SPATIAL AND TEMPORAL DISTRIBUTION OF FIRE TEMPERATURES FROM PRESCRIBED FIRES IN THE MIXED OAK FORESTS OF SOUTHERN OHIO

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Prescribed surface fires are being investigated, in conjunction with thinning, as silvicultural tools for assisting in the regeneration of mixed oak forests in the Central Hardwoods Region. Fires were conducted on 2001 March 28 and 2001 April 4-5, respectively, at the Tar Hollow (TAR) and Zaleski (ZAL) State Forests, and at the Raccoon Ecological Management Area (REMA) in southern Ohio. The three sites had been previously surveyed into a 50-m grid. A total of over 400 grid points was established across the three areas.

Each of the sites was previously divided into two treatments of roughly 20 ha each: burn only [B] or thin plus burn [TB]. Thinning had been performed during the 4 months prior to the burns. Just prior to the fires, the grid points were instrumented with stainless steel temperature probes (Type K thermocouple) installed 25 cm above the ground surface, with air temperature logged every 2 s. Buried Hobo®, (Onset Computer Corporation) data loggers successfully captured temperature data for 290 of the points. Because of difficulties with sensor failure at the first burn (TAR), only about a quarter of the grid points were assayed for that site. Nearly 100 percent of the sensors recorded data on the other two sites.

With these data, four measures of fire intensity or timing were available at each grid point:

1) maximum temperature;
2) duration of temperature above 30º C;
3) a heat index, defined as the summed temperatures above 30º C (an integral under the temperature curve); and
4) time of maximum temperature.

These data showed that TAR, though less well assayed because small sample size, had the coolest and most patchy fires, with maximum and average temperatures of 226º C and 103º C for the TB unit and 293º C and 114º C for the B unit (table 1). Less than 30 percent of these sensors recorded temperatures of at least 150º C, a temperature shown earlier to cause significant mortality to saplings.

The REMA fires had maximum and average temperatures of 356º C and 124º C for the TB unit and 354º C and 155º C for the B unit (table 1). A greater percentage (33 to 42 percent) of these sensors recorded temperatures of at least 150º C. The most intense fires were recorded on the ZAL site, with maximum and average temperatures of 415º C and 139º C for the TB unit and 397º C and 172º C for the B unit. The highest proportion (35 to 68 percent) of these sensors recorded temperatures of at least 150º C.

Interestingly, the TB units consistently burned cooler than the B units; perhaps the additional slash resulting from the thinning had not dried sufficiently to increase fire intensity on the sites, but rather it inhibited the movement of flames across the units. In addition, the skid roads and other logging activity likely disrupted the fuel layer, and thus fire movement, in some regions.

The temporal assessment of the maximum temperatures allowed us to evaluate and visualize some aspects of the fire behavior, including a web-based simulation of the fire at the Zaleski site: http://www.fs.fed.us/ne/delaware/4153/ffs/zaleski_burn.html. The simulation shows that fires were generally cooler with a slower rate of spread in the valleys, with hotter, faster fires on the higher ground.

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Table 1.—*Summary of fire temperature data at grid points, at three sites*

Site	Treat[1]	Number Sensors	Max. Temp., °C Abs. Max.	Max. Temp., °C Average Max.	Heat Index[2] Abs. Max.	Heat Index[2] Average Max.	Heat Dur., s Abs. Max.	Heat Dur., s Average Max.	Sensors > 150°C Number	Sensors > 150°C Percent
REM	TB	64	356	124	49880	9865	1007	488	21	32.8
REM	B	65	354	155	42491	12201	1918	971	27	41.5
TAR	TB	18	226	103	22138	5748	1214	363	4	22.2
TAR	B	17	293	114	15364	5205	796	317	5	29.4
ZAL	TB	66	415	139	58625	9968	2956	640	23	34.8
ZAL	B	60	397	172	44029	10050	4472	565	41	68.3
Total/average		**290**	**340**	**134**	**38754**	**8839**	**2061**	**557**	**20**	**38**

[1]B=Burn only, TB=thin and burn

[2]index = temp over 30°C summed over duration (integral under curve)

The spatial assessment of temperature data, when combined with GIS information on vegetation, fuels, topography, weather, and an integrated moisture index, allows us to evaluate some of the factors associated with the fire temperatures. For example, on the ZAL site, there was a slight negative relationship between integrated moisture index and the heat index or duration of burn, i.e., as the topographic moisture regime increased, the fire intensity decreased. Armed with these relationships, we are attempting to model the fire behavior so that spatial estimates of fire temperature and subsequently, fire effects can be achieved.

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