

Harvard Study of the Pisgah Forest

The study by members of the Harvard Forest community seeks to describe the vegetation and disturbance regime of the natural forest vegetation of the area now encompassed by Pisgah State Park. The research has two components: a historical reconstruction of the composition, structure, and dynamics of old growth stands throughout the park and the post-hurricane dynamics and environmental relations of the modern communities occupying the twenty-acre Harvard tract. Substantial historical information for the first part of the study includes photographs and quantitative analysis of the area in 1907, 1908, and 1917, a detailed survey of old growth stands in 1929-30 (Branch, Daly, and Lotti 1930), stand analysis and tree-ring chronologies of old-growth stands cut in 1929-30, and three published studies of the area (Cline and Spurr 1942, Spurr 1956, Henry and Swan 1974). The second part of the study will complement the first by providing information of the modern forest and updating the extensive information available through the 1930's study.

Field studies and laboratory analyses are in progress and will continue at least through the summer of 1985. Specific investigations will include the following:

1. Quantitative sampling of the vegetation of the Harvard Tract to provide information on phytosociology, density and basal area of the arboreal stratum, and relations of the various communities.
2. Age-structure analysis of the forest. Extensive age-structure information is available for the old growth stands, most of which originated following windstorms in 1635 and 1778, or fire in 1665, 1779, and 1790. The current study will examine age structure relations of the forest that developed following the 1938 hurricane.

3. Dead wood distribution. Massive trunks, 40-120 cm in diameter and exceeding 15 m in length remain on the forest floor 45 years after the hurricane. The volume of wood (and therefore the dynamics of forest floor organics) will be measured in different communities. In addition the orientation of the stems is being measured in order to document the importance of the hurricane in controlling this structural aspect of the forest.
4. Seed bank composition. The composition of the vegetation following disturbance is largely governed by the original vegetation, the available propagules in the soil, and the dispersal of new propagules. The second component is being analyzed on a transect across the Harvard Tract that crosses a variety of vegetation types including: a rich sugar maple-ash community, ridge-top herb and shrub community, beech-black birch-paper birch forest, and dense hemlock stands. Coupled with information on the post-hurricane and present composition of the stands this information will address important questions concerning the possible directions of vegetation change and the role and location of successional and "fugitive" species in the pre-settlement vegetation.
5. Paleoecological investigation of vegetation change and disturbance history. Extant historical and botanical sources provide information on the historical composition of the original vegetation and the environmental forces impinging on it. To lengthen and expand on this record sediment cores from small basins on the Harvard Tract will be analyzed for pollen content, macrofossil composition, and charcoal fragments. Of especial interest will

be the history of fire in this area and a comparison of the determined fire frequency with the known history of fires in 1665, 1778^{and 1850's}. Temporal control for the study will be provided by C-14 dates, the Tsuga fall (4500 B.P. sensu Davis et al. 1980), the settlement horizon (mid-1700's), and the chestnut decline.

The outlined research will provide a comprehensive investigation of the vegetation and disturbance regime of the natural vegetation of SW New Hampshire and should facilitate further ecological studies in the Pisgah area.

The Harvard Pisgah Tract, Southwestern New Hampshire

As early as 1905 Professor R. T. Fisher, first director of the Harvard Forest, took groups of forestry students to the Pisgah Mountain area of Winchester, New Hampshire to survey the virgin forest. At that time it was estimated that 100-200 ha. of old-growth forest remained, primarily in three tracts lying to the east, north, and northwest of Pisgah Reservoir. In the 1920's a decision by the Dickinson family, who owned most of the area, to cut the remaining large trees prompted Fisher to organize sportsmen, naturalists and friends to purchase 11 ha. of the most magnificent hemlock-white pine-hardwood forest. Fisher's efforts were advertised nationally in the Boston Herald and New York Times and the tract was given to Harvard University in 1922 with the stipulation that it remain forever natural. This tract and approximately 20 ha. of hardwood forest purchased by the state of New Hampshire in the early 1960's are the only remnants of the original virgin forest.

The hurricane of September 21, 1938 uprooted most of the Harvard Tract and severely damaged much of the surrounding forest. A. C. Cline, then director of the Harvard Forest, followed the terms of the gift and spared the Harvard Tract from the post-hurricane salvage that occurred throughout New England under the Northeastern Timber Salvage Administration. In the 1960's the state of New Hampshire began to acquire land surrounding the Harvard Tract for the establishment of Pisgah State Park. At present the park encompasses 5,300 ha. and is retained in an undeveloped state.

Continued study of the Pisgah forest by researchers at the Harvard Forest provides a broad background on the organization and dynamics of the vegetation. Fisher's earliest vegetation survey, conducted in 1905, is a comparison of old-growth stands at Richmond, New Hampshire, at the Harvard Forest in Petersham, Massachusetts, and at the Pisgah forest. Information in the Harvard Forest archives from the period of acquisition of the Harvard Tract (1923-1928) provides detail on the settlement history, ownership patterns, logging activity, and the vegetation of the area. In anticipation of the logging in the 1930's a comprehensive survey of old-growth stands was conducted in 1929-1930 (Branch et al. 1930). That study consisted of two major portions: the sampling of extant old-growth stands and an age-structure analysis of the forests after cutting. A total of 105 0.04 ha. plots were sampled and information was collected on disturbances such as fires, wind damage, chestnut mortality, and animal damage. Approximately 30 photographs and a 16 mm movie taken by W. Branch, A. C. Cline and N. Hosley from 1915 to 1930 complement this historical documentation. Griffith, Hartwell and Shaw collected soils and vegetation data from Pisgah for their classic research on the effect on hardwood and conifer forest on soil development.

