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THE VALUE OF A FOREST: A CRITIQUE
OF THE
GROOME AND ASSOCIATES IRR METHOD

by

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1. Introduction

The purpose of this paper is to critically analyze a measure of the value of a standing forest developed by Groome and Associates[1] (GA). That calculating the value of a forest is a useful exercise is not a matter of dispute here. Government forest managers who must decide not only an appropriate harvest strategy but also whether to harvest a forest at all surely gain by using an accurate estimate of the value of a forest's timber. Private forest managers already make their decisions based on some notion of forest value and benefit from an accurate system for measuring that value. The owners of small forest plots in many ways have the most to gain from this exercise. These individuals usually lack the expertise and experience of managers of large forests and often face difficult choices between using land for lumber and non-lumber agriculture.

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[1]Groome and Associates, "Valuation of Forests."

A number of methods of estimating the value of a forest have been suggested. In their paper, GA summarize two of these methods and propose an alternative. Although theirs seems an attractive choice, the GA technique has several critical flaws. The next section of this paper summarizes the GA method. The third section presents the simplest method of estimating the value of a forest, a method particularly adapted to small-scale forests. The fourth section summarizes use of net present value, the theoretically correct technique to calculate forest value. Subsequent sections of this paper deal in turn with each of the major problems with the GA system and, where appropriate, discusses the way net present value addresses these problems.

2. The Groome and Associates Method

As do most economists, GA simplify the problem of estimating a forest's value by assuming the forest is only valuable for the wood products it produces. The forest has no aesthetic value, value as a wildlife habitat, or value for erosion protection. The sensibility of this assumption depends on circumstance of each forest. However, altering this assumption affects neither GA's technique nor the other available methods.

As an additional simplification, GA use a forest with particular characteristics. The forest contains twenty-six plots of two hectares each. The first of the plots is cleared and ready for planting. The second plot contains trees aged one year. Successive plots contain trees of successive age classes ending with a plot of trees aged twenty-five years, ready for harvest. In each year, one plot is harvested, one plot is planted, and one plot is thinned. Annual cost, revenue from timber sale, and land value is provided.

To determine the value of this type of forest, GA use what they term "the Internal Rate of Return method, or IRR method."[2] The method first calculates the internal rate of return on a forest plot planted in year zero and harvested in year twenty-five where internal rate of return is the average rate of growth in revenue less cost of the plot's trees. Additional cost and revenue from the forest occur in each of twenty-six years as plots are harvested, thinned, and planted.

Adding net revenue from the forest over time requires caluclating present discounted value of each plot's net revenue. This calculation in turn requires choosing a discount rate. GA's internal rate of return method uses as its discount rate the internal rate of return previously determined. The resulting sum of discounted cost and revenue for all plots is GA's measure of the forest's value.

The important advantage of this method, GA argue, is that the discount rate and thus the value of the forest is measured objectively. Any forest manager should be able to

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[2]Groome and Associates, p. 5

estimate accurately the value of any forest and estimates made by different managers should be the same. If correct, the GA method is both simple and compelling. Unfortunately, a careful examination shows a number of errors, errors serious enough to call the entire technique into question.

3. A Modest Proposal

Before considering the GA method in detail, it is appropriate to describe what is surely the easiest way to determine the value of a forest. Although it has practical limits, this method is particularly useful to managers of small forests.

The term "value" has a simple general definition to economists. The value of an object is the amount someone is willing to pay for that object. If the object is exchanged in a market, the value of the object in the market is simply its price. This notion applies no less for assets with a long life than it does for items consumed immediately. The market implicitly considers the life of the asset and its potential cost and revenue over time.

Stock markets are an excellent example of markets for long lived assets. The price of a stock represents the market's evaluation of the net revenue of the company over what may be a very long period of time. Of course the value of a stock changes as people's expectations about that future net revenue change.

Thus, if a market for timber land exists, the value of a forest is the current market price of the forest. A forest manager wishing to estimate forest's value need only discover the current price at which similar forest acreage is selling.[3] The current price is the market's evaluation of the cost and revenue of the forest over its lifetime. Of course, the value of a given forest changes as expectations about current and future cost and revenue change.

As a practical matter, each piece of forest has a different value; each has different growing conditions and cost of cutting. Market prices for particular types of forest may not be available. In some cases, differences between a given plot and a plot for which the market price is available are large enough to make relying on available market prices impossible. In other cases the differences are small enough to be irrelevant. Even when the market price of a particular type of forest is not publicly available, it should be possible to estimate the market's value simply by letting bids for the forest and using the highest bid as the measure of value.

