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A Need for Extensive Forest Management

by

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Abstract

Canada with its large amount of forest land of low productivity should manage the majority of the forest extensively rather than intensively. Extensive management can keep our stumpage rates or subsidies low, and help us remain competitive with the expanding areas of more productive forest in the world. Factors that influence and indicate that extensive management is more feasible than intensive management include: the low average productivity of Canadian forests, stumpage rates or subsidies, allocation of present funds, present net value calculations, interest rates, risk factors, non-timber values, technological developments, present natural regeneration, lack of management information, current timber supplies, and protection of the forest. The challenges to the forester are to obtain and practice the extensive management skills necessary to produce a profitable resource for world markets. To meet these challenges will require that foresters treat the growing of trees as a profit source rather than as a cost to the people of Canada.

Key words: Extensive management, intensive management, forest management.

Résumé

Le Canada, avec sa grande proportion de terres forestières à faible productivité, devrait aménager la plus grande partie de ses forêts de façon extensive plutôt qu'intensive. L'aménagement extensif peut maintenir bas nos droits de coupe ou nos subventions, et nous aider à demeurer compétitif face à l'accroissement des régions forestières plus productives du monde. Les facteurs qui influencent et indiquent que l'aménagement extensif est encore plus réalisable que l'aménagement intensif, comprennent : la faible productivité moyenne des forêts canadiennes, les droits de coupe ou les subsides, l'allocation des fonds actuels, les calculs de la valeur nette actuelle, les taux d'intérêts, les facteurs de risque, les valeurs autres que la matière ligneuse, les développements technologiques, la régénération forestière en place, le manque d'information en aménagement, les approvisionnements actuels en bois, et la protection des forêts. Les défis du forestier sont d'obtenir et de mettre en pratique les compétences nécessaires en aménagement pour produire une ressource profitable sur les marchés mondiaux. Les forestiers voulant relever ces défis, devront considérer la croissance des arbres comme une source de profit et non comme un coût pour les Canadiens.

Mots-clés: Aménagement extensif, aménagement intensif, aménagement forestier.

Introduction

In recent years, awareness and concern of both the public and foresters about managing Canadian forests intensively have arisen from the fear of future timber shortages (Reed *et al.* 1978, Science Council of Canada 1983, Canadian Pulp and Paper Association 1983, Macdonald Report 1985), and more currently the need to "mitigate problems of missing age classes" (Canadian Council of Forest Ministers 1987). Intensive forest management has been recommended as a solution to these problems by the above authorities and others (Horner *et al.* 1985, Burch 1980). In the process of replacing exploitation of our forests with effective management procedures, we have focused on increasing forest productivity by arguing that more money be spent on intensive management to regenerate and improve

the forest. By increasing the amount of money spent on silviculture, we hope to keep our forest industries in business by providing a continuous, if not increasing, supply of wood. However, one of our greatest assets for competing on the world forestry market has been the cheaper price of exploiting our inherited natural forests compared with the more expensive plantation forests of the Scandinavian countries and the United States (Pittis 1987).

Remaining competitive in the future will require us to produce the cheapest wood products possible compared with European, U.S., and new intensively managed tropical plantations (Macdonald Report 1985, Canadian Council of Forest Ministers 1987). The Europeans and Americans, with smaller areas of productive forest in total and per capita, have been forced to manage their more productive lands intensively to increase production. Instead of trying to emulate the intensive management strategies of the Scandinavians and Americans, it may be to our competitive advantage to consider extensively managing our larger, but less productive

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forests, to produce a second forest at the lowest regeneration cost possible.

Extensive forestry is defined as, "The practice of forestry on a basis of low operating and investment costs per acre" (Society of American Foresters 1983). It involves the use of modified cuts and other management procedures to encourage natural regeneration. On the other hand, intensive forestry is "The practice of forestry so as to obtain a high level of volume and quality of outturn per unit of area through the application of the best techniques of silviculture and management" (Society of American Foresters 1983). This method uses genetically superior seedlings for artificial regeneration, and silvicultural techniques such as scarification, cleaning, thinning, fertilizing, spacing, and pruning. Between these two levels, Reed *et al.* (1978) identified basic management as usually including "standard protection activities together with some assistance in artificial regeneration."

The concept of extensively managing our forests is relatively new. Both Sedjo (1986) and Marshall (1987) recommended that Canada's forest should be managed extensively. Earlier, Zobel (1980) stated that only 20% of Canada's forests were suitable for management by clearcut and plant methods. Present arguments for shifting to intensive management rely on a variety of economic and emotional approaches. There have been no clear or complete studies on the complex problems confronting Canadian forestry, or the alternative procedures that could be used to manage our forests (Pearse 1985). As foresters, we should be objective and apply our business and scientific knowledge to management of our forests. The complications that should discourage us from practicing intensive management on all productive forest land will be examined below and compared with the extensive management alternative.

