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C-Lines of Stocking for Southern Bottomland Hardwoods: A Guide to Identifying Insuff icient Stocking

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SUMMARY

A B-line on a stocking chart represents suggested residual stocking after thinning, or minimum full stocking. A stand at the C-line on a stocking chart will achieve the B-line after a period of growth usually specified as 10 years. Four C-lines that reflect insufficient stocking of southern bottomland hardwoods are presented. These C-lines represent 10, 15, 20, and 25 years to reach B-line stocking. Alternative C-lines may be used to determine different silvicultural opportunities-the C-line based on 10 years may be used to identify stands that do not require intervention in the near future; a C-line based on 20 years may be used to identify stands requiring regeneration.

INTRODUCTION

Goelz (1994) presented a stocking guide for southern bottomland hardwoods. He used a data set from Putnam and others (1960) to fit a stocking equation and a B-line equation.The B-line represents suggested residual stocking after thinning.

The classical stocking guide, as developed by Gingrich (1967), includes a C-line. The C-line represents a stand that will achieve the B-line after 10 years of growth. Gingrich chose the lo-year period arbitrarily. Although not explicitly stated in Gingrich (1967), Safford (1983) has interpreted the C-line to be the minimum stocking for a manageable stand.

A forest manager has a choice among several decisions regarding understocked hardwood stands. If the stand is marginally understocked, the manager will not plan any intermediate harvests in the near future. If the stand is severely understocked in desirable growing stock, the manager may decide to regenerate the stand by clear-felling, with or without subsequent planting; such stands can often become well stocked from regeneration arising from both sprouts and seed. If the stand is understocked in desirable growing stock, but well stocked when all stems are considered, the stand may be a candidate for timber stand improvement. This paper represents an aid in making these decisions.

Kellison and others (1981) provided a guide to identify insufficient stocking of even-aged hardwood stands. They suggested harvesting all stands of low stocking. Their guide was presented as a line on a graph of basal area versus age. If a stand had lower basal area at a given age than that indicated by the graphed line, then complete harvest was recommended. A 20-year-old stand required about 20/ft^2 acre of basal area; a 40-year-old stand required about 60/ft^2 acre of basal area. The line flattened out such that older stands required about 65/ft^2 acre of basal area. The main conceptual drawback of the line is that the only criterion used is basal area—number and size of the trees-are not explicitly considered. Thus, if a stand had slow, early growth but an adequate number of trees, the decision would be to harvest the stand even though stand density might be acceptable for trees of that size. Because slow, early growth could be due to early competition or low site quality, this situation could be encountered often.

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METHODS

Putnam and others (1960) indicated that under good management, average 1 O-year diameter growth would be 3.5 inches for trees 6 to 12 inches in d.b.h., 4.0 inches for trees 14 to 18 inches in d.b.h., 4.5 inches for trees 20 to 28 inches in d.b.h., and 4.0 inches for trees 30 inches and larger in d.b.h. I extrapolated to assume that trees smaller than 6.0 inches in d.b.h. averaged 3.0 inches of diameter growth in 10 years.These diameter growth rates were used to "shrink" the quadratic mean diameter of the B-line given in Goelz (1995) to provide C-lines that reflect 10,15, 20, and 25 years of growth to achieve the B-line. Mortality was assumed to be negligible at stocking levels below the B-line.

RESULTS AND APPLICATION

The four alternative C-lines and the B-line of Goelz (1995) are presented in figure 1 .The C-lines are roughly, but not exactly, parallel to the B-line because diameter growth varies with average stand diameter.

The C-lines may be used to identify stands of low density. Because stands may be treated in various ways, the selection of the proper C-line to use should reflect the management decision that results from the identification of insufficient density. In the simplest situation, stands below the C-line will have no intermediate cuttings planned for the immediate future. Thinning will probably decrease volume growth considerably for a stand below the C-10 line; a thinning would not be done for 15 to 25