Using market price may not be appropriate for cases where a manager is estimating the value of a large forest. The market price of timber depends on the total quantity of timber offered for sale. In most cases, the quantity of

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[3]GA may inadvertently have provided this very information in their example by giving a figure for "Land Value" (p. 1). If so, their ensuing mathematical gymnastics were hardly justified.

timber in a forest is too small to affect market price so market price accurately measures value. By contrast, selling the timber from a large forest would affect market price. This being the case, current market price is not an accurate measure of value since the timber could only be sold at a price below current market price.[4]

Use of market price is offered here not as the best possible method, although for many cases it will be. This discussion is intended to to show at least one system of estimating forest value as compelling and even simpler than the GA method.[5]

4. Net Present Value

While details of calculating net present value of a forest are discussed along with respective elements of the GA method, a brief summary is appropriate here. In each year trees are harvested and sold, parts of the forest thinned, and seedlings planted. Land rent may also be paid. Thus, in each year, revenue is earned and costs are

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[4]For large forests a difference also exists between market value as measured by price and total value as measured by consumer surplus, a difference of particular interest to managers of publicly owned forests whose objective may be to maximize more than profit from sale of timber.

[5]The market price of forest land has another interesting use. Both net present value and the GA method estimate the value of a forest. The market makes that same estimate, in a situation where inaccuracy is punished by more than scholarly embarrassment. As a test of the two models, why not compare net present value and GA estimates to the market price of a particular forest?

incurred. Revenue minus cost in each year is net revenue for that year. This flow of net revenue continues as long as the forest is harvested. Additional revenue is earned if the land is eventually sold.

Because it is earned in different years, the value of a forest is not simply the sum of net revenue from each year. Net revenue in each year must be converted to a common year by using a process called discounting, a process similar to converting one country's currency to another's in order to compare the two.

One way to understand the necessity to discount is to consider whether an individual would be willing to give up one dollar today and receive one dollar next year as compensation. Even with no inflation, a person considers one dollar received in the future to have less value than one dollar received today. Likewise a dollar sacrificed one year from now is less onerous than one sacrificed today.

Converting dollars received or spent in the future to equivalent dollars today is called discounting. Calculating net present value means discounting both cost and revenue when they occur over a number of time periods. Net present value is the value of an asset whose revenue and cost occur over time. Net present value of a forest is the value of a forest when its cost and revenue occur over time.[4]

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[4] A number of forestry and economics texts discuss net present value and discounting. See for example, William A. Duerr et al., Forest Resource Management; Decision-Making Principles and Cases (New York: W.B. Saunders, Co., 1979), pp. 131-146 and Edwin Mansfield, Microeconomics; Theory and

5. To Harvest or Not To Harvest

One asserted advantage of the GA method is that it avoids arbitrary numbers subject to disagreement among managers. Considering their aversion, it is perhaps curious that GA use an unexplained and apparently arbitrary number at the heart of their example. Nowhere do GA indicate the reason trees are harvested after twenty-five years of growth. Even in an example, the use of a twenty-five year harvest age is misleading since the year of harvest must be calculated as part of the process of estimating forest value.

The value of a forest depends on the harvest year chosen. An improper choice of harvest year means an incorrect (meaning too low) value for the forest. Clearly, if the forest in GA's example consists of a set of age classes of trees, each occupying one hectare and increasing in age to fifty years, its value is different than a forest with four hectare blocks of trees harvested in twelve years. GA ignore the fact that choice of harvest year is an integral part of determining forest value.[7]

GA's method of calculating forest value neglects choice of harvest year. By contrast, net present value is

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Applications, 5th ed. (New York: W.W. Norton and Co., 1985), pp. 519-535.

[7]The year in which to thin and fertilize a stand of timber should also be decided as part of the process of estimating forest value. Net present value can make this determination using the method described shortly.

easily adapted to calculate the value of a forest based on an appropriate choice of harvest year. When should a tree be cut? The tree should be cut in the year which yields greatest net present value. What is the value of a forest? The value of a forest is its net present value having chosen the best year in which to cut the trees. The first calculation yields the answer to the second.

