North Atlantic
Fire Science Exchange

FIRESCIENCE.GOV
Research Supporting Sound Decisions

Research Brief for Resource Managers

Release: June 2018
Contact: Dr. Inga La Puma
Phone: 732-447-7168
Email: inga.lapuma@rutgers.edu

North Atlantic Fire Science Exchange | c/o Erin Lane USDA Forest Service, Northern Research Station, 271 Mast Rd. Durham, NH 03824 USA

Understanding fire behavior using modern equipment and methods

Mueller EV, Skowronski N, Clark K, Gallagher M, Kremens R, Thomas JC, El Houssami M, Filkov A, Hadden RM, Mellg W, Simeoni A. (2017) ***Utilization of remote sensing techniques for the quantification of fire behavior in two pine stands.*** *Fire Safety Journal 91: 845–854.*

Click here for original paper.
Click here for webinar series on this project.

Management Implications

- Detailed measurements with modern equipment will improve fire behavior models.
- Fire scientists could not have conducted this experiment without working with fire managers trained in prescribed fire.
- Managers will benefit from studies like these when smoke and fire spread predictions for prescribed and wildfire incidents are improved over traditional calculations.

Fire scientists are trying to understand the driving mechanisms of fire behavior in prescribed and wildland fire. They are doing this because many tools for understanding fire spread and behavior are currently based on Richard Rothermel's equations from 45 years ago, when today's sophisticated instruments and computing power were not yet available. Although Rothermel's equations have served the fire science community well, numerous groups are pursuing an update for physics-based fire spread and behavior models, including the Department of Defense Strategic Research and Development Program (SERDP) research group in the New Jersey Pinelands. This brief covers a recent paper by the SERDP group describing some early observations and results from highly instrumented fires in 2017.

Two research fires were conducted in the pitch pine scrub-oak forest type by the New Jersey Forest Fire Service and the USDA Forest Service. The researchers utilized infrared sensors aboard planes for heat detection and LiDaR (light detection and ranging) sensors to understand forest structure, as well as sonic anemometers, dataloggers, and fire-proof video cameras. They measured fuel moisture content by drying adjacent plots in non-burned sections, determined fuel loading by harvesting adjacent un-burned plots, gathered three-dimensional wind direction and strength at different heights along the fire front with the sonic anemometers, and calculated fuel structure and density via LiDaR data.

Weather conditions consisted of light winds, cool March air, and moderate fuel moisture levels. Canopy height was between 12 and 14 meters. The results in mathematical terms describe the movement of the fire front and the factors contributing to it. The fire front itself varied from one meter to 10 meters wide. Areas that experienced crown fire had larger fire fronts. The scientists noted much faster spread in torching areas and determined fire spread from infrared flights at 0.10–0.20 meters per second (or between a quarter and half a mile per hour). In this prescribed fire, needle litter was the most significant contributor to fuel loads as well as the amount of biomass consumed.

Overall, numerous measurements concerning behavior and spread were conducted, and preliminary analyses suggest that detailed fuel size measurements may be needed for physics-based models due to their influence in this study. The fires in these experiments were not strongly wind-driven, but rather, the fire itself pulled in oxygen, which dominated the movement of air within the fire front environment. Overall, the scientists gained a plethora of data to begin to connect the real environment to models that can be used in operations during a wildfire or planning for prescribed fire effects.

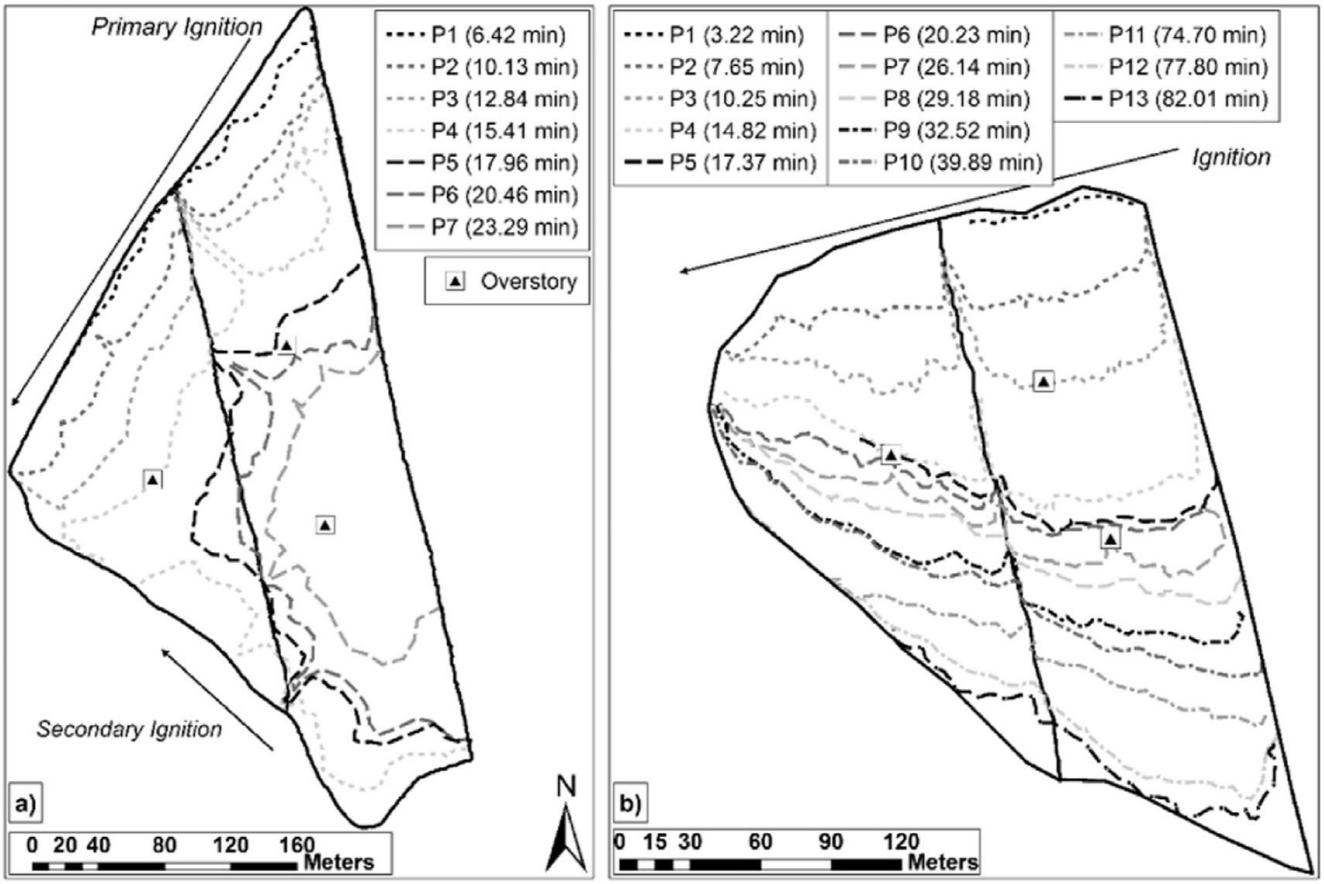

Figure 2 from the paper showing the progression of the fire front determined by infrared cameras aboard a plane along with ground sensors.

Figure 7 from the paper showing before and after fuel consumption (same location, different camera angle).