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FOREST RESOURCES OF THE

Monocacy River Watershed

OF MARYLAND AND PENNSLVANIA

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F O R E W O R D

The Monocacy River Watershed Council, organized in November 1949 with broad representation of the various local interest and civic organizations, is in process of developing a program of conservation for the water and land resources of that area. One of the major objectives is to regulate the streamflow and reduce the silt load of the Monocacy River and its tributaries.

The Maryland Department of State Forests and Parks is cooperating with the Council in the development of this program. The Department recently asked the Northeastern Forest Experiment Station to make a study of the forest resources of the watershed area--keeping in mind both the watershed and the timber values. It is my hope that this report will be helpful to the Department and to the Council in the development of a program for the Monocacy River Watershed.

We recommend emphasis on the following measures to safeguard and improve watershed values of forest land and to increase timber productivity:

1. Maintain and improve efficiency in fire protection with increased local voluntary support in fire-prevention programs. Increased attention to the problems of preventing and controlling forest fires in the unusual periods of extreme hazard.

2. More widespread and effective programs of forest management on some 156,000 acres of forest land, largely in small private ownership. The purpose is to build up and main-

tain forests for increased timber production and improved soil and water relations. This can be done by supporting and promoting expanded programs of technical assistance to landowners and of education in farm woodland management, such as is being provided on a limited scale at the present time by state forestry and extension agencies. Forest cooperatives in which forest-land owners organize to provide their own market outlets and to gear timber utilization to forest management needs may also be practicable and effective.

3. Tree planting on some 18,000 acres of present pasture and cultivated land that should be returned to forest use. In addition, some 7,000 acres in poorly-stocked forest would benefit from reinforcement planting. This would require expansion of state forest nursery capacity to provide for a stepped-up rate of planting.

4. Prevention of damage to forest watersheds by livestock. On some farms the fencing of the forest land and the improvement of open pasture may be required.

A comprehensive program including the above measures can best be developed through cooperation on the part of individual landowners with agencies like the Monocacy River Watershed Council, the forest conservancy district boards, the soil conservation districts, and other state and Federal agencies that can render assistance.

V. L. Harper
Director

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FOREST RESOURCES OF THE MONOCACY RIVER WATERSHED OF MARYLAND AND PENNSYLVANIA

by

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INTRODUCTION

THE MONOCACY RIVER has its source in Adams County, Pennsylvania, whence it flows south-southwest through central Maryland to the Potomac. The Pennsylvania sector of the watershed includes about a third of Adams County. The Maryland sector includes most of Frederick County, about half of Carroll County, and a corner of Montgomery County. The entire watershed contains about 620,800 acres or 970 square miles.

The Monocacy River drainage basin lies wholly within the Piedmont Plateau. The eastern rim is in a series of rolling hills--hardly perceptible from the general landscape. The western rim, however, is the clearly-defined Catoctin Hills, which extend from the Potomac River northward into Pennsylvania, where they merge with South Mountain. The more extensive areas of forest land lie on the eastern slopes of this upland.

When the first white settlers arrived, the Monocacy River basin, like most of eastern United States, was covered

with heavy forest growth. By the time of the Revolution much of the area was cleared for crops and pasture. Most of the farms had woodlots to supply them with fuel. The acreage of cleared land reached its maximum about 1890. Since then, some land on poorer soils has been abandoned and allowed to revert to forest. But the net change in forest land area during the past 50 years has been rather small.

FOREST AREA

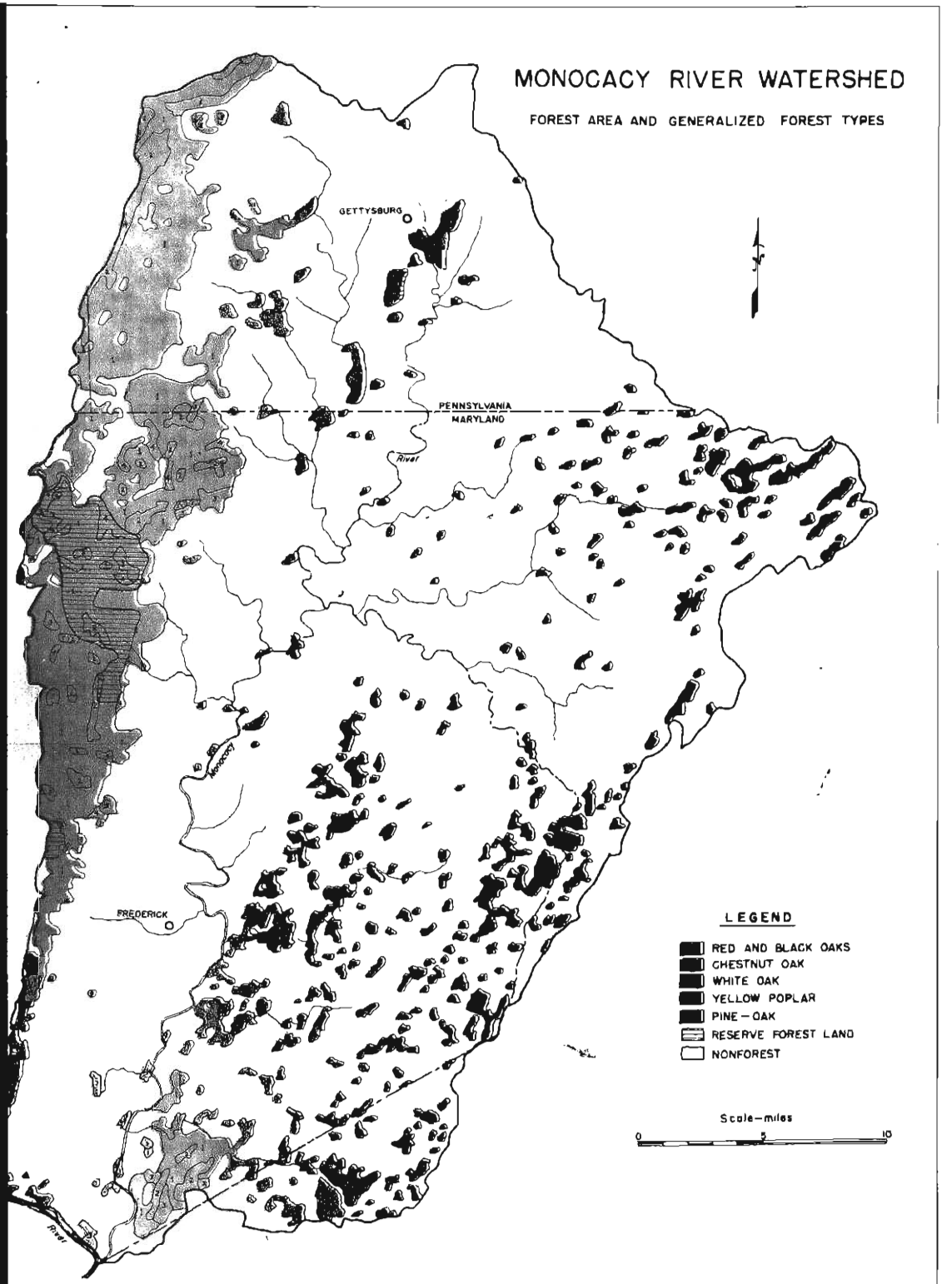
Location Of The Forest Land

THE LOCATION OF the existing forest land is shown in figure 1. This, of course, is a generalized map that cannot delineate forest and nonforest area in tracts of much less than 100 acres. There is a considerable amount of additional farm-woodlot area in tracts of 10, 20, or 30 acres that, if shown, would appear as mere dots on a map of this scale. And, on the other hand, there are small blocks of nonforest land within the forest areas that could not be shown for the same reason.