At first glance, it seems that calculating cutting year might require considerable mathematical manipulation. Fortunately, the decision to harvest can often be made using a simple year-by-year comparison.[8]

In its early years, a tree grows at a relatively high rate. Each year the percentage by which the amount of sellable timber in the tree increases is large. As a tree ages, the rate at which it grows declines. The amount of useable timber in the tree increases, but at a decreasing rate each year. Likewise, the value of the lumber (less cutting cost) is growing rapidly for a young tree and less rapidly as the tree ages.

A tree can, like any other asset, be thought of as money in a kind of bank account. If the tree is kept another year, the balance in the "tree" account grows at the

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[8]For a more detailed treatment including complications, see Paul Samuelson, "Economics of Forestry in an Evolving Society," Economic Inquiry (December 1976): 466; J. Hirshleifer, Investment, Interest and Capital (Englewood Cliffs, N.J.: Prentice-Hall, Inc., 1970), pp. 81-92; and Richard Hartman, "The Harvesting Decision When a Standing Forest Has Value," Economic Inquiry (March 1977): 52. economists. See Gregory. The technique originated with.

rate the net value of the tree grows. Fertilizer and thinning affect cost and rate of growth and thus net value. If the tree is cut and sold, the money can be placed in a regular bank account or some other investment. If the net sawn value of the tree in a year grows faster than the rate of interest in the regular bank account, the tree should not be cut. It is more valuable as an investment. If it grows in net value more slowly than the rate of interest, the tree should be cut. The regular bank account is now a more attractive investment than the "tree" bank account. In fact, the tree should be cut at just the point where the two rates of growth are equal.

This year-by-year process of deciding whether to cut a tree is in fact an adaptation of net present value. If the rate of growth of the net value of a tree is greater than the interest (discount) rate, the net present value of the tree is growing. When the rate of tree growth and rate of interest are the same, net present value has reached its maximum. When the rate of tree growth is less than the interest rate, present value is falling. This simplified method obviously works best when changes in tree growth, cost, and prices are gradual and continuous.

What if the value of the tree always grows at a rate faster than the rate of interest? Why, then never cut the tree. In a few thousand years, that one tree will cover the South Island of New Zealand and should provide sufficient tourist revenue to compensate for the loss of grazing land.

If its value always grows at a rate less than the rate of interest, the error in planting the tree at all should not be compounded by continuing to let it grow.

Of course, the GA technique could be applied to successive ages of trees to determine the appropriate year to cut. Such an application would require considerable mathematical calculation and would, in any case, remain the wrong technique.[7]

To review. The value of a forest depends on the year chosen to cut its trees, a critical consideration ignored by GA. Net present value not only can determine the value of a forest, but can be adapted easily to determine the optimal cutting year.

6. The Internal Rate of Return

The internal rate of return is a measure of the average growth rate in net value of an investment over the investment's life. GA claim to calculate the internal rate of return on a forest plot harvested at twenty-five years and use that rate to discount net revenue from each other plot. This section shows that GA incorrectly calculate the internal rate of return on the forest plot and improperly measure the life of the investment called a forest.

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[7]For a critique of the use of internal rate of return to determine optimal cutting year see Samuelson, "Economics of Forestry," and Hirshleifer, Investment, Interest and Capital, pp. 81-92.

According to GA, internal rate of return is "the rate of interest at which discounted revenue exactly matches forest development costs."[10] Internal rate of return is a rate of interest earned on an asset. This interest rate is chosen so that the present (discounted) value of revenue is just equal to cost. In other words, internal rate of return is a present value calculation where the discount rate is chosen so that the net present value of a forest plot is equal to zero. By contrast, the present value method uses some market rate of interest to discount cost and revenue.

Properly calculated and using the internal rate of return as the discount rate, the net present value of a forest plot planted this year and harvested twenty-five years hence is equal to zero. The calculation should include all cost and revenue for the forest plot investment. Yet GA conclude in their example that the value of a forest plot about to be planted is $436. Since discounting by the internal rate of return should yield a value of zero, GA's calculation must be in error. From GA's table the error occurs because the "value of land" has been subtracted from one of the columns. Note also that the value of land was included previously when the original internal rate of return was calculated. All costs, including proper consideration for the cost of land, should be included to determine internal rate of return.

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[10]Groome and Associates, p. 5.

The internal rate of return calculation requires that the present value of the year zero trees be zero. GA have a present value different than zero because of a curious inclusion of land value. Either the original internal rate of return calculation incorrectly includes land value or land value should be excluded in the final set of figures in the table. Since the same land value manipulation is made for each age class of trees in the table, whatever error occurs in the year zero tree value is repeated, perhaps compounded, in determining the value of other age classes.

