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Hours of Sunshine and Fire Season Severity over the Vancouver Forest District

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"How effective improved protection measures really are can only be determined if the effect of significant weather factors (of which sunshine is an index) can be found and adjusted for."

Abstract

The accumulated hours of bright sunshine provide a simple index of fire season severity for the southern coastal area of British Columbia. This index, based on the period May 1 to August 31, is highly correlated with the annual acreage burned over the Vancouver Forest District.

By removing that part of the year-by-year deviation in area burned which can be attributed to variations in this weather index, it is possible to see more clearly the effects of other controls on the annual fire load.

The existence of appreciable fluctuations of summer sunshine over periods of the order of decades would suggest that 10-year averages of fire statistics are not long enough to be independent of the effects of weather.

L'ensoleillement et la sévérité de la saison des feux de forêts dans le dictrict forestier de Vancouver

Résumé

L'accumulation des heures d'ensoleillement clair fournit un indice simple de la sévérité des feux, pour la partie sur de la région côtière de la Colombie britannique. L'indice calculé pour la période s'étendant du 1er mai au 31 août est en corrélation étroite avec la surface incendiée annuellement dans le district forestier de Vancouver.

Si l'on met de côté la portion de la déviation des aires incendiées, année par année, attribuable aux variations causées par l'indice du temps, il est possible de voir plus clairement les effets des autres variables sur l'importance des feux, pour une année donnée.

L'existence de variations considérables de l'ensoleillement durant l'été, pour des périodes s'étendant sur plusieurs décennies nous inviterait à croire qu'une décennie, pour établir une moyenne de statistiques d'incendie, est une période trop courte pour être indépendante des effets du temps.

Introduction

Whenever standard records of fire danger are available, the local rating of fire season severity may be obtained by such methods as that outlined by Williams (1959). However, if this is to be extended more than a few years into the past, the task of computation, or lack of suitable weather records often proves to be an effective stumbling block.

It would be desirable if a simple weather parameter requiring little or no manipulation and representative of a relatively large administrative unit, could be found to represent some aspect of fire season severity. One such weather element that shows consistent variations over large areas from one season to the next is the duration of bright sunshine.

