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Forest Service

Southwestern Region

Air Quality Specialist Report

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Forest Plan Revision FEIS

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Introduction

This report evaluates and discloses the potential environmental consequences on air quality that may result with the adoption of a revised land management plan. It examines four different alternatives for revising the 1988 Kaibab National Forest land management plan.

Impacts to air quality originating from the Kaibab are from primarily from prescribed fires and wildfires, and are the focus of this report. The airsheds affected by these fires are the Colorado River Airshed, the Little Colorado River Airshed, and the Verde River Airshed. (Figure 1)

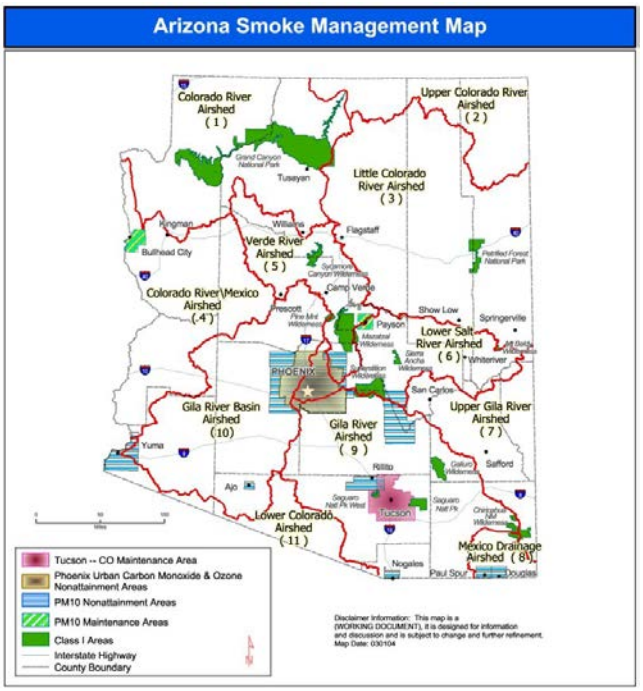


Figure 1: Map of Arizona Airsheds

No desired conditions for air quality exist in the current Forest Plan. This was identified in the Specialist Report for Air Resources: Kaibab National Forest (Fitch, Truman 2007) as a need for change in the Revised Forest Plan.

This analysis compares how well each alternative achieve the desired conditions for air quality. The desired conditions for Air Quality are:

- Air quality meets or surpasses State and Federal ambient air quality standards.
- Management activities on the Kaibab National Forest do not adversely impact Class I airshed visibility as established in the Clean Air Act.

Two guidelines are also proposed for the Revised Forest Plan. They are:

- Project design for prescribed fires and strategies for managing wildfires should incorporate as many emission reduction techniques as feasible, subject to economic, technical, and safety criteria, and land management objectives.

- Decision documents, which define the objectives and document line officer approval of the strategies chosen for wildfires, should identify smoke sensitive receptors, and identify appropriate objectives and courses of action to minimize and mitigate impacts to those receptors.

Management actions that have a direct effect on air quality, namely prescribed fires, are expected to achieve the desired conditions for air quality under all alternatives, and hence, Air Quality is not expected to be a primary driver in selecting one alternative over another.

Some comparison between alternatives can be made by looking at the indirect effects of management activities that reduce the likelihood of high severity fires. High severity active crown fires produce large quantities of emissions that are often heavily concentrated. The alternative that best alters stand structure to promote characteristic surface fire over active crown fire would have the least negative environmental consequences to Air Quality, and is the focus of comparison between alternatives in this report.

Relevant Laws, Regulations, and Policy that Apply

In 1955, Congress passed the first Federal Clean Air Act with later amendments in 1967, 1970, 1977, and 1990. Implementation of this Federal Law is largely the responsibility of the States which may develop programs that are more restrictive than the Clean Air Act requires but never less. The State of Arizona has a State Implementation Plan that outlines how the State is implementing the goals of the Clean Air Act, and Statutes that regulate burning, including prescribed fires on Federal and State lands. Two types of air quality impacts are addressed by these laws and regulations: health hazards from pollutants, and visibility impacts in Class I Air Sheds.

The Clean Air Act establishes National Ambient Air Quality Standards (NAAQS) for six principal pollutants that pose health hazards: carbon monoxide (CO), lead, nitrogen dioxide, particulate matter less than 10 microns in size (PM 10), particulate matter less than 2.5 microns in size (PM 2.5), ozone, and sulfur dioxide. The major pollutant of concern in smoke from wildland fire, including prescribed fires and wildfires, is fine particulate matter (Ottmar 2001). Particles larger than 10 microns in size tend to settle out of the air; smaller particles remain airborne, and can cause respiratory problems. Studies indicate that 90 percent of smoke particles emitted during wildland fires are PM 10, and about 90 percent of PM 10 is PM 2.5 (Ward and Hardy 1991). Human health studies on the effects of particulate matter indicate that it is PM 2.5 that is largely responsible for health effects (Core and Peterson 2001). Because of its small size PM 2.5 has an especially long residence time in the atmosphere and penetrates deeply into the lungs (Ottmar 2001). The Clean Air Act defines the NAAQS for PM 2.5 as an annual mean of 15$\mu g/m^3$, and a 24 hour average of 35$\mu g/m^3$. At this concentration or above, PM 2.5 is considered to have a detrimental effect on public health. It is important to note that it is not the total amount of emissions from a fire that have effects on human health, but rather how concentrated pollutants in ambient air are for a period of time. Atmospheric conditions during a fire have a considerable influence on how particulate matter is distributed through the ambient air, and its potential to affect public health. Wind speed, wind direction, mixing layer height, atmospheric temperature profile upward in the atmosphere, and atmospheric stability all impact where and how well smoke will disperse.

The same particulate matter that poses health risks is also largely responsible for impairments to visibility. “The combination of light absorption by elemental carbon and light scattering caused by the very small particles that make up wildland fire smoke explains why emissions from wildland fire play such an important role in visibility impairment (Core 2001a).”

Over 280 million people visit our nation’s national parks and wildernesses areas every year. Visitors expect to view the scenery through clean fresh air. To protect visibility in these areas of high scenic value, Congress designated all wilderness areas over 5,000 acres and all national parks over 6,000 acres as mandatory federal Class I areas in 1977, subject to the visibility protection requirements in the Clean Air Act. There are 156 national parks and wilderness areas that have been designated by Congress as “mandatory federal Class I areas”. The Class I areas most likely to be impacted by activities on the Kaibab National Forest are the Grand Canyon National Park and Sycamore Canyon Wilderness Area. The national visibility goal of the Clean Air Act is, “the prevention of any future, and the remedying of any existing, impairment of visibility in mandatory Class I areas in which impairment results from manmade air pollution.” Some manmade sources of visibility impairment are industry, transportation, construction, mining, agricultural activities, and home heating; prescribed fires fall into this category. Wildfires are considered to be natural sources of visibility impairment, and generally outside State control or prevention.

