the Ridge Fire.

community. The Ridge Fire also had nearly 3,000 acres (29 percent) with no recorded canopy mortality. The soil burn severity analysis indicated the Ridge Fire was predominantly a low intensity fire (Figure 19). More than 88 percent of the burn area was low severity (57 percent) or unburned/undetected (31 percent). Across the seven fires in this review for which soil burn severity data was available there were only 451 acres of high severity and 94 percent (425 acres) of those high severity acres occurred on the Ridge Fire. These high severity acres only accounted for four percent of the Ridge Fire area.

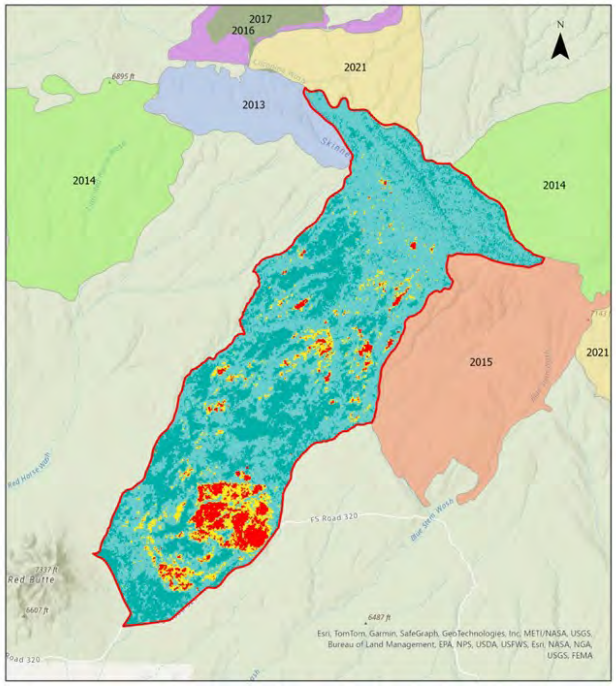
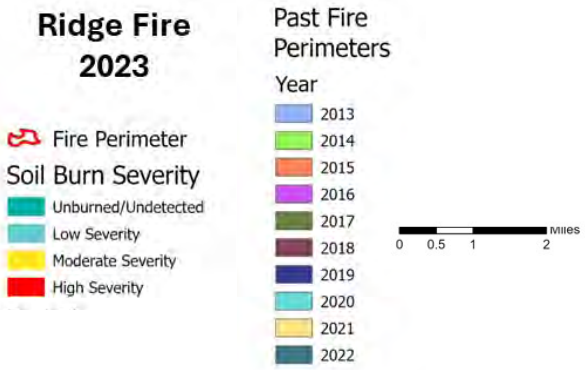


Figure 9. Soil burn severity in the Ridge Fire.



Beehive Fire, Arizona

- Cause: Human
- Location: Santa Cruz County, AZ
- Incident start: 06/30/2023
- Incident close: 07/17/2023
- Acreage: 10,745
- Cost: $5 million

The Beehive Fire was discovered on June 30 in the Coronado National Forest burning south of the Tumacácori Mountains 10 miles north of the Mexican border. When it was identified, the Beehive Fire was a 10-acre fire burning actively in fine fuels. The ICS-209 reports indicate that the fire quickly grew to 1,200 acres with no containment after the first operational shift. Dried out fine fuels like grasses and brush with terrain-dominated winds contributed to the rapid fire spread of this high desert wildfire.

Fire managers chose to pursue a full suppression approach as fire crews endured near-record heat and unseasonably dry conditions. Based on a values-driven strategy, fire managers used direct, indirect and point protection strategies to contain the Beehive Fire. The rugged topography made access to several areas challenging.

Fire personnel were able to stop the progression of the Beehive Fire on July 4 using direct attack with aircraft support. Resources on the fire peaked at 302. Within a few days the fire had grown to its final 10,745-acre size and the fire management team started to transition to suppressing the Beehive Fire 2 located just south. No injuries, evacuations, or damaged structures were reported.

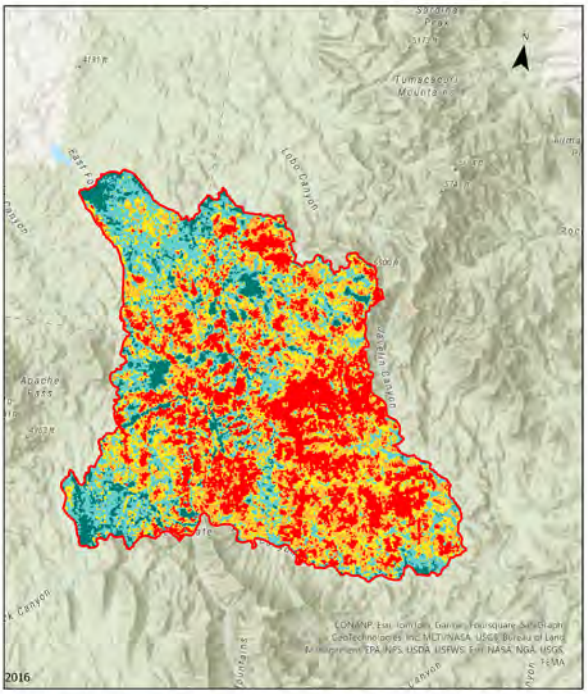
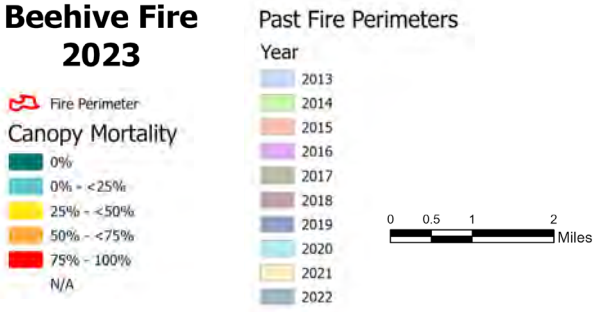


Figure 10. Canopy mortality in the Beehive Fire.



Management of the Beehive Fire was estimated at $5 million, or about $465 per acre.

Vegetation and Past Fires

The Beehive Fire burned through scrub (44 percent), grass (28 percent), conifer-oak (20 percent), and chaparral (5 percent), along with several other vegetation types. Eighty-two percent of the vegetation within the Beehive Fire was classified as high (45 percent) or medium (37 percent) departure from historical conditions. None of the areas within the Beehive Fire perimeter had burned in the last ten fire seasons. The perimeter of the Beehive Fire did not share a boundary with any past fires.

Fire Severity

Over 2,800 acres (26 percent) of the Beehive Fire displayed canopy mortality greater than 75 percent. This highest level of canopy mortality was in the grass and scrub communities spread through the center of the burn area (Figure 14).