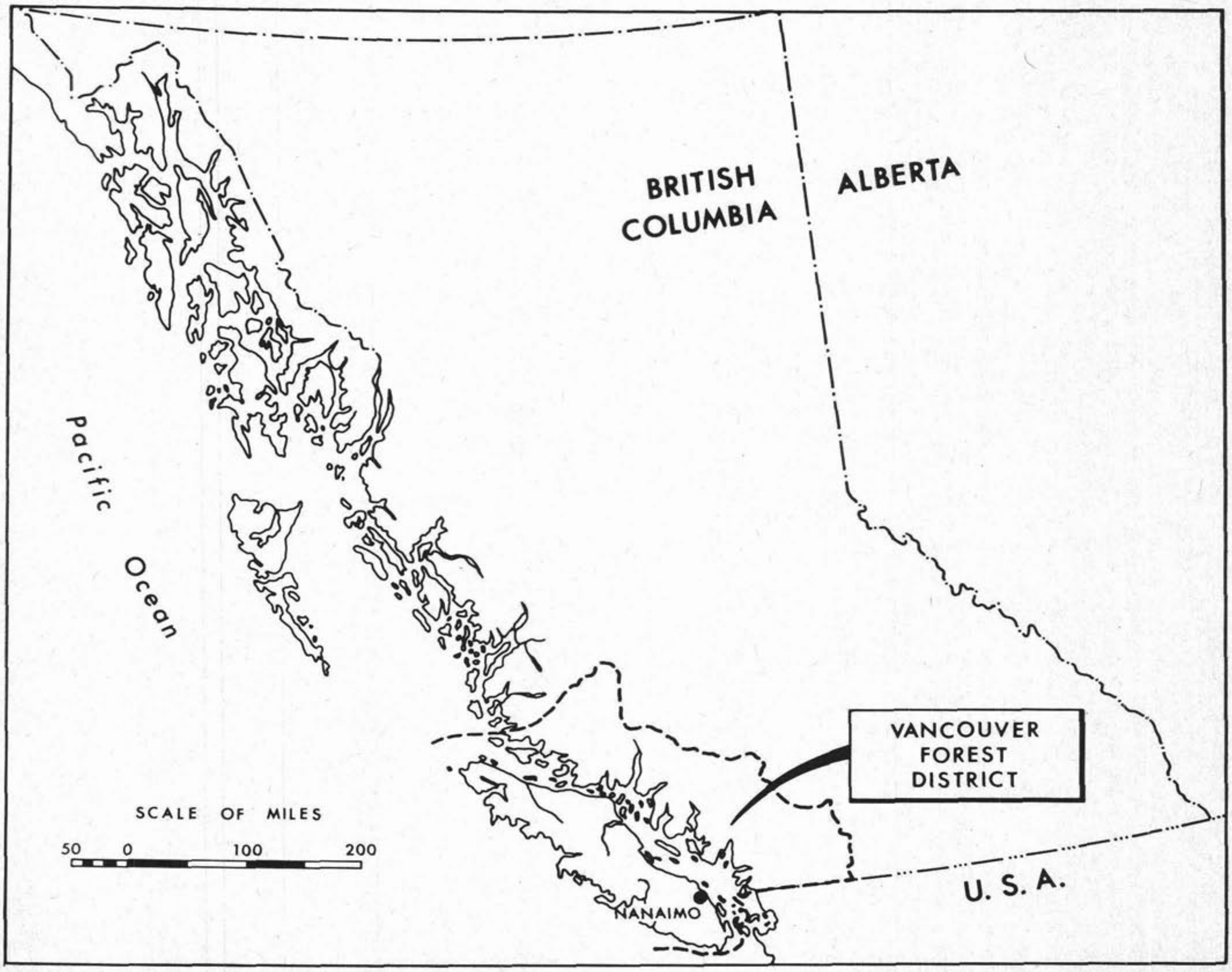
The extent of such an area having the required homogeneity will be governed by the size of the semi-permanent pressure systems and the major topographic features. The Vancouver Forest District (Fig. 1), comprising Vancouver Island and the adjacent mainland of British Columbia west of the coast mountains, was chosen as a suitable administrative unit having reasonably uniform large-scale climatic controls.

Table I shows the relative rank of four significant weather parameters from a number of stations in the Vancouver Forest District over a 10-year period compared to the "severity rank" of the same fire seasons as indicated by the annual burned acreage. It can readily be seen that the duration of bright sunshine is the most efficient of the four parameters shown in ranking the fire season severity; furthermore, there is more consistency among stations in the ranking according to sunshine than there is for other weather factors.

Lightning activity is not useful by itself as an index of fire season severity, although the two most severe fire seasons were also the heaviest lightning years. These two years were, in addition, the warmest and sunniest of the 10 years shown. Such a relationship between lightning activity and warm sunny summers is not unexpected here, since much of the summer lightning activity along the southern British Columbia coast has been shown to be associated with the ending of a severe drying cycle (Turner 1953).

This suggests that the accumulated hours of bright sunshine at one station can be used effectively as an index of the fire season severity for the Vancouver Forest District without need for averaging or further computation.

Fig. 1. Map showing Vancouver Forest District and Nanaimo.



There was no clear-cut case for the choice of one station over any of the others; however, Nanaimo was used because it gave slightly better results than some of the other stations in preliminary tests. The period from May 1 to August 31 gave distinctly better results over the full period of record than any other length of season despite the fact that there were years when a significant proportion of the season's fires occurred in April or September.

