Deliverable: Wildfire Smoke Risk Awareness Assessment

Report for PSU-EM (Portland State University Emergency Management) and PBEM (Portland Bureau of Emergency Management)

PSU ANTH 412/512 Ethnographic Methods

With ACRN (Anthropology Career Readiness Network)

December 2025

Executive Summary

For this research, we undertook the following **activities**:

- Reviewed recent academic and grey literature related to wildfire smoke risk
- Outlined relevant theory and background information, including broad themes:
    - Environment, health, policy, risk perception, risk communication and outreach
- Designed an ethnographic research project specific to Portland populations
- Interviewed and conducted focus groups with Portland community members in multiple domains:
    - Neighborhood Emergency Team (NET) Volunteers
    - Structural and wildland firefighters
    - Meals on Wheels (MoW) patrons
    - Medically vulnerable individuals
    - Portland State University campus populations
- Coded transcript data for themes in participant responses using ATLAS.ti
- Identified strategies and areas for future research regarding wildfire smoke risk communication

Based on this research, we make the following **recommendations** to **PBEM**:

- Emphasize/ expand publicly accessible information on wildfire smoke
    - Resource sheets, videos, call centers, trusted one-stop informational site, using population-specific outreach styles
- Collaborate with trusted community organizations for outreach efforts

We make the following **recommendations** to **PSU-EM**:

- Quick wins: Provide information on existing safety infrastructural of campus (e.g., high quality MERV-13 filters); increase internet "findability" of existing EM resources; increase opt-in for campus alerts; "game-ify" hazard communication; provide seasonally relevant hazard information by tabling or holding workshops
- Long-term: Build an efficient communication network with PBEM and Multnomah County; build trust by advocating for student concerns; organize a "Safety Club" or a campus NET team

Introduction

As Portlanders learned during the 2020 Labor Day Wildfire Smoke Emergency, our community is vulnerable to an emerging threat that many in our population know little about and for which emergency managers in our area now need to prepare. During Fall 2025, students[1] in the Portland State University course Anthropology 412/512: Ethnographic Methods engaged in an applied research project to understand people's awareness of and preparedness for air quality hazards related to wildfire smoke.

Students undertook this course-based endeavor in conversation with two community partners: Tiara Halsey, the Director of Emergency Management at Portland State University (PSU-EM) and Jeremy Van Keuren, Community Preparedness Manager at the Portland Bureau of Emergency Management (PBEM), under the guidance of Dr. Elizabeth Briody with the Anthropology Career Readiness Network. The research took place between September and December of 2025. The recommendations that grew out of the research aim to help emergency managers shape messaging and prepare services for future air quality emergencies.

Overarching Research Questions

We set out to understand people's awareness of and preparedness for air quality hazards related to wildfire smoke. Students compared interview data gathered from Portland residents who did

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and did not experience the Labor Day 2020 wildfire smoke event to determine how prior experience with air quality hazards related to wildfire smoke affected levels of awareness and preparedness.

Our research focused on three key questions:

- How aware are people of air quality hazards related to wildfire smoke?
- How prepared are people for air quality hazards related to wildfire smoke?
- What information and services would people expect from campus and city emergency managers in the event of future wide-spread smoke in the air?

In the remainder of this document, we present background information and theoretical perspectives that frame our discussion, with a focus on environmental trends, health effects of air quality hazards, and policies that shape environmental regulation and public health. We consider social science research related to how people understand and react to risks, and we consult the literature for best practices in effective public outreach. We then discuss our research design and methodology and present our findings. We consider some limitations of our study and make suggestions for future research. We conclude with some recommendations for short-and long-term initiatives for emergency managers at PSU-EM and PBEM to consider.

Background

In this section, we outline the environmental situation within which wildfires increasingly occur. We consider the health effects of exposure to wildfire smoke. We discuss the policy landscapes that regulate management of forests and air quality. We conclude the section with some social

science perspectives on how people perceive and manage risk, examining best practices in outreach to support people in taking protective actions.

Fires, Human Health, and Regulations

Forest fires have increased in the Western United States over recent decades (Heidari et al. 2021). Since 1984, due to an increase in fuel aridity, forest fire area has doubled, with areas that once would have been too wet to burn now susceptible to fires (Abatzoglou and Park Wiliams 2016; Alizadeh et al. 2021). Vegetation types, fuel types, and drought conditions all affect behavior of wildfires (Wasserman and Mueller 2023). Wildfire projections for the Pacific Northwest show that high-elevation fires have seen the most significant rates of increase compared to fires at lower elevations (Alizadeh et al. 2021). Throughout the Western United States, the rate of natural-caused forest fires is projected to increase throughout the rest of the century alongside the increase in temperature and decrease in precipitation (Heidari et al. 2021). Emissions from wildfires are projected to increase by 50% (Liu et al. 2007). This will directly cause an increase in severity of air pollution events throughout the Western United States over coming decades. Because the frequency, severity, spread, and season of wildfires is expected to increase over the coming decades due to anthropogenic climate change, emergency planning and support for the community must take into account not only current wildfire conditions, but also the projected future prevalence of wildfire events.

Because widespread exposure to wildfire smoke is a relatively new occurrence in the Pacific Northwest, both researchers and the general population lack awareness of its the long-term health consequences. Existing information on air pollution suggests that it affects multiple vital systems in the human body. Heightened exposure to particulate matter (PM) caused by wildfire

smoke is capable of evoking cardiac arrhythmias, worsening heart failure, and triggering atherosclerotic/ischemic cardiovascular (arterial plaque buildup) complications. (Chen et al. 2021). The two primary negative outcomes of exposure to wildfire smoke are elevated blood pressure and atherosclerosis, and other effects include dyslipidemia, insulin resistance, diabetes, gestational diabetes, obesity, left ventricular hypertrophy, diastolic dysfunction, and myocardial fibrosis (Hadley et al. 2022). In addition, recent research suggests both short- and long-term effects on cognition and mental health (Braverman 2021). Newspaper reporting suggests increased incidence of cancer among wildland firefighters (Zarkhin 2025). Exposure time has a direct correlation with increases in lung-cancer incidence and mortality among firefighters (Kang and Lui 2025). Although scientists cannot adequately assess the risks associated with this air quality hazard because they lack sufficient long-term research on the effects of wildfire smoke on human health, the existing data suggest that exposure to wildfire smoke has significant negative health consequences. This hazard therefore warrants attention from emergency managers.

Two areas of the policy environment relate to wildfire smoke: the governance of air quality and the management of forests. The Clean Air Act of 1963 classifies wildfires under the “Exceptional Event Rule,” which enabled states to ignore dangerous smoke emissions in reports they submit to the National Ambient Air Quality Standards (AAQS) databases. This omission grows increasingly urgent, as more wildfires ravage public and federal lands (Kelp et al. 2025). Emissions from wildfires travel hundreds of miles, crossing state and national borders (Vargo et al. 2023). Climate change has also affected weather patterns on a global scale (Krupnick et al. 2025), and smoke-carrying wildfires pose a huge threat to the global community (Qiu et al. 2024). In short, policies governing wildfire smoke are lacking at both the federal and the international level.

In terms of the management of forest resources, current research suggests that decades of the current fire suppression policies have increased forest vulnerability to large-scale, hot-burning blazes. The altered fire regime characteristics brought by Euro-American colonization that has led to the increased intensity, frequency, and duration of wildfire events in the states of California, Oregon, and Washington (D'Evelyn et al. 2022). Addressing these issues on a regional level, with an implementation of the environmental stewardship practiced by Indigenous communities throughout millennia, would aid the dire needs of the land and the people to minimize these risks (D'Evelyn 2022). Addressing decades of mismanagement will take time, during which regional, national, and international populations face enhanced risk from wildfires and wildfire smoke.

