Wildfires are a common occurrence in Kentucky. Millions of dollars are spent in controlling them annually; unfortunately most fires in Kentucky are attributed to arsonists.

Wildland fires continue to plague Kentucky woodlands. From 2001 to 2010, the Kentucky Division of Forestry (KDF) reported that 15,585 wildland fires occurred, affecting 517,492 acres. Man caused 99 percent of the fires, with lightning responsible for 1 percent. Unfortunately, data indicate that 61 percent of the fires were attributed to arson. Wildfires cost taxpayers in suppression costs, create long-term damage to timber values, impact the forest ecosystem, and can cause immediate loss of property and human life. In 2006 the Governor's Task Force on Wildland Arson detailed that from 2000 to 2006, KDF spent an estimated $20.1 million on direct wildland fire suppression costs, averaging $2.87 million per year! Estimates of loss of property value and human life were not included in this work. While it is widely known that wildfire can cause long-term reductions in timber volumes and values, little data was available for the task force to make estimates on this issue. In 2008 KDF sponsored a research project conducted by the University of Kentucky Department of Forestry to provide estimates of the long-term timber value loss attributed to wildland fires.

Wildland Fires' Long-Term Costs to Kentucky's Woodlands

Photo courtesy: Kentucky Division of Forestry

by Christopher Reeves and Jeff Stringer

Collecting data for this determination is difficult because of the lack of accurate historical fire histories in the region. Significant time was spent by researchers finding and selecting 10 pairs of stands in eastern Kentucky and Tennessee where one of the stands in the pair had a well-established fire history and the other stand had no history of fire. Further, the researchers also needed the paired stands to encompass a wide range of fire disturbance from mild to severe and had no other forms of recent or recorded harvests or other disturbance — a difficult thing to find in the region. Stands ranged in size from 11 to 35 acres. Each stand in the pair had similar soils, topography, management history, and the stands were located in close proximity (<1/2 mile). The fires ranged from a small fire ten years before the study, a devastating canopy fire five years before the study, and several stands with small repeated fires over the last three decades. Detailed analysis of species composition, timber volume, and cull deductions were made on all stands. A consulting forester measured and estimated the timber value and board foot (BF) volume in each stand using common timber estimation techniques and by felling and cutting into two foot sections a subset of trees to determine detailed cull deductions and determinations of net timber volume. BF volumes and dollar values lost by fire were determined by subtracting the calculated values in the burned stands from the unburned stands.

Table 1 shows the wide range of volume lost from 330 bf/ac to 4,930 bf/acre with a range of 12 to 56% of the total volume lost to fire. Value losses range from $8.57 per acre up to $1,222.44 per acre with a percent loss of total value from 5 to 65%.

One important aspect of this study was to determine where the loss of value comes from. Is most of the devaluation from volume lost due to internal tree rot resulting from wounds caused by the fires, or is it from less obvious changes in stand composition and structure? Fire in our region is generally confined to the forest floor and

Table 1. Board Foot and Dollar Loss per Acre from Wildland Fires

Paired Stands	Board Feet per Acre			Dollars per Acre		
	Burned	Unburned	Loss	Burned	Unburned	Loss
1	2,070	3,900	1,830	$228	$336	$109
2	2,280	4,360	2,080	$158	$362	$204
3	3,910	5,480	1,570	$299	$400	$101
4	2,470	5,840	3,370	$109	$631	$522
5	2,560	5,940	3,380	$135	$661	$526
6	4,570	6,790	2,220	$348	$731	$384
7	5,620	6,790	1,170	$441	$731	$291
8	3,870	8,800	4,930	$649	$1,872	$1,222
9	6,560	8,660	2,100	$1,228	$1,902	$673
10	2,380	2,710	330	$173	$181	$9
Average	3,629	5,927	2,298	$377	$781	$404

moves through the litter. Fire damages the base of the tree, and the resulting heartrot affects the volume and the value of the lowest log contained in the tree. This rot generally increases and continues to progress as the tree continues to decay. The unburned stands were used to assess the internal volume loss attributed to causes other than wildfire, and this value was used along with the total volume loss in the burned stands to determine the volume loss attributed to wildfire in the burned stands. Wildfires can also change the species composition and overall density and structure of woodlands. Structural changes include killing whole trees and changing regeneration. Repeated fires, if intense enough, can also lead to a continued "resetting" of tree ages in a stand, resulting in a reduction in overall timber volume and value.

The amount of volume and value lost from rot was easily determined using the paired stands by calculating the change in volume and grade of individual trees that had internal rot produced from fires. This calculation was possible because of the detailed analysis of individual tree internal rot determined from trees in both the burned and unburned stands in each pair. The loss due to changes in stand structure was determined through the comparison of stand-level data that included species composition, size, grade, volume, and other parameters affecting value. Table 2 details the results. In this study an average of 38 percent of the BF timber volume per acre was lost due to wildland fires. Over two-thirds of volume loss was due to structural change (whole tree mortality and age/size class changes), while less than a third of the volume loss was due to cull (individual tree rot and grade changes) produced from the fires. An average of 47% of total value was lost from wildland fires. Nearly three-fourths of this loss was from a long-term change in stand structure and only one-fourth due to cull loss. The results from this study indicates that the common perception that the primary degradation from wildland fires is the production of internal heartrot may be over simplistic and underestimate the devaluation associated with wildland fires.

Photo courtesy: Gerald Crowell, Virginia Department of Forestry, Bugwood.org

Wildfires can lead to internal decay in trees by damaging the base of the tree and opening it up to decay agents such as fungus, diseases, and insects.

Table 2. Contribution of Cull and Structural Change to Total Value and Volume Loss from Wildland Fires

	Lost to Cull	Lost to Structural Change	Total Loss
$/acre	13.1%	34.3%	**47.4%**
BF/acre	8.9%	29.1%	**38.0%**

The data also were analyzed to determine if there was a relationship between slope position (upper, middle or lower slope) and volume loss. As expected, the data showed a trend for highest volume loss in the upper slope position (43 percent) compared to mid and lower slope positions with 38% and 26% volume loss, respectively. The burned stands were also classified into one of 10 fire severity index ratings. One represents a stand with a low severity of fire disturbance as indicated by being subject to only one event described as a low-intensity ground fire, and 10 represents multiple events described as high-intensity ground fires or a single canopy fire. As expected, this analysis indicates a positive relationship between the index and value loss and shows that a single low-intensity wildland fire has minimal impact on timber value, while stands subjected to multiple low-intensity burns or an intensive single burn result in significant (greater than 20 percent) loss.

While this study was designed to investigate the detailed devaluation of stands subjected to wildland fires, the results (most importantly the average per acre volume and value losses) cannot be used to provide blanket loss estimates for an individual fire. Specific loss information requires an assessment of actual fire damage, which is related to fire parameters and species present. However, the data can be used to provide general estimates and ranges associated with fire damage in the state. Regardless, wildland fire does have long-term effects on timber values. The KDF, as is true for a large number of state and federal agencies, spends millions of dollars on fighting fires. However, given the potential long-term devaluation that can occur from wildland fires these expenditures are warranted. The time to avoid potential damage to your timber is before a fire approaches and moves through your woodlands. Please contact the Kentucky Division of Forestry or a professional forester to help protect your woodlands from financial impacts from wildland fire by completing a woodland management plan with an eye towards reducing the risk of wildfires in your woodlands.

Photo courtesy: Christopher Reeves

Most wildfires in Kentucky are predominately "ground" fires—notice the fire marks on the trees in the image. Even though these wildfires do not reach the canopy they cause significant damage and value loss with the majority of that loss associated with stand structural change.

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