

Communicating About Smoke from Wildland Fire: Challenges and Opportunities for Managers

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Abstract Wildland fire and associated management efforts are dominant topics in natural resource fields. Smoke from fires can be a nuisance and pose serious health risks and aggravate pre-existing health conditions. When it results in reduced visibility near roadways, smoke can also pose hazardous driving conditions and reduce the scenic value of vistas. Communicating about smoke, whether in the preparation phases before a planned burn or during a wildfire event, can enable those at risk to make informed decisions to minimize their exposure to smoke or choose alternate activities that mitigate smoke completely. To date, very little research has been completed on the social aspects of smoke, such as communication or public perceptions. Here, we present findings from an exploratory study that examined challenges and opportunities related to communication (within agencies or to the public) for management of smoke from wildland fires. Interviews were conducted in California, Oregon, Montana, and South Carolina among a purposive sample of individuals, who are involved in fire or smoke management. Findings indicate that smoke poses several challenges to management

agencies. Findings also provide insight into potential strategies to address such challenges by improving communication in both inter- and intra-agency situations as well as with members of the public. In particular, prioritizing fire and smoke-related communication within agencies, allocating agency resources specifically for training in communication and outreach endeavors, taking advantage of existing resources including informal social networks among the public, and building long-term relationships both between agencies and with the public were viewed as effective.

Keywords Wildland fire · Wildfire · Smoke · Prescribed fire · Public acceptance · Tolerance

Introduction

Each year thousands of people are impacted by smoke from wildfire and prescribed fire (hereafter referred to collectively as wildland fire) (e.g., Almaguer and Johnson 2013). Smoke can be a serious concern for managers and the public alike due to its ability to cause impacts across areas considerably larger than the source fire itself. Both nearby and distant communities can be affected. Smoke can cause a variety of negative impacts ranging from irritation to eyes, nose, and throat, to decreased lung function and aggravation of previous heart or respiratory conditions including asthma, and, depending on where it occurs, may also result in decreased visibility along roadways (Bowman and Johnston 2005; Kocki et al. 2012; McCaffrey and Olsen 2012; Richardson et al. 2012). In addition, smoke events may lead to less direct effects that, nevertheless, may have a larger-scale impact. For example, wildfire smoke may cause destination vacationers to cancel their

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trip due to concerns about automobile accidents and general discomfort (Thapa et al. 2004), or because the scenic quality of their destination has been negatively impacted. Perceived impacts and expressed concerns about smoke may vary depending on several factors including weather patterns, smoke dispersion, location of fire events, proximity to human populations, as well as characteristics of the fire itself including the source, the intensity of the smoke event, and the duration people are exposed to resulting smoke emissions.

Prescribed fire—the intentional ignition and management of fire to meet defined objectives—is usually planned to minimize smoke impacts, yet sometimes conditions change (e.g., shift in wind direction) or fires escape containment boundaries leading to significant “smoke out” events (e.g., Brunson and Evans 2005). For community residents, this can impact daily lives and cause distress, particularly for those with respiratory ailments. Similarly, smoke from wildfire events can unexpectedly impact very large landscapes and communities at great distances from the fire itself. People in areas affected by smoke are often alarmed and uncertain about potential impacts or actions they should take. Such perceptions are not simply based on characteristics of the smoke emissions themselves (e.g., smoke density, particulate counts, etc.) but may also be tied to perceptions about the source and purpose behind the fire. For example, Weisshaupt et al. (2005) found that residents were more tolerant of smoke emitted from prescribed fires conducted with broad ecological objectives than they were of agricultural burning that was viewed as providing benefits only to the individual landowner while the costs of the smoke were borne by all. Ultimately, both wild and prescribed fires are important in maintaining and restoring ecological health and reducing future fire risk (Agee and Skinner 2005; Prestemon et al. 2002). Thus, strategies for planning for, communicating about and mitigating the impact of smoke are important, both within land management and regulatory agencies, and with local communities and the broader public. Increasing our understanding of smoke communication within these contexts can improve the ability of managers to prepare for future smoke events and work more effectively with partners and community members to use prescribed fire as a management tool.

The results presented here are part of a larger project examining public beliefs and attitudes toward smoke and smoke management. This multi-phase, multi-year project began with the exploratory work presented here to identify and better understand key concepts related to wildfire smoke emissions and management with a particular emphasis on communication strategies (both within and between management and regulatory agencies as well as with the general public) within our study locations. In the subsequent phases

of research, we will assess these variables and expected associations across the general populations within our study locations, and then conduct experiments to examine the influence of selected communication messages. The purpose of this paper is threefold: 1) to contribute to the broader literature on communication about wildland fire management and associated impacts; 2) to provide baseline data on public engagement and partnership efforts, both among agencies and with the public, as a means to contribute to improved smoke management programs; and 3) to identify challenges and opportunities that have been experienced in regions where smoke is a common issue.

