The Smoke Dilemma: A Head-on Collision!

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A head-on collision is imminent! The drivers are people. The vehicles are special interests. The road is smoke! Those concerned about air quality ride in the first car; those concerned about natural resource management ride in the second.

In this paper, we look at what smoke is and why it is sometimes dangerous, factors leading to a collision, and what we can do to avoid a collision.

What is the Road?

What is smoke? Two sources of health and visibility hazards produced by forestry smoke are of interest to us today—water vapor and particulate matter. Researchers analyzing the chemistry of smoke from southern prescribed fires have found that more than 90 percent of the mass emitted is in carbon dioxide and water vapor (USDA Forest Service 1976). Water vapor is important because it can affect visibility near a fire. At night, near the ground, when a cooled airmass is already near saturation (relative humidity = 100 percent), water

vapor injected from smoldering fuels can cause the airmass to become supersaturated, that is, the relative humidity will briefly exceed 100 percent. If sufficient hygroscopic nuclei (particles that water can condense on) are present (and in the South, there almost always is an abundance of these particles), the supersaturated airmass can flash into a super-dense fog.

Particulate matter is defined as any dispersed aggregate matter, solid or liquid (other than water), that is larger than 0.0002 micrometers (um) in diameter, but smaller than 500 um in diameter. Particulate matter makes up approximately 1 to 3 percent of the total mass released in forestry smoke (USDA Forest Service 1976). Particles greater than 10 to 20 um in diameter will fall out of the atmosphere within 0.5 to 1.0 mile from the source of production. This is especially the case during near-calm wind conditions.

Smoke emissions from prescribed burns can release large amounts of particles—about 90 percent are 10 um (PM-10) or less, and 70 percent are 2.5 um (PM-2.5) or less. These are the particles that scatter headlight beams from automobiles and create health hazards for people when inhaled.

Toward a Collision on Smoke

Increasing Population and Air Quality

Not only are the cars heading toward a collision, they are accelerating! Pressing the gas pedal in the first car is population growth. The mild, mostly snow- and ice-free winters make the southern climate ideal for the development of retirement communities. Thousands of older people, some with respiratory problems, have relocated into these communities. Many of these retirees have little or no experience with forestry practices and, therefore, may not be receptive to frequent incursions of smoke into their communities. Human health concerns and issues of nuisance smoke have led to increased regulation.

The U.S. Environmental Protection Agency (EPA) has the responsibility under the Clean Air Act to propose, revise and promulgate National Air Quality Standards (NAAQS) for airborne pollutants. Implementation and enforcement of NAAQS are the responsibility of state, local and tribal air pollution agencies. These agencies develop implementation plans which describe techniques and strategies to implement the NAAQS.

New NAAQS for particulate matter have been proposed. The revised standard focuses on particulate matter which are PM-10 and PM-2.5. The EPA claims the added standards for PM-2.5 will provide better health protection. Those with heart and lung problems, including asthma sufferers, particularly among children and the elderly, have been statistically correlated to more health problems than people living in areas with lower PM-2.5 concentrations.

According to the EPA, the new PM-2.5 standard would also improve visibility in wildernesses and national parks designated as Class I air quality. The Clean Air Act Amendments of 1977 specifically mention that visibility should not be impaired by human releases of air pollution. The regulations require action to make reasonable progress toward improving visibility where impairment exists, such as found in some areas of the eastern U.S. and in many areas of the western U.S. The PM-2.5 size class of particles are primarily responsible for visibility impairment (regional haze) in Class I areas.

Roadway Hazards and Smoke-related Accidents

In the southern United States, there exists an extensive road network that connects the many cities, towns and villages that grew up in the old agricultural South. As population increases and the number of tourists driving to resort areas increases, the number of highway accidents related to smoke and smoke/fog could also increase. Visibility reductions caused by smoke or a combination of smoke and fog already have been implicated in multiple-car pileups, numerous physical injuries, heavy property damage and fatalities.

Most of the serious accidents have occurred at night or around sunrise, as smoke trapped in stream valleys and basins is carried across roadways. Several attempts have been made to compile records of smoke-implicated highway accidents. The available accident data is admittedly incomplete. The most comprehensive study was undertaken by Mobley (1989) for the 10-year period from 1979 to 1988. He reported 28 fatalities, more than 60 serious injuries, numerous minor injuries and millions of dollars in lawsuits. Using less-complete data from 1989 to March 1991, Mobley recorded five additional fatalities.

During the period from October 1996 through June 1997, eight smoke on the highway incidents that ranged from minor accidents to road closures were reported in South Carolina. The record was admittedly incomplete. Based on South Carolina data, similar smoke incident frequencies can be estimated for other southern states. If the South Carolina data are modified for areas devoted to forestry and agriculture in other states, the number of smoke-induced highway incidents throughout the South can be estimated conservatively to be more than 150 annually.

We also examined legal computer data bases (Westlaw and Lexis/Nexis) to identify published judicial decisions involving any alleged problems associated with prescribed burning conducted in conjunction with forestry management operations. This investigation does not reveal all cases on the subject. On the state level, many trial court level decisions are not reported (on Westlaw, Lexus, or any other readily accessible source). The outcomes of these cases often are reported only if trial court level decisions are appealed and there is a

resulting decision on appeal prior to settlement. In federal courts, not every decision of the trial court (i.e., district court) is reported. Additionally, the majority of cases filed in state and/or federal courts are settled prior to trial; thus, there are no reported decisions for these cases.

