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(RISP) model**

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Public use of Information about Smoke Emissions: Application of the Risk Information Seeking and Processing (RISP) model

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Abstract

In the last few decades, the number of people living in fire prone ecosystems has increased, placing more people and private property at risk to future fire events. Substantial research has demonstrated consistent public support for the use of prescribed fires in fuels reduction efforts; however, continuing public concern regarding smoke emissions and negative air quality impacts exists. To date, limited research has specifically examined public attitudes toward smoke emissions. In this study, we use a mail-back/internet survey to assess citizen information seeking behaviors regarding smoke emissions in four communities in high fire risk areas. Path analysis was used to apply the Risk Information Seeking and Processing (RISP) model to examine factors that motivate people to seek information relevant to smoke emissions. We find that residents were concerned about smoke emissions and believed they needed more information. Residents' intentions to seek information were influenced by information (in)sufficiency, the number of sources used, and smoke acceptability, among other factors. Findings suggest that currently available information resources on smoke may not be sufficient to meet residents' information needs, particularly for those most motivated to learn more about emissions.

Introduction

Smoke emissions from prescribed and wildfires are an important issue for many Wildland Urban Interface (WUI) residents. Over the last two decades, the number of acres treated by prescribed fires in the United States (US) has increased (NIFC, 2016), while some regions have also seen increases in the number of acres burned by wildland fires (NIFC, 2016). These regional increases may in part be attributed to the lengthening of the fire season, a problem likely to be exacerbated in some areas due to the effects of climate change (Doerr and Santín 2016). Over this same period, the WUI population has also grown (Hammer et al. 2009; Radeloff et al. 2005), resulting in larger numbers of residents that may experience smoke emissions. Among other outcomes, smoke emissions can cause irritated sinuses, coughing, and headaches among exposed populations, impacts of particular significance for the approximately 30% of WUI households which contain members with health problems that may be worsened by smoke (McCaffrey and Olsen 2012). How these local residents perceive the management of smoke emissions is likely to be an important influence in the continued support for the use of prescribed fires. Should WUI residents decide the negative costs associated with smoke emissions outweigh the benefits offered by prescribed burns, it may become difficult for land managers to implement prescribed burns in the area (Weisshaupt et al. 2005).

Accordingly, resource managers are looking for ways to engage local residents regarding prescribed fire use and smoke emissions, as well as manage perceptions and potential impacts on nearby populations. These resource managers also point to communication challenges, including uncertainty about the effectiveness of potential communication strategies and inconsistency in messages from different sources regarding smoke emissions (Olsen et al. 2014). Additionally, there is a growing awareness that simply providing information to members of the public

(knowledge deficit approach) does not necessarily lead to better decision-making or greater support for science (Brossard and Lewenstein 2010). Rather, managers must be aware of the needs and concerns of residents to engage effectively about smoke emissions. Substantial research has found that risk perceptions can be affected, either positively or negatively, by the provision of information designed to evoke specific feelings (e.g., Keller et al. 2006; Slovic et al. 2004). For instance, Keller et al. (2006) found that risk perceptions can be exacerbated by providing information that results in negative emotions or causes the consideration or recall of potential negative outcomes. However, while previous work has addressed the impact of information provision, limited research has examined the factors that motivate residents to seek information about smoke emissions. The purpose of this paper is to begin to address this research gap using the framework provided by the Risk Information Seeking and Processing (RISP) model.

Perceptions of prescribed fires and smoke emissions

One common approach to managing perceptions of smoke emissions is by providing information regarding the benefits of prescribed fires, actions taken by fire managers to reduce smoke emissions, or potential behaviors that residents may adopt to minimize the impact of emissions, among others. Substantial prior research has found that acceptance of fuel treatments is positively associated with greater understanding of the treatment and its likely outcomes (e.g., Blanchard and Ryan 2007; McCaffrey 2004; Shindler and Toman 2003). Moreover, outreach programs, based in a diversity of approaches to science communication (Brossard and Lewenstein 2010), have contributed to more supportive beliefs and attitudes toward the use of

prescribed fires among local residents (e.g., Bright et al. 2007; McCaffrey 2004, 2006; Toman et al. 2006).

While prior research has found high levels of acceptance for the use of prescribed fire, some studies have also identified concern regarding smoke emissions (e.g., Brunson and Evans 2005; Shindler and Toman 2003). Similarly, managers have raised issues regarding smoke emissions impeding their ability to use prescribed fire (Wolcott et al. 2007). Smoke emissions can potentially influence both those near the treatment site and those far removed as weather patterns disperse smoke across the landscape. As Pyne et al. (1996) note, smoke emissions are often the most visible impact for the public, can threaten public health, and the resulting air quality impacts can lead to restrictions on prescribed burning opportunities to maintain compliance with air quality standards.

Limited scholarship has specifically emphasized smoke, with much research including only a few questions about beliefs or attitudes toward smoke within a broader study focused on acceptance of fuels treatments; in most cases, attitudes toward smoke were largely included as an explanatory variable of treatment acceptance. However, Ryan and Wamsley (2008) found that concerns about smoke may be alleviated by increased knowledge of prescribed fire, suggesting that outreach programs describing their beneficial outcomes may not only contribute to increased understanding and acceptance of prescribed fire but also decreased concerns about adverse effects, such as smoke. Through a series of focus groups on smoke emissions and management, Weisshaupt et al. (2005) illustrated that attitudes toward smoke were still largely malleable. While several focus group participants acknowledged smoke emissions were part of life in WUI areas, many formed their attitudes toward smoke throughout the discussions. Based on these focus groups, a number of factors influenced tolerance for emissions: the source of smoke (forest

burning was generally preferable to agricultural burning), the ability to manage emissions from prescribed fire and potentially reduce emissions from a later wildfire, and recognition that prescribed burns would result in ecological benefits.

