2022 Wildfire Season: An Overview

Southwestern US

SEPTEMBER 2023

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) is a way for managers, scientists, and policy makers to interact and share science. SWFSC's goal is to see the best available science used to make management decisions and scientists working on the questions managers need answered. The SWFSC tries to bring together localized efforts to develop scientific information and to disseminate that to practitioners on the ground through an inclusive and open process.

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Cover photo: Lone Peak Hotshots, a Type 1 Interagency Hotshot Crew, on night shift at the Cerro Pelado Fire in New Mexico. *Photo courtesy InciWeb.*

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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 have adapted to fire over thousands of years. For example, ponderosa pine forests need regular, low-severity fires to remain healthy. Without fire, ponderosa pines grow in dense thickets and compete for water, nutrients, and sunlight, leaving the trees spindly and small. Over decades without fire on the landscape, fuel loads from overgrown landscapes accumulate and lead to 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, livelihoods, water resources, and homes. Some fires will leave many patches unburned, creating a mosaic burn pattern, whereas others will burn more contiguously. Weather, climate, vegetation type, fuel conditions, and topography all influence how an individual wildfire burns and whether it has beneficial effects.

This report is the tenth in a series of annual Southwest wildfire season 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 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 ten wildfires, each over 10,000 acres, in Arizona and New Mexico in 2022. It is worth noting the overwhelming social and ecological dimension of one fire, the Hermits Peak Calf Canyon (HPCC) Fire. The causes and impacts of this fire are covered in more detail in other reports and publications, as noted in the HPCC section below.

As in previous overviews, this report covers the time period each fire burned, fire management costs, vegetation types, previous burn footprints, and, where available, burn severity. The conclusion section summarizes these same measures for the large wildfires in the region. These fire season overview reports serve as the only continual resource to Southwest wildfire information and provide a unique opportunity to compare fires and fire seasons year to year.

Wildfire Management

Managers can approach each wildfire with multiple objectives, as the 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 2022.

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, and 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 2022 Fire Season

In 2022, wildfire burned 1,054,740 acres in the Southwest (Arizona and New Mexico), which is double the average (515,862 acres) burned annually in these two states over the previous ten-year period. A disproportionate amount of the area that burned was in New Mexico. Arizona had half as many wildfire acres than its ten-year average (145,422 compared to 341,744 acres), while New Mexico had five times more acres of wildfire than its ten-year average (909,318 compared to 174,083 acres). Unplanned human ignitions caused 78 percent of wildfire acres burned in the Southwest in 2022; however, these estimates excluded wildfires with an unknown cause. Due to the extreme climatic conditions and a USDA Forest Service pause on prescribed fires due to escapes, managers were limited in their ability to use prescribed fire in the Southwest. Only 111,000 acres received prescribed fire in 2022 compared to the ten-year average of 164,331 acres (Figure 1). Information on prescribed fire is based on national-level reporting for the Southwest region.[3] The Southwest Geographic Area Coordination Center (GACC) states that "prescribed fire reporting is getting overhauled and will be available starting with the 2023 Annual Report."[4]

1 *2021, 2020, 2019, 2018, 2017, 2016, 2015, 2014,* and *2013 Wildfire Season: An Overview, Southwestern U.S.* https://cdm17192.contentdm.oclc.org/digital/collection/p17192coll1/id/877/rec/3

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

3 USDA Forest Service, Fiscal Year 2024 Budget Justification. https://www.fs.usda.gov/sites/default/files/FS-FY24-Congressional-Budget-Justification.pdf

4 SW GACC, Southwest Area Annual Report: 2022 Fire Year. https://gacc.nifc.gov/swcc/////predictive/intelligence/Historical/AnnualReports/2022SWA_AnnualReport.pdf

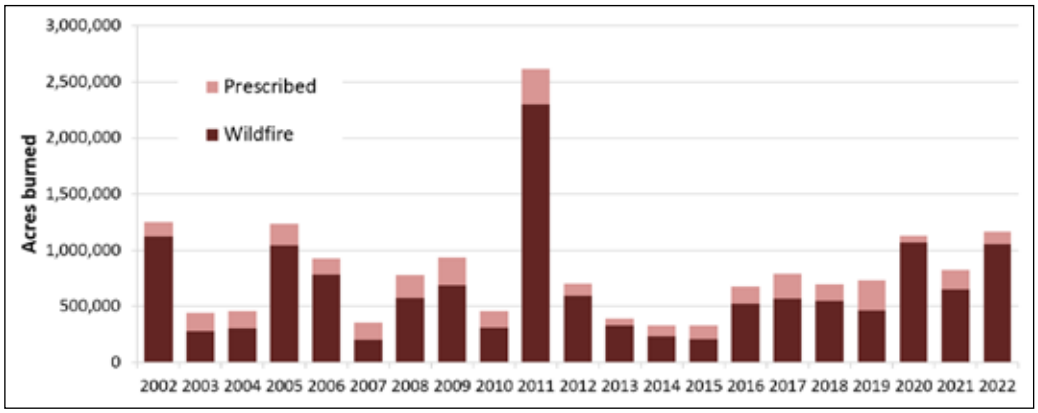


Figure 1. Number of acres burned annually by wildfire and prescribed fire from 2002 to 2022.

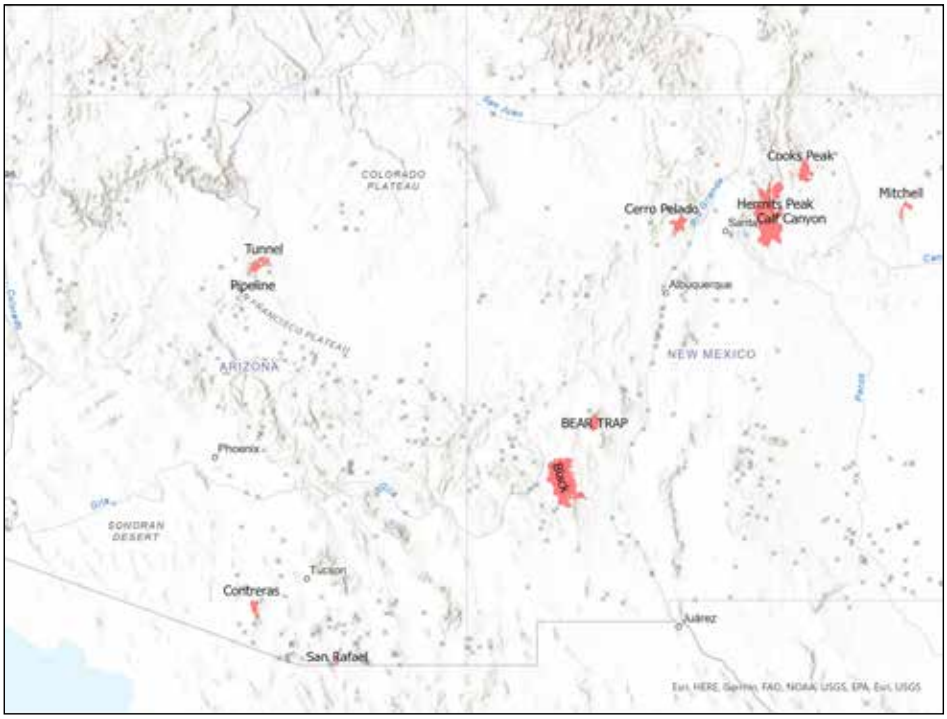


Figure 2. Location of the 10 largest fires in the Southwest in 2022 included in this report.

Data on fire management strategy were difficult to acquire for 2022 and this lack of transparency prevents comparisons with previous years. As noted in the recent report Managed Wildfire: A Research Synthesis and Overview[1], confusion and changes of the nomenclature for strategies other than full suppression also make reporting very difficult.

This overview focuses on the ten largest fires by acreage in the region, which, in order of size, are: the HPCC, Black, Cooks Peak, Cerro Pelado, Bear Trap, Contreras, Pipeline, Mitchell, and Tunnel fires. The ten large fires in this report represent 87 percent of the acres burned by wildfire in 2022 (Figure 2).

Regional Context

The Southwest headed into the spring of 2022 with near average snowpack in the higher elevations of the Rocky Mountains and a below average snowpack for the lower elevations. Winter 2021–2022 temperatures were near average for the Southwest. Eastern New Mexico experienced an exceptional drought with well below normal precipitation.[6] In 2022, a third year of La Niña continued to drive the storm track north and deprived the Southwest of some spring moisture. By May, much of New Mexico was in extreme or exceptional drought. Arizona fared a little better with some areas of moderate drought. Overall, spring temperatures were above average for the region (five of the ten fires included in this report started in April). The summer monsoon brought

5 Bean, R., and A. Evans. 2023. Managed Wildfire: A Research Synthesis and Overview. Special Report. Forest Stewards Guild, New Mexico, and Ecological Restoration Institute and Southwest Fire Science Consortium, Northern Arizona University. 12 p.

6 NIFC Wildland Fire Summary and Statistics Annual Report

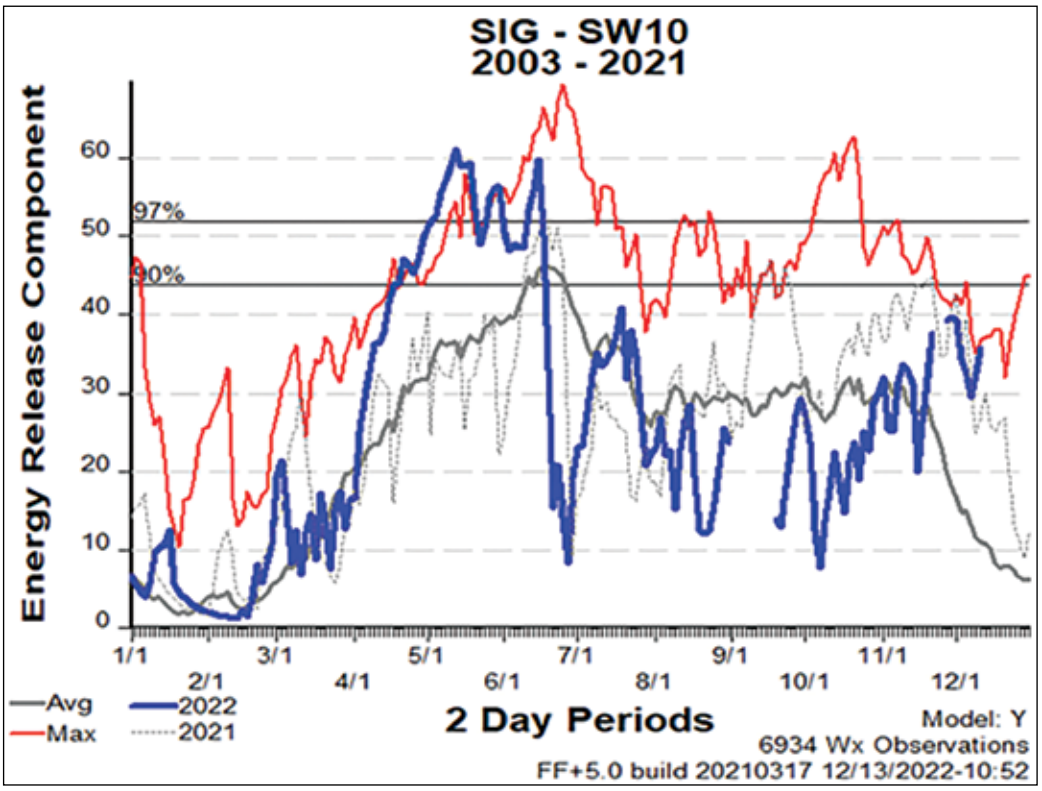


Figure 3. Energy release component (ERC) index for 2022 in northern New Mexico. Note ERCs exceeded the historical maximum in April and then dropped after the onset of monsoons.

good precipitation to the Southwest but over 70 percent of the western US was in drought at the end of July. Tropical Storm Kay, which made landfall in early September, added additional rain. Monsoon activity eventually lessened the drought in Arizona and New Mexico.[7]

The Energy Release Component (ERC) is an index that estimates the potential available energy released per unit area in the flaming front of a fire and is based on the fuel model and the live and dead fuel moistures of the area.[8] The ERC is often used to track seasonal fire danger and includes all types of live and dead fuels. However, changes in the heavy fuels (6 inches or larger in diameter) have a greater impact on the ERC than a change in the fine fuels (1/4 inch or less in diameter). ERC values show little daily change in part because wind speed is not part of the calculation. A graph of ERC from northern New Mexico shows the 2022 fire season (blue line) in comparison to the ten-year average (gray line) and ten-year maximums (red line) (Figure 2).[9] Note that the 2022 ERCs in New Mexico exceeded the historical maximum in April before dropping after the onset of monsoons. This ERC chart covers the geographic area of the HPCC, which started as ERCs climbed to unprecedented levels in April. ERC patterns in Arizona were similar if slightly less extreme.