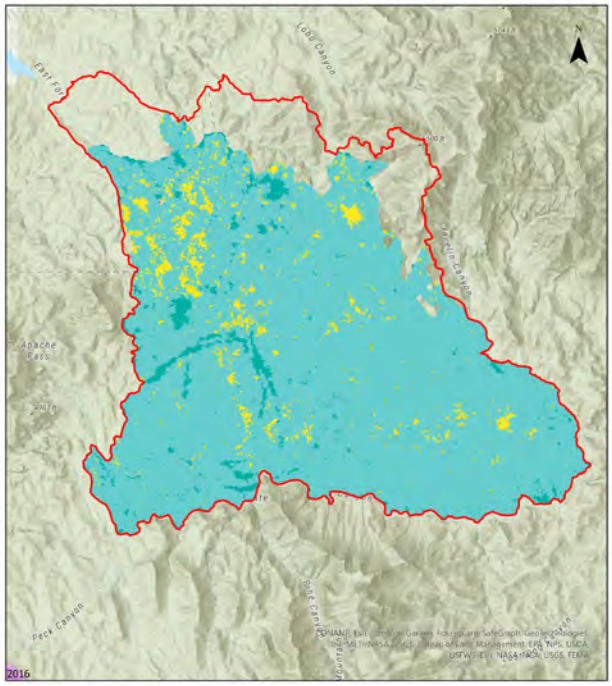


Figure 11. Soil burn severity in the Beehive Fire.

The areas of low or undetected canopy mortality were primarily on the northwestern and southwestern corners of the fire. Soil burn severity data was available for approximately 86 percent of the Beehive Fire and indicated a lower severity fire than the RAVG canopy data. Ninety-one percent of the area with soil burn severity data was identified as low severity (Figure 15). None of the Beehive Fire was identified as high soil burn severity and only scattered areas were identified as moderate severity (5 percent).

The Beehive Fire is an example of why it is important to review several data types and cross-reference the data with the vegetation type. The ecological impact of canopy mortality differs between vegetation communities. For instance, the impact of near-complete canopy mortality in the grass/scrub area of the Beehive Fire is very different from the canopy mortality in a ponderosa pine or mixed-conifer forest system. High-severity fire is a necessary component of many healthy grasslands and—if the patch size is appropriate—shrublands as well. Careful interpretation finds that canopy mortality does not always result in negative ecological effects.

Pilot Fire, Arizona

- Cause: Human
- Location: Yavapai County, AZ
- Incident start: 07/01/2023
- Incident close: 07/19/2023
- Acreage: 34,810
- Cost: $1.25 million

The Pilot Fire began on July 1 as a human-caused wildfire about 20 miles east of Wikieup, Arizona and 50 miles northwest of Prescott, Arizona near Pilot Knob and Mahon Mountain in Mohave and Yavapai Counties. The fire spread through the Mohon Mountains for 18 days reaching nearly 35,000 acres, making it the largest Arizona wildfire of the 2023 season.

Fire managers used a full suppression strategy on the Pilot Fire. The wildfire burned in steep, treacherous terrain that was a five-hour drive to the fire line for some fire crews. As a result, crews were spiked out on the fire line and received meals and additional equipment via helicopters. Only four miles along the southern perimeter was contained along a jeep trail, the remainder of the perimeter was contained without the aid of roads or trails.

No evacuation orders were issued. No injuries or damaged/destroyed structures were noted in the ICS-209 reports. Management of the Pilot Fire was estimated at $1.25 million, or $36 per acre.

Vegetation and Past Fires

The area affected by the Pilot Fire was predominantly

chaparral (36 percent), grass (33 percent), and piñon-juniper (24 percent) with 5 percent unvegetated and scattered pockets of several other vegetation types. Over 95 percent of the Pilot Fire had a low departure from historical vegetation conditions (Figure 12). The Pilot Fire completely reburned the 2018 Happy Fire and 1,600 acres of the 4,000-acre 2016 Baca Fire. The rest of the area affected by the Pilot Fire had not burned in any of the previous 10 years. The southern portion of the Pilot Fire shares a perimeter with the 11,000-acre 2020 Pilot Knob Fire.

Fire Severity

No fire severity data were available for the Pilot Fire.

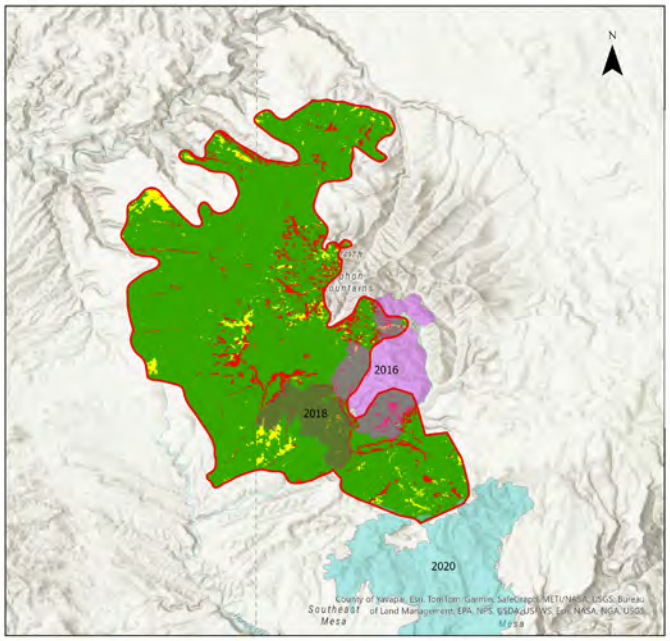


Figure 12. Vegetation departure from historical conditions based on the LANDFIRE Vegetation Condition Class analysis in the Pilot Fire.

Divide Fire, New Mexico

- Cause: Lightning
- Location: Catron County, NM
- Incident start: 07/13/2023
- Incident close: 08/11/2023
- Acreage: 26,514
- Cost: $1.8 million

Lightning started the Divide Fire on July 13 in the Elk Mountains of the Gila National Forest in western New Mexico. The fire burned moderately in a ponderosa pine fuel type with backing, flanking, and single tree torching observed. The Divide Fire burned toward the Hay Fire which was burning concurrently to the north and west.

According to the ICS-209 reports, fire managers utilized a combination of monitor, confine, point zone protection, and full suppression approaches that allowed the fire to play its role in removing fuels, promoting healthy vegetation, and improving forest health. The fire was backing into private property lines along the east flank and fire managers chose to use operational ignitions around subdivisions to create defensible space for the Elk Springs Community. This also helped crews secure that flank and increase containment. Fire crews dealt with erratic and gusty winds caused by scattered thunderstorms. These storms brought moisture to the area and lowered fire activity in the first week of the fire, but the following weeks brought drier and warmer conditions. The ICS-209 report stated that 10 homes were threatened during the operations and two injuries were reported during the incident.

