



NORTHERN HARDWOOD NOTES

Stocking Level, Stand Structure, Cutting Cycle, And Growth Rates

Stocking, structure, and cutting cycle-how do they affect growth rates? To understand the interrelations we need first to understand the terms.

Stocking-Tells how well the site is being occupied and is expressed in basal area per unit area. When we refer to stocking it will be in terms of beginning basal area or residual basal area after a cut.

Stand structure-How many trees of each size there are-can be characterized by size-class distribution. In an uneven-aged forest this follows a simple geometric progression. The many small trees and relatively few large ones produce an inverted "J"-shaped distribution of tree size. The main reason we manage uneven-aged stands using structural goals is to provide a balanced diameter distribution that will support periodic harvest of nearly equal volumes.

Cutting cycle-The time between harvest cuts.

Also, here are some definitions for the various components of growth:

Survivor growth-Growth on trees present at both the beginning and end of a measurement period within a given size class.

Ingrowth-Growth on trees that grow into the 4.6-inch d.b.h. class during a measurement period (new growing stock) or growth on trees that grew into the 9.6-inch d.b.h. class (new saw log trees).

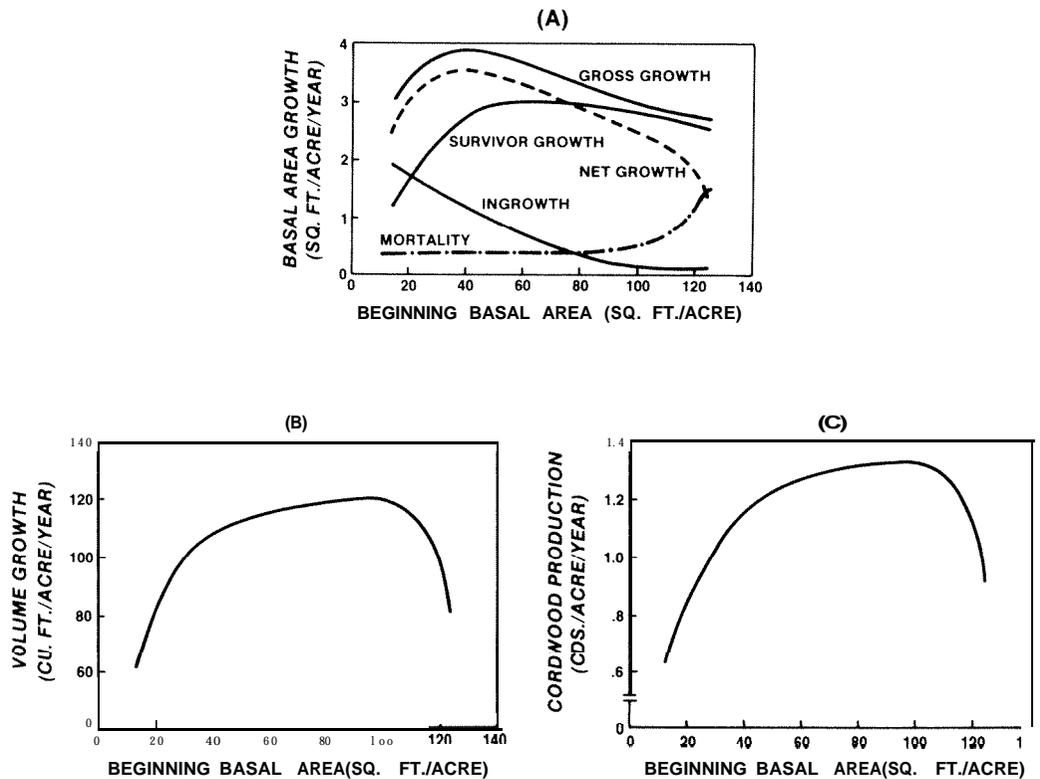
Mortality-Volume or basal area of all trees that died during a measurement period.

Gross growth-Survivor growth plus ingrowth.

Net growth-Gross growth minus mortality.

Stocking levels strongly affect growth in all forest stands. To show this for a sugar maple forest, we plotted various kinds of growth (in square feet) against beginning basal area (fig. 1A). Note that ingrowth declines with increasing basal area, while survivor growth increases rapidly at low stocking levels and then declines slightly. Mortality doesn't change across a wide range of stocking levels, but increases rapidly above 100 square feet per acre of beginning basal area. The combined effects of these relations produces a rapid increase in basal area growth as initial stocking increases at the low range to a maximum growth rate at 45 square feet, followed by a gradual decline between 50 and 120 square feet per acre and a rapid decline above 120 square feet per acre.

