

# Fire Weather Index

## THE BASIS FOR FIRE DANGER RATING IN BRITISH COLUMBIA

A SLIDE-TAPE PRESENTATION

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Canadian Forestry Service



Fisheries  
and Environment  
Canada

Forestry  
Service

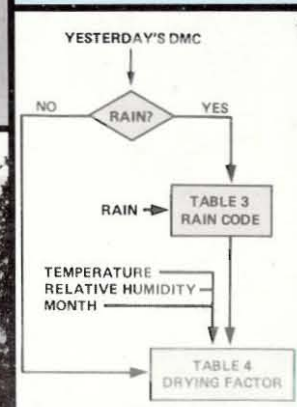
Pêches  
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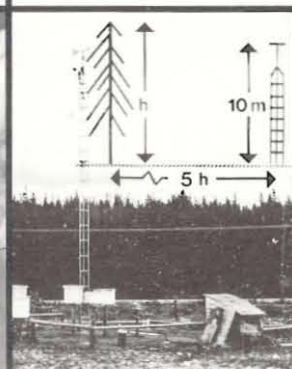
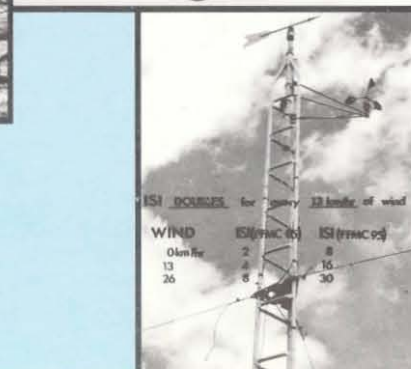
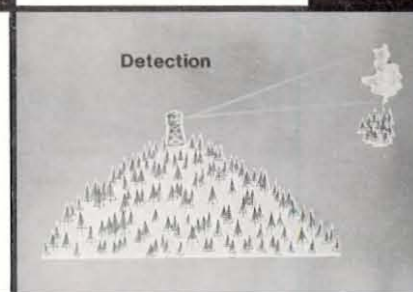


Coast and Wet Interior Region I

Buildup Index	Fire Weather Index				
	0	1-7	8-16	17-30	31+
0 - 19	I				
20 - 42		II			
43 - 69			III		
70 - 118				IV	
119 +					V



- Fuel Type B**
- \* OPEN CONIFER STANDS or YOUNG CONIFER PLANTATIONS
  - \* SURFACE FUELS: GRASS, FIREWEED, BRACKEN, or CARIBOU MOSS (CLADONIA)
  - \* SCATTERED TO MODERATE DOWNED WOOD
  - \* LITTER LAYERS LOOSELY COMPACTED
  - \* DUFF LAYERS SHALLOW



## FOREWORD

The Canadian Forest Fire Weather Index was introduced by the Canadian Forestry Service in 1969-70, as a stage in an ongoing development program of a Canadian Forest Fire Danger Rating System. The B.C. Forest Service has applied the Fire Weather Index, along with other CFS guides on fire behavior and fire use, in a package of fire management decision aids.

This text is the commentary of a 35 mm slide-audio tape program to improve the understanding of fire danger rating systems used by management agencies in British Columbia. It introduces the basic components of these fire management decision aids, with particular emphasis on the Fire Weather Index, for students and fire managers who will be taking additional training courses or who want a simplified overview of the material.

The slide-tape presentation can be broken into four short sections, allowing question periods to be introduced by instructors. The following format is used:

Copies of the slides and tapes are available on loan from  
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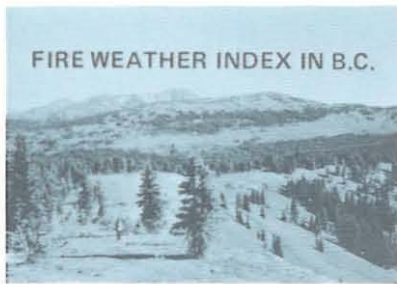
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## ACKNOWLEDGMENTS

The author acknowledges the work of illustrator J. Wiens, of PFRC, who prepared many of the graphic slides. Many others, including J. Muraro, R. Silversides, C. Van Wagner and R. Russell, contributed slides from their research work. G. Robertson and W. Cave, of the fire research group, along with the PFRC photographic section, worked on graphic production, and their efforts are appreciated.

<u>Section</u>	<u>Slide No's.</u>	<u>Subject</u>
Ia	1 - 46	Scope of Canadian Forest Fire Danger Rating System; Moisture Codes of the Fire Weather Index.
Ib	47 - 69	Fire Behavior components of the FWI.
II	70 - 117	FWI as a fire danger index.
III	118 - 160	Guides for site-specific fire management decisions, including Wildfire Behavior Indices and Prescribed Fire Predictor.





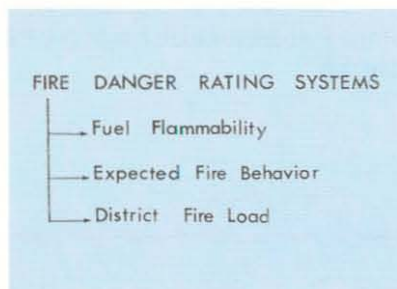
## 1) FIRE WEATHER INDEX

The basis for fire danger rating in British Columbia

### SECTION 1a - SCOPE OF CANADIAN FOREST FIRE DANGER RATING SYSTEM



2) Pre-organization and planning are basic functions of fire management organizations. Activities, ranging from seasonal and day-to-day implementation of Fire Prevention Regulations and Suppression Crew preparedness to the pre-organizing of a prescribed burning program, can be more effectively planned by evaluating **FIRE DANGER** information.



3) Fire danger rating systems provide quantitative information about fuel flammability, expected fire

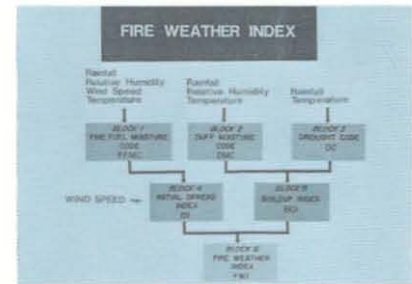
behavior, and historic relationships between fire load experienced on given areas and danger index values.



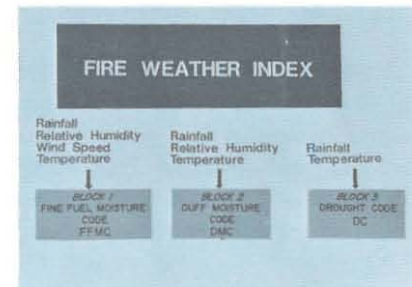
4) The reason for using the **CANADIAN FOREST FIRE DANGER RATING SYSTEM (CFFDRS)** as a decision-making aid for forest operations in B.C. is to ensure that organized knowledge and experience contained in fire reports and from field studies of fuel flammability and fire behavior relationships is utilized in fire management planning.



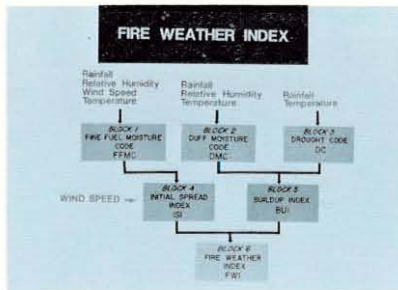
5) Fire behavior is the result of three broad groups of interacting factors. These are **WEATHER**, **FUELS** and **TOPOGRAPHY**, which together determine the fire environment. Fire danger rating systems attempt to evaluate many elements of the fire environment, so that indices or ratings of fire behavior characteristics or fuel flammability characteristics can be computed and used in daily planning activities. The CFFDRS produces two families of indices: the **FIRE WEATHER INDEX** and the **FIRE BEHAVIOR INDICES**.



6) Basic to effective use of the CFFDRS in everyday planning of fire activities is an understanding of the system's most important constituent, the **FIRE WEATHER INDEX**. The FWI is the backbone of the system, and the components of the FWI are used in various phases of the B.C. Forest Service Decision Aids package, from establishing Danger Class for a day at a given fire weather station to rating the difficulty of control of a prescribed burn.



7) The FWI is a way of evaluating fuel flammability by accounting for effects of past and present weather on three kinds of forest floor fuels. The FWI provides numbers called **MOISTURE CODES** which are a measure of the moisture content of those fuels.

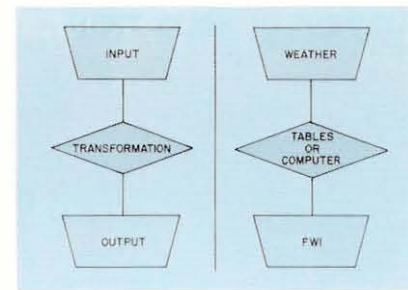


8) In addition, the FWI takes the moisture contents expressed by the codes, combines them with wind and with an index of amount of available fuel, and produces a final index number related to fire intensity in a standard forest type.

