A RESOURCE AT THE CROSSROADS:

A HISTORY OF THE CENTRAL HARDWOODS

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Abstract: The Central Hardwood Forest is an oak-dominated deciduous forest that stretches from Massachusetts to Arkansas and occurs in hilly to mountainous terrain. It is the largest and most extensive temperate deciduous forest in the world.

During the past 20 million years or so, angiosperms have been gradually replacing gymnosperms as the dominant plant form on earth, and deciduous hardwoods are particularly adapted to the fluctuating seasonal climate and moderate rainfall associated with the Central Hardwood Region. As the glacial ice sheets retreated about 12-14 thousand years ago, forests re-invaded the region. Native peoples populated the area and practiced extensive burning to improve habitat for game and to aid in land clearing for agriculture. By the time the early Europeans arrived, about 450 years ago, the Native People had adopted a sedentary lifestyle and their population had increased to levels comparable to that of Western Europe. The first European explorers brought with them diseases that decimated the native populations, and for almost 200 years the central hardwood forest re-grew to become the "primeval forest" of legend.

By the late 18th century, settlement by subsistence farmers using European methods (draft animals and metal tools) was in full swing. Much of the tillable land in the central hardwood region was cleared, including substantial areas of steep and hilly land. The industrial revolution in the post-Civil War period ushered in a trend away from subsistence farming and marginal land was abandoned to revert back to forest.

The last 100 years has seen an era of exploitive logging in the central hardwood region, followed by a re-growing forest. Human influences have predominated in shaping the present forest and these include logging, burning, grazing, fire control, wildlife management and pest introductions. In the past 30 years, societal attitudes toward land and forests has had a profound effect on governmental policy as it relates to forestry. The maturing central hardwood forest, mostly owned by private individuals, is rapidly becoming a **resource at the crossroads**.

INTRODUCTION

The historical developments that shaped the central hardwood region are significant in understanding how the present forests came to be and, as always, knowledge of history enables us to learn from past successes and failures. Thus, history provides not only the background, but also the context for future management. For purposes of this discussion, the history of the central hardwoods will focus on the period after the last ice age (the period of human impact). Because the particular forest that exists today is mostly a result of events that have occurred during the life of the trees that presently comprise it, this period will be emphasized.

The overriding factors that predispose a given geographic region to a particular vegetation type are the climate and soil (site), and this has been true throughout the hundreds of millions of years that vegetation has existed on earth. Furthermore the prevailing vegetation creates habitat for animal forms which are adapted to it, and they, in turn, have a biofeedback relationship with the vegetation. This type of association is the basis for what is called an **ecosystem** (Odum 1971).

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EVOLUTION AND THE DECIDUOUS FOREST

The ability of plants to capture solar energy by using readily available elements (carbon, hydrogen, oxygen, etc.) has been the key to all biological development on earth. Fossil evidence is our window to the past, and although incomplete, it appears that this process of **photosynthesis** first developed in primitive marine algae between 400 and 500 million years ago (Eyre 1963). From these evolved the primitive land plants that occupied the earth's surface prior to the Carboniferous Period (more than 200 million years ago). During the Carboniferous Period (215-280 million years ago), ferns and their relatives dominated the earth. Around 190 million years ago, the gymnosperms began to take over as the principal vegetation, and they have given way to the dominance of angiosperms (including deciduous hardwoods) during the last 50 or so million years. The angiosperms, though relatively recent in their development, have shown a remarkable ability to adapt to the changing conditions of the earth. From this point of view, it might be said that the central hardwoods represent the cutting edge of evolutionary change, as compared to the boreal conifer forest.

Perhaps the most recent (and most significant) episode of climatic and vegetational change to affect the distribution of present-day vegetation was the so-called **ice age**. The continental glaciers extended down through North America into southern Illinois, and a zone of tundra extended well down into much of the present central hardwood region (Davis 1983). As the Wisconsin ice sheet began to retreat northward about 14,000 years ago, a boreal forest type replaced the tundra and vestiges of this forest still exist as the high-elevation spruce and spruce-fir communities in the Appalachians (Maxwell and Davis 1972). The deciduous forest community has gradually become the dominant vegetation of the region and now forms the most extensive forest of this type in the world.

IMPACT OF THE NATIVE PEOPLE ON THE PRE-COLUMBIAN FOREST

As important as the ice age, and its retreat, has been, the impact of humans has probably been just as significant in shaping the central hardwood forest. The indigenous people occupied the central hardwood region for at least 10,000 years before Europeans came (Lesser 1993). In the southern portion of the region, human occupancy probably dates back as long as 14,000 years ago owing to the more hospitable climate farther south (Buxton and Crutchfield 1985). Archaeologists classify the human occupancy of North America into Late Prehistoric, Mississippian, Woodland, Archaic and Paleo periods (Lesser 1993). Table 1 shows the chronology of these periods and outlines their cultural lifestyle as well as broad climatic and vegetational environments (Buckner 1992). Prior to the Woodland period, indigenous peoples were nomadic hunter-gatherers. Their influence on the forest during this period was most likely through the setting of fires. Accidental human-caused fires no doubt occurred during this time, and perhaps intentional fires were set to drive out game or to retain habitat. MacCleery (1992) speculates that the early Europeans' observations of abundant game (bison, elk, etc.) in the central hardwood region indicates a greater proportion of grassland occurred than currently exists, which implies that burning probably took place. Such burning, most likely would have been the work of the indigenous population.

Around 1,000-500 B.C., the Native Americans adopted a more sedentary lifestyle, and at some point during that time, they began the practice of agriculture (Swanton 1979). They also constructed elaborate burial mounds which can be found in places, such as Moundsville, West Virginia; Marietta and Hillsboro, Ohio; East St. Louis, Illinois; and Cartersville, Georgia. During this agricultural phase, which extended into the Late Prehistoric Period until European contact (about A.D. 1600), the Native Americans generally lived in permanent villages, often on the level land of river floodplains (Davis 1978). The village would often have a structural layout with houses of thatch or pole construction surrounded by gardens and fields. During this time, the Native Americans used tools as well as fire to clear land. MacCleery (1992) states the case as follows: " The south was dominated by fire-created forests, such as long-leaf pine savannas on the Coastal Plain and Piedmont. The hardwood forests of the Appalachian Mountains were also burned frequently by native peoples. Virginia's Shenandoah Valley—the area between the Blue Ridge Mountains and the Alleghenies—was one vast grass prairie. Native peoples burned the area annually." MacCleery further states: "On the western fringe of the eastern forest, fire-dominated forests, such as oak and oak-pine savannas, covered tens of millions of acres." Martin and Houf (1993) indicated that remnants of so-called "balds" still exist in the Ozarks of southwestern Missouri. These grassy glades usually occur on dolomitic limestone soils, and require periodic fires for their maintenance. They tolerate intermittent grazing, as would have occurred

when migratory herds of bison occupied the area, but under year-round grazing imposed by the European settlers, eastern redcedar began to overtake the glades. Beilman and Brenner (1951) use several lines of evidence to indicate that extensive forest cover is a relatively recent development in the Ozark region. They refer to Houck's (1908) account of Ferdinand DeSoto's observations of the region in 1541 where he described fertile alluvial bottoms planted in maize, pecans, plums and mulberry trees. The open, park-like countryside was in contrast to the hardwood and pine forests that exist today. Another description of park-like vegetation in the Ozark region was provided by the explorer Coronado, where he noted the hunting of buffalo by the Osage Indians. Although substantial prairie-like areas probably occurred throughout the central hardwood region, Steyermark (1959) indicates that even within the Ozark region, where grasslands were common, substantial areas of hardwood forests existed prior to European settlement.