Data Sources

Management, Objectives, and Cost

The InciWeb website (inciweb.nwcg.gov) provides background information on most large fires including location and start date. 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 management costs. These costs do not reflect any post-fire costs such as rehabilitation or soil stabilization. The cost data from each fire is collected in a final table at the end of the document. Incident Status Summaries also provide "strategic objectives," which briefly describe the desired outcome for the incident, high-level objectives, and in some cases, strategic benefits. Review of the most common or persistent strategic objectives for each fire provides some insight into the overarching management goals, though it should be emphasized that strategic objectives often change during a fire.

Perimeters

Boundaries for each fire were taken from the National Interagency Fire Center Open Data Site archive of fire perimeter maps (https://data-nifc.opendata.arcgis.com/). NIFC Open Data Site also provides historical perimeters of wildfires, which provided context for how past fire influenced the 2022 fires.

Vegetation

Basic information about vegetation and topography of burned areas is available from LANDFIRE (www.landfire.gov). LANDFIRE provides nationally consistent, scientifically based

7 NIFC Wildland Fire Summary and Statistics Annual Report 2022
8 The National Fire-Danger Rating System: basic equations https://www.fs.usda.gov/psw/publications/documents/psw_gtr082/psw_gtr082.pdf
9 http://gacc.nifc.gov/swcc//predictive/fuels_fire-danger/nfdrs_charts/Areawide.htm

maps of existing vegetation as well as Vegetation Condition Class (VCC). Vegetation Condition Class shows how existing vegetation has departed from estimated natural or historical condition. In frequent-fire systems, this departure is generally due to fire exclusion and past logging and grazing and results in a greater density of trees and less healthy conditions. Other ecosystems are less likely to be departed from historical conditions, such as deserts not adapted to fire or spruce fir forests adapted to long fire return intervals. Fire can help return fire-adapted ecosystems to historical conditions when it burns in ways similar to past wildfires. Vegetation Condition Class 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. New (2020) VCC maps include a more detailed breakdown of the vegetation's departure from historical conditions and each of the three previous categories has been split in to two, resulting in six total categories of departure. This finer detail means the departure for each fire is reported at a finer grain in this year's report than in past years.

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 (https://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 products derived from the differenced Normalized Burn Ratio (dNBR). The dNBR measures the change in the ratio of near infrared which is what healthy green vegetation reflects to the shortwave infrared which is what is 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 into a "low/ unchanged" category. The distribution of soil burn severity is included in 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 (https://burnseverity.cr.usgs.gov/ravg/). The USDA Forest Service Remote Sensing Applications Center provides RAVG analysis as a first approximation of areas that may require reforestation treatments because of canopy killed by high-severity fire. RAVG maps are created for wildfires that burn greater than 1,000 acres of wooded USDA Forest Service lands and for other fires when requested. The maps are produced by measuring the change between a satellite image before and immediately after a wildfire using an algorithm called 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 used for soil burn severity maps but is more sensitive to vegetation mortality than the dNBR.

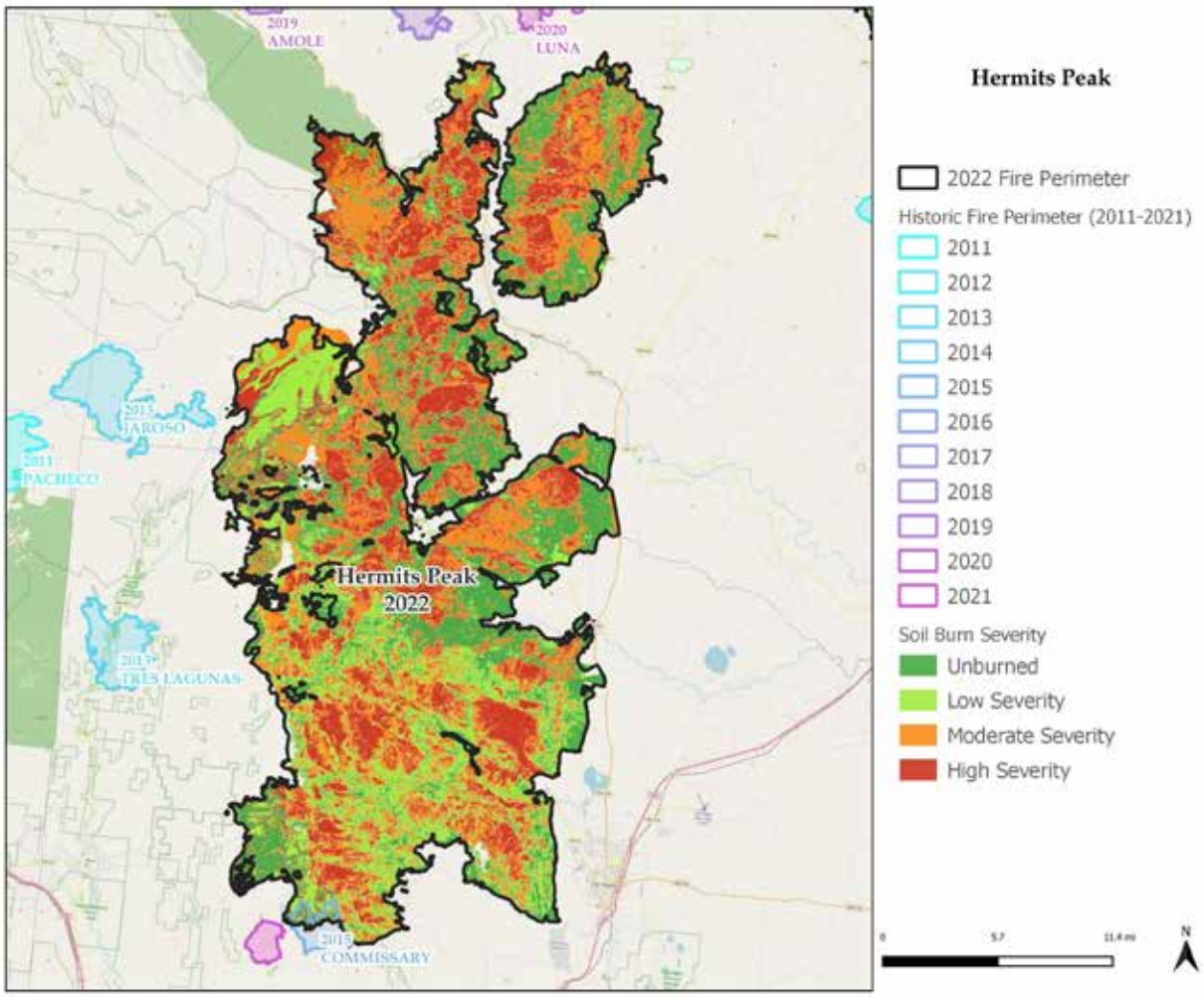
While soil burn severity maps and RAVG canopy mortality maps use similar satellite change detection methods, they measure fundamentally different forest attributes. In many areas, canopy mortality and soil burn severity patterns are similar. However, in some vegetation types, such as chaparral or grass,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

Caveats

There are essential caveats for all data used in this summary. First, the fire information presented here was taken from official sources between November 2022 and March 2023 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 ten large wildfires that each burned over 10,000 acres in Arizona and New Mexico in 2022. We cover when each fire burned, fire management costs, vegetation types, previous burn footprints, and burn severity, where available. The fires are ordered based on the start date and represent 87 percent of the acres burned by wildfire in the Southwest in 2022.



Hermits Peak/ Calf Canyon Fire

- **Cause:** Human
- **Location:** San Miguel County, New Mexico; Santa Fe and Carson National Forests
- **Incident Start Date:** 04/06/2022
- **Incident Final Date:** 10/27/2022
- **Final Acreage:** 341,735
- **Final Cost:** $330,100,293 ($966 per acre)

The Hermits Peak Fire was declared a wildfire on April 6, ignited by the Las Dispensas prescribed burn. The prescribed burn was started near the Pecos/ Las Vegas District of the Santa Fe National Forest with the intent to reduce fuel loads in the area. While weather conditions were within range to allow the burn to take place, unexpected erratic winds pushed a spot fire outside of the unit's boundary. The burn was declared a wildfire at approximately 4:30 pm on April 6 and began approximately 12 miles northwest of Las Vegas at the base of Hermits Peak in the Pecos Wilderness. On April 19, the fire reached 7,573 acres and fire officials called it 91 percent contained. A full, official review of the Las Dispensas Prescribed Fire is available here.

The Calf Canyon Fire was also a prescribed burn turned wildfire. A sleeper fire from a pile burn operation in January, it survived three winter storm events and became a wildfire on April 9. A sleeper fire, or a holdover fire, is when a prescribed burn stays ignited for a long period of time beyond the prescribed burn operations. The fire stays dormant, burning in the dry duff under the snowpack. By the 21st, the Calf Canyon Fire reached 123 acres and had no containment. Because prescribed burn operations started both the Calf Canyon and the Hermits Peak Fire, the USDA Forest Service (https://www.frames.gov/documents/usfs/USFS_20220908_National-Prescribed-Fire-Program-Review.pdf) their prescribed fire polices and recommended improvements in tactics and oversight.[10]

By April 22, the two fires had merged to become the Hermits Peak Calf Canyon Fire (HPCC) and the combined size quickly reached 54,000 acres with 12 percent containment. By the start of May, the HPCC was over 116,000 acres and the 1,000 personnel on the fire had achieved 30 percent containment. Unfortunately, red flag warning conditions, high winds, very low humidities, and record ERCs (Figure 3) allowed the fire to continue to spread. On both April 29 and May 1 the fire grew by over 30,000 acres. Extremely active fire behavior persisted at night as humidity failed to recover, and winds remained very strong. By May 6, a month after ignition, the fire had grown

10 National Prescribed Fire Program Review https://www.frames.gov/documents/usfs/USFS_20220908_National-Prescribed-Fire-Program-Review.pdf

to 168,000 acres and containment had been reduced to 20 percent. May 10 was another day of tremendous fire growth; another 33,000 acres were added in one day to reach a total over 236,000 acres. At this point, the majority of fire growth was across a long perimeter east into the Pecos Wilderness and north, threatening more communities.

After May 15, daily fire growth dropped to around 2,000 acres or less, but the overall HPCC footprint had reached nearly 300,000 acres with only 26 percent containment. By May 24, over 3,000 people were assigned to work on the HPCC fire and containment had reached 46 percent. Managers were able to achieve 50 percent containment by May 27 with the fire at 314,228 acres. Weather conditions were still dangerous and fire behavior remained extremely active. Fuels were extremely dry: 1-, 10-, and 100-hour fuels were at 2 percent and 1,000-hour fuels were at 8 percent moisture. Direct attack strategies were challenged by extreme fire behavior. Erratic winds and periods of limited visibility due to smoke restricted the ability to use aviation resources. Fire impacts in the wildland-urban interface created hazards for firefighters, including downed power lines and smoke from structure fires. By June 22, HPCC had reached its maximum size and firefighters were able to reach 72 percent containment. Weather conditions improved with scattered rain showers and high relative humidities. Winds were generally from the southwest at 10 to 15 miles per hour but exposed ridges still experienced gusts of up to 35 miles per hour.

Flooding and debris flows as a result from the HPCC impacted roads, culverts, drainages, and private property for the first time on July 1 and significant efforts shifted from suppression to repair and remediation. At the end of July, the fire was 96 percent contained. Heavy precipitation continued to cause flooding, which limited repair operations in some areas. Managers reached 100 percent containment on August 20 as over 400 people continued to work on repair.