The importance of these factors for tolerance of smoke emissions has been demonstrated across additional studies, with some important differences. Recent studies have also found that smoke tolerance is impacted by the smoke source, however the most acceptable source varied from fires started by lightning strikes (Blades et al. 2014) to wildfires under active suppression (Engebretson et al. 2016) to uncontrolled wildfires (Olsen et al. 2017). Present in each of these studies, however, was a moderate to high level of tolerance (or acceptance) of smoke emissions, including those from prescribed-natural fires and prescribed burns. Once again in line with Weisshaupt et al. (2005), Olsen et al. (2017) found higher acceptance when the fires were expected to benefit society rather than individuals (e.g., agricultural or pile burns). In addition to the origin of the smoke, a number of other tolerance influencers emerged. Blades et al. (2014) found that tolerance was impacted by public warning in advance, expected severity of health effects from the smoke (particularly at unhealthy levels for everyone or sensitive populations), and smoke duration. Higher levels of tolerance emerged if resource managers openly stated the forest health objectives behind the prescribed fire event (Engebretson et al. 2016). While dependent on the fire source, Olsen et al. (2017) found acceptance generally influenced by risk perceptions of smoke, confidence in managers, expected benefits of the fire, and demographic characteristics, including age, education, and rural or urban residence. Lastly, those with previous negative health effects from smoke were generally less tolerant (Blades et al. 2014; Engebretson et al. 2016), but some evidence indicates that health concerns are strongly important

for only a subset of the population, such as those with existing medical conditions (Olsen et al. 2017).

Based on the importance of information for WUI residents, both in terms of awareness of fire events and in shaping attitudes toward smoke emissions and prescribed fires, a better understanding of how residents interact with information is needed. The Risk Information Seeking and Processing (RISP) model enables us to explore one aspect of this relationship, motivations to seek information.

Risk Information Seeking and Processing (RISP) model

A risk is defined as “the chance, within a time frame, of an adverse event with specific consequences” (Burgman 2005, p. 1). Risk perceptions, then, are intuitive judgments about a risk that are dependent on two general components: 1) how much the hazard is feared or how catastrophic the outcomes are likely to be (dread) and 2) how much is unknown about the hazard (Burgman 2005; Slovic 1987). For this study, we consider smoke emissions to be a risk.

To understand what motivates individuals to seek additional information regarding perceived risks, communication scholars developed the Risk Information Seeking and Processing (RISP) (Griffin et al. 1999; Kahlor et al. 2006; Trumbo 1999). The RISP (Figure 1) model was originally intended to address direct personal risks (risks with firsthand impacts on an individual, such as drinking contaminated water or experiencing floods) and was based on two existing theoretical models: the Heuristic-Systematic Model (HSM) and the Theory of Planned Behavior (TPB). Briefly, the HSM conceptualizes differences across how much effort is used to process information: slowly and thoroughly using systematic processing or more economically relying on shortcuts (e.g., message characteristics or source identity) with heuristic processing (Eagly

and Chaiken 1993). The TPB examines the factors which influence an individual's decision to engage in a specific behavior, including intentions to act, perceived control over a behavior, beliefs about success or failure, normative beliefs, and motivation to follow the expectations of referents (Ajzen 1991).

– Insert Figure 1 About Here –

The RISP model describes the theoretical relationship between several variables that are conceptualized to influence information seeking and processing behaviors (described in Table 1): *individual characteristics, perceived hazard characteristics, affective response, informational subjective norms, information (in)sufficiency, relevant channel beliefs, perceived information gathering capacity, information seeking, and information processing.*

– Insert Table 1 About Here –

The proposed relationships specified in the RISP model have primarily been applied within the context of health risks related to environmental issues (e.g., Clarke 2009; Griffin et al. 1999; Kahlor et al. 2003; Trumbo 1999). Recent work has also examined the model in the context of impersonal risks, or those that focus on societal-level impacts (Kahlor et al. 2006). This has relevance to our study as smoke emissions can be perceived as leading to both personal (e.g., causing breathing issues for an individual) and impersonal (e.g., aesthetic degradation within an area) impacts. Additionally, while much of the previous RISP related research has focused on the information seeking and processing behaviors of the general public (e.g., Griffin et al. 1999; Griffin et al. 2008; Kahlor et al. 2006), this project provides an opportunity to test the RISP model applied to a more knowledgeable public. That is, prior research has found that many WUI residents like those in our study generally recognize the complexity of fuel hazards and have a sophisticated understanding of prescribed fires and fire risks (e.g., Brunson and

Shindler 2004; Toman et al. 2014), although level of engagement in the issue can vary across communities (Paveglio et al. 2015). In this study we focus on the information seeking behaviors regarding smoke emissions and management for residents of select WUI areas (we do not assess information processing). Based on the relationships outlined in the RISP model, we propose the following hypotheses (*H*; Figure 2):

H1: Individual characteristics (i.e., age, gender, acceptability of smoke) significantly influence *perceived hazard characteristics*.

