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Understanding the Fire Hazards from Fences, Mulch, and Woodpiles

Kathryn Butler*
National Institute of Standards and Technology, Gaithersburg, Maryland, USA,
kathryn.butler@nist.gov

Erik Johnsson
National Institute of Standards and Technology, Gaithersburg, Maryland, USA,
erik.johnsson@nist.gov

Introduction

Wildland-urban interface (WUI) fires threaten communities in many locations around the world. Fences, mulch, and woodpiles have been identified as contributors to the spread of WUI fires within communities [Maranghides and McNamara (2016), Maranghides et al. (2015)]. Once ignited, these fuels become sources that may ignite nearby objects through radiation, direct flame contact, and firebrands. It is important to understand the mechanisms by which combustible landscaping elements can transport fire to a home in order to find ways to address the risk. Such knowledge helps with proactive design within the community. It also helps fire departments to plan defensive strategies, placing resources and assigning tasks where they will be the most effective.

More than 230 field experiments on combustible fences, mulch and woodpiles have been carried out in an ongoing study at the National Institute of Standards and Technology (NIST). The fire behavior of these fuels, including flame spread rate, spotting due to firebrands, and ignition potential downwind, was observed under various conditions of applied wind and proximity to a structure.

Experimental Method

The field experiments were designed to investigate the fire behavior of a variety of combustible landscaping elements and the spread of fire to a building through firebrand spotting. A schematic of the experimental setup is shown in Figure 1. A wind machine, consisting of an airboat fan mounted on a trailer, was aimed toward a small structure. A flow straightener in front of the wind machine directed the wind slightly downward to allow the wind field to extend from the base of the combustible object being tested to its top.

The wind field was monitored by a set of bidirectional probes placed just upwind of the fence, mulch bed, or firewood. Four video cameras monitored each experiment from right and left sides and from each side of the fan. The test object was ignited by a propane burner applied for 90 s to the end farthest from the structure. At this time the burner was removed and the fan was started, marking the beginning of the test at time t = 0.

* Corresponding author: Dr. Kathryn M. Butler, National Institute of Standards and Technology, Engineering Laboratory, 100 Bureau Drive Stop 8662, Gaithersburg, MD 20899-8662, kathryn.butler@nist.gov,
https://www.nist.gov/el/fire-research-division-73300/wildland-urban-interface-fire-73305.

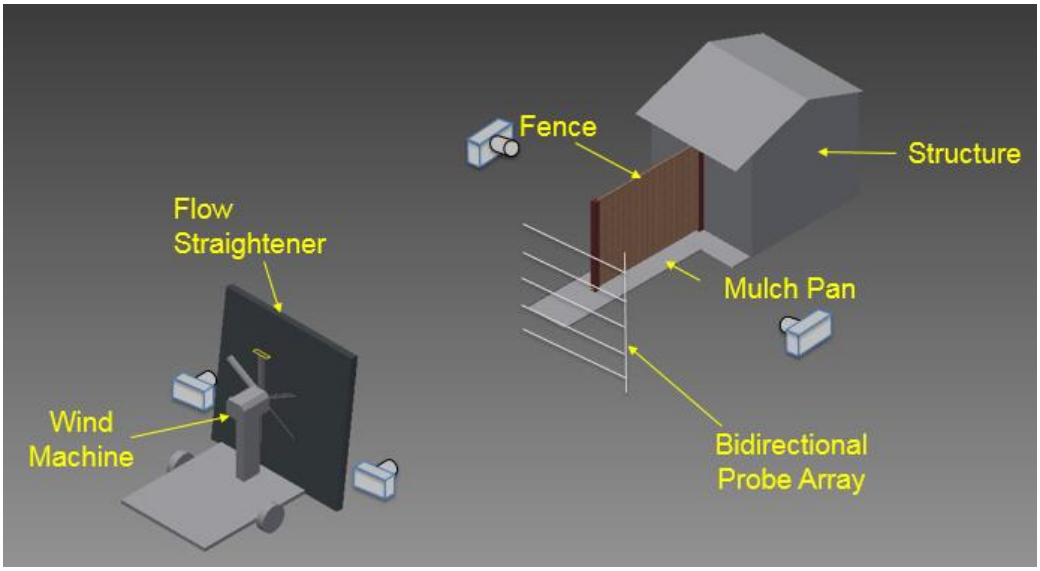

Figure 1: Experimental setup

The experiments were performed under wind speed conditions from 6 m/s to 17 m/s and separation distances from the structure of 0 m to 1.8 m (7.3 m for woodpiles). Fence types included western red cedar (WRC) and vinyl privacy fences, redwood and pine lattice fences, good neighbor fences, and aged privacy fences. Mulches included shredded hardwood (HW), pine bark, pine straw, and rubber mulch. Woodpile experiments were performed with dry and moist oak, maple, and softwood in a variety of configurations relative to the wind and structure.

Examples of Fire Behavior

WRC Privacy Fence with HW mulch

Figure 2 shows an image from a typical experiment with a WRC privacy fence sitting in a bed of HW mulch. This experiment was performed at medium wind speeds averaging about 11 m/s at

Figure 2: WRC privacy fence with HW mulch, in medium wind, at t = 5 min.

the center midline of the fence, with the fence/mulch combination separated from the building by 1.8 m. The image shows the conditions at t = 5 min. At this time the fence was burning along its full length, with burn marks indicating that the flames have remained below the halfway point of the fence. Firebrands have ignited spot fires in a separate mulch bed at the base of the structure at several locations. This target mulch bed represented any fine combustible material situated next to a house that could ignite and pose an immediate threat.

Parallel WRC Privacy Fences with HW mulch

A set of experiments was performed with two fence panels side-by-side, representing a situation in which neighbors build adjacent fences along the property line of their respective parcels, perhaps for reasons of aesthetics or functionality.

The addition of a second WRC privacy fence parallel to the first changed the fire behavior completely. Figure 3 shows the fire conditions at t = 5 min for a set of parallel WRC privacy fences spaced apart by 20 cm. This experiment was performed at low wind speeds, averaging about 7 m/s at the center of the fence. The space between the fences is partially shielded from the wind field, which promotes flame attachment and spread. The changes in convective heat transfer introduced by the second fence, in addition to the radiative exchange between the fences, act to intensify the fire.

Figure 3: Parallel WRC privacy fences spaced apart by 20 cm, with HW mulch in low wind, at t = 5 min.

WRC Privacy Fence alone

In the absence of mulch beneath the WRC privacy fence, the fence experienced glowing combustion, which progressed slowly. Figure 4 shows the hole near the point of ignition that resulted at t = 30 min under the same wind conditions as for Figure 2. The majority of fences without mulch did not result in spot fires in the target mulch bed at the base of the structure. This favorable outcome required the base of the fence to be completely free of fine combustibles—a circumstance that may be difficult to achieve in the winds of a WUI fire.

Figure 4: WRC privacy fence without mulch, in medium wind, at t = 30 min.

Discussion

The experiments in this study demonstrated a range of hazards from various configurations of fences, mulch, and firewood in a wind field in close proximity to a structure. Wood fences erected parallel to each other resulted in flames exceeding the height of the fence within a few minutes of ignition. The burning of fences without mulch was limited to glowing combustion near the area of ignition, although it would be difficult in practice to keep a fence completely clear of fine combustible materials during a WUI fire. Flame spread over fences and mulch was affected by wind flow fields, fence design, and the type of mulch. The information can be used by homeowners, city planners, and fire officials to reduce fire hazards in communities.

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