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Demand for Information for Wildland Fire Management

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Abstract: Significant resources have been devoted to increasing the supply of data and information products for wildland fire management. There has been comparatively less emphasis on understanding the demand for these products. There are large differences in the number of information sources that fire managers use in decision making. We developed a value-of-information model for wildland fire managers to formulate hypotheses about what factors drive these differences. Data from a comprehensive internet survey targeting a well-defined population of the Southwest wildland fire managers are used to test these hypotheses. Results are generally consistent with hypotheses generated from the value-of-information model. Multiple regression results suggest information use increases with the number of decisions that managers make and is greater during fire season than before. Information use is affected by a manager's level of education, age, experience, job type, the agencies they work for, and the multi-agency dispatch centers where they work. Agency and dispatch center effects explain more of the variation in information use than differences in the respondents' personal characteristics. To better understand fire manager demand for information, future research could explore in more detail what specific attributes of agencies and dispatch centers affect use of information for wildland fire management.

Keywords: wildland fire; information; value of information; data; fire management; Southwest

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1. Introduction

Wildland fires are non-structured fires that occur in the wildland (as opposed to in developed or urban areas) [1]. Wildland fire can be classified into two types:

- Prescribed fire: A fire ignited by fire managers on purpose to achieve a specific, beneficial objective [1]. This may be to reduce fuel levels to lower the risk of future fires. These are also referred to as "controlled burns".
- Wildfire: An unplanned, unwanted wildland fire including unauthorized human-caused fires, as well as wildland fire use fires and prescribed fires that escape intended areas of control [1]. For wildfires, the objective of fire management is to put the fire out (suppression).

Over the past decade, an average of 62,000 wildland fires have started each year in the United States, burning an average of 7 million acres per year. Over this same period, federal wildland fire suppression costs have averaged more than $2.5 million per year [2]. The economic burden from wildland fires are estimated to be much larger. Economic burden combines the costs of fire prevention and suppression with economic losses from fire, including destruction of property and loss of human life. The National Institute of Standards and Technology has estimated the economic burden of wildland fire to range from $71.1 billion to $347.8 billion (2016 US) annually [3].

Given these costs, it is not surprising that multiple federal agencies have developed data products and decision support systems to help wildfire managers make better-informed fire management decisions. Along with data products and information sources specially tailored to wildland fire management, managers also rely on other weather, climate, and drought data products.

While significant resources have been devoted to the supply of information for fire management, less attention has been paid to the demand side. Recent empirical work relying on qualitative research methods suggests that fire managers are not using decision support systems or data products developed for fire management (or at least, not using them as intended) and that existing information may not meet fire manager needs [4–11]. Currently, there is a research gap in assessing the demand for fire management information. A better understanding of what information fire managers use, how they use it, and what is not used will help in developing not just more data products, but ones that are actually useful to wildland fire managers.

There are large differences in the number of information sources that fire managers use in decision making. We developed a value-of-information model for wildland fire managers to formulate hypotheses about what factors drive these differences. Data from a comprehensive internet survey targeting (Appendix B) a well-defined population of the Southwest wildland fire managers are used to test these hypotheses. The remainder of the article is organized as follows. First, we discuss survey methods and the survey population. There is strong evidence that our survey population is representative of our target population of fire managers. Next, we introduce a conceptual framework similar to other work in the "value of information" literature to examine the demand for information from fire managers. A formal optimization model is developed, and its results are used to develop testable hypotheses about the information used by fire managers. Section 3 presents tests of these various hypotheses. Results are generally consistent with hypotheses generated from the value-of-information model. Multiple regression results suggest information use increases with the number of decisions that managers make and is greater during fire season than before. Information use is affected by manager education, age, experience, job type, the agencies they work for, and the multi-agency dispatch centers where they work. Agency and dispatch center effects explain more of the variation in information use than differences in the personal characteristics of respondents. We conclude with a discussion of the implications for policy and future research.

2. Materials and Methods

2.1. Survey Methods

Quantitative data were collected through an internet survey instrument developed in Qualtrics. The survey population was drawn from the Southwest Area Interagency Fire, Aviation and Dispatch Directory. The Dispatch Directory includes personnel from the twelve interagency dispatch centers covering the Southwest Area (primarily Arizona and New Mexico, but including some bordering areas), plus the Southwest Coordination Center (SWCC) in Albuquerque, New Mexico. The population covers a wide range of operational fire management personnel (regional, state, and unit level), including higher-level firefighters, aviators and aviation program managers, incident commanders and incident command staff, fire planners, fire ecologists, fire prevention specialists, fire environment decision support specialists, and miscellaneous support staff. National Weather Service (NWS) forecasters and incident meteorologists from NWS offices serving the Southwest were also included. Most of the survey population is involved in making or supporting strategic and/or tactical wildland fire management decisions. The Dispatch Directory used to build our population includes names, positions, locations, organizations, and contact information for Southwest fire management professionals from federal agencies (Bureau of Indian Affairs, Bureau of Land Management, Fish and Wildlife Service, Forest Service, National Oceanic and Atmospheric Administration, and National Park Service) and state agencies (Arizona Department of Environmental Quality, Arizona Department of Forestry and Fire

Management, New Mexico Energy, Minerals and Natural Resources Department (EMNRD) Forestry Division, and individual Tribal fire management and forestry agencies). To better define our target population, we removed positions listed in the directory from our target population that were not directly related to fire management decisions (e.g., accountants, budget analysts, and clerical staff). This left an email list of 485 potential respondents as our target population of Southwest wildland fire management professionals.

A draft survey instrument was pre-tested by colleagues in The University of Arizona Cooperative Extension and the Climate Assessment for the Southwest (CLIMAS) and revised in response to comments and suggestions. Potential respondents were sent an introductory email informing them of the purpose of the survey followed by a second email with a survey link in the second week of October 2021. Eight subsequent reminders were sent. The survey was open for five weeks, ending after the third week of November.

From the original 485 people contacted, four responded that they did not use weather and climate information as part of their jobs and another four responded that they were no longer in a position where that was the case. These eight were therefore not part of our intended population, reducing the pertinent population to 477 respondents. Of these, 206 provided responses about use of climate and weather information, for an overall response rate of 206/477 = 43.2%. This compares favorably to response rates from previous surveys of wildland fire managers: 17% [10], 28% [12], 24% [13], and 34% [14].

Our target population is well-defined and small. However, as population size falls, the response rate needs to increase to avoid imprecision and to safeguard against non-response bias [15–17]. A concern with non-responses is that the sample population may not be representative of the target population. Information about the target population, however, can be used to evaluate the representativeness of the sample. The Dispatch Directory provides information about the agencies where both respondents and the entire target population work. The distribution of respondents by agency in the sample was quite close to the distribution for the target population as a whole (Table 1). Response rates were higher from agencies with fewer people (except for Tribal agencies), but absolute differences were small. The sample appears quite representative of the target population, at least with respect to the agencies where respondents work.

Table 1. Distribution of the sample population and total population with respect to agency where the wildland fire manager works.

