

## Impact of Market-Based Disturbance on the Composition of West Virginia's Forest Resource

by

William G. Luppold and John E. Baumgras<sup>1</sup>

### Abstract

The eastern hardwood resource has been shaped by a combination of human and natural disturbances. This impact on the forest resources of West Virginia has been especially dramatic. This resource has changed from a virgin forest dominated white oak, chestnut, spruce, white pine, and hemlock in the late 19th century, to one dominated by red oak in the 1950's, to today's forest with rapidly increasing volumes of yellow-poplar. This paper examines changes in the composition of West Virginia's forests based on the concept of market-based disturbance. This concept assumes that past market activities influence future forest composition, that changes in resource composition can influence near-term derived and consumer demands, and that these changes in demand eventually change forest composition. Of specific interest is how market disturbance has influenced the proportion of red oak, white oak, yellow-poplar, and hard maple in the forests of West Virginia. This paper also examines how the market for timber has adjusted to a-changing forest resource and how market-based disturbance may shape future forests.

### INTRODUCTION

The eastern hardwood resource has been shaped by human and natural disturbances. Early human disturbance of the eastern forests included land clearing for agriculture; temporary Native American villages and towns; and selective timber harvesting for the construction of dwelling and ships, furniture, and cooperage. As the U.S. population and market economy expanded during the last half of the 19th century, greater volumes of timber were cut for lumber (Steer 1948). Harvesting in the eastern United States peaked in the early 20th century. Forests in West Virginia at higher elevations were one of the few areas that remained undisturbed.

As late as 1870 more than 60 percent of West Virginia's forests (10 million acres) were in a truly virgin state containing chestnut trees that were more than 10 feet in diameter and white oak more than 100 feet tall with diameters of over 6 feet (Carvell 1986). There also was nearly one-half million acres of spruce forests that yielded as much as 80 to 100 thousand board feet per acre (Carvell 1986). However, by 1910 only 1-1/2 million acres remained and by 1920 only a few isolated areas of virgin forest remained (Carvell 1986). Only a small portion of the forest resource was regenerating on lands cut before 1870. As late as 1949 West Virginia's forest contained only 17.5 billion board feet of sawtimber. Still, the resiliency of this resource was evident by 1989 as the states sawtimber volume swelled to 57.8 billion board feet. However,

the forests of West Virginia differ considerably with respect to species composition from 1900 to 1989 as the result of market induced and natural disturbances. .

In this paper we examine the biological history of West Virginia's forest resource using the concept of market-based disturbance. We also explain how and why market disturbance occurred, how this and natural disturbances shaped the state's current forest, how the market for timber has adjusted to a changing forest resource, and how market-based disturbance may shape future forests.

### MARKET-BASED DISTURBANCE

The concept of market-based disturbance is based on three premises: 1) that market activities in period i influenced forest composition in much later period j; 2) that forest composition in period j influence near-term derived and consumer demands for forest products at the harvesting, primary, and secondary market levels; 3) that future forest composition will be affected by current derived demands. The second premise is based on the assumption that market forces cause the forest resource to be exploited in an - economically efficient manner subject to regulations designed to conserve ecological services

The term "market activities" includes harvest intensity, species selection, harvest method, and efforts designed to reduce environmental impacts. Of

<sup>1</sup>The authors are, Project Leaders, USDA Forest Service, Northeastern Res. Stn., 241 Mercer Springs Road, Princeton, WV 24740.

these, harvest intensity and species selection have the greatest influence on future forest composition. We use the term "influencing" rather than "determines" because the interaction of market and natural forces ultimately determines forest composition.

