Communicating with the public about wildland fire preparation, response, and recovery

A literature review of recent research with recommendations for managers

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About the Northwest Fire Science Consortium:

The Northwest Fire Science Consortium works to accelerate the awareness, understanding, and adoption of wildland fire science in Washington and Oregon. It connects managers, practitioners, scientists, local communities, and collaboratives working on fire issues on forest and range lands. The Northwest Fire Science Consortium is one of the 15 regional exchanges established by the Joint Fire Science Program's Fire Science Exchange Network to bring fire science users together to address regional fire management needs and challenges. Each regional exchange provides current and regionally relevant wildland fire science information to users in the region. For more information: http://www.nwfirescience.org/

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Abstract

This literature review synthesizes empirical research about wildland fire communication to provide practitioners, such as land managers, public health and safety officials, community groups, and others working with the public, evidence-based recommendations for communication work. Key findings demonstrate that it is important to recognize communication as a context-specific and dynamic process, not a linear pathway or prescription, or one-size-fits-all approach. We found that practitioners engaging in this work may be most effective when they get to know their diverse publics, engage in honest and sincere relationship building, and communicate in ways that are locally and culturally relevant. This review offers recommendations from the academic literature for how and where to engage in communication about wildland fire and smoke from wildland fire. These recommendations are not intended to be a set of rigid prescriptions; rather, they are intended to provide a starting point for practitioners to think about the multiple ways to engage with the diverse groups with whom they work.

How to use this report

Authors recommended using the tables in this report and the companion guide[1] of summary findings to problem solve contextually and culturally relevant strategies appropriate to their own roles and situations. These resources provide a wide range of information and recommendations for practitioners wishing to communicate with the public about wildland fire, including:

1. People and places to engage in wildland fire communication (Figure 2, page 8);

2. Approaches for wildland fire communication engagement (Figure 3, page 9);

3. How to strategically select and leverage different communication media and messengers to accomplish wildland fire communication goals (Table 2, page 11);

4. Specific content that communicators could include when engaging with the public about wildland fire (Table 3, page 12);

5. Processes communicators can use to engage with the public about wildland fire and smoke (Table 4, page 13).

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[1] Communicating with the public about wildland fire: A resource for practitioners to plan engagement strategies. 2021. Available at: https://ewp.uoregon.edu/sites/ewp.uoregon.edu/files/Wildfire_Communication_Guide.pdf.

Introduction

Wildland fire,[2] is rapidly increasing in frequency, intensity, and impacts to communities and ecosystems around the world. As a result, people living in fire-prone landscapes must regularly make decisions about how to live with and respond to recurring instances of wildland fire and smoke. Communication about wildland fire and smoke can help people mitigate, prepare for, respond to, and recover from wildland fire and smoke by providing notification to help people anticipate and mitigate potential impacts, helping people stay calm by increasing understanding of potential hazards, or increasing public acceptance of fire management strategies that can help protect them (Olsen et al. 2014). Consequently, there is an urgent need to evaluate and improve communication approaches between fire managers, researchers, and diverse publics.

Researchers have studied effective strategies for communicating with the public about natural hazards for decades. Several previous research syntheses have offered lists of "best practices" for risk communication. For example,

- Sellnow et al. (2009) recommended: involving the public in an exchange of information; communicating with honesty, openness, and accessibility; including risk communication in policy decisions; understanding communication as a process; accounting for inherent uncertainty in risk and acknowledging that risk tolerance might be different for everyone; designing communication to be culturally sensitive; and working with credible information sources to disseminate information.

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[2] Defined as "Any non-structure fire that occurs in vegetation or natural fuels" (National Wildfire Coordinating Group Glossary of Wildland Fire, https://www.nwcg.gov/about-the-nwcg-glossary-of-wildland-fire). This includes terms such as wildfire, forest wildfire, and brush fire. We also consider smoke events from wildland fires to be encompassed in our definition of "wildland fire" and its impacts.

- Similarly, Seeger (2006) recommended: engaging in pre-event planning; understanding public concern and treating the public as a legitimate partner; proactively working with the media; providing concrete actions that people can take; being honest throughout communication while working with credible sources and acknowledging uncertainty.

- Toman and Shindler (2006, p. 112) proposed four principles of effective communication, which they explain as:

  1. *Effective communication is a product of effective planning*
  2. *Both unidirectional (one-way) and interactive approaches to communication have a role in public outreach. The strengths of each should be used to build a program.*
  3. *Communication activities that focus on local conditions and concerns can decrease the uncertainty that citizens associate with fire management and build their capacity to participate in solutions.*
  4. *A comprehensive communication strategy will emphasize meaningful interaction among participants and build trust along the way.*

A more limited set of literature reviews have specifically synthesized communication strategies within the context of wildland fire (see, for example, Brady and Webb 2013; Steelman and McCaffrey 2013; Fish et al. 2017; Westcott et al. 2017; Remenick 2018). While these reviews provide insight into the research that has been done related to wildland fire communication, their utility for wildland fire managers, agency personnel, practitioners, and professional communicators is limited in several ways. First, the scope and scale of these reviews were either very specific or very broad. Some of the reviews were very specific, such as focusing on a single dimension of communication (e.g., the utility of using maps for communication, as in Stieb et al. 2019; the effectiveness of communication apps, as in Kulemeka 2015; communicating with animal owners, as in Westcott et al. 2017) or focusing on a limited geography or one type of wildfire (e.g., Brady and Webb 2013). Other reviews were very broad and focused on multiple dimensions of social

science related to wildland fire, inclusive of, but not limited to, communication (e.g., McCaffrey 2015; Toman and Shindler 2006). Second, several of the reviews were conducted more than five to ten years ago, when wildland fire conditions and communication tools were notably different than they are today. Third, some reviews were rapid in nature, synthesizing only a small number of empirical research publications (e.g., Fish et al. 2017). Finally, many of these reviews' recommendations were conceptual in nature and did not offer tangible examples for where and how practitioners could implement the principles they put forth.

The purpose of this document is to build on previous research and literature reviews by summarizing recent empirical research about how wildland fire managers, agencies, and other practitioners can effectively communicate with the public about preparation, response, and recovery from wildland fire. Specifically, we (1) provide an overview of the relevant literature on this topic, (2) present a short catalogue of communication strategies and engagement approaches ideas, derived from this literature, and (3) summarize key recommendations made in this literature regarding how, where, and what to communicate about wildland fire and smoke events. This work is intended to serve as a resource to guide those engaging in wildland fire communication and scholars seeking a better understanding of research gaps and opportunities.

Approach

We conducted a literature review from May to August 2021 in consultation with a professional research librarian at University of Oregon. The entire body of peer-reviewed and gray literature on disaster communication, risk communication, natural hazards communication is far too large for any single paper to encompass. Therefore, we focused our review specifically on best practices for communicating with the public about fire impacts and fire risk, which was identified previously as a high priority wildland fire communication research need by the Northwest Fire Science Consortium's wildland fire science needs assessment across Oregon and Washington (Ellison et al. 2019).

We bound our review by four search criteria to ensure the articles we reviewed were relevant and the information they contained was reliable. Our criteria were that each article needed to: (1) be peer-reviewed, (2) present empirical (i.e., based on observation or experience rather than theory or logic exclusively) research about communication strategies that guided recommendations made in the article, (3) be published recently (2010 through present (May 2021)), and (4) explicitly focus on managers' communication about wildland fire or smoke from wildland fire with the public (e.g., exclude articles

about media coverage). We further removed articles that were related, but not central, to our research topic, such as those primarily investigating ecology, health impacts, or risk perceptions of wildland fire and smoke.

