A SIMPLE SUBJECTIVE FUEL CLASSIFICATION SYSTEM FOR ONTARIO

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Frontispiece. Pre- and post-burn views of a jack-pine slash fire in Garrison township, Swastika District, 1971.

ABSTRACT

Fuel classification and mapping are considered important aspects of forest fire control planning. Techniques currently in use are generally out of date or require a great effort to maintain. A simple subjective system for classifying forest fuels in Ontario is suggested. The system, which is based on information readily obtained from existing forest inventory maps, will be tested in northwestern Ontario in 1972.

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INTRODUCTION

Although rapid advances in the fields of forest fire detection and suppression have been made in Canada and the United States, especially over the last decade, presuppression planning for forest fire control does not appear to have kept abreast of these changes. For example, most existing fuel type systems are based largely on a method developed over 30 years ago before any information existed on specific relations between measured fuel characteristics and fire behavior.

According to Hornby (1936), fuels should be mapped according to relative rate-of-spread and resistance-to-control, initially for planning purposes, but most frequently for dispatching.[1] Gisborne (1939), summarizing Hornby's principles of fire control planning after the latter's death, stated that the chief purpose of the fuel classification work was to determine the normal high rate of perimeter increase which could be expected so frequently or consistently that it should be planned for and that this normal high-rate varies significantly according to fuel type. In 1942, Jamison and Keetch combined Hornby's subjective ratings with an analysis of fire reports to establish hour-control zones, and to predict fire size by fuel zones and danger classes in the northeast. During this period, the same information was compiled for use in the Lake States where some 38 fuel types were recognized (Davis, 1959), although as early as 1929 the distinctive fire-carrying fuels of this region had been recognized and discussed (Mitchell, 1929). By the end of the 1930's in the United States and parts of Canada, the fuel type map was firmly entrenched as a planning tool and other avenues of classification were investigated to replace or supplement Hornby's subjective method.

Regional variations of the system provided photographic manuals for identifying fuel types, and most gave relative descriptors for rate-of-spread and resistance-to-control. For example, "Low", "Medium", "High" and "Extreme" were used to describe the relative conditions of fuel with fuel types being designated as "Low-Medium (LL)", "Medium-High", etc., with rate-of-spread always the first element, and resistance-to-control the second.

After the war, Hornby's massive classifications were outdated and seldom revised. In 1948, the Ontario Department of Lands and Forests presented, as a supplement to their Fire Control Planning Manual, a system of fuel type mapping that included a list of 50 fuel types (Anon, 1948). Each type was rated for expected rate-of-spread and resistance-to-control for two seasons, a spring-fall period and summer period. Thus, 100 highly subjective ratings for a rather detailed breakdown of

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[1] A comprehensive review of literature and discussion of principles of fuel classification is presented in a paper by S.J. Muraro (1965).

fuel conditions were available. The subsequent lack of use of this, or a similar system, can be attributed to the fact that fire control personnel in a particular area were felt to have sufficient knowledge of the fuel types in their protection locale; thus the great amount of time and effort involved in delineating the various types and constructing and maintaining fuel maps became only a paper exercise. Recent correspondence with fire control supervisors in other provinces indicates that their lack of any current fuel classification system also is generally due to this factor.

Long use of Hornby's general ideas, especially in the United States, would appear to indicate that they did have great practical use in fire suppression and especially in fire control planning. Perhaps this long use, however, is based more on the failure of fire researchers to develop a more suitable system, in spite of numerous efforts.

A study initiated in the late 1950's by a Federal fire researcher in Ontario probably came closest to proposing any advances in fuel classification (Winkworth, 1961). A questionnaire was circulated to fire protection personnel in Ontario and Quebec to obtain their opinions on the relative fire hazard and the relative tendency to spot and crown of 27 fuel types. A subsequent analysis of the questionnaire revealed that age was considered an important factor among softwoods but season was not. The opposite was found true for hardwoods but both age and season were significant factors among mixedwoods. Generally, the softwoods were given a higher average rating than the hardwoods. A significant correlation existed between the ratings for fire hazard and tendency to crown and between hazard and tendency to spot. Unfortunately, the project was never really followed up so that the valuable information obtained was not put to any practical use. Information obtained from this analysis coupled with some actual fire behavior observations may yet lead to improved methods of fuel evaluation.

