VIGNETTES OF THE

2015 Rough Fire

Sequoia and Kings Canyon National Parks

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A message from the Superintendent of Sequoia & Kings Canyon National Parks

For the first time in modern history, over 10 million acres burned nationally during the 2015 fire season. The Rough Fire, lasting 99 days, contributed over 151,000 acres to that total and impacted Sierra National Forest, Sequoia National Forest, Giant Sequoia National Monument, and Sequoia and Kings Canyon National Parks. Some 9,285 of those acres specifically burned in Kings Canyon National Park.

At the height of the fire, it grew over 10,000 acres a day on its way to become the 13th largest fire in recorded California history. The smoke produced from this fire impacted hundreds of thousands of people all the while defying many of the predictions made by computerized fire-behavior models.

This landscape was then experiencing a fourth year of drought and bark-beetle infestations, as well as what are likely the effects of climate change. Yet park lands fared well, including park infrastructure, the private community of Wilsonia surrounded by the park, and cultural and natural resources. Despite the fire's intense activity and the large area it affected, the park landscape proved resilient to the fire's effects. A wide range of effects on the land were documented—some negative, such as watershed damage, and others positive. The areas where park management had included prescribed fires and mechanical thinning showed the greatest resilience.

Impacts to residents and visitors, the region, and those who live and work in our national parks and forests were significant. Hundreds of stories surround the Rough Fire, from firefighters working back-to-back assignments away from their families, to visitors losing what may have been their one chance to see the Kings Canyon, to residents fearing that their homes might be lost. This document strives to capture and share the lessons related directly to fire. Every fire has something to teach us, and the Rough Fire taught us more than most.

This document offers a look at how fire-management strategies on the landscape, prior to the Rough Fire, affected fire activity and spread, and suggest management priorities for the future.

Thank you for taking the time to read these vignettes.

Woody Smeck, Superintendent

Summary

Ways that Earlier Fires and Fuel Treatments Aided in Fighting the Rough Fire

1. **They provided safe locations for bases for fire operations.**

   The 2005 Grant West Burn provided a solid anchor point for control operations along Highway 180 at the NPS boundary. The 2014 North Boundary Burn above Highway 180 effectively eliminated the need for holding resources from the park boundary to the handline.

2. **They provided solid points from which firefighters could anchor firelines.**
   Critical prescribed-burn treatments in Grant Grove (all of which were the second time action was taken to restore fire to its historic level of frequency had full fire exclusion not occurred.) include 2004/2005 Grant West and 2013 Swale West. These burns created an anchor point for firelines to the west of the park that successfully protected developments around Sequoia Lake.

3. **They made it relatively easy to keep fire at bay when it approached previous burns areas.**
   Fuel treatments on the valley floor in Cedar Grove permitted relatively easy holding actions with fewer adverse impacts by the fire on forest stands. Critical prescribed-burn treatments (all second-entry burns) include 2013/2014 Valley Floor, 2011 Hole-in-the-Wall, and 2011 Nature Trail, 1994/1996 Cedar Grove.

4. **They slowed and, in some cases, stopped the fire when it reached the edges of earlier burns.**
   Growth of the Rough Fire along most of its eastern perimeter was stopped by three earlier fires that had been managed to restore the landscape to pre-fire exclusion conditions. (2005 Comb, 2008 Tehipite, and 2010 Sheep fires). The 2010 Sheep Fire provided a strong barrier to fire spread and did not require control operations within its footprint.

Summary

Lessons Learned for Future Fire Management

In order to be successful, we need to focus on the following for future fire management:

1. To reduce risk of large-scale, destructive wildfires, we need a sustained investment of funding and operational focus on the use of prescribed fire and managed wildfire over a long period of time, such as 20-40 years.
2. Treatments need to be landscape in scale if they are to alter large-fire behavior and growth.
3. Treatments need to be interagency endeavors, with shared planning and implementation, to be most effective.
4. We must use all of the fuels treatment tools available: mechanical, prescribed fires, managed wildland fire, and pre-existing full-suppression wildfires. All of these played a role in protecting park assets; no single tool would have been effective in helping to control the Rough Fire.

Arrowhead Hotshots Interagency Hotshot Crew. Kari Greer.

Background

A Short Statement on Fire in the Sierra Nevada

Fire is a natural force that has shaped the vegetation of the Sierra Nevada regularly, frequently, and for eons. How it affects each area that it passes through—the "fire effects"—depends largely on the type of vegetation or fuel there and on the time since the last fire. Because natural fires tend to be relatively frequent and prevent large accumulations of fuel, the effects of successive fires tend to be relatively light. As a result, the ecosystems were resistant or resilient to fire – that is, they could resist some of its effects (as in the thick bark of sequoia trees helping to insulate the living tissue in their trunks from the heat), or they could be resilient, renewing themselves with new growth relatively quickly after fire. Where fuels had built up, fire burned hotter and some aspects of the ecosystem tended to sustain more fire damage or take longer to recover, but even then some components of the system adapted to take advantage of these "hot spots."

Although Native Americans used fire to manage vegetation for thousands of years, this role that fire plays in the forest was not understood by Euro-Americans who moved into the area. The same was true of most early national park and forest managers; therefore, for more than a century, fire suppression has been the norm in this society. As a result, vast areas of wildlands are far outside their natural fire-return interval, and the vegetation that has grown and died over this time has not been removed. Historical data shows that modern forests average four times as many trees per acre as there would have been prior to fire exclusion by forest managers.

When these areas finally burn, as they always do, these loads of fuel burn hotter than normal. This does more extensive damage to the ecosystem, makes fires harder to control, and produces more smoke. By contrast, areas with previous and recent fire history have lower fuel loads, which when burned produce less damage and less smoke (when less material is burning, less smoke is produced).

In the last 50 years, as land managers learned more about fire ecology, they started to understand the need to reduce fuel loading before fire returned on its own schedule. They use several techniques to do it, including mechanical thinning and removal of fuels, and prescribed (planned) burns. Wildfires can also accomplish the same goals as prescribed burns, if a fire starts in the right place at the right time and goals are planned in advance.

The Rough Fire was not one of the latter, and suppression

efforts started immediately.

Many factors affect the behavior of fire and its effects on the landscape, as well as how and where firefighters can attack it. These factors include:

- Weather at the time of burn
- Drought conditions
- The presence of dead trees and other vegetation
- Steep slopes and terrain
- Types of vegetation, from low-elevation shrubs, to conifer forest, to sparse, high-elevation vegetation
- How long ago the area last burned
- How long ago the area was "treated" to reduce fuels, including mechanical thinning and/or prescribed burns.

A Brief History of the 2015 Rough Fire

Lightning ignited the fire on July 31st on the Sierra National Forest, high on a slope north of the Kings River. Named for a creek near where it started, the Rough Fire indeed proved to be tough to tame.

Very rugged, steep terrain, and dry, hot conditions typically make firefighting difficult in the southern Sierra Nevada. After four years of harsh drought leaving thousands of dead trees, responding to the Rough Fire was extremely challenging. For one, in such steep country, fire-fighting aircraft need to be able to see a certain distance in order to fly to the fire, release water or retardant accurately, then accelerate up and out of the mountains. The fire's thick smoke, held in the canyons, made it impossible for pilots to fly at times.

The fire ran east from Sierra National Forest to the park boundary northwest of Cedar Grove, as well as westward down the river canyon toward civilization. On August 18th, the flames sped south, jumped the Kings River, and ran into Sequoia National Forest. It leapt up the south side of the Kings Canyon and crossed Highway 180 at Horseshoe Bend, east of Grant Grove. This closed the only route to the park's popular Cedar Grove development and forced that area's evacuation.

As the fire raced south and west on national forest land, officials closed facilities at Hume Lake. Soon after, they also closed the Grant Grove area of Kings Canyon National Park to visitors. Two days later, a change in fire behavior allowed this area to open again.

The threat to Grant Grove then increased from the west as the fire continued toward the foothills and the San Joaquin Valley. Winds and very active fire behavior drove the flames uphill and southward, starting spot fires up to one-half mile ahead of the fire front. That meant that visitors and park and concession employees and families

had to leave Grant Grove, and residential areas west of the park were also evacuated.

Over 3,700 firefighters were engaged at the height of the fire. Thousands of residents were evacuated, and thousands more visitors had to be evacuated or turned away. A shift in the weather on September 14th finally helped firefighters. A rainstorm lowered temperatures and raised humidity just enough to turn conditions to the crews' advantage. Subsequently, as more containment line was completed, workers in Grant Grove, Cedar Grove, and areas in both forests began the process of removing hundreds of miles of hose. They tried to shore up areas that might be prone to erosion during coming winter rains.

On September 18th, as evacuation orders were lifted, the road closure at Highway 180 and 245 was moved eastward to the junction of Highway 180 and the Generals Highway. This opened road access into Giant Sequoia National Monument and through Sequoia and Kings Canyon National Parks. Grant Grove reopened to the public on September 22nd. The Rough Fire was finally completely contained by firebreaks and firelines on November 6, 2015. Cedar Grove and many forest lands remained closed to the public throughout the winter.

