

# **Economically Sustainable Working Forests: Financial Analysis Principles and Applications**

October 24, 2005

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Published November 2005

This paper is part of a series of discussion papers written to provide background information on salient issues identified as important by participants at the *Saving Washington's Working Forest Land Base* forum in November 2004.

## **Abstract**

Economic viability is an important part of the sustainability of working forests. With landowners facing increasing regulatory complexity, increasing demand for a diversity of forest outputs, and economic pressures to convert to non-forest uses, it is important to understand the financial principles that drive economic viability. A fundamental principle is that the value of money is time-sensitive such that present costs and benefits carry greater weight than those in the future. This has profound implications given the long-term nature of forestry investments. The principles of compounding and discounting allow for equivalent comparisons of costs and benefits occurring at disparate times. These principles are the key to understanding the economic value of land and timber, and they allow for analysis of economic optimization relative to both timber and non-timber values. Likewise they allow for analysis of the economic impacts of policy measures such as taxes and regulations, providing important insights to help policymakers to better achieve goals and avoid unintended consequences.

## I. Introduction

Economic viability is critical for the long term sustainability of private, working forests in the Pacific Northwest. Private, working forests are business enterprises for which landowners and managers generally rely on a reasonably competitive economic return in order to stay in business. When forest management is no longer economically competitive, landowners are often motivated to convert to non-forest uses where such opportunities exist (Murphy et al. 2005). This is especially true in western Washington, where the rate of forest conversion to real estate development has been high (MacLean and Bolsinger 1997, WADNR 1998). Small forest landowners are particularly vulnerable, as they are often located in proximity to major highways and lowland streams, providing many opportunities for conversion (Rogers 2001).

Private forest landowners are facing increasing regulatory complexity and increasing demand for a diversity of product and ecosystem service outputs. In this context it is important to plan for economic viability. An understanding of the principles of forest finance is needed to assess the economic viability of forest management alternatives. These principles are applicable to timber and non-timber values and can provide common performance metrics for disparate goods and services. These principles can also be used to evaluate the economic impacts of regulations and taxes, providing useful information that can help policymakers better achieve objectives. This paper introduces the basic principles of forest finance and demonstrates their application for management decision-making and policy evaluation.

## II. Basic principles of forest finance

### 1. Compounding and discounting

The adage that “time is money” is quite 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 an 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 higher value on present use.

Interest compounds over time. Consider a loan or investment of \$100 at an annual interest rate of 10%. After one year, the balance of the loan would be the original \$100 (called the principal) plus \$10 interest for a total of \$110. However, after the second year, 10% interest would be owed not only on the \$100 principal, but also on the \$10 interest that accrued the first year. The second year’s accrued interest would be \$11 for a new balance of \$121.

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  $n^{\text{th}}$  power (*Equation 1*). This can also be done in reverse, which 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  $n^{\text{th}}$  power (*Equation 2*) (Gunter and Haney 1984).

**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:

$V_0$  = Present value

$V_n$  = Future value at year  $n$

$i$  = Interest rate

$n$  = Number of years

Compound interest results in exponential growth, as demonstrated in *Table 1*. \$100 compounded over 100 years at 10% interest will grow to almost \$1.4 million. The opposite (discounting) is also true, meaning that \$1.4 million to be received 100 years in the future is worth only \$100 today assuming 10% interest. The importance of this calculation to forestland management may be observed by noting that a \$100 investment in land and stand establishment 50 years ago must be valued at 11.47 times as much (\$1,147) today (50 years later) using a 5% interest rate and assuming no other costs.

**Table 1: Future values of \$100 invested today at 5% or 10% interest.**

Years	5%	10%
5	\$128	\$161
10	\$163	\$259
50	\$1,147	\$11,739
100	\$13,150	\$1,378,061

It is often useful to compute the present or future value of a series of payments, such as annual expenses or regular contributions to an investment account, rather than a single amount. There are four types of series. There are annual (payment each year) or periodic (payment at regular intervals other than one year, such as every five years) series, and each of these can be either perpetual (payments continue forever) or terminating (payments last for a finite period of time). 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).

