THE U.S. HARDWOOD SITUATION RELATED TO EXPORTS

Philip A. Araman
Project Leader - Hardwood Research

John B. Tansey
Supervisory Forester - Inventory and Analysis

[Abstract] The U.S. grows more hardwood timber each year than is being used for domestic and export markets. However, we do have some problems. In this presentation, the authors present a quick look at our hardwood resource situation (species, quality, availability). We show describe where the timber is growing for several species, talk about availability in the Southeast region, and suggest necessary cooperation by our export customers to help assure adequate supplies of hardwood products. Resources and exports by species are compared to make some necessary points.

The authors are with the USDA Forest Service, Southeastern Forest Experiment Station, Brooks Forest Products Center, Virginia Tech University, Blacksburg, VA 24061-0503 and P.O. Box 2680, Asheville, NC 28804

The United States has become a major player in the world marketplace for hardwood logs, lumber, and veneer. For the last 15 years, U.S. exports of these products have been growing, and the future looks bright. The major hardwood species demanded on the export market are the select red and white oaks, hard maple, black walnut, black cherry, the ashes, and yellow birch. The select oaks make up over 60 percent of U.S. hardwood lumber exports. The other select species make up nearly half of the remaining hardwood lumber exports.

Because U.S. hardwood exports are centered around this group of species and the domestic markets for these species are strong, several questions arise that need answers if purchasers are to be assured of continued adequate supplies of these species. For instance, if recent wood use trends continue, can the United States continue to supply the domestic and export markets? Can U.S. exports increase? Are U.S. resources being depleted? What is the hardwood resource situation in the United States? How much secondary-quality material will be produced in the future while generating the needed top-quality clear, or almost clear, export material? Furthermore, what is the availability of the U.S. sawtimber that shows up in our resource reports?

In this review of the hardwoods in the United States, information is provided to answer these question, or to allow opinions to be formed relating to the export market. We will also briefly discuss: (1) the ownership of our hardwood forests; (2) the location of these forest; (3) the timber sizes in our forests; (4) the most important species (addressing the above questions); and (5) export demands for hardwood lumber.

WHO OWNS THE FORESTS?

In the United States, 23 percent of the total land is considered timberland (Bones, 1987). This is land that is capable or is producing crops of commercial timber. Hardwoods timber is predominant on 52 percent of the timberland. Eastern forests which includes the Southern and the Northern regions contain most of the hardwood timber. Most of the hardwood timberland in the East is owned by farmers and other private ownership (75 percent). Public land ownership is almost 14 percent and forest industry controls 11.5 percent. Public ownership for all regions is almost 16 percent and forest industry owns over 11 percent of the U.S. timberland base.

WHERE IS THE HARDWOOD TIMBER?

Waddell et al. (1989) reported that in 1987 that the total volume of growing stock in the United States was 305 billion cubic feet. This included 797.7 billion board feet of sawtimber-size material (Table 1). The North and the South have almost equal amounts of growing stock material, but more of the Southern hardwood is in larger sawtimber sizes. The West has about 1/10 of the hardwood resources.

DISTRIBUTION OF TIMBER SIZES

The greatest percentage of hardwood is in the small diameter pulpwood and fuelwood sizes between 5 and 10.9 inches in diameter (Table 2, Waddell et al., 1989). The next timber size class (11-14.9 inches) contains small sawlogs which are primarily sawn into a combination of lumber and cants for pallet or mine material. Some are sawn directly into pallet or mine material. Many of these trees are bypassed during logging operations that concentrate on cutting larger diameter sawtimber. The largest sizes comprise 30 percent of our growing stock. These size trees are primarily harvested to produce sawlogs and veneer logs.

Table 1. Volume of hardwood growing stock and sawtimber on timberlands of the United States, by region, 1987 (Waddell et al., 1989)

Region	Growing Stock	Sawtimber
	(Billion Cubic Feet)	(Billion Board Feet) (Int 1/4" Rule)
North	141.1	338.5
South	134.2	377.0
West	29.7	82.2
All Regions	305.0	797.7

Table 2. Distribution of net hardwood growing stock voluime on timberland in the United States, by region and tree diameterf 1987 (Waddell et al., 1989)

Region	Tree Diameter (inches) 5-10.9	11-14.9	15+	Total
North	64.8	38.7	37.6	141.2
South	50.6	38.4	45.2	134.2
West	12.5	7.4	9.8	29.7
All Regions	127.9	84.5	92.6	305.0

THE MOST IMPORTANT SPECIES

The major hardwood species highly demanded on the domestic and export markets are the select red and white oaks, yellow birch, hard maple, black walnut, black cherry, and the ashes. We will refer to this group as the select species. The select oaks make up over 60 percent of U.S. hardwood lumber exports. The other select species make up nearly half of the remaining U.S. hardwood lumber exports. A complete paper on U.S. hardwood log, lumber, and veneer exports by species and major customers was reported by Araman (1988).

Because U.S. hardwood exports are centered around this group of species and the domestic market for these species is strong, several questions arise on continued adequate supplies. For instance, if recent wood use trends continue, can the United States continue to supply the export market? Can U.S. exports increase? Are U.S. select species resources being depleted? How much secondary-quality material could be produced in the future while generating the needed top-quality clear, or almost clear, export material? (The words quality and grade are synonymous in this paper.)

To answer these questions, we will take a look at the estimated 1987 sawtimber volumes by species, for the Northern, Southern and Western regions of the United States. Next, we will look at the log grade distribution in U.S. commercial sawtimber resources and translate these data into estimates of top-, secondary-, and lower-grade lumber output.