Rita Baysinger

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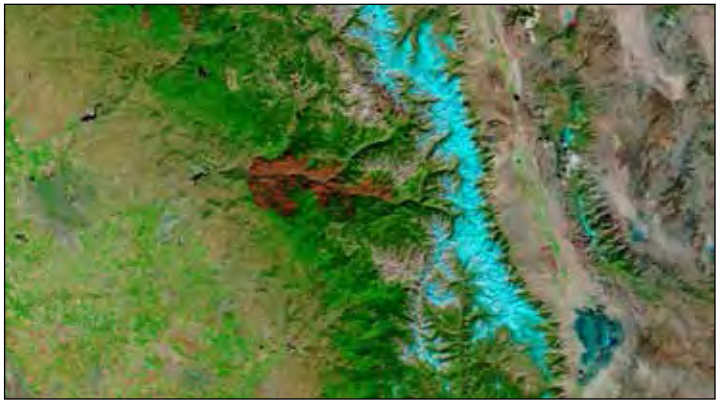
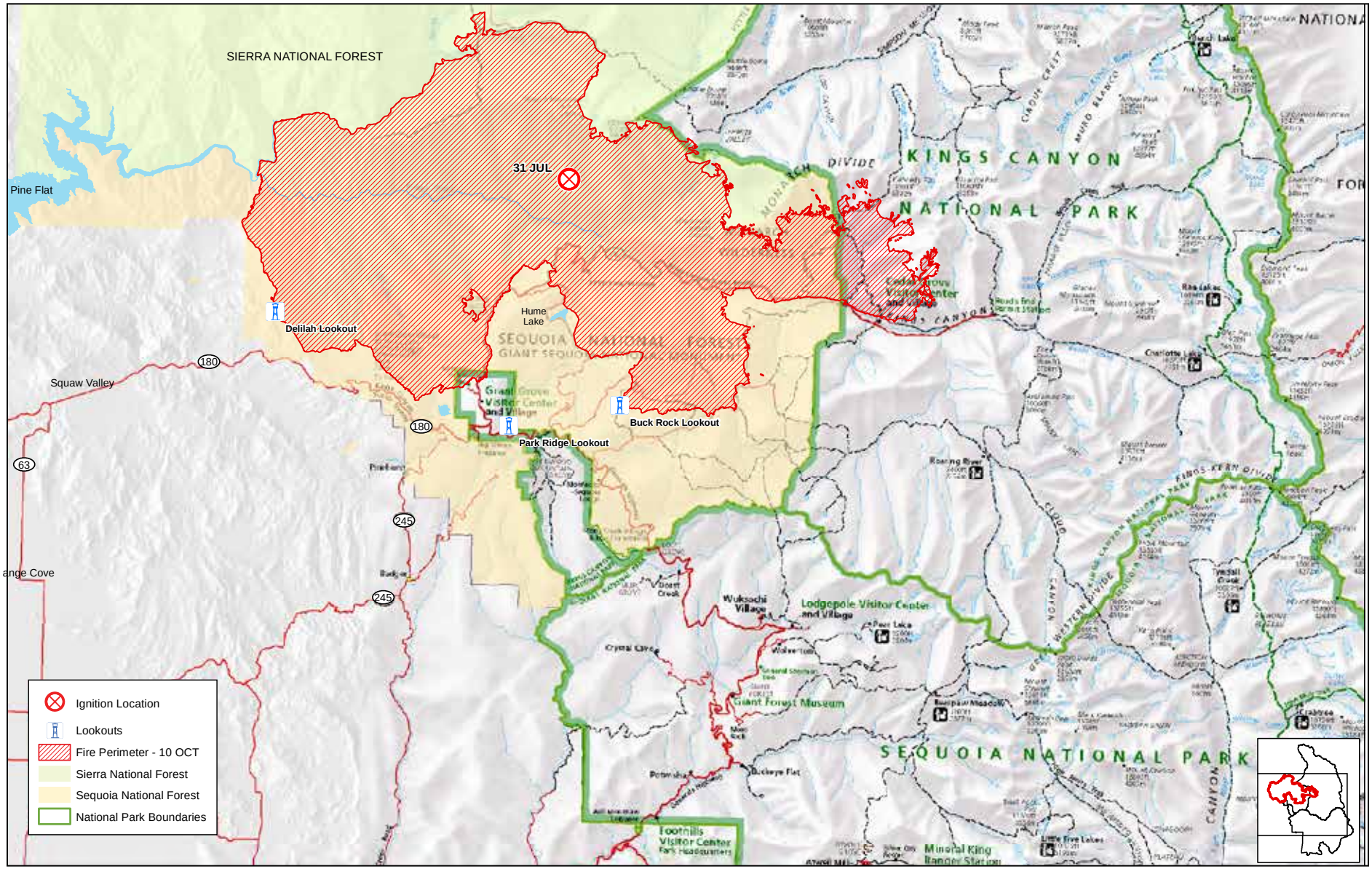


NASA

Map of the 2015 Rough Fire and Surrounding Area



This map shows the extent of the Rough Fire that affected Sierra and Sequoia national forests and Kings Canyon National Park. The fire started on July 31, 2015 and remained uncontained for 99 days.

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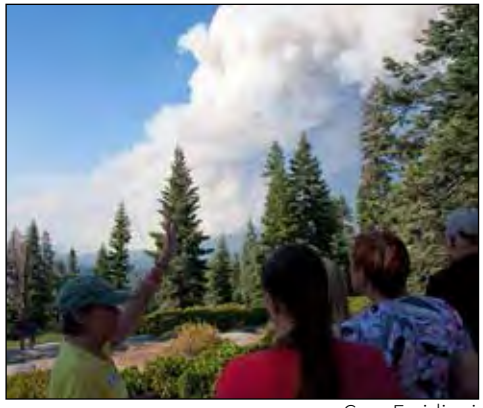


Greg Freidiani

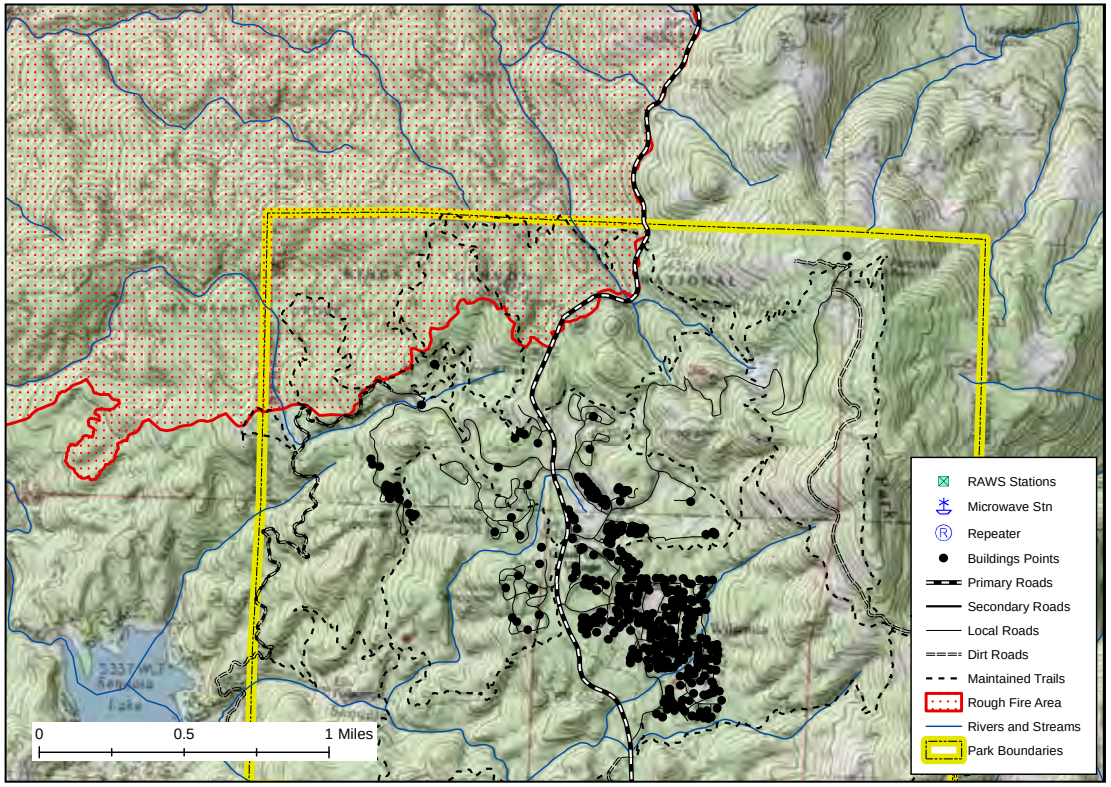
Rough Fire Activity in Areas of Kings Canyon National Park

Rough Fire Activity in Grant Grove

Grant Grove, a peninsula of park land surrounded by U.S. Forest Service land, is home to the second-largest giant sequoia on Earth, the General Grant Tree (also known as the Nation's Christmas Tree). While areas in Grant Grove impacted by the Rough Fire have been treated with prescribed fires twice, much of the sequoia groves and surrounding area within the Grant Grove peninsula has been treated at least once and, in some cases, three or four times, within the last 30 years.

Previous Fire Activity, Treatments, and Observations

Prescribed burning throughout most of Grant Grove had already provided broad areas of reduced fuel loading that could serve as anchor points during suppression operations. Mechanical thinning had been completed around structures, improvements, and developed areas, including the private community of Wilsonia that is surrounded by park land. The overall effect of past fuel-reduction treatments was a significant reduction of risk to employees, residents, visitors, buildings, and infrastructure.



This map shows how close the Rough Fire came to park facilities in Grant Grove.

Most modern prescribed burning in the area began in the 1980s (the first burn was 1979). Following research conducted in the 1960s in the nearby Redwood Mountain grove and fire treatments in other park areas that showed favorable regeneration of giant sequoias, fire managers recognized that this species was largely dependent on fire to reproduce. They realized that a healthy forest was one in which fire plays an ongoing role in the environment, just like rain, snow, and climate.

Fire managers also realized that suppression of all lightning-caused fires resulted in the accumulation of heavy fuel loads, which in turn would feed unnaturally intense, destructive wildfires. Therefore, reducing these loads using prescribed fire would also make managing unwanted wildfire more feasible, particularly in areas like the Grant Grove peninsula. One of the big motivators for treating

McGee Fire. San Joaquin Valley & Sierra Foothill Photo Heritage, Tulare County Library

Grant Grove in foreground and McKenzie Ridge (west of park) in distance. NPS/Tony Caprio.

fuels around Grant Grove was the 1955 McGee Fire that burned 17,000 acres just outside the peninsula (many signs of firefighting activities from this fire were exposed by the Rough Fire).

During the Rough Fire

Fire managers believed that their fuel treatments would one day play a role in suppression of a major wildfire. This is, in fact, what happened with the Rough Fire, one of the biggest and hardest to contain wildfires in California history. Previous prescribed-fire treatments allowed

fire-suppression resources to fall back and build containment lines in areas with reduced fuel loadings and open forest canopies. Once the Rough Fire crossed Hoist Ridge and was making a hard push towards Grant Grove, firefighters were forced to move to treated forested areas that were thinner—more like pre-1900 densities. There, firefighters were able to construct line with ease. In some locations the Rough Fire, burning as an active head fire, ran into these open stands of treated park forests and stopped. It never made it to those containment lines because of the reduced wildland fuels within the national park.

