

Public information seeking, place-based risk messaging and wildfire preparedness in southern California

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Abstract. Southern California is a challenging environment for managing and adapting to wildland–urban interface fires. Previous research shows risk perception and information seeking are related and that public information dissemination influences locally specific risk perception and preparedness actions. Here, we examine relationships between residents' wildfire knowledge and experience, readiness actions and media choice to determine how to integrate preparedness information and the recently developed Santa Ana Wildfire Threat Index into public information. Based on frequencies, means tests and correlations, we find television most frequently used for both daily news and wildfire information and that most people intend to seek information from the same sources in future fires. Wildfire knowledge, experience and past preparedness actions influence the number of sources from which respondents report seeking information. We note significant geographic differences in information sources used before and during wildfire, with higher percentages of residents in more rural areas relying on television, radio, Reverse 911, and friends and family for information during a wildfire. Findings support previous research results indicating sources considered trustworthy are not always considered the most up-to-date. Our findings support other empirical research recommending a multimedia, two-way communication model for event-based and readiness information supplemented with one-way sources like television.

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Introduction

Research has shown increased risk perception based on adequate communication of risk to the public relates to information use and action during disasters. For instance, local information seeking and public information dissemination influence both locally specific risk perception (Brenkert-Smith *et al.* 2013) and wildfire preparedness actions (McCaffrey 2004). Recent social science literature related to wildfire demonstrates a clear relationship between risk perception, public communication, information seeking and preparedness actions, but less knowledge exists on the effects of prefire interaction and incident communication with local residents (McCaffrey *et al.* 2013a). Our study addresses a significant gap in communication literature examining how to integrate geographically specific threat indices into public information dissemination efforts, establishing whether information-seeking patterns in southern California mirror information-seeking patterns in other areas, and by considering renters as well as homeowners in our study.

We study these elements in the context of the southern California wildland–urban interface (WUI) to identify how to effectively integrate wildfire preparedness and geographically specific risk information from the Santa Ana Wildfire Threat Index (SAWTI) into public information dissemination in southern California. To address this, we use secondary data from a

telephone survey to examine information sources southern California WUI residents use for daily information and for fire-related information during wildfire in their area, which sources they trust and consider up-to-date, and the relationship between information seeking and wildfire knowledge or preparedness actions.

Southern California is a particularly challenging environment for fire management because hot temperatures, a dry climate, extreme wind conditions and heavy fuel loads contribute to rapid fire growth. These conditions combined with population density in fire-prone areas and geographic conditions like difficult terrain increase the complexity of fire-related communications and operations. At the time of our study, local communities assessed fire risk through 'Red Flag' warnings alerting land-management agencies (and consequently response agencies) of critical fire weather and moisture conditions that could lead to rapid occurrence or spread of wildfire (National Weather Service 2013). Along with spot weather forecasts, Red Flag warnings are one of the best tools for assessing critical fire weather potential (Werth *et al.* 2011). However, this risk indicator is frequently issued and often covers wide geographic areas, making it difficult for residents to determine when and how to react to the warnings. Red Flag warnings, therefore, can fail to provide fire managers, emergency managers, public utilities and residents

locally specific information that may cause them to take evacuation preparedness actions.

Additionally, Mestres and Manta (2014) stress the potential financial importance (economic savings) of early warnings provided by Meteorological Forest Fire Risk Indices (MFFRI) as well as potential to use such indices for prevention and control. Manta *et al.* (2006) conclude that MFFRIs should be geographically specific to enable an appropriate match to local climate conditions. To address the lack of local specificity in the Red Flag warning tool, a multi-agency effort began in 2010 to develop a threat index predicting large-fire growth potential, building on a previously developed offshore wind index designed to better forecast Santa Ana wind events. This effort resulted in SAWTI, a geographically specific threat index that identifies jurisdictions at particular risk of WUI fires at a given time, enabling residents and responders to better prepare for an incident. The USDA Forest Service and Predictive Services produce SAWTI. SAWTI depicts the anticipated fire potential of Santa Ana winds for several coastal counties using predictive modelling based on live and dead fuel moisture, greenness of annual grasses, wind speed and atmospheric pressure compared with climatological data and historic fire data. The public can access maps that show fire threat based on the index and recommended actions based on risk levels through the USDA's SAWTI website (see <http://sawti.fs.fed.us>, accessed 30 May 2017).