H2: Perceived hazard characteristics (i.e., smoke impact likeliness, smoke impact severity, impact in next five years, proximity) positively influence *affective response*.

H3: Affective response positively influences *information (in)sufficiency*.

H4: Informational subjective norms positively influences *information (in)sufficiency*.

H5: Perceived information (in)sufficiency positively influence *information seeking* intent.

H6: Relevant channel beliefs (i.e., number of sources, source usefulness, state information score, and federal information score) significantly influence *information seeking* intent.

H7: Perceived information gathering capacity positively influence *information seeking* intent.

– Insert Figure 2 About Here –

Methods

The data reported here were collected as part of a broader study on acceptance of smoke emissions and influencing factors in four locations across the US. The study locations include human populations in close proximity to fire dependent ecosystems where active fuels reduction programs are underway to reduce the likelihood of fire and restore forest conditions (Evans et al.

2011; Summers et al. 2011). Accordingly, residents are likely to have previous experience with fire and smoke emissions and view these topics as highly relevant. The specific sites were selected due to their proximity to substantial WUI communities, active fuels reduction programs, recent wildland fire activity, and the diversity of locations and forest and fire ecology represented. Data reported here come from four study locations comprising communities adjacent to the following National Forests:

1. *Shasta-Trinity National Forest*. Located in northern California, this National Forest consists of chaparral and conifer forests. Fire regimes in this forest include both infrequent, stand-replacing fires and frequent, low to moderate severity fires (Evans et al. 2011; Summers et al. 2011).
2. *Kootenai National Forest*. Located in northwest Montana, this National Forest consists of mixed conifer forests including douglas-fir, lodgepole pine, and spruce-fir. Fire regimes include a mix of infrequent, low to stand-replacing severity fires (Evans et al. 2011; Summers et al. 2011).
3. *Fremont-Winema National Forest*. Located in southern Oregon, this National Forest consists of ponderosa, lodgepole pine, and mixed conifer forests. The ecosystem experiences moderate frequency, low to mixed severity fires (Evans et al. 2011; Summers et al. 2011).
4. *Francis Marion Ranger District of the Francis Marion and Sumter National Forests*. Located in southeastern South Carolina, this National Forest consists of longleaf pine and hardwood forests and the fire regime consists of high frequency, low severity fires (Summers et al. 2011).

221 *Research design*

222 This study uses data collected from a mail-back/internet survey, based on a random
223 sample purchased from a professional sampling company. The sample consisted of adult
224 residents (ages 18 and older) from counties containing the National Forests, and included a 50/50
225 mixture of rural and urban zip codes (with the exception of Montana, as there was no nearby
226 urban area). Conducted between March and June 2012, the survey followed a modified “tailored
227 design method” (Dillman et al. 2009). First, the participants received a postcard notifying them
228 of the coming survey instrument packet, followed by a complete survey instrument packet (cover
229 letter, questionnaire, and pre-paid postage return envelope) a few days later. The cover letter
230 also contained a link to an online version of the survey instrument. Two weeks later, a reminder
231 postcard went to those who had not yet responded, followed by a second complete survey
232 instrument packet three weeks later. No incentive was provided to participate in the study.

233 A total of 4,800 questionnaires (1,200 per site) were mailed to residents, which decreased
234 to an adjusted sample size of 4,325 after correcting for non-deliverables (approximately 10%
235 were returned with incorrect addresses). Of these, 992 questionnaires were completed; nearly all
236 were returned by mail with only 9% of the questionnaires completed online. The overall,
237 adjusted response rate for the survey was 23% and varied from a high of 30% ($N = 323$) in
238 Montana to a low of 13% ($N = 147$) in South Carolina. To assess whether respondents were
239 representative of the larger populations within the study areas we compared demographic
240 characteristics of respondents to the general population in the sampled counties (United States
241 Census Bureau 2015). Respondents were reasonably similar in race and income to the larger
242 population; however, the results show a modest oversampling of males and a notable
243 oversampling of older adults and those with more education. Gender, age, and education bias is

fairly common in survey research, particularly on natural resources topics (Gigliotti and Dietsch 2014; Jacobson et al. 2007).

– Insert Table 2 About Here –

Data analysis

Based on mean comparisons (using a Tukey post-hoc correction) of demographic traits across sites, participants were similar in terms of gender and level of education (Table 2). Some differences emerged for age (on average, respondents in South Carolina were younger) and for household income (respondents in Montana had lower incomes compared to California and South Carolina, while Oregon was lower than South Carolina). Given the mixed evidence concerning geographic differences in attitudes toward fuels management (for a review, see Toman et al. 2014) and that the purpose of this paper is to explore the information seeking behaviors of diverse residents in fire dependent ecosystems with active fuels reduction programs, we do not believe these demographic differences are detrimental to the analyses and data were aggregate across all of the study sites. For each of the tested models, the sample size was within an acceptable range for the sample size to estimated parameter ratio recommended for path analysis (Kline 2015). Path models were developed using the Linear Structural Relations (LISREL) software to investigate relationships between variables as described in the RISP model. Path analysis is used to test a series of relationships, including both direct relationships (assessing the influence of variables on immediately subsequent variables) and mediated relationships (where independent variables are proposed to influence dependent variables indirectly through an additional variable) (Kline 2015). A total of four RISP models were developed and tested: one that closely followed the relationships described in the RISP model and three additional models designed to better fit the data.

