

Air Quality, Wildland Fire, and Smoke Management in the U.S. The Nature Conservancy, Global Fire Initiative

This document outlines basic information on wildland fire management and air quality, including impacts on public health and welfare. It includes information on air quality regulations, and the fundamental techniques used in smoke management. It also contains general recommendations for Conservancy fire practitioners, a case study, and links to further information on these subjects. It does not explore the relationship between fire, smoke, particulates and climate change.

Introduction

Wildland fire management, including prescribed fire and fire use, is an essential tool for restoring and maintaining the health of fire-dependent ecosystems. It also provides community benefits by reducing the potential wildfire hazard to homes and people caused by build-up of dangerous amounts of vegetation.

However, fire produces smoke, which in some instances has negative impacts on public health and welfare, and lofts greenhouse gases and particulates into the atmosphere. Mechanical treatment, the chopping or cutting of vegetation using specialized heavy equipment, produces fewer emissions than the use of prescribed fire, but does not mimic the physiological or chemical effects of fire. The heat release and consumption of vegetation and organic soil layers that occur during a fire may have essential biophysical impacts on ecosystems that cannot be reproduced with current mechanical technology. Exclusion of fire from a fire-dependent ecosystem can have negative effects on species and systems targeted by conservation efforts, rendering them non-viable.

Air Quality Regulations

Air quality regulations are developed at the federal, state and local levels. Any of these may impact prescribed burning. They may also apply to fire use, or the management of naturally-ignited fires for specifically defined benefits of natural resources.

The Clean Air Act

The Clean Air Act (CAA) of 1970 and the subsequent 1990 amendment are the basis for most air quality regulations today. The U.S. Environmental Protection Agency (US EPA) is charged with promulgating and enforcing rules under the CAA. It is important to understand that the States have responsibility for monitoring air quality, reporting monitoring data to the US EPA, and developing a plan for bringing their air quality into compliance with standards if they are found to be in exceedance. The States therefore have significant authority in determining how the CAA is implemented.

Of particular importance to fire management are the nine criteria pollutants, substances defined in the CAA whose negative impacts on the public may be so serious as to endanger public health and welfare. The maximum allowable concentrations of these pollutants that may be present in an airshed (the mass of air contained within a definite boundary, usually determined by topography) are defined in the National Ambient Air Quality Standards (NAAQS). The NAAQS are determined by the US EPA. By law, the NAAQS for each criteria pollutant must be reviewed every five years, a timeline that is in

practical terms unrealistic. Usually the review timeline is much longer. Reviews are often prompted by lawsuits against the US EPA.

As mentioned above, States are responsible for monitoring their air to determine compliance with the NAAQS. If data show that an airshed does not meet the standard for a specific criteria pollutant, it is declared "non-attainment" for that pollutant. The State must then go through the time-consuming and laborious procedure of developing a State Implementation Plan (SIP), which defines a process to bring its air into compliance with the NAAQS. In determining how they will achieve the standard, state regulators may decide to severely limit prescribed burning, or they may focus on some other pollutant source. Although the state has the responsibility for developing the SIP, it must be approved by the US EPA. A list of non-attainment areas can be found in the EPA's Green Book (see Resources list at end of document).

The EPA also regulates regional haze, which is a measure of the visibility in an airshed. This is an especially important standard in western states where high value is placed on the aesthetics of vistas, and in national parks and wilderness areas with relatively pristine air quality. Although fire was found to contribute nationally only about 3-7% of regional haze, these regulations may have an impact locally on prescribed burning and fire use.

Criteria Pollutants

There are several criteria pollutants of concern to prescribed burners, chiefly, particulate matter and ozone. (The others are carbon monoxide, lead, nitrogen oxide and sulfur dioxide.) Carbon dioxide is discussed below because of concern related to the greenhouse effect.

