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Preliminary Results From a Survey of U.S. Forest Service Wildfire Managers' Attitudes Toward Aviation Personnel Exposure and Risk

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Abstract: *The U.S. Department of Agriculture, Forest Service (USFS) has, in recent years, increasingly emphasized the importance of safety to its employees, but wildfire management remains a risky endeavor. While wildfire management decisions affecting safety and exposure of firefighters to the wildland fire environment may be aided by decision support tools such the Wildfire Decision Support System , use of such tools may be influenced by the way information is presented and by manager responses to risk. A recent survey of wildfire managers conducted by the USFS Rocky Mountain Research Station and the National Fire Decision Support Center used a fire management lottery experiment to elicit manager attitudes toward aviation personnel exposure and several dimensions of risk. Preliminary results suggest that wildfire managers have assimilated the USFS' recent emphasis on personnel safety, though their degree of sensitivity to potential personnel risk depends on how relevant information is presented.*

Keywords: *wildfire management; safety; risk preferences; decision support*

Introduction

Over the past several years, the U.S. Department of Agriculture, Forest Service (USFS) has reaffirmed its commitment to safety. The Chief of the USFS recently initiated an agency-wide "Safety Journey," which aims to make the USFS a zero-fatality organization (Tidwell 2011). Within the hazardous arena of wildfire management, the agency has defined success as "safely achieving objectives with the least firefighter exposure necessary, while enhancing stakeholder support for our management" (Tidwell 2012).

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In making fire management decisions that affect personnel safety and other management objectives, managers rely, in part, on decision support tools such as the Wildfire Decision Support System (WFDSS). However, such tools cannot predict outcomes with certainty (wildfire management is inherently risky), available information may be imperfect, and managers may face external pressure from a variety of sources. Therefore, a variety of human factors, including incentives, socio-political constraints, and cognitive decision biases, may govern managers' responses to the information available to them within decision support tools (Canton-Thompson and others 2008; Maguire and Albright 2005; Wilson 2010). Managerial attitudes toward risk may influence outcomes with respect to fire fighter safety, for example. Further, risk attitudes may influence outcomes to suppression cost and values at risk, such as private property, and risk attitudes may vary over these several attributes—fire managers may be risk-averse with respect to safety and risk-seeking with respect to suppression cost.

Evidence suggests that the way relevant information is presented can also affect decision-making. The degree of risk fire managers are willing to expose firefighters to may differ depending on the way decision support systems present information and the associations fire managers make between exposure and risk of injury or fatality. Understanding how USFS managers perceive and respond to risk and how the information they use shapes this response can help the USFS improve decision support tools available to fire managers. Ultimately, such improvements may result in increased safety, better risk management, and better fire outcomes.

We recently administered a survey to USFS wildfire managers in which managers were asked to choose from a series of fire management strategy pairs the strategy they would prefer to use in managing a hypothetical wildfire, where every strategy involved risk over exposure to aviation personnel, private property, and suppression costs. Results from this survey will facilitate investigation of the questions: how do fire managers understand and respond to risk, and how does the information they rely on shape these responses? We briefly describe the process used to design and implement the survey and present preliminary results from it. Finally, we review preliminary conclusions that can be drawn from these results.

Survey Development and Administration

In addition to the fire management strategy choices, the survey included a series of questions regarding managers' attitudes toward relevant aspects of wildfire management and risk, and a monetary lottery experiment in which respondents were asked to choose their preferred gamble in a series of paired hypothetical monetary lotteries (see Appendix A).

We pre-tested the complete survey with three groups of USFS employees—first, with students at the Washington Institute Technical Fire Management class in Financial

Forest Management; second, with employees at the National Fire Decision Support Center; and third, with employees at the Rocky Mountain Research Station. Pre-tests were used to refine the survey instrument and ensure that it effectively communicated the intended information to respondents.

Because of our specific interest in employees with decision-making authority on wildfire incidents, we identified potential survey respondents primarily using USFS public distribution lists of agency administrators and wildfire managers, including Fire Management Officers (FMOs), Assistant Fire Management Officers (AFMOs), and command and general staff of incident management teams. Command and general staff of incident management teams sometimes include managers employed by Department of Interior (DOI) agencies in addition to USFS employees; however, nearly 95% of our final sample was USFS employees. April 3, 2012, we sent e-mail invitations to participate in the survey to a total of 1934 USFS and DOI employees, accompanied by a letter of support from Tom Harbour, USFS Director of Fire and Aviation Management, emphasizing the importance of completing the survey. Invitations included a link to a web site where managers could complete the web-based questionnaire. In the three weeks following the initial contact, we sent three reminders to respondents who had not yet started the survey and who had only partially completed the survey. We received at least partial responses from 1197 managers, and 1073 managers completed the fire management lottery experiment portion of the survey. Based on this latter number, we achieved a response rate of 55.5%. Twelve days after the final reminder, we sent very brief questionnaires to those who had not responded and who had partially completed the survey to investigate their reasons for not completing the survey and potential non-response bias.

Characteristics of the sample are given in Table 1. These characteristics were elicited near the end of the survey; therefore, percentages given in the table reflect

Table 1—Sample characteristics.

	Count	Percent		Count	Percent
Position			**Geographic area**		
Agency administrator	354	29.57	Alaska	11	0.92
Fire manager (fuels/fire use)	103	8.60	Eastern	72	6.02
Fire manager (suppression/operations)	298	24.90	Eastern Great Basin	81	6.77
			Northern California	59	4.93
Other	292	24.39	Northern Rockies	118	9.86
No response	150	12.53	Pacific Northwest	219	18.30
			Rocky Mountain	95	7.94
Current Federal grade (GS) level			Southern	114	9.52
5-6	41	3.42	Southern California	81	6.77
7-8	132	11.03	Southwest	121	10.11
9-10	132	11.03	Western Great Basin	49	4.09
11-12	352	29.41	Other	30	2.51
13-15	381	31.83	No response	147	12.28
SES	3	0.25			
Other	10	0.84			
No response	146	12.20			

the fact that a significant number of respondents did not complete the survey and therefore gave no response. Because we targeted respondents in decision-making roles, the majority of respondents had Federal grade (GS) levels of 11 to 15. We received responses from a variety of geographic areas, particularly the Pacific Northwest. Respondents were primarily fire managers with suppression and/or operations foci and agency administrators; however, many respondents specified their position as "Other," which can include a variety of position descriptions.

Preliminary Results

Results from Attitudinal Questions

Figure 1 provides respondents' attitudes toward a series of statements regarding wildfire management. The figure indicates that a majority of respondents disagreed that risk to aviation and ground-based personnel can be eliminated through operational risk mitigation, and that respondents generally agreed that increased exposure tends to lead to greater probability of an injury or fatality. Nearly 59% of respondents agreed that agency administrators appropriately weight firefighter exposure relative to values protected.

Managers generally supported conventional notions of risk management. About 63% of respondents agreed that the cost of an incident is an outcome of risk management decisions, and 65.4% of respondents said they believed that probability of success should be considered when determining whether to protect homes and private property from wildfire. Indeed, slightly more respondents agreed (43%) than disagreed (35%) that "Agency leadership supports appropriate risk-based decisions in the field, even when those decisions sometimes lead to bad fire management outcomes." Almost half of respondents disagreed that "aggressive suppression strategies are typically the most effective way to minimize damage while limiting fire fighter exposure." Despite these views, about 48% of respondents disagreed that "Incident managers only staff fires to the degree those resources can be efficiently utilized to meet established objectives."