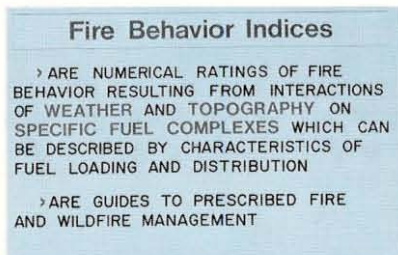


#### 10) MECHANICS OF THE FIRE WEATHER INDEX

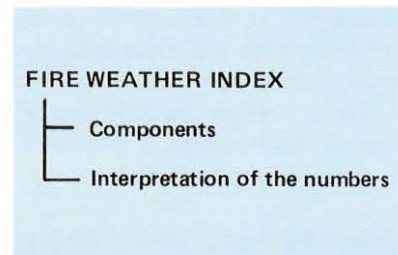
Dealing with the first index family, the FWI, we will look at how the component codes and indices are constructed; what kinds of fuels are represented,



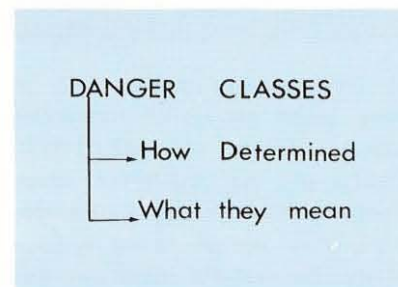
13) Like many solid-state electronic systems, the FWI is composed of modules or independently functioning units, each producing an output that the user can utilize independently of other outputs. In addition, if all modules are combined in a circuit or flow governed by tables or as processed by a computer program, a final output value, the Fire Weather Index itself, is the result.



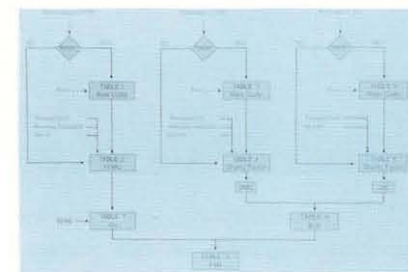
9) The second index family, the **FIRE BEHAVIOR INDICES**, is presently structured as a group of five broadly differentiated fuel types. These guides relate the component moisture codes and indices of the FWI with differences in amount and condition of fire carrying fuels to express Ease of Ignition, Rate of Spread and Difficulty of Control classes for each fuel type. Fuel types are differentiated on the basis of stand canopy closure, presence of fire-carrying fuels which are subject to seasonal curing, depth of duff layers, amounts of brush, dead down woody fuel and other variables.



11) and what interpretations can be made from the daily calculated FWI values for a number of representative weather stations throughout a district.



12) We will look at how past fire control experience was used, together with FWI numbers, to establish the recommended fire danger classes throughout the province, and consider how the use of fire danger rating information can aid in both long-term and daily planning of a variety of fire management activities.



14) There are six modules or components of the FWI. The fuel and topography variables of the fire environment are held as fixed quantities, and the daily weather elements are the variables measured and plugged into the system.

The three basic building blocks of the FWI are the **FUEL MOISTURE CODES**.

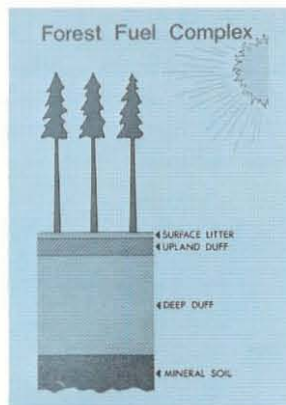


### Weather Observations

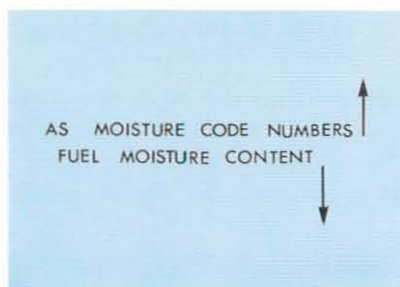
TO CALCULATE FIRE WEATHER INDEX, WEATHER OBSERVATIONS MUST BE MADE AT 1200 (NOON) LOCAL STANDARD TIME EVERY DAY. MEASUREMENTS REQUIRED ARE:

- TEMPERATURE - WET & DRY BULB
- RELATIVE HUMIDITY
- WIND SPEED & DIRECTION
- RAINFALL

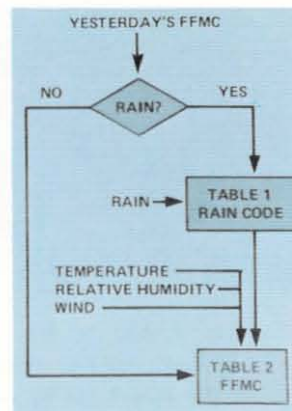
15) Noon local standard time or 1300-hour daylight saving time observations of temperature, relative humidity, wind velocity and past 24-hour cumulative precipitation are entered, in various combinations, into a series of tables that provide the user with code numbers



16) related to fuel moisture content of fine, medium and deep compact forest floor fuels.



17) All three moisture codes are constructed so that higher numbers represent lower fuel moisture content percentages, or drier fuels.



18) Each fuel moisture code has a wetting phase that accounts for any rain effects on increasing fuel moisture and a drying phase that evaluates the effect of that day's weather on removal of moisture from fuels. This daily procedure has the effect of a memory so that each moisture code calculation reflects past weather effects over a portion of the fire season, as well as current daily weather effects on fuel moisture.

### BLOCK 1

#### Fine Fuel Moisture Code FFMC

IS A NUMERICAL RATING OF THE MOISTURE CONTENT OF LITTER AND OTHER CURED FINE FUELS IN A FOREST STAND. FFMC IS AN INDICATOR OF RELATIVE EASE OF IGNITION.

19) FINE FUEL MOISTURE CODE (FFMC) is the first FWI module, and it has the shortest memory of the three moisture codes.



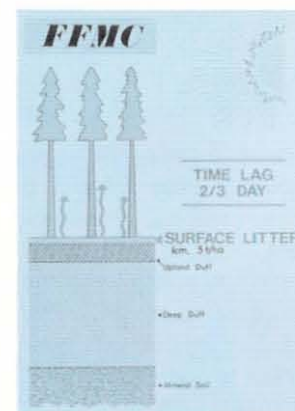
20) FFMC reflects the past several

days' weather effects on the dryness of cured fine fuels on the forest floor of open pine stands. Representative litter layers are 1 to 2 cm deep and weigh about 5 t/ha. FFMC is sensitive to daily temperature, relative humidity, windspeed and rainfall.

### Timelag

the number of days with noon temp. 21° and RH 45% for fuel to lose 2/3 of its free moisture.

21) In terms of timelag, which is a mathematical way of describing the speed at which fuels dry from saturation, similar to the "half-life" of nuclear decay in radioactive materials, the drying rate of FFMC fuels is quite fast. Under the "standard drying day" conditions of 21°C temperature, 45% relative humidity and a wind of 13 km/h at noon, the timelag of FFMC is only about two-thirds of a day.



22) This means that in less than one normal day with these temperature and humidity conditions at noon, fine fuels represented by FFMC can be expected to lose about two-thirds of their free moisture.

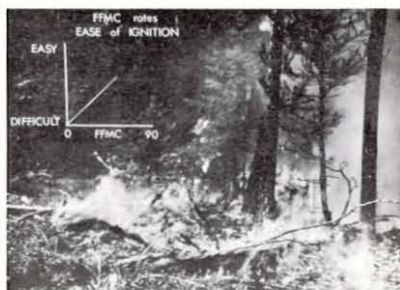
## FFMC - HAS A SHORT MEMORY

0	1	2	3	4	5	6
		days since rain				
			ffmc			
2	64	82	87	88	89	89

23) If you follow FFMC through several days of these same temperature and RH values, you find that the code levels off after increasing for five days, assuming you are starting at a saturated condition. This means that after five days of losing moisture at this rate, there is essentially no more to lose and the fine fuels are at or near equilibrium with their environment. Of course wind, higher temperatures and lower humidities all speed up the fuel drying rate and reduce the final moisture content reached at equilibrium.

FFMC predicts fuel moisture from noon weather to mid-afternoon "heat of the day"

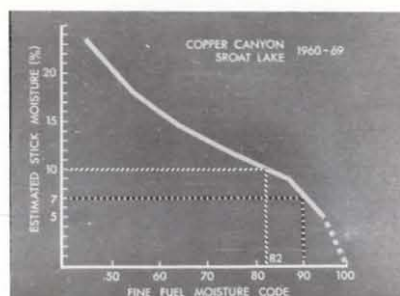
24) Another important thing about the FFMC is that it has a built-in prediction feature. The code you calculate from noon standard time weather readings represents the moisture content expected in the fine fuels during the mid-afternoon peak fire danger period, between 1400 and 1600 hours.



25) Because FFMC is the FWI module that accounts for moisture content of the fine fuels in which fires generally ignite, it is the number best suited to rating **ease of ignition**. It is used for this purpose in all Fire Behavior Indices and the Prescribed Fire Predictor, usually alone, but in some fuel types it is combined with Duff Moisture Code to rate ease of ignition. FFMC reappears later in the modular flow toward Fire Weather Index where it is combined with wind to calculate the Initial Spread Index.



26) The long-familiar B.C. Forest Service hazard sticks are closely related to FFMC. Sticks have been used for many years as ignition guides for slash burning in B.C.



27) This graph shows that for a couple of coastal sites, an FFMC of 82 corresponds to an open stick

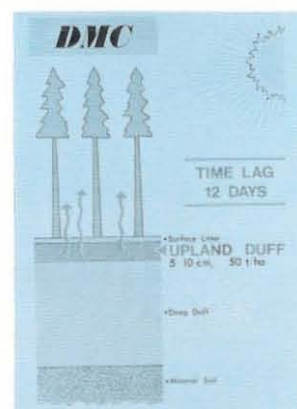
reading of 10% at 1600 hr. FFMC 90 would produce a stick reading of about 7%. Stick readings can be used to estimate FFMC if the required weather observations are not available.

## BLOCK 2

Duff Moisture Code  
DMC

IS A NUMERICAL RATING OF MOISTURE CONTENT OF LOOSELY COMPACTED ORGANIC LAYERS 5 cm TO 10 cm DEEP.