Following the 1938 hurricane field descriptions and photographs were taken to document the damage (Spurr, unpubl.). Post-hurricane vegetation surveys were conducted in 1942 and 1948, followed by a study of forest reconstruction in 1968 (Henry and Swan 1974). Ongoing studies include a survey of the vegetation, the analysis of the structure and distribution of downed wood, a dendrochronological investigation of stand development, and the paleoecological study of pollen, macrofossils, and charcoal in small hollows and swamps (Foster, Schoonmaker).

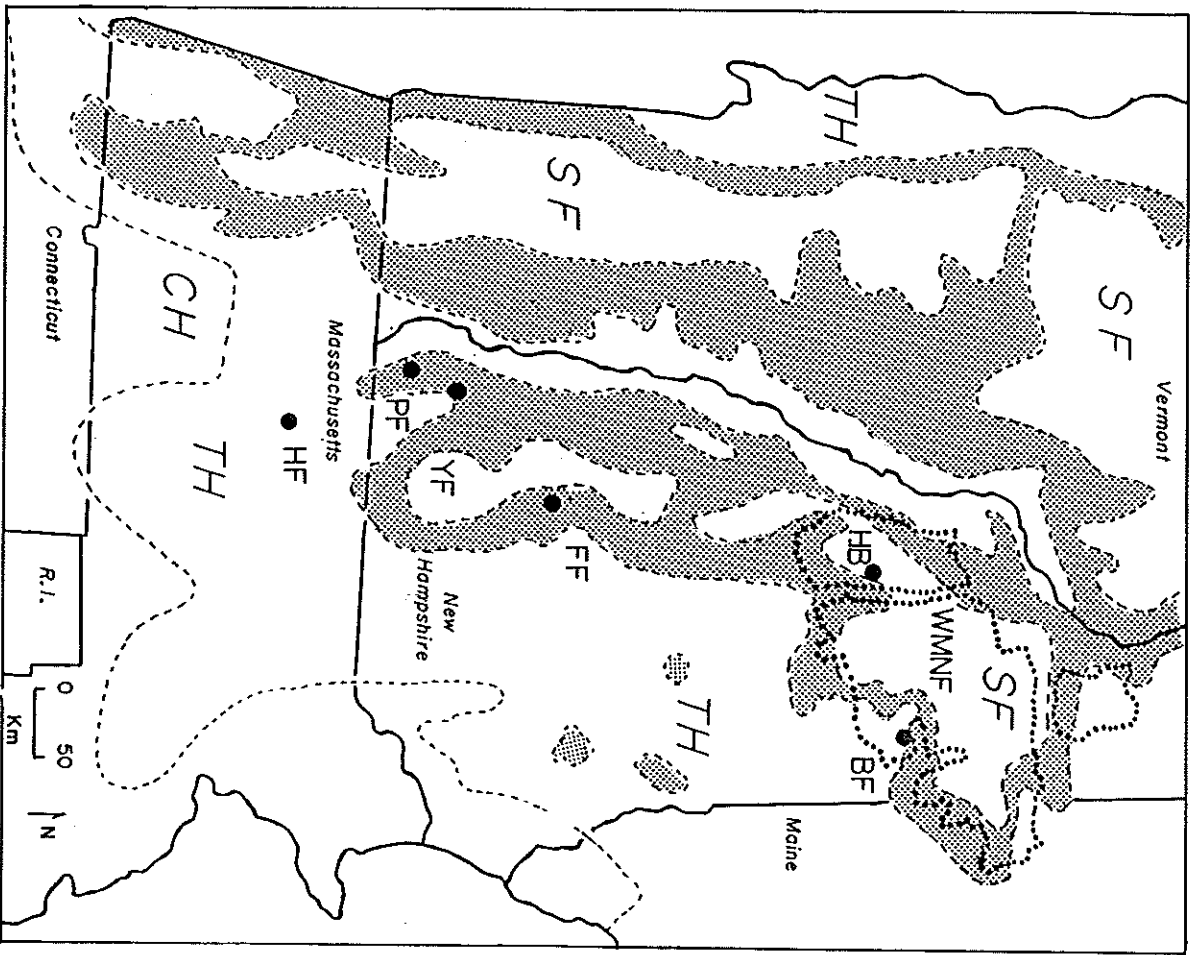


Fig. 1. Central New England showing the major vegetation zones (CH: Cen. Hdws - Hem-WP; TH: Trans. Hdws - Hem-WP; Shaded area: N. Hdws - Hem-WP; SP: Spr - Fir - N Hdws). HF - Harvard Forest, PF - Pisgah Forest, YF - Yale Forest, HB - Hubbard Brook, WMNF - White Mt. Nat. Forest.

