# THINNING YOUNG OAK STANDS FOR SMALL MINE TIMBERS — AT A PROFIT

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## THE PROBLEM

Young red oak-white oak stands[2] in the Anthracite Forest Region of Pennsylvania occupy nearly 3/4 million acres of land (fig. 1). At present they are a source of lagging, forepoles, and small props used in the coal mines. Under good cutting practice, a substantial quantity of these mine timbers could be produced by thinning these stands, which would at the same time build them up so they could produce more and better timber.

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[1]This study was made in cooperation with the Lehigh Coal and Navigation Company, which permitted the use of a portion of its forest land in Carbon County, Pa.

[2]Seedling and sapling stands that have less than 5 standard cords (about 10 tons) of wood per acre in trees in the 4-inch diameter class and larger. (Diameter is measured 4½ feet above the ground, called diameter breast height, or d.b.h.)

Figure 1.--Young oak stands occupy 3/4 million acres in the Anthracite Region.

The usual method of operation, however, is to cut everything that is salable. Normally, trees down to a 2-inch diameter-breast-high limit are removed. Inferior species--gray birch, sassafras, and pin cherry--are not generally cut (fig. 2), and because of their ability to reproduce readily they soon take over the site. On many areas fire follows in the heavy slashings created by overcutting, and oftentimes the site is so depleted that scrub oak becomes the dominant species. It then may take more than 50 years for the initial commercial species to make a satisfactory replacement, unless expensive restoration measures are resorted to. Thousands of acres revert annually to this deteriorated state.

In 1943, local landowners in the Anthracite Region received nearly $2,000,000[3] for trees removed from their woodlands for mining use. Yet, to fill the demands of the mining industry, a fourth of the mine boards and a small portion of the mine timbers, principally larger sizes used in gangways, had to be imported from adjacent counties and from other States.

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[3]Ineson, Frank A., and Ferree, Miles J. The Anthracite Forest Region--a problem area. U. S. Dept. Agr. Misc. Pub. 648. 71 pp., illus. Washington, D. C. 1948.

Figure 2.--A young stand after a typical mine-timber cutting. All the salable trees have been cut, and nothing remains except the inferior species: sassafras, gray birch, and pin cherry.

Better cutting practices are needed if the local forests are to contribute their full share to the region's economy. Data obtained from the present study indicate that young oak forests can be thinned for small mine timbers at a profit while building them up for large mine timbers and high-grade sawlogs.

## GETTING THE FACTS

Four 3-acre plots were laid out in 1947 in a typical 30-year-old, second-growth red oak-white oak stand averaging 20 tons[4] per acre on lands of the Lehigh Coal and Navigation Company in Carbon County, Pa. The stand included white oak, red oak, scarlet oak, red maple, sassafras, gray

[4]In trees 2 inches d.b.h. and larger. One ton here is equivalent to an average solid content of 34 cubic feet or about ½ cord.

birch, pin cherry, and serviceberry. These trees ranged mostly between 3 and 5 inches d.b.h. and 15 to 20 feet in height. Approximately half of the trees were single-stemmed and of seedling origin. A few larger trees left from previous cutting operations were scattered through the stand.

Three of the plots were partially cut; 22, 40, and 65 percent of the volume was removed. The fourth was clear-cut in accordance with local practice. The partial cuttings were in the nature of thinning and improvement operations, removing the poorer trees and reserving the better ones. The trees and tonnage inventoried and marked for cutting are shown on a per-acre basis in table 1. The number of trees and tons per acre were reasonably uniform among the cutting areas.

Table 1.--Number of trees and tons per acre by degree of cutting

| Intensity of cutting[1] (percent) | Trees per acre | | | Tons per acre | | |
|---|---|---|---|---|---|---|
| | Before | Cut | After | Before | Cut | After |
| 22 | 894 | 201 | 693 | 22 | 5 | 17 |
| 40 | 987 | 485 | 502 | 19 | 8 | 11 |
| 65 | 911 | 572 | 339 | 17 | 11 | 6 |
| 94[2] | 991 | 863 | 128 | 23 | 22 | 1 |

[1]Percent of original tonnage.