Agency	Total Population	Sample Population
U.S. Forest Service	49.5%	47.6%
Bureau of Land Management	15.9%	13.1%
Bureau of Indian Affairs	12.2%	10.7%
AZ Department of Forestry & Fire Management	7.8%	9.7%
National Park Service	5.0%	5.3%
NM Forestry Division	2.9%	3.9%
Fish & Wildlife Service	2.7%	4.4%
Tribal Agencies	1.9%	1.5%
NOAA	1.5%	2.4%
AZ Department of Environmental Quality	0.6%	1.5%

2.2. Survey Population

Nearly half of all respondents worked for the U.S. Forest Service (Table 1). Table 2 provides other basic information about the survey population. Virtually all respondents were based in either Arizona or New Mexico. Most operated in one or both of these states, while 11% to 19% also operated in other western states. Nearly 63% of respondents had 20 years of experience or more. More than 80% had 15 or more years of experience. The most common age category was 40–49 years (45% of respondents). Few respondents were younger than 30 or had less than five years of experience. Nearly 15% of respondents had masters, professional, or PhD degrees, while 45% had bachelor's degrees. Another third of respondents had some college, but no bachelor's degree, while less than 7% had high school degrees only. Only 3.4% of respondents were administrators, while 41.5% stated their role as fuels and fire management (prevention), 27.3% stated their role was fire suppression, and 27.8% listed "Other" as their primary role in fire management. Of the respondents, 12% work at the Southwest Coordination Center, while the remaining 88% work at regional dispatch centers.

Table 2. Survey respondent characteristics.

Variable	Percent of Respondents	Variable	Percent of Respondents
Age (years)		Education Level	
Less than 30	0.6%	High School Graduate	6.8%
30–39	17.1%	Some College	33.5%
40–49	44.9%	College Graduate	44.9%
50–59	27.3%	Masters/Prof. Degree	13.1%
>60	10.2%	Doctoral Degree	1.7%
Experience (years)		Job within Agency	
0–4	2.9%	Agency Administrator	3.4%
5–9	5.7%	Fire Manager, fuels and fire	41.5%
10–14	10.9%	Fire Manager, suppression	27.3%
15–19	17.7%	Other	27.8%
20–29	48.6%		
>30	14.3%		
Dispatch center		Dispatch center	
Southwest Coord. Center	12.0%	NM-Alamogordo	8.6%
AZ-Flagstaff	8.0%	NM-Albuquerque	7.4%
AZ-Phoenix	6.3%	NM-Santa Fe	9.1%
AZ-Prescott	4.6%	NM-Silver City	9.7%
AZ-Springerville	6.3%	NM-Taos	4.6%
AZ-Tucson	9.1%	Other	2.3%
AZ-Williams	1.1%		

Respondents were also asked to "select which fire management decisions you either make, help to make, or provide information for (check all that apply)". Choices included the following:

- Hire or extend fire crew personnel
- Allocate personnel, tanker planes, or equipment
- Request additional resources (severity requests)
- Prescribed fire or wildland fire use decisions
- Public awareness, public notices
- Brief administrators, congressional staff, etc.

The number of decisions averaged 3.9 with a median of 4 and a standard deviation of 2.

2.3. Value of Information Conceptual Framework

As a conceptual framework, we draw on two strands of literature on the value of information. A basic premise of this literature is that the value of information can be measured as the difference in the benefit of decision making using some specific type of information versus the benefit received if making the decision without using that information. Decision makers will use a particular type of information if the expected net benefits of using it are positive. One strand of this literature has focused on the value of using weather information [18–23].

Another has focused on the demand for economic information [24–27]. While many such studies concentrate on decisions made by agricultural producers, [28] applies this value-of-information approach directly to wildland fire management. A common theme addressed in this literature is the effect of information quality (e.g., forecast accuracy, timeliness) on the value of information. Another theme is the effect of factors affecting people's capacity to access and process information usefully. This may reflect user education or training in information use.

2.4. Model of Demand for Fire Management Information

One may express the value of information V_i to an individual fire manager making a particular decision i as

$$V_i \{b_i [k, \rho, \alpha, \delta, x (s_i)] - b_{i0} (k, \rho, a, x_{i0})\} A - c_i (s_i, k, A, \rho, \alpha, \delta) \tag{1}$$

where

A = land area managed
$b [x (s_i)]$ = benefits per unit land area given information
$b_0 (x_0)$ = benefits per unit land area when information is not accessed
x_{i0} = decision made, or action taken when information is not accessed (for decisions i = 1, . . ., n)
$x_i (s_i)$ = decision made or action taken given new information (for decisions i = 1, . . . n)
s_i = amount of information sources accessed or the intensity of use from a given source to make decision i
c_i = costs of processing information for decision i, including time costs and costs of delay
k = index of knowledge or technical capacity
ρ = individual's job or role within the fire management system
α = agency that the individual works for
δ = dispatch center where the individual works

In the optimization problem, the fire manager may make multiple decisions. This can be written as

$$\max \Sigma V_i \{b_i [k, \rho, \alpha, \delta, x(s_i)] - b_i (k, \rho, a, x_{i0})\} A - \Sigma c_i (s_i, k, A, \rho, \alpha, \delta) \tag{2}$$

with respect to s_i for i = 1, . . . n decisions, and subject to $t_i (s_i) \leq \underline{t}_i$ where $\underline{t}_i$ is some constraint on the decision maker. This could be a resource constraint, or it could be a time constraint. Decision makers must take action over some fixed time interval. They only have so much time to collect information.

The Lagrangian for the fire manager's constrained optimization problem is

$$max\ L = \Sigma V_i \{b_i [k, \rho, \alpha, \delta, x_i (s_i)] - b_{0i} (k, \rho, a, x_{i0})\} A - \Sigma c_i (s_i, k, A, \rho, \alpha, \delta) + \Sigma \lambda i (\underline{t}_i - t^i (s_i)) \tag{3}$$

where the λ_i terms represent the shadow costs of the decision maker's time constraints. The first order conditions for optimal information acquisition for each decision is

$$(\partial V_i/\partial b_i) (\partial b_i/\partial x_i) (\partial x_i/\partial s_i) = \partial c_i/\partial s_i + \lambda_i (\partial t_i/\partial s_i) \tag{4}$$

The decision maker will acquire information up to the point where the marginal benefit meets the marginal cost of acquiring more information, including the shadow cost of the time constraint. If the time constraint is binding ($\lambda_i > 0$), it means the decision maker has used up all their allotted time and must decide/take action with information gathered at that point.

The value of information to the fire manager is the increase in benefits from using information to make decisions minus any costs entailed in accessing and processing the information. Benefits might be measured in terms of damages avoided. Costs need not be strictly monetary costs. They could be costs of the manager's time to access information and apply it to decisions. With a time dimension, there could also be costs of delays in implementing a decision. A prompt decision with limited information could be better than a more-informed decision that is made "too late". We do not observe the actual benefits and costs to the fire manager of accessing information. Following [19,29], we assume that a fire manager will only access an information source if the expected benefits outweigh the costs.

Just et al. [25] posit that the value of information will depend on the decision maker's occupation or role within the system where they operate (specified as ρ). They also posit that the value of information will depend on the overall system where they operate. This is captured in our study by two variables: α, the agency that the individual works for, and δ, the dispatch center where they work.

2.5. Testable Hypotheses

One can solve the optimization problem in Equation (2) for the optimal level of total information use $S_j = \Sigma\, s_{ij}$ for each individual, j, as a function of a fire manager's personal and employment characteristics: $S_j = S_j\,(k, A, \rho, \alpha, \delta)$. This suggests some testable hypotheses about a fire manager's use of information.

