DEVELOPMENT OF AN INITIAL ATTACK PREPAREDNESS SYSTEM FOR MANITOBA[1]

K.G. Hirsch[2]

ABSTRACT: The 1989 fire season was the most severe in 71-years of recorded fire history in Manitoba. A total of 1147 fires burned 3.28 million ha and cost over $63 million (CDN) to suppress. The events of 1989 resulted in the development and implementation of a new Initial Attack Preparedness (IAP) System in Manitoba. This system provides a process for assessing the forecasted wildfire ignition potential, fire behavior and fire suppression difficulty thereby increasing the probability of suppressing wildfires while they are small. The IAP System is structured and systematic but is also flexible allowing for unique situations and input based on field experience. It assists fire managers in determining the number, location and desired response times (i.e., 60, 30 or 15 minutes) of initial attack crews in Manitoba and also provides guidelines for other presuppression activities. The IAP System was successfully utilized during the 1990 fire season however, a few structural changes will be implemented in 1991. Eventually the system will be integrated into a comprehensive, computerized fire management decision-support system.
KEYWORDS: preparedness planning, initial attack, decision-support systems.

INTRODUCTION

One of the primary objectives of a fire suppression organization is to control and extinguish all unwanted wildfires while they are relatively small. The probability of this occurring can be significantly increased when the number, type and location of initial attack resources are systematically altered in response to changes in the fire environment and in accordance with organizational policy. This procedure is defined as a fire suppression preparedness system (Lanoville and Mawdsley 1990).

The need for a revised approach to preparedness planning in Manitoba became apparent after a review of the 1989 fire season (Benson et al. 1990). During the 1980s, seven fire seasons had an above average number of fires and area burned, however the fire activity in 1989 was unprecedented in 71-years of documented fire history (Hirsch 1991; Hirsch and Flannigan 1990). In 1989, 1147 fires burned an area of 3.28 million ha or approximately 9% of the total forested area in the province. These fires also caused the evacuation of 24,500 people from 32 different communities and cost over $63 million (CDN) to suppress.

In response to the events of the 1989 fire season a new Initial Attack Preparedness (IAP) System was developed for Manitoba by the Manitoba Natural Resources (MNR) department and Forestry Canada (Manitoba Natural Resources

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1990). It was implemented on a province-wide basis during the 1990 fire season at all levels of the organization and a post-fire season evaluation of the system was completed. The purpose of this paper is to:

- describe the theory and structure of the IAP System,
- review how the system was used during the 1990 fire season and the modifications that will be implemented in 1991, and
- discuss how advances in fire research and computerized fire management decision-support systems could benefit the preparedness planning process in Manitoba in the future.

FIRE ENVIRONMENT IN MANITOBA

The Province of Manitoba is located in the geographical centre of Canada (latitude 49°N - 60°N; longitutde 90°W - 102°W) and the majority of its forested area lies within the Boreal Forest Region as defined by Rowe (1972). The primary tree species in Manitoba are *Picea mariana* (Mill.) B.S.P. (black spruce), *Pinus banksiana* Lamb. (jack pine) and *Populus tremuloides* Michx. (trembling aspen). The climate is classified as cool continental. Mean annual daily temperatures for the 1951-80 period averaged between -7°C in northern areas of the province to +3°C in the south (Environment Canada 1982a). Total precipitation averages from 400-600 mm per year with most of the precipitation falling in the summer months (Environment Canada 1982b). Topographically, the province has very few features that would significantly affect wildfire behavior and therefore is generally considered to be flat or gently undulating.

The fire cycle for a given area in the boreal forest can vary between 40 and 250 years, depending on the conditions of the local fire environment (Chandler et al. 1983). In Manitoba, fire history records from 1918 to 1989 indicate that an average of 404 fires per year have produced an annual area burned of 171,000 ha (Hirsch 1991). Wildfires occurring prior to the flushing of vegetation ("green-up") in the spring and after curing in the fall are usually human-caused while most summer fires are ignited by lightning. Fire behavior is commonly characterized by large, high intensity, stand replacing, crown fires that are often associated with blocking ridges which produce extended periods of extreme fire weather.