[2]Considered clear-cut for all practical purposes.

Two men in the mine-prop business contracted to do the cutting. Since they lacked experience in cutting selectively-marked young oak timber, they were uncertain of the price they could afford to pay the landowner for the standing trees marked for cutting. A flat rate of $0.28 per ton was agreed upon, on the presumption that at this rate they would make a fair profit from the entire job. The stumpage rate that could have been paid for each degree of cutting was computed when the job was completed.

The operation was handled on a strictly commercial basis. Trees designated for removal were marked and the operators were asked to utilize all portions of felled trees having a sale value as mine timber, and to exercise reasonable care on the partially cut areas to avoid damage to the remaining trees

The wage rate of each partner was $1.00 per hour. They employed two laborers at $0.75 per hour. The four men worked together as one crew.

Double-bit axes and 2-man crosscut saws were used for felling and bucking. Usually three men prepared the products and one man drayed them to the roadside with a 1½-ton truck, but at times all four engaged in felling, limbing, bucking, or draying. Since the timbers were small enough for one or two men to handle (fig. 3), skidways or landing decks were nnnecessary.

Figure 3.--Mine props, lagging, and forepoles piled along roadside ready for delivery to the coal mines.

Only one plot was cut at a time. Man-hour and production records were kept separately for each. All activities were grouped into two major categories, namely, felling-bucking-draying and miscellaneous (table 2).

Table 2.--Production and labor requirements, by degree of cutting

| Item | Clear-cutting | Thinning cut, in percent of tons in original stand | | |
|---|---|---|---|---|
| | | 65 | 40 | 22 |
| **PRODUCTION** | | | | |
| Cut per acre ..... tons.. | 21.86 | 11.32 | 7.75 | 4.94 |
| Cut per man-day ..... tons.. | 1.74 | 1.73 | 1.49 | 1.44 |
| Area cut per man-day..acres.. | .08 | .15 | .19 | .29 |
| **LABOR REQUIREMENTS** | | | | |
| | Man-hours | Man-hours | Man-hours | Man-hours |
| Felling, bucking, draying: | | | | |
| Per ton | 3.86 | 3.88 | 4.47 | 4.73 |
| Per acre | 84.33 | 44.00 | 34.66 | 23.33 |
| Miscellaneous:[1] | | | | |
| Per ton | .74 | .73 | .89 | .81 |
| Per acre | 16.25 | 8.25 | 6.92 | 4.00 |
| Total labor: | | | | |
| Per ton | 4.60 | 4.61 | 5.36 | 5.54 |
| Per acre | 100.58 | 52.25 | 41.58 | 27.33 |

[1] Includes loading, temporary road clearing, rests, smoking, tool sharpening, and maintenance of other equipment.

These records show that the man-hour requirements per ton were practically identical for clear-cutting and for the 65-percent cut (4.60 and 4.61), but increased substantially for the lower intensities of cutting.

The cutters received an average price of $5.15 per ton for the products at roadside. This is based on $5.25 and $5.00 per ton received for mine timbers, and $3.75 per ton for some fuel wood. The operating costs, returns, and computed stumpage by degree of cutting are shown in table 3. These data show:

Table 3.--Costs, returns, and computed stumpage per ton, by degree of cutting

| Item | Clear-cutting | Thinning cut, in percent of original stand removed | | |
|---|---|---|---|---|
| | | 65 | 40 | 22 |
| | | Per A | Per A | Per A |
| Selling price | $5.15 | $5.15 | $5.15 | $5.15 |
| Operating costs[1] | 4.18 | 4.25 | 4.93 | 5.09 |
| Gross return | .97 21.20 | .90 10.18 | .22 1.70 | .06 0.30 |
| Margin for profit and risk | .42 | .42 4.75 | .22 | .06 |
| Computed stumpage[2] | .55 12.00 | .48 5.43 | (3/) | (3/) |

[1]Includes wages, insurance, social security, compensation, and truck fuel.

