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GRAPHIC AIDS TO EVALUATION OF PLANTATION MANAGEMENT ALTERNATIVES INVOLVING SURVIVAL AND HEIGHT GROWTH

Abstract. --Many forest managers are faced with decisions as to whether to invest, or how much to invest, in site preparation or other promising cultural treatments (some so recently introduced that their effects upon merchantable yields cannot be determined for many years). Such decision making can be aided by estimating how much survival or growth must be increased to recoup, with interest, the cost of the treatment. This paper presents graphically such information for planted slash pine under various combinations of treatment costs, site indices, and survival. The paper explains how similar graphs can be constructed for any timber species, provided tables are available that present merchantable yields by site index and number of trees per acre.

INTRODUCTION

Decisions concerning the level of expenditure most beneficial to a forest enterprise can be guided by the ranking of discounted net worths. Such net worths are the estimated differences between discounted cash flows of incomes and the costs generated by alternative treatments (including the alternative of taking no management action).

The amount to spend on site preparation is one of the most pressing decisions confronting many forest managers today. This decision can be made with confidence when the now-young plantations on prepared sites reach rotation age. Then, increases in merchantable yields can be measured, and discounted net returns to various site preparation treatments can be computed.

Such treatment-response schedules for varying species, sites, and treatments are badly needed. In their absence, it is not possible to determine which treatments will maximize profits. It is possible, however, to determine how much heights and survival must be increased to generate acceptable profits from treatments of varying costs. Thus, a forest manager would apply a particular treatment to a particular site only if, in his opinion, it would increase heights and survival to or above the point necessary to recoup its cost at an acceptable rate of interest.

Sometimes the forest manager will know that similar treatments on similar sites have produced the necessary increases in height and survival

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within a few years after planting. This knowledge would strengthen an affirmative decision to prepare sites, if he is willing to assume these gains made early in the rotation will remain constant or increase during the remainder of the rotation.

HOW TO MAKE SITE PREPARATION DECISIONS

Figure 1 provides the height and survival increases in planted slash pine (Pinus elliottii var. elliottii) that are necessary to recoup various costs of site preparation. To use the figure for a particular planting site, the forest manager must know or estimate site index (base age 25) and survival at age 25 for slash pine planted at a density of 600 trees per acre without site preparation. (The reader may protest that he cannot estimate closely the site indices and survival for many of his sites. In such cases, he can choose his lowest estimates of site index and survival, which will result in information that is economically more conservative.)

For example, say the forest manager judges his plantation, without site preparation, to be site index 60 and likely to have about 300 surviving trees per acre at age 25 if 600 were planted. He consults graph C, because its vertical and horizontal axes intersect at 60 feet and 300 trees. Graph C indicates that a 3.8-foot gain in the average heights of dominants and codominants (the point at which the $10 curve intercepts the vertical axis) will result in enough increased income[1] to pay for $10 of site preparation expense. Similarly, a $10 initial site preparation expense can be recouped by increasing survival to 440 trees per acre (the point at which the $10 curve intercepts the horizontal axis). This line represents all combinations of increased height growth and increased survival having a combined present net worth of $10.

The forest manager now has an aid for evaluating plantation establishment alternatives. Under the conditions stated, he should add a $10 site preparation cost to his plantation establishment expenses only if he reasonably expects a growth or survival increase at least equal to that of the $10 curve. (How much response to expect from site preparation is beyond the scope of this paper. The forest manager must rely on his own experience or his evaluation of research results.)

The three other curves of graph C represent the combinations of increased heights and survival required to recoup site preparation expenses of $15, $20, and $25 per acre, still assuming a site index of 60 and a survival of 300 trees in the absence of site preparation. The six graphs of figure 1 provide this information for various situations in which, without site preparation, site indices are 50, 60, or 70 and survival is 300 or 400 trees per acre at age 25.

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[1]Discounted at 6 percent to the year of plantation establishment, and assuming all trees larger than 4.5 inches d. b. h. will be sold as pulpwood at $9 per cord stumpage.