**Equation 3: 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

**Equation 4: 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

**Equation 5: 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

**Equation 6: 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

**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

**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

## 2. Assessing Forestry Investments

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, invested \$100/acre 15 years later to pre-commercially thin (PCT) that stand, received \$14,000/acre in stumpage revenue when the stand was harvested at age 50, and incurred annual overhead costs of \$15/acre. In terms of financial performance, it is not appropriate to subtract \$1,150/acre in total costs from \$14,000/acre in total revenue to compute a net profit of \$12,850/acre.<sup>1</sup> Because these cash flows occurred at different times, they need to be compounded or discounted to a common year and then compared.

Typically all cash flows are discounted back to the present. This can be done with a combination of single amounts and series. The present value of the costs is then subtracted from the present value of the revenues to compute a net present value (NPV). This is also referred to as a discounted cash flow analysis. 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 acceptable. Likewise if the NPV is negative, the present value of the costs exceeds the present value of the revenues and the investment is not acceptable. When considering multiple acceptable alternatives, a higher NPV is preferable.

Considered another way, 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, the NPV at 5% interest is \$599/acre, meaning that the money invested in stand establishment and tending

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<sup>1</sup> However, this sort of approach is used to compute profit for income tax purposes.

yields a return greater than 5% at final harvest. Likewise, if the money for stand establishment and tending was borrowed at 5% interest, the future harvest revenue would be able to pay back that interest and still yield a profit. Indeed we can confirm using our future value formulas for a single amount (*Equation 1*) and a terminating annual series (*Equation 3*) that \$300 compounded for 50 years plus \$100 compounded for 35 years plus \$15 each year compounded over 50 years at 5% interest yields \$7,132. The difference between this and the \$14,000 timber revenue, discounted back 50 years to the present, yields our NPV of \$599.

The NPV of an investment depends heavily on the interest rate that is used, also called the discount rate or target rate of return. In the example above, growing Douglas-fir over 50 years resulted in a NPV of \$599 at 5% interest. However, at 10% interest the NPV would be -\$353. For a meaningful analysis, it is important that an appropriate target rate of return be used 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.

The appropriate target rate of return depends on several factors. If capital is being borrowed to pursue a forest enterprise, the rate of return should reflect the cost of that capital (the borrowing interest rate). For someone looking 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, if 6% interest could be earned from a savings or mutual fund account, this might be used as the benchmark to assess an alternative investment in forestry. Other factors include investment risk. Most people tend to be risk averse such that they demand a higher rate of return for riskier investments. This is evident in market interest rates which are low for relatively risk-free investment vehicles like treasury notes and higher for riskier investments.

The impact of inflation must also be considered. Inflation is the general increase in the price of goods over time. It diminishes the purchasing power and hence the value of money, and acts like a reverse interest rate. This can distort investment analysis. Market interest rates are nominal, meaning that they are 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.

As with the interest rate, cash flows can either be in nominal terms, reflecting actual prices 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. If cash flows are in nominal dollars, a nominal interest rate must be used. Likewise if cash flows are in constant dollars, a real interest rate must be used. This is perhaps the easiest way to account for inflation when assessing forestry investments. In the Douglas-fir example above, the future costs and revenues reflect today's (constant) dollars instead of the inflated values we would expect 15 or 50 years in the future. The target rate of return for this example is accordingly a real rate.

### 3. Land and Timber Valuation

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 revenues and costs. This value is not limited to a finite period of time, such as a single forest rotation, as the land does not end up with 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 the same use. Because there is always that residual value at the end of a use cycle, the full economic value of land must consider its potential to provide economic benefits in perpetuity.

The economic value of bare land is called soil expectation value (SEV) or land expectation value. SEV 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 the rotation for the actual 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 for forestry use given management expectations (Klemperer 1996).

SEV is computed 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. Mathematically this is done by computing the net future value at the end of a single rotation (year  $R$ ) and treating this as a perpetual, periodic series that repeats every  $R$  years (*Equation 9*). Note that the annual overhead costs term of this equation has been simplified as a perpetual, annual series.

**Equation 9: 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

For land that is not bare but has existing timber, the combined land and timber value, or forest value (FV), 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 10*). FV depends partly on SEV, which is treated as a constant, underlying value of the land regardless of the status of existing timber. Thus when computing FV, SEV must be computed first based on expectations of the subsequent management regime once the land is bare at the end of the existing rotation.