Respondents appeared to believe that community expectations with respect to wildfire management are somewhat unreasonable. About 79% of respondents agreed that "meeting community and partner expectations frequently requires higher levels of suppression effort than would otherwise be necessary." However, a substantially greater number of respondents agreed that Federal agencies do a good job managing community wildfire management expectations during wildfire incidents (62%) than agreed Federal agencies do a good job managing community expectations before wildfire incidents (33%).

Figure 1—Degree of agreement and disagreement with fire management statements.

Although 43% of respondents agreed that "current fire management objectives overemphasize protection of private property," responses to several other statements indicated that respondents generally felt that private property owners should take greater responsibility for protecting their property. More than 81% of respondents strongly agreed that it is the responsibility of individual private landowners to take actions that reduce the risk of fire on their property, and 62% of respondents disagreed that it is the responsibility of Federal agencies to invest in large-scale suppression efforts to protect private property within fire-prone areas. Interestingly, despite these strong results, respondents were relatively evenly split on whether "the potential effects of fires on ecological values should be given equal weight with private property values when deciding how to manage a wildland fire."

Figure 2 provides results from a question asking fire managers to rank a series of factors in terms of importance to fire management decision-making. More than 94% of respondents ranked safety of firefighting personnel as the most important factor. Protection of private property was most often listed as the second most important factor. Opinions varied somewhat regarding the importance of the remaining factors, but total cost of suppression efforts was most often listed as the least important factor in fire management decision-making.

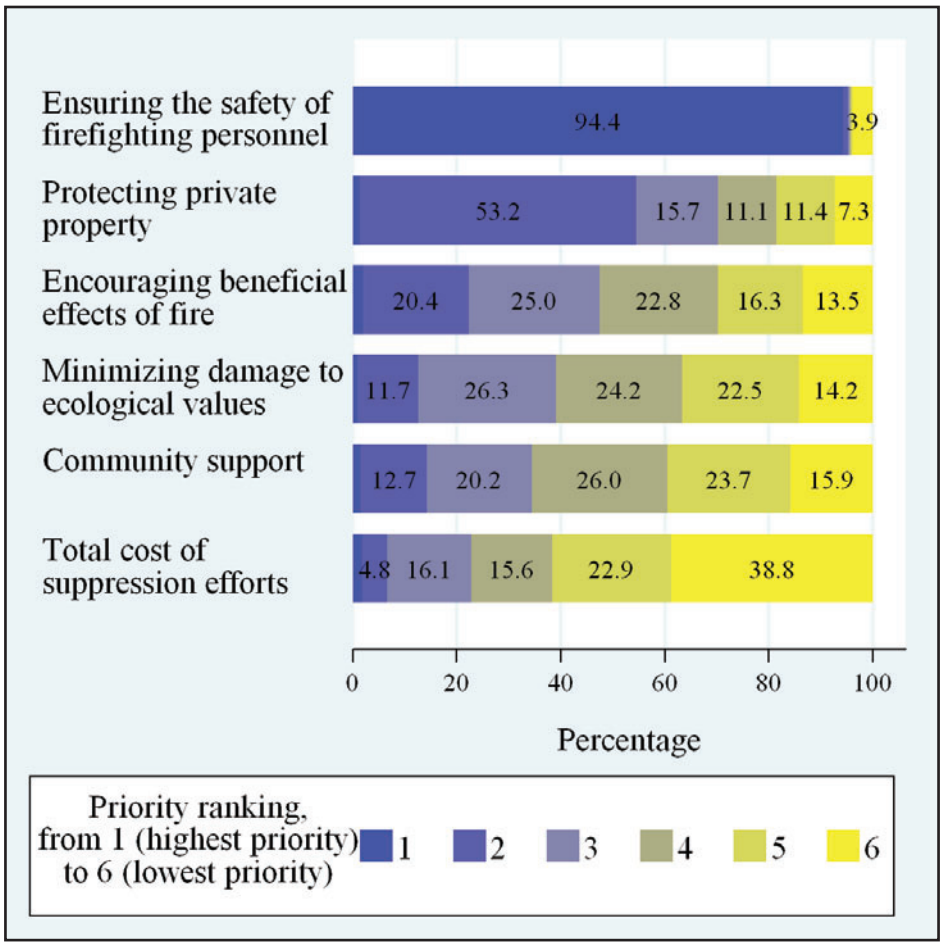

Figure 2—Relative rankings of fire management priorities.

Figure 3 shows respondents' attitudes toward a series of statements regarding risk and uncertainty in the household financial context and in the fire management context. We asked fire managers to respond to statements about risk in both these contexts because (1) we were interested in how well managers' understanding of their attitudes toward risk mapped to their fire management strategy choices later in the survey; and (2) we were interested in how personal risk preferences, as indicated in responses to these statements and in the Holt-Laury lottery task (described below), related to attitudes toward risk in the professional context. We have yet to explore these questions fully, but preliminary results indicate that most fire managers are at least somewhat risk-averse. This is not altogether surprising since previous studies have indicated that risk aversion is very common. Interestingly though, attitudes toward risk differed somewhat across the household financial and fire management contexts. More managers agreed that they are risk-averse and prefer certainty to uncertainty in the household financial context than in the fire management context, though slightly more managers indicated that they would be willing to take higher risks to achieve better outcomes in the household financial context than in the fire management context. Also of interest is that in both the household and professional contexts, more respondents indicated strong preferences for certainty than those who identified strongly as risk-averse.

