Identifying factors affecting plantation performance in boreal forests of Ontario

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Application. Stepwise multiple linear regression analysis may be used to identify and/or quantify factors affecting plantation performance. Variables so chosen then may be included in nonlinear models describing plantation survival and growth. It should be noted, however, that variables chosen by stepwise procedures do not necessarily represent cause-and-effect relationships.

Abstract. Plantation data from northern Ontario were subjected to stepwise regression analysis to express survival and total height as functions of site factors, planting stock characteristics and age for each of black spruce (Picea mariana [Mill.] B.S.P.), white spruce (P. glauca [Moench] Voss) and jack pine (Pinus banksiana Lamb.).

Total height and height increment were affected more significantly, but by fewer factors, than survival. Black spruce survival was the most heterogeneous variable, as six factors accounted for 55.6% of its variability. Between one and five qualitative site factors (represented by dummy variables) accounted for less than 23% and 30%, respectively, of the variability in survival rate and total height. Stock type, planting season, weed control and chemical site preparation showed low but significant correlations with the response variables. Quality index was significant in every case, while shoot:root ratio, root collar diameter and dry weight were significant in some cases. The single most significant variable was plantation age, accounting for up to 30% and 63%, respectively, of the variability in survival rate and total height.

Introduction

Forest renewal is the most pressing problem currently facing forest managers in Canada (see Fellows (1986) for a historical review). Because of the impending wood supply problems and the backlog of cutover areas, federal and provincial agencies and the forest industry will be investing increasingly large sums of money annually in forest regeneration.

Recent symposia on forest regeneration (Anon. 1981; Mroz and Berner 1982; Scarratt et al. 1982) effectively illustrate the need for synthesis of
information on forest renewal for each province. In Ontario, artificial forest regeneration practices have been studied for many years. Investigations have taken into account everything from biological factors to economic considerations. Much is known about the individual factors affecting seedling survival, growth, and production costs. However, researchers have not completely addressed the interrelationship of the important factors identified. Therefore, there is a strong need to synthesize the knowledge currently available in order to understand the regeneration process as a whole. Such an understanding would be facilitated by the development of a management-oriented computer simulation model.

Research to develop a model for artificial regeneration systems in Ontario began at the Great Lakes Forestry Centre in 1985. The intent of the study is to integrate biological factors fully with the economic component of regeneration systems. The preliminary stage of model development requires the identification of critical factors (both biological and managerial) significantly affecting the performance of the candidate species during the regeneration phase. The objective of this paper is to describe the procedures employed to identify significant factors affecting plantation performance in northern Ontario.

Materials and methods

The data used are from a cooperative research study between the Great Lakes Forestry Centre and the Ontario Ministry of Natural Resources to compare the outplanting performance of bare-root and paperpot planting stock, as a function of time of planting (i.e. spring or summer), under a variety of site conditions in northern Ontario. Recently, Wood and Dominy (1985) reported the results of this study by species in 18 separate outplanting experiments located across northern Ontario. Approximately 22,000 crop trees were planted and assessed for survival, growth, and condition at the end of the first, third and fifth growing seasons (i.e. plantation ages of 3 and 5 years). Detailed descriptions of the experiments and results are given by Wood and Dominy (1985).

Stepwise multiple linear regression analysis was used to screen for factors influencing plantation performance. Both continuous and categorical variables are used as predictors. For each categorical variable, \( (k-1) \) dummy variables were used to distinguish \( k \) classes (see Draper and Smith 1966; Chatterjee and Price 1977; Sokal and Rohlf 1981). For example, a two-category variable such as weed control, planting season, or stock type is represented by a single dummy variable \( D \) (\( D = 1 \) if the case belongs to the first category, \( D = 0 \) otherwise). The three site preparation methods