Productive Base

Our huge forestry land base of 201 million hectares of Crown productive forest land (Bonnor 1982) is both a blessing and a curse. As a blessing, we have been supplied with a productive forest producing 425 million m³/yr (Bickerstaff *et al.* 1981) that has provided income, jobs and recreation to Canadians. As a curse, the land has a low average productivity. Estimates of the mean annual increment (MAI) at rotation of Canadian forests range from 0.9 (Reed *et al.* 1978) to 1.7 m³/ha (Bickerstaff *et al.* 1981). The MAI at rotation of 1.7 m³/ha indicates the capability of the naturally established unmanaged forest to produce wood (Bickerstaff *et al.* 1981). Whether on a national or management unit level, the amount of wood that can be produced on a sustained yield basis is limited in the long term by the MAI at rotation, multiplied by the productive land base (Davis *et al.* 1987). Intensive management can increase the yield to be expected from a forest. Boyd's (1985) predictions of production levels for various treatments of Douglas fir (*Pseudotsuga menziesii* [Mirb.] Franco) included a theoretical potential increase of 22 times present MAI, and a theoretical possible increase of 3 times present MAI. If these increases were possible across Canada, the theoretical potential average MAI at rotation would be 37 m³/ha, while the theoretical possible with current technology would be 5.1 m³/ha. Currently, we may expect up to a doubling of the yield or 3.4 m³/ha, if intensive management is applied (Reed *et al.* 1978, Science Council of Canada 1983).

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Table 1. Comparisons of mean annual increment per hectare at rotation age.

Regions	Species	Assumed MAI (m ³ /ha)
Canada*	Average natural forests	1.7
Canada plantations**		
BC Coast	<i>Pseudotsuga Menziesii</i>	9.0
BC Interior	<i>Pinus contorta</i>	5.4
Alberta	<i>Picea glauca</i>	5.5
Ontario	<i>Pinus resinosa</i>	9.0
New Brunswick	<i>Picea</i>	8.0
Foreign plantations		
South America***		
Brazil, Amazonia	<i>Pinus caribaea</i>	16.0
Brazil, Southern	<i>Pinus taeda</i>	20.0
South Africa***	<i>Pinus patula</i>	15.0
New Zealand***	<i>Pinus radiata</i>	25.0
Europe, Nordic***	<i>Picea abies</i>	5.0

*From Bickerstaff (1981). All species are included.

**From Canadian Pulp and Paper Association (1983). Selected areas that are assumed to maintain the MAI to rotation.

***From Sedjo (1983).

Competitors

Even if intensive forestry doubles our production, we shall be competing with more productive areas of the world. Both the Canadian Council of Forest Ministers (1987) and the Macdonald Report (1985) recognized that our future world competitors will be from productive southern forests. Sedjo (1983) estimated that only 70 million hectares, capable of producing 20 m³/ha/yr, would be needed to fill the 1978 world demand for roundwood. The 1984 world demand of 3.1 billion m³ could have been met by 153 million hectares or 5% of the world's forest land producing 20 m³/ha/yr. As tropical plantations continue to develop from an estimated 9 million hectares, our proportion of the world's market may continue to decline (Macdonald Report 1985, Boulter 1986), particularly if their production costs are more competitive than ours. The MAI of tropical forests is one of the main factors that can keep their production costs low.

Averages of MAI at rotation for southern and tropical plantations were reported to range from 15 to 25 m³/ha (Table 1). Some of the better areas² have a maximum MAI at rotation of 120 m³/ha with an average of 60 m³/ha. Growth rates such as these can be discouraging to Canadian foresters who manage sites with an average MAI at rotation age of 1.7 m³/ha, and an average yield of all maturity classes for Canada of 108.6 m³/ha (Horner *et al.* 1985). Other factors in favour of the tropics are shorter haul distances, a smaller land base required to supply an equivalent amount of Canadian timber, and uniform species quality that allows easier pulping and production of a uniform product.

A quantification of the advantages of tropical and southern plantations was made by Sedjo's (1983) estimates of the comparative net present value (NPV) for pulpwood and sawtimber for plantations in various regions of the world. He calculated a shadow stumpage price by subtracting the values of international transport, harvest costs, processing, and regional wood transport from the final market price. If the timber were grown for an integrated operation with standard quality sawtimber, values as high as \$4 715/ha were obtained for *Pinus taeda* L. in southern Brazil, \$3 742/ha for *P. taeda*, in the southern U.S., and \$154/ha for Norway spruce (*Pinus abies* [L.] Karst.) in Nordic Europe. In comparison, similar

calculations for Ontario resulted in a value of -\$490 for black spruce (*Picea mariana* [Mill.] B.S.P.) plantations, and \$49/ha for black spruce regenerated naturally (Benson 1986). The economic return from investing in intensive forest management is more attractive on land with higher productivity, even if that land is further from the marketplace than Canadian forests. While intensive management of species on Canadian sites of relatively low productivity may not be competitive with southern competitors, our more productive sites may be able to compete. For example, Sedjo (1983) showed that Douglas fir on high-yield sites in the US Pacific Northwest with a rotation MAI of 17.7 m³/ha produced a NPV of \$2 248. However, as investments in intensive forestry on lands of high productivity in the U.S. (Bingham 1985) and the southern hemisphere (Brett-Davis 1987) continue, we may expect Sedjo's (1983) prediction of a "southward shift of the world's forest resource production" to become more plausible. To an investor the advantages of tropical plantations are attractive.

