8.1A FIRE DANGER AND THE STANDARDIZED PRECIPITATION INDEX

Paul M. Schlobohm*
Bureau of Land Management, Reno, Nevada

Timothy J. Brown
Desert Research Institute, Reno, Nevada

1. INTRODUCTION

Wildland fire management agencies are increasingly interested in long-range forecasts of fire business, including suppression of unwanted fires and opportunities for fire use. Currently available to fire managers are tomorrow's forecasted fire danger ratings, 1-5 day National Weather Service (NWS) fire weather forecasts, 6-30 day NWS Climate Prediction Center (CPC) outlooks, and 28-day Wildland Fire Potential Assessments from the National Interagency Coordination Center (NICC). In anticipation of severe fire potential in a region, special fire potential assessments may be conducted to establish the severity of the situation and forecast the end of the region's fire season (Zimmerman *et al* 2000). Missing from this collection of tools are 30-90 day (and possibly longer) fire potential forecasts available for operational use. The Bureau of Land Management (BLM) and other agencies would like to use this type of information for strategic planning of large scale prescribed fire events and suppression resource prioritization.

Given the influence of precipitation on fuel moisture, and therefore, fire danger (Deeming, *et al*, 1977), one indicator of climate patterns that may be useful to climate forecasting for fire is the Standardized Precipitation Index (SPI). SPI is a description of precipitation surplus or deficit over a range of time-scales. It is designed to recognize the beginning, ending, and magnitude of wet and dry periods (Guttman 1998). SPI values can be compared temporally and spatially. Previous work by this lead author suggests that SPI may provide a signal for large fire events in several fuel types throughout the United States (Schlobohm 2000).

The objective of this work is to analyze the relationship of SPI to fire danger ratings and fire business at the administrative unit level (e.g., National Forest or BLM Field Office). Results will contribute to a larger study of SPI as a predictor of long-range fire business.

2. DATA COLLECTION

SPI is typically and regularly computed for standard U.S. climate divisions (see http://www.wrcc.dri.edu/spi/spi.html and http://enso.unl.edu/ndmc/watch/spicurnt.htm) and by extrapolation between individual station values (http://ulysses.atmos.colostate.edu/SPI.html). For SPI to be applied to fire management, it may need to be computed for specific management areas, as is done with fire danger rating and fire occurrence analyses.

This study is expected to be applied throughout the US. To begin, two locations were selected: the Boise National Forest in Idaho and the BLM Elko Field Office in Nevada. These sites were chosen for their geographic proximity yet differing vegetation and fire regimes, and for the relative contiguous arrangement of the administrative unit.

Sources of data for SPI and fire danger rating are generally different weather stations. SPI calculations require continuous non-missing monthly precipitation data that have been regularly provided by NWS co-op stations for more than 100 years at some locations. The National Fire Danger Rating System (NFDRS) requires eight weather measures from worst case locations provided by a relatively young (<25 years) multi-agency network of Remote Automated Weather Stations (RAWS). These sites typically do not provide year-round precipitation observations.

The weather stations used in this analysis are shown in Table 1. RAWS data were obtained from the National Interagency Fire Management Integrated Database (NIFMID) in Kansas City, Missouri. Co-op monthly precipitation data were acquired from the Western Regional Climate Center, Reno, Nevada.

SPI is commonly calculated for varying monthly-incremented timescales (e.g., 1, 3, 12, 36, 72 months). For this analysis, daily fire danger indices were converted to monthly values to match the SPI time-scale. The intent is to evaluate SPI and fire danger in a strategic sense. At the monthly timescale, some site-specific NFDRS parameters, such as wind and fuel model, are less relevant. For this reason, energy release

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**Corresponding author address:* Paul M. Schlobohm, Bureau of Land Management, Office of Fire and Aviation, 2215 Raggio Parkway, Reno, NV 89512; email: pschlobo@dri.edu.

component (ERC), which is not impacted by wind, and NFDRS Fuel Model G, which may best represent fuels in general (Bradshaw 2001), were selected for both study units.

Table 1. Weather stations used for SPI analysis associated with the Boise National Forest and the Elko Field Office Units.

