

Financial Analysis Principles and Applications for Private Forest Lands

WSU EXTENSION MANUAL EM030E



Financial Analysis Principles and Applications for Private Forest Lands

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Introduction

There are many reasons for owning forestland. Some are financial, such as generating income from timber harvest or a real estate sale after long-term investment. Others are not financial, such as aesthetics, recreation, or wildlife habitat. Most forest landowners have reasons that fall into both categories. Whatever your ownership objectives may be, even if they are not primarily financially motivated, understanding basic financial principles as they apply to forestry will help you make informed decisions for sustainable management of your forest.

Your forest is one of the greatest capital assets that you own. Just as biological and ecological health are important, financial health is also important. A financially healthy forest is one in which costs and revenues are carefully planned for, minimizing financial burdens to landowners and providing opportunities for supplemental income that can offset the costs of management, be reinvested in the land to support stewardship activities, be invested in the stewardship of additional acreage, or be used to meet other family needs.

Financial analysis is useful for day-to-day decision making, such as purchasing or upgrading a piece of equipment or planning a timber stand improvement activity such as thinning or pruning. It can also be used for long-term management planning, such as a future harvest. Forests need to be managed over long time horizons because there may be several decades between harvests. Depending on rotation length and ownership turnover, some forest owners may only harvest once in their lifetime. A little bit of financial planning can make the difference between a successful harvest that meets multiple objectives or a poorly timed harvest that leads to needless loss for the landowner.

The purpose of this manual is to introduce the basic principles of forest finance and provide examples of how these principles might be applied to the management of your property. Some advanced concepts are presented later in the manual in case



Sidebar 1: Forest Finance Calculator

An online Forest Finance Calculator is available as a companion to this manual. This easy-to-use calculator includes all of the formulas presented in this manual—you need only type in the numbers. By working through the examples in this manual with the Forest Finance Calculator and letting it do the complex equations, you can concentrate on the principles and applications. The Forest Finance Calculator is available at <http://forestry.wsu.edu/nps/forestcalc/>

you wish to go deeper into the subject matter. *It is important to note that the goal of this financial analysis is not to maximize monetary profits from your forest, but instead to provide a “tool in the toolbox” for use along with other analysis tools that together consider the multiple benefits your forest provides, and will thus help you make informed decisions that meet your specific ownership objectives.* In many cases you will find that such carefully planned management activities improve wildlife habitat, forest health, aesthetics, as well as the financial return from your forest.

Many of the examples that follow focus on monetary forest benefits (e.g., timber harvest revenue). This is not intended to discount the many non-timber benefits that landowners (and society) receive from forests. Rather, these examples are intended to simplify the illustration of basic concepts. Non-timber benefits will be dealt with later in this manual.

Basic principles of forest finance

A forest can be viewed from a financial perspective as an investment. The startup costs such as purchasing land and planting trees represent the initial investments. Maintenance costs and forest improvements (e.g., pruning, pre-commercial thinning, weed control) represent subsequent investments. Growth of the trees and development of high quality habitat and aesthetic features represent interest over time. Harvest revenues or the enjoyment of habitat, recreation, and aesthetics represent future returns from the investment.

Because forestry is a long-term enterprise, it may be decades before you realize a return (from either timber or non-timber benefits) on your investments. Understanding the time value of money will help you understand the economic relationship between forestland investments and returns.

Compounding and discounting

The adage that “time is money” may indeed be true, as the value of money has a time component. Money received today is worth more than money received in the future. Thus, if someone gives up a certain amount of money today by loaning it out, they expect to receive a greater amount in return in the future. Likewise, borrowers are willing to pay back a greater amount of money in the future in order to have the use of money today. The additional future value is known as interest. The interest rate reflects the time value of money, with higher interest rates reflecting a greater preference for present over future use.

The power of interest is that it compounds over time. Consider an investment of \$100 at an annual interest rate of 5%. After one year, the balance of the account will be the original \$100 (called the principal) plus \$5 interest for a total of \$105. However, after the second year, 5% interest will be paid not only on the \$100 principal, but also on the \$5 interest that

accrued the first year. The second year's accrued interest is \$5.25, for a new balance of \$110.25. Interest payments will continue to increase each year as interest is paid upon interest (Table 1).

To compute the future value of an amount of money (loan or investment) today compounded at i interest for n years, multiply the initial principal by a factor of $(1+i)$ to the n th power. Doing this in reverse is called discounting. To find the present value of a future amount of money discounted at i interest for n years, divide the future value by a factor of $(1+i)$ to the n th power (Gunter and Haney 1984). The shorthand versions of this are expressed in Equations 1 and 2. As a reminder, for those who prefer to work directly with equations, these and the other equations presented in this manual can be solved using a hand calculator or spreadsheet program. For those who prefer simpler mathematics, the online Economagic calculator (Sidebar 1) offers an easy-to-use interface with no formulas required (e.g., Figure 1).

Equation 1. Compounding to a future value.

$$V_n = V_0 (1+i)^n$$

Where:

V_n = Future value at year n

V_0 = Present value

i = Interest rate

n = Number of years

Equation 2. Discounting to a present value.

$$V_0 = \frac{V_n}{(1+i)^n}$$

Where:

V_n = Future value at year n

V_0 = Present value

i = Interest rate

n = Number of years

Table 1. Compound interest at 5% over five years on a principal value of \$100.

Year	Principal	Previous Interest	Interest on principal	Interest on previous interest	Account balance
1	\$100.00	\$0.00	\$5.00	\$0.00	\$105.00
2	\$100.00	\$5.00	\$5.00	\$0.25	\$110.25
3	\$100.00	\$10.25	\$5.00	\$0.51	\$115.76
4	\$100.00	\$15.76	\$5.00	\$0.79	\$121.55
5	\$100.00	\$21.55	\$5.00	\$1.08	\$127.63

Present Value of a Single Sum

Calculate what an amount of money in the future is worth today

Future Value (\$):

Number of Years:

Interest Rate (%):

Example: 5%=5

Figure 1. The online Economagic calculator greatly simplifies financial calculations.

Compound interest results in exponential growth, as demonstrated in Figure 2. \$100 compounded over 50 years at 5% interest will grow to \$1,447. If the interest rate doubles to 10%, the value grows to \$11,739. This also true with discounting, meaning that \$11,739 to be received 50 years in the future is worth approximately \$100 today assuming 10% interest. Applying the concept of compound interest to a forestry context, an investment in land and stand establishment 50 years ago would have to be valued at 11.47 times as much today (50 years later) if the landowner desires to earn 5% interest on that investment.

