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Multi-attribute evaluation of landscape-level fuel management to reduce wildfire risk

Dan W. Ohlson[a,*], Trent M. Berry[a], Robert W. Gray[b], Bruce A. Blackwell[c], Brad C. Hawkes[d]

[a] *Compass Resource Management Ltd., 200 - 1260 Hamilton St., Vancouver, British Columbia, Canada V6B 2S8*
[b] *R.W. Gray Consulting Ltd., 6311 Silverthorne Road, Chilliwack, British Columbia, Canada V2R 2N1*
[c] *B.A. Blackwell and Associates Ltd., 3087 Hoskins Road, North Vancouver, British Columbia, Canada V7J 3B5*
[d] *Natural Resources Canada, Canadian Forest Service, Pacific Forestry Centre, 506 W Burnside Road, Victoria, British Columbia, Canada V8Z 1M5*

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Abstract

This paper provides an example of the practical application of multi-attribute trade-off analysis (MATA) to wildfire management. The MATA approach supports more informed decision-making because it exposes important trade-offs among competing management objectives (requiring value-based choices), helps guide and structure necessary technical judgements, explicitly represents uncertainty (i.e., not just expected outcomes but risk profiles around outcomes) and addresses temporal trade-offs. MATA promotes critical thinking about what analysis is required for decision-making. A MATA approach can be applied for all types of forest and fire management decisions. In this paper, we provide a sample application of MATA to an evaluation of landscape-level fuel treatments for managing wildfire risk. The study area is located in southeastern British Columbia, Canada where historical fire suppression policies and expanding development in wildland urban interface areas have resulted in an increase in both the probability and the consequences of stand replacement fires. We specify management objectives and develop measurable attributes for fire management costs, timber supply, property damage, landscape-level biodiversity, local air quality and climate change. We then simulate the effects on these attributes of four alternative fuel management strategies that include combinations of mechanical treatments and prescribed burning over a 100-year period. The evaluation illustrates the key features of MATA while highlighting the benefits and challenges of implementing the approach.

Keywords: Wildfire risk management; Multi-attribute trade-off analysis; Multi-criteria decision-making; Fuel management; Wildland urban interface

* Corresponding author. Tel.: +1 604 641 2875; fax: +1 604 641 2880.
E-mail address: dohlson@compassrm.com (D.W. Ohlson).

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1. Introduction

The United States recently embarked on a massive program of prescribed burning, mechanical thinning and commercial harvest to reduce surface fuels, improve stand conditions and reduce wildfire risk in public forests (United States General Accounting Office, 2000). These problems are attributed in part to historical fire suppression policies and forest management practices across the U.S. (Covington et al., 1994; Mutch, 1994; Conard et al., 2001). A recent study of forest conditions in southeastern British Columbia, which has a shorter history of fire suppression and harvest activity, also suggests changes in vegetation structure and increasing fuel loadings relative to historical conditions (Blackwell et al., 2003). Recent large and severe wildfires in the U.S. and British Columbia have heightened public sensitivity to this issue and have stimulated calls for public agencies to do something.

Regardless of the factors that may have contributed to any increase in wildfire frequency and severity, the best alternatives for dealing with this risk going forward are far from obvious. How much should be spent on fuel management relative to other alternatives for reducing the risk or impacts of wildfire (e.g., land use and building codes) and relative to other spending priorities in society? What are the best approaches to fuel management in a given region? How should money for fuel management be allocated among regions and among individual forest stands within each region?

Some of the questions are technical in nature. For example, what are the effects of fuel reduction on the frequency, extent and severity of wildfire? Are there minimum thresholds for treatment areas to have measurable effects on wildfire risk? Other questions involve value trade-offs. For example, what is the relative importance of local air quality impacts versus providing quality habitat for wildlife? What is our relative tolerance for the low probability of a large but severe fire relative to a higher probability of small but less severe fires? The evaluation of policies and management strategies requires that technical information be structured in a manner that supports both relevant technical input and transparent value-based trade-offs. In an applied setting, information and analysis must be oriented towards supporting management decisions, rather than simply producing more detailed and precise understanding of individual dimensions of fire behaviour or impacts.

This paper promotes the use of multi-attribute trade-off analysis (MATA) to support wildfire risk management decisions. We illustrate the key features and strengths of a MATA, through a case study examining long-term, landscape-level fuel treatment alternatives in a region of southeastern British Columbia.

2. Common evaluation challenges addressed by MATA

Good decision-making requires an evaluation of the pros and cons of alternative courses of action. Unfortunately, many evaluations suffer from one or more shortcomings that hinder timely and transparent decisions. First, many evaluations focus on producing precise and detailed information about a narrow set of impacts. For example, an evaluation may examine the detailed effects of fire on stand regeneration or air quality. Often the evaluation is also limited to a single spatial or temporal scale. Real-world decisions, however, involve trade-offs among multiple objectives and different scales of concern (e.g., short-term costs vs. long-term savings or local biodiversity vs. regional biodiversity). An adequate and balanced representation of key trade-offs is more critical for good decisions than a detailed and potentially unbalanced analysis of one or a few impacts, or as Tukey (1962) argues: “Far better an approximate answer to the right question. . .than an exact answer to the wrong question.”

Second, many methods focus on the development and evaluation of a single preferred alternative, rather than an open exploration of a range of different alternatives. As a result, the evaluation process can become defensive and antagonistic, producing distrust and misunderstanding. A good evaluation method encourages analysts and decision-makers to develop a wide range of alternatives and it provides clear and unbiased documentation on the logic and rationale for ultimate decisions (Keeney, 1992; Skinner, 1999). Too often, a lot of additional data gathering and analysis is conducted to prove not only that one alternative is best, but also precisely how much better it is.