[2]Computed stumpage = selling price - (operating costs + 10 percent for profit and risk).

[3]Unable to pay stumpage.

(1) That by clear-cutting, gross returns above operating costs were 97 cents per ton. Allowing the operator 42 cents per ton as margin for profit and risk (10 percent of operating costs), leaves 55 cents available for stumpage. The growing stock, however, was completely destroyed, with little prospect for further income to the landowner for at least 30 years.

(2) That by cutting 65 percent of the volume (11 tons per acre) the operation yielded a gross return of 90 cents per ton over costs, provided 42 cents profit and 48 cents for stumpage. Here a substantial part of the growing stock was removed, but the trees left were the larger and better-formed elements of the stand.

(3) That by cutting 40 percent of the volume (8 tons per acre) the operation yielded a gross return of 22 cents per ton over costs. This is not adequate for the full 10 percent margin for the operator and provides for no stumpage payment to the landowner. On the other hand, a good reserve of growing stock for future production was left on the land.

(4) That by cutting 22 percent of the volume (5 tons per acre), the operation paid only 6 cents per ton over costs, that is, it barely paid its way. Here, too, nothing remained for stumpage, but the land was left fully stocked for rapid increase in volume production in the near future.

## REMOVE 50 PERCENT OF THE VOLUME

When these results are evaluated, it is apparent that the 65-percent cut of 11 tons per acre does not fully meet the requirements of good timber management. It opened up the stand excessively and reduced the growing stock too much to maintain full volume production. On the other hand, the 40 percent cut of 8 tons per acre yielded no return to the landowner and insufficient return to be attractive to the operator. Somewhere between these two intensities of cutting must lie a point where a partial cut less severe than 65 percent can be made that will provide the operator a fair profit and the landowner a moderate amount for stumpage.

For oak stands about 30 years old, such as these, that point appears to be around 57½ percent, which would remove 11½ tons per acre. With conditions as they were when this study was made a cut of 11½ tons per acre would have paid the operator's 10 percent profit and about 25 cents per ton stumpage to the landowner. A stand so cut would have about 375 trees per acre remaining, and in 10 to 15 years could again provide a profitable cut. Such treatment constitutes fair cutting practice, or the first step in forestry.

A cut of about 50 percent of the volume would have yielded the operator his 10 percent profit and risk allowance but would have left no residual for stumpage (fig. 4). Such a cut might appear unattractive to a landowner, yet the larger volume of better trees left as growing stock would have a higher growth rate. The waiting period for the next cut would thereby be shortened.

It appears likely that with improved logging equipment, more skilful operators, and good timing of cutting with seasonal markets, partial cuts as low as 8 tons per acre could be made profitably. When all conditions are favorable such a cut might even yield some stumpage in addition to the benefits in improved growth and quality that result from good cutting practices.

