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A Wildfire Threat Rating System

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Introduction

Reducing the risk of wildfire is a complex challenge facing most land managers in British Columbia. Although fire is a natural process which has shaped and defined many of British Columbia's ecosystems, it threatens forest values including timber supplies, recreational opportunities and wildlife habitat. Wildfires still consume 30,000 ha. annually (1986-1996 avg.) in British Columbia.

The Wildfire Threat Rating System will help to reduce the risk of large, intense wildfires.

Canada's Fire Weather Index and Fire Behavior Prediction Systems are excellent tools which have been copied and adapted by many countries throughout the world. Recently, researchers have developed a prototype Wildfire Threat Rating System (WTRS) which takes the existing Fire Danger Rating System forward by incorporating spatial information.

WTRS provides a repeatable means of integrating and analyzing key factors that contribute to wildfire threat. When used with a Geographic Information System (GIS), wildfire threat analysis allows resource managers to explore:

- the effect of management actions on the threat of wildfires;
- the potential impact of those fires on forest resources; and
- options to reduce the probability of large, intense wildfires.

The WTRS system will also assist with pre-suppression planning.

Background

A prototype WTRS has been produced for the McGregor Model Forest (MMF) based on a similar system initially developed for Australia. As one of ten forests in a network of model forests across Canada, McGregor provides a site to develop, test and apply state-of-the art forest research and forest management practices contributing to sustainability. One of the greatest benefits of utilizing McGregor as the site for development of the WTRS, is the opportunity to integrate the system with landscape management planning and witness its ability to test fire-related impacts of various resource management strategies.

The McGregor Model Forest is situated 30 km northeast of Prince George, British Columbia. It is 181,000 ha. dominated by the Sub-boreal spruce and Engelmann Spruce - Subalpine fir biogeoclimatic zones.

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The Wildfire Threat Rating System

Wildfire threat is a function of four main components:

- risk of ignition;
- values to be protected;
- suppression capability; and
- likely fire behavior.

Each of these components is assessed and mapped separately and then combined to provide an overall rating of wildfire threat. A significant amount of data and information must be assembled in order to develop each component. The data sources used to define the components are detailed in Table 1. The computer modeling, spatial analysis and mapping required for the wildfire threat analysis process were run on GIS using the GRID program in ARC/INFO.

One of the strengths of this system is that it can be adjusted and adapted to reflect the specific conditions of a given landscape.

Threat Components

Risk of Ignition

Risk of ignition is the probability or chance of a fire starting. For this exercise, both natural and human sources of ignition were considered. Fire risk was determined using historical fire frequency records from 1950-1991 and has been expressed as the number of fires per 4 km^2 over 41 years.

In the McGregor Model Forest, lightning-caused fires have been far more prominent than human-caused fires and thus have been assigned a higher weighted value. The fire risk map (Fig. 1) reflects the spatial distribution of both lightning and human-caused fires. Risk of ignition is very useful for pre-suppression planning and the development of operational fire prevention programs.

Values at Risk

The values at risk, or values to be protected from wildfire, include human life, community and commercial assets, and natural resources. Four factors were assessed to determine the overall rating for this component:

- size and type of development within or near the model forest;
- proximity to a populated area;
- the most prominent timber values within 2.5 km; and
- visual quality for recreation.

The factors indicating a potential for loss of life, namely the size and type of development and distance to a populated center, were weighted highest in the calculation of the total values at risk. Timber and visual quality factors were given equal emphasis but weighted less heavily than the first two factors.

Values at risk is a critical component of the WTRS because life and property have been a driving force

Table 1. Components of Wildfire Threat Data Sources

Data Source	Scale	Risk of Ignition	Values at Risk	Fire Behavior	Suppression
Forest Inventory	1:10 000		X	X	
Silviculture	1:10 000			X	
Rivers and Lakes	1:250 000				X
Road Details	1:10 000				X
Digital Elevation Model	1:20 000			X	
Fire History	point of origin	X			
Towns, Recreation Sites, and Visual Quality	1:65 000		X		
Initial Attack Bases	point locations				X

and justification for fire suppression programs over the last 50 years. Identification and incorporation of all significant resource values, such as critical wildlife habitat or significant silvicultural investments, into the values at risk component will strengthen the outcome of WTRS analysis for its users.

