Human Influence on Fire Disturbance in Northern Wisconsin

Dr. Brian R. Sturtevant[1], Dr. David T. Cleland[1], and Dr. Sari C. Saunders[2]

[1]USDA Forest Service, North Central Research Station, Rhinelander, WI 54501 (email: bsturtevant@fs.fed.us)

[2]School of forestry, Michigan Technological University, Houghton, MI 49931

North Central Research Station

ACKNOWLEDGEMENTS

We thank the Wisconsin Department of Natural Resources and the US Forest Service offices responsible for recording and compiling the Wisconsin fire database. Thanks also to Maureen Mislivets for her assistance in compiling the spatial datasets, and Jeff Cardille for his expertise and guidance with fire data analyses.

Literature Cited

Atkinson, E.J. & T.M. Therneau. 2000. An introduction to recursive partitioning using the RPART routines. The Mayo Foundation, 33pp.

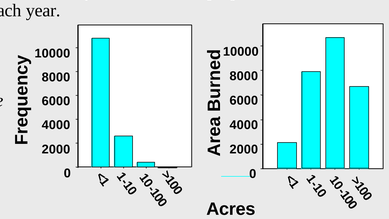
Cardille, J.A., Ventura, S.J., and Turner, M.G. 2001. Environmental and Social Factors Influencing Wildfires in the Upper Midwest, United States. Ecological Applications 11: 111-127.

Cleland, D. T., P. E. Avers, W.H. McNab, M. E. Jensen, R.G. Bailey, T. King, and W. E. Russell. 1997. National hierarchical framework of ecological units. In M. S. Boyce and A. Haney (eds.), Ecosystem Management: Applications for Sustainable Forest and Wildlife Resources, Yale University Press, New Haven & London. pp 181-200.

INTRODUCTION

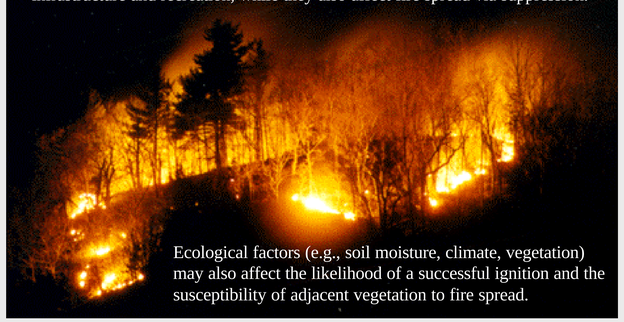
Historically, fire disturbance played a major ecological role in the structure and function of many forested ecosystems of the upper Midwest. Human activity patterns have since disrupted the historic fire regime following human settlement. Human-related activity is currently responsible for igniting approximately 97% of all fires in the region (Cardille et al. 2000), but all fires are actively suppressed. The resulting fire regime is therefore dominated by very frequent but small fires. Nonetheless, large fires are ecologically important because they contribute a disproportionate area to the total area burned each year.

Fire frequency and area burned by fire size in Northern Wisconsin (1985-2000).



Human versus Ecological Influence

Two characteristics of fires are essential to understanding fire patterns across landscapes: fire *ignition* and fire *spread*. Humans influence the spatial pattern of ignitions through their patterns of activity associated with development, infrastructure and recreation, while they also affect fire spread via suppression.



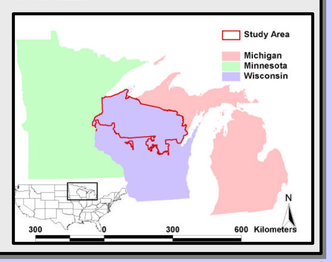
Ecological factors (e.g., soil moisture, climate, vegetation) may also affect the likelihood of a successful ignition and the susceptibility of adjacent vegetation to fire spread.

OBJECTIVE

Evaluate the relative importance of human and ecological factors affecting the spatial pattern of fire ignition and size in northern Wisconsin

STUDY AREA

We focused on the Laurentian Mixed Forest Province (Bailey 1995) within Northern Wisconsin, where either the Wisconsin Department of Natural Resources or the USDA Forest Service had primary wildfire attack responsibility. The area is primarily forested, with scattered residential areas, seasonal lakeshore development, and low to moderate levels of agricultural activity.



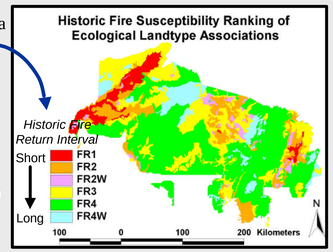
METHODS

Fire Database

A total of over 12,800 fires were recorded in the study area by either the Wisconsin Department of Natural Resources or the USDA Forest Service between 1985 and 2000. Each fire record includes data such as fire size in acres, the date and time the fire was observed, the estimated cause of the fire, and the cover type at the origin of the fire. Each fire is assigned to a square mile area corresponding with a section of the Wisconsin General Land Office survey. Forest fires were separated from the rest of the database using the recorded cover type, and the section boundaries were used to calculate mean values for the independent variables used in the analyses, described below.