Hardwood Sawtimber Quantity

The base resource data is from U.S. Forest Service state resource evaluation surveys. Data was gathered on all major hardwood sawtimber including the group of select species (Waddell et al., 1989).

The results show that 28 percent, or 226 billion board feet (International 1/4-inch rule), of the 1987 estimated hardwood sawtimber inventories are in select sawtimber species (Table 3). Of that total, 60 percent are select oaks, 18 percent hard maple, 11 percent ashes, 2 percent walnut, 5 percent cherry, and 4 percent yellow birch. This review also reveals that the select species are increasing slightly faster than the average for all commercial hardwood sawtimber inventories. Hard maple, ash, walnut, cherry and oak resources are increasing much faster than the yellow birch inventories. Select oaks increases may be decreasing due to heavier demands of last few years. Furthermore, the annual inventory increases may start declining due to reported slower growth rates in hardwood growing stock.

On a regional basis, the 1987 estimates show that the South has 11 percent more commercial hardwood sawtimber than the North. However, when considering only the select species, the North has 89 percent more sawtimber than the South. The volume of select oak resources in the South is close to the North's, but the North has greater quantities of the other select species.

The United States has many additional species that should and will be more important in the future such as the gums, yellow poplar, soft maple, hickory, and cottonwood. There are sufficient quantities of these species to support increased harvests. All species show positive changes in sawtimber volumes from 1977-1987.

Hardwood Sawtimber Quality

Two grading systems are used to present information on the quality of the standing sawtimber hardwood resources in the Eastern United States. The first is a log grading system described by Rast et al. (1979). The system is used by U.S. Forest Service inventory analysts to define the quality of potential sawlogs in a standing tree. The top grade of logs include veneer logs. The second is a lumber grading system for hardwood lumber developed by the National Hardwood Lumber Association (1986 latest issue). In general, top grade FAS&Sel (Firsts-and-Seconds and Select) lumber goes to demanders of clear or almost clear lumber. Included are mouldings, millwork, export, and some other markets. Secondary-quality lumber, graded 1C (No. 1 Common) and 2C (No. 2 Common) goes to dimension, furniture, cabinet, flooring, and other manufacturers. Material in the below 2C grade area is used as sleepers (ties), and mine timbers, or for the production of pallet parts and flooring.

The base data used in this section to develop estimates of quality came from U.S. Forest Service state resource reports. By state, we gathered the sawtimber quality information for the select species. The state data were combined to generate the Eastern data shown in Table 4. Using yield tables developed by Hanks et al. (1980), the standing timber information was transformed into potential output of sawn lumber by lumber grade. The lumber grade results assumed the production of lumber from the distribution of logs found in the woods. in actual practice, many of the small diameter, low-grade logs and many other larger, low-grade logs never leave the forests. So, the quality of logs removed from the woods is actually better than our inventory tallies. This improves the distribution of sawn lumber produced over the numbers shown in Table 4. We will also restate that these are all estimates.

The Eastern results show that 15 percent of the select species are in log grade 1, 24 percent in log grade 2. The remaining 61 percent are in log grades 3 and 4. Overall sawtimber quality was similar for both regions. Potential output of sawn lumber by lumber grade for the Eastern United States is 12 percent in top grade (FAS&Sel), 50 percent in the 1C/2C grades, and 38 percent in the below 2C grades. The hard maple and yellow birch results are slightly lower. The combined ash, walnut, and cherry (based only on cherry yields) results are slightly hlgher than the overall percentages.

The markets for the llmlted top grade lumber (FAS&Sel) are the most profitable. On the other end, sawmillers are satisfied to cover their costs in the sale of below 2C material. Therefore, the 1C/2C lumber, which can account for about half of a sawmiller's total production, must have adequate and profitable outlets if the sawmiller's overall profit picture is to be positive.

SPECIES COMPARISONS FOR U.S. EXPORTS AND RESOURCES

Figure 1 shows a percentage comparison of hardwood lumber exports (Luppold and Hansen, 1990) and U.S. standing hardwood sawtimber by species (Waddell et al., 1989). We choose to focus on lumber exports, because of the dominance of this product. Log exports would show a different picture.

Select red and white oaks are by far the most highly demanded species on the lumber export market. They combine for over 60 percent of U.S. exports. Select red and white oaks however, only make up about 17 percent of our sawtimber resources. This total could increase to around 40 percent, if you could add the non-select oaks to the select total. In fact some of the "non-select" oaks are included in some export shipments. However this is an area that should be explored by oak users not needing the more rigid wood standards of the select oaks.

Ash, red alder, and black walnut are also in higher relative demand than what we have in our forests. Black cherry percent demand and potential supply are about the same.

Species that are underused based on demand and potential supply are yellow-poplar, hard maple, soft maple, beech, yellow birch, hickory, and a group called "other species." The "other Species" would include large quantities of sweetgum, tupelo and blackgum, cottonwood, and aspen.

WHAT ABOUT AVAILABILITY?

We will focus on the hardwood situation in the Southeast. Availability as you will see can be very dynamic based upon changes in technology, economics, and public opinion. We feel that the following look at availability must be seriously considered along with our forest survey results.

Timberland in the Southeastern United States supports an abundant hardwood sawtimber resource--189.7 billion board feet (International 1/4-inch Log Rule) regionwide (Table 5). All oak species collectively account for 42 percent of the total sawtimber inventory, while yellow-poplar alone makes up 15 percent. More than 42 percent of all hardwood sawtimber in the Southeast is found in the Atlantic Coastal Plain, 33 percent in the Piedmont Plateau, and 25 percent in the Blue Ridge Province.

