Advantage

FPInnovations FERIC

NOT Restricted to Members and Partners of FPInnovations – FERIC

Vol. 10 No. 3 May 2008

Contents

Effectiveness of mowing grass to reduce potential fire behaviour in corridors

Abstract

FPInnovations investigated the effectiveness of mowing grass to reduce potential fire behaviour in corridors in Alberta. Plots of grass mowed in the spring or the previous fall were spring burned alongside plots of standing grass, and fire behaviour was documented. Results showed that mowing does influence fire behaviour in grass, and that season of mowing affects fire intensity. Mowing the grass in spring decreased the fire intensity values by 50% relative to no mowing, and fire intensity values decreased by a further 50% if mowing was completed in the fall.

Keywords

Fire management, Mowing, Fuels, Fuel loading, Fire behaviour, Fire intensity, Grass, Grasslands, Alberta.

Author

Greg Baxter
Western Region

Introduction

Mowing grass along right-of-ways is a treatment used by various agencies to reduce the potential for extreme fire behaviour. The thinking is that, if the grass is mowed, less and shorter grass should lead to fewer fires, and those that do occur should be less intense. Also, reducing fuel loads and promoting green-up should lower the fire risk in the critical spring fire period in Alberta. However, few studies have investigated the actual effectiveness of mowing treatments (Cheney et al. 1993). Research on the behaviour of grass fires has been conducted in Australia, South Africa, the United States, and Canada, but little of it has compared fire behaviour in standing grass to that in mowed grass.

To fill this gap in knowledge, from 2004 to 2007 FPInnovations–Feric Division conducted burns in spring, prior to green-up, to compare the fire behaviour in three types of grassy plots: plots that had not been mowed, plots that had been mowed the previous fall, and plots that had been mowed that same spring. These burns were conducted near Fort McMurray and Slave Lake, Alberta.

Objectives

The objectives of the study were to:

- Measure fuel loading and describe degree of curing for plots that had been mowed in fall, plots that had been mowed in the spring, and plots that were not mowed (standing grass, control plots).
- Conduct burns in the spring to compare fire behaviour in plots of grass that had been mowed the previous fall to fire behaviour in plots that were not mowed (standing grass, control plots).
- Conduct burns in the spring to compare fire behaviour in plots of grass that had been mowed that same spring to fire behaviour in plots that were not mowed (standing grass, control plots).

Methods

Alberta Sustainable Resource Development (SRD), ATCO Electric, and Vanderwell Contractors (1971) Ltd. volunteered trial sites in northern Alberta near Fort McMurray and Slave Lake. Table 1 lists the season of mowing and burning for each trial.

Ten trials were conducted (Table 1) and each plot received one of three treatments:

- control (standing grass, no grass mowed), and burned in spring;
- grass mowed in fall and burned the following spring; and
- grass mowed in spring and burned the same spring.

The plots were established in grass fields and treatment boundaries were marked; the minimum plot size was 30 x 30 m, but the majority of plots were 50 x 50 m. The plots within each trial had a common boundary and were located along a general east/west line. Treated plots were mowed by a mower pulled by an ATV (Figure 1).

Figure 1. Mowing during fall 2006, near Slave Lake.

All burns were conducted in the spring, before green-up occurred. The spring-mowed plots in Trials 1, 2, 3, and 4 were burned two to three weeks after being mowed. However, the spring-mowed plots in Trials 9 and 10 were mowed only one day before burning because poor weather conditions did not permit earlier mowing.

Temperature, relative humidity and wind speed data were collected using a hand-held Kestral 3000 Pocket Weather Meter, starting 1 h before the time of ignition and continuing through the burn period. The burns were conducted over a range of weather conditions (Table 2), although all burns took place in relatively dry conditions. Temperatures ranged from 4.4 to 25°C. The cooler temperatures corresponded with burns conducted in the morning due to very high hazard conditions that would have made burning in the afternoon risky. At 17.0 to 30.5%, the range of relative humidity values was narrower than the range for temperature. Wind speeds ranged from 5 to 20 km/h. The Initial Spread Index values ranged from 8.6 to 17.1 (Table 2).

Immediately prior to the plots being burned, a minimum of three samples of grass were taken from each plot to determine the amount (t/ha), degree of curing (in percent), and grass height (Table 3).

Prior to a plot being burned, in-fire cameras[1] were placed in the middle of each plot and along the edges to capture images

Table 1. Season and year of mowing treatments and burns

Trial (no.)	Mowing treatment	Time of burn
1	a. Control, no mowing.	Burned in spring 2004.
2	b. Mowed in spring 2004.	
3		
4		
5	a. Control, no mowing.	Burned in spring 2005.
6	b. Mowed in fall 2004.	
7	a. Control, no mowing. b. Mowed in fall 2005.	Burned in spring 2006.
8	a. Control, no mowing. b. Mowed in fall 2005. c. Mowed in spring 2006.	
9	a. Control, no mowing.	Burned in spring 2007.
10	b. Mowed in fall 2006. c. Mowed in spring 2007.	