Forests are increasingly using prescribed fire, and wildfires exhibiting desirable effects to achieve resource objectives, and to reduce future risk of high severity wildfires. Federal land managers have somewhat conflicting roles when it comes to protecting visibility in Class I areas. On the one hand, they are given the responsibility of protecting and meeting visibility standards. On the other hand they are tasked to allow fire, as nearly as possible, to function in its natural role in the ecosystem (USDA, USDI 1995). This puts the land manager in the awkward position of being the polluter, and in the difficult position of explaining why smoke from prescribed fires and wildfires may be acceptable, while other types of pollution are not. The response to this dilemma is that wildernesses and national parks are managed to preserve and protect natural conditions and processes. So in this context, smoke and visibility impairment from wildland fire that closely mimics what would occur naturally is generally viewed as acceptable (Peterson 2001).

Regional haze is air pollution that is transported long distances, causing reduced visibility in national parks and wilderness areas. The Regional Haze Rule, 40 CFR 51.308-309 (US EPA 1999), provides direction to the states for developing and adopting regional haze implementation plans. Under section 309, the State of Arizona has developed a State Implementation (SIP) plan with long-term strategies out to the year 2064 to make “reasonable progress: in improving visibility in Class I areas inside the state and in neighboring jurisdictions (US EPA 1999),” and focuses on anthropogenic sources of emissions. The 2003 Arizona SIP outlines an Enhanced Smoke Management Plan meeting criteria in the Regional Haze Rule that comprises a series of key policies and management practices to address visibility protection. A revised SIP has been submitted to the EPA for review as statewide visibility is not improving as it should.

Visibility is measured in deciviews (dv). A deciview is a metric of visibility proportional to the logarithm of the atmospheric condition. The deciview haze index corresponds to incremental changes in visual perception from pristine to highly impaired conditions. Visibility conditions are monitored and tracked through the Interagency Monitoring of Protected Visual Environments (IMPROVE) network. The data can be accessed at http://vista.cira.colostate.edu/tss/. This

includes data for all of the Class I areas that have monitors, including the Grand Canyon National Park, and Sycamore Canyon Wilderness.

The key policy resulting from the Enhanced Smoke Management Plan pertaining to prescribed fire operations in Arizona is Arizona Revised Statute Title 18 Chapter 2 Article 15. This law regulates burning by Federal and State land managers, as well as burning by Tribal, private, and municipal burners who have a Memorandum of Understanding with the Arizona Department of Environmental Quality (ADEQ). This Statute defines the request and approval process for all prescribed fires, and provides the mechanisms for tracking emissions from prescribed fires. Enforcement of this statute is facilitated by the Smoke Management Group, housed at ADEQ. This group is comprised of a Forest Service employee, a Dept. of Interior employee, and an ADEQ employee. This group collects all burn requests daily, makes recommendations to ADEQ on requests to be approved based on forecasted meteorological conditions, number of concurrent prescribed fires and wildfires, residual pollutants from previous fires or other sources, and other factors. This group also performs much of the work to track and summarize annual emissions from prescribed fires and wildfires to prepare required annual reports, and monitors regional haze levels. Additionally this group installs, maintains and collects data from a variety of air quality monitors around the state to monitor air quality. These monitors are strategically located in areas of concern to ensure adherence to NAAQS and progress towards visibility standards.

Problem or Nuisance Smoke is defined by the Environmental Protection Agency (EPA) as the amount of smoke in the ambient air that interferes with a right or privilege common to members of the public, including the use or enjoyment of public or private resources. While there are no laws or regulations governing nuisance smoke, it effectively limits opportunities of land managers to use fire. Public outcry regarding nuisance smoke often occurs long before smoke exposures reach levels that violate NAAQS (Achtemeir and others 2001). “Probably the most common air quality issues facing wildland fire managers are those related to public complaints about nuisance smoke. Complaints may be about the odor or soiling effects of smoke, poor visibility, and impaired ability to breathe or other health-related effects. Sometimes complaints come from the fact that some people don’t like or are fearful of smoke intruding into their lives (Hardy et al. 2001).”

Description of Affected Environment (Existing Condition)

Coconino County enjoys good air quality. For the past ten years, 70% or more days were rated in the Good category by the EPA Air Quality Index. Good is the best rating, where air pollution poses little risk to human health. Less than 1% of days per year rated in the Unhealthy for Sensitive Groups category, and no days were rated Unhealthy, Very Unhealthy or Hazardous (US EPA 2010).

The Kaibab National Forest and surrounding lands are all classified as being in attainment (meaning “in compliance”) for all criteria pollutants of the National Ambient Air Quality Standards. This includes compliance for the small diameter particulate matter (PM_{10} and $PM_{2.5}$) that is largely responsible visibility impacts to Class I airsheds.

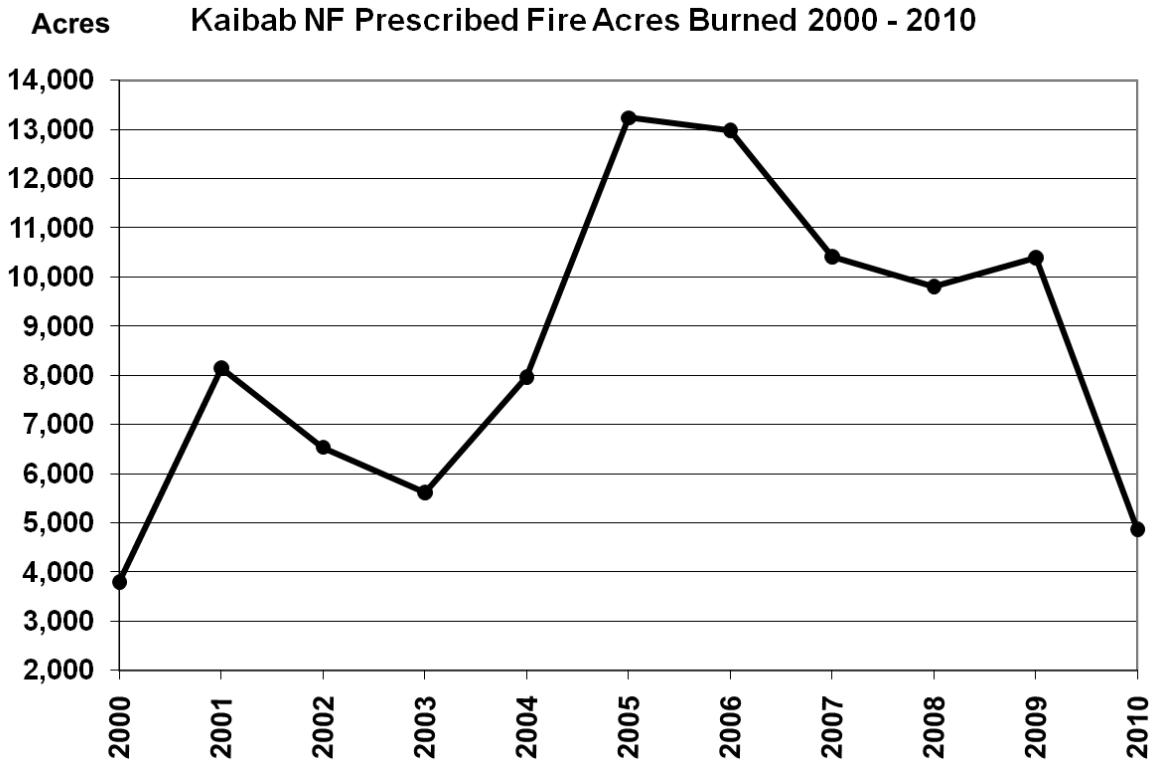
Few pollution sources, such as large metropolitan areas, industry, or power plants exist in Northern Arizona, contributing to its reputation for clean air. On rare occasions, pollution from distant large population centers in California affects the air quality in the area. Huge dust storms that occur during the summer monsoons in the Phoenix valley can produce large amounts fugitive dust that have also been known to affect air quality in Northern Arizona, but these events are generally limited to a few days a year. Particulate levels as measured by the Interagency Monitoring of Protected Visual Environments (IMPROVE) network are generally low, but episodic events that are usually, but not always, associated with wildfires in Arizona and California do occur (BLM 2011).