Figure 1 .-Relation of basal area growth (A), volume growth (B), and cordwood production (C), to beginning basal area. (All trees 4.6 inches d.b.h. and larger; site index 65 at age 50 for sugar maple. Values based on 15-year measurements in second-growth hardwoods dominated by sugar maple.)



Cubic foot volume growth (fig. 1 B) and cordwood volume growth (fig. 1 C) show the same basic trends when related to beginning basal area. Both increase sharply at low basal areas, continue to increase at a reduced rate until 100 square feet, then decline sharply at higher stocking levels because of increasing mortality.

Board foot growth parallels growth in other units (table 1), except that optimum stocking is more obvious when you deal with saw logs. Maximum net growth in board feet occurs at 70 square feet of residual basal area. At 30 and 50 square feet of residual stocking, stands are understocked for survivor growth. At 90 square feet, ingrowth declines and mortality increases; both result in lower net growth.

Stand structure is generally said to be important in maintaining sustained yield in uneven-aged stands, but not important in affecting growth rates. However, we can show that the distribution of beginning stand basal area in saw log-size and pole-size classes is a good indicator of future volume growth-both for uneven-age and even-age management.

Table 1 .-Average annual growth in board feet per acre (Scribner rule) for trees 9.6 inches d.b.h. and larger (values based on 20-year study in mature stands dominated by sugar maple)

Residual ¹ basal area	Survivor growth	Ingrowth	Gross growth	Mortality	Net growth
30	179	18	197	20	177
50	201	18	219	15	204
70	243	14	257	22	235
90	235	10	245	32	213

¹Residual basal area for saw log size class.

To show this, we developed a model of beginning stocking in poles and saw logs with their corresponding board-foot yields (fig. 2). The same comparison in cubic-foot volume is in figure 3. The stands used in constructing these models were young and increasing rapidly in merchantable height, so we don't expect the high growth rates to be sustained. However, the trends for different combinations of stocking are meaningful for net volume growth.