MANITOBA INITIAL ATTACK PREPAREDNESS SYSTEM

Background

Most preparedness systems are based on the premise that a rapid and aggressive initial attack will ensure that the majority of fires (usually more than 90%) will not escape initial suppression efforts. This, in turn, decreases the total number of costly campaign fires, the impact (i.e., wood volume destroyed, property losses, etc.) of unwanted wildfires and total fire suppression costs.

The first "formal" preparedness system in western Canada was developed in Alberta (Gray and Janz 1985) in 1983. This was followed soon after by systems in the Northwest Territories (Lanoville and Mawdsely 1990) and Saskatchewan (De Groot 1990). Interestingly, the Alberta and Saskatchewan systems were developed after a series of severe fire seasons, much the same as the Manitoba system.

The MNR developed its first "ALERT System" in response a series of campaign fires in September of 1983. This system was based solely on the Buildup Index (BUI) of the Canadian Forest Fire Weather Index (FWI) System (Van

Wagner 1987). Given the BUI is only an indicator of available fuel and changes relatively slowly, the ALERT System was suitable for a late summer or fall fire season but was inappropriate for the wind-driven, fine fuel fires occurring in the spring and early summer. In 1986 this system was significantly altered when a "guided thought process" was added to it. The purpose of this change was to create greater flexibility in the system by incorporating a wider range of fire danger criteria into the preparedness planning process, however field staff found this approach to be too complicated and time consuming. Then Alexander and De Groot (1988) published a fire intensity chart that indicated the effectiveness of various suppression actions in relation to fire intensity for a mature pine fuel type. This chart, because of its simplicity, soon became the sole criterion on which preparedness planning was conducted in some regions and districts, however it did not address the concerns of staff in all parts of the province. Thus, a standardized preparedness system was needed to ensure that effective presuppression planning could be conducted on a province-wide basis.

Objective and Structural Considerations

The main objective of the Manitoba IAP System is to identify serious fire situations before they occur so that fire managers can take action to increase the probability of controlling fires while they are small. To this end, five primary considerations were taken into account when the system was built. They were:

- both the risk of fire ignitions and the potential fire behavior had to be considered by the system,
- all fires occurring in Manitoba's primary forested area would require an appropriate initial attack response based on the general values-at-risk,
- the system had to be structured and systematic but also required flexibility in order to allow for unique situations and input based on field experience,
- the system would be built for initial attack conducted by trained crews travelling via helicopter (i.e., helitac crews), and
- the system would also provide guidelines for other presuppression activities to ensure optimum initial attack effectiveness.

System Structure

The IAP System has 3 levels of presuppression preparedness. At each level a desired initial attack time objective for the helitac crews is specified (i.e., Level I -60 minutes, Level II - 30 minutes, Level III - 15 minutes) along with recommended actions for fire prevention, fixed and aerial detection, and airtanker and heavy equipment positioning. The determination of the preparedness level and the appropriate presuppression activities for a particular area for "tomorrow" involves a four step procedure, which is followed each day (Figure 1).

Step 1: Determining a Standard Preparedness Level

The first step in the planning process is to calculate a standard preparedness level based on the forecasted components of the FWI System (Figure 2). Twenty-four hour forecasted FWI System values are provided to the MNR by the Atmospheric Environment Service (AES) for each of the approximately 50 fire weather stations in the province. The forecasts are used to estimate the fire potential for the next day thereby allowing for advance hiring and placement of fire suppression resources.