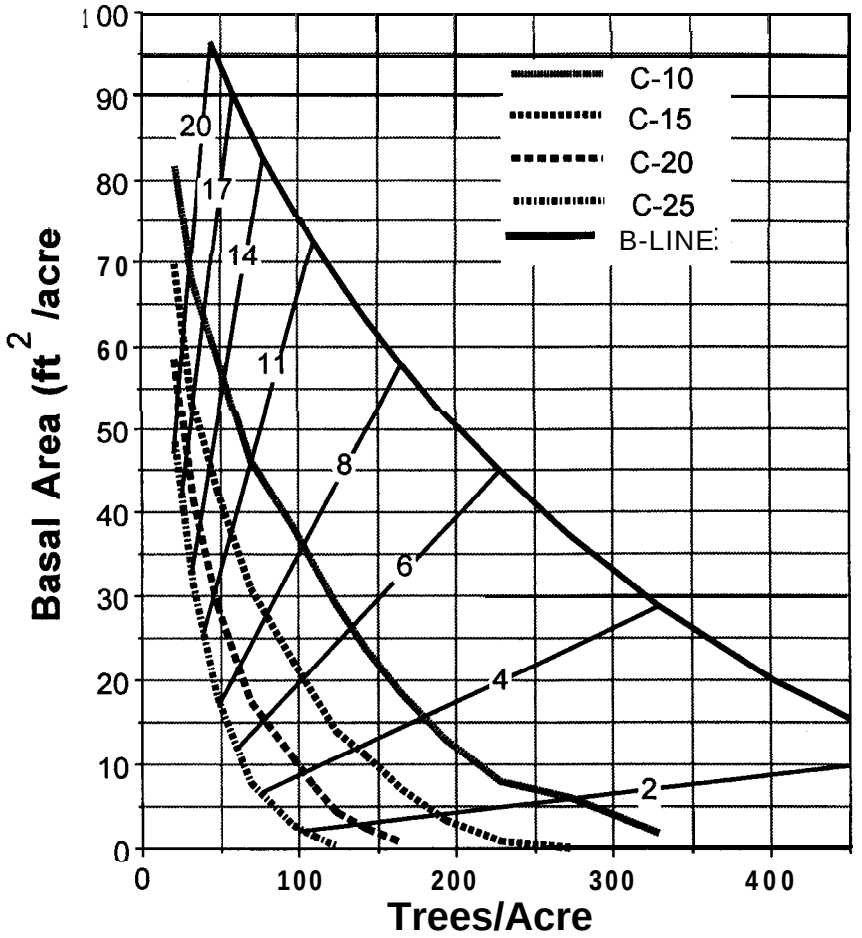

Figure 1.— Plotting of four C-lines on the axes of basal area and trees/acre: these four C-lines are based on 10, 15, 20, and 25 years to achieve the B-line developed by Goelz (1995). In addition, lines of constant quadratic mean diameter are given for 2, 4, 6, 8, 11, 14 and 17 inches.

years. Thinning in a stand below the C-25 line would be delayed for 30 to 40 years. Thus, if the C-line is used to identify stands that should not be thinned within some planning horizon, the line selected should be approximately equal to the planning horizon minus 5 to 15 years.

If managers wish to identify stands of such deficient stocking as to require regeneration by clearfelling with or without subsequent planting, then they need to use a C-line based on a long period to achieve the B-line. The C-20 line is probably appropriate under most circumstances for the following reason: the C-20 line represents stands that should probably not be thinned for 30 years. Thirty years is roughly one-half the rotation for well-spaced, free-to-grow oaks on good sites (Clatterbuck and Orr 1989). Additionally, plantation spacing of 15 by 15 feet is the widest suggested for preferred bottomland hardwoods. This spacing is only suggested for reforestation when timber production is a low priority. Assuming 70-percent survival when the stand achieves an average diameter of 2 inches, this results in approximately 135 trees per acre. Thus, the C-20 line also reflects this lower limit of stocking. Contrary to the recommendation of Kellison and others (1981), use of the C-20 line would not suggest regeneration of a stand of small sawtimber that possesses 60 ft^2/acre of basal area. Use of the C-20 line seems reasonable throughout the range of conditions of bottomland hardwood stands, although it is not necessarily the best. A simulation study would be required to determine the line representing the optimal solution to the question of whether to maintain or regenerate a stand.

When the decision is made to maintain a low-density stand rather than regenerate it, two conditions are implied: (1) tree value will be below the potential of the site and species because merchantable heights are shorter, branches are larger, and grade of trees is poorer when grown at low stocking; and (2) the value of the stand will be greater if it is maintained to a normal rotation age than if it is harvested at once and starting over. The second condition may or may not apply with the lines represented here, although the lines may reasonably approximate this condition. Again, the optimal decision line is unknown and would require a formal optimization from a suitable growth and yield model, and there is no suitable growth and yield model for bottomland hardwoods.

When assessing stocking, a user needs to distinguish between desirable and undesirable growing stock. Undesirable growing stock includes trees of unmerchantable species, poor log quality, and very low vigor, but it does not include those trees unmerchantable by virtue of their small size. A high stocking in all growing stock, coupled with a low stocking in desirable growing stock, would imply an opportunity for timber stand improvements of some sort. An extremely low stocking of desirable growing stock, coupled with high overall stocking, might indicate a need to regenerate the stand. When regeneration is suggested, the method for doing so might include any system suited to the site, species, and management goals.

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