We systematically searched three databases using keywords as search criteria. We searched Web of Science, the Social Science Premium Collection, and Google Scholar to ensure that we captured articles from a broad set of search engines and sources. We adapted the following search terms for three databases:

> Search ALL FIELDS and include if contains (wildfire* OR "wildland fire") AND (communicat* OR outreach OR message* OR extension) AND (public OR stakeholder* OR communit* OR population*)

> Search ALL FIELDS and exclude if contains ("spread* like wildfire") OR ("digital wildfire")

In total, we identified 1,364 potential articles through our search process. One author screened titles and abstracts to remove articles that clearly did not meet the inclusion criteria and all three authors reviewed the 397 remaining abstracts to determine whether or not they met the inclusion criteria. After filtering, we identified 32 total articles to include in this review. Our review and paper elimination process is detailed in Figure 1. All searches were completed the week of May 14, 2021.

The lead author read each of the 32 included articles and systematically catalogued and paraphrased information about three key areas of content. First, they catalogued the article's authors, author affiliations, study context, objectives, findings, communication strategies or ideas supported by findings, and recommendations about best practices for communicating with the public about wildland fire and smoke. Second, the same author also systematically recorded any text in the articles that mentioned venues (e.g., physical places, community groups, media channels) where communication could occur as well as approaches for how to conduct outreach or engagement at those venues (e.g., disseminating print, radio, television of social

media posts; hosting meetings and events; developing alert systems; public signage). The same author then thematically coded and summarized the resulting list of communication ideas in two ways: (1) people and places where communicators can conduct outreach in a community, and (2) mechanism, tools, and media through which communication can occur. Third, the same author recorded excerpts in which the articles' authors made explicit recommendations regarding communication. All three authors then thematically coded, organized, and summarized recommendations from the articles into four categories, including recommendations about: (1) the medium and/or messenger for communication, (2) the content to include in communication messages, (3) the process for how to engage with and communicate with different communities, and (4) future research needs.

We endeavored to increase the reliability of our analysis through two strategies. First, all three authors reviewed each other's coding to identify and resolve incongruities; authors met regularly throughout the project's duration to review, discuss, and resolve disagreements. Second, three external reviewers reviewed this document.

Figure 1 Overview of literature review and article elimination process
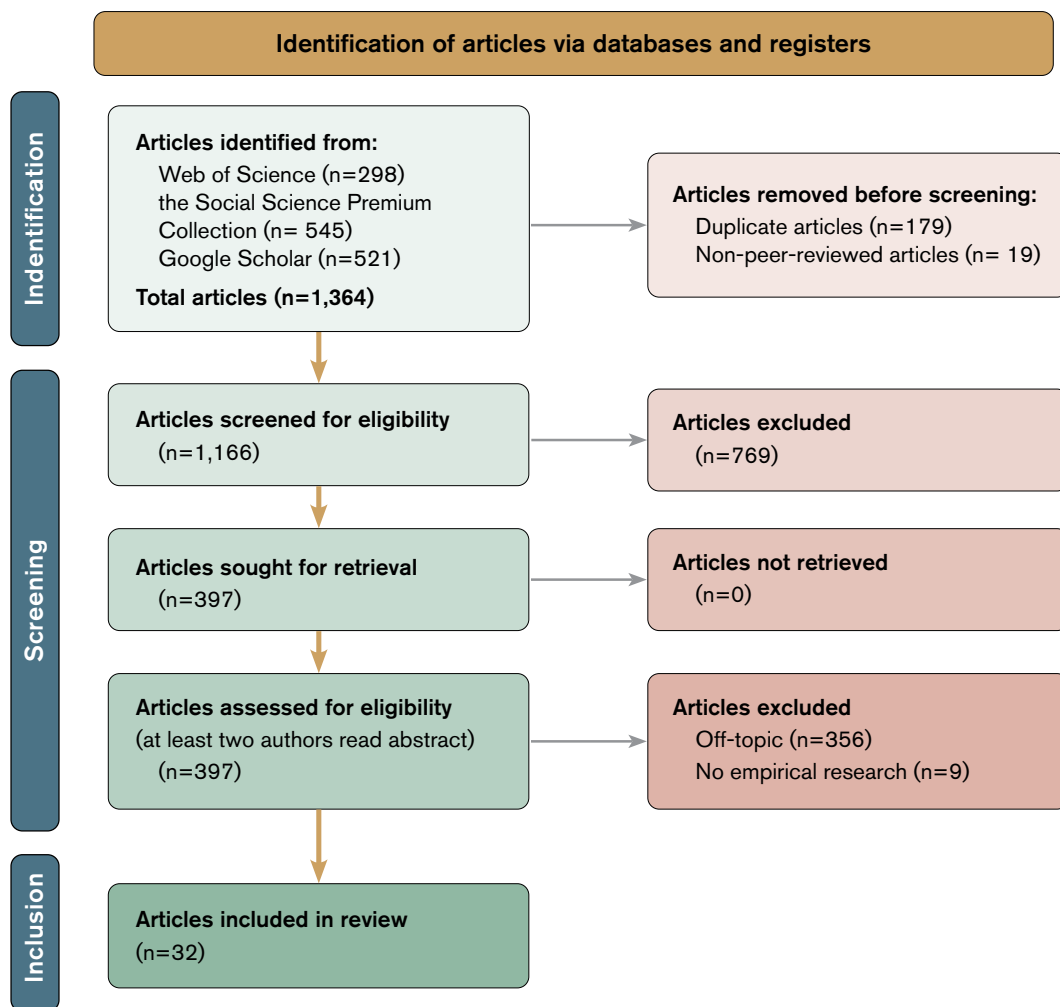

Figure adapted from Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. BMJ 2021; 372:n71. doi: 10.1136/bmj.n71

Findings

Below we summarize the 32 articles we reviewed, including an overview of publication sources, author affiliations, and the findings presented in the articles. Individual summaries of each paper are presented in Appendix A.

I. Article sources, authors, and author affiliations

Reviewed articles reviewed came from 22 different peer-reviewed journals (Table 1), spanning a wide array of disciplines.

We identified 111 unique authors with 51 unique institutional affiliations, of which the majority were academic (n = 33). Non-academic affiliations included government (n = 9), nonprofit organization (n = 7), Tribal (n = 1), or unknown (n = 1). The affiliated organizations were located in the USA (n = 28), Australia (n = 13), Canada (n = 4, including Sandy First Nation), India (n = 2), Sweden (n = 2), and South Africa (n = 1).

Table 1   Summary of publication titles

Journal title	Number of articles	Article ID*
Environmental management	3	4, 20, 27
International Journal of Wildland Fire	3	21, 22, 32
Natural Hazards	3	17, 28, 29
Australian Journal of Emergency Management	2	5, 24
International Journal of Disaster Risk Reduction	2	2, 3
Journal of Rural Studies	2	8, 23
Society and Natural Resources	2	14, 25
California Agriculture	1	19
Communication Studies	1	15
Corporate Communications	1	13
Fire Ecology	1	6
Forest Policy and Economics	1	18
Forestry: An International Journal of Forest Research	1	1
Frontiers in Public Health	1	16
Geographical Research	1	10
Global Environmental Change	1	7
Information, Communication & Society	1	31
International Journal of Environmental Research and Public Health	1	11
Journal of Applied Communication Research	1	26
Journal of Health Communication	1	30
Natural Hazards Review	1	12
Risks, Hazards and Crisis in Public Policy	1	9

* Article IDs with main findings are in Appendix A, page 18; full citations are on pages 23–24.