In the MMF, only 5% of the area was found to have extreme or high values at risk rating (Fig. 1) because the developments and populated centers are relatively small and concentrated in the south. WTRS analysis will be more beneficial in areas of the province where there is significantly more development.

WTRS will help us determine how different land use decisions will affect the wildfire threat in a given area.

Suppression Capability

The ability to suppress fires depends on the speed of detection, the time of initial attack after detection, and the physical characteristics of the landscape such a steepness of terrain, access to water and ground transportation access. Four factors were assessed to determine suppression capability:

- initial attack time from the permanent heli-attack base in Prince George;
- steepness of terrain based on slope classification;
- proximity to a water source (rivers and lakes); and
- proximity to roads.

Table 2. Wildfire Threat Components and Contributing Factors

Threat Component	Contributing Factor	Maximum Value	No. of Classes	Data Range	Units
Risk of Ignition	2	62	4		
	Lightning Caused	41	4	0-7	No. per 4 km^2
	Person Caused	21	4	0-3	from 1950 to 1991
Values at Risk	4	62	4		
	Development	25	5	0-25	n/a
	Proximity to populated area	24	5	1-40	km
	Visual quality for recreation	7	4	1-7	n/a
	Timber Values	6	5	0-6	n/a
Suppression Capability	4	62	4		
	Helitak time	25	4	15-40	min
	Steepness of terrain	20	5	0->47	%
	Proximity to water source	10	2	0->100	m
	Proximity to roads	7	5	0->2	km
Fire Behavior	3	62	4		
	Fire Intensity	25	6	0->30,000	kW/m
	Crown fraction burned	25	4	0-100	%
	Rate of Spread	12	5	0->40	m/min

Detection factors were not included because they are changeable and difficult to quantify. Initial attack time was given the highest weight in determining the overall suppression capability value because aggressive initial attack is emphasized in British Columbia. Steepness of terrain was given the second highest weight because of its potential to restrict crew access and fireline productivity. Ground and water access were not weighted as high as the first two factors.

This component could be strengthened by incorporating more detailed information, such as distance and travel times for ground crews, or if and when roads are useable. As suppression capability is essential to protecting all values and minimizing timber losses, analysis of this component will be useful when making decisions about road deactivation and location of fire suppression resources.

Fire Behavior

Fire behavior is an important part of the WRTS because it influences both the extent of resource damage and the success of any suppression action. In order to determine potential fire behavior, spatial information was compiled on:

- fuel types;
- topography (slope and aspect); and
- fire weather (FWI codes and indices based on extreme conditions).

This information was then fed into the Canadian Fire Behavior Prediction System. The following key factors of potential fire behavior were calculated:

- rate of spread;
- fire intensity; and
- crown fraction burned.

In calculating the fire behavior component value, fire intensity and crown fraction burned were both given highest weight because of their direct effect on suppression difficulty and resource damage. Rate of spread was weighted at half this value.