**Equation 10: Forest value (FV) is the combined economic value of land and standing timber.**

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

Where:

FV = Forest value

$m_t$  = Mid-rotation cash flow in year  $t$

$h_r$  = Final harvest revenue in year  $n$

$r$  = End year of current rotation

$a$  = Annual overhead costs

SEV = Soil expectation value

$i$  = Interest rate

The economic value of the existing timber alone can be derived by subtracting SEV from FV. Subtracting SEV from *Equation 10* yields *Equation 11*. The SEV term in this equation represents “land rent.” This reflects the opportunity cost of using the land to hold the existing timber instead of starting a new rotation. This term is equivalent to the present value of a terminating, annual series over  $r$  years of an interest payment  $(i)(SEV)$ .<sup>2</sup>

**Equation 11: The economic value of standing timber, including land rent.**

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

Where:

TV = Timber value

$m_t$  = Mid-rotation cash flow in year  $t$

$h_r$  = Final harvest revenue in year  $n$

$r$  = End year of current rotation

$a$  = Annual overhead costs

SEV = Soil expectation value

$i$  = Interest rate

SEV and FV are economic values—values tied to expected future cash flows based on an individual’s costs, target rate of return, and other factors. One individual’s economic value will be different than another’s. Economic value should not be confused with the market value for which forestland would actually be bought or sold. Market values reflect the equilibrium price for an aggregate of buyers and sellers in the marketplace. SEV and FV are also 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.

The challenge in computing SEV and FV is selecting appropriate input variables. For example, consider how the SEV values for the earlier Douglas-fir rotation example change depending on two key variables: rate of return and annual overhead costs. The rate of return has perhaps the most significant leverage on financial outcomes. Annual overhead costs can represent a significant portion of overall costs and can be highly variable between different landowners. *Table 2* lists SEV values for the earlier Douglas-fir example for target rates of return of 4%, 5%,

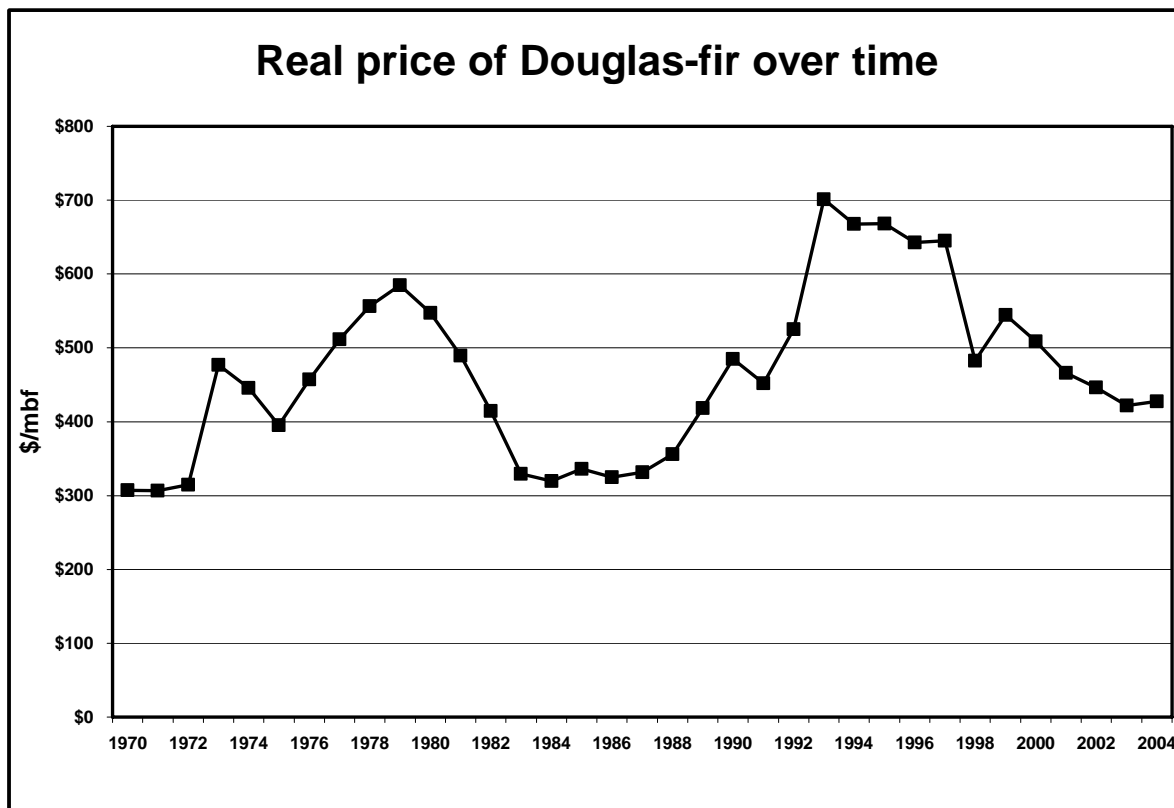
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<sup>2</sup> This has been simplified in *Equation 11*, canceling the interest rate  $i$  in the rent payment with  $i$  in the denominator of the equation for a terminating annual series.

