Wildland Fire Operations

Western Division

Results of Experimental Burns on Grass Plots with Mowing Treatments Slave Lake, Alberta

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May 2006

Introduction

In 2003, FERIC's Wildland Fire Operations Research Group initiated a project to investigate fuels and fire behaviour associated with linear disturbances. The objective is to determine treatments that result in reduced adverse behaviour. As part of the project, we have undertaken prescribed, experimental burns to document the differences in fire behaviour between mowed plots of grass and standing grass.

To date, FERIC has completed six pairs of burns comparing fire behaviour in plots mowed either in the fall or in the spring, to fire behaviour in standing grass (see http://fire.feric.ca in the Planning Section – Linear Disturbance - for previous reports). None of FERIC's burns had yet compared the fire behaviour between all three conditions burned at the same time (fall mow, spring mow and standing grass). Consequently, this three-way comparison was completed at Slave Lake Alberta on Vanderwell Contractors (1971) Ltd.'s operations in April 2006.

Methodology

With the assistance of Vanderwell Contractors. (specifically Lou Foley), the burn sites were selected in the fall of 2005. Five plots were established and ranged in width from 33 to 39 m with lengths of 50 m (Figure 1). Two plots were mowed during the fall and allowed to settle all winter. The day before the experimental fires, one spring plot was mowed. The plots were measured (width and length) and fuel load samples were collected. Randomly-located samples were measured using the grass disk meter (seven per plot) with three of those samples cut and oven dried to determine fuel loads (tonnes/ha). As well seven fuel height measurements were taken in each plot. Fuel moisture samples were also collected from each plot immediately prior to burning. These were random samples and were oven dried to determine the fuel moisture content by weight.

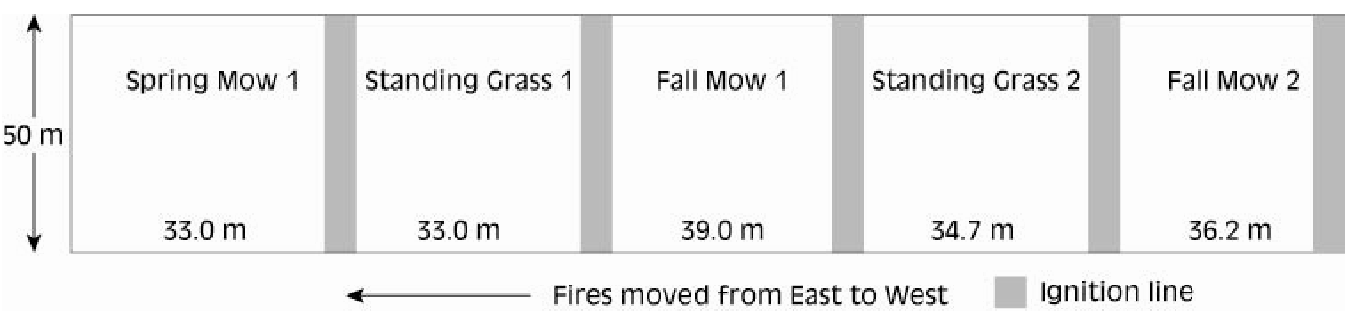

Figure 1. Layout of the study plots.

Fall mow 1, Standing grass 1 and Spring mow 1 were ignited at the same time along the north-south boundary and the fires moved east to west (from the right to left on the diagram). Once these burns were completed, plots Fall mow 2 and standing grass 2 were ignited and these fires also moved east to west. The lengths shown in Figure 1 indicate the distance that the fires moved (east to west) before encountering the next plot or the edge of the study area.

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In-fire cameras were set up in the middle and along the edges of the plots to film the fire behaviour. During the fire the following information was collected:

- Ignition time
- Flame length (estimated visually and with video and digital photos)
- End time for each plot (to calculate rate-of-spread)

Fire intensity values can be calculated from the collected data (rate of spread and fuel loads) or estimated using general rules of thumb based on flame height.

Weather data were collected prior to and during ignition of the plots using a handheld Kestral 3000. Weather data were also collected hourly from the closest remote automatic weather station (RAWS) located in the town of Kinuso. The Fire Weather Index (FWI) was calculated automatically using weather station data.