From bottomland hardwood forests in the lower Atlantic Coastal Plain to upland coves in the Southern Blue Ridge (Mountains), the net annual growth of hardwood sawtimber exceeds that of annual removals, resulting in annual increases in hardwood sawtimber inventory. Even on dry chestnut oak slopes, annual change in hardwood sawtimber inventory is positive. In the Mountains, growth of hardwood sawtimber exceeds annual cut by more than 4 times (Table 6). Growth exceeds removals in this region for all species groups. In the Piedmont and Coastal Plain, the annual change is not as great, but growth does surpass removals in both regions, by 89- and 67 percent, respectively. In both of these regions, the annual change in inventory is positive for all species groups.

Forest inventory and Analysis (FIA) statistics show that hardwood sawtimber inventories have been increasing for some time. These trends are based upon the periodic remeasurement of some 28,000 sample locations. The locations are randomly distributed across the Southeast representing all forestland types and nonforest uses. Still, many managers find it difficult to get adequate sawtimber supplies.

Table 3. Volumes of hardwood sawtimber on timberlands of the United States by species and region, 1987 (Waddell et al., 1989 and Bones, 1987)

Species	Region			All Regions	Percent Change 1977-1987
	North	South	West		
	(Billion Board Feet, International 1/4-inch rule)				
Select red oaks	39.8	23.7		63.5	
white oaks	31.5	40.1		71.6	
Other red oaks	30.7	78.9		109.6	
white oaks	13.8	33.3		47.1	
(All oaks)	(115.8)	(166.2)	18.6	(310.4)	(+35)
Hickory	12.7	27.9	-	40.6	+22
Yellow Birch	8.6	.1	-	8.7	+11
Hard Maple	38.4	2.9	-	41.3	+38
Soft maple	34.5	13.3	-	47.8	+66
Beech	14.2	7.0	-	21.2	+23
Sweetgum	1.6	38.0	-	39.6	+22
Tupelo and blackgum	1.2	29.7	-	30.9	+14
Ash	16.1	10.0	-	26.1	+43
Basswood	10.1	1.6	-	11.7	+42
Yellow-poplar	12.6	40.3	-	52.9	+54
Cottonwood and aspen	29.5	3.1	19.6	52.2	+46
Black walnut	2.5	1.0	-	3.5	+60
Black cherry	11.2	.3	-	11.5	+75
Red alder	-	-	26.5	26.5	+18
Other species	29.5	25.6	17.4	72.5	+11
All species	338.5	377.0	82.2	797.7	+33

Table 4. Estimated quality of Eastern United States select species sawtimber and potential output of sawn lumber by lumber grade.

Species	Log Grade			Lumber grade			
	1	2	3&4	FAS&Sel	1C	2C	Below 2C
	----------Percent----------						
All select hardwoods	15	24	61	12	23	27	38
Select oaks	15	24	61	12	24	27	37
Hard maple	12	23	65	11	21	26	42
Ash, walnut, cherry	15	25	60	19	25	29	27
Yellow birch	11	26	63	12	21	24	43

Table 5. Volume of hardwood sawtimber, by species and region, Southeast

Species	All Southeast	Mountains	Piedmont	Coastal Plain
	Billion board feet (International 1/4-Inch Rule)			
Oaks	79.639	25.546	27.359	26.734
Other hard hardwoods	21.388	7.430	7.827	6.131
Tupelo and blackgum	20.819	.328	1.870	18.621
Sweetgum	19.199	.217	7.267	11.715
Yellow-poplar	29.232	8.893	3.677	6.662
Other soft hardwoods	19.396	4.118	4.991	10.287
Total	189.673	46.532	62.991	80.150

