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The Impact of Human Activities on the Upland Forests of Western Virginia

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ABSTRACT

Forest communities dominated by such species as red oak (*Quercus rubra*), chestnut oak (*Q. prinus*), white oak (*Q. alba*), and red maple (*Acer rubrum*) still cover large areas in the mountains of western Virginia. Although various human activities (e.g., lumbering operations, fires, and the clearing of land for agriculture) have had an impact upon these forest communities, the very limited data available from surveyor's records and other early accounts at least suggest that present-day forests are compositionally fairly similar to presettlement forests. Indeed, the most important change in composition that seems to have occurred is the almost complete elimination (at least from the forest canopy) of the American chestnut (*Castanea dentata*) by the chestnut blight. Prior to the blight, which was introduced into North America at the beginning of this century, chestnut was one of the most abundant trees in the upland forests of the mid-Appalachians. However, the potential for even greater change would seem to exist as a result of the spread of the gypsy moth (*Lymantria dispar*) into western Virginia, since oaks are among the tree species most susceptible to defoliation by this introduced insect pest.

Key Words: Forests, vegetation, Virginia, oaks, *Quercus*, perturbation, logging, agriculture, fire, gypsy moth, chestnut blight

INTRODUCTION

> "From the Atlantic to well beyond the Mississippi, and covering all the south, stretched an almost unbroken primeval forest. A squirrel might leap from bough to bough for a distance of a thousand miles and see scarcely a flicker of sunlight on the ground, so continuous were the tree crowns and so dense the foliage" (Chase, 1936).

Virginia's landscape, altered by millennia of environmental changes and natural perturbations and extensively modified by the Indians in pre-colonial times, was characterized as a diverse mosaic of forest communities when the Europeans began settlement. The Commonwealth's present landscape represents over 200 years of change and modification by an ever increasing human population. In the eastern

and central portions of the state, forests have been significantly altered by conversion to agricultural land, a process that dates from colonial times, and to urban areas, a process that has become increasingly more important in modern times.

Except for a few fragments of mostly bottomland hardwoods, the forest acreage that exists today is highly disturbed or heavily managed. However, in the more mountainous western portion of Virginia, large areas of forest still exist, most of which are in public ownership. Although a number of historical and economic factors were involved, the major reason these forests escaped destruction is simply because the land they occupy is not suitable for agriculture.

Although forests still cover large areas in the mountains of western Virginia, it does not necessarily follow that these forests are identical to or even fairly similar in composition to the original virgin forests as the first settlers found them. There is very little doubt that various human activities have had some impact upon these forest communities. The purpose of this paper is first to describe, using the rather limited data that are available, presettlement forest conditions in western Virginia and then to discuss some of the ways in which these forests have been affected by various human activities, including such things as the clearing of land for agriculture, fire, logging operations, and the inadvertent introduction of biotic agents destructive to specific tree species. Nomenclature used herein follows that of Radford et al. (1968).

EARLY ACCOUNTS OF FOREST COMPOSITION

Very little is known about the original forests of western Virginia, since relatively little quantitative data or even fairly detailed first-hand descriptions are available. However, the early survey records found in the archives of county courthouses often contain a surprising amount of information that can be used by ecologists (Spurr, 1951) and archeologists (Holland, 1980). Surveyors recorded names of trees encountered on survey perimeters (property lines) and at points where line direction changed. The metes-and-bounds (metes = bearings and distances; bounds = adjoiners) method was employed for measuring boundary lines in Virginia, the other 12 original colonies (which at that time included both Tennessee and Kentucky), and Texas (Stewart, 1935). Surveyors followed "natural" landmarks (e.g., rivers) rather than "straight" lines in establishing property boundaries. Sometimes descriptions were quite unusual (e.g., "Beginning at the old crow's nest on the north fork of the Kentucky..."). Understandably, questions of bias and inaccuracy arise in these kinds of data (Bourdo, 1956). Surveyors may have misidentified species or prejudicially selected only certain species (due to their known long-lived nature, their size, or their age). Nevertheless, these early survey records do provide an available source of information about the kinds of trees (and, presumably, their relative abundance) that existed in surveyed areas in the past. If this information seems reasonable in terms of present composition and known distribution for the tree species, one can have more confidence in the data.