Risk Perception & Motivation

To understand how people respond to the risks associated with wildfire smoke, we have to examine both how they perceive these risks and what motivates them to protect themselves. Risk perception deals with people's subjective judgements of hazards and, as Fokaefs and Sapontzaki (2022, 279) show, is reflected in their "reactions, behaviours, and decision-making." The evaluation of risks takes place in two dimensions: cognitive and emotional. Managers and first responders generally experience risk perception from the cognitive (logical deliberation) domain. People in the general population often experience it through both the cognitive and the emotional domains; in the remainder of this section, we explore aspects of emotional reactions to risk.

Protection Motivation Theory (PMT) links risk perception to behavior by explaining what motivates people to take protective actions when they perceive a threat. According to PMT, both *threat* (severity and vulnerability) and *coping appraisals* (self-efficacy, response efficacy, and

response costs) determine people's motivation, which in turn predicts intentions to adopt protective behaviors (Duan and Bombara 2023, 2-3; Prestwich 2024, 16-18).

Personal experience and trust, or lack thereof, in authorities and experts have the most substantial impact on risk perception (Wachinger et al. 2013, 1049). Importantly, high risk perception doesn't reliably lead to preparedness or action; this situation is known as the "Risk perception paradox," for which Wachinger et al. (2013, 1054) provide three possible reasons: "(1) Experience and motivation, (2) trust and responsibility, and (3) personal ability (economic and personal conditions)."

Intention is a key predictor of behavior, but only partly explains what people actually do, as other constraints, habits, beliefs, and social norms often impact their decision-making process. This is known as the "Intention-behavior gap" (Prestwich 2024, 31-33). People can know the risks without feeling that risk personally. Awareness or prior experience on their own do not always translate to action. Furthermore, PMT suggests that coping appraisals such as 'Can I actually do this?', 'Will it work?', and 'What will it cost me?' often affect actions more than how severe they think the risk is. Mitsushita et al. (2023) show that recognition of hazard properties and their subsequent controllability also determine risk perception. This can be related to normalcy bias, where people think that a hazard won't happen, which may be a result of limited knowledge of disasters, as well as both optimistic bias and perceived control (Kim and Lee 2024, 978).

Perceived knowledge and prior experience also shape the appraisal process. Research connecting PMT to wildfire smoke shows how both are tied to feeling personally vulnerable to the risk, rather than its severity, and people's intent to act increased with how vulnerable they felt and if they felt the protective behaviors would work (Duan and Bombara 2023, 9-10). This decreased when

response costs, the “financial, time, effort, and emotional costs of the behaviors” (Duan and Bombara 2023, 3), felt too high. In short, severity of the risk often matters less than feeling personally exposed, and believing that effective, low-cost actions are available is key to increasing the likelihood of action. Response costs are often rooted in material and practical conditions such as income, housing, working conditions, and access to care. These “social determinants of health” are structural aspects that messaging alone cannot fix (Office of Disease Prevention and Health Promotion n.d.).

Grid/Group theory also has an effect on risk perception. This theoretical framework positions that “perception of risk is directly tied to culture, or more specifically, to cultural biases that reflect people's worldviews” (Steel et al. 2023, 581). Scholars used this theory to explore how culture shapes an individual’s perception of environmental risk. In this perspective, culture is not a static set of values and beliefs but rather a dynamic, routinely evolving system that adapts over time. The authors stress the relevancy and importance of social hierarchies and power structures in sorting cultural practices and values, in addition to how culture may contribute to social conflicts and inequality (Steel et al. 2023, 581). In this study, grid/group theory is used to illustrate that risk perception is tied to cultural biases and overarching policies that both reflect and shape people’s ideology regarding wildfire preparedness.

Steel et al. (2023, 581) explain how the theory of motivated reasoning, which asserts that an individual's “beliefs and attitudes are influenced by not only by experience and evidence, but also by emotional and motivational factors.” This theoretical framework suggests that individuals will selectively process “information to support their pre-existing beliefs and values, while largely discarding information that conflicts with their predispositions” (Steel et al. 2023, 581). Individuals

tend to interpret information in ways that affirm their existing values and beliefs rather than through a purely objective lens. Moreover, these authors show that individuals are “more likely to accept information that bolsters their social identity or group affiliation, even if that information is not entirely accurate” (Steel et al. 2023, 581). Additionally, “Continued exposure to biased information has been found to be one of the main reasons people’s attitudes and positions on many issues become progressively extreme” (Steel et al. 2023, 581). The theory of motivated reasoning posits that individuals “are not purely rational beings but are instead influenced by their belief system and values” (Steel et al. 2023, 581). In this study, the theory of motivated reasoning is used to illustrate that individuals will process information in ways which support their existing beliefs, rather than merely considering objective evidence about wildfire smoke.

Risk Communication & Outreach

Effective risk communication and outreach is the link between the difference in how emergency managers and the wider public perceive risk. These perceptions and how risk is communicated play a direct role in the impact on preparedness levels (Fokaefs and Sapontzaki 2023, 280). Yet, even prompt communication from authorities, in the case of new technology that was able to forecast hurricanes earlier, did not translate into protective action behavior (Meyer et al. 2014). This may be due to a lack of proximity cues, as well as poor mental models such as optimistic bias (Kim and Lee 2024). Political identity also influences behavior related to natural disasters (Chae et al. 2025). For example, a study focusing on US Climate messaging showed how they produce reactance along political lines, potentially hindering communication amongst certain populations (Ma et al. 2019).

Emergency managers can design messaging toward coping and threat appraisals, while also associating it with both the cognitive and the emotional dimensions of wildfire smoke risks. Furthermore, messaging design can be broken down into three different categories that fit within the PMT framework: action, information, and community (Slavik et al. 2024, 3). Action messages target coping appraisals by encouraging specific protective behaviors, while also helping people plan, which research shows can bridge the intention-behavior gap (Prestwich 2024, 24). Information messages target threat appraisals, focusing on the cognitive dimensions associated with wildfire smoke risks. Community messages speak to the emotional dimensions, focusing on care, connection, and encouraging dialogue to increase trust, which "can influence the adoption of prosocial behaviors" (Slavik et al. 2024, 3).

For effective outreach, information alone is not enough. Technical, scientific, and numerical information that conveys a description of risk may be difficult for the public to understand. Savadori et al. (2022) recommend making risk comparisons and positive scenarios that could more meaningfully impact communication, regardless if the population has experience with that specific risk. Using the framework of PMT, communication efforts must also strengthen people's coping appraisals, while supporting low-cost, feasible actions. Moreover, as Wachinger et al. conclude, "Public participation measures are probably the most effective means to create awareness" of potential risks, strengthen trust, and encourage preparedness and protective behaviors (2013, 1063). To this end, effective communication relies on trust, which "acts as a fundamental base for the adoption of recommendations" (Fokaefs and Sapontzaki 2022, 280). These points shape our understanding of the results we gathered from our research project.

Research Design

Students set out to compare wildfire awareness between Portland residents who did and did not experience the Labor Day 2020 wildfire smoke event (or a similar event). In technical terms, this is a two-group post-test only design without random assignment (Bernard 2018, 96). We sought to speak with people whom we assumed would be relatively well informed about risks, as well as with those who might be less so. We also wanted to capture populations who are particularly vulnerable to air quality hazards.

