USING THE PROBABILITY OF BURNING TO PLAN FOR WILDLAND FIRE USE

Carol Miller*, Brett Davis, Anne Black
Aldo Leopold Wilderness Research Institute,
Rocky Mountain Research Station, Missoula, MT

Unroaded areas and areas managed as wilderness provide unique opportunities for applying wildland fire use (that is, allowing lightning-caused fires to burn) as a cost-effective fuels management strategy (Miller 2003) and as a method for restoring fire regimes and fire-adapted ecosystems. Yet, most lightning-caused fires are suppressed, in part because the majority of these areas don't have fire management plans that allow wildland fire use (WFU). We are using estimates of the annual probability burning to help determine where WFU can be realistically considered and using this information to help develop fire management plans.

We developed a GIS model, BurnPro, to predict the probability of burning for every pixel on a raster landscape (Miller, *in press*). BurnPro uses topography, historical weather, maps of fuels, and historical ignition locations to estimate the likelihood of burning given the speed and direction a fire might spread from any ignition point. The approach in BurnPro follows logic similar to that used in the fire management application tool RERAP (Rare Event Risk Assessment Program), which estimates the likelihood that a fire will threaten a designated geographic location or point of concern before a fire ending event (i.e., precipitation) will occur (FRAMES 2003). Whereas RERAP is used to perform a nonspatial analysis for a single fire incident, BurnPro translates this concept to a spatially explicit landscape for multiple possible fire incidents occurring over time periods ranging from years to decades. The probability that fire will travel through space and time from an ignition source to any point on the landscape depends upon 1) the time required for fire to travel the distance from the ignition to the target, 2) the time remaining in the fire season, and 3) the frequency distribution of fire-stopping weather events (e.g., heavy rains) within the fire season.

To compute this probability, several spatial data layers were derived: five classes of ignition density for each month during the fire season (Figure 1), the time required for fire to spread from

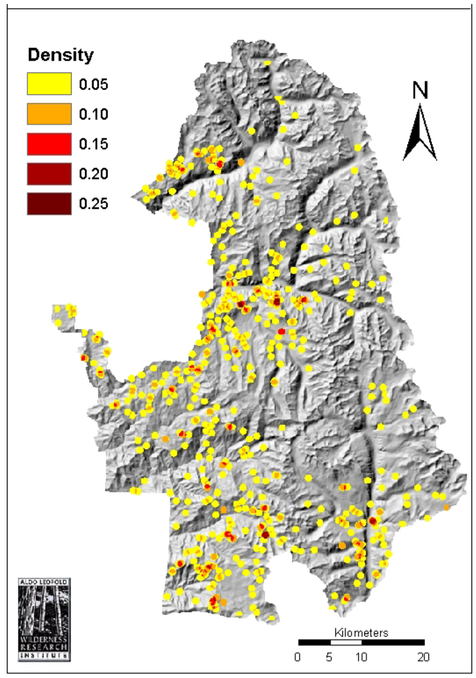

Figure 1. Annual density (km^{-2}) of lightning-caused ignitions in Sequoia-Kings Canyon National Parks, California. Derived from 20 years of ignition data (1981-2000).

an ignition to any point on the landscape under different classes of fire weather (Figure 2), and the length of the fire season (Figure 3). Historical fire weather were used to derive fire spread times under 4 different percentile fire weather conditions and to determine the frequency of fire-stopping precipitation events during the fire season. Several existing modeling tools were used to generate the intermediate information needed to implement this approach, including Fire Family Plus (Main et al. 1990); FARSITE (Finney 1994, 1995); and FlamMap (M. Finney, U.S. Forest Service Fire Sciences Lab, unpublished model). AMLs (Advanced Macro Language) were used in ARC/INFO (ESRI 1998) to manipulate and derive these spatial data.