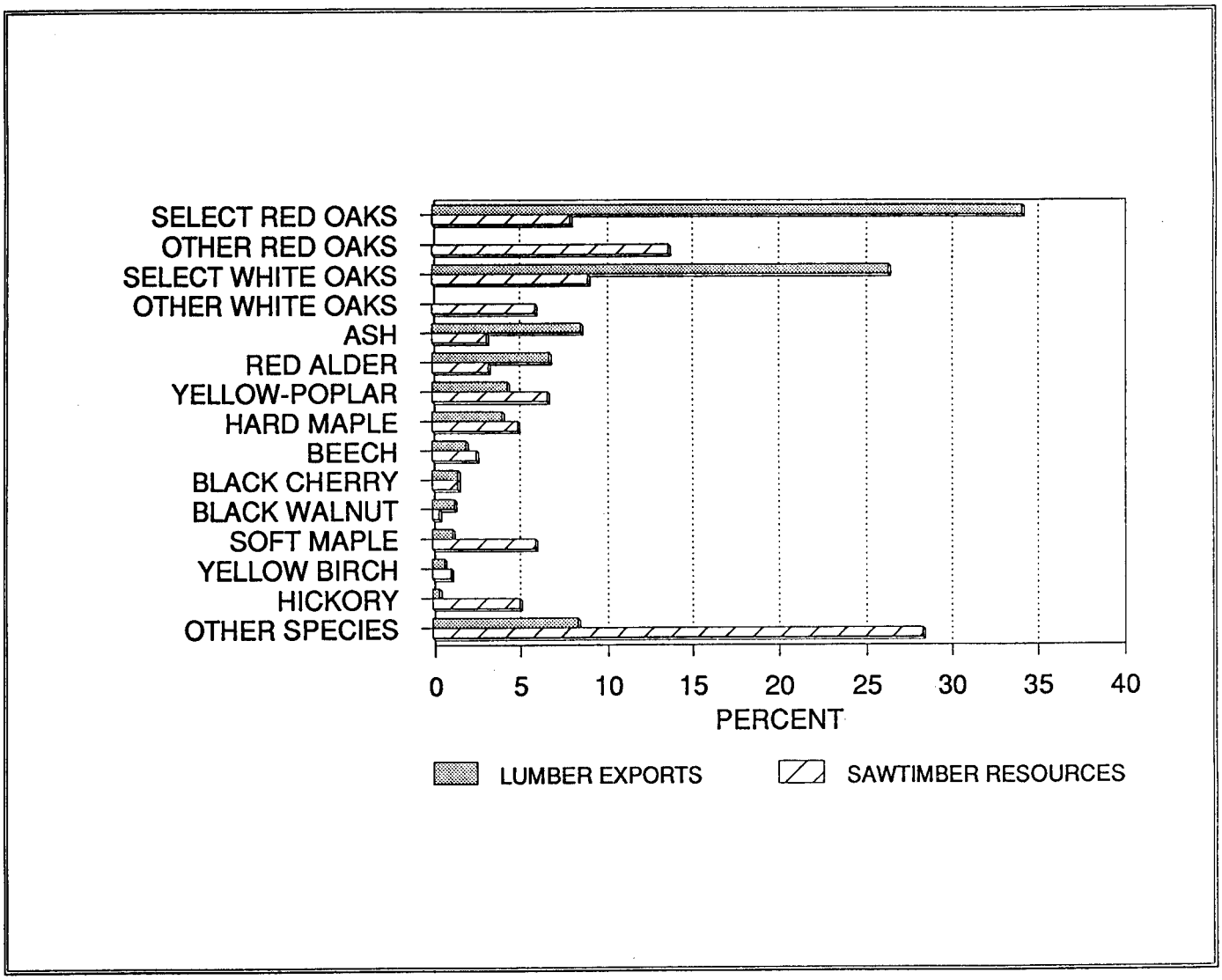


Figure 1. Percentage of U.S. hardwood lumber exports for 1989 and sawtimber resources for 1987 by major species

This section deals with the availability of hardwood sawtimber. The inability of some mills to get the logs they are seeking suggests possible physical, economic, and societal constraints that limit the availability of hardwood sawtimber.

Physical constraints can restrict the available supply of hardwood timber. The rugged, often steep terrain of the Blue Ridge and the deep swamp forests of the Atlantic Coastal Plain are obvious barriers to timber harvests. Not least among factors that may limit availability are landowner attitude toward management and harvest of timber. Administrative policy on the harvesting and removal of commercial wood products from public lands also will limit availability.

Economic constraints have considerable impact on timber availability. Stumpage cost aside, timber harvesting may be impractical because of the expense of building roads to remote stands. Low volume of desired species per acre, or an abundance of low-grade, poor-quality timber are other problems.

Several environmental constraints limit hardwood availability. Best Management Practices (BMP's) may prevent timber harvesting in areas bordering streams and other areas where hydrologic function would be altered. Hardwood stands on steep slopes, or on moderate slopes with shallow, fragile soil may also be unavailable for harvest using conventional logging methods.

Using stand area descriptors collected at each FIA sample location, timberland in the Southeast can be screened or "discounted" to remove stands with characteristics that may limit timber availability. The hardwood sawtimber volume can be removed to estimate the volume that is realistically available for harvest. Screening criteria and the level of screening are subjective. For this analysis, we chose the criteria we thought best reflected restrictions to normal harvesting. Although the degree of restriction and the particular attributes chosen to screen are arbitrary, any area descriptor collected and any degree of restriction could be used to meet specific circumstances. This technique has been applied to the three main geographic provinces in the Southeast, the Blue Ridge (or Mountains), the Piedmont Plateau, and the Atlantic Coastal Plain.

The discounting steps or screening criteria chosen and applied in each region are listed below:

1. Hardwood sawtimber occurring in primarily softwood types.
2. Stands with slopes steeper than 40 percent.
3. Stands with year-round water problems such as deep swamps.
4. Stands that are inaccessible because of extremely broken terrain or because of excessive distance to existing usable roads.
5. Stands near urban buildup, streams, or major highways.
6. Stands adjacent to lakes or other permanent water bodies.
7. Publicly owned timberland.
8. Poorly stocked stands, poletimber stands, and very young stands.

Mountains

In the Mountains, hardwood sawtimber volume totals 46.5 billion board feet. About 3 percent of this volume, or 1.3 billion board feet occurs as scattered hardwoods in stands predominantly composed of softwoods. The average sawtimber volume on pine sites regionwide is 5,630 board feet/acre (13,912 Bf/Ha). Hardwoods account for only 11 percent of this volume, or 667 board feet/acre (1,648 Bf/Ha). These hardwood trees are often remnants of former stands and may be of poor form. The relatively low volume per stand prevents economical harvest unless both hardwoods and softwoods are harvested. Frequently, the hardwoods are left standing or are felled and left on the ground during a softwood harvest. By discounting this volume, hardwood sawtimber inventory is reduced to 45.2 billion board feet (Table 7). This situation presents more of a problem in the Piedmont and Coastal Plain, because 84 percent of all timberland stands in the Mountains are predominantly hardwood. Furthermore, management in the Coastal Plain and Piedmont is directed primarily toward pine.