Increased Stumpage

Countries investing in intensive management in our hemisphere have higher stumpage rates than ours in order to cover its costs on private land. If we continue to follow the path of government funded intensive management on all our Crown lands, our stumpage charges could change from 2 to 7% of industrial woods costs, to equal the 50 to 60% of industrial wood costs for intensively managed areas such as Sweden, Finland and the southeast U.S. (Thirgood 1987). The Canadian Pulp and Paper Association (1983) has pointed out the necessity for Canadian producers to reduce costs to remain competitive. The inherent lower costs of extensive management can keep wood and stumpage costs lower, thus permitting us a better opportunity of remaining competitive.

Government Funding

The alternative to increasing the stumpage rate is to rely on the government to subsidise intensive management by not recovering the cost of growing the forest. Although Will Rogers pointed out "It's a good thing we don't get all the government we pay for", there are demands in Canada for more government involvement in funding of forest renewal and plant modernization. Grants for modernization have created inequities, reduced the attractiveness of investment in the forest sector, reinforced oversupply problems, and postponed private sector restructuring (Canadian Council of Forest Ministers 1987). Noble (1986) was more direct when he stated "... the grants transformed pulp and paper companies into free money addicts." Proposals were made to use investment tax credits and depreciation methods in lieu of grants (Canadian Council of Forest Ministers 1987). Behind the qualms about inequities lurks the fear that pulp and paper could be the next target for US protectionist action. Regardless of the approach the U.S. contemplates, we should have government policies that encourage industrial investment and risk taking.

In contrast to the strong arguments made against providing grants to industry, the literature is replete with arguments for increasing the spending of government money on silviculture (Canadian Institute of Forestry 1983, Science Council of Canada 1983, Canadian Pulp and Paper Association 1983, Canadian Council of Forest Ministers 1987). Anderson (1985) noted that "Private sector managers who would not consider an investment in plant and equipment that failed to yield 'normal' after-tax returns are apparently willing to advocate such

investments in timber capital *provided they are funded by the public sector.*" The main problems of government investing in intensive management are our inability to subsidise to the same extent as other countries, the possibility of retaliatory practices by competing countries, and the difficulty of justifying the investment to the public.

Estimates for the amount of public money needed to refurbish our forests vary from \$650 million to \$1 billion (Canadian Pulp and Paper Association 1983, Benson 1983), and will probably continue to increase. These estimates were based on the application of intensive management to harvested areas, which comprise only 34% (759 450 ha) of the annual forest depletion (Honer *et al.* 1985). To increase intensive management efforts from reforestation 7% (166 000 ha) of the depletion (Honer *et al.* 1985) to 100% (2.22 million ha) would require considerably more funds for regeneration and protection. As Canada was unable to subsidise our farmers at the same level as the European Common Market or the U.S. (Jones 1987), it is unlikely that forestry can be subsidised nationally.

Funds for regeneration efforts are provided ostensibly to promote intensive forestry in an effort to curtail timber shortages, provide additional employment, increase sales and exports, raise tax revenue, adjust the age class structure, and create more recreational opportunities. Unless these arguments for investing in intensive management are supported by financial and benefit-cost analyses to show the economic worth of the investment, we can expect the same problems that modernization grants created. Intensive management projects that are not economically viable will be a form of yearly subsidy that will create provincial and international inequities. International inequities can lead to retaliatory practices detrimental to our export oriented forest industry. In the long term, the efficiency of governments increasing expenditures of public money for intensive forest management will be questioned by the people providing the funds.

Present Investments

Investing public funds in intensive management can be questioned because of the areas being treated. Most of the forested areas to be harvested in Canada over the next 20 years will be increasingly difficult to access, farther from the mills, and of low site classes (Osborn 1986). Thus, the increasing amounts of money spent on silviculture will be invested on some sites of low productivity with high harvesting and silvicultural costs. Intensive management, if practiced at all, should be concentrated on our accessible, more productive sites, close to mills (Reed *et al.* 1978, Armson 1976, Bingham 1985). Extensive management would be more appropriate for the low productive, difficult to access areas proposed for harvesting in the next 20 years.

Recent federal funding has not been focused on accessible, more productive forest lands. Only 27% (Anon. 1987b) of the federal government's federal-provincial contribution of \$548.9 million is being invested in British Columbia, the province with the highest MAI and the most productive forest land. Alberta, with more productive forest land and a higher average MAI than Saskatchewan, Manitoba, Nova Scotia, New Brunswick, P.E.I. or Newfoundland (Bickerstaff *et al.* 1981), received the least federal funding. Although Alberta has 111 times more productive forest land than P.E.I., they received less federal funding than the \$13.6 million received by P.E.I. The federal funding was designed to

encourage regional economic development (Anon. 1987b), rather than to regenerate our most productive sites. If these funds were used for extensive rather than intensive management, not only would regional development be encouraged, but also a larger area capable of producing a lower-cost final crop could be managed.