H1: *Managers who make more decisions will access more information. With n decisions, each decision has the potential to be improved upon by collecting information.*

H2: *Managers have incentives to use more information sources during fire season than before, as more resources will be at immediate risk (and more damage to potentially reduce). During fire season, however, time constraints on using information could be more pressing. Managers may not have time to seek more information. The overall effect on information use will depend on which of these two effects (potential damages vs. time constraints) are stronger.*

H3: *Managers operating at a regional scale will access more information than those at a more local scale, as the benefits of information can be applied over a wider area.*

H4: *More formal education encourages information use as it increases knowledge or technical capacity, lowering costs of processing and utilizing information.*

H5: *Age and experience may have countervailing effects. Managers may acquire "on-the-job" knowledge via years of experience, reducing the costs of information use. Conversely, younger (and less-experienced) managers may have been exposed to newer forms of information technology and be better able to interact with newer data sources. Age and experience may signal more on-the-job knowledge, but also signal less familiarity with newer forms of information technology.*

H6: *Following [25], a decision maker's occupation or role within the system where they operate (in this case, the fire management system) will affect their demand for information.*

H7: *The agency and dispatch center will affect an individual manager's use of information. Following [25], the attributes of the system where a decision maker works affects demand for information. The environment of an agency or dispatch center may influence the information that the managers use and share among themselves.*

These hypotheses will be tested via a linear regression analysis of factors affecting the total number of information sources used by fire managers in the survey.

3. Results

Respondents were asked among 33 information sources which they used for fire management decisions. They were asked separately about sources used before and during fire season. In Arizona and New Mexico, the fire season has historically been defined as beginning in April (in low desert areas) and May (to the north) and running through October. For respondents, operationally the main difference is between a period of preparation and fire fuels management and a period of fire suppression. Appendix A lists the different data sources respondents relied upon and the percentage of respondents using that source. Only four sources were used by 75% or more respondents before fire season. During fire season, six sources were used by 75% or more respondents (Appendix A).

3.1. Variation in Use of Information Sources

Figure 1 compares the percentage of respondents using each of the 33 information sources before and during fire season. Here, the sample is split into low information using, medium information using, and high information using respondents. The sample was split roughly into thirds, grouping respondents by total number of information sources used. Among the high-information respondents, there were several information sources used by more than 75% of respondents. Among the low-information respondents, there was only one source used by 75% of respondents. Among the high-information users, 21 sources were used by more than half of respondents. For the low-information users, this figure was only three sources. Use rates for the medium-information users lay between these extremes.

Figure 1 shows that the most-used information sources for the low-, medium-, and high-information respondents are the same sources, even though average use rates differ systematically. Similarly, the least-used sources are the least used for each of the three groups. Figure 1 also illustrates the strong correlation between use rates across seasons. Sources used more frequently before fire season were also used more frequently during fire season. Sources used infrequently before fire season were also used infrequently during fire season. Most differences across season were not statistically significant (see Appendix A).

There was wide variation in the number of information sources respondents used, ranging from 0 to 33 per season (Figure 2). While there were 206 respondents in the survey, 31 did not respond fully. Although they reported on their use of information sources, they did not report on their personal characteristics, such as age, experience, job/role, or education level. There were data on the agency and dispatch center where all 206 respondents worked. For regression analysis, two different specifications were used. One (the sub-sample) included age, experience, job/role, and education variables in a regression with 350 observations (175 respondents using information in two different seasons). The other regression (full sample) used all 412 observations (206 respondents using information in two seasons) but had a smaller number of explanatory variables (because of missing data).

Table 3 shows the distribution of information sources in both the full sample and the sub-sample. In the full sample, respondents consulted an average of 13.9 sources before and 15.2 sources during the fire season. The median was 15 sources for both periods. While 25% of respondents consulted 19 sources or more (75th percentile), another 25% consulted 11 sources or fewer (25th percentile). In the sub-sample, median information as well as minimum and maximum values were the same as for the full sample. The average number of sources used was also quite similar across the sub- and full samples.

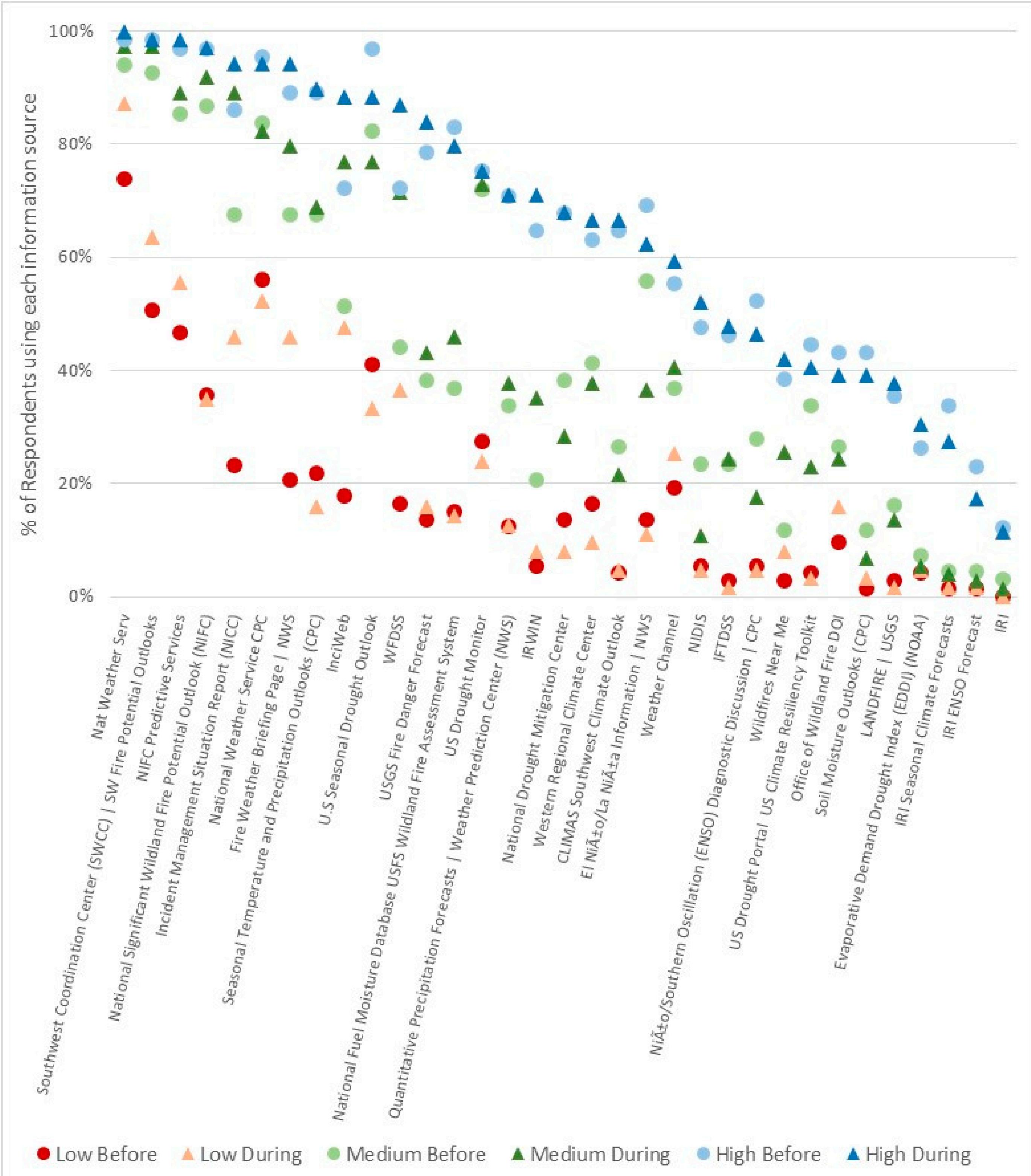

Figure 1. Percentage of respondents using different information sources for fire management separately before and during fire season divided between low-, medium-, and high-information users.

