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Developing A Prescribed Fire Insurance Liability Product:
Actuarial Analysis of Survey Data

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Executive Summary

This report was generated for the project "Developing A Prescribed Fire Insurance Liability Product" funded by the U.S. Department of Agriculture's Risk Management Agency. The Iowa Department of Natural Resources Bureau of Forestry managed project funding, with Agren, Inc. coordinating most project activities. The desired project outcome is development of a prescribed fire liability policy for private contractors conducting prescribed burns provided by private insurance companies. To achieve this outcome, this report summarizes project data and statistical analysis and describes the data files available for use by those wishing to conduct their own analysis of the data.

Major project activities included a mail survey of prescribed burners in several states, a follow-up telephone survey of those prescribed burners reporting escapes, and a summary and analysis these survey data to develop initial estimates of premiums for a prescribed fire liability policy. This report contains extensive summaries of the mail and telephone surveys, including the "typical" prescribed burner and prescribed fire escape. Analysis includes a statistical model estimating the expected number of prescribed fire escapes for a prescribed burner and another statistical model estimating the expected property damage for an escape, including the characteristics of prescribed burners at higher risk for escapes and property damage. These models are then combined to develop an estimate of the actuarially fair premium for a prescribed fire liability policy based on the characteristics of a prescribed burner, including a spreadsheet to perform calculations needed to estimate premiums based on these statistical models. Several caveats for these premiums are explained, including summaries of supplementary data on catastrophic losses from an informal survey of state foresters and on liability insurance expectations of prescribed burners from focus groups. Finally, descriptions of the spreadsheets providing project data from the two surveys are provided, along with copies of survey instruments, to facilitate use of project data by others who want to conduct their own analysis.

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Introduction

Fires have historically been an important component affecting ecosystems. However, nearly a century of federal fire policies to suppress and prevent fires on wildlands, coupled with the lack of planned (prescribed) burning, has substantially increased the amount of both living and dead fuels on much of the public and private land in the U.S. An estimated 190 million acres of federal forest land and rangeland in the U.S. face high risk of catastrophic fire due to hazardous level of fuels accumulation and more than 107 million acres of non-federal lands are classified in the Historical Fire Regime Condition Class 3, the most altered from natural fire frequency (Schmidt et al. 2002). The increased fuel loading has ultimately led to an increased risk of wildfires and the associated destruction of public and private property and injury and loss of life.

Prescribed fire is a primary tool to reduce these hazardous fuel accumulations. Resource managers have learned to use fire to cause changes in ecosystems to meet their objectives. Prescribed burning is fire applied in a knowledgeable manner on a specific land area under selected weather conditions to accomplish predetermined, well-defined management objectives (Wade and Lunsford 1988). Prescribed fire is more affordable with much less risk to the habitat and destruction of site and soil quality than chemical or mechanical methods. Hence, the 2003 Healthy Forests Restoration Act mandates the use of prescribed burning and thinning on federal lands to reduce fuel loads that promote catastrophic fires (USDA-Forest Service 2006). No comparable program exists for private lands.

According to a recent study, the fear of liability is as the most significant barrier to the application of prescribed fire by private landowners. Risk and liability concerns have decreased private consultants' and contractors' willingness to conduct prescribed burns. Liability insurance covering prescribed fire is not readily available to the private sector and liability concern has forced many small private businesses to discontinue their prescribed fire services. This problem limits additional resources for prescribed burning on federal lands and diminishes prescribed burning on private lands. The primary risk for prescribed fire is that the prescribed fire will escape from its intended boundaries and cause property damage or personal injury before the escaped fire is extinguished.

In an effort to address the needs of private contractors and reduce their liability risks associated with conducting prescribed burns, the Iowa Department of Natural Resources Bureau of Forestry proposes to develop a risk management tool in the form of a liability insurance product and to make project data available for others to use for similar purposes. This report summarizes the results from the major activities of this project.

This report is organized as follows. First is a description of the survey data collected for this project, with appendices for copies of the actual surveys. Next follows a non-technical summary of the statistical analysis of the data, conducted to develop actuarially fair premiums for a liability policy by estimating the expected number of escapes for a prescribed burner and the amount of damage caused by each escape. Accompanying this report is a spreadsheet that uses the statistical results to estimate the actuarially fair premium based on the characteristics of a specific prescribed burner. Another spreadsheet contains the raw survey data for use by those wishing to conduct their own analysis.

Extensive Summary of Survey Data

Two surveys were conducted for this project. First, a mail survey was sent to a list of private contractors involved in fire suppression and prescribed burning in several states. The survey asked questions concerning the characteristics of the business and prescribed fire practices, including how many of prescribed fire escapes they had. Next, a telephone survey was conducted of those who reported escaped fires on the mail survey. Questions focused on the escaped fires and the amount of property damage and suppression costs. This section of the report provides and extensive summary of the data collected from these two surveys. Both of these surveys were developed by first convening a panel of experts from around the U.S. in January 2002 to discuss prescribed fire, the risks of escapes and property damage, the concerns of stakeholders, and the types of data available and needed to develop a prescribed fire liability policy. Panel members included state foresters and U.S. Forest Service personnel managing fire suppression and prescribed burning activities, private prescribed burners, underwriters for private insurance companies, and academics with expertise in insurance and liability.

Mail Survey

A mail survey of prescribed burners was conducted following Dillman's (2000) method. Thus the survey process involved sending pre-survey letters, an initial survey mailing, a follow-up postcard and attempted telephone call, and then a second survey mailing. Initial mailings began in January 2005 and most surveys were mailed in February. The initial mailing list consisted of 460 individuals and private contractors from eight states (Florida, Iowa, Minnesota, Missouri, Oklahoma, Oregon, Texas, and Wisconsin) conducting fire suppression and prescribed burns for landowners. Appendix A provides a copy of the actual mail survey.

Of the 460 on the initial mailing list, 232 surveys were returned (50%). Of the 228 non-respondents, 57 were contacted by telephone and stated that they did not conduct prescribed burns (only fire suppression) and 43 had incorrect or out-of-date addresses and/or telephone numbers. No contact was made with the remaining 128 non-respondents. These findings were sufficient to convince us that we had reached almost all contractors on the list who conducted prescribed burns. Of the 232 returned surveys, 103 reported conducting no prescribed burns during 1999 to 2003. Of the remaining surveys, an additional 17 were dropped because they provided no information concerning the number of escapes and/or the number of burns for any of the years. The final data set consisted of 112 useable surveys that reported the prescribed burns and associated number of escapes for at least one year from 1999 to 2003. Because not all respondents conducted prescribed burns in all five years of the survey, the total number of burner-years was 458. The data from the mail survey are included in the spreadsheet. These data include the raw survey data, the reduced data set of the 112 useable surveys, and the final data set of the 458 burner-year observations used for statistical analysis, as well as a summary sheet used to develop Tables 1-20.

The survey asked a variety questions concerning prescribed fire practices and experiences during the five years (1999-2003), as well as the general business characteristics of respondents. What follows is a series of tables providing an extensive summary of the information collected through the mail survey. Each table summarizes responses to a specific survey question identified in the table title. Readers should consult the copy of the survey in Appendix A for the specifics of each

question asked and the available response categories. In addition, the spreadsheet file accompanying this report contains the raw mail survey data that readers can use to construct their own summaries of the responses. Finally, note that to protect the anonymity of respondents, responses to some questions are not summarized here nor are they included in the spreadsheet.

The "Typical" Prescribed Burner

Below are several general statements that describe the "typical" prescribed burner based on the responses to the mail survey and summarized in the indicated tables.

Technical Practices: (Tables 1 and 7)

- Most (68%) use written burn plans Always or Often, but 17% Never or Rarely do.
- Almost all (90%) predict smoke behavior Always or Often.
- Most (67%) wear protective equipment Always or Often, but 20% Never or Rarely do.

- Most (73%) Never or Rarely begin a burn after sunset.
- Most (72%) Never or Rarely burn with open flames for more than 24 hours.
- One third Sometimes extinguish a burn after sunset, 23% Often or Always do.

General Practices: (Tables 2-4 and 18-20)

- Most burn for private land owners (88%) and farmers and ranchers (52%).
- Most (78%) burn 2000 or fewer total acres per year.
- Most (87%) conduct 30 or fewer prescribed burns per year.
- Half report conducting burns with others not employed by their company, most commonly not government agencies or other private consultants.

- Half report burning in the South, a third in the Midwest, most commonly in Florida, Texas, and Wisconsin.
- Almost half (48%) burn in 1 state and almost a third (31%) burn in 3 or more states.

Prescribed Fire Characteristics: (Tables 5, 6, and 8)

- Almost all (87%) conduct some burns in the wildland/urban interface, but most (55%) conduct less than 25% of their burns in the wildland/urban interface.
- Most (69%) conduct less than 25% of their burns next to public lands.
- Most (53%) conduct more than half of their burns in sparsely populated areas.

- Grass is the most common fuel type (43% of burns) and then Timber (32%).
- Some burn exclusively in one fuel type (Grass, Timber, Slash or Brush).

- The median low size range for a typical burn is 15 acres.
- The median high size range for a typical burn is 150 acres.
- Most (66%) fires have a high size range less than 200 acres, but some are quite large—11% report a high range of at least 1,000 acres; 2% of at least 10,000 acres.

Experience and Certification: (Table 14)

- The average years of experience with prescribed fire is 18.5 years, with a range from 1 to 50 years.
- One third report having no fire suppression experience.
- For those with fire suppression experience, the average years of experience is 16.2 years, with a range from 1 to 50 years.
- Almost half (46%) did not know if their burn boss had the Burn Boss II designation
- A third (34%) had the Burn Boss II designation or higher.

Escape Experience: (Tables 9-11)

- Annually, most (74%-80%) have no escapes. Those who have escapes usually have only 1 escape (1 is the median and mode). A few have 10-20 escapes.
- Claims for smoke damage from prescribed burns are rare. Only 1 reported a smoke claim from an escape and only 3 reported a total of 6 smoke claims from non-escaped fires.

Insurance Experience: (Tables 12 and 13)

- Most (86%) report having some form of general business liability insurance in the years they conducted burns, with a median premium of $3,000.
- About half (55%) report having a policy providing some form of liability coverage for prescribed burns; 18% have no coverage and 20% left the question blank.

Business Characteristics: (Tables 15-17 and 19)

- Almost a third (30%) report less than $100,000 in gross income, 51% report less than $250,000 in gross income, and 24% report more than $1 million in gross income.
- Prescribed burning on average is 11% of their business income, with most income (62% on average) from other activities not related to controlling woody vegetation or fire.

- On average have been in business for 21 years and conduct burns 4 months a year.
- Most (69%) planned on conducting prescribed burns in the coming year.

These statements are generalizations intended to indicate typical responses to the survey and should be fairly representative of the population of prescribed burners in the states surveyed. No cross tabulation between characteristics (e.g., how do the gross income responses correlate with experience with escapes) has been conducted or reported here. Readers can develop any desired summaries or cross tabulations using the data in the accompanying spreadsheet.

Mail Survey Tables

Table 1. Summary of Responses to Question 2: Prescribe Fire Practices.

	Use Written Burn Plan		Predict Smoke Behavior		Wear Personal Protection	
	Responses	%	Responses	%	Responses	%
Never	7	6%	1	1%	14	13%
Rarely	12	11%	2	2%	8	7%
Sometimes	16	14%	7	6%	13	12%
Often	18	16%	16	14%	17	15%
Always	58	52%	85	76%	58	52%
Blank	1	1%	1	1%	2	2%

Table 2. Summary of Responses to Question 3: Clients.

	Lumber Companies		Farmers Ranchers		Game Preserves		Private Land Owners		Government	
	Responses	%	Responses	%	Responses		Responses	%	Responses	%
Yes	27	24%	58	52%	32	29%	99	88%	48	43%
Blank	85	76%	54	48%	80	71%	13	12%	64	57%

Table 3. Summary of Responses to Question 4: Number of Prescribed Burns.

	1999		2000		2001		2002		2003	
	Responses	%	Responses	%	Responses		Responses	%	Responses	%
Exceeding 0	92	82%	90	80%	88	79%	95	85%	96	86%
Equal 0	10	9%	11	10%	11	10%	10	9%	9	8%
Blank	10	9%	11	10%	13	12%	7	6%	7	6%
Responses Exceeding 0										
Average	26.4		27.5		30.9		32.8		32.3	
Minimum	1		1		1		1		1	
Maximum	814		814		814		814		814	
Median	8.5		10		10		10		11.5	
Average Over All Years	30.0				Median Over All Years				10.0	

Table 4. Summary of Responses to Question 4: Total Acres Burned.

	1999		2000		2001		2002		2003	
	Responses	%	Responses	%	Responses		Responses	%	Responses	%
Exceeding 0	92	82%	90	80%	88	79%	95	85%	96	86%
Equal 0	8	7%	10	9%	11	10%	10	9%	9	8%
Blank	12	11%	12	11%	13	12%	7	6%	7	6%
Responses Exceeding 0										
Average	1,636		1,828		2,107		2,249		2,552	
Minimum	2		3		2		2		2	
Maximum	34,100		34,100		34,100		34,100		34,100	
Median	350		475		580		630		600	
Average Over All Years	2,075				Median Over All Years				500	

Table 5: Summary of Responses to Questions 5-7: Prescribed Burn Characteristics.

	Wildland/Urban Interface		Next to Public Lands		Sparsely Populated Areas	
Range	Responses	%	Responses	%	Responses	%
0%	15	13%	28	25%	11	10%
1-25%	47	42%	49	44%	9	8%
26-50%	13	12%	14	13%	25	22%
51-75%	12	11%	8	7%	25	22%
76-100%	17	15%	6	5%	35	31%
Blank	8	7%	7	6%	7	6%

Table 6. Summary of Responses to Question 8: Percentage of Burns by Primary Fuel Type.

	Grass		Brush		Timber		Slash	
	Responses	%	Responses	%	Responses		Responses	%
Exceeding 0	82	73%	37	33%	84	75%	53	47%
Equal 0	23	21%	67	60%	20	18%	51	46%
Blank	7	6%	8	7%	8	7%	8	7%
Average	43%		7%		32%		18%	
Responses Exceeding 0								
Average	55%		21%		40%		35%	
Minimum	4%		3%		2%		1%	
Maximum	100%		60%		100%		100%	

Table 7. Summary of Responses to Question 9: Prescribed Burned Practices.

	Begin after Sunset		Open Flame > 24 Hours		Extinguish after Sunset	
	Responses	%	Responses	%	Responses	%
Never	56	50%	45	40%	14	13%
Rarely	26	23%	36	32%	28	25%
Sometimes	18	16%	19	17%	37	33%
Often	4	4%	4	4%	14	13%
Always	1	1%	1	1%	11	10%
Blank	7	6%	7	6%	8	7%

Table 8. Summary of Responses to Question 10: Typical Size Range.

	Low End Acres		High End Acres	
	Responses	%	Responses	%
Exceeding 0	105	94%	105	94%
Equal 0	0	0%	0	0%
Blank	7	6%	7	6%
Responses Exceeding 0				
Average	156		712	
Minimum	1		2	
Maximum	12,500		30,000	
Median	15		150	

Table 9. Summary of Responses to Question 11: Number of Escaped Fires.