Trends in Management

The inefficiency of governments in administering the forest resource (Kennedy 1947, Armson 1976, Baskerville 1986) and related accounting procedures (Provincial Auditor 1986) have been well documented. Various recommendations have been suggested to improve the efficiency of government management. Kennedy (1947) recommended forest operating companies be formed to manage watershed units with the purpose of providing mills with wood, "at the lowest possible cost commensurate with sound forestry practice." The proposed companies would operate with a minimum of government administration or funding. Suggestions were made to have Ontario forest harvesting operators cover the cost of regenerating licenced areas (Ontario Economic Council 1970). Although no action was taken in Ontario, producers in British Columbia (British Columbia 1987) have recently been obligated by their government to cover the cost of regenerating cutovers, while in Quebec (Ministère de l'Énergie et des Ressources, 1987) producers are required to regenerate cutovers with a portion of the funds derived from stumpage charges.

Clawson (1976) proposed that the US Forest Service produce capital account balance sheets that would force the Forest Service to be as responsible to the public as a corporation is to its shareholders. Other US proposals included the forming of public or mixed public and private corporations to encourage rational decision making and economic efficiency (Clawson 1985). The US Forest Service is required to manage their forest to maximize the net public benefits and to obtain a reasonable rate of return on public investments (Morrison 1987). In Great Britain, a radical change in forest policy was made in 1981 when the Forestry Commission was obligated not only to operate at a profit, but also to generate a profit for the British treasury.

The trend of national and international policies are pointing in the direction of economic efficiency in forest management by either transferring the responsibilities to licensees or to use economic analyses of forest management options. Benefit-cost analyses are uncommon occurrences in government forest management plans or silvicultural prescriptions in Canada, although the concern for economic analyses for forest management projects in Canada have been expressed by both foresters (Hohol 1985, Pearse *et al.* 1986a & b) and others (McGillivray 1983, Thompson 1985, Macdonald Report 1985, Canadian Council of Forest Ministers 1987).

Economic Analysis

Need for Economic Analyses

The idea of applying conventional economic analysis to silvicultural projects is met usually with abhorrence by

foresters in Canada (Pearse 1985). In our state of "let's practice forest management" euphoria, we tend to neglect the economic facets of our training. There appears to be reluctance to measure the value of a dollar spent on forestry in the same way we would value one invested in the stock market or a savings account. As the practice of forestry changed from exploitation to the realization that it must be managed to sustain it and the industry, the concept of the forest as a revenue producer changed to one of producing the forest at a cost (Reed *et al.* 1987). It should not be unrealistic to expect governments to be productive and efficient with the funds they spend. The importance of forestry to Canada and the increased expenditure of public money on forest management activities are strong reasons for foresters to account for their management efforts. If our proposed intensive management procedures do not lead to the promised "Green Gold" (Anon. 1987a) of the future, or produce increased economic activity and create jobs, the credibility of foresters' ability to manage Canada's forests will be lost. The issue of applying economic analyses in forestry is complicated by various factors that can affect the analysis. These factors include our large, low productive forest land base, productivity, stumpage rate, interest rates and time, risk, other values, and sustaining industries and employment.

A Model

Ideally, a method for analyzing investments in forest management would maximize the net present value (NPV) of all future net benefits (Brett-Davis 1987). The primary features most commonly measured by foresters (Davis *et al.* 1987, Holtman 1987) and others (Anderson 1979, Hyer 1988) are the direct return of stumpage to the land owner and the costs associated with returning that land to production. Whether determined for projects at the level of a stand, a management unit, or a country, NPV is a measure of the worth of an investment (Pearse *et al.* 1986b, Gregory 1987, Duerr 1985).

Investments in silviculture projects are not always economically viable (Anderson 1979, Pearse *et al.* 1986b). To appreciate the results of economic analysis for average Canadian sites, recent Ontario data was used to calculate the NPV for one rotation of a forest stand under three levels of management, two levels of growth, two stumpage values, and three interest rates. In the model, three hypothetical levels of management were applied, extensive (administration only), medium intensity, and intensive management. The expected growth rates for each level of management were 1, 1.5 and 2 times the base average MAI of 1.7 m³/ha for average sites, and the base average of 10 m³/ha for more productive sites. Harvest yields at rotation were 170, 204, and 230 m³/ha for extensive, medium intensity, and intensive management respectively when a base MAI of 1.7 m³/ha was used. With a base MAI of 10 m³/ha, the harvest yields were 1 000, 1 200, and 1 400 m³/ha. Three interest rates used were 4%, 6%, and 8%. Costs and rotations used are indicated in Table 2. Expenditures on all forest management activities, \$668.2 million for Canada in 1983 (Barron *et al.* 1986), divided by the productive land base of 201 million hectares produces an additional annual charge of \$3.31/ha. To protect intensively managed forests, this charge would increase. The future value, assuming a 1% increase in real price (Fraser 1985), of a normal stumpage of \$3.75³ and \$10/ha were used. A best situation was assumed, all treatments are 100% successful, and experience no loss to fire, insects, or disease.

In this paper, the use of a national growth average and provincial cost information is meant to illustrate the relative,

³The average bonus and crown dues collected per m³ for black spruce derived from Ontario Ministry of Natural Resources 1986. This value is used for stumpage as it measures the direct return of capital to the land owner for the activities pursued.

Table 2. Silvicultural costs for treatment levels.