Literature Review

The body of fire-related social science literature has grown substantially in the last decade, as has the research on communication in natural resources contexts. However, there is very limited social research to draw from on the topic of smoke or communication specific to smoke from wildland fire (used throughout this paper to include both naturally ignited wildfires and prescribed fires intentionally ignited by managers to achieve resource management objectives). To date, the majority of the published data on perceptions of smoke emissions and management come from a few questions included within larger projects examining public beliefs and attitudes toward the use of prescribed fire. Much of what we think we know about smoke-related communication and public acceptance of smoke stems from managers’ anecdotal experiences or research that focused on wild or prescribed fire itself rather than on smoke itself which may be perceived very differently. Despite the dearth of literature on communicating about smoke, literature from related fields can be useful in examining this phenomenon.

In an analysis of the risk, crisis, and wildfire literature, Steelman and McCaffrey (2013) identified five best practices of effective communication: (1) use interactive dialogue or processes; (2) develop an understanding of the social context of the threat; (3) focus on providing accurate, reliable, honest, and timely information; (4) interact with authority figures and other credible sources; and (5) communicate both before and during crisis events. Another recent study that examined how the public expected wildfire to be managed suggests that aligning the agency culture with the local community, building communication lines prior to a fire event, and investing efforts in publicly interpreting the benefits of less aggressive fire management techniques may give agencies greater latitude in management techniques (Steelman and McCaffrey 2011).

Generally speaking, wildland fire smoke-related communication with the public may have the goal of (1)

providing a notification about a particular smoke event so that people can mitigate potential impacts; (2) reducing public anxiety about smoke and the wildland fires that cause it by increasing understanding about current conditions, the ecological role of fire, the use and expected outcomes of prescribed fires, and smoke management activities; and (3) increasing public acceptance of fire management strategies. A number of studies link different types of communication approaches with increased public awareness and acceptance of fire management practices, and becoming more prepared for smoke impacts (Loomis et al. 2001; Manfredi et al. 1990; Shindler and Toman 2003; Winter et al. 2002). While research has suggested that the public is slightly more familiar with traditional unidirectional fire-related communication methods such as printed notices or sign boards (Toman et al. 2006), it is generally agreed that fire-related communication delivered through personal and interactive formats is more helpful to the public (McCaffrey 2004; Shindler and Gordon 2005; Toman et al. 2006). Similar findings have arisen when examining air pollution communication (e.g., Alaszewski 2005). Furthermore, studies have shown that communications about contentious fire-related issues must go beyond simple notification of the public. Instead, communications should be locally relevant and provide the opportunity for non-specialists to gain a better understanding of associated impacts and risks (Toman and Shindler 2006; Weisshaupt et al. 2005). While the media does provide some information about fire and smoke events, it is often generalized, sensationalized, and not specific enough to meet contextual needs (e.g., Mehaffey and Robbins 2012; Mitchell 2012; Scott 2012; Taylor et al. 2005).

Several studies have identified smoke from prescribed fire as a major health concern for approximately one-third of the population, many of whom have respiratory ailments (Brunson and Evans 2005; Jacobson et al. 2001; Loomis et al. 2001; Shindler and Toman 2003). Some research suggests knowledge about the ecological benefits of prescribed fire is associated with less concern and more acceptance of the resulting smoke (Blanchard and Ryan 2007; Loomis et al. 2001; McCaffrey 2004; Weisshaupt et al. 2005). One study found the public preferred suppression of a naturally ignited fire rather than monitoring and allowing such fires to burn to meet ecological goals if such actions would result in more smoke than an actively suppressed fire (Kneeshaw et al. 2004). Research also suggests that citizen acceptance and concerns for smoke may differ depending on the source of the fire. Weisshaupt et al. (2005) found that smoke from agricultural burns was less acceptable than prescribed burns because the ecological benefits of the burn are reaped by a private entity while all those in the area may bear the burden of smoke emissions, whereas prescribed fires on public land benefit the



Fig. 1 Location of four study sites across the United States

greater area and multiple parties and, therefore, the smoke is more tolerable.

Although informative, there are several significant gaps in understanding of communication challenges and opportunities associated with smoke emissions. Indeed, while smoke is managed across a number of management and regulatory agencies, we know of no research that examines interactions between agencies to coordinate fire or smoke management efforts or how they engage local residents regarding smoke events. This paper begins to address this research gap by reporting findings from interviews with resource managers and smoke regulators in four locations.

Methods

Using a case-study design, we completed semi-structured interviews among a broad array of natural resource managers (including federal and state fire management personnel, conservation organizations, and hunting groups) and regulators in four research locations—northern California, northwestern Montana, south-central Oregon, and central coast South Carolina (Fig. 1). These locations were selected to provide a diverse array of geographic, ecological, and social conditions, as well as a variety of communication strategies and partnerships related to smoke management issues.