The extensive forest areas lie on the western side of the watershed, in the Catoctin Hills-South Mountain upland. The remainder of the forest land--on the eastern side of the Monocacy River--is widely scattered in small tracts, and the greatest concentration is in the southeastern part of the watershed.

The forest land comprises 27 percent (167,600 acres) of the entire watershed.[1] The Federally owned Catoctin Recreational Demonstration Area, the Gettysburg National Military Park, and the Gambrill State Park include some 11,600 acres of forest land that has been withdrawn from commercial timber use. This land has been indicated in fig-

[1] THESE VARIOUS ESTIMATES OF FOREST AREA, TIMBER VOLUME AND TIMBER GROWTH, AND DEPLETION FROM CUTTING AND OTHER CAUSES ARE DERIVED BY SAMPLING METHODOLOGY; AND OF COURSE THIS INVOLVES A MARGIN OF ERROR. SOME ERRORS, SUCH AS MISTAKES IN MEASUREMENT, IMPERFECT VOLUME TABLES, AND IMPERFECT CLASSIFICATION, ARE KEPT TO A MINIMUM BY CLOSE SUPERVISION AND CHECKING OF FIELD AND OFFICE WORK. THE OTHER CLASS OF ERRORS IS THAT DUE TO USE OF SAMPLING PROCEDURE AS A METHOD FOR MEASURING WHOLE MAGNITUDES. THESE SAMPLING ERRORS CAN BE DETERMINED BY MATHEMATICAL CALCULATION. THE SAMPLING ERROR BASED ON ONE STANDARD DEVIATION IS CALCULATED TO BE PLUS OR MINUS 1.5 PERCENT FOR TOTAL ACREAGE OF FOREST LAND IN THE MONOCACY RIVER WATERSHED. THE CORRESPONDING ERROR FOR TOTAL VOLUME OF TIMBER (CUBIC-FOOT BASIS) IS 7 PERCENT. FOR SAW-TIMBER VOLUME (BOARD-FOOT BASIS) IT IS 10 PERCENT.



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Good forest management calls for the maintenance of the largest practicable area in the more valuable species like white oak and yellow-poplar. It would probably be desirable also to have more pine.

Condition Of The Timber Stand

The present stand condition of the commercial forest land is shown graphically in figure 2.

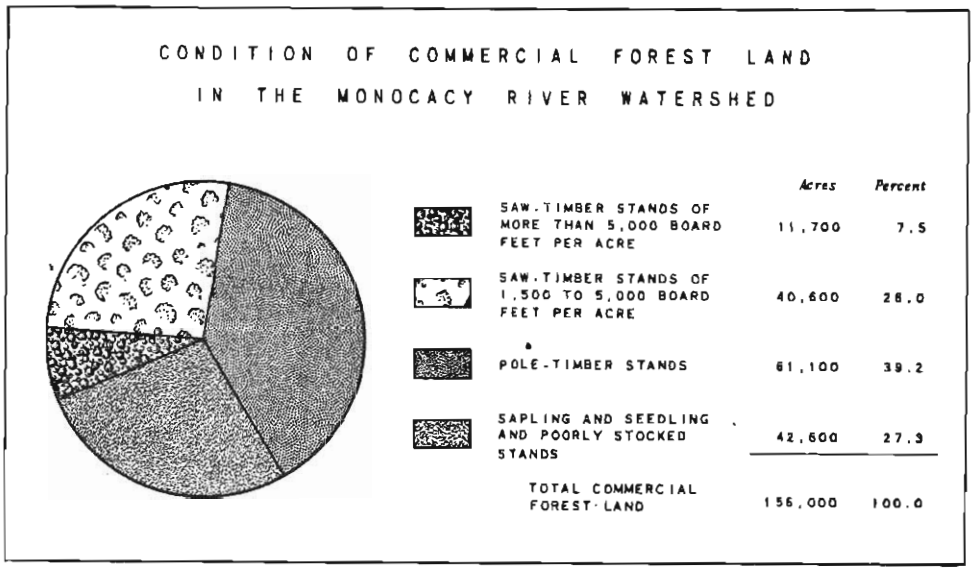

Figure 2.--Approximately one-third of the commercial forest land is occupied by saw-timber stands. Pole-timber stands occupy 39 percent of the land.

Saw-timber stands--those having volumes of not less than 1,500 board feet per acre in trees of saw-timber size[2]--occupy 33.5 percent of the commercial forest area. Of this saw-timber acreage, however, only about one-fifth has a stand of more than 5,000 board feet per acre. Stands of pole timber[3] occupy 39.2 percent of the commercial forest area. Such stands contain less than 1,500 board feet per

[2] SOFTWOODS 9 INCHES OR LARGER IN DIAMETER AT BREAST HEIGHT, HARDWOODS 11 INCHES OR LARGER.

[3] SOFTWOODS FROM 5 TO 9 INCHES D.B.H.; HARDWOODS 5 TO 11 INCHES.

acre of sawlog material, but have at least 200 cubic feet (about 3 cords) per acre in trees of pole size and larger. The remaining 27.3 percent of the commercial forest land is occupied by stands of saplings and seedlings or areas too poorly stocked to meet the minimum requirement for pole-timber stands. In general, this sapling and seedling and poorly stocked area had been stripped of all merchantable timber.

Forest-Land Ownership

More than four-fifths (82.4 percent) of the commercial forest land is in private ownership--half of it in forest land on farms and the remainder in other small ownerships. The publicly owned commercial forest area amounts to 27,500 acres, of which 19,100 are held by the states and 8,400 by counties and municipalities (table 1).

Table 1.--Ownership of commercial forest land in the Monocacy River watershed

Ownership class	Commercial forest land	
	Acres	Percent
Private		
Farm woodland	78,600	50.4
Other private	49,900	32.0
Total private	128,500	82.4
Public		
State	19,100	12.2
County and municipal	8,400	5.4
Total public	27,500	17.6
All ownerships	156,000	100.0

SAW-TIMBER VOLUME

THE MEASUREMENT OF timber volume in standing trees is not so simple as weighing a ton of coal or measuring a bushel of corn. It involves the establishment of certain specific limits of tree size and quality of material.