SAWTI is one of many geographically specific risk indices developed to better understand extreme wildfire risk conditions, and is intended to inform the public of risk as well as position resources for control. The tool generates 6-day forecasts for Large Fire Potential. It is publicly accessible as of September 2014, with the potential to create a public better informed about wildfire risk and enable the public and fire and emergencies managers to better prepare for extreme fire events. Although the tool is available to the public online, to properly disseminate geographically specific fire risk warnings based on SAWTI and provide adequate information about wildfire conditions and preparedness actions before the fire season, it is important to understand sources from which the public seeks information both on a daily basis and when wildfire is in the area.

Risk indices and communication strategies link together, requiring joint consideration. In *Fundamentals of Emergency-Management*, the Federal Emergency Management Administration (FEMA) recommends basing strategies for communicating risk to the public on local receiver characteristics including geography and demographic characteristics (Lindell *et al.* 2006). Recommendations for emergency managers suggest that local information-seeking patterns show clear preferences in both media type and specific media outlets. Althaus *et al.* (2009) examine geography of news consumption in the USA and find regional differences, possibly resulting from common cultural preferences for certain information sources. They note that news media both shape and conform to regional characteristics and cultural information-seeking preferences. Other studies show clear differences in information-seeking patterns across demographic characteristics such as age, race and gender (Lachlan *et al.* 2008; Spence *et al.* 2007, 2006). Together, these documents strongly suggest that considerations of both population characteristics as well as

geographic and place-based attributes must be included in communicating risk.

The purpose of the present study was to determine how to effectively integrate wildfire preparedness and risk information from the SAWTI into public information dissemination in southern California. Several guiding research questions were established:

- How does geographic location influence information seeking?
- What information sources do southern California WUI residents use for daily information?
- Do they use different sources for fire information?
- Is there a relationship between wildfire information seeking and knowledge or preparedness actions? In this context, does information seeking differ by gender?

The results exhibit immediate applicability for fire personnel in the study area to tailor their fire risk and preparedness messaging. Although specific information-seeking behaviours described in the present study are context-specific and not generalisable in terms of locally specific information-seeking behaviour, results are important in underscoring the need to consider geographically specific risk in relation to localised information-seeking behaviour. Whereas many studies involving human dimensions of wildfire focus solely on homeowners, our sample draws from the general public to include non-homeowners, which is more representative of area households. Recommendations for fire management personnel in southern California developed here provide useful guidance for other fire management personnel seeking to increase public communication efficacy and trust among the public. We now turn to a more thorough review of the literature and related hypotheses.

Wildfire risk communication

The risk and crisis communication literature asserts that effective disaster and wildfire management requires communication before and during events, as one can influence the other (McCool *et al.* 2006; Steelman and McCaffrey 2013). This suggests effective messaging to the public regarding wildfire risk necessarily involves prefire communication about land-management activities that require public participation (e.g. brush clearing on private land, household evacuation planning) and up-to-date risk communication during wildfire events. Information dissemination sources and media use before an event and public trust in those sources play an important role in information seeking during wildfire events (Steelman *et al.* 2015) and can therefore influence communication reception and application. As one-way risk communications about disaster inconsistently lead to public action (Neil 1989; Tierney 1993; Fischhoff 1995), recent recommendations focus on the efficacy of targeted messaging appropriate to cultural and social settings that encourage two-way interactions to ensure trust in the message (Chess 2001; Heath *et al.* 2011; McCaffrey *et al.* 2013b). This relies on the idea that trust in the messenger leads to greater trust in the message and will therefore more likely motivate the public to take action (Rowan 1991).

In addition to the importance of information trustworthiness during wildfire events, it is particularly important to the public that media sources are timely and up-to-date (McCaffrey *et al.*

2013b). Steelman *et al.* (2015) examine recipient perspectives of used, useful and trustworthy information sources in five wildfires, finding that most-used sources were considered most trustworthy. The authors also find a high correlation between information sources most used before and during the fires regardless of whether those sources are the most useful or trustworthy. In summary, prior research suggests that familiarity with a media source is a key element in effectively reaching the public with risk communications.

What we would expect in wildfire-related information seeking

Existing literature leads to several hypotheses about public information seeking before and during wildfire events. Below, each hypothesis appears following a review of selected relevant literature related to each area of interest.