The HPCC was contained after burning 341,735 acres and became the largest fire recorded in New Mexico. Over 27,000 people had to evacuate during the HPCC. Twenty-seven residences were damaged, and the fire destroyed 433 homes. Fifty-eight other structures were damaged and 470 destroyed. Over half (58 percent) of the HPCC burned on private land. It is not an exaggeration to say that the HPCC threatened cultural and community survival in the area. Many families in the area trace their histories back hundreds of years to Spanish land grants and they have a distinct northern New Mexico Hispanic culture which is threatened by the damage and displacement caused by the HPCC Fire.

Vegetation and Past Fires

Nearly half of the HPCC Fire burned in ponderosa pine (48 percent). The other vegetation types that burned in large areas were mixed conifer (30 percent) and spruce fir (12 percent). Because of the large area of the fire, even the one percent of riparian areas that burned covered over 4,000 acres.

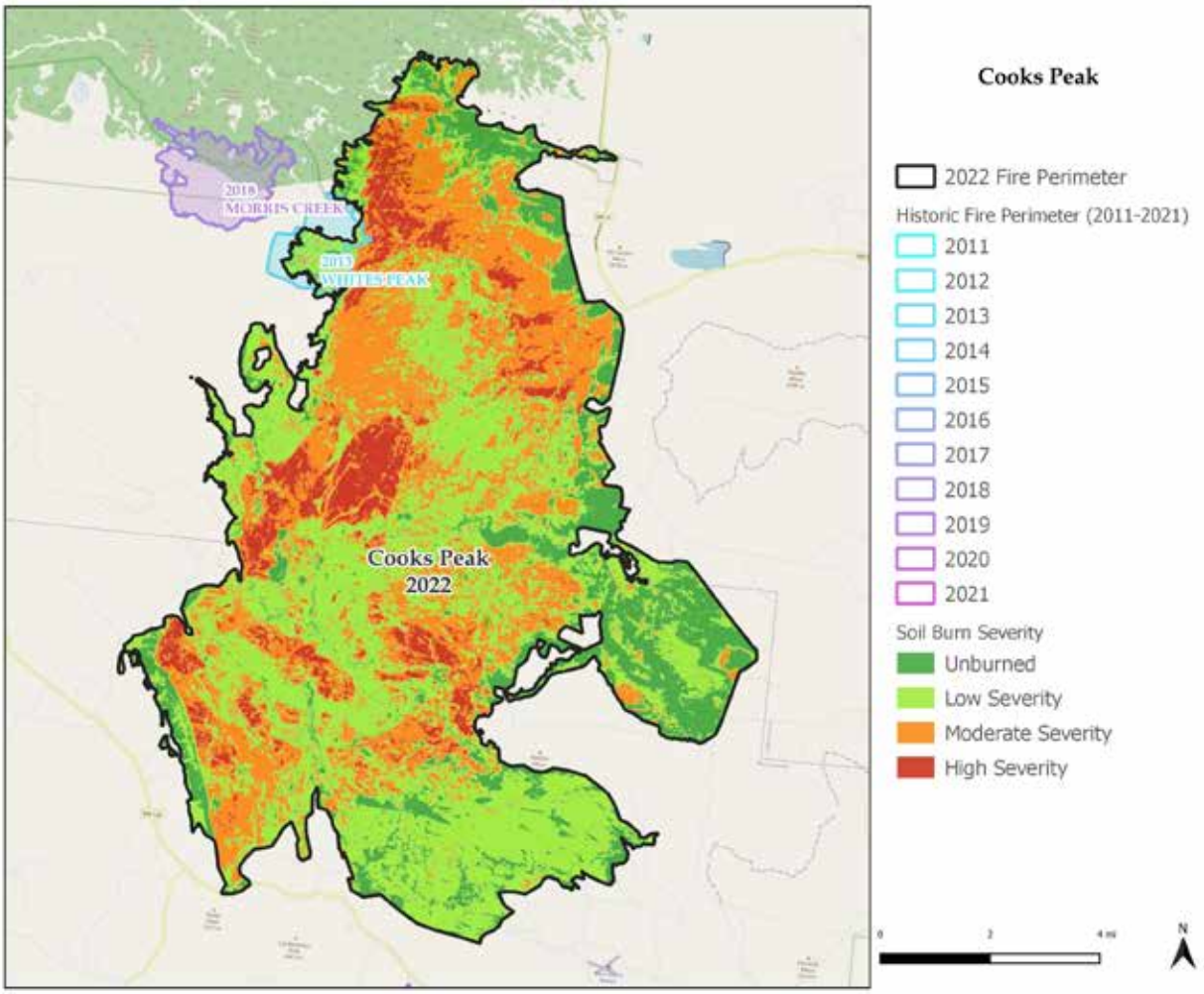
Only a very small portion, less than one percent, of the area burned in HPCC had burned recently. The area burned in the 2015 Commissary Fire was reburned by the HPCC Fire. Nearly half (49 percent) of the HPCC burned through areas that had moderate-to-high departure from historical conditions (VCC class III.B) with an additional 29 percent in low-to-moderate departure (VCC class III.a).

Fire Severity

The HPCC Fire had 48 percent unburned or low severity, 30 percent moderate, and 22 percent high soil burn severity. These percentages may mask the impacts of such a large fire in the landscape and the number of acres gives a fuller picture of the HPCC's effects. Over 76,000 acres burned with high severity for soils which damaged the local watersheds. Similarly, while nearly 60 percent of HPCC had 50 percent or less canopy mortality, 33 percent, or 113,000 acres, had over 75 percent canopy mortality.

Over 29,000 acres of the HPCC Fire caused high soil burn severity on slopes greater than 30 percent with over 38,000 acres of moderate soil burn severity on slopes greater than 30 percent. Rain on post-fire soils causes flooding and given these large areas of moderate-to-high soil burn severity, particularly on these steep slopes, it is not surprising that after the fire there has been significant flooding in downstream communities such as Mora, Ocate, and Rayado.

From vegetation transitions and the restoration effort to flooding, social justice and socio-political structures, the impacts of HPCC will ripple across the region for decades to come. More information on this fire and its socio-ecological impacts and response is available on the New Mexico Forest and Watershed Restoration Institute's Story Map of the HPCC. A Post-Fire Resource Hub can be found here.



Cooks Peak Fire

- **Cause:** Undetermined
- **Location:** Ocote, Mora County, New Mexico
- **Incident Start Date:** 04/17/2022
- **Incident Final Date:** 05/31/2022
- **Final Acreage:** 59,359
- **Final Cost:** $12.5 million ($211 per acre)

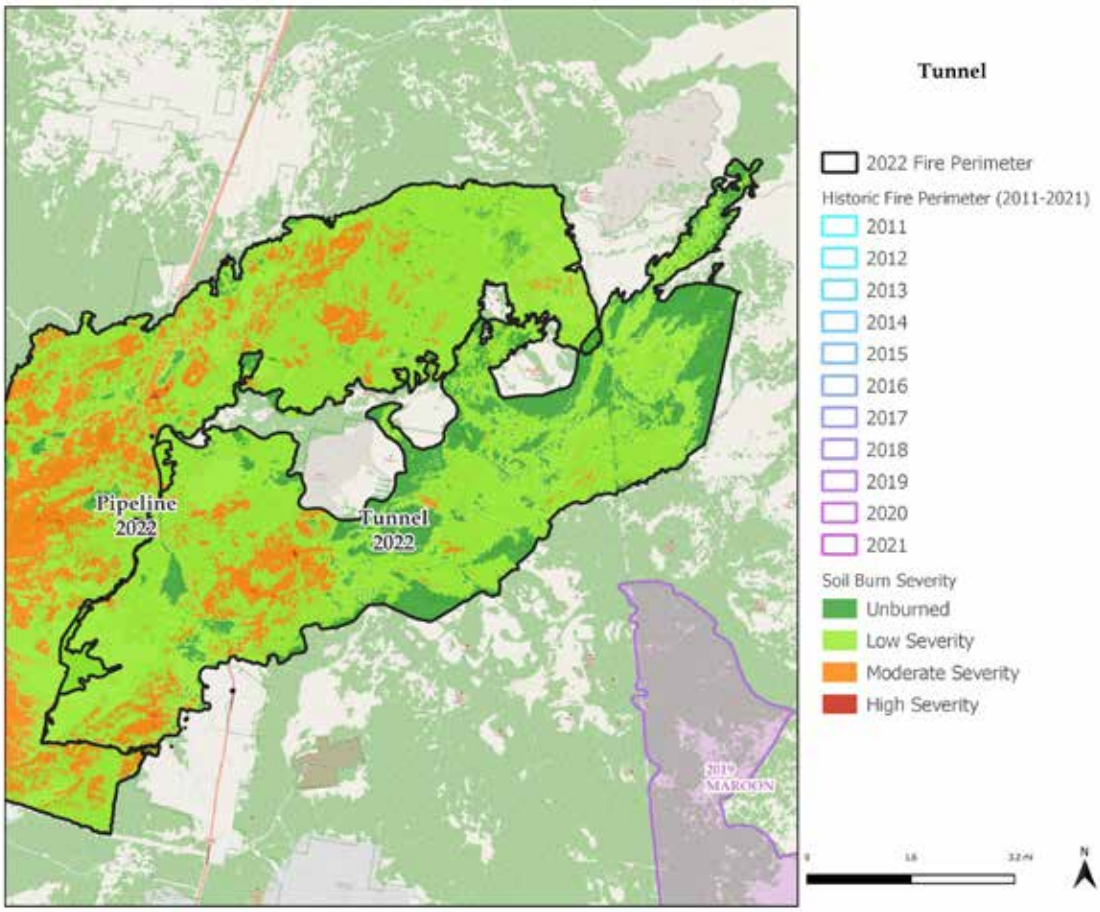
The Cooks Peak Fire was discovered on April 17, burning actively at 2,209 acres, nine miles south of Cimarron and northeast of Ocate, New Mexico under the same hot windy weather and dry fuels conditions as HPCC. The fire was burning in timber with grass and understory fuels on private and state trust lands. The fire was difficult to contain due to rapid spread and safety issues caused by high winds. High winds also reduced the ability for aviation resources to provide support and made it more likely for fire-weakened or dead trees to fall unexpectedly. Since the HPCC was already burning by the time Cooks Peak Fire started, management occurred in the context of intense competition for resources and a stressful fire season. The first few operational days included evacuations for 74 residents. By April 21, the fire had grown to 23,000 acres and fuels moisture was still very low. The 1,000-hour fuel was at about 8 percent and fine dead fuels moisture was between 3 to 5 percent. Even with low fuels moisture and extreme winds, the fire exhibited moderate fire behavior as it grew to over 55,000 acres.

Vegetation and Past Fires

Cooks Peak burned mainly in ponderosa pine (59 percent) and grassland (21 percent). Riparian areas and mixed conifer forest also burned totaling 2,000 (4 percent) and 1,700 acres (3 percent), respectively. A small portion, about one percent, of the Cooks Peak Fire burned in the footprint of the 2013 White's Peak Fire. Very little of the Cooks Peak Fire burned in areas that were highly departed from historical conditions (6 percent). Most (51 percent) of the fire was low-to-moderate or less departed from historical conditions.

Fire Severity

Only about eight percent or 5,000 acres of the Cooks Peak Fire caused high soil burn severity. The majority (59 percent) of the fire was low or unburned soil burn severity. However, Cooks Peak Fire created nearly 2,500 acres of high or moderate soil burn severity on slopes greater than 30 percent. The soil burn severity maps were provided by the New Mexico Forest and Watershed Restoration Institute based on the same methodology used by the USDA Forest Service. No canopy mortality mapping was available.



Tunnel Fire

- **Cause:** Undetermined
- **Location:** Flagstaff, Coconino County, Arizona
- **Starting Acreage:** 20,339
- **Incident Start Date:** 04/17/2022
- **Incident Final Date:** 06/01/2022
- **Final Acreage:** 19,105
- **Final Cost:** $1 million ($266 per acre)

The Tunnel Fire was reported burning 14 miles northeast of Flagstaff, Arizona on the Coconino National Forest on April 17. When it was discovered, the fire was burning with extreme behavior, making wind-driven runs, and short spotting on the head and the flanks. The Tunnel Fire burned in timber and grass and in 6-foot chaparral. The cause of the 19,105-acre fire is still under investigation. According to the ICS-209 reports, 420 resources fought to contain the Tunnel Fire that threatened over 1,300 residents and would go on to destroy 30 homes. The fire was fully contained on May 20.