28) The second basic building block of the FWI is the **DUFF MOISTURE CODE**. This module produces numbers related to the dryness of moderately deep duff layers 5 to 10 cm deep, weighing about 5 kg/square meter or about 50 tonnes/hectare.



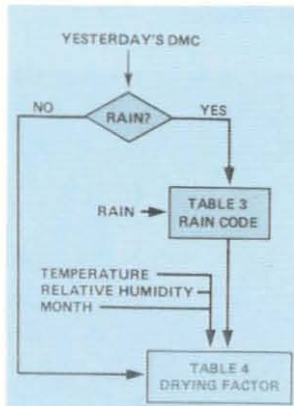
29) As with the other two moisture codes, the DMC is modelled after the wetting and drying mechanisms observed in forest stands.



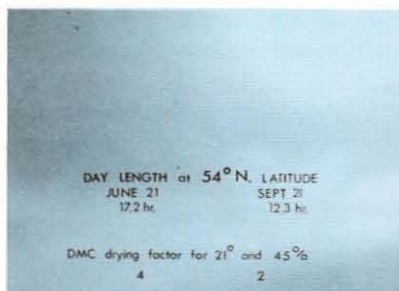
30) The fuel component modelled



by DMC is loosely compacted duff, roughly corresponding to the F or fermentation layer described by soil scientists, and is a principal source of energy produced by a moving fire front in most of our fuel types.



31) The weather factors involved in DMC calculation are daily rainfall, temperature, humidity, and a factor for day length, which varies from month to month through the fire season.



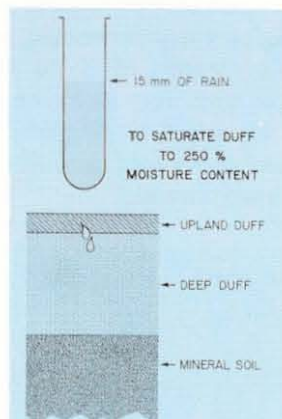
32) The length of the day influences duration of drying. A temperature of 21° and an RH of 45% in June (the month with longest day length) represents almost twice as much daily drying power as a day in September, with the same noon weather. Therefore, the DMC daily drying factor for June is 4, compared to 2 for the same conditions in September.

#### Time lag

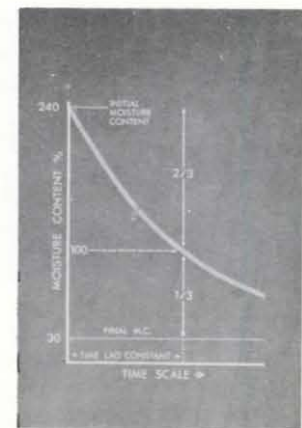
Number of days for a fuel to lose two thirds of its available moisture

FFMC 2/3 day  
DMC 12 days

33) Comparing the timelag of DMC with FFMC, we see that DMC is much slower to dry to equilibrium moisture content levels.



34) DMC also represents fuels that hold much more water at saturation than the fine fuels. The duff layers which DMC models will hold 15 mm of rain before run-through occurs, resulting in moisture contents up to 250% of dry weight. Fine fuels, on the other hand, will only hold about half a millimetre of rain before runoff starts, and generally the fine twigs and needle litter do not hold much more than 100% of their dry weight in water.



35) DMC has a time lag of 12 days, compared to the less than one day lag of FFMC. To get an impression of this drying rate, a timelag of 12 days means that a duff layer starting out saturated at 240% moisture content and zero DMC would dry to about 100% m.c. after 12 dry days, at which time DMC would be about 50.

DUFF MOISTURE and DMC		
Day 0	12	48
MC% 240	100	20
DMC 0	50	200

36) If no rain fell for 48 days, the duff would continue drying to its equilibrium or lowest level of about 20% and the DMC would be around 200. Of course, each time rain falls, the DMC rainfall table is used to decrease the code value by an appropriate amount and the drying process starts again.

The transforming of the DMC into estimates of fuel flammability is handled in the FWI calculation and in the various Fire Behavior Indices and the Prescribed Fire Predictor.

## BLOCK 3

**DROUGHT CODE  
(D.C.)**

IS A NUMERICAL RATING OF MOISTURE CONTENT OF DEEP COMPACT ORGANIC LAYERS. D.C. IS A USEFUL GUIDE FOR LONG RANGE PRE-SUPPRESSION ACTIVITIES OVER LARGE AREAS.

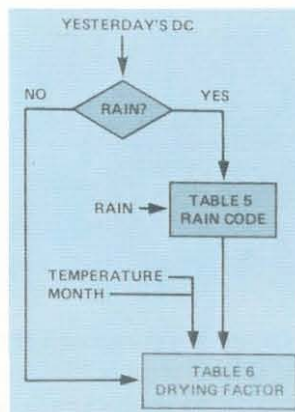
37) Finally, we will look at the third of these moisture codes of the FWI, the long-term drought indicator or **DROUGHT CODE**.



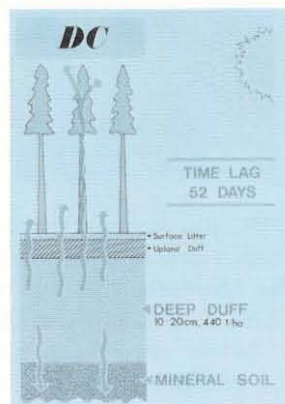
38) Deep, persistent burning, great fuel consumption and mop up difficulty is often experienced in parts of B.C. that have deep compact organic layers associated with mature and overmature coniferous forests and where long periods of drying occur.



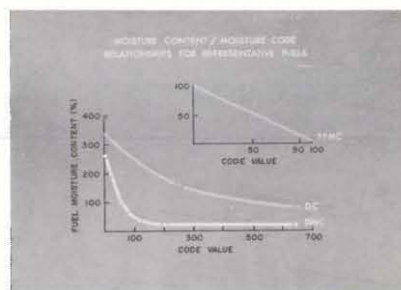
39) These forests require a fuel moisture indicator which is sensitive to the seasonal drought. In the coastal rain-shadow and plateaus adjacent to the interior dry belts, these last for 2, 3 or occasionally 4 months.



40) Drought Code (DC) uses daily rainfall, noon temperature and month to produce a number related to the moisture content of 10- to 20-cm-deep compact duff layers weighing about 44 kg/m<sup>2</sup> or 440t/ha. These deep duff layers hold up to 20 cm of water when saturated.



41) They dry rather slowly. When saturated, these layers hold as much as 350 to 400% of their dry weight in moisture, and dry so gradually through the process of evapotranspiration that their timelag is 52 days.



42) Because deep duff layers hold

so much moisture and dry so slowly, a whole timelag period of drying weather may elapse before they are dry enough to support combustion. In areas subject to summer drought, when DC values of 500 or greater are reached, these fuels can be a real fire control problem.



43) At drought codes of 500 or more, moisture contents in the deep duff layers are usually around 100%, well able to support long-duration smoldering combustion and add to mop up and control difficulty on wildfires and prescribed burns.



44) Occasionally, in parts of the province, overwinter precipitation falls short of the 20 cm of water required to recharge the deep, heavy fuels represented by Drought Code. In some years, fall rains do not have a chance to saturate the heavy fuels before winter freeze-up occurs. Sometimes snowpacks in spring are so light that runoff occurs before the deep



organic layers have fully thawed, resulting in runoff rather than percolation.

Overwinter adjustment to DC starting value  
EXAMPLE  
1) Sept 30 DC = 500  
2) Oct - Mar precip. 100 mm  
3) April 1 DC = 211

45) Where recharging of the deep duff layer has not occurred, a spring adjustment to DC starting values can be made by users. It is applied when necessary to fire weather network stations by the regional fire weather forecast unit. The adjustment procedure is detailed in the User's Manual for the CFFDRS.

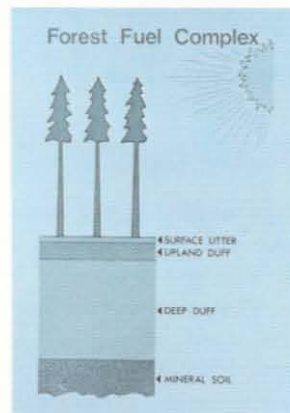
#### Moisture Codes

FFMC - fine fuels - ease of ignition  
DMC - duff layers - ignition, fire intensity  
DC - deep duff - mopup and control difficulty

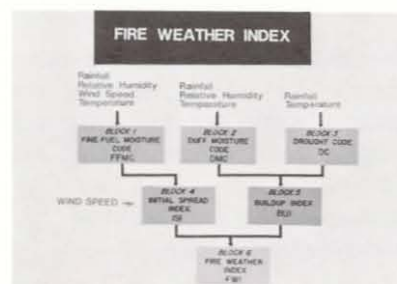
46) So much for a brief introduction to the three moisture codes of the FWI, what they are called, the kinds of fuels they are designed to represent, and some idea of their meanings in terms of ease of ignition and fire persistence.

Instructors Note: Stop tape here for question period

## SECTION 1b-FIRE BEHAVIOR COMPONENTS OF THE FWI



47) The idea of a "standard" fuel in the Fire Weather Index is basic to the design of the system. The FWI was conceived as an index that would be based on weather variables only, so that a uniform scale could be applied anywhere in Canada. The field data on moisture content and fire behavior used in the design of the moisture codes and the Fire Weather Index came from pine types, so jack pine and lodgepole pine stands were designated as the "standard" fuel.



