EFFECT OF ORGANIC LAYER MOISTURE ON PRESCRIBED BURNING

by

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DEPARTMENT OF FORESTRY
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FORESTRY BRANCH
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In 1967, extensive loss resulted from escaped slash fires on Vancouver Island. Conditions at the beginning of the slash burning period seemed normal and unusual patterns of fire behaviour were not anticipated. Rain had alleviated summer drought, humidity was increasing, cooler temperatures prevailed and appreciable nighttime recovery of relative humidity was occurring; fire danger was low. While the obvious conditions that signify "safe" burning were present, the moisture content of the organic layer was not typical of a normal season, due to the summer drought.

The summer drought of 1967 caused the entire organic layer to become abnormally dry. In early September there were several days of heavy rain within a short period of time which seemingly replenished the organic moisture content to a near normal level.

Table 1 shows rainfall values for four weather stations in the area north of Sooke, B. C.

Table 1. Rainfall Values in Inches September 1-15

Date	Empress Lookout 1/	Shepherd Lookout 1/	Bear Creek Reservoir Dam 2/	Sooke Lake North 2/
September 1	0.25	0.24	1.94	0.17
2	-	-	-	-
3	-	-	-	-
4	-	-	-	-
5	0.36	0.41	0.87	0.47
6	-	-	-	-
7	-	-	-	-
8	0.20	0.14	-	0.15
9	0.32	0.33	-	0.60
10	0.92	1.17	2.16 3/	0.62
11	-	-	-	-
12	-	-	-	-
13	-	-	-	-
14	-	-	-	-
15	-	-	-	-

1/ British Columbia Forest Service - Protection Division.

2/ Department of Transport - Meteorological Branch.

3/ Cumulative total for September 8, 9 and 10.

Following the rains the weather cleared and during the next few days there was seemingly normal drying conditions. Another storm was implied within 72 hours and because forest operators felt this might be the last chance in the year for burning, a number of areas were ignited on the 12th, 13th and 14th. The expected storm did not materialize, instead continuation of an extreme drying regime prevailed. Effect of the summer drought and the rapid drying of the organic layer after the rains were important factors contributing to the escape and subsequent control difficulties of fires ignited on the above days.

Ordinarily, if the predicted storm had not materialized, the fires probably would not have escaped, but if escape did occur, control would have been easy. Instead the fires escaped causing considerable damage and were extremely costly to control.

The abnormally low moisture content of the lower organic layer and the coarse fuels was directly responsible for the erratic fire behaviour. Organic materials in various stages of decomposition form a mantle on the mineral soil. It is composed of three separate layers; the upper one composed of fine and generally loose materials, a mid-layer which is partially compacted and decomposed and a lower layer that is heavily compacted and almost completely decomposed. The total depth of the organic layer may vary from a few inches to several feet and is commonly referred to as duff.

Other forest fuels are grouped into three classes; fine fuels (twigs, needles, etc.) whose moisture content fluctuates rapidly and is influenced by changes in relative humidity, medium fuels (limbs, sticks, etc.) whose moisture content is influenced by seasonal moisture patterns and coarse fuels (logs, etc.) whose moisture content changes slowly and cumulatively over long periods of time. The three layers of duff can be classed into the three fuel categories:

Fuel class		Duff layer
fine	-------	upper
medium	-------	middle
coarse	-------	lower

The basis of classification is ignition and moisture characteristics. Therefore the lower layer can often be used as an analogue of the coarse fuel condition.

The summer drought of 1967 reduced the moisture content of large fuels to an extremely low level. Evidence of this is the number of large fires and the high fire intensities developed. Early September rains, although heavy, occurred over a short period, thereby allowing much of the moisture to be lost to runoff, interception and evaporation. Fine and medium class fuels, including the upper and middle duff layers, had high moisture contents resulting from the rains. The coarse fuels, including the lower duff layer, were scarcely affected. The subsequent dry weather caused a rapid decrease in fuel moisture content of the fine fuel. Therefore at the time the fires were ignited the fine fuels were dry and inflammable. The middle layer of duff and the medium fuels were "wet" and would not ignite or burn readily. The large coarse fuels, and the lower duff layer, were much drier than normal. Figure 1 shows a profile of the organic layer moisture content that existed on September 28, 1967, north of Sooke, B. C. both in the open and in an adjacent stand of timber. Figure 2 shows a normal moisture profile for a season without severe summer drought or if the same quantity of rain had been extended over a two week period allowing the relative humidity increase to have an effect and to prevent excessive runoff and evaporation.

