# WILDLAND FIRE OCCURRENCE IN CANADA

## Errata

There must exist an irrefutable law to the effect that regardless of the number of times a manuscript is reviewed or the number of persons involved, the final error will not be detected until after publication. Further, the error will be so blatant that the failure to detect it will be incomprehensible to all involved. One can criticize the draftsman for making the original error; in some cases, the typesetter for perpetuating it; and the proofreaders for not finding it. Ultimately, however, it is the author who is judged by the quality or lack thereof of the material to which his name is affixed. While the quality of the map is less than desired, the considerable expense that would have to be borne by the Canadian taxpayer for reprinting is not justified. It was, therefore, decided to release the map for distribution as is. Responsibility for all errors of commission or omission is accepted by the author.

The following errors have been noted:

Geralton should be Geraldton
Ennadi should be Ennadai
Grand Prairie should be Grande Prairie

The last five lines of the next-to-last paragraph should be deleted.

A. J. Simard

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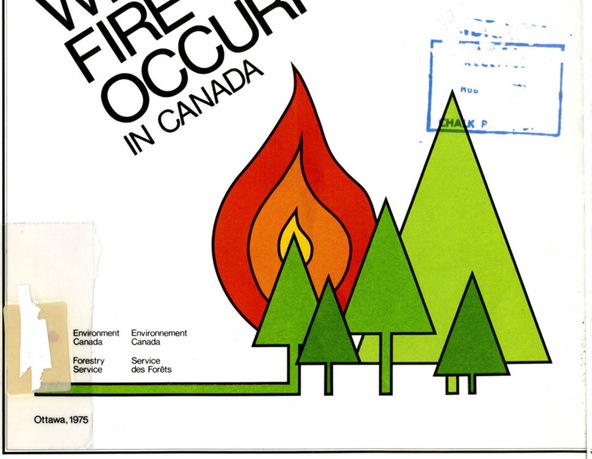
by A. Simard




Environment Canada / Environnement Canada

Forestry Service / Service des Forêts

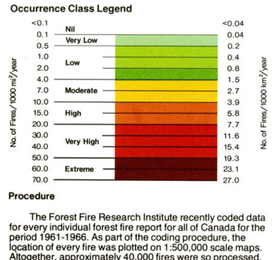
Ottawa, 1975

## Introduction

Man has been attempting to manage wildland fires for over half a century. Recognizing that information is the lifeblood of management, a great mass of data relating to wildland fires has been accumulated. Information can be divided into two classes — that which describes the process itself and that which is needed to manage it. Since we must describe a process before we can manage it, the most fundamental type of information is descriptive in nature.

Two types of information are needed to describe wildland fires: fire occurrence and fire behaviour. Fire occurrence involves questions such as when, where and how many fires occur. Fire behaviour considers rate of spread and fire intensity which are, in turn, related to weather, fuels and topography. This is the second in a series of reports whose purpose is to describe the wildland fire situation across Canada. The first dealt with fire weather zones of Canada[1]. In this report we will consider fire occurrence — specifically the number of fires that have been recorded and where they have occurred.

### Occurrence Class Legend




## Procedure

The Forest Fire Research Institute recently coded data for every individual forest fire report for all of Canada for the period 1961-1966. As part of the coding procedure, the location of every fire was plotted on 1:500,000 scale maps. Altogether, approximately 40,000 fires were so processed. Even a casual examination of the maps disclosed very pronounced patterns to the distribution of fires. The influence of man's activities was unmistakable. The predominant feature was the clustering of fires around population centres. Second in predominance were bands of fire along roads. Lastly, many lakeshores and river valleys had higher occurrence densities than surrounding areas. Interestingly, these patterns were readily discernible despite the fact that lightning fires had not been removed from the sample, indicating the preponderance of man-caused fires.

Every fire management organization in Canada maintains pin maps showing fire locations for current seasons. Seasonal maps show predominant patterns such as those described above. Few organizations maintain these maps for more than one season however. As a result, many of the more subtle occurrence patterns would not be evident. Further, this type of information has never before been presented graphically at a national level. Thus, it seemed logical that a fire occurrence map for Canada should be prepared.

Preparation was a straight-forward process. First, the country was divided into cells. Since the fires were plotted on standard topographic maps, the grid pattern was based on latitude and longitude. The fact that the maps were gridded at thirty minute intervals influenced the choice of cell size. Fortunately, a cell size of thirty minutes on each side was considered appropriate for a Canada-wide map.

The second step was to count the number of fires in each cell. Third, the counts were converted to average number of fires per thousand square miles per year. The conversion factor was A/6, where A adjusted the count to a cell of 1000 square miles[2] and the division reduced the six year sample to a single season. Since the cell area varied from a low of 421 square miles at 70° N to a high of 862 square miles at 45° N, a separate adjustment factor was calculated for each 30 minutes of latitude. For example, at 45° – 00′ N, A = 1.1605 while at 70° – 00′ N, A = 2.3744.