From these intermediate data layers and manipulations, probability of burning was calculated for each ignition density class, each month, and each weather class. The resulting estimate of annual probability of burning (Figure 4) was computed as a weighted average of these individual probability maps. The average annual probability of burning is being used in combination with information on values at risk to help managers delineate zones where WFU may be a feasible fire management strategy. Where current conditions allow for WFU, we are evaluating if

*Corresponding author address: Carol Miller, Aldo Leopold Wilderness Research Institute, P.O. Box 8089, Missoula, MT 59087

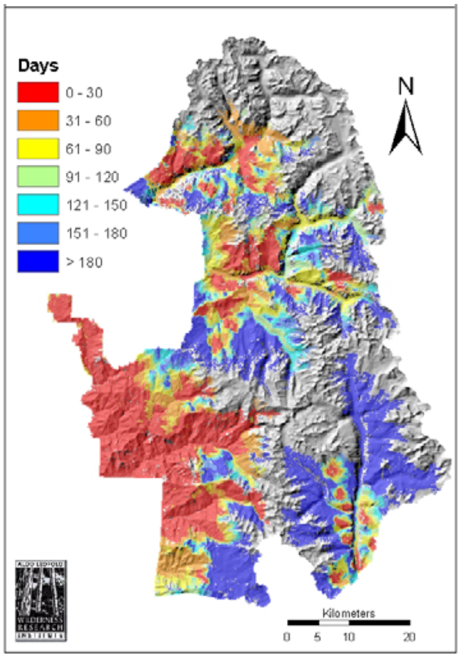

Figure 2. Cumulative time required for fires to spread from under 98th percentile fire weather conditions, assuming winds are blowing from the southwest, and using June ignitions in the lowest density class (0.05 km^{-2}).

there are sufficient natural ignitions to restore natural fire frequencies. We are identifying those areas where restoration objectives can be most easily met through the use of natural ignitions; these areas could be given priority for implementing WFU programs. This information is also be used to help identify areas within candidate WFU zones where the number, location, and timing of natural ignitions are inadequate for restoring historical fire regimes. In these areas, the use of prescribed fire, or even accidental human-caused ignitions, is being evaluated in light of restoration objectives. We are currently conducting these analyses for four national parks (Yosemite, Sequoia-Kings Canyon, Grand Canyon, and Great Smoky Mountains) and two Forest Service wilderness areas (Selway-Bitterroot and Gila-Aldo Leopold) improve fire management plans and refine management objectives.

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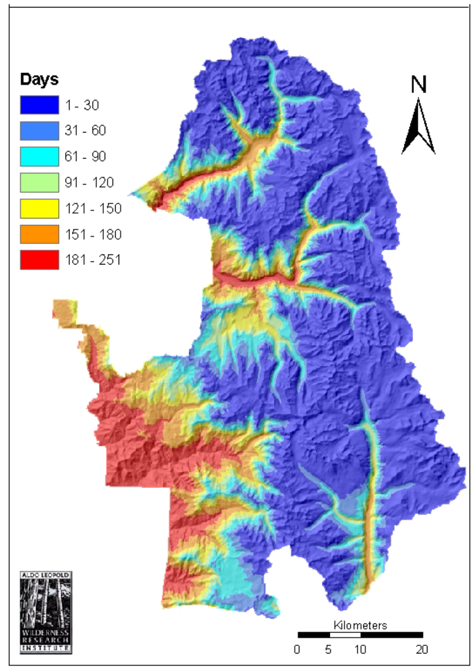

Figure 3. Length of the fire season approximated using a simulation model of soil moisture (Urban et al. 2000).

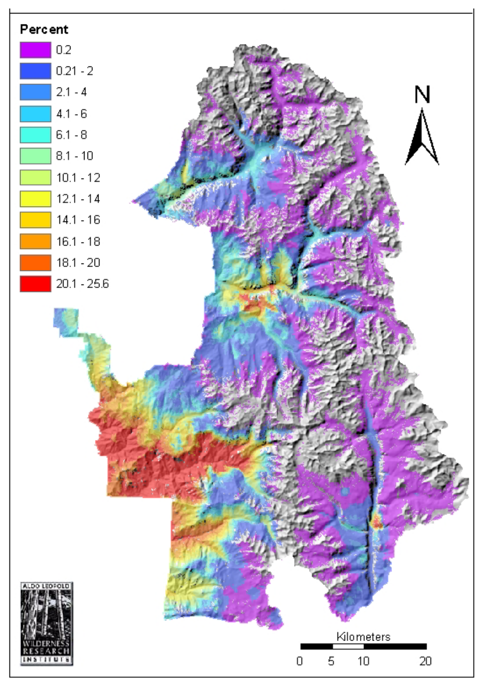

Figure 4. Annual probability of burning for current fuel conditions averaged over 5 classes of ignition density, 4 months of ignitions, 4 classes of weather conditions and 8 wind directions.

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