Sampling Strategy & Methodology

In our non-probability, purposive sample (Bernard 2018, 147), we spoke with volunteers from PBEM's Neighborhood Emergency Team (NETs) and firefighters to capture two populations whom we hoped would be well informed about risks in general and risks from smoke in particular. We are grateful to PBEM for facilitating outreach to these groups. We spoke with individuals who experience asthma to capture a population who are exceptionally vulnerable to particulate matter in the air. We interviewed individuals at two local Meals on Wheels dining halls, with the assumption that they might represent a segment of the Portland community who are older and have lower socioeconomic status. We also spoke with dormitory residents and first-year students at PSU, with the purpose of sampling people who might be new to the area, young, and/or less aware of air quality hazards; in addition, PSU bears a heightened responsibility for people living in university dorms.

In order to navigate the unique time constraints of the project and the wide variety of cultural competency groups sampled, our team used a combination of convenience, purposive, and snowball sampling (Bernard 2018, 147-150). Methods varied within these categories: team

members used formal email correspondence, asked friends & acquaintances for interviews, cold-called people, and even advertised the project in PSU classrooms. Further, about one-third of our correspondence took place online (email, Zoom, Discord).

Of the 63 people sampled, 7 declined,[2] leaving a total of 56 interlocutors. 42 respondents took part in semi-structured interviews and 14 participated in guided focus groups, contributing an average of 34 minutes. (For semi-structured interview and focus group questions used, see Appendices A - E. See Appendix F for a log of de-identified participants).

Coding with ATLAS.ti

With licensing provided by Portland State University's Office of Information Technology, we used the web version of ATLAS.ti to collect, organize, and code field notes and transcripts from our interviews and focus groups. We used the software to help us analyze themes and establish patterns. (See Appendix G for codes used.) We uploaded a total of 43 documents, and our preliminary coding effort resulted in nearly 100 codes. These codes were used to tag and highlight almost 700 selections from across those texts. The initial distribution of codes was collaboratively narrowed down to a more manageable number in order to bring prominent themes forward for further analysis. The software provided visualizations of the data that aided in this analysis and narrowing effort. ATLAS.ti proved a useful tool for the purposes of such a large collaborative project, although students encountered difficulties in accessing the software, which hampered our ability to use to its full potential. In particular, delays in student access scuttled efforts to achieve

[2] All people who declined were Meals on Wheels patrons who had a language barrier or hearing difficulties with team members. They have been included in the sample, as this provides valuable information about environmental risk & vulnerable populations.

inter-coder reliability. Future projects may wish to allocate additional training time to avoid similar roadblocks.

Results and Discussion

When preparing for this research, we assumed that those who had experienced the 2020 Labor Day Wildfire Smoke Event would be more aware of the associated health dangers and better prepared to protect themselves from future wildfire smoke events. Although this assumption proved accurate for NET volunteers and asthmatics (who said they would prepare for such events even without having experienced the Labor Day 2020 smoke event), our interviews with PSU's Campus community, firefighters, and Meals on Wheels patrons revealed that many factors besides prior experience influence preparation. In short, our initial assumption was overly simplistic, as the Protection Motivation Theory framework predicts.

Among both firefighters and MoW patrons, many participants were aware of wildfire smoke risks but did not or could not protect themselves for various reasons. Urban firefighters acknowledged their heightened exposure to smoke and expressed concern about differences in protective measures compared to wildland firefighters, who viewed smoke events as routine and faced practical and social pressure against mask-wearing. MoW patrons were more focused on socioeconomic challenges, such as limited finances, which overshadowed concerns about wildfire smoke. Among PSU dorm residents, apathy toward wildfire smoke was common, as many expressed skepticism about the university's ability to protect them from it. Individuals with asthma noted abundant awareness of how smoke exposure impeded their daily life. They had no other choice but to take protective behaviors, lest their health conditions worsen. Additionally,

participants all around mentioned anxiety about the dangers of wildfire smoke, which could paradoxically deter them from wanting to educate others or learn more themselves.

Throughout our research, we noted patterns related to misinformation, apathy, and lack of resources. Among wildland firefighters, misinformation, cultural attitudes (specifically machismo), and lack of Personal Protective Equipment (PPE) led to lack of self-protective behaviors. In contrast, structural (urban) firefighters were aware of the hazards of smoke exposure and regularly used PPE. NET volunteers had increased awareness, but also felt that the dangers of smoke were obvious. Amongst MoW patrons and students, a general lack of trust in programs to support them and a lack of resources to support themselves were prominent. People on campus perceived a difference in how information was disseminated to different people and groups on campus.

This research has revealed that some Portlanders - as evidenced by wildland firefighters and Meals on Wheels participants - may know the risks of smoke inhalation but are unable to or discouraged from protecting themselves due to factors such as apathy, peers, inability to prepare (cost, location, knowledge, space), and other priorities. Wildland firefighters have high levels of exposure but are similar to the general public in that they lack training and have a false sense of safety because they're still outdoors, breathing "fresh" air. We observed potential patterns related to age and gender, but further research would be needed on these topics.

In conclusion, we found that even though individuals who experienced the 2020 event are somewhat aware of short-term and long-term risks of exposure to smoke, this experience does not

automatically mean that they are prepared for future smoke events. Factors leading to lack of preparation include a lack of funding, misinformation, and, in some cases, desensitization. In addition, we found that research participants worried about the quality of the information they received, which some found inequitably circulated and sometimes overbearing; this finding demonstrates a need for more research into the most effective ways to disseminate information, which we discuss below.

For simplicity, we organized our analysis using a four-square grid with two axes. One axis divided participants between those who had and had not experienced the 2020 Labor Day smoke event (or a similar event). We called these our “aware” groups. The other axis divided participants between those who did and did not use or plan to use protective measures to minimize their exposure to smoke in the event of future air quality hazards. We called these our “prepared” groups. See Figure 1 for a diagram of this schematic. In the subsections that follow, we explain why we have placed various subject populations into the respective boxes and the implications of these patterns for future emergency management planning.

