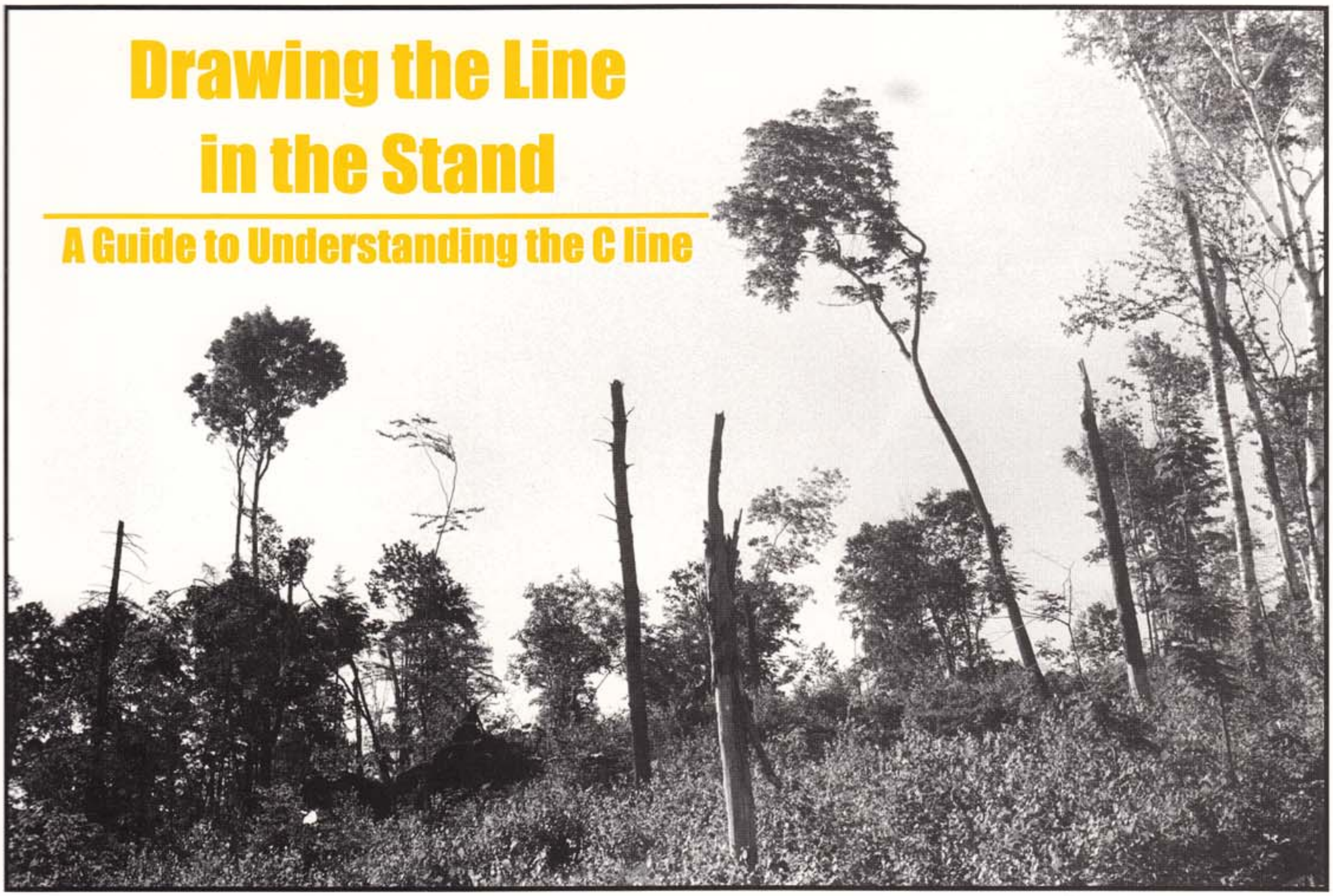
Drawing the Line in the Stand

A Guide to Understanding the C line



Stephen Long

By Stephen Long

When the heavy cutting law went into effect earlier this year, it introduced some new terminology into the vocabulary of everyone involved in managing Vermont's forests. And because the law makes landowners ultimately responsible for what happens on their land, many were left scratching their heads over fairly esoteric terms like C line, basal area and stocking guides.

