Have you ever wondered what a forest tree is worth, what it might be worth in the future and whether or not it will earn an expected rate of return? A "Rule of Thumb" table (Forestry Facts No. 38, September, 2003) can help determine whether a tree is earning a satisfactory rate of return, but only under very restrictive assumptions. The assumptions limit the table’s usefulness because they abstract from some real world phenomena like changing tree quality and changing timber demand and supply conditions.

This Fact Sheet presents a set of charts that eliminate these restrictive assumptions when estimating present and future tree values, and the expected rate of return. Chart 1 contains four separate graphs: Chart 1a is for estimating tree volume (using DBH and number of logs), and Chart 1b is for estimating tree value (using tree volume and stumpage price). Chart 1 can first be used to estimate a tree's current value and then, after a few decisions about expected future conditions, the chart can be used a second time to estimate the tree's future value. Chart 1c is for estimating the ratio of future value to present value (future value of the tree divided by the value of the tree now), and Chart 1d is for estimating the rate earned (using the future value/present value ratio and the expected time to reach the future conditions). Instructions for using these charts are discussed in the following sections.

Chart 1 is not restricted by many limiting assumptions, and thus can be applied to a wider number of situations. But a warning is in order. Using Chart 1 requires the user to estimate future tree volume and value, and some landowners will not feel comfortable making predictions about these variables. So, as is true of most situations in real life, there are tradeoffs. If you want generality, Chart 1 can provide it, but you must take responsibility for making some of the decisions about how you expect tree volume and value to change over time.

A second warning relates to the rates of return that we are talking about. Chart 1 can help you determine the rate of return an individual tree is expected to earn, but that rate may not apply to your entire timber stand. The rate earned for a timber stand can only be estimated by measuring a number of sample trees, and then calculating an average rate. A single tree may have high potential, but the stand may collectively earn a rate of return very different from that earned by some of the trees within the stand.
USING CHART 1 TO DETERMINE A TREE’S RATE OF RETURN

Step 1: On Chart 1a, find the tree’s diameter at breast height (DBH) on the x-axis.

Step 2: Run a line upward from the DBH until it intersects a line corresponding to the number of 16-foot logs in the tree.

Note: You can interpolate between the lines in Charts 1a-d. For example, in Chart 1a, if you have 1.5 logs, simply find the point that is vertically midway between the line for 1 log and the line for 2 logs.

Step 3: From the point of intersection located in Step 2, run a line to the right into Chart 1b until it intersects a line with the appropriate stumpage price.

Step 4: From the point of intersection located on Chart 1b in Step 3, run a line down to the x-axis, on which you can read the stumpage value for a tree with the diameter and number of logs you specified in Steps 1-2, and with the stumpage price per thousand board feet you specified in Step 3.

Step 5: Drop a line from the stumpage value determined on the x-axis in Chart 1b Step 4 down to the same stumpage value on the x-axis on Chart 1c.

Step 6: Estimate the value of the tree at a specified time in the future, usually 10, 15, 20 or 25 years later.

Note: This is where the user is called upon to exercise judgment about how the tree will change in volume, quality and value over time. The assumptions about tree growth that were presented in Forestry Facts No. 38 can serve as one source of information for estimating changes in diameter and number of logs as a tree grows, but the user must still make his or her own assumptions about changes in tree grade and stumpage price. If it is assumed that neither tree grade nor stumpage price change over time, then there is no real advantage to using Chart 1 and the Rule of Thumb in Forestry Facts No. 38 will serve just as well for estimating the rate of return.

Information about how and why tree value changes with time and size is presented in Forestry Facts No. 97-What’s My Timber Worth? And Why?

Step 7: Using the estimated future value of the tree determined in Step 6, find the point where the appropriate future stumpage value line intersects the line you drew from Chart 1b to Chart 1c in Step 5. The y-axis indicates the ratio of future value to present value.

Step 8: From the point of intersection located in Step 7, run a line to the left from Chart 1c to Chart 1d until it intersects the line corresponding to the time period for which you are doing the estimation.