II. Community engagement ideas from literature review

The articles presented a wide variety of examples for how and where to engage with the public in communication about wildland fire and smoke. We identified 45 unique examples of places or venues to communicate. We grouped and summarized these examples into a typology of 24 different "People and Places" to engage in communication efforts (Figure 2). Venues included physical places where outreach could be conducted (e.g., key community locations such as schools, libraries, medical offices, and local businesses), communities or networks (e.g., organizations such as local sporting and book clubs, homeowners' associations), and key figures that, with support and encouragement, might be equipped or positioned to expand the reach of communication (e.g., government entities such as law enforcement and emergency management).

The articles also presented a wide variety of approaches that could be useful for engaging the public about wildfire and smoke. We identified 106 unique ideas for ways that wildland fire communication engagement can occur, which we further categorized into a typology of 36 different approaches, including tools, activities, and strategies (Figure 3). These tools included, for example, ideas such as audiovisual cues (e.g., billboards, maps, radio announcements, alarms, video feeds, social media), personal learning experiences (e.g., field trips, trainings, conferences), planning assistance (e.g., helping with community evacuation plans), hosting or taking advantage of community gatherings (e.g., tabling at events, hosting picnics, open houses), developing personalized information and warnings (e.g., private property information, personal phone calls or door-to-door canvassing), and opportunities to interact with fire personnel.

Figure 2   People and places to engage in efforts to communicate with the public about wildland fire

Key Community Locations
- Schools *(athletic events, open houses, and other events that bring community together)*
- Healthcare, medical, nursing homes
- Libraries
- Local businesses
- Restaurants and hotels
- Visitor information centers
- Taxis/transportation shuttles
- Routine markets
- Festivals and other local events
- Public meetings
- Key employers specific to a local areas

Government
- Local emergency management and fire authorities
- Local law enforcement
- County commissioners and other local government

Community Organizations
- Sporting clubs and groups
- Mothers' and play groups
- Book clubs
- Service clubs
- Religious groups
- Homeowner associations
- Chambers of commerce
- Humanitarian organizations

Figure 3   Communication approaches: Tools, activities, and strategies to use in efforts to communicate with the public about wildland fire

Communication Tools, Activities, and Strategies

Brainstorm where and how to engage with the public about wildfire

Risk assessment / Planning

- Fire risk and hazard assessments for residents *(and personalized assessments for private property owners)*
- Community wildfire plans, bushfire survival plans, including evacuation plans and maps
- Monitoring data collection on private lands
- Fire risk and planning surveys of homeowners
- Government regulation and ordinances, including requirements for mitigation in the WUI
- Integrate fire into accreditation requirements at local health service
- Preparedness kits

Meetings and Events

- Public meetings, open houses, community and neighborhood meetings
- Interagency meetings between responsible government units
- Field trips, meetings in the field, and community tours
- Tours with local media outlets
- Public road shows and public speeches
- Tabling or presenting at public events
- Conferences

Media

- Radio
- TV and films
- Facebook, Twitter, social media posts or campaigns
- Newspaper and other print media
- Press conferences and daily briefings during incidents

Education

- Drills: simulation and evacuation
- Workshops and webinars
- Training courses
- School-based education programs
- Demonstration projects

Informative Resource

- Call-in number *(call center, 1-800 number, emergency hotline)*
- Brochures, flyers, pamphlets, factsheets
- Mobile applications and online resources such as blogs and interactive websites, electronic publications *(fire prevention/home protection)*
- White papers *(for policy makers, industry, etc.)*
- Maps of area risks, fire maps overlaid onto Google Earth
- Information about defensible space and fire-safe native plants that homeowners can plant
- List of emergency contact phone numbers
- Welcome bags for new residents, gift bags at events

Alerts/Warnings

- 'Reverse 911' system, target precise geographic areas and deliver in several languages
- Emergency Alert Systems broadcasts, alarms, and sirens
- Personalized alerts *(desktop/mobile computing systems)*

Communication Networks/Interpersonal Communication

- Conversations with incident management team representative
- Phone bank and personal phone calls
- Email listservs
- Personal and door to door visits for new residents and businesses
- Create county department communications programs for contacting industries

Advertising

- Signage in public and along roadways
- Stickers or cards in hired cars and vans
- Billboards and electronic reader signs
- Magnets with key phone numbers
- Printed materials in mail

III. Recommendations for communicating with the public about wildland fire and smoke

We identified over 250 instances in which authors made explicit recommendations about communicating with the public about wildland fire and smoke. We identified and paraphrased 144 unique recommendations after reducing redundancy (i.e., authors restating a recommendation multiple times within the same paper). Recommendations ranged from very specific, place-based recommendations to general principles that were broadly applicable. We organized recommendations into four themes: medium and messenger for engaging in communication (Table 2), content of communication messages (Table 3), process of communication (Table 4), and future research needs (page 14). Below we summarize the recommendations by each theme and offer examples for how recommendations were implemented or conceptualized in different research articles.

Medium and messenger for engaging in communication

We identified eight unique recommendations related to how those wishing to communicate with the public about wildland fire and smoke can strategically select and leverage different media and messengers to accomplish their goals (Table 2). Recommendations under this theme were present in 20 of the 32 total articles we reviewed. Overall, these recommendations suggested that knowing your audience, including who they trust and where they go for information, is critically important. Many of these articles suggested that getting to know your audience is something that should typically take place before emergency communication.

> *Engage and know your audience, and reach out the community to understand which information sources they trust and use.*

Table 2   Recommendations regarding medium and messenger for communicating about wildland fire and smoke

Recommendation	Sources*	Specific examples with sources
Create audience-specific communication	10	Offer women-specific trainings or events (10).
Leverage social media to amplify simple messages, as a gateway to more complex information, and to promote interaction with audiences	15, 16, 18, 31, 32	Use Twitter to amplify and reinforce messages (31). Present a simple message on social media and include links to more detailed air quality and health resources (16). Solicit questions and feedback on social media, use subsequent posts to respond (32).
Communicate via diverse media outlets for diverse audiences	6, 21, 24, 32	Offer a variety of types of interaction (e.g., simple messages to interactive workshops or collaborative processes) in multiple languages to meet the preferences of a diverse public (21). Integrate arts into programming by, for example, convening scientists, managers, and artists to co-produce science-based artwork that can be exhibited publicly (6).
Use direct outreach approaches with vulnerable and at-risk populations	30, 32	Use automated calling systems, door-to-door canvassing, site visits, public information meetings, and public service announcements in vulnerable communities (30, 32).
Share information via news sources that members of the public are in the habit of using	32	Concentrate outreach on television and websites in communities where people most often get daily weather information from those media (32).
Draw upon interactive media to build relationships and mutual understanding	3, 4, 8, 10, 21, 22, 25, 32	Prioritize facilitated conversations, interviews, workshops, or community listening sessions as tools for building relationships with communities (4, 8).
Utilize existing citizen networks and individual "influencers" to disseminate messages	6, 10, 14, 22, 26, 32	Assign formal or informal outreach roles to volunteers from networks of neighbors/interested individuals (14, 26).
Engage authoritative and trusted messengers to disseminate messages	4, 9, 15, 16, 28, 29, 32	Ask authority figures (e.g., emergency management and public health agencies) or well-respected leaders (e.g., volunteer firefighters, those who have experienced fire) to transmit information (4, 15, 28). Concentrate outreach on local television in communities where people feel local television is the most trustworthy news outlet (32).