<u>The life of a forest asset</u>

The usual forest management strategy envisions a forest producing timber products indefinitely. Such a sustained yield forest has an infinite life. In the example considered here, the forest "provides a continuous equal annual flow of wood from the two hectares which are felled every year, and then replanted."[11] Any proper determination of value of a sustained yield forest must therefore consider its infinite life.

Although GA cite a sustained yield forest in their example, the GA method implicitly assumes each forest plot ceases to have value at the moment it is first harvested. This ommission may not be an oversight, however, since the internal rate of return is impossible to calculate for infinitely lived assets. By contrast, calculating the net

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[11]Groome and Associates, p. 1.

present value of an infinitely lived asset in general, and a sustained yield forest in particular, is simple.

To GA, a plot of land on which trees aged twenty-five years are growing has an investment life of zero years. Plots of trees of successively lower ages have successively longer investment lives. The fate of a forest plot which has just been harvested is not clear. Apparently a harvested plot either is sold for six hundred dollars, reverting to its alternative use (grazing?), or simply disappears, depending on how the value of land is intended to enter the calculation. Thus, in their example, GA conclude that a forest plot ceases to have value after its trees are cut. While it is true that the life of a tree ends when the tree is cut, it is not true that the life of a forest plot ends when when the forest plot is harvested or, for that matter, that the life of a forest ends when each of its plots are first harvested.

The previous section of this paper deals with the question of the proper age at which to cut a tree. Assume that a twenty-six year cycle is adopted. Either it is the optimal cycle (and GA give us no reason to believe it is) or some legal restriction forces the forest manager to rotate trees on a twenty-six year cycle. A reasonable person would take GA at their earliest word and assume each plot of land is to be replanted as it is cleared. If, as reason suggests, this is the appropriate management strategy, GA have grossly miscalculated the value of a forest, even using their own incorrect method of determining the discount rate.

Each plot in a sustained yield forest has an infinite life. The forest produces a never-ending stream of lumber and so a never-ending stream of cost and revenue. Adapting GA's method to sustained yield requires calculating the internal rate of return on a forest plot which is about to be planted, will be harvested in twenty-five years, will be replanted in twenty-six years, and so on ad infinitum. The internal rate of return so calculated is then used to discount the cost and revenue from the other plots, each of which also has an infinite cycle of planting and harvesting. For the average pocket calculator with an internal rate of return program this is an interesting exercise. Readers with such calculators are encouraged to try it. In fact, no computer can make this calculation.

On the other hand, the net present value of a sustained yield forest or any infinitely lived asset is easy to calculate. In fact, as this example shows, the present value is easier to calculate for an infinitely lived asset than for an asset with a finite life. The example forest comprises twenty-six plots of two hectares each and has the following revenue and cost in each year:

Two hectares cut and sold	$ 10,465
Two hectares planted	- 200
Two hectares thinned	- 180
Overhead ($18/plot)	- 468
Net revenue per year	$ 9,617

This example assumes the forest manager can ignore land rent. Treatment of land in the value of a forest is considered in detail later. Remember that different plots are cut, planted, and thinned in each year but that total cost and revenue for the forest remains the same.

This forest is earning revenue in excess of cost in perpetuity. The present value of the forest is the discounted sum of this perpetual stream of income. To a mathematician, it is the sum of an infinite series. The sum of an infinite series of discounted numbers like this is given by:

$$\text{present value} = \frac{\text{annual net revenue}}{\text{discount rate}}$$

Using the annual net revenue calculated above and the discount rate chosen for GA's example yields:

$$\$97{,}127 = \frac{\$9{,}635}{.0992}$$

Clearly, the net present value of an infinitely lived asset is simple to determine. Remember that the discount rate chosen in this example is not in general correct and is only used for comparison.

The internal rate of return is an appealing technique for calculating an appropriate discount rate. To be useful, however, it must be applied correctly. To be correct, internal rate of return implies a net present value of zero for a forest plot about to be planted. The GA example shows a present value different from zero, an important error.

