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The relationship of large fire occurrence with drought and fire danger indices in Glacier National Park, 1984-2008: the role of temporal scale

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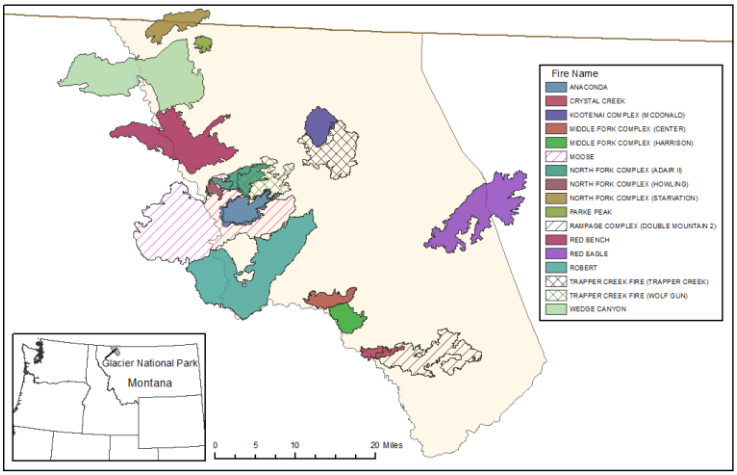
Wildfires play an important role in the Crown of the Continent ecosystem (Figure 1 and 2), providing a number of ecosystem services such as increasing forage for bears. Estimation of fire risk also affects land management planning and budgeting for firefighting. However, it is difficult to predict the timing and location of large fires in the Crown of the Continent ecosystem, since most wildland fires in this area are ignited by lightning during summer convective storms. Understanding how short- and long-term droughts are associated with large fire occurrence can help land managers know when and where fire risk is heightened.

Figure 1. The Red Eagle Fire area on the east side of Glacier National Park near St. Mary, approximately one year after the fire, in 2007.

During the period of this study (1984-2008), 17 fires larger than 1000 acres occurred within the boundaries of Glacier National Park (Figure 2). This number is not large enough to conduct statistical analysis of drought and fire occurrence for the Park itself, but by enlarging the analysis area to the surrounding Omernik ecoregions (Northern Rockies, Middle Rockies, Idaho Batholith, and Canadian Rockies), which are relatively similar in terms of vegetation and climate, there is a sufficient number of fires for statistical analysis (*n*=782, Figure 3).

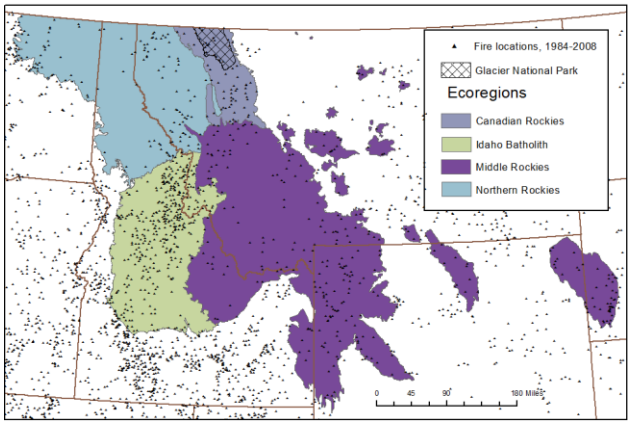
Figure 2. Fires larger than 1000 acres in Glacier National Park from 1984-2008. Source: Monitoring Trends in Burn Severity (www.mtbs.gov).



Area burned was strongly correlated with several drought indices (Figure 4). Drought indices were calculated based upon 4-8 km gridded daily or monthly weather values (Daly et al. 1994), and were converted to percentiles to indicate local anomalies in weather conditions (percentiles near 50 indicate average conditions, while values near zero indicate dry conditions and values near 100 indicate wet conditions for most indices). Drought indices measuring time periods ranging from as short as one month to as long as one year demonstrated strong correlations with area burned in these forested

ecoregions. Methods are described in more detail in Riley et al. (In Press). Correlations between drought indices and area burned were strong for Palmer Drought Severity Index (R^2=0.90), monthly precipitation (R^2=0.89), the Energy Release Component for fuel model G in the National Fire Danger Rating System (R^2=0.83), 3-month Standardized Precipitation Index or SPI3 (R^2=0.83), 9-month SPI (R^2=0.82), and 12-month SPI (R^2=0.86). Correlations between fire occurrence and 24-month SPI were of moderate strength (R^2=0.55).