* Article IDs with main findings are in Appendix A, page 18; full citations are on pages 23–24.

Content of communication

We identified seven unique recommendations related to the specific content that communicators should include when engaging with the public about wildland fire and smoke (Table 3). Recommendations under this theme were present in 16 of the 32 total articles we reviewed. Overall, authors recommended including key hazard and safety information, but also suggested using a style that was specific, clear, actionable, engaging, and positive in tone. They also recommended including elements of communication that would make the risk, hazard, or desired behaviors more relatable (e.g., footage of familiar places or people).

> *Include key information in specific, clear, actionable, and relatable messages using appropriate tone.*

Process of communication

> *Build understanding of, relationships with, and capacity to support communities' needs and priorities.*

We identified 11 unique recommendations related to the processes communicators can use to successfully engage with the public about wildland fire and smoke (Table 4). Overall, authors recommended making efforts to intentionally build greater understanding of, relationships with, and capacity to support the needs and priorities of the communities with whom wildland fire communicators are engaging. Many of the recommendations emphasized the need to dedicate time and resources to build enduring, trusting relationships with communities. These relationships would help practitioners learn about, recognize, and learn to value the communities' goals, values, and knowledge. Several process-related recommendations focused on prioritizing, coordinating, and working with community partners.

Table 3   Recommendations regarding message content for communicating about wildland fire and smoke

Recommendation	Sources*	Specific examples with sources
Messages should be specific, clear, actionable, and appropriately complex for each audience	18, 28, 30, 31, 32	Make messages specific and clear to reduce the need for additional information searches and not overwhelm audiences (18, 30).
Include hazards and safety info	3, 11, 15, 16, 17, 22, 30, 31, 32	Include information about fire suppression status, evacuation center name and address, road closures, health impacts of smoke, and parcel-specific information for landowners (3, 17, 20).
Include familiar faces and places	4, 5, 12, 30	Share archival footage of past fires in familiar places, spatial mapping of fire movement, or personal testimony from local people (5).
		Explain what other people typically do or think should be done to protect themselves when wildland fire or smoke exposure occurs (12).
Include strategy and rationale info, with details about limitations	11, 21, 25, 28	Communicate the purpose and spatial context of proposed agency actions (21, 28).
		Explain limitations of scientific risk modeling and conflicting recommendations made by different agencies (11, 25).
Include coping and recovery info	15	Include information about obtaining disaster aid, especially for long-lasting crises (15).
Use a positive or supportive tone	15	Include positive language, such as inspirational and gratitude messages (15).
Include visual elements	3, 30	Include well-designed maps that illustrate key fire and evacuation information.** Use pictures or graphics to illustrate desirable actions or to clearly label recommended items (e.g., labeling HEPA filters, or N95 respirators in a store) (3, 30).

* Article IDs with main findings are in Appendix A, page 18; full citations are on pages 23–24.

** See Cao et al. 2016 (p.192, Table 8) for a summary of findings about optimal designs, critical text descriptors, and potential cartographic improvements for wildfire warning messages

Table 4   Recommendations regarding process for communicating about wildland fire and smoke

Recommendation	Sources*	Specific examples with sources
Anticipate and prepare for future obstacles	15, 24	Be prepared to manage local expectations when community engagement programs end (24).
Build familiarity and relationships between fire personnel and communities (especially before fires)	1, 4, 7, 20, 27, 28, 29	Make it convenient for local community members to interact with local agency representatives, local law enforcement, and local fire departments before fires happen, such as at community events (e.g., via citizen science initiatives, community tours, developing and implementing educational programs) (1, 27, 29).
Collaborate and partner with others to increase capacity and ensure consistent messaging and communication strategies	9, 11, 13, 22, 32	Develop an understanding of, and relationships with, potential partner agencies and key community groups (e.g., NGOs, local governments, and media, researchers) (9, 22). Discuss communication plans among different agencies and groups to ensure that messages are not contradictory (22).
Continually learn about local community and local meanings or ideas. Tailor communication and planning to local conditions, audiences, and decision-making processes	4, 8, 21, 25, 26, 28, 31	Actively discuss with communities the values most important to them (e.g., homes, livestock, cropland, forestland) and confirm with them (e.g., in public meetings) whether or not the agency's understanding of local values is accurate. Share information about likely outcomes of different management alternatives and allow communities to shape decisions (21). Allow community members to contribute to defending their most important values by, for example, contributing to firefighting efforts (8). Learn about the diverse groups of people within a community, how communication works among them (e.g., existing social networks, communication pathways), the most effective ways to meet local communication needs, and local understandings of wildland fire (8).
Create processes for overcoming intractability	13, 26, 27	Promote opportunities for respectful dialogue about different understandings of wildland fire (e.g., through informal exchange of stories or formal methods like Q-method, fuzzy cognitive mapping, futures visioning, scenario building). Create avenues for community involvement in formal decision-making (e.g., multi-party monitoring). When differences cannot be resolved, pursue management options that are relatively insensitive to points of disagreement (26, 27).
Foster creativity, discretion to act, and humility among local leadership	1, 12, 13, 15, 20	Ensure agency policies allow local field staff (who are willing) to engage with the public about areas of contention or disagreement with the agency's plans and creatively address local disputes (rather than, for example, bringing in unknown outside legal experts to resolve conflicts) (1, 12, 15, 21). Encourage leaders to focus on mitigating the negative effects of crises rather than managing reputations (15).
Reflect on, learn from, and adapt in accordance with past experiences	2, 13, 26, 27	Deliberately discuss collective goals, outcomes, and processes by, for example, adding interruptions in group processes to evaluate what is and is not working (13).
Secure sufficient upfront investments, resources, and institutional commitments	2, 3, 4, 10, 15, 20, 22, 24	Ensure that there is institutional support for communication efforts such that agencies and communities will have sufficient resources to train and support leaders, staff, and volunteers to support communities' needs (such as to create wildland fire evacuation plans) (2, 20, 24).
Use available resources and toolkits	15, 28	Use existing message catalogues (e.g., http://hdl.handle.net/ 1903/24703) or communication checklists (e.g., Steelman and McCaffrey 2013, Table 1, p.689-690) to evaluate communication (15, 28).
Engage in interactions that are sincere, honest, genuine, friendly, open, and realistic	4, 20, 21, 22, 28	Engage in sincere and honest interactions and genuine discussion of problems, solutions, and decision-making processes (22).
Learn about inequities in the community and make a plan to reach vulnerable groups	8, 10, 11, 13, 16, 22, 30, 32	Preemptively identify vulnerable communities and try to avoid impacting them. Develop an understanding of inequities that define many disaster-prone communities (8, 22). Involve, empower, and target communication to vulnerable groups, such as rural, homeless, children, elderly populations, or people in high-risk areas (10,11).