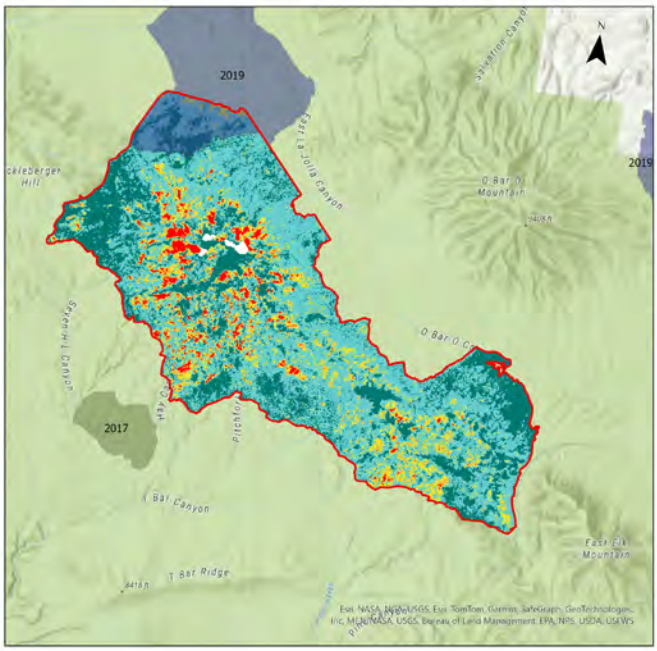
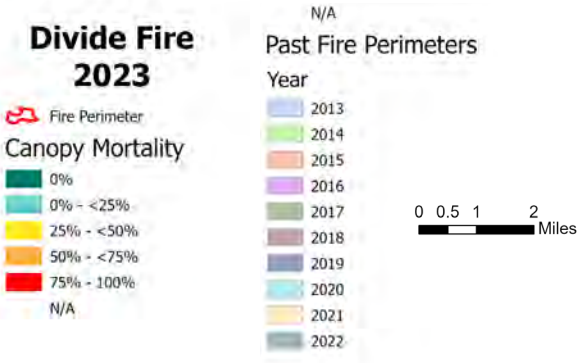


Figure 13. Canopy mortality in the Divide Fire.



Fire managers made significant progress on containment by July 30 and reached full containment on August 11. The Divide Fire burned for 29 days, eventually encompassing more than 26,500 acres. The cost for managing the Divide Fire was estimated at $1.8 million, or about $68 per acre.

Vegetation and Past Fires

The Divide Fire burned through predominantly ponderosa pine (76 percent) and piñon-juniper (11 percent) with small areas of mixed conifer, scrub, conifer-oak, grass, and chaparral. Nearly 62 percent of the area within the Divide Fire perimeter was classified as being highly departed from historical vegetation conditions. Most of the Divide Fire had not been burned in the preceding 10 years except for 1,400 acres in the northern part of the fire that burned/overlapped the 6,300-acre 2019 Collins Park Prescribed Fire.

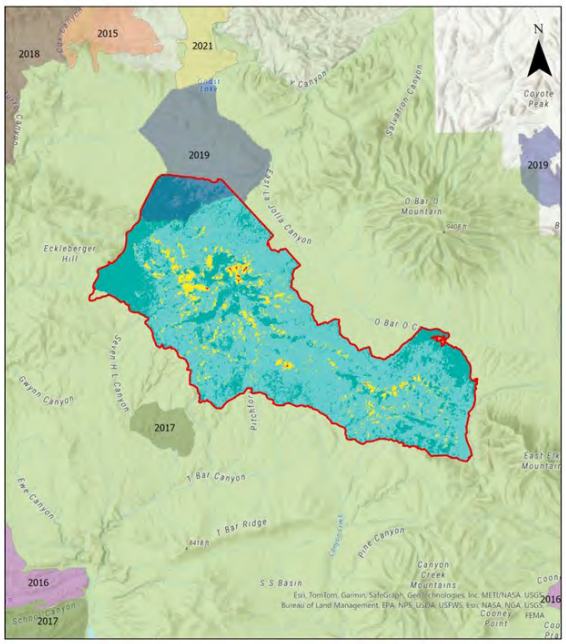
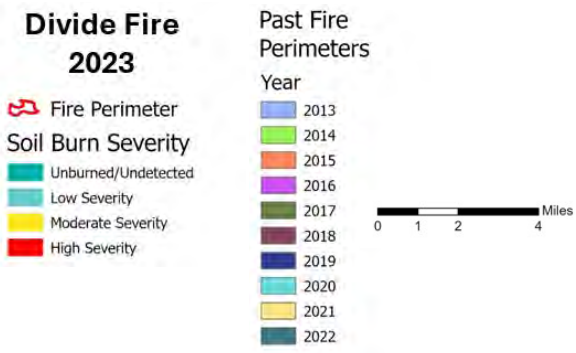


Figure 14. Soil burn severity in the Divide Fire.



Fire Severity

Canopy mortality varied across the Divide Fire but was primarily (84 percent) under 25 percent mortality (Figure 7). There were scattered pockets of near-complete canopy mortality in the burn area, but only accounted for about 800 acres (3 percent) of the fire. These high mortality areas were split across vegetation community types but made up a higher percentage of the scrub and chaparral communities. The soil burn severity suggests a low intensity fire and a similar spatial distribution of severity levels to the RAVG canopy mortality data. Nearly 94 percent of the burn area was low severity or unburned/undetected (67 percent and 27 percent respectively). Only 19 acres of the Divide Fire were classified as high severity and 1,500 acres as moderate severity.

Prior Fire, New Mexico

- Cause: Lightning
- Location: Catron County, NM
- Incident start: 07/26/2023
- Incident close: 09/21/2023
- Acreage: 12,841
- Cost: $100,000

The Prior Fire was reported on July 26 in a remote area of the Gila National Forest. This lightning-caused fire was

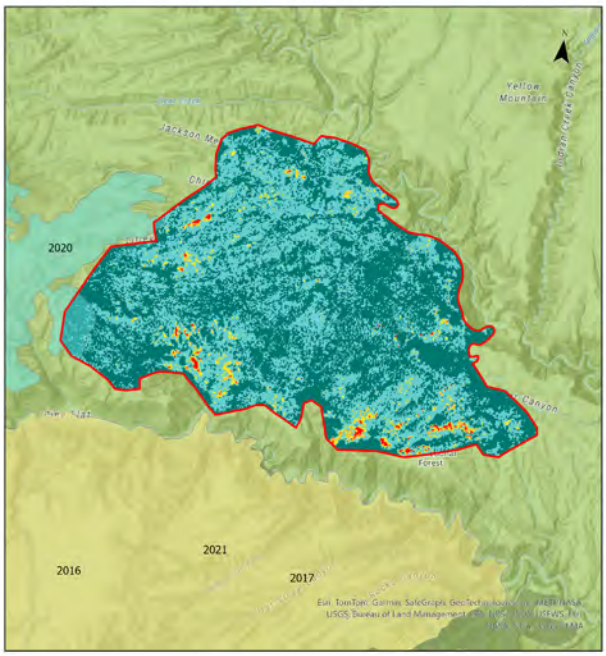
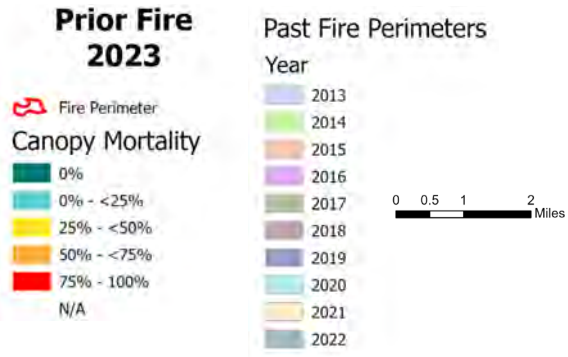