The goodness of fit for each model was examined through several measures including: modified chi-squared (X^2/df), Root Mean Square Error of Approximation (RMSEA), and Comparative Fit Index (CFI) (Hu and Bentler 1999; Kline 2015; Steiger 1990). For the modified chi-squared test, a value of less than five ($X^2/df < 5$) indicates a good fit, values between five and ten are considered acceptable, and values above ten are inadequate ($X^2/df > 10$) (Kline 2015). For the RMSEA measure, values less than 0.05 indicate a very good model fit, values in the range of 0.05 to 0.08 indicate a good or reasonable fit, while values above 0.10 indicate a poor fit (Steiger 1990). Finally, for the CFI measure, a value of one represents a “perfect” fit, while those above 0.90 are considered acceptable (Hu and Bentler 1999).

Measures

Each of the RISP variable measures were based on previous RISP model studies (e.g., Griffin et al. 2008; Kahlor et al. 2006). Most measures used a seven-point scale with a neutral midpoint, and “don’t know” responses were excluded list-wise from the analyses. Table 3 contains additional information on the scales used to assess each variable. For scales containing three or more items, the internal consistency was measured using Cronbach’s alpha with a designated Cronbach’s $\alpha = 0.70$. The reliability for scales of two items was measured using Pearson correlations, with an acceptable level of $r = \pm 0.3$ and a significance level of $\alpha = 0.05$. Of note, ‘current knowledge’ was self-reported and is a measure of perceived knowledge (Ladwig et al. 2012).

– Insert Table 3 About Here –

To ensure the suitability of the variables for path analysis, the skewness and kurtosis measurements were examined; only two variables displayed unacceptable levels of kurtosis and

skewness. ‘Proximity to potential fire’ had levels of both kurtosis and skewness outside of the normal range while ‘impact in next 5 years’ had non-normal levels of kurtosis. It is likely that the skewness and kurtosis of each of these variables was influenced by our research design and do not require additional action. By focusing on residents living in fire dependent areas with ongoing fire and fuels management activities, it was extremely unlikely that responses would be normally distributed on either of these items.

– Insert Table 4 About Here –

Results

Respondents were most likely to be male, around 62 years old, and had at least some college education (Table 2). Descriptive information for the RISP variables is provided in Table 4. Briefly, respondents indicated acceptance of smoke emissions, had moderate expectations of smoke impact severity, lived very close to areas which might burn ($M = 3.44$ miles), and worried about smoke (affective response). Respondents indicated they needed more information than they currently held (information (in)sufficiency) and used few sources to find additional smoke information ($M = 4.76$ out of 16 possible sources). Lastly, respondents were split in their intentions to seek additional smoke information: 29% of respondents intended to seek more information, 39% did not intend to do so, and the remaining 33% did not have any intentions either way.

List-wise deletion was employed for missing responses, resulting in an effective sample size of 652 for the path analysis. Assessment of model fit can be found in Table 5. The Baseline Model most closely followed the relationships described in the theoretical RISP model (displayed in Figure 1), but it exhibited poor fit and was not consistent with the observed data ($X^2 = 1331.41$, $df = 60$, $p < 0.001$, $X^2/df = 22.190$, RMSEA = 0.180). Following standard path

analysis procedure, the Baseline Model served as a reference point for the subsequent models. Variables without significant relationships were removed one at a time, beginning with component items which only partially represented their respective RISP variables, and the data was once again tested to examine the impact on fit (Kline 2015; Yang et al. 2010). Testing continued until the model fit measures were acceptable or good and did not improve substantially with further variable removal.

– Insert Table 5 About Here – Model 1 removed only *informational subjective norms* resulting in a slight improvement in model fit, although the overall fit was still poor (Table 5). Model 2 removed only the ‘smoke impact severity’ measure (*perceived hazard characteristic*). The goodness of fit for Model 2 improved substantially, with the modified chi-squared and RMSEA measures indicating acceptable fits. Model 3 removed both *informational subjective norms* and ‘smoke impact severity,’ once again resulting in an improved goodness of fit with modified chi-squared, RMSEA, and CFI values all indicating acceptable fits ($X^2 = 231.90$, $df = 44$, $p < 0.001$, $X^2/df = 5.270$, RMSEA = 0.081, CFI = 0.901). The RISP Model 3 presented here explained 11.8% of the variance in information seeking behaviors, $p < 0.001$. See Figure 3 for a diagram of Model 3. As Model 3 best maintained relationships representative of the RISP model while achieving a good model fit, this model was examined in greater depth. A number of significant relationships were found and will be considered in light of the hypotheses.

– Insert Figure 3 About Here –

Model 3 had eight significant relationships (Table 6). Two of the *individual characteristics*, ‘acceptability of smoke’ and ‘gender,’ had a significant influence on the *perceived hazard characteristics* ‘smoke impact likeliness’. That is, females and those with lower acceptability of smoke were predicted to view smoke as a greater hazard (*HI*). Next,

affective response was significantly positively influenced by the *perceived hazard characteristic* ‘smoke impact likeliness’ and negatively influenced by ‘proximity to potential fire’; participants who believed they were likely to be impacted by smoke and lived closer to an area that might burn have a higher affective response (*H2*). *Information (in)sufficiency* was significantly positively influenced by *affective response*; individuals who indicated they worry about smoke felt they did not have enough information (*H3*). However, *information (in)sufficiency* was also predicted to be influenced by *informational subjective norms* (*H4*), but the initial models did not find support for this relationship and the variable was removed from the model.