By far, the most significant deterrent to hardwood availability in the Mountains is steep slopes. Extremely steep slopes cause operability problems. Even where machinery can be used effectively, erosion and site degradation can occur if sites are harvested improperly. There are systems for harvesting timber on steep slopes in an environmentally sound manner. However, these systems often cannot be employed in a cost-effective manner when dealing with relatively low-grade timber or species not in high demand. In this discount, an arbitrary slope of 40 percent was chosen. All hardwood timber in stands with an average slope more than 40 percent was removed. This discount reduces the available hardwood volume by 24.6 billion board feet, or by more than half of the total in the region.

There are few stands In the Mountains that have year-round water problems (sites where standing or ponded water limits operability continuously throughout the year). This screening criteria had no effect in discounting hardwood sawtimber volume in the Mountains.

Accessibility to stands from existing roads presents a big constraint to availability. Building adequate mountain roads can be costly and may be impractical to harvest stands with low volume per acre or with a high proportion of cull timber. Also in the Mountains, broken terrain, washes, and gullies may limit on-the-ground harvesting practices. In this discount, stands were excluded that were inaccessible because of broken terrain. Stands that were more remote than 1/2 mile (0.8 km) from the nearest road usable and passable for logging were also removed. This discount reduced the available hardwood volume by another 3 percent to 19.3 billion board feet.

Land-use conflicts, landowner attitudes, and public opinion all heavily influence timber management. In many states, voluntary BMP's suggest leaving buffer strips around sensitive areas when timber is harvested. Discounting timber within 100 feet (30.4 m) of a land-use conflict reduces available volume by 338 million board feet, or by less than 1 percent. Again, this is more of a problem in other regions where timberland is more fragmented and interspersed with non-forest land uses.

Timberland margins surrounding seeps, ephemeral streams, and permanent streams and riparians are often configured as bands or strips relating to the course of water. This is especially true in more fragmented forestland in the Piedmont and Coastal Plain. To avoid disrupting hydrologic function and sedimentation of rivers and streams, these areas are sometimes best left unharvested. Discounting hardwood stands configured as this reduces available hardwood sawtimber volume by about 2 percent in the Mountains.

Many stands are close to large bodies of water, such as rivers over 10 feet wide (3 m), permanent lakes, or, in the Coastal Plain, coastal bays and estuaries. In some instances, harvesting may cause site degradation. Also, public policy may limit cutting in these areas or landowner opinion may favor preservation or management strictly for recreation. Removing such stands from the timberland base in the Mountains reduces available hardwood volume by only a small amount.

Ownership of timberland in the Southeast varies by region, but in all regions ownership is diverse. Considering hardwood types only, about 3 percent of timberland in the Mountains is controlled by forest industry. About 69 percent is owned by private individuals or Corporations not involved in forest products manufacture. This group includes many types of landowners--farmers, lawyers, laborers, absentee owners, and corporations such as banks and landholding companies. About 25 percent of Mountain timberland is in National Forests, and the remaining 3 percent is controlled by other public owners such as States, counties, and municipalities. Management on much of the public land is not directed toward timber production. Policy on National Forests Is geared toward multiple use management, with some areas totally dedicated to uses other than timber production. Because of these situations, a constant and readily available supply of timber from public

Table 6. Net annual growth and annual removals of hardwood sawtimber, by species and region

Species	Mountains		Piedmont		Coastal Plain	
	Net Annual Growth	Annual Removals	Net Annual Growth	Annual Removals	Net Annual Growth	Annual Removals
	Billion board feet (International 1/4-Inch Rule)					
Oaks	.890	.257	1.292	.713	1.120	.696
Other hard hardwoods	.262	.061	.294	.153	.200	.118
Tupelo and blackgum	.006	.002	.057	.034	.395	.227
Sweetgum	.012	.001	.337	.202	.486	.384
Yellow-poplar	.531	.118	.762	.360	.367	.215
Other soft hardwoods	.228	.034	.220	.106	.447	.168
Total	1.929	.473	2.962	1.568	3.015	1.808

Table 7. Volume of hardwood sawtimber, discounted by region, 1990

Discount Screening criteria	Mountains		Piedmont		Coastal Plain	
	Discount	Residual	Discount	Residual	Discount	Residual
	Billion board feet (International 1/4-Inch Rule)					
None--Total volume	--	46.532	--	62.991	--	80.150
Minus hardwood volume in:						
1. Softwood types	1.295	45.237	3.312	59.676	3.578	76.572
2. Stands with slopes > 40%	24.592	20.645	4.018	55.661	.384	76.188
3. Stands with year-round water problems	--	20.645	.679	54.982	10.073	66.115
4. Inaccessible stands	1.372	19.273	1.004	53.978	3.862	62.253
5. Stands < 100 feet to land use conflict	.338	18.935	3.011	50.967	2.551	59.702
6. Stands in strips, stingers, and bands	.822	18.113	9.248	41.719	19.076	40.626
7. Stands with permanent water on acre	.117	17.996	.818	40.901	.801	39.825
8. Public ownerships	4.376	13.620	1.834	39.067	2.123	37.702
9. Hardwood sawtimber stands	2.145	11.475	7.771	31.296	6.024	31.678

land is questionable, and so these stands have been discounted. This step reduces the hardwood sawtimber inventory by 4.4 billion board feet, or by 9 percent.

Some volume of hardwood sawtimber that is readily accessible, available for timber management, and located in stands with no operability problems or in stands which are not environmentally sensitive may still be "unavailable" from an economic standpoint. Poletimber stands and poorly stocked or young stands often include some sawtimber-sized trees. As with hardwoods in pine stands, these trees are often remnants of former stands left as a result of poor management and harvesting practices. It Is impractical to enter these stands to harvest small volumes of sawtimber in isolated trees. This discount removes sapling and poletimber stands and other stands with not enough stocking of sawtimber-sized quality timber. In so doing, available hardwood sawtimber volume is reduced by another 2.1 billion board feet, or by 5 percent.