Figure 15. Canopy mortality in the Prior Fire.



first observed with moderate fire behavior, running, flanking and creeping through the Tularosa Mountains in brush and timber with grass and litter understory. The fire was initially unstaffed and monitored via lookouts and aircraft. Point protection strategies centered around firefighter safety and allowed for fire to play its natural role on the landscape. Managers used a suppression strategy on the east side of the fire to prevent it from spreading toward the Gila Cliff Dwellings. Fire behavior on the Prior Fire included flanking and backing activity in drainages. Thunderstorm outflows caused short runs that were often coupled with precipitation that reduced fire activity.

Weather played a huge part in helping contain the Prior fire. Moisture increased and temperatures decreased on August 7, allowing for nighttime humidity recovery of 50 to 60 percent. Because of the precipitation, resources were pulled out of spike camps and routed to the Turkey Fire. At the peak, 42 people worked to manage the 12,841-acre wildfire, and the final report was on September 21, 58 days after ignition. No injuries, evacuations or damaged structures were reported in the ICS-209 Incident Status Summary reports. The cost for managing the Prior Fire was estimated at $100,000, or $7.79 per acre.

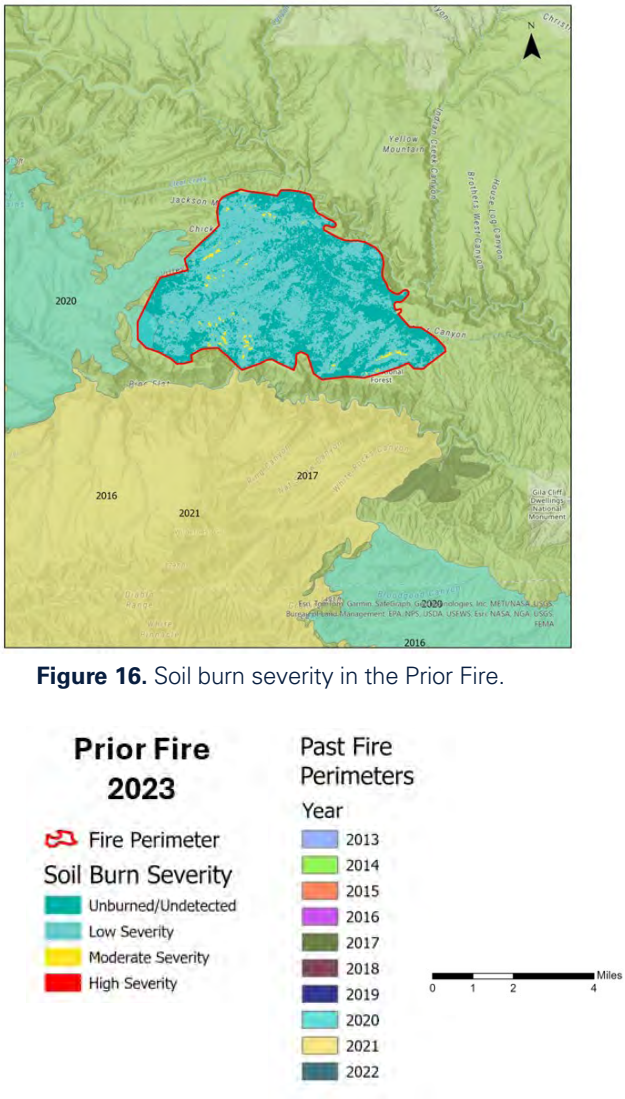


Figure 16. Soil burn severity in the Prior Fire.

Vegetation and Past Fires

The Prior Fire burned almost exclusively in ponderosa pine (47 percent), piñon-juniper (46 percent), and conifer-oak (6 percent). Vegetation departure from historical conditions in the Prior Fire perimeter was split relatively evenly between low (47 percent) and high (40 percent) departure. Most of the areas affected by the Prior Fire had not burned in any of the previous 10 years. The western boundary of this fire overlaps the 24,500-acre 2020 Cub Fire. A review of the Cub Fire was provided in the 2020 Fire Season Overview. The southern boundary of the Prior Fire nearly touches a series of fires that burned 2016, 2017, and 2021 in the Gila Mountain Wilderness. Similarly, the area of the Prior Fire had previously burned in the 1990s and 2000s as part of the Gila National Forest's fire management work.

Fire Severity

More than 12,400 acres (97 percent) of the Prior Fire were classified as less than 25 percent canopy mortality (Figure 9). The soil burn severity analysis also indicated the Prior Fire was a relatively low intensity fire (Figure 10). Nearly all of the burn area was rated as low severity (57 percent) or unburned/undetected (42 percent). None of the Prior Fire was identified as high severity and only 143 acres were classified as moderate severity.

Pasture Fire, New Mexico

- Cause: Lightning
- Location: Catron County, NM
- Incident start: 07/23/2023
- Incident close: 08/11/2023
- Acreage: 10,986
- Cost: $2 million

The Pasture Fire was a nearly 11,000-acre lightning-caused wildfire in the Tularosa Mountains in western New Mexico. The fire was reported on July 23 burning actively in short grass, brush, and timber with grass understory. This remote part of the Gila National Forest featured difficult terrain, which made access difficult and restricted tactical options. Winds were accelerated by thunderstorm outflows and when these outflows aligned with topographical features the rate of spread increased quickly to the north and east.

The Pasture Fire threatened various resources including private property, timber sales, range improvement, and cultural heritage sites. Fire managers chose to use a combination of confine, monitor, full suppression, and point zone protection on this naturally ignited wildfire. This allowed fire managers to protect life and property in a remote and rugged landscape with limited resource availability. Several large fires in the area were a potential constraint on resources, but fire managers had sufficient resources to accomplish their stated objectives. A total

of 105 people worked to contain the fire at the peak of operations around July 26. Fire crews were able to make gains in containment by August 3 and by August 11 the fire was fully contained. Two injuries or illnesses were reported. No evacuations or damaged structures were reported. The wildfire cost an estimated $2 million, or $182 per acre.

