THE ECONOMICS OF TRUE FIR MANAGEMENT

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Introduction

Management of the true fir-hemlock forests in the Pacific Northwest is attracting increasing attention as the frontiers of harvesting the last remaining vestiges of old-growth timber stocks are pushed higher into the Cascade and coastal mountain ranges. With the removal of existing timber stands, foresters and landowners are faced with the problem of deciding how to manage the second growth stands which follow. The principle objective of this paper is to address the economics of the management of second growth true fir stands. It is assumed that economic efficiency is the primary goal, although other considerations temper the analysis. Therefore, identification of those true fir management regimes which produce the maximum difference between benefits and costs when properly adjusted for time are the object of the analysis. Only those regimes with positive net benefits are considered economically feasible and worthy of further consideration (Waggener, 1978).

Due to time limitations numerical results are only presented for true fir forests occurring at the higher elevations on the west side of the Cascade mountains. These forests are composed primarily of Pacific silver fir, mountain and western hemlock, Alaskan yellow and western redcedar, and noble fir. Other species such as lodgepole pine, western white pine, Douglas fir, subalpine fir, and Shasta red fir assume importance in certain vegetational zones (Franklin and Dyrness, 1969).

In order to conduct a meaningful analysis of any timber growing investment it is essential that three types of information be available: (a) silvicultural, (b) mensurational, and (c) economic. Although all three types of information are important, it is imperative that the analysis be based on a solid ecological/silvicultural foundation. Presently this foundation is either nonexistent or extremely weak vis-a-vis true fir forests. However, the foundation is expected to improve as new knowledge of true fir ecosystems accummulates. More importantly, for an economic analysis, is the present dearth of mensurational information regarding the effects of intensive management practices on second growth timber yields. For example, no published managed stand yield tables exist for the true fir-hemlock type. Further, with the exception of Cochran's (1979) net gross and yield tables for grand and white fir in eastern Oregon and Washington and some old normal yield tables for white and red fir (Schumacher, 1926; 1928) adequate published yield information for natural unmanaged true fir-hemlock stands does not exist. Obviously this type of basic information is required if a meaningful economic analysis is to be conducted. This also points out the glaring need for much additional research into growth and yield of true fir forests. The last class of information needed to conduct an investment analysis concerns a variety of economic inputs regarding the current and expected costs of management practices, prices of wood, interest rates and tax rates.

Although the information needed to conduct an economic analysis is not as good as one might expect, there are other reasons for going ahead with such an exercise. These reasons were stated by Webster and Meadows (1971) in discussing an economic analysis of oak management. They argued that in spite of poor basic information an "economic evaluation can enhance the usefulness of silvicultural and other biological knowledge . . . by linking this knowledge directly to some of the human purposes for which forest and related resources are managed". More specifically, an economic analysis forces the forester-decision maker to: (a) objectively and systematically examine the array of available alternatives, (b) quantitatively express the impacts of the alternatives so they can be compared, and (c) increases the value of silvicultural/mensurational knowledge by integrating this information with economic information which is more closely linked to the human objectives of forest management. Thus, if only for these reasons, I believe it is worthwhile to examine the economics of any timber growing investment.

Investment Model

In this paper an economic analysis is conducted on a per acre basis for a hypothetical corporate forest landowner using an after-tax cash flow soil expectation value investment criterion. The soil expectation value reveals the value of all future incomes less all future costs when properly discounted to the present at an appropriate rate of interest. Such a value illustrates the potential value of an acre of bare forest land which is to be managed under an assumed silvicultural regime. By expressing the soil expectation value in terms of after-tax cash flows we are better able to simulate a corporate taxpayer who: (a) receives capital gains treatment when timber is harvested, (b) offsets certain timber-related expenses against surplus ordinary income, and (c) converts ordinary income into capital gains income. With the tax rate on ordinary corporate income set at 46 percent and the capital gains tax rate (excluding the alternative tax) set at 28 percent this third condition implies a tax rate savings of 18 percent. The alternative tax rate of 1.125 percent is ignored in the sample calculations which follow.