Table 1. Chronology of Native People from Buckner (1992)

Cultural Event	Date	Years ago	Climatic/vegetational stages
HISTORIC PERIOD:			
Modern Times. Settlement Times.	2000	0	Man-made forests widespread.
High Indian mortality.			Exploitation of forests and soil.
America discovered.	1500	500	Indian impacts (cultivation and fire) mold forest character.
MISSISSIPPIAN PERIOD:			
Indian cultures largely agrarian, large palisades.	1000	1,000	
WOODLAND PERIOD:			
Pottery	500	1,500	
Corn cultivated; bow and arrow			
	AD		Northern pines had moved into Canada
Burial mounds	0	2,000	while southern pines had moved into
	BC		Tennessee - their present distributions.
ARCHAIC PERIOD:	1000	3,000	
Marked increase in Indian population; exchange with other regions.	2000	4,000	Sea level rises to modern position.
Beginnings of cultivation with fire as the only feasible tool for land clearing.	3000	5,000	"Southern pine rise" results in marked increase in dominance of southern pines in SE.
Archeological evidence that Archaic Indians used total landscape of So. Appalachians.	4000	6,000	
	5000	7,000	Increased summer warmth and drought.
	6000	8,000	
	7000	9,000	Central hardwood oak-hickory forests became established.
	8000	10,000	Periglacial climate extended as far south as an east-west line thru Ashville, NC
PALEO-INDIAN PERIOD:			
Largely hunting/gathering tribes; fire was an available tool.	9000	11,000	Temperate, deciduous forests replace Jack pine/spruce/fir/larch in TN and NC.
First evidence of humans in SE	10000	12,000	
		15,000	Jack pine, spruce and fir are the primary forest types as far south as Tennessee.
		18,000	FULL GLACIAL MAXIMA

Because the indigenous people tended to settle on floodplains of major rivers, their influence was probably greatest in such areas. Therefore, in many of the regions that are dominated by uplands where rivers have narrow flood-plains, such as interior West Virginia, western Kentucky, southeastern Virginia and into the Cumberland Plateau of Tennessee, the evidence of Native American influence is more limited. However, their use of fire may have enabled them to exert an influence far removed from their settlements. Cronon (1983), with reference to the American Indian influence on the landscape states: "It is tempting to believe that when the Europeans arrived in the New World they confronted Virgin Land, the Forest Primeval, a wilderness which had existed for eons uninfluenced by human hands. Nothing could be farther from the truth—Indians had lived on the continent for thousands of years, and had to a significant extent modified its environment to their purposes." The population density of Native Americans is still being debated, with estimates ranging from 1 million to more recent higher estimates, up to 18 million (Buckner 1992). At higher levels, their impact on the forest would have been greater, but in any event, they most certainly had a significant effect on the central hardwood region.

POST EUROPEAN SETTLEMENT TO 1860

The first Europeans in North America, apart from settlers in colonial villages along the Atlantic seaboard, were essentially hunter/trapper/explorers. They had a limited direct impact on the forest, but their indirect impact was profound. They brought very little with them in the way of equipment, livestock or supplies, but they did bring something that proved to be more significant than any of these—disease. As Williams (1989) points out, the epidemic of disease introduced by the Europeans affected the native peoples to such a degree that between 1520 and 1700, there was a return to a more forested landscape in North America (Buckner 1992). It was this forest that most historians refer to as the "impenetetrable anchient forests." Early explorers kept few records of their observations, but they opened the way for others including botanists, surveyors, etc. Britain offered huge grants of land to individuals, such as Lord Fairfax and William Penn, to encourage settlement of the new world and to gain control of the land from the native population. By 1600 A.D. waves of European immigrants, looking for a better life and an opportunity to escape the feudal system, made their way to the new world.

Most early settlers were subsistence farmers, a technology the Europeans had adopted 1,000 years earlier (Blethen and Wood 1985). The European model had proved very successful in their homeland, therefore, the immigrants set about clearing the North American forest to plant their crops and graze their livestock, in much the same way as they had "tamed" the European landscape about 1,000 years earlier. They brought with them two things the native people lacked—metal tools (ploughs, axes) and draft animals. Their attitude was that the forest represented an obstacle to be conquered. The forest also harbored wolves, mountain lions and bears which posed a threat to domesticated livestock, such as sheep and hogs.

Although the forest was a challenge to be overcome, forests also provided many of the early settlers' needs. For example, nearly every family lived in a wooden house and kept their livestock in a wooden barn (usually log construction). Additionally, wood was the primary fuel for heating. It was not uncommon for a family to use 20-40 cords of wood annually to heat and cook (MacCleery 1992). Wood was used for fencing. MacCleery (1992) estimated that it required about 8,000 fence rails to enclose a 40-acre square field, and by 1850 there were about 3.2 million miles of rail fence in the United States (mostly in the East). Potash was another important product from American forests in the early- to mid-eighteenth century. The demand for potash in Britain was great during that time. It was used as a soil amendment and as an ingredient in industrial processing (Williams 1989). Hardwoods, especially oaks and maples, produced the highest amounts of potash per unit wood burned and were preferred by potash producers.

From the middle 1700's into the 1800's, many naturalists trekked across North America in pursuit of unknown, unnamed or undescribed species of plants and animals. Some were students of Carolus Linnaeus, the Swedish botanist. Others, such as Andre Michaux (1805) and John Bartram (1751) and his son William (1791) published detailed accounts of their travels through the central hardwood region. From their descriptions and others, such as surveyors' field notes, we can get an idea of what the forest was like at that time.

By this time the Native American populations had been decimated by disease, and the deciduous forests had been virtually free from their effect for between 150 to 250 years. These observers wrote about vast forests of hardwoods. Stephenson (1993) quotes Diss Debar's description of the high-elevation forests of West Virginia on the "table-lands" of the Cheat and Greenbriar mountains: "Here, also neither Oak, Poplar nor Hickory are to be found, but in their room thrive noble specimens of Sugar Maple, Ash, Beech, Birch, Wild Cherry and Black Walnut." But observers who wrote about the Ridge and Valley and Appalachian Plateau forests of lower elevation noticed an abundance of oaks, hickories, maples, and yellow-poplar. Using the frequency of mention as an index to species abundance, from John Bartram's (1751) travels through Pensilvania [sic] to Onandaga, the following ranking of species in order of importance was developed (Table 2). Although the age and size of trees and extent of the forest was greater in 1750 than it is today, the species mix looks fairly typical of present-day stands in the northern part of the central hardwood region.

Table 2. Summary of frequency of mention by species (or species groups) from Bartram's (1751) trip through Pennsylvania

Species	Number times mentioned	Ranking
White oak and black oak	25	1
White pine	12	2
Chestnut	10	3
Spruce	10	3
Hickory	8	4
Sugar maple	8	4
Linden	7	5
Pitch pine	7	5
Elm	6	6
Beech	6	6
White walnut (butternut?)	6	6
Birch (yellow?)	5	7
Poplar (yellow-poplar?)	4	8
Ash	4	8
Sugar birch (black?)	3	9
Great magnolia (cucumber?)	3	9
Locust (black?)	2	10
Walnut (black?)	1	11
Hophornbeam	1	11
Plane (sycamore?)	1	11

The early immigrants settled along the Atlantic Coast and generally used rivers as a primary means of transportation. Westward progress of settlement was relatively slow from 1600 well into the 1700's, mostly due to the lack of a transportation system. The Fall Line of the Peidmont marked the limit of navigability on most eastern rivers; thus, many settlements were established at this position along the frontier. Innovative feats of engineering created water transportation systems, such as the C and O Canal, brainchild of George Washington, but it was only possible to proceed from the Chesapeake Bay to Cumberland, Maryland. The Allegheny Front proved too formidable for the technology of the day. It was the railroads that finally opened the land beyond the Alleghenies. Even though roads (such as the Drover's Road in North Carolina) were used during this time, they were not suitable for transporting heavy materials. Lewis (1995) indicated that it was the construction of the railroads into West Virginia's back counties that allowed a "timber boom" to occur and transformed subsistence farming into "commercial" agriculture in the state.