Heavy equipment used on paved and unpaved roads during the implementation of projects has the potential to create localized impacts from fugitive dust. With high wind events, this fugitive dust has the potential to be carried for several kilometers. Control measures developed for site specific projects can reduce these localized particulate matter emissions, such as reducing travel speeds on unpaved surfaces, ceasing work activities during periods of high winds, applying gravel or soil stabilizers on dust problem areas, covering loads, and covering ground surfaces with water during earth moving activities. (BLM 2011)

Ozone levels are increasing in the Flagstaff area. Natural background ozone concentrations are naturally high in the West; transport from industry and large urban areas in Californinia and other non-local sources also contributes significantly (Koo and others 2010, Tong and Mauzerall 2008). Under current regulations, ozone levels in northern Arizona are largely outside of the regulatory control of the State of Arizona. Spikes seen in ozone levels do not correlate with fire activity although, under certain weather conditions, smoke from fires has the potential to create ozone. As yet, how much ozone is created from wildland fire, or prescriptive criteria to deter ozone creation are not available. No NAAQS are in non-attainment for the Forest.

The Forest management activity with the largest direct impact on Air Quality is prescribed fires. The Kaibab National Forest has burned an average of 8,500 acres per year with prescribed fire since 2000 (Figure 2). No notice of violation of NAAQS standards has ever been issued to the Kaibab National Forest.

Figure 2: Chart of acres burned with prescribed fire per year on the Kaibab National Forest from 2000 thru 2010.



Wildfires, though they are not planned Forest management activities, also contribute to air quality impacts. If naturally ignited by lighting, the Forest may use wildfires to achieve resource objectives if current and expected fire behavior is desirable. Among the many factors fire managers and line officers must carefully weigh when deciding whether to suppress a wildfire, or manage it to perform its natural role as in the ecosystem, is whether the potential benefits of the wildfire outweigh the smoke impacts to the airshed, affected communities and rural residents. On these fires, fire managers are able to manage smoke impacts to some degree. Firing operations can often be timed to occur when ventilation conditions are favorable. It may be possible to check a fire's edge on days when reduced emissions are needed. Activities on prescribed fires and wildfires in an airshed can be coordinated between fire managers, in conjunction with ADEQ, to either spread high emission producing events from multiple wildfires over several days to reduce the concentration of pollutants, or facilitate these events to occur simultaneously on days with favorable ventilation to move the pollutants up and out of the airshed all at once to reduce the duration of smoke impacts.

The Kaibab managed its first wildfires to achieve resource objectives in 2003. Because fuel moistures, weather, and fire danger vary so much from year to year, the number of acres treated by wildfire also fluctuates greatly. The average number of acres per year treated by wildfires for resource objectives since 2003 is 11,700 (Figure 3).

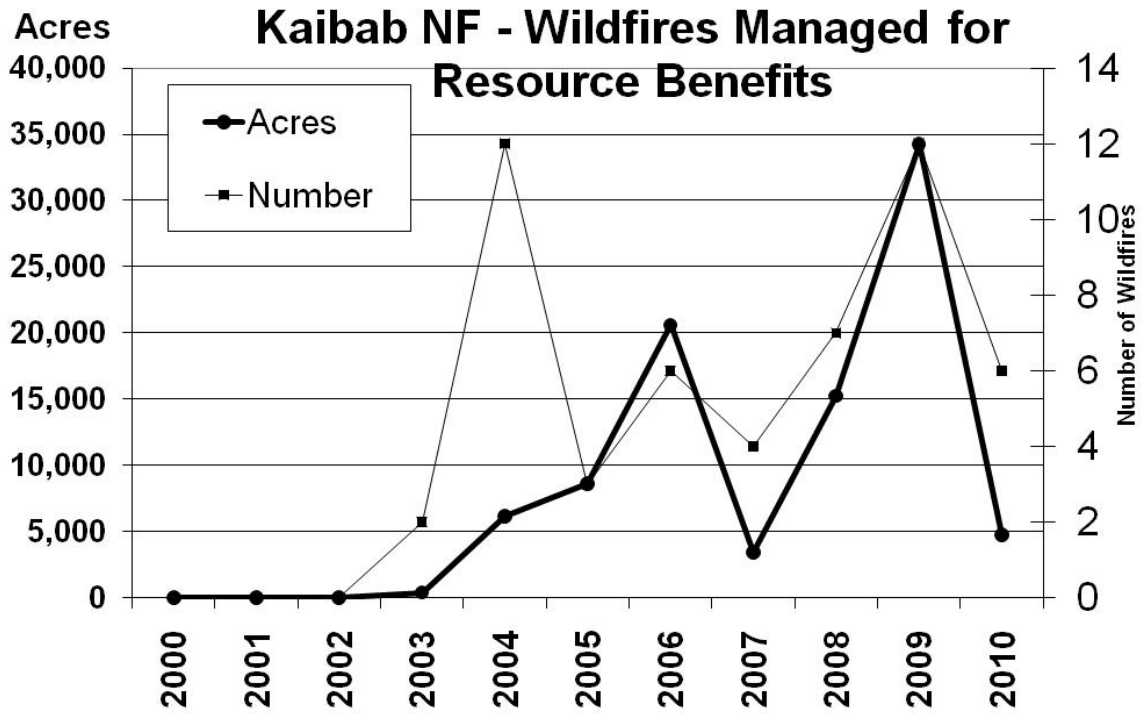


Figure 3: Chart depicting the number of naturally caused fires that have been managed to achieve resource objectives, and the number of acres treated by those fires.