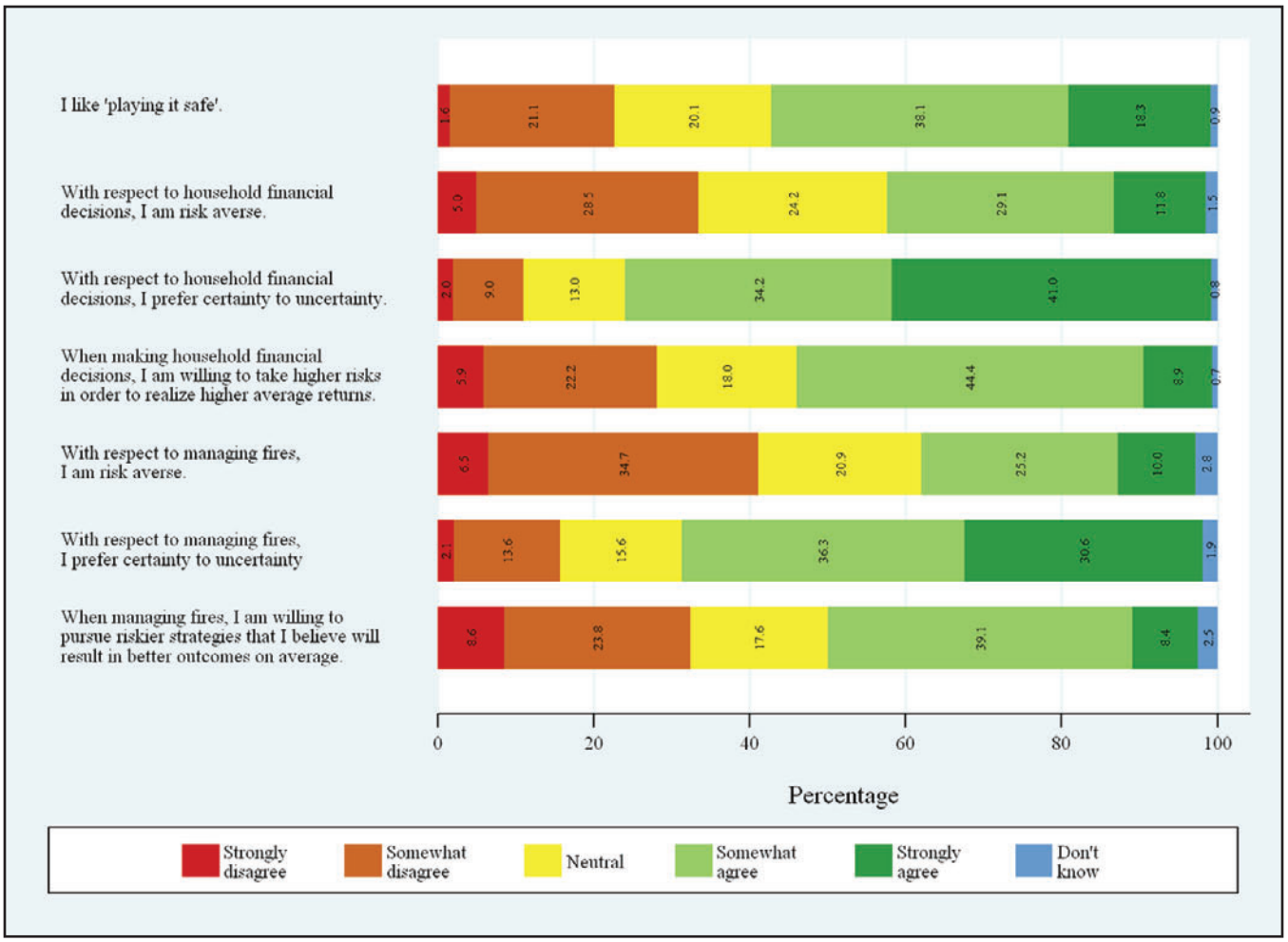

Figure 3—Degree of agreement and disagreement with risk attitude statements.

Holt-Laury Experiment Results

In the lottery experiment of Holt and Laury (2002), respondents are asked to select their preferred gamble from a series of pairs, each of which is described in Table 2. Pay-offs for both options remained the same throughout the experiment, but the probability that the respondent would win either gamble increased over the series of choices. As the probability of winning each gamble increased, the expected value of the risky option, which has a better up-side but a worse down-side than the safe option, increased relative to the expected value of Option A. Economic theory defines a risk-neutral person to be someone who will always prefer the gamble with a higher expected value. Therefore, looking at the third column in Table 2, a risk-neutral person will choose Option A in rows 1 through 4 and choose Option B in rows 5 through 10. The extent that respondents vary from this response pattern reveals whether they are more risk-averse or risk-seeking.

We asked respondents to complete the Holt-Laury experiment, but with hypothetical payoffs, in order to test managers' personal risk preferences and the degree to which they correspond or diverge from the managerial risk preferences revealed in the fire management lottery experiment. Half of respondents were assigned a "5x" version of Holt-Laury experiment in which hypothetical winnings for both lottery options were multiplied by five. For example, in this version, Option A provided a 10% chance of winning $10 and a 90% chance of winning $8 in the first row. The remaining respondents received a "60x" version of the Holt-Laury experiment. The sizes of the gambles were varied to test whether respondents demonstrated more or less risk aversion when the magnitude of the gambles offered increased.

Table 2—Lottery choices in the Holt-Laury task, adapted from Holt and Laury (2002).

Option A	Option B	Difference between expected payoffs of options A and B
10% of $2.00, 90% of $1.60	10% of $3.85, 90% of $0.10	$1.17
20% of $2.00, 80% of $1.60	20% of $3.85, 80% of $0.10	$0.83
30% of $2.00, 70% of $1.60	30% of $3.85, 70% of $0.10	$0.50
40% of $2.00, 60% of $1.60	40% of $3.85, 60% of $0.10	$0.16
50% of $2.00, 50% of $1.60	50% of $3.85, 50% of $0.10	-$0.18
60% of $2.00, 40% of $1.60	60% of $3.85, 40% of $0.10	-$0.51
70% of $2.00, 30% of $1.60	70% of $3.85, 30% of $0.10	-$0.85
80% of $2.00, 20% of $1.60	80% of $3.85, 20% of $0.10	-$1.18
90% of $2.00, 10% of $1.60	90% of $3.85, 10% of $0.10	-$1.52
100% of $2.00, 0% of $1.60	100% of $3.85, 0% of $0.10	-$1.85

Figure 4 summarizes results from the Holt-Laury experiment. As the probability that respondents would win each gamble increased, their propensity to select Option B also increased. The shapes of the curves indicate that many respondents began selecting Option B after row 5, signifying some level of risk aversion. On the other hand, a significant number of respondents selected Option B prior to row 5, which is consistent with risk-seeking behavior. Patterns of response were similar to those found by Holt and Laury in the first iteration of this experiment, which suggests that fire managers may not have personal risk preferences that differ substantially from those of the general population. Further, the red line in Figure 4 lies above the blue line for most of its length. This suggests that managers were more risk averse over large-magnitude gambles than over small-magnitude gambles, which is consistent with results found by Holt and Laury.

