Executive Summary

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A Linear Programming Framework for Models of Forest Management Strategy

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INTRODUCTION

The conventional approach to modelling forest management strategy uses models ill-suited to modelling strategically relevant spatial resolution that ignore industry. Addressing these limitations, a Model One linear programming (LP) framework was developed in which models built can model strategically relevant spatial resolution, and include industry representation. Models from this framework were compared with the commercial modelling system Woodstock™, and then used to make an argument for including industry representation in models of forest management strategy.

METHOD

Through collaboration with the Nova Scotia Department of Natural Resources (NSDNR), two case-studies were performed on Nova Scotia's Crown Central Forest. The first was a comparison between Model One and Model Two modelling frameworks for the purposes of modelling strategically relevant spatial resolution. Model Two is a widely used LP framework that represents problems differently than Model One. Models from the proposed framework were used for Model One and Woodstock™ was used for Model Two. The second case-study compared a conventional model, one that did not include industry, with a model that did include industry. Industry was represented through the inclusion of transportation costs and product demand. Then, using models that included industry, novel analysis was demonstrated. Both case-studies were performed on a forest of 176,240 stands aggregated into 68,000 stands.

RESULTS

Figure 1 shows the linear growth in Model One (solid blue) solution time and exponential growth in Model Two (hatched green) solution time as spatial resolution of models increases. Both models had similar prescription sets, and achieved objective function values within 1% of each other.

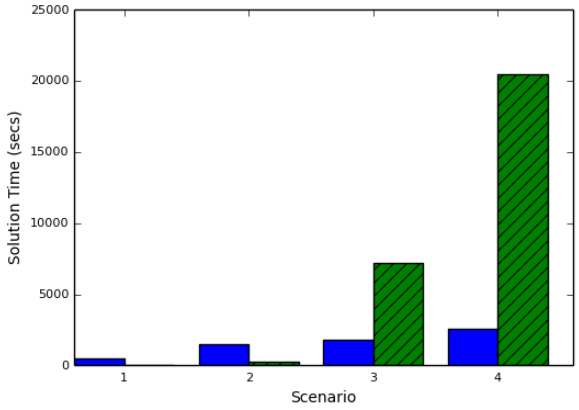

Figure 1: Model One (blue), Model Two (green) Solution Times

Figure 2 shows a substantial difference in spruce-fir harvest levels between a conventional model, i.e. one that does not include industry representation (green circles), and a model with industry representation (blue triangles).

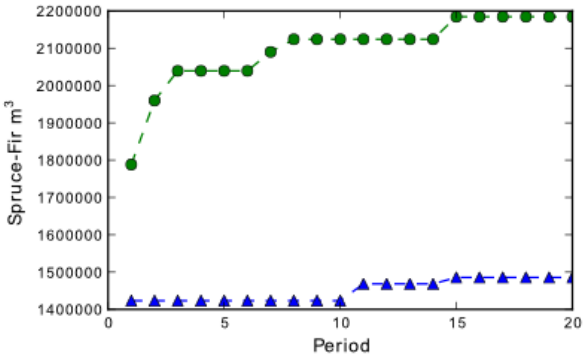

Figure 2: Conventional Model (green) and Industry Model (blue) Harvest Volumes

VCO Value Chain Optimization
NSERC CRSNG
FPInnovations

DISCUSSION

Model One, Model Two Comparison

The Model One, Model Two comparison shows why Model Two is ill-suited to modelling forest management strategy on multiple levels of spatial resolution. As spatial resolution increases, Model Two size increases exponentially, leading to the exponentially increasing solution times shown in Figure 1. Increasing spatial resolution only causes Model One size to increase marginally; its solution times reflect this.

Industry Modelling

Observe in Figure 2 that the model with industry representation schedules 33% less timber for harvest than the conventional model. The reason for this is that once transportation costs and product demand are considered, much of the wood scheduled for harvest in the conventional model is not profitable to harvest. The repercussion of this is that conventional models may misrepresent what sustainable harvest levels should be.

The argument to include industry representation in modelling is supported in Martin (2013) where practical industry based analysis is demonstrated. For example, an industrial expansion scenario is presented where the effect on harvest levels and profit of building a new sawmill was assessed. The comparison showed that the new mill raised harvest levels by 25% and industry profit proportionately. This analysis demonstrates that the forest is capable of increasing harvest levels, if the appropriate industrial demand exists.

Additionally, the cost of instituting a clearcut restriction was assessed. Alternative, profit-based, harvest regulation strategies to non-declining yield were advanced, and the benefit of allowing harvested wood to be left in the forest was examined. These examples provide a sampling of the kind of analysis that is possible once industry is represented in modelling.

CONCLUSION

This work draws attention to limitations in the conventional approach to modelling forest management strategy, where models grow large as multiple levels of spatial resolution are modelled and may misrepresent sustainable harvest levels by ignoring industry. The proposed modelling framework addresses both of these issues. Models built from it can include multiple levels of spatial resolution without growing large, and can include considerations for industry via transportation costs and product demand.

Using models from this framework, a Model One Model Two comparison was performed that illustrated Model One's linear growth in size and solution time, and Model Two's exponential growth in size and solution time, as the spatial resolution of models increases. Next, an argument was made for including industry representation in models of forest management strategy by first showing that conventional models may schedule unprofitable timber for harvest, and then presenting examples of practical analysis that models with industry representation can perform.

A limitation of this work is that the study forest was quite small. The Crown Central Forest is less than a quarter of the entire Central Nova Scotian Forest, imposing limitations on the industry representation. It would be interesting to model an entire forest. Results displayed in Martin (2013) show that the solution time of models from this framework may be robust to increasing the size of the land base modelled.

It would also be interesting to recruit policy makers to integrate models with industry representation in their strategic planning process. Perhaps they would observe similar results to those presented here when comparing the solutions of their conventional models with those of models that include industry representation.

FURTHER READING

Martin, A. (2013). A Linear Programming Framework for Models of Forest Management Strategy. M.A.Sc Thesis. Dalhousie University, Canada.