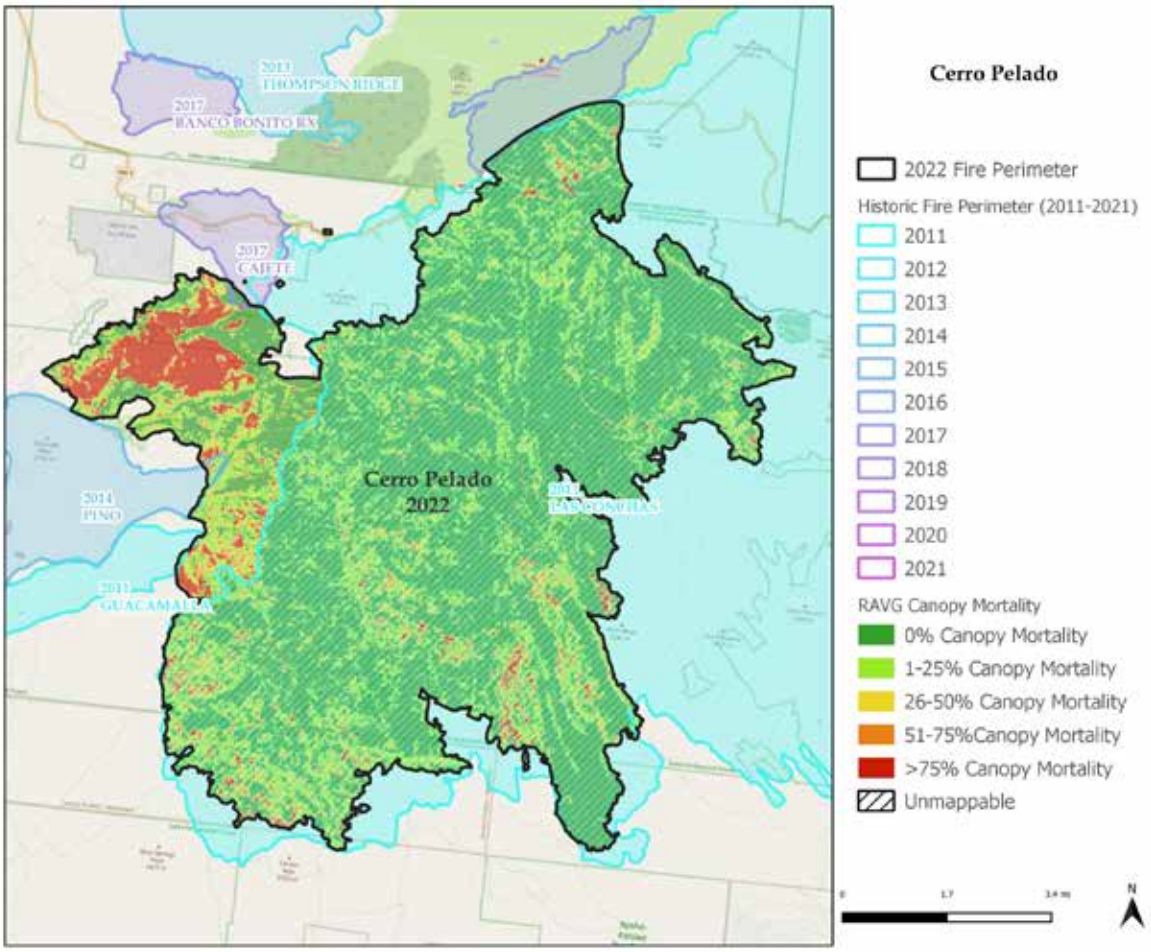
According to the ICS-209 reports, initial attack efforts were challenged due to fire behavior and the extreme terrain. With temperature, wind, and humidity levels pushing dangerous thresholds, the initial suppression strategy was focused on firefighter and public safety. Red flag warnings and overhead hazards from patches of snags added to the risk. Containment focused on securing the perimeter closest to evacuation areas so that the 2,600 residents could return to their homes safely. Fire behavior calmed as it progressed, red flag warnings and wind gusts up to 40 miles per hour continued. On May 25, firefighters were able to maintain some control of the Tunnel Fire with help from a short-lived rain event. The mop-up phase followed for the next two weeks. In total, the fire burned 54 structures.

Vegetation and Past Fires

The Tunnel Fire mainly burned in ponderosa pine forest (56 percent) and piñon-juniper (13 percent). Notably, 19 percent of the Tunnel Fire footprint was non-vegetated. On the northeastern side of the fire, volcanic cinder fields provided natural fuel breaks. Although the Tunnel Fire did not burn through the footprint of any recent fires, an area of an older burn created snags that presented a danger to firefighters. Half of the area burned in the Tunnel Fire was classified as low-to-moderate departure from historical conditions and the next largest category (21 percent) was classified as high with 16 percent labeled barren. The Pipeline Fire that started later in June would eventually meet up with the Tunnel burn and is further described in this report.

Fire Severity

Despite burning 30 homes, none of the Tunnel Fire was mapped as high soil burn severity. Only eight percent was mapped as moderate severity and the remaining 92 percent was mapped as low or unburned. On the other hand, 12 percent of the canopy mortality map for the Tunnel Fire was greater than 75 percent mortality with another eight percent 50–75 percent canopy mortality.



Cerro Pelado Fire

- **Cause:** Human
- **Location:** Ponderosa, Sandoval County, New Mexico; Santa Fe National Forest
- **Incident Start Date:** 04/22/2022
- **Incident Final Date:** 07/11/2022
- **Final Acreage:** 45,605
- **Final Cost:** $46.8 million ($1,026 per acre)

Located in the southern Jemez Mountains, the Cerro Pelado Located in the southern Jemez Mountains, the Cerro Pelado Fire was found on April 22 exhibiting extreme fire behavior and burning through timber, with grass and understory fuels, and brush. An investigation identified slash pile burning as the likely cause.[11] Discovered at 50 acres, the fire quickly grew to 3,445 acres by the next shift. Most of the fire was managed with a full suppression strategy because of the values at risk, including those of tribal, cultural, historical, and natural significance. Both the Sierra Los Pinos Subdivision and Cochiti Mesa Subdivision were evacuated with about 100 residences in total. By April 24, managers were able to use a confine and contain strategy on about 15 percent of the fire while maintaining a full suppression strategy for the rest of the fire. At this point, the fire was creeping and backing with moderate fire behavior. The ICS-209 reports note numerous recent fuel reduction treatments within and adjacent to the fire. By May 3, managers moved to a full suppression strategy as the fire grew to 25,000 acres. Unfortunately, ten structures were burned in the fire. The final acreage of the fire was 45,605 acres on July 11.

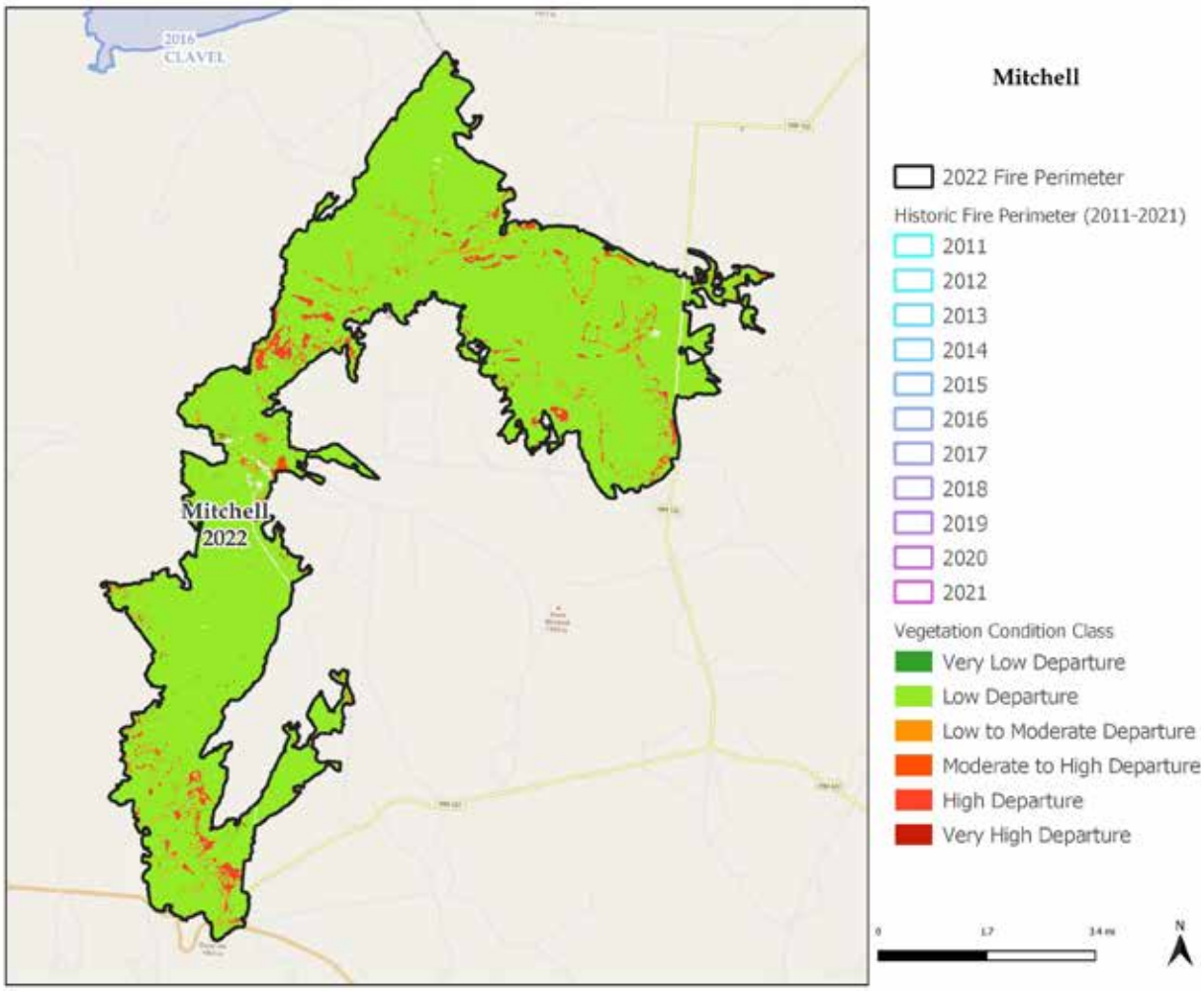
Vegetation and Past Fires

The majority of the Cerro Pelado Fire burned in ponderosa pine forests (41 percent) with additional areas of mixed conifer (20 percent), grassland (16 percent), and oak-conifer (9 percent). About 86 percent of the Cerro Pelado Fire had burned in the 2011 Las Conchas Fire. The Cerro Pelado Fire also burned to the edges of the 2017 Cajete Fire in the north and the 2014 Pino Fire in the south. Within the pervious burn perimeters, fuels were moderate to heavy dead and down logs with light grass/ shrub cover. Fifty two percent of the Cerro Pelado Fire was classified as low or low-to-moderate departure from historical conditions. The remaining 46 percent was moderate-to-highly departed.

Fire Severity

Two thirds of the Cerro Pelado Fire (67 percent) resulted in minimal or low soil burn severity with only one percent, or 380 acres, experiencing high soil burn severity. Less than half of the acres of high soil burn severity occurred on slopes greater than 30 percent. Similarly, 88 percent of the fire caused less than 25 percent canopy mortality. A little over 2,000 acres (5 percent) experienced high mortality of the canopy. The largest areas of high severity fire in the Cerro Pelado Fire were to the east where forests had not burned recently.