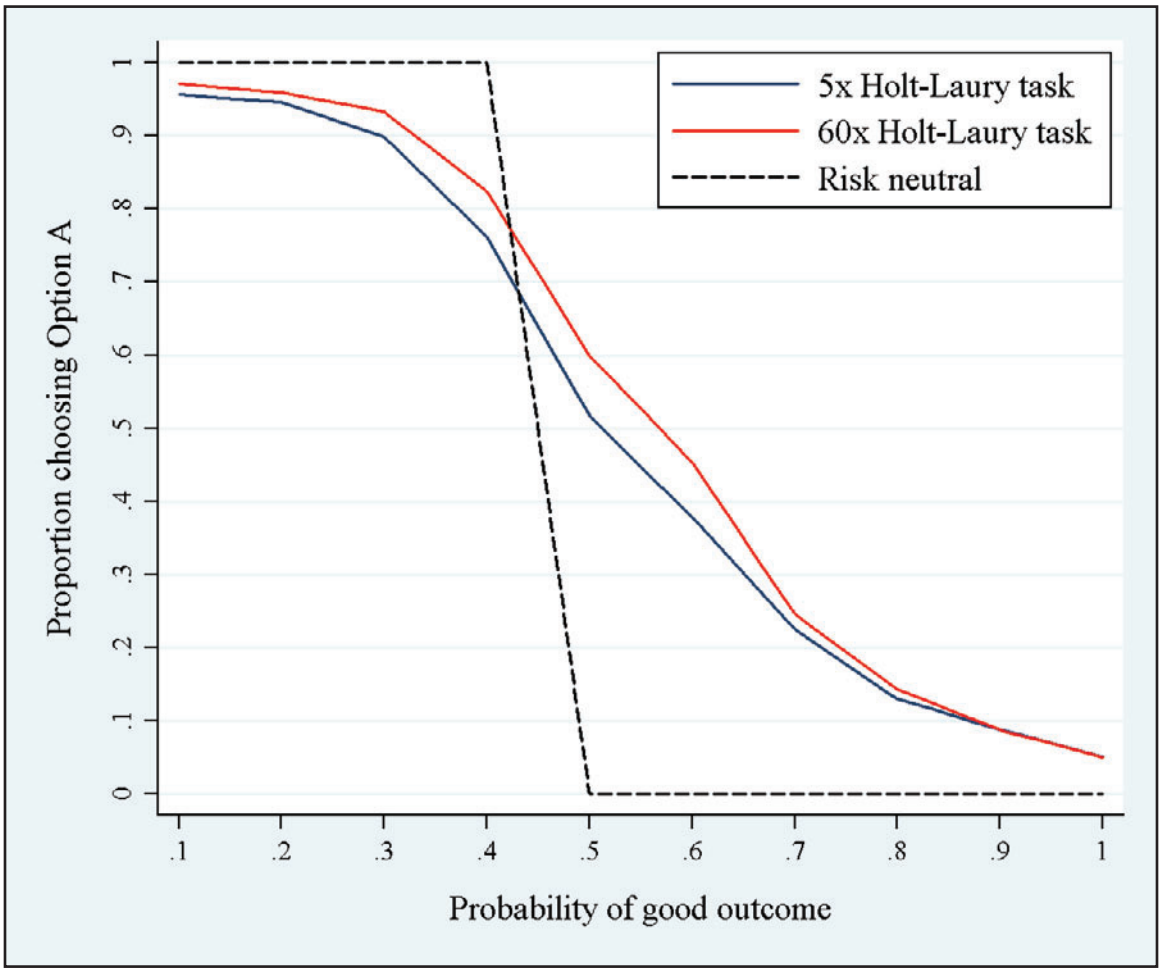

Figure 4—Responses to Holt-Laury lottery experiment.

Fire Management Lottery Experiment Results

We extended the Holt-Laury design to choices with multiple attributes in the fire management context using a fire management lottery choice experiment in which we presented managers with a hypothetical wildfire management scenario (see Appendix A) and asked them to indicate their preferred management strategy from a series of paired fire management lotteries. Each pair, which we refer to as a "choice set," offered a relatively "safe" strategy and a relatively "risky" strategy. Under the safe strategy, the hypothetical wildfire could be contained with reasonable assurance of success through moderate use of suppression resources and only moderate damage to private property, though the specific outcomes of this strategy would vary probabilistically. Under the risky strategy, the wildfire would be monitored and would probably result in a fire that would do only slightly greater damage to private property and require far fewer suppression resources, including less aviation personnel exposure to potential hazards. However, the risky strategy involved some possibility that extreme fire weather would result in a large and damaging fire, which would require heavy use of suppression resources.

Potential outcomes to each of the attributes under both the safe and risky strategies are given in Table 3. Across the choice sets seen by each respondent, good and bad outcomes under the safe strategy and good outcomes under the risky strategy were held constant. However, the risky strategy's bad outcomes were varied systematically using an experimental design to enable examination of the trade-offs managers were willing to make over potential outcomes to private property, aviation personnel exposure, and suppression cost, and to enable examination of managers' risk preferences over these various attributes. We also varied the probabilities of each strategy achieving its good and bad outcomes. Using the same design as the Holt-Laury experiment, the probability of achieving the good outcome was the same for each choice set's safe and risky strategy. Across our choice sets, strategies achieved their good outcomes with probabilities of .7, .85, .9, .95, .98, and .995, while bad outcomes were assigned complementary probabilities.

Table 3—Potential outcomes of safe and risky strategies used in the experimental design.

	Safe		Risky	
Attribute	**Good**	**Bad**	**Good**	**Bad[a]**
Aviation exposure	50 hours	75 hours	10 hours	300 hours 1200 hours
Private property damage	$600,000	$1.25 million	$700,000	$3 million $14 million
Suppression cost	$300,000	$500,000	$25,000	$2 million $12.5 million

[a]Each attribute has two potential bad outcomes under the risky strategy. Bad outcomes to the attributes, and the probability the bad outcome would result, were varied systematically among the choice sets using an experimental design.

Half of the surveyed sample (called the "control group") received a version of the survey where aviation exposure was given in aviation person-hours. USFS statistics indicated that over the past 10 years, the agency has experienced 4.801 fatalities in every 100,000 flight hours (U.S. Forest Service 2010). We used this average historical fatality rate to calculate expected frequencies of fatalities on fires requiring the given levels of aviation exposure. The remaining sample (called the "treatment group") received a version of the survey with aviation exposure described in terms of these expected frequencies (see Appendix B). Aviation exposure attribute levels provided to the control group and the corresponding treatment group levels are given in Table 4. Both the control group and treatment group were presented with the 10-year average USFS aviation fatality rate in the fire management lottery experiment instructions.

An example treatment group choice set is provided in Figure 5. Respondents were asked to select the strategy they would most likely choose if actually faced with the choices offered to them in the choice set. We asked every respondent to complete eight strategy choice sets.

Table 4—Treatment group aviation exposure attribute levels, by corresponding control group attribute level.

Control group	Treatment group
10 hours	0.5 deaths in 1000 fires
50 hours	2.4 deaths in 1000 fires
75 hours	3.6 deaths in 1000 fires
300 hours	14 deaths in 1000 fires
1200 hours	58 deaths in 1000 fires

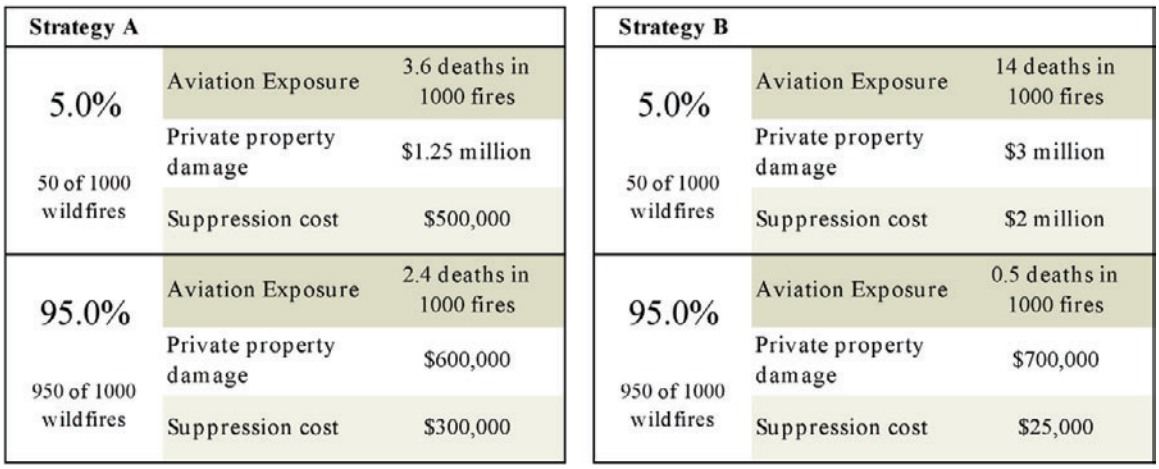

Figure 5—Example fire management lottery experiment choice set from treatment group.