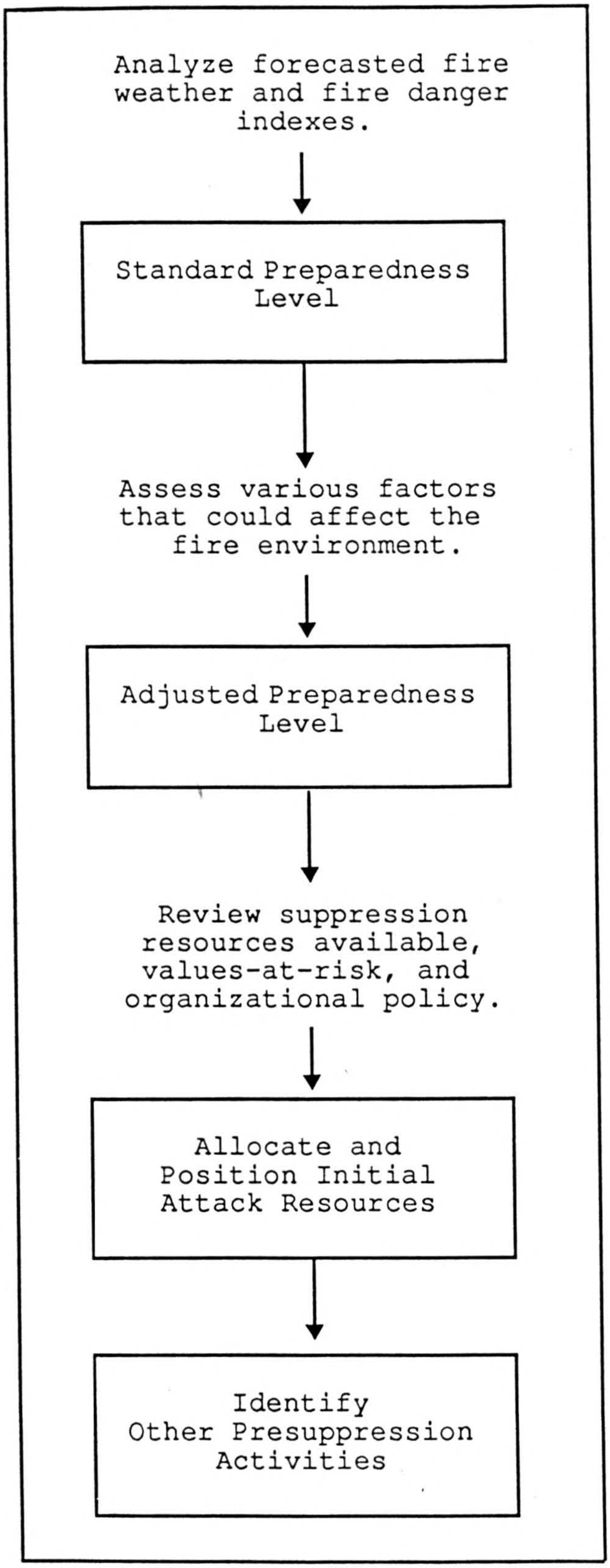

Figure 1. Flow chart of the daily procedures used in the Manitoba Initial Attack Preparedness System.

Three of the six FWI System components, namely the Fine Fuel Moisture Code (FFMC), Duff Moisture Code (DMC) and the Fire Weather Index (FWI) were chosen for use in determining the standard preparedness level (Figure 2). The FFMC is a general indicator of the relative ease of ignition and flammability of the fine fuels (Canadian Forestry Service 1984) and was selected because of the large number of human-caused fires in the spring and fall. The DMC, in combination with the FFMC, has shown good correlation with fires ignited from lightning strikes, which occur mostly in the summer. Finally, the FWI was selected because it is an indicator of the difficulty of suppressing a fire (Alexander and De Groot 1988) and it accounts for both a fire's potential rate of spread and the amount of fuel available to the fire.

Separate tables were developed for the spring/fall fire seasons and the summer fire season because of a distinct difference in the source of fire ignitions. The length of each fire season varies throughout the province and is determined by the timing of vegetative flushing and curing. Also, it is worth noting that the break points between the three standard preparedness levels were based on a review of the fire danger classes for Manitoba (MNR 1990) and the opinions of experienced fire management personnel.

Step 2: Adjusting the Preparedness Level

The second step of the IAP System requires the regional duty officer to assess a wide variety of factors that could affect the fire environment. If there is an influence that could significantly alter the occurrence, behavior or ability to suppress a wildfire, then the standard preparedness level for the affected weather station(s) is adjusted up or down one level accordingly. The advantages of this procedure are that it allows field staff to use their experience and local knowledge to account for the many variables that could not be incorporated into a rigid preparedness system. Also, it results in both field staff and managers documenting the reasons for their decisions, permitting better communication and evaluation.