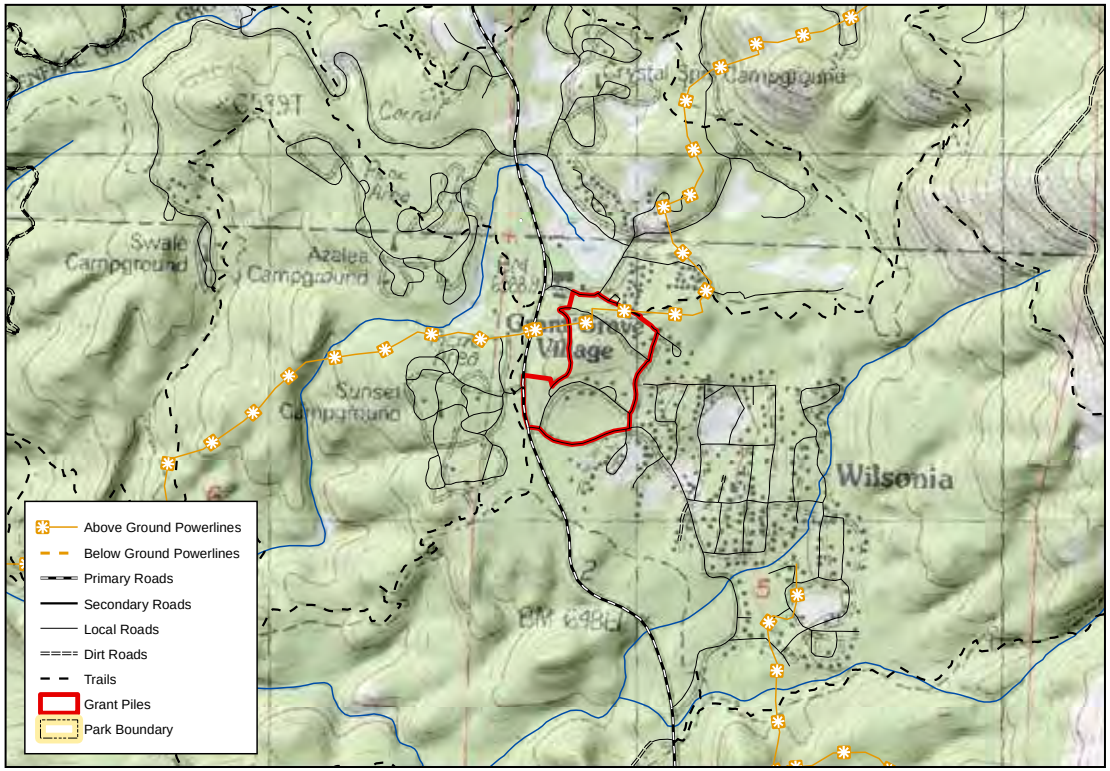
What did we learn?

If not for the history of prescribed fire and mechanical treatments in Grant Grove, important facilities such as the visitor center and campgrounds, along with historic assets and natural resources, would likely have been lost.

With clear evidence that prescribed-fire treatments successfully protected the Grant Grove area, fire and park managers need to be able to use it to help protect ecosystems and assets from high-intensity wildfires through measured repeat intervals. In addition, lower tree density makes more water resources available for the remaining trees. The trees in Grant Grove appear to have been more resilient (fewer dead trees) during this fourth year of drought than trees in surrounding areas.

Such work needs to be continued and expanded. Because the area receives high visitor use throughout the year, allowing natural fire to maintain the area may be unrealistic. Fire managers need to implement and maintain prescribed fire and mechanical treatments to ensure that the forest maintains a healthy and resilient state, and

Grant Grove Mechanical Map



that visitors and residents are not impacted by smoke for extended periods of time. Reduced fuel loads will also significantly reduce the amount of smoke released during major wildfire events.

Continued treatments are needed to maintain more natural fuel loads and restore/maintain a fire regime that results in a more resilient ecosystem. Sequoia and Kings Canyon fire management staff have prioritized continued treatments within their five-year fuels management plan and resilient landscape proposal (the latter was funded in 2015). As such, current thinning treatments ongoing in Grant Grove through the Resilient Landscape Project allows for that work to be done. In the next two to three years, burns are planned in the Big Stump, Panoramic Point, and Park Ridge areas.

Investing in these types of treatments will help to ensure continued protection of both the park and the public.

In Grant Grove, residents of the private community of Wilsonia have been generally supportive of these treatments. Much effort has been made to keep the community and the concessioners informed of current and proposed treatments in order to maximize understanding and minimize negative effects on visitors and residents. Continued outreach will be necessary to ensure future support. One benefit to the Rough Fire was the validation of the effectiveness of the parks' fuels management program in Grant

Effects of the Rough Fire along the North Loop Trail in an area with previous fuels treatments (top, burned twice) and without fuels treatments (bottom) along the west boundary.

Grove to both employees, residents, media, and the public at large.

It is critical that future fuels treatments are interagency in scope. If previous prescribed burns had extended past park boundary lines on the Grant Grove Peninsula, the area most likely would not have seen the giant sequoia mortality on the west side of Grant Grove, by the North Grove Loop Trail. Therefore, it is imperative to get away from firelines and prescribed fire areas being constrained by agency boundaries. Boundary lines are not always the most suitable or safest location for a fireline. One solution is to work with the neighboring U.S. Forest Service on an interagency five-year burn plan cycle. We are currently working with the Sequoia National Forest on several inter-agency cross-boundary prescribed fires.

Conclusion

With much of the Grant Grove peninsula having been treated with prescribed fire over the last 35 years, tree density has been dramatically reduced and is in better alignment with conditions that existed when the park was established in 1890.

Tree density in an area of Grant Grove without fuels treatments (northwest boundary prior to the fire)

Rough Fire Activity in Cedar Grove

The developed area in the heart of the Kings Canyon itself is called Cedar Grove. It lies at 4500 feet in elevation, and gives park visitors a chance to view spectacular glacially carved scenery. It is also an area that historically has seen a high fire-return-interval rate. Natural fire would go through this area every three to five years; significantly more often than areas that contain giant sequoia groves, which have natural fire-return intervals of five to twenty years. This is different from the way that other ecosystems in the parks function and shows that each area needs to be addressed indivifually; there is not a one-size-fits-all solution.

Previous Fire Activity, Treatments, and Observations

Historically, fire burned on the valley floor in Cedar Grove every three to five years, according to tree-ring studies. Native Americans who frequented the area burned to enhance the black oak trees' production of acorns, an important source of food for them. As these fires moved through, they would clear young conifer trees and keep the area open. While oaks would benefit from having the competition for water and nutrients reduced, they would not be the only species remaining after a fire. Ponderosa pine, incense-cedar, and a few white fir trees would survive. This was due to the low-intensity type of fire that worked its way through the valley on a frequent return interval.

Cedar Grove has a rich fire history over the last 40 years. Many of the slopes and surrounding ridges have burned because of lightning strikes that were allowed to spread. In recent times, the lightning-caused Sheep Fire of 2010 showed that wildfires allowed to burn during normal precipitation years offer much benefit to land managers. As national park and national forest staff worked together to manage it, the fire carried easily with low to moderate intensity through the Monarch sequoia grove on Forest Service land, causing little damage to the mature

Reduced fuel load after a prescribed burn. Areas that have been treated in this way provide significant barriers to wildfires such as the Rough Fire.

sequoias. This interagency effort, while initially difficult to coordinate, was ultimately successful and the area was now on its way to more natural conditions, instead of having decades of unnatural fuel build-up. The final effects that the fire had on the ecosystem were lower considering the intensity of the fire; fire understory burned well, with little scorch of the canopy on both NPS and USFS land.

Past lightning fires that were managed for resource benefit that are a normal part of the fire ecology of the Sierra Nevada also played a role. When the Rough Fire spread through the area of the Comb Fire of 2005 north of Cedar Grove (which was started by lightning but managed for resource benefit), it did so with less intensity and severity than if the area had not recently burned. To the south, the managed Sheep Fire of 2010 stopped the Rough Fire several miles west of Cedar Grove.

During the Rough Fire

The benefits of past fuels treatments in Cedar Grove were clearly evident during the Rough Fire. Prescribed burning has occurred on a continuous basis for several decades (since 1970) along the valley floor from east of Roads End to Lewis Creek. A combination of burning and past thinning treatments provided reduced fuels and defensible space around government and concession buildings and

The Lewis Creek area of Cedar Grove, before and after the Rough Fire. Previous fire history in the area kept the Rough Fire from growing large enough to harm mature trees.

housing. This defensible space gave firefighters an area to backfire from during suppression operations.

However, eighteen years after the 1997 Choke Fire, which occurred above the valley floor (MAP), the Rough Fire burned through it as a head fire with high intensity, almost as if there was no fire history in that area. In contrast, when the Rough Fire reached the 2005 Comb Fire, it stalled briefly before continuing as a head fire with a mix of moderate intensity and some areas of higher intensity.

Fires help protect the canyon floor from unwanted fires burning aggressively into it. That is exactly what fire managers witnessed as the Rough Fire was burning over a mile a day toward Cedar Grove. As expected, it raced through brush and bear clover up the slope to the timber line. As the fire pushed through old burn scars, however, it varied in intensity. The variation was directly related to how long it had been since areas had experienced natural fire frequency (i.e., how long they had been outside the natural fire-return interval). As fire suppression denies fires to areas that are accustomed to it (i.e., causes the area to miss a fire-return cycle due to fire suppression), fuels continue to accumulate and tree spacing grows tighter. As the fire moved through lower elevations of the 1980 Lewis Creek wildfire, 2005 Lewis Creek prescribed burn, 2005 Comb Fire, and the 1997 Choke Fire, severity was dependent on the fire return-interval cycles. Areas better aligned with their natural fire return intervals experienced less-intense wildfires.

Fire managers must work with land managers to understand consequences of all decisions in the management of subsequent wildfires. It is important to understand that a decision to suppress a fire today will increase the risk of fire there in the future.