Forest survey specifications were used in preparing this report. For saw-timber trees they are as follows: Softwood trees must be at least 9 inches in diameter at breast height (d.b.h.) and hardwood trees must be not less than 11 inches d.b.h. A saw-timber tree (softwood or hardwood) must contain at least one merchantable log 8 feet long. At least half of the gross board-foot volume must be merchantable material--a tree that fails to meet this requirement is classified as a cull tree and is excluded from saw-timber volume. The board-foot volume of a saw-timber tree comes from that portion of the stem between stump height and the point on the upper stem where branches, deformity, or small diameter make it unusable for sawlog purposes. If this portion of the stem contains visible defect--such as canker, swollen knots, butt rot, spiral seam, crook or sweep, and so on--a cull deduction is made. The remaining merchantable volume is the value expressed in the net board-foot volume figures.

The Forest Survey uses the International 1/4-inch log rule. This rule indicates very closely the lumber volume that can be obtained from logs by a skilled sawyer. Those who are accustomed to using some other log rule should therefore make proper adjustments in interpreting the saw-timber volume figures given in this report.

The estimated total net volume of saw timber on commercial forest land in the Monocacy River watershed amounts to 213 million board feet (table 2).

Table 2.--Volume in live saw-timber trees by species and stand-size class, board-foot basis, 1950

(International 1/4-inch rule)

Species	In saw-timber stands of—				In pole-timber and other stands		In stands of all sizes	
	More than 5,000 bd.ft. per acre		1,500 to 5,000 bd.ft. per acre					
	M bd.ft.	Percent	M bd.ft.	Percent	M bd.ft.	Percent	M bd.ft.	Percent
Red and black oaks	21,300	10.0	33,300	15.6	10,700	5.0	65,300	30.6
White oak	8,900	4.2	13,300	6.2	3,200	1.6	25,400	12.0
Chestnut oak	15,500	7.3	19,000	8.9	3,000	1.4	37,500	17.6
Yellow-poplar	12,600	5.9	11,200	5.3	4,000	1.8	27,800	13.0
Hickory	300	.1	12,400	5.8	1,900	.9	14,600	6.8
Other species	3,800	1.8	13,200	6.2	25,600	12.0	42,600	20.0
Total	62,400	29.3	102,400	48.0	48,400	22.7	213,200	100.0

This is a considerable volume of timber, but only a part of it can be utilized at the present time. Only 29 percent (62 million board feet) is in saw-timber stands that contain more than 5,000 board feet per acre. The over-all

average for these heavier stands is 5,333 board feet per acre. The lighter saw-timber stands (1,500 to 5,000 board feet per acre) contain 48 percent of the saw-timber volume--103 million board feet. The average per-acre volume for these lighter stands is 2,522 board feet. The remainder of the saw-timber volume, 23 percent or 48 million board feet, is scattered throughout pole-timber and sapling and seedling stands or is on poorly stocked areas. Very little of this can be harvested profitably for sawlogs at present. Much of it is in low-quality trees left over from past cutting operations.

Table 3.--Saw-timber volume by tree-diameter classes, 1950

(International 1/4-inch rule)

Diameter class (inches)	Volume	
	M bd.ft.	Percent
11.0 - 12.9	42,200	20
13.0 - 14.9	49,500	23
15.0 - 16.9	32,700	15
17.0 - 18.9	21,700	10
19.0 - 20.9	21,100	10
21.0 - 22.9	9,200	4
23.0 - 24.9	10,300	5
25.0 - 26.9	7,400	4
27.0 and over	19,100	9
Total	213,200	100

More than half (57 percent) of the saw-timber volume in the Monocacy River watershed is in trees 15 inches d.b.h. and larger. Some 22 percent is in trees 21 inches d.b.h. and larger (table 3).

Estimate Of Saw-Timber Quality

Recognizing that volume per acre and tree size are only two of the factors that determine whether or not a given block of timber can be utilized, the field survey of the Monocacy watershed was expanded to include a determination of timber quality. The study was confined to hardwood saw timber in saw-timber stands. The volume of softwood saw timber is not of much importance.

The quality determinations were made by grading the sawlog material in saw-timber trees on a random sample of field plots. The grading system is a combination of the

Forest Products Laboratory specifications[4] for factory-lumber sawlogs and supplementary grading specifications for logs of lower quality that are nevertheless regarded as merchantable for sawn products other than standard factory lumber.

The various specifications for each log grade cannot be summarized in a few words.[5] In general, though, an F-1 sawlog yields about two-thirds its volume in standard factory lumber grading "number one common or better." An F-2 sawlog yields about one-half its volume in these same higher grades of lumber. An F-3 sawlog yields less than one-third its volume in this quality of lumber. Much of the F-3 sawlog material is of marginal quality for factory lumber. It can be processed at a profit only when the demand for lumber is relatively great and prices are somewhat high as a result of this demand. Sawlogs of the "Structural" grade are below the quality necessary for factory lumber but are suitable for railroad ties, structural timbers, and rough construction uses.

The results of applying these quality-criteria to the hardwood saw timber in saw-timber stands are summarized in table 4.

Table 4.--Quality distribution of hardwood sawlog volume in saw-timber stands, by stand-size class, 1950

(International 1/4-inch rule)

Log grade	In stands of more than 5,000 bd.ft. per acre		In stands of 1,500 to 5,000 bd.ft. per acre		In all saw-timber stands	
	M bd.ft.	Percent	M bd.ft.	Percent	M bd.ft.	Percent
F-1	15,700	25	4,900	5	20,600	12
F-2	20,100	33	37,500	37	57,600	35
F-3	16,500	26	40,800	39	57,300	35
Structural	10,100	16	19,200	19	29,300	18
All grades	62,400	100	102,400	100	164,800	100

[4] FOREST PRODUCTS LABORATORY. HARDWOOD LOG GRADES FOR STANDARD LUMBER. PROPOSALS AND RESULTS. FOREST PROD. LAB. RPT. D1737. 65 PP., ILLUS. MADISON, WIS. 1949.

[5] LOCKARD, C. R. SUPPLEMENTARY INFORMATION ON HARDWOOD LOG GRADING. NORTHEAST. FOREST EXPT. STA. 15 PP. UPPER DARBY, PA. 1949.
LOCKARD, C. R., PUTNAM, J. A., AND CARPENTER, R. D. LOG DEFECTS IN SOUTHERN HARDWOODS. U.S. DEPT. AGR., AGR. HANDB. 4. 37 PP., ILLUS. 1950.

Somewhat more than half (58 percent) of the volume in the heavier stands is in logs of F-1 and F-2 grades--material unquestionably suitable for factory lumber. In the lighter stands the F-1 and F-2 logs make up 42 percent of total volume, but very little (only 5 percent) of this is material of F-1 grade. This, of course, points to the importance of heavier stands of growing stock as a means for increasing the quality of timber.