Harvesting intensity ranges from single-tree selection to clearcutting and is influenced by factors such as stand composition, the expectations of the land owner, topography, and technology. Species selection can be active e.g., harvesting specific species, or passive e.g., cutting one species to gain access to another, or even ignoring a particular species: The market ultimately influences species selection through log prices, lumber prices, procurement costs, and transformation costs; though cost relationships are affected by derived demands. These demands in turn can be affected by technological efforts to exploit biologically abundant species. Consumer demand can be affected by the abundance of a certain species when this abundance causes a low enough price for the species to be initially accepted. The assumption that market forces eventually develop technology and consumer preferences that exploit an abundant biological resource results in the seemingly contradictory notion that current biological abundance can result in long-term economic scarcity.

#### **HUMAN AND MARKET DISTURBANCES BEFORE 1949**

Carvell (1986) describes the three periods of human impact on West Virginia's forest: the era of land clearing, the era of light selective cutting, and the era of heavy cutting. The period of land clearing was the least documented of these eras as Native Americans and early farmers left few permanent structures and tended to abandon land when crop yields declined. These small clearings tended to regenerate quickly with desirable species. According to Carvell, the best old growth stands in the state are growing on farm lands from 1850 to 1900 (Carvell 1986).

The era of selective cutting also had minimal impact on the forest as only large diameter trees of specific species were cut. This timber usually was sawn into lumber by small steam or water propelled circle sawmills, hand hued, or whip (pit) sawn. During this period, white oak was cut extensively for the production of tight cooperage for barrels (Carvell 1986).

The era of heavy cutting began in the early 1880's with the construction of large band sawmills and the development of locomotives capable of climbing

steep terrain (Clarkson 1964). A few large mills apparently existed before this period but were supplied with timber close to river banks (Clarkson 1964). Once the Shay and later the Climax and Heisler locomotives were put into operation, the virgin forests of West Virginia were fully accessible. Timber was cut for lumber, pulp, tannin (hemlock bark), railroad construction material, kindling, and charcoal (Clarkson 1964). Vast amounts of timber were left as slash or used on skid trails and flumes to transport desirable logs. Thus, the 1.5 billion board feet of lumber produced in West Virginia during the peak year of 1905 represents only a fraction of the total volume of timber cut.

The tremendous volumes of slash and other debris left in the forests during the era of heavy cutting often resulted in massive forest fires. The role of fire in the development of the hardwood forest remains unclear due to numerous other factors affecting hardwood forest developments including low deer populations, drought, chestnut blight, and earlier overcutting of white oak for cooperage. As the result of these factors, northern red oak became the dominant component of West Virginia's emerging and remaining forests. Ironically, red oak was considered an unmerchantable species during the first half of the 20th century (Carvell 1986).

#### **MARKET-BASED DISTURBANCE FROM 1949 TO 1974**

The first inventory of the West Virginia forests was conducted nearly 30 years after the era of heavy cutting had ended. By this time, most of the giant band mills had closed but smaller mills used the remaining residual timber and timber that emerged from farms that were abandoned in the 19th century. Much of the forest also was regenerating on land cut over during the era of heavy cutting and on abandoned farmland. Growing-stock growth was exceeding removals by a ratio of 2.36 to 1 while sawtimber growth was exceeding removals by a ratio of 1.5 to 1 indicating a young, rapidly growing forest (Wray 1952) (see Table I). The total sawtimber volume of 17.5 billion board feet in 1949 was roughly equivalent to the volume of lumber produced between 1901 and 1916. By 1974, sawtimber and growing stock volumes had more than doubled. However, the composition of this forest differed greatly from the previous forest.

The area classified as spruce forest declined from one-half million acres prior to the era of heavy cutting to slightly more than 100,000 acres in 1949 (Clarkson 1964, Wray 1952). White oak had been totally

removed from many mountain areas (Carvell 1986). The 1949 survey report included perhaps the most revealing statement on how the forest had changed: "The oak types are the most extensive; they occupy half the forest land. The red oak type alone takes up nearly one-third of the forested area. This type occupies nearly every kind of site from cool, moist bottomland to dry southern slopes. Many of the red oak stands are red only because the more desirable species such as white oak, yellow-poplar, and basswood have been removed." (Wray 1952).