Areas covered by water were not deleted from the cell area. To do so would have required a considerable effort to measure the area involved. Further, the question of a minimum water area to consider would have had to be resolved. Thus, there may be some anomalies in the number of fires in cells where a significant percentage of the area is covered by water. This potential problem is restricted to coast lines and the shores of large lakes. This problem was subjectively considered when the contour lines were being drawn.

Finally, the contour lines were drawn, connecting points of equal fire occurrence density. A progressively increasing contour interval was chosen rather than a more traditionally uniform interval. A uniform interval which displayed adequate detail at low occurrence densities required far too many contour lines at higher densities. Conversely, an appropriate interval for high densities displayed no information at all over most of Canada. After trial and error, a set of fourteen contours was selected as being most appropriate for displaying Canada-wide fire occurrence data. They are: (in terms of number of fires per 1000 square miles per year): 0.1,0.5, 1, 2, 4, 7, 10, 15, 20, 30, 40, 50, 60, 70. Additionally, as an aid to visualizing the occurrence patterns, the intervals were grouped into "zones" with each zone assigned a different color: less than 0.1,0.1- 0.5, 0.5-2, 2-4, 4-10, 10-20, 20-50, and more than 50.

## Results

Wildland fire occurrence ranges from a low of zero to a high of an average of 73 fires per 1000 square miles per year. In general, low fire occurrence densities (less than 4 fires per 1000 square miles per year) are found throughout the Territories; the northern half of British Columbia, Alberta, Saskatchewan and Manitoba; the northern two-thirds of Quebec and Ontario; most of Newfoundland and all of Labrador. Not surprisingly, these are also regions of relatively low population and road density. In addition, low occurrence densities are found throughout the primarily agricultural regions of Alberta, Saskatchewan, Manitoba, Ontario and Quebec. Finally, there are numerous isolated areas of low occurrence scattered throughout higher occurrence regions across the country.

Moderate occurrence densities (4 to 10 fires per thousand square miles per year) are found throughout Canada. In general, there is a pronounced band of moderate occurrence density starting in the Maritimes and crossing southern Quebec and Ontario. The band becomes discontinous across central Manitoba and Saskatchewan and all but ends in eastern Alberta. Additionally, significant areas of moderate occurrence are found in central Alberta and in southern British Columbia. Finally, isolated areas of moderate occurrence, primarily in the vicinity of population centres, are found throughout generally lower occurrence regions across the country.

The significant areas of high occurrence (10 to 20 fires per 1000 square miles per year) are in the interior valleys of British Columbia, including Vancouver Island, southeastern Ontario and southwestern Quebec and the central Maritimes. Again, there are scattered high occurrence areas in the vicinity of population centres and major highways throughout the generally moderate occurrence regions.

Very high occurrence areas (in excess of 20 fires per 1000 square miles per year) are found primarily in the vicinity of population centres and along roads in southern British Columbia, southern Ontario, western Quebec, the Maritimes and Newfoundland. An exception to the above is a significant general area in southeastern Ontario and southwestern Quebec — a region noted for a high density of recreationists and cottages.

The highest occurrence density in Canada (73 fires per 1000 square miles per year) is in the vicinity of Sudbury, Ontario. This is followed by 53 fires around Halifax, Nova Scotia. With the above two exceptions occurrence densities do not exceed 40 fires per 1000 square miles per year.

Average annual fire occurrence is only one attribute of a many faceted problem. Average fire seasons tend to be exceptions rather than rules. Good and bad years, which deviate significantly from the norm are important, and particularly in the latter case, critical to the fire management organization. Thus, the variance of fire occurrence for each of the plotted contours was determined.

Six years of data were available. Six observations are, at best, marginal for determining a probability distribution. The reliability of the results can be greatly improved however, by determining an average, based on a series of six observations. From previous work[3] fire occurrence data had been tabulated for 609 ground suppression stations across Canada. Thus, 609 samples of 6 observations were available. The stations were classed according to occurrence density and an average distribution for each fire occurrence density was obtained. The results are summarized in Table 1.

The distributions varied little at densities greater than 10 fires per 1000 square miles per year. They ranged from a low of about ½ of the mean to a high of about twice the mean value. Lower occurrence densities for individual stations tended to have a greater variance. At the 0.5 level, the range was from zero to four times the average level. As occurrence density increased, the variance gradually decreased, such that at the 7 contour, the range was from 15% to just slightly over twice the mean value. At all occurrence densities, the mean value occurred at the 60% probability level.

