THINNING STRATEGIES TO INCREASE THE REGIONAL AVAILABILITY OF OAK TIMBER IN THE MID-APPALACHIAN REGION

John R. Brooks, Jingxin Wang, and Chris LeDoux[1]

Abstract.—Plot data from 6,727 fully stocked oak-hickory stands were selected from Forest Inventory and Analysis data from five ecoregions common to West Virginia, Pennsylvania, Maryland, Virginia, Kentucky, and Ohio. Each plot was thinned from below using an existing thinning algorithm, where 30, 50, and 70 percent of the existing basal area was removed. These thinning strategies were selected to capture most thinning intensities applied in this region. Utilizing three (low, average, and high) delivered pulpwood and sawtimber values and estimated harvesting and transportation costs from the ECOST simulator, we determined net thinning value for two cut-to-length (CTL) systems and two feller buncher systems. Net thinning value increased with increasing thinning intensity, higher pricing levels, and use of feller-bunchers. Under the low pricing scenario, neither CTL system was profitable based on average net value per acre. The feller buncher systems possessed, on average, a slightly positive net value with little difference exhibited by thinning intensity. An attempt was made to isolate those stand variables that would correctly identify profitable thinning scenarios. The main problem with quadratic mean diameter (QMD) and the other stand variables explored, is that negative thinning values are found across the range of the stand variable examined. Under higher price regimes and heavier thinning intensities, however, value tends to increase directly with the stand QMD.

INTRODUCTION

Many fully stocked oak-dominated stands exist in the central Appalachian region. Thinning is one operation that could be employed to provide landowners a possible source of income while improving stand condition and residual density for the remaining trees without conducting a complete harvest. Whether thinning can be done economically, given current estimates of harvest and delivery costs, is unknown. This study is designed to examine this question and investigate the feasibility of economical thinning operations in fully stocked oak-hickory stands in the central Appalachian region.

METHODS

The current study utilizes U.S. Forest Service Forest Inventory and Analysis data from all available plot data through 2006. In this analysis, each location (made up of four 24-foot radius subplots) was considered a stand. Per-acre estimates of number of stems, basal area, and volume are based on the reported unadjusted plot size. Volumes used were the reported net board foot volume, net merchantable cubic volume for pulpwood-sized trees, net cubic foot volume for sawtimber-sized trees, and merchantable dry weight of pulpwood-sized trees. For this analysis, pulpwood-sized trees are considered as trees from 5.0 to 11.5 inches

[1]Professor of Forest Biometrics (JRB) and Associate Professor of Wood Science (JW), Division of Forestry and Natural Resources, West Virginia University, 322 Percival Hall, Morgantown, WV 26506; Research Industrial Engineer (CL), Northern Research Station, USDA Forest Service, 180 Canfield Street, Morgantown, WV 26505. JRB is corresponding author: to contact, call (304)293-2941 or email at jrbrooks@mail.wvu.edu.

diameter at breast height (d.b.h.) and sawtimber trees are those having a d.b.h. of at least 11.6 inches and having sufficient quality to be considered a sawtimber tree. Plot data were selected for West Virginia and the neighboring counties of the same ecological regions in Pennsylvania, Maryland, Virginia, Kentucky, and Ohio (Fig. 1). Plot selection in the states bordering West Virginia was based at the county level. All plot data were queried to select only oak-hickory stands, living trees, those having a d.b.h. greater than 4.9 inches, and those trees that are considered growing-stock quality. From this subset, only those stands that were at least "near" full stocking were included. A method for evaluating stocking based on stand density index (SDI) as published by Williams (2003) was employed. Only those stands having an SDI value of at least 125 were retained. This dataset contained 6,727 plots meeting these criteria (Fig. 2).

Each plot (stand) was thinned from below using a thinning algorithm developed by Brooks and Wang (unpublished). Stands were thinned using three thinning intensities:

Intensity 1: Remove 70 percent of the existing stand basal area
Intensity 2: Remove 50 percent of the existing stand basal area
Intensity 3: Remove 30 percent of the existing stand basal area

These intensities were selected because they represent the range of most current thinning intensities utilized in Appalachian hardwoods. Tree lists were sorted from smallest to largest by d.b.h. and removed sequentially until the target basal area was approximated.