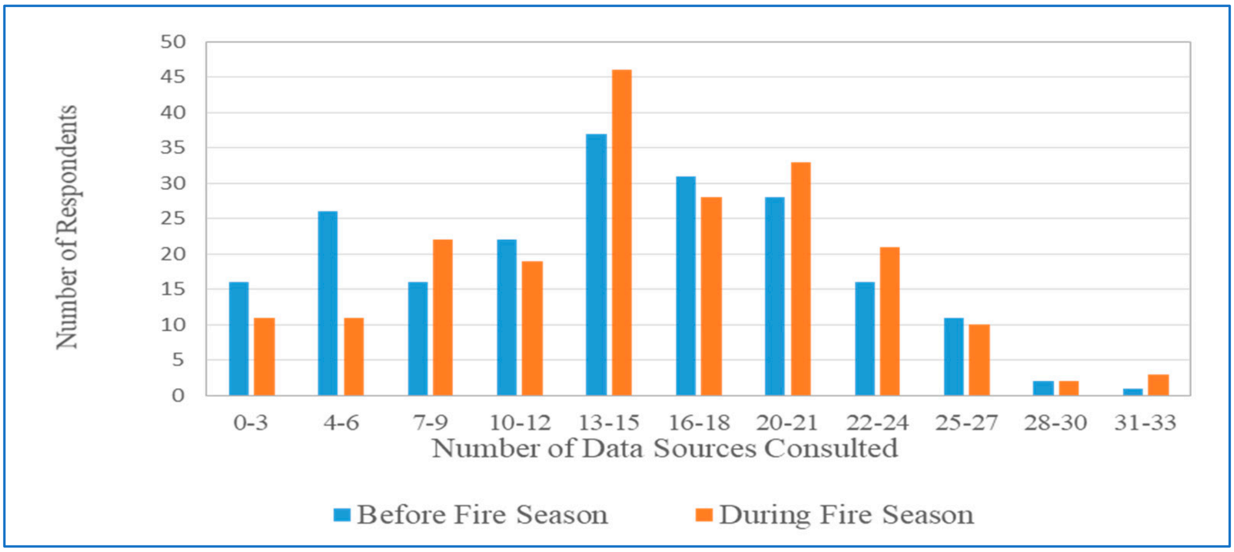

Figure 2. Distribution of data sources consulted by fire managers before and during fire season.

Table 3. Distribution of data sources used by fire managers before and during fire season.

	Full Sample, *n* = 412		**Sub-Sample, *n* = 350**	
Number of Data Sources Used	**During Fire Season**	**Before Fire Season**	**During Fire Season**	**Before Fire Season**
Mean	15.2	13.9	15.8	14.3
Standard Deviation	6.7	7.1	6.9	6.9
Minimum	0	0	0	0
Maximum	33	33	33	33
25th Percentile	11	8	12	9
Median	15	15	15	15
75th Percentile	20	19	20	19

3.2. Regression Results

The regression specification is

$$Sources = \alpha + \beta Season + \gamma Decisions + \boldsymbol{\delta}'\boldsymbol{Agency} + \boldsymbol{\eta}'\boldsymbol{Age} + \boldsymbol{\theta}'\boldsymbol{Experience} + \boldsymbol{\lambda}'\boldsymbol{Job} + \boldsymbol{\mu}\boldsymbol{Education} + \boldsymbol{\nu}\boldsymbol{Dispatch} + \varepsilon \quad (5)$$

where

Sources = the total number of information sources the manager used in a season
Season = 1 if it is during fire season and =0 if before fire season
Decisions = the total number of different fire management decisions made by the manager
Agency = a vector dummy variables for the agency where the manager works
Age = a vector dummy variables for manager age categories
Experience = a vector dummy variables for manager experience categories
Job = a vector of dummy variable for manager job type
Education = a vector of dummy variable for manager education levels
Dispatch = a vector of dummy variables for the dispatch center where the manager works
ε = the regression error term.

The terms α, β, γ, $\boldsymbol{\delta}$, $\boldsymbol{\eta}$, $\boldsymbol{\theta}$, $\boldsymbol{\lambda}$, $\boldsymbol{\mu}$, and $\boldsymbol{\nu}$ are regression coefficients to be estimated. One specification (for the sub-sample) includes all the variables above, while another only includes *Season*, *Decisions*, ***Agency***, and ***Dispatch*** for the full sample (because of missing personal characteristic data).

Table 4 reports results of a multiple regression model that examines how respondent personal characteristics and place in the fire management system affect the number of information sources they use. For the sub-sample, with fewer observations but more explanatory variables, the simple value-of-information model explains nearly 30% of the variation in manager uses of information sources ($R^2 = 0.296$). Each additional decision a respondent made increased use by about one source per decision (consistent with hypothesis **H1**).

Table 4. Multiple regression analysis of factors affecting total number of information sources used by wildland fire managers (variable coefficients significant at $p < 0.10$ in boldface).

Dependent Variable: Total Information Sources Used in a Season	**Full Sample, *n* = 412 R^2 Adjusted = 0.2818**			**Sub-Sample, *n* = 350 R^2 Adjusted = 0.2962**		
Variable	**Coefficient**	**Std. Error**	***p* > |t|**	**Coefficient**	**Std. Error**	***p* > |t|**
During fire season	**1.33**	**0.58**	**0.021**	**1.53**	**0.60**	**0.011**
Total decisions made	**1.28**	**0.15**	**0.000**	**1.07**	**0.20**	**0.000**
Agency variables						
BLM	−1.01	0.96	0.295	−0.94	1.05	0.374
Bureau of Indian Affairs	**2.27**	**1.01**	**0.025**	**2.68**	**1.08**	**0.014**
National Park Service	−1.48	1.40	0.291	−2.30	1.60	0.152
AZ Dept of Forestry & Fire Mgmnt	**−5.54**	**1.37**	**0.000**	**−4.56**	**1.55**	**0.004**
NM Forestry Division	2.33	1.58	0.141	2.92	2.09	0.163
US Fish & Wildlife Service	0.07	1.52	0.962	0.55	1.81	0.763
Tribal Agency	−3.27	2.56	0.202	0.15	3.30	0.965
NOAA	**5.18**	**2.72**	**0.058**	4.98	3.70	0.180
AZ Dept of Env Quality	3.40	3.26	0.297	1.20	4.27	0.779
Age variables						
<30 years old				**13.62**	**6.05**	**0.025**
30–39 years old				0.85	1.04	0.411
50–59 years old				−0.55	0.88	0.532
≥60 years old				0.60	1.42	0.672
Experience variables						
<5 years of experience				−2.17	2.34	0.356
5–9 years of experience				1.03	1.76	0.557
10–14 years of experience				0.10	1.15	0.932
15–19 years of experience				**2.70**	**1.00**	**0.008**
≥30 years of experience				1.43	1.15	0.216
Job/role variables						
Agency administrator				**−4.77**	**2.14**	**0.026**
Fire manager, suppression				0.95	0.82	0.248
Other job				0.18	0.88	0.839
Education variables						
High school graduate				**−3.07**	**1.39**	**0.027**
Some college				1.16	0.74	0.115
Masters/professional degree				1.66	1.06	0.120
Doctoral degree				0.85	3.27	0.794
Dispatch center variables						
AZ-Flagstaff	**−4.83**	**1.42**	**0.001**	**−3.44**	**1.57**	**0.029**
AZ-Phoenix	**−4.69**	**1.63**	**0.004**	**−4.76**	**1.75**	**0.007**
AZ-Prescott	0.84	1.51	0.578	0.79	1.77	0.655
AZ-Springerville	−0.65	1.56	0.677	0.20	1.72	0.909
AZ-Tucson	**−5.20**	**1.38**	**0.000**	**−5.10**	**1.47**	**0.001**
AZ-Williams	**−6.17**	**2.18**	**0.005**	**−5.35**	**3.08**	**0.083**
NM-Alamogordo	**−3.64**	**1.33**	**0.007**	**−2.96**	**1.55**	**0.058**
NM-Albuquerque	−0.25	1.44	0.860	1.59	1.58	0.313
NM-Santa Fe	−1.50	1.33	0.260	0.08	1.43	0.953
NM-Silver City	**−3.17**	**1.36**	**0.020**	**−3.05**	**1.43**	**0.033**
NM-Taos	**−6.65**	**1.48**	**0.000**	**−5.18**	**1.73**	**0.003**
Other	**−6.95**	**3.24**	**0.033**	**−10.30**	**4.27**	**0.017**
Constant	**11.82**	**1.17**	**0.000**	**10.55**	**1.46**	**0.000**
Shapiro-Wilk normality test:		$p = 0.504$			$p = 0.561$	