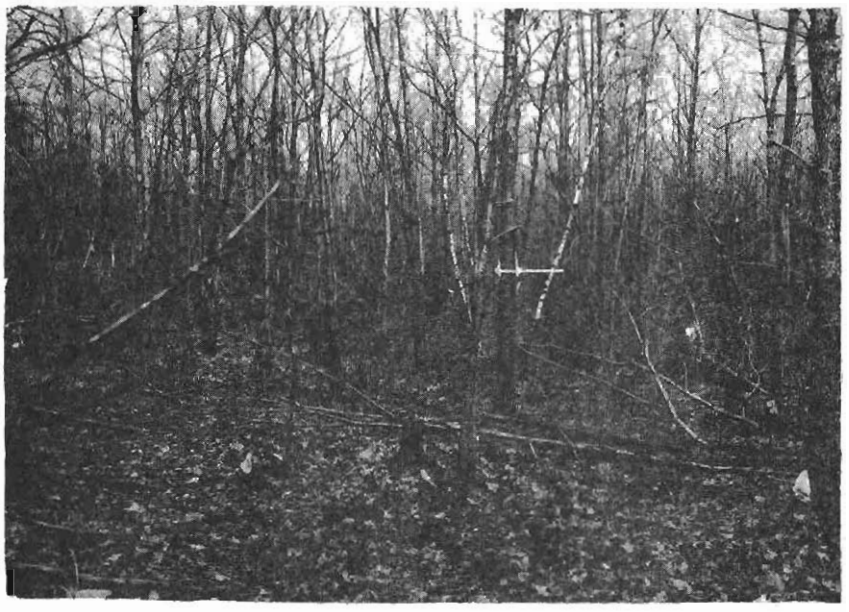


Figure 4.--The area shown in Figure 1 looked like this after a thinning cut. Thinning 10 tons per acre in 30-year-old oak timber would be profitable for both cutter and landowner.

## WHAT THESE RESULTS MEAN TO THE ANTHRACITE FOREST REGION

Most young oak stands in the Anthracite Forest Region contain a high percentage of trees of inferior species, poor form, and sprout origin; this is a result of past overcutting, abuse, and neglect. Improvement cuttings are necessary to build up these stands for optimum volume and quality production. Owners of such timber, however, have considered the cost of stand improvement prohibitive and have allowed the stands to be clear-cut or have left them untouched for nature to take its course. Given enough time, with protection from fire, these stands would develop into saw timber, but not of the best quality. Since the present condition was largely man-created, it is reasonable that man should lend a hand in rectifying his mistakes. As this study shows, improvement cuttings can pay for themselves and can even bring in a little profit.

If a major portion of the large acreage of young oak forests in the region could have 50 percent of its present volume removed, that is, volume in trees of inferior species, poor form, and sprout origin, the Anthracite Region would be well along toward building up a supply of badly needed high-quality timber. Moreover, much of the present clear-cutting of older stands to meet demands for lagging, forepoles, and small props would become unnecessary. With demands for these small mine timbers filled with improvement cuttings in young stands, the young trees in older stands could be reserved for further growth.

## TREE SPACING AS A GUIDE FOR PARTIAL CUTTING

Since most landowners will not wish to undertake detailed inventory and marking procedures preparatory to cutting, spacing between trees as shown in table 4 may be used as a guide for approximating the different cutting intensities in young oak stands similar to the one utilized in this study.

Table 4.--Number of trees to leave and spacing per tree, by degree of cutting

| Intensity of cutting (percent) | Trees to leave per acre[1] | Approximate spacing of trees left |
|---|---|---|
| | Number | Feet |
| 22 | 693 | 8 x 8 |
| 40 | 502 | 9 x 9 |
| 50 | 410 | 10 x 10 |
| 57½ | 375 | [2] 10½ x 10½ |
| 65 | 339 | 11 x 11 |

[1] Trees 2 inches d.b.h. and larger.

[2] Actually 10.8 x 10.8.

Spacing should be varied between individual trees so that straight, sound stems of good commercial species--chiefly red oak, white oak, chestnut oak, and red maple--are left in the reserved stand. Generally, you should cut all sprouts in a clump or none at all.

## SUPPLEMENTAL INFORMATION

Reliable figures concerning weights and volumes by diameter and species have long been needed by foresters, timber dealers, and landowners for making better timber appraisals. Converting factors of tons per cubic foot, tons per thousand board feet, number of pieces per ton, and the like, for the region's numerous commercial species would solve many of the problems encountered in buying and selling mine-timber products. A limited amount of such data was obtained from the present study. It is included in the following tables.