Research Sites

Northern California

Communities in and around the Shasta-Trinity national forest (STNF) were chosen for study, including Mt. Shasta, Redding, Weaverville, and Hayfork. The majority of the land area in this region is federally owned and largely forested. The STNF is marked by wilderness areas, steep

gradients, and dense forests, making fire management particularly challenging. Prescribed burns are generally conducted on the STNF to reduce surface fuels and/or treat slash piles between October 1 and June 1 each year. Wildfire is a yearly occurrence in the STNF region, generally occurring in the summer and fall, and smoke from wildland fires and other sources (e.g., agricultural field burning) regularly impact local communities. In an effort to mitigate smoke effects from prescribed burning, many forest and air quality managers in this region have developed a partnership called the Northeast Air Alliance. Members report and discuss planned burn projects and collectively determine project suitability based on potential smoke impacts to the surrounding areas.

Northwestern Montana

Libby and Eureka, Montana were selected for this study for their proximity to the Kootenai National Forest (KNF), which is bordered to the north by British Columbia, Canada. The KNF ranges from open lands characterized by gentle rolling hills to mountainous regions with rugged peaks. The KNF averages approximately 145 wildfires each year, usually in mid or late summer, just under half of which are attributed to escaped debris burning. The prescribed burn season occurs in the spring and late fall, avoiding the winter season when snow is on the ground and air stagnation is more common. These burns are generally conducted to treat surface fuels and slash. Inversions and air stagnation have contributed to the larger of these two towns, Libby, being listed by the U.S. Environmental Protection Agency (EPA) as air quality non-attainment for PM-2.5 (particulate matter). Forest managers working within and near the KNF are members of the Idaho-Montana Airshed Management Group (AMG), which manages burn projects for smoke impacts.

South-central Oregon

Communities in and around the Fremont–Winema National Forest (FWNF) were selected for study, including Chiloquin, Chemult, Klamath Falls, Bly and Lakeview. The majority of the land area in this region is federally owned and ranges from heavily timbered mountains to arid shrublands. Similar to the region in northwestern Montana, the local topography surrounding the communities of Klamath Falls and Lakeview creates a pre-disposition for air inversions and stagnation, especially during the cold winter months. Wood stove use (as a home heating source) contributes to the challenge of air quality attainment in this region; both Klamath Falls and Lakeview are very close to a EPA designation of PM-2.5 non-attainment. Prescribed

fires are generally conducted to reduce surface fuels and treat slash from October through March, and wildfire season is summer through early fall. A number of formal local partnership groups actively collaborate on forest health and management concerns, including the Lake County Resources Initiative (LCRI), the Lakeview Stewardship Group, the Klamath-Lake Forest Health Partnership, and the Lakeview Collaborative Forest Landscape Restoration Project (CFLRP).

Central Coast South Carolina

Communities in and around the Francis Marion District of the Francis Marion-Sumter National Forest (FMSNF) including Charleston, Awendaw, and Mount Pleasant, Columbia, and Cordesville were selected for this study. Located in the coastal plain of South Carolina, the Francis Marion Ranger District (FMRD) is situated between the metropolitan areas of Myrtle Beach and Charleston, and exhibits a diverse ecosystem ranging from fire-dependent longleaf pine stands to swamp and marshland. Prescribed burning on the FMRD is generally conducted between January and May. State and non-governmental organizations, and private landowners also commonly utilize prescribed fire in this region. Numerous partnership alliances emphasize forest management within the state and the Southern region. Multi-state efforts such as the Southeast Regional Partnership for Planning and Sustainability (SERPPAS) and the Southeast Fire Ecology Partnership (SEFEP) advocate forest health through the responsible use of prescribed fire. Also evident in the region is public education and outreach for prescribed fire use carried out on the state and local level by groups such as South Carolina Prescribed Fire Council.

Data Collection

Our findings are derived from interviews conducted between January and May 2011. We selected this methodology because of their flexibility in allowing probing questions when topics of interest or new ideas are raised by interview participants. Interviews also allow the collection of rich details, which is appropriate in a descriptive study (Berg and Lune 2012). Interviews were semi-structured, meaning they were guided by an interview instrument which included a series of open-ended questions about the participant's role in fire and/or smoke management, experiences and strategies for communication, partnerships they are involved in, and challenges and ways to address these challenges.