Results

Fire weather

The weather data collected are shown in Tables 1 and 2. Note the temperature values are the Kinuso station compared to the on-site readings.

Table 1. Weather observations prior to and at the time of ignition using the Kestral 3000.

Time	Temperature (ºC)	Relative humidity (%)	Windspeed/gusting (km/h)	Direction
0800	2.9	31	4.5/8.8	E
0815	5.7	31	4	E
0825	4.1	32	10	E
0831 (ignition)	4.4	26	10	E
0855	6.7	24	6.5/11	E
0900 (ignition)	7.6	25	6.7	E

Table 2. RAWS hourly weather from the Kinuso data.

Time	Temperature (ºC)	Relative humidity (%)	Windspeed/gusting (km/h)	Direction
0800	8.5	36	8	E
0900	11.2	32	10	E
1000	14.5	28	7	E
1100	15.9	27	8/28	NW

The fire weather index values were calculated from the Kinuso data. These results are shown in Table 3. These values represent High fire danger.

Table 3. Fire Weather Index values (using weather data from the Kinuso automatic weather station)

Date	Fine Fuel Moisture Code (FFMC)	Duff Moisture Code (DMC)	Drought Code (DC)	Build Up Index (BUI)	Initial Spread Index (ISI)	Fire Weather Index (FWI)
April 18	92	20	375	35	13.7	23
April 19	92	23	379	40	17.1	29

Fuel loading

Fuel loading results are shown in Table 4. Values ranged from a low of 2.5 t/ha for Fall mow 2, to a high of 15.2 t/ha for Standing grass 2.

Table 4. Fuel loading calculated, by treatment.

Treatment	Fuel loading (t/ha)
Fall mow 1	7.2
Fall mow 2	2.5
Spring mow 1	12.8
Standing grass 1	14.6
Standing grass 2	9.6 (flattened) 15.2 (standing)

The difference in the fuel loadings for the two fall mowings may be due to microsite conditions. Fall mow 2 was slightly lower than Fall mow 1and thus may be slightly wetter allowing more decomposition to occur. Because the spring mow was done the day before burning, no decomposition took place and therefore fuel loading was similar to the loading in the standing grass plots.

The standing grass had an average height of 1.35 m with stocks up to 2.1 m. Grass cover was 100% in the these plots and snow press[1] was estimated to be 10% of total area in Standing grass 1 and 5% in Standing grass 2. In the mowed plots, fuel loading on fall treatments averaged 7.25 cm in depth while the spring mow was 9.2 cm in depth.

The degree of curing was visually estimated to be 100% in all plots. Individual green stems were visible but these would have had little weight. For our purposes, the plots were classified as 0% live (green).

Fuel moisture

Three moisture content samples were randomly collected immediately prior to burning. The results are 13.5 %, 9 %, and12.5 % for a mean of 11.6 %. These results approximate a FFMC value of 89. This is slightly lower from the calculated FFMC value (92), which is based on noon weather conditions at the Kinuso station.

Head fire rates of spread

Head fire rate of spread was measured by timing the fire as it moved from ignition to the end of the plot. The results by treatment unit are presented in Table 5. The rate of spread in the standing grass was the highest, at least twice that of the other treatment units.

Table 5. Head fire rates of spread by treatment unit.

First series of fires		Second series of fires	
Treatment	Rate of spread (m/min)	Treatment	Rate of spread (m/min)
Fall mow 1	10.6	Fall mow 2	6.2
Spring mow 1	9.0		
Standing grass 1	28.7	Standing grass 2	14.3

Flame length

Figures 2, 3 and 4 show the fires as they move through the plots. Flame length was estimated as follows:

- Spring mow: mean flame length was 0.5 m.
- Fall mow: mean flame length was 0.25 m.
- Standing grass: flame length varied from 1.5 m with flashes up to 4.0 m.

[1] Snow press describes the grass that was flattened due to the weight of the snow.

Figure 2. Fire behaviour in a fall mowed plot.

Figure 3. Fire behaviour in standing grass (note flame at top of smoke).

Figure 4. Comparison of fire behaviour in standing grass (left and right side of photo) and fall mowing (middle). Flame length is visually the most obvious difference.