Table 5.--Height, volume, and weight of standing timber by diameter class

| D.b.h.[1] (inches) | Height[2] | Volume[3] | Weight |
|---|---|---|---|
| | Feet | Cubic feet | Pounds |
| 2 | 7 | 0.20 | 12 |
| 3 | 13 | .52 | 31 |
| 4 | 18 | 1.05 | 62 |
| 5 | 21 | 1.81 | 107 |
| 6 | 24 | 2.76 | 164 |
| 7 | 26 | 4.17 | 248 |
| 8 | 27 | 5.97 | 355 |
| 9 | 27 | 8.15 | 484 |

[1]Diameter breast high: 4½ feet above ground level.

[2]Average usable height, generally to a 2-inch top diameter.

[3]Volumes and weights are for white oak, red oak, scarlet oak, and red maple trees averaged together. Basis: 167 trees.

Table 6.--Converting factors by species and product[1]

| Species | Average number per ton[2] | Pounds per cubic foot | Tons per cubic foot | Cubic feet per ton |
|---|---|---|---|---|
| | | 6-FOOT LAGGING | | |
| Red oak | 97 | 64.7 | 0.0323 | 30.9 |
| White oak | 116 | 55.9 | .0279 | 35.8 |
| Red maple | 186 | 56.9 | .0284 | 35.1 |
| Sassafras | 210 | 38.6 | .0193 | 51.8 |
| | | 6-FOOT PROPS | | |
| Red oak | 32 | 63.5 | .0317 | 31.5 |
| White oak | 35 | 60.6 | .0303 | 33.0 |
| | | 12-FOOT FOREPOLES | | |
| Red oak | 25 | 63.8 | .0319 | 31.3 |
| White oak | 28 | 55.8 | .0279 | 35.8 |

[1]Source of data: Samples weighed on the job, and weighed truck loads delivered to the mines Pieces on each load were tallied by mid-diameter class, species, and product.

[2]Green weight, including bark. Averaged from entire job.

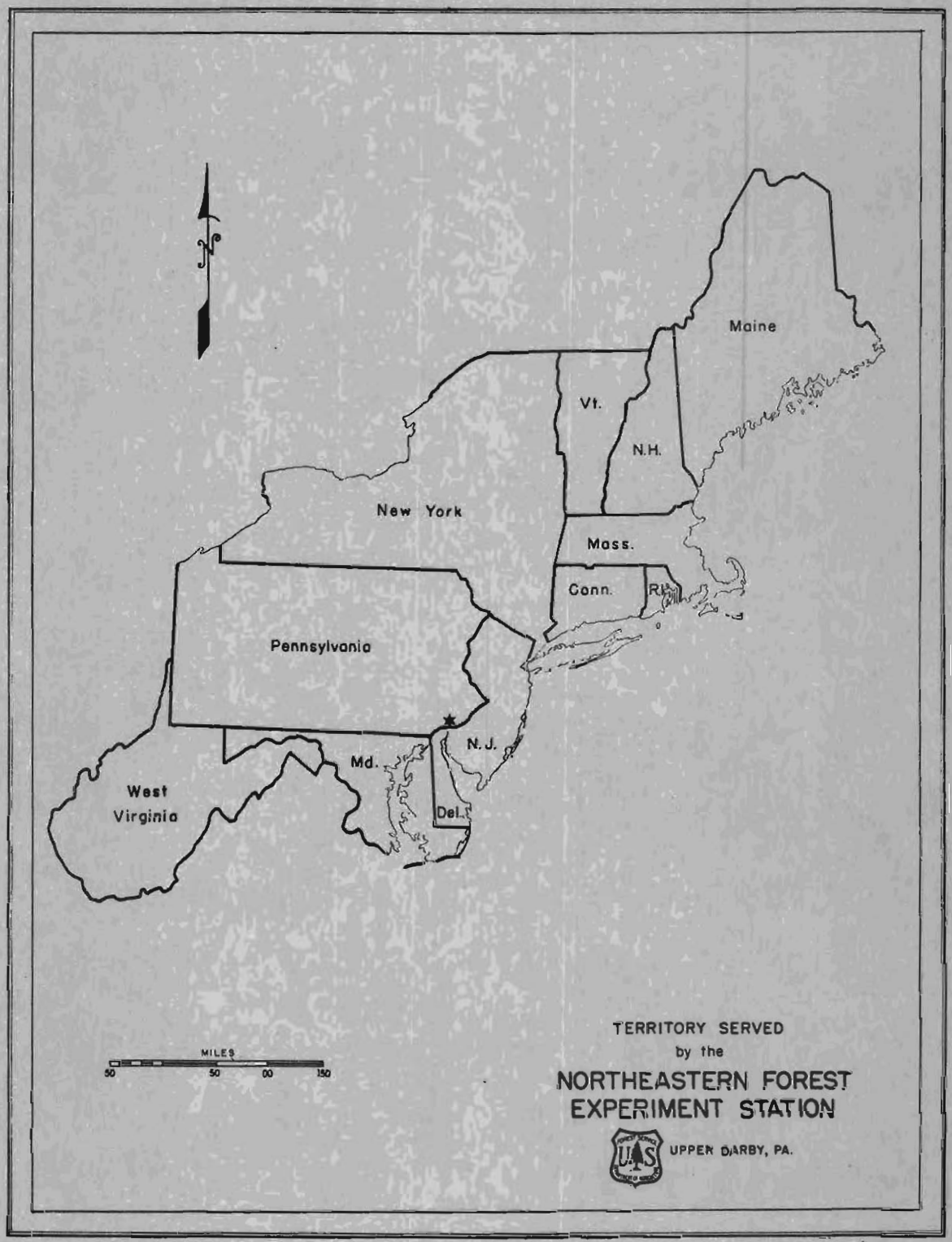
Table 7.--Average volume, weight, and pieces per ton of timbers used in anthracite mines