On the Kaibab, as well as nationally, 0.5% to 2% of undesirable wildfires escape initial attack efforts. The high intensity of these fires consumes much of the forest canopy as well as litter and duff on the forest floor, resulting in heavily concentrated emissions. Emissions from these events are largely outside the control of the fire managers. Pollutants emitted from these fires can no more be controlled than outcomes from other natural events such as tornados, or floods. The ten year running average occurrence for wildfires on the Kaibab National Forest is around 200 fires per year. Most are contained and controlled at a tenth of an acre in size or less. While fire occurrence has stayed fairly stable, the acreage burned by the small percentage of high severity fires that escape initial attack efforts began a dramatic increase in 1996 and now has a running average of over 5,000 acres per year (Figures 4 and 5).

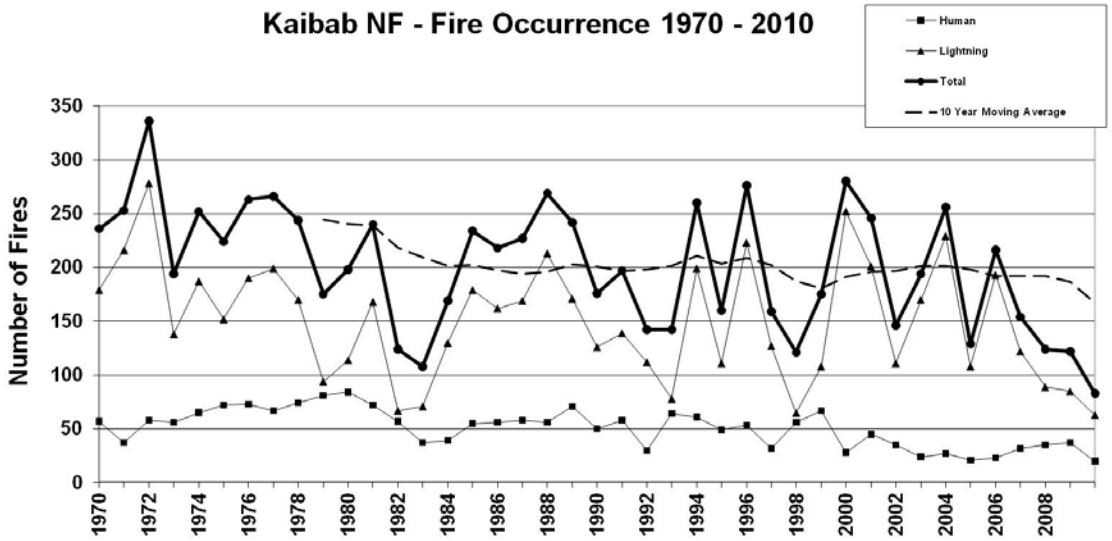


Figure 4: Chart depicting the number of fires per year from 1970 through 2010.

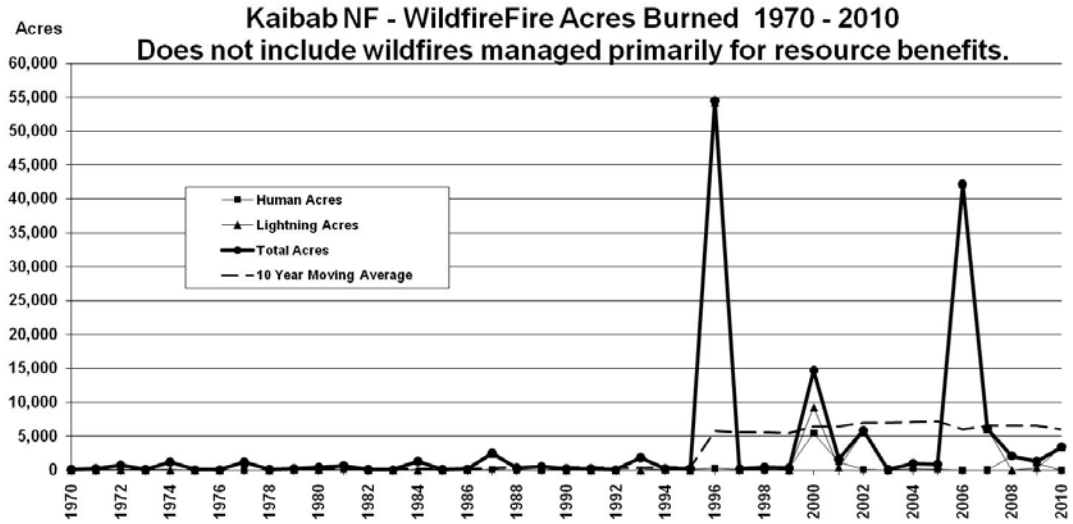


Figure 5: Chart of the number of acres burned by wildfires from 1970 through 2010 not including those wildfires managed for resource objectives.

Baseline visibility conditions have been established for the Grand Canyon National Park and Sycamore Canyon Wilderness which are the two Class I areas potentially affected by activities and wildfires on the Kaibab National Forest (Table 1). The Forest Service will continue to adhere to requirements in the Arizona State Implementation Plan to meet natural condition visibility goals. (Fitch and Truman 2007).

Class I Area	Baseline Data Years	Baseline Conditions	2064 Goal in 2003 AZ SIP
Grand Canyon NP	1999-2000, 2002-2004	11.6 dv	6.95 dv
Sycamore Canyon Wilderness	2001-2004	15.2 dv	6.96 dv

Table 1: Baseline and 2064 goal in 2003 Arizona State Implementation Plan for Natural Conditions (Fitch and Truman 2007).

During the comment period for the proposed land management plan and draft environmental impact statement, a comment was received expressing concern that accumulated radionuclides would be released from prescribed fires and wildfires. In Northern Arizona there are several types of radioactive elements. Most of these are naturally occurring, such as Radon, Potassium, and Thorium. Northern Arizona also has deposits of Uranium, which can and has been used for commercial purposes. In addition, Northern Arizona, like much of the world, also has traces of man-made radioactive material, primarily from weapons testing conducted in the mid-twentieth century. These radioactive elements include Cesium and Strontium. These man-made forms of radiation tend to be non-volatile.

Radioactive elements are often found in plants and soils, although the concentration levels are

very low. This is a type of background radiation that is always present. Our bodies are able to withstand this amount of radiation.

Communication with the EPA (Gerdes 2012, Graham 2012), and studies that addressed wildfire emissions (Schollnberger et al. 2002) indicate that radioactive isotopes and other undesirable chemicals are present in wildfire emissions. When a fire burns through an area, the radioactive elements these radioactive particles may become re-suspended and drift into the air and spread, much like any other fire emission. The levels of radioactive material that could be released in a prescribed fire or other fire, based on studies that have been conducted on other fires, are very low and below thresholds which produce a health risk.