Fire History of the Vancouver Forest District

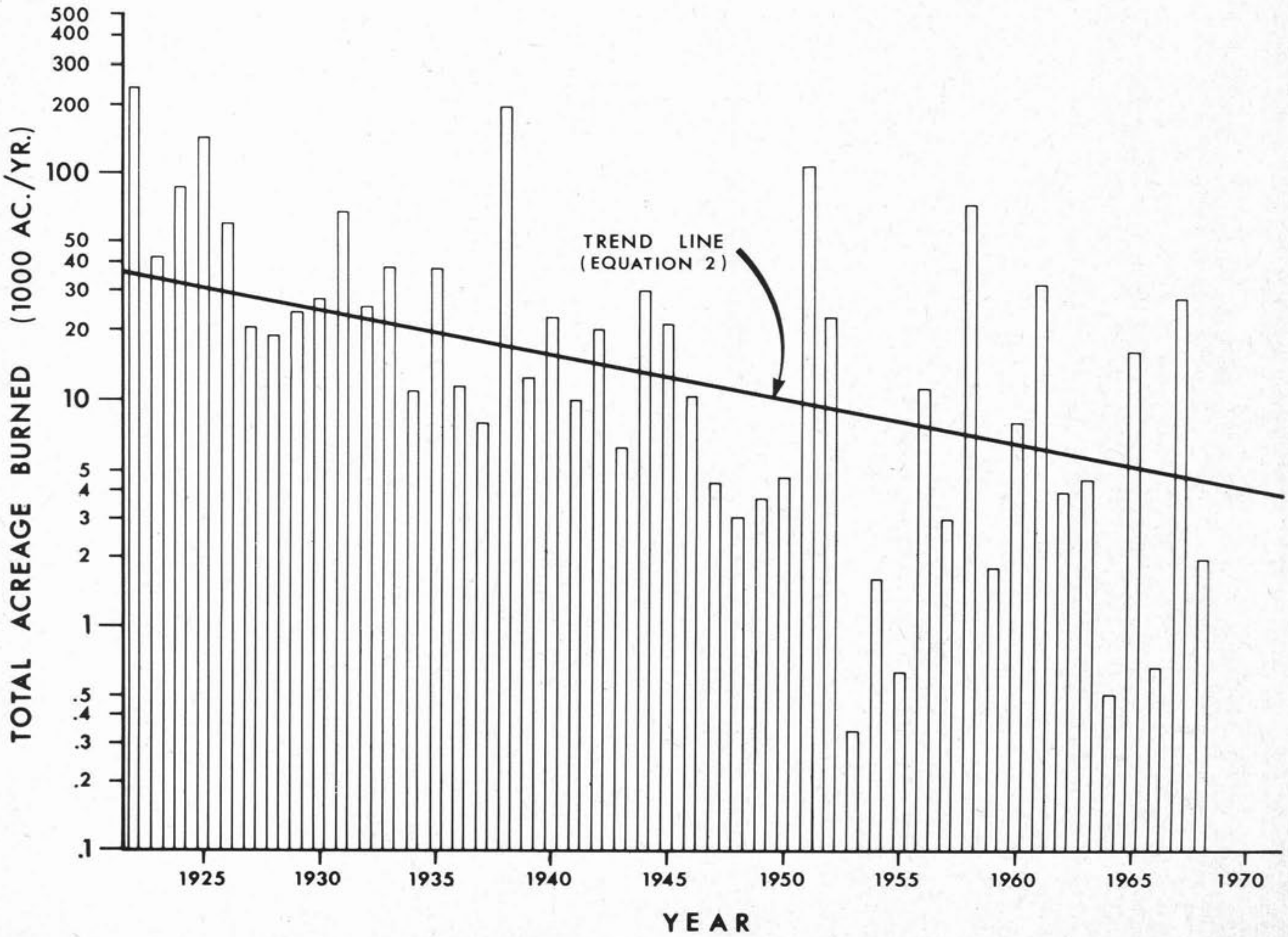
The basic fire statistic used in this study is the annual area burned for the Vancouver Forest District, as reported in the Annual Reports of the British Columbia Forest Service. However, other read-

TABLE I — Seasonal Rank* According to Factors Shown For Station or Area Indicated

