

# 2011 Fires in the Southwest

## An Analysis of Burn Severity

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A Report from



**WILDEARTH  
GUARDIANS**  
A FORCE FOR NATURE

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### **MISSION STATEMENT**

WildEarth Guardians protects and restores the wildlife, wild places and wild rivers of the American West.

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Cover Photos (*left column, top to bottom*): Las Conchas Fire, Van Clothier; Juniper Fire Scar, Bryan Bird; Satellite Photo Wallow Fire Burn Severity, NASA/Jesse Allen

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## **Executive Summary**

The 2011 wildland fire season in the Southwest is one for the record books: Arizona and New Mexico both documented their largest wildfires in history. To date 7.5 million wildland acres in the U.S. have burned in 57,735 fires. The ten-year average since 2002 is 6.2 million. Wildfires in Arizona and New Mexico account for 17% of all acres burned in 2011 and that figure jumps to 37% if Texas is excluded. Just two fires account for over half of the acres burned in the two states and 17% of all acres burned in the nation not including Texas: the Wallow fire in Arizona and Las Conchas fire in New Mexico.

Many years of human intervention - logging, overgrazing, and fire suppression - have altered the structure and function of forest ecosystems. Coupled with rapidly changing climate and housing development in the forest interface, these conditions endanger Southwestern forests. But thinning and fire suppression are expensive and can simply compound the problem of fuel buildup. Nationally, fire suppression costs for the Forest Service regularly reaches or exceeds \$1 billion. Southwestern forests evolved with fire and need it to remain healthy. Fire is an essential element in forest renewal and its use as a management tool to prevent uncharacteristic fires is a key recommendation in forest management.

Here we analyze four very different fires in Arizona and New Mexico from the 2011 fire season to

better understand how these fires behaved. In an attempt to understand both the positive and negative consequences from the fires, we look closely at the specific types of vegetation that burned and how severe were the burns in various vegetation types.<sup>3</sup> We conducted this analysis on the Wallow and Horseshoe II fires in Arizona as well as the Las Conchas and Pacheco fires in New Mexico.

These four fires exhibited very different characteristics and consequences because of the wide variety of ecosystems in which they burned as well as the variable conditions. Not all of the acreage within the fire perimeters burned severely and in fact much was unburned or burned only at low and moderate severity. Although it is possible to conclude some of the areas and forest types within the fire perimeters burned uncharacteristically, much of these areas burned as we would expect them to and were likely beneficial for fuel management and restoration purposes. However, the dry forest types that did burn atypically indicate restoration and fuels treatments remain a high priority.

## **Methodology for Wildfire Burn Severity Analysis**

### Input Data

Three main datasets were used for each wildfire analysis, fire perimeter, burn severity and existing vegetation

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<sup>3</sup> We use the term burn severity generally as the loss of organic matter in or on the soil surface. (NWCG 2006).

type. The final fire perimeter for each fire was obtained from the Geospatial Multi-Agency Coordination Group (GeoMAC).

<http://www.geomac.gov/index.shtml>

The burn severity data was obtained from the U.S. Forest Service Burned Area Emergency Response (BAER) program (<http://activefiremaps.fs.fed.us/baer/download.php>). The burn severity datasets are termed Burned Area Reflectance Classifications (*BARC*) and are remotely sensed estimations of burn severity (BS). They have not been field validated. The burn severity data are created by comparing pre and post satellite images of the burn area. The greatest strength of satellite imagery is the capability of capturing data beyond the visible portion of the electromagnetic spectrum (EMS). There is a lot of information in the infrared wavelengths. This portion of the EMS is especially useful for measuring vegetative vigor and bare earth characteristics. Two bands of the EMS from satellite imagery are compared, the near infrared light which is reflected by healthy vegetative growth and mid-infrared light which is largely reflected by rock and bare soil. Imagery acquired pre-fire will have very high near infrared values and very low mid-infrared values. The post fire data is likely to be the opposite. Essentially the pre-fire image is subtracted from the post-fire image and the areas that have changed the most are classified as having high burn severity.

Existing vegetation was obtained from LANDFIRE  
<http://www.landfire.gov/NationalPro>

[ductDescriptions21.php](#). LANDFIRE is a five-year, multi-partner wildland fire, ecosystem, and wildland fuel mapping project. LANDFIRE is supported by the U.S. Department of Agriculture (USDA) Forest Service Office of Fire and Aviation Management, the U.S. Department of Interior (DOI) Office of Wildland Fire Coordination, and The Nature Conservancy. The Existing Vegetation Type 1.1.0 (EVT) layer represents the vegetation currently present at a given site. LANDFIRE vegetation map units are derived from NatureServe's Ecological Systems classification, which is a nationally consistent set of mid-scale ecological units.

All data were projected to UTM ,zone 13, NAD 83. Existing vegetation type was clipped to the extent of the final fire perimeter. ArcGIS v10 was used to create all products.

