



2014 Wildfire Season: An Overview

Southwestern U.S.

JULY 2015



**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 and 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: The McRae Fire was one of the 12 largest fires of 2014 (larger than 4,000 acres) described in this report. The fires detailed in this report represent about 80% of the area burned by wildfire in the Southwest in 2014. *Photo courtesy of Prescott Crew 2, USDA Forest Service via InciWeb.*

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Introduction

Southwestern ecosystems are fire-adapted and fire is arguably the most important process in these forests and grass lands. This overview is designed to help everyone from the general public to natural resource managers better understand the past fire season. This report describes the vegetation impacted by the 12 largest fires (greater than 4,000 acres) of 2014 and the degree to which fires affect resources including soils, vegetation, and structures.

Weather, climate, vegetation type, fuel conditions, and topography all influence how an individual wildfire burns on the landscape and whether it will result in beneficial effect. Some fires will leave a large number of unburned patches creating a mosaic burn pattern, whereas others will burn more continuously. Managers approach each fire with multiple objectives that range from managing the fire to protect public safety, homes, and property to managing the fire to improve natural resources. As 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

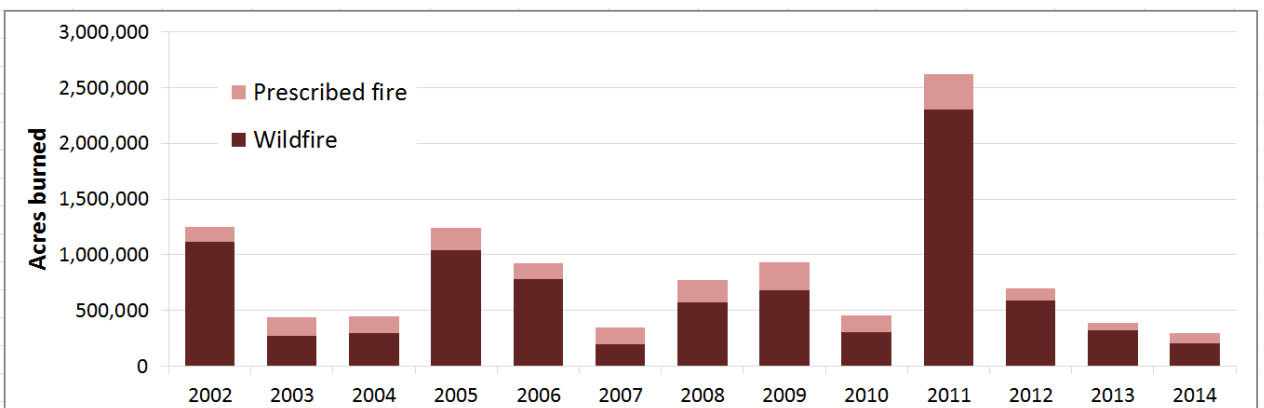
A full range of wildland fire response strategies may be employed to meet these objectives, including containing, confining or suppressing the wildfire. Multiple wildland fire management activities such as point protection, direct line construction, and monitoring exist within these strategies. Wildland fire management strategies are based on a thoughtful and systematic risk-based approach that takes into

account firefighter and public safety, cause of the wildfire, location, land management plans, availability of resources, values at risk, and social factors. Federal policy dictates that “initial action on human-caused wildfire will be to suppress the fire.”¹ Regardless of the wildland fire management strategies, wildfires in fire-adapted ecosystems often result in resource benefits, whether they fit the criteria for the management of that wildfire or not. Again, it is useful to refer to federal policy: “fire management is one tool in the restoration process and should be integrated with other land management activities.”¹

This report follows the format of last year’s *2013 Wildfire Season: An Overview, Southwestern U.S.*³ to facilitate a comparison between years. In 2013, the eight largest fires burned 215,380 acres. In 2014, the 12 largest fires (those greater than 4,000 acres) burned only 177,907 acres, which represents nearly 80% of the total acreage burned in 2014 in the Southwest. 2014 stands out as having the fewest acres burned in the last 13 years according to National Interagency Fire Center.

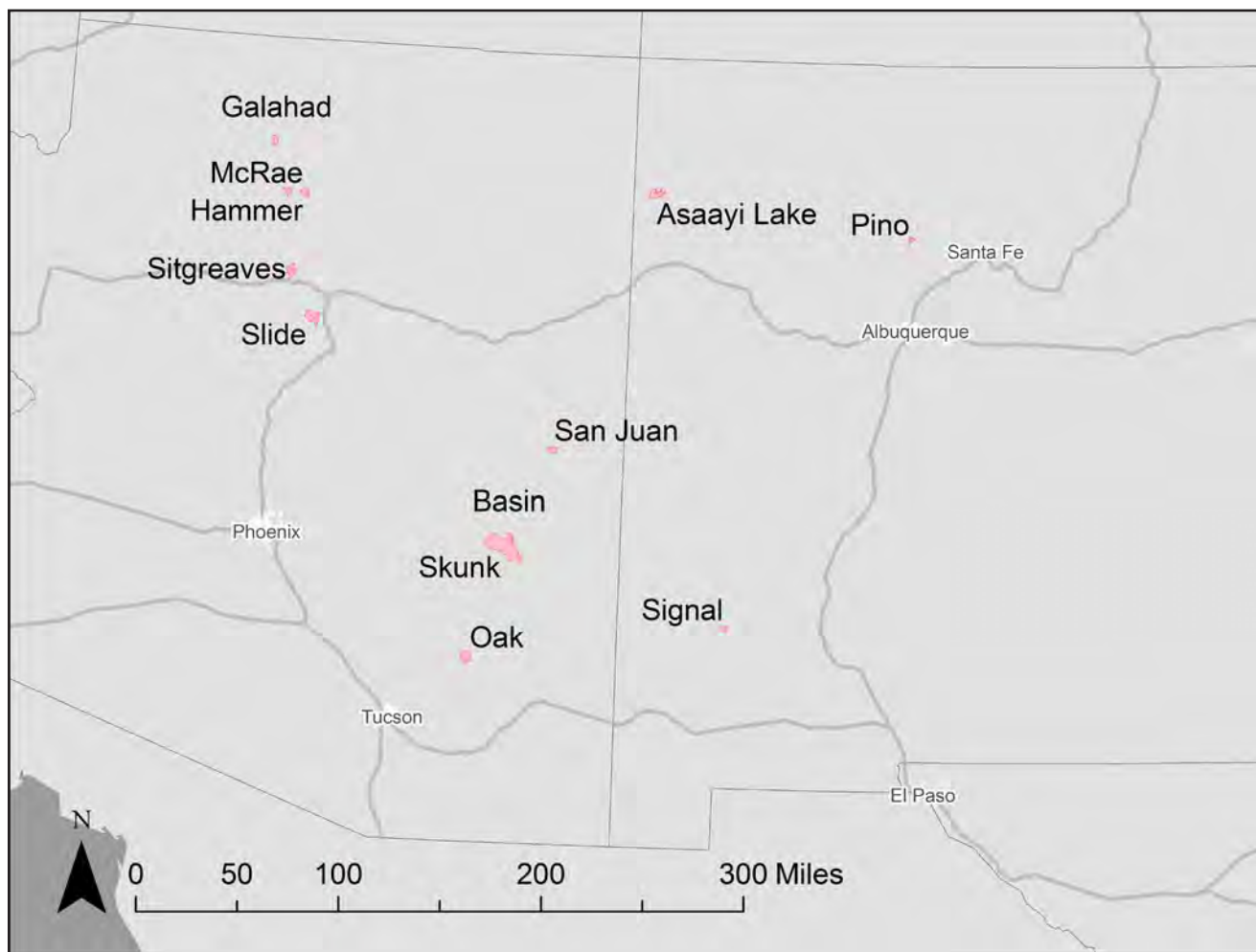
Though 2014 had fewer acres burn, a greater percentage burned under controlled conditions through prescribed fire. In most years since 2002, about 20% of the total acres that burned were prescribed, but in 2014, 30% of the acres burned were prescribed fire. Based on the Southwest Coordination Center’s (SWCC) listing, managers used confine and containment strategies on more of the large fires in 2014 than in

1. *Guidance for Implementation of Federal Wildland Fire Management Policy* www.nifc.gov/policies/policies_documents/GIFWFMP.pdf
2. *2013 Wildfire Season: An Overview, Southwestern U.S.* <http://nau.edu/ERI/Banner/2013-Wildfire-Season--An-Overview-Southwestern-U-S-/>
3. National Interagency Coordination Center Wildland Fire Annual Reports (www.predictiveservices.nifc.gov/intelligence/intelligence.htm)



All wildfires and prescribed fires in Arizona and New Mexico.³





The large fires from 2014 analyzed in this report.

previous years and a full suppression strategy less often.⁴ In 2014, only 65% of the fires larger than 100 acres were managed with full suppression strategies, whereas in 2013, that number was 86%. Put another way, in 2014 more than 79,000 acres burned in fires where the wildland fire management strategy was point protection, containment, confinement, or monitoring. It is important to emphasize that multiple strategies were used in each individual fire, so categorizing a fire as a “suppression fire” is inherently problematic. In fact, federal agencies only recognize two types of fires: prescribed fires and wildfire. However, there appear to be notable differences (such as cost) between those fires where the wildland fire management strategies focused on full suppression and those fires where confine and contain strategies were more prevalent.

Most of the 2014 fires burned in Arizona and

4. 2014 Southwest Area Year-To-Date Wildland Fires > 100 Acres from the Southwest Coordination Center available at: http://gacc.nifc.gov/swcc/predictive/intelligence/ytd_historical/historical/fire_data/ICS-209_Fires/Data_Tables/2014/Documents/2014_ICs-209_Text.pdf

included about 85% of the total acreage in the Southwest. This overview only includes three New Mexico fires: Assayii Lake, Pino, and Signal Fires; the other nine fires all burned in Arizona: Basin, Galahad, Hammer, McRae, Oak, San Juan, Sitgreaves, Skunk, and Slide. These 12 fires are listed in order of size starting with the largest (with adjacent fires listed together).

Regional Context

Seasonal fire potential outlooks updated monthly by SWCC Predictive Services starting in early 2014 highlighted the severe and long-term drought and accurately predicted some reduction in drought in New Mexico (http://gacc.nifc.gov/swcc/predictive/predictive_services.htm). Most importantly, the outlooks accurately reflected decreasing expectations for a severe fire season as they were updated through the early spring. Fine fuel loading was normal to above normal going into the 2014 fire season due to periods of above normal precipitation during the 2013 monsoon. Below normal snowpack during the 2013–2014 winter added to long term drought impacts. Despite these factors, increasingly variable weather through spring 2014 brought



bouts of cooler and more moist conditions that mitigated the threat for widespread fire outbreaks and long duration fires. This more variable weather pattern through spring 2014 and the fairly robust monsoon during summer 2014 were likely connected to a gradual shift towards an El Niño pattern, which usually brings wetter weather to the Southwest.

Data Sources

The same data sources used in the 2013 report were used for this year's overview. Most details on the 2014 fires were drawn from the Inciweb website. Inciweb (inciweb.nwcg.gov) is an interagency information management system designed to provide the public a single source of incident related information. Because Inciweb only sporadically reports costs, where possible, Incident Status Summary (ICS-209) reports were collected to document suppression or management costs. The cost data from each fire are collected in a final table at the end of the document. The 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. Though the strategic objectives change during a fire, review of the most common or persistent strategic objectives for each fire provides some insight into the overarching objectives.

