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Moisture changes from sprinkler watering

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Abstract

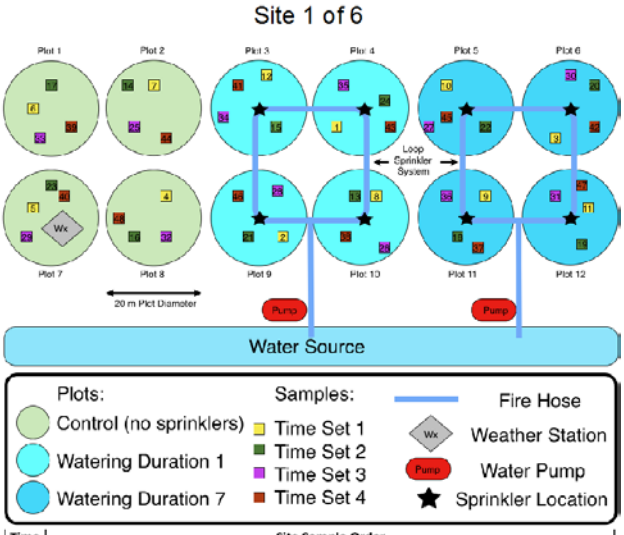
Interest in the use of sprinklers to support wildfire operations has generated questions about how they affect fuel moisture. Fire managers use fuel moisture to assess the availability of organic matter for fires to burn. This report documents the amount of water distributed and fuel moisture changes from sprinkler watering treatments using a loop sprinkler system. It is recommended that feather moss (0–5 cm) and upper duff (5–13 cm) in lowland boreal forests receive 10 and 20 mm of sprinkler watering to raise moisture near saturation levels for a 24-hour period. If sprinklers were combined with fuel treatments and prescribed fire, they could help manage forest dynamics by controlling the spread and intensity of wildfires around assets.

Introduction

Certain wildfire stories and studies describe how sprinkler systems can be a valuable tool for managing fire behaviour. The effect of wetting fuel surfaces is understood, but water absorption and retention is rarely considered. This study measures the effect of sprinkler watering duration on fuel moisture changes in order to quantify the efficient use of sprinkler systems for operations. Sprinkler systems allow firefighters to avoid dangerous wildfire situations, while allowing them to introduce wildland fire proactively in a controlled manner.

Methodology

Each research site had a control treatment and two sprinkler watering duration levels, containing 12 treatment plots and 48 samples (Figure 1). A sprinkler treatment is a combination of watering intensity and duration. Sprinkler watering duration levels were altered by litres of gas supplied to the water pump, and sprinkler watering intensity was controlled by attaching a 345-kPa water pressure regulator to the sprinklers. Sample locations were randomly placed, and the plot sampling order was equally divided into 4 time sets throughout the afternoon. Samples measured water distribution and fuel moisture content before and after sprinkler watering to determine the treatment effect. Sprinklers were operated during the evening to maximize fuel moisture changes, and a portable weather station was deployed to record local weather conditions during the experiment.



Time Set	Site Sample Order											
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th
1	Plot 4	Plot 9	Plot 6	Plot 8	Plot 7	Plot 1	Plot 2	Plot 10	Plot 11	Plot 5	Plot 12	Plot 3
2	Plot 10	Plot 2	Plot 3	Plot 8	Plot 1	Plot 11	Plot 12	Plot 6	Plot 9	Plot 5	Plot 7	Plot 4
3	Plot 2	Plot 10	Plot 5	Plot 9	Plot 7	Plot 6	Plot 12	Plot 8	Plot 1	Plot 3	Plot 4	Plot 11
4	Plot 11	Plot 10	Plot 1	Plot 7	Plot 3	Plot 6	Plot 4	Plot 2	Plot 5	Plot 9	Plot 12	Plot 8

Figure 1. Research site map showing a control treatment and 2 sprinkler watering duration levels, with a total of 12 treatment plots and 48 sample locations.

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Results

Sprinkler watering distribution was variable because the spray collided with surrounding vegetation. Table 1 lists the moisture changes caused by different sprinkler watering treatment levels. Generally, a longer watering duration caused moisture to seep deeper into soils, which resulted in prolonged water retention. The sprinkler watering effect began to diminish as feather moss and upper duff values approached saturation levels around 10 and 20 mm of equivalent rainfall. Then feather moss (0–5 cm) and upper duff (5–13 cm) moisture samples were converted into Fine Fuel Moisture Code (FFMC) and Duff Moisture Code (DMC) to show fuel hazard changes.