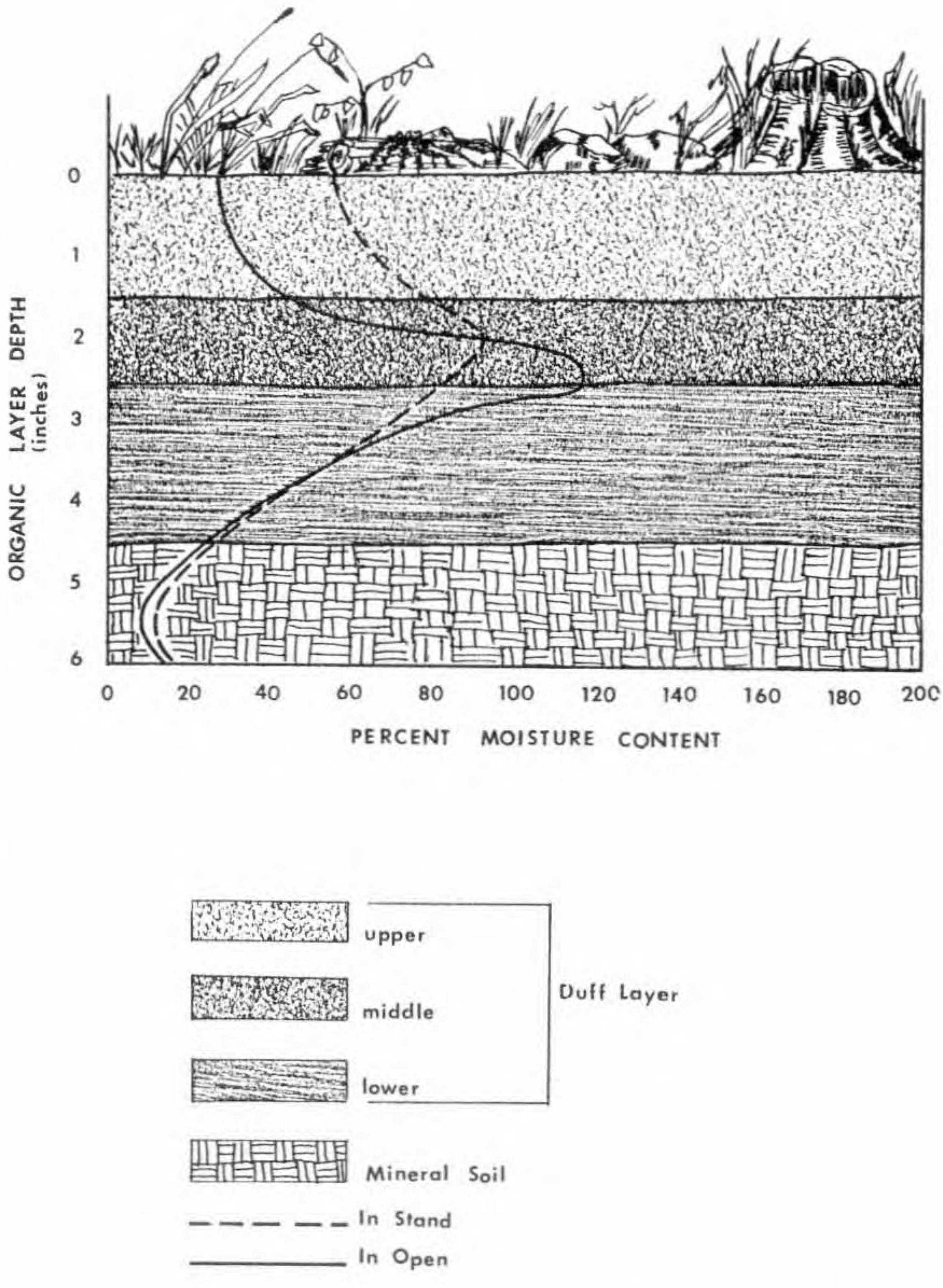

Figure 1. Percent moisture content of the organic layer in relation to depth. September 28, 1967, north of Sooke, B. C.