Interviews took place at the participant's place of work or, in some cases, at public locations. Interviews lasted from 45 to 90 min and were usually conducted with a single participant, though some were small group interviews. A

Table 1 Number and type of interview participants

#	Participant type
16	Federal Agency
15	State or Local Agency
6	Air Quality
6	Local Fire Protection
4	Timber Industry
5	Environmental Non-Governmental Organization
8	Private Landowner
60	Total Interviewees

total of 60 individuals were interviewed across all four locations. Participants were purposively chosen as key informants based on their position as a critical manager to make decisions about smoke management or as a key stakeholder engaged in fire and smoke management discussions (Berg and Lune 2012). To get a broad understanding of smoke-related communication concerns, the study sample included land managers and air quality regulators, representatives of environmental non-governmental organizations, private individuals who use fire on their land, local governments, local fire protection, and timber industry (Table 1). Interviews were conducted until interviews were no longer uncovering new information (Robson 2011). All interviews were digitally recorded and transcribed, resulting in 312 pages of transcripts. The resulting transcripts were systematically analyzed as described below.

Data Analysis

Interview data were analyzed using a standard iterative qualitative analysis approach (Patton 2002; Seidman 2006; Berg and Lune 2012). Two researchers independently reviewed the transcripts, beginning with an interpretive, line-by-line coding process where phenomena are named and sorted into categories through close examination of the data (i.e., interview transcripts) (Strauss and Corbin 1990; Robson 2011). Coding allows the volume of data to be reduced without loss of the integrity of the information. A total of 121 codes were compared and built into nine coding frames (categories) which were later combined into broad themes related to our research questions and guided by existing literature (Berg and Lune 2012; Creswell 2013). The two researchers then compared codes, frames, and themes to assess inter-coder reliability (consistency in approach between coders) (Robson 2011). Differences in codes were reviewed and addressed. The final results were reviewed and validated by the full research team. Results are presented here as key themes and sub-themes related to our research questions with some direct quotes from participants to further illustrate and provide explanation of the theme.

Table 2 Public communication strategies used around smoke

Newspaper and other print media
Flyers and brochures
Radio and television announcements
Road signage
Websites
Hotlines
Reverse call system
Tabling or presentation at public events
School programs
Community field trips
Face-to-face discussion
Tapping social networks
Personal phone calls
Open houses
Public meetings

Table 3 Communication challenges identified by interview participants associated with managing smoke near communities

<i>Uncertainty about effectiveness</i>	Uncertainty about whether communication strategies are effective and whether they are reaching the intended audience
<i>Inconsistent messages</i>	Communication message may conflict with messages from other agencies, and burn regulations and communications about them are confusing
<i>Internal priorities</i>	Communication is not a priority for many ground personnel, but they may be the ones who actually see the public

Findings

The goal of this study was to examine communication around smoke management from wildland and prescribed fires, associated challenges and successes, and to provide baseline data on partnership efforts among agencies and with the public and public engagement efforts as a means to contribute to improved smoke management programs. At a broad level, many of the challenges and successes associated with smoke communication were consistent regardless of location. Findings are organized to describe these communication strategies (Table 2), challenges (Table 3), and the approaches used by participants to address them (Table 4).

Communication Strategies

The range of communication and outreach strategies used in these research locations was broad, though a number of key strategies came up regularly across interviews. Table 2 displays the strategies for engaging or informing the public

Table 4 Mechanisms for addressing current smoke-related communication challenges identified by interview participants

Management consistency across boundaries	Consistent and coordinated land, smoke, and communication management provides a greater understanding of the social and spatial landscape generally leading to more informed individual land, smoke, and communication management decisions.
Prioritizing and strategizing to reach current and extended audiences	<p><i>Making communication an institutional priority</i> Institutionalizing the importance of communication makes it more pervasive</p> <p><i>Coordinating messages across and within agencies</i> Plan for communication early and take advantage of opportunities</p> <p><i>Utilize social networks</i> Take advantage of social networks and “trap lines” to spread information</p> <p><i>Optimizing resources</i> Take advantage of underutilized physical and communication resources</p>
Fostering relationships with the public	<p><i>Engage in-person</i> Personal one-on-one or face-to-face interactions were viewed as more successful at establishing relationships</p> <p><i>Get involved in partnerships</i> Stable partnerships provided more opportunities for building personal relationships</p>

that were identified for communicating about smoke; the most commonly used were radio announcements, websites, hotlines, and public meetings.

Strategies for communication within and among agencies were also identified. Involvement in partnerships or coordinating groups that include multiple agency and burner representatives was the most commonly cited. Others mentioned include formal topical workgroups, collaboration on projects, and informal relationships built on topical interests.

Communication Challenges

Three challenges emerged that complicated the process of communicating about smoke: (1) uncertainty about the effectiveness of communication strategies, (2) confusion caused by inconsistent messages from different agencies, and (3) internal priorities about the importance of communicating with stakeholders.