Treatments	Year of treatment	Level of management		
		Extensive (Rotation of 100 years)	Medium intensity (Rotation of 80 years)	Intensive (Rotation of 70 years)
			(dollars per hectare)*	
Scarification	0	0.00	162.59	250.76
Planting	0	0.00	489.27**	489.27**
Release	15	0.00	32.43	32.43
Release	25	0.00	32.43	32.43
Release	35	0.00	0.00	32.43
Fertilization	20	0.00	0.00	170.00
Total silviculture costs		0.00	749.15	1007.32
Other management costs		3.31	3.31	3.31

*Fertilizing cost from Paillé (1981). Remaining costs from Ontario Ministry of Natural Resources (1985).

**Planting costs include an estimated \$296.55 for nursery stock.

not the absolute, implications of applying intensive management to all our forests. Investing in a particular management unit should be determined by the unique growth, rotation, and cost information for that area. As Bickerstaff *et al.* (1981) pointed out, present growth data are inadequate for intensive or extensive forest management planning at the management unit or national level.

Table 3 indicates that negative returns on the investment may be expected at all treatment levels, when rotation MAI's of 1.7, 2.55, and 3.4 m³/ha, and a stumpage of \$3.75/m³ were used. The intensive effort had the largest negative values. Silvicultural costs for Canada appear to be higher than the conservative \$861/ha used in the example. In 1980/81 a total of 245 867 hectares were planted or seeded (Kuhnke *et al.* 1986) while silvicultural expenditures were \$272.4 million (Barron *et al.* 1986). The average cost per hectare was \$1 108. Cost for regenerating the 815 415 hectares of 1981 cutover in Canada would be \$903 million. If all 2.2 million hectares of depleted areas (Honer *et al.* 1985) were intensively managed, the yearly cost would be over \$2.5 billion at 1981 rates. Investing such amounts on our average Canadian forest sites is questionable.

Growth Increased

When productivity rates of 10, 15 and 20 m³/ha, and a stumpage of \$3.75 were used in the model, a positive NPV value was obtained for extensive management at the lowest interest rate (Table 3). This indicates that extensive management could be profitable for high yield areas. In British Columbia, natural forests can have a MAI at rotation as high as 15 m³/ha (Pearse *et al.* 1986b). Under the conditions assumed in the model, these more productive areas would be more economical to manage extensively.

Stumpage Increased

An increase in stumpage has been recommended as an incentive for silviculture and intensive management (Pearse 1985, Hagner 1986). When the future values of a present stumpage of \$10.00/m³ and the yields at rotation MAI's of 1.7, 2.55, and 3.4 m³/ha were used in the model, only the extensive management option at the lowest interest rate was profitable (Table 3). If the stumpage levels continued to increase from \$10.00 to \$39.52, the most intensive management would produce the highest return at 4% interest. Stumpage rates as high as \$70.88 have been used to illustrate

the profitability of intensive forest management (Anon. 1983), but actual stumpage rates in Canada are lower and ranged from \$0.04 to \$39.26/m³ in 1987 (Canadian Pulp and Paper Association 1987). The model suggests that stumpage rates need to rise to justify extensive management for our average Canadian forest site.

Stumpage and Growth Increased

When increased growth rates of 10, 15, and 20 m³/ha, and stumpage of \$10.00 were used, profitable results were obtained for all options at the 4% interest rate, and for the extensive option at the 6% rate. It would appear feasible to opt for intensive management on productive sites if stumpage rates are high enough. However, Table 3 shows that the more productive forest land (10 m³/ha) can be extensively managed at a profit with a lower stumpage charge (\$3.75). The crucial question is, what level of stumpage can industry afford to pay and remain competitive? Southern world competitors with their more productive forest land are producing intensively managed forests at lower management costs per m³. Intensive management of our average sites may increase the yields, but it will increase the costs of our wood and make us less competitive in the world market. If our stumpage costs become too high because of intensive management, companies may find it advantageous to purchase wood from abroad or move their mills to where the stumpage charges are lower.

Intensive management may be viable for specific areas of Canada that are close to the mill and highly productive, but these special cases should be examined for the economic viability of an individual basis. The majority of our productive forest land with its low productivity warrants the use of the cheaper extensive management option.

Interest Rate

In the examples shown above, the interest rate used has a dramatic effect on the results. One of the biggest problems facing the forester who wishes to apply an economic analysis to forestry projects, is the question of the interest rate to use. Textbooks and papers present arguments for and against interest rates that vary from 3 to 15 percent (Fraser 1985, Duerr 1985, Gregory 1987, Pearse *et al.* 1986b, Davis *et al.* 1987). The long-term nature of our forestry investments makes it preferable to use the lower interest rate, not only to make the investment possible, but also to appreciate the fact

Table 3. Net present value of different treatment levels for different yields/ha, interest rates, and stumpage.

