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THINK LONG TERM: THE COSTS AND BENEFITS OF PRESCRIBED BURNING IN THE SOUTH WEST OF WESTERN AUSTRALIA

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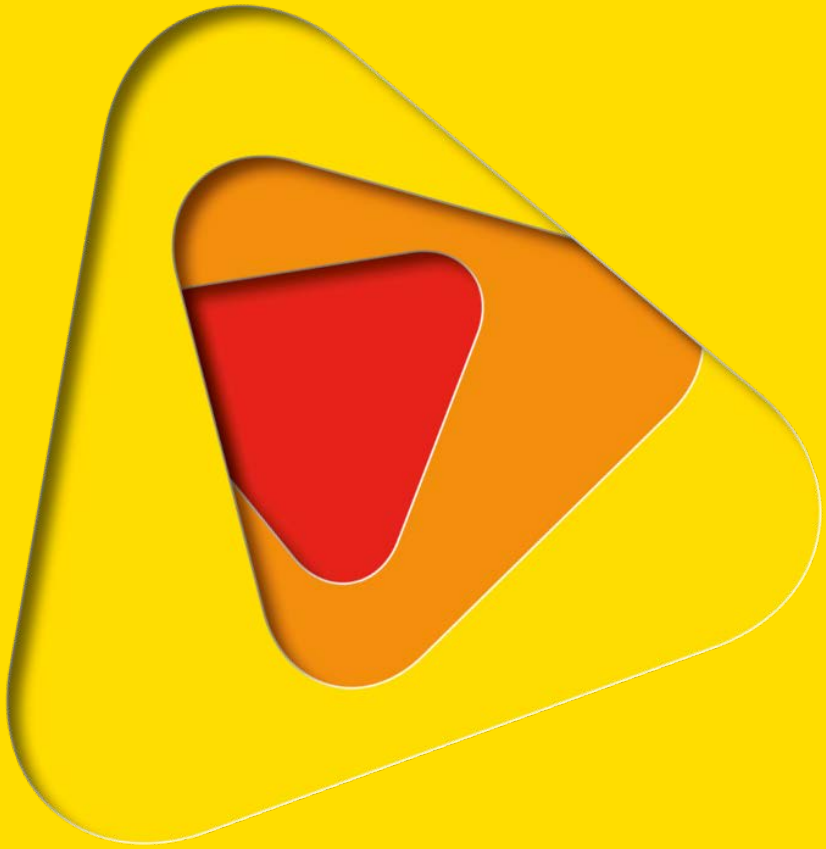

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Wildfires are a worldwide phenomenon that can cause significant damage to ecosystems, life and property (Gill 2005; Bowman et al. 2009). Every year in Australia large, uncontrolled fires burn in a variety of landscapes destroying economic, environmental and social assets (Williams et al. 2011). But wildfires are also a natural, inevitable and vital element of the Australian environment that cannot (and should not) be eliminated (Pyne et al. 1996; Pyne 2006). Hence fire management must be an integral part of land and ecosystem management (Bradstock et al. 2012b; Burrows and McCaw 2013).

In recent years, the frequency and severity of large wildfires have increased in most of the vegetated landscapes around the world (Bowman et al. 2009), including Australia. For instance, the fires of Black Saturday on February 2009 caused the highest loss of life and property from a wildfire in Australian history (Teague et al. 2010). The total cost of the Black Saturday fires was estimated to be AU$4.2 billion (Attiwill and Adams 2013). These large fires and losses occur despite advances in fire-fighting technology, greater suppression capacity, considerable suppression efforts, and record expenditures in wildfire suppression (Toman et al. 2011; Attiwill and Adams 2013).

Indeed, the costs of wildfire management, and in particular the costs of wildfire suppression, have increased substantially in the last few decades in many parts of the world (Morgan et al. 2007; Cochrane et al. 2012; Gude et al. 2013; Thompson et al. 2013a). In countries like the US and Australia, fire suppression expenditures have reached record highs (Morgan et al. 2007; Thompson et al. 2013a). These increases in suppression costs have been attributed to the cumulative effects of: (1) the increase in the number, size and intensity of wildfires due to changes in weather patterns, (2) the continuous expansion of the wildland-urban interface (WUI), and (3) decades of fire exclusion and aggressive suppression that resulted in extensive fuel build-ups in fire-prone landscapes (Liang et al. 2008; Stetler et al. 2010; Stockmann et al. 2010a; Cochrane et al. 2012; Thompson et al. 2013b). And this increasing trend in suppression expenditures is expected to continue. However, increasing suppression capacity alone will not solve the problem of the increasing fire threat (Marino et al. 2014). There is a risk that Australia will continue to increase its fire-fighting capacity and suppression expenditures without improving its management of fire in the landscape (Morgan et al. 2007). As the likelihood of suppressing bushfires decreases with growing fire intensity and size, it becomes increasingly important to apply effective policies that reduce the risk of mega–fires.