To be a real improvement, any new approach should (1) be based on objective measurement of specific fuel characteristics, (2) be more flexible and versatile than the present system, and (3) use a universal rating scale (Fahnestock, 1970).

After several years of research, Fahnestock has developed a new system for recognizing and tentatively evaluating the fire spread potential and the crowning potential of fuels in the field, from readily observed characteristics and without prior technical knowledge of vegetation or experience with fire. He employs the dichotomous key, familiar to natural scientists, which is supplemented by a vocabulary of newly defined terms for describing fuel characteristics. His ultimate goal is to establish the framework for a permanent, universal fuel appraisal system. At first glance, this system too would apparently require extensive field work to initiate and maintain. The method does show some promise, however, because the job of distinguishing between two complex fuels is reduced to a series of rather minor decisions, each of which can be made by objective observation or measurement. If the right basic attributes are used for characterization, critical levels can be redefined, outputs can be recalculated, combinations can be added, and keys can be combined or separated to incorporate new knowledge without invalidating the system.

Studies concerned with the concept of total available fuel weights have been conducted in western Canada (Muraro 1962, 1964; Kiil, 1968) and I have undertaken limited work on fuel weights in jack pine, *Pinus divaricata* (Ait.) Dumont (= *P. banksiana* Lamb.), in Ontario. These projects were designed mainly to attempt correlation between the fuel complex and various stand parameters.

Important factors to consider when developing a fuel classification system are its final uses and users. The uses might briefly be described as (1) planning, (2) dispatching, and (3) suppression; and the users would consequently be those personnel involved in these fire protection activities. Planning and dispatching from a central control office which considers the fire situation in a large area, e.g., the Province, would probably derive most benefits from a fuel typing system, whereas as mentioned previously, field personnel generally have a certain familiarity with fuels in their division. Thus, in direct suppression activities a fuel classification system would probably have only limited application. Its major use would be in the areas of central planning and dispatching.

Ideally, a fuel classification technique should be basically simple to initiate and maintain. It should, where possible, avoid excessive, redundant sampling requirements and consequently make use of existing forest inventory information. It should be universal so that it can be applied and understood within major forest regions, and to keep the system simple should employ as few types or classes as possible.

Today, suppression costs are rising rapidly with the employment of sophisticated machinery and airtanker systems, with intensive training of skilled and highly paid suppression crews, and with values other than those of timber being placed on forested lands. Therefore, presuppression planning, including a revival and improvement of fuel classification techniques, should be intensified. However, an immediate solution to the problem of developing a meaningful fuel typing system may be difficult and time-consuming. Much more sophisticated research is required before a truly definitive and objective method can be developed. Work is presently underway in Ontario to meet this end, but in the meantime Fire Protection agencies require a workable fuel classification system.

This report suggests a basic subjective classification system for immediate (but hopefully *interim*) use in Ontario by forest fire control personnel, until a more objective system can be developed. The system proposed here was developed at the request of the Ontario

Department of Lands and Forests (Environmental Protection Section) who, in keeping with their high standards of forest fire control planning, realized the importance of an improved fuel typing technique in the planning and dispatching phases of their operations.

PROPOSED SYSTEM

The proposed system gives a subjective numerical rating that represents relative fire behavior expected under high to extreme burning conditions.

The basis of the ratings is my experience and some widely known facts about fire behavior, with some guidance from the 1948 Ontario ratings and Winkworth's (1961) questionnaire analysis; no scientific or objective measurements have been introduced into the ratings. Therefore, should the principles of the system appear acceptable, the ratings are definitely open to revision and adjustment.