Level of management	MAI* m ³ /ha	Stumpage (\$)	Yield/ha (m ³)	Net present value (\$)		
				4%	6%	8%
Extensive	1.7	3.75	170	-46.97	-49.92	-40.57
Medium	2.55	3.75	204	-695.84	-715.78	-706.71
Intensive	3.4	3.75	238	-818.42	-842.26	-826.65
Extensive	10	3.75	1000	119.72	-25.11	-36.75
Medium	15	3.75	1200	-336.64	-637.53	-689.16
Intensive	20	3.75	1400	-256.86	-694.24	-786.65
Extensive	1.7	10.00	170	9.93	-41.45	-39.27
Medium	2.55	10.00	204	-573.22	-689.07	-700.72
Intensive	3.4	10.00	238	-626.72	-791.73	-812.99
Extensive	10	10.00	1000	454.44	24.71	-29.06
Medium	15	10.00	1200	384.64	-430.38	-653.94
Intensive	20	10.00	1400	870.78	-397.01	-706.32

*The MAI for the levels of management are 1 × Base MAI for Extensive, 1.5 × Base MAI for Medium, and 2 × Base MAI for Intensive.

that long-term investments have lower interest rates. Fraser (1985) points out two different procedures for calculating the interest rate to use. The opportunity cost of capital usually exceeds the social rate of time preference. He used rates of 10% and 5% respectively on his analysis of forestry projects, but points out that these rates are not excessively high as many analysts would prefer a rate of 15% or higher. The Canadian Federal Treasury Board uses a 10% discount rate to evaluate the economic worth of public sector investments, while the US Forest Service uses a 4% base rate and a sensitivity testing rate of 10%. Duerr (1985) points out that the alternative to government spending would include, "a large fraction of high-rate personal-spending opportunities". Thus, the rate of return expected for a government could be higher than corporate rates.

The higher the interest rate used, the larger the stumpage charge that must be used to produce a positive NPV. For a given interest rate, the stumpage increase necessary to produce a positive NPV is less for extensive management than for intensive management. In the example used with a base productivity of 1.7 m³/ha/yr, the stumpage necessary to produce a positive NPV at the 4, 6, and 8% interest rates are \$8.91, \$40.60, and \$197.90/m³, respectively. The comparable stumpage rates for the intensive management option are \$30.44, \$107.94, and \$382.12/m³. As interest rates increase, extensive management can keep stumpage rates lower than intensive management. By keeping stumpage charges as low as possible through the extensive management option, lower wood costs or subsidies will result for our average sites.

Risk

Interest rates may be increased to allow for the risk and uncertainty involved in an investment. Our long rotations with their long payback period make estimating future prices, costs, yields, interest rates, marketing and harvesting methods, plantation success, and chances of surviving fires, insects, and diseases, very difficult. Another uncertainty to consider is the efficiency level of governments in managing such an important resource for Canadians without the stimulus of profit motivation. Continuity of government funding (possibly an oxymoron) necessary for successful intensive management is another element of uncertainty. These unknown factors increase the element of risk and uncertainty to the investor. Some factors of which we do have limited knowledge, such as a low rate of plantation success (Ontario Ministry of Natural Resources 1974, Kuhnke *et al.* 1986,

Boisvert 1987, Swift 1983) and the large losses to insects, fire, and diseases (Honer *et al.* 1985), increase the element of risk. To allow for the risk and uncertainty of an investment, the discount rate is usually increased (Gregory 1987). As shown above and in Table 3, increases in interest rates make extensive management more feasible than intensive management.

Other Values

An argument sometimes used to justify intensive management is the need to protect and maintain values in addition to those of timber. Canada with its large area of Crown land is fortunate in that governments may manage the land for the benefit of a variety of users now and in the future, rather than for short-term economic gains that may occur with private land management. Harvesting invariably causes some harm to the environment, such as erosion, lower aesthetic and water values, and change in or losses of habitat for fish and wildlife (Ontario Ministry of Natural Resources 1987a, Ernst *et al.* 1981, Alberta Forest Service 1975). To protect and maintain, or restore these other values on public land, we must regenerate cutovers. However, if reforestation costs exceed the value returned to the Crown for timber harvested, then the total cost, including environmental losses will exceed the return to the nation. It has been questioned why such areas are harvested and regenerated expensively when the net return is negative (Veeman 1986). With the lower cost of extensive management, the possibilities of obtaining a positive return are higher.

Of course, a harvested area can have positive values other than for timber, such as access for hunting, fishing, and recreation. Both extensive and intensive management can produce these positive values, although it is unlikely that our large areas of low productive forest land can generate enough non-timber benefits to cover intensive management costs (Anderson 1979). The greater forest diversity created by the modified management techniques of extensive management would provide more wildlife habitat and recreation opportunities. In addition, the longer road network required for extensive management provides more access to the other values than intensive management. Management plans in Canada have not evaluated the multiple use levels that may be obtained through extensive or intensive management, but it would appear that extensive management can produce greater values for other uses than intensive management.

The US Forest Service has made considerable advances in the management of multiple resources. By applying high values for other uses of the forest, the US Forest Service has created a situation where harvesting can be justified as it will increase the value of other recreational resources, even though the cost of timber management exceeds the revenue generated (Benfield 1987, Morrison 1987). In some management plans, the value of other users exceeds the timber revenue generated. The US approach may be detrimental to timber management in the future as it has become more efficient economically to increase funding for water, recreation, wilderness, fish and wildlife, and minerals, rather than for timber production (Binkley *et al.* 1987). Extensive management can avoid this pitfall by relying on cheaper regeneration methods to justify harvesting without relying on the artificial other use values.