We obtained data from the records of 50 original surveys (for the period 1823-1824) performed on warranted lands that were public domain in Allegheny County, Virginia (Lipford et al., 1985). Descriptions were read from original survey books retained at the county courthouse in the city of Covington. Each time a kind of tree was mentioned, this fact was recorded along with any additional information

such as size of tree or its habitat (e.g., by a stream, on a ridge). A total of 39 kinds of trees was recorded. This certainly would suggest that these surveyors were very knowledgeable about the trees they encountered. Because they gave only the common name, the exact scientific name was sometimes difficult to ascertain.

In fact, 2 kinds of trees named in the records we examined ("maple locust" and "locust hickory") could not be definitely assigned scientific names. The trees named most often in survey records were white oak (*Quercus alba*) 26%, pines (*Pinus* spp.) other than white pine (*P. strobus*) 13%, chestnut oak (*Q. prinus*) 10%, and hickories (*Carya* spp.) 9%. American chestnut (*Castanea dentata*), which is thought to have been an abundant species in the region at that time, represented only 5% of the total number of trees tallied. It is interesting to note that pines were recorded as being relatively more abundant on ridges and sides of hills than any other kinds of trees. White oak achieved this status at the bottoms of hills and on banks.

Records from surveys carried out by George Washington in northern Virginia and adjacent areas of West Virginia during the period 1748-1750 (Spurr, 1951) were fairly similar in overall tree composition to those compiled for Allegheny County (Figure 1). In both regions, these early forests were dominated by oaks, pines, and hickories. Oaks were slightly less abundant in Allegheny County than in northern Virginia, and there was a greater variety of other species present in the former region. The composition of forests in Allegheny County today appears to be rather similar, with dominance by oaks, particularly chestnut oak (*Quercus prinus*), pines, and hickories(Figure 2). At least some of the differences in relative dominance for the various tree species are probably attributable to differences in sampling methods. Data for present day forests in Allegheny County are based on studies by the second author and were obtained from 40 plots (each plot = 0.1 ha), located at 3.2 square kilometer intervals, mostly in the eastern half of the county. This grid was developed to assure that all habitat types within the county would be sampled. In contrast, early survey records tended to be limited mainly to bottomlands (where white oak typically is more abundant even today) in the central portion of the county.

The first general accounts of the forest vegetation of western Virginia date from the latter part of the last century. Among these are those of Hough (1878), who indicated that

> "The Blue Ridge is mostly covered with forests of white, black, red, and rock oak, hickory, chestnut, locust, birch, some excellent yellow pine, and other trees. This section has furnished great quantities of charcoal for the manufacture of iron from the ores on its western margin, and it will long remain a source of supply as the forests renew themselves rapidly."

and also that

> "Appalachia is both rich and poor in forestal wealth. On the Sandstone Mountain ranges, and in the slate and shale valleys, the trees are small, but the growth is dense, of oaks, and other hard woods, pines, &c., good for charcoal, with larger trees in the hollows and more fertile spots. On the limestone ridges and adjacent valleys, as also in the calcareous and some shale valleys, oaks, walnuts, white and yellow tulip-poplars, birches, beeches, locusts, cherries, sycamores, and other timber trees are found to grow to a large size, often several feet in diameter, and to a great height.

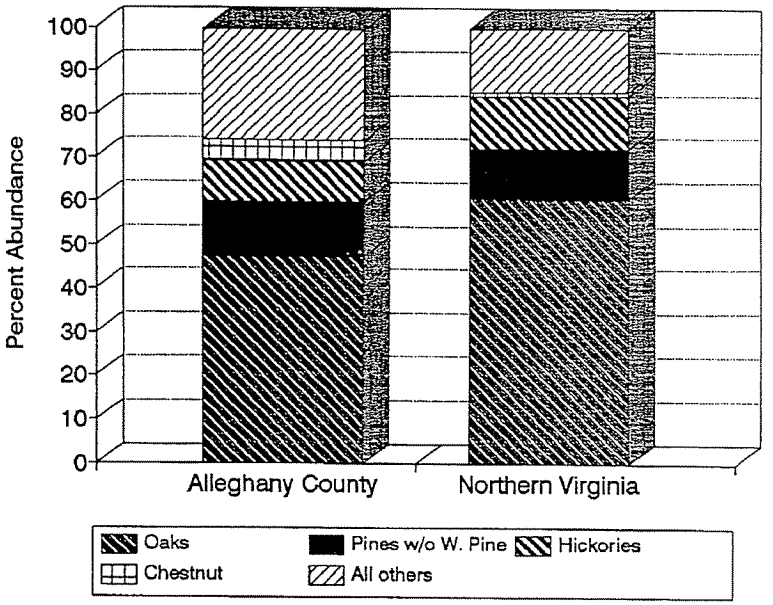

FIGURE 1. Comparison of early forest composition in Alleghany County, Virginia, and northern Virginia (and a portion of what is now West Virginia). Both are based on early survey records, with those for the northern Virginia area conducted by George Washington in the late 1700s (Spurr, 1951). Note overall similarity in composition. Oaks were slightly less abundant in surveys in Alleghany County, but there was a greater variety of other species.