Ecological Factors

- ***LTA*** : Ecological Land Type Associations (Cleland et al. 1997) were ranked according to their historic fire return interval, (FR1 = shortest, FR4 = longest), where a "W" indicates a wetland-dominated ecosystem.
- Percent of 4 major cover types within the section: Agric. & Grassland (***AG***), ***Forest***, ***Water***, ***Wetland***
- ***RelFireResist:*** Forest vegetation estimated from classified TM imagery (WISCLAND) were rank ordered according to an *exponential* scale of decreasing flammability.
- AWC: Available water-holding capacity (STATSGO)
- Mean Climatic Variables
  - ***AugMaxT***: Mean maximum August temperature
  - ***MarPrecip***: Mean March Precipitation
  - ***JunPrecip***: Mean June Precipitation



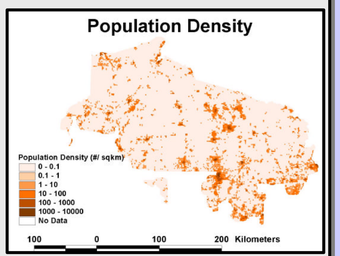
Social Factors

Block-level census data (1990):

- Population density (***PopDens***, residents/sq. km)
- Housing density (***HouseDens***, # homes/sq. km)
- Percent of homes occupied by owners (***PropOwn***)
- Percent of seasonally occupied homes (***PropSeas***)

Infrastructure:

- Distance to nearest road (***DistRoad***, meters)
- Road Density (***RoadDens***, linear km/square km)
- Distance to nearest railroad (***DistRail***, meters)
- Rail Density (***RailDens***, linear km/ square km)



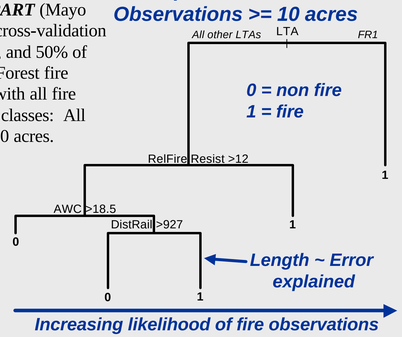
CLASSIFICATION TREE ANALYSES

We applied classification tree analyses to binary (fire/nonfire) section observations using ***RPART*** (Mayo Foundation). Trees were pruned using the cross-validation procedures of Atkinson & Therneau (2000), and 50% of observations were reserved for validation. Forest fire observations were analyzed in comparison with all fire observations in each of three minimum size classes: All fires (ignitions), fires >= 1 acres., fires >= 10 acres.

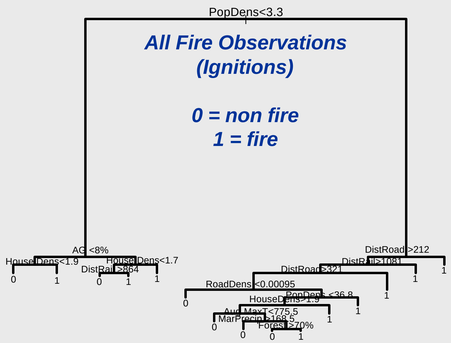
Interpreting Classification Trees

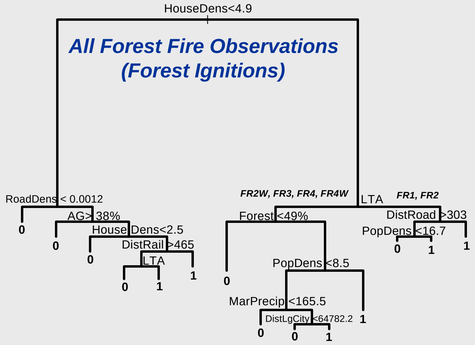
- Read like a dichotomous key
- Decision variable shown at each split
- True statements flow to the left
- Length of branch reflects error explained
- Nonfire predictions (0) fall to the left, Fire predictions (1) fall to the right.

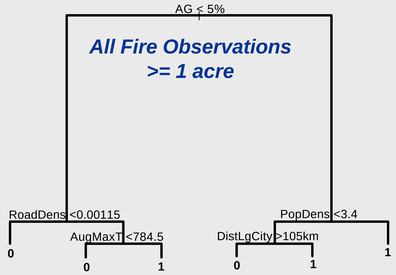
Example: All Forest Fire Observations >= 10 acres

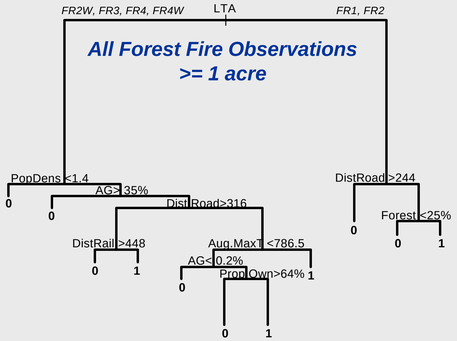


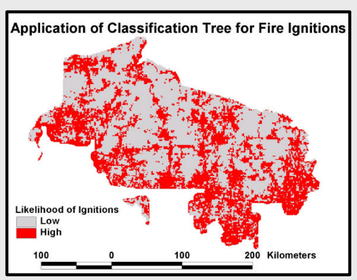
RESULTS

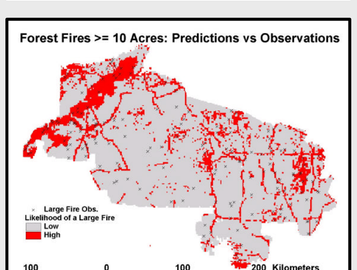












CONCLUSIONS

Results suggest that fire ignitions are related primarily to factors associated with human populations. Less important indicators of ignition risk include variables associated with human access, such as distance to nearest road or railroad. However increasing the minimum fire size increases the importance of ecological indicators of fire risk. For example, vegetation within agricultural and grassland areas are susceptible to fire at certain times of the year, as indicated by the importance of that cover type in predicting fire observations greater than 1 acre in size. Similarly, landtype association is the most important indicator of forest fire observations greater than one acre. This suggests that the LTAs historically prone to fires are still susceptible to fires today, despite an aggressive fire suppression policy practiced throughout the region. ***Collectively, our results indicate that while humans factors dominate the probability of fire ignitions, ecological factors constrain the ability of those fires to spread.***

The graphics to the left show example applications of the classification trees to geographic data, illustrating the relative likelihood of fires of a given type.