

APPLICATIONS OF A STUMP-TO-MILL COMPUTER
MODEL TO CABLE LOGGING PLANNING

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ABSTRACT

Logging cost simulators and data from logging cost studies have been assembled and converted into a series of simple equations that can be used to estimate the stump-to-mill cost of cable logging in mountainous terrain of the Eastern United States. These equations are based on the use of two small and four medium-sized cable yarders and are applicable for harvests of timber from 6 to 24 inches in diameter. Cost components can be easily calculated on a hand-held calculator. A computer program that could be adapted to many desktop and microcomputers is available that will calculate the total stump-to-mill logging cost for a specified set of logging conditions. The paper focuses on the application of the stump-to-mill computer model to actual East Coast forest conditions.

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An initial step in planning any cable logging operation involves estimation of the logging costs for the sale or tracts in question. Traditionally, loggers and managers use some combination of time-study data, practical experience, and/or rules of thumb. Such approaches are cumbersome and time consuming, and the estimates are generally not very detailed or accurate. Recent interest in cable logging of eastern hardwood forests led to the development of a detailed, reliable, stump-to-mill cable logging costing methodology called ECOST (LeDoux 1985a).

The stump-to-mill computer model (ECOST) consists of a series of simple linear and curvilinear equations that can be used to estimate the stump-to-mill cost of cable logging in the mountainous terrain of the Eastern United States. The equations are based on the use of two small and four medium-sized cable yarders and are applicable for harvests of timber from 6 to 24 inches in diameter. The computer model is applicable only to uphill skyline cable logging. The model can be used for equipment selection, timber-stand prescription planning, optimization of silvicultural decisions, break-even analysis, and silvicultural investment analysis. This article illustrates the application of the model for yarder selection, timber tract sale appraisal, and silvicultural treatment comparison and selection using East Coast stand types and conditions.

YARDER SELECTION

The cable yarder selected for yarding hardwood logs will significantly affect the production rate and cost of a harvest unit. Yarders vary in capacity and efficiency according to terrain, average size of logs removed, and volumes cut per acre. The ECOST model was used to develop figure 1 which illustrates the impact of average tree size on yarding costs. Figure 1 shows this variability for five cable yarders on terrain with an average volume cut of 4,000 cubic feet per acre and slope distances that average 450 feet. Specific crewing and operating costs of individual yarders are presented in LeDoux 1985a.

Comparisons such as those shown in figure 1 can help planners, loggers, and managers select equipment best suited to their stand conditions. For example, the Bitterroot^{1/} yarder would be best for stands with average tree d.b.h. less than 10 inches, while the Ecologger I and the Urus 1000-3 yarders would best be matched with the larger tree sizes. Similar comparisons and selections can be made, given respective stand conditions and the ECOST computer model.

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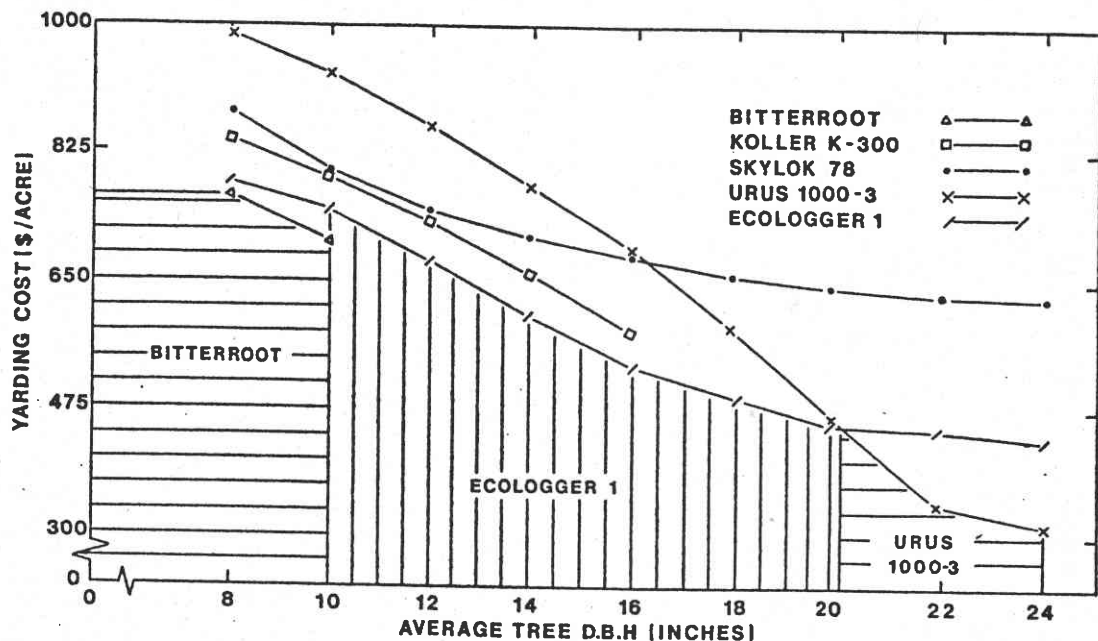