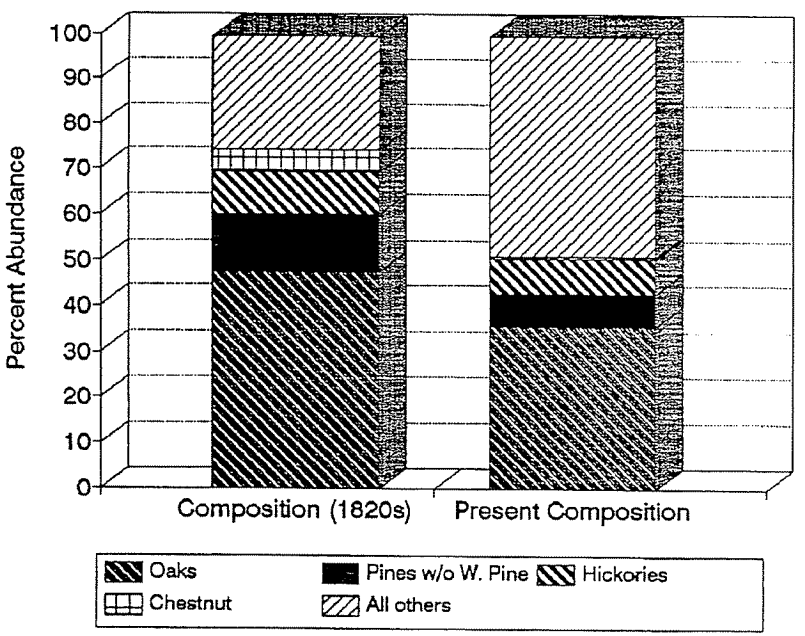

FIGURE 2. Comparison of early (survey records) and present (plot studies) forest composition in Alleghany County, Virginia. Composition is generally similar, although American chestnut has all but disappeared today. present studies included more "other" species, presumably because more habitats were included than was the case for early surveys.

> Only portions of this region have been reached by railroads, and extensive forests of excellent timber remain without means of reaching markets."

As a general observation, the trees named by Hough are the same as those recorded as important in recent studies of the upland forests of these same regions (e.g., Adams and Stephenson, 1983; Stephenson et al., 1991).

CLEARING OF LAND FOR AGRICULTURE

When the first settlers arrived in eastern North America, they encountered what seemed to be an almost continuous forest. However, these pre-colonial forests were by no means completely undisturbed. Even in the more mountainous western portion of what is now Virginia, where Indian populations were probably never very high, some clearing of land for the cultivation of such crops as corn and beans had already taken place (Robison, 1960; Hudson, 1982). Most such cleared tracts of land were located in the fairly level mountain valleys, particularly along larger streams (Robison, 1960). For the most part, the earliest settlements in the region also tended to be located on the same types of sites. when these lands were settled, trees were girdled, chopped and burned as the forests were cleared to made way for homes and fields (Tice, 1987). As land in the stream valleys became increasingly scarce, settlers moved onto the lower slopes of the mountains, some of which had already been used for grazing livestock. However, relatively little use was ever made of steeper slopes and ridgetops, which were simply not suitable for agriculture. Based on figures provided by Hough (1878), the period during and immediately following the Civil War was marked by an unusually rapid reduction in forest acreage in western Virginia (Table 1). Nevertheless, even during the early part of the present century, when the amount of land being used for agriculture was at its peak, forests still occupied about half of the total land area in western Virginia (Table 2). Since that time, as more and more small farms have been abandoned, forest acreage has actually increased.