\$100 in 50 years at 5% interest (using Equation 1):
 $V^{50} = \$100(1+.05)^{50} = \$1,147$

\$100 in 50 years at 10% interest (using Equation 1):
 $V^{50} = \$100(1+.10)^{50} = \$11,739$

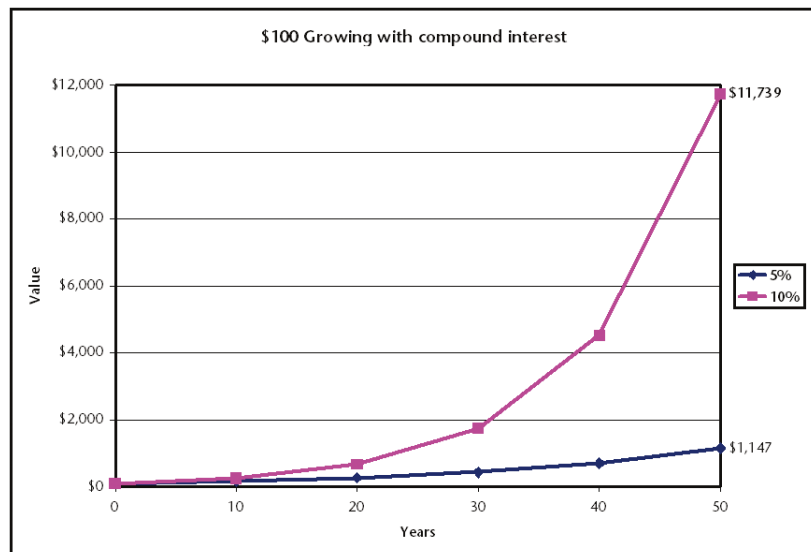


Figure 2. Future values of \$100 invested today at 5% and 10% interest over 50 years. Compound interest causes money to grow exponentially, especially at higher interest rates.

Sidebar 2: Is the future worth anything?

When evaluating the present value of expected goods (monetary or otherwise) received far in the future, it may begin to appear that the future is of little worth today (or even worthless at a high enough interest rate or over a long enough period). Forestry is unique in its long-term nature, and foresters and forest owners tend to be particularly forward thinking and future-oriented, often growing trees not for themselves but for their children, grandchildren, and beyond.

Foresters and landowners have long struggled with the concept of compound interest because of its tendency to be present-centric. Some argue that because of forestry's long time horizons, lower interest rates should be used (e.g., Foster 1983). Others, such as Klemperer (1976), maintain that the application of competitive interest rates allows for efficient allocation of scarce resources (though Klemperer also notes that looking too far into the future is not a realistic investment horizon).

If it is to be practical and relevant to forestry, financial analysis must be reasonable both in time horizon and expected interest rate. Financial analysis may have the most obvious practicality for short-term management decisions. When evaluating forestry investments over the long term (e.g., an entire forest rotation or beyond), consider financial principles as one of many tools that can help guide decision-making.

Perhaps the best way to approach the issue of compounding and discounting is to realize that even small investments made today, especially in growing trees, will yield enormous dividends for future generations in the form of both economic and environmental values.

Example 1. Road maintenance.

Suppose you estimate that in 5 years you will need to spend \$10,000 to resurface one of your forest roads. If your bank account pays 5% interest, how much do you need in the account today in order to have \$10,000 in 5 years to cover the cost?

Solution: In this case, you know the future value and need to solve for present value.

Using Equation 2:
$$V_0 = \frac{\$10,000}{(1+.05)^5} = \$7,835$$

You can also solve this problem using the Economagic calculator to compute the present value of a future sum, entering the appropriate values for the future amount, interest rate, and number of years (Figure 1).

Sidebar 3: Rule of 72

A quick trick to approximate the number of years it will take an investment to double in value is to divide the number 72 by the interest rate (Blatner and Cross 1989). For example, if you want to know how long it will take for \$100 to grow to \$200 at 5% interest, divide 72 by 5. This yields approximately 14 years, which you can check using Equation 1:

$$\$100(1.05)^{14} = \$198.$$

Example 2. Harvest now or later?

Suppose you are trying to decide whether to harvest today or wait another 5 years. A harvest today will yield \$8,000/ac, which you can put in your bank account at 5% interest. However, timber markets are forecast to improve such that in another 5 years you expect your timber to yield \$11,000. Should you harvest now or wait?

Solution: Use Equation 1 to find out how much \$8,000 in timber revenue today will be worth after 5 years in the bank at 5% interest.

$$V_5 = \$8,000(1+.05)^5 = \$10,210$$

In this case, you would be better off to let your timber grow another 5 years when it will yield \$11,000.

Payment series

So far you have looked at how to convert single sums between present and future values. Oftentimes, though, you deal with a repeating series of payments, such as regular investments in a retirement account or payments on a loan. You can determine the present or future value of a payment series.

A payment series may be perpetual (payments continue forever), terminating (payments last for a finite period), annual (payment each year), or periodic (payment at regular intervals other than one year, such as every five years). This yields four possible series types: 1) perpetual annual, 2) terminating annual, 3) perpetual periodic, and 4) terminating periodic. Except for the future value of a perpetual series, which would be infinite, the present or future value of each type of series can be found using Equations 3–8 (Gunter and Haney 1984). Each of these equations includes an example of how it might be used. As with the earlier equations, all are available in a simplified format in the Economagic calculator.

Equation 3. Present value of a terminating, annual series.

$$V_0 = a \left[\frac{(1+i)^n - 1}{i(1+i)^n} \right]$$

Where:

V_0 = Present value

a = Payment amount

i = Interest rate

n = Number of years

Example 3. Tax savings.

Suppose you enroll in a current use tax program that saves you \$1,000 in property taxes every year. What is the present value of the savings over 20 years at 5% interest?

Solution: Find the present value of an annual series that terminates at 20 years.

Using Equation 3:

$$V_0 = \$1,000 \left[\frac{(1.05)^{20}-1}{.05(1.05)^{20}} \right] = \$12,462$$

Equation 4. Future value of a terminating, annual series.

$$V_n = a \left[\frac{(1+i)^n-1}{i} \right]$$

Where:

V_n = Future value at year n

a = Payment amount

i = Interest rate

n = Number of years

Example 4. Tax savings revisited.

Suppose you put your \$1,000/year of tax savings from Example 3 in the bank for 20 years at 5% interest. How much will you have in your bank account after 20 years?

Solution: Find the future value of an annual series that terminates at 20 years.

Using Equation 4:

$$V_{20} = \$1,000 \left[\frac{(1.05)^{20}-1}{.05} \right] = \$33,066$$

Equation 5. Present value of a terminating, periodic series.

$$V_0 = a \left[\frac{(1+i)^n - 1}{((1+i)^p - 1)(1+i)^n} \right]$$

Where:

V_0 = Present value

a = Payment amount

p = Payment period

i = Interest rate

n = Number of years

Example 5. Periodic harvest revenues.

Suppose you plan to harvest \$5,000 worth of timber every 5 years for the next 15 years (three total harvests). What is the present value of these revenues?

Solution: Find the present value of a periodic series that terminates in 15 years.

Using Equation 5:

$$V_0 = \$5,000 \left[\frac{(1+.05)^{15} - 1}{((1+.05)^5 - 1)(1+.05)^{15}} \right] = \$9,392$$

Equation 6. Future value of a terminating, periodic series.

$$V_n = a \left[\frac{(1+i)^n - 1}{(1+i)^p - 1} \right]$$

Where:

V_n = Future value at year n

a = Payment amount

p = Payment period

i = Interest rate

n = Number of years

Example 6. Periodic harvest revenues revisited.

Suppose you could harvest \$5,000 worth of timber every 5 years for the next 15 years and invest the money in your child's college fund. At 5% interest, how much will the fund be worth after 15 years?

Solution: Find the future value of a periodic series that terminates in 15 years.

