SEARCH and RESCUE DOGS TECHNICAL NOTE

SCENT TRANSPORT AND DIFFUSION

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The transport of scent through the air is essential in the airscenting process. As scent is transported it is mixed with surrounding air and diffused or diluted till it reaches a level at some distance from the source where it is no longer perceptible to the dog. Diffusion of scent is affected by (1) vertical mixing from convection turbulence, eddying, and plume rise from convective lift; (2) lateral mixing and spread from changing wind direction and gustiness; and (3) by removal processes such as sedimentation (fallout), washout (rain, snow), sinks, and absorption by vegetation.

Dog handlers need to recognize atmospheric conditions that contribute to diffusion so that they can beter judge the ease or difficulty with which their dogs can perform and then adjust their search patterns accordingly.

Convectional turbulence

That part of the atmosphere located at the surface consists of a boundary layer that varies in depth according to meteorologic conditions. The depth or height of this layer is referred to as the “mixing height.” National Weather Service Forecast offices can supply the height of the mixing layer. The greater the height, the more volume of air available for mixing and the more quickly scent can be diffused.

Atmospheric turbulence is influenced by the velocity of the wind as well as the vertical distribution of temperature through the boundary layer. The latter determines the stability of the air. The more unstable the air, the more difficult (more looping of plumes, more diffusion) will be the airscenting conditions. (See SAR Dog Technical Note No. 2)

Since surface wind speed tends to overcome convective rise, vertical mixing is lessened at higher wind speeds. Cloud cover and cloud height along with the angle of the sun also have a great effect on air stability.

The following table derived from Pasquill, as modified by Lavdas, indicates in general terms the stability class at a given time. It may be seen that on clear summer days with little wind when the sun is more directly overhead, the air is highly unstable and scent will be diffused most rapidly. Sectors searched under these conditions should be considered for rechecking under better conditions. Better still, search early and late and give your dog a break during mid-day in June and July. Except on south-facing slopes, handlers in Alaska will find longer shadows (probably never less than 3.5')and probably have much less instability.

Table 1 - Stability estimating method

Surface Windspeed (mph)	DAY									NIGHT	
	Clear or 50% or less cloud cover w/low clouds; or any high clouds			More than 50% low & mid clouds			More than 50% low clouds			50% or more cloud cover w/low & mid clouds or high over-cast	Clear or less than 50% cloud cover w/low & middle clouds
	6-foot vertical standard shadow length (in feet)										
	Less than 3.5	3.5 to 8.5	Greater than 8.5	Less than 3.5	3.5 to 8.5	Greater than 8.5	Less than 3.5	3.5 to 8.5	Greater than 8.5		
Less than 4	**A**	**A-B**	**B**	**A-B**	**B**	**D**	**B**	**D**	**D**		
4-7	**A-B**	**B**	**C**	**B**	**C**	**D**	**C**	**D**	**D**	**E**	**F**
8-10	**B**	**B-C**	**C**	**B-C**	**C**	**D**	**C**	**D**	**D**	**D**	**E**
11-14	**C**	**C-D**	**D**	**C-D**	**D**	**D**	**D**	**D**	**D**	**D**	**D**
More than 14	**C**	**D**	**D**	**D**	**D**	**D**	**D**	**D**	**D**	**D**	**D**

After Pasquill (1975), with insolation estimates incorporating shadow length and cloud cover after Lavdas (1976).

<u>How to use the Table:</u>

1. Locate main column head for Day or Night. (Night applies from 1 hour before sunset to 1 hour after sunrise.)
2. Locate subcolumn head for cloud cover.
3. If for Day, locate sub-subcolumn for shadow length.
4. Locate row for surface windspeed.
5. In row and under column, read stability class category.

Example: Day with more than 50% low and mid clouds and shadow length less than 3.5 feet and with windspeed 8 to 10 mph, read stability class B-C.

Pasquill’s data indicate the wide difference in concentration of pollution (scent) with differences in air stability. Lateral spread and gustiness are greater in unstable conditions and are included in these calculations. At 100 meters from the source and with constant wind speed, the scent is approximately 40 times more dispersed under A class conditions than at F, about four times more so than at C. The relative concentrations of the different stability categories are:

A = .025
B = .050
C = .100
D = .250
E = .400
F = 1.00

Is it any wonder dogs do better on some days than others?

Eddying

Mechanical turbulence caused by surface variations—hills, treelines, buildings, etc. are described in Syrotuck's *Scent and the Scenting Dog* and Bryson's *Search and Rescue Dog Training.* We will deal with these effects in more detail in a later paper. For purposes of this discussion, the more violent the eddies, usually caused by stronger winds, the more mixing that will occur.

Plume rise from convective lift

On a still day with stable air conditions, the scent plume will be affected by the surrounding (ambient) air temperature. If the air is cooler than the scent particles and vapors released by the victim, there will be a convective lift of the scent plume for several feet as heat is released by the scent until it reaches equilibrium with the ambient air. The scent plume will then lose its columnar form and fan out and remain above the ground. On very warm days (85°+)with cloud cover (stable air)there will be no plume rise and scent will fan out at ground level.

Atmospheric stability is an important variable at all times but the heat release rate may be important on clear, cold nights or days—especially with little wind. Winds tend to push and bend or shear the column and restrict the total possible plume rise. Strong winds may push the column nerly horizontally until all the heat is release and no more convective lift occurs.

Deposition of airborne scent material

Scent material may be in the form of solid particles large enough for sedimentation and deposition to occur, or in the form of gases and vapors which are absorbed by vegetation and other surfaces.

Deposition of airborne scent on the ground may occur in three ways—general sedimention of particles: retention at the ground surface by processes such as impaction and absorption, with subsequent downward turbulent transport to the *sink* thereby formed; and washout of the scent material in association with rain, snow,etc. In depleting the plume of scent material, all three mechanisms ultimately hasten the reduction of airborne concentration otherwise occurring by diffusion, but the associated contamination of the ground surface and, in the case of sedimentation, the possibility of increasing the concentration close to the source, represent additional opportunities of practical importance (e.g. trailing).

Sedimentation

Studies have shown that plumes of scent with little vertical rise (fanning, coning, fumigating) lead ot higher rates of deposition over a narrower band downwind than rising plumes (looping and lofting).

Retention of small particles and gases at the ground

Studies with spores and with radioactive iodine have shown an increase in deposition where similar material has already been absorbed. This would indicate that over time scent would build up in these *sink* locations. In conducting these studies it was found that grass had deposition velocities (rates of deposition) three times those on the horizontal surfaces used for collection.

Washout by rain, etc.

Scent materials are washed out by collision with falling drops and swept clear by the stream-lines around the drop. The collection efficiency, as might be expected, increases with the rate of rainfall; it also increases with the terminal velocity of the raindrops which is a function of size. A heavy cloudburst or gullywasher will washout more scent than a light mist.

Trapping of scent in vegetation

Little quantitative information exists on gas exchange in the leaves of various types of vegetative overstory and undergrowth. We do know stomata (pores) in the leaves open in the day and take in air and its contents. Carbon dioxide is used by the plant in its photosynthetic process. How other gases and scent particles may be affected is not known, although it is assumed that some of them are trapped or significantly changed by this process.

The stomata close at night. Opening, in the morning, takes about one hour. Closing is faster. On hot days, as a moisture conservation mechanism, plant stomata close. This usually occurs at temperatures of 86° to 95°F (30-35°C).

References:

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