Once the thinned tree list was created, the delivered price for the thinned material was determined by stand, based on low, average, and high delivered price scenarios. For pulpwood products, the thinned merchantable dry weight was converted to green weight by multiplying by 1.85, an average value obtained as the average difference between green and dry weight estimates based on equations by Wiant and others (1979). Delivered

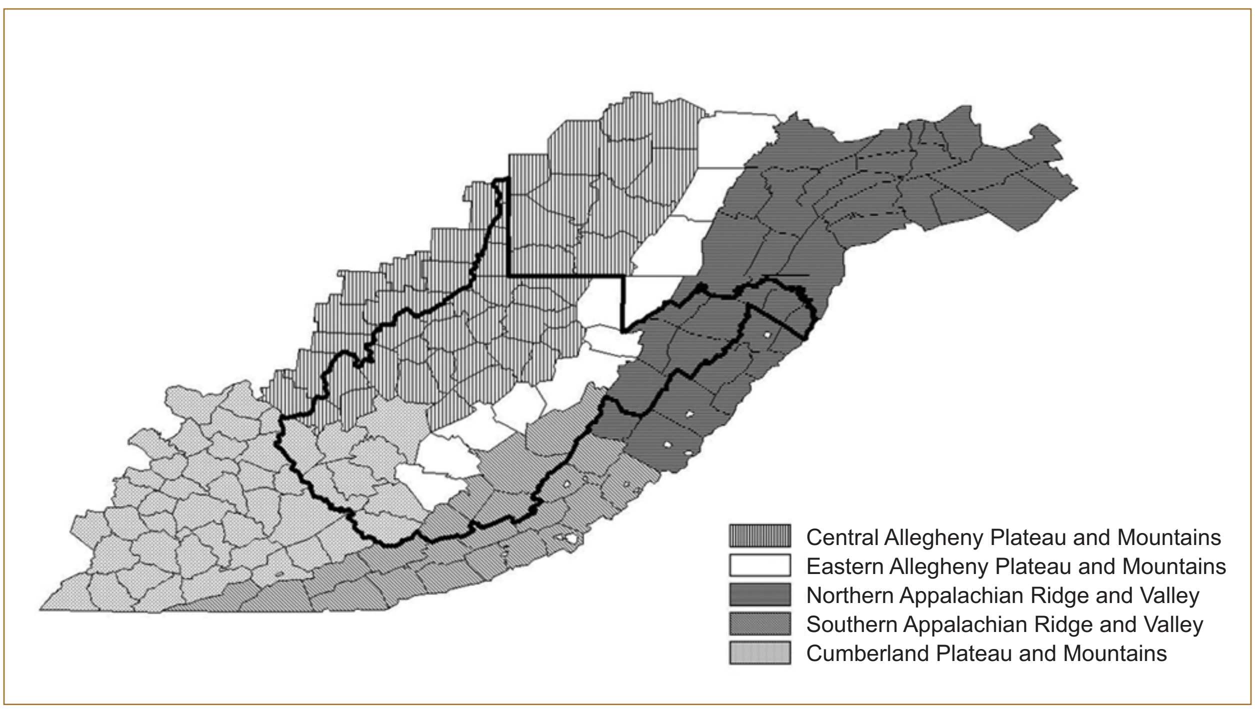

Figure 1.—Ecological regions of the central Appalachian area.