Boundaries for each fire were taken from the Geospatial Multi-Agency Coordination (GeoMAC) archive of fire perimeter maps (rmgsc.cr.usgs.gov/outgoing/GeoMAC/). GeoMAC also provides the perimeters of fires back to 2000, which provided a historic context for this year's fires.

LANDFIRE: Vegetation

Basic information about the vegetation and topography of the area burned is available from the LANDFIRE project (www.landfire.gov). LANDFIRE provides nationally consistent, scientifically based maps of existing vegetation as well as vegetation condition class (VCC). VCC was formerly referred to as Fire Regime Condition Class or FRCC. VCC is a map of how the existing vegetation has departed from an estimated natural or historic condition. In the Southwest, this departure is generally due to a lack of fire, past logging, and grazing and results in greater density of trees and less healthy conditions. VCC is a particularly useful metric because it integrates information on existing vegetation, historic vegetation, and fire regimes into one variable. It has been used to help determine where to focus restoration efforts.

Wildland Urban Interface (WUI)

Another geospatial dataset that helps put fires in context is the location and density of housing, often referred to as the WUI. The Silvis Lab at University of Wisconsin developed a nationwide map of the WUI based on U.S. Census data (silvis.forest.wisc.edu/

maps/wui/2010/download). The Silvis map uses fairly standard definitions of the two main WUI conditions: intermix (one or more structures per 40 acres) and interface (three or more structures per acre, with shared municipal services).

Soil Burn Severity

Soil burn severity maps provide Burned Area Emergency Response (BAER) teams a method to quantify soil impacts and the potential for post-fire erosion (<http://activefiremaps.fs.fed.us/baer/download.php>). In the immediate aftermath of a fire, 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 the 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; but some combine the last two categories into a "low/unchanged" category. The distribution of soil burn severity is included for those fires for which it is available both in the individual fire discussions as well as in final summary table.

Rapid Assessment of Vegetation Condition after Wildfire (RAVG)

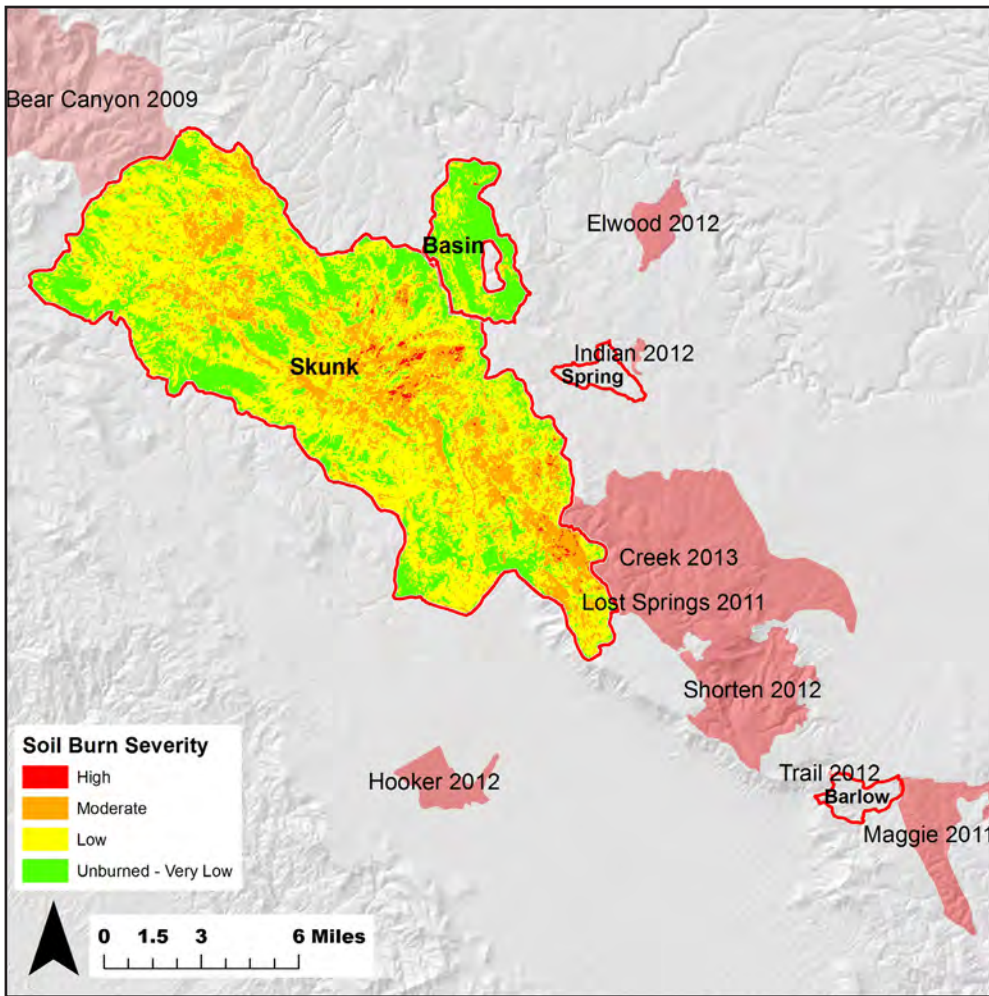
RAVG maps estimate canopy mortality (www.fs.fed.us/postfirevegcondition). The U.S. Forest Service Remote Sensing Applications Center provides RAVG analysis as a first approximation of areas that may require reforestation treatments because of canopy killed by high severity fire. RAVG maps are created for wildfires that burn greater than 1,000 acres of forested U.S. Forest Service land or fires where it is 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 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.

Caveats

There are important caveats for all the data used in this summary. First, the fire information presented here was taken from official sources in October 2014 and may not include updates or revisions. Second, the geospatial data used to generate the maps and tables are also based





Soil burn severity map for the Skunk and Basin Fires

on the best available information, but these data have errors and uncertainties. For example, the remote sensing data used in all these datasets can include errors introduced during collection, processing, and interpretation. Management decisions should be based on more detailed observations on the ground.

Skunk Fire

The Skunk Fire was naturally ignited on April 19 and continued to burn until August 26 on the San Carlos Apache Reservation. Over that time, the Skunk Fire burned about 73,622 acres, making it the largest fire in the Southwest in 2014. The cost of the Skunk Fire was \$2 million, or about \$27 per acre. The Southwest Coordination Center lists the Skunk Fire as managed using suppression strategy and other official bulletins also indicate that it was being managed to meet resource objectives. A recent essay describes in detail how the San Carlos Apache fire team managed the Skunk Fire to benefit the forest and help restore the natural fire

5. Squaring the Triangle: Fire at San Carlos by Stephen Pyne www.wildfirelessons.net/viewdocument/?DocumentKey=4ac708d6-fd70-4aff-a1f9-6ba991ad5ecc

regime.⁵ The Basin Fire burned an area adjacent to the Skunk Fire and is described in the next section. Two other small fires, the Spring Fire and the Barlow Fire burned nearby, but are smaller than 2,000 acres and hence details for these fires are not included in this overview.

Vegetation, Past Fires, and Wildland-Urban Interface

The Skunk Fire burned through a wide range of vegetation types including piñon-juniper, chaparral, conifer-oak, and ponderosa pine.

Vegetation Type	Percent within Fire Perimeter
Piñon-juniper	44%
Chaparral	13%
Conifer-oak	17%
Ponderosa	12%
Mesquite	5%
Riparian	4%
Grassland	4%



The Skunk Fire burned up to a matrix of past fires. The 2009 Bear Canyon Fire footprint is on the northwest edge of the Skunk Fire perimeter, while the 2013 Creek Fire and 2011 Lost Springs Fire footprints are on the southeast edge. A number of other, smaller fires have burned in the area since 2000. Most of the area burned in the Skunk Fire (65%) was moderately departed from historic conditions. Only a very small portion (3%) was mapped as highly departed from historic conditions. The area where the Skunk Fire burned is classified as uninhabited on the WUI maps.

Fire Severity

Preliminary soil burn severity maps were available for the Skunk Fire and they indicated that the majority of area burned with little or no soil impacts. No areas were classified as high soil burn severity and 80% of the fire area was labeled low or unburned. Fire severity was similar across all vegetation types, though the proportion of moderate soil impacts was greatest (33%) in chaparral while conifer-oak, riparian, and mesquite had the lowest proportions of area with moderate or high severity soil impacts.

Basin Fire

The Basin Fire was started by lightning on April 22 on the San Carlos Apache Reservation, just three days after the Skunk Fire started. According to the Southwest Coordination Center's listing, the Basin Fire was managed with a "monitor / confine / contain" strategy until it was fully contained a month later. The cost of the 6,018-acre Basin Fire was \$21,000, or about \$3 per acre. *Vegetation, Past Fires, and Wildland-Urban Interface*
The Basin Fire burned in vegetation similar to its neighboring fire, the Skunk Fire. It included a greater percentage of ponderosa pine and less chaparral.

Vegetation Type	Percent within Fire Perimeter
Piñon-juniper	39%
Oak - conifer	22%
Ponderosa	26%
Riparian	8%
Chaparral	3%

The Basin Fire burned in the same matrix of past fire footprints as described above for the Skunk Fire, but no recent wildfire (except the Skunk) was directly adjacent to the Basin Fire. Almost all of the area in the Basin Fire perimeter (95%) was mapped as moderately departed from historic conditions. As with the Skunk Fire, the Basin Fire burned in an area mapped as uninhabited.

Fire Severity

Based on the same preliminary data used to describe the Skunk Fire above, the Basin Fire had an even smaller

effect on soils. Most of the area within the perimeter was mapped as unburned (72%) or low severity (27%) and less than 60 acres were mapped as moderate soil impacts (1%). Since the Basin Fire had so few effects on soils (according to the preliminary maps) there are few soil burn severity differences between the vegetation types.

Slide Fire

The Slide Fire burned in and around Oak Creek Canyon in Arizona starting on May 20. The fire was started by humans. By May 21, the strategic objectives in the ICS-209 for the Slide Fire were to keep fire out of structures, mitigate any loss, and keep the fire within a well-defined perimeter. Fire managers fully contained the fire on June 4 after it had burned 21,227 acres at a cost of \$10,211,000, or about \$481 per acre. A virtual field trip of the Slide Fire and more discussion of the fire's management is available from the Southwest Fire Science Consortium (<http://swfireconsortium.org/slide-fire-field-trip-june-13-2014/>). The Slide Fire also received an award for progressive management tactics and strategies used to apply beneficial fire to the landscape under difficult conditions.⁶

Vegetation, Past Fires, and Wildland-Urban Interface

Most of the vegetation within the Slide Fire was ponderosa pine forest, though the perimeter included small patches of a number of other vegetation types.

Vegetation Type	Percent within Fire Perimeter
Ponderosa	77%
Riparian	7%
Piñon-juniper	4%
Chaparral	4%
Mixed Conifer	3%
Conifer-oak	3%

The Slide Fire burned up to the footprints of two fires from 2009: the Taylor and Bear fires. Most of the area burned in the Slide Fire was moderately departed from historic conditions (90%). Though no areas classified as intermix or interface burned in the Slide Fire, Oak Creek Canyon was evacuated soon after the Slide Fire started and two large neighborhoods to the north were in pre-evacuation status.

