Photo: Simon Hunt (Parks Canada)

THE FACTORS CONTROLLING BURN PROBABILITY IN A LARGE BOREAL LANDSCAPE

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Photo: Simon Hunt (Parks Canada)

PART 1 STUDY AREA: WOOD BUFFALO NATIONAL PARK

Wood Buffalo National Park (WBNP) is the largest park in Canada (4.5 M ha). The fire regime is one of large high-intensity crown fires that undergo only minimal fire suppression. The terrain is relatively flat, with a fine-grained patchwork of coniferous, deciduous, and mixedwood forests intermixed with grasslands, wetlands, and large open water bodies. Extreme fire weather conditions occur frequently between June and August.

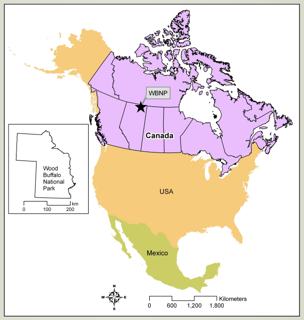

Fig 1. Wood Buffalo National Park (WBNP) in the northern boreal plains.

PART 2 BURN PROBABILITY MODELING

Burn probability (BP) models have been developed to understand how spatially heterogeneous landscapes in fire-dominated areas are generated and maintained. These techniques combine the stochastic components of fire regimes (ignitions and weather) with sophisticated fire growth algorithms to produce high-resolution spatial estimates of BP for a snapshot in time (as opposed to models that account for vegetation succession). BP is derived by simulating a very large (e.g., >10,000) number of fires that ignite and spread under the full range of natural variability.

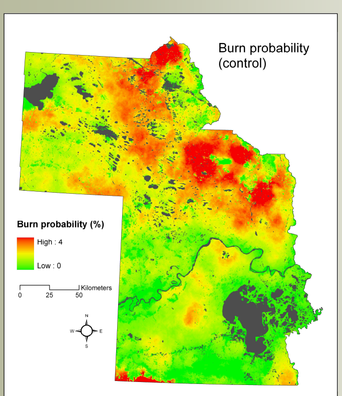

Fig 2. The annual burn probability of WBNP created from the full range of fire environment parameters. The areas in grey represent open water and nonfuels.

The Burn-P3 BP model was used to compute annual estimates of BP for WBNP based on fire environment parameters derived from historical data (Fig. 2). The fires were simulated according to:

(1) spatially and temporally heterogeneous ignition patterns,

(2) variable landscape conditions (fuels and topography),

(3) variable burning conditions (weather conditions and duration of the burning period).

RESEARCH QUESTION

What is the **relative importance** of the major **environmental factors** controlling **burn probability** in a large boreal landscape in Wood Buffalo National Park, Alberta, Canada?

PART 3 ISOLATING THE INFLUENCE OF ENVIRONMENTAL FACTORS ON BP

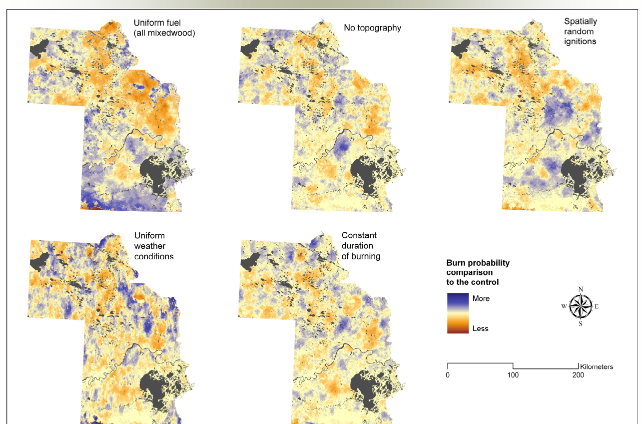

Fig 3. Maps of burn probability departures for each experimental treatment: the BP estimates produced with the environmental factor of interest "homogenized" were subtracted from the control treatment (full input set; Fig. 1). The mean BP of each treatment was standardized in order to emphasize the spatial variation in BP.

We used a jackknife-like approach, where BP patterns produced using the full set of variables (control treatment) were compared to those produced with "homogenized" variables (experimental treatments). Subtracting the BP map of each treatment from the control BP map provided the patterns in BP explained by the homogenized environmental factor (Fig. 3).

A generalized linear model of control treatment BP (dependent variable) was parameterized according to the values of BP departure maps of the 5 treatments and their 2-way interactions. Partial R^2 values were used to measure the explained variance for each factor.

PART 4 FLAMMABILITY PATTERN CREATION IN THE WESTERN BOREAL FOREST

Results suggest that, at the spatial scale of WBNP, fuels are the most important environmental control on annual BP (Table 1). However, further exploration has shown that the influence of fuels obscured the true contribution of the other environmental factors because of correlations among factors. In fact, the departure maps of Figure 3 show that all factors affect BP patterns to some extent.

Table 1. The percent contribution of environmental factors controlling burn probability patterns in WBNP. The first model used all factors (i.e., values from the maps of Figure 3), and the second model ignored fuels.

Environmental factor[A]	Model 1: Variance explained (all factors) (%)	Model 2: Variance explained (no fuels) (%)
Fuels	86.8	—
Topography	0. 3	12.2
Ignition patterns	4.7	41.7
Weather	1.3	39.1
Duration of burning	0.2	0.4
Fuels × Ignitions	3.6	—
Fuels × Weather	2.3	—
Topography × Ignitions	<1	1.3
Ignitions × Weather	<1	1.1
Weather × Duration	<1	2.9

[A]Only interactions with a variance explained ≥ 1% were included.

A second model that did not include the effect of fuels (the "uniform fuels" treatment of Figure 3) was created to measure the relative importance of the other four factors independent of fuels. In this model, ignition patterns were the most influential, followed by weather and topography.

PART 5 WHAT'S NEXT…

Building on this analysis, the environmental factors will be subdivided into several components in subsequent analyses. Furthermore, different types of interactions among factors will be fully assessed, as these can be more important than the main effects.

We acknowledge that our results are highly contingent on the particular landscape and fire environment under study; therefore, another next step consists of undertaking the same exercise for other North American landscapes for comparison purposes.

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