This last discount reduces the hardwood sawtimber volume available in the Mountains to only 11.5 billion board feet, 25 percent of the total in the region.

The discounting procedure also reduces the amount of net annual growth and the amount of annual removals of hardwood sawtimber (Table 8). Stands that are accessible would be expected to have a higher removal or harvest rate than stands that are inaccessible. Assuming there is no difference in site productivity between accessible and inaccessible stands, the growth/removal relationship should be slightly lower on the most readily accessible and operable stands. The growth/removal relationship for the last discount (step 9) is not valid, since the stands removed were in fact stands most likely harvested 15 to 20 years ago (now young stands or poletimber stands). These stands would not likely have been harvested again during the most recent survey remeasurement period. These young, often medium-stocked stands have much lower removal rates and higher growth rates than the average stand. Ignoring this last discounting step, and comparing growth and removals for the previous discount level, we find that the growth removal relationship in fact is lower for screened (the residual timberland remaining after a discount is applied) timberland - 3.8:1, compared to 4.1:1 for all unscreened (no discounts) timberland.

Piedmont

In the Piedmont, hardwood sawtimber volume totals 63.0 billion board feet. About 5 percent of this volume, or 3.3 billion board feet occurs as scattered hardwoods in pine stands. Average sawtimber volume for pine sites in the Piedmont is 4,080 board feet/acre (10,082 Bf/Ha). Hardwoods account for only 8 percent of this volume, or 321 board feet/acre (793 Bf/Ha). Discounting this volume reduces hardwood sawtimber inventory to 59.7 billion board feet (Table 7).

Portions of the Piedmont Region extend into the foothills of the Blue Ridge and there are some stands with average slopes more than 40 percent. However, steep slopes are not nearly as common in either the Piedmont or Coastal Plain as Is in the Mountains. This discount reduces the available hardwood volume by 4.0 billion board feet, or by 8 percent.

Most stands with year-round water problems are found in the Coastal Plain, but some occur in the Piedmont. Removing these stands reduces hardwood sawtimber volume by about 1 percent to 55.0 billion board feet.

Accessibility to stands from existing usable roads poses some problems in the Piedmont. Removing stands that are inaccessible because of broken terrain, or stands that are more than 1/2 mile (0.8 km) from the nearest usable and passable logging road reduces the available hardwood volume by another 2 percent to 54.0 billion board feet.

Land-use conflicts, landowner attitudes, and public opinion also influence timber management in the Piedmont. Removing timberland within 100 feet (30.4 m) of a land use conflict reduces available volume by more than 3.0 billion board feet, or by 5 percent.

In the Piedmont, where much timberland is fragmented and interspersed with agricultural land, a lot of timberland is in strips, stringers, and bands. Often, hardwood timberland next to streams is bordered by agricultural fields. Discounting hardwood stands configured as such reduces available hardwood sawtimber volume by more than 9.2 billion board feet, or by almost 15 percent. This is the most significant discount criterion in the Piedmont.

In the Piedmont as in the Mountains, many stands are close to larger bodies of water, such as rivers over 10 feet wide, lakes, and reservoirs. Removing such stands from the timberland base reduces available hardwood volume by about 818 million board feet, or by 1 percent.

Almost 11 percent of the hardwood area in the Piedmont is owned by forest industry. Private landowners not directly involved with forest products manufacture (Non-industrial private forest landowners) control about 85 percent of the area. Only 2 percent is in National Forest ownership, and the remaining 3 percent is controlled by other public owners. Removing public timberland reduces the hardwood sawtimber inventory by 1.8 billion board feet, or by 3 percent.

The final discount removes poletimber stands and poorly stocked or young stands. This discount reduces available hardwood sawtimber volume by 7.8 billion board feet, or by 12 percent.

All discounts combined reduce the hardwood sawtimber volume available in the Piedmont to 31.3 billion board feet, about half of the total in the region.

The discounting procedure also reduces the amount of net annual growth and the amount of annual removals of hardwood sawtimber (Table 4). However, in comparing growth and removals for discount level 8 (discount level 9 is ignored, since the growth/removal relationship is affected by past management), we find that the growth/removal relationship is about the same for screened timberland - 1.97:1, compared to unscreened timberland - 1.9:1.

Coastal Plain

In the Coastal Plain, hardwood sawtimber volume totals 80.2 billion board feet. About 4 percent of this volume, or 3.8 billion board feet occurs as scattered hardwoods in pine stands. Average sawtimber volume for pine sites in the Coastal Plain is 3,388 board feet/acre (8,372 Bf/Ha). Hardwoods account for only 5 percent of this volume, or 169 board feet/acre (418 Bf/Ha). In the Coastal Plain, compared with the Piedmont and Mountains, a larger proportion of pine sites are well managed pine plantations, accounting for the very low hardwood component. It is very unlikely that this hardwood would be used. Discounting this volume reduces hardwood sawtimber inventory to 76.6 billion board feet (Table 7).

There are very few sites in the Coastal Plain with average slopes more than 40 percent. Applying this discount reduces the available hardwood sawtimber inventory by less than 0.5 percent.

Operability problems due to year-round water are common in the Coastal Plain. About 3 percent of all timberland is classified as deep swamps or backwater sloughs. Floodplains of rivers make up another 12 percent of all timberland. In addition, some mesic sites in the Coastal Plain, especially broad flatwoods, are flooded, ponded, or experience soil saturation close to the surface for a significant period of time during the rainy season. These problems effectively limit harvesting operations for a portion of the year. Discounting stands with year-round water problems reduces the available hardwood inventory by 10.1 billion board feet, or by 13 percent.