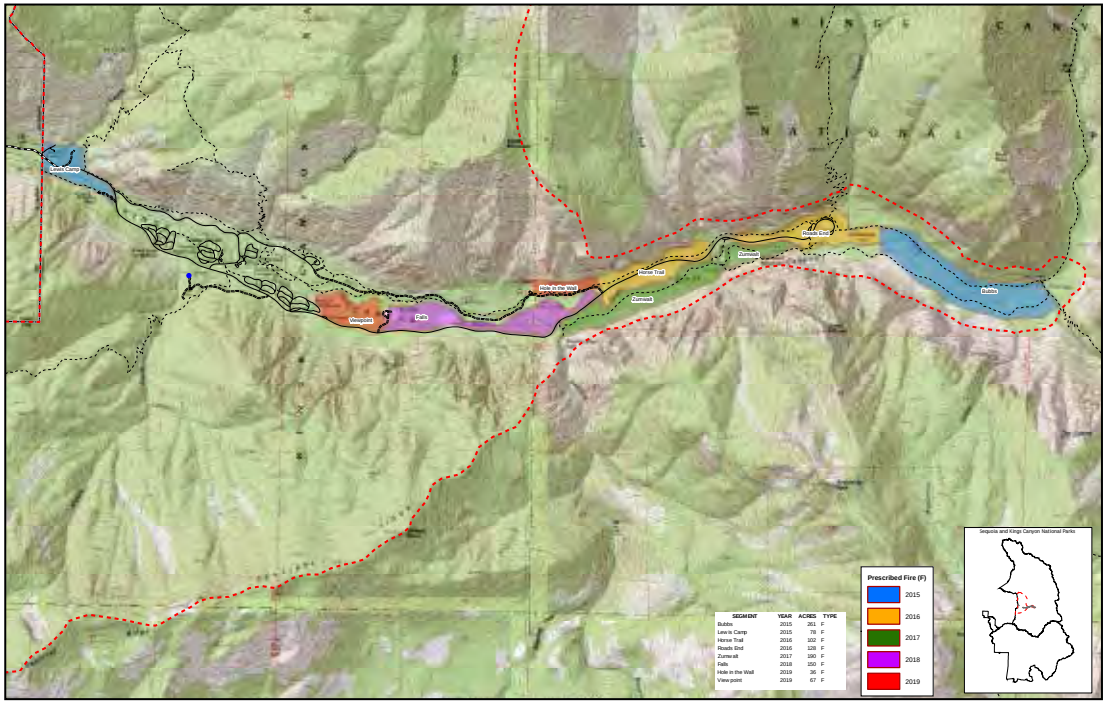
What did we learn?

Because of the rapid re-accumulation of burnable fuels in ponderosa pine/black-oak forests in Cedar Grove, fire managers need to take advantage of having two recent burns securing fire from leaving the park and blocking off the lower canyon, such as the 2010 Sheep Fire and the 2015 Rough Fire. In order to be successful, the parks need to increase the frequency of prescribed burning in ponderosa/black-oak forests in Cedar Grove to maintain the five-year return interval and reduce fuel buildup.

The challenge faced by fire managers is to reintroduce fire in the canyon at a high enough frequency to mimic nature. The area is a favorite vacation spot for many visitors during the summer, with many families returning every year. Smoke can remain in the valley for long periods during days of poor dispersion common in summer and fall. Even though the forest will benefit by improved resilience to

disease, insects, and unwanted wildfire, smoke impacts and visitor health need to be weighed in every decision made to manage fire for resource benefit.

Fire was, and is, a frequent visitor to many areas of the Cedar Grove landscape. This is evidenced by the short historic fire-return intervals (as often as once every three years on the valley floor), based on fire scars found on many trees in the area. For this reason, the parks' fire management program places a high emphasis on maintaining this interval utilizing prescribed burning. Priorities include continuous treatment of the valley floor within the five year fuels plan and managing natural fires in surrounding lands as opportunities arise. Support for the program is generally high, including by both the public and concession staff.



Future project work in Cedar Grove

Conclusion

The parks have invested a lot of resources in managing fuels in the greater Cedar Grove area and have successfully begun the restoration of fire across much of this landscape. There is inherent risk in managing natural fires and conducting prescribed burns, including the risk of escape and short-term smoke impacts. However, as the Rough Fire showed, there is a greater risk from not proactively managing fire and/or reducing fuels.

Rough Fire Activity in Areas of Recent Wildfires

Sheep Fire, 2010

Lightning started this fire in 2010 inside a rugged, steep area that was planned for a prescribed burn, the Upper Sheep Creek prescribed burn unit. The lighting fire was not expected to survive the first 24 hours because the storm also brought three-quarters of an inch of rain. However, the start did survive, and the resulting fire was an interagency management effort by the parks and Sequoia National Forest. The result was the treatment of 9,020 acres that had no recent fire history and were far outside their natural fire cycle. Two of the considerations in allowing this fire to continue were that 2010 was a wet year (150% of normal), and that it was likely to be beneficial to the ecosystem.

The Sheep Fire was contained by the road system to the south, the Kings River to the north, natural barriers and trails, and limited hand-dug firelines.

This low-intensity understory burn reduced fuels and restored the ecosystem by eliminating dead and down plants and trees and by opening the forest floor, allowing new plants to thrive. The effects were so good that fire managers believed that the Sheep Fire's footprint could be used as a barrier to fire spread for many years. Five years later, when the Rough Fire jumped the Kings River

2010 Sheep Fire. NPS Photo.

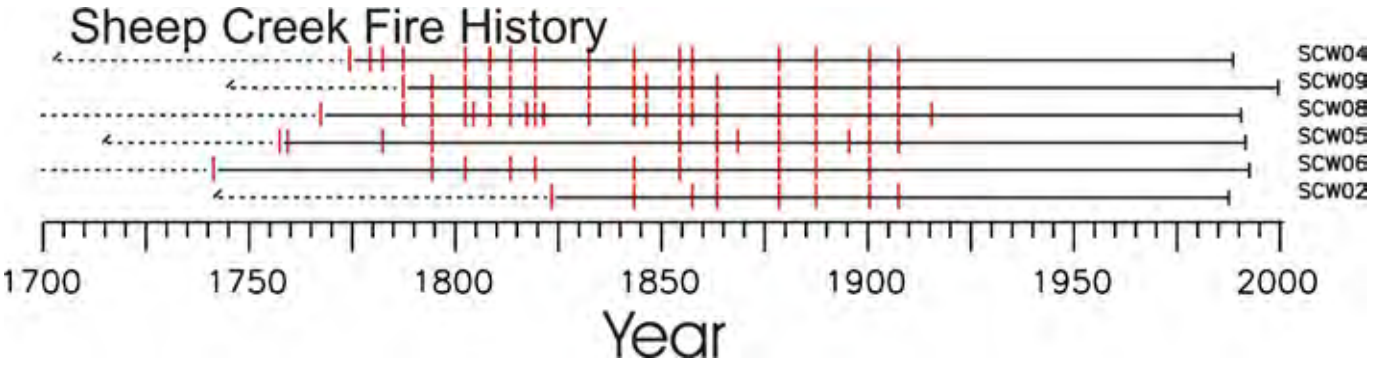
Area burned by the Sheep Fire in 2010. NPS / Tony Caprio.

from north to south, planning was implemented to use the Sheep Fire perimeter as a barrier to the Rough Fire's spread.

Previous Fire Activity, Treatments, and Observations

It has been documented that previously burned areas may reduce or stop fire spread; given the reduced amount of fuel available to the flames, fire generally loses intensity and becomes more manageable in these areas. This proved to be the case here.

The area of the Sheep Fire is difficult for conducting prescribed burns due its steep rugged slopes and proximity to a park boundary; the parks work to keep fire from crossing boundaries unless an interagency agreement is in place. The plan to prescribe burn the area had been in place for around a decade before the lighting start. Fire managers knew that the Sheep Creek area needed treatment: It didn't have recorded fire history and sampling of fire-scarred trees there showed frequent fire in the years before fire suppression. The relatively wet conditions under which lightning started the Sheep Fire were essentially the same conditions under which a prescribed fire would have been ignited by park managers, so there was the



Record from 1700 to 2000 of past fires in the Sheep Creek area from one group of fire-scarred trees. Each horizontal black line represents one sampled tree and the time period it was alive. Each vertical red line represents the year in which a fire was hot enough to mark that tree. Fire suppression effectively excluded fire from this area beginning in about 1909.

opportunity to reduce fuels and restore fire to the ecosystem during a period that would have the greatest benefit and success. This truly demonstrates why interagency actions are critical to the a holistic approach to fire and fuels management, rather than actions limited by agency boundaries.

During the Rough Fire

The unplanned but timely lightning fire of 2010 was managed to successfully treat the Sheep Creek area. In 2015, concern with the Rough Fire spreading in the direction of the 2010 Sheep Fire was low because the previous fire had reduced the fuels to the point that, when the Rough Fire reached the perimeter of the 2010 fire, its intensity would drop and possibly stop the fire spread. When the Rough Fire did meet the western edge of the Sheep Fire perimeter, it initially reduced spread and then stopped spread.

This greatly reduced the need to have firefighters risking themselves to cut line on such steep slopes. The Incident Management Team also didn't have to spend time, energy, and money trying to stop the Rough Fire on that boundary.

What did we learn?

It is critical that we promote an understanding and acceptance of allowing naturally ignited fires to consume fuels when and where appropriate. Additionally, work with local air regulators to provide opportunities for this type of management activity on a larger scale is a fire-management priority. These fires can have important fire control benefits for many years, as well as the ecological benefits that they bring.

Eventually, the Sheep Fire footprint will start to accumulate fuels such as smaller trees and brush. These will once again begin to compete with larger trees for water and nutrients, and will supply an unnatural quantity of fuel when the next fire comes along. The area will need to be monitored and fire managers will need to ensure that the area is treated with natural fire or prescribed fire before it misses another fire-return interval.

Comb Fire, 2005

The Comb Fire was started by lighting in the Sequoia – Kings Canyon Wilderness, and allowed to grow for the benefit of the ecosystem. The 1980 Lewis Creek wildfire, started by people, had burned in the same area but was aggressively suppressed at the time. Some 35 years later, the fuel loading conditions were not a concern. The park

managed the 2005 Comb Fire to allow the area to return to its natural fire-return interval.

Previous Fire Activity, Treatments, and Observations

Most fires in the Lewis Creek drainage could be contained along the ridge that defines the park boundary to the west of the drainage. Firefighters successfully held the 1980 Lewis Creek Fire there and the plan was to hold the 2005 Comb Fire there as well. However, when a thunder cell passed over the Comb Fire and caused major downdrafts of wind, the fire quickly raced west to the top of the ridge and crossed onto U.S. Forest Service/Sequoia National Forest, where the fire eventually was contained with firecrews and handline. To the east on National Park Service land, the fire was permitted to move freely as long as it stayed within the park wilderness. It eventually worked its way several miles to the east on the canyon wall before winter rains extinguished the fire.

During the Rough Fire

As it reached the mouth of the Lewis Creek drainage, the Rough Fire burned into the Comb Fire footprint. With wind, slope, and fuels creating the perfect storm, the

2005 Comb Fire in Lewis Creek. NPS / Tony Caprio.

Rough Fire rapidly burned through the lower-elevation vegetation that had, in the decade since the Comb Fire, reached the end of its natural fire-return interval. As the Rough Fire reached higher elevations in the Comb's area, with sparser fuels and a longer fire-return interval, the Rough Fire's activity was moderated. Due to the fuel loads that were removed and reduced by the Comb Fire, the Rough Fire never made it as far east as the 2005 Comb Fire did.