* Article IDs with main findings are in Appendix A, page 18; full citations are on pages 23–24.

Future research needs

Finally, we identified and categorized 50 recommendations about areas of future research to better inform communication about wildland fire and smoke. We identified five primary categories of these recommendations for future research, including:

- **Effectiveness of messenger, medium, content or process used**. Many authors identified different evaluative needs related to, for example: effectiveness of messages that use different norms or analogies [11, 12]; effectiveness of information based on the order in which it is presented, presentation approaches, and public usability [3, 12]; how communities understand and value information about wildland fire risk mitigation [4]; the effect of social media use during local significant wildland fire events; and whether strategies deemed more effective by wildland fire professionals (e.g., face-to-face interactions) would be worth the extra cost [9]. Authors also identified a need to evaluate the relationships between the source of the message and the messenger, specifically with regard to Incident Management Team or local fire departments [29]; the effectiveness of risk communication activities conducted during previous wildland fire smoke events; and the reach of different communication mechanisms (e.g., radio, print, social media) [11].

- **Drivers of individual actions and behaviors.** Authors emphasized a need to better understand individual-level behaviors related to mitigation and wildland fire response to inform communication efforts. This included, for example, citizen entrepreneurs' patterns of behavior [14]; drivers of individual actions when facing wildland fire threats [25]; possible interventions for increasing risk mitigation on private property [17]; behaviors during smoke events [11] and wildland fire events and threats [23, 25]; and how climate variability affects people's responses [27].

- **Linking to disaster research**. Authors described a need to: link findings about wildland fire response to other disaster arenas [9]; understand how communities, organizations, and policies interact beyond the initial response period [26]; look for factors that affect messaging during different types of disasters [31]; and understand how different information sources are used or deemed trustworthy to recipients across different disaster settings [29].

- **Longitudinal changes over time**. Authors identified a need for more research over longer time periods to improve understanding of individuals' behaviors and actions and how that might inform communication efforts. They identified a need for more research on long term effects of evacuation (such as on economic health and physical, mental, or emotional wellbeing) [2], and to see if at longer time intervals residents would both perform wildland fire preparatory actions and remember recommended actions [12].

- **Indigenous populations**. Authors recommended researching barriers faced by Indigenous communities to conduct hazard preparedness, and communication strategies to support overcoming them. They also identified a need to understand short- and long-term effects of evacuation on Indigenous communities, especially communities that had experienced multiple evacuations [2].

Conclusion

Wildland fire and smoke are growing threats to communities and ecosystems across the globe. As a result, fire managers and the public must communicate and make decisions about how to mitigate, prepare for, respond to, and recover from increasing wildland fire and smoke exposure. The overall purpose of this paper was to summarize recent empirical research about how wildland fire managers, agencies, and other practitioners can effectively communicate with the public about preparation for, response to, and recovery from wildland fire and smoke. We reviewed 32 studies and (1) characterized the authors and institutions conducting recent research on this topic, (2) identified and compiled ideas and recommendations made by researchers to help managers understand how to effectively communicate with the public about wildland fire and smoke, and 3) synthesized researchers' suggestions

for future research to expand current knowledge on wildland fire communication.

We found that the most prevalent recommendations made by researchers about communication were related to the *process* of communicating with diverse publics about wildland fire. This includes the need to build relationships with diverse groups and audiences, understand and legitimize local concerns, and be transparent and sincere throughout the communication process. The focus on process highlights an important conclusion for managers: there is not a single standard message, messenger, or set of messages that will be effective for communicating with different publics about wildland fire and smoke. Rather, communication may be better thought of as a process for building mutual understanding, relationships, and trust between communities and wildland fire professionals (e.g., Olsen and Sharp 2013).

Communication strategies that prioritize greater interaction and information exchange between "experts" and communities are beneficial for several reasons. Developing deeper mutual understanding and relationships with target audiences makes it easier to effectively deliver locally or personally relevant information to them, through a greater understanding of: audience need and values (Paveglio et al 2015, Eriksen and Prior 2011). In addition, these relationships and understanding will inform managers' knowledge of what specific information will be most salient (McCaffrey et al. 2012), and the information sources that are preferred, trusted, or habitually used (e.g., Cooper et al. 2020). Interactive communication strategies can also build familiarity and trust between parties that will be useful during and after a crisis (e.g., Jahn and Johansson 2018). Furthermore, local communities may have relevant local knowledge or values that conflict with "expert" opinions about what is best for that community. As Eriksen and Prior 2011 explained, *"people hold widely varying experiences, beliefs, attitudes and values relating to wild[land] fire, which influence their understanding and interpretation of risk messages" (p. 1).* Developing an interactive communication process can help all parties figure out how to best integrate diverse viewpoints into wildland fire preparation and response plans. Fire managers and community members may be better able to understand how their own beliefs about the role of wildland fire may differ from others in their community, and this understanding can inform effective communication.

Researchers' recommendations also included suggestions about the *content, media, and messengers* to use in communication. These focused on providing accurate hazard information, maximizing the use of routinely used channels, and collaborating with trusted sources for information dissemination. While there is no standard message or messenger that will be effective for communicating with different publics about wildland fire and smoke, there are best practices for message creation and dissemination. Fire managers should include all relevant information about the hazard, its impact, time, location, and the inherent uncertainty or rationale about recommended actions. Messages should also be designed in a way that is clear, specific, accurate, and consistent (Table 3). Through proactive engagement with diverse publics, fire managers can also know what are the most routinely used channels and sources of information in affected communities, and work to provide information through routinely used and trusted sources of information (Table 2).

Our findings suggest that the success of communication efforts is further dependent on more than just those individuals who seek to engage in communication—context also plays an important role. First, effective communication depends on the viability of communications infrastructure (Jahn and Johansson 2018). Second, public safety also depends on residents receiving and heeding information from trusted, credible sources. Recognizing communication as an iterative process highlights the importance of understanding context for communication. A community's past experience with wildland fire and smoke can inform strategies for clear communication in the community, engage new community members, and reveal important lessons for supporting adaptation to new or changing conditions in the community (Colavito et al. 2020). In essence, communication is not a one-time exchange of information, but an ongoing process that can build a community's capacity to prepare for, respond to and recover from current and potential future natural hazards (Jahn and Johansson 2018; Colavito et al. 2020).

The articles we reviewed offered many ideas and examples for how managers might expand the reach of their communication activities about wildland fire and smoke and creatively engage different publics. Our lists of "People and Places" to engage in communication activities and "Communication Tools, Activities, and Strategies" are intended to capture the diversity of communication ideas described in the articles we reviewed. Wildland fire managers can think of these lists as problem solving tools to think about where and how they might expand the reach and depth of communication strategies in the communities where they work. It is not, however, a comprehensive or prescriptive checklist of communication strategies. These lists provide a starting point to better understand recommendations made by researchers in the reviewed literature and offer examples of how managers have tried to strengthen communication to support community adaptability to hazards.