	1999		2000		2001		2002		2003	
	Responses	%	Responses	%	Responses		Responses	%	Responses	%
Exceeding 0	24	21%	15	13%	15	13%	21	19%	21	19%
Equal 0	83	74%	92	82%	90	80%	87	78%	87	78%
Blank	5	4%	5	4%	7	6%	4	4%	4	4%
Responses Exceeding 0										
Average	2.0		2.5		3.3		2.7		3.5	
Minimum	1		1		1		1		1	
Maximum	10		15		20		20		20	
Median	0		0		0		0		0	
Average Over All Years			2.8		Median Over All Years				0	

Table 10. Summary of Responses to Question 11: Number of Smoke Claims with Escapes.

	1999		2000		2001		2002		2003	
	Responses	%	Responses	%	Responses		Responses	%	Responses	%
Exceeding 0	0	0%	0	0%	0	0%	1	1%	0	0%
Equal 0	107	96%	107	96%	105	94%	106	95%	107	96%
Blank	5	4%	5	4%	7	6%	5	4%	5	4%
Responses Exceeding 0										
Average	--		--		--		1		--	
Minimum	--		--		--		1		--	
Maximum	--		--		--		1		--	
Average Over All Years			1							

Table 11. Summary of Responses to Question 11: Number of Smoke Claims without Escapes.

	1999		2000		2001		2002		2003	
	Responses	%	Responses	%	Responses		Responses	%	Responses	%
Exceeding 0	0	0%	2	2%	2	2%	0	0%	0	0%
Equal 0	107	96%	105	94%	103	92%	107	96%	107	96%
Blank	5	4%	5	4%	7	6%	5	4%	5	4%
Responses Exceeding 0										
Average	--		1.5		1.5		--		--	
Minimum	--		1		1		--		--	
Maximum	--		2		2		--		--	
Average Over All Years			1.5							

Table 12. Summary of Responses to Questions 12-13: General Liability Coverage.

	General Liability in Any Year 1999-2003		General Liability Currently	
	Responses	%	Responses	%
Yes	96	86%	87	78%
No	15	13%	10	9%
Don't Know	1	1%	0	0%
Blank	0	0%	15	13%

Table 13. Summary of Responses to Questions 14-15: General Liability Coverage.

	Premium			General Liability Experience	
	Responses	%		Responses	%
Exceeding 0	70	63%	No	20	18%
Equal 0	41	37%	No, but covered	13	12%
Blank	1	1%	Yes, but no claims	43	38%
Responses Exceeding 0			Yes, and claims	6	5%
Average	$33,926		Don't know	8	7%
Adj. Avg.*	$8,331		Blank	22	20%
Minimum	$45				
Maximum	$1,800,000				
Median	$3,000				

*Does not include firm reporting premium of $1,800,000.

Table 14. Summary of Responses to Questions 16-18: Experience and Burn Boss Training.

	Prescribed Burn Experience		Fire Suppression Experience			Training	
	Responses	%	Responses	%		Responses	%
Exceeding 0	111	99%	74	66%	< Burn Boss II	15	13%
Equal 0	1	1%	37	33%	= Burn Boss II	25	22%
Blank	0	0%	1	1%	> Burn Boss II	13	12%
Responses Exceeding 0					Don't Know	52	46%
Average	18.5		16.2		Other	6	5%
Minimum	2		1		Blank	1	1%
Maximum	50		50				

Table 15. Summary of Responses to Question 21: Business Gross Revenue.

	Responses	%
< $100,000	34	30%
$100,000-$250,000	23	21%
$250,000-$500,000	13	12%
$500,000-$1,000,000	2	2%
$1,000,000-5,000,000	19	17%
> $5,000,000	8	7%
Blank	13	12%

Table 16a. Summary of Responses to Question 22: Gross Revenue by Activity.

	Prescribed Burns		Mechanical Clearing		Chemical Treatment	
Range	Responses	%	Responses	%	Responses	%
Exceeding 0	90	80%	46	41%	45	40%
Equal 0	20	18%	48	43%	48	43%
Blank	2	2%	18	16%	19	17%
Responses Exceeding 0						
Average ≥ 0	11%		9%		6%	
Average > 0	14%		18%		12%	
Minimum	1%		1%		1%	
Maximum	95%		100%		50%	

Table 16b. Summary of Responses to Question 22: Gross Revenue by Activity.

	Fire Suppression		Consulting		Other 1 & 2	
Range	Responses	%	Responses	%	Responses	%
Exceeding 0	19	17%	34	30%	84	75%
Equal 0	72	64%	56	50%	10	9%
Blank	20	18%	22	20%	18	16%
Responses Exceeding 0						
Average ≥ 0	6%		3%		62%	
Average > 0	31%		8%		70%	
Minimum	1%		1%		1%	
Maximum	90%		100%		100%	

Table 17. Summary of Responses to Questions 23-24: Months Burn and Years in Business.

	Months Burn per Year		Years Firm in Business	
	Responses	%	Responses	%
Exceeding 0	106	95%	108	96%
Equal 0	6	5%	3	3%
Blank	0	0%	1	1%
Responses Exceeding 0				
Average > 0	4.3		21.1	
Minimum	1		1.5	
Maximum	12		100	

Table 18. Summary of Responses to Question 25: States Where Conducting Prescribed Burns.

State	Number of Respondents	State	Number of Respondents
FL	29	AR	4
TX	27	ID	4
WI	25	IL	4
GA	16	MT	4
AL	15	AZ	3
LA	15	UT	3
OR	12	NM	2
IA	10	WY	2
CA	7	CO	1
MN	7	IN	1
WA	6	KS	1
MO	5	MI	1
MS	5	NV	1
OK	5	ND	1
		SD	1

Region	Respondents	%
South	55	49%
Midwest	37	33%
West	12	11%
Blank	8	7%

Number of States	Respondents	%
1	54	48%
2	24	21%
3	15	13%
4	5	4%
5	4	4%
6	2	2%
Blank	8	7%

Table 19. Summary of Responses to Questions 26 and 27: Burning Practices and Plans

	Conduct Burns with Others			Conduct Burns in Coming Year	
	Responses	%		Responses	%
Yes	57	51%	Yes	77	69%
No	48	43%	No	16	14%
Blank	7	6%	Other	4	4%
			Don't Know	8	7%
			Blank	7	6%

Table 20. Summary of Responses to Questions 26: Hours Burned with Others.

	Other Private Consultants		Government Agencies		Other	
Range	Responses	%	Responses	%	Responses	%
Exceeding 0	12	11%	12	11%	29	26%
Blank	100	89%	100	89%	83	74%
Responses Exceeding 0						
Average > 0	30.1		32.9		175.5	
Minimum	5		3		10	
Maximum	100		100		960	

Telephone Survey

A telephone survey was conducted to collect data for estimating the probability and magnitude of damage from escaped fires. During July and August 2005, attempts were made to contact the 61 prescribed burners in the mail survey who reported an escaped fire or claims for smoke damage from a prescribed burn. Of these 61, 7 were not able to be reached with the telephone number reported in the mail survey (see question 20) and/or the mailing list and 5 never answered the telephone even after repeated calls. Dropping these observations left 49 (80% of the initial 61) useable telephone surveys. Of these 49, 47 reported only one or more escapes and 2 others reported smoke claims without any escapes. The 47 with escapes were asked several questions about each escaped fire, up to four escaped fires per respondent. Because some respondents had more than one escape, the final data set for escapes consists of responses by 47 different private contractors regarding a total of 74 escaped fires. The 2 respondents with smoke claims each had one claim, so the final data set for smoke claims had information for 2 private contractors.

The Center for Survey Statistics and Methodology (CSSM) at Iowa State University conducted the telephone data collection. The telephone questionnaire was programmed using Blaise (http://www.blaise.com/index.htm), a widely used software package for computer-assisted telephone interviewing. Blaise includes edit checks to detect illegal values and logic errors as responses are entered into the computer during the interview. CSSM personnel recruited, trained and supervised telephone interviewers.

Appendix B provides a copy of the coding manual, which reports the text of the interviews and indicates how the answers were coded for the data file. An accompanying spreadsheet includes the raw data collected from the telephone survey. Additional sheets in the file provide the extracted data for the 74 escapes used to construct Tables 21-26 and for the 2 smoke claims. The file also contains a summary sheet and answers to open ended survey questions.

Note that this count of 61 respondents reporting escapes includes 6 that were dropped from the final mail survey data set and not included in the data summaries in Tables 1-20. Though they answered some of the mail survey questions, they were dropped because they left the questions blank on the number of burns they conducted each year (and other questions as well). These 6 are part of the final telephone survey data summarized below and were used for the statistical analysis of damage from escaped fires. However, their responses were not included in the statistical analysis of the factors determining escapes, since their data were incomplete.

The interviews included a variety questions regarding the details of each escaped fire or smoke claim and the value of all damage claims paid by the contractor and his/her insurance companies. What follows is a series of tables providing a summary of the information collected through the telephone survey. Each table summarizes responses to a specific question identified in the table title by the field name from the coding manual in Appendix B. Readers should consult the coding manual for the specifics of each question asked and the available response categories. In addition, the spreadsheet file accompanying this report contains the raw telephone survey data that readers can use to construct their own summaries of the responses. Finally, note that to protect the anonymity of respondents, responses to some questions are not summarized here nor are they included in the spreadsheet.

The "Typical" Prescribed Fire Escape

Below are several general statements that describe the "typical" prescribed fire escape based on the responses to the telephone interview and summarized in the indicated tables. Remember that these bullets described prescribed burns that escaped and were reported in our telephone survey.

Location (Table 21)

- Most occurred in the South (49%) and the Midwest (47%), largely following the location of the survey population.

Fuels and Sizes (Tables 22 and 23)

- Most commonly prescribed burns that escape were burns in Grass (42%) or Slash (31%).
- Most commonly escaped fires burned additional Grass (46%) or Timber (27%).
- Most (89%) escaped prescribed burns are less than 200 acres; 60 acres is the median size.
- Most (70%) burned less than 10 additional acres, 2 additional acres was the median.

Extinguishing the Escape (Tables 24 and 26)

- Most (72%) took less than 3 hours to extinguish, almost all (97%) took 10 or fewer hours.
- Additional costs to extinguish the escape ranged $35 to $2,500, with a median of $500.
- Additional resources to extinguish the escape typically included plows, trenchers, and bulldozers (30% of the escapes) and other fire fighters (28%).

Training and Experience (Table 25)

- Most (69%) burn crews had 2-5 members besides the burn boss.
- Over half (56%) had crews with Excellent or Very Good experience.
- Most (69%) had burn bosses with Excellent or Very Good experience.

Monetary Value of Damages (Tables 27 and 28)

- Almost all (97%) reported no property damage.
- None reported any payments for bodily injury.
- Most (84%) reported paying no out of pocket costs to settle damage claims.
- For the 15% of escapes paying claims, the total payment from all sources ranged $15 to $22,000, with an average of $5,674 and a median of $1,500.

Smoke Claims without Escapes (Table 29)

- Smoke can be costly even without an escape—the survey found one case of spending $2,000 for traffic control help to deal with unexpected smoke behavior.

These statements are generalizations intended to indicate typical responses to the telephone survey and should be fairly representative of the escapes that occurred in the states surveyed. No cross tabulation between variables has been conducted or reported here. Furthermore, no summaries that link information from the mail and telephone surveys has been conducted or reported here. Readers can develop any desired summaries or cross tabulations using the data in the accompanying spreadsheet, including for the combined mail and telephone survey data.

Telephone Survey Tables

Table 21. Summary of Responses to Fields Num1a and StateAb: Number and Location of Escaped Fires.

Year	Escapes	%
1999	16	22%
2000	12	16%
2001	9	12%
2002	11	15%
2003	24	32%
2004	2	3%

Region	Escapes	%
South	36	49%
Midwest	35	47%
West	3	4%

State	Escapes	%
Florida	15	20%
Texas	12	16%
Wisconsin	12	16%
Missouri	8	11%
Oklahoma	6	8%
Minnesota	5	7%
Iowa	4	5%
Louisiana	4	5%
Georgia	3	4%
Oregon	3	4%
Alabama	1	1%
Arkansas	1	1%

Table 22. Summary of Responses to Fields Fuel3a, Fuel3b, Plan4: Fuels and Burn Plan Use.

	Prescribed Fire		Escaped Fire			Burn Plan	
Fuel	Escapes	%	Escapes	%	Answer	Escapes	%
Grass	31	42%	34	46%	Yes	63	85%
Brush	5	7%	12	16%	No	11	15%
Timber	11	15%	20	27%			
Slash	23	31%	4	5%			
Other	4	5%	4	5%			

Table 23. Summary of Responses to Fields Intend5 and Addl5: Acres Burned.

	Prescribed Fire (ac)	Escaped Fire (ac)
Average	116.0	25.0
Minimum	0.1	0.1
Maximum	1400	500
Median	60	2

Table 24. Summary of Responses to Fields Cost6 and Hours7: Cost to Suppress and Hours to Extinguish Escaped Fire.

	Suppression Cost ($)		Hours to Extinguish	
All Responses	Escapes	%	Escapes	%
Exceeding 0	19	26%	74	100%
Equal 0	53	72%	0	0%
No Response	2	3%	0	0%
Average	205		9.3	
Median	0		1	
Responses Exceeding 0				
Average	778		9.3	
Minimum	35		0.1	
Maximum	2,500		500	
Median	500		1	

Table 25. Summary of Responses to Fields Crew8, Exper9, and Train10: Crew Size and Experience and Burn Boss Training.

Crew Size			Crew Experience			Burn Boss Training	
Crew	Escapes	%	Experience	Escapes	%	Escapes	%
0	3	4%	Excellent	19	26%	21	28%
1	5	7%	Very Good	22	30%	30	41%
2	11	15%	Good	23	31%	12	16%
3	11	15%	Fair	8	11%	0	0%
4	20	27%	Poor	1	1%	0	0%
5	9	12%	Don't Know	1	1%	11	15%
6	4	5%					
7	1	1%					
8	1	1%					
9	3	4%					
10	2	3%					
11	1	1%					
12	2	3%					
13	0	0%					
14	1	1%					
Average	4.3						
Median	4.0						

Table 26a. Summary of Responses to Fields Use11b: Additional Resources Used for Escape.

Resource	Hand Crews		Water Tenders		Lookout Crews		Other Fire Fighters	
	Escapes	%	Escapes	%	Escapes	%	Escapes	%
Exceeding 0	15	20%	10	14%	8	11%	21	28%
Equal 0	58	78%	63	85%	66	89%	52	70%
No Response	1	1%	1	1%	0	0%	1	1%
Average	0.8		0.2		0.3		1.1	
Median	0		0		0		0	
Responses Exceeding 0								
Average	3.8		1.7		2.9		3.7	
Minimum	3		1.5		2		3	
Maximum	2		1		2		1	
Median	9		4		7		14	

Table 26b. Summary of Responses to Fields Use11b: Additional Resources Used for Escape.

Resource	Plows		Light Engines		Med/Hvy Engines		Bulldzers	
	Escapes	%	Escapes	%	Escapes	%	Escapes	%
Exceeding 0	22	30%	17	23%	3	4%	22	30%
Equal 0	52	70%	57	77%	71	96%	52	70%
No Response	0	0%	0	0%	0	0%	0	0%
Average	0.4		0.3		0.1		0.4	
Median	0		0		0		0	
Responses Exceeding 0								
Average	1.5		1.4		1.3		1.3	
Minimum	1		1		1		1	
Maximum	1		1		1		1	
Median	3		3		2		2	

Table 26c. Summary of Responses to Fields Use11b: Additional Resources Used for Escape.