An additional critical flaw in the GA method is its treatment of forest life. In the example they provide, GA ignore revenue and cost from forest plots after they have first been harvested, ignoring a vital characteristic of a sustained yield forest: its infinite life. However, even if they try to include infinitely lived plots in their forest example, GA will fail. Internal rate of return cannot be calculated for assets with a perpetual life. By contrast, calculating net present value for a sustained yield forest is simple, requiring only the mathematical equation for the sum of an infinite series of discounted numbers.

7. The Discount Rate

Perhaps the most appealing characteristic of GA's method of determining forest value is that the interest rate used to discount cost and revenue is "objectively calculated."[12] Any student of forest management in particular and economic theory in general is familiar with the endless debate and controversy over the appropriate discount rate. That the GA method arrives at a discount rate objectively is indisputable. Unfortunately, an objective method is not necessarily a correct method.

An appropriate discount rate calculates the difference in value between dollars spent or earned in different years. Since one dollar received one year from now is different

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[12]Groome and Associates, p. 8.

from one dollar received today, comparing the two requires an exchange or discount rate. The discount rate is like an exchange rate to convert currencies of different countries except that the different countries are different years.

For a given individual, the same discount rate is used for all assets.[13] This is only logical, since discounting compares or translates dollar amounts in different years regardless of the source of those dollar amounts. This is an important point. The GA method uses a different discount rate for each forest that has a different growth rate[14] and, by implication, a different discount rate for every other asset in an individual portfolio. Using a different discount rate for each asset violates the principle purpose of the discount rate, to translate dollars in different time periods, regardless of source, to a common standard of measure.

Choosing an appropriate discount rate is of obvious importance. An incorrect discount rate means an inaccurate estimate of forest value. For assets with very long lives, like forests, an error is compounded over a long enough time that the estimated value can be wildly inaccurate.

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[13]Both GA and this discussion ignore another complication in choosing an appropriate discount rate. The discount rate may need to be altered to respond to differences in risk over time for different assets and different forests. See K.J. Arrow and R.C. Lind, "Uncertainty and the Evaluation of Public Investment Decisions," American Economic Review (June 1970): 364-378.

[14]See GA's comparison of different discount rates for different forests, p. 8.

Despite the apparent controversy in the literature and despite GA's claims, making a reasonable choice of discount rate need be neither controversial nor arbitrary. This does not mean, however, that the choice is always simple, that all forest managers will make the same choice, or that choice of a discount rate is as objective as with the GA method.

For most forest managers, choosing a discount rate requires an understanding of what economists call opportunity cost. A forest is a valuable asset, producing revenue each year. However, the forest is only one of the available valuable assets. In deciding to own and exploit a forest for another year, an individual gains the revenue from the forest asset but sacrifices a year's earnings from another asset. The particular other asset whose earnings are sacrificed depends on the choices available.

If the forest were sold, its owner would have funds available to invest elsewhere. Having sold the forest, the owner obviously would choose the best available other asset in which to invest. Some owners would have few investment alternatives. Other owners would have many choices. By choosing to keep the forest for another year, the forest owner sacrifices the rate of return possible on the next best available investment. The rate of return on the next best investment is what economists call the opportunity cost of the forest investment and is used as the discount rate to calculate net present value of the forest.

Why use opportunity cost? The opportunity cost is the rate at which the forest owner can convert dollars today to dollars tomorrow using the alternate investment. It is the rate available to exchange dollars denominated in different time periods. A dollar invested today in the alternate asset returns something more than one dollar next year. Similarly, one dollar paid next year is worth less than one dollar today when invested in the alternate asset.

The conclusion is relatively simple. Use as a discount rate the rate of return on the next best available investment. Note that one available investment may be converting the forest land to some other use. Note also that a private forest owner must consider rates of return after taxes. Finally, note that inflation should be included in the rate of return only if predicted revenue from the forest and the alternate investment are in inflated dollars. If revenue estimates are in real dollars, rates of interest and discount rates should also be in real terms.

One obvious implication of this discussion is that different forest managers may use different discount rates. Managers of different forests may well have different alternate investments. In this sense, choice of a discount rate is arbitrary. However, in the sense that any manager given the same set of alternatives should arrive at the same discount rate, the technique presented here does not yield arbitrary results.

Another implication of using opportunity cost is that the discount rate and thus value of the forest changes as rates of return on alternate investments change. Not only is this true, but any other result would be surprising. The value of all long lived assets changes when interest rates change. Witness the response of stock, bond, and real estate markets to changes in current or anticipated interest rates. Such changes in discount rates make estimating a forest's value difficult. That difficulty is a characteristic of real world markets and cannot be eliminated by using a simple but incorrect method.