Examples of the most common factors that influence the preparedness level in Manitoba are:

- extra human activity in the forest (e.g., long-weekends, hunting season, berry picking season, etc.),
- agricultural burning,
- unrepresentative fire weather observations (usually caused by scattered precipitation),
- occurrence of or potential for lightning (especially "dry" lightning),
- potentially volatile fuels such as cured grass and immature pine,
- persistence or breakdown of an upper ridge,
- passage of a frontal system, and
- limited availability of staff and resources (e.g., helicopters, airtankers, etc.) due to an existing high fire load.

Step 3: Allocate and Position Initial Attack Resources

The number and location of the initial attack crews and helicopters is based on the desired initial attack response times for a given area. Response time is defined as the time from when a fire is reported until the start of active fire suppression. They were designated based upon a review of the other preparedness systems in western Canada (e.g., De Groot 1990), the opinions of experienced fire management personnel and traditional dispatching standards.

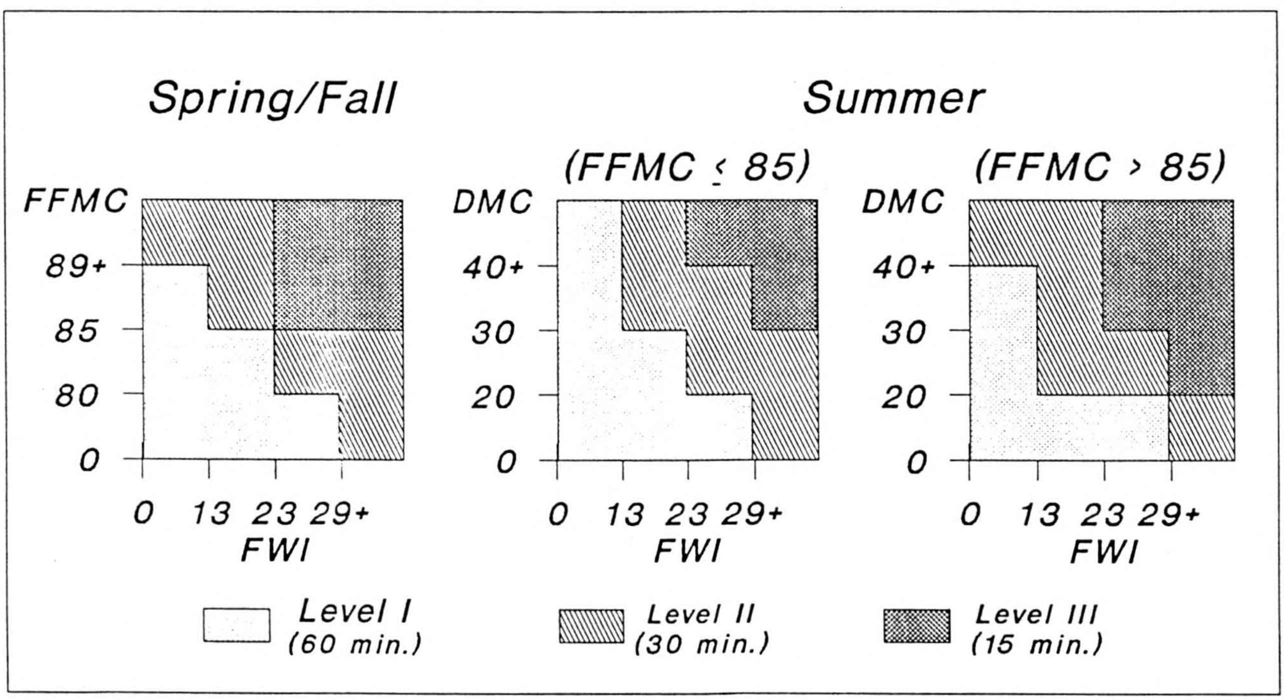

Figure 2. Standard preparedness levels and desired initial attack times used in the 1990 Manitoba Initial Attack Preparedness System.