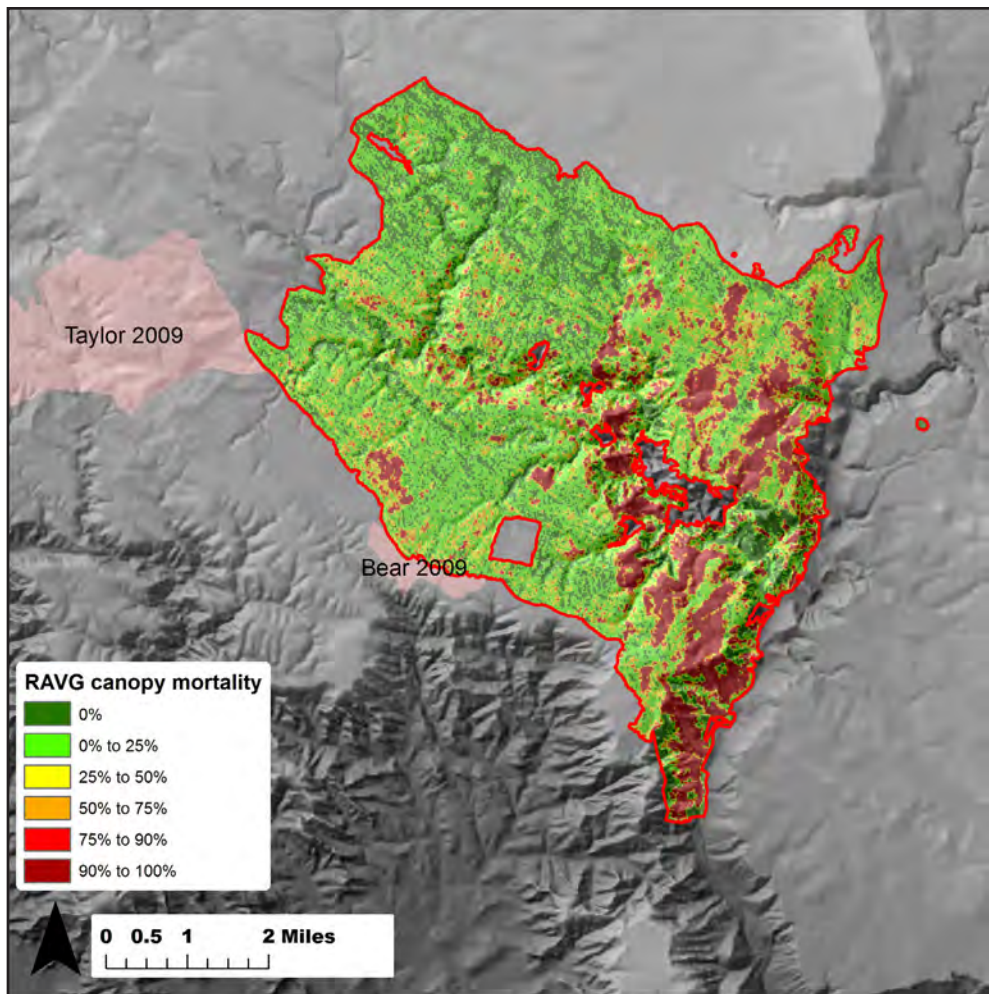
Fire Severity

The preliminary map suggests that most of the Slide Fire burned with low or no soil burn severity. Only 14%, or nearly 3,000 acres, burned with high soil burn severity. Thirty two percent of the Slide Fire was classified as moderate severity with the remainder as either low or unburned.

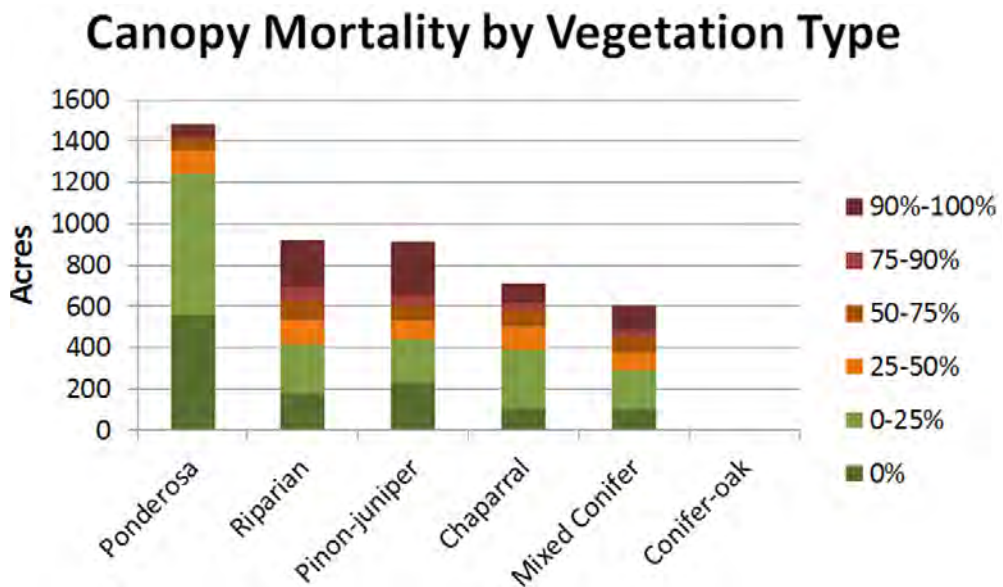
The RAVG data on canopy mortality are similar to the soil burn severity data; most acres are in the

6. 2014 Incidents of the Year <http://swfireconsortium.org/2014-incident-of-the-year/>



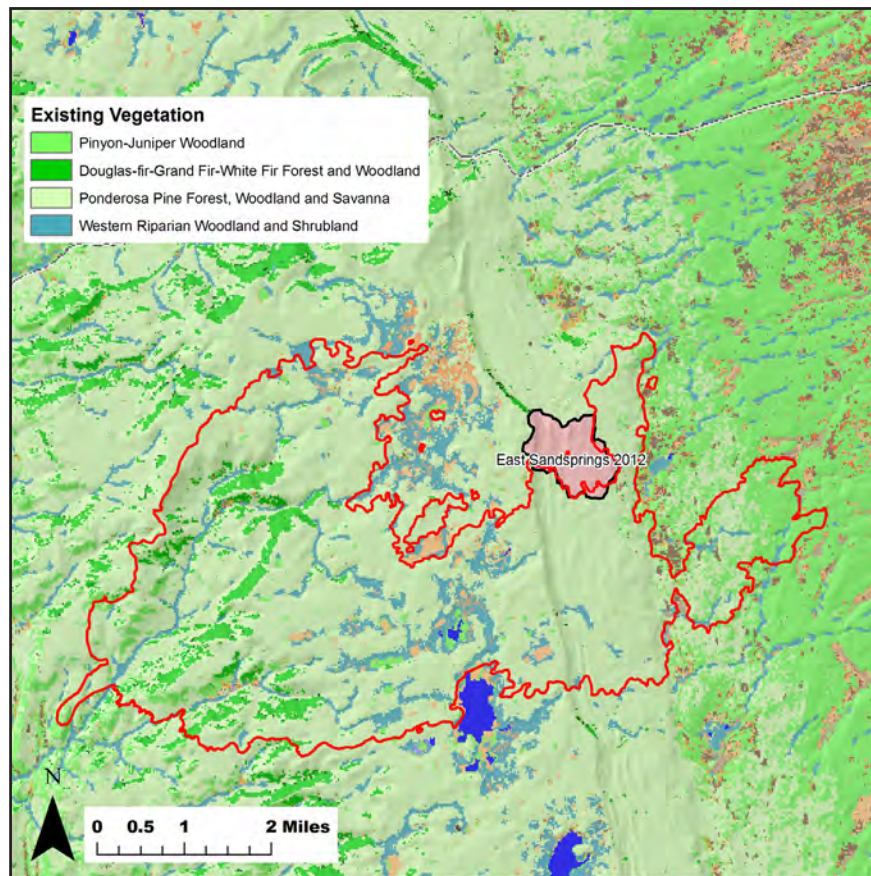


Canopy mortality by vegetation type for the Slide Fire.



Canopy mortality by vegetation type for the Slide Fire.





Map of existing vegetation within the Assayii Lake Fire

low severity categories (64% less than 25% canopy mortality). Eleven percent of the Slide Fire area caused greater than 90% canopy mortality. Most of the patches of near complete canopy mortality occurred during the first two to three days of the fire.

In comparison to piñon-juniper, chaparral, riparian, or mixed conifer forests, the Slide Fire caused a relatively small percentage of ponderosa pine forest to have high canopy mortality. While riparian, chaparral, and mixed conifer forests had 20% or more in the high canopy mortality category, only 4% of the ponderosa pine had 90% or more canopy mortality.

Assayii Lake

The Assayii Lake Fire started by humans on June 13 about 10 miles northeast of Navajo, New Mexico. The fire burned quickly and exhibited extreme fire behavior pushed by high winds, with gusts up to 50 mph. When it was finally contained, the Assayii Lake Fire had burned 14,712 acres. The estimated cost of the Assayii Lake Fire was \$7.4 million, or about \$503 per acre.

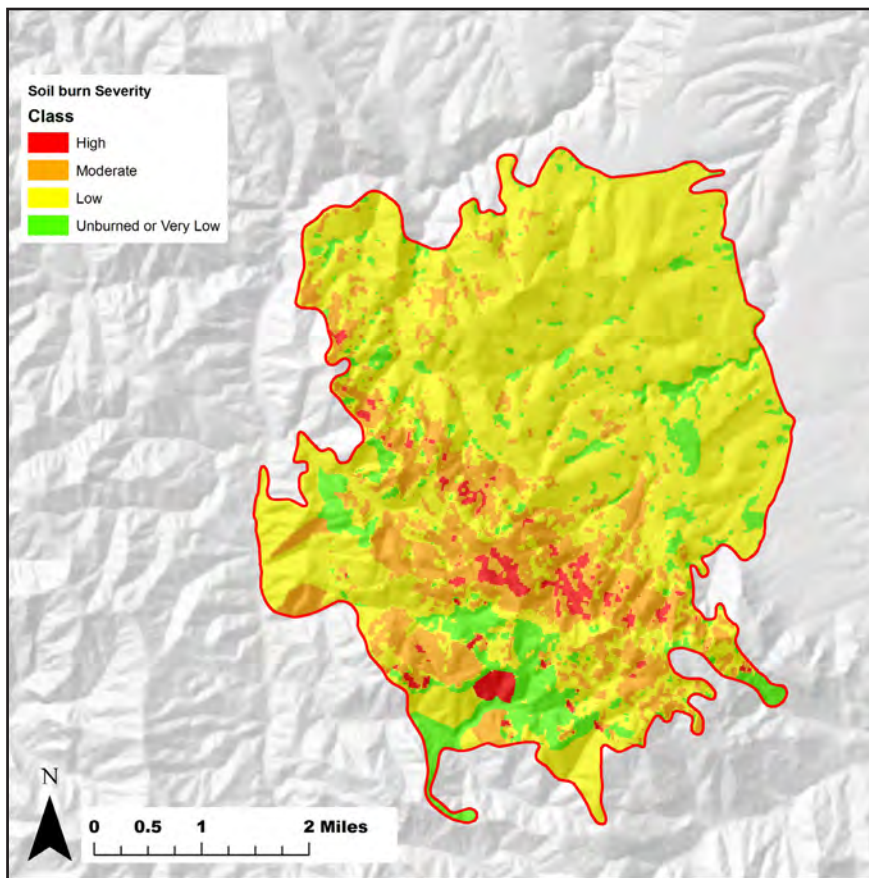
Vegetation, Past Fires, and Wildland-Urban Interface
The Assayii Lake Fire burned in the Chuska Mountains

with the northeast side of the fire burning around the footprint of the 440-acre East Sansprings Fire from 2012. Although the area around Assayii Lake is not heavily populated, the fire did force evacuations and burned through areas classified as WUI intermix. According to news reports, four structures were destroyed and approximately 50 residences were threatened. Most of the Assayii Lake Fire burned through ponderosa pine forests (75%), though smaller portions of riparian (8%), piñon-juniper (8%), and mixed conifer (6%) also burned. Most of the area burned was classified in LANDFIRE as moderately departed from historic conditions. In other words, composition and structure of vegetation and fuel were moderately different from estimates of natural conditions. Forty percent of the Assayii was classified as low departure from historic conditions and only 5% of the area was considered significantly departed. The Assayii Fire burned up to and around the area that burned in 2012 during the East Springs Fire.