This demonstrates one of the value of re-establishing a mosaic of fire footprints of different ages, with more recently burned areas helping to limit the spread and intensity of future fires. Indeed, one of the reasons that

attempts to suppress all fires is leading to larger, more intense fires is the loss of this historic mosaic of burns, and its replacement by unnaturally heavy, evenly spread fuels. Such unnatural fuel continuity facilitates the rapid spread of destructive wildfires that are increasingly common to recent fire seasons. That is why reestablishment of natural burn mosaics has been an underlying principle driving the NPS fire program for the past forty-five years.

What did we learn?

It is imperative that the parks continue to manage fire on the canyon walls. The wide range of fire intensities and effects in this area over this time has returned the Comb Fire footprint to its natural return-interval variation. The Rough Fire re-treated much of this area. Fire managers will need to continue to ensure that natural fire starts are allowed to play their role in the environment.

Tehipite Fire, 2008

Lightning started the Tehipite Fire in the summer of 2008 on the northwest side of the Middle Fork of the Kings River. It eventually burned into Crown Valley on the Sierra National Forest, affecting 11,646 acres between July 19 and December 1.

Previous Fire Activity, Treatments, and Observations

Fire managers could not suppress the fire due to its very steep slope, which firefighters could not access. Once the fire moved into an area where fire personnel could be inserted by helicopter, two Hotshot crews and park fire-management personnel were flown in. Their job was to steer the fire away from the park boundary so it would not

Tehipite Fire burning in the Middle Fork of the Kings River.
NPS / Brit Rosso and Karen Folger.

cross onto Sierra National Forest. Northern California was in the midst of a busy fire season, and statewide resources were spread thin. During the course of suppression efforts, several firefighters were seriously injured due to work in such a rugged environment. Due to the injuries, a plan to manage the fire was developed with the Sierra National Forest. In the long run, the plan and related operations were successful.

During the Rough Fire

When the Rough Fire reached the park boundary in 2015, it almost went out when it hit the footprint of the 2008 Tehipite Fire. The Rough Fire backed downhill from Tombstone Ridge into this location. The only substantial part of this area that burned in the Rough Fire area was one island of fuel that had not burned in 2008—about one hundred acres that were almost surrounded by cliffs and prominent avalanche chutes. That fact that the Tehipite

Kari Greer

Fire was unable to spread into the rocky areas in 2008 suggested strongly that the Rough Fire front would eventually be contained by the same rocky chutes and cliffs, thus eliminating the need for putting crews in this area.

What did we learn?

It is important that NPS collaborate with neighboring interagency partners to allow fire to burn across administrative boundaries so that successes such as this—the stopping of the Rough Fire by the interagency-managed Tehipite Fire with little to no suppression efforts—can be repeated.

Conclusion

While not always popular at the time because of smoke and the limited but real risk for fire escape, managing naturally ignited fires is essential for forest health and dramatic reduction of risk exposure for firefighters. Having these options is critically important to fire managers. It allows them the ability to take the widest range of actions possible to mitigate the risk of an undesired outcome from a fire.

The lack of managed fires leads to the unnatural buildup of fuels that will inevitably result in intense wildfires, which threaten safety, air quality, and natural and cultural resources. Suppressing all fires, thus, results in increased risk from intense wildfires, and limits options available to park managers to use and control fire.

Two key decisions and lessons can be learned from this:

- Early communications and pre-fire planning with other land-management units, such as neighboring national forests, are critical if there is the potential for fire moving from the parks onto their land.
- Another critical component of a successful interagency fire-management strategy is working jointly and directly with both national forests and the San Joaquin Valley Unified Air Pollution Control District to build the draft smoke-management planning tool—a system to help predict smoke impacts and outputs from fires as part of overall air management.

Fire Management and the Rough Fire

Focus on Firefighter and Visitor Safety

As is true for every wildfire, safety is the first priority for all operations. It is always the number-one objective on all incident action plans and at every briefing. Reducing risk to firefighters and the public is the first priority in every fire-management activity, as no structure, natural resource, or cultural resource is worth the loss of human life. During the Rough Fire, the terrain of the Kings Canyon drainage added a significant challenge to this aspect of firefighting. It is one of the steepest drainages in North America. Using direct handline tactics in many places was not only impossible, but very unsafe.

Previous Firefighting Activity, Treatments, and Observations

Many times this emphasis on safety can be misunderstood by those unfamiliar with wildland firefighting. They may perceive it as inaction and therefore the reason for failure to suppress a fire immediately.

For decades, firefighters have been largely successful at suppression, at least as measured in terms of successful initial attack when the first responding units get the fire contained or controlled; this occurs about 97% of the time. This has built a false public expectation that today's fires can be fought as successfully and quickly as those in the past, when in fact situations have changed. Firefighters are now working under increasingly difficult conditions such as unprecedented fuel loads, multi-year drought conditions, and the long-term effects of climate change.

The above photo illustrates the potential difficulty of extracting firefighters in the event of an injury. Since the 2008 death of NPS employee Andrew Palmer from a falling snag, fire managers and incident-management teams are now required to plan in greater detail for the extraction of injured firefighters prior to engaging them on the fireline. NPS Photo.

During the Rough Fire

Where there had been previous fuel treatments—including prescribed burns lit by managers, managed natural fire lit by lightning, and mechanical methods such as thinning—risk and exposure was reduced, compared to those areas with little to no recent fire history. Areas that had previously been treated were used as containment and control lines on more than 40% of the Rough Fire perimeter. This reduced the exposure to fire personnel and allowed them to focus their attention on more volatile areas.

Studies from the national Ready, Set, Go! Program on wildfire preparedness have shown that communities that prepare for wildfire fare better when wildfire does come. When residents of a fire-prone community clear brush, trees, and other flammable materials adequate distances away from their homes and other structures, it helps keep residents and firefighters safer. For example, the community of Hume Lake were able to evacuate over 2,000 people in approximately 2 hours because of their preparation.

The public and media wondered why containing the Rough Fire was taking so long, was so difficult, or why specific tactics were not working here. Firefighters certainly felt this pressure. They made gallant efforts to halt the spread of the Rough Fire on Hoist Ridge, which posed a significant threat to the Hume Lake Camps. Despite the fact that the fire was then growing nearly 10,000 acres a day, firefighters did complete firing operations in time to save the development. Yet for all their efforts, during which twelve firefighters suffered various injuries, the Rough Fire continued to outflank and spread westward.

What did we learn?

Whether unwanted or not, fire will continue to be an integral part of the Sierra Nevada. It will continue to be true that, at the end of the day, the only thing that truly matters is that everyone makes it home safely. The future likely will hold increased risks to firefighters associated with snags (dead trees) due to effects of drought and insects on the forests, climate change, and due to the past lack of fire that would have removed fuels such as standing dead trees. Instead, the snags remain standing, threatening firefighters who are rushed to the scene. Approaches to fire control will likely change based on these risks.

There is a strong need to communicate with the public and media to spread understanding of exactly what firefighters are able, and unable, to do, and how long incidents may last. This may involve using available technology to convey the actual steepness of slope (which contributes both to fire rolling downhill and to the speed with which it climbs), the ruggedness of and difficult

access to terrain, and the extreme volatility of fuels, all within the context of an extended drought in an area with little to no recorded fire history. The ways in which smoke limits the visibility for fire-fighting aircraft needs to be understood, as does the danger of flying in steep, narrow canyons. All these factors combined in the early stages of the Rough Fire and prevented firefighters from safely being able to conduct initial attack on this aggressively spreading fire. In addition, fire-fighting agencies need to share the way in which the availability of fire-fighting personnel and equipment can be affected by fire activity far from a specific fire, which can affect the availability of attack resources including crews and aircraft.

Conclusion

Safety is paramount in all that is done. There is no benefit in rushing or taking unnecessary risks in what is already an inherently dangerous job. It is important that stakeholders and the public be perpetually reminded of this, as their support is a key component to a successful operation.

Creating Defensible Space around Developments

Kings Canyon National Park has infrastructure and building history that spans more than two centuries. Many of these irreplaceable assets are from the late 1800s and early 1900s. Additionally, within Grant Grove stand historical assets related to the community of Wilsonia. There are also significant developments in Cedar Grove.

Both of these areas also have housing units for park staff, concession staff, and their families. Furthermore, there are considerable assets related to visitor services in both places. These not only enhance visitor experience, but provide food and lodging opportunities that generate revenue for the park concessioner and jobs for employees.

A key aspect to protecting these assets is creating defensible space around the structure, a buffer where fire won't carry. By removing things that are hazardous, flammable, and volatile, from grasses and limbs to construction material and firewood, fuel for the fire to burn is eliminated.

Previous Fire Activity, Treatments, and Observations

The parks have invested in treating fuels for decades. This includes the use of mechanical treatments to reduce overgrowth and fuel loading where prescribed fires are not a suitable tool, such as near structures or because of unreasonable smoke effects on visitors and staff. This method is generally more costly per acre compared to prescribed fire but given the expanse and topography of the park, it is used only in key non-wilderness areas.

Additionally, the parks have worked with community members and homeowners, including park residents, to encourage them to take an active role in reducing fuel loads around their homes. However, relationships between Sequoia and Kings Canyon National Parks and private in-holdings such as Wilsonia have not always been easy. In several cases, it was observed that the parks were asking residents to create defensible space but the parks were not doing it themselves.

In recent years, relationships have improved significantly. Work by fire personnel and other park staff has improved the interpersonal dynamic between the agency and residents of Wilsonia. This has been helped by the parks addressing more fuel treatments through mechanical cutting and the pile burning piles; through grants and funding received for projects related to the Resilient Landscapes Program; and by the development of inspection forms with Tulare County Fire Department to provide guidance and information on what individuals can do for themselves.

During the Rough Fire

Prior to the Rough Fire, the parks had used prescribed fires to complete a ring of reduced fuel around the outside of the Grant Grove and Cedar Grove developments. Yet, during the Rough Fire, protection within this ring proved to be just as critical.

Firefighters and vehicles were staged within Grant Grove and Cedar Grove as the fire threatened these park developments and communities. Firefighters wrapped a few historical buildings with resistant foils and completed additional mechanical thinning based on fuel accumulation from that year in the event that the Rough Fire made it into the areas. Because of work done before the fire, the task was manageable despite being done with a very active fire nearby. As the fire spread into the area, those treatments saved over $400 million in facility assets, such as the historic Gamlin Cabin and national landmarks like the General Grant Tree, which is the Nation's Christmas Tree and the only living national memorial to veterans.