#### Initial Analysis

The overall acreage of each fire and the breakout of burn severity (BS) for each, was calculated by determining the acreage total for each BS class and then summing the result. The composition of the fire perimeter by vegetation type was accomplished by computing the zonal geometry of the clipped vegetation dataset. Zonal geometry calculates specific geometric values (acreage etc.) for each zone in a dataset. It is especially useful for calculating areas from raster (pixel based) datasets. Here the existing vegetation type value was used as the zone.

### Composition of each Burn Severity Class

The burn severity raster layer was converted to a vector polygon layer and broken out into distinct GIS layers by BS class. Each of these resultant layers was used to clip the EVT layer. This resulted in existing vegetation that had burned with high, moderate and low severity. Zonal geometry was used again to compute the composition of the vegetation types that had burned in each BS category.

### Burn Severity by Existing Vegetation Type

For this analysis the existing vegetation was converted to a vector polygon layer. A model was designed that would iterate through all of the unique vegetation type values within the fire perimeter and compute how intensely each type burned. Use of the model iterator allowed the workflow to be set up once, and then automatically repeated for each vegetation type for a given fire. In these large fires there were typically three dozen vegetation types effected in each fire.

The model workflow consisted of selecting each individual vegetation type and converting the selection to a vector layer. This layer was used to clip the burn severity. This resulted in a burn severity layer for each vegetation type. Zonal geometry was run against the resultant EVT-BS layer, and then the necessary fields (acres and percentage) added, populated and exported as well formatted summary tables.

All the data was presented as MS Excel spreadsheets.

## **Results**

### *Fires in the Southwest Region 2011*

- The National Interagency Fire Center reports that New Mexico and Arizona had 1,445 wildland fires to date, burning a total of 1,310,861 acres.
- There were 259 prescribed fires in New Mexico and Arizona in 2010, burning a total of 127,718 acres.<sup>4</sup>
- To date in 2011, there were 125 prescribed fires in New Mexico and Arizona, burning a total of 267,872 acres.

### *Fuel Treatment*

- The USFS Southwestern Region treated 202,414 acres (76,661 in NM and 125,753 in AZ) in 2010 for high hazardous fuel loads and to date 87,438 acres (35,208 in NM and 52,230 in AZ) in 2011.<sup>5</sup>
- In 2010, 63% of the hazardous fuels treatments in AZ were accomplished with prescribed fire and 72% in New Mexico. The Southwestern Region is utilizing fire more often than mechanical means for fuel treatments.
- In 2010, 60% of all hazardous fuels treatments in AZ and NM were in the Wildland Urban Interface.
- For 2005-2006 (the last analysis available), according to figures provided by the

<sup>4</sup>

[http://www.nifc.gov/fireInfo/fireInfo\\_statistics.html](http://www.nifc.gov/fireInfo/fireInfo_statistics.html). Accessed September 6, 2011.

<sup>5</sup>

<http://www.forestsandrangelands.gov/resources/reports/>. Accessed August 17, 2011.

Forest Service, the average cost of a fire-treated acre was \$56, while the cost to treat an acre mechanically was four times that amount, at \$205 on average.

*The Wallow Fire (AZ)*

The Wallow fire started May 29th, 2011 and burned 538,049 acres (841 square miles), 15,407 acres were in N.M. (24 square miles). See attached map. It was human caused. The majority vegetation type- 320,403 acres – within the burn perimeter is

severity and almost 20% at moderate severity. Nearly 40% (34,266 acres) of the high burn severity consisted of Southern Rocky Mountain Mesic Montane Mixed Conifer Forest and Woodland and nearly 30% (25,494 acres) was Southern Rocky Mountain Ponderosa Pine Woodland. Over 45% (47,820 acres) of the moderate severity burn consisted of Southern Rocky Mountain Ponderosa Pine Woodland and almost 18% (18,799 acres) was Southern Rocky Mountain Mesic Montane Mixed Conifer Forest and Woodland.

In the ponderosa pine vegetation

Burn Severity	Southern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest and Woodland		Southern Rocky Mountain Mesic Montane Mixed Conifer Forest and Woodland		Southern Rocky Mountain Ponderosa Pine Woodland	
	Acres	Percentage	Acres	Percentage	Acres	Percentage
High	4,953	24.63	35,114	39.78	24,875	10.73
Moderate	5,124	25.48	18,924	21.44	47,883	20.65
Low	7,446	37.03	24,039	27.23	132,536	57.16
Unburned	2,586	12.86	10,202	11.56	26,586	11.47
<b>Total</b>	<b>20,109</b>	<b>100</b>	<b>88,279</b>	<b>100</b>	<b>231,880</b>	<b>100</b>

**Table 1. Wallow Fire Burn Severity by Major Vegetation Type**

Southern Rocky Mountain Ponderosa Pine Woodland (43% of the burn area) and then Southern Rocky Mountain Mesic Montane Mixed Conifer Forest and Woodland (16.4%).<sup>6</sup> Eight percent of the area or 43,176 acres is Southern Rocky Mountain Montane-Subalpine Grassland.

type, 10.73% burned at high severity and 20.65% burned at moderate severity.

Over 64% of the area within the fire perimeter burned at low severity or not at all, while 16% burned at high

<sup>6</sup> Mesic is defined here as: of, characterized by, or adapted to a moderately moist habitat.