The law requires that a landowner file an intent to cut if he or she intends to conduct a heavy cut on 40 or more acres. If the rationale for the heavy cut meets the silvicultural standards, the landowner will be issued a permit. If not, he will be denied the authorization to proceed.

One of the problems facing the crafters of the legislation was to define a heavy cut in a way that was unambiguous, quantifiable, repeatable and applicable to every forest stand. For instance, the legislation could have simply outlawed clearcutting on any stand over 40 acres, but the absence of a workable definition of a clearcut would have left a loophole large enough to drive a grapple skidder through. The result could have been an increase in commercial clearcuts like the one pictured above — the logger left a few trees standing, but only those that had no value at the time of the harvest.

After pondering various options, the law's writers chose the stocking guides that have been developed by the U.S. Forest Service through years of research as the best way to quantify a heavy cut. They defined a heavy cut as "a harvest leaving a residual stocking level of acceptable growing stock below the C line as defined by the U.S. Department of Agriculture silvicultural stocking guides for the applicable timber type." Silviculturally speaking, stocking refers to the density of trees growing in a particular stand. It can range from an overstocked stand so dense you can't walk through it to one that is understocked like the one pictured above.

Like jargon in any field, these terms can be understood with a little effort, and they are a good starting point for those who wish to understand more about forestry. Let's begin at the beginning, with a description of how trees grow. If a forester could grow a single tree under optimal conditions, the chosen tree's life cycle would begin with strong competition from similar-sized trees. Let's assume the tree is a sugar maple seedling growing in a pure stand of at least 3,000 other sugar maples on one acre. Like its cohorts, this seedling is less than one inch in diameter and stands a little more than one foot tall. It grows in this close proximity for 10 or so years and develops into a sapling. The competition forces the tree to grow straight toward the sun, and as it puts on girth and height, it loses its lower branches because their leaves no longer get sufficient light.

It will take another 20 to 25 years for the sapling to reach pole size — a diameter of 4 inches — and, adhering to Darwinian principles, the most vigorous trees will suppress the less vigorous, relegating them to the understory. The process of self-pruning continues, and the sugar maple develops clear knot-free wood in its trunk. If the lower branches were to continue to develop, there would be knots throughout the trunk, reducing the tree's utility and its value. The forester is trying to produce a long, straight, clear trunk instead of one resembling a yard tree whose stout lower branches have held generations of climbing children.

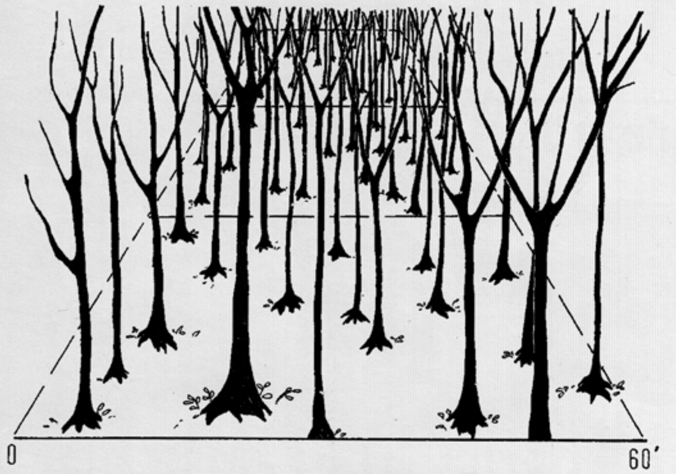
Standing above its nearest competition, the sugar maple's expanding crown helps it continue to put on girth. Then, as if they were involved in a single elimination tournament, the winners of each round move on to compete with each other. Instead of competing with trees two or three feet away, the trees now compete with those eight or 10 feet away. The same principle applies that got the tree off to a good start — competition fosters strong, straight, valuable growth. With the trees now 35 to 45 years old, the contest is carried out among fewer but larger trees.

At this time, when less than one-third of the tree's height is made up of a live crown, the forester intervenes for the first time. He or she will choose the crop trees and remove those that are inferior in form. The goal of the initial thinning is to maintain the crop tree's good growth rate by giving the crown room to expand but not so much room that it compromises the continued development of a clear bole. Like any thinning, it will reduce the stocking by about one-third. Giving each crop tree space to grow a larger crown increases its capacity for photosynthesis, and it responds by growing taller and by increasing the trunk's diameter at a faster rate.