Resource	Explosives		Airtankers		Smokejumpers		Other	
	Escapes	%	Escapes	%	Escapes	%	Escapes	%
Exceeding 0	0	0%	2	3%	0	0%	11	15%
Equal 0	74	100%	72	97%	74	100%	63	85%
No Response	0	0%	0	0%	0	0%	0	0%
Average	0		0.0		0		0.3	
Median	0		0		0		0	
Responses Exceeding 0								
Average	0		1.0		0		1.8	
Minimum	0		1		0		1	
Maximum	0		1		0		1	
Median	0		1		0		5	

Table 27. Summary of Responses to Fields Prop15a, Injury15, and Pay16b: Cost of Escaped Fire Damage.

	Property Damage		Bodily Injury		Private Payment		Total Payment	
	Escapes	%	Escapes	%	Escapes	%	Escapes	%
Exceeding 0	2	3%	0	0%	11	15%	11	15%
Equal 0	72	97%	74	100%	62	84%	62	84%
No Response	0	0%	0	0%	1	1%	1	1%
Average	$527		$0		$321		$855	
Median	$0		$0		$0		$0	
Responses Exceeding 0								
Average	$19,500		$0		$2,129		$5,674	
Minimum	$18,000		$0		$15		$15	
Maximum	$21,000		$0		$8,000		$22,000	
Median	$19,500		$0		$1,000		$1,500	

Table 28. Raw Positive Responses to Fields Prop15a, Injury15, and Pay16b: Cost of Escaped Fire Damage, Sorted by Total Payment.

Rank	Total Payment	Property Damage	Bodily Injury	Private Payment
1	$22,000	$21,000	$0	$1,000
2	$20,000	$18,000	$0	$2,000
3	$8,000	$0	$0	$8,000
4	$6,000	$0	$0	$6,000
5	$3,500	$0	$0	$3,500
6	$1,500	$0	$0	$1,500
7	$650	$0	$0	$650
8	$400	$0	$0	$400
9	$200	$0	$0	$200
10	$150	$0	$0	$150
11	$15	$0	$0	$15

Table 29. Summary of Responses to Fields Smoke18a to Pay27b: Smoke Claims without Escapes.

State	Year	Fuel	Smoke Prediction Method	Private Payment	Total Payment
Florida	1999	Timber	Weather	$2,000*	$2,000
Texas	2004	Grass	Weather	$0	$0**

*For traffic control help.

**No damage claims made, only received several complaints.

Loss Analysis

The goal of the analysis here is to develop estimates of actuarially fair premiums for an insurance policy to cover damages from escaped prescribed burns. The analysis proceeds in two steps. First, the annual expected number of escapes is estimated as a function of the characteristics of a prescribed burner using the mail survey data. Second, given that an escape has occurred, the probability that damage occurs and, if it does, how much damage occurs are estimated as functions of the characteristics of the prescribed burner using the data from both the telephone and mail survey. The description of the analysis here is terse by choice. The goal here is to present the results of the analysis, not a justification of the methods and an exhaustive analysis of alternative models. Some work of this sort has been completed and described elsewhere (e.g., Mitchell, Buman, and Buman 2006). In addition, the description here focuses on the final results and how to use them for estimating premiums; the technical details are not presented or justified as for an academic or peer-reviewed journal audience. For this report, the primary goal is to present a reasonable analysis as a first cut at the data to illustrate their potential. This analysis is not intended to be a comprehensive and finalized analysis of these data and associated insurance premiums. The statistical model and approach of analysis likely can be refined or modified to better fit questions that others may have, but the general results are not likely to change dramatically. To facilitate this process of improving the insurance analysis and exploring other topics with these data, the survey data are available in the accompanying spreadsheets for those who wish to conduct their own analysis.

Note that the variables used for estimation from the mail and telephone surveys are those that can be used to determine an insurance premium, as opposed to variables that are important, but could not be used. For example, the intended size of the prescribed burn is available from the telephone survey of escapes and has a statistically significant impact on the probability and magnitude of monetary damages from escapes. However, an insurance company typically does not insure a single prescribed burn, but rather an individual prescribed burner for a year/season. Hence, this implies that the variable to use to estimate the impact of prescribed burn size on the probability and magnitude of monetary damages is the average or typical size of prescribed burns the prescribed burner conducts as reported in the mail survey. The effect of variables such as the intended size of the prescribed burn is important, but not useable by an insurance company. However, such variables may be important for other types of analyses, and so all the survey data are available in the accompanying spreadsheets for those wishing to conduct their own analysis.

The analysis also combines ordinal categorical responses into fewer variables and converts continuous variables to discrete variables. For example, Business Gross Revenue was originally collected in the mail survey for six ranges (Table 15/Questions 21). For the analysis described below, these are combined into three ranges. Similarly, the responses to Questions 8 on the mail survey (Percentage of Burns by Primary Fuel Type: Table 6) were continuous variables, but were converted to indicator (dummy) variables equal to 1 if the response exceeded 33%. This combining/conversion of responses was used for several reasons. First, estimated coefficients were often statistically insignificant from zero on not statistically different from each other if all categories were used, but if categories were combined, this problem was eliminated or reduced. Second, a parsimonious model with few variables and mostly categorical variables seemed more consistent with insurance company practices. For example, car insurance premiums are based a

few age categories and do not varying continuously with age. Third, using fewer categories ensured smooth, monotonic effects for changes in responses, rather than "jumpy" responses that sometimes changed direction. For example, as the percentage of burns in the wildland-urban interface increases (Table 6/Question 8), the expected number of escapes follows the general pattern of the data and decreases. However, if a separate effect is estimated for each categorical variable, only one coefficient is significant and the effect is no longer monotonic for all cases. Different groupings of categorical variables and break points for converting continuous variables to indicator variables were explored statistically for the analysis here, but we do not present the details of this selection process, as it is rather tedious. Nevertheless, because different groupings or break points could be used or may be preferred for other applications, the survey data are available in the accompanying spreadsheets for those wanting to do their own analysis.

Escape Model

The mail survey is used to estimate the expected number of escapes. Because respondents reported several variables for each of up to five years, the data were "stacked" to obtain annual observations. For example, respondents were asked the number of escapes each year for 1999 to 2003. If a respondent listed escapes in each year, then five observations were made for the respondent. From the 112 useable surveys, this process generated 458 burner-year observations, which were summarized in the section on the mail survey.

Because the number of escapes a prescribed burner has each year must be an integer, count data models were used to estimate the expected number of escapes each year. For an overview of count data models, see Cameron and Trivedi (1998) and Greene (2003). Several count data models were estimated, including variants of the Poisson and negative binomial distributions, as well as the geometric, modified Borel, and Yule distributions (Mitchell, Buman, and Buman 2006). The final model used for the analysis here is a sample-size weighted Poisson model, which assumes the number of escapes is an integer with a Poisson distribution, with a mean and variance that depend on burner characteristics and the annual number of burns conducted. Table 30 reports the variables from the mail survey used and a brief description. Table 31 reports the maximum likelihood coefficient estimates and associated statistics.

Using Table 31

Let e_i be the number of escapes in a year for burner i. The set (vector) of variables describing the characteristics of burner i is the vector W_i. The variables listed in the first column of Table 31 are these characteristics W_i for each burner i. For the sample-size weighted restricted generalized Poisson model, the probability density function of e_i is

$$(1) \qquad f(e_i) = \left(\frac{\mu_i}{1+\lambda\mu_i}\right)^{e_i} n_i\left(n_i+\lambda k\right)^{e_i-1} \exp\left[\frac{-\mu_i(n_i+\lambda e_i)}{1+\lambda\mu_i}\right] / e_i!,$$

where μ_i and λ are parameters determining the mean and variance, and n_i is the number of burns conducted by burner i. The expected escape rate per burn for burner i is

$$(2) \qquad \mu_i = \exp(\theta' W_i)$$

and the expected (average) number of escapes per year for burner i is

$$(3) \qquad \mathrm{E}[e_i] = n_i\mu_i,$$

where θ is the set (vector) of estimated coefficients reported in Table 31, and $\theta' W_i$ is the vector product (the sum of each coefficient times the appropriate variable). In other words $\theta' W_i =$

$\sum_{j=1}^{19} \theta_j W_{ij}$, where j = 1 to 19 indexes the coefficients in Table 31 and the value of the variables W_i for burner i. Based on this model, the probability that burner i will have k escapes is

$$\Pr[e_i = k] = \left(\frac{\mu_i}{1+\lambda\mu_i}\right)^k n_i \left(n_i + \lambda k\right)^{k-1} \exp\left[\frac{-\mu_i(n_i+\lambda k)}{1+\lambda\mu_i}\right] / k! \quad (4)$$

where k! is the factorial of k. for this study, the parameter vector θ and λ are estimated using maximum likelihood based on the probability density function defined by equations (1) and (2) (Mitchell, Buman, and Buman 2006; Sarker and Surry 2004). Lastly, the variance of the annual number of escapes for burner i is

$$\mathrm{Var}[e_i] = n_i\mu_i(1 + \lambda\mu_i)^2. \quad (5)$$

To simplify calculations, an accompanying Excel spreadsheet allows users to calculate the expected number of escapes and the probability of the different number of escapes using these formulas and pull-down menus to choose the value of most regressors.

Interpretation of Coefficients in Table 31

The coefficients in Table 31 indicate whether the variables have a positive or negative effect on the expected (average) number of escapes. If the coefficient is positive, then the variable increases the expected number of escapes. However, note that the magnitude of the increase is unclear, since the effect of any variable depends on the current expected number of escapes $\mathrm{E}[e_i] = n_i\exp(\theta' W_i)$. Specifically, using calculus and equations (1) and (2) indicates that

$$\partial \mathrm{E}[e_i] \Big/ \partial W_{ij} = n_i \exp(\theta' W_i)\theta_j, \quad (6)$$

where θ_j is the coefficient for regressor variable W_j for burner i.

The p-value is the estimated probability that the estimated coefficient θ_j is actually zero (i.e., the variable W_{ij} has no effect on the expected number of escapes). Table 31 indicates that most of the variables are significant at the 1% level. All but one are significant at the 10% level. The insignificant variable (Primary Fuel > 33% Brush) is included because comparable variables were included for all fuel types.

Finally, note that when a prescribed burner is categorized into one of several categories, one of the variables must be dropped from estimation to prevent singularity of the regressor matrix. Thus, coefficients must be interpreted as the effect of the variable relative to the excluded category. For example, the estimated coefficients for Burn in Midwest and Burn in West are both negative in Table 31, implying that those conducting burns in the Midwest or the West will have on average fewer escapes relative to those who Burn in South (the excluded category).

Examining the coefficients in Table 31 indicates that, besides these regional effects, fuel types are also important. Those burning more than a third of their burns in grass, brush, and slash on average have more expected escapes than those who burn less than a third of their burns in each of these fuel types (the coefficients for Primary Fuel > 33% Grass, Brush, and Slash are positive). However, the coefficient for Brush is small in statistically insignificant. Timber fuels have the opposite effect—those burning more than a third in Timber have fewer expected escapes than those who burn less than a third in timber fuels. Relative to a company conducting

prescribed burns evenly distributed among fuel types (25% for each), a company specializing in Slash would have the largest expected number of escapes, then a company specializing in Grass, while a company specializing in Timber would have fewer expected escapes and a company specializing in Brush would have only slightly more expected escapes.

Using annual business revenue as an indicator of size shows that the size of the company also has an effect on the expected number of escapes. Relative to companies with less than $100,000 in annual revenue, larger companies have more expected escapes, but the positive effect decreases as the company gets larger (the positive coefficient for Annual Revenue > $1,000,000 is smaller than for the other categories). These results may be evidence that small companies have fewer expected escapes because they conduct fewer and smaller prescribed burns.

The negative coefficient for > 50% Burns in Wildland-Urban Interface is evidence that those burning in this location with more potential for larger scale damage take more precautions to prevent escapes. However, the positive coefficient for At Least 10 Years Suppression implies that the expected number of escapes increases if the burn boss has more than 10 years of experience in fire suppression. One interpretation is that those with substantial fire suppression experience are less worried about escapes and so put forth less effort to prevent them. Also, note that the full effect of fire suppression experience will depend on how it affects the expected damage once an escape occurs, which is determined in the next estimated model.

The negative coefficient for Burn Boss II Certification implies that companies using burn bosses with recommended training have fewer expected escapes. Similarly, the negative coefficient for Never/Rarely Start Burns after Sunset implies that this practice increases the expected number of escapes. These findings are consistent with the opinion of subject matter experts with whom we discussed our results—beginning burns after sunset is usually considered higher risk and those with burn boss II designation are trained in recommended techniques for prescribed burns.

Companies earning more than 25% of their annual revenue from prescribed fire activities have fewer expected escapes (the coefficient for > 25% Revenue from Burns). This may be evidence that companies specializing in prescribed fire have fewer escapes and are generally more careful to prevent escapes, since an escape may create a bad reputation for their company and thus reduce their annual revenue. This reputation effect is also evident in the negative sign for > 5% Revenue from Burn Consulting. Those teaching others how to conduct prescribed burns or helping others with modeling or preparing burn plans would have strong incentives to uphold a reputation as a good prescribed burner, plus would be more likely to follow recommended practices, all of which should reduce the expected number of escapes.

The negative coefficient for Annual Number of Burns implies that the more prescribed burns a company conducts, the fewer escapes it has, holding annual acreage burned constant. This result can be interpreted as evidence that, as the average size of burns a company conducts decreases, the expected number of escapes also decreases. The positive coefficients on Annual Acres Burned (1000's) and Lower Size of Burns Exceeds 10 Acres implies that the more total acres a company burns and the larger these burns (holding the number of burns constant), the greater the expected number of escapes. These results seem consistent, since burning more acres and larger burns creates the potential for more escapes.

Interestingly, the positive coefficient on Has Prescribed Fire Liability Coverage implies that prescribed burners with some form of liability coverage have more escapes on average. Those without liability coverage exert more effort to reduce escapes (and the potential for damage), because they would be responsible for the full cost of any escape causing damage, while those with insurance coverage have reduced incentives for this effort, since they will not pay the full cost of any damages. This coefficient captures this moral hazard effect that insurance can have on the behavior of those with insurance and is important to include when determining insurance premiums.

Finally, as equation (5) indicates, the variance of the expected number of escapes depends on the parameter α, as well as the expected escape rate μ and the number of burns n. The restricted generalized Poisson model is more flexible because it restricts the relationship between parameters so that the mean the variance of the number of escapes are no longer proportional, as imposed by the Poisson and generalized Poisson models (Sarker and Surry 2004). The negative estimate for λ in Table 31 has not direct interpretation, except to note that it implies that increasing the expected number of escapes can either increase or decrease the variance of the number of escapes, depending on the specific values of μ and n.

Characteristics of Prescribed Burners at Higher Risk for Escapes

The following bullet points are meant to be a convenient and short summary of these results. According to these statistical results in Table 31, the following are characteristics of prescribed burners who have a larger expected number of escapes:

- Conduct prescribed burns in the South
- Conduct more than a third of their burns in slash or grass fuels
- Have at least 10 years of fire suppression experience
- Sometimes, often, or always start prescribed burns after sunset
- Do not have Burn Boss II or better designation
- Earn more than $100,000 in annual business revenue
- Earn less than 25% of their business revenue from prescribed burns
- Earn less than 5% of their business revenue from teaching prescribed burning
- Conduct a low number of burns annually
- Burn a large number of acres annually with the smallest size exceeding 10 acres
- Conduct less than 50% of their prescribed burns in the wildland-urban interface

Damage Model

The purpose of the damage model was to estimate the expected amount of damage that would occur once an escape had occurred. The primary source of data was the telephone survey on the value of damage from escapes linked with data from the mail survey on prescribed burner characteristics. Several off the 47 prescribed burners contacted for the telephone survey had more than one escape, so that the final data set of damages from escaped prescribed fires contained 74 observations. Most (84%) of these escapes had no damage associated with them (see Tables 27 and 28). This large number of observations with zero damage creates statistical problems when estimating the expected damage that require non-conventional regression methods (Greene 2003, pp. 761-780).