48) Fire behavior characteristics, derived mainly from field studies in the "standard" fuel types, are indicated to the user by the final three blocks of the Fire Weather Index system. The fourth and fifth blocks, Initial Spread Index and Buildup Index, are really intermediate components between the moisture codes and the FWI. They provide the necessary links between fuel moisture content and fire intensity.

Fire Weather Index, the sixth and final block, is an index value related to head fire intensity expressed as an energy output rate per unit length of fire front.

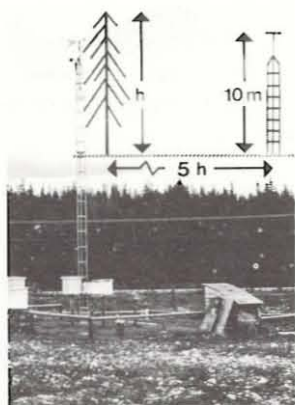


49) While the intermediate stages between fuel moisture and FWI could have been hidden from the user in a complex calculation, it was felt that the two calculated values would be of some worth to the user in danger rating applications. For this reason, Initial Spread Index and Buildup Index are calculated daily and enable the user to interpret the relative importance to fire danger on any given day of wind speed compared to the amount of available fuel.

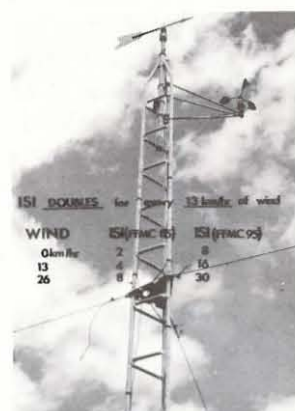
### BLOCK 4 Initial Spread Index ISI

IS A NUMERICAL RATING OF THE RELATIVE FIRE SPREAD EXPECTED IMMEDIATELY AFTER IGNITION IN A STANDARD FUEL TYPE.

50) INITIAL SPREAD INDEX (ISI), Block 4 of the FWI system, combines wind speed with fine fuel moisture, through FFMC, to produce a number related to spread rate immediately following ignition in the "standard" fuel.



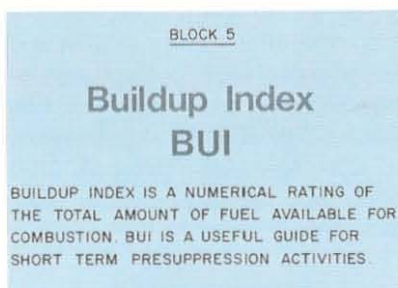
**51)** ISI requires the open wind speed measured at the fire weather station, ideally a 10 m mast located in an opening with a radius at least five times the height of surrounding timber or buildings.



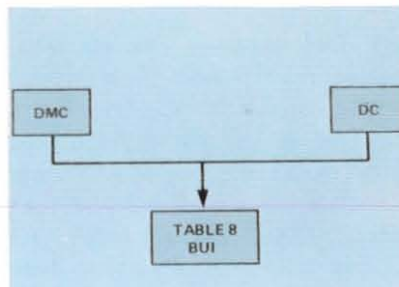
**52)** The only other input into ISI is the FFMC, resulting in an ISI scale which, for any given fuel moisture, doubles for every 13 km/h increase in wind speed. This ISI scale represents the initial spread rates of experimental fires quite well, but may not correlate exactly to observed spread rates on established fires spreading through wildland fuels where varying amounts of available fuel may affect the spread rate.



**53)** To keep the system simple and workable, the assumption is made that, at least for the period immediately following ignition and for moderate wind speeds up to 40 km/h, the ISI combination of FFMC and wind is a realistic representation of fire spread in open light-fuel stands during the period immediately after ignition. This experimental fire in lodgepole pine north of Prince George is spreading 1 m/min at an ISI of 6 and a wind of 6 km/h.



**54)** BUILDUP INDEX, the other intermediate module between the moisture codes and the FWI, is a weighted combination of DMC and DC which is designed to be an index of amount of available fuel dry enough for combustion.



**55)** The two moisture codes are combined in such a way that the

upper duff layers, represented by DMC, really control the Buildup Index (BUI).

If DMC zero, DC does not increase BUI.

		DC	
		100	300 600
DMC	BUI		
0	0	0	0

**56)** For instance, if DMC is zero, indicating saturated surface fuels, the level of the DC has no effect on BUI and the BUI also stays at zero, no matter how high the DC.

If DMC greater than zero, DC increases BUI, but never more than double the DMC

		DC	
		100	300 600
DMC	BUI		
40	43	62	71
101	103	114	147

**57)** However, when DMC is greater than zero, the DC effect increases the value of the BUI above the DMC value, in recognition of a contribution to available fuels in proportion to the size of the DC. The maximum possible effect of DC is to make the BUI double the DMC.

This rather complicated weighting procedure makes the Buildup Index primarily an upper organic layer moisture monitor with a deep duff warning bell built in. Hence there is a difference in the way users should interpret buildup and long-term drought, at least with reference to the FWI system. Long-term drought is measured in the system by Drought Code, and reflects, by its value at any time in the fire season, the cumulative effects of seasonal rainfall and temperature regime.





58) DC should be expected to relate to smouldering in deep duff layers and long duration of slow consumption of heavy fuels long after passage of fire fronts.

BUI normally increases through the fire season  
VERNON averages 1957-1966

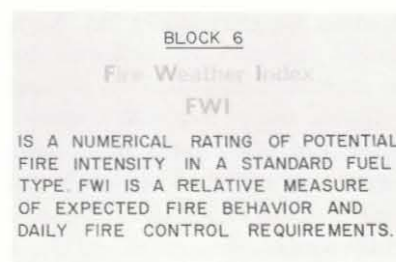
	May	June	July	Aug.	Sept.
DMC	44	49	55	65	38
DC	130	255	390	516	538
BUI	48	66	81	99	65

59) DC tends to rise gradually through the fire season, peaking in late August or early September in this province. This gives a slight seasonal effect to BUI, making it somewhat higher in late summer for a given DMC.

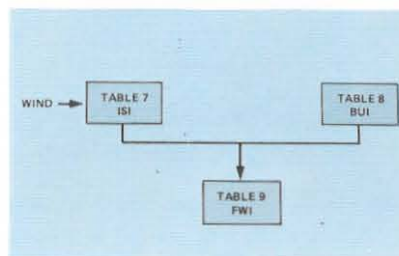
Use BUI as guide to fuel available for combustion by moving fire front.  
Use D.C. as guide to seasonal and overwinter Drought. Relates to total fuel consumption, smouldering in deep duff and large logs.

60) All of this shows that the system treats buildup and long-term drought somewhat differently. BUI gives the available fuel factor for fire intensity determinations and is controlled mainly by the DMC,

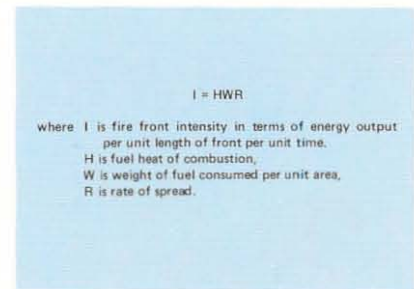
but is modified by the DC. Long-term drought is accounted for by DC throughout the fire season and even from one season to another. However, DC is best thought of as being related to **total fuel consumption** and the relative amount of smouldering combustion expected after passage of a fire's main front, rather than the **actual intensity** delivered from the moving fire front.



61) The sixth and final block is the **Fire Weather Index** itself. It is a combination of all the preceding five components in such a way that an FWI value has a relationship to fire frontal intensity.



62) The rate of spread contribution to fire intensity comes from ISI, while the weight of fuel available for consumption is derived from BUI.



63) The resulting FWI is the single index number most closely related to fire intensity observed on the fire line. Fire intensity can be described by the equation

$$I = HWR$$

where I is fire front intensity in terms of rate of energy output per unit length of fire front. H represents the heat of combustion contributed per unit of fuel weight. W is the weight of fuel actually consumed during passage of the fire front. R is the forward rate of spread.



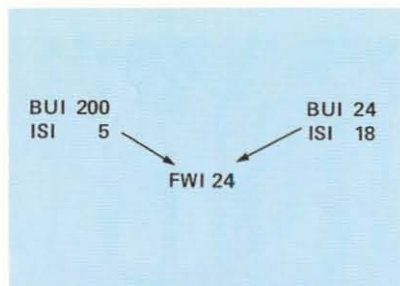
64) This experimental fire of Van Wagner's, Red Pine 3, was one of those used in establishing the relationship between FWI and fire intensity. Intensity was calculated as 2,456 kilowatts per meter of fire front at an FWI of 22.

$$I = HWR$$

↑                      ↑                      ↑  
 FWI                      constant                      BUI                      ISI

**65)** FWI represents intensity of the fire front in the equation. Heat of combustion (H in the equation) varies so little from fuel to fuel that it can be thought of as a constant. Buildup Index represents fuel consumed (W) and Initial Spread Index represents rate of spread (R).

The individual index component values tell you more about the relative importance of each contributing factor to fire intensity than you can derive just from the FWI itself.



**66)** For example, a BUI of 200 and an ISI of 5 give an FWI of 24. The same FWI 24, and presumably the same fire intensity, occurs with BUI 24 and ISI 18. Obviously, if the fire front generates the same energy output on both days, it is important to be aware that much higher spread rates are involved in the second case, although fuel consumption would be less. In addition, it may be significant whether the ISI of 18 in the second case resulted from a high wind of 40 km/h and a moderate FFMC of 86 or from a low wind of only 10 km/h but very dry fine fuels, FFMC 97.