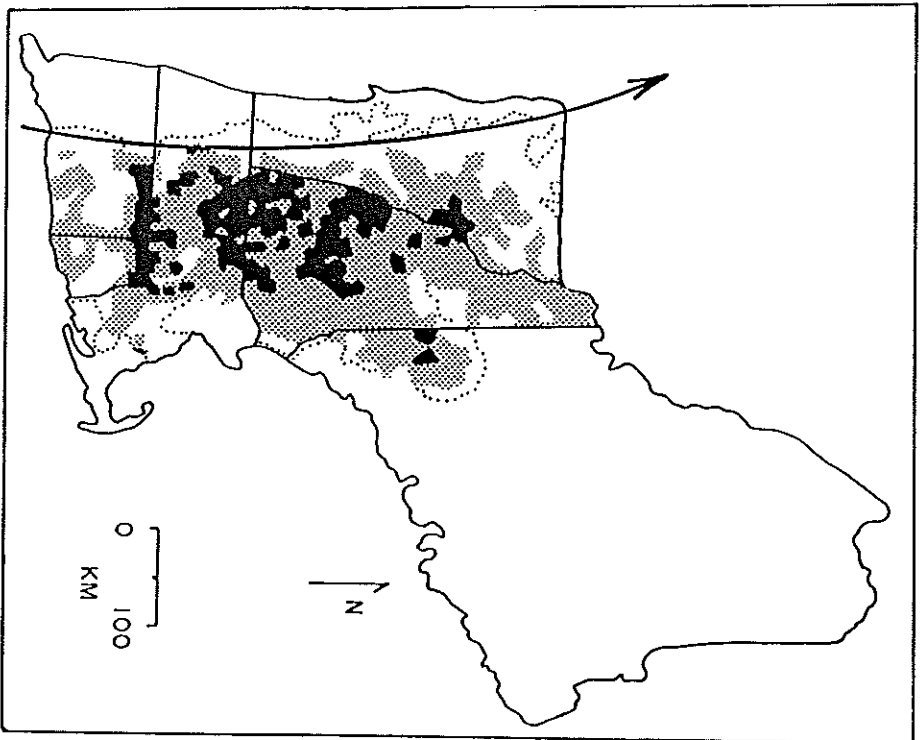
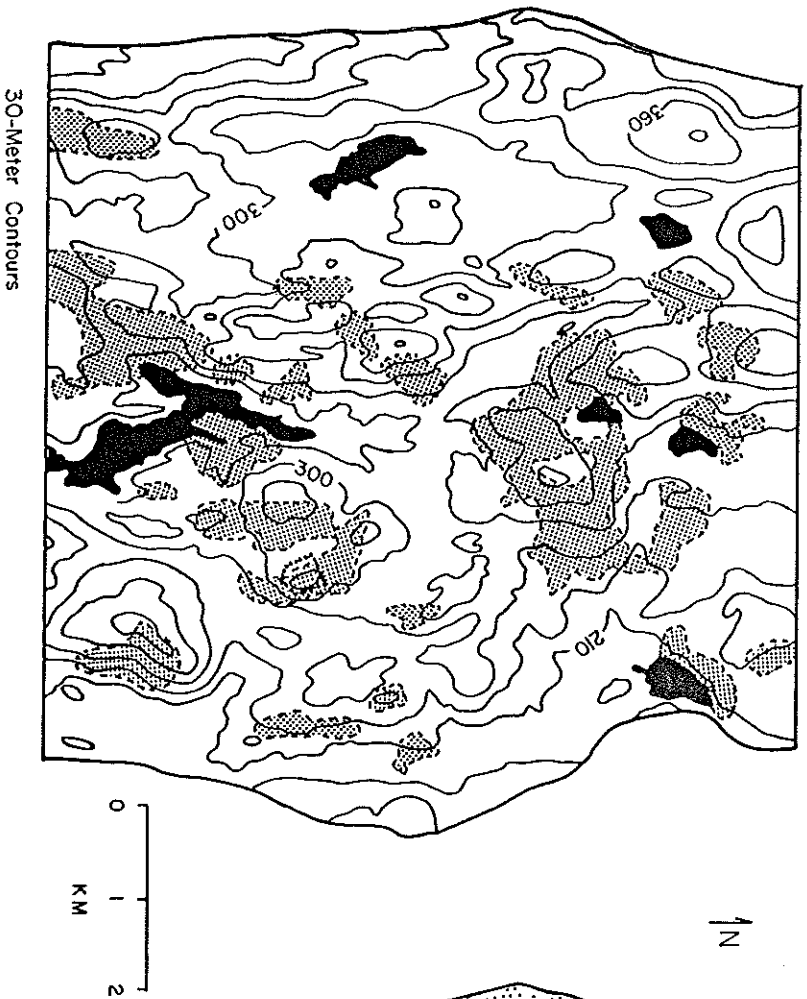


Fig. 2. Track of the 1938 hurricane (arrow) and area damaged by the storm. White area enclosed by dotted line - slight damage; stippled area - moderate damage; black areas - extreme damage (>10 million MBF of timber destroyed/town).