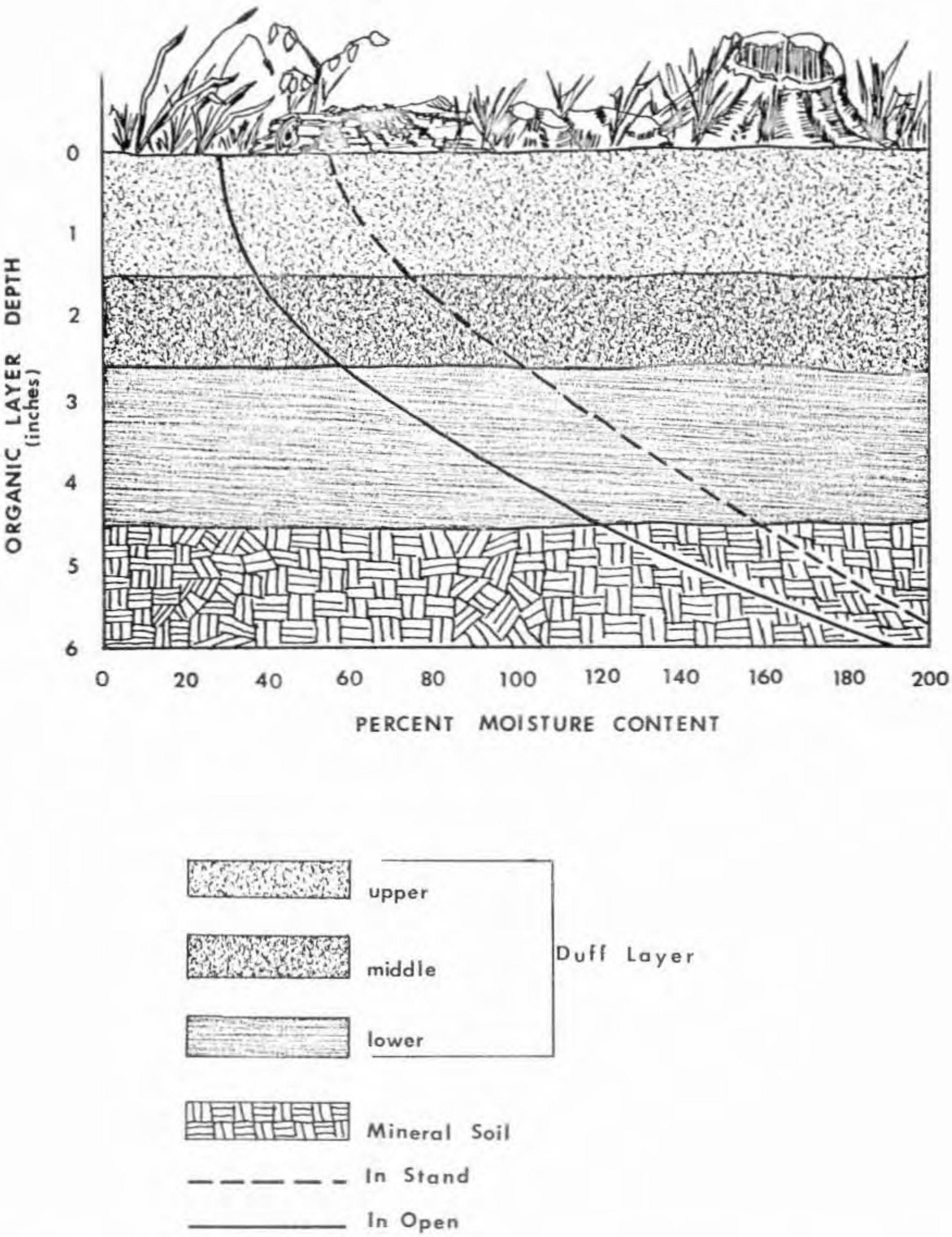

Figure 2. Percent moisture content of the organic layer in relation to depth under normal conditions, theoretical curve.

Table 2 shows the moisture content values on September 28, 1967.