On average, respondents used 1.53 more sources during the fire season than before it. Hypothesis **H2** suggested that more resources at risk would increase demand for information, but also that time constraints might limit information gathering during fire season. Our results suggest that the resources-at-risk effect dominates.

The baseline respondent was a Forest Service employee working in the SWCC, aged 40–49 years, with 20–29 years of experience, a bachelor's degree, and the job of fire manager, fuels and fire. The model coefficients measure effects of deviations from this baseline profile. Working at the Bureau of Indian Affairs (BIA) increased information use by more than two sources, working at NOAA increased use by more than five sources, and working at the Arizona Department of Forestry and Fire Management reduced use by more than five sources. While working at the BIA increased information use relative to working at the Forest Service, there was no statistically significant difference between those working for Tribal fire agencies and the Forest Service. Respondents younger than 30 years used more than 13 additional sources. Other age groups were no different from the default. Those with 15–19 years of experience used 2.7 more sources, while Agency administrators used nearly five fewer sources. Those with just a high school degree used about three fewer sources than college graduates.

For the sub-sample, there were statistically significant and negative coefficients for managers at eight dispatch centers, who used between 3.17 and 6.95 fewer sources than managers in the default category, SWCC (Table 4). The SWCC is the focal point for logistical support between the other Southwest Area Dispatch Centers and with the National Coordination Center. As such, it covers the entire Southwest Area. This confirms **H3:** Managers operating at a broader, regional scale will access more information. Conversely, respondents in Dispatch Centers outside SWCC would use fewer data sources.

Results for the full sample were quite similar to the sub-sample. Dropping fire manager characteristics (except agency and dispatch center) reduced the adjusted R^2 only slightly, from 0.2962 down to 0.2818). The variables that were significant in the full sample were also significant in the sub-sample. The magnitude of the regression coefficients are roughly the same. The results are robust across sample sizes for common variables.

3.3. Summary of Hypothesis Tests

Table 5 reports results of *t*-tests for the significance of the effects of season and decisions made and F-tests on the joint significance of respondent personal characteristic and place-of-work effects. The null hypothesis is that all the regression coefficients for a given category equal zero (e.g., all agency coefficients, or all age coefficients, or all experience coefficients, etc., equal zero). Generally, the results provide support for our hypotheses **H1** to **H7**. Except for age, we reject the null hypothesis that the grouped variables have no effect on information use. For the fire manager job type variable, the null hypothesis is rejected at a 10% significance level, but we fail to reject the null at a 5% level.

Table 5. Joint hypothesis tests for groups of variable coefficients measuring combined effects.

Null Hypothesis	*t* Test Statistic	*p*-Value	Hypothesis Test Result
Information use is independent of number of decisions made	5.34	0.0000	Rejected (consistent with H1)
Information use does not increase during fire season even though risks are greater	2.56	0.0108	Rejected (consistent with H2)
Information use does not decrease during fire season because time is limited	2.56	0.0108	Rejected (consistent with H2)

Table 5. *Cont.*

Joint Null Hypothesis	F Test Statistic	*p*-Value	Hypothesis Test Result
No dispatch center effects	F(12, 310) = 3.87	0.0000	Rejected (consistent with H3 & H7)
No education effects	F(4, 310) = 3.01	0.0184	Rejected (consistent with H4)
No age effects	F(4, 310) = 1.53	0.1936	Failed to reject
No experience effects	F(5, 310) = 2.26	0.0485	Rejected (consistent with H5)
No job description effects	F(3, 310) = 2.30	0.0775	Rejected at 10% level, failed to reject at 5% level (consistent with H6)
No agency effects	F(9, 310) = 3.04	0.0017	Rejected (consistent with H7)

3.4. Robustness Checks

For both regressions, we fail to reject the null hypothesis that the regression residuals are normally distributed, based on the Shapiro–Wilk W test. The *p*-value of the test exceeded 0.5 in both cases (Table 4). Regression coefficients and their statistical significance change little between the full sample and sub-sample regressions. One exception is the coefficient for working at NOAA, which is no longer significant in the regression and includes additional respondent personal characteristics.

The base regression specification in Table 4 assumes a simple linear relationship between the number of decisions made and the total number of information sources used. We experimented with a quadratic specification that could capture whether there were diminishing effects of decisions on information use (see Appendix A). The quadratic term, however, was not statistically significant. We fail to reject the simple linear specification.

While we reject the joint hypothesis of no experience effects, we fail to reject the hypothesis of no joint age effects (Table 5). Only one experience variable was singly significant (15–19 years of experience); while only one age variable was singly significant (less than 30 years old). The lack of individual significance of variables, combined with joint significance for experience, but not age, may be an indicator of multi-collinearity between age and experience variables. Appendix A Table A3 reports alternative specifications of our base regression. One includes age variables but excludes experience variables. The other includes experience variables but excludes age variables. Excluding one category of variables has little impact on the results for the other category. No additional age variables become significant when experience variables are excluded. No additional experience variables become significant when age variables are excluded. Excluding age or experience variables has no substantive impact on other regression coefficients.

Age and years of experience were included as variables that may affect the costs of processing information for decision making and manager's knowledge or technical capacity to benefit from information. Age may be too imprecise or too inaccurate an indicator of these effects. Other studies have noted the role of training and lack of training as a barrier to fire manager information use [5–9,11,30,31]. Future research examining the role of specific types of training may better capture effects on costs of processing information and the capacity to benefit from it.