Uncertainty About Effectiveness

Many interview participants across all locations expressed uncertainty about how to most effectively communicate with the public about smoke and indicated a level of doubt about whether their messages reach as many people as they intended. One manager in Oregon described his uncertainty about his approach: “I try to get out a few different ways to communicate, through the media and others and no I’m not sure what the best is but I sure would like to find out.” Interview respondents in all four locations reported employing a number of communication methods with the intention of reaching a broader audience base, though many had responses similar to the one above. In areas where busy roadways could be impacted by smoke, such as in South Carolina, interviewees acknowledged the magnitude of their communication task as the affected public may not just include local residents but others using the nearby roadway. A manager there explained “That will be a big project with getting the word out to the public if we burn in the area and it’s a highway. We just don’t know how to reach them all.”

Inconsistent Messages

Most of our interview participants felt the public lacked understanding of fire risk and the associated impacts from smoke. One possible explanation for public uncertainty was offered by interviewees in several locations: the messages coming from different agencies and entities are often unclear or even contradictory. For example, one participant in South Carolina described two agencies using billboards to relay opposite messages: “It was kind of embarrassing because we were at this meeting, and they [U.S.D.A. Forest Service] were talking about their [fire is good for the forest] campaign, and [the S.C. Bureau of Air Quality has got an [anti-] open burning campaign that’s going on at the same time, and we’re both using billboards. Sometimes they are even next to each other.” A colleague on the same district summed it up: “What complicates this issue is when there are so many different messages out there [about fire and smoke] and the communities and the public are so confused about it.” This was a common story told by a number of participants in each location.

Some interviewees connected the lack of clarity about smoke and burning back to regulations that are difficult to understand. In California one manager explained “The burn regs [sic] are pretty complex in terms of not being very uniform for residential burning. The reason for that is because we have burn regs [sic] that were adopted in the 1970s and we have a lot of different fire districts. It is really hard to follow, even for an expert.” Interviewees in other locations referred to frequent public complaints that

illustrate confusion over regulations. Several described receiving complaints when community members would see smoke from agency-ignited burns during times when residential burning was restricted. A fire manager in Montana voiced his sentiment “That is the biggest issue. How come you [agencies] can burn and we [public] can’t?” A similar story was echoed by an active community member in South Carolina: “Why is this guy lighting this big fire with all the smoke but I can’t burn a pile of leaves the size of a shoebox?” Participants in all four locations expressed that when regulations were confusing and messages were not coordinated, communicating with the public about smoke was a challenge.

Internal Priorities

Participants in all locations indicated that communicating with local residents regarding fire management and smoke emissions was generally a lower priority than many other resource management needs. This was delicately explained by a participant from South Carolina “One of the first challenges we had, I had been out on the front lines working with the communities so I was always pushing public participation and involvement, but the culture of our agency having a lot of engineers and people that are not comfortable in communicating with the communities, they want to do only what is [minimally] required.” Others referenced a working atmosphere where communication outside of the agency was not highly valued, or that doing such activities took away from what was perceived as more important work on the ground. Some participants who personally prioritized public communication described their attitude as “sticking their neck out” in an organizational culture that viewed public interaction as a lower priority than other objectives.

Addressing Current Challenges

Three broad themes emerged from interviews regarding approaches to address communication challenges: (1) importance of consistent and coordinated smoke and communication management, (2) prioritizing and strategies to reach current and extended audiences, and (3) develop personal relationships with members of the affected public (Table 3).

Management Consistency Across Boundaries

Several participants emphasized the importance of communication and development of partnerships between organizations to provide a greater return for fuel treatments on the ground as well as for their communication efforts. These coordinated efforts were cited as helping managers

achieve success across political boundaries (such as between states), where air quality regulations may differ, across management units or between agencies. For example, an agency land manager in Oregon described his work with managers across the border in California: “We have not done it in a while, but we will sometimes do inter-agency border meetings. We are so close to the border, and California has their rules and we have ours. So we’ll get together. All the players get together and discuss common interests and future plans. It’s important since we can smoke each other out sometimes.” While participants expressed some challenges with such partnerships, overall, they were quite positive about their experiences with coordinated management across boundaries.

The primary benefit of these partnership efforts identified by participants was that consistent and coordinated management led to a greater understanding of the social and spatial landscape. For example, respondents suggested that such cross-boundary coordination allowed them to develop a more sophisticated understanding of the larger landscape and provided them with greater context when planning their own smoke management decisions. This deeper understanding, in turn, influenced how they communicated with each other and with the public about smoke. A land manager in California explained how a daily conference call gave him a better handle on what was occurring on the forests around him and the overall potential risk for impacting the airshed with burn projects: “I think it [the conference call] is probably the best tool that we have. You get to talk to the meteorologist, the air districts, the board, and the other burners. You can kind of get a good feel for how high the stakes are for burning that day. Sometimes it is a little cumbersome because you have to spend half an hour listening to burns in other areas that you don’t care about, but it is worth it because I think it is the single most important thing we do when we are getting ready to give authorization for a burn.”