Table 2. Moisture Content of Organic Layer [4/]

Layer		Depth from surface (inches)	Moisture Content (percent)
In open	upper	0.0 - 1.5	28.7
	middle	1.5 - 3.0	110.1
	lower	3.0 - 4.5	41.2
In stand	upper	0.0 - 1.5	55.8
	middle	1.5 - 3.0	93.0
	lower	3.0 - 4.5	52.3
	mineral soil	5.0 - 5.5	13.2

[4/] September 28, 1967; 11:00 PDT: near ridge-top east of west fork of Leech River; south west aspect; 10 percent slope. Data collected by S. J. Muraro and R. C. Henderson.

Effect of the abnormal organic layer moisture profile was not apparent at the onset of the burning. All operators were satisfied with the behaviour of their fires until the morning of September 15, 1967. The rapid surface fires consumed the upper duff layer and other fine fuels, then appeared to be extinguished. Neither the middle duff layer nor medium and coarse fuels burned. However, in spots, after a few hours (many cases, days) the fire smouldered through the middle layer and into the lower and more combustible layer. Figure 3 illustrates how the fires smouldered into the lower organic layer.

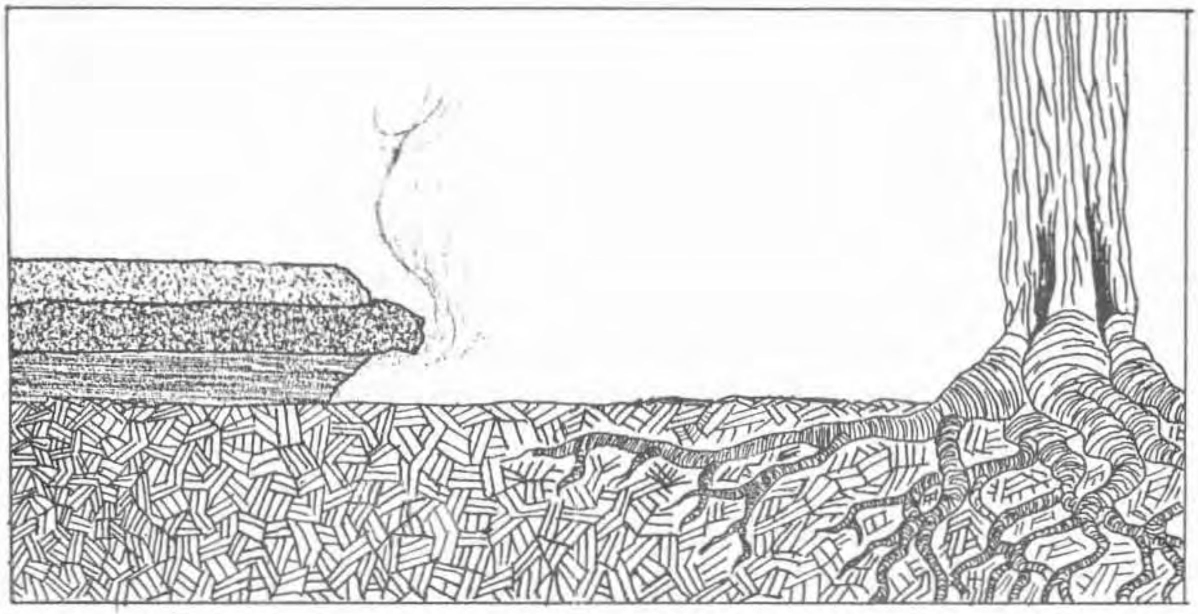

Figure 3. Smouldering Fire. Note that the outline of burned material resembles the organic moisture profile illustrated in Figure 1.

During the afternoon of September 15th, high winds increased smouldering in the lower duff layer. The wind also increased drying of medium fuels and the middle duff layer. These fuels subsequently ignited and, with the help of high winds, ignited the coarse fuels causing the fire to rampage out of control.

It is desirable to burn a clearcut area when it is surrounded by a region of less danger. This may be a mineral soil fire-guard or a forested area. Generally, higher fuel moisture contents prevail within a stand than in the open. Under normal conditions fuel in a clearcut area is contained in a "dish-like" zone of moisture. This zone occurs below the fuel as well as around it. Figure 4 illustrates the normal condition and the condition that existed during mid and latter September. The ideal "dish-like" zone of moisture was not present during September, but instead the "dish" was inverted.