Years of experience may also be too imprecise a measure. Future research may collect data on types of experiences that fire managers have had (e.g., experience with large fires, experience with prescribed burns that got out of control). There is also research indicating that experience may substitute for information use rather than be a complement for it. [9,14,32,33].

4. Discussion

We found that, controlling for other factors, those working for the Arizona Department of Forestry and Fire Management used substantially fewer information sources than those in other agencies. It is beyond the scope of the present study to account for why this might be the case or even if this constitutes a problem. A number of empirical studies using qualitative research methods have identified lack of training or specific educational experience as barriers to use of information and decision support tools for fire management [4–10,30]. Future research could examine differences in training opportunities across fire management agencies. Although 6.8% of respondents had only a high school education, this group also used fewer sources of information. This group might be targeted for additional training opportunities.

Previous studies of fire manager use of information have relied on structured interviews and other qualitative research methods [4–6,8,9,11,34]. These provide important insights into fire manager information use and barriers to information use. Yet, these studies have all been conducted with fewer than 50 interviewees, often from a subset of all the relevant agencies. While these studies have taken care to recruit a representative group of participants, this approach raises questions about how generalizable their findings are. By contrast, our study is based on a larger and more institutionally-inclusive and representative sample of wildland fire managers. The qualitative studies have focused on the dominant attitudes and behaviors of fire managers. This study has focused on differences in information use between fire managers.

This value-of-information modelling approach to fire management is closest in spirit to [28]. This allowed us to formulate and test hypotheses about fire manager information use. Key findings include that there are important agency and dispatch center effects that influence fire manager information use and that these effects explain more of the variation in behavior than manager personal characteristics. The role organizational and institutional factors conditioning or limiting fire manager information use has been a common theme in earlier work [4,5,10,11,34–36]. We have identified that these organizational effects matter. An important area for future research will be to explore intra-agency dynamics to better determine how and why they matter.

5. Conclusions

An internet survey of wildland fire managers in the Southwestern United States revealed that there is wide variation among managers in their use of information sources in decision making. A value-of-information model was developed to generate hypotheses that could account for such variation. The overall results are generally consistent with the hypotheses generated from our value-of-information model. Specifically, there was support for the following hypotheses:

- Managers who make more decisions will access more information as each decision has the potential to be improved by collecting information.
- Managers will use more information sources during fire season than before, as more resources will be at immediate risk (and more damage to potentially be reduced).
- Managers operating at a regional scale will access more information than those at a more local scale, as the benefits of information can be applied over a wider area.
- More formal education encourages information use as it increases knowledge or technical capacity, lowering costs of processing and utilizing information.
- A decision maker's occupation or role within the system where they operate (in this case, the fire management system) will affect their demand for information.
- The agency and dispatch center where a manager works will affect a manager's use of information.

Agency and dispatch center effects explain more of the variation in information use than differences in respondents' personal characteristics. While variables for personal characteristics were jointly significant, including them did not greatly improve the fit of the regression model. This finding is consistent with the demand for economic information literature that emphasizes decision maker demand for information as a function of the characteristics of the system in which the decision maker participates [24–27]. Our results suggest that the agency and dispatch center where a wildland fire manager works exert significant influence on their use of information for fire management. It is beyond the scope of this present analysis to identify what features of agencies, or differences in agency or dispatch center dynamics drive this influence. To better understand fire manager demand for information, future research could explore in more detail what specific attributes of agencies and dispatch centers affect use of information for wildland fire management.

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Institutional Review Board Statement: The study was conducted in accordance with the Declaration of Helsinki and approved by the Institutional Review Board of the University of Arizona in March 2021 for studies involving humans.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

Data Availability Statement: The informed consent used for this project included the following statement: "Information collected about you will not be used or shared for future research studies". This statement was included in an effort to ensure study participants would fully participate in the study without fear of recriminations for their statements in interviews or focus groups or in their responses to survey questions. Therefore, all data for this study will be confidentially archived with the lead author in a HIPAA compliant repository for a period of 1 year after the publication of all study results. After that time the data will be destroyed.

Conflicts of Interest: The authors declare no conflicts of interest.

Appendix A

In this survey, sources of information for wildland fire management were grouped into broad categories: general websites and portals, forecasts and outlooks, situation reports and information products, and decision support tools. Respondents could select among these 33 sources and could also input names of other sources not listed. Few respondents input other source names in the survey. While fire managers rely on many sources, a smaller number of sources receive heavier use. Before fire season, four sources—the National Weather Service (NWS), the National Interagency Fire Center (NIFC) | Predictive Services, The NWS Climate Prediction Center (CPC), and the Southwest Coordination Center (SWCC) | SW Fire Potential Outlooks—were used by 75% of respondents (Table A1). Ten sources were used by half of respondents. During fire season, six sources were used by 75% of respondents, while twelve were used by half.

There was a strong correlation between data sources used before and during fire season. The rank order correlation coefficient was 0.95. The same sources that are used by many (few) respondents in one season are also used by many (few) in the other season. Sites focusing on drought or ENSO data tended to be used more before fire season than during it. Yet, there was only one site, El Nino/La Nina Information | NWS, where the difference was statistically significant ($p < 0.10$). Two decision support tools—Wildland Fire Decision Support System (WFDSS) and Integrated Reporting of Wildland-Fire Information (IRWIN)—were used more during fire season than before, with the differences statistically significant ($p < 0.05$).

Table A1. Percentage of respondents using different data sources before and during fire season.

Data Source	Percentage Using During the Fire Season	Percentage Using Before the Fire Season
General Websites & Data Portals		
National Weather Service *	95%	88%
National Interagency Fire Center (NIFC) | Predictive Services *	82%	75%
National Weather Service Climate Prediction Center (CPC)	77%	78%
The Weather Channel | weather.com	42%	36%
Western Regional Climate Center	39%	39%
National Drought Mitigation Center	35%	39%
Office of Wildland Fire | Department of the Interior	27%	26%
NIDIS (Drought.GOV)	23%	25%
US Drought Portal | US Climate Resiliency Toolkit	23%	27%
International Research Institute for Climate & Society	4%	5%
Forecasts & Outlooks		
Southwest Coordination Center (SWCC) | SW Fire Potential Outlooks *	87%	80%
National Significant Wildland Fire Potential Outlook (NIFC)	76%	72%
U.S Seasonal Drought Outlook	67%	72%
Seasonal Temperature and Precipitation Outlooks (CPC)	60%	58%
USGS Fire Danger Forecast **	49%	42%
Quantitative Precipitation Forecasts | Weather Prediction Center (NWS)	41%	38%
CLIMAS Southwest Climate Outlook	32%	31%
Soil Moisture Outlooks (CPC)	17%	18%
IRI Seasonal Climate Forecasts	11%	13%
Situation Reports & Information Products		
Incident Management Situation Report (NICC) *	78%	58%
InciWeb: the Incident Information System *	72%	46%
Fire Weather Briefing Page | NWS *	74%	58%
US Drought Monitor	59%	57%
National Fuel Moisture Database | USFS Wildland Fire Assessment System	48%	44%
El Nino/La Nina Information | NWS **	37%	45%
Wildfires Near Me *	26%	17%
El Nino/So. Oscillation (ENSO) Diagnostic Discussion | CPC	23%	28%
Evaporative Demand Drought Index (EDDI) (NOAA)	14%	12%
IRI ENSO Forecast	7%	9%
Decision Support Tools		
Wildland Fire Decision Support System (WFDSS) *	66%	43%
Integrated Reporting of Wildland-Fire Information (IRWIN) *	39%	29%
Interagency Fuel Treatment Decision Support System (IFTDSS)	25%	23%
LANDFIRE-Landscape Fire and Resource Management Planning Tools | USGS	18%	17%

* Difference in proportion of respondents using the data source before and during fire season are different ($p < 0.05$). ** Difference in proportion of respondents using the data source before and during fire season are different ($p < 0.10$).