In 1949, select red oak accounted for nearly 20 percent of the sawtimber inventory in West Virginia (Table 2). The quality of this timber probably was quite high given that 40 percent of all red oaks had butt logs of grade 1 or 2 (Wray 1952). However, there were few buyers of high-grade red oak lumber. The two markets that existed for red oak lumber, railroad crossties and strip flooring, did not require high-grade material. In 1955, nearly 1.5 million board feet of flooring was produced (U.S. Department of Commerce 1963). Later, carpet began to displace oak as a floor covering and crosstie production also began to decline, though a rapidly developing pallet industry soon consumed large quantities of lower grade red oak. Although there were large markets for lower grade red oak lumber, prices of mid and higher-grade red oak lumber lagged behind other species (Table 3). Midgrade lumber prices in the 1950's and 1960's reflect the fact that the wood furniture industry used little oak; when oak was used it was normally white oak (Frye 1996). During this period formal and contemporary styles were popular and were commonly constructed with walnut, mahogany, or cherry veneers and stained yellow-poplar or maple lumber. The core stock for the veneer portions of furniture usually was yellow-poplar heartwood.

The dominance of the formal look in furniture is reflected in the annualized removal estimates before 1975. Yellow-poplar was the most cut species during this period (Bones 1978, Ferguson 1964), especially between 1949 and 1960. Red and white oaks also were being cut at high volumes but the reporting of these volumes in the 1964 survey did not distinguish between select and other oaks (Bones. 1978). Hickory and beech were cut in relatively high volumes and had growth removal ratios of less than 1 between 1960 and 1974. Many

furniture manufacturers used hickory to produce formal furniture with a walnut appearance. The relatively low price of this species is the result of low yields of dimension due to natural variations (character marks) in hickory.

The relatively abundant supply of select red oak timber was most apparent during the 1960 and 1974 surveys. Select red oak was the only major species in West Virginia with an annualized growth to removal ratio (G/R ratio) of greater than 2 (Bones 1978). The G/R ratio for red oak was 10 percent higher than that for yellow-poplar even though sawtimber volumes of the latter species were growing nearly 30 percent faster due to ingrowth (Bones 1978).

#### **MARKET-BASED DISTURBANCE FROM 1975 TO 1989**

The early 1970's was an extremely volatile period in the hardwood lumber market as wage and price controls restricted supplies. Also, the Japanese demand for hard maple for bowling alley construction caused domestic manufacturers to consider an alternate species. Exports of bard wood lumber began to increase as the dollar was allowed to float in international currency markets. However, the greatest change resulted from the increased use of red oak by furniture manufacturers.

The price of No.1 Common (most utilized grade for furniture) white and red oak doubled between 1972 and 1974 before dropping by more than 20 percent in 1975 (Hardwood Market Report 1998). In 1974, oak price exceeded maple price and equaled the price of yellow-poplar. During the 1980's, red oak became the dominant appearance lumber in the domestic market while white oak became the most important species exported. The hardwood lumber industry attributes the increased use of red oak in furniture production to promotional efforts by industry beginning in the mid-1950's. Another factor that contributed to the increased use of red oak was a growing population of young furniture buyers desiring less formal designs. However, the authors believe that the relatively low initial price of oak furniture facilitated a change in consumer preference for this species.

Although the increased use of hardwood lumber in general and increased demand for red oak was the

TABLE 1.-- Sawtimber and growing-stock volumes for hardwood and softwood timber in West Virginia 1949, 1961,1974, and 1989 (Bones 1978, DiGiovanni 1990, Ferguson 1964, Wray 1952).