During the Cerro Grand fire that burned in the city of Los Alamos and the Los Alamos National Laboratory (LANL) in New Mexico in 2000, there was considerable public concern regarding the potential release of radionuclides from the Los Alamos National Laboratory (LANL). Following the Cerro Grande fire, the US Environmental Protection Agency (EPA), New Mexico Environment Department (NMED), and LANL partnered with Department of Energy to operate radiological monitoring systems as well as to initiate several studies to assess the impacts of the fire.

The following risk summary is from "2002 Fact Sheet: Cerro Grand Fire Releases to Air" which may be viewed at:
ftp://ftp.nmenv.state.nm.us/www/doe/publications/lanl/2002FireAirFactSheet.pdf

"The primary health risks during the Cerro Grande fire were associated with breathing materials released into the air. It was estimated the risk of cancer from breathing any LANL-derived chemical or radioactive material that may have been carried in the smoke plume to be less than 1 chance in 10 million. Potential exposures in the surrounding communities to LANL-derived chemicals that are not carcinogenic were about 10 times lower than acceptable intakes established by the U.S. Environmental Protection Agency (EPA). The risk of cancer from breathing chemicals and radioactive materials in and on the natural vegetation that burned in the Cerro Grande Fire was greater than that from LANL derived materials, but still less than 1 chance in 1 million. The vegetation that burned contained naturally occurring chemicals and radioactive materials and radioactive fallout produced during atmospheric tests of nuclear weapons. These materials and the risks they posed are present during any forest fire."

LANL, the Department of Energy, and NMED also monitored radionuclide concentrations in smoke from the Las Conchas fire that burned through the Los Alamos area in the summer of 2011 and reported no significant detection levels (http://www.nmenv.state.nm.us/aqb/WildfireSmokeResources).

A study that included Lockett Meadow on the neighboring Coconino National Forest, found levels of radioactive materials in the soil were no different than background levels, and would provide no added human health risk (Ketterer et al 2004, Graham 2012a).

Winds from the southwest are predominant throughout Arizona and the Southwest. As such, during daytime hours, fire activity on the Kaibab is most likely to affect smoke sensitive receptors to the north and east of fire locations. Nighttime settling of residual smoke from fires, however, generates far more concerns and complaints of nuisance smoke.

The Williams Ranger District has the largest number of smoke sensitive receptors they must consider during fire management activities, where nuisance smoke can be an issue. Receptors include the City of Flagstaff, the City of Williams, and the community of Parks, as well as multiple smaller housing developments scattered across the District. The most sensitive smoke receptor in the State of Arizona is the Verde Valley, which is easily impacted with nuisance smoke from the cumulative burning on the southern part of the Williams Ranger District, the western side of the Coconino National Forest, and the eastern side of the Prescott National Forest, as diurnal drainage of smoke from fires settles into this valley. Considerable coordination between Forests takes place when prescribed fires and wildfires that can affect the Verde Valley take place, facilitated by the interagency Smoke Management Group housed at ADEQ. Multiple smoke monitors in the Verde Valley track emissions concentrations, as well as equipment that captures images of visibility conditions. Spikes are found in particulate matter concentrations as smoke from fire activity on the surrounding Forests settles into the Valley at night, although levels have not, as yet, exceeded NAAQS thresholds. Many complaints of nuisance smoke in the Sedona area are primarily concerned with the reduced quality of highly valued scenic views of the Red Rocks. Visibility in the Class I area of Sycamore Canyon Wilderness can also be affected by smoke from fires in the southeast portion of the District.

The predominant smoke sensitive receptors on the Tusayan District are the town of Tusayan, and the Grand Canyon Airport, and the developed areas in the Grand Canyon National Park. Smoke which may affect the visibility and scenic values of the Park is always a concern.

The North Kaibab has relatively few smoke sensitive receptors that are small and widely scattered. Few complaints on nuisance smoke are ever received. On the southwest side of the District, smoke from fires may settle into the Grand Canyon overnight, and reduce visibility until inversion layers lift the following day.

Revision Topics Addressed in this Analysis

A comprehensive evaluation report (CER) was prepared in April of 2009 to evaluate the needs for change in light of how management under the current Kaibab Forest Plan is affecting the current conditions and trends related to sustainability. This report was based upon the sustainability reports (which describe the social, economic, and ecological conditions and trends) and other recent information.

An internal Management Review of this CER was conducted in December of 2008 to determine which needs for change issues would be carried forward into plan revision. The Forest Leadership Team identified four priority topics to focus the scope of the Kaibab's plan revision. These topics reflect the priority needs and potential changes in program direction that will be emphasized in the development of the Revised Forest Plan components. They are:

- Modify forest structure and species composition to restore or maintain sustainability and restore historic fire regimes.
- Regenerate aspen to insure long-term healthy aspen populations.
- Restore natural waters and wetlands to insure healthy riparian communities.
- Restore grasslands by reducing tree encroachment and restoring fire.

Modifying stand structure and density towards reference conditions and restoring historic fire regimes is the revision topic primarily addressed in this report. Fire is a necessary component in achieving this need for change; smoke and air quality impacts are its by-products. The two major vegetation communities of size on the Kaibab National Forest that are affected by this need for change are ponderosa pine, and frequent fire (dry) mixed conifer. (The pinyon-juniper vegetation community is the other predominant vegetation type on the Forest; fire is one of several natural disturbance processes in this type, but there are no proposed objectives in the developed alternatives due to limited capacity for treatment through the planning period.)

Restoring historic fire regime in turn plays a direct or indirect role in achieving or maintaining the remaining three priority needs for change. Fire, when it mimics reference conditions, is one of the disturbance factors that maintains and regenerates aspen stands. Regular fire entry in the vegetation surrounding seeps and springs helps maintain stand structure and function, which in turn supports hydrologic function. Fire entry within reference fire intervals, curtails encroachment of tree and shrub seedlings in grasslands.

Summary of Alternatives

Four alternatives are evaluated in this analysis.

Alternative A, No Action – Current Plan

Under the no-action alternative, the current management plan would continue to guide management on the Kaibab NF. The current plan emphasizes producing timber products; providing quality habitat for Mexican spotted owls, the Northern goshawk, and its prey; providing recreation opportunities to meet demand; livestock grazing; and improvement of soil resources. The current plan has no articulated desired conditions air quality. This analysis evaluates the effectiveness of each of the alternatives, including the No Action Alternative (current plan) for how well they meet the desired conditions for air quality that are specified in the Proposed Action.

The forest is currently implementing approximately 2,000 acres per year of mechanical thinning and roughly 8,500 acres of prescribed fire within ponderosa pine type, with small amounts of treatments in the mixed conifer. In addition, the forest is currently implementing roughly 200 acres per year of grassland restoration projects. Aspen restoration has been occurring, but at a low and variable rate. Protection of ephemeral wetlands has also been occurring, but spring protection and restoration have been minimal. While the current plan allows for higher rates of implementation, their lack of emphasis has resulted in low and variable results.

