Photo credit: Forest Service

Factors controlling burn probability in four landscapes of western North America

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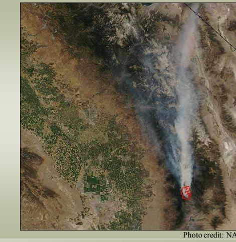

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Introduction

This study examined the relative importance of environmental controls on the spatial patterns of annual burn probability (BP). While fuels are generally assumed to be a major driving factor at landscape scales, the relative importance of other key variables, such as topography, ignition patterns, and fuel breaks, remains unclear. We designed a simulation modeling experiment that aims to disentangle the relative contributions of several major environmental factors controlling BP and examined four landscapes (fig. 1) experiencing different fire regimes and fire environments.

Study areas

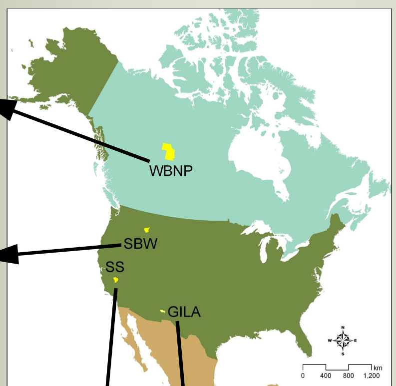
1. Southern Sierra (SS): 570,000 ha
2. Gila and Aldo Leopold Wilderness areas (GILA): 319,000 ha
3. Selway-Bitterroot Wilderness area (SBW): 655,000 ha
4. Wood Buffalo National Park (WBNP): 4,560,000 ha

Figure 1. Study areas

Patchy mosaic in Wood Buffalo National Park.

Photo credit: Marc Parisien

Map showing location of the four study areas



HeslipWFU fire (2002); Selway-Bitterroot Wilderness

Photo credit: Forest Service

The Kawaeh drainage within the southern Sierra study area

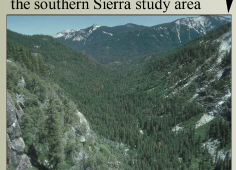


Photo credit: Carol Miller

Dry Lakes WFU fire (2003); Gila Wilderness

Photo credit: Charlie Elliott

Methods

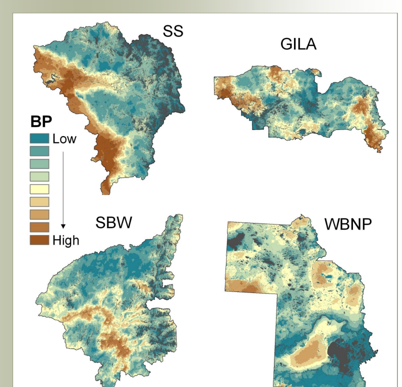
Burn probability was estimated by simulating the ignition and spread of a very large number of fires. For the U.S. study areas, we simulated wildfires, and hence BP, using a command line version of FlamMap, named "Randig", which uses the minimum travel time (MTT) fire spread algorithm. For the Canadian study area, we created a BP grid using the Burn-P3 model, which uses Prometheus as its fire growth engine. These BP models combine the stochastic components of fire regimes (e.g., ignitions and wind) with sophisticated fire growth algorithms to produce high-resolution estimates of BP for a snapshot in time (one year in this case).

To disentangle the relative importance of the major factors contributing to BP patterns, we produced BP maps with the full suite of variables ("control"; fig. 2), which we then compared to BP maps produced with one variable either homogenized or randomized ("experimental treatments"). The difference between the BP of the control and each treatment provides a measure of the effect of each variable.

We tested the influence of six major factors on BP through six experimental treatments.

Environmental factor	Experimental treatment
Fuel configuration	Randomly distributed according to observed proportions on the landscape; areas of non-fuel are maintained
Topography	Flat
Ignition pattern	Randomly distributed
Wind variability	Random direction; uniform speed
Duration of burning variability	All fires burn the same number of days
Fuel breaks	Areas of non-fuel (water, barren, etc.) were converted to random fuel types according to observed proportions

Figure 2. Burn probability using the full suite of inputs (control) for each study area.

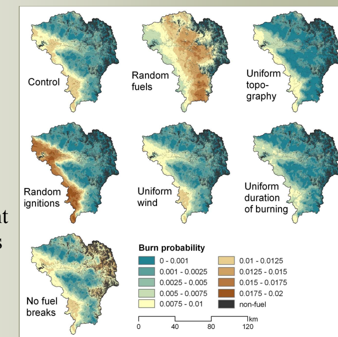


The relative contribution of each environmental factor was assessed by summing the absolute values of all pixel-wise differences between the BP of the control and each treatment.

Results

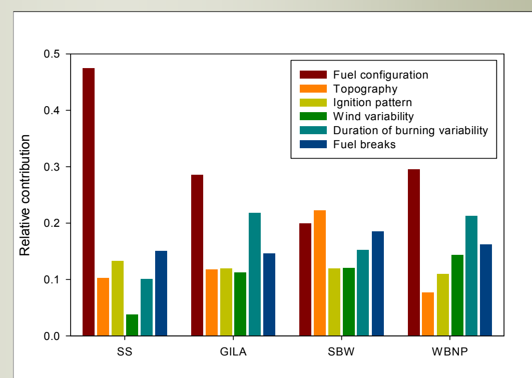
The maps (fig. 3) show the BP patterns for the control and each experimental treatment for the southern Sierra study area.

Figure 3. BP maps for the control and each experimental treatment for the southern Sierra study area.



Results (fig. 4) indicate that fuel configuration is the dominant factor contributing to BP patterns in all study areas except the Selway- Bitterroot Wilderness, where topography is most important. Wind has a negligible effect in the southern Sierra (< 4%), but contributes much more (> 11%) in other study areas. Ignition pattern has a similar contribution across all study areas (11 – 13%), as do fuel breaks (15 – 19%).

Figure 4. The relative contribution of each factor in explaining BP patterns.



Conclusions

The results of this study have enhanced our ability to interpret estimates of BP and improve models of fire likelihood. Contrasting results among study areas reaffirm the complexity among factors controlling fire regimes and suggests that there may not be a universal set of rules controlling BP. However, many factors contributing to BP patterns are interrelated, which may partly mask the "true" effects of environmental factors. Therefore, more advanced statistical procedures are required to disentangle these complex interrelationships to gain a better understanding of the more direct influences on BP.

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