It is also assumed that the hypothetical corporate taxpayer has excess ordinary income against which certain timber management activities can be expensed. Included in this category are precommercial thinning, state yield tax, annual land tax and other annual costs. It is further assumed that the costs of site preparation and planting are capitalized and recovered through depletion at the time of thinning or final harvest. The unit depletion rate is determined by dividing the sum of these two costs by the total volume produced over the rotation. The impacts of recently enacted legislation allowing forest owners to amortize reforestation expenditures over seven years and to receive an investment tax credit are omitted from this example.

The standard definition of after-tax cash flow is used in this analysis. This definition holds that the after-tax cash flow is computed as:

Cash flow = After-tax profits + Depletion expense - Capitalized expenditures + Amortization expenses

This formula is used to calculate the actual flow of cash through an organization in any given investment period. Depletion and amortization expenses are additive terms because they are not out-of-pocket expenses which require the expenditure of cash. However, since they are deducted when calculating after-tax profits they need to be added when calculating after-tax cash flows. Capitalized expenditures such as planting and site preparation are subtracted, recognizing that an actual cash outlay has been made even though such expenditures are not subtracted when calculating after-tax profits.

The cash flow formula is the basis for the treatment of all expensed and capitalized expenditures included in this analysis. For those expenditures being expensed against surplus ordinary income the after-tax cash flow is computed as:

$$(S - E) - 0.46\ (S - E) = 0.54\ S - 0.54\ E$$

Where S = Surplus ordinary income

E = Expenditures being expensed against ordinary income.

For the investments being considered, S is assumed to exceed E but the former is not directly included in the per acre analysis because the intent is to determine the profitability of forestry investments. Thus, S is assumed to be zero. All expenditures being expensed (i.e., precommercial thinning, state yield tax, annual land tax and other annual costs) are computed at 54 percent of their before-tax values when calculating the after-tax cash flow.

For capitalized expenditures such as planting and site preparation, the after-tax cash flow is calculated at 100 percent of the before-tax value. This reflects the fact that these expenditures cannot be expensed against surplus ordinary income.

Income from a revenue generating activity such as thinning or final harvest affects the after-tax cash flow as shown below:

$$(T - D) - 0.28\ (T - D) + D = 0.72\ T + 0.28\ D$$

Where T = Timber income from thinning or final harvest

D = Depletion expense.

All after-tax cash flows are discounted to the present at the appropriate rate of interest to obtain the present value for one rotation. The soil expectation value is then derived by multiplying the present value for one rotation by the infinite rotations adjustment factor.

True Fir Numerical Example

To illustrate the economics of high elevation true fir management on the west side of the Cascades consider the following hypothetical example. Assume that a corporate forest landowner is considering an investment on a single acre of bare forest land. Two levels of management intensity are considered in the analysis: (a) natural and (b) intensive. Under the latter regime, the acre is planted with 2-0 stock following a one year regeneration delay and precommercially thinned in years 23, 27 and 30 for site indices 110, 90 and 70, respectively. No commercial thinnings are assumed to occur and final harvest is via a clear cut. Under the natural regime no form of intensive management is undertaken.

The Scribner board foot yields for both management regimes are shown in Tables 1 and 2. These yields were provided by Charles Chambers of the Washington State Department of Natural Resources and correspond to the yields used in the Department's sustainable yield calculations for the trust lands they manage. The yield estimates for both regimes are derived from yields for western hemlock and are not based on permanent growth information from true fir stands.

The economic assumptions incorporated in the example are shown in Table 3. These data are assumed to reflect the average corporate forest

Table 1. Natural Scribner Board Foot Yields (32 Foot Logs) for High Elevation True Fir (50 Year Site Index).

SITE INDEX

	90		110	
Total Age	Av. Dia.	BF Yield	Av. Dia.	BF Yield
50	8.7	6,788	10.1	12,544
60	10.1	14,280	11.9	23,602
70	11.6	23,403	13.7	35,549
80	13.0	33,163	15.5	47,101

Assumptions: Natural regeneration with no spacing control

Source: Charles Chambers, Washington State Department of Natural Resources, Olympia, Personal Communication, February, 1981.