Table A2. Regression analysis of factors affecting number of information sources used by wildland fire managers testing quadratic relationship between decisions made and information sources used (variable coefficients significant at $p < 0.10$ in boldface).

Dependent Variable: Total Information Sources Used in a Season	**R^2 Adjusted = 0.2809 Full Sample, *n* = 412**			**R^2 Adjusted = 0.2940 Sub-Sample, *n* = 350**		
Variable	**Coefficient**	**Std. Error**	***p* > |t|**	**Coefficient**	**Std. Error**	***p* > |t|**
During fire season	**1.33**	**0.58**	**0.021**	**1.53**	**0.60**	**0.011**
Total decisions made	**1.69**	**0.59**	**0.004**	**0.85**	**0.98**	**0.389**
Total decisions made squared	−0.06	0.08	0.471	0.03	0.12	0.815
Agency variables						
BLM	−0.97	0.96	0.314	−0.96	1.06	0.365
Bureau of Indian Affairs	2.27	1.01	0.025	2.66	1.09	0.015
National Park Service	−1.54	1.41	0.273	−2.29	1.60	0.154
AZ Dept of Forestry & Fire Mgmnt	**−5.50**	**1.37**	**0.000**	**−4.61**	**1.57**	**0.004**
NM Forestry Division	2.27	1.58	0.153	2.96	2.10	0.159
US Fish & Wildlife Service	0.26	1.54	0.865	0.50	1.82	0.784
Tribal Agency	−3.26	2.56	0.204	0.09	3.31	0.977
NOAA	**5.17**	**2.72**	**0.058**	4.84	3.75	0.197
AZ Dept of Env Quality	3.25	3.27	0.320	1.16	4.28	0.786
Age variables						
<30 years old				**13.55**	**6.06**	**0.026**
30–39 years old				0.88	1.04	0.401
0–59 years old				−0.53	0.89	0.549
≥60 years old				0.60	1.42	0.674
Experience variables						
<5 years of experience				−2.11	2.36	0.373
5–9 years of experience				1.07	1.77	0.547
10–14 years of experience				0.12	1.15	0.918
15–19 years of experience				**2.74**	**1.02**	**0.008**
≥30 years of experience				1.43	1.15	0.217
Job/role variables						
Agency administrator				**−4.78**	**2.14**	**0.026**
Fire manager, suppression				0.97	0.83	0.242
Other job				0.15	0.89	0.866
Education variables						
High school graduate				**−3.11**	**1.40**	**0.027**
Some college				1.14	0.74	0.123
Masters/professional degree				1.66	1.07	0.121
Doctoral degree				0.85	3.28	0.795
Dispatch center variables						
AZ-Flagstaff	**−4.74**	**1.43**	**0.001**	**−3.46**	**1.58**	**0.029**
AZ-Phoenix	**−4.64**	**1.63**	**0.005**	**−4.78**	**1.75**	**0.007**
AZ-Prescott	0.94	1.51	0.535	0.75	1.78	0.674
AZ-Springerville	−0.41	1.60	0.797	0.12	1.76	0.945
AZ-Tucson	**−5.13**	**1.38**	**0.000**	**−5.14**	**1.48**	**0.001**
AZ-Williams	**−6.01**	**2.19**	**0.006**	**−5.48**	**3.14**	**0.081**
NM-Alamogordo	**−3.51**	**1.35**	**0.010**	**−3.02**	**1.58**	**0.056**
NM-Albuquerque	−0.22	1.44	0.876	1.56	1.58	0.325
NM-Santa Fe	−1.33	1.35	0.328	0.00	1.47	0.998
NM-Silver City	**−3.02**	**1.38**	**0.029**	**−3.11**	**1.45**	**0.033**
NM-Taos	**−6.36**	**1.53**	**0.000**	**−5.26**	**1.77**	**0.003**
Other	**−6.82**	**3.25**	**0.037**	**−10.29**	**4.28**	**0.017**
Constant	**11.24**	**1.43**	**0.000**	**10.95**	**2.23**	**0.000**

Positive but diminishing effects of decisions made on sources used implies a positive coefficient for decisions made, but a negative one for decisions made squared. The coefficient on the squared term is not statistically significant. We fail to reject the null hypothesis of a linear relationship between number of decisions made and sources used.

Table A3. Regression analysis of factors affecting total number of information sources used by wildland fire managers. Alternative specifications excluding age or experience variables (variable coefficients significant at $p < 0.10$ in boldface).

Dependent Variable: Total Information Sources Used in a Season	**R^2 Adjusted = 0.2821 Sub-Sample, *n* = 350**			**R^2 Adjusted = 0.2914 Sub-Sample, *n* = 350**		
Variable	**Coefficient**	**Std. Error**	**$p > \|t\|$**	**Coefficient**	**Std. Error**	**$p > \|t\|$**
During fire season	**1.53**	**0.60**	**0.012**	**1.53**	**0.60**	**0.011**
Total decisions made	**1.03**	**0.20**	**0.000**	**1.06**	**0.20**	**0.000**
Agency variables						
BLM	−0.76	1.05	0.468	−0.85	1.04	0.415
Bureau of Indian Affairs	**2.81**	**1.08**	**0.009**	**2.49**	**1.06**	**0.019**
National Park Service	−2.11	1.60	0.190	−2.06	1.60	0.200
AZ Dept of Forestry & Fire Mgmt	**−4.32**	**1.50**	**0.004**	**−4.67**	**1.51**	**0.002**
NM Forestry Division	3.19	2.10	0.130	3.16	1.95	0.106
US Fish & Wildlife Service	1.47	1.80	0.414	0.71	1.81	0.694
Tribal Agency	1.15	3.24	0.723	0.72	3.23	0.825
NOAA	**6.43**	**3.69**	**0.083**	3.40	3.65	0.351
AZ Dept of Env Quality	2.21	4.23	0.602	4.39	4.03	0.277
Age variables						
<30 years old	**11.56**	**5.49**	**0.036**			
30–39 years old	1.49	0.95	0.117			
50–59 years old	−0.23	0.87	0.794			
>60 years old	1.20	1.25	0.337			
Experience variables						
<5 years of experience				−0.13	2.18	0.953
5–9 years of experience				0.36	1.66	0.827
10–14 years of experience				0.40	1.08	0.710
15–19 years of experience				**3.07**	**0.95**	**0.001**
>30 years of experience				1.65	1.02	0.106
Job/role variables						
Agency administrator	−5.09	1.98	**0.011**	**−4.98**	**2.09**	**0.018**
Fire manager, suppression	0.63	0.81	0.438	1.04	0.81	0.202
Other job	0.08	0.84	0.928	0.07	0.88	0.941
Education variables						
High school graduate	**−2.43**	**1.36**	**0.076**	**−3.09**	**1.39**	**0.027**
Some college	**1.29**	**0.74**	**0.082**	**1.22**	**0.73**	**0.096**
Masters/professional degree	1.52	1.05	0.150	1.56	1.05	0.139
Doctoral degree	0.58	3.17	0.854	0.68	3.26	0.835
Dispatch center variables						
AZ-Flagstaff	**−3.19**	**1.53**	**0.037**	**−3.99**	**1.53**	**0.009**
AZ-Phoenix	**−4.64**	**1.70**	**0.007**	**−5.23**	**1.71**	**0.002**
AZ-Prescott	0.64	1.77	0.718	0.62	1.76	0.724
AZ-Springerville	0.65	1.68	0.699	0.47	1.72	0.784
AZ-Tucson	**−5.10**	**1.48**	**0.001**	**−5.22**	**1.44**	**0.000**
AZ-Williams	−4.83	3.08	0.118	-5.43	3.08	0.079
NM-Alamogordo	−2.28	1.51	0.132	**−3.05**	**1.54**	**0.048**
NM-Albuquerque	1.10	1.55	0.477	1.59	1.57	0.311
NM-Santa Fe	0.21	1.43	0.882	0.00	1.43	1.000
NM-Silver City	−2.84	1.41	**0.045**	**−2.92**	**1.42**	**0.041**
NM-Taos	−4.68	1.74	**0.007**	**−5.09**	**1.73**	**0.004**
Other	−11.65	4.19	**0.006**	**−7.20**	**4.07**	**0.078**
Constant	10.98	1.46	**0.000**	**10.57**	**1.45**	**0.000**

