USING THE PROBABILITY OF BURNING TO PLAN FOR WILDLAND FIRE USE

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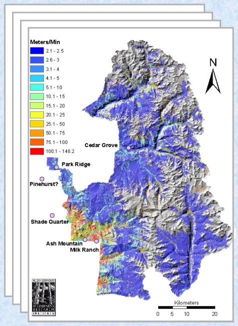
The GIS model BurnPro predicts the annual probability of burning for every pixel in a raster landscape. BurnPro uses topography, historic weather, maps of fuels, and historic ignition locations to estimate the likelihood of burning given the speed and direction a fire might burn from any ignition point, the length of the fire season, and the likelihood of fire-stopping precipitation events during the fire season. These estimates are used to assist in developing fire management plans.

RATE OF SPREAD

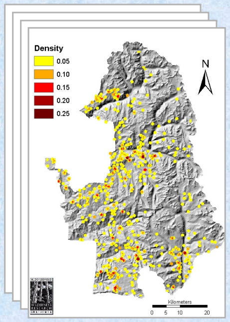


(example: extreme weather)

20 years of historic weather data were analyzed for 3 weather stations. FireFamilyPlus (Main et al. 1990) was used to compute Spread Component (SC) index; these were used to define 4 classes (low, moderate, high, and extreme) of fire weather conditions.

Expected rate of spread (ROS) was calculated using FlamMap (Fire Sciences Lab 2003) for every combination of the 4 weather classes and 8 separate wind directions. FlamMap computes potential fire behavior for every cell in a raster landscape.

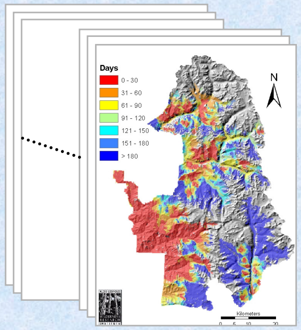
IGNITIONS

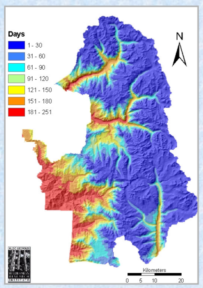


Point location data for 20 years of lightning-caused ignitions were separated into 4 months (June, July, August, and September) and then used to derive ignition density maps representing 1, 2, 3, 4, and 5+ ignitions per km^2 per month.

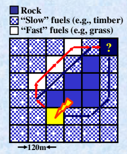
These 20 maps (4 months x 5 density classes) were used in the next step to compute the least accumulative spread time.

BurnPro follows logic similar to RERAP, a nonspatial model which estimates the probability that a fire will threaten a point of concern before a fire-ending event (rain) occurs (FRAMES 2003). BurnPro translates this to a spatially explicit landscape and to many possible fires that may occur over many years (Miller 2003). The probability that a pixel will burn depends on 1) the time required for fire to spread from an ignition to that pixel relative to the time remaining in the fire season, and 2) the frequency of fire-ending rain events within the fire season.





LEAST ACCUMULATIVE SPREAD TIME (T)



The inverse of ROS is the cost (in time) per unit of surface distance. ArcGIS PATHDISTANCE was used to find the least accumulative spread time from each ignition source to every cell on the landscape. The function accounts for horizontal factors like wind and slope that influence the time needed to move from cell to cell. 20 ignition grids x 4 ROS grids x 8 wind directions = 640 "T" grids

LENGTH OF FIRE SEASON (drought-days)

Fire season may range from several months at low elevations to perhaps only a few days at the highest elevations. Simulations of a drought-day index (Urban et al. 2000) were used to approximate the length of the fire season at 100-m elevation intervals across the landscape. The frequency distribution of drought-days from 100 replicate simulations for each elevation was fit to a waiting-time (Weibull) function to derive parameters α and β.

Probability of burning = Pburn1 x Pburn2

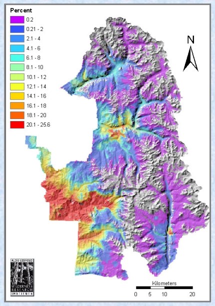
$$\text{Pburn1} = 1 - \exp\left[-\left(\frac{T}{\beta}\right)^{\alpha}\right]$$

The probability that fire will spread to each pixel on the landscape before the end of the fire season is calculated for each of the Least Accumulative Spread Time maps (T). The parameters α and β describe the variability and length of the fire season.

$$\text{Pburn2} = 1 - \text{P(significant rain)}$$

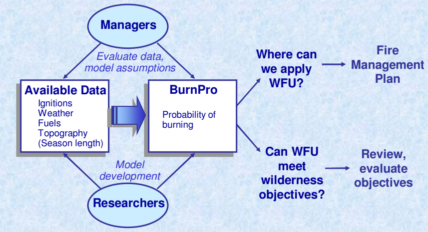
FireFamilyPlus (Main et al. 1990) was used to determine the probability that a significant rain event (at least 0.5 inches within 5 days or less; Latham and Rothermel 1993) would stop a fire before the end of the fire season. Subtracting this probability from 1 gives the probability that fires are unhindered by precipitation during the fire season.

ANNUAL PROBABILITY OF BURNING



The probability of burning grids were combined using a weighted average approach where the weights were assigned according to the frequency of occurrence (Miller 2003).
The result was an average estimate of the annual probability of burning.

Estimates of probability of burning are being used to identify where wildland fire use (WFU) is feasible given the current conditions of fuels and the risks to ecological and social values. This information is also being used to evaluate if the number, location, and timing of WFU ignitions are adequate for restoring historic fire regimes in wilderness and parks.



These analyses are being conducted for 3 National Parks (Yosemite, Sequoia-Kings Canyon, and Great Smoky Mountains) and 2 Forest Service wilderness areas (Selway-Bitterroot and Gila-Aldo Leopold) to improve fire management plans and refine management objectives.

This poster is part of the National Fire Plan and Joint Fire Science Program Project: "Can Wildland Fire Use Restore Historical Fire Regimes?"

The Aldo Leopold Wilderness Research Institute is administered by the USFS Rocky Mountain Research Station and operates under an agreement with the US Forest Service, Bureau of Land Management, National Park Service, US Fish and Wildlife Service, and US Geological Survey.

The goals of the Leopold Institute are to develop the knowledge needed to protect and preserve wilderness and the ecological and social derived from it, and to communicate and apply this knowledge to management agencies and other user groups. Visit our web site at http://leopold.wilderness.net

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