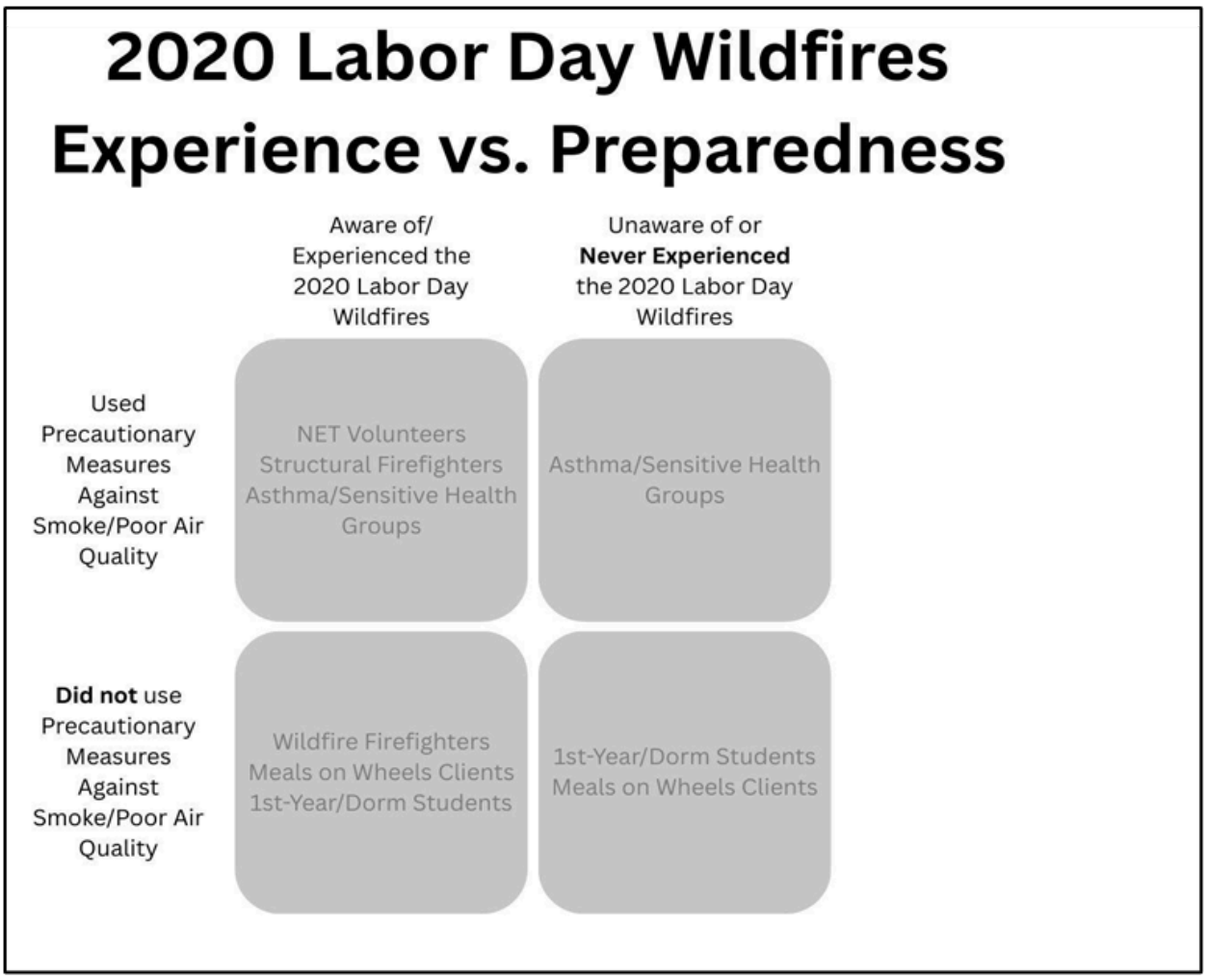

Fig 1. Groups clustered by awareness of 2020 Labor Day Wildfire Smoke Event and preparation for future adverse smoke events.

Results: Meals on Wheels

The student group working with the Meals on Wheels patrons approached 31 individuals for interviews; 19 fully participated. We approached individuals who declined interviews due to language barriers (Korean, Taiwanese, and Chinese speakers) and difficulties in hearing. The

two-group posttest-only design comparing wildfire smoke risk awareness between Portland residents who did and did not experience the Labor Day 2020 wildfire smoke event (or a similar event) shows that individuals at MoW were split into two groups. 26% (5/19) had not experienced a wildfire smoke or related event. From this group, we found that 100% of these individuals were neither aware of nor prepared for wildfire smoke events, similar to the overall findings from 1st-year PSU students.

We also observed meaningful patterns associated with non-participation and non-responsive behavior. For some participants, wildfire smoke did not feel personally urgent, which may explain why 39% declined to participate in the interview. This pattern suggests that messaging about wildfire smoke must compete with other pressing life concerns and may not always feel relevant to dining hall patrons. This pattern is consistent with the Theory of Motivated Reasoning (Steel et al. 2023, 581); as noted above, PMT suggests that coping appraisals such as 'Can I actually do this?', 'Will it work?', and 'What will it cost me?' often affect actions more than how severe they think the risk is.

Seventy-four percent (14/19) of the people we interviewed had experienced a wildfire smoke or related event. These participants demonstrated varying levels of awareness of and preparedness regarding wildfire smoke events. About 64% (9/14) of participants with direct experience of for smoke. They were more likely to recognize the risks and take at least some preparedness measures. We found that participants who regularly accessed media sources (Facebook, Fox News, Weather apps, Oregon State updates, NPR, KGW, Fox 12) were more likely to stay indoors or limit outdoor activities during smoke events. This pattern supports our finding that factors such as education, existing health conditions, and institutional support contributed to both awareness

and ability to prepare. This social-economic pattern is consistent with Grid/group cultural theory (Steel et al. 2023, 581), which suggests that larger social and political structures affect group behavior.

However, dining hall patrons who were aware of air quality hazards demonstrated varying degrees of preparedness. Three individuals expressed that they knew about AQI or smoke color codes (yellow, red). In regards to preparedness, several individuals expressed that they would change behavior by choosing to go shopping on different days, but they also said that they would not put on masks. Only one person mentioned N95 masks, the only type of mask effective against the dangerous PM 2.5 particles. Many Meals on Wheels participants with limited financial resources were unable to purchase N95 masks[3] and instead either went without or used homemade masks, which are insufficient for wildfire smoke according to OHSU (Robinson 2022). The observation about affordability aligns with Protection Motivation Theory predictions that socioeconomic factors influenced how participants prioritized wildfire smoke risks (Duan and Bombarda 2023, 2). Additionally, participants who stayed indoors during smoke events often did not have access to air purifiers or the means to create Multnomah County's recommended "clean room" (Multnomah County 2024). 21% (3/14) participants demonstrated awareness without preparation.

In our study, women tended to recognize the risks of wildfire smoke and adopt protective behaviors, whereas many men acknowledged wildfire smoke but minimized its severity and made fewer behavioral changes. This pattern may reflect broader cultural norms around toughness, or 'badge of honor' attitudes. Moreover, 14% (2/14) participants with no awareness tended not to take protective actions, often due to inexperience or existing beliefs (e.g., "it doesn't affect me").

[3] We note that during the 2020 Labor Day smoke event, N95 masks were in short supply due to the COVID-19 pandemic.

These are both consistent with the Theory of Motivated Reasoning, a selectively process in which individuals focus on “information to support their pre-existing beliefs and values, while largely discarding information that conflicts with their predispositions” (Steel et al. 2023, 581).

In terms of messaging, three individuals expressed that the City of Portland is doing enough in providing not only information but institutional support by being an authority that handles wildfire smoke events. Five individuals in the “aware and prepared” box expressed that they would like to see the City of Portland provide more messaging directly relating to preparedness, either through access to resources (masks, filters) or safe locations (clean air shelters) for marginalized communities, such as the unhoused.

The results of the comparative approach of the two-group posttest show that exposure, in dining hall participants, did have an effect regarding their awareness and preparedness. Those who were not exposed did not take any precautions. Some of those who were exposed did take precautions; 64% (9/14) individuals both had awareness and preparedness guided by successful messaging from various news sources including the City of Portland. The remaining individuals either protected themselves (often due to being medically vulnerable) despite not having experienced the 2020 wildfire event or knew about the risks but did not take proactive measures to protect themselves (often due to the high perceived cost of preparing, the inability to modify rented dwellings, or competing priorities among multiple perceived risks). We recognize that emergency managers have neither the personnel nor the budget to address the long-term, pernicious social issues of poverty and marginalization, and thus will not be able to overcome these particular barriers to emergency preparation.

Results: Health

We interviewed individuals within the community who are especially medically vulnerable to wildfire smoke in order to understand whether or not they have an increased perception of risk. Prior to conducting our interviews, we assumed that these individuals would be more aware of wildfire smoke risks and the need for precautions. We found that they are acutely aware of the health risks related to wildfire smoke exposure, though levels of preparedness varied.