11 Cerro Pelado Fire Investigation report https://www.fs.usda.gov/sites/default/files/2023-07/Cerro%20Pelado%20ROI_Approved__Redacted.pdf



Mitchell Fire

- **Cause:** Undetermined
- **Location:** Mosquero, Harding County, New Mexico
- **Incident Start Date:** 04/22/2022
- **Incident Final Date:** 04/29/2022
- **Final Acreage:** 25,000
- **Final Cost:** $135,000 ($5 per acre)

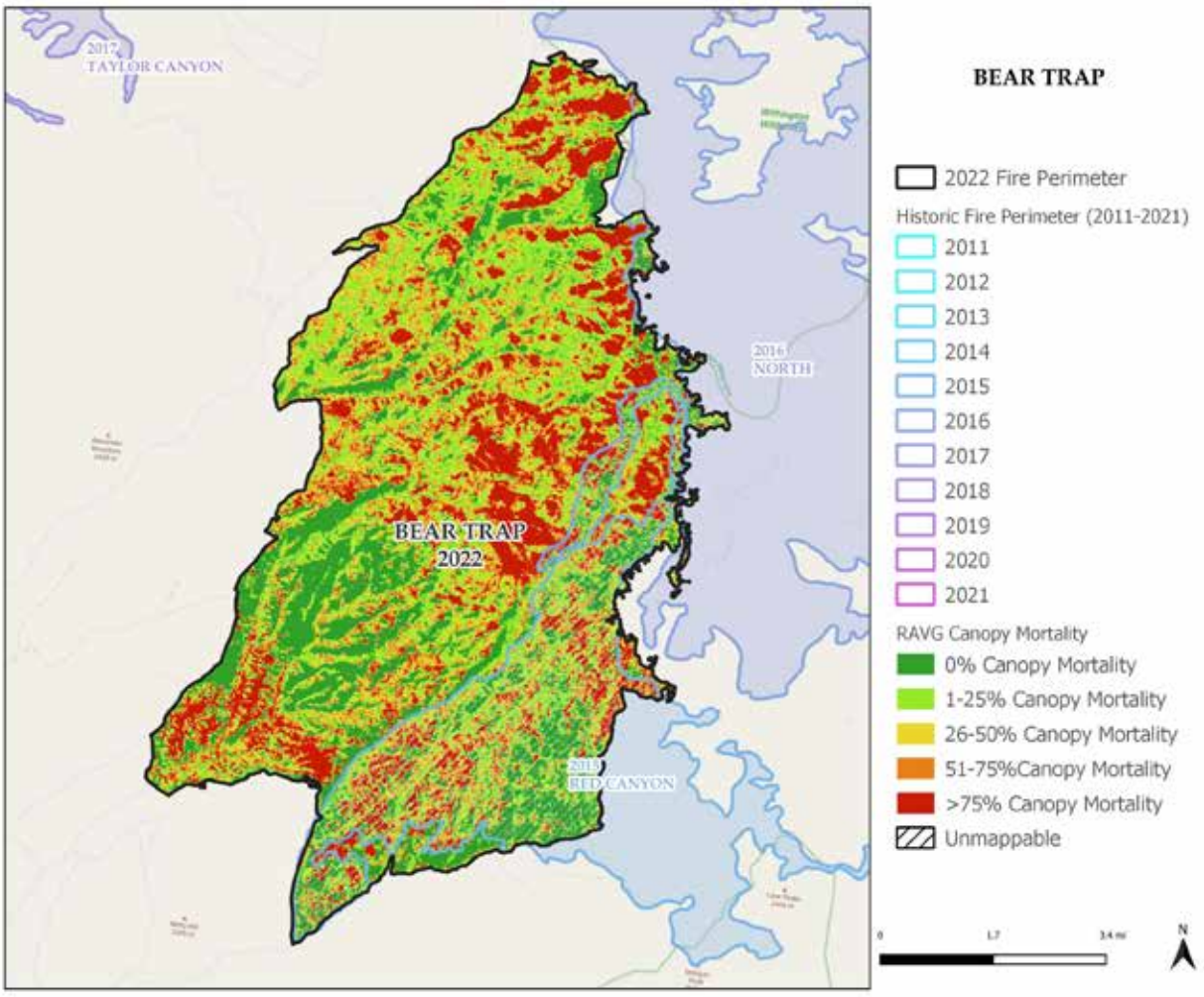
On April 22, the Mitchell Fire was discovered burning with extreme behavior seven miles east of the town of Mosquero, New Mexico. The fuel type carrying the fire was tall grass and brush. Most of the burning happened during the first operational period with 12-mile-per-hour winds from the southeast. Crews were able to make progress early using a full suppression strategy. Within the next two shifts, the fire was more than 50 percent contained and by April 29, containment was at 100 percent.

Vegetation and Past Fires

The Mitchell Fire burned through grasslands (77 percent) with scattered portions of piñon-juniper (7 percent) and scrub (15 percent). The Mitchell Fire did not overlap with any recorded recent fires. Almost all of the Mitchell Fire (93 percent) was classified as low departure from historical conditions.

Fire Severity

Neither soil burn severity nor canopy mortality was available for the Mitchell Fire.



Bear Trap Fire

- **Cause:** Undetermined
- **Location:** Magdalena, Socorro County, New Mexico; Cibola National Forest
- **Incident Start Date:** 05/01/2022
- **Incident Final Date:** 06/08/2022
- **Final Acreage:** 38,225
- **Final Cost:** $19 million ($497 per acre)

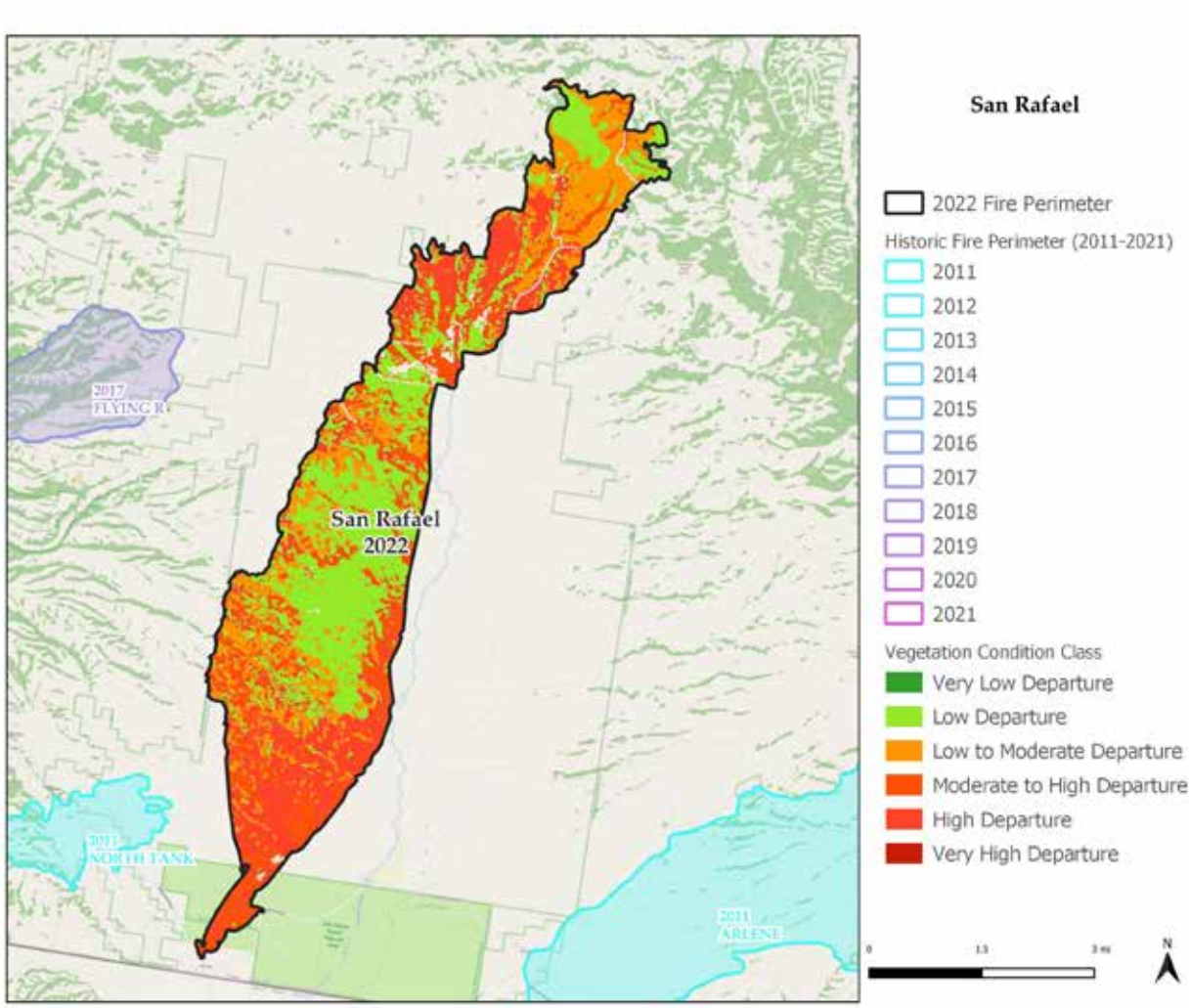
The Bear Trap fire was found May 1, in Socorro County, New Mexico, 22 miles south of the town of Magdalena on the Cibola National Forest. Burning in timber litter and short grass, the Bear Trap Fire was 800 acres with active fire behavior, short crown runs, and short-range spotting. Managers used a full suppression strategy on the Bear Trap Fire. Values at risk included the Withington Lookout and the USDA Forest Service campgrounds, Bear Trap and Hughes Mill. Because of red flag warning conditions, the fire grew to 1,900 acres over the course of one day. With the help of single digit relative humidity, abnormally warmer and drier conditions, back-to-back red flag warning days with poor nighttime relative humidity recoveries, and winds at 20 to 30 miles per hour and gusting up to 40 miles per hour, the fire grew to 5,619 acres in a week's time.

Vegetation and Past Fires

The Bear Trap Fire burned through a mix of ponderosa pine (43 percent), piñon-juniper (30 percent), and mixed conifer (17 percent) forests. A quarter of the Bear Trap Fire burned in the footprint of the 2015 Red Canyon Fire (predominantly the southeast portion, about 9,400 acres). The eastern flank of the Bear Trap Fire also burned into the perimeter of the 2016 North Fire. Past prescribed fires on the northwest flank of the fire also served as control lines. Most (85 percent) of the fire was classified as low or low-to-moderate departure from historical conditions with 14 percent in the moderate-to-high or high departure classes.

Fire Severity

Almost all of the Bear Trap burned with minimal soil burn severity (91 percent) and only 8 percent burned at high severity. Over 2,000 acres of the high soil burn severity were on slopes greater than 30 percent. The canopy mortality mapping suggests a greater impact on aboveground vegetation, with 21 percent greater than 75 percent mortality and another 11 percent at 50 to 75 percent mortality.



San Rafael Fire

- **Cause:** Human
- **Location:** Senoita, Santa Cruz County, Arizona
- **Incident Start Date:** 05/07/2022
- **Incident Final Date:** 05/15/2022
- **Final Acreage:** 11,620
- **Final Cost:** $2.5 million ($215 per acre)

Found in Santa Cruz County, Arizona, on May 5, the San Rafael Fire started in short grass and brush near the town of Senoita, just north of the Mexican border. The initial estimate of the fire was 10,560 acres and it threatened 100 homes and 160 people were evacuated. Red flag warning conditions contributed to the rapid rate of spread. The fire tested the control lines that fire personnel attempted to establish early on. The San Rafael Fire made an initial push to the north from its origin due to valley winds.