We found that most research on communication about wildland fire preparation, response, and recovery was conducted by researchers affiliated with institutions in the western continental United States and Australia, and that they published their work in a wide variety of academic journals related to natural resources, communication, health, and hazard management. While not the primary focus of this review, we find it important to note the geographic area where much of this work is being produced. Previous work has shown that communities in high fire risk areas each require particular information and assistance to successfully navigate risks (Martin, Bender, and Raish 2007, cited in Westcott et al. 2017). We suggest that it would also be useful to expand research into other fire-prone regions of the world, such as the Amazon, central Asia, and the Arctic, to understand communication needs and how they may differ in those contexts as well. However, we also recognize that the apparent lack of research about wildland fire communication in these areas may, in part, be an artifact of using English search terms The relevance of the recommendations presented here also extend to regions not directly experiencing wildland fires. For example, wildland fire can create major air quality risks in communities and economies thousands of miles away, affecting the health and safety of people who are far away from the flames themselves (Doer & Santin, 2016; Navarro, et al. 2018). It would be useful to expand research to better understand the communication needs in these areas where public health is increasingly affected by wildland fire smoke.

Finally, we found that there is still a great deal to learn on this topic. There is an urgent need to evaluate and improve communication approaches between fire managers, public health and emergency response experts and managers, researchers, and diverse publics. Researchers suggested that additional research is needed in many areas, including: a deeper understanding of the drivers of individual actions and behaviors; longitudinal and updated studies; understanding the effectiveness of messenger, medium, content, or communication process; and dynamics in Indigenous communities. The need to link this work to broader disaster research, as noted by several authors, is a point we underscore here as relevant and timely. This is particularly important as people living in fire-prone landscapes increasingly must make life-changing decisions about how to live with and respond to recurring and often unpredictable instances of wildland fire and smoke. Linking local understandings of wildland fire to scientific knowledge can help inform research agendas and the relevance of findings (Colavito et al. 2020, citing Miles 2010; Curtis, Reid, and Ballard 2012; St. George et al. 2017).

Appendix A:
Reviewed literature approaches, objectives, and main findings

Full citations for reviewed literature are pages 23–24.

ID	Author, Year. Journal	Study location; Population	Study approach	Research objectives	Main findings
1	Asah, 2014. *Forestry: An International Journal of Forest Research*	Washington, USA; Professionals involved in forest fire management and outreach	Focus group and key informant interviews	Explore how fire management professionals understand and explain public attitudes towards forest fires and smoke	Unfavourable attitudes towards forest fires may be symptomatic of other problems. Unfavourable attitutudes are, in part, expressions of community discontent with the declining dependence on the forest for their livelihoods and inadequate community-agency interactions. Professionals' personalities and perceived organizational obstruction undermine community–agency interactions and ulitmately interfere with the accomplishment of fire management objectives.
2	Asfaw et al., 2019. *International Journal of Disaster Risk Reduction*	Ontario, Canada; Evacuated populations and managers involved in evacuations	Community-based research using semi-structured interviews and focus groups	Examine how issues related to pre-event preparedness and during-event communication influenced evacuation experiences of Sandy Lake First Nation residents	Several factors negatively affected residents' experiences during evacuation, including the difficulty of obtaining timely, site-specific, and reliable information; a lack of clarity about emergency protocols to be followed; and perceived constraints in government wildfire management policy. This study underscores the importance of taking into account the unique characteristics and needs of of Indigenous communities in wildfire preparedness.
3	Cao et al., 2016. *International Journal of Disaster Risk Reduction*	Western Australia; Residents of wildfire-prone areas	Online survey using experimental design	Compare the effectiveness of maps versus traditional text-based approaches for communicating spatial-related wildfire warning information	Appropriately designed maps prevailed over text messages for the communication of most wildfire warning information by improving comprehension, elevating risk perceptions, and increasing appeal to the public. An optimal communication approach would be to couple map designs with several imperative textual descriptors, particularly names and addresses of safe shelters.
4	Champ et al., 2012. *Environmental management*	Colorado, USA; Producers and consumers of information about wildfires	Interviews and focus groups	Compare formal members of a collaborative partnership with stakeholders outside the partnership in the context of how they understand and frame wildfire risk mitigation	Those promoting a collaborative partnership's project to mitigate wildfire risk and stakeholders outside of the partnership used different discourses in their communication. Collaborative partners framed communication using a discourse of scientific management; stakeholders followed a discourse of community. It is important to recognize and value these different frames more equally, and increase engagement and understanding.
5	Chapple et al., 2017. *Australian Journal of Emergency Management*	New South Wales, Australia; Fires of Change film viewers	Online survey and public seminar	Evaluate the effectiveness of a film to demonstrate fire risk, internalise risk awareness, and motivate residents to be bushfire-prepared	Watching Fire Stories prompted increased bushfire safety activity that was sustained over at least 20 months. The film increased respondents' concern for others in their community, including neighbors and vulnerable people. Effective elements of the film included: archival footage of fires burning in familiar and inhabited locations, and personalising the experience using local eyewitness accounts.
6	Colavito et al., 2020. *Fire Ecology*	Arizona and New Mexico, USA; Art exhibit visitors and creators	Paper and online surveys	Describe the development, impact, and lessons learned from a collaborative art exhibit designed to communicate about the shifting fire regimes of the United States Southwest	Fires of Change exhibits increased visitors' understanding of the effect of climate change on fire regimes and support for management actions to address the effects of climate change on fire behavior. Art can be an effective mechanism for (1) increasing understanding of fire and climate change; (2) building public support for management actions; and (3) developing partnerships among diverse science, management, and artistic audiences.
7	Cook et al., 2019. *Global Environmental Change*	Victoria, Australia; "Expert" risk managers	Semi-structured interviews	Explore the promise of public empowerment via public participation in bushfire management	Managers explained that a primary assumption in disaster risk reduction is that it is necessary to improve public knowledge/understanding. However, many experts paradoxically recognized that this strategy is rarely successful, and contradicts evidence that structural forces (e.g., capacity to act, financial impediments, class, gender dynamics) may be more important in shaping risk. For knowledge/awareness to influence publics' behaviours it must be wanted. A better measure of impact is the capacity of publics to act rather than solely their "awareness."
8	Cooper et al., 2020. *Journal of Rural Studies*	Victoria, Australia; Residents, service providers, representatives of key local organisations	Case study, semi-structured interviews and focus groups	Identify how locality and community features inform resident perceptions of bushfire risk and preferences for bushfire information	Successful bushfire risk communication depends on community engagement in the process and tailoring to locality-specific characteristics, such as physical features, diverse groups of people, existing social networks, and communication pathways. Local sources of information (e.g., local news outlets, long-term residents, Country Fire Authority brigade) were generally perceived to be more timely and trustworthy than external and centralised sources.