The most prevalent measures taken by our informants were the use of masks and air filters, and lockdown or evacuation behaviors such as staying indoors. We found that medically vulnerable individuals would benefit from receiving increased resources such as emergency inhalers and educational resources regarding precautionary and safety measures specific to their medical conditions. We placed this population in the “prepared” tier of our four-square diagram, noting that the people we spoke with were, compared with the rest of the people interviewed, well prepared for air quality hazards regardless of whether they had experienced the 2020 Labor Day smoke event or a similar event. We also note that, due to their medical vulnerability, these individuals may need from emergency managers more and different information and support than the general population does.

Results: Firefighters

We interviewed 8 firefighters, all of whom had wildland firefighting experience. 7 out of the 8 firefighters had experienced the 2020 wildfires. Only the 4 whom we interviewed at Portland’s Urban Station 1 had urban or structural firefighting experience, and they seemed particularly well

aware of the risks of smoke. Several firefighters mentioned that they view structural/urban as the worse, more unhealthy smoke given that more man-made chemicals have the chance of burning (Station 1, Urban FF#2, 4; MW Hill FF). The structural firefighters pointed out the incorrect culture assumptions that smoke from wildland fires is “cleaner” or “safer” than that from urban or structural fires. Wildland firefighters believed this assumption.

We found that an important policy influenced the distribution of PPE. Wildland firefighters are partially exempt from the rules defined in OAR 437-002-1081 of OSHA, which codify the way in which employers are responsible for keeping their employees informed on AQI and providing them with masks. Due to this partial exemption, no such standard is practiced in the field. Structural firefighters, meanwhile, are hyper-aware of smoke exposure and try to mitigate as much as possible.

Among the firefighters, both groups were exposed to smoke, but policy and cultural assumptions influenced which groups perceived and took steps to mitigate the risk (the structural firefighters) and which ones did not (the wildland firefighters). We placed the structural firefighters in the “aware and prepared” box and the wildland firefighters in the “aware and unprepared” box.

Results: NET Volunteers

Across four focus groups with a total of 10 NET volunteers from PBEM, participants expressed overall moderate concerns about future air quality during wildfire smoke exposure events. This logical assessment of hazards, likely informed by their roles as secondary responders, is consistent with the assumptions generated during our literature review (Fokaefs & Sapontzaki 2022). Participants expressed feelings of anxiety related to the inevitability of future wildfire events.

Some became more conscious of air quality issues due to past wildfire experiences. One participant attributed their development of asthma to a past wildfire smoke event. Although the NET volunteers were likely more aware of risks from wildfire smoke than were other populations in our study, they tended to monitor AQI only when symptoms appeared, rather than proactively checking levels on their weather apps.

Transcripts from our four focus groups with a total of 10 NET volunteers revealed a range of preparedness strategies for wildfire smoke exposure events:

- Some use N95 masks, though they doubt their complete effectiveness against harmful particles and prolonged smoke exposure.
- Many employed air purifiers and kept spare filters on hand.
- All volunteers opted for indoor vs. outdoors activities to avoid smoke inhalation.
- Volunteers closed windows and sealed them with tape to prevent smoke from entering their homes.

Although trained by PBEM, they noted that their emergency preparedness training isn't specifically focused on wildfire events, leaving gaps in their ability to protect themselves and their communities. Some volunteers insisted that they were “not prepared enough” despite objectively being more prepared individuals than average due to their NET training. This pattern may relate to NET volunteers’ risk perception traits; their lack of perceived control (demonstrated in their eagerness for more information, training, and preparedness) contributes to less optimistic bias and ultimately more preventative behavior measures (Kim and Lee 2024). This proactive approach

to managing risk might help explain some of the gap between relatively well-prepared NET volunteers and relatively poorly-prepared wildland firefighters despite similar levels of training and informational available to both groups. In general, we placed the NET volunteers in the “aware and prepared” box on our diagram.

Results: Campus

We spoke to a total of 9 people representing the campus community, using semi-structured interviews that lasted about 30 minutes each.

When people have greater knowledge of how a phenomenon or event might hurt them, they are more likely to undertake precautionary actions in order to protect themselves (Marikyan and Papagiannidis 2025, 3-5). On campus, we see the Protection Motivation Theory in action in the statements provided by interviewed students and campus employees. Those who had not previously experienced a wildfire event did not know what the concern was, or what information they were lacking. Participants who had previously experienced wildfire events were more aware of risks associated, and more likely to seek out emergency information for new events. Wuerzer (2024) found that students who had previously experienced a wildfire event - either through the cancellation of recreational activities or through the damage to property - were more aware of wildfire risks than students who had not. Our data follow a similar pattern.

Interviews with PSU’s campus community reveal a low overall priority of concern for wildfire smoke events. Though the campus community members did not voice concern specifically about this air quality hazard, they did express dissatisfaction with the university’s safety procedures more broadly. Related to air quality, students mentioned infrastructural issues such as lack of

ventilation (and lack of control over ventilation) in dorms. More broadly, students did not have the funds or the control over their environment to make them feel that they could take steps to improve any of the infrastructure related to their air quality safety. We thus place students in the campus community in the "unprepared" category, regardless of whether they were aware of hazards from wildfire smoke.

Students also noted gaps in communication from campus public safety and a perceived tendency for the university to deliver timely warnings too late. Dissatisfaction with campus safety stemming from prior experiences or emergencies. Many of the respondents said they had difficulty finding easily digestible information from campus safety in the past. They therefore do not count campus safety as their most trusted resource for information about risk assessment or mitigation. This pattern suggests that the people we interviewed would turn to the university to inform their actions related to a variety of dangers, including air quality hazards, but that at the same time they did not entirely trust this designated authority to fulfill its obligation perfectly.

Results: Summary

Our interactions with members of the public and the campus community reveal intriguing patterns in the data. Medically vulnerable individuals (represented in our sample by people suffering from asthma) were prepared for wildfire smoke events regardless of whether they had experienced the 2020 Labor Day fires or not. Members of the campus community seemed unprepared for smoke events, again regardless of whether they had experience of prior air quality hazards. NET volunteers were, in general, aware of and prepared for a variety of hazards, though not trained in specific for wildfire smoke. Protective measures in an equally aware population, firefighters,

depended on policies and practices of their employers; structural firefighters regularly wore PPE, whereas wildland firefighters did not. People interviewed at MoW, representing a slice of the general population, fell into all four of the boxes.

In terms of specific take-aways from these patterns, we suggest that for the “aware and prepared” population, timely, factual information with affordable to-do items will result in successful action. A medically vulnerable populations may not be aware of a specific air quality hazard but may be prepared to take protective action; this population may welcome information tailored to their particular level of vulnerability. The “unaware and unprepared” population will presumably split into “aware and unprepared” or “aware and prepared” once an air quality emergency begins.

The “aware and unprepared” population is the most puzzling and most difficult to motivate to take self-protective actions. Our research indicates a number of barriers, including presence of other pressing priorities; cultural practices, attitudes, and policies that hinder coping strategies; absence of funding to undertake preventative measures; and structural obstacles such as living in a rental property or a dorm in which they cannot personally modify their built environment to take effective action. Presumably the unhoused population would experience even more barriers to creating a space with relatively clean area in which to shelter. Other issues include reaching people, formulating an effective message, and making sure that the recipients trust and act on that message.