Limited summaries of results from this experiment are presented in Tables 5 and 6. Table 5 shows that as the probability that each strategy would achieve its preferred outcome increased, respondents were more willing to select the risky alternative. Interestingly, respondents in the treatment group were consistently less willing to select the risky option; that is, respondents were less willing to risk a larger wildfire when presented with information on the expected odds of a fatality, based on historical USFS statistics, on such a fire. Differences between the control and treatment groups are substantial enough to suggest that the way aviation exposure information is presented to fire managers can influence preferences and decision-making on wildfire events. However, it should be noted that Table 5 over-simplifies results from this experiment. Table 5 presents percentages of respondents selecting Option B, the risky strategy, but potential outcomes under Option B were not consistent across choice sets. Rather, we varied the risky strategy's bad outcomes to the three attributes using an experimental design so we would be able to measure relative preferences over outcome attributes and risk. These variations are obscured in Table 5 and will require more thorough analysis.

Table 5—Percentage of respondents selecting Option B by probability of good outcome and exposure frame.

Probability of good outcome	Control group	Treatment group
.7	30.09	24.55
.85	50.63	41.81
.9	58.95	51.01
.95	66.25	58.05
.98	70.82	67.37
.995	75.42	70.14

Table 6—Percentage of respondents selecting Option B by attribute outcomes under the risky strategy's bad outcome and by exposure frame.

Risky strategy bad outcome	Control group	Treatment group
Aviation exposure		
300 hours/14 deaths in 1000 fires	62.58	56.77
1200 hours/58 deaths in 1000 fires	58.06	48.62
Private property damage		
$3 million	63.20	57.47
$14 million	53.32	52.08
Suppression cost		
$2 million	62.01	51.94
$12.5 million	58.64	53.47

Table 6 indicates that, in general, as the risky strategy's bad outcomes for each of the three attributes became increasingly worse, the percentage of managers willing to select the risky alternative decreased. However, the percentage of managers selecting the risky strategy under each potential attribute outcome varied across the control and treatment groups. Tellingly, respondents in the treatment group were uniformly less likely than control group respondents to select the risky alternative. Further, respondents in the control frame were more sensitive to the potential outcomes for private property damage and suppression cost than respondents in the treatment frame. However, the disclaimer applied to Table 5 also applies here—Table 6 obscures how probabilities of each strategy's bad outcome and how other attributes potential outcomes were experimentally varied across choice sets.

Discussion

A stated preference choice experiment survey of Federal wildfire managers conducted in 2009 indicated that personnel exposure was not a primary determinant of managers' preferences over suppression strategies (Calkin and others). In the time since that study, the USFS has increased the emphasis it places on personnel safety. Though our present results cannot be directly compared with those of the earlier study, they suggest that USFS managers have assimilated this message. Fire managers consistently ranked the safety of firefighting personnel as their top concern when deciding upon fire management strategies. Respondents, especially in the fire management lottery experiment treatment group, were sensitive to potential consequences for aviation exposure and were typically sensitive to potential consequences for private property damage and suppression cost. Treatment group respondents were less likely to select the risky option in general, but they were less sensitive to the magnitude of potential consequences for private property damage and suppression cost. More detailed analysis is necessary to indicate whether this reflects a greater degree of risk-aversion with respect to aviation exposure within the treatment frame, or a lesser degree of risk-seeking, and to reveal the roles of managers' relative risk preferences and preferences over the three attributes in determining decision-making in this experiment. Future work will explore the potential for integration of knowledge from this and other studies into the decision support available to Federal wildfire managers in order to improve risk management and enhance personnel safety.

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Appendix A

Version 1.1.1

Federal Wildfire Manager Decision-Making

We would like to know about the factors that are important in determining managers' choices among potential fire management strategies. This information will be highly valuable in improving the efficiency of wildfire management. Your responses to this questionnaire will be kept anonymous and will be used only for statistical purposes.

This questionnaire will consist of five sections and will take approximately 45 minutes to complete. The first section asks about your attitudes related to fire management. The second section provides a short warm-up task in which you will be asked to choose between a series of lotteries. The third section describes a hypothetical wildfire management scenario followed by a series of "choice sets." In each choice set, you will be asked to choose the wildfire management strategy you would be most likely to select if faced with the given wildfire scenario. The fourth section asks about your perceptions and understanding of risk, and the fifth section asks about your demographic characteristics and level of experience in wildfire management.

Name _____

Date_____

Section 1: Attitudes Related to Wildfire Management and Risk

In this section we will ask you about your attitudes regarding risk and the management of wildland fires. There are no right or wrong answers; the best response is the one that most closely matches what you think.

Attitudes about risk

Indicate your level of agreement (from "Strongly Disagree" (1) to "Strongly Agree" (5)) with each of the following statements by checking the appropriate box for each statement.

	Strongly Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Strongly Agree	Don't know
I like "playing it safe."	1	2	3	4	5	9
With respect to **household financial decisions**, I am risk averse.	1	2	3	4	5	9
With respect to **household financial decisions**, I prefer certainty to uncertainty.	1	2	3	4	5	9
When making **household financial decisions**, I am willing to take higher risks in order to realize higher average returns.	1	2	3	4	5	9
With respect to **managing fires**, I am risk averse.	1	2	3	4	5	9
With respect to **managing fires**, I prefer certainty to uncertainty.	1	2	3	4	5	9
When **managing fires**, I am willing to pursue riskier strategies that I believe will result in better outcomes on average.	1	2	3	4	5	9

Attitudes about wildfire management

Indicate your level of agreement (from "Strongly Disagree" (1) to "Strongly Agree" (5)) with each of the following statements by checking the appropriate box for each statement.

	Strongly Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Strongly Agree	Don't know
Risks of an escaped fire associated with prescribed burning are negligible if fire managers follow established guidelines.	1	2	3	4	5	9
The benefits of prescribed burning outweigh the potential harm of an escaped prescribed fire.	1	2	3	4	5	9
A large commitment by the Forest Service to reduce heavy fuels would help reduce the need for aggressive fire suppression in the future.	1	2	3	4	5	9
The potential effects of fires on ecological values should be given equal weight with private property values when deciding how to manage a wildland fire.	1	2	3	4	5	9
The risk of an accident involving aircraft increases when the use of helicopters and air tankers on a fire increases.	1	2	3	4	5	9
The risks to pilots of helicopters and air tankers are minimal when established safety guidelines are followed.	1	2	3	4	5	9
Factors outside of a manager's control, such as the weather and fuel loads, mostly determine whether a fire can be quickly contained.	1	2	3	4	5	9
When a fire threatens homes and other private property, managers should only try to protect those structures when the probability of success is high.	1	2	3	4	5	9

	Strongly Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Strongly Agree	Don't know
Managers should not pursue an aggressive suppression strategy for a fire when the probability of damage to private property is very low.	1	2	3	4	5	9
Whether or not a fire management strategy achieves its objectives is largely determined by the actions of managers and fire crews.	1	2	3	4	5	9
Letting a fire burn, rather than aggressively suppressing a fire, is a good way to reduce the costs of managing wildland fires.	1	2	3	4	5	9
Limiting the amount of resources used to suppress a fire is likely to increase a fire's potential damage.	1	2	3	4	5	9
Limiting the amount of resources used to suppress a fire is likely to reduce the risks of injury or fatalities for firefighters.	1	2	3	4	5	9
It is the responsibility of individual private landowners to take actions that reduce the risk of fire on their property, like creating "defensible space."	1	2	3	4	5	9
It is the responsibility of the Forest Service to invest in large-scale suppression efforts to protect private property within fire-prone areas.	1	2	3	4	5	9