Fire Severity

RAVG and soil burn severity maps were not available for the Assayii Lake Fire.





Soil burn severity map for the Oak Fire.

Oak Fire

The Oak Fire burned 13,920 acres and was managed with a monitor/confine/contain strategy on the Coronado National Forest in southern Arizona. The Oak Fire was ignited by lightning on June 17 within the Galiuro Wilderness. Fire managers’ strategic objectives in the ICS-209s were to manage fire within their planning area boundary using “strategy and tactics necessary to minimize impacts to sensitive areas and values at risk while maximizing benefits to resources.” Managers used Minimum Impact Suppression Tactics (MIST) for operations in the wilderness area. The Oak Fire cost about \$3.8 million, or about \$291 per acre.

Vegetation, Past Fires, and Wildland-Urban Interface

The Oak Fire burned through woodland and shrub vegetation types, which were mostly dominated by juniper or oak species.

Vegetation Type	Percent within Fire Perimeter
Juniper-oak	19%
Conifer-oak	12%
Piñon-juniper	42%
Chaparral	15%

The area of the Oak Fire had not experienced fire in at least 14 years. However, most of the area was mapped as having low (55%) to moderate (44%) departure from historic conditions.

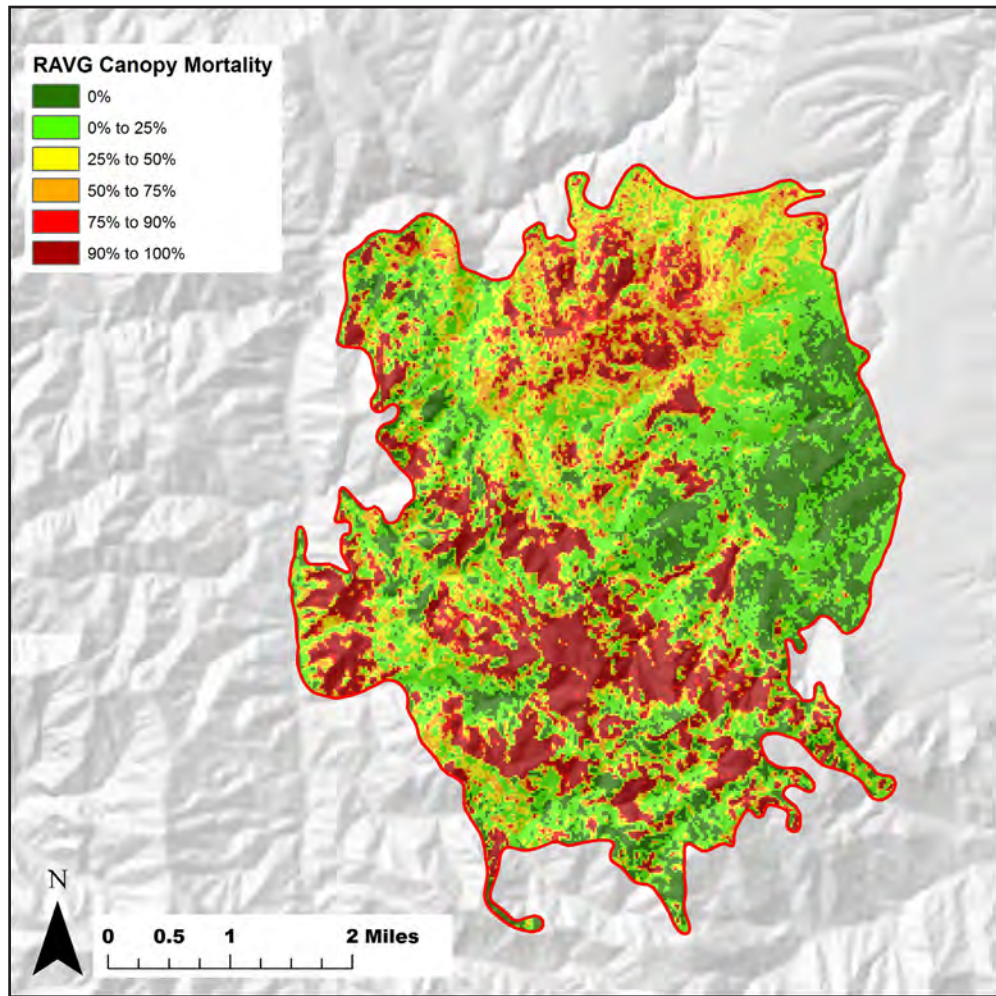
Fire Severity

Only a very small percentage of the Oak Fire had high severity soil impacts. Most soil impacts were minor (79%) or moderate (19%). Small patches of high soil burn severity occurred near Kennedy Peak and consisted of about 2% of the burned area.

Almost all of the chaparral burned with low soil severity, the piñon-juniper had a slightly high proportion of moderate soil burn severity, and the juniper-oak and conifer-oak areas had the highest proportion of moderate and high soil burn severity.

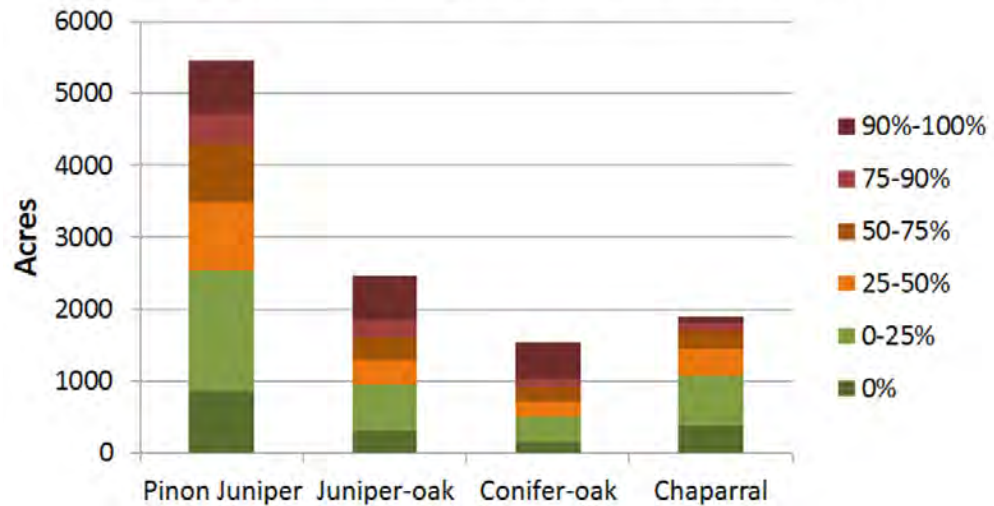
The RAVG canopy cover mortality suggests there were areas of complete canopy mortality and low or moderate soil impacts within the Oak Fire. As mentioned in the introduction, the soil burn severity and RAVG maps measure different fire effects. It is possible that areas where fire moved relatively quickly through chaparral or woodland vegetation might kill almost all the overstory without inflicting much damage on the soils below. Another explanation is that because the dNBR used in the soil burn severity maps measures





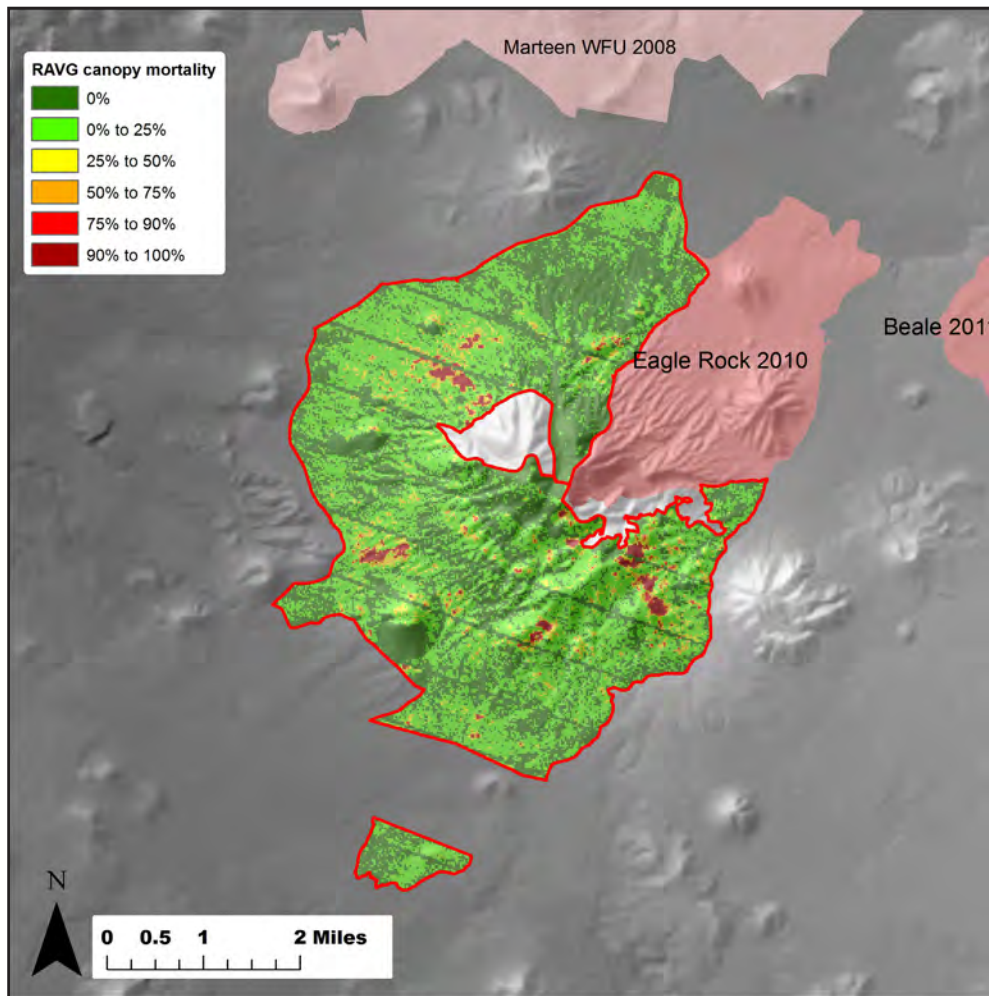
RAVG canopy mortality map for the Oak Fire.

Canopy Mortality by Vegetation Type



Canopy mortality by vegetation type for the Oak Fire.





RAVG canopy mortality map for the Sitgreaves Complex

absolute difference between before and after fire satellite images, dNBR can underestimate severity in areas with little pre-fire vegetation or open vegetation. The difference between soil burn severity and RVAG was also visible during the 2013 fire season in fires such as the Soldier Basin Fire.⁷

Although the majority of the Oak Fire caused less than 50% canopy mortality, there were significant patches (16%) where greater than 90% of the canopy was killed. The proportion of severe canopy mortality was similar across vegetation types.

