

Smoke Management

Prescribed burning helps achieve many desired resource objectives, but it nevertheless pollutes the air. We therefore have an obligation to minimize adverse environmental effects. If this obligation is disregarded, prescribed burners can be held liable for damages from accidents or problems resulting from their actions. Use the following guidelines to reduce the impact from smoke.

A. Define objectives.—Be sure you have clear resource objectives and have considered both on-site and off-site environmental impacts.

B. Obtain and use weather and smoke management forecasts.—Weather information, and fire-weather and smoke management forecasts are available to all resource managers through State forestry agencies. Be sure to use them. Such information is needed to predict smoke generation and movement as

well as fire behavior. If the forestry weather outlook does not agree reasonably well with the radio/TV forecast, find out why.

C. Don't burn during pollution alerts or stagnant conditions.—Smoke will tend to stay near the ground and will not disperse readily. Many fire-weather forecasters include this in their regular forecasts.

D. Comply with air pollution control regulations.—Know the regulations that apply at the proposed burn site when you make the prescription. Check with your State fire control agency.

E. Burn when conditions are good for rapid dispersion.—Ideally, the atmosphere should be thermally neutral to slightly unstable so smoke will rise and dissipate, but not so unstable as to cause a control problem. Again, your local forestry agency can help. Some States use Category Day based on the ventilation rate, but

if the Dispersion Index is calculated for your area, it is a better indicator (see table 1). Reassess a decision to burn when the daytime Dispersion Index value is below 41.

F. Use caution when near or upwind of smoke-sensitive areas.—Burning should be done when wind will carry smoke away from public roads, airports, and populated areas. Do not burn if a smoke-sensitive area is within 1/2 mile downwind of the proposed burn.

G. Use caution when smoke-sensitive areas are down drainage.—Minimize the production of residual smoke. Use aggressive mopup as necessary.

Prescribed Fire Reduces Air Pollution From Wildfires

TABLE 1.—Relationship of Dispersion Index to On-the-Ground Burning Conditions

Dispersion Index	Burning conditions
>100	Very good — Burning conditions may be so good that fires may be hazardous and present fire control problems. Reassess decision to burn.
61 - 100	Good — preferred range for prescription burns.
41 - 60	Generally OK — climatological afternoon values in most inland forested areas fall in this range.
21 - 40	Fair — stagnation may be indicated if accompanied by low windspeeds. Reassess decision to burn.
13 - 20	Generally poor — do not burn. Stagnant if persistent, although better than average for a night value.
7 - 12	Poor — do not burn. Stagnant during the day, but near or above average at night.
1 - 6	Very poor — represents the majority of nights at many locations.

H. *Estimate the amount and concentration of smoke you expect to generate.*—This guideline is especially important near highways and populated areas (see table 2). Smoke management guidelines will help you develop this estimate. Some States tie allowable smoke generation to Category Day.

I. *Notify your local fire control office, nearby residents, and adjacent landowners.*—Notification is common courtesy and is required in most areas. People need to know that your burn is not a wildfire. In addition, the burner will get advance notice of any adverse public reaction and be made aware of special problems, such as respiratory ailments, washday, etc.

J. *Use test fires to confirm smoke behavior.*—Set these in or adjacent to the area proposed for burning, away from roads or other edge effects.

K. *Use backing fires when possible.*—Backing fires consume dead fuels more completely and produce less smoke. Even though slower and more expensive, they produce fewer pollutants and restrict visibility less.

L. *Burn during middle of the day when possible.*—Atmospheric conditions for dispersion of smoke will be most favorable.

M. *Consider burning in small blocks if Dispersion Index is below 61.*—The larger the area being burned, the higher the concentration of particulates put into the air, and the longer the duration of the visibility reduction downwind. However, if weather conditions are good for rapid smoke dispersion, e.g., the Dispersion Index is above 60, it is often better to burn the whole area at one time from a smoke management standpoint.