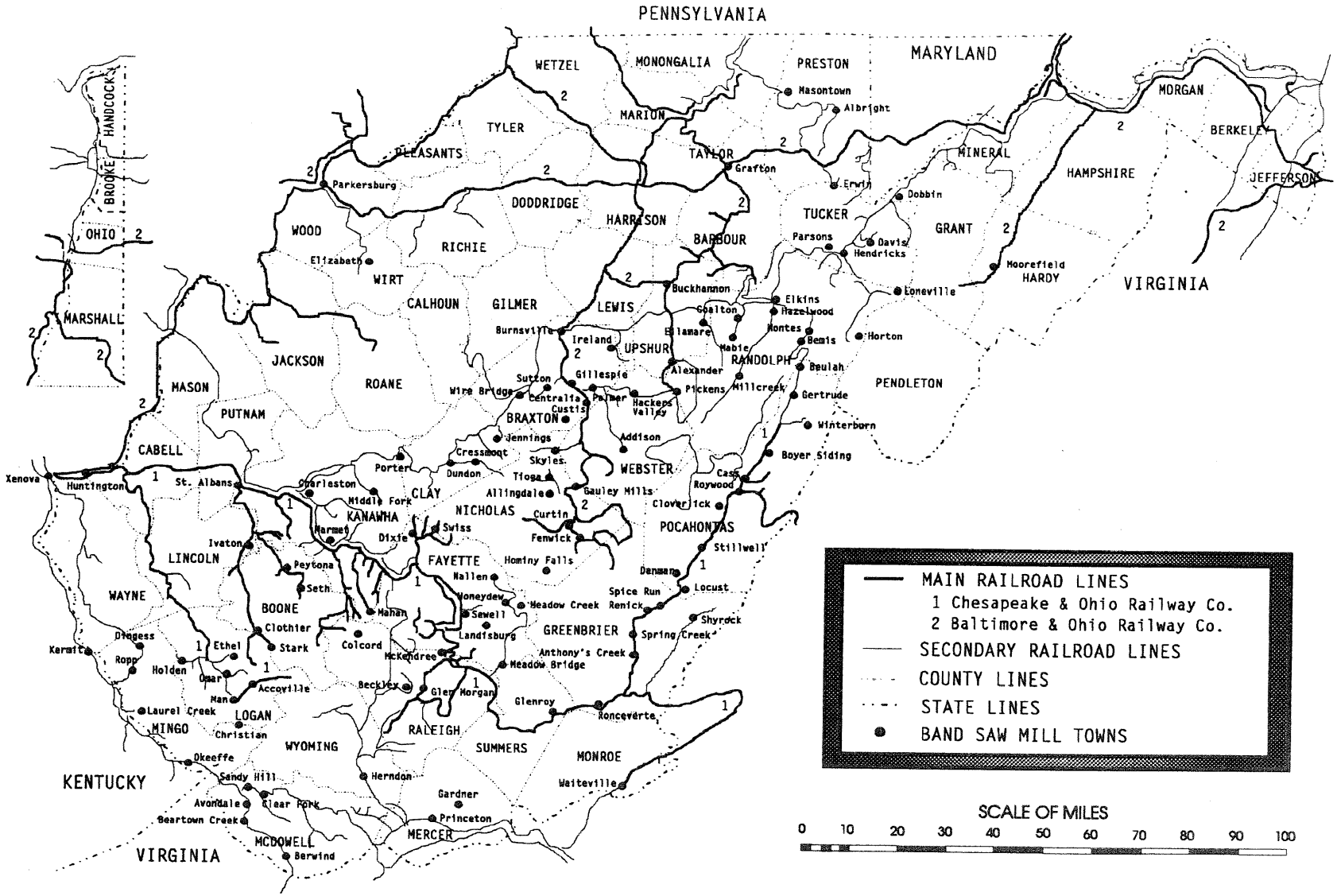


Figure 1. Clarkson's (1964) map of West Virginia railroads in 1917 and band saw mill towns, 1875-1920.

A fledgling iron industry was developing in the eastern United States, especially in the Appalachian Plateaus. Low-grade iron ore was processed in stone furnaces using local limestone for purification and charcoal for heating. Charcoal was produced by clearing patches of forest 1-3 acres in size (Clatterbuck 1990). Luther (1977) estimated that the 11 furnaces operating in the mid-1800's on the Highland Rim of Middle Tennessee required 375 square miles (240,000 acres) of timber to support them. Similar operations in West Virginia, Pennsylvania and elsewhere combined would have consumed several million acres of forestland in the central hardwood region.

THE INDUSTRIALIZATION PERIOD, 1861-1929

As is often the case in a post-war era, the Reconstruction period following the Civil War ushered in a period of sweeping change. The steam engine, which could be moved from place to place, was taking the place of water power for milling. The factories of the North were being converted to peacetime production. And the development of a massive rail transportation system was well under way, spurred on initially to supply troops in the war (Figure 1). With the end of slavery, many large plantation farms were unprofitable. Many subsistence farmers throughout the central hardwood region gave up farming for a more lucrative lifestyle to work in factories, mines or logging camps. Extensive tracts of land were purchased and consolidated by large timber or mineral companies as a speculative enterprise (Eller 1985). The migration of farmers to logging, milling or mining camps was taking place nation wide (Figure 2), but was more pronounced in areas, such as the central hardwood region, where small subsistence farming predominated.

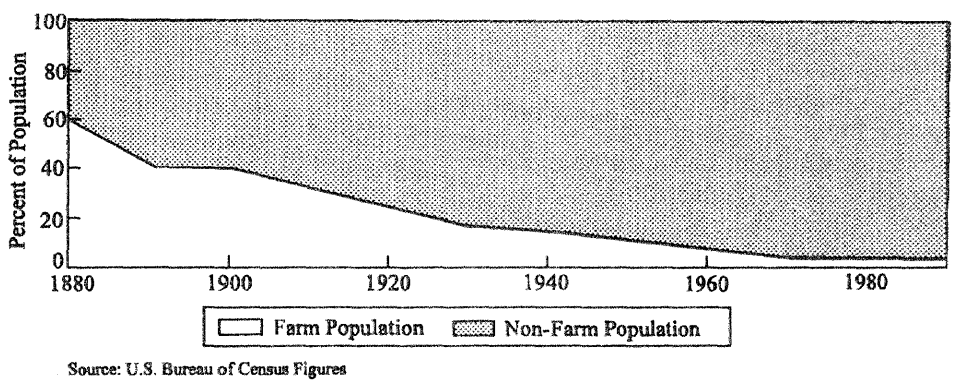
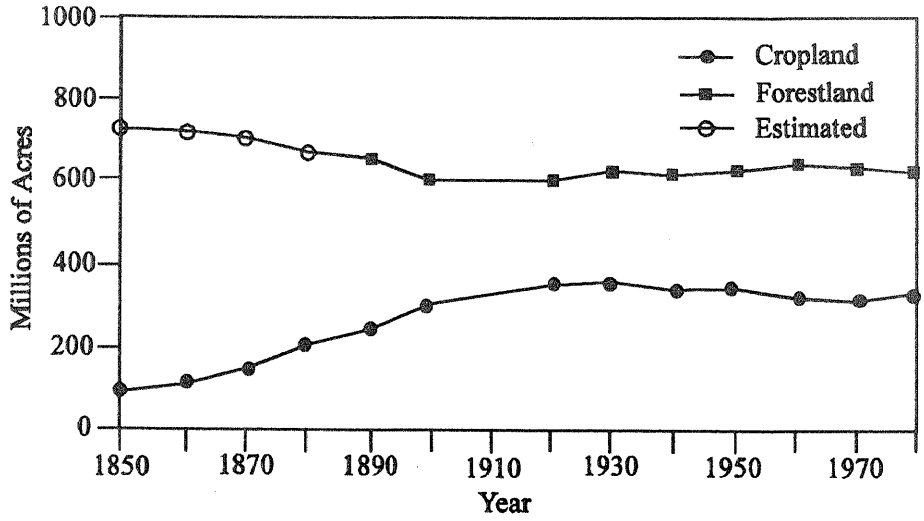


Figure 2. Farm and non-farm population, 1880-1988, from MacCleery (1992).

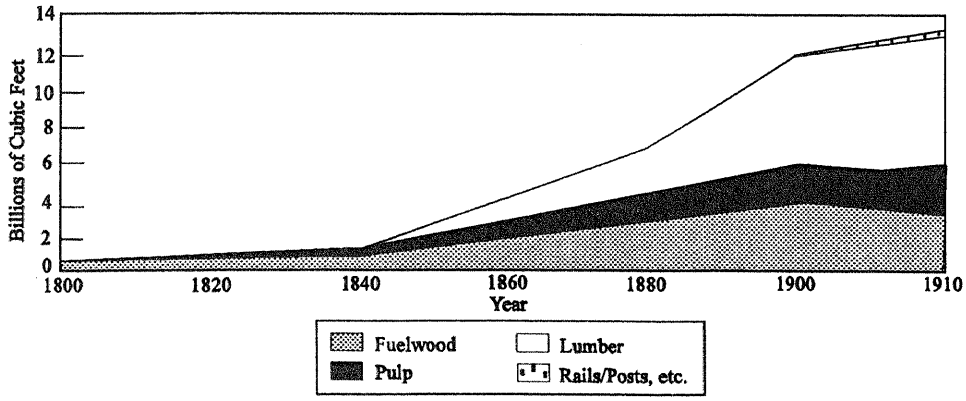


Source: RPA Technical Report, RM-175, USDA-Forest Service, 1989.

Figure 3. Cropland vs forest area, 1850-1980, from MacCleery (1992).

In addition to the emergence of America as an industrial nation, the Industrial Revolution brought about significant changes in agriculture. Tractors powered by steam, and later gasoline, replaced draft stock, and the use of fertilizers and genetically improved plants and animals increased production per unit area. Up until about 1908, as the population of the United States grew, more land needed to be placed under cultivation, and, conversely, land was taken out of forest production (Figure 3). The amount of forestland and cropland has stabilized with the small additional withdrawals of forestland coming from urbanization and rights-of-way for highways, pipelines and power transmission. Mechanization of agriculture also caused a shift in the type of land that could be easily cultivated. Much of the steeper land within the central hardwood region became submarginal and was abandoned. The capital investment required to buy large machinery put agriculture on more of a business level than that of a homesteading operation.