Sawlog volume of F-3 grade amounts to 26 percent of the heavier stands and 39 percent of the lighter stands. This material is normally of marginal value for factory lumber, but much of it could probably be moved at a profit under present demand. The Structural material amounts to 16 percent of the heavier stands and 19 percent of the lighter stands.

The quality distribution differs greatly according to species. More than 70 percent of the white oak volume is in sawlogs of F-1 and F-2 grades. The red and black oaks show less than half their volume in these two higher grades. Chestnut oak logs of F-1 grade were not found at all, but 41 percent of the volume of this species is of F-2 grade. Yellow-poplar has an unusually high proportion of volume (39 percent) in F-1 grade material. Virtually all of the

Table 5.--Quality distribution of hardwood sawlog volume in saw-timber stands, by species

(International 1/4-inch rule)

Species	Log grades								All grades	
	F-1		F-2		F-3		Structural			
	M bd.ft.	Percent	M bd.ft.	Percent	M bd.ft.	Percent	M bd.ft.	Percent	M bd.ft.	Percent
Red and black oaks	4,900	9	20,200	37	16,400	30	13,100	24	54,600	100
White oak	4,000	18	11,700	53	5,800	26	700	3	22,200	100
Chestnut oak	--	--	14,100	41	12,800	37	7,600	22	34,500	100
Yellow-poplar	9,300	39	6,200	26	8,100	34	200	1	23,800	100
Hickory	--	--	600	5	6,600	52	5,500	43	12,700	100
Other hardwood	2,400	14	4,800	28	7,600	45	2,200	13	17,000	100
All hardwood	20,600	12	57,600	35	57,300	35	29,300	18	164,800	100

yellow-poplar is potential material for factory lumber. Hickory, on the other hand, tends to be very poor--only 5 percent of the volume grades F-2 and none of it is F-1. The various other hardwoods show 42 percent in the two highest grades (table 5).

T I M B E R V O L U M E

I N A L L L I V E T R E E S

ATTENTION HAS BEEN given thus far only to the timber volume in saw-timber trees (softwoods 9 inches d.b.h. and larger, hardwoods 11 inches and larger) in terms of board feet--a measurement limited to the sawlog portion of such trees. The reason for this emphasis is that a large part of the wood-processing industry can utilize only material of sawlog size.

There are, of course, uses for timber of pole size and for the tops and limbs of saw-timber trees. It is therefore important to know the approximate total timber volume in all trees above sapling size. This lower limit for volume measurements has been set at 5 inches d.b.h. on stems and 4 inches diameter inside bark on tops and limbs. Other details of these limits need not concern us in this report.

Table 6.—Volume in trees 5 inches d.b.h. and larger by stand-size class and kind of material, cubic-foot and standard-cord bases

Stand-size class	In trees of saw-timber size				All other material[1]		Total	
	Sawlog portion		Top portion					
	Million cu.ft.	M cords	Million cu.ft.	M cords	Million cu.ft.	M cords	Million cu.ft.	M cords
In saw-timber stands:								
5,000 bd.ft. and over per acre	12.1	186	4.4	68	4.3	66	20.8	320
1,500 to 5,000 bd.ft. per acre	21.3	328	8.2	126	14.9	229	44.4	683
Total	33.4	514	12.6	194	19.2	295	65.2	1,003
In pole-timber stands	8.2	126	2.7	42	23.6	363	34.5	531
In all other stands	1.9	29	.4	6	8.5	131	10.8	166
In all stands	43.5	669	15.7	242	51.3	789	110.5	1,700

[1] Includes pole-timber trees, also the sound volume in cull trees and the limbs of hardwood saw-timber trees.

These all-inclusive volume measurements are made in terms of cubic feet of solid wood, i.e., excluding bark volume. Unfortunately, however, this cubic-foot-of-solid-wood unit is not the one that is in general commercial use. Most timber other than saw timber is bought and sold in the "standard cord" unit--a pile of stacked round bolts 4 feet

Table 7.—Species distribution of timber volume in all live trees (5 inches d.b.h. and larger) by kind of material, cubic-foot and standard cord bases

Species	In trees of saw-timber size				All other material		Total		
	Sawlog portion		Top portion						
	Million cu.ft.	M cords	Million cu.ft.	M cords	Million cu.ft.	M cords	Million cu.ft.	M cords	Percent
Red and black oaks	13.7	210	4.9	76	9.3	143	27.9	429	25.2
White oak	4.7	72	1.7	26	2.0	31	8.4	129	7.6
Chestnut oak	7.6	117	3.2	49	12.4	191	23.2	357	21.0
Yellow-poplar	5.1	79	1.5	23	4.3	66	10.9	168	9.9
Hickory	3.3	51	1.3	20	3.5	54	8.1	125	7.3
Other species	9.1	140	3.1	48	19.8	304	32.0	492	29.0
Total	43.5	669	15.7	242	51.3	789	110.5	1,700	100.0

wide, 4 feet high, and 8 feet long. While the over-all dimensions of this unit include 128 cubic feet, a considerable part of this space is occupied by bark and by air space between the round sticks. The actual wood content of a standard cord varies considerably with the diameter of the stacked bolts, their relative straightness, and the thickness of bark. The converting factors used by the Forest Survey in translating cubic feet of solid wood into standard cords with bark are 65 cubic feet for hardwood and 78 cubic feet for softwood. In the Monocacy watershed, the softwood volume is too small to justify estimates based on sampling method. It is therefore grouped with "other species."

The estimated volume in all trees 5 inches d.b.h. and larger amounts to 110.5 million cubic feet or 1,700,000 cords (table 6). Of this total some 39 percent (43.5 million cubic feet or 669,000 cords) is sawlog material. An additional 14 percent (15.7 million cubic feet or 242,000 cords) is in the top portions of saw-timber trees. The remaining 47 percent (51.3 million cubic feet or 789,000 cords) is in pole-timber trees and in sound cull material not classed as saw timber.

The average-per-acre volume varies greatly by stand-size:

		Average per-acre volume	
	Acres	*Cubic feet*	*Cords*
Saw-timber stands	52,300	1,247	19.2
Pole-timber stands	61,100	565	8.7
Sapling and seedling and poorly-stocked areas	42,600	253	3.9

There is obviously a major job in rebuilding the growing stock on the sapling, seedling, and poorly-stocked area. Time and protection from fire and grazing are the major factors in any such rebuilding program. Planting or direct seeding might also be desirable on limited areas.

