Fire Damage to Commercial Hardwoods in Southern Bottom Lands

E. RICHARD TOOLE*
Southern Forest Experiment Station
Forest Service, U.S.D.A.

IN RECENT YEARS the commercial hardwood forests of the South have contributed about 45 percent of the national requirements for hardwood sawtimber. The southern hardwood territory has long been recognized as including the lower Mississippi River Valley, the lower Piedmont, and the Southern Coastal Plain from Virginia to Texas. Within this area about 70 million acres, largely bottom land, should be managed for hardwood production.

Fire is often the beginning of a process that eventually turns healthy hardwoods into standing junk. Of course, the bottom lands do not burn over every year. During average or wet years fires are so infrequent that they are of little importance. But when a fire does occur, it damages trees of all sizes from seedlings to sawtimber. One fire in 10 years makes it impossible to manage hardwoods profitably.

In addition to completely killing trees of any size, fire may severely wound trees that do survive, causing progressive decay and degradation.

---

* Stationed at the Southern Hardwoods Laboratory, which is maintained at Stoneville, Mississippi, by the Southern Forest Experiment Station in cooperation with the Mississippi Agricultural Experiment Station and the Southern Hardwood Forest Research Group.

STAND DAMAGE

The damage to timber depends on a number of factors that will be different for almost every fire. The hotter the fire, the greater the damage. Heat of the fire is determined by the amount of fuel on the ground, the dryness of the fuel, and whether the fire burns with the wind (head fire), across the wind (flank fire), or against the wind (back fire). Wind velocity and air temperature also influence fire intensity.

Detailed information is available on damage caused by a specific wildfire in bottom-land hardwoods near Vance, Mississippi. Early in November 1952, this fire burned over a tract where the Southern Forest Experiment Station had installed some study plots. Most of the stand had been given an improvement cut 5 years previously and contained a large proportion of stems with prospects of yielding high-quality lumber. Many young seedlings were growing thriftily in the openings made by the cutting. There was an average of 111 stems per acre larger than 5.5 inches in breast-high diameter.

How has this fire changed this forest? A sample of 70 acres of the area before and after the fire gives the answer (Fig. 1). The young growth was nearly wiped out (Fig. 2). The flames killed all of the seedlings and 1-inch trees, two-thirds of the 2-inch trees, and one-third of the trees between 3 and 5.5 inches in diameter.

Damage to the larger trees was closely related to the severity of the burn. Where the fire was very hot (head fire) and where slash from the improvement cutting had increased the fuel supply, 33 percent of the trees larger than 5.5 inches in breast-high diameter were killed. Of the larger trees that were of especially high quality, 87 percent were either killed or damaged.

Damage was somewhat less where the fire was moderate (flank or back fires). It was also somewhat less where stands had not been cut over previously. But for the entire forest, this one fire reduced the estimated value by at least $15 per acre or 23 percent of the total value. In some parts the value was reduced by $25 to $30 per acre.

Within 1 year after the fire, over 3,000 sprouts or seedlings per acre were recorded on the area. While the proportion that will become high-quality stems cannot be definitely estimated, many of the seedlings will grow into desirable sawtimber trees in 60 to 70 years.

Because of the sprouting ability of hardwoods, the small-tree component is replaced very quickly after a fire—although the proportion of desirable stems may be somewhat less in the new crop. But it takes many years to replace larger high-quality stems.

Although these figures from the Vance tract cannot be applied to other stands burned by other fires, they do indicate the type of damage that can be expected from wildfires in bottom-land hardwood forests.

DAMAGE TO INDIVIDUAL TREES

Trees that are not killed by fire may be so severely damaged that they have little or any value. As the fire passes, the bark on at least one side of a tree is usually burned and charred, and the cambium beneath is cooked. Cracks develop, insects attack, the bark sloughs away, and rot and other fungi take hold. The tree is doomed. It either dies or becomes one more of the millions of hollow culls that take up good timber sites.

The first external indication that a tree may be wounded is discolored bark, but the exact area of the wound is not evident until callus growth develops and dead bark loosens or sloughs off (Fig. 3).