Table 2. Managed Scribner Board Foot Yields (32 Foot Logs) for High Elevation True Fir (50 Year Site Index).

SITE INDEX

	70		90		110	
Total Age	Av. Dia.	BF Yield	Av. Dia.	BF Yield	Av. Dia.	BF Yield
50	7.1	2,799	9.7	7,600	12.5	15,155
60	8.9	7,510	11.5	16,088	14.3	27,064
70	10.6	14,091	13.2	26,034	16.0	39,288
80	12.2	21,785	14.8	36,322	17.6	50,748

Assumptions: Planting followed by a precommercial thinning at age 23 for Site 110; age 27 for Site 90; and age 30 for Site 70, respectively.

Source: Charles Chambers, Washington State Department of Natural Resources, Olympia, Personal Communication, February, 1981.

Table 3. Economic Data Used in True Fir Example.

Current Stumpage Price: [1]	$150/MBF		
Current Costs ($/A):			
Stand Establishment	$150		
Precommercial Thinning	$ 80	Annual	$4
Other Economic Inputs:			
Nominal Interest Rate	15%	Yield Tax Rate	6.5%
Inflation Rate	8%	Price Appreciation Rate [2]	10 %
Cost Appreciation Rate [2]	11%	Federal Income Tax Rates	
		Capital Gains	28 %
		Ordinary	46 %

1) Stumpage price from Washington State Department of Revenue, (1st Half 1981, W. Washington), for timber less than 100 years old.

2) Only assumed over one rotation.

landowner as of 1981. Cost and price appreciation rates for deriving future costs and prices are also shown in Table 3. The interest rate and all rates of appreciation shown in Table 3 are in nominal terms (i.e., including inflation).

A sample worksheet illustrating the calculation of cash flows and soil expectation values for the precommercial thinning regime for site index 110 and a 60-year rotation is presented in Table 4. The after-tax soil expectation value for this sample acre is -97¢. This is the maximum amount that an investor can spend and earn 15 percent on his investment using the assumed board foot yields and economic inputs. The corresponding before-tax soil expectation value is $27.60 per acre.

The results of the soil expectation value analysis for the remaining sites for both managed and natural stands are shown in Table 5. The numbers in parentheses represent the rotation age which maximizes the soil expectation value. This is generally regarded as the age the stand reaches financial maturity. Based on the board foot yields shown in Table 2 for managed stands and the economic assumptions shown in Table 3 it appears that a nominal 15 percent rate of return cannot be earned growing true fir. The only exception is the positive before-tax soil expectation value for the high site acre. However, the after-tax soil expectation value for high site is also negative, again indicating a nominal rate of return below 15 percent. An interesting, but not entirely unexpected, result observed in Table 5 is the relationship between the before and after-tax soil expectation values for the managed low site acre. The acre is actually worth more on an after-tax than a before-tax

Table 4. Example of Cash Flow Worksheet Used in Investment Analysis.

SITE 110 (50-YR BASIS)

($/A)

End of Year	Activity	Cash Flow Before-Tax	Cash Flow After-Tax	Present Value Single Rotation Before-Tax	Present Value Single Rotation After-Tax
1	Stand Establishment	-166.50	-166.50	-144.78	-144.78
23	Precommercial Thinning	-882.10	-476.33	-35.44	-19.14
60	Final Harvest	1,236,073.66	889,973.04	281.95	203.00
60	Harvest Depletion	166.50	46.62	0.04	0.01
60	Yield Tax	-80,344.79	-43,386.19	-18.33	-19.90
1-60	Annual	-4.00	-2.16	-55.85	-30.16
	Present Value of One Rotation			27.59	-.97
	Soil Expectation Value			27.60	-.97

Table 5. Results of Soil Expectation Value Analysis and Sensitivity to Changes in Input Parameters ($/A)