The species distribution of volume in all trees 5 inches d.b.h. and larger is shown in table 7. While the general pattern here is similar to that for saw-timber volume, the proportion in the more desirable species such as white

Table 8.--Timber volume in all live trees (5 inches d.b.h. and larger) by tree-diameter class, cubic-foot and standard-cord bases

Tree-diameter class	Volume		Percentage distribution	
			By class	Cumulative, smallest to largest
Inches	M cu.ft.	M Cords	Percent	Percent
5.0 to 6.9	16,800	259	15.2	15.2
7.0 to 8.9	19,400	298	17.6	32.8
9.0 to 10.9	15,100	232	13.7	46.5
11.0 to 12.9	14,000	215	12.7	59.2
13.0 to 14.9	14,600	224	13.2	72.4
15.0 to 16.9	9,000	138	8.1	80.4
17.0 to 18.9	5,700	88	5.2	85.7
19.0 to 20.9	5,200	81	4.7	90.4
21.0 to 22.9	2,300	36	2.0	92.4
23.0 to 24.9	2,200	33	2.0	94.4
25 and larger	6,200	96	5.6	100.0
Total	110,500	1,700	100.0	--

oak and yellow-poplar is considerably less. This, of course, means a higher percentage in the less desirable species such as chestnut oak, hickory, and the minor species. Such conditions are a mark of forest deterioration due to repeated cutting of only the better timber. Under such practices the residual stands acquire an increasing proportion of the less desirable species.

Of the total volume in all trees 5 inches d.b.h. and larger, some 46.5 percent is in trees less than 11 inches d.b.h. While there is considerable utilization of trees smaller than 11 inches d.b.h. for sawlogs, it would be much better if such timber were left to attain better size. These

trees are just reaching the stage where they begin to put on quality wood at a rapid rate.

CURRENT ANNUAL GROWTH

ESTIMATING THE GROWTH rate of timber within a large area such as the Monocacy River watershed--where there are wide variations in the amount and quality of growing stock--presents a number of problems. With no previously established system of measured sample plots that can be remeasured, the initial Forest Survey must rely upon less direct methods for determining growth.

The procedure used is somewhat complicated, and it involves a certain amount of personal judgment. The first step is the extraction of "increment cores" from a sample of living trees. An increment core is a pencil-size section of wood obtained by boring into the trunk of the tree along one of its radii with a hollow bit. Measurements of the annual growth rings give an indication of the rate at which the tree is putting on wood; these measurements provide the basis for estimating the growth to be expected in the future. Additional calculations are made to account for "ingrowth"--pole trees that reach saw-timber size and saplings that reach pole-timber size in the course of a year. This procedure gives an estimate of the gross volume of wood that is being put on by the growing stock. The gross figure is then adjusted to "net growth" by deducting the expected annual normal mortality--losses from causes such as suppression, windthrow, endemic insects and tree diseases, normal forest fires, and other similar causes. The final figure is the current annual net growth.

The indications are that the Monocacy River watershed has a current annual net growth in sawlog material of about 11.6 million board feet. The total net growth in all trees 5 inches d.b.h. and larger amounts to about 5 million cubic feet or 77,530 cords. The distribution of that growth by stand-size class is shown in table 9.

The growth rate in the heavier saw-timber stands averages 237 board feet per acre per year, and in the lighter stands it averages 145. For the saw-timber stands as a whole, the average growth rate is 166 board feet per acre

Table 9.--Estimated current annual net growth of timber in the Monocacy River watershed, 1950

Stand-size class	Sawlog material		Total net growth in all trees 5 inches d.b.h. and larger		
	M bd.ft.	M cu.ft.	M cu.ft.	Cords	Percent
Saw-timber stands:					
More than 5,000 bd.ft. per acre	[1]2,775	460	630	9,690	12.5
1,500 to 5,000 bd.ft. per acre	[2]5,885	980	2,160	33,230	42.9
Total	8,660	1,440	2,790	42,920	55.4
Pole-timber stands	2,940	490	1,710	26,310	33.9
Sapling and seedling and poorly stocked areas	(3)	--	540	8,300	10.7
All stands	11,600	1,930	5,040	77,530	100.0

[1] Of this, 535,000 board feet is ingrowth.
[2] Of this, 2,409,000 board feet (41 percent) is ingrowth.
[3] Too small to justify an estimate.

per year. The annual net growth of sawlog material in the stands of pole timber is 48 board feet per acre per year.

The growth rate of all trees 5 inches d.b.h. and larger averages 53 cubic feet or 0.8 cord per acre per year in the saw-timber stands; 28 cubic feet or 0.4 cord in the pole-timber stands; and 13 cubic feet or 0.2 cord in the sapling, seedling, and poorly stocked areas.

The timber-quality analysis presented above indicates that about half the volume of sawlog material is of F-3 grade or poorer. It is probable that a corresponding proportion of the current net growth is of like quality. In the pole-timber and other stands the percentage of saw-timber growth in the poorest grades is even greater, because so many of the larger trees in such stands are low-quality individuals left in past cutting operations.

COMMODITY DRAIN ON THE FOREST GROWING STOCK

LOSSES IN THE FOREST growing stock due to normal mortality have already been taken into account in arriving at the estimate of net growth. The other element of drain is, of course, the harvest of timber products.

An estimate of this drain (table 10) was made through canvassing the wood-using plants that draw raw material from the watershed. This provided information on the drain of sawlogs, veneer logs, and cooperage bolts. Pulpwood and feltwood buyers supplied data on the approximate cut for these two products. The harvest of fuel wood and fence posts

Table 10.--Estimated harvest of primary timber products and consequent drain on the forest growing stock, 1949

Timber product class	Harvest in standard units of measure		Consequent drain on the forest growing stock	
	Unit	Quantity	M cu.ft.	Percent
Sawlogs, veneer logs and cooperage bolts	M bd.ft.	5,854	975	38.0
Pulpwood and feltwood	Cords	1,000	78	3.0
Fuelwood	Cords	17,000	1,100	42.9
Posts	Pieces	19,000	20	.8
Logging waste	--	--	390	15.3
Total commodity drain		--	2,563	100.0

was estimated on the basis of a sampling survey of the consumption of these two commodities. Since neither one is hauled long distances, the sampling was done wholly within the watershed. A further sampling survey of logging operations provided data for an estimate of the growing stock volume that is left in the woods as logging waste.

The estimated proportion of the total commodity drain that comes from sawlog material is indicated in table 11. While this estimate is subject to a considerable margin of

error, it seems quite clear that the timber harvest from saw-log material in 1949 was somewhat under the net board-foot growth in saw-timber stands.

Table 11.--Estimated proportion of total commodity drain from sawlog material

Item	Cut from sawlog material		
	Percent	M bd.ft.	M cu.ft.
Sawlogs, veneer logs and cooperage bolts	100	5,854	975
Pulpwood and feltwood	10	[1] 50	8
Fuelwood	20	[1] 1,700	220
Posts	5	[1] 6	1
Logging waste	10	[1] 234	39
Total	—	7,844	1,243

[1] Converted on the basis of 1 cubic foot round wood equals 6 board feet.