Vegetation and Past Fires

The Pasture Fire burned primarily in ponderosa pine (72 percent) and piñon-juniper (20 percent), with small areas of conifer-oak (5 percent), mixed conifer (2 percent), and grass (1 percent). Sixty-eight percent of the Pasture Fire was identified as a high departure from historical conditions. The area impacted by the Pasture Fire had not burned in any of the previous 10 years. The northern tip of the fire touches the southern extent of the 51,000-acre 2018 Buzzard Fire. Despite not having any fuel breaks from recent fires, it appears fire managers were able to use gravel jeep roads to contain the Pasture Fire.

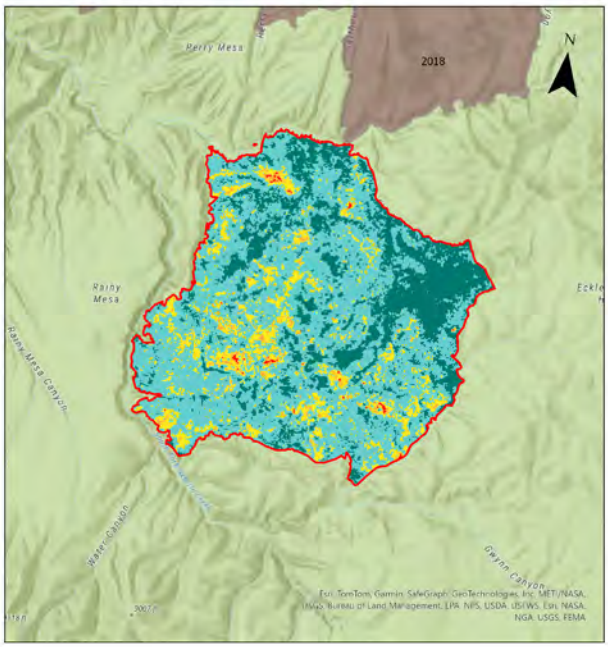
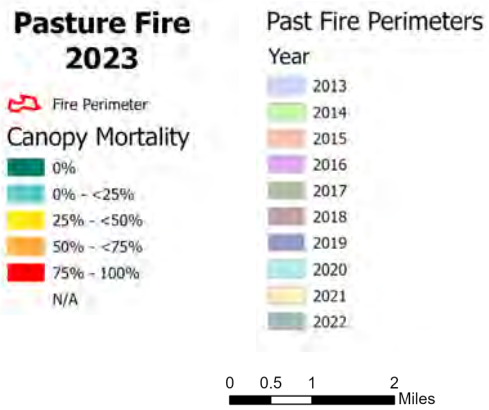


Figure 17. Canopy mortality in the Pasture Fire.



Fire Severity

Canopy mortality varied across the Pasture Fire but was primarily (86 percent) under 25 percent mortality (Figure 12). More than 2,500 acres (25 percent) of the burn area experienced no mortality. This included a large area on the eastern side of the fire that was predominantly ponderosa pine. The soil burn severity analysis also indicated the Pasture Fire was a relatively low intensity fire (Figure 13). Nearly 98 percent of the burn area was unburned/undetected (63 percent) or low severity (35 percent). None of the Pasture Fire was classified as high severity and only 240 acres experienced moderate severity.

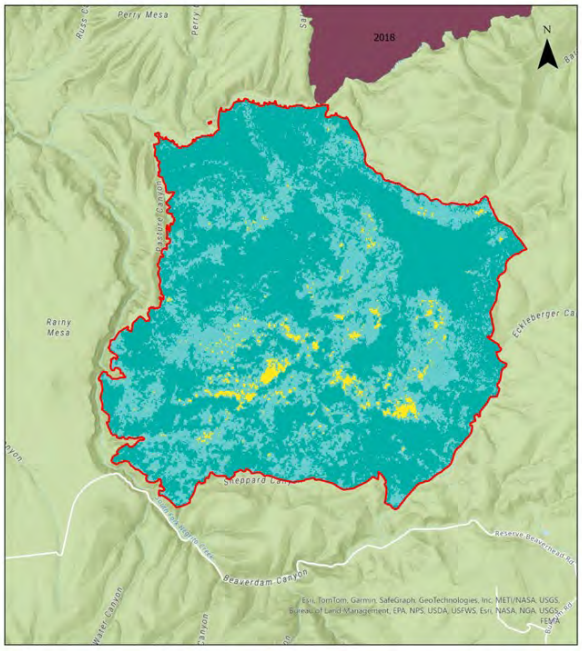
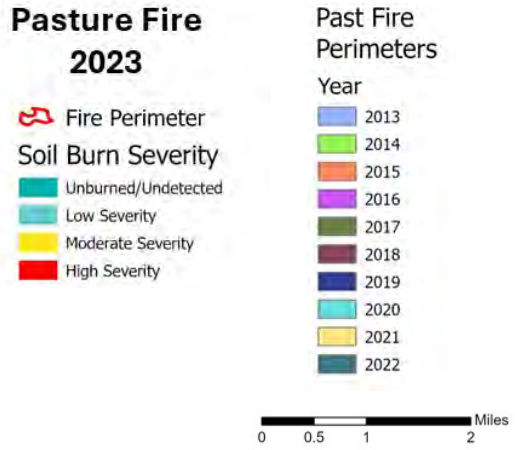


Figure 18. Soil burn severity in the Pasture Fire.



Still Fire, Arizona

- Cause: Lightning
- Location: Coconino County, AZ
- Incident start: 09/14/2023
- Incident close: 11/1/2023
- Acreage: 11,233
- Cost: $2 million

The Still Fire was a lightning-caused wildfire in the Coconino National Forest about 35 miles southeast of Sedona, Arizona. The fire started on September 14 and burned nearly 11,250 acres before it was fully contained on November 1. About seven miles of the northern perimeter were bounded by Arizona Highway 87 and smoke on the state highway was a significant concern. Fire managers chose to use a full suppression approach to the Still Fire to contain it in the designated operational area with a focus on protecting identified values at risk and reducing smoke impacts along Highway 87 and surrounding communities. Firing operations secured the Highway 87 corridor and crews worked to protect several campgrounds, a ranger station, and power, communication, and rangeland infrastructure. Firefighters encountered rocky terrain with snags, stump holes, and ash pits within the previous burn scars that posed operational hazards. Two responder injuries or illnesses were reported in the ICS-209 reports for the Still Fire. The cost for managing the Still Fire was estimated at $2 million, or about $178 per acre.