Sitgreaves Complex

The Sitgreaves Complex in the Kaibab National Forest was started by multiple lightning ignitions at the end of July. By July 17 the strategic objective of the fire managers reported on the ICS-209 was to manage the fires of the Sitgreaves Complex “within a planning area

boundary and minimize large high severity fire events.” The fire managers made a decision not to put the fire out at an acre and rather to manage the Sitgreaves Complex over two months with aerial ignitions and careful smoke management.⁸ The complex eventually covered 11,063 acres. The complex was managed with a confine and contain strategy and cost \$731,000, or about \$66 an acre.

Vegetation, Past Fires, and Wildland-Urban Interface

The majority of the Sitgreaves Complex burned in ponderosa pine forest (85%) or pockets of mixed conifer (11%) and riparian forest (2%). The Sitgreaves Complex burned up to and around the 2010 Eagle Rock Fire perimeter. Most of the Complex burned through forests that were within the historic range of conditions (84%). Less than 10% of the area was mapped as highly departed from historic conditions. The Sitgreaves Complex burned on USDA Forest Service land, though

7. 2013 Wildfire Season: An Overview, Southwestern U.S. <http://nau.edu/ERI/Banner/2013-Wildfire-Season--An-Overview-Southwestern-U-S/>

8. 2014 Fire Season - Successes in Acres Burned, a PIO Perspective By Holly Krake. http://swfireconsortium.org/wp-content/uploads/2015/01/Sitgreaves_Krake.pdf



about half of the burned area was classified as very low density WUI because of nearby structures along highway 141. These structures were not impacted by the fire.

Fire Severity

The RAVG fire severity data appear to confirm the vegetation departure data because only 2% of the Sitgreaves Complex killed more than 75% of the canopy. In fact over 90% of the Complex burned at low severity, killing less than 25% of the canopy. The RAVG data contain some striping likely due to the scan line corrector failure of Landsat 7.

Mixed conifer had the highest percentage of high severity (5% >= 75% canopy mortality), which is not surprising given mixed conifer forests had a mixed severity fire regime before European settlement. Soil burn severity maps are not available for the Sitgreaves Complex.

Hammer Fire

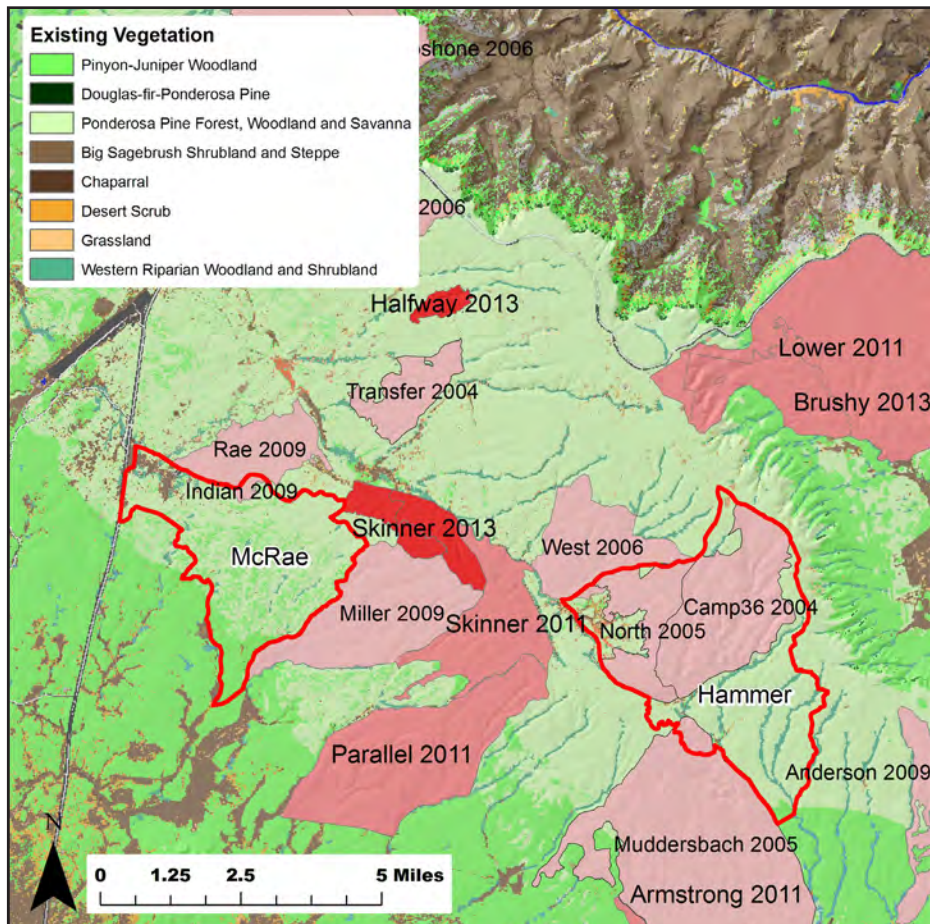
The Hammer Fire was discovered on July 29 and burned 8,871 acres in an uninhabited area about 10 miles southeast of Tusayan, Arizona on the Kaibab National Forest. The Hammer Fire was combined with the nearby McRae Fire to form the McRae Complex. Fire professionals used point protection and limited

perimeter control tactics to manage the entire McRae Complex. The strategic objective reported on the ICS-209 for the Hammer Fire on June 29 was to monitor fire growth while protecting archeological resources and forest infrastructure. As described on Inciweb, the fires were “managed for resource benefit to meet multiple resource management objectives.” The Hammer Fire cost \$5,000, or approximately \$0.56 per acre.

Vegetation, Past Fires, and Wildland-Urban Interface
Based on the LANDFIRE existing vegetation layer, the majority of the Hammer Fire burned in forests dominated by ponderosa pine.

Vegetation Type	Percent within Fire Perimeter
Piñon-juniper	1%
Ponderosa	88%
Riparian	7%
Grassland	2%

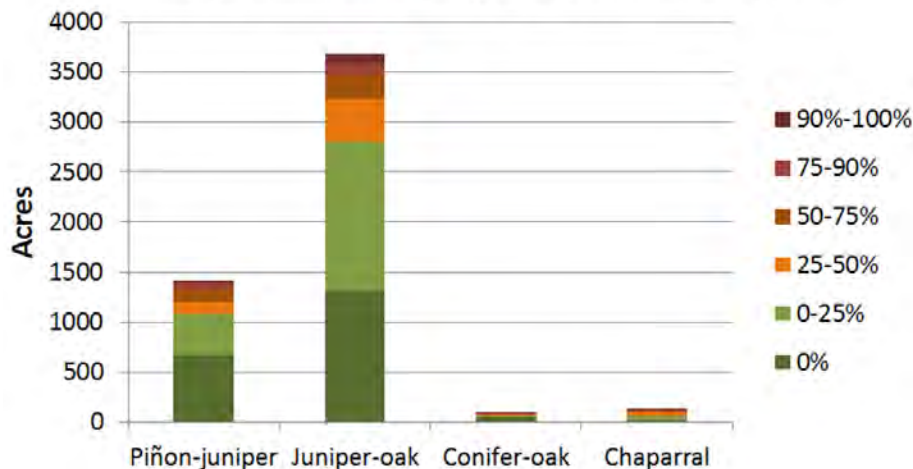
Much of the area burned in the Hammer Fire had previously burned in the 2005 North Fire, the 2004 Camp Fire, or the 2005 Muddersbach Fire. Before European settlement, ponderosa pine forest burned



McRae Complex including the Hammer Fire with existing vegetation



Canopy Mortality by Vegetation Type



RAVG canopy mortality map for the McRae Fire

frequently, so the fact that the Hammer Fire reburned areas is not uncharacteristic. The vegetation departure maps from LANDFIRE also suggest that most of the area burned by the Hammer Fire was only moderately departed from historic conditions (80%). The Hammer Fire burned on the Kaibab National Forest in an uninhabited area and did not threaten structures.

Fire Severity

Neither soil burn severity or RAVG maps are available for the Hammer Fire.

McRae Fire

The McRae Fire was started by lightning on July 4 and it burned for a month. The strategic objective from the ICS-209 for the McRae was to allow the fire to burn to a predetermined perimeter. Managers used point protection and limited perimeter control tactics on the McRae Fire. The wildfire burned across 5,505 acres at a cost of about \$150,000, or about \$27 an acre.

Vegetation, Past Fires, and Wildland-Urban Interface

The McRae fire burned through a mixture of piñon-juniper and ponderosa pine forests. A portion of the McRae Fire had previously burned in the 106-acre Indian Fire of 2009. Two other fires from 2009, the Rae and the Miller, defined the north and east boundaries of the McRae Fire. As with the Hammer Fire, the McRae Fire burned on the Kaibab National Forest in an uninhabited area and did not threaten structures.

Vegetation Type	Percent within Fire Perimeter
Piñon-juniper	26%
Ponderosa	67%
Riparian	2%

Most of the footprint of the McRae Fire was classified as within the range of historic conditions (85% low departure). Only about 10% of the fire, the southern tip, burned in piñon-juniper labelled as highly departed from historic conditions.

Fire Severity

No soil burn severity data are available for the McRae Fire, but RAVG data indicate very little of the fire burned at high severity. The RAVG data suggest that only 3% of the area burned in the McRae Fire (about 144 acres) caused greater than 90% canopy mortality.