Alternative B, Proposed Forest Plan – Preferred Alternative

This alternative was developed focusing on the four priority needs for change:

The multiple ecological, social, and economic benefits of reducing the risk of uncharacteristic fires made are a primary area of focus in this alternative. The proposed forest plan defines desired characteristics of forested ecosystems including: species composition; structural characteristics such as spacing tree groups and tree density; and disturbance patterns such as frequency, severity, intensity, and size of fire.

Objectives in the proposed plan would increase the amount and rate of mechanical thinning and managed fire treatments to reduce the risk of uncharacteristic fire and to improve forest resiliency in the face of climate change. Reducing the risk of uncharacteristic wildfire would also provide increased protection from uncharacteristic wildfire for communities, infrastructure, and watersheds, and air sheds.

Objectives under the proposed forest plan would increase mechanical thinning to between 11,000 and 19,000 acres annually in ponderosa pine and between 1,200 and 2,100 acres annually in frequent fire mixed-conifer forests. Objectives would also treat up to 55,000 acres annually with a combination of prescribed fire and naturally ignited wildfire in ponderosa pine and up to 13,000 acres annually in frequent fire mixed conifer.

Alternative C

Alternative C – This alternative contains the same objectives as in Alternative B. It differs in that it contains a new Land Management Area called the “North Kaibab Wildlife Habitat Complex.” This Land Management Area would be approximately 260,000 acres in size. This Land Management Area would not be managed for timber or biomass production. Stand structure would be modified as nearly as possible towards desired conditions using a combination of

mechanical thinning treatments, prescribed fires, and wildfires with beneficial fire effects. After that, no further mechanical treatments would take place, so fewer and fewer acres would be mechanically thinned over time. Maintenance of desired conditions would be largely with wildland fire.

Alternative D

This alternative also contains the same objectives as in Alternative B. If differs in that Forestwide, no lands would be managed for timber or biomass production. Mechanical treatments would be used to move stand structure as nearly as possible to desired conditions; after that no further mechanical treatments would take place, so fewer and fewer acres would be mechanically thinned over time. Again, maintenance of desired conditions would be largely with wildland fire.

Assumptions

Air Quality is not expected to be a primary driver in selecting one alternative over another, as predicted ***direct*** impacts between alternatives are not dramatically different. The reasons large differences do not exist include:

- Smoke is a by-product of restoring fire adapted ecosystems. Fire is a necessary part of the equation, and therefore emissions with the potential to impact air quality are part of all alternatives.
- All alternatives are expected to achieve the desired conditions for air quality.
- During windows of opportunity, whenever fire weather and fire effects are favorable, fire managers on the Kaibab strive to treat as many acres with wildland fire as possible every year, yet still remain within **legal, climatological, social,** and **logistical** limits. In other words, the number of acres treated with wildland fire per year, under all alternatives, is likely to be the same, due to limitations imposed by these constraints. This is true under the current Plan, and expected to continue under all Alternatives to the Revised Plan.
- **Legal** limits to smoke emissions from prescribed fires are imposed by Federal and State Law. Therefore there is an upper limit to the number of acres that can be treated with wildland fire imposed by regulation. Wildfire emissions, including those from wildfires that are being used to achieve resource benefits, are not regulated by Law. However, fire managers are guided to include smoke management objectives on all wildfires.
- Impacts of smoke from wildfires and prescribed fires on the Kaibab, as well as on other federal and state lands, are cumulative. Therefore wildland fire activities on other agency lands may further limit the ability to utilize wildland fire on the Forest.
- **Climatological** limits are set by weather and fuel moisture, which profoundly affect fire behavior and fire effects. As weather varies from year to year so does the risk of high severity fires and the ability to use prescribed fires and wildfires to achieve resource objectives. Large fluctuations in the number of days of opportunity varies widely from year to year, creating large fluctuations in the number of acres treated with wildland fire. Running averages over many years must be used in order to view trends in fire use or undesirable fire effects.

- Meteorological conditions also limit how much smoke the airshed can absorb at any point in time without violating NAAQS, or visibility thresholds.

- Public Tolerance for smoke, though not law, regulation, or policy, effectively sets the **social** limit to the number of acres treated with wildland fire. Community public relations and education coupled with pre-burn notification greatly improve public acceptance of fire management programs. The general public will tolerate several days in a row, and several weeks a year, but even the most supportive and informed have tolerance limits. In order to maintain public support for prescribed fires and the beneficial use of wildfires, land managers must be responsive to the public's tolerance thresholds.

- Public acceptance of smoke varies greatly from year to year. Acceptance of smoke from prescribed fires and beneficial wildfires is high following seasons with high profile, high severity events, and during extremely dry years when the threat of large, high severity incidents is elevated. Conversely, acceptance wanes during wetter years when the threat of uncharacteristic fires is low. This is unfortunate because climatology in milder years is the most favorable for achieving desired fire effects, especially in areas highly departed from reference conditions.

- **Logistical** limits are also set by the capacity of firefighting resources available. Capacity varies from year to year due to congressional funding, or resources absorbed by other wildfire activity in the Region, or nationally.

Other assumptions are also made in this analysis, as follows.

This analysis uses the running averages of acres of ponderosa pine and frequent fire (dry) mixed conifer treated by wildland fire from the objectives for each alternative as a fixed number per year in order to make broad comparisons between alternatives. In reality, the climatological, social, and logistical limits discussed above cause wide fluctuations in the number of acres treated each year.

Fuel model, fuel loading and fuel moisture are highly variable over time and turf. For making broad comparisons between the alternatives of "least", "more", and "most" air quality impacts, these inputs are greatly simplified. For site-specific projects, fuel loadings are more precisely estimated, and emissions are predicted in accordance with Arizona Statutes, and ADEQ regulations.

This analysis does not attempt or pretend to predict the actual total emissions that would be produced under each alternative. Rather it aims to present a rationale for which alternatives are likely to produce the "least", "more", and "most" emissions. It assumes that, over time, there is some degree of correlation between total emission production, and total air quality impacts; while impacts are measured as the *concentration* of emissions, not the total *amount* of emissions, over the course of ten, fifty or two-hundred and fifty years, the alternative that produces the most *emissions* is likely to produce the most air quality *impacts*. Though meteorological conditions vary immensely by time of day, and from one weather system to the next, over the course of years the averaging effect over time of these varying conditions supports a correlation between total emissions and total impacts.

Methodology and Analysis Process

Comparison of air quality impacts was analyzed using outputs from the Vegetation Dynamics Development Tool (VDDT).

