RESEARCH in Progress

Forest Products Laboratory

Flammability of Invasive Species Investigated with Cone Calorimetry

Cone calorimetry test of vegetation as exposed to heat flux of 50 kW/m^2.

Wildfires substantially affect the biotic and abiotic compositions of ecosystems. The role of fire on ecosystems is a complex problem, but understanding it is necessary for implementing property fire management policies. For example, reintroduction of surface fires in Eastern U.S. deciduous forests has been suggested for limiting the spread of invasive vines such as Japanese honeysuckle. Invasive species may increase fine fuel loads, fire hazard, and potential fire severity and may affect rangeland forage, wildlife habitat, and other values. Invasive species that colonize fire-adapted ecosystems can change the type, frequency, and intensity of fires within these ecosystems and lead to the decline of native species, but we have very little data on the flammability of invasive species (Lambert et al. 2010).

Background

Dibble et al. (2007) characterized the flammability of foliage for 42 species (half of which are invasive) using the cone calorimeter, using four flammability properties: ignitability was related to time to ignition of the fuel, combustibility to peak heat release rate, sustainability to total heat release rate, and consumability to heat of combustion. They found that invasive species overall had slightly lower heat of combustion than their native counterparts; they had difficulty making further comparisons (peak heat release rate, time to ignition, and total heat release) because of differences in initial sample mass caused by difficulties containing leaves and twigs within the sample holder. They also noted that differences in moisture content (MC) between invasive and noninvasive species may have a large effect on flammability. Prince and Fletcher (2014) determined the importance of MC on thermal degradation of single live leaves of Manzanita shrub under different laboratory conditions—all flammability characteristics were affected but were not predictable.

Objective

The objective of this research is to better characterize the flammability of foliage for invasive and noninvasive species. The study will improve testing conditions in the cone calorimeter and take advantage of improved instrument features, such as the FTIR gas analysis and high-precision weigh scale.

Exploratory work will optimize testing to provide flammability characteristics that can be rated and classified and to provide detailed time-resolved data suitable for fire modeling of foliage or fire behavior models. This optimized testing will then be applied to live foliage samples of various invasive and noninvasive plants from regions subject to forest fires.

U.S. Department of Agriculture • Forest Service
Forest Products Laboratory
www.fpl.fs.fed.us

Approach

A hybrid of the methods of Prince and Fletcher (2014) and Dibble et al. (2007), along with some modifications, will be implemented. Exploratory work with demonstration samples will (1) devise shipping, storage, and conditioning protocols to ensure sample quality, (2) design the sample holder and cone heater environment to ensure heat stability and containment of intact leaves, (3) optimize radiant flux levels and conditioned air flows under piloted ignition, (4) devise thermocouples for sample insertions, and (5) ensure stable and fast time response of FTIR and NDIR gas analyzers, laser extinction, and weigh scale. Data analyses are provided in an Excel worksheet, but deviations from standard procedures may be required for additional analysis.

Expected Outcomes

We expect foliage flammability knowledge to be enhanced to the point where it can be effectively used. One example application would be understanding effects on forest floor litter of flaming heat of combustion and time to ignition related to fire behavior of maple or oak as traced to their conditioning in the forest (Dickinson et al. 2016). Characterizing live fuel flammability in sufficient detail may make it possible to use it in fire modeling, such as a fire ecologist using fire effects modeling for tree mortality and habitat development. Although prescribed fire may reduce or eliminate some invasive species, as suggested for Japanese honeysuckle, it may be counterproductive for others. If invasive species need to be addressed, foresters should have every possible tool at their disposal.

Timeline

The project will begin January 2017. Samples will be collected throughout 2017. Testing will be performed in 2017 and 2018. The final report should be available before December 2018.

Cooperators

USDA Forest Service, Northern Research Station

Tallgrass Prairie and Oak Savanna Fire Science Consortium

Contact Information

Mark Dietenberger
USDA Forest Service, Forest Products Laboratory
Madison, Wisconsin
(608) 231-9531; mdietenberger@fs.fed.us

References

Dibble, A.; White, R.H.; Lebow, P.K. 2007. Combustion characteristics of north-eastern USA vegetation tested in the cone calorimeter: invasive versus non-invasive plants. International Journal of Wildland Fire. 16: 426-443.

Dickinson, M.B.; Hutchinson, T.F.; Dietenberger, M.A.; Matt, F.; Peters, M.P. 2016. Litter species composition and topographic effects on fuels and modeled fire behavior in an oak-hickory forest in the eastern USA. PLOS ONE. DOI:10.1371/journal.pone.0159997: 1-30.

Lambert, A.M.; D'Antonio, C.M.; Dudley, T.L. 2010. Invasive species and fire in California ecosystems. Fremontia. 38: 2-3.

Prince, D.R.; Fletcher, T.H. 2014. Differences in burning behavior of live and dead leaves, part 1: measurements. Combustion Science and Technology. 186: 1844-1857.