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Integrating a random utility model for non-timber forest users into a strategic forest planning model

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Abstract

In this paper, we developed a mixed-integer non-linear programming model that integrates access road development and a utility theoretic spatial choice model of hunters into a strategic forest harvest-scheduling model. The model was applied to an operationally sized Forest Management Agreement (FMA) area in central Alberta, Canada. The resulting behavioral model had approximately 2.6 million decision variables and about 96,000 constraints, and was used to examine the impacts of timber harvesting on hunters' preference for hunting sites. We also evaluated the impacts of various levels of hunter welfare on: (i) the degree of tradeoff between timber and hunting benefits, (ii) timber harvest schedules, and (iii) the marginal costs of producing timber products. The results showed significant tradeoffs between timber and hunting benefits and a clear link between landscape characteristics and changes and behavioral responses by hunters.

JEL classification: Q230

Keywords: Decomposition techniques; Harvest-scheduling; Random utility model; Landscape; Recreational hunting

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Introduction

Increasing public demand for non-timber goods and services from forests has provided the motivation for forest managers to incorporate these benefits into strategic forest management planning. Incorporating non-timber values into traditional timber supply models has the potential to change optimal rotation ages and consequently affect timber harvest schedules. Furthermore, non-timber values affect the normal issues of choosing stands for harvest to achieve concentration in space as well as profitability based only on timber values. Concentration is desired over space because of economies of scale associated with concentrating harvests over the landscape. Forest operations such as harvesting and road construction also affect wildlife and other non-timber values within the forest. When multiple forest benefits are considered, forest management activities become interdependent, and any one activity ultimately affects other values directly or indirectly.

The challenge for forest managers is not only how to incorporate these multiple values into existing forest planning models, but also to understand the nature and degree of tradeoffs that may be associated with the provision of multiple benefits. To understand these tradeoffs, we need to know the nature of the relationships between the various forest uses. Determining the relationships between the various forest uses is a task of considerable complexity, though these relationships are known to fall into three main categories: independent, complementary, or competitive (Teeguarden, 1982). One way to evaluate these tradeoffs is to integrate timber and non-timber values into forest management scheduling models. Whilst timber output levels are often easy to set, it is usually difficult to determine how much non-timber goods and services to produce and where, and the effect of timber management activities on non-timber users of the forests. These and other multiple-use questions are fundamental to long-term planning that ensures the sustainability of forests and allows society to derive maximum benefits from forest resources.

This paper provides an effort to incorporate a specific type of non-timber value into a strategic forest management model. We developed a utility theoretic spatial choice model and applied it to a Forest Management Agreement (FMA) area in Alberta, Canada. We use mixed-integer non-linear programming (MINLP) to incorporate a spatially explicitly utility function for hunter recreation values into a forest level harvest scheduling and access road development model. The resulting behavioral model was used to examine the impacts of various levels of hunter welfare on: (i) the degree of tradeoff between timber and hunting benefits, (ii) timber harvest schedules, and (iii) the marginal costs of producing timber products. Because of the importance of hunting to many communities in Alberta, this activity is used as an example to investigate the above objectives, which we believe are crucial to analyses of tradeoffs arising from conflicts in providing timber and non-timber benefits. This paper contributes significantly to our understanding of the link between landscape characteristics and changes and behavioral responses by hunters and recreationists. This knowledge is important if the prediction of how hunting patterns will change in response to different management scenarios is required. It is important to emphasize that though our specification of non-timber values is not exhaustive, the methods