*The Horseshoe II Fire (NM)*

The Horseshoe II fire started on May 8<sup>th</sup>, 2011 and burned 222,954 acres (348 square miles). See Attached Map. It was human caused. A little more than 31% (69,348 acres) of the area within the fire perimeter consisted of Madrean

severity (38%) or not at all (19.7%), while just 12% burned at high severity. Forty percent (11,221 acres) of the high burn severity area consisted of Madrean Pinyon-Juniper Woodland, 40% (10,920 acres) was Madrean Lower Montane Pine-Oak Forest and Woodland, and 11.2% (3,102 acres) was Madrean Encinal. Almost 36% (23,697 acres) of the

	Madrean Encinal		Madrean Lower Montane Pine-Oak Forest and Woodland		Madrean Pinyon-Juniper Woodland	
Burn Severity	Acres	Percentage	Acres	Percentage	Acres	Percentage
High	3,097	7.3	10,879	17.2	11199	16.2
Moderate	11,860	27.8	21,812	34.5	23631	34.2
Low	19,418	45.5	19,186	30.4	23287	33.7
Unburned	8,288	19.4	11,239	17.8	11029	15.9
No Data	8	0.0	22	0.0	17	0.0

**Table 2. Horseshoe II Fire Burn Severity by Major Vegetation Type**

Pinyon-Juniper Woodland, 28.5% (63,497 acres) is Madrean Lower Montane Pine-Oak Forest and 19.2% (42,789 acres) is Woodland Madrean Encinal.<sup>7</sup> The next largest representation within the burn perimeters is Rocky Mountain Montane Riparian Systems and Apacherian-Chihuahuan Semi-Desert Grassland and Steppe.

Nearly 58% of the area within the burn perimeter burned at low

moderate severity burn area was Madrean Pinyon-Juniper Woodland, 33% (21,952 acres) was Madrean Lower Montane Pine-Oak Forest and Woodland, and 18% (11,878 acres) was Madrean Encinal.

In the ponderosa pine vegetation type, 11% burned at high severity and 28% at moderate severity, though this vegetation type is only a small portion of the overall burned area (0.7%). In the dry-mesic mixed conifer forest type, 14% burned at high severity and 34% at moderate severity, though again this is a small proportion of the burned area (1.2%).

<sup>7</sup> Madrean encinal, or oak woodland, occurs throughout southeastern Arizona, southwestern New Mexico, northeastern Sonora, and northwestern Chihuahua, discontinuously distributed in the foothills of isolated mountain ranges at elevations ranging from 3,600 to 6,500 ft. (Schussman, H. and E. Smith 2006).

*The Las Conchas Fire (NM)*

The Las Conchas fire started June 26, 2011 and burned 156,593 acres (245 square miles). See attached map. It was human caused. Two vegetation types dominate the burn area: 22% (34,239 acres) of the area is Southern Rocky Mountain Mesic Montane Mixed Conifer Forest and Woodland and 22% (34,052 acres) is Southern Rocky Mountain Ponderosa Pine Woodland. Another 24% of the burn area is Colorado Plateau Pinyon-Juniper Woodland (19,480 acres) and

Southern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest and Woodland (19,238 acres). Finally, 11% (16,708 acres) of the burn area is Inter-Mountain Basins Aspen-Mixed Conifer Forest and Woodland.

Nearly 20% of the fire area burned at high severity, 29% at moderate severity and 39% at low severity. Of the area that burned at high severity, 37.2% (10,773 acres) was Southern Rocky Mountain Mesic Montane Mixed Conifer Forest and Woodland, 19.4% (5,618 acres) was Southern Rocky Mountain Ponderosa Pine Woodland, 15.4% (4,455 acres) was Southern

Burn Severity	Colorado Plateau Pinyon-Juniper Woodland		Southern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest and Woodland		Southern Rocky Mountain Mesic Montane Mixed Conifer Forest and Woodland		Southern Rocky Mountain Ponderosa Pine Woodland		Inter-Mountain Basins Aspen-Mixed Conifer Forest and Woodland	
	Acres	%	Acres	%	Acres	%	Acres	%	Acres	%
High	1,705	8.9	4,427	23.1	10,682	31.6	5,591	16.6	3,060	18.6
Moderate	5,003	26.0	6,387	33.4	11,206	33.2	10,053	29.8	6,031	36.7
Low	11,368	59.1	6,981	36.5	8,111	24.0	15,633	46.4	4,857	29.5
No data	617	3.2	1,136	5.9	2,956	8.8	1,857	5.5	1,881	11.4
Unchanged	544	2.8	212	1.1	796	2.4	565	1.7	614	3.7
<b>Total</b>	<b>19,237</b>	<b>100</b>	<b>19,143</b>	<b>100</b>	<b>33,751</b>	<b>100</b>	<b>33,699</b>	<b>100</b>	<b>16,443</b>	<b>100</b>

**Table 3. Las Conchas Fire Burn Severity by Major Vegetation Type**



Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest and Woodland, and 10.7% (3,109 acres) was Inter-Mountain Basins Aspen-Mixed Conifer Forest and Woodland.