Using Equation 6:

$$V_{15} = \$5,000 \left[\frac{(1+.05)^{15}-1}{(1+.05)^5 -1} \right] = \$19,526$$

Equation 7. Present value of a perpetual, annual series.

$$V_0 = \frac{a}{i}$$

Where:

V_0 = Present value

a = Payment amount

i = Interest rate

Example 7. Endowment fund.

Suppose you want to establish an endowment fund to provide scholarships at your favorite forestry school. If the fund earns 5% interest, how much would you have to put in the fund today in order to provide a \$1,000 scholarship each year in perpetuity?

Solution: Find the present value of an annual series that continues in perpetuity.

Using Equation 7:

$$V_0 = \frac{\$1,000}{.05} = \$20,000$$

Equation 8. Present value of a perpetual, periodic series.

$$V_0 = a \left[\frac{1}{(1+i)^p - 1} \right]$$

Where:

V_0 = Present value

a = Payment amount

p = Payment period

i = Interest rate

Example 8. Endowment fund revisited.

Suppose you want to establish an endowment to provide a \$1,000 scholarship for forestry students. You do not have enough to invest in the fund to provide the scholarship each year (\$20,000 according to Example 7), but you want to know what it would take to provide the scholarship every 5 years.

Solution: Find the present value of a periodic series that continues in perpetuity.

Using Equation 8:

$$V_0 = \$1,000 \left[\frac{1}{(1+.05)^5 - 1} \right] = \$3,619$$

Equations 3–8 demonstrate how to solve for a present or future value when a payment series is involved and the payment amount is known. In many cases, though, the present and future values are known, but the payment amount is unknown. The sinking fund formula (Equation 9) solves for the annual payment needed to accumulate a desired amount in a given number of years in the future. Similarly, the installment payment formula (Equation 10) solves for the annual payment needed to pay off a present debt over a given number of years.

Equation 9. Sinking fund formula.

$$a = V_n \left[\frac{i}{(1+i)^n - 1} \right]$$

Where:

a = Payment amount

V_n = Future value

i = Interest rate

n = Number of years

Example 9. Road maintenance revisited.

Recall from Example 1 that you solved for the amount of money that needed to be invested in the bank today at 5% interest in order to have \$10,000 in 5 years to resurface a road. What if instead you want to see how much you need to invest each year over the next 5 years to meet that \$10,000 goal?

Solution: Find the annual payment amount to accumulate a future value.

Using Equation 9:

$$a = \$10,000 \left[\frac{.05}{(1+.05)^5 - 1} \right] = \$1,810$$

Equation 10. Installment payment formula.

$$a = V_0 \left[\frac{i(1+i)^n}{(1+i)^n - 1} \right]$$

Where:

a = Payment amount

V_0 = Present value of debt

i = Interest rate

n = Number of years

Example 10. Road maintenance on credit.

Now suppose that you borrowed \$10,000 at 5% interest to resurface the road, and you want to pay off the loan over 5 years. How much would you have to pay per year?¹

Solution: Find the annual payment amount to pay off a present debt.

Using Equation 10:

$$a = \$10,000 \left[\frac{.05(1+.05)^5}{(1+.05)^5 - 1} \right] = \$2,310$$

Assessing forestry investments

Net present value

Utilizing compounding and discounting is necessary when assessing forestry investments, as forestry is a long-term enterprise in which costs and revenues occur at different times. Suppose a landowner invested \$300/acre to establish a stand of Douglas-fir, spent \$100/acre 15 years later to pre-commercially thin (PCT) the stand, generated \$1,000/acre of net revenue in year 35 from a commercial thin, and received \$14,000/acre in net revenue when the stand was harvested at age 50 (Figure 3). Over the course of the 50 years, \$10/acre was spent every year on taxes and general maintenance. In terms of financial performance, it is not appropriate to take the total costs of \$900/acre (\$300 + \$100 + 50 x \$10) and subtract them from the total revenues of \$15,000/acre (\$1,000 + \$14,000) to compute a net profit of \$14,100/acre.² *Because these cash flows occur at different times, they should be compounded or discounted to a common year and then compared.*

Typically, all costs and revenues are discounted back to the present to establish a discounted cash flow. This can be done with a combination of single amounts and series. The net sum of the present value of the costs and the present value of the revenues is known as net present value (NPV). NPV allows an apples-to-apples comparison of costs and revenues that occur at different times. Table 2 below shows the NPV at 5% interest for the Douglas-fir rotation described above. Each cost and revenue has been discounted back to year 0 (using Equation 2 for the single sums and Equation 3 for the annual maintenance costs).

¹ Loans are typically paid on a monthly basis. For simplicity, this example assumes a yearly payment.

² However, this sort of approach is used to compute profit for income tax purposes.

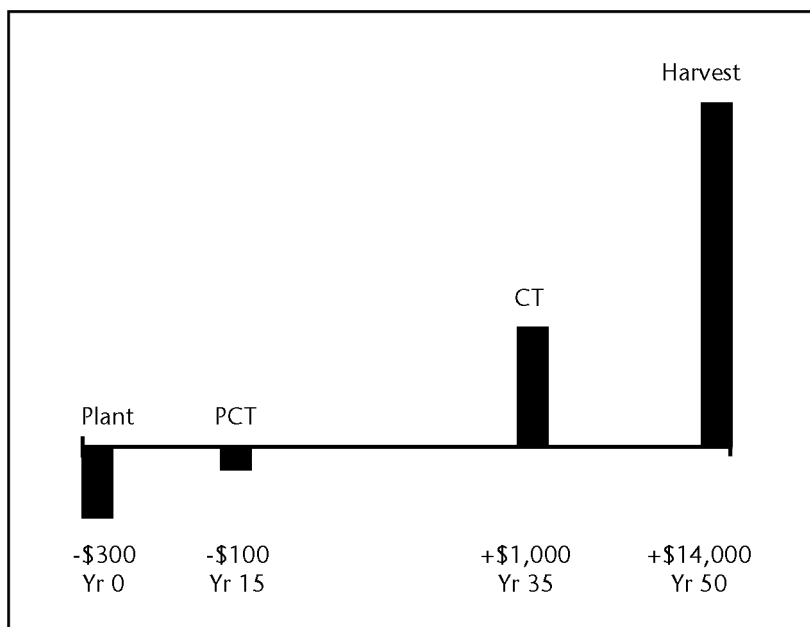


Figure 3. Timeline of costs and revenues over the course of a Douglas-fir rotation (not to scale and not including annual maintenance costs).

Table 2. Net present value of an example Douglas-fir rotation at 5% interest.

Item	Year	Value	Present Value
Plant	0	-\$300	-\$300
PCT	15	-\$100	-\$48
CT	35	\$1,000	\$181
Harvest	50	\$14,000	\$1,221
Maintenance	Annually	-\$10	-\$183
Net Present Value:			\$871

If the NPV is positive, then the present value of the revenues exceeds the present value of the costs and the investment can be considered financially acceptable. Likewise, if the NPV is negative, the present value of the costs exceeds the present value of the revenues and the investment is considered financially unacceptable. When considering multiple acceptable alternatives, a higher NPV is preferable. Alternatively, a positive NPV means that the future revenues provide a return on the invested costs that exceeds the given interest rate. In the Douglas-fir example above (Table 2), the NPV at 5% interest is \$871/acre, meaning that the revenues from commercial thinning and final harvest yield a 5% return from the money invested in stand establishment and PCT, plus additional returns equal to a present value of \$871. Put another way, if instead of growing trees you invested the money in the bank at 5% interest, you would have to add \$871 beyond the cost of stand establishment and PCT to generate the same return as growing trees. Likewise, if the money for stand establishment and thinning were borrowed at 5% interest, the future harvest

Sidebar 4: What does a zero or negative NPV mean about my forest rotation?