| Mid-diameter (inches, o.b.) | White Oak | | | Red Oak | | | Red Maple | | |
|---|---|---|---|---|---|---|---|---|---|
| | Cubic feet | Lbs.[1] | Pieces per ton | Cubic feet | Lbs. | Pieces per ton | Cubic feet | Lbs. | Pieces per ton |
| | | | | LAGGING[2] | | | | | |
| 2 | 0.14 | 8 | 250 | 0.14 | 9 | 222 | 0.14 | 8 | 250 |
| 3 | .30 | 16 | 125 | .29 | 19 | 105 | .29 | 16 | 125 |
| 4 | .55 | 31 | 64 | .54 | 34 | 59 | .52 | 29 | 69 |
| | | | | PROPS | | | | | |
| 4 | 0.55 | 31 | 64 | 0.54 | 34 | 59 | 0.52 | 29 | 69 |
| 5 | .87 | 52 | 38 | .87 | 55 | 36 | .85 | 45 | 44 |
| 6 | 1.29 | 77 | 26 | 1.25 | 78 | 26 | -- | -- | -- |
| 7 | 1.79 | 108 | 18 | 1.65 | 103 | 19 | -- | -- | -- |
| 8 | 2.39 | 145 | 14 | 2.08 | 130 | 15 | -- | -- | -- |
| | | | | FOREPOLES | | | | | |
| 3 | 0.75 | 40 | 50 | 0.73 | 45 | 44 | 0.63 | 36 | 55 |
| 4 | 1.20 | 66 | 30 | 1.10 | 70 | 28 | 1.07 | 60 | 33 |
| 5 | 1.98 | 114 | 17 | 1.74 | 112 | 18 | 1.70 | 98 | 20 |
| 6 | 3.15 | 180 | 11 | 2.64 | 168 | 12 | -- | -- | -- |

[1]Green weight, including bark.

[2]Lagging is 6 feet long, 2 to 3 inches at small end. Props are 6 feet long, 4 to 8 inches at small end. Forepoles are 12 feet long, 3 to 4 inches at small end. Sizes vary with each coal mine. Round wood is sold by weight, by linear foot, or by the piece.

AGRICULTURE--FOREST SERVICE--UPPER DARBY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