Appendix B

Survey Instrument
Thank you for agreeing to participate in this survey today.
Uses of Weather and Climate Information for Wildfire Management in the Southwest
Thank you for agreeing to participate in this survey. The data that we gather from this will contribute to a project funded by the National Oceanic and Atmospheric Administration to researchers associated with the Climate Assessment for the Southwest (CLIMAS) program at the University of Arizona. Its purpose is to help us better understand how weather and climate information is (or is not) used in the wildfire management community in the Southwest in order to assess the value of that information. Your responses to this survey will be kept anonymous and confidential. If you consent to the use of your survey responses in this research please continue on to the survey. The survey should take about 15 min to complete.
An Institutional Review Board responsible for human subjects research at The University of Arizona reviewed this research project and found it to be acceptable, according to applicable state and federal regulations and University policies designed to protect the rights and welfare of participants in research.
A1 In your normal work, do you use climate or weather data/information? Yes ____ No (End Survey) ___
The next set of questions will ask you about the different types of weather or climate data and information sources that you use. These are grouped into: (1) General Websites & Data Portals (often organization main websites) (2) Forecasts & Outlooks (3) Situation Reports & Information Products (more conditions on the ground, than forecasts or predictions) (4) Decision Support Tools So, if you don't immediately see an information source that you use, it may appear on a later page.
General Information Use
General Websites & Data Portals
Which general websites and data portals do you consult for climate or weather information? Check all that apply. To see the web page of the information source, can click on its name.

General Websites & Data Portals	Prior to the Fire Season	During the Fire Season
National Weather Service Climate Prediction Center (CPC)		
IRI (International Research Institute for Climate & Society, Columbia University)		
Western Regional Climate Center		
National Drought Mitigation Center		
NIDIS (Drought.GOV)		
US Drought Portal ∣ US Climate Resiliency Toolkit		
National Interagency Fire Center (NIFC) ∣ Predictive Services		
Office of Wildland Fire ∣ Department of the Interior		
The Weather Channel ∣ weather.com		
National Weather Service		
Other Website/Data Portal 1		
BEFORE entering a name, CHECK BOX(ES) at RIGHT		
Other Website/Data Portal 2		
BEFORE entering a name, CHECK BOX(ES) AT RIGHT		

Forecasts & Outlooks
Which Forecasts and outlooks do you consult for climate or weather information? Check all that apply. To see the web page of the information source, you can click on its name.

Forecasts & Outlooks	Prior to the Fire Season	During the Fire Season
U.S Seasonal Drought Outlook		
Seasonal Temperature and Precipitation Outlooks (CPC)		
Soil Moisture Outlooks (CPC)		
CLIMAS Southwest Climate Outlook		
USGS Fire Danger Forecast		
Southwest Coordination Center (SWCC) | SW Fire Potential Outlooks		
National Significant Wildland Fire Potential Outlook (NIFC)		
Quantitative Precipitation Forecasts | Weather Prediction Center (NWS)		
IRI Seasonal Climate Forecasts		
Other Forecast/Outlook 1		
BEFORE entering a name CHECK BOX(ES) AT RIGHT		
Other Forecast/Outlook 2		
BEFORE entering a name CHECK BOX(ES) AT RIGHT		

Situation Reports & InformationProducts
Which Situation reports and information products do you consult for climate or weather information? Check all that apply. To see the web page of the information source, you can click on its name.

Situation Reports & Information Products	Prior to the Fire Season	During the Fire Season
Evaporative Demand Drought Index (EDDI) (NOAA)		
US Drought Monitor		
National Fuel Moisture Database | USFS Wildland Fire Assessment System		
Wildfires Near Me		
Incident Management Situation Report (NICC)		
Fire Weather Briefing Page | NWS		
El Niño/La Niña Information | NWS		
El Niño/Southern Oscillation (ENSO) Diagnostic Discussion | CPC		
IRI ENSO Forecast		
Other Situation Report or Information Product 1		
(Before entering a name CHECK BOX(ES) AT RIGHT >)		
Other Situation Report or Information Product 2		
(Before entering a name CHECK BOX(ES) AT RIGHT >)		

Decision Support Tools
Which decision support tools do you consult for climate or weather information? Check all that apply. To see the web page of the information source, you can click on its name.

Decision Support Tools	**Prior to the Fire Season**	**During the Fire Season**
InciWeb: the Incident Information System		
Interagency Fuel Treatment Decision Support System (IFTDSS)		
Integrated Reporting of Wildland-Fire Information (IRWIN)		
LANDFIRE-Landscape Fire & Resource Management Planning Tools ǀ USGS		
Wildland Fire Decision Support System (WFDSS)		
Other Decision Support Tool 1		
(Before entering a name CHECK BOX(ES) AT RIGHT >}		
Other Decision Support Tool 2		
(Before entering a name CHECK BOX(ES) AT RIGHT >)		

Decisions Informed by Information
From the list below, please select which fire management decisions you either make, help to make, or provide information for (check all that apply).

Hire or extend fire crew personnel
Allocate personnel, tanker planes, or equipment
Request additional resources (severity requests)
Prescribed fire or wildland fire use decisions
Public awareness, public notices
Brief administrators, congressional staff, etc.
Other

Demographics
Which agency do you work for?

Forest Service
BLM
Bureau of Indian Affairs
National Park Service
NOAA
Arizona Department of Forestry and Fire Management
New Mexico Forestry Division
Arizona Department of Environmental Quality
New Mexico Environment Department, Air Quality Bureau

Which state(s) do you operate in? (check all that apply)

Arizona
New Mexico
California
Colorado
Nevada
Utah
Texas
Other

What is your age?

Less than 30
30–39
40–49
50–59
60 or more

How many years of fire management experience do you have?

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

How would you describe your job within your agency or organization?

Agency Administrator
Fire Manager, fuels and fire
Fire Manager, suppression
Other

What is your highest level of educational attainment?

High School Graduate
Some College
College Graduate
Masters/Professional Degree
Doctoral Degree

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