and 6% and for annual overhead costs of \$10, \$15, and \$20 per acre. There is a range of over \$1,500 between the value extremes in this example. In some cases the choice of input variables can be the difference between achieving or not achieving the target rate of return.

**Table 2: The variation in SEV/acre under different assumed annual costs and target rates of return.**

Annual Cost	Target rate of return		
	4%	5%	6%
\$10/acre	\$1,629	\$756	\$276
\$15/acre	\$1,504	\$656	\$192
\$20/acre	\$1,379	\$556	\$109



**Figure 1: Average Puget Sound Region prices (from Log Lines Price Reporting Service) for #2 and #3 Douglas-fir sawlogs adjusted for inflation in 2002 dollars for the period from 1970-2004.**

The challenge in selecting input variables is further complicated by the long time horizon. In particular, future timber prices are highly unpredictable. Using constant dollars assumes that all costs and revenues will rise proportionally over time. However, there may be a real increase in the price of timber over time relative to other variables. Assuming a 1% real increase in timber prices over 50 years, the \$14,000 timber revenue in the Douglas-fir example would increase to \$23,025, more than doubling SEV from \$656 to \$1,518. Whether or not to assume a real price increase is an important consideration. *Figure 1* plots Douglas-fir log prices (from Log Lines Log Price Reporting Service), adjusted for inflation, over a 34-year period from 1970 to 2004. There was an overall real price increase over this time period, but there was also significant year-

to-year volatility. Future price trends are ultimately unknown. There are a variety of price forecasting models that can provide reasonable predictions, but as with any forecast, there are no guarantees, only educated guesses.

Despite these challenges, SEV and FV 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 important, these tools can reveal relative trends in economic performance among forest management alternatives.

### III. Economic Optimization

A significant function of forestry financial analysis tools like SEV is that they provide economic performance metrics for comparative analysis of management alternatives. SEV is particularly well-suited to such analyses because of its infinite time horizon. Consider the earlier example of the 50-year Douglas-fir rotation for which the NPV of a single rotation at 5% interest was \$599/acre. Now consider an alternative management option of growing a 30-year red alder rotation. Assuming the same stand establishment cost of \$300/acre, a \$100/acre PCT cost at age 9, \$5,000/acre stumpage revenue at age 30, and \$15/acre annual overhead costs, the NPV of this rotation at 5% interest is \$562/acre, which is lower than the NPV for Douglas-fir. However, the rotation length difference must be considered, as at the end of the 50-year Douglas-fir rotation a second red alder rotation could be 2/3 complete. To equally compare these two rotations, the cash flow on a per year basis that would yield the equivalent NPV for each rotation (called equivalent annual income) could be computed and compared, or NPV could be computed to a common rotation endpoint (such as 150 years for this example). The infinite time horizon of SEV functions as a common endpoint, allowing direct comparisons between rotations of different lengths. An SEV analysis yields \$656/acre for the Douglas-fir rotation and \$731/acre for the red alder rotation, correctly ranking the red alder rotation higher for this example (*Table 3*).

**Table 3: Comparison of a single rotation NPV with SEV between a 50-year Douglas-fir rotation and a 30-year red alder rotation. Because of different rotation lengths, SEV provides the more accurate assessment of economic performance.**

Rotation	Single rotation NPV @ 5%	SEV @ 5%
50-year Douglas-fir	\$599	\$656
30-year red alder	\$562	\$731

Because SEV allows direct financial comparisons between rotations, SEV can be used to rank the economic performance of different management alternatives. This allows economic optimization relative to various management decisions including stand establishment (method, species, spacing, preparation), rotation length, thinning strategies, and so forth. For example, consider the earlier example of a 50-year Douglas-fir rotation with alternative rotation lengths of 45 and 55 years that would yield \$10,500 and \$18,000 net harvest revenue respectively. The 50-year rotation yields the highest SEV and thus is financially optimal (*Table 4*). Analysis of economically optimal decisions should not be done independently, as the optimal choice for a given management decision depends on the other variables (e.g., the optimal rotation age depends on the species planted). All key decision variables should be considered simultaneously.