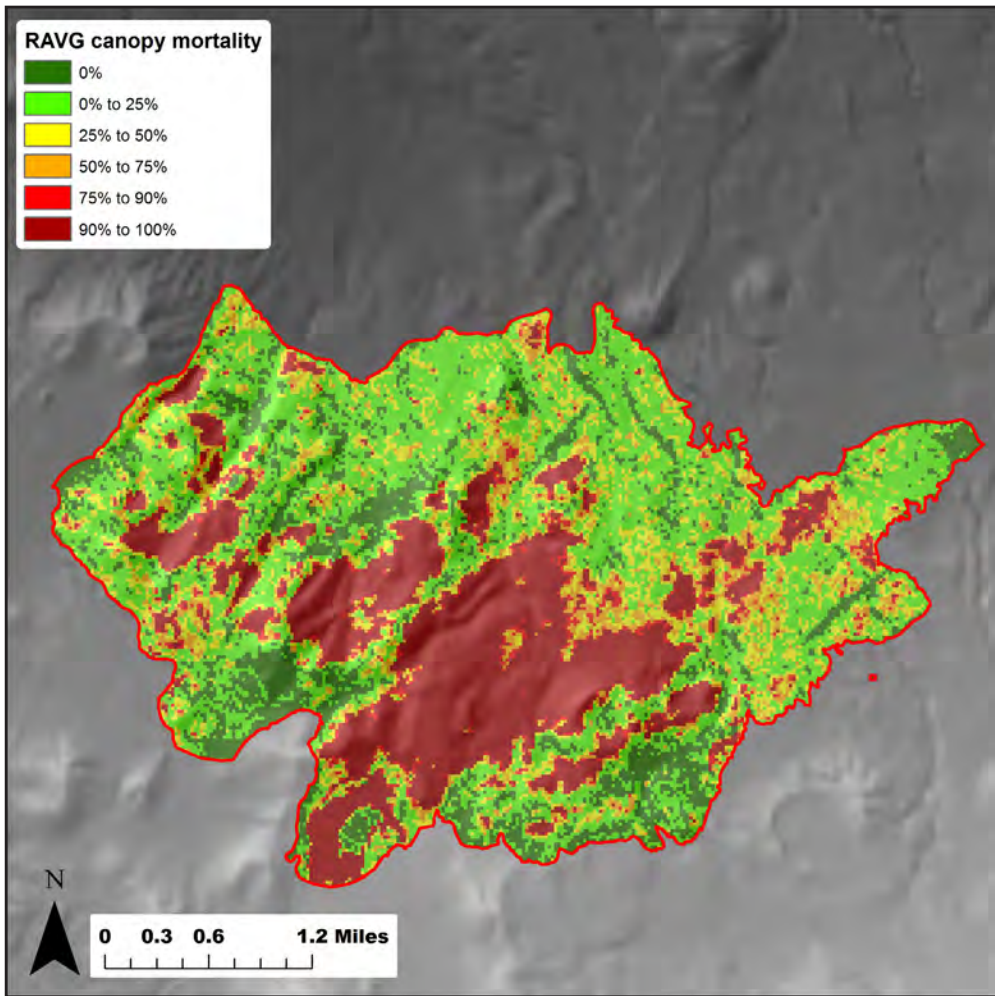
San Juan Fire

The San Juan Fire was started by humans on June 26 halfway between Springerville and Show Low, Arizona and burned on the White Mountain Apache Reservation and the Apache-Sitgreaves National Forests. According to the Southwest Coordination Center, fire managers responded to the fire with a full suppression strategy and were able to contain it by July 8. Strategic objectives included using pine restoration treatment areas and roads for control features. Burn out operations (fires intentionally set in order to consume fuel between the edge of the fire and the control line) increased the size of the San Juan Fire, but generally occurred in previously thinned areas. More than 600 people were assigned to the fire which eventually cost \$5.8 million dollars or about \$832 an acre.

Vegetation, Past Fires, and Wildland-Urban Interface

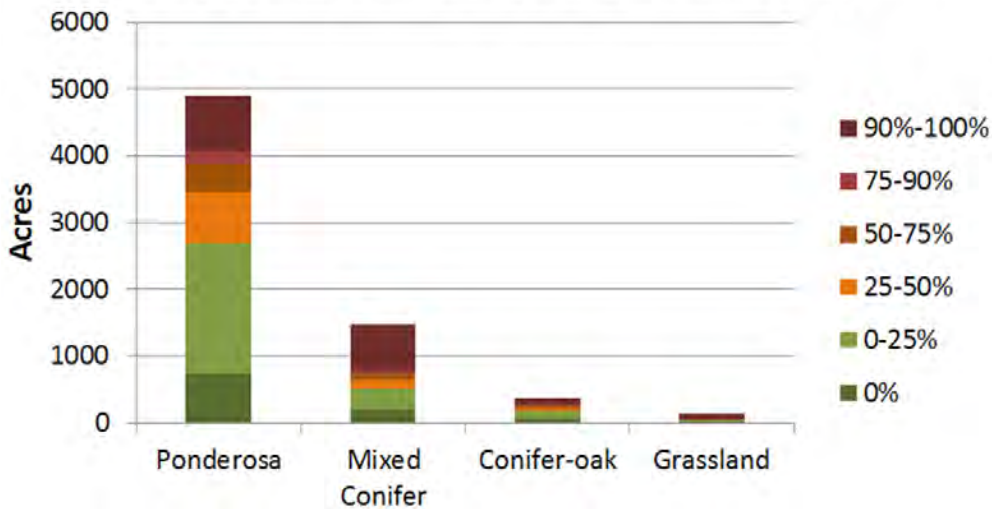
The San Juan Fire burned through ponderosa and mixed conifer forests as well as small patches of conifer-oak woodlands and grasslands.





RAVG canopy mortality map for the San Juan Fire

Canopy Mortality by Vegetation Type



RAVG canopy mortality map for the San Juan Fire



Vegetation Type	Percent within Fire Perimeter
Ponderosa	70%
Mixed conifer	21%
Conifer-oak	5%
Grassland	2%

No wildfires had burned in the San Juan Fire footprint for at least 14 years, though it was only about 10 miles from the Wallow Fire of 2011. The majority of the San Juan Fire perimeter was classified as moderately departed from historic conditions on the LANDFIRE maps (81%). Though it burned in uninhabited areas on the WUI maps, the San Juan Fire caused mandatory evacuations in the communities of Red Cabin Ranch, Whiting Homestead, and Carlock Ranch.

Fire Severity

RAVG maps for the San Juan Fire indicate that though most of the fire did not kill much of the canopy (63% less than 50% mortality), a quarter of the burned area had almost complete mortality. The largest patches of canopy mortality within the San Juan Fire centered on the mixed conifer forest and the grasslands, but also included surrounding ponderosa pine forests. While 46% of the

mixed conifer within the San Juan perimeter burned at high severity, only 19% of the ponderosa pine forest burned at high severity.

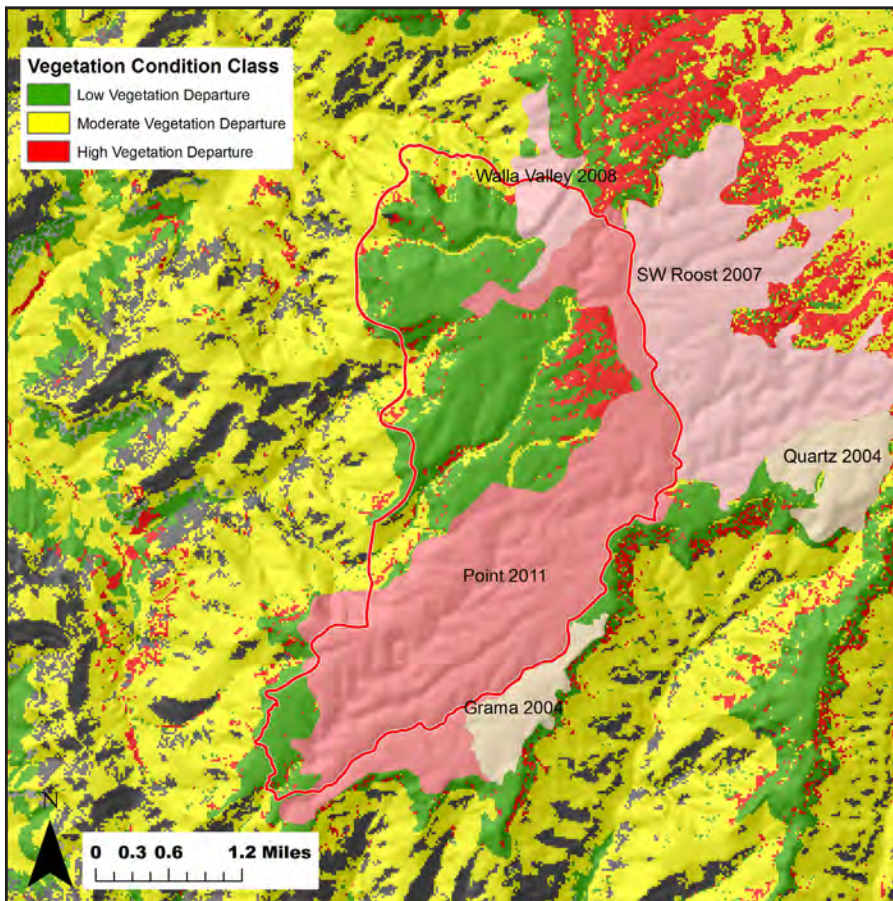
Galahad Fire

The lightning ignited Galahad Fire was discovered on May 23. National Park Service fire managers at the Grand Canyon decided:

“The fire’s remote location and the fact that it was not posing any direct threats to infrastructure or park resources made it a perfect candidate to manage for both resource and protection objectives. Resource objectives for the fire included returning fire to a fire-adapted ecosystem to maintain forest health and the protection of sensitive cultural resources and wildlife habitat.”⁹

The fire continued to burn until July 15. In total, the Galahad Fire burned 6,143 acres. Fire behavior was

- 9. National Park Service Fire and Aviation Management www.nps.gov/fire/wildland-fire/connect/fire-stories/2014-parks/grand-canyon-national-park.cfm



Galahad Fire



generally moderate with isolated and group torching. Fire personnel constructed control line to prevent damage to the historic Kanabownits Cabin and most of the fire was naturally contained by the canyon rim and past fire footprints. The estimated cost of the Galahad Fire was \$2,341,000 or about \$381 per acre.

Vegetation, Past Fires, and Wildland-Urban Interface

The portion of Walla Valley Peninsula where the Galahad Fire burned was mainly ponderosa pine (76%), with smaller patches of mixed conifer (9%), piñon-juniper (5%), oak-conifer (4%), and riparian forest (4%). Most of the area was in conditions within the historic range of variability. LANDFIRE mapped riparian draws are moderately departed from historic conditions, while the mixed conifer areas were most departed from historic conditions. This may be related to species composition changes over the last century that make stands that were historically dominated by ponderosa pine appear more like mixed conifer stands. Overall most of the area (80%) had low levels of departure from historic conditions.

Most of the Galahad Fire burned within 2011 Point Fire and the 2001 Tower Fire footprints. The northeast edge of the Galahad Fire abutted the burned area by the 2003 Poplar Fire and the 2007 SW Roost Fire. These previous fires contributed to the fact that forest conditions were generally in the range of historic conditions by removing fuel and reducing the density of trees.

Fire Severity

Neither soil burn severity or RAVG maps are available for the Galahad Fire.

Signal Fire

A human ignition started the Signal Fire on May 11 and fire managers contained it on May 23. Over that time, it burned 5,484 acres and cost \$8 million, or \$1,459 per acre. The threat of the Signal Fire caused evacuations and a closure of a portion of Highway 15. The strategic objectives from the ICS-209s focused on “using a full-suppression strategy to minimize impacts and damage to critical values and resources.”

Vegetation, Past Fires, and Wildland-Urban Interface

The Signal Fire burned through mixed conifer, ponderosa pine, conifer-oak, and piñon-juniper vegetation types.

Vegetation Type	Percent within Fire Perimeter
Ponderosa	33%
Mixed Conifer	48%
Conifer-oak	12%
Piñon-juniper	3%

The northern edge of the Signal Fire burned into

a small portion of the footprint of the 2006 Skates Fire. The fire also completely burned over the 2009 Allie Fire and to the western edge of the 2009 Hightower Fire. Fifty-five percent of the Signal Fire was highly departed from historic conditions. Many of these highly departed areas were mixed conifer forests.

The Signal Fire did not burn any interface or intermix areas, though about half of the fire perimeter was classified as very low density WUI (the other half was uninhabited).

Fire Severity

Much of the Signal Fire’s total area burned during the first day. The fire also created a large high severity patch on the first day. On the soil burn severity map, this high severity is 23% of the total area with another 13% classified as moderate severity.

The RAVG map looks very similar to the soil burn severity map with significant portions of high severity. However, the RAVG maps indicate more areas of no canopy mortality (39%) than the soil burn severity maps have mapped as unburned. Twenty-four percent of the area had greater than 90% canopy mortality.

Much of the high severity fire occurred in the mixed conifer forests within the Signal Fire footprint. Also worthy to note is that the high severity patch ended as the fire burned into the footprint of the 2009 Allie Fire. It is beyond the scope of this overview to speculate as to the impact the Allie Fire footprint might have had on fire behavior and effects of the Signal Fire, but it may be worth future study.