In the ponderosa pine vegetation type, 17% (5,591 acres) burned at high severity and 30% (10,053 acres) at moderate severity. In the mesic-montane mixed conifer, 32% (10,682 acres) burned at high severity and 33% (11,206 acres) at moderate severity. Finally, in the dry-mesic montane mixed conifer 23% (4,427 acres) burned at high severity and 33% (6,387 acres) burned at moderate severity.

*The Pacheco Fire (NM)*

The Pacheco Fire started June

18th, 2011 and burned 10,250 acres (16 square miles). See attached map. Its cause is still under investigation. Almost 30% (2,988 acres) of the area inside the burn perimeter was Southern Rocky Mountain Mesic Montane Mixed Conifer Forest and Woodland. Another 21% (2,085 acres) was Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland. The remaining major vegetation types were Southern Rocky Mountain Dry-Mesic Montane Mixed Conifer Forest and Woodland (1,795 acres, 17.76%), Rocky Mountain Aspen Forest and Woodland (1,340 acres, 13.26%), and Inter-Mountain Basins Aspen-Mixed Conifer Forest and Woodland (1,049 acres, 10.38%).

Almost 37% of the burn area burned at high severity and another

	Southern Rocky Mountain Mesic Montane Mixed Conifer Forest and Woodland		Southern Rocky Mountain Ponderosa Pine Woodland		Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland	
Burn Severity	Acres	Percentage	Acres	Percentage	Acres	Percentage
High	1,142	38.2	62	16.5	1,036	50.1
Moderate	730	24.4	144	38.4	323	15.6
Low	623	20.9	102	27.2	107	5.2
Unburned	492	16.5	67	17.9	600	29.0
<b>TOTAL</b>	<b>2,987</b>	<b>100</b>	<b>375</b>	<b>100</b>	<b>2,066</b>	<b>100</b>

**Table 4. Pacheco Fire Burn Severity by Major Vegetation Type**

27% at moderate severity. In the high severity burn, 31% (1,140 acres) was Southern Rocky Mountain Mesic Montane Mixed Conifer Forest and Woodland, 28.0% (1,040 acres) was Rocky Mountain Subalpine Dry-Mesic Spruce-Fir Forest and Woodland, 16.4% (610 acres) was Rocky Mountain Aspen Forest and Woodland, and 11.3% (422 acres) was Inter-Mountain Basins Aspen-Mixed Conifer Forest and Woodland.

### **Conclusions**

The fires of 2011 in New Mexico and Arizona were remarkable as well as historic as far as their sheer size (area within the burn perimeter). However, it is important to understand that not every acre burned within the perimeters and those that did burn experienced variable severities of fire. On the whole, portions of the fires will ecologically improve forest conditions the burned area, assuming regular maintenance burns where appropriate. On the other hand, some vegetation types, in particular ponderosa pine woodlands, experienced higher portions of burn severity than normal, at least in recent history (post-1900) indicating a continuing need for attention.

Large fires seasons as measured in total acres burned are closely associated with climate cycles, both large and small. Throughout climate history, fire seasons have fluctuated with larger climate cycles such as drought periods as well as short-term cycles such as El Nino. (Whitlock 2004; Pierce et al. 2004). Contrary to common assumptions, modern fire behavior may be more closely related

In the mesic montane mixed conifer, 38% (1,142 acres) burned at high severity and 24% (732 acres) burned at moderate severity. In the dry-mesic spruce-fir, over 50% (1,036 acres) burned at high severity and 16% (323 acres) burned moderate.

Finally, in the ponderosa pine, 16.5% (62 acres) burn at high severity and 38.4% (144 acres) burned moderate.

to climate change than to recent or historical forest management. Large wildfire activity increased in the mid-1980s, with higher large-fire frequency, longer wildfire durations, and longer wildfire seasons that seem to be strongly associated with increased spring and summer temperatures and an earlier spring snowmelt (Westerling et al. 2006).

Fire behavior is also influenced by local conditions such as fuel buildup, weather, topography and even fire-driven conditions. But one thing is clear, Southwestern forests evolved with fire and will continue to co-exist with this critical ecological process. Portions of recent fires have been uncharacteristically hot and large. However, these fires may be consistent with historic burns and contribute to healthy functioning ecosystems (Baker and Ehle 2003; Kotliar et al 2003).

Natural fire behaves differently in different forest types or in other words, each major vegetation type is associated with distinct fire characteristics. Generally speaking in the Southwest, drier, low elevation forest types experienced frequent low severity fire (short fire return intervals). These forest types include pure ponderosa pine, dry-mesic mixed

conifer and some piñon-juniper woodlands. Wetter, high-elevation forest types experienced less frequent but higher severity fires often stand-replacing (long fire return intervals). These forest types include mesic mixed conifer, spruce-fire, aspen-mixed conifer and some piñon-juniper woodlands. Of course there are exceptions and anomalies to these general rules.

