FUEL TYPES AND FOREST FIRE BEHAVIOR IN NEW BRUNSWICK

J. D. WALKER

GREAT LAKES FOREST RESEARCH CENTRE
SAULT STE. MARIE, ONTARIO

INFORMATION REPORT O-X-154

CANADIAN FORESTRY SERVICE
DEPARTMENT OF THE ENVIRONMENT
OCTOBER 1971

Copies of this report may be obtained from

*The Director,
Great Lakes Forest Research Centre,
Box 490, Sault Ste. Marie, Ontario.*

ABSTRACT

Fire data from New Brunswick were analyzed in relation to the fuel types in which the fires occurred. The study showed that some complex relationships do exist among forest fuel types and fire behavior with respect to final acreage and difficulty of control.

TABLE OF CONTENTS

INTRODUCTION

Fire Researchers and Fire Control Officers have long recognized the importance of forest fuel types to fire behavior. Although a great number of reports on wildfires exist across the country, no major analyses of the relationship of forest fuels to behavior of fire have been made. This is undoubtedly because the vast quantity of information available does not easily lend itself to such analysis.

The purpose of this minor study was to analyze some New Brunswick fire data in relation to the fuel types in which the fires occurred. The study was conducted in 1967 while the author was attending the University of New Brunswick, on educational leave from the Great Lakes Forest Research Centre, Sault Ste. Marie, Ontario.

METHODS, RESULTS AND DISCUSSION

The data studied were taken from the files of the New Brunswick Department of Natural Resources and include the years 1961-66. The information recorded was attack interval, detection interval, size at attack, control interval, final size, and danger index. Only the data from those forest fire reports which were fully completed and for which the total acreage burned was less than 50 acres were used because, if all pertinent data were not available, "guessing" could lead to unreliable results and for fires over 50 acres, accurate descriptions of fuel types could not be recorded. Only those classed as forest fires were considered (as opposed to railway fires and grass fires--two other fire classes used in New Brunswick).

Table 1 summarizes *all* fires in New Brunswick for the years 1961-1966 (Anon. 1966).

In this study, 211 forest fires for which available data complied with the above criteria were analyzed. Seven fuel types were recognized and identified.

Type 1 Old burns, ferns, debris other than slash.

Type 2 Conifer slash, piled or scattered.

Type 3 Conifer regeneration, understory or plantation, and associated vegetation.

Type 4 Mature conifer and mixedwood.

Type 5 Hardwood litter and associated vegetation.

The author is a Research Officer, Great Lakes Forest Research Centre, Sault Ste. Marie, Ontario.

Type 6 Nonforested (barren), moss, rocky areas.

Type 7 Mixed regeneration and associated vegetation.

Occurrence of the fires as related to Danger Index class and fuel type is given in Table 2. Danger Index refers to the 0 to 16 scale then used in New Brunswick (Anon. 1957) and arranged into classes as follows: Low, 0-4; Moderate, 5-8; High, 9-12; and Extreme, 13-16.

Table 1 Summary of forest fires in New Brunswick (includes grass and railway fires)[a]

Year	No. of fires	Acreage	Damage ($)	Fire fighting costs ($)
1961	320	14,735	273,995	133,230
1962	355	47,082	660,959	129,724
1963	376	2,388	22,009	20,291
1964	512	5,770	68,865	27,836
1965	743	21,534	558,538	575,788
1966	639	4,224	66,550	141,320

[a] Grass and railway fires could not be separated from statistics shown in the table.

Table 2 Distribution of fires by index and fuel type

Burning index	No. of fires/fuel type							
	1	2	3	4	5	6	7	Total
Low	–	–	2	–	–	2	2	6
Moderate	–	37	12	1	9	4	3	66
High	5	42	22	3	23	2	9	106
Extreme	–	14	5	2	3	2	7	33
Total	5	93	41	6	35	10	21	211

The greatest number of fires analyzed occurred in fuel type 2, the slash fuel type (Table 2). Table 2 gives a representative picture of forest fires by fuels and Danger Index in New Brunswick between 1961-66, but does not indicate the distribution of the number of days occurring in each Danger Class throughout the season. It also shows that not enough fires were analyzed to permit any valid statistical conclusions.

For each fuel type and danger class, an initial spread rate in terms of perimeter increase was calculated. To calculate fire perimeter, the shape of the fire must be known (or assumed). Van Wagner (1969) and Pirsko (1961), as well as others, have suggested that fires are usually elliptical. In these calculations the shape of the fire was assumed to be an ellipse whose length is twice its width. Van Wagner (1969) pointed out that rate of perimeter increase with time is constant when considering an elliptical shape. Knowing elapsed time to attack and area at attack, it was possible to obtain a perimeter increase value (in chains per hour) for the free-burning time of the fire's growth from a straight line alignment chart presented by Pirsko (1961).

An approximate expression for perimeter of an ellipse is

$P = 2\pi \frac{a^2 + b^2}{2}$ where a and b are the long and short semiaxes. Using this equation and knowing the area of an ellipse to be $A = \pi ab$ and $b = a/2$ in this instance, I calculated approximate perimeters (in chains) for each fire from the simplified expression $P = 12.53\ (\sqrt{A})$ where A is fire size, in acres.

By using an expression of total perimeter and the total time in hours required to *control* the fire, an expression of difficulty of control in terms of hours per chain of held perimeter can be calculated.

Tables 3 to 5 give the results of the analysis and Figures 1 and 2 show, by means of horizontal histograms, the summaries of average final size and average difficulty of control for all fires in all fuel types and index classes. As might be expected, average final size increases with increasing danger index when all fuel types are combined (Fig. 1a).