Pino Fire

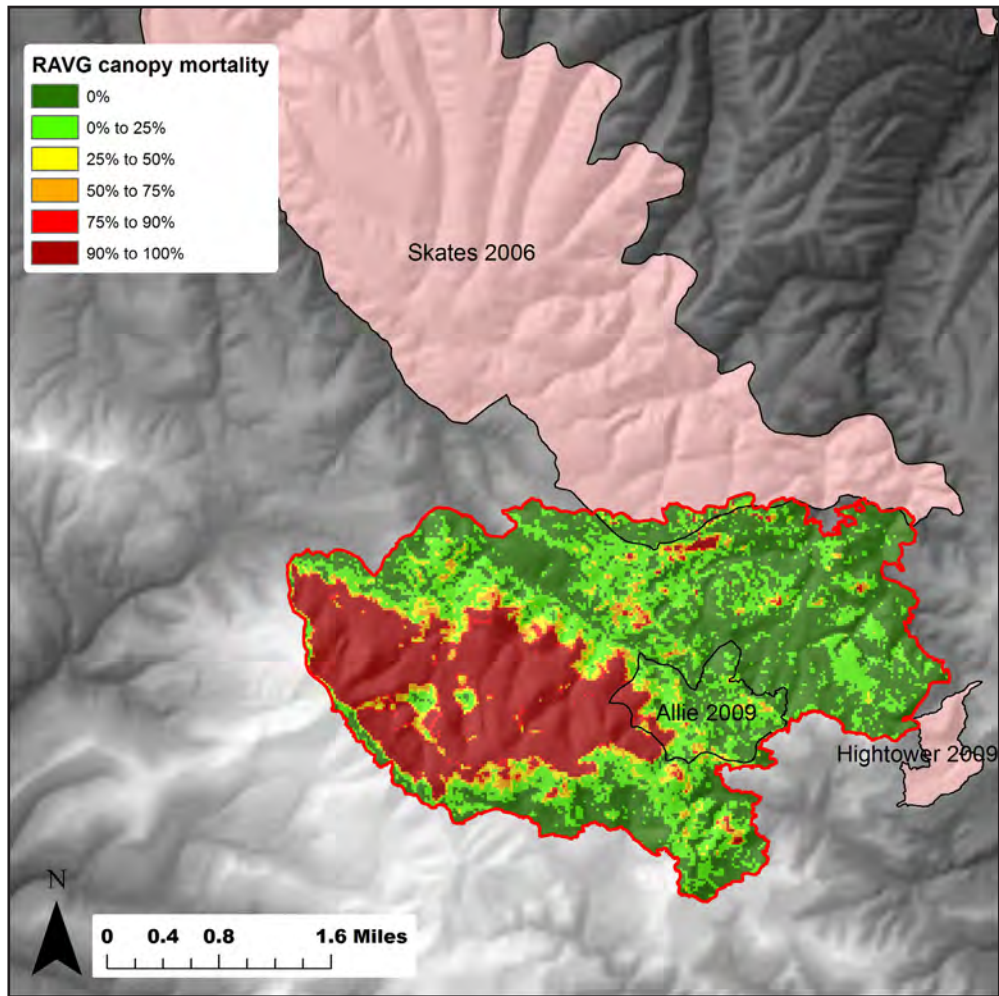
Lightning started the Pino Fire on August 13 on the Santa Fe National Forest east of Jemez Springs, New Mexico. The ICS-209 reported that the fire was “managed for multiple objectives with the overarching objective being resource benefit.” When the fire was meeting the objectives, managers used aerial and hand ignition to shorten the duration. The Pino Fire burned to the predetermined boundaries and covered 4,313 acres at a cost of \$700,000, or about \$162 per acre. The Pino Fire received an award for progressive management tactics and strategies used to apply beneficial fire to the landscape under difficult conditions.¹⁰

Vegetation, Past Fires, and Wildland-Urban Interface

The Pino Fire burned through ponderosa pine (65%) and mixed conifer forests (27%) with small areas of riparian (3%) and piñon-juniper forests (2%). Most of the forest within the Pino Fire was mapped as moderately departed from historic conditions. Within the area burned of the Pino Fire, 70% was moderately departed from historic conditions and 26% was highly departed. Much of

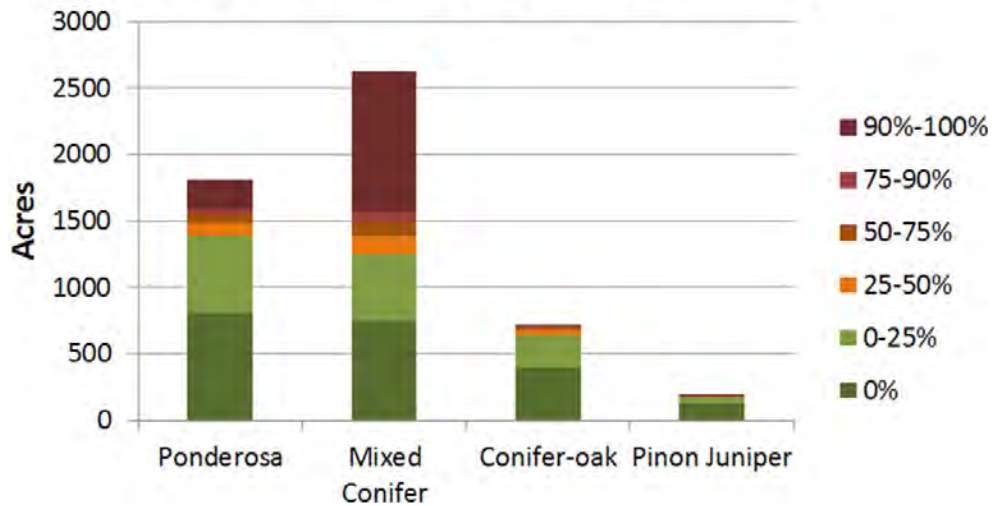
10. 2014 Incidents of the Year <http://swfireconsortium.org/2014-incident-of-the-year/>





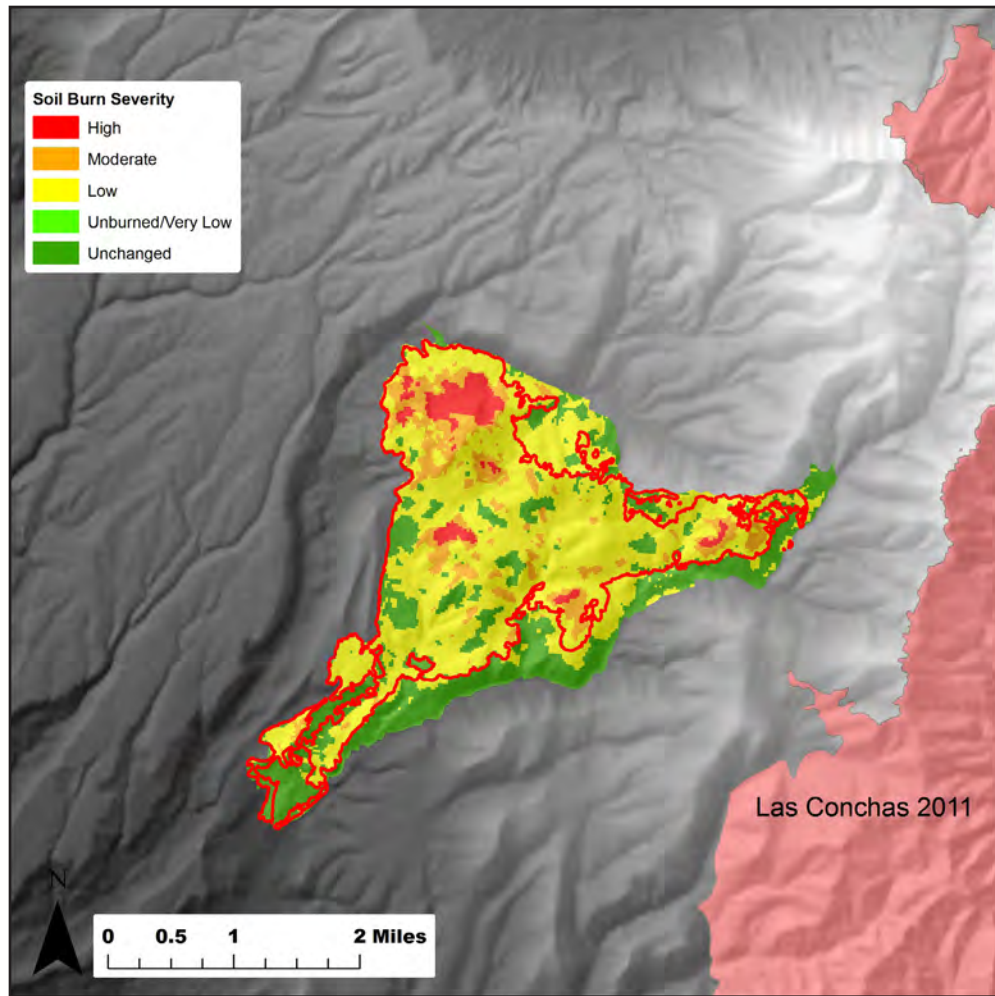
RAVG canopy mortality map for the Signal Fire

Canopy Mortality by Vegetation Type



Canopy mortality by vegetation type for the Signal Fire.





Soil burn severity map for the Pino Fire

the area beyond the Pino Fire, including the western edge of the 2011 Las Conchas Fire, was labeled highly departed from historic conditions. Though there are no recent fires that overlap the Pino Fire footprint, the Las Conchas Fire is only about one mile away. The Pino Fire burned on U.S. Forest Service land labeled uninhabited on the WUI maps.

Fire Severity

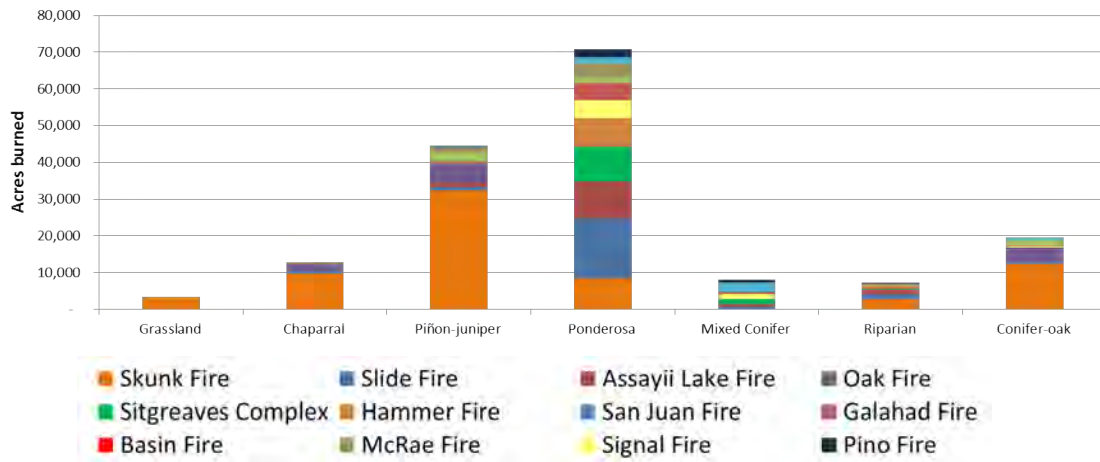
Most of the Pino Fire had minimal impacts on soil resources. Soil burn severity maps indicate only 21% burned with moderate or high soil burn severity. The mixed conifer forest type had the highest percentage of high and moderate soil burn severity (15% and 23% respectively). The majority of the ponderosa pine forest within the Pino Fire burned at low or no soil burn severity (84%). The greater prevalence of high severity fire in mixed conifer in comparison to ponderosa pine forest conforms to the general understanding of historic fire regimes; mesic mixed conifer forests had mixed severity fire regimes while low severity fire was commonplace in ponderosa pine forests.