FIRE AS AN ECOLOGICAL FACTOR

Fire represents an environmental factor of considerable importance in some types of forest ecosystems (Williams, 1991) and has undoubtedly played a major role in the evolutionary development of some tree species, including Table Mountain pine (*Pinus pungens*) (Zoebel, 1969). Before the advent of aboriginal man into eastern North America, most fires were caused by lightning. Ecological and meteorological evidence suggests that such fires were comparatively rare and affected a relatively small percentage of the total forest acreage (Van Lear and Waldrop, 1989). However, the frequency and ecological impact of fire increased dramatically upon the arrival of Indians in the region about 10,000 years ago (Keel, 1976; Van Lear and Waldrop, 1989). Apparently, wherever there were Indians, there was fire (Stewart, 1963). Indians purposefully used fire for a number of different reasons, including such things as driving game from cover, clearing the forest for agriculture, and removing undergrowth to make the gathering of acorns and chestnuts easier (Tice, 1987). Settlers began moving into the mountains of western Virginia in some numbers in the mid-1700s. To these early settlers, forests were considered a hindrance and fire was often used to clear areas of trees and/or undergrowth. In some locations, annual burning to retard the growth of woody

TABLE 1. Woodlands in various regions of Virginia reported as included in farms in 1860 and 1870. Figures given are numbers of acres and are from Hough (1878).

Region	1860	1870
Blue Ridge	413,944	349,381
The Valley	1,810,512	1,457,146
Appalachia	1,708,987	1,072,395

TABLE 2. Total land area by type of use in 1940. Figures given are from Lotti and Evans (1943).

Type of use	Area in acres	Percent of total land area
Forest		
Commercial	4,664,900	51.2
Reserved public	107,000	1.2
Non-commercial	184,400	2.0
Total forest	4,956,300	54.4
Non-forest		
Old cropland	1,622,700	17.8
New cropland	26,300	0.3
Pasture	2,209,100	24.2
Abandoned cropland	77,600	0.9
Other non-forest	214,000	2.4
Total non-forest	4,149,700	45.6
All uses	9,106,000	100.0

undergrowth in areas used for grazing livestock was a standard practice until well into the present century (Robison, 1960). Some evidence as to the extent and impact of fires in the forests of western Virginia in the late 1880s is provided by Hough (1882), who described the conditions that existed for a number of areas. For Allegheny County, Hough reported that

> "Fires occurred in the mountains of this county in April and May, chiefly in a young growth of timber. Perhaps a tenth part of the wood-lands in this county are burned over annually.--(A. A. McAllister, Covington, Va.)"

and for Craig County, he noted that

> "Fires occurred in February, March, and April, burning over a large area of mountain land and killing a considerable amount of timber.--(Z. T. Kale, Newcastle, Va.)."

As already indicated, fire was a relatively more important factor in certain types of forest communities than in others. For example, based on data for Shenandoah National Park (Table 3), some forest types were characterized by an exceedingly high frequency of fires, whereas fire was an uncommon occurrence in other types (Berg and Moore, 1941). During the present century, particularly since the 1920s, the fire suppression policies of the USDA Forest Service and other agencies have greatly reduced the use of fire in forests. Consequently, fire is less of a factor in forests than at any time in the recent past.

LOGGING OPERATIONS

The homes of early settlers were almost invariably constructed from logs or lumber produced from trees on or near the building site (Tice, 1987). In addition, considerable quantities of wood were used for fencing and as a source of fuel. At first, the actual impact of logging upon forests was relatively limited and quite localized. However, as the demand for wood increased, logging become more and more important. During the late 1800s, timber companies began buying large tracts of land in western Virginia, and by the beginning of the present century, even the most remote and inaccessible areas were being logged (Van Lear and Waldrop, 1989). In 1909 logging reached its peak in Virginia, with 2.1 billion board feet of lumber being produced, ranking the state sixth in the nation (Tice, 1987). Unfortunately, logging operations usually left behind a considerable amount of slash, which often burned. The resulting fires, some of which were deliberately set, were sometimes rather extensive and destructive.

The forests of western Virginia produced more than just logs for lumber. In a few areas (e.g., Allegheny County), where deposits of low-grade iron ore are found, appreciable amounts of wood were used to produce the charcoal used in iron furnaces during the period when these were in operation (which extended from the late 1700s through the 1800s). Moreover, the bark from such trees as chestnut oak was used in the tanning industry. It is interesting to note that the selective removal of chestnut oak seems not to have had a major impact upon the relative abundance of the species in at least those areas where it was most characteristic. Hough (1878) indicated that

> "The lands upon which the chestnut oak grows in Virginia are mountain lands, too steep and rocky for any purpose of agriculture, other than vineyarding, orcharding, or perhaps with some of it, grazing, and are valuable only for bark, wood for smelting the iron ores abundant here, and of fine quality and high per cent. In this locality the furnace men utilize large quantities of the timber cut by the tanner. Bark forests, when cut down, do not give place to other kinds of timber, as is so frequently the case with other kinds of timber lands, but rapidly and thriftily shoots up a new growth to the exclusion of the other timber, and, in time, renews the bark supply."

