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INVESTMENT-DECISION MODEL EVALUATES DRAINED AND FERTILIZED PEATLAND BLACK SPRUCE USING MANAGER'S INPUTS

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INTRODUCTION

Nearly half of Ontario's inventory of black spruce (*Picea mariana* [Mill.] B.S.P.) occurs on peatlands (Ketcheson and Jeglum 1972). The growth of trees on these sites is slow, largely because of excess moisture and the unavailability of nutrients. In Europe, drainage and fertilization of similar sites have proved to be cost-effective methods of increasing productivity and they are widely applied on an operational scale. Consequently, there is considerable interest in determining the potential of these treatments for application to Ontario's black spruce peatlands.

Growth analysis of trees located on a 40-year drainage experiment site in northern Ontario indicated a good response to treatment, both at the individual tree and stand levels (Payandeh 1973a), and economic analysis showed an average rate of return of 2.5% (Payandeh 1973b). Another study in the same area showed a 5-year growth response of 7 m^3/ha of extra wood resulting from the combined effect of drainage and fertilization (Payandeh 1982).

More recently, a major forest drainage study, the Wally Creek Drainage Project, was established by the Ontario Ministry of Natural Resources and the Canadian Forest Service – Ontario, near Cochrane, Ontario (Rosen 1986). The purpose of this project was to determine not only the biological and ecological effects of drainage and fertilization, but the economic feasibility of these treatments when applied on an operational scale. The actual costs of this trial, together with growth response data from earlier research studies, provided the basis for development of a model to economically evaluate drainage and fertilization of peatland black spruce (Payandeh 1988). The highlights of the 1988 study are presented here.

THE MODEL

A computer program called FIDME – PC (Forestry Investment Decisions Made Easy on Personal Computers) was developed to assist forest managers in evaluating long-term investment decisions (Payandeh et al. 1991). The program permits the comparison of up to four alternative treatments using one or more conventional economic criteria: (1) cost-effectiveness, (2) benefit:cost ratio, (3) present net worth, and (4) internal rate of return. The model estimates a cost range into which actual values should fall. For all estimates there is a 10% probability that costs will be lower than the low estimate and a 90% probability that they will be lower than the high estimate. The model runs on MS-DOS compatible personal computers and makes use of estimates provided by the user on the basis of available data and/or knowledge and experience.

THE EXAMPLE

FIDME-PC was used to evaluate the present net worth of drainage and fertilization, singly and in combination, as applied to a 55-year-old black spruce stand in the Wally Creek area. Based on the results of earlier studies, it was assumed that the increase in growth rate following treatment would produce a higher yield and permit a reduction in rotation age. The analysis was carried out for three possible rotation ages for each of the three treatments (drained,

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fertilized, and drained and fertilized) and one rotation age for the control (*See* Figure 1). Rotation ages for the drained stand were 80, 90, and 100 years (i.e., this assumes that drainage might reduce the rotation age by 40, 30, or 20 years in relation to that of the control).

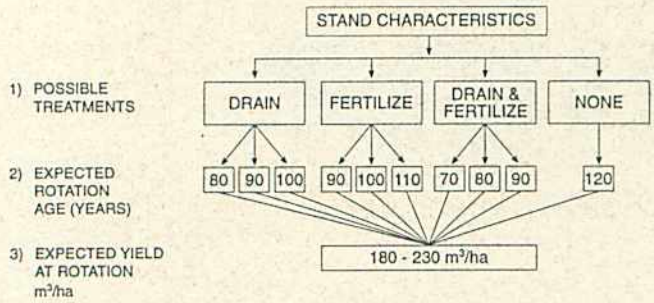

Figure 1. Ten alternatives for stand improvement in a 55-year-old peatland black spruce stand located in the Wally Creek drainage project near Cochrane, Ontario.

Input estimates are summarized in Table 1. The first of these is an annual cost (ground rent and fire protection) of $2.00/ha. This remains the same with or without treatment. Treatment costs are based on the actual costs incurred in the Wally Creek project, but are expressed as subjective probability estimates to account for the variability that occurs in nature, largely as a result of site conditions. For example, estimates for the cost of drainage range from a low of $190/ha to a high of $220/ha, with a 10% probability that costs will be lower than $190/ha and a 90% probability that they will be lower than $220/ha.