When working with net present values, the concept of “worth” can be tricky. An NPV of zero does not indicate zero value. Rather, it means that the investment (e.g., forest rotation) earns exactly the rate of return used in the computation. Depending on the interest rate (e.g., 5%), this may be a very respectable economic return that outperforms many investment alternatives.

A negative NPV does not necessarily indicate poor investment performance either, but that the present value of the costs exceed the present value of the revenues *at the interest rate used*. If you find that the NPV of your forest rotation or other project is less than zero, it would be wise to examine ways to reduce your costs. You should also look closely at the interest rate on which your NPV is based, because it may be unrealistically high. The NPV of any investment will be negative at a high enough interest rate. You may also wish to consider the non-market benefits of your forest. Investment performance may be mediocre when only monetary revenues are considered. Factor in non-market benefits such as clean air, clean water, wildlife habitat, aesthetics, recreation, and quality of life, and your forest may be your best-performing asset.

revenue would be able to pay back the loan plus interest and still yield an \$871 profit.³

NPV is a useful tool for comparing management alternatives and guiding management decisions. This can include individual decisions such as whether or not to thin or prune, as well as overall management paradigms for entire rotations. Below are several examples. Note that the Economagic calculator has a built-in NPV function to simplify calculations.

Notice that in Example 11 the rotations are the same length (40 years). If the rotations are different lengths, the unequal time horizon does not allow for the same direct comparison of performance. For example, a simple NPV comparison of a 30-year rotation and a 50-year rotation does not account for the fact that by the time the 50-year rotation is complete, you could be 20 years into a second 30-year rotation. The methods to account for unequal time horizons and allow direct comparisons are covered in the Advanced Analysis section later in this manual.

Interest rates

The NPV of an investment depends heavily on the interest rate used. This interest rate is also called the discount rate or the target rate of return. In Figure 3 and Table 2, growing Douglas-fir over 50 years results in an NPV of \$871 at 5% interest. However, at 10% interest the NPV is -\$268. For a meaningful analysis, *it is important to use a target rate of return that accurately reflects the investor's time value of money*. If the rate is set too high, cash flows that occur sooner will be weighted too heavily relative to cash flows that occur later, and opportunities for future returns may be missed. Likewise, a rate that is too low will cause future cash flows to be weighted too heavily and may undervalue present needs and opportunities.

An appropriate interest rate depends on several factors. If you borrow capital to fund forestry activities, the rate of return should reflect the cost of that capital (the borrowing interest rate). If you want to invest existing capital, the rate of return should similarly reflect the opportunity cost, which is the alternative rate of return that could be achieved elsewhere. For example, earning 5% interest from a savings or mutual fund account could be used as a benchmark to assess an alternative investment in forestry.

Another interest rate factor is investment risk. Most people tend to be risk averse such that they demand a higher rate of return for riskier investments (Klemperer 1996). This is evident in market interest rates that are low for relatively risk-free investment vehicles like treasury notes and higher for riskier

³ That is, \$871 present value, which is equal to \$9,988 at the end of the rotation (using Equation 1).

Example 11. Rotation planning.

Suppose you just harvested timber and are now ready to plant and plan for the next rotation. Your interest rate is 5% and you are considering two choices.

1. *Plant denser and thin mid-rotation.* Planting costs would be \$500/acre, you would receive \$1,500 in thinning revenue in year 20, and \$5,000 of final harvest revenue in year 40.
2. *Plant lighter and skip the mid-rotation thinning.* Planting costs would be \$300/acre, and you would receive \$7,000 of final harvest revenue in year 40.

Solution: Because the costs and revenues of each rotation occur at different times, to make an apples-to-apples comparison, the NPV should be computed by discounting everything back to the present (Figure 4).

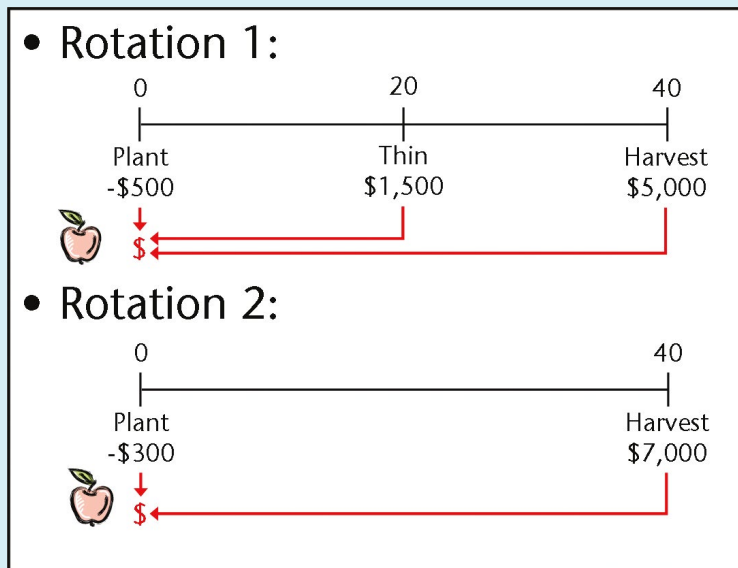


Figure 4. Discounting all costs and revenues back to the present and computing the NPV allows for an apples-to-apples comparison of cash flows that occur at different times.

$$\text{Rotation 1: NPV} = -\$500 + \frac{\$1,500}{(1+.05)^{20}} + \frac{\$5,000}{(1+.05)^{40}} = -\$500 + \$565 + \$710 = \$775$$

$$\text{Rotation 2: NPV} = -\$300 + \frac{\$7,000}{(1+.05)^{40}} = -\$300 + \$994 = \$694$$

In this example, the first rotation yields the higher NPV and thus is more desirable given the interest rate and assumptions, all other values being equal.

Example 12. Pruning.

Suppose you are considering hiring someone to prune the dominant trees in your young stand at a cost of \$150/acre. You expect the improved wood quality to increase your stumpage value by \$500/acre when you harvest in 20 years.⁴ Is this a good investment given a 5% interest rate?

Solution: Compute the NPV of the pruning cost today and the increased timber revenues 20 years in the future.

$$\text{NPV} = -\$150 + \frac{\$500}{(1+.05)^{20}} = -\$150 + \$188 = \$38$$

The NPV of \$38 is greater than zero. This means that, given the assumptions, investing in pruning today will yield greater than a 5% return over the next 20 years. Had the NPV been less than zero, it may have been more beneficial to leave the \$150 in the bank rather than invest it in pruning, unless there were other benefits (e.g., aesthetics) to consider.⁵

Example 13. Carbon credits.

Suppose you have the opportunity to sell carbon credits from your forest. You expect to earn \$80/acre/year in carbon credits for the next 15 years. However, it will cost you \$1,000/acre to complete a rigorous inventory, management plan, and other necessary administrative steps in order to be able to trade your carbon in the marketplace. Is the startup expense worth it?