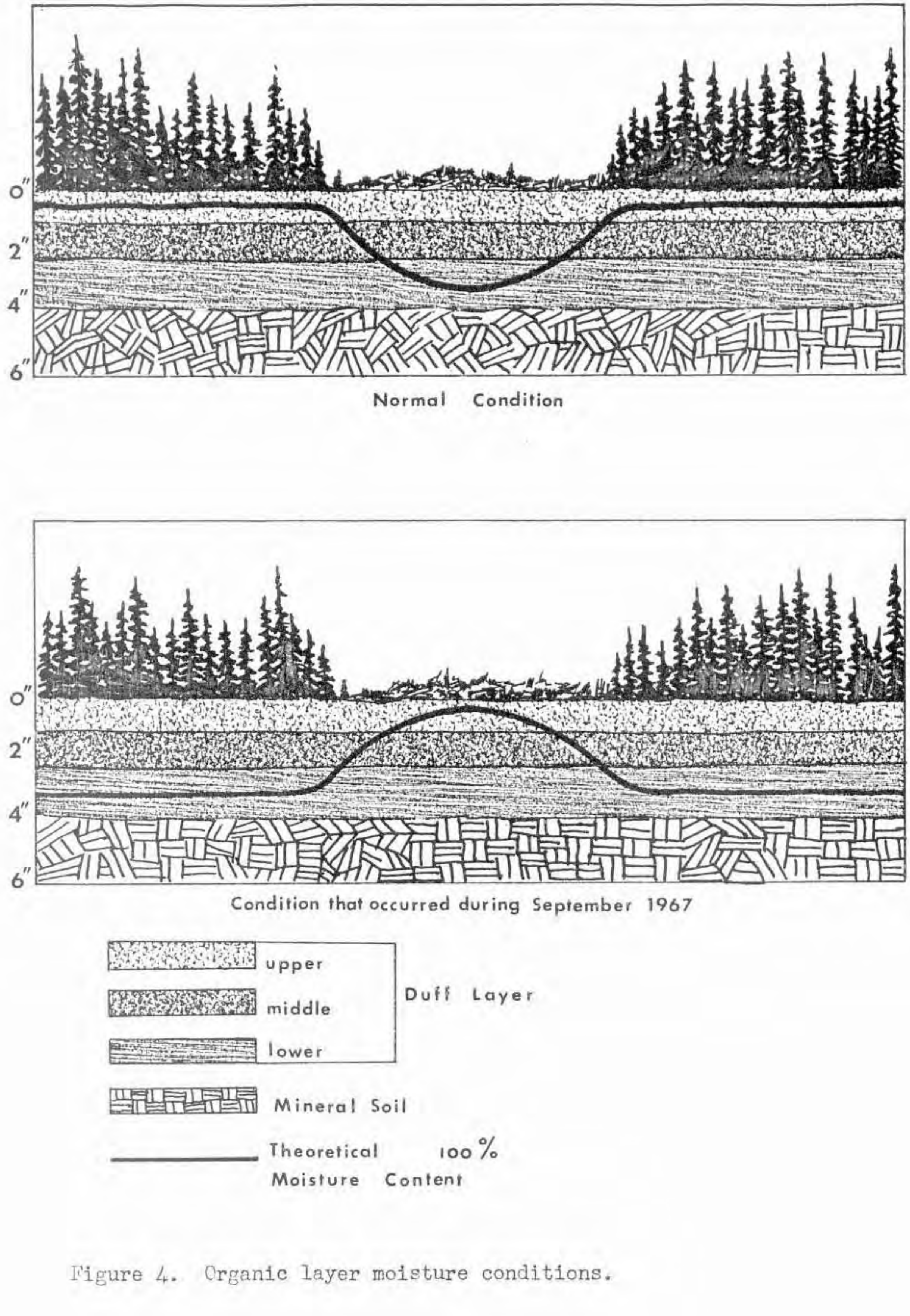

Figure 4. Organic layer moisture conditions.

Because moisture content of organic fuels is directly related to fire behaviour, it must be evaluated for fire danger prediction. Since accurate fuel moisture measurements are time consuming and expensive to obtain, the following operational procedure is suggested. Dig through the organic layer exposing the mineral soil. If the mineral soil and the lower duff layer is dry and the upper layers are moist, it is probable that burning is unsafe, unless extra control measures are taken. This method is highly subjective but as long as moisture content increases with depth, at least to the mineral soil, subsequent control problems will be minimized.