

Hurricane Damage To Loblolly Pine On Bigwoods Experimental Forest

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On October 15, 1954, a violent tropical hurricane passed over the Bigwoods Experimental Forest, near Franklin, Virginia. It was the first severe hurricane affecting this area in many decades. The experimental forest, devoted mainly to a large-scale test of management systems, provided a unique opportunity to determine the extent of hurricane damage in different types of managed stands. Results show that severe losses were confined to light stands of large seed trees.

The Storm

Hurricane Hazel came inland from the Atlantic Ocean at the North Carolina-South Carolina line and proceeded northward. The storm center crossed directly over Rocky Mount, North Carolina, and to the west of Richmond, Virginia. The following statements describing the storm appeared in the Weather Bureau's October 1954 summaries of Climatological Data for North Carolina and for Virginia.

"Hurricane force winds with gusts of 80-100 mph were experienced near the path of the storm center and eastward to the coast. . . . Rainfall in the eastern half of the storm was astonishingly light, several stations reported less than an inch. . . . At least ten stations in North Carolina reported the highest rainfall amounts of record in connection with Hazel."

This last statement refers to the area west of the storm center, where uprooting of trees was more common than to the east.

In the Bigwoods Experimental Forest in Hertford County, North Carolina, the soils were dry as a result of general drought conditions prevailing in the summer of 1954. During the first two weeks of October, 0.15 inch of rainfall was recorded at neighboring Gatesville, North Carolina, with but 0.84 inch of rain on the day of the storm.

The damage described in this report resulted from winds with maximum speeds of 80 to 100 mph striking firmly rooted loblolly pine trees and stands. The direction of broken trees showed that the destructive wind came from the south or southeast.

The Forest

The experimental forest is a 1,365-acre area of loblolly pine made available for research in 1946 through cooperation of the Camp Manufacturing Company, Inc., of Franklin, Virginia, with the U. S. Forest Service. The major portion of the forest is divided into 37 compartments varying in size from 25 to 45 acres.

The experimental forest when acquired in 1946 was a well stocked stand of old-growth timber which had not been cut for a considerable time and was not representative of average Coastal Plain forest stands. Most of the trees were forest-grown loblolly pines 60 to 80 or over 100 years of age. The area south of a small drain known as Fort Branch has a lighter soil than the remainder of the forest; there the stand in 1946 was composed of 90-year-old pine of old-field origin. In the extreme northwest corner was a younger old-field stand. This well stocked stand had five acres of 35-year-old pine and the remainder in the 25-year age class. By 1954,

cutting treatments had altered the original conditions, leaving but two uncut areas.

Some of the compartments had been cut over, leaving eight scattered seed trees per acre; others were clearcut in parallel strips three chains wide leaving intervening one chain strips of standing trees. In all of the strip-cut areas and all but four of the seed-tree cuts the seed-source trees were removed after satisfactory regeneration had been obtained, leaving two residual trees per acre as an insurance against fire. Another series of 13 compartments were harvested by the selection method in which partial cuts are made at regular intervals but a timber stand always occupies the area. Two small areas of over-mature saw-timber were retained in an uncut condition to show the original size and quality of the timber. With the exception of these two uncut areas, the entire forest has received one or more harvest cuts. When the storm struck, the older pines were in uncut, selectively cut, and seed-tree stands. The younger pines stood in uniform heavy stands that had been thinned in 1950.

Advantage was taken of the opportunity provided by this large-scale study with detailed records on the past history and stand composition to obtain quantitative data on storm damage caused by the hurricane in stands of different structure.

Exposure

With wind from the south and southeast, there was little protection afforded the forest by adjacent timbered stands. On the south were sparse stands of seed trees or young second-growth well below the crowns of the trees of the forest, and on the southeast a

low lying swamp bordered the forest. The two most southerly selection compartments and the broad sides of both uncut stands were exposed to the southerly winds.

Beyond this thin screen the winds had a clean sweep over 19 seed-tree stands with only a small uncut island of timber in its path. In the northeast corner of the forest an adjacent seed-tree cutting let the winds into the other seed-tree areas.

The remaining selectively cut stands were in two large blocks to the west and north of the main seed-tree area. Here there was less stand margin exposed to the winds than in the most southerly selectively cut forest.

Damage By Stand Condition

On the 1,302 acres that had saw-timber trees, 6.1 per cent of all pine trees 10 inches d.b.h. and larger, containing 8.8 per cent of the saw-timber volume, were broken or blown over by this storm. On the remaining 45 acres of young pulpwood-sized stands the damage was slight (Table 1).

Table 1.—Number and volume of merchantable pine trees destroyed and corresponding percent of total number and volume destroyed, by stand conditions.