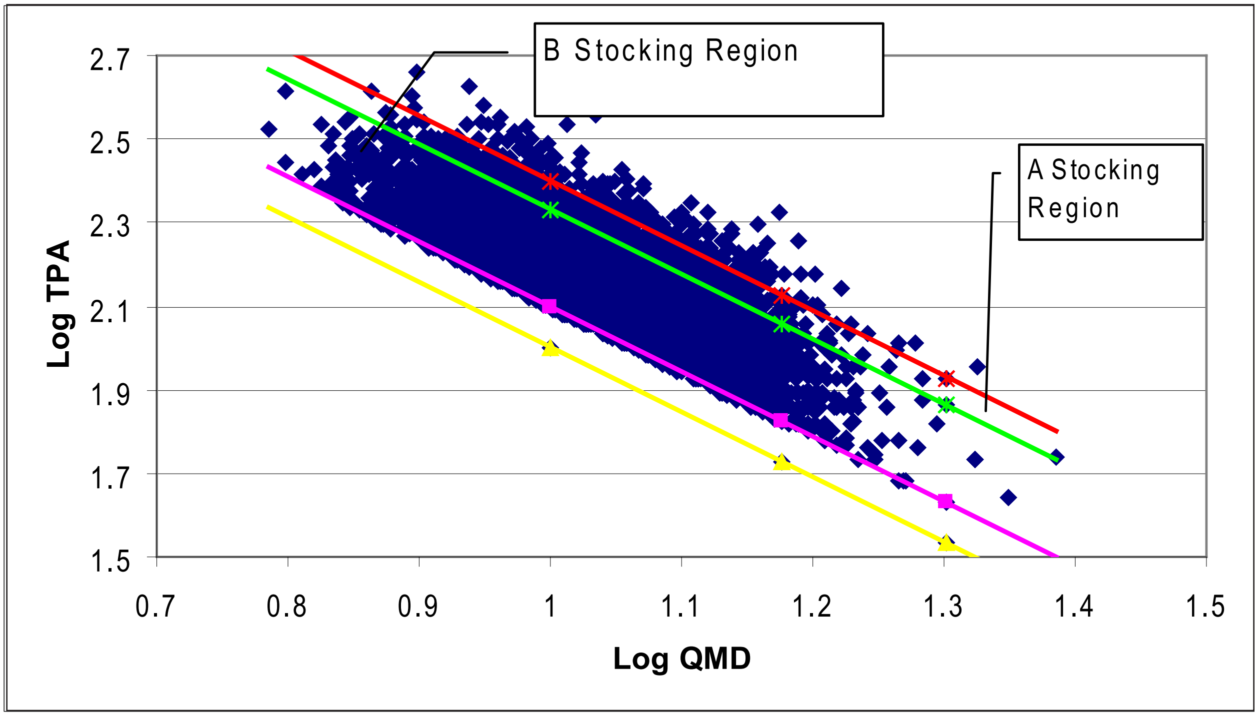

Figure 2.—Distribution of plot stand density index (SDI) for fully-stocked oak-hickory stands in central Appalachia (QMD is quadratic mean diameter and TPA is trees per acre).

price per ton for 2007 was obtained from NewPage Corporation in Luke, MD (personal communication) and the three scenarios were defined as:

Scenario 1:	Low pulpwood value:	$15.50/ton
Scenario 2:	Average pulpwood value	$21.50/ton
Scenario 3:	High pulpwood value	$27.50/ton

Sawtimber value was based on delivered log value prices by species and grade. A low, average, and high value were assigned by species based on existing sale records in the Pennsylvania Woodlands Market Report (Pennsylvania State University 2007). The simulation utilized the higher product value for each tree. Thus, if pulpwood value was higher than sawtimber value for any tree, the higher value was employed. Total value per acre for the thinned stems was calculated, along with thinned volume, basal area, trees per acre, and the average diameter of the removed trees. These data were exported to ECOST simulator (LeDoux 1985, 1987) to determine harvesting and hauling costs for truck class 1 and 2 using road class 2 and 3. These classes are defined as:

Truck Class 1:	Truck tractor, 6x4, tandem axle with tandem 30- to 35-foot trailer w/additional 15- to 20-foot trailer.
Truck Class 2:	Truck tractor, 6x4, tandem axle with tandem trailer
Road Class 2:	Designated Speed 35 mph
Road Class 3:	Designated Speed 25 mph.