Research demonstrates a relationship between risk perception, information seeking and geographic location. Although many social science studies of fire management understanding, preparedness actions and attitudes to fuel treatments have found little geographic variation (McCaffrey and Olsen 2012), previous studies on wildland fire risk perception and information seeking indicate that there will likely be differences in information use based on several factors. Brenkert-Smith *et al.* (2013) found that geographic location was one factor shown to increase risk perception, and risk perception ties to information seeking. According to Lachlan *et al.* (2008), those in urban areas tend to find out about disaster incidents from other people, either face-to-face or by mobile phones or landline calls, whereas personal contacts at agencies and radio stations tend to be preferred as an information source for those in more rural areas (Cohen *et al.* 2007). But a study by the American Red Cross (2011) finds people in urban areas more likely to use television, and Ryan (2013) finds people in urban areas are likely to rely on television for flooding information, whereas those in rural areas report radio as more helpful. Additionally, Althaus *et al.* (2009) find regional differences in news consumption from newspaper, television and radio sources. Although there are no clear patterns found in regional or urban versus rural information-seeking differences, together, this literature suggests:

H1. Most-commonly used information sources differ by geographic area

Public information-seeking behaviour is also influenced by disaster context and familiarity with information sources. Ryan (2013) conducted an interview-based, snowball-sample pilot study of information seeking in floods based on Savolainen's information-seeking model (Savolainen 1995, 2008) in developing a framework for a more detailed survey about information seeking in Australian disasters. She points out that 'the type of disaster determines how people seek out information' (p. 229) and that slow-moving floods caused people to seek information from other people and the internet, confirming the information by radio, whereas fast-moving flash floods were often initially communicated by others and confirmed using television. The majority of interviewees in both slow- and fast-moving floods reported that they likely would seek information in the same way for future flooding events. Winter and Cvetkovich (2010) discuss

the importance of trust in fire management and communication between fire management officials and the public. Steelman *et al.* (2015) study information use in five wildfires and find that during wildfires, people are likely to use the information sources with which they are most familiar from before the fire, regardless of whether they report these sources as the most trustworthy or most useful. Based on previous research, we expect to see the following wildfire-related information seeking behaviour from WUI residents in the study area:

H2. People will be most likely to seek information during fires from the same sources they use when no fire is occurring

H3. Sources considered most trustworthy will not be the same as those considered most up-to-date

Wildfire experience and knowledge have also been linked to differences in information seeking. A study on information seeking in a large urban fire by Fischer *et al.* (1995) finds that family, friends and neighbours were the most sought information sources for evacuees. McCaffrey *et al.* (2013b) examine information-seeking behaviour differences in wildfire evacuees and non-evacuees using mail surveys of residents affected by wildfires in Arizona and Colorado in 2010, and find that evacuees seek information more actively, and from more interactive sources than do non-evacuees. As evacuees seek information more actively than those who are not directly affected by wildfires, those who have prepared to evacuate will seek information more actively as well. Brenkert-Smith *et al.* (2013) find a connection between risk and information source in Colorado residents in areas at high WUI risk, and Heath *et al.* (2011) find that preparedness actions in Western Australia are largely tied to information from fire authority pamphlets. Therefore, we expect:

H4. There will be a positive correlation between wildfire knowledge and the total information sources used to seek information about wildfire

H5. There is a relationship between the type of preparedness actions undertaken and the total information sources used to seek information about wildfire

Several studies have found differences in information seeking according to demographic characteristics. A 2011 study by the American Red Cross on the use of social media in disaster finds that younger people are more likely to use social media in addition to traditional media sources. In examining the effects of demographic characteristics on information seeking during Hurricane Katrina, Spence *et al.* (2007) find that African-Americans and women are more likely to seek information from more sources than are other segments of the population. Although Lachlan *et al.* (2008) find women are more likely to use the internet to find out about disasters, this contradicts a previous study by Spence *et al.* (2006) that reports that men were more likely to use the internet to find out about the 2001 World Trade Center attack. Although this literature does not lead to clear expectations about exactly how information seeking differs by gender, we expect:

H6. Information seeking differs by gender

Data and methods

Survey methods and sample selection

The present study relies on secondary data from a telephone survey of residents in southern California households that another research team collected in 2012. Data were collected as part of a larger inter-organisational effort launched in 2010 to develop SAWTI with the goal of creating a publicly accessible wildfire threat forecasting tool that could be used by fire and emergency managers as well as the public to better prepare for extreme wildfire. An initial survey instrument contained questions measuring residents' understanding of weather conditions, climate and meteorological conditions contributing to large fire growth potential; wildfire experience; preparedness and evacuation readiness actions; and wildfire risk perception. Risk perception measures were adapted from C. W. Trumbo, L. Peek, M. Mayer, H. Marlatt, B. McNoldy and E. Gruntfest (pers. comm.). The survey pilot involved US Forest Service (USFS) Predictive Services Southern California Geographic Coordination Area Center meteorologists and fire managers giving feedback used for adjustments to survey instrument design before data collection. The Bureau of Business and Economic Research at the University of Montana (UM BBER) collected data, and administered a telephone survey in both English and Spanish. Sample selection within the targeted area was random, and occurred in two stages. UM BBER generated the sample by first selecting locations within the study area with CAL FIRE designation as very high fire severity zones away from the highly urban core and adjacent to forested landscapes. These WUI areas were divided into small, equally sized geographic sampling units (GSUs), which were randomly sampled. The second stage of sampling involved randomly selecting households in each GSU designated as addresses of dwellings through the Computer Assisted Mass Appraisal (CAMA) database from the Washington, DC, Office of Tax and Revenue. UM BBER sampled GSUs and dwellings to yield at least 400 completed telephone interviews, and non-homeowners as well as homeowners were included if their dwellings were selected in the random sampling process. UM BBER identified telephone numbers for households in the area through a web search for landline or cellular numbers associated with each sampled dwelling address. Although cellular telephones were not excluded, they were not systematically targeted or tracked, meaning many of the respondents may have responded from landlines. Calls were made in the afternoon and evening on weekdays and weekends, with each sampled number receiving an average of seven contacts, minimising the influence of the hour, presence of people at home and availability of survey time.

A total of 1126 people were successfully contacted, and 459 completed the questionnaire for an adjusted response rate of 41%. On average, respondents were 56 years of age, and 56% were female. Although this is a limitation because it does not reflect the overall population, it is typical of telephone surveys that respondents are older and more likely to be female than the general population (Dillman *et al.* 2008). It is also reflective of

other wildfire-focused studies finding that the population in fire-prone areas is often older than the population average. Additional limitations include the timeframe during which the fires in question took place – as many of the incidents occurred as far back as 2007, there may have been subsequent changes in information-seeking behaviour including more reliance on social media. However, recommendations to tailor information dissemination by geography and consider community characteristics and the breadth of sources from which the public seeks information still stand.

Sample areas

Southern California is appropriate for study because managing and adapting to wildfire in the area is increasingly challenging as the number of residents living in WUI areas grows. The areas represented in the present study, rural-suburban San Diego County around Ramona and Alpine, and more urban areas of Santa Clarita, Beverly Hills and Mount Washington in Los Angeles County, were chosen in part because of their previous history and high risk of wildfires. They were also sampled on the variation in geography and variation in density and associated degree of urbanisation in the two counties, the significant populations in the two counties at risk for evacuation in the case of a WUI incident, and restrictions during Red Flag alerts.

Data analyses

Hypotheses were tested using descriptive statistics, Fisher's exact tests, difference of means tests (both *t*-tests and ANOVAs) and Pearson correlations. Fisher's exact test (also called the Fisher–Irwin test) is typically computed as a one-tailed test and is used instead of chi-square tests in 2×2 cross-tabulation tables with unexpected frequencies of five or less (Garson 2012). As with many significance tests, Fisher's exact test is significant at 0.05 or less.

To test our hypotheses, we created additive indices of the total number of news sources used for daily local news and for the total number of news sources used to seek information about wildfire. Surveys included a list of sources (newspaper, TV, Facebook, Twitter, radio, news websites and 'other') and respondents indicated whether they use the source for daily news. If they had experienced a wildfire in the area, they were also asked (based on the same list of sources plus Reverse 911^A, friends and family), 'How did you find out information about what was going on when this wildfire was happening?' We also created an additive index of wildfire knowledge using binary agreement with questions regarding conditions residents agree 'make a wildfire get big fast' and several environmental indicators. This index comprises binary indicators of conditions likely to cause wildfire (see Table 1).

Results

Below, we describe information sources most commonly used in the study area, then present findings related to each hypothesis.

^AA 'Reverse 911' system is a type of emergency alert system that allows emergency services to quickly push recorded emergency alert messages and related public information about evacuation notices out to large members of the public concurrently by calling landlines or cell phones of registered local residents. Messages can target precise geographic areas and may be delivered in several languages.