The effect varies somewhat among tree species. In one study all of the red oaks with blackened bark were wounded, but nearly one-fifth of the white oaks and one-third of the hickories escaped injury even though their bark was discolored. By one year after the fire, cracks had developed in areas of blackened bark on approximately one-third of all trees. After two years bark had loosened on almost half of the trees. Bark had sloughed off all the wounded hickories after three years, off all the white oaks after five years, but off only 80 percent of the red oaks after seven years. The area of wood thus exposed corresponded closely to that of bark discoloration noted immediately after the fire, except that with the red oaks the wound height was much greater than the area of blackened bark.

Within a year, ambrosia beetles had bored into wounded areas of the trunks; 7 percent of the white oaks, 27 percent of the red oaks, and 43 percent of the hickories were invaded. Round-headed and flat-headed borers also were present behind loose bark.

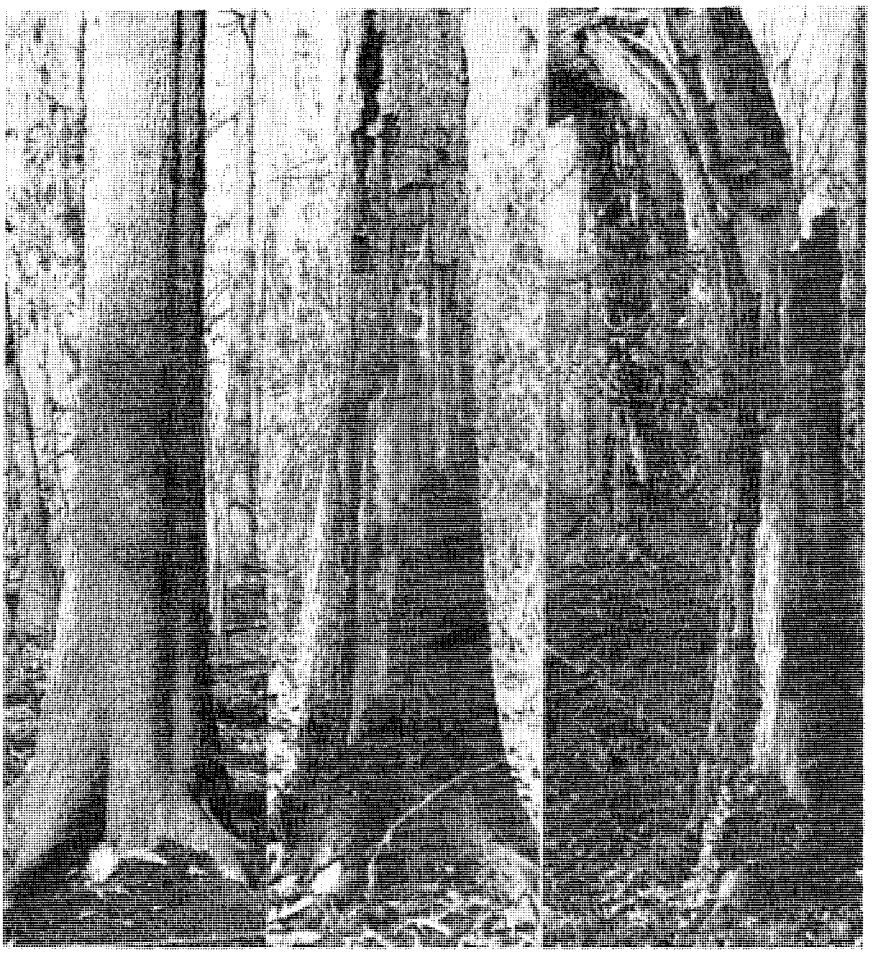

FIG. 3. This 10-inch willow oak appeared sound immediately after the fire (left). Two years later the wound was evident (center). Three years after the fire the tree broke at the wound (right).

During the second year after the fire, insect attack became much heavier; infestation of wounded red oaks rose to 60 percent. Ambrosia beetles, cerambycid beetles, and buprestid beetles were common.

Fruiting bodies of fungi served as rough external indicators of the age of fire wounds. They occurred on one-tenth of the trees after one year, on about one-half of the trees after two years, and on two-thirds after three years. Some species of fungi fruited on red oaks up to seven years following wounding.

