Timberland Value:
From Inventory to Cash Flows

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Most forest owners that consider their timber to be an investment will eventually thin and harvest their timber. The forest inventory is converted into a cash flow and the forest produces an investment return. The forest owner should understand the process that creates this cash flow and the importance of the cash flow pattern that will determine investment return.

A forest is an ecosystem consisting of an extensive tree cover. Forest managers break forests into stands; these are contiguous groups of trees that are similar in terms of age, species composition, structure, and that grow on a site of relatively uniform productivity. Stands are the basic management units used on the forest. For example, a stand usually receives management treatments as a unit; all the trees in a stand would be thinned or harvested at one time.

Soil productivity in forestry, the quality of forestland to grow trees, is measured by site index. Site index always refers to a particular tree species on a specific site, for example loblolly pine or white oak. Few species grow equally well on the same site. Specifically, site index is the average total height of the dominant trees in a forest stand at an index age.

In the South, an index age of 50 years is commonly used for natural pine stands and 25 years for pine plantations. If forestland has the capacity to grow dominant loblolly pines to an average height of 90 feet in 50 years, it is classified as site index 90 land for loblolly pines, base age 50. Site index is important because of its dramatic impact on timber yield at harvest. Table 1 shows loblolly pine yields by site index for a 20-year old pine plantation. The amount of pulpwood produced is over three and a half times as much on the higher site index land.

Because site quality has such a major effect on timber yield, it should be a key element in valuing any forest tract. Higher site index land is worth more than lower site index land for timber production. If the forest is an investment and investment capital is limited, the highest site index portion of your forest should receive investment priority since it has the capability for higher timber production.

Table 1. Pulpwood yields for a 20-year old loblolly pine stand on Virginia's coastal plain with 700 trees per acre.

Site Index (base age 25)	Yield (tons per acre)
50	60.5
60	92.3
70	141.5
80	216.4

Yield is just that, what the forest yields in timber products. Pulpwood is usually expressed in cords (4 X 4 X 8 foot stacks of wood), cubic feet, or tons. Sawtimber is usually expressed in board feet (a 1 inch X 1 foot X 1 foot board contains 1 board foot) or tons. There are other products like chip-n-saw (small timber that can produce some sawtimber, with the rest of the tree chipped for pulpwood) and large high quality logs suitable for plywood or poles.

Tree size is measured as diameter 4½ feet above the ground, called diameter at breast height or DBH. Trees are often grouped into 2 inch diameter classes, for example, a 10 inch tree would vary from 9.00 inches to 10.99 inches. Larger trees produce more valuable products and higher timber revenue (assuming they are of good quality). In the South, pulpwood is commonly trees in size from 6 inches to 10 inches (using 2 inch diameter classes, from 5.00 to 9.99 inches), chip-n-saw is commonly 10 to 12 inches, and sawtimber is 14 inches and above. Keep in mind the larger diameter products have significantly higher values. Pulpwood might be worth $8 per ton on the stump, while chip-n-saw could be worth $20 per ton, and sawtimber could be worth $30 per ton. Poles and plywood quality sawtimber might be worth $45 per ton.

A forest inventory is necessary to determine the timber volume on a tract. It should list trees per acre by DBH classes. Further, the trees can be converted into timber volumes by product, leading to an estimate of total timber value. Basically, forest yield and stumpage price (price of timber on the stump) are the basis of defining the revenue expected from a timber sale. The forest yield is determined by site index, but is also greatly impacted by stocking.

Stocking is a measure of how many trees are in a forest stand relative to how many are needed to attain the best growth. There are two common measures of stocking: trees per acre and basal area. Basal area is the cross-sectional area of trees at breast height (4½ feet above the ground) per acre, measured in square feet. Or, in plain English, basal area is the square foot area of the top of all the tree stumps on an acre of land if all the trees are cut 4½ feet above the ground.