Managers in all four locations also suggested that this greater contextual understanding facilitated by internal conversations led to reduced smoke impacts on communities. Recognizing the benefits of this improved understanding, an Oregon agency employee indicated “We talk to one another and coordinate when each of us is going to burn. But that is an internal thing and it’s not going out to the public, but that helps the public because then we are not shoving the same amount of smoke in one spot at a given time. But mostly they don’t know we are coordinating behind the scenes like this.” One manager in South Carolina spoke about the prescribed fire council meetings where prescribed fire practitioners come together to talk about techniques and plans: “...the sharing of techniques for mitigating [smoke] when you burn next to a community and that kind of stuff is what they try and get to share in

these meetings. Then we don't all smoke out the same town." While the pathways to coordinate management efforts differed between locations, it was clear that many managers felt that coordinating their management decisions was advantageous in clarifying communication and for reducing impacts of smoke on local and distant communities. The diversity of approaches reflected the stakeholders, agencies, and contextual differences in each location.

Prioritizing and Strategizing to Reach Current and Extended Audiences

As demonstrated earlier, many managers perceived that communicating with the public was a challenge for numerous reasons. Managers also discussed a number of strategies they were adopting to help address this challenge. These included (1) making public communication an institutional priority, (2) coordinating messages across and within agencies, (3) utilizing social networks, and (4) optimizing resources.

One example that demonstrates efforts to demonstrate institutional support for public engagement comes from South Carolina, where public interaction is the subject of internal trainings. A state agency participant described "...we have been doing public participation fundamentals training to really drive home what the basics of public participation are and what we are encouraging our staff to do and change the mindset, really incorporating the public and not just a checklist but how to make it meaningful and pay attention to those concerns that you hear." This participant felt these trainings were making a positive influence on how personnel interacted with the public, and they acknowledged that the trainings would not be happening if they did not have institutional support. While this example shows institutional support for public engagement at a fairly involved level, most interview participants brought up smaller-scale examples (e.g., open houses, Q&As, and clear pathways to the information officer) that required fewer institutional resources. Still, an undercurrent of all these examples was that support from supervisors and institutions was important for managers to know that communication was viewed as a legitimate use of agency resources and provides a valuable contribution toward achieving the agency's mission.

Discussing communication plans among different agencies and groups in order to ensure that messages were not contradictory was a strategy identified for improving effectiveness of public communication efforts in all four sites. This flows directly from the challenge identified earlier of having lack of clarity or contradiction in messages relating to smoke. While contradictory messages still occurred in some instances, interviewees felt the effort to

coordinate messages did significantly reduce instances of lack of clarity and/or contradiction. An example of this effort is in the South with the *One Message Many Voices* campaign. Several participants from South Carolina highlighted the influence this campaign has had, suggesting "that you can get a new car in Miami and drive it up through Georgia and South Carolina and get a consistent [radio and billboard] message about fire." Even with such campaigns, some participants pointed out that managers must still think outside the box when it comes to coordinating information pathways to the public. In other words, a coordinated, one-size-fits-all message cannot be the only message communicated to the public; messages specific to the local situation and scenario were also very important.

Taking advantage of informal social networks was a strategy cited by multiple interview participants. An Oregon agency manager explained this idea well with the idea of "trap lines" or established networks or pathways of communication: "Information trap lines for communication...who is the official or even unofficial gossip of the area...who is that person that you know that if you talk to them, within an hour there are going to be 100 other people that are going to hear your message." This interview participant also described his process of developing relationships with key people at the major employers in town, who could serve as key contacts to help informally share information. A similar idea was occurring in California, as mentioned by one fire manager: "we had a community organization, so we contacted their leaders who essentially went door-to-door telling people what we were doing [conducting a prescribed burn]...We have been fortunate here in Northern California that there are some people that are really engaged at trying to get the information to the public." In doing so, this manager found that residents seemed less likely to be concerned about the smoke because they knew it was not a wildfire. Networks were also used in South Carolina, though in a physical rather than social sense. Interview participants thought of trap lines as key locations in town rather than as people. One manager described the typical locations on a trap line circuit: "they kind of just go around to all the country stores throughout the county, especially in areas where we have historically had wildfires or boundary burns going on, and we drop off brochures, magnets with our phone number, or other stuff. We'll hit popular restaurants too." The bottom line is, in all cases managers identified a way to connect with existing social networks to reach a broader audience that may not otherwise be accessible to the fire and smoke management message. In addition to potentially broadening the audience, this approach may also allow the message to be carried by a trusted source of information within an individual's social network rather than an unknown agency representative.