The problem of a large number of zeros for the dependent variable (damage) generally requires use of censored regression techniques that formulate a two step process. The first step estimates whether the dependent variable (damage) is zero or positive and the second step estimates for the magnitude of the positive observations. Tobit models assume the same variables determine both steps, while the more flexible double-hurdle models use different regressors to simultaneously predict each step. The analysis of the data here indicated that a double-hurdle model was preferred to a Tobit model. Technically, the double hurdle model here estimates a probit model for the probability that damage occurs after an escape and then estimates a truncated normal regression model for the amount of damage. The truncated regression for the second step allows the model to predict that no damage occurs even if the first step indicates that it may occur. The name double hurdle is used because for positive damage to occur with the model, two hurdles must be passed. First the probability that damage occurs must be positive, and then, if this probability is positive, the magnitude of damage must be positive.

Let c_i denote the occurrence of damage from an escaped prescribed burn conducted by burner i and assume that this occurrence is determined as follows:

$$c_i = \begin{cases} 1 & \text{if } c_i^* > 0 \\ 0 & \text{if } c_i^* \le 0 \end{cases} \tag{6}$$

$$c_i^* = \alpha' Z_i + u_i, \tag{7}$$

where c_i^* is a latent (unobserved) variable determining when damage has occurred, Z_i is a set (vector) of regressors for burner i, α is a set (vector) of parameters to estimate and u_i is a standard normal error with mean zero and variance one. Again, $\alpha' Z_i$ denotes the vector product (the sum of each coefficient in α times the appropriate variable in Z_i).

Let d_i denote the amount of damage that occurs from an escaped prescribed burn conducted by burner i and assume that this damage is determined as follows:

$$d_i = \begin{cases} d_i^* & \text{if } d_i^* > 0 \text{ and } c_i^* > 0 \\ 0 & \text{otherwise} \end{cases} \tag{8}$$

$$d_i^* = \beta' X_i + \varepsilon_i, \tag{9}$$

where d_i^* is an latent (unobserved) variable determining the amount of damage that has occurred, X_i is a set (vector) of regressors for burner i, β is a set (vector) of parameters to estimate and ε_i is a normal mean zero error with standard deviation σ.

For the analysis here, the errors u_i and ε_i are assumed to be independent. In addition, the error ε_i is assumed to not depart significantly from the assumed normality and to have constant variance σ^2 (i.e., no heteroscedasticity). The description of this process is the standard double hurdle model applied to the damage from escapes prescribed burns, but alternative model specifications are possible that test and correct for violations of these assumptions (Gould 1992; Jensen and Yen 1996; Yen and Jones 1997).

Table 33 reports the coefficient estimates for the vectors α and β. The top part of Table 33 reports the coefficients of α used to predict if damage occurs, while the bottom part reports the coefficient of β to predict how much damage occurs. The next section explains how to use the

estimates in Table 33 to predict when and how much damage occurs from an escape on average for a specific prescribed burner.

Using Table 33

Using Table 33 to predict the expected damage is more complicated than for Table 31. The method requires using the standard normal cumulative distribution function and probability density function to use the probit model, then again to calculate the inverse of the Mill's Ratio to calculate the mean of the truncated normal density estimated for damage. Again, for convenience, these calculations for the expected damage and probability are put together in an Excel spreadsheet. However, the equations used are given here as well.

For the double hurdle model, the probability that damage occurs with an escape by prescribed burner i ($d_i > 0$) is

$$\Pr[d_i > 0] = \Phi(\alpha' Z_i)\Phi(\beta' X_i / \sigma), \tag{10}$$

where $\Phi(\cdot)$ is the standard normal cumulative distribution function. The expected damage from this escape conditional on damage occurring is

$$\mathrm{E}[d_i \mid d_i > 0] = \beta' X_i + \sigma \frac{\phi(\beta' X_i / \sigma)}{\Phi(\beta' X_i / \sigma)}, \tag{11}$$

where $\phi(\cdot)$ is the standard normal probability density function and the term $\phi(\cdot)/\Phi(\cdot)$ is also known as the Inverse Mill's Ratio. The unconditional expected damage for an escape is

$$\mathrm{E}[d_i] = \Pr[d_i > 0]\mathrm{E}[d_i \mid d_i > 0] \tag{12}$$

$$\mathrm{E}[d_i] = \Phi(\alpha' Z_i)\Phi(\beta' X_i / \sigma)\left(\beta' X_i + \sigma \frac{\phi(\beta' X_i / \sigma)}{\Phi(\beta' X_i / \sigma)}\right).$$

Note that equation (12) gives the expected damage per escape, not per year. An equation ofr expected damage per year is reported in a later section.

The variables includes in this analysis of damages were chosen because they were statistically significant. Several other variables were tried in different model not reported here. The data are available in the accompanying spreadsheet for those wishing to try other variables or models.

Interpretation of Coefficients in Table 33

Again, the signs of the coefficients in Table 33 indicate the general direction of the impact of each variable on the probability that damage occurs or its magnitude. The specific marginal effects for each variable can be determined via simple derivatives of equations (10-(12), but note that they will depend on the levels of the other regressors (Gould 1992). This report only discusses the general direction of each variable's effect, not the specific marginal effects, as these seem outside the focus of the report.

The variables in the top part of Table 33 influence the probability that an escaped prescribed burn causes damage. The positive value for Burn in South in Table 33 implies that escapes from prescribed burns in the South are more likely to cause damage relative to escaped prescribed The burns in the Midwest or West. The data and this analysis do not allow determining whether these regional differences arise from regional differences in conditions or from practices and the level of effort by prescribed burners.

The positive coefficient for Business Revenue > $250,000 indicates that escaped fires from prescribed burns conducted by moderate to large sized firms are more likely to cause damage than those escaping from small sized firms. This estimated effect may indicate that small firms generally conduct smaller burns under less dangerous conditions to protect themselves from liabilities they cannot afford to pay.

The negative sign for the coefficient for At Least 10 Years Fire Suppression indicates that escapes from prescribed burners with substantial suppression experience are less likely to cause damage. Combined with the positive coefficient for this variable in Table 31, the estimation results imply that those with substantial suppression experience can be expected to have more escapes per year, but these escapes are more likely to cause no damage relative to prescribed burners with less fire suppression experience.

The variables in the bottom portion of Table 33 determine the magnitude of damage if damage occurs. Because the estimated model is linear, the estimated coefficient can be interpreted directly in terms of the dollar value of damages. However note that these coefficients are the effect of the variable on expected damages, given that damage occurs. If the combined effect of all variables is negative damage, then no damage occurs. Thus, if the burn crew has excellent or very good experience, the expected damage (conditional on damage occurring) decreases well over $23,000. Similarly, the expected damage (conditional on damage occurring) decrease by more than $47 for each acre the average size a company's prescribed burns increases.

The primary fuel in which a prescribed burner operates has an important effect on expected damage. If a burner has more than 33% of his/her burns with timber as the primary fuel, the expected damage from an escape (conditional on damage occurring) increases by more than $50,000. The effect of burning more than 33% of prescribed burns with grass as the primary fuel increases expected damage by more than $31,000, while the effect for slash is almost $19,000. Notre that the data contained no cases in which escapes that caused damage occurred for prescribed burners who had more than a third of their prescribed burns with brush as the primary fuel type, so no value for this variable could be estimated. These results imply that when escapes occur in Timber or Grass, they are likely to cause more damage then escapes that occur in slash. Slash has smaller expected damage because the valuable timber has already been removed and areas where logging is occurring are far from residences and similar types of property that could be destroyed by an escaped fire.

The positive coefficient for Business Revenue > $1,000,000 indicates that escaped fires from prescribed burns conducted by large firms have higher expected damage. This may be evidence that larger firms are more willing to burn in areas near property that could be damaged if an escape occurred. This behavior by larger firms could be due to their ability to pay more in liabilities for damages without endangering their business survival.

Characteristics of Prescribed Burners at Higher Risk for Property Damage

The following bullet points are meant to be a convenient and short summary of these results. According to these statistical results in Table 33, the following are characteristics of prescribed burners who have greater likelihood for damage to occur once an escape has occurred:

- Conduct prescribed burns in the South
- Have 10 or fewer years of fire suppression experience
- Earn more than $250,000 in annual business revenue

According to these statistical results in Table 33, the following are characteristics of prescribed burners who have a larger expected damage once an escape has occurred:

- Conduct more than a third of their burns in timber or grass fuels
- Use a crew with less than excellent or very good experience
- On average conduct smaller burns
- Earn more than $1,000,000 in annual business revenue

Answers to Open Ended Questions

The telephone survey had two open ended questions for respondents. One asked about any additional resource they used. Another asked "Can you briefly summarize why the prescribed burn escaped and the extent of the damage it caused." In addition, respondents were offered the opportunity to offer final comments. The answers to these questions are included in the spreadsheet for the telephone survey data. The responses to the second question are particularly useful to understand the nature of escapes and those that cause damage. The final comments also offer a window into the type of people conducting prescribed burns and their experiences with escapes, damage, and insurance. An insurance company considering offering a prescribed fire liability policy would do well to read these responses.

Loss Analysis Tables

Table 30. Variables used to estimate the expected number of escapes per year.

Variable Name	Description
Burn in Midwest	Equals 1 if conduct burns mostly in IA, IL, IN, KS, MI, MN, MO, ND, SD, WI
Burn in West	Equals 1 if conduct burns mostly in AZ, CA, CO, ID, MT, NM, NV, OR, UT, WA, WY,
Primary Fuel > 33% Grass	Equals 1 if at least 33% of burns have grass (including scattered sagebrush, savannas and open pine with grass understory) as primary fuel
Primary Fuel > 33% Brush	Equals 1 if at least 33% of burns have brush (including chaparral and pocosins) as primary fuel
Primary Fuel > 33% Slash	Equals 1 if at least 33% of burns have slash (logging residues from partial or clear cuts) as primary fuel
Primary Fuel > 33% Timber	Equals 1 if at least 33% of burns have timber (closed canopy stands of short/long needle pine, hardwoods, or dense conifers) as primary fuel
> 50% Burns in Wildland-Urban Interface	Equals 1 if conduct more than 50% of burns in wildland-urban interface
At Least 10 Years Fire Suppression	Equals 1 if burn boss has at least 10 years of fire suppression experience
Never/Rarely Start Burns after Sunset	Equals 1 if never or rarely start prescribed burns after sunset
Burn Boss II Certification	Equals 1 if burn boss training equals or exceeds National Wildfire Coordinating Group Burn Boss II designation
> 25% Revenue from Burns	Equals 1 if at least 25% of Business Revenue from conducting prescribed burns
> 5% Revenue from Burn Consulting	Equals 1 if at least 5% of revenue from consulting on prescribed fire (modeling, teaching, preparing burn plans)
Annual Revenue $100,000-$250,000	Equals 1 if business revenue in listed range
Annual Revenue $250,000-$1,000,000	
Annual Revenue > $1,000,000	
Annual Number of Burns	Reported number of prescribed burns conducted
Annual Acres Burned (1000's)	Reported total acreage burned
Lower Size of Burns Exceeds 10 Acres	Equals 1 if reported lower size range of burns exceeds 10 acres
Has Prescribed Burn Liability Coverage	Equals 1 if reports having some type of liability coverage for prescribed burn damages

Table 31. Coefficient estimates for the expected number of escapes per year.

Variable	Coefficient	Error	t-statistic	p-value
Intercept	-4.132	0.398	-10.391	<0.001
Burn in Midwest	-0.792	0.346	-2.287	0.022
Burn in West	-2.309	0.669	-3.449	0.001
Primary Fuel > 33% Grass	0.748	0.339	2.203	0.028
Primary Fuel > 33% Brush	0.0349	0.542	0.064	0.949
Primary Fuel > 33% Slash	1.146	0.243	4.711	<0.001
Primary Fuel > 33% Timber	-1.619	0.245	-6.611	<0.001
> 50% Burns in Wildland-Urban Interface	-1.269	0.383	-3.310	0.001
At Least 10 Years Fire Suppression	1.300	0.255	5.103	<0.001
Never/Rarely Start Burns after Sunset	-1.043	0.294	-3.548	<0.001
Burn Boss II Certification	-0.471	0.262	-1.795	0.073
> 25% Revenue from Burns	-2.269	0.767	-2.958	0.003
> 5% Revenue from Burn Consulting	-1.017	0.529	-1.924	0.054
Annual Revenue $100,000-$250,000	1.161	0.354	3.283	0.001
Annual Revenue $250,000-$1,000,000	1.081	0.332	3.252	0.001
Annual Revenue > $1,000,000	1.036	0.303	3.424	0.001
Annual Number of Burns	-0.0307	0.00326	-9.398	<0.001
Annual Acres Burned (1000's)	0.0254	0.0142	1.781	0.075
Lower Size of Burns Exceeds 10 Acres	1.145	0.306	3.744	<0.001
Has Prescribed Burn Liability Coverage	0.798	0.249	3.202	0.001
Variance Parameter λ	-0.510	0.164	-3.102	0.002

Table 32. Variables used to estimate the expected damage if an escape occurs.

Variable	Description
Burn in South	Equals 1 if conduct burns mostly in AL, AR, FL, GA, LA, MS, OK, TX
At Least 10 Years Fire Suppression	Equals 1 if burn boss has at least 10 years of fire suppression experience
Business Revenue > $250,000	Equals 1 if business revenue exceeds $250,000
Crew Experience Excellent or Very Good	Equals 1 if crew experience reported as excellent or very good
Primary Fuel > 33% Grass	Equals 1 if at least 33% of burns have grass (including scattered sagebrush, savannas and open pine with grass understory) as primary fuel
Primary Fuel > 33% Slash	Equals 1 if at least 33% of burns have slash (logging residues from partial or clear cuts) as primary fuel
Primary Fuel > 33% Timber	Equals 1 if at least 33% of burns have timber (closed canopy stands of short/long needle pine, hardwoods, or dense conifers) as primary fuel
Business Revenue > $1,000,000	Equals 1 if business revenue exceeds $1,000,000
Average Size of Burn (Acres)	Average of lower end and higher end of reported size range for typical burn

Table 33. Coefficient estimates for the expected damage if an escape occurs.

Variable	Coefficient	Error	t-statistic	p-value
Intercept	-1.984	0.649	-3.056	0.002
Burns in South	1.860	0.675	2.753	0.006
At Least 10 Years Fire Suppression	-1.388	0.695	-1.998	0.046
Business Revenue > $250,000	1.795	0.684	2.626	0.009
Intercept	-21,532	11,697	-1.841	0.066
Crew Experience Excellent or Very Good	-23,608	10,034	-2.353	0.019
Primary Fuel > 33% Grass	31,478	9,050.4	3.478	0.001
Primary Fuel > 33% Slash	18,744	11,575	1.619	0.105
Primary Fuel > 33% Timber	50,720	11,444	4.432	0.000
Business Revenue > $1,000,000	19,091	8,958.1	2.131	0.033
Average Size of Burn (Acres)	-47.119	22.456	-2.098	0.036
Variance Parameter σ	8,967.5	1,981.1	4.527	0.000

Insurance Analysis

This section explains how to use the estimation results for escapes and losses described in the previous sections to estimate insurance premiums. Several equations are provided and explained, and an explanation of how to use the accompanying spreadsheet to calculate premiums is included. Finally, a subsection provides several caveats for these results and some of the limits of this analysis.