Industries and Employment

There are situations where it may be argued that the practice of subsidising intensive management is necessary to sustain the industry and provide local employment. In the short term, government aid to specific localities is a political reality. What is less realistic is to expect long-term national government aid to forestry to sustain industry and employment across Canada (Macdonald Report 1985). The option of practicing cheaper extensive management to provide the basic raw material and employment desired, without relying on the larger subsidies required by intensive management, should be determined for each management unit. Moreover, the social objective of trying to obtain sustained yield management in the hope of preserving communities dependent upon the forest resource may be unrealistic as the demand for a specific product may change faster than the means to produce the required timber, particularly for our long-rotation species.

Technology

Technological changes occur more rapidly than we can change the production of our long-rotation forests. The more complete utilization of a species and the use of different species have been occurring since Canada was occupied by man. The rationale of planting long-rotation species for a specific end was terminated by the industrial revolution and the concomitant rapid technological changes. Oaks planted to build men-of-war now serve as aesthetic monuments to a past era. Expensive and not always successful plantations for railway ties in the U.S. created forest that were never used. Technological advances in the use of creosote and concrete, and the use of new species, obliterated idealistic long-term planning for yesterday's markets of railway ties (Olson 1971). The application of intensive forest management of Canada's productive forest land to provide for today's industry could be another such monument to the past. Harvesting in Canada has progressed from birch (*Betula* L.) bark, through white pine (*Pinus strobus* L.) and most other species and will eventually lead us back to the current Canadian weed species, white birch (*Betula papyrifera* Marsh.). Recently, increased utilization of poplar (*Populus* L.), a former weed species in Ontario, has become evident (Balatinecz *et al.* 1987, Osborn 1986). The use of our future tree crop is guaranteed to be different from what it is now. Rather than try to expensively reforest our cutovers and backlog with species we now use, it would be cheaper and more ecologically responsible to regenerate our forests by extensive management of species adapted to specific sites. Technology will develop to utilize the crop we grow, and the cheaper we can grow it, the more successful we shall be.

In addition, intensive forestry would produce forests with shorter rotations and a higher MAI, but they would include more juvenile wood, which produces lower quality lumber than mature wood (Yang 1987). Furthermore, changes in pulping characteristics of intensively managed forests would be different and might be detrimental (Zobel 1980). By producing higher quality, slow grown trees with extensive management, we may be able to obtain a niche in the world market that cannot be filled by lower quality, faster grown trees.

A Backlog?

Of the yearly depletion of productive forest land, 20% is estimated to go out of production as not satisfactorily restocked (NSR). It was estimated that 14% (31 million hectares) of our forest land could be NSR (land that has failed to regenerate within 10 years of harvesting or destruction) by the year 2000, if only 1% of the NSR returns to production per year (Honer *et al.* 1985). Estimates and definitions of NSR are far from accurate or uniform (Pearse *et al.* 1986a, Honer *et al.* 1985). For example, recent surveys in Ontario have found that the NSR land (productive forest land not stocked to a specified standard or not free from competition) is far better condition than originally thought. For one management unit, 20% of the NSR initially classed as requiring expensive treatment, moved up to a free-to-grow status (Ontario Ministry of Natural Resources 1987b). In addition, Pease *et al.* (1986b) found much of the land in British Columbia classed as NSR (not stocked to the Ministry's acceptable standard) to be adequately stocked.

Our knowledge of ecological development should make us to realize that nature is working to restore NSR to production. The time required for the return of a productive forest will depend upon the inherent capability of that land to absorb the impact of our harvesting methods (Kimmins 1974). To date our neglect of management has not created deserts from forests, but it appears to have created a second forest that is below the quality of the original forest (Frisque *et al.* 1978), and perhaps with a longer rotation than we assume desirable.

The management of the majority of our forests has been at a low level and has been a form of extensive management, although little forestry technology was applied to increase the quality of the natural regeneration. In spite of the fact that 72% of the regeneration of our annual depletion of productive forest is by natural regeneration, only 14% of the natural regeneration is a result of management (Honer *et al.* 1985). Only one province, Québec, has made the adaptation of harvesting methods to encourage natural regeneration a priority (Ministère de l'Énergie et des Ressources 1987). If we apply a modicum of extensive management modified harvesting and operational techniques, the amount of forest going into NSR could be reduced now and a second forest of better quality obtained at a relatively low cost.

Insufficient Information

A technical difficulty in trying to practice intensive forest management is the lack of pertinent data. The more intensive forest management is practiced, the greater the need for accurate information (Hagner 1975). There is a need for resource information on inventory, site maps, growth and regeneration studies, and biological and economic data (Reed *et al.* 1978, Honer *et al.* 1985, Weetman 1986, Pearse *et al.* 1986a&b, Canadian Council of Forest Ministers 1987). In spite of the lack of essential information needed for successful intensive management, the people of Canada are being asked

to provide more funds for this function (Anon. 1987a). Also governments are reluctant to release information that may reveal their failures in managing the resource (Swift 1983). The application of intensive management programs, without an adequate data base or system of reporting to the people who are funding the effort, is not likely to gain continuous support nor success. Obtaining a data base sufficient to intensively manage 201 million hectares would be an expensive effort for the relatively small gain in yields. Without sufficient information available to practise intensive management effectively, we should limit our management activities to the more economical extensive management that requires a smaller, less costly data base.