Several secondary effects of the industrialization period on the central hardwoods were also felt. For example, the factories, machines and vehicles needed fuel which promoted rapid development of the fossil fuel industry. Coal, oil and gas production was spurred on throughout the central hardwood region. Forests were withdrawn from production by surface mining, roads, well sites, pipelines, etc. In addition, the booming economy required wood for construction of factories, new housing for factory workers (either immigrants or relocated farmers), mine timbers, etc.



Source: Frederick &Sedjo, RFF (1991)

Figure 4. Domestic production, 1800-1910.

The booming economy ushered in by the industrial revolution and the vast resource base in North America swept over the timber industry as well. According to Frederick and Sedjo (1991), production of forest products tripled in the United States between 1860 and 1910 (Figure 4), mostly as a result of increased production of lumber. Lumber production in West Virginia, where hardwoods predominated, showed a similar trend (Figure 5). The economic boom in North America for consumer goods continued until the beginning of the Great Depression, but the timber boom had peaked in the central hardwood region by 1920, mostly as a result of overcutting. Ahern (1928) in his booklet "Deforested America" stated the situation as follows: "In 1919 the annual drain on our forest resources was estimated at four times the annual growth." Other estimates, although less dramatic, show the same trend where drain exceeded growth during this period (Figure 6).

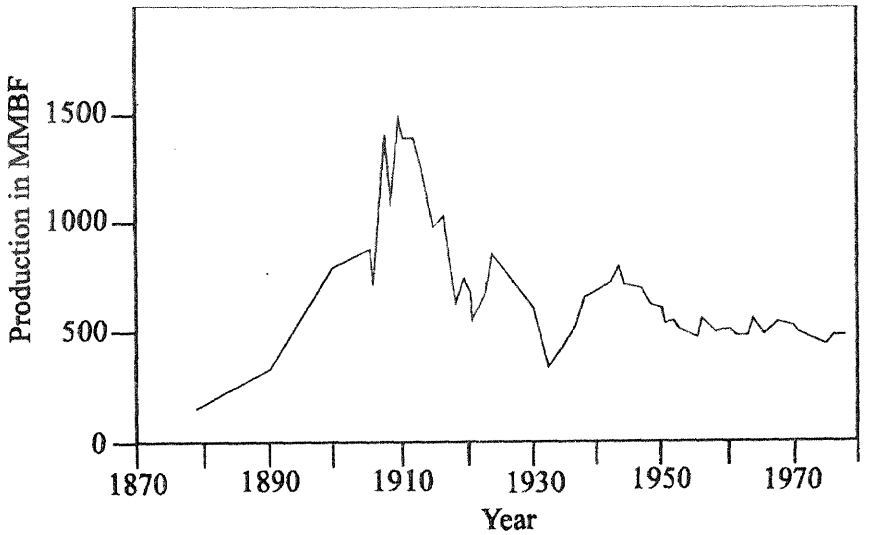


Figure 5. West Virginia lumber production from Zinn and Jones (1984).

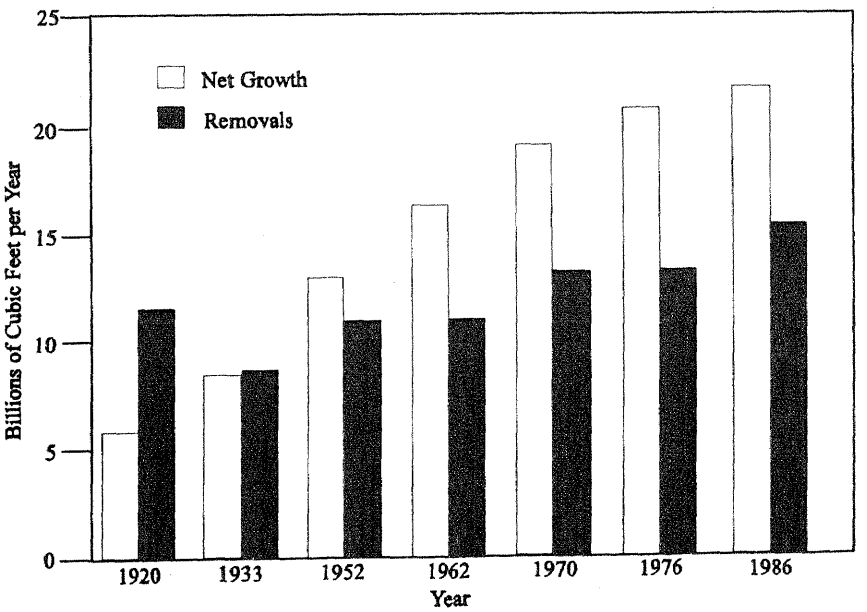


Figure 6. Timber growth/removals from MacCleery (1992).

The history of the North American logging boom is the subject of several books (Blackhurst 1954, Brown 1923, Clarkson 1964, Fries 1951), and like similar events, such as the California Gold Rush, the timber boom is surrounded by a certain amount of folklore as well as fact. But, in any event, it had a more dramatic effect on our present day central hardwood forest than any single event. Almost all the forests that had any merchantable value were cut over during that period. Only small pockets remained, such as found in the Joyce Kilmer Memorial Forest in North Carolina (Lorimer 1976). The use of steam engines for logging and steam donkeys for skidding exacerbated the effect in causing numerous fires which burned repeatedly through the logging slash and forest floor, exposing the mineral soil to erosion. Eller (1985) quotes Thomas Wolfe of Ashville, North Carolina, as follows: "The great mountain slopes and forest had been ruinously detimbered; the farm-soil on the hillsides had eroded and washed down; high up, upon the hills one saw raw scars of old mica pits, the dump heaps of deserted mines. . . . It was evident that a huge compulsive greed had been at work." Boom towns, such as Davis and Spruce, West Virginia; Tellico Plains and Gatlinburg, Tennessee; and Fontana, North Carolina, developed rapidly; some are completely gone today, and others turned to other industry or tourism to survive. But in spite of the apparent devastation, the forests of the central hardwood region started to regrow, resulting from natural regeneration (stored seed, seed distributed by wind or animals, seedling sprouts or stump sprouts). This period of recovery is the focus of the following section.

THE REGROWING FOREST, 1930-1996

Well before 1930, several persons in positions of leadership in American forestry had expressed grave concern about the state of the forest in North America. Gifford Pinchot, generally regarded as the father of American forestry, stated his opinion in Ahern's (1928) publication, as follows: "Forest fires are steadily growing worse in America, and fire prevention is absolutely indispensable. But the axe, carelessly used is the mother of forest fires. The axe and not fire is our greatest danger. Until the axe is controlled there can be no solution of the fire problem, or of the problem of forest devastation in America." Pinchot, who was a consummate politician, had been trained in forestry in Europe. His first job had been as a forester on the huge Vanderbilt estate near Asheville, North Carolina, in 1892 (later to become the site of the Biltmore Forest School), but his greatest accomplishments were in the political arena. He became a Washington political insider and the first Chief of the USDA, Forest Service. He was instrumental in establishment of the Yale School of Forestry and the Society of American Foresters. Pinchot's influence on the central hardwood forest came mostly through the establishment of the eastern National Forests. Earlier, Pinchot's influence on then President Theodore Roosevelt had resulted in substantial additions to the national forest reserve between 1905-1909. About 80 million acres of federal land in the western states had been set aside as forest reserves as Pinchot and others became increasingly concerned about overcutting in the East.

But the eastern lands had been purchased by private owners and were not so easily annexed by the federal government. The breakthrough came in 1911 with passage of the "Weeks Act" which authorized the federal government to purchase lands in eastern America. Initially, the purpose for acquiring the land was to protect headwaters of navigable streams. Lands which formed the nucleus of many of our current National Forests were purchased under the Weeks Act authority. Almost all the initial purchases were cut-over, and often burned-over, lands belonging to large corporate owners and were bought for prices of $2 to $4 per acre; hence, they were called "the lands that no one wanted."

In 1924, the Clarke-McNary Act added the production of timber to the mandate for National Forest lands. By 1930, the Great Depression was in full swing, and land prices, especially the cut-over forest lands, were extremely low, as corporate owners often viewed the land as a tax burden with no foreseeable harvest of timber in sight. For example, in 1933 a purchase of almost 330,000 acres for the Monongahela National Forest was made at an average cost of $3.43 per acre (USDA Forest Service 1970). From these beginnings, the eastern National Forests developed (Figure 7), many within the central hardwood region.