A forest stand should be fully stocked to get the best growth, not under-stocked or over-stocked. In the South, as a rule-of-thumb, the basal

area of a mature forest stand should approximate the 50-year site index of the land. Using this rule, site index 90 land should have a stocking of 90 square feet of basal area per acre. Trees per acre is a less reliable measure of stocking, unless you have an idea of tree size and how the trees are spaced in the stand. But it has the great advantage of being easily understood.

Stocking has little effect on total yield of a forest if you are only interested in cubic feet or tons of wood produced. Stocking has a great impact, however, on the timber products available at harvest. You need a properly stocked stand to grow sawtimber. For example, for a 30-year old loblolly pine stand, stocking differences can account for nearly five times more sawtimber from a stand. Table 1 shows the pulpwood volumes from a pulpwood only sale for this 30-year old stand and Table 2 shows the amount of pulpwood and sawtimber that results from various stocking levels for the same stand. A forester will be needed to appraise stocking levels. Notice if you are just growing tons of wood, then stocking does not matter. But if you are growing quality timber products, then it is critical. Existing stocking will be a factor to consider when evaluating a timber investment.

Table 2. Pulpwood and sawtimber yields for a 30-year old loblolly pine stand, site index 70, on the Virginia coastal plain.

Trees Per Acre	All Trees as Pulpwood (tons per acre)	Multiple Products	
		Sawtimber (tons per acre)	Pulpwood (tons per acre)
500	140.7	46.8	86.9
600	141.0	34.6	99.5
700	140.7	25.5	108.6
800	139.6	18.7	115.0
900	138.3	13.8	119.3
1,000	138.3	10.1	122.0

Age Class Distribution

For purchased timberland, a key determinant of value will be the age class distribution of the timber. The older the timber, the greater the timber volume, plus the greater the proportion of more-valuable timber products. Proper forest management ensures the optimum tree species for a site is regenerated and that stocking is controlled to produce optimum growth, both in volume and timber products. Forest stands may be thinned periodically, to generate timber revenue and to improve stocking. Consider the simple case of a natural loblolly stand in Virginia, as it becomes older, more and more of the timber volume becomes sawtimber. Figure 1 illustrates this with real-world data. This illustration is for just pulpwood and sawtimber to keep the example simple. If chip-n-saw was included, much more of the wood would be sawtimber; plus, poles and plywood-quality sawlogs would add more value if included. The difference is more pronounced if the illustration is viewed in terms

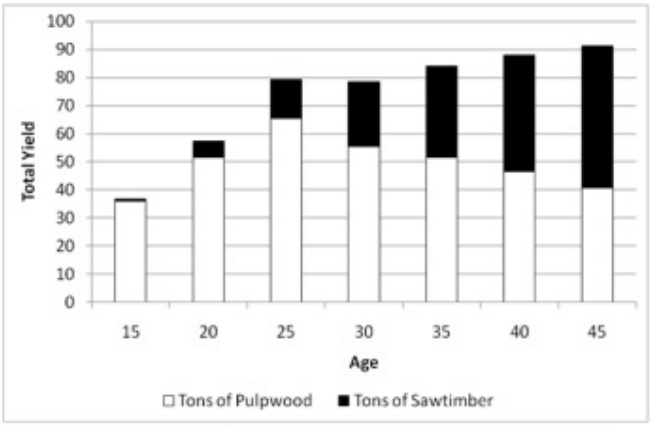

Figure 1. Yield of pulpwood and sawtimber for a natural loblolly stand, site index 80, basal area 110, Virginia coastal plain.

of value. If pulpwood is valued at $8 per ton and sawtimber at $30 per ton, the comparison shows how much value is added by the sawtimber (Figure 2).