Step 9: From the point of intersection located in Step 8, drop a line down to the x-axis where you can read off the estimated rate of return the tree will earn over the time period you specified.
TWO EXAMPLES
1. Suppose you are interested in a 15-inch red oak tree that has a merchantable length of 2 logs. From the x-axis in Chart 2a, we run a line vertically above the 15-inch DBH until it intersects the 2-log line in Chart 2a. This produces a volume estimate of approximately 140 board feet. We then extend a line from the point of intersection to the right into Chart 2b until it intersects the stumpage price for red oak in our area, which we take to be $400/mbf. Running a line down from the point of intersection to the x-axis in Chart 2b, we determine that the present tree value is $56. We then extend the lien downwards from the value of $56 in Chart 2b to the same value on x-axis in Chart 2c.

We must now estimate what the tree will be worth at some time in the future, and we must specify what that time period will be. We assume a 15-year growth period and estimate that the tree will increase in diameter to 18 inches, increase in merchantable height to 2.5 logs, and that 15 years from now, red oak stumpage price will increase in real terms (i.e., net of inflation) to $500/mbf. Returning to Chart 2a and interpolating between 2- and 3-log lines, we determine that an 18-inch tree with 2.5 logs will have a volume of approximately 250 board feet. Multiplying this volume (0.25 mbf) times the expected stumpage price of $500/mbf, we get an estimated tree value of $125. Interpolating between the $100 and $150 future value lines in Chart 2c, we get a future-value-to-present-value ratio of approximately 2.2. We extend a line from the point of intersection to the left onto Chart 2d until the line intersects the 15-year line in that chart. We then drop the line downward to the x-axis in Chart 2d and read off the estimated rate of return of 5.5%.

2. Now let’s assume an 18-inch hard maple with 2 log of merchantable height. The analysis is shown in Chart 3. This tree has a volume of approximately 210 board feet. At an assumed stumpage price of $400/mbf, the tree has a current value of $84. We estimate that the tree will add another 4 inches in diameter and another log in merchantable height in 20 years, and that the real stumpage price will be $600/mbf. The tree will have a volume of 450 board feet and a stumpage value of $270, giving it a future-value-to-present-value ratio of 3.2. This corresponds to an estimated rate of return of 6% over the 20-year period.

The charts can also be used to examine the effects on rate of return of different assumptions about future tree volume, quality and stumpage price. For example, suppose the stumpage price for our hard maple tree in Example 2 is really only $500/mbf, rather than the $600/mbf we assumed. How much difference would that make?

We redo the analysis, this time looking for the intersection of the $84 present value line with the $500 stumpage price line and determine that the future-value-to-present-value ratio would then be only 2.7. In Chart 3d we see that this decreases the rate of return from 6% to 5%.

Note that at each and every step along the way in the examples, we could have calculated the relevant values by hand to verify that Chart 1 works. Of course, Chart 1 is not as refined as a calculator so any lines drawn on the charts or values read from them will be slightly less accurate than if the actual calculations are done. Nevertheless, Chart 1 provides a quick and easy way to get an approximation to the rate of return.

A FINAL WORD
The financial rate of return is only one of several factors that foresters and landowners need to consider when deciding whether or not to harvest trees. When the expected rate of return drops below what the landowner considers acceptable form a financial point of view, there still might be good ecological or silvicultural reasons for letting the tree grow. Before making any forest management decisions, it is best to consider all the factors that influence the stand and forest. A forester can help you think through the consequences of any action of inaction.
Chart 1c

Value of tree in the future

$100 $200 $300

Years in growth period

15 years
20 years
25 years

Chart 1d

Ratio of current value to future value

Rate of return

1% 3% 5% 7% 9% 10%

10 years
20 years
25 years

Value of tree today

$0 $60 $120 $180 $240 $300

$100 $150 $250
Chart 3a
Number of logs in tree

Chart 3b
Current stumpage price per 1,000 board feet

Chart 3c
Value of tree in the future

Chart 3d
Years in growth period

Chart 3: Illustration of determining the rate of return for Example 2.