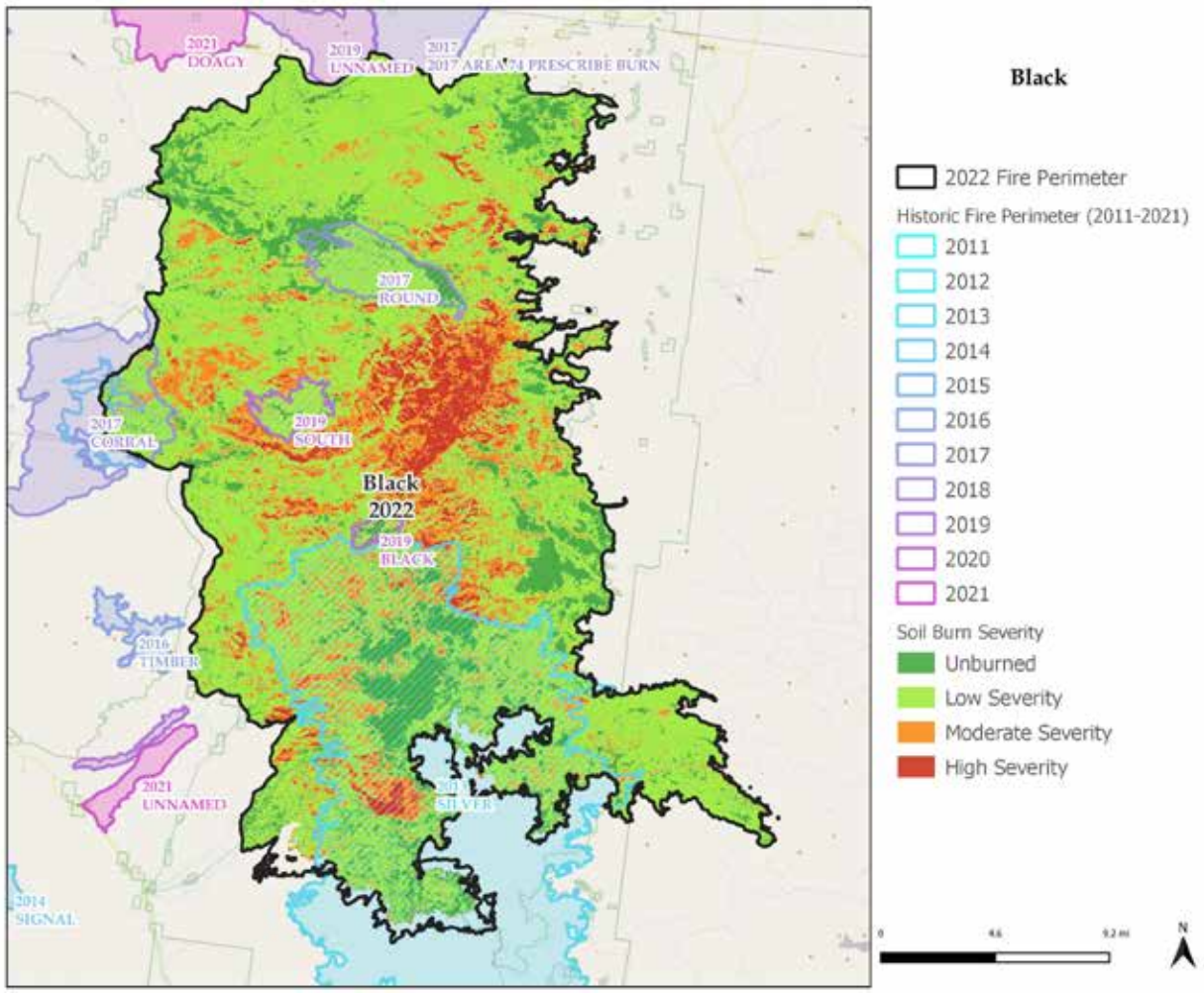
The eight-day, wind-driven fire burned 11,620 acres before full containment on May 15. According to the ICS-209 reports, the strategic goals of fire managers were to fully contain and control the perimeter due to the proximity of wildland-urban interface communities. The fire managers faced two major issues: 1) red flag warning days with high wind speeds and low relative humidity readings and 2) a lack of resources. Initially, fire managers relied on fixed and rotor wing aircraft because of a lack of personnel. It took four days for the firefighters to make significant progress in containing the San Rafael Fire. It took another five days to fully contain.

Vegetation and Past Fires

The San Rafael Fire burned mainly through grass (79 percent) with patches of scrub (7 percent) and conifer-oak (8 percent). The vegetation condition class mapping indicates that the area burned was fairly evenly distributed between low (32 percent), low-to-moderate (21 percent), moderate-to-high (18 percent), and high (26 percent). No recent fires overlapped with the San Rafael Fire.

Fire Severity

No burn severity mapping was available for the San Rafael Fire.



Black Fire

- **Cause:** Human
- **Location:** Mimbres, Catron County, New Mexico; Gila National Forest
- **Incident Start Date:** 05/13/2022
- **Incident Final Date:** 11/17/2022
- **Final Acreage:** 325,136
- **Final Cost:** $6.19 million ($19 per acre)

The Black Fire started 24 miles north of Mimbres and just west of Truth or Consequences, New Mexico. When it was discovered on May 13 at 1,174 acres, it was burning through tall grass and timber litter, making short runs, and spotting. The fire spread through the east side of the Gila National Forest and burned in Sierra County, Catron County, and Grant County. At 325,136 acres, this fire became larger than the Whitewater-Baldy Complex Fire and the second biggest fire recorded in New Mexico. The Black Fire primarily burned in timber with grass and litter understory. Extremely dry fuels and low relative humidity helped push the fire spread. Relative humidities in the single digits and hot, windy conditions caused red flag warnings.

According to the ICS-209 reports, the initial management strategy of the 1,174-acre fire was "confine" on 60 percent of the fire and "full suppression" on 40 percent. One property was threatened at the start of the fire, but no evacuations were necessary initially. In a single day, the Black Fire more than quadrupled in size—reaching more than 7,500 acres by the second day. Once the Type 2 team took over management on May 17, the fire had grown to over 77,000 acres and the strategy shifted to 100 percent full suppression. Fire managers struggled to gain control due to the extremely dry fuels and low relative humidity with little to no recovery at night. Rapid growth of the fire was driven by high fire activity at night and a large fine fuel load due to the previous year's wet monsoon season. On the south and southeast sides of the fire, high winds sent flames and embers into canyons and drainages. By June 6, 50 people had to evacuate. The final ICS-209 report, which declared 100 percent containment, was released on November 17 when the fire had reached 325,136 acres.

Vegetation and Past Fires

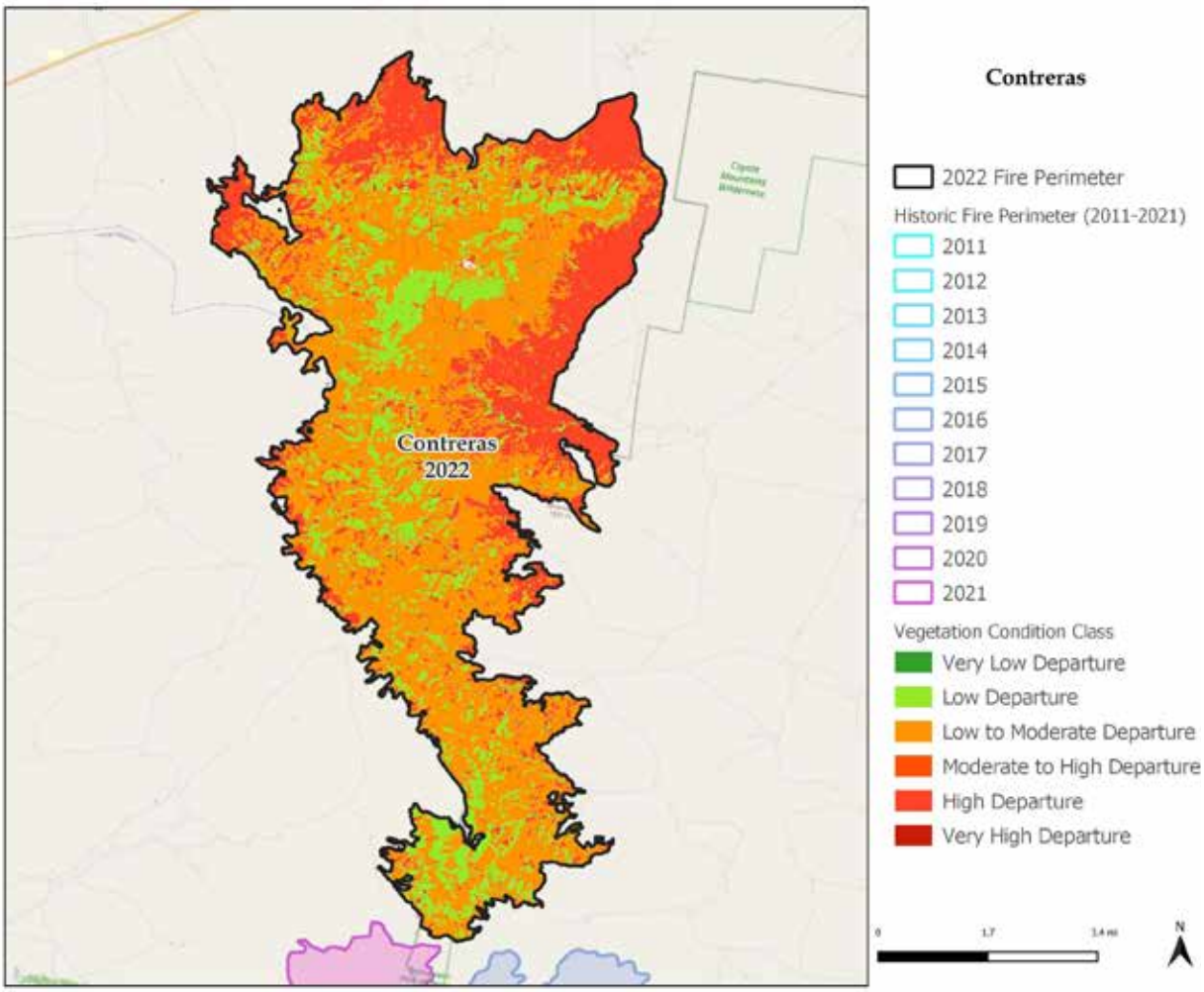
The Black Fire mainly burned through ponderosa pine (36 percent) and piñon-juniper (33 percent). The perimeter also included smaller areas of mixed conifer (11 percent), conifer-oak (nine percent), and grassland (five percent). Because of the fire's size, even the one percent of riparian forest that burned covered over 2,300 acres.

Twenty-nine percent of the 2022 Black Fire had burned recently in the 2019 Silver, 2019 Black, 2019 South, 2017 Round, and 2017 Corral fires. These past fires are likely related

to the relatively high proportion of the Black Fire that burned in vegetation conditions with low and low-to-moderate departure from historical conditions (25 percent and 41 percent). However, over 94,000 acres (29 percent) burned in high departure areas.

Fire Severity

Only 23 percent of the Black Fire burned with moderate or high soil burn severity, though, in this large fire that amounted to over 74,000 acres. Over 245,000 acres of the fire had low or minimal soil burn severity (77 percent). Similarly, 91 percent of the Black Fire experienced less than 25 percent canopy mortality. It is important to note that over 12,000 acres of the Black Fire burned with high soil burn severity on slopes greater than 30 percent, emphasizing the risk of post-fire flooding.



Contreras Fire

- **Cause:** Lightning
- **Location:** Pima County, Arizona
- **Incident Start Date:** 06/11/2022
- **Incident Final Date:** 07/03/2022
- **Acreage:** 29,482
- **Cost:** $13,385 ($0.50 per acre)