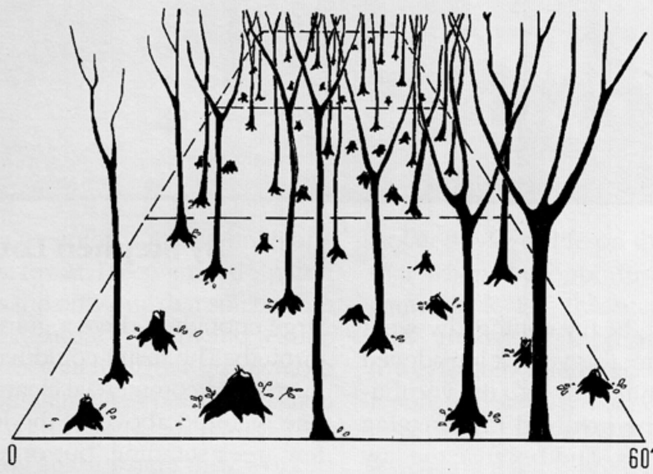
Fifteen or so years later, when the crop trees have clear boles of at least 24 feet in height, and the diameter growth has slowed to an unacceptable rate, the forester intervenes again by choosing the best trees and removing their immediate competition. Now instead of pole-sized trees, they have reached the sawtimber stage with 12-inch diameters. They are becoming more valuable each year. Given room, their growth rate increases again, and they will need another thinning in the future. Finally, when the crop tree reaches its maturity — 100 years or more for a sugar maple — it has developed into a veneer-quality tree worth hundreds of dollars. In a perfect forest, that process is

Same Stand, Different Stocking

Northern Hardwoods: mean stand diameter of 10 inches



Example of A-line stocking: For the northern hardwood forest type, this level is considered overstocked (overcrowded) at 220 trees per acre. For a mean stand diameter of 10 inches, there is approximately 120 square feet of basal area and an average of 14 feet between trees. This drawing shows three 60-foot squares, each .08 acre, and each of which has 18 trees on it.



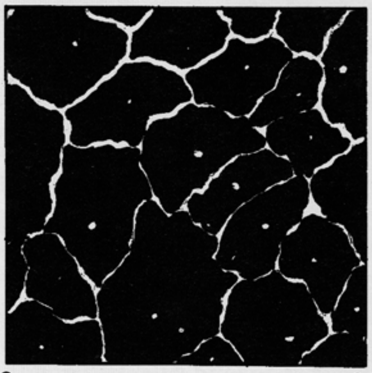
B-line stocking: A reduction of about 108 stems per acre brings stocking down to the B line with 112 trees per acre and an average distance between trees of 20 feet.

Illustrations by Cecilia Polansky

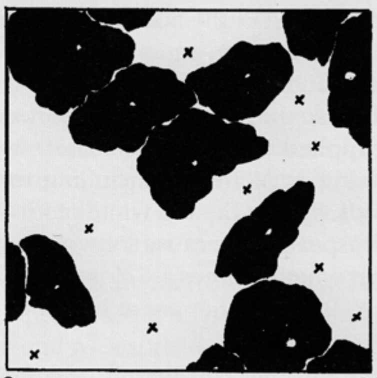
C-line stocking: The further removal of 29 stems per acre, for a total stocking of 83 trees per acre, constitutes C-line stocking; average distance between trees is 23 feet.

Bird's-eye View of a Northern Hardwood Forest

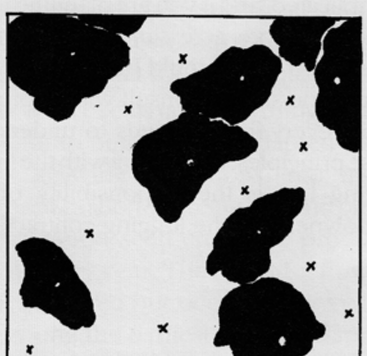
Mean Stand Diameter = 10 inches



A-LINE: Overstocked at 220 trees per acre. Growth of diameter and volume are slowing. Competition for sunlight is high.



