USDA Forest Service
U.S. DEPARTMENT OF AGRICULTURE

Northern Research Station

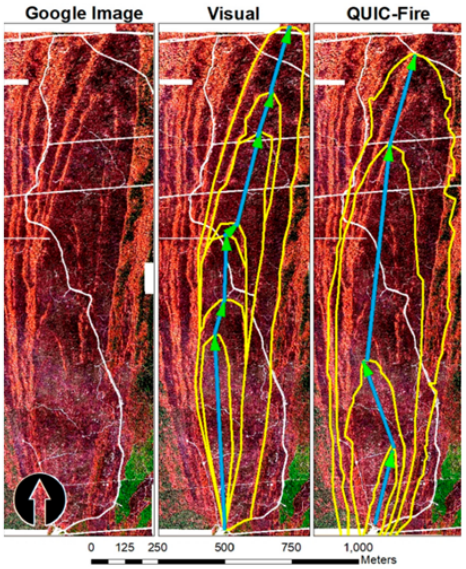
Rooted in Research

ISSUE 19 | SEPTEMBER 2023

Simulating the Spring Hill Fire: Using QUIC-Fire to Predict Wildfire Size and Spread

Accurately modeling wildland fire behavior is crucial for both planning prescribed burns and responding to wildfires. Predicting fire behavior, however, is difficult. Fuel and atmospheric factors change and interact in complex ways across space and time, even within a single prescribed burn. Many fire simulation models exist. These models range from simple models that are easy to run but lack complexity and accuracy to more complicated models that require powerful computers and highly specialized skills to run. However, the need remains for reliable tools that are manager friendly and quick, yet sophisticated enough to simulate complex ignitions and fuel-fire interactions, such as those found in prescribed fires.

New physics-based models simple enough to run on a laptop yet complex enough to represent the physical processes and interactions among fuels and the atmosphere needed to produce accurate predictions provide the best of both worlds and offer managers the opportunity for sophisticated fuel treatment and wildfire planning. QUIC-Fire, a combination of an existing fire simulation model (FIRE-CA) and a wind movement model originally developed for urban areas (QUIC-URB), is one such tool.



Comparison of Google Earth imagery, visual fire path based on managers' observations, and the fire path simulation produced by QUIC-Fire. Source: Gallagher et al. (2021).

KEY MANAGEMENT CONSIDERATIONS

- QUIC-Fire is becoming a promising decision support tool for planning prescribed burns.
- QUIC-Fire allows managers to quickly explore how different ignition, weather, and fuel scenarios may interact during prescribed burns to produce different fire behavior and ecological outcomes, as well as test the ability of treatment results to halt or alter potential future wildfires.
- Within a numerical modeling environment, QUIC-Fire simulations are used to quickly and safely explore contrasting treatment scenarios to help identify optimum treatment regimens to reduce fire spread rates and size.

QUIC-Fire Collaborations

Research scientists Michael Gallagher and Nicholas Skowronski with the U.S. Department of Agriculture, Forest Service, Northern Research Station recently conducted research to evaluate the effectiveness of QUIC-Fire in predicting wildfire behavior. Gallagher, Skowronski, and their team used the model to replicate the Spring Hill Fire of 2019. The fire, which started from an abandoned campfire near the Spring Hill Plains area of the New Jersey Pinelands National Reserve, ultimately burned nearly 10,000 acres over the span of 13 hours before it was controlled by local land managers. In addition to windspeed and fuel data inputs from nearby weather towers and research plots maintained by the Silas Little Experimental Forest, Gallagher and Skowronski worked closely with managers from the New Jersey Forest Fire Service who fought the fire to obtain additional data needed to run the model.

Collaboration with the local fire management community was critical to Gallagher and Skowronski's research. Scientists from the Silas Little Experimental Forest and the region regularly collaborate on research and technical transfer activities with local fire management agencies, including the New Jersey Forest Fire Service, the U.S. Department of Defense, and U.S. Fish and Wildlife Service. Some of these well-established partnerships were developed nearly 100 years ago to produce some of the nation's first prescribed fire research. The collaborations are a successful example of "coproduction" in which managers and researchers work together to investigate fire behavior, advancing research while developing more useful tools for managers.

Gallagher and Skowronski benefitted greatly from the experience and expertise of the managers who had fought the Spring Hill Fire, and with their help, the research team was able to successfully reproduce the fire. Detailed fire progression data, maps, time stamps, and observations were crucial in informing the simulation model in QUIC-Fire. Once Gallagher's team had developed the first simulations, managers provided input during a workshop sponsored by the North Atlantic Fire Science Exchange (NAFSE) in September 2020 to help improve the model and refine further research directions. The simulation resulted in over two thirds of the simulated fire area representing true positives (e.g., the model correctly predicted that fire occurred in that location) and only 6 percent of pixels representing false negatives (e.g., the model predicted that the area had not burned, but it actually had).

Fuel Influence on Fire Size and Spread

After confirming the Spring Hill fire could reliably be replicated in QUIC-Fire, Gallagher and Skowronski's team tested nine additional management scenarios. Fuel loading (i.e., amount of surface fuel) and structure (i.e., incorporating regular prescribed burns or past wildfire) were varied to see how these factors would influence the fire size, growth, and spread. In about half of these scenarios, the amount of surface fuels was reduced to 50 percent. In six of these scenarios, they simulated repeated prescribed fire to see how frequent burning in the past might affect wildfire spread. In two other scenarios, they simulated the effects of repeated wildfire. Stand density was reduced by 25 percent in many of the models to simulate the results of thinning on fire behavior.

The results of these scenarios shed light on the effects of forest management on fire response. The scenario with the greatest fire size, spread, and growth was the original simulation of the Spring Hill fire. This fire took place in a part of the pinelands that historically had been frequently burned, but more recently, fire had been suppressed. In general, both reducing the fuel load to 50 percent and altering fuel structure through prescribed burning reduced fire size, spread, and growth. Fuel loading, however, had the greatest influence on fire size and growth, and fuel structure had the greatest influence on fire spread.

It is important to note it is not yet known how results from the dwarf pitch pine forest and tall pine forest conditions investigated in this study may apply to other forest types. Testing QUIC-Fire on historical fires in other forest types is one of many future directions in which this research can go next. A new interagency fuels monitoring effort is generating a growing library of fuel conditions for models. As more fuel input information becomes available, it will be possible for managers to use QUIC-Fire to simulate fires more accurately in other forest types.

Local fire managers respond to the 2019 Spring Hill Fire in the Pinelands National Reserve, New Jersey. USDA Forest Service photo by Michael Gallagher.

Project Lead

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FURTHER READING

Gallagher, Michael R.; Cope, Zachary; Giron, Daniel Rosales; Skowronski, Nicholas S.; Raynor, Trevor; Gerber, Thomas; Linn, Rodman R.; Hiers, John Kevin. 2021. Reconstruction of the Spring Hill Wildfire and Exploration of Alternate Management Scenarios Using QUIC-Fire. Fire. 4(4): 72. 17 p. https://doi.org/10.3390/fire4040072.

Spring Hill Fire and QUIC-Fire Model Simulation I Prescribed Fire Science Workshop Webinar Series -- You Tube

Model Report-out and Co-Production Discussion I Prescribed Fire Science Workshop Webinar Series -- You Tube

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