Figure 2 demonstrates an apparent anomaly because although type 6 (barren areas) had the largest average final size for all indexes combined (Fig. 1b), relatively less time was required for control per chain of perimeter in this fuel type. Type 4 (mature conifer and mixed-wood) required the greatest control time per chain of perimeter under all conditions. (Time in this case refers to actual hours, not man-hours). Figure 2a shows that difficulty of control does not necessarily increase with increased burning index; in fact, it sometimes decreases. This could, however, be explained by a stepped-up attack effort being in effect on higher index days and also by the fact that, say, five men can control 6 acres almost as easily as 2 acres in many cases. In other words, if

Table 3 Average final size for all fires in all fuel types and index classes in acres

	Fuel type						
Index	1	2	3	4	5	6	7
Low	–	–	2.0	–	–	20.0	3.4
Moderate	–	6.3	12.7	30.0	6.3	25.5	15.1
High	6.7	11.3	10.0	7.1	11.4	2.5	13.6
Extreme	–	16.4	14.1	13.7	11.3	15.2	12.2

Table 4 Average initial perimeter increase for all fires in all fuel types and index classes (chains/hour)

	Fuel type						
Index	1	2	3	4	5	6	7
Low	–	–	12	–	–	6	76
Moderate	–	34	32	10	38	28	63
High	33	34	37	63	49	15	46
Extreme	–	43	55	28	48	33	36

Table 5 Average difficulty of control for all fires in all fuel types and index classes (hours/chain of perimeter held)

	Fuel type						
Index	1	2	3	4	5	6	7
Low	–	–	0.18	–	–	0.02	0.06
Moderate	–	0.09	0.13	0.73	0.11	0.09	0.03
High	0.08	0.09	0.08	0.35	0.07	0.08	0.04
Extreme	–	0.09	0.09	0.37	0.04	0.02	0.11

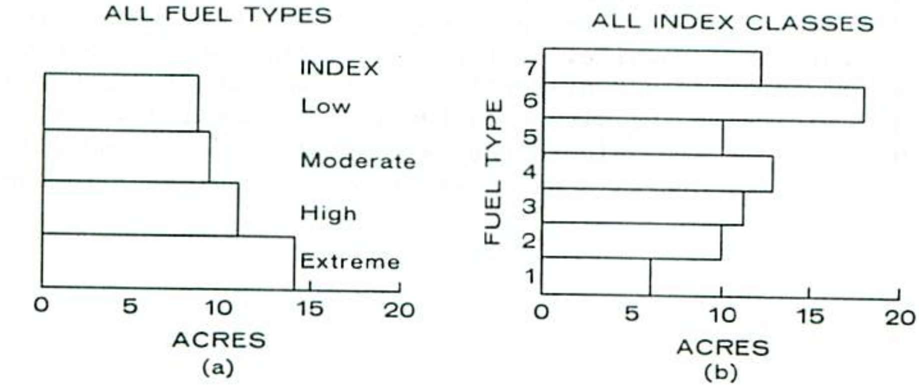

Figure 1. Average final size for all fires in all fuel types and index classes.

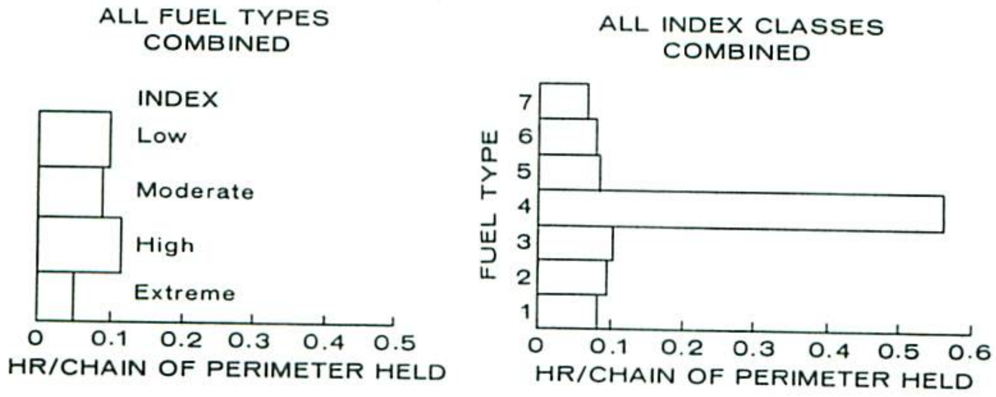

Figure 2. Average difficulty of control for all fires in all fuel types and index classes.

there is a minimum-sized suppression force sent to most fires regardless of initial size, then the analysis suggests an increase in efficiency and/or size of suppression crews with increasing Danger Index.

CONCLUSIONS

This limited study shows that some complex relationships exist among forest fuel types and fire behavior with respect to final acreage and difficulty of control. More detailed and comprehensive studies of this nature might be worthwhile. Unfortunately the data on most provincial fire report forms do not presently lend themselves to such analysis. Perhaps actual visits to the site of a few well-documented wildfires will provide data more amenable to the assessment of fuels and fire behavior than will any analysis of a vast number of forest fire reports.

REFERENCES

Anon. 1957. Maritimes forest fire danger tables. Can. Dep. Forest. Publ. No. 1151.

Anon. 1966. Annual Report. New Brunswick Dep. Natur. Res.

Pirsko, A.A. 1961. Alignment chart of perimeter increase of fires. U.S. Forest Serv. Fire Control Notes 22(1): 1-4.

Van Wagner, C.E. 1969. A simple fire-growth model. Forest. Chron. 45: 103-104.