R E L A T I O N S H I P

O F G R O W T H T O D R A I N

UNLIKE THE CONDITION so often found in forests of the eastern United States, the Monocacy River watershed has a probable small surplus of growth over drain even in the saw-timber stands, and a fairly substantial surplus of total saw-timber growth over saw-timber drain (table 12). The over

Table 12.--Relationships of current net growth to commodity drain, 1949

Kind of material	Current annual growth	Commodity drain	Surplus	Drain as percent of growth
	M bd.ft.	M bd.ft.	M bd.ft.	Percent
Sawlog material in saw-timber stands	8,660	[1]7,844	816	91
Total sawlog material	11,600	7,844	3,756	68
	M cu.ft.	M cu.ft.	M cu.ft.	Percent
Material of all kinds	5,040	2,563	2,477	51

[1]A minor part of this drain may have come from saw-timber trees in pole-timber and other stands.

all ratio of net growth in all trees 5 inches d.b.h. and larger to total commodity drain is even more favorable.

With these margins of growth over drain, especially in the young timber, it should be possible to rebuild the growing stock and, at the same time, greatly improve the quality of the stands. In this respect the Monocacy River watershed offers a good opportunity--better than many other localities can offer--for the improvement of forest management.

S U M M A R Y

O F T H E F O R E S T S I T U A T I O N

A GENERAL SUMMARY of the main facts at this point will help to draw the picture into focus:

- Land area of the watershed: 620,880 acres or 970 square miles.
- Present forest area: 167,600 acres or 27 percent of total land--
  Commercial forest area: 156,000 acres.
  Reserved forest area : 11,600 acres.
- Forest-land area by dominant forest types: Red oak-black oak, 70 percent; chestnut oak, 13 percent; white oak, 12 percent; yellow-poplar, 2 percent; pine-oak, 3 percent.
- Forest-land area by stand-size class: Saw-timber stands of more than 5,000 board feet per acre, 8 percent; saw-timber stands of 1,500 to 5,000 board feet per acre, 26 percent; pole-timber stands, 39 percent; sapling-seedling and poorly stocked stands, 27 percent.
- Commercial forest-land ownership: Private farm woodland, 50 percent; other private, 32 percent; total private, 82 percent; state, 12 percent; county and municipal, 6 percent; total public 18 percent.
- Saw-timber volume: In stands of more than 5,000 board feet per acre, 62 million board feet; in stands of 1,500 to 5,000 board feet per acre, 103 million board feet; in stands of pole timber and in other stands, 48 million board feet; in stands of all sizes, 213 million board feet.
- Saw-timber volume by tree-diameter class: Under 15 inches at breast height, 43 percent; between 15 and 21 inches d.b.h., 35 percent; over 21 inches, 22 percent.
- Saw-timber volume (hardwood) by log grade: F-1, 12 percent; F-2, 35 percent; F-3, 35 percent; Structural, 18 percent.
- Timber volume in all live trees 5 inches d.b.h. and larger: Sawlog material, 43.5 million cubic feet or 669,000 cords; top sections of saw-timber trees, 15.7 million cubic feet or 242,000 cords; pole-timber trees, 51.3 million cubic feet or 789,000 cords; total volume, 110.5 million cubic feet or 1,700,000 cords.

- Species distribution of volume in all live trees: Red and black oaks, 25 percent; white oak, 8 percent; chestnut oak, 21 percent; yellow-poplar, 10 percent; hickory, 7 percent; other species, 29 percent.
- Current annual net growth: Sawlog material in saw-timber stands, 8.7 million board feet; sawlog material in all stands, 11.6 million board feet; total growth in all trees 5 inches d.b.h. and larger, 5,040 M cubic feet or 77,530 cords. Average growth rates per acre per year: Saw-timber in saw-timber stands, 166 board feet; all trees 5 inches d.b.h. and larger in saw-timber stands, 53 cubic feet or 0.8 cord; in pole-timber stands, 28 cubic feet or 0.4 cord; in all other stands, 13 cubic feet or 0.2 cord.
- Commodity drain 1949: From sawlog material, 7,988 M board feet; from all kinds of material, 2,563 M cubic feet or 39,400 cords.
- Relationship of drain to growth in terms of percentage: Drain of sawlog material from saw-timber stands, 92 percent of current net growth; of sawlog material from total saw-timber growth, 69 percent; of all kinds of material from total growth in all trees 5 inches d.b.h. and larger, 51 percent.

TIMBER-BASED INDUSTRIES AND INCOME

THE FIELD SURVEY of timber-processing plants showed that 66 sawmills drew all or the major part of their log supply from the Monocacy River watershed in 1949 (table 13). Of this total, 40 mills were small part-time operations that cut less than 50,000 board feet per year.

The majority cut much less than this because the average production for the whole group was only 9,700 board feet--about 2 or 3 days' output for a very small mill. The lumber sawed by this group amounted to only 7 percent of the total cut. Another 9 percent of the lumber output was sawed by 7 mills that had an average production of 70,000 board feet. Most of the mills in this second class were also part-time operations. The bulk of the lumber (84 percent) was cut by 12 mills that averaged 142,000 board feet and 7 larger mills that averaged 445,000 board feet.

Table 13.--Lumber production of sawmills drawing all or a major part of their log supply from the Monocacy River watershed, 1949[1]

Production class (in M bd.ft. per year)	Mills	Lumber cut	Average per mill	Distribution
	Number	M bd.ft.	M bd.ft.	Percent
Less than 50	40	386	9.7	7
50 to 99	7	489	70.0	9
100 to 249	12	1,706	142.0	30
250 ond more	7	3,113	445.0	54
Total	66	5,694	--	100

[1]A minor part of this part of this production was from logs obtained outside the watershed. This is offset, however, by another small quantity of lumber sawed at more distant mills that drew only a small part of their log supply from the watershed.

It is probably fortunate that so large a proportion of the sawlogs from the watershed are processed by the larger mills. These mills are more likely to be interested in sustaining the supply of raw material and in the cutting practices that will make that possible. Then too, they provide a more stable market outlet for the timber growers and a stable source of income for the dependent communities.

In addition to the sawmills, there is one veneer plant located in the watershed. This plant obtains some logs from the watershed but, because of scarcity of suitable material, is forced to go far outside to supply its needs. The watershed is within the buying range of several other veneer plants. Hence, markets are available for any additional quantity produced.

A tight-cooperage plant is located on the edge of the watershed. It now receives a considerable portion of its white oak from the area. Suitable white oak is not plentiful.

Although no pulp, wood felt, or excelsior plants are located within the area, 1,000 cords of pulpwood, feltwood, and excelsior wood were cut in 1949. Production was unusually low that year. The normal yearly production is probably close to 2,000 cords, according to buyers of such products. Pine species are preferred for these products. However, approximately 85 percent of those products obtained from the watershed in 1949 were of hardwood species. Any increase in

the amount of pine made available through planting would find ready markets as pulpwood, feltwood, excelsior-wood, or sawlogs.