Assuming Prices and Costs Shown in Table 3

Soil Expectation Value

Site Index	Managed Before-Tax	Managed After-Tax	Natural Before-Tax	Natural After-Tax
70	-142.55(70)	-126.65(70)	-	-
90	- 71.05(70)	- 73.67(70)	88.05(70)	75.68(70)
110	27.60(60)	- .97(60)	174.09(60)	138.28(60)

Assuming a Reduced Planting Cost of $100/A

Soil Expectation Value

Site Index	Managed Before-Tax	Managed After-Tax	Natural Before-Tax	Natural After-Tax
70	- 94.29(70)	- 78.38(70)		
90	- 22.79(70)	- 25.41(70)	Same as above	
110	75.87(60)	47.30(60)		

Assuming an Increased Stumpage Price of $250/MBF

Soil Expectation Value

Site Index	Managed Before-Tax	Managed After-Tax	Natural Before-Tax	Natural After-Tax
70	- 83.87(70)	- 83.66(70)	-	-
90	37.34(70)	5.73(70)	185.50(70)	147.06(70)
110	203.39(60)	127.80(60)	327.39(60)	250.58(60)

NOTE: Numbers in ( ) refer to rotation ages.

basis. This is not a fluke, but is often observed in other situations. It illustrates the distortion the current tax laws can induce in an investment analysis.

The soil expectation values for the natural regime also shown in Table 5 reveal that true fir management earns more than the required 15 percent nominal rate of return on the two higher sites. Furthermore, the prudent investor would opt for natural management as it produces higher returns than does the intensively managed acre. Obviously, the conclusions drawn from results shown in Table 5 must be highly qualified as they only apply if the input assumptions are valid. However, the sensitivity of these results to changes in input assumptions can be examined by conducting a sensitivity analysis. For example, if the assumed planting cost is reduced from \$150/acre to \$100/acre, while all other inputs are held constant at their original values, the soil expectation values for the managed stands become positive for high site acres (Table 5). Further the optimum rotation ages remain unchanged (to the nearest ten years). Even though the soil expectation values are low, the optimal financial rotation ages fall in the range one would expect. This provides some useful information and further indicates that the analysis is producing reasonable results. Also shown in Table 5 are soil expectation values which result when the current stumpage price of \$150/MBF is increased to \$250/MBF while keeping the planting cost and all other costs fixed at their original levels. Although all soil expectation values for both managed and natural stands increase, it is clear that natural stand management is still prefered to intensively managed stands. However, with a \$250/MBF stumpage assumption, sites 90 and 110 are also supramarginal if intensively managed.

This brief numerical example has ended like many economic analyses before it have--without reaching a conclusion. This is probably indicative of economic analyses in general as many of them end by saying . . . . . . it all depends. It is clear that conclusions concerning the profitability of true fir management depend entirely upon the establishment of a much firmer silvicultural/mensurational/economic foundation than presently exists. However, the results shown in Table 5 indicate that true fir management may be profitable under certain input assumptions.

Comparison of True Fir with Douglas Fir

To provide additional perspective concerning the results presented above, it is instructive to compare true fir soil expectation values with those for Douglas fir grown on land of the same site quality under similar economic assumptions and levels of management. Table 6 compares the cubic foot yields for both species expected under the precommercial thinning regime previously discussed. Although the yields are not perfectly compatible, due to different merchantability standards, they do indicate that true fir and Douglas fir produce comparable volumes of wood over similar rotations. Using a set of economic assumptions for Douglas fir similar to those shown in Table 3 for true fir, a set of after-tax cash flow soil expectation values are obtained (see Table 7). These results clearly illustrate that Douglas fir is the superior investment where there is a choice to grow either species. However, the purpose of the comparison is not to suggest that Douglas fir be planted in lieu of true fir. In addition to being biologically impossible in many cases, the analysis is only meant to show the relative ranking of

Table 6. Comparison of Douglas Fir and True Fir Managed Yield Tables.