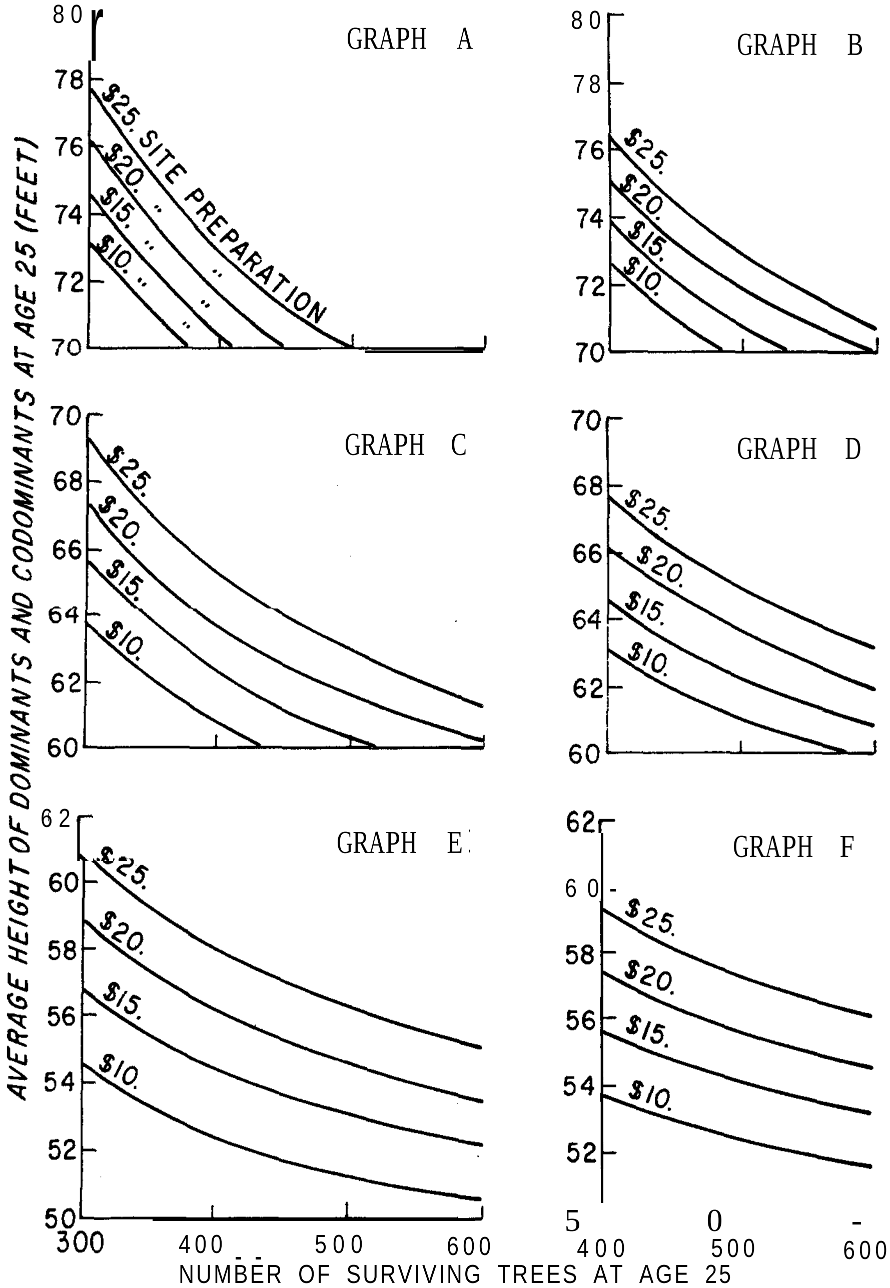

Figure 1. --Survival and height increases necessary to recoup various costs of site preparation at 6 percent interest compounded annually, assuming 600 trees are planted per acre and all trees larger than 4.5 inches d. b. h. are sold as pulpwood at $9 per cord stumpage.