Conclusion

This report covers the 12 largest fires and about 80% of the area burned by wildfire in the Southwest in 2014. It is worth reiterating that these data are based on remote sensing information, some of which is preliminary. These data are the best currently available, but in-depth local investigations could add nuance to this overview.

Ponderosa pine was the most common forest type burned in large fires during 2014, while in 2013, fires burned more mixed conifer than any other forest type. In 2013, one fire (the Silver Fire) burned 138,000 acres and dominated the summary statistics for the year. In 2014, the largest fire (the Skunk Fire) was half the size of the Silver Fire.

In 2013 only 16% of large fires were on tribal land, but in 2014, half of the large fires occurred on tribal land (112,913 acres). The largest fire, the Skunk Fire, as well as Assayii Lake Fire and Basin Fire burned on tribal land. The WUI plays a very small role in the 2014 fires. Only one of the fires in this overview (Assayii Lake) burned on lands mapped as intermix or interface, though all of the human ignited fires required evacuations.



Summary of acres burned by major vegetation types

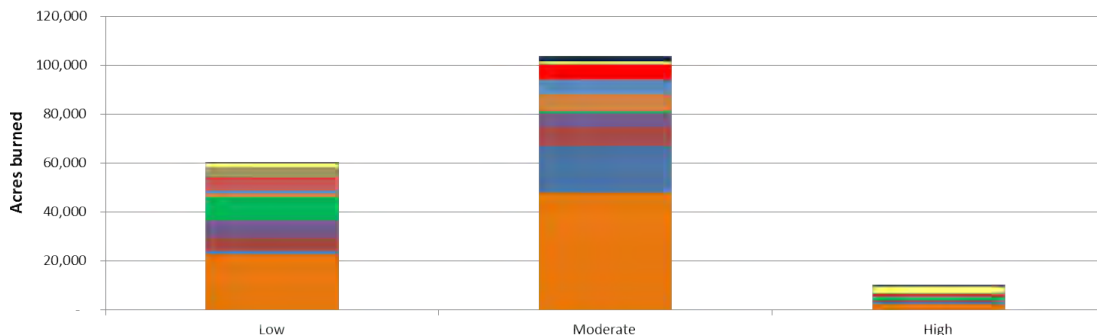
Managers used full suppression strategies on all of the fires included in the 2013 overview, but in 2014 the 12 largest fires included three fires managed mainly with a point protection tactics and four fires managed mainly with a confine and contain strategy, based on the Southwest Coordination Center’s categorization. Including the Skunk Fire increases the proportion of fires where the wildland fire management strategy was point protection, containment, confine, or monitoring. This pattern holds when all fires larger than 100 acres are included. In 2014, only 65% of the fires larger than 100 acres were managed with full suppression strategies, whereas in 2013, that number was 86%.¹¹

Costs for the 12 largest fires of 2014 was over \$41 million dollars and per acre costs varied considerably from less than a dollar per acre for the Hammer Fire to nearly \$1,500 an acre for the Signal Fire (Appendix I). Suppression fires, which were managed with full suppression strategies, had higher per acre costs than those fires that could be managed with other strategies.

11. *Southwest Area Year-To-Date Wildland Fires > 100 Acres for 2013 and 2014* available at: http://gacc.nifc.gov/swcc/predictive/intelligence/ytld_historical/historical/fire_data/historical_fires_and_acres.htm

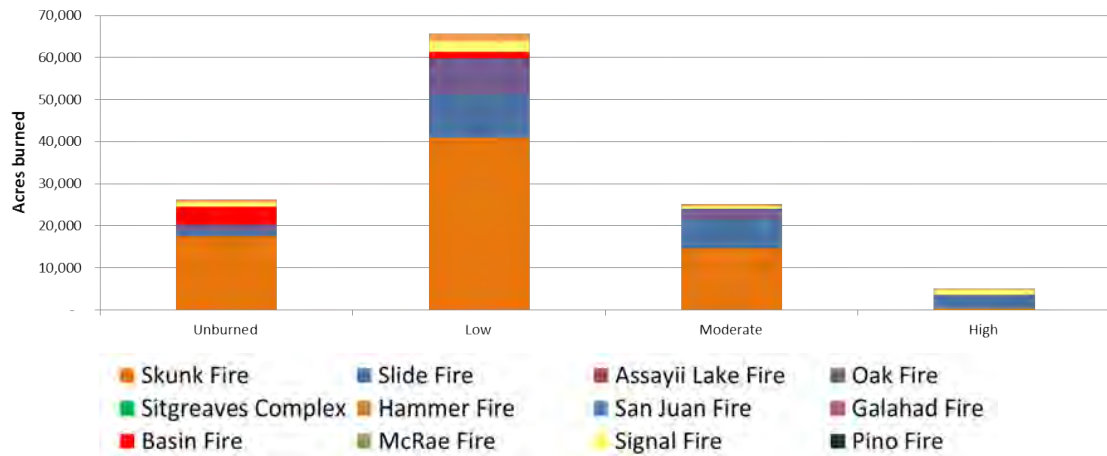
Though it should be reiterated that the label of “suppression fire” is not an official federal agency term and that multiple tactics were used in each individual fire. The total suppression fire costs divided by the total acreage of suppression fires yields an average of \$649 per acre whereas the average for fires managed with other strategies is \$76 per acre (including the Skunk Fire). These costs are not a value judgment as each fire burns in different terrain, different vegetation, during different weather conditions, and puts different values at risk. Fire managers must make the best decision to protect lives and properties for each fire. It is also important to note that these costs do not include post-fire rehabilitation or other indirect costs of the fires.

Weather and the condition of the vegetation that burned may have presented more opportunities to use other confine and contain strategies during 2014. As mentioned in the “Regional Context” section above, cooler and more moist conditions in the spring likely reduced fire outbreaks and long duration fires. In 2013, about 30% of the eight largest fires burned in vegetation that was highly departed from historic conditions. In 2014, only 6% of the 12 largest fires burned in vegetation that was highly departed from historic conditions.

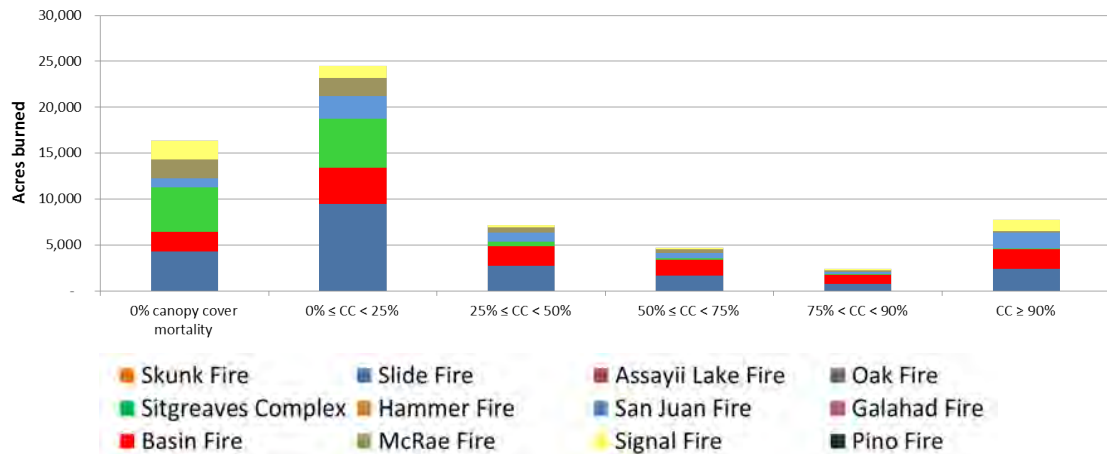


Summary of acres burned by LANDFIRE vegetation condition class.





Summary of acres burned by soil burn severity class.



Summary of acres burned by RAVG canopy mortality class.

For the fires where soil burn severity maps were available, a very small percentage (2%) of their footprint burned at high severity (compared to 26% in 2013). Eighty percent of the mapped soil burn severity in 2014 was unburned or low.

The RAVG maps of canopy mortality show a similar pattern where 65% of the mapped canopy mortality was low (less than 25% mortality). In fact, just six large fires in the Southwest experienced low severity fire across about 41,000 acres, which is on par with the 52,546 acres of hazardous fuels treatments implemented outside the WUI by the USDA Forest Service Southwest Region in 2013.¹² In other words, low severity fire played a

significant role on the landscape in 2014. In addition, areas of high severity fire were relatively limited and in many cases occurred in forest types such as mixed conifer where patches of high severity fire are not outside the historic range of variation. In 2013, 31% of the mapped canopy mortality was high (greater than 75% mortality), but in 2014 only 16% of the canopy mortality was in the high class.

Eight of the 12 fires in this overview burned up to, around, or through recent fire footprints (six of which were from the last five years). Visual inspection of the maps suggests that in many, if not all, of these cases the old fire footprint had an effect on fire behavior or spread. It is beyond the scope of this analysis to examine the full impact of old fire footprints on fires of 2014, but it appears an interesting avenue for future research.

12. USDA Forest Service. 2014. Integrated Resource Restoration FY 2013 Report. Washington, D.C. www.fs.fed.us/restoration/documents/irr/IRR2013AnnualReportFinal.pdf



Appendix I – Fire Statistic

Name	Acres	Cost	cost/ac	Vegetation Departure		
				Low	Medium	High
Skunk	73,622	\$2,000,000	\$27	31%	65%	3%
Basin	6,018	\$21,000	\$3	3%	95%	2%
Slide	21,227	\$10,211,000	\$481	6%	90%	4%
Assayii Lake	14,712	\$7,400,000	\$503	40%	55%	5%
Oak	13,057	\$3,800,000	\$291	55%	44%	1%
Sitgreaves	11,063	\$731,000	\$66	84%	6%	9%
Hammer	8,871	\$5,505	\$1	19%	80%	2%
San Juan	6,975	\$5,800,000	\$832	14%	81%	5%
Galahad	6,143	\$2,341,000	\$381	80%	11%	9%
McRae	5,505	\$150,000	\$27	85%	4%	10%
Signal	5,484	\$8,000,000	\$1,459	28%	19%	53%
Pino	4,313	\$700,000	\$162	3%	71%	26%

Name	Soil Burn Severity				RAVG canopy mortality					
	Unburned	Low	Moderate	High	0%	< 25%	< 50%	< 75%	< 90%	≥ 90%
Skunk	24%	56%	20%	0%						
Basin	72%	27%	1%	0%						
Slide	6%	48%	32%	14%	20%	44%	13%	8%	4%	11%
Assayii Lake										
Oak	12%	67%	19%	2%	16%	31%	16%	13%	7%	16%
Sitgreaves					44%	48%	5%	2%	1%	1%
Hammer										
San Juan					14%	35%	14%	8%	4%	25%
Galahad										
McRae					39%	37%	11%	8%	3%	3%
Signal	20%	45%	13%	23%	39%	26%	5%	4%	2%	24%
Pino	15%	64%	15%	6%						

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