Topography



Hurricane Damage - 1938

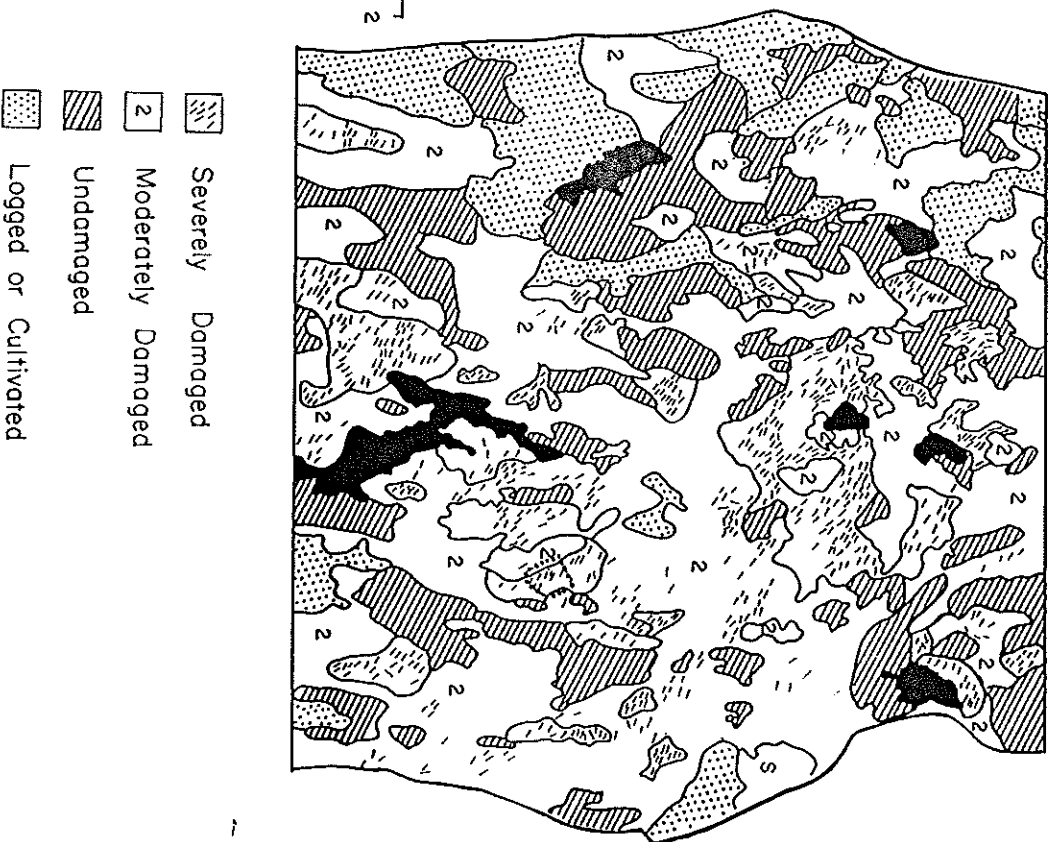


Fig. 3. Aerial photograph interpretation of the relationship between physiography and damage from the 1938 hurricane in Pisgah State Park, SW New Hampshire. Black areas are water bodies and the Harvard Tract is 1 km east of the northern tip of the long lake (Pisgah Reservoir) in the S and center of the area. Small lines in the severely damaged area indicate the position of individual windthrows on aerial photographs.