Limitations & Recommendations for Further Research

Our research took place within the short period of one academic quarter (11 weeks). Several limitations arise due to this circumstance. First, we relied on a convenience sample. As the name suggests, convenience samples gather information from people whom the researchers were able to contact and meet with easily. Small convenience samples can miss important segments of the general population. Second, we reached out to particular groups as representatives of larger populations. We recognize, however, that NET volunteers do not completely represent all wealthy, educated, and risk-informed individuals in Portland. Similarly, people who live with asthma do not fully represent all of the people that live with medical vulnerabilities to wildfire smoke. Third, the PSU community encompasses many commuter students; we did not sample this group. Fourth, we were unable to communicate with Meals on Wheels patrons who spoke languages other than English; we would have liked to learn more about their awareness and preparedness for hazards. Fifth, we recognize that the 2020 Labor Day smoke event coincided with the COVID-19 pandemic, and we cannot disentangle the interactions between these two airborne hazards. For example, during the height of the pandemic, many people sought air purifiers and masks (though both were in short supply) and may have these items as protection against wildfire smoke as well as airborne viruses, thus complicating the analysis of preparedness. Finally, we recognize the question of temporality. Five years after the events of 2020, people may have forgotten about some of the protective measures that they took; they may also not yet have realized some of the long-term adverse effects of their exposure.

Further research is necessary to understand the multitude of factors that affect wildfire smoke awareness and preparedness. During the interviews, we asked participants what they would like more information on regarding wildfire smoke. This prompted multiple people to mention the need for more resources and research on the long-term health impacts of wildfire smoke.

Specifically, firefighters requested more specific research surrounding wildland firefighters' exposure and risk. Throughout our research, we noticed the potential of age and gender as factors in wildfire smoke awareness and concern. Targeting risk perceptions among age and gender demographics could reveal further patterns we were unable to identify. Additionally, our results highlighted the potential for a longitudinal sample of those who have experienced the 2020 wildfires to discern whether these concerns and views stay consistent or change over time.

Policy Recommendations

Conversations with our community partners reveal that they are grappling with the tension between providing factual information about hazards and avoiding fear-based messaging. Research suggests that fear- and shame-based messages often fail to create productive, effective action. Different groups respond differently to numerical, factual, cognitive information vs. narrative, emotionally-salient messaging (Aminpour et al. 2022). We recognize the importance of these issues and note that our research did not get very far along this important avenue of investigation.

In this section, we provide some preliminary recommendations for PBEM and PSU-EM based on the research that we have performed this term. We include "quick wins" that can be acted upon easily. We also include a list of longer-term suggestions, some of which may require collaborations with other institutions.

PBEM

For the general public, resource sheets with easy-to-digest information, including what to do in the event of poor air quality in Portland, and also the locations of clean air shelters with public transportation information, would be beneficial.

Some individuals, especially older and disabled people, may find it difficult to navigate the internet to find more information on risks and hazards. In addition, the unhoused population may have difficulty connecting with the internet. For example, research found that 75% of the homeless population were uninformed during the 2020 Labor Day fires (Vargo et al. 2023). An accessible call center for easy access to resources and support, and a potential collaboration with trusted local organizations to disseminate information to vulnerable and minority populations, would increase the likelihood that these populations understand what to do, when to do it, and why.

Relatedly, a report by Damon et al. (2010) notes that citizens may become apathetic to wildfire smoke risk due to the perceptions of wildfires becoming “annual, predictable events.” To counteract false complacency, a video for students in Portland schools discussing the long-term effects of wildfire smoke exposure could be a quick and effective way to help people visualize and understand the effects of PM2.5 while they are young, so they can prevent exposure early.

Younger populations also discussed the use of phones, but in the form of alert text messages or phone alerts based on zip codes when hazards, including poor air quality, are present in their area. Today's use of phones opens the door to quick, easy access to information, but also to misinformation. Making PBEM into trusted source where anyone can find real, scientifically backed information could be highly beneficial for growing awareness and protecting the public.

Long-term goals can be difficult to collaborate on and discuss across different domains of authority, but we still felt they were necessary to guide policy decisions in a way that better supports the community. We believe it would be beneficial to support more studies of the long-term health effects of wildfire smoke exposure.

In general, we recommend the following initiatives for PBEM (with the understanding that many of these initiatives will necessarily overlap with those taken by Multnomah County and other City organizations):

- Real-time updates via TV, radio, apps, and emergency alerts via mobile devices.
- Easily readable hazard and evacuation maps
- Increased clean air shelters, especially for vulnerable populations
- Plain language educational materials about the dangers of wildfire smoke inhalation and what to do in the event of a wild fire smoke event to mitigate those dangers; these resources should be available the multiple languages spoken by populations in the city.
- Clarity about where to obtain protective gear and resources to mitigate wildfire smoke exposure, which should be free for vulnerable populations.
- On the ground outreach from authorities, including the police and firefighter distributing information about resources and up to date wildfire information
- Widespread and easily accessible educational materials about practical steps to mitigate exposure distributed by the city.
- Health insurance companies proactively reaching out to notify clients of dangerous AQI levels that may affect their clients based on their provided addresses
- Hotlines to get real, live, up to date information

- Alerts to specific neighborhoods and specifically vulnerable populations with tailored recommendations to keep safe in such events
- City-provided free emergency kits to support vulnerable populations during hazardous wildfire smoke events.
- Long-term collaboration with local organizations that have the trust of hard-to-reach and underserved communities. These organizations may include faith-based organizations and organizations centered on various local areas, ethnicities, or ancestral heritages.

PSU

During our research on campus, our interlocutors frequently asked how the risks from wildfire smoke stacked up against risks from other hazards. Abstract quantitative measures, like AQI, are not always enough to direct individual behaviors on their own; giving people a comparative understanding of wildfire smoke risk might yield behaviors that reduce individual exposures (McCarron et al. 2023; Savadori et al. 2022). Providing students with a comparative frame between wildfire smoke exposure events and other risks would ensure that students could make better behavior and intervention decisions.

Students expressed concern about lack of temperature control and ventilation in PSU buildings, particularly dormitories. High temperatures may cause an increase of smaller PM, which deposit further inside the body, contributing to worsened health outcomes (Chang et al. 2023, 3), and has been shown to increase the risk of cardiovascular mortality (Hadley et al. 2022, 791). Long term changes to infrastructure on PSU campus must take this heat and ventilation issue into account.

Ensuring that new housing is constructed with means to regulate temperature, and old housing is updated to meet this need, should be a priority for PSU.

It would be beneficial for the campus overall to follow indigenous models of interpersonal and environmental stewardship. Indigenous student leaders on campus and involved in the project want to highlight approaches that emphasize community care, observation, and holistic well-being. These approaches can help PSU not only improve safety outcomes but also build stronger relationships and resilience among students by encouraging collective responsibility and awareness. Indigenous practices often prioritize collective care, meaning that safety is approached not just individually, but as a shared responsibility. The establishment of peer networks will encourage students to form peer and community networks to share safety information, check in on each other, and support vulnerable community members. For PSU, this could include designated student “safety ambassadors” in dorms or clubs who disseminate alerts, explain mitigation strategies, and help ensure all students understand and can act on emergency information. These networks would reinforce top-down alerts from PSU-EM while also creating trust and engagement within the student body.

Safety information should integrate strategies that address both physical and mental well-being. Indigenous frameworks often view health as interconnected smoke or heat exposure doesn’t only pose a physical risk, but can affect emotional and spiritual wellness. Advisories could include guidance on hydration, stress reduction, mental health strategies, and creating safe indoor spaces for social support. This approach ensures students understand that managing exposure goes beyond immediate physical precautions and considers overall well-being.

Students expressed an interest in “game-ified” hazard information; an interactive, fun interface might receive extended interaction and, hopefully, result in enhanced self-protective behaviors.