N. *Do not ignite organic soils.*—It is virtually impossible to put out an organic soil fire without submerging it in water. It will smoke for weeks despite control efforts, creating severe smoke problems for miles around. Such fires can also reignite surface fuels, resulting in a wildfire.

O. *Be very cautious of nighttime burning.*—Smoke drift and visibility are very difficult to predict at night. The wind may lessen or stop completely keeping smoke concentrations high in the vicinity of the burn. Burn at night only when you have a definite forecast of optimum conditions. A

TABLE 2--Effect of Smoke Concentration on Visibility

Smoke concentration (micrograms/m ³)	Visibility (miles) ¹
125	2.0 - 8
250	1.0 - 4
500	0.5 - 2
1,000	0.25 - 1

¹These numbers only valid when relative humidity is below 70 percent.

nighttime smoke patrol is often necessary.

P. *Anticipate down-drainage smoke flow.*—Atmospheric conditions tend to become stable at night. Stable conditions tend to keep smoke near the ground. In addition, downslope winds generally prevail at night. Thus, smoke will flow down drainage and concentrate in low areas. When relative humidity rises above 80 percent and smoke is present, the formation of fog becomes increasingly likely as moisture condenses on the smoke particles. There seldom are satisfactory solutions to these problems, so they should be avoided entirely whenever possible.

Q. *Mopup along roads.*—Start mopup along roads as soon as possible to reduce impact on visibility. Extinguish all stumps, snags and logs. Mopup should be particularly aggressive whenever roads are in areas where smoke could travel downslope or up or down a drainage.

R. *Have an emergency plan.*—Be prepared to extinguish a prescribed burn if it is not burning according to plan or if weather conditions change. Have warning signs available. If wind direction changes, be prepared to quickly contact the local law enforcement agency and to direct traffic on affected roads until traffic control personnel arrive.

**Caution: Check For Down
Drainage Smoke Flow At Night!**

Screening System for Managing Smoke

Most southern States have either voluntary or mandatory smoke management guidelines that should be followed when planning a prescribed burn. Your local State forestry office can advise you of recommended or required procedures. Many of these guidelines use a term called the ventilation rate or ventilation factor which estimates the atmosphere's capacity to disperse smoke. Another way to estimate this capacity is to use the Dispersion Index (see table 1) developed at the Southern Forest Fire Laboratory. This calculated index is better able to incorporate diurnal changes in the lower atmosphere.

If you will be burning in a State that has not issued guidelines, use the *Southern Forestry Smoke Management Guidebook* (see Suggested Reading section, second listing under U.S. Department of Agriculture). This guidebook tells you how to predict smoke concentrations at any distance downwind. An improved and computerized version, called *PRESMOK*, simplifies use of this prediction system. Copies are available from the Southern Forest Fire Laboratory. Use of this smoke screening system does *not* take precedence over State guidelines. The full system cannot be discussed here, but an updated version of the Initial Screening System based on the Guidebook is presented below. This system has five steps: (1) Plot direction of the smoke plume, (2) Identify smoke-sensitive areas, (3) Identify critical smoke-sensitive areas, (4) Determine fuel type, and (5) Minimize risk.

Figure A

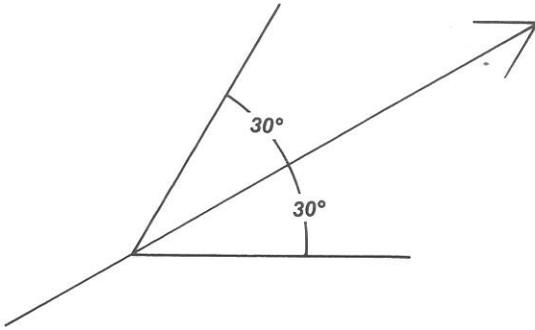
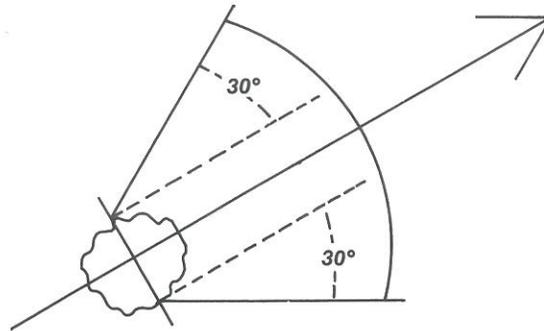


