Responding to Wildfire Events: Influences in Fire Manager Decision-Making

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What would you do if you were presented with the following fire management decision? You could take an action that was sure to save 25 homes, or another action that had a 25% chance of saving 100 homes and a 75% chance of saving no homes. Tough choice. Do you try to hit a single or do you swing for the fences?

Fire managers are pressed to make these kinds of complex decisions in situations with high uncertainty regarding how the decisions will turn out. These decisions are complex because of factors such as diverse values at risk, efforts to control cost, the need to ensure safety of firefighters and the public, and tension between short and long-term management objectives. In a study of fire decision-making, we asked fire managers to consider three scenarios: 1) choosing between a sure thing and a gamble when the consequences were presented as either a potential loss or a potential gain; 2) choosing from one of nine management options that each involved some tradeoff between minimizing short versus long-term risk; and 3) choosing between fire use and fire suppression when suppression was presented as either a risky or a certain option.

We found evidence for risk-based biases in our respondents' answers. Additionally, when property, public safety, or threatened and endangered species were at risk, the majority of respondents preferred minimizing short-term risk, and long-term risk was seen as more important when ecosystem health was threatened. Also, fire use was preferred regardless of the risk context; however those with more experience in suppression were more likely to choose suppression again in the future.

Examining the processes underlying these complex decisions may help improve the quality of decisions by helping managers overcome common biases (as suggested by Bornstein and Emler 2001), by improving the presentation of information provided to managers, and by improving tools developed to help fire managers make decisions.

The timing for this type of analysis seems ideal; we heard from one district ranger that said, "I have been very involved in WFU and act as part of a national cadre - we are at a critical time I believe to develop

more understanding internally as well as externally regarding the role of fire as an agent of ecosystem change and continuing to engage the public. Our actions should be confident while at the same time humble in the face of uncertainty. Managing one fire for ecosystem benefits while also managing for values at risk is a giant step but will need skilled communication to be successful."

Risk Scenarios

Complex external and agency-related factors influence decisions made pre-fire, during an incident, and post-fire. External factors include political issues and polarization over public lands (Black et al. 2008, Canton-Thompson et al. 2008, Carroll et al. 2008), air quality standards, biophysical conditions, and public opinion (Black et al. 2008, Williamson 2007). Agency-related factors include fire management policies, interactions with administrators, and limitations of human and material resources (Black et al. 2008, Canton-Thompson et al. 2008).

Considerations affecting individual decision-makers, such as a fire manager's attitude towards risk may also affect fire decisions (Black et al. 2008). Some fire managers may emphasize risk avoidance, where actions expected to prevent harm are overwhelmingly preferred to others that may confer benefit, but with some risk of adverse side effects. This pattern of decision making has become known as the precautionary principle or "better safe than sorry" (MacGregor & González-Cabán 2008). A national survey of users of a fire weather prediction service suggested that the precautionary principle drives preferences for how information is presented to them (Winter & Bigler Cole 2008).

Most research focused on fire managers and their decision-making has involved syntheses of previous work or analyses of fire incident records, interviews, and surveys. There is little experimental research on risk management with actual fire management decision-makers. One exception is the work of Cortner et al. (1990), where researchers manipulated risks in an online survey to see what factors most influenced risk-related behavior by fire managers. Safety and public opinion were among the most important factors to emerge from this study.

Some have suggested that fire managers may use mental shortcuts for risky decisions, resulting in outcomes contrary to the objectives of the managing agency (Maguire & Albright 2005). In related experimental research in the health care field, such biases in decision-making were revealed by a number of studies (Bornstein and Emler 2001). Potential remedies included developing decision tools that would help overcome potential biases in decision-making, and informing decision-makers about biases, which may increase attention to factors that appear to cause decision errors and thus decrease the probability of making those errors (Bornstein and Emler 2001).

We conducted our research to test several aspects of risk-related decisions in an online experiment with 206 Forest Service fire managers with both line and incident management experience. Four survey versions were created and participants were randomly assigned to one version. Each survey contained three experimental scenarios for which respondents were asked to make a hypothetical management decision in response to a wildland fire that had occurred. In each version, the selections were described as consistent with an existing management plan. In addition to our subjects' answers to hypothetical fire management choices, we also analyzed how years of experience in fire management, reported tendencies to take or avoid action perceived as risky, and the perceived risk associated with wildland fire use and suppression affected their choices.

The three scenarios were designed to test for loss aversion (Kahneman & Tversky 1979), high discount rates (Camerer & Kunreuther 1989), and a status quo bias (Samuelson & Zeckhauser 1988). Loss aversion suggests that potential losses or negative outcomes are given more weight in a decision than are equally probable gains. High discount rates suggest that managers will severely discount future consequences in making a decision, instead focusing on immediate effects (Maguire and Albright 2005). Finally, the status quo bias suggests that managers are likely to continue with traditional responses to risk, even if those responses are not ideal. Maguire and Albright (2005) use decisions about prescribed fire to illustrate how "future gains to habitat and ecosystem health are overshadowed by the potential for large losses from escaped fires" (p. 51).