How important are the following factors when deciding how to manage a fire? Rank from 1 (most important) to 6 (least important) the importance of each of the following factors that you consider when choosing a management strategy:

_____ Reducing heavy fuel loads

_____ Encouraging beneficial effects of fire for wildlife habitat, plant life, and ecological values

_____ Minimizing damage to ecological values

_____ Protecting private property

_____ Ensuring the safety of firefighting personnel

_____ Total cost of suppression efforts

Section 2: Warm-up Task

To prepare you to complete the fire management choices in section 3 of this questionnaire, this section asks you to complete a series of choices between two lotteries. You will choose "Option A" and "Option B" by selecting the lottery you would prefer if your chosen lottery were being played for real money. If you choose Option A in the row shown below, you will have a 1 in 10 chance of earning $2.00 and a 9 in 10 chance of earning $1.60. Similarly, Option B offers a 1 in 10 chance of earning $3.85 and a 9 in 10 chance of earning $0.10.

Choice	Option A		Option B		I select option…
Example	10% 90%	$2.00 $1.60	10% 90%	$3.85 $0.10	☐ A ☐ B

You will complete a decision table in which each row contains a pair of choices similar to Option A and Option B. You make your choice by checking the box beside the letter denoting your preferred gamble. Only one option in each row can be selected, and you may change your decision as you wish.

Please complete the decision table below by **selecting in each row the lottery you would prefer** if your chosen lottery were being played for real money.

Choice	Option A		Option B		I select option…
1)	10% 90%	$10.00 $8.00	10% 90%	$19.25 $0.50	☐ A ☐ B
2)	20% 80%	$10.00 $8.00	20% 80%	$19.25 $0.50	☐ A ☐ B
3)	30% 70%	$10.00 $8.00	30% 70%	$19.25 $0.50	☐ A ☐ B
4)	40% 60%	$10.00 $8.00	40% 60%	$19.25 $0.50	☐ A ☐ B
5)	50% 50%	$10.00 $8.00	50% 50%	$19.25 $0.50	☐ A ☐ B
6)	60% 40%	$10.00 $8.00	60% 40%	$19.25 $0.50	☐ A ☐ B
7)	70% 30%	$10.00 $8.00	70% 30%	$19.25 $0.50	☐ A ☐ B
8)	80% 20%	$10.00 $8.00	80% 20%	$19.25 $0.50	☐ A ☐ B
9)	90% 10%	$10.00 $8.00	90% 10%	$19.25 $0.50	☐ A ☐ B
10)	100% 0%	$10.00 $8.00	100% 0%	$19.25 $0.50	☐ A ☐ B

Section 3: Wildfire Management Strategy Choices

In this section you will be asked to consider a hypothetical wildfire scenario followed by a series of "choice sets." Choice sets will consist of two alternative fire management strategies, and you will be asked to select the more appropriate management strategy. Fire management is inherently risky. Fire and fuels management professionals face risk when choosing to undertake fuels management, when choosing to manage a fire for resource benefit, and when exposing fire management staff to hazards. Therefore, in this section, each wildfire strategy you encounter will have risk associated with its potential outcomes to private property, suppression cost, and hazard to aviation personnel.

Please read the following wildfire scenario and explanations of the attributes used to describe potential outcomes of wildfire management strategies, and then complete the subsequent choice sets.

Wildfire Scenario

A fire has started on National Forest land resulting from a lightning strike. Initial and extended attack efforts have failed to contain the fire's spread, and you have been assigned to manage the response for this fire, including selecting the overall suppression strategy. The fire is currently burning at a moderate intensity in mixed timber with moderate-to-heavy fuel loads.

Over the next three to four days, the weather is forecasted to be calm. Beyond this time, the forecast is less certain, and there is the potential that extreme weather will result in a large and damaging fire. If calm weather conditions continue, the fire will likely spread slowly and help reduce heavy fuel loads in the area.

The area where the fire is burning has limited road access. Terrain is moderate to high difficulty, with varied slope and elevation. The area immediately threatened by the fire does not currently include any specially designated areas, such as critical endangered species habitat. However, a large and damaging fire would likely degrade some valuable specially designated areas and critical habitat.

The area is used for recreation (such as hiking, camping, and fishing), and some timber of commercial value is nearby. There are no large towns nearby, but the fire threatens to spread beyond the forest boundaries on to private land. Private grazing land, several residences, and outbuildings on a nearby ranch would be in the path of the fire if it expands quickly. However, residents in the area have already prepared for evacuation and there is little threat to the safety of nearby residents. Other impacts of the fire, such as potential dangers to human health from smoke, damage to critical public infrastructure, or wildlife habitat degradation, appear to be of low to moderate concern, even if the fire expands rapidly.

Attributes

Aviation exposure – Aircraft such as air tankers and helicopters are frequently used to help control wildland fires. "Aviation exposure" refers to the total number of personnel hours necessary for operating air tankers and helicopters over the course of the fire for each potential outcome.

For example:

- If a single helicopter manned by a pilot and an "overhead" personnel is used on a wildland fire incident for a total of 20 flight-hours, this incident uses a total of 40 aviation-hours.
- On average, a death resulting from an aviation accident occurs once every 21,000 aviation personnel hours. So 520 fires requiring 40 aviation-hours would result in one fatality, on average.

Consider:

- Both ground operations and aviation activities are dangerous; however, current accident rates indicate that aviation poses greater risk to firefighters than ground-based activities.
- Increasing the use of aircraft can accelerate containment and prevent further damage from the fire, but also carries the risk of injuries and fatalities for flight crews.
- Median personnel hours used for combined air tankers and helicopters was approximately 40 hours per fire in recent years, meaning that half of fires used less personnel time for aviation, and half of fires used more.

Suppression costs – Managing wildland fires costs money. The suppression cost of a strategy's outcome is the total cost of suppression and post-fire emergency response to taxpayers (including federal, state, and local costs). These costs include payments for aviation activity, ground crews, engines, and overhead.

Consider:

- Costs increase in proportion to the use of ground resources. If more crews and other resources are used on a wildland fire incident, the final suppression costs of that fire will be higher.
- The median total suppression cost of USFS fires over 300 acres is about $250,000, meaning that half of the fires cost more than $250,000, and half cost less than $250,000.
- Since 2009, the total USFS budget for fire suppression (excluding other fire-related activities, such as rehabilitation and hazardous fuels treatments) has been between $1.0 billion and $1.4 billion per year.

Private property damage – Wildland fires can damage private property, including private homes, businesses, farm and ranch land, and other infrastructure (such as telecommunications equipment). "Private property damage" refers to the total dollar value of damage to private property caused by the fire for each potential fire outcome.

Consider:

- Extreme fires that burn uncontrolled will cause more private property damage than fires that are controlled with suppression or that are less severe due to favorable conditions.
- Since 2000, wildland fires have caused an average of $484 million of private property damage per year.
- Most wildland fires cause little or no damage to private property, but a small number of fires can cause large losses to private property. For example, the 2010 Fourmile Canyon fire in Colorado caused an estimated $217 million in damage. In 2007, several fires in Southern California destroyed over 3,300 homes and caused $1.8 billion in damage.