[1] An in-fire camera is a video recorder inside a highly insulated box on a stand. The entire unit can withstand temperatures up to 1300° C. It was specially designed for studying fire behaviour. See http://fire.feric.ca/36112001/InFireCamera.htm.

Table 2. Weather conditions for each burn

Trial (no.)	Temperature (°C)	Relative humidity (%)	Wind speed (km/h)	Initial Spread Index [a]
1	21.0	25.0	6	10.5
2	21.6	30.5	5	10.5
3	25.0	17.0	12, gusts to 16	11.1
4	24.0	23.6	12, gusts to 15	11.1
5	17.9	17.0	10, gusts to 12	10.0
6	17.0	18.0	8	10.0
7	4.4	26.0	10	17.1
8	7.6	25.0	7	17.1
9	16.0	26.0	10	8.6
10	15.4	28.0	10, gusts to 20	8.6

[a] The Initial Spread Index (ISI) is a component of the Canadian Forest Fire Weather Index System. ISI is a numeric rating of the expected rate of fire spread, based on wind speed and the Fine Fuel Moisture Code.

Table 3. Summary of fuel loading, proportion of cured fuels, and rate of spread for each burn

	Control plots, no mowing			Plots mowed in fall, and burned the following spring			Plots mowed in spring, and burned the same spring		
Trial (no.)	Fuel load (t of grass/ha)	Amount of cured grass (%)	Rate of spread of fire (m/min)	Fuel load (t of grass/ha)	Amount of cured grass (%)	Rate of spread of fire (m/min)	Fuel load (t of grass/ha)	Amount of cured grass (%)	Rate of spread of fire (m/min)
1	3.1	99	11.1				2.7	99	9.1
2	3.7	99	12.5				7.4	99	11.0
3	3.5	92	11.1				5.0	84	5.0
4	1.9	88	13.3				2.9	83	11.2
5	4.1	89	24.6	2.8	88	2.4			
6	3.1	95	16.8	3.8	88	9.0			
7	12.5	100	14.3	2.5	100	6.2			
8	14.6	100	28.7	7.2	100	10.6	12.8	100	9.0
9	6.6		16.8	2.9		5.4	3.1		9.6
10	6.6		18.0	2.9		6.2	3.1		11.8
Average	6.0		16.7	3.7		6.6	5.3		9.5

that would allow researchers to examine the behaviour of the fires in more detail later. Digital still photographs were also taken during the burn, specifically flame length.

Time of ignition, when the fire reached the end of the plot, and flame length were recorded. Fuel load and rate of spread data were then used to calculate fire intensity. Flame length data were also used to estimate fire intensity to provide two intensity values for comparison. All the fires within a trial were ignited at the same time, along the upwind boundary of each plot and using drip torches.

Results

Results (Table 3) show large differences in fire behaviour between the three treatments tested, as well as differences in fuel loading. Average rate of spread ranged from 16.7 m/min in standing grass (control) to 9.5 m/min in the spring-mowed plots, and 6.6 m/min in the fall-mowed plots.

Although some burns were conducted during the low temperatures of early morning (Table 2), the fire in the standing grass still travelled fairly quickly, for example, at 14.3 m/min for the control plot in trial 7. The relationship of Initial Spread Index (Table 2) to rate of spread (ROS) of fire for standing grass closely followed that used in the Canadian Forest Fire Behaviour Prediction (FBP) System (Hirsch 1996).

Discussion

The data show significant differences in both fire behaviour and fuel loading relative to the three treatments tested. The reduction in fuel loading caused by the mowing, especially in the case of the fall mowings, has a large impact on flame length, head fire rate of spread, and overall fire intensity. Fuel loading for the fall-mowed grass averaged 2.3 t/ha less than for the standing grass (Table 3).

Fuel loading

Plots mowed in fall had the lightest fuel loads. It is hypothesized that grass cut in the fall is in closer contact with the ground than standing grass, and for a longer period than grass cut in the spring. Decomposition occurs both before freeze-up and following snow melt, thereby reducing fuel loading. This reduction in fuel loading is directly related to overall fire intensity and thus affects the ability to control a fire fuelled by grass.

Flame length

The flame lengths were greater in the plots of standing grass than in the plots mowed in spring or fall (Figure 2). Flame length relates directly to fire intensity and type, and to amount of initial attack.

Figure 2. Flame length was much longer in standing grass, i.e., at the center right and far left of this photo. The fire was moving from standing grass (right center) into a mowed area (left center) and then back in to standing grass (far left).

Head fire rate of spread

The average head fire rate of spread was the greatest in standing grass at 16.7 m/min, but it was only 9.5 m/min in plots mowed in spring and 6.6 m/min in plots mowed in fall (Table 3).

A fire's rate of spread has many implications for the difficulty of control. The faster a fire is moving, the sooner initial attack crews must arrive at the fire if they are to have a chance to control it. Fast-moving grass fires along linear corridors can travel long distances over short time periods and can move into adjoining forests.

Fire intensity

When one number is chosen to describe a fire, it is usually intensity.[2] This number makes it possible to visualize how fast a fire is moving and how much fuel is burning, both important to fire-control efforts.