With more severe wildfire impacts and suppression expenditures at record highs, other strategies need to be implemented for the management of wildfires. A strategy available to fire managers is managing fuel levels through prescribed burning (Mercer et al. 2008; Stockmann et al. 2010b; Toman et al. 2011). The purposeful application of fire to the landscape in mild weather conditions is used in many fire-prone landscapes for wildfire management and protection of human assets (Fernandes and Botelho 2003; Penman et al. 2011). More recently it has been used for the protection of ecological assets and ecosystems restoration (Bradstock et al. 2012a; McCaw 2013). However, the increased focus on prescribed burning to mitigate potential wildfire effects has generated considerable debate (Penman et al. 2011; Ryan et al. 2013). Much of this debate revolves around the efficacy of prescribed burning in reducing wildfire extent and severity (Fernandes and Botelho 2003), but little attention has been given to the economic impacts of prescribed burning programs and the trade-offs in the allocation of resources between different

fire management activities. Despite much land being prescribed burned in some parts of Australia, there has been almost no evaluation of the costs and benefits of the practice. Without the help of sound economic analyses, it is not clear which option yields the best returns on investment.

Most of the literature that applies economic analysis to fire management has focused on one single aspect of the problem in isolation: the costs, the benefits or the losses. A very small number of studies have dealt with the three aspects simultaneously. This study aims to fill these gaps in research and provide a framework through which the trade-offs between prescribed burning, wildfire suppression and wildfire damages can be brought to light and interpreted. Through the application of economic analysis to fire management in the south-west of Western Australia (WA), the main goal is to appraise the impacts of changing the prescribed burning strategy under different scenarios. This study seeks to provide improved understanding about the implications of different uses of limited resources in fire management, taking into account the following facts: (1) prescribed burning costs change with the size and location of treatments (Berry et al. 2006; Calkin and Gebert 2006), (2) varying the size and the location of the treatments can strongly affect their efficiency (Fernandes and Botelho 2003), and (3) the assets protected differ in nature and value (Ganewatta 2008).

We used an economic model in conjunction with a wildfire simulator to test different prescribed burning strategies (varying the amount and the location of the burns) and identify the strategy that yields the highest returns to society under different scenarios. The economic model used for this study is the cost plus net value change (C+NVC) model, a monetary-based framework that minimises the total sum of pre-suppression costs, suppression costs and net fire damages (Venn and Calkin 2011), similar to a benefit-cost analyses. The C+NVC is the commonly accepted model for evaluating bushfire management programs (Ganewatta 2008; Gebert et al. 2008). The simulator used for this study is the AUSTRALIS Bushfire Simulator developed at the School of Computer Science and Software Engineering, the University of Western Australia. We conducted a short-term analysis (one year) and a long-term analysis (15+ years) in order to evaluate the impact of short-term and long-term decisions in fire management and examine the differences between the two approaches.

We found that for a short-term analysis, there is not a significant difference in the economic results when the level of prescribed burning is varied over a wide range of values (using the current spatial strategy that the Department of Parks and Wildlife has in place). What changes in the short term are the proportion of management costs and the proportion of damages for different prescribed-burning rates. At low levels of prescribed burning, the vast majority of the costs arise from the damages sustained and the amount of money that has to be spent in suppression. At higher levels of prescribed burning (>10%), expenditure in prescribed burning and in suppression costs are approximately the same, and the proportion of damages is reduced. Damages then account for 2/3 of the C+NVC, while management costs correspond to 1/3 of the total C+NVC. But in any case, damages are always much larger than management costs, being twice or three times larger than suppression and prescribed burning expenditures together. Compared to a no-prevention strategy (0% prescribed burning), short-term investments in prescribed burning in the south-west of WA generate a benefit of AU$0.7 to AU$1.5 per dollar invested. The issue with a short-term analysis is that it cannot be used to answer a key question for fire managers: what would be the cost to society of not prescribed burning for several years?

A long-term analysis can answer this question and in fact it shows an entirely different outcome. The long-term analysis shows that not doing any prescribed burning for several years can be very costly for the south-west forest region, with large increases in damages and in suppression expenditures, much higher than indicated by the short-term model. In addition, the long-term analysis shows a more clear-cut answer. It suggests that at a 0% or at a 5% prescribed-burning rate there are substantial benefits that can be gained from increasing the amount of area prescribed burned per year in the south-west forest region. However, there are still several near-optimal options when a rate of 10% or higher is applied in the long term. The results from the long-term model indicate that prescribed burning may generate between AU$10 and AU$47 benefits every year per dollar invested compared to a no-prescribed-burning scenario.

The model shows that with the current prescribed-burning program that the Department of Parks and Wildlife have in place, applying the treatment to an average of 6% to 7% of their managed land in the region, they are already generating substantial benefits for society. If no prescribed burning was applied in the south-west forest region, average annual suppression expenditure would be around four times higher than the current level and damages would be around five times higher. On average, the current prescribed-burning program generates AU$31 million savings per year in suppression expenditures and AU$169 million savings in damages compared to a no-prescribed-burning scenario.

The optimal rate obtained from the long-term model suggests an increase in prescribed burning in the region to the levels applied in the 1960s and 1970s. However, increasing prescribed burning to these levels will come at an additional cost that may be high. In addition, in today's context in the South West forest region, this would be an exceptionally high level of prescribed burning and it may not be possible for several reasons: climate change (Bradstock et al. 2009; Cary et al. 2012; Barbero et al. 2015), the accumulation of fuels in the south-western forests of WA for the past 50 years (Boer et al. 2009), fire exclusion policies and the expansion of the WUI (Mutch et al. 2011), have all contributed to create a landscape in which the application of high rates of prescribed burning is increasingly difficult (Burrows and McCaw 2013; McCaw 2013). Nevertheless, this study emphasises the importance of keeping a minimum level of prescribed burning per year in the south-west forest region.

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