With this in mind, the fires of 2011 generally burned as we might have expected them to in most vegetation types. The exception is ponderosa pine where much of that vegetation type experienced high severity fire when in the past it might not have. The critical question is how to live with fire safely and strategically treat fuel buildup where it is a problem in a manner that does not strain federal and state budgets.

Of the 11 western states, New Mexico has the 8<sup>th</sup> and Arizona the 10<sup>th</sup> largest area of undeveloped, forested private land bordering fire-prone public lands, and New Mexico is 7<sup>th</sup> and Arizona 8<sup>th</sup> among western states in the amount of forested land where homes have already been built next to public lands.<sup>8</sup> New Mexico has 600 square miles of undeveloped, forested private lands adjacent to fire-prone public lands and Arizona 400 square miles. Building homes in these high-risk areas puts lives and property in the path of wildfires and creates a significant financial burden on state and federal government to fight wildfires.

Managers of Southwestern forests must foster fire as a cost-efficient and environmentally preferable management tool. The renewing force of fire should be reintroduced to Southwestern forests, restoring the region's ecology and lessening the chances of catastrophic fires. Not every acre can be burned without prior mechanical treatments, but thinning projects should be geographically limited and ecologically grounded. Thinning is not appropriate when prescribed wildland fire can accomplish the same goals.

Forest managers should prioritize the protection of interface communities through joint-fuels reduction programs. However, the obligation to take protective measures should rest squarely on private property owners. Fire proofing structures and immediate surroundings, commonly known as the Firewise program, is most critical for homes to withstand severe fire conditions (Cohen 1995; Cohen and Butler 1998; Cohen 1999). To protect forest communities, their immediate surroundings must be treated, local fire departments must be adequately funded, and evacuation routes must be identified. Once communities in the forest interface are reasonably protected, fire can become a viable forest management tool.

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<sup>8</sup> Gude, P., R. Rasker, and J. van den Noort. 2008. <http://headwaterseconomics.org/pubs/wildfire/nm.php>. Accessed September 8, 2011.

## Recommendations

In order to improve the management of hazardous fuels on Forest Service lands in the Southwest, restore the critical role of fire, reduce the risks to firefighters, and control the rising costs of fighting fires, WildEarth Guardians offers the following recommendations.

1. Counties must take responsibility for restrictive zoning ordinances in the Wildland Urban Interface, where flammable forests meet developed communities.
2. Private property and homeowners should take steps to make their immediate surroundings more fire safe.
3. Once the Wildland Urban Interface is adequately treated, fire should be used extensively to manage fuels in the backcountry.
4. Restoration and fuels treatments should be strategically targeted in the forest types that are experiencing uncharacteristic fire behavior rather than universally.
5. Controlled maintenance burns must be applied regularly to burned areas according to natural fire return intervals for appropriate vegetation types.