Figure 3. Locations of 782 fires larger than 1000 acres that occurred in the ecoregions in and near Glacier National Park during 1984-2008. Fires are from the Monitoring Trends in Burn Severity dataset (www.mtbs.gov).

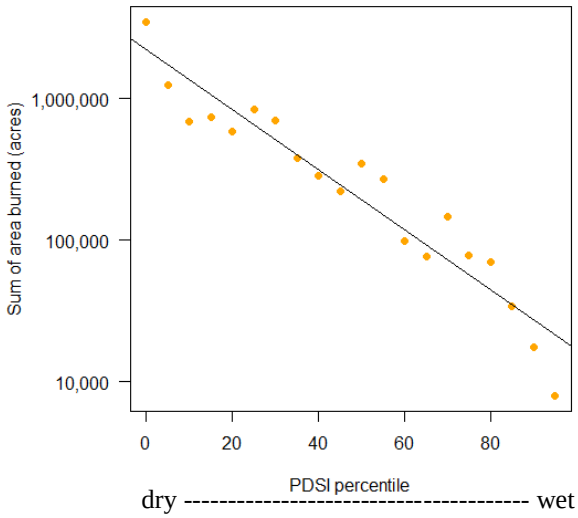


These results suggest a different relationship between fire occurrence and drought than we found in the western USA as a whole, where correlations were strong only between area burned and short-term drought indices, especially monthly precipitation totals and the Energy Release Component. Longer-term indices, including the Palmer Drought Severity Index and 24-month Standardized Precipitation Index, did not have strong correlations with fire occurrence at the scale of the western US.

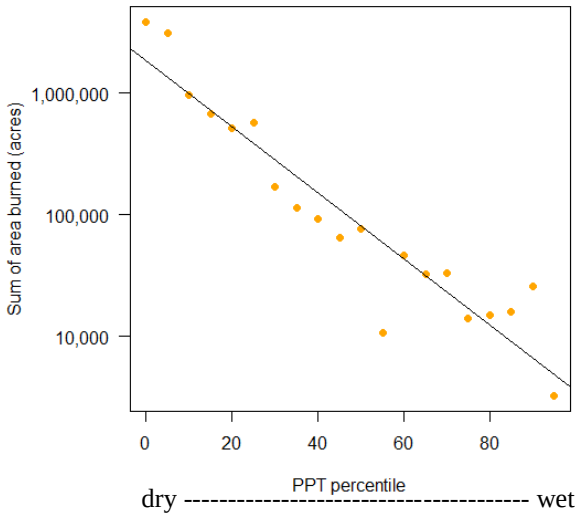
The four ecoregions in and near Glacier National Park are different from much of the rest of the western US in terms of climate, vegetation, and management, which likely affects dynamics between drought and wildfire. Fires in Glacier National Park and wilderness areas to the south (the Bob Marshall, Scapegoat, Selway-Bitterroot, etc.) are often allowed to burn under mild and moderate weather conditions, whereas wildland fires in much of the western US are actively suppressed. Longer-term drought metrics (3 months and greater) often do not capture weekly or monthly periods of dryness that can contribute to extremely dry fuel moisture values that

Figure 4a and b. Drought indices versus sum of area burned by large wildfires (>1000 acres) in four Northern Rockies ecoregions from 1984-2008. Palmer Drought Severity Index (PDSI) is shown in Figure 4a, and monthly precipitation (PPT) is shown in Figure 4b. Index values near zero indicate drought, while values near 100 indicate wet conditions. Area figures are plotted on logarithmic axes, meaning that area burned increases exponentially with drought.

a) **Sum of area burned by PDSI percentile**



b) **Sum of area burned by PPT percentile**



correspond with periods when fires cannot be suppressed; however, longer-term metrics do capture multi-month dry periods that signify drought stress of the forest canopy, shrubs, and herbaceous vegetation, which may experience increased mortality.

The results of this project suggest that land managers in Glacier National Park may be able to predict active fire seasons further in advance than land managers in the rest of the western US. Because correlations are high for drought metrics that are calculated based on yearly precipitation values, conditions contributing to an active fire season could be identified up to a year in advance (if dry conditions continue into fire season).

References

Daly C, Neilson RP, Phillips DL (1994b) A statistical-topographic model for mapping climatological precipitation over mountainous terrain. *Journal of Applied Meteorology* **33**, 140-158.

Riley, Karin, John Abatzoglou, Isaac Grenfell, Anna Klene, and Faith Ann Heinsch. In Press. The relationship of large fire occurrence with drought and fire danger indices in the western USA, 1984-2008: the role of temporal scale. *International Journal of Wildland Fire*.

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