Solution: Compute the NPV of the startup costs today and the credits earned over the next 15 years (utilizing Equation 3).

$$\text{NPV} = -\$1,000 + \$80 \frac{(1+.05)^{15}-1}{.05(1+.05)^{15}} =$$
$$-\$1,000 + \$830 = -\$170$$

In this example, NPV is less than zero such that you would be better off leaving your money in the bank at 5% interest than paying the expenses required to receive carbon credits.

⁴ The \$500/acre figure is used for illustration purposes only. In some cases it may be challenging to estimate future benefits.

⁵ Non-market benefits such as aesthetics are discussed later in the non-timber values section.

investments. The risks for growing timber include physical threats such as fire or storm damage, as well as socio-economic risks such as market fluctuations and changing regulatory environments.

At the same time, many see forestland as an attractive long-term investment that tends to be insulated from or even counter-cyclical to the market fluctuations of stocks, bonds, and other investment alternatives (Wilent 2008). Some institutional investors view forestland as a way to reduce portfolio risks because timber has the advantage not only of immunity to most market shifts, but continued biological growth regardless of market conditions. Even if log markets are down, trees continue to add volume and unlike perishable short-term crops, they can be held until markets improve (Kelly 1996). There is still some level of risk here, however, as the timber may be subject to fire, disease, or other unforeseen event. Ultimately, perceptions of risk and expectations for associated returns vary relative to the level and nature of one's forestry investments.

Inflation

When dealing with long-term investments, you must consider the impact of inflation. Money today is worth more than in the future even independent of time preference because of the general increase in the price of goods over time (known as inflation). Inflation diminishes the purchasing power and hence the value of money, acting like a reverse interest rate. Based on the U.S. Consumer Price Index (CPI), a national measure of inflation, the average inflation rate over the 30-year period from 1979 to 2009 was between 3% and 4%.⁶

Inflation can distort investment analysis. Market interest rates are nominal, meaning not adjusted for the impact of inflation. Interest rates that have been adjusted for inflation are known as real interest rates, as they reflect an actual increase in value net of the general inflation. Discounting future values to account for inflation is just like discounting with an interest rate (i.e., Equation 2): you divide by a factor of $(1+f)$ to the n^{th} power, where f is the rate of inflation and n is the number of years. To convert from a nominal interest rate to a real (net of

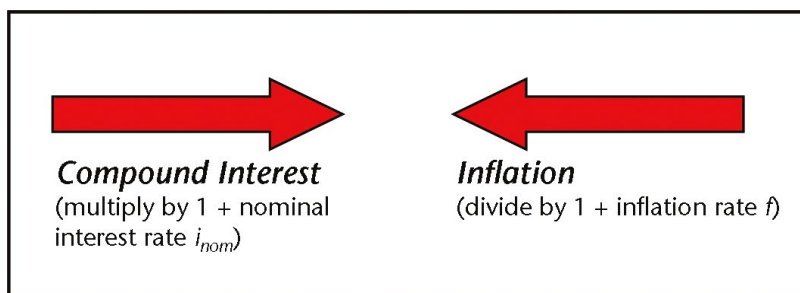


Figure 5. Real (net of inflation) interest rates combine the effects of compound interest and inflation.

⁶ The U.S. Department of Labor's Bureau of Labor Statistics offers an online inflation calculator and other information about inflation and the CPI at http://www.bls.gov/data/inflation_calculator.htm.

Equation 11. Converting from a nominal to real interest rate.

$$i_{\text{real}} = \frac{(1+i_{\text{nom}})}{(1+f)} - 1$$

Where:

i_{real} = Real interest rate

i_{nom} = Nominal interest rate

f = Inflation rate

Example 14. Computing a real rate of return.

Suppose you have a bank account that pays 5% interest (nominal). If inflation is 3.5%, what is the real (net of inflation) interest rate you earn at the bank?

Solution: Convert the nominal interest rate to a real interest rate using Equation 11.

$$i_{\text{real}} = \frac{(1+.05)}{(1+.035)} - 1 = 1.4\%$$

With inflation factored in, bank accounts may yield much lower, and even negative rates of return in which the loss of purchasing power outweighs the growth of interest. This is important to consider, especially when making comparisons with forestry investments presented in real terms.

inflation) interest rate, combine the compounding work of the interest rate with the discounting work of inflation (Figure 5). Mathematically, this is demonstrated in Equation 11.

As with the interest rate, cash flows can either be in nominal terms, reflecting actual (inflated) costs and revenues in the years they occur, or they can be in real or constant dollars, in which all cash flows reflect the purchasing power of a given base year. Perhaps the easiest way to remove the distorting effect of inflation in forest finance is to keep all cash flows in terms of today's (constant) dollars. Relating costs and revenues to today's purchasing power is the easiest frame of reference. This assumes no *real* price changes for forestry goods and services, but that any price changes will be proportional relative to prices of other goods and services (following the general trend of inflation).⁷

⁷ For additional discussion on inflation and the use of constant dollars, see Lesson 3 in the Economagic online learning module.

Whether this assumption of no real price changes for forestry will hold true is unknown. Ultimately, keeping everything in real terms using today's dollars is not an unreasonable assumption, and it provides a relatively simple approach for removing inflationary distortions when doing forestry financial analysis.⁸

Whether you use nominal or real figures, the most important thing is to keep like things together. If cash flows are in nominal dollars, you must use a nominal interest rate. However, if cash flows are in constant dollars, you need to use a real interest rate. In the Douglas-fir example shown in Figure 3 above, the future costs and revenues reflect today's (constant) dollars instead of the inflated values expected 15 or 50 years in the future. The target rate of return for this example is accordingly a real rate. Since interest rates for bank accounts and other common investments are usually quoted as nominal rates, it is important to convert them to real rates (e.g., Example 14) before comparing with a forestry investment analysis done in real terms.

Advanced analysis: Land and timber valuation in perpetuity

The basic principles of forest finance covered previously, including compounding and discounting, payment series, NPV, and inflation, are useful to compare alternatives and make (especially short-term) decisions, and they will be sufficient for many forest landowners. For those who wish to go further with forestry financial analysis, more advanced concepts are offered next. These concepts provide a framework for long-term forest land use analysis and management planning. It is important to note, however, that greater uncertainties are associated with longer time horizons, which means application of the principles discussed below has practical limits.

Soil expectation value

The principles of discounted cash flow analysis can be used to determine the economic value of forestland and timber (Faustmann 1849). In the case of bare land, the economic value for forestry use is the NPV of expected future benefits⁹ and costs. This value is not limited to a finite period of time, such as a single forest rotation, as the land does not drop to zero value at the end of the rotation. Rather, the land retains the same earning potential it started with, as the rotation could be repeated or the land could be sold to someone else for similar or different use. Because there is always residual value at the end

⁸ Using real figures to remove the effects of inflation assumes a pre-tax analysis. If taxes are incorporated into the analysis (beyond the scope of this manual), you'll need to use nominal figures and factor in inflation.

⁹ Benefits may be monetary or non-monetary (e.g., ecosystem values). For simplicity of illustration, only monetary benefits will be assumed at first. Later on, non-monetary benefits will be considered.

Sidebar 5: Why perpetuity?