The minimum cost of drainage was estimated at $175/ha. This includes per-hectare costs of $10 – 30 for planning and topographic survey, $40 – 70 for line clearing, and $125 – 150 for digging ditches. Although not used in this calculation, there could be an additional $8 – 10 cost for the construction of sedimentation ponds.

Similarly, the low, high, and minimum estimates of the per-hectare cost of fertilization (with 150, 100, and 100 kg/ha of N, P, and K, respectively) were $550, $700, and $480,

Table 1. Input estimates used in the FIDME – PC model to compare the present net worth of forest drainage and/or fertilization of a 55-year-old peatland black spruce stand in the Wally Creek Drainage Project, Cochrane, Ontario. (An interest rate of 6% and an inflation rate of 1% were used.)

Input	Treatment[a]	Point estimate ($/ha)	Subjective estimate				
			Range (low–high)		Probability[b] (low–high)		Minimum
Annual cost ($/ha)	D	2.00	–	–	–	–	–
	F	2.00	–	–	–	–	–
	D&F	2.00	–	–	–	–	–
	Control	2.00	–	–	–	–	–
Treatment[c] ($/ha)	D	–	190	220	0.10	0.90	175
	F		550	700	0.10	0.90	480
	D&F	–	740	920	0.10	0.90	655
	Control	–	–	–	–	–	–
Yield (m^3/ha)	D	–	190	240	0.10	0.95	150
	F	–	185	235	0.10	0.85	150
	D&F	–	195	245	0.10	0.95	150
	Control	–	180	230	0.10	0.95	150
Rotation age (years)	D (80, 90, 100)						
	F (90, 100, 110)						
	D&F (70, 80, 90)						
	Control (120)						

[a] D = drained, F = fertilized, D&F = drained and fertilized.

[b] Probability (low – high) refers to the probability of a value below the low end of the range or below the high end of the range, respectively.

[c] Applied as a single periodic cost at a stand age of 55 years.

respectively. Input costs per hectare for drainage plus fertilization are simply additive and the same probabilities apply.

As indicated in Table 1, the physical yield at rotation age was assumed to be nearly the same for all treatments, but because optimum yield occurs earlier for treated stands there is a small increase in value. The low-yield estimates are 180 m^3/ha for the control, 185 m^3/ha if fertilized, 190 m^3/ha if drained, and 195 m^3/ha if drained and fertilized. The corresponding high estimates are 230, 235, 240, and 245 m^3/ha, respectively. In all cases, the minimum yield estimate is 150 m^3/ha.

Rotation ages were assumed to be reduced by 20, 30, or 40 years as a result of drainage; by 10, 20, or 30 years as a result of fertilization; and by 30, 40, or 50 years as a result of drainage plus fertilization (Table 1). The future value of pulpwood (stumpage only) was estimated at a minimum of \$3.00/m^2, a low of \$4.00/m^3, and a high of \$8.00/m^3.

RESULTS AND DISCUSSION

Using the foregoing input estimates, the FIDME – PC model provided an economic evaluation of drainage and fertilization, singly and in combination, applied to a 55-year-old stand of peatland black spruce (Table 2).

For example, the eighth line of Table 2 indicates that there is a 70% chance that with a rotation age of 120, the present net worth of pulpwood from the untreated stand will exceed \$719/ha. It also indicates (with the same probability) that with a rotation age of 90 years, the present net worth of the drained stand will exceed \$708/ha. For the same rotation age, the present net worth of the fertilized and of the drained and fertilized stands are \$653 per ha and \$701 per ha, respectively.

Table 2 also illustrates that for any given treatment, a difference in the length of rotation makes only a minor difference in present net worth. However, note that a difference in the expected probability of exceeding a given value produces significant differences in the present net worth. For example, there is a 50% probability that the present net worth of the drained stand will exceed \$837 per ha but there is a 90% chance that it will exceed \$560 per ha, for a rotation age of 90 years.

SUMMARY AND CONCLUSIONS

By applying estimates of actual operational costs and the results of previous research studies, an economic evaluation was made of drainage, fertilization, and drainage plus fertilization of a 55-year-old peatland black spruce stand. Treatments were evaluated on the basis of the present net worth of pulpwood produced over rotations ranging from 70 to 120 years.