Table 8. Net annual growth and annual removals of hardwood sawtimber, discounted by region, 1990

Discount	Screening criteria	Mountains		Piedmont		Coastal Plain	
		Net Annual Growth	Annual Removals	Net Annual Growth	Annual Removals	Net Annual Growth	Annual Removals
		Billion board feet (International 1/4-Inch Rule)					
None--Total volume		1.929	.473	2.962	1.568	3.015	1.808
Minus growth and removals in:							
1.	Softwood types	1.864	.442	2.773	1.336	2.828	1.518
2.	Stands with slopes > 40%	.891	.225	2.611	1.293	2.816	1.517
3.	Stands with year-round water problems	.891	.225	2.590	1.291	2.548	1.461
4.	Inaccessible stands	.843	.220	2.548	1.281	2.430	1.425
5.	Stands < 100 feet to land use conflict	.829	.204	2.424	1.258	2.345	1.376
6.	Stands in strips, stingers, and bands	.801	.203	2.048	1.031	1.693	1.121
7.	Stands with permanent water on acre	.797	.202	2.014	1.017	1.664	1.089
8.	Public ownerships	.623	.166	1.930	.978	1.583	1.075
9.	Hardwood sawtimber stands	.456	.058	1.305	.274	1.127	.294

Accessibility problems in the Coastal Plain are primarily due to distance and interbraided streams or sloughs rather than broken terrain and gullies. Still, accessibility presents problems. Removing these stands reduces the available hardwood volume by another 5 percent to 62.3 billion board feet.

Removing timberland within 100 feet (30.4 m) of a land-use conflict reduces available' hardwood sawtimber volume by more than 2.6 billion board feet, or by 3 percent.

Discounting hardwood stands In strips, stringers, or bands along rivers, cypress strands, and other riparian areas reduces available hardwood sawtimber volume by more than 19.1 billion board feet, or by almost 24 percent.

Removing stands close to permanent water from the timberland base reduces available hardwood volume by about 801 million board feet, or by less than 1 percent. Most stands such as these were removed in previous discounting steps.

The public owns 10 percent of all timberland in the Coastal Plain, more than in the Piedmont, but much less than in the Mountains. Forest industry owners control a much higher proportion of timberland in this region than in other regions--30 percent. Nonindustrial private owners account for 60 percent of the timberland ownership in the Coastal Plain. Removing public timberland reduces the hardwood sawtimber inventory by 2.1 billion board feet, or by 3 percent.

Removing poletimber stands and poorly stocked or young stands reduces available hardwood sawtimber volume by 6.0 billion board feet, or by 8 percent.

All discounts combined reduce the available hardwood sawtimber volume in the Coastal Plain to 31.7 billion board feet, only 40 percent of the total in the region.

The discounting procedure significantly reduces the volume of net annual growth and also annual removals of hardwood sawtimber (Table 8). For unscreened timberland growth exceeds removals by about 67 percent (1.67:1). For screened timberland at step 8 (public ownerships removed), growth exceeds removals by slightly less, 47 percent (1.47:1).

Southeast Total

Hardwood sawtimber volume for the entire Southeast (all regions combined) totals almost 190 billion board feet. Combined discounted volume totals only 74.4 billion board feet, a reduction of almost 61 percent in available timber. We do not mean to imply that this is the actual hardwood sawtimber volume available in the Southeast. The criteria applied in the discounts were rigorous and extensive. Demand for timber products and specific species, available harvesting techniques and equipment, and changing land-use policy can change rapidly.

These factors combined, in addition to others not mentioned, influence availability. We do suggest that, at any time, a large proportion of the standing timber is not available for harvest.

One aspect not adequately addressed in this paper is the extent of landowner attitude or intention in determining timber availability. In the Southeast, especially in the Mountains, individual homeowners are purchasing large tracts of timberland for construction of single-family dwellings. Many developments are also being placed in wooded settings with large areas of untouched or preserved forestland. Considerable timberland acreage can be involved. Many times, there is no evidence of suburban development, and the area is apparently available for Commercial timbering. However, this particular forestland is unlikely to be managed for timber. Management for recreational and aesthetic enjoyment or just for protection from urban sprawl seems most likely. Now, area descriptors that can adequately quantify the volume associated with such management intentions are not collected. However, it is apparent that the acreage and associated volumes are significant and that they will increase in coming years.

SUMMARY AND THE FUTURE

The United States has abundant quantities of hardwood timber resources. The demands for this timber have been far below the annual growth in our forests. The Eastern United States has large quantities of select species, and these resources are increasing and not decreasing as some fear. By the year 2000, US. inventories of select export species sawtimber could increase to a greater percentage of our hardwood resources. Thus, it would appear that the United States has and will have the resources necessary to continue to supply domestic markets; to continue as a major player in the world hardwood market for log, lumber, and veneer products; and to increase exports of further processed hardwood products. However, we have discussed the availability of our hardwood resources using the Southeast area as an example. in our analysis, we estimated that around 39 percent of our hardwood sawtimber is available for harvesting at this time. Many things such as technology, stumpage prices, land-use policies, and other factors could change this availability picture.

When considering the quality of the standing sawtimber and the potential output by lumber grade, about 50 percent of the output is secondary-quality (1C/2C) material. Only about 12 percent would be in our highly demanded top grades (FAS&Sel) for export and domestic markets. The vitality of the markets for the secondary-quality material dictates the overall economic performance of a sawmill and, therefore, is very important. improvements in present and potential markets and development of new uses for this quality range of material, such as value-added export dimension, need to be constant goals.