– Insert Table 6 About Here –

Lastly, *information seeking* intention was significantly positively influenced by *information (in)sufficiency* (*H5*) and the ‘number of sources’ participants already used to receive smoke information (*relevant channel belief*; *H6*), and negatively influenced by *information gathering capacity* (*H7*). While significant, *information gathering capacity* was in the opposite direction than predicted. Respondents who believed they did not currently have enough information, already used more sources of information, and indicated it was difficult to find information intended to seek more smoke emissions information. As these findings indicate, a number of the hypothesized relationships were supported (*H3*, *H5*) or partially supported (*H1*, *H2*, *H6*).

Model 3 provided support for the RISP model as the path analysis relationships were generally consistent with the proposed relationships. While some of the component items of the RISP variables were not significant (e.g., the *individual characteristic* ‘age’ or the *perceived hazard characteristic* ‘impact in next 5 years’), all but two of these RISP variables were represented within the model by other variable measures (e.g., the *individual characteristic*

‘acceptability of smoke’ or the *perceived hazard characteristic* ‘proximity to potential fire’). As noted above, the RISP variable *informational subjective norms* was removed to increase the goodness of fit and was not represented in the model. Thus, the hypothesis concerning the relationship between *information (in)sufficiency* and *informational subjective norms* was not supported (*H4*).

Discussion

In this paper, we examined the information seeking behaviors of WUI residents regarding smoke emissions from wild and prescribed fires. Specifically, the Risk Information Seeking and Processing (RISP) model was employed to better understand the underlying variables that motivate information seeking behaviors of residents in the study locations. We find that WUI residents’ *information seeking* behaviors are directly influenced by their perceived information needs, beliefs about their ability to find information, and the number of sources they already draw on for relevant information.

Before discussing the main findings from this study, some limitations are considered. First, beyond *information seeking* behaviors, it is also important to know how individuals process information they receive. This study did not assess *information processing* and greater understanding of this component is needed to more fully understand how WUI residents interact with risk related information; this component of the RISP model merits investigation in future research. Additionally, our measure of information seeking was based on a self-reported intention to find additional information. A more stringent test of actual information seeking behavior itself may yield different results. Second, the *affective response* variable was based on a single measure. Although the variable performed well in the analyses, we recommend

employing a more comprehensive measure in future studies. Third, as mentioned previously, the theoretical RISP model proposes a relationship between *information (in)sufficiency* and *information seeking* which is moderated by *information gathering capacity* and *relevant channel beliefs*. Due to analysis constraints, we were unable to include the moderated relationship and instead predicted a direct relationship between *information gathering capacity* and *relevant channel beliefs*, consistent with past research. We suggest testing the full proposed theoretical relationship in subsequent scholarship. Lastly, other measures of *individual characteristics*, *perceived hazard characteristics*, and *relevant channel beliefs*, such as health, past experiences, or trust in the information source, may have important impacts on smoke information seeking behaviors and warrant investigation. With these limitations in mind, several key findings emerge from this analysis that merit further discussion.

First, the path analysis generally supported the current RISP literature and the study hypotheses that followed the RISP relationships proposed in previous research (apart from those relationships including *informational subjective norms*, see above). Notably, the models presented here and in the literature support positive relationships between: 1) *perceived hazard characteristics* and *affective response* (H2) (Kahlor 2007), 2) *affective response* and *information (in)sufficiency* (H3) (Griffin et al. 2008; Kahlor 2007), and 3) *information (in)sufficiency* and *information seeking* (H5) (Griffin et al. 2008; Kahlor et al. 2006).

Moreover, as has been found in previous studies, the relationship between *information seeking* and *relevant channel beliefs* (H6) was inconsistent (Clarke and McComas 2012; Griffin et al. 2008), with only one of the four components significantly predicting *information seeking* intentions. Previous research has found *relevant channel beliefs* to be a weak and inconsistent predictor for *information seeking*; results elsewhere have not provided evidence of a clear

positive or negative relationship and significance has rarely been found. In part, this is hypothesized to be a result of *relevant channel beliefs* acting as a direct predictor of *information seeking* rather than a predictor of the relationship between *information seeking* and *information (in)sufficiency* as proposed in the theoretical model (Griffin et al. 2008).

A few surprising differences from previous literature were found. Prior studies have demonstrated the expected positive relationship between *information seeking* and *perceived information gathering capacity*, with those who believe they are able to find and understand information being more likely to seek it (Griffin et al. 2008). However, a negative relationship was demonstrated in this study, with those who believed it was difficult to find information intending to seek additional information.