Table 1. Questions regarding knowledge of wildfire in the area

Questions (response type: binary indicators)
What weather or vegetation conditions do you think make a wildfire get big fast: how hot it is?
What weather or vegetation conditions do you think make a wildfire get big fast: how dry it is?
What weather or vegetation conditions do you think make a wildfire get big fast: lots of dead vegetation?
What weather or vegetation conditions do you think make a wildfire get big fast: weather before fire?
What weather or vegetation conditions do you think make a wildfire get big fast: high winds?
What weather or vegetation conditions do you think make a wildfire get big fast: other?
Do you think wildfires are worse at particular times of the year compared with other times of the year, or not?
In your opinion, are plants, trees and shrubs that are brown more susceptible to wildfire or are plants, trees and shrubs that are green more susceptible to wildfire?
What causes wildfires to start in your local area: lightning?
What causes wildfires to start in your local area: people deliberately starting fires?
What causes wildfires to start in your local area: accidents of some kind?

Commonly used information sources

The majority of respondents (67%) reported relying on only one source of information for their local news, 2% relied on two sources and only 5% relied on three sources. Approximately 4% of respondents reported not using any local news sources, and less than 1% reported using four sources for local news information. Respondents reported on the most important pieces of information for them to know or stay current when wildfires were in their area, and the majority of respondents from Los Angeles (53%) and San Diego (55%) agreed that information on area and location of a fire were most important. For respondents that listed a second piece of important information needed, those in San Diego most often wanted information on the predicted direction of spread (38%), whereas Los Angeles respondents most often reported wanting information about evacuation (18%) or predicted direction of spread (17%).

Differences in information seeking by geographic area

Hypothesis 1 predicting most commonly used information sources differ by geographic area was supported. We found several significant differences in information use in exploring differences in information sources used by geographic area, reinforcing findings by Cohen *et al.* (2007), Lachlan *et al.* (2008), the American Red Cross (2011) and Ryan (2013). We found those in heavily urbanised Los Angeles used newspapers (40 vs 28%) and news websites (31 vs 21%) for daily news information more than those in rural San Diego county. Respondents in San Diego, however, used Facebook marginally more (1 vs 0%) and television more (64 vs 43%) than those in Los Angeles. This pattern held during fire for television use, with those in the more rural San Diego County (44%) using television more than Los Angeles County (25%), and those in San Diego also relying on radio (20 vs 8%), Reverse 911 (7% vs 2%), and family and friends (21 vs 7%) more (Fig. 1).

Information seeking during wildfire incidents

Hypothesis 2 (H2), that people will be most likely to seek information during fires from the same sources they use when no fire is occurring, was not entirely supported. Fisher's exact tests were significant for before- and during-fire use of television (0.019), news websites (0.002) and radio (0.001), partially

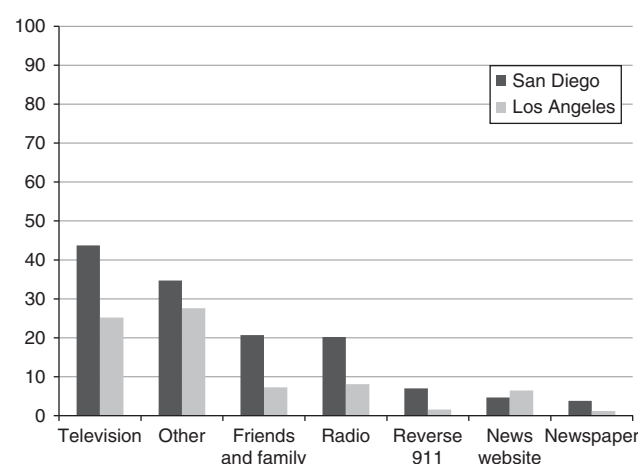


Fig. 1. Percentage of people using each information source during fires by geographic area.

supporting H2 and findings by others (Ryan 2013). They also were significant, however, for before-fire use of television with during-fire use of friends and family (0.017) and with during-fire use of other sources (0.039), primarily made up experiential cues like the smell or sight of smoke, or information from others (like fire department or sheriff's department employees) with access to fire behaviour information. They were not significant for before- and during-fire use of newspaper, or for other sources. When respondents were asked about information sources they used for daily news, 53% reported relying on television, 34% on newspapers, 26% on news websites, 14% on radio and ~3% on 'other'. Less than 1% reported relying on Facebook (only two respondents) or Twitter (no respondents).