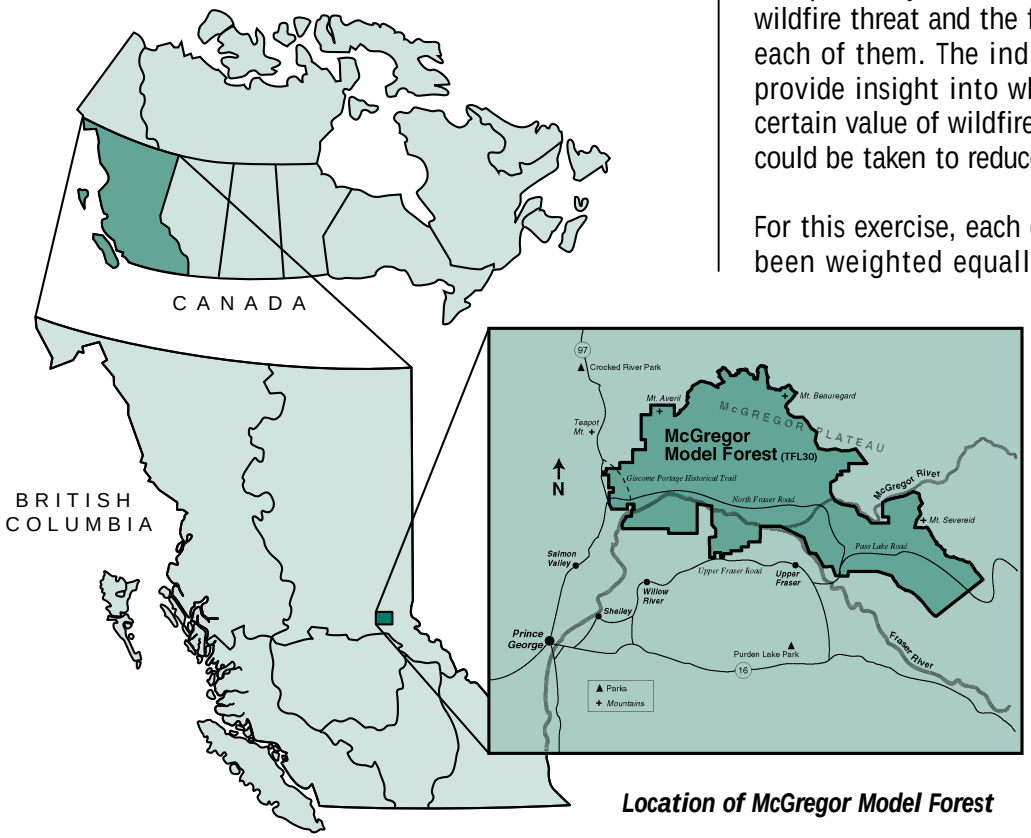
Fuel type, along with slope and aspect, constitutes the basis of fire behavior predictions. Since fuel types will change over time as young stands mature and older stands are harvested, they will need to be modeled in order to make management decisions about future landscapes.

The potential fire behavior component will assist resource managers in determining suppression resource requirements, potential damage and probability of initial attack success.

Wildfire Threat

The final wildfire threat map produced combines the four components into an overall wildfire threat value (Fig. 1). A wildfire threat map is best interpreted by examining the four components of wildfire threat and the factors that contribute to each of them. The individual component maps provide insight into why a particular area has a certain value of wildfire threat and what action(s) could be taken to reduce the risk.

For this exercise, each of the four components has been weighted equally. It would be possible to place different weights on each of the components to reflect different land management objectives and scales, such as a Tree Farm License versus the entire province of British Columbia.