**67)** The FWI is used only as a final index for the broadest of planning activities where a single number is preferable to the multiple numbers which make it up. Many danger rating-related activities can be planned more effectively through judicious use of the FWI's components, but FWI, alone or in association with BUI, is generally the most effective way to describe classes of fire danger.



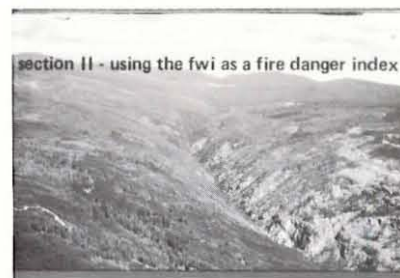
**68)** In everyday use, the FWI and its components are arrived at in one of two ways. They can be calculated from a set of tables which approximate the values obtained from a series of mathematical equations. Or the second, more accurate way is from a computer programmed to solve the FWI equations.



**69)** The Fire Weather Forecast Unit of the Atmospheric Environment Service presently provides calculated indices in conjunction with its fire weather forecast service. Tables provide acceptable estimates of the indices, but differences will arise between table and computer calculated values, because of the use of classes and rounding of values necessary to keep the tables to a manageable size.

**Instructor's Note:** Stop tape here for question period. Project Slide 70 on screen before starting tape for Section II.

## SECTION II - USING THE FIRE WEATHER INDEX AS A FIRE DANGER INDEX



**70)** How does the Fire Weather Index become a fire danger index? What sort of planning activities can be aided with a danger index? What activities can be better handled with other decision aids? These questions and others are dealt with as we move from the inner workings of the FWI, just covered, to what can be done with the indices.



## FIRE DANGER INDEX

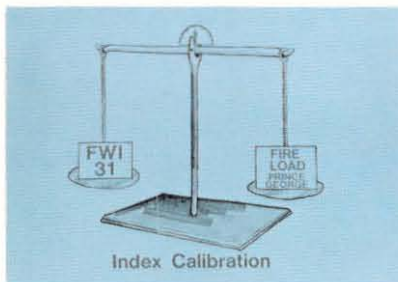
A numerical rating of fire danger factors affecting ignition, spread, control difficulty and damage caused by forest fires.

## FIRE DANGER INDEX...

... is used to judge day to day Preparedness and Suppression requirements via a scale of Fire Danger Classes.

**71)** A commonly held view of fire protection agencies for many years has been that a fire danger index should give the user a rating of probability of fires occurring and their potential for spread and damage.

**74)** A Fire Danger Index should rate each day in an area on a scale related to the level of effort the fire organization has expended to handle the fire load under similar weather conditions in the past.



**72)** This philosophy guided the calibration of the Fire Weather Index into a danger rating index for B.C. The assumption was made that the fire danger class for a day on an area represented by a fire weather station could best be defined in terms of expected fire load on that area.



**75)** This province has such a wide range of fire weather severity and, consequently, of fire load, that developing a suitable fire danger rating scale for the whole province is difficult. It doesn't take any analysis to realize that the Kamloops-Okanagan regions normally have the most severe fire climate of any forested region in Canada, while the outer west coast has about the least severe fire climate. The difficulty arises in providing a scale of rating fire danger relative and relevant to the fire load normally experienced in any part of the region.

## FIRE LOAD

The number and magnitude of fires requiring suppression action during a given period within a specified area.

**73)** Fire load can be thought of as the total amount of fire suppression required per units of area and time, measured by the number of fires requiring action and the amount of fire perimeter requiring line building, holding, mop up and patrol.



**76)** We have assumed that managers planning prevention and preparedness activities can respond to about five levels of fire danger. Because of its extreme fire weather and fire load potential, Kamloops requires different values for setting these five danger levels from those required for most other districts.



**77)** By doing an extensive analysis of both fire weather occurrence and corresponding fire load experienced over a number of years throughout the province, a way was found to establish fire danger classes. The method is an attempt to classify the relative magnitude of the fire control problem in any broad portion of a district.



78) Briefly, the studies showed that the normally very wide range of fire weather severity in B.C. can be broken down into **three** large areas, where the average fire season weather is similar.



79) Of course, there is much variation within each of the three areas because of elevation, topography, rain shadows created by mountain ranges, etc., but the Fire Weather Indices recorded at key weather stations over many years verify these three broadly similar regions, now called **Danger Regions**.



80) Danger Region 1 is a very large area including all of the coast west of the Coast Mountains, the northern interior and the southern interior wet belt. Because of very low fire danger generally experienced, some

exceptions to the rule of general similarity of weather are included in Danger Region 1. These are the wet north coast, west coast of Vancouver Island and west coast of the Charlottes.

Instructor's Note: Change tapes and slide trays. Project Slide 1,81 on screen before restarting tape.



1,81) Danger Region 2 is transitional in fire weather severity between wetter Region 1 and drier Region 3. Region 2 encompasses the drier portions of the Cariboo and the Chilcotin Plateau, lying in the rain shadow of the Coast Mountains and generally south of the summer storm tracks which take Pacific weather systems across the north half of the province.



2,82) This region roughly corresponds to the Cariboo Aspen-Lodgepole pine-Douglas-fir Biogeoclimatic Zone of B.C.



3,83) Danger Region 3 is the driest region of the province, and includes the Thompson-Okanagan semi-arid valleys and summer-dry plateaus of the southern interior. The west and east Kootenay regions, which lie in a partial horseshoe around the interior wet belt, are also included in Danger Region 3.

CALIBRATION SUMMARY			
period	no. of weather stations	type of station	no. of fires
1957-66	20	AES	8700 mean 6600 firing
1970-73	46	AES BCFS	3995 mean 3471 firing

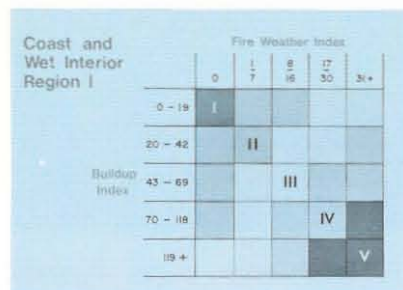
4,84) Each fire between 1957 and 1966 and between 1970 and 1973 was assigned indices from the most appropriate available weather station selected for calibration. This study showed that similar percentages of each danger region's fire load was associated with the few most severe days of fire weather as measured by the Fire Weather Index and Buildup Index.

Expect **THREE TIMES** the fire load with each increase in **DANGER CLASS** on average over any danger region.

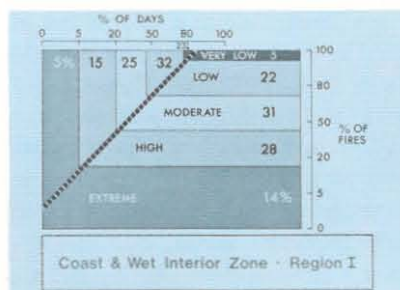
5,85) Depending on the Danger Region and the study period, between



3 and 9% of the days were put into the highest danger class. These days of highest fire danger were at one time called Extreme, but are now referred to as "Class V Days". Danger classes are designated with Roman numerals I through V, each higher class representing roughly three times the fire load expected in the next lower class. This distribution of threefold increase in fire load with each increasing Danger Class is not absolute for all districts or zones surrounding key fire weather stations. It does give the manager some idea of how fire business in his district has correlated with fire weather severity in the recent past. Past performance of a fire control organization under the kinds of weather and numbers of fire starts it is used to handling should be a good guide for making broad preparedness plans. The following illustrations show the recommended Danger Classes and how a few fire statistics stack up for the different Danger Regions.



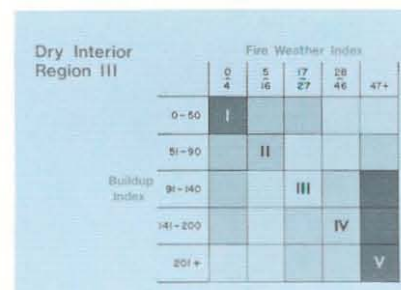
**6, 86)** In Danger Region 1, danger classes are recommended on the basis of this chart of Fire Weather Index and Buildup Index. Danger Class V days, for instance, are all days exceeding FWI 30 and days exceeding FWI 16, if the BUI is greater than 118.



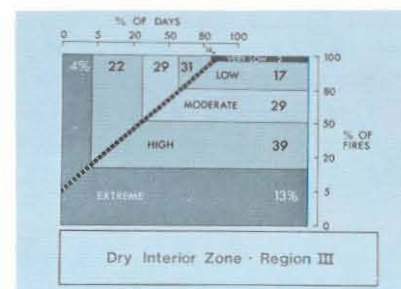
**7, 87)** Danger Region 1, as a whole, spends about 5% of the days between May 1 and September 30 in Danger Class V. This is the average number of days in which BUI and FWI exceeded the limits for Danger Class V at a number of key weather stations between 1957 and 1966 and again for the 1970 to 1973 period. On those 5% of the days, about 8 days on the average, the number of man-caused fires experienced through Danger Region 1 was about 14% of the total man-caused fires occurring in the season.

DANGER CLASS	REGION I COAST AND WET INTERIOR	REGION III DRY INTERIOR
I	1.1 ha	3 ha
II	2.8	7.8
III	6.5	1.8
IV	13.0	11.7
V	66.5	42.5

**8, 88)** For the 10-year period, these Class V day fires had an average size of 60 ha, almost 5 times the fire size of Class IV day fires. Average fire size dropped to 11 ha in the more recent period, but this was still about 5 times the fire size of Class IV days.