Most (86%) respondents reported having heard that conditions were right for wildfire on the news or from other information sources. Only 2.4% reported getting information from newspapers when there was a wildfire in the area, but 34% got information from television, 14% from radio, 14% from friends and family, 6% from news websites, 4% from Reverse 911 and 30% from other sources during fires. No respondents reported using Twitter or Facebook to find out about wildfire in the area (Fig. 2). Recent figures (Blumberg and Luke 2013 in

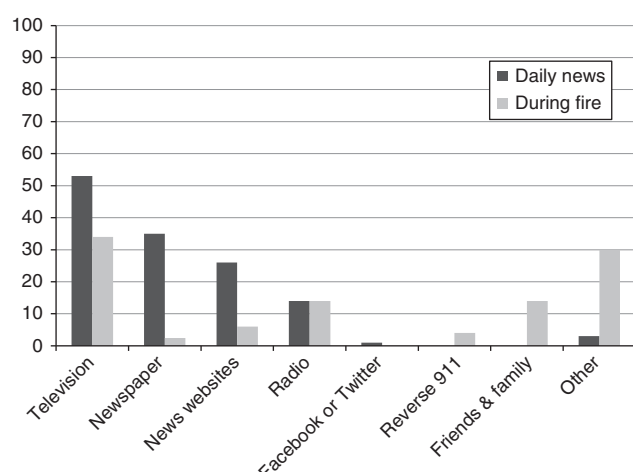


Fig. 2. Percentage of people using each information source for daily news and for information during wildfire events.

Dillman *et al.* 2014) show that only 58% of households had a landline in 2013, and that ‘people who are cell-only lead different lifestyles than their landline counterparts’ (Dillman *et al.* 2014, p. 60).

Anticipated information seeking in future incidents

Respondents responded in thinking about future wildfire events whether they thought their media sources for information about a wildfire would change, and 70% reported that they would not. Only 24% reported future information sources would change, with 6% reporting that they did not know. This supports Hypothesis 2 in that the majority of people reported intent to use the same information sources for future fires as they had in the past.

Trustworthy and up-to-date information sources

To test Hypothesis 3 (sources considered most trustworthy will not be the same as those considered most up-to-date), we created a binary variable indicating agreement between the source considered the most up-to-date and the source considered most trustworthy. Of the 9% of respondents who answered both questions, the majority (57%) did not report the same source as both the most up-to-date and the most trustworthy; 30% reported the same source as both the most up-to-date and the most trustworthy and 13% reported that they did not know which sources were most up-to-date or trustworthy. This supports Hypothesis 3 as well as other findings by the authors. Only local television stations were chosen as being among the most trustworthy and most up-to-date by more than 20% of respondents.

When respondents reported the media sources most up-to-date about emergency wildfire information, 16% reported non-specific local TV, 9% reported non-specific radio, 7% reported internet and websites in general, 6% reported local San Diego television stations (including CBS and ABC affiliates and an independent station), and 3% reported local Los Angeles TV (an ABC affiliate). An equal number reported non-CAL FIRE emergency personnel or scanners, or Reverse 911, and 2% reported CAL FIRE (through either website or personnel).

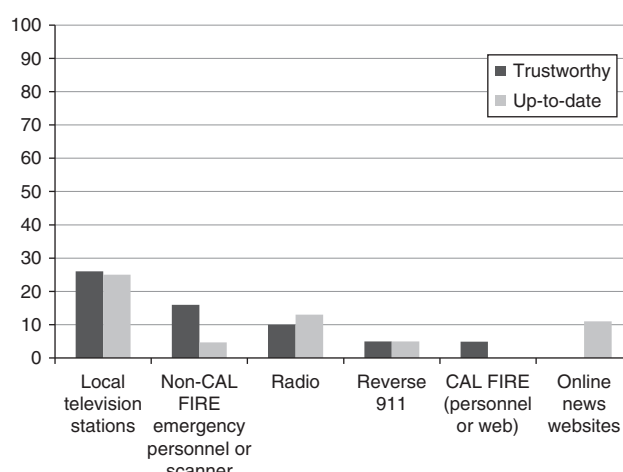


Fig. 3. Percentage of people rating each information source most trustworthy or most up-to-date.

When condensed, one-quarter of respondents considered local TV up to date about emergency wildfire information.

When respondents responded which media sources were most trustworthy in terms of emergency wildfire information, the most frequently reported source was non-specific local TV (19%), whereas 12% reported non-California Department of Forestry and Fire Protection (CAL FIRE) emergency personnel or scanners. A much lower percentage of respondents (4% each) mentioned Reverse 911 and CAL FIRE (website or personnel) (Fig. 3).

Respondents considered local television both the most up-to-date and most trustworthy news source, differing from findings by others (McCaffrey *et al.* 2013b) that radio is most trustworthy, followed by newspapers. Respondents considered non-CAL FIRE emergency personnel were the second-most trustworthy source, but only 3% of respondents considered them most up-to-date (Fig. 3).