Using opportunity cost as the discount rate has thus far been restricted to calculating net present value of privately owned forests. Opportunity cost can be used with publicly owned forests, although a variety of issues make such use more controversial than in the private case. Some writers argue private opportunity cost sets a minimum on the discount rate since public projects should earn at least the return available for private investments.[15] Such a view has been adopted officially by New Zealand's Treasury Department. Other writers feel private markets overestimate the social discount rate

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[15]For a review and one version see Robert Haveman, "The Opportunity Cost of Displaced Private Spending and the Social Discount Rate," Water Resources Research (October 1969): 947.

because of private attitudes toward risk,[16] imperfections in capital markets,[17] or the shortsighted nature of private decisions.

Choice of a discount rate for estimating value of a publicly owned forest is a controversial issue. This issue is controversial because of the complicated nature of social decisions, complications largely absent from private decisions. While it is appealing to imagine a simple way to avoid addressing its complications, choosing a discount rate for public projects is not a simple process. A simple but incorrect method of selecting a discount rate only hides the complications, it does not eliminate them.

8. The Value of Land

An important consideration in estimating the value of a forest is properly accounting for the land on which the forest grows. As mentioned earlier, GA include land value when calculating internal rate of return and include it again when discounting revenue and cost of each forest plot. Unfortunately, no explanation is provided for these two choices. Omitting an explanation of the use of land value is of critical importance since forest value is significantly affected by treatment of land value.

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[16] S.A. Marglin, "The Social Rate of Discount and the Optimal Rate of Investment," Quarterly Journal of Economics (February 1963): 95-111.

[17] IW.J. Baumol, "On the Social Rate of Discount," American Economic Review (September 1968): 788-802.

The value of land can be included in two ways in a net present value calculation. The first assumes land value is actually a cost, the annual rental or lease cost of the land. If a forest manager rents or leases land from someone else, the annual fee must, along with other annual costs, be subtracted from annual revenue. Net present value of a forest to the non-owning manager includes the cost of using someone else's land.

The second way to treat land is as an asset to be sold in the future. A forest owner may be planning to sell the land at some known year in the future. If so, the sale revenue from the land should be included in that year and be discounted to present value. Since an owner who sells the land is unlikely to continue to manage its forest, cost and revenue for the net present value calculation must also cease in the year when the land is sold.[18]

9. Summary

The Groome and Associates Internal Rate of Return method for estimating the value of a standing forest is compelling in its simplicity. A forest manager need only be aware of current lumber prices, aware of harvesting cost, and able to estimate the average rate of growth in the value

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[18]For what price will the land sell? If the best use of the land is as a forest, the land will sell for the net present value of the forest in the year it is sold. Note that this implies that the net present value of the forest today will not change if the owner plans to sell the land in the future or if the owner changes the year of sale.

of a tree about to be planted. The technique also produces consistent results. Any forest manager should arrive at the same estimate of value for any forest.

However, the simplicity of the method disguises several important errors. The age at which trees are harvested influences a forest's value. If trees are cut in the wrong year, the value of the forest is reduced. Determining cutting year is properly an explicit part of estimating forest value, but is excluded from the GA method. By contrast, net present value easily calculates optimal cutting year.

The internal rate of return is defined as the discount rate at which the net present value of an asset equals zero. The GA method calculates the internal rate of return on a plot of land about to be planted. However, in the subsequent estimation, the net present value of that same plot of land is given as about four hundred dollars. GA appear not to be correctly applying their own method.

A more fundamental error arises from use of a finite lifetime when calculating internal rate of return on an infinitely lived asset. If a forest is managed for sustained yield, its cost and revenue continues forever. Not only do GA ignore the forest's infinite life, but the internal rate of return is impossible to determine for such assets even if GA had tried.

Although their method easily estimates it, the discount rate GA use is conceptually flawed. The discount rate translates dollars in different years to a common measure, regardless of the source of those dollars. The discount rate is an exchange rate that should be applied to all of an individual's assets and reflects investment opportunities available to that individual. The GA method yields different discount rates for different forests, and, by implication, different investments.

Determining the value of a privately owned and especially a publicly owned forest is difficult. Using a simple but incorrect technique only hides the difficulty, however. A technique like net present value is clearly more difficult to use, but properly used yields correct results. The problems with net present value can be minimized by using reasonable assumptions and by exploiting available market information.