**9, 89)** A similar pattern shows for Danger Region 3, the interior dry belt. It takes a much more severe drying spell to reach the BUI/FWI threshold for Danger Class V in this region. FWI must exceed 46 and BUI must exceed 90 before Danger Class V is reached.



**10, 90)** About 4% of the days in the early period and about 9% of the days in the recent period fell into Danger Class V. On those few worst days in Danger Region 3, about 13% of all the man-caused fires started and they burned to an average final size of three times the size of Danger Class IV fires.

DANGER CLASS	REGION I COAST AND WET INTERIOR	REGION III DRY INTERIOR
I	1.1 ha	3 ha
II	2.8	7.8
III	6.5	1.8
IV	13.0	11.7
V	66.5	42.5

**11, 91)** The average sizes were 42 ha for the 10-year period and 40 ha for the more recent period.



DANGER CLASS	FIRE LOAD INDEX	
	REGION I COAST AND WET INTERIOR	REGION III DRY INTERIOR
I	1.2	2.8
II	4.5	8.5
III	25	15
IV	56	64
V	134	164

**12, 92)** If you calculate a number that combines the numbers of fires occurring on an area in a given time and their sizes, this number can be called a **Fire Load Index** and is related to the expected relative length of the final fire perimeter. Fire Load Index numbers are, in fact, about **three times** as large for Danger Class V days as for Danger Class IV days, regardless of whether you are speaking of Danger Region I or 3 and regardless of whether you consider the 10-year period 1957-1966 or the more recent 1970-73.

Interior Plateau Region II		Fire Weather Index				
Buildup Index		0-4	5-16	17-26	27-37	38+
	0-48	I				
	49-85		II			
	86-118			III		
	119-158				IV	
	159+					V

**13, 93)** Danger Region 2 is transitional between the other two regions. Days with FWI greater than 37 are class V days if BUI is above 118. An additional block of class V occurs when FWI exceeds 26 and BUI exceeds 158. For the 1970 to '73 period, 3% of the days fell into Class V, accounting for 6.4% of the man-caused fires. These fires were about seven times the average size of the man-caused fires on Class IV days, and the Fire Load Index was three times the size comparing Class V days with Class IV, identical to the relationship found for the other danger regions.

Clearly, such a calibration of the Fire Weather Index and Buildup Index to form Danger Classes based on past fire weather and past fire control experience is the broadest kind of a calibration that could be done and, as such, is probably suited only to rather broadbased management applications. Many factors affect fire history analyses, not the least of which are:



**14, 94)** similarity of weather at the fire weather stations used to calculate the indices and the on-site fire conditions;



**15, 95)** use of indices on the day of ignition to represent fires that may have burned through several burning periods having significantly different weather affecting fire behavior and control efforts applied;



**16, 96)** that lightning fire risk is

associated with different weather regimes and elevational zones from most man-caused risk elements;



**17, 97)** that multiple fire starts in a particular area of responsibility can greatly affect the area burned, raising the resultant fire load index for any fire danger class compared with single fires at the same or higher fire danger.



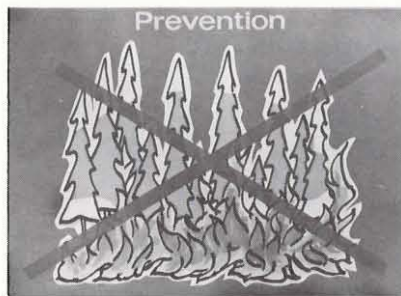
**18, 98)** In other words, it takes more than a simple knowledge of Fire Danger Class to know whether a "lightning bust", which will prove unmanageable, will arise only when Class V days are reached or whether, in fact, the bulk of the lightning bust situations with multiple large fires could well be expected to start on Class IV days in certain districts.

However, it is fair to say that no matter how fire weather severity is evaluated for day-to-day planning of preparedness, all the above complications of the fire danger picture in B.C. have to be taken into account

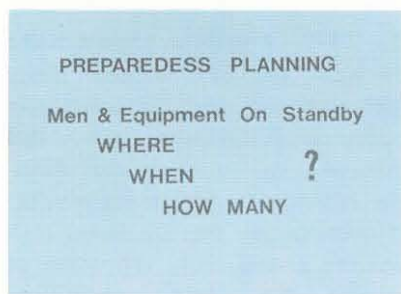


by the fire manager. Fire Danger Class, through its relation to past experience with fire load under various weather regimes, provides a certain amount of guidance for broad-based planning and perhaps less useful information when considering site-specific actions.

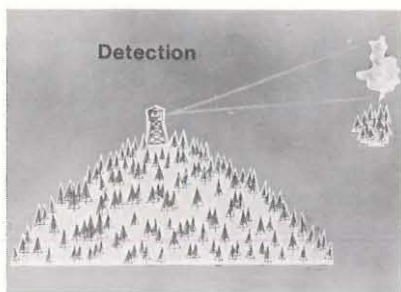
Some broad-based fire planning activities concerning managers at both Forest District and Ranger District levels can be aided by fire danger class information for portions of districts.



**19, 99)** Certain Prevention,



**20, 100)** Preparedness and



**21, 101)** Detection activities fall in this category. Guidelines for some of these activities related to Fire Danger Class have been prepared,

and include:



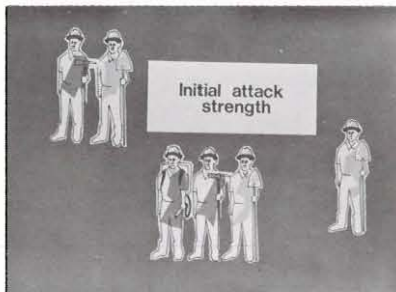
**22, 102)** 1. Air Tanker Readiness level.



**23, 103)** 2. Lookout manning.



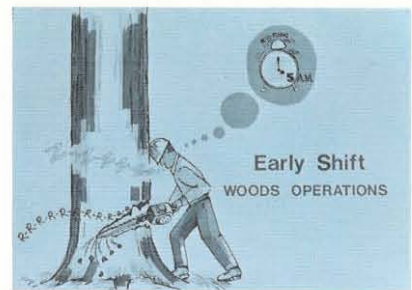
**24, 104)** 3. Selection and frequency of air patrol route flying.



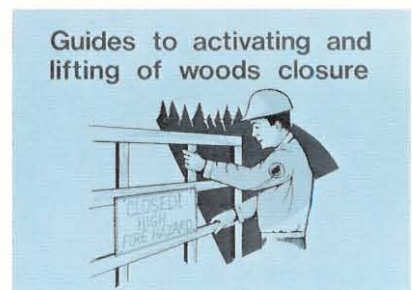
**25, 105)** 4. Suppression crew status.



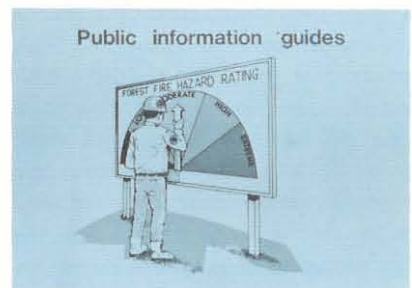
**26, 106)** 5. Requirements for watchmen,



**27, 107)** 6. early shift or



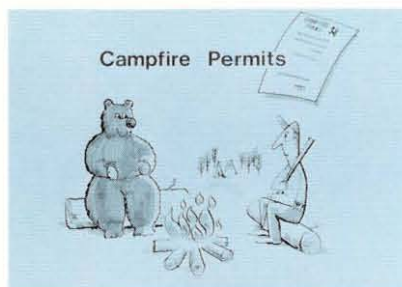
**28, 108)** 7. full industrial woods closure.



**29, 109)** 8. Permission for industry to ban public access to leased lands.



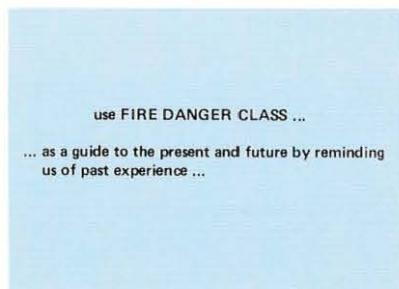
**30, 110)** 9. Issuance of burning permits.



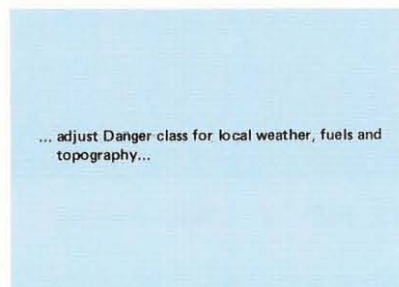
**31, 111)** 10. Banning of campfires.



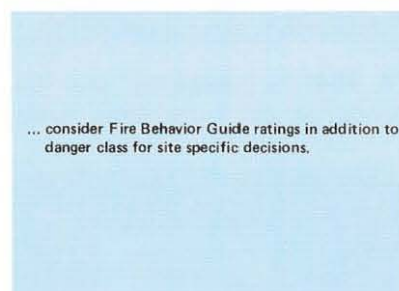
**32, 112)** Most of these fire management activities involve large areas, often diverse fuels, topography, and a range of weather conditions. Some are concerned with controlling man-caused fire risk, some mainly lightning fire detection, and some a combination of both. Some of these activities can also be site-specific from a ranger staff and industry point of view. Examples are the fire prevention regulations on woods operations and issuance of burning permits. The only way to manage effectively such a diverse range of activities as these is to:



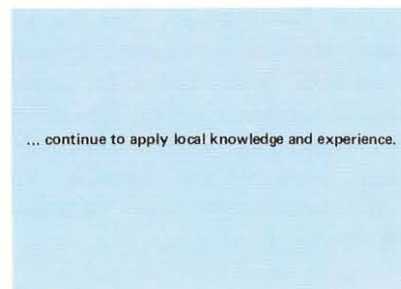
**33, 113)** i) Regard Fire Danger Class as a **potential warning indicator** to guide prevention and preparedness decisions in light of recent past experience. The recommended danger classes are designed to emphasize the "problem fire days" over large areas.