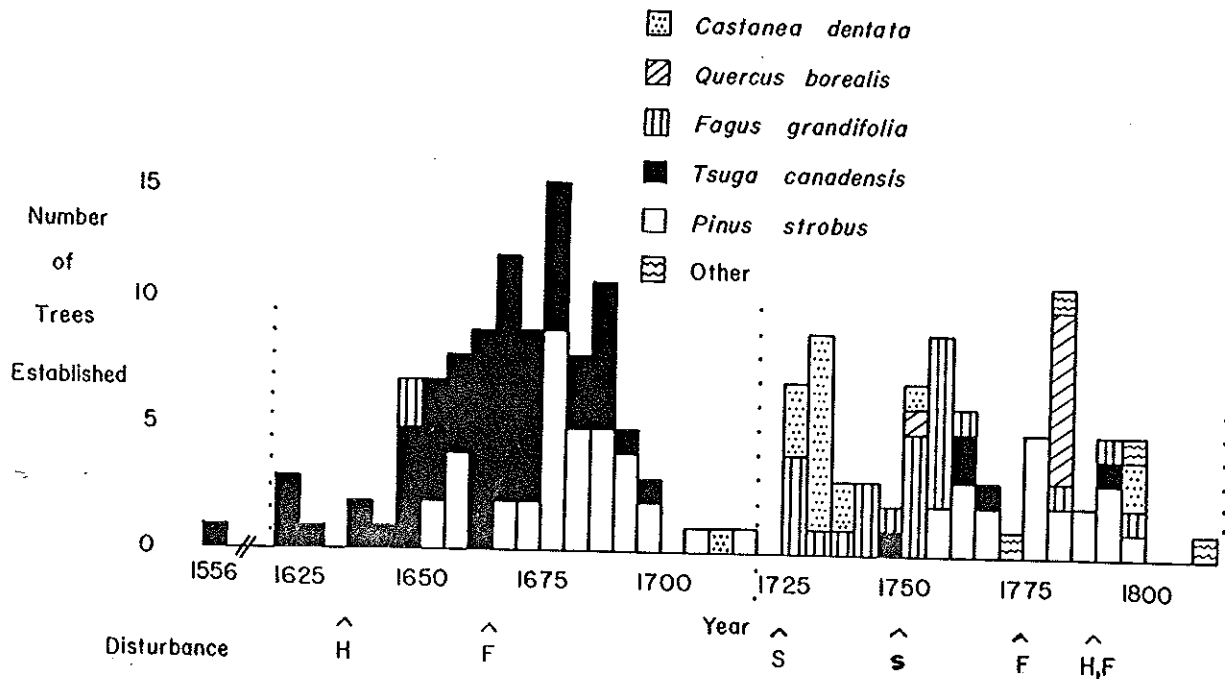


Fig. 4. Age-structure of the pre-hurricane and old-growth forest at Pisgah. Data collected in 1928-29. Disturbance: H - hurricane, F - fire, S - windstorm.

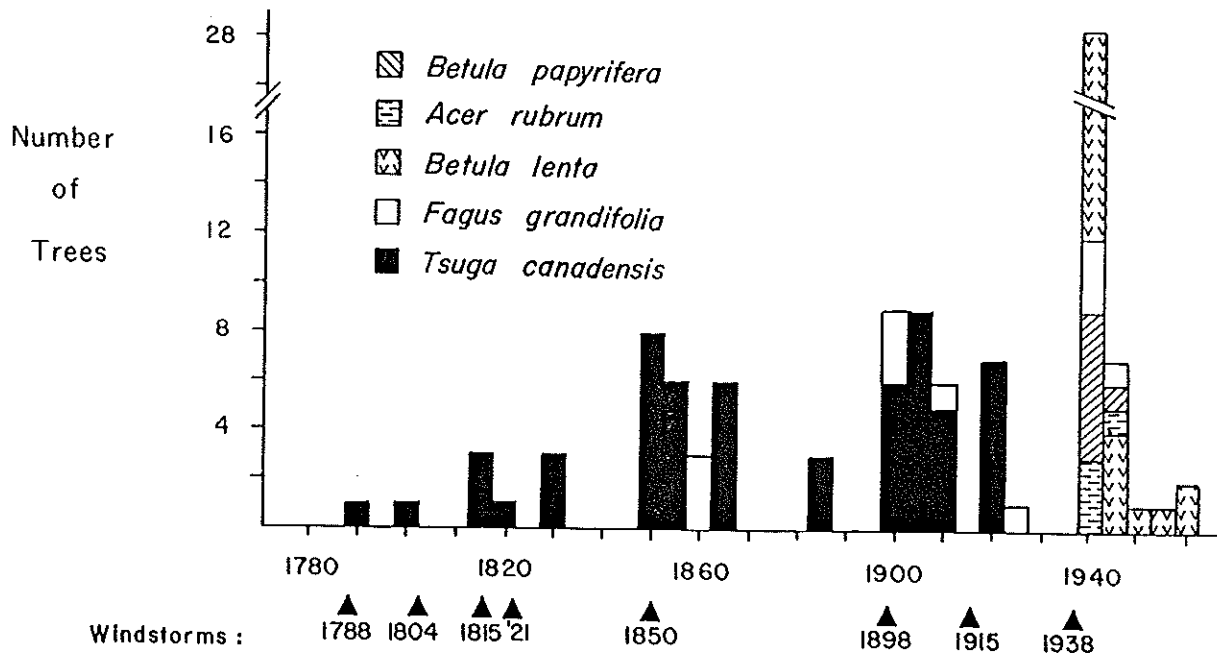


Fig. 5. Age-structure of the post-hurricane forest at Pisgah. Data collected in 1984. Trees less than 5 cm basal diameter were not sampled, however, a later sample demonstrated that most of these were hemlock 35-45 years old.