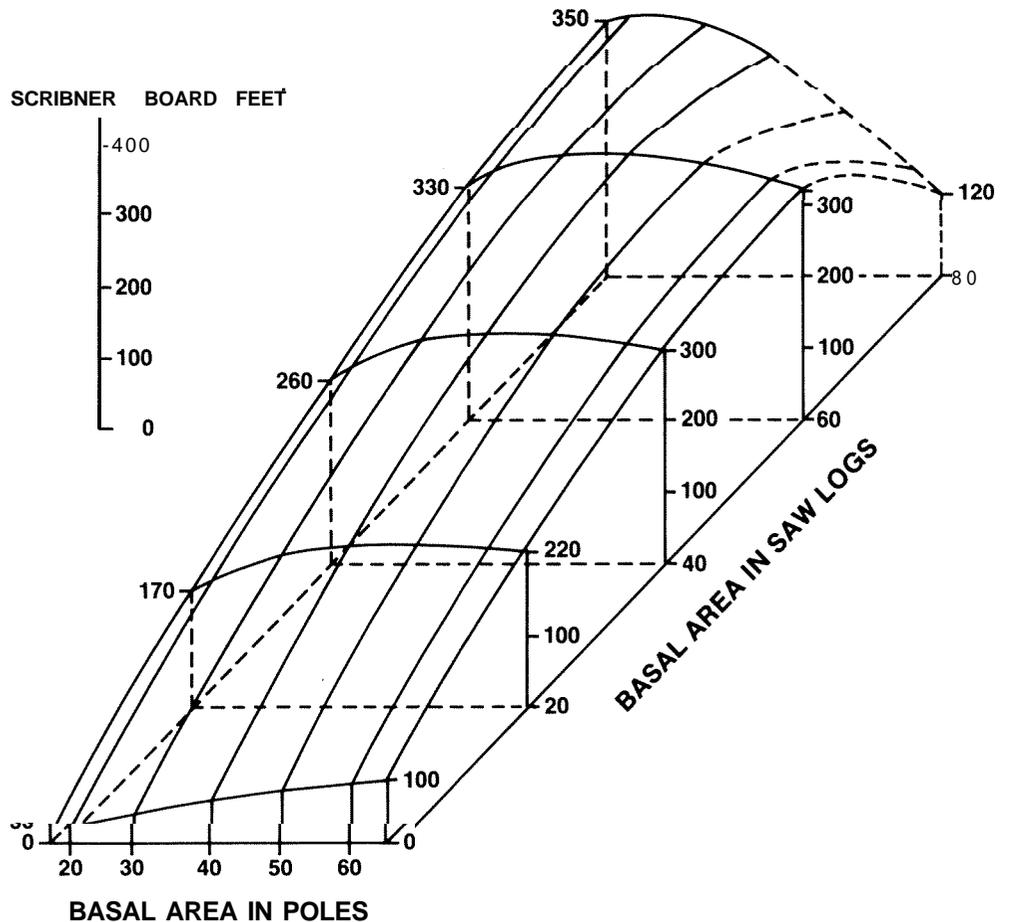


Figure P.-Relation of annual Scribner net board-foot growth to beginning basal area of poles (4.6 to 9.5 in. d.b.h.) and of saw log sized trees (9.6 in. d.b.h. and larger).

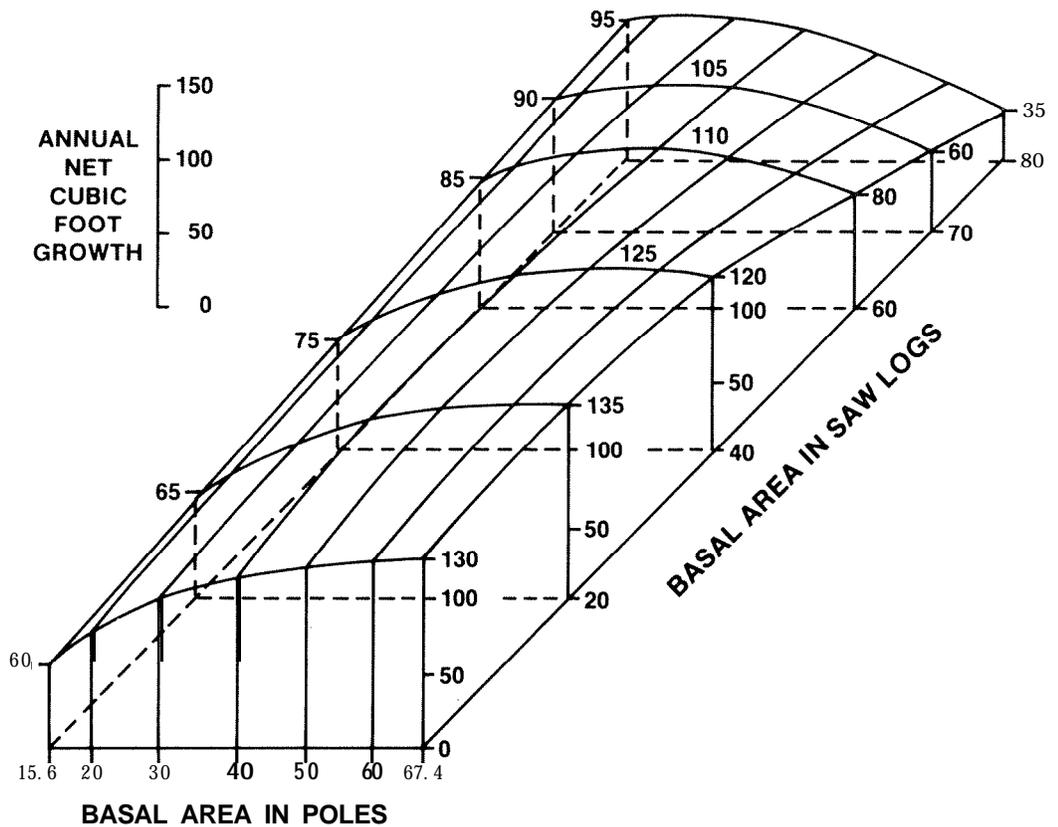


Figure 3.-Relation of annual net cubic foot growth to beginning basal area of poles (4.6 to 9.5 in. d.b.h.) and saw log-sized trees (9.6 in. d.b.h. and larger).

Growth rates vary with length of cutting cycle, although the differences are small and probably not significant within the range of cutting cycles recommended-5 to 15 years. In general, survival growth increases and mortality decreases as the length of the cutting cycle decreases. Cutting a stand more frequently reduces competition and allows high risk trees to be removed that might otherwise die. Extremely short cycles are not economical in most cases. On the other hand, growing stock should not be allowed to increase to a point where growth stagnates. A balance is generally reached with a 10 to 12-year cutting cycle.

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