Outcome probability –"Outcome probability" represents the chance that a fire management strategy will achieve a particular outcome. The outcomes of a given wildfire management strategy are seldom known with certainty. How large and damaging a wildfire turns out to be is determined in part by fire management and in part by chance or by factors outside the control of fire managers (like the weather).

For example:

- The probability that a fire crosses a ridge and damages homes may be predicted to be 0.70. This means that 7 times out of 10 a similar fire would damage the homes, and 3 times out of 10 it would stop spreading and not damage the homes.
- A probability of 0.50 indicates that each outcome is equally likely to occur, like flipping a coin.

Consider:

- For the purposes of the choices you make below, assume that outcome probabilities are generated with state-of-the-art wildfire risk assessment models.

Example

For the fire scenario described above, there are a number of potential wildfire management strategies that might be used. We will ask you to make a series of choices between two potential wildfire management strategies. As in the warm-up task, each option will have two potential outcomes, and the chance that each outcome will occur will be given as a probability. The figure below provides an example.

Option A			Option B		
70.0%	Personnel Exposure	50 hours	70.0%	Personnel Exposure	10 hours
	Private property damage	$600,000		Private property damage	$700,000
700 of 1000 wildfires	Suppression cost	$300,000	700 of 1000 wildfires	Suppression cost	$25,000
30.0%	Personnel Exposure	75 hours	30.0%	Personnel Exposure	150 hours
	Private property damage	$1.25 million		Private property damage	$2 million
300 of 1000 wildfires	Suppression cost	$500,000	300 of 1000 wildfires	Suppression cost	$1.5 million
I select...		Option A ☐			Option B ☐

EXAMPLE

If you check the box marked Option A in the final row, there will be a 70% probability that fire suppression will require 50 hours of aviation exposure and cost $600,000, and that it will cause $300,000 in private property damage. However, there is a 30% probability fire suppression will require 75 hours of aviation exposure and cost $1.25 million, and that it will cause $500,000 in private property damage. If you select Option B, there will be a 70% probability that the fire will require fewer aviation-hours, cost less, but do only slightly more damage to private property than in either of the potential outcomes if Option A is chosen. However, there is a 30% probability that substantially worse outcomes for the three attributes will result.

Choice Sets

For the following 8 choice sets, **please select the fire management strategy you expect you would be more likely to choose if actually faced with the wildfire scenario described above.**

Choice 1

Option A			**Option B**		
99.5% 995 of 1000 wildfires	Aviation Exposure	50 hours	99.5% 995 of 1000 wildfires	Aviation Exposure	10 hours
	Private property damage	$600,000		Private property damage	$700,000
	Suppression cost	$300,000		Suppression cost	$25,000
0.5% 5 of 1000 wildfires	Aviation Exposure	75 hours	0.5% 5 of 1000 wildfires	Aviation Exposure	300 hours
	Private property damage	$1.25 million		Private property damage	$14 million
	Suppression cost	$500,000		Suppression cost	$2 million
I select…	Option A ☐			Option B ☐	

Choice 2

Option A			**Option B**		
99.0% 990 of 1000 wildfires	Aviation Exposure	50 hours	99.0% 990 of 1000 wildfires	Aviation Exposure	10 hours
	Private property damage	$600,000		Private property damage	$700,000
	Suppression cost	$300,000		Suppression cost	$25,000
1.0% 10 of 1000 wildfires	Aviation Exposure	75 hours	1.0% 10 of 1000 wildfires	Aviation Exposure	1200 hours
	Private property damage	$1.25 million		Private property damage	$3 million
	Suppression cost	$500,000		Suppression cost	$2 million
I select…	Option A ☐			Option B ☐	

Choice 3

Option A			Option B		
97.5%	Aviation Exposure	50 hours	97.5%	Aviation Exposure	10 hours
975 of 1000 wildfires	Private property damage	$600,000	975 of 1000 wildfires	Private property damage	$700,000
	Suppression cost	$300,000		Suppression cost	$25,000
2.5%	Aviation Exposure	75 hours	2.5%	Aviation Exposure	300 hours
25 of 1000 wildfires	Private property damage	$1.25 million	25 of 1000 wildfires	Private property damage	$3 million
	Suppression cost	$500,000		Suppression cost	$2 million
I select…	Option A ☐			Option B ☐	

Choice 4

Option A			Option B		
87.5%	Aviation Exposure	50 hours	87.5%	Aviation Exposure	10 hours
875 of 1000 wildfires	Private property damage	$600,000	875 of 1000 wildfires	Private property damage	$700,000
	Suppression cost	$300,000		Suppression cost	$25,000
12.5%	Aviation Exposure	75 hours	12.5%	Aviation Exposure	1200 hours
125 of 1000 wildfires	Private property damage	$1.25 million	125 of 1000 wildfires	Private property damage	$14 million
	Suppression cost	$500,000		Suppression cost	$12.5 million
I select…	Option A ☐			Option B ☐	

Choice 5

Option A			Option B		
80.0%	Aviation Exposure	50 hours	80.0%	Aviation Exposure	10 hours
	Private property damage	$600,000		Private property damage	$700,000
800 of 1000 wildfires	Suppression cost	$300,000	800 of 1000 wildfires	Suppression cost	$25,000
20.0%	Aviation Exposure	75 hours	20.0%	Aviation Exposure	1200 hours
	Private property damage	$1.25 million		Private property damage	$3 million
200 of 1000 wildfires	Suppression cost	$500,000	200 of 1000 wildfires	Suppression cost	$12.5 million
I select…		Option A ☐			Option B ☐

Choice 6

Option A			Option B		
99.9%	Aviation Exposure	50 hours	99.9%	Aviation Exposure	10 hours
	Private property damage	$600,000		Private property damage	$700,000
999 of 1000 wildfires	Suppression cost	$300,000	999 of 1000 wildfires	Suppression cost	$25,000
0.1%	Aviation Exposure	75 hours	0.1%	Aviation Exposure	300 hours
	Private property damage	$1.25 million		Private property damage	$14 million
1 of 1000 wildfires	Suppression cost	$500,000	1 of 1000 wildfires	Suppression cost	$12.5 million
I select…		Option A ☐			Option B ☐

Choice 7

Option A			Option B		
92.5%	Aviation Exposure	50 hours	92.5%	Aviation Exposure	10 hours
	Private property damage	$600,000		Private property damage	$700,000
925 of 1000 wildfires	Suppression cost	$300,000	925 of 1000 wildfires	Suppression cost	$25,000
7.5%	Aviation Exposure	75 hours	7.5%	Aviation Exposure	300 hours
	Private property damage	$1.25 million		Private property damage	$3 million
75 of 1000 wildfires	Suppression cost	$500,000	75 of 1000 wildfires	Suppression cost	$2 million
I select…		Option A ☐			Option B ☐

Choice 8

Option A			Option B		
95.0%	Aviation Exposure	50 hours	95.0%	Aviation Exposure	10 hours
	Private property damage	$600,000		Private property damage	$700,000
950 of 1000 wildfires	Suppression cost	$300,000	950 of 1000 wildfires	Suppression cost	$25,000
5.0%	Aviation Exposure	75 hours	5.0%	Aviation Exposure	1200 hours
	Private property damage	$1.25 million		Private property damage	$14 million
50 of 1000 wildfires	Suppression cost	$500,000	50 of 1000 wildfires	Suppression cost	$12.5 million
I select…		Option A ☐			Option B ☐

Section 4: Questions regarding perceptions of risk

Wildland fires involve risk and uncertainty, and they require managers to make judgments about how to respond in risky situations. This section asks questions about how you understand and respond to probabilities and risk. Remember, your answers are confidential and will not be associated with any personally identifiable information.