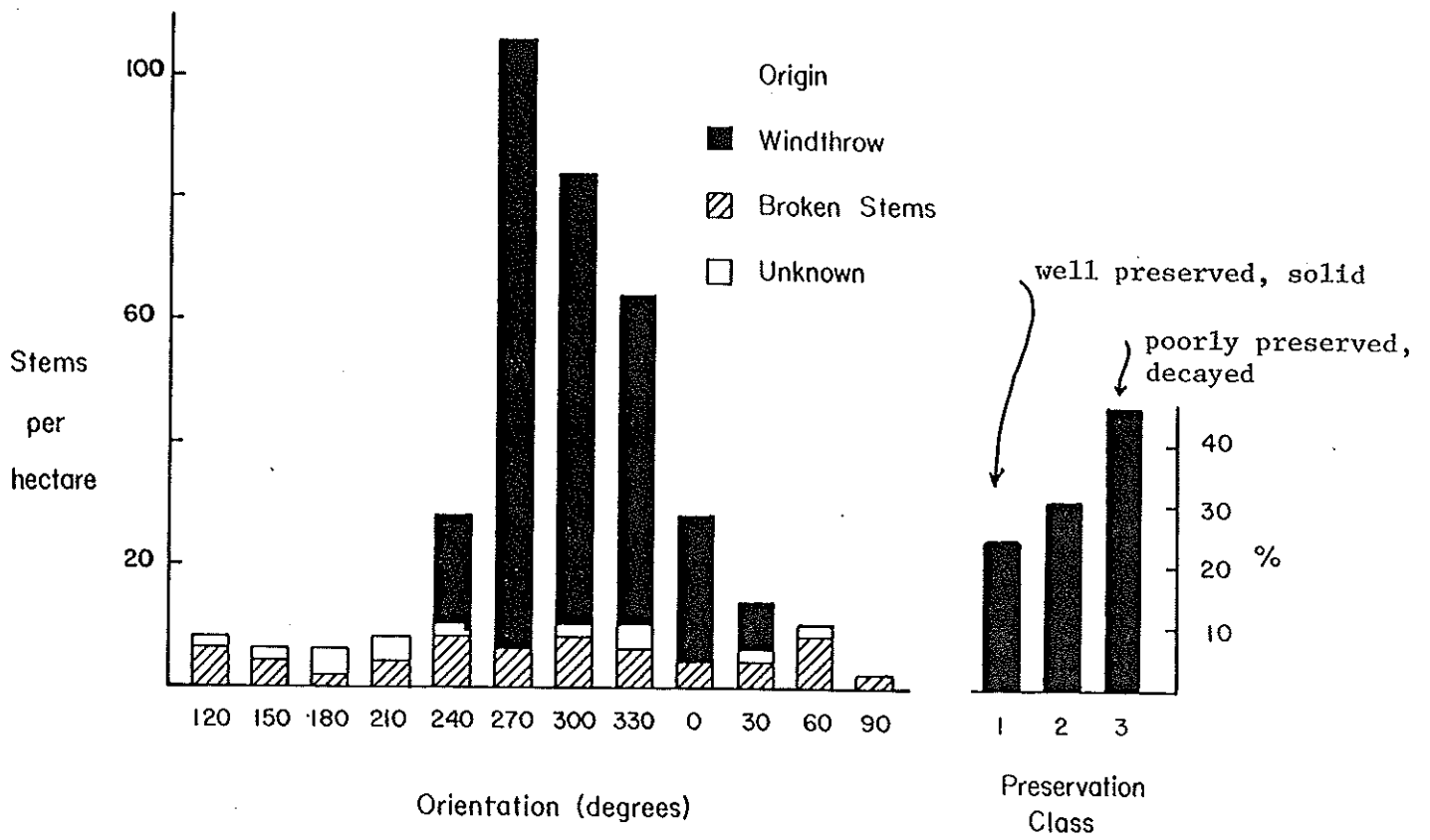


Fig. 6. Orientation, origin and preservation class of coarse dead wood.