Actuarially Fair Insurance Premium with Deductible

Equation (12) gives the expected damage per escape, not per year. Let D_i be the damage from all escaped fires by prescribed burner i. The expected damage per year is then the product of the expected number of escapes as given by equations (2) and (3) and the expected damage per escape as given by equation (12):

(13) $$\mathrm{E}[D_i] = \mathrm{E}[e_i]\mathrm{E}[d_i]$$

$$\mathrm{E}[D_i] = n_i \exp(\theta' W_i)\Phi\left(\alpha' Z_i\right)\Phi\left(\beta' X_i / \sigma\right)\left(\beta' X_i + \sigma \frac{\phi\left(\beta' X_i / \sigma\right)}{\Phi\left(\beta' X_i / \sigma\right)}\right).$$

Annual expected damage as defined by equation (13) is actuarially fair insurance premium implied by this empirical analysis of the mail and telephone survey data, i.e., the premium that equals expected indemnities and would give an expected loss ratio of one.

Using equation (13) as an estimate of the actuarially fair insurance premium is problematic because the calculations do not a deductible that must be met before insurance indemnity is triggered. Incorporating a deductible into the calculations requires modifying equations (10)-(13). Let δ_i be the deductible chosen by burner i. With a deductible, equation (10) becomes

(14) $$\Pr[d_i > \delta_i] = \Phi\left(\alpha' Z_i\right)\Phi\left((\beta' X_i - \delta_i)/\sigma\right).$$

The probability that damage occurs for the first hurdle remains unchanged at $\Phi\left(\alpha' Z_i\right)$, but for damage to exceed the deductible raises the second hurdle from 0 to δ_i, so that the probability of exceeding this hurdle becomes $\Phi\left((\beta' X_i - \delta_i)/\sigma\right)$.

With a deductible, equation (11) becomes

(15) $$\mathrm{E}[d_i \mid d_i > \delta_i] = \beta' X_i - \delta_i + \sigma \frac{\phi\left((\beta' X_i - \delta_i)/\sigma\right)}{\Phi\left((\beta' X_i - \delta_i)/\sigma\right)}.$$

The deductible reduces the mean loss paid by the amount δ_i and the Inverse Mill's Ratio must also be adjusted to capture the effect of the deductible.

With these changes due to the deductible, equations (12) and (13) then become

(16) $$\mathrm{E}[d_i] = \Phi\left(\alpha' Z_i\right)\Phi\left((\beta' X_i - \delta_i)/\sigma\right)\left(\beta' X_i - \delta_i + \sigma \frac{\phi\left((\beta' X_i - \delta_i)/\sigma\right)}{\Phi\left((\beta' X_i - \delta_i)/\sigma\right)}\right).$$

(17) $$\mathrm{E}[D_i] = n_i \exp(\theta' W_i)\Phi\left(\alpha' Z_i\right)\Phi\left((\beta' X_i - \delta_i)/\sigma\right)\left(\beta' X_i - \delta_i + \sigma \frac{\phi\left((\beta' X_i - \delta_i)/\sigma\right)}{\Phi\left((\beta' X_i - \delta_i)/\sigma\right)}\right).$$

Using the Analyzer Spreadsheet

The spreadsheet Prescribed Fire Analyzer.xls accompanying this document should be fairly easy to use for those familiar with spreadsheets, so that the mechanics of navigating and using the spreadsheet are not explained here. Users characterize a prescribed burner by answering several questions with pull-down menus or by entering numbers. The escape and damage models described above then use these answers as the regressors (vectors W_i, Z_i, and X_i) to estimate for the prescribed burner several values of interest to an insurance company, such as the expected number of escapes per year and the expected damage per year. In addition, the user must enter an insurance deductible. Users not interested in insurance should set the deductible to zero. The discussion here describes in more detail each of the values estimated by the spreadsheet. Finally, several caveats are applied to help users understand the weaknesses of the spreadsheet and what the analysis does not include.

Expected Escape Rate per Burn: This value is the estimated average number of prescribed fire escapes that will occur per prescribed burn, which in terms of the escape model is the μ_i calculated for burner i using equation (2).

Expected Escapes per Year: This value is the estimated average number of prescribed fire escapes that will occur over a year, which in terms of the escape model is the $E[e_i]$ calculated for burner i using equation (3). This value will typically exceed the Expected Escape Rate per Burn since most prescribed burners conduct more than one prescribed burn per year.

Probability of Damage > Deductible for an Escape: This value is the expected probability that positive damage will occur above the deductible when a prescribed fire escapes, which in terms of the damage model is the $\Pr[d_i > \delta_i]$ calculated for burner i using equation (14).

Expected Payment for Escape when Damage > Deductible: This value is the estimated average damage that will occur for an escaped prescribed fire when damage occurs that exceeds the deductible, which in terms of the damage model is the $E[d_i \mid d_i > \delta_i]$ calculated for burner i using equation (15).

Expected Damage for an Escape: This value is the estimated average damage that will occur in excess of the deductible for an escaped prescribed fire, which in terms of the damage model is the $E[d_i]$ calculated for burner i using equation (16). This value is typically lower than the Expected Payout for an Escape when Damage Occurs because damage is generally not expected to occur for every escape.

Expected Damage per Year/Actuarially Fair Premium: This value is the estimated average damage that will occur in excess of the deductible over a year, which in terms of the escape model is the $E[D_i]$ calculated for burner i using equation (17). This value is the expected annual payout that an insurance company would make for damages above the deductible caused by this prescribed burner, and so is also the actuarially fair insurance premium for the burner.

Probability of Escapes: This table gives the probability of prescribed burner i having 0, 1, 2, …, 10 escapes per year, which in terms of the escape model is calculated for burner i using equation (4) and $k = 0, 1, 2, \ldots, 10$.

In some cases, the calculated premium may be very low because the characteristics of the prescribed burner imply a low risk of escapes and/or damages. In these cases, the discussion in previous sections can help determine the likely cause of this low premium and the user can decide if the result makes sense. The discussion of the effect of each variable on the expected number of escapes and/or the probability and magnitude of damage can help determine whether each variable will increase or decrease expected escapes and damage. Also, the user can compare the values set for the regressors and the bullet points identifying the characteristics of prescribed burners at higher risk for escapes and damage. Prescribed burners with more than one of these high risk characteristics may have high premiums and those with none of them may have very low premiums. Finally, the spreadsheet reports values for many of the intermediate steps in the calculation, which are discussed in a previous section. The user can use these values to identify which value is very small or large and drives the unexpected premium.

Caveats for Insurance Results

This section explains in more detail several factors missing from the analysis and thus that do not affect the calculated premiums the spreadsheet reports. The discussion explains the nature of the problem with the analysis and the likely effect of incorporating some of these factors.

No Administrative or Catastrophic Loads on Premiums

The reported premiums are estimates of the fair premium, and so do not include an administrative load for a company to recover costs and earn a normal rate of return for the risk they bear. In addition, these premiums do not include any sort of catastrophic load to build surpluses for years when insured burners file more than the usual number of claims. The magnitude of these loads is likely comparable to those used for other liability policies. There potentially may be a larger than usual systematic component to the liability risk, in that regional factors such as drought may contribute to higher than average claims. For example, the large number of wild fires in northern Texas and Oklahoma during the winter of 2005-2006 was due to the dryer and windier than normal weather during this period. However, these were wildfires and certified prescribed burners would likely not conduct prescribed burns under these conditions, which would mitigate this systematic risk to some extent.

Lack of Catastrophic Losses in Survey Data

In general, the data used for this study did not include any large losses. As Tables 27 and 28 show, the largest single loss for an escape was $22,000. Some probability for catastrophic claims exists and should be incorporated into insurance premiums. However, estimating the probability and magnitude of such claims is difficult without data. To understand the magnitude of this problem, personnel at Agren, Inc. conducted an informal survey of state fire/forestry contacts and state fire leads for The Nature Conservancy, a non-profit organization that conducts prescribed burns in numerous states. A letter was sent to a list of contacts asking for assistance (see Appendix C for a copy of the letter). The written/email and telephone responses to this survey are reported in Table 34. To maintain anonymity, all names and identifiers have been removed from response and some errors of grammar, syntax, or sense were corrected.

Responses from 24 states were returned, with responses from more than one person in some states. Respondents in states from all regions but the South reported no knowledge/awareness of

prescribed fire escapes that exceeded $100,000 in property damages, suppression costs, and personal injury. In the South, several states report such catastrophic damages. Specifically, state officials reported such incidents in Florida, Georgia, Louisiana, and South Carolina, and The Nature Conservancy (TNC) state respondents reported such incidents in Alabama, Arkansas, Florida, and Louisiana. In addition, a respondent from Georgia sent a copy of a report by Mobley (1996) describing the number of smoke related accidents and associated fatalities and damages from prescribed fires in several southern states, including Alabama, Florida, Georgia, Louisiana, Mississippi, and South Carolina.

The implication of this data and the Mobley (1996) report is that in areas other than the South, catastrophic damages from escaped prescribed fires and/or smoke damage are rare. In the South, the mail and telephone survey used for this study only included prescribed burners with mailing addresses in Florida and Texas, though many of these conducted prescribed burns in several southern states. It would seem that prescribed burners who had catastrophic losses during the surveyed years in the southern states identified by Mobley (1996) and in Table 34 were not in our survey population. Of the mentioned escapes or smoke claims in Mobley (1996) and Table 34, only the escape mentioned by The Nature Conservancy comment for Florida should have been in the data collected for this study, but was not. These findings indicate that the estimated expected damages and actuarially fair premiums are likely too low for the southern region because data on known larger escapes was not available for use in estimation.

Smoke Damages, Bodily Injury, and Suppression Costs Not Included

Due to a lack of data, the estimated damages and associated premiums do not include claims made for damage from smoke. Of the original 232 returned mails surveys with 458 useable burner-years observations, only 2 smoke claims were reported, both of which occurred without an escape. Of these, one reported no actual damage; rather that he received several complaints for smoke. The other smoke claim reported $2,000 spent for traffic control used to reduce the likelihood of accidents, not for property damage caused by the burn (see Table 29). Statistically, it is almost meaningless to estimate a multiple-parameter model with only two observations. As a result, without further data, this analysis does not incorporate smoke claims. However, Mobley (1996) indicates that serious traffic accidents with significant personal injury and several fatalities have occurred due to smoke from prescribed burns in southern states not in the survey population for this study (see discussion above).

Also due to a lack of data, the estimated damages and associated premiums do not include claims made for bodily injury. The follow-up telephone survey of all mail survey respondents reporting escapes had no prescribed burners reporting any claims for bodily injury. Again, as a result, without further data, this analysis does not incorporate claims for bodily injury. However, Mobley (1996) and an informal survey summarized in Table 34 indicates that such claims have occurred in the past and that incidents of this sort were not captured in our survey data.

The analysis of losses from escapes does not include the cost of additional suppression activities, either by the company conducting the prescribed burn or others brought in to assist, such as public fire fighters. As Table 24 indicates, these costs were in general small. Only 26% of the escapes in the telephone survey reported additional suppression costs (beyond salaries for employees). Of these, the range in costs was $35 to $2,500, with an average of $778 and a

median of $500. These were not included as a cost that an insurance company would pay, but treated as a cost the prescribed burner pays, in some sense like a deductible. If these costs were to be included as part of a prescribed burner liability policy, the analysis could be repeated and include these as part of the total damage. A quick examination of the data indicates that these costs would increase the total damages for the escapes that caused damage by at most $2,500 and would add 11 more escapes with positive losses ranging from $35 to $1,600. These numbers show that adding these suppression costs as reported in the telephone survey would not greatly increase the expected damages or premiums. However, these available data do not include suppression costs for catastrophic escaped fires, which can be quite large. For example, the informal survey summarized in Table 34 reports $300,000-$400,000 in suppression costs for an escaped prescribed burn in Florida. The main point is that suppression costs are not included in this analysis, but if the suppression costs from the survey data were included, premiums would not increase substantially. However, as for smoke damages and bodily injury, there is a general lack of data for catastrophic escapes with high suppression costs.

Liability Cap Not Included

The analysis and associated premiums do not impose a cap on indemnities paid, a common feature of most liability policies. Including such a cap would involve subtracting factors from equations (14)-(17) that would be similar in form as these equations that incorporated a deductible. However, such caps would likely be large, and, because the data and associated analysis do not assign much probability to high value loss events, incorporating such caps would reduce premiums a very small amount. As a result, to avoid adding more model complexity to obtain essentially the same results, the analysis and estimated premiums do not include liability caps. Imposing such caps based on this analysis of these data would reduce estimated fair premiums a very small amount. The amount that premiums should decrease due to imposing the cap can be determined with the Prescribed Fire Escape and Damage Analyzer by entering the cap as the deductible. The amount of the Expected Damage per Year/Actuarially Fair Premium is then the amount that the fair premium would decrease as a result of imposing the cap.

Out of Sample Predictions

Those using the accompanying spreadsheet to calculate the actuarially fair premiums must choose or enter values for each of the variables used as regressors. The coefficients used to calculate premiums were estimated using the mail and telephone survey data, and so are dependent on the sample data used. If values are entered that are outside of the range of the sample data or in some sense extreme, the calculated premiums can become zero or very large. This problem or weakness results from using the model to predict outside of the sample data with which it was estimated. An attempt was made to choose variables as regressors that would help mitigate this problem. As a result, several of the regressors are indicator variables that change from 0 to 1 once a variable falls within a certain range. For example, instead of using the percentage of prescribed burns with the primary fuel type of grass as a continuous regressor, the reported data converts responses into either a 0 or 1 depending on whether it exceeds 33% or not. However, even this does not prevent someone from choosing “More than 33%” for all four fuel types, even though such a response is not mathematically possible. The main point is that sometimes, depending on the values set for the regressors, the model will generate premiums that are not realistic.

Expectations of Prescribed Burners for Liability Insurance

As part of this project, a focus group was held at a conference that included several prescribed burners in attendance. This focus group consisted of nine individuals from around the Midwest, with most from Wisconsin (where the conference was held). Table 36 reports some of the information collected from participants.

Table 36 shows that these prescribed burners preferred a prescribed burn liability policy with a deductible $1,000 to $5,000, except for one who wanted a $50,000 deductible (essentially a catastrophic policy). In terms of willingness to pay for such a policy, four reported a premium $1,000 or less, the remaining responses ranged $3,000 to $9,000. Using the spreadsheet to calculate premiums for typical Midwestern prescribed burners indicates that premiums for many prescribed burners would be in (or less than) the range they expect. For smaller companies (annual business revenue less than $250,000), the calculated premium is often quite small. However, the calculation does not include the several factors identified in the previous section, such as standard administrative loads, plus adjustments for the potential for catastrophic loss events, as well as smoke claims and bodily injury, as well as suppression costs.

Finally, the spreadsheet file for the telephone survey included several responses to open ended questions. In particular, one questions asked respondents to describe why the escape occurred and the extent of the resulting damage, while the survey ended by offering respondents to offer any comments they wished. These responses are useful for understanding escapes and fires that cause damage and the type of people conducting prescribed burns and their experiences with escapes, damage, and insurance. These comments could be useful for an insurance company considering offering a prescribed fire liability policy.

Insurance Analysis Tables

Table 34. Responses to request for information on prescribed fire escapes causing more than $100,000 in damage or personal injury in the last ten years (see Appendix C for copy of letter).