This advanced section explores forest rotations repeated in perpetuity (forever). Such an infinite time horizon may initially seem unrealistic. However, the benefits of extending the analysis into perpetuity are quite practical. Recall from Example 11 earlier in this manual that you were able to compare the NPV of two forest rotations because they were the same length. But what if you want to compare two 30-year red alder rotations, one 50-year Douglas-fir rotation, or even longer rotation options for wildlife benefits?

In each case, you need a common time horizon to directly compare the NPV of different management alternatives. Computing present values of perpetual investment cycles is relatively easy to do mathematically (recall Examples 7 and 8), and perpetuity provides the common time horizon.

of a use cycle, the full economic value of land must include its potential to provide economic benefits in perpetuity.

Soil expectation value (SEV) is a special application of NPV that provides an economic value of bare land. It is the NPV, given expected future cash flows, of growing timber in perpetuity starting with bare land. As such, it represents the maximum additional outlay that could be made at the beginning of a rotation for the purchase of the land while still earning the target rate of return on the total investment. Thus, SEV is also considered the maximum willingness to pay for land given management expectations of forestry use (Klemperer 1996).

You can compute SEV by summing the present value of all expected costs and revenues, including establishment costs, mid-rotation cash flows (e.g., PCT costs or commercial thin revenues), final harvest revenue, and annual overhead costs, over a perpetual series of rotations beginning with bare land. The simplest way to determine SEV is to treat the net future value at the end of a single rotation (year R) as a perpetual, periodic series that repeats every R years using Equation 12. Note that Equation 12 includes elements of Equations 1, 7, and 8.

The SEV of the hypothetical Douglas-fir rotation in Example 15 is \$955. Note that this is higher than the single-rotation NPV

Equation 12. SEV is the NPV of all expected costs and revenues for an even-aged rotation repeated in perpetuity starting with bare land.

$$SEV = \frac{-E(1+i)^R \pm M_T(1+i)^{(R-T)} + H_R}{(1+i)^R - 1} - \frac{a}{i}$$

Where:

SEV = Soil expectation value

E = Establishment cost

M_T = Mid-rotation cash flow in year T

H_R = Final harvest revenue in year R

R = Rotation length

a = Annual overhead costs

i = Interest rate

Example 15. The SEV of a 50-year Douglas-fir rotation.

Recall the example shown in Figure 3 and Table 2 in which it costs \$300/acre to establish a Douglas-fir stand and \$100/acre at year 15 to pre-commercially thin (PCT). At year 35 there is \$1,000/acre of net revenue from a commercial thin, and at year 50 there is \$14,000/acre in net revenue from the final harvest. Annual overhead/maintenance costs are \$10/acre/year. What is the SEV of this management regime at 5% interest?

Solution: Treat this forest rotation as a perpetual cycle using Equation 12 (or the Economagic calculator, as show in Figure 6).

$$SEV = \frac{-\$300(1+.05)^{50} - \$100(1+.05)^{(50-15)} + \$1,000(1+.05)^{(50-35)} + \$14,000}{(1+.05)^{50} - 1} - \frac{\$10}{.05} = \$955$$

Soil Expectation Value (SEV)

Calculate Soil Expectation Value (SEV) for an Even-Aged Rotation

Cash Flow Description	Type	Amount (\$)	Year
Stand Establishment	Cost	300	0
Mid-Rotation 1	Cost	100	15
Mid-Rotation 2	Revenue	1000	35
Mid-Rotation 3	Cost		
Mid-Rotation 4	Cost		
Final Harvest	Revenue	14000	50
Net Annual Cash Flow	Cost	10	

Interest Rate (%):
 Example: 5%=5

Figure 6. SEV can be calculated by entering the indicated parameters into the Economagic calculator.

of \$871, accounting for the additional value of subsequent rotations repeated in perpetuity.¹⁰ This means that you could pay up to \$955/acre to purchase forestland for the purpose of growing trees (given the cost and revenue assumptions) and still earn a 5% return on your total investment in both purchasing

¹⁰ Although the incorporation of subsequent rotations only adds a small amount relative to the initial rotation, this does not mean the subsequent rotations have little value. Looking beyond the initial rotation is not meant to be a realistic or reasonable investment horizon; rather, it is a mathematical tool for dealing with residual land values (after the initial use cycle) as well as establishing a common time horizon to make direct comparisons between disparate alternatives. Also recall from the earlier discussion of NPV that caution must be used when moving from the concept of NPV to the broader concept of worth.

Sidebar 6: Does a zero or negative SEV mean the land is worthless?

Recall Sidebar 4 about zero and negative NPV values. SEV is a type of NPV calculation, so the same considerations apply.

If SEV is zero, it means that growing timber from bare land, given your assumptions, will earn exactly the interest rate that you used in the analysis. However, a zero SEV does not leave room for additional investment to purchase the land itself. If you already own the land, this would not be an issue since you do not need to budget for a land purchase. If you are considering purchasing (or leasing) the land, though, you need to realize that you would not earn your target rate of return for your investment. You should consider a lower interest rate, rethink your management plan to lower costs or increase revenues, or refrain from bidding on this particular piece of land. Alternatively, the property may be well-suited to a non-forestry land use or the production of non-monetary forest values.

the land and growing trees on it. Because this value reflects forest rotations repeated in perpetuity, it becomes independent of a time horizon and can be directly compared with other rotation lengths or even other land uses.

SEV should not be confused with the actual market value of a piece of land. SEV is the theoretical willingness to pay for a piece of land by an individual investor for the purpose of growing timber given assumptions of costs, revenues, and a desired rate of return. The market value of the land represents the market clearing price for an aggregate of buyers and sellers (each with their own assumptions) in the marketplace. SEV is also by definition based on forestry use. Forestland may have a different value for a competing, non-forest use such as development. When the economic value for a non-forest use exceeds the economic value for forestry use, there is economic pressure to convert.

Forest value

For land that has existing timber, the combined land and timber value, or forest value, can be computed by adding the present value of expected costs and revenues over r years until the end of the existing rotation along with the present value of the return to bare land (Equation 13). Forest value depends partly on SEV, which is treated as a constant, underlying value of the land regardless of the status of existing timber. When computing forest value, SEV should be based on the expectations of the management regime in place once the land is bare at the end of the existing rotation.

Notice that the SEV in Equation 13 is discounted. The difference between a discounted and non-discounted SEV is

Equation 13. Forest value is the combined economic value of land and standing timber.

Forest Value =

$$\pm \frac{m_t}{(1+i)^t} + \frac{h_r}{(1+i)^r} - a \left[\frac{(1+i)^r - 1}{i(1+i)^r} \right] + \frac{SEV}{(1+i)^r}$$

Where:

m_t = Mid-rotation cash flow in year t

h_r = Final harvest revenue in year r

r = End year of current rotation

a = Annual overhead costs

SEV = Soil expectation value

i = Interest rate

referred to as “land rent.” Land rent accounts for the fact that you do not get bare land back (i.e., it is not available for a new rotation) until the existing rotation is complete. Thus, it reflects the opportunity cost of using the land to hold the existing timber instead of starting a new rotation.

Forest value represents the total economic value of a forest, both land and timber. It is the NPV of all costs and revenues in perpetuity when starting with existing timber (the inclusion of SEV in the equation incorporates everything after the end of the current rotation, in perpetuity). Like SEV, the importance of forest value is that it allows direct comparisons between different management alternatives for a mature or immature forest.