A final strategy discussed by managers for improving information dissemination suggested that going after underutilized resources and piggybacking off of existing communication programs was also helpful in addressing smoke-related challenges and getting the messages out to more people. This may mean capitalizing on actual physical resources that are not currently used, as identified by one Oregon manager: “We have a big electronic reader sign, but we don’t use it. We should use that more! It must have cost a fortune.” It may also mean tapping into ongoing communication programs, such as described by one South Carolina manager: “We would contact the county department. They have a couple of groups that are set up for contacting the industries there.” He also described a relationship with the media that allowed them quick access to get critical information out immediately.

Fostering Relationships with the Public

A third mechanism for addressing communication challenges related to smoke management was to foster improved relationships with members of the public. This emerged both in the sense that relationships need to be developed with a wider cross section of the public and deeper relationships need to be cultivated where some initial relationships have been developed. Specifically, engaging in-person and getting involved in partnerships were key themes.

Interview participants highlighted a number of ideas that helped them in building relationships across diverse public groups. Most of these ideas are not new, yet participants emphasized them in these interviews as specifically important when talking about smoke because of the highly emotional nature of impacts. Because many conversations about smoke with the public centered on potential health concerns, participants acknowledged the importance of personal, face-to-face contact (rather than simply relying on brochures or public service announcements) and empathy. One South Carolina manager pointed out “If we are going to be in an area where private individuals will be affected by smoke at their homes, we try to make personal phone calls or go door-to-door. It helps. They appreciate that and tend not to complain later if we do that.” In California a similar message was heard: “People want to know you care and what is going to impact them. By making that personal contact, it shows you care. It is easier for them to say that we know it will be impacting them and they accept that it will only be a day or so and then they tolerate it.” An Oregon manager conducted face-to-face meetings out in the field, and felt that made a difference: “If there is a potential issue...I’ll call and ask if we can go out and meet. I’d rather go out [in the field]. I find it is more effective to meet with rural people on their ground.

Most of the time they are just curious and want to know you hear their concerns and questions.”

A final point that was made by a number of participants suggested that long-term agency–organization partnerships (e.g., air quality partnerships and forest management collaborative groups) helped with building personal relationships and ultimately cleared the path for improving communications about smoke. An Oregon interviewee spoke about how this works for them: “It [partnerships] is a focus for the agency right now. Developing those partnerships and making sure we are working in a collaborative manner.” A colleague elaborated further on a dedicated partnership with a local Native American nation: “In the last couple of years we have worked with the tribe very closely and they are actually helping us to develop (fuel reduction) projects. We have a new tribal forester. We have biologists. They are out here on the ground helping us to develop projects. It is really great to see, and fun. I have been here since the early 1980s. Seeing the history of conflict, even to the point of lawsuits to turn around and see now where we are. They are right on board with us. They are sitting in on our ID [interdisciplinary] teams and are filling in with us, saying yeah let’s get this thing going.” Interviewees recognized how these partnerships allowed them to get to know individual people, making it easier to define problems and address the challenges of smoke management in a more collaborative way.

Discussion

In this study, we set out to examine communication around smoke management from wildland and prescribed fires, associated challenges and successes, and to provide baseline data on public engagement and partnership efforts among agencies and with the public as a means to contribute to improved smoke management programs. Although the data presented here come from interviews in four locations and across a variety of participant types, many of the challenges and strategies associated with communication regarding smoke management were consistent across locations. This suggests that findings may have broader application beyond the study locations.

A key implication of the findings from this study is that exchanges of information—whether between managers within an agency, managers in different agencies, or from an agency to the public—are important in the management of smoke around human populations. This exchange gives managers the opportunity to gain insight about smoke impacts that may not otherwise have been apparent by receiving comments and asking questions of other managers and the public. More importantly, as several participants in this research pointed out, this often requires

having the right people in the right place. In other words, the personnel on the front lines who do this interacting need to be genuine, friendly, and good listeners. These overarching findings are consistent with research on other social aspects of forest health and management. Prior research on communication strategies in fire contexts highlights the value of interactive and personal learning experiences to develop relationships and provide meaningful information exchange with the public (McCaffrey 2004; Toman et al. 2006). Additionally, Weisshaupt et al. (2005) posit that for contentious issues such as smoke, communication needs to go beyond “informing” the public and use more locally relevant and engaging formats that allow the building of relationships. This sentiment clearly emerged among the mechanisms for addressing challenges identify by our study participants.

This research identified several communication strategies that are worth considering in the context of smoke management. Some of these approaches will be fairly easy to implement, while others will require significant resources and institutional support. Recognizing existing social or communication networks can provide an efficient means of expanding the reach of agency messages fairly easily and with little monetary investment, particularly in smaller, or more rural communities. This approach can provide valuable connections to otherwise inaccessible segments of a community. Institutionalizing the importance of communication through agency training sessions requires strategized planning and a much more extensive resource base, as interview participants in South Carolina pointed out. Yet, both approaches, despite the differences in resource investment, were strongly supported by our participants.