[2] Fire intensity (kW/m) is the rate of heat energy release per unit time per unit length of fire front. It is a major determinant of certain fire effects and difficulty of control. Numerically, it is equal to the product of the net heat of combustion, the quantity of fuel consumed in the flaming front, and the linear rate of spread.

Maximum fire intensity can be estimated using the equation: I (kW/m) = 259.833 (L) $^{2.174}$ where I is fire intensity and L is flame length in metres.

Using the flame lengths estimated in Table 4, maximum fire intensities were calculated as 5291 kW/m for standing grass and 260 kW/m for mowed grass.

Fire intensity can also be calculated using the equation:

$I = hwr$

where:

I = fire intensity (kW/m)

w = fuel load (kg/m^2)

r = head fire rate of spread (m/min)

h = 300 and represents the heat of combustion (18 000 kJ/kg), divided by 60 to present m/minute rather than m/second.

When the mean rates of spread and mean fuel weights for each treatment (Table 3) are used, the mean calculated values were 3006 kW/m for the control plots (no mowing), 1510 kW/m for the plots mowed in spring, and 732 kW/m for the plots mowed in fall.

When the grass was burned in spring, the fire intensity of spring-mowed grass was 50% less than the fire intensity of standing grass, and the fire intensity of grass mowed in the preceding fall season was 50% less than that of the grass mowed in spring. And, fire intensity of grass mowed in fall was 25% of that in the control plots (standing grass, no mowing). These are important and valuable reductions in intensity that have many implications for firefighting agencies.

An intensity value over 4000 kW/m is considered an extreme fire, in which case direct attack is not possible and indirect attack methods such as line building or the use of aircraft are required. A fire intensity less than 500 kW/m is considered low, and direct attack by ground crews is possible. Therefore, if fire intensity can be reduced, the chances of controlling a fire increase, as do the chances of reducing firefighting costs.

Relationships

The relationships between head fire rate of spread, wind speed, and fuel loading were investigated. Calculations revealed a relationship between rate of spread and fuel loading in standing grass, but no relationship between rate of spread and wind speed. Fall mowing had a similar relationship between rate of spread and fuel loading, and a weak relationship existed between rate of spread and wind speed. No relationships existed for the plots mowed in spring for either wind speed or fuel loads relative to rate of spread. This differs from other research on grass fire behaviour that identified wind speed as the most important variable influencing rate of spread. In fact, one report (Cheney et al. 1993) states "fuel load did not influence rate of spread."

Degree of curing ranged from 88 to 100% for all treatment units and did not influence rate of spread.

Table 4. Estimated flame lengths

Year of spring burn	Control, grass not mowed (m)	Grass mowed in spring (m)	Grass mowed in fall (m)
2004	2.0 to 4.0	0.25	-
2005	1.5 to 2.5	0.4 to 1.0	0.5 to 1.0
2006	1.5 to 4.0	0.5	0.25
2007	1.0 to 3.0	0.35	0.20

Conclusion and implementation

This research demonstrated that mowing does influence fire behaviour in grass, and that season of mowing affects fire intensity. Mowing the grass in spring resulted in decreasing the fire intensity values by 50% relative to no mowing, and fire intensity values decreased by a further 50% if mowing was completed in the fall. Decreasing the potential fire intensity by 25% provides a greater chance of controlling a fire in grass fuels, with corresponding reductions in costs to the firefighting agencies.

This study has shown that mowing grass fuels in either the spring or fall reduces potential fire behaviour, although reductions are somewhat greater when mowing is done in the fall. Land managers and fuel-management personnel can utilize this information in their fuel-management plans to reduce the risk of extreme fire behaviour along linear corridors such as right-of-ways.

References

Cheney, N.P.; Gould, J.S.; Catchpole, W.R. 1993. The influence of fuel, weather and fire shape variables on fire-spread in grasslands. *International Journal of Wildland Fire* 3(1):31–44.

Hirsch, K.G. 1996. Canadian Forest Fire Behaviour Prediction (FBP) System: user's guide. Natural Resources Canada, Canadian Forest Service, Northern Forestry Centre, Edmonton, Alberta. Special Report 7.

Acknowledgements

I would like to thank Alberta Sustainable Resource Development in Fort McMurray and Slave Lake for their assistance in locating plots, providing fire crews, and igniting the burns. I would also like to thank Vanderwell Contractors (1971) Ltd. for providing an area to burn and constructing firebreaks around the plots, and for the assistance of its fire crews during the burns. ATCO Electric in Slave Lake also provided us with an area to burn and assisted in the burns. Gary Dakin's assistance with all the burns and the mowing of the plots was greatly appreciated.

FPInnovations – Feric

Find us Online!
www.feric.ca

Eastern Region
580 boul. St-Jean
Pointe-Claire, QC, H9R 3J9
(514) 694–1140
(514) 694–4351
admin@mtl.feric.ca

Western Region
2601 East Mall
Vancouver, BC, V6T 1Z4
(604) 228–1555
(604) 228–0999
admin@vcr.feric.ca

Publications mail #40008395 ISSN 1493-3381