Figure 1.--Yarding costs for five cable logging systems used on mountainous terrain (450-foot average yarding distance, 4,000 ft³ removed per acre). Shaded region indicates diameter range best suited for individual machines.

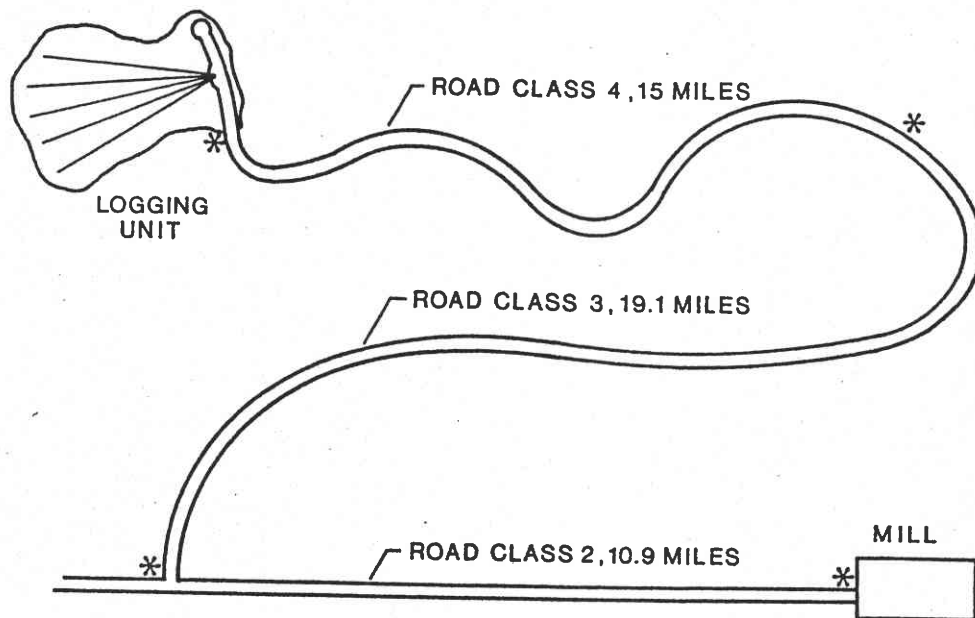


Figure 2.--Hypothetical logging unit and transportation network to delivery mill.

TIMBER TRACT APPRAISAL

ECOST can be used to appraise timber tracts for cable logging. For example, stump-to-mill estimates can be developed (Table 1) by using the hypothetical scenario detailed in figure 2 and the stand data for forest model plot No. 13: Average tree d.b.h. (inches)--12.7; average merchantable height to 4-inch top (feet)--48.8; number of trees per acre--148; species mix--basswood, beech, black cherry, cucumber, hard maple, red maple, red oak, white oak, and yellow-poplar; cubic-foot volume per acre (Smalian's method)--4,379; board-foot volume per acre (Doyle rule)--11,586. A major advantage of ECOST is that stump-to-mill costs can be estimated component-by-component allowing planners maximum flexibility to substitute component costs as necessary. Move costs for this scenario are approximately 5.4 percent of total stump-to-mill costs. Move costs are highly variable and difficult to estimate. Planners could easily substitute alternate move or delay costs to reflect their specific unique situations.

Table 1.--Estimated stump-to-mill costs per acre for hypothetical logging unit and transportation network.^{a/}

Activity	Cost Dollars
Fell, buck, limb	645.98
Yarding	776.75
Loading	165.01
Hauling	1,372.22
Move	175.61
Delay	<u>131.37</u>
Total stump-to-mill	3,266.94
Total revenue at mill	3,677.67 ^{b/}
Potential stumpage	410.73

^{a/} Conditions - forest model plot No. 13; minimum merchantable d.b.h., 5 inches; yarder, Koller-K300; average yarding distance, 450 feet; truck class, 3.