	1949	1950	1951	1952	1953	1954	1955	1956	1957	1958
Acreage Burned										
Vancouver F.D.:	6	5	1	3	10	8	9	4	7	2
Duration of Lightning Activity										
Five Airports:	3	7½	2	9½	4	5½	9½	7½	5½	1
Duration of Bright Sunshine (May-Aug.)										
Agassiz	6	4	1	3	8	10	9	5	7	2
Cowichan Bay	6	4	2	5	9	10	8	3	7	1
Nanaimo	6	4	1	5	9	10	8	3	7	2
Vancouver	6	3	2	5	9	10	8	4	7	1
Victoria	6	4	1	5	9	10	8	3	7	2
Mean Daily Temperature (May-Aug.)										
Agassiz	4	6	2½	6	8	9	10	2½	6	1
Cowichan Bay	3½	3½	2	5½	5½	9	10	7	8	1
Nanaimo	8	5	2	6	7	9	10	2½	4	1
Victoria	6½	6½	3	8	4½	9	10	2	4½	1
Total Precipitation (May-Aug.)										
Agassiz	5	3	2	6	4	8	10	9	7	1
Cowichan Bay	4	5	1	2	6	7	9	8	10	3
Nanaimo	6	1	1	4	2	5	8	9	10	7
Victoria	3	7	1	5	4	9	10	8	6	2

*Season with greatest value during the 10-year period assigned rank 1, etc., except for precipitation where rank 1 assigned to year with least value of summer rainfall.

Fig. 2. Annual Area Burned by years, Vancouver Forest District from 1922 to 1968. Trend line was obtained by substituting mean value of S(1027.5) in Equation 2.



ily available parameters, such as the total number of fires exceeding 10 acres could have well been used as an index of the annual fire load.

The fire history of the district since 1922 is summarized in Figure 2. A logarithmic scale is used to plot the area burned so that a better representation is possible over the whole range of values. Furthermore, the distribution of the logarithmic values approximates that of a Gaussian curve.

One of the heaviest seasons (in terms of burned area) in recent years was 1967. However, it had been exceeded three times in the preceding 20 years and five times in the 20 years before that. On the other hand, all the totals less than 1000 acres have occurred since 1952.

There is a progressive decrease in the area burned each year. The regression line, given by

$$\mathrm{Log}_{10}A = 4.819 - 0.030\ (Y - 1921)\ \ldots\ (1)$$

with a correlation coefficient $r = -.607$

where A = annual burned area in acres;

and Y = calendar year

indicates that the area burned this year is, on the average[1] one half of what it was ten years ago, and one quarter of what it was 20 years ago. This relationship does not take into account the variations in the weather.

It is tempting to attribute this marked reduction in burned area over the years entirely to more intensive and more effective protection measures. How effective these measures really are can only be determined accurately if the effect of variations in significant weather factors can be substantially removed.

[1] The geometric average is implied here rather than the more familiar arithmetic average.

The effect of sunshine

The significance of variations in the duration of summer sunshine is indicated by the value of the simple correlation coefficient $r = .774$ between the logarithm of the annual burned area and the total hours of bright sunshine at Nanaimo for the season May 1 to August 31.

If the effects of trend and sunshine are considered together, the result is the multiple regression equation:

$$\mathrm{Log}_{10}A = 0.597 - 0.0201\ (Y - 1921)\ 0.00388\ S\ \ldots\ (2)$$

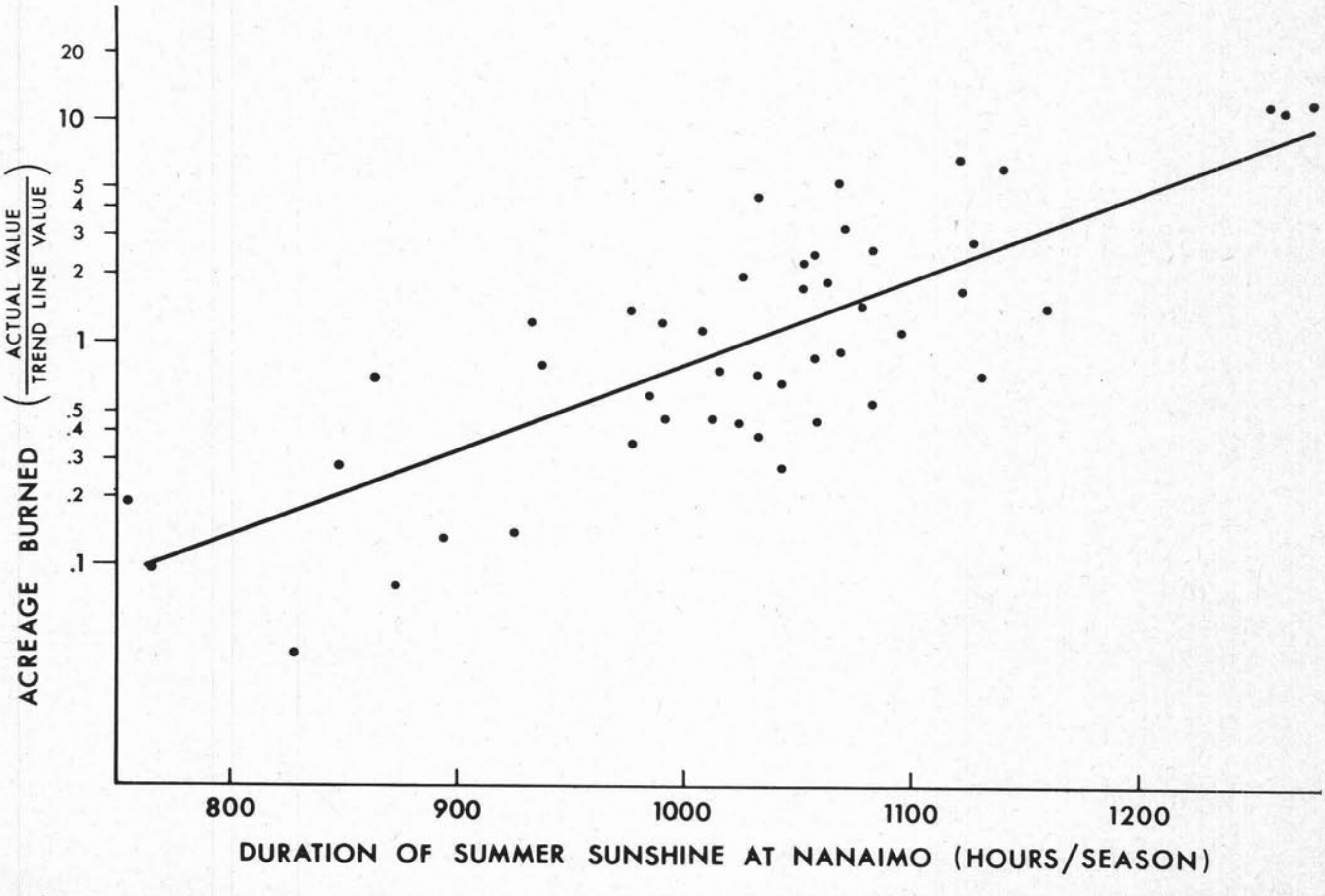
where S = total hours of sunshine, May to August.

The total correlation, $R = 0.866$ indicating that 75% of the total variance is taken into account.

This can be expressed more effectively by the two following rules of thumb:

1) The annual burned acreage for the Vancouver Forest District in any given year may be expected to double for each 77.5 hours of bright sunshine accumulated at Nanaimo through the period May 1 to August 31. (This relationship is shown in Fig. 3).
2) The annual burned acreage (after the effect of variations in sunshine are removed) is roughly halved in any 15-year period. Extrapolation of such a trend to the future should be approached with caution.

Fig. 3. Effect of sunshine with linear trend removed.



Some of the apparent reduction in burned area indicated in the previous section was the result of a downward trend in hours of sunshine which, though slight (r = −.309), was still sufficient to exert a significant effect on the acreage burned. This decreasing trend of summer sunshine could reverse itself at any time (Powell, 1965) and may even have done so. Any forecast of the current trend of area burned should be made with this possibility in mind.

Relation to other fire weather elements

Duration of bright sunshine has been shown previously to have a strong correlation with other important fire weather factors. For example, McHattie (1966) found a correlation coefficient of −.74 between daily minimum relative humidity and hours of sunshine for southern Alberta. The author has obtained a correlation of .87 between the yearly values of accumulated May to August sunshine at Nanaimo; and the percentage of days during the fire season on which fuel moisture sticks for six locations on Vancouver Island gave readings below 8%.