Results indicated that drainage was the most economical treatment for the black spruce stand in question, followed by fertilization plus drainage. It is not possible to verify the accuracy of the assumptions, since they are based on subjective estimates. However, since the input estimates used were taken from an actual field trial, the magnitude of the results of the model should be reliable approximations. As long as the assumptions were unbiased, the relative ranking of the alternatives will remain valid.

Table 2. Output of FIDME – PC for an economic evaluation of drainage, fertilization, and fertilization plus drainage for a peatland black spruce stand near Cochrane, Ontario. (An interest rate of 6% and an inflation rate of 1% were used.)

	Present net worth (\$/ha), by rotation age									
	Drainage			Fertilization			Fertilization and drainage			None (control)
	Assumed rotation age (years)									
Probability of exceeding	80	90	100	90	100	110	70	80	90	120
0.0	1908	1907	1907	1609	1609	1609	1688	1687	1687	1470
0.1	1163	1163	1162	1125	1125	1125	1139	1138	1138	1137
0.2	1035	1035	1035	1004	1004	1004	1046	1046	1046	1019
0.3	977	977	977	904	904	903	947	947	947	925
0.4	895	894	894	818	818	818	869	868	868	867
0.5	838	837	837	757	757	757	814	813	813	814
0.6	775	774	774	703	703	702	755	755	754	769
0.7	708	708	708	653	653	653	702	701	701	719
0.8	641	640	640	591	590	590	636	635	635	644
0.9	561	560	560	535	535	535	552	551	551	564
1.0	385	385	384	366	366	366	418	417	417	436

Since the publication of the original report, interest rates have fallen significantly and stumpage rates have more than doubled. Since these factors affect all the variables in the study uniformly, the return expected from treatments has varied but their relative position has remained the same. In this case, the value of the standing timber has more than doubled and the cost of borrowing has diminished considerably.

A diskette copy of FIDME – PC and input examples may be obtained from Natural Resources Canada, Canadian Forest Service – Ontario.

REFERENCES AND FURTHER READING

Ketcheson, D.E.; Jeglum, J.K. 1972. Estimates of black spruce and peatland areas in Ontario. Dep. Environ., Can. For. Serv., Sault Ste. Marie, ON. Inf. Rep. O–X–172. 29 p.

McEwen, J.K. 1966. An effect of Sphagnum on the growth of black spruce. For. Chron. 42(2):175–183.

Payandeh, B. 1973a. Analysis of a forest drainage experiment in northern Ontario. I. Growth analysis. Can. J. For. Res. 3(3):387–398.

Payandeh, B. 1973b. Analysis of a forest drainage experiment in northern Ontario. II. An economic analysis. Can. J. For. Res. 3(3):399–408.

Payandeh, B. 1982. Five-year growth response of northern Ontario peatland black spruce to fertilization and drainage. Dep. Environ., Can. For. Serv., Sault Ste. Marie, ON. Inf. Rep. O–X–340. 20 p.

Payandeh, B. 1988. Economic evaluation of forest drainage and fertilization in northern Ontario peatland, with an investment decision model. New For. 2:145–160.

Payandeh, B. 1991. Cost-effectiveness of forest drainage and fertilization in northern Ontario peatlands. p. 197–203 *in* J.K. Jeglum and R.P. Overend, eds. Proceedings Symposium '89. Peat and Peatlands Diversification and Innovation. Vol. 1. Peatland Forestry. 6 – 10 August 1989, Quebec City, PQ. Can. Soc. for Peat and Peatlands. 227 p.

Payandeh, B.; Basham, D.; Haig, R.A. 1991. Forestry investment decisions made easy on personal computers (FIDME–PC). For. Can., Ont. Reg., Sault Ste. Marie, ON. Frontline Technical Note No. 3. 4 p.

Payandeh, B.; Sundström, E.; Haig, R.A. 1994. Drainage and fertilization improve growth and value of peatland black spruce. Nat. Resour. Can., Canadian Forest Service – Ontario, Sault Ste. Marie, ON. Frontline Technical Note No. 64. 4 p.

Rosen, M.R. 1986. Management plan for the Wally Creek Area Forest Drainage Project. Ont. Min. Nat. Resour., Cochrane, ON. File Rep.

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