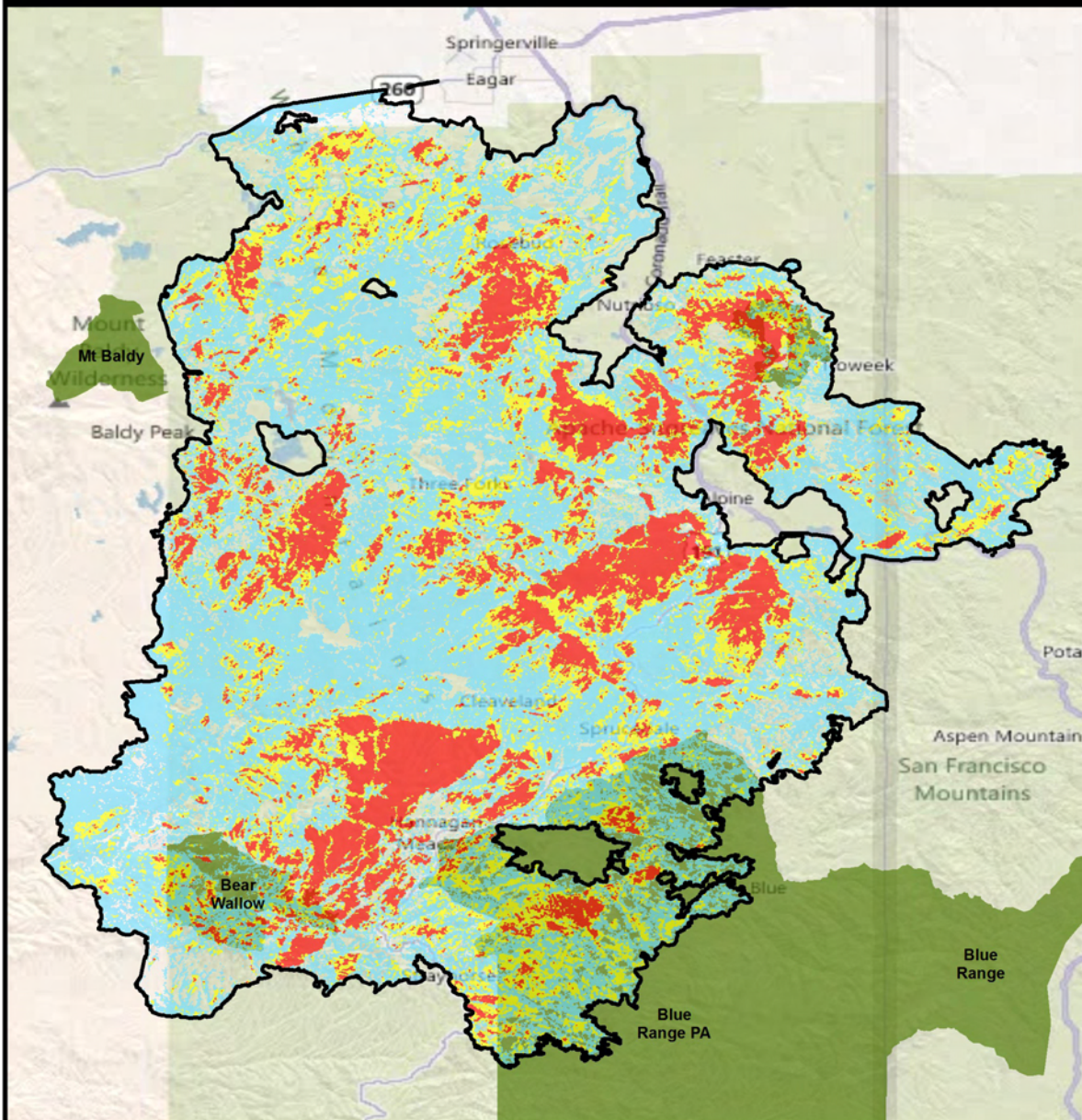


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# Wallow Fire Burn Severity (6/27/2011)



Cartography: Kurt A. Menke, GISP  
Bird's Eye View - GIS Services  
www.BirdsEyeViewGIS.com  
Data Sources: USFS BAER & GeoMAC  
Date: July 13, 2011

Wallow Fire Perimeter  
(6/27/11) (538,049 acres)



Burn Severity

- Unburned (16%)
- Low (48%)
- Moderate (20%)
- High (16%)