Particulate Matter (PM). In 1998, the EPA passed new regulations to govern particulate emissions at a finer scale than previously regulated, resulting from medical evidence that smaller particles are more dangerous to public health. The new regulations set a standard for PM_{2.5} (fine particulates 2.5 microns in diameter or less), and retained the former standard for PM₁₀ (coarse particulates 10 microns or less). The move to regulate PM_{2.5} may have a serious impact on prescribed burning in some parts of the country, since 70 - 80% of the smoke produced from burns falls into this category. States and tribes spent three years gathering data and submitted it to the EPA. In December 2004, the EPA designated non-attainment areas for PM_{2.5}. States and tribes have three years to develop a SIP, and must reach attainment by 2010.

Ozone. Ozone is a concern as a precursor to greenhouse gases. It is produced by large wildland fires under certain conditions. As a criteria pollutant, ozone production may be regulated by a SIP, or prescribed burns may be banned under ozone alerts.

Carbon Dioxide. Wildland fire has come under scrutiny as a producer of CO₂ in light of concern over global climate change. Biomass burning contributes to the release of greenhouse gases, and in some instances, eliminates a carbon sink. An argument can be made, however, that prescribed fires maintain the bank of carbon in vegetation by preventing mass release in catastrophic wildfire.

Although prescribed fire is generally not limited by CO₂ concerns now, it may surface as a regulatory issue in the future.

The EPA's Air Quality Policy on Wildland and Prescribed Fire

As the EPA reviewed the air quality standard for particulate matter in 1998, it recognized a conflict would exist between the new regulations and plans for federal land managers to dramatically increase wildland fire management accomplishments. They formed a working committee of regulators and fire managers to develop a compromise that would protect public health, but allow fire to be retained as a land management tool. The resulting document, the Wildland Fire and Air Quality Policy recommendation, gives guidance to the states for treating emissions from prescribed fire smoke. (Emissions from wildfires are treated differently. They are covered under the Natural Events Policy and therefore exempt from NAAQS.)

The Policy recommends that states develop a voluntary Smoke Management Program (SMP), which must be certified by the EPA. Once the SMP is certified and implemented, the EPA will allow two exceedances of the NAAQS for PM_{2.5} attributable to prescribed burning without declaring the airshed out of attainment. The states will instead be allowed to review their SMP and make adjustments if it is found inadequate. On the third violation, the area will be designated out of attainment, the Smoke Management Program will become mandatory, and a SIP must then be prepared.

In the normal process of reviewing their air quality data, individual states may request an exemption from the US EPA for the occurrence of an "unusual event" that violated the standards. Some states may include data from a particularly bad prescribed fire smoke incursion in that process. The EPA may use its discretion to exclude that data from the NAAQS calculations.

County Laws and Regulations

Individual counties may pass air quality regulations that are stricter than those of the NAAQS. Such rules may severely impact wildland fire management. State and county laws may also regulate nuisance smoke, which is smoke from prescribed fires that may cause a risk to public safety, or impact the right of the public to enjoyment of public and private places. Examples include a law that regulates minimum visibilities on roadways, or that forbids burning on Sundays.

Effects of Smoke on Public Health

The effects of wildland fire smoke range from irritation of the eyes and respiratory tract to more serious disorders, including asthma, bronchitis, reduced lung function and premature death. Studies have found that fine particulate matter is linked (alone or with other pollutants) with a number of significant respiratory and cardiovascular-related effects, including increased mortality and aggravation of existing respiratory and cardiovascular disease. In addition, airborne particles are respiratory irritants, and laboratory studies show that high concentrations of particulate matter may cause persistent cough, wheezing and physical discomfort in breathing. Particulate matter can also alter the body's immune system and affect removal of foreign materials, such as pollen and bacteria, from the lungs.

Individuals exposed to toxic air pollutants at sufficient concentrations and durations may have an increased chance of getting cancer or experiencing other serious health problems. However, in general it is believed that the long-term risk from toxic air pollutants from wildland fire smoke is very low.

Not everyone who is exposed to smoke will have health problems. Concentration of smoke, duration of exposure, age, individual susceptibility and other factors play a significant role in determining whether or not someone will experience smoke-related problems. The most sensitive populations are the elderly, children, and those with pre-existing health problems.