Stand Condition and acreage	Pine destroyed		destroyed Bd. ft. Proportion of total stand	
	Trees Number	Volume Bd. ft.	% Trees	% Volume
Seed trees (807.9A)	754	371,033	34.2	37.6
Uncut (34.4A)	121	67,323	8.7	8.8
Selection (454.6A)	330	141,317	2.1	2.9
Old-field 45 yrs. (5.0A)	7	1,253	2.4	2.4
Old-fields 35 yrs. (45.0A)	5	555	0.05	0.13
Entire forest	1,217	581,481	4.1	8.2

Scattered large seed trees were particularly vulnerable. These trees were exposed to the full force of the storm and were firmly rooted in dry soil. Large trees were broken off clean at various heights—usually in the lower half—as one would break a match stick.

The over-all damage to relatively well

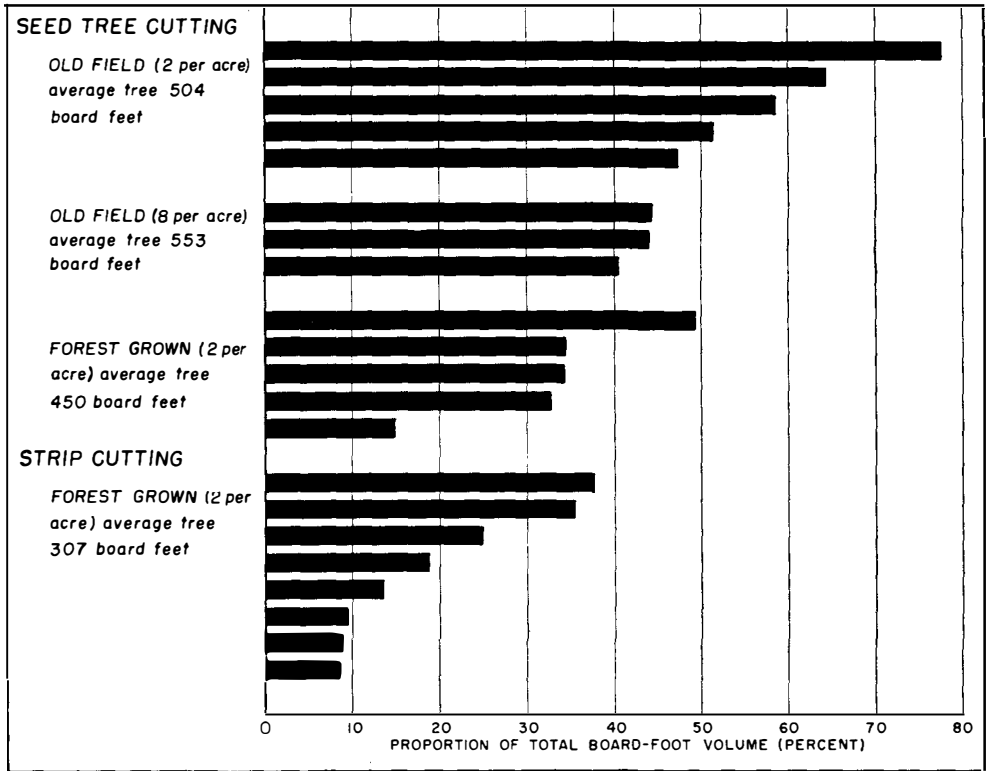


FIGURE 1.—Hurricane mortality in per cent of total volume per acre for 21 compartments, grouped by method of harvest, stand origin, and number of residual trees per acre.



FIGURE 2.—Damage in a stand of eight seed trees per acre. Picture 2A, left, was taken October 14, 1954 to illustrate wind damage from a violent late summer storm. Picture 2B was taken from the same point after the hurricane of October 15, 1954.

stocked stands was more severe in the uncut stands and less extensive in the selection stands. These two types of stands contained trees of the same age classes, but in the selection stands the first cycle cut had already removed the obviously defective trees. Within the uncut stands breakage occurred in many instances at cankers, forks, heart-rot infestations, and fire scars. The hurricane did relatively little damage to young stands of pulpwood or small sawlog-size trees, all of which had been thinned in 1950. The majority of the damage that did occur in the 45-year-old stand was caused by breakage at cankers.

The damage encountered among the seed-tree stands was related to tree size and stand origin (Fig. 1). The eight trees per acre originally selected as seed trees and the two per acre left later as insurance trees were all large trees with well developed crowns. Where areas had been strip cut, the insurance trees were often selected from the co-dominant stems. Consequently, the size of the average insurance trees from strips was considerably smaller than that of insurance trees left from a seed-tree cut. Trees of old-field origin growing on the lighter soils seemed more vulnerable to storm damage than did the forest-grown trees on the heavier

soils. Large full-crowned trees suffered more breakage than did the smaller residuals.

Stand Damage

Photographs taken of a heavily damaged part of the 100-year-old stands of old-field origin illustrate the type of damage caused by the hurricane. Figure 2A was taken the day before the storm struck and illustrates the damage caused by a small violent windstorm in a stand of eight seed trees per acre. The hardwoods five inches d.b.h. and over had been poisoned. Figure 2B was taken of the same area a few days after the hurricane. Forty-four per cent of the standing seed trees in the compartment had been broken by the hurricane. The most distant seed trees in this view are in an adjacent compartment containing two trees per acre, very few of which survived the hurricane.