Timber type	1949	1961	1974	1989
Hardwood sawtimber (million board feet)	16,077	27,183	33,600	53,959
Softwood sawtimber (million board feet)	1,471	1,596	2,521	3,802
Total sawtimber (million board feet)	17,548	28,779	36,121	57,761
Hardwood growing stock (million cubic feet)	5,665	10,495	12,909	17,822
Softwood growing stock (million cubic feet)	509	566	993	1,219
Total growing stock (million cubic feet)	6,174	11,061	13,902	19,041

TABLE 2.--Percentage of hardwood sawtimber volumes by species in West Virginia in 1949, 1961,1974, and 1989. (Bones 1978, DiGiovanni 1990, Ferguson 1964, Wray 1952).

Species group	1949	1961	1974	1989
Select white oak <sup>1</sup>	6.5	8.4	8.2	9.1
Select red oak <sup>2</sup>	19.5	12.2	10.9	10.2
Other white oak <sup>3</sup>	8.5	10.5	9.2	8.6
Other red oak <sup>4</sup>	8.5	12.5	11.4	9.7
Hard maple	6.9	4.9	4.3	4.7
Soft maple	2.7	3.3	4.0	5.5
Beech	9.1	6.7	6.6	5.1
Hickory	5.7	8.1	5.5	5.4
Yellow-poplar	6.6	9.7	15.6	18.2

<sup>1/</sup> Includes white, swamp white, bur, swamp chestnut, and chinkapin oaks.

<sup>2/</sup> Includes northern red, Shumard, and cherrybark oaks.

<sup>3/</sup> Includes chestnut, overcup, and post oaks.

<sup>4/</sup> Includes black, scarlet, northern/pin, southern red, bear, shingle, lurel, blackjack, water, pin, and willow oaks.

TABLE 3.--Price of No.1 Common hardwood Appalachian lumber for selected species 1953, 1961, 1974, 1989, and 1994. (Hardwood Market Report 1998).

Species group	1953	1961	1975	1989	1994
	-----dollars-----				
White oak	125	110	225	465	535
Red oak	120	105	225	535	780
Hard maple	125	160	240	380	750
Soft maple	115	150	270	350	600
Beech	110	120	200	255	355
Hickory	78	82	235	320	385
Yellow-poplar	135	130	220	290	425

hallmark of the 1980's, the impact of this increase is difficult to see in the 1989 inventory as this was a period of tremendous resource ingrowth and accretion. Also, average removal ratios for red oak indicate that demand for this species was considerably greater at the end of the survey period than at the beginning~ Between 1975 and 1989, average annual removals of select red oak were 67 million board feet per year (DiGiovanni 1990), though the 1987 Timber Product Output (TPO) report estimated 129 million board feet produced (Widmann and Murriner 1990). Still, the hardwood market was influencing the forest resource by reducing the relative demand for yellow-poplar during a period when the poplar resource was growing twice as fast as the select red oak resource. During this period the G/R ratio for yellow-poplar was 6.9 versus 3.1 for select red oak (DiGiovanni 1990).

The relatively weak market for both hard and soft maple was another factor that was influencing the West Virginia resource: There was little demand for maple from the late 1970's to the mid-1 980's. At the High Point, North Carolina furniture market displays of maple furniture declined from a high of 20 percent in 1966 to a low of 2.5 percent in 1986 (Frye 1996). From 1975 to 1989 this lack of demand for maple resulted in a G/R of 6.5 for hard maple and 5.6 for soft maple. The proportion of the resource base in maple increased from 8.3 to 10.2 percent during this period (DiGiovanni 1990).

#### **MARKET-BASED DISTURBANCE SINCE 1989**

The rapid growth of West Virginia's second-growth hardwood resource in the 1970's and 1980's was noticed by industry by the early 1990's. The first major change was a rapid increase in sawlog production. The TPO reports indicate that hardwood sawlog production totaled 470 million board feet in 1965 (Bones and Glover 1977) and 550 million board feet in 1987 (Widmann and Murriner 1990). Since 1987, the size of existing sawmills has increased and new sawmills have been built causing sawlog production to increase more than 40 percent to 794 million board feet by 1994 (Widmann and Wharton 1998).