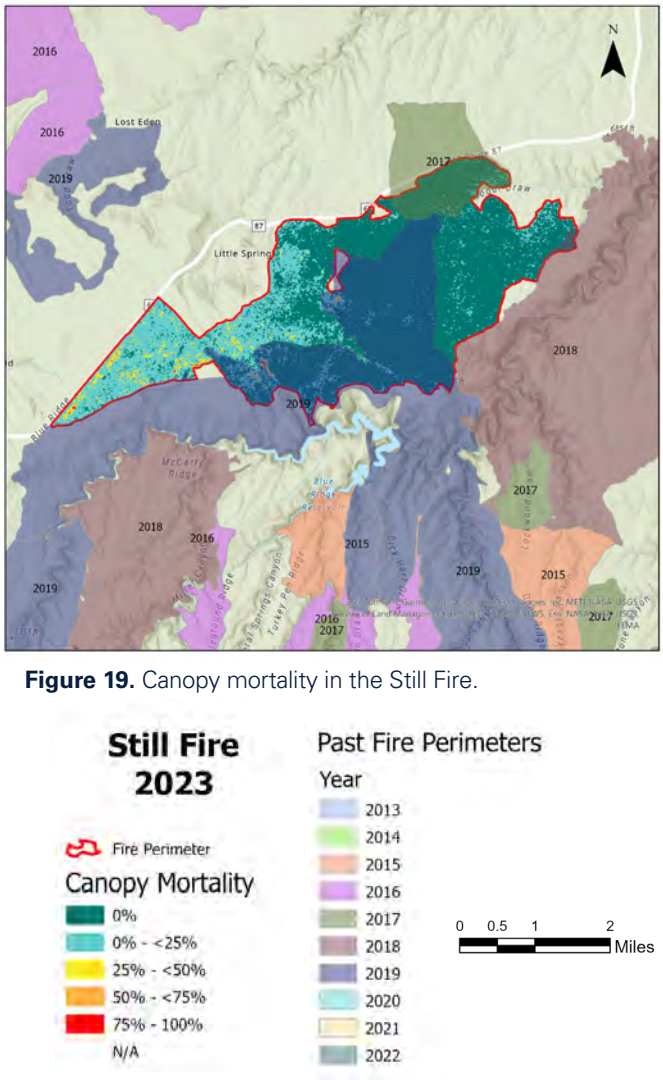


Figure 19. Canopy mortality in the Still Fire.

Vegetation and Past Fires

The Still Fire burned primarily in ponderosa pine (81 percent) with areas of grass (10 percent) and scrub (6 percent). Sixty percent (6,185 acres) of the vegetation within the Still Fire had high departure from historical conditions. Approximately 3,700 acres of the Still Fire reburned areas treated in the 2019 Cragin Prescribed Fire. Available data indicated that this area reburned at a very low intensity indicating this prescribed fire had helped reduce fuel loading and reduced the risk of catastrophic wildfire. Several other fires have burned in this area, especially to the south, over the past 10 years.

Fire Severity

More than 11,000 acres (98 percent) of the Still Fire were classified as having less than 25 percent canopy mortality (Figure 11). Only seven acres were identified as 75–100 percent canopy mortality. Soil burn severity data was not available for the Still Fire at the time of this report.

Conclusion

This report covers the nine largest wildfires in Arizona and New Mexico during the 2023 fire season. These nine wildfires represented 49 percent of all acres in the Southwest burned by wildfire in 2023. Ponderosa pine and piñon-juniper comprised 70 percent of the vegetation types affected by these nine fires (45 and 25 percent respectively). The total number of acres and the distribution of acres across vegetation community types varies from year to year. Ponderosa pine was the main vegetation type in 2023. The lower fire intensities observed in 2023 were likely driven by a major of fires burning in ponderosa pine and the mild climatic conditions.

Soil burn severity data were available for seven of the nine fires analyzed in this report, covering 140,500 acres (75 percent of the acres in this report). None of the fires reviewed in this report had a large portion of high soil burn severity. Ninety-six percent of the area covered by these seven fires was classified as low soil burn severity or unburned/undetected. Only 451 acres for which soil burn severity data were available experienced high soil burn severity. Ninety-four percent of these high-severity acres were in the Ridge Fire.

Rapid Assessment of Vegetation Condition after Wildfire (RAVG) data were available for eight of the nine fires

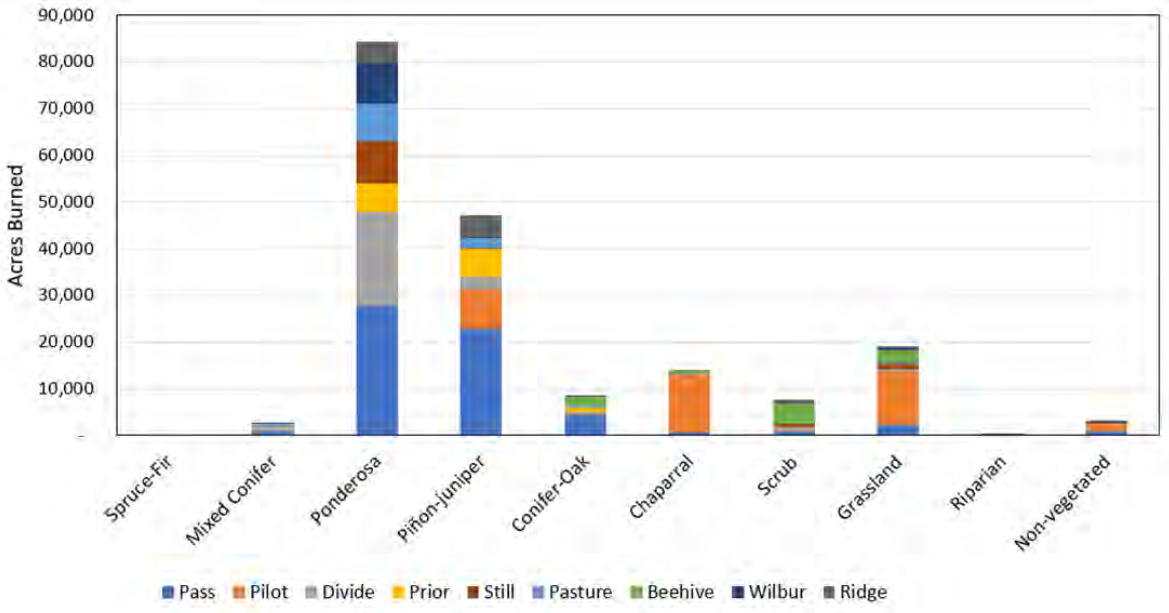


Figure 20. Summary of area burned in the largest fires of the 2023 fire season by vegetation type.