It would be expected that variations in rainfall amounts would have to be considered in any meaningful index of fire season severity. Table I suggests that this may not be as important as one would like to believe. It would seem to be much more valuable to consider the distribution of rainfall throughout the season, since frequent light rains can be much more effective than a few very heavy falls. Variations in this element are reflected in the seasonal total of bright sunshine.

The seasonal accumulation of sunshine is an effective index because it integrates these important factors in a convenient fashion.

Other influences on the trend

The effect of the yearly variations in the duration of sunshine may be removed effectively by calculating what the burned area might have been for a "standard" fire season. Taking such a standard to be one with an accumulated May to August sunshine of 1000 hours, the adjusted acreage can be readily obtained according to equation (2) by decreasing the logarithm of the actual burned acreage by .00388 for each hour of sunshine accumulated over 1000 hours. Conversely the logarithm should be increased for each hour less than 1000 hours.

The adjusted values so calculated have been plotted in Figure 4. It is readily seen that most of the large oscillations in Figure 2 have been removed. The remaining fluctuations and the trend are expected to be largely the result of other influences. Advances in the techniques of forest protection usually take place in an irregular manner, i.e., the availability of new equipment, and these tend to show up as deviations from the regular trend line,[2] although cumulatively they may be responsible for the trend.

One significant discontinuity of this type showed up as a pronounced decrease in adjusted acreage following the 1925 fire season. Referring to the Annual Report of the British Columbia Forest Service for that year, the following statement is made:

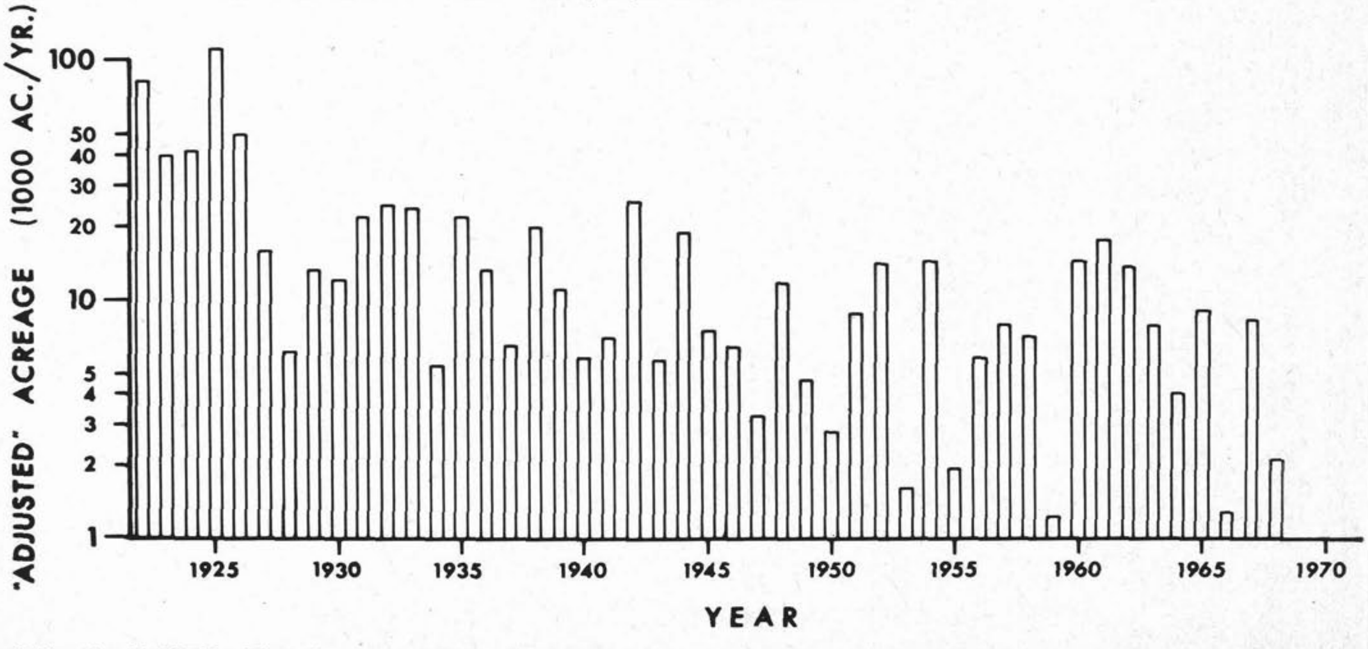
"Fire Weather Warning Service"