Once the adjusted preparedness level is established for each fire weather station, the initial attack crews are positioned so that the desired response time for any particular area is achievable. To this end, sixty permanent and day bases were identified as staging points for initial attack crews. Positioning of these crews is a relatively easy task under low or moderate fire danger conditions because the area covered by one crew is quite large. However, positioning can become more difficult as the fire danger, and thus the demand for suppression resources, increases. If suppression resources are limited, the decision to man-up or man-down may need to be made according to values-at-risk as well as fire danger. This decision is usually made at the provincial headquarters with the assistance of a fire priorities map. Presently this map identifies five general priority levels based only on forestry values, however a more comprehensive valuation system is being developed.

Step 4: Identify Other Presuppression Activities

The final step in the IAP System is to provide guidelines for other presuppression activities such as prevention, fixed and aerial detection, positioning airtankers and hiring heavy equipment. General guidelines for each activity are specified for each preparedness level however implementation is usually left to the discretion of the regional or provincial duty officer. These guidelines are necessary since the effectiveness of an initial attack crew is directly related to fire detection and, in some cases, the support received from other suppression resources such as airtankers and heavy equipment. Also, under extreme fire danger conditions a fire may escape initial attack even if a 15 minute response time is achieved, therefore it may be necessary to use fire prevention measures such as forest closures and travel restrictions to stop potential fire ignitions.

USE OF THE IAP SYSTEM IN 1990

The IAP System was introduced to field staff though a series of workshops and was implemented at the start of the 1990 fire season. The standard and adjusted preparedness levels were determined each afternoon at the province's seven regional fire offices. This information was then forwarded to the provincial headquarters where the duty officer reviewed the preparedness plan and revised the resource allocation requests if required. Positioning of resources was conducted that afternoon and then the situation was re-assessed the next morning when the 0800 Local Daylight Time weather observations and 6 hour forecasts were available.

The IAP System was generally well received by field and headquarters staff once the logistical problems of operating the system and sharing information were solved. Feedback was especially positive about the process of preparedness planning and the benefits of following a structured planning system on a daily basis. Also the flexibility of the system to account for unique situations was vital to its acceptance and use by field staff. As staff became more familiar with the system they also found a few short-comings. This led to a post-fire season evaluation of the system and a number of recommended changes that will be implemented prior to the 1991 fire season (Table 1).

The 1990 fire season in Manitoba was a "relatively normal" year with 515 fires producing an estimated area burned of 14600 ha. Analysis of selected weather stations in the province (MNR 1990) shows that on average 76% of the days during the fire season had a standard preparedness level of 1, while 20% were at level 2 and only 4% at level 3. Operating costs for the IAP System in 1990 were calculated by MNR staff to be $1.8 million (CDN).

Assessing the cost-effectiveness of any new fire suppression technique in an objective manner is always difficult because the number of hectares, and

Table 1. Primary changes to the Manitoba Initial Attack Preparedness System that will be implemented in the 1991 fire season.

Change	Reason
1. A preparedness level 0 will be added.	At very low fire danger conditions a response time greater than 60 minutes would still be acceptable.
2. A preparedness level 4 will be added.	Under extreme fire danger conditions a potential for multiple ignitions exists requiring more than 1 crew at a given attack base.
3. The primary protection area will be divided into two "ALERT" Response areas.	The ignition of fires from lightning varies significantly according to geology (precambrium shield vs. non-precambrium shield).
4. The "block" structure of the standard preparedness level charts will become curve-linear.	To avoid making a direct jump from preparedness level 1 to preparedness level 3 in some instances.
5. Regional resource requirements at various preparedness levels will be revised.	The original resource requirements for some regions were not appropriate for the desired initial attack coverage.

dollars, saved by suppressing a fire while it is small cannot be determined. Subjectively, both headquarters and field staff have stated that there were a number of fires that could have escaped initial attack had the response time not been so rapid. However, a further comparison of the 1990 fire statistics to the historical fire data for Manitoba is required to support this intuitive response and develop an estimated dollar value for the savings provided by the system.