Fire intensity

The equation used to calculate fire intensity was: $\boldsymbol{I} = \mathbf{300\ w\ (kg/m^2)\ r\ (m/min)}$
where:

I = fire intensity (kW/m)
w = fuel load (kg/m^2)
r = head fire rate of spread in m/min.
300 represents the heat of combustion (18 000 kJ/kg) divided by 60 (so we can use m/min rather than m/sec).

The results were therefore:

Spring mow 1:	300 (1.28 kg/m^2) (9.0) = 3456 kW/m
Fall mow1:	300 (0.72 kg/m^2) (10.6) = 2289 kW/m
Standing grass 1:	300 (1.46 kg/m^2) (28.7) = 12570 kW/m
Fall mow 2:	300 (0.25 kg/m^2) (6.2) = 465 kW/m
Standing grass 2:	300 (1.24 kg/m^2) (14.3) = 5320 kW/m

Discussion

As observed and documented in previous experimental burns performed by FERIC in mowed and standing grass plots,[2] fire behaviour was more intense in the standing grass in terms of both rates of spread and flame lengths (and ultimately fire intensity).

Unfortunately, a true comparison of the fall and spring mow plots may not have occurred during the first burn. All three plots were ignited at the same time but the fire in the standing grass plot travelled much faster than in the mowed plots. Video evidence shows that the standing grass plot influenced the fire behaviour in the spring-mowed plot.[3] The presence of firewhirls was noted in the spring plot and the flames were observed leaning back towards the standing grass plot (which was against the wind). Once the standing grass plot had burned itself out, flame lengths were noticeably longer in the spring plot than in the fall mowed plot.

Because there had been little continuous snowpack over the winter, the effects of snow press and decomposition were not as pronounced at this location as in Fort McMurray the previous year. Fall mowed plots had fuel loads approximately half those of the standing grass and spring mowed plots. The similarity of fuel loading for the spring mowed plot and the standing grass plots resulted because mowing was done the day prior to burning and no decomposition or pressing by snow could take place. Snow press acts to compact the grass, holds moisture longer, and increases decomposition. All of these factors reduce fuel height and fuel loading, and ultimately lessen fire behaviour.

Fuel loads in fall mowed plots in Fort McMurray in 2005 were reduced by 40%, compared to unmowed, with a moderate snow load. In the Slave Lake study, fuel loads were reduced by 60% with little snow. The reason why fuel loads were reduced more with less snow is not known, but fall mowing clearly does reduce fuel loads the following spring.

The grass plots burned at Slave Lake had the tallest and heaviest species of grass of all the sites in our experimental burning program (Reed Canary grass). This grass produced high fire intensities and fire behaviour more extreme than ground crews could control using conventional direct attack techniques. Flame lengths were nearly 4 m and the calculated fire intensities in the standing grass were well over 4000 kW/m. This intensity is the threshold representing extreme fire behaviour. These were hot, fast moving fires where wide firebreaks or air attack would be required to achieve control.

[2] See http://fire.feric.ca Planning/Linear Disturbance.
[3] Personal communication, Gary Dakin, April 2006.

Conclusions

Fire behaviour in the mowed plots was dramatically less intense than in the standing grass. Flame lengths were less than 1.0 m in height and rates of spread were less than half of those in the standing grass plots. Initial attack crews would be able to handle fires in these fuels using direct attack unless a change in fuel type occurred.

Future work

Another set of experimental burns comparing fall and spring mowing fire behaviour was planned for Fort McMurray during the spring of 2006, but burning was initially cancelled due to extreme hazards and then followed up by rain and warm temperatures. This allowed the grass to green-up, quickly resulting in conditions where burns were cancelled. Another set of burns is planned for the spring of 2007 at Slave Lake. FERIC would like to burn both fall and spring mowed plots at the same time and the plots will be laid out so the standing grass plots do not influence fire behaviour in the mowed plots.

Acknowledgements

FERIC would like to thank Vanderwell Contractors (1971) Ltd. for its support on these burns. The company provided the mower and the dozer to cut firebreaks and had a crew on site during the burns (with equipment) as a precaution. In particular, we would like to thank Lou Foley for all his assistance in finding a site and organising all the pre-fire work. Kris VanderBerg of Atco Electric and Gary Dakin also assisted with the trial.

If you want more information about this study, please call Greg Baxter at 780 865 6981.