B-LINE: Maximum growth of basal area and volume occur at 112 trees per acre. There is space for crowns to both expand and make nearly full use of sunlight.



C-LINE: At 83 trees per acre, space is not being used efficiently. This is considered to be the minimum stocking worth managing.

happening on every acre, and from a starting point of more than 3,000 stems, an acre can produce 75 perfect 20-inch diameter trees.

Let the jargon begin

At the point when the forester first intervenes in the perfect forest by thinning out the immediate competition, the stocking level of the stand is approaching the A line, which is defined as fully stocked. After thinning, the density will be just above the B line, which is defined as the density at which the greatest number of trees put on the best growth. Because a forest is always growing, it will not remain at the B line. Over time, the crowns will fill in the spaces in the canopy and the stand will move toward the overcrowded condition represented by the A line. Then, when the stocking nears the A line, it will once again be thinned back to just above the B line.

If the thinning had removed even more trees, the stocking level would have approached — or dropped below — the C line, which is the point of no return. At the C line, you have minimum stocking — the site is being underutilized. Below the C line, the stand is no longer worth managing. From a silvicultural perspective, reducing the density below the C line is a waste of the space and the time that has gone into growing these trees. The few remaining trees will grow quickly, but in essence, the landowner is cashing in on the parent trees and starting from scratch long before it makes silvicultural and economic sense. It removes trees that haven't had a chance to reach their potential and regenerates new trees that are one hundred years away from theirs. The increased light reaching the forest floor will mean that the regeneration will include more sun-loving but less valuable trees like aspen, white birch and pin cherry, along with heavy competition from raspberries.

The A line, B line and C line refer to lines on a graph that depict stocking levels with which the volume of trees in a particular stand can be compared (see the stocking guide on the following page). The stocking of any stand can be represented by a point on the graph at the confluence of two measurements: the basal area per acre measured in square feet, and the number of trees per acre. Basal area is best described as the amount of space taken up by the trunks of trees on a per acre basis. It is measured in a plane parallel to the ground at breast height, or 4.5 feet above the ground. If all the trees were cut off at breast height, the total square footage of the remaining flat wood surface would be the basal area. A 10-inch DBH (diameter at breast height) tree has a basal area of .55 square feet.

Take a look at the illustrations to the left. Note that an acre of 10-inch northern hardwoods stocked at the A line has 220 trees on it, and the basal area is 120 square feet; at the B line, it has 112 trees and the basal area is 64; and at the C line, it has only 83 trees and the basal area is 47. Note also the increased distance between trees as the stocking moves to the C line.

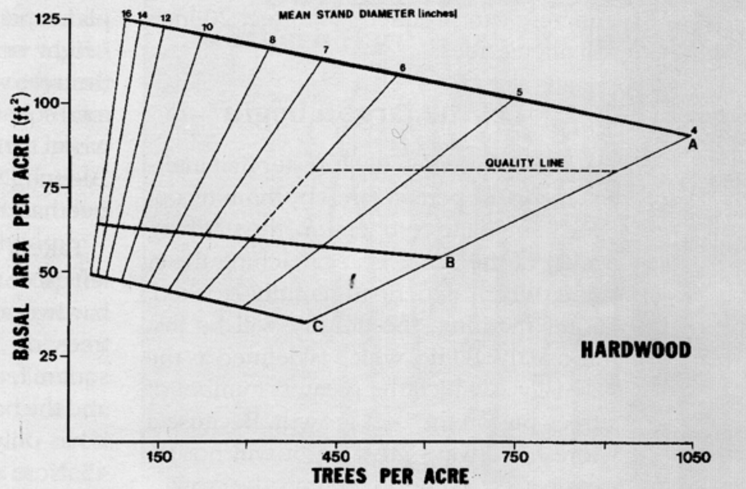
Measuring basal area

There are a few methods for computing basal area per acre, the most common in Vermont being an instrument called a 10-factor prism. At a number of randomly determined points (enough to provide a thorough evaluation of the stand), you look through the prism at the surrounding trees using the following method. Select a point on the ground and mark it with an X. Holding the prism over the X, close one eye, and move clockwise in a circle, looking at each trunk at breast height. Although you can't see the full acre, the prism adjusts the view so that each tree that registers represents 10 square feet of basal area. If 12 trees register, then the basal area is 120 square feet per acre as measured at that point. If only five trees register, then it's 50 square feet. In our example of a mean stand diameter of 10 inches, 120 square feet is A line stocking; 50 square feet is just above the C line. For an entire forest stand, you take the average of the basal areas found at all the points.