Write the correct answer in the space provided, or circle the letter beside the correct answer if the question is multiple choice. Do not use a calculator.

1. In the BIG BUCKS LOTTERY, the chance of winning a $10.00 prize is 1%. What is your best guess about how many people would win a $10.00 prize if 5,000 people each buy a single ticket to BIG BUCKS?

   _____

2. In the ACME PUBLISHING SWEEPSTAKES, the chance of winning a car is 1 in 1,000. What percent of tickets to ACME PUBLISHING SWEEPSTAKES will win a car?

   _____

3. Imagine that we rolled a fair, ten-sided die 1,000 times. Out of 1,000 rolls, how many times do you think the die would come up even (2, 4, 6, 8, or 10)?

   _____

4. Imagine that we rolled two fair, ten-sided dice 1,000 times. Out of 1,000 rolls, how many times do you think **both** would come up even (2, 4, 6, 8, or 10)?

   _____

5. Imagine that we rolled two fair, ten-sided dice 1,000 times. Out of 1,000 rolls, how many times do you think **either**: (1) both will come up ones **or** (2) both will come up tens?

   _____

6. Which of the following numbers represents the biggest risk of getting a disease?
   a) 1 in 100
   b) 40 in 5000
   c) 5 in 400

7. If Person A's risk of getting a disease is 1% in ten years, and Person B's risk is double that of A's, what is B's risk?

   _____

8. If the chance of getting a disease is 10%, how many people would be expected to get the disease:

   A: Out of 50 people?

   _____

   B: Out of 850 people?

   _____

9. If the chance of getting a disease is 20 out of 500, this would be the same as having a ___% chance of getting the disease.

   _____

10. The chance of getting a viral infection is .0005. Out of 10,000 people, about how many people are expected to get infected?

    _____

Section 5: Tell us about yourself

Please complete the following questions:

1. Are you:

☐ Male

☐ Female

2. What year were you born?

1 9 ___ ___

3. Are you Hispanic or Latino(a)?

☐ No

☐ Yes

4. With which racial group(s) do you most closely identify? Select one or more:

☐ American Indian/Alaskan Native

☐ Asian

☐ Black/African American

☐ Native Hawaiian or other Pacific Islander

☐ White

5. What is the highest level of schooling you have completed?

- ☐ Fourth grade or less
- ☐ 5th through 8th grades
- ☐ 9th through 11th grades
- ☐ 12th grade, no diploma
- ☐ High-school graduate (including GED)
- ☐ Some college
- ☐ Associate's degree
- ☐ Bachelor's degree
- ☐ Graduate or professional degree

6. How long have you worked with federal land management agencies?

- ☐ 0-4 years
- ☐ 5-9 years
- ☐ 10-14 years
- ☐ 15-19 years
- ☐ 20-29 years
- ☐ 30 or more years

7. What is your current Grade level?

- ☐ 5-6
- ☐ 7-8
- ☐ 9-10
- ☐ 11-12
- ☐ 13-15
- ☐ SES
- ☐ Other

8. For which federal agency do you currently work?

- ☐ FS
- ☐ BIA
- ☐ BLM
- ☐ NPS
- ☐ FWS
- ☐ Interagency

9. Which of the following most closely describes your current position?

- ☐ Agency administrator
- ☐ Fire manager (fuels/fire use focus)
- ☐ Fire manager (suppression/operations focus)
- ☐ Other (please specify) _____

10. On how many wildfire incidents have you been involved as a firefighter?

- ☐ 0
- ☐ 1-5
- ☐ 6-10
- ☐ 11-15
- ☐ 16-25
- ☐ More than 25

11. On how many large fires (> 300 acres) have you had management responsibilities?

- ☐ 0
- ☐ 1-5
- ☐ 6-10
- ☐ 11-15
- ☐ 16-25
- ☐ More than 25

12. Have you ever been involved in a wildfire incident on which there was a fatality?

- ☐ Yes
- ☐ No

If yes, was the fatality (or at least one of the fatalities, if you have been involved in multiple incidents involving fatalities) related to the use of aviation resources?

- ☐ Yes
- ☐ No

Section 5: Debriefing Questions [Pre-test Only]

For the following statements, please indicate your degree of agreement by checking one box for each statement:

	Strongly Disagree	Somewhat Disagree	Neutral	Somewhat Agree	Strongly Agree	Don't know
I do not think the wildland fire scenario presented in section 3 was realistic.	1	2	3	4	5	9
I do not think the choices among fire management strategies in section 3 were realistic.	1	2	3	4	5	9
I do not think the dollar values for **private property damage** in section 3 were realistic.	1	2	3	4	5	9
I think the probabilities of each of the management strategy outcomes in section 3 were within a reasonable range.	1	2	3	4	5	9
I do not believe that outcome probabilities can be known with as much accuracy as was presented in the survey questions.	1	2	3	4	5	9
The fire outcomes described in the choice sets were not believable.	1	2	3	4	5	9
I primarily considered the **worst-case scenario** outcomes while completing choice sets in section 3.	1	2	3	4	5	9
I primarily considered the **best-case scenario** outcomes while completing choice sets in section 3.	1	2	3	4	5	9
I considered possible outcomes to **each of the attributes** and the **probabilities** of those outcomes while completing choice sets in section 3.	1	2	3	4	5	9
I found the survey confusing.	1	2	3	4	5	9
The survey was biased.	1	2	3	4	5	9

Please rank from 1 (most important) to 3 (least important) the importance you placed on each of the following attributes in determining your choices of fire management strategies in section 3.

_____ Aviation exposure

_____ Private property damage

_____ Suppression costs

For the following questions, please write your answers in the space provided.

1) Did you find the instructions to sections 2 and 3 easy to understand? If not, what did you find confusing?

2) About how long did it take you to complete the choice sets in section 2? Did you find the choices presented to be difficult?

3) Please describe the decision process you used to complete the choice sets in section 2. How did you decide what was an acceptable probability at which to select option B?

Thank you for completing the questionnaire!

Appendix B

Example of a survey question (from the web-based survey) to illustrate how the experimental treatments were presented.

Section 3: Wildfire Management Strategy Choices

Please select from the following two strategies the fire management strategy you would be more likely to actually choose if faced with the wildfire scenario described above.

Strategy A			Strategy B		
99.5% 995 of 1000 wildfires	Aviation Exposure	2.4 deaths in 1000 fires	99.5% 995 of 1000 wildfires	Aviation Exposure	0.5 deaths in 1000 fires
	Private property damage	$600,000		Private property damage	$700,000
	Suppression cost	$300,000		Suppression cost	$25,000
0.5% 5 of 1000 wildfires	Aviation Exposure	3.6 deaths in 1000 fires	0.5% 5 of 1000 wildfires	Aviation Exposure	58 deaths in 1000 fires
	Private property damage	$1.25 million		Private property damage	$14 million
	Suppression cost	$500,000		Suppression cost	$2 million

I select:

- ○ Strategy A
- ○ Strategy B

Prev Next

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