^{b/} Equivalent to \$35.45 per M bf. Does not include administrative costs nor margin for profit and risk.

For this scenario, the total revenue for products at the mill would be \$3,677.67 (LeDoux 1985b). The potential stumpage would be approximately 12.57 percent of total stump-to-mill costs or about \$35.00 per M bf. Similar appraisals could be developed for potential harvest sites by using ECOST and appropriate logging plan and transportation network inputs.

SILVICULTURAL TREATMENT COMPARISON

ECOST can also be used to compare and evaluate alternate silvicultural options given the necessary stand input data. For example, stump-to-landing cost estimates can be determined (Table 2) by using stand data from forest model No. 3: Stand age (years)--40; average tree d.b.h. (inches)--8.6; number of trees per acre--201; species mix--red oak and white oak; cubic-foot volume per acre (Smalian's method)--1,945; basal area (ft^2/acre)--81.3, and considering three levels of thinning intensity (Table 3). Since ECOST is structured in components, planners can evaluate stump-to-landing costs for roadside firewood sales instead of stump-to-mill costs when thinnings are necessary in low-volume and low-value stands.

Thinning-level options can be compared and treatments selected based on entry costs and silvicultural objectives. For this scenario, a heavy thinning would yield the greatest net value, but may not yield the best final product in the future stand. However, planners can evaluate numerous silvicultural options quickly and inexpensively using ECOST and a minimal number of stand attributes.

Table 2.--Stump-to-landing cost estimates of three thinning levels for forest model plot No. 3.^{a/}

Thinning level	Average cut d.b.h. Inches	Stems removed No.	Volume removed ft^3	Stump-to-landing cost Dollars/acre	Firewood revenue	Net value
Light	6.3	87	405	132.31	136.52	4.21
Medium	6.9	119	677	215.23	228.00	12.77
Heavy	7.4	146	978	303.49	330.00	26.51

^{a/} Conditions - site index, 70; minimum merchantable d.b.h, 5 inches; average slope distance, 400 feet; 89 ft^3 per cord; delay cost, \$0.04 per ft^3 ; move cost, \$0.03 per ft^3 ; yarding, Bitterroot yarder; stand age, 40 years; stand composition, red oak and white oak.

Table 3.--Simulated silvicultural treatments for forest model plot No. 3

Silvicultural treatment	Percent stems removed per acre	Percent basal area removed Ft^2/acre	Residual tree spacing Feet
Light thinning	43	23	20 x 20
Medium thinning	59	38	23 x 23
Heavy thinning	73	43	28 x 28

CONCLUSIONS

Although only three applications of ECOST have been illustrated, many opportunities for application exist. Planners should study ECOST carefully and compare this program to methods in current use. The model has value to planners estimating cable-logging costs for eastern forests. Although the model is currently programmed on a Hewlett-Packard 9845T, it could easily be programmed on other desktops, microcomputers, and hand-held calculators. Planners are encouraged to study and experiment with the model for a variety of applications.

The computer program described in this article is available on request with the understanding that the U.S. Department of Agriculture cannot assure its accuracy, completeness, reliability, or suitability for any other purpose than that reported. The recipient may not assert any proprietary rights thereto nor represent it to anyone as other than a Government-produced computer program. For cost information, please write: Chris B. LeDoux, USDA Forest Service, P. O. Box 4360, Morgantown, WV. 26505

LITERATURE CITED

- LEDOUX, C. B. 1985a. Stump-to-mill timber production cost equations for cable logging eastern hardwoods. USDA For. Serv. Res. Pap. NE-566. 6 p.
- LEDOUX, C. B. 1985b. When is hardwood cable logging economical? J. For. 83(5):295-298.

PROGRAM TITLE

ECOST: Stump-to-mill timber production cost equations for cable logging
eastern hardwoods.

PROGRAMMER

C. B. LeDoux

HARDWARE/SOFTWARE REQUIREMENTS

Computer make and model.....Hewlett-Packard HP 9845T
Operating system.....Basic
Program(s) required.....None
Minimum memory.....56K
Floppy disk drives required.....None
Hard disk drive required.....no
Printer required.....yes
Additional peripherals required.....none

PROGRAM AVAILABLE FROM

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CHARGE FOR HANDLING AND MAILING

None