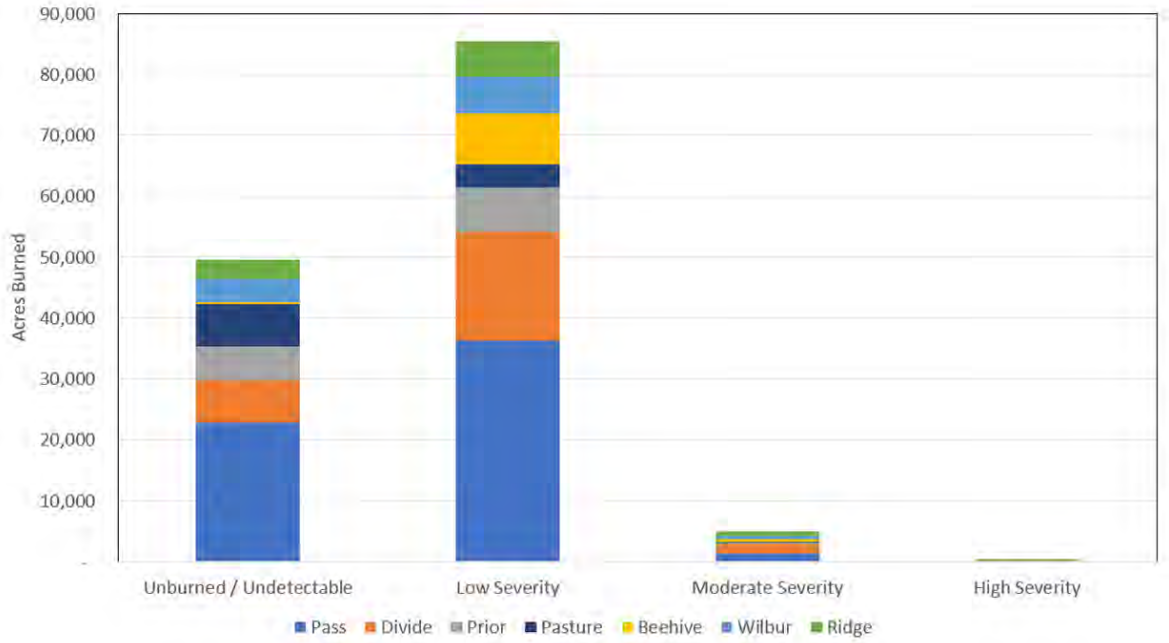


Figure 21. Summary of area burned by soil burn severity class.

included in this report, covering 152,700 acres (81 percent). Of these acres, 42 percent showed no detectable canopy mortality, and another 45 percent had less than 25 percent canopy mortality. Only 6,400 acres had greater than 75 percent canopy mortality. The Beehive and Ridge fires account for more than 80 percent of the highest canopy mortality areas. In the Beehive Fire, this highest canopy mortality class was primarily in scrub, grass, and conifer-oak, whereas much of the high canopy mortality in the Ridge Fire was ponderosa pine and piñon-juniper. Canopy mortality in these ponderosa pine forests can have greater negative ecological effects than fires that primarily burn in vegetation such as grass, scrub, and chaparral because these vegetation types are more adapted to high severity fire. This is an example of why it is important to cross reference canopy mortality with vegetation type. High-severity fire is a necessary component of many healthy grasslands and—if the patch size is right—in shrublands as well, and careful interpretation needs to be taken to not equate all canopy mortality with negative ecological effects.

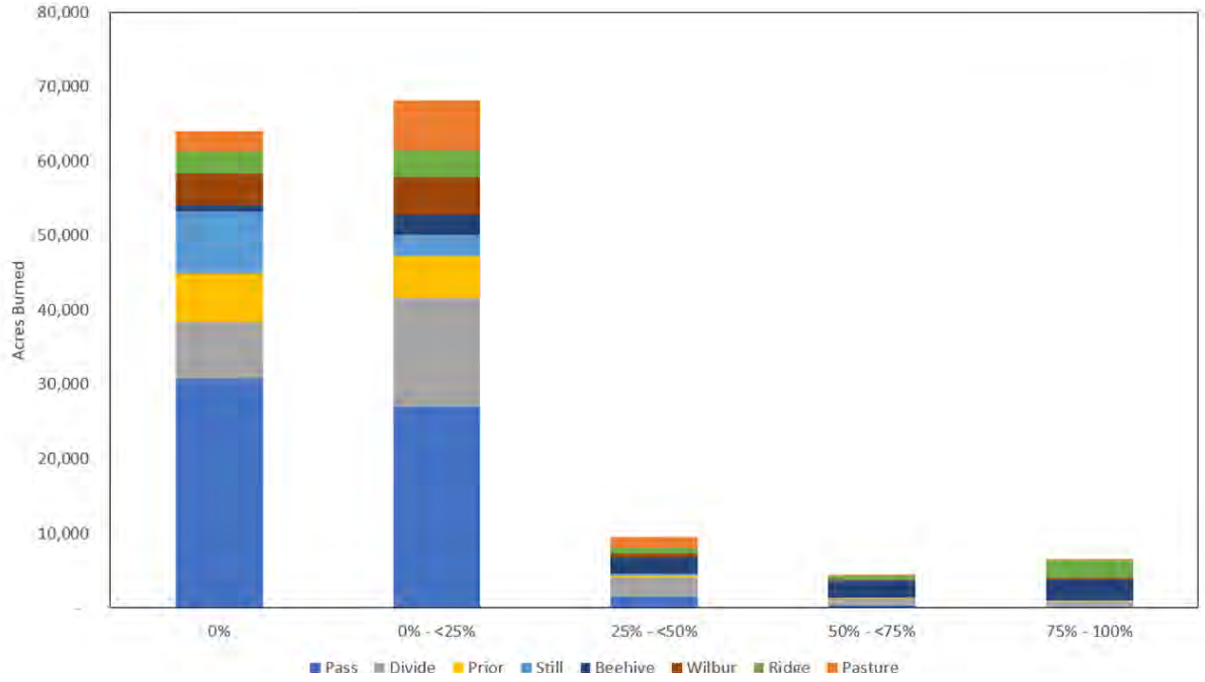


Figure 22. Summary of acres burned by canopy mortality class.