**Table 4: Comparison of SEV/acre for three alternative rotation lengths given expected net harvest revenues. The 50-year rotation is economically optimal as it yields the highest SEV.**

Rotation length (years)	Net harvest revenue/acre	SEV/acre at 5%
45	\$10,500	\$623
50	\$14,000	\$656
55	\$18,000	\$646

An SEV analysis of optimal alternatives is applicable when looking at an entire rotation starting with bare land. When making decisions about existing timber such as whether or not to thin or when to harvest, FV is the appropriate metric. FV, which includes SEV, is the NPV of all costs and revenues in perpetuity when starting with existing timber and thus also allows for direct comparison of unequal rotations. For example, consider a 35-year-old stand of Douglas-fir which could yield net revenue of \$9,700/acre if harvested at age 40, \$13,000/acre if harvested at age 45, or \$16,500/acre if harvested at age 50. *Table 5* compares the FV of each option assuming annual overhead costs of \$15/acre and an SEV of \$656/acre. Harvesting at age 45 is economically optimal in this example, as it yields the highest FV.

**Table 5: Comparison of FV/acre for three alternative harvest ages for a rotation in progress. Harvesting at age 45 is economically optimal as it yields the highest FV.**

Harvest age	Net harvest revenue/acre	FV/acre at 5%
40	\$9,700	\$8,049
45	\$13,000	\$8,277
50	\$16,500	\$8,096

There is often concern that economic optimization excludes non-timber values and thus may not reflect truly optimal decisions. However, the same financial principles can apply to non-timber as well as timber values. As an example, suppose a landowner enjoys an aesthetic or recreation benefit with an annual value of \$100/acre from having large, standing trees. *Table 6* shows the FV/acre from the example above adjusted for this benefit, which increases the optimal harvest age from 45 to 50 while also increasing the total optimal value by almost \$800/acre. Accounting for non-timber values can justify longer rotations or never harvesting at all if the non-timber values are high enough, such as wilderness areas (Hartman 1976, Klemperer 1996).

**Table 6: Comparison of FV/acre for three alternative harvest ages with and without non-timber values included. Non-timber values increase the optimal harvest year from 45 to 50.**

Harvest age	FV/acre timber only	FV/acre with non-timber value
40	\$8,049	\$8,482
45	\$8,277	\$9,039
50	\$8,096	\$9,055

The challenge with non-timber values is properly assigning them monetary values. There are also challenges based on who receives the non-timber values. In the example above, the landowner receives the value. However, suppose it is the landowner's neighbors or others who enjoy the \$100 benefit. The socially optimal harvest time might be age 50, but the landowner's (private) optimal harvest time could remain age 45. This sort of situation can lead to resource management conflict. In theory, a mutually satisfactory arrangement could be made between the parties if the

neighbors compensated the landowner to synchronize the private and social optimalities, but this assumes zero transaction costs (Coase 1988).

All of the examples so far have assumed even-aged management, which is common in western Washington and for which SEV and FV are perhaps best suited. SEV can be adapted for uneven-aged management regimes (see Klemperer 1996 for a discussion of this). This can be useful if actually establishing a forest on bare land with the intention of uneven-aged management. More common is an existing uneven-aged forest, for which it is straightforward to compute FV if harvesting is done 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 FV). It is conceptually difficult (and not necessarily useful) to extract SEV (the underlying economic value of the land) from FV in the case of uneven-aged management, as there is no expectation of returning to a bare land condition.

#### **IV. Assessing Public Policy Impacts**

The use of financial analysis tools for comparative analysis of management alternatives is also useful for assessing the impacts of public policies such as regulations and taxes. Regulations can affect the economic performance of a forestry enterprise by increasing costs or decreasing revenues. Understanding these impacts is important for avoiding unintended consequences and addressing equity issues.