State	Response by State Officials	Response by The Nature Conservancy
Alabama		The Grand Bay fire is the one known as Yellowhammer, which was in Alabama.
Arkansas		Arkansas recently (2005) had a private contractor who was insured pay out $250,000 to a timber company. He lost his insurance - I think the payout happened in 2006. It was an escape from one timber company on to another - and I believe all the damage was to standing timer or seedlings. I don't know of any others in the last 3 years.
Connecticut	To my knowledge we have none.	
Delaware	I am unaware of any fires in Delaware that caused damages in excess of $100,000.	
Florida	Carlton Prescribed fire: In 1998 a private contractor had a prescribed fire that escaped and may have burned down a structure. The resulting claim was over $1,000,000. There was at least one home burned and several damaged. I do not remember the exact number that were damaged, but I had to stop saying that a prescribed burn had NEVER burned anyone's home in Florida after that fire.	Sarasota County Environmental Lands Program contracted their prescribed fire out to a low-bid private vendor. The provider burned on a very risky day. The fire escaped and burned off-property, Jumped I-75 South. The fire Burned several homes and a logging camp. $300,000-$400,000 suppression cost plus damages to private property. I believe it was 2002/2003. For more information see, http://www.redcross.org/news/ds/fires/010423florida.html
Georgia	The chances of a prescribed fire causing a highway accident diminish greatly with burning distance of more than ½ mile from the highway. Here is a data chart from Georgia with 4 years of data showing total permitted silvicultural fires and escaped fires and numbers (Chart given as Table 35).	

State	Response by State Officials	Response by The Nature Conservancy
Iowa	I'm not aware of any prescribed fire that has been out of control that has incurred damages of that nature. I do not know of any fires that caused over 100,000 in damages. I am not aware of any damages that were a result of prescribed fire in Iowa by a private contractor or non-government organization that occurred in the past 10 years that may have been over $100,000	
Kansas	We burn thousands of acres annually in the area of the state referred to as the Flinthills, huge tracts of grassland with dwellings, improvements and communities sprinkled throughout. We, to my knowledge have not had a prescribed fire that cause a $100,000 in damage in my 25 year career in fire suppression. This year we did suffer one fire loss that exceeded that dollar amount, but it was caused by dry lightning.	
Kentucky	I do not know of any prescribed fire damages over $100,000 in Kentucky.	
Louisiana	I am not aware of any claims over $100,000 in the last ten years. I think there was a claim around $5 million around 1984. A site preparation burn contributed to a fatality involving a bus on Interstate 12. Most contractors were unable to retain insurance following this accident and many of them just quit the practice. I know of one case in litigation that an escaped prescribed burn may result in a claim of $70,000.	As per the request below, I'm sending along information regarding an "incident" on a prescribed burn conducted by TNC in LA in 2003, and resulting suit and settlement. Date of incident: 2 June 2003 Location: Allen Parish, LA Accident Brief Summary: Smoke traveled across a public gravel road during a prescribed burn being conducted by TNC-Louisiana Field Office personnel. A passing motorist was stopped and warned/advised of the situation before entering the smoke zone, then, according to TNC fire crew on the scene, did not abide by the directions given to him, and proceeded to crash into a TNC tractor on the road

State	Response by State Officials	Response by The Nature Conservancy
		performing patrol. Motorists (1 male and 1 female) claimed personal injuries resulting from this accident. Of interest, State Farm Insurance reimbursed TNC for the estimated cost of damages to the tractor resulting from the accident. Suit and Outcome: Motorists filed suit against TNC within a few months, and even though the local TNC office believed we would win hands-down against the claimants in a court case, TNC's insurer settled with the claimants for the total sum of $235,000 in July 2005.
Maine	There have been no damages caused by prescribed fire. Maine has only recently (last 4-5 years) been using prescribed fire (approximately 200 acres annually). TNC is the leading non govt. entity using fire. I am not aware of any significant damage resulting from their fires.	
Missouri	To my memory, I cannot recall any escaped prescribed fire in Missouri which has resulted in losses greater than $100,000	
Nebraska		I don't know of any. We've been pretty lucky in Nebraska on proper, planned, permitted fires. I'm not aware of any liability claims with TNC prescribed fires in Nebraska.
New Hampshire	I do not know of any damages from prescribed fire in New Hampshire amounting to $100,000 in the last 10 years, or at all for that matter. The vast majority of prescribed fire in NH is conducted by the White Mountain National Forest, the New Hampshire Division of Forests and Lands, or the New Boston Air Force Station, all government agencies. The Nature Conservancy plans on starting to conduct some burns on	

State	Response by State Officials	Response by The Nature Conservancy
	their property, and there are several private blueberry growers who burn their own property to stimulate berry production, but I know of no damages. The only escaped prescribed fire I am aware of was on the DOD New Boston Air Force base several years ago, but again, that was government.	
North Carolina	I've polled the field & NC doesn't have any burns that meet the criteria.	
Ohio	During the past 10 years there have been no instances of a prescribed fire being lead by a contractor or non-governmental organization that caused damages over $100,000 in the State of Ohio. In fact I only know of one case in the past 10 years in Ohio of a prescribed burn that was lead by a contractor or non-governmental organization that caused damage and the cost of this damage was in the $1,000 - 2,000 range.	
Oklahoma	Based upon our recent discussion about the possibility of offering insurance coverage for prescribed burning activities in Oklahoma, and your inquiry as to whether we were aware of any prescribed burning related incidents that may have led to a claim in excess of $100,000 or which may have contributed to a highway accident, I asked for input from four other State Forestry agency employees and two other individuals familiar with prescribed burning in Oklahoma (not listed here). Each of these people responded to my inquiry. To our knowledge, we are not aware of any specific incident within the past ten years that meets the criteria described above that was associated with a prescribed burn. One person	

State	Response by State Officials	Response by The Nature Conservancy
	vaguely recalled a traffic accident in the late 1980's east of Enid, Oklahoma where a farmer was burning stubble at night and smoked in the highway. He could not remember any details or the result of any claims that may have resulted.	
Oregon	The Oregon Department of Forestry provides wildfire protection services on approximately 15.8 million acres of private, municipal, state and federal forestland throughout Oregon. In an average year the Department responds to about 1,100 fires, of which two-thirds are human caused, which burn across 22,000 acres. A recent query of our wildfire statistics database indicated that no fire in the past ten years, which was related to a cause of prescribed burning, cost more than $100,000 to suppress. We track the cost to suppress fires very closely, but do not track the cost of damage that fires cause to property, crops, timber or to other values at risk with any degree of accuracy.	
Pennsylvania		Within the last 10 years, there are only two escapes in PA that I know of- TNC-PA has had one escape- 6 acres that burned an area of the property that was scheduled to be burned the following year- no damages, but about $1000 in suppression costs. NPS had an escape of several hundred acres from a Rx burn, but was contained on the park property. It did get some media attention, but as far as I know, did not result in insurance claims.
South Carolina	The best information I have shows 2 prescribed burns in South Carolina that meets the requirements stated in your letter. One burn escaped and timber damage from the fire was estimated over $100,000. We don't	

State	Response by State Officials	Response by The Nature Conservancy
	have exact figures. On one burn, smoke caused visibility problems on an interstate resulting in a multi car wreck and 1 fatality and several injuries. Again, no exact dollar figure, but estimates put it over $100,000.	
South Dakota	I'm not aware of any large scale fires that escaped control from Non-Governmental Organizations (NGO's) that resulted in any serious civil damage claims against the persons or the NGO lighting the fires here in South Dakota.	
Tennessee	There have been property losses in Tennessee from Rx fire but I am not aware of any that are over $100,000.	
Texas	None. Tom Buman (Agren, Inc.) has hard copy of letter stating: "In reviewing our Agency records for the past 10 years, we can not find any cases of escaped prescribed burning causing damages in excess of $100,000. This is primarily in the eastern 1/3 of the state and would include burns done by contractors and agencies.	
Wisconsin	To my direct knowledge, I know of no incident of an escaped prescribed fire with my agency's involvement that caused over $100,000 of claims to an insurance company.	

Table 35. Table adapted from table sent by Georgia state respondent to informal survey of knowledge of prescribed fires exceeding $100,000 in damage in last 10 years. See comments in Table 34 of Georgia respondent.

	Fiscal Year			
Item	2003	2004	2004	2004
Total Silviculture Permits	15,164	20,885	20,722	24,327
Permitted Silviculture Acres Burned	706,907	955,329	952,652	1,098,589
Number of Wildfires Resulting from Prescribed Burns	158	537	277	523
Wildfire Acres resulting from escaped Prescribed Burns	544	3,755	1,687	3,645
Number of Escaped Prescribed Burn Caused Wildfires Over 100 Acres	0	5	0	3
Site Preparation Caused Wildfires	154	374	211	402
Site Preparation Caused Wildfires Acre	417	2,871	999	2,013
Number of Site Preparation Caused Wildfires Over 100 Acres	0	4	2	2

Table 36. Summary of results from focus group.

ID	Years Fire Experience	% Income from Fire	Annual Burns	Annual Acres	Preferred Deductible	Preferred Premium	Preferred Policy*
FG-1	9	15			5000	5000	Combined
FG-2		25	45	800	5000	9000	Combined
FG-3	15				2000	700	Combined
FG-4		5	50	10 to 15	50,000	1000	Separate
FG-5	11	10	15	200	2000	200-500	
FG-6	18				1000	3000	Either
FG-7					1000-1500	5000	
FG-8			100-150	900-2000	1000-2000	3000	Combined
FG-9	18				1000	500	

*Do you prefer a prescribed burn liability policy combined with a general liability policy, or a separate prescribed burn liability policy.

Summary of Spreadsheet Data Files

This report is accompanied by two spreadsheet files that contain the data from the mail and telephone surveys (Mail Survey.xls and Phone Survey.xls). In each spreadsheet are multiple sheets. This section will briefly describe these sheets and what they contain.

Mail Survey.xls
Raw Data: This sheet contains the raw data from each returned mail survey. Each survey has a unique numerical identifier in the first column and respondent answers to each question are in the row with that identifier. Each column is the answer of all respondents to a particular question. Each question is numbered as on the original survey (see Appendix A) and this number appears at the top of each column. In addition, each column has a short title used for each variable in other sheets. Some questions have been dropped from this sheet to maintain anonymity of respondents. The answers to each question are as on the survey, and so many are verbal or use short codes. The given responses can be understood by examining the specific questions in the original survey as provided in Appendix A.

The second column reports the status of the observation in that row as either "drop" or "keep." Drop means the observation was dropped because the respondent did not conduct prescribed burns, or did not provide response to questions on the number of prescribed burns conducted per year or acres burned, or both. Observations with keep were used for the analysis of escapes, bit the responses required further processing for use in estimation.

Observations Kept: This sheet contains all the raw observations kept from the Raw Data sheet, as indicated by their status reported in the second column of the Raw Data sheet. In addition, missing responses were converted to -999 in this sheet.

Stacked and Cleaned: This sheet contains the final data used for the statistical analysis of escaped fires. In this sheet, all responses are converted to numbers. Categorical responses were converted to 0, 1, 2, 3, … generally following the order in the original mail survey. Examining responses in the Observations Kept sheet and comparing them to those in this sheet will indicate the specific coding used for each variable. In addition, because respondents provide information on burns in more than one year, this sheet "stacks" the observations by making responses for each year one observation. Thus the 112 useable surveys become 458 burner-year observations.

Summary: This sheet contains tables summarizing responses to individual questions. These summaries were used to create Tables 1-20 in this report.

Telephone Survey.xls
Raw Data: This sheet contains the raw data from each telephone survey as generated by the Blaise software used by the Center for Survey Statistics and Methodology at Iowa State University. Each survey has a unique numerical identifier in the first column that is the same as used for the mail survey. Respondent answers to each question are in the row with that identifier. Each column is the answer of all respondents to a particular question. Each question is numbered as given in the Coding Manual in Appendix B. Again, some questions have been dropped from this sheet to maintain anonymity of respondents. Narrow empty columns have

been inserted to separate responses to each of up to four escaped fires and responses to smoke claims. Blaise software codes missing or non-applicable responses as some form of repeating 8's. Most of these remain in this form, though some have been converted to -999.

Cleaned Escapes: This sheet is a cleaned version of the Raw Data sheet responses for escaped fires. This cleaning includes converting all missing responses to -999. In addition, since some respondents report information for more than one escaped fire, these responses have been "stacked" by making each escaped fire a single observation, which converts the 47 useable responses for escaped fires into 74 observations. Finally, each variable title at the top of each column has been replaced with short title derived from what the variable actually reports. The coding manual in Appendix B has the actual question from which these titles were derived.

Cleaned Smoke Claims: This sheet contains responses for the two smoke claims after they have been processed in much the same manner as for the Cleaned Escapes sheet.

Summary: This sheet contains tables summarizing responses to individual questions. These summaries were used to create Tables 21-29 in this report.

Open Questions: This sheet contains the text recording the responses to the two open questions and the opportunity to offer final comments. The second column identifies the question to which the text is the response.

Combined Mail and Telephone: This sheet contains the final data used for the statistical analysis of the damage caused by escaped fires. This data is the same data as in the Cleaned Escape sheet, combined with the data from the Stacked and Cleaned sheet in the Mail Survey.xls spreadsheet. Note that some observations in the Cleaned Escape sheet were not in the Stacked and Cleaned sheet from the mail survey because the respondents did not provide answers to questions about the number of burns conducted each year and the acres burned each year, and as a result did not have a "keep" status. The data for these cases were taken from the Raw Data sheet in the mail survey spreadsheet and processed the same as the observations in the Observations Kept and the Stacked and Cleaned sheets in the mail survey spreadsheet.

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Appendix A: Mail Survey Instrument

The next section of the document is a copy of the mail survey.

OMB Approval Number: 0563-0071
Expiration Date: 02/29/2008

PRESCRIBED FIRE LIABILITY INSURANCE SURVEY

Conducted on behalf of
Risk Management Agency
U.S. Department of Agriculture

Results of this survey will be used to determine the feasibility of developing an affordable risk management tool for contractors who conduct prescribed burns. If it is determined to be feasible, these results will also be used in design of an insurance program. Participation in the survey is voluntary. All information provided will be treated confidentially. Results will be aggregated to avoid disclosure of individual responses.

Survey on Prescribed Fire Operations and Insurance

The information you provide on this survey will be invaluable for determining the feasibility of offering an affordable and accessible prescribed fire insurance policy.

INSTRUCTIONS
The person **MOST** responsible for prescribed fire activities should fill out and return the survey.

We are only interested in surveying people or businesses that have been paid to conduct prescribed burns as a part of their business within the 5-year period of 1999 - 2003. If you do not meet these requirements, please answer QUESTION #1 of the survey and return it in the enclosed business reply envelope, so we do not attempt to contact you again.

Please answer all of the questions. If you wish to comment on any questions or qualify your answers, please feel free to use the space in the margins or to attach an additional sheet(s) of paper. Your comments will be read and taken into account as we develop the insurance policy.

Again, thank you for your time and information!