Harvesting scenarios are based on four types of equipment, small and large cut-to-length (CTL) systems and two feller buncher (FB) units. In this study we used harvesting performance data for two of the Timbco 400 series feller bunchers to simulate the felling, sorting, and bunching of the trees. To simulate the cut-to-length operations, we used a Timbco T425 and a John Deere 988 to represent a small and large machine scenario, respectively. A Valmet 524 forwarder was used to simulate the transportation of the processed trees to the landing. Mechanized feller bunchers such as the Timbco 425 and the 445 models can fell, sort, and bunch the trees as they are being processed. Mechanized CTL machines such as the Timbco T425 and the John Deere 988 can fell, delimb, debark, sort, and bunch the trees. All of these machines are track-mounted and work very well on flat, moderate, or moderately steep terrain. The Timbco 445 is a larger machine and has a wider track than the Timbco 425 model. The narrower track gives the smaller machine an advantage over the 445 model in that it is easier to maneuver within the stand. The Timbco machines have Caterpillar undercarriages and can be equipped with a range of cutting heads and cut-to-length heads. In this study, all machines were equipped with single grip, fixed saw tooth felling heads. The Valmet forwarder has a load capacity of about 600 cubic feet.

This simulation is based on an average slope yarding distance of 850 feet and a one-way trucking distance of 25 miles. Restrictions on the use of a particular harvesting system included eliminating the small CTL system if average thinned diameter exceeded 14.0 inches and using the feller bunchers only if average thinned diameter exceeded 20 inches. Harvesting and hauling costs were deducted from the thinning value, discussed earlier, to determine the net thinning value.

The purpose of this study was to determine under what combinations of thinning intensity, pricing scenarios, and four commonly employed yarders, could profitable thinning operations be conducted for fully stocked oak-hickory stands in this region.

RESULTS AND DISCUSSION

Net thinning value increased with increasing thinning intensity, higher pricing levels, and the employment of feller-bunchers (Fig. 3). The results for thinning intensity and product pricing scenarios were not unexpected, but what is more important is under what equipment, pricing, and thinning intensities can these operations be expected to produce a positive net value. Average net values for Truck Class 1 and Road Class 1 were based on the mean net value for the 6,727 thinned plots. Figure 3a indicates that under low-pricing scenarios, average net value for CTL systems does not appear to be profitable under any thinning intensity. However, the feller buncher systems do show a positive net value that roughly doubles as thinning intensity is increased from 30 to 50 percent of current basal area. For the average pricing scenario, all systems appear to provide an average positive net value; the feller buncher units exhibited a higher average net value (Fig. 3b). The increase in value between the lower thinning intensity (30 percent) and the middle thinning intensity (50 percent) for the first feller buncher is approximately 1.9 times that of the lower thinning intensity. Under the high-pricing scenario, all simulations provided positive average net values. The feller buncher systems show a positive net value that roughly doubles as thinning intensity is increased from 30 to 50 percent of current basal area (Fig. 3c). The difference between the average net value under the low- and high-pricing scenarios was 3.2 and 3.6 times greater for the 30-percent and 50-percent thinning intensity, respectively.

Average net values based on utilizing Truck Class 2 and Road Class 2 are shown in Figure 4. Under the low-pricing scenario, neither CTL system is profitable based on average net value per acre. The feller buncher systems possessed, on average, a slightly positive net value with little difference exhibited by thinning intensity. Differences for the average and high pricing were similar to those shown for the net values for Truck Class 1 and Road Class 1 values, except that they were 29 percent and 17 percent lower, respectively.