When evaluating the impact of a regulation on an existing forest, the resulting change in FV will reflect the impact on the economic value of that forest. This is only part of the picture. Assessing the impact on SEV individually is also important. In the case of even-aged forestry, the forest will return to a bare land condition at the end of the current rotation, at which point the landowner will be faced with a decision of whether to reinvest capital in forestry or in an alternative enterprise. The competitiveness of SEV will be the economic motivation behind this decision, which makes SEV an important indicator of long term economic viability.

Consider an example of two landowners. Suppose that each landowner has a 40-year-old forest. Landowner 1 expects to receive stumpage revenue of \$11,000 at age 50. Landowner 2 has a lower quality site and expects stumpage revenue of \$10,000 at age 55. Assume that these rotations could be repeated, yielding the same respective harvest values at the end of the subsequent rotations. Both landowners expect to incur establishment costs of \$300/acre, PCT costs of \$100/acre at age 15, and \$15/acre in annual overhead costs. Given a 5% target rate of return, FV would be \$8,882 and \$6,232 and SEV would be \$370 and \$60 for Landowner 1 and Landowner 2, respectively (*Tables 7 and 8*).

Now suppose a regulation is enacted, such as a riparian buffer that prohibits harvest on 20% of each landowner's acreage (e.g., Zobrist 2003). For the acres that cannot be harvested, there are no longer any expected future costs or revenues except for the annual overhead costs, which can

be assumed to remain the same whether or not those acres are harvested.<sup>3</sup> The resulting FV and SEV could both be interpreted as  $\frac{a}{i}$ , or -\$300.<sup>4</sup>

Table 7 shows the resulting decrease in the overall (average) FV per acre for each landowner. The decrease is \$1,433 and \$977 for Landowner 1 and Landowner 2 respectively, representing approximately a 21% loss in total economic value for each landowner. This is slightly higher than the percentage of land impacted (20%), demonstrating how the total economic impact can extend beyond the simple percent of acres affected, as all revenues for those acres are eliminated but some fixed costs (i.e., overhead) are not. This is especially true for SEV, which is more sensitive to impacts (Table 8). Thus it is not appropriate to characterize the impact of the regulation as simply 20%—the larger economic picture should be considered.

**Table 7: The impact on the overall FV/acre of a regulation that prohibits harvest on 20% of the acreage for two example landowners.**

Landowner	Without Reg.	With Reg.	Change	% Change
1	\$6,864	\$5,431	\$1,433	21%
2	\$4,683	\$3,687	\$997	21%

**Table 8: The impact on the overall SEV/acre of a regulation that prohibits harvest on 20% of the acreage for two example landowners.**

Landowner	Without Reg.	With Reg.	Change	% Change
1	\$370	236	\$134	36%
2	\$60	-\$12	\$72	120%

Comparing the two landowners, Landowner 1 has a higher total economic cost. Higher sites with greater economic value result in higher costs when restricted. Thus focusing on lower sites to achieve environmental objectives is one approach to minimizing the overall economic costs of these objectives (Latta and Montgomery 2004). However, even though lower sites incur a lower absolute cost, they incur a higher proportional cost. In the case of Landowner 2 in the example, the loss in SEV is only \$72 compared \$134 for Landowner 1. However, the percent loss for Landowner 2 is 120% compared to only 36% for Landowner 1.

This raises equity issues as well as issues of unintended consequences, as Landowner 2 can no longer achieve the target rate of return for future rotations and is much more likely to convert to another land use at the end of the current rotation. Regulatory uncertainty may also have unintended consequences on management strategies. Uncertainties in future regulations are similar to other market or operating uncertainties (i.e., risks) which as noted earlier require a

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<sup>3</sup> Since the overhead for the total property can be expected to remain the same whether or not all acres are harvested, the same per acre cost can be applied to all acres or the overhead can be assessed only to harvested acres, resulting in a higher per-acre rate for those acres. The final outcome for the total acreage is the same with either approach.

<sup>4</sup> It is somewhat conceptually difficult to consider SEV in this case, since the land will never return to a bare condition. However, this approach will allow an assessment of the economic value of the property as a whole at the end of the current rotation when the rest of the acres are bare, and future rotations are considered. It also maintains the equivalence with the alternative approach of assessing SEV only on the harvestable acres but at a higher (concentrated) overhead rate.

higher interest rate. A higher interest rate in turn reduces the optimal rotation age and lowers the land value relative to other conversion alternatives.