A rough estimate of the stumpage value of the 1949 timber harvest in the Monocacy River watershed can be made by applying average stumpage values:

- Sawlogs, veneer logs, cooperage bolts:
  5,854 M at average $20 per M $117,080
- Pulpwood and feltwood:
  1,000 cords at average $3 per cord 3,000
- Fuel wood:
  17,000 cords at average 50 cents per cord 8,500
- Posts:
  19,000 pieces at average 3 cents per post 570

Total stumpage value $129,150

Thus it appears that timberland owners got about $130,000 for standing timber. The logging, transportation, and processing of that timber added further value roughly estimated as follows:

- Lumber: 5,694 M bd.ft. at average $75 per M, deducting $20 for stumpage $313,170
- Veneer and cooperage: 160 M bd.ft. at average $100 per M, deducting $20 for stumpage 12,800
- Pulpwood and feltwood: 1,000 cords at average $12 per cord, deducting $3 for stumpage 9,000
- Fuelwood: 17,000 cords at average $12 per cord, deducting 50 cents for stumpage 195,500
- Posts: 19,000 pieces at average 30 cents per post, deducting 3 cents for stumpage 5,130

Total all products $535,600

The total values realized from the timber harvest probably amounted to about $664,750. At $2,500 per year this sum would provide livelihood for about 260 families. This is apparently about the extent to which the forests now contribute to the present economy of the watershed. There is some additional income from recreation but it is difficult to estimate how much.

Forest land on farms now contributes a very small part of total cash farm income. Data for the watershed by itself are not available, but those for the three counties of Frederick, Carroll, and Adams are doubtless indicative. The Census of Agriculture shows that for these three counties as a whole, the 1944 cash income from the sale of farm forest products represented about 0.4 percent of the total cash income from sale of farm products.

Actually, about 6 percent of the farms reporting woodland acreage reported sales of forest products. The average receipt per farm for those making such sales was $300. On the assumption that the 3-county averages are about the same as those within the watershed, sales of forest products from the farm woodlands of the watershed must have amounted to about $68,000—an over-all average of 86 cents per acre. In northern New England, where farmers harvest much of their own woodland products and sell at roadside or deliver to the mill, county-wide annual returns of $2 to $3 per farm woodland acre are not uncommon.[6]

The farmers of the Monocacy River watershed could substantially increase the cash returns from their forest land by harvesting more of the products themselves and selling the products at the roadside instead of on the stump. Farmers who thus do their own cutting are more apt to treat their forests with the same kind of intelligence that they bestow on their crop lands, their pastures, and their livestock.

BETTER FOREST MANAGEMENT FOR WATER AS WELL AS TIMBER

MEASURES NEED TO BE taken to improve the forest lands in the Monocacy River watershed. Such improvement will serve a dual purpose: it will conserve the water resource

[6] RETTIE, JAMES C., BANKS, WAYNE G. AND DOVERSPIKE, GEORGE E. PRELIMINARY SURVEY OF THE MARKETING OF FARM WOODLAND PRODUCTS IN THE NORTHERN NEW ENGLAND STATES. NORTHEAST. FOREST EXPT. STA. PAPER 25. 28 PP., ILLUS. UPPER DARBY, PA. 1949.

by regulating streamflow (with less erosion and siltation), and it will, at the same time, increase the quantity and quality of timber products.

As suggested in the Foreword of this report, the major efforts should be made on four main fronts: Fire protection, forest management, forest planting, and elimination of grazing from farm forests.

Fire Protection

The last big fire that swept the Catoctin Hills occurred about a generation ago. Meanwhile, an efficient fire-protection system has been developed. It is, however, difficult to maintain the necessary vigilance as time goes on and more and more people forget the last great disaster. Complacency about fire is a creeping ailment that must be combatted, not alone by the public agencies who have the responsibility for protection, but also through continuous strong support on the part of local organizations such as the Monocacy River Watershed Council and the various organizations that are represented in it.

There is a continuous job to be done in education for forest fire prevention. Then too, there is the need for being prepared for the unusual season of extreme hazard that may come only once in a lifetime. The great forest fire that swept southwestern Maine in October 1947 simply overpowered a control organization that has been for many years sufficient to meet the need.

One great fire can undo a lifetime of constructive work on watershed improvement. Adequate plans to recognize and deal with such emergencies quickly are vitally important. Although the protection record in the Monocacy River watershed is excellent, local people and organizations should not rest on their oars and assume that the State fire-control organization can or should do the whole job of preventing fire.

The effects of fire on forest growth and on the water-absorbing properties of forest soils are too well known to require discussion here.

Forest Management

Well-stocked forest lands are important for watershed purposes as well as for producing timber. The permeable,

humus-covered soils that well-stocked forests develop are essential for good water management. Restoring forest lands to well-stocked condition is chiefly a matter for forest management.

Both Maryland and Pennsylvania now provide free assistance to owners of small woodlands who request help in managing their timber. This service, provided by technically trained foresters under supervision of the state foresters, normally consists of a preliminary examination of the forest property, done so the owner may be advised whether he has any merchantable timber. If he has such timber that should be taken out of the stand--either as a harvest or as an improvement cutting--the forester will mark such trees and estimate their volume and current market value. He will also suggest some of the market possibilities that the owner can explore, and recommend a form of written sale contract.

The forester can also make recommendations about how the logging should be done, giving special attention to the location of skid trails and roads in order to prevent erosion and gullying. He may even check to see that the job is being done properly. Although this program has been in operation for a number of years, only a part of the small-woodland owners have taken advantage of it. Much more could be done by various civic organizations to support and promote it.

Another avenue to better forest practices lies in the establishment of a forest cooperative, in which the timber owners themselves organize to provide their own forester and their own market outlet for timber products. A number of these cooperatives have been set up in other localities. Some have been successful and others have failed. Experience seems to indicate that a cooperative organized to give complete service--from woodland management through timber harvesting and processing and marketing of lumber and other finished products--has the best chances to succeed. It also has a better opportunity to get for the members the full financial return from their timber. It likewise eliminates the troublesome conflict of interests between the timberland owner who wants to preserve and improve the productivity of his forest land, and the sawmill operator who wants to cut all of that timber and only that timber that will return a profit to him. The experience of the largest and most suc-

cessful forest cooperative in the United States has recently been summarized in a Department of Agriculture bulletin.[7]

The possibility of organizing a forest cooperative in the Monocacy River watershed is certainly worth consideration. The present timber cut is unusually favorable in relation to growth. There is a large volume of low-quality saw timber that should be harvested as soon as possible in the interests of stand improvement. A modern, cooperatively owned processing plant could move much of this material in periods when the market will absorb it. Handling the products of many timber owners, it would be in a stronger bargaining position than any single owner or independent sawmill operator can be. Such a cooperative could develop new outlets for improvement cuttings and thinnings. Chipped or shredded wood for cattle bedding and for a soil mulch is one possibility that should be explored.