VDDT is a Windows-based computer tool which provides a modeling framework for examining the role of various disturbance agents and management actions in vegetation change. The interaction of human activity, fires, insects, pathogens, growth and competition is complex, and the combined effects are difficult to predict over long periods. The development tool allows for testing of the sensitivity of the ecosystem to a multitude of activities and agents of disturbance, to compare alternatives. With the tool a vegetation type is assigned various states, some of which are seral states found within the historic range of variability, and others that are unnatural states not present in the historic range of variability. Inputs to the model are agents of disturbance, such as number of acres mechanically treated to restore stand structure, or acres that are burned by fire under low, moderate or high fire weather conditions; outputs are the transition of the vegetation, by percent, from one state to another. For example, a high severity fire input would move a percentage of dense states to more open states.

Models for ponderosa pine and frequent fire mixed conifer were developed by the Forest Service at the Regional level to be used specifically to compare alternatives for Forest Land Management Plans in Region 3. For ponderosa pine and frequent fire (dry) mixed conifer there are fourteen states each, defined by the variables of predominant diameter class, canopy cover, single storied versus multi-storied, and potential for natural regeneration. States A, B, C, D, E, J, K, and N are "open states" in that canopy cover is 30% or less. The others six states are classed as "closed" with greater than 30% canopy cover.

For the Kaibab National Forest, inputs to the model are numerous, including multiple management activities and natural disturbances. They are developed from management activities under the current Kaibab Land Management Plan, and from the objectives for ponderosa pine and frequent fire mixed conifer for the developed alternatives. The amount of mechanical treatment, coupled with wildland fire treatment, under each alternative over time, have the most noticeable influence on outputs. For a full discussion of the development, calibrations, and assumptions used in the VDDT models for the Kaibab, as well as all outputs from the model, refer to the Vegetation and Fire Specialist Report (Higgins and Kleindienst 2011).

The VDDT output used in this analysis is the summation of the percent attainment of open states by alternative at the zero, ten, fifteen, fifty and two-hundred and fifty years time marks.

Environmental Consequences

The land management plan provides a programmatic framework that guides site-specific actions but does not authorize, fund, or carryout any project or activity. Because the land management plan does not authorize or mandate any site-specific projects or activities (including ground-disturbing actions) there can be no direct effects. However, there may be implications, or longer term environmental consequences, of managing the forests under this programmatic framework.

Transient impacts to Air Quality from fire are present in all alternatives. Most of the Forest is occupied by fire adapted vegetation types, and smoke from fires, regardless of ignition source or fire effects, is inevitable.

All alternatives are expected to achieve the desired conditions for air quality:

- Air quality meets or surpasses State and Federal ambient air quality standards.
- Visibility in Grand Canyon National Park, a Class 1 area, makes reasonable progress towards, or meets national visibility goals established in the Clean Air Act, the Regional Haze Rule, and the Arizona State Implementation Plan.

These desired conditions pertain specifically to the management activity of prescribed fires. No other management activities on the Forest have been found to affect air quality on a regional level.

The number of acres burned with prescribed fire is expected to be the same under all alternatives due to legal, climatological, social, and logistical limits. The reasons for this are fully explored in the Assumptions section of this report.

The desired conditions focus on adherence to State and Federal regulations. The Smoke Management Group, housed at ADEQ, greatly facilitates the Forest's ability to adhere to the Arizona SIP, and adhere to Federal and State regulations. This also is true under all alternatives.

Again, Air Quality is not expected to be a primary driver in selecting one alternative over another, as predicted ***direct*** impacts between alternatives are not dramatically different, and desired conditions are expected to be met under all alternatives.

Some comparison between alternatives can be made by looking at the ***indirect*** effects of management activities that reduce the likelihood of high severity fires. High severity active crown fires produce large quantities of emissions that are often heavily concentrated. Less biomass is consumed by a fire during a surface fire, because primarily only litter and debris on the forest floor are consumed, but a crown fire consumes the canopies of the trees as well. The alternative that best alters stand structure to promote characteristic surface fire over active crown fire would have the least negative environmental consequences to air quality.

Mechanical treatments to restore stand structure have indirect beneficial effects on air quality because they alter future fire behavior. Stands with open states, with 30 percent canopy cover or less, are more likely to exhibit surface fire behavior, even under elevated fire weather conditions. The crown bulk density is lower, and gaps and interspaces in the canopy inhibit the spread of active crown fire from group to group (Friederici 2005, Rothermel 1991, Scott and Reinhardt 2001). Some passive crown fire (individual tree torching and isolated group torching) occurs in open states, even under low or moderate fire weather conditions, but is not sustained from group to group as active crown fire across the landscape.

The amount of mechanical treatment, modeled for each alternative in VDDT, influences the attainment of open states, promoting surface fire over active crown fire, and thus fewer emissions from wildfires.

Alternatives are compared using outputs from VDDT of summation of the percentage of ponderosa pine, and frequent fire (dry) mixed conifer in open states with 30% crown cover or less. For further information on the VDDT analysis, refer to (Higgins 2011). Tables 2 and 3

below display the percentage of area in open states for ponderosa pine and frequent fire mixed conifer, for each alternative, and at current and four future time marks. The highest attainment of open states at each time mark is in bold print.

Alternative	Time Mark – Years				
	0	10	15	50	250
A	36	46	48	59	67
B		**64**	**68**	**76**	**78**
C		42	46	68	70
D		44	47	75	71

Table 2: Percentage of the ponderosa pine vegetation community in open states with 30% crown cover or less.

Alternative	Time Mark – Years				
	0	10	15	50	250
A	33	28	30	34	43
B		43	**47**	**52**	**59**
C		41	44	46	50
D		**44**	**47**	47	53

Table 3: Percentage of frequent fire mixed conifer vegetation community in open states with 30% crown cover or less.

In ponderosa pine, Alternative A has 11 to 20 percent less area in open states than Alternative B. This is because of the lower rate of mechanical thinning treatments to create more open stand structure. In ponderosa pine, Alternatives C and D have a similar amount of area in open states as Alternative A at the 10 and 15 year time mark, again with about 20 percent less area than in Alternative B. At the 50 and 250 year time marks Alternatives C and D exhibit an increasing area in open states even though the amount of mechanical thinning treatment is decreasing. This is due to continued entry with wildfire. At the 250 year time mark it should be noted that there is an elevated percentage of area in the open state N. State N is an unnatural open state that is the result of high severity fire. These areas take a long time to regenerate and attain desired conditions, as the areas are large, so seed sources at the edges are distant, and because the large

old trees that are part of the desired condition take a hundred years or more to grow. Alternative B has the least area in State N at all time marks.

In frequent fire mixed conifer, Alternatives C and D have a similar amount of area in open states as Alternative B at the 10 and 15 year time marks. This is because at these time marks mechanical treatments to achieve more open states is occurring in all three alternatives. By the 50 and 250 year time marks Alternatives C and D have 5 to 9 percent less area in open states than in Alternative B, as mechanical treatments continue to decrease. Alternative A, with a lower application of thinning treatments than all other Alternative fares the worst, with 7 to 18 percent less area in open states than all other alternatives at all time marks.