One possible explanation of this difference could be due to the nature of the risk and the availability of information. While smoke emissions are a concern for residents, there has typically been limited information available on smoke emissions. As such, while residents are motivated to learn more about smoke emissions and management, it may be difficult to find appropriate smoke information. This may cause motivated residents to put forth more effort and search through information only tangentially related to smoke emissions; this interpretation is supported by additional evidence in this study as motivated individuals also drew on a greater number of informational sources. Notably, residents who still intend to seek additional information also already use a large number of informational sources. Alternatively, while the RISP model focuses on those intending to seek information, this finding could indicate that those who believed it was easy to find information have already met their informational needs and, thus, do not feel compelled to seek additional information. Future research should investigate the relationship between *information gathering capacity* and *information seeking intentions*.

As mentioned previously, many of the previous RISP studies have focused on the seeking and processing behaviors of the general public (e.g., Griffin et al. 1999; Kahlor 2007; Kahlor et al. 2006). However, our population of WUI residents is likely to have some awareness and potential experiences with smoke issues and may have already sought information in the past. Some of the differences identified in this work may be due to the previous engagement of our participants with smoke and fire topics.

Similar to the differences found with *perceived information gathering capacity*, *informational subjective norms* were previously demonstrated to have a positive relationship with *information (in)sufficiency* (Clarke and McComas 2012; Griffin et al. 2008; Kahlor 2007; Kahlor et al. 2006). Kahlor et al. (2006) found a surprisingly strong relationship between the two variables within the context of an impersonal environmental risk, suggesting that when a hazard does not cause direct personal harm, the expectations of important others may have a greater influence on information seeking behaviors than the risk posed by the hazard. In our case, we did not identify a significant relationship between *informational subjective norms* and *information (in)sufficiency*; indeed, removing the *informational subjective norms* variable resulted in improved goodness of fit. The lack of a significant relationship may be due to the inconsistency between our measures and the theoretical RISP model. Although generally not adhered to in RISP research, the theoretical RISP model proposes *informational subjective norms* are influenced by *individual characteristics* (*individual characteristics* are related only to *perceived hazard characteristics* in tested models based on Griffin et al. (2008)). It is possible that removing the influence of *individual characteristics* limited the impact *informational subjective norms* could have within the model.

Second, while almost half of our participants indicated that they needed more information about smoke emissions, only 29% indicated they intended to seek additional information. This finding emphasizes that *information seeking* intentions depend on more than just perceived information need, likely including various *individual characteristics* and the relative priority of concern given to smoke emissions. Moreover, while participants generally drew on a small number of information sources and felt it was easy to find smoke emissions information those who intend to seek additional information reported that they were already making use of a number of information sources and believe that information is difficult to find. That is, residents who report the greatest intentions to seek additional information are already engaged in effortful information seeking, but believe relevant information is difficult to find or is not sufficient to meet their information needs. This finding may reflect inconsistencies noted in messages from relevant management agencies identified by smoke management personnel in prior research (Olsen et al. 2014). In addition, the unexpected relationship between *information seeking* intentions and the ‘number of sources’ used points to differences in how residents interact with available information, especially for residents with different levels of information seeking intentions.

Lastly, the analysis also emphasized the importance of both the direct and indirect relationships among risk perceptions and information seeking. While the *perceived hazard characteristics* of smoke were found to predict *information seeking* behaviors, this relationship seemed to be primarily driven by one variable—‘smoke impact likeliness.’ ‘Smoke impact likeliness’ indirectly influenced *information seeking* through the *affective response* and *information (in)sufficiency* variables, meaning participants who believed they were likely to be impacted by smoke emissions were also more likely to worry about smoke, to need more

information than they had, and to seek additional information. Interestingly, the counterpart of this variable, 'smoke impact severity,' performed poorly in the model and was removed from analysis to improve goodness of fit. A potential explanation for this difference is that residents may view any impact of smoke emissions as equally severe, or undesirable, causing them to focus on whether any smoke impacts at all are likely to occur.

Management implications

Although a large portion of WUI residents in fire dependent areas have heard or read about smoke emissions from fires, this study demonstrates that smoke emissions and their impacts are important to WUI residents. Almost half of the residents indicated they worry about smoke emissions, while almost a third indicated experiencing personal health effects due to smoke in recent years. As such, residents may have a high risk perception of smoke emissions from wild and prescribed fires. As suggested elsewhere, management of smoke emissions can influence public perceptions and support of prescribed fires. Moving forward, smoke emissions are an issue that may need to be addressed to maintain public acceptance of prescribed fire and alleviate residents' concerns.

There are several important implications from this research for fire managers in WUI areas. First, although a seemingly straightforward finding, it is important to keep in mind that individual characteristics and risk perceptions will influence how individuals assess smoke emissions and their impacts. There is no universal risk rating among WUI residents, rather, residents will evaluate risks based on their individual circumstances. Prior work suggested managers purposefully engage residents on smoke questions, often emphasizing communication about risks with populations they recognize as being more vulnerable to impacts (e.g., residents

496 of nursing homes, individuals adjacent to planned burns) (Olsen et al. 2014). Findings here
497 provide additional support for such an approach while also suggesting that perceived information
498 needs may also be driven by variables that are less obvious without more in-depth study of
499 residents and supports the value of social research to develop a more informed understanding of
500 local communities. Second, managers cannot assume that residents who already use multiple
501 information resources do not need any more information. Indeed, findings here suggest that the
502 opposite may be true in some cases as individuals who have used more sources also intend to do
503 additional research and believe it is difficult to find information on smoke emissions. Residents
504 who have already sought information about smoke emissions should not be disregarded as
505 knowing enough about the topic. Finally, these findings indicate that smoke emissions
506 information currently available to residents may not be sufficient, especially in consideration of
507 the large discrepancy between information need and seeking intention. Residents of fire
508 dependent areas are in need, and want, relevant and useful smoke emissions information.
509

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Table 1. Description of RISP variables.