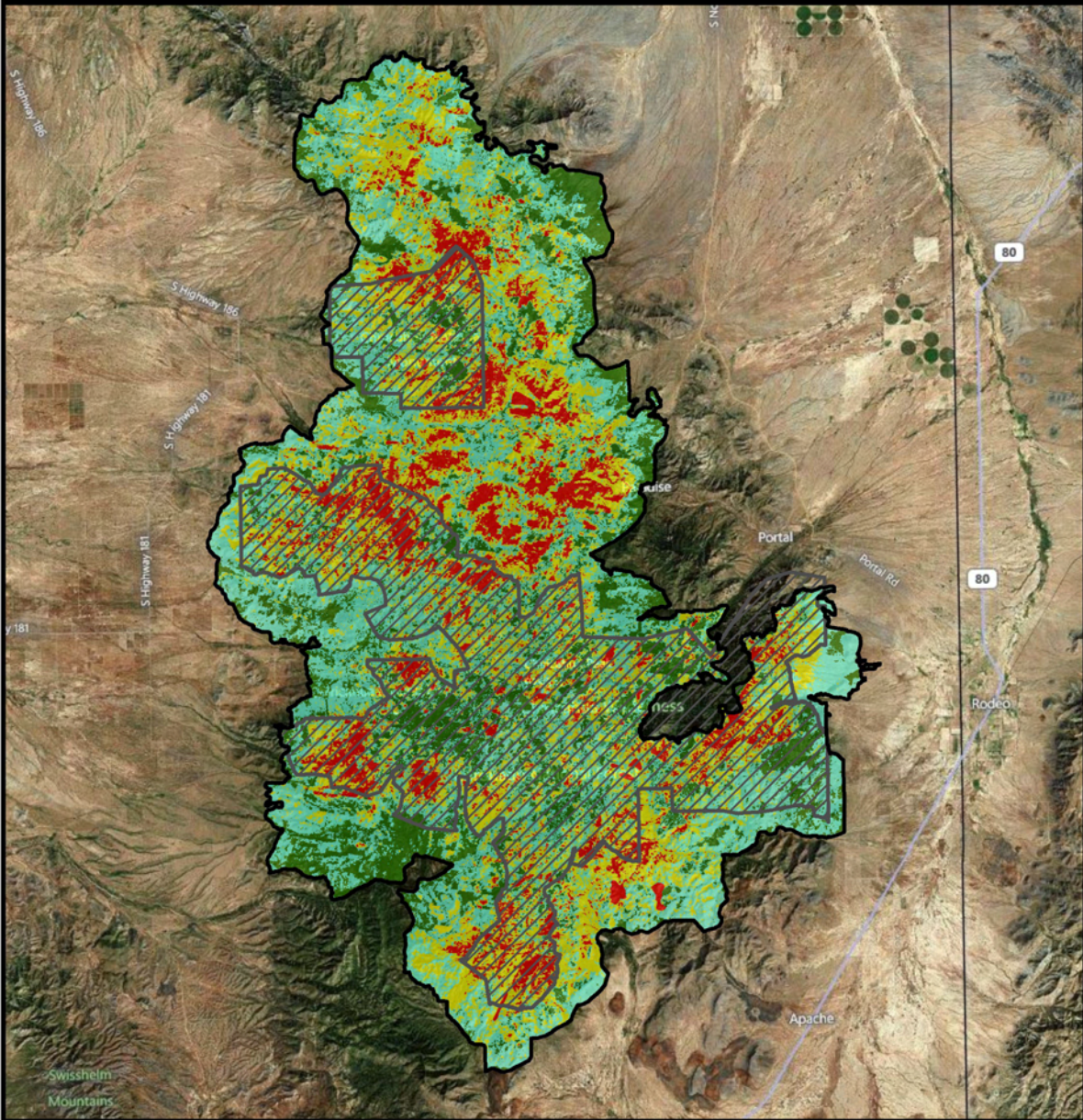
Wilderness







# Horseshoe 2 Fire Burn Severity



Cartography: Kurt A. Menke, GISP  
Bird's Eye View - GIS Services  
www.BirdsEyeViewGIS.com  
Data Sources: USFS BAER & GeoMAC  
Date: September 5, 2011



Fire Perimeter (6/21/11)

Wilderness

### Burn Severity

High (12.4%)

Moderate (29.7%)

Low (38%)

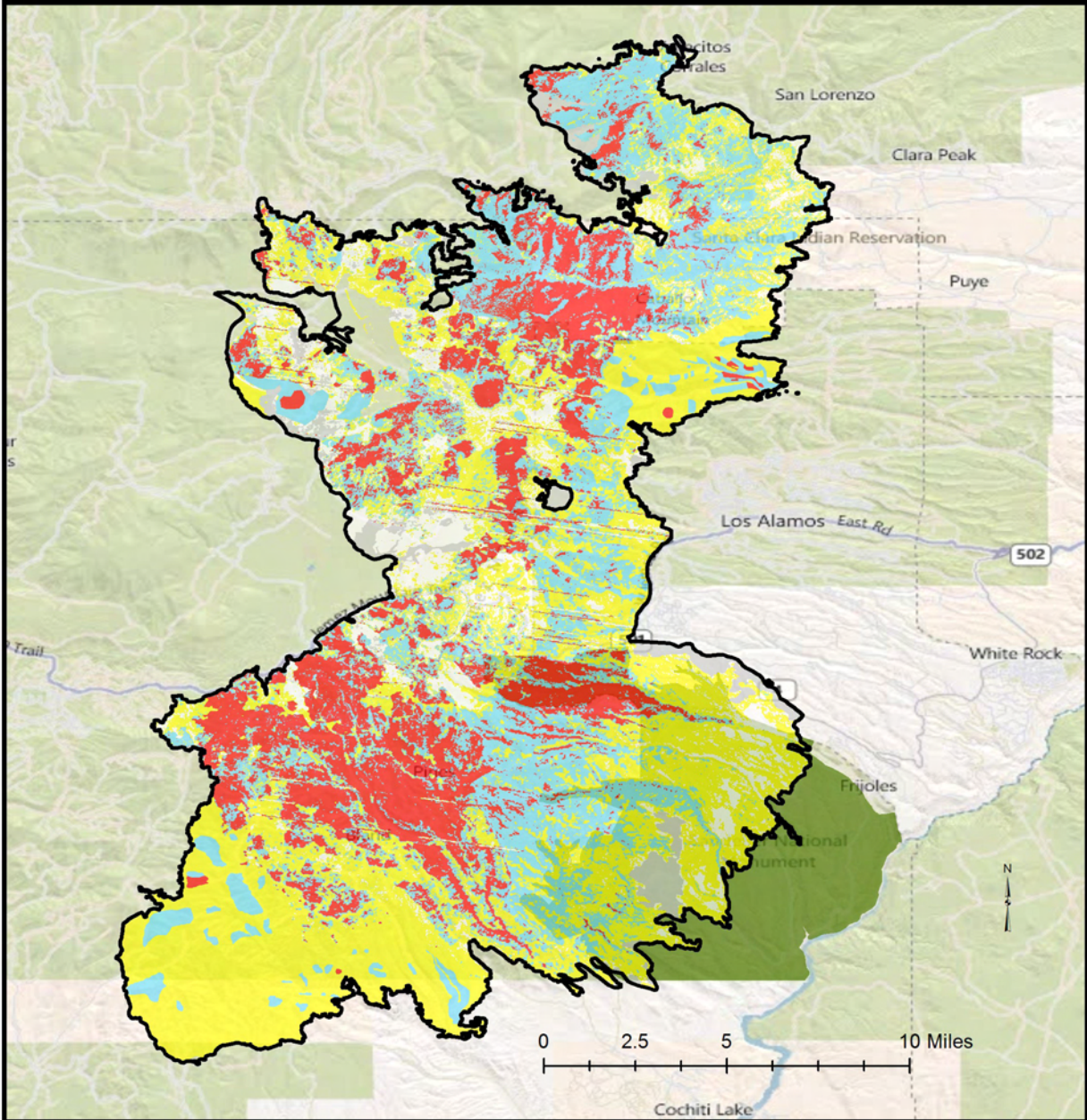
Unburned (19.7%)