How the 10-factor prism works is beyond the scope of this article. It's a deceptively simple looking wedge of glass that performs an incredibly complex function. A much more primitive method is to substitute a penny for the prism. The procedure is the same, but instead of looking through the prism, look beyond the penny at the trunks, and if the trunk is wider than the penny, count it. If it's smaller, don't count it. For those that are the same size as the penny, count every other one. Multiply the number of trees you have counted by 10 square feet and you have the basal area at that point. The penny works fine as a starting point, but keep in mind that the prism is a much more accurate tool.

Also keep in mind that the heavy cutting law states that "the stocking of *acceptable growing stock* will not be below the C line." It defines acceptable growing stock as a tree having a DBH of at least 4.5 inches, which has the potential of producing a sawlog product of a commercial species of any grade, now or in the future. If the tree's form is so defective that it will never produce even a pallet grade log, it can't be counted in the acceptable basal area measurement. So when you are taking your readings with the 10-factor prism, you need to ignore those poorly formed trees. The defects that remove a tree from consideration are: unsound wood, twisted seams, cankers, large branch stubs, scars, and excessively crooked or twisted trunks.

Northern Hardwood Stocking Guide



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In a stand of northern hardwoods — which is by far the most common forest type in Vermont, accounting for 60% of the forest — basal area is the most important consideration. If you are contemplating a cut and want to be sure that you don't go below the C line, think in terms of maintaining the acceptable basal area above a threshold of 50 square feet in northern hardwood stands. That means that an average of five acceptable trees will register as you make your circle with the prism or the penny.

The other measurement you need in order to determine the stocking level is the number of trees per acre. You get this at the same time that you measure the basal area, but instead of counting every tree, you count only those that register with the prism or the penny, and then measure each one's diameter. A forester commonly uses a Biltmore stick to measure diameters, and along with a 10-factor prism, this inexpensive forestry tool is a good investment for any landowner or logger. Lacking a Biltmore stick, your best bet is to measure the tree's circumference with a tape measure and divide by *pi* (use 3.14). Diameters are normally tallied only in even numbers — an eight-inch tree is any tree larger than seven inches but smaller than nine inches. A 10-inch tree ranges from nine to 11, and so on.

At each plot point, tally up the number of trees at each diameter and plug them into the chart below. The chart accounts for the conversion inherent in the prism and provides a multiplier for each diameter. In our example, we have used the B line stand illustrated on the previous page. On one plot point within that stand, there are two eight-inch trees, one 10-inch-tree, two 12-inch trees, and one 14-inch tree. Using the multiplier, that translates to 111 trees per acre.

Calculating Trees per Acre

Diameter	# of trees	Multiplier	Trees per acre
5		73	
6		51	
8	2	29	58
10	1	18	18
12	2	13	26
14	1	9	9
16		7	
18		6	
20		5	
22		4	
24		3	
26		3	
			111

When you know the basal area and the trees per acre, the stocking guide will give you the mean stand diameter. Knowing these variables, you can determine whether your stand's density is at the A, B, or C line.

Of necessity, we have been talking only about the perfect forest. And we have been talking specifically about the perfect forest of the northern hardwood variety. However, most forests are not perfect and many are not northern hardwoods, so these same principles need to be applied to the other forest types growing in Vermont, including mixed woods, spruce-fir, and white pine. Generally speaking, because softwood grows better when the trees are closer together, the A, B and C lines are at higher densities.

Unfortunately, there's no easy rule of thumb in softwood stands — you can't assume that if you leave five trees per prism point, you'll be above the C line. In white pine or spruce-fir, the C line ranges widely depending on the mean stand diameter. Softwood stands are much more complicated, and if you are planning to cut on 40 or more acres and you are at all concerned that it could be cut below the C line, you should consult with a forester. While every logger needs to understand these principles, complying with the heavy cutting law is the responsibility of the landowner, not the logging contractor.