TABLE 3. Summary of total acreages and net burned acreages by each forest type for the period 1925-1940 in Shenandoah National Park. Figures given are from Berg and Moore (1941).

Forest Type	Total Acreage	Net Burned Acreage	Percentage Burned
Chestnut Oak	60,190	32,301	53.7
Red Oak	55,730	8,091	14.5
Open	29,450	402	1.4
Scarlet Oak	15,510	9,446	60.9
Pitch Pine	11,440	9,421	82.4
Cove Hardwoods	11,390	649	5.7
Bear Oak	6,710	6,158	91.8
Other	3070	187	6.1
Total	193,490	66,655	34.4

Chestnut oak continues to be an important species in the present-day forests of western Virginia and is often the single most abundant tree on southern exposures at moderate elevations (Adams and Stephenson, 1983; Stephenson et al., 1991).

INTRODUCED BIOTIC AGENTS

Introduced biotic agents have had a major impact upon the forests of western Virginia. Indeed, the single most important change in composition that seems to have occurred is the almost complete elimination (at least from the forest canopy) of the American chestnut by the chestnut blight.

Prior to the blight, which was introduced into North America at the beginning of this century, chestnut was one of the most abundant trees in the upland forests of the mid-Appalachians (Stephenson, 1986). Evidence as to the relative abundance of chestnut in forests of a portion of western Virginia just north of Allegheny County is provided by a description given by Ingalls (1949), who noted that

> "Over huge areas chestnut was the dominant species. In the nineties anyone standing in front of the Homestead on a midsummer day and looking toward the warm Spring Mountains might have thought there had been a snowfall, so completely did the white chestnut blooms cover the slopes."

Quantitative descriptions of the pre-blight composition of chestnut-dominated forest communities are few in number, but in 1932 Braun (1950) surveyed one such community on the slopes of Salt Pond Mountain near Mountain Lake in Giles County. At that time, chestnut made up 85% of all stems in the forest canopy (Table 4). When this same community was resampled 50 years later, the species had disappeared completely from the canopy.

However, the potential for even greater change would seem to exist as a result of the spread of the gypsy moth (*Lymantria dispar*) into the forests of western Virginia. For many years this insect pest, which was introduced into North America from Europe in 1869, appeared to be contained in New England and eastern New

TABLE 4. Comparison of pre- and post-blight composition for a former chestnut-dominated community on an open, north-facing slope in the Mountain Lake area of southwestern Virginia. Values given are relative density.

Species	Date sampled 1932*	1982**
American Chestnut	84.6	0.0
Red Oak	11.1	57.0
White Oak	2.6	1.4
Red Maple	0.8	11.3
Cucumber Magnolia	0.8	0.5
Black Birch	0.0	5.4
Other species	0.0	24.4
Total	99.9	100.0

*after Braun (1950)
**after Stephenson (1986)

TABLE 5 Incidence of gypsy moth egg masses on stems ≥ 10 cm DBH in stands sampled on Massanutten Mountain and North Fork Mountain in 1990 (unpublished data supplied by D. Lawrence).

Study site	No. of stands	Incidence of gypsy moth egg masses (%) Range	Mean
Massanutten	19	0-52	18.5
North Fork	22	0-42	5.0

York. However, during the latter part of the present century the gypsy moth has extended its range northward into Quebec, west to Michigan,and south through Maryland into Virginia. At the present time, the forests of western Virginia are on the leading edge of gypsy moth infestations. For example, based on data collected during the 1990 field season from forest stands on Massanutten Mountain (located in northern Virginia) and North Fork Mountain (located in eastern West Virginia), the incidence of gypsy moth egg masses is substantially higher for stands in northern Virginia than is the case for stands in regions farther west (Table 5).

Gypsy moth larvae are known to be capable of feeding upon the foliage of at least 500 different species of plants, but they show a decided preference for certain species, which often suffer extensive defoliation as a result. Forest trees that undergo repeated severe defoliations are subject to relatively higher levels of mortality than would otherwise be the case. Among the preferred tree species are

various oaks, including chestnut oak, black oak (*Quercus velutina*), red oak (*Q. rubra*), and white oak (Gansner and Herrick, 1985).

Because the major forest types in western Virginia contain a substantial oak component, they are particularly susceptible to gypsy moth defoliation.

In conclusion, despite past forest removal for agriculture, logging, and various other reasons, overall composition of today's forests appears to be fairly similar to that of presettlement forests. This perhaps illustrates the extraordinary resilience that is innate to these mid-Appalachian forest communities.

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