Seven years after a fire, the wounded trees were cut and the spread of rot measured. For the white oaks and hickories, the lineal extent of heart rot was equal to or slightly more than the height of the deadened bark. In red oaks, rot had spread to two and one-half times the height of the bark discoloration.

In a sample of wounded trees not completely girdled by fire, almost half died during the first five years. Mortality ranged from 80 percent in the hickories to 33 percent in the oaks. Losses were greatest in the third year; none occurred after the fifth year. Most trees died from breakage at the wound, where rot had weakened the stem.

Wounds on root spurs or high on the stem where dead vines had burned were usually small (less than two inches in diameter) and quick to heal (Fig. 4).

In general, the size of the wound determines the rate and progress of decay. Wounds less than 2 inches wide (regardless of length) usually heal before rot enters. Larger wounds almost invariably become infected. Once in the tree, the rot takes an average of four years to work through the sapwood to the heart. After that, it moves faster. In one study on red oaks where the original wound was at least 2 inches wide, average upward travel of the rot was 1.3 feet in ten years. It progressed more rapidly when the original fire scar went more than one-fifth of the way around the tree, and more slowly when less than one-fifth of the circumference had been scarred.

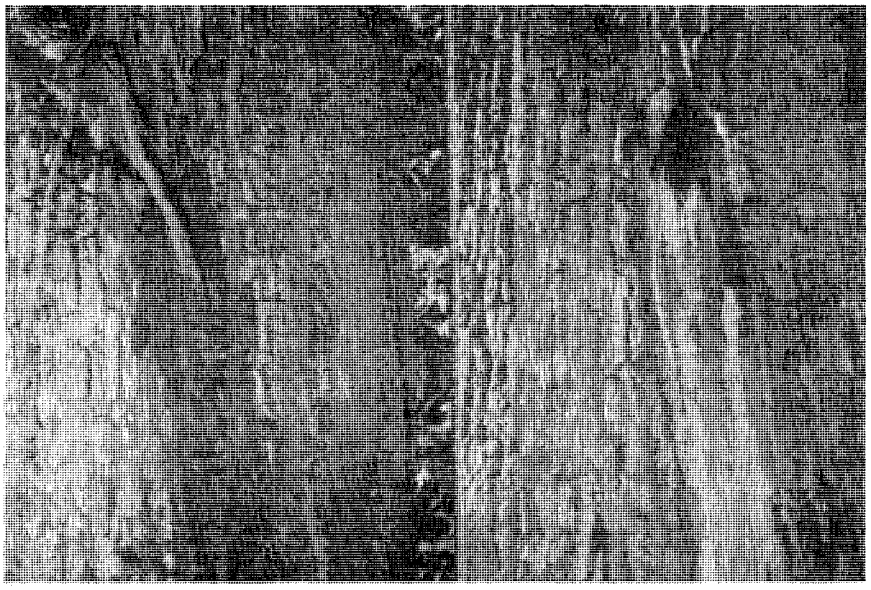

FIG. 4. Left: Damage to a large overcup oak where a vine burned against the bark. Right: The same stem with dead bark removed.