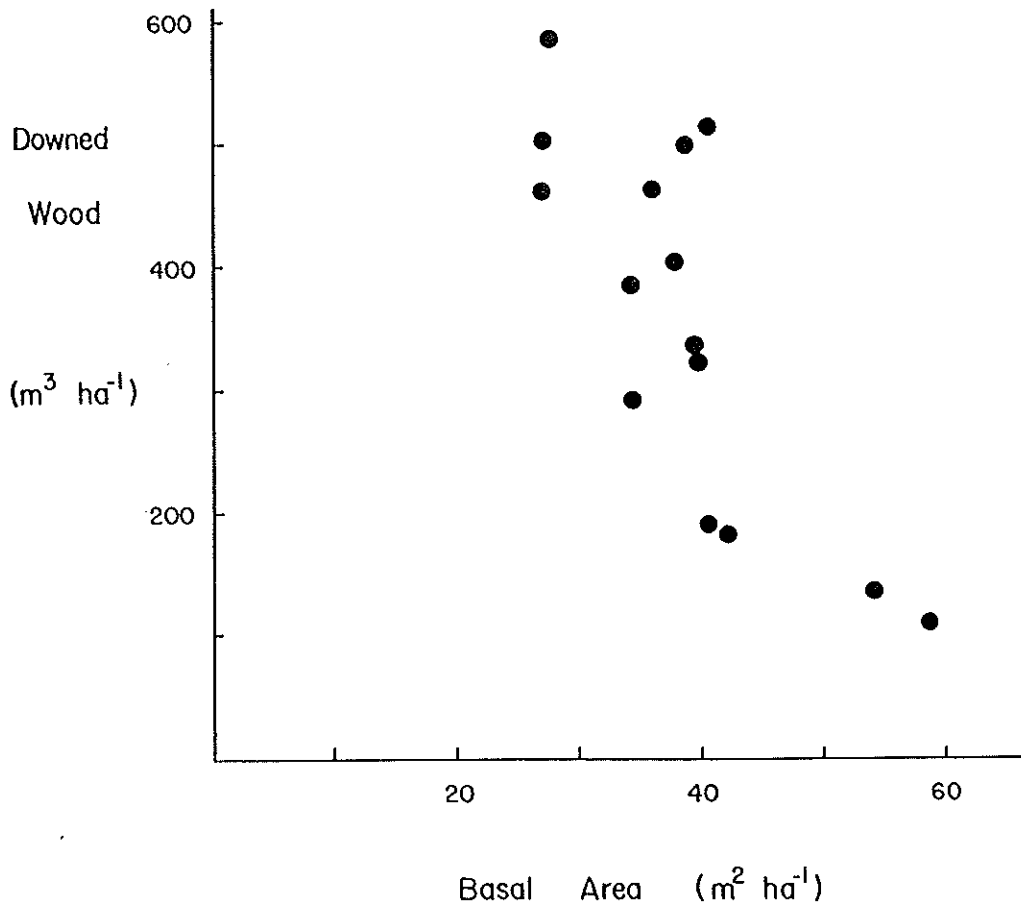


Fig. 7. Relationship between the volume of coarse downed wood and basal area in 400 m² plots at Pisgah.

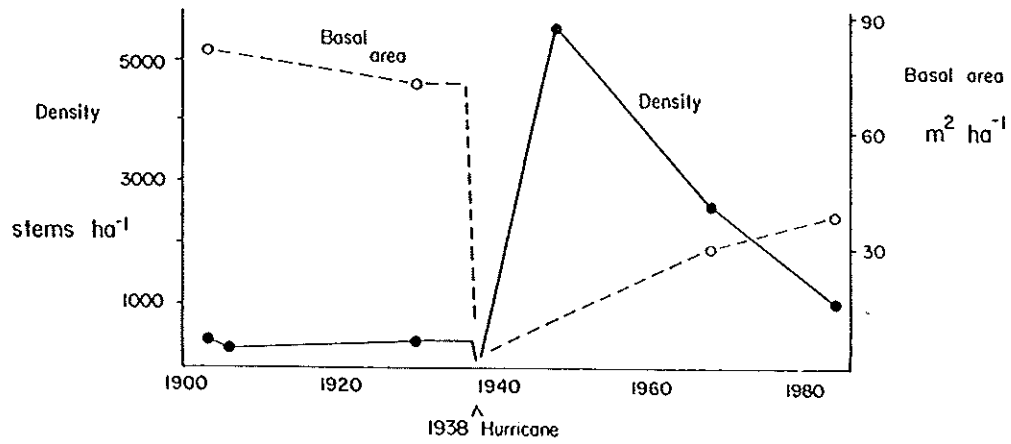


Fig. 8. Changes in density and basal area (1907–1984) at Pisgah.