Example: A forest manager is considering a treatment costing $20 per acre in an area that without site preparation would be site index 70 and have about 400 surviving trees. He enters graph B because its origin is at 70 and 400, and finds he can recoup his $20 with 6 percent compound interest if the treatment increases heights by 5 feet, or increases heights by 2 feet and survival by 100 trees, or increases heights and survival to any other point along the $20 curve.

CONSTRUCTION OF GRAPHS

The curves show discounted values of the increases in yields to be expected from given increases in height and survival as calculated from yield tables.[3] Increased height growth in effect increases site index with an equivalent effect on yield. As shown by the following tabulation (taken from the yield table), increased yields at age 25 can also be expected from increases in surviving number of trees:

Site index (Feet)	Trees per acre (Number)	Pulpwood yield (Cords)
70	300	42.9
	400	49.2
	500	54.7
	600	59.5

The information in figure 1 is valid only for one set of cost, price, and yield assumptions, and for a rotation age of 25 years. A change in any one of these parameters changes the relationships. The number of combinations is large; however, it is not difficult to calculate the relationships for any given set of inputs.

Should the reader wish to construct graphs using different parameters or the yield table for another species, he can use as an example the following calculation of the $10 curve in graph C:

1. From a compound interest table, it was determined that a $10 cost (for site preparation) carried at 6 percent for 25 years (the rotation length) becomes a $42. 92 cost.

2. Dividing the $42.92 by $9.00 (the assumed stumpage price per cord) shows that 4.8 cords must be gained by age 25 to recoup the $10 investment.

3. The yield table shows that 300 trees on site index 60 (the assumed situation without site preparation) should produce 30 cords at age 25. Thus to recoup the $10 cost, the prepared site must yield 34.8 cords per acre.

4. Interpolations from the yield table[3] indicate 34.8 cords can be expected from 300 trees on site index 63.8, from 350 trees on site index 62.2, from 400 trees on site index 60.7, or from 440 trees on site index 60. Plotting these paired figures as coordinates on graph C and connecting the points produces the $10 curve.

‘Bennett, F. A., and Clutter, J. L. Multiple-product yield estimates for unthinned slash pine plantations--pulpwood, sawtimber, gum. Southeast. Forest Exp. Sta., U. S. Forest Serv. lies. Pap. SE-35, 21 pp. 1968.

[3]Interpolation is easier if the yield data are first graphed as number-of-trees-per-acre curves by plotting cords at age 25 over site index.

Interpolation is necessary for this particular yield table because its yield estimates were not derived from a yield equation. Interpolation is not necessary if coordinates are to be determined from a yield equation that includes number of trees per acre and site index as independent variables. In such cases, any pair of coordinates is determined by entering number of trees (one coordinate) and cordwood volume into the yield equation and solving for site index (the other coordinate).

Whether coordinates are to be found by interpolation or by solving a yield equation, a computer can speed the construction of graphs. Another advantage of computerizing the process is that the program could be easily expanded to generate graphs for many combinations of costs, interest rates, stumpage prices, planting densities, survival rates, and rotation ages.

OTHER APPLICATIONS AND CERTAIN LIMITATIONS OF THE GRAPHS

We wish to emphasize that this method is intended only as a guide to aid the forest manager's judgment. The true relationships are not as static as the illustrations imply, which is apparent when considering rotation length. The curves in figure 1 are based on a rotation length of 25 years. However, the increased values resulting from an effective change in site index might best be taken as a reduced rotation length. Conversely, increased stand density resulting from better survival will tend to increase the optimum rotation length. These dynamic time-value relationships are not considered in this paper; instead, a static rotation length is assumed. Also, a single stumpage price is assumed, although changes in density and size of trees resulting from site preparation could affect harvesting costs and thereby change stumpage prices. Nevertheless, we believe the technique will be valuable to the forest manager faced with the immediate problem of how much to spend on stand establishment.

These and similar curves should be of value in assessing desirable spending levels for other stand treatments, such as drainage and fertilization. Premiums paid for genetically superior planting stock could be assessed in the same manner. Researchers using this graphic technique could better estimate whether treatments being tested might eventually become economically feasible,

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