Example 16 demonstrates the concept of an economically optimal rotation length. When planning a rotation from the beginning (bare land), the economically optimal rotation is that which maximizes SEV. When dealing with an existing stand, the economically optimal harvest time is that which maximizes forest value. Economic optimization is not limited to rotation length, but can be done relative to various management decisions, including stand establishment (method, species, spacing, preparation) and thinning. It is critical that you analyze economically optimal options in the context of all the variables involved (e.g., the optimal rotation age depends on the species planted).

Input variables

SEV and forest value are economic values tied to expected future cash flows based on an individual’s costs, interest rate, and other factors. *One individual’s economic value may be different from another’s, as inputs and costs vary.* A major challenge in computing SEV and forest value is selecting appropriate input variables. For example, consider how the SEV values change depending on interest rate and annual maintenance costs.

Interest rate has perhaps the most significant leverage on financial outcomes. Annual costs can represent a significant portion of overall costs and can be highly variable between different landowners. Table 3 lists SEV values for Example 15 for 4–6% interest rates and annual costs of \$10, \$15, and \$20 per acre. Such value ranges represent a difference of almost \$1,700. In some cases the choice of input variables makes the difference between achieving or not achieving the target rate of return.

Sidebar 7: Why pay rent on the land you own?

The terminology of “land rent” often causes confusion. Why pay rent on land that you own? Some argue against incorporating this into financial analysis as an unreasonable expectation (e.g., Irland 1986).

This rent, however, serves a practical mathematical function in forestry financial analysis because it keeps the sequential management timeline intact and accounts for the fact that future rotations (remember that SEV is the NPV of all future rotations in perpetuity starting from bare land) will not begin until the current one is finished. Without land rent, you would be computing the NPV as if a new rotation had already started and was occurring concurrently with the existing rotation, thus double-counting the productive ability of the land.

Making sure land rent is included can also help guide management decision-making. In the case of a well-growing, productive stand, the analysis will likely show that it is advantageous to keep the existing timber growing rather than starting from scratch. In the case of a degraded, poorly-growing stand, the analysis would reveal the opportunity cost of continuing to maintain such a poor stand of timber, which is the lost opportunity of beginning a fresh rotation with better growth, yield, and forest health.

Example 16. When to harvest.

Suppose you have a stand of 40-year-old timber. If you harvest today it will yield \$9,000 in net revenue. If you wait another 10 years, you expect it to yield \$16,000. If you wait 20 years you expect it to yield \$25,000. Based on your plans for future rotations, you have computed SEV to be \$955/acre. Annual maintenance costs are \$10/acre, and your interest rate is 5%. Which is the best financial option?

Solution: Compare the forest value of each alternative using Equation 13 (or the Economagic calculator).

$$\text{ForestValue}_{\text{now}} = \frac{\$9,000 + \$955}{(1+.05)^{50} - 1} = \$9,955$$

$$\text{ForestValue}_{10 \text{ years}} = \frac{\$16,000}{(1+.05)^{10}} - \$10 \left[\frac{(1+.05)^{10} - 1}{.05(1+.05)^{10}} \right] + \frac{\$955}{(1+.05)^{10}} = \$10,332$$

$$\text{ForestValue}_{20 \text{ years}} = \frac{\$25,000}{(1+.05)^{20}} - \$10 \left[\frac{(1+.05)^{20} - 1}{.05(1+.05)^{20}} \right] + \frac{\$955}{(1+.05)^{20}} = \$9,658$$

In this case it is better to wait 10 years because the additional timber growth will earn a greater return than harvesting today, putting the money in the bank at 5% interest, and beginning a new rotation. However, waiting 20 years will cause forest value to decline, meaning that you would be better off to harvest at age 40, put the money in the bank, and begin a new rotation.

Had the interest rate been higher, say 7%, the forest value would have been highest for the option to cut immediately. Higher interest rates tend to drive shorter rotation lengths, as future revenues become more heavily discounted.

Note that for computing the current forest value of a harvest (and therefore returning to bare land today), the equation was greatly simplified because you could use a non-discounted SEV.

Table 3. The variation in SEV/acre for Example 15 under various annual costs and target rates of return.

Annual Cost	Target rate of return		
	4%	5%	6%
\$10/acre	\$1,924	\$955	\$413
\$15/acre	\$1,799	\$855	\$330
\$20/acre	\$1,674	\$755	\$247

The challenge in selecting input variables is further complicated by long time horizons and associated uncertainties. Nevertheless, SEV and forest value remain part of a useful analytical framework for assessing economic performance. Given carefully selected input variables based on the best available information, reasonable estimates of economic value can be established. More importantly, these tools can reveal relative trends in economic performance among forest management alternatives.

Uneven-aged management

All of the examples so far have assumed even-aged management, which is most common in Washington¹¹. However, if you are considering establishing a forest on bare land with the intention of uneven-aged management, you can adapt SEV to guide this decision (Klemperer 1996). You can also do an SEV analysis for an uneven-aged forest with the understanding there is not a return to “bare land” per se, but rather a consistent minimal stocking. Forest value is more straightforward to compute for an existing uneven-aged forest if you harvest on a consistent basis. The harvests can be treated as a perpetual, periodic series to derive the NPV of all future costs and revenues in perpetuity given the existing timber (which is forest value).

Non-timber values

The focus on monetary benefits from growing and selling timber has been to simplify concepts rather than imply that non-timber benefits such as aesthetics, habitat, or enjoyment are less important. On the contrary, for many family forest owners these non-timber benefits are even more important than generating timber revenue.

Many hold the false perception that financial analysis and non-timber benefits are two different or even mutually exclusive ways to value forests. On the contrary, the same financial principles apply to non-timber as well as timber values. The challenge is in assigning the non-timber benefits realistic

¹¹ Uneven-aged management may be relevant to some eastern Washington forest owners. It is not typically used in western Washington. For more information about these management types, see Hanley and Baumbartner 2005.

monetary values.¹² Reconsider the optimization analysis in Example 16. Suppose that you enjoy non-timber benefits from having mature trees, such as the aesthetics, recreation opportunities, and wildlife habitat that the mature forest cover provides. Suppose you can quantify this into an estimated annual value of \$200/acre. Table 4 shows the new forest value/acre for each harvest option, adjusted for these non-timber benefits.

Table 4. Comparison of forest value/acre for three alternative harvest ages with and without non-timber values included.

Harvest age	Forest value/acre timber only	Forest value/acre with non-timber value
40	\$9,955	\$9,955
50	\$10,332	\$11,876
60	\$9,658	\$12,149

Notice how the non-timber values increase the forest value for the longer harvesting periods and the optimal harvest time from age 50 to 60. If non-timber values are high enough, it may never make sense to harvest.

Because financial analysis is commonly misperceived to run counter to non-timber benefits, you may consider your forest land management decisions to be outside the realm of economics, when in fact you are making very economic decisions. You may not assign concrete monetary values to non-timber benefits or do a formal financial analysis, but rather make decisions intuitively. If you decide to delay or even forgo timber harvest, you understand that the non-timber benefits are worth more to you than the cash value of the timber. You may find that making these types of decisions works best for the holistic, long-term management of your forest, and that formal financial analysis is better suited to individual, short-term decisions. There is nothing wrong with this—just remember that you are indeed economically optimizing.