This work also suggests that some strategies for addressing challenges specific to smoke management can address, also serve to address, other challenges simultaneously. For example, coordinating between agencies on management efforts can serve multiple purposes including increasing manager understanding of potential outcomes of their management decisions, reducing conflicting communication messages from different agencies, identifying potential impacts to communities across broader landscapes, and planning coordinated messages for engaging the public about smoke. Once developed, such partnerships may go beyond smoke or fire management to provide a forum to address other management objectives that may cross ownership boundaries or disciplinary expertise.

A final noteworthy implication has to do with the health effects of smoke. Human health did not emerge as a top challenge in these interviews, which at first glance may seem contrary to the finding reported in a recent synthesis that identified potential health impacts as the primary public concern with smoke emissions (McCaffrey and Olsen 2012). Before drawing such a conclusion, it is

important to consider the study population here. Our findings come largely from individuals experienced with land and air management, who are more apt to take a longer-term perspective on outcomes (i.e., a little smoke now means less smoke in the long run), and not members of nearby communities who are likely to be those most impacted by smoke. Results from most other research looking at concerns about the health effects from smoke come from the public, among whom on average approximately one-third of households have a respiratory ailment which may be significantly affected by smoke (McCaffrey and Olsen 2012). For these affected individuals, their viewpoint about exposure to smoke is likely to be much more immediate and focused on the potential for likely impacts, i.e., will the upcoming smoke event make me sick or force me to leave my home? A takeaway message here is what managers are already practicing in some locations—it is beneficial to preemptively identify these populations with health effects and try to avoid impacting them when possible. When smoke impacts from wild or prescribed fire are unavoidable, managers can provide sufficient notice about when and where smoke impacts could occur so individuals can choose to avoid smoke or take other actions to reduce their exposure. While developing an understanding of the ecological benefits of prescribed fire, including the potential to reduce the likelihood or intensity of future wild fire events, may serve to increase the acceptability of prescribed fire treatments, for these individuals, this acceptance will not likely allay their concerns regarding potential impacts. Rather, individuals with respiratory or other health ailments that may be negatively effected by smoke will likely want specific information about the smoke event (e.g., duration and intensity) and potential actions that can be taken to reduce their exposure to smoke.

As these findings demonstrate, a variety of communication approaches should be used depending on agency goals, audience needs, and they type of fire event. Managers will likely be more successful if they develop an understanding of, and relationships with, potential partner agencies and key community groups prior to a smoke event. Doing so will allow thoughtful consideration of the most appropriate communication approaches and allow time to developing necessary communication networks.

A few assumptions and limitations regarding this study are worth noting. First, our sampling methods and data collection procedures do not allow for statistical generalizations to broad populations. However, as the findings presented here are in line with expectations based on related research, it is likely that the thematic findings can offer insight that may be useful at other locations with characteristics similar to those examined in this research (such analytical generalization is common in case-study

research) (Yin 2009). Second, as a descriptive study, the findings should be viewed as a first step in examining the topic of communicating about smoke. Next steps within this larger research project include examining different populations (i.e., the general public) with larger samples and quantitative methods to further test variables and potential relationships identified here. Finally, this study focused on four research sites of varied geographic, ecological, and social context, but fire and smoke occurs across far greater landscapes with different scenarios than those examined here. As such, this work can serve as a base comparison for future investigations into other settings.

Conclusion

This research helps address an important research gap and adds to the existing small base of literature that focuses on smoke from a social perspective. As an exploratory, descriptive study, this work provides a baseline of findings about the challenges of smoke management and communication, and mechanisms for addressing these challenges. This initial study provides data that may be helpful in improving smoke management programs around the country. Respondents in all locations desired a better understanding of effective communication strategies to better inform the public regarding smoke from different sources in their communities, and how to engage each other and their communities about smoke concerns and plans. Coupled with the finding that institutional support for communication-related training was identified as important, this suggests additional federal, state, and/or local resources may be well spent on such opportunities.

Future research on the social aspects of smoke and fire management is certainly warranted. This study examined a variety of community members with a strong focus on land and air quality managers, yet there is still lack of a thorough understanding of public perceptions of smoke and what may influence those perspectives. The next phase of this research project will begin addressing this gap through surveys among community members at our research sites. With this continuing work and other future studies, the goal is to continue to improve our understanding of the role smoke plays in land management dynamics and decisions.

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Compliance with Ethical Standards This research included human subjects. It was approved by the Oregon State University

Institutional Review Board, and complies with current laws in the United States.

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