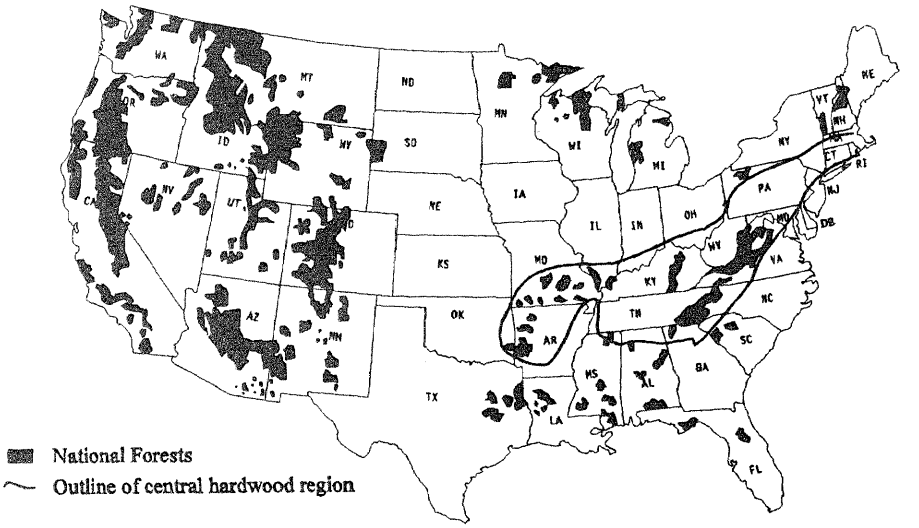


Figure 7. Distribution of National Forests.

The Weeks and Clark-McNary Acts, in addition to mandating the acquisition of land, also provided funding to states for fire control. The Forest Service also became the lead agency in promoting forest fire control at the federal level. The results came slowly at first, but by the 1960's, forest fires which consumed an average of 40-50 million acres in the 1930's were reduced to 2-5 million acres (USDA Forest Service 1987) (Figure 8). Although the central hardwood region is not as fire prone as conifer-dominated regions of the country, fire has always been a significant disturbance in the oak forests of the central hardwood region (Van Lear and Waldrop 1989). For example, in 1987 more than 50% of the land area in Mingo County, West Virginia burned over (Hicks and Mudrick 1993) (Figure 9).

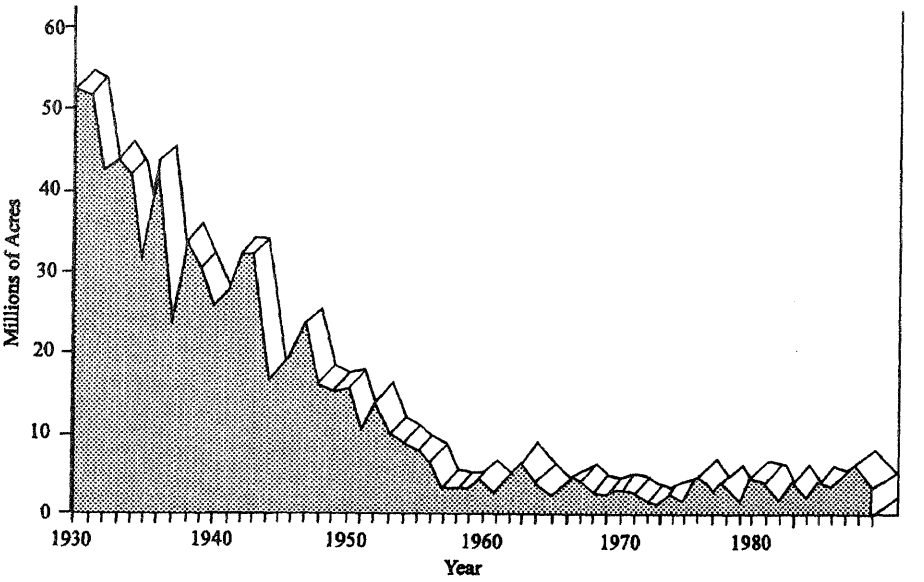


Figure 8. US wildfire trends, from MacCleery (1992).

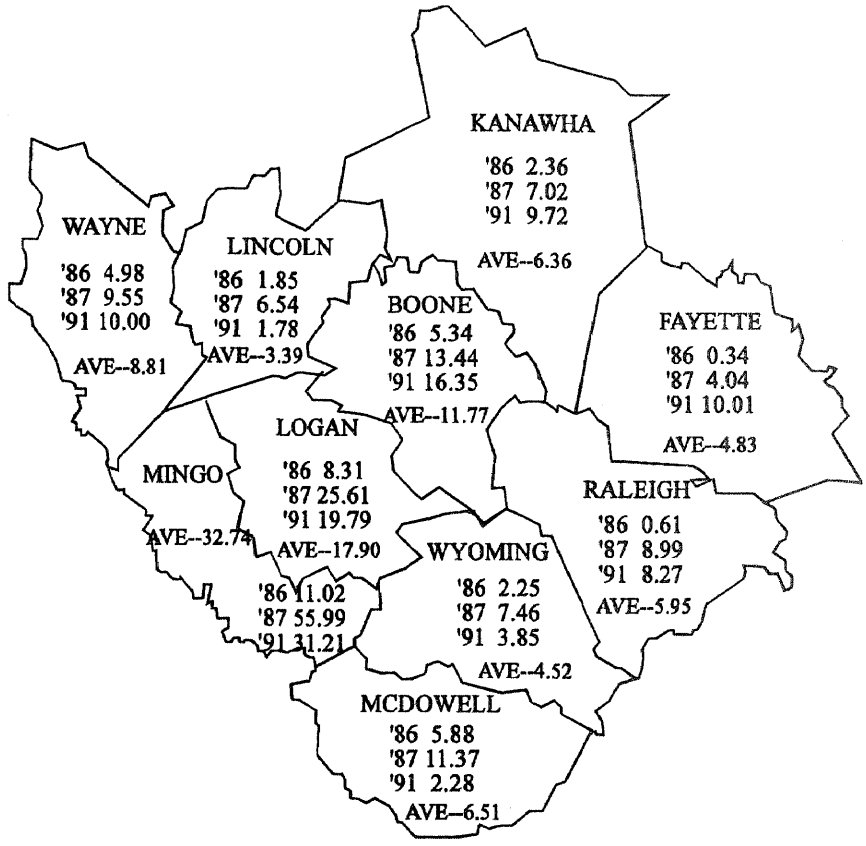


Figure 9. Percentage of West Virginia counties burned in 1986, 1987 and 1991.

In 1933, President Franklin D. Roosevelt signed the Civilian Conservation Corps bill into law. The CCC was part of Roosevelt's "New Deal," intended to solve two problems (unemployment and environmental destruction). It was estimated that nearly 250,000 young men who were of employment age, were out of work during the 1930's and Major Stuart, Chief of the USDA Forest Service, suggested that the army be used to build camps and generally administer the program. But unemployed civilians made up the work force. Many CCC camps were established within National Forests and their activities included planting of trees, fire control, watershed improvements, road improvement and construction of recreational facilities. Although their impact on today's central hardwood forests are largely undetectable, they planted millions of trees (mostly conifers) on denuded lands, and many of the recreational structures they built are still usable today, almost 60 years later.

The Depression drove more people from marginal farms, and the trend in reversion of farmland to forest continued through the 1930's. In 1942, the Depression ended with America's entry into World War II. The war accomplished what governmental programs could not by employing millions of Americans, either as soldiers or in the factories that manufactured war materials. The war put technological development into high gear, and many of the devices that have significantly affected our society were developed during this period. The post-war economy was booming when soldiers returned home, many to take factory jobs, marry and raise families. The impact of these developments on the central hardwood region was a shift in the lifestyle and objectives of land owners. Many people kept their residence in a rural setting while seeking employment in mills and factories elsewhere. The reason for owning land shifted away from utilitarian (production) objectives toward recreational/aesthetic enjoyment/ residential objectives (Birch and Kingsley 1978) (Figure 10).