Section I. Prescribed Fire Operations

1. **Has your business or organization conducted prescribed burns as a part of doing business in the five year period of 1999 - 2003?**

   ❒ Yes
   ❒ No ➔ *Please return the survey in the enclosed pre-paid envelope. Thank you for your time.*

2. **We are interested in knowing how often your business currently engages in the following practices. For each practice, check the box that *most closely applies*.**

	Frequency of Occurrence				
Practice	**Never**	**Rarely**	**Sometimes**	**Often**	**Always**
Use a written burn plan	❒	❒	❒	❒	❒
Predict smoke behavior.....	❒	❒	❒	❒	❒
Wear personal protective equipment (Nomex, leather boots and gloves, and a helmet).....	❒	❒	❒	❒	❒

3. **We are also interested in knowing what client groups you serve. Please check <u>all</u> the categories that apply.**

   - ❒ Lumber companies
   - ❒ Farmers or ranchers
   - ❒ Game farms or hunting preserves
   - ❒ Private land owners (not full-time farmers/ranchers)
   - ❒ Federal/State/Local jurisdictions
   - ❒ Other, please specify _____

4. **Please indicate below the number of prescribed burns conducted and total acres burned for the five year period, starting with 1999.**

Year	Number of Burns Conducted	Total Acres Burned
Jan. 1999 – Dec. 1999	_____	_____
Jan. 2000 – Dec. 2000	_____	_____
Jan. 2001 – Dec. 2001	_____	_____
Jan. 2002 – Dec. 2002	_____	_____
Jan. 2003 – Dec. 2003	_____	_____

For the following set of questions, the timeframe we are interested in knowing about includes the **five year period of January 1999 to December 2003**.

5. **What percentage of prescribed burns have you conducted that occurred in a <u>wildland/ urban interface</u>, or areas where human communities are built in close proximity to flammable fuels found in wildlands?**

   - ❒ 0%
   - ❒ 1–25%
   - ❒ 26–50%
   - ❒ 51–75%
   - ❒ 76–100%

6. **What percentage of prescribed burns have you conducted that occurred on <u>land next to public lands</u>?**

   - ❒ 0%
   - ❒ 1–25%
   - ❒ 26–50%
   - ❒ 51–75%
   - ❒ 76–100%

7. What percentage of prescribed burns have you conducted that occurred in <u>sparsely populated areas</u>?

- ❒ 0%
- ❒ 1–25%
- ❒ 26–50%
- ❒ 51–75%
- ❒ 76–100%

8. Consider the <u>primary fuel</u> that is the carrier of prescribed fires that you ignite. In the five year period, approximately what percentage of burns did you conduct in each of the following fuel categories? If you have conducted none in a given type, please enter 0 for the percentage.

Fuel Type	% Conducted <u>in this type</u>
I. **Grass** – Grasslands, scattered sagebrush, savannas, and open pine stands with grass understory	_____
II. **Brush** – Dense fields of brush including chaparral and pocosins	_____
III. **Timber** – Closed canopy stands of short or long needle pine, hardwoods, or dense conifer stands with heavy ground fuels	_____
IV. **Slash** – Logging residues including partial and clear cuts.....	_____
Total	100%

9. We are interested in knowing how often your business has engaged in the following practices over the five year period. For each practice, check the box that *<u>most closely applies</u>*.**

	Frequency of Occurrence				
	<u>Never</u>	<u>Rarely</u>	<u>Sometimes</u>	<u>Often</u>	<u>Always</u>
Initiated a prescribed burn after sunset	❒	❒	❒	❒	❒
Conducted prescribed burn where open flames are present for more than 24 hours	❒	❒	❒	❒	❒
Extinguished smoldering fire along containment lines after sunset	❒	❒	❒	❒	❒

10. Consider the size of prescribed burns you conduct *most frequently*. In acres, what is the low end of the range? What is the high end of the range? *(Please note: We are not interested in the biggest or smallest fire you have conducted, but a range that covers the majority of your prescribed burns.)*

Low end of the range = _____ acres

High end of the range = _____ acres

The next question refers to escaped fires and non-escape smoke claims. Please refer to and use OUR definitions for escapes and non-escape smoke claims below.

Escaped fire = Any fire that has burned beyond the planned perimeter.

Non-escaped smoke claim = A claim made against you or your insurance company for damages resulting from smoke from a non-escaped fire.

11. Please fill in the following table to indicate *how often* the following have occurred over the five-year period.

Year	Number of Escaped Fires	Number of Smoke Claims from an Escaped Fire	Number of Smoke Claims from a Non-Escaped Fire
1999	_____	_____	_____
2000	_____	_____	_____
2001	_____	_____	_____
2002	_____	_____	_____
2003	_____	_____	_____

Section II. Business' Experience with Insurance

For the following questions, 'General Liability Insurance' pertains to that coverage your business has to protect itself from claims made against the business.

12. Has your business carried general liability insurance in any year of the five year period?

- ❒ Yes
- ❒ No ➔ **Go to Question 16, Section III.**
- ❒ Don't Know

13. Does your business currently carry general liability insurance?

- ❒ Yes
- ❒ No ➔ **Go to Question 16, Section III.**
- ❒ Don't Know

14. What do you currently pay for comprehensive general liability insurance per year?

$ _____ per year

15. Does your comprehensive general liability insurance policy have language in it that ***specifically* addresses your prescribed fire operations? Please check the response that ***most accurately*** reflects your answer.**

- ❒ No
- ❒ No, but my agent assures me the policy would cover my prescribed fire operations
- ❒ Yes, but no claims have been made against the policy
- ❒ Yes, and claims have been settled under the policy
- ❒ I do not know

Section III. Business Characteristics

For the following questions, the 'burn boss' could be you or another person in your company who is primarily responsible for prescribed fire activities in the field.

16. How many *total* years of prescribed fire experience does your burn boss have? (Include years with entities other than your current business.)

_____ years

17. How many *total* years of wildfire suppression experience does your burn boss have? (Include years with entities other than your current business.)

_____ years

18. How does the amount of accumulated training in prescribed fire that your burn boss has, compare with the National Wildfire Coordinating Group (NWCG) Burn Boss II designation? Please check the category that ***most closely applies*.

- ❒ Less than NWCG Burn Boss II
- ❒ Roughly equal to NWCG Burn Boss II
- ❒ More than NWCG Burn Boss II
- ❒ I don't know
- ❒ Other (Please explain _____)

19. What is your role with the company? Please include your title and a short description of your duties.

_____

_____

_____

20. If we need to call back for clarification of an answer, for whom should we ask?

Person's Name: _____ Daytime Telephone: _____

The next two questions ask specific information about your business. This information will be used to determine the feasibility of offering an **affordable and accessible** prescribed fire liability insurance policy.

21. Over the five year period (1999 – 2003), what was your business' average gross income (per year)?

- ❒ Less than $100,000
- ❒ $100,000–$249,999
- ❒ $250,000–$499,999
- ❒ $500,000–$999,999
- ❒ $1 million–$5 million
- ❒ Greater than $5 million

22. Please fill in the following table to indicate the range of activities your business is engaged in and the approximate percentage of gross revenue from each activity. (If you are not engaged in a listed activity, please record 0% for that activity.)

Activity	% of Gross Revenue
Prescribed fire	_____%
Mechanical clearing of woody vegetation.....	_____%
Chemical treatment of woody vegetation	_____%
Fire suppression.....	_____%
Consulting on prescribed fire (modeling, teaching, helping prepare burn plans, etc.).....	_____%
Other, please specify _____	_____%
Other, please specify _____	_____%
Total = 100%	100%

23. In a typical year, how many *months* does your burn season last? _____ months

24. How many years has your firm been in business? _____ years

25. Please list the states where your business conducts prescribed burns.

_____

_____

_____

26. When you conduct prescribed burns, do other prescribed burners *not* employed by your company work on the site with you? If 'yes', please indicate the type of prescribed burners that work on site with you, and the total number of hours worked by those burners per year.

		Types of Burners		Number of Hours Spent by Other Burners Per Year
❒ Yes	➔	❒ Other private consultants	➔	_____
		❒ Government agencies	➔	_____
		❒ Other, please specify _____	➔	_____
❒ No				

27. Provided that work is available in the geographic area your business operates in, will you be conducting prescribed fires this year? Please check the box that best represents your answer.

❒ Yes

❒ No ➔ Why not? _____

_____

❒ I have not decided yet ➔ Why not? _____

_____

❒ Other, please explain _____

_____

Thank you for your time! You have now completed the survey. Please share any additional comments or thoughts with us in the space below. When you are finished, please send the completed survey back to us in the enclosed prepaid envelope.

Your additional comments will be considered.

Appendix B: Phone Interview Text and Coding Manual

The next section of the document is a copy of the coding manual for the telephone interviews and should be used to understand abbreviations and variable names in Tables 21-29 and the spreadsheet files accompanying this report.

Escaped Fires Study
Coding Manual
September 2005

Position	FieldName	Fieldtext
1 – 3	CaseID	ISU Case ID
4 – 11	AgrenID	Agren Case ID
12 – 13	IntID	Interviewer ID
14 – 23	State	State location of business
24 – 28	Minutes	Interview length
29 – 36	IntDate	Interview date (MMDDYYYY)
37 – 38	Num1a	1a. First I'll ask a series of questions about escaped fires over a 5-year period from 1999 through 2003. By an escaped fire, I mean any prescribed fire that burns beyond the planned perimeter of the fire. I'm interested in any escape, no matter what size, and whether or not any damage occurred. How many escaped fires did you have from 1999 through 2003? IF 0, Positions 39-668 = 8-8 (Not Applicable)
39 – 40	Num1b	IF Num1a > 7, ASK: 1b. How many of these fires required additional resources or resulted in property damage? 88 Not Applicable (NA)

Position	FieldName	Fieldtext
41-208		STATE/TOWN/DATE OF ESCAPED FIRES. **2a**. Please give me the location – state and closest town – and the date of each of these fires. 88 NA 99 Don't know (DK) **2b**. What date did that fire occur? 8-8 NA 9-9 DK

	2a. State		2a. Town		2b. Date	
Fire	**Position**	**FieldName**	**Position**	**FieldName**	**Position**	**FieldName**
1	41 – 42	StateAbb	43 – 72	Town	73 – 82	Date
2	83 – 84	StateAb2	85 – 114	Town2	115 – 124	Date2
3	125 – 126	StateAb3	127 – 156	Town3	157 – 166	Date3
4	167 – 168	StateAb4	169 – 198	Town4	199 – 208	Date4

ESCAPED FIRE 1.

209	Fuel3a	3a. What would you say was the primary fuel type for the (Fill date of first escaped fire) prescribed fire? 1 Grass 2 Brush 3 Timber 4 Slash 5 Other – Brush/debris pile, Palmetto and wire grass, Even mixture of brush and grass 8 NA
210	Fuel3b	3b. What was the primary fuel type that burned in the escaped fire? 1 Grass 2 Brush 3 Timber 4 Slash 5 Other – Peat, Dried up swamp, Palmetto and wire grass, Even mixture of brush and grass 8 NA

Position	FieldName	Fieldtext
211	Plan4	4. Did you have a burn plan for this fire? (Prescribed Fire Plan) 1 Yes 2 No 8 NA
212 – 217	Intend5	5a. How many acres was the prescribed burn area intended to be? (This would be what was intended to be burned.) 0.1 = 0.1 acres or less 888888 NA
218 – 224	Addl5	5b. How many additional acres burned? (Beyond what you originally intended to burn?) 0.1 = 0.1 acres or less 8888888 NA
225 – 231	Cost6	6. What were the total suppression costs in dollars for the escaped fire, not including salaries for you or your employees? 8888888 NA 9999999 DK
232 – 236	Hours7	7. About how many hours was it from the time the escape was discovered until the escape was extinguished? 88888 NA
237 – 239	Crew8	8. Now I'll ask about some of the resources that were used to address the escape. How many individuals were working on your burn crew when the escape occurred? 0 = None; Fire resumed and escaped after burn crew had left. 888 NA

| Position | FieldName | Fieldtext |

240	Exper9	9. For this escape, how would you rate the crew's combined knowledge of and experience with prescribed burns, not including the burn leader? Overall, was the crew's knowledge and experience ... 1 Excellent 2 Very Good 3 Good 4 Fair 5 Poor 8 NA 9 DK
241	Train10	10. About how much training did the person in charge of the fire have, compared to Burn Boss II designation from the National Wildfire Coordinating Group (NWCG)? Was the amount of training that person had at the time ... 1 Less than Burn Boss II 2 Roughly equal to Burn Boss II 3 More than Burn Boss II 8 NA 9 DK, Don’t know what Burn Boss II is.
242	Intro	Placeholder

Position	FieldName	Fieldtext

243 – 290 ***ADDITIONAL RESOURCES USED, FIRE 1.***

11a. Now I'll read a list of additional resources that could be used to put out escaped fires. As I read the list, please tell me whether these resources were used for the (Fill date first fire) escaped fire. Resources used for the prescribed burn should not be included here. Did you use (fill resource)?

1 Yes
2 No
8 NA

11b. How many?

888 NA
999 DK

Type of resource	a. Did you use?		b. How many?	
	Position	FieldName	Position	FieldName
1. Trained hand crews	243	Use11a	244-246	Use11b
2. Water tenders	247	Use11a2	248-250	Use11b2
3. Lookout or monitoring crews	251	Use11a3	252-254	Use11b3
4. Other firefighters	255	Use11a4	256-258	Use11b4
5. Plows or trenchers	259	Use11a5	260-262	Use11b5
6. Light engines (200 gallons or less)	263	Use11a6	264-266	Use11b6
7. Medium or heavy engines	267	Use11a7	268-270	Use11b7
8. Bulldozers	271	Use11a8	272-274	Use11b8
9. Explosive crews	275	Use11a9	276-278	Use11b9
10. Airtankers or helitankers	279	Use11a10	280-282	Use11b10
11. Smokejumpers or Helitack crews	283	Use11a11	284-286	Use11b11
12. Any other additional resources? (SEE EscapeFiresopen.xls FILE.)	287	Use11a12	288-290	Use11b12

Position	FieldName	Fieldtext
291 – 298	Prop15a	15a. How much did your insurance company pay out for property damage, including any smoke damage, as a result of this escaped fire? 88888888 NA
299 – 306	Injury15	15b. How much for bodily injury? (How much did your insurance company pay out for bodily injury as a result of this escaped fire?) 88888888 NA
307 – 315	Settle15	IF BOTH 15a & 15b = DK, ASK: 15c. What was the total settlement payout? 888888888 NA
316	Pay16a	16a. Did your business or organization pay anything out of pocket to settle any claim resulting from this fire? 1 Yes 2 No 8 NA
317 – 323	Pay16b	IF 16a = YES, ASK: 16b. How much? 8888888 NA
		17. Can you briefly summarize why the prescribed burn escaped and the extent of the damage it caused? (SEE EscapeFiresopen.xls FILE.)

Position	FieldName	Fieldtext
ESCAPED FIRE 2.		
324	Fuel3a2	3a. What would you say was the primary fuel type for the (fill date of second fire) prescribed fire? 1 Grass 2 Brush 3 Timber 4 Slash 8 NA
325	Fuel3b2	3b. What was the primary fuel type that burned in the escaped fire? 1 Grass 2 Brush 3 Timber 4 Slash 8 NA
326	Plan5	4. Did you have a burn plan for this fire? (Prescribed Fire Plan) 1 Yes 2 No 8 NA
327 – 332	Intend6	5a. How many acres was the prescribed burn area intended to be? (This would be what was intended to be burned.) 888888 NA
333 – 339	Addl6	5b. How many additional acres burned? (Beyond what you originally intended to burn?) 0.1 = 0.1 acres or less 8888888 NA

Position	FieldName	Fieldtext
340 – 346	Cost7	6. What were the total suppression costs in dollars for the escaped fire, not including salaries for you or your employees? 8888888 NA 9999999 DK
347 – 351	Hours8	7. About how many hours was it from the time the escape was discovered until the escape was extinguished? 88888 NA
352 – 354	Crew9	8. Now I'll ask about some of the resources that were used to address the escape. How many individuals were working on your burn crew when the escape occurred? 888 NA
355	Exper10	9. For this escape, how would you rate the crew's combined knowledge of and experience with prescribed burns, not including the burn leader? Overall, was the crew's knowledge and experience ... 1 Excellent 2 Very Good 3 Good 4 Fair 5 Poor 8 NA
356	Train11	10. About how much training did the person in charge of the fire have, compared to Burn Boss II designation from the National Wildfire Coordinating Group (NWCG)? Was the amount of training that person had at the time ... 1 Less than Burn Boss II 2 Roughly equal to Burn Boss II 3 More than Burn Boss II 8 NA 9 DK
Position	**FieldName**	**Fieldtext**

357 Placeholder

358 – 405 ***ADDITIONAL RESOURCES USED, FIRE 2.***

11a. Now I'll read a list of additional resources that could be used to put out escaped fires. As I read the list, please tell me whether these resources were used for the (fill date second fire) escaped fire. Resources used for the prescribed burn should not be included here. Did you use (fill resource)?

