CALIFORNIA FIRE SCIENCE CONSORTIUM

Research Brief for Resource Managers

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Fire history changes the interpretation of common severity metrics

Saberi, SJ and BJ Harvey. 2023. "What Is the Color When Black Is Burned? Quantifying (Re)Burn Severity Using Field and Satellite Remote Sensing Indices." Fire Ecology 19: 24. https://doi.org/10.1186/s42408-023-00178-3.

Management Implications

- The usefulness of Composite Burn Index and satellite-based fire severity metrics depends on whether the land had burned recently and how severely. Therefore, these metrics cannot be interpreted the same for areas that burned twice within 30 years as with areas that burned only one time.
- Neither metric captures "deep char", an important feature of reburned areas.

"Fire severity" – or the degree of change due to a wildfire -- can be quantified in several ways, from estimating injuries at the organism level (percent of limbs remaining, amount of scorch, etc.), to a particular vegetation type (percent of trees killed), to indices integrating multiple vegetation types (Composite Burn Index), to indices of changes apparent in remotely-sensed images. Previous work has shown how these measures of severity align – for example, to ensure that a high-severity area identified with satellite imagery corresponds with a high-severity condition on the ground (reviewed in *Morgan et al. 2014*).

While these methods have been widely adopted, it is unclear how accurate they are in cases where landscapes have burned multiple times within a short period of time (a "short-interval reburn"). To evaluate this, Saberi and Harvey assessed many of these metrics in areas that had burned twice within 30 years and calculated the correspondence between metrics.

When the researchers compared the Composite Burn Index (CBI), a metric that averages the effects of fire across layers of vegetation, to more specific field-based measurements, they found that correspondence between the metrics depended on the severity of the first fire. If the first fire was a stand-replacing fire, CBI underestimated several key field metrics (change in canopy cover, needle loss, basal area mortality, and char height). If the first fire was not stand-replacing, CBI overestimated surface char.

Similarly, RdNBR (a common index from satellite imagery) underestimated change in canopy cover, needle loss, basal area mortality (see subsequent figure), and tree mortality when reburns occurred in areas that initially had a stand-replacing fire, and RdNBR also overestimated surface char where the first fire was not stand-replacing. Notably, neither CBI nor RdNBR captured "deep char", the shiny black char seen on incompletely combusted wood that is typical of reburned sites.

These findings imply that CBI and RdNBR cannot be interpreted the same way for areas that burned twice within 30 years as with areas that only burned one time; the same values correspond with very different fire effects on the ground. The specific direction of under- and over-estimation is contingent on the initial burn

severity as well as the specific fire effects intended to be measured. Therefore, users of these metrics will need to calibrate their interpretations based on the fire history of the site. Given that CBI and RdNBR do not capture deep char, users may also need to consider alternate strategies for assessing this element of the post-wildfire landscape.

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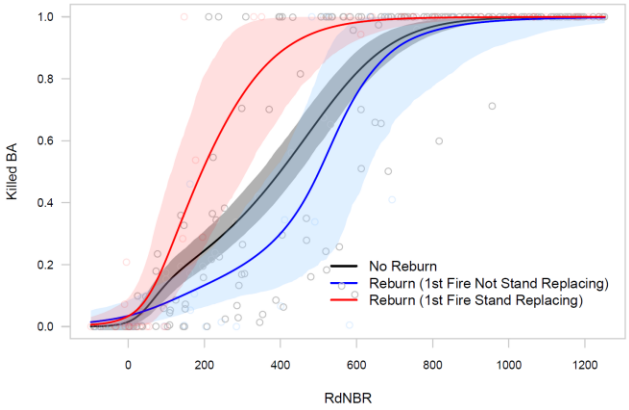
The following figure is an example of results found in the paper. Here, the relationship between RdNBR and basal area (BA) mortality is similar between "no reburn" sites and reburned sites where the initial fire was not stand replacing. However, BA mortality is much greater than that predicted by RdNBR where the initial fire was stand replacing.



These patterns are also summarized in the following table, showing how field-measured basal area loss corresponds with different RdNBR values depending on the site's fire history. A more complete look-up table is available at cafiresci.com

RdNBR Value			
% Basal Area Loss	Non Reburn	Reburn 1st Fire Not Stand Replacing	Reburn 1st Fire Stand Replacing
0%	-98	-98	-98
25%	205	358	110
50%	399	503	196
75%	522	602	303
95%	755	792	494

Also referenced:

Morgan, P., R. E. Keane, G. K. Dillon, T. B. Jain, A. T. Hudak, E. C. Karau, P. G. Sikkink, Z. E. Holden, and E. K. Strand. 2014. Challenges of assessing fire and burn severity using field measures, remote sensing and modelling. International Journal of Wildland Fire 23: 1045–1060.