What did we learn?

Continued work by the parks must take place to mechanically treat areas within Wilsonia on National Park Service lands and within infrastructure areas of Grant Grove and Cedar Grove. Individuals must also take an active role in planning for their own defense from unwanted wildfire. The same is true in other areas with residences in the parks such as Silver City, Faculty Flat, and Mineral King.

While the creation of the ring of reduced fuel prior to the advent of the Rough Fire did give firefighters a window of time to complete defensible-space efforts inside the ring, such a window may not always be available and cannot be planned for.

After the Rough Fire, comments by park residents, concession staff, and members of the Wilsonia community indicate that the Rough Fire demonstrated to these stakeholders the need for an active fire and fuels-management program. While challenging to deal with, it demonstrated how investments ahead of time can and will pay dividends.

Conclusion

Defensible space works. Time after time, the need for residents and businesses to prepare for wildfire has been shown in pictures and videos. As people continue to move into more forested and natural areas, known as the wildland-urban interface, the need to complete defensible space and have a wildfire escape plan is ever more critical. Warming due to climate change will only escalate the need for this.

Fuel Treatments by Mechanical Projects

Prescribed burning is not always an option, especially around structures or in areas with extreme fuel loadings,and/or a high potential for fire escape or severe fire effects. This is why mechanical thinning is an important tool for land managers to have available. Mechanical-thinning projects are based on a prescription written by a professional forest ecologist. They usually involve removing smaller trees and other vegetation, which removes fuels and encourages remaining trees to get healthier and bigger (more resistant to fire). Removal of fuels removes the opportunity for fire to carry across the space to something that needs protecting. It is a great way to reduce ladder vegetation that can carry fire from the ground to the tree canopy (also known as ladder fuels) as well as low vegetation in wildland-urban areas. Ladder fuels can be the single factor in taking a low-intensity ground fire into a raging crown fire. Material that is removed can be piled and burned on site or chipped.

Previous Fire Activity, Treatments, and Observations

The parks have used mechanical treatments throughout multiple areas in Grant Grove. Staff started prior to the Rough Fire the second round of mechanical treatments around infrastructure. Most treatment areas range from two acres up to sixty. Just like prescribed fire, the areas need to be maintained over time so multiple treatments are needed. For example, small trees and brush will grow back quickly.

During the summer of 2015, fire crews completed 46 acres of mechanical treatment around park housing in Grant Grove. Thirty acres of the 66 acres around the community of Wilsonia that had been scheduled for mechanical treatment were also completed. Nearly 275 piles were created and later burned in the Grant Grove area.

During the Rough Fire

Having an already reduced fuel load in this historical and densely populated area, firefighters were able to create additional defensible-space plans, provide for structure protection, and do any minor additional work that would add to the overall safety of the area. Having a mechanically treated area inside the outer ring of previous prescribed burns around Grant Grove Village and Wilsonia, gave the infrastructure that much more protection.

What did we learn?

It is imperative that fuels-reduction projects continue near high-value areas. On-going mechanical treatments in key locations will be vital to the safe completion of future prescribed fire / fuel-reduction projects that, in combination, will aid in future wildfire-suppression efforts. The continuing maintenance of previous work in mechanical treatments will need to continue, as will identification of future treatment areas.

Conclusion

Alone, mechanical treatments, like prescribed burning, cannot fix the problem of fuel accumulations due to 100 years of fire suppression. A combination of treatments is needed to help land-management agencies restore landscapes to a natural fuel-loading standard. Continued maintenance of treatment areas will be key to providing the defensible space needed.

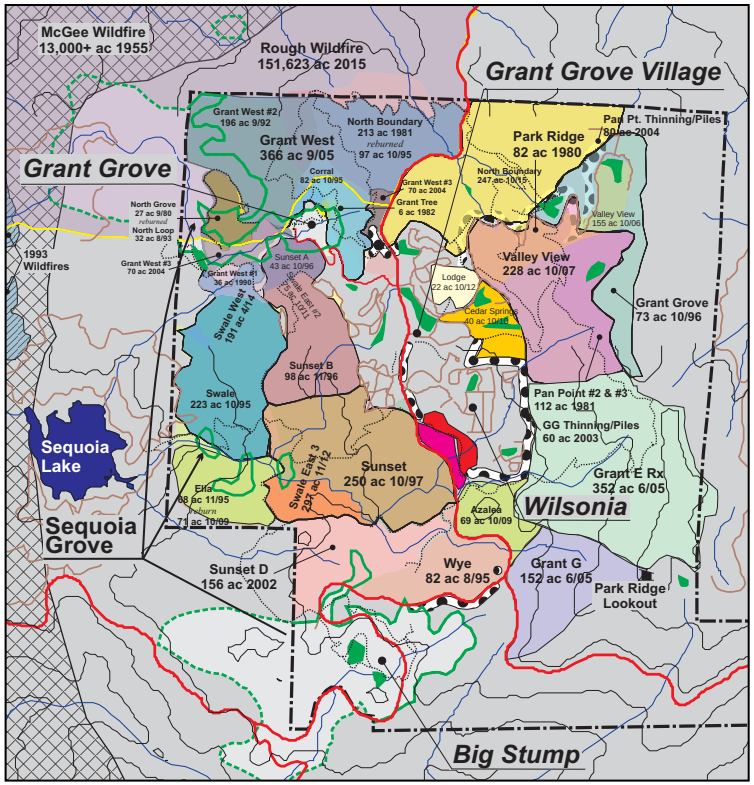
Fuel Treatments by Prescribed Fire

Given the long absence of natural fire due to fire suppression, prescribed fire is the most valuable tool to mimic the role fire plays in the ecosystem. Fire is a natural, needed disturbance in park ecosystems that have been shaped by it for thousands of years. Without fire, forest litter and duff often accumulate at rapid rates, tree health is suppressed due to overcrowding and competition, and vegetation types can unnaturally change over time. A healthy forest with more natural amounts of fuel is more likely to survive a wildfire and to benefit from it. Our mixed-conifer forests have evolved with frequent low to moderate intensity fire and have adapted to it. Animals and birds that live there have also, generally, done the same.

In many cases our untreated mixed-conifer forests now have fuel loadings over 100 tons per acre. Prescribed burning can reduced that number to a healthy 10 to 20 tons per acre in most areas.

Reintroducing fire back into the environment through prescribed fire may be the best tool available to land managers due to the expanding wildland-urban interface because it addresses landscape-scale areas. By approaching the wildland-urban interface with prescribed fire treatment in the surroundings and then targeting mechanical treatments around structures, the areas become easier to defend. Allowing fire to burn naturally may work in isolated areas, but not close to somebody's home. With the other 3% of unsuccessful initial attack fires accounting for approximately 97% of all wildfire acres annually, prescribed fires are keys to success. Fire managers can plan and execute a prescribed fire when conditions are right and achieve the desired results without threatening communities with extreme fire, as wildfires may do. This doesn't mean prescribed fire is without risk. Unexpected

Grant Grove Burned Areas



outcomes can happen with prescribed fire. On very rare occasions, an escaped prescribed fire has resulted in the loss of structures. Consequently, fire managers are always mindful of the risks associated with prescribed burning, although the risks are far smaller than those from wildfire. Each year hundreds of thousands of acres across the United States are treated with prescribed burning, but that number doesn't come close to the acres burned in wildfires. The ten-year average for wildfires is 6,702,831 acres burned annually, but in 2015, 10,125,149 burned.

Previous Fire Activity, Treatments, and Observations

Since the mid-1960s, these parks have been using prescribed fire as a tool to overcome these factors that put forests at risk. The idea of fighting fire then was not a common practice by any means; it was revolutionary when the parks started doing it. However, fire managers were listening to the scientists saying that something needed to be done to help mitigate the effects of an unwanted wildfire by reducing fuels and thinning trees. With fewer trees, competition for resources such as water and nutrients is reduced and forests may be more resilient to drought and other stressors.

Starting in 2011, our forests have been experiencing multi-year drought and increased insect attacks, which contribute more to the ever-increasing fuel loadings. These drive fire events and their impacts once a wildfire starts.

During the Rough Fire

One example of the value of prescribed burns occurred on August 19, 2015. The Rough Fire was racing towards Hume Lake and the more than 450 buildings there, of which 350 are single-family homes. Fire fighters were able to successfully use areas in which fuels treatment had been conducted as anchors from which to burn out firelines in advance of the main fire. This action diverted the fire away from the homes and buildings. This also created an anchor point to contain the fire on the south side.

What did we learn?

Every prescribed fire in the parks has specific objectives based on fire-research results and natural-resource needs. There is always a reason that managers decide to burn on certain days and not others. The idea is that the fire will be able to meet objectives and at the same time remain within the control lines. Most prescribed fires happen in early spring or late fall when conditions are less dry, but

Sequoia and Kings Canyon National Parks have been known to burn throughout the summer when appropriate. This is due to the fact that scientists and fire managers are working to mimic natural conditions, and most naturally occurring fires start and burn during dry summer months. As long as conditions within a prescribed burn unit are within a desired prescription (taking into account weather, moisture, and smoke-management parameters), the burn can go forward.

Conclusion

Prescribed burning alone, like mechanical treatments, cannot fix the problem of 100 years of fire suppression. A combination of treatments is needed to help land-management agencies restore the landscapes back to a more natural condition, including fuel loadings. Continued maintenance of treatment areas with prescribed fire will be key in attaining these objectives and providing the defensible space needed.

Giant Sequoia Dependence on Fire

Decades of research conducted within Sequoia and Kings Canyon National Parks have shown that giant sequoias will not reproduce in the absence of fire. Fire plays several critical roles: It provides the necessary heat source required to open sequoia cones and release their seeds.

Redwood Mountain prescribed burn, 2011

These cones are serotinous, meaning they will remain closed until trigged by an outside process such as the heat from a fire. It creates a favorable ash and mineral soil seedbed rich with nutrients. Without all of the above, sequoia seeds will not fall and germinate, and seedlings will not survive. Fire also creates gaps in the forest by killing some overstory trees. Because these openings receive more sunlight, sequoia seedlings and saplings grow more rapidly and are more successful on these sites.

Sequoia seeds (size of oatmeal flakes) and cone opened by the fire resting on a bed of ashes in Grant Grove. NPS / Tony Caprio.