The 1994 TPO report also indicates a continual strong demand for the oaks, particularly northern red oak. As a group, the oaks accounted for 38 percent of the sawtimber resource base in 1989 (DiGiovanni 1990) but 53 percent of sawlog production in 1994

(Widmann and Wharton 1998). Northern red oak accounted for 10 percent of the resource and 22 percent of the production. The production of yellow-poplar and maple sawlogs also increased between 1987 and 1994 but at levels closer to their proportion of the resource base.

The 1994 TPO study coincided with the year that prices for higher grade red oak lumber reached all-time high. The price of lower grade red oak also increased in 1994 reaching a record high in 1998 as wood flooring production continued to increase.

The impact of the continual strong demand for red oak also seems to be reflected in G/R ratios developed from the partial survey of West Virginia in 1995. Although the information in this survey is not directly comparable to that of previous surveys because gross rather than net board foot volumes were reported and National Forest timber was excluded; the decline in the G/R ratio for red oak is disturbing (Table 4). However, the decline in these ratios for red oak is not surprising given the heavy cutting of this species combined with the inability of this species to regenerate on the better sites over the last 50 years. Although the oaks remain an important species in furniture production, formal style furniture made from cherry, maple, and other closed-grained lumber has been increasingly shown at the furniture markets in the late 1990's (Frye 1997). In October 1998, the price of No. 1 Common hard maple exceeded comparable prices of red oak lumber by 10 to 17.percent depending on color (Hardwood Market Report 1998). The demand for and price of birch also have increased with the resurgence of styles that use closed-grained lumber.

Since 1994 there also has been a large increase in roundwood production in West Virginia to supply two oriented strand board (OSB) plants with a combined consumption capacity of 625,000 cords per year. These plants were built in response to reduced National Forest sales of western softwood timber and ample supplies of fast growing yellow-poplar timber. Although yellow-poplar is the primary species consumed by these plants, other low-density and some high-density hardwood species also are used. The roundwood used by these plants are poletimber and the upper logs of larger diameter trees. However, some foresters are concerned that these plants will consume growing-stock trees and small sawtimber trees before they mature to larger sizes, thus reducing future supplies of sawtimber.

TABLE 4-- Ratios of net annual growth divided by net annual removals for net board-foot volume of specific species in West Virginia for the 1975-89 survey cycle (DiGiovanni 1990) and the net annual growth divided by net annual removal of gross board- foot volume for the 1989-95 partial survey (Murriner 1995)

Species groups	1979-89 survey	1989-95 survey
Select white oak	4.35	1.26
Select red oak	3.01	0.74
Other white oak	4.68	1.12
Other red oak	2.42	0.80

### SUMMARY AND CONCLUSIONS

The forests of West Virginia have undergone substantial change over the last 120 years. What was once vast virgin wilderness became denuded hillsides but rebounded to become one of the world's largest hardwood forest resources. Yet, this resource continues to change with respect to species distribution. Thirty years after the era of heavy cutting, northern red oak was the predominant species, accounting for nearly 20 percent of the volume. Since that time, the proportional volume of northern red oak has declined as the volume of yellow-poplar has increased. Other species such as hard maple and beech experienced a proportional decline during the 1950's due to strong demand by furniture manufacturers.

The current market for all hardwood species and resulting cutting levels may begin to erase the gains in sawtimber volumes achieved since the era of heavy cutting. The rotation for yellow-poplar could shorten as increasing volumes of small-diameter growing stock is consumed by OSB and other engineered wood-product plants. We will begin to learn the extent and effects of current harvesting levels when the 1999 West Virginia inventory is completed. There already is evidence that the market has affected forest composition and that forest composition has affected the market. However, additional monitoring and analysis of the relationship between the market and the forest resource is-needed before we can begin to see if efforts to control, limit, or augment market-based disturbance are needed. We also must remember that forest composition is influenced by many other factors, so any analysis of market-based disturbance must incorporate biological, silvicultural, and climatological factors.

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