Table 1. Effects of sprinkler watering treatments on fuel moisture changes

Treament Level		Sprinkler Watering		Feather Moss			Upper Duff		
Gas (L)	Water pump operation time (min)	Equivalent rainfall (mm)	Water (L) consumed*	FFMC before**	FFMC after**	Moisture (%) changes***	DMC before**	DMC after**	Moisture (%) changes***
0.0	0	0.0	0	67	78	-15	44	50	-12
1.9	98	6.9	2 168	86	8	188	51	38	31
3.8	206	10.0	3 142	68	13	140	58	39	39
4.2	218	12.5	3 927	47	0	243	44	20	73
7.6	424	21.2	6 660	75	0	280	45	18	84
11.4	532	28.0	8 796	73	2	209	67	33	72
15.1	776	35.0	10 996	51	0	417	13	0	115
17.0	869	32.4	10 179	69	0	356	48	12	120

* Assumed sprinkler plot radius was 10 m.

** Conversion of mean feather moss and upper duff moisture into Fine Fuel Moisture Content (FFMC) and Duff Moisture Content (DMC).

*** Mean moisture changes between before and after samples.

Discussion

Sprinkler systems are an affordable option for helping protect assets from wildfires. Sprinkler watering caused a significant change in fuel moisture content between repeated measures. Sprinklers can be used alone or in combined treatments, such as tree spacing and pruning, sprinkler watering, and prescribed fire to manage wildfires proactively (Figure 2). In the wildland–urban interface, property owners can install sprinkler systems to suppress falling embers and reduce radiant heat around their assets. For a broader community-based approach, a sprinkler system can provide a containment line for ignition operations if trained personnel are available. Sprinkler protection could also play a pivotal role in reclaiming fire-driven landscapes by using "water–fire" tactics that reintroduce wildland fire in a controlled manner to restore ecological resilience.

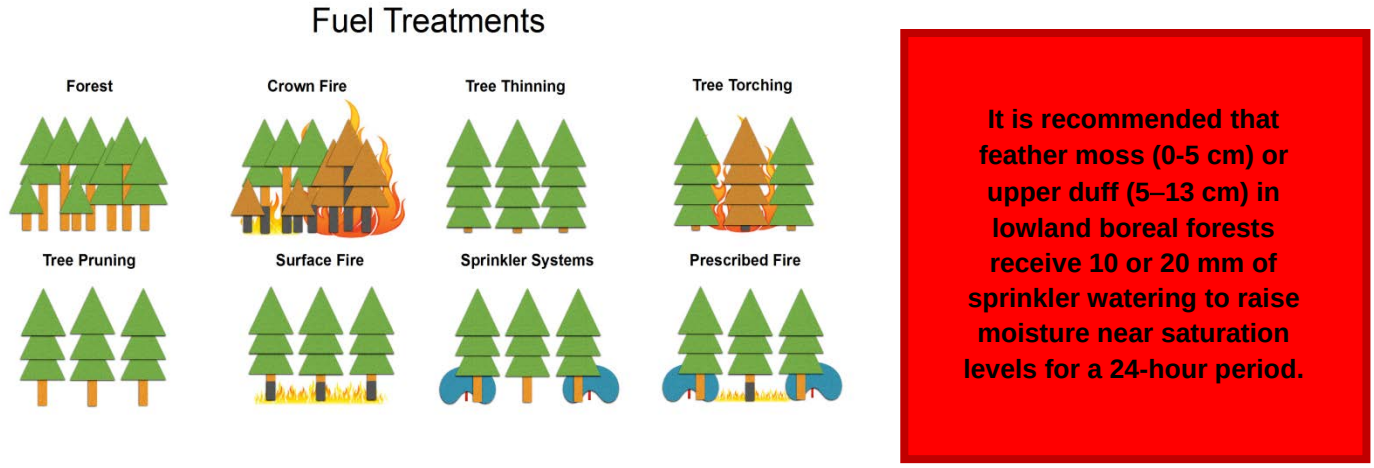

Figure 2. Fuel treatments used for wildfires: tree thinning and pruning, sprinkler watering, and prescribed fire.

Conclusion

This research demonstrates that sprinkler systems can help protect people and their property from wildfires, while managing a balance between ecosystem renewal and forest preservation. Sprinkler watering treatment influences fire behaviour by hydrating fuels, which can improve safety for firefighters by allowing them to avoid dangerous wildfire situations. Results show that most samples that were subjected to sprinkler watering achieved moisture increases beyond their ignition threshold. If sprinkler systems were combined with fuel treatments, wildfires would be easier to control. The use of sprinklers for protection against wildfires should increase, and widespread adoption of sprinkler protection programs will lead to further innovation in tactics.