When considering the hardwood species mix, opportunities for expanded use of species not considered to be select species are great. We saw that we have an imbalance when considering our exports of lumber by species and what we have in standing sawtimber. Some species such as the select red and white oaks, ash, and walnut are being heavily demanded when compared to their occurrence. Several species are not. Some of these species such as yellow poplar (sometimes referred to as American tulipwood) are being used more in the United States and by export customers. Demands for other species such as soft maple, hickory, and the non-select oaks could be greatly increased.

Demands on the hardwood forests are predicted to increase in the future. Pulpwood and to a lesser degree fuelwood harvests could increase substantially. These demands will be filled primarily with low grade and small diameter hardwoods. Sawlogs, veneer log, and miscellaneous demands will also increase in the future.

Efforts have been and are continuing to be made at the Federal, and State levels to respond to the predicted rising demands and environmental concerns by: (1) developing improved management techniques in our various forest types; (2) developing improved techniques and systems to more fully utilize each tree harvested; and (3) developing new products or improved markets for low-grade trees and non-select species.

LITERATURE CITED

Araman, Philip A. 1988. New patterns of world trade in hardwood timber products. Proceedings, Outlook '88, 64th Agricultural Outlook Conference, United States Department of Agriculture, Washington, D.C. pp 391-401.

Bones, James T. 1987. Hardwood Forest Resources of the United States. Proceedings, Seminar on the valorization of secondary-quality temperate-zone hardwoods, Economic Commission for Europe Food and Agricultural Organization - Timber Committee and the European Forestry Commission, Nancy, France. 11p.

Hanks, Leland F., Glenn L. Gammon, Robert L. Brisbin, and Everette D. Rast. 1980. Hardwood log grades, and lumber grade yields for factory lumber logs. USDA For. Serv. Res. Pap. NE-468. 92p.

Haynes, Richard W. 1988. Long-term demand for hardwoods In the U.S. Proceedings of the Eighteenth Forestry Forum “Eastern hardwoods - an emerging forestry frontier”, Virginia Cooperative Extension Service, Virginia Tech, Blacksburg, Virginia. pp 6-19.

Luppold, William G., Bruce G. Hansen. 1990. New estimates of 1989 hardwood lumber exports volume. Wood Products: International Trade and Foreign Markets. USDA FAS Circular Series WP 1-90, March 1990. pp 31-34.

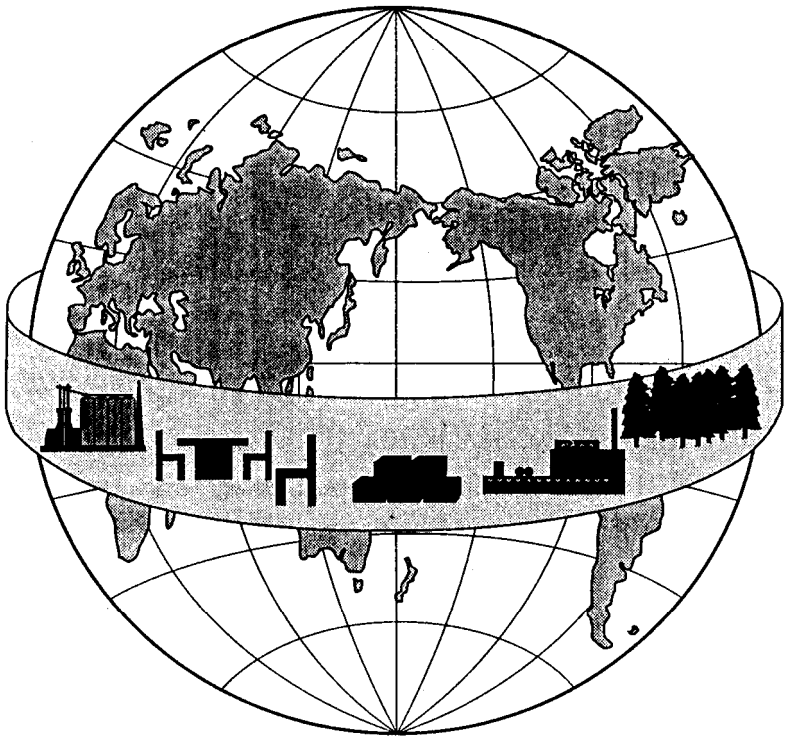
National Hardwood Lumber Association. 1986. Rules for the measurement and inspection of hardwood and cypress. Nat. Hardwood Lumber Assoc., P.O. Box 34518, Memphis, TN.

Rast, Everette D., David L. Sonderman, and Glen L. Gammon. 1979. A guide to hardwood log grading (revised). USDA For. Serv. Gen. Tech. Rep. NE-1. 32 p.

Waddell, Karen L.; Oswald, Daniel D.; Powell, Douglas S. 1989. Forest statistics of the United States, 1987. Resour. Bull. PNW-RB-168. Portland, OR: US. Department of Agriculture, Forest Service, Pacific Northwest Research Station. 106 p.

PROCEEDINGS OF THE 1990 JOINT INTERNATIONAL CONFERENCE ON

PROCESSING AND UTILIZATION OF LOW-GRADE HARDWOODS AND INTERNATIONAL TRADE OF FOREST-RELATED PRODUCTS



Sponsored by:

Graduate Institute of Forestry
National Taiwan University, ROC

and

The School of Forestry
Auburn University, USA