Previous Fire Activity, Treatments, and Observations

Numerous past prescribed burns have also shown that giant sequoia reproduction becomes even more prolific with fires that burn with hotter intensity in specific areas. Early burns conducted in Redwood Canyon proved this time and time again. To this day one can walk through thick stands of 35-year-old sequoia saplings that got their start after a hot fire. However, there is a balance to the how hot a fire gets in a particular grove. If a fire is too hot or intense, it can damage the existing giant sequoias' canopy, thus killing the trees. If the fire is not hot enough, the cones will not open. The best treated areas are where this was this balance.

Burning in giant sequoia groves has long been a priority for park fire managers. Emphasis has been on the more accessible groves, which include Giant Forest, Redwood Canyon, Grant Grove, and in portions of the East Fork of the Kaweah River drainage. There are still numerous groves in these parks that have not been treated or burned naturally in recent history, so they remain at increasing risk from wildfire. The parks will continue to prioritize giant sequoia burning, with the priority split between maintaining fire intervals in groves that have already burned and restoring fire to reduce fuels and begin to restore the natural fire interval in groves that have not.

During the Rough Fire

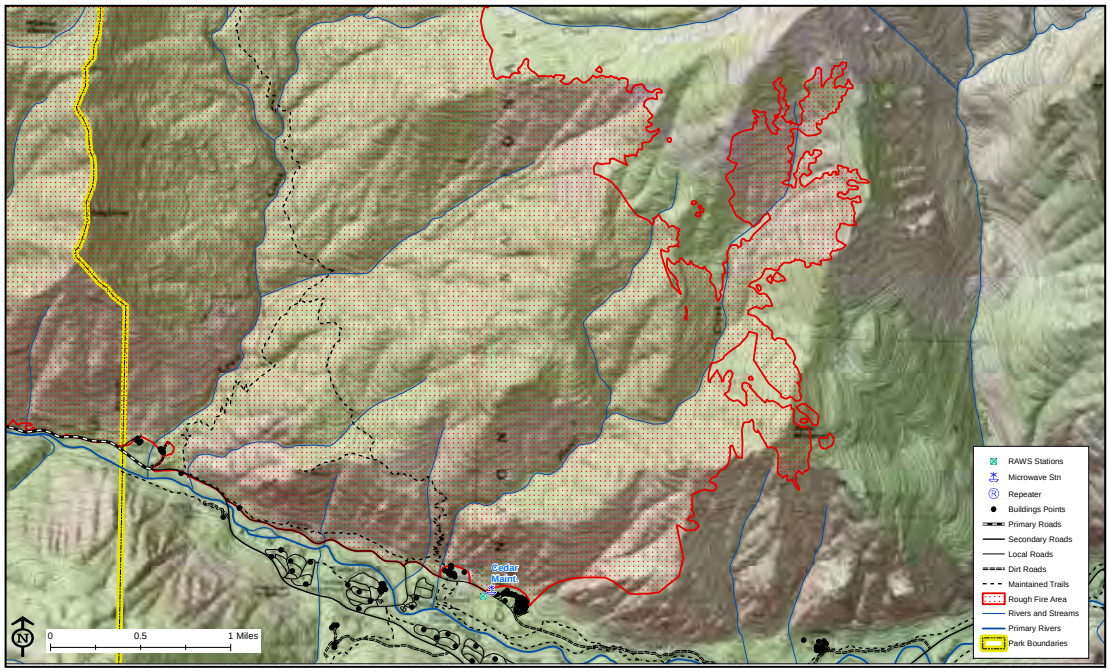
The Rough Fire burned through several giant sequoia groves on U.S. Forest Service land and a portion of the General Grant sequoia grove in Kings Canyon National Park. Many factors will affect what will happen in these groves after the Rough Fire. Throughout most of these groves, huge numbers of seeds rained down from opened cones in overstory trees following the fire. Adequate rain and snowpack will clearly benefit regeneration; a continued drought will not. It is too early to see how these groves will fare over the next few years, but as past burning has shown, thoseat specific areas in the Rough Fire that have burned the hottest and most intensely may have the best chance for robust regeneration.

What did we learn?

A continued active fuel-management program in giant sequoia groves is paramount for the trees' survival. This is increasingly important as climate change leads to more intense and destructive fires, which can be mitigated through fuels management. Having support from park managers, agency administrators at both the federal and state level, along with increased public understanding will only add to the health and longevity of this species.

Ongoing research will continue to contribute information that improves fire management and ecology. Monitoring is equally important. By observing fire effects, learning from previous treatments—both positive and negative—knowledge is compounded. Monitoring must be ongoing and at multiple locations to provide understanding of the process at a landscape scale.

Areas in and near Cedar Grove burned by the Rough Fire



Conclusion

Years of management investments in the parks' giant sequoia groves is paying dividends. In order to protect these groves from catastrophic fires and increased chances of their demise, fire management must continue. Sequoia and Kings Canyon National Parks must maintain and expand on the scientific understand of these unique trees. This is even more critical now, as changing climates are having impacts on both a regional and global scale.

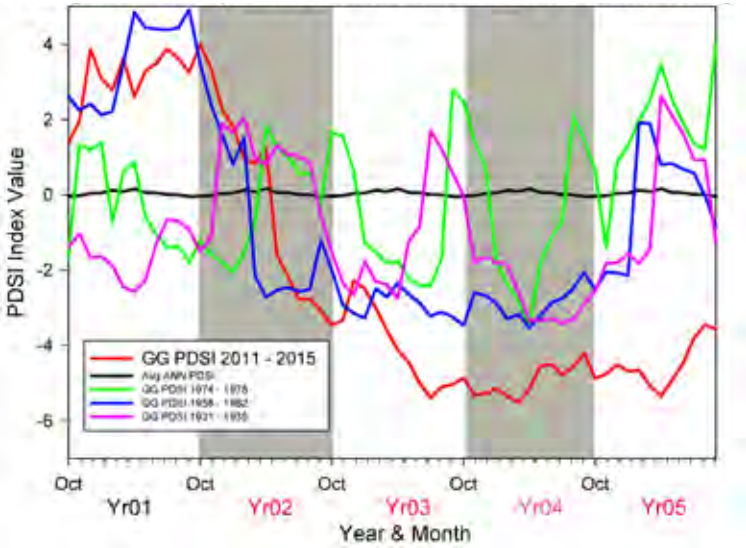
Effects of the Current Drought

Since the latest drought started in 2011, fire behavior has drastically changed on the western front of the Sierra Nevada, especially in the central and southern portions. Estimates indicate over 10 million trees that are either dead or on the verge of dying. A drought of this scale has not been seen in the last 100 years in the central Sierra; only the 1961 drought approaches it in scale.

Previous Fire Activity, Treatments, and Observations

Low fuel moistures combined with longer hot, dry weather have been making for longer fire seasons and tough fire-fighting. Fires have been larger and more tenacious than previous fires. These extremes of weather include large-scale tree mortality from direct drought stress and insect / bark beetle infestations. Additionally, years of fuel loading accumulation due to fire suppression have compounded the impacts from the current drought situation.

Comparison of Palmer drought severity index (PDSI) at Grant Grove to three previous droughts in the last 100 years over five year periods. The current four-year drought ending in 2015 is shown by Yr02 to Yr05 (in red).



Fire-behavior prediction models have tended to underestimate recent fire behavior compared to projections made in years prior to the current drought. This has been demonstrated by the occurrence of many large-scale wildfires in recent years, with many western states experiencing the largest wildfires in their histories.

During the Rough Fire

The drought conditions have resulted in increasing difficulty in establishing anchor points for fireline construction on quick-moving, volatile fires such as this one.

During the two months that the Rough Fire burned most actively, it repeatedly defied control efforts, confounded fire-behavior analysts, turned fire-behavior predictions and models on their heads, and challenged the knowledge of local fire managers. The fire consistently behaved in a way many firefighters had never seen before, including the crossings it made of the Middle Fork and the South Fork of the Kings River.

Much of this high-intensity fire and rapid fire growth during the Rough Fire was attributed to the ongoing drought. Aerial and ground observations show widespread ponderosa pine and incense-cedar mortality in the between 3,000 and 6,000 feet in elevation. Brush and oak species are

Drought/insect-related mortality in ponderosa pines Cedar Grove. Donald Quintana.

behaving as if dormant and have low live-fuel moistures. All of this contributed to a volatile fuel bed and resulted in explosive burning conditions.

What did we learn?

The current drought is unprecedented in the last 100 years. Effects of the drought appear to have increased each year. Thus the question must be asked, if the drought continues, what does this portend for the ecosystem, homeowners, the public, and fire managers? What should the response be?

There are no easy answers to the above questions. Research is showing that previously burned areas are more resilient to drought than unburned areas. What can be deduced is that previously treated areas, whether with prescribed fire, natural fire, and/or mechanical means, did provide barriers to fire spread even under drought conditions.

Conclusion

The challenge for park fire managers will be to find opportunities to use prescribed and natural fire even during drought. Prescribed fires may need to be conducted earlier or later in the fire season, if that's when prescribed conditions occur. Natural fires will have to be carefully evaluated upon detection and during the life of the fire to ensure that any risks are identified and mitigated effectively. What is clear, however, is that doing nothing with regard to fuel treatments will not reduce risk. It merely transfers that risk to a later date.

Managing Fire on Large Landscapes

Resilient Landscape Project

In 2015, the Grant Grove Peninsula Resilient Landscapes Collaborative was established with the goal to address forest health and reduced fire danger. The collaborative had several successes, despite the continuing drought and the Rough Fire, which burned 13,797 acres of the collaborative area. This was a high-profile fire, with many concerned about the potential impact to giant sequoia groves. The political concern over the combined effects of drought and fire led to requests that the parks' fire GIS specialist map the sequoia groves impacted by the Rough Fire, and that the parks fire ecologist visit and assess post-fire grove condition throughout the burned area.

Previous Fire Activity, Treatments, and Observations

The North Boundary prescribed fire, successfully completed in October 2014, served as an anchor point for suppression of the Rough Fire, and aided in the defense of the Grant Grove and Wilsonia communities. The Grant Grove and Wilsonia mechanical projects done in the past few years were also timely, providing additional layers of defensible space for those communities.