FUTURE OF PREPAREDNESS PLANNING IN MANITOBA

Advances in technology and fire research along with the development of computerized fire management decision-support systems (DSS) will have a significant impact on preparedness planning in Manitoba in the near future. Some fire management agencies in Canada have already moved away from a "manual" preparedness system to a more comprehensive DSS (Lee and Anderson 1991; Kourtz 1984) because of its ability to collect, analyze and display a wide range and large amount of information in near-real time. Possible benefits of using a computerized fire management system for preparedness planning in Manitoba include:

- automated compilation and analysis of data (e.g., fire weather observations, fire danger indexes, fire behavior predictions, fire weather forecasts, etc.),

- incorporation of a variety of fuel types and topographic features,

- expert systems can be used to incorporate values-at-risk data, organizational policies, and fire impact information, and

- complex, mathematically-based systems that spatially interpolate weather, optimize for maximum suppression coverage, predict fire behavior, and determine optimal detection routes can be included.

Fire research and new technology will also benefit preparedness planning as new information and techniques to predict, detect and suppress wildfires are formulated. This could include:

- development of a human-caused and lightning-caused fire occurrence prediction system for Manitoba,
- expansion, validation and/or refinement of the Canadian Forest Fire Behavior Prediction (FBP) System,
- development of accessory fuel moisture codes to account for unique fuel types, high latitudes, different aspects, etc.,
- development of quantitative initial attack containment models for crews and airtankers,
- use of infra-red scanners for the detection of fires, and
- use of global positioning systems for locating and tracking fire suppression resources.

Clearly there are many other factors that will improve preparedness planning in Manitoba however the development of a complete listing goes well beyond the intended scope of this paper.

SUMMARY

Preparedness planning is a process designed to increase the probability of controlling wildfires when they are relatively small in size. The Manitoba IAP System attempts to do this by assessing the forecasted wildfire ignition potential, fire behavior and suppression difficulty. The IAP System is structured and systematic but is also flexible allowing for unique situations and input based on field experience. The system determines the number and location of initial attack crews so that a 60-minute, 30-minute or 15-minute response time can be achieved in Manitoba's primary forested areas.

The IAP System was implemented during the 1990 fire season and was accepted as a positive presuppression planning tool. A few changes to the system will be implemented in 1991 and eventually the Manitoba IAP System will be linked to a computerized fire management decision-support system. Such a system will utilize advanced technology and a wide range of fire research information to assist the fire manager in assessing the fire environment and determining appropriate levels of fire suppression preparedness.

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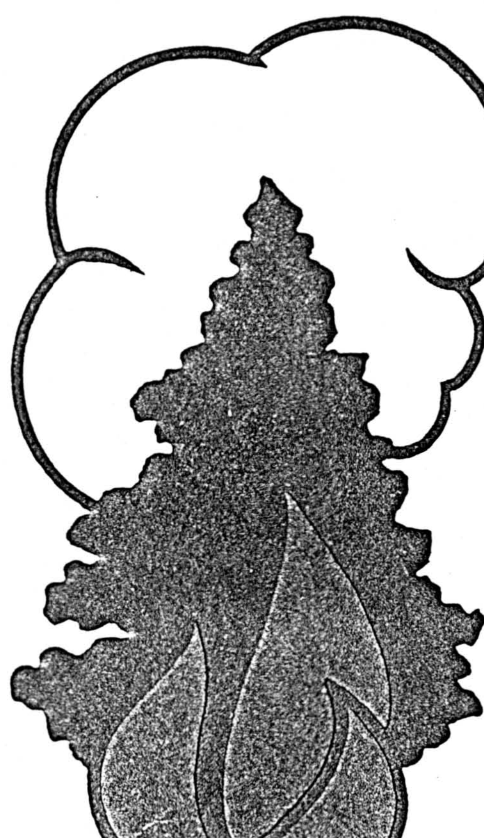

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