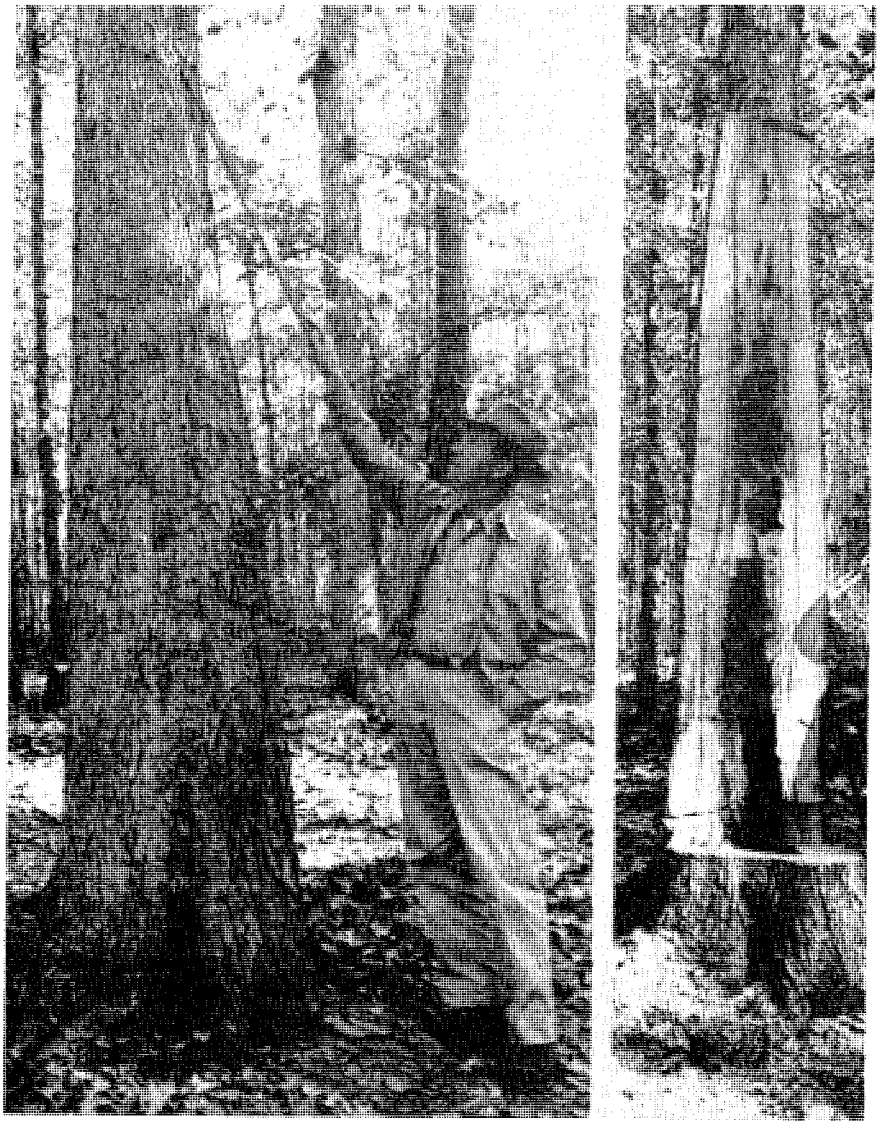

FIG. 5. Left: This swamp chestnut oak was wounded by fire 31 years ago. The external evidence is a partly healed scar at the base and a butt that is bulged to a height of about ten feet. Right: The tree cut open to show extent of hollow and decay.

Rotten wood developing in the tree trunk quickly disintegrates, leaving the hollow found in many trees in bottom-land forests. The length of this hollow is closely related to the extent of the rotten wood above the hollow. On the average, the rot will extend 1.8 feet above the top of the hollow (Fig. 5). Most hollow trees develop pronounced butt bulge. The rot extends an average of 3.7 feet above the bulge.

One can frequently find evidence of repeated fire injury on the stems of hardwoods.

WHAT TO DO WITH FIRE-DAMAGED HARDWOODS

It is obvious that wildfire should be prevented in stands of present or potential good hardwood timber. However, some fires do occur. Experience and experiment have yielded some suggestions for handling hardwood timber that has suffered fire damages.

Trees killed or seriously damaged should be salvaged as soon as is feasible. Any specific recommendation should be applied with consideration for the cutting cycle, and for the vigor and length of stem of each affected tree. But generally a tree should be salvaged if:

The bark is charred for more than six feet above the stump.

The char extends around more than one-half of the tree's circumference and reaches more than two and one-half feet above the stump.

In estimating the extent of rot behind older wounds, and the rot to be expected in the future, it is helpful to keep in mind that on the average:

Rot does not start in the heartwood until four years after a fire.

Wounds less than 2 inches wide are not important as a source of rot.

Rot exceeds hollow length about 2 feet.

Rot exceeds butt bulge about 3½ feet.

In 10 years rot will extend 1½ feet above the original scar if about one-fourth of the tree's circumference was damaged. If more than one-fourth of the circumference was damaged, the rot may go higher.