In ponderosa pine, VDDT modeling for Alternative B indicates the least susceptibility to high severity wildfires with elevated emissions over time inferred from greater attainment of open states at all time marks. Alternatives A, C, and D are fairly comparable at all but the 50 year time mark, when Alternative A has 9 percent less open states than Alternative C, and 16 percent less area than Alternative D.

In frequent fire mixed conifer, Alternative A has a markedly lower percent of area in open states than Alternatives B, C, and D, and thus the greatest susceptibility to high severity, elevated emission production fires with 7 to 18 percent less area in open states than all other alternatives at all time marks. Alternatives B, C, and D are fairly comparable. However, Alternative B has somewhat more area in open states than Alternative C at all time marks, and equal or more than Alternative D at three of four time marks, so Alternative B is the alternative the least susceptible to high severity wildfires with elevated emissions.

Overall, in both ponderosa pine and frequent fire mixed conifer, Alternative B results in the highest percentage of open states at all but two time marks, and the least susceptible to high severity fires with elevated emission production.

Cumulative Environmental Consequences

Examining cumulative effects from smoke on air quality differs from the evaluation of cumulative effects for many other resources; this is due to the transient nature of air quality impacts from smoke. It is a relatively simple exercise to estimate the total tons per acre of emissions from prescribed fires on the Kaibab, and other land management agencies, but there is no calculation that correlates total annual emissions to total concentrations of emissions. Again, impacts are measured as concentrations of emissions, whether it's in $\mu g/m^3$ for NAAQS, or in deciviews measuring visibility in Class I Areas. Cumulative effects are not the total emissions produced in a day or a year, but rather the concentration of all fire emissions in a given airshed at a given time. For NAAQS these concentrations have a varying time weighted period depending on the pollutant. For PM_{10} and $PM_{2.5}$, they are measured as a 24 hour average, and as an annual arithmetic mean.

Cumulative effects from prescribed fires and from wildfires that are not being actively suppressed on Federal, State, and Tribal lands, are largely mitigated through implementation of the Enhanced Smoke Management Program, in the Arizona SIP, by the previously mentioned Smoke Management Group. When the Federal land managers actively began prescribed fire programs in

the 1970s, they became rapidly aware that smoke does not respond to artificial boundaries or delineations, and that a pro-active program for the coordination of prescribed fires would be vital to obtain and continue support of prescribed fire programs by ADEQ and the public. An interagency Smoke Management Group was developed in partnership with the State, and housed in the ADEQ offices in Phoenix. The personnel in the group are funded largely by the Federal agencies, demonstrating the initiative of the agencies to, in some degree, self-regulate emissions produced from prescribed fires, across Federal and State boundaries.

This group assists land managers in not exceeding NAAQS or visibility thresholds through the following services:

- Serves as a central collection point for all prescribed fire requests from the numerous Federal, State, and Tribal land managers who are all competing to produce smoke that will impact the same airsheds during limited windows of opportunity.
- Evaluates potential emissions from individual and multiple, and determines how meteorological forecasts will affect smoke concentrations both during the burn, and during diurnal settling. The Group considers cross-boundary impacts; and weighs firing decisions against possible health, visibility, and nuisance effects.
- Assists in coordinating activities within and between agencies when potential emissions would likely exceed desired conditions.
- Makes recommendations on the approval or disapproval of each burn request to ADEQ officials.
- Tracks the use of Best Management Practices and Emission Reduction Techniques used by land managers, to document efforts by land managers to minimize impacts to Air Quality. This information is used promote support from both ADEQ and the public.
- Monitors data gathered from the IMPROVE network to assess visibility impacts in Class I areas, and track progress towards Arizona SIP goals.

While emissions from wildfires are not regulated, Federal, State, and Tribal land managers understand their responsibility to balance the ecological benefits of wildfires with the social impacts of the smoke they produce. The Smoke Management Group also assists land managers in this area through:

- Limiting prescribed fire approvals during periods when wildfires are already impacting an airshed.
- Making recommendations on the timing, or assisting in the coordination between units, of tactical operations such as burn outs, that will produce large amounts of emissions, so that they are completed, when possible, when ventilation conditions are most favorable, or spread out over several burning periods to reduce total emissions when ventilation is not as good.
- Assisting land managers in determining the strategy to take on new wildfires. There may be enough fires burning that suppression on a new start is recommended to reduce cumulative smoke impacts even though all other fire effects would be desirable, and move the fire area towards desired conditions in the Land Management Plan.
- Acting as a sounding board for public complaints. In keeping tabs on the type and number of complaints, the Group is able to provide land managers feedback from beyond their local publics on the state of public smoke tolerance. This is vital in maintaining

general public support of allowing wildfires to perform their natural role in the ecosystem under the right circumstances in future windows of opportunity.

Through the services of the Smoke Management Group, cumulative effects from wildland fire that are within the control of Federal and State Land Managers, are thus managed to keep Air Quality across Arizona within desired conditions, including not exceeding NAAQS, protecting visibility in Class I Areas, and additionally promoting general public support of prescribed fire and wildfire management programs.

Unavoidable Adverse Impacts, Irreversible and Irretrievable Commitment of Resources

The land management plan provides a programmatic framework that guides site-specific actions but does not authorize, fund, or carryout any project or activity. Before any ground-disturbing actions take place, they must be authorized in a subsequent site-specific environmental analysis. For prescribed fires this includes both National Environmental Policy Act analysis, and a prescribed burn plan signed by the authorizing line officer. On wildfire incidents, the analysis, objectives, and courses of action selected are supported, documented, and signed in the Wildfire Decision Support System (WFDSS). Because the land management plan does not authorize or mandate any site-specific project or activity, therefore none of the alternatives cause unavoidable adverse impacts, or cause an irreversible or irretrievable commitment of resources.

Adaptive Management

All alternatives assume the use of adaptive management principles. Forest Service decisions are made as part of an on-going process, including planning, implementing projects, and monitoring and evaluation. The land management plan identifies a monitoring program. Monitoring the results of actions will provide a flow of information that may indicate the need to change a course of action or the land management plan. Scientific findings and the needs of society may also indicate the need to adapt resource management to new information. The Forest Supervisor annually evaluates the monitoring information displayed in the evaluation reports through a management review and determines if any changes are needed in management actions or the plan itself. In general, annual evaluations of the monitoring information consider the following questions:

- What are the effects of resource management activities on the productivity of the land?
- To what degree are resource management activities maintaining or making progress toward the desired conditions and objectives for the plan?
- What changes are needed to account for unanticipated changes in conditions?

In addition to annual monitoring and evaluation, the Forest Supervisor reviews the conditions on the land covered by the plan at least every 5 years to determine whether conditions or demands of the public have changed significantly. The forest plan is ordinarily revised on a 10-year cycle and the Forest Supervisor may amend the plan at any time.

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