Cubic Foot Volume/A

SITE INDEX

	70		90		110	
Age	DF[1]	TF[2]	DF[1]	TF[2]	DF[1]	TF[2]
45	2,313	-	3,405	-	4,837	-
50	-	1,780	-	2,965	-	4,252
55	3,217	-	4,728	-	6,671	-
60	-	3,332	-	5,019	-	6,506
65	3,896	-	5,815	-	8,151	-
70	-	5,006	-	7,000	-	8,519
75	4,404	-	6,664	-	9,278	-
80	-	6,652	-	8,803	-	10,267
85	4,796	-	7,278	-	10,051	-

[1] Douglas fir cubic foot volume to 4 inch top as reported by Washington State Department of Natural Resources, Land Expectation Values for Western Washington Timber Species, Washington Forest Productivity Study, Phase III, Part II, Appendix E.

[2] True fir total stem cubic foot volume from Charles Chambers, Washington State Department of Natural Resources, Olympia, Personal Communication, February, 1981.

NOTE: These yields assume stand establishment by planting followed by a precommercial thinning.

Table 7. Comparison of True Fir and Douglas Fir Soil Expectation Values for Managed Stands.

After-Tax Soil Expectation Values ($/A)

Site Index	Douglas Fir[1]	True Fir[2]
90	-69(55)	-74(70)
110	47(55)	- 1(60)

Assumptions:
- Planting followed by precommercial thinning.
- 7% real rate of interest.
- 2% real rate of increase in costs and prices for Douglas fir; and

  2% real rate of increase for prices and

  3% real rate for costs for true fir.
- Corporate ownership.

[1] From Washington State Department of Natural Resources, Land Expectation Values for Western Washington Timber Species, Washington Forest Productivity Study, Phase III, Part II, Appendix B.

[2] From Table 5.

true fir investments vis-a-vis Douglas fir. Further, since Douglas fir soil expectation values increase with increasing levels of management intensity, the comparison suggests that better information concerning true fir yields may also show that intensive true fir management is superior to natural stand management.

As a further example of intensive management, consider the thinning regime shown in Table 8. The yields shown in Table 8 represent noble fir grown in the British Isles on a low site. The commercial thinning regime calls for the removal of approximately 600 cubic feet/acre every five years. These thinnings are of an intermediate nature concentrating on the removal of subordinate trees with some dominants being removed when necessary to encourage the development of surrounding competitors. Comparison of the yields shown in Tables 6 and 8 shows the volumes that may be produced under intensive management. However, it is doubtful if thinning cycles as low as five years will ever prove feasible.

Conclusions

What conclusions can be drawn from the foregoing analysis? Unfortunately, this extremely important question can only be answered conditionally. Therefore, all results and conclusions reported in this paper must be interpreted in light of all input (i.e., silvicultural, mensurational, and economic) information used in the analysis. As previously discussed, the utility of any economic analysis of true fir management regimes is severely limited by the paucity of good input information. Thus, all conclusions drawn from such an analysis should be cautiously interpreted. Nevertheless based on the input assumptions used in the

Table 8. Per Acre Cubic Foot Yields for Noble Fir to 7cm Top Diameter with Commercial Thinning (Yield Class of 171 Ft^3/A of MAI)

Age	Thinning Volume	Final Harvest Volume	Cumulative Volume
30	543	-	543
35	600	-	1,143
40	600	-	1,743
45	600	-	2,343
50	600	-	2,943
55	600	-	3,543
60	600	-	4,143
65	486	-	4,629
70	-	7,374	12,003

Note: For this yield class MAI reaches a maximum at age 73.

Source: Forest Management Tables (Metric), Forestry Commission Booklet No. 34, British Forestry Commission, P. 177.

present analysis it is clear that: (a) intensive management (i.e., planting, precommercial thinning and final harvest) is inferior to natural stand management, (b) low site land (i.e., site index 70 or lower) appears marginal or submarginal under reasonable input assumptions, (c) true fir produces soil expectation values below those of Douglas fir grown under comparable conditions, and (d) conclusions appear sensitive to assumed input conditions. In short, the results of the economic analysis depend heavily upon the confidence placed in the input assumptions. Therefore, it is not possible to give an unequivocal answer to the question raised above.

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