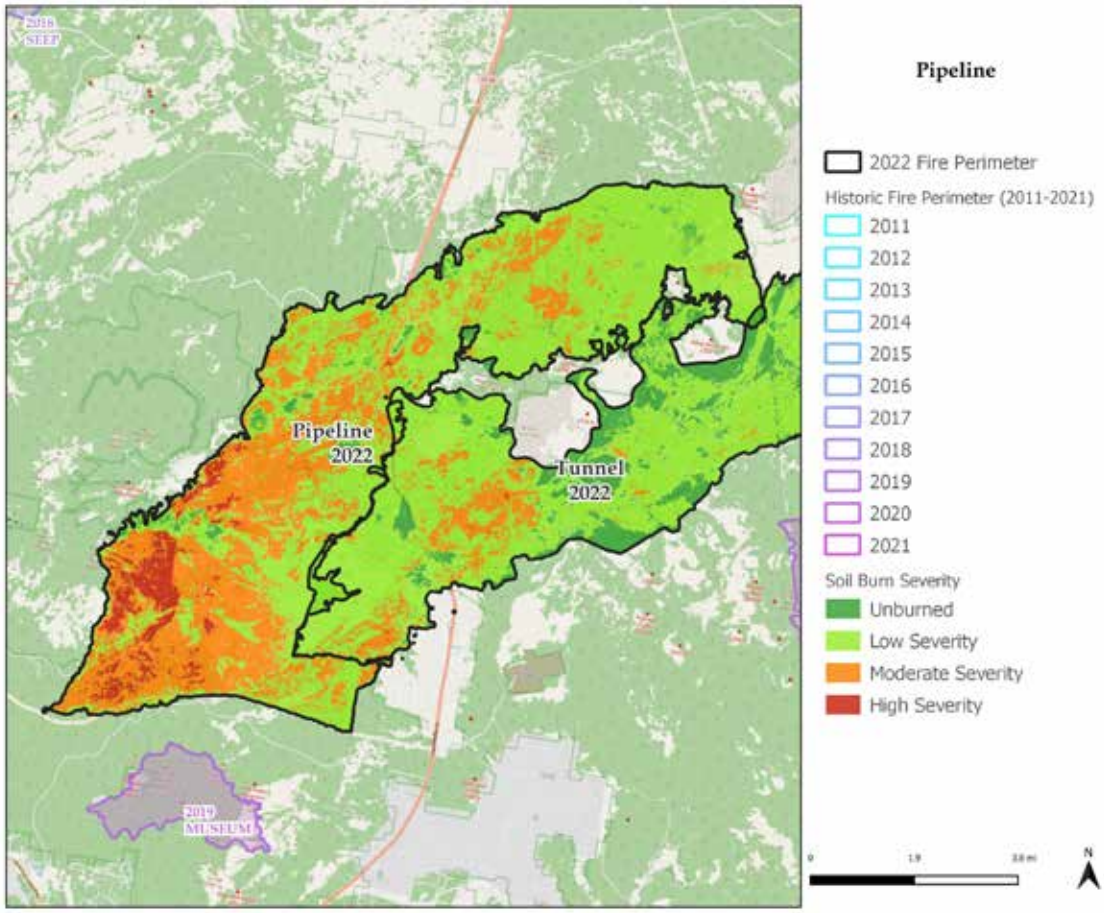
The Contreras Fire started in Pima County, Arizona and was found June 11. The fire was ignited by a lightning strike and found exhibiting moderate fire behavior, backing and flanking in short grass and brush. By the next operational period, and with the help of hot temperatures and low relative humidities, the fire grew to 2,750 acres, with active fire behavior, making wind-driven runs up slopes, and threatening Kitty Peak Observatory and other residential areas. During the following days, the fire burned with extreme behavior. On June 16, the fire rapidly grew to more than 11,000 acres. With the help of extremely dry conditions, a heavy fine fuel component, and grasses standing three feet tall, fire crews experienced a quarter of a mile per hour rate of spread with spotting up to half a mile and 3–6-foot flame lengths.

Vegetation and Past Fires

The Contreras Fire burned in conifer-oak (40 percent), scrub (36 percent), and chaparral (11 percent). The southern and central portions of the fire were low (16 percent) and low-to-moderate (57 percent) departure from historical conditions while the northern portions of the fire tended to be high (26 percent) departure from historical conditions. This fire did not burn in areas that had recently experienced fire.

Fire Severity

No burn severity mapping was available for the Contreras Fire.



Pipeline Fire

- **Cause:** Human
- **Location:** Flagstaff, Coconino County, Arizona
- **Incident Start Date:** 06/12/2022
- **Incident Final Date:** 07/27/2022
- **Final Acreage:** 26,532
- **Final Cost:** $2.3 million ($88 per acre)

When the Pipeline Fire was found on June 12, west of the very recent Tunnel Fire on the Coconino Forest, it had already reached 5,000 acres. Just 11 days after the Tunnel Fire's final report, the Pipeline Fire was described burning with extreme behavior, having wind-driven runs, and long-range spotting. The fuel sustaining the Pipeline Fire was timber, brush, and 2.5-foot-tall grass. The cause of this 26,532-acre fire was listed undetermined, though court documents suggest it was caused by a man burning toilet paper. With resource totals peaking at 835 people, the Pipeline Fire caused the evacuation of 2,100 residents, destroyed one home, and had ten injury/illness reports from responders. One hundred percent containment was reported on July 27.

According to the ICS-209 reports, red flag warning conditions dominated the first few days of the Pipeline Fire. Several years of persistent drought, low relative humidity levels, and high winds pushed the Pipeline Fire northeast, up and around the San Francisco Peaks, toward the 2022 Tunnel Fire scar. Along with threatening over 3,100 homes, these conditions triggered six communities to evacuate and four to be held in "set" status. Wildlife habitats, local watersheds, powerlines, and gas pipelines were other values at risk. The complexity of this fire went from Type 2 to Type 1 because fire personnel were managing not only the Pipeline Fire but also the smaller Haywire Fire that was located east of the Tunnel Fire.

After June 16, when the weather was favorable for firefighters, crews made considerable progress. With a quarter inch of rainfall, temperatures dropping to the mid-30s at the higher elevations, and 90 to 100 percent nighttime humidity recoveries, crews went from 27 percent containment to 60 percent in four operational shifts.

Vegetation and Past Fires

The Pipeline Fire burned in ponderosa pine (52 percent) and piñon-juniper (11 percent) with scattered areas of other vegetation types. Nearly half of the Pipeline Fire was considered high departure (47 percent) from historical conditions with most of the remaining area considered low-to-moderate departure (34 percent). The Pipeline Fire burned into the footprint of the Tunnel Fire that had started earlier in the summer and been contained on June 1.

Fire Severity

The majority of the Pipeline Fire burned at minimal severity (61 percent) with 34 percent in the moderate soil burn severity category. Only five percent of the Pipeline Fire was mapped as high soil burn severity. However, there were over 3,300 acres of moderate burn severity on slopes greater than 30 percent.

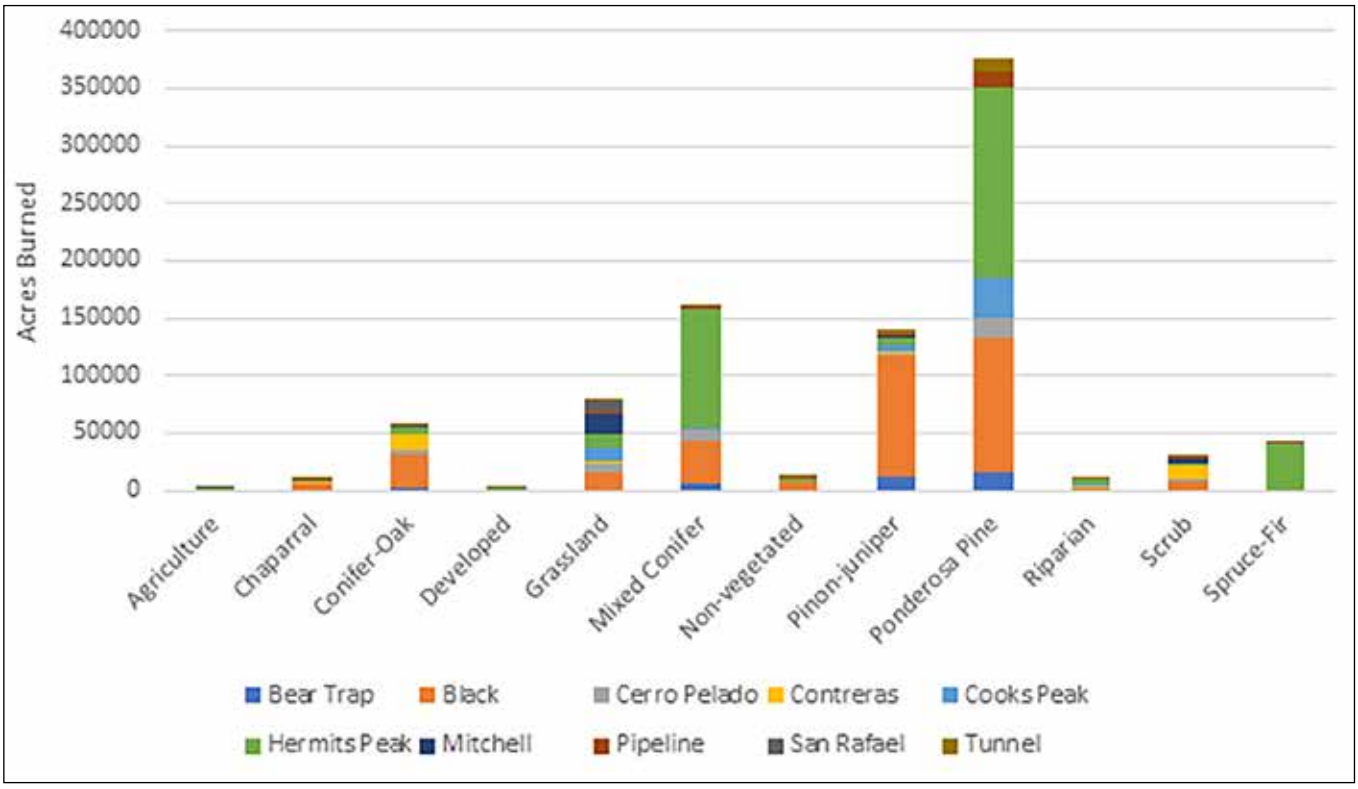


Figure 4. Summary of acres burned in the largest fires of the 2021 fire season by vegetation type.

Conclusion

This report covers the ten largest wildfires of the 2022 fire season in Arizona and New Mexico. These ten wildfires represented 87 percent of all acres in the Southwest burned by wildfire in 2022. The most widespread vegetation types affected by these fires were ponderosa pine, piñon-juniper, and mixed conifer (Figure 4). The fires reviewed in this report cover more area than recent reports in this series. More than three times the area of ponderosa pine forest burned in the fires covered by this year's report compared to a similar set of fires in 2021. While almost no mixed-conifer forests burned in the largest fires of 2021, in 2022 over 150,000 acres of mixed conifer burned in the just the ten largest fires. The distribution of vegetation types was strongly influenced by the two largest fires, HPCC and the Black Fire. These fires both burned significant areas of ponderosa pine, but the HPCC burned more mixed conifer and Black Fire burned more piñon-juniper.

Full soil burn severity data were available for seven of the ten fires analzyed in this report, covering 855,000 acres (93 percent of acres in report). Sixty-four percent of the area covered by these three fires was classified as low or moderate soil burn severity (Figure 5). The HPCC caused most of the areas of high soil burn severity.

Rapid Assessment of Vegetation Condition after Wildfire (RAVG) data were available for six of the twelve fires covered in this report or 86 percent of the acres burned (Figure 3). Over half of the RAVG mapped areas (426,000 acres) showed no detectable canopy mortality, while nearly 17 percent (136,000 acres) showed greater than 75 percent mortality. The HPCC was responsible for the most high canopy morality acres, while the Black Fire resulted in the majority of the low and unburned acres. This difference may be due to recent fires in the areas where the Black Fire burned and relatively low departure from historical conditions of much of that area.

Only 14 percent of the area covered in this analysis was highly departed from historical conditions based on the LANDFIRE Vegetation Condition Class analysis (Figure 6). Fires such as the Mitchell Fire that burned through grass tend to be classified as less departed from historical conditions and have lower soil burn severity. In some ecosystems, such as lower elevation deserts, even small areas of fire can have negative ecological impacts. Fires in 2022 had many more acres classified as moderately departed from historical conditions than 2021, but many fewer acres in the low departure category.

Despite not causing any fatalities, the fires of 2022 had a significant negative impact on people and communities. As described above, the HPCC alone caused over 27,000 people to evacuate and damaged or destroyed over 1,000 structures. The Black, Cerro Pelado, Contreras, Pipeline, and Tunnel fires all destroyed structures. Seven of the ten fires in this review caused evacuations. Both the Tunnel and Pipeline fires forced the evacuation of over 2,000 people.