Surplus Wood and Protection

Although several studies have stressed the need for intensive management, Reed *et al.* (1985) and Horner *et al.* (1985) found an overall excess of allowable cut values over harvest volumes. The annual volume accruing on our forest lands was 50.5 million m³ greater than the amount depleted by all causes. With the exception of local supply problem areas, it is difficult to fathom the necessity of intensive management to increase our wood supply, while we are not utilizing our existing productive forests. In the case of local wood supply problems that are a result of previous management actions (Reed *et al.* 1978), the application of intensive management to retain or increase a wood supply is an expensive corrective measure for past mismanagement. The alternative of supplying wood that can be produced extensively from the area and shifting excess demand to other areas should be analysed.

Only 43% of the sustainable MAI at rotation age was harvested during 1977-81, while another 43% was lost to fire, insects, and diseases (Honer *et al.* 1985). During the same period, an estimated 66% of the area, and 50% of the volume depletions were by fire, insects, and diseases. It appears obvious that our national supply of wood could be increased dramatically by more efficient protection methods. If volumes equal to or greater than the volumes expected through intensive management can be obtained with cheaper protection methods, the increased protection option should be favoured. Unfortunately, the amount of protection we can expect to achieve for our forests is unknown. Similarly, we do not know whether the same high losses as above will occur in intensively managed forests. If the same high area and volume losses can be expected in intensively managed forests, it would be more advantageous to manage our forests extensively.

Extensive Management

The most obvious benefits of extensive management of our low productive forest lands are the lower silviculture and wood costs, and a better return on our investment than with intensive management (Table 3). The challenge to the forester will be to develop extensive silvicultural methods that will ensure that we obtain a future crop of equal or greater productivity than the existing forest. There has been a paucity of research on natural regeneration problems, and the new proposed direction of the Canadian Forest Service to do more basic research (Anon. 1986) will decrease the applied research necessary (Canadian Pulp and Paper Association 1986). For the boreal forest, regeneration by natural means and modified harvesting is possible (Fraser *et al.* 1976, Jeglum 1984) and has been accepted as necessary by the forest industry (Innes 1984). There may be additional harvesting

costs associated with methods such as strip cutting (Ketcheson 1977) or selective logging (Trew 1982), but establishment costs associated with strip cut methods can be cheaper than clear cut methods (Johnson *et al.* 1987). On the other hand, Begin (1986) found that modified operating and harvesting methods can be used to obtain adequate regeneration often without additional costs being incurred. Natural regeneration was obtained successfully in the pine and tolerant hardwood forests of the Great Lakes — St. Lawrence Forest region (Brown 1987). To determine the most cost efficient and effective biological methods of extensive management requires more applied research on our variety of forest types and harvesting systems.

Even if governments do not develop policies encouraging extensive management, I predict that circumstances will force us to apply extensive management to our sites of average productivity. Continuous government funding in amounts sufficient to apply intensive management to all our productive forest land is not likely to occur. In provinces where industry is required to fund regeneration efforts, the most cost effective methods, extensive management, will be developed for the less productive sites. Where government funds the management, both industry and government will realise eventually that stumpage charges will need to rise to cover the cost of growing the second forest. With the recognition of a stumpage increase, governments will be persuaded to adopt cheaper extensive management to keep costs low. After accepting the necessity of extensive management, we shall attempt to remain in the forefront of forestry by acquiring knowledge of extensive and intensive silvicultural alternatives and costs for our wide variety of sites. The earlier the benefits of extensive management are accepted, the sooner we may begin the management of the forest to remain competitive and produce a profit.

The above changes necessary to practice extensive forest management may be easier to achieve than a change in the attitude of foresters. Our predilection for intensive forest management may be partially a result of our European forestry heritage. When the European forestry profession developed, there were few virgin natural forests to manage. Intensive management was their only alternative. Yet, the intensive management applied to their less productive sites has led to degradation of those sites while extensive management of low productive sites can help preserve the natural ecosystem and productivity of our forest sites (Jablanczy 1987). A background education in forestry based on European techniques has not prepared us for the extensive management necessary for our much larger low productive forests. We have the opportunity to break the expensive chain of clearcutting and planting by practising extensive management on our natural forests.

In the early history of our country, the harvest of the forest provided much of the capital needed for our development (Nelles 1974), albeit most of the capital went to Great Britain and the US prior to Confederation (Lower 1967). We foresters have moved from being suppliers of resource money to demanders of money. Instead of generating capital to fill government coffers, we have become another social cause seeking to drain the public purse. In the future, we can try to become more entrenched as social foresters or we can take the more difficult task of applying scientific, economic business, and social principles to the management of the forest to produce a profitable resource for world trade. The most important of the above reasons for using extensive management is the lower cost. This lower cost, whether

translated as a stumpage charge or subsidy, will allow us to produce cheaper, more competitive wood than intensive management. Our huge productive forest land base of 201 million ha allows us to produce a large amount of wood without intensive management. Extensive management of this land base can allow us to produce a profit.

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