Wildland Fire Smoke Management

Wildland fire managers are keenly aware of the potential negative consequences of smoke. They recognize that it is in their best interest to conduct prescribed burns or fire use projects to minimize the impacts of smoke on the public. As a result, virtually every prescribed burn or fire use plan contains a special section that addresses smoke management strategies, and other sections of the plan take smoke management concerns into account.

Smoke Management Techniques

Methods used to manage smoke fall into two main categories: *reduce* or *redistribute* emissions. The smoke management strategies used for a particular burn are the result of a compromise between meeting overall objectives for the burn, minimizing smoke impacts, and cost considerations. Sometimes, potential ecological benefits of a burn may be limited by overriding smoke concerns.

Fire managers may *reduce* emissions in many ways. One method is as simple as burning small areas, which limits the amount of smoke sent into the airshed on a given day. Or, a burn may be conducted under conditions under which some of the fuel (vegetation, fallen logs, organic material on the ground, etc.) will not burn. For example, when it is dry enough for small twigs and leaves to burn, but large logs contain too much moisture to ignite. Using this technique, the particulates that would have been introduced into the atmosphere from the burning logs are not released, reducing potential emissions. Alternatively, the ignition pattern of the burn may be designed to limit emissions, as certain ignition patterns (e.g., backing fires) produce fewer emissions than others.

Emissions may be *redistributed* either through space or time. To redistribute smoke through space, fire managers rely on meteorological conditions that favor smoke dispersal quickly into a large volume of air, and in a favorable direction. Wind direction and atmospheric lifting conditions are frequently the determining factors for whether a burn is conducted on a given day, as the burn boss will want to keep smoke from blowing over an area sensitive to smoke, and use conditions that loft smoke high into the atmosphere and away from people. To redistribute emissions over time, a fire manager may choose not to burn on days when others in the same airshed are burning, thus not overloading the atmosphere. The fire manager may also burn small areas on sequential days, allowing for smoke to clear overnight before releasing more emissions through additional ignition.

Spelling out specific limitations in burn plans to mitigate smoke considerations, such as windows of acceptable meteorological or fuel conditions, is an important tool for fire managers. Adherence to these smoke management parameters allows fire managers to minimize expected smoke impacts. However, when an unexpected event occurs that suddenly makes smoke impacts unacceptable, such as a wind shift that sends smoke over a road, the burn boss must also be able to extinguish a burn in progress, or otherwise mitigate smoke impacts. This sort of contingency planning is also a part of the overall burn plan.

What should The Nature Conservancy do?

The Conservancy supports maintaining air quality standards that protect public health and welfare. However, we believe that it is possible to manage smoke from prescribed fire and fire use projects so that its impacts on the public are minimal. There are several steps we can take to help our own staff and partner agencies balance these concerns.

It is important for wildland fire managers to develop relationships with state air quality staff, and educate them about the crucial role of fire in the region's ecosystems. Many air quality regulators have little understanding of the degree of care prescribed burners take in smoke management planning. Fire managers can explain to them the smoke management process, and review a history of success on previous burns. They should also bring the regulator's attention to the Air Quality Policy on Wildland and Prescribed Fire, as those who work in states without significant wildland fire activity may not be familiar with it. This educational process will be especially important if a SIP is required in the state, as we may be able to work with air regulators to provide consideration for prescribed burning in the development of the SIP. Because the non-attainment areas for PM_{2.5} will be announced in late 2004, this process should be going on now in areas where staff suspect this will be an issue.

Fire managers should also be proactive in working with the local county and city administrators to educate them about the importance of fire management in ecosystem health and risk reduction. In Florida, the Prescribed Fire Councils (local associations of fire users from federal, state and private interests) have promoted passage of county resolutions that support the use of fire as a land management tool. In several instances, the resolutions have been important in quelling attempts by individuals to limit burning in their counties.