Non-timber values can also be challenging based on who receives the benefit. In Table 4 above, you as the landowner profit. However, suppose it is your neighbors who enjoy the \$200/acre. It may be socially optimal to harvest on a long rotation (or not at all), but privately (for you as the landowner) optimal to harvest on a shorter rotation. This sort of situation can lead to resource management conflict.

Consider the perennial policy issue of forestland that is lost to development. You may find that, given your particular values and needs, the cash offered by developers is worth more

¹² It may seem strange, or even inappropriate, to consider these types of values in terms of dollars and cents. The point is not to be focused on generating cash, but to find a common unit of measure to make comparisons.

than the benefits of owning a forest. However, the benefits to society of maintaining that forest may be worth far more than the developer paid. In theory, mutually satisfactory arrangements could be made between the parties if neighbors or society compensated you to synchronize the private and social optimalities. This may not be realistic, though, as it assumes, among other factors, zero transaction costs (Coase 1988).

Summary

Forestry financial analysis tools use the concepts of compounding and discounting to find common reference points such that costs and revenues that occur at different times can be directly compared. This can be particularly important for forest management because of its uniquely long time horizon. The principles of discounted cash flow can be applied to derive the economic value of land and standing timber for a landowner. These tools allow comparisons of different management alternatives and identification of economically optimal choices.

It is important to emphasize that economic optimization is not limited to timber management, as financial analysis principles apply to both timber and non-timber values. The key in both cases is to make appropriate assumptions about input variables. As in any analysis, the quality of the outputs is only as good as the quality of the inputs. In situations where values are hard to quantify (such as non-timber benefits), decisions might be made intuitively. Private optimization may differ from social optimization, though, causing resource conflicts. Ultimately, financial analysis tools are not intended to advocate for any particular management outcome, but reveal economic outcomes to help individuals (whether landowners, policymakers, or other stakeholders) make informed management decisions.

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Glossary

Alternative rate of return. The interest rate that could be achieved by investing money elsewhere (such as a bank account or mutual fund). This can be the basis for selecting an interest rate to use when analyzing forestry investments, as it represents the opportunity cost of investing money in growing trees instead of using it to earn interest elsewhere.

Annual maintenance (administrative, overhead) costs. These are costs that are incurred every year as part of owning and operating a forestry enterprise. Examples are property taxes, regular maintenance, services (accountant, utilities, etc.), and equipment costs.

Annual series. A payment series that occurs every year.

Bare land value. See Soil expectation value.

Base year. The year used as the common reference point when keeping values in constant dollars. Values in different years are expressed in terms of the purchasing power of the common base year in order to remove the effect of inflation.

Cash flow. Any revenue or expense.

Commercial thin (CT). A thinning in which the trees removed are large enough to have commercial value and generate a net revenue.

Compound interest. Compound interest is the effect of interest accruing on interest—interest not only accrues on the original amount (principal), but also on any interest that has already accrued. In this way the amount of interest increases each year.

Compounding. The growth of money over time due to compound interest.

Consumer price index (CPI). An index that measures inflation by tracking the combined price of a “basket” of goods and services consumed by a typical consumer.

Constant dollars. Values that occur at different times in terms of the purchasing power of a common base year to remove the effects of inflation.

Cost of capital. The interest rate you would pay a lender when borrowing money to cover the expenses of a forestry investment (e.g., purchasing land or planting trees). This can be the basis for selecting an interest rate to use when analyzing the forestry investments, as it will incorporate the cost of the interest you will have to pay back over time on the borrowed funds into the analysis of the investment performance.

Discount rate. The interest rate used to discount values that occur in the future.

Discounted cash flow. A cash flow that has been discounted from the time it occurs to the present.

Discounting. Reducing the value of money in the future relative to today due to compound interest (i.e., compounding in reverse).

Establishment cost. The cost of establishing a stand of timber, such as planting and site preparation.

Forest value. A measure of the total economic value of a forest, including both land and timber, given expectations about future cash flows. It incorporates the NPV of all costs and revenues in perpetuity when starting with existing timber.

Future value. What money today will be worth in the future due to compounding.

Inflation. The general increase in wages and prices over time and subsequent reduction in the purchasing power of money.

Installment payment formula. The formula for determining the annual payment needed to pay off a present debt.

Interest. The cost of money, or the amount of additional money that must be paid/received in the future to use/give up money today.

Interest rate. Quantification of the time value of money; specifies the percentage rate at which interest accrues. Also referred to as the discount rate or rate of return.

Land expectation value. See Soil expectation value.

Market value. The actual price that something (e.g., forestland) will sell for based on an aggregate of buyers and sellers in the marketplace (as opposed to the economic value for an individual, such as SEV or forest value).

Mid-rotation cash flows. Any revenue or expense that occurs in the middle of rotation (between stand establishment and final harvest), including PCT, CT, vegetation control, etc.

Net present value (NPV). The total present value of cash flows (revenues and expenses) over time (i.e., the sum of discounted cash flows).

Nominal interest rate. An interest rate that has not been adjusted for inflation (such as what you would be quoted at the bank).

Nominal price. The actual price of something in the year it occurs.

Nominal price change. The actual change in the price of something over time, including the effect of inflation.

Opportunity cost. The lost opportunity to invest in something other than the investment you chose. For example, when investing in forestry, you lose the interest that money could earn in a savings account.

Payment series. A cash flow that occurs at regular intervals over time, such as payments on a loan or regular income or expenses.

Periodic series. A payment series that occurs at some intervals other than every year.

Perpetual annual series. A payment series that occurs every year forever.

Perpetual periodic series. A payment series that occurs at some interval other than every year and continues forever.

Perpetual series. A payment series that continues forever.

Perpetuity. Continuing forever.

Pre-commercial thin (PCT). A thinning, usually early in the life of a stand, in which smaller, poorer-quality trees are removed to improve the growth of the remaining trees. The trees that are removed have little or no commercial value and are usually left on the ground.

Present value. What money in the future will be worth today due to discounting.

Principal. The amount of money actually borrowed or invested, not including interest.

Purchasing power. The amount of goods and services that an amount of money can buy. Purchasing power is diminished over time because of inflation.

Rate of return. Another term for the interest rate.

Real interest rate. An interest rate that is adjusted for (net) inflation.

Real price. A price that has been adjusted for inflation.

Real price change. A change in price that is net of inflation. A real price change reflects an actual change in value relative to wages and other goods as opposed to a change in value because of a general inflation of prices.

Rotation. The commercial life cycle of a forest stand, from stand establishment to final harvest.

Sinking fund formula. The formula for determining the annual investment needed to accumulate a future amount.

Site preparation. The preparation of land for planting trees, which may include herbicide or broadcast burning to control competing vegetation, soil scarification, etc.

Soil expectation value (SEV). The economic value of bare land for forestry use given expectations about future cash flows. It incorporates the NPV of all management costs and revenues in perpetuity when starting with bare land. It can be used as an economic performance benchmark for making direct comparisons between different management options and land uses.

Terminating annual series. A payment series that occurs every year for a finite period of time.

Terminating periodic series. A payment series that occurs at some interval other than every year and lasts for a finite period of time.

Terminating series. A payment series that occurs for a finite period of time (i.e., it terminates at some point).

Today's dollars. Constant dollars, using today as the base year (i.e., expressing prices over time in terms of today's purchasing power to remove the effects of inflation).

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