**Table 1**
**Cumulative Probability Distribution for Annual Fire Occurrence for each Occurrence Contour**

| | Average Fire Occurrence Contour | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| No. of Fires/ 1000 mi² | 0.1 | 0.5 | 1 | 2 | 4 | 7 | 10 | 15 | 20 | 30 | 40 | 50 |
| 1000 km² | 0.04 | 0.2 | 0.4 | 0.8 | 1.5 | 2.7 | 3.9 | 5.8 | 7.7 | 11.6 | 15.4 | 19.3 |
| Percent of Years | Number of Fires | | | | | | | | | | | |
| .00 | 0 | 0 | 0 | 0 | 0 | 1 | 3 | 5 | 8 | 11 | 17 | 21 |
| .10 | 0 | 0 | 0 | 0 | 1 | 2 | 4 | 6 | 9 | 14 | 20 | 26 |
| .20 | 0 | 0 | 0 | 0 | 1 | 3 | 5 | 7 | 11 | 17 | 23 | 30 |
| .30 | 0 | 0 | 0 | 0 | 2 | 4 | 6 | 9 | 13 | 20 | 27 | 34 |
| .40 | 0 | 0 | 0 | 1 | 2 | 5 | 7 | 11 | 15 | 23 | 31 | 39 |
| .50 | 0 | 0 | 0 | 1 | 3 | 6 | 8 | 13 | 17 | 27 | 36 | 45 |
| .60 | 0 | 0 | 1 | 2 | 4 | 7 | 10 | 15 | 20 | 31 | 41 | 51 |
| .70 | 0 | 1 | 2 | 3 | 5 | 8 | 12 | 18 | 24 | 35 | 47 | 58 |
| .80 | 1 | 1 | 2 | 4 | 7 | 10 | 14 | 22 | 29 | 42 | 56 | 70 |
| .90 | 1 | 2 | 3 | 5 | 9 | 13 | 18 | 27 | 35 | 52 | 70 | 86 |
| 1.00 | 2 | 2 | 4 | 7 | 12 | 16 | 23 | 34 | 43 | 64 | 85 | 105 |

As a check on the above, distributions were tabulated for 82 forest regions across Canada. Variations of the regional distributions were negligible regardless of density. They closely resembled the distributions for higher occurrence density stations (in excess of 10).

Use of the occurrence probability distributions is as follows: Consider an area close to the 10 contour. From Table 1, it can be seen that in 60% of the fire seasons (6 years out of every 10), 10 or fewer fires per 1000 square miles would occur. At the low end, in 10% of the years 4 or fewer fires would be likely. Further, the occurrence of less than 3 fires in one year is extremely unlikely (though not impossible). At the other end of the range, in 40% of the fire seasons more than 10 fires per 1000 square miles will probably occur. Ten percent of the seasons will have 18 or more fires, while as many as 23 may occur, perhaps once in a century. Finally, it should be noted that an average of, for example, 8 to 12 fires will occur only 30% of the time.

Due to the limited sample and age of the data, the results presented here are likely to be more accurate in a relative than an absolute sense. There is little doubt that some occurrence and frequency patterns have changed in the decade since the six year sample was taken. This is particularly likely in low occurrence regions and in areas to which organized protection has been extended since the time of the sample. The possibility of discrepancies between the results presented here and what is actually happening on the ground today should be taken into consideration when attempting to apply these results. which have been recently developed. The possibility of discrepancies between the results presented here and what is actually happening on the ground today should be taken into consideration when attempting to apply these results.

Despite the deficiencies however, the results reflect the best information currently available. As such, they portray an important aspect of the wildland fire situation — where do the fires occur and how many are there? Such information, when coupled with fire behaviour and fire impact data form a solid foundation upon which fire management decisions can be based.

## Sommaire

Cette carte a été préparée afin d'illustrer les tendances relatives à la fréquence des incendies forestiers à travers le Canada. Les données de base ont été extraites des 40,000 rapports d'incendies complétés au cours des années 1961 à 1966. La préparation de la carte a nécessité trois étapes; soit la détermination du nombre d'incendies à l'intérieure de chaque secteur de 30′ × 30′, le calcul du nombre d'incendies par 1000 miles carrés et une dernière étape qui consistait à relier tous les points ayant la même fréquence d'incendies.

Le carte démontre l'importance de l'homme sur la fréquence des incendies forestiers. D'ailleurs, la plupart des zones les plus durement atteintes se situent à proximité des centres urbains, des principaux centres de récréation en plein air et en bordure des routes. Par contre, les zones ou la fréquence des incendies est peu élevée, si on exclus les régions à caractère essentiellement agricole, sont surtout situées dans les régions à faible densité de population ou difficiles d'accès.

La distribution de probabilité de la fréquence des incendies à été déterminée pour chaque contour. Pour la plupart des contours, le nombre d'incendies susceptibles d'éclater au cours d'une année donnée varie du tiers au double de la valeur moyenne. Enfin, il convient de souligner que les tendances ont peut être changées au cours de la décennie qui s'est écoulée depuis que cette étude a été effectuée. Aussi, une telle possibilité devrait être considérée lors de l'interprétation des données présentées ci-haut.

[1] Simard, A. J., 1973. Forest Fire Weather Zones of Canada, Environment Canada Dept. Pub.

[2] 1 km² = 0.3861 mi²

[3] Simard, A. J., et. al., 1973. Development of Computer Processing Techniques for Individual Forest Fire Report Data, Forest Fire Research Institute, Ottawa, Ontario. Information Report FF-X-40.

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