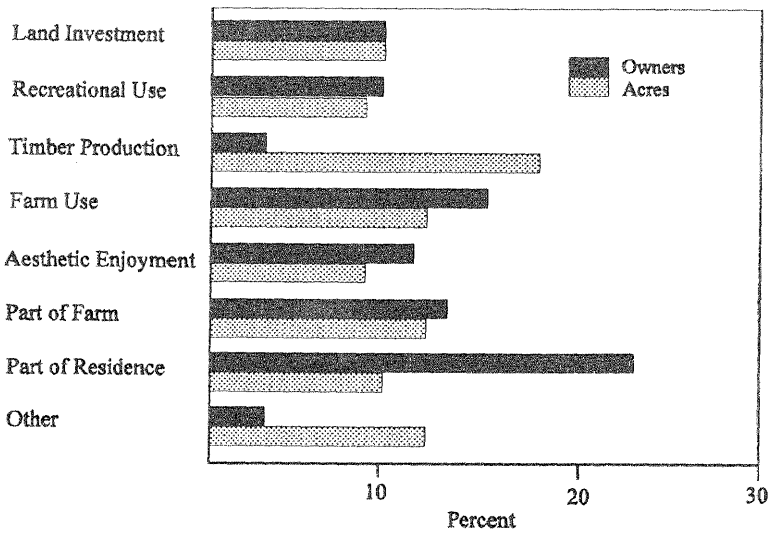


Figure 10. Reason for owning land in West Virginia (Birch and Kingsley 1978)

The changing land ownership characteristics have continued into the most recent decades throughout the central hardwood region. This is illustrated by the changes that occurred from 1957 to 1975 in West Virginia, a state that experienced little or no total population growth over that period. In 1957, the West Virginia Forest Industries Committee reported that there were 133,570 private owners of forestland, who owned over 8.9 million acres. The average size of ownership was 66.6 acres in 1957. By 1975, the number of owners had increased to 207,500 and the forestland acres had also increased to 10.3 million acres. But the average size of ownership had dropped to 49.8 acres (Birch and Kingsley 1978). Twenty percent of the land owners in 1975 were not from rural or farm backgrounds. Twenty-two percent of the land owners held their land primarily for aesthetic enjoyment or recreation, and another 23% owned the land primarily for their residence. Only 3% owned land primarily for timber production. Similar changes have taken place throughout the central hardwood region.

Alig (1990) reported the trends in forested land by states. If the 11 states that constitute the bulk of the central hardwood region are summarized (Table 3), the trend in total forestland is depicted in Figure 11. A decrease of about 2.5 percent in forestland is projected to occur by 2040, mostly due to urban expansion.

Table 3. Summary of forested lands by state in the central hardwood region

States	1952	1962	1970	1977	1987	2000	2010	2020	2030	2040
	(Millions Acres)					Projected				
NC	19.6	20.0	20.1	19.4	18.4	17.7	17.6	17.5	17.5	17.5
VA	15.5	15.7	15.9	15.9	15.4	15.0	15.0	15.0	15.0	15.0
AK	19.6	19.9	18.0	16.8	16.6	15.6	15.4	15.1	15.1	15.1
KY	11.5	11.6	11.8	11.9	11.9	12.1	12.2	12.3	12.5	12.5
TN	12.5	13.4	12.8	12.9	12.6	12.4	12.3	12.3	12.3	12.3
MD	2.9	2.8	2.7	2.5	2.5	2.4	2.3	2.2	2.1	2.1
MA	3.3	3.0	2.8	2.8	3.0	3.0	2.9	2.8	2.7	2.6
PA	14.6	16.3	16.1	15.9	16.2	16.3	16.3	16.0	16.0	15.8
WV	10.3	11.4	11.4	11.5	11.8	11.8	11.8	11.8	11.8	11.8
OH	5.4	6.0	6.4	6.9	7.1	7.3	7.3	7.1	7.0	7.0
MD	14.3	13.5	12.5	12.3	12.0	12.0	12.0	11.9	11.9	12.0
Total	129.5	133.6	130.5	128.8	127.5	125.6	125.1	124.0	123.9	123.7
Change (from 1987)	+2.0	+6.1	+3.0	+1.3	0	-1.9	-2.4	-3.5	-3.6	-3.8
Percent Change	+1.6%	+4.8%	+2.3%	+1.0%	0	-1.5%	-1.9%	-2.7%	-2.8%	-2.9%

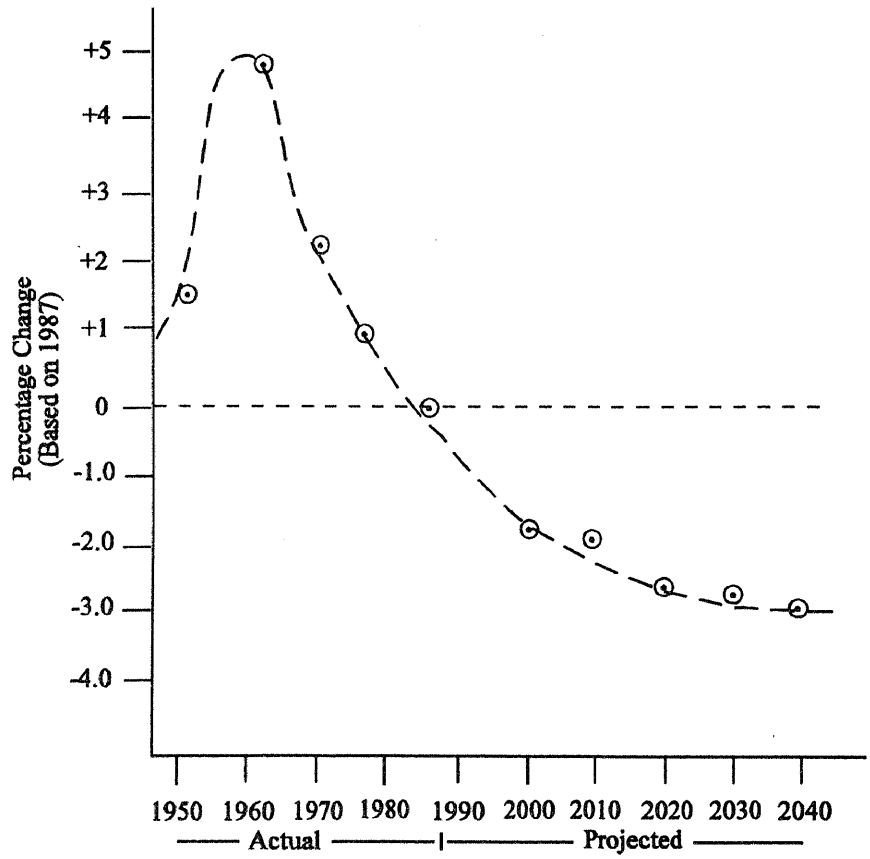


Figure 11. Change in forestland (actual and predicted) for 11 states with significant area within the central hardwood region (AR, KY, MA, MD, MO, NC, OH, PA, TN, VA WV), 1950-2040, from Alig (1990).

Agricultural policy continued to have an impact on forestry throughout the post-war period. The Conservation Reserve Program in the 1960's provided compensation to farmers to convert cropland to forest by planting trees. The Forest Incentives Program provide cost sharing to small private land owners for tree planting and other forest practices. The Stewardship Incentives Program of the 1990's provides federal cost sharing to small forest land owners to develop and carry out planned forest management. Some states have offered additional property tax incentives to land owners enrolled in the Stewardship Incentives Program. These programs are designed to promote good forest management among the many and varied small private land owners, a type of ownership that predominates in the central hardwood region. Technical support for forestry is provided to private land owners through state forestry agencies, Agriculture Extension Agents and the USDA Forest Service, State and Private Forestry. But in spite of this large effort, the level of participation among private forest land owners in the central hardwood region has generally lagged behind government expectations, partly due to the inherent independence of property owners, partly due to a lack of interest or economic incentives and partly due to an inability to inform land owners of the availability of such programs.

The withdrawal of forestland for agriculture leveled off in about 1933, but during the post-war decades, some decline in forest area has occurred. This has mostly resulted from development-related activities. One example is the interstate highway system which was developed during the 1960's and 1970's for the most part. Rights-of-way for gas transmission and electric power transmission also consume large corridors through the forest, and surface mining and urban development have taken up significant amounts of forestland. Topography and economic factors have resulted in the central hardwood region's being an area that is currently among the highest in the eastern United States for coverage with natural vegetation (Kolpatek and others 1979) (Figure 12).