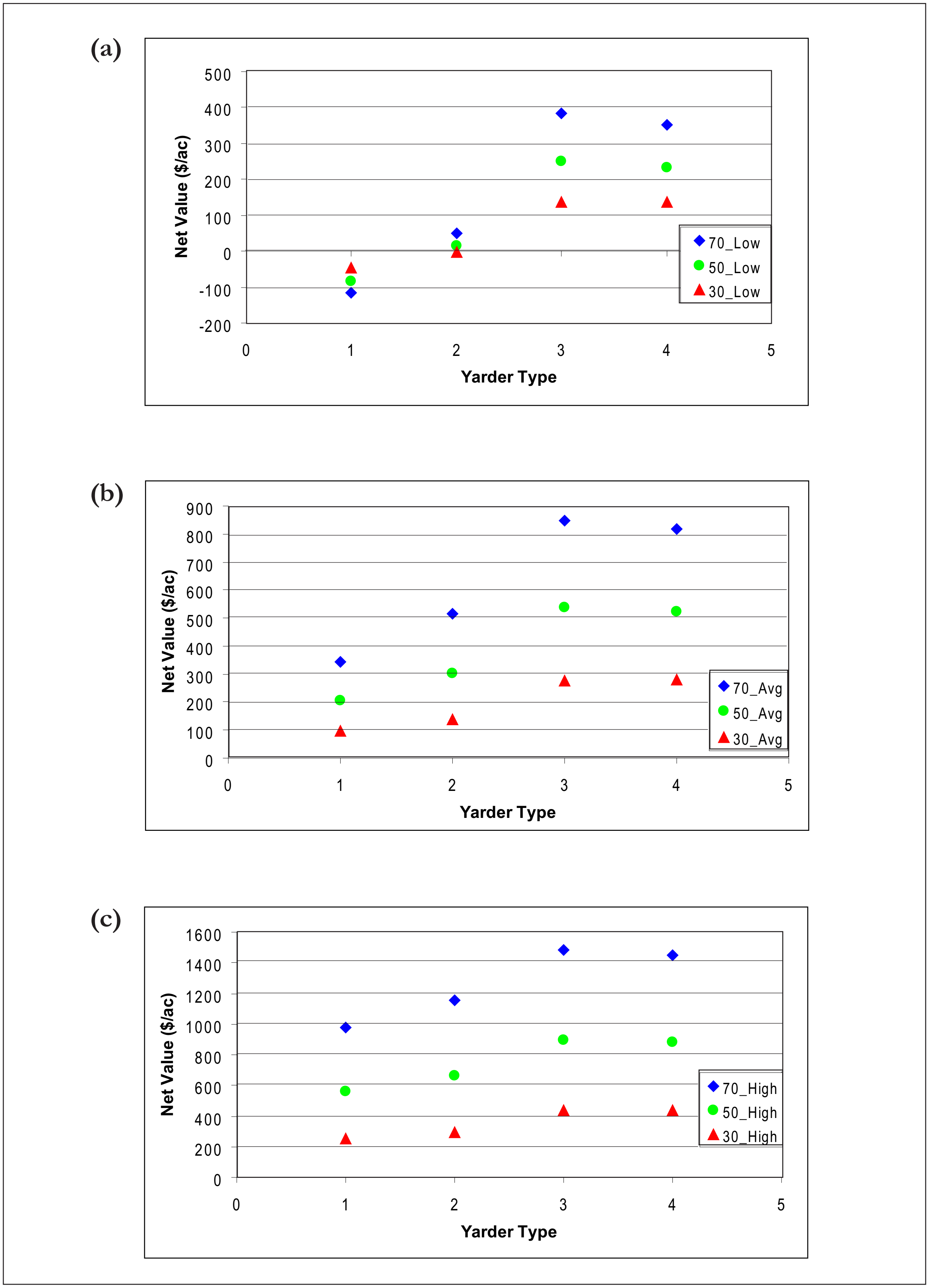

Figure 3.—Net thinning value per acre by yarder type (small CTL [1], large CTL [2], small FB [3], large FB [4]) for three thinning intensities (30-70 percent) using three pricing scenarios (low [a], average [b], high [c]) for Truck Class 1, Road Class 1.