"Through the courtesy of the Superintendent of the Meteorological Service, Victoria and the Daily Province, Vancouver, a daily weather forecast was broadcast each evening during the season from station CFYC Vancouver. When bad fire conditions were approaching this forecast was especially worded with a view to warning foresters of the approaching fire danger. Warnings were also broadcast during the danger period from the Forest Service Radio Stations at Vancouver, Myrtle Point and Thurston Bay."

A further extract from the Annual Report for 1926 states: "An influential factor in keeping down fire losses on the coast can be laid in part to the extraordinary precautions taken by logging oper-

[2] These deviations from a linear trend are in part responsible for the scatter of points in Figure 3.

Fig. 4. Annual Burned Area, Vancouver Forest District, adjusted to a "standard" season of 1,000 hours' sunshine.



ators. Fully fifty per cent of the coast operators suspended work entirely during dangerous periods and the majority of those who continued to work did so on the early shift plan. Many operators installed hygrographs or humidity reading devices and watched for the approach of dangerous conditions."

It would be facetious to suggest that these factors alone were responsible for the pronounced decrease in the adjusted values of area burned. However, the two references may be taken as symptoms of an increased awareness that fires were not always a necessary evil, and that it was possible to take effective action to combat them. The fact that no significant trend is evident since that time should not be taken as an indication that current protection techniques are no more effective than those employed 30 years ago. It is more probable that increasing hazard and increasing risk, as new areas are opened up to logging and recreation, are being balanced by improved protection methods.

Acknowledgements

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Plowing Trials for Afforestation in Newfoundland

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"Plowing trials indicate that plowing for site amelioration purposes is both feasible and practical."

Essai de labourage simple en vue de travaux d'afforestation en pays terreneuvien

Résumé

En 1966 et 1967, on essaya la charrue forestière Parkgate en terrain de basse lande ainsi que dans une tourbière à sphaignes. On a pu établir, à tous les 6 pieds, des sillons simples d'une profondeur de 18 pouces.

On mit 4 heures pour labourer 1 acre de terrain de basse lande mais seulement 2 heures furent requises en condition de tourbières.

La densité et la hauteur de la végétation, l'épaisseur de l'humus brut, la fréquence et la grosseur des boulders sont les facteurs qui ont ralenti la vitesse du labourage.

Abstract

Trials with a Parkgate forestry plow were carried out on open heathlands and boglands during 1966 and 1967. Single-furrow plowing to a depth of 18 inches at 6-foot intervals was feasible on both land types. Production rates were approximately one acre in four hours on heathland sites, and one acre in two hours on bogland sites. The factors affecting the production rates are density and height of ground cover, depth of matted raw humus, and frequency and size of boulders.

Plowing trials to improve wasteland sites for afforestation began in Newfoundland in 1966. They were undertaken because earlier afforestation attempts, without site improvement, were unsuccessful (Lewis, 1954).

Ground-preparation methods are similar to those being used successfully in the United Kingdom (Zehetmayer, 1960). The basic requirement is to make the site more suitable for tree growth by loosening and aerating the soil, providing better drainage, and reducing vegetative competition. These improvements may be accomplished by plowing, usually in single, spaced furrows, with specialized equipment and by establishing a system of drainage compatible with local conditions. Sites are usually prepared at least one year prior to planting to allow time for ground consolidation. Planting normally takes place in the spring, and fertilization is usually coincident with planting.

Various types of plowing equipment are in general use in the United Kingdom, but the Parkgate forestry plow, because of its strength and versatility, has gained wide acceptance by the Forestry Commission of Great Britain. This plow has performed well in northern Scotland, where conditions are similar to those in eastern Newfoundland (Wil-