Figure B



Step 1. Plot Direction of the Smoke Plume

- A. Use maps on which the locations of smoke-sensitive areas can be identified. Plot the anticipated downwind smoke movement a distance of: 5 miles for grass fuels regardless of fire type; 10 miles for palmetto-gallberry fuels when using line-backing fires or spot fires; 20 miles for palmetto-gallberry fuels using line-heading fires; 30 miles for all logging debris fires; 5 miles for line backing fires in all other fuel types; and 10 miles for line-heading fires in all other fuel types, or burns of 250 acres or more. First locate the planned burn area on a map and draw a line representing the centerline of the path of the smoke plume (direction of transport wind) for the distance indicated. If the burn will last 3 or more hours, draw another line showing predicted wind direction at completion of the burn.
- B. To allow for horizontal dispersion of smoke as well as shifts in wind direction, draw two other lines from the fire at an angle of 30 degrees from the centerline(s) of observed wind direction (45 degrees if forecast wind direction used). If fire is represented as a spot, draw as in figure A. If larger, draw as in figure B. The result is your probable daytime smoke impact area.
- C. Now go *down-drainage* for one-half the distance determined above, but do not spread out except to cover any valleys or bottoms. The result is your probable nighttime impact area, providing the burn will be completed at least 3 hours before sunset, and providing the forecast night winds are light and variable.

Step 2. Identify Smoke-Sensitive Areas

Identify and mark any smoke-sensitive areas (such as airports, highways, communities, recreation areas, schools, hospitals, and factories) within the impact zone plotted in step 1. These areas are potential targets for smoke from your burn.

- A. If *no* potential targets are found, you may burn as prescribed.
- B. If the area to be burned contains organic soils that are likely to ignite, do not burn.
- C. If any targets are found, continue this screening system.

Step 3. Identify Critical Smoke-Sensitive Areas

- A. Critical smoke-sensitive areas are:
 - 1. Those that already have an air pollution or visibility problem.
 - 2. Those within the probable smoke impact area as determined below. If the distance determined in step 1 was:
 - a) 5 miles, any smoke-sensitive area within 1/2 mile is critical, both downwind and down-drainage.
 - b) 10 miles, any smoke-sensitive area within 1 mile is critical.
 - c) 20 miles, any smoke-sensitive area within 2 miles is critical.
 - d) 30 miles, any smoke-sensitive area within 3 miles is critical.
- B. If any critical smoke-sensitive areas are located, **DO NOT BURN** under present prescription!
 - 1. Prescribe a new wind direction that will avoid such targets and return to the beginning of this screening system, or
 - 2. If smoke-sensitive area is in last half of distance criteria, reduce

the size of the area to be burned by approximately one half, complete burn at least 3 hours before sunset, and aggressively mopup and monitor, or

- 3. Use an alternative other than burning.

- C. If no critical smoke-sensitive areas are found, or criteria B1 or B2 is met, continue the screening system.

Step 4. Determine Fuel Type

The smoke produced may vary greatly by type, amount, and condition of fuel consumed.

- A. From the list below determine which broad type best fits your fuel.
 - 1. Grass (with pine overstory)
 - 2. Light brush
 - 3. Pine needle litter
 - 4. Palmetto-gallberry
 - 5. Windrowed logging debris
 - 6. Scattered logging debris or small dry piles
- B. Review fuel categories or combinations.
 - 1. If the fuel type is described by one of the above categories, continue.
 - 2. If your fuel type is not comparable to any of the above, pick the fuel type for which fire behavior and smoke production most nearly compare with yours and proceed with **EXTREME CAUTION** on the first few burns.
- C. If the fuel type is windrowed logging debris, and you have identified smoke-sensitive areas, **DO NOT BURN** under present prescription. Smoke production is great and can last for weeks.