The system bases the ratings on species, age, stocking, and season. The two most equally hazardous fuel conditions possible were felt to be (1) dense, immature jack pine on a dry site in the summer and (2) heavy concentrations of softwood slash which is less than 2 years old. These conditions represent a maximum rating of 100 points; all other combinations of types are rated lower, and relative to these. The final rating is obtained by adding individual components according to stand conditions (Table 1). As an example, consider a stand described on a standard Ontario Department of Lands and Forests inventory map as follows (Dixon, 1965):

$$\begin{array}{c} \underline{P_j\ 10} \\ 45 - 50' - 0.9 \\ 2 \\ 80 \end{array}$$

The rating computed would be: 35 for species value, 15 for age, and 25 for stocking. If rated for the summer period (20), the total rating would then be 95.

Insect-killed, blowdown, or decadent stands should be given the highest possible rating for the particular species. For species combinations, take a weighted average (based on percent composition) of the two most common species as the species value and use the highest corresponding ratings in other categories. For example, consider a stand described

$$\begin{array}{c} Po_8\ Sb_2 \\ 45 - 70' - 0.8 \\ 1 \\ 72 \end{array}$$

Table 1. Fuel rating components according to stand parameters

	Softwoods	Hardwoods	Slash
Species	White pine......15 Red pine........15 Spruce/fir......25 Jack pine.......35	Maple........... 5 Beech........... 5 Yellow birch.... 5 Poplar.......... 5 White birch.....15	Hardwood....25 Softwood....50
Age	Regeneration....10 Immature........20 Mature..........15	Regeneration.... 3 Immature........ 8 Mature..........10	<2 years....20 >2 years....10
Stocking	0-25........... 5 26-50...........10 51-75...........15 76-100..........25	0-25........... 3 26-50........... 5 51-75........... 7 76-100..........10	Light.......15 Medium......25 Heavy.......30
Season	Spring..........10 Summer..........20 Fall............10	Spring..........15 Summer.......... 5 Fall............10	

The species factor would be: $\frac{(8 \times 5) + (2 \times 25)}{10} = 9$. The age factor and stocking factor would be taken from the softwood section and would be 15 and 25, respectively. Again considering the summer season, for softwoods (20) the total rating would be 69.

The Ontario Department of Lands and Forests has assessed and accepted in principle this proposed fuel rating system and suggested that it be given field trials during the 1972 field season.

Suggested areas for these trials are the Dryden, Sioux Lookout, and possibly Geraldton Chief Ranger Divisions. Dryden and Sioux Lookout were suggested because the Department is also conducting aerial fire retardant trials in these areas and an assessment of fuel rating methods would tie in closely with this project. Geraldton is being considered because of the relatively high fire occurrence in the district. Fuel ratings for one or more of these areas will be calculated before the next field season with the help of Lands and Forests inventory and fire personnel.

By using forest inventory maps and data which are available for computer processing (currently on magnetic tapes), a numerical rating of each numbered forest stand may be obtained with the aid of a very simple programme. Then by transferring these ratings to the inventory map and combining adjacent stands with similar resultant ratings, the relative fuel conditions may be delineated on a broader scale. It will, however, be necessary to consider that inventory data is probably outdated so that adjustments should be made. As well, cut-over (slash) areas, insect infestations, and other changes in forest conditions must be taken into account and noted on the final maps.

CONCLUSIONS

The advantages of the proposed system are:

1) It gives a definite numerical rating that can be related with observed fire behavior.

2) Ratings can be assigned from inventory maps and data (and possibly aerial photos), thus minimizing field work.

3) A fuel index for any district or region could be calculated by using a weighted average based on areas of various fuel types. Thus fire districts or divisions could readily be compared concerning relative fuel rating.

4) The system could be made more sophisticated by applying risk and accessibility factors to the ratings.

5) With most of Ontario's inventory data available for computer processing, it will be easy to obtain relative fuel ratings on a large scale.

Until verified or modified in the light of fire behavior data, this fuel rating scheme remains subjective and relative. Meanwhile it will perhaps provide interim aid in this increasingly important area of forest fire control planning.

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