Financial analysis can also be done to assess the economic impacts of forest taxes. In Washington, property tax on forestland is assessed separately on the land and the timber. The land is taxed on an annual ad valorem basis, while the timber is assessed through the Forest Excise Tax (FET), which is 5% of the stumpage value at the time of harvest. Using the earlier example of the two landowners, *Table 9* shows the impact of the FET on SEV. As with the regulation example, the total cost is higher for Landowner 1, the percentage cost is higher for Landowner 2, and the overall economic impact is significantly higher than 5%.

**Table 9: Change in SEV/acre from a 5% Forest Excise Tax (FET) for two example landowners.**

Landowner	Without FET	With FET	Change	% Change
1	\$370	\$317	\$53	14%
2	\$60	\$23	\$37	61%

The reason the FET has so much leverage on SEV is that it is assessed on stumpage revenue alone without taking into account the costs associated with that revenue, such as establishment and overhead costs compounded over time. A tax assessed on gross revenue represents a much larger proportion of the overall net profit (revenue less costs) and can easily exceed a profit that is marginal. In contrast, land value (and any tax thereon) is based in theory on the NPV of both the expected revenues and the expected costs (i.e., SEV).<sup>5</sup> This brings up another issue, which is that the annual ad valorem tax on land already incorporates future timber values to some degree. Because of this, there have been concerns that the additional FET on timber represents double-taxation and results in an economic bias against forestry as a land use.

Double taxation issues notwithstanding, given a property tax on timber, an approach like the FET is intended to minimize economic impacts. Assessing the tax at the end of the rotation minimizes the impact on present value and thus has a lower economic impact than other property tax approaches such as an annual ad valorem tax on the current value of the timber or an annual site productivity tax. It is also not biased against longer rotations or capital intensive forestry to the extent of an ad valorem tax (Klemperer 1996).

Another important tax issue is income tax. The economic impacts of income taxes are not as straightforward as those associated with an excise tax, as income taxes can yield economic benefits as well as economic costs. To provide economic incentives for forestry land use, a number of tax deductions are allowed for forest landowners. For a landowner qualifying as an “active business,” operating costs (e.g., PCT, overhead, etc.) can be deducted against any income source in the year they occur (Haney et al. 2001, Schlosser et al. 1998). This is a benefit equal to the landowner’s tax rate times the cost. Furthermore, since the deduction can be taken against any income source, the benefit can be at the higher ordinary income tax rate while the cost of the tax on timber income is often at the lower capital gains rate.

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<sup>5</sup> In Washington, land values are not based on SEV per se, but rather are determined by statute formulae and adjusted annually from stumpage price trends.

With these factors in mind, it is possible under some circumstances for the present value of income tax deductions for a forestry enterprise to exceed the present value of the income tax on the timber. Consider a rotation in which establishment costs are \$300/acre, a PCT in year 15 costs \$100/acre, \$10,000/acre of stumpage revenue expected in year 50, and annual overhead costs are \$15/acre. The before-tax SEV of this regime at a 5% target rate of return is \$274/acre. Assuming the timber is taxed at a capital gains rate of 15% and ordinary income is taxed at 28%, the after-tax SEV of this regime would be \$321—17% higher than the before-tax SEV.

## V. Summary

Forestry financial analysis tools use the concepts of discounted cash flow to derive the economic value of land and standing timber for a landowner. These tools can be used to compare management alternatives and identify economically optimal choices. Financial analysis principles apply to both timber and non-timber values. The challenge in both cases is to make appropriate assumptions about input variables—the quality of the outputs are only as good as the quality of the inputs. Financial analysis techniques can be used to assess the economic impacts of public policies, such as taxes and regulations, on forest landowners. Financial analysis tools do not address questions of whether a policy is good or bad. Rather, these tools are available to inform policymakers and stakeholders of economic outcomes to help them assess whether goals are achieved.

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## **Acknowledgments**

The Northwest Environmental Forum and the author appreciate the comments by **John Ehrenreich**, *Director*, Forest Taxation & Economics, Washington Forest Protection Association, **Bruce Lippke**, *Director*, Rural Technology Initiative, College of Forest Resources, University of Washington, and **Mark Longrei**, *Operations Manager*, Forest Tax Division, Washington State Department of Revenue, provided during the preparation of this material.