ID	Author, Year. Journal	Study location; Population	Study approach	Research objectives	Main findings
9	Crow et al., 2015. *Risks, Hazards and Crisis in Public Policy*	Western USA; Fire professionals, residents in communities affected by recent wildfire event	Comparative case study using in-depth, semi-structure interviews and focus groups	Develop a deeper understanding of the strategies that agencies use to promote wildfire risk mitigation, fire professionals' sense of strategy effectiveness, and support for regulatory approaches	For promoting risk mitigation behavior, interviewees found face-to-face/interactive approaches, outreach, and education preferable and more effective than website information, literature, or other passive approaches. However, passive approaches were used more often, potentially due to "historical institutionalism" and resource constraints. "Neighbor networks" were seen as highly effective and managers prefered incentives rather than regulatory approaches/ordinances to promote risk mitigation behavior.
10	Eriksen, 2014. *Geographical Research*	New South Wales, Australia; Community engagement staff and volunteers from rural fire services	Online survey, focus group workshops at conference	Identify perceived aids and obstacles for engaging women in bushfire risk management	Managers can increase women's bushfire awareness and preparedness by providing opportunities for hands-on, in person learning, where women can voice questions and concerns in a safe and supportive environment. Networks, such as schools or health services, can act as a vehicle for engaging women. Piggybacking on other events or institutional set-ups can provide a shortcut to wider networks. Respondents felt a 'culture change' was paramount for a more gender-balanced and gender-just engagement approach to bushfire preparedness.
11	Errett et al., 2019. *International Journal of Environmental Research and Public Health*	Washington, USA; Washington state practitioners and academics with expertise in wildfire smoke and health	"World Café Method" small group discussions	Present information gaps and research priorities identified during an interactive workshop, with the ultimate goal of reducing community-wide risks from exposure to wildfire smoke	Public health practitioners identified research they needed to better communicate about wildfire smoke risk, including: exposure science, health risk research, risk communication research, behavior change and interventions research, and legal and policy research. Participants identified a need for communication-related research to evaluate the effectiveness of specific messages, how to effectively communicate risk to resistant populations, address fear/outrage/anxiety, communicate inconsistencies across air quality indices, and identify the reach of communication mechanisms (e.g., radio, print).
12	Howe et al., 2018. *Natural Hazards Review*	Australia and USA; Americans from M-Turk (pilot study); residents in Victoria and New South Wales (field study)	Online experiments (pilot studies) to inform online survey (field study)	Determine whether communicating social norms is an effective way of increasing preparedness for wildfires	A social norm message was found to significantly increase wildfire preparedness in a hypothetical game. When the equivalent message was trialed in an actual field study by surveying residents twice (19 days apart, on average), the number of preparedness actions performed by residents increased by 11%. These results indicate that social norm messages can play a useful role as part of a larger information campaign about wildfire preparedness.
13	Jahn and Johansson 2018. *Corporate Communications*	Västmanland County, Sweden; Members of crisis communication network established to respond to wildfire	Observation and analysis of discourse in telephone meetings	Explain how adaptive capacity is accomplished through communication processes and can contribute to enhancing disaster resilience	This study showed how a network of crisis communications specialists compiled, organized, revised, and made crisis information available through a combination of stable, yet flexible communication practices. These practices included communications to (1) integrate people as members to the network, (2) structure how network members interact, (3) contextualize and delegate actions, and (4) position the network in a larger social system.
14	Koebele et al., 2015. *Society and Natural Resources*	Colorado, USA; Wildfire protessionals, local residents	Comparative case study using semi-structured interviews and focus groups	Introduce the concept of citizen entrepreneurs and examine the role they can play in wildfire outreach	Citizen entrepreneurs are highly motivated community members who can help resource-constrained wildfire agencies encourage mitigation on private property by directly engaging with wildland urban interface (WUI) residents. Citizen entrepreneurs may be particularly adept at engaging fellow WUI residents in interactive, face-to-face manners and can alleviate agencies's personnel constraints by engaging WUI residents during brief windows of opportunity for effective outreach that occur immediately post-fire.
15	Liu et al., 2020. *Communication Studies*	California, USA; Government leaders across the USA who experienced crisis, Government leaders during the Tubbs Fire in California	Semi-structured interviews, quantitative content analysis of USA government communication	Identify crisis communication strategies that leaders can employ during crises	Effective crisis communication leadership involves: (1) crisis perceptiveness, (2) humility, (3) flexibility, (4) presence, and (5) cooperation. Strategies for effective crisis communication leadership include: using report-outs, limiting jargon, building pre-crisis relationships, following established plans, trusting employees with information, deferring to those with content expertise, offering internal praise, and providing resources for employees who themselves are crisis survivors. Challenges faced in crisis communication leadership include: frequent turnover among government employees, conflicting missions and crisis response priorities among government organizations, limited resources, and leaders who are not experienced crisis communicators.
16	Marfori et al., 2020. *Frontiers in Public Health*	Tasmania, Australia; Residents/households in the Huon Valley recruited to be in a HEPA cleaner study	Semi-structured interviews	Explore smoke-affected peoples' responses to smoke-related health advisories and evaluate the acceptability of HEPA cleaners for home use	Public health messaging was widely shared and understood, and social media played a central role. However, some participants wanted more detailed, timely, and practical information or recommendations, or noted that messages about wildfire were, at times, contradictory or dominant over messages about smoke. Communication about smoke and fire hazard should continue to be disseminated through multiple avenues, with a focus on disseminating simple messages through social media and making more detailed information available from a trusted central source.

ID	Author, Year. Journal	Study location; Population	Study approach	Research objectives	Main findings
17	Meldrum et al., 2021. *Natural Hazards*	Colorado, USA; Households in Western Colorado	Field experiment including mailing households 1 of 3 versions of a "nudge" letter and measuring follow-up visits to a website	Investigate whether parcel-level wildfire risk assessment data can be used to "nudge" homeowners to engage further with wildfire risk mitigation education and support	Providing parcel-specific wildfire risk information can influence behavior. Informational and social comparison nudges may not change how many people engage with wildfire mitigation organizations, but both nudge types can affect who engages.
18	Mylek and Schirmer, 2020., *Forest Policy and Economics*	Australian Capital Territory and New South Wales, Australia; Residents	Postal survey to urban/rural residential addresses	Propose and test a modified "Integrative Complexity" (IC) scoring method in order to better target communication about fuel management to various groups	There is a need to gradually build complexity of messaging using traditional one-way mediums for simple messages and through these mediums encourage engagement with mediums that better lend themselves to building greater integrative complexity. Those with lower IC scores typically preferred one-way communication conducive to short, simple messages. Those with higher IC preferred methods more conducive to including detailed information.
19	Nader and De Lasaux, 2015. *California Agriculture*	California, USA; Homeowners, fire departments, youth, county supervisors, volunteer fire department chiefs, realtors and concerned residents, policymakers, parents	Homeowner survey, various field training projects, publications, and youth education programs	Describe education, outreach, and applied research projects undertaken in wildfire-prone counties through partnerships between fire safe councils and UC Cooperative Extension	Fire safe councils and the UC Cooperative Extension (UCCE) have worked together to implement education and applied research activities in wildfire-prone counties. UCCE provides science-based forestry and wildfire information to help the fire safe councils fulfill their educational mission.
20	Olsen et al., 2014. *Environmental Management*	California, Oregon, Montana, and South Carolina, USA; Purposive sample of individuals involved in fire or smoke management, including: government officials, NGO's, private landowners	Case study using semi-structured interviews	Identify challenges and opportunities related to communication (within agencies or to the public) for management of smoke from wildland fire	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. Potential approaches to address communication challenges were: (1) prioritize coordinated smoke and communication management, (2) allocate agency resources specifically for training in communication, (3) leverage social networks, and (4) build long-term, personal relationships.
21	Olsen and Sharp, 2013. *International Journal of Wildland Fire*	Australia and USA; Fire-affected residents, land managers	Comparative case using semi-structured interviews	Identify common factors influencing community-agency trust-building in wildfire management	Trust and trustworthiness can be built interpersonally and institutionally. Integrity and sincerity were factors that enhanced respondents' perceived trustworthiness of agencies. Good communication practices (e.g., being upfront about "sensitive subjects"; two-way exchanges; active outreach) and meaningful engagement (e.g., clear integration of public feedback into decisions and actions, inclusive, interactive) helped build a more trusting relationship with agencies. Flexible policies are important for implementation of locally appropriate outreach and management plans.
22	Olsen and Shindler, 2010. *International Journal of Wildland Fire*	Oregon, USA; Citizens who have demonstrated past interest in local forest issues	Mail survey informed by prior interviews	Assess public opinion of citizen–agency interactions, trust in federal agencies, and measure acceptance of post-fire management strategies	Positive citizen–agency relations need to be long-term and developed well before a fire occurs if post-fire actions are to be supported by communities. Positive relationships develop by engaging citizens in real problem discussion and deliberation. Respondents indicated broad acceptance for several post-fire management strategies (i.e., erosion control, replanting, reseeding), but acceptance was dependent on trust between communities and agencies. Many respondents indicated they lost trust in agencies because of how agencies handled forest planning after recent fires.
23	Paveglio et al., 2015. *Journal of Rural Studies*	Washington, USA; Residents, community leaders, wildfire and forest managers	Case study using semi-structured interviews	Provide the basis for outreach strategies that will best reduce conflicts among communities and hazard response teams	Local rural landowners' and some local firefighters' experiences during the Columbia Complex Fire appear to have increased their distrust about the effectiveness of externally-based fire response. Residents who came into conflict with firefighters felt that their perspectives were never considered by the Incident Command (IC) team. Residents felt the IC system was not able or willing to shift to protect locally held values and conflicts were never resolved. Better mechanisms are needed to understand where mismatches in values and priorities between local communities and IC organizations will occur.
24	Phillips et al., 2016. *Australian Journal of Emergency Management*	Victoria, Australia; Parents of young people participating in arts-based education program, community leaders, Country Fire Authority (CFA) staff & program facilitators	Semi-structured interviews	Explore key stakeholder perspectives on the effectiveness of an arts-based initiative to enhance community bushfire resilience	Arts-based programming promoted positive agency-community relationships and had a positive impact on community networks. Perceived limitations of the program included concerns about whether or not the program promoted new knowledge or if knowledge translates to actual preparedness, local social dynamics, and concerns about ongoing resourcing. Community engagement initiatives reveal complex social relations. The benefits of this initiative lie in strengthening community networks rather than explicit educational outcomes.