1. Prescribe a new wind direction to avoid *all* smoke-sensitive areas and return to the beginning of the system.
 2. If you cannot avoid all smoke-sensitive areas, you will need a better procedure than this simple screening system. Refer to the *Southern Forestry Smoke Management Guidebook* or use *PRESMOK*.
- D. If the fuel type is scattered logging debris or small, essentially dirt-free, dry piles, the following conditions should be met:
1. Size of area to burn less than 100 acres.
 2. No major highways within 5 miles down drainage.
 3. No other smoke-sensitive areas within 3 miles down drainage.
 4. If relative humidity is predicted to stay below 80 percent and surface winds above 4 m.p.h. all night, the distances in 2 and 3 above can be cut in half.
- E. If your comparable fuel type is one listed in 4A above, determine your total per-acre fuel loading. See below or *Southern Forestry Smoke Management Guidebook* for tables to assist you.
1. If less than 10 tons per acre, continue. Generally, the *total* fuel loading will be less than 10 tons in the fuel types listed below when age of rough is:
 - a. Grass (with pine overstory), any age. Also wheat fields and other agricultural burns.
 - b. Light brush, 7 years old or less (10 years if basal area is under 100 square feet per acre).
 - c. Loblolly pine with
 - a. palmetto-gallberry understory, 7 years or less if basal area is under 150 square feet per acre.
 - b. little or no understory, 15 years or less if basal area is under 150 square feet per acre.
 - d. Slash pine with
 - a. palmetto-gallberry understory, 5 years or less if basal area is under 150 square feet per acre.
 - b. little or no understory, 8 years or less if basal area is under 150 square feet per acre.
 2. If greater than 10 tons per acre, refer to the *Southern Forestry Smoke Management Guidebook* or double the distance determined in step 1A. Use 1 1/2 times the distance if close to 10 tons.

Step 5. Minimize Risk

To meet your smoke management obligations when any smoke-sensitive area may be affected by your burn, you *must* meet all of the following criteria to minimize any possible adverse effects.

- Height of mixing layer (mixing height) is 1,650 feet (500 meters) or greater.
- Transport windspeed is 9 mph (4 meters per second) or greater.
- Background visibility is at least 5 miles within the plotted area.
- If rough is older than 2 years, use a backing fire. If burn can be completed 3 hours before sunset, or if no smoke-sensitive areas are located in the first half of the impact area, other firing techniques can be used.
- Promptly mopup and monitor to minimize smoke hazards.
- If a smoke-sensitive area is in the overlapping trajectory of two smoke plumes, it should be 1 mile from either source (2 miles if one is from logging debris).
- For night burns, backing fires with surface windspeed greater than 4 mph and relative humidity under 80 percent should be prescribed.
- If it appears that stumps, snags, or logs may cause a residual smoke problem, take steps to keep them from burning. If they do ignite, extinguish them.
- Daytime value of the Dispersion Index between 41 and 60 is adequate for small fires and low levels of burning activity. As either size of individual fires or level of burning activity increases, the Dispersion Index value should also increase.

Many variables affect the behavior and resulting smoke from a prescribed burn. The above system works best in flat terrain and was not designed for use in mountainous country. It does not attempt to consider all the variables: it can only offer broad guidelines. If your prescribed fire complies with all conditions in these five steps, you should be able to safely burn without causing a smoke problem. If you have any marginal answers, areas that are especially sensitive to smoke, heavy fuel loadings or wet fuels, use the prediction system mentioned in the *Southern Forestry Smoke Management Guidebook*. You must make the final judgement.

CAUTION: Be Sure Atmospheric Conditions Are Conducive To Good Dispersion!