Location of McGregor Model Forest

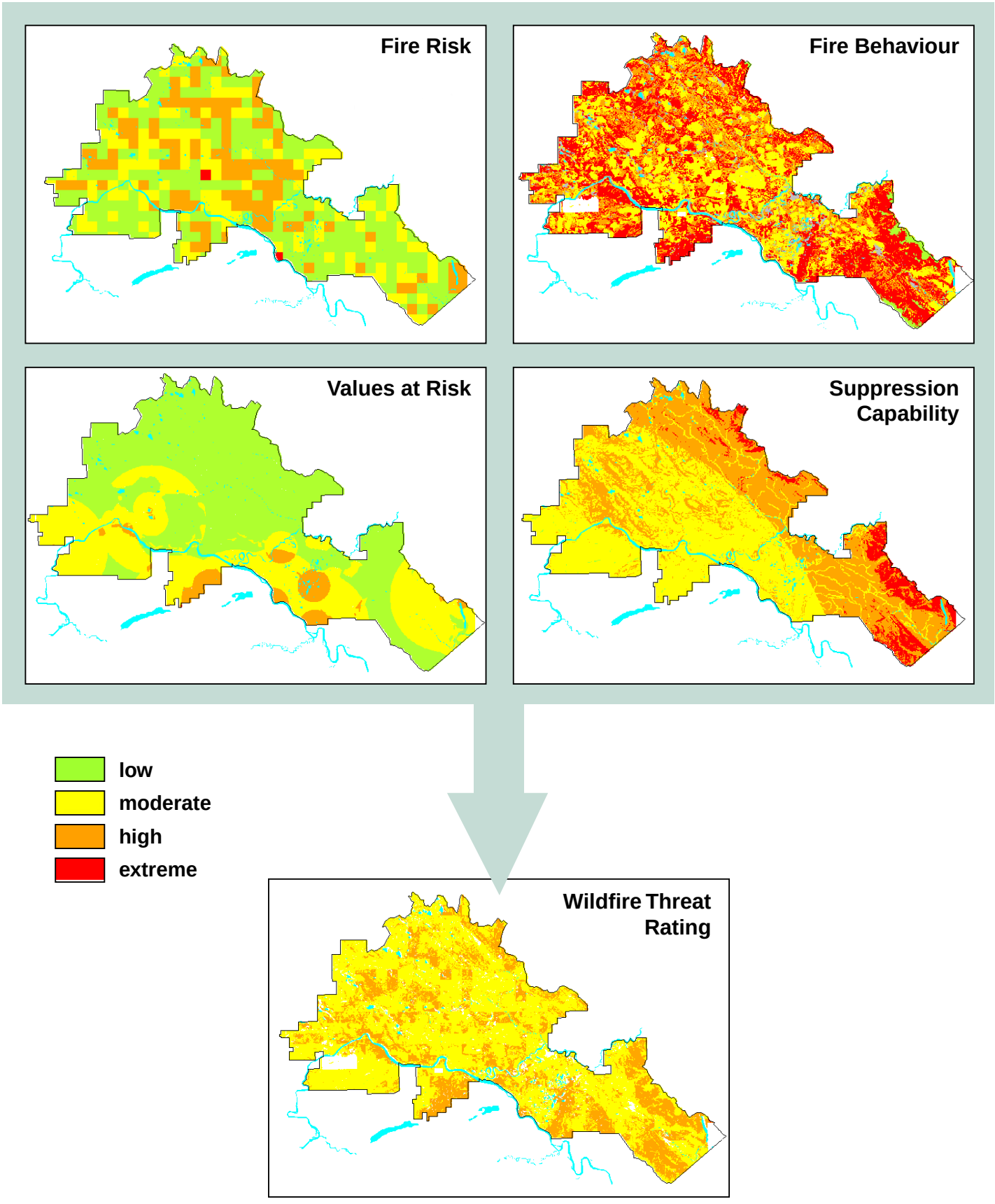


Figure 1. Wildfire Threat Map and Four Component Maps of the Wildfire Threat Rating System for McGregor Model Forest.

Management Implications

The primary use of wildfire threat analysis is to support fire management planning at the strategic level. However, it could be used to support tactical suppression planning and fire prioritization if daily time information on suppression resources, fire weather and fire occurrence were available. Other possible applications of wildfire threat rating include:

- examining the implications of a major shift in harvesting and silvicultural systems;
- evaluating access management plans and identifying those roads best suited to service protection activities;
- evaluating alternative locations for initial attack bases; and
- determining the best locations for conducting prescribed burns in wilderness areas and parks.

The prototype WTRS presented in this paper is a first approximation. The system will evolve as feedback from potential users is received and incorporated. One of the strengths of this system is that it can be adjusted and adapted to reflect the specific conditions of a given landscape. For example, seasonal wildfire threat influences could be incorporated to reflect the differences between northern and southern British Columbia. Developing a WTRS on a provincial scale would be a challenge. Assembling the data bases, range of values and management objectives for such an undertaking would be difficult due to differences in agency and jurisdictional interests and responsibilities. However, the benefits of meeting such a challenge would be tremendous and far-reaching.

Incorporating WTRS into landscape management planning will assist resource managers with decision making and lead to a reduction in wildfire risk. Ultimately this will help to save lives, property, timber supplies and other forest values.

For Additional CFS Information

visit our web site at:
http://www.pfc.cfs.nrcan.gc.ca

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