The 2022 fire season was also unusual because only one of the ten large fires was clearly caused by lightning. While the cause of some of these large fires remains under investigation, it is

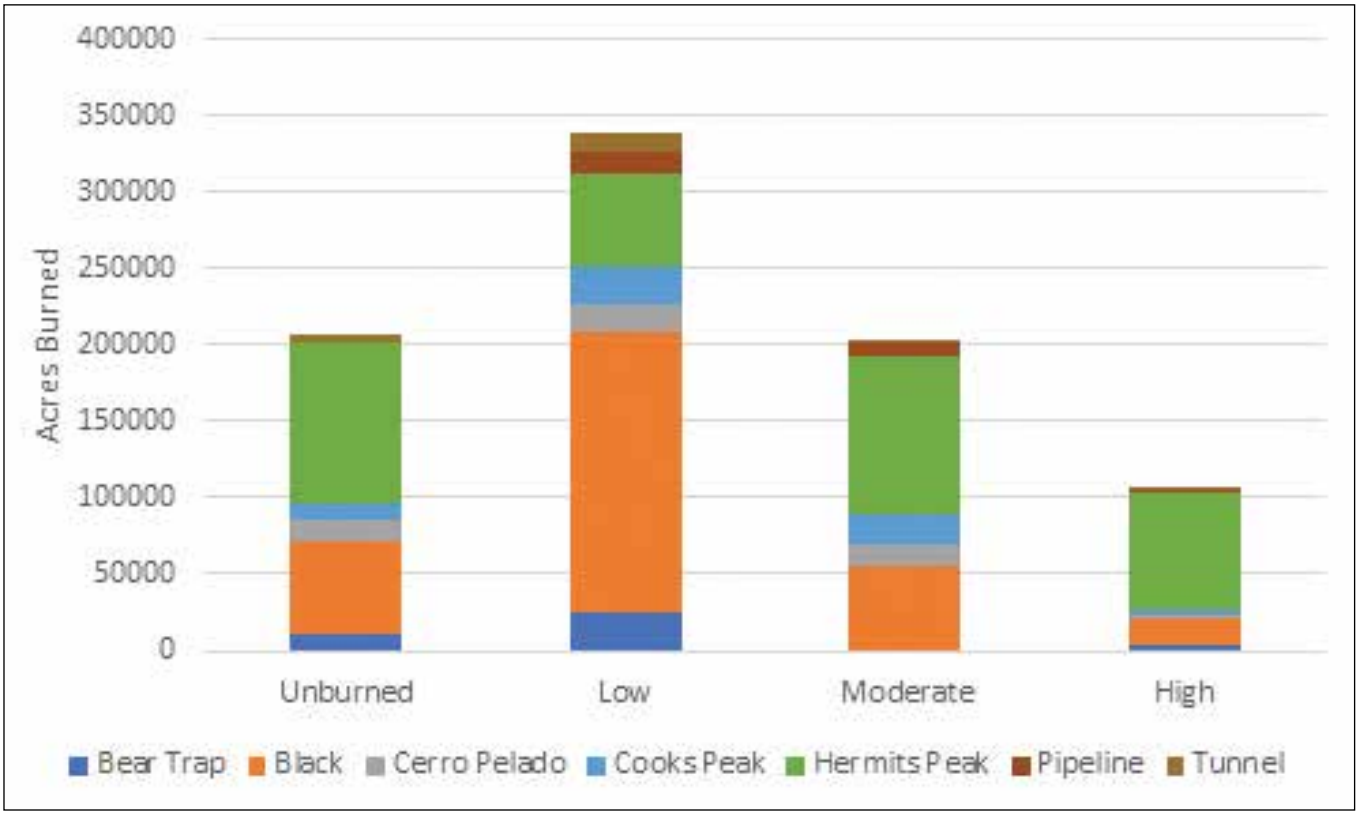


Figure 5. Summary of acres burned by soil burn severity class.

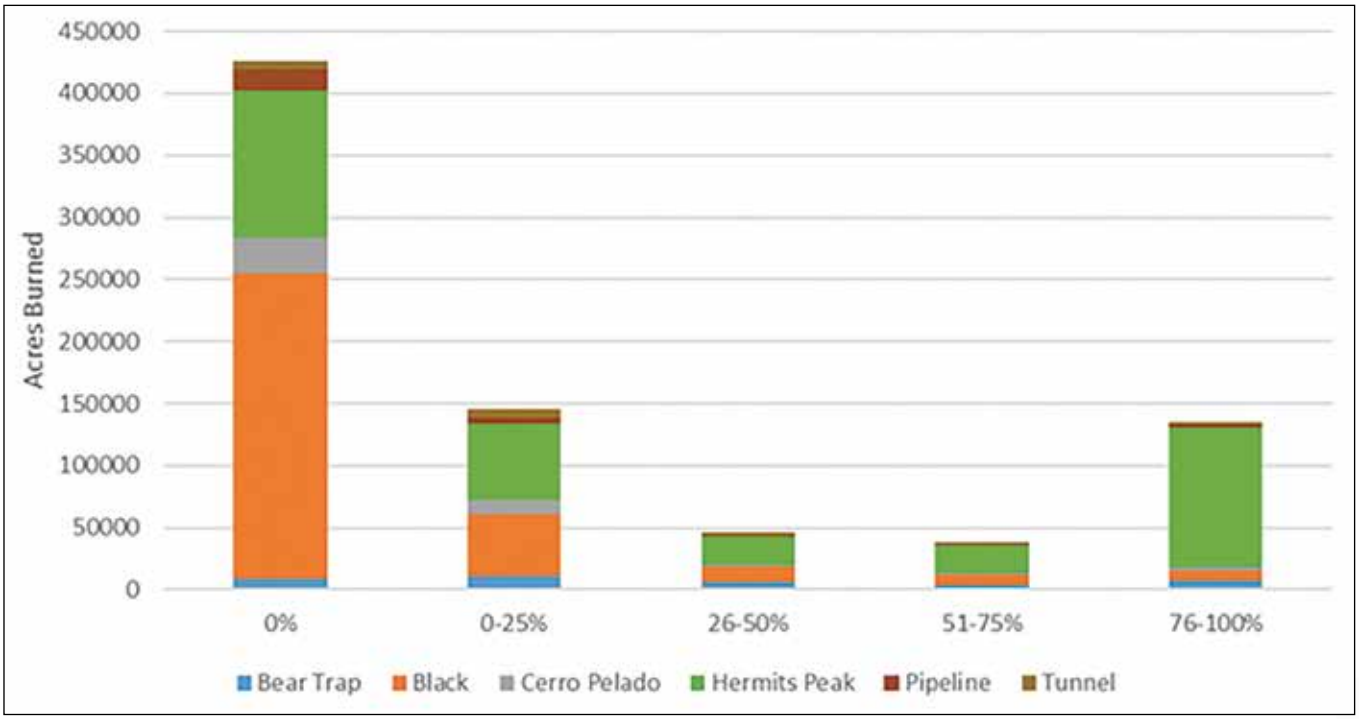


Figure 6. Summary of acres burned by canopy mortality class.

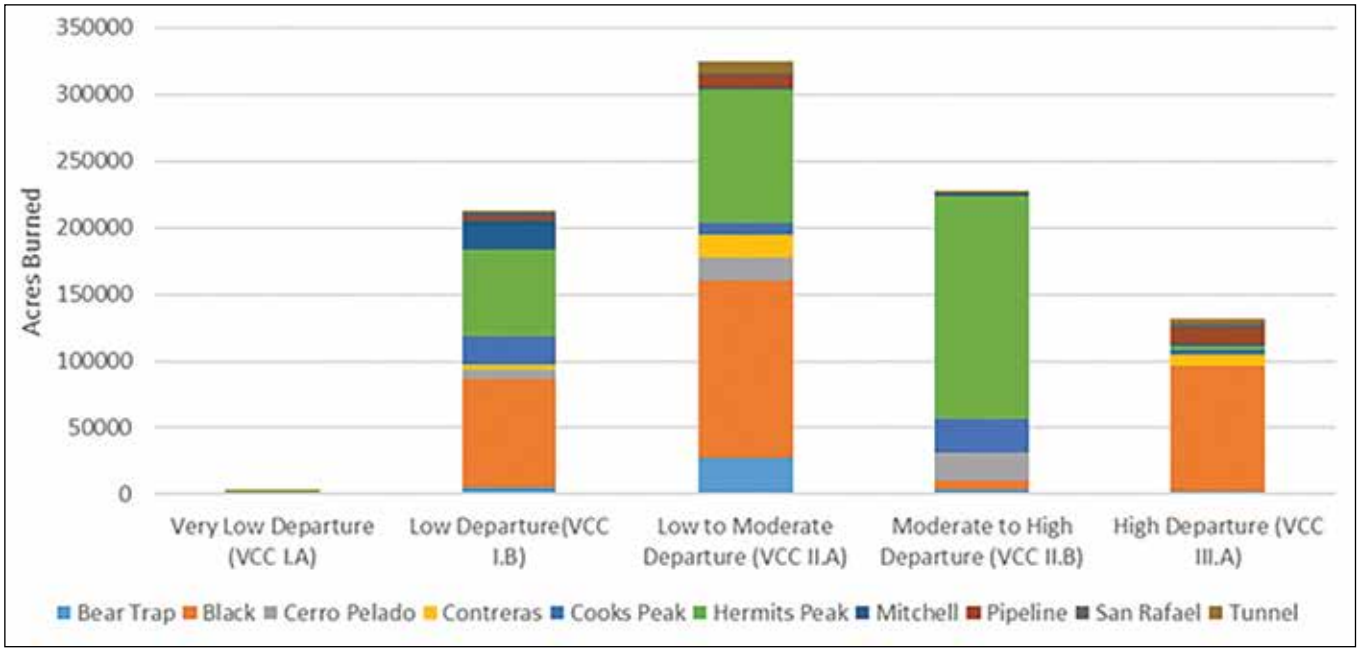


Figure 7. Summary of acres burned by vegetation condition class.

clear humans drove large fire ignitions in 2022. Past season overview reports noted that the majority of the large fires in the Southwest are caused by lightning (i.e., naturally ignited).

Most of the large fires of 2022 burned in areas that had not burned recently. About 145,000 acres, or about 16 percent, of the ten large fires in this review reburned pervious fire footprints. For three fires, past fires (both prescribed and wildfire) were a key part of suppression. Both prescribed fires and the 2016 North Fire became control lines for the Bear Trap Fire. The Cerro Pelado Fire burned to the edges of the 2017 Cajete Fire in the north, the 2014 Pino Fire in the south, and reburned large portions of the 2011 Las Conchas Fire. The Black Fire burned in a landscape of past burns, including some prescribed fires on the northern edge.

The HPCC alone cost over $330 million just for suppression (post-fire rehabilitation will be a tremendous additional cost). The remaining nine fires cost $95 million and ranged from over $1,000 per acre for the Cerro Pelado Fire to less than a dollar per acre for the Contreras Fire. This wide variation in costs highlights the differences in values at risk, vegetation types, and other factors.

In past years, managers were able to take advantage of conditions to use strategies other than full suppression on some fires or portions of fires. In 2022, managers used a full suppression strategy almost exclusively on the fires in this review. This was likely driven by dangerous weather conditions, values at risk, and the constraints on firefighting resources caused by multiple large fires (e.g., the HPCC and the Black Fire). The hot, dry, and windy conditions that drove the largest fires of 2022 fire season aligns with the climate trends predicted for the region.

Appendix I. Fire Statistics

General				Vegetation Departure		
Name	**Acres**	**Cost**	**cost/ac**	**Low**	**Medium**	**High**
HPCC	341,735	$330,100,293	$966	19%	78%	1%
Cooks Peak	59,359	$12,500,000	$211	36%	57%	6%
Tunnel	19,105	$5,078,000	$266	5%	53%	21%
Cerro Pelado	45,605	$46,800,000	$1,026	14%	85%	0%
Mitchell	25,000	$135,000	$5	93%	3%	3%
Bear Trap	38,225	$19,000,000	$497	14%	79%	6%
San Rafael	11,620	$2,500,000	$215	32%	40%	26%
Black	325,136	$6,190,000	$19	25%	43%	29%
Contreras	29,482	$13,385	$0.45	16%	58%	26%
Pipeline	26,532	$2,330,000	$88	14%	35%	47%
Sum	**921,799**	**$94,546,385**	**$329**			

	Soil Burn Severity - percentages				RAVG Canopy Mortality -				
Name	**Unburned**	**Low**	**Moderate**	**High**	**0%**	**0-25%**	**26-50%**	**51-75%**	**76-100%**
HPCC	30	18	30	22	35	18	6	7	33
Cooks Peak	17	42	33	8	-	-	-	-	-
Tunnel	25	67	8	0	36	33	11	8	12
Cerro Pelado	31	36	32	1	63	25	4	2	5
Mitchell	-	-	-	-	-	-	-	-	-
Bear Trap	19	58	17	6	23	29	16	11	21
San Rafael	-	-	-	-	-	-	-	-	-
Black	19	58	17	6	76	15	4	2	2
Contreras	-	-	-	-	-	-	-	-	-
Pipeline	5	56	34	5	64	16	5	4	12

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