UNIT	RAWS	CO-OP
Boise N.F.	Bearskin	Anderson
	Pine Creek	Arrowrock
	Town Creek	Cascade
		Garden Valley
		Idaho City
		Yellow Pine
Elko F.O.	Antelope Lake	Carlin Mine
	Long Hollow	Contact
	Rock Spring Creek	Elko Airport
	Spring Gulch	Emigrant Pass
	Spring Mountain	Gibbs Ranch
		Montello
		Mountain City

ERC was computed using FireFamily Plus 2.0 software (Bradshaw and Brittain, 2000). Each RAWS station was weighted equally to compute a single daily index for the study unit. Monthly averages were computed, standardized, and inverted (multiplied by -1) so that negative and dry values of ERC could be compared directly to negative and dry values of SPI.

Fire occurrence data were obtained from NIFMID for the Boise N.F. and from the BLM's Wildland Fire Management Information for the Elko F.O. and loaded into FireFamily Plus to obtain fire danger values.

SPI was computed for the area of each study unit by combining the co-op stations together in a similar manner as the climate division computations (Redmond 2001). Each station has at least a 30-year climatology of monthly precipitation and was given equal weight in the area calculation. Months with more than 5 missing daily observations were estimated based on that station’s monthly average and the percent of average precipitation at the other stations for that particular month. Station data were averaged into one precipitation record for the study unit. SPI was computed for 1-, 3-, 6-, 12-, 24-, 36-, 48-, 60-, and 72-month timescales for each July and August using source code from Guttman (1999).

A typical time series of SPI is shown in Figure 1. The 1-month SPI value of -2.08 means that the precipitation total for August 2000 was 2 standard deviations below the August long-term mean for the Boise National Forest. Daily ERC values reflected this dry period - each day in August experienced a new all-time high value for the day indicating extreme fire danger.

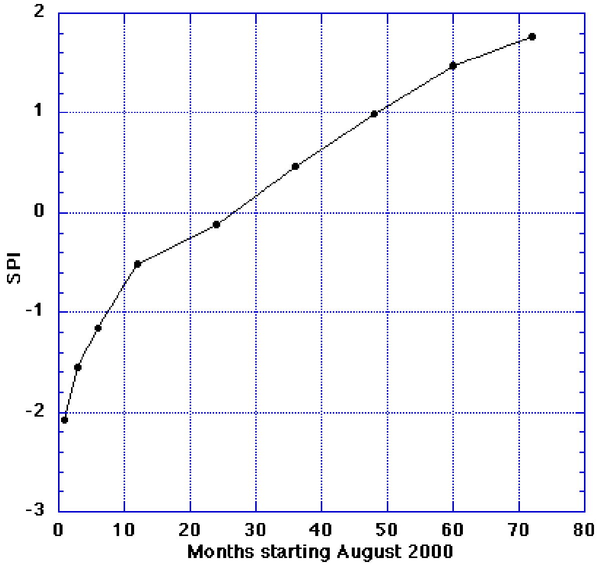

Figure 1. Standardized Precipitation Index for the Boise National Forest unit. Points represent number of months combined starting with August 2000.

The 3-month June – August 2000 SPI value of approximately –1.5 in Figure 1 is again well below average based upon the June - August climatology period. During this same time, ERC was at or near all-time high values.

McKee *et al* (1993) defined drought as SPI less than -1. Figure 1 shows that the Boise National Forest had been experiencing drought for at least 6 months, reflecting a dry spring and late winter. However, precipitation for the past 12-months was -0.51, indicating that precipitation from September 1999-February 2000 was closer to average for the year ending in August, but still dry. The remainder of the SPI trend indicates that precipitation was well above average during the previous 4-6 years leading up to the dry period.

3. DISCUSSION

The NFDRS computes ERC based on estimates of primarily 100- and 1000-hour time-lag fuels (Cohen and Deeming 1985). These particular dead fuel models respond slowly to environmental changes in moisture (e.g., relative humidity, precipitation duration). In turn, the ERC responds slowly to periods of wetting and drying conditions, making it a useful indicator of the current seasonal trend in fire danger.

SPI is calculated directly using precipitation amount rather than duration. But durations of surplus and deficit conditions can readily be obtained from the index. The 3- and 6-month SPI represent seasonal descriptions of precipitation that may relate to ERC. We intend to explore this relationship more fully for June-August at the two study units.

ERC calculations are based on initial fuel moisture values at model startup in spring and current year observations. Multiple year memory is not built directly into the calculations. Long-term memory is a feature of SPI. It may enable SPI to describe the magnitude and duration of drought (and wet periods) in a way that is applicable to fire management. We will examine the relation of 12-72 month SPI to summertime fire danger and occurrence at the study units.

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