During the Rough Fire

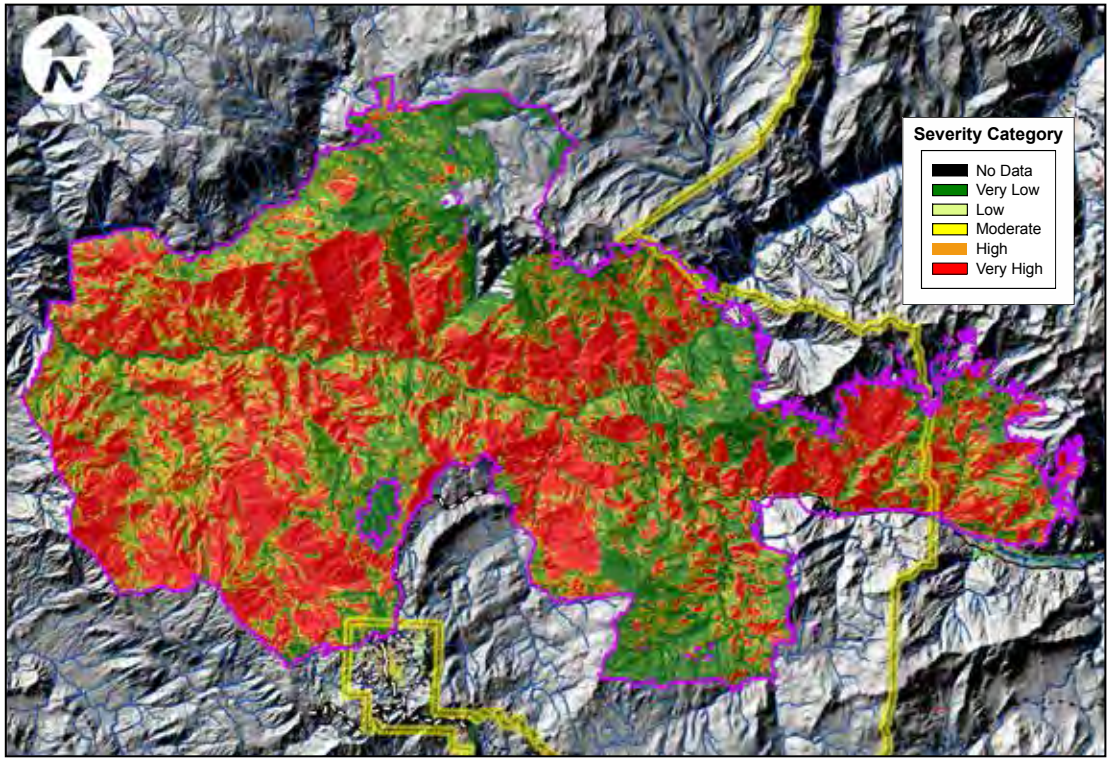
In all, the Rough Fire burned 8,892 acres within a number of sequoia groves. In the General Grant sequoia grove, the Rough Fire came within 215 yards of the General Grant Tree. Previous prescribed fires in past years slowed the fire and contributed to saving the General Grant Tree and the General Grant sequoia grove as a whole.

It burned 1,257 acres within several giant sequoia groves that are within the Resilient Landscapes Collaborative area. This included 100 acres in Grant Grove (Kings Canyon National Park) and 1,157 acres in the Giant Sequoia National Monument area of the Sequoia National Forest (including portions of Grant Grove, Cherry Gap, Abbott, Converse Basin, and Evans groves, most of which are second-growth sequoia groves). Over half of the acres burned were in the lower categories of the BARC soil burn severity mapping. It is expected that the majority of effects on sequoia groves will be positive.

Several prescribed-burn projects planned for the future were partially burned in the Rough Fire, including 112 acres of the Grant Grove North prescribed fire, 192 acres of the Grant Grove West prescribed fire, and 844 acres of

the USFS Boulder Creek prescribed fire unit in Sequoia National Forest (within the collaborative area).

About 6,200 acres of the collaborative area that burned are in the lower categories of soil burn severity, while over 5,800 acres are in the moderate category. A smaller amount (1,724 acres) is in the high soil-severity category. However, soil burn severity may not equate to vegetation burn severity. It is not uncommon for areas with moderate or even low soil burn severity to have severe vegetation burn severity. Therefore, until mapping of the vegetation in the area is done, it will be difficult to quantify the complete resource effects.



This map shows the Rapid Assessment of Vegetation Condition after Wildfire (RAVG) with reds indicating more severe burning of vegetation and greens less burn severity within the perimeter of the Rough Fire.

What did we learn?

The Sequoia Creek prescribed burn unit in Grant Grove had to be postponed due to the Rough Fire and the drought. Interagency prescribed fires with the US Forest Service will be completed in the coming years. Future years of fire treatment work are being developed between the National Park Service and Hume Lake District of the Sequoia National Forest to increase fuels treatment in areas with shared boundaries.

Conclusion

Previous prescribed fires proved to be of significant benefit when the Rough Fire came racing up the canyon. While the Rough Fire may have had some negative ecological effects in Kings Canyon National Park, the benefits will continue for years to come. For example, the park will be able to use this fire as a holding line for future planned events. Future funding will allow the parks to expand these treatments.

Relationships with the Air District

The parks actively work with local partners, agencies, and local communities to provide accurate and timely information related to smoke and air-quality issues.

Air quality is one of the biggest concerns in the Central Valley. It is the top-most public concern for the parks when completing prescribed burning and/or managing natural fire. However, given the natural fire regime in the central Sierra Nevada, it is not a matter of if an area will burn, but when. The Rough Fire provided a dramatic example of what happens to air quality, both locally and regionally, when large acreages burn in an uncontrolled fashion. The parks also have tools for being proactive in reducing large-scale smoke events. Another tool is to carefully manage natural fires under specific temporal, spatial, and environmental conditions. Ironically, one of the best tools is to conduct prescribed burns to reduce fuels and provide future barriers for wildfire spread. A challenge for land managers is to minimize these inevitable, episodic smoke events from large, intense wildfires through the use of prescribed fire and managed wildfire, which have lower smoke-emission levels.

There are a range of strategic options fire managers have when a wildfire occurs. It can be aggressively suppressed, allowed to burn in some areas but suppressed in others, simply monitored until it goes out naturally, or a blend of all the above. Many factors go into these decisions, but air quality is usually considered first and foremost, after firefighter and public safety.

Previous Fire Activity, Treatments, and Observations

For this reason, the parks and the San Joaquin Valley Unified Air Pollution Control District (SJVUAPCD, or "Air District") have built a partnership over the years. Both agencies have different missions, yet they work closely together to manage smoke. Sometimes the agencies' objectives are competing; however, the relationship between the parks and the Air District has turned to collaborative problem solving. An understanding has been generally reached that can best be stated as, a little prescribed fire smoke now, or much worse smoke from intense wildfire later. Both agencies have the same objective: to minimize the negative effects of wildland fire smoke to acceptable levels.

Three previously managed wildfires and several prescribed burns played a key role in stopping or slowing the Rough Fire. There were localized smoke impacts associated with all these events, particularly with the 2010 Sheep Fire. Through all of this, the Air District provided input and in some cases enforced regulations against the parks.

Nevertheless, the Sheep Fire was successfully managed with Air District participation.

The parks participate in a landscape air-quality monitoring program that measures both ozone and PM 2.5 (Particulate Matter 2.5 microns and smaller) for scientific and health considerations. The park fire management program works closely with the San Joaquin Valley Unified Air Pollution Control District to get authorization and/or permits for prescribed fires. Additionally, the fire management program works closely with the Air District to assess smoke and air-quality concerns when there is a wildfire and it is determined to be of benefit to the ecosystem.

During the Rough Fire

If the Rough Fire demonstrated anything, it is that these earlier treatments were worth the temporary impact of smoky skies. The parks could not have completed any of these important prescribed burns without Air District approval, or successfully managed these natural fires without their input. Without this past cooperation, and the earlier treatments conducted with the concurrence of the Air District, the smoke impacts from the Rough Fire would have been much, much worse. For this reason, it is important to recognize the Air District's role in partnering with land-management agencies in managing both fire and smoke on the landscape.

A prescribed burn in the foothills of Sequoia National Park

At one point, it was estimated that the Rough Fire generated over 8,000 tons per day of PM10 (Particulate Matter 10 microns and smaller), over 2,500 tons per day of nitrous oxides (NOx), and over 5,000 tons per day of volatile organic compounds (VOC). Total estimates for each of these pollutants for the entire duration of the Rough Fire were over 60,000 tons for PM10, 19,000 tons for NOx, and over 40,000 tons for VOC.[1] For comparison, on a typical "non-wildfire" summer day in the jurisdiction of the SJVUAPCD, all stationary, area, and mobile sources emit approximately 334 tons per day of PM10, 69 tons per day of PM2.5, 314 tons per day of NOx, and 354 tons per day of VOC.[2]

What did we learn?

For the future, the parks and SJVUAPCD must continue to foster this relationship in order for both agencies to be successful in their respective missions. This includes working to find the most optimal smoke-dispersion windows for both prescribed burns and naturally caused fires. If this does not occur and prescribed fires and managed wildfires are rarely permitted due to air-quality concerns, wildland fuels will again accumulate and future wildfires will be larger, more intense and costly, and emit huge volumes of air pollutants in comparison to short-duration and localized events.

Conclusion

The long-term monitoring of the airshed both in our national parks and the areas surrounding them will be a priority for generations to come. From decreases in scenic visibility to short- and long-term health issues, smoke impacts will play a significant role in fire and fuels management. One thing is clear: the practice of suppression-only fire management is not the right solution. A hybrid of effective fire and fuels management is the solution for the long-term health and sustainability of our parks, airsheds, and ecosystems.

Monitoring smoke conditions during a prescribed burn. NPS / Vernon

1 E-mail from the NPS dated 9/28/15 from Leland Tarnay

2 E-mail from the SJVUAPCD dated 9/28/15 from Shawn Ferria

Afterword to the Vignettes

The Rough Fire had a direct or indirect impact on nearly a million people, from smoke traveling into the San Joaquin Valley and the eastside of the Sierra to closing park areas to thousands of visitors who planned for a lifetime to visit the crown jewels of the Sierra Nevada.

The mountains, forests, and wildlife of this region are experiencing an unprecedented barrage of threats from vast overgrowth of vegetation and fuels, prolonged periods of drought and erratic deluge, invasive species, and the increasing effects of climate change. The reality is becoming more and more apparent; mega-fires like the Rough Fire are becoming the new norm. They have the power to change ecosystems, to burn up revered forests of giant trees, and to destroy expensive facilities and historic structures.

Now is the time for action, for using the lessons learned from the Rough Fire and other conflagrations. We need to continue doing the things that worked and to break the habit of doing things that are ineffective or contribute to the problem. If we choose to do nothing, we are not adequately protecting these national treasures, our world's heritage, for ourselves and future generations.

Front cover photo courtesy of Rita Baysinger. Back cover photo courtesy of Donald Quintana.