ID	Author, Year. Journal	Study location; Population	Study approach	Research objectives	Main findings
25	Reid and Beilin, 2014. *Society and Natural Resources*	Victoria, Australia; Full-time residents who work in tourism and retail	Semi-structured interviews	Investigate how "Fire Danger Rating" messages are interpreted by residents and how those interpretations influenced evacuation actions taken during wildfire event	Respondents understood the intent of the Fire Danger Ratings (FDRs), but did not follow their recommendations because they thought the complex local knowledge generated by their everyday experiences of the physical landscape and local narratives about past fires gave them a better understanding of fire risk than FDRs. Fire management agencies can work with communities to develop a co-constructed view of bushfire risk that incorporates local bushfire knowledge into Fire Danger Ratings.
26	Rice and Jahn, 2020. *Journal of Applied Communication Research*	Western USA; Community residents opposed to fuels treatment, Office of Emergency Management training participants, public commenters	Ethnographic observation, semistructured interviews, and content analysis	Examine how communities remember and forget lessons through everyday communication surrounding their preparedness activities	Both cases pointed to the importance of involving residents in disaster preparedness to facilitate community efforts to disseminate accurate information about risks and best practices. Local resilience practices were enabled and constrained by national frameworks and policies related to resilience.
27	Rist et al., 2016. *Environmental Management*	India, South Africa, USA/Koyukon Athabascan villages; Community members, scientists/researchers, resource managers	Multi-case study	Explore how fundamental differences in ecological knowledge between actors contribute to suboptimal outcomes in forest management	The authors suggest divergent perspectives on forest management come from differences in: (1) historical views of ecosystem characteristics and change, (2) temporal and spatial foci, (3) perspectives on drivers of change, (4) perspectives on the impact of resource use, (5) views of the relative importance of system components, (6) prioritization of ecological processes and forest products, and (7) external narratives, local observations, or place-based research. Limited progress in many forests is symptomatic of a need to pay more detailed attention to points of divergence.
28	Steelman and McCaffrey, 2013. *Natural Hazards*	California, Montana, and Wyoming, USA; Federal and local officials working on the fire, members of the affected local community	Literature review, comparative case studies using semi-structured interviews, triangulation with archival material	Build framework of key characteristics associated with best communication practices and apply framework to three case studies of wildfires	Less conventional disaster response strategies were more publicly acceptable when pre-existing communication and relationships existed between managers and community. Building strong relationships before a fire starts may thus be more important than the response strategy in shaping outcomes.
29	Steelman et al., 2015. *Natural Hazards*	California, New Mexico, Arizona, and Colorado, USA; Residents affected by five large wildfire events	Mail survey, follow-up telephone survey, literature review and synthesis	Understand what kinds of information sources people who were affected by a wildfire used, trusted, and found useful to better inform more effective communication during a disaster	Information sources that were most used during fires were family/friends/neighbors, mass media, and maps. Information sources found to be most useful and/or trustworthy were: local fire department, maps, conversations with local Forest Service representatives or Incident Management Team representative, and law enforcement. This suggests people turn to the information sources that are familiar, regardless of their perceived usefulness or trustworthiness. Shifting the patterns of what is used during the disaster may entail shifting the patterns of which sources are used before the disaster.
30	Sugerman et al.,2012. *Journal of health communication*	California, USA; Residents	Phone survey, random digit dialing	Determine residents' exposure to, understanding of, and compliance with messages broadcast to reduce exposure to air pollution from nearby wildfires	Health communications should be simple, short, and tailored to vulnerable groups. Recall, understanding, and compliance with nontechnical emergency messages (e.g., "stay indoors,") were higher than technical messages ("use N95 respirators during cleanup"). Message compliance was lower among vulnerable populations, the elderly, less educated, minorities, and those of low income.
31	Sutton et al., 2014. *Information, Communication & Society*	Colorado, USA; Local, state, and federal organizations serving in public-safety capacity who Tweeted about an active wildfire	Content and style analysis of tweets to inform predictive models	Identify how message content, message style, and public attention to tweets relate to the behavioral activity of retransmitting (i.e. retweeting) a message in disaster	Retweeting was associated with messages about 'hazard impact' and 'advisory' messages that were broadly applicable to the entire population. Other factors associated with retweeting were: using an imperative sentence, more direct exposure (# followers, # friends), and clear language. Factors that were not associated with retweeting were: number of prior messages posted, exclamatory content, capitalization for emphasis, and inclusion of a weblink.
32	Velez et al., 2017. *International Journal of Wildland Fire*	California, USA; Residents in wildfire-prone areas away from urban core and adjacent to forested landscapes	Secondary analysis of previous telephone survey	Examine relationships between residents' wildfire knowledge and experience, readiness actions, and media choice to determine how to integrate preparedness information into messages	There were significant geographic differences in information sources used before and during wildfire, with residents in more rural areas relying on television, radio, Reverse 911, and friends and family for information. Respondents most frequently used television for both daily news and wildfire information, and most people intended to seek information from the same sources in the future. Television, in particular, was powerful for disseminating information, but should be complemented with locally trusted, two-way, engagement-based communication practices that allow for feedback.

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