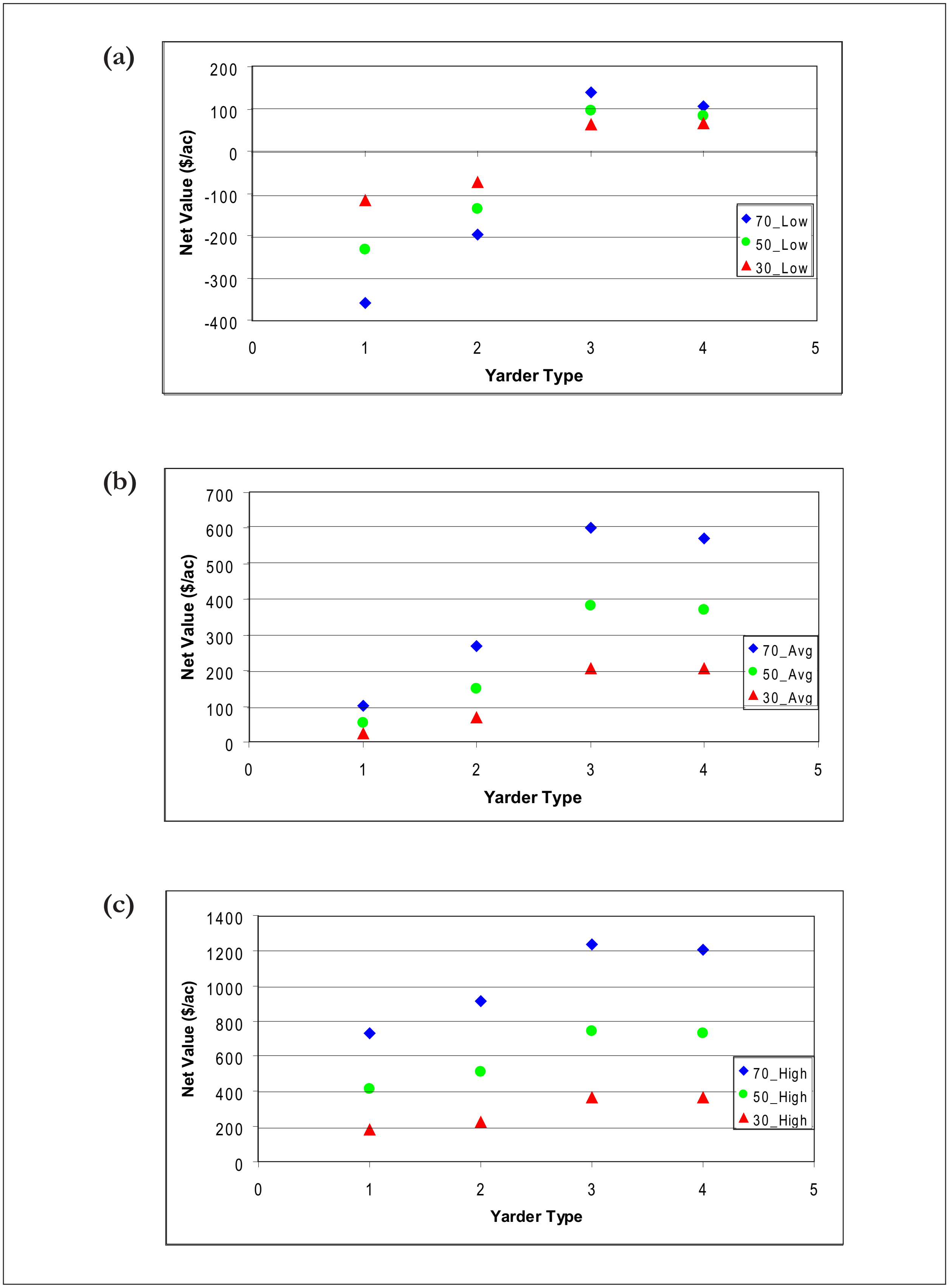

Figure 4.—Net thinning value per acre by yarder type (small CTL [1], large CTL [2], small FB [3], large FB [4]) for three thinning intensities (30-70 percent) using three pricing scenarios (low [a], average [b], high [c]) for Truck Class 2, Road Class 2.