Oregon residents have been found to prefer text messaging as the medium for hazard communication across demographic groups (Castillo et al. 2024). Campus group interviewees also appeared to reflect this preference for text-messaging. Text-messaging is quick, non-disruptive, and largely accessible communication. Interviewees also mentioned peer-to-peer communication as a timely (though possibly less accurate) method of spreading important information about campus safety issues. Additionally, extending lines of communication regarding risk through recreational resources improve engagement (Wuerzer 2024). Our data suggest a need to improve the trust-based relationship between the campus community and campus public safety. Communication must be consistent, while avoiding being so repetitive as to lose effectiveness. We recognize the difficulty in getting students to “opt in” to campus alerts and keep their subscription active.

Students in the class, as well as students interviewed for the project, suggested a series of possible educational venues for conveying risks about wildfire smoke and other hazards, including offering a for-credit course, creating a “Safety Club” on campus, or organizing a PSU NET team. These groups could organize projects such as building air filters (Stinson 2023) and putting together “go bags” for emergencies. For these initiatives, PSU-EM can partner with local organizations such as PBEM, the NET volunteers, and other community-based organizations to provide details, alert students to what resources are available to them, and give students information on how these resources communicate and can be reached out to in the event of an emergency. Another option is to reach out to student clubs and organizations to attend a safety orientation, so that they can

then disseminate that information to their club attendees. For example, Wuerzer (2024) found that having extended lines of communication through recreational programs was an effective means of bringing safety information to students.

List of Appendices

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Appendix E: Interview Questions for Medically Vulnerable Individuals

Appendix F: Interview Log

Appendix G: ATLAS.ti Coding Data

Appendix H: Suggested Reading List

Appendix I: Bibliography

References

Abatzoglou, John T., and A. Park Williams. 2016. “Impact of Anthropogenic Climate Change on Wildfire across Western US Forests.” *Proceedings of the National Academy of Sciences* 113 (42): 11770–75. https://doi.org/10.1073/pnas.1607171113.

Alizadeh, Mohammad Reza, John T. Abatzoglou, Charles H. Luce, Jan F. Adamowski, Arvin Farid, and Mojtaba Sadegh. 2021. “Warming Enabled Upslope Advance in Western US Forest Fires.” *Proceedings of the National Academy of Sciences* 118 (22). https://doi.org/10.1073/pnas.2009717118.

Aminpour, Payam, Jennifer F. Helgeson, and Paul J. Ferraro. 2022. “The Choice of Message and Messenger to Drive Behavior Change That Averts the Health Impacts of Wildfires: An Online Randomized Controlled Experiment.” *BMC Public Health* 22 (December): 1–10. https://doi.org/10.1186/s12889-022-14801-6.

Bernard, H. Russell. 2018. *Research Methods in Anthropology: Qualitative and Quantitative Approaches*. 6th ed. Rowman & Littlefield.

Bourgois, Philippe, Seth M. Holmes, Kim Sue, and James Quesada. 2017. “Structural Vulnerability: Operationalizing the Concept to Address Health Disparities in Clinical Care.” *Academic Medicine* 92 (3): 299–307. https://doi.org/10.1097/acm.0000000000001294.

Braverman, Marc T, sponsoring body Marion County, issuing body Oregon State University College of Public Health and Human Sciences, issuing body Oregon State University College of Forestry, Sandi Cleveland Phibbs, Amanda Rau, and Elijah Penner. 2021. A Community Health Impact Assessment of the Santiam Canyon : One Year after the 2020 Labor Day Wildfires. Corvallis, Oregon: College of Public Health and Human Sciences

Castillo, Charles, Ruth Dittrich, Vivek Shandas, Elliott Gall, and Olyssa Starry. 2024. “Mitigating Wildfire Smoke inside Homes: Evidence from Oregon, September 2020.” *Risk Analysis* 44 (5): 1114–27. https://doi.org/10.1111/risa.14252.

Chae, Rebecca L, Rafay Siddiqui, and Yan Xu. 2025. “Vulnerability to Natural Disasters and Sustainable Consumption: Unraveling Political and Regional Differences.” *Proceedings of the National Academy of Sciences - PNAS* 122, no. 5. https://doi.org/10.1073/pnas.2409851122.

Chang, Jer-Hwa, Yueh-Lun Lee, Li-Te Chang, et al. 2023. “Climate Change, Air Quality, and Respiratory Health: A Focus on Particle Deposition in the Lungs.” Annals of Medicine 55 (2): 2264881. https://doi.org/10.1080/07853890.2023.2264881.

Chen, Hao, James M. Samet, Philip A. Bromberg, and Haiyan Tong. 2021. “Cardiovascular Health Impacts of Wildfire Smoke Exposure.” *Particle and Fibre Toxicology* 18 (1): 2. https://doi.org/10.1186/s12989-020-00394-8.

Damon, Scott A.; Naylor, Roger; Therriault, Shannon. 2010. "Public Communication in Unplanned Biomass Burning Events." *Inhalation Toxicology* 22 (2): 113-116. https://doi.org/10.3109/08958370903008896.

D'Evelyn, Savannah M., Jihoon Jung, Ernesto Alvarado, et al. 2022. "Wildfire, Smoke Exposure, Human Health, and Environmental Justice Need to Be Integrated into Forest Restoration and Management." Current Environmental Health Reports 9 (3): 366–85. https://doi.org/10.1007/s40572-022-00355-7.

Duan, Ran, and Christian Bombara. "Protective Behaviors against Wildfire Smoke in the Western United States: An Extended Protection Motivation Theory Perspective." *International Journal of Disaster Risk Reduction 96* (2023). https://doi.org/10.1016/j.ijdrr.2023.103956.

Fokaefs, Anna, and Kalliopi Sapontzaki. 2022. "The Seismic Risk Perception of Emergency Managers and First Responders- a Public Survey in Greece." *All Earth* 34, no. 1: 279–90. https://doi.org/10.1080/27669645.2022.2139011.

Gerrard, Michael B. 2025. "Wildfire Smoke and U.S. Law." *Columbia Journal of Environmental Law* 50 (S): 209–300. https://doi.org/10.52214/cjel.v50is.13639.

Hadley, Michael B., Sarah B. Henderson, Michael Brauer, and Rajesh Vedanthan. 2022. "Protecting Cardiovascular Health From Wildfire Smoke." Circulation 146 (10): 788–801. https://doi.org/10.1161/CIRCULATIONAHA.121.058058.

Heidari, Hadi, Mazdak Arabi, and Travis Warziniack. 2021. "Effects of Climate Change on Natural-Caused Fire Activity in Western U.S. National Forests." *Atmosphere* 12 (8): 981. https://doi.org/10.3390/atmos12080981.

Kang, Augustine W., and Natalie S. Lui. 2025. "Factors Associated with Lung Cancer among Firefighters: A Systematic Literature Review." BMC Public Health 25 (1): 281. https://doi.org/10.1186/s12889-025-21432-0.

Kelp, Makoto, Noah Diffenbaugh, and Marshall Burke. 2025. "The Effectiveness of Prescribed Fire: Prescribed Burning, a Strategy to Reduce Wildfire Risk, Significantly Cuts Wildfire Severity and Smoke Emissions, Especially Outside Populated Areas." Stanford Woods Institute for the Environment. JSTOR. https://www.jstor.org/stable/resrep71591.

Khalemsky, Michael, David G. Schwartz, Raphael Herbst, and Eli Jaffe. 2020. "Motivation of Emergency Medical Services Volunteers: A Study of Organized Good Samaritans." *Israel Journal of Health Policy Research* (London) 9 (1): 11. https://doi.org/10.1186/s13584-020-00370-9.