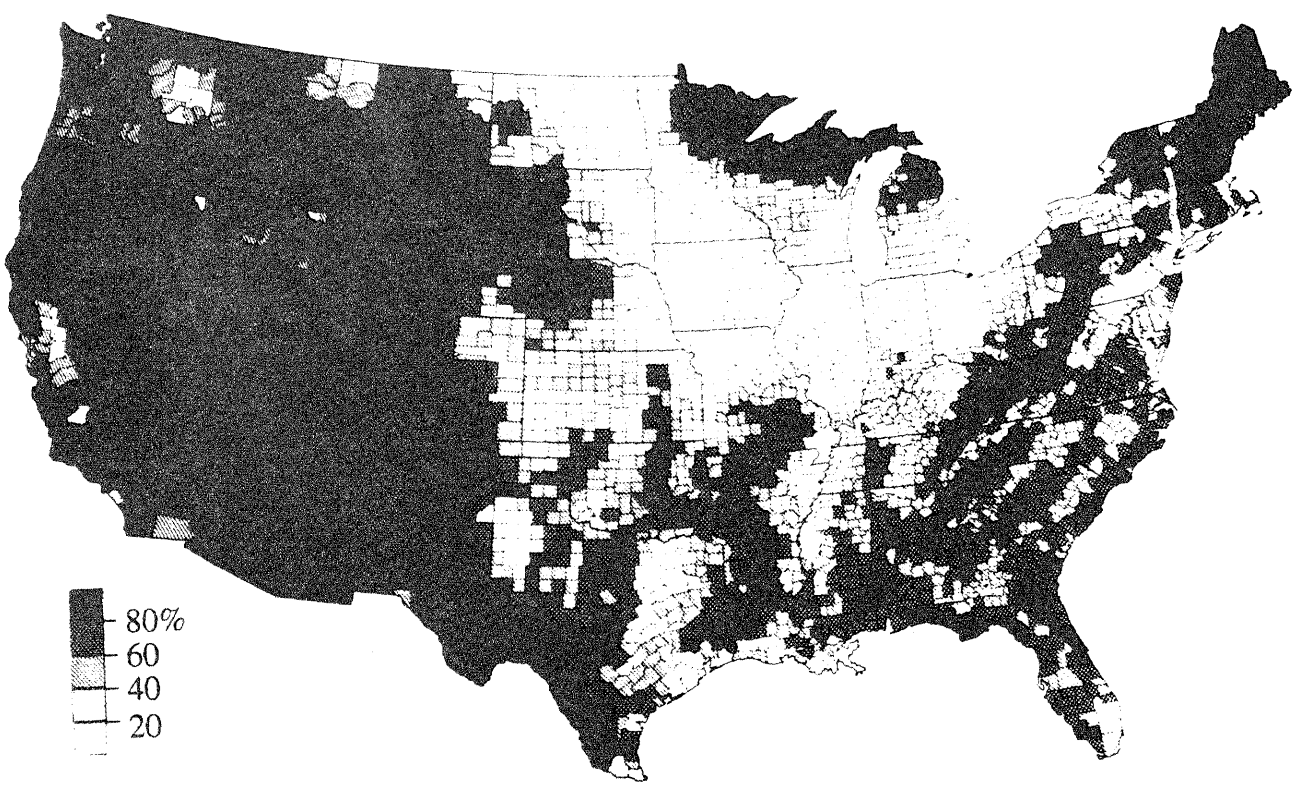


Figure 12. Coverage of natural vegetation by county in the US (Klopatek and others 1979).

Some of the most significant changes to the central hardwood forest in recent years have been brought about as a result of human introduction of insects and disease organisms. These changes are often not dramatic, but their impact is unquestionably large. The list of important introduced pests includes dogwood anthracnose, Dutch elm disease, oak wilt and beech bark disease. But the two with the most impact or potential impact on the central hardwood forest are **chestnut blight** and **gypsy moth**. The former is a disease that has effectively eliminated a species, which at one time was among the most widely distributed and economically important in the central hardwood region. The latter is an introduced insect that continues to spread southwestward through the central hardwood region and seems to have the potential to spread through the entire region over the next 50 to 75 years.

The **chestnut blight** fungus (*Cryphonectria parasitica*) was introduced to the New York Botanical Gardens in 1904 (Murrill 1904, Giddings 1912). By 1915 most states east of the Mississippi River reported infected trees. By the late 1930's, most mature chestnut trees were dead throughout the eastern states. The following should provide a frame of reference for the significance of American chestnut. Chestnuts were a source of food and commercial enterprise for mountain farmers. During the settlement period, log cabins were often constructed of chestnut logs due to their durability and decay resistance. Most split-fence rails and posts were constructed of chestnut where it was available. And due to its durability, chestnut lumber was widely used in construction of barns, sheds and even for the manufacture of furniture. The bark of chestnut was an important source of tannin for leather tanning factories.

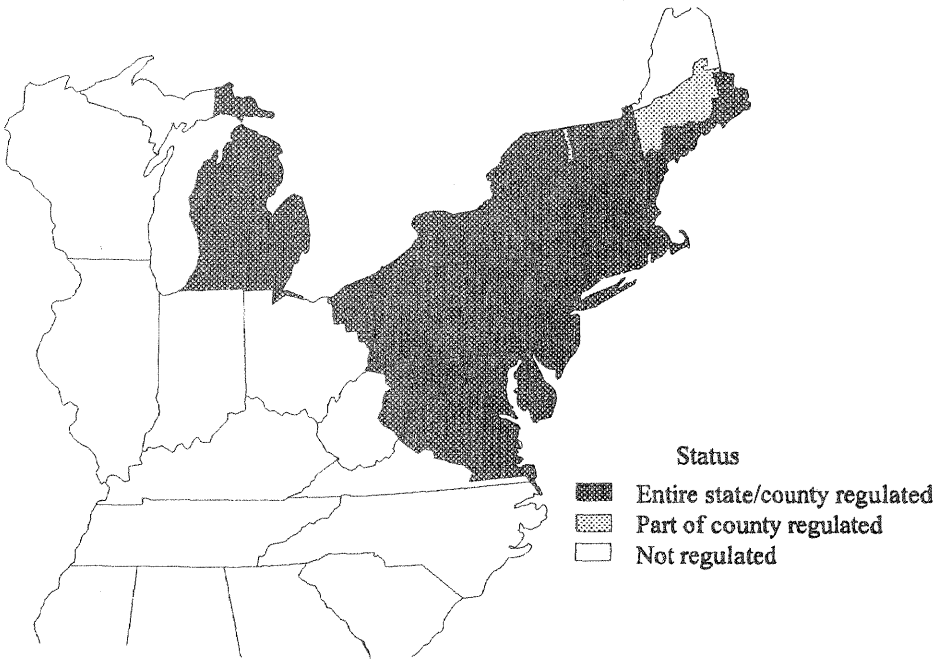
Chestnut also occupied an important position in the hardwood ecosystem. Braun (1950) used the name **oak-chestnut** to identify one of the most significant forest formations in the eastern deciduous forest. American chestnut was an important source of mast for a variety of wildlife species (animals and birds) most of which served as prey for larger predatory mammals. The impact of the loss of American chestnut can never be fully assessed. But Brooks (1915) indicated the following facts regarding chestnut in West Virginia alone. The annual harvest of chestnut in West Virginia in 1915 was 118 million board feet. The entire volume of chestnut in West Virginia was estimated to be 5 billion board feet. At a stumpage value of $8 per thousand board feet, in 1915, the entire chestnut inventory was estimated to be worth $55 million. At current stumpage prices for red oak that value would be about $1.5 billion. The only evidence remaining of the once important chestnut are occasional root sprouts, which usually survive to the sapling stage before being killed by the blight, and the grey remains of stumps of salvaged trees. Ironically, many of these stumps still have coatings of charcoal, evidence of the fires that burned over the area, probably after the chestnuts had already succumbed to the blight.

Gypsy moth (*Lymantria dispar*) is an introduced insect that potentially could have as great, or greater, impact on the central hardwoods than chestnut blight. Gypsy moth was inadvertently introduced into the Boston area in 1869 by Leopold Trouvelot (Liebhold 1989), who was interested in hybridizing the gypsy moth with native silkworms. The spread of gypsy moth has continued, and it is potentially capable of becoming established throughout the central hardwood region. Although gypsy moth can defoliate a variety of tree species, including conifers, deciduous species are their preferred hosts. Oaks are among the most preferred hosts of gypsy moth (Bess and others 1947, Gansner and Herrick 1987). Black cherry, hickory and maples are intermediate in preference while species, such as yellow-poplar and ashes, are virtually resistant. The significance of this to the central hardwood region is the fact that susceptible species make up the bulk of the forest composition throughout the region, the exception being yellow-poplar, especially in the mixed mesophytic forest.

Currently, gypsy moth has become established in, and is endemic to, an area stretching from Michigan to North Carolina (Figure 13). But isolated populations occur throughout the central hardwood region, having been spread by movement of vehicles, logs or other objects containing egg masses.

As a defoliator, gypsy moth's impact on the tree is to reduce its photosynthetic surface. The major defoliation occurs during the spring (May-June) which is a period of critical importance to deciduous trees since the soil moisture is generally high and the temperature is moderate during this time. Usually one defoliation is not lethal to trees, but a single defoliation during a drought year or multiple years of defoliation can lead to extensive tree mortality (Fosbroke and Hicks 1989). The factors that precipitate extensive gypsy moth outbreaks include presence of a suitable host plus climatic conditions that favor buildup. Since gypsy moth is situated in an oak-dominated region, the host is generally suitable, thus outbreaks can occur whenever weather triggers them. As can be seen in

Figure 14, cycles of outbreaks seem to occur about every 10 years. The outbreaks in recent years have been affecting more acres than in previous outbreaks, mostly due to the spread of gypsy moth to occupy a larger endemic range.