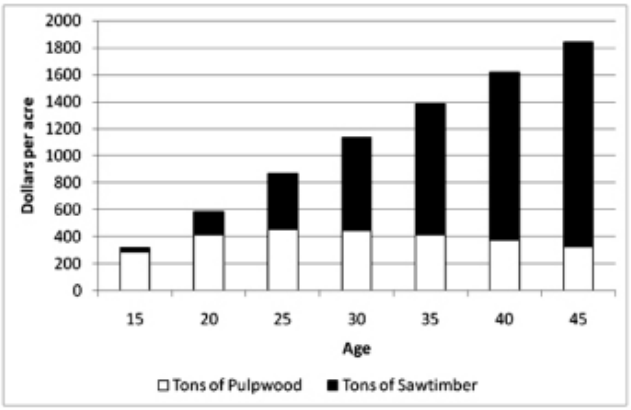

Figure 2. Proportionate value of pulpwood and sawtimber for a natural loblolly stand, site index 80, basal area 110, Virginia coastal plain.

Thus, one of the first questions that should be asked when determining timberland value for potential purchase is the age distribution of the stands. Where is the timber in terms of its growing cycle? Is it premerchantable timber, young timber about to become sawtimber, or mature timber ready for the market? How well was it managed for growth? Was it properly thinned when necessary? While the overall volume of timber per acre is relevant, the overall proportions of various timber products are even more important.

Cash Flow Distribution

The importance of the age class distribution is that it controls the cash flow distribution. Timberland property can have negative or positive annual cash flows. The age class distribution controls the sequence of thinning and harvest revenues. Often, in the absence of significant annual revenue sources (like hunting lease revenue; for example), annual cash flow can be negative. Consider the typical loblolly pine management regime in Table 3. The value of forestland managed under

Table 3. Hypothetical timber management regime for loblolly pine with actual and discounted cash flows per acre.			
Year	**Activity**	**Cash Flow**	**Discounted Cash Flow @ 4%**
0	Site prepare/plant	-$200.00	-$200.00
1	Weed control	-75.00	-72.12
18	Thinning revenue	+300.00	+148.09
25	Harvest revenue	+2,204.71	+827.02
1-25	Annual cost	-5.00	-78.11
Net present value			$624.88
Net future value (at end of rotation) = $624.88(1.04)25 = $1,665.84 Land expectation value (bare land value) per acre = $1,000.00			

this management regime with these costs and revenues is $1,000.00 per acre based on discounted cash flows over a perpetual time horizon. This is called bare land value (BLV) and the calculation is a standard one in forestry. BLV is the value of a forest in permanent perpetual timber management; it is the value of the first rotation and all the additional future rotations, considering interest. A single rotation of timber has a net present value of $624.88 per acre; an infinite number of these rotations has a net present value of $1,000.00 per acre. BLV is $1,000.00 per acre.

Consider the cash flow generated by this management regime. There are negative cash flows until the timber is thinned at year 18 and even then the cumulative cash flow considering interest is negative. However, at final harvest the major positive cash flow occurs, but that is at year 25. The cumulative cash flow considering interest at year 25 is $1,665.84.

Several key characteristics of timberland investments control its cash flows. First, unless the forest is already established, there are usually potentially large initial costs. Site preparation, planting, herbaceous weed control, and fertilizer occur early in the investment. Bare land will mean significant initial costs. Second, the age class structure, as already discussed, will control cash flows. If the age class structure is limited, potential revenue might be infrequent and delayed. Fortunately, forest yields from any age class distribution can be easily predicted. Third, forestry investments tend to be long-term. A single timber rotation in the South can be 35 or more years. In the West the range can be 50 to 100 years.

A managed timberland creates value through a cash flow. Like any investment, timberland value is essentially a discounted cash flow. Site index, a measure of forest productivity, will determine the size of the "forest engine" and forest management practices, like control of stocking, will determine the quality and quantity of forest output. Eventually, the age class distribution determines the timing of those outputs. That same timing is also a cash flow distribution. The same financial criteria that are used to evaluate standard financial investments apply equally well to forestry investments. Net present value, internal rate of return, and bare land value are all functions of a discounted cash flow. Forest owners will use these same techniques to evaluate their forestry investments. They will find the timing of cash flows, resulting from stocking and age class distribution decisions, will control the profitability of their forestry investments and thus timberland value.