No Data (0.02%)





# Las Conchas Fire Burn Severity (7/19/2011)



Cartography: Kurt A. Menke, GISP  
 Bird's Eye View - GIS Services  
 www.BirdsEyeViewGIS.com  
 Data Sources: USFS BAER & GeoMAC  
 Date: September 2, 2011

**Las Conchas Fire Perimeter**  
 156,593 Acres

**Burn Severity**

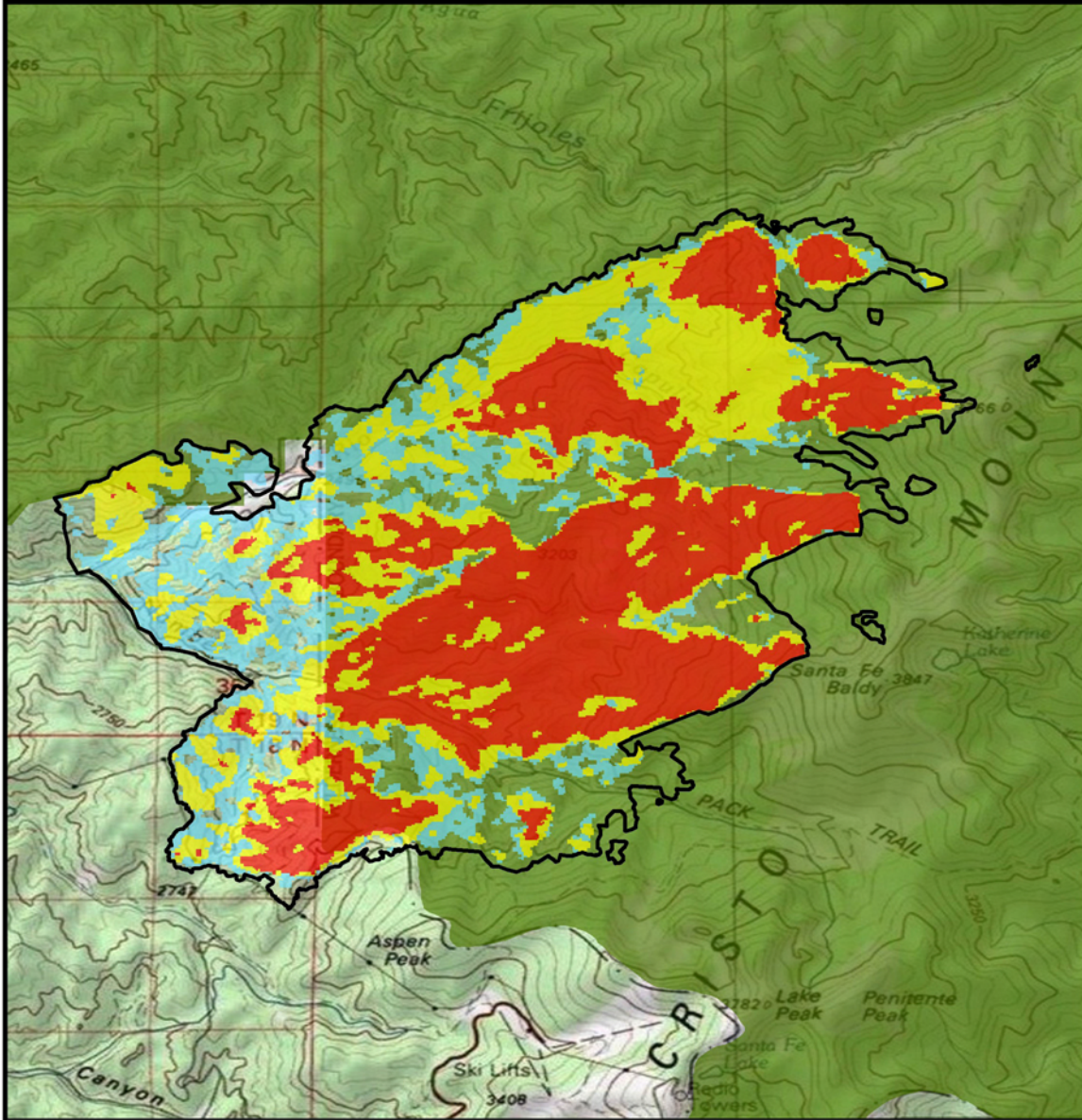
High (19%)	Low (39%)
Moderate (29%)	Unchanged (9%)
No data (4%)	

**Wilderness**





# Pacheco Fire Burn Severity (6/30/2011)







Cartography: Kurt A. Menke, GISP  
Bird's Eye View - GIS Services  
www.BirdsEyeViewGIS.com  
Data Sources: USFS BAER & GeoMAC  
Date: July 27, 2011

**Pacheco Fire Perimeter**  
(6/30/11) (10,107 acres)



**Burn Severity**

-  Unburned (19%)
-  Low (18%)
-  Moderate (26%)
-  High (37%)

**Wilderness**