In the first scenario we presented the consequences of a fire management choice as either avoiding loss (stated in terms of homes lost) or pursuing gain (stated in terms of homes saved). These losses and gains were further presented as either certain, or uncertain (the risky option) through the way each probability was stated (see Table 1 for the wording variations used).

Table 1. *Scenario 1 where respondents received one of two versions of the choice between a sure thing (Option 1) and a gamble (Option 2). In one version the outcomes were presented as losses (i.e., homes lost) while in the other version outcomes were presented as gains (i.e., homes saved).*

Option 1:	
You are sure to save 25 homes.	Certain gain
Option 2:	
25% chance of saving 100 homes and a 75% chance of saving no homes.	Uncertain gain
_____	
Option 1:	
You are sure to lose 75 homes.	Certain loss
Option 2:	
75% chance of losing 100 homes and a 25% chance of losing no homes.	Uncertain loss

Results from this scenario showed that management decisions were influenced by both the way the choice was framed (loss or gain) and the individual's attitude toward risk. The majority of managers preferred the risky choice when the outcome of the choice was framed as a loss (worded as homes lost). However, the majority went with the certain choice when the outcome was framed as a gain (worded as homes saved). Odds of choosing the certain option were 18 times higher in the gain (78%) than in the loss frame (15%). Individuals who were more likely to take management risks in general were also more likely to choose the risky option regardless of whether the choice involved losses or gains.

In the second scenario, we asked respondents to choose from one of nine management options with different emphases on minimizing short versus long-term risk. (This experiment explored discounting of future consequences, see Figure 1). The majority preferred minimizing short-term risk when property, public safety, or threatened and endangered species were at risk. When ecosystem health was the primary objective, there was a greater focus on minimizing long-term risk. Individuals who indicated minimizing long-term risk was an important factor in their decisions and those with greater experience

in fire management were more likely to choose an option that minimized long-term over short-term risk. This finding suggests that discounting may vary depending on which values are at risk.

The third scenario asked about preferences for fire use versus fire suppression in the context of risky or certain options. We found that fire use was preferred regardless of how the options were presented. However, the reported status quo (how they typically manage fires) mattered, so that those with a pattern of choosing suppression in the past were more likely to choose it again in the future. Individuals with more years in fire management were also more likely to choose suppression. In follow-up telephone interviews with managers who did not complete the survey, we were often told that contextual differences such as number of surrounding homes, forest conditions, climate, and current management plans drove choices more than personal feelings about risk and how to manage it. They indicated that these contextual factors weighed heavily in decisions to choose suppression, and that if their choices were independent of these factors, they would tend towards fire use more often. This may explain the high rate of support for fire use in our online study, where some of these contextual factors were absent.

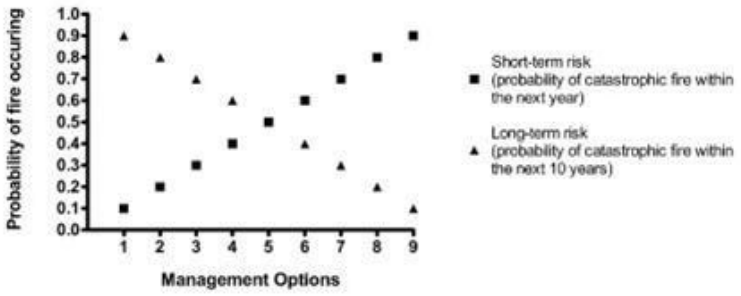

Figure 1. The management options weighing short and long-term risk presented in Scenario 2. Managers were asked to "Please select the management option that is most acceptable to you based on the tradeoff between short and long-term risk. Remember that you are primarily concerned in this context about minimizing risk to [x[1]]."

[1] *X would be equal to one of four values at risk including property, public safety, threatened and endangered species or ecosystem health.*

Our results provide evidence that risk-based biases do exist among federal fire managers, although they are certainly not the only factor influencing decision making. The biases we examined were a result of both situational cues and individual differences in risk attitudes and years of experience. In particular, loss aversion affected fire management decisions more among respondents who were generally risk averse, discounting was less pronounced among the more experienced, and the status quo bias was more pronounced among the more experienced. There is evidence that fire management decisions currently rest on intuitive preferences born out of experience and risk attitudes. In developing information and decision support tools we need to ensure that experience informs rather than dominates decisions. In tool development we ultimately need to ask, what is the correct balance between intuition and more deliberative analysis? As stated by one of our respondents: "The day line officers rely on decision trees is the day they should stop being a line officer." The goal therefore is to build decision support tools that inform fire managers' decisions, but do not make decisions for them.

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