BACKGROUND AND PHILOSOPHY OF THE NATIONAL FIRE-DANGER RATING SYSTEM

FIRE DANGER RATING AND FIRE MANAGEMENT

Before we get into the specifics of the National Fire-Danger Rating System, it is essential that we establish a perspective of fire-danger rating in relation to the fire management system. This is essential because of the appreciation that you must develop for the philosophy of fire-danger rating which is the basis for the National Fire-Danger Rating System, and for the assumptions that were made in the technical development of the system.

In fire management there are two distinct situations to be considered, each requiring a unique level of fire intelligence. The first is what we commonly term the presuppression or planning phase. The objective of presuppression planning is to determine ahead of time, usually the day before, an estimate of the potential size of the fire suppression job on a protection unit so that an appropriate level of readiness of the suppression forces can be determined and implemented.

At this stage, the fire manager is looking at the big picture -- at a scale which is gross, both in time and in space. He is looking at an entire protection unit which may be a Ranger District, a National Forest, a county unit, a half of a state, a BLM District -- perhaps as much as several million acres of land. In time, the fire manager is dealing with periods up to 24 hours -- normally our planning is done on the basis of the calendar day.

The type of information that he is trying to glean, as far as fire behavior or fire potential is concerned, is rather general. All the fire manager really needs to know is how the day that he is planning for compares with the current day, or how it compares with another day which he may use as a reference. In other words, ratings can be relative. To be realistic, when we are dealing with such a large target in time and space, the expression of fire danger on a dimensionless scale is the only feasible method.

The second point in the management process where fire information is needed is at the time a fire is actually reported. This is a much different situation than in presuppression -- the objective here is to determine the behavior of a reported fire so that the optimum dispatch can be made. The fire manager is looking at that point in space and time where the fire is occurring -- the topography, the aspect, the fuels, and hopefully, the actual weather.

In contrast to the generalities acceptable at the presuppression stage, the type of information that is needed is very specific. The fire dispatcher would like to know how fast the fire is spreading -- its rate of perimeter increase -- and how intense the fire is burning. Of course, the other information which he would have at his disposal, in addition to

those parameters which would affect the fire behavior, would include trafficability, accessibility, and the resistance to control -- fuels, workability of the soils, etc. The point is that he needs specifics, not generalities.

So, how does this relate to the subject for the day? Fire-danger rating was conceived and designed to satisfy the needs at the presuppression stage of fire management. This is an extremely important point for you as fire managers to realize. You must distinguish between the presuppression and the suppression requirements. Fire-danger rating is capable of providing the information that is needed for presuppression planning. However, it can only be used as a guide to the prediction of the behavior of a reported fire. The state-of-the-art of fire behavior technology, if I may use that term, is such that only the requirements of the presuppression phase can be satisfied. The prediction of exactly what a given fire will do under specific conditions of topography, fuels, and weather, at least to the degree of accuracy that is required for efficient dispatch, is not presently within our capabilities.

One of the very common mistakes made in fire control is to use fire-danger ratings as predictors of the behavior of specific fires. This is just not reasonable, and as you become familiar with the many, many problems that have had to be faced in putting together a fire-danger rating system, you will see the problem in using fire-danger ratings, at face value, in the suppression phase. I am not saying that the fire-danger rating values cannot be used in suppression. They can be a very important guide, but only another tool that the fire dispatcher has at his disposal.

Research is not ignoring the needs of the fire dispatcher with regard to the specifics of fire behavior. A tremendous amount of work is presently being done in basic research, and also in the management field, with regard to the cataloging of data and the "real time" interpretation of all the specifics that govern fire behavior.

THE CASE FOR A NATIONAL FIRE-DANGER RATING SYSTEM

Though it is obvious to most of us, there are probably a few people, still, who do not recognize why a national system of fire-danger rating is desirable. Let us briefly review the needs that such a system would satisfy.

First of all, there is a need for a common fire control language. In this day and age when communications facilities are so sophisticated, it is essential that people in one part of the country are able to communicate effectively with those in another part. Modern transportation has made it possible to exchange fire control personnel during periods of emergency -- both within and between organizations. During periods of emergency when a mix of forces from different organizations is being utilized, the risk of misinterpreting fire-danger information is not acceptable.

At a much higher level of management, there is also a need for a national system. At that echelon, fire-danger rating can be used as a tool to help with the allocation of funds. This is particularly important with large organizations which have units spread to the far reaches of the country -- fire protection organizations within the Federal Government are good examples. The National Forest System extends from New Hampshire to California, from Florida to Alaska. The Bureau of Land Management, though it is confined to the western part of the country, has responsibilities from Texas to Alaska.

United States federal aid is available to the different private and State fire control agencies. A national system provides a means for comparison of the needs of these different groups.

HISTORY OF THE NATIONAL FIRE-DANGER RATING SYSTEM

At fire control conferences called by the USDA Forest Service in Ogden, Utah, in 1940 and 1954, the need for a nationally uniform fire-danger rating system was emphasized. Conference committees made the following recommendations concerning such a system:

1. It should be based on those environmental factors which control the moisture content of fuels;

2. It should apply nationwide.

In 1954, there were eight different fire-danger rating systems in use across the country.