Kim, Hyuksoo, and YoungAh Lee. 2024. "Influencing Optimistic Bias: Moderating Roles of Perceived Severity and Proximity." *Journal of Consumer Behaviour* 23, no. 4: 1832–43. https://doi.org/10.1002/cb.2307.

Kleiner, Tuuli-Marja. 2025. “On Good Deeds and the Reproduction of Social Inequality: An Empirical Study on Social Class and Volunteering in Germany.” *Sociology-the Journal of the British Sociological Association* (London) 59 (5): 943–61. https://doi.org/10.1177/00380385251343282.

Korndoerfer, Martin, Boris Egloff, and Stefan C. Schmukle. 2015. “A Large Scale Test of the Effect of Social Class on Prosocial Behavior.” *PLoS ONE* (San Francisco) 10 (7): e0133193. https://doi.org/10.1371/journal.pone.0133193.

Krupnick, Alan, Nathan Richardson, Matthew Wibbenmeyer, and Yuqi Zhu. 2025. “Wildfire Smoke, the Clean Air Act, and the Exceptional Events Rule: Implications and Policy Alternatives.” *Environmental Science & Technology* 59 (6): 2917–27. https://doi.org/10.1021/acs.est.4c08946.

Liu, Jianguo, Thomas Dietz, Stephen R. Carpenter, Marina Alberti, Carl Folke, Emilio Moran, Alice N. Pell, et al. 2007. “Complexity of Coupled Human and Natural Systems.” *Science* 317 (5844): 1513–16. https://www.jstor.org/stable/20037795.

Ma, Yanni, Graham Dixon, and Jay D Hmielowski. 2019. "Psychological Reactance from Reading Basic Facts on Climate Change: The Role of Prior Views and Political Identification." *Environmental Communication* 13, no. 1: 71-86. https://doi.org/10.1080/17524032.2018.1548369.

Marikyan, Davit, and Savvas Papagiannidis. 2025. “Protection Motivation Theory: A Review.” In *TheoryHub Book*, 78–93. https://open.ncl.ac.uk/theories/10/pdf/protection-motivation-theory/.

McCarron, Amy, Sean Semple, Christine F. Braban, Vivien Swanson, Colin Gillespie, and Heather D. Price. 2023. “Public Engagement with Air Quality Data: Using Health Behaviour Change Theory to Support Exposure-Minimising Behaviours.” Journal of Exposure Science & Environmental Epidemiology 33 (3): 321–31. https://doi.org/10.1038/s41370-022-00449-2.

Meyer, Robert J, Jay Baker, Kenneth Broad, Jeff Czajkowski, and Ben Orlove. 2014. “The Dynamics of Hurricane Risk Perception: Real-Time Evidence from the 2012 Atlantic Hurricane Season.” *Bulletin of the American Meteorological Society* 95, no. 9: 1389–1404. https://doi.org/10.1175/bams-d-12-00218.1.

Mitsushita, Kenta, Shin Murakoshi, and Masato Koyama. 2023. “How Are Various Natural Disasters Cognitively Represented?: A Psychometric Study of Natural Disaster Risk Perception Applying Three-Mode Principal Component Analysis.” *Natural Hazards (Dordrecht)* 116, no. 1: 977–1000. https://doi.org/10.1007/s11069-022-05708-x.

Moran, Rebecca, Julie Hollenbeck, and Cassandra Phoenix. 2013. “Structural Vulnerability and Narrative: Sensitising Concepts for Understanding the Health Impacts of Climate Change.”

In *Ecological Health: Society, Ecology and Health*. Emerald Group Publishing. https://doi.org/10.1108/S1057-6290(2013)0000015009.

Multnomah County. 2024. "Protect yourself from hazardous air." *Multnomah County*. https://multco.us/info/protect-yourself-hazardous-air.

Office of Disease Prevention and Health Promotion. n.d. "Healthy People 2030." U.S. Department of Health and Human Services. Accessed December 6, 2025. https://odphp.health.gov/healthypeople/priority-areas/social-determinants-health.

Piff, Paul K., Daniel M. Stancato, Andres G. Martinez, Michael W. Kraus, and Dacher Keltner. 2012. "Class, Chaos, and the Construction of Community." *Journal of Personality and Social Psychology* (Washington) 103 (6): 949–62. https://doi.org/10.1037/a0029673.

Prestwich, Andrew. 2024. "Theory." In *Health Behavior Change*, 15–76. Routledge. https://doi.org/10.4324/9781003302414-3.

Qiu, Minghao, Jessica Li, Carlos F Gould, Renzhi Jing, Makoto Kelp, Marissa L Childs, Jeff Wen, et al. 2025. "Wildfire Smoke Exposure and Mortality Burden in the US under Climate Change." *Nature*, September, 1–3. https://doi.org/10.1038/s41586-025-09611-w.

Robinson, Erik. 2022. "Best Prescription for Avoiding Wildfire Smoke: Stay Inside." *OHSU News*, September 9, 2022. https://news.ohsu.edu/2022/09/09/best-prescription-for-avoiding-wildfire-smoke-stay-inside-6878819.

Savadori, Lucia, Piero Ronzani, Giacomo Sillari, Daniela Di Bucci, and Mauro Dolce. 2022. "Communicating Seismic Risk Information: The Effect of Risk Comparisons on Risk Perception Sensitivity." Frontiers in Communication 7 (March). https://doi.org/10.3389/fcomm.2022.743172.

Slavik, Catherine E, Daniel A Chapman, Alex Segrè Cohen, Nahla Bendefaa, and Ellen Peters. 2024. "Clearing the Air: Evaluating Institutions' Social Media Health Messaging on Wildfire and Smoke Risks in the US Pacific Northwest." *BMC Public Health* 24 (February): 1–16. https://doi.org/10.1186/s12889-024-17907-1.

Steel, Brent S., Nicholas P. Lovrich, and John C. Pierce. 2023. "Cultural Theory, Wildfire Information Source, and Agency Public Trust: A Central Oregon Case Study." *Environmental Management* 73 (3): 579–94. https://doi.org/10.1007/s00267-023-01909-7.

Vargo, Jason, Brooke Lappe, Maria C Mirabelli, and Kathryn C Conlon. 2023. "Social Vulnerability in US Communities Affected by Wildfire Smoke, 2011 to 2021." *American Journal of Public Health* 113 (7): 759–67. https://doi.org/10.2105/ajph.2023.307286.

Wachinger, Gisela, Ortwin Renn, Chloe Begg, and Christian Kuhlicke. 2013. "The Risk Perception Paradox-Implications for Governance and Communication of Natural Hazards." *Risk Analysis* 33 (6): 1049–65. https://doi.org/10.1111/j.1539-6924.2012.01942.x.

Wasserman, Tzeidle N, and Stephanie E Mueller. 2023. "Climate Influences on Future Fire Severity: A Synthesis of Climate-Fire Interactions and Impacts on Fire Regimes, High-Severity Fire, and Forests in the Western United States." *Fire Ecology* 19 (43). https://doi.org/10.1186/s42408-023-00200-8.

Wuerzer, Thomas. 2024. "University Population and Wildfire Risk: An Analysis of Perception-Based Variables and Geospatial Differences." *Papers in Applied Geography* 10 (4): 393–411. https://doi.org/10.1080/23754931.2024.2397374.

Zarkhin, Fedor. 2025. "U.S. Forest Service to provide firefighters with masks after news coverage highlights health risks." Oregon Live, September 11, 2025. https://www.oregonlive.com/crime/2025/09/us-forest-service-to-provide-firefighters-with-masks-after-news-coverage-highlights-health-risks.html