The primary legal theories that could be associated with a lawsuit alleging that smoke or fire from a controlled burn caused damage include, but are not limited to:

- *Negligence*—based on the allegation that the controlled burn was conducted in an unreasonable manner causing damage.
- *Nuisance*—based on the allegation that the controlled burn was conducted in an unreasonable manner that interfered with another person's use and enjoyment of their property.
- *Strict Liability*—based on the allegation that controlled burning is an ultrahazardous and/or inherently dangerous activity, and this activity caused damage.
- *Trespass*—based on the allegation that the defendant intentionally, willfully and/or with reckless disregard caused fire or smoke to invade a neighboring property, thereby causing damage.

Reported cases directly involving prescribed burns in the forestry setting are limited. These cases primarily involve instances where fire from a prescribed burn escaped the controlled setting and damaged adjacent property, or where smoke from the controlled burn drifted across a road or highway, obscured drivers' vision and resulted in an accident. The issues in these cases generally appear to be whether the damage occurred as a result of unreasonable behavior (i.e., negligence) on the part of the individuals responsible for controlling the prescribed burn.

Increasing Demand for Habitat Management

Pressing the gas pedal in the second car is growth in the need for prescribed burning of southern forestland. Prescribed fire is a tool of choice for managing forests for game and non-game wildlife (Landers 1987). Prescribed fire eliminates species that compete for nutrients and reduces buildup of dead and live fuels that increase the hazard of destructive wildfire.

The Endangered Species Act requires land managers to manage habitat to preserve or increase populations of threatened and endangered species. For fire-dependent ecosystems such as longleaf pine this means an expansion of prescribed burning. For example, prescribed fire is used in the coastal plains and Piedmont regions of the Southeast to improve habitat for the endangered red-cockaded woodpecker (*Picoides borealis* Vieillot).

Another example of the pending collision between conflicting legislation is found in the Southern Appalachians. There, a low-growing shrub species called *Hudsonia montana* Nuttall is listed as a threatened species under the Endangered Species Act. *H. montana* is dependent upon fire for survival. Including prescribed burning in a recovery plan would be straightforward except that the largest populations of *H. montana* are found within and adjacent to the Linville Gorge Wilderness, a Class I area.

Rebuilding the Road

Policy

The EPA recognizes that conflicts between resource objectives and air quality objectives can exist. Therefore, the agency released a draft wildland fire/air quality policy in late 1997. If implemented, state and local air pollution control agencies could establish smoke management programs. Burn plans provided by the land management agency would be used by the air pollution control agency before a burn is authorized. The EPA would then use its discretion not to designate an area as nonatainment if a prescribed burn significantly contributed to a PM-2.5 or PM-10 NAAQS violation, and the air pollution control agency authorized the burn under a smoke management plan. Implementation of EPA policy should allow land managers to achieve their resource objectives, but the resource agencies will need to work even more closely with air pollution control agencies so that public health and welfare are protected from the harmful effects of air pollution.

A number of southern states (Alabama, Georgia, Mississippi, Florida) have adopted new legislation aimed at reducing the liability of "certified" prescribed burners. To become certified, a burner must attend training and pass an examination. Some of these laws contain language that asserts a landowner's right to use prescribed burning. For example, Alabama's new law (1995) declares, "that the application of prescribed burning is a landowner's property right and a land management tool that benefits the safety of the public, the environment, the natural resources, and the economy of Alabama ...."

Science and Technology

Unless more prescribed burning is done during marginal burn conditions, increasing the use of prescribed fire for managing fire-dependent ecosystems will add smoke to that already produced by existing burning programs. There will be either an increase of atmospheric "loading" of smoke leading to NAAQS violations during favorable burn periods or a decrease in overall burning as various agencies compete for available burn times. The probability of

smoke "incidents" (NAAQS violations, nuisance complaints or highway accidents) rises in either case. Thus, for the South, the Clean Air Act (less smoke) meets head-on with the Threatened and Endangered Species Act (more fire).

Can science change the road to avoid the collision or to reduce the impact? Clearly, science cannot make smoke go away nor can science produce a forestry burn that does not produce smoke. However, new developments in science and technology will make available to land managers tools which can significantly improve their management of smoke.

The National Center for Environmental Prediction (NCEP) of the National Weather Service continuously improves the computer models that predict weather over the globe and develops new models as computer resources and other technology permit. In 1998, a new model will become operational that will allow routine resolution of weather systems on a much finer scale than in the past, providing better resolution of wind fields over complex terrain such as mountains and coastlines. More accurate prediction of local winds and timing of wind direction and speed changes will also be possible.

Florida has implemented a pilot study to use a research computer weather model to predict local winds over the state (Herbster 1998). This model is able to resolve the formation and timing of local sea breezes and other winds that frequent the Florida peninsula. Winds generated by this model will be input into smoke dispersion models and made available to land managers, thus giving them information *relevant to the time and location of their specific burn.*

Recognizing that most smoke-implicated personal injury and property damage occurs during highway accidents at night, researchers with the USDA Forest Service have developed PB-Piedmont, a smoke movement model that has successfully tracked smoke moving along the ground at night at scales as fine as 90 feet (30 m) (Achtemeier 1994). The model, which is undergoing user tests, monitors the movement of smoke in real time. A future version will couple with the new NCEP models to give 12- to 24-hour predictions of smoke movement along the ground. Thus, where smoke might go after dark will become a factor in land managers' decisions on whether to burn or where follow-up monitoring may be required.

Plans are to create a Coastal Plain version of the model. PB-Piedmont, PB Coastal Plain and other dispersion models for daytime smoke such as VSMOKE (Lavdas 1996) should give forest managers an additional "edge" in maximizing the number of favorable burn days and minimizing the rise of unfavorable smoke incidents.

Conclusion

A head-on collision involving smoke impacts on air quality is imminent. The collision threatens to curtail the use of prescribed fire for wildlife and

other land management purposes. We have summarized some factors which contribute to the pending collision and some reasons why we can lessen the impact, if not avoid the crash.

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