Figure 3A shows the type of old-field insurance trees left after the removal of six of the eight seed trees per acre. The small hardwoods on this area were treated by disking prior to logging, and the large residuals were poisoned. In the background are stands of eight seed trees per acre. This same view after the hurricane (Fig. 3B) shows the typical breakage. After the storm, 78 per cent of all of these insurance trees in this

compartment were down. The removal by the storm of both pines and hardwoods in the background permits a view of a continuous line of pine trees in the distance. This line of trees is an uncut stand about one-half mile away.

Individual Tree and Lumber Damage

Most of the severely damaged trees were broken off, but a few were overturned and uprooted along the moist stream-bottoms. Trees with heartrot, cankers, stump rot, or worm holes gave way at the point of defect; forked trees parted at the crotch; and sound trees splintered at various points from within the crown to near ground level, but generally within the first two log lengths of the four- to five-log trees.

Some trees that did not break or over-turn at the time of the storm may be seriously weakened by internal structural failure. Figure 4 shows a tree with a sharp bend in the bole at the point of partial fracture. This tree has since broken and been salvaged. There are many trees still standing which undoubtedly contain structural defects caused by the storm. Considerable main-stem breakage has occurred since the hurricane with relatively light winds from the opposite direc-



FIGURE 3.—Damage in a stand of two insurance trees per acre. Picture 3A, left, was taken October 1953 to illustrate the effect of cultural work upon hardwoods. Picture 3B was taken October 1954 following the storm. Typical breakage of main bole is shown.



FIGURE 4.—The main stem of this tree was fractured. It fell later.

tion. Ordinarily these lighter winds would not cause any damage.

Over 90 per cent of the damaged trees were logged in a salvage operation and over 90 per cent of the timber volume affected by the storm was recovered. Salvage was necessarily incomplete because breakage occurred in the most valuable section of the bole and a considerable amount of trimming was necessary.

Some additional loss became apparent when the lumber was manufactured. Some apparently sound logs contained fractures that

did not show up until the lumber was dressed. The fractures extend completely through each piece of lumber shown, and were not limited to the place where breakage occurred. There were several horizontal fractures in the original piece of molding shown in Figure 5, indicating failure at several points. The percentage loss from such defects in the lumber of the salvage trees was low, but its exact extent is not known.

Summary

The over-all effect of the hurricane upon the Bigwoods Experimental Forest was not as serious as it might have been. In most cases a satisfactory stand of regeneration had already been established on the cut-over areas. The only damage sustained by this young reproduction as a consequence of the storm was injury and loss caused by the logging operation salvaging the damaged and residual trees.

In general, the damage to the timber stand was directly correlated with the size and exposure of the mature timber. Where large residuals were completely exposed, as in the stands of two trees per acre, the damage was high. In the denser stands of young timber the loss was minor. Between these two extremes the extent of damage was largely governed by degree of exposure.

Some trees that were not broken or over-turned suffered internal damage to the wood which will not become apparent until they fail at the point of weakness at a future time, or the defect is exposed by manufacture. Breakage has occurred at a higher than normal rate on the Experimental Forest in relatively minor windstorms since the hurricane, and some standing trees show a pronounced bend or lean as a result of the

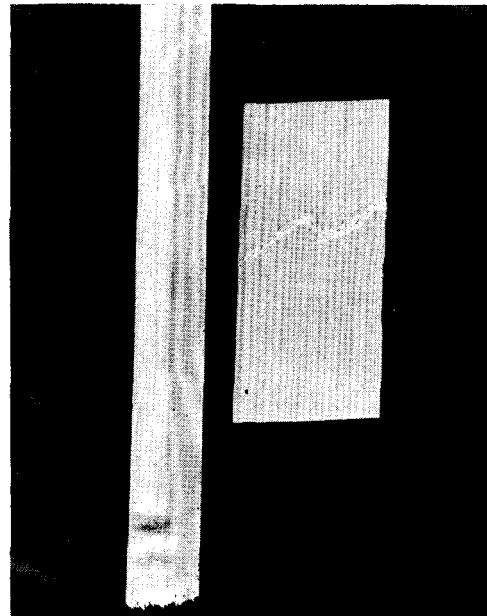


FIGURE 5.—Lumber damage that showed up after lumber was dressed. The molding was fractured at two points and broke after dressing.

hurricane winds. This will involve an adverse effect on future growth through the formation of compression wood until the trees can be cut. Finished lumber from salvaged storm-damaged trees has shown a small amount of defect directly traceable to the hurricane. However, all in all, the amount of damage in forest stands in the path of the hurricane generally was not as great as that sustained on the Experimental Forest, because the trees in average stands are smaller and younger than timber in the Bigwoods.

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