In 1958, a joint committee composed of fire research and fire control personnel of the Forest Service met and decided that development of a national system was feasible. In June, the Washington Office, Division of Fire Research, organized a team to formulate and carry out the development program; a year later, full-time work on the project began.

By 1961 the basic structure for a four-phase rating system had been outlined and the first, the spread phase, was ready for field testing. The spread phase was field tested in 1962 and 1963; in 1964 a Forest Service Handbook (FSH 5109.11) covering the spread phase was issued for field use.

Since the remaining phases -- ignition, risk, and fuel energy -- were not available, a number of fire control agencies did not adopt the new system, but preferred instead to remain with the systems then in use. User adaptations, interpretations, and additions quickly followed, making it obvious that the spread phase was not uniformly applicable across the country. Continued development was urgently needed.

In 1965, a research project headquartered at Seattle was established to provide a fresh look at the needs and requirements for a national system.

The Seattle project canvassed many fire control agencies across the country, analyzed their requirements, and recommended direction for research which would lead to the development of a complete National Fire-Danger Rating System.

In March 1968 the present National Fire-Danger Rating Research Work Unit was established at Fort Collins, Colorado.

As part of the organization phase, the following points were formulated:

1. A target date of 1972 was established for getting a completed system ready for operational field use. It was the consensus of numerous fire researchers that a fire-danger rating system superior to any in use at the time could be developed from current "state of the art" knowledge.

2. Closely related to (1), the basic structure of the system would be designed so that new knowledge such as better prediction equations and improved fuel information could be incorporated readily.

3. The system would not be introduced "piece-meal" but would be implemented as a complete, comprehensive package.

4. The complete system would include a subjective evaluation of "risk." The development of an objective method would be deferred until the physics of fuel moisture relationships and fire behavior had been developed sufficiently to meet the needs of the system.

5. Ultimately, the system would be purely analytical, being based on the physics of moisture exchange, heat transfer, and other known aspects of the problem.

The preliminary version of the system was inaugurated in May 1970, in Arizona and New Mexico. Stations on eight National Forests, one Bureau of Land Management district, two National Park Service units, and in the State of Georgia participated. In 1971, an improved version of the system was used operationally in the Southwest.

With the publishing of the USDA Forest Service Research Paper RM-84 in February 1972, the National Fire-Danger Rating System was released for implementation.

THE UNDERLYING PHILOSOPHY OF THE NATIONAL FIRE-DANGER RATING SYSTEM

Before actual work could begin, a framework within which the development could proceed had to be built; this constituted what is now called the "philosophy" of the NFDR System. It can be summarized as follows:

1. The system would consider only the "initiating fire." This is defined as a fire which is not behaving erratically; it is spreading without spotting through fuels which are continuous with the ground (no crowning).

2. The system would provide a measure of that portion of the potential job of containment which is attributable to fire behavior. The concept of containment as opposed to extinguishment is basic. Those portions of the containment job dealing with accessibility, soil condition, and resistance to line construction must still be evaluated by other means.

3. The length of the flames at the head of the fire was assumed to be directly related to the contribution that fire behavior makes to the job of containment.

4. The system would attempt to evaluate the "worst" conditions on a rating area by (a) taking the measurements when fire danger is normally the highest (usually in the early afternoon), (b) measuring fire danger in the open, and (c) where possible, measuring fire danger on extreme (southerly or westerly) exposures.

5. The system would provide ratings which would be physically interpretable in terms of fire occurrence and behavior. These evaluations could then be used alone or in combinations, giving the system the flexibility needed to deal with the entire spectrum of fire control planning and dispatch problems.

6. Ratings would be relative, not absolute. The ratings would be linearly related to the activity being evaluated. This means that when a component or index doubles, a doubling of the rated activity relative to what has previously been observed should be anticipated.

COMPARISON OF THE 1972 NATIONAL FIRE-DANGER RATING SYSTEM TO THE MAJOR SYSTEMS CURRENTLY IN USE

Whenever something new comes along, especially something that involves a lot of training and changes in the routine, the question always comes up, and justifiably so, why? What is this new procedure going to provide for us that the old procedure did not? Will it help us to improve? There is no doubt in the minds of the developers that the new NFDR System is a distinct improvement over all of the other systems which have been developed, but to spotlight those areas where you can expect improvements from existing systems, let us compare the 1972 national system with two of the most commonly used fire-danger rating systems in use at this time.

National Fire-Danger Rating System, 1964
(Spread Phase)

First, let us look at the NFDR spread phase which was released in 1964.

Similarities

There are a number of similarities between the two systems. First of all, the ratings are on a relative scale. If a rating doubles, you can expect a doubling of the activity being rated. Secondly, the spread evaluation for both systems applies to the linear rate of spread of the head fire. With regard to the fuels, the heaviest fuels considered by both systems are the same -- about 3 inches in diameter for roundwoods or branch woods, and about 4 inches deep for duff and litter, and both systems consider the living lesser vegetation.