Under the simulations tested, the smaller feller buncher provided the highest average net value under all regimes, although the values for both feller buncher systems did not vary greatly. The average net values for Truck Class 1 and Road Class 1 for the three thinning intensities (30-, 50-, and 70-percent basal area removal) and the three pricing scenarios are displayed in Figure 5.

CONCLUSIONS

An attempt was made to isolate those stand variables that would correctly identify profitable thinning scenarios. Figure 6 displays the net value per acre for each plot for the small feller buncher using the average pricing schedule at both the 30-percent thinning intensity (Fig. 6a) and the 70-percent thinning intensity (Fig. 6b) by quadratic mean diameter. The main problem with QMD and the other stand variables explored, is that negative thinning values are found across the range of the stand variable examined. It is apparent that under higher price regimes and heavier thinning intensities, value does tend to increase directly with the stand parameter being examined. Additional work on this topic is justified.

LITERATURE CITED

Brooks, J.R.; Wang, J. n.d. **Thinning strategies to increase the regional availability of oak timber.** Unpublished report.

LeDoux, C.B. 1985. **Stump-to-mill timber production cost equations for cable logging eastern hardwoods.** Res. Pap. NE-566. Broomall, PA: U.S. Department of Agriculture, Forest Service, Northeastern Forest Experiment Station. 6 p.

LeDoux, C.B. 1987. **ECOST – A stump-to-mill timber production cost-estimating program for cable logging eastern hardwoods.** The Compiler. 5(4): 33-34.

Pennsylvania State University. 2007. **Pennsylvania woodlands timber market report.** University Park, PA: Pennsylvania State University.

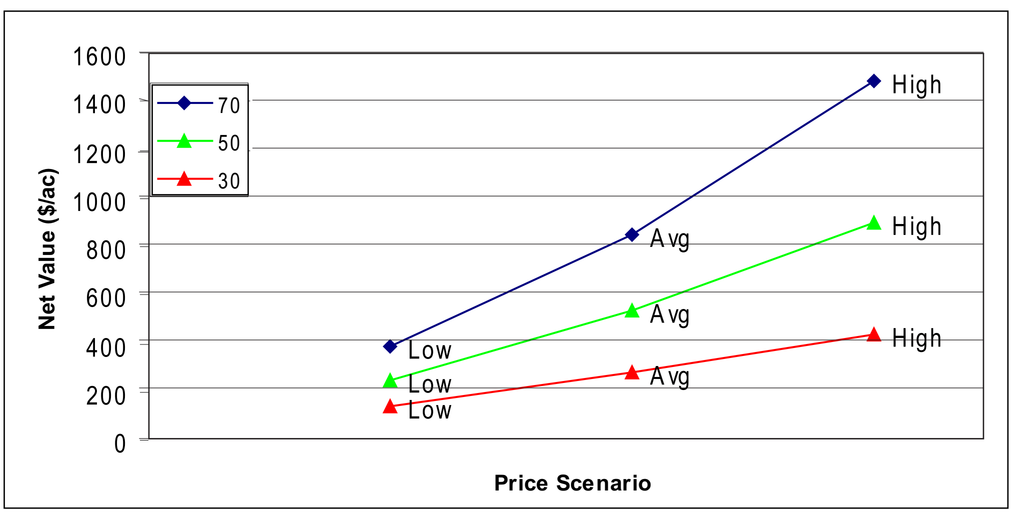

Figure 5.—Net thinning value per acre for the smaller feller buncher by thinning intensity and pricing scenario (Truck Class 1, Road Class 1).

Wiant, H.V., Jr.; Castaneda, F.; Sheetz, C.E.; Colaninno, A.; DeMoss, J.C. 1979. **Equations for predicting weights of some Appalachian hardwoods.** WV Forestry Notes No. 7. Morgantown, WV: West Virginia University, Division of Forestry: 21-26.

Williams, Roger A. 2003. **Use of stand density index as an alternative to stocking percent in upland hardwoods.** Northern Journal of Applied Forestry. 20(3): 137-142.