Much of the data needed for determining the feasibility of a forest cooperative is now at hand. The present report gives information on timber volume, quality, rate of growth and drain, timberland ownership, and existing timber-based industries. Many of the woodland owners of the Monocacy River watershed are active in other cooperatives. This form of business enterprise is not new to them. They know its advantages and have seen it operating successfully.

Supplementing and reinforcing these approaches to the job of getting better forest management is another important step that has been taken by the State of Maryland. The Forest Conservancy District Act, now being put into effect, requires that timber operators meet certain minimum standards in all their cutting operations. These cutting practice regulations are designed to assure that forest land shall be kept in a reasonably good condition for stand regeneration. It should put a stop to the widespread clear-cutting that has been so prevalent in the past, and also put some restraint on the cutting of premature timber.

This is of vital importance in the Monocacy River watershed, where 39 percent of the forest land is in pole-timber stands--just reaching the stage when they begin to

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[7] RETTIE, JAMES C., AND INESON, FRANK A. OTSEGO FOREST PRODUCTS COOPERATIVE ASSOCIATION OF COOPERSTOWN, NEW YORK. AN EVALUATION. U.S. DEPT. AGR., AGR. INF. BUL. 17. 42 PP., ILLUS. 1950.

put on the most rapid growth of quality wood. State regulation of timber-cutting practices applies, however, only in the Maryland part of the watershed. Pennsylvania has not taken such action.

Considering further the physical measures--in addition to better harvest cutting methods--that should be taken to rebuild the timber resource, the most important is stand-improvement work. This means getting rid of the nonmerchantable components of the stand--old and decadent "wolf trees" that have been left in earlier cuttings, young trees of poor form that will not grow into merchantable timber, thinnings that should be made to speed up the growth of crop trees, weed species that should be removed to give room for the more desirable species. Some of this material can be cut and used for fuelwood, round timbers for the farm, and even for pulpwood and feltwood. Some of it can be eliminated simply by killing the trees either by "girdling" or by the use of tree poisons such as ammonium sulfamate.

Another line of effort--one that has a direct relationship to the reduction of sediment in streams--involves logging roads and trails. It is very important that these be located properly, to avoid unnecessary damage to the residual stand or unnecessary disturbance of the forest soil. Roads or skid trails running straight up and down slopes are almost sure to result in gullies within a short time. Even when properly located, there is need for after-logging care of skid trails and roads. The specific treatment varies according to soil, slope, and other conditions. In some instances, the seeding of grasses or the planting of trees on the exposed soil is needed. In other cases, mulching with straw may be desirable. Disposal of water from road drainage ditches and culverts is almost always important.

One example of the care that should be exercised on some of the critical watersheds is found on the municipal watershed land owned by the City of Frederick. The City has entered into cooperative arrangements with the Maryland Department of State Forests and Parks to provide the planning and direction of logging operations that will safeguard watershed values.

Forest Planting

The major part of the watershed sedimentation problem stems directly from poor land use. Studies made by the Soil

Conservation Service in the Maryland part of the watershed indicate that there is a considerable acreage of land now in cultivation or pasture that should be returned to forest land. There is also a considerable acreage of poorly stocked woodland that needs reinforcement planting. The conditions in the Maryland part of the watershed are probably somewhat better than in the Pennsylvania part--because of the generally steeper terrain in the Pennsylvania part.

On the basis of this assumption, the total acreage that should be planted amounts to about 25,000 acres: 18,000 in pasture or cultivation that should go into woodland and 7,000 in poorly stocked forest that needs reinforcement planting. The planting of this area would certainly make a substantial contribution to the reduction of silt-load in the streams. It would transform what is now a social and economic liability into an asset.

The local Forest Conservancy District Boards are aware of this need and have begun planning to meet it. The Frederick County Forestry Board, for example, has set a goal of 1 million trees to be planted in 1951. The Maryland Department of State Forests and Parks is now providing planting stock free of charge for watershed planting. The Soil Conservation Districts also provide free planting stock to farmers who have signed up as cooperators.

Unfortunately, neither of these agencies now has sufficient planting stock available to fully meet these needs. In order to get the job done within 10 years, it would be necessary to plant about 2,500 acres annually. This would require about 2 million trees per year and 7,500 man-days of labor. The planting program is important because of the large area of poorly stocked land which, because of soil characteristics and slope, is not providing proper infiltration of rainfall and snow melt.

Elimination Of Grazing

Another condition that needs attention is the continued grazing of forest land on farms by livestock. This practice is not only injurious to the hardwood seedlings that are eaten off by cattle and other animals; it also impairs the watershed efficiency of forest land.

Trampling not only destroys reproduction but also compacts the soil, destroying the spongy litter and humus that normally absorbs and holds large quantities of moisture

where it falls. Rapid runoff develops, which, when concentrated, causes gullies and erosion. Failure to get water into the ground also means lower water tables, which are reflected in springs and wells drying up and decreased streamflow during dry periods. Exposure to the ground and destruction of the litter of dead leaves and twigs also exposes the soil to solid freezing in the winter. Land in such a condition will not absorb the water from melting snow. Runoff is thereby increased during periods of excessive precipitation in winter and spring. Such conditions contribute to floods.

The 1945 Census of Agriculture shows that 14,000 acres (18 percent) of the farm forest land in the Monocacy River watershed are still being grazed. The program of woodland improvement should certainly seek to eliminate the grazing of woodlands. On most farms, the fencing of the woodlot and the improvement of the open pasture land is all that is necessary. Where this will not suffice, it is far better to clear a part of the woodlot, seed that to pasture, and fence the balance. If it is necessary to provide shade for stock, a small portion of woodland can be fenced into the pasture or, better still, shade trees can be planted in the pastures. These measures, when properly applied, will produce good pasture and good woodlot in place of inferior pasture and inferior woodlot.

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The various measures recommended here are the main elements in a forest-land program for retarding runoff and preventing erosion. They are also measures for increasing the timber yield from forest land.

Such a program is partially in operation in the higher drainages of the Potomac River basin. However, the Monocacy River watershed was not included in the Department of Agriculture's Flood Control surveys that preceded the establishment of the existing Potomac basin program. Congress has recently authorized a review of the watershed-management problems of the entire Potomac River basin. When this has been done a more detailed program of remedial measures dealing specifically with siltation and other water problems can be formulated.

Meanwhile, enough is already known to make a substantial beginning on such a program. The problem of rebuilding and maintaining the forest resource for its many products and services can be solved only through cooperation of individual landowners with agencies like the Monocacy River Watershed Council, the Forest Conservancy District Boards, the Soil Conservation Districts, and other state and Federal agencies that can give assistance.

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