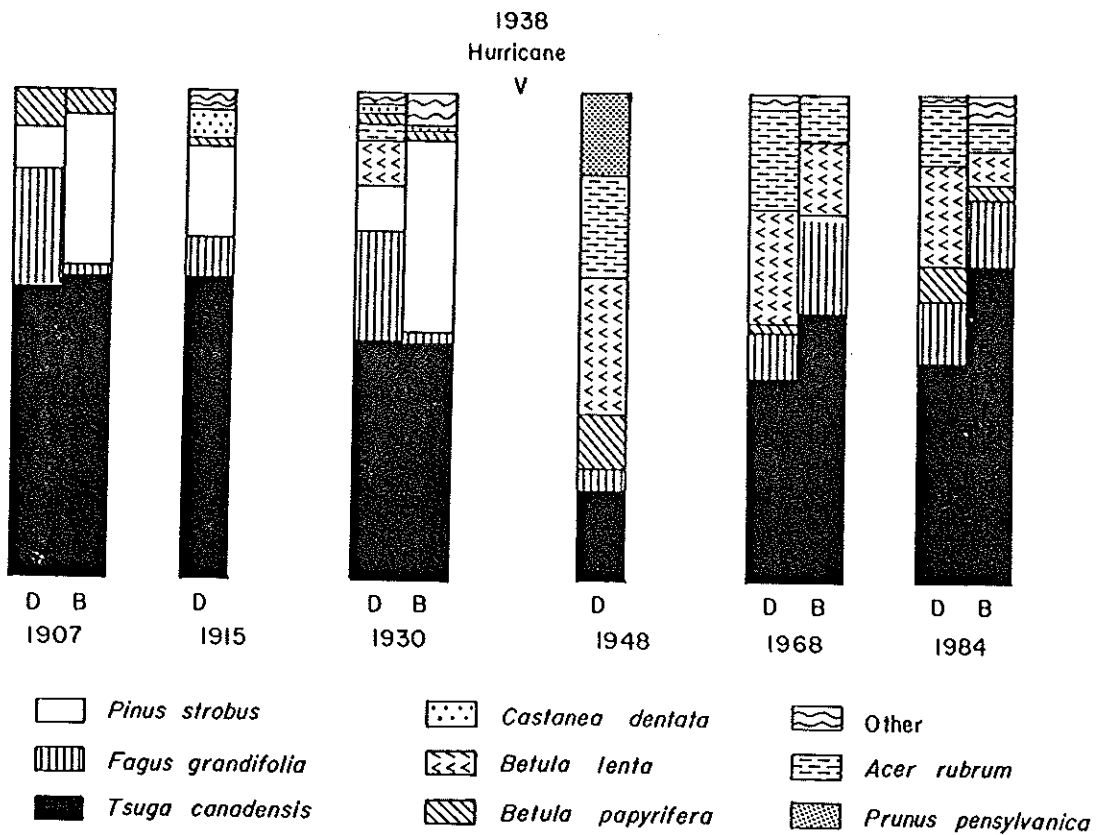


Fig. 9. Changes in relative density (D) and relative basal area (B) from 1907 to 1984 at Pisgah. Sample size varies from 0.1 acre (Henry and Swan - 1968) to 1.5 acre (1930 and 1984).

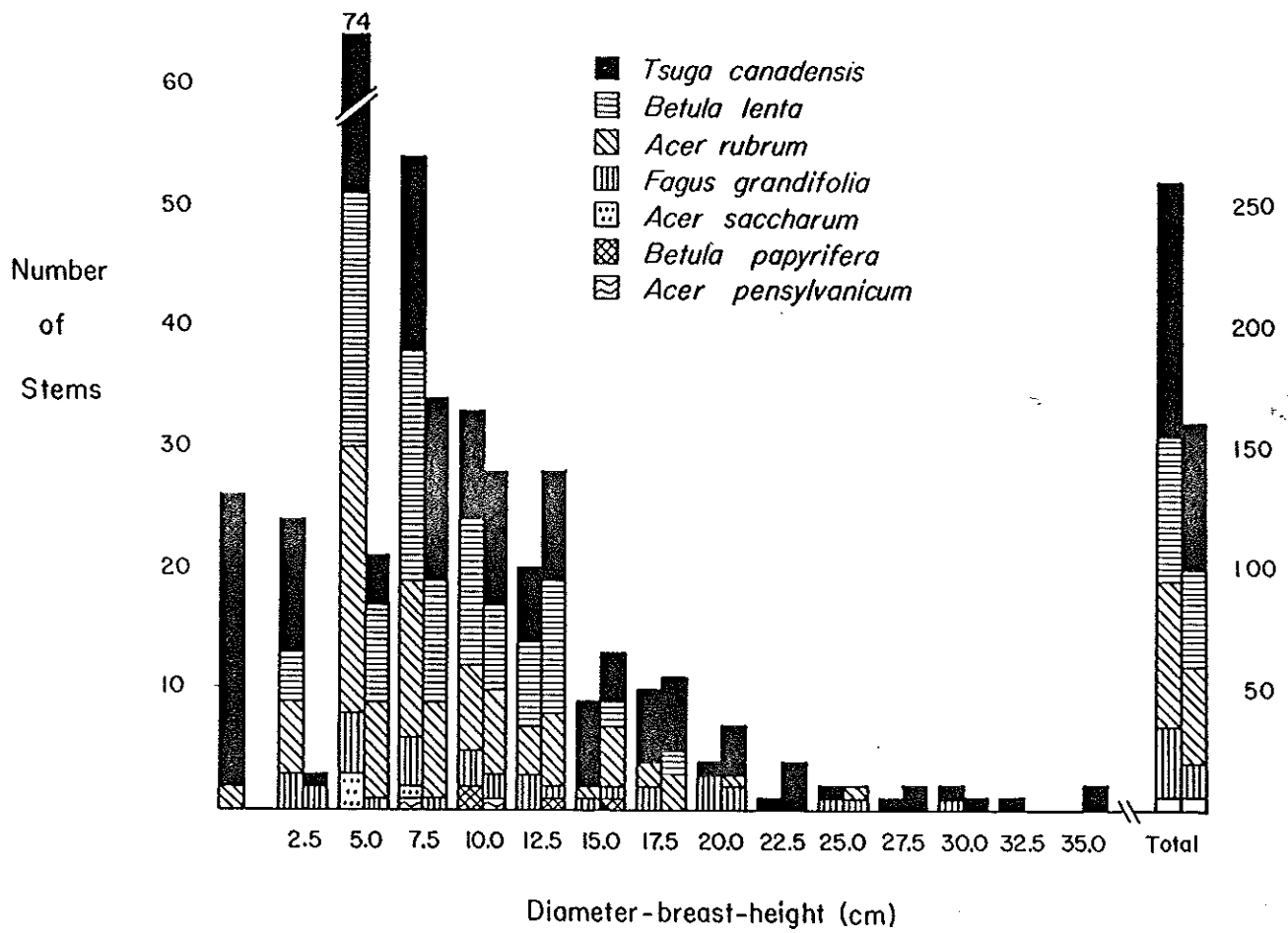


Fig. 10. Changes in size distribution and composition of the Henry and Swan plot at the Harvard Forest. Above each 2.5 cm size class the left hand bar indicates the 1968 sample and the right hand bar indicates the 1984 sample.