Both systems are designed to evaluate the worst conditions on a fire-danger rating area during a rating period. Another very important similarity, and one which we will talk about in detail later on, is that the fuel moisture evaluations for both systems are for roundwood -- neither system incorporates a separate moisture evaluation for duff and litter. Both assume that the relationships derived for roundwood apply equally to duff and litter.

Differences

The major differences between the 1972 and 1964 systems will be of more interest to you. First of all, for 1972, all four phases are available. These include ignition, risk, spread, and fuel energy, or as it is called, the energy release. Also available in 1972, the manager can choose between nine different fuel situations, whereas the 1964 system considered only two -- fuels in the open and fuels under a forest canopy. The 1972 system introduces the concept and emphasizes the importance of duration of precipitation as opposed to amount -- this will be discussed in detail later.

The 1972 system is analytically based, whereas the 1964 system was derived from the analysis of empirical data collected primarily in the Southeastern United States. In addition to considering the herbaceous living material, the 1972 system also considers the living woody plants in the understory. The fine fuel moisture relationships that were derived for the 1972 system consider the effects of sunshine or, as it is technically known, insolation. All fuel moisture values will now be expressed as percent; in the 1964 system the fine fuel moisture was expressed in percent while the 10-day timelag, or the buildup fuel moisture, was indicated on an open-ended scale -- the higher the index, the lower the fuel moisture.

The 1964 system did not consider intermediate fuels, only the fine fuels and the buildup fuels. A more complete picture is now available because the NFDR System considers not only the fine and buildup fuels, but the intermediate-sized fuels.

A last, but very significant, difference between the 1964 and 1972 versions of the NFDR System is that the 1972 system includes slope in its spread evaluation, whereas the 1964 system did not.

Wildland Fire Danger Rating System

The only other system currently in use that will be discussed is the California Wildland Fire-Danger Rating System which has been in use since the mid-50's.

Similarities

Like the 1964 and 1972 NFDR Systems, the Wildland system ratings are expressed on a relative scale. Both the Wildland and the 1972 systems consider the intermediate fuels. The Wildland system has used the ponderosa pine dowel fuel moisture as basic input information. The Wildland system, like the 1972 NFDR system, is a multiple index system -- it rates spread, energy release, and ignition. However, it does not rate risk.

Like the 1972 system, the Wildland system considers two classes of living fuels -- the lesser herbaceous material and the woody vegetation. Lastly, both systems include slope in their spread evaluation.

Differences

First, one that has already been mentioned, is that in the 1972 national system, risk is available. In the Wildland system the largest fuel considered has a timelag of about 1,000 hours, which is equivalent to a log approximately 6 inches in diameter. The largest fuel that the NFDR System considers has a 100-hour timelag -- a diameter of about 3 inches. The California system recognizes three general fuel types -- grass, brush, and timber, while the NFDR System at the present time recognizes nine fuel types.

The 1972 system uses precipitation duration instead of precipitation amount, which is the primary measure of rainfall used by the Wildland system. Another improvement that the 1972 national system has incorporated is the effect of insolation on the fine fuel moisture.

A very significant difference between the two systems involves the spread evaluation. In the NFDR System it is applicable to the forward rate of spread of the head fire, whereas in the Wildland system, spread

is related to the rate of perimeter increase. The NFDR System considers that the magnitude of the containment job is a function of the flame length, while, in the Wildland system, the containment job is considered as a function of the area of line that has to be built.

The last difference that you should be aware of is that in the NFDR System the ratings between fuel models are comparable. In other words, a spread component of 10, whether it be in grass, hardwood, timber, or pocosin, would mean the same thing. In the Wildland system, comparability between the different fuel types does not exist. All three fuel types had a potential spread of 100. A 100 in brush does not mean the same in terms of perimeter increase as a 100 in grass, or 100 in timber.

SUMMARY

In summary, there are a number of points which should be emphasized. First of all, the NFDR System is designed to satisfy the requirements of the presuppression planning in the fire management system. Fire-danger rating can be used as an aid to dispatch, but it must be used with judgment -- it cannot predict the behavior of a specific fire. The ratings are general, applying to a large area over an extended period of time. They are expressed in index form which indicates relative levels of fire danger.

A very important concept is that of the initiating fire. The NFDR system is dealing with a fire which is spreading from a point source through a fuel that is continuous. It is not spotting, nor is it exhibiting any of the other characteristics of an extreme behavior such as crowning or fire whirls.

Remember also that we are dealing with the containment of a fire and not with its extinguishment. You will recognize the significance of this concept when we begin to talk about fuels. Another basic part of our philosophy is that the flame length at the head of the fire is a measure of the containment job. Basically, we are saying that if the head fire can be stopped, the flanks and the rear can be handled.

The ratings are aimed at evaluating the worst conditions which will be encountered on the fire-danger rating area during the rating period. The idea being that if the fire manager has a measure of the worst, then any extrapolations that he must make from those values will always be toward lesser severity. If the fire suppression forces are prepared to handle the worst conditions to be encountered on the fire-danger rating area, then certainly they should have no trouble handling situations which are of lesser severity.