Conservancy fire managers should continue to engage in careful smoke management planning and prescribed fire implementation. All burn bosses should be trained in smoke management techniques, and those burning in especially smoke sensitive areas should attend advanced smoke management training, such as Rx410 Smoke Management.

Smoke concerns should be considered as a potentially limiting factor when conducting conservation planning at larger scales, such as ecoregional or site-level. The practical implications of fire management should be weighed in the decision to make a conservation investment in a site containing fire-dependent ecosystems. Issues such as urban interface (e.g., nearby homes, highways or industry) may make a specific site or landscape extremely difficult to manage effectively with fire, or very costly. Sometimes simple steps, such as acquiring buffer space around a key area can mitigate such issues, but planning in advance is the best way to avoid management problems.

Case Example: Albany Pine Bush Preserve, NY

An interesting case example of effective smoke management enabling a prescribed fire program to succeed under difficult circumstances is the Albany Pine Bush Preserve. The Preserve is a 2750-acre fire-managed natural area within the city limits of Albany, NY. The NY State Thruway bisects the preserve, and it is bordered by the Adirondack Northway and Thruway interchange. Adjacent to the property are three nursing homes (including a high-rise that specializes in respiratory care), a methane-emitting landfill, and hundreds of private homes and commercial structures. Despite these enormous challenges, the staff carries out a successful prescribed fire program. How do they do it?

First and foremost, they have cultivated the respect and trust of the community. They used various means to educate the public, including mailings, town meetings, newspaper and television media, conveying the message that fire is essential to the health of the Pine Bush. They also keep neighbors informed through an annual pre-burn mailing to over 1800 households and businesses, giving approximate dates of their upcoming burns. On the day of the burn, several of the fire crew establish a phone bank, calling up to 100 individuals who asked to be notified before burns occur in their local area. Neighbors have an opportunity to comment at the end of the burn season through a post-burn mailing that lists burns and accomplishments, and asks for feedback. Typically, only two or three negative comments are received at the end of the season.

The fire crew also uses both reduction and redistribution techniques to manage smoke. They reduce emissions by burning small units (no greater than 30 acres) and ensuring that the fire is completely extinguished before sunset. They practice avoidance and dilution techniques by strictly adhering to meteorological parameters for wind direction and dispersion. The crew also recognizes situations when they must close down a burn because of smoke intrusion, and are prepared with the staff and equipment to do so.

Although the cost of the burn program is high relative to more remote sites, the benefits are substantial. The vitality of the fire-dependent ecosystem, home to an endangered species and several species of concern, is improving as a result of persistence and careful fire application. Fuel hazards are reduced in urban interface areas, and recreational opportunities have increased as dense stands are thinned by fire, allowing neighbors greater ease of access. The support of the community remains high for continuation of the prescribed fire program.

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Selected Resources

Publications

Smoke management guide for prescribed and wildland fire: 2001 edition.

A comprehensive review of smoke and smoke management, including but not limited to: smoke characteristics, impacts on the public, regulations, meteorology, monitoring and emissions.

(Download from: <http://www.treesearch.fs.fed.us/pubs/viewpub.jsp?index=5388>)

Wildland Fire in Ecosystems: Effects of Fire on Air

A state-of-knowledge review of the subject, including air chemistry, monitoring smoke, modeling transport and dispersion of emissions, and social consequences of wildland fire smoke.

(Download from: <http://216.48.37.142/pubs/viewpub.jsp?index=5247>)

Internet Resources

- AirNow – daily status reports on air quality

<http://cfpub.epa.gov/airnow/>

US Environmental Protection Agency: Office of Air and Radiation

- Interim Air Quality Policy on Wildland and Prescribed Fires

<http://www.epa.gov/ttncaaa1/t1/meta/m27340.html>

- Air Quality Planning and Standards

<http://www.epa.gov/air/oaqps/>

- The Green Book: Nonattainment Areas for Criteria Pollutants

<http://www.epa.gov/oar/oaqps/greenbk/>

- PM_{2.5} NAAQS Implementation

http://www.epa.gov/ttn/naaqs/pm/pm25_index.html