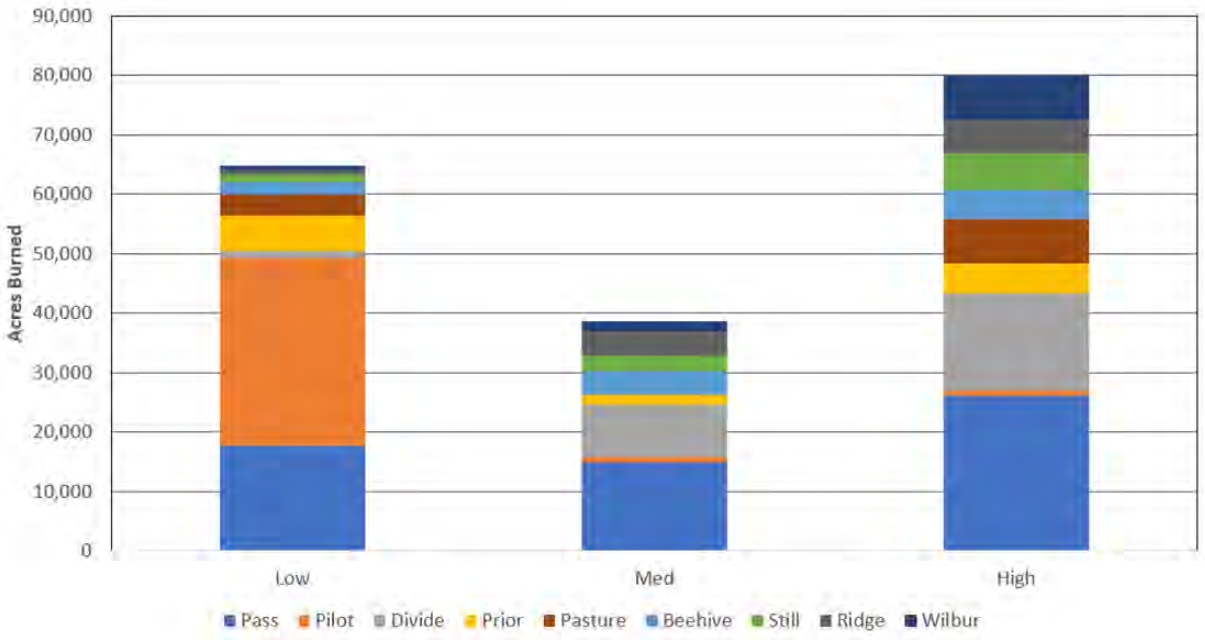


Figure 23. Summary of acres burned by LANDFIRE vegetation condition class.

Almost half of the area covered in this analysis was highly departed from historical conditions based on the LANDFIRE Vegetation Condition Class analysis. Wildfires often burn at lower severities in areas that are closer to historical conditions. The fire with the highest percentage of low departure from historical conditions was the Pilot Fire; however, that was the only wildfire for which severity data was not available. The 2023 fire season was notable for generally low severity, but this was likely more related to the vegetation types and the weather than the vegetation departure.

While there were required evacuations, locally intense fire conditions, and smoke-related impacts, the 2023 fire season featured fewer total acres, smaller fires, and generally low fire severity compared to recent fire seasons. Human communities were largely unaffected and no homes or structures destroyed or damaged by the nine large fires reviewed in this report. Impacts to human communities as a result of these nine fires should not be minimized, but it appears that fire played a natural, and necessary, role in the region during the 2023 fire season with several low intensity fires that caused limited property damage and relatively few reported evacuations.

Past wildfire season overview reports noted that most of the large fires in the Southwest are caused by lightning (naturally ignited), but nine of the ten large fires covered in 2022 were listed as human caused or undetermined at the time of writing. The 2023 fire season returned to the historical trend, with most of the fires reported as lighting caused.

The role of past fires was highly variable in the fires summarized in this report. Several of the 2023 fires occurred in areas that had not burned in many years. Other fires, such as the Still Fire had significant overlap with past fires. The Still Fire featured 3,700 acres that were treated in the 2019 Cragin Prescribed Fire. Available data indicated that this area reburned at a very low intensity indicating this prescribed fire had helped reduce fuel loading and reduced the risk of catastrophic wildfire. It should be noted that fire regimes vary significantly across vegetation types and time since fire may be less or more meaningful depending on vegetation type. Additionally, there are several places where 2023 fires shared a perimeter with past burn areas. These shared boundaries may be based on convenience due to a road or some other landscape holding feature but may also indicate these previously burned areas served as fire breaks.

The nine fires in this analysis were managed at an estimated cost of nearly $24.2 million dollars, for an average of $129 per acre. The average cost per acre was lower than the costs reported in several of the past fire season analyses and varied by the fire from a high of $465 per acre on the Beehive Fire to a low of under $8 per acre on the Prior Fire. As noted above, managers identify the most appropriate strategy for each wildfire to minimize threats and maximize positive outcomes. In 2023, managers classified their strategy as full suppression on only three of the nine fires. This is a marked decrease from the last couple of fire seasons and is more in line with our findings from earlier reports where we observed approximately 50 percent of the acres approached with full suppression. Human ignitions, dangerous weather conditions, values at risk, COVID-19, and constraints on firefighting resources caused by multiple large fires likely factored into these approaches in the last couple of fire seasons. It should also be noted that while the overall strategy is sometimes listed as full suppression, the implementation of specific wildland fire strategies includes a variety of factors that often lead to a variety of approaches. While there was a wide variety of vegetation types across these fires, they all displayed relatively low severity and it is likely that a significant portion of the 382,000 acres that burned in 2023 provided some ecological benefit.

Appendix I. Fire Statistics

GENERAL					VEGETATION DEPARTURE		
Name	**State**	**Acres**	**Cost**	**Cost/Acre**	**Low**	**Medium**	**High**
Pass	NM	59,833	$7,000,000	$116.99	30.1%	25.5%	44.5%
Pilot	AZ	34,810	$1,250,000	$35.91	95.2%	2.4%	2.4%
Divide	NM	26,514	$1,800,000	$67.89	4.4%	33.7%	61.9%
Prior	NM	12,841	$100,000	$7.79	47.2%	12.9%	39.9%
Still	AZ	11,233	$2,000,000	$178.05	14.4%	25.6%	60.0%
Pasture	NM	10,986	$2,000,000	$182.05	31.8%	0.0%	68.2%
Beehive	AZ	10,745	$5,000,000	$465.33	18.6%	36.5%	44.9%
Wilbur	AZ	10,279	$3,000,000	$291.86	6.3%	39.1%	54.6%
Ridge	AZ	10,210	$2,000,000	$195.89	8.5%	18.0%	73.5%
Sum		**187,451**	**$24,150,000**	**$128.83**	**35.37%**	**21.09%**	**43.54%**

SOIL BURN SEVERITY					RAVG CANOPY MORTALITY				
Name	**Unburned**	**Low**	**Moderate**	**High**	**0%**	**0% < 25%**	**25% < 50%**	**50% < 75%**	**75% - 100%**
Pass	38%	61%	2%	0%	51%	45%	3%	1%	0%
Pilot	-	-	-	-	-	-	-	-	-
Divide	27%	67%	6%	0%	29%	55%	61.9%	4%	3%
Prior	42%	57%	1%	0%	52%	45%	39.9%	1%	0%
Still	-	-	-	0%	73%	25%	60.0%	0%	0%
Pasture	63%	35%	2%	0%	25%	61%	68.2%	1%	0%
Beehive	4%	78%	4%	0%	9%	24%	44.9%	21%	26%
Wilbur	37%	58%	5%	0%	41%	49%	54.6%	2%	2%
Ridge	31%	57%	7%	4%	29%	35%	73.5%	5%	23%