Map provided by the USDA Animal and Plant Health Inspection Service

Figure 13. Gypsy moth quarantine area as of 1996.

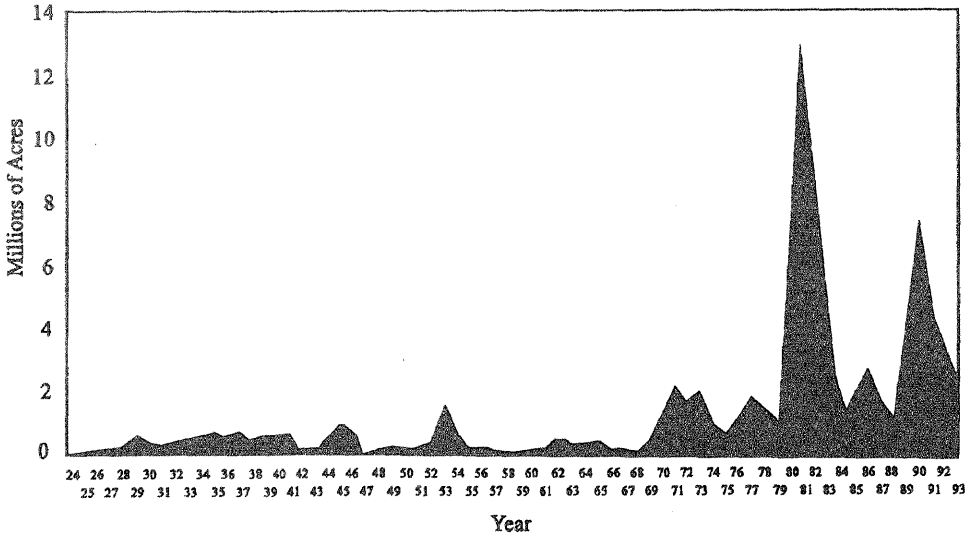


Figure 14. Outbreak history of gypsy moth in the Northeast.

The gypsy moth story is still unfolding, but its impact on the central hardwood forest has already been experienced throughout the portion of the region where it has spread. As reported by Gansner and Herrick (1987), oak experienced an average mortality rate of 24.2% between 1979 and 1984. Quimby (1987) reported a similar result where summer droughts plus gypsy moth defoliation in 1980-1983 resulted in the premature loss of 68 million trees in Pennsylvania, a mortality rate of 27.6%. Much of the mortality occurred in oak stands. Hicks and Fosbroke (1987) reported similar rates of tree mortality in southwestern Pennsylvania and western Maryland. The forest invaded by gypsy moth as it entered northeastern Pennsylvania has been dubbed "the new frontier" by Herrick and Gansner (1988), and essentially this new frontier represents the oak-dominated forest of the central hardwood region. The reduction in oak stocking that has occurred in the part of the central hardwood forest where gypsy moth has become established will most likely represent what can happen throughout the entire region.

Another episode in recent history that has had a significant impact on the central hardwood forest is the decline and later reestablishment of **wildlife populations** across the region. In addition to white-tailed deer, elk, and bison were found extensively throughout the region prior to European settlement. Those species were, in part, hunted into extinction but mostly were displaced due to habitat destruction by land clearing for farming. Farmers also eradicated predator species, such as eastern mountain lion, eastern timber wolf and black bear, since these predators were a threat to their livestock. By 1910, bison, elk, mountain lion, and wolf had been eradicated from the central hardwood forest, and white-tailed deer and black bear were found only in small isolated populations in remote and mountainous regions.

Wildlife advocates and hunters pushed for, and obtained, stricter hunting regulations, such as seasonal hunting, bag limits and bucks-only hunting. The results for white-tailed deer have been remarkable. In the absence of natural predators, and with the second-growth hardwood forest providing prime habitat, the deer herd has risen sharply throughout the central hardwood region. In fact, deer have generally become a serious problem to forest regeneration in many areas. Deer consume 1-1.5 kg of vegetation daily, consisting of twigs, acorns and some grass and herbs (Smith 1993). Deer are selective and prefer seedlings of oaks and maples to those of black cherry (Marquis 1981). Overbrowsing by deer can result in development of a fern-dominated understory where tree seedlings have a difficult time getting established due to competition and allelopathy (plant toxins). Thus, the long-term effect of deer on the forest may be to retard the process of regeneration, selectively change the species composition and reduce the overall diversity of species.

The modern chapter in forest history also includes a marked change in the **social context** of forest resources. This has been brought about by a combination of factors including the changing demographics in America, where people today are physically removed from the land. But other factors have come into play. For example, abusive and exploitive land uses, such as exploitive timbering, unregulated mineral extraction, air and water pollution, and uncontrolled development are all sources of public concern. The environmental movement began to take shape as a cultural phenomenon during the late 1960's. Rachel Carson's book, *Silent Spring*, did for environmentalism what Harriett Beecher Stowe's *Uncle Tom's Cabin* did for the emancipation movement. Against a backdrop of Kennedy altruism and polarizing issues, such as the cold war, racism and a budding Viet Nam conflict, it seems, in retrospect, inevitable that the environmental movement, led by altruistic urban youth, should flourish. Most foresters, at that time, were from rural backgrounds and had come through their forestry training with a paternalistic approach toward resource management, being one in which the forester is regarded as the trained professional, and should be trusted to make the appropriate decisions regarding management of the resource. Thus, the elements of conflict were in place. The political arena became the venue for the struggle. Environmental activist groups gained strength. The **Wilderness Act** of 1964 represented a milestone in environmental policy legislation whereby areas in the National Forests could be set aside for "wilderness," and timber cutting in these areas would be prohibited (Dana and Fairfax 1980). Controversy over the use of clearcutting on public land resulted in the landmark **Monongahela Decision** of 1970 that recommended uneven-age management as a primary management policy for the Monongahela National Forest in West Virginia. This decision was more significant as a precedent than it was to the Monongahela National Forest. In effect, it imposed the will of the public over that of foresters, who had always been regarded as the experts in forest resource management.

The issue of the 90's seems to revolve around regulation of private land. The so-called "spotted owl" controversy in the Pacific Northwest has set the tone. The perceived situation was one in which an endangered organism's habitat (old-growth forest) was not limited to a single land owner but extended to private land as well as public land.

The debate extending to small non-industrial private forest (NIPF) owners has progressed from the passage of regulations requiring the use of "best management practices" for logging to a more comprehensive and controversial debate over whether or not land use should be controlled at the **landscape level**. If such control is needed to facilitate what is called **ecosystem management**, how can it work in areas, such as the central hardwood region, where over 75% of the land is owned by NIPF owners? Proposed solutions include a combination of government educational and assistance programs plus incentive programs (Campbell and Kittredge 1996). The use of legislative regulation to achieve the goals of ecosystem management is a controversial approach (Argow 1996) and one that evokes strong emotions. The fear among private owners—that they will lose prerogatives to use their land—is not unfounded. Examples abound where the "general good" of the public has taken precedence over the desires of the individual.

On the other side of the issue are those representing private land owners (Farm Bureau, National Woodland Owners Association, etc.) who contend that the loss of management options to a private land owner due to regulation constitutes a "taking" under the Fifth Amendment of the Constitution, for which the owner is entitled to be compensated. As these debates continue, the outcomes will most certainly affect the way forests can be, and will be, managed and exploited in the central hardwood region in the years to come.

In summary, the history of the central hardwood forests is one that is based on the actions and interactions of climatic and biological factors, and, in more recent times it has been strongly affected by humans and their actions (Table 1). Going back to the retreat of the last glaciers (12,000-14,000 years ago) and the climatic warming trend that has followed, the deciduous forests found an ideal environment and flourished in the central hardwood region. Indigenous people used fire and cultivated land, and their activities peaked about the time European settlement began. The forest regrew for about 200 years, and then clearing for subsistence farming began in ernest. This proceeded until about the time of the Civil War and the onset of the industrial revolution. This period marked the beginning of a shift in agriculture to more level land, and abandoned hill lands in the central hardwood region began to regrow into forest. A period of exploitive logging around the turn of the 20th century has been followed by a regrowing forest. Forest land owners and the public have changed in their attitudes concerning forest resources in recent times. Now with many hardwood stands in the central hardwood region approaching 100 years of age, the resource is maturing. Many forces are mustering for a piece of the action. Developers, speculators, industries, agencies, advocacy groups and environmentalists are all becoming aware of this unique and diverse forest. Our actions today will be the history of the future, and foresters should be prepared to participate in, and hopefully guide, the decision-making process at this important crossroad in the central hardwood regions development.

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