RISP variable	Description
<i>Individual characteristics</i>	These include demographic information or past experiences with a risk. Recent work has conceptualized individual characteristics as directly influencing perceived hazard characteristics (e.g., Griffin et al. 2008); this approach was followed in the present study.
<i>Perceived hazard characteristics</i>	These include individual judgments about a risk or feelings of dread and are conceptualized to directly influence the individual's affective response; those who believe they are at greater risk from a hazard are more likely to have a strong emotional response to that hazard (Kahlor 2007).
<i>Affective response</i>	This measures emotional responses to a risk (e.g., fear, worry, anger) and directly influences information sufficiency (those with a strong affective response are expected to feel they lack information about the specified hazard).
<i>Informational subjective norms</i>	This measures an individual's assessment about the level of knowledge others expect them to have about a risk. Those who believe they are expected to know more about the topic are predicted to have a larger information (in)sufficiency.
<i>Information (in)sufficiency</i>	Difference between the amount of information an individual desires (information threshold) to appropriately deal with a risk and his or her current knowledge. Predicted to influence information seeking and processing behaviors (moderated by relevant channel beliefs and perceived information gathering capacity); when the sufficiency threshold is much higher than the current knowledge, individuals are predicted to seek additional information, use active seeking, and systematically process information (Kahlor 2007).
<i>Relevant channel</i>	Individual beliefs about quality of available information sources (e.g.,

<i>beliefs</i>	usefulness, trustworthiness). These beliefs are expected to moderate the relationship between information (in)sufficiency and information seeking and processing behaviors; if individuals believe information is of high quality (relevant channel beliefs), they may be motivated to process it more carefully and put forth more effort (McLeod et al. 1991).
<i>Perceived information gathering capacity</i>	This refers to an individual's beliefs about his or her ability to access and understand the information about a particular risk. Similar to <i>relevant channel beliefs</i> , this is expected to moderate the relationship between information (in)sufficiency and information seeking and processing behaviors; individuals who believe they are capable of finding and understanding information on an issue (perceived information gathering capacity), will be more motivated to actively seek and process information (Griffin et al. 1999; Kahlor 2007; Kahlor et al. 2006).
<i>Information seeking</i>	Efforts to gather information can be passive with information gathered from sources an individual uses on a regular basis or active with an individual expanding his or her efforts to include sources outside of his or her normal information gathering routine.
<i>Information processing</i>	Received information is either processed systematically (greater effort used to analyze and understand the information) or heuristically (relying on peripheral characteristics of the message, provider, or methods of communication rather than evaluations of the information itself) (e.g., Chaiken 1980).

Table 2. Descriptive statistics for demographic information.

Variables	All	CA	MT	OR	SC
Age (median years)	62.0	64.0	61.0	61.5	57.0
	%	%	%	%	%
Gender (male)	57.9	60.4	57.4	58.4	54.0
Education					
High school or less	28.1	21.0	35.2	27.5	25.9
Some college	25.9	29.6	21.9	27.9	24.4
Bachelor's or Associate's degree	29.6	32.5	26.9	28.3	32.6
Some graduate or graduate degree	16.5	16.9	15.9	16.4	17.0
Personal health effects from smoke					
Any source	26.7	29.4	32.6	27.3	16.0
Prescribed fires	12.2	13.4	17.6	9.3	3.4
Wildfires	16.0	22.4	18.9	13.1	4.1
Worry about smoke	45.7	46.0	43.2	44.4	53.2
Heard or read about...					
Prescribed fires	93.4	93.2	96.9	92.8	87.8
Impacts of smoke	81.6	80.9	82.8	83.4	76.9
Reported information (in)sufficiency	51.7	56.2	49.5	45.6	59.0
Intend to seek additional smoke information	28.5	32.2	23.2	28.2	34.6

Table 3. RISP variables, scales, and reliability tests (Cronbach's alpha, Pearson correlation) used in analysis.

RISP variables	Items	Scales	Cronbach's alpha (α)	Pearson correlation (r)
Component variables				
Individual characteristic				
Age	1	Years	-	-
Gender	1	0 "Male" and 1 "Female"	-	-
Acceptability of smoke	8	7 point; "Strongly disagree" to "Strongly agree"	0.86	-
Perceived hazard characteristics				
Smoke impact likeliness	8	7 point; "Very unlikely" to "Very likely"	0.93	-
Smoke impact severity	8	7 point; "No impact" to "Very severe impact"	0.94	-
Impact in next 5 years	1	4 point; "Very unlikely" to "Very likely"	-	-
Proximity to potential fire	1	Miles; 0 "Right next door (or less than 1 mile)"	-	-
Affective response	1	7 point; "Strongly disagree" to "Strongly agree"	-	-
Informational subjective norms	2	7 point; "Strongly disagree" to "Strongly agree"	-	0.60**
Information (in)sufficiency	2	200 point; -100 "Complete knowledge while needing none" to 100 "No knowledge while needing complete "	-	-
Current knowledge	1	100 point; "Know nothing about smoke" to "Everything that could possibly be known about smoke"	-	-
Sufficiency threshold	1		-	-
Relevant channel beliefs				
Number of sources	16	16 total sources (summed)	-	-
Usefulness of sources	16	5 point; "Not useful" to "Very useful"	0.93	-
State information score (best, enough, and timely information provision)	3	7 point; "Strongly disagree" to "Strongly agree"	0.96	-
Federal information score (best, enough, and timely information provision)	3	7 point; "Strongly disagree" to "Strongly agree"	0.95	-
Perceived information gathering capacity	2	7 point; "Strongly disagree" to "Strongly agree"	-	0.30**
Information seeking behaviors	3	7 point; "Strongly disagree" to "Strongly agree"	0.70	-

Note: ** $p < 0.001$

Table 4. One-way ANOVA with Tukey post-hoc correction for RISP variables.