FIRE ALWAYS HURTS HARDWOODS

Our research on fire effects in hardwoods has settled once and for all some facts that seem obvious but are often forgotten. In hardwoods there is no such thing as a harmless fire. All fires fry the reproduction and wound larger trees. Any wound bigger than a silver dollar is probably going to admit rot that will surely destroy the valuable butt log. Fires must be prevented where we grow hardwood crops.

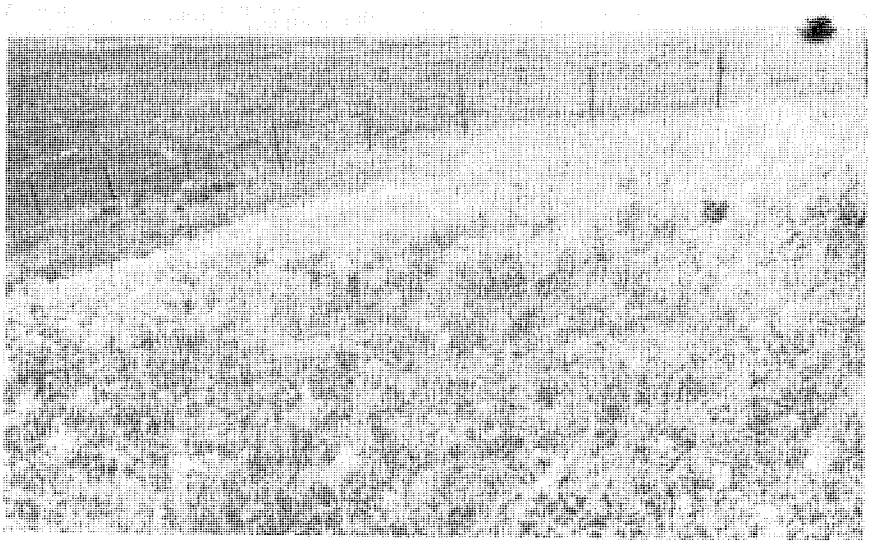

FIG. 1. Whitebract hymenopappus (*Hymenopappus scabiosaeus*). This biennial forb was abundant in the foreground pasture burned May 1, 1963 and scarce in the background pasture burned May 1, 1964. Photo by Kling Anderson, May, 1965.

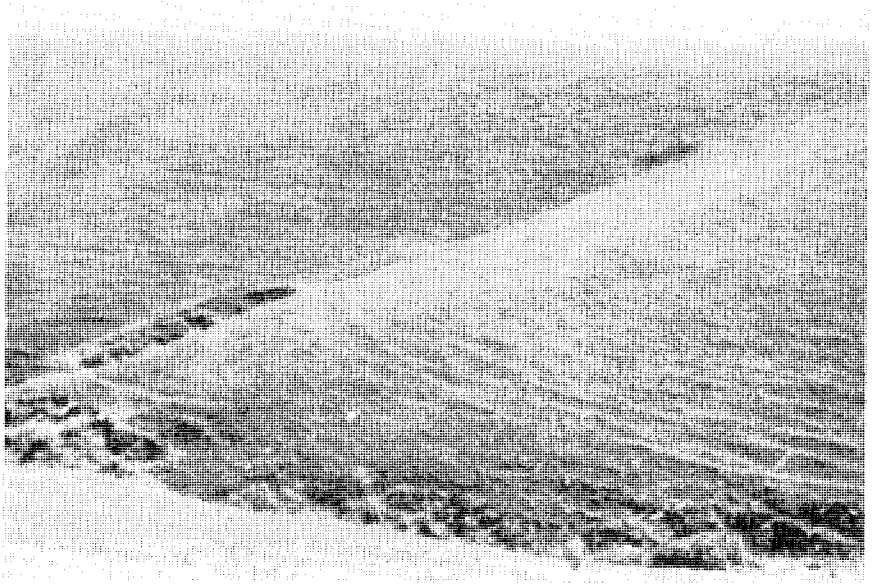

FIG. 2. Cattle trails show after burning away the old grass. About a week has elapsed and new growth is about 3-4 inches tall. These cattle trails are a fairly common feature of permanent pastures. Photo by Kling Anderson.