1 Yes
2 No
8 NA

11b. How many?

888 NA

Type of resource	a. Did you use?		b. How many?	
	Position	FieldName	Position	FieldName
1. Trained hand crews	358	Use11a13	359-361	Use11b13
2. Water tenders	362	Use11a14	363-365	Use11b14
3. Lookout or monitoring crews	366	Use11a15	367-369	Use11b15
4. Other firefighters	370	Use11a16	371-373	Use11b16
5. Plows or trenchers	374	Use11a17	375-377	Use11b17
6. Light engines (200 gallons or less)	378	Use11a18	379-381	Use11b18
7. Medium or heavy engines	382	Use11a19	383-385	Use11b19
8. Bulldozers	386	Use11a20	387-389	Use11b20
9. Explosive crews	390	Use11a21	391-393	Use11b21
10. Airtankers or helitankers	394	Use11a22	395-397	Use11b22
11. Smokejumpers or Helitack crews	398	Use11a23	399-401	Use11b23
12. Any other additional resources? (SEE EscapeFiresopen.xls FILE.)	402	Use11a24	403-405	Use11b24

Position	FieldName	Fieldtext
406 – 413	Prop15a2	15a. How much did your insurance company pay out for property damage, including any smoke damage, as a result of this escaped fire? 88888888 NA
414 – 421	Injury16	15b. How much for bodily injury? (How much did your insurance company pay out for bodily injury as a result of this escaped fire?) 88888888 NA
422 – 430	Settle16	IF BOTH 15a & 15b = DK, ASK: 15c. What was the total settlement payout? 888888888 NA
431	Pay16a2	16a. Did your business or organization pay anything out of pocket to settle any claim resulting from this fire? 1 Yes 2 No 8 NA
432 – 438	Pay16b2	IF 16a = YES, ASK: 16b. How much? 8888888 NA
		17. Can you briefly summarize why the prescribed burn escaped and the extent of the damage it caused? (SEE EscapeFiresopen.xls FILE.)

Position	FieldName	Fieldtext
ESCAPED FIRE 3.		
439	Fuel3a3	3a. What would you say was the primary fuel type for the (fill date of third fire) prescribed fire? 1 Grass 2 Brush 3 Timber 4 Slash 8 NA
440	Fuel3b3	3b. What was the primary fuel type that burned in the escaped fire? 1 Grass 2 Brush 3 Timber 4 Slash 8 NA 9 DK
441	Plan6	4. Did you have a burn plan for this fire? 1 Yes 2 No 8 NA
442 – 447	Intend7	5a. How many acres was the prescribed burn area intended to be? (This would be what was intended to be burned.) 888888 NA 999999 DK
448 – 454	Addl7	5b. How many additional acres burned? (Beyond what you originally intended to burn?) 0.1 = 0.1 acres or less 8888888 NA 9999999 DK

Position	FieldName	Fieldtext
455 – 461	Cost8	6. What were the total suppression costs in dollars for the escaped fire, not including salaries for you or your employees? 8888888 NA
462 – 466	Hours9	7. About how many hours was it from the time the escape was discovered until the escape was extinguished? 88888 NA 99999 DK
467 – 469	Crew10	8. Now I'll ask about some of the resources that were used to address the escape. How many individuals were working on your burn crew when the escape occurred? 888 NA 999 DK
470	Exper11	9. For this escape, how would you rate the crew's combined knowledge of and experience with prescribed burns, not including the burn leader? Overall, was the crew's knowledge and experience ... 1 Excellent 2 Very Good 3 Good 4 Fair 5 Poor 8 NA 9 DK
471	Train12	10. About how much training did the person in charge of the fire have, compared to Burn Boss II designation from the National Wildfire Coordinating Group (NWCG)? Was the amount of training that person had at the time ... 1 Less than Burn Boss II 2 Roughly equal to Burn Boss II 3 More than Burn Boss II 8 NA 9 DK

Position **FieldName** **Fieldtext**

472 Intro3 Placeholder

473 – 520 ***ADDITIONAL RESOURCES USED, FIRE 3.***

11a. Now I'll read a list of additional resources that could be used to put out escaped fires. As I read the list, please tell me whether these resources were used for the (fill date third escape fire) escaped fire. Resources used for the prescribed burn should not included here. Did you use (fill resource)?

1 Yes
2 No
8 NA
9 DK

11b. How many?

888 NA

Type of resource	a. Did you use?		b. How many?	
	Position	FieldName	Position	FieldName
1. Trained hand crews	473	Use11a25	474-476	Use11b25
2. Water tenders	477	Use11a26	478-480	Use11b26
3. Lookout or monitoring crews	481	Use11a27	482-484	Use11b27
4. Other firefighters	485	Use11a28	486-488	Use11b28
5. Plows or trenchers	489	Use11a29	490-492	Use11b29
6. Light engines (200 gallons or less)	493	Use11a30	494-496	Use11b30
7. Medium or heavy engines	497	Use11a31	498-500	Use11b31
8. Bulldozers	501	Use11a32	502-504	Use11b32
9. Explosive crews	505	Use11a33	506-508	Use11b33
10. Airtankers or helitankers	509	Use11a34	510-512	Use11b34
11. Smokejumpers or Helitack crews	513	Use11a35	514-516	Use11b35
12. Any other additional resources? (SEE EscapeFiresopen.xls FILE.)	517	Use11a36	518-520	Use11b36

Position FieldName Fieldtext

521 – 528	Prop15a3	15a. How much did your insurance company pay out for property damage, including any smoke damage, as a result of this escaped fire? 88888888 NA
529 – 536	Injury17	15b. How much for bodily injury? (How much did your insurance company pay out for bodily injury as a result of this escaped fire?) 88888888 NA
537 – 545	Settle17	IF BOTH 15a & 15b = DK, ASK: 15c. What was the total settlement payout? 888888888 NA
546	Pay16a3	16a. Did your business or organization pay anything out of pocket to settle any claim resulting from this fire? 1 Yes 2 No 8 NA
547 – 553	Pay16b3	IF 16a = YES, ASK: 16b. How much? 8888888 NA
		17. Can you briefly summarize why the prescribed burn escaped and the extent of the damage it caused? (SEE EscapeFiresopen.xls FILE.)

Position	FieldName	Fieldtext
ESCAPED FIRE 4.		
554	Fuel3a4	3a. What would you say was the primary fuel type for the (fill date for fourth escape fire) prescribed fire? 1 Grass 2 Brush 3 Timber 4 Slash 8 NA
555	Fuel3b4	3b. What was the primary fuel type that burned in the escaped fire? 1 Grass 2 Brush 3 Timber 4 Slash 8 NA 9 DK
556	Plan7	4. Did you have a burn plan for this fire? 1 Yes 2 No 8 NA
557 – 562	Intend8	5a. How many acres was the prescribed burn area intended to be? (This would be what was intended to be burned.) 888888 NA 999999 DK
563 – 569	Addl8	5b. How many additional acres burned? (Beyond what you originally intended to burn?) 0.1 = 0.1 acres or less 8888888 NA 9999999 DK

Position	FieldName	Fieldtext
570 – 576	Cost9	6. What were the total suppression costs in dollars for the escaped fire, not including salaries for you or your employees? 8888888 NA
577 – 581	Hours10	7. About how many hours was it from the time the escape was discovered until the escape was extinguished? 88888 NA 99999 DK
582 – 584	Crew11	8. Now I'll ask about some of the resources that were used to address the escape. How many individuals were working on your burn crew when the escape occurred? 888 NA 999 DK
585	Exper12	9. For this escape, how would you rate the crew's combined knowledge of and experience with prescribed burns, not including the burn leader? Overall, was the crew's knowledge and experience ... 1 Excellent 2 Very Good 3 Good 4 Fair 5 Poor 8 NA 9 DK
586	Train13	10. About how much training did the person in charge of the fire have, compared to Burn Boss II designation from the National Wildfire Coordinating Group (NWCG)? Was the amount of training that person had at the time ... 1 Less than Burn Boss II 2 Roughly equal to Burn Boss II or 3 More than Burn Boss II 8 NA 9 DK

Position FieldName Fieldtext

587 Intro4 Placeholder

588 – 635 ***ADDITIONAL RESOURCES USED, FIRE 4.***

11a. Now I'll read a list of additional resources that could be used to put out escaped fires. As I read the list, please tell me whether these resources were used for the (fill date fourth escape fire) escaped fire. Resources used for the prescribed burn should not included here. Did you use (fill resource)?

1 Yes
2 No
8 NA
9 DK

11b. How many?

888 NA

Type of resource	a. Did you use?		b. How many?	
	Position	FieldName	Position	FieldName
1. Trained hand crews	588	Use11a37	589-591	Use11b37
2. Water tenders	592	Use11a38	593-595	Use11b38
3. Lookout or monitoring crews	596	Use11a39	597-599	Use11b39
4. Other firefighters	600	Use11a40	601-603	Use11b40
5. Plows or trenchers	604	Use11a41	605-607	Use11b41
6. Light engines (200 gallons or less)	608	Use11a42	609-611	Use11b42
7. Medium or heavy engines	612	Use11a43	613-615	Use11b43
8. Bulldozers	616	Use11a44	617-619	Use11b44
9. Explosive crews	620	Use11a45	621-623	Use11b45
10. Airtankers or helitankers	624	Use11a46	625-627	Use11b46
11. Smokejumpers or Helitack crews	628	Use11a47	629-631	Use11b47
12. Any other additional resources? (SEE EscapeFiresopen.xls FILE.)	632	Use11a48	633-635	Use11b48

Position	FieldName	Fieldtext
636 – 643	Prop15a4	15a. How much did your insurance company pay out for property damage, including any smoke damage, as a result of this escaped fire? 88888888 NA
644 – 651	Injury18	15b. How much for bodily injury? (How much did your insurance company pay out for bodily injury as a result of this escaped fire?) 88888888 NA
652 – 660	Settle18	IF BOTH 15a & 15b = DK, ASK: 15c. What was the total settlement payout? 888888888 NA
661	Pay16a4	16a. Did your business or organization pay anything out of pocket to settle any claim resulting from this fire? 1 Yes 2 No 8 NA
662 – 668	Pay16b4	IF 16a = YES, ASK: 16b. How much? 8888888 NA
		17. Can you briefly summarize why the prescribed burn escaped and the extent of the damage it caused? (SEE EscapeFiresopen.xls FILE.)

Position	FieldName	Fieldtext
SMOKE CLAIMS.		
669	Smoke18a	18a. Next I'd like to ask about smoke claims. From 1999 through 2003, did your company receive any smoke claims from prescribed fires that did not escape? 1 Yes 2 No
670 – 671	Num18b	18b. How many? IF 0, Positions 672-753 = 8-8 (Not Applicable) 88 NA
672 – 673	StateAb5	Please give me the location – state and closest town – and the date of each of these fires. STATE OF FIRST FIRE WITH SMOKE CLAIM. 88 NA
674 – 703	Town5	TOWN OF FIRST FIRE WITH SMOKE CLAIM. 88 NA
704 – 713	Date5	What date did that fire occur? 8-8 NA
714	Fuel20	20. What would you say was the primary fuel type for the (fill date first fire with smoke claim) prescribed fire? 1 Grass 2 Brush 3 Timber 4 Slash 8 NA

Position	FieldName	Fieldtext
715	Predict2	21. Did anyone at your business try to predict smoke behavior for the prescribed burn on (fill date first fire with smoke claim)? 1 Yes 2 No 8 NA
716	Method22	22. Which of the following smoke prediction methods did your company use for this fire? 1 Protractor method 2 Smoke behavior modeling 3 Weather predictions 4 Something else 8 NA
717	Dev23	23. How much would you say the smoke deviated from the anticipated direction or expected behavior? 1 A lot 2 Some 3 A little 4 Not at all 8 NA 24. Why do you think the smoke deviated from the predicted direction or behavior? (SEE EscapeFiresopen.xls FILE.)
718	Notify25	25a. Next I'll read several precautions that are sometimes used to reduce the risks from smoke. Please tell me whether each of these was used. Were neighbors in the path notified of the burn? 1 Yes 2 No 8 NA
719	Block25b	25b. Did local authorities take additional precautions, such as police blocking access to certain roads? 1 Yes 2 No 8 NA

Position	FieldName	Fieldtext
720	Notice25	25c. Were notices placed in local newspapers? 1 Yes 2 No 8 NA
721	Bull25d	25d. Were public bulletins circulated to announce the fire? 1 Yes 2 No 8 NA
722	Radio25e	25e. Were announcements made on local radio stations? 1 Yes 2 No 8 NA
723	Other25f	25f. Were any other precautions taken to reduce risks from smoke? 1 Yes 2 No 8 NA
724 – 730	Prop26a	26a. How much did your insurance company pay out for property damage for this smoke claim? 8888888 NA
731 – 737	Injury26	26b. How much for bodily injury? (for this smoke claim) 8888888 NA
738 – 745	Settle26	IF BOTH 26a & 26b = DK, ASK: 26c. What was the total settlement payout? 88888888 NA

| Position | FieldName | Fieldtext |

746	Pay27a	27a. Did your business or organization pay anything out of pocket to settle the claim? 1 Yes 2 No 8 NA
747 – 753	Pay27b	27b. How much? 8888888 NA

FINAL COMMENTS APPEAR IN EscapeFiresopen.xls FILE.

Appendix C: Text of Letter Requesting Information on Catastrophic Losses

Below is the text of a letter sent to a list of state fire/forestry officials and state contacts for The Nature Conservancy (TNC). Responses to this letter were used to construct Tables 34 and 35.

Date

I am looking for some basic data on prescribed fires over the past 10 years.

Our company is contracting with USDA's Risk Management Agency to collect the necessary data to rate an insurance policy for private contractors and non-government organizations wanting liability coverage for prescribed fire (see attached abstract for details). To date we have surveyed private contractors and non-government organizations in eight states.

When we shared this data with insurance companies, they were concerned that our survey responses did not include information on any major damages caused by prescribed fires.

In an effort to help fill these gaps, I would like to know if you have any knowledge of a prescribed fire(s), conducted by private contractors or non-government organizations, causing over $100,000 in damage in your state. This damage can be the result of an escaped fire, smoke damage from a prescribed fire, traffic accidents caused by smoke from an prescribed fire, etc.

I am NOT looking for an exact accounting. Instead I am looking for some very general information.

If you know of any damages that were a result of prescribed fire:

- in your state
- by a private contractor or non-government organization
- that occurred in the past 10 years
- that may have been over $100,000

I would appreciate you writing a sentence on the basic information of that fire. This information is very critical to the success of the project.

If you do not know of any damages of over $100,000 please let me know that too.

If you have any questions please feel free to call me at:

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