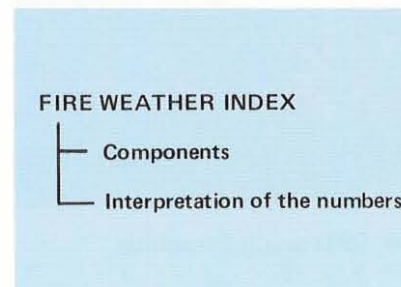
**34, 114)** ii) Make adjustments based on local knowledge of weather, fuels and topography that may not be represented by any weather station or any of the existing guides.



**35, 115)** iii) Make adjustments, especially for site-specific activities, based on such considerations as Fire Behavior Index ratings of Ease of Ignition, Rate of Spread, and Difficulty of Control for a particular fuel type.



**36, 116)** Local knowledge and experience is still most important. Fire Danger Rating and the related guides discussed here are aids to effective fire management. They can never be substitutes for experience, nor should they be made fall-guys for failures.



**37, 117)** A greater understanding of what the Fire Weather Index represents and how the fire danger classes were developed will enable managers to use, but not abuse, the information the indices provide. If nothing else, the fire danger class permits, at any time, comparison of relative fire danger conditions throughout geographic areas of the province.

This is an obvious advantage resulting from the adoption of a single danger rating system and one that is suited to computer calculation of the indices. More people now have daily access to "processed" weather information from most areas of their districts. Weather information is "processed" through the Danger Rating System in a way that builds in a memory for people of how bad is bad; are conditions worse now than last



month, last year, or in the next drainage or district. The FWI and Fire Danger Class associated daily with each fire weather station in a large network is a relatively simple way of organizing a lot of past experience and up to the minute data for people who might not be able to do as effective a job without such an aid.

Instructor's Note: Stop tape here for question period. Slide 38, 118 should be on screen before Tape is started for Section III.

### SECTION III - GUIDES FOR SITE-SPECIFIC FIRE MANAGEMENT DECISIONS



**38, 118)** An understanding of the Fire Weather Index and an appreciation of the advantages and disadvantages of fire danger rating classes for broad administrative use is the starting point for a discussion of the more site-specific fire management aids now available.

These two additional aids are different in their suggested uses, but have one thing in common -- consideration of **fuel** as a **variable**, rather than as a fixed, standardized factor as in the FWI.

The two decision aids to be discussed briefly are:



**39, 119)** (1) Fire Behavior Indices



**40, 120)** (2) Prescribed Fire Predictor

We will look at what kinds of information they provide and how the information can be used in planning.

### Wildfire Behavior Indices

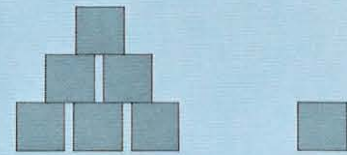
> describe relative **EASE OF IGNITION**, **RATE OF SPREAD**, and **DIFFICULTY OF CONTROL** for five general fuel types using codes and indices of the Fire Weather Index.

**41, 121)** First the **FIRE BEHAVIOR INDICES**

**What are they?** Ratings of three fire behavior characteristics of concern to any fire control organization. These characteristics are:

EASE OF IGNITION  
RATE OF SPREAD  
DIFFICULTY OF CONTROL

### Fuel Quantity



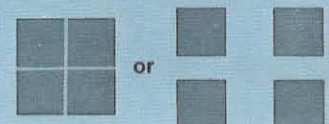
**42, 122)** How is **fuel variability** accounted for? Five broad fuel types have been described on the basis of how their:

### Fuel Size



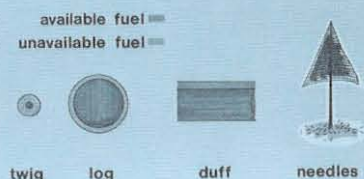
**43, 123)** Fuel loadings,

### Arrangement



**44, 124)** arrangements and

### Moisture Content



**45, 125)** drying rates compare to the "standard fuel" type of the Fire Weather Index.



**46, 126)** Research data on ease of ignition,



**47, 127)** rate of spread and some characteristics of control difficulty



**48, 128)** were assembled for fires in types similar to the

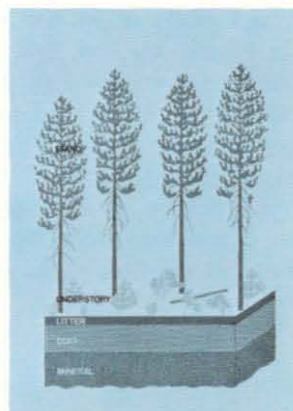


**49, 129)** five broad fuel types. Codes and indices of the Fire Weather Index were combined in various ways to account for observed fire behavior in each of these five types.

All problem fuel types have not been considered in the present version of the indices because of lack of research information or lack of a suitable moisture code in the FWI to account for fire behavior in certain fuels. However, with five types available, a level of planning beyond what can be done simply with Fire Danger Class or FWI is feasible.

Fuel Type A	
•	OPEN CONIFER STANDS
•	SURFACE FUELS NOT COMPLETELY SHADED
•	LITTLE OR NO UNDERSTORY CONIFERS OR BRUSH
•	SCATTERED TO MODERATE DOWNED WOOD
•	LITTER LAYERS LOOSELY COMPACTED
•	DUFF LAYERS SHALLOW

**50, 130)** Fuel Type A is designed for fuel complexes similar to the "model fuel" in the FWI. Open coniferous stands with crown density insufficient to completely shade surface fuels describes the general growth habit. There is little or no coniferous understory, brush or annual vegetation; downed woody fuels are scattered to moderate; litter layers are loosely compacted, as are the shallow duff layers.



**51, 131)** The stand model is represented by pure lodgepole pine stands with needle litter and moss surface fuels. Such stands are common as succession types following fire throughout



**52, 132)** the sub-boreal spruce biogeoclimatic zone north and west of Prince George.

EASE OF IGNITION		
FFMC	IGNITION CLASS	PROBABILITY OF FIRE STARTS
0-82	DIFFICULT	+50% of ignition sources start fires
83-85	MODERATE TO EASY	51-75% of ignition sources start fires
86+	VERY EASY	+75% of ignition sources start fires

**53, 133)** Studies in this fuel type suggest **Ease of Ignition** would be **Very Easy** when FFMC is 86 or greater and that more than 75% of ignition sources like matches and campfires would start fires under these conditions.



Fuel Type A

RATE OF SPREAD

ISI	SPREAD CLASS	INTERPRETATION
0-7	SLOW	ROS < 5 fpm (1.5 m/min)
8-12	MODERATE	ROS < 10 fpm (3.0 m/min); some spotting and torching
13-17	FAST	ROS up to 20 fpm (6.1 m/min); probable crowning
18+	VERY FAST	ROS up to 60 fpm (18.3 m/min); crowning and multiple fronts

**54, 134)** Four Rate of Spread classes have been established on the basis of ISI. Spread is rated **Very Fast** when ISI is 18 or greater, and spread rates could range up to 18 m/min in these fuel types under such conditions. Slopes steeper than 20% would increase spread rates above the maximums suggested in the fire behavior guides.

Fuel Type A

DIFFICULTY OF CONTROL

DMC	SPREAD CLASS	INTERPRETATION
1-2	Easy	EASY: direct attack feasible; caution in spring when crowning possible before fuels
3-4	Moderate	MODERATELY DIFFICULT: heavier fuel involvement increases mop-up; some torching
5-6	Difficult	HIGHLY DIFFICULT: crowning probable; major mop-up effort
7-8	Extreme	EXTREMELY DIFFICULT: extensive crowning; erratic behavior

**55, 135)** Difficulty of Control classes from **Easy** through **Extreme** are defined on the basis of spread class and fuel availability, as indicated by DMC, for Fuel Type A. Conditions under which crowning can be expected are indicated by considering both Control and Spread classes.



**56, 136)** Warnings are given to watch for reduced tree foliar moisture content in spring in some

areas which may induce crowning even though **Difficulty of Control** may be rated **Easy** or **Moderate**.

Fuel Type B

- \* OPEN CONIFER STANDS or YOUNG CONIFER PLANTATIONS
- \* SURFACE FUELS: GRASS, FIREWEED, BRACKEN, or CARIBOU MOSS (CLADONIA)
- \* SCATTERED TO MODERATE DOWNED WOOD
- \* LITTER LAYERS LOOSELY COMPACTED
- \* DUFF LAYERS SHALLOW

**57, 137)** The remaining four fuel types consider other significant fuel characteristics and give additional interpretive help to the user in



**58, 138)** applying codes and indices from the FWI to everyday planning.

Either singly, or in combination with fire danger class, the guides can be used for fire prevention and preparedness planning. Portions of areas of responsibility can be broadly fuel typed. Daily indices from representative weather stations can be used to calculate the indicated fire behavior characteristics to compare fire potential in various fuel types from time to time or from place to place.

Fuel Type D

- \* CLOSED SHORT-NEEDLE CONIFER STANDS; GENERALLY DENSE, MATURE, OR OVER-MATURE
- \* SURFACE FUELS COMPLETELY SHADED
- \* MODERATE TO HEAVY UNDERSTORY CONIFERS, BRUSH AND ANNUAL HERBS
- \* MODERATE TO HEAVY DOWNED WOOD
- \* LITTER LAYERS COMPACT
- \* DUFF LAYERS DEEP

**59, 139)** The user may wish to calculate daily fire behavior indices for one fuel type which represents the major fire problem in a particular area.