RISP variables	All	CA	MT	OR	SC	F
	Mean	Mean	Mean	Mean	Mean	
Individual characteristic						
Acceptability of smoke	4.80	4.73	4.84	4.75	4.92	0.97
Perceived hazard characteristics						
Smoke impact likeliness	3.67	3.71	3.62	3.61	3.80	0.55
Smoke impact severity	3.47	3.50	3.40	3.46	3.57	0.34
Impact in next 5 year (4-point)	3.43	3.50	3.34	3.49	3.39	0.61
Proximity to potential fire (miles)	3.44	3.56	0.61 ¹	4.81	7.22 ²	36.49***
Affective response	4.31	4.48	4.12	4.21	4.61	2.58
Informational subjective norms	3.49	3.47	3.56	3.36	3.59	1.08
Information (in)sufficiency (200-point)	7.59	9.05	6.14	5.06	12.58	2.39
Current knowledge (100-point)	58.78	58.25	61.27 ³	58.53	54.53 ³	2.80*
Sufficiency threshold (100-point)	66.12	67.18	66.99	63.34	67.10	1.33
Relevant channel beliefs						
Number of sources (out of 16)	4.76	4.93 ⁴	5.21 ⁴	4.53	3.87 ⁴	5.24***
Usefulness of sources (5-point)	3.05	2.92	3.07	3.09	3.15	1.75
State information score	3.94	3.75 ⁵	3.85	4.09	4.20 ⁵	3.92**
Federal information score	3.72	3.64	3.64	3.79	3.91	1.45
Perceived information gathering capacity	4.33	4.28	4.46	4.30	4.22	1.39
Information seeking behaviors	3.99	4.11	3.85 ⁶	3.91	4.25 ⁶	4.11**

Note: Scales are 7-point, unless otherwise noted; *** $p \leq 0.001$, ** $p \leq 0.01$, * $p \leq 0.05$

¹ MT was significantly lower than all other states, $p \leq 0.001$

² SC was significantly higher than all other states, $p \leq 0.01$

³ SC and MT significantly differed, $p \leq 0.05$

⁴ SC differs from CA ($p \leq 0.05$) and MT ($p \leq 0.001$)

⁵ SC and CA, $p \leq 0.05$

⁶ SC and MT, $p \leq 0.05$

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Table 5. Goodness of fit for each RISP model.

Models	Variables	X^2	df	p	X^2/df	RMSEA	CFI
Baseline	16	1331.41	60	<0.0001	22.190	0.180	-
1	15	1197.83	54	<0.0001	22.182	0.180	0.616
2	15	357.54	49	<0.0001	7.297	0.098	-
3	14	231.90	44	<0.0001	5.270	0.081	0.901

Note: LISREL was unable to provide CFI values for Baseline and Model 2 due to multicollinearity.

Table 6. Structural equations for RISP Model 3.

Dependent variable	Explanatory variables	Unstand. Coefficient		<i>R</i> ²
		<i>B</i>	Std. Error	
Smoke impact likeliness	Age	0.005	0.004	0.329***
	Gender	0.529	0.110***	
	Acceptability of smoke	-0.698	0.042***	
Impact in next 5 years	Age	-0.002	0.004	0.003***
	Gender	0.135	0.114	
	Acceptability of smoke	0.007	0.044	
Proximity to potential fire	Age	-0.021	0.021	0.010***
	Gender	1.085	0.574	
	Acceptability of smoke	-0.288	0.221	
Affective response	Smoke impact likeliness	0.624	0.043***	0.248***
	Impact in next 5 years	0.038	0.050	
	Proximity to potential fire	-0.021	0.010*	
Information sufficiency	Affective response	2.159	0.535***	0.025***
Information seeking	Information sufficiency	0.013	0.002***	0.118***
	RCB: Number of sources	0.049	0.015***	
	RCB: Usefulness of sources	-0.010	0.051	
	RCB: Federal information score	0.064	0.054	
	RCB: State information score	-0.058	0.054	
	Information gathering capacity	-0.137	0.037	

Note: ****p* ≤ .001, ***p* ≤ .01, **p* ≤ .05

Figure 1. Modified RISP model based on Griffin et al. (2008) showing the relationships between the influences on information seeking and processing behaviors (Griffin et al. 1999).

Figure 2. Modified RISP model displaying the relationships tested in the hypotheses.

Note: * significance at $p < 0.05$ level (and **bolded**)

Figure 3. Path analysis model explaining information seeking RISP Model 3 with standardized coefficients (β); variables removed are informational subjective norms and smoke impact severity.