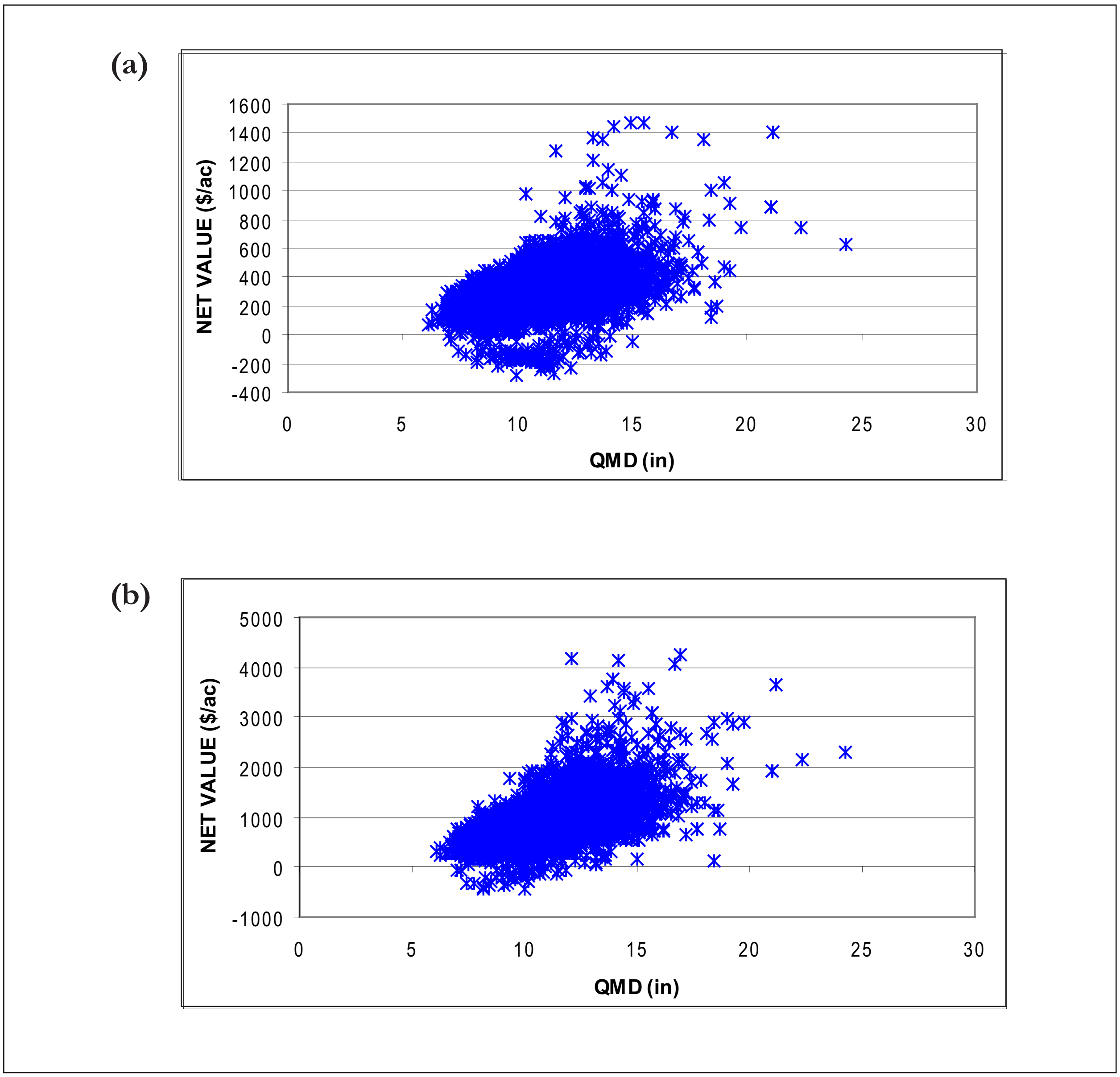

Figure 6.—Net thinning value per acre by stand quadratic mean diameter using the average pricing schedule for the smaller feller buncher by thinning intensity (30 percent[a] and 70 percent[b]) for Truck Class 1 and Road Class 1.