Seeking information from multiple sources

To investigate Hypothesis 4, we conducted *t*-tests and found significant support (0.000) predicting a positive correlation between wildfire knowledge and the total number of information sources used to seek information about wildfire. To look for an association between the variables, we then ran a Pearson product correlation between the total number of information sources used and the additive index of wildfire knowledge and found a weak but positive Pearson correlation (0.199) with a significance level of 0.000.

Wildfire preparedness and information seeking

Hypothesis 5 (H5) (predicting a significant difference between the type of preparedness actions undertaken and the total number of daily information sources use to seek information about wildfire) was supported. We ran an ANOVA and found a significant difference (0.000) between the primary types of preparedness actions undertaken before a fire and the total number of information sources used while a wildfire was in the respondent’s area. Of those that did not undertake preparedness

actions, 45% reported not seeking fire information from any sources, 42% reported relying on one source, 11% on two sources and only 2% on three sources. For several preparedness actions (e.g. creating defensible space, backing up important documents, general brush trimming or clearing and staying up to date on news of potential fires), more than half of respondents reported seeking information from only one source during a fire, with no respondents seeking information from more than three sources. Information was sought from four sources by one respondent who reported stocking extra supplies, one respondent who planned evacuation routes and meeting places and one respondent with an ember suppression system or fireproof roof.

Differences in information seeking by gender

Lastly, we examined hypothesised differences in information seeking by gender and found no significant differences, meaning there was no support found for Hypothesis 6 (H6). Gender differences in wildfire information seeking appeared only for television, which females used more frequently (55%) than did males (50%). This partially supports findings by [Spence et al. \(2006, 2007\)](#) and [Lachlan et al. \(2008\)](#), who found differences in information seeking by gender.

Discussion

Our findings underscore the importance of considering geographic location and place attributes in public information seeking and risk messaging ([Lindell et al. 2006](#); [Althaus et al. 2009](#)). Empirical research shows how perceptions of wildfire risk influence the types of mitigation efforts residents are willing to undertake, an important relationship to consider during communication planning. Wildfire mitigation efforts and support among the public have been linked to both risk perception ([Champ et al. 2013](#)) and framing mitigation in relation to forest health and fire risk reduction ([Ascher et al. 2013](#)). Trust, risk perception and information processing have been shown to be closely interrelated, so it is important to make certain that media sources disseminating locally specific wildfire information like SAWTI use trusted sources and also use sources that are considered up to date and that are most frequently used. Although CAL FIRE personnel were not considered among the most up-to-date information sources in our study, this may be because interactions with CAL FIRE personnel are relatively infrequent compared with other information sources, and therefore people are likely to have heard information elsewhere before hearing it directly from a CAL FIRE representative. Findings from the present study add to literature demonstrating that trust, risk perception and information processing are related. The present study provides a solid baseline of geographically specific information-seeking patterns in southern California, and supports findings by others that information seeking differs by geographic area. However, as the survey focused on communication during past fire events, which at the time of the survey was often in 2011, there are limitations regarding the understanding of area information-seeking patterns and information needs related to social media use. Additionally, the lack of support found in our study for differences in information seeking by gender is quite unexpected given long-standing beliefs that women have different risk aversions and related patterns of

behaviour than men. This bears revisiting, especially in the context of information seeking through social media. As people report intent to seek information from the same sources in future wildfire situations to those they have used in the past, it is important to local fire managers to know which sources are used, and how these behaviours may be evolving.

The present study is most immediately applicable to CAL FIRE public information personnel, because our findings provide a better understanding of how citizens in their jurisdiction are likely to seek information before and during wildfire incidents. For instance, although Los Angeles County is the more urbanised area in the study, suggesting residents may be more likely to rely on television for information (ex [Ryan 2013](#)), television use was more frequent in more rural San Diego County. However, as expected following research by [Cohen et al. \(2007\)](#), those in rural San Diego County relied far more heavily on radio as an information source than did those in urban Los Angeles County. Information-seeking patterns may differ from expectations in some areas, and our findings are likely to be more accurate than some other studies on WUIs as our data include renters as well as homeowners. This also provides a better baseline for future research in the area. Nuanced information can aid in developing robust and effective communication plans to better inform the public of risk and necessary preparedness actions before fire incidents. Better understanding public information-seeking behaviour and combining information dissemination methods also can lay the groundwork for more effective communication of incident information during wildfire events in the area.