**60, 140)** Perhaps the ease of ignition rating for all the fuel types over the managed area represented by good weather stations better suits the need.



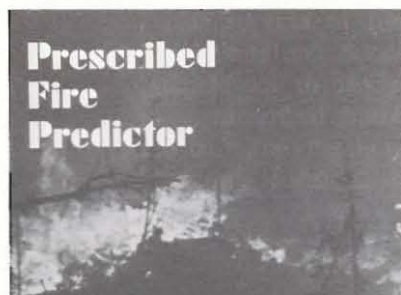
**61, 141)** One thing to keep in mind concerning the fire behavior indices is that on-site weather is necessary to accurately predict fire behavior. Predicting rate of spread class requires a representative wind reading, and wind is highly variable. A poorly located weather station or poorly exposed anemometer can



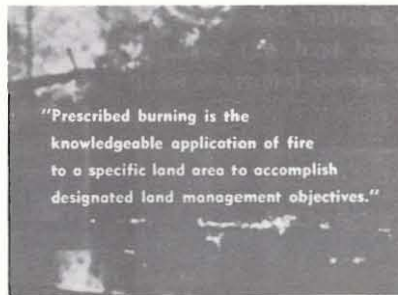
cause gross errors in fire behavior indicators. Similarly, a valley bottom station cannot be expected to give accurate ease of ignition or difficulty of control ratings to plateau fuels 1000 m higher.



**62, 142)** For these reasons, the fire behavior indices are more demanding of good weather data than fire danger class determination, so the selection of weather stations and fuel types is more critical. The returns from use and familiarity with the fire behavior indices should include a greater appreciation of the range of fuel flammability that occurs throughout a district at any particular time in the fire season and of the seasonal variation in fuel flammability common to many of our fuels.



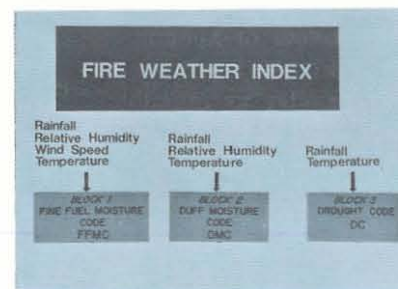
**63, 143)** Prescribed Fire Predictor We have described the Fire Weather Index, its calibration and use as a danger index, and the introduction of fuel characteristics to form a system of wildfire behavior indices.



**64, 144)** This brings us to the most site-specific of the decision aids, the **Prescribed Fire Predictor**. This aid is similar to the others in that the components of the Fire Weather Index are the basic building blocks of the Predictor. It is different, however, in its application; the other aids are planning aids to minimize effects of unwanted fires, whereas the Prescribed Fire Predictor aids planning to achieve the optimum effects from wanted fire.

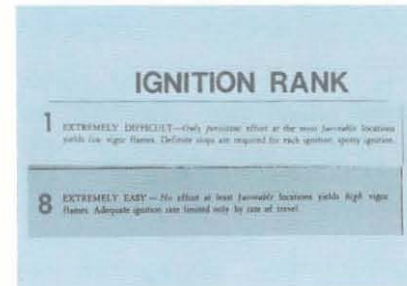


**65, 145)** Specifically, the Predictor enables the user to predict the effects of igniting a clearcut area having certain measured or estimated topographic, fuel loading and distribution characteristics.



**66, 146)** The fire effects may be predicted for on-site weather conditions as measured today, in terms of Fire Weather Index components.

The Predictor also gives the user future planning capability by allowing him to choose the effects he wants to achieve from the prescribed burn, and indicating to him the burning conditions required to achieve those results.



**67, 147)** Weather, topography and fuel variables are related through the Predictor's slide-rule tables, to Ease of Ignition,



**68, 148)** Rate of Spread,



**69, 149)** Difficulty of Control



**IMPACT RANK**  
EFFECT OF IMPACT RANK ON

IMPACT RANK	PERCENT REDUCTION OF DUFF DEPTH		PERCENT REDUCTION OF IMPACT RANK		PERCENT REDUCTION OF SLASH AREA RATING	
	1-4	5-8	1-4	5-8	1-4	5-8
1	100	100	100	100	100	100
2	80	80	80	80	80	80
3	60	60	60	60	60	60
4	40	40	40	40	40	40
5	20	20	20	20	20	20
6	10	10	10	10	10	10
7	5	5	5	5	5	5
8	0	0	0	0	0	0

NOTE: DECREASE OR INCREASE IN SLASH AREA RATING FOR IMPACT RANKS 4-5 ADD 10% TO SLASH AREA RATING FOR IMPACT RANKS 6-8 ADD 20% TO SLASH AREA RATING

**70, 150)** and Fire Impact. Each of these four characteristics of fire behavior and effect is ranked on a scale of one to eight. Each rank is provided, in addition to its number, with a color code, a descriptive phrase and some explanatory text to aid user interpretation.

**SLASH AREA RATING GUIDE**

1. This guide is used to determine the slash area rating for a given site. It is based on the slash area rating guide and the slash area rating guide.

2. The slash area rating guide is used to determine the slash area rating for a given site. It is based on the slash area rating guide and the slash area rating guide.

3. The slash area rating guide is used to determine the slash area rating for a given site. It is based on the slash area rating guide and the slash area rating guide.

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10. The slash area rating guide is used to determine the slash area rating for a given site. It is based on the slash area rating guide and the slash area rating guide.

**71, 151)** Once the decision to use broadcast fire has been made by the land manager, on the basis of such guidelines as Slash Area Rating Guides, and burn objectives set, the Predictor can be used to assess his probable success in achieving those objectives. The Predictor can be used in two ways, mentioned. First, as a real-time predictor.

**Daily Prescribed Fire Planner**

1. This planner is used to plan the burning conditions for a given site. It is based on the slash area rating guide and the slash area rating guide.

2. The slash area rating guide is used to determine the slash area rating for a given site. It is based on the slash area rating guide and the slash area rating guide.

3. The slash area rating guide is used to determine the slash area rating for a given site. It is based on the slash area rating guide and the slash area rating guide.

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10. The slash area rating guide is used to determine the slash area rating for a given site. It is based on the slash area rating guide and the slash area rating guide.

**72, 152)** Side I, Daily Prescribed

Fire Predictor is consulted to help estimate the ease of each task and the resources required to achieve acceptable burn results while maintaining control. The Predictor may suggest that if the burn is conducted under today's conditions, objectives will not be met, or resources required may exceed what is available so that the burn should be postponed until more suitable conditions are achieved.

**Prescribed Fire Planner**

1. This planner is used to plan the burning conditions for a given site. It is based on the slash area rating guide and the slash area rating guide.

2. The slash area rating guide is used to determine the slash area rating for a given site. It is based on the slash area rating guide and the slash area rating guide.

3. The slash area rating guide is used to determine the slash area rating for a given site. It is based on the slash area rating guide and the slash area rating guide.

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10. The slash area rating guide is used to determine the slash area rating for a given site. It is based on the slash area rating guide and the slash area rating guide.

**73, 153)** Second, Side II, Prescribed Fire Planner, can be used to pre-plan the burning conditions, in terms of a range of Fire Weather Index code values required on each specific burn to achieve objectives. This process helps the manager assess how realistic his burning objectives are in terms of his chances of getting the required weather conditions indicated by the Prescribed Fire Planner.



**74, 154)** Also, the Planner points up in advance the relative difficulty of control associated with achieving the manager's burn objectives. A basis is then provided for selecting an alternate method of treating the site, if risk of burning is considered excessive.

Requirements for effective use of the Prescribed Fire Predictor include:

1. On-site FFMC (or Sticks), DMC, DC
2. Fuel characteristics for Slash Area Rating Guide
3. Wind

**75, 155)** 1) On-site measurements of FFMC or stick moisture, DMC and DC

2) Fuel characteristics on-site as determined in the hazard rating section of Slash Area Rating Guide

3) Wind velocity

4. Slope
5. Duff depth & Age of logging
6. Treatment Objectives and local knowledge

**76, 156)** 4) Slope

5) Duff depth and age of logging

6) Treatment objectives and local knowledge



**77, 157)** The importance of on-site weather is greater with respect to the Predictor than for the Fire Behavior Indices, because of the

different level of application of the information. The Fire Behavior Indices are not intended to predict fire behavior on a particular 40 ha block - fuel variables are not differentiated sufficiently, nor is topography.



**78, 158)** However, the Predictor does attempt to predict fire behavior on a specific 40 ha clearcut, so representative weather, which has acted on those fuels over the season, is a key input the user must be prepared to provide. If on-site weather measurements are unobtainable, moisture code adjustments will help the user allow for effects of aspect, slope, drainage, major elevational differences, precipitation differences, and the influence of valley fog.



**79, 159)** The Prescribed Fire Predictor is the last of the decision aids to be discussed. We have dealt at some length with the inner workings of the Fire Weather Index because of its role in the Danger Rating Class, in the Wildfire Behavior Indices and in the Prescribed Fire Predictor.



**80, 160)** All these tools and decision aids have assembled information from research studies and from practical experience of many people in government and industry. None of the decision aids can replace an individual's local knowledge, experience and skill. But as fire management continues to demand more specialized skills, the decision aids discussed here will benefit managers, ranging from the new recruit to the seasoned veteran.

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