We recommend that locally specific risk information like SAWTI be distributed through trusted, up-to-date, frequently used sources like local television, but caution against reliance solely on unidirectional information sources. Prior to the fire season, the public should be educated on geographically specific risk to encourage mitigation using engagement-based communication between officials and the public, and short, actionable items for homeowners. Risk information must be geographically specific, from a risk index like SAWTI, to spur homeowners to action, but they will not receive the information if it is not distributed through the channels they use to access information.

As we found the most frequently used, most up-to-date and most trustworthy source in the area was television, it is important to remember the power of television in disseminating information. Relying solely on unidirectional sources like television, however, can be problematic. This is because there is no way for those receiving information from television to seek clarification or additional interaction from the source. The aforementioned claim provides a rationale for multimedia communication strategies that evoke both unidirectional and two-way communication, allowing for a social feedback loop that provides fire officials an opportunity to shape risk perceptions and promote appropriate mitigation efforts. This supports a large body of literature recommending use of two-way communication channels for event-based information and avoiding relying solely on one-way communication channels like television. It also supports the need for greater outreach in areas of greater risk as well as direct communication between officials and residents.

Others have found interaction with authorities and targeted information to be very important in communicating risk and risk mitigation strategies. Heath *et al.* (2011) found that preparedness actions taken by residents in Australia were based largely on information in pamphlets that were sent by the Fire and Emergency Services Authority. Relatedly, according to Brenkert-Smith *et al.* (2013), information from local experts, specifically the county specialists and local fire departments, is most strongly correlated with risk perception, but media are not. Brenkert-Smith *et al.* (2013) support use of community-based programs to educate residents about wildfire, noting that these programs are unlikely to reach all community members and that those least likely to attend may be those who are least aware of the risk in the area. They therefore recommend that 'community-based programs may need efforts to more actively reach out to all community members, not just those who already think fire is an issue'. McCaffrey (2004) concludes that combining educational material and more individual, personal interactions has been found most effective in providing residents with wildfire management and mitigation information. As media coverage that is not geographically specific can influence perception, establishing locally trusted engagement-based communication practices that residents can rely on for information about wildfire preparedness, risk and evacuation preparedness is important. Being informed on geographically specific wildfire risk to their properties means people are better informed about how to mitigate this risk and therefore more likely to do so (Champ *et al.* 2013).

This supports the need to disseminate geographically specific risk information using SAWTI risk assessments, but also means that the media by which such information is shared with the public are crucial, and that trusted agencies that seek to inform the public about fire risk and readiness must be aware of the need for interactive communication that mirrors information disseminated through unidirectional media. Infrequent use of social media is likely a result of the survey mode that probably excluded many respondents without landline telephones and of the timing of the data collection, when social media was not as popular a means of communication as it now is. This suggests the need for a follow-up study in the same area. Such a study would allow examination of ways information use and perceptions may have changed resulting from increased social media use and significant wildfire events in the area over the past several years, facilitated by the baseline of information-seeking behaviour provided by these data. At the same time, agencies should focus on disseminating information through social media as one form of unidirectional communication to be complemented by more interactive efforts. Part of this effort may include workshops or educational outreach programs to inform members of the public, public managers and local decision-makers about SAWTI, so that they are better able to assess the threat to their properties and may be motivated to engage in readiness actions before wildfire events in their area and to evacuate when a fire is in the area. The public should be familiarised with SAWTI through public information meetings, public service announcements, and, if possible, door-to-door canvassing in areas of highest risk. Along with our findings, this reinforces the need to use two-way, localised communication to ensure residents are informed of risks and mitigation strategies. Although data collection for the current study focused on fires that took place before widespread

use of social media, we believe social media can be leveraged as an effective tool to promote interaction between agency professionals and the public, both in sharing risk and wildfire mitigation information, but also during disaster response.

During the fire season, it is important that officials ensure consistent messages between unidirectional and interactive information sources. During times of large fire growth potential, preparedness and evacuation messages should be concentrated with daily weather information sites and television and internet news sources. These messages should contain short, succinct, actionable content for the public. Acknowledging primary public information needs during fires (fire location and evacuation information) of WUI affected populations also is necessary, as is ensuring multiple venues for information dissemination – including greater public access to response agency representatives during wildfire events. During times when SAWTI reveals large fire growth conditions, preparedness and evacuation messages should be concentrated on television and websites where people most often get daily weather information. Post-ignition, personal communication networks should be targeted along with one-way media sources. Officials disseminating fire growth potential and incident-specific information should take care to link short, succinct, specific and key preparedness and evacuation readiness actions